RESEARCH ARTICLE



Milnesium berladnicorum sp. n. (Eutardigrada, Apochela, Milnesiidae), a new species of water bear from Romania

Daniel Adrian Ciobanu¹, Krzysztof Zawierucha², Ioan Moglan¹, Łukasz Kaczmarek^{2,3}

 Faculty of Biology, Alexandru Ioan Cuza University of Iaşi, B-dul Carol I, no. 20A, 700505 Iaşi, Romania
 Department of Animal Taxonomy and Ecology, Faculty of Biology, A. Mickiewicz University in Poznań, Umultowska 89, 61-614 Poznań, Poland 3 Prometeo researcher, Laboratorio de Ecología Natural y Aplicada de Invertebrados, Universidad Estatal Amazónica, Puyo, Ecuador

Corresponding author: Daniel Adrian Ciobanu (danieladrian.ciobanu@gmail.com)

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Abstract

In a lichen sample collected from a tree in Bârlad town (Vaslui County, Romania), a new tardigrade species belonging to the genus *Milnesium (granulatum* group) was found. *Milnesium berladnicorum* **sp. n.** is most similar (in the type of dorsal sculpture) to *Milnesium beasleyi* Kaczmarek et al., 2012 but differs from it mainly by having a different claw configuration and some morphometric characters. Additionally, the new species differs from other congeners of the *granulatum* group by the different type of dorsal sculpture, claw configuration and some morphometric characters.

Keywords

Europe, new species, Palearctic, Tardigrada, taxonomy

Introduction

In Romania, studies on tardigrades were rather fragmentary and with a significant discontinuity in time (last 40 years). Even though during this period more than 150 taxa (species and subspecies) were reported for this region (Rudescu 1964), many of them are now considered as non-valid, have been synonymized, or require confirmation. In fact, in the light of modern taxonomy, only 127 tardigrades species are consider to be present in Romania (in 26 of 41 Romanian counties) (Ciobanu et al. 2014). Species from the genus *Milnesium* Doyère, 1840 are known from many localities throughout the world, from the Antarctic through tropical and temperate zones to the Arctic regions (e.g. Tumanov 2006; Kaczmarek et al. 2012a, b; Michalczyk et al. 2012a). Since the genus was recently re-described (Michalczyk et al. 2012a, b) new records and species have been reported from various localities (e.g. Kaczmarek et al. 2012a; Meyer et al. 2013; Zawierucha et al. 2014; Ciobanu et al. 2014). Taking into consideration that some morphological characters were omitted in older records of *Milnesium* specimens, all such records should be verified (Michalczyk et al. 2012a, b). Until now in Romania only three *Milnesium* species have been reported: *Milnesium tardigradum* sensu lato Doyère, 1840, *M. granulatum* (Ramazzotti, 1962) and *M. asiaticum* Tumanov, 2006, but all early records of the first species should be verified (Michalczyk et al. 2012a, b; Ciobanu et al. 2014). In this paper a new species of the genus *Milnesium* is described and illustrated.

Materials and methods

In a lichen sample collected by the first author in Bârlad town in July, 2013, 53 individuals and two exuvia (with 16 eggs) of the new species were found. Additionally, 55 specimens of *Ramazzottius oberhaeuseri* (Doyère, 1840) were found in the same sample, including 9 specimens in simplex stage and 9 eggs.

All specimens were extracted according to Dastych (1980, 1985) and mounted on microscope slides in Hoyer's medium. Observations, measurements and photomicrographs were taken using Phase Contrast Microscopy (PCM) (Olympus BX41 with digital camera ARTCAM-300Mi). All measurements (determined with QuickPhoto Camera 2.3) are given in micrometers [µm].

Body length was measured from the mouth to the end of the body excluding the hind legs. The buccal tube and claws characteristics were measured according to Tumanov (2006) and Michalczyk et al. (2012a). Subsequently, claw configuration is described according to Michalczyk et al. (2012a, b). Other morphometric data were calculated using the *pt* ratio: the ratio of the length of a given structure to the length of the buccal tube, expressed as a percentage (Pilato 1981). The *pt* values are always provided in *italics* in order to differentiate them from length values.

Characteristics and measurements of the species used in the differential diagnosis are given according to the original descriptions (Ramazzotti 1962; Pilato et al. 2002; Kaczmarek et al. 2004; Tumanov 2006; Kaczmarek and Michalczyk 2007; Wallendorf and Miller 2009; Kaczmarek et al. 2012a; Meyer et al. 2013) or are based on direct examination of type material (holotype and paratypes of *Milnesium beasleyi* Kaczmarek et al. 2012a). *Ramazzottius* specimens were verified and identified using the key to the World Tardigrada (Ramazzotti and Maucci 1983), a more modern key to the genus *Ramazzottius* (Biserov 1998), and remarks discussed by Pilato et al. (2013).

Morphometric data were handled using the "Apochela" ver. 1.1 template available from the Tardigrada Register (Michalczyk and Kaczmarek 2013). Raw data underlying the description of *Milnesium berladnicorum* sp. n. are deposited in the Tardigrada Register under http://www.tardigrada.net/register/0014.htm

Results

Taxonomic Account Phylum: Tardigrada Doyère, 1840 Class: Eutardigrada Richters, 1926 Order: Apochela Schuster, Nelson, Grigarick and Christenberry, 1980 Family: Milnesiidae Ramazzotti, 1962 Genus: *Milnesium* Doyère, 1840

Milnesium berladnicorum sp. n.

http://zoobank.org/FBF8C785-2B53-48B2-B696-D442BAD89A0F http://www.tardigrada.net/register/0014.htm Figs 1–6, Table 1

Material examined. Holotype (female), 52 paratypes and 2 exuvia with 7 and 9 smooth eggs.

Description (measurements and statistics in Table 1). Body brownish (in live specimens) or transparent (in fixed specimens) with eyes (visible before and after mounting in Hoyer's medium - 90% of fixed specimens had eyes). Six peribuccal papillae (ventral papilla smallest) and six peribuccal lamellae (of equal size) around the mouth opening present. Two cephalic papillae positioned laterally. The cuticle is covered with numerous tiny, shallow and rounded depressions (pseudopores) (Figs 4–5). Under PCM these pseudopores are visible as light spots, placing the species within the *granulatum* group. Bucco-pharyngeal apparatus of the *Milnesium* type (Fig. 6). Buccal tube funnel-shaped, wider anteriorly (on average the posterior diameter is 73% of the anterior di-



Figures 1. Milnesium berladnicorum sp. n. Habitus (ventral view). (Scale-bar measurement in µm.)



Figures 2–6. *Milnesium berladnicorum* sp. n.: **2** claws III **3** claws IV **4** sculpture on dorsal cuticle above II–III pair of legs **5** sculpture on dorsal cuticle above IV pair of legs **6** buccal apparatus (ventral view). (Scale-bar measurements in µm.)

ameter). Pharyngeal bulb elongated, pear-shaped and without placoids or septulum. Claws of the *Milnesium* type, slender (Figs 2–3). Primary branches on all legs with small accessory points on the top of the branch. Secondary claws of all legs with rounded basal thickenings (lunules) (sometimes barely visible) (Fig. 3). Secondary branches of external claws I–III and posterior and anterior claws IV with two points. Secondary branches of internal claws I–III with three points (i.e. claw configuration: [2-3]-[2-2]) (Figs 2–3). Single, long transverse, cuticular bars under claws I–III present (Fig. 2).

Eggs. Smooth, deposited in exuvia.

No males were found.

Locus typicus. 46°14.74167N, 27°40.27333E; 99 m asl: Romania, Vaslui County, Bârlad town, coppice, lichens (*Xanthoria parietina* (L.) Th. Fr. (1860)) from tree.

		RANGE						MEAN		SD		Holotype	
CHARACTER			un	 1		ħ		um	t t	um	t t	um	nt
Body length	15	400		734	1557	<u></u>	1942	62.2	1742	107	127	630	1619
Peribuccal papillae length	15	4.0	_	7.9	14.8	_	20.5	6.2	17.4	1.2	1.6	7.0	18.0
Lateral papillae length	15	3.6	_	6.9	12.7	_	17.9	5.2	14.5	1.0	1.6	5.6	14.4
$\begin{array}{c cccc} Lateral paper action for the set of the s$													
Length	15	24.7	_	41.5		_		35.7	_	5.3	_	38.9	
Stylet support insertion point	15	17.2	_	28.3	66.6	_	71.2	24.6	69.2	3.6	1.3	27.4	70.4
Anterior width	15	8.9	_	17.8	.35.0	_	47.1	14.8	41.3	3.0	3.4	16.4	42.2
Standard width	15	7.8	_	14.7	30.6	_	.38.9	12.0	33.5	2.2	2.3	12.7	32.6
Posterior width	12	7.2	_	13.6	27.7	_	36.0	11.0	30.3	1.8	2.2	11.5	29.6
Standard width/length ratio	15	31%	_	39%		-		33%		2%	_	33%	
Posterior/anterior width ratio	12	69%	_	79%		_		73%		3%	_	70%	
Claw 1 lengths				1									
External primary branch	14	10.0	_	18.0	40.5	_	47.6	15.6	43.9	2.5	2.2	17.6	45.2
External base + secondary branch	14	10.2	_	15.9	32.9	_	45.3	13.9	39.3	2.0	3.0	14.6	37.5
External spur	0		_			_		_	_	_	_	_	_
Internal primary branch	14	9.9	_	18.1	38.1	_	45.6	14.8	41.8	2.3	2.2	15.6	40.1
Internal base + secondary branch	14	9.9	_	15.0	33.9	_	41.7	13.1	37.3	1.8	2.2	13.2	33.9
Internal spur	9	3.0	-	4.7	9.0	-	12.5	4.0	11.2	0.6	1.1	3.5	9.0
Claw 2 lengths													
External primary branch	15	11.5	_	20.0	43.3	_	53.5	17.2	48.4	2.6	3.2	20.0	51.4
External base + secondary branch	15	10.4	_	16.2	36.9	-	44.4	14.4	40.6	1.9	2.2	15.8	40.6
External spur	0		_			_		-	-	-	-	_	-
Internal primary branch	15	11.4	—	18.7	39.9	_	51.8	16.1	45.4	2.3	3.1	17.2	44.2
Internal base + secondary branch	15	9.8	—	15.8	34.4	_	42.5	13.5	38.0	2.0	2.7	14.4	37.0
Internal spur	6	2.6	—	5.9	10.2	_	15.6	4.1	12.4	1.2	2.2	?	?
Claw 3 lengths													
External primary branch	15	11.1	-	20.5	44.9	-	54.8	17.6	49.5	2.8	3.1	17.9	46.0
External base + secondary branch	15	9.9	_	16.9	37.8	-	44.5	14.6	40.9	2.2	2.1	16.4	42.2
External spur	0		_			-		-	-	-	-	-	
Internal primary branch	15	10.6	-	20.0	39.4	_	53.7	16.5	46.4	2.8	4.5	15.5	<i>39.8</i>
Internal base + secondary branch	13	9.9	-	17.6	33.6	-	45.6	13.7	38.9	2.2	3.2	15.2	39.1
Internal spur	5	3.2	-	5.3	10.6	-	14.0	4.3	12.0	0.8	1.4	?	?
Claw 4 lengths		_			_								
Anterior primary branch	15	15.0	-	27.0	57.9	_	74.8	22.7	63.8	3.4	4.7	24.8	63.8
Anterior base + secondary branch	15	11.5	-	20.2	40.0	_	50.0	16.7	46.9	2.6	3.0	18.5	47.6
Anterior spur	0		-			-		-	-	_	-	_	_
Posterior primary branch	15	14.2	-	25.8	54.2	-	70.4	22.1	62.0	3.4	4.6	24.0	61.7
Posterior base + secondary branch	15	11.3	-	19.6	38.2	-	52.2	16.5	46.2	2.9	4.0	17.4	44.7
Posterior spur	0		-			-		_	_	-	-	_	_

Table 1. Measurements and *pt* values of selected morphological structures of fifteen females from the type population of *Milnesium berladnicorum* sp. n.

Etymology. This new species is named after the Berladnici, an ancient population with a controversial origin (most probably Slavs) who previously lived in the area of the present Bârlad town.

Type depositories. Holotype (female; slide: P8-8) and 29 paratypes (females) and 1 exuvium with eggs (slides: P8-4, P8-5, P8-6, P8-9, P8-13, P8-14, P8-15, P8-



Figure 7. The administrative map of Romania with 13 highlighted counties in which species of the genus *Milnesium* were reported: *M. tardigradum* sensu lato (according with Rudescu 1964; see Discussion): I Argeş 2 Bistrița-Năsăud 3 Caraș-Severin 4 Cluj 5 Dâmbovița 6 Harghita 7 Ilfov County and Bucharest City 8 Maramureş 9 Mehedinți II Suceava 12 Tulcea. *M. granulatum* and *M. asiaticum* (according to Ciobanu et al. 2014): I0 Neamț (in green). *M. berladnicorum* sp. n. (present study): I3 Vaslui (in blue). Map outline according to Wikipedia: http://ro.wikipedia.org/wiki/Fi%C8%99ier:Romania_counties_blank_big.png

17, P8-19) are preserved at the Department of Animal Taxonomy and Ecology, A. Mickiewicz University in Poznań, Umultowska 89, 61–614 Poznań, Poland. Additionally, 14 paratypes (females) and 1 exuvium with eggs (slides: P8-1, P8-3, P8-16, P8-18) are deposited at Natural History Museum of "Alexandru Ioan Cuza" University from Iași (Bd. Independentei No.16, 700101), 4 paratypes (females; slides: P8-7, P8-12) are deposited at collection of Binda and Pilato (Museum of the Department of Animal Biology "Marcello La Greca", University of Catania, Italy) and 5 paratypes (females; slides: P8-2, P8-10, P8-11) are deposited at the Natural History Museum, University of Copenhagen Universitetsparken 15, DK-2100 Copenhagen, Denmark.

Differential diagnosis

Due to the sculptured cuticle, *Milnesium berladnicorum* sp. n. belongs to the *granula-tum* group (Michalczyk et al. 2012a, b). The new species differs from all other species in the *granulatum* group by the presence of a unique claw configuration [2-3]-[2-2] that is not present in any other species in this group. Besides the claw configuration, the new species differs from:

- M. alabamae Wallendorf and Miller, 2009: by having a different cuticular sculpture (sparse pseudopores on the cuticle which do not form a true reticulum in M. berladnicorum sp. n. vs a finely punctuated (probably pseudopores) cuticle arranged in bands on caudal segments in M. alabamae), a different claw configuration ([2-3]-[2-2] in M. berladnicorum sp. n. vs [3-3]-[3-3] in M. alabamae), the presence of accessory points on primary branches and by presence of eyes.
- M. beasleyi Kaczmarek, Jakubowska and Michalczyk, 2012: by having a different claw configuration ([2-3]-[2-2] in M. berladnicorum sp. n. vs. [2-3]-[3-2] in M. beasleyi), a different posterior/anterior width ratio (69%–79% in M. berladnicorum sp. n. vs 90%–96% in M. beasleyi) and stylet supports inserted in a more posterior position (pt=66.6–71.2 in M. berladnicorum sp. n. vs pt=61.6–65.6 in M. beasleyi).
- 3. *M. granulatum* (Ramazzotti, 1962): by having a different cuticular sculpture (sparse pseudopores on the cuticle which do not form a true reticulum in *M. berladnicorum* sp. n. *vs* a reticular sculpture in *M. granulatum*) and different claw configuration ([2-3]-[2-2] in *M. berladnicorum* sp. n. *vs* [3-3]-[3-3] in *M. granulatum*).
- 4. *M. katarzynae* Kaczmarek, Michalczyk and Beasley, 2004: by having a different cuticular sculpture (sparse pseudopores on the cuticle which do not form a true reticulum in *M. berladnicorum* sp. n. *vs* a reticular sculpture in *M. katarzynae*), a different claw configuration ([2-3]-[2-2] in *M. berladnicorum* sp. n. *vs* [2-2]-[2-2] in *M. katarzynae*), larger body size (400–734 µm in *M. berladnicorum* sp. n. *vs* 285.0–294.5 µm in *M. katarzynae*), stylet supports inserted in a more anterior position (*pt=66.6–71.2* in *M. berladnicorum* sp. n. *vs pt=73.3–78.3* in *M. katarzynae*) and by the presence of eyes.
- M. krzysztofi Kaczmarek and Michalczyk, 2007: by having a different cuticular sculpture (sparse pseudopores on the cuticle which do not form a true reticulum in M. berladnicorum sp. n. vs dorsal cuticle with pseudopores arranged in a fine reticular design in M. krzysztofi), a different claw configuration ([2-3]-[2-2] in M. berladnicorum sp. n. vs [2-3]-[3-2] in M. krzysztofi) and by presence of eyes.
- 6. *M. lagniappe* Meyer, Hinton and Dupré, 2013: by the presence of six peribuccal lamellae (four in *M. lagniappe*), a different cuticular sculpture (sparse pseudopores on the cuticle which do not form a true reticulum in *M. berladnicorum* sp. n. vs nine dorsal and lateral sculptured bands bearing a reticulated pattern of polygons in *M. lagniappe*), a different claw configuration ([2-3]-[2-2] in *M. berladnicorum* sp. n. vs. [2-3]-[3-2] in *M. lagniappe*), a smaller anterior width of buccal tube

(8.9–17.8 µm in *M. berladnicorum* sp. n. *vs* 20.7–25.1 µm in *M. lagniappe*), a smaller standard width of the buccal tube (7.8–14.7 µm in *M. berladnicorum* sp. n. *vs*. 19.4–23.6 µm in *M. lagniappe*), a smaller posterior width of the buccal tube (7.2–13.6 µm in *M. berladnicorum* sp. n. *vs* 18.9–23.2 µm in *M. lagniappe*), a smaller posterior/anterior width ratio (69%–79% in *M. berladnicorum* sp. n. *vs* 86%–99% in *M. lagniappe*) and a smaller standard width/length ratio (31%–39% in *M. berladnicorum* sp. n. *vs* 63%–78% in *M. lagniappe*).

 M. reticulatum Pilato, Binda and Lisi, 2002: by the lack of dorsal gibbosities, the presence of six peribuccal lamellae (four in *M. reticulatum*), a different claw configuration ([2-3]-[2-2] in *M. berladnicorum* sp. n. vs [2-3]-[3-2] in *M. reticulatum*) and slightly larger body length (400–734 µm in *M. berladnicorum* sp. n. vs. 270–405 µm in *M. reticulatum*).

Because of the claw configuration [2-3]-[2-2], *M. berladnicorum* sp. n. is similar to *M. almatyense* Tumanov, 2006 (Michalczyk et al. 2012a, b) but differs by having a sculptured dorsal cuticle and by presence of eyes.

Discussion

Until 1990, the genus *Milnesium* Doyère, 1840 was considered as monotypic with only one described cosmopolitan species, *Milnesium tardigradum* Doyère, 1840. In 1990, Binda and Pilato described a second species, *Milnesium brachyungue* from Chile. Later, additional species in the genus *Milnesium* were described sporadically up to 2006 when Tumanov published the first, but partial, revision of the genus *Milnesium* and described five new species (Tumanov 2006). In 2012, the genus *Milnesium* was redescribed in more detail by Michalczyk et al. (2012 a, b), and the nominal species *M. tardigradum tardigradum* sensu stricto Doyère,1840 obtained a clear and definitive diagnosis.

At present the genus *Milnesium* consists of 21 species and one subspecies (Degma et al. 2014), which have been divided into two groups (based on the presence/absence of a sculptured cuticle): *tardigradum* and *granulatum* (Michalczyk et al. 2012 a,b). Due to the sculptured cuticle, *Milnesium berladnicorum* sp. n. belongs to the *granulatum* group. Including the new species, the *granulatum* group now consists of eight species: *M. alabamae* Wallendorf and Miller, 2009 (from USA), *M. berladnicorum* sp. n. (from Romania), *M. granulatum* (Ramazzotti, 1962) (from Chile, Italy, Romania and USA), *M. katarzynae* Kaczmarek et al., 2007 (Costa Rica and Peru), *M. reticulatum* Pilato et al., 2002 (Seychelles), *M. beasleyi* Kaczmarek et al., 2012 (Turkey) and *M. lagniap-pe* Meyer et al., 2013 (USA) (Ramazzotti 1962; Pilato et al. 2002; Kaczmarek et al. 2013; Kaczmarek et al. 2014; Bartels

et al. 2014). Thus, *granulatum* group is equivalent to *ca.* 39% of all known *Milnesium* taxa and the "sculptured species" are distributed around the World.

According to Rudescu (1964), *Milnesium tardigradum* sensu lato Doyère, 1840 was firstly reported in Romanian territory by Botezat (1903) in the area of Suceava County (Austro-Hungarian Empire at the time). Later, it was reported numerous times at different Romanian localities by: Rodewald (1936), Iharos (1937, 1940, 1962), Péterfi (1956), Botoşăneanu and Negrea (1961), and Rudescu (1964). However, based on modern literature, all these records should be considered as dubious and need verification (Michalczyk et al. 2012 a, b). This is now even more necessary due to the discovery in 2014 of two other *Milnesium* species in Romania (Ciobanu et al. 2014): **a)** *Milnesium asiaticum* Tumanov, 2006, previously known only from three localities in Kyrgyzstan (Tumanov 2006), Spitsbergen (Kaczmarek et al. 2012b) and Estonia (Zawierucha et al. 2014); and **b)** *Milnesium granulatum* (Ramazzotti, 1962) previously known only from three localities in Chile, Italy and USA (McInnes 1994; Bartels et al. 2014) (see map above).

Including the new species described here, the total number of valid tardigrade taxa recorded in Romania is 128, with three valid *Milnesium* species (not including *M. tardigradum tardigradum* sensu stricto, which requires confirmation of presence in Romania).

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RESEARCH ARTICLE



Replacement names and nomenclatural comments for problematic species-group names in Europe's Neogene freshwater Gastropoda. Part 2

Thomas A. Neubauer¹, Mathias Harzhauser¹, Andreas Kroh¹, Elisavet Georgopoulou¹, Oleg Mandic¹

I Geological-Paleontological Department, Natural History Museum Vienna, 1010 Vienna, Austria

Corresponding author: Thomas A. Neubauer (thomas.neubauer@nhm-wien.ac.at)

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Abstract

In the course of a new database project on Miocene to Recent freshwater gastropods of Europe, a great many of primary and secondary homonyms were revealed. Such nomenclatural issues need clarification in order to avoid misunderstandings and wrong statements about geographical distributions and temporal ranges. The following 16 new names are introduced to replace existing homonyms: *Theodoxus militaris jurisicpolsakae* **nom. n.**, *Viviparus stevanovici* **nom. n.**, *Melanopsis haueri ripanjensis* **nom. n.**, *Melanopsis wolfgangfischeri* **nom. n.**, *Micromelania ramacanensis* **nom. n.**, *Pseudamnicola welterschultesi* **nom. n.**, *Muellerpalia haszprunari* **nom. n.**, *Muellerpalia pseudovalvatoides* **nom. n.**, *Lithoglyphus gozhiki* **nom. n.**, *Valvata heidemariae willmanni* **nom. n.**, *Radix macaleti* **nom. n.**, *Gyraulus okrugljakensis* **nom. n.**, *Gyraulus rasseri* **nom. n.**, *Gyraulus vrapceanus* **nom. n.**, *Planorbarius halavatsi* **nom. n.**, and *Segmentina mosbachensis* **nom. n.** Additionally, six cases of homonyms are discussed that are not replaced by new names, because they are considered junior synonyms.

Keywords

Homonyms, synonyms, nomina nova, fossil freshwater gastropods

Introduction

The latest estimate of living freshwater gastropod species involves about 4,000 described and valid species world-wide (Strong et al. 2008). Including the names for fossil gastropods, which were not considered in that study, certainly doubles if not multiplies the estimation on introduced and formally available species-group names. The practice to use common, descriptive terms (e.g., "*carinatus*", "*rugosus*" or "*elongatus*") as speciesgroup names resulted in a great number of primary and secondary homonyms.

As to the fossil part, there are several publications dealing explicitly with this problem. In four subsequent works Pallary (1916, 1920, 1925, 1926) compiled the existing names of fossil and Recent melanopsid species described up to that time and introduced many new names for numerous homonyms. Likewise, Wenz came across a great number of such homonyms for terrestrial and freshwater gastropods when gathering literature for his Fossilium Catalogus (Wenz 1923–1930). In a series of eleven short nomenclatural works, he disposed of such errors by introducing replacement names (Wenz 1919a, 1919b, 1919c, 1922, 1923a, 1924, 1925, 1928b, 1928sc, 1929b, 1930).

The newly established FreshGEN (Freshwater Gastropods of the European Neogene) database project, an initiative aimed at a pan-European reconstruction of the Neogene and Quaternary biodiversity of lacustrine gastropods, successively uncovered nomenclatural mistakes that have not yet been detected and/or revised. Following the first part of the resulting nomenclatural amendment (Neubauer et al. 2014), the current paper settles newly disclosed conflicts by introducing replacement names where required. This contribution is certainly just a small part in a greater picture, but is an essential basis for any future studies. In almost all cases this regards primary homonyms; only for two secondary homonyms replacement names are established, where the generic attribution is considered reliable. Only those primary homonyms are replaced that are today considered accepted taxa, ergo not disused junior synonyms. Such cases as well as two apparent homonyms are additionally discussed.

The systematics follows Bouchet et al. (2005), Jörger et al. (2010), Criscione and Ponder (2013), and the WoRMS database. Where available, information about type locality, age of the deposits, and type material is taken from the original publications. In cases where this information is lacking, insufficient or wrong, other sources were consulted and are specified accordingly.

Homonyms

Class Gastropoda Cuvier, 1795 Subclass Neritimorpha Golikov & Starobogatov, 1975 Order Cycloneritimorpha Frýda, 1998 Superfamily Neritoidea Rafinesque, 1815 Family Neritidae Rafinesque, 1815 Subfamily Neritininae Poey, 1852

Genus Theodoxus Montfort, 1810

Type species. *Theodoxus lutetianus* Montfort, 1810 [currently considered as a synonym of *Theodoxus fluviatilis* (Linnaeus, 1758)]. Recent, Europe. Type by original designation (Welter-Schultes 2012, p. 26).

Theodoxus militaris jurisicpolsakae nom. n.

Theodoxus (Theodoxus) militaris oblongus Jurišić-Polšak, 1979: 28, pl. 10, fig. 2 [non Neritina leobersdorfensis oblonga Handmann, 1887].

Etymology. In honor of Zlata Jurišić-Polšak (Croatian Natural History Museum), who contributed to our knowledge of Neogene Neritidae.

Type locality. Malino, Croatia.

Age. Late Pliocene to Early Pleistocene ("Paludina Beds").

Syntypes. Croatian Natural History Museum, coll. no. 9454.

Discussion. Handmann (1887, p. 9) described and figured *Neritina leobersdor-fensis* var. *oblonga* from the Late Miocene of the Vienna Basin and made it thus available as species-group name (published before 1961, see ICZN 1999, Articles 45 and 57.1). The subspecific status was maintained by Papp (1953, p. 99), who recombined the species with *Theodoxus*. Although Jurišić-Polšak (1979) mentioned that species and cited both works in her study about Miocene and Pliocene neritids from Croatia, she established the name *oblongus* for a different species-group taxon in *Theodoxus*. Thereby she referred to a determination by Spiridion Brusina, who had established the name "*Neritina militaris* var. *oblonga*" for material in the collection but never published it. Jurišić-Polšak accepted this "*in schedis*"-determination and formally described the subspecies, obviously unaware of the fact that this would create a secondary homonym. It can be separated from the nominal species by the more elevated spire and the fewer axial ribs.

Subclass Caenogastropoda Cox, 1960 Order unassigned Superfamily Viviparoidea Gray, 1847 Family Viviparidae Gray, 1847 Subfamily Viviparinae Gray, 1847

Genus Viviparus Montfort, 1810

Type species. *Viviparus fluviorum* Montfort, 1810 [currently considered as a synonym of *Viviparus viviparus* (Linnaeus, 1758)]. Recent, Northern Eurasia, Europe, Anatolia and Northern America. Type by original designation (Welter-Schultes 2012, p. 31).

Viviparus stevanovici nom. n.

- Viviparus elongatus Stevanović, 1978: 325, pl. 5, figs 1-3 [non Paludina elongata d'Orbigny, 1837].
- *Viviparus elongatus* Stevanović; Stevanović 1990: 501, pl. 14, figs 9–10 [non d'Orbigny 1837].

Etymology. In honor of Petar M. Stevanović (Belgrade), who greatly contributed to our knowledge of the mollusc fauna and biostratigraphy of the Late Miocene of Serbia.

Type locality. Kostolac opencast mine, Serbia.

Age. Late Miocene to Early Pliocene (Late Pannonian, Late Portaferrian).

Holotype. Natural History Museum, Belgrade, coll. no. 5683.

Discussion. Since *Paludina* Férussac, 1812 is a junior objective synonym of *Viviparus* Montfort, 1810 (ICZN 1959, Op. 573), this species is a primary homonym of the Late Eocene *Viviparus elongatus* (d'Orbigny, 1837) from the Paris Basin and needs a nomen novum. The Eocene species has been synonymized with the co-occurring *Hydrobia pyramidalis* (Férussac, 1814) by Sandberger (1873, p. 266), a decision followed by Wenz (1926, p. 1968).

Order unassigned Superfamily Cerithioidea Fleming, 1822 Family Melanopsidae Adams & Adams, 1854 Subfamily Melanopsinae Adams & Adams, 1854

Genus Melanopsis Férussac, 1807

Type species. *Melania costata* Olivier, 1804. Recent, Europe. Subsequent designation by Gray (1847, p. 153).

Melanopsis haueri ripanjensis nom. n.

Melanopsis austriaca serbica Brusina, 1902: pl. 6, figs 73–74 [non Melanopsis serbica Brusina, 1893].

Melanopsis haueri serbica Brusina; Wenz 1929a: 2743 [non Brusina 1893].

Etymology. Named after the type locality.

Type locality. Ripanj, Serbia.

Age. Late Miocene (Early-Middle Pannonian; Pavlović 1927).

Syntypes. Croatian Natural History Museum, Zagreb, coll. no. 2530-176/1-2 (Milan et al. 1974, p. 86).

Discussion. Obviously unaware of the fact that also subspecific or variety names can constitute homonyms, Brusina (1902) introduced *M. austriaca serbica* from the Early Pannonian of Serbia, although this name was already preoccupied by another species described by himself, *M. serbica* Brusina, 1893 (p. 50). The latter species was also described from the Early Pannonian of Serbia (locality Begaljica, c. 15 km E Ripanj), but clearly represents a different taxon as evident from Brusina's descriptions and illustrations. Here we follow the taxonomic decision of Wenz (1929a), who synonymized *M. austriaca* Handmann, 1882 with *M. haueri* Handmann, 1882 (both from the Kottingbrunn, Austria) and consequently ranked the here discussed taxon as subspecies of *M. haueri*. *Melanopsis haueri serbica* can be distinguished from *M. haueri haueri* in its distinctly stronger spruce-like outline.

Melanopsis wolfgangfischeri nom. n.

[Mel. Martiniana] Var. rugosa Handmann, 1887: 26, pl. 5, figs 5–7 [non Melanopsis rugosa Matheron, 1842].

Melanopsis rugosa Handmann; Papp 1953: 136, pl. 10, figs 13–16 [non Matheron 1842]. *Melanopsis rugosa* Handmann 1887; Fischer 1996: 23 (cum syn.) [non Matheron 1842].

Etymology. In honor of Wolfgang Fischer (Vienna), who greatly contributed to nomenclature and taxonomy of fossil and Recent melanopsids.

Type locality. Wittmannsdorf near Leobersdorf, Austria (Fischer 1996).

Age. Late Miocene (Early Pannonian, Slavonian; Papp 1951).

Type material. Geological Survey Austria, Vienna, no number indicated (Fischer 1996).

Discussion. This taxon is a primary homonym of *Melanopsis rugosa* Matheron, 1842 (p. 293, pl. 37, fig. 11), a fossil species from SE France. *Melanopsis rugosa* Handmann, 1887 is a member of the complexly evolving *M. impressa*-species lineage in the Late Miocene Lake Pannon (Geary 1990, Geary et al. 2012, Neubauer et al. 2013a). The morphological variability in this group resulted in the description of many names, most of which are today synonymized. While Wenz (1929a, p. 2719) regarded *rugosa* Handmann as synonym of *M. fossilis* (which is the accepted name of "*M. martiniana*"), Papp (1953), Lueger (1980) and Fischer (1996) treated it as separate species. As implied by Neubauer et al. (2013a) the validity in a biological sense of this and other species-group taxa is doubtful. Nevertheless, since many authors clearly referred to it as a separable unit, a replacement name is inevitable.

Additionally, there exists another primary homonym of *M. rugosa*, i.e. *M. lan-zaeana rugosa* Brusina, 1897 from the Middle Miocene deposits of the Sinj Basin. It was synonymized with *M. lanzaeana* by Neubauer et al. (2011, p. 205), who treated it as a mere morphotype and already mentioned the problem of homonymy. We therefore avoid introducing another name for this Croatian taxon, which is not used anymore.

Order Littorinimorpha Golikov & Starobogatov, 1975 Superfamily Truncatelloidea Gray, 1840 Family Hydrobiidae Stimpson, 1865

Subfamily Micromelaniinae Dybowski and Grochmalicki, 1914

Note. The taxonomic status of the Micromelaniinae is currently under discussion. The rank as subfamily follows Wenz (1926, p. 2126; erroneously written as "Micromelaninae"). See also Kabat and Hershler (1993) and Wilke et al. (2007). The classification of the Hydrobiidae within the Truncatelloidea follows the latest molecular systematics established by Criscione and Ponder (2013).

Genus Micromelania Brusina, 1874

Type species. *Micromelania cerithiopsis* Brusina, 1874. Late Miocene, Croatia. Subsequent designation by Brusina (1892, p. 164).

Micromelania ramacanensis nom. n.

Micromelania sp. Brusina: pl. 7, figs 59–60. *Micromelania Brusinai* Pavlović, 1927: 96 [non *Micromelania brusinai* Andrusov, 1905].

Etymology. Named after the type locality.

Type locality. Ripanj, Ramača hamlet (also read Ramaća), Serbia.

Age. Late Miocene (Early-Middle Pannonian; Pavlović 1927).

Syntypes. Brusina (1902, pl. 7, figs 59–60); Croatian Natural History Museum, Zagreb, no number indicated (Milan et al. 1974).

Discussion. This is a classic case of a primary homonym requiring a replacement name according to ICZN (1999, Article 57.2). *Micromelania brusinai* Andrusov, 1905 from the Maeotian of the Crimean Peninsula, Ukraine, is currently considered synonymous with *M. gorianovici* Andrusov, 1897 (Davitashvili 1931, p. 27). The latter name was introduced as nomen novum by Andrusov (1897, p. 431) for the primary homonym *Micromelania striata* Andrusov, 1890 non Gorjanović-Kramberger 1890.

Subfamily Pseudamnicolinae Radoman, 1977

Genus Pseudamnicola Paulucci, 1878

Type species. *Paludina macrostoma* Küster, 1853. Recent, Europe. Subsequent designation by Wagner (1928, p. 276; see also Kabat and Hershler 1993, p. 45).

Pseudamnicola welterschultesi nom. n.

Valvata minima Fuchs, 1877: 14, pl. 1, figs 25–27 [non *Valvata minima* Hislop, 1859]. *Valvata (Cincinna) minima* Fuchs; Wenz 1928a: 2439 (cum syn.) [non Hislop 1859]. *Pseudamnicola minima* (Fuchs, 1877); Willmann 1981: 212, textfig. 74 [non Hislop 1859].

Etymology. In honor of Francisco W. Welter-Schultes (University of Göttingen), a great expert for the living non-marine mollusks of Europe.

Type locality. Megara, Greece.

Age. Pliocene (Papp and Steininger 1979).

Lectotype and paralectotypes. Natural History Museum Vienna, coll no. 1878/0020/0023 (designation by Willmann 1981, p. 212).

Discussion. This species is a primary homonym of *Valvata minima* Hislop, 1859 (p. 170, pl. 5, fig. 13) from the Tertiary of East India (see also Haszprunar 2014, p. 69) and needs a replacement name. Based on general shape and the lack of striae on the protoconch typical of *Valvata*, Willmann (1981) combined this species with *Pseudamnicola*, what is followed herein.

Jekelius (1944), Stevanović (1951) and Bartha (1955) and several other authors also documented this taxon from various localities of the early Late Miocene of Lake Pannon. Given the stratigraphical and biogeographical gaps, these records probably represent different species.

Subfamily unknown

Genus Muellerpalia Bandel, 2010

Type species. *Planorbis bicincta* Fuchs, 1870 in Fuchs 1870b. Recent, Europe. Type by original designation (Bandel 2010, p. 103).

Muellerpalia haszprunari nom. n.

Valvata simplex Fuchs, 1870 in Fuchs 1870b: 535, pl. 21, figs 4–6 [non *Valvata tricarinata* var. *simplex* Gould, 1841].

Valvata (Valvata) simplex simplex Fuchs; Wenz 1928a: 2474 (cum syn.) [non Gould 1841]. *Valvata simplex* Fuchs; Strausz 1942: 80 [non Gould 1841].

Hauffenia simplex (Fuchs); Schlickum 1978: 247, pl. 18, fig. 3 [non Gould 1841]. *Hauffenia simplex* (Fuchs 1870); Harzhauser and Binder 2004: 9 [non Gould 1841].

Etymology. In honor of Gerhard Haszprunar (Bavarian State Collection of Zoology Munich and Ludwig Maximilians University Munich), who summarized all existing names of living and fossil valvatids in a comprehensive nomenclator (Haszprunar 2014).

Type locality. Tihany at Lake Balaton, Veszprém, Hungary.

Age. Late Miocene (Late Pannonian, Transdanubian sensu Sacchi and Horváth 2002; Sztanó et al. 2013).

Type material. According to the inventory books of the Natural History Museum Vienna the material should be stored there, but despite great effort it could not be located.

Discussion. This species is a primary homonym of the extant taxon *Valvata tricarinata* var. *simplex* Gould, 1841 (p. 226) from Massachusetts, USA. The American taxon was elevated to species level by Fluck (1932). As the European species was combined with various genera since its first description and several subspecies have been described, a summary of its history is given below.

Already Schlickum (1978) considered *V. simplex* Fuchs, 1870 to belong to the Hydrobiidae and placed it in the genus *Hauffenia*, based on similarities of morphology and size. Recently, Bandel (2010) introduced the new genus *Muellerpalia* for *V. bicincta* Fuchs, 1870 in Fuchs (1870b), *V. carinata* Fuchs, 1870 in Fuchs (1870b), *Planorbis varians* Fuchs, 1870 in Fuchs (1870a), *V. simplex* Fuchs, 1870 in Fuchs (1870b), and two new species (see discussion in Neubauer et al. 2014 for the rather confusing systematics applied in Bandel 2010). We follow Bandel and place the species within *Muellerpalia*.

The following subspecies have been introduced or ranked within V. simplex Fuchs, 1870:

- Valvata bicincta Fuchs, 1870 [erroneously "bicinata" on p. 536; from captions and description there is no doubt about the correct name] from Tihany: It was considered a subspecies of *V. simplex* by Lőrenthey (1906, p. 166), what was followed by Wenz (1928a, p. 2475) and Strausz (1942, p. 36). Bandel (2010, p. 103) treated it as separate species and combined it with the new genus *Muellerpalia*. Current status: *Muellerpalia bicincta*.
- 2) Valvata carinata Fuchs, 1870 (p. 536) from Tihany: It was considered as subspecies of *V. simplex* by Pană et al. (1981) and Pană (2003), but recombined with the new genus *Muellerpalia* by Bandel (2010, p. 104). It is, however, a primary homonym of *Valvata carinata* Sowerby, 1834 (replacement name is introduced below).
- 3) Valvata simplex öcsensis Soós, 1934 (p. 189) from Öcs: Schlickum (1978, p. 246) clearly separated this taxon from "Hauffenia simplex" and retained it in Valvata. Wenz and Edlauer (1942, p. 83) elevated it to species level, what was followed by Papp (1953, p. 109), and Harzhauser and Binder (2004, p. 10). In some of the mentioned publications the name was erroneously emended to "oecsensis"; the correct emendation following ICZN rules is "ocsensis", since it is not derived from a German expression (ICZN 1999, Article 32.5.2.1). Current status: Valvata ocsensis.
- 4) Valvata octonaria Brusina, 1902 (pl. 13) from Tihany: It was also ranked as subspecies of *V. simplex* by Wenz (1928a, p. 2476). Since it was not referred to by Bandel (2010), its generic affiliation is uncertain. Current status (needs revision): *Muellerpalia haszprunari octonaria*.

- 5) Valvata simplex polycincta Lőrenthey, 1906 (p. 167) from Tihany: It was synonymized with V. simplex octonaria by Wenz (1928a, p. 2476). Current status: junior synonym of Muellerpalia haszprunari octonaria.
- 6) *Valvata simplex unicincta* Lőrenthey, 1906 (p. 165) from Tihany (Fehérpart): The status of this taxon is doubtful. It was not mentioned by Wenz (1928a) or Bandel (2010). Given the similarity with *simplex* and *bicincta* stated by Lőrenthey, it might fall into the intraspecific variability of either of these species. Current status (needs revision): *Muellerpalia haszprunari unicincta*.

Muellerpalia pseudovalvatoides nom. n.

- Valvata carinata Fuchs, 1870 in Fuchs 1870b: 535, pl. 21, figs 10-12 [non Valvata carinata Sowerby, 1834].
- Valvata (Valvata) carinata Fuchs; Wenz 1928a: 2465 [non Sowerby 1834].
- Valvata (Valvata) carinata Fuchs, 1870; Gillet and Marinescu 1971: 47, pl. 19, figs 10–12 [non Sowerby 1834].
- Muellerpalia bicincta (Fuchs, 1870); Bandel 2010: 103, pl. 7, figs 82–85 [non Planorbis bicincta Fuchs, 1870 in Fuchs 1870b].
- **Etymology.** To denote that it is despite its similar shape not a member of the genus *Valvata*. **Type locality.** Tihany at Lake Balaton, Veszprém, Hungary.

Age. Late Miocene (Late Pannonian, Transdanubian sensu Sacchi and Horváth 2002; Sztanó et al. 2013).

Type material. According to the inventory books of the Natural History Museum Vienna the material should be stored there, but despite great effort it could not be located.

Discussion. Up to now it has been overlooked by several authors, including ourselves (Neubauer et al. 2014), that this species is a primary homonym of *V. carinata* Sowerby, 1834 (see also Haszprunar 2014, p. 28). According to Bandel (2010, p. 104) this species should be classified within the new hydrobiid genus *Muellerpalia*, particularly because of its strongly different protoconch sculpture. This systematic concept is followed herein. For a more detailed discussion about the involved taxa and the species confusions in Bandel (2010) see Neubauer et al. (2014).

Family Lithoglyphidae Tryon, 1866

Genus Lithoglyphus Menke, 1830

Type species. *Paludina naticoides* Pfeiffer, 1828. Recent, Europe. Subsequent designation by Herrmannsen (1846, p. 612).

Lithoglyphus gozhiki nom. n.

Lithoglyphus maeoticus Gozhik in Gozhik and Datsenko 2007: 88, pl. 81, figs 1–3 [non *Lithoglyphus maeoticus* Papaianopol, 2006].

Etymology. In honor of Piotr F. Gozhik (Kiev), who intensively studied the Neogene deposits of Ukraine and southern Russia.

Type locality. Nizhniy Dnepr (= lower Dnieper), Ukraine.

Age. Late Miocene (Early Maeotian, Oltenian).

Holotype. Institute of Geological Sciences, National Academy of Sciences of Ukraine, Kiev, coll. no. 2174.

Discussion. A classic case of a primary homonym. Probably as a result of prolonged publication times, Gozhik had no chance to become aware of this problem. However, the taxonomic status of *L. maeoticus* Papaianopol, 2006 from the Early Maeotian of the Dacian Basin is doubtful. It greatly resembles and might be a synonym of the Dacian species *L. acutus* Cobălcescu, 1883 (p. 145, pl. 14, fig. 10; see also Wenz 1942, p. 48, pl. 15, figs 195–198).

Clade Heterobranchia Informal Group Lower Heterobranchia Superfamily Valvatoidea Gray, 1840

Family Valvatidae Gray, 1840

Note. The here applied suprageneric systematics of Valvata follows Bouchet et al. (2005).

Genus Valvata Müller, 1773

Type species. Valvata cristata Müller, 1774. Recent, Europe. Type by subsequent monotypy (Müller 1774, p. 198; for details see Welter-Schultes 2012, p. 42).

Valvata heidemariae willmanni nom. n.

Valvata heidemariae bicarinata Willmann, 1981: 158, textfigs 56D–F [non Valvata bicarinata Lea, 1841].

Etymology. In honor of Rainer Willmann (University of Kiel), who intensively studied the Plio-Pleistocene deposits and freshwater mollusks of Greece.

Type locality. Vokasia Valley 3 km SE of Kos City, Kos Island, Greece. **Age.** Early Pleistocene (Middle Irakli Formation).

Type material. Geological-Paleontological Institute, University of Kiel, no number indicated; Willmann (1981, textfigs 56D–E).

Discussion. The species-group name *bicarinata* in combination with *Valvata* is preoccupied by the Recent species *Valvata bicarinata* Lea, 1841 from Pennsylvania, USA. The taxonomic separation from *V. heidemariae* Willmann, 1981 seems plausible, given the presence of a strong median keel on the upper whorl surface that is lacking in the nominal species.

Clade Panpulmonata Jörger et al., 2010 Superorder Basommatophora Keferstein in Bronn, 1864 Order Hygrophila Férussac, 1822 Superfamily Lymnaeoidea Rafinesque, 1815 Family Lymnaeidae Rafinesque, 1815 Subfamily Lymnaeinae Rafinesque, 1815

Genus Radix Montfort, 1810

Type species. *Helix Auricularia* Linnaeus, 1758. Recent, Europe. Type by original designation (for details see Welter-Schultes 2012, p. 51).

Radix macaleti nom. n.

Radix socialis Macalet, 2000: 252, pl. 2, figs 2-3 [non Limnaea socialis von Zieten, 1832].

Etymology. In honor of Rodica Macaleț (Bucharest), who studied the mollusk fauna of the Dacian Basin.

Type locality. Butuci near Sângeru, Prahova, Romania.

Age. Latest Miocene to earliest Pliocene (Pontian, Portaferrian-Bosphorian).

Holotype. Collection of the Geological Institute of Romania, coll. no. 19.546.

Discussion. This species is a secondary homonym of *Limnaea socialis* von Zieten, 1832, of which the presently accepted and widely used combination is *Radix socialis* (e.g., Wenz 1923b, Gall 1972, Kókay 2006). Macaleţ (2000) omitted the "sp. nov." in the heading of the description, which he indicated for all other species newly introduced by him in this paper, but gave it in the figure captions and the text and he designated a holotype. *Radix macaleti* is one of several similar species newly introduced by Macaleţ (2000). Although the Lymnaeinae of the Dacian Basin are not well represented in the older literature, several of these new taxa may actually represent synonyms of one another, given the extreme variability of this clade (see, e.g., Glöer 2002, Welter-Schultes 2012). A revision of the entire group in the Dacian Basin would be necessary to clarify this issue.

Superfamily Planorboidea Rafinesque, 1815 Family Planorbidae Rafinesque, 1815 Subfamily Planorbinae Rafinesque, 1815

Genus Gyraulus Charpentier, 1837

Type species. *Planorbis albus* Müller, 1774. Recent, Europe. Subsequent designation by Dall (1870, p. 351).

Gyraulus okrugljakensis nom. n.

Planorbis clathratus Brusina, 1884: 171, pl. 30, fig. 29 [non Planorbis (Helisoma) clathratus Sandberger, 1880].

Gyraulus (Gyraulus) clathratus (Brusina); Wenz 1923c: 1545 [non Sandberger 1880].

Etymology. Named after the type locality.

Type locality. Okrugljak (today within the city limits of Zagreb), Croatia.

Age. Late Miocene (Late Pannonian, Portaferrian; Geary et al. 2010).

Syntype. Croatian Natural History Museum, Zagreb, coll. no. 2953-599/1 (Milan et al. 1974, p. 117).

Discussion. This species represents a primary homonym of *Planorbis (Helisoma) clathratus* Sandberger, 1880 from the Pleistocene of West Runton, Norfolk, United Kingdom. We follow Wenz (1923c), who placed Brusina's species within *Gyraulus*. The classification of the British species within *Helisoma* by Sandberger is rather doubt-ful. This North American genus was artificially introduced to Europe, wherefore an occurrence in the Pleistocene of the British Isles is unlikely. The morphology as depicted in Sandberger (1880) suggests an attribution to *Planorbarius*.

Gyraulus rasseri nom. n.

Planorbis discoideus Pavlović, 1903: 181, pl. 5, figs 14–17 [non Planorbis multiformis discoideus Hilgendorf, 1867].

Gyraulus (Gyraulus) discoideus (Pavlović); Wenz 1923c: 1552 [non Hilgendorf 1867].

Etymology. In honor of Michael W. Rasser (State Museum of Natural History Stuttgart), who studied the *Gyraulus* species flock of Lake Steinheim.

Type locality. Orahovac (= Rahovec), Kosovo.

Age. Early Pliocene (Late Dacian to Early Romanian; Popović 1969).

Holotype. Natural History Museum, Belgrade, coll. no. 1176 (Milošević 1962, p. 27).

Discussion. The name *Planorbis discoideus* as established by Pavlović (1903) represents a primary homonym of *P. discoideus* Hilgendorf, 1867. The latter species is a member of the *Gyraulus* species flock in the Middle Miocene Lake Steinheim and is presently considered a junior synonym of *G. sulcatus* by Rasser (2013). From the rather character-poor shell it is impossible to reliably attribute Pavlović's species to *Planorbis* or *Gyraulus*. Here we follow the taxonomic decision of Wenz (1923c) to place it in *Gyraulus*.

Gyraulus vrapceanus nom. n.

Planorbis dubius Gorjanović-Kramberger, 1890: 156, pl. 6, fig. 6 [non *Planorbis dubius* Hartmann, 1844].

Gyraulus (Gyraulus) dubius (Gorjanović-Kramberger); Wenz 1923c: 1552 [non Hartmann 1844].

Etymology. Named after the type locality.

Type locality. Vrapče (also read as Vrabče; today within the city limits of Zagreb), Croatia.

Age. Late Miocene (Early Pannonian, Slavonian).

Syntype. Croatian Natural History Museum, Zagreb, coll. no. 5195-360/2 (Milan et al. 1974, p. 119).

Discussion. The name *Planorbis dubius* was first used by Hartmann (1821, p. 254) for an extant species from Zurich region in Switzerland. The name is not available from this publication, since Hartmann did not give a description or indication (see also AnimalBase project 2005–2014). He first described and thus formally introduced it in Hartmann (1844, p. 111). Today its status is disputed. Glöer (2002, p. 253) ranked it as forma within *P. carinatus* Müller, 1774. Later, Glöer and Pešić (2010) stated that Hartmann's material contained two different taxa, i.e. *P. planorbis* and *P. carinatus*, making *P. dubius* a junior synonym of both. Finally, Kantor et al. (2010) listed it as accepted species in their catalogue of Russian continental mollusks. In summary, although the status of the extant species is doubtful, the name is available. This makes *Planorbis dubius* Gorjanović-Kramberger, 1890 a primary homonym of *Planorbis dubius* Hartmann, 1844. Here follow Wenz (1923c) and classify the replacement name within *Gyraulus*.

Genus Planorbarius Duméril, 1806

Type species. *Helix cornea* Linnaeus, 1758. Recent, Europe. Subsequent monotypy by Froriep (1806).

Planorbarius halavatsi nom. n.

Planorbis grandis Halaváts, 1903: 57, pl. 3, fig. 5 [non *Planorbis grandis* Dunker in Küster et al. 1850].

Coretus grandis (Halaváts); Wenz 1923c: 1472 [non Dunker in Küster et al. 1850].

Planorbarius grandis (Halaváts); Sauerzopf 1953: 50, pl. 1, figs 3–4 [non Dunker in Küster et al. 1850].

Etymology. In honor of Gyula von Halaváts (Budapest), who greatly contributed to our knowledge of Pannonian mollusks.

Type locality. Balatonfőkajár, Veszprém, Hungary.

Age. Late Miocene (Late Pannonian, ?Transdanubian sensu Sacchi and Horváth 2002). Holotype. Hungarian Geological Institute, Budapest, coll. no. Pl. 121 (Boda 1964, p. 130).

Discussion. As both taxa were introduced within *Planorbis*, the species described by Halaváts is a primary homonym. Both are today unambiguously assigned to the genus *Planorbarius* (for the Pannonian species see, e.g., Sauerzopf 1953, Harzhauser and Tempfer 2004) and are in common usage, making the introduction of a replacement name indispensable. *Planorbis grandis* Dunker in Küster et al., 1850, an extant taxon from SE Europe, is currently ranked as subspecies of *P. corneus* (see Fauna Europaea project, De Jong 2013).

Genus Segmentina Fleming, 1818

Type species. *Nautilus lacustris* Lightfoot, 1786 [currently considered as a synonym of *Segmentina nitida* (Müller, 1774)]. Recent, Europe. Type by monotypy (Welter-Schultes 2012, p. 70).

Segmentina mosbachensis nom. n.

Planorbis (Segmentina) micromphalus Sandberger, 1875: 777, pl. 33, figs 19–19c [non *Planorbis micromphalus* Fuchs, 1870 in Fuchs 1870a].

Planorbis nitidus Müll. var. *micromphalus* Sandb.; Rzehak 1888: 308 [non Fuchs 1870a].

Etymology. Named after the type locality.

Type locality. Mosbach, Hessen, Germany.

Age. Early Pleistocene.

Type material. No storage or types indicated.

Discussion. The species name established by Sandberger is a primary homonym of *P. micromphalus* Fuchs, 1870, although he was apparently aware of the existence of this

name (compare Sandberger, 1875, p. 700). Also Lőrenthey (1902, p. 190) knew about the identical naming and discussed the differences between both taxa, but did not take appropriate steps to clarify this problem. Fuchs' species was first described from the Pannonian of Rădmănești in Romania and has been recombined with *Gyraulus* by Wenz (1923c, p. 1562; see also Harzhauser et al. 2002, p. 106).

Discussions

In the following, we present six cases of primary and secondary homonyms that seem not to be in use anymore (e.g., are unambiguously considered junior synonyms). We were unable to find any recommendation in the Code regarding the necessity of replacement names for disused junior homonyms. Following the intent expressed in Article 23.9.5, which seems to discourage the proposal of unnecessary replacement names, we choose not to introduce new names for these cases. In addition, the statuses of two taxa apparently constituting homonyms are discussed.

Superfamily Viviparoidea Gray, 1847 Family Viviparidae Gray, 1847 Genus *Viviparus* Montfort, 1810

Viviparus lomejkoi brevis Popović, 1970 non (Tournouër, 1876)

Viviparus (V.) lomejkoi brevis Popović, 1970: 318, figs 1: 7, 7a, 8 [non Paludina (Vivipara) brusinai brevis Tournouër 1876].

Type locality. Gjurakovc (= Đurakovac), Kosovo.

Age. Late Pliocene to Early Pleistocene (= "Levantin").

Holotype. Collection de l'Institut de recherches géologiques et géophysiques de Belgrade, no number indicated.

Discussion. Tournouër (1876) introduced *Paludina (Vivipara) Brusinai* var. *brevis* from the Early Pleistocene of Kos Island. Both genus-group names stated by Tournouër (1876) are, however, invalid. *Paludina* Férussac, 1812 is a junior objective synonym of *Viviparus* Montfort, 1810 (ICZN 1959, Op. 573) and *Vivipara* represents an incorrect subsequent spelling (Melville and Smith 1987, p. 185). The species-group name *brevis* in combination with *Viviparus* as introduced by Popović (1970) is therefore a homonym of *Viviparus brevis* (Tournouër, 1876). The latter taxon was elevated to species level by Willmann (1977); for thorough description, synonymy list, and discussion see Willmann (1981, p. 151).

Still we refrain from introducing a replacement name, because the taxonomic status of this subspecies is highly doubtful. It greatly resembles the nominal species *V. lomejkoi* Pavlović, 1932 from Crmljan and Orahovac (like the type locality Gjurakovc in the Metohia Basin). The only difference is the stronger degree of whorl stepping, which is not documented by Pavlović's original description and illustrations. This is regarded to fall into intraspecific variability, why we suggest synonymizing *V. lomejkoi* brevis with *V. lomejkoi*. If, however, another author keeps both forms separate, a replacement name has to be introduced.

Viviparus berbestiensis grandis Lubenescu & Zazuleac, 1985 non Neumayr in Herbich & Neumayr, 1875

Viviparus berbestiensis grandis Lubenescu & Zazuleac, 1985: 109, pl. 28, figs 15–17, pl. 29, fig. 12 [non *Vivipara grandis* Neumayr in Herbich and Neumayr 1875].

Viviparus cucestiensis grandis Lubenescu; Papaianopol and Marinescu 1995, pl. 44, fig.

5 [non Neumayr in Herbich and Neumayr 1875].

Type locality. Puilor Valley, Buzău, Romania.

Age. Early Pliocene (Late Dacian, Parscovian).

Holotype. Institut de Géologie et Géophysique, Bucharest, coll. no. 17055.

Discussion. *Vivipara*, as given by Neumayr in Herbich and Neumayr (1875, p. 413) and many other authors of this time, is an incorrect subsequent spelling of *Viviparus* Montfort, 1810 (Melville and Smith 1987, p. 185). The species-group name *grandis* in combination with *Viviparus*, as introduced for a new species by Lubenescu and Zazuleac (1985), therefore is a primary homonym of *Viviparus grandis* (Neumayr in Herbich & Neumayr 1875) and would require a replacement name (see also Wenz 1928a, p. 2323). We refrain from introducing a nomen novum because of the highly doubtful taxonomic status of this subspecies. The only criterion for Lubenescu and Zazuleac (1985, p. 110) to separate this form from the nominal species was the additional whorl and thus bigger size (therefore the name *grandis*). Apart from that it completely corresponds to *V. berbestiensis* Lubenescu & Zazuleac, 1985. Consequently, we regard *V. berbestiensis grandis* as junior synonym of *V. berbestiensis*.

Papaianopol and Marinescu (1995) ranked *V. berbestiensis grandis* as subspecies of *V. cucestiensis* Lubenescu & Zazuleac, 1985, but without explanation and only in the figure captions. Here we follow the original authors to avoid additional confusion.

Superfamily Cerithioidea Fleming, 1822 Family Melanopsidae Adams and Adams, 1854 Genus *Melanopsis* Férussac, 1807

Melanopsis pygmaea inflata Sauerzopf, 1952 non Handmann, 1882

Melanopsis pygmaea inflata Sauerzopf, 1952: 13, pl. 2, fig. 4 [non Melanopsis pygmaea inflata Handmann, 1882].

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Type locality. No locus typicus given; occurs in Stegersbach, Litzelsdorf, Olbendorf, and Oberdorf in the Styrian Basin, Austria.

Age. Late Miocene (Pannonian, Serbian, biozones E-F).

Type material. No storage or types indicated (material derived from Sauerzopf's private collections).

Discussion. There are several issues with the name *Melanopsis inflata*. First, the name introduced by Sauerzopf definitely constitutes a primary homonym of *M. pygmaea inflata* Handmann, 1882. Sauerzopf (1952) explicitly introduced it as new taxon, although the combination is identical to that established by Handmann. Both taxa were obviously erected for different morphologies: while Sauerzopf's form is elongated conical, Handmann's subspecies is rather globular. Handmann's taxon is meanwhile considered as junior synonym of *M. pygmaea* Hörnes, 1856 (Wenz 1929a, p. 2813). *M. pygmaea inflata* Sauerzopf, 1952, in turn, highly resembles *M. fuchsi* Handmann, 1882 concerning its size, the regular conical outline and the slightly inflated last whorl. Exactly these last two criteria were for both authors the reason to separate their forms from *M. pygmaea* (see Handmann 1887, p. 13; Sauerzopf 1952, p. 13). Therefore we consider both synonymous and refrain from introducing a replacement name.

The second problem regards the availability of *Melanopsis inflata* Handmann, 1882. This name was already introduced as subordinate taxon by Férussac (1823) within *M. buccinoidea*. Whether it is available as species-group name, however, cannot easily be determined, given the chaotic system in Férussac's work (see also discussion of *M. elongata* below) and the fact that it is not found to be used as species-group name attributed to Férussac in the literature, which would have made it available via ICZN 1999, Article 45.6.4.1. If Férussac's name is accepted as species-group name, Handmann's taxon would become a primary homonym. Since this is apparently not the case and Handmann's subspecies was synonymized anyway, the introduction of a replacement name would be inexpedient.

Melanopsis elongata auctores

In the biological and palaeontological literature several species-group taxa were introduced as "*Melanopsis elongata*". The first mention traces back to Férussac (1823, p. 150), who described a subordinate taxon within *M. buccinoidea*, which he described two pages above, from Épernay, France. From Férussac's remarks it is not clear, if *elongata* has subspecific or infrasubspecific rank. Moreover, the inconsistent formatting in this work leaves doubts about what is intended to be a taxon's name and what a descriptive term. Usually it is important to find out the exact rank of a taxon, since infrasubspecific taxa are not governed by the Code. In this case, however, we follow ICZN (1999, Article 45.6.4.1), stating that an infrasubspecific taxon is deemed to be subspecific from its original publication if, before 1985, it was adopted as the valid name of a species or subspecies. This criterion is at least fulfilled by the publication of Pallary (1916). Consequently, all later introduced taxa also named "*Melanopsis elongata*" are primary homonyms of *M. elongata* Férussac, 1923. According issues are provided by Gassies (1874, p. 384), Locard (1878, p. 58; 1893, p. 178), Doncieux (1908, p. 202), Jooss (1911, p. 72), and Gillet and Marinescu (1971, p. 55). Pallary (1916) was aware of the homonyms produced by Gassies and Doncieux and introduced the replacement names *M. goulvaini* and *M. sublongata* (erroneously written "*sublonga*" in Pallary 1926 and "*subelongata*" in Wenz 1929a). *M. elongata* Gassies, 1874 (= *M. goulvaini*) has meanwhile been synonymized with *M. frustulum* Morelet, 1857 (Bouchet 2013). Probably the problems we are presently aware of are only several of many invalidly erected taxa named "*Melanopsis elongata*".

The names introduced by Locard, Jooss and Gillet and Marinescu have not yet undergone nomenclatural revision. Although primary homonyms are invalid, it is, however, not expedient to introduce new names for taxa that are not used anymore. This particularly regards *Melanopsis narzolina elongata* Locard, 1878 from the Late Miocene of Tersanne, which was apparently not used at all by subsequent authors and synonymized by Wenz (1929a) with *M. narzolina narzolina*. If later authors regard this taxon as distinct from *M. narzolina*, a new name will have to be introduced.

A more complicated case in terms of synonymy is presented by *Melanopsis callosa elongata* Jooss, 1911 from the Aquitanian of the Mainz Basin. Wenz (1929a, p. 2729) cited the record of *M. callosa* from Jooss (1911) in the synonymy list for *M. fritzei* Thomä, 1845, both of which he considered synonymous, but either overlooked that Jooss had introduced a new variety or forgot to state it in the catalogus. The synonymization by Wenz is preliminarily accepted here, so as not to introduce yet another, probably superfluous name. A more thorough taxonomic revision is needed to clarify the taxonomic status of this subspecies and whether a new name is needed.

The remaining two homonyms are still in usage and thus require a more detailed assessment.

Melanopsis citharella elongata Locard, 1893 non Férussac, 1823

Melanopsis citharella var. elongata Locard, 1893: 178, pl. 9, fig. 17 [non Melanopsis elongata Férussac, 1823].

Melanopsis citharella elongata Locard; Wenz 1929a: 2693 [non Férussac 1823].

Type locality. Ueken, Aargau, Switzerland.

Age. Middle to Late Burdigalian ("Helvetian").

Type material. Paleontological Institute and Museum, University of Zurich, no number indicated.

Discussion. Unlike the case of *M. narzolina elongata* Locard, 1878, this taxon was not synonymized by Wenz (1929a, p. 2693). Despite separating it from *M. ci-tharella*, Wenz noted that this form is probably indistinguishable from the nominal species. After review of Locard's description and illustrations we fully agree with Wenz,

and draw the taxonomic conclusion to synonymize *M. citharella elongata* with *M. citharella*. Hence, although it is a primary homonym, we avoid introducing another superfluous name.

Melanopsis defensa elongata Gillet & Marinescu, 1971 non Férussac, 1823

Melanopsis defensa elongata Gillet & Marinescu 1971: 55, pl. 23, figs 38–48 [non Melanopsis elongata Férussac, 1823].

Type locality. Rădmănești, Romania.

Age. Late Miocene (Late Pannonian, Transdanubian sensu Sacchi and Horváth 2002; Geary et al. 2010).

Holotype. Gillet and Marinescu (1971) designated the specimen illustrated by Fuchs (1870a, pl. 14, fig. 79) as holotype. According to the inventory books of the Natural History Museum Vienna the material should be stored there, but despite great effort it could not be located.

Discussion. This case represents another primary homonym of *M. elongata* Férussac, 1823. Here some specific notes are necessary to elucidate the history of this taxon. Gillet and Marinescu (1971) erroneously linked the holotype of *M. defensa* to the variety *trochiformis* Fuchs, 1870 (Fuchs 1870a, pl. 14, figs 77–78), who explicitly separated these two specimens from the typical form (Fuchs 1870a, p. 354). Since Fuchs did not denote a holotype, all material studied by him, except the two specimens determined as *trochiformis*, are syntypes of *M. defensa defensa*. It was unwise, though nomenclaturally correct as the nominal subspecies was still based on several (not illustrated) syntypes, to assign the new name *elongata* to the remaining figure of *M. defensa* in Fuchs (1870a, pl. 14, fig. 79). If, however, a lectotype would be designated from Fuchs's original material and one would choose the figured specimen (pl. 14, fig. 79) as such, *M. defensa elongata* would become an objective synonym of *M. defensa defensa*. In conclusion, we avoid introducing a replacement name because of the obvious misapprehension of Gillet and Marinescu (1971) and synonymize *M. defensa elongata* with *M. defensa defensa*.

A part of the material of *M. defensa defensa* in Gillet and Marinescu (1971, pl. 23, fig. 10) was later separated as the new species *M. lebedai* by Lueger (1980, p. 104).

Order Littorinimorpha Golikov & Starobogatov, 1975 Superfamily Truncatelloidea Gray, 1840 Family Bithyniidae Gray, 1857

Genus Bithynia Leach in Abel, 1818

Type species. *Helix tentaculata* Linnaeus, 1758. Recent, Europe. Subsequent designation by Herrmannsen (1846, p. 114).

Bithynia socialis (Papaianopol & Macalet, 2006) non Westerlund, 1886

Bulimus (Tylopoma) socialis Papaianopol & Macaleț 2006: 82, pl. 4, figs 1–5 [non *Bythinia socialis* Westerlund, 1886].

Type locality. Bengești, Gorj, Romania.

Age. Early Pliocene (Early Dacian, Getian).

Holotype. Collection of the Geological Institute of Romania, coll. no. 18.906.

Discussion. The genus-group name *Bulimus* Scopoli, 1777 was suppressed under Plenary Powers and placed on the Official Index of Rejected and Invalid Generic Names in Zoology by ICZN (1957, Op. 475). Bithyniid species originally attributed to this genus are now referred to *Bithynia* Leach, 1818. In a strict sense, this makes this species a primary homonym of *Bithynia socialis* Westerlund, 1886. Latter taxon has been recombined with *Paraelona* Beriozkina & Starobogatov in Anistratenko and Stadnichenko 1995, which is considered a junior synonym with *Bithynia* (Glöer and Maassen 2009; see also Kantor et al. 2010).

The status of *Bithynia socialis* (Papaianopol & Macaleț 2006), however, is doubtful. The bithyniids of the Dacian Basin are quite well studied (e.g., Cobălcescu 1883, Stefanescu 1896, Krejci-Graf and Wenz 1932, Wenz 1942, Pană et al. 1981), including material from the localities mentioned by Papaianopol and Macaleț (2006). The species closely resembles the co-occurring *Tylopoma speciosa* (Cobălcescu, 1883) and differs only in the stronger, rib-like growth lines, which were to a minor extent also detected for *T. speciosa* (Wenz 1942, p. 53). Therefore, we regard *Bithynia socialis* (Papaianopol & Macaleț 2006) as junior synonym of *T. speciosa* and do not introduce a nomen novum.

Family Hydrobiidae Stimpson, 1865 Subfamily Hydrobiinae Stimpson, 1865

Genus Hydrobia Hartmann, 1821

Type species. Cyclostoma acutum Draparnaud, 1805. Recent, France. Type by monotypy.

Hydrobia obtusa tenuis Wenz, 1913 non Penecke, 1886

[Hydrobia obtusa] mut. tenuis n. mut. Wenz, 1913: 113, pl. 1, figs 12–15. Hydrobia obtusa tenuis Wenz; Wenz 1926: 1922.

Locality. No type locality indicated; occurs in several places in Frankfurt am Main, Germany.

Age. Early Miocene (Aquitanian, upper *Corbicula* beds = Rüssingen Formation).

Syntypes. Only one of the syntypes is stored in the Senckenberg Research Institute and Natural History Museum, coll. no. SMF 245299/1 (pers. comm. R. Janssen, Frankfurt).

Discussion. This tricky case requires a careful assessment of the original literature. Penecke (1886, p. 35) introduced a new species, *Hydrobia tenuis*, from the Paludina beds of Malino and Sibinj in Croatia. Later, Wenz (1913) described a different new taxon as *Hydrobia obtusa tenuis* from the Frankfurt area. Despite the identical naming, Wenz' taxon is no primary homonym. Since Wenz clearly introduced this taxon as "mutation" it is not available as species-group name (ICZN 1999, Articles 45.5 and 45.6), although he erroneously cited it as "variety" when referring to his own work in the Fossilium Catalogus (Wenz 1926). The latter record is in fact a nomen nudum (as is true for the mutations *aperta*, *distorta*, *incrassata*, and *umbilicata*). We are not aware of any work making *Hydrobia obtusa tenuis* available by treatment as valid species or subspecies (ICZN 1999, Article 45.6.4.1).

Subfamily Pseudamnicolinae Radoman, 1977 Genus *Pseudamnicola* Paulucci, 1878

Pseudamnicola minima (Lőrenthey, 1893) non (Fuchs, 1877)

Cyclostoma (?) *minima* Lőrenthey, 1893: 211, 306, pl. 4, fig. 1. *Hydrobia (Pannona) minima* Lörent. sp., Lőrenthey 1902: 230, pl. 16, figs 9–11. *Amnicola (Amnicola) minima* (Lőrenthey); Wenz 1926: 2068. *Pseudamnicola (Pseudamnicola) minima* (Lőrenthey); Papp 1953: 117, pl. 7, fig. 10.

Type locality. Şimleu Silvaniei (= Szilágy-Somlyó), Sălaj, Romania.

Age. Late Miocene (Middle Pannonian, Serbian).

Type material. No storage or types indicated; probably stored in the Hungarian Geological Institute, Budapest.

Discussion. Both involved taxa were originally combined with different genera, but have been attributed to *Pseudamnicola* in the second half of the 20th century. Lőrenthey's species was recombined with Amnicola by Wenz (1926), based on overall shell morphology. Because an attribution of a European species to this North American genus is relatively doubtful (Paulucci 1878, Wenz 1938-1944), Papp (1953) recombined this species with Pseudamnicola. Valvata minima Fuchs, 1877, described from the Pliocene of Megara (Fuchs 1877, p. 14, pl. 1, figs 25-27), was recombined with Pseudamnicola by Willmann (1981, p. 212). This would make Pseudamnicola minima (Lőrenthey, 1893) a secondary homonym of Pseudamnicola minima (Fuchs, 1877). However, as pointed out by Haszprunar (2014), Valvata minima Fuchs, 1877 is a primary homonym of V. minima Hislop, 1859 from the Tertiary of East India and is thus not available (for replacement name see above). Lőrenthey's species consequently is no secondary homonym and needs no replacement name. Anyway, the generic classification of neither species appears to be settled. Several species of the Miocene of Central and Southeastern Europe previously attributed to *Pseudamnicola* have been shown lately not to belong to this genus (Neubauer et al. 2013b, c).

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RESEARCH ARTICLE



Status of the enigmatic Oriental genus Rhithrogeniella Ulmer, 1939 (Ephemeroptera, Heptageniidae)

Michel Sartori^{1,2}

I Zoologisches Museum und Biozentrum Grindel, Martin-Luther-King-Platz 3, D-20146 Hamburg, Germany
 2 Museum of Zoology, Palais de Rumine, Place Riponne 6, CH-1005 Lausanne, Switzerland

Corresponding author: Michel Sartori (michel.sartori@vd.ch)

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Abstract

Based on historic collections and new material from Sumatra and Java, the species *Rhithrogeniella ornata* Ulmer, 1939, type species of the genus *Rhithrogeniella*, is reinvestigated. The nymph is described for the first time and is closely related to the continental Southeast Asian species *Rhithrogeniella tonkinensis* Soldán and Braasch, 1986. *Rhithrogeniella* belongs to the subfamily Ecdyonurinae, and is related to the genera *Nixe* Flowers, 1980 and/or *Paracinygmula* Bajkova, 1975 based on characters of the nymphal stage. Species described from Taiwan in the genus *Nixe* are transferred to the genus *Rhithrogeniella: Rh. littoralis* (Kang and Yang, 1994) **comb. n.**, *Rh. mitifica* (Kang and Yang, 1994) **comb. n.** and *Rh. obscura* (Kang and Yang, 1994) **comb. n.**

Keywords

Rhithrogeniella ornata, Rhithrogeniella tonkinensis, Nixe, Paracinygmula, new combinations, Sumatra, Java

Introduction

Ulmer (1939) established the genus *Rhithrogeniella* to accommodate the species *Rhithrogeniella ornata* Ulmer, 1939 known from imagos and subimagos from Java and Sumatra. According to Ulmer (1939), the genus was characterized by genitalia resembling those of *Rhithrogena*, with two simple lobes lacking spines or titillators. On

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the other hand, the new genus differed from *Rhithrogena* in the tarsal proportions on fore- and hind legs. Interestingly, in the key to the genera (Ulmer 1939), *Rhithrogeniella* is keyed with the genus *Afronurus* Lestage, 1924 from which it differs by the tarsal composition of the foreleg. During the following years, nothing substantial was added to the knowledge of the genus, and keys which included *Rhithrogeniella* were based on Ulmer's description and drawings (Tomka and Zurwerra 1985; Tshernova 1974).

Major advancement was made by Soldán and Braasch (1986) who described a new species from Vietnam (Rh. tonkinensis) based on subimagos, together with the first description of the nymphal stage. This nymph exhibits typical Ecdyonurinae morphology, with scattered setae on the maxillae. The genus can be distinguished from all relatives by the peculiar structure of the cerci and terminal filament which possess a row of stout setae in the proximal part and bunches of long and thin setae in the medial and distal parts. Later, Rh. tonkinensis was reported from Thailand and the male imago described (Braasch 1990). According to figures of Braasch (1990), the genitalia bear median titillators, the penis lobes are much more rounded than in Rh. ornata, and the styliger plate is of an unusual shape with two triangular sublateral processes. In their revision of worldwide Heptageniidae, Wang and McCafferty (2004) proposed several nomenclatorial changes; in particular, they combined *Rhithrogeniella ornata* with the genus Rhithrogena, hence placing Rhithrogeniella in synonymy with Rhithrogena, and they assigned Rhithrogeniella tonkinensis to the genus Ecdyonurus (E. tonkinensis) based on subimaginal, larval and egg morphology. This account was never discussed later on and Braasch and Boonsoong (2010) mentioned the presence of Rhithrogeniella ornata in West Malaysia based on male subimagos, and Boonsoong and Braasch (2013) listed Rhithrogeniella tonkinensis in the Heptageniidae fauna of Thailand.

Two questions need to be resolved. Are Wang and McCafferty (2004) correct in synonymizing *Rhithrogeniella* with *Rhithrogena* (subfamily Rhithrogeniae), and assigning *Rh. tonkinensis* to the genus *Ecdyonurus* (subfamily Ecdyonurinae)? Is the association between unreared nymphs and subimagos of *Rh. tonkinensis* accurate or not?

The type material of *Rh. ornata*, deposited in the collection of the Zoological Museum of Hamburg University, Germany (ZMH) has been reinvestigated together with new material from Sumatra. It is now possible to provide the first description of the nymph of *Rh. ornata*.

Material and methods

Material studied here is deposited in the following institutions:

Zoologisches Museum und Biozentrum Grindel, Hamburg, Germany [ZMH] Musée cantonal de zoologie, Lausanne, Switzerland [MZL] Lembaga Ilmu Pengetahuan Indonesia (Indonesian Institute of Sciences), Museum of Zoology, Bogor, Indonesia [LIPI] (Bogor was formerly known as Buitenzorg) Drawings were made with the help of a camera lucida taken from stereomicroscope Leica DM 750 and pictures from microscope Zeiss Axioscop 2 or Visionary Digital Passport II. Final digital drawings were performed on Adobe Illustrator CS6. For scanning electronic microscope (SEM) pictures, the eggs were dehydrated, carbon coated, and observed under a LEO 1525 at 5.00kV; maxillae were dehydrated, critical point dried, and then platinum coated, and observed under a FEI Quanta 250 at 5.00kV. Final plates were assembled in Adobe Photoshop CS6.

Nymphs and adults were associated with the help of the egg structure (Fig. 5).

Results

Rhithrogeniella ornata Ulmer, 1939

Rhithrogeniella ornata Ulmer, 1939, male, female imagos and subimagos Rhithrogena ornata Wang & McCafferty, 2004

Material. One male holotype, one female allotype: Indonesia, Java, Buitenzorg, VII 1932, Dr. Lieftinck leg. [ZMH]

Paratypes: 4 female subimagos, 1 male subimago: Indonesia, Java, Buitenzorg, Bellevue, caught at light, VII.1929, Prof. Thienemann leg. [ZMH]; 4 female imagos, 2 male subimagos: Indonesia, Sumatra, Padang, VII 1925, Prof. Fulmek leg. [ZMH]; 1 male subimago: Indonesia, Sumatra, Pangkalang, Kota baru, X 1925, Prof. Fulmek leg. [ZMH]

All specimens in ethanol, except fore- and hind legs, fore- and hind wings of the male subimago from Buitenzorg mounted on slide in Canada balsam.

Other material: 5 nymphs: Indonesia, Sumatra Barat, Sawahlunto, stream, 275m, 00°41.33'S 100°46.72'E, (UN5), 10.XI.2011, M. Balke leg. [ZML]; 26 nymphs, of which two entirely mounted on microscopic slides: Indonesia, Sumatra Barat, Talawi, Ombilin River, 277m, 00°34.15'S 100°43.54'E, (UN4), 8.XI.2011, M. Balke leg. [ZMH, MZL, LIPI]

Complementary description of the male imago (holotype). Specimen completely faded; for color patterns see Ulmer (1939).

Mesonotum with transverse suture; medial depression of furcasternum sub parallel anteriorly.

Foreleg with tarsi sub equal in length to the tibia, which is 1.25x longer than the femur. Tarsal composition: 2>3>4>5>1.

Genitalia (Fig. 1): margin of the styliger plate straight to slightly convex, with two small sub-lateral rounded processes; last gonopod segment ca $0.7\times$ the length of the previous, both together ca $0.75\times$ the length of the antepenultimate. Penis constituted of two kidney-shape lobes, separated by a "U" incision, i.e. the inner margin of each lobe is concave and slightly hooked near the apex. No lateral or median titillators, no apical spines visible.



Figures 1–4. *Rh. ornata* Ulmer, 1939. I Genitalia of the male imago (holotype) in ventral view **2** Foreleg of a male subimago (paratype) **3** Hindleg of a male subimago (paratype) **4** Penis lobes of a male subimago (paratype): plain line, cuticular structures of the subimago; dotted line, outline of the imago penis lobes.

Complementary description of the male subimago. Fore leg (Fig. 2) with femur ca 1.15x the length of tibia, which is subequal in length to tarsi. Tarsal composition $4\ge 2>3\ge 1>5$.

Hind leg (Fig. 3) with femur ca 1.35x the length of tibia, which is ca $1.45 \times$ the length of tarsi. Tarsal composition $1=2=5>3\geq 4$.



5

Figure 5. *Rh. ornata* Ulmer, 1939, SEM pictures of egg structures. **5a** Egg extracted from a female subimago paratype from Padang, Sumatra **5b** Details of the chorionic structure of a female nymph from Ombilin River, Sumatra **5c** Details of the chorionic structure and micropyle of a female subimago paratype from Buitenzorg [Bogor], Java **5d** chorionic surface of the female allotype from Buitenzorg [Bogor], Java.

Genitalia (Fig. 4) with penis lobes rounded, ellipsoid, without any spine or titillators; in median position, a pair of membranous processes ending with a spine like sclerotization present in ventral view.

Complementary description of the female imago (allotype). Thoracic structures similar to the male.

Eggs (Fig. 5): ovoid, ca 130 μ m × 90 μ m; chorion regularly covered with hexagonal mesh ridges, with KCT in-between, not larger at poles; micropyle rounded to slightly oval in equatorial area.

First description of the nymph. Size: Body length: up to 5.2 mm and 5.6 mm for male and female respectively; cerci and terminal filament subequal and ca ³/₄ the length of the body.

Coloration similar to Figs 6 and 7.



Figures 6-7. Rh. ornata Ulmer, 1939. 6 Male nymph 7 Female nymph with slight color variations.

Labrum (Fig. 8) moderately expended laterally, ca 2.6× wider than long; lateral margins regularly rounded; no anteromedian emargination; dorsal face covered with long and thin setae anteriorly; ventral face with shorter and stout setae along the anterior margin. Mandibles covered with numerous long and thin setae on the outer margin; right mandible with outer incisor saw-like, inner one with a trifid apex with 2–3 pectinate setae below it, and 2–3 long and simple setae below the mola; left mandible with outer incisor saw-like, inner one with 3–4 pectinate setae below it, and 3–4 long and simple setae below the mola. Maxillary palp three-segmented; first segment covered with thin setae on inner and outer margin; second segment with thin setae on the outer margin; third segment slightly pointed, only with long and thin setae. Maxillae with fimbriate scattered setae on the ventral surface (Fig. 13): 13–14 comb-shape setae on the crown of the galea, median ones with 10–11 teeth (Fig. 14); proximal dentiseta bifid, outer margin feathered; distal dentiseta simple, entire and unbranched (Fig. 12). Labium (Fig. 9) with glossae rhomboid, inner margin covered with long and thin setae, apex characteristic with scale-like margin (Fig. 10); paraglos-



Figures 8–11. *Rh. ornata* Ulmer, 1939, nymphal mouthparts. 8 Labrum in dorsal view 9 Left glossae and paraglossae of the labium 10 Detail of the glossae from 9 11 Hypopharynx, ventral view lingua and left superlingua.

sae moderately expended laterally. Hypopharynx (Fig. 11) with rhomboid lingua bearing a tuft of short and thin setae at apex; superlinguae well developed and expended laterally with rounded apex and setae on the outer margin extended beyond the apex.



Figures 12–14. *Rh. ornata* Ulmer, 1939, SEM pictures of the maxilla. **12** Dentisetae (DP: proximal dentiseta, DD: distal dentiseta) **13** Fimbriate setae on the ventral surface **14** Comb-shape setae on the crown of the galea-lacinia.



Figures 15–19. *Rh. ornata* Ulmer, 1939. 15 Outer margin of the fore tibia 16 Outer margin of the hind tibia 17 Bristles on the dorsal surface of hind femur 18 Tarsal claw 19 Posterior margin of tergite V.



Figures 20-23. Rh. ornata Ulmer, 1939. 20 Gill I 21 Gill IV 22 Gill VI 23 Gill VII.

Pronotum moderately expended laterally. Foreleg with femur ca 2.6× longer than wide; outer margin covered with long and stout setae, becoming thinner near the apex; inner margin with only few spine-like setae on the distal third. Outer margin of tibia with very few thin and short setae (Fig. 15), inner margin with few spine-like setae in the middle; tarsi with only a few spine-like setae in the middle of the inner margin. Hind leg similar, except the spine-like setae on inner margin of the femur present on the whole margin; outer margin of tibia with a row of long and thin setae (Fig. 16) and inner margin with more numerous spine-like setae. Middle leg similar to hind leg, except spine-like setae on the inner margin of the femur only present on the distal half. Bristles on the upper face of femora variable in length, always with divergent margins and rounded apically (Fig. 17). Tarsal claw moderately hooked, bearing 4–6 teeth (Fig. 18). No supracoxal spurs present.

Abdomen with posterolateral extensions weakly developed, visible only on segments V-VIII. Gills present on abdominal segments I-VII. Gill I banana-shape



Figures 24–25. *Rh. ornata* Ulmer, 1939. 24 Proximal part of the terminal filament 25 Median part of the terminal filament.

(Fig. 20), with fibrillar part well developed, gill IV ca 1.5× longer than wide, strongly asymmetrical (Fig. 21), gill VI with well-developed fibrillar part, more elongated and slightly asymmetrical (Fig. 22), gill VII ca 2.5× longer than wide, without fibrillar part and slightly asymmetrical (Fig. 23). Posterior margin of abdominal terga with weakly developed spines of different size and shape (Fig. 19). Cerci and terminal filament with long and stout setae in whorls on the proximal part (Fig. 24), together with long and thin setae in the median and distal part (Fig. 25).

Sequence data. One specimen has been used for the study by Vuataz et al. (2013) under the name "Heptageniidae 1" in figures and "Heptageniidae sp. 1" in table S1, with one mitochondrial (CO1) and two nuclear genes (H3, wg) sequenced. Access numbers in GenBank are for CO1: HF536605, for wg: HF536598, for H3: HF536591.

Discussion

The genitalia of the male imago differ slightly from those described by Ulmer (1939, page 577, fig. 169), being wider and less cylindrical than illustrated. The presence of a

transverse suture on the mesonotum together with the shape of the depression of the furcasternum (not narrowed anteriorly) indicates that Rh. ornata cannot be a member of Rhithrogeninae; thus, it is not a synonym of *Rhithrogena* as suggested by Wang and McCafferty (2004). Moreover, the presence of scattered setae on the ventral side of the maxilla is a character only found among members of Ecdyonurinae, as suggested already by Soldán and Braasch (1986). When using the key of Webb and McCafferty (2008), Rhithrogeniella will key to the genus Afronurus Lestage, 1924 for the adults and to the genus Nixe Flowers, 1980 for the nymphs. Nearctic workers consider the genus Nixe as valid (Flowers 1986; McCafferty 2004; Wang and McCafferty 2004; Webb and McCafferty 2008), but European authors think that its concept is similar to Paracinygmula Bajkova, 1975 (Jacob et al. 1996). The Holarctic species joernensis (Bengtsson, 1909) is therefore treated either as Paracinygmula joernensis (Bauernfeind and Soldán 2012) or as Nixe joernensis (Kjaerstad et al. 2012). Nymphs of Rhithrogeniella share some characters with this concept, including the presence of swimming setae on cerci and terminal filament, and the chorionic structures of the eggs (Flowers 1980). Nymphs of Nixe/Paracinygmula however present gills with a weakly developed fibrillose part, either absent or reduced to a single filament in gill VI, which is not the case in Rhithrogeniella (Fig. 22 and Soldán and Braasch, 1986, fig. 4). Contrary to Nixe/Paracinygmula, the male genitalia have a very different shape and lack well developed median titillators as well as basal sclerite spines.

Three species of *Nixe* known only from the nymphal stage are reported from Taiwan (Kang and Yang 1994). Bauernfeind and Soldán (2012) transferred them to the genus *Paracinygmula* without new data, because they considered *Nixe* as a subjective junior synonym of *Paracinygmula*. Examination of paratypes of these species, deposited in the collections of MZL, revealed that they perfectly match the concept of *Rhithrogeniella* developed here, and therefore the following new combinations are proposed:

Rhithrogeniella littoralis (Kang and Yang 1994) comb. n. (= *Nixe (Nixe) littoralis* Kang and Yang 1994 = *Paracinygmula littoralis* Bauernfeind and Soldán 2012;

Rhithrogeniella mitifica (Kang and Yang 1994) comb. n. (= *Nixe (Nixe) mitificus* Kang and Yang 1994 = *Paracinygmula mitifica* Bauernfeind and Soldán 2012;

Rhithrogeniella obscura (Kang and Yang 1994) comb. n. (= *Nixe (Nixe) obscurus* Kang and Yang 1994 = *Paracinygmula obscura* Bauernfeind and Soldán 2012.

Nixe/Paracinygmula is therefore restricted to the Holarctic Realm, whereas *Rhithrog-eniella* is Oriental, reported from Taiwan, continental Southeast Asia and from Java and Sumatra in the Sunda Islands. The genus is presently recorded neither from Borneo (Braasch 2011; Sartori et al. 2003) nor from the Philippines (Braasch 2011).

Based on the Bayesian majority-rule consensus tree reconstructed from the combined data set in Vuataz et al. (2013), *Rhithrogeniella* appears more related to the tribe Compsoneuriini sensu Sartori (2014) (*Compsoneuria, Compsoneuriella* and *Notonurus*), than to other Ecdyonurinae (*Thalerosphyrus, Asionurus, Atopopus, Afronurus*), although low posterior probability and bootstrap support does not allow to determine its exact relationships. It is possible that further studies may show that a new tribe should be established to accommodate this genus.

One remaining question concerns the presence or absence of titillators on Rhithrogeniella male genitalia. These structures are mentioned by Soldán and Braasch (1986) in the male subimago of *Rhithrogeniella tonkinensis* as well as in the subimago of Rh. ornata (Soldán and Braasch 1986, page 204). Although we have not dissected the holotype (the only male imago of *Rhithrogeniella* known at the moment), we feel confident that this specimen lacks median titillators. The structures of the subimago male genitalia, illustrated in Fig. 4, are not "well-developed, cylindrical medial titillators with sclerotized apices" (Soldán and Braasch 1986), because they are only cuticular processes, weakly sclerotized except at the apex which is spine-like. In all Ecdyonurinae subimagos which do possess true titillators, these structures are deeply sclerotized, profoundly rooted inside the penis lobes, and are present in the imaginal stage after the subimaginal molt. The cuticular processes mentioned in Rhithrogeniella are thus likely to disappear with the subimaginal molt. We conclude therefore that, to our present knowledge, Rhithrogeniella lacks true titillators. The supposed male imago of Rh. tonkinensis briefly described by Braasch (1990) possesses median titillators as well as a very curious styliger plate, with two large triangular processes. These processes should already be present in the subimago and easily visible; but because they are present neither in the male subimago of *Rh. ornata* nor *Rh. tonkinensis*, we can conclude that the male of Braasch (1990) is misassociated and possibly belongs to a species of Afronurus.

Differential diagnosis

Rhithrogeniella ornata appears to be closely related to *Rhithrogeniella tonkinensis*, known from Vietnam and Thailand. It differs from the latter mainly by the ornamentation of the crown of the galea-lacinia, with 13–14 comb-shape setae, median ones with 10–11 teeth, whereas *Rh. tonkinensis* bears only 10–11 comb-shape setae, median ones with 6–8 teeth. Additional nymphal characters , and egg chorionic structure are also very similar. Differences between subimagos of both species proposed by Soldán and Braasch (1986) are tenuous, and rely mainly on the tarsal composition of the hind leg (1=2=5>3≥4 in *Rh. ornata* compared to 1=5>2=3>4 in *Rh. tonkinensis*). Tibia of foreleg is distinctly shorter than the femur in *Rh. ornata*, whereas it is reported as subequal to the femur in *Rh. tonkinensis*. Subimaginal male genitalia are rather similar, although penis lobes appear more rounded in *Rh. ornata* than in *Rh. tonkinensis*.

Compared to the Taiwan species, *Rh. ornata* can be easily separated from *Rh. lit-toralis* and *Rh. obscura* by the shape of the mandibles with inner and outer incisors subequal in length (inner incisor much shorter in *Rh. littoralis* and *Rh. obscura*), from *Rh. mitifica* and *Rh. obscura*, by the higher number of teeth on the comb-shape setae of the galea-lacinia (4–5 teeth only in *Rh. mitifica* and *Rh. obscura* vs 10–11 in *Rh. ornata*), from *Rh. mitifica* by the shape of the spines on the posterior margin of the tergites (pointed in *Rh. ornata* vs tabular in *Rh. mitifica*), and from *Rh. littoralis* by the much more elongated gill VII.

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RESEARCH ARTICLE



A new species of *Dictyotenguna* Song & Liang, 2012 from China (Hemiptera, Fulgoromorpha, Dictyopharidae)

Yan-Li Zheng^{1,2}, Xiang-Sheng Chen¹

Institute of Entomology, Guizhou University; The Provincial Key Laboratory for Agricultural Pest Management of Mountainous Region, Guiyang, Guizhou 550025 P.R. China 2 Guizhou Normal College, Guiyang, Guizhou, China 55001 P.R. China

Corresponding author: Xiang-Sheng Chen (chenxs3218@163.com)

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Abstract

A new planthopper species *Dictyotenguna angusta* **sp. n.** is described and illustrated from Guangxi, China. The photographs of the adults of the species are presented.

Keywords

Fulgoroidea, Oriental Region, morphology, taxonomy, distribution

Introduction

The Oriental dictyopharid planthopper genus *Dictyotenguna* was established by Song & Liang (2012) for a single species, *D. choui* Song & Liang, from China. Here we describe and illustrate a second species of the genus from Guangxi Autonomous Region, Southern China.

Material and methods

Dry specimens were used for the observation, description and illustration. Genital segments of the specimens examined were macerated in boiling solution of 10% NaOH and drawn from preparations in glycerin jelly under a Leica MZ12.5 stereomicroscope. Color pictures for adult habitus were obtained by a KEYENCE VHX-1000 system. Illustrations were scanned with Canon CanoScan LiDE 200 and imported into Adobe Photoshop CS6 for labeling and plate composition. Terminology of morphology, genital characters and measurements follow Yang and Yeh (1994).

The following abbreviations are used in the text, BL: body length (from apex of cephalic process to tip of fore wings); HL: head length (from apex of cephalic process to base of eyes); HW: head width (including eyes); FWL: forewing length.

Type specimens as well as material examined here are deposited in the Institute of Entomology, Guizhou University, Guiyang, China (GUGC).

Taxonomy

Dictyotenguna Song & Liang

Dictyotenguna Song & Liang, 2012: 29.

Type species. Dictyotenguna choui Song & Liang, 2012

Diagnosis. For the relationship and diagnosis of *Dictyotenguna* see in Song and Liang (2012).

Distribution. Oriental region.

Dictyotenguna choui Song & Liang

Dictyotenguna choui Song & Liang, 2012: 211.

Material examined. CHINA: 1 \Diamond , Sichuan, Guangyuan, Micangshan, 21 August 2007, coll. Yubo Zhang. 1 \Diamond , Sichuan, Mianyang, Qianfoshan, 840 m, 13 August 2007, coll. Yubo Zhang.

Distribution. China (Fujian, Guangxi and Sichuan).

Dictyotenguna angusta sp. n.

http://zoobank.org/286B2C86-75D7-461C-8819-0B8846325E15 Figs 1–5, 6–16,17-21

Description. ∂, BL: 14.6 mm HL: 1.8 mm HW: 1.7 mm FWL: 11.5 mm. ♀, BL: 17.3 mm HL: 2.0 HW: 1.8 mm FWL: 14.1 mm.

Body green. Carinae and veins of wings dark green. Frons between lateral intermediate carinae orange red. Rostrum blackish at extreme apex. Femora with a black marking at apex.

Head (Figs 1, 2, 6) relatively short, shorter than pronotum and mesonotum combined, the ratio of length about 0.6:1. Vertex (Figs 1, 2, 4, 6, 8) relatively narrow, two



Figures 1–5. Habitus of *Dictyotenguna angusta* sp. n. **1** *D. angusta* sp. n., male, holotype **2** Same, head and thorax, dorsal view **3** Same, frons and clypeus, ventral view **4** Same, head and pronotum, lateral view **5** *D. angusta* sp. n., female, paratype. Scale bars: **1–5** = 0.5mm.

times as wide as long between eyes, media carina conspicuous and strongly, lateral margins carinate sub-parallel at base, slightly sinuate in front of eyes, then gradually narrowing to arrowhead at apex. Frons (Figs 3, 7) nearly rectangle, length 2.5 times long than wide, lateral carinae reaching to the back of eyes. Pronotum (Figs 1–2, 6) distinctly shorter than mesonotum medially, with ratio about 0.2:1, disc broad with median carina distinct, lateral carina very faint. Mesonotum (Figs 1–2, 6) with median longitudinal carina diatinct, not reach to the apex, lateral carinae curverging at



Figures 6–16. *Dictyotenguna angusta* sp. n. **6** Head and thorax, dorsal view **7** Frons and clypeus, ventral view **8** Head and pronotum, lateral view **9** Forewing **10** Hind Wing **11** Pygofer and anal tube, dorsal view **12** Pygofer and parameres, ventral view **13** Genitalia, lateral view **14** Aedeagus, lateral view **15** Aedeagus, dorsal view **16** Aedeagus, ventral view. Scale bars: **6–10** = 1 mm, **11–16** = 0.5mm.

the front. Forewings (Figs 5, 9) with Sc+R, M and Cu all branched apically, stigma distinct, with 4 cells. Legs moderately elongate.

Male genitalia. Pygofer (Figs 11–13) with a large process on posterior margin, and the process with lots of setae; anterior margin relatively straight. Anal tube



Figures 17–21. *Dictyotenguna angusta* sp. n. **17** Genitalia ventral view of female **18** Genitalia dorsal view of female **19** First valvulae (lateral view) **20** Second valvulae (ventral view) **21** Third valvulae (lateral view). Scale bars: **17–21** = 0.5mm.

(Figs 11, 13) large and broad, apex U-shaped in dorsal view. Parameres (Figs 11, 12) large in lateral view, posterior margin with a dorsally directed black-tipped process, and with a ventrally directed process near sub-middle on outer upper edge. Aedeagus (Fig. 14) with a pair of processes extended dorsally. Phallobase (Figs 14–16) basally sclerotized and pigmented, with apical membranous lobes: dorsal apical lobes slender and connected (Fig. 15); ventral lobes composed of two parts: one pairs large on apex, the other one small and the base produced near middle part (Fig. 16).

Female genitalia. Anal tube (Fig. 18) round and large in dorsal view, with ratio of length to width at middle about 1:1. First valvulae (Fig. 19) sclerotized with 6 teeth of different sized in lateral view; second valvulae (Fig. 20) triangular, symmetrical in

ventral view, connected at base and separated from 1/4 base; third valvulae (Fig. 21) with 2 sclerotized lobes, lateral lobe with 5 long spines at apex, and one of the five separate from others.

Type material. Holotype \Diamond , China: Guangxi, Huaping, 900 m, 31 July 2007, coll. Pei Zhang. Paratype, 1 \bigcirc , same data as holotype.

Etymology. This new species is derived from the Greek word "*angusta*", indicating that the apical lobes of phallobase slender.

Distribution. China (Guangxi).

Remarks. This species is similar to *Dictyotenguna choui* Song & Liang, but can be distinguished from the latter by aedeagus with a pair of processes extended anteriorly (Fig.15) in dorsal view (processes extended to left and right sides in *D. Choui*), and pygofer with anterior margin quite straight(Fig.11) in later view(anterior margin angular in *D. Choui*).

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Taxonomic revision of the Pyrgulopsis gilae (Caenogastropoda, Hydrobiidae) species complex, with descriptions of two new species from the Gila River basin, New Mexico

Robert Hershler¹, Victoria Ratcliffe², Hsiu-Ping Liu², Brian Lang³, Claire Hay⁴

Department of Invertebrate Zoology, Smithsonian Institution, P.O. Box 37012, Washington, DC 20013-7012, USA 2 Department of Biology, Metropolitan State University of Denver, Denver, CO 80217, USA
 New Mexico Department of Game and Fish, One Wildlife Way, Santa Fe, NM 87507, USA 4 Department of Earth and Atmospheric Sciences, Metropolitan State University of Denver, Denver, CO 80217, USA

Corresponding author: Robert Hershler (hershlerr@si.edu)

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Abstract

We describe two new species of springsnails (genus *Pyrgulopsis*) for populations from the middle Fork and upper East Fork of the Gila River Basin (New Mexico) that had been previously identified as *P. gilae*. We also restrict *P. gilae* to its originally circumscribed geographic range which consists of a short reach of the East Fork Gila River and a single spring along the Gila River (below the East Fork confluence). These three species form genetically distinct lineages that differ from each other by 3.9–6.3% for mtCOI and 3.7–8.7% for mtNDI (the latter data were newly obtained for this study), and are diagnosable by shell and penial characters. Collectively the three species form a strongly supported clade that is distinguished from other congeners by the unique presence of two glandular strips on the dorsal surface of the penial filament. These findings suggest that the conservation status of *P. gilae*, which was recently removed from the list of candidates for listing as endangered or threatened by the United States Fish and Wildlife Service, should be revisited and that the two new species may also merit protective measures given their narrow geographic ranges.

Keywords

Gastropoda, United States, freshwater, taxonomy, conservation

Introduction

Pyrgulopsis is a large genus (137 species; Hershler et al. 2013) of freshwater gastropods that is distributed in North America west of the Mississippi River basin. The tiny species in this genus live in spring-fed habitats and usually have very small geographic ranges. *Pyrgulopsis* is a current focus of conservation efforts owing to threats posed by groundwater extraction, livestock grazing and other anthropogenic activities (Hershler et al. 2014). Recent molecular studies have shown that several congeners are composites of genetically divergent lineages and are in need of taxonomic revision (e.g., Liu et al. 2003, Liu and Hershler 2007, Hershler and Liu 2010). This is the second in an anticipated series of papers that clarifies the taxonomy of these species (Hershler et al. 2013).

Pyrgulopsis gilae (Taylor, 1987) was described for specimens from single springs along the lower East Fork (type locality) and main stem Gila River in Grant County, New Mexico. Field surveys in the 1990's and 2000's resulted in the discovery of new populations in two other reaches of the upper Gila River watershed (Middle Fork, upper East Fork) that are currently being treated as *P. gilae* (NMDGF 2012). Hurt (2004) delineated substantial divergence in mtCOI sequences (6.8% average) between specimens from the upper East Fork reach (Wall Spring) and three localities within the originally circumscribed range of *P. gilae*. In a more comprehensive survey of COI variation within *P. gilae*, populations from the upper East Fork, Middle Fork, and lower East Fork (and main stem Gila River) reaches were resolved as three divergent (3.9-6.3%) sub-clades which were postulated to be distinct species (Liu et al. 2013). Here we document a congruent pattern of variation in a second mitochondrial DNA marker (NDI) and delineate morphological differences supporting recognition of the upper East Fork and Middle Fork Gila River populations as new species, which are described herein.

Methods

For the current molecular study we used the same samples that were analyzed in our previous phylogeographic investigation of *P. gilae* across its entire geographic range (Liu et al. 2013; Fig. 1). Genomic DNA was extracted from single, entire snails using a CTAB protocol (Bucklin 1992); 3-8 specimens were analyzed (separately) from each sample. ND43F and RND592F (Liu et al. 2003) were used to amplify a 530 bp fragment of NADH dehydrogenase subunit I (NDI). This primer pair did not amplify the region for specimens from two localities (G8, G11) and consequently we designed a second set of oligonucleotide primers for these snails, ND30 (5'TCT TAY ATR CAR ATW CGT AAA GG3') and RND490 (5'ATG TTA CAA ATC ATA TAA ATG3'), based on conserved regions of NDI in an alignment from *P. gilae* and two closely related species (*P. deserta* [Pilsbry], *P. davisi* [Taylor]). Degenerate positions are represented by the following ambiguity codes: Y=C/T; R=A/G; W=A/T. Amplification conditions and sequencing of amplified polymerase chain reaction product followed Liu et al. (2003). Sequences were determined for both strands and then edited and aligned using SEQUENCHER[™] version 5.0.1.



Figure 1. Map showing the distribution of mtDNA clades I-III.

The 56 newly sequenced specimens of *P. gilae* were analyzed both separately and together with our previously published COI dataset (Liu et al. 2013). We included the same set of outgroup taxa as in our prior study of *P. gilae* (Liu et al. 2013), with *Floridobia floridana* again being used as the root. The GenBank accession numbers for these sequences (COI, NDI) are given in Appendix 1. Note that we newly sequenced specimens of *P. "mimbres"* for COI (using the methods of Liu et al. 2003) and NDI as part of this study (GenBank accession numbers: COI, KM205358; NDI, KM205359). The newly obtained haplotypes from each *P. gilae* sampling locality were deposited in GenBank. Sample information and GenBank accession numbers are given in Table 1. One example of each haplotype detected in a given sample was used in our analyses.

Code	Locality (all in New Mexico)	COI	NDI
G1	Spring along East Fork Gila River, ca. 1.53 km north, 2.9 km east of State Route 527 bridge crossing, Grant County	KC571284, KC571285	KM079175, KM079176
G2	Spring along East Fork Gila River, ca. 1.29 km north, 0.56 km west of Black Canyon confluence, Grant County	KC571286, KC571287	KM079177, KM079178
G3	Spring along East Fork Gila River, ca. 1.53 km north, 2.38 km east of State Route 527 bridge crossing, Grant County	KC571288, KC571289, KC571290	KM079176
G4	Seepage along Taylor Creek, ca. 0.32 km south, 0.93 km west of Wall Lake dam (below Wall Lake), Catron County	KC571291, KC571292, KC571293, KC571294	KM079180
G5	Hillside seep, 1.61 km north, 0.97 km east of Burnt Corral Canyon, Catron County	KC571295	KM079181
G6	Spring along Beaver Creek, ca. 0.29 km north, 0.40 km west of Taylor Creek confluence, Catron County	KC571296, KC571297, KC571298	KM079181, KM079182
G7	Seepage along Taylor Creek, 50 m west of Whitetail Canyon, Catron County	KC571292	KM079183
G8	Spring along Middle Fork Gila River, ca. 0.97 km north, 0.64 km west of Jordan Canyon, Grant County	KC571299, KC571300, KC571301, KC571302	KM079187, KM079188
G9	Fall Spring, 1.61 km north, 0.56 km east of Burnt Corral Canyon, Catron County	KC571303 KC571304	KM079184, KM079185
†G10	Fall Spring, 1.61 km north, 0.56 km east of Burnt Corral Canyon, Catron County	KC571304	KM079185, KM079186
G11	Spring along Middle Fork Gila River, ca. 0.48 km north, 0.48 km west of Jordan Canyon, Grant County	KC571305	KM079187, KM079189, KM079190
G13	Spring along Taylor Creek, 0.81 km north, 1.13 km east of Wall Lake Dam, Catron County	KC571292	KM079183
G14	"Alum Hot Spring," ca. 1.93 km south, 0.16 km west of State Route 527 bridge crossing. Grant County	KC571288, KC571306	KM079179

Table 1. Sample codes, collection localities, and GenBank accession numbers for P. gilae mtDNA sequences.

†Very small (juvenile) specimens initially thought to be distinct from P. gilae.

The partition homogeneity/incongruence length difference test (Farris et al. 1994) was used to determine whether the COI and NDI datasets were consistent and could be combined for the phylogenetic analysis. This test, which was conducted using parsimony-informative sites only and 1,000 replicates, did not detect significant incongruence (*P*=0.21) and consequently we combined the two datasets in the phylogenetic analysis. MRMODELTEST 2.3 (Nylander 2004) was used to obtain an appropriate substitution model (using the Akaike Information Criterion) and parameter values for this analysis. Phylogenetic relationships were inferred by Bayesian analysis using MR-BAYES 3.1.2 (Huelsenbeck and Ronquist 2001). Metropolis-coupled Markov chain Monte Carlo simulations were run with four chains (using the model selected through
MRMODELTEST) for 2,000,000 generations, and Markov chains were sampled at intervals of 10 generations to obtain 200,000 sample points. We used the default settings for the priors on topologies and the GTR + I + G model parameters selected by MRMODELTEST as the best fit model. The Tracer program was used to analyze runs for Effective Sample Size (ESS, greater than 200) to ensure that sufficient sampling occurred. At the end of the analysis, the average standard deviation of split frequencies was less than 0.01 (0.002) and the Potential Scale Reduction Factor (PSRF) was 1, indicating that the runs had reached convergence. The sampled trees with branch lengths were used to generate a 50% majority rule consensus tree with the first 25% of the samples removed to ensure that the chain sampled a stationary portion.

Genetic relatedness within *P. gilae* was further assessed by a haplotype network that was generated by TCS version 1.21 using the default settings (e.g., 95% connection limit) and fixing the connection limit at 90 steps (Clement et al. 2000). NDI sequence divergences (maximum composite likelihood) within and between lineages were calculated using MEGA6 (Tamura et al. 2013), with standard errors estimated by 1,000 bootstrap replications with pairwise deletion of missing data. Structuring of variation among lineages was evaluated by an AMOVA using Arlequin 3.5 (Excoffier and Lischer 2010).

Types and other voucher material were deposited in the National Museum of Natural History (USNM) collection. Specimens of P. gilae from the Bell Museum of Natural History (BellMNH) were also examined during the course of this study. Series of large adults (n>10) were used for shell measurements. Whorl counts refer to the entire shell. Sexual dimorphism in shells, which is occasionally observed in *Pyr*gulopsis (Taylor 1987), could not be quantified owing to small sample sizes. The total number of shell whorls was counted (WH) for each specimen; and the height and width of the entire shell (SH, SW), body whorl (HBW, WBW), and aperture (AH, AW) were measured from camera lucida outline drawings using a digitizing pad linked to a personal computer (see Hershler 1989). In addition, three ratios were generated from the raw data (SW/SH, HBW/SH, AH/SH). Descriptive statistics were generated using SYSTAT FOR WINDOWS 11.00.01 (SSI 2004). T-tests (two-tailed) of differences among shell variables were conducted using an on-line calculator (http:// in-silico.net/tools/statistics/ttest); data for type material of P. gilae were from Taylor (1987, table 11). Penial variation was described from series of adult specimens that were relaxed with menthol crystals and fixed in dilute formalin prior to preservation in 70% ethanol. Descriptive penial terminology is from Taylor (1987) and Hershler (1994, 1998). Variation in the number of cusps on the radular teeth (n=5) was assessed using the method of Hershler et al. (2007).

We used a conservative, evolutionary lineage concept in describing new species only for those snails that are morphologically diagnosable as well as phylogenetically independent and substantially divergent genetically (Hershler et al. 2007). Inasmuch as the principal goal of our paper was to delimit species, we provide only brief taxonomic descriptions which focus on those aspects of morphology that have proven most useful in previous such studies of *Pyrgulopsis* (Taylor 1987, Hershler 1994, Hershler 1998).

Results

Sixteen (16) NDI haplotypes of *P. gilae* were detected, 11 of which were restricted to single populations (Table 2). The others were shared by pairs of populations along the lower East Fork (haplotype II), upper East Fork (haplotypes VII, IX, XI) and Middle Fork (haplotype XIII) Gila River. Six (6) samples each contained a single haplotype (G3, G4, G5, G7, G13, G14). The TCS analyses (not shown) recovered three well differentiated haplotype groups composed of specimens from along the lower East Fork and main stem Gila River (clade I), Middle Fork Gila River (II), and the upper East Fork Gila River (III). These groups differed from each other by 3.7-8.7% sequence divergence; variation within groups was minor (Table 3). The AMOVA indicated that most of the detected variation (91.7%) was partitioned among these groups; variation within populations, and among populations within the groups was much smaller (1.35, 6.93%) but nonetheless was significant (Table 4). The three previously reported clades (I-III; Liu et al. 2013) were similarly recovered in Bayesian analyses of both the NDI dataset, and the combined COI + NDI dataset (Fig. 2). Based on the genetic evidence of distinctiveness and the diagnosable shell and penial characters that are detailed below we recognize two of these lineages as new species which are described herein (clade II as *P. marilynae*, clade III as *P. similis*) and restrict *P. gilae* (clade I) to its originally circumscribed geographic range.

Haplotype (specimen code)	Sample												
	G1	G2	G3	G4	G5	G6	G 7	G8	G9	G10	G11	G13	G14
I (G1A)	2												
II (G1C)	1		3										
III (G2B)		2											
IV (G2D)		1											
V (G14B)													4
VI (G4B)				3									
VII (G5A)					4	1							
VIII (G6B)						4							
IX (G7A)							8					4	
X (G9A)									2				
XI (G9C)									2	2			
XII (G10A)										2			
XIII (G8A)								5			1		
XIV (G8D)								1					
XV (G11F)											2		
XVI (G11H)											2		
n	3	3	3	3	4	5	8	6	4	4	5	4	4

Table 2. Frequency distribution of NDI haplotypes detected in *P. gilae*. *n*=sample size.

Table 3. Mean NDI sequence divergence (maximum composite likelihood) within and among *P. gilae* clades. I: G1, G2, G3, G14; II: G8, G11: III: G4, G5, G6, G7, G9 G10, G13.

	Clade I	Clade II	Clade III
Clade I	0.003+/-0.002		
Clade II	0.037+/-0.011	0.002+/-0.001	
Clade III	0.087+/-0.021	0.075+/-0.019	0.006+/-0.003

Table 4. Genetic differentiation among *P. gilae* clades based on NDI sequences. Sub-groups=(G1, G2, G3, G14), (G8, G11), and (G4, G5, G6, G7, G9, G10, G13). Asterisked Φ values are highly significant (*P*<0.001).

	df	variance components	% of variation	Φ statistic
Among groups	2	13.95	91.72	0.91*
Among populations within groups	10	1.05	6.93	0.84*
Within populations	43	0.21	1.35	0.99*



Figure 2. Bayesian tree based on the combined (COI, NDI) dataset. Posterior probabilities for nodes are given when >95%. Specimen codes are from the Table 1.

Systematic descriptions Family Hydrobiidae Subfamily Nymphophilinae Genus Pyrgulopsis Call and Pilsbry, 1886

Pyrgulopsis marilynae Hershler, Ratcliffe, Liu, Lang and Hay, sp. n. http://zoobank.org/A641736C-650D-4649-B8AD-5A012AFB3396 Figs 3, 4A–B

Pyrgulopsis gilae (clade II).—Liu et al. 2013.

Types. Holotype, USNM 1135068 (a dry shell), spring 0.48 km north, 0.48 km west of Jordan Canyon, Catron County, New Mexico, 33.2909°N, 108.2681°W, 1 October 2009, Michelle Christman. Paratypes, USNM 1231474 (from same lot).

Referred material. NEW MEXICO. *Catron County*: USNM 1123432, USNM 1123588, spring 0.8 km north, 0.64 km west of Jordan Canyon (33.2889°N, 108.2683°W), USNM 1135067, spring 0.97 km north, 0.64 km west of Jordan Canyon (33.2924°N, 108.2696°W), USNM 883175, Jordan Hot Spring (33.2927°N, 108.2692°W).

Diagnosis. Distinguished from *P. gilae* and the species described next (*P. similis*) by its narrower shell (mean shell width/shell height 0.613 vs. 0.682, t=-9.6588, df=36.2176, *P*<0.0001, *n*=30 for *P. gilae*; 0.613 vs. 0.734, t=-16.3617, df=18.9656, *P*<0.0001, *n*=11 for *P. similis*), more pronounced whorl shoulders, and broad overlap of the ventral surface of the penis by the terminal gland (probably reflecting fusion with a distal ventral gland). Further differs from *P. gilae* in its smaller size (mean shell height 2.77 vs. 3.47 mm, t=-11.3848, df=21.9544, *P*<0.0001) and (basal) extension of the outer penial gland to mid-line or left edge of penis. Further differs from *P. similis* in its larger size (mean shell height 2.77 vs. 2.36 mm, t=7.3691, df=15.3701, *P*<0.0001), smaller number of dorsal glands on the penis, and larger size of the terminal and ventral glands on the penis.

Description. Shell (Fig. 3A–B) narrow-conic, whorls 4.5–5.0. Teleoconch whorls convex, shoulders narrow, angular, sutures impressed. Aperture ovate, angled above, parietal lip complete, usually slightly disjunct, umbilicus narrow. Outer lip thin, orthocline.

Operculum (Fig. 3C–D) as for genus; edges of last 0.5 whorl weakly frilled on outer side; portion of muscle attachment margin thickened on inner side. Radula (Fig. 3E–G) as for genus; dorsal edge of central teeth concave, lateral cusps four–five, basal cusp one. Lateral teeth having two–three cusps on both inner and outer sides. Inner marginal teeth with 14–20 cusps, outer marginal teeth with 17–22 cusps. Radula data are from USNM 1135067.

Penial filament and penial lobe about equal in length (Fig. 4A–B). Filament having two (penial) glands on dorsal surface; inner gland shorter. Outer penial gland curving to mid-line (10/24 specimens) or left edge of penis (14/24 specimens), the latter condition probably represents fusion with a gland on the left edge (Dg2). Terminal gland elongate, horizontal, broadly overlapping ventral surface of penis. Dorsal surface of penis



Figure 3. Shells, opercula and radula, *P. marilynae* n. sp. **A** Holotype, USNM 1135068 **B** Shell, USNM 1135067 **C**, **D** Opercula (outer, inner sides), USNM 1135067 **E** Portion of radular ribbon, USNM 1135067 **F** Central teeth, USNM 1135067 **G** Lateral and inner marginal teeth, USNM 1135067. Scale bars **A**, **B** 1.0 mm; **C**, **D** 100 μm; **E** 20 μm, **F**, **G** 10 μm.

Table 5. Shell parameters for *P. marilynae*. Measurements are in mm.

	WH	SH	SW	HBW	WBW	AH	AW	SW/SH	HBW/SH	AH/SH
Holoty	vpe, USNM	1135068								
	4.75	2.99	1.78	2.12	1.56	1.22	1.15	0.60	0.71	0.41
USNN	1 12231474	(<i>n</i> =10)								
Mean	4.60	2.77	1.70	2.01	1.51	1.16	1.6	0.61	0.73	0.42
S.D.	0.13	0.15	0.08	0.10	0.07	0.05	0.05	0.01	0.02	0.0
Range	4.50-4.75	2.51-3.06	1.53-1.83	1.83-2.15	1.37-1.62	1.04-1.22	0.95-1.12	0.60-0.64	0.69-0.76	0.40-0.44

having gland along right edge of lobe (Dg3) and 2-3 additional glands (22/24 specimens); one specimen did not have any additional glands and one specimen had four additional glands. Ventral gland positioned near centrally. Penial data are from USNM 1135067.

Etymology. The specific epithet is a patronym honoring Marilyn Myers (United States Fish and Wildlife Service, retired) for her dedicated efforts to survey *Pyrgulopsis* habitats in the upper Gila River basin.

Distribution. A series of seeps and springs along the north side of short reach (ca. 0.25 km) of the Middle Fork Gila River just below Jordan Hot Spring (Fig. 1). The type locality is a seep wall which is the lower-most occurrence of *P. marilynae* along the Middle Fork Gila River; the water temperature at this site was 25°C on 1 October 2009.

Remarks. *Pyrgulopsis marilyane* was resolved as sister to *P. gilae* (100% posterior probability) in the molecular phylogenetic analysis (Fig 2). The apparent fusion of the terminal and distal ventral glands of the penis that characterizes this species (in part) was previously reported for *P. sadai* (Hershler 1998, fig. 39I). The sample attributed to Jordan Hot Spring (USNM 883175) may have been collected instead from a closely proximal spring as *P. gilae* has not been found at the former locality during recent surveys (USFWS 2011b).

Pyrgulopsis similis Hershler, Ratcliffe, Liu, Lang and Hay, sp. n. Figs 4C–D, 5

Pyrgulopsis gilae.—Hurt 2004 (in part; Wall Lake population). *Pyrgulopsis gilae* (clade III).—Liu et al. 2013.

Types. United States: Holotype, USNM 1135064 (a dry shell), spring along Beaver Creek, ca. 0.29 km north and 0.4 km west of confluence with Taylor Creek, Catron County, New Mexico, 33.3405°N, 108.1097°W, 21 May 2009, BKL and Marilyn Myers. Paratypes, USNM 1135065, 1231475 (from same lot).

Referred material. NEW MEXICO. *Catron County*: USNM 854684, USNM 1135057, USNM 1123589, USNM 1135058, USNM 1135059, Fall Spring, 1.61 km north, 0.56 km east of Burnt Corral Canyon (33.294°N, 108.1302°W), USNM 1123590, hillside seep 1.61 km north, 0.97 km east of Burnt Corral Canyon (33.2951°N, 108.1268°W), USNM 854685, USNM 1123594, USNM 1135060, USNM 1135061, seepage along Taylor Creek, ca. 0.32 km south, 0.93 km west of Wall Lake dam (33.3457°N, 108.0904°W), USNM 854683, USNM 1123592, USNM 1135062, USNM 1135063, spring along Taylor Creek, ca. 0.81 km north, 1.13 km east of Wall Lake Dam (33.3581°N, 108.0673°W), USNM 854682, USNM 1123593, NM: Catron Co., seepage along Taylor Creek, ca. 50 m west of Whitetail Canyon (33.3613°N, 108.0576°W).

Diagnosis. Differs from *P. gilae* in its smaller size (mean shell height 2.36 vs. 3.47 mm, t=--22.7297, df=36.4071, *P*<0.0001, n=30 for *P. gilae*), larger number of glands on the dorsal surface of the penis, frequent extension of outer penial gland and/or Dg2 to the mid-line of the penis, and smaller size of the terminal and ventral glands on the penis. Contrasted with *P. similis* above.



Figure 4. Penes (dorsal, ventral surfaces). **A, B** *P. marilynae* n. sp., USNM 883175 **C, D** *P. similis* n. sp., USNM 1135065 **E, F** *P. gilae*, BellMNH 20898. Scale bars **A–F** 200 μm. **Dg2** dorsal gland along left edge **Dg3** dorsal gland along right distal edge **Ipg** inner (left) penial gland **Opg** outer (right) penial gland **Tg** terminal gland **Vg** ventral gland.

Description. Shell (Fig. 5A–B) ovate- to narrow conic, whorls 3.75–4.50. Teleoconch whorls medium convex, narrowly shouldered. Aperture pyriform, parietal lip complete, usually adnate, sometimes slightly disjunct, umbilicus small. Outer lip thin, orthocline.

Operculum (Fig. 5C–D) as for genus; edges of last 0.5 whorl frilled on outer side; inner side near smooth. Radula (Fig. 5E–G) as for genus; dorsal edge of central teeth concave, lateral cusps four–six, basal cusp one. Lateral teeth having two–three cusps on inner sides and two–four cusps on outer sides. Inner marginal teeth with



Figure 5. Shells, opercula and radula, *P. similis* n. sp. **A** Holotype, USNM 1135064 **B** Shell, USNM 854684 **C, D** Opercula (outer, inner sides), USNM 1135065 **E** Portion of radular ribbon, USNM 1135065 **F** Central teeth, USNM 1135065 **G** Lateral and inner marginal teeth, USNM 1135065. Scale bars **A, B** 1.0 mm; **C, D** 200 μm; **E** 20 μm, **F, G** 10 μm.

15–20 cusps, outer marginal teeth with 16–25 cusps. Radula data are from USNM 1135059, USNM 1135064.

Penial filament longer than lobe (Fig. 4C–D). Filament having two (penial) glands on dorsal surface; inner gland shorter. Outer penial gland sometimes extending (basally) to mid-line (4/30 specimens) or left edge (7/30 specimens); Dg2 sometimes curving (basally) to mid-line (11/30 specimens). Terminal gland transverse, rather small. Dorsal surface of penis having gland along right edge of lobe (Dg3) and 3-7 additional glands (30/30 specimens) which form long, slightly oblique strips. Ventral gland small, positioned near centrally; second gland rarely present (4/30 specimens). Penial data are from USNM 1135065.

	WH	SH	SW	HBW	WBW	AH	AW	SW/SH	HBW/SH	AH/SH
Holoty	rpe, USNM	1135064								
	4.25	2.52	1.73	1.94	1.48	1.24	1.10	0.69	0.77	0.49
USNN	1 1231475	(<i>n</i> =11)								
Mean	4.05	2.36	1.73	1.89	1.50	1.22	1.04	0.73	0.80	0.52
S.D.	0.10	0.10	0.09	0.07	0.07	0.06	0.04	0.02	0.02	0.02
Range	4.00-4.25	2.16-2.50	1.62-1.89	1.78-2.01	1.41-1.61	1.14-1.30	0.98-1.09	0.71-0.76	0.78-0.83	0.49-0.55

Table 6. Shell parameters for *P. similis*. Measurements are in mm.

Distribution. Springs along a short reach (ca. 10 km) of the East Fork Gila River from just above Wall Lake to slightly above the mouth of Burnt Corral Canyon (Fig. 1). The type locality is a spring brook (ca. one m wide and 0.25 m deep) that discharges at the base of the canyon wall along the east side of Beaver Creek; the water temperature at this locality was 22.1°C on 21 May 2009. The flow at this locality is augmented by numerous small seeps.

Etymology. The specific epithet is an adjective referring to the close resemblance between this species and both *P. gilae* and *P. marilynae*.

Remarks. *Pyrgulopsis similis* was resolved as sister to the clade composed of P. *marilynae* and *P. gilae* (100% posterior probability) in the Bayesian analysis of molecular data (Fig. 2).

Pyrgulopsis gilae (Taylor, 1987)

Fig 4E-F

Fontelicella gilae Taylor 1987: 16-18, fig. 7, tables 11–13 (springs on north side of East Fork of Gila River, center of sec. 3, T13S, R13W, unsurveyed, Grant County, New Mexico).
Pyrgulopsis gilae.—Hershler 1994: 36–38, figs 15a–c, 46c (new combination).
Pyrgulopsis gilae.—Hurt 2004 (in part; Gila I-III populations).
Pyrgulopsis gilae (clade I).—Liu et al. 2013.

Types. Holotype, LACM 2214; paratypes, BellMNH 20898, BellMNH uncat., UTEP 10054, USNM 854087 (from same lot as holotype).

Referred material. NEW MEXICO. *Grant County*: USNM 1135050, USNM 1135052, spring ca. 1.29 km mile north, 0.55 km west of confluence of East Fork Gila River and Black Canyon (33.1864°N, 108.1675°W), USNSM 1123426, USNM 1135055, USNM 1135056, spring ca. 1.53 km north, 2.38 km east of State Route 527 bridge crossing (33.1946°N, 108.1804°W).

Other material examined. NEW MEXICO. *Grant County*: topotypes, USNM 1004620, USNM 1135043, USNM 1135044, spring ca. 1.53 km north, 2.90 km east of State Route 527 bridge crossing (33.1917°N, 108.1742°W), BellMNH uncat., USNM 873211, USNM 1068942, "Alum Hot Spring," ca. 1.93 km south, 0.16 km west of State Route 527 bridge crossing (33.1618°N, 108.2081°W).



Figure 6. Shells, P. gilae. A USNM 1135052 B USNM 854574. Scale bars A, B, 1.0 mm.

Distribution. Several groups of springs in the lower reach of the East Fork Gila River (below the mouth of Black Canyon) and a single spring along the Gila River ca. 2 km below the East Fork confluence (Fig. 1).

Remarks. Examination of the large series of penes that Taylor scored for this species (BellMNH 20898, BellMNH uncat.) indicated that neither the outer penial gland nor Dg2 extends appreciably onto the dorsal surface of the penis (Fig. 4E–F; also see Taylor 1987, fig. 7b–c) in contrast with *P. marilynae* and *P. similis*. Specimens from the two new populations (Fig. 6A), which are closely proximal to the type locality, and the disjunct "Alum Spring" population (Fig. 6B) conformed to *P. gilae* in all morphological details. *Pyrgulopsis gilae* co-occurs sympatrically with *P. thermalis* (Taylor) at several localities (Taylor 1987).

Discussion

The results of this study provide additional evidence that the current taxonomy of *Pyrgulopsis* in some cases masks cryptic species diversity. Our previous revision of widely ranging *P. micrococcus* revealed this taxon to be a polyphyletic composite of five species, three of which were undescribed (Hershler et al. 2013). Here we have shown that, in contrast, *P. gilae* (in the broad sense) is a monophyletic species complex diagnosed by a unique penial character—the presence of two glandular strips on the dorsal surface penial filament. (Note that *P. merriami* [Pilsbry and Beecher], which is distributed in

an isolated basin in southeastern Nevada, has a somewhat different pattern consisting of two glands on the dorsal and one gland on the ventral surface of the filament; Hershler 1994). These disparate findings underscore the complexity of and taxonomic challenges posed by the *Pyrgulopsis* radiation, which is characterized by endemism on very fine geographic scales and extensive morphological homoplasy (Hershler 1994, Liu and Hershler 2005).

The delineation of cryptic species complexes often has important consequences for conservation (Bickford et al. 2007). *Pyrgulopsis gilae* was recently removed from the federal candidate list for listing as endangered or threatened in part owing to the discovery of populations from along the East Fork and Middle Fork of the Gila River (USFWS 2011a, USFWS 2011b) that are assigned herein to two new species. The resulting restriction of *P. gilae* to its originally circumscribed geographic range—several groups of springs in the lower reach of the East Fork Gila River (below the mouth of Black Canyon) and a single spring along the Gila River ca. 2 km below the East Fork confluence—suggests the conservation status of this species should be re-visited by the USFWS. The narrow endemism of the two new species suggests that these may also merit consideration for possible listing by the USFWS.

Our findings also underscore the need for additional field surveys to further delineate the occurrences of *Pyrgulopsis* in New Mexico and to supplement the recent monograph by Taylor (1987). Large portions of the Gila River and other drainage basins in the state have yet to be carefully searched for these tiny animals.

Acknowledgements

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Supplementary material I

Appendix 1

Authors: Robert Hershler, Victoria Ratcliffe, Hsiu-Ping Liu, Brian Lang, Claire Hay Data type: specimens data.

Explanation note: GenBank accession numbers for outgroup mtDNA sequences.

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RESEARCH ARTICLE



A remarkable new pygmy grasshopper (Orthoptera, Tetrigidae) in Miocene amber from the Dominican Republic

Sam W. Heads¹, M. Jared Thomas¹, Yinan Wang²

I Illinois Natural History Survey, Prairie Research Institute, University of Illinois at Urbana-Champaign, 1816 South Oak Street, Champaign, Illinois 61820, USA 2 1101 South Arlington Ridge Road, Arlington, Virginia 22202, USA

Corresponding author: Sam W. Heads (swheads@illinois.edu)

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Abstract

A new genus and species of pygmy grasshopper (Orthoptera: Tetrigidae) is described from Early Miocene (Burdigalian) Dominican amber. *Electrotettix attenboroughi* Heads & Thomas, **gen. et sp. n.** is assigned to the subfamily Cladonotinae based on the deeply forked frontal costa, but is remarkable for the presence of tegmina and hind wings, hitherto unknown in this subfamily.

Keywords

Orthoptera, Tetrigidae, pygmy locust, grouse locust, Hispaniola, Caribbean, amber, fossil

Introduction

The Tetrigidae (pygmy grasshoppers, grouse locusts or ground hoppers) are a diverse group of small orthopterans characterized by their often remarkable morphological crypsis. These diminutive insects are primarily ground-dwelling and most commonly encountered among leaf litter on the forest floor, or in wet, marshy habitats bordering rivers, streams or standing water. With more than 1,700 species in over 250 genera, the Tetrigidae are, among Caelifera, second only to Acrididae in terms of species diversity (Steinmann 1962, 1969, 1970, 1971; Otte 1997). The family has a cosmopolitan

distribution and is most diverse in the tropics (Hancock 1907; Rentz 1991; Heads 2009a). Tetrigids are herbivorous and feed primarily on bryophytes and algae, and occasionally on lichens and small vascular plants (Verdcourt 1947; Hodgson 1963; Reynolds et al. 1988; Hochkirch et al. 2000; Kočarek et al. 2008). Due to their affinity for wet and semi-aquatic habitats, many tetrigids are capable swimmers both above and beneath the water surface (Hancock 1902; Lucas 1920; Amédégnato and Devriese 2008). In spite of their diversity and fascinating life histories, the tetrigids remain one of the most neglected groups of Orthoptera and little is known of their biology or evolution (Hochkirch et al. 2006; Heads 2009a; Kočarek et al. 2011).

Members of the family are readily distinguished from other orthopterans by the marked posterior elongation of the pronotum which covers the entire dorsal surface of the abdomen and often extends well beyond it as an acuminate process (Hancock 1902, 1907; Rentz 1991; Heads 2009a). In addition to their comparatively small size, tetrigids also share several morphological characters with Tridactyloidea (in particular, Tridactylidae and Ripipterygidae), including the reduction of the pro- and mesotarsi to only two tarsomeres, the absence of arolia between the pretarsal claws, and the presence of a precoxal bridge connecting the pronotum to the prosternum (Rentz 1991; Heads 2009a, b, 2010). In both tetrigids and tridactylids/ripipterygids, the tegmina are markedly reduced in both size and venation, or absent entirely. When present and well-developed, the hind wings of both groups have M closely associated or fused with R, and all longitudinal veins unbranched except for a basal division of Cu (Heads 2009a, 2010). These similarities have long been considered as supporting a close relationship between Tetrigidae and Tridactyloidea, and the two have traditionally been united at either superfamilial or infraordinal rank (e.g. Beier 1955; Dirsh 1961; Sharov 1968). However, such a relationship is not supported by molecular analyses which have consistently failed to recover a tetrigid-tridactyloid clade, instead resolving Tetrigidae as sister to Acridomorpha to the exclusion of Tridactyloidea (e.g. Rowell and Flook 1998; Flook et al. 1999).

Tetrigidae are extraordinarily rare in the fossil record. To date, only nine species have been described (Table 1) of which, five (including the new fossil described herein) are from fossil resins. The oldest fossil tetrigids are known from compression fossils in Early Cretaceous vulcano-sedimentary deposits of the Turga Formation, Transbaikalia, Russia. Sharov (1968) described two monotypic genera from this deposit, namely *Archaeotetrix locustopseiformis* and *Prototetrix reductus*, known from partially preserved body fossils and isolated wings. Both *Archaeotetrix* and *Prototetrix* possessed well-developed tegmina and wings with primitive venation (Sharov 1968, figs 38a–c and pl. viii) and likely represent stem-Tetrigidae. Two tetrigids are known from Eocene Baltic amber: *Acrydium bachofeni* Zeuner, 1937 and *Succinotettix chopardi* Piton, 1938. Gorochov (2010) speculated that *A. bachofeni* may be a second species of *Succinotettix* or even conspecific with *S. chopardi*, though he did not examine the types of either species. Piton's holotype of *S. chopardi* is probably lost but Zeuner's holotype of *A. bachofeni* was recently located in the Bachofen-Echt collection at the Bayerische Staatssammlung für Paläontologie und Geologie in Munich,

Species	Locality and age
Acrydium bachofeni Zeuner, 1937	Baltic amber (Middle Eocene)
Antillotettix electrum Heads, 2009	Dominican amber (Early Miocene)
Archaeotetrix locustopseiformis Sharov, 1968	Turga Fm, Transbaikalia, Russia (Early Cretaceous)
Baeotettix lottiae Heads, 2009	Dominican amber (Early Miocene)
<i>Electrotettix attenboroughi</i> Heads & Thomas, this paper	Dominican amber (Early Miocene)
Eotetrix unicornis Gorochov, 2012	Green River Fm, Wyoming, USA (Middle Eocene)
Prototetrix reductus Sharov, 1968	Turga Fm, Transbaikalia, Russia (Early Cretaceous)
Succinotettix chopardi Piton, 1938*	Baltic amber (Middle Eocene)
<i>Tettigidea gracilis</i> Heer, 1865*	Oeningen, Switzerland (Late Miocene)

Table 1. Alphabetized list of fossil Tetrigidae described to date with their geological and geographical provenance. Asterisks indicate that the whereabouts of the type specimen is unknown.

Germany (M. Nose pers. comm. 2014) and will be redescribed in a future paper. The only other Eocene representatives of the family are organic compression fossils from lacustrine deposits of the Green River Formation and were recently described and named *Eotetrix unicornis* by Gorochov and Labandeira (2012). The latter authors did not publish photographs of their specimens and it would appear that they are rather poorly preserved, thus limiting interpretation. However, it is clear from their line drawings that *Eotetrix unicornis* bears some resemblance to certain Neotropical Batrachideinae and is strikingly similar to the extant genus *Scaria* Bolívar, 1887 in the form of the anterior pronotal process. Miocene tetrigids are known as compression fossils from the Late Miocene of Oeningen, Switzerland (*Tettigidea gracilis* Heer, 1865) and as inclusions in Early Miocene amber from the Dominican Republic (*Antillotettix electrum* Heads, 2009a and *Baeotettix lottiae* Heads, 2009a).

Here, we describe a new genus and species of tetrigid from Dominican amber. Like other Dominican amber Tetrigidae, the new genus belongs to the subfamily Cladonotinae; a circumtropical group defined primarily by a deeply forked frontal costa (Hancock 1902, 1907; Pérez-Gelabert et al. 1998; Heads 2009a). Unlike other members of the subfamily however, the new genus possesses both tegmina and hind wings, which are absent in all other cladonotines.

Material and methods

The holotype is deposited in the Paleontology Collection of the Illinois Natural History Survey (INHS), at the University of Illinois. The piece of amber contained multiple insect and plant inclusions and was cut into three pieces in order to better view the specimen. Cuts were made using a jeweler's saw with care taken not to damage other inclusions. Facets were then ground flat and given a final polish with 50,000 mesh diamond paste to remove visible scratches. The holotype of *Electrotettix attenboroughi* was studied using Olympus SZX12 zoom stereomicroscope with 1× and 2× objectives and a Zeiss SteREO Discovery V.20 stereomicroscope with 0.63× and 1.5× objectives.

Photomicrographs were produced using an AxioCam HRc Rev. 3 digital camera attached to the Zeiss. Images were focus-stacked using Helicon Focus version 5.3 and the panorama was stitched in Adobe Photoshop CS5. Illustrations were produced using Adobe Illustrator CS5. The age and origin of Dominican amber is reviewed by Iturralde-Vinent and MacPhee (1996), Iturralde-Vinent (2001), Grimaldi and Engel (2005) and Penney (2010). Terminology follows that of Heads (2009a).

Systematic palaeontology

Order Orthoptera Olivier, 1789 Suborder Caelifera Ander, 1936 Family Tetrigidae Audinet-Serville, 1838 Subfamily Cladonotinae Bolívar, 1887

Genus *Electrotettix* Heads & Thomas, gen. n. http://zoobank.org/FBFDB93E-802F-4639-8063-86AFBB4D83A5

Type species. *Electrotettix attenboroughi* Heads & Thomas, gen. et sp. n.

Diagnosis. The new genus is distinguished from all other Cladonotinae by the presence of tegmina and vestigial hind wings. Frontal costa forked just superior of antennal torulae. Anterior margin of frons at frontoclypeal margin broadly emarginate. Antennal flagellomere 3 approximately half as long as other flagellomeres. Pronotum with distinct lobe superior to humeral sinus. Posterior margin of pronotum forming a slightly upturned, blunt acuminate process.

Etymology. The genus-group name is a combination of *electrum* (Latin from Greek, meaning "amber") and *tettix* (Greek, meaning "grasshopper").

Electrotettix attenboroughi Heads & Thomas, sp. n. http://zoobank.org/C2884326-0785-414A-B9AF-243A52B53F82 Figs 1–7

Diagnosis. As for the genus (see above), by monotypy.

Description. *Female*: Approximately 8.0 mm long measured from fastigium verticis to posterior apex of pronotum (Figs 1–3). Head hypognathous, robust and dorsoven-trally elongate (Figs 4–5). Integument granulose; genae markedly so, bearing numerous tuberculae. Compound eyes large, globose, projecting somewhat dorsally; ventral margin acutely rounded. Vertex with low median carinula becoming lower as it crosses the fastigium, and two stronger, well-defined lateral carinae forming small dorsolaterally produced fastigial horns between compound eyes. Lateral foveae deep, longer than wide, deeper anteriorly than posteriorly. Fastigium verticis not projecting anteriorly beyond compound eyes. Interocular distance c. 0.30 mm. Frontal costa nascent immediately beneath fastigium, becoming prominent c. 0.25 mm from fastigial ridge and bifurcating at the lateral



Figures 1–2. *Electrotettix attenboroughi* Heads & Thomas, gen. et sp. n. **I** holotype in oblique right lateral view (scale bar 1.0 mm) **2** holotype in oblique left lateral view (scale bar 1.0 mm).

ocelli, diverging into two prominent ridge-like costal lobes between antennal torulae and ending at median ocellus. Frontal carina bifurcating *c*. 0.52 mm beneath median ocellus. Fronto-clypeal margin distinct, broadly emarginate Clypeus narrow; anterior margin



Figure 3. *Electrotettix attenboroughi* Heads & Thomas, gen. et sp. n., explanatory drawing of holotype in oblique left lateral view (scale bar 1.0 mm).

with broad, shallow emargination. Labrum shield-like, markedly larger than clypeus with rounded apex. Mandible robust. Gena somewhat inflated with strongly granulose/tuberculate ornament; delimited anteriorly by a deep subocular furrow running the entire length of the fronto-genal region. Antennae filiform, with at least ten flagellomeres. Scape subcylindrical, approximately twice as large as pedicel and somewhat compressed laterally. Pedicel subspherical, narrower than scape but wider than flagellomeres. Flagellum at least 1.24 mm long. Flagellomeres cylindrical, longer than wide; flagellomere 3 approximately half as long as the others.

Pronotum robust, c. 6.55 mm long, with coarsely granulose ornament; anterior margin with small tectate process extending slightly above vertex of head; posterior process almost reaching apex of abdomen and terminating in a blunt and slightly upturned acuminate tip. Median carina forming distinct keel. Lateral carinae well-developed. Transverse sulci distinct, crossing and cutting the lateral carinae but not cutting the median carina. Thoracic sterna robust. Tegmen present, scale-like, longer than wide; venation indistinct, comprising numerous closed cells. Hind wing approx. 2.5 mm long, tightly folded (Fig. 6); costal lobe well-developed; Sc reaching costal margin almost reaching apex of wing; R and M entirely fused, running very close to Sc; area between R+M and Cu with numerous crossveins; CuA not visible; CuP approximating running close to 1A for its entire length; anal veins numerous.



Figure 4. *Electrotettix attenboroughi* Heads & Thomas, gen. et sp. n., frontal view of head capsule; the flower bud preserved alongside the head is visible to the left (scale bar 0.5 mm).

Profemur 1.75 mm long, subquadrate in section with poorly developed carinae. Protibia at least 1.5 mm long and markedly more slender than profemur. Protarsus largely obscured by bubbles and debris in the amber. Mesofemur quadrate in section and similar in length to profemur but with carinae well-developed and complete for entire length of femur. Mesotibia 1.5 mm long, more slender than mesofemur but not as slender as protibia. Mesobasitarsus 0.2 mm long with bilobed euplantulae; second tarsomere 0.7 mm long, apically inflated with two strong pretarsal claws. Metafemur large and robust (Fig. 7), 5.5 mm long, with prominent upper and lower carinulae, dorsal keel and ventral carinae; superior and inferior marginal areas with transverse patches of rugose integument separated by smooth cuticle; medial area with prominent herringbone ornamentation comprising roughly diamond-shaped 'cells' of smooth cuticle, delimited by raised areas of rugose integument; femoral lobe low and distinctly rounded, not forming a spine; genicula bulbous with prominent dorsal process. Metatibia 5.0 mm long with prominent genicular bulb; 6 inner and 6 outer robust dorsal spines; 2 inner and 2 outer curved apical spurs, with inner spurs longer than outer



Figure 5. *Electrotettix attenboroughi* Heads & Thomas, gen. et sp. n., explanatory drawing of head capsule in frontal view (scale bar 0.5 mm).

spurs. Metabasitarsus robust, 1.0 mm long, with distinct, dorsal apical spine and two bilobed euplantulae situated in its basal half; second tarsomere much shorter, 0.3 mm long; third tarsomere almost as long as basitarsus, distinctly curved and somewhat inflated apically, bearing two pretarsal claws.

Abdomen at least 4.0 mm long, though apical damage prevents accurate measurement. Subgenital apically bilobed. Ovipositor approximately 1.0 mm long, with strong denticles on dorsal valvulae and fewer, smaller denticles on the ventral valvulae. Dorsal parts of terminalia (epiproct, cerci, etc.) obscured by bubbles and detritus.

Male: Unknown.

Holotype. INHS 10175, Early Miocene (Burdigalian) amber from the La Toca region, near Santiago de los Caballeros, Santiago Province, Dominican Republic. Well-



Figures 6–7. *Electrotettix attenboroughi* Heads & Thomas, gen. et sp. n. **6** right hind wing (scale bar 0.25 mm) **7** detail of the superior marginal and medial areas of right metafemur (scale bar 0.25 mm).

preserved adult female in a piece of amber approximately 20 × 15 × 12 mm. Numerous syninclusions are also present within the piece, including: an indet. chalcid wasp (Hymenoptera: Chalcidoidea); an indet. proctotrupoid wasp (Hymenoptera: Proctotrupoidea); a single worker ant of the genus *Solenopsis* (Hymenoptera: Formicidae); numerous smaller ants, possibly of the genus *Azteca* (Hymenoptera: Formicidae); a springtail (Collembola); three net-winged midges (Diptera: Blephariceridae); numerous botanicals including a well-preserved flower bud and a leaf fragment with possible epiphytic fungus.

Etymology. The specific epithet is a patronym honouring Sir David Attenborough, British naturalist and film maker, who has been an inspiration not only to the authors of this paper, but to an entire generation of natural scientists.

Remarks. *Electrotettix* is very distinctive among Neotropical cladonotines in that it possesses tegmina and rudimentary hind wings. Although the hind wings are much reduced, they nevertheless have complete venation and demonstrate full rotation, confirming that the holotype is a brachypterous adult and not a nymph with wing pads. *Electrotettix* is similar to *Baeotettix* in the large eyes projecting dorsally above the fastigium, but differs in the smaller fastigial horns and the absence of superior lobes on the frontal costa. Both *Baeotettix* and *Electrotettix*, Haitianotettix, Mucrotettix and Hottotettix (Pérez-Gelabert et al. 1998) including the densely rugose integument, compact body form and presence of fastigial horns, though the latter are not present in all Antillean cladonotines, being absent from genera such as *Truncotettix* and *Antillotettix* (Pérez-Gelabert 2003).

Discussion

Fossil taxa are widely recognized as a valuable source of data concerning the morphology and evolution of their extant relatives. Such taxa often present novel combinations of plesiomorphic and derived character states, which provide unique insight into the acquisition and transformation of morphological characters through deep time (Donoghue 2005; Grimaldi and Engel 2005; Heads 2008). The presence of wings, however well-developed, among fossil representatives of exclusively wingless modern taxa is often an indicator of their basal position with respect to the crown group, as is thought to be the case for the fossil proscopiid grasshopper, *Eoproscopia* from the Cretaceous of Brazil (Heads 2008). However, care must be taken when interpreting such occurrences in taxa that are otherwise highly derived. *Electrotettix* is clearly related to a group of Antillean cladonotines characterized by a coarsely granulose integument and comparatively low pronotal crest (Pérez-Gelabert et al. 1998; Pérez-Gelabert 2003), but remarkable for the presence of tegmina and hind wings which are unknown in any other Cladonotinae, Antillean or otherwise (Hancock 1907; Günther 1938; Blackith 1992; Heads 2009a). While the presence of wings may be considered plesiomorphic, it is unlikely that *Electrotettix* is basal to all extant cladonotines given that it shares several characters with modern Antillean genera (see remarks above). If a close relationship between *Electrotettix* and extant Antillean taxa is confirmed, it would suggest that wings were lost at least twice within the subfamily.

While a robust comparative phylogenetic analysis is not yet available for Cladonotinae, there is evidence to support the existence of an Antillean clade characterized by coarsely granulose integument, presence of fastigial horns or tubercles, and low, nonfoliaceous pronotal crests. Such a clade would comprise the fossil genera *Baeotettix* and *Electrotettix* as well as all extant Antillean cladonotines with the exception of the leaf-

mimics Choriphyllum and Phyllotettix (see Heads 2009a). However, with a detailed phylogenetic analysis lacking, the precise relationships of the cladonotine genera (and indeed all Tetrigidae) remain uncertain and a great deal more work is needed before such questions can be adequately addressed. Nevertheless, it is clear from the great diversity of Antillean cladonotines, that the group have undergone rapid diversification in the Caribbean region. Of the thirty or so tetrigid species now known from the West Indies, over 70% are cladonotines (Heads 2009a). This diversity contrasts markedly with that of mainland South and Central America, where the tetrigid fauna is dominated by Batrachideinae, Lophotettiginae and Tetriginae (Heads 2009a). Pérez-Gelabert et al. (1998) and Heads (2009a) postulated that the diversification of Cladonotinae in the Caribbean was a result of radiations fueled by frequent vicariance events resulting from the dynamic geological evolution of the Antillean archipelago. Cladonotinae are unable to fly and are therefore, more sensitive to geographic isolation than other taxa. While *Electrotettix* did possess wings, they were much reduced and would not have allowed the animal to fly. While an understanding of the evolution of Caribbean biota is difficult given the complex geological history of the region (Grimaldi and Engel 2005), the limited dispersal potential of cladonotines would almost certainly have contributed to their diversification among the many isolated islands, mountain ranges and valleys of the Antilles.

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RESEARCH ARTICLE



Revision of the genus Hemisaprinus Kryzhanovskij, 1976 (Coleoptera, Histeridae, Saprininae)

Tomáš Lackner^I

l Czech University of Life Sciences, Faculty of Forestry and Wood Sciences, Department of Forest Protection and Entomology, Kamýcká 1176, CZ-165 21 Praha 6 – Suchdol, Czech Republic

Corresponding author: Tomáš Lackner (tomaslackner@me.com)

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Abstract

The monophyletic genus *Hemisaprinus* Kryzhanovskij in Kryzhanovskij & Reichardt, 1976 is revised herein. All three species *Hemisaprinus subvirescens* (Ménétries, 1832), *H. lutshniki* (Reichardt, 1941) and *H. cyprius* (Dahlgren, 1981) are found to be correctly assigned to the genus and their monophyly is supported by the synapomorphy of the presence of prosternal foveae. The three species are re-described and supplemented with colour photographs as well as SEM micrographs outlining their differences. Male genitalia drawing of *H. subvirescens* and *H. lutshniki* are provided and a key to the species is given. *Hemisaprinus subvirescens* (Ménétries, 1832) is newly reported from Armenia, Azerbaijan, Kyrgyzstan, Uzbekistan, Turkmenistan, Tajikistan, Jordan, Cyprus and Mongolia. The lectotypes and paralectotypes of the following species are designated herein: *Saprinus foveisternus* Schmidt, 1884, *Saprinus syriacus* Marseul, 1855 and *Saprinus viridulus* Marseul, 1855.

Keywords

Coleoptera, Histeridae, Saprininae, Hemisaprinus, Palaearctic Region, taxonomic revision

Introduction

The genus *Hemisaprinus* was established by Kryzhanovskij in Kryzhanovskij and Reichardt (1976) based on the species *Hister subvirescens* Ménétries, 1832. At the time of its designation *Hemisaprinus* was a mere subgenus of the genus *Saprinus* Erichson, 1834

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and Kryzhanovskij (1976) included in it another species, *Saprinus lutshniki* Reichardt, 1941 which was until then treated only as an aberration of *Saprinus cribellatus* Marseul, 1855. Kryzhanovskij and Reichardt (1976) used the presence of the prosternal foveae as the discriminating character for the erection of the new subgenus. *Hemisaprinus* remained as a subgenus of *Saprinus* until Mazur (2011) elevated its rank to a fully-fledged genus without any explanation or justification for his action. Dahlgren (1981) described *Saprinus cyprius* from Cyprus, remarking that this species should probably not be included in the subgenus *Hemisaprinus*, since it is morphologically different from the other two species. *Saprinus cyprius* was, however, placed into the subgenus *Hemisaprinus* as self-standing genus as well as the placement of *Saprinus cyprius* into *Hemisaprinus* are upheld and clarified in the discussion. This work presents another contribution to the ongoing revisionary work of the genera of the subfamily Saprininae (Lackner 2009a, 2009 b, 2009c, 2010, 2011a, 2011b; Tishechkin and Lackner 2012; Lackner 2012; Lackner 2013a, 2013b; Lackner and Gomy 2013; Lackner 2014; Lackner and Tishechkin 2014).

Material and methods

All dry-mounted specimens were relaxed in warm water for several hours or overnight, depending on the body size. After removal from original cards, the beetles were sidemounted on triangular points and observed under a Nikon 102 stereoscopic microscope with diffused light. Body structures were studied using methods described by Ôhara (1994): male genitalia were macerated in a hot 10% KOH solution for about 15 minutes, cleared in 80% alcohol, macerated in lactic acid with fuchsine, incubated at 60°C for two hours, and subsequently transferred into a 1:1 mixture of glacial acetic acid and methyl salicylate, heated at 60°C for 15 minutes and cleared in xylene. Specimens were then observed in α -terpineol in a small glass dish. Digital photographs of the male terminalia were taken by a Nikon 4500 Coolpix camera and edited in Adobe Photoshop CS4. Based on the photographs or direct observations, the genitalia were drawn using a light-box Hakuba klv-7000. SEM photographs were taken with a JSM 6301F microscope at the laboratory of Faculty of Agriculture, Hokkaido University, Sapporo, Japan and colour images were produced by F. Slamka (Bratislava, Slovakia). All available specimens were measured with an ocular micrometre. Beetle terminology follows that of Ôhara (1994) and Lackner (2010). Separate lines of the same label are demarcated by a slash (/). The following acronyms of museums and private collections are used throughout the text:

CAS	Alexander Sokolov collection, Moscow, Russia;
CND	Nicolas Dégallier collection, Paris, France;
MMBC	Moravské Zemské Muzeum Brno, Czech Republic (P. Baňař);
MNHN	Musém National d'Histoire Naturelle, Paris, France (A. Taghavian);
MNHUB	Museum für Naturkunde, Humboldt- Universität, Berlin, Germany (B. Jaeger);

MZLU	Museum of Zoology Lund, Lund, Sweden (C. Fägerström);
NCB	Naturalis Biodiversity Centre, Leiden, Netherlands (B. Brugge);
TLAN	Tomáš Lackner collection, temporarily housed at Naturalis Biodiversity
	Centre, Leiden, Netherlands;
ZIN	Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia
	(B. Kataev).

Abbreviations. Abbreviations of morphological measurements follow Ôhara (1994) and are used throughout the text as follows:

APW	width between anterior angles of pronotum
EL	length of elytron along elytral suture
EW	maximum width between outer margins of elytra
PEL	length between anterior angles of pronotum and apices of elytra
PPW	width between posterior angles of pronotum.

Taxonomy

Hemisaprinus Kryzhanovskij, 1976

Hemisaprinus Kryzhanovskij, 1976 in Kryzhanovskij and Reichardt (1976): 111, 182 (as a subgenus of *Saprinus* Erichson, 1834). Type species: *Hister subvirescens* Ménétriés, 1832, original designation.

Hemisaprinus (as a subgenus of *Saprinus* Erichson, 1834): Mazur (1984): 62; Mazur (1997): 231; Mazur (2004): 96; Lackner (2010): 63, 205.

Hemisaprinus: Mazur (2011): 188.

Diagnosis. Although *Hemisaprinus* has been recently diagnosed by Lackner (2010), the published diagnosis has to be adapted with respect to the newly examined *H. cyprius* as follows: dark-brown to entirely black species usually with greenish hue to bicolored species, with bronze metallic hue and partly reddish-brown elytra. Frons wholly punctate; frontal stria widely interrupted, can be slightly prolonged onto clypeus; mandibles punctate; pronotum punctate, pronotal depressions vaguely impressed to absent; pronotal hypomeron asetose; prosternal foveae present; carinal prosternal striae stopping short of prosternal foveae (*H. subvirescens*) or entering them (*H. lutshniki*, *H. cyprius*). Lateral prosternal striae terminating in prosternal foveae (*H. subvirescens*) or terminating near apices of carinal prosternal striae (*H. lutshniki*, *H. cyprius*). Elytra with vaguely to well-defined glabrous to sparsely punctate 'mirror'; dorsal elytral striae 1–4 present, reaching approximately elytral half apically; in one species (*H. cyprius*) 2nd dorsal elytral stria missing.

Differential diagnosis. By the presence of prosternal foveae *Hemisaprinus* can be readily differentiated from members of the genus *Saprinus*, which it otherwise strongly

resembles, by the absence of complete frontal stria as well as general appearance. The sensory structures of the antenna (Figs 3, 15) are typically *Saprinus*-like as well, with four oval sensory areas on ventral side of the club with a corresponding vesicle situated under internal distal sensory area. The reader is referred to the Key to the genera of the Palaearctic Saprininae by the author (Lackner 2010: 60) for more information.

Biology. *Hemisaprinus subvirescens* is found chiefly on carcasses in arid regions while *H. lutshniki* is found in decomposing vegetable matter, and has not been found on carcasses so far (Lackner 2010). The biology of *Hemisaprinus cyprius* Dahlgren, 1981 is completely unknown.

Distribution. This genus includes three described species: *Hemisaprinus subvirescens* (Ménétriés, 1832) known from Georgia, southern Russia, Kazakhstan, Turkey, Syria, Israel, Iran, Iraq, Afghanistan, Pakistan, Burma and China (Mazur 2011). It is herein newly reported from Azerbaijan, Tajikistan, Kyrgyzstan, Uzbekistan, Turkmenistan, Jordan, Armenia, Cyprus and Mongolia. *Hemisaprinus lutshniki* (Reichardt, 1941) is known from southern Russia, western Siberia and Kazakhstan (Mazur 2011) and *Hemisaprinus cyprius* Dahlgren, 1981 is only known from northern Cyprus: Kyrenia (Dahlgren 1981).

Hemisaprinus subvirescens (Ménétriés, 1832)

Figs 1-12

Hister subvirescens Ménétriés, 1832: 171.

Hister subvirescens: Faldermann (1835): 230.

Saprinus subvirescens: Marseul (1855): 736; Reichardt (1922): 50; Reichardt (1941): 184, 240, fig. 87; Dahlgren (1968): 87, 93, figs 2G, 5A.

Saprinus (Hemisaprinus) subvirescens: Kryzhanovskij and Reichardt (1976): 127, 183, figs 357–360; Mazur (1984): 62; Mazur (1997): 231; Mazur (2004): 96; Lackner (2010): 205, figs 10, 69, 103, 135, 643–659.

Saprinus syriacus Marseul, 1855: 469. Synonymized by Reichardt (1941): 240. Saprinus viridulus Marseul, 1855: 468. Synonymized by Dahlgren (1968): 87. Saprinus foveisternus Schmidt, 1884: 9. Synonymized by Auzat (1920): 3. Hemisaprinus subvirescens: Mazur (2011): 188.

Type locality. Russia, Caucasus.

Type material examined. *Saprinus subvirescens*: Holotype: spec., "*subvirens* / Mén. Cauc (written) / Salian (red label, printed) / Holotypus (red label, printed) / round golden label" (ZIN).

Saprinus foveisternus Schmidt, 1884: Lectotype (present designation): female, glued on a mounting point with the following labels: "Baku" (written); followed by: "foveisternus / mihi typ." (written); followed by: "Type" (brick-red label, printed); followed by: "coll. J. Schmidt" (printed); followed by: "foveisternus / Schmidt" (double-margined, written label); followed by: "Saprinus / foveisternus / Coll. Schmidt-



Figure 1. Hemisaprinus subvirescens (Ménétries, 1832) habitus.

Bickhardt" (printed); followed by: "Saprinus / foveisternus / Schmidt, 1884 / LEC-TOTYPE / des. Lackner 2014" (red label, written) (MNHUB). Paralectotype (present designation): female, with following labels: "Baku" (written); "Type" (brick-red label, printed); followed by: "foveisternus" (written); followed by: "Saprinus / foveisternus / Schmidt, 1884 / PARALECTOTYPE / des. Lackner 2014" (red label, written). Paralectotype (present designation): male, with the following labels: "Baku" (written); "Type" (brick-red label, printed); followed by: "Saprinus / foveisternus / Coll. Schmidt-Bickhardt" (printed); followed by: "Saprinus / foveisternus / Schmidt, 1884 / PARALECTOTYPE / des. Lackner 2014" (red label, written) (both MNHUB). Paralectotype (present designation), unsexed specimen, all tarsi, left meso- and metatibia missing, with the following labels: "Bakou / Caucase" (written); followed by: "in Col. Bonnaire" (written); followed by: "TYPE" (red label, printed); followed by: "coll. Dr. Auzat" (light green label, written); followed by: "foveisternus / mihi Typ" (written); followed by: "Saprinus / foveisternus / Schmidt, 1884 / PARALECTOTYPE / des. T. Lackner 2014" (red label, written) (MNHN).

Saprinus syriacus Marseul, 1855: Lectotype (present designation): male, with genitalia extracted, glued to the same mounting card as the specimen, right protibia broken off, glued next to specimen, right mid-leg and left hind leg missing, with the following labels: "90 / Saprinus / syriacus / Syrie m. ♂ / Laferté" (round yellow label, written); followed by: "Saprinus / syriacus m / Syria / 89" (yellow label, written); followed by: "Ti...further illegible text / 63" (tiny yellow label, written); followed by: "342" (orange label, written); followed by: "Schm. / 31" (written); followed by: "MUSEUM PARIS / COLL. / DE MARSEUL 1890" (printed); followed by: "TYPE" (red-printed label); followed by: "Sapr. subvires- / cens Men. / G. Dahlgren det" (printed-written); followed by: "Saprinus syriacus / Marseul, 1855 / LECTOTYPE 2014 / des. T. Lackner" (red label, written) (MNHN). This species has been described from unknown number of specimens and the lectotype designation fixes the identity of the species.

Saprinus viridulus Marseul, 1855: Lectotype (present designation): female, right metatarsus missing, with the following labels: small pink rectangular label, followed by: "89 / Saprinus / viridulus / Kurmaul / Deyr. Inde" (yellow, round label, written); followed by: "Q" (written); followed by: "MUSEUM PARIS / COLL. / DE MAR-SEUL 1890" (printed); followed by: "TYPE" (red-printed label); followed by: "Sapr. subnites- / cens Men. / G. Dahlgren det" (printed-written); followed by: "Saprinus viridulus / Marseul, 1855 / LECTOTYPE 2014 / des. T. Lackner" (red label, written) (MNHN). The species was described from unknown number of specimens and the lectotype designation fixes the identity of the species. Note that Dahlgren mistakenly identified it as *Saprinus subnitescens* Ménétriés (sic!). What he meant was *Saprinus sub-virescens*, which was indeed described by Ménétriés, and not *S. subnitescens*, which was in turn described by Bickhardt in 1909.

Additional material examined. ISRAEL: 2 ♂♂, Adullam, 17.v.2002, Y. Mandelik & V. Chikatunov lgt. (TLAN); 2 specs., Jerusalem, coll. Lange, no further data (MNHUB). TAJIKISTAN: 5 ♂♂, Aruk Tau Mts., 20.iv.1978, A. Olexa lgt.; 1 ♂, Vachrobod, 8.vi.1966, A. Olexa leg.; 1 spec., Tigrovaya Balka, 2.–6.vi.1966, A. Olexa leg.; 1 ♂ Aruk-Tau (Garavuti), 29.iv.1978, M. Dvořák leg. (all exs. TLAN). 1 spec., Khujand, 21.iv.1921, Arkhangelskij leg.; 1 spec., Yagnob, Chichartob, 1892, Glasunov leg.; 4 specs., Pyanzh, from Khorod to Ishkashim, 6.vi.1928, Grishin leg.; 2 specs., Koktau Mts., near Kurgan-Tyube pass, 28.iv.1962, Guryeva leg.; 2 specs., Tian-Shan, Musart, vi.1894, Hauser leg.; 1 spec., Gandzhina, 15.iv.1966 (all exs. ZIN). 2 specs., Tian-Shan, Tekesthal, no further data (BMNH). 1 spec., Pyandzh Karatau ridge Mt. Astana 23.iv.1991, Gratchev leg.; 1 spec., Tigrovaya Balka reserve right side Vakhsh river 16.iv.1989, V. Gorbatovskiy leg. (all exs. CAS). TURKMENISTAN: 1 ♂, Turkmenistan, Firjuza, Ashghabad, 27.iv.1977, A. Olexa leg.; 1 spec., ibid, but 22.iv.1981, J. Strnad leg.; 7 ♂♂ & 1 ♀, Ashgabat, Nisa,



Figure 2. Hemisaprinus subvirescens (Ménétries, 1832) head, dorsal view.



Figure 3. Hemisaprinus subvirescens (Ménétries, 1832) antennal club, showing the sensory structures.

21.iv.1975, A. Olexa leg.; 1 & Amurdarya-Kirki, 1.–5.v.1993, collector unknown; 1 🗟 & 1 spec. Kopet Dagh, near Firjuza, Vanovskij, 21.v.1991, Z. Kejval leg.; 1 🖏 Tekke, no further data; 1 3, Annau, Karakum, 21.iv.1981, A. Olexa leg.; 7 specs., Annau, 15.iv.1985, Kapler leg.; 1 spec., Firjuza, 18.iv.1988, Kafka leg.; 2 specs., Ashghabad, 14.iv.1988, S. Jákl leg.; 1 spec., ditto, but 29.iv.1991, R. Dunda leg.; 5 specs., Chuli, 12.-13.iv.1990, M. Kafka leg.; 4 specs., Tusly Kala, 11.iv.1990, R. Dunda leg. (all exs. TLAN). 1 spec., Kopet-Dagh Mts., further locality illegible, 15.x.1969, collector unknown, near Opimus burrow; 1 spec., Atrek River, Jacobson leg.; 1 spec., Chikishlyar, 30.-31.iv.1916, V. Ilin leg.; 2 specs., Kushka, 18.v.1936, Kreizberg leg.; 1 👌 & 1 spec., Badkhyz, Penkhatchetpe, 6.iv.1971, Tikhomirova leg.; 2 dd, Badkhyz, Kyzyl-Dzhar, 18.iv.1970, Tikhomirova leg.; 3 specs., Kelif, 18.iv.1988, Atamuradov leg.; 3 3 8 & 2 specs., Kara-Kala env., 19.v.1968, Tikhomirova leg.; 4 specs., Firjuza, 30.iii.1952, Kryzhanovskij leg.; 2 specs., Kopet-Dagh Mts., Geok-Tepe, Izgait, desert, 10.iv.1987, V.N. Prasopov leg.; 1 spec., Ashghabat, no further data; 3 specs., idem, but 23.iii.1903, G. Jacobson leg.; 7 specs., idem, but 19.iv.1929, sands, Vlasov leg.; 2 specs., idem, but 6.iv.1928; 7 specs., idem, but 6.vi.1925, Opanin leg.; 3 specs., idem, but 22.iii.1952, Romadina leg.; 8 specs., Repetek, 23.iii.1983, Krivoshatskij leg.; 1 spec., idem, but 17.iv.1914, Plavilstshikov leg.; 2 specs., idem, but 5.ii.1904, E. Fisher leg.; 1 spec., Germab, 12.x.1988, collector unknown; 2 specs., Murgab, no further data; 1 spec., Iolatanj, 1.iv.1927, Kizeritskij leg.; 4 specs., Tedzhen, 21.vi.1904, Arris leg.; 4 specs., Krasnovodsk (=Turkmenbashi), 28.iii.1919, B. Ilin leg.; 1 spec., Kopet-Dagh Mountains, 12 km S of Kyzyl-Arbat, 25.iv.1952, D. Stenberg leg.; 2 specs., Kara-Bogaz, 40 km N from Kyzyl-Arbat, 21.iv.1952, Sternberg leg.; 2 specs., 2-6 km N of Kara-Kala, 24.v.1952, Kryzhanovskij leg.; 1 spec., Sumbar river, 1894, Herz leg.; 1 spec., Firjuza env., 30.iii.1952, V. Ilichyov leg.; 1 spec., Annau, 12.v.1928, V. Gussakovskij leg.; 6 specs., Gyaurs, 3.iv.1984, Kh. Atamuradov leg.; 6 specs., Karabil, Shiram-Kuy, 22.iv.1984, Kh. Atamuradov leg. (all exs. ZIN). 1 spec., Amudaryinskiy reserve, Amudarya River, Nargiz island, 9–16.iv.1983, S. Alexeyev leg. (CAS). 1 spec., Badkhyz Penhancheshme, 6.iv.1971, Tikhomirova leg. (CND); 1 spec., Repetek, v. 1914, N. Plaviltshikov leg. (MNHN). JORDAN: 1 2, Al Qatrana Saliya, 15.iv.2002, Wadi Mujib env., M. Snížek leg. (TLAN). KAZAKHSTAN: 2 🖧 & 2 specs. Akkol, Jambul, 8.v.1979, A. Olexa leg.; 2 specs., ibid, but 10.v.1978, M. Dvořák leg.; 11 specs., Tjunja, Charyn River, 26.v.1994, collector unknown. (all exs. TLAN). 1 spec., Alma-Atinskaya oblast, Kuskuduk, 30.iv.1930, Kirschenbladt leg.; 1 spec., Alma-Atinskaya oblast, Karatalsk, 18.v.1930, Kirschenbladt leg.; 3 specs., SE Kazakhstan, Ilijskij, 22.viii.1911, Matissep leg.; 1 spec., Chelkar, 2.vi.1928, Olenev & Popov leg.; 1 spec., Aktyubinskaya oblast, Dzhilandy,11.vi.1908, D. Borodin & B. Uvarov leg.; 1 spec., Ostashkino, Almatinka, 20.vii.1928, Shnitnikov leg.; 2 specs., Mogyl Daumchar on River Emba, Temirsk region, 30.v.1908, Borodin leg.; 2 specs., Astau-Sardy, banks of River Emba, Temirsk region, 28.v.1908, Borodin leg.; 1 spec., Ak-Buta mountains, Temir, 2.vi.1908, Borodin leg.; 9 specs., Dzhilandy, Uralskaya oblast', Temirskij uezd, 11.vi.1908, D. Borodin & B. Uvarov


Figure 4. Hemisaprinus subvirescens (Ménétries, 1832) prosternum.

leg.; 20 specs., surroundings of lake Inder, 4.vi.1907, B. Uvarov leg.; 1 spec., idem, but 10.vi.1907, A. Borodin leg.; 1 spec., Karatal (= Ush-Tobe), 16.v.1930, Kirschenbladt leg. (all exs. ZIN). 4 specs., North slope Talass ridge. near Talass vill., iv. 1993, no collector (CAS). 1 spec., Kapchagay env., Ili River, 10.v.1993, A. Ogarkov leg.; (CAS). TURKEY: 1 🖒 Cappadocia, 7.–10.vii. 1983, Avanos env., A. Olexa leg.; 1 Å, Eskishehir, 5.v.1969, C. Holzschuch leg.; 1 Å, Demircili, 70 km W Silifke, 5.iv.1992, O. Kapler leg. (all exs. TLAN). 1 spec., Kars env., Kaladzhika, 1.v.1915, Olsufyev leg. (ZIN); 1 spec., Anatolia, 29.iii.1977, 10 km SE Serefli Kochisar, Tuz Gölü, 1. Orient Exkursion, Inst. f. Zool. Mainz, Prof. R. Kinzelbach leg. (MNHN). **UZBEKISTAN**: 1 \bigcirc & 2 $\bigcirc \bigcirc$ & 1 spec., Tashkent, 22.iv.1972, A. Olexa leg.; 3 3 8 2 specs., Samarkand, Aman Kutan, 21.iv.1972, A. Olexa leg.; 1 spec., ibid, but 20.iv.1972; 1 2, Khamsa-Abad, Ferghana, 26.iv.1972, A. Olexa leg.; 1 spec., Chimgan (Tian-Shan), 2500 m, 17.vii.1979, M. Dvořák leg.; 1 spec., Ak-Tash (Tashkent), 30.iv.1978, M. Dvořák leg.; 2 specs., 200 km W of Tashkent, Kyzyl-Kum Desert, Chardara (Koksu), 3.-5.v.1990, J. Turna leg. (all exs. TLAN). 3 specs., Ursatevskaya (=Khavast), 19.v.1920, I. Ivanov leg., on the ground in steppe; 1 spec., upper Upalanga river, Gissar Mt. range, 1898, Willberg, leg.; 1 spec., Tashkent, behind the Salar canal, 28.iii.1920, Ivanov leg.; 1 spec., Tashkent env., 16.v.1920, Ivanov leg.; 1 spec., idem, but 11.vi.1909, V. Grekov

leg.; 1 spec., Sansar, 1892, Glasunov leg.; 4 specs., Kalma-Tai, 1892, Glasunov leg.; 2 specs., Tamdy, 1892, Glasunov leg.; 2 specs., Dzhizak, 1892, Glasunov leg.; 5 specs., Jgam-Berdy, 1892, Glasunov leg.; 1 spec., Kschtut Artutch, 1892, Glasunov leg.; 43 specs., Khodjent env., Golodnaya step, 23.iv.1903, G. Jakobson leg.; 1 spec., Bukhara region, Guzar-Tengi, Khoram, 28.iv.1897, Kaznakov leg.; 1 spec., Kammashi, N of Guzar, Bukhara region, 15.iv.1931, Gussakovskij leg.; 9 specs., Kizilcha, Bukhara region, Guzar env., 23.iv.1926, Gerasimov leg. (all exs. ZIN). AZERBAIJAN: 1 spec., Kobystan, Baku, 16.v.1975, A. Olexa leg. (TLAN). 1 spec., Kyurdamyr, near Baku, 15.v.1923, Bezrukov leg.; 3 specs., Pirsaat valley, 6.vii.1907, collector unknown; 1 spec., Baladzhary near Baku, 5.iv.1927, Kirschenbladt leg.; 2 specs., Lenkoran region, Nova Andreevka, 3.v.1923, Bezrukov leg.; 1 spec., Baku region, Belosovar, 5.v.1923, Bezrukov leg.; 1 spec., Ganja, no date, Dr. Kolenati leg.; 2 specs., Baku env., 18.iv.1927, Kirschenbladt leg. (all exs. ZIN). KYRGYZSTAN: 1 3, Kashka-su, v. 1984, J. Palička leg. (TLAN). 8 exs., Przhevalsk, 7.v.1930, Titov leg. (ZIN). 1 spec., Tian-Shan, Musart, no further data (BMNH). 1 spec., Kungey Alatau ridge, Grigoryevskoye canyon, 2000 m, 12-22. vii.1993 A. Ogarkov leg. (CAS).

SYRIA: 1 spec., Syria, no further data (BMNH). 1 spec., Palmyra, 10.–15.v.1995, P. Kabátek leg. (TLAN); 2 specs., Tadmor, Palmyra, Turkish Bath, 12.iii.1977, 1. Orient Exkursion, Inst. f. Zool. Mainz, Prof. R. Kinzelbach leg. (MNHN). ARMENIA: 1 spec., Rozdan, viii. 1981, Kletečka leg. (TLAN). AFGHANISTAN: 7 exs., Nengrahar prov., Jalalabad, 560 m, 20.iv.1967, D. Povolný et coll. leg. (MMBC). 1 👌 & 1 spec., Laghman prov., Shamakat, 900 m, 22.iv.1972, Kabakov leg.; 1 spec., idem, but river Shamakat, ca 1000m, 31.iii.1972, Kabakov leg.; 1 spec., Herat prov., Anardara, 1200 m, 30.iii.1971, Kabakov leg.; 1 👌 + 4 specs., Lataband pass, 30 km E Kabul, 4.iv.1970, Kabakov leg.; 1 spec., 15 km W of Jalalabad, 700 m, 30.iv.1972, Kabakov leg.; 1 spec., Nuristan prov., Petch, 1500 m, 21.x.1971, Kabakov leg.; 2 👌 & 2 specs., Nuristan prov., Dara-i-Petch, 1600 m, 21.v.1971, Kabakov leg.; 14 specs., Kabul, 21.iii.1970, Kabakov leg.; 1 🖧 & 6 specs., idem, but 1800 m, 20.iii.1970; 4 specs., idem, but 26.iii.1971; 1 spec., idem, but 7.vi.1973; 1 spec., idem, but 15.iv.1970; 1 spec., idem, but 9.iv.1971; 1 spec., idem, but 12.iii.1971, 1800 m; 6 specs., idem, but 19.iii.1971 (all exs. ZIN).; 1 spec., 46 km NO Jalalabad, 800 m, Sar Kardou, 25.v.1962, Dr. K. Lindberg leg.; 21 specs., Ghourmatch, between Gaiar & Dala Morghab, carcass of Herrison, 16.iv.1959, Dr. K. Lindberg leg.; 6 specs., Decht-Bazar, 27.vii.1962, Dr. K. Lindberg leg., 1 \mathcal{Q} , prov. Bamyan, dirt track from Lanjaw to Bissoude, 2800 m, 23.viii.1978, G. Ledoux leg. (all exs. MNHN). IRAQ: 1 spec., Mesopotamia, without further data (ZIN). 1 spec., Euph. [=Euphrat?], no further data (BMNH); 5 specs., Mosul, no further data (MNHUB). MONGOLIA: 1 spec., Mongolia bor., without further data. (ZIN). **IRAN**: $1 \Diamond$, Teheran, without further data; 1 spec., Kerman, Sargad, 4.v.1901, N. Zarudnij leg.; 1 spec., idem, but 13.iii.1928, B. Kuznetsov leg. (all exs. ZIN). 1 spec., Kerman, 4.iii.1935, H.E.J. Biggs leg. (BMNH). 1 &, Evine (Tehran), no date, Petrovitz leg. (CND). GEORGIA: Tbilisi, 19.iv.1880, collector unknown (ZIN). RUSSIA: 2 specs., Dagestan, Petrovsk, 1.v.1925, Kirishechenko leg.; 1 spec., Sarepta,



Figures 5–12. 5 *Hemisaprinus subvirescens* (Ménétries, 1832) 8th sternite and tergite, ventral view **6** ditto, dorsal view **7** ditto, lateral view **8** *Hemisaprinus subvirescens* (Ménétries, 1832) 9th + 10th tergites, dorsal view; spiculum gastrale, ventral view **9** *Hemisaprinus subvirescens* (Ménétries, 1832) 9th + 10th tergites, spiculum gastrale, lateral view **10** *Hemisaprinus subvirescens* (Ménétries, 1832) aedeagus, dorsal view **11** ditto, lateral view **12** *Hemisaprinus subvirescens* (Ménétries, 1832) apex of aedeagus, dorsal view.

Bekker leg., no further data; 1 spec., idem, but no date or collector; 3 specs., Stavropol reg., Faust leg.; 1 spec., Stavropol region, Roguli, 1925, collector unknown; 1 spec., Astrakhan, no date, A. Semenov-Tian-Shanskij leg.; 1 spec., Samara, Dr. Bols leg.; 1 spec., Stavropol'skij kray, Mitrofanovskoe, iv. 1925, collector unknown; 6 specs., Selitrennoe, Yenot uezd, 10.vi.1910, Chernovin leg. (all exs. ZIN). 1 spec., South Russia, Kalmykiya, 10 km S Tchernozemelskiy vill., 15.iv.1982, A. Zamesov leg.; 1 spec., Astrakhan reg. near Lower Baskunchak vill., Mt. Bogdo, 43°07.880'N, 46°49.168'E, 23–25.v.2013, A. Shadenkov leg. (all exs. CAS). **CYPRUS**: 6 specs., Cyprus, Nicosia, 19.iii.[19]35, Th. Shiakides leg. in cow dung (BMNH). **INDIA**: 1 spec., India, no further data (BMNH). 1 spec., Uttaranchal state, Naini Tal distr., near Sathkol vill., 20–28.vi.2006, S. Saluk leg.; (CAS). **PAKISTAN**: 1 spec., 22.ii.1978, Gujranwala, S. Kinelski leg. (CND).

Re-description. Although this species has been recently re-described by the author (Lackner 2010: 205), and the reader is referred there for the exhaustive account of SEM micrographs and drawings of the mouthparts and sensory structures of the antenna, I prefer to repeat its re-description here for the sake of completeness of the revision, especially since the two subsequent species are morphologically rather similar and differ from the type species of the genus in their cuticular colour.

Body length: PEL: 2.25–3.00 mm; APW: 0.75–1.00 mm; PPW: 1.75–2.00 mm; EL: 1.50–1.90 mm; EW: 1.87–2.50 mm.

Body (Fig. 1) roundly oval, convex, cuticle pitch-black usually with greenish hue, shining, but older specimens can be completely dark without hue; legs, mouthparts and antennae dark brown; antennal club black.

Antennal scape (Fig. 2) not particularly thickened, with shallow sparse punctures and two short setae; club round, without visible articulation, entire surface with dense short sensilla intermingled with sparser longer erect sensilla; sensory structures of antennal club (Fig. 3) in form of four ovoid sensory areas on ventral side and one vesicle situated under internal distal margin.

Mouthparts: mandibles (Fig. 2) with rounded outer margin, laterally with deep dense punctures, moderately curved inwardly, mandibular apex pointed; sub-apical tooth obtuse, inconspicuous; labrum (for fig. see Lackner 2010, fig. 69) convex, densely punctate, anterior margin medially with a small convexity interrupting concavity; labral pits deep, each with two well-sclerotized long setae; terminal labial palpomere elongated, its width about one-third its length; mentum sub-trapezoid, anterior margin (for fig. see Lackner 2010, fig. 135) medially with deep notch surrounded with sparse short setae, lateral margins with single row of sparse shorter setae, several setae present also on disc of mentum; cardo of maxilla with few short setae; stipes triangular, with three short setae; terminal maxillary palpomere elongated, its width about onefourth its length, approximately 2.5 times as long as penultimate.

Clypeus (Fig. 2) flat, constricted laterally, with coarse and dense punctures; frontal stria largely interrupted medially, for short distance prolonged onto clypeus, supraorbital stria well impressed, carinate; frontal disc (Fig. 2) with coarse and dense punctures; eyes convex, well visible from above.

Pronotal sides moderately (Fig. 1) narrowing anteriorly, apical angles obtuse, pronotal depressions vaguely impressed, almost absent, anterior incision for head shallow, almost straight in middle; marginal pronotal stria complete; pronotal disc laterally with longitudinal depression, with very coarse and dense punctures, punctures become finer and sparser medially; row of ovoid punctures present along pronotal base; pronotal hypomeron glabrous; scutellum small, but visible.

Elytral epipleuron with scattered fine punctures, area between marginal epipleural stria and elytral margin smooth; marginal epipleural stria fine, complete; marginal

elytral stria straight, well impressed and slightly carinate, continued as weakened complete apical elytral stria; along marginal elytral stria a row of round dense punctures present. Humeral elytral stria weakly impressed on basal third; inner subhumeral stria present as short median fragment; all four dorsal elytral striae 1–4 weakly impressed, short, not reaching elytral half apically, in shallow punctures; fourth dorsal elytral stria basally vaguely connected with sutural elytral stria; sutural elytral stria well-impressed and complete, in deep punctures, apically connected with apical elytral stria; entire elytral disc with punctuation, punctures dense and coarse; along elytral margin, on elytral humeri and on interval between fourth dorsal and sutural elytral striae punctation weakens, extreme apex of elytra impunctate.

Propygidium and pygidium densely and coarsely punctate, punctures separated by about half their own diameter.

Anterior margin of median portion of prosternum (Fig. 4) almost straight; marginal prosternal stria present laterally and as a short anterior fragment; prosternal process concave, surface between carinal prosternal striae with scattered fine punctuation, laterally finely strigulate, punctures coarser and deeper; carinal prosternal striae well-impressed, on prosternal apophysis parallel, slightly divergent anteriorly, not connected apically; prosternal foveae deep; lateral prosternal striae carinate, sub-parallel, apically terminating in prosternal foveae.

Anterior margin of mesoventrite (for fig. see Lackner 2010, fig. 649) deeply emarginate medially; discal marginal mesoventral stria well impressed, carinate, slightly weakened medially; disc of mesoventrite with scattered punctuation; meso-metaventral sutural stria marked as straight row of coarse punctures; intercoxal disc of metaventrite (for fig. see Lackner 2010, fig. 649) flattened (in male with median longitudinal excavation), with fine punctures, becoming coarser and denser along posterior and lateral margins (especially behind hind coxa); lateral metaventral stria (for fig. see Lackner 2010, fig. 650) well impressed, carinate, almost straight, shortened; lateral disc of metaventrite (for fig. see Lackner 2010, fig. 650) slightly concave, with dense shallow setiferous punctures; metepisternum with even denser and coarser punctuation, punctures not setiferous; fused metepimeron with somewhat sparser punctures; metepisternum + fused metepimeron with metepisternal stria, interrupted on fusion between metepimeron and metepisternum.

Intercoxal disc of the first abdominal sternite laterally with incomplete stria; except for median part with coarse round punctures, becoming finer along posterior margin.

Protibia (for fig. see Lackner 2010, fig. 651) slightly dilated, outer margin with 5 moderately large triangular teeth topped with short rounded denticle, diminishing in size in proximal direction, followed by 4 tiny denticles; setae of outer row regular, rather short; protarsal groove deep, strigulate; anterior protibial stria complete apically; setae of intermedian row about as long as those of outer row, becoming more sclerotized apically; two tarsal denticles present near tarsal insertion; protibial spur short, bent, growing out from apical margin of protibia; apical margin of protibia posteriorly with 3 tiny denticles abutting each other; outer part of posterior surface (for fig. see Lackner 2010, fig. 651) obscurely variolate, separated from glabrous median part of

posterior surface by vague boundary and row of short sclerotized setae; posterior protibial stria complete, with a row of tiny sclerotized setae becoming thicker apically; inner row of setae double, setae dense and short.

Mesotibia slender, outer margin with two rows of short denticles; setae of outer row regular, dense, shorter than denticles; setae of intermedian row shorter and finer than those of outer row, regular; posterior mesotibial stria almost complete; anterior surface of mesotibia (for fig. see Lackner 2010, fig. 645) strigulate-punctate; anterior mesotibial stria complete, terminating in single tiny inner anterior denticle; mesotibial spur short; apical margin of mesotibia anteriorly with two short denticles; claws of apical tarsomere slightly bent, shorter than half its length; metatibia slenderer and longer than mesotibia, in all aspects similar to it, but denticles on outer margin much sparser and claws of apical tarsomere slightly longer than half its length.

Male genitalia: Eighth sternite (Figs 5–6) widely separated medially, covered with pseudo-pores, apically with numerous close-set setae forming a conspicuous apical brush, velum with dense, much shorter and finer setae; on outer margin fringed with a single row of longer setae; eighth tergite (Fig. 6) apically straight; eighth tergite and eighth sternite fused laterally (Fig. 7). Ninth tergite (Figs 8–9) fused medially, laterally with pseudo-pores; spiculum gastrale (Fig. 8) almost parallel with apical end strongly, and basal end only slightly expanded. Aedeagus (Figs 10–12) slender; basal piece of aedeagus short, ratio of its length : length of parameres 1 : 3.50; parameres fused almost along their apical three-fourths; aedeagus constricted apically, thence slightly dilated, curved ventrad (Fig. 11).

Hemisaprinus lutshniki (Reichardt, 1941)

Figs 13-25

Saprinus cribellatus ab. lutshniki Reichardt, 1941: 257, 392.
Saprinus (Hemisaprinus) lutshniki: Kryzhanovskij and Reichardt (1976): 183; Mazur (1984): 62; Mazur (1997): 231; Mazur (2004): 96.
Hemisaprinus lutshniki: Mazur (2011): 188.

Type locality. Russia: Totskiy Rayon, near Samara.

Type material examined. Saprinus cribellatus ab. lutshniki: Lectotype, sex unidentified, left mesotarsus missing, with following labels: circle, gold label, followed by: "Totskij lag / Samarsk. g. / 26.iv. 1917" (hand-written label in Russian); followed by: "Saprinus cribell. / a. lutshniki nov. / A. Reichardt det." (printed-written); followed by: "Lectotypus / S. lutshniki Rchdt. / Kryzhanovskij det., 66" (red label, printed-written). Paratypes: 1 \Im , with following labels: "Saratov / N.L. Sacharov" (black-margined label, written-printed); followed by: "Paratypus" (red label, printed). 1 spec., with the following labels: "O.B. Don 15.iv.[1]912 / Persianovka / B. Kizeritskij" (printed-written); followed by: "Paratypus" (red label, printed). 1 \Im , with following labels: "G. Temir Ural Obl. / 15.iv.[19]07 / D. Borodin & V. Uvarov" (printed-written in Russian); followed



Figure 13. Hemisaprinus lutshniki (Reichardt, 1941) paratype, habitus.

by: "Paratypus" (red label, printed); followed by: "Zoological / Institute RAS / St. Petersburg" (yellow label, printed); followed by: "lutshniki" (yellow, pencil-written label) and: "09-063" (yellow, pencil-written label) added by myself. 2 specs., with following labels: "Peremezhnoe, / okr. Uralska / Lyubishev 1.v.[19]33" (hand-written label in Russian); followed by red label, printed: "Paratypus" (all exs. ZIN).

Additional material examined. KAZAKHSTAN: 1 Å, River Ural near Kharkin, 14.v.1951, L. Arnoldi leg. (NCB); 56 exs., Ural River, near Kharkin, 14.v.1951, L. Arnoldi, under desert plants *Atraphaxys* (Polygonaceae) (ZIN); 1 spec., Ganibek nat. reserve, 49°23' N, 46°47' E, 1.v.2003, O. Khrulyova leg. (CAS); 2 specs., Ural River, Kharkin, 14.v.1951, L. Arnoldi leg. (MNHN). **RUSSIA**: 1 Å, Orenburskaya oblast, 3 km NW Pervomaiskij, Donguz, steppe, 1.v.–28.vi.2009, Kozminykh V.O. leg. (TLAN). 1 spec., Volgograd, ovrag (=ravine) of the Tsaritsa River, 23.iv.1986, Matveev leg.; 2 specs., Samarskaya gubernia, Nikolaevskij distr., Bostanyhoglo leg., 1917;



Figure 14. Hemisaprinus lutshniki (Reichardt, 1941) paratype, head, dorsal view.

1 spec., Samara, no date, Dr. Volz leg.; 1 spec., Kalmytskaya ASSR, Priozernij rayon, Tugtyn, 11.v.1976, Iviliev leg.; 1 spec., Petrovsk-port, N. Caucasus, 4.v.1931, M. Ryabov leg.; 1 spec., Tverskaya obl., Pokhot'-Krugloe, Zubtsovskij uezd, 30.v.1925, collector unknown; 3 exs., Kuybyshevskaya obl., Pestravskij rayon, kolkhoz "Rodina", 14–15.v.1960, collector unknown; 4 specs., idem, but selo "Mosty", 14.v.1960, under *Agropyron* plants in a ditch (all exs. ZIN); 1 spec., Kuybyshiev distr., 14.v.1960, Alejnikova leg. (BMNH); 1 spec., Astrakhan reg., 10 km S Upper Baskunchak vill., "Shikli" sands, 4.v.1995, I. Melnik leg. (CAS); 2 specs. Astrakhan reg., Palass distr., N side Elton lake, right side Khara River, 20–31.v.2006, A. Matalin leg. (CAS).

Re-description. Body length: PEL= 2.75–3.35 mm, APW= 1.00–1.25 mm, PPW= 2.00–2.35 mm, EW= 2.25–2.60 mm, EL= 1.90–2.20 mm. Body (Fig. 13) rectangular oval, convex, elytra widest at humeri; cuticle of elytra on impunctate 'mirror' dark brown to black, on punctate part reddish-brown, shining, pronotum dark, almost black; body ventrally dark brown to almost black; abdominal ventrites (except for first visible) rufescent; legs, mouthparts and antennae rufo-castaneous; antennal club somewhat darker.

Antennal scape (Fig. 14) slightly thickened, substrigulate, finely punctate, lower margin carinate, with few short setae; club (Figs 14,15) round, pointed apically, without visible articulation, entire surface with dense short sensilla intermingled with sparser longer erect sensilla; sensory structures of antennal club in form of four ovoid sensory areas on ventral side (Fig. 15); vesicle(s) not examined.



Figure 15. *Hemisaprinus lutshniki* (Reichardt, 1941) paratype, antennal club, ventro-lateral view showing sensory structures of the antenna.

Mouthparts: mandibles (Fig. 14) stout, densely punctate, mandibular apex pointed; sub-apical tooth of left mandible not examined; labrum convex, densely punctate, with slight median concavity interrupted by semi-globular convexity; labral pits deep, each with two well-sclerotized long setae; terminal labial palpomere elongated, about twice as long as pen-ultimate, its width about one-third its length; mentum sub-trapezoid, anterior margin medially with deep notch surrounded with sparse rather long setae, lateral margins with single row of sparse shorter ramose setae; cardo of maxilla with few short setae; stipes triangular, with three short setae; terminal maxillary palpomere elongated, pointed apically, about three times as long as pen-ultimate; its width about one-third its length.

Clypeus (Fig. 14) flat, gradually sloping down laterally, rugulose-lacunose; frontal stria broadly interrupted medially, for short distance prolonged onto clypeus, supraor-



Figure 16. Hemisaprinus lutshniki (Reichardt, 1941) paratype, prosternum.

bital stria well impressed, carinate; frontal disc (Fig. 14) very coarsely and densely punctate; eyes convex, well visible from above.

Pronotal sides (Fig. 13) on basal half moderately narrowing anteriorly, strongly narrowing on apical half; apical angles obtuse; median emargination for head shallow; pronotal depressions absent; marginal pronotal stria complete, somewhat weakened behind head; pronotal disc shining on most part, with sparse punctures separated by several times their diameter, laterally and behind head more coarse and dense punctures appear, punctures form a depressed band of confluent punctuation, between it and pronotal margin a narrow band with simple punctuation present; several rows of ovoid punctures present along pronotal base; pronotum with faint ante-scutellar depression; pronotal hypomeron asetose, in fine scattered punctures; scutellum well visible.

Elytral epipleura glabrous; marginal epipleural stria fine, complete; marginal elytral stria straight, well impressed and slightly carinate, continued as weakened complete apical elytral stria. Humeral elytral stria weakly impressed on basal fourth, doubled, surface between it and second dorsal elytral stria in longitudinal irregular strioles; inner subhumeral stria present as short median fragment; elytra with thin striae 1-4; striae with weak punctures within, except for first stria which is shorter than the others reaching approximately elytral half apically; fourth dorsal elytral stria basally connected with sutural elytral stria by broad arch; sutural elytral stria well-impressed and complete, fine punctures within, apically connected with apical elytral stria, between it and elytral suture a row of fine punctures present; elytral humeri and flanks almost impunctate, elytral disc along sutural elytral stria on apical two-fifths with dense, almost confluent punctation, forming longitudinal rugae; weakened punctuation slightly enters elytral intervals, apically punctuation weakens, leaving an impunctate band before extreme elytral apex; rest of elytral disk with large impunctate 'mirror', most prominent on 2-4 elytral intervals; this mirror occasionally bears fine scattered punctures, in most cases limited to second elytral interval.

Propygidium and pygidium densely and coarsely punctate, punctures separated by about half to their own diameter; interspaces with microsculpture.

Anterior margin of median portion of prosternum (Fig. 16) rounded; marginal prosternal stria present laterally and as short anterior fragment; prosternal process on apical sixth distinctly elevated in respect to the remaining part; surface between carinal prosternal striae slightly convex, with scattered fine punctation, punctures surrounded by microsculpture; carinal prosternal striae well-impressed, parallel on prosternal apophysis, thence divergent anteriorly, terminating in deep and large prosternal foveae; lateral prosternal striae carinate, sub-parallel, apically terminating near the point where carinal prosternal striae enter prosternal foveae.

Anterior margin of mesoventrite broadly, but shallowly inwardly arcuate; discal marginal mesoventral stria well impressed, carinate; disc of mesoventrite with dense deep large punctures intermingled with much smaller microscopic punctuation; meso-metaventral sutural stria marked as straight row of punctures; intercoxal disc of metaventrite slightly convex with scattered microscopic punctures, becoming coarser and denser along basal margin; lateral metaventral stria well impressed, carinate, almost straight, shortened; lateral disc of metaventrite concave, with regular shallow large setigerous punctures; metepisternum with denser and coarser punctation, punctures almost confluent; fused metepimeron with somewhat sparser punctures; metepisternum + fused metepimeron with metepisternal stria.

Intercoxal disc of first abdominal ventrite incompletely striate laterally; on basal third with irregular scattered fine punctures separated by several times their own diameter; rest of first visible abdominal ventrite with scattered microscopic punctuation.

Protibia slightly dilated, outer margin apically with single low tooth topped by tiny denticle, in proximal direction three low triangular teeth topped by short rounded denticle appear, all three approximately of the same size, followed by another low tooth (occasionally bearing two tiny denticles), followed by a single tiny denticle growing out directly from outer margin of protibia; setae of outer row regular, rather short; protarsal groove rather deep; anterior protibial stria very shortened (absent?); setae of intermedian row situated on ridge delimiting proximal margin of protarsal groove; single tarsal denticle present near tarsal insertion; protibial spur short, bent, growing out from apical margin of protibia; apical margin of protibia posteriorly with three tiny denticles almost abutting each other; outer part of posterior surface obscurely variolate, punctate, separated from imbricate median part of posterior surface by vague boundary and row of short sclerotized setae; posterior protibial stria complete, bearing a row



Figures 17–25. 17 *Hemisaprinus lutshniki* (Reichardt, 1941) paratype, 8th sternite and tergite, ventral view **18** ditto, dorsal view **19** ditto, lateral view **20** *Hemisaprinus lutshniki* (Reichardt, 1941) paratype, 9th + 10th tergites, dorsal view **21** ditto, lateral view **22** *Hemisaprinus lutshniki* (Reichardt, 1941) paratype, spiculum gastrale, ventral view **23** ditto, lateral view **24** *Hemisaprinus lutshniki* (Reichardt, 1941) paratype, type, aedeagus, dorsal view **25** ditto, lateral view.

of fine sparse setae along its length, terminating in two tiny inner denticles; inner row of setae double, setae dense and short.

Mesotibia slender, outer margin with a single row of short denticles situated on low teeth; setae of outer row regular, sparse, about as long as denticles themselves; setae of intermedian row shorter and finer than those of outer row, regular; posterior mesotibial stria almost complete; anterior surface of mesotibia imbricate, with another row of approximately seven shorter denticles than those of outer row; anterior mesotibial stria complete, terminating in single tiny inner anterior denticle; mesotibial spur short; apical margin of mesotibia anteriorly with three short denticles; claws of apical tarsomere slightly bent, shorter than half its length; metatibia slenderer and longer than mesotibia, outer margin with approximately five short denticles situated on even lower teeth than those of mesotibia; apical-most tooth bearing two denticles; setae of outer row distinctly longer than denticles themselves; anterior face of metatibia punctate, with a row of approximately five tiny denticles; claws of apical-most metatarsomere longer than half of its length; metatibia otherwise similar to mesotibia.

Male genitalia: Eighth sternite (Figs 17–18) longitudinally medially separated, apically with medially-sized velum covered with dense micro-pores and several larger pseudopores medially; eighth tergite inwardly arcuate; eighth tergite and sternite fused laterally (Fig. 19). Ninth tergite (Fig. 20) medially with strong longitudinal sclerotization, apically inwardly slightly arcuate; tenth tergite outwardly arcuate apically, basally slightly inwardly arcuate. Spiculum gastrale (Figs 22–23) basally strongly dilated, outwardly arcuate; apically slightly triangularly dilated, without typical inwardly-turned apical "tails". Aedeagus (Figs 24–25) sub-parallel, parameres fused approximately on their apical halves, apex of aedeagus blunt. Basal piece of aedeagus rather short, ratio to parameres approximately 1:6; aedeagus curved laterally (Fig. 25).

Remarks. This species is very similar to *H. cyprius*, differing from it chiefly by the presence of a second dorsal elytral stria, absent with *H. cyprius* and aciculate elytral punctuation, as well as shining pronotum (matt in *cyprius*).

Hemisaprinus cyprius (Dahlgren, 1981)

Figs 26-28

Saprinus cyprius Dahlgren, 1981: 112.

Saprinus (Hemisaprinus) cyprius: Mazur (1984): 62; Mazur (1997): 231; Mazur (2004): 96. Hemisaprinus cyprius: Mazur (2011): 188.

Type locality. Cyprus, Kyrenia.

Type material examined. Saprinus cyprius: Holotype, \bigcirc , side-mounted on triangular mounting point with left antennal club missing, female genitalia extracted, glued to another mounting label below the specimen, with the following labels: "Cypern, Kyrenia / 22/2 - 14/3 [19]62 / Th. Palm leg." (printed); followed by: "HOLOTYPE



Figure 26. Hemisaprinus cyprius (Dahlgren, 1981) paratype, habitus.

/ SAPRINUS / CYPRIUS / G. DAHLGREN / 25.1.1981" (written in black ink); followed by: "Zool. Mus. Lund Sweden / Type No. 2280: 1-2 / Histeridae" (printedwritten); followed by: "**MZLU** / 2013 / 313" (green label, printed) (MZLU). Paratype, female, with following labels: "Q" (printed); followed by: "KYRENIA / CYPERN / 28.2.1962 / T. PALM LEG." (written in black ink); followed by: "PARATYPE / SAP-RINUS / CYPRIUS / G. DAHLGREN / 25.1.1981" (written in black ink); followed by: "Type No. / 2280:2" (printed-written); followed by: "**MZLU** / 2013 / 314" (green label, printed) (MZLU).

Re-description. Body length: PEL: 3.00–3.05 mm; APW: 1.00–1.05 mm; PPW: 2.15–2.25 mm; EL: 1.85–2.10 mm; EW: 2.35–2.50 mm. Body (Fig. 26) roundly oval, convex, elytra widest at humeri; cuticle of elytra castaneous, shining, pronotum



Figure 27. Hemisaprinus cyprius (Dahlgren, 1981) paratype, head, dorsal view.

dark, almost black, matt; body ventrally dark brown to almost black; abdominal ventrites (except for first visible) rufescent; legs, mouthparts and antennae rufo-castaneous; antennal club somewhat darker.

Antennal scape (Fig. 27) slightly thickened, densely punctate, lower margin carinate, with few short setae; club round, pointed apically, without visible articulation, entire surface with dense short sensilla intermingled with sparser longer erect sensilla; sensory structures of antennal club in form of four ovoid sensory areas on ventral side; vesicle(s) not examined.

Mouthparts: mandibles with rounded outer margin, densely punctate, mandibular apex pointed; sub-apical tooth of left mandible not examined; labrum convex, densely punctate; labral pits deep, each with two well-sclerotized long setae; terminal labial palpomere elongated, about twice as long as pen-ultimate, its width about one-third its length; mentum sub-trapezoid, anterior margin medially with deep notch surrounded with sparse rather long setae, lateral margins with single row of sparse shorter ramose setae; cardo of maxilla with few short setae; stipes triangular, with three short setae; terminal maxillary palpomere elongated, pointed apically, about three times as long as pen-ultimate; its width about one-third its length.



Figure 28. Hemisaprinus cyprius (Dahlgren, 1981) paratype, prosternum + mesoventrite.

Clypeus (Fig. 27) flat, gradually sloping down laterally, coarsely and densely punctate, punctures almost confluent; frontal stria largely interrupted medially, for short distance prolonged onto clypeus, supraorbital stria well impressed, carinate; frontal disc (Fig. 27) with coarse and dense punctures similar to those of clypeus, punctures in bottom with microsculpture; eyes convex, well visible from above. Pronotal sides (Fig. 26) on basal half moderately narrowing anteriorly, strongly narrowing on apical half; apical angles obtuse; median emargination for head shallow; pronotal depressions absent; marginal pronotal stria complete, somewhat weakened behind head; pronotal disc matt due to very dense microsculpture, laterally with very coarse and dense punctures, separated by less than their own diameter, punctures become finer and sparser medially where they are separated by several times their diameter; several rows of ovoid punctures present along pronotal base; pronotum with ante-scutellar depression; pronotal hypomeron asetose, with fine scattered punctures; scutellum well visible.

Elytral epipleuron with scattered fine punctures; marginal epipleural stria fine, complete; marginal elytral stria straight, well impressed and slightly carinate, continued as weakened complete apical elytral stria. Humeral elytral stria weakly impressed on basal fourth, doubled, surface mesad from it with irregular longitudinal strioles; inner subhumeral stria present as short median fragment; elytra with thin, impunctate striae 1, 3-4 (stria 2 absent); striae stopping short of elytral half apically; fourth dorsal elytral stria basally connected with sutural elytral stria by broad arch; sutural elytral stria well-impressed and complete, fine punctures within, apically connected with apical elytral stria; elytral humeri and flanks almost impunctate, elytral disc along sutural elytral stria on apical 2/5 with fine regular punctuation, punctures aciculate, separated by about twice their own diameter, interspaces with very dense microsculpture, punctuation enters elytral intervals, reaching its climax along first dorsal elytral stria where it reaches elytral base, toward elytral apex microsculpture as well as punctuation weakens; extreme elytral apex impunctate.

Propygidium and pygidium densely and coarsely punctate, punctures separated by about half to their own diameter; interspaces with microsculpture.

Anterior margin of median portion of prosternum (Fig. 28) almost straight; marginal prosternal stria present laterally and as short anterior fragment; prosternal process between carinal prosternal striae slightly convex, surface between carinal prosternal striae with scattered fine punctuation, punctures surrounded by microsculpture; carinal prosternal striae well-impressed, parallel on prosternal apophysis, thence divergent anteriorly, terminating in deep and large prosternal foveae; lateral prosternal striae carinate, sub-parallel, apically terminating near the point where carinal prosternal striae enter prosternal foveae.

Anterior margin of mesoventrite (Fig. 28) broadly inwardly arcuate; discal marginal mesoventral stria well impressed, carinate; disc of mesoventrite with dense shallow large punctures intermingled with much smaller microscopic punctuation; meso-metaventral sutural stria marked as a straight row of punctures; intercoxal disc of metaventrite slight-ly convex with scattered microscopic punctures, becoming coarser and denser along basal margin; lateral metaventral stria well impressed, carinate, almost straight, short-ened; lateral disc of metaventrite concave, with dense shallow large punctures; metepisternum with even denser and coarser punctation, punctures almost confluent; fused metepimeron with somewhat sparser punctures; metepisternum + fused metepimeron with metepisternal stria, which is almost unrecognizable under coarse punctuation.

Intercoxal disc of the first abdominal ventrite incompletely striate laterally; on basal third with irregular larger punctures separated by about their own to twice their diameter; rest of first visible abdominal ventrite with scattered microscopic punctuation. Protibia slightly dilated, outer margin with four moderately large triangular teeth topped by short rounded denticle, diminishing in size in proximal direction, followed by three tiny denticles growing out directly from outer margin of protibia; setae of outer row regular, rather short; protarsal groove deep; anterior protibial stria shortened on basal half; setae of intermedian row not examined; two tarsal denticles present near tarsal insertion; protibial spur short, bent, growing out from apical margin of protibia; apical margin of protibia posteriorly with four tiny denticles almost abutting each other; outer part of posterior surface obscurely variolate, punctate, separated from glabrous median part of posterior surface by vague boundary and row of short sclerotized setae; posterior protibial stria complete, terminating in several tiny inner denticles; inner row of setae double, setae dense and short.

Mesotibia slender, outer margin with a single row of short denticles situated on low teeth; setae of outer row regular, sparse, longer than denticles; setae of intermedian row shorter and finer than those of outer row, regular; posterior mesotibial stria not examined; anterior surface of mesotibia glabrous, with another much sparser row of shorter denticles than those of outer row; anterior mesotibial stria complete, terminating in single tiny inner anterior denticle; mesotibial spur short; apical margin of mesotibia anteriorly with three short denticles; claws of apical tarsomere slightly bent, shorter than half its length; metatibia slenderer and longer than mesotibia, in all aspects similar to it, but denticles on outer margin much sparser, situated on even lower teeth than those of mesotibia; apical-most tooth bearing two denticles.

Male unavailable.

Remarks. Dahlgren (1981) does not mention the absence of the second dorsal elytral stria, which is perhaps the best separating character from the similar species, esp. *H. lutshniki*.

Key to the species of the genus Hemisaprinus

- 2(1) Usually bi-colored species: pronotum dark, almost black; elytra at least partly reddish-brown; dorsal cuticle without greenish hue, with slight to prominent bronze metallic tinge (Figs 13, 26); carinal prosternal striae terminate in prosternal foveae, lateral prosternal striae terminate near apices of carinal prosternal striae (Figs 16, 28).
- tures, with slight bronze lustre; punctures on punctate part of elytra less

Discussion

Although Mazur (2011) did not provide any background information or justification for separating Hemisaprinus from Saprinus and erecting it as an independent genus he was motivated by the presence of the prosternal foveae in Hemisaprinus for his nomenclatural act (Mazur, pers. comm. 2014). Indeed, the presence of prosternal foveae is completely alien to Saprinus species and can justify the separation of Hemisaprinus from Saprinus. In the recently performed phylogenetic analysis aimed at disentangling the relationships of the genera and subgenera of the Saprininae (Lackner, unpublished) the type species of Hemisaprinus, H. subvirescens was recovered deeply nested in the clade containing most of the type species of the Palaearctic and Nearctic taxa traditionally allied with Saprinus (sensu Mazur 2011). Its position is, however, not near the type species of Saprinus, S. semistriatus and its placement in the clade was unambiguously supported by one synapomorphy: sensory structures of the antenna, which form regular patches on ventral side of the club and are usually four in number (Fig. 3). Saprinus, with 154 currently valid species is the most species-rich and widely distributed genus of the entire subfamily occurring on all continents except Antarctica (Mazur 2011). The genus Saprinus is most likely non-monophyletic and its phylogeny-based revision is highly necessary (see also Lackner 2010).

Hemisaprinus, although presumably related to *Saprinus* based on external as well as genitalic characters (Lackner, unpublished), is presumed to be monophyletic sharing the synapomorphy of present prosternal foveae. It contains three species that, on one hand, share the synapomorphy of the presence of prosternal foveae, on the other hand, however, the species differ in the arrangements of the two sets of prosternal striae. Carinal prosternal striae of *H. subvirescens* do not enter the prosternal foveae; while the lateral prosternal striae do. In the case of the two other species (*H. lutshniki* and *H. cyprius*) the carinal prosternal striae do terminate in the prosternal foveae, while the lateral prosternal striae terminate near the apices of carinal prosternal striae. According to my recent studies on the morphology of the Saprininae, the configuration of the two sets of prosternal striae was found to be a rather variable character, even within one genus (and even within one species!) and I was unable to score this character unambiguously or parse it into discrete character states. Hence, I refrained from using this character in my phylogenetic studies (Lackner, unpublished) and do not use the different arrangements of the two sets of striae to further split *Hemisaprinus*.

On the other hand, a very similarly structured prosternal process, including the prosternal foveae is found among some members of the Nearctic and Neotropical subgenus *Hesperosaprinus* Wenzel, 1962 of the genus *Euspilotus* Lewis, 1907. The author is not familiar with most members of this species-rich subgenus (45 currently

valid species, Mazur 2011), but based on the morphology studied and dissections of the antennal club of the type species of the subgenus, E. (H.) assimilis (Paykull, 1811) at least two fundamental differences among this species on one hand, and members of Hemisaprinus on the other hand, were observed. The prosternal foveae of E. (H.) assimilis are connected by marginal prosternal stria, whereas such stria is lacking in members of Hemisaprinus; and, furthermore, the sensory structures of the antenna of E. (H.) assimilis consist of two (ventral and dorsal) circular sensory areas and a single, ball-shaped vesicle. The antennal character perhaps best separates the members of the respective genera Hemisaprinus and Euspilotus. However, further studies of this enigmatic structure are required, especially among Nearctic and Neotropical Saprininae.

Dahlgren (1981) had some doubts about the placement of *Saprinus cyprius* into the subgenus *Hemisaprinus*, and remarked that: "Because the prosternal foveae are normally present in [S. (*Hemisaprinus*)] subvirescens and [S. (*H.*)] lutshniki this species [S. cyprius] should be assigned to the subgenus *Hemisaprinus*. However, the appearance of cyprius is very different from these [two] species, and thereby the subgenus would be very heterogeneous. It seems that the genus *Saprinus* shows a tendency to produce species with prosternal pits and this tendency becomes manifested in different branches of the genealogical tree". Although Dahlgren (1981) did not explicitly place S. cyprius into *Hemisaprinus*, Mazur included it in this subgenus already in the first edition of his catalogue (1984) without providing any reason. Presumably it was likewise the presence of the prosternal foveae that inspired this placement.

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