ZooKeys 320: 1–28 (2013)
doi: 10.3897/zookeys.320.4565
www.zookeys.org

RESEARCH ARTICLE

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

Chaetopteryx bucari sp. n., a new species from the *Chaetopteryx rugulosa* group from Croatia (Insecta, Trichoptera, Limnephilidae) with molecular, taxonomic and ecological notes on the group

Mladen Kučinić[1,†], Ildikó Szivák[2,‡], Steffen U. Pauls[3,§], Miklós Bálint[3,|], Antun Delić[4,¶], Ivan Vučković[5,#]

1 *Department of Biology (Group for Systematic Zoology & Entomology), Faculty of Science, University of Zagreb, Rooseveltov trg 6, 10000 Zagreb, Croatia* **2** *Balaton Limnological Institute, Centre for Ecological Research, Hungarian Academy of Science, H-8237 Tihany, Klebelsberg Kuno u. 3, Hungary* **3** *Biodiversity and Climate Research Centre (BiK-F), Senckenberg Gesellschaft für Naturforschung, Senckenberganlage 25, 60325 Frankfurt am Main, Germany* **4** *Faculty of Ecudation, Department in Petrinja, University of Zagreb, Matice Hrvatske 12, 44250, Petrinja, Croatia* **5** *Elektroprojekt d.d., Civil and Architectural Engineering Department, Alexandera von Humboldta 4, 10000 Zagreb, Croatia*

† *http://zoobank.org/62E138E2-169A-4680-B96E-232BC4FB9C4B*
‡ *http://zoobank.org/3ACAC586-1156-4EE3-9B52-0B40966801DA*
§ *http://zoobank.org/16F1195D-04AE-4C13-87E9-017C632969E0*
| *http://zoobank.org/9131E7ED-B036-44C3-B996-78B8C317B82E*
¶ *http://zoobank.org/BE7462E8-4584-4F0B-A50F-DC7BC696809C*
# *http://zoobank.org/C38ECB62-BDA7-4A53-84C3-166C13856AF9*

Corresponding author: *Mladen Kučinić* (kucinic@zg.biol.pmf.hr)

Academic editor: *R. Holzenthal* | Received 23 December 2012 | Accepted 27 June 2013 | Published 31 July 2013

http://zoobank.org/2ABD421F-E3D0-4D8B-A03E-AD67EE489FEE

Citation: Kučinić M, Szivák I, Pauls SU, Bálint M, Delić A, Vučković I (2013) *Chaetopteryx bucari* sp. n., a new species from the *Chaetopteryx rugulosa* group from Croatia (Insecta, Trichoptera, Limnephilidae) with molecular, taxonomic and ecological notes on the group. ZooKeys 320: 1–28. doi: 10.3897/zookeys.320.4565

Abstract

We describe a new autumnal caddisfly species *Chaetopteryx bucari* **sp. n.** from 8 localities in the Banovina region of Croatia. We also present molecular, taxonomic and ecological notes (emergence, sex ratio and seasonal dynamics) on the new species and discuss the distribution of *Chaetopteryx* species in general and the *C. rugulosa* group in particular. Based on Bayesian phylogenetic analysis *C. rugulosa schmidi* was sepa-

rated from the clade containing the other subspecies of *C. rugulosa*. Thus the subspecies *C. r. schmidi* is here raised to species level, *C. schmidi*, as it was described originally. We further present distribution data on rare species in the genus *Chaetopteryx* in Croatia.

Keywords
Chaetopteryx, aquatic insects, new species, distribution, Croatia

Introduction

The genus *Chaetopteryx* belongs to a small number of caddisfly genera with adults that are adapted to low air temperatures and emerge in autumn or winter, mostly from October-January. The larvae of most species live in small headwater streams and springs. This genus is distributed in Europe and parts of Asia (e.g., Asia Minor, Iran) (Malicky 2004, Lodovici and Valle 2007, Sipahiler 2010). In Europe, *Chaetopteryx* comprises 25 species (Malicky 2004, Lodovici and Valle 2007, Oláh 2011a, 2011b). A particularly interesting species group in the genus is the *Chaetopteryx rugulosa* group. This radiation consists of 6 species and 3 subspecies: *Chaetopteryx rugulosa rugulosa* Kolenati, 1848; *Chaetopteryx rugulosa mecsekensis* Nógrádi, 1986; *Chaetopteryx rugulosa noricum* Malicky, 1976; *Chaetopteryx rugulosa schmidi* Botosaneanu, 1957; *Chaetopteryx clara* McLachlan, 1876; *Chaetopteryx euganea* Moretti & Malicky, 1986; *Chaetopteryx goricensis* Malicky and Krušnik, 1986; *Chaetopteryx irenae* Krušnik & Malicky, 1986 and *Chaetopteryx marinkovicae* Malicky and Krušnik, 1988 (Malicky 2004).

Four years ago we started systematically collecting adults of the genus *Chaetopteryx*, including members of the *C. rugulosa* group in Croatia. This paper has 2 main objectives, first to present and describe a new species from the *C. rugulosa* group found in Croatia, and second to present new molecular, taxonomic, distributional, and ecological information on the *C. rugulosa* group.

Material and methods

Fieldwork. We collected specimens of *Chaetopteryx* including *C. rugulosa* group species in the continental (central Croatia, Banovina, Hrvatsko zagorje, Kordun, Slavonia), mountain (Gorski kotar, Lika regions) and Mediterranean (Istria and Dalmatia) regions of Croatia. Collecting methods included the use of entomological nets and handpicking specimens from walls of small buildings or wells, or from the riparian vegetation near springs and headwater streams. In one spring (Pecki spring, Banovina region) (Table 1) we installed 5 pyramid-type emergence traps in 2010 and 2011 to investigate the emergence dynamics of caddisflies (Figure 1). This investigation is part of a multi-year study on emergence dynamics of aquatic insects in springs and other aquatic habitats in Croatia and the Dinaric karst of the Balkan Peninsula (Bosnia and Herzegovina) (Kučinić 2002, Previšić et al. 2007, Ivković et al. 2011, Semnički et al.

Table 1. Localities where *Chaetopteryx bucari*, sp. n., was collected, including habitat type, elevation (m a.s.l.), and geographic coordinates.

Location	Character of location	Altitude (m)	Geographic coordinates
Bijele stijene	wellspring and stream	144	45°25'23"N, 16°13'23"E
Gore	wellspring	165	45°24'21"N, 16°14'22"E
Hrvatski Čuntić	stream	159	45°21'28"N, 16°17'04"E
Marića točak	wellspring	163	45°21'29"N, 16°17'03"E
Pašino vrelo	spring	185	45°17'16"N, 16°25'13"E
Pecki	spring	161	45°23'50"N, 16°14'40"E
Slabinja	wellspring	104	45°13'05"N, 16°37'52"E
Varoški bunar	wellspring	130	45°13'34"N, 16°33'12"E

Figure 1. Type locality of *Chaetopteryx bucari*, sp. n., showing pyramid-type emergence traps, Pecki spring, Croatia.

2011, 2012, M. Kučinić unpublished data). The emergence trapping methodology was presented in detail by Kučinić (2002) and Previšić et al. (2007).

In pyramid-type emergence traps caddisflies were collected in 1% formaldehyde and thereafter stored in 80% alcohol. All other collected specimens were stored directly in 80% or 96% alcohol. All specimens were deposited in the collections of the first and second authors. The holotype is deposited in the Croatian Natural History Museum in Zagreb.

Laboratory work. For the phylogenetic analysis we compiled mtCOI DNA sequence data for 103 specimens from the *C. rugulosa* group (Table 2). We also sequenced several outgroup taxa of varying putative phylogenetic depths including congeneric species (e.g., *Chaetopteryx gessneri* McLachlan, 1876, *Chaetopteryx fusca* Brauer, 1857*, Chaetopteryx major* McLachalan, 1876, *Chaetopteryx villosa* (Fabricius, 1798)), other members of the tribe Chaetopterygini (*Chaetopterygopsis maclachlani* (Stein, 1874)), other members of the subfamily Limnephilinae (*Limnephilus centralis* Curtis, 1834), and members of a different subfamily of Limnephilidae (e.g. *Metanoea rhaetica* Schmid, 1955, *Drusus alpinus* (Meyer-Dür, 1875), *Drusus rectus* McLachlan, 1868).

Systematic presentation follows Morse (2013). The terminology and morphological assessment of the *C. rugulosa* group follows Malicky et al. (1986), Malicky and Krušnik (1988), Urbanič and Krušnik (2003), Botosaneanu and Giudicelli (2004), Holzenthal et al. (2007), Oláh (2011a), and Vučković et al. (2011). Comparative assessments of morphological features of *C. bucari* were based on the other specimens collected in Croatia (*C. r. rugulosa*, *C. marinkovicae*) or based on literature (e.g., *C. r. schmidi*, *C. r. mecsekensis*, Malicky et al. 1986, Malicky 2004). Morphological features of genitalia of *C. bucari* were analysed from 84 specimens (40 males and 44 females).

The mitochondrial COI barcodes were generated at the Canadian Centre for DNA Barcoding, University of Guelph, Canada. Standard barcoding protocols for DNA extraction (Ivanova et al. 2006), PCR amplification and COI sequencing (Hajibabaei et al. 2005, de Waard et al. 2008) were used. Full-length COI-5P DNA barcodes were amplified using C_LepFolF/C_LepFolR (Folmer et al. 1994, Hajibabaei et al. 2006) and LCO1490/HCO2198 (Folmer et al. 1994) primer sets. COI barcodes and detailed specimen information can be found in the Barcode of Life Data Systems (BOLD; http://www.boldsystems.org/) (Ratnasingham and Hebert 2007) within the project "*Chaetopteryx* of Europe." Unpublished COI barcodes of additional *Chaetopteryx* outgroups were provided by Karl Kjer, Rutgers University, USA (Table 2). The sequence of *Limnephilus centralis* Curtis, 1834 was taken from Malm and Johanson (2011) (Table 2).

Phylogenetic analysis. Sequences were edited manually and aligned using the program Geneious 5.4 (Drummond et al. 2011). The final alignment was 617 base pairs (bp) long. Bayesian phylogenetic analyses were performed using the Markov chain Monte Carlo method (B/MCMC) using MrBayes 3.2 (Buckley et al. 2002, Ronquist and Huelsenbeck 2003). We selected the best-fitting models of DNA substitution using Akaike information criterion (AIC) implemented in jModelTest 0.1.1 (Guindon and Gascuel 2003, Posada 2008). jModelTest indicated a general time re-

Table 2. List of species included in the DNA analysis (mtCOI sequences). Localities are given with country code, locality/specimen data, and collection date.

Species name	Locality	Specimen ID	Accession number	Collectors/ Source
Chaetopteryx aproka	ROU, Ignis Mts., springs near Desesti-Statiunea Izvoare, 21.10.2010	CAxJC0101	HE858253	Ecsedi, Olah & Szivak
Chaetopteryx aproka	ROU, Ignis Mts., springs near Desesti-Statiunea Izvoare, 21.10.2010	CAxJC0102	HE858254	Ecsedi, Olah & Szivak
Chaetopteryx aproka	ROU, Ignis Mts., springs near Desesti-Statiunea Izvoare, 21.10.2010	CAxJC0103	HE858255	Ecsedi, Olah & Szivak
Chaetopteryx bosniaca	BIH, Livno, Sturba river, 08.11.2009	CBxED0101		Kučinić, Delić & Mihoci
Chaetopteryx bosniaca	BIH, Livno, Sturba river, 08.11.2009	CBxED0102		Kučinić, Delić & Mihoci
Chaetopteryx bosniaca	BIH, Livno, Sturba river, 08.11.2009	CBxED0103		Kučinić, Delić & Mihoci
Chaetopteryx bosniaca	BIH, Livno, Sturba river, 08.11.2009	CBxED0104		Kučinić, Delić & Mihoci
Chaetopteryx bosniaca	BIH, Livno, Sturba river, 08.11.2009	CBxED0105		Kučinić, Delić & Mihoci
Chaetopteryx clara	SLO, Ljubljana, Mostec park, Przanec stream, 06.12.2009	CCxEA0101	JF891164	Dery & Szivak
Chaetopteryx clara	SLO, Ljubljana, Mostec park, Przanec stream, 06.12.2009	CCxEA0102	JF891165	Dery & Szivak
Chaetopteryx clara	SLO, Ljubljana, Mostec park, Przanec stream, 06.12.2009	CCxEA0103	JF891166	Dery & Szivak
Chaetopteryx clara	SLO, Ljubljana, Mostec park, Przanec stream, 06.12.2009	CCxEA0104	JF891167	Dery & Szivak
Chaetopteryx clara	SLO, Ljubljana, Mostec park, Przanec stream, 06.12.2009	CCxEA0105	JF891168	Dery & Szivak
Chaetopteryx goricensis	SLO, spring of Lokavscek stream near Predmeja, 06.12.2009	CGREG0101	JF891159	Dery & Szivak
Chaetopteryx goricensis	SLO, spring of Lokavscek stream near Predmeja, 06.12.2009	CGREG0102	JF891160	Dery & Szivak
Chaetopteryx goricensis	SLO, spring of Lokavscek stream near Predmeja, 06.12.2009	CGREG0103	JF891161	Dery & Szivak
Chaetopteryx goricensis	SLO, spring of Lokavscek stream near Predmeja, 06.12.2009	CGREG0104	JF891162	Dery & Szivak
Chaetopteryx goricensis	SLO, spring of Lokavscek stream near Predmeja, 06.12.2009	CGREG0105	JF891163	Dery & Szivak
Chaetopteryx goricensis	SLO, spring near Čekovnik (Hlevise), 05.12.2009	CGREG0201	JF891154	Dery & Szivak
Chaetopteryx goricensis	SLO, spring near Čekovnik (Blask), 05.12.2009	CGREG0301	JF891155	Dery & Szivak
Chaetopteryx goricensis	SLO, spring near Čekovnik (Blask), 05.12.2009	CGREG0302	JF891156	Dery & Szivak
Chaetopteryx goricensis	SLO, spring near Čekovnik (Blask), 05.12.2009	CGREG0303	JF891157	Dery & Szivak

Species name	Locality	Specimen ID	Accession number	Collectors/ Source
Chaetopteryx goricensis	SLO, spring near Čekovnik (Blask), 05.12.2009	CGREG0304	JF891158	Dery & Szivak
Chaetopteryx irenae	SLO, Susica stream near Misliče, 06.12.2009	CIxEI0101	JF891169	Dery & Szivak
Chaetopteryx irenae	SLO, Susica stream near Misliče, 06.12.2009	CIxEI0102	JF891170	Dery & Szivak
Chaetopteryx irenae	SLO, Misliče, Susica stream, 06.12.2009	CIxEI0103	JF891171	Dery & Szivak
Chaetopteryx irenae	SLO, Misliče, Susica stream, 06.12.2009	CIxEI0104	JF891172	Dery & Szivak
Chaetopteryx irenae	SLO, Misliče, Susica stream, 06.12.2009	CIxEI0105	JF891173	Dery & Szivak
Chaetopteryx major	HUN, Mecsek Mts., Vár valley, Pásztor spring 05.11.2010	CMJKB0101	JF891233	Olah, Szivak & Uherkovich
Chaetopteryx major	HUN, Mecsek Mts., Vár valley, Pásztor spring 05.11.2010	CMJKB0102	HE858256	Olah, Szivak & Uherkovich
Chaetopteryx major	HUN, Mecsek Mts., Vár valley, Pásztor spring 05.11.2010	CMJKB0103	HE858257	Olah, Szivak & Uherkovich
Chaetopteryx major	HUN, Mecsek Mts., Vár valley, Pásztor spring 05.11.2010	CMJKB0104	HE858258	Olah, Szivak & Uherkovich
Chaetopteryx major	AUT, valley Hottmannsgraben, Unteraspang (Aspang Markt) 19.11.2009	CMJDJ0101	JF891234	Dery & Szivak
Chaetopteryx marinkovicae	CRO, Kompanj, 14.11.2009	CMREI0101	JF891174	Kučinić & Vučković
Chaetopteryx marinkovicae	CRO, Kompanj, 14.11.2009	CMREI0102	JF891175	Kučinić & Vučković
Chaetopteryx marinkovicae	CRO, Kompanj, 14.11.2009	CMREI0103	JF891176	Kučinić & Vučković
Chaetopteryx marinkovicae	CRO, Kompanj, 14.11.2009	CMREI0104	JF891177	Kučinić & Vučković
Chaetopteryx marinkovicae	CRO, Kompanj, 14.11.2009	CMREI0105	JF891178	Kučinić & Vučković
Chaetopteryx rugulosa mecsekensis	HUN, Mecsek Mts., Nagy-Mély valley, Kánya spring, 14.11.2009	CRMKB0101	JF891179	Szivak
Chaetopteryx rugulosa mecsekensis	HUN, Mecsek Mts., Vár valley, Pásztor spring, 06.11.2009	CRMKB0201	JF891180	Szivak & Uherkovich
Chaetopteryx rugulosa mecsekensis	HUN, Mecsek Mts., Melegmányi valley, Mésztufa spring, 14.11.2009	CRMKB0301	JF891203	Szivak
Chaetopteryx rugulosa mecsekensis	HUN, Mecsek Mts., Vár valley, Iharos spring, 06.11.2009	CRMKB0401	JF891204	Szivak
Chaetopteryx rugulosa noricum	AUT, Saualpe, Klieningbach stream near Kliening, 21.11.2009	CRNDI0101	JF891187	Dery & Szivak
Chaetopteryx rugulosa noricum	AUT, Saualpe, springs of the Klippitzbach stream near Klippitztörl 21.11.2009	CRNDI0201	JF891188	Dery & Szivak
Chaetopteryx rugulosa noricum	AUT, Saualpe, springs of the Klippitzbach stream near Klippitztörl 21.11.2009	CRNDI0202	JF891189	Dery & Szivak

Species name	Locality	Specimen ID	Accession number	Collectors/ Source
Chaetopteryx rugulosa noricum	AUT, Saualpe, springs of the Klippitzbach stream near Klippitztörl 21.11.2009	CRNDI0203	JF891219	Dery & Szivak
Chaetopteryx rugulosa noricum	AUT, Saualpe, springs of the Klippitzbach stream near Klippitztörl 21.11.2009	CRNDI0204	JF891220	Dery & Szivak
Chaetopteryx rugulosa noricum	AUT, Saulape, spring of the Löllingbach stream near Stranach, 21.11.2009	CRNDI0301	JF891190	Dery & Szivak
Chaetopteryx rugulosa noricum	AUT, Saulape, spring of the Löllingbach stream near Stranach, 21.11.2009	CRNDI0302	JF891191	Dery & Szivak
Chaetopteryx rugulosa noricum	AUT, Saulape, spring of the Löllingbach stream near Stranach, 21.11.2009	CRNDI0303	JF891217	Dery & Szivak
Chaetopteryx rugulosa noricum	AUT, Saulape, spring of the Löllingbach stream near Stranach, 21.11.2009	CRNDI0304	JF891218	Dery & Szivak
Chaetopteryx rugulosa rugulosa	HUN, Kőszegi Mts., Hörmann spring near Velem, 18.11.2009	CRRDJ0101		Szivak
Chaetopteryx rugulosa rugulosa	HUN, Kőszegi Mts., Hörmann spring near Velem, 18.11.2009	CRRDJ0102		Szivak
Chaetopteryx rugulosa rugulosa	AUT, Mitterneuwald, Hermann spring, 19.11.2009	CRRDJ0201	JF891184	Dery & Szivak
Chaetopteryx rugulosa rugulosa	AUT, Sommeralm, Mixnitzbach stream, 20.11.2009	CRRDJ0301		Dery & Szivak
Chaetopteryx rugulosa rugulosa	AUT, Sommeralm, Mixnitzbach stream, 20.11.2009	CRRDJ0302	JF891214	Dery & Szivak
Chaetopteryx rugulosa rugulosa	AUT, Hochegg bei Grimmenstein, spring and its outlet, 19.11.2009	CRRDJ0401	JF891205	Dery & Szivak
Chaetopteryx rugulosa rugulosa	AUT, Hochegg bei Grimmenstein, spring and its outlet, 19.11.2009	CRRDJ0402	JF891206	Dery & Szivak
Chaetopteryx rugulosa rugulosa	AUT, Hochegg bei Grimmenstein, spring and its outlet, 19.11.2009	CRRDJ0403	JF891207	Dery & Szivak
Chaetopteryx rugulosa rugulosa	AUT, Ausserneuwald, spring, 19.11.2009	CRRDJ0501	JF891208	Dery & Szivak
Chaetopteryx rugulosa rugulosa	AUT, Ausserneuwald, spring, 19.11.2009	CRRDJ0502	JF891209	Dery & Szivak
Chaetopteryx rugulosa rugulosa	AUT, Plenzengreith, upper reach of stream Schöcklbach, 20.11.2009	CRRDJ0601	JF891230	Dery & Szivak
Chaetopteryx rugulosa rugulosa	AUT, Plenzengreith, upper reach of stream Schöcklbach, 20.11.2009	CRRDJ0602	JF891231	Dery & Szivak
Chaetopteryx rugulosa rugulosa	AUT, Plenzengreith, upper reach of stream Schöcklbach, 20.11.2009	CRRDJ0603	JF891232	Dery & Szivak
Chaetopteryx rugulosa rugulosa	SLO, Pohorje Mts., Osankarica (Lukanja), 10.11.2008	CRRDG0101	JF891186	Popijač
Chaetopteryx rugulosa rugulosa	SLO, Pohorje Mts., Osankarica (Lukanja), 10.11.2008	CRRDG0102	JF891215	Popijač

Species name	Locality	Specimen ID	Accession number	Collectors/ Source
Chaetopteryx rugulosa rugulosa	SLO, Pohorje Mts., Osankarica (Lukanja), 10.11.2008	CRRDG0103	JF891216	Popijač
Chaetopteryx rugulosa rugulosa	CRO, Medvednica Mts., Mrzlak spring near Sljeme, 18.11.2006	CRREE0101	JF891185	Popijač
Chaetopteryx rugulosa rugulosa	CRO, Medvednica Mts., Mrzlak spring near Sljeme, 18.11.2006	CRREE0102	JF891213	Popijač
Chaetopteryx rugulosa rugulosa	CRO, Medvednica Mts., Kraljičin Zdenac spring, Kraljičin Zdenac, 19.11.2009	CRREE0201	JF891210	Kučinić & Vučković
Chaetopteryx rugulosa rugulosa	CRO, Medvednica Mts., Bliznec stream, Podsljeme (Pilana), 09.12.2009	CRREE0301	JF891211	Kučinić & Vučković
Chaetopteryx rugulosa rugulosa	CRO, Žumberak Mts., Slapnica stream, Ribička kuća, 28.10.2009	CRREF0101	JF891212	Kučinić & Vučković
Chaetopteryx schmidi	ROU, spring brook in Cerna valley near Tatu, 13.11.2010	CRSJF0101	HE858259	Ecsedi & Szivak
Chaetopteryx schmidi	ROU, spring brook in Cerna valley near Tatu, 13.11.2010	CRSJF0102	HE858260	Ecsedi & Szivak
Chaetopteryx schmidi	ROU, spring brook in Cerna valley near Tatu, 13.11.2010	CRSJF0103	HE858261	Ecsedi & Szivak
Chaetopteryx schmidi	SRB, Derdap Mts., stream valley N of Golubinje, 13.10.2006	CRSGE0101	JF891182	Danyi, Kontschan & Muranyi
Chaetopteryx schmidi	SRB, Derdap Mts., stream valley N of Golubinje, 13.10.2006	CRSGE0102	JF891201	Danyi, Kontschan & Muranyi
Chaetopteryx schmidi	SRB, Derdap Mts.,Grgeci spring, Donji Milankovac, 13.10.2006	CRSGE0201	JF891183	Danyi, Kontschan & Muranyi
Chaetopteryx schmidi	SRB, Derdap Mts.,Grgeci spring, Donji Milankovac, 13.10.2006	CRSGE0203	JF891202	Danyi, Kontschan & Muranyi
Chaetopteryx bucari sp. n.	CRO, Kriz spring near Petrinja, 08.12.2009	CxxEC0101	JF891192	Kučinić, Delić & Bučar
Chaetopteryx bucari sp. n.	CRO, Kriz spring near Petrinja, 07.11.2009	CxxEC0102	JF891222	Kučinić, Delić & Bučar
Chaetopteryx bucari sp. n.	CRO, Kriz spring near Petrinja, 07.11.2009	CxxEC0103	JF891223	Kučinić, Delić & Bučar
Chaetopteryx bucari sp. n.	CRO, Kriz spring near Petrinja, 04.11.2009	CxxEC0104	JF891224	Bučar
Chaetopteryx bucari sp. n.	CRO, Kriz spring near Petrinja, 08.12.2009	CxxEC0105	JF891225	Kučinić, Delić, Bučar & Vučković
Chaetopteryx bucari sp. n.	CRO, Hrvatski Cuntic, Marića točak spring, 22.11.2009	CxxEC0201	JF891193	Kučinić, Delić & Bučar
Chaetopteryx bucari sp. n.	CRO, Hrvatski Cuntic, Marića točak spring, 21.11.2009	CxxEC0202	JF891221	Kučinić, Delić & Bučar
Chaetopteryx bucari sp. n.	CRO, Hrvatska Kostajnica, Varoški bunar spring, 06.12.2009	CxxEC0301		Kučinić, Delić & Bučar

Species name	Locality	Specimen ID	Accession number	Collectors/ Source
Chaetopteryx bucari sp. n.	CRO, Šuplji Kamen, Slabinja spring, 29.11.2009	CxxEC0401	JF891194	Kučinić, Delić & Bučar
Chaetopteryx bucari sp. n.	CRO, Banovina region, Pecki spring, 15.12.2009	CxxEC0501	JF891195	Kučinić, Delić & Bučar
Chaetopteryx bucari sp. n.	CRO, Banovina region, Pecki spring, 21.11.2009	CxxEC0502	JF891228	Kučinić, Delić & Bučar
Chaetopteryx bucari sp. n.	CRO, Banovina region, Pecki spring, 21.11.2009	CxxEC0503	JF891229	Kučinić, Delić & Bučar
Chaetopteryx bucari sp. n.	CRO, Banovina region, Gora spring, 10.12.2009	CxxEC0601	JF891226	Bučar
Chaetopteryx bucari sp. n.	CRO, Mečenčani, Pašino vrelo, 29.11.2009	CxxEC0701	JF891227	Kučinić, Delić & Bučar
Chaetopterygopsis maclachlani	AUT, Lower Austria, Rohrwiesteich, 20.10.2004	08HMCAD-331*	HMTRI331-09*	Malicky
Chaetopteryx fusca	AUT, Lower Austria, Rohrwiesteich, 20.10.2004	08HMCAD-333*	HMTRI333-09*	Malicky
Chaetopteryx gessneri	ITA, Umbria, Perugia, Fium Nera above Visso,11.12.2005	07HMCAD-0177*	HMCAD177-08*	Malicky
Chaetopteryx moretti	ITA, Belluno, Val Canzoi, Veneto, 31.10.2003	HM09Cm7*	HMTRI421-09*	Malicky
Chaetopteryx villosa	AUT, Lower Austria, Sarleinsbach, 27.06.2005	07HMCAD-0134*	HMCAD134-08*	Malicky
Drusus alpinus	IT, Valprato Soana, Ronchietto, 10.07.2004	HM09Dalp8*	HMTRI456-09*	Delmaistro
Drusus discolor	SK, Lower Tatra, Stream above Partizanska L'upča, 09.06.2008	ESCAD909-17*	KKCAD497-09*	Bonada
Drusus rectus	ES, Camprodon/Setcases Alta Val de Ter, 27.07.2004	HM09Drec8*	HMTRI423-09*	Aistleitner
Metanoea rhaetica	AUT, Carinthia, Valentinbach, Plockenstrasse, 08.07.2007	08HMCAD-020*	HMTRI020-08*	Malicky
Limnephilus centralis	NORWAY	NHRS:FI9	FN601020	Malm & Johanson 2011

versible model (Rodríguez et al. 1990) with a significant proportion of invariant sites (I=0.607) and with gamma-distributed rate heterogeneity (α=1.049) (GTR+I+G). We conducted Bayesian tree construction with 6 chains, 2 independent runs and 8 million generations. Trees were sampled every 1000th generation. The first 9000 generations were discarded as burn-in. We plotted the log-likelihood scores of sample points against generation time using Tracer 1.5 (Rambaut and Drummond 2009) to ensure that stationary was achieved after the first 9000 generations by checking whether the log-likelihood values of the sample points reached a stable equilibrium plateau. We used the remaining trees with average branch lengths to create a 50% majority-rule consensus tree with the sumt option of MrBayes. Posterior probabilities (pp) were obtained for each clade, whereby pp≥0.95 indicated significant support for clades. Finally, we also calculated the uncorrected pairwise distances between individuals based on mtCOI sequences using MEGA 5.1 (Tamura et al. 2011).

Figure 2. Bayesian tree for members of the *Chaetopteryx rugulosa* species group based on mitochondrial COI sequence. Black circles on nodes mark Bayesian posterior probabilities pp>0.95.

Microphotography and measuring. Microphotographic images of genitalia and forewing measurements were taken using a Leica Wild MZ8 stereomicroscope and Olympus SP-500 UZ digital camera. The photographs were processed with

the Olympus Quick Photo Camera 2.2. software package. Geographic coordinates and altitudes of sampling localities were recorded with a Garmin 'Oregon 450' GPS device.

Results

Phylogenetic analyses. In the Bayesian phylogenetic tree based on mtCOI sequences the *C. rugulosa* group species clustered into 4 strongly supported clades (Figure 2). *Chaetopteryx marinkovicae* was basal within the species group. The remaining species fell into 3 clades: a basal clade with *C. r. schmidi*, *C. bucari* sp. n., and 2 derived sister clades comprising *C. clara*, *C. goricensis*, *C. irenae*, and *C. r. rugulosa*, *C. r. noricum*, *C. r. mecsekensis*. *Chaetopteryx bucari* sp. n. is sister to the highly supported *C. r. schmidi*. The mean value of the uncorrected pairwise distance (p distance) was 2.02% between them (Table 3). The p distance did not reach 1% within the 2 clades (*C. bucari* sp. n.: 0.17%; *C. r. schmidi*: 0.75%). The relationship of the nominal species of the group *C. r. rugulosa* and *C. r. noricum* was not resolved, as the 4 subclades formed a polytomy. In the phylogenetic tree *C. r. schmidi* was clearly separated from the clade containing the subspecies of *C. rugulosa* (Figure 2). The mean values of p distance between the 3 subspecies of *C. rugulosa* ranged between 1.61–3.02 %, while the mean values between the *C. r. schmidi* and the other subspecies of *C. rugulosa* were distinctly higher (4.66 – 5.85%) (Table 3).

***Chaetopteryx bucari* Kučinić, Szivák & Delić, sp. n.**
http://zoobank.org/E775EC69-0E8A-4AF0-A027-F290BB31E76E
http://species-id.net/wiki/Chaetopteryx_bucari
Figures 3–16

Type material. Holotype male: CROATIA, Pecki spring, 45°23'50"N, 16°14'40"E, 161 m a.s.l., 15 December 2009, leg. Bučar, Delić, Kučinić, dry specimen, DNA Barcode ID: HGCAD046-10, deposited in the Croatian Natural History Museum in Zagreb.

Paratype: CROATIA, ♂ and ♀ (n=49): 1 female, Pecki spring, 21 November 2009, leg. Bučar, Delić, Kučinić, dry specimen, DNA Barcode ID: HGCAD087-10; 14 males, Pecki spring, 31 October 2011; 9 females, Pecki spring, 31 October 2010; 20 females, Pecki spring, 30 November 2011; 2 males and 2 females, Hrvatski Čuntić stream, 45°21'28"N, 16°17'04"E, 159 m a.s.l., 22 October 2010; 1 male, Marića točak, 45°21'29"N, 16°17'03"E, 163 m a.s.l., 23 November 2012, leg. Bučar, Delić, Kučinić (all specimens in alcohol).

Diagnosis. Male of *C. bucari* is most similar to *C. r. mecsekensis* and *C. r. schmidi* but differs in the following features: 1. In lateral view the inferior appendages in *C. bucari* are always with a pointed apex on the dorsal side, not rounded as in *C. r. mecsekensis*; 2. Bristles in *C. bucari* are set more distally from the membranous part of the aedeagus than in *C. r. mecsekensis* and *C. r. schmidi* and never reach (touch) the lateral

Table 3. Estimates of evolutionary divergence over sequence pairs within and between phylogenetically defined species and subspecies based on mtCOI sequence data. Distance matrix is shown with the mean ± SD values of the intraspecific and interspecific pairwise genetic distances for the all Chaetopterygini species included in the analysis. Abbrev.: CRR – *Chaetopteryx rugulosa rugulosa*, CRN – *C. r. noricum*, CRM – *C. r. mecsekensis*, CCX – *C. clara*, CGR – *C. goricensis*, CIX – *C. irenae*, CBU – *C. bucari* sp.n., CRS – *C. schmidi*, CMR – *C. marinkovicae*, CBO – *C. bosniaca*, CMO – *C. morettii*, CFU – *C. fusca*, CVI – *C. villosa*, CGE – *C. gessneri*, CAX – *C. aproka*, CMA – *Chaetopterygopsis maclachlani*, CMJ – *Chaetopteryx major*.

	CRR	**CRN**	**CRM**	**CCX**	**CGR**	**CIX**	**CBU**	**CRS**	**CMR**
CRR	1.05±0.97	1.61±0.49	3.02±0.17	4.87±0.24	4.55±0.24	4.79±0.27	4.63±0.30	5.44±0.39	9.24±0.46
CRN		1.20±0.89	2.83±0.31	5.06±0.23	4.74±0.24	5.26±0.20	5.17±0.18	5.85±0.11	9.45±0.27
CRM			0.17±0.11	4.79±0.09	4.47±0.10	4.69±0.12	4.38±0.11	4.66±0.13	8.87±0.07
CCX				0.00±0.00	0.37±0.07	3.80±0.08	5.86±0.14	5.69±0.06	9.92±0.00
CGR					0.03±0.07	3.48±0.10	5.54±0.15	5.37±0.08	9.93±0.05
CIX						0.10±0.09	4.41±0.16	5.11±0.18	10.15±0.08
CBU							0.17±0.13	2.02±0.20	8.79±0.13
CRS								0.75±0.57	8.72±0.06
CMR									0.00±0.00
CBO									
CMO									
CFU									
CVI									
CGE									
CAX									
CMA									
CMJ									

	CBO	**CMO**	**CFU**	**CVI**	**CGE**	**CAX**	**CMA**	**CMJ**
CRR	12.64±0.15	12.85±0.33	12.69±0.20	12.69±0.20	14.03±0.20	12.00±0.39	12.32±0.20	14.17±0.16
CRN	12.85±0.08	12.66±0.12	12.83±0.12	12.83±0.12	14.06±0.12	12.18±0.14	11.98±0.24	14.14±0.39
CRM	11.89±0.07	11.97±0.08	11.76±0.14	11.76±0.14	12.44±0.14	11.60±0.12	11.47±0.08	13.78±0.00
CCX	12.61±0.00	12.61±0.00	12.77±0.00	12.77±0.00	13.61±0.00	12.77±0.00	12.61±0.00	14.49±0.07
CGR	12.62±0.05	12.62±0.05	12.79±0.05	12.79±0.05	13.63±0.05	12.78±0.05	12.62±0.05	14.17±0.08
CIX	12.67±0.08	13.21±0.09	12.54±0.09	12.54±0.09	13.04±0.09	13.38±0.09	13.55±0.09	15.39±0.11
CBU	12.48±0.13	12.65±0.14	12.48±0.14	12.48±0.14	12.65±0.14	11.21±0.08	12.89±0.08	14.00±0.16
CRS	12.24±0.06	13.04±0.13	12.05±0.21	12.05±0.21	12.67±0.23	11.56±0.22	13.93±0.06	14.44±0.15
CMR	11.60±0.00	11.60±0.00	11.93±0.00	11.93±0.00	13.11±0.00	11.76±0.00	12.94±0.00	12.77±0.18
CBO	0.00±0.00	2.69±0.00	4.87±0.00	4.87±0.00	6.05±0.00	12.61±0.00	12.61±0.00	15.26±0.17
CMO		0.00±0.00	5.55±0.00	5.55±0.00	6.55±0.00	12.94±0.00	11.76±0.00	14.82±0.08
CFU			0.00±0.00	0.00±0.00	5.88±0.00	13.05±0.19	12.94±0.00	15.83±0.08
CVI				0.00±0.00	5.88±0.00	13.05±0.19	12.94±0.00	15.83±0.08
CGE					0.00±0.00	13.45±0.00	13.44±0.00	15.87±0.09
CAX						0.35±0.00	11.71±0.19	13.44±0.11
CMA							0.00±0.00	13.04±0.15
CMJ								0.47±0.51

Figure 3. *Chaetopteryx bucari*, sp. n., adults at type locality, Pecki spring, Croatia.

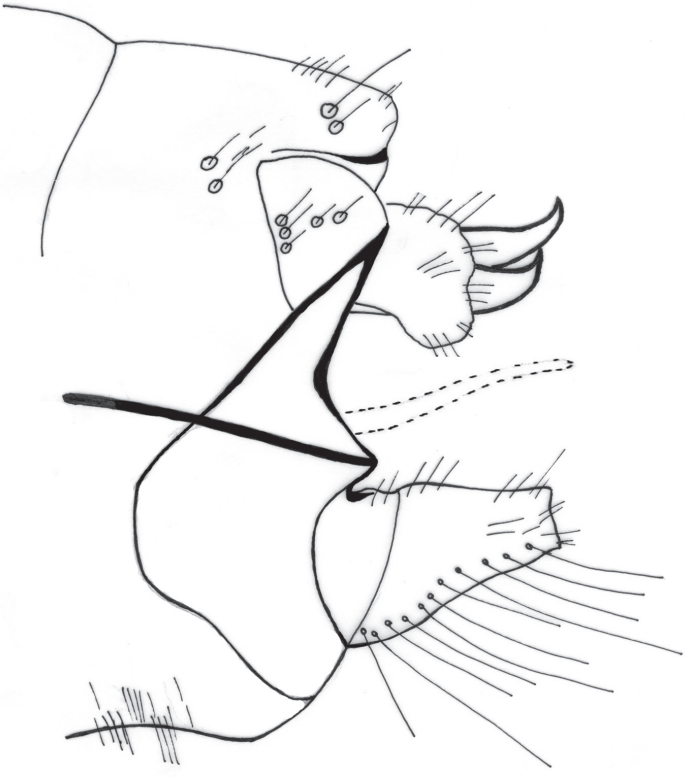


Figure 4. *Chaetopteryx bucari* sp. n., male genitalia, lateral view.

Figure 5. *Chaetopteryx bucari* sp. n., male genitalia, lateral view.

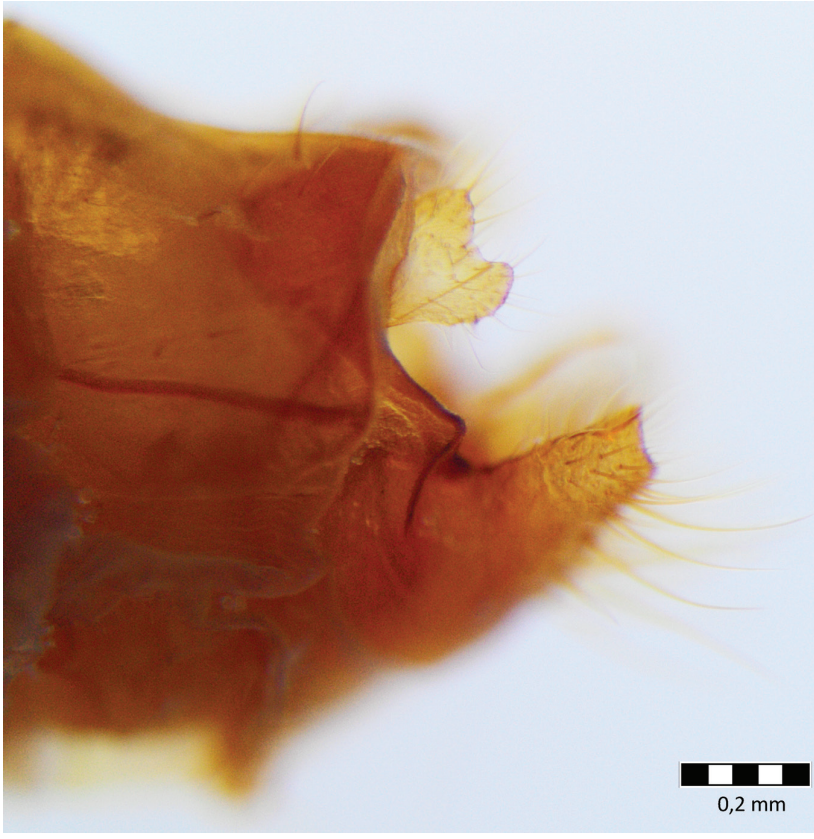


Figure 6. *Chaetopteryx bucari* sp. n., male genitalia, lateral view.

membranous finger, as in *C. r. mecsekensis*. Female of *C. bucari* is clearly different from other species in the *C. rugulosa* group (e.g., form of the visible finger on lateral side, form of the anal tube, form of the supragenital plate of segment X in lateral and ventral views, form of the median lobe of the vulvar scale in ventral view). We did not find strong morphological variability among the females of the new species (except the median lobe of the vulvar scale). Females of *C. bucari* have in lateral, ventral and dorsal views very visible finger-shaped proturbances (ventral lobes of tergite IX) on the anal tube which is lacking in *C. r. mecsekensis* and *C. r. schmidi*. In lateral view the excision of the anal tube in *C. r. rugulosa* is more pronounced than in *C. bucari*. The median lobe of the vulvar scale in *C. r. mecsekensis*, *C. r. rugulosa* and *C. r. schmidi* is longer and more visible than in *C. bucari*.

Description. Wings and legs yellow to yellowish-brown; veins darker in both sexes (Figure 3). Antennae long, grey to fuscous. Scapus yellow to yellowish-brown, thorax and abdomen yellow. Spur formula male 0,3,3, female 1,3,3. Ocelli present. Forewing with round apex; length 7.7–9.9 mm in males, 7.2–10.1 mm in females.

Male genitalia (Figures 4–11). In dorsal view, spinulose zone of tergite VIII well developed with yellow setae. Segment IX ventrally broad, dorsally narrow in lateral view (Figures 4–5). Superior appendages with small yellow setae, shape of superior appendages variable (Figures 4–7b–d), usually in one of two forms (Figures 4–6). In lateral view, 1st form with posterior edge slightly rounded apically, concave at middle (Figure 5); in 2nd form, dorsal side more protuberant with round or irregular apex (Figures 4, 7b). In some specimens triangular or rectangular intermediate forms are found (Figure 7c-d). Inferior appendages in lateral view rectangular, anterior part broad, posterior part narrow (Figures 4–7a). Apical flap of inferior appendage developed, in lateral view with pointed apex (tip) and ventral side slightly rounded; or with apex forked, long setae present on ventral side (Figures 4–7a). Intermediate appendages (paraproctal complex) elongated in lateral view with long, connecting middle section, apical hook narrowing with upward–curving apex (Figures 4–5), basal triangular part of paraproct relatively large in caudal view (Figures 8–9). Phallic organ (phallus) a single tube consisting of phallic apodeme, phallobase, aedeagus and parameres. Aedeagus relatively long, sclerotized, in posterior part with membranous lobes, lateral lobes membranous finger-like proturbances (endophallus) (Figures 10a–d). Two relatively short parameres set very distant from posterior membranous part of aedeagus (Figures 10a–b, 10d); parameres with sclerotized, straight, stout, brown bristles (Figures 10a–b, 10d, 11a–f). Bristles vary in width and length (Figure 11a–f); lateral bristles shorter; bristles arranged in 1 fan-like row (Figure 11a–f); in specimens with more bristles, some form 2nd row; bristles vary from 5-10.

Female genitalia (Figures 12–16). Anal tube (fusion of tergites IX and X) in lateral view broad, relatively elongated with one excision and very distinct finger-shaped proturbance (lobes of tergite IX) on ventral side (Figures 12–13). Apex of proturbance rounded or slightly pointed with small yellow setae (Figures 12–15). In 2/3rds of specimens examined ventral and dorsal lips of anal tube equal in length, in 1/3rd ventral lip longer. In dorsal view anal tube thickened with digitate proturbance on lateral side

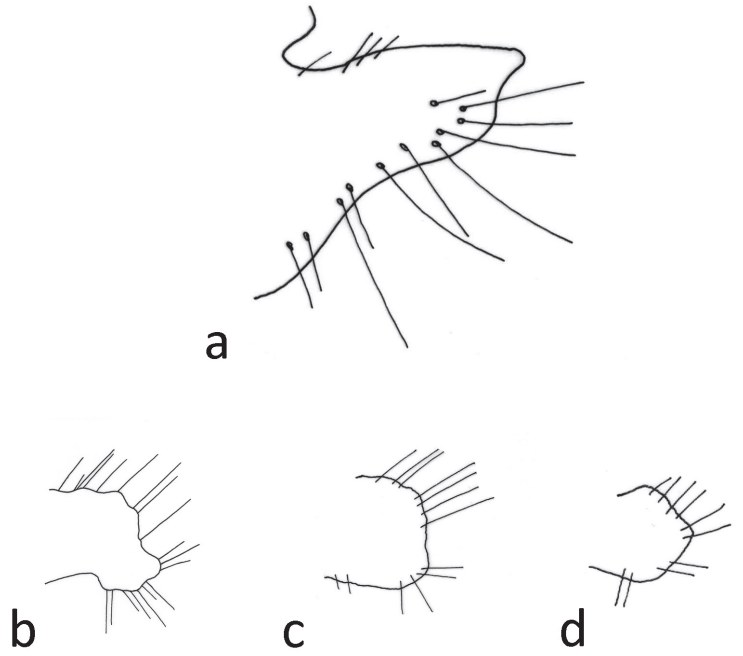


Figure 7. *Chaetopteryx bucari* sp. n., male genitalia, lateral view **a** inferior appendages **b–d** superior appendages.

Figure 8. *Chaetopteryx bucari* sp. n., male genitalia, caudal view.

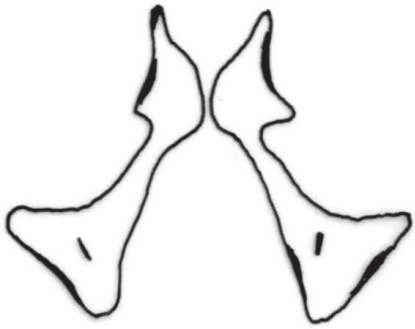


Figure 9. *Chaetopteryx bucari* sp. n., male genitalia, intermediate appendages (paraproctal complex), caudal view.

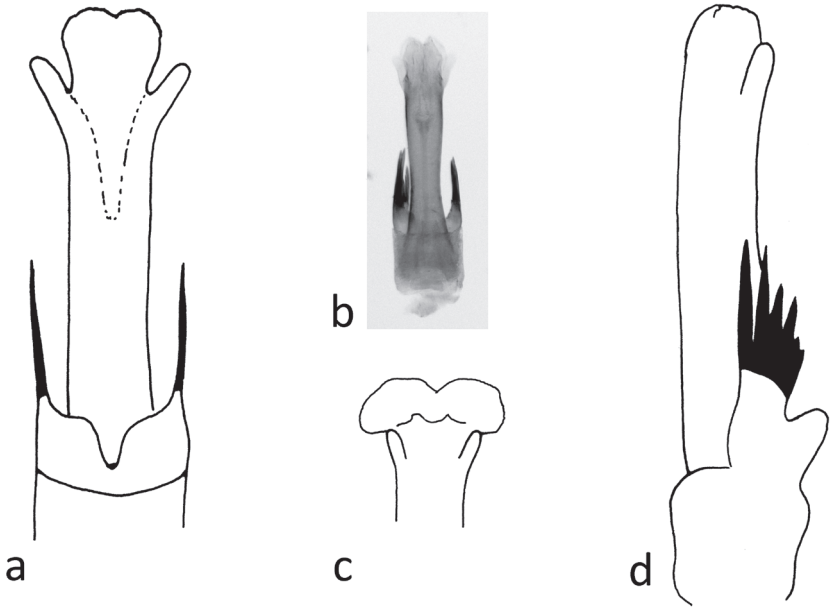


Figure 10. *Chaetopteryx bucari* sp. n., male genitalia, phallic organ (phallus): **a** dorsal view **b** ventral view **c** posterior membranous part of aedeagus **d** lateral view.

and small excision (recess) in middle (Figure 14). In ventral view anal tube broad with larger excision (recess) in middle than in dorsal side (Figure 15). Supragenital plate of segment X well-developed, triangular in shape in lateral and ventral views (Figures 12, 15). Lateral segment of vulvar scale relatively short in ventral view, with flat or slightly rounded apex (Figure 16a–c). Median lobe of vulvar scale (lower vulvar lip) with very small rounded or pointed apex (Figure 16b–d). In ca. 1/3rd of specimens' median lobe of vulvar scale not visible (Figure 16a).

Etymology. The species is dedicated to Professor Matija Bučar from the Faculty of Education, Department in Petrinja, University of Zagreb.

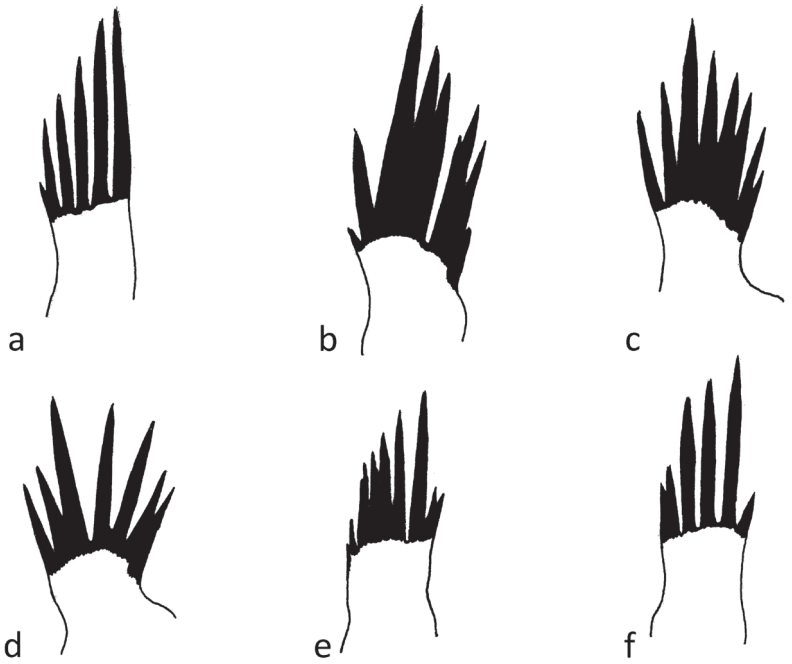


Figure 11. *Chaetopteryx bucari* sp. n., male genitalia **a-f** parameres with sclerotized bristles.

Figure 12. *Chaetopteryx bucari* sp. n., female genitalia, lateral view.

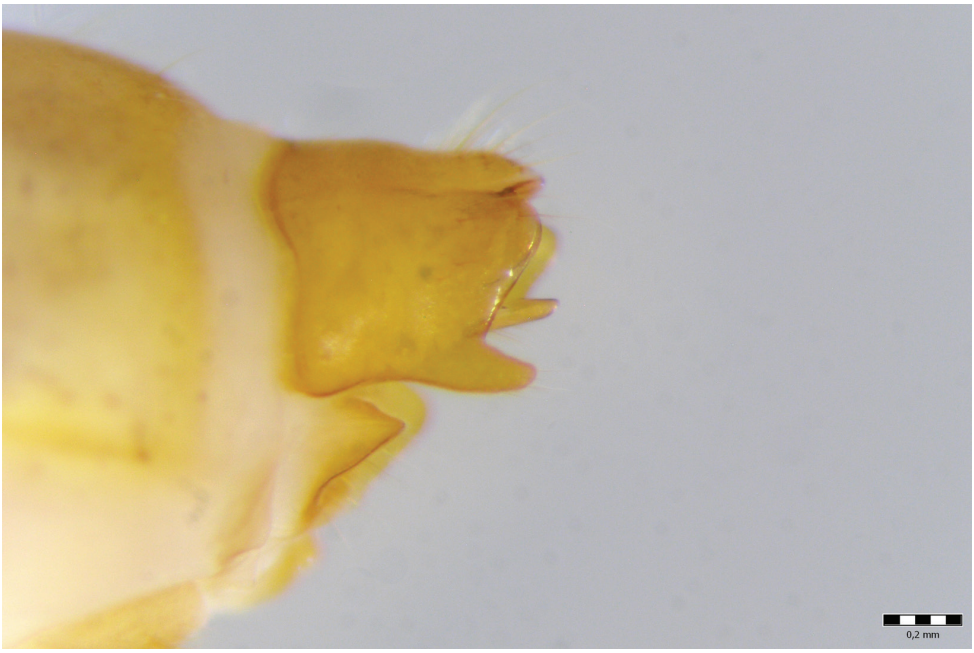


Figure 13. *Chaetopteryx bucari* sp. n., female genitalia, dorso-lateral view.

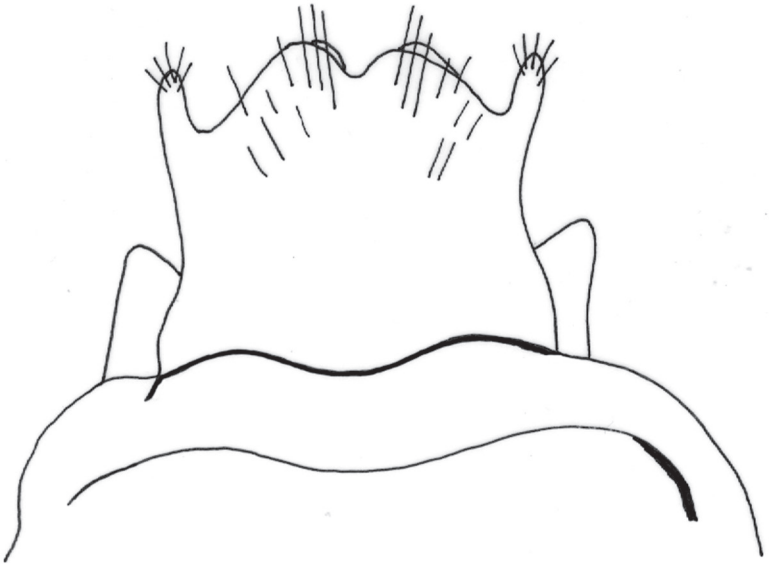


Figure 14. *Chaetopteryx bucari* sp. n., female genitalia, dorsal view.

Ecological notes and distribution. During our recent faunal surveys in Croatia and the Western Dinaric Balkan *Chaetopteryx bucari* was found only at 8 localities in the Banovina region (Table 1). The most distant sampling sites are 40 km apart (Slabi-

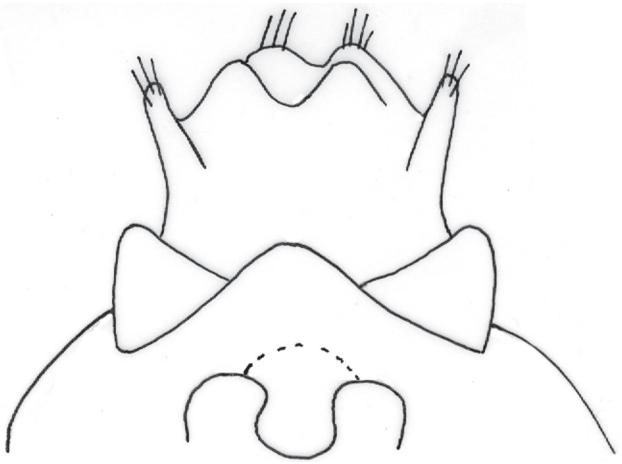


Figure 15. *Chaetopteryx bucari* sp. n., female genitalia, ventral view.

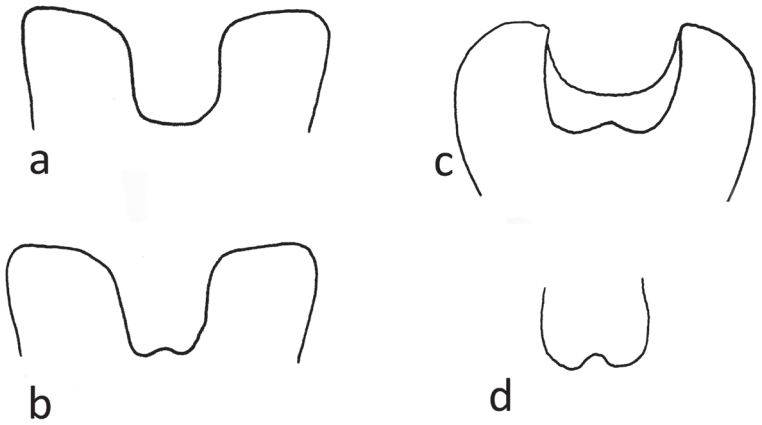


Figure 16. *Chaetopteryx bucari* sp. n., female genitalia **a–d** vulvar scale and median lobe of vulvar scale, ventral view.

nja and Gore). We collected *C. bucari* from 2 springs, 5 wellsprings and 1 location in the stream (Table 1). In total, we collected more than 580 specimens of *C. bucari* (85% were collected in pyramid-type emergence traps). The most abundant populations were found at Pecki spring and a headwater stream in Hrvatski Ćuntić. Over 150 specimens of *C. bucari* were observed on the night of October 14, 2010 on the walls of a small building next to the stream in Hrvatski Čuntić. In Pecki spring more than 50 specimens were observed on the night of October 31, 2010. *Chaetopteryx bucari* was recorded at low altitudes between 104–185 m a.s.l. (Table 1).

Chaetopteryx bucari was collected in pyramid-type emergence traps from the end of September-December. The highest number of specimens was collected in October and November in both years. The sex ratio in both years was biased toward males, 1:1.37 (♀♀: ♂♂) in 2010, and 1:1.40 (♀♀:♂♂) in 2011. Besides *C. bucari*, *Chae-*

topteryx gonospina Marinković-Gospodnetić, 1966 and 2 additional caddisfly species (*Limnephilus rhombicus* (Linnaeus, 1758), *Potamophylax pallidus* Klapálek, 1898) were recorded in the emergence traps.

In addition to *C. bucari* 2 other species of the *C. rugulosa* group were collected in Croatia during our recent surveys. *Chaetopteryx marinkovicae* was collected from its type locality on the stream and spring in Kompanj village (Istria region); *C. r. rugulosa* was caught on Mt. Žumberak and Mt. Medvednica (northeast and central Croatia). Other species of *Chaetopteryx* found during this investigation were *Chaetopteryx bosniaca* Marinković-Gospodnetić, 1959 (Lika region), *Chaetopteryx gonospina* Marinković-Gospodnetić, 1966 (Banovina region), *C. fusca* (central Croatia, Dalmatia and Lika regions), and *C. major* (central Croatia).

Discussion

Systematic and taxonomic implications. Based on molecular evidence, we could confirm the hypothesis that *Chaetopteryx bucari* is a distinct species. Although *C. bucari* does not have a pp >0.95, it represents the sister taxon (pp>0.95) to the highly supported *C. r. schmidi*. Furthermore, the mean genetic distance (2.02%) between *C. bucari* and *C. r. schmidi* barely reached the 2-3% divergence observed as an interspecific genetic divergence in mtCOI sequences among some well-defined caddisfly species (Bálint et al. 2009, Pauls et al. 2009, Kučinić et al. 2011). However, among other well-defined caddisfly species this value can reach much higher levels (e.g., Zhou et al. 2007, Pauls et al. 2010), but also much lower values (e.g., Waringer et al. 2007). Thus reliance on distance methods alone for defining species boundaries is not advisable and species boundaries should be supported by additional lines of evidence such as additional, independent genes, morphology, or other independent characteristics (Zhou et al. 2007), particularly in taxa where hybridization is possible as is the case in *Chaetopteryx* (Malicky et al. 1986, Malicky and Pauls 2012). In the present study the genetic distinctiveness of *C. bucari* in combination with differences in morphological characters compared to its congeners, provide strong evidence to justify describing it as a new species.

In both sexes, especially in the adult female, *C. bucari* is relatively easily distinguishable from other taxa of the *C. rugulosa* group. The genetic data also show that specimens from 7 populations across the known range of the species from a clearly distinct clade from all other analysed *Chaetopteryx*. It is interesting that the female of *C. bucari* is particularly informative in diagnosing the species. In caddisflies this is quite unusual as males are generally more easily distinguished and females are often very difficult to differentiate from one another.

Based on the phylogenetic position of *C. r. schmidi* in relation to *C. r. rugulosa* and the other *C. rugulosa* subspecies, *C. r. schmidi* is well-defined and quite divergent from other members of the *C. rugulosa* clade based on molecular data. Thus, the subspecies *C. r. schmidi* is here re-established as a distinct species, *C. schmidi*, as it was described

originally by Botosaneanu (1957) (Table 2) and not recognized as a subspecies of *C. rugulosa* as proposed by Malicky (2004, 2005).

Ecology. The emergence pattern of *C. bucari* corresponds with the general autumnal emergence patterns of the genus, usually from September-December, though emergence can be prolonged through January for some *Chaetopteryx* species (Kučinić 2002), including *C. bucari* (some specimens were collected by handpicking during January 2011). The emergence data from 2 years revealed that the sex ratio of *C. bucari* at the spring of Pecki stream is not exactly 1:1, but biased towards a surplus of males. In other studies applying the same methodology only a few species had 1:1 sex ratios (Kučinić 2002). In some species the sex ratio was 1:6 in favour of females (Previšić et al. 2007) and in other species males were dominant (Kučinić 2002, Semnički et al. 2011). These results are influenced by biological features of the species (e.g., emergence, oviposition behaviour of females), but may also be affected by trapping method (e.g., types of emergence pyramid-traps) (Malicky 2002).

Research on the diversity of large karst springs on the Balkan Peninsula has revealed high levels of caddisfly diversity. In some cases more than 20 species were collected from a single spring (Marinković-Gospodnetić 1979, Kučinić et al. 2008). This high alpha diversity of large karst springs does not, however, diminish the faunal significance of smaller springs. These are usually characterized by a small number of species, but often these species are highly specialized or local endemic species, such as *C. bucari* at the Pecki spring.

Distribution of *Chaetopteryx rugulosa* group in Croatia. At present, the genus *Chaetopteryx* is represented by 9 taxa in Croatia (Marinković-Gospodnetić 1979, Malicky and Krušnik 1988, Malicky 1996, 2004, Kučinić 2002, Kučinić et al. 2010, Previšić and Popijač 2010, Oláh 2010, 2011a). Including the new species *C. bucari*, 4 species from the *Chaetopteryx rugulosa* group (Malicky and Krušnik 1988, Malicky 1996, 2004, Oláh 2010) are now known from Croatia (Figure 17). Rare species from the genus *Chaetopteryx* are *Chaetopteryx uherkovichi* Oláh, 2011 distributed in eastern Croatia (Slavonia region) so far recorded only at the type locality (Oláh 2011a), *C. r. mecsekensis* known from only 1 locality in Croatia (Malicky 1996, 2004, Oláh 2010), but also distributed in Hungary (Malicky et al. 1986, Malicky 2004) and Serbia (Oláh 2010), and *C. marinkovicae* established in 3 localities in Istria (Malicky and Krušnik 1988). Our research did not confirm the presence of the latter species in 2 of these localities (Malicky and Krušnik 1988), but found specimens at the type locality in Kompanj village. *Chaetopteryx marinkovicae* is also known from Slovenia (Urbanič 2004).

Until now, the new species *C. bucari* was found only in the Banovina region, which is situated between rivers Sava and Kupa to the north and the state border with Bosnia and Herzegovina to the south and east (Figure 17). The Banovina region is characterised by rolling hills up to 600 m a.s.l. There are many small springs and streams in the region, and 3 large rivers, Una, Kupa and Sava, that form the border of the region. It is possible that *C. bucari* is also distributed in some other parts of continental Croatia or in Bosnia and Herzegovina, because we found this species in the valley of the Una River (Slabinja spring, Varoški bunar spring), which forms the border between these 2 countries.

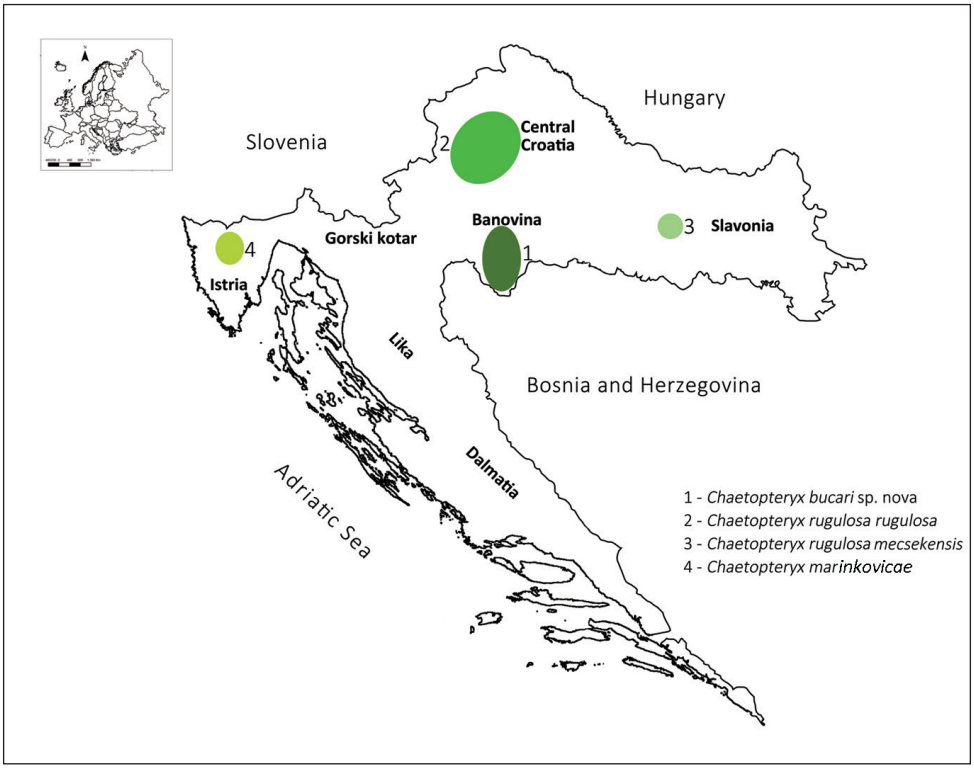


Figure 17. Distribution of *Chaetopteryx rugulosa* group in Croatia.

According to the current findings, *C. bucari* is not rare in the Croatian fauna. In fact, it is one of the most dominant caddisflies in the Banovina region. Along with *C. fusca* (Kučinić 2002, Semnički et al. 2011, Cerjanec 2012, M. Kučinić unpublished data) it is one of the most frequently found species from genus *Chaetopteryx* in Croatia. *C. bucari* inhabits springs and headwaters of small streams. The only known larger limnocrene spring that *C. bucari* inhabits is the Pašino vrelo spring.

Taxa from the *C. rugulosa* group have allopatric distributions in Croatia (Figure 17): *C. bucari* is distributed in the Banovina region, *C. r. rugulosa* in northern Croatia on Mt. Medvednica and Mt. Žumberak, *C. r. mecsekensis* in eastern Croatia on Mt. Papuk and *C. marinkovicae* in the sub-Mediterranean part of Croatia in Istria (Malicky and Krušnik 1988, Malicky 1996, 2004, Oláh 2010). Systematic research in mountain areas in Lika and Gorski kotar (Kučinić 2002, Kučinić et al. 2008, Previšić and Popijač 2010, Cerjanec 2012, Semnički et al. 2011, 2012) and the Mediterranean part of Croatia (Dalmatia region) (Graf et al. 2008, Waringer et al. 2009, Vučković 2011, Vučković et al. 2011, M. Kučinić unpublished data) did not result in collections of *C. rugulosa* group species in these areas.

Many members of the genus *Chaetopteryx* are either small-scale endemics or species with a low number of disjunct populations. This makes the group very interesting for biogeographic studies. There are several reasons that could explain the observed pattern

of distribution: small populations, poor mobility of the winter emerging adults, and distribution in springs and in headwater reaches of small streams. Besides naturally isolating individual populations from one another, these aspects can also cause difficulties for investigating the genus, as it is hard to access many of the sites, especially in winter. Future investigations of this genus will be focused on poorly researched areas in Croatia and the western Balkans to gain a better understanding of the distribution and biogeography of *Chaetopteryx* in the region.

Acknowledgements

We express our gratitude to Xin Zhou for handling the mitochondrial barcoding of our specimens within the Barcoding of Life initiative. We thank Karl Kjer for sharing the previously unpublished "outgroup" data from BOLD. We thank two anonymous reviewers and Ralph Holzenthal for their valuable comments that helped improve the manuscript. For technical help we acknowledge senior curator Iva Mihoci, PhD, from the Croatian Natural Museum in Zagreb, Nediljko Landeka form the Institute of Public Health in Pula, and Milivoj Franjević from the Foresty Faculty, University of Zagreb. ISz was partially funded through an incoming research grant of the Biodiversity and Climate Research Centre in the frame of the research funding program Landes-Offensive zur Entwicklung Wissenschaftlich-ökonomischer Exzellenz (LOEWE) of Hesse's Ministry of Higher Education, Research, and the Arts, Germany. SUP and MB acknowledge financial support from the research fundprogram "LOEWE – Landes-Offensive zur Entwicklung Wissenschaftlich-ökonomischer Exzellenz" of Hesse's Ministry of Higher Education, Research, and the Arts. This research was supported by the Austrian Science Fund (FWF) as a part of Project P 23687-B17 and Croatian Ministry of Science, Education and Sports as a part of Project No. 119–1193080–1206.

References

Bálint M, Botosaneanu L, Ujvárosi L, Popescu O (2009) Taxonomic revision of *Rhyacophila aquitanica* (Trichoptera: Rhyacophilidae) based on molecular and morphological evidence and change of taxon status of *Rhyacophila aquitanica* ssp. *carpathica* to *Rhyacophila carpathica* sp. n**.** Zootaxa 2148: 39–48.

Botosaneanu L (1957) Quelques Trichopteres nouveaux de Roumanie. Tijdschrift voor entomologie 100: 179–194.

Botosaneanu L, Giudicelli J (2004) Contributions to the knowledge of the fauna of caddisflies (Insecta: Trichoptera) from south-east France, with description of new taxa. Annales de Limnologie - International Journal of Limnology 40: 15–32. doi: 10.1051/limn/2004002

Buckley T–R, Arensburger P, Simon C, Chambers G (2002) Combined data, Bayesian phylogenetics, and the origin of the New Zealand *Cicada* genera. Systematic Biology 51: 4–18. doi: 10.1080/106351502753475844

Cerjanec D (2012) Ecological and biogeographical features of caddisflies (Insecta: Trichoptera) in different types of habitats in drainage of the Dobra River. PhD thesis (on Croatian), Zagreb, Croatia: University of Zagreb.

de Waard JR, Ivanova NV, Hajibabaei M, Hebert PDN (2008) Assembling DNA barcodes: analytical protocols. In: Martin CC (Ed) Environmental Genomics, Methods in Molecular Biology. Volume 410. Humana Press, Totowa, New Jersey, -275–283.

Drummond AJ, Ashton B, Buxton S, Cheung M, Cooper A, Duran C, Field M, Heled J, Kearse M, Markowitz S, Moir R, Stones-Havas S, Sturrock S, Thierer T, Wilson A (2011) Geneious v5.4, http://www.geneious.com/

Folmer O, Black M, Hoeh W, Lutz R, Vrijenhoek R (1994) DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. Molecular Marine Biology and Biotechnology 3: 294–299.

Graf W, Kučinić M, Previšić A, Vučković I, Waringer J (2008) The larva, ecology and distribution of *Tinodes braueri* McLachlan, 1878 (Trichoptera: Psychomyiidae). Aquatic Insects 30 (4): 295–299. doi: 10.1080/01650420802331158

Guindon S, Gascuel O (2003) A simple, fast and accurate method to estimate large phylogenies by maximum-likelihood. Systematic Biology 52: 696–704. doi: 10.1080/10635150390235520

Hajibabaei M, Dewaard JR, Ivanova NV, Ratnasingham S, Dooh RT, Kirk SL, Macki PM, Hebert PDN (2005) Critical factors for assembling a high volume of DNA barcodes. Philosophical Transactions of the Royal Society of London Series B: Biological Sciences 360: 1959–1967. doi: 10.1098/rstb.2005.1727

Hajibabaei M, Janzen DH, Burns JM, Hallwachs W, Hebert PDN (2006) DNA barcodes distinguish species of tropical Lepidoptera. Proceedings of the National Academy of Sciences of the United States of America 103: 968–971. doi: 10.1073/pnas.0510466103

Holzenthal RW, Blahnik RJ, Prather AL, Kjer KM (2007) Order Trichoptera Kirby, 1813 (Insecta), Caddisflies. Zootaxa 1668: 639–698.

Ivanova NV, Dewaard JR, Hebert PDN (2006) An inexpensive, automation-friendly protocol for recovering high-quality DNA. Molecular Ecology Notes 6: 998–1002. doi: 10.1111/j.1471-8286.2006.01428.x

Ivković M, Mičetić Stanković V, Mihaljević Z (2011) Emergence patterns and microhabitat preference of aquatic dance flies (Empididae; Clinocerinae and Hemerodromiinae) on a longitudinal gradient of barrage lake system. Limnologica 42 (1): 43–49. doi: 10.1016/j.limno.2011.07.003

Kučinić M (2002) Diversity and distribution of caddisflies in Plitvička Lakes. PhD thesis (on Croatian), Zagreb, Croatia: University of Zagreb.

Kučinić M, Bučar M, Delić A (2010) Prvi prilog poznavanju faune tulara (Insecta, Trichoptera) na području Banovine. In: Bučar M (Ed) Zbornik radova: Zrinska gora: regionalni park prirode. Matica hrvatska: 226–235.

Kučinić M, Previšić A, Gottstein A, Hrašovec B, Stanić-Koštroman S, Pernek M, Delić A (2008) Description of the larvae of *Drusus radovanovici septentrionis* Marinković-Gospodnetić, 1976 and *Drusus croaticus* Marinković-Gospodnetić, 1971 (Trichoptera: Limnephilidae) from Bosnia and Herzegovina and Croatia. Zootaxa 1783: 1–17.

Kučinić M, Previšić A, Graf W, Jelaska L S, Stanić-Koštroman S, Waringer J (2011) Larval description, genetic and ecological features of *Drusus radovanovici radovanovici* Marinković-Gospodnetić, 1971 (Trichoptera, Limnephilidae) with some phylogenetic and taxonomic data on the *bosnicus* group in the Balkan Peninsula. Deutsche Entomologische Zeitschrift 58 (1): 135–153. doi: 10.1002/mmnd.201100010

Lodovici O, Valle M (2007) New data on the genus *Chaetopteryx* in Northern Italy and a description of *C. morettii* sp.n. Braueria 34: 15–16.

Malm T, Johanson KA (2011) A new classification of the long-horned caddisflies (Trichoptera: Leptoceridae) based on molecular data. BMC Evolutionary Biology 11: 10. doi: 10.1186/1471-2148-11-10

Malicky H (1996) Das Problem der allopatrischen Arten bei europäischen Köcherfliegen (Insecta: Trichoptera). Natura Croatica 5 (1): 11–23.

Malicky H (2002) A quantitative field comparasion of different types of emergence traps in a stream: general, Trichoptera, Diptera (Lemoniidae and Empididae). Annales de Limnologie – International Journal of Limnology 38: 133–149. doi: 10.1051/limn/2002011

Malicky H (2004) Atlas of European Trichoptera. Springer, Dordrecht, 359 pp.

Malicky H (2005) Ein kommentiertes Verzeichnis der Köcherfliegen (Trichoptera) Europas und des Mediterrangebietes. Linzer biologische Beiträge 37(1): 533–596.

Malicky H, Krušnik C (1988) *Chaetopteryx marinkovicae* sp.n. (Trichoptera, Limnephilidae) from Istria, Yugoslavia. Aquatic Insects 11 (3): 180. doi: 10.1080/01650428909361366

Malicky H, Krušnik C, Moretti G, Nógrádi S (1986) Ein Beitrag zur Kenntnis der *Chaetopteryx rugulosa* Kolenati, 1848 - Gruppe (Trichoptera, Limnephilidae). Entomofauna 7 (1): 1–27.

Malicky H, Pauls SU (2012) Cross-breeding of *Chaetopteryx morettii* and related species, with molecular and eidonomical results (Trichoptera, Limnephilidae). Annales de Limnologie - International Journal of Limnology 48: 13–19. doi: 10.1051/limn/2011054

Marinković-Gospodnetić M (1979) Trichoptera (Insecta) velikih karstnih izvora u Dinaridima. In: Rauš (Ed) Drugi kongres Ekologa Jugoslavije (Second Congress of Ecologists of Yugoslavia). Savez društava ekologa Jugoslavije, Zagreb: 1837–1849.

Morse JC (Ed) (2013) Trichoptera World Checklist. http://entweb.clemson.edu/database/trichopt/index.htm [accessed 26 May 2013]

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

Oláh J (2011a) New species and records of Balkan Trichoptera. Folia Historico Naturalia Musei Matraensis 35: 111–121.

Oláh J (2011b) A new species of *Chaetopteryx* (Trichoptera, Limnephilidae) from the Northeast Carpathians. Braueria 38: 9–10.

Pauls SU, Blahnik RJ, Zhou X, Wardwell TC, Holzenthal RW (2010) DNA barcode data confirm new species and reveal cryptic diversity in Chilean *Smicridea* (*Smicridea*) (Trichoptera: Hydropsychidae). Journal of the North American Benthological Society 29: 1058–1074. doi: 10.1899/09-108.1

Pauls SU, Theissinger K, Ujvarosi L, Balint, M., Haase P (2009) Patterns of population structure in two closely related, partially sympatric caddisflies in Eastern Europe: historic intro-

gression, limited dispersal, and cryptic diversity. Journal of the North American Benthological Society 28: 517–36. doi: 10.1899/08-100.1

Posada D (2008) jModelTest: Phylogenetic Model Averaging. Molecular Biology and Evolution 25: 1253–1256. doi: 10.1093/molbev/msn083

Previšić A, Kerovec M, Kučinić M (2007) Emergence and Composition of Trichoptera from Karst Habitans, Plitvice lakes Region, Croatia. International Review of Hydrobiology 92 (1): 61–83. doi: 10.1002/iroh.200510921

Previšić A, Popijač A (2010) Caddisfly (Insecta: Trichoptera) fauna of Kupa and Čabranka rivers and their tributaries, Gorski kotar, W Croatia. Natura Croatia 19 (2): 357–368.

Rambaut A, Drummond AJ (2009) Tracer Version *1.5*, http://beast.bio.edsac.uk/Tracer

Ratnasingham S, Hebert PDN (2007) BOLD: the Barcode of Life Data System (www.barcodinglife.org). Molecular Ecology Notes 7: 355–364. doi: 10.1111/j.1471-8286.2007.01678.x

Rodríguez F, Oliver JL, Marin A, Medina JR (1990) The general stochastic model of nucleotide substitution. Journal of Theoretical Biology 142 (4): 484–501. doi: 10.1016/S0022-5193(05)80104-3

Ronquist F, Huelsenbeck JP (2003) MrBayes 3: Bayesian phylogenetic inference under mixed models. Bioinformatics 19: 1572–1574. doi: 10.1093/bioinformatics/btg180

Semnički P, Previšić A, Ivković M, Čmrlec K, Mihaljević Z (2011) Emergence of caddisfly (Trichoptera, Insecta) at tufa barriers in Plitvice Lakes National Park. Entomologia Croatica 115 (1–4): 145–161. doi: 10.1002/iroh.201101500

Semnički P, Previšić A, Ivković M, Čmrlec K, Mihaljević Z (2012) Tufa Barriers from a Caddisfly's Point of View: Streams or Lake Outlets? International Review of Hydrobiology 97 (6): 465–484.

Sipahiler F (2010) Two New Species of *Chaetopteryx* Stephens, 1837 from Turkey with a Description of the Unknown Female of *C. bektasensis* Sipahiler, 2008 (Trichoptera, Limnephilidae: Limnephilinae: Chaetopterygini). Psyche: A Journal of Entomology. doi: 10.1155/2010/180671

Tamura K, Peterson D, Peterson N, Stecher G, Nei M, Kumar S (2011) MEGA5: Molecular Evolutionary Genetics Analysis using Maximum Likelihood, Evolutionary Distance, and Maximum Parsimony Methods. Molecular Biology and Evolution 28: 2731–2739. doi: 10.1093/molbev/msr121

Urbanič G (2004) Ecology and distribution of caddisflies (Insecta: Trichoptera) in some watercourses in Slovenia. PhD thesis (on Slovenian), Ljubljana, Slovenia: University of Ljubljana.

Urbanič G, Krušnik C (2003) The female of *Chaetopteryx irenae* Krušnik & Malicky 1986. Acta Entomologica Slovenica 10 (1): 21–24.

Vučković I (2011) Faunal, taxonomical and ecological characters of caddisflies (Insecta, Trichoptera) drainage of the River Cetina. PhD thesis (on Croatian), Zagreb, Croatia: University of Zagreb. doi: 10.1080/01650424.2011.641181

Vučković I, Previšić A, Graf W, Kučinić M (2011) Description of the female and distribution of *Annitella apfelbecki* Klapálek, 1899 (Insecta: Trichoptera). Aquatic Insects 33 (4): 381–389.

Waringer J, Graf W, Kučinić M, Previšić A, Vučković A (2009) The Larva and life cycle of *Annitella apfelbecki* Klápalek, 1899, including a re-description of *Melampophylax nepos*

McLachlan, 1880 (Trichoptera: Limnephilidae). Aquatic Insects 31 (1): 71–80. doi: 10.1080/01650420802616327

Waringer J, Graf W, Pauls S, Lubini V (2007) The Larva of *Drusus nigrescens* Meyer-Dur, 1875 (Trichoptera: Limnephilidae: Drusinae) with notes on its ecology, genetic differentiation and systematic position. Annales de Limnologie - International Journal of Limnology 43: 161–166. doi: 10.1051/limn:2007010

Zhou X, Kjer KM, Morse JC (2007) Associating larvae and adults of Chinese Hydropsychidae caddisflies (Insecta: Trichoptera) using DNA sequences. Journal of the North American Benthological Society 26: 719–742. doi: 10.1899/06-089.1

ZooKeys 320: 29–41 (2013)
doi: 10.3897/zookeys.320.4447
www.zookeys.org

RESEARCH ARTICLE

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

A new *Pseudophoxinus* (Teleostei, Cyprinidae) species from Southwestern Anatolia, with remarks on the distribution of the genus in western Anatolia

Fahrettin Küçük[1,†], İskender Gülle[2,‡], S. Serkan Güçlü[1,§], Yılmaz Çiftçi[3,|], Ömer Erdoğan[1,¶]

1 *Süleyman Demirel University, Eğirdir Fisheries Faculty, Isparta-Turkey* **2** *Mehmet Akif Ersoy University, Faculty of Science and Literature, Biology Department, Burdur-Turkey* **3** *Ordu University, Fatsa Marine Science Faculty, Fatsa-Ordu-Turkey*

† *http://zoobank.org/50084B6D-BEF2-4953-B39B-D618AC621473*
‡ *http://zoobank.org/D0A0B5E8-DF8E-4775-B4E5-84EDC2F4BE5F*
§ *http://zoobank.org/8198016F-FCF4-4582-91F9-F0E98C5DF567*
| *http://zoobank.org/20F86C78-9771-422A-948A-424B0BEBABAB*
¶ *http://zoobank.org/2A9040D4-682F-4F55-8F83-401B2B17929E*

Corresponding author: *Fahrettin Küçük* (fahrettinkucuk@sdu.edu.tr)

Academic editor: *N. Bogutskaya* | Received 4 December 2012 | Accepted 24 June 2013 | Published 31 July 2013

http://zoobank.org/E1297225-20A1-4814-A0C3-E1CA82A253AE

Citation: Küçük F, Gülle İ, Güçlü SS, Çiftçi Y, Erdoğan Ö (2013) A new *Pseudophoxinus* (Teleostei, Cyprinidae) species from Southwestern Anatolia, with remarks on the distribution of the genus in western Anatolia. ZooKeys 320: 29–41. doi: 10.3897/zookeys.320.4447

Abstract

Pseudophoxinus burduricus **sp. n.** is described from drainages of Salda and Burdur lakes, southwestern Turkey. It is distinguished from other Anatolian *Pseudophoxinus* by a combination of characters: lateral line incomplete, with 21–39 (commonly 26–37) perforated scales and 47–57+1-2 scales in lateral series; 10½–12½ scale rows between lateral line and dorsal fin origin, 3–4(5) scale rows between lateral line and the pelvic fin origin; dorsal fin commonly with 7½ branched rays; anal fin commonly with 6½ branched rays; 7–8(9) gill rakers on the first branchial arch; a faint and diffuse epidermal black stripe from eye to caudal fin base in alive and preserved individuals; mouth slightly subterminal, tip of mouth cleft on about level of lower margin of eye; snout rounded, its length greater than eye diameter. Comparison is given with all *Pseudophoxinus* species from western Anatolia.

Keywords
Western Anatolia, Cyprinidae, Taxonomy, *Pseudophoxinus*, new species

Introduction

According to Perea et al. (2010), there are 14 distinct clades within Leuciscinae of inner waters across the Mediterranean Region, 9 of which being represented in Anatolia. Among these, phylogenies of the genera *Petroleuciscus* and *Pseudophoxinus* are most debated; indeed even taxonomic status of some *Pseudophoxinus* species is uncertain. Two well-defined monophyletic clades represent Anatolian *Pseudophoxinus* species: first of these corresponds to Central Anatolian species complex including *P. alii, P. anatolicus, P. antalyae, P. battalgilae, P. crassus, P. elizavetae, P. evliyae, P. fahrettini, P. ninae,* and a probable undescribed species; while the other includes Levantine taxa, namely *P. firati, P. kervillei, P. zeregi* and *P. zekayi* (Perea et al. 2010). Speciation in *Pseudophoxinus* is heterogenous, as mentioned by Hrbek et al. (2004) and Bogutskaya et al. (2007), and discrepancies between morphological and molecular relationships can be seen (Perea et al. 2010). Separation of the *Pseudophoxinus* taxa in Anatolia and western Asia into two groups by Bogutskaya et al. (2007), according to a comparison of morphological parameters (sensory pores, scales and their arrangement on the body, vertebral counts, and supraethmoid bone) with that of the type species *P. zeregi* is another example of the high degree of variability in the genus.

Morphological and phylogenetic distinctness of *P. egridiri* (Hrbek et al. 2004: 305), and its closeness to the *Pelasgus-Delminichthys* lineage (Perea et al. 2010) brings some doubts about monophyly of the Anatolian *Pseudophoxinus* taxa.

As stated by Hrbek et al. (2002, 2004), Anatolia is an important diversification center for the genus *Pseudophoxinus* which shows allopatric speciation especially in basins of Bey Dağları, Büyük Menderes, Tuz Lake and Lakes District. However, the complex taxonomy of the genus in these basins is still unresolved. Although including several lakes and springs of Lakes Region (Lake Salda, Karapınar Spring near Yeşilova district, Düğer Spring, Lake Bahçeözü, Sazak Spring and Kırkpınar Springs) in the distribution area of *P. maeandri,* Bogutskaya (1992) mentioned that *P. maeandri* populations from Upper Büyük Menderes basin (Lake Işıklı and Düden Spring near Dinar) morphologically differed from remaining populations in having larger scales and shorter lateral line, fewer lateral series scales and gill rakers on the first branchial arch, as well as fewer vertebrae.

According to molecular data presented by Hrbek et al. (2004) Kırkpınar (Lake Söğüt source, Korkuteli) and Avlan source (Elmalı) populations were clearly separated from those in the basins of the lakes Salda and Burdur. Freyhof and Özuluğ (2009) identified populations of Kırkpınar as a new species, *P. evliyae*, and populations of Lake Salda and Lake Burdur basin as *P. ninae*. Perea et al. (2010) did not examine any material from either the type locality (Onaç Stream-Bucak) or other known localities of *P. ninae* (Kestel Swamp-Bucak, Düğer Spring, Lake Karataş and Sazak Spring) and used only mitochondrial and nuclear DNA markers of Lake Salda specimens as representatives of *P. ninae*.

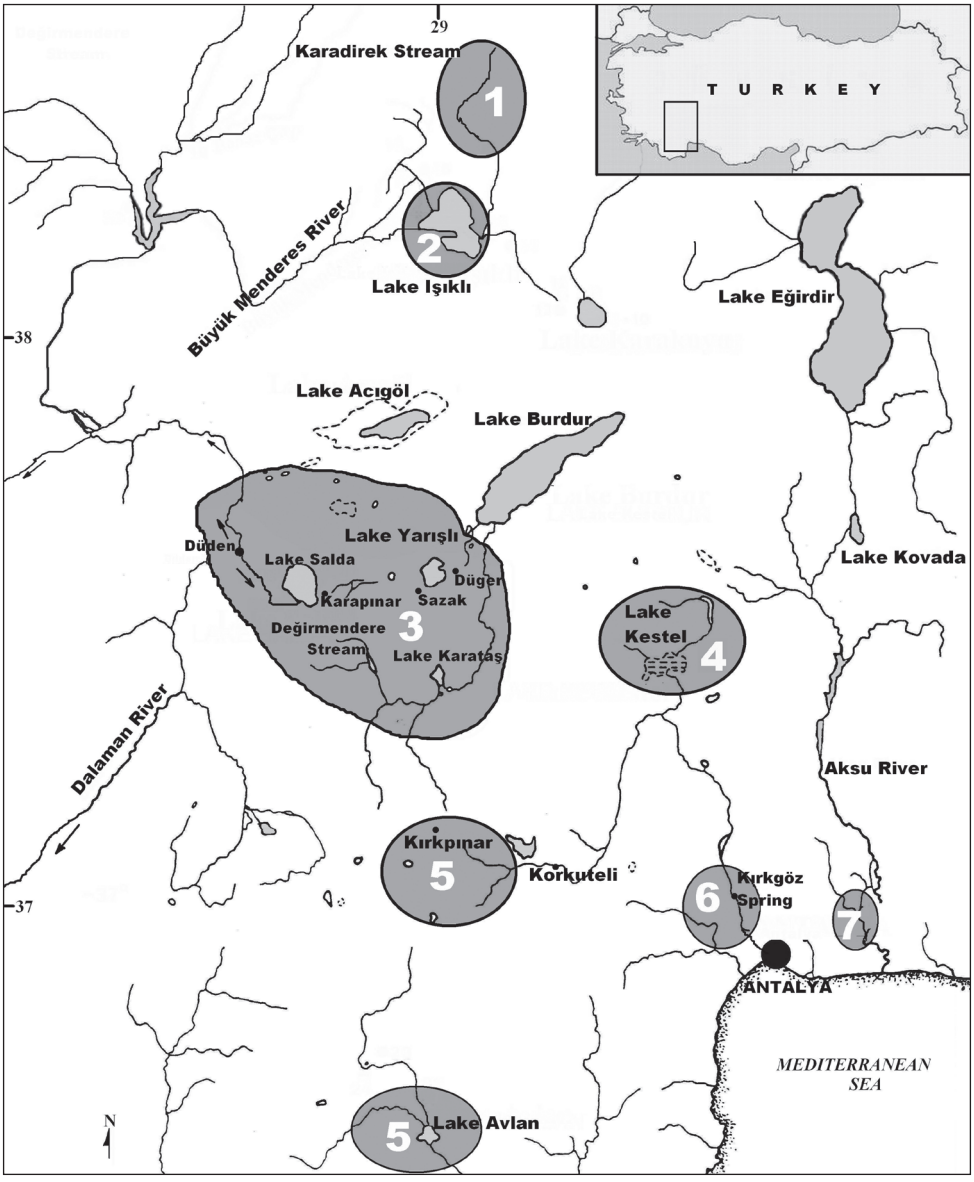


Figure 1. Map showing localities of *Pseudophoxinus* species in western Anatolia **1** *P. maeandricus* **2** *P. maeandri* **3** *P.burduricus* sp. n. **4** *P. ninae* **5** *P. evliyae* **6** *P. antalyae* **7** *P. alii*

Thus, it was not possible to explain diversification of *Pseudophoxinus* in southwestern Anatolia (Fig.1) in its entirety. Furthermore, since its description by Ladiges (1960), sufficient information on distribution and taxonomy of *P. maeandricus* has not been given up to date. With regard to the above mentioned morphological and molecular data, it became apparent that the taxonomic position of *Pseudophoxinus* populations in Burdur and Salda lake basins needed clarification and this led to the present study.

Materials and methods

Fish specimens were caught by pulsed DC electrofishing equipment and killed by over anaesthetization, preserved in 5% formalin. Material is deposited in: IFC-ESUF, Inland Fishes Collection, Eğirdir Fisheries Faculty of Süleyman Demirel University. Counts and measurements follow Kottelat and Freyhof (2007), all measurements being point to point made with a digital calliper (0.01 mm sensitive). Standard length (SL) was measured from the tip of the upper lip to the end of the hypural complex. The length of the caudal peduncle was measured from behind the base of the last anal fin ray to the end of the hypural complex, at mid-height of the caudal fin base. Lateral line scales are counted from the anteriormost scale (the first one to touch the shoulder girdle) to the posteriormost one. Scales in lateral series are counted along the midlateral line from the first one to touch the shoulder girdle to the last scale at the end of the hypural complex. Scales on the caudal fin itself are indicated by "+" (Freyhof and Özuluğ 2009). The last two branched dorsal and anal fin rays articulating on a single pterygiophore were counted as 1½. Vertebral counts were obtained from radiographs and counted as total, predorsal, abdominal and caudal vertebrae following Naseka (1996). Abdominal vertebrae were counted from the first Weberian vertebra to the one just anterior the first caudal vertebra. The first caudal vertebra is that with its haemal spine fully developed. The count of total and caudal vertebrae includes the last complex vertebra bearing hypurals. Osteological characters were examined in cleared and stained with alizarin Red-S specimens and from radiographs (Bogutskaya 1996).

The morphometric characters of the two species of *Pseudophoxinus* from Turkey were compared by Principal Component Analysis (PCA) using a covariance matrix on log–transformed measurements and counts with the software package PAST version 1.8 (Hammer et al. 2001).

Abbreviations. CSO, supraorbital canal; CIO, infraorbital canal; CPM, preoperculo-mandibular canal; HL, lateral head length; SL, standard length. IFC-ESUF, Inland Fishes Collection, Eğirdir Fisheries Faculty of Süleyman Demirel University, Turkey. IUSHM, Istanbul University, Science Faculty, Hydrobiology Museum, Istanbul.

Results

***Pseudophoxinus burduricus* sp. n.**
http://zoobank.org/5734C2B8-1D58-40E4-ABD6-43A9C610B1AB
http://species-id.net/wiki/Pseudophoxinus_burduricus
Figures 2, 3

Holotype. IFC-ESUF 0427, female, 62.80 mm SL; Turkey, Burdur Prov., Değirmendere Creek, Karamanlı, Lake Burdur drainage; 37°24'18"N, 29°49'06"E, 07 November 2009, coll. F. Küçük, İ. Gülle and Ö. Erdoğan.

Figure 2. *P. burduricus* sp. n. IFC-ESUF 0427, holotype, 62.80 mm SL, female; Turkey: Değirmendere Creek, Burdur.

Figure 3. *P. burduricus* sp. n. IFC-ESUF 0428, paratype, 65.82 mm SL, female; Turkey: Değirmendere Creek, Burdur.

Paratypes. IFC-ESUF 0428, 17 (11 males, 6 females), 39.90–86.69 mm SL; same as holotype.

Additional material. IFC-ESUF 0236, 7, 45.31–54.40 mm SL; Burdur Prov., Salda Stream near Lake Salda; F. Küçük, M.A. Atalay, 13 June 1998. –IFC-ESUF 0289, 3, 31.98–71.56 mm SL, Burdur Prov., Düğer Spring; F. Küçük, A. Altun, M. Telli, 05 August 2006. –IFC-ESUF 0429, 5, 51.34–80.08 mm SL, Burdur Prov., Sazak Spring near Lake Yarışlı; F. Küçük, İ. Gülle, S.S. Güçlü, 13 July 2009.- IFC-ESUF 0430, 6, 41.91–55.95 mm SL, Burdur Prov., Salda Stream near Lake Salda; F. Küçük, İ. Gülle, S.S. Güçlü, 13 December 2009. –IFC-ESUF 0449, 8, 46.10-60.43 mm SL, Burdur Prov.; Salda Stream near Lake Salda; F. Küçük, İ. Gülle, 16 April 2010. –IFC-ESUF 0475, 7, 46.10–60.43 mm SL, Burdur Prov.; Dereköy Stream; F. Küçük, İ. Gülle, S.S. Güçlü. 18 May 2012.

Diagnosis. *Pseudophoxinus burduricus* is distinguished from all other species of Anatolian *Pseudophoxinus* by the following unique combination of characters: head short, its length equal or slightly greater than body depth at dorsal fin origin; mouth slightly subterminal, the tip of the mouth cleft on approximately level of with lower margin of eye; snout rounded, its length greater than eye diameter; a faint and diffuse epidermal black stripe from eye to caudal fin base in alive and preserved individuals;

Table 1. Morphometry of *P. burduricus* sp.n. (holotype IFC-ESUF 427, paratypes IFC-ESUF 428, n=17) and *P. ninae* (IFC-ESUF 263, n=15).

	P. burduricus		*P. ninae*
	Holotype	**Paratypes**	
In percent of standard length			
Head length	26.9	25.7–27.8 (26.8)±0.6	27.1–30.7 (28.6) ±1.0
Body depth of dorsal fin origin	26.6	24.1–27.1 (25.7) ±0.7	27.8–32.1 (29.3) ±1.2
Predorsal distance	56.6	51.6–57.4 (55.0) ±1.7	56.6–60.9 (58.0) ±1.1
Prepelvic distance	52.1	50.4–54.7 (52.6) ±1.5	53.9–56.7 (55.7) ±0.9
Preanal distance	72.4	68.7–74.0 (72.0) ±1.5	72.6–76.5 (74.5) ±1.1
Distance between pectoral and anal-fin origins	48.4	43.0–51.1 (48.1) ±2.5	47.3–51.3 (49.0) ±1.1
Distance between pectoral and pelvic-fin origins	26.7	24.6–31.2 (27.7) ±1.8	27.3–30.6 (29.0) ±0.8
Distance between pelvic and anal-fin origins	21.8	17.7–22.8 (20.0) ±1.6	18.3–22.2 (20.0) ±1.4
Dorsal fin depth	20.8	16.9–22.1 (20.1) ±1.7	16.9–21.7 (19.6) ±1.5
Anal fin length	18.3	15.2–20.6 (17.8) ±1.5	14.1–20.1 (17.0) ±1.7
Pectoral fin length	19.4	17.6–25.0 (21.3) ±2.1	17.7–22.1 (19.8) ±1.4
Pelvic fin length	15.6	13.7–19.1 (16.3) ±1.6	13.6–18.6 (15.7) ±1.4
Caudal peduncle length	20.5	17.5–23.0 (20.1) ±1.4	17.3–21.3 (19.0) ±1.3
Caudal peduncle depth	13.1	11.4–14.9 (12.6) ±0.9	12.7–14.9 (13.5) ±0.6
In percent of head length			
Snout length	29.4	26.5–32.9 (29.6) ±1.9	22.0–28.9 (25.4) ±1.8
Eye diameter	22.6	22.0–25.9 (24.5) ±1.4	20.5–23.3 (21.9) ±0.9
Interorbital distance	38.3	34.6–40.5 (38.2) ±1.6	30.6–36.3 (33.6) ±1.9
Head width at nape	59.8	55.3–61.7 (58.7) ±1.6	53.8–63.2 (58.0) ±2.8
Head depth at interorbital region	60.6	50.2–62.2 (56.7) ±3.3	49.7–58.2 (53.7) ±2.6
Head depth at nape	79.4	76.5–85.3 (80.7) ±2.8	70.8–80.7 (74.9) ±1.5
Operculum depth	42.0	40.0–48.8 (43.4) ±2.3	36.5–46.6 (40.1) ±2.6
Lower jaw length	36.0	32.6–38.6 (35.5) ±1.2	31.3–35.6 (33.5) ±2.1

pared fins and caudal peduncle distinctly sexual dimorphic (male with longer pelvic and pectoral fins and slenderer caudal peduncle); lateral line incomplete, with 21–37 (commonly 26–37) perforated scales and 47–57+1-2 scales in lateral series (commonly 50–55); 10½–12½ scale rows between lateral line and dorsal fin origin; 3–4 rarely 5 scale rows between lateral line and the pelvic fin origin; 7–8 (9) gill rakers on the first branchial arch; pharyngeal teeth 5–4 or 5–5, slightly serrated and hooked at tip; dorsal fin commonly with 7 (8)½ branched rays; anal fin with 6 (7)½ branched rays.

Description. See Figs 2–3 for general appearance and Tables 1-2 for morphometric and meristic data.

A Moderately deep-bodied, elongate and wide headed species. Dorsal profile of body slightly convex in predorsal area, ventral profile more convex than dorsal profile. Predorsal distance 52–57% SL, mean 55.0 and preanal distance 69–74% SL, mean 72.0. Head short, its length 26–28% SL, mean 26.8, approximately 1.0–1.1 times body depth at dorsal-fin origin, and its dorsal profile slightly convex on snout. Head depth at interorbital region 2.1–2.7 times eye diameter and 1.3–1.6 times interorbital

Table 2. Meristic features of the western Anatolian *Pseudophoxinus* species.

Species	Lateral series	Lateral line	Pharyngeal teeth	Total vertebrae	Abdominal vertebrae	Caudal vertebrae
P. alii	41–44	38–41	5–5	37–39	21–23	16–17
P. antalyae	52–64	42–59	5–5	37–39	20–22	16–17
P. anatolicus(*)	93–109	78–93	5–5	41–42	23–24	17–18
P. battalgilae (**)	53–61	53–60	5–5	37–38(39)	20–21	17–18
P. burduricus sp.n.	47–57	21–39	5–4(5)	36–39	21–22	15–17
P. crassus (*)	65–78	62–73	5–5	40	22	18
P. elizavetea (**)	60–68	33–60	5–5	36–37 (38)	22	14–16
P. evliyae	52–66	16–30	5–4	36–37	21–22	14–16
P. hittitorum	83–96	83–94	5–5	39	21–22	17–18
P. maeandri	41–45	19–27	5–4	35–36	19–20	15–16
P. maeandricus (**)	66–67	58–65	5–5	36–37	20–21	16
P. ninae	46–53	10–32	5–4	36	21	15

(*) from Atalay 2005; (**) Bogutskaya et al. 2007

distance. Mouth slightly subterminal, posterior extremity of upper jaw slightly in front of anterior margin of eye. Snout rounded, its length 27–33% HL, mean 29.6, greater than eye diameter. Caudal peduncle slightly deep, its depth 1.4–1.9, mean 1.6 times in its length.

Lateral line incomplete, usually reaching above anal fin origin, 32 perforated scales in the holotype (26–37 in paratypes), 47–57+1-2 scales in lateral series. Dorsal fin with 3 simple and 7½ (n=18, in one specimen 8½) branched rays, outer margin slightly convex. Anal fin with 3 simple and 6 (15)½ or 7 (3)½ branched rays, outer margin slightly convex. Pectoral fin with 13–14 branched rays, outer margin straight or slightly convex. Pelvic-fin with 7 branched rays. Caudal fin forked, lobes rounded. There is no pelvic axillary lobe and keel between posterior pelvic fin base and anus. Pharyngeal teeth 5–4 or 5–5, slightly serrated, hooked at tip (developed on the left side). Gill rakers short and thick, with 7–8 (9) in outer side of first gill arch. Preoperculo-mandibular (CPM) and infraorbital (CIO) sensory canals disconnected, CSO with 10–12 pores, CIO with 14–19 pores, CPM with 14–18 pores, total vertebrae 36–39, 21–22 abdominal and 15–17 caudal vertebrae, vertebral formulae: 36–39:21–22+15–17.

Sexual dimorphism. In Değirmendere population, there is no tubercules on snout and head in males, which have longer pelvic and pectoral fins and slender caudal peduncles than females. In Lake Salda population, on the other hand, tubercules present in males on entire body (concentrated on operculum) and all fins except for the caudal fin.

Coloration. Body silvery, dorsal light brown or olive green and scales irregular with small epidermal spots in specimens larger than 50 mm SL. There is a faint epidermal black or violet (in Sazak population) stripe along lateral midline from eye to caudal fin base in alive. The dark stripe indistinct or slightly distinct in anterior part of body but distinct in posterior part of body in preserved specimens. Lateral line scales with

small brown to black spots above and below pores in some individuals. Fin membranes whitish or light grey, rays with black-spotted. In individuals smaller than 50 mm SL: body silvery, dorsal dusty grey, ventral pearl grey.

Distribution. *Pseudophoxinus burduricus* is known only from the lakes and their sources in Lake Burdur Endorheic Basin: Değirmendere Creek, Lake Karataş, Düğer and Sazak (or Kümbet) springs, Dereköy Stream, Lake Salda and Salda Stream (Fig. 1). Değirmendere Creek is a 5 km long creek flowing into the Karamanlı reservoir, which is connected with artificial reservoir Lake Karataş. Düğer spring is a source of Lake Burdur, while Sazak Spring is a source of Lake Yarışlı. Dereköy Stream is an approximately 5 km long rivulet formerly draining into Çorak (or Akgöl) Lake which, due to a small reservoir constructed in 1970, no more can reach the lake. The new species can be encountered in the shallow parts of the reservoir and the small stream flowing into it.

Other species present were: *Chondrostoma fahirae* (Ladiges, 1960), *Oxynoemacheilus anatolicus* Erk'akan, Özeren & Nalbant, 2008 and *Oncorhynchus mykiss* (Walbaum, 1792) (an escape from fish farms in Karamanlı reservoir) in Değirmendere, in Düğer Spring only *O. anatolicus* and in Salda Stream only *Aphanius splendens* (Kosswig & Sözer 1945).

Etymology. The species is named after the Burdur Province where the type locality is located.

Discussion

Hrbek et al. (2004) stated that monophly of Anatolian *Pseudophoxinus* taxa was not well supported and these represented 6 distinct clades. Of these, Lakes Region populations (Lakes Salda and Karataş, Düğer Spring, Karapınar) identified as *P. maeandri* formed Clade IV, while the Avlan and Kırkpınar populations identified as *P. fahirae* (now *P. evliyae*) formed a separate clade (Clade VI). Perea et al. (2010) mentioned of two well defined monophyletic groups within Anatolian *Pseudophoxinus* taxa, though not discussion interrelationships of these two. A phylogenetic tree based on the cytb gene sequence, Hrbek et al. (2004: 299) showed presence of two different clade; (I) Lake Avlan and Kırkpınar (Lake Söğüt source) populations (*P. evliyae*) and (II) populations from Burdur and Salda basins.

In this study, we also morphologically compared the new species with *Pseudophoxinus ninae* (the Onaç Stream and Kestel Swamp), *P. evliyae* (dried Lake Söğüt [Kırkpınar Village, Korkuteli] and source of Lake Avlan [Elmalı]), *P. maeandri* [Lake Işıklı], *P. maeandricus* (Karadirek Stream [Upper Büyük Menderes basin]), *P. alii* (Köprüçay and Ilıca Stream), *P. battalgilae* (Manavgat River basin, Lake Akgöl [Ereğli], Lake Çavuşcu [Ilgın] and Lake Suğla [Seydişehir]), *P. fahrettini* (Köprüçay River basin [Bağıllı Village and Değirmenözü Stream]), *P. antalyae* (Kırkgöz Spring, Karamanlı Stream and tributaries of Düden canal in Antalya), and *P. elizavetae* (Sultansazlığı [Kayseri]).

Pseudophoxinus burduricus is most similar to *P. ninae* (Fig. 4). It is distinguished from *P. ninae* by having fewer branched pelvic fin rays (7, vs. 8 or 9), slightly fewer

Figure 4. *P. ninae* IFC-ESUF 0263, 66.37 mm SL; Turkey: Pınargözü Spring-Bucak.

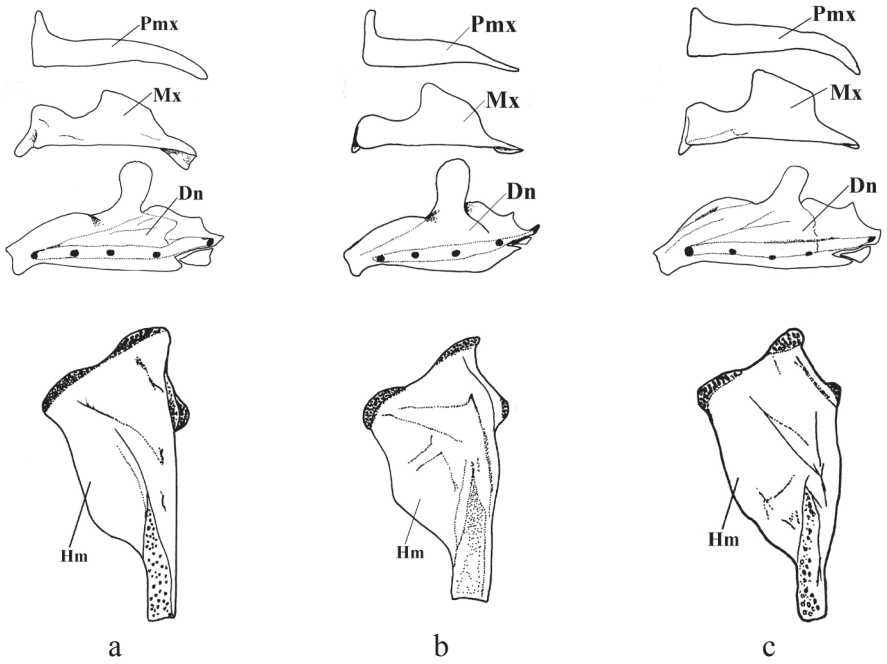


Figure 5. Left jaws and hyomandibular bones of *P. burduricus* sp. n. (**a**) *P. ninae* (**b**) and *P. maeandri* (**c**) (Pmx: premaxilla, Mx: maxilla, Dn: Dentale, Hm: Hyomandibulare)

gill rakers in outer side of the first gill arch (7–8, rarely 9, vs. 8–9) and a longer caudal peduncle (caudal peduncle length 1.4–1.9 times caudal peduncle, vs. 1.3–1.4). It further differs from *P. ninae* by having a shorter predorsal distance (52–57% SL, mean 55.0, vs. 57–61, mean 58.0), a shorter preanal distance (69–74% SL, mean 72.0, vs. 73–77, mean 74.5), a somewhat shorter head (head length 26–28 % SL, mean 26.8, vs. 27–31, mean 28.6), and narrower and relatively deeper hyomandibular bone (vs. wide and shallow) (see Figs 5a, b, c). Also *Pseudophoxinus burduricus* and *P. ninae* were compared by Principal Component Analysis (PCA). The PCA was performed in us-

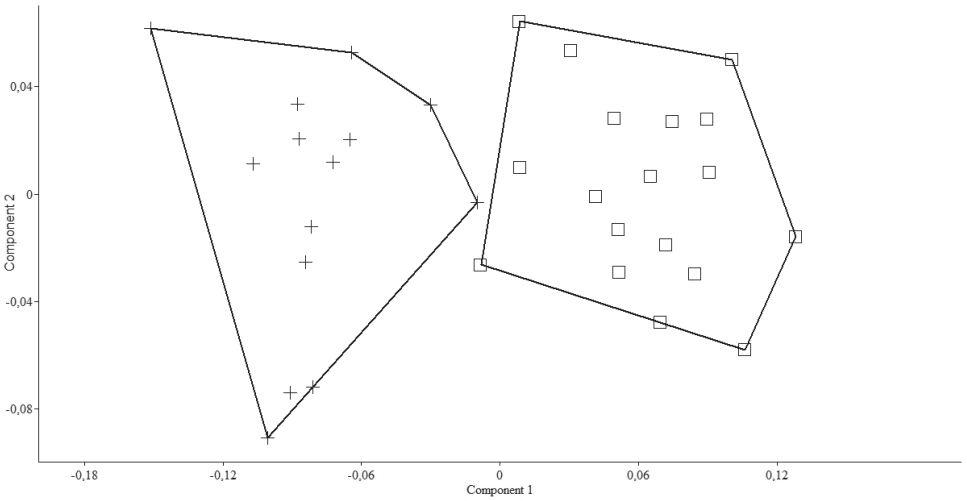


Figure 6. A scatter plot of the scores of the first two principal components (PC I, PC II) for 32 specimens of the two *Pseudophoxinus* species (*P. burduricus* sp. n. (+) and *P. ninae* (□), based on 18 morphometric characters.

ing 18 morphometric characters of the two *Pseudophoxinus* species. The PCA clearly separated *Pseudophoxinus burduricus* from *P. ninae* (Fig. 6). Variables loading on the first metric PC I–II are given in Table 3.

Pseudophoxinus burduricus is distinguished from *P. evliyae* by having fewer scales in lateral series (47–57+1-2, vs. 54–64+1-2), fewer branched pelvic fin rays (7, vs. 8), fewer gill rakers in outer side of first gill arch (7-8, rarely 9, vs. 8-9 to 10 in some specimens), fewer scales between lateral line and dorsal fin origin (10½-12½, vs. 13½-15½), and a faint epidermal black or violet stripe along lateral midline from eye to caudal fin base (vs. black prominent stripe). *Pseudophoxinus burduricus* is distinguished from *P. maeandri* by having more lateral line and lateral series scales (21–39, vs. 19–27 and 47–57+1-2, vs. 40–44+1-2 respectively), more total vertebrae, 36-39 (vs. 35–36) (see Table 2). *Pseudophoxinus burduricus* differs from *P. maeandricus* by having an incomplete lateral line (vs. complete), a shorter pelvic-fin (reaching to anus, vs. not reaching), wider and deeper head (head width at nape 55-62 % HL, vs. 46–48; head depth at nape 77–85 % HL, vs. 67–73). *Pseudophoxinus burduricus* is distinguished from *P. alii* by having more scales in the lateral series (47–57+1-2, vs. 38-43+1-2), fewer perforated scales (21–39, vs. 38–41) and smaller eyes (eye diameter 22–26 % HL, vs. 26–32). *Pseudophoxinus burduricus* is distinguished *P. antalyae* by presence of a faint black or violet lateral stripe (vs. plain golden or orange stripe when alive), rounded snout (vs. pointed) and shorter pharyngeal teeth. *Pseudophoxinus burduricus* is distinguished from *P. battalgilae* by an incomplete lateral line (vs. complete), fewer gill rakers in outer side of first gill arch (7–8, rarely 9, vs. 13–16), fewer branched anal fin rays (6–7, vs. 8, respectively), and the absence of a keel between the pelvic fin base and the anus (vs. presence). *Pseudophoxinus burduricus* is distinguished *P. fahrettini* by an incomplete lateral line (vs. complete), fewer perforated scales lateral line (21–39, vs.

Table 3. Character loading on principal components I–II for 18 measurements taken on 32 specimen of two *Pseudophoxinus* species (*P. burduricus* sp.n. and *P. ninae*).

Morphometric features		
In percent of standard length	PC I	PC II
Head length	0.196	-0.103
Body depth of dorsal-fin origin	0.335	0.222
Predorsal length	0.140	0.119
Prepelvic length	0.147	0.145
Preanal length	0.083	0.156
Dist. from pectoral-fin origin to anal fin	0.060	0.331
Dist. from pectoral-fin origin to pelvic fin	0.140	0.396
Dist. from pelvic-fin origin to anal fin	0.012	0.368
Length of caudal peduncle	-0.300	-0.383
Depth of caudal peduncle	0.180	0.112
In percent of head length		
Snout length	-0.445	0.322
Eye diameter	-0.285	-0.118
Interorbital distance	-0.420	0.166
Head width (at operculum)	-0.054	0.300
Head depth (at interorbital region)	-0.202	0.080
Operculum depth	-0.290	0.155
Head depth operculum	-0.208	0.164
Length of lower jaw	-0.172	0.164

73–88) and fewer gill rakers in outer side of first gill arch (7–8, rarely 9, vs. 11–13). *Pseudophoxinus burduricus* is distinguished *P. elizavetae* by having fewer scales in the lateral series (47–57+1-2, vs. 56-62+2-3), fewer gill rakers in outer side of first gill arch (7–8, rarely 9, vs. 11–13).

Comparative material (all from Turkey)

Pseudophoxinus alii: IFC-ESUF 0169, 13 paratyps, 53.33–98.48 mm SL; Antalya Prov.: Ilıca Stream at Manavgat, F. Küçük, 05 May1996.

Pseudophoxinus antalyae: IFC-ESUF 0159, 10, 64.07–97.10 mm SL; Antalya Prov.: Düden Canal, W.V.Neer, F. Küçük, R.Wildekamp, M. Ünlüsayın, 28 July 1996.

Pseudophoxinus battalgilae: IFC-ESUF 0161, 18, 46.51-109.68 mm SL; Antalya Prov.: Oymapınar Dam Lake at Manavgat, F. Küçük, 05 May 1996.

Pseudophoxinus elizavetae: IFC-ESUF 0174b, 10, 49.29-67.47 SL; Kayseri Prov.: Sultansazlığı, M.A. Atalay, 23 August 2004.

Pseudophoxinus evliyae: IFC-ESUF 0237, 26, 25.38–57.51 SL; Antalya Prov.: Kırkpınar-Korkuteli, F. Küçük, İ. Gülle, 10 May 1998. IFC-ESUF 0269, 10, 26.17–66.92 mm SL; Antalya Prov.: Kırkpınar-Korkuteli, F. Küçük, T. Şahan,

25 May 2007.- IFC-ESUF 0268, 1, 73.39 mm SL; Antalya Prov.: Kazanpınarı-Elmalı, F. Küçük, T. Şahan, 25 May 2007.

Pseudophoxinus maeandri: IFC-ESUF 0248, 8, 46.70–55.96 mm SL; Denizli Prov.: Lake Işıklı source, F. Küçük, M.A. Atalay, N. Bogutskaya & A.Naseka, 14 August 2006.

Pseudophoxinus maeandricus: 3, 60.71–78.70 mm SL; Afyon Prov.: Karadirek Stream-Sandıklı, V. Yeğen, 29 June 2006.

Pseudophoxinus ninae: IFC-ESUF 0263, 4, 48.9–67.5 mm SL; Burdur Prov.: Pınargözü-Bucak, F. Küçük, T. Şahan, 25 May 2007. –IUSHM 33900-928, 15, 46.4–68.4 mm SL; Burdur Prov.: Onaç Stream, M. Özuluğ, J. Freyhof, 12 June 2006.

Acknowledgments

This study was supported by the Research Fund of Süleyman Demirel University (grant SDÜ-08.M.1354). The authors thank to Dr. M. Özuluğ (İstanbul Üniversity) and V. Yeğen (Ministry of Food, Agriculture and Livestock) for donating some fish specimens, and Dr. Davut Turan (Recep Tayyip Erdoğan University) and three anonymous reviewers for commenting on earlier versions of the manuscript.

References

Atalay MA (2005) *Pseudophoxinus* (Pisces, Cyprinidae) Genusu'nun Anadolu'da Yayılışı ve Taksonomik Özelliklerinin Belirlenmesi (Distribution of the genus *Pseudophoxinus* (Pisces, Cyprinidae) in Anatolia and Determination of its Taxonomic Features. PhD thesis, Isparta, Turkey: Süleyman Demirel University). [In Turkish]

Bogutskaya NG (1992) A revision of species of the genus *Pseudophoxinus* (Leuciscinae, Cyprinidae) from Asia Minor. Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut 89: 261–290.

Bogutskaya NG (1996) Contribution to the knowledge of leuciscine fishes of Asia Minor. Part 1. Morphology and taxonomic relationships of *Leuciscus borysthenicus* (Kessler), *Leuciscus smyrnaeus* Boulenger and *Ladigoesocypris ghigii* (Gianferrari) (Cyprinidae,Pisces). Publ. espec. Inst. Esp. Oceanogr. 21: 25–44.

Bogutskaya NG, Küçük F, Atalay MA (2007) A description of three new species of the genus *Pseudophoxinus* from Turkey (Teleostei: Cyprinidae: Leuciscinae). Zoosystematica Rossica 15: 335–341.

Freyhof J, Özuluğ M (2009) *Pseudophoxinus evliyae,*a new species of spring minnow from Western Anatolia with remarks on the distribution of *P. ninae* and the systematic position of *P. fahirae* (Teleostei: Cyprinidae). Ichthyological Exploration of Freshwaters 20: 309–318.

Hammer O, Harper DAT, Ryan PD (2001) PAST: paleontological statistics software package for education and data analysis, Palaeontologia Electronica 4: 9.

Hrbek T, Küçük F, Frickey T, Stölting KN, Wildekamp RH, Meyer A (2002) Molecular phylogeny and historical biogeography of the *Aphanius* (Pisces, Cyprinodontiformes) species

complex of central Anatolia, Turkey. Molecular Phylogenetics and Evolution 25: 125–137. doi: 10.1016/S1055-7903(02)00203-8

Hrbek T, Stölting KN, Bardakçı F, Küçük F, Wildekamp RH, Meyer A (2004) Plate tectonics and biogeographical patterns of the *Pseudophoxinus* (Pisces: Cypriniformes) species complex of central Anatolia, Turkey. Molecular Phylogenetics and Evolution 32: 297–308. doi: 10.1016/j.ympev.2003.12.017

Kottelat M, Freyhof J (2007) Handbook of European freshwater fishes. Kottelat, Cornol and Freyhof, Berlin, xiv + 646 pp.

Ladiges W (1960) Süsswasserfische der Turkey 1. Teil Cyprinidae. Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut 58: 105–150.

Naseka AM (1996) Comparative study on vertebral column in the Gobioninae (Cyprinidae, Pisces) with special reference to its systematics. Esp. Oceanogr. 21: 149–167.

Perea S, Bohme M, Zupancic P, Freyhof J, Sanda R, Özulug M, Abdoli A, Doadrio I (2010) Phylogenetic relationships and biogeographical patterns in Circum-Mediterranean Subfamily Leuciscinae (Teleostei, Cyprinidae) inferred from both mitochondrial and nuclear data. BMC Evol. Biol. 10 (1): 265. doi: 10.1186/1471-2148-10-265

ZooKeys 320: 43–49 (2013)
doi: 10.3897/zookeys.320.5147
www.zookeys.org

RESEARCH ARTICLE

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

A new species of *Polypedilum* (*Uresipedilum*) Oyewo & Sæther, 1998 from Zhejiang Province of Oriental China (Diptera, Chironomidae)

Xiaolong Lin[1,†], Xin Qi[2,‡], Ruilei Zhang[3,§], Xinhua Wang[1,|]

1 *College of Life Science, Nankai University, Tianjin 300071, China* **2** *College of Life Science, Taizhou University, Taizhou, Zhejiang 318000, China* **3** *College of Fisheries and Life Science, Shanghai Ocean University, Shanghai, 201306, China*

† *http://zoobank.org/AC3964DC-0709-4DCB-96AA-6EBEDFA04C07*
‡ *http://zoobank.org/C902B210-CE50-4C13-885B-CE172F2F633B*
§ *http://zoobank.org/779D0E50-116D-4C16-835B-6F2ABE0D1ED1*
| *http://zoobank.org/ACC3483B-5DD1-4F2D-88F7-1CE4C6458B68*

Corresponding author: *Xinhua Wang* (xhwang@nankai.edu.cn)

Academic editor: *V. Blagoderov* | Received 17 March 2013 | Accepted 26 July 2013 | Published 31 July 2013

http://zoobank.org/C2311A94-09EE-43CE-9A3D-EDA1B83C71D9

Citation: Lin X, Qi X, Zhang R, Wang X (2013) A new species of *Polypedilum* (*Uresipedilum*) Oyewo & Sæther, 1998 from Zhejiang Province of Oriental China (Diptera, Chironomidae). ZooKeys 320: 43–49. doi: 10.3897/zookeys.320.5147

Abstract

A new species of *Polypedilum* (*Uresipedilum*) Oyewo & Sæther, 1998, *P.* (*U.*) *minimum* **sp. n.** is described as male. A key to adult males of the subgenus from China is presented.

Keywords

Chironomidae, *Polypedilum* (*Uresipedilum*), key, new species, China

Introduction

Polypedilum is one of the largest chironomid genera containing about 440 described species. The larvae mostly occur in sediments, with a few species mining wood or grazing epilignic and epilithic surfaces (Cranston et al. 1989). At present, the genus

Polypedilum comprises eight subgenera: *Polypedilum* Kieffer, 1912, *Pentapedilum* Kieffer, 1913, *Kribionympha* Kieffer, 1921, *Tripedilum* Kieffer, 1921, *Tripodura* Townes, 1945, *Uresipedilum* Oyewo & Sæther, 1998, *Cerobregma* Sæther & Sundal, 1999 and *Probolum* Andersen & Sæther 2010 (Sæther et al. 2010).

Sasa and Kikuchi (1995) proposed *Uresipedilum* for the *Polypedilum convictum* group sensu Niitsuma (1992), but they failed to designate the type species. Oyewo and Sæther (1998) validated the name by designating *Polypedilum* (*Uresipedilum*) *convictum* (Walker, 1856) as the type species. Zhang and Wang (2004) reviewed the subgenus on the basis of 14 species recorded in China. Sæther and Oyewo (2008) and Sæther et al. (2010) revised the subgenus around the world and transferred *P.* (*U.*) *bullum* Zhang & Wang, 2004, *P.* (*U.*) *pedatum excelsius* Townes, 1945 and *P.* (*U.*) *simantokeleum* Sasa, Suzuki & Sakai, 1998 to the newly proposed subgenus *Probolum*. Up to date, *Uresipedilum* includes 46 known species.

The adult males of the subgenus *Uresipedilum* are separated from other subgenera by having the basal portion of the superior volsella much longer than wide, with an apicomedian projection without setae placed on the inner margin of the base and directed medially and without prominent inner projection; wing membrane without markings or setae and fore tibial scale nearly always without spur (Sæther et al. 2010).

Based on the material from Zhejiang Province of Oriental China, a new species is described and illustrated as male. A complemented key to adult males of *Polypedilum* (*Uresipedilum*) from China is presented.

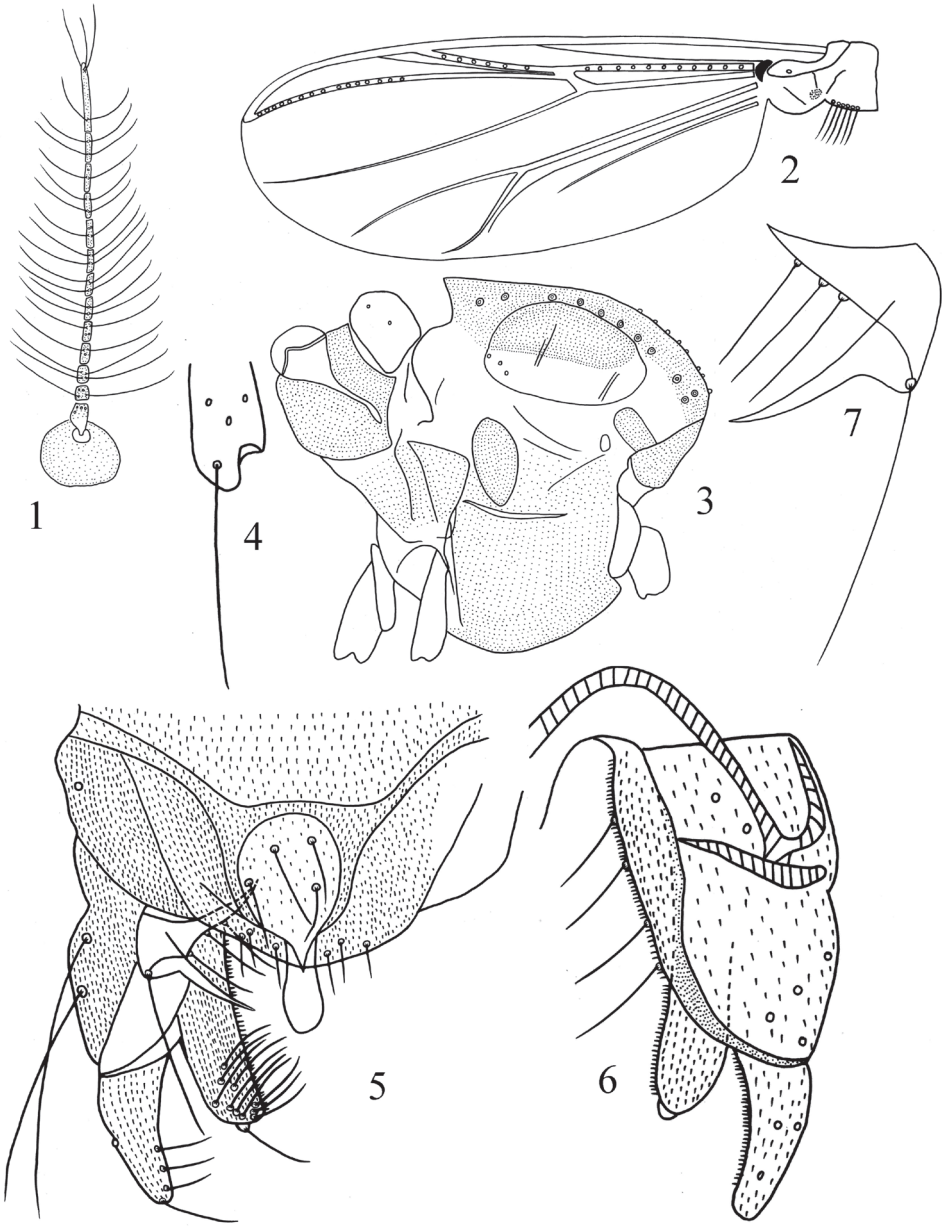
Materials and methods

The morphological nomenclature follows Sæther (1980) and the abbreviations of structures measured follow Qi et al. (2012). The material examined was slide-mounted, following the procedure by Sæther (1969). The specimen examined in this study is deposited in the College of Life Science, Nankai University, China.

Taxonomy

***Polypedilum* (*Uresipedilum*) *minimum* sp. n.**
http://zoobank.org/3237A70B-1254-4EB7-969B-6FD4ACC1883D
http://species-id.net/wiki/Polypedilum_minimum
Figures 1–7

Diagnosis. The male adult can be distinguished from known species of the subgenus by the following combination of characters: low AR (0.27); frontal tubercles present; fore tibial scale rounded; anal point broad; superior volsella strongly projected posteriorly, pointed at apex, without microtrichium; high HV (4.90).



Figures 1–7. *Polypedilum* (*Uresipedilum*) *minimum* sp. n. **1** Antenna. **2** Wing. **3** Thorax **4** Fore tibia scale **5** Dorsal view of hypopygium **6** Ventral view of hypopygium **7** Superior volsella.

Description. Male adult (n = 1). Total length 1.47 mm. Wing length 0.89 mm. Wing length/length of profemur 2.98.

Coloration. Head, legs and abdomen yellow. Thorax yellow with brown vittae, postnotum and preepisternum.

Head. AR 0.27. Antenna with 13 flagellomeres, ultimate flagellomere 93 μm long (Fig. 1). Frontal tubercles 38 μm long, 15 μm wide at base. Temporal setae 7, including 2 inner verticals, 4 outer verticals and 1 postorbital. Clypeus with 15 setae. Tentorium 70 μm long, 10 μm wide. Stipes 75 μm long, 10 μm wide. Palpomeres length (in μm): 18, 15, 38, 55, 103. L: $5^{th}/3^{rd}$ 2.73.

Wing (Fig. 2). VR 1.54. Brachiolum with 1 seta, R with 11 setae, R_1 with 6 setae, R_{4+5} with 15 setae. Squama with 6 setae.

Thorax (Fig. 3). Acrostichals 8; dorsocentrals 11; prealars 3. Scutellum with 4 setae.

Legs. Terminal scale (Fig. 4) of fore tibia rounded, 15 μm long, without spine. Spur of mid tibia 25 μm long, comb 10 μm long; unspurred comb 15 μm long. Spur of hind tibia 25 μm long, comb 10 μm long; unspurred comb 10 μm long. Apex of fore tibia 25 μm wide, of mid tibia 23 μm wide, of hind tibia 38 μm wide. Mid ta_1 without sensilla chaetica. Lengths (in μm) and proportions of legs in Table 1.

Hypopygium (Figs 5–6). Tergite IX with 4 strong median setae. Laterosternite IX with 1 seta. Anal point broad, 18 μm long, with swollen, rounded apex. Phallapodeme 34 μm long; transverse sternapodeme 13 μm long. Gonocoxite 62 μm long, with 2 long setae. Superior volsella (Fig. 7) 16 μm long, with 3 basal inner setae and 1 strong apical seta, without microtrichium; apicomedial projection 17 μm long, pointed at apex. Inferior volsella 41 μm long, with 10 dorsal setae and 1 prominent apical seta. Gonostylus 30 μm long, apex blunt, with 3 setae along inner margin and 1 apical seta. HR 2.07. HV 4.90.

Type materials. Holotype: adult male, China, Zhejiang Province: Jinhua City, Pan'an County, Dapanshan National Nature Reserve, 120.50°N, 29.00°E, 18.vii.2012, leg. Lin XL, sweep net.

Etymology. From Latin *minimum*, little, referring to the small body length and antennal ratio.

Remarks. The new species resembles *Polypedilum* (*Uresipedilum*) *obtusum* Townes, 1945, *P.* (*U.*) *aviceps* Townes, 1945, *P.* (*U.*) *infundibulum* Zhang & Wang, 2004, *P.* (*U.*) *surugense* Niitsuma, 1992 and *P.* (*U.*) *paraviceps* Niitsuma, 1992 in the general

Table 1. Lengths (in μm) and proportions of legs of *Polypedilum* (*Uresipedilum*) *minimum* sp. n.

	P_1	P_2	P_3
fe	299	365	374
ti	215	251	308
ta_1	317	165	194
ta_2	143	75	120
ta_3	115	60	115
ta_4	85	38	65
ta_5	40	38	50
LR	1.47	0.66	0.63
BV	2.17	3.70	2.50
SV	1.62	3.73	3.52
BR	3.60	4.33	5.14

Table 2. Differences between *P.* (*U.*) *minimum* sp. n. and *P.* (*U.*) *breviplumosum* Zhang & Wang, 2004

	***P.* (*U.*) *minimum* sp. n.**	**P. (*U.*) *breviplumosum***
TL	1.47 mm	2.24–2.57 mm
WL	0.89 mm	1.43–1.59 mm
Setae on squama	6	9–12
Anal point	board	slender
Superior volsella	strongly projected posteriorly, bare, with 3 inner setae, pointed at apex	rounded at apex, covered with microtrichia
Fore tibial scale	rounded	pointed
HR	2.07	1.25–1.40
HV	4.90	2.57–2.73

Female and immature stages unknown.

structure of hypopygium, but it can be separated by the superior volsella without microtrichium, which present in the latter species; the low antennal ratio (AR= 0.27), AR>1 in the latter species. The new species most resembles *P.* (*U.*) *breviplumosum* Zhang & Wang, 2004 in the low antennal ratio (AR= 0.22–0.23), but it differs from the latter species by the following combination of characters in Table 2.

Key to adult males of *Polypedilum* (*Uresipedilum*) from China

1 Anal point semicircular **2**
– Anal point triangular **5**
2 Base of superior volsella without microtrichium **3**
– Base of superior volsella with microtrichia **4**
3 AR 1.25–1.48, superior volsella without inner seta ..... ***P.* (*U.*) *infundibulum* Zhang & Wang, 2004**
– AR 0.27, superior volsella with 3 inner setae ..... ***P.* (*U.*) *minimum* sp. n.**
4 Subapical tubercle of inferior volsella present ..... ***P.* (*U.*) *paraviceps* Niitsuma, 1992**
– Subapical tubercle of inferior volsella absent ..... ***P.* (*U.*) *surugense* Niitsuma, 1992**
5 AR about 0.2, frontal tubercles present ..... ***P.* (*U.*) *breviplumosum* Zhang & Wang, 2004**
– AR>0.8, frontal tubercles absent **6**
6 Anal point with several lateral setae **7**
– Anal point without lateral setae **8**
7 Inner margin of superior volsella bulging ..... ***P.* (*U.*) *lateralum* Zhang & Wang, 2004**
– Inner margin of superior volsella medially constricted ..... ***P.* (*U.*) *dilatum* Zhang & Wang, 2004**

8 Inferior volsella with large ventral apical process ..... ***P.* (*U.*) *prominens* Zhang & Wang, 2004**
– Inferior volsella without large ventral apical process **9**
9 Fore tibial scale rounded **10**
– Fore tibial scale pointed **11**
10 Base of superior volsella with 1–3 inner setae, projected posteriorly ..... ***P.* (*U.*) *convictum* (Walker, 1856)**
– Base of superior volsella with 4–5 inner setae, not projected posteriorly ..... ***P.* (*U.*) *crassiglobum* Zhang & Wang, 2004**
11 Base of superior volsella without seta ... ***P.* (*U.*) *medium* Zhang & Wang, 2004**
– Base of superior volsella with several setae **12**
12 Superior volsella with 2–5 apical setae .... ***P.* (*U.*) *cultellatum* Goetghebuer, 1931**
– Superior volsella with 1 apical seta **13**
13 Apicomedial projection of superior volsella much shorter than base ..... ***P.* (*U.*) *basilarum* Zhang & Wang, 2004**
– Apicomedial projection of superior volsella much longer than base ..... ***P.* (*U.*) *xuei* Zhang & Wang, 2004**

Acknowledgements

Financial support from the National Natural Science Foundation of China (NSFC, grant No. 31272284, 31201739, J1210005), the Zhejiang Provincial Natural Science Foundation of China (grant No. Y3100486), Fauna of China (FY120100) are acknowledged with thanks.

References

Cranston PS, Dillon ME, Pinder CV, Reiss F (1989) The adult males of Chironominae (Diptera: Chironomidae) of the Holarctic region -Keys and diagnoses. In: Wiederholm T (Ed) Chironomidae of the Holarctic region. Keys and diagnoses: Part 3. Adult males. Entomologica Scandinavica Supplement 34: 353–532.

Kieffer JJ (1912) Tendipedidae (Chironomidae) (Dipt.). H. Sauter's Formosa-Ausbeute. Supplementa entomologica 1: 27–43.

Kieffer JJ (1913) Nouveaux Chironomides (Tendipédides) d'Allemagne. Bulletin de la Société d'Histoire naturelle de Metz 28: 7–35.

Kieffer JJ (1921) Synopse de la tribu des Chironomariae (Diptères). Annales de la Société scientifique Bruxelles 40: 269–277.

Niitsuma H (1992) The *Polypedilum convictum* species group (Diptera, Chironomidae) from Japan, with descriptions of two new species. Japanese Journal of Entomology 60: 693–706.

Oyewo EA, Sæther OA (1998) Revision of Afrotropical *Polypedilum* Kieffer subgenus *Uresipedilum* Sasa et Kikuchi, 1995 (Diptera: Chironomidae), with a review of the subgenus.

Annales de Limnologie 34: 315–362. http://www.limnology-journal.org/download.php?file=%2FANL%2FANL34_03%2FS0003408898000284a.pdf&code=96e7063756d7391113924f0d065b8fde, doi: 10.1051/limn/1998028

Qi X, Lin XL, Wang XH (2012) Review of *Dicrotendipes* Kieffer from China (Diptera: Chironomidae). Zookeys 183: 23–36. doi: 10.3897/zookeys.183.2834

Sasa M, Kikuchi M (1995) Chironomidae (Diptera) of Japan. University of Tokyo Press, Tokyo, 333 pp.

Sasa M, Suzuki H, Sakai T (1998) Studies on the chironomid species collected on the shore of Shimanto River in April, 1998. Part 2. Description of additional species belonging to Orthocladiinae, Diamesinae and Tanypodinae. Tropical Medicine 40: 99–147.

Sæther OA (1969) Some Nearctic Podonominae, Diamesinae and Orthocladiinae (Diptera: Chironomidae). Bulletin of the Fisheries Research Board of Canada 170: 1–154.

Sæther OA (1980) Glossary of chironomid morphology terminology (Diptera: Chironomidae). Entomologica scandinavica, Supplement, 14: 1–51.

Sæther OA, Sundal A (1999) *Cerobregma*, a new subgenus of *Polypedilum* Kieffer, with a tentative phylogeny of subgenera and species groups within *Polypedilum* (Diptera: Chironomidae). Journal of the Kansas Entomological Society 71: 315–382.

Sæther OA, Oyewo EA (2008) Keys, phylogenies and biogeography of *Polypedilum* subgenus *Uresipedilum* Oyewo et Sæther (Diptera: Chironomidae). Zootaxa 1806: 1–34. http://www.mapress.com/zootaxa/2008/f/z01806p034f.pdf

Sæther OA, Andersen T, Pinho L, Mendes H (2010) The problems with *Polypedilum* Kieffer (Diptera: Chironomidae), with the description of *Probolum* subgen. n. Zootaxa 2497: 1–36. http://www.mapress.com/zootaxa/2010/f/zt02497p036.pdf

Townes HK (1945) The Nearctic species of Tendipedini. (Diptera: Tendipedidae (= Chironomidae)). American Midland Naturalist 34: 1–206. doi: 10.2307/2421112

Walker F (1856) Insecta Britannica, Diptera. Volume 3. Reeve & Benham, London, xxiv + 352 pp.

Zhang RL, Wang XH (2004) *Polypedilum* (*Uresipedilum*) Oyewo and Sæther from China (Diptera: Chironomidae). Zootaxa 565: 1–38.

ZooKeys 320: 51–62 (2013)
doi: 10.3897/zookeys.320.4927
www.zookeys.org

RESEARCH ARTICLE

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

New species and records of *Parametriocnemus* Goetghebuer from China (Diptera, Chironomidae)

Xing Li[1,†], Xiao-long Lin[1,‡], Xin-hua Wang[1,§]

1 *College of Life Sciences, Nankai University, Tianjin 300071, China*

† *http://zoobank.org/1C8254AA-C0A3-4AEB-A940-F32E0DBF09AC*
‡ *http://zoobank.org/AC3964DC-0709-4DCB-96AA-6EBEDFA04C07*
§ *http://zoobank.org/37612E15-93C0-4263-80F7-5322036240F9*

Corresponding author: *Xinhua Wang* (xhwang@nankai.edu.cn)

Academic editor: *V. Blagoderov* | Received 28 February 2013 | Accepted 26 July 2013 | Published 31 July 2013

http://zoobank.org/23066AA4-A164-4961-AFB3-BFBB28CC979F

Citation: Li X, Lin X-l, Wang X-h (2013) New species and records of *Parametriocnemus* Goetghebuer from China (Diptera, Chironomidae). ZooKeys 320: 51–62. doi: 10.3897/zookeys.320.4927

Abstract

The Chinese species of *Parametriocnemus* Goetghebuer are reviewed. Two species, *P. fortis* **sp. n.** and *P. vittatus* **sp. n.** are described and illustrated as males, and *P. ornaticornis* (Kieffer), *P. scotti* (Freeman) and *P. brundini* Sinharay & Chaudhuri are recorded from China for the first time. A key to the males of the seven Chinese *Parametriocnemus* species is given.

Keywords

Chirnomidae, *Parametriocnemus*, new species, new records, China

Introduction

The genus *Parametriocnemus* was described as a subgenus of *Metriocnemus* van der Wulp by Goetgebuer (1933), based on *M. stylatus* Kieffer, 1924. It was raised to genus by Brundin (1956). The genus presently include 34 species worldwide. Seven species are recorded from the Oriental Region, 19 from the Palaearctic Region, 6 from the Nearctic Region, 1 from the Neotropical Region, 3 from the Afrotropical Region and 2 from the Australasian Region (Ashe and O'Connor 2012).

Wang (2000) listed two species of *Parametriocnemus* from China, *P. stylatus* and *P. lundbecki*, based on males, while a record of *P. lundbeckii* was treated as dubious. Based on recently collected material from China, two new species are described and three additional species are recorded. A key to the males of the Chinese *Parametriocnemus* is presented.

Materials and methods

The morphological nomenclature follows Sæther (1980). The material examined was mounted on slides in Canada balsam, following the procedure outlined by Sæther (1969). Measurements are given as ranges.

The types and other material is housed in the College of Life Sciences, Nankai University, China (BDN).

Species descriptions

***Parametriocnemus brundini* Sinharay & Chaudhuri**
http://species-id.net/wiki/Parametriocnemus_brundini

Parametriocnemus brundini Sinharay & Chaudhuri, 1979: 119.

Meterial examined. CHINA: Fujian Province, Daiyun Mountain, 25°41'0.38"N, 118°11'23"E, 1 male, 13.iv.2002, light trap, Z. Liu.

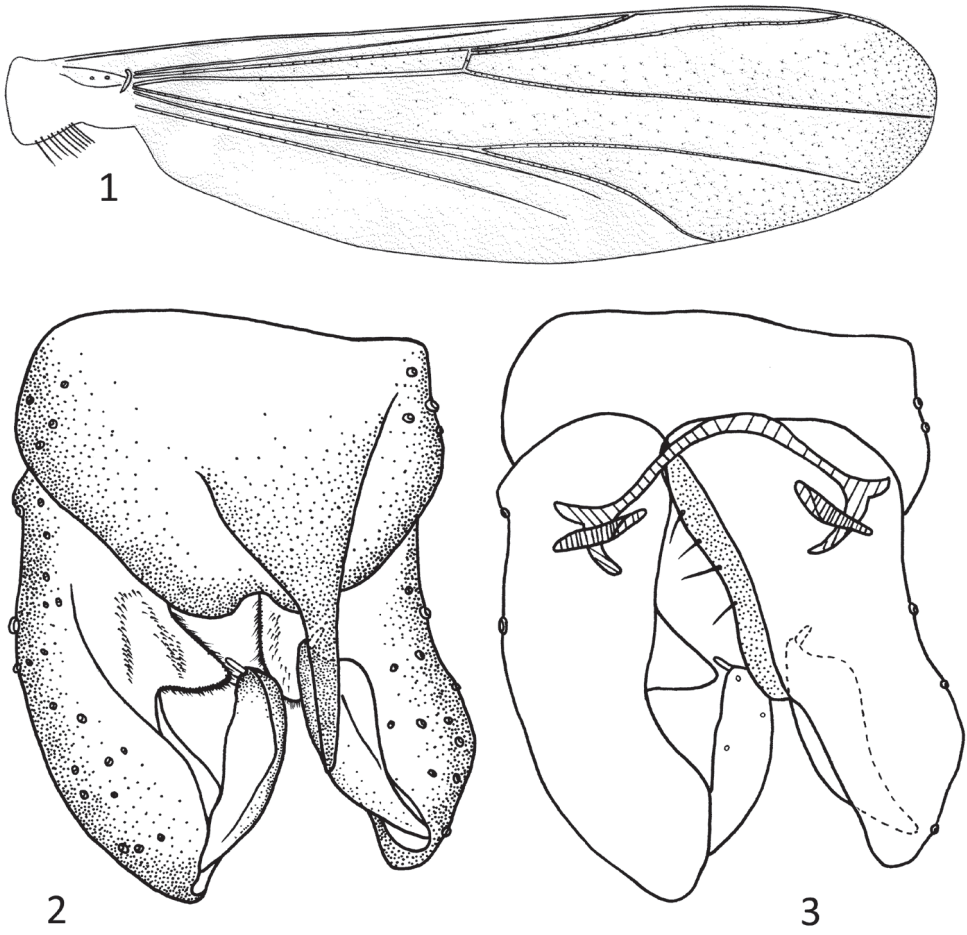
Remarks. The species can be separated from other members of the genus by having a brown body; absence of band on mesonotum; setae on abdominal terga in transverse rows; long anal point; and a triangular inferior volsella. According to Sinharay and Chaudhuri (1979), the color of the India specimen is brown. The Chinese specimen is lighter brown; other differences between specimens from China and India as in Table 1.

Distribution. In China the species is known from the Fujian Province in the Oriental region only.

***Parametriocnemus fortis* sp. n.**
http://zoobank.org/FA0E5DF9-3AD6-430E-BB7A-2BCF02A97084
http://species-id.net/wiki/Parametriocnemus_fortis
Figs 1–3

Material examined. Holotype male (BDN No.007), CHINA: Tibet, Shergmla Mountain, Lulang, 29°56'36"N, 94°47'57"E, 29.ix.1997, light trap, T. Solhøy & J. Skartveit.

Diagnostic characters. The male differs from other members of the genus by having a long, strong anal point, twice as long as gonostylus, and a high HV.



Figures 1–3. *Parametriocnemus fortis* sp. n., male. **1** wing **2** hypopygium(dorsal view) **3** hypopygium (ventral view).

Table 1. Difference between specimens from China and India of *Parametriocnemus brundini* Sinharay & Chaudhuri, male.

***P. brundini* Sinharay & Chaudhuri**	**Chinese specimens(n=1)**	**India specimens (n=1)**
AR	1.03	1.06
Color of thorax	yellowish	brown
Color of abdomen	yellowish	I–IV brown, rest dark brown
LR_1	0.82	0.77
LR_3	0.62	0.44

Etymology. From Latin, adjective, *fortis*– meaning strong, referring to the long and strong anal point.

Description. Male (n=1).

Total length 3.03 mm. Wing length 2.08 mm. Total length / wing length 1.46. Wing length / length of profemur 2.59.

Coloration. Head and wing light brown. Legs yellow. Thorax and abdomen blackish brown.

Head. AR 0.57. Temproal setea 13, including 8 inner verticals, 2 outer verticals and 3 postobitals. Clypeus with 11 setae. Tentorium 185 μm long, 38 μm wide. Palpomeres lost.

Wing (Fig. 1). Anal lobe reduced. VR 1.06. Costal extension 75 μm long, ending above to very slightly proximal to apex of M_{3+4}. Brachiolum with 1 seta, C extension with 5 non-marginal setae, Sc bare, R with 23 setae, R_1 with 16, R_{4+5} with 37, RM with 1, M with 2, M_{1+2} with 64, M_{3+4} with 39, Cu with 20, Cu_1 with 28, Pcu with 30, and An with 22 setae. Cell m proximal to RM with 9 setae, r_{4+5} with 162, m_{1+2} with 176, m_{3+4} with 125, an with 2, and cu with 23 setae. Squama with 8 setae.

Thorax. Antepronotum with 1 setae. Dorsocentrals 20, acrostichals 3, prealars 6. Scutellum with 7 setae.

Legs. Spur of fore tibia 43 μm long, spurs of mid tibia 20 μm and 18 μm long, of hind tibia 43 μm and 25 μm long. Width at apex of mid tibia 40 μm. Comb of 10 setae, shortest seta 30 μm long, longest seta 50 μm long. Lengths (in μm) and proportions of legs as in Table 2.

Hypopygium (Figs 2–3). Anal point strong, 143 μm long, 88 μm wide at base. Tergite IX including anal point with 5 setae. Laterosternite IX with 4 setae. Pallapodeme 43 μm long, trasverse sternapodeme 60 μm long. Gonocoxite 163 μm long, interifor volsella triangular. Gonostylus 71 μm long, megaseta 14 μm long. HR 2.31, HV 4.30.

Remarks. The species is similar to *P. stylatus* (Kieffer) in the structure of the hypopgium, but can be distinguished by having much stronger anal point.

Distribution. The specimen was collected in Tibet in Palaearctic China.

***Parametriocnemus lundbeckii* (Johannsen)**

http://species-id.net/wiki/Parametriocnemus_lundbeckii

Metriocnemus lundbeckii Johannsen, 1905: 302.
Parametriocnemus lundbeckii (Johannsen); Sublette (1967: 5379); Sæther (1969: 115).

Material examined. CHINA: Zhejiang Province, Tianmu Mountain, 30°18'44"N, 119°26'35"E, 7 males, 12.xi.1998, light trap, H. Zhou.

Remarks. The species differs from other members of the genus by having a triangular, broad inferior volsella with bluntly rounded corner. The species is very similar to *P. stylatus* (Kieffer), but differs in the shape of the inferior volsella, and the preapical projection of the gonostylus is much smaller and pointed than that in *P. lundbeckii* (Brundin 1956). According to Sæther (1969), the immature stages seem to be inseparable, and as *P. stylatus* is known to be very variable (see Thienemann 1937) it might be a synonym of *P. lunbdbeckii*.

Distribution. The species has been recorded from the Oriental, Neotropical and Nearctic Regions, and occurs in both of Oriental and Palaearctic China.

Table 2. Lengths (in μm) and proportions of legs segments of *Parametriocnemus fortis* sp. n., male (n = 1).

	fe	**ti**	**ta_1**	**ta_2**	**ta_3**	**ta_4**
p_1	800	920	640	–	–	–
p_2	820	810	420	185	137	93
p_3	910	990	640	300	–	–
	ta_5	LR	BV	SV	BR	
p_1	–	0.70	–	–	–	
p_2	80	0.52	4.16	–	3.22	
p_3	–	0.65	–	–	–	

***Parametriocnemus ornaticornis* (Kieffer)**
http://species-id.net/wiki/Parametriocnemus_ornaticornis

Metriocnumus ornaticornis Kieffer, 1917: 225.
Parametriocnemus ornaticornis (Kieffer); Freeman (1961: 660); Hazra et al. (2002: 45).

Meterial examined. CHINA: Fujian Province, Daiyun Mountain, 25°41'0.38"N, 118°11'23"E, 2 males, 13.ix.2002, light trap, Z. Liu. Yunnan Procince, Eryuan County, Meiyou River, 26°6'40"N, 99°57'3"E, 1 male, 24.v.1996, light trap, C. Zhou. Henan Province, Luanchuan County, Lonyuwan National Forest Park, 33°46'41"N, 111°37'45"E, 1 male, 10.vii.1996, J. Li. Hunan Province, Yanling county, Taoyuan Hole, 26°25'21"N, 113°40'9"E, 1 male, 16.vii.2004, light trap, C. Yan.

Remarks. The species can be separated from other members of the genus by having a comparatively low AR (0.31–0.46), macrotrichiae forming streaks in the apical half of the wing, squama with 4–5 setae, and anal point with bare apex and 3–4 setae on each side. The species was described from Australia by Kieffer (1917) as a member of *Metriocnemus* van der Wulp, and was transferred to *Parametriocnemus* Goetghebuer by Freeman (1961). The specimens from China are in accordance with the original description, but have a lower LR and AR than specimens from India. The differences between specimens from China and India are listed in Table 3.

Distribution. The species has been recorded from Australia (Kieffer 1917) and India (Hazra et al. 2002). It occurs in both Oriental and Palaearctic China.

***Parametriocnemus scotti* (Freeman)**
http://species-id.net/wiki/Parametriocnemus_scotti

Metriocnemus scotti Freeman, 1953: 129.
Parametriocnemus scotti (Freeman); Lehmann (1979: 42).

Material examined. Ningxia Hui Autonomous Region, Liupan Mountain, 35°47'22"N, 106°17'36"E, 1 male, 9.viii.1987, light trap, X. Wang. Zhejiang Province, Taizhou City,

Table 3. Difference between specimens from China and India of *Parametriocnemus ornaticornis* (Kieffer), male.

***P. ornaticornis* (Kieffer)**	**Chinese specimens (n=5)**	**India specimens (n=4)**
AR	0.31–0.46	0.41–0.46
TL	1.44–2.42	2.25–2.52
TL/WL	1.04–1.75	1.77–1.88
LR_1	0.69–0.83	0.81–0.82
LR_2	0.49–0.55	0.55–0.56
LR_3	0.58–0.63	0.60–0.63
SV_1	2.03–2.74	3.08–3.14
SV_2	3.93–4.42	5.09–5.13
SV_3	3.06–3.39	4.00–4.11
BR_1	0.77–2.13	2.20–2.25
BR_2	2.00–2.75	2.40–4.00
BR_3	2.63–3.56	3.00–3.83

Xianju County, Shenxianju Mountain, 28°42'17"N, 120°36'38"E, 1 male, 14.iv.2011, sweep net, X. Lin.

Remarks. The species can be separated from other members of the genus by having a short anal point with bare, rounded apex; triangular inferior volsella, and clavate antenna with numerous curved bristles apically. The species is similar to *P. brundini* Sinharay et Chaudhuri in the structure of the hypopgium; it has a short anal point with bare apex, while that in *P. brundini* is longer. The species was redescribed and figured by Lehmann (1979, figs 124–125). However, no data for the legs was given; lengths (in μm) and proportions of the legs of the Chinese specimens are therefore given in Table 4.

Distrubution. The species has been recorded from Ethiopia (Abyssinia), Kenya, Uganda and Zimbabwe (Rhodesia) in the Afrotropical Region (Lehmann 1979), and it occurs in both Oriental and Palaearctic China.

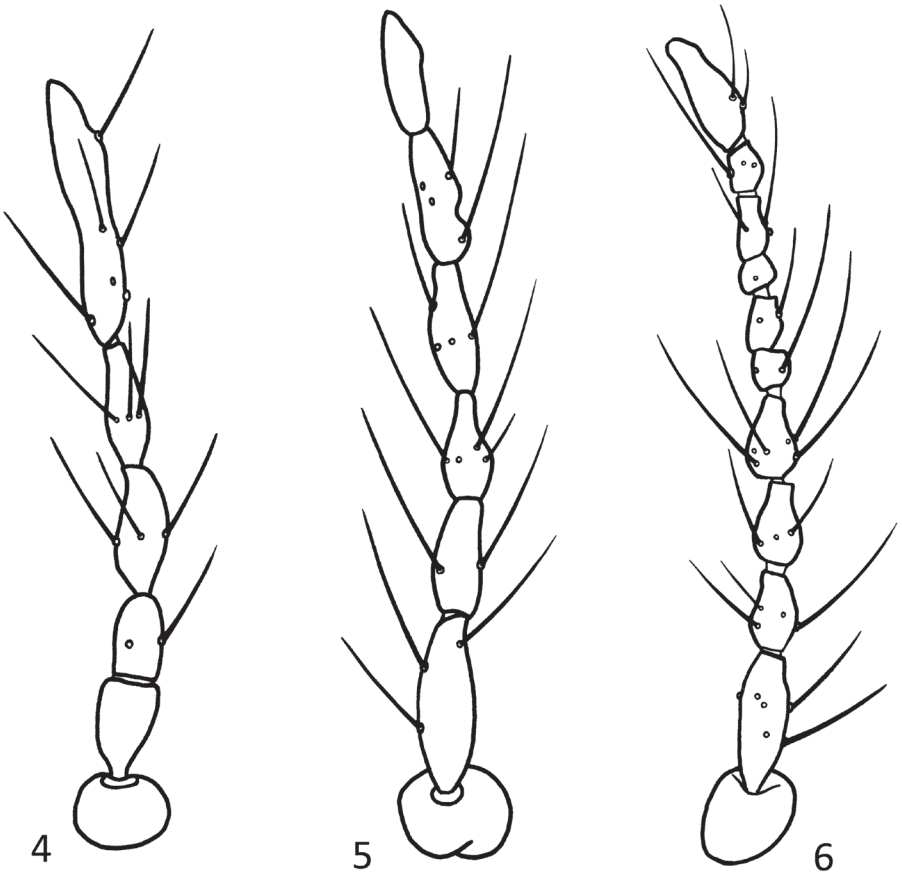
***Parametriocnemus stylatus* (Kieffer)**
http://species-id.net/wiki/Parametriocnemus_stylatus
Figs 4–6

Metriocnemus stylatus Kieffer, 1924: 97.
Parametriocnemus stylatus (Kieffer); Wang (2000: 638).

Meterial examined. CHINA: Fujian Province, Wuyi Mountain, 27°43'46"N, 118°1'52"E, 1 male, 24.iv.2002, light trap, W. Bu. Fujian Province, Wuyi Mountain, 27°43'46"N, 118°1'52"E, 1 female, 30.viii.1993, light trap, X. Wang. Fujian Province, Shanghang Country, Buyun Mountain, Shiyankeng, 25°15'59"N, 116°51'50"E, 1 male, 6.v.1993, light trap, X. Wang. Beijing City, Huairong District, 40°19'15"N,

Table 4. Lengths (in μm) and proportions of legs segments of Chinese specimens of *Parametriocnemus scotti* (Freeman), male (n=2).

	fe	**ti**	**ta_1**	**ta_2**	**ta_3**	ta_4
p_1	610–680	690–700	500–560	215–300	194–218	138–141
p_2	590–700	560–750	282–490	132–245	97–193	62–105
p_3	660–720	720–740	430–480	194–248	150–178	88–105
	ta_5	LR	BV	SV	BR	
p_1	98–128	0.71–0.81	2.47–2.64	2.45–2.62	1.10–2.75	
p_2	58–93	0.50–0.65	3.06–3.50	2.96–4.08	2.20–3.0	
p_3	40–78	0.60–0.65	3.19–3.84	3.05–3.21	2.67–6.13	



Figures 4–6. *Parametriocnemus stylatus* (Kieffer), intersex. **4** antenna, five segmented **5** antenna, six segmented; **6** antenna, ten segmented.

116°37'59"E, 2 males, 15.x.1994, light trap, X. Wang. Henan Province, Luanchuan County, Longyuwan National Forest Park, 33°46'41"N, 111°37'45"E, 1 male, 10.vii.1996, light trap, J. Li. Sichuan Province, Yaan City, Yajiang River, Sandaoqiao

Town, 29°53'48"N, 103°10'19"E, 1 male, 9.vi.1996, light trap, X. Wang. Sichuang Province, Yanan City, Yajiang County, 29°53'48"N, 103°10'19"E, 1 female, 14.vi.1996, light trap, X. Wang. Shannxi Province, Zhouzhi County, Banfangzi Town, 34°9'47"N, 108°13'19"E, 1 male, 7.viii.1994, light trap. X. Wang. Zhejiang Province, Tianmu Mountain, 30°18'44"N, 119°26'35"E, 2 males, 12. xi.1998, light trap. X. Wang. Yunnan Province, Eryuan County, Niujie Town, Futian Village, Meigong Stream, 26°6'40"N, 99°57'3"E, 5 males, 24.v.1996, light trap, C. Zhou. Guizhou Province, Daozhen County, Dasha River, 26°38'19"N, 108°3'41"E, 3 larvae, 23.v.2004, leg, H. Tang.

Remarks. The male differs from other members of the genus by having AR 0.79–1.09, wing membrane with numerous setae, a rather slender gonostylus without projection, robust anal point, and gonocoxite with a broad, subrectangular inferior volsella.

According to Wang (2000), five females of this species were collected in the Yunnan Province. After re-examing the specimens, we found that all five specimens apparently are intersexes. One of these intersexes has a 10 segmented antenna, two have a 6 and two a 5 segmented antenna. They are morphologically similar to males, but differ from all species of *Parametricnemus* in structure of the male hypopygium and the female-like antenna, reduced number of setae on the antennal flagellum, and low antennal ratio (Figs 4–6). None of the males from the other localities appear to be intersexes.

Distribution. The species has been recorded from the Palaearctic and Nearctic Regions and occurs in both Oriental and Palaearctic China.

***Parametriocnemus vittatus* sp. n.**
http://zoobank.org/01BC3723-E3F3-4C4F-8711-DA3897875EBC
http://species-id.net/wiki/Parametriocnemus_vittatus
Figs 7–11

Type material. Holotype male (BDN No.11836), CHINA: Sichuan Province, Shimian County, Sala River, 29°13'40"N, 102°21'34"E, 16.vi.1996, sweep net, X. Wang.

Diagnostic characters. The male differs from other members of the genus by having a low AR, and tergites II–III with brown vita, tergites IV–V with three brown patches, and tergites VI–VII all brown. Ultimate flagellomere is expanded in the middle, tapering toward apex, with 4 long, curved sensilla chaetica subapically.

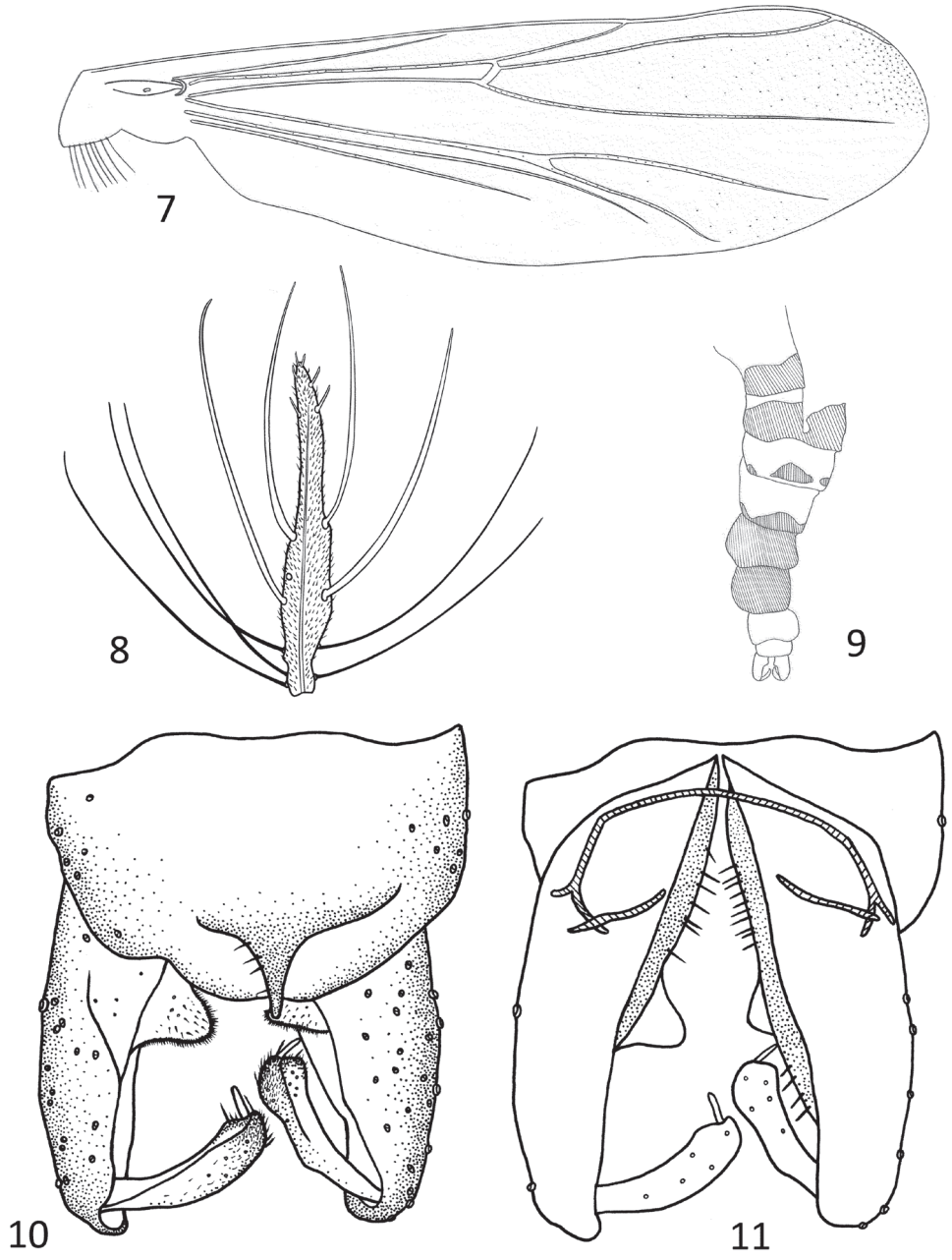
Etymology. From Latin, noun, *vitta*– meaning ribbon, referring to tergites II–VII having brown vita.

Description. Male (n=1).

Total length 2.55 mm. Wing length 1.43 mm. Total length / wing length 1.58. Wing length / length of profemur 2.30.

Coloration. Head, legs and antenna brown. Thorax light brown. Abdomen yellowish, tergites II–III with brown vita, 2/3 the width of the tergite, tergites IV–V with three brown patches on each tergite, and tergites VI –VII all brown (Fig. 7).

Head. AR 0.58. Ultimate flagellomere expand in the middle, tapering toward apex, with 4 long, curved sensilla chaetica subapically (Fig. 8). Temporal setae 9, including



Figures 7–11. *Parametriocnemus vittaus* sp. n., male **7** abdomen **8** antenna **9** wing **10** hypopygium (dorsal view) **11** hypopygium(ventral view).

4 inner verticals, 4 outer verticals and 1 postobital. Clypenus with 13 setae. Tentorium 110 μm long, 10 μm wide. Length of palpomeres (in μm): 23, 30, 85, 105, 160. Length ratio of palpomere 5/3 1.88.

Table 5. Lengths (in μm) and proportions of legs segments of *Parametriocnemus vittatus* **sp. n.**, male (n=1).

	fe	**ti**	**ta_1**	**ta_2**	**ta_3**	**ta_4**
p_1	620	670	540	264	194	132
p_2	660	610	300	136	97	78
p_3	690	750	410	180	154	90
	ta_5	LR	BV	SV	BR	
p_1	100	0.81	2.65	2.39	1.36	
p_2	75	0.49	4.07	4.23	1.80	
p_3	88	0.55	3.61	3.51	1.43	

Wing (Fig. 9). Anal lobe reduced. VR 1.22. Costal extension 120 μm long. Brachiolum with 1 seta, R with 20, R_1 with 9, R_{4+5} with about 300, M without setae, M_{3+4} with 17 setae. Most of the wing membrane densely covered with setae; cell r_{4+5} with 141 setae, m_{3+4} with 13 setae. Squama with 8 seta.

Thorax. Antepronotum with 1 setae. Dorsocentrals 10, acrostichals 13, prealars not visible. Scutellum with 8 setae.

Legs. Spur of fore tibia 33 μm long, spurs of mid tibiae 23 μm and 20 μm long, of hind tibia 50 μm and 18 μm long. Width at apex of fore tibia 35 μm, of mid tibia 40 μm, of hind tibia 50 μm. Comb of 10 setae, shortest seta 28 μm long, longest seta 60 μm long. Lengths (in μm) and proportions of legs as in Table 5.

Hypopygium (Figs 10–11). Tergite IX including anal point with 5 setae. Laterosternite IX with 6 setae. Anal point 38 μm long, 33 μm wide. Gonocoxite 208 μm long, inferior volsella triangular. Gonostylus 75 μm long, megaseta 13 μm long. HR 2.77, HV 3.4.

Remaks. The new species is similar to *P. stylatus* in the structure of the hypopyium, while the body color is close to *P. scotti*. However, both *P. stylatus* and *P. scotti* lack brown vita on tergites II–VII.

Distribution. The species was collected in Sichuan Province in Oriental China.

Key to adult males of *Parametriocnemus* in China

1 Ultimate flagellomere with 3–4 long, curved sensilla chaetica subapically ... **2**

– Ultimate flagellomere without long, curved sensilla chaetica subapically, sometimes with numerous short curved bristles **3**

2 AR 0.31–0.46; ultimate flagellomere short, not expended in the middle; tergites II–VII without brown vita or patches; inferior volsella broadly rounded ..... ***P. ornaticornis* (Kieffer)**

– AR 0.58; ultimate flagellomere long, expended in the middle, tapering towards apex; tergites II–VII with brown vita or patches; inferior volsella trangular ..... ***P. vittatus* sp. n.**

3 Inferior volsella broadly rounded; entire wing membrane densely clothed with setae **4**

– Inferior volsella triangular; basal half of wing membrane bare or at most with scattered setae in anal cell..... **5**

4 Gonostylus with broad, transparent, preapical crista dorsalis..... ..... ***P. lundbeckii* (Johannsen)**

– Gonostylus without transparent, preapical crista dorsalis . *P. stylatus* (Kieffer)

5 Anal point 80–143 μm long, extending well below posterior margin of tergite IX; squama with 8 setae; AR≤ 0.6 or ≥ 1.0; antenna without numerous curved bristles..... **6**

– Anal point short, 25–40 μm long, not extending below posterior margin of tergite IX; squama with 2–5 setae; AR 0.77–0.88; antenna with numerous curved bristles..... ***P. scotti* (Freeman)**

6 AR 0.57; anal point 143 μm long, without setae; setae on terga not arranged in rows; acrostichichals in single, irregular rows; HV 4.3 ..... ***P. fortis* sp. n.**

– AR 1.03, anal point 80 μm long, with setae; setae on terga arranged in transverse rows; acrostichichals in two irregular rows; HV 3.12..... ..... ***P. brundini* Sinharay et Chaudhuri**

Acknowledgements

We are indebted to Trond Andersen, University Museum of Bergen, for valuable advice and discussions. Mr. Ji Bing-Chun, Mrs. Li Yu-Fen made the slide preparations. Financial support received from the National Natural Science Foundation of China (NSFC) (grant No. 30770249, 30870329, J0630963), Zhejiang Provincial National Science Foundation of China (Y3100486) and Fauna of China (FY120100) is thankfully acknowledged.

References

Ashe P, O'Connor JP (2012) A World Catalogue of Chironomidae (Diptera). Part 2. Orthocladiinae. Irish Biogeographical Society & National Museum of Ireland, Dublin, 986pp.

Brundin L (1956) Zur Systematik der Orthocladiinae (Dipt. Chironomidae). Reports from the Institute of Freshwater Research, Drottningholm 37: 5–185.

Freeman P (1953) Chironomidae (Diptera) from Western Cape Province - I. Proceedings of the Royal Entomological Society (Series B) 22 (7/8): 127–135.

Freeman P (1961) The Chironomidae (Diptera) of Australia. Australian Journal of Zoology 9: 611–737. doi: 10.1071/ZO9610611

Goetghebuer M (1933) Ceratopogonidae et Chironomidae nouveaux ou peu connus d'Europe (Deuxième note). Bulletin et Annales de la Société Entomologique de Belgique 72 (11/12): 287–294.

Hazra N, Saha GK, Chaudhuri PK (2002) Records of Orthoclad species from the Darjeeling-Sikkim Himalayas of India (Diptera: Chironomidae), with notes on their ecology. Hydrobiologia 474: 41–55. doi: 10.1023/A:1016511702944

Johannsen OA (1905) Aquatic nematocerous Diptera II. Chironomidae. In: Needham JG, Morton KJ, Johannsen OA (Eds) May flies and midges of New York. Bulletin of the New York State Museum 68: 1–352.

Kieffer JJ (1917) Chironomides d'Australie conservés au Musée National Hongrois de Budapest. Annales Historico-Naturales Musei Nationalis Hungarici 15: 175–228.

Kieffer JJ (1924) Chironomides nouveaux ou rares de l'Europe centrale. Bulletin de la Société d'Histoire Naturelle de la Moselle 30: 11–110.

Lehmann J (1979) Chironomidae (Diptera) aus Fließgewässern Zentralafrikas (Systematik, Ökologie, Verbreitung und Produktionsbiologie). I. Teil: Kivu-Gebiet, Ostzaire. Spixiana Supplement 3: 1–144.

Sæther OA (1969) Some Nearctic Podonominae, Diamesinae, and Orthocladiinae (Diptera: Chironomidae). Bulletin of the Fisheries Research Board of Canada 170: 1–154.

Sæther OA (1980) Glossary of chironomid morphology terminology (Diptera: Chironomidae). Entomologica Scandinavica Supplement 14: 1–51.

Sinharay DC, Chaudhuri PK (1979) Genus *Parametriocnemus* Goetghebuer from India (Diptera: Chironomidae). Entomologica Scandinavica Supplement 10: 119–123.

Sublette JE (1967) Type specimens of Chironomidae (Diptera) in the Cornell University Collection. Journal of the Kansas Entomological Society 40: 477–564.

Thienemann A (1937) Chironomiden-Metamorphosen (Diptera). XV. Mitteilungen Entomologischen Gesellschaft zu Halle 15: 22–36.

Wang X (2000) A revised checklist of Chironomidae from China (Diptera). In: Hoffrichter O (Ed) Late 20th Century Research on Chironomidae. An sAnthology from the 13th International Symposium on Chironomidae. Shaker Verlag, Aachen, 629–652.

ZooKeys 320: 63–95 (2013)
doi: 10.3897/zookeys.320.5352
www.zookeys.org

RESEARCH ARTICLE

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

Aroid scarabs in the genus *Peltonotus* Burmeister (Coleoptera, Scarabaeidae, Dynastinae): key to species and new distributional data

Mary Liz Jameson[1], Alain Drumont[2]

1 *Department of Biological Sciences, Wichita State University, Wichita, Kansas, 67260–0026, USA* **2** *Institut Royal des Sciences Naturelle de Belgique, B-1000 Brussels, Belgium*

Corresponding author: *Mary Liz Jameson* (maryliz.jameson@gmail.com)

Academic editor: *Andrey Frolov* | Received 18 April 2013 | Accepted 8 July 2013 | Published 31 July 2013

Citation: Jameson ML, Drumont A (2013) Aroid scarabs in the genus *Peltonotus* Burmeister (Coleoptera, Scarabaeidae, Dynastinae): key to species and new distributional data. ZooKeys 320: 63–95. doi: 10.3897/zookeys.320.5352

Abstract

The southeast Asian scarab beetle genus *Peltonotus* Burmeister (Scarabaeidae, Dynastinae, Cyclocephalini) is reviewed. New country records for *Peltonotus morio* Burmeister (Myanmar and Vietnam), *P. nasutus* Arrow (southern China and Cambodia), and *P. favonius* Jameson and Wada (Myanmar) are reported, including a new record in the Palearctic/Sino-Japanese biogeographic region. The first female specimen of *P. favonius* is described. Biological associations with aroid inflorescences are reviewed, and human consumption of *Peltonotus* beetles is reported. A key to all species, paralectotype designations for *P. nasutus*, diagnoses, and distributions using dynamic mapping tools are included.

Keywords

Edible insects, Palearctic region, Sino-Japanese region, Araceae, dynamic mapping

Introduction

The scarab beetle genus *Peltonotus* Burmeister (Scarabaeidae, Dynastinae) includes 25 species that are distributed in forest habitats in Southeast Asia and that are associated with aroid inflorescences (Araceae) (Jameson and Wada 2004). Adult beetles use inflorescences as sites for mating and feeding, and they serve as pol-

linators (Moore and Jameson in press, Maia et al. 2012). Species in the genus are intimately tied to host aroids and their forest habitats, and we predict that many species await discovery. Members of the genus form a natural group based on a unique, articulated maxillary tooth. The first monograph for the genus (Jameson and Wada 2004) included 19 species; since this time, six additional species have been described (Jameson and Wada 2009, Jameson and Jakl 2010), a 30% increase in species diversity.

Identification of species in the genus *Peltonotus* is hampered by sexual dimorphism that makes association of conspecific sexes difficult, absence of male or female specimens for some species, rarity of some species (perhaps due to brief activity patterns and host plant phenology), and color variability within species. For this reason, we amalgamate existing keys into one identification guide for males and females and provide diagnoses.

Species of *Peltonotus* are associated with aroid inflorescences (Araceae) (Jameson and Wada 2004). However, in comparison to the abundant research on aroid and scarab beetle interactions in the New World tropics (e.g., Gibernau et al. 2010; Maia et al. 2012; Young 1988), little research is being conducted on *Peltonotus* and aroids in the Old World. *Peltonotus malayensis* Arrow is associated with inflorescences of the climbing aroid, *Epipremnum falcifolium* Engl. (Araceae) (Jameson and Wada 2004). Male and female beetles (as well as many small beetles and arthropods) have been reported around the base of the spathe where adult *P. malayensis* were observed mating and feeding. Inflorescences of the cultivated aroid, *Amorphophallus paeoniifolius* (Dennst.) Nicolson (Araceae), attract aggregations of *Peltonotus nasutus* Arrow (Grimm 2009). This plant (also called the elephant foot yam or corpse plant) grows on the forest floor in dappled shade or in the open sun in secondary forest or highly disturbed areas. The large flower (up to 40 cm) smells like a rotting dead animal and deceptively attracts insects that may serve as pollinators (Schiestl and Dötterl 2012) including the carrion scarabs *Phaeochrous dissimilis* Arrow, *Ph. emarginatus* Laporte, and *Ph. intermedius* Pic (all Scarabaeoidea, Hybosoridae), and the aroid scarab *P. nasutus* (Grimm 2009). Additional research on aroids and *Peltonotus* species is needed in order to clarify plant-insect interactions including evolution, ecology, and pollination.

In addition to being associated with aroid inflorescences, adults are attracted to lights at night, and some have been collected in malaise traps. Adults may have short seasonal activity patterns. Some adults have been recorded for only two nights during season-long, intensive collecting efforts. Larvae are not known for any species in the genus.

Survey efforts and collecting in Southeast Asia have provided new distributional data for species in the genus, thus yielding a clearer understanding of distribution patterns. Herein, we report new distributional data for three species of *Peltonotus*. Because identification of species requires use of three publications (Jameson and Wada 2004, Jameson and Wada 2009, Jameson and Jakl 2010), we provide a comprehensive key to all species in the genus, short diagnoses, new paralectotype designations for *P. nasutus*, and maps with associated files for dynamic mapping capabilities.

Material and methods

Characters and specimens were examined using a dissecting microscope (6–48× magnification) and fiber-optic illumination. Digital images of specimens and structures were captured using the Leica Application Suite V3.8. Images were edited in Adobe Photoshop CS2 (background removed, contrast manipulated). In the absence of images for some specimens, illustrations are used. Specimen localities that were not recorded in latitude and longitude on original labels were translated using GoogleEarth (www.google.com/earth/index.html) or by using the Global Gazetteer Version 2.2 (www.fallingrain.com/world/). It should be noted that older localities have a wide margin of error, and their lack of precision is not conducive to ecological or niche modeling. Maps were generated by entering these data into Microsoft Excel 2008 and uploaded to EarthPoint (www.earthpoint.us/Excel-ToKml.aspx) and GoogleEarth (Appendix 1). These mapping tools allow for interactive mapping and addition of data by subsequent users. Locality information in species treatments is recorded with the country in bold letters, followed by the state/province/district, and the specific locality in parentheses.

This work unifies some character state definitions (e.g., form of labrum, male protibial teeth, female elytral epipleural pillow) previously used for identification of *Peltonotus* species. Species are characterized by combinations of characters including the form of the labrum (weakly sinuate, bi-emarginate/broadly emarginated, or deeply bilobed) (Figs 20–24), mentum apex and second labial palpomere (compared with palpomere 1) (Figs 25–35), mala of maxilla with or without thickened and strongly flattened setae ("lamellate setal brush") (Figs 36–44), stipes of maxilla with or without curly setae (Figs 36–44), male protibia tri- or bidentate (Figs 45–49), form of male protarsomeres (Figs 50–54), form of the male parameres (Figs 55–72), and form of the female epipleuron in ventral view in relation to the position of the metacoxa (Figs 73–91). Expansions of the female elytral epipleuron may have an inflated area (or pillow) in dorsal view (Moore 2012). Setae are important for species diagnosis and are defined as minute if they are less than 0.2 mm, short if between 0.2–0.5 mm, moderately long if between 0.5–1.0 mm, and long if between 1.0–2.0 mm (as measured with an ocular micrometer). Punctures may lack setae, possess one seta (unisetigerous), or possess multiple setae (multisetigerous). Male parameres are highly asymmetrical, and we elected to illustrate the lateral view that best assists in identification.

We follow the phylogenetic species concept (Wheeler and Platnick 2000) that states that "A species is the smallest aggregation of (sexual) populations or (asexual) lineages diagnosable by a unique combination of character states." Specimens examined for this research are deposited in the following institutions and private collections: the Institut Royal des Sciences Naturelle de Belgique (IRSNB), the Alain Drumont Collection, Brussels, Belgium; the Masayuki Fujioka Collection, Tokyo, Japan (FUJI); the Museum National d'Histoire Naturelle, Paris, France (MNHN); Andreas Reichenbach Collection, Leipzig, Germany (AREC); the Mary Liz Jameson collection, Wichita, Kansas (MLJC); the Shinji Nagia Collection (Nagano, Japan); and The Natural History Museum, London, England (BMNH).

New distributional records, human consumption, and paralectotype designations for *Peltonotus nasutus*

Peltonotus nasutus (Figs 14–15) is the most distinctive species within the genus *Peltonotus* due to its large body size (~20 mm), tubercle at the apex of the clypeus in the male (Fig. 23), and greatly enlarged protibial claw in the male (Fig. 52).

Large aggregations of adults (over 100) have been found in association with the large, fetid-smelling aroids in the genus *Amorphophallus* (Grimm 2009; label data at BMNH). In Thailand, the stench of flowering *A. paeoniifolius* attracts a profusion of *P. nasutus* individuals that serve to pollinate the inflorescence. Seventy eight specimens were recorded in one flower, and these were collected, fried with fish sauce and salt, and then consumed by the Karen-speaking tribe in the Tak province in northern Thailand (Danell 2010). Thai people consume more insects per capita than other people and cultures (Chen et al. 1998), and this beetle species is a new record for human consumption.

The species is distributed in Myanmar, Thailand, Laos, and Vietnam (Jameson and Wada 2004; Li et al. 2012) (Fig. 92). Adults inhabit deciduous dipterocarp forests between 100–800 m elevation and have been collected at mercury vapor light traps. Examination of additional specimens provided **new country records** for *P. nasutus* in Cambodia and China. This species was not previously recorded as occurring in the Palaearctic region (as defined by Löbl and Smetana 2003). These records demonstrate that the species occurs in the Guangxi and Guizhou provinces of southern portion of China in what is considered the Palaearctic biogeographic region (Löbl and Smetana 2003) or the Sino-Japanese biogeographic region (Holt et al. 2013). **New Country Record: CHINA** (6 males, 2 females deposited in Drumont Collection; AREC): Guangxi Zhuang Autonomous Region (Guangxi), Guizhou (Weining, Mt. Ping-Qing-Liang-Zi), Yunnan (Jinggu, Mt. Longtanshan; Menglian, Mt. Daheishan). Specimens were collected from May to July: May (1), June (3), July (4). **New Country Record: CAMBODIA** (9 males, 12 females deposited at IRSNB): Pursat (Phnom Samkos Wildlife Sanctuary), Ratanakiri (Phumi Kalai Thum), Pailin (Pailin). Specimens were collected from April to June and November: April (3), May (2), June (3), November (13). The new country record in Weining, China extends the known range of the species over 600 km north.

During the course of our research, we discovered two unrecorded paralectotype specimens. The male lectotype (at BMNH) and eight paralectotypes (6 at BMNH, 2 at MNHN) were previously designated (Jameson and Wada 2004). Two additional paralectotypes (1 male, 1 female) were found at IRSNB. The paralectotype male at IRSNB is labeled: a) “Cochinchina” (handwritten), b) “Collection E. Candèze” (type set with scribed, black box), c) “Type” (type set, red ink, with scribed, black box), d) “Peltonotus nasutus, Arrow co-type” (handwritten), e) “Peltonotus nasutus Type Arrow det Arrow 1908” (handwritten and type set), f) our paralectotype label. The paralectotype female at IRSNB is labeled: a) “Cochinch” (handwritten), b) “Collection E. Candèze” (type set with scribed, black box), c) “Type” (type set, red ink, with scribed, black box), d) “Peltonotus nasutus Type Arrow det Arrow 1908” (handwritten and type set), e) our paralectotype label.

New distributional records and description of first female specimen for *Peltonotus favonius*

Peltonotus favonius Jameson and Wada (Fig. 4) was previously known based only on one male specimen from Vietnam (Jameson and Wada 2009). This species is most similar to *P. pruinosus*, a species for which only the female holotype is known. The discovery of additional male specimens and the first female specimens facilitates identification of the species, expands the characteristics of the species, and broadens our understanding of the distribution of the species. **New Country Record** (2 male and 2 female specimens deposited in MLJC): **MYANMAR,** Mt. Nweezin, ~750m, 10 km NNE of Puta-o, North Kachin, June 16–21, 1998. The new record extends the known range of the species over 2000 km from Vietnam to Myanmar. Specimens were provided by Shinji Nagai. Male specimens from Myanmar (n=2) possess black and reddish-brown elytra (the holotype specimen from Vietnam possessed black elytra). Female specimens (n=2) differ from the male specimens in the following respects: Color: Head, pronotum, scutellum, propygidium, pygidium, and venter shining black; elytra black or dark reddish-brown with iridescent bloom. Elytron: Epipleuron in ventral view (Fig. 75) broadly expanded from base to apex of metacoxa, weakly convex, not incised at apex, with sparse, setose punctures, setae reddish, moderately long; in dorsal view expansion not developed (lacking dorsal pillow), instead with concave groove adjacent to epipleuron. Propygidium: Surface moderately densely punctate; punctures simple and ocellate, mixed, not setigerous. Pygidium: Surface moderately densely punctate; punctures simple and ocellate, not setigerous. Legs: Protibia tridentate. Proclaws of female 3/4 length of protarsomere 5, claw angled ventrally.

New distributional records for *Peltonotus morio*

Peltonotus morio Burmeister (Fig. 12) is the type species for the genus *Peltonotus* and is one of the most wide-spread species in the genus (Fig. 92). It is distinguished from its close congener, *P. nasutus* Arrow (Figs 14–15), by its incomplete pronotal basal bead (complete in *P. nasutus*), form of the male parameres (Figs 65–66), lack of a small tubercle at the apex of the clypeus in the male (Fig. 24) (present in *P. nasutus* [Fig. 23]), and form of the epipleuron in females (Figs 80 versus 82).

The species is found in northeastern India, Nepal, Bhutan, and Thailand (Jameson and Wada 2004). It can be collected at lights (Dhoj et al. 2009). Within the Palearctic region (Löbl and Smetana 2003) or Sino-Japanese region (Holt et al. 2013), it is the only recorded species of Cyclocephalini (Dynastinae), and it was recorded from Bhutan, Nepal, and Sikkim (Krell 2006). Examination of additional specimens provided **new country records** for *P. morio* in Myanmar and Vietnam. **New Country Record: MYANMAR** (2 specimens deposited in FUJI): Tanintharyi (near Tenasserim), May-1992, 1 male; Mt. Dawna, May-1992, 763 m elevation, 1

female. **New Country Record: VIETNAM** (1 specimen deposited in IRSNB): Lào Cai Province, June 10, 1917, 1 male. Despite the antiquity of the specimen (nearly 100 years old), the new record in Vietnam extends the known range of the species over 600 km from northern Thailand to northern Vietnam. Based on these distributional data, *P. morio* and *P. nasutus* may be narrowly sympatric in southern Myanmar and Thailand.

Key to Male *Peltonotus* Species

Males: Protibial claws with one claw enlarged and expanded; elytral epipleuron not developed in ventral view. Males of *P. kyojinus, P. nethis, P. pruinosus, P. suehirogarus, P. mushiyaus,* and *P. tigerus* are not known.

1 Apical half of mentum acute, triangular (e.g., Figs 25, 34–35) **2**
– Apical half of mentum rounded (Figs 26–29, 31–33) or quadrate (Fig. 30) **4**
2 Punctures of frons and clypeus unisetigerous; parameres as in Fig. 71 .... ***P. talangensis*** **Jameson & Jakl**
– Punctures of frons and clypeus multisetigerous (at least laterally); parameres not as in Fig. 71 ..... **3**
3 Smaller protarsal claw deeply arcuate (Fig. 54); parameres as in Fig. 59 .... ***P. deltamentum*** **Jameson & Wada**
– Smaller protarsal claw simply arched; parameres as in Fig. 70 .... ***P. sisyrus*** **Jameson & Wada**
4 Apex of labrum weakly sinuate (Figs 23–24) **5**
– Apex of labrum bi-emarginate (Figs 21–22) to deeply bilobed (Fig. 20) **6**
5 Protibia tridentate with well-developed basal tooth (e.g., Fig. 46); apex of clypeus at middle with tubercle (Fig. 23); parameres as in Fig. 66 .... ***P. nasutus*** **Arrow**
– Protibia tridentate with weakly developed basal tooth (e.g., Fig. 49); apex of clypeus lacking tubercle (Fig. 24); parameres as in Fig. 65..... ***P. morio*** **Burmeister**
6 Labrum with apex deeply bilobed (e.g., Fig. 20) **7**
– Labrum with apex bi-emarginate (Figs 21–22) **10**
7 Mala of maxilla with setae thick and strongly flattened (with well developed lamellate setal brush); Borneo, Malaysia, and Sumatra; parameres not as in Fig. 63 ..... **8**
– Mala of maxilla with setae not thick and strongly flattened (lacking well developed lamellate setal brush) (Fig. 40); South Vietnam; parameres as in Fig. 63 ..... ***P. karubei*** **Muramoto**
8 Punctures of frons lacking setae; parameres as in Fig. 57 .... ***P. brunnipennis*** **Benderitter**
– Punctures of frons with dense, velutinous and/or moderately long setae; parameres not as in Fig. 57 ..... **9**

9 Protarsus with larger claw gracile, subequal at middle and base; maxillary stipes with setae curly at apex (e.g., Fig. 41); Sarawak ..... ***P. gracilipodus* Jameson & Wada**

– Protarsus with larger claw robust, much wider at middle than at base; maxillary stipes with setae straight, not curly at apex; Malaysia (Cameron Highlands) ..... ***P. podocrassus* Jameson & Wada**

10 Labial palpomere 2 greatly enlarged and dorsoventrally flattened, 2–3 times wider than apical palpomere 1 (Fig. 28) **11**

– Labial palpomere 2 not greatly enlarged and flattened, less than 1.5 times wider than apical palpomere 1 (Fig. 33) **13**

11 Maxillary stipes with setae curly at apex (e.g., Fig. 36); parameres not as in Fig. 68 ..... **12**

– Maxillary stipes with setae straight, not curly at apex; parameres as in Fig. 68 ..... ***P. silvanus* Jameson & Wada**

12 Elytral color reddish, lighter in color than pronotum and scutellum; punctures of pygidium multisetigerous, setae minute and moderate in length; parameres as in Fig. 64 ..... ***P. malayensis* Arrow**

– Elytral color castaneous, similar in color to pronotum and scutellum (Fig. 1); punctures of pygidium unisetigerous, setae moderate in length; parameres as in Fig. 56 ..... ***P. animus* Jameson & Wada**

13 Protibia tridentate, basal tooth well developed or weakly developed (Figs 46, 48, 49) **14**

– Protibia bidentate (Fig. 47, 51) **15**

14 Protibia with basal tooth well developed (Figs 46, 48), external margin without velutinous setae from middle to near base; parameres as in Fig. 61 ..... ***P. fujiokai* Jameson & Wada**

– Protibia externally with basal tooth weakly developed (Fig. 49), external margin with velutinous setae from middle to near base; parameres as in Fig. 67.. ***P. rubripennis* Miyake & Yamaya**

15 Elytra reddish with castaneous vittae (Figs 18–19); parameres as in Fig. 72... ***P. vittatus* Arrow**

– Elytra lacking vittae, entirely reddish, castaneous, or black; parameres not as in Fig. 72 ..... **16**

16 Pronotal basal bead lacking, terminating at basolateral angle; length less than 15.0 mm; parameres as in Fig. 60 ..... ***P. favonius* Jameson & Wada**

– Pronotal basal bead present, extending beyond basolateral angle (obscured anterior to scutellum); length greater than 17.0 mm; parameres not as in Fig. 60 ..... **17**

17 Protarsomere 5 with well-developed internoapical protrusion (Fig. 50), lacking weak medial protrusion; region surrounding Mt. Bawang, Kalimantan... ***P. adelphosimilis* Jameson & Wada**

– Protarsomere 5 lacking internoapical protrusion; weak protrusion at middle (Fig. 53); Sabah ..... ***P. similis* Arrow**

Key to Female *Peltonotus* Species

Females: Protibial claws similar in size and shape; elytral epipleuron developed or simple in ventral view. Females of *P. deltamentum, P. karubei,* and *P. animus* are not known.

1 Apical half of mentum acute, triangular (Figs 25, 34–35) **2**
– Apical half of mentum rounded (Figs 26–29, 31–33) or quadrate (Fig. 30) **3**
2 Punctures of frons and clypeus multisetigerous ..***P. sisyrus*** **Jameson & Wada**
– Punctures of frons and clypeus unisetigerous ***P. talangensis*** **Jameson & Jakl**
3 Apex of labrum weakly sinuate (Figs 23–24) **4**
– Apex of labrum bi-emarginate (Figs 21–22) to deeply bilobed (Fig. 20) **5**
4 Apex of clypeus with weak, medial tubercle; lateral pillow of elytron (dorsal view) elongate-oval, extending more than half length of epipleuron; epipleuron as in Fig. 82 ..... ***P. nasutus*** **Arrow**
– Apex of clypeus lacking weak tubercle; lateral pillow of elytron (dorsal view) narrower at apex and broader at base, extending less than half length of epipleuron; epipleuron as in Fig. 80 ..... ***P. morio*** **Burmeister**
5 Elytra with castaneous vittae or maculae (e.g., Figs 13, 18–19) **6**
– Elytra lacking vittae, entirely castaneous, reddish, or black **7**
6 Elytral epipleuron in ventral view simple, lacking apical incision (Fig. 81) ..... ***P. mushiyaus*** **Jameson & Wada**
– Elytral epipleuron in ventral view incised at apex (Fig. 91). ***P. vittatus*** **Arrow**
7 Labrum with apex deeply bilobed (e.g., Fig. 20) **8**
– Labrum with apex bi-emarginate (e.g., Figs 21–22) **13**
8 Elytral epipleuron in ventral view simple, not emarginated (Fig. 83) ..... ***P. nethis*** **Jameson & Wada**
– Elytral epipleuron in ventral view emarginated (e.g., Fig. 73) **9**
9 Maxillary stipes with setae curly at apex (e.g., Fig. 41) **10**
– Maxillary stipes with setae straight, not curly at apex **11**
10 Epipleural emargination with well-developed tooth in ventral view (Fig. 73) ..... ***P. brunnipennis*** **Benderitter**
– Epipleural emargination with moderately developed tooth in ventral view (Fig. 77) ..... ***P. gracilipodus*** **Jameson & Wada**
11 Elytra entirely reddish (Fig. 17) ..... ***P. tigerus*** **Jameson & Wada**
– Elytra entirely black **12**
12 Lateral pillow of elytron (dorsal view) well-developed, extending medially at least ¼ elytral width, visible in ventral view (Fig. 88) ..... ***P. suehirogarus*** **Jameson & Wada**
– Lateral pillow of elytron (dorsal view) moderately developed, extending medially about 1/8 elytral width, not visible in ventral view (Fig. 77) ..... ***P. podocrassus*** **Jameson & Wada**
13 Elytral epipleuron in ventral view broad, nearly parallel from base to near metacoxa, lacking emargination (Fig. 75, 84) **14**

– Elytral epipleuron in ventral view narrowing from base to near metacoxa (not parallel-sided), with or without emargination (e.g., Figs 76, 78–79) **15**

14 Elytral epipleuron in ventral view with sparse, reddish, moderately long setae..... ***P. favonius*** **Jameson & Wada**

– Elytral epipleuron in ventral view without setae..... ***P. pruinosus*** **Arrow**

15 Labial palpomere 2 greatly enlarged and dorsoventrally flattened, 2–3 times wider than palpomere 1 (e.g., Fig. 28) **16**

– Labial palpomere 2 not greatly enlarged and flattened, at most 1.5 times wider than palpomere 1 (e.g., Fig. 33) **17**

16 Maxillary stipes with setae curly at apex (Fig. 41); lateral pillow of elytron (dorsal view) well-developed, visible in ventral view (Fig. 79) .... ***P. malayensis*** **Arrow**

– Maxillary stipes with setae straight, not curly at apex; lateral pillow of elytron (dorsal view) moderately developed, not visible in ventral view (Fig. 77) .... ***P. silvanus*** **Jameson & Wada**

17 Body length more than 20 mm; epipleuron in ventral view simple, not emarginate (Fig. 78) ..... ***P. kyojinus*** **Jameson & Wada**

– Body length less than 20 mm; epipleuron in ventral view simple or emarginate (Figs 74, 76, 85–86)..... **18**

18 Elytral epipleuron emarginate in ventral view (Fig. 86) **19**

– Elytral epipleuron simple in ventral view (Figs 76, 85)..... **21**

19 Elytral epipleuron in ventral view with round emargination (Figs 74, 86); not occurring in Mt. Bawang, Kalimantan region of Borneo..... **20**

– Elytral epipleuron in ventral view with elongate-oval emargination; Mt. Bawang, Kalimantan region of Borneo.... ***P. adelphosimilis*** **Jameson & Wada**

20 Punctures of frons and clypeus mulitsetigerous, setae minute and/or short; elytral epipleuron as in Fig. 86; Borneo..... ***P. similis*** **Arrow**

– Punctures of frons and clypeus unisetigerous, setae minute; elytral epipleuron as in Fig. 74; Sumatra ..... ***P. cybele*** **Jameson & Wada**

21 Elytral epipleuron in ventral view terminating near metacoxa (Fig. 85)..... ..... ***P. rubripennis*** **Miyake & Yamaya**

– Elytral epipleuron in ventral view extending posterior of metacoxa, terminating near sternite 3 (Fig. 76)..... ***P. fujiokai*** **Jameson & Wada**

Peltonotus species diagnoses

Peltonotus adelphosimilis **Jameson & Wada, 2004**
http://species-id.net/wiki/Peltonotus_adelphosimilis
Figs 50, 55

Diagnosis (male and female). Length 20.3–18.9 mm, color overall black or castaneous, elytra black or castaneous with or without iridescent bloom, head with some multisetiger-

ous punctures, labrum bi-emarginate, mentum rounded in apical half, labial palpomere 2 not enlarged or obviously dorsoventrally flattened, mala lacking lamellate setal brush, maxillary stipes without setae curled at apices, male protibia bidentate, protarsomere 5 of male with internoapical protuberance (Fig. 50), form of parameres (Fig. 55), female epipleuron incised and with rounded emargination (similar to *P. similis*, Fig. 86).

Distribution. Indonesia, Borneo Island (Kalimantan).

***Peltonotus animus* Jameson & Wada, 2009**
http://species-id.net/wiki/Peltonotus_animus
Figs 1, 36, 45, 56

Diagnosis (male only). Length ~16.5 mm, color overall castaneous, elytra castaneous with weak iridescent bloom (Fig. 1), frons with some multisetigerous punctures, labrum bi-emarginate, mentum rounded in apical half, labial palpomere 2 enlarged and dorsoventrally flattened, mala with dense lamellate setal brush (Fig. 36), maxillary stipes with some setae curled at apices (Fig. 36), male protibia tridentate with basal tooth obsolete (Fig. 45), and male parameres (Fig. 56).

Distribution. Indonesia, Sumatra Island.

***Peltonotus brunnipennis* Benderitter, 1934**
http://species-id.net/wiki/Peltonotus_brunnipennis
Figs 57, 73

Diagnosis (male and female). Length 14.5–16.9 mm, color overall castaneous, elytra reddish-orange or black with iridescent bloom, head punctate and lacking setae, labrum deeply bi-lobed, mentum rounded in apical half, labial palpomere 2 enlarged and obviously dorsoventrally flattened, mala with lamellate setal brush, maxillary stipes with some setae curled at apices, male protibia tridentate, form of parameres (Fig. 57), female epipleuron incised and with oval emargination (Fig. 73).

Distribution. Malaysia, Borneo Island (Sabah and Sarawak).

***Peltonotus cybele* Jameson & Wada, 2009**
http://species-id.net/wiki/Peltonotus_cybele
Figs 2–3, 37, 46, 58, 74

Diagnosis (male and female). Length 14.5–16.5 mm, color overall castaneous, elytra castaneous suffused with dark red or reddish-brown and iridescent bloom (Figs 2–3), head with some unisetigerous punctures, labrum bi-emarginate, mentum rounded in apical half, labial palpomere 2 not enlarged or obviously dorsoventrally flattened, mala lacking lamellate setal brush (Fig. 37), maxillary stipes without setae curled at apices

1 *Peltonotus animus*, male

2 *Peltonotus cybele*, male

3 *Peltonotus cybele*, female

4 *Peltonotus favonius*, male

5 *Peltonotus fujiokai*, male

6 *Peltonotus fujiokai*, male

7 *Peltonotus fujiokai*, male

8 *Peltonotus fujiokai*, female

9 *Peltonotus karubei*, male

10 *Peltonotus malayensis*, male

11 *Peltonotus malayensis*, female

12 *Peltonotus morio*, male

Figures 1–12. *Peltonotus* species dorsal habitus. **1** *P. animus*, male **2–3** *P. cybele*, male and female (respectively) **4** *P. favonius*, male **5–7** *P. fujiokai*, males (showing variation) **8** *P. fujiokai*, female **9** *P. karubei*, male **10–11** *P. malayensis*, male and female (respectively) **12** *P. morio*, male.

(Fig. 37), male protibia tridentate (Fig. 46), form of parameres (Fig. 58), female epipleuron incised and with rounded emargination (Fig. 74).

Distribution. Indonesia, Sumatra Island.

***Peltonotus deltamentum* Jameson & Wada, 2004**
http://species-id.net/wiki/Peltonotus_deltamentum
Figs 25, 38, 54, 59

Diagnosis (male only). Length ~16.6 mm, color overall castaneous, elytra castaneous with weak iridescent bloom, head with some multisetigerous punctures, labrum bi-emarginate, mentum triangular in apical half (Fig. 25), labial palpomere 2 enlarged and dorsoventrally flattened, mala with dense lamellate setal brush (Fig. 38), maxillary stipes with setae curled at apices (Fig. 38), male protibia tridentate with basal tooth weakly developed, male proclaw strongly arcuate in ventral view (Fig. 54), form of parameres (Fig. 59).

Distribution. Indonesia, Borneo Island (Kalimantan).

***Peltonotus favonius* Jameson & Wada, 2009**
http://species-id.net/wiki/Peltonotus_favonius
Figs 4, 39, 51, 60, 75

Diagnosis (male and female). Length ~14.6 mm, color overall black, elytra black or dark reddish brown with iridescent bloom (Fig. 4), head with simple punctures (lacking setae), labrum bi-emarginate, mentum rounded in apical half, labial palpomere 2 not enlarged or obviously dorsoventrally flattened, mala lacking lamellate setal brush (Fig. 39), maxillary stipes without setae curled at apices (Fig. 39), male protibia bidentate (Fig. 51), form of parameres (Fig. 60), female epipleuron broadly expanded, weakly convex, extending from base to metacoxa, lacking incised apex (Fig. 75).

Distribution. Vietnam and Myanmar.

Remarks. This species is most similar to *P. pruinosus*, a species for which only the female holotype is known. Previously, this species was only known from the male holotype specimen from Vietnam.

***Peltonotus fujiokai* Jameson & Wada, 2004**
http://species-id.net/wiki/Peltonotus_fujiokai
Figs 5–8, 61, 76

Diagnosis (male and female). Length 14.1–14.6 mm, color overall castaneous, elytra reddish-brown with castaneous vittae, reddish-brown, or black with iridescent bloom (Figs 5–8), head with some unisetigerous punctures, labrum bi-emarginate, mentum rounded in apical half, labial palpomere 2 not enlarged and not dorsoventrally flat-

tened, mala without dense lamellate setal brush, maxillary stipes without setae curled at apices, male protibia tridentate, form of parameres (Fig. 61), female epipleuron simple, not incised and lacking emargination (Fig. 76).

Distribution. Indonesia, Borneo Island (Kalimantan); Malaysia, Borneo Island (Sabah).

***Peltonotus gracilipodus* Jameson & Wada, 2004**
http://species-id.net/wiki/Peltonotus_gracilipodus
Figs 26, 62, 77

Diagnosis (male and female). Length 14.4–16.8 mm, color overall castaneous, elytra castaneous with weak iridescent bloom, head with some multisetigerous punctures, labrum deeply bi-lobed, mentum rounded in apical half (Fig. 26), labial palpomere 2 enlarged and obviously dorsoventrally flattened (Fig. 26), mala with lamellate setal brush, maxillary stipes with some setae curled at apices, male protibia bidentate, form of parameres (Fig. 62), female epipleuron incised and with oblong-oval emargination (Fig. 77).

Distribution. Indonesia, Sumatra Island.

Remarks. *Peltonotus gracilipodus* and *P. podocrassus* (distributed in peninsular Malaysia) have quite similar male parameres and females have quite similar epipleura, perhaps indicating recent isolation of ancestral populations.

***Peltonotus karubei* Muramoto, 2000**
http://species-id.net/wiki/Peltonotus_karubei
Figs 9, 20, 40, 63

Diagnosis (male only). Length 13.4–14.5 mm, overall color black or castaneous, elytra reddish orange or black with iridescent bloom (Fig. 9), head with some multisetigerous punctures, labrum deeply bilobed (Fig. 20), labial palpomere 2 enlarged and obviously dorsoventrally flattened (Fig. 40), mala with weak lamellate setal brush (Fig. 40), maxillary stipes without setae curled at apices, male protibia bidentate, form of male parameres (Fig. 63).

Distribution. Vietnam (southern).

***Peltonotus kyojinus* Jameson & Wada, 2004**
http://species-id.net/wiki/Peltonotus_kyojinus
Figs 27, 78

Diagnosis (female only). Length 21.3 mm, color overall castaneous, elytral disc brown with iridescent bloom, head with some multisetigerous punctures, labrum bi-emarginate, mentum rounded in apical half (Fig. 27), labial palpomere 2 not enlarged and not obviously

dorsoventrally flattened, mala without lamellate setal brush, maxillary stipes without setae curled at apices, female epipleuron simple, not incised and lacking emargination (Fig. 78).

Distribution. Indonesia, Borneo Island (Kalimantan).

Remarks. *Peltonotus kyojinus* is the largest species of *Peltonotus.*

***Peltonotus malayensis* Arrow, 1910**
http://species-id.net/wiki/Peltonotus_malayensis
Figs 10–11, 21, 28, 41, 47, 64, 79

Diagnosis (male and female). Length 14.4–17.2 mm, color overall castaneous or black, elytra reddish-brown or black with weak iridescent bloom (Figs 10–11), head with some multisetigerous punctures, labrum bi-emarginate (Fig. 21), mentum rounded in apical half (Fig. 28), labial palpomere 2 enlarged and obviously dorsoventrally flattened (Fig. 41), mala with weak lamellate setal brush, maxillary stipes setae curled at apices (Fig. 41), male protibia bidentate (Fig. 47), form of male parameres (Fig. 64), female epipleuron incised and with rounded emargination (Fig. 79).

Distribution. Brunei; Indonesia, Borneo Island (Kalimantan); Malaysia, Borneo Island (Sarawak).

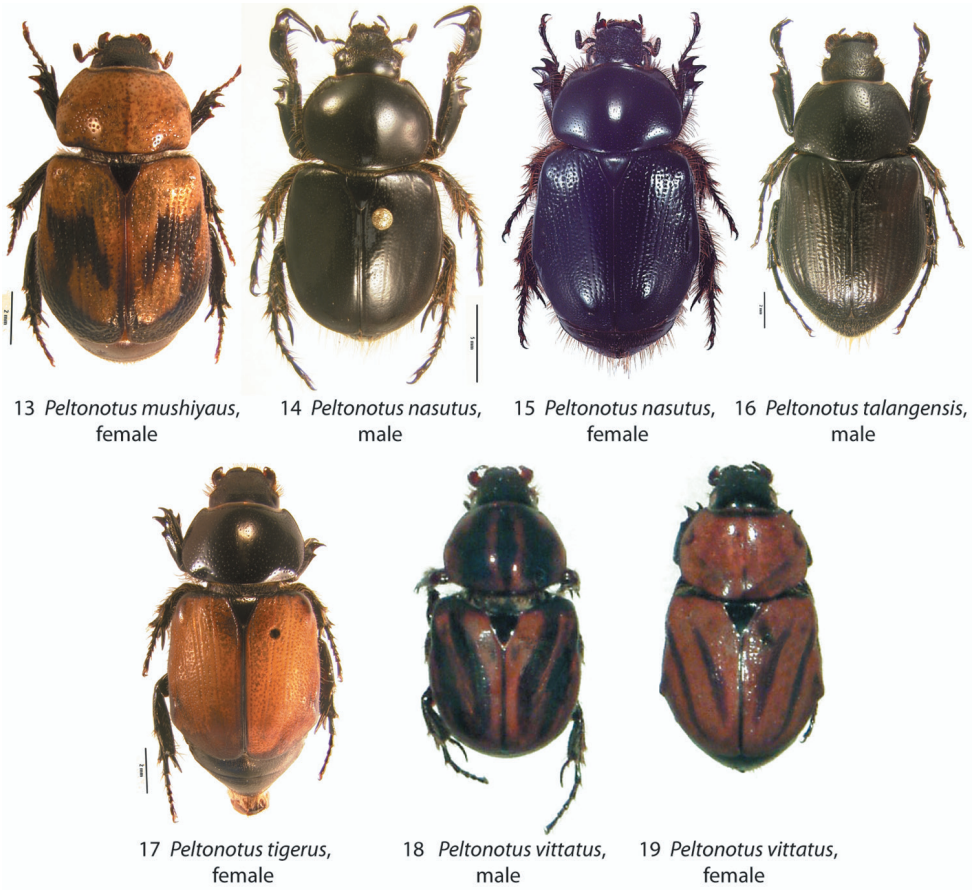
***Peltonotus morio* Burmeister, 1847**
http://species-id.net/wiki/Peltonotus_morio
Figs 12, 24, 65, 80, 92

Diagnosis (male and female). Length 14.0–18.0 mm, color overall black or castaneous, elytra black or castaneous and shining (Fig. 12), head with unisetigerous punctures, labrum weakly sinuate (Fig. 24), mentum quadrate in apical half, labial palpomere 2 not enlarged and not dorsoventrally flattened, mala lacking lamellate setal brush, maxillary stipes without setae curled at apices, male protibia tridentate with basal tooth weakly developed, form of male parameres (Fig. 65), female epipleuron weakly, quadrately incised (Fig. 80) and with moderately developed dorsal pillow.

Distribution (Fig. 92). Bhutan, India (northeastern), Myanmar, Nepal, Thailand, Vietnam.

***Peltonotus mushiyaus* Jameson & Wada, 2009**
http://species-id.net/wiki/Peltonotus_mushiyaus
Figs 13, 42, 81

Diagnosis (female only). Length ~11.8 mm, overall color castaneous, elytral disc orangish-tan with castaneous maculae and iridescent bloom (Fig. 13), head with some unisetigerous punctures, labrum bi-emarginate, mentum rounded in apical half, labial palpomere 2 not enlarged or obviously dorsoventrally flattened, mala lacking lamellate



Figures 13–19. *Peltonotus* species dorsal habitus. **13** *P. mushiyaus*, female **14–15** *P. nasutus*, male and female (respectively) **16** *P. talangensis*, male **17** *P. tigerus*, female **18–19** *P. vittatus,* male and female (respectively).

setal brush (Fig. 42), maxillary stipes without setae curled at apices (Fig. 42), female epipleuron simple, not expanded (Fig. 81).

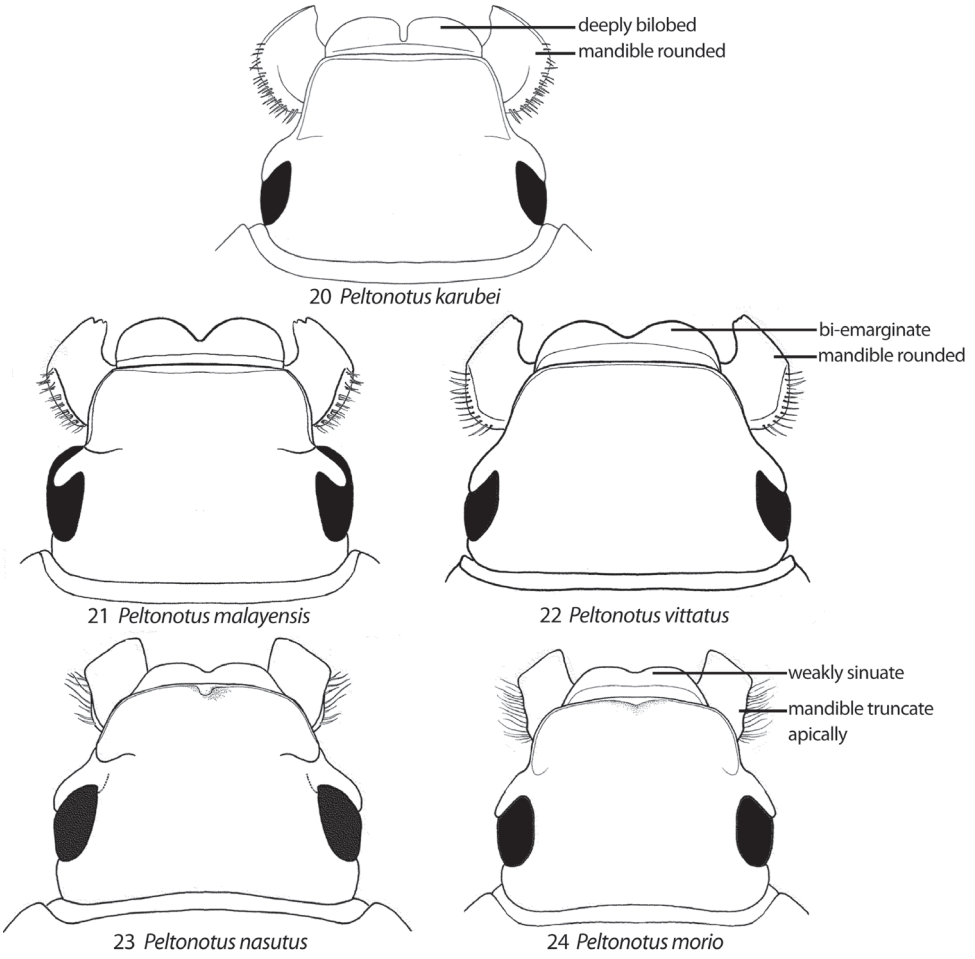
Distribution. Malaysia, Borneo Island (Sabah).

Remarks. *Peltonotus mushiyaus* is the smallest species in the genus. We hypothesize that males of this species will possess orangish-tan elytra with castaneous maculae, similar to males of *P. vittatus*.

Peltonotus nasutus **Arrow, 1910**

http://species-id.net/wiki/Peltonotus_nasutus
Figs 14–15, 23, 30, 52, 66, 82, 92

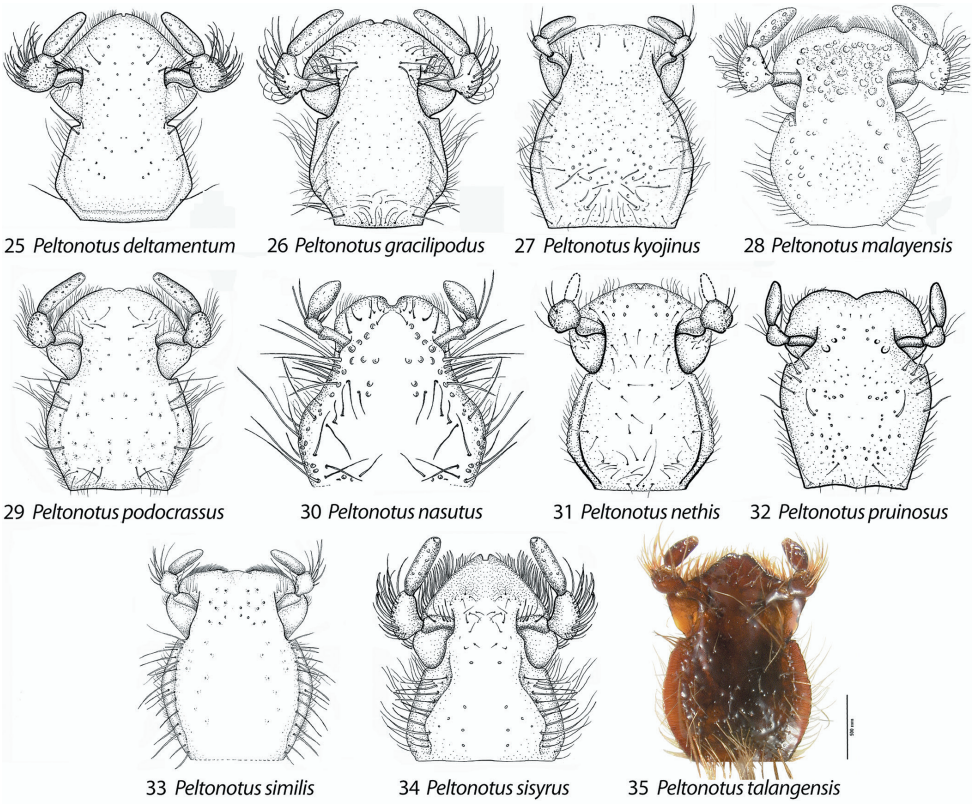
Diagnosis (male and female). Length 19.6–20.6 mm, color overall black or castaneous, elytra black or castaneous and shining (Fig. 14–15), head with unisetigerous punctures and apex of clypeus with weak tubercle medially (Fig. 23), labrum weakly sinuate



Figures 20–24. Head (dorsal view) showing characters of the labrum, mandible, and clypeus. **20** *P. karubei* (apex of labrum deeply bi-lobed; apex of mandible rounded laterally) **21** *P. malayensis* (apex of labrum bi-emarginate; apex of mandible rounded laterally) **22** *P. vittatus* (apex of labrum bi-emarginate; apex of mandible rounded laterally) **23** *P. nasutus* (apex of labrum weakly sinuate; apex of mandible quadrate laterally with broadly truncate apex; apex of clypeus with weak tubercle in male) **24** *P. morio* (apex of labrum weakly sinuate; apex of mandible quadrate laterally with broadly truncate apex; apex of clypeus without tubercle in male).

(Fig. 23), mentum quadrate in apical half (Fig. 30), labial palpomere 2 not enlarged and not dorsoventrally flattened, mala lacking lamellate setal brush, maxillary stipes without setae curled at apices, male protibia tridentate with well developed basal tooth, male protibial claw greatly enlarged (Fig. 52), form of male parameres (Fig. 66), female epipleuron weakly, quadrately incised (Fig. 82) and with well developed dorsal pillow.

Distribution (Fig. 92). Cambodia, China (southern), Laos, Myanmar, Thailand, Vietnam.



Figures 25–35. Mentum, ventral view, showing form of apical half of mentum and form of labial palpomere 2 (in comparison to palpomere 1). **25** *P. deltamentum* **26** *P. gracilipodus* **27** *P. kyojinus* **28** *P. malayensis* **29** *P. podocrassus* **30** *P. nasutus* **31** *P. nethis* **32** *P. pruinosus* **33** *P. similis* **34** *P. sisyrus* **35** *P. talangensis*.

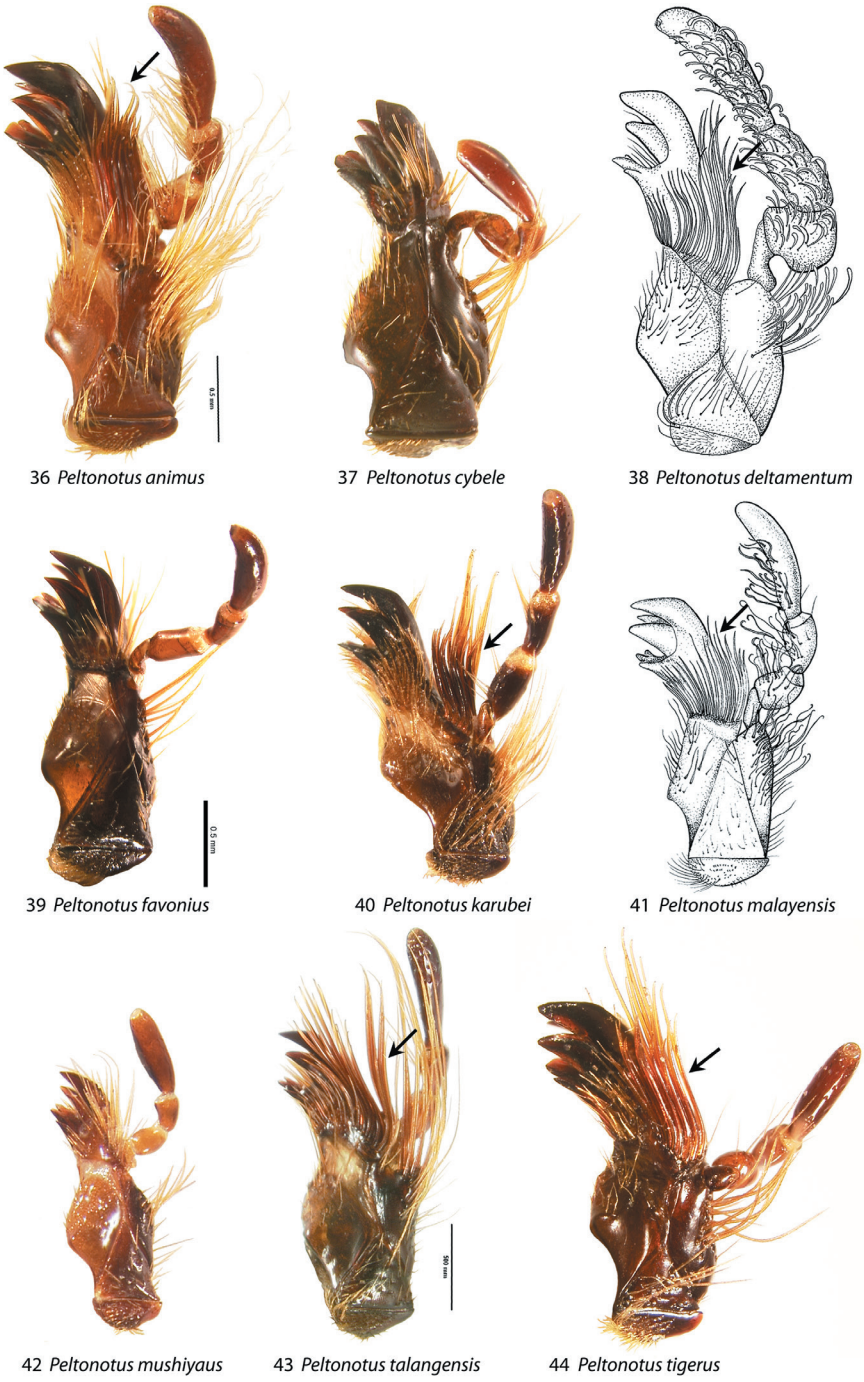
Remarks. *Peltonotus nasutus* is the most common species in the genus and the only species with an apicomedial tubercle on the clypeus (male only).

Peltonotus nethis Jameson & Wada, 2004

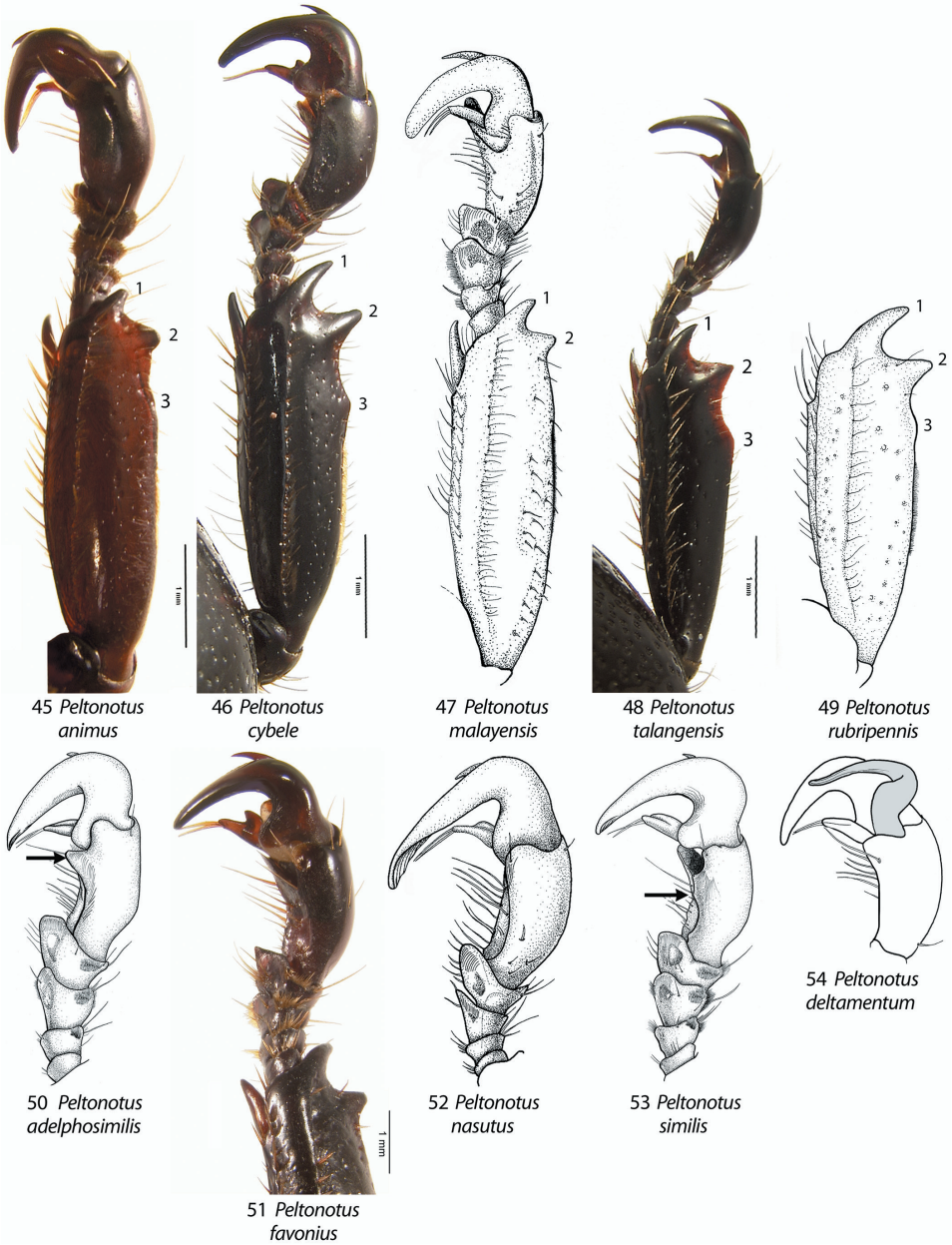
http://species-id.net/wiki/Peltonotus_nethis
Figs 31, 83

Diagnosis (female only). Length ~13.7 mm, color overall black, elytra black with iridescent bloom, head with unisetigerous punctures or lacking setae, labrum bi-emarginate, mentum rounded in apical half (Fig. 31), labial palpomere 2 greatly enlarged and dorsoventrally flattened, mala with lamellate setal brush, maxillary stipes without setae curled at apices, female epipleuron simple, not incised (Fig. 83).

Distribution. Malaysia, Borneo Island (Sabah).



Figures 36–44. Maxilla, ventral view, showing mala with or without lamellate setal brush (setae thick and strongly flattened), and showing stipes with or without setae curly at apices. **36** *P. animus* **37** *P. cybele* **38** *P. deltamentum* **39** *P. favonius* **40** *P. karubei* **41** *P. malayensis* **42** *P. mushiyaus* **43** *P. talangensis* **44** *P. tigerus.* Arrows indicate lamellate setal brush.



Figures 45–54. Male prolegs, dorsal view (**45–49**), male protarsomeres, dorsal view (**50–53**), and male protarsomere 5, ventral view (**54**), of *Peltonotus*. **45** *P. animus* (male protibia tridentate with basal tooth obsolete) **46** *P. cybele* (male protibia tridentate with basal tooth well developed) **47** *P. malayensis* (male protibia bidentate) **48** *P. talangensis* (male protibia tridentate with basal tooth well developed) **49** *P. rubripennis* (male protibia tridentate with basal tooth weakly developed) **50** *P. adelphosimilis* (arrow showing protarsomere 5 of male with internoapical protuberance) **51** *P. favonius* (male protibia bidentate) **52** *P. nasutus* (male protibial claw greatly enlarged) **53** *P. similis* (arrow showing protarsomere 5 of male with internomedial protuberance) **54** *P. deltamentum* (male proclaw strongly arcuate in ventral view).

***Peltonotus podocrassus* Jameson & Wada, 2004**
http://species-id.net/wiki/Peltonotus_podocrassus
Figs 29, 62, 77

Diagnosis (male and female). Length 17.6–18.7 mm, color overall castaneous, elytra castaneous with weak iridescent bloom, head with some multisetigerous punctures, labrum deeply bi-lobed, mentum rounded in apical half (Fig. 29), labial palpomere 2 enlarged and obviously dorsoventrally flattened (Fig. 29), mala with lamellate setal brush, maxillary stipes lacking setae curled at apices, male protibia bidentate, form of parameres (Fig. 62), female epipleuron incised and with oblong-oval emargination (Fig. 77).

Distribution. Malaysia (Peninsular Malaysia).

Remarks. *Peltonotus podocrassus* and *P. gracilipodus* (distributed in Sumatra) are similar with respect to the male parameres and female epipleura. This may be indicative of recent divergence from a common ancestor.

***Peltonotus pruinosus* Arrow, 1910**
http://species-id.net/wiki/Peltonotus_pruinosus
Figs 32, 84

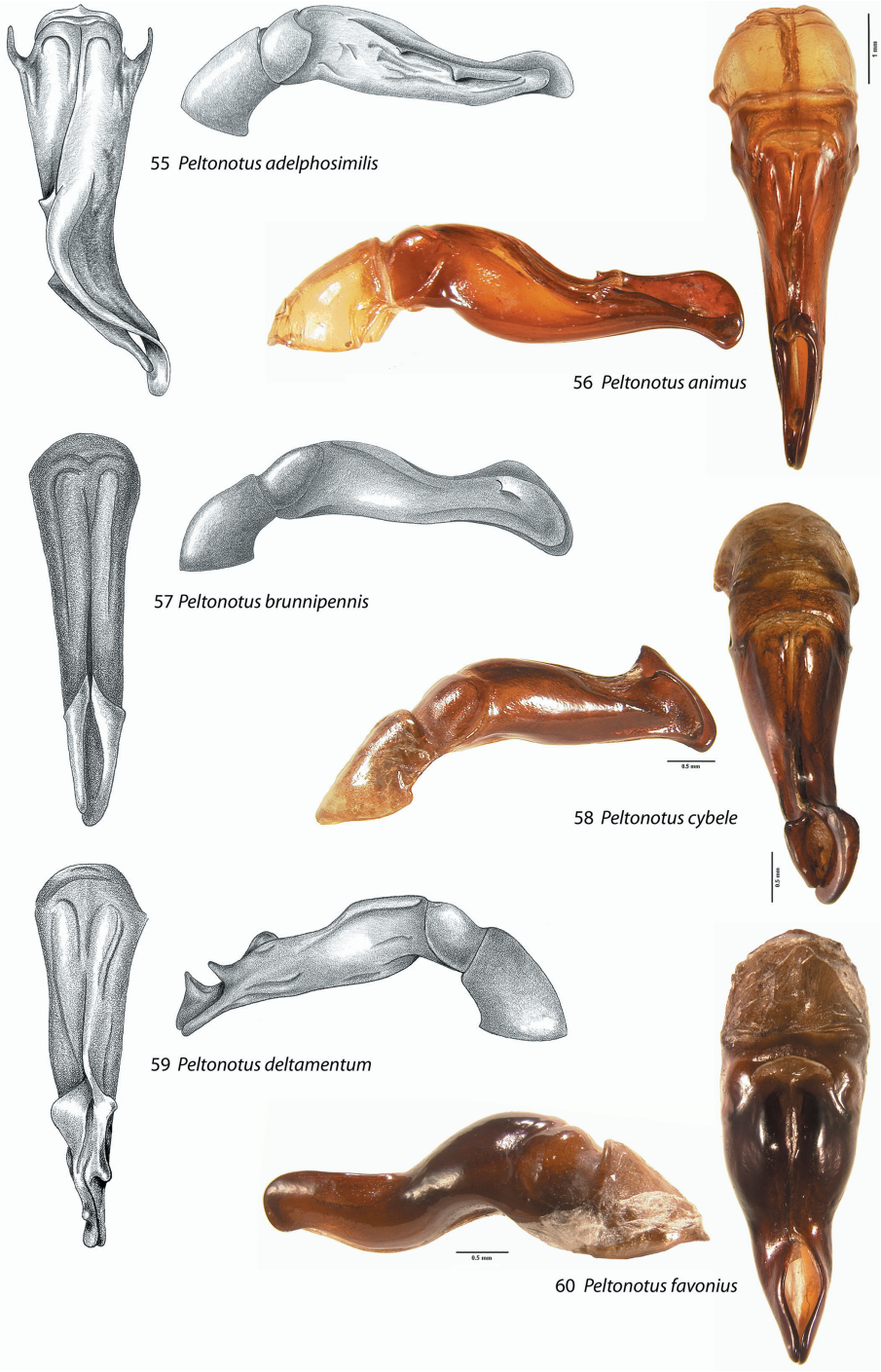
Diagnosis (female only). Length ~15.7 mm, color overall black, elytra black with iridescent bloom, head punctate and lacking setae, labrum bi-emarginate, mentum rounded in apical half and moderately bi-lobed at middle (Fig. 32), labial palpomere 2 not enlarged and not obviously dorsoventrally flattened (Fig. 32), mala without lamellate setal brush, maxillary stipes without setae curled at apices, female epipleuron broadly expanded and lacking emargination at apex (Fig. 84).

Distribution. India.

***Peltonotus rubripennis* Miyake & Yamaya, 1994**
http://species-id.net/wiki/Peltonotus_rubripennis
Figs 49, 67, 85

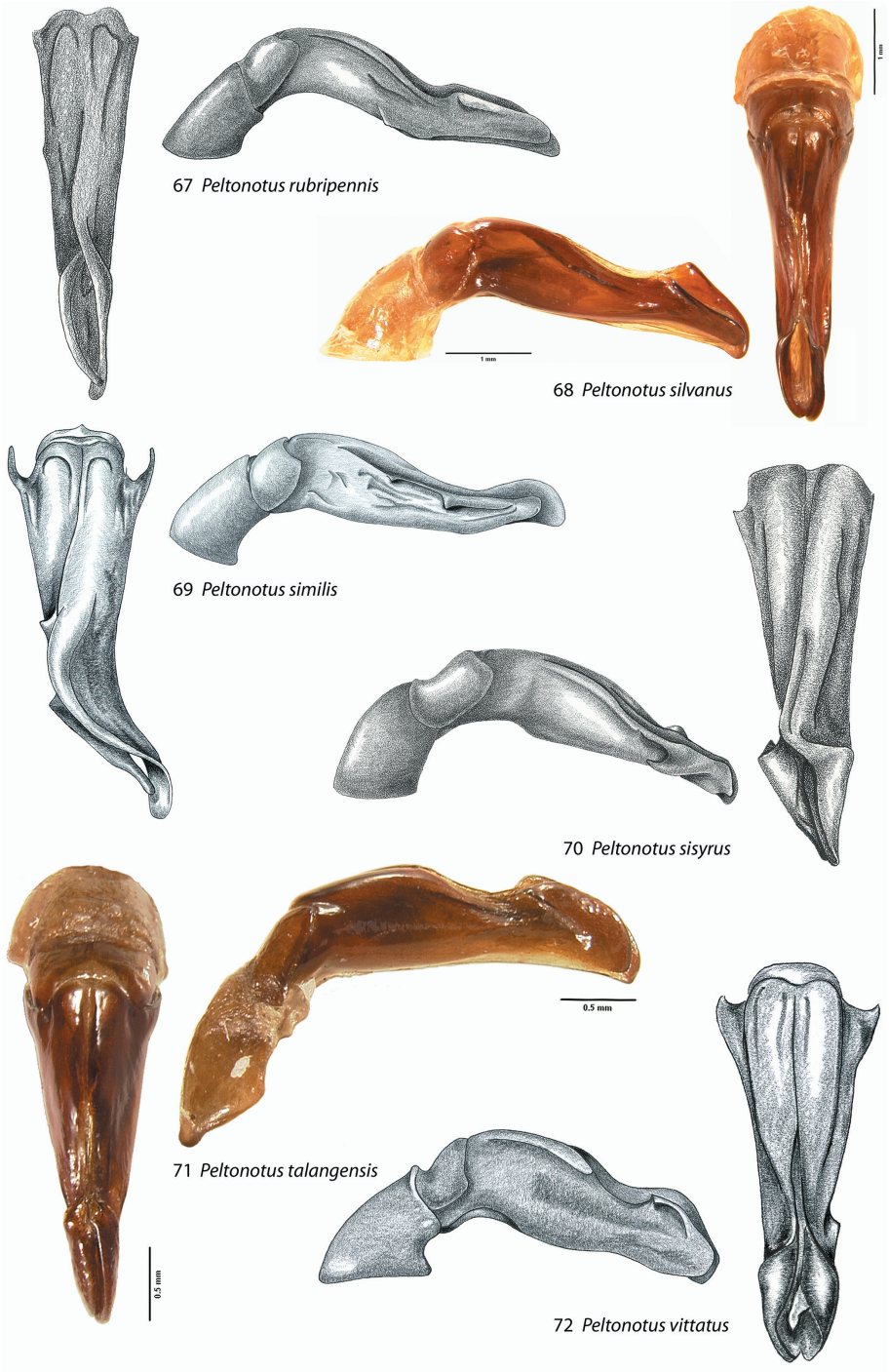
Diagnosis (male and female). Length 12.0–12.5 mm, color overall castaneous, elytral disc brown with iridescent bloom, head with unisetigerous punctures, labrum bi-emarginate, mentum rounded in apical half, labial palpomere 2 slightly enlarged and not obviously dorsoventrally flattened, mala lacking lamellate setal brush, maxillary stipes lacking setae curled at apices, male protibia tridentate with basal tooth weakly developed (Fig. 49), form of parameres (Fig. 67), female epipleuron simple and lacking emargination at apex (Fig. 85).

Distribution. Malaysia, Borneo Island (Sabah and Sarawak).



Figures 55–60. Male parameres (with or without phallobase), dorsal and lateral views, in *Peltonotus*. Male parameres are highly asymmetrical, and we illustrate the lateral view that best assists in identification. **55** *P. adelphosimilis* **56** *P. animus* **57** *P. brunnipennis* **58** *P. cybele* **59** *P. deltamentum* **60** *P. favonius*.

Figures 61–66. Male parameres (with or without phallobase), dorsal and lateral views, in *Peltonotus*. Male parameres are highly asymmetrical, and we illustrate the lateral view that best assists in identification. **61** *P. fujiokai* **62** *P. gracilipodus* and *P. podocrassus* **63** *P. karubei* **64** *P. malayensis* **65** *P. morio* **66** *P. nasutus*.



Figures 67–72. Male parameres (with or without phallobase), dorsal and lateral views, in *Peltonotus*. Male parameres are highly asymmetrical, and we illustrate the lateral view that best assists in identification. **67** *P. rubripennis* **68** *P. silvanus* **69** *P. similis* **70** *P. sisyrus* **71** *P. talangensis* **72** *P. vittatus*.

***Peltonotus silvanus* Jameson & Wada, 2004**
http://species-id.net/wiki/Peltonotus_silvanus
Figs 68, 77

Diagnosis (male and female). Length 16.3–17.8 mm, color overall castaneous, elytra castaneous, dark-brown, or black with weak iridescent bloom, head with some multisetigerous punctures, labrum bi-emarginate, mentum rounded in apical half, labial palpomere 2 enlarged and obviously dorsoventrally flattened, mala with lamellate setal brush, maxillary stipes lacking setae curled at apices, male protarsomeres 2–4 with apices expanded, male protibia bidentate, form of parameres (Fig. 68), female epipleuron incised and with oblong-oval emargination (Fig. 77).

Distribution. Indonesia, Borneo Island (Kalimantan); Malaysia, Borneo Island (Sarawak).

***Peltonotus similis* Arrow, 1931**
http://species-id.net/wiki/Peltonotus_similis
Figs 33, 53, 69, 86

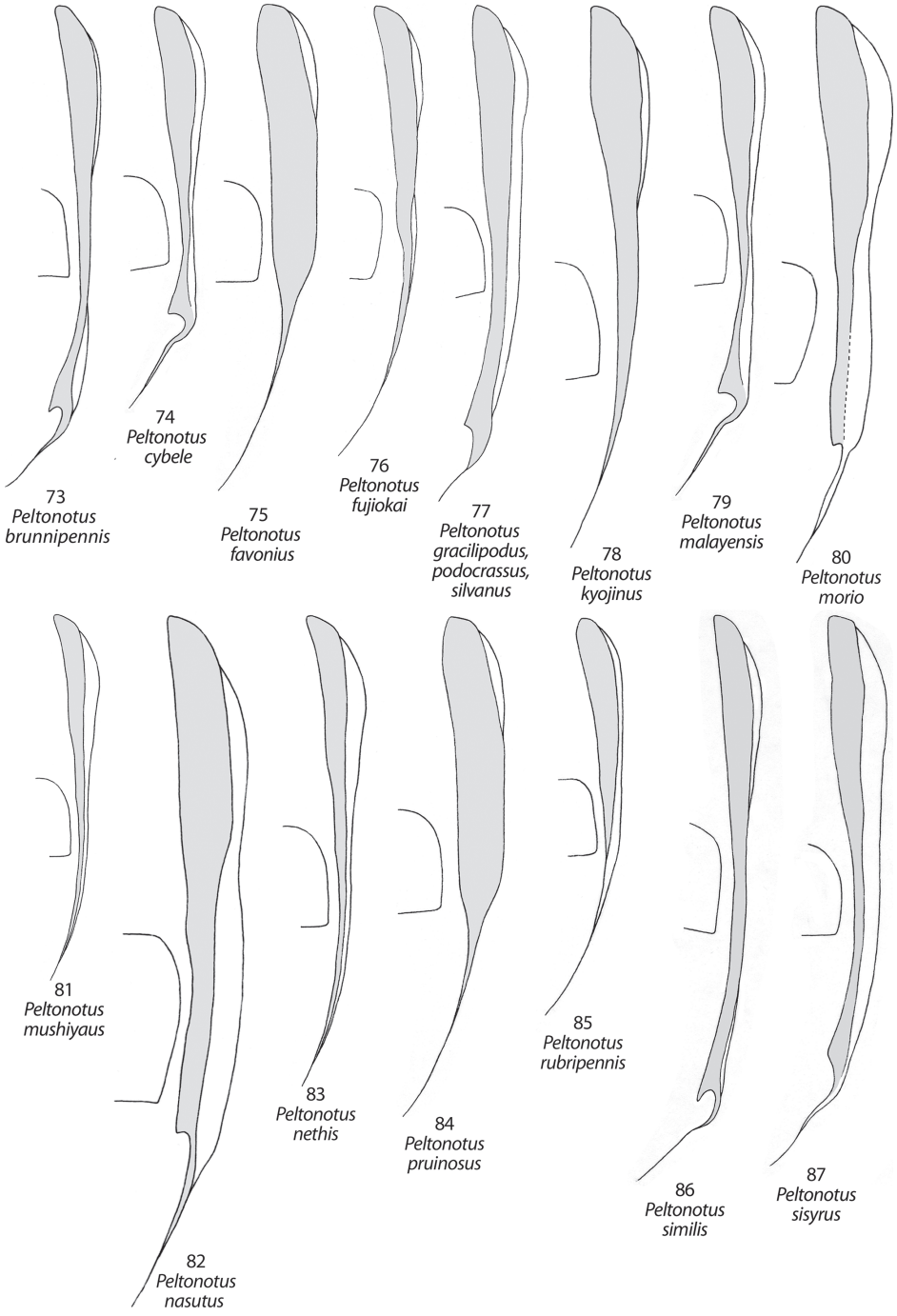
Diagnosis (male and female). Length 18.0–20.9 mm, color overall dark brown or black, elytra dark brown or black with or without iridescent bloom, head with some multisetigerous punctures, labrum bi-emarginate, mentum rounded in apical half (Fig. 33), labial palpomere 2 slightly enlarged and not obviously dorsoventrally flattened (Fig. 33), mala without lamellate setal brush, maxillary stipes without setae curled at apices, protarsomere 5 of male with internomedial protuberance (Fig. 53), male protibia bidentate, form of parameres (Fig. 69), female epipleuron incised and with rounded emargination (Fig. 86).

Distribution. Malaysia, Borneo Island (Sabah).

***Peltonotus sisyrus* Jameson & Wada, 2004**
http://species-id.net/wiki/Peltonotus_sisyrus
Figs 34, 70, 87

Diagnosis (male and female). Length 16.1–16.4 mm, overall castaneous, elytra castaneous with weak iridescent bloom, head with some punctures multisetigerous, labrum bi-emarginate, mentum triangular in apical half (Fig. 34), labial palpomere 2 enlarged and obviously dorsoventrally flattened (Fig. 34), mala with lamellate setal brush, maxillary stipes without setae curled at apices, male protibia bidentate, form of parameres (Fig. 70), female epipleuron incised and with broad, elongate emargination (Fig. 87).

Distribution. Indonesia, Sumatra Island.



Figures 73–87. Female elytral epipleuron (gray, ventral view) and position relative to metacoxa in *Peltonotus*. **73** *P. brunnipennis* **74** *P. cybele* **75** *P. favonius* **76** *P. fujiokai* **77** *P. gracilipodus, P. podocrassus* and *P. silvanus* **78** *P. kyojinus* **79** *P. malayensis* **80** *P. morio* **81** *P. mushiyaus* **82** *P. nasutus* **83** *P. nethis* **84** *P. pruinosus* **85** *P. rubripennis* **86** *P. similis* **87** *P. sisyrus*

***Peltonotus suehirogarus* Jameson & Wada, 2004**
http://species-id.net/wiki/Peltonotus_suehirogarus
Fig. 88

Diagnosis (female only). Length 16.9–18.0 mm, color overall black, elytra black with iridescent bloom, head with some multisetigerous punctures, labrum bi-emarginate, mentum rounded in apical half, labial palpomere 2 enlarged and obviously dorsoventrally flattened, mala with lamellate setal brush, maxillary stipes with some setae weakly curled at apices, female epipleuron incised and with oblong-oval emargination (Fig. 88).

Distribution. Indonesia, Borneo Island (Kalimantan); Malaysia, Borneo Island (Sarawak).

***Peltonotus talangensis* Jameson & Jakl, 2010**
http://species-id.net/wiki/Peltonotus_talangensis
Figs 16, 35, 43, 48, 71, 89

Diagnosis (male and female). Length 14.1–15.2 mm, color overall castaneous, elytra castaneous or with weak reddish tones and lacking iridescent bloom (Fig. 16), head with some punctures unisetigerous, labrum bi-emarginate, mentum triangular in apical half (Fig. 35), labial palpomere 2 enlarged and obviously dorsoventrally flattened (Fig. 35), mala with lamellate setal brush (Fig. 43), maxillary stipes without setae curled at apices (Fig. 43), male protibia tridentate (Fig. 48), form of parameres (Fig. 71), female epipleuron simple, not incised (Fig. 89).

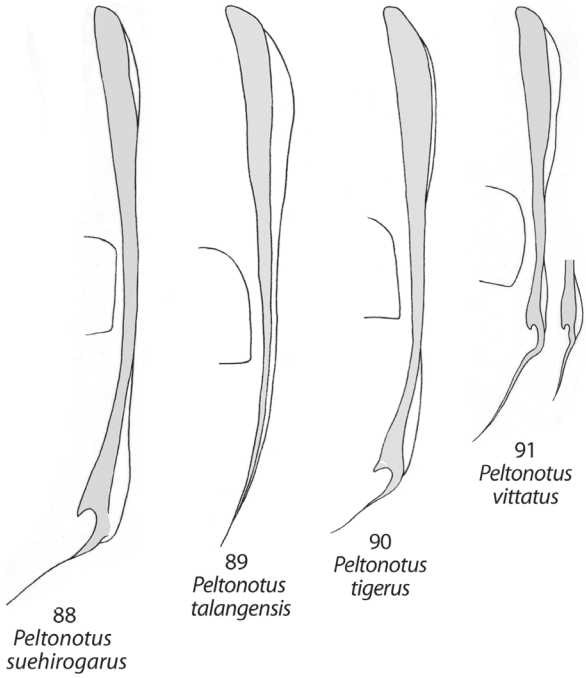
Distribution. Indonesia, Sumatra Island.

***Peltonotus tigerus* Jameson & Wada, 2009**
http://species-id.net/wiki/Peltonotus_tigerus
Figs 17, 44, 90

Diagnosis (female only). Length ~13.7 mm, overall color black or castaneous, elytra reddish-brown with weak iridescent bloom (Fig. 17), head with some punctures multisetigerous, labrum bi-emarginate, labial palpomere 2 enlarged and dorsoventrally flattened, mala with well developed lamellate setal brush (Fig. 44), maxillary stipes without setae curled at apices (Fig. 44), female epipleuron incised with a round or oval emargination (Fig. 90).

Distribution. Thailand.

Remarks. We hypothesize that males of this species will possess reddish-brown elytra, similar to the coloration of the female.



Figures 88–91. Female elytral epipleuron (gray, ventral view) and position relative to metacoxa in *Peltonotus*. **88** *P. suehirogarus* **89** *P. talangensis* **90** *P. tigerus* **91** *P. vittatus.*

***Peltonotus vittatus* Arrow, 1910**
http://species-id.net/wiki/Peltonotus_vittatus
Figs 18–19, 22, 72, 91

Diagnosis (male and female). Length 12.3–14.4 mm, color overall black or castaneous with pronotum reddish or black and with dark discal maculae, elytra reddish and with dark discal maculae and iridescent bloom (Figs 18–19), head with some multisetigerous punctures, labrum bi-emarginate (Fig. 22), mentum rounded in apical half, labial palpomere 2 not enlarged and not obviously dorsoventrally flattened, mala without lamellate setal brush, maxillary stipes without setae curled at apices, male protibia bidentate (or tridentate with basal tooth weakly developed), form of parameres (Fig. 72), female epipleuron narrowly incised (Fig. 91) with well developed dorsal pillow.

Distribution. Malaysia, Borneo Island (Sabah and Sarawak).

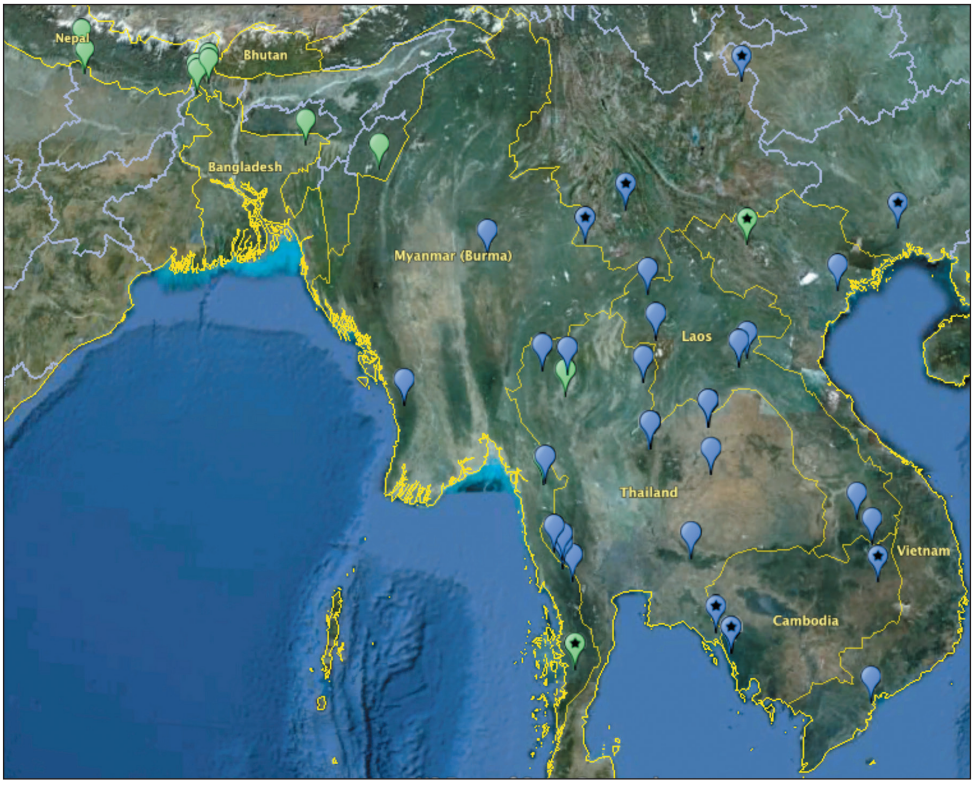


Figure 92. Distribution of *P. morio* (green icon) and *P. nasutus* (blue icon) in southeast Asia. Icons with stars indicate new country records for each species. Map was generated using data in **Table 1**.

Table 1. *Peltonotus* Locality Table. Locality information for *P. morio* and *P. nasutus*. The Appendix file can be used for dynamic mapping using EarthPoint and GoogleEarth.

Latitude	Longitude	Species name	Collection or Reference	Locality Information
16°40'27"N	98°17'59"E	*P. morio*	FUJI	S. Burma, Mt. Dawna, V.1992, 1 male, ele. 763m, NEW COUNTRY RECORD
12°05'N	99°00'E	*P. morio*	FUJI	S. Burma, Tenasserim, V.1992, 1 female, NEW COUNTRY RECORD
26°52'41"N	88°17'25"E	*P. morio*	BMNH	India, Kurseong Div., Lat Panchar, 4000 ft., VI. 1934, 6 specimens, Col. Champion
27°39'N	84°19'E	*P. morio*	Dhoj et al. 2009	Nepal, Chitwan Central region, Gunjanagar, 230 m
27°39'N	84°21'E	*P. morio*	Dhoj et al. 2009	Nepal, Rampur, 230 m, amid maize-maize-vegetables in sandy soil from farming sites.
22°29'N	103°57'E	*P. morio*	IRSBN	Vietnam, Lao Cai Prov., VI.10.1917, 1 male NEW COUNTRY RECORD
18°49'16"N	98°55'11"E	*P. morio*	Jameson and Wada 2004	Thailand, Doi Suthep

Latitude	Longitude	Species name	Collection or Reference	Locality Information
27°18'42"N	88°35'57"E	*P. morio*	Jameson and Wada 2004	Sikkim, India
24°39'32"N	93°54'22"E	*P. morio*	Jameson and Wada 2004	India, Manipur
25°22'05"N	91°45'13"E	*P. morio*	Jameson and Wada 2004	India, Meghalaya, Khasi Hills
27°09'33"N	88°36'56"E	*P. morio*	Jameson and Wada 2004	India, Pedong
27°02'09"N	88°14'08"E	*P. morio*	Jameson and Wada 2004	India, Darjeeling
28°16'N	84°05'E	*P. morio*	Jameson and Wada 2004	Nepal, Chhachok
14°48'00"N	106°49'59"E	*P. nasutus*	FUJI	S. Laos, Attapu, V.13.2007, 1 male, 1 female, ele 450m
14°88'N	105°87'E	*P. nasutus*	FUJI	S. Laos, Champasak Province, 2 females,
16°42'18"N	98°20'44"E	*P. nasutus*	FUJI	S. Burma, Mt. Dawna, V.1992, 1 female
18°38'31"N	94°42'56"E	*P. nasutus*	FUJI	Myanmar, Arakan Province, Nianjyo, 1070m, 1 male, 1 female
15°N	98°32'E	*P. nasutus*	BMNH	W. Thailand, Kanchanaburi Prov., Thung Yai Wildlife Sanctuary, mixed riverside forest, M. Brendell, V.8.1988, 10 specimens, within spathe of *Amorphophallus* inflorescence
19°25'N	103°30'E	*P. nasutus*	BMNH	Laos, Xiankhouang Prov. V.18.1919, 1 male
26°51'22"N	104°13'59"E	*P. nasutus*	Drumont	Chine, Guizhou, Mt. Ping-Qing-Liang-Zi, Weining county, 1-10/VII-2009, 1 male, 3 female NEW COUNTRY RECORD
23°28'5"N	100°41'E	*P. nasutus*	Drumont	Chine, Yunnan, Mt. Longtanshan, Jinggu county, VI.11-20, 3 male, Col. Li Jingke NEW COUNTRY RECORD
22°35'N	99°33'E	*P. nasutus*	Drumont	Chine, Yunnan, Mt. Daheishan, Menglian county, V.20-31-2009, Col. Li Jingke, 1 female NEW COUNTRY RECORD
22°47'56"N	108°19'44"E	*P. nasutus*	AREC	China, Guangxi Zhuang Automonus Region NEW COUNTRY RECORD
17°28'59"N	101°4'0"E	*P. nasutus*	IRSBN	Thailand, Changwat Loei, Na Haeo Bio. Sta., V-15-19-2003, light trap, Col. Constant, Smets, and Grootaert, 1 male, 2 female
17°28'59"N	101°4'0"E	*P. nasutus*	IRSBN	Thailand, Changwat Loei, Na Haeo Bio. Sta., V.17.2003, edge pond, Col. Constant and Smets, 2 female
17°28'59"N	101°4'0"E	*P. nasutus*	IRSBN	Thailand, Changwat Loei, Na Haeo Bio. Sta., V.5-12-2001, light trap, Col. Constant and Grootaert, 2 female
19°27'N	98°20'E	*P. nasutus*	IRSBN	N. Thailand, Mae Hong Son Prov., 600 m, 28-V to 2-VI-1999, Col. D. Hauck, 2 male, 2 female
14°16'07"N	98°59'12"E	*P. nasutus*	IRSBN	Thailand, Kanchanaburi Prov., Sai Yok NP, VI.4–5.2003, Constant and Smets, 1 male, 1 female

Latitude	Longitude	Species name	Collection or Reference	Locality Information
13°49'59"N	106°57'0"E	*P. nasutus*	IRSBN	Cambodia, Ratanakiri Prov., Phumi Kalai Thum., VI.1-19.2007, Col. Li Jingke, 1 male, 2 female NEW COUNTRY RECORD
12°18'09"N	102°59'20"E	*P. nasutus*	IRSBN	Cambodia, Pursat Prov., Phnum Samkos Wildlife Sanctuary, XI.15, 2005, light trapping, col. Smets and Van, 5 male, 4 female NEW COUNTRY RECORD
12°18'09"N	102°59'20"E	*P. nasutus*	IRSBN	Cambodia, Pursat Prov., Phnum Samkos Wildlife Sanctuary, IV.13-14, 2005, light trapping, primary forest edge, col. Smets and Van, 1 female, 1 male,
12°18'09"N	102°59'20"E	*P. nasutus*	IRSBN	Cambodia, Pursat Prov., Phnum Samkos Wildlife Sanctuary, IV.16, 2005, light trapping, col. Smets and Van, 3 female, 1 male NEW COUNTRY RECORD
12°18'09"N	102°59'20"E	*P. nasutus*	IRSBN	Cambodia, Pursat Prov., Phnum Samkos Wildlife Sanctuary, IV.15, 2005, light trapping, col. Smets and Van, 1 female NEW COUNTRY RECORD
12°51'2"N	102°36'34"E	*P. nasutus*	Drumont	Cambodia, Pailin Prov., 270m, V.6-16.2008, col. Murzin, 2 female NEW COUNTRY RECORD
21°17'13"N	101°10'02"E	*P. nasutus*	IRSBN	NW Laos, Louang Namtha Prov., Muang Sing, Houaylong-Kao, VI.2-19.2010, 6 male, 16 female
17°58'0"N	102°35'59"E	*P. nasutus*	IRSBN	Laos, Vientiane Prov., IV.4-1915, 1 female
17°58'0"N	102°35'59"E	*P. nasutus*	IRSBN	Laos, Vientiane Prov., V.18-1915, 1 male
20°09'0"N	101°19'53"E	*P. nasutus*	Li et al. 2012	Laos, Bokeo Prov., Pha Ngam
16°46'30"N	102°37'10"E	*P. nasutus*	Jameson and Wada 2004	Thailand, Khorat
14°35'21"N	98°44'29"E	*P. nasutus*	Jameson and Wada 2004	Thailand, Pu Nam Long Hot Spring
14°47'53"N	98°44'29"E	*P. nasutus*	Jameson and Wada 2004	Thailand, Khao Leam Dam
19°05'47"N	100°57'09"E	*P. nasutus*	Jameson and Wada 2004	Thailand, Nan Province
19°21'46"N	98°59'01"E	*P. nasutus*	Jameson and Wada 2004	Thailand, Ban Chiang Dao
14°43'02"N	102°01'23"E	*P. nasutus*	Jameson and Wada 2004	Thailand, Khorat Prov., Pak Thong Chai
17°57'46"N	102°36'54"E	*P. nasutus*	Jameson and Wada 2004	Laos, Vientane
19°36'41"N	103°43'44"E	*P. nasutus*	Jameson and Wada 2004	Laos, Xiangkhouang
22°20'59"N	96°55'00"E	*P. nasutus*	Jameson and Wada 2004	Myanmar, Gokhteik
21°14'14"N	106°22'34"E	*P. nasutus*	Jameson and Wada 2004	Vietnam, Tonkin (north Vietnam)
10°44'57"N	106°40'43"E	*P. nasutus*	Jameson and Wada 2004	Vietnam, Cochinchina (southern Vietnam)

Acknowledgements

We kindly thank the curators and collections managers who assisted in providing specimens for this research (see Materials and Methods): Max Barclay and Malcolm Kerley (BMNH), Patrick Grootaert (IRSNB), Matt J. Paulsen and Brett Ratcliffe (USNM currently housed as UNSM), and Andreas Reichenbach (AREC). Shinji Nagai (Japan) kindly provided specimens of *P. favonius*. Matt R. Moore and David Wickell (both Wichita State University) are thanked for imaging of some specimens and characters for this work, and Aura Paucar (University of Nebraska) is thanked for illustrations for some specimens and characters.

References

Arrow GJ (1910) On the lamellicorn beetles of the *Peltonotus* with descriptions of four new species. Annals and Magazine of the Natural History (Series 8) 5: 153–157.

Chen PP, Wongsiri S, Jamyanya T, Rinderer TE, Vongsamanode S, Matsuka M, Sylvester HA, Oldroyd BP (1998) Honey bees and other edible insects used as human food in Thailand. American Entomologist Spring: 24–29.

Danell E (2010) Dokmai dogma: *Amorphophallus* and its edible beetles. http://dokmaidogma.wordpress.com/2010/05/27/amorphophallus-and-its-edible-beetles/ [accessed March 19 2013]

Dhoj YGC, Keller S, Nage P, Kafle L (2009) Abundance and diversity of scarabaeid beetles (Coleoptera: Scarabaeidae) in different farming areas in Nepal. Formosan Entomology 29: 103–112.

Gibernau M, Chartier M, Barabé D (2010) Recent advances towards an evolutionary comprehension of Araceae pollination. In: Seberg O, Petersen G, Barfod AS, Davis JI, Editors. *Diversity, phylogeny, and evolution in the Monocotyledons*. Aarhus University Press, Denmark, 101–114.

Grimm R (2009) *Peltonotus nasutus* Arrow, 1910 und *Phaeochrous*-Arten als Bestäuber von *Amorphophallus paeoniifolius* (Araceae) in Thailand (Coleoptera: Scarabaeidae). Entomologische Zeitschrift 119: 167–168.

Holt BG, Lessard J-P, Borregaard MK, Fritz SA, Araújo MB, Dimitrov D, Fabre P-H, Graham CH, Graves GR, Jønsson KA, Nogués-Bravo D, Wang Z, Whittaker RJ, Fjeldså J, Rahbek (2013) An Update of Wallace's Zoogeographic Regions of the World. Science 339: 74–78. doi: 10.1126/science.1228282

Krell F-T (2006) *Dynastinae* MacLeay, 1819. In: Löbl I. & Smetana A. 2006. Catalogue of Palaearctic Coleoptera, volume 3. Scarabaeoidea - Scirtoidea - Dascilloidea - Buprestoidea - Byrrhoidea. Eds Löbl I. & Smetana A., Apollo Books, Stenstrup, Denmark, 277–283.

Jameson ML, Wada K (2004) Revision of the genus *Peltonotus* Burmeister (Coleoptera: Scarabaeidae: Dynastinae) from Southeastern Asia. Zootaxa 502: 1–66.

Jameson ML, Wada K (2009) Five new species of *Peltonotus* Burmeister (Scarabaeidae: Dynastinae: Cyclocephalini) from Southeast Asia. Insecta Mundi 102: 1–16.

Jameson ML, Jakl S (2010) Synopsis of the aroid scarabs in the genus *Peltonotus* Burmeister (Scarabaeidae, Dynastinae, Cyclocephalini) from Sumatra and description of a new species. ZooKeys 34: 141–152. doi: 10.3897/zookeys.34.302

Li J, Keith D, Gao M, Lin L (2012) Coléoptères Scarabaeoidea de Pha Ngam (province de Bokeo, Laos). L'Entomologiste 68 (5): 273–276.

Löbl I, Smetana A (2003) Catalogue of Palaearctic Coleoptera, volume 1. Archostemata-Myxophaga-Adephaga. Löbl & Smetana, eds., Apollo Books, Stenstrup, Denmark, 819 pp.

Maia ACD, Gibernau M, Carvalho AT, Gonçalves EG, Schlindwein C (2012) The cowl does not make the monk: scarab beetle pollination of the Neotropical aroid *Taccarum ulei* (Araceae, Spathicarpeae). Biological Journal of the Linnean Society (early view online version), 13 pp. doi: 10.1111/j.1095-8312.2012.01985.x

Miyake Y, Yamaya S (1994) Some new scarabaeid species from southern Asia preserved in the Nagaoka Municipal Science Museum (II). Bulletin of the Nagaoka Municiple Science Museum 29: 37–43.

Moore MR (2012) A new female elytral character for the tribe Cyclocephalini (Coleoptera: Scarabaeidae: Dynastinae) and an observation of its possible function. The Coleopterists Bulletin 63(3): 200–202. doi: 10.1649/072.066.0303

Moore MR, Jameson ML (in press) Floral associations of cyclocephaline scarab beetles. Journal of Insect Science.

Schiestl FP, Dötterl S (2012) The evolution of floral scent and olfactory preferences in pollinators: coevolution or pre-existing bias? Evolution 66(7): 2042–2055. doi: 10.1111/j.1558-5646.2012.01593.x

Wheeler QD, Platnick NI (2000) The phylogenetic species concept, 55–69. In: Wheeler QD, Meier R (Eds) Species Concepts and Phylogenetic Theory: A Debate. Columbia University Press, New York, NY.

Young HJ (1988) Differential importance of beetle species pollinating *Dieffenbachia longispatha* (Araceae). Ecology 69: 832–844.

Appendix

Supplemental file for dynamic mapping. (doi: 10.3897/zookeys.320.5352.app) Microsoft Excel document (xls).

Explanation note: Distribution maps were generated by entering latitude and longitude data into Microsoft Excel 2008 and uploaded to EarthPoint (http://www.earthpoint.us/ExcelToKml.aspx) and GoogleEarth (http://www.google.com/earth/index.html). This supplementary file allows addition of data and interactive mapping or niche modeling. Please note, however, that older localities have a wide margin of error and their lack of precision is not conducive to ecological or niche modeling.

Citation: Jameson ML, Drumont A (2013) Aroid scarabs in the genus *Peltonotus* Burmeister (Coleoptera, Scarabaeidae, Dynastinae): key to species and new distributional data. ZooKeys 320: 63–95. doi: 10.3897/zookeys.320.5352 Supplemental file for dynamic mapping. doi: 10.3897/zookeys.320.5352.app

ZooKeys 320: 97–101 (2013)
doi: 10.3897/zookeys.320.5372
www.zookeys.org

SHORT COMMUNICATION

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

Rediscovery and redescription of the holotype of *Liolaemus lemniscatus* Gravenhorst, 1838 (Reptilia, Squamata, Liolaemidae)

Bartosz Borczyk[1]

1 *Department of Evolutionary Biology and Conservation of Vertebrates, University of Wroclaw, ul. Sienkiewicza 21, 50-335 Wrocław, Poland*

Corresponding author: *Bartosz Borczyk* (borczyk@biol.uni.wroc.pl)

Academic editor: *Johannes Penner* | Received 20 April 2013 | Accepted 19 July 2013 | Published 31 July 2013

Citation: Borczyk B (2013) Rediscovery and redescription of the holotype of *Liolaemus lemniscatus* Gravenhorst, 1838 (Reptilia, Squamata, Liolaemidae). ZooKeys 320: 97–101. doi: 10.3897/zookeys.320.5372

Abstract

The presumed lost holotype of *Liolaemus lemniscatus* Gravenhorst 1838 has been found at the Museum of Natural History of the University of Wrocław and identified by the individual pattern of head scales which matches Gravenhorst's drawing. The first detailed description of this specimen is provided.

Keywords

Chile, holotype, *Liolaemus*, redescription, Squamata

Introduction

The former Zoologisches Museum Breslau, currently Natural History Museum of the University of Wroclaw (UWZM), housed a large collection of amphibians and reptiles including many type specimens. Unfortunately, many have been lost or are presumed to have been lost towards the end of World War II when the Museum building together approximately 75% of the city of Wrocław (then turned into Festung Breslau) were destroyed. Large parts of the collection catalogue went up in flames (Wiktor 1997). In the 50s of the 20th century most of the specimens were placed in new jars and/or the preserving fluids were replaced. Unfortunately, in many cases the original labels were replaced, which may have occasionally led to some loss of information (see Wiktor 1997). The political and economic situation together with inadequate curation led to

the further degradation of the collection. Regarding the Gravenhorst collection, the previous Museum's Director Prof. Andrzej Wiktor stated that it had been lost except for a few insect specimens (an unpublished letter to Alain Dubois, see Dubois and Ohler 2000: 13). However, recent efforts to overhaul and ultimately to rebuild the collection yielded the holotype of *Liolaemus lemniscatus* Gravenhorst, 1838.

Currently, the genus *Liolaemus* (family Liolaemidae) comprises more than 230 species ranging from southern Argentina to northern Peru. There are numerous recent studies of the systematics, phylogeny and evolution of this group (e.g. Espinoza 1999, Etheridge 2000, Lobo and Espinoza 2004, Lobo 2001 and Abdala 2007, Lobo et al. 2012, Quinteros 2012).

Liolaemus lemniscatus was briefly described by J. L.C. Gravenhorst in 1838: "The dorsal scales form 25 rows and the belly scales 33 rows. Forehead with six pairs of consecutive enlarged scales. Drawing: Above warts light brown, with a black spot above the upper arm and on the sides with two long white lines and two rows of black and brown spots" (Gravenhorst 1838: 731). Next, a detailed redescription of this rediscovered holotype specimen is provided.

Methods

The measurements and scale counts follow the description and terminology in Lobo (2001) and Abdala (2007) whereas the color pattern description follows the terminology in Lobo and Espinoza (1999). All measurements have been made using a digital caliper to the nearest 0.01 mm with the aid of a dissecting microscope.

Results and redescription

The specimen has been identified as the holotype on two grounds. First, there is a "n. spec. (?)" annotation on the label that remains on the jar. Inside the jar there is another label that was made in 1951 to replace the original one, and it holds only the species name with its authority. The species name is misspelled as "*Liolaemus lemnisodatus*" and the question mark suggests that the author of the label was not sure whether it really is the holotype of *L. lemniscatus*. Second, on comparison with the drawing of the holotype's head in Gravenhorst (1838: table LIV, fig. 12; reprinted in Fig. 1C herein), there is an exact match in the pattern and shapes of the dorsal head scales between the specimen and Gravenhorst's drawing. It is known that the variation in head scales size and shape permits individual recognition of lizards and snakes in the field (e.g., Borczyk 2000). It is thus reasonable to conclude that the specimen is indeed the one J. L.C. Gravenhorst used to describe *L. lemniscatus*.

The specimen is in a good condition. The only damage is a small hole near the left mouth corner for the lost label string (see introduction) and the separate tail stored together with the specimen. Also, the right anterior quarter of the belly bears a small

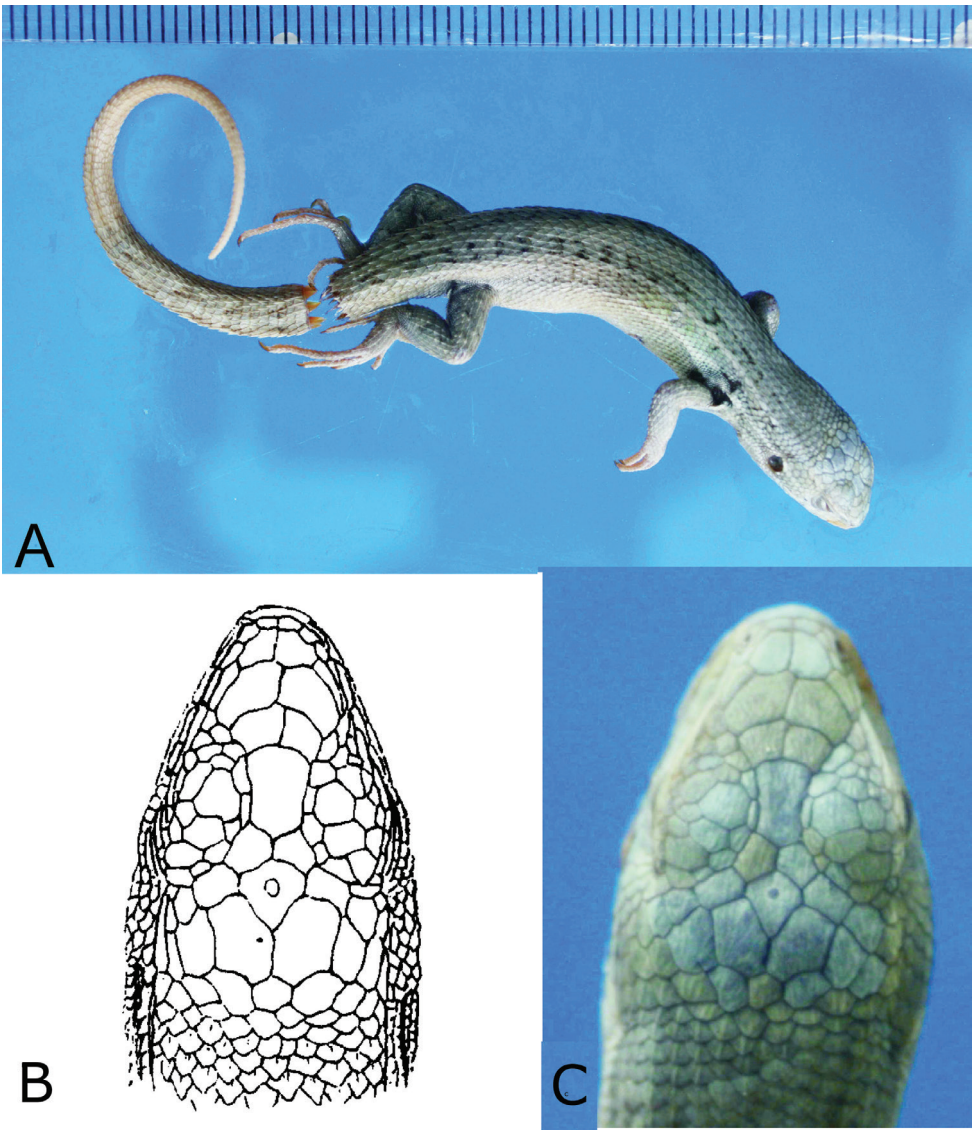


Figure 1. Holotype of *Liolaemus lemniscatus* Gravenhorst, 1838. **A** dorsolateral view **B** original drawing of the holotype (reprinted from Gravenhorst 1838) **C** dorsal view on head.

wound that must have been incurred while it the individual was still alive as it seems to show the beginning of healing process.

Holotype description. Adult female UWZM Re 0027, collected in Valparaíso, Chile. The measurements (in mm) and scale counts are as follows: SVL 42.18; tail broken at 5.65 from the vent, the remaining part is 46.94 long with terminal 31.2 regenerated; head length (from anterior border of auditory meatus to tip of snout) 8.86; head width (at the anterior border of the auditory meatus) 6,98; head height 5.47; axilla-groin dis-

tance 20.46; tail width at the base 4.69; interorbital distance (between postorbital semicircles) 5.38; eye-auditory meatus distance 3.61; internarial distance 1.97; arm length 4.71; thigh length 6.01; shank length 7.77; foot length (from the ankle to the tip of the 4th toe) 11.9. Subocular 3.3; preocular 0.68; rostral 0.62 length and 2.22 wide; mental 0.93 long and 2.3 wide; auditory meatus 1.93 high and 1.4 wide. Dorsal head scales slightly rough. Interparietal scale hexagonal, elongated posteriorly, surrounded by six scales and smaller than the parietals. Frontal scale pentagonal, elongated, with slightly concave lateral margins, anteriorly wider. Three enlarged supraoculars, the first being the largest. Four scales between the frontal and supercilliaries. Seven supercilliaries, strongly elongated. Canthal separated from nasal by one scale. The loreal region slightly concave. Nasal surrounded by seven scales, contacts the rostral. Three loreals, one in contact with subocular. Five supralabials, the 4th and 5th strongly elongated with posterior border of the 5th scale oblique. Four infralabials. Four internasals. Orbit with 12 upper and 13 lower ciliares. Nineteen gulars between auditory openings; four scales in contact with 2nd infralabial, the neck region scales smaller than dorsal scales; temporal and lateral neck scales keeled; lateral neck scales lanceolate, imbricate and carinate; 16 scales between posterior border of the auditory meatus and arm base; 40 dorsal scales between occiput and anterior surface of thighs; 80 scales between mental and cloaca. 42 scales around midbody. Dorsal scales are lanceolated, imbricated, keeled with mucron and lack interstitial granules. Dorsal scales are bigger than ventral scales. Number of infradigital lamellae on the 3rd finger 14/15 (right/left); number of infradigital lamellae on the 4th toe 20/21 (right/left).

The color pattern as seen in the preservative. Back and flanks grey-green. Vertebral field three scales wide at mid-length, vertebral line absent. Paravertebral field two scales wide, only slightly darker than vertebral field. Paravertebral markings almost black, tend to form a stripe along their dorsal margins anteriorly and to break up in two rows of spots toward the tail. Dorsolateral and ventrolateral stripes one-scale wide, creamy white. Lateral field darker than dorsolateral field. Belly creamy white. Barely visible stripes between jaws and throat.

Acknowledgements

I would like to thank Jan Kotusz and Tadeusz Stawarczyk (UWZM) for their permission and assistance during work with the collection. I thank Prof Andrzej Elżanowski for linguistic improvement to the text. An anonymous reviewer made valuable comments on the manuscript.

References

Abdala CS (2007) Phylogeny of the *boulengeri* group (Iguania: Liolaemidae, *Liolaemus*) based on morphological and molecular characters. Zootaxa 1538: 1–84.

Borczyk B (2000) A review of marking and identification techniques for amphibians and reptiles. Przegląd Zoologiczny 45: 165–167. [in Polish, English summary].

Dubois A, Ohler A (2000) Systematics of *Feyervaria limnocharis* (Gravenhorst, 1829) (Amphibia, Anura, Ranidae) and related species. 1. Nomenclatural status and type-specimens of the *Rana limnocharis* Gravenhorst, 1829. Alytes 18: 15–50.

Etheridge R (2000) A review of lizards of the genus *Liolaemus wiegmannii* group (Squamata, Iguania, Tropiduridae), and a history of morphological change in the sand-dwelling species. Herpetological Mononographs 14: 293–352. doi: 10.2307/1467049

Gravenhorst JLC (1838) Beiträge zur genauern Kenntniss einiger Eidechsengattungen. Nova Acta Academiae Caesareae Leopoldino-Carolinae 18: 712–784.

Lobo F, Espinoza RE (1999) Two new cryptic species of *Liolaemus* (Iguania: Tropiduridae) from Northwestern Argentina: Resolution of the purported reproductive bimodality of *Liolaemus alticolor*. Copeia 1999: 122–140. doi: 10.2307/1447393

Lobo F (2001) A phylogenetic analysis of lizards of the *Liolaemus chiliensis* group (Iguania: Tropiduridae). Herpetological Journal 11: 137–150

Lobo F, Espinoza RE (2004) Two new *Liolaemus* from Puna Region of Argentina and Chile: Further resolution of purported reproductive bimodality in *Liolaemus alticolor* (Iguania: Liolaemidae). Copeia 2004: 850–867. doi: 10.1643/CH-03-241R1

Lobo F, Espinoza RE, Quinteros AS (2010) A critical review and systematic discussion of recent classification proposals for liolaemid lizards. Zootaxa 2549:1–30.

Wiktor J (1997) Muzeum Przyrodnicze Uniwersytetu Wrocławskiego. Historia i ludzie, 1814 – 1994. Acta Universitatis Wratislaviensis, No. 1920. 130 pp. [in Polish, English summary]