

Mountainous millipedes in Vietnam. II. A conspicuous *Tylopus* species from Northern Vietnam (Diplopoda, Polydesmida, Paradoxosomatidae)

Anh D. Nguyen^{1,2}, Katsuyuki Eguchi³

1 Institute of Ecology and Biological Resources, Vietnam Academy of Science and Technology, 18, Hoangquocviet Rd., Caugiay District, Hanoi, Vietnam **2** Graduate University of Science and Technology, Vietnam Academy of Science and Technology, 18, Hoangquocviet Rd., Caugiay District, Hanoi, Vietnam **3** Department of Biology, Faculty of Science, Tokyo Metropolitan University, Hachioji-shi, Tokyo Prefecture, Japan

Corresponding author: Anh D. Nguyen (ducanh410@yahoo.com)

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Abstract

A conspicuous *Tylopus* species is described from Northern Vietnam, namely *T. helicorhomorphoides* sp. nov. The new species is clearly diagnosed by the gonopodal solenophore completely sheathing the solenomere, both being coiled three times, and the absence of spine z and process h of the gonopod. Fragments of the COI and 16S rRNA genes were extracted, and the phylogenetic analysis also supports the new species.

Keywords

Biodiversity, COI, 16S rRNA, mountain fauna, taxonomy

Introduction

The genus *Tylopus* was established by Jeekel (1968) with type species *Agnesia sigma* Attems, 1953. Jeekel (1965, 1968) diagnosed this genus by having well-developed paraterga, first pair of legs without modifications, the presence of tibial and tarsal brushes and adenostyles (= ventral tubercles on the podonomeres), gonopod with

somewhat distally enlarged femorite, a distinctly laterally demarcated postfemoral region, postfemorite with 1–3 processes, and both lamina medialis and lamina lateralis well developed. The genus was extensively revised, and morphological terms for the genus *Tylopus* were standardized by Golovatch and Enghoff (1993) and updated by Likhitrakarn et al. (2010, 2016).

Tylopus is considered the most species-rich genus within the family Paradoxosomatidae Daday, 1889. Currently, it contains 77 species (Golovatch and Semenyuk 2021; Likhitrakarn et al. 2021; Sierwald and Spelda 2021) distributed from Southern China down to Indonesia and Malaysia, and from Myanmar to Vietnam. They are seemingly dominant in Southeast Asia, especially in Thailand, Laos, and Vietnam, although this may be due to research bias. In Vietnam, 21 species were recorded so far (Attems 1938, 1953; Golovatch 1984; Korsós and Golovatch 1989; Golovatch and Enghoff 1993; Nguyen 2012; Golovatch and Semenyuk 2018, 2021), all of which completely agree with the typical diagnosis for the genus.

As a continuation of our contributions to the millipede fauna of mountainous regions of Vietnam, this work aims to describe a conspicuous *Tylopus* species from northern Vietnam and to discuss relationships between Vietnamese *Tylopus* species.

Materials and methods

Material was collected from two localities in Northern Vietnam, Tam Dao National Park and Bac Me Natural Reserve (Fig. 1), and preserved in 90% ethanol. Specimens were observed under an Olympus SZX10 microscope. Images were taken at various focal planes using a Nikon imaging system (Nikon-Br) coupled with a SMZ800N Nikon stereomicroscope. Images were stacked using Helicon Focus version 7.0 and assembled in Adobe Photoshop CS6.

Total DNA was extracted from several midbody legs using the QIAGEN DNeasy Blood & Tissue Kit. Fragments of the mitochondrial cytochrome c oxidase subunit I (COI) and 16S rRNA genes were amplified using two pairs of primers: COI-1F (5'-ACTCTACTAATCATAAGGAT-3') and COI-1R (5'-TAAACCTCCGGGTGACCAA-3'), 16S-1F (5'-CCGGTTTGAAGTCAGATCA-3') and 16S-1R (5'-TGACTGTTTAGCAAAGACAT-3'). The amplification protocol followed a previously published method by Nguyen et al. (2017). Each successfully amplified and sequenced fragment was assembled using ChromasPro v.2.1.8 and confirmed by BLAST 2.6.0+ searches (Zhang et al. 2000).

All confirmed sequences were aligned using Cluster X ver.2.0 (Larkin et al. 2007), and ambiguous nucleotide sites and gaps were removed using MEGA X (Kumar et al. 2018). The COI sequences were translated into amino acids for confirmation using transversion code in MEGA X. The concatenated dataset (COI+16S) was created from the COI dataset and 16S rRNA dataset using the software GBLOCK 0.91b.

The nucleotide frequencies were statistically calculated using MEGA X. The final dataset contains 956 bp, including 586 bp of the COI gene and 370 bp of the 16S rRNA gene. It has nucleotide frequencies of 26.1, 38.3, 17.5, and 18.0 for A, T, G,

and C, respectively. The GC content accounts for 35.5% of total nucleotides. The dataset has 324 parsimony-informative and 403 variable sites.

The phylogenetic tree was reconstructed using the Maximum Likelihood (ML) analysis with the best model resulting the ModelFinder (Kalyaanamoorthy et al. 2017), performed in IQTREE ver.1.6.2 for Windows (Minh et al. 2020). Models with the lowest BIC scores (Bayesian Information Criterion) are considered to describe the best substitution pattern. As a result, the model TIM3+F+G4 was selected (BIC score of 12506.102; $-\ln L = 6033.252$).

All specimens, including holotype and paratypes and DNA vouchers, have been deposited in the Department of Soil Ecology, Institute of Ecology and Biological Resources (**IEBR**), Vietnam Academy of Science and Technology, Hanoi, Vietnam. A total of 24 new sequences were deposited in GenBank, with accession numbers as presented in Table 1.



Figure 1. Distribution of *Tylopus helicorthomorphoides* sp. nov. Tam Dao (Red triangular); Bac Me (Red circle)

Table 1. Analyzed species, locality data, deposition voucher numbers, and GenBank accession numbers. Accession numbers in bold font are new sequences.

No	Species	Locality	Voucher	16S rRNA	COI
1	<i>Tylopus crassipes</i> Golovatch, 1984	Sapa, Lao Cai	IEBR- Myr 92	OM978927	KX096920
2	<i>Tylopus hilaroides</i> Golovatch, 1984	Cuc Phuong, Ninh Binh	IEBR- Myr 543	OM978921	MW384914
3	<i>Tylopus hilaroides</i> Golovatch, 1984	Cuc Phuong, Ninh Binh	IEBR- Myr 198	KX755588	MW384918
4	<i>Tylopus hilaroides</i> Golovatch, 1984	Cuc Phuong, Ninh Binh	SVE- Myr 149	OM978930	MW384905
5	<i>Tylopus hilaroides</i> Golovatch, 1984	Cuc Phuong, Ninh Binh	SVE- Myr 173	OM978931	MW384904
6	<i>Tylopus hilaroides</i> Golovatch, 1984	Tam Dao, Vinh Phuc	SVE- Myr 55	OM978932	MW384903
7	<i>Tylopus nodulipes</i> (Attems, 1953)	Huong Son, Ha Tinh	IEBR- Myr 105	OM978913	MW384919
8	<i>Tylopus nodulipes</i> (Attems, 1953)	Minh Hoa, Quang Binh	IEBR- Myr 557	OM978924	MW384912
9	<i>Tylopus roseiparaterga</i> Nguyen, 2012	Ba Vi, Ha Noi	SVE- Myr 70	OM978933	MW384902
10	<i>Tylopus sapaensis</i> Nguyen, 2012	Sa Pa, Lao Cai	IEBR- Myr 93	OM978928	MW384908
11	<i>Tylopus spinisternus</i> Nguyen, 2012	Bi Doup – Nui Ba, Lam Dong	IEBR- Myr 234	OM978915	MW384916
12	<i>Tylopus</i> sp.1	Ba Vi, Ha Noi	SVE- Myr 73	OM978934	MW384901
13	<i>Tylopus</i> sp.1	Ba Vi, Ha Noi	SVE- Myr 74	OM978935	MW384900
14	<i>Tylopus</i> sp.2	Phong Nha – Ke Bang, Quang Binh	IEBR- Myr 210	OM978914	MW384917
15	<i>Tylopus</i> sp.2	Phong Nha – Ke Bang, Quang Binh	IEBR- Myr IPE6	OM978929	MW384907
16	<i>Tylopus</i> sp.3	Sa Pa, Lao Cai	IEBR- Myr 556	OM978923	MW384913
17	<i>Tylopus</i> sp.4	Son Dong, Bac Giang	IEBR- Myr 509	OM978919	MW384915
18	<i>Tylopus helicorthomorphoides</i> sp.nov.	Tam Dao, Vinh Phuc	IEBR- Myr 603	OM978925	MW384910
19	<i>Tylopus</i> sp.7	Muong Nhe, Dien Bien	IEBR- Myr 617	OM978926	MW384909
20	<i>Oxidus gigas</i> (Attems, 1953)	Sapa, Lao Cai	IEBR-Myr 113	KX755581	KX096921
21	<i>Oxidus gigas</i> (Attems, 1953)	Duc Xuan, Ha Giang	IEBR-Myr 516	OM978920	KX096928
22	<i>Oxidus riukiaria</i> (Verhoeff, 1940)	Ryukyu, Japan	IEBR-H500	OM978918	KX096926
23	<i>Oxidus riukiaria</i> (Verhoeff, 1940)	Ryukyu, Japan	IEBR-H500J	KX755583	KX096927
24	<i>Oxidus gracilis</i> (C.L. Koch, 1847)	Taiwan	IEBR- Myr 549	OM978922	KX096931
25	<i>Oxidus gracilis</i> (C.L. Koch, 1847)	Ryukyu, Japan	IEBR- Myr 466	OM978916	KX096924
26	<i>Oxidus gracilis</i> (C.L. Koch, 1847)	Ryukyu, Japan	IEBR- Myr 471	OM978917	KX096925
27	<i>Oxidus gracilis</i> (C.L. Koch, 1847)	USA	IEBR-Myr USA	KX096919	KX096931
28	<i>Sellanucheza grandis</i> (Golovatch, 1984)	Xuan Son, Phu Tho	IEBR-Myr 177	KX755584	KR818296
29	<i>Sellanucheza hoffmani</i> Nguyen, 2011	Phong Nha – Ke Bang, Quang Binh	IEBR- Myr 182	KX755585	KR81829
30	<i>Sellanucheza variata</i> (Attems, 1953)	Duc Xuan, Ha Giang	IEBR- Myr 515	KX755586	OM919709
	<i>Antheromorpha pumatensis</i> Nguyen, 2018	Pu Mat, Nghe An	IEBR- Myr IPE3	MG669559	MG669372

Taxonomy

Order Polydesmida

Family *Paradoxosomatidae* Daday, 1889

Genus *Tylopus* Attems, 1953

Tylopus helicorthomorphoides **sp. nov.**

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Figs 1–5

Material examined. Holotype. VIETNAM • 1 male; Vinh Phuc Province, Tam Dao National Park on the way to Tam Dao 2; 1,100 m a.s.l.; 25 Feb. 2017; Anh D. Nguyen leg.; natural forests; IEBR-Myr 603H.

Paratypes. VIETNAM • 2 females; same data as for holotype; IEBR-Myr 603P • 1 male; Vinh Phuc Province, Tam Dao National Park, on way to TV tower; 21.46065°N,

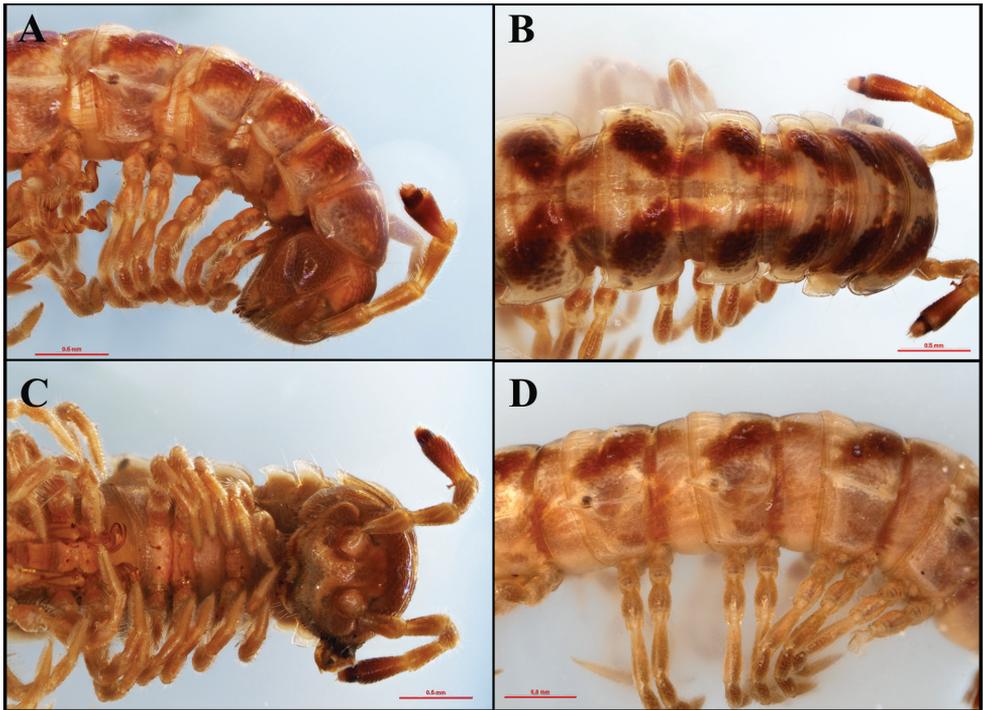


Figure 2. *Tylopus helicorthomorphoides* sp. nov. Holotype (IEBR-Myr 603H). Anterior part of body, lateral view (A) dorsal view (B) ventral view (C) midbody segments, lateral view (D).

105.64863°E; 1,081 m a.s.l.; 10 Dec. 2019; Hoang Quang Duy leg.; natural forests; IEBR-Myr 876.

Non-type. VIETNAM • 1 male; Ha Giang Province, Bac Me Natural Reserve, Minh Ngoc commune, Lung Can village; 22.71814°N, 105.17997°E; 361 m a.s.l.; 12–13 Dec. 2018; Anh D. Nguyen leg.; bushes (IEBR-Myr 809).

Diagnosis. The new species distinctly differs from its congeners in having a three-times spiraled solenophore of the gonopods and postfemoral lamella I present while spine z and process h totally absent. The new species is slightly similar to its congener *T. strongylomoides* (Korsórs & Golovatch, 1989), from the same locality (Tam Dao National Park), in having a twisted solenophore and solenomere. However, the new species obviously differs from *T. strongylosomoides* in having a more strongly coiled solenophore and solenomere (3× vs 1.5×).

Regarding the gonopod conformation, the new species is somewhat similar to species of the genus *Helicorthomorpha* in the twist of both the solenophore and solenomere. However, the postfemoral region of *Helicorthomorpha* members is more elaborate, twisted, and carries no additional processes, whereas that of the new species is spiraled or coiled rather than twisted, and has a postfemoral lamella.

Etymology. The species epithet, *helicorthomorphoides*, is used to emphasize the similarity of the gonopod solenophore between the new species and those of the genus *Helicorthomorpha*.

Description. Body length ~ 14.4 mm (male) and 14.9 mm (female). Width of midbody pro- and metazona ~ 1.2 mm (male), 1.6 mm (female) and 1.6 mm (male), 1.9 mm (female), respectively.

Body generally brownish yellow or darkish yellow except antennomere 7 and metaterga with a darker, median, V-shaped region (or median triangular-shaped area on metaterga) (Figs 2–4).

Head (Fig. 2B, C) slightly smaller than collum, labroclypeous region densely setose. Epicranial suture clearly distinct, dividing frons into two equal parts, with 2+2 setae along suture. Frons convex. Antenna (Fig. 2A–C) short, reaching to approximately tergum 2 laterally. Antennomere 1=7<2=3=4=5<6; antennomere 6 largest, obviously clavate.

Collum (Fig. 2B) oval-shaped, surface smooth, without granulates or tubercles, but with 2+2 setae near anterior margin and 2+2 setae in intermediate area. Paratergum well developed, subtriangular, with broad corner.

Body segments 3<4<2=5–17, thereafter gradually tapering towards telson. Prozonae and metazonae clearly divided by deep, striated waists. Prozonae smooth, shining, yellowish brown, with a median, broad, longitudinal yellow stria (Figs 2B, 3A). Metazonae (Figs 2B, 3A) smooth, shining, with 2+2 setae near anterior margin, two lateral spotted areas, and 2+2 or 3+3 oblong knobs near posterior margin. These knobs more obvious on posterior segments.

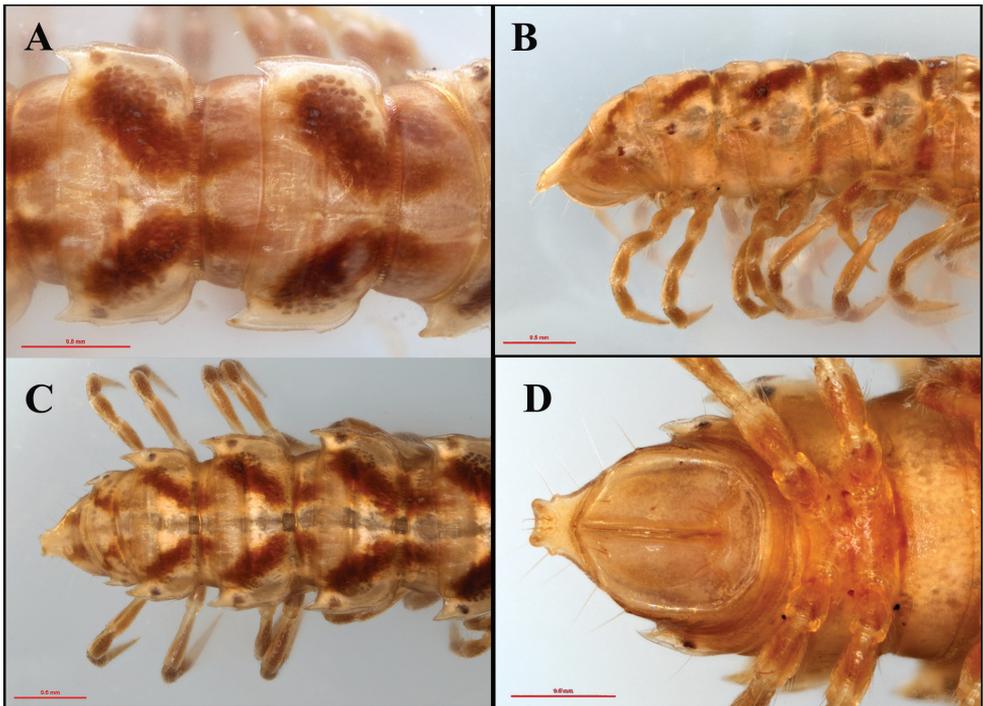


Figure 3. *Tylopus helicorthomorphaoides* sp. nov. Holotype (IEBR-Myr 603H). Midbody segments, dorsal view (A) posterior part of body, lateral view (B) dorsal view (C) ventral view (D).

Metatergal sulcus starting on segment 4 but clearly present from segment 5, nearly reaching base of paraterga (Fig. 2B). Axial line distinct.

Paraterga (Figs 2A, B, D, 3A–C) well developed, wing-shaped, with at least one setiferous incision near anterior, broadly round corner; caudal corner acute, more pointed from mid-body segment onwards, but never reaching following segment. Caudal corner of paraterga 17–19 very pointed, spine-like (Fig. 3C, D).

Ozopores located inside round hollows at the caudolateral sides of paraterga 5, 7, 9, 10, 12, 13, and 15–19 (Figs 2A, D, 3B).

Pleurites (Figs 2A, D, 3B) smooth, not granulated. Pleurosternal carinae (Fig. 2A) present until segment 8, with a small tubercle-like projection, then gradually reduced or missing on subsequent segments.

Telson (Figs 3C, D, 4A). Epiproct strongly concave, forming two long lateral tubercles. Hypoproct sub-trapeziform, with two separated distolateral setiferous knobs.

Sterna. Cross impression distinct. Sternum 5 with a large rectangular lamina between coxae 4 (Fig. 4B).

Leg short, ~ 1.5× as long as midbody height. Prefemora swollen dorsally. Tarsal brushes present till legs 21, then gradually thinner and absent on subsequent legs. Adenostyles present on postfemora and tibiae, each with a small knob/tubercle (Fig. 4C).

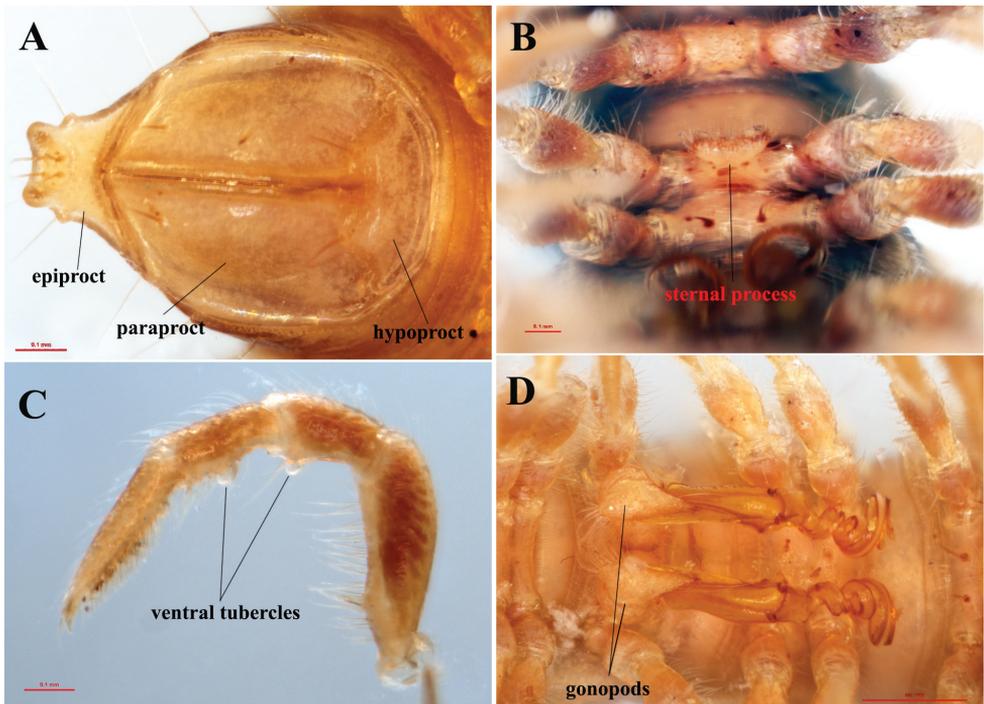


Figure 4. *Tylopus helicorthomorphoides* sp. nov. Holotype (IEBR-Myr 603H). Epiproct, paraproct and hypoproct (A) sternal process between coxae 4, ventral view (B) leg 6 (C) gonopods, ventral view (D).

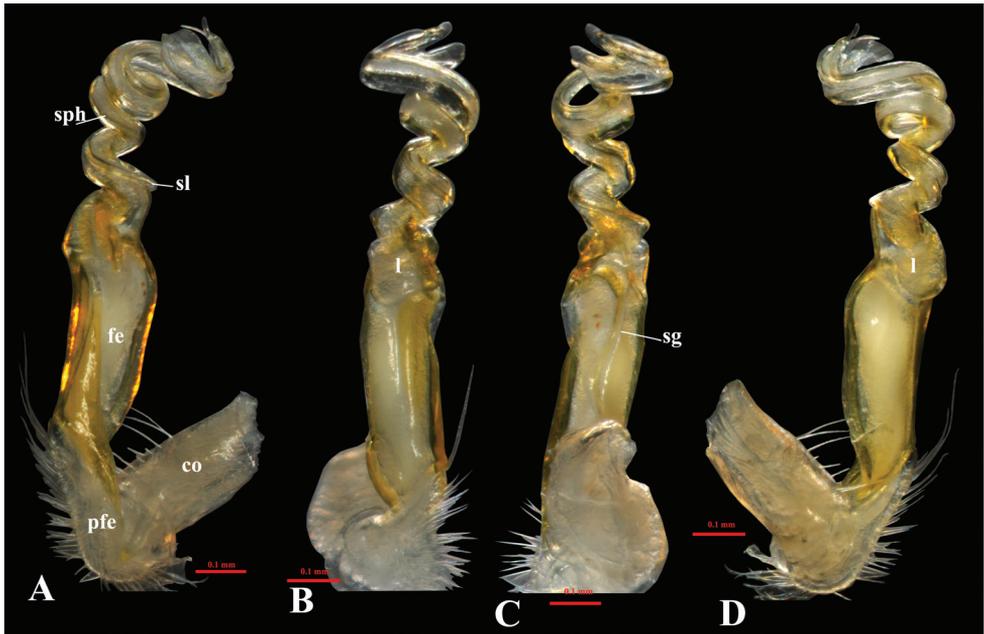


Figure 5. *Tylopus helicorthomorphoides* sp. nov. Holotype (IEBR-Myr 603H). Right gonopod, mesal view (A) ventral view (B) dorsal view (C) lateral view (D). Scale bar: 0.1 mm. co = coxite, pfe = prefemorite, fe = femorite, sl = solenomere, sph = solenophore, sg = seminal groove, l = lamella I.

Gonopod suberect, simple (Figs 4D, 5, 6). Coxite short, with sparsely setose distoventral part. Telopodite long and erect. Prefemorite densely setose, separated from femorite by an oblique sulcus laterally. Femorite somewhat enlarged distally and slightly twisted, without modifications or additional processes. Postfemoral region consisting of a solenomere and a solenophore, both completely coiled 3×; lamina I present, spine z and process h missing. Seminal groove running entirely on mesal side of femorite, then entering flagelliform solenomere completely sheathed by solenophore. Tip of gonopod strongly bifid.

Genetic distance. The COI Kimura 2-Parameter (K2P) distance between the new species and other *Tylopus* species was reported in Anh et al. (2021). The distance was from 12.2% to 15.6%. This distance was obviously narrower than the distances between *Sphaerobelum* species (from 20.2% to 24.4%) (Zhao et al. 2020), but more likely similar to the distances between *Glomeris* species (from 11.5% to 17.1%) (Wesener 2015).

Phylogenetic analysis. The twenty included samples of *Tylopus* members were divided into two different lineages (Fig. 7). The first lineage, *Tylopus* I, consisting of three species, *T. hilaroides*, *T. sapaensis*, and *Tylopus* sp.1, was a sister clade of the genus *Oxidus* with 95% bootstrap support.

The second lineage, *Tylopus* II, was clearly separated from the clade *Oxidus* + *Tylopus* I with high bootstrap support (97%). The new species, *T. helicorthomorphoides* sp. nov.,

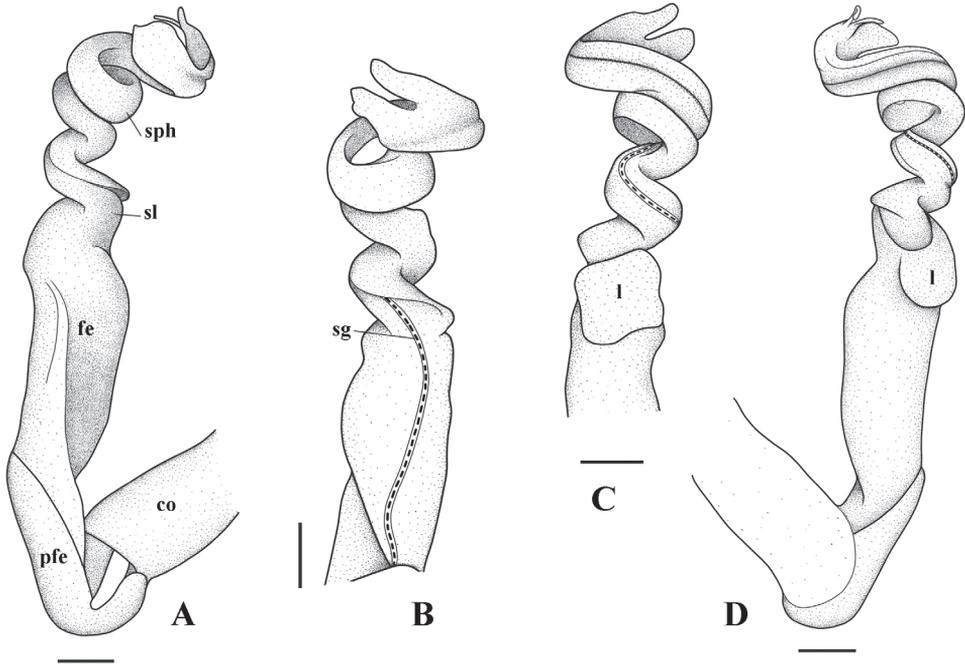


Figure 6. *Tylopus helicorthomorphaoides* sp. nov. Holotype (IEBR-Myr 603H). Right gonopod, mesal view (A) dorsal view (B) ventral view (C) lateral view (D). Scale bar: 0.1 mm. co = coxite, pfe = prefemorite, fe = femorite, sl = solenomere, sph = solenophore, sg = seminal groove, l = lamella I.

was positioned in this lineage and is closely related to *Tylopus* sp. 4 (IEBR-Myr 509), but with low bootstrap support (49%). In addition, the relationship between *Tylopus* species in the second lineage was very poorly supported (bootstrap less than 70%), except the clade *T. crassipes* + *T. roseiparaterga*, with a bootstrap value of 90%.

Discussion

Both Jeekel (1965) and Golovatch and Enghoff (1993) agreed that the gonopod solenophores sheath the flagelliform solenomere for its greater part, curving caudad first, then laterad and finally cephalad in *Tylopus* members. In the new species, the solenophore and solenomere morphology agree with this statement but are completely coiled three times, the gonopod spine z and process h are absent, whereas only postfemoral lamina I is present. Our phylogenetic analysis also supports the taxonomic position of the new species within the genus *Tylopus*.

The genus *Tylopus* is, phylogenetically, divided into two clades as reported above. This also agrees with the results presented by Anh et al. (2021) using only a fragment of the COI gene. It is, therefore, suggested that the genus *Tylopus* needs to be revised accordingly, using both morphological and molecular data. This case may be similar

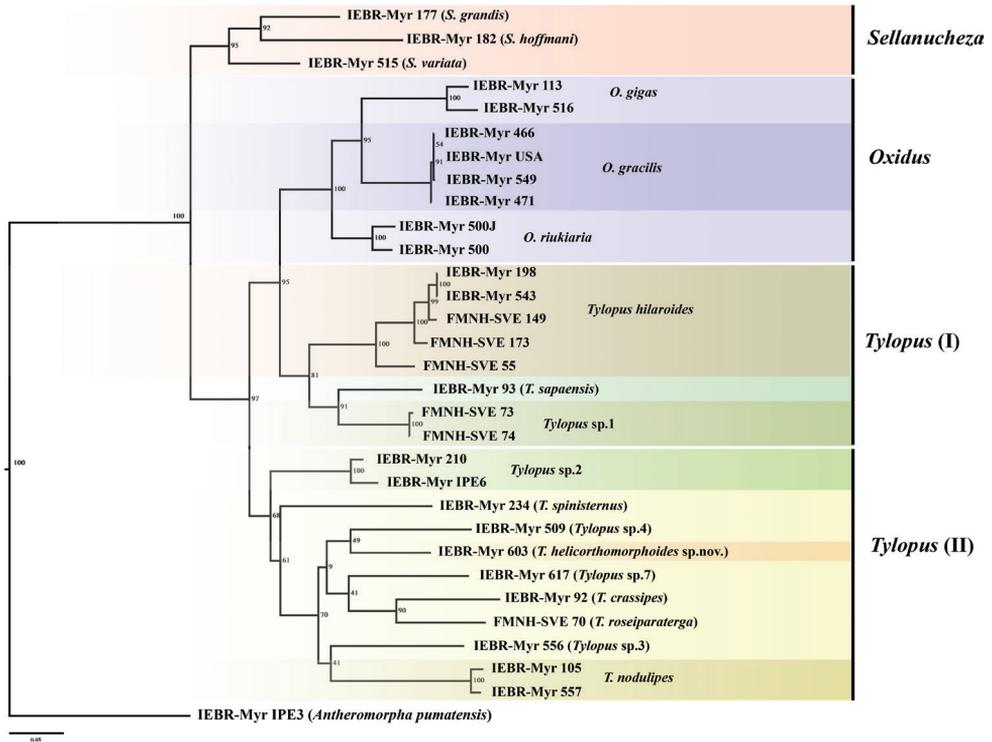


Figure 7. Phylogenetic diagram inferred from the 956 bp COI-16S rRNA dataset using Maximum Likelihood analysis. Numbers shown at nodes are bootstrap values.

to that of the genus *Desmoxystes* Chamberlin, 1923, which was recently intensively revised by Srisonchai et al. (2018a, 2018b, 2018c, 2018d). Finally, the genus *Hylomus* Cook & Loomis, 1924 has been re-validated, with three new genera proposed for other so-called *Desmoxystes* members (Srisonchai et al. 2018a, 2018b, 2018c, 2018d). Furthermore, the relationship between *Tylopus* species was very poorly supported (less than 70% bootstrap value), especially within the second lineage. More samples and species are required for a better analysis.

The genus *Tylopus* has been found in both lower and higher lands in northern Vietnam, but it has only been recorded in higher lands in southern Vietnam, and has never been found in the Mekong delta (Nguyen 2012; Golovatch and Semenyuk 2018, 2021). The distributional pattern of this genus in Vietnam is similar to that in Thailand, where *Tylopus* species are mostly found in mountainous regions with altitudes of more than 500 m in northern and central Thailand (Likhitrakarn et al. 2010). The highest recorded altitude is 2,300m in Ngoc Linh Mt. (Vietnam) for *Tylopus hilaris* (Attems, 1937) and *T. phanluongi* Nguyen, 2012. Furthermore, as mentioned by Nguyen et al. (2019, 2021), the mountainous region of Vietnam harbors a rich biodiversity in Vietnam, but it is far from completely known because access to the region is difficult and intensive surveys are still lacking.

Conclusion

With the new species described herein, the number of *Tylopus* species known for Vietnam increases to 22. However, this number is still far from representing the true diversity of the genus in Vietnam. More intensive surveys will reveal more new discoveries, especially in the diverse high mountainous regions of Vietnam, which remain underexplored.

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Supplementary material I

The COI-16S rRNA dataset

Authors: Anh D. Nguyen, Katsuyuki Eguchi

Data type: DNA data

Explanation note: The COI-16S rRNA dataset contains 956 bp, including 586 bp of the COI gene and 370 bp of the 16S rRNA gene.

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Link: <https://doi.org/10.3897/zookeys.1091.80094.suppl1>

Additional fauna of *Coelostoma* Brullé, 1835 from China, with re-establishment of *Coelostoma sulcatum* Pu, 1963 as a valid species (Coleoptera, Hydrophilidae, Sphaeridiinae)

Zuqi Mai¹, Jian Hu¹, Fenglong Jia^{1,2}

1 School of Agriculture, Sun Yat-sen University, Guangzhou, 511436, Guangdong, China **2** Institute of Entomology, Life Sciences School, Sun Yat-sen University, Guangzhou, 510275, Guangdong, China

Corresponding author: Fenglong Jia (fenglongjia@alilyun.com)

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Abstract

Six new species of *Coelostoma* Brullé, 1835 are described from China: *Coelostoma bannanicum* Mai & Jia, **sp. nov.**, *C. dactylopunctum* Mai & Jia, **sp. nov.**, *C. fortunum* Mai & Jia, **sp. nov.**, and *C. pseudomartensi* Mai & Jia, **sp. nov.** from Yunnan; *C. mixtum* Mai & Jia, **sp. nov.** from Fujian; and *C. nankunshanense* Mai & Jia, **sp. nov.** from Guangdong. *Coelostoma surkhetensis* Hebauer, 2002 is a new record from China (Xizang). *Coelostoma huangi* Jia, Aston & Fikáček, 2014 is reported from Yunnan, *C. hajeki* Jia, Aston & Fikáček, 2014 from Hunan, *C. jaechi* Jia, Lin, Chan, Skale & Fikáček, 2017 from Guangdong, *C. turnai* Hebauer, 2006 from Fujian, Guizhou and Chongqing, and *C. wui* Orchymont, 1940 from Shanxi and Zhejiang, all for the first time. *Coelostoma transcaspicum* Reitter, 1906 is excluded from Chinese fauna. *Coelostoma sulcatum* Pu, 1963 is confirmed as a valid species and its variations of aedeagus are illustrated. The specimens treated as *C. wui* Orchymont, 1940 by previous authors possibly contain two species. The diversity and habitats of Chinese *Coelostoma* are discussed. A modified key to the species of Chinese *Coelostoma* is provided.

Keywords

habitat, modified key, new records, new species, valid name, variations

Introduction

Coelostoma Brullé, 1835 is a typical Old World group, with most of the species distributed in the Oriental, Afrotropical, and Palearctic regions. Only a few species occur in the Australian region (Hansen 1999; Jia et al. 2014; Fikáček et al. 2019). With more than 110 described species, *Coelostoma* represents one of the largest genera of Hydrophilidae. They occur in wet places with grass or stones, such as the edges of ponds and streams with grass, muddy lands beside paddy fields, under grass roots on wet stones, and the stone walls with running waters etc. Occasionally, some species can be found in small puddles. Adults usually are active at night and exhibit phototaxis (Hansen 1999; Jia 2005; Short and Hebauer 2006; Short and Fikáček 2011; Jia et al. 2014, 2017, 2019; Liu et al. 2020; Sheth et al. 2020). In the Nearctic and Neotropical regions, *Coelostoma* is replaced by the genera *Phaenonotum* Sharp, 1882, *Phaenostoma* Orchymont, 1937 and *Lachnodacnum* Orchymont, 1937 (Gustafson and Short 2010; Deler-Hernández et al. 2013; Clarkson et al. 2014; Jia et al. 2014).

Coelostoma can be separated from other genera of Coelostomatini by following characters combined: broadly oval and convex body shape; loosely segmented antennal club; prosternum convex medially; mesoventrite with an elevated arrowhead-shaped process in the middle; metaventral process projecting anteriorly between mesocoxae, abutting mesoventral elevation; the first metatarsomere distinctly longer than the second one; elytra with dense punctures and sutural stria, without serial punctures in most species; the first abdominal ventrite with or without carina medially (e.g., Jia et al. 2014; Sheth et al. 2020).

A total of 24 species has been recorded from China since 1874 (Sharp 1874; Orchymont 1925, 1936, 1940; Wu 1937; Pu 1963; Hebauer 2006; Jia et al. 2014, 2016, 2017, 2019; Liu et al. 2020). Among these species, *Coelostoma transcaspicum* Reitter, 1906 reported by Orchymont (1925) from Shandong is doubtful (Balfour-Browne 1951). Sheth et al. (2020) removed *C. sulcatum* Pu, 1963 from the synonymy of *C. stultum* (Walker, 1858) and considered it as a likely synonym of *C. bhutanicum* Jayaswal. Hence the status of *C. sulcatum* Pu, 1963 is now unclear.

The aim of this study is to describe the new species, update the species of the Chinese fauna, and verify the status of *C. sulcatum* Pu, 1963 as well as promoting the knowledge of Chinese *Coelostoma*. Until now, a total of 30 species has been recorded in China including the six new species in this paper.

Material and methods

Representative specimens were dissected. After 8 min in 10% KOH at 100 °C, dissected male genitalia were transferred to a drop of distilled water, remaining membranes were removed under a compound microscope, and the cleaned genitalia were subsequently mounted in a drop of soluble resin on a piece of paper card attached below the respective specimen after photography. Habitus photographs were taken using a Nikon DS-Ri2

mounted on a Nikon SMZ25; layers were captured and stacked in the NIS-Elements software. Photographs of genitalia were taken using a Zeiss AxioCam HRc mounted on a Zeiss AX10 microscope with the Axio Vision SE64 software. These images were then stacked in Helicon focus (v7.0.2). Habitat images were taken using Canon or Nikon digital camera. SEM photographs were taken with a Phenom Pro scanning electronic microscope. All images were digitally enhanced using Adobe Photoshop CS6. Label data of the type specimens are cited verbatim and enclosed in double quotes; a slash divides separate rows on the same label, a double slash divides separate labels. Morphological terminology used in the description largely follows Hansen (1991) and Jia et al. (2014). Examined specimens are deposited in the following collections:

HBUM Hebei University Museum, Baoding, Hebei Province, China;
IZCAS Chinese Academy of Sciences, Institute of Zoology, Beijing, China;
SYSU Sun Yat-sen University, Guangzhou, China.

The following additional specimen was examined for comparative purposes:

Dactylosternum latum (Sharp, 1873): 1 male (SYSU), China, Yunnan, Baoshan Prefecture, Gaoligong Natural Park, 24.91°N, 98.81°E, 1751 m, 22.v.2016, Yudan Tang & Ruijuan Zhang leg.

Results

Descriptions of new species

***Coelostoma (Lachnocoelostoma) bannanicum* Mai & Jia, sp. nov.**

<http://zoobank.org/121BDE4F-418D-4B74-A774-8A0796B528E9>

Figure 1A–E

Type material examined. *Holotype*: male (SYSU), China, Yunnan, Xishuangbanna Dai Autonomous Prefecture, Mengla County, Menglun Reservoir, 21°55'57"N, 101°11'25"E, 710 m, 5.vii.2016, Jiang, Liu, Huang & Liu leg. *Paratypes*: 4 spec. (SYSU), same data as the holotype.

Diagnosis. Length 5.4–5.7 mm. Head, pronotum and elytra with similar punctation. Prosternal carina with a prominent tooth anteromedially. Elytra slightly parallel-sided in the middle, without serial punctures laterally. Mesofemora densely pubescent, except on extreme apex. First abdominal ventrite with distinct median carina on basal two-thirds. Fifth ventrite slightly emarginate and with a row of stout setae apically. **Aedeagus** (Fig. 1D, E): 1.1 mm long. Median lobe slightly emarginated apically, slightly widened in the middle; gonopore situated subapically. Parameres longer than median lobe, strongly expanded and truncate at apex, outer apical angle rounded and inner apical angle nearly rectangular; apex of parameres wider than apex of median lobe.

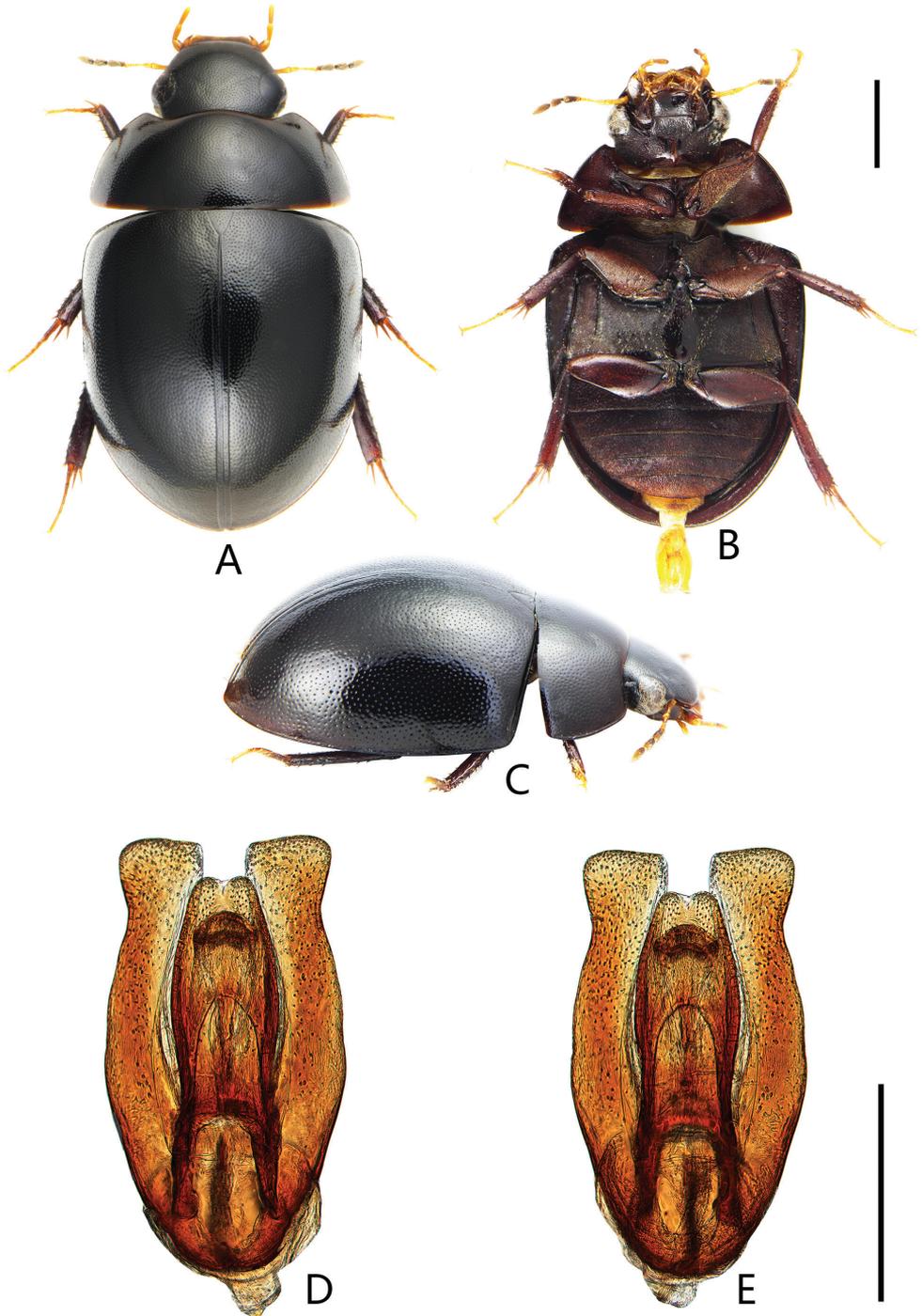


Figure 1. *Coelostoma (Lachnocoelostoma) bannanicum* Mai & Jia, sp. nov. **A** dorsal view **B** ventral view **C** lateral view **D, E** aedeagus (**D** dorsal view **E** ventral view). Scale bars :1.0 mm (**A–C**); 0.5 mm (**D, E**).

Description. Form and colour (Fig. 1A–C). Total length 5.4–5.7 mm (holotype: 5.6 mm); maximum width 3.1–3.3 mm (holotype: 3.2 mm); body broadly oval, slightly parallel-sided in the middle, moderately convex. Dorsum black and shiny. Labrum, maxillary palpi and labial palpi reddish brown, antennae yellowish to reddish brown with dark club. Ventral surface reddish brown to black. Femora and tibiae dark reddish brown, tarsi pale reddish.

Head. Dorsal surface with dense fine punctures. Interstices between punctures smooth. Clypeus subtruncate anteriorly. Eyes of moderate size, distinctly emarginated anteriorly in lateral view, separated by ca. $3.6 \times$ the width of one eye. Mentum strongly emarginate anteriorly and depressed in anterior half, with sparse punctures except on the depressed portion. Antennae with 9 antennomeres, antennal club (antennomeres 7–9) densely pubescent. Maxillary palpomere 2 strongly swollen, palpomere 4 truncate apically, slightly longer than palpomere 3. Gula narrow and glabrous.

Thorax. Pronotum widest posteriorly, gradually narrowed anteriorly, with punctures as on head, anterolateral angles obtusely rounded, posterolateral angles blunt, anterior and lateral margins with narrow marginal bead. Prosternum with a carina medially and a prominent tooth anteromedially. Scutellum almost in shape of equilateral triangle, with punctures finer than those on pronotum. Elytra with more or less coarser punctures than those on pronotum, punctures on lateral and posterior portions somewhat coarser than those on disc; elytra without serial punctures; sutural stria reaching anterior third of elytra; lateral margin of elytra with bead but not explanate.

Legs. Pro- and mesofemora bearing dense pubescence, except on extreme apex. Metafemora not pubescent, with dense microsculptures and sparsely fine punctures. Meso- and Metatibiae slightly flattened, with strong apical spurs and series of sparse stout spines laterally. Tarsi with long dorsal setae and gold ventral setae; metatarsi with fifth tarsomere almost as long as third and fourth combined. Claws curved, with a pair of long setae beneath.

Abdomen. Abdominal ventrites densely pubescent. First ventrite with distinct median carina on basal two-thirds. Fifth ventrite with fine marginal bead and slightly emarginated apically, with a row of stout setae apically.

Male genitalia (Fig. 1D, E). Aedeagus ca. 1.1 mm long. Median lobe slightly emarginated apically, widest in the middle, ca. $3.2 \times$ as long as wide. Gonopore situated subapically, wider than long. Parameres longer than median lobe; outer face strongly sinuate at anterior third, strongly expanded and truncate at apex, outer apical angle rounded and inner apical angle nearly rectangular; apex of parameres wider than apex of median lobe.

Etymology. This species is named after the type locality, Xishuangbanna Dai Autonomous Prefecture.

Biology. On the basis of private communication to the collector, Dr. Ri-Xin Jiang (Guizhou University), the specimens were collected under stones at the edges of a mountain stream.

Remarks. This species is very similar to *C. coomani* Orchymont, 1932 and *C. jaechi* Jia, Lin, Chan, Skale & Fikáček, 2017 in the weakly emarginate apex of the

median lobe, and to *C. surkhetensis* Hebauer, 2002 in the shape of the median lobe. It can be distinguished from *C. coomani* (Jia et al. 2014: fig. 24) by the gonopore situated subapically (Fig. 1D, E) (situated at midlength in *C. coomani*) and outer margin of parameres strongly sinuate subapically (Fig. 1D, E) (not or only slightly sinuate in *C. coomani*). It differs from *C. jaechi* (Jia et al. 2017: fig. 11) by larger body size (body size < 5 mm in *C. jaechi*), median lobe widest at midlength (Fig. 1D, E) (widest in apical third in *C. jaechi*). It can be distinguished from *C. surkhetensis* (Fig. 8A–E) by parameres strongly expanded apically (Fig. 1D, E) (apex not expanded in *C. surkhetensis* (Fig. 8D, E)), median lobe widest at midlength (Fig. 1D, E) (outer face subparallel throughout in *C. surkhetensis* (Fig. 8D, E)).

Distribution. Only known from type locality. China (Yunnan).

***Coelostoma (Lachnocoelostoma) dactylopunctum* Mai & Jia, sp. nov.**

<http://zoobank.org/4D897D7D-B3BD-48F1-A916-D47B042F9D1D>

Figures 2A–E, 12A

Type material examined. Holotype: male (SYSU), China, Yunnan, Honghe Hani and Yi Autonomous Prefecture, Lvchun County, Huanglianshan Mountain, Huanglianshan Reservoir (黄连山水库), 22.8898°N, 102.2952°E, 1717.3 m, 30.iv.2021, in a forest stream at night, Jiang, Yang, Huang & Mai leg. **Paratypes:** 2 males (SYSU), same data as the holotype.

Diagnosis. Length 4.3–4.5 mm. Head and pronotum with similar punctation. Prosternum carinate medially, with a fine tooth anteromedially. Elytra not parallel-sided in the middle, each elytron with ten distinct rows of serial punctures; intervals between series with two sizes of punctures especially in posterior half of elytron, the finer punctures as on pronotum and much finer and shallower than the coarser punctures, coarser punctures almost as coarse as those of the series (Fig. 12A). Mesofemora densely pubescent, except on extreme apex. First abdominal ventrite with complete median carina. Fifth ventrite slightly emarginate and with a row of stout setae apically. **Aedeagus** (Fig. 2D, E): 0.87 mm long. Median lobe emarginate apically, outer face nearly parallel-sided from basal to middle, then gradually narrowing towards apex, gonopore situated subapically, wider than long. Parameres slightly longer than median lobe, gradually expanded from anterior fourth to apex, broadly truncate apically, inner apical angle acute, pointed; middle part of parameres ca. 0.5 × as wide as median lobe at the same level.

Description. Form and colour (Fig. 2D, E). Total length 4.3–4.5 mm (holotype: 4.5 mm); maximum width 2.8–3.0 mm (holotype: 3.0 mm); body broadly oval, not parallel-sided in the middle, moderately convex. Dorsum black to reddish brown, with lateral margin of pronotum and elytra paler. Labrum, maxillary palpi and labial palpi reddish brown, antennae yellowish to reddish brown with dark club. Ventral surface reddish brown. Femora and tibiae dark reddish brown, tarsi pale reddish.

Head. Dorsal surface with dense fine punctures. Interstices between punctures smooth. Clypeus subtruncate anteriorly. Eyes of moderate size, slightly emarginated

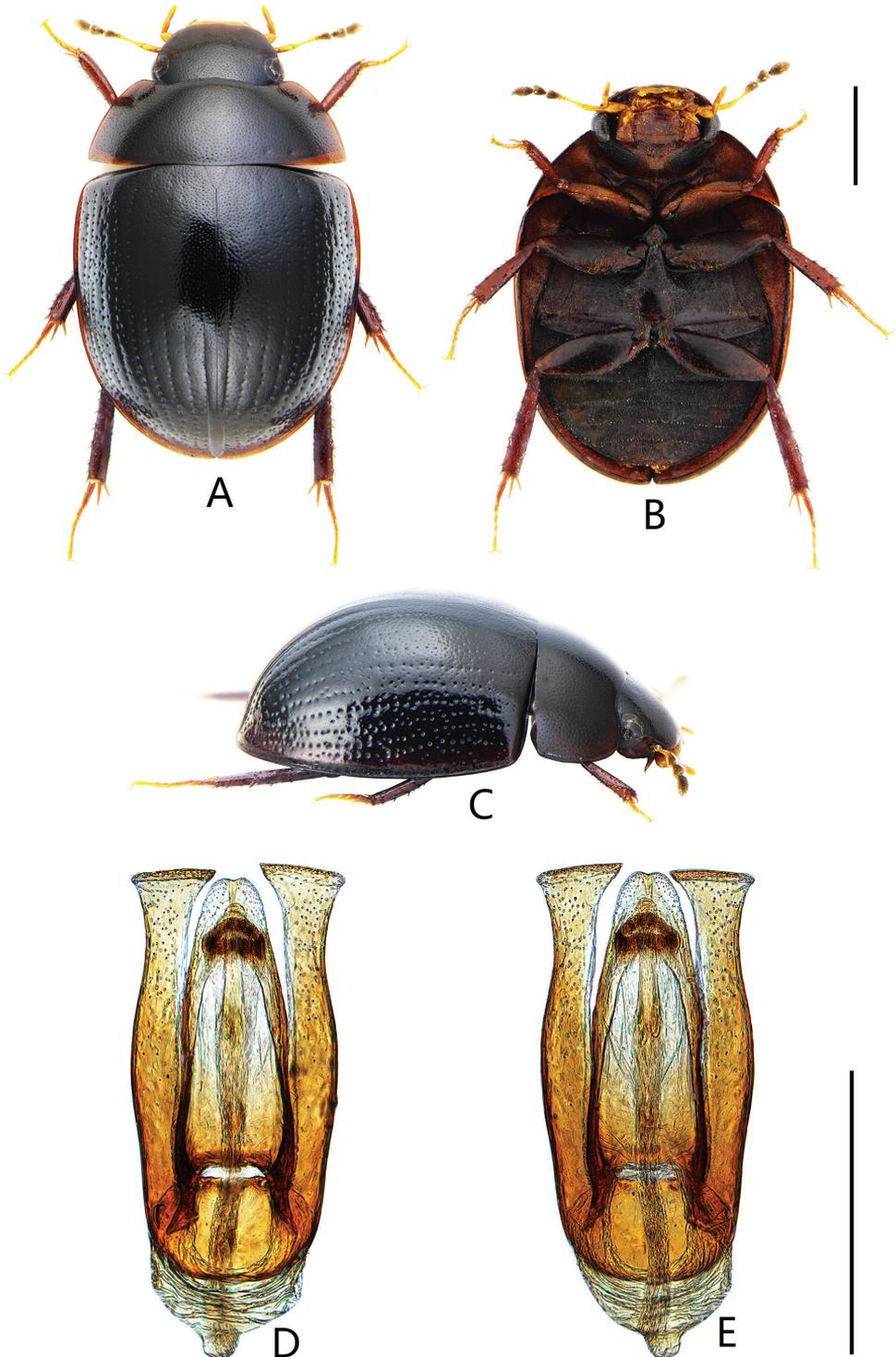


Figure 2. *Coelostoma (Lachnocoelostoma) dactylopunctum* Mai & Jia, sp. nov. **A** dorsal view **B** ventral view **C** lateral view **D, E** aedeagus (**D** dorsal view **E** ventral view). Scale bars: 1.0 mm (**A–C**); 0.5 mm (**D, E**).

anteriorly in lateral view, separated by ca. $5.3 \times$ the width of one eye. Mentum emarginate anteriorly and depressed in anterior half, with sparse punctures except on the depressed portion. Antennae with nine antennomeres, antennal club (antennomeres 7–9) densely pubescent. Maxillary palpomere 2 strongly swollen, palpomere 4 truncate apically, slightly longer than palpomere 3. Gula narrow and glabrous.

Thorax. Pronotum widest posteriorly, gradually narrowed anteriorly, with punctures as on head, anterolateral angles obtusely rounded, posterolateral angles blunt, anterior and lateral margins with narrow marginal bead. Prosternum with a carina medially and slightly projecting anteromedially. Scutellum in shape of equilateral triangle, with punctures as on pronotum. Each elytron with ten distinct rows of serial punctures; intervals between series with two sizes of punctures especially in posterior half of elytron, the finer punctures as on pronotum and much finer and shallower than the coarser punctures, coarser punctures almost as coarse as those of the series (Fig. 12A); series 1 and 2 reaching basal half of elytron, series 1 overlap with sutural stria; series 3 and 4 nearly reaching elytral base and fused together subposteriorly; series 5–10 reaching elytral base, slightly sulcate posteriorly; the outer four serial punctures coarser and stronger than the inner six serial punctures (Fig. 12A). Lateral margin of elytra with bead and slightly explanate.

Legs. Pro- and mesofemora bearing dense pubescence, except on extreme apex. Metafemora not pubescent, with dense microsculptures and sparsely fine punctures. Meso- and Metatibia slightly flattened, with strong apical spurs and series of sparse stout spines laterally. Tarsi with long dorsal setae and gold ventral setae; metatarsi with fifth tarsomere almost as long as third and fourth combined. Claws curved, with a pair of long setae beneath.

Abdomen. Abdominal ventrites densely pubescent. First ventrite with complete median carina. Fifth ventrite slightly emarginate and with fine marginal bead, with a row of stout setae apically.

Male genitalia (Fig. 2D, E). Aedeagus ca. 0.87 mm long. Median lobe emarginate apically, widest basally, ca. $3.5 \times$ as long as wide; outer face nearly parallel-sided from base to middle, then gradually narrowing towards apex; gonopore situated subapically, wider than long. Parameres slightly longer than median lobe, gradually expanded from anterior fourth to apex, broadly truncate apically, inner apical angle acute, pointed; middle part of parameres ca. $0.5 \times$ as wide as median lobe at the same level.

Etymology. The species name is a combination of *Dactylosternum*, a genus in the same tribe Coelostomatini, and the Latin *punctum*. The name refers to the fact that this species with distinct serial punctures on elytra which is similar to many species of *Dactylosternum* Wollaston, 1854.

Biology. Aquatic. Adults were found on the edges of a forest stream at night.

Remarks. This species is easily recognized as a member of *Dactylosternum* by the ten rows of serial punctures on elytra, which is different to any known *Coelostoma* species. *Coelostoma martensi* Hebauer, 2002 and *C. gentilii* Jia, Aston & Fikáček, 2014 (Fig. 13B) are also known with serial punctures on elytra, but only visible laterally. *Coelostoma rubens* Hebauer, 2002 (Jia et al. 2019: figs 4, 5), *C. jaculum* Jia, Angus &

Bian, 2019 (Jia et al. 2019: figs 2, 3) and *C. phototropicum* Jia, Angus & Bian (Jia et al. 2019: fig. 1) are similar to this new species in the shape of aedeagus. However, none of these species with serial punctures on elytra.

Distribution. Only known from type locality. China (Yunnan).

***Coelostoma (Lachnocoelostoma) fortunum* Mai & Jia, sp. nov.**

<http://zoobank.org/878E3932-8BA5-44B0-8F9F-B255EB1A0268>

Figures 3A–E, 12B

Type material examined. *Holotype*: male (SYSU), China, Yunnan, Dehong Dai and Jingpo Autonomous Prefecture, Yingjiang County, Xima Town (昔马镇), Hulukou (葫芦口), Xingyun Secondary power station (星云二级电站), 1000 m, vi.2019, light trap, Zhao-yang Tang leg. *Paratypes*: 2 females (SYSU), same data as the holotype.

Diagnosis. Length 4.4–4.6 mm. Head and pronotum with similar punctation. Prosternum carinate medially, with a prominent tooth anteromedially. Elytra not parallel-sided in the middle, each elytron with 10 distinct rows of serial punctures; intervals between series with two sizes of punctures especially in posterior half of elytron, all finer than those of the series, the finer punctures finer and shallower than the coarser punctures but not extremely so (Fig. 12B); lateral margin of elytra with bead but not explanate. Mesofemora densely pubescent, except on extreme apex. First abdominal ventrite with carina on basal two-thirds. Fifth ventrite slightly emarginate and with a row of stout setae apically. *Aedeagus* (Fig. 3D, E): 1.1 mm long. Median lobe widest basally, almost truncate apically, outer face nearly parallel-sided throughout; gonopore situated subapically, rounded, almost as wide as long. Parameres almost the same length as median lobe, outer face continually curved, apex of paramere pointed, curved inwards.

Description. *Form and colour* (Fig. 3A–C). Total length 4.4–4.6 mm (holotype: 4.5 mm); maximum width 2.6–2.7 mm (holotype: 2.7 mm); body broadly oval, not parallel-sided in the middle, moderately convex. Dorsum black to reddish brown, with lateral margin of pronotum and elytra slightly paler. Labrum, maxillary palpi and labial palpi reddish brown, antennae yellowish to reddish brown with dark club. Ventral surface reddish brown. Femora and tibiae dark reddish brown, tarsi pale reddish.

Head. Dorsal surface with dense fine punctures. Interstices between punctures smooth. Clypeus subtruncate anteriorly. Eyes of moderate size, slightly emarginated anteriorly in lateral view, separated by ca. $4.2 \times$ the width of one eye. Mentum emarginated anteriorly and depressed in anterior half, with sparse punctures and transverse microsculpture. Antennae with 9 antennomeres, antennal club (antennomeres 7–9) densely pubescent. Maxillary palpomere 2 strongly swollen, palpomere 4 truncate apically, slightly longer than palpomere 3. Gula narrow and glabrous.

Thorax. Pronotum widest posteriorly, gradually narrowed anteriorly, with punctures slightly sparser than those on head, anterolateral angles obtusely rounded, posterolateral angles blunt, anterior and lateral margins with narrow marginal bead. Prosternum with a carina medially and a prominent tooth anteromedially. Scutellum in shape of

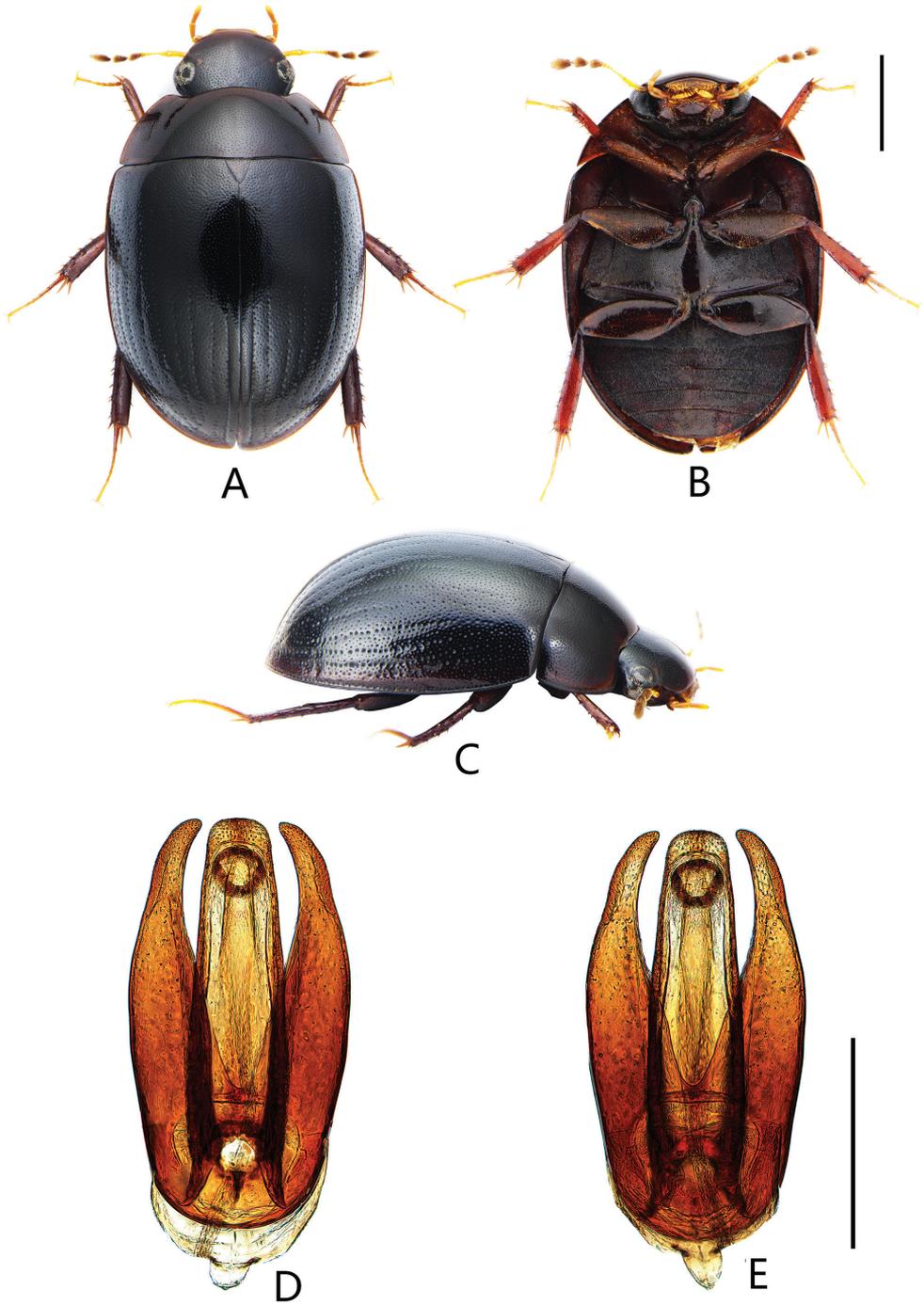


Figure 3. *Coelostoma (Lachnocoelostoma) fortuneum* Mai & Jia, sp. nov. **A** dorsal view **B** ventral view **C** lateral view **D, E** aedeagus (**D** dorsal view **E** ventral view). Scale bars: 1.0 mm (**A–C**); 0.5 mm (**D, E**).

equilateral triangle, with punctures as on pronotum. Each elytron with ten distinct rows of serial punctures; intervals between series with two sizes of punctures especially in posterior half of elytron, all finer than those of the series, the finer punctures finer and shallower than the coarser punctures but not extremely so (Fig. 12B); series 1–4 only visible in posterior half of elytron, series 1 overlaps with sutural stria, series 3 and 4 fused together subposteriorly; series 5–10 nearly reaching elytral base, slightly sulcate posteriorly. The outer four serial punctures coarser and stronger than the inner six serial punctures (Fig. 12B). Lateral margin of elytra with bead but not explanate.

Legs. Pro- and mesofemora bearing dense pubescence, except on extreme apex. Metafemora not pubescent, with dense microsculptures and sparsely fine punctures. Meso- and Metatibia slightly flattened, with strong apical spurs and series of sparse stout spines laterally. Tarsi with long dorsal setae and gold ventral setae; metatarsi with fifth tarsomere almost as long as third and fourth combined. Claws curved, with a pair of long setae beneath.

Abdomen. Abdominal ventrites densely pubescent. First ventrite with distinct median carina on basal two-thirds. Fifth ventrite slightly emarginate and with fine marginal bead, with a row of stout setae apically.

Male genitalia (Fig. 3D, E). Aedeagus ca. 1.1 mm long. Median lobe widest basally, ca. 3.9 × as long as wide, almost truncate apically, outer face nearly parallel-sided throughout; gonopore situated subapically, rounded, almost as wide as long. Parameres almost the same length as median lobe, outer face continually curved, apex of paramere pointed, curved inwards.

Etymology. This new species is derived from the Latin adjective *fortuna*, fortunate, meaning the senior author was lucky to collect the new species.

Biology. All specimens were collected in a light trap

Remarks. This species also with ten rows of serial punctures on elytra as *C. dactylopunctum* sp. nov. It can be distinguished from the latter by apex of median lobe truncate and not emarginate (Fig. 3D, E) (slightly emarginate and rounded apically in *C. dactylopunctum* sp. nov. (Fig. 2D, E)), apex of paramere pointed (Fig. 3D, E) (paramere broadly truncate apically in *C. dactylopunctum* sp. nov. (Fig. 2D, E)), first ventrite with median carina on basal two-thirds (with complete median carina in *C. dactylopunctum* sp. nov.).

Distribution. Only known from type locality. China (Yunnan).

***Coelostoma (Lachnocoelostoma) mixtum* Mai & Jia, sp. nov.**

<http://zoobank.org/DBD0A5A3-6C16-435E-B4EF-463D3632DF6F>

Figures 4A–C, 5A–C

Type material examined. **Holotype:** male (SYSU), China, Fujian, Wuyishan, Sangang Village (三港村), 16–28.v.2004, Cai-xia Yuan & Jing Li leg.

Diagnosis. Length 6.13 mm. Head, pronotum and elytra with similar punctuation. Prosternum carinate medially, with a prominent tooth anteromedially. Elytra parallel-

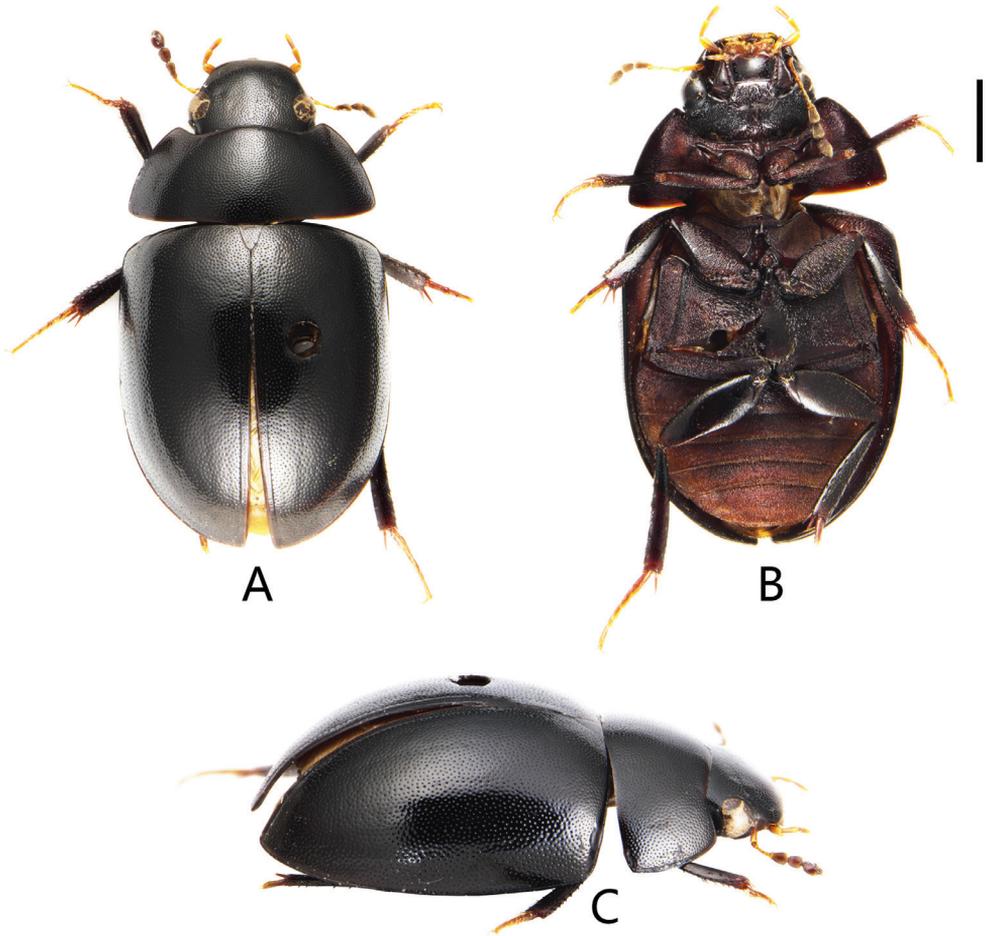


Figure 4. *Coelostoma (Lachnocoelostoma) mixtum* Mai & Jia, sp. nov. **A** dorsal view **B** ventral view **C** lateral view. Scale bar: 1.0 mm (**A–C**).

sided in the middle, without serial punctures laterally. Mesofemora densely pubescent, except on extreme apex. First abdominal ventrite with median carina on basal one-thirds. Fifth ventrite slightly emarginate and with a row of stout setae apically. **Aedeagus** (Fig. 5A–C): very large, similar to *Coelostoma vagum* Orchymont, 1940, but median lobe narrowly rounded apically, apex without a sharp prominent tooth ventrally; parameres abruptly widened apically, distinctly bent inward.

Description. Form and colour (Fig. 4A–C). Total length 6.13 mm; maximum width 3.3 mm; body broadly oval, parallel-sided in the middle, moderately convex. Dorsum black and shiny. Labrum, maxillary palpi and labial palpi reddish brown, antennae yellowish to reddish brown with dark club. Ventral surface reddish brown to black. Femora and tibiae dark reddish brown, tarsi pale reddish.

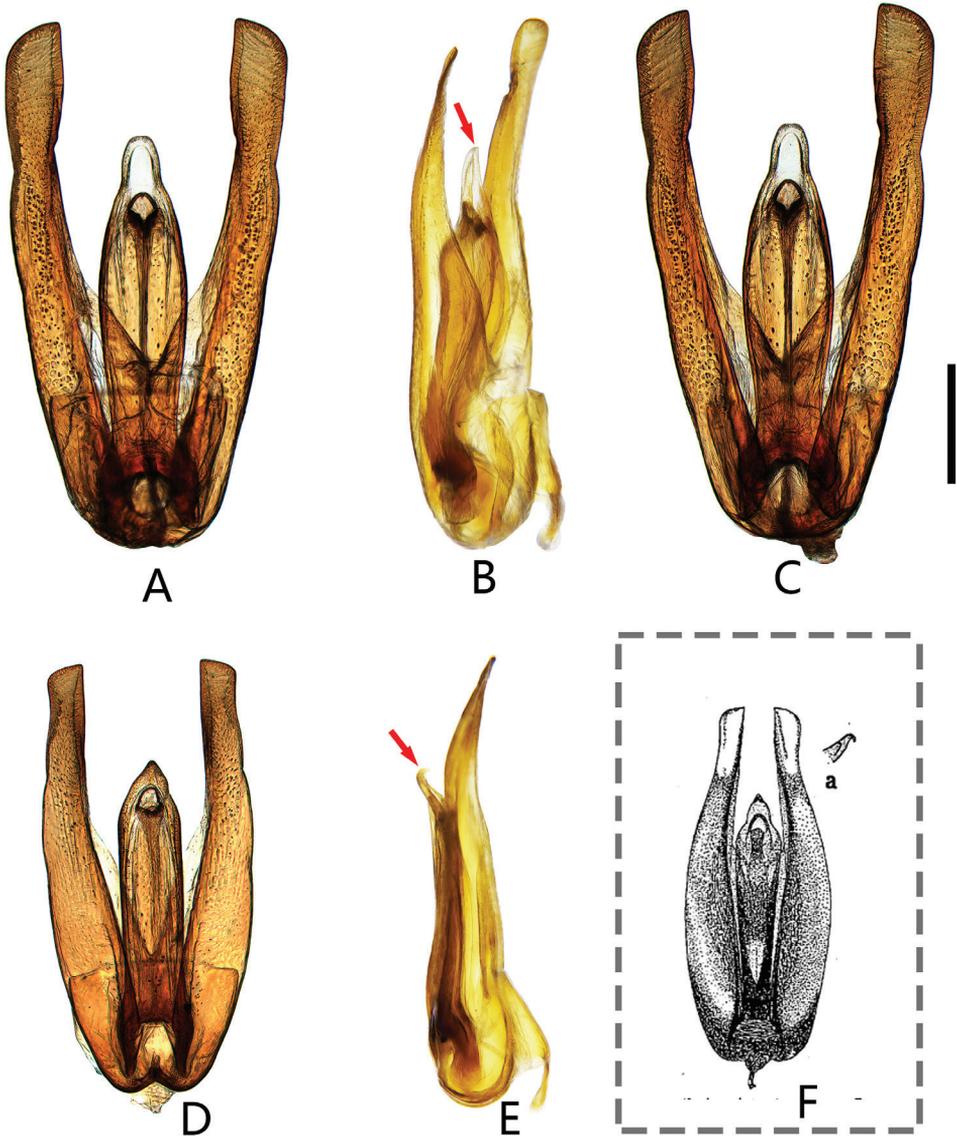


Figure 5. Aedeagus of *Coelostoma mixtum* Mai & Jia, sp. nov. and *Coelostoma vagum* Orchymont, 1940. **A–C** *C. mixtum* sp. nov. **A** dorsal view **B** lateral view **C** ventral view **D–F** *C. vagum* **D** dorsal view **E** lateral view **F** illustration by Orchymont (1940). Scale bar: 0.5 mm (**A–E**).

Head. Dorsal surface with dense fine punctures. Interstices between punctures smooth. Clypeus subtruncate anteriorly. Eyes of moderate size, distinctly emarginate anteriorly in lateral view, separated by ca. 4 × the width of one eye. Mentum strongly emarginated anteriorly and depressed in anterior half, with sparse fine punctures. Antennae with nine antennomeres, antennal club (antennomeres 7–9) densely pubescent.

Maxillary palpomere 2 strongly swollen, palpomere 4 truncate apically, slightly longer than palpomere 3. Gula narrow and glabrous.

Thorax. Pronotum widest posteriorly, gradually narrowed anteriorly, with punctures as on head, anterolateral angles obtusely rounded, posterolateral angles blunt, anterior and lateral margins with narrow marginal bead. Prosternum with a carina medially and a prominent tooth anteromedially. Scutellum in shape of equilateral triangle, with punctures finer and denser than those on pronotum. Elytra with punctures as on pronotum; elytra without serial punctures; sutural stria reaching anterior half of elytra; lateral margin of elytra with bead but not explanate.

Legs. Pro- and mesofemora bearing dense pubescence, except on extreme apex. Metafemora not pubescent, with dense microsculptures and sparsely fine punctures. Meso- and Metatibia slightly flattened, with strong apical spurs and series of sparse stout spines laterally. Tarsi with long dorsal setae and gold ventral setae; metatarsi with fifth tarsomere almost as long as third and fourth combined. Claws curved, with a pair of long setae beneath.

Abdomen. Abdominal ventrites densely pubescent. First ventrite with distinct median carina on basal one-thirds. Fifth ventrite with fine marginal bead and slightly emarginate apically.

Male genitalia (Fig. 5A–C). Aedeagus very large, 2.3 mm long. Median lobe widest at midlength, ca. 5 × as long as wide; median lobe gradually narrowing towards apex, with a small finger like apex, narrowly rounded apically; gonopore rounded, situated subapically; parameres much longer than the median lobe, abruptly widened apically, distinctly bent inward.

Etymology. This species is derived from the Latin verb *mixtus*, mix, refers to the fact that this species is similar to *Coelostoma vagum* Orchymont, 1940 in shape of the median lobe and similar to *C. wui* Orchymont, 1940 in shape of parameres.

Biology. Unknown, this species was collected with *C. wui* Orchymont, 1940 in the same place.

Remarks. The holotype of this species was identified as *C. vagum* Orchymont, 1940 in Jia et al. (2017). However, it is different from *C. vagum* in the form of the aedeagus. Hence, the distribution of *C. vagum* in Fujian needs to be verified. This species is the seventh known species of the *Coelostoma phallicum* group. This group can be recognized by a large and very elongate aedeagus with an extremely reduced phallobase and large subapical gonopore (Liu et al. 2020). This species is most similar to *C. vagum* Orchymont, 1940 (Fig. 5D–F) and *C. bipunctatum* Jayaswal, 1972 in shape of the median lobe but can be distinguished from them by the narrowly rounded apex of median lobe (apex pointed in *C. vagum* and *C. bipunctatum*), median lobe widest in the middle (median lobe nearly parallel-sided in the middle in *C. vagum* and *C. bipunctatum*). It also can be distinguished from *C. vagum* by apex of median lobe without a sharp prominent tooth ventrally (Fig. 5B) (apex with a sharp prominent hook-shaped tooth ventrally in *C. vagum* (Fig. 5E))

Distribution. Only known from type locality. China (Fujian).

***Coelostoma (Lachnocoelostoma) nankunshanense* Mai & Jia, sp. nov.**

<http://zoobank.org/13D63201-5029-4548-8B86-1BD8BEBCA175>

Figures 6A–F, 16G, K

Type material examined. *Holotype*: male (SYSU), China, Guangdong, Longmen County, Nankunshan Mountain, Guanyintan (观音潭), 23°38'13"N, 113°51'1"E, 503.7 m, 24.iii.2021, Mai, Jiang, Yang & Huang leg. *Paratypes*: 14 spec. (SYSU), 2 spec. (IZCAS), same data as the holotype;

Diagnosis. Length 4.7–5.0 mm. Head, pronotum and elytra with similar punctation. Prosternum carinate medially, with a prominent tooth anteromedially. Elytra slightly parallel-sided in the middle, without serial punctures laterally. Mesofemora densely pubescent, except on extreme apex. First abdominal ventrite with median carina on basal two-thirds. Fifth ventrite slightly emarginate and with a row of stout setae apically. *Aedeagus* (Fig. 6D–F): similar to *Coelostoma turnai* Hebauer, 2006 (Jia et al. 2014: fig. 21), but median lobe wider and shorter, outer face of parameres distinctly incised subapically.

Description. *Form and colour* (Fig. 6A–C). Total length 4.7–5.0 mm (holotype: 4.9 mm); maximum width 2.6–3.2 mm (holotype: 3.0 mm); body broadly oval, slightly parallel-sided in the middle, moderately convex. Dorsum black and shiny. Labrum, maxillary palpi and labial palpi reddish brown, antennae yellowish to reddish brown with dark club. Ventral surface reddish brown to black. Femora and tibiae dark reddish brown, tarsi pale reddish.

Head. Dorsal surface with dense fine punctures. Interstices between punctures smooth. Clypeus subtruncate anteriorly. Eyes of moderate size, distinctly emarginate anteriorly in lateral view, separated by ca. 3.5 × the width of one eye. Mentum strongly emarginated anteriorly and depressed in anterior half, with sparse punctures and dense transverse microsculpture. Antennae with nine antennomeres, antennal club (antennomeres 7–9) densely pubescent. Maxillary palpomere 2 strongly swollen, palpomere 4 truncate apically, slightly longer than palpomere 3. Gula narrow and glabrous.

Thorax. Pronotum widest posteriorly, gradually narrowed anteriorly, with punctures as on head, anterolateral angles obtusely rounded, posterolateral angles blunt, anterior and lateral margins with narrow marginal bead. Prosternum with a carina medially and a prominent tooth anteromedially. Scutellum in shape of equilateral triangle, with punctures finer and denser than those on pronotum. Elytra with punctures as on pronotum, punctures on lateral and posterior portions somewhat coarser than those on disc; elytra without serial punctures; sutural stria reaching anterior third of elytra; lateral margin of elytra with bead but not explanate.

Legs. Pro- and mesofemora bearing dense pubescence, except on extreme apex. Metafemora not pubescent, with dense microsculptures and sparsely fine punctures. Meso- and Metatibia slightly flattened, with strong apical spurs and series of sparse stout spines laterally. Tarsi with long dorsal setae and gold ventral setae; metatarsi with fifth tarsomere almost as long as third and fourth combined. Claws curved, with a pair of long setae beneath.

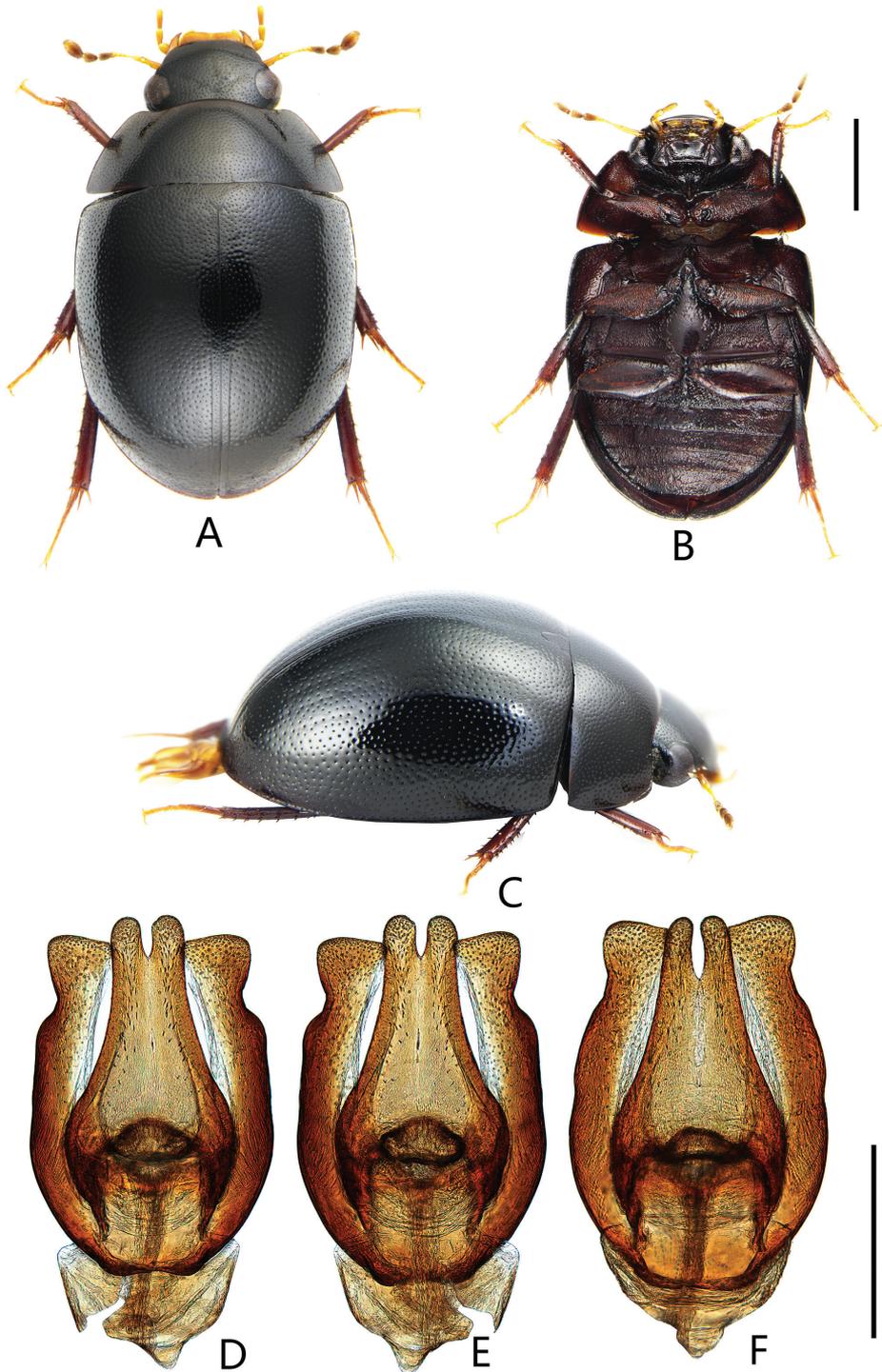


Figure 6. *Coelostoma* (*Lachnocoelostoma*) *nankunshanense* Mai & Jia, sp. nov. **A** dorsal view **B** ventral view **C** lateral view **D–F** aedeagus **D, E** holotype **D** dorsal view **E** ventral view **F** aedeagus of a paratype (dorsal view). Scale bars: 1.0 mm (**A–C**); 0.5 mm (**D–F**).

Abdomen. Abdominal ventrites densely pubescent. First ventrite with distinct median carina on basal two-thirds. Fifth ventrite with fine marginal bead and slightly emarginate apically.

Male genitalia (Fig. 6D–F). Aedeagus ca. 1.0 mm long. Median lobe widest basally, bottle-shaped with apex emarginate (depth of emargination are variable in individuals as in Fig. 6F), ca. $1.8 \times$ as long as wide; gonopore situated basally, wider than long; parameres slightly shorter than median lobe, distinctly incised on outer face subapically, broadly truncate apically

Etymology. This species is named after the type locality, Nankunshan, a nature reserve in Guangdong Province.

Biology (Figs 16G, K). All specimens were collected at night on some large stones in a forest stream. Individuals feed on algal mat and mate on the habitat. Some individuals of *Coelostoma bifidum* Jia, Aston & Fikáček, 2014 were also collected together.

Distribution. Only known from type locality. China (Guangdong).

***Coelostoma (Lachnocoelostoma) pseudomartensi* Mai & Jia, sp. nov.**

<http://zoobank.org/3A2C7D93-1840-43BD-A0C7-B99FA4BB2DDB>

Figures 7A–E, 13A

Type material examined. Holotype: male (SYSU), China, Yunnan, Honghe Hani and Yi Autonomous Prefecture, Lvchun County, Huanglianshan Mountain, Huanglianshan Reservoir (黄连山水库), 22.8898°N, 102.2952°E, 1717.3 m, 30.iv.2021, in a forest stream at night, Jiang, Yang, Huang & Mai leg.

Diagnosis. Length 5.4 mm. Head and pronotum with similar punctation. Prosteronum carinate medially, with a prominent tooth anteromedially. Elytra slightly parallel-sided in the middle, each elytron with ten serial punctures, somewhat difficult to separate them from the ground punctures in anterior half of elytron; intervals between series with two sizes of punctures especially in posterior half of elytron, coarser punctures slightly finer than those of the series (Fig. 13A). lateral margin of elytra with bead but not explanate. Mesofemora densely pubescent, except on extreme apex. First abdominal ventrite with carina on basal half. Fifth ventrite slightly emarginate and with a row of stout setae apically. **Aedeagus** (Fig. 7D, E): 1.0 mm long. Median lobe widest at anterior third, rounded apically, outer face nearly parallel-sided in the middle; gonopore situated subapically, in shape of triangle, almost as wide as long. Parameres almost the same length as median lobe, straight, not curved, gradually narrowed from middle to apex, narrowly rounded apically.

Description. Form and color (Fig. 7A–C). Total length 5.4 mm; maximum width 3.3 mm; body broadly oval, nearly parallel-sided in the middle, moderately convex. Dorsum black, with lateral margin of pronotum and elytra dark reddish brown. Labrum, maxillary palpi and labial palpi reddish brown, antennae yellowish to reddish brown with dark club. Ventral surface reddish brown. Femora and tibiae dark reddish brown, tarsi pale reddish.

Head. Dorsal surface with dense fine punctures. Interstices between punctures smooth. Clypeus subtruncate anteriorly. Eyes of moderate size, slightly emarginate anteriorly in lateral view, separated by ca. $4.5 \times$ the width of one eye. Mentum strongly

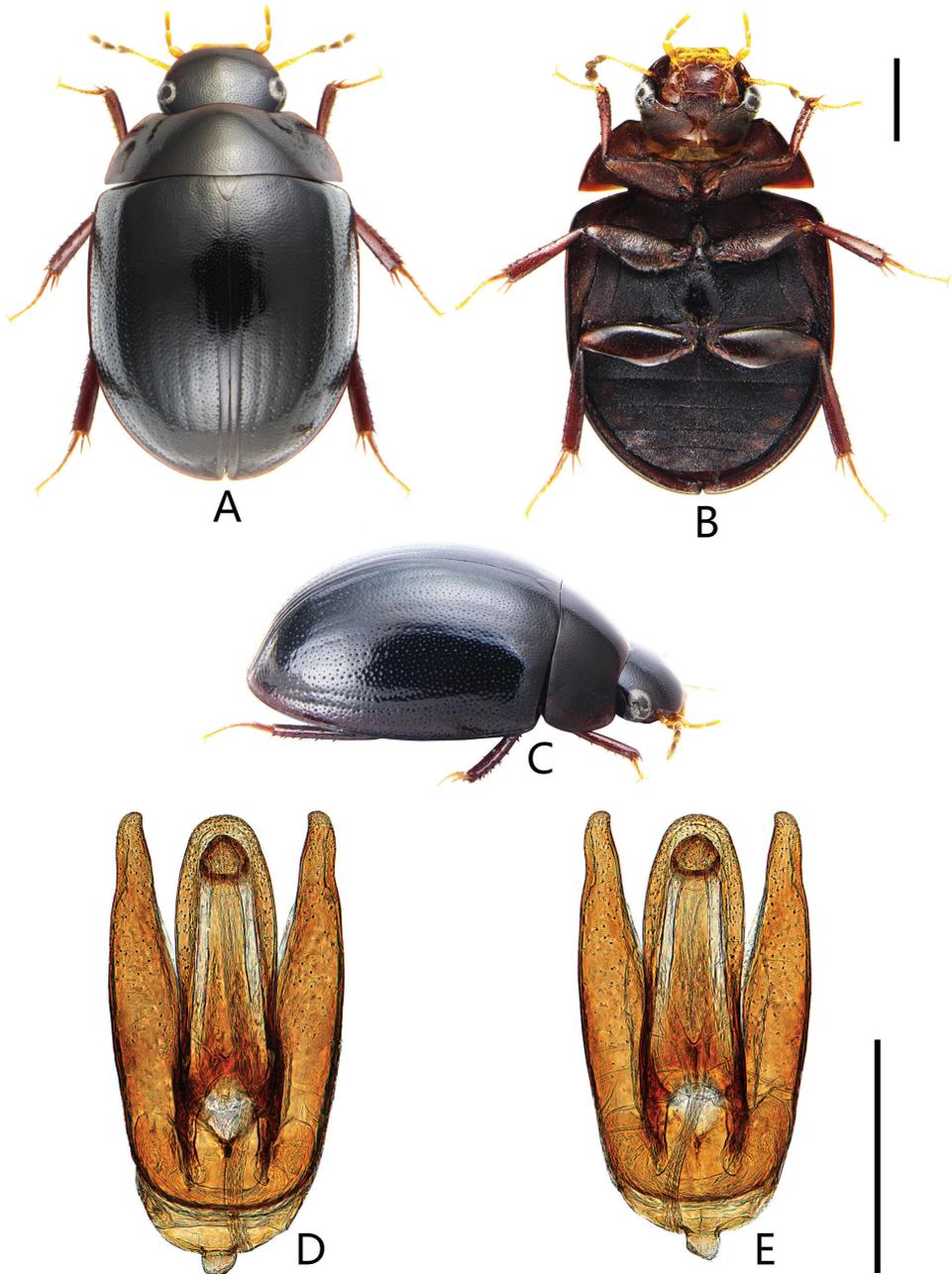


Figure 7. *Coelostoma (Lachmocoelostoma) pseudomartensi* M Jia, sp. nov. **A** dorsal view **B** ventral view **C** lateral view **D, E** aedeagus **D** dorsal view **E** ventral view. Scale bars: 1.0 mm (**A–C**); 0.5 mm (**D, E**).

emarginate anteriorly and depressed in anterior half, with sparse punctures and transverse microsculpture. Antennae with 9 antennomeres, antennal club (antennomeres 7–9) densely pubescent. Maxillary palpomere 2 strongly swollen, palpomere 4 truncate apically, slightly longer than palpomere 3. Gula narrow and glabrous.

Thorax. Pronotum widest posteriorly, gradually narrowed anteriorly, with punctures as on head, anterolateral angles obtusely rounded, posterolateral angles blunt, anterior and lateral margins with narrow marginal bead. Prosternum with a carina medially and a prominent tooth anteromedially. Scutellum slightly longer than wide, in shape of equilateral triangle, with punctures as on pronotum. Elytra with ground punctures as on pronotum, becoming coarser posteriorly. Each elytron with ten rows of serial punctures, somewhat difficult to separate them from the ground punctures in anterior half of elytron; intervals between series with two sizes of punctures especially in posterior half of elytron, coarser punctures slightly finer than those of the series; series 1 overlap with sutural stria; series 8 and 9 slightly sulcate posteriorly; series 10 short and becoming indistinct posteriorly (Fig. 13A). Lateral margin of elytra with bead, not explanate.

Legs. Pro- and mesofemora bearing dense pubescence, except on extreme apex. Metafemora not pubescent, with dense microsculptures and sparsely fine punctures. Meso- and Metatibia slightly flattened, with strong apical spurs and series of sparse stout spines laterally. Tarsi with long dorsal setae and gold ventral setae; metatarsi with fifth tarsomere almost as long as third and fourth combined. Claws curved, with a pair of long setae beneath.

Abdomen. Abdominal ventrites densely pubescent. First ventrite with distinct median carina on basal half. Fifth ventrite slightly emarginate and with fine marginal bead, with a row of stout setae apically.

Male genitalia (Fig. 7D, E). Aedeagus ca. 1.0 mm long. Median lobe widest at anterior third, ca. $3.7 \times$ as long as wide, rounded apically, slightly narrowed in the middle; gonopore situated subapically, in shape of triangle, almost as wide as long. Parameres straight, widest basally, almost the same length as median lobe, not curved inwards, gradually narrowed from middle to apex, with a narrowed and rounded apex.

Etymology. This species name is a combination of the Latin *pseudo-*, false, and another species of the genus, *Coelostoma martensi*. The name refers to the fact that this species is similar to *C. martensi* in some morphology characters.

Biology. This species lives mixed with *Coelostoma dactylopunctum* sp. nov.

Remarks. This species is similar to *Coelostoma martensi* Hebauer, 2002 (Hebauer 2002: fig. 7; Jia et al. 2014: fig. 28) not only in the shape of aedeagus but also in the serial punctures on lateral elytra. It can be distinguished from the latter by median lobe widest subapically (widest medially in *C. martensi*), paramere with a narrowed and rounded apex (apex of paramere broad and truncate in *C. martensi*), elytron with ten rows of serial punctures (only with serial punctures sublaterally in *C. martensi*).

Distribution. Only known from type locality. China (Yunnan).

New records and faunistic data

Coelostoma (Lachnocoelostoma) surkhetensis Hebauer, 2002

Figures 8A–E, 16H

Material examined. CHINA: Xizang: 1 male (SYSU), Muotuo County, Miri Village, 29°25'06"N, 95°24'23"E, 820 m, 23.vi.2018, Shi-shuai Wang & Zu-long Liang leg.;

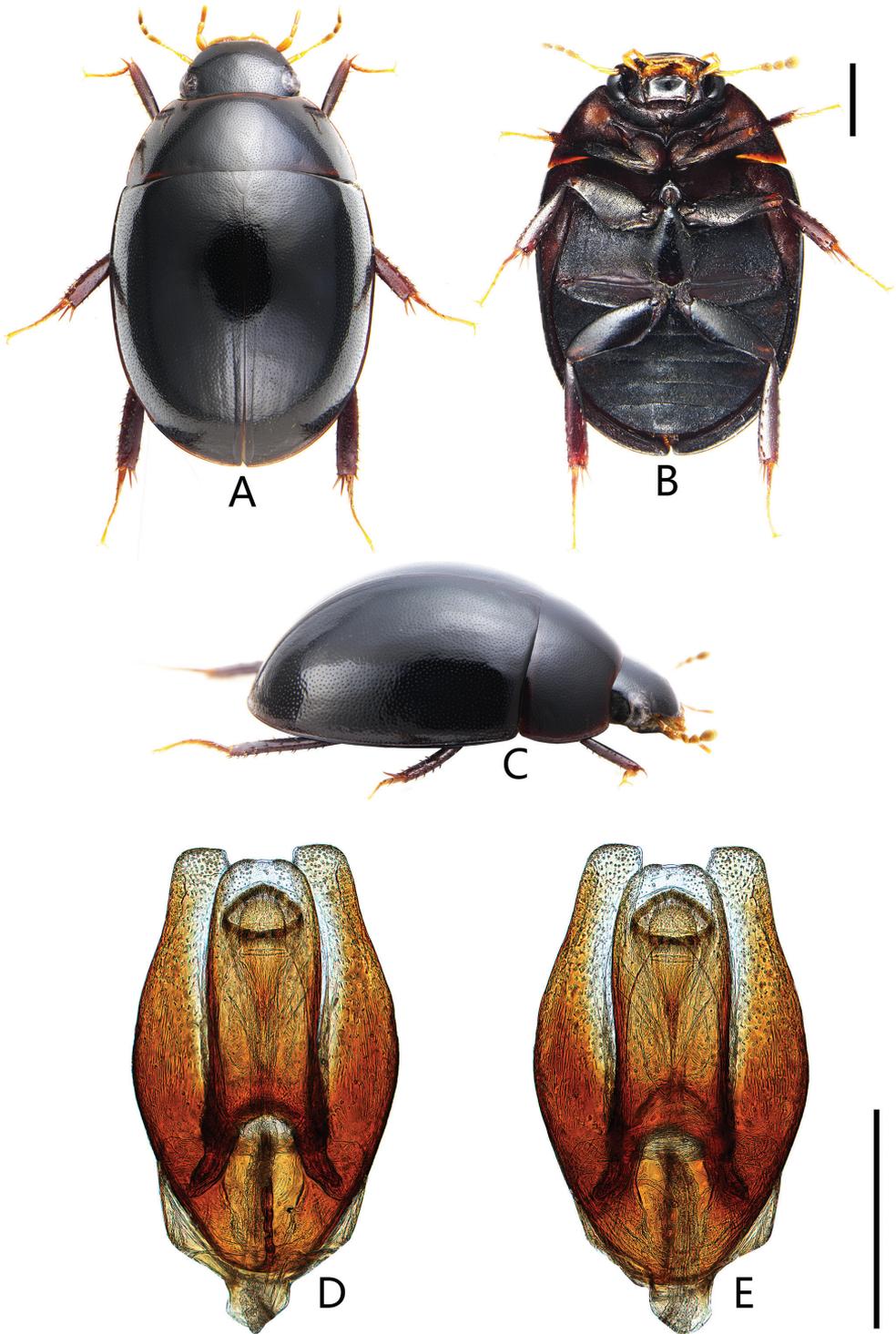


Figure 8. *Coelostoma (Lachnocoelostoma) surkhetensis* Hebauer, 2002 **A** dorsal view **B** ventral view **C** lateral view **D, E** aedeagus **D** dorsal view **E** ventral view. Scale bars: 1.0 mm (**A–C**); 0.5 mm (**D, E**).

6 spec. (SYSU), Muotuo County, Muotuo Town, 29.269°N, 95.227°E, 766 m, in a stream beside 219 national highway, Qian-le Lu leg.

Diagnosis. Length 5.4–5.8 mm. Head, pronotum and elytra with similar punctuation. Prosternum carinate medially, with a prominent tooth anteromedially. Elytra not parallel-sided in the middle, without serial punctures laterally. Mesofemora densely pubescent, except on extreme apex. First abdominal ventrite with distinct median carina on basal two-thirds. Fifth ventrite slightly emarginate and with a row of stout setae apically. *Aedeagus* (Fig. 8D, E): 1.2 mm long. Median subtruncate apically, nearly parallel-sided throughout; gonopore situated subapically. Parameres slightly longer than median lobe, gradually broadened from base to middle, outer face not curved, apical third parallel-sided, apex narrower than apex of median lobe, truncate, rounded outwards and nearly rectangularly inwards.

Biology (Fig. 16H). On the basis of private communication to collector Mr. Qian-Le Lu, the specimens from Xizang were collected on wet stones on the edges of a forest stream. A single specimen of *C. phototropicum* Jia, Angus & Bian, 2019 was collected at the same place.

Distribution. Previously known only from Nepal (Hebauer 2002; Przewoźny 2021). New record for China (Xizang).

Coelostoma (Lachnocoelostoma) huangi Jia, Aston & Fikáček, 2014

Material examined. CHINA: Yunnan: 32 spec. (SYSU), Qyjing, Shizong (师宗) County, Fenghuanggu (凤凰谷) Valley, 24.618168°N, 104.264414°E, 929 m, 20.v.2021, Bao-ping Huang, Zhuo-yin Jiang & Zu-qi Mai leg.

Biology. In Yunnan, specimens were collected along sides of a rocky stream in a valley at night. *Coelostoma coomani* Orchymont, 1932 and *C. phallicum* Orchymont, 1940 were also collected in the same habitat. Adult individuals attracted by light (Jia et al. 2014).

Distribution. China (Guangxi, Jiangxi, Yunnan), Thailand (Jia et al. 2014, 2017). New record for Yunnan.

Coelostoma (Lachnocoelostoma) hajeki Jia, Aston & Fikáček, 2014

Material examined. CHINA: Hunan: 30 spec. (SYSU), Yizhang, Mangshan Town, Xiling Village, 24°58'54"N, 112°49'15"E, 642 m, 8.vii.2021, Zu-long Liang leg.

Distribution. China (Guangdong, Guangxi, Hunan). New record for Hunan.

Coelostoma (Lachnocoelostoma) jaechi Jia, Lin, Chan, Skale & Fikáček, 2017

Material examined. CHINA: Guangdong: 1 male (SYSU), Shenzhen City, Dapeng District, Tiantoushan Mountain, Light trap, 22°40'12"N, 114°24'45"E, 208 m, Yang, Jiang, Guo & Ji leg.

Distribution. China (Hong Kong, Guangdong). New record for Guangdong.

***Coelostoma (Lachnocoelostoma) turnai* Hebauer, 2006**

Figure 16A

Material examined. CHINA: Chongqing: 4 spec. (SYSU), Jiangjin District, Simianshan Nature Reserve, Dawopu (大窝铺), 20.vi.2014, Jian-yue Qiu & Hao Xu leg.; 1 spec. (SYSU), Jiangjin District, Simianshan Nature Reserve, Er'tai (二台), Hao Xu leg.; **Fujian:** 17 spec. (SYSU), Longyan (龙岩), Mt. Jiangshan (江山), 600 m, 7.iv.2020, Yu-chen Zheng leg.; **Guizhou:** 2 spec. (SYSU), Weng'ang Town, Maolan Nature Reserve, 25°15'08"N, 107°53'56"E, 814 m, 24.vii.2015, Ren-chao Lin & Yu-dan Tang leg.

Biology (Fig. 16A). On basis of private communication with the collector Mr. Yu-Chen Zheng (China Agricultural University), the specimens from Fujian were collected on wet rocky ground beside a river at night.

Distribution. Only known from China (Fujian, Guizhou, Hubei, Hunan, Chongqing) (Jia et al. 2014). New record for Fujian, Guizhou, and Chongqing.

***Coelostoma (Lachnocoelostoma) wui* Orchymont, 1940**

Figures 14A–I, 16I, L

Material examined. CHINA: Hunan: 4 spec. (SYSU), Taoyuan County, Wuyunjie, Zhushan Village, 100 m, 15.vi.2019, Hao Xu leg.; **Henan:** 2 spec. (SYSU), Neixiang County, Getiaopa Village (葛条爬村), 630 m, 22.vi.2021, Hao-yi Liu leg.; **Shaanxi:** 1 spec. (SYSU), Xi'an County, Dayu, 12.v.2011, Feng-long Jia leg.; **Shandong:** 3 spec. (HBUM): Feixian, Tashan Forest Farm, 16.–17.v.2007, Feng-yan Wang, Ji-liang Wang & Qi-qi Wu leg.; 2 spec. (HBUM): Pingyi, Dawa Forest Farm, 13–15.v.2007, Feng-yan Wang, Ji-liang Wang & Qiqi Wu leg.; **Shanxi (山西):** 8 spec. (SYSU), Jincheng, Yangcheng (阳城) County, Manghe (蟒河) National Nature Reserve, 700 m, 27.iv.2016, Zu-qi Mai leg.; **Zhejiang:** 3 spec. (SYSU), Quanzhou City, Ji-angshan County, Shuangxikou Town, Laofoyan Village (老佛岩村), 27°55'02.72"N, 119°11'34.47"E, 496 m, high-voltage mercury light trap, 11.viii.2018, Chen & Miao leg.; 7 spec. (SYSU), Lin'an City, Yinlongwu Town, Shibalongtan, 30°08'24.88"N, 118°52'23.56"E, 683 m, 28.iv.2018, Shifting, Cheng & Shen leg.; 2 spec. (SYSU), Jinhua City, Pan'an County, Lingjiangyuan (灵江源), 28°57'39.33"N, 120°38'59.72"E, 750 m, mixed leaf litter, Shifted, 21.V.2018, Puthz, Tang, Cheng & Shuai leg.

Additional material examined (possibly another undescribed species). CHINA: Guangdong: 5 spec. (SYSU), Shaoguan City, Chebalin (车八岭) Nature Reserve, 23°14'46"N, 113°33'56"E, 496 m, 28–29.v.2017, Feng-Long Jia, Shi-Shuai Wang & Zu-Long Liang leg.; 24 spec. (SYSU), Shaoguan City, Chebalin (车八岭) Nature Reserve, 24°43'24"N, 114°15'23"E, 400 m, 24.viii.2020, Zu-Long Liang leg.; **Jiangxi:** 91 spec. (SYSU), Longnan, Jiulianshan, 06–vii.2008, Fenglong Jia leg.; **Fujian:** 2 spec. (SYSU), Wuyishan, Sangang, 16–28.v.2004, Cai-Xia Yuan & Jing Li leg.;

Biology (Figs 15D, 16I, L). Collected on the ground beside a mountain river in Shanxi, active at night.

Remarks. The specimens we studied contained two different forms of male genitalia (Fig. 14B–I). It may be inferred that the specimens treated by previous authors as *C. wui* Orchymont, 1940 possibly contain two species (see Discussion).

Distribution. China (Hubei, Hunan, Jiangxi, Shaanxi, Shandong, Shanxi, Taiwan, Xinjiang, Zhejiang), Korea. (Hansen 1999; Jia et al. 2014; Liu et al. 2020). First record for Shanxi and Zhejiang.

Re-establishment of *Coelostoma sulcatum* Pu, 1963 and distribution of *C. stultum* (Walker, 1858)

Coelostoma (Holocoelostoma) sulcatum Pu, 1963

Figures 9A, 10A–J, 16B, F, J

Coelostoma sulcatum Pu, 1963: 77. Type locality: Xishuangbanna Dai Autonomous Prefecture, Yunnan, China.

Coelostoma (Holocoelostoma) stultum (Walker, 1858): Jia et al. 2014: 370. Synonym.

Coelostoma (Holocoelostoma) bhutanicum Jayaswal, 1972: Sheth et al. 2020: 21. Possible synonym.

Type material examined. *Coelostoma sulcatum*: **Holotype** (Fig. 10A, B): male (IZ-CAS), “Yunnan, Xishuangbanna, Gannanba / 540 m / 1952.IV.17 / Guang-Ji Hong leg. (with Chinese and Russian labels) // *Coelostoma sulcata* Pu // HOLOTYPE”; **Paratype**: male (SYSU), “Jingdong / 1200 m / 26.iv.1957 // A. Monchadskiy leg. (with Chinese and Russian labels) // *Coelostoma sulcata* Pu // Paratype”

Material examined. CHINA: **Fujian**: 1 spec. (SYSU), Nanjing County, Hexi Town, in a pond, 13.vii.2010, Feng-long Jia leg.; 2 spec. (SYSU), Ningde District, Mountain behind Ningde Teachers College, 29°01'N, 115°16'E, 315 m, 2.x.2012, Ze-yu Wang leg.; 1 spec. (SYSU), Fu'an District, x.1963, Shan-xiang Lin leg.; **Guangdong**: 1 male (SYSU), Ruyuan County, Longxi, 4–5.x.1964, light trap; 1 spec. (SYSU), Zhuhai, Qi'ao Island, 12.vii.2005, Feng-long Jia leg.; 2 spec. (SYSU), Guangzhou, Shipai, pig farm, 25.vii.1985. Wu Wu leg.; 1 spec. (SYSU), Guangzhou City, Shipai, pig farm, 20.vii.1985. Wu Wu leg.; 1 spec. (SYSU), Guangzhou City, South bank of Zhujiang River, cattle farm, 10.x.1985. Wu Wu leg.; 1 spec. (SYSU), Guangzhou, viii.1938. Zhe-long Pu leg.; 3 spec. (SYSU), Shenzhen City, Inner Lingding Island, 8–12.iv.1998, Peng & Chen leg.; 33 spec. (SYSU), Shenzhen City, Dapeng Peninsula, Getian Village, 22.48157°N 114.52643°E, 12 m, 3.vii.2019, Feng-long Jia & Zu-qi Mai leg.; 1 male (SYSU), Shenzhen City, Dapeng Peninsula, Getian Village, 22°29'25"N, 114°30'59"E, -6 m, 14.xi.2020, Zu-qi Mai, Zhuoyin Jiang & Shu-jiao Jiang leg.; 1 spec (SYSU), Shenzhen City, Dapeng Peninsula, Jin'gui Village, 22°39'35"N, 114°23'10"E, 62 m, 15.v.2019, Wei-cai Xie leg.; 2 spec. (SYSU), Shenzhen City, Dapeng Peninsula, Pai-yashan Mountain, 22°37'37"N, 114°26'17"E, 34 m, 5. xi.2018, Lan-bin Xiang leg.; 1 spec (SYSU), Shenzhen, 8–11.viii.2006, Feng-long Jia leg.; 3 spec. (SYSU), Shenzhen City, Pingtoulung Mountain, 25.ix.2021, Bao-ping Huang leg.; 1 spec. (SYSU),

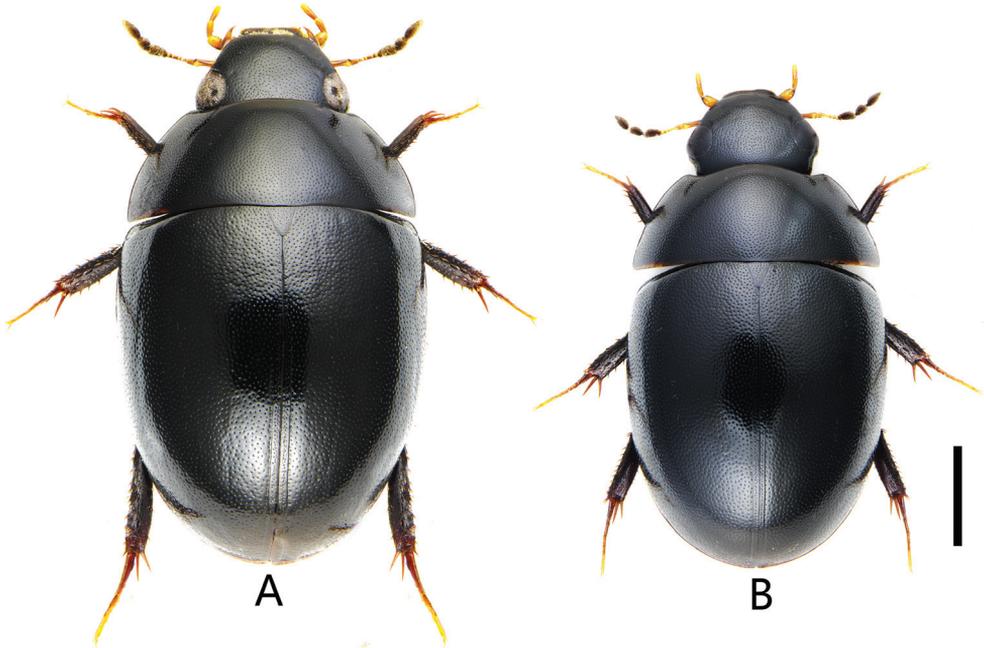


Figure 9. Dorsal view of Chinese *Holocoelostoma* **A** *Coelostoma sulcatum* Pu, 1963 **B** *Coelostoma stultum* (Walker, 1858). Scale bar: 1.0 mm (**A, B**).

Danxiashan Mountain, Jinshiyan, pool under a stone wall, 11.vi.2011, Feng-long Jia leg.; 1 male (SYSU), Fengkai County, Heishiding, in a pool, 13.viii.2010, Feng-long Jia leg.; 1 spec. (SYSU), Dinghushan Mountain, 4.vi.1958, Cui-ying Li leg.; **Guangxi:** 1 male (SYSU), Jinxiu County, Luoxiang, 400 m, 16.v.1999, Ming-yuan Gao leg.; 1 male (SYSU), Shangsi County, Hongqi Forestry Centre, 300 m, 29.v.1999, Xing Ke leg.; 4 spec. (SYSU), Nanning City, 22.vi.1958, Zhe-long Pu leg.; 6 spec (SYSU), Nanning City, 19.vi.1977, Zhi-he Huang leg.; Longlin County, Jinzhongshan Mountain, viii.2014, Shan-yi Zhou leg.; **Jiangxi:** 10 spec. (SYSU), Jing'an County, Zaodu (噪都) Town, Nanshan Village (南山村), 315 m, 29°01'N, 115°16'E, 2.viii.2015 Ren-chao Lin & Yu-dan Tang leg.; 4 spec. (SYSU), Jing'an County, Shanzhaolun, Tangli Village (塘里村), 260 m, 29°04'03"N, 115°17'23"E, 3.viii.2015, Ren-chao Lin & Yu-dan Tang leg.; 1 spec. (SYSU), Jing'an County, Jinggangshan, Bijianshan Mountain, 390 m, 26°31'12"N, 114°11'45"E, 22–25.vii.2014, light trap, Chen, Hu, Lv & Yu leg.; 1 spec. (SYSU), Jing'an County, Jinggangshan, Baiyinhu Lake, 800 m, 27.v.2011, Feng-long Jia leg.; **Macao:** 6 spec. (SYSU), Dangzai Mangrove Reserves, First area, 22°8'24"N, 113°33'11"E, 12 m, 16–17.i.2021, on edges of lagoon at night, Feng-long Jia & Zu-qi Mai leg.; 4 spec. (SYSU), Dangzai Mangrove Reserves, First area, 11–12.vii.2018, Feng-long Jia & Wei-cai Xie leg.; 4 spec. (SYSU), Dangzai Mangrove Reserves, First area, 10.x.2020, Feng-long Jia & Wei-cai Xie leg.; 1 spec. (SYSU), Dangzai Mangrove Reserves, First area, 17.vi.2016, Feng-long Jia leg.; 33 spec. (SYSU), Dangzai Mangrove Reserves, First area, 8.iv.2014, Wei-cai Xie & Jin-wei Li leg.; 1

spec. (SYSU), Dangzai Mangrove Reserves, First area, 3.xi.2014, Ren-chao Lin leg.; 1 spec. (SYSU), Coloane, KoloaneAlto (叠石塘), 27.iii.2014, Feng-long Jia leg.; **Taiwan**: 4 spec. (SYSU), Taidung County, Donghe Town, Xinchang (興昌), 25.x.2016, Wen-yi Zhou leg.; **Xizang**: 2 spec., Motuo, Beibeng, 850 m, 25.v.1983, Yinheng Han leg., each with a yellow label “Paratype, *Coelostoma xizangensis*, det. Wu Wu”; 1 male, same data as the former, but with a red label “Holotype, *Coelostoma xizangensis*, det. Wu Wu”; 1 female, same data as the former, but with a label “Allotype, *Coelostoma xizangensis*, det. Wu Wu”; 2 spec., same data as the former, but with a label “*Coelostoma xizangensis*”; 5 spec. (SYSU), Muotuo County, Miri Village, 29°25'06"N, 95°24'23"E, 800 m, 23.vi.2018, Shi-shuai Wang & Zu-long Liang leg.; **Yunnan**: 5 spec. (SYSU), Xishuangbanna Dai Autonomous Prefecture, Botanical Garden, Lake besides Royal Water Lily Hotel, 4–11.iv.2021, Bao-ping Huang leg.; 6 spec. (SYSU), Xishuangbanna Dai Autonomous Prefecture, Botanical Garden, Lake besides Royal Water Lily Hotel, 4–11.iv.2021, Bao-ping Huang leg.; 5 spec. (SYSU), Xishuangbanna Dai Autonomous Prefecture, Botanical Garden, Lake besides Royal Water Lily Hotel, 21.9295°N, 101.2483°E, 500 m, 2.v.2021, Zhuo-yin Jiang, Zhen-ming Yang, Bao-ping Huang & Zu-qi Mai leg.; 1 spec. (SYSU), Xishuangbanna Dai Autonomous Prefecture, Botanical Garden, 21.92262°N, 101.27710°E, 567 m, light trap, 23.v.2011, Ke-qing Song leg.; 2 spec. (SYSU), Xishuangbanna Dai Autonomous Prefecture, Naban Village, 7.i.2004, Li & Tang leg.; 2 spec. (SYSU), Mengla County, Wangtianshu Reserve, light trap, 22.vii.2014, Yun Li leg.; 1 spec. (SYSU), Xishuangbanna Dai Autonomous Prefecture, Gannanba, 500 m, 13.iii.1957, Qiu-zhen Liang leg.; 9 spec. (SYSU), Yingjiang County, Nabang Town, 24.75°N, 97.56°E, 239 m, 27.v.2016, Yu-dan Tang & Rui-juan Zhang leg.; 1 spec. (SYSU), Yingjiang County, Tongbiguan Town, Kaibangya Lake, 24.58°N, 97.67°E, 1289 m, 25.v.2016, Yu-dan Tang & Rui-juan Zhang leg.; 1 spec. (SYSU), Dehong Dai and Jingpo Autonomous Prefecture, Yingjiang County, Xima Town (昔马镇), Hulukou(葫芦口), Xingyun Secondary power station (星云二级电站), 1000 m, vi.2019, light trap, Zhao-yang Tang leg. **Zhejiang**: 1 male (SYSU), Lin'an County, Mt. Tianmushan, 300–400 m, 11–15.vi.2006, Hu & Wang Leg.; 1 spec (SYSU), Mt. W. Tianmushan, 10–21.viii.2004, N.-C. Li Leg.;

Diagnosis. Length 4.5–5.8 mm. Head, pronotum and elytra with similar punctation. Prosternum moderately convex medially, not carinate, without anteromedian process. Elytra slightly or not parallel-sided in the middle, without serial punctures. Mesofemora without dense pubescence, but with punctures bearing strong setae laterally. First abdominal ventrite not carinate, fifth ventrite emarginate and with a row of stout setae apically. **Aedeagus** (Fig. 10B–J): 0.9–1.4 mm long. Median lobe widest basally, almost parallel from base to apical fourth, then distinctly narrowed apically (materials from Macao slightly narrowed); gonopore situated apically. Parameres longer than median lobe, outer face slightly curved or sinuate medially and strongly curved inwards apically.

Biology (Figs 15G, H, 16B, F, J). This species can be found in various of aquatic environments. It can be collected on wet ground near rivers, streams or natural lakes. It also occurs at some artificial environments, such as on sandy gutters with very shal-

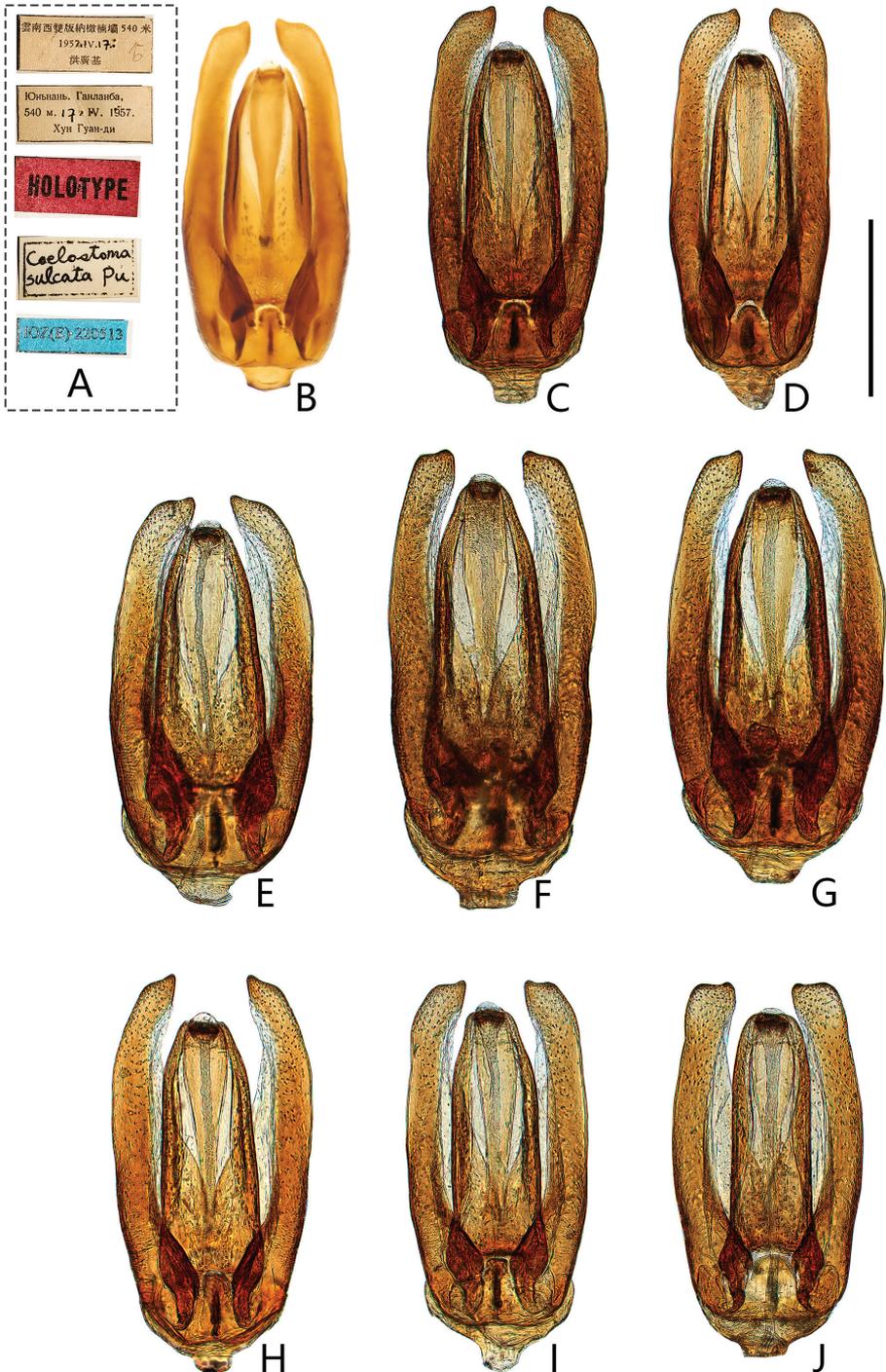


Figure 10. Aedeagus of *Coelostoma sulcatum* Pu, 1963 (dorsal view) **A, B** holotype of *C. sulcatum* **A** labels **B** aedeagus **C** from Jing'an County (Jiangxi) **D** from Shenzhen City (Guangdong) **E** from Longlin County (Guangxi) **F** from Xishuangbanna (Yunnan) **G** from Xima (昔马) Town (Yunnan) **H** from Tongbiguan Town (Yunnan) **I** from Muotuo County (Xizang) **J** from Macao. Scale bar: 0.5 mm (**A–J**).

low flowing waters in Shenzhen (Fig. 16B), on the edges of an artificial lake (Fig. 15G) and also lives with *Coelostoma phallicum* Orchymont, 1940 in Xishuangbanna. It also occurs on the muddy edges of a brackish lagoon in a mangrove reserve in Macao (Fig. 15H). Adults are active at night and sometimes attracted by light.

Remarks. Jia et al. (2014) thought this species was a synonym of *Coelostoma stultum* Walker. Liu et al. (2020) and Sheth et al. (2020) stated that it is a different species from *C. stultum* Walker after they studied a paratype of *C. stultum*, and considered as a likely synonym of *Coelostoma bhutanicum* Jayaswal, 1972 (Sheth et al. 2020). Here, we recovered the status of *C. sulcatum* Pu as a valid species.

Coelostoma sulcatum Pu, 1963 is morphologically variable in shape of aedeagus, especially in parameres. Compared with the original description (Jayaswal 1972) and photos of *C. bhutanicum* from India (Sheth et al. 2020), *C. bhutanicum* is very similar to *C. sulcatum* especially in aedeagus, which outer face of median lobe is slightly narrowing or subparalleling from base to apical fourth and distinctly narrowed subapically (Fig. 10B–I). This indicates *C. bhutanicum* and *C. sulcatum* possibly refer to the same species.

Liu et al. (2020) reported *C. bhutanicum* Jayaswal, 1972 from Taiwan. In his illustration of aedeagus, median lobe is of almost same width throughout, only slightly narrowed apically (Liu et al. 2020: fig. 2E). This character is inconsistent with the median lobe of *C. bhutanicum* drawn by Jayaswal (1972), but very closed to *C. bhutanicum* from Japan (Watanabe and Minoshima 2020) and *C. sulcatum* from Macao (Fig. 10J). This character has not been found in other specimens of *C. sulcatum* and *C. bhutanicum*. Hence, it is possible that the specimens with this character represent another undescribed species or just intraspecific variation of *C. sulcatum*. However, solving the problem of synonymization of *C. bhutanicum* and *C. sulcatum* is not easy until the type of *C. bhutanicum* can be examined. Hence, we prefer to treat specimens from China as *C. sulcatum* and not treat *C. bhutanicum* in the key to species of Chinese *Coelostoma* at present.

Distribution. China (Fujian, Guangdong, Guangxi, Jiangxi, Macao, Taiwan, Yunnan, Xizang, Zhejiang).

Coelostoma (Holocoelostoma) stultum (Walker, 1858)

Figures 9B, 11A–F

Note. For complete synonymy, see Hansen (1999).

Material examined. CHINA: **Guangdong:** 3 spec. (SYSU), Sihui District, Dasha Town, 5.vi.1998, Feng-long Jia leg.; 1 male (SYSU), Huaxian County, Dapuling, 26.viii.1983, Zhi-he Huang leg.; 2 spec. (SYSU), Lianjiang District, 25.ix.1985, Wu Wu leg.; 1 male (SYSU), Xinhui District, viii.2001, Xiao-li Tong leg.; **Guangxi:** 45 spec. (SYSU), Yangshuo (阳朔), viii.1984, Shou-jian Chen leg.; 6 spec. (SYSU), Shiwandashan Forest Park, 267 m, light trap, 9.vii.2011, Ke-qing Song leg.; **Hainan:** 1 male (SYSU), Lingshui, Diaoluoshan Mountain, Xiaomei (小妹), 29.xi.1963, Bai-ge Chen leg.; **Hubei:** 1 male (SYSU), Wuhan City, Wuhan Botanical Garden,

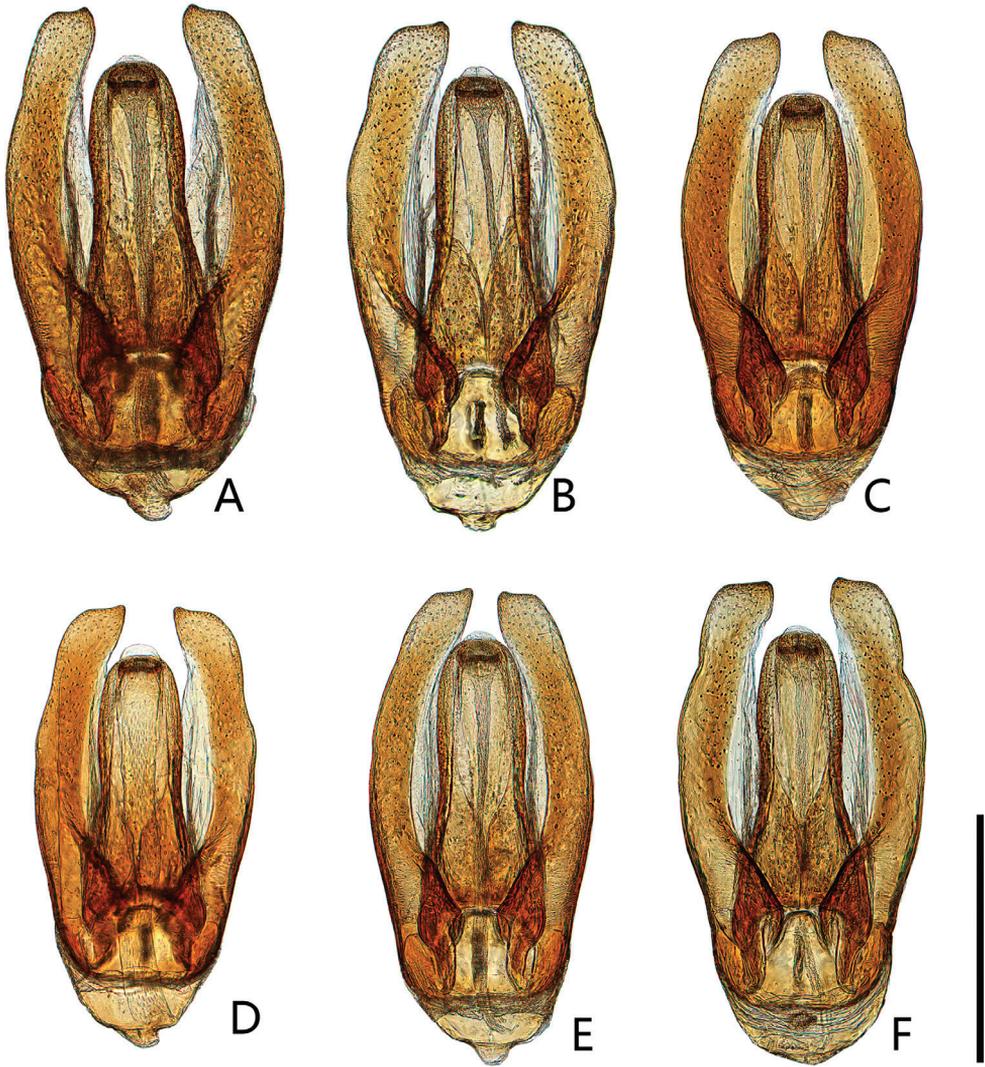


Figure 11. Aedeagus of *Coelostoma stultum* (Walker, 1858) (dorsal view) **A** from Huaxian County (Guangdong) **B** from Sihui District (Guangdong) **C** from Mt. Shiwandashan (Guangxi) **D** from Yangshuo (Guangxi) **E** from Yizhang (Hunan) **F** from Mt. Diaoluoshan (Hainan). Scale bar: 0.5 mm (**A-F**).

31.viii.2020, Zi-hao Shen leg.; **Hunan**: 2 spec. (SYSU), Yizhang (宜章), 16.iii.1941, Zhe-long Pu leg.; **Jiangxi**: 4 spec. (SYSU), Jing'an County, Guanyinyan (观音岩), 29°01'48"N, 115°25'00"E, 195 m, 1.viii.2015, Ren-chao Lin & Yu-dan Tang leg.; 3 spec. (SYSU), Jiujiang District, Duchang County, Linshan Village Committee, 15–20.viii.2010, Yan Mei leg.; **Yunnan**: 5 spec. (SYSU), Mengla Nature Reserve, 4–5.viii.2007, Jia-hui Li leg.; **Zhejiang**: 1 male (SYSU), Quzhou City, Kecheng District, 29.0063°N, 118.8063°E, 112 m, 15.iii.2020, Zhuo-yin Jiang leg.; 1 male (SYSU), Quzhou City, Kecheng District, Wangdu Village, 28.9875°N, 118.6898°E, 102 m,

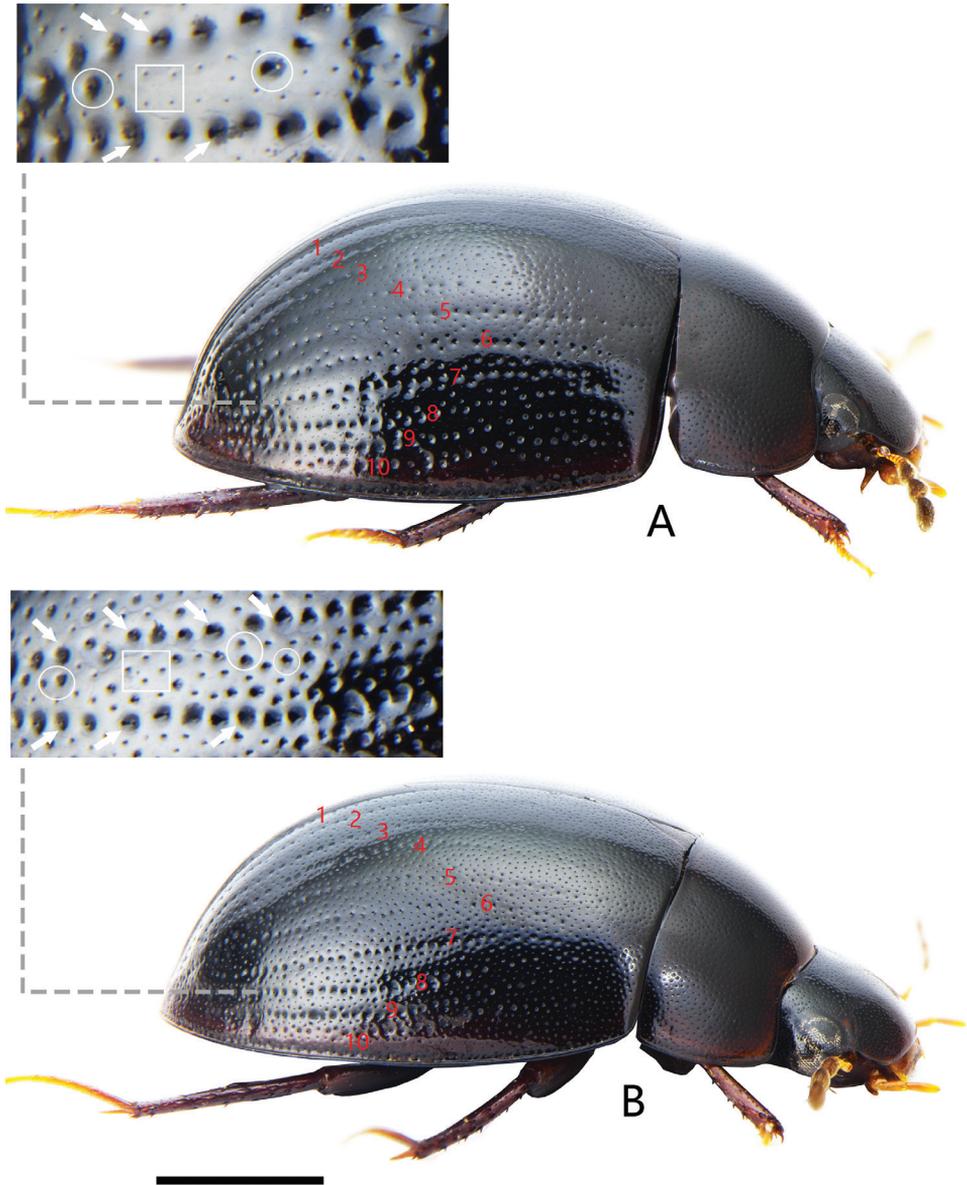


Figure 12. Lateral view of *Coelostoma* spp. (the red figures indicate the serial number of elytral serial punctures; the white arrows indicate the punctures of series; the circles indicate the coarser punctures; the squares indicate the finer punctures) **A** *Coelostoma dactylopunctum* sp. nov. **B** *Coelostoma fortunum* sp. nov. Scale bar: 1 mm (**A, B**).

7.iii.2020, Zhuo-yin Jiang leg.; 7 spec. (SYSU), Kaihua County, Zawanhua (砸碗花) Wetland Park, 11.iii.2020, Zhuo-yin Jiang leg.

Additional material examined. CAMBODIA: 17 spec. (SYSU), Boeng, Kampong Thom Pro., Khleung, light trap beside a rice field, 13.viii.2017, Zu-qi Mai leg.

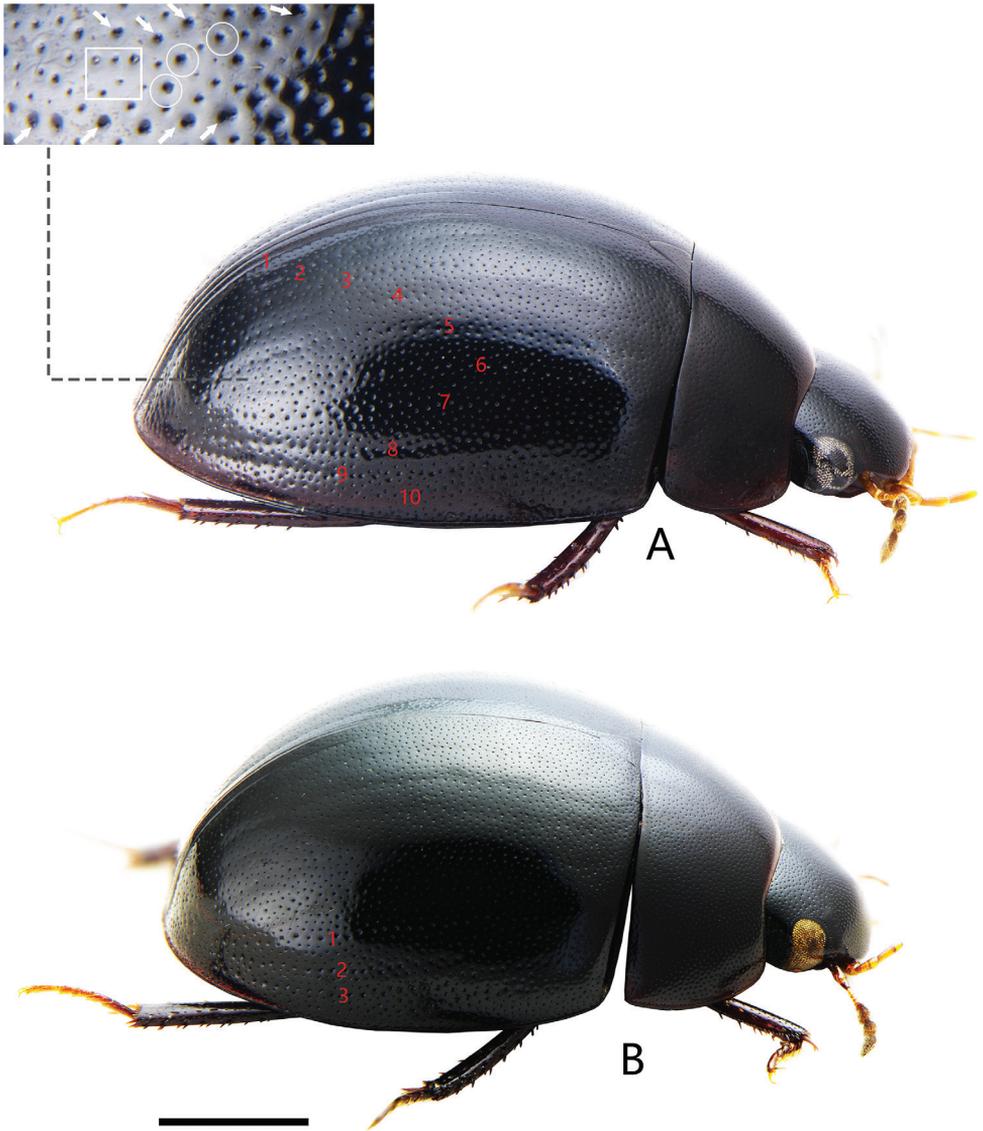


Figure 13. Lateral view of *Coelostoma* spp. (the red figures indicate the serial number of elytral serial punctures; the white arrows indicate the punctures of series; the square indicates the elytral ground punctures) **A** *Coelostoma pseudomartensi* sp. nov. **B** *Coelostoma gentilii* Jia, Aston & Fikáček, 2014. Scale bar: 1 mm (**A**, **B**).

Diagnosis. Length 4.3–5.2 mm, similar to *C. sulcatum* in morphological characters. **Aedeagus** (Fig. 11A–F): 0.8–1.0 mm long. Median lobe widest basally, distinctly narrowed medially, then slightly widened at apical third; gonopore situated apically. Parameres longer than median lobe, outer face continually curved and strongly curved inwards apically.

Biology. This species has the similar habitations of *C. sulcatum* Pu, 1963.

Occurrence in China. This species was reported widely distributed in China (Chongqing, Fujian, Guangxi, Guangdong, Jiangxi, Hainan, Hunan, Hong Kong,

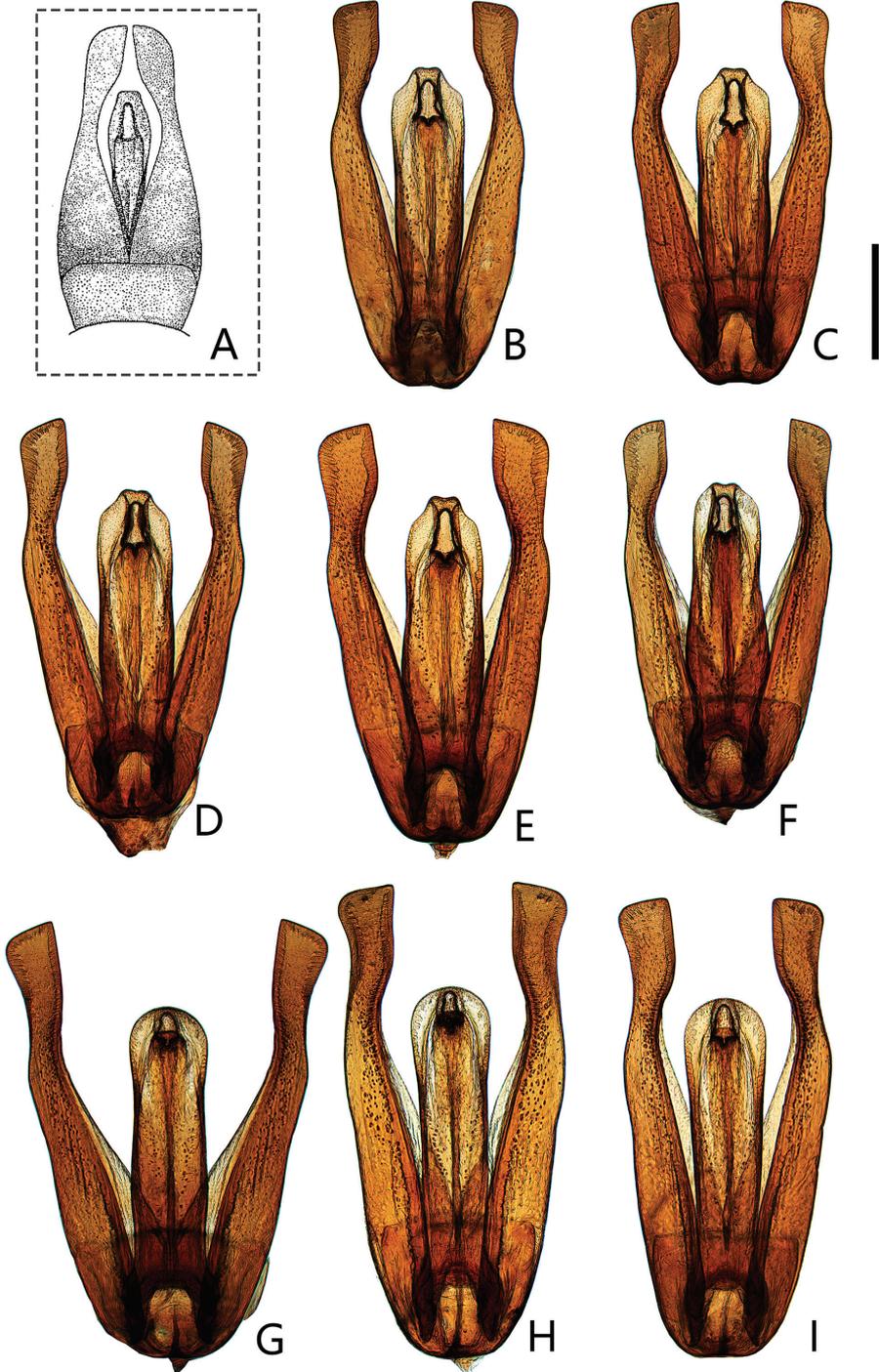


Figure 14. Aedeagus of *Coelostoma wui* Orchymont, 1940 (dorsal view) **A** illustration by Orchymont (1940) **B** from Pingyi County (Shandong) **C** from Getiaopa (葛条爬) Village (Henan) **D** from Hanzhong (Shaanxi) **E** from Taoyuan County (Hunan) **F** from Quanzhou City (Zhejiang) **G** from Wuyishan (Fujian) **H** from Mt. Jiulianshan (Jiangxi) **I** from Mt. Chebaling (Guangdong). Scale bar: 0.5 mm.

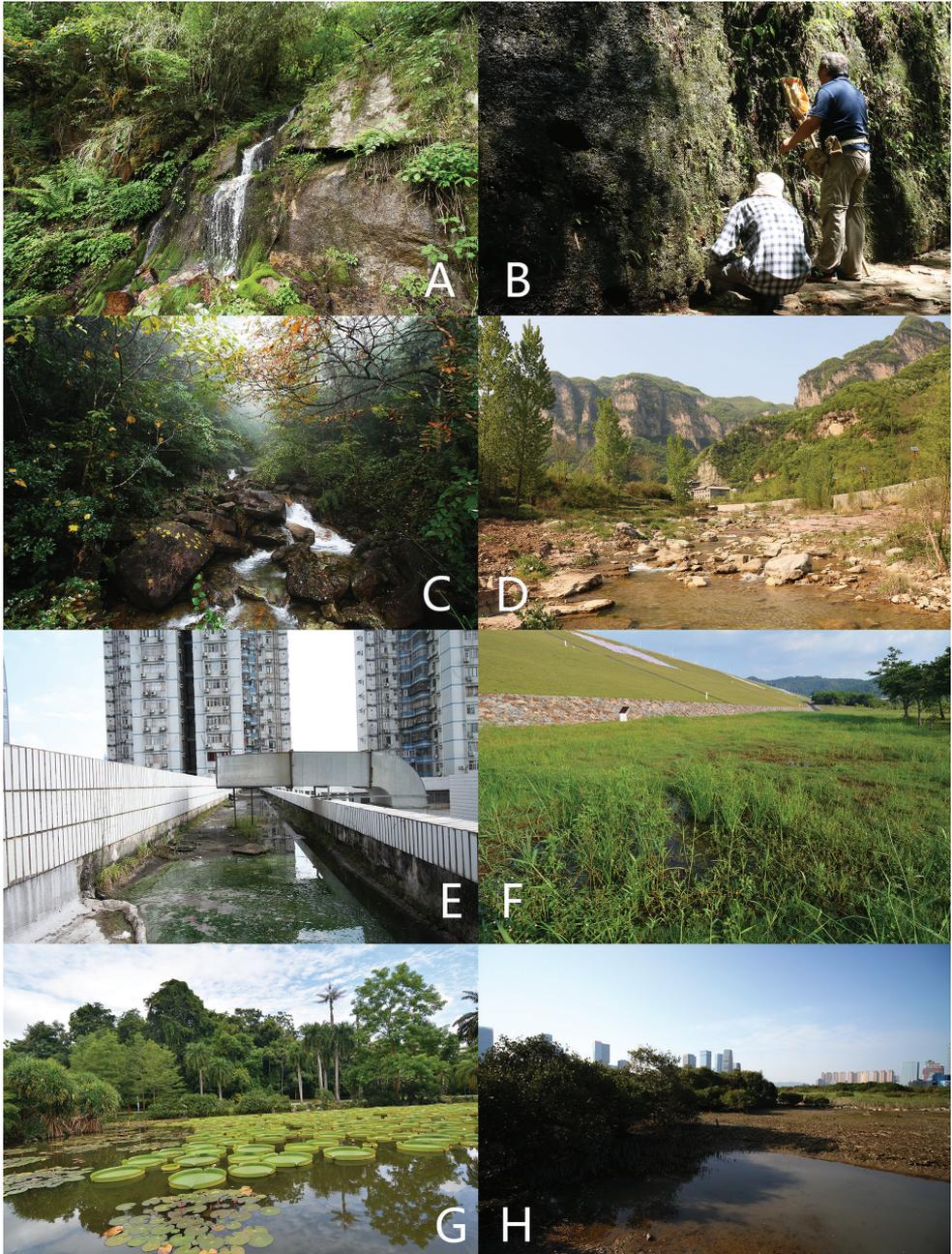


Figure 15. Habitats of Chinese *Coelostoma* **A** stone walls with running waters in forest (Yunnan) **B** wet stone walls with moss (Guangdong) **C** mountain stream in forest (Guangdong) **D** mountain river with rocky edges (Shanxi) **E** wastewater in city downtown (Guangdong) **F** lowland marshes with vegetation (Guangdong) **G** artificial lake (Yunnan) **H** brackish lagoon in mangrove reserve (Macao).

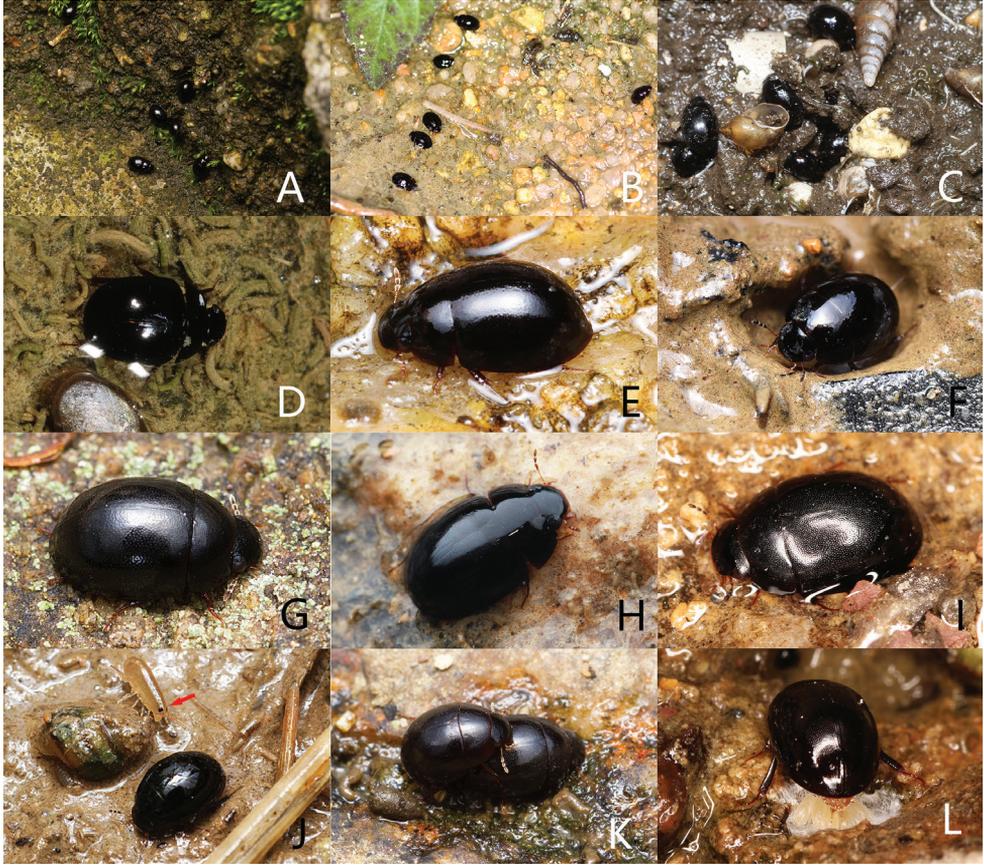


Figure 16. Habitats of Chinese *Coelostoma* spp. **A** *C. turnai* Hebauer, 2006 active at wet rocky ground beside a river at night (Fujian) **B** *C. sulcatum* Pu, 1963 on sandy gutterway with shallow flowing waters at night (Guangdong) **C** *C. phallicum* Orchymont, 1940 hided under a brick beside the wastewater during the day (Guangdong) **D** *C. phallicum* Orchymont, 1940 dived under water and fed on algal mats at night (Guangdong) **E** *C. bifidum* Jia, Aston & Fikáček on wet stone wall at night (Guangdong) **F** *C. sulcatum* Pu, 1963 on muddy edge of artificial lake at night (Yunnan) **G** *C. nankunshanense* sp. nov. on a stone in the middle of a forest stream at night (Guangdong) **H** *C. surkhetensis* Hebauer, 2002 in a wet stone on the edges of a forest stream at night (Xizang) **I** *C. wui* Orchymont, 1940 on the edges of a mountain river at night (Shanxi) **J** *C. sulcatum* Pu, 1963 on muddy edges of brackish lagoon at night, with a marine Amphipoda beside it (Macao) **K** *C. nankunshanense* sp. nov. mating at night (Guangdong) **L** *C. wui* Orchymont, 1940 ovipositing eggs on wet land at night (Shanxi).

Shandong, Sichuan, Taiwan, Yunnan, Xizang) (Jia et al. 2014, 2017; Liu et al. 2020; Przewoźny 2021). However, some records should be based on misidentification. We examined all the specimens assigned as *C. stultum* in SYSU. After excluded the specimens of *C. sulcatum*, the distribution of *C. stultum* in China is confirmed: Guangdong, Guangxi, Jiangxi, Hainan, Hubei, Hunan, Taiwan, Yunnan, Zhejiang.

A key to species of Chinese *Coelostoma*

This key is modified based on Jia et al. (2014, 2017) and Liu et al. (2020). *Coelostoma taiwanense* Liu, Hu & Fikáček, 2020 from Taiwan is based on the original description.

- 1 Mesofemora densely pubescent except at extreme apex (Jia et al. 2014: fig. 9). (Subgenus *Lachnocoelostoma*) **2**
- Mesofemora not pubescent, glabrous, more or less coarsely punctate and sparsely covered by short setae (Jia et al. 2014: figs 11, 13) **24**
- 2 Elytra with distinct serial punctures laterally (Figs 12A, B, 13A, B)..... **3**
- Elytra without serial punctures laterally **6**
- 3 Elytra serial punctures only visible laterally, without serial punctures on disc (Fig. 13B). Gonopore situated at midlength of median lobe (Jia et al. 2014: fig. 25)..... ***C. gentilii* Jia, Aston & Fikáček, 2014**
- Elytra series punctures visible on disc (Figs 12A, B, 13A). Gonopore situated subapically (Figs 2D, E, 3D, E, 7D, E) **4**
- 4 Elytron with 10 serial punctures, somewhat difficult to separate from the ground punctures in anterior half of elytron (Fig. 13A). Inner face of paramere straight, not curved inwards apically; median lobe rounded apically, not truncate or emarginate apically (Fig. 7D, E) ***C. pseudomartensi* sp. nov.**
- Elytron with 10 distinct serial punctures (Fig. 12A, B). Inner face of paramere curved inwards apically; apex of median lobe truncate or emarginate (Figs 2D, E, 3D, E) **5**
- 5 Intervals between series with two sizes of punctures, the small punctures much finer and shallower than the big punctures, big punctures almost as coarse as those of the series (Fig. 12A). First ventrite with complete median carina. Median lobe emarginate apically, outer face nearly parallel-sided from basal to middle, then gradually narrowing towards apex; gonopore distinctly wider than long; paramere gradually expanded from anterior fourth to apex, broadly truncate apically (Fig. 2D, E) ***C. dactylopunctum* sp. nov.**
- Intervals between series with two sizes of punctures, all finer than those of the series, the small punctures finer and shallower than the big punctures but not extremely so (Fig. 12B). First ventrite with median carina on basal two-thirds. Median lobe truncate apically, not emarginate, outer face nearly parallel-sided throughout; gonopore rounded, almost as wide as long; apex of paramere pointed (Fig. 3D, E) ***C. fortunum* sp. nov.**
- 6 Body size < 4.0 mm. Pronotum with much finer and sparser punctation than on elytra (Jia et al. 2014: fig. 7). Gonopore situated almost at midlength, median lobe with distinct lateral projections (Jia et al. 2014: fig. 23) ***C. hongkongense* Jia, Aston & Fikáček, 2014**
- Body size > 4.0 mm. Pronotum with punctation at most slightly finer and sparser than punctation on elytra. Median lobe of the aedeagus without subapical lateral projections..... **7**

- 7 Median lobe of aedeagus trilobate apically **8**
- Median lobe of aedeagus not emarginate to deeply emarginate apically..... **10**
- 8 Aedeagus narrowly elongate; Median lobe not wider than paramere (Jia et al. 2014: fig. 26)..... ***C. phallicum* Orchymont, 1940**
- Aedeagus relatively wider; median lobe wider than paramere **9**
- 9 Aedeagus large (ca. 1.1 mm long), median lobe strongly sclerotized, highly modified, saddle-shaped in lateral view, rather shorter than parameres; parameres rather broadened subapically inwards (Jia et al. 2017: figs 1–4)..... ***C. tangliangi* Jia, Lin, Chan, Skale & Fikáček, 2017**
- Aedeagus small (ca. 0.6 mm long), weakly sclerotized, median lobe plain, only slightly bent in lateral view, not so shorter than parameres; parameres not so broadened subapically inwards (Jia et al. 2017: figs 5–8) ***C. horni* (Régimbart, 1902)**
- 10 Aedeagus large (> 1.5 mm long), parameres largely overlapping apex of median lobe..... **11**
- Aedeagus smaller (< 1.5 mm long), parameres only slightly longer than median lobe..... **14**
- 11 Apex of the median lobe widely rounded or slightly emarginated, parameres broadly widened apically (Fig. 14A–I) ***C. wui* Orchymont, 1940**
- Apex of the median lobe narrowly rounded or angulate **12**
- 12 Median lobe widest in the middle, with a small rounded finger like apex; parameres broadly widened apically (Fig. 5A–C)..... ***C. mixtum* sp. nov.**
- Median lobe nearly parallel-sided in the middle, apex pointed or angulate; parameres not distinctly widened apically **13**
- 13 Apex of median lobe widely angulate; parameres weakly narrowing in apical third, slightly bent inward (Liu et al. 2020: fig. 1C)..... ***C. taiwanense* Liu, Hu & Fikáček, 2020**
- Median lobe strongly narrowing near apex, apex with a sharp prominent hook-shaped tooth ventrally; parameres relatively slender, with inner face almost straight (Fig. 5D, E)..... ***C. vagum* Orchymont, 1940**
- 14 Median lobe of aedeagus distinctly emarginate apically; gonopore situated basally or slightly before the midlength of the median lobe..... **15**
- Median lobe of aedeagus not or slightly emarginate; gonopore situated subapically to apically..... **19**
- 15 Median lobe bottle-shaped, strongly broadened basally; gonopore situated basally..... **16**
- Median lobe widest in the middle; gonopore situated slightly above the midlength of the median lobe **18**
- 16 Outer face of parameres convex basally; median lobe strongly widened basally, gonopore extremely transverse..... **17**
- Outer face of parameres nearly straight basally; basal portion of median lobe moderately widened, gonopore transverse round (Jia et al. 2014: fig. 22)..... ***C. hajeki* Jia, Aston & Fikáček, 2014**

- 17 Median strongly broadened basally. Outer face of parameres distinctly incised subapically (Fig. 6D–F) ***C. nankunshanense* sp. nov.**
- Median lobe not so broadened basally. Outer face of parameres slightly curved subapically (Jia et al. 2014: fig. 21) ***C. turnai* Hebauer, 2006**
- 18 Median lobe deeply emarginate apically; apex of paramere widened, sharply protruding inwards (Jia et al. 2014: fig. 20)
..... ***C. bifidum* Jia, Aston & Fikáček, 2014**
- Median lobe shallowly emarginate apically; paramere not widened apically, obtusely truncate at apex (Jia et al. 2014: fig. 24).....
..... ***C. coomani* Orchymont, 1932**
- 19 Median lobe of aedeagus not emarginate apically **20**
- Median lobe of aedeagus slightly emarginate or truncate apically **21**
- 20 Median lobe with a distinct subapical tooth and a lateral ridge subapically (Jia et al. 2019: figs 2, 3) ***C. jaculum* Jia, Angus & Bian, 2019**
- Median lobe with a rounded apex (Jia et al. 2019: fig. 1)
..... ***C. phototropicum* Jia, Angus & Bian, 2019**
- 21 Parameres obliquely truncate inwards apically (Jia et al. 2017: fig. 9).....
..... ***C. huangi* Jia, Aston & Fikáček, 2014**
- Inner face of parameres rounded or angulate apically **22**
- 22 Parameres strongly expanded apically, apex of paramere distinctly wider than apex of median lobe..... **23**
- Parameres not expanded apically, apex of paramere narrower than apex of median lobe (Fig. 8D, E) ***C. surkhetensis* Hebauer, 2002**
- 23 Size larger than 5.0 mm. Median lobe widest at midlength (Fig. 1D, E)
..... ***C. bannanicum* sp. nov.**
- Size smaller than 5.0 mm. Median lobe widest at apical third (Jia et al. 2017: fig. 11)..... ***C. jaechi* Jia, Lin, Chan, Skale & Fikáček, 2017**
- 24 Fifth abdominal ventrite slightly emarginate posteromesally, bearing strong setae mesally (Jia et al. 2014: fig. 30) (subgenus *Holocoelostoma*) **25**
- Posterior margin of the fifth abdominal ventrite entire, not emarginate in the middle (Jia et al. 2014: fig. 32) (subgenus *Coelostoma* s. str.)..... **26**
- 25 Median lobe almost parallel at basal third-fourth, apical fourth distinctly narrowed subapically; outer face of parameres more or less parallel, only slightly curved medially (Fig. 10B–J) ***C. sulcatum* Pu, 1963**
- Median lobe distinctly narrowed medially, then slightly widened at apical third; outer face of parameres broadened medially (Fig. 11A–F)
..... ***C. stultum* (Walker, 1858)**
- 26 Aedeagus slender, median lobe gradually attenuate toward apex, sharpened apically. Parameres strongly narrowed from apical fifth to apex, pointed apically (Jia et al. 2014: fig. 19) ***C. orbiculare* (Fabricius, 1775)**
- Aedeagus robust, median lobe and parameres not strongly narrowing apically **27**

- 27 Posterior femora broad to almost oval in form. Median lobe of aedeagus broad and short, parameres slender (Jia et al. 2014: fig. 16) ***C. vitalisi* Orchymont, 1923**
- Posterior femora not broadened, aedeagus not as above **28**
- 28 Body length 4.1–4.2 mm. Mesofemora finely and sparsely punctate. Median lobe of aedeagus strongly broadened at basal half, abruptly narrowed mesally, and almost parallel-sided in apical half, gonopore subtriangular, situated ca. at midlength of the median lobe (Jia et al. 2014: figs 17, 18) ***C. vividum* Orchymont, 1936**
- Body length 4.7–5.4 mm. Mesofemora with coarse and dense punctuation. Median lobe of aedeagus not so broadened basally and not so extremely narrow from middle to apex, gonopore apical or subapical **29**
- 29 Median lobe of the aedeagus bottle-shaped, with broad base and abruptly narrowed and gradually slightly narrowed toward apex, gonopore in shape of number 8 (Jia et al. 2014: fig. 15) ***C. fallaciosum* Orchymont, 1936**
- Median lobe of aedeagus gradually narrowed from base to apex, not abruptly narrowed, gonopore rhomboid in shape (in Jia et al. 2014: figs 12–14) ***C. subditum* Orchymont, 1936**

Discussion

Species excluded from Chinese fauna

Orchymont (1925) reported *Coelostoma transcaspicum* Reitter from China based on a series of specimens from Kiau-Tschau (Shandong) without examining the male genitalia (Balfour-Browne 1951). Later, he treated these specimens as *Coelostoma wui* without description (Orchymont 1935). When Orchymont (1940) described *C. wui* Orchymont 1940 as a new species, he assigned a male of the specimens from Kiau-Tschau as the holotype. Balfour-Browne (1951) also doubted the reliability of *C. transcaspicum* recorded by Orchymont in China. There is no doubt that the record of *C. transcaspicum* in China by Orchymont (1925) is based on misidentification because he assigned the specimens identified by him as *C. transcaspicum* Reitter in 1925 as *C. wui* Orchymont. Other reports on *C. transcaspicum* Reitter from China (Hansen 1999; Jia et al. 2019; Przewoźny 2021) are based on Orchymont (1925) report without any further examination to materials. We hence remove this species from the Chinese fauna. The records from other areas of Oriental realm are also dubious (Balfour-Browne 1951).

The status of *Coelostoma (Lachnocoelostoma) wui* Orchymont, 1940

Orchymont (1940) described *Coelostoma wui* Orchymont, 1940 from Kiau-Tschau (Shandong) and Chin-Kiang (Xinjiang). Jia et al. (2014, 2017) reported *C. wui* from

Fujian, Henan, Hubei, Hunan, Jiangxi and Shaanxi. Liu et al. (2020) reported *C. wui* from Taiwan. Hence it is widely distributed in China based on the reports above.

Jia et al. (2014) and Liu et al. (2020) illustrated the male genitalia of *C. wui*, which both clearly show the widely rounded apex of median lobe. This character is different from the aedeagus of *C. wui* drawn by Orchymont (1940) (Fig. 14A), but it has been neglected maybe because Orchymont's drawing was based on a dehydrated aedeagus. However, after we dissected more specimens assigned to *C. wui* Orchymont, 1940 from different locations, we found there are two different forms of aedeagus among these specimens, one of which has the median lobe corresponding with the illustrations by Jia et al. (2014) and Liu et al. (2020) (Fig. 14G–I), while the other form of median lobe is slightly emarginate apically and obliquely truncate subapically (Fig. 14B–F). This later one is more in conformity with Orchymont's drawing of the apex of the median lobe, but its median lobe does not abruptly widen subapically as Orchymont's drawing.

All specimens with an emarginate apex were found from the north of Nanling Mountains (Henan, Hubei, Hunan, Shandong, Shaanxi, Shanxi and Zhejiang), one of which (Pingyi County) (Fig. 14B) is close to the type locality of *C. wui*. Conversely, the specimens with a rounded apex of median lobe were only collected from the south of Nanling Mountains (Mt. Chebaling in Guangdong, Mt. Jiulianshan in Jiangxi and Wuyishan area in Fujian). This indicates the possibility that the specimens with a rounded apex of median lobe and the specimens with an emarginate apex of median lobe each maybe represents different species. The specimens collected from the south of Nanling Mountains, with a widely rounded apex of median lobe possibly represents another undescribed species (Fig. 14G–I). We prefer to treat all of specimens as *C. wui* here until the type of *C. wui* can be examined in order to prevent new synonymy.

The diversity and habitats of Chinese *Coelostoma* Brullé

The genus *Coelostoma* is a typical tropical group, only several species occurring in temperate region (Hansen 1999; Jia et al. 2014; Fikáček et al. 2019). In China, 90% species are only known from south of the Qinling Mountain-Huaihe River line, which is considered as the boundary of southern and northern China. The species diversity of the genus in China is high in Yunnan, Guangxi, Guangdong, Jiangxi Province and south-east part of Xizang where there is a part of Oriental realm (Jia et al. 2014, 2017, 2019), probably because of the warm and moist climate and the mountain terrain conditions.

Currently, 30 species of *Coelostoma* are known from China, of which two species are assigned to the subgenus *Holocoelostoma*, five species to *Coelostoma* (s. str.), and 23 species to *Lachnocoelostoma*. Compared with the fauna of other regions, we can come to following conclusions: (1) the Chinese fauna has a large species diversity of *Lachnocoelostoma* and nearly half of them seem to be very local and are likely endemic (Jia et al. 2014, 2017, 2019; Liu et al. 2020). (2) The diversity of *Coelostoma* (s. str.) and *Holocoelostoma* is comparatively low in China, all of them widespread species in Oriental realm (Jia et al. 2014, 2017; Liu et al. 2020; Sheth et al. 2020). This phenomenon also happens in some other Oriental fauna (Sheth et al. 2020). Sheth et al. (2020) considered this pattern of Oriental *Coelostoma* depends on their habitat preferences: Oriental species of *Coelostoma*

(s. str.) and *Holocoelostoma* occur in lowland standing waters, while *Lachnocoelostoma* has a much wider spectrum of habitats, including running waters (Sheth et al. 2020).

Previous studies on aquatic beetles indicate that species occurring in standing water tend to have larger ranges than species in running waters (e.g., Ribera and Vogler 2000; Liang et al. 2021). The assumption by Sheth et al. (2020) might explain why *Lachnocoelostoma* tends to have a larger diversity than *Coelostoma* (s. str.) in China. South China (Yunnan, Guangxi, Guangdong, Jiangxi, Taiwan and southeast part of Xizang) is a mountainous area where is fit to live for most of *Lachnocoelostoma* species. Some endemic species of *Lachnocoelostoma* only inhabit wet stone walls and edges of clean running water in mountainous areas (Fig. 15A–D), such as *C. bifidum* Jia, Aston & Fikáček, *C. hajeki* Jia, Aston & Fikáček, and *C. huangi* Jia, Aston & Fikáček (Jia et al. 2014). They were rarely collected in flatlands. In contrast, some widespread species of *Coelostoma* (s. str.) mostly occur in lowland standing water (Fig. 15F) (for example *C. fallaciosum* Orchymont). A few species of *Lachnocoelostoma* are widespread in different kinds of aquatic environments, even in cities. For example, Liu (2021) reported *C. phallicum* Orchymont inhabits water ditches in city streets of Taiwan. We also found *C. phallicum* occurring in wastewater, which leaked from the drain pipes under a tall residential building in downtown Shenzhen (Guangdong) (Figs 15E, 16C). In the wild, *C. phallicum* usually inhabits edges of mountain streams, rice fields and lowland ponds (Fig. 15G). Some *Holocoelostoma* can also be found in both standing and running waters (Fig. 16B), even in brackish water (Figs 15H, 16J) (for example *C. sulcatum* Pu). The species of *Holocoelostoma* are usually more widespread than species of *Lachnocoelostoma* and *Coelostoma* (s. str.), but with low diversity.

The characters of Chinese *Coelostoma* Brullé

Hansen (1991) provided the following characters as diagnostic characteristics for *Coelostoma*: (1) the first segment of hind tarsi distinctly longer than second, (2) the antennal club loosely segmented, (3) tarsi without fringe of swimming hairs, (4) elytra without serial punctures. However, the third and fourth characteristics show considerable variation among known Oriental *Coelostoma* species, especially in subgenus *Lachnocoelostoma*. For example, *C. thienemanni* Orchymont, 1932 with distinct dorsal swimming hairs on meso- and metatarsi (Fikáček et al. 2019); *C. martensi* Hebauer, 2002 and *C. gentilii* Jia, Aston & Fikáček, 2014 with serial punctures on elytra sublaterally; three new species described here, *C. dactylopunctum* sp. nov., *C. fortunum* sp. nov. and *C. pseudomartensi* sp. nov., with distinct serial punctures on the disc and lateral portion of the elytra (Figs 12A, B, 13B), which seems not to support these species as members of *Coelostoma*. These three species may be recognized as members of *Dactylosternum* based on this character. However, they are all aquatic (except biology of *C. fortunum* sp. nov. remains unknown), and extremely similar to all other species of *Coelostoma*. So, they are hence considered as members of *Coelostoma*. The terrestrial genus *Dactylosternum* seems to serve as a “dustbin” for coelostomatine species lacking any apparent generic characters (e.g., Fikáček 2010). Many species assigned to *Dactylosternum* lack biological information as do some unusual *Coelostoma* species (private communication from Fikáček). As a result,

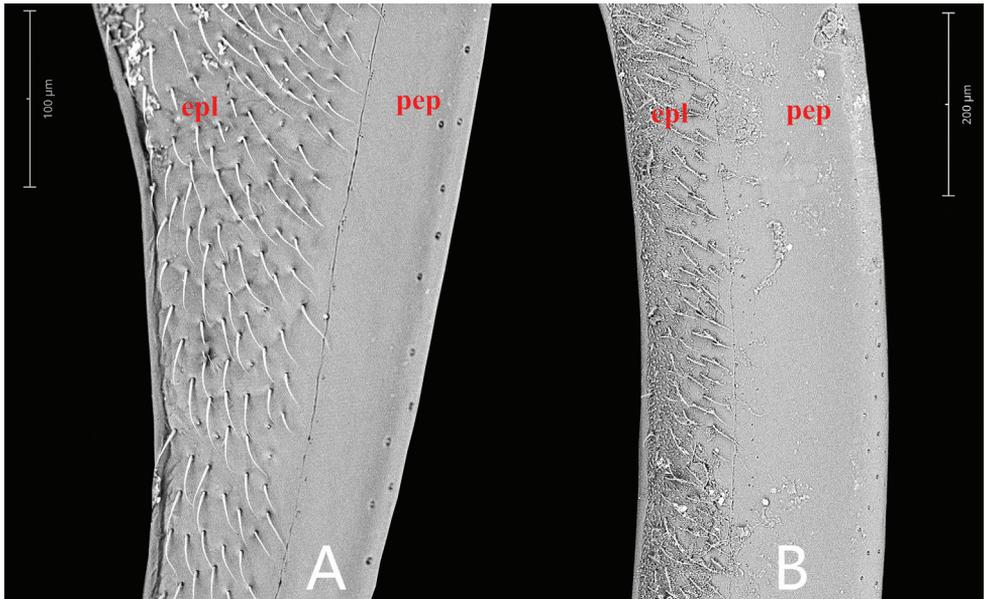


Figure 17. SEM micrographs of epipleuron (epl) and pseudepipleuron (pep) at the metacoxa level **A** *Coelostoma dactylopunctum* sp. nov. **B** *Dactylosternum latum* (Sharp, 1873).

we summarized the characteristics combined for distinguishing *Coelostoma* from *Dactylosternum* (1) aquatic or amphibious, (2) antennal club loosely segmented, (3) elytra with or without serial punctures, (4) elytral margin not explanate (except some species slightly explanate), (5) epipleuron wider than pseudepipleuron at the metacoxa level (Fig. 17A) (epipleuron distinctly narrower than pseudepipleuron at the metacoxa level in *Dactylosternum*; Fig. 17B). These characters allow a reliable identification of all Chinese species.

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Four new species of *Ditrigona* Moore (Lepidoptera, Drepanidae) in China and an annotated catalogue

Xiao-Jiang Guo^{1,2}, Rui Cheng¹, Shan Jiang¹, Da-Yong Xue¹, Hong-Xiang Han¹

1 Key Laboratory of Zoological Systematics and Evolution, Institute of Zoology, Chinese Academy of Sciences, Beijing 100101, China **2** College of Life Science, Hebei University, Baoding, Hebei 071000, China

Corresponding author: Hongxiang Han (hanhx@ioz.ac.cn)

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Abstract

The Chinese species of the genus *Ditrigona* Moore, 1888 are reviewed and an annotated catalogue is provided. Four new species are described from China: *Ditrigona sinespina* Jiang & Han, **sp. nov.**, *Ditrigona parva* Jiang & Han, **sp. nov.**, *Ditrigona concava* Guo & Han, **sp. nov.**, and *Ditrigona fusca* Guo & Han, **sp. nov.** *Derocra crystallina* Chu & Wang, 1987 and *Auzatella pentesticha* Chu & Wang, 1987 are newly combined into, respectively, the *derocina* and *quinaria* species groups of *Ditrigona*. *Ditrigona diana* Wilkinson is newly recorded in China. This results in 43 species of *Ditrigona* for the fauna of China. Illustrations of habitus and genitalia of the new species and most known species are presented.

Keywords

DNA barcoding, Drepaninae, new combination, taxonomy

Introduction

The genus *Ditrigona* was originally established by Moore (1888) on the basis of *Urapteryx triangularia* Moore, 1868 from India. Later, Warren (1922) described *Ditrigona regularis* Warren from Assam, and Bryk (1943) described *Ditrigona regularis differentiatia* Bryk from Burma. After a long silence in research into *Ditrigona*, Wilkinson (1968) provided the most comprehensive revision of the genus. He established three new generic synonyms of the genus, and transferred most of the species involved into *Ditrigona*; altogether he recorded 40 species and 12 subspecies for the genus, including

the description of 18 new species and five new subspecies. He also placed the species into four species groups, and provided descriptions and diagnosis of the genus, species groups, species, and subspecies. More recently, on the basis of Wilkinson's work, Chu and Wang (1988) recorded 36 species from China, including description of a new species *Ditrigona uniuncusa* Chu & Wang, and these species were included in vol. 3 of *Fauna Sinica* (Chu and Wang 1991). Holloway (1998) described two species *Ditrigona paludicola* and *Ditrigona wilkinsoni* from Borneo. The most recent research was provided by Li et al. (2015), who described *Ditrigona clavata* from Guangdong, China, and by Jiang and Han (2019), who described *Ditrigona tenuiata* from Sichuan, China and provided a checklist of the *triangularia* species group.

Further study of the specimens of *Ditrigona* from IZCAS and MHBUS shows that four new species need to be described. The purposes of this paper are to provide a survey and an annotated catalogue of Chinese *Ditrigona* species, to describe four new species, to newly record *Ditrigona diana* Wilkinson, 1968 from China, to transfer two species into the genus, and to provide illustrations of external features and genitalia of new species and most known species. This results in 43 species and 8 subspecies of *Ditrigona* for the fauna of China.

Materials and methods

The depositories of all the types and examined specimens are indicated as follows:

NHMUK	The Natural History Museum, London, UK;
ZFMK	Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany;
NHRS	Naturhistoriska Riksmuseet, Stockholm, Sweden;
IZCAS	Institute of Zoology, Chinese Academy of Sciences, Beijing, China;
MHBUS	The Museum of Hebei University, Baoding, China;
XTBG	Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Yunnan, China;
SCAU	South China Agricultural University, Guangzhou, China;
MNHN	Muséum National d'Histoire Naturelle, Paris, France;
DEI	Deutsches Entomologisches Institut, Germany.

Terminology for the genitalia is based on Wilkinson (1968). Moths were photographed with a digital camera (Canon Pc1057). Composite images were generated using Auto-Montage software version 5.03.0061 (Synoptics Ltd). The sharpness-contrast of the photos was enhanced and the plates compiled using Adobe Photoshop (CS 5.1).

A total of 16 specimens of the species of the *triangularia* species group bearing a tail process were used for sequencing the DNA barcoding region of the mitochondrial COI gene. DNA barcodes of 15 specimens were successfully obtained in this work, and one sequence of *D. concava* was downloaded from BOLD: its related voucher specimen was donated by Prof. Akihior Nakamura from Xishuangbanna Tropical

Table 1. Details of specimens used in molecular analysis of the DNA barcode region.

Sample ID	Species	Date Collected	Locality	Collectors	GenBank/BOLD accession number
LEP M 33040	<i>D. parva</i>	6–8.Aug.2016	Tengchong, Yunnan	Ban XS	OL664050
LEP M 33049	<i>D. parva</i>	6–8.Aug.2016	Tengchong, Yunnan	Ban XS	OL664048
LEP M 33059	<i>D. parva</i>	6–8.Aug.2016	Tengchong, Yunnan	Ban XS	OL664049
LEP M 33016	<i>D. regularis</i>	9–12.Aug.2016	Yunlong, Yunnan	Ban XS	MK087682
LEP M 33027	<i>D. regularis</i>	6–8.Aug.2016	Tengchong, Yunnan	Ban XS	MK087683
LEP M 32911	<i>D. regularis</i>	10–13.Aug.2017	Xinping, Yunnan	Cui L	MK087678
LEP M 35671	<i>D. regularis</i>	14–16.Jul.2018	Anha, Sichuan	Cui L, Jiang S	MK087688
LEP M 32976	<i>D. triangularia</i>	13–14.Jul.2014	Weixi, Yunnan	Pan XD	MK087679
LEP M 25081	<i>D. tenuiata</i>	11.Sep.2016	Luding, Sichuan	Li XX	MK087687
LEP M 23038	<i>D. tenuiata</i>	7–10.Aug.2016	Kangding, Sichuan	Cui L	MK087685
LEP M 33029	<i>D. sinespina</i>	9–12.Aug.2016	Yunlong, Yunnan	Ban XS	MK087684
LEP M 33001	<i>D. sinespina</i>	9–12.Aug.2016	Yunlong, Yunnan	Ban XS	MK087680
LEP M 33002	<i>D. sinespina</i>	9–12.Aug.2016	Yunlong, Yunnan	Ban XS	MK087681
LEP M 33196	<i>D. sinespina</i>	26–27.Jun.2014	Tengchong, Yunnan	Pan XD	MK087677
LEP M 32975	<i>D. concava</i>	13–14.Jul.2014	Weixi, Yunnan	Li XX	OL664047
ARB00027811	<i>D. concava</i>	11.Aug.2011	Ailao Shan, Yunnan	Kitching RL, Ashton LA	SCDBC000200

Botanical Garden, Chinese Academy of Sciences (XTBG). Four of these specimens were *D. regularis*, one of *D. triangularia*, two *D. tenuiata*, four *D. sinespina* sp. nov., three *D. parva* sp. nov., and two *D. concava* sp. nov.

Protocols of DNA extraction and sequencing followed Ban et al. (2018). Details of studied specimens, including GenBank and BOLD accession numbers are summarized in Table 1. Pairwise distances within and between *Ditrigona* species for the COI barcoding region (612 bp) were calculated, and a neighbour-joining (NJ) tree (Saitou and Nei 1987) was constructed based on the Kimura two-parameter (K2P) method (Kimura 1980) using MEGA 6.0.

Systematics

Genus *Ditrigona* Moore, 1888

Ditrigona Moore, 1888: 258. Type species: *Urapteryx triangularia* Moore, 1867.

Leucodrepana Hampson, 1893: 333. Type species: *Leucodrepana idaeoides* Hampson, 1892.

Leucodrepanilla Strand, 1911: 198. Type species: *Corycia sacra* Butler, 1878.

Auzatella Strand, 1917: 148. Type species: *Auzata micronioides* Strand, 1917.

Thaleridia Moore, 1888: 266. Type species: *Thaleridia pruinosa* Moore, 1888.

Generic characters. The generic characters of *Ditrigona* and its differentiation from related genera are detailed in Wilkinson (1968) and Jiang and Han (2019).

Distribution. The species of *Ditrigona* are mainly distributed in the Oriental region.

derocina species group

Wilkinson (1968) placed three species in the *derocina* species group: *Ditrigona derocina* (Bryk), *Ditrigona diana* Wilkinson, and *Ditrigona pruinosa* (Moore). The two former species have been recorded in China, and a further species, *Deroca crystallata* Chu & Wang, 1987 is newly placed in this species group in this work.

Species of the *derocina* species group are characterized by unipectinate antennae and semi-transparent wings. In the male genitalia, the *derocina* species group is unusual in *Ditrigona* in having sclerotization of the vinculum, and a quite long and narrow aedeagus. The eighth sternite is distinguished by large and curved octavals, and the tergite protrudes strongly. The female genitalia are characterized by having a very long ductus bursae, an ostial plate, an accessory sac and a long and narrow signum.

1. *Ditrigona derocina* (Bryk, 1943)

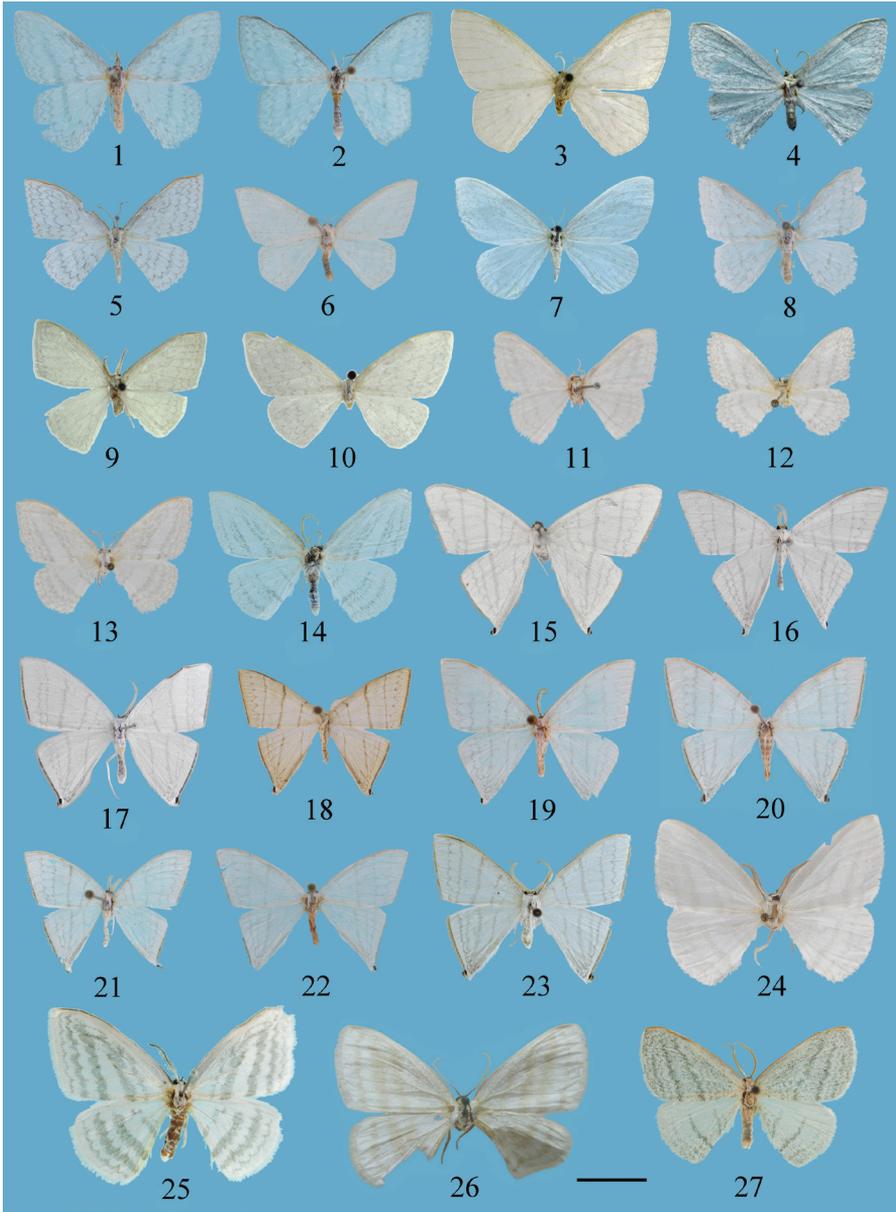
Figs 1, 48, 82, 116, 152

Peridrepana derocina Bryk, 1943: 6. Holotype ♀, Burma: Kambaiti (NHRS).

Ditrigona derocina: Wilkinson, 1968: 418.

Material examined. CHINA: **Hubei** (IZCAS): 1♂7♀, Xuanen, Liangxihe, 796 m, 20–22.IX.2015, leg. Yao Jian, Zhao Kaidong. **Hunan** (IZCAS): 2♀, Sangzhi, Badagong Shan, Xiaozhuangping, 1420 m, 14.VI.2015, leg. Yao Jian, Zhao Kaidong. **Sichuan** (IZCAS): 1♀, Emei Shan, 0km, 1288 m, 31.VII.2013, leg. Cheng Rui. **Chongqing** (IZCAS): 1♂, Wu Shan, Wulipo, Dangyangcongping, 1773 m, 25.VII.2013, leg. Cheng Rui. **Yunnan** (IZCAS): 1♀, Lushui, Yaojiaping, 2500 m, 4.VI.1981, leg. Liao Subai; 2♂1♀, Tengchong, Houqiao, 1620 m, 6–8.VIII.2016, leg. Ban Xiaoshuang; 3♀, Tengchong, Heinitang, 1930 m, 28–30.V.1992, leg. Xue Dayong; 1♂1♀, same locality, 1824 m, 26–27.VI.2014, leg. Li Xinxin, Pan Xiaodan; 2♂3♀, Tengchong, Dahaoping, 2020 m, 24–26.V.1992, leg. Xue Dayong; 5♂2♀, same locality, 2020 m, 5–7.VIII.2007, leg. Wu Chunguang, Xue Dayong; 3♀, Lushui, Pianma, 1980 m, 3–4.VII.2014, leg. Pan Xiaodan; 1♀, Pianma, Dianxin hotel, 1970 m, 8–12.V.2011, leg. Yang Xiushuai, Wang Ke; 1♀, Gongshan, Puladi, 1298 m, 6–7.VII.2014, leg. Pan Xiaodan. **Tibet** (IZCAS): 1♂, Zham, 2400 m, 4.VII.1975, leg. Wang Ziqing; 2♀, same locality and collector, 2200 m, 23–30.VI.1957; 1♂1♀, Bomi, Tangmai, 2000 m, 26–28.VI.2015, leg. Li Xinxin; 1♀, Bomi, Tangmaidaqiao, 2037 m, 13–14.VI.2016, leg. Li Xinxin. **INDIA** (ZFMK): 1♂, Sikkim, Namchi, 1000 m, 2.VIII.1986, leg. W. Thomas, photograph examined.

Distribution. China (Hubei, Hunan, Sichuan, Chongqing, Yunnan, Tibet), India, Myanmar.



Figures 1–27. Adults of *Ditrigona* **1** *D. derocina*, male **2** *D. diana*, male **3** *D. crystallina*, holotype, male **4** *D. spilota*, male, ZFMK **5** *D. furvicosta*, male **6** *D. jordanaria*, male **7** *D. media*, paratype, male, ZFMK **8** *D. sericea*, male **9** *D. sericea*, male (*Auzatella pentesticha* Chu & Wang, allotype) **10** *D. pentesticha*, holotype, female **11** *D. q. erminea*, holotype, male, ZFMK **12** *D. q. spodia*, holotype, male, ZFMK **13** *D. q. leucophaea*, holotype, male, ZFMK **14** *D. obliquilinea thibetaria*, male **15** *D. triangularia*, lectotype, male **16** *D. uniuncusa*, male **17** *D. tenuiata*, holotype, male **18** *D. regularis*, male **19, 20** *D. sinespina* sp. nov., **19** holotype, male **20** paratype, female **21, 22** *D. parva* sp. nov., **21** holotype, male **22** paratype, female **23** *D. concava* sp. nov., holotype, male **24** *D. titana*, holotype, male, ZFMK **25** *D. pomenaria* male **26** *D. polyobotaria*, holotype, female, ZFMK **27** *D. typhodes*, male. Scale bar: 1 cm.

2. *Ditrigona diana* Wilkinson, 1968; new record for China

Figs 2, 49, 83, 117, 153

Ditrigona diana Wilkinson, 1968: 420. Holotype ♂, India: Gopaldara (NHMUK).

Material examined. INDIA: 1♂ (ZFMK), paratype, Khasis, IV.1895, Nat. Coll., Collectio. H.J. Elwes, moth photographed examined. CHINA: Guangxi (IZCAS): 1♂1♀, Napo, Defu, 1350 m, 19.VI.2000, leg. Li Wenzhu. Yunnan (IZCAS): 1♀, Xishuangbanna, Mengla, Menglun, 550 m, 12–15.V.2017, leg. Jiang Shan; 5♂2♀, Xishuangbanna, Mengla, Bubang, 680 m, 18–20.V.2017, leg. Jiang Shan; 1♂, Tengchong, Zhengding, 1833 m, 6–7.VIII.2013, leg. Li Xinxin; 1♂, Pingbian, Daweishan, 2090 m, 4–8.VIII.2017, leg. Cui Le; 1♂, Baoshan, Baihualing, 1520 m, 11–13.VIII.2007, leg. Wu Chunguang; 1♀, Tengchong, Dahaoping, 2020 m, 5–7.VIII.2007, leg. Wu Chunguang; 1♀, Tengchong, Heinitang, 1824 m, 26–27.VI.2014, leg. Pan Xiaodan; 1♀, Ruili, Wanding, Forest Garden, 900 m, 29.IV.2011, leg. Yang Xiushuai, Wang Ke; 2♀, Ruili, Wanding, Tianehu, 923 m, 30.IV.–1.V.2011, leg. Yang Xiushuai, Wang Ke; 8♀, Ruili, Mengmao, Mangling, 900 m, 26–27.IV.2011, leg. Yang Xiushuai, Wang Ke. Tibet (IZCAS): 1♂2♀, Mêdog, Yarang, 1091 m, 20–23.VIII.2006, leg. Lang Songyun.

Distribution. China (Guangxi, Yunnan, Tibet), India.

3. *Ditrigona crystallata* (Chu & Wang, 1987), comb. nov.

Figs 3, 50, 84, 118, 154

Deroca crystallata Chu & Wang, 1987: 116. Holotype ♂, China: Yunnan: Lushui: Yaojiaping (IZCAS).

Note. The species *Deroca crystallata* Chu & Wang, 1987 was described from Yunnan, Sichuan and Tibet. Its male genitalia obviously belong to the *derocina* species group of *Ditrigona*, and we therefore transfer the species to *Ditrigona*. The male genitalia are almost identical to those of *D. derocina*. However, the corpus bursae of the female genitalia is scobinate, which is different from the smooth ones of *D. derocina* and *D. diana*, though they share a very long and narrow ductus bursae and a slender curved signum. The ostial plate is invisible in *D. crystallata*, and it is most probably present, though it seems that the sternite was incorrectly removed and the abdomen is not preserved on the slide.

Material examined. CHINA: Yunnan (IZCAS): 1♂, holotype of *Deroca crystallata*, Lushui, Yaojiaping, 2500 m, 4.VI.1981, leg. Liao Subai; 1♂, Tengchong, Dahaoping, 2020 m, 24–26.V.1992, leg. Xue Dayong; 1♂, same locality, 5–7.VIII.2007, leg. Wu Chunguang, Xue Dayong. Sichuan (IZCAS): 1♀, allotype of *Deroca crystallata*, Guan Xian, Qingcheng Shan, 700–1600 m, 4.VI.1979, leg. Shang Jinwen. Tibet (IZCAS): 1♂, paratype of *Deroca crystallata*, Zham, 2400 m, 4.VII.1975, leg. Wang Ziqing.

Distribution. China (Sichuan, Yunnan, Tibet).

***quinaria* species group**

Wilkinson (1968) recorded 11 species in the *quinaria* species group: *Ditrigona spilota* Wilkinson, *Ditrigona inconspicua* (Leech), *Ditrigona furvicosta* (Hampson), *Ditrigona jordanaria* (Oberthür), *Ditrigona media* Wilkinson, *Ditrigona innotata* (Hampson), *Ditrigona sericea* (Leech), *Ditrigona quinaria* (Moore), *Ditrigona obliquilinea* (Hampson), *Ditrigona idaeoides* (Hampson), and *Ditrigona spatulata* Wilkinson. The former 10 species are recorded in China, and *Auzatella pentesticha* Chu & Wang is newly combined to *Ditrigona* in this work.

Species of the *quinaria* species group share bipectinate or serrate antennae with some species of the *triangularia* and *mytllata* species groups. In the male genitalia, the uncus is usually single, but sometimes bifurcate or notched. The single uncus resembles that of species of the *derocina* species group, but the group can be differentiated by the lack of sclerotization on the vinculum, and the large and broad saccus. The small and setose valva lacking a posterior projection also differs from those in the *triangularia* and *mytllata* species groups. The aedeagus is often characterized by the presence of a minute to large apical projection (not present in *D. spilota* and *D. obliquilinea*, and the situation unknown in *D. innotata* and *D. idaeoides*). The eighth sternite is modified with short octavals, and the tergite is often shallowly to moderately concave, occasionally straight or protruding with tiny lateral projections. The female genitalia lack an ostial plate; the ductus bursae is short and broad, and the corpus bursae usually has an accessory sac and a long and thin signum.

4. *Ditrigona spilota* Wilkinson, 1968

Figs 4, 51, 85, 119, 155

Ditrigona spilota Wilkinson, 1968: 423. Holotype ♂, China: Yunnan, Likiang (ZFMK).

Material examined. CHINA: Yunnan: 1♂ (ZFMK), paratype, Li-kiang (China), Provinz Nord-Yuennan, 16.VIII.1935, H. Höne, dissected in this work; 1♀ (ZFMK), same locality, 20.VIII.1935, H. Höne, dissected in this work; 1♀ (IZCAS), Tengchong, Danzhalinchang, 2500 m, 2–4.VI.1992, leg. Xue Dayong; 1♂1♀ (IZCAS), Lijiang, 3700 m, 9.VIII.2012, leg. Ashton; 2♂, same locality and collector, 3400 m, 17.VIII.2012. Sichuan (IZCAS): 1♀, Luding, Moxi, Hailuogou, 2596 m, 12.IX.2016, leg. Li Xinxin; 1♀, Luding, Moxi, Hailuogou Guancezhan, 3000 m, 10.IX.2016, leg. Li Xinxin.

Distribution. China (Sichuan, Yunnan).

Remarks. Compared to the male genitalia of the holotype (fig. 17 in Wilkinson 1968) of *D. spilota*, the socii of the paratype examined are much broader and blunter, while the aedeagus and 8th segment have no distinct differences. Further study is needed to investigate whether this is intraspecific variation, or more than one species is present in the large type series.

5. *Ditrigona inconspicua* (Leech, 1898)

Teldenia inconspicua Leech, 1898: 363. Lectotype ♂, China: Sichuan, Ta-Chien-lu (NHMUK).

Peridrepana inconspicua: Warren, 1922: 449.

Ditrigona inconspicua: Wilkinson, 1968: 425.

Material examined. No.

Distribution. China (Sichuan).

6. *Ditrigona furvicosta* (Hampson, 1912)

Figs 5, 52, 86, 120, 156

Leucodrepana furvicosta Hampson, 1912: 1271. Lectotype ♂, India: Sikkim (NHMUK).

Ditrigona furvicosta: Wilkinson, 1968: 428.

Material examined. CHINA: Yunnan: 1♀ (IZCAS), Tengchong, Danzhalinchang, 2500 m, 2–4.VI.1992, leg. Xue Dayong; 1♂1♀ (IZCAS), same locality, 2479 m, 30.VI.–1.VII.2014, leg. Pan Xiaodan; 2♂ (IZCAS), Lijiang, Alpine Botanical Garden, 3260–3452 m, 20.VI.2009, leg. Qi Feng; 1♂ (ZFMK), Li-kiang (China), Provinz Nord-Yuennan, 23.VI.1935, H. Höne, moth photograph examined. Tibet (IZCAS): 2♀, Yadong, Yadonglinchang, 2690 m, 24.VI.2016, leg. Li Xinxin; 1♂3♀, Nyingchi, Pêlung, 2115 m, 1.IX.2005, leg. Wang Xuejian; 1♂ (MHBU), Zham, 27.VII.2005, leg. Shi Aimin.

Distribution. China (Yunnan, Tibet), India.

7. *Ditrigona jordanaria* (Oberthür, 1923)

Figs 6, 53, 87, 121

Corycia jordanaria Oberthür, 1923: 238. Lectotype ♂, China: Sichuan, Ta-t sien-lu (ZFMK).

Ditrigona jordanaria: Wilkinson, 1968: 429.

Material examined. CHINA: Henan (IZCAS): 1♂, Baiyun Shan, 1550 m, 13–15.VIII.2008, leg. Xue Dayong, Song Wenhui. Shaanxi (IZCAS): 1♂, Ningshan, Huoditang, 1520 m, 13–17.VIII.2016, leg. Cheng Rui, Jiang Shan. Sichuan: 1♂ (IZCAS), Luding, Hailuogou, 3010 m, 2–4.VIII.2014, leg. Pan Xiaodan; 1♂ (ZFMK), Ta-t sien-Lou, 1899, Chasseurs indigenes, Ex. Oberthür Coll., Brit. Mus. 1927-3, moth photograph examined.

Distribution. China (Henan, Shaanxi, Sichuan, Tibet).

8. *Ditrigona media* Wilkinson, 1968

Figs 7, 54, 88, 122

Ditrigona media Wilkinson, 1968: 431. Holotype ♂, China: Sichuan, Ta-tsien-Lou (NHMUK).

Material examined. CHINA: **Sichuan** (ZFMK): 1♂, paratype, Batang, Tibet [Sichuan], Alpine Zone, ca. 5000 m, 7.VI.1936, H. Höne, moth photograph examined; 1♂, same locality, 23.VI.1938, H. Höne, dissected in this work. **Gansu** (IZCAS): 1♂, Dangchang, Guanegou, 2045 m, 1–3.VIII.2016, leg. Cheng Rui, Jiang Shan.

Distribution. China (Gansu, Sichuan, Tibet).

9. *Ditrigona innotata* (Hampson, 1893)

Drepana innotata Hampson, 1893: 335. Lectotype ♀, China: Kulu (Young) (NHMUK).

Peridrepana innotata: Warren, 1922: 449.

Ditrigona innotata: Wilkinson, 1968: 433.

Material examined. No.

Distribution. China (Tibet).

10. *Ditrigona sericea* (Leech, 1898)

Figs 8–9, 55–56, 89–90, 123, 157

Teldenia sericea Leech, 1898: 263. Lectotype ♂, China: Sichuan, Moupin (NHMUK).

Drepana fulvicosta Dudgeon, 1899: 652. Syntype, India.

Peridrepana fulvicosta: Gaede, 1931: 7.

Leucodrepana nivea brimanica Bryk, 1943: 7. Holotype ♀ (as ♂): Burma: Kambaiti (NHRS).

Ditrigona sericea: Wilkinson, 1968: 434.

Material examined. CHINA: **Shaanxi** (IZCAS): 2♀, Ningshan, Huoditang, 1520 m, 13–17.VIII.2016, leg. Cheng Rui, Jiang Shan. **Sichuan**: 3♂1♀ (IZCAS), Luding, Moxi, Boyangcun, 1691 m, 1.VIII.2014, leg. Li Xinxin; 1♀ (IZCAS), Baoxing, Dashuigou, Guanhuozhan, 1591 m, 1–5.VIII.2016, leg. Cui Le; 1♀ (IZCAS), Emei Shan, Qingyinge, 800–1000 m, 14.V.1957, leg. Zhu Fuxing; 1♂ (ZFMK), Ta-Tsien-Lou, Tche To, Chasseurs Indigènes, 1894, Ex. Oberthür Coll., Brit. Mus. 1927-3, moth photograph examined; 1♂ (ZFMK), Siao-Lou, 1903, Coll. R. P. Déjean. **Yunnan** (IZCAS): 1♂1♀, Tengchong, Houqiao, 1553 m, 28–29.VI.2014, Pan Xiaodan, Li Xinxin; 11♂17♀,

same locality, 1620 m, 6–8.VIII.2016, leg. Ban Xiaoshuang; 1♀, same locality, 1080 m, 31.V.–1.VI.1992, leg. Xue Dayong; 3♂5♀, Tengchong, Dahaoping, 2020 m, 24–26.V.1992, leg. Xue Dayong; 3♂1♀, same locality, 2020 m, 5–7.VIII.2007, leg. Xue Dayong; 5♂1♀, same locality and date, leg. Wu Chunguang; 1♂2♀, ibidem, leg. Lang Songyun; 1♂2♀, Tengchong, Heinitang, 1824 m, 26–27.VI.2014, leg. Pan Xiaodan; 1♀, same locality and date, leg. Li Xinxin; 1♂, Tengchong Shidi, 1730 m, 3–5.VIII.2016, leg. Ban Xiaoshuang; 1♂3♀, Tengchong, Qushi, Dabacun, 1873 m, 4.VIII.2013, leg. Liu Shuxian; 2♂, same locality, 1823 m, 5.VIII.2013, leg. Liu Shuxian; 15♂5♀, Gongshan, Dulongjiang, 1505 m, 8–9.VII.2014, leg. Pan Xiaodan; 1♀, Gaoligong, Nankang, 2000 m, 21.III.2007, leg. Zhang Peiyi; 1♀, Gaoligong, Baihualing, 1500 m, 16.IX.2007, leg. Zhang Peiyi; 1♂, Baoshan, Bawan, 1040 m, 8–10.VIII.2007, leg. Wu Chunguang; 1♂, Pingbian, Dawei Shan, 2043 m, 19–20.VII.2016, leg. Ban Xiaoshuang; 5♂7♀, same locality, 2090 m, 4–8.VIII.2017, leg. Cui Le; 1♀, Yongsheng, Liude, 2300 m, 9.VII.1984, leg. Chen Yixin; 3♂1♀, Kunming, Xishan, 2100 m, 23.III.1958, leg. Meng Xuwu; 1♂, Lushui, Pianma, 1980 m, 3–4.VII.2014, leg. Li Xinxin; 1♂, Weixi, Pantiange, 2570 m, 15–16.VII.2014, leg. Pan Xiaodan; 2♂, Dali, Cangshan, 2226 m, 23–24.VI.2014, leg. Pan Xiaodan; 3♂1♀, same locality and date, leg. Li Xinxin; 1♂1♀, Yunlong, Tianchi, 2570 m, 9–12.VIII.2016, leg. Ban Xiaoshuang; 1♂2♀, Yunlong, Tianchi, 2570 m, 9–12.VIII.2016, leg. Ban Xiaoshuang; 2♂, Ailao Shan, 2000 m, 19–20.VIII.2011, leg. Ashton, ex. XTBG. **TIBET** (IZCAS): 1♂, allotype of *Auzatella pentesticha* Chu & Wang, 1987, Zham, 2400 m, 26.VI.1975, leg. Huang Fusheng; 1♂, Bomi, Tangmai, 2000 m, 26–28.VI.2015, leg. Li Xinxin; 2♂7♀, Mêdog, Hanmi, 2095 m, 10–11.VIII.2006, leg. Lang Songyun; 1♂3♀, Mêdog, Aniqiao, 1060 m, 12–13.VIII.2006, leg. Lang Songyun; 1♀, Mêdog, Dayandong, 2880 m, 9.VIII.2006, leg. Lang Songyun; 1♀, Mêdog 108K, 848 m, 4.VIII.2014, leg. Cheng Rui, Cui Le; 1♂2♀, Nyingchi, Pëlung, 1900 m, 24–25.VI.2015, leg. Li Xinxin; 1♂1♀, same locality, 2115 m, 1.IX.2005, leg. Wang Xuejian; 1♀, Nyingchi, Pëlung, Mamba, 2115 m, 1–2.IX.2005, leg. Wang Xuejian; 1♂1♀, Cona, Lexiang, Senmuzha, 2741 m, 2–3.VI.2016, leg. Li Xinxin; 1♀, Cona, Lexiang, Lewangdaqiao, 2423 m, 7.VI.2016, leg. Li Xinxin; 1♂, Yadong, Yadonglinchang, 2690 m, 24.VI.2016, leg. Li Xinxin; 1♂, Gyirong, Resuo, 18.VIII.1984, leg. Pu Qiongqiong; 1♀, Gyirong, Tuowu, 3300 m, 4.VIII.1975, leg. Huang Fusheng; 1♀, Zham, Kouan, 26.IX.1984, leg. Li Aihua; 1♀, Zham, 20.IX.1984, leg. Guo Sengbao, 1♀, Zham, Daqu, 3300 m, 2.VII.1957, leg. Wang Ziqing; 1♀, Zham, Nyalam, 2200 m, 9.V.1966, leg. Wang Shuyong. **MYANMAR** (ZFMK): 1♀, Upper Burma Htawgaw, 6000ft, Coll. A.E. Swann.

Distribution. China (Shaanxi, Sichuan, Yunnan, Tibet), India, Myanmar.

Remarks. Chu and Wang (1987) described *Auzatella pentesticha* based on four specimens from Tibet and Hubei Province, and designated the female from Quxam, Tibet as the holotype, the male from Zham, Tibet as the allotype, and another two females from Hubei as paratypes. Unfortunately, the genitalia slide of the female holotype could not be found. In the original description, the figure of the female genitalia is from one of the paratypes from Hubei Province. The only male from Tibet has genitalia identical to those of *D. sericea*, and the two females from Hubei belong to *D. quinaria*. Although the holotype and allotype specimens were collected from two very close localities (Quxam

and Zham are less than 30 km apart), and in a very similar season (7 July, 26 June), we hesitate to synonymize *Auzatella pentesticha* Chu & Wang with *Ditrigona sericea* (Leech) without having seen the genitalia of the holotype; however, we redetermine the male allotype as *D. sericea*, and the two paratypes as *Ditrigona quinaria erminea* Wilkinson.

11. *Ditrigona pentesticha* (Chu & Wang, 1987), comb. nov.

Fig. 10

Auzatella pentesticha Chu & Wang, 1987: 108. Holotype ♀, China: Tibet: Quxam (IZCAS).

Material examined. CHINA: Tibet (IZCAS): 1 ♀, holotype, Quxam, 3300 m, 7.VII.1975, leg. Wang Ziqing.

Distribution. China (Tibet).

Remarks. As stated under the above species, this species now only includes the female holotype. The validity of the species needs further study, for example, by obtaining a DNA barcode from the holotype.

12. *Ditrigona quinaria* (Moore, 1867)

Drepanodes quinaria Moore, 1867: 618. Neotype ♂, India: Darjiling (NHMUK).

Ditrigona quinaria: Wilkinson, 1968: 438.

Note. At present, *D. quinaria* comprises five subspecies; four are recorded from China, the exception being *D. quinaria nivea* (Hampson), which is distributed in India.

***Ditrigona quinaria quinaria* (Moore, 1867)**

Material examined. No.

Distribution. China (Tibet), India.

***Ditrigona quinaria erminea* Wilkinson, 1968**

Figs 11, 57, 91, 124, 158

Ditrigona quinaria erminea Wilkinson, 1968: 442. Holotype ♂, China: Shaanxi, Tapaishan-im-Tsinling (ZFMK).

Material examined. CHINA: Shaanxi (ZFMK): 1 ♂, holotype, Tapaishan im Tsinling, Sued-Shensi, ca. 3000 m, 26.VI.1936, H. Höne, slide no. 1493, moth photograph examined; 1 ♂, Tapaishan im Tsinling, Sued-Shensi, China, ca. 3000 m, 11.VIII.1936,

H. Höne, dissected in this work; 1♀, same locality and collector, 17.VI.1936, dissected in this work. **Hubei** (IZCAS): 2♀, paratypes of *Auzatella pentesticha* Chu & Wang, 1987, Shennongjia, Juhulinchang, 1840 m, 16.VIII.1981, leg. Han Yinheng.

Distribution. China (Shaanxi, Hubei).

Ditrigona quinaria spodia Wilkinson, 1968

Figs 12, 58, 92, 125

Ditrigona quinaria spodia Wilkinson, 1968: 442. Holotype ♂, China: Yunnan, A-tun-tse (ZFMK).

Material examined. CHINA: **Yunnan:** 1♂ (ZFMK), holotype, A-tun-tse (N Yunnan), Aus Höhe ca. 4000 m, 25.VII.1937, H. Höne, Drepanidae genitalia slide No. 1487, moth photograph examined; 1♀ (ZFMK), Paratype, A-tun-tse (N. Yunnan), Aus Höhe, ca. 4000 m, 15.VI.1937, H. Höne; 1♂ (ZFMK), paratype, Li-kiang, ca. 3000 m, Prov. Nord-Yuennan, 15.IV.1934, H. Höne; 1♂1♀ (IZCAS), Tengchong, Heinitang, 1930 m, 28–30.V.1992, leg. Xue Dayong; 1♂ (IZCAS), Xianggelila, Gezan, 3141 m, 20–21.VII.2014, leg. Li Xinxin; 1♂ (IZCAS), Weixi, Tacheng, 2800 m, 13–14.VII.2014, leg. Li Xinxin.

Distribution. China (Yunnan).

Ditrigona quinaria leucophaea Wilkinson, 1968

Fig. 13

Ditrigona quinaria leucophaea Wilkinson, 1968: 443. Holotype ♂, China: Tibet [Sichuan], Batang (ZFMK).

Material examined. CHINA: **Sichuan:** 1♂ (ZFMK), holotype, Batang (Tibet), Im Tal dea Yantze, ca. 2800 m, 16.V.1936, H. Höne, Drepanidae genitalia slide No. 1486, moth photograph examined.

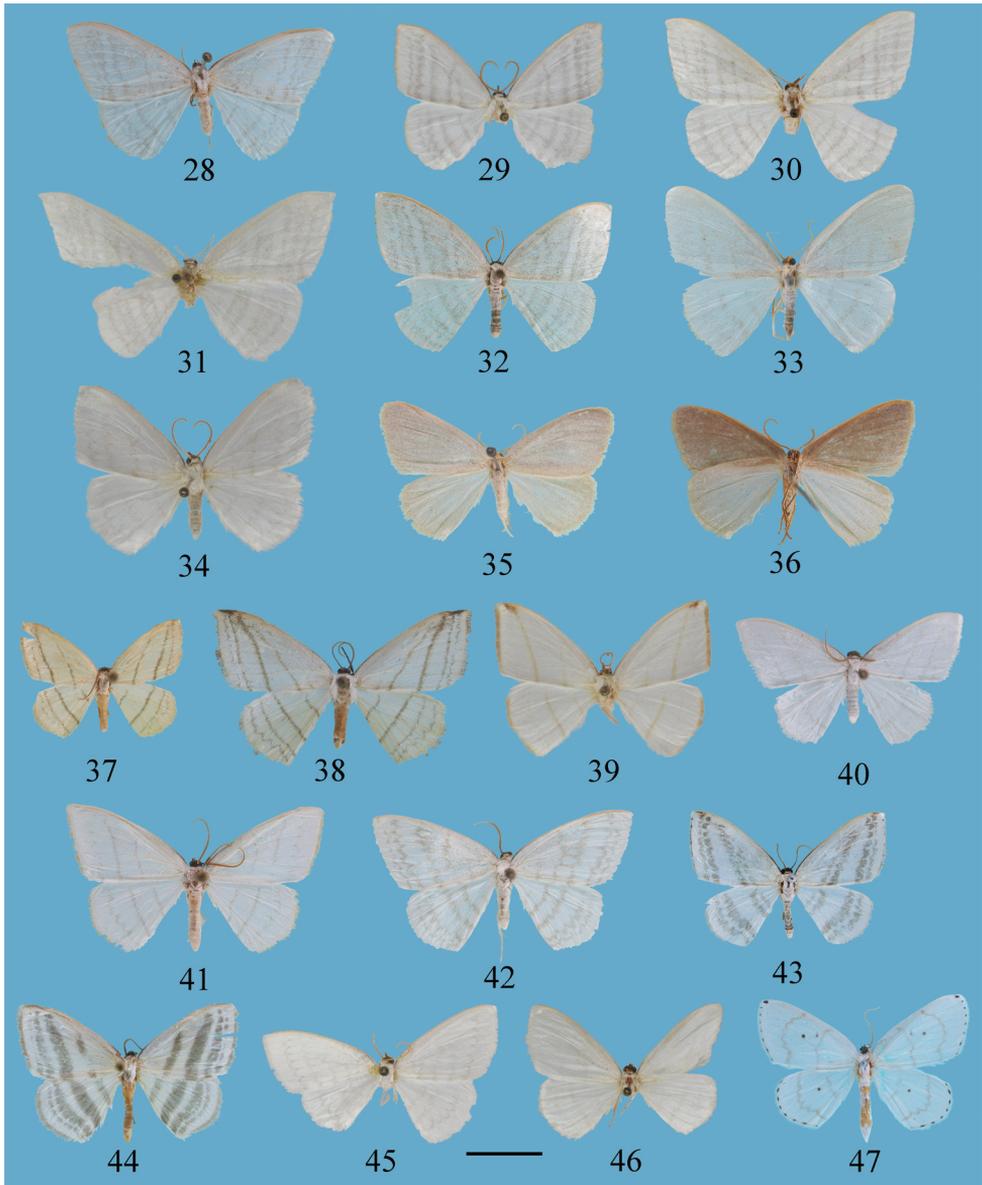
Distribution. China (Sichuan).

13. *Ditrigona obliquilinea* (Hampson, 1893)

Leucodrepana obliquilinea Hampson, 1893: 333. Lectotype ♂, India: Assam, Naga Hills (NHMUK).

Ditrigona obliquilinea: Wilkinson, 1968: 444.

Note. *Ditrigona obliquilinea* includes two subspecies, and the nominate subspecies is distributed in India and Myanmar.



Figures 28–47. Adults of *Ditrigona* **28** *D. lineata lineata*, male **29** *D. lineata tephroides*, holotype, male, ZFMK **30** *D. legnichrysa*, paratype, male, ZFMK **31** *D. policharia*, lectotype, female, ZFMK **32** *D. artema*, male **33** *D. candida*, paratype, male, ZFMK **34** *D. chionea*, paratype, male, ZFMK **35**, **36** *D. fusca* sp. nov., holotype, male **35** upperside **36** underside **37–38** *D. conflexaria micronioides* **37** male **38** female **39** *D. conflexaria cerodeta*, holotype, male, ZFMK **40** *D. margarita*, male **41** *D. berres*, male **42** *D. chama*, male **43** *D. platytes*, male **44** *D. clavata*, male **45** *D. marmorea*, paratype, female ZFMK **46** *D. aphyta*, male **47** *D. cirruncata*, male. Scale bar: 1 cm.

***Ditrigona obliquilinea thibetaria* (Poujade, 1895)**

Figs 14, 59, 93, 126, 159

Micronia thibetaria Poujade, 1895: 311. Lectotype ♂, China: Thibet [Sichuan], Moupin (MNHN).

Leucodrepana thibetaria: Leech, 1898: 311.

Corycia pnocaria Oberthür, 1923: 238

Ditrigona obliquilinea thibetaria: Wilkinson, 1968: 445.

Material examined. CHINA: Hunan (IZCAS): 1♂4♀, Sangzhi, Badagong Shan, Xiaozhuangping, 1420 m, 14.VI.2015, leg. Yao Jian, Zhao Kaidong. Sichuan: 2♂ (IZCAS), Jiguan Shan, Shaoyaogou, 1556 m, 11–16.VII.2016, leg. Cui Le; 1♂ (ZFMK), Tien-Tsuen, Yui-Kin, 1899, Chasseurs indigènes, moth photograph examined. Tibet (IZCAS): 1♀, Gyirong, 26.V.1984, leg. Daci; 1♂, Cona, Mama, 2930 m, 18–20.VI.2015, leg. Li Xinxin; 1♂, Cona, Lexiang, Senmuzha, 2741 m, 2–3.VI.2016, leg. Li Xinxin.

Distribution. China (Shaanxi, Zhejiang, Hubei, Hunan, Sichuan, Tibet).

14. *Ditrigona idaeoides* (Hampson, 1893)

Leucodrepana idaeoides Hampson, 1893: 333. Lectotype ♂, Sikkim: Tonglo (NHMUK).

Ditrigona idaeoides: Wilkinson, 1968: 447.

Material examined. No

Distribution. China (Sichuan), India.

***triangularia* species group**

Based on Wilkinson (1968) and Jiang and Han (2019), the *triangularia* species group contains ten species, in which *Ditrigona triangularia* (Moore), *Ditrigona regularis* Warren, *Ditrigona uniuncusa* Chu & Wang, and *Ditrigona tenuiata* Jiang & Han bear elongate posterior projections of the hind wings (tail process); the other six species, *Ditrigona titana* Wilkinson, *Ditrigona pomenaria* (Oberthür), *Ditrigona typhodes* Wilkinson, *Ditrigona polybotaria* (Oberthür), *Ditrigona sciara* Wilkinson, and *Ditrigona fasciata* (Hampson) lack the tail process. The first nine species are recorded in China, and three new species (*D. sinespina*, *D. parva*, *D. concava*) with the tail process are described in this work.

The species with a tail process on the hind wing have quite distinct wing patterns: the hind wing has the postmedial and submarginal lines approaching each other near the anal angle, and bears a small black patch at the upper angle of the tail. The species lacking a tail process resemble some species of the *mytylata* species group, in that they have transverse lines which often resemble a narrow band. In the male genitalia, the valva is characterized by having a small flap-like extension. The species with a tail

process can also be distinguished by the large rounded socii and the stout aedeagus bearing a brush-like cornutus. In the species lacking a tail process, the aedeagus is narrow, straight or bent, and the cornutus is a simple process or absent. The eighth sternite is small, shallowly concave or protruding in species with a tail process, and the eighth tergite almost unmodified. Both eighth tergite and sternite often possess octavals in the species lacking a tail process. In the female genitalia, the ostium bursae is usually large, and the ductus bursae is often indiscernible, but wide and obvious in *D. typhodes*. The corpus bursae bears a small accessory sac in species with a tail process. (modified from Wilkinson, 1968)

16 DAN barcoding sequences were obtained for *D. regularis*, *D. triangularia*, *D. tenuiata*, *D. concava* sp. nov., *D. parva* sp. nov., and *D. sinespina* sp. nov., and the six species are clearly separated from each other in the COI barcode fragment (fig. 178). The genetic distance between these species is 8.92% (min. 7.16%, max. 12.32%).

15. *Ditrigona triangularia* (Moore, 1867)

Figs 15, 60, 94, 127

Urapteryx triangularia Moore, 1867: 612. Lectotype ♂, India: Darjiling (NHMUK).
Ditrigona triangularia: Moore, 1888: 258.

Material examined. INDIA: 1♂ (NHMUK), lectotype, Darjiling, Moore Coll. 94-106, moth photograph examined. CHINA: Yunnan: 1♂ (IZCAS), Weixi, Tacheng, 2800 m, 13–14.VII.2014, leg. Pan Xiaodan; 1♂ (ZFMK), Li-kiang (China), Provinz Nord-Yuennan, 28.VI.1935, H. Höne, moth photograph examined.

Distribution. China (Fujian, Taiwan, Yunnan, Sichuan), India, Myanmar.

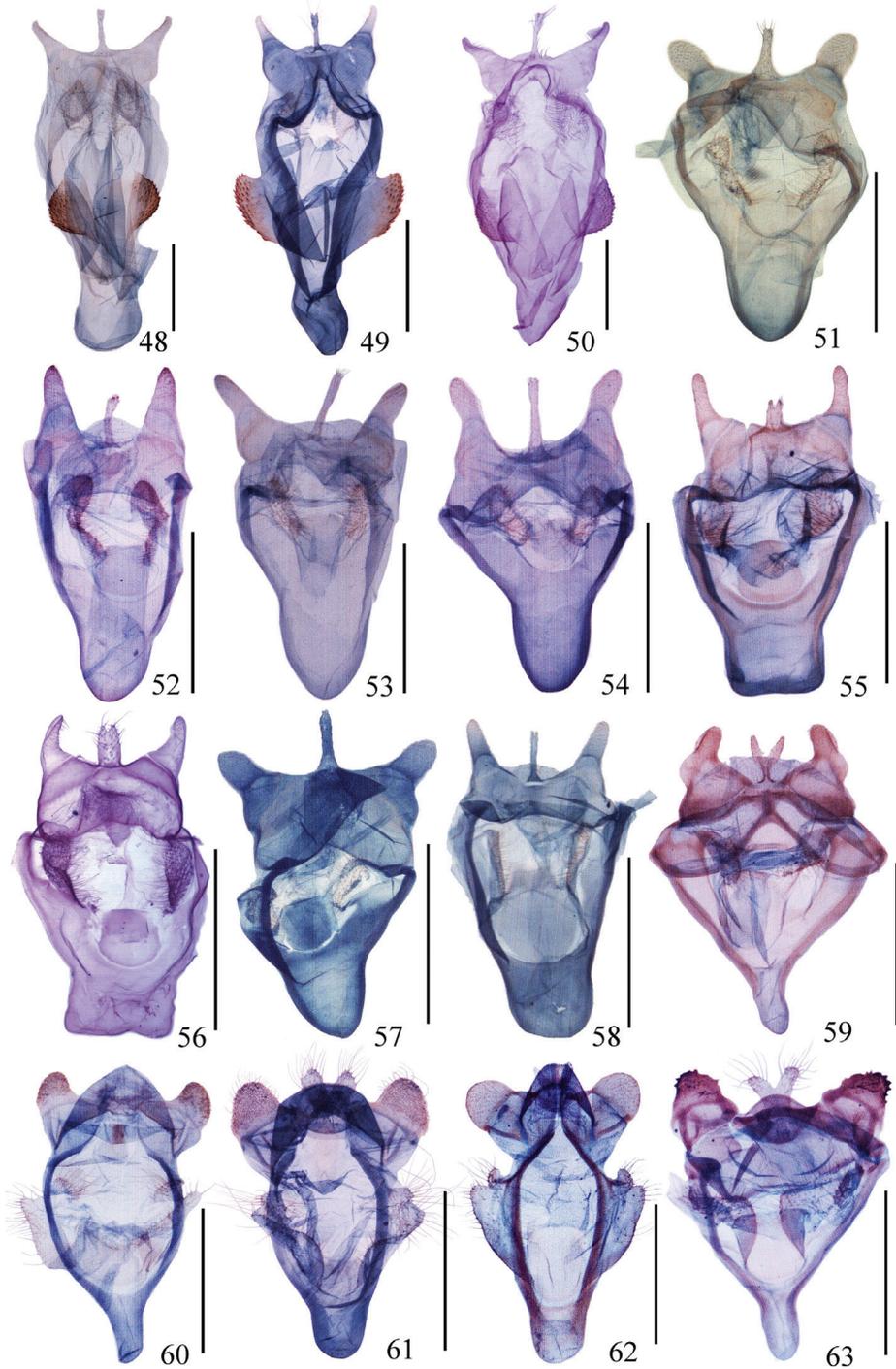
16. *Ditrigona uniuncusa* Chu & Wang, 1988

Figs 16, 61, 95, 128, 160

Ditrigona uniuncusa Chu & Wang, 1988: 202. Holotype ♂, China: Fujian, Wuyi Shan (IZCAS).

Material examined. CHINA: Fujian (IZCAS): 1♂, holotype, Wuyi Shan, 22.VI.1982, leg. Zhang Baolin; 1♀, same locality, 704 m, 12.VIII.1979, leg. Song Shimei; 1♀, Wuyi Shan, Sangang, 704 m, 23.X.1980, leg. Cai Rongquan; 1♀, same locality, 1.VI.1983, leg. Mai Guoqing; 3♀, same locality, 31.VII.2005, leg. Wang Jiashe; 1♂20♀, same locality, 20–21.X.2005, leg. Han Hongxiang, Lang Songyun, Yang Chao; 2♀, same locality, X.1979, leg. Huang Juyi; 1♀, same locality, 8.X.1979, leg. Xu Zhanfei; 1♀, same locality, 15.VI.1981, leg. Jiang Fan; 1♀, same locality, 21.VI.1981, leg. Wang Jiashe, Jiang Fan. Sichuan (IZCAS): 1♀, Luding, Moxi, 19–20.V.2009, leg. Li Jing.

Distribution. China (Fujian, Sichuan).



Figures 48–63. Male genitalia of *Ditrigona* **48** *D. derocina* **49** *D. diana* **50** *D. crystallina*, holotype **51** *D. spilota*, ZFMK **52** *D. furvicosta* **53** *D. jordanaria* **54** *D. media* **55** *D. sericea* **56** *D. sericea* (*Auzatella pentesticha* Chu & Wang, allotype) **57** *D. quinaria erminea*, ZFMK **58** *D. quinaria spodia* **59** *D. obliquilinea tibetaria* **60** *D. triangularia* **61** *D. uniuncusa* **62** *D. tenuiata*, holotype **63** *D. regularis*. Scale bars: 1 mm.

17. *Ditrigona tenuiata* Jiang & Han, 2019

Figs 17, 62, 96, 129, 161

Ditrigona tenuiata Jiang & Han, 2019: 84. Holotype, ♂, China: Sichuan, Kangding (IZCAS).

Material examined. CHINA: Sichuan (IZCAS): 1♂, holotype, Kangding, Xikangyinxiang hotel, 2582 m, 7–10.VIII.2016, leg. Cui Le, M23028; 1♀, paratype, Luding, Hailuogou, 2569 m, 11.IX.2016, leg. Li Xinxin, M25081.

Distribution. China (Sichuan).

18. *Ditrigona regularis* Warren, 1922

Figs 18, 63, 97, 130, 162

Ditrigona regularis Warren, 1922: 463. Lectotype ♂, India: Assam, Khasia (NHMUK).
Ditrigona regularis diflerentiata Bryk, 1943: 9.

Material examined. CHINA: **Guangxi** (IZCAS): 2♀, Napo, Defu, 1350 m, 19.VI.2000, leg. Li Wenzhu. Sichuan: 1♀, Emei Shan, Qingyinge, 800–1000 m, 29.IV.1957, leg. Huang Keren; 2♀, Emei Shan, 0km, 1288 m, 31.VII.2013, leg. Cheng Rui; 1♀, Huili, 19.VII.1974, leg. Han Yinheng; 2♂1♀, Anha, Luoji Shan, 2044 m, 14–16.VII.2018, leg. Cui Le, Jiang Shan. **Yunnan** (IZCAS): 1♀, Pianma, Dianxin hotel, 1970 m, 8–12.V.2011, leg. Yang Xiushuai, Wang Ke; 1♀, Tengchong, Dahaoping, 2020 m, 24–26.V.1992, leg. Xue Dayong; 1♂, same locality, 2020 m, 5–7.VIII.2007, leg. Xue Dayong; 1♀, Tengchong, Shidi, 1730 m, 3–5.VIII.2016, leg. Ban Xiaoshuang; 2♂2♀, Tengchong, Houqiao, 1620 m, 6–8.VIII.2016, leg. Ban Xiaoshuang; 1♀, Lushui, Yaojiaping, 2500 m, 4.VI.1981, leg. Zhang Xuezhong; 1♀, Ruili, Dengga, 980 m, 6–8.VI.1992, leg. Xue Dayong; 2♂3♀, Pingbian, Daweishan, 2090 m, 4–8.VIII.2017, leg. Cui Le; 1♀, Kunming, Shuanglongxiang, 2100 m, 11.VIII.2006, leg. Ma Rong; 1♀, Xinping, Gasa, Yaonan, 1900 m, 10–13.VIII.2017, leg. Cui Le; 1♀, Yunlong, Tianchi Baohuqu, 2570 m, 9–12.VIII.2016, leg. Ban Xiaoshuang. **Tibet** (IZCAS): 1♀, Medôg, 1091 m, 22.VIII.2006, leg. Lang Songyun. **THAILAND** (ZFMK): 1♂, Chiangmai Doi Suthep, 1325 m, 21.XI.–4.XII.1989, leg. Schnitzler, moth photograph examined.

Distribution. China (Guangxi, Sichuan, Yunnan, Tibet), India, Myanmar, Thailand.

19. *Ditrigona sinespina* Jiang & Han, sp. nov.

<http://zoobank.org/B95C0171-9D11-419C-B668-371D07B000E3>

Figs 19–20, 64, 98, 131, 163

Description. Head. Antennae bipectinate, with proximal rami shorter than outer rami, the longest ramus about four times diameter of antennal shaft in male; rami quite short in female, almost equal to diameter of antennal shaft. Frons flattened, width less than

diameter of compound eyes; white, upper half with a narrow pale brown transverse band. Labial palpus slender, not extending beyond frons, with outside brown, inner side whitish. Vertex white, pale brown anteriorly.

Thorax. Dorsal and ventral sides of thorax white. Tegula white. Hind tibia with two pairs of spurs in both sexes. Forewing length: ♂♀ 16 mm. Both fore- and hind wings white, transverse lines grey. Forewing with costa pale brown, distal half deeper. Sub-basal and antemedial lines slightly bent inwards at middle and costa, the former narrower; postmedial line broad, almost straight; submarginal line double, the inner one slightly wavy and the outer one deeply wavy. Hind wing with antemedial line straight, merging into the elongate grey area along anal margin; postmedial line broader, almost straight, closing to submarginal line near anal angle, forming large pointed teeth on CuA₂ and anal fold; submarginal line double, with the inner one nearly straight and only wavy near anal angle, the outer one wavy, the two lines gradually approximating towards anal margin. Anal margin less extended, possessing a quite short tail process, longer in female, with a small black patch. Fringes pale brown. Forewing underside with costa deep brown in basal half.

Abdomen. Dorsal and ventral sides of abdomen white. Eighth tergite large, nearly quadrate, with posterior margin shallowly concave; eighth sternite concave at middle, forming two small lateral blunt processes.

Male genitalia. Uncus bifurcate over its whole length, both halves short and very narrow. Socii large, rounded. Valva small, ventral margin smoothly curved, distal and posterior margins straight, forming a blunt angle; posterior protrusion rounded. Saccus blunt and rounded. Juxta indistinctly shaped. Aedeagus very stout, terminal part narrower; cornutus a large oval spinose patch.

Female genitalia. Papillae analis short; apophyses anteriores moderate, broad basally. Ostium bursae large; ductus bursae indiscernible; corpus bursae round, signum absent.

Diagnosis. On the wing pattern, *D. sinespina* is close to *D. tenuiata*, but it can be differentiated by the larger distance between the two submarginal lines on the forewing, and the smaller tail process. Compared to *D. triangularia* and *D. uniuncusa*, the anal margin of *D. sinespina* is less extended, and the tail process is distinctly shorter than in those two species. Compared to *D. parva* sp. nov. and *D. concava* sp. nov., *D. sinespina* is larger (with forewing length 16 mm), and the tail process on the hind wing is less developed.

In the male genitalia, the slender uncus is similar to that of *D. tenuiata* and *D. concava*, but it is longer than in *D. tenuiata* and shorter than in *D. concava*. The straight distal margin of the valva is also different from these two species. The shape of the aedeagus, which is broad and blunt posteriorly, also can be distinguished from these two species. The eighth tergite of the male is similar to that of *D. concava*, but the eighth sternite is different: in *D. sinespina* it is narrowly and deeply concave, forming two blunt protrusions, while in *D. concava* it is widely and shallowly concave, forming two small lateral processes. The female genitalia of *D. sinespina* are also similar to those of *D. tenuiata*, but can be differentiated by the lack of a signum.

Type material. Holotype, ♂, CHINA: Yunnan (IZCAS): Yunlong, Tianchi, 2570 m, 9–12.VIII.2016, leg. Ban Xiaoshuang, slide no. Drep-1054, M33001. Paratypes: Yunnan (IZCAS), 1♂, same data as holotype, M33002, posterior part of abdomen missing; 1♂, same data as holotype, M33029; 1♀, Tengchong, Heinitang, 1824 m, 26–27.VI.2014, leg. Pan Xiaodan, slide no. Drep-1060, M33196.

Distribution. China (Yunnan).

Etymology. The species is named from the Latin words *sine* and *spina*, which refers to the lack of a signum in the female genitalia.

Molecular data. The mean intraspecific distance of *D. sinespina* is 1.55% (min. 0%, max. 2.24%, $n = 4$). The nearest related species is *D. tenuiata*, with genetic distance 7.16%.

20. *Ditrigona parva* Jiang & Han, sp. nov.

<http://zoobank.org/3E199CD5-F712-4F67-B30E-E04C94EA34E9>

Figs 21–22, 65, 99, 132, 164

Description. Head and thorax almost identical to those of *D. sinespina*. Forewing length: ♂11.5 mm, ♀14 mm. Antemedial line almost straight apart from an inward bend at costa. Outer line of the double submarginal lines serrate. Anal margin of hind wing elongate, with relatively large tail process. Fringes brown. Forewing underside with costa brown at basal half.

Male genitalia. Uncus bifurcate over whole length, both sides broad. Socii large, terminally semicircular, scobinate. Valva small, distal margin shallowly concave, posterior protrusion rounded. Saccus blunt and rounded. Juxta with posterior margin almost straight. Aedeagus very stout; cornutus a large oval spinose patch. Eighth tergite quadrate, with a pair of small anterior apodemes; eighth sternite quite small, posterior margin slightly convex.

Female genitalia. Papillae analis short; apophyses anteriores moderate, broad basally. Ostium bursae large; ductus bursae indiscernible; corpus bursae rounded, posteriorly with a large wrinkled sclerotized area and accessory sac, signum short and narrow.

Diagnosis. The wing pattern is very close to that of *D. uniuncusa*. The antemedial line on the hind wing is straight in *D. parva*, but slightly convex in *D. uniuncusa*. The width between the two submarginal lines is larger than in *D. uniuncusa*, especially in the female. In the male genitalia, *D. parva* shares a stout uncus with *D. uniuncusa* and *D. regularis*, but the terminal half of the socii are quite different: scobinate and semicircular in *D. parva*, scobinate and tapering in *D. uniuncusa*, and spinose in *D. regularis*. The female genitalia are also different: the sclerotized area on the corpus bursae is rounded, less sclerotized and smaller than that in *D. uniuncusa*, which has a large oval well sclerotized area; the signum is shorter than in *D. uniuncusa*.

Type material. Holotype, ♂, CHINA: Yunnan (IZCAS): Tengchong, Houqiao, 1620 m, 6–8.VIII.2016, leg. Ban Xiaoshuang, slide no. Drep-1057, M33049.

Paratypes: 1♂, same data as holotype, M33059; 1♀, same data as holotype, slide no. Drep-1059, M33040; 1♂, same locality, 1553 m, 28–29.VI.2014, leg. Pan Xiaodan.

Distribution. China (Yunnan).

Etymology. The species is named referring to the Latin word *parvus*, which refers to the small wings.

Molecular data. The three specimens of *D. parva* have no genetic distance between them. The nearest related species is *D. concava*, with a genetic distance of 9.56%.

21. *Ditrigona concava* Guo & Han, sp. nov.

<http://zoobank.org/AB4E8887-3422-4197-AA1C-DC8363354992>

Figs 23, 66, 100, 133

Description. Characters of head and thorax in male same as in *D. sinespina*. Forewing length 16 mm in male. Fore- and hind wings white, transverse lines grey. Forewing with costa pale brown. Subbasal line slightly bent inwards at middle and costa; antemedial line straight and only bent inwards near costa; postmedial line broad, almost straight; submarginal line double, the inner one slightly wavy and the outer one deeply wavy. Hind wing with antemedial line slightly convex at middle, bent outwards and merging into the elongate grey area along the anal margin; postmedial line broader, almost straight, slanting outwards and closing to meet submarginal line near anal angle, forming large pointed teeth on CuA_2 and anal fold; submarginal line double, with the inner one nearly straight and only wavy near anal angle, the outer one wavy, the two lines gradually approximating towards anal margin. Anal margin less extended, with a quite short tail process, longer in the female, with a small black patch. Fringes pale brown. Forewing underside with costa deep brown in basal half.

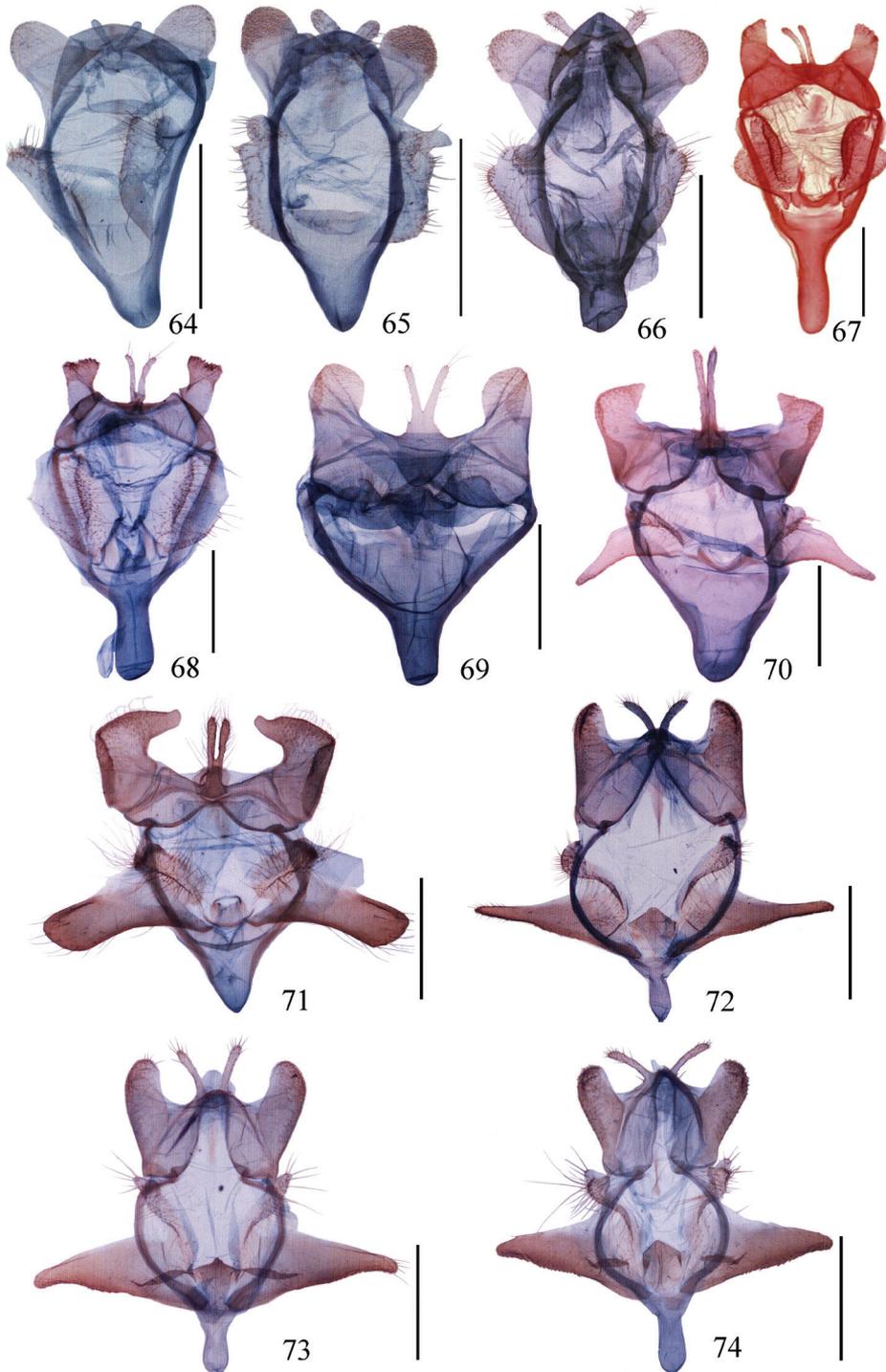
Male genitalia. Uncus bifurcate over its whole length, both arms slender. Socii large, terminally semicircular, rough apically. Valva small, distal and posterior margin shallowly concave, posterior protrusion rounded. Saccus blunt and rounded. Juxta large, slightly sclerotized, indistinctly shaped. Aedeagus stout, terminal part narrow; cornutus an oblong spinose patch. Eighth tergite quadrate, posterior margin almost straight; eighth sternite shallowly concave, with two small lateral protrusions.

Female genitalia. Unknown.

Diagnosis. The most distinctive character of *D. concava* lies in the male eighth sternite, which is different from all other congeners by the wide and shallow concavity, bearing two small lateral processes. The male genitalia are similar to those of *D. tenuiata* and *D. sinespina*, and can be differentiated by the following differences: the uncus is longer than in those two species; the distal and posterior margins of the valva are shallowly concave in *D. concava*, but the two margins are straight in *D. sinespina*.

Type material. Holotype, ♂, **CHINA: Yunnan** (IZCAS): Ailao Shan, 2600 m, 11.VIII.2011, leg. Kitching Ashton, slide no. Drep-1095, ARB00027811, ex. XTBG. Paratype: 1♂, **Yunnan** (IZCAS): Weixi, Tacheng, 2800 m, 13–14.VII.2014, leg. Li Xinxin, slide no. Drep-1091, M32975.

Distribution. China (Yunnan).



Figures 64–74. Male genitalia of *Ditrigona* **64** *D. sinespina* sp. nov., holotype **65** *D. parva* sp. nov., holotype **66** *D. concava* sp. nov., paratype **67** *D. titana*, ZFMK **68** *D. pomenaria* **69** *D. typhodes* **70** *D. lineata lineata* **71** *D. artema* **72** *D. candida*, paratype, ZFMK **73** *D. chionea* **74** *D. fusca* sp. nov., holotype. Scale bars: 1 mm.

Etymology. The species is named after the Latin word *concauus*, which refers to the shallowly concave 8th male sternite.

Molecular data. An intraspecific distance of *D. sinespina* of 2.07% ($n = 2$) was recorded. The nearest related species is *D. parva*, with a genetic distance of 9.56%.

22. *Ditrigona titana* Wilkinson, 1968

Figs 24, 67, 101, 134

Ditrigona titana Wilkinson, 1968: 453. Holotype ♂, China: Yunnan, Likiang (ZFMK).

Material examined. CHINA: Yunnan: 1♂ (ZFMK), holotype, Li-kiang, ca. 3000 m, Prov. Nord-Yuennan, 13.IX.1934, H. Höne, moth photograph examined.

Distribution. China (Yunnan).

23. *Ditrigona sciara* Wilkinson, 1968

Ditrigona sciara Wilkinson, 1968: 458. Holotype ♂, China: Sichuan, Ta-t sien-lou (NHMUK).

Material examined. No.

Distribution. China (Sichuan).

24. *Ditrigona pomenaria* (Oberthür, 1923)

Figs 25, 68, 102, 135

Corycia (Bapta) pomenaria Oberthür, 1923: 238. Lectotype ♂, China: Sichuan, Moupin (ZFMK).

Ditrigona pornenaria: Wilkinson, 1968: 454.

Material examined. CHINA: Sichuan (ZFMK): 1♂, holotype, Mou-Pin, 1897, ex. R.P. Déjean, photograph examined; 1♂, Jiguan Shan, Shaoyaogou, 1556 m, 11–16. VII.2016, leg. Cui Le.

Distribution. China (Sichuan).

25. *Ditrigona polyobotaria* (Oberthür, 1923)

Fig. 26

Corycia polyobotaria Oberthür, 1923: 237. Lectotype ♀, China: Sichuan, Siao-lou (ZFMK).

Ditrigona polybotaria: Wilkinson, 1968: 458.

Material examined. CHINA: **Sichuan** (ZFMK): 1♀, holotype, Siao-Lou, 1900, Chasseurs indigènes, photograph examined.

Distribution. China (Sichuan).

26. *Ditrigona typhodes* Wilkinson, 1968

Figs 27, 69, 103, 136, 165

Ditrigona typhodes Wilkinson, 1968: 456. Holotype ♂, China: Yunnan, Likiang (ZFMK).

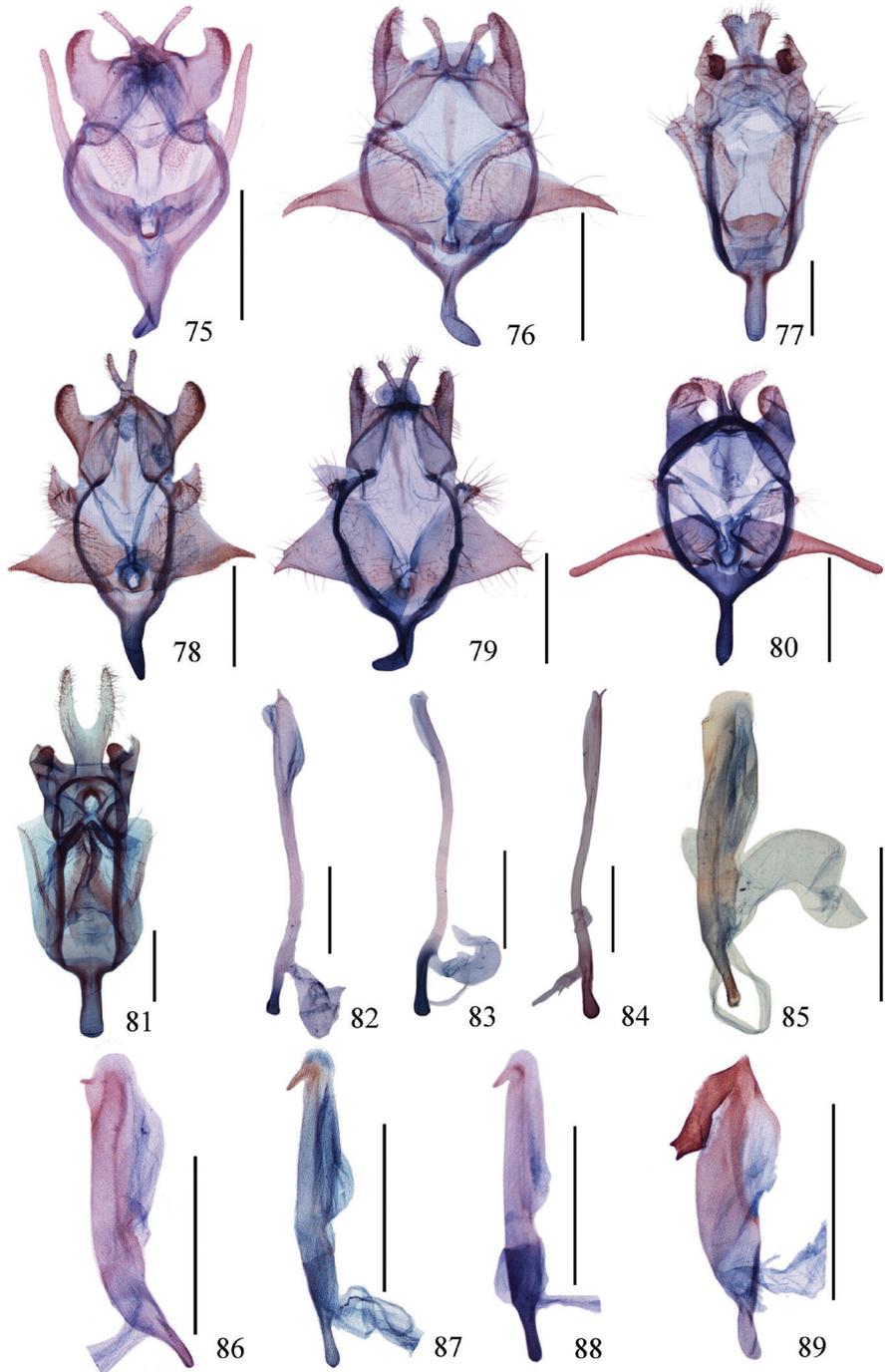
Material examined. CHINA: **Yunnan**: 1♂ (ZFMK), holotype, Li-kiang, ca. 3000 m, Prov. Nord-Yuennan, 19.VIII.1934, H. Höne, moth photograph examined; 5♂1♀ (IZCAS), Ailao Shan, 2400–2600 m, 6–13.VIII.2011, leg. Ashton, ex. XTBG; 4♂4♀ (IZCAS), Lijiang, 3200–3600 m, 9–14.VIII.2012, leg. Ashton; 2♀ (IZCAS), Lijiang, Yulongshan, 22.VII.–2.VIII.1962, leg. Song Shimei; 1♂ (IZCAS), Lijiang Alpine Botanic Garden, 3272 m, 15–16.VIII.2013, leg. Li Xinxin; 1♀ (IZCAS), Weixi, Tacheng, 2800 m, 13–14.VII.2014, leg. Pan Xiaodan; 1♀ (IZCAS), Lushui, Yaojiaping, 2500 m, 4.VI.1981, leg. Liao Subai; 2♀, Yongsheng, Liude, 2250 m, 10.VII.1984, leg. Liu Dajun. **Sichuan** (IZCAS): 1♂2♀, Yajiang, Bingzhan, 3340 m, 30–31.VII.2014, leg. Li Xinxin.

Distribution. China (Sichuan, Yunnan), Myanmar.

mytilata species group

In Wilkinson (1968) and Li et al. (2015), 15 species in the *mytilata* species group were recorded in China: *Ditrigona lineata* (Leech), *Ditrigona legnichrysa* Wilkinson, *Ditrigona policharia* (Oberthür), *Ditrigona artema* Wilkinson, *Ditrigona marmorea* Wilkinson, *Ditrigona candida* Wilkinson, *Ditrigona conflexaria* (Walker), *Ditrigona margarita* Wilkinson, *Ditrigona aphyra* Wilkinson, *Ditrigona berres* Wilkinson, *Ditrigona chama* Wilkinson, *Ditrigona chionea* Wilkinson, *Ditrigona platytes* Wilkinson, *Ditrigona cirruncata* Wilkinson, and *Ditrigona clavata* Li & Wang. A new species *D. fusca* is described in this work.

This species group is characterized by usually having lamellate antennae, and the valva of the male genitalia usually possessing a long posterior extension. Other characters are summarized as follows: the forewing is sometimes weakly falcate; the streaks vary considerably, with transverse lines linear, band-like or absent; the uncus is bifurcate, and the socii are very large; the aedeagus is usually arcuate; both eighth sternite and tergite are modified, the former with short octavals, and the latter concave with small or large protrusions; in the female genitalia, the ostial pocket is characteristic, and the corpus bursae lacks an accessory sac. (modified from Wilkinson, 1968)



Figures 75–89. (75–81) Male genitalia of *Ditrigona* **75** *D. conflexaria micronioides* **76** *D. margarita* **77** *D. berres* **78** *D. chama* **79** *D. platytes* **80** *D. clavata* **81** *D. cirruncata*. (82–89) Aedeagus of *Ditrigona* **82** *D. derocina* **83** *D. diana* **84** *D. crystallata*, holotype **85** *D. spilota*, ZFMK **86** *D. furvicosta* **87** *D. jordanaria* **88** *D. media* **89** *D. sericea*. Scale bars: 1 mm.

27. *Ditrigona lineata* (Leech, 1898)

Leucodrepana lineata Leech, 1898: 364. Holotype ♂, China: Sichuan, Omei-Shan (NHMUK).

Ditrigona lineata: Wilkinson, 1968: 462.

Currently, *D. lineata* includes two subspecies, and both are distributed in China.

***Ditrigona lineata lineata* (Leech, 1898)**

Figs 28, 70, 104, 137, 166

Material examined. CHINA: Sichuan (IZCAS): 1♂, Emei Shan, 15.VIII.1977; 1♂1♀, Emei Shan, Leidongping, 2444 m, 7–8.VIII.2014, leg. Pan Xiaodan; 2♀, Pingwu, Wanglang, Changbaigou, 2480 m, 24.VII.2016, leg. Cui Le. Yunnan: 2♂ (IZCAS), Lijiang, Yulong Shan, 30.VII., 4.VIII.1962, leg. Song Shimei; 1♂ (ZFMK), Li-kiang, China, 6.VIII.1935, Coll. H. Höne.

Distribution. China (Sichuan, Yunnan).

***Ditrigona lineata tephroides* Wilkinson, 1968**

Fig. 29

Ditrigona lineata tephroides Wilkinson, 1968: 464. Holotype ♂, China: Shaanxi, Tapaishan-im-Tsinling (ZFMK).

Material examined. CHINA: Shaanxi (ZFMK): 1♂, holotype, Tapaishan im Tsinling, Sued-Shensi, ca. 3000 m, 12.VIII.1936, H. Höne, moth and genitalia photos examined.

Distribution. China (Shaanxi, Tibet).

28. *Ditrigona legnichrysa* Wilkinson, 1968

Fig. 30

Ditrigona legnichrysa Wilkinson, 1968: 466. Holotype ♂, China: Tibet [Sichuan] (NHMUK).

Material examined. CHINA: Sichuan (ZFMK): 1♂, paratype, Tien-Tsuen, 1897, ex. R.P. Déjean, moth photograph examined.

Distribution. China (Zhejiang, Sichuan, Yunnan, Tibet).

29. *Ditrigona policharia* (Oberthür, 1923)

Fig. 31

Corycia (Bapta) policharia Oberthür, 1923: 237. Lectotype ♀, China: Sichuan, Tsien-Tsuen (ZFMK).

Ditrigona policharia: Wilkinson, 1968: 468.

Material examined. CHINA: Sichuan (ZFMK): 1 ♀, lectotype, Tien-Tsuen, 1897, ex. R. P. Déjean, moth photograph examined.

Distribution. China (Sichuan).

Remarks. This species was described based on a single female specimen only. Wilkinson (1968) stated that the female genitalia are similar to those of *Ditrigona legnichrysa* Wilkinson, and he also had difficulty in distinguishing it from *D. legnichrysa*, though he listed several tiny differences. He suggested that further material was needed to clarify the relationship between the two species.

30. *Ditrigona artema* Wilkinson, 1968

Figs 32, 71, 105, 138, 167

Ditrigona artema Wilkinson, 1968: 469. Holotype ♂, China: Sichuan, Siao-lou (NHMUK).

Material examined. CHINA: Sichuan: 1 ♂ (ZFMK), paratype, Ta-tsien-Lou, Chasseurs du P. Déjean, 1904, Ex. Oberthür Coll., Brit. Mus. 1927-3, moth photograph examined; 1 ♀ (ZFMK), paratype, Wahuipass, 4000 m, Süd. Tatsienlu, VII.–VIII.1930, leg. Friedrich, Coll. Dr. Wehril, moth photograph examined; 1 ♀ (IZCAS), Emei Shan, 15.VIII.1977; 2 ♂ (IZCAS), Luding, Hailuogou Erhaoyingdi, 2569 m, 11.IX.2016, leg. Li Xinxin; 1 ♂6 ♀ (IZCAS), Luding, Moxi, Hailuogou, 2596 m, 12.IX.2016, leg. Li Xinxin. Tibet (IZCAS): 1 ♂, Yadong, 2760 m, 23–25.VIII.2014, leg. Cheng Rui, Cui Le.

Distribution. China (Sichuan, Tibet).

31. *Ditrigona candida* Wilkinson, 1968

Figs 33, 72, 106, 139, 168

Ditrigona candida Wilkinson, 1968: 472. Holotype ♂, China: Yunnan, Likiang (ZFMK).

Material examined. CHINA: Yunnan (ZFMK): 1 ♂, holotype, Li-kiang (China), Provinz Nord-Yuennan, 5.VIII.1935, H. Höne, moth photograph examined; 1 ♂, paratype, Li-kiang, ca. 2000 m, Prov. Nord-Yuennan, 15.VII.1934, H. Höne, dissected in this work; 1 ♀, paratype, Li-kiang (China), Provinz Nord-Yuennan, 2.VIII.1935, H. Höne, dissected in this work.

Distribution. China (Yunnan).

32. *Ditrigona chionea* Wilkinson, 1968

Figs 34, 73, 107, 140, 169

Ditrigona chionea Wilkinson, 1968: 490. Holotype ♂, China: 'Chasseurs Thibetains' (NHMUK).

Material examined. CHINA: Yunnan: 1♂1♀ (ZFMK), paratypes, Li-kiang. ca. 3000 m, Prov. Nord-Yuennan, 24.VII.1934, 14.VI.1934, H. Höne, moth photograph examined; 1♂6♀ (IZCAS), Lijiang Alpine Botanic Garden, 3260–3452 m, 15–20.VI.2009, leg. Xue Dayong, Yang Chao, Han Hongxiang, Qi Feng; 1♀ (IZCAS), Lijiang, Wenhai, 3097 m, 19.VI.2009, leg. Xue Dayong; 1♀ (IZCAS), Lijiang, Ganheba, 3296 m, 23.VI.2009, leg. Qi Feng. Shaanxi (IZCAS): 1♀, Zhouzhi, Diaoyutai, 1480 m, 29.VI.2008, leg. Bai Ming.

Distribution. China (Shaanxi, Hubei, Sichuan, Yunnan).

33. *Ditrigona fusca* Guo & Han, sp. nov.

<http://zoobank.org/ED43239E-A79D-4818-B3D3-D4F58984B228>

Figs 35–36, 74, 108, 141, 170

Description. *Head.* Antennae simple in both male and female. Frons yellow, width less than diameter of compound eyes. Labial palpus with outside deep brown, inner side yellowish. Vertex pale yellow.

Thorax. Tegula pale brown. Dorsal and ventral sides of thorax pale brown. Hind tibia with two pairs of spurs in both sexes. Forewing length: ♂16 mm, ♀15–17 mm. Both wings pale brown, evenly decorated with brown scales, less in basal half of hind wing. Transverse lines absent. Fringes yellowish brown. Underside with forewing deep brown, distal part paler, costa yellowish brown; hind wing with costa yellowish brown, other parts identical to upperside. Fringes yellowish brown.

Abdomen. Dorsal and ventral sides of abdomen pale brown. The eighth tergite with posterior margin concave, with two blunt lateral protrusions; the eighth sternite with posterior margin slightly convex, with two small hooked lateral processes.

Male genitalia. Uncus bifurcate over whole length, the arms narrow and slender. Socii large, tongue-like, of even width, with tips blunt and scobinate. Valva nearly triangular, with tip blunt, ventral margin decorated with tiny spines; basal posterior process bent, tip expanded, with a small accompanying bursa. Juxta rounded, with posterior margin protruding, mound-like. Saccus narrow. Aedeagus slender, almost even in width, tip blunt.

Female genitalia. Ostial pocket band-like. Lamella antevaginalis paired leaf-like. Ductus bursae indiscernible. Corpus bursae rounded; signum a narrow longitudinal sclerotized strip; accessory sac absent.

Diagnosis. The wing pattern is distinctive in lacking transverse lines on both fore- and hind wings. The male genitalia are very close to those of *D. candida*, *D. chionea* and *D. margarita* in the *mytylata* species group, in that they share the slender bifid uncus and tongue-like socii. *D. fusca* and *D. chionea* can be differentiated from those two species by

the broader valva, on the base of which a sclerotized ridge is present. The difference between *D. fusca* and *D. chionea* in the male genitalia lies in the shape of the juxta, which is widely protruding posteriorly in *D. fusca*, but only with a tiny process at middle in *D. chionea*. The aedeagus is also different, straight and almost even in width in *D. fusca*, but tapering and twisted in *D. chionea*. The female genitalia of *D. fusca* and *D. chionea* are almost identical.

Type material. Holotype, ♂ (IZCAS), **CHINA: Yunnan:** Lijiang, Yulong Shan, 23.VIII.1962, leg. Song Shimei, slide no. Drep-1092. Paratypes (IZCAS): **Yunnan:** same locality and collector as holotype, 1♂, 3.VIII.1962, slide no. Drep-954; 1♀, 30.VII.1962; 2♀, 2.VIII.1962; 1♀, 3.VIII.1962, 2900 m; 3♀, 4.VIII.1962, slide no. Drep-953; 1♀, 23.VIII.1962; 1♀, 25.VIII.1962; 4♀, 30.VIII.1962; 1♀, Xianggelila, Xiaozhongdian, 3235 m, 15–16.VIII.2016, leg. Ban Xiaoshuang, slide no. Drep-1093; 1♀, Lijiang, Alpine Botanical Garden, 3260–3452 m, 16–18.VI.2009, leg. Qi Feng.

Distribution. China (Yunnan).

Etymology. The specific name is from the Latin word *fuscus*, which refers to the pale brown wing colour.

34. *Ditrigona conflexaria* (Walker, 1861)

Acidalia conflexaria Walker, 1861: 148. Holotype ♂, N. China (NHMUK).

Ditrigona conflexaria: Wilkinson, 1968: 475.

Based on Wilkinson (1968), *D. conflexaria* comprises three subspecies, all distributed in China.

Ditrigona conflexaria conflexaria (Walker, 1861)

Material examined. No.

Distribution. North China.

Ditrigona conflexaria micronioides (Strand, 1917)

Figs 37–38, 75, 109, 142, 171

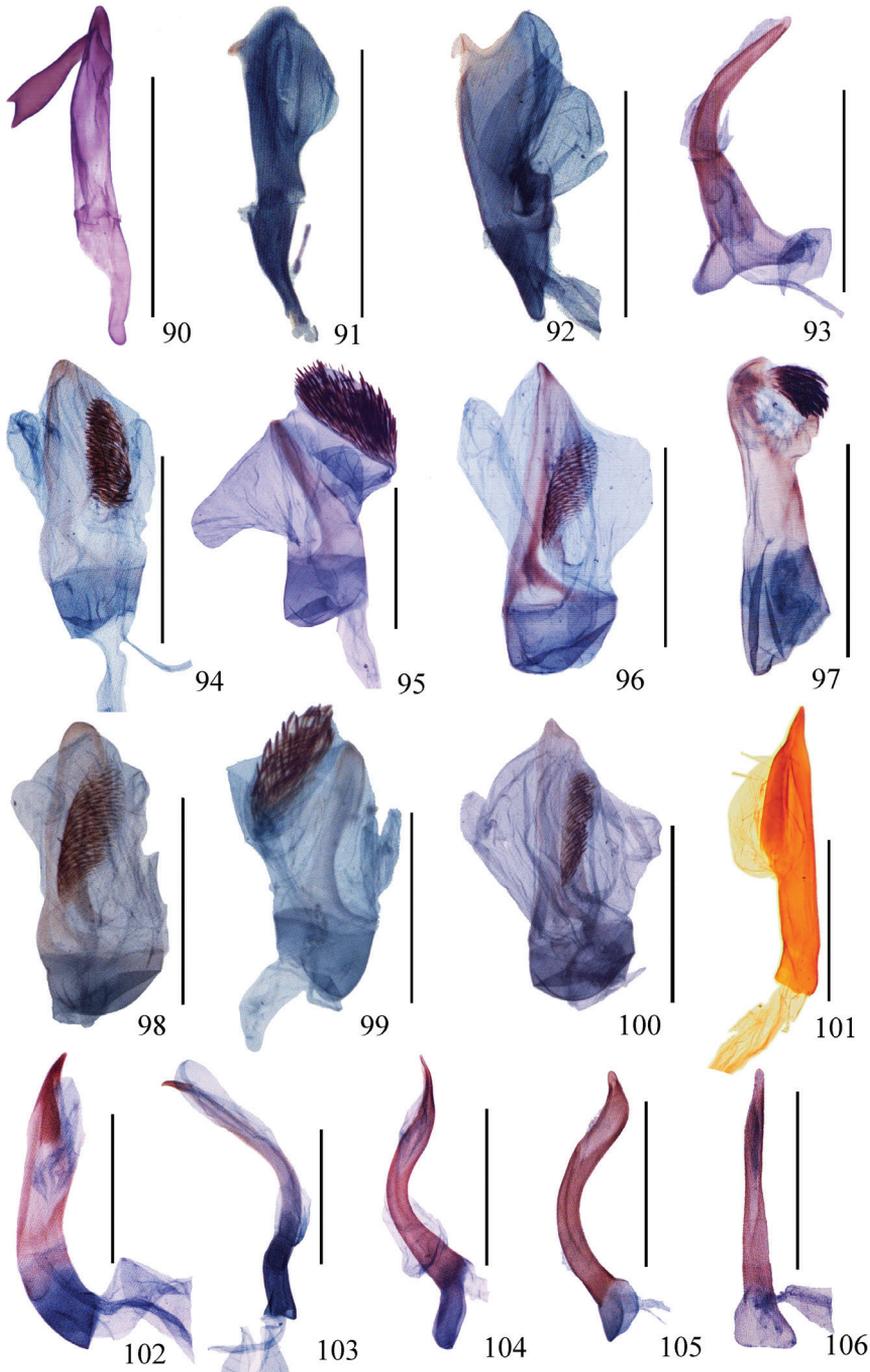
Auzata (Auzatella) micronioides Strand, 1917: 148. Holotype ♀, China: Formosa (DEI).

Leucodrepana micronioides: Watson, 1959: 232.

Auzatella micronioides: Inoue, 1962: 12.

Ditrigona conflexaria micronioides: Wilkinson, 1968: 475.

Material examined. CHINA (IZCAS): Shanxi: 1♂1♀, Yicheng, Dahelinchang, 1212 m, 13–15.VIII.2018, leg. Zhang Xinyi; 1♀, Yuanqu, Huangguman, 1258 m, 21–22.VIII.2018, leg. Zhang Xinyi. **Henan:** 1♂1♀, Baiyun Shan, 1550 m, 13–15.VIII.2008, leg. Song Wenhui; 1♂1♀, Nanyang, Baotianman, 14.VII.2006, 27.VII.2006, leg.



Figures 90–106. Aedeagus of *Ditrigona* **90** *D. sericea* (*Auzatella pentesticha* Chu & Wang, allotype) **91** *D. quinaria erminea*, ZFMK **92** *D. quinaria spodia* **93** *D. obliquilinea thibetaria* **94** *D. triangularia* **95** *D. uniuncusa* **96** *D. tenuiata*, holotype **97** *D. regularis* **98** *D. sinespina* sp. nov., holotype **99** *D. parva* sp. nov., holotype **100** *D. concava* sp. nov., paratype **101** *D. titana*, ZFMK **102** *D. pomenaria* **103** *D. typhodes* **104** *D. lineata lineata* **105** *D. artema* **106** *D. candida*, ZFMK. Scale bars: 1 mm.

Shen Xiaocheng et al.; 13♂1♀, Baotianman, 1407 m, 10–11.VIII.2008, leg. Jiang Nan, Song Wenhui, Xue Dayong. **Shaanxi**: 1♂, Shangnan, Jinsixia, 777 m, 23–25.VII.2013, leg. Jiang Nan; 5♂, same locality, 766 m, 16–19.VII.2017, leg. Cui Le; 3♂, Ningshan, Yueba, 1052 m, 1–3.VIII.2018, leg. Zhang Xinyi; 3♂, Mei Xian, Honghegu, Shenxianling, 1239 m, 21–22.VII.2018, leg. Zhang Xinyi; 2♀, same locality, 874 m, 20.VII.2018, leg. Zhang Xinyi; 6♂, Foping, Longcaoping, 1218 m, 4.VIII.2018, leg. Zhang Xinyi; 4♂, Taibai, Huangbaiyuan, 1279 m, 15–17.VII.2018, leg. Zhang Xinyi. **Zhejiang**: 5♂, Zhoushan, Putuo, Taohuadiao, 40 m, 4.VIII.2016, leg. Li Xinxin; 1♂, Taishun, Wuyanling, Shangfengxiang, 1050 m, 30.VII.2005, leg. Lang Songyun. **Hubei**: 8♂4♀, Lichuan, Xingdoushan, Sanxianchang, 1144 m, 17–19.V.2017, leg. Li Henan; 5♂, Xuanen, Changtanhe, Lianghekou, 949 m, 13–14.V.2017, leg. Li Henan; 5♂2♀, Xuanen, Changtanhe, Dawolong, 713–794 m, 15–16.V.2017, leg. Li Henan; 1♀, Ying Shan, Wujiashan, 500 m, 30.VI.2014, leg. Xue Dayong. **Jiangxi**: 1♂1♀, Jinggangshan, Huangyangjie, 1090 m, 4.VIII.2013, leg. Pan Xiaodan. **Hunan**: 3♀, Zhangjiajie, Wulingyuan, Wenfeng, 475 m, 10.VI.2015, leg. Yao Jian, Zhao Kaidong; 1♂1♀, Yanling, Taoyuandong, 631 m, 4–8.VII.2008, leg. Chen Fuqiang. **Fujian**: 1♂, Meihua Shan, Huyuan, 1276 m, 19.VII.2013, leg. Xue Dayong; 1♀, Masu, 25.IX.1981, leg. Jiang Fan. **Guangxi**: 1♀, Maoershan, Jiuniuchang, 1150 m, 7.VII.1985, leg. Fang Chenglai; 1♀, Maoershan, Jiuniutang, 1146 m, 16.VIII.2012, leg. Yang Chao; 1♂, Huanjiang, Yangmeiao, 1189 m, 18–22.VII.2015, leg. Jiang Nan. **Sichuan**: 1♂, Anha, Luojuoshan, 2044 m, 14–16.VII.2018, leg. Cui Le, Jiang Shan; 1♂, Hongya, Wawushan, Jinhuaqiao, 1147 m, 12–14.VIII.2016, leg. Cui Le; 12♂6♀, Emei Shan, Qingyinge, 800–1000 m, 16.IV., 17.IV., 19.IV., 24.IV., 26.IV., 27.IV., 29.IV., 30.IV., 12.V., 17.V., 18.VII.1957, leg. Huang Keren, Zhu Fuxing, Lu Youcai, Wang Zongyuan; 1♂, Emei Shan, 1100 m, 22.VI.1955, leg. Li Jinhua; 2♂, Wan Xian, Wangerbao, 1200 m, 27.IX.1994, leg. Song Shimei; 1♂ (ZFMK), Ost Tien-mu-shan, Chekiang, 14.VII.1931, H. Höne, moth photograph examined. **Chongqing**: 1♀, Jinyun Shan, 800 m, 13.VI.1994, leg. Li Wenzhu; 2♂4♀, Chongqing, 800 m, 20.VI., 22.VI.1974, leg. Han Yinheng. **Guizhou**: 2♀, Qianping Shan, Fudingshan, 604 m, 1–4.V.2018, leg. Zhao Kaidong.

Distribution. China (Shanxi, Henan, Shaanxi, Zhejiang, Hubei, Jiangxi, Hunan, Fujian, Taiwan, Guangxi, Sichuan, Chongqing, Guizhou), Japan.

Ditrigona conflexaria cerodeta Wilkinson, 1968

Fig. 39

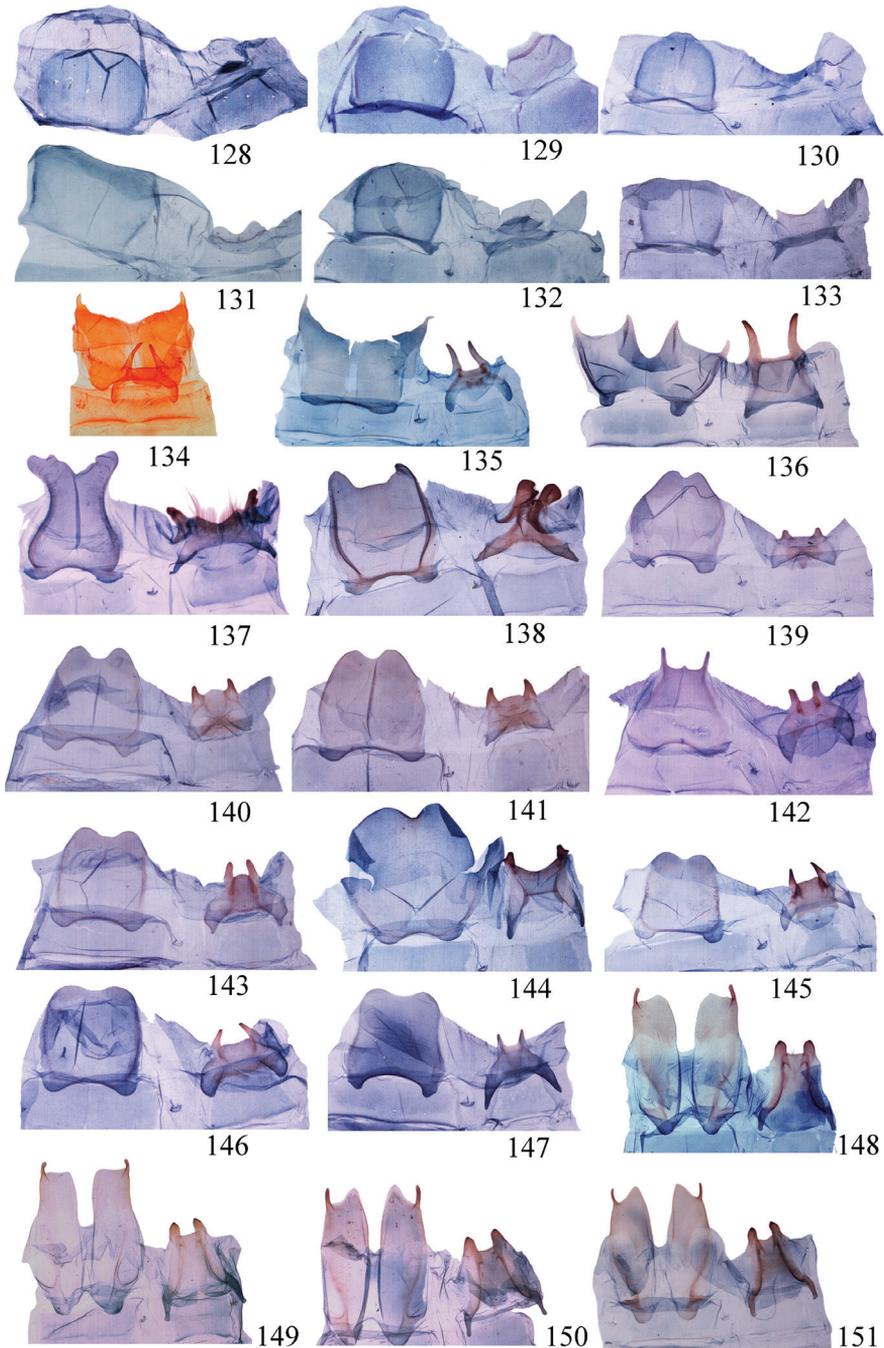
Ditrigona conflexaria cerodeta Wilkinson, 1968: 477. Holotype ♂, China: Likang (ZFMK).

Material examined. CHINA: **Yunnan**: 1♂ (ZFMK), holotype, Li-kiang, ca. 3000 m, Prov. Nord-Yuennan, 8.VIII.1934, H. Höne, moth photograph examined; 1♀ (ZFMK), paratype, Li-kiang, ca. 3000 m, 4.VIII.1934, H. Höne, moth photograph examined.

Distribution. China (Yunnan).



Figures 107–127. (107–115) Aedeagus of *Ditrigona* **107** *D. chionea* **108** *D. fusca* sp. nov., holotype **109** *D. confluxaria micronioides* **110** *D. margarita* **111** *D. berres* **112** *D. chama* **113** *D. platytes* **114** *D. clavata* **115** *D. cirruncata*. Scale bars: 1 mm. (116–127) Eighth segment of *Ditrigona* **116** *D. derocina* **117** *D. diana* **118** *D. crystallina*, holotype **119** *D. spilota*, ZFMK **120** *D. furvicosta* **121** *D. jordanaria* **122** *D. media* **123** *D. sericea* **124** *D. quinaria erminea*, ZFMK **125** *D. quinaria spodia* **126** *D. obliquilinea thibetaria* **127** *D. triangularia*



Figures 128–151. Eighth segment of *Ditrigona* **128** *D. uniuncusa* **129** *D. tenuiata*, holotype **130** *D. regularis* **131** *D. sinespina* sp. nov., holotype **132** *D. parva* sp. nov., holotype **133** *D. concava*, paratype **134** *D. titana*, ZFMK **135** *D. pomenaria* **136** *D. typhodes* **137** *D. lineata lineata* **138** *D. artema* **139** *D. candida*, ZFMK **140** *D. chionea* **141** *D. fusca*, sp. nov., holotype **142** *D. conflexaria micronioides* **143** *D. margarita* **144** *D. berres* **145** *D. chama* **146** *D. platytes* **147** *D. clavata* **148–151** *D. cirruncata* **148** from Shaanxi **149–150** from Emei Shan, Sichuan **151** from Zhejiang.

35. *Ditrigona margarita* Wilkinson, 1968

Figs 40, 76, 110, 143, 172

Ditrigona margarita Wilkinson, 1968: 483. Holotype ♂, China: Shaanxi, Tapaishan-im-Tsinling (ZFMK).

Material examined. CHINA: Shaanxi: 1♂ (ZFMK), holotype, Tapaishan-im-Tsinling, Sued-Shensi. ca. 1700 m, 22.VI.1936, H. Höne, moth photograph examined; 1♂ (IZCAS), Ningshan, Huoditang, 1538 m, 11–15.VII.2012, leg. Cheng Rui; 5♂ (IZCAS), Nanzheng, Liping, 1540 m, 27–30.VII.2017, leg. Li Henan. **Henan** (IZCAS): 1♂, Baotianman, 27.VII.2006, leg. Shen Xiaocheng et al. **Ningxia** (IZCAS): 1♂, Jingyuan, Qiuqianjialinchang, 1822 m, 23.VI.2008, leg. Song Wenhui; 1♀, Jingyuan, Erlonghe, 1984 m, 11–12.VII.2008, leg. Song Wenhui. **Gansu** (IZCAS): 1♀, Kang Xian, Qinghelinchang, 1400 m, 8.VII.1999, leg. Zhu Chaodong; 1♀, Zhouqu, Shatanlinchang, 2400 m, 14.VII.1999, leg. Yao Jian; 1♀, Wen Xian, Qiujiaba, 2350 m, 21.VII.1999, leg. Zhu Chaodong; 1♀, same locality and date, leg. Yao Jian. **Sichuan** (IZCAS): 1♂, Mao Xian, 9–11.VII.2015, leg. Li Xinxin; 1♀, Jiguan Shan, Baliping, 1470 m, 15–16.VII.2016, leg. Cui Le; 1♂, Jiguan Shan, Shaoyagou, 1556 m, 11–16.VII.2016, leg. Cui Le; 2♀, Pingwu, Wanglang, Qikeshu, 2446 m, 21–22.VII.2016, leg. Cui Le.

Distribution. China (Shanxi, Henan, Shaanxi, Ningxia, Gansu, Sichuan).

36. *Ditrigona berres* Wilkinson, 1968

Figs 41, 77, 111, 144, 173

Ditrigona berres Wilkinson, 1968: 486. Holotype ♂, China: Shaanxi, Tapaishan-im-Tsinling (ZFMK).

Material examined. CHINA: Shaanxi: 1♂ (ZFMK), holotype, Tapaishan-im-Tsinling Sued-Shensi, ca. 3000 m, 23.VI.1936, H. Höne, moth photograph examined; 1♂ (IZCAS), Feng Xian, Jialingjiangyuantou, 1510 m, 21–24.VII.2017, leg. Cui Le. **Hubei** (IZCAS): 2♀, Shennongjia, Dajiuhu, 1800 m, 1.VIII.1981, leg. Han Yinheng; 1♂, Xingshan, Longmenhe, 1300 m, 14.VI.1993, leg. Li Hongxing. **Hunan** (IZCAS): 2♂1♀, Sangzhi, Badagongshan, Xiaozhuangping, 1420 m, 18.VI.2015, leg. Yao Jian, Zhao Kaidong.

Distribution. China (Shaanxi, Hubei, Hunan).

37. *Ditrigona chama* Wilkinson, 1968

Figs 42, 78, 112, 145, 174

Ditrigona chama Wilkinson, 1968: 488. Holotype ♂, China: Sichuan, Siao-lou (NHMUK).

Material examined. CHINA: Yunnan: 1♂ (ZFMK), paratype, Li-kiang. ca. 3000 m, Prov. Nord-Yuennan, 28.VII.1934, H. Höne, moth photograph examined; 2♂

(IZCAS), Yongsheng, Liude, 2250 m, 10.VII.1984, leg. Liu Dajun; 1♂ (IZCAS), Tengchong, Qushi, Dabacun, 1873 m, 4.VII.2013, leg. Liu Shuxian. **Shanxi** (IZCAS): 15♂14♀, Pangquangou, Erhezhuang, 1670 m, 4–6.VII.2018, leg. Cui Le, Jiang Shan. **Shaanxi** (IZCAS): 1♂, Mei Xian, Honghegu, Shenxianling, 1239 m, 21–22.VII.2018, leg. Zhang Xinyi; 1♂, Ningshan, Huoditang, 1497 m, 29–31.VII.2018, leg. Zhang Xinyi; 1♀, Zhouzhi, Diaoyutai, 1480 m, 29.VI.2008, leg. Bai Ming; 1♂, Foping, Longcaoping, 1256 m, 3.VII.2008, leg. Liu Wangang, Cui Junzhi; 2♂, Taibai, Huangbaiyuan, 1323 m, 17–18.VI.2012, leg. Li Jing, Liu Shuxian; 1♂1♀, Feng Xian, Jialingjiangyuantou, 1510 m, 21–24.VII.2017, leg. Cui Le; 1♂1♀, Zhashui, Yingpanzhen, Niubeiliang, Laolin, 1046 m, 11–15.VII.2017, leg. Cui Le. **Gansu** (IZCAS): 1♂, Kang Xian, Qinghelinchang, 1400 m, 7.VII.1999, leg. He Tongli, Yao Jian; 1♂, Zhouqu, Shatanlinchang, 2350 m, 5.VII.1998, leg. Yuan Decheng. **Zhejiang**: 2♀, Tianmu Shan, 26.VI.1957, leg. Su Jiyao. **Sichuan** (IZCAS): 1♀, Emei Shan, Jiulaodong, 1800–1900 m, 6.VII.1957, leg. Zhu Fuxing; 1♀, Jiguan Shan, Shaoyaogou, 1556 m, 11–16.VII.2016, leg. Cui Le.

Distribution. China (Shanxi, Shaanxi, Gansu, Zhejiang, Hubei, Sichuan, Yunnan, Tibet).

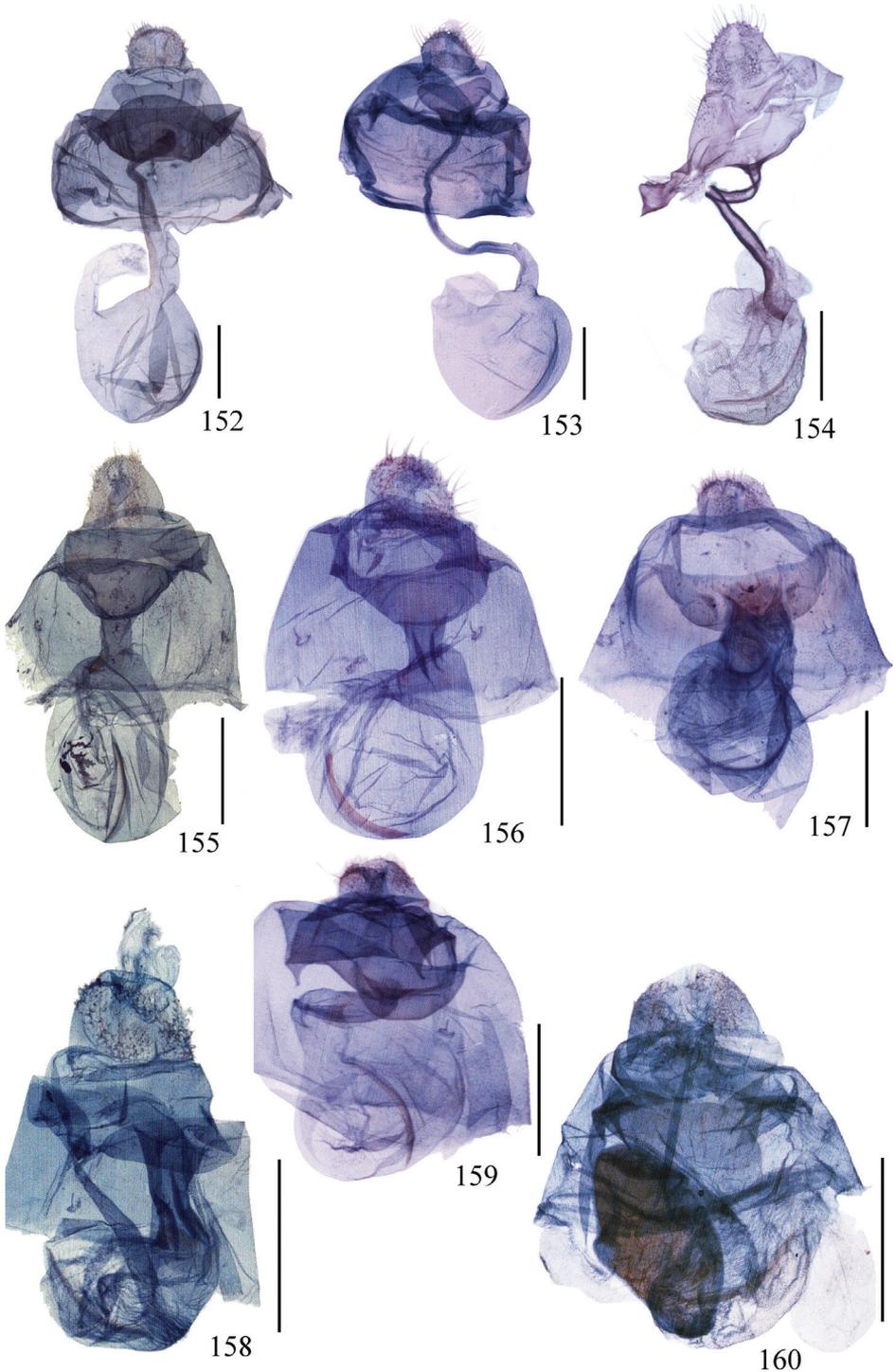
38. *Ditrigona platytes* Wilkinson, 1968

Figs 43, 79, 113, 146, 175

Ditrigona platytes Wilkinson, 1968: 492. Holotype ♂, China: Chekiang, West Tien-mu-Shan (ZFMK).

Material examined. **CHINA: Zhejiang:** 1♂ (ZFMK), holotype, West Tien-mu-shan, Prov. Chekiang, 29.V.1932, H. Höne, moth photograph examined; 1♂ (IZCAS), Tianmu Shan, 26.VI.1957, leg. Su Jiyao; 2♂ (IZCAS), West Tianmu Shan, Qianmutian, 1330 m, 30.VII.2011, leg. Yan Keji, Cheng Rui. **Fujian:** 1♀ (ZFMK), paratype, Kuantun, 2300 m, 26.V.1938, leg. J. Klapperich, moth photograph examined. **Shaanxi** (IZCAS): 2♂, Ningshan, Huoditang, 1538 m, 11–15.VII.2012, leg. Yang Xiushuai, Cheng Rui; 1♂, same locality, 1520 m, 13–17.VIII.2016, leg. Cheng Rui, Jiang Shan; 4♂5♀, same locality, 1497 m, 29–31.VII.2018, leg. Zhang Xinyi; 2♂, Baoji, Jialingjiangyuantou, 1620 m, 8–9.VII.2014, leg. Xue Dayong, Ban Xiaoshuang; 2♂1♀, Nanzheng, Liping, 1540 m, 27–30.VII.2017, leg. Li Henan; 1♂, Zhashui, Yingpanzhen, Niubeiliang, Laolin, 1046 m, 11–15.VII.2017, leg. Cui Le; 8♂7♀, Zhashui, Yingpanzhen, Niubeiliang, 1373 m, 24–26.VII.2018, leg. Zhang Xinyi; 1♂, Foping, Longcaoping, 1218 m, 4.VIII.2018, leg. Zhang Xinyi. **Hubei** (IZCAS): 1♂, Yichang, Dengcunxiang, Dalaoling; 1709 m, 15.VII.2013, leg. Cheng Rui. **Sichuan** (IZCAS): 1♀, Emei Shan, Jiulaodong; 1800–1900 m, 28.VII.1957, leg. Huang Keren; 1♂, Baoxing, Dashuigou, 1591 m, 1–5.VIII.2016, leg. Cui Le; 1♂1♀, Jiguan Shan, Shaoyaogou, 1556 m, 11–16.VII.2016, leg. Cui Le. **Yunnan** (IZCAS): 4♂, Pingbian, Dawei Shan, 2090 m, 4–8.VIII.2017, leg. Cui Le.

Distribution. China (Shaanxi, Zhejiang, Hubei, Fujian, Sichuan, Yunnan).



Figures 152–160. Female genitalia of *Ditrigona* **152** *D. derocina* **153** *D. diana* **154** *D. crystallina*, allotype **155** *D. spilota*, ZFMK **156** *D. furvicosta* **157** *D. sericea* **158** *D. quinaria erminea*, ZFMK **159** *D. obliquilinea thibetaria* **160** *D. uniuncusa*. Scale bars: 1 mm.

39. *Ditrigona clavata* Li & Wang, 2015

Figs 44, 80, 114, 147, 176

Ditrigona clavata Li & Wang, 2015: 567. Holotype ♂, China: Guangxi, Mao'ershan National Nature Reserve (SCAU).

Material examined. CHINA: Shaanxi (IZCAS): 1♂, Liuba, Chengguanzhen, 1007 m, 21–22.VI.2012, leg. Li Jing; 1♂, same locality, 966 m, 23.VI.2012, leg. Liu Shuxian; 1♂, Yang Xian, Huayangzhen, 1099–1108 m, 25–27.VI.2012, leg. Li Jing; 7♂1♀, Ningshan, Yueba, 1052 m, 1–3.VIII.2018, leg. Zhang Xinyi; 2♂, Kang Xian, Qinghelinchang, 1400 m, 8.VII.1999, leg. Zhu Chaodong. Guangxi (IZCAS): 2♂1♀, Huanjiang, Yangmeiao, 1189 m, 18–22.VII.2015, leg. Jiang Nan, Li Xinxin.

Distribution. China (Shaanxi, Gansu, Guangdong, Guangxi).

40. *Ditrigona marmorea* Wilkinson, 1968

Fig. 45

Ditrigona marmorea Wilkinson, 1968: 471. Holotype ♂, Assam: Mishmi Hills (NHMUK).

Material examined. CHINA: Yunnan (ZFMK): 1♂, paratype, Li-kiang (China), Provinz Nord-Yuennan, 25.VI. 1935, H. Höne, moth photograph examined.

Distribution. China (Yunnan), India.

41. *Ditrigona quinquelineata* (Leech, 1898)

Leucodrepana quinquelineata Leech, 1898: 364. Holotype ♂, Japan (NHMUK).

Auzatella quinquelineata: Inoue, 1962: 13.

Ditrigona quinquelineata: Wilkinson, 1968: 480.

Material examined. No.

Distribution. China (Sichuan), Japan.

42. *Ditrigona aphyra* Wilkinson, 1968

Fig. 46

Ditrigona aphyra Wilkinson, 1968: 485. Holotype ♂, China: Shaanxi, Tapaishan-im-Tsinling (ZFMK).

Material examined. CHINA: Shaanxi (ZFMK): 1♂, holotype, Tapaishan-im-Tsinling Sued-Shensi, ca. 1700 m, 20.VI.1936, H. Höne, moth photograph examined.

Distribution. China (Shaanxi).



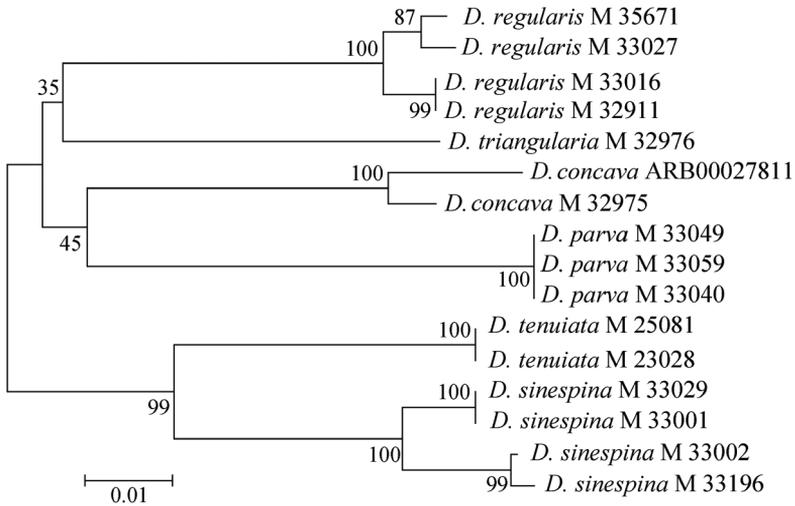
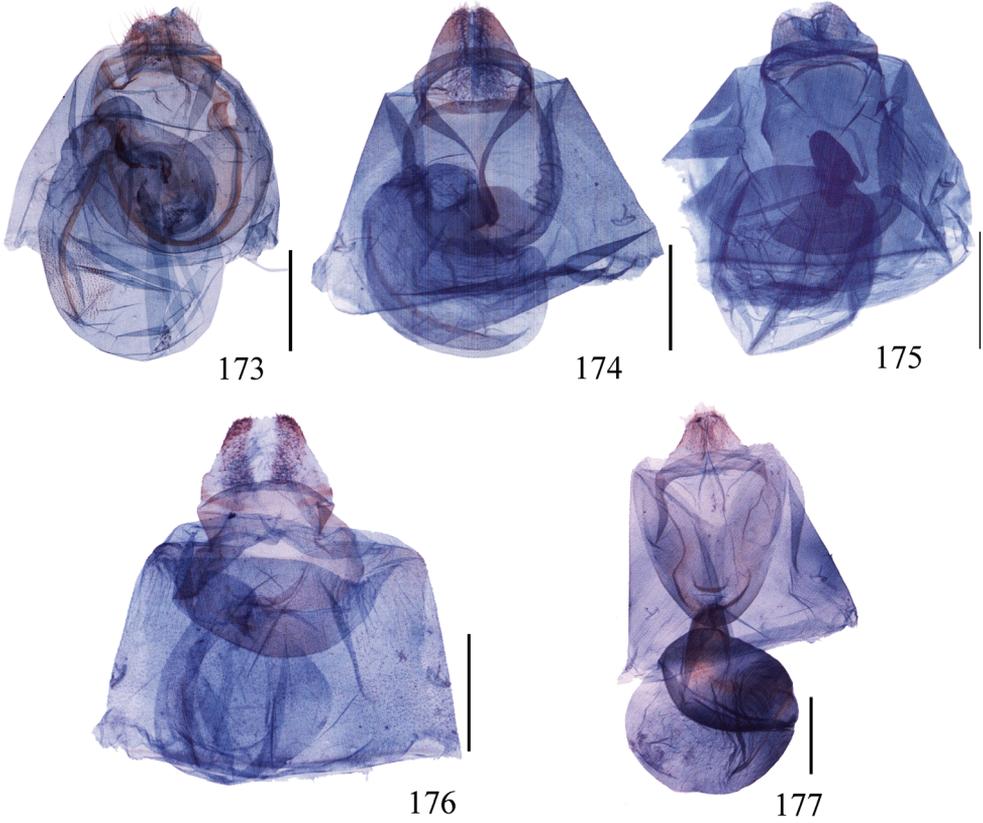
Figures 161–172. Female genitalia of *Ditrigona* **161** *D. tenuiata*, paratype **162** *D. regularis* **163** *D. sinespina* sp. nov., paratype **164** *D. parva* sp. nov., paratype **165** *D. typhodes* **166** *D. lineata lineata* **167** *D. artema* **168** *D. candida*, paratype, ZFMK **169** *D. chionea* **170** *D. fusca* sp. nov., paratype **171** *D. conflexaria micronioides* **172** *D. margarita*. Scale bars: 1 mm.

43. *Ditrigona cirruncata* Wilkinson, 1968

Figs 47, 81, 115, 148–151, 177

Ditrigona cirruncata Wilkinson, 1968: 497. Holotype ♂, China: Sichuan, Siao-lou (ZFMK).

Material examined. China: Sichuan: 1♂ (ZFMK), paratype, Kwanhsien Dist. Suchwan, 16.VIII.1925, leg. G.M. Franck, moth photograph examined; 31♂14♀ (IZCAS), Emei Shan, Qingyinge, 800–1000 m, 14.IV., 16.IV., 17.IV., 18.IV., 19.IV., 24.IV., 25.IV., 26.IV., 27.IV., 29.IV., 30.IV., 1.V., 2.V., 5.V., 6.V., 20.VI., 29.VI., 16.VIII., 18.IX., 20.IX.1957, leg. Wang Zongyuan, Zhu Fuxing, Huang Keren, Lu Youcai; 3♂ (IZCAS), Jiulong Shan, Shizipo, 810 m, 29–31.VII.2016, leg. Cui Le; 2♀, Baoxing, Dashuigou, 1591 m, 1–5.VIII.2016, leg. Cui Le; 1♂2♀ (IZCAS), Hongya, Wawu Shan, Jinhuaqiao, 1147 m, 12–14.VIII.2016, leg. Cui Le; 1♂5♀ (MHBU), Emei Shan, 17–19.IX.2010, leg. Niu Yiping. **Shanxi** (IZCAS): 1♂, Qinshui, Manghe, 557 m, 19–20.VIII.2018, leg. ZhangXinyi. **Henan** (IZCAS): 1♂, Baotianman, 1407 m, 10–11.VIII.2008, leg. Jiang Nan. **Shaanxi:** 11♂17♀ (IZCAS), Ningshan, Huoditang, 1520 m, 13–17.VIII.2016, leg. Cheng Rui, Jiang Shan; 3♂9♀ (IZCAS), same locality, 1497 m, 29–31.VII.2018, leg. Zhang Xinyi; 1♂ (IZCAS), Ningshan, Yueba, 1052 m, 1–3.VIII.2018, leg. Zhang Xinyi; 1♂ (IZCAS), Zhashui, Yingpanzhen, Niubeiliang, 1373 m, 24–26.VII.2018, leg. Zhang Xinyi; 1♀ (IZCAS), Foping, Longcaoping, 1218 m, 4.VIII.2018, leg. Zhang Xinyi; 1♀ (MHBU), Ningshan, Huoditang, 1505 m, 14.VIII.2013, leg. Zhu Xichao, Tian Ying; 1♀ (MHBU), Ningshan, Guanghuojie, 1135 m, 10.VIII.2013, leg. Zhu Xichao, Tian Ying. **Gansu** (IZCAS): 3♀, Wen Xian, VI.–IX.2002, leg. Wang Hongjian; 3♂, Bikou, Bifenggou, 720 m, 8–10.VIII.2016, leg. Cheng Rui, Jiang Shan. **Zhejiang** (IZCAS): 3♂, Lin'an, West Tianmushan, 400 m, 26–27.VII.2003, leg. Xue Dayong, Han Hongxiang; 2♀, West Tianmushan, Xianrending, 1506 m, 27.VII.2011, leg. Yan Keji, Cheng Rui; 1♀, West Tianmushan, Qianmutian, 1330 m, 30.VII.2011, leg. Yan Keji, Cheng Rui; 1♂1♀, Yuyao, Simingshan, 809–853 m, 22–22.VII.2015, leg. Cheng Rui. **Anhui:** 1♀ (MHBU), Shitai, Shanshan, 7.VIII.2010, leg. Ba Yibin, Zhang Zhenxing. **Hubei** (IZCAS): 2♀, Shennongjia, Honghua, 860 m, 21.VIII.1981, leg. Han Yinhe; 1♂, Ying Shan, Taohuachong, 590 m, 23–27.VI.2014, leg. Jiang Nan; 4♂, Xuanen, Changtanhe, Lianghekou, 949 m, 13–14.V.2017, leg. Li Henan; 1♀, Xuanen, Changtanhe, Dawolong, 713 m, 15.V.2017, leg. Li Henan; 2♂1♀, same locality and collector, 794 m, 16.V.2017, leg. Li Henan; 1♀, Lichuan, Xingdou Shan, Sanxianchang, 1144 m, 17–19.V.2017, leg. Li Henan. **Jiangxi** (IZCAS): 1♂, Kuling, 13.VI.1974, leg. Zhang Baolin. **Hunan** (IZCAS): 1♂, Sangzhi, Bamaoxi, Shuitiannan, 370 m, 1.VIII.2009, leg. Wei Zhongmin; 1♂1♀, Sangzhi, Bamaoxi, Shuitianba, 370 m, 5–6.VIII.2009, leg. Wei Zhongmin; 1♂, Sangzhi Badagong Shan, Xiaozhuangping, 1420 m, 18.VI.2015, leg. Yao Jian, Zhao Kaidong; 2♂1♀, Yongshun, Xiaoxixiang, Xiaoxicun, 463–506 m, 21–24.IV.2018, leg. Zhao Kaidong. **Guangxi** (IZCAS): 1♀, Mao'er



Figures 173–178. Female genitalia of *Ditrigona* **173** *D. berres* **174** *D. chama* **175** *D. platytes* **176** *D. clavata* **177** *D. cirruncata* Scale bars: 1 mm. **178** Neighbour-Joining (NJ) tree of selected *triangularia* species group based on the Kimura two-parameter model.

Shan, Jiuniuchang, 1100 m, 11.VII.1985, leg. Fang Chenglai; 1♂, Mao'er Shan, Jiuniutang, 1146 m, 16.VIII.2012, leg. Cheng Rui; 1♀, Mao'er Shan, Antangping, 1579 m, 17–18.VIII.2012, leg. Cheng Rui.

Distribution. China (Shanxi, Henan, Shaanxi, Gansu, Anhui, Zhejiang, Hubei, Jiangxi, Hunan, Guangdong, Guangxi, Sichuan).

Remarks. There are some variations in the eighth tergite (Figs 148–151), even in specimens collected from the same locality: for example, both Fig. 149 and Fig. 150 are from Emei Shan, Sichuan Province. Inoue (1962) recorded the distribution of *D. virgo* in central and west China, and was followed by Chu and Wang (1988, 1991). However, when checking the collection of IZCAS, only *D. cirruncata* was found. The record of *D. virgo* in China is doubtful. The situation is similar in *D. komarovi* (Kurentzov), a species recorded from Manchuria, and was combined from *Leucodrepana* by Wilkinson (1968). Chu and Wang (1988, 1991) recorded this species from Northeast China. However, when examining the collection of IZCAS, this species was not found, and its record in China is also doubtful.

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Molecular and morphological evidence revalidates *Acrobrycon tarijiae* (Characiformes, Characidae) and shows hidden diversity

Yanina F. Briñoccoli^{1,6}, Sergio Bogan², Dahiana Arcila³,
Juan J. Rosso^{4,6}, Ezequiel Mabragaña^{4,6}, Sergio M. Delpiani^{4,6},
Juan Martín Díaz de Astarloa^{4,6,7}, Yamila P. Cardoso^{5,6}

1 Laboratorio de Ictiofisiología y Acuicultura, Instituto Tecnológico Chascomús, Universidad Nacional de San Martín, Av. Intendente Marino km 8200 CC 164 7130, Chascomús, Buenos Aires, Argentina **2** Fundación de Historia Natural “Félix de Azara”, Centro de Ciencias Naturales, Ambientales y Antropológicas, Universidad Maimónides, Hidalgo 775 piso 7, C1405BDB, Buenos Aires, Argentina **3** Sam Noble Oklahoma Museum of Natural History and Department of Biology, University of Oklahoma, Norman, Oklahoma, 73072, USA **4** Grupo de Biotaxonomía Morfológica y Molecular de Peces, Instituto de Investigaciones Marinas y Costeras (IIMyC), Facultad de Ciencias Exactas y Naturales, Universidad Nacional de Mar del Plata, Funes 3350, 7600 Mar del Plata, Argentina **5** Laboratorio de Sistemática y Biología Evolutiva, Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata. Paseo del Bosque S/N, B1900FWA, La Plata, Buenos Aires, Argentina **6** Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Buenos Aires, Godoy Cruz 2290, CABA, Argentina **7** Departamento de Biología, Facultad de Ciencias Exactas y Naturales, Universidad Nacional de Mar del Plata, Funes 3250, 7600 Mar del Plata, Argentina

Corresponding author: Yamila P. Cardoso (yamilapcardoso@gmail.com)

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Abstract

We conducted a revision of the Neotropical genus *Acrobrycon*. A previous study synonymized the species, *A. ipanquianus*, distributed from the western portion of the Amazon River to the north-western region of the La Plata River Basin, and *A. tarijiae*, with type locality in the Lipeo River in Bolivia. We revisited this result by collecting new morphometric, meristic, and genetic data (*COI* mitochondrial gene) for 24 individuals distributed along La Plata River Basin in Argentina, and discussed our results in the context of multiple biogeographic processes of isolation in that basin. Our results revealed a more complex history of diversification and geographic distribution across *Acrobrycon* species than previously suspected, probably associated with multiple biogeographic processes of isolation in La Plata River Basin. We present new

evidence that led us to reconsider the validity of *A. tarijae*, which is distinguishable from *A. ipanquianus* by the number of vertebrae (37–39 vs. 41–42) and pleural ribs (12–13 vs. 14). These results were also supported by our molecular analyses that revealed a genetic divergence >4% between *A. ipanquianus* and *A. tarijae*. We also identified two main genetic clusters within *A. tarijae*: the first cluster consisted of specimens from the Bermejo, Pilcomayo, Itiyuro and Juramento river basins (northern Argentina); and the second cluster included specimens from the southernmost basins, such as the Salí River in Tucumán, Cuarto River in the province of Córdoba and the Quinto River in the province of San Luis. Our results suggest that the genetic structure observed in *A. tarijae* is the result of the type of drainage (endorheic vs. exorheic) and geographical distance.

Keywords

Endorheic, freshwater fishes, La Plata River Basin, mitochondrial DNA, Stevardiinae

Introduction

Among freshwater fishes, Characidae is the most diverse family of the order Characiformes with over 1180 valid species (Fricke et al. 2021). Phylogenetic relationships among characids based on reproductive, morphological and molecular characters have been largely controversial due to the taxonomic complexity of this family (Javonillo et al. 2010; Mirande 2010, 2019; Menezes et al. 2020; Ferreira et al. 2021). For instance, the genus *Acrobrycon* Eigenmann & Pearson, 1924 was initially proposed as most closely related to the genera *Diapoma* Cope, 1894 and *Planaltina* Böhlke, 1954 based on one reproductive character, the presence of pheromone organs overlying the basal portions of the caudal fin, which united the tribe Diapomini (Weitzman et al. 1988). Subsequent morphological studies, examining a large number of osteological and external characters suggested instead that *Acrobrycon* was most closely related to *Mimagoniates* Regan, 1907, *Pseudocorynopoma* Perugia, 1891, and *Diapoma* (Mirande, 2010). More recently, the examination of molecular characters provided additional insights about the relationships of *Acrobrycon*, indicating the genus *Hemibrycon* Günther, 1864 as its sister group (Thomaz et al. 2015). Both *Acrobrycon* and *Hemibrycon* along with *Boehlkea* Géry, 1966 share the presence of teeth along more than one-half the length of the dentigerous margin of the maxilla, which resulted in the reclassification of these three genera in the reclassified tribe Hemibryconini (Thomaz et al. 2015). Further studies based on morphological data recovered *Acrobrycon* as separate from the Hemibryconini, as the sister clade of the Stevardiini (Vanegas-Ríos 2018). Later, based on a combined phylogenetic analysis, Mirande (2019) corroborated a sister-group relationship between *Acrobrycon* and *Hemibrycon*, including both genera within Hemibryconini, a result also shown in Vanegas-Ríos et al. (2020).

Currently, *Acrobrycon* is composed of three species that were revised in Arcila et al. (2013). *Acrobrycon ipanquianus* (Cope, 1877) is distributed from the western portion of the Amazonas Basin through the north-western region of the La Plata River Basin, including a current junior synonym, *A. tarijae* Fowler, 1940; *A. starnesi* Arcila, Vari & Menezes, 2013, only known from the Thyumayu River in the southwestern portion of the Amazon Basin in Bolivia; and *A. ortii* Arcila, Vari & Menezes, 2013, distributed in the upper Pilcomayo River in Bolivia. Arcila et al. (2013) erroneously indicated the

occurrence of *A. ortii* on the northwestern La Plata River Basin including Argentina. However, no references of the presence of this species in this location are listed and the references for valid species from Argentina do not include the occurrence of *A. ortii*, only *A. ipanquianus* as the only confirmed species in this territory (Liotta 2022; Mirande and Koerber 2020).

In 1877, Cope described a wide series of freshwater fish collected by Prof. James Orton (1830–1877) during his exploration of the Upper Amazon in Peru (Cope 1877; Fowler 1901) including *Tetragonopterus ipanquianus* (Cope, 1877), from the Urubamba River. Following Cope's description, Fowler (1906) proposed the reclassification of *T. ipanquianus* to *Astyanax* Baird & Girard, 1854. Later, Eigenmann (1910; 1921), reclassified these species to the genus *Hemibrycon*. In 1924, Eigenmann and Person, describing the fishes collected by the biological exploration of Mulford organized by Henry Hurd Rusby (1855–1940), referred to the new specimens from Bolivia at 3080 m.a.s.l., as the same species described by Cope, but this time they proposed a new genus: *Acrobrycon*.

Eigenmann and Pearson (1924) designated *Acrobrycon ipanquianus* as the type species of the monotypic genus *Acrobrycon*, and indicated a relationship with *Hemibrycon*, with the exception that *Acrobrycon* presented a large caudal pouch observed in mature males. This dimorphism can be clearly seen in the holotype of the species and in the additional materials used to define the genus. In 1940, Fowler described the fishes collected by M. A. Carriker (1879–1965) during 1936 and 1937 in Bolivia, and proposed a new species, *Acrobrycon tarijae*. The type locality of this new species was identified as the Lipeo River in Tarija, Bolivia. However, recent studies have shown that Carriker's route unequivocally puts the collection point of *Acrobrycon tarijae* within the Argentinian territory, in the province of Salta (Ringuelet et al. 1967; López et al. 2003; Mirande and Koerber 2020). Fowler differentiated *Acrobrycon tarijae* from *A. ipanquianus* (Cope) by the more anterior insertion of the anal fin, which is arranged forward under the front of the base of the dorsal fin, a few more teeth along the maxillary edge, and the dorsal-fin origin clearly closer to the base of the tail than to the tip of the snout. More recently, a morphological revision of the genus *Acrobrycon* conducted by Arcila et al. (2013) using external morphological characters showed that *A. tarijae* could not be distinguished from *A. ipanquianus*, placing *A. tarijae* as a synonym of *A. ipanquianus*. Here, we present new sources of evidence, including osteological and molecular characters from multiple specimens of *Acrobrycon* to evaluate the genetic diversity of the genus and the validity of *A. tarijae* across the La Plata River Basin.

Materials and methods

Institutional abbreviations

- ANSP** The Academy of Natural Sciences, Drexel University, Philadelphia, Pennsylvania;
- CFA-IC** Colección de Ictiología de la Fundación de Historia Natural Félix de Azara, Buenos Aires, Argentina;

UNMDP Instituto de Investigaciones Marinas y Costeras, Universidad Nacional de Mar del Plata, Mar del Plata;

USNM National Museum of Natural History, Smithsonian Institution, Department of Vertebrate Zoology, Washington D.C.

Catalog numbers are followed by the total number of samples in alcohol, the number of cleared and stained samples, and the presence of tissue samples from specimens directly preserved in alcohol for molecular studies.

After each collection code, the number of individuals from which measurements (30) were taken or molecularly analyzed (22) is indicated between brackets. Other revised materials were included in the Suppl. material and in the Figs 2, 3.

Material examined

Argentina: SALTA. CFA-IC-4996 [1 with genetic data] Bermejo River and National Route 34 km 1340, near Embarcación. Coll. Y.P. Cardoso, S. Bogan, J.M. Meluso 23°14'58.96"S, 64°8'18.56"W, 10/17/2015; **CFA-IC-5180** [2 with genetic data] Pescado River and National Route 50, near Oran. Coll. Y.P. Cardoso, S. Bogan, J.M. Meluso, (FHN-2293 and 2294), 22°57'53.80"S, 64°21'53.24"W, 10/15/2015; **CFA-IC-5207** [1 with genetic data] Pilcomayo River in Santa María. Coll. Y.P. Cardoso, S. Bogan, J.M. Meluso (FHN-2394), 22°8'7.73"S, 62°48'45.18"W, 10/16/2015; **CFA-IC-5223** [2 with genetic data] Saladillo River and National Route 34 near General Güemes. Coll. S. Bogan, J.M. Meluso (FHN-2120 and 2121), 24°35'42.96"S, 65°4'47.26"W, 10/13/2015; **CFA-IC-5557** [2 with genetic data] Las Conchas River and National Route 9 km 1463, Metan. Coll. J. Montoya-Burgos, Y.P. Cardoso, L.J. Queiroz (AR15-1101 to 1105), 25°28'31.82"S, 64°58'31.46"W, 11/10/2015; **CFA-IC-10369** [3 with morphological data] Las Cañas River, in RP 5, between Lumbraera and Las Víboras (loc. 53). Anta Department. Coll. A. Miquelarena et al., 25°07'S, 64°34'W, 10/11/1988; **CFA-IC-5171** [2 with genetic data] Itiyuro River downstream from the landfill. Coll. Y.P. Cardoso, S. Bogan, J.M. Meluso (FHN-2343 to 2346), 22°6'32.97"S, 63°43'24.44"W, 10/15/2015; **CFA-IC-11453** [8 with morphological data] river in Las Víboras, RP 5, between Las Víboras and Pozo de la Cruz (loc. 54). Anta Department. Coll. R. Menni, A. Miquelarena, 25°00'S, 64°34'W, 10/09/1988; **CFA-IC-11458** [11 with morphological data] first stream after the Juramento River, in Tararipa (loc. 5). Anta Department. Coll. R. Menni and A. Miquelarena, 25°17'S, 64°36'W, 03/28/1987. **UNMDP** [3 with genetic data] Yutón River Route 34. Coll. J.J. Rosso, E. Mabragaña, H. Regidor 23°38'37.73"S, 64°32'23.251"W (UNMDP-4176 to UNMDP-4178), 29/9/2015; [3 with genetic data] Sauzalito River Route 34. Coll. J.J. Rosso, E. Mabragaña, H. Regidor 23°40'16.975"S, 64°33'42.494"W (UNMDP-4198 to UNMDP-4200), 29/9/2015. **SANTIAGO DEL ESTERO. CFA-IC-3165** [2 with morphological data] Horcones River, Locality 13. Coll. Y.P. Cardoso, A. Paracampo, C. Rivera, J. Montoya-Burgos (AR11-939 to 944 and 946 to 950) 26°2'49.68"S, 64°22'8.70"W, 11/27/2011. **TUCUMÁN. CFA-IC-3126** [2 with genetic data – 6 with morphological data] Dulce-Salí River Tributary. Locality 15. Coll. Y.P. Cardoso, A. Paracampo, C. Rivera, J. Montoya-Burgos (AR11-765 to 770)

26°38'01.9"S, 65°03'19.1"W, 11/28 2011; **CFA-IC-5657** [1 with genetic data] Pools linked to the Vïpos River. Coll. J. Montoya-Burgos, Y.P. Cardoso, L.J. Queiroz (AR15-1174), 26°29'1.10"S, 65°19'53.40"W, 11/11/2015. **SAN LUIS. CFA-IC-3967** [1 with genetic data] Quinto River and Ruta 14, Justo Daract, Locality 11. Coll. Y.P. Cardoso, A. Jauregui, M.B. Cabrera (YC13-942), 33°55'7.70"S, 65°9'3.40"W, 11/30/2014. **CÓRDOBA.** [3 with genetic data] Santa Catalina River linked to the Cuarto River. Coll Y.P Cardoso, A. Paracampo, C. Rivera, J. Montoya-Burgos (AR11-1353 to 1355), 33°12'03.2"S, 64°25'43.2"W, 02/12/2011.

Molecular approach

Phylogenetic reconstruction and haplotype network. A total of 24 individuals of *Acrobrycon* from 11 localities of La Plata River Basin in Argentina were included in all molecular analyses (Fig. 1). The mitochondrial cytochrome c oxidase I (*COI*) gene was amplified at the Argentine International Barcode of Life Laboratory reference (IIMyC, CONICET, Mar del Plata, Argentina) and the Canadian Centre for DNA Barcoding, Biodiversity Institute of Ontario (CCDB, University of Guelph, Guelph, Ontario) using the cocktail primers described by Ivanova et al. (2007). Sequencing was performed in the CCDB. A molecular phylogenetic approach was used to describe the genetic relationships between the *Acrobrycon* species and some *Hemibrycon* sequences available in GenBank. *Nantis indefessus* (Mirande, Aguilera & Azpelicueta, 2004) and *Diapoma alburnum* (Hensel, 1870) were used as root of the analyses. Maximum likelihood (ML) analyses were conducted using MEGA 7.0.26 (Kumar et al. 2018). Branch support was assessed using the bootstrap algorithm with 1000 replicates. The optimal nucleotide substitution model was selected according to the Bayesian information Criterion (BIC) by JModelTest 2.1.10 (Darriba et al. 2015).

Haplotype network construction is a widely used analysis to assess and visualize the relationships among DNA sequences within a population or species. This approach was effective to explore haplotype partitioning between and within disparate different genetic lineages in a widely distributed Neotropical migratory species (Rosso et al. 2018). Here, this analysis is intended to explore the genetic structure within *A. tarijajae* of different basins. The minimum spanning network of the *COI* haplotypes of the *Acrobrycon* sequences was constructed using PopART 1.7 (Leigh and Bryant 2015) to assess the connections and frequencies of haplotypes. The network was colored following the Barcode Index Number (BIN) as indicated below.

Genetic diversity is discussed in the context of three biogeographic processes: isolation-by-distance (IBD; Wright 1943), isolation-by-environment (IBE; Wang and Bradburd 2014) and isolation-by-barrier (IBB; Rahel 2007). To assess the role of geographical distance on the genetic structure of the genus *Acrobrycon*, we used the Mantel test (Mantel 1967) with the aim of testing by the presence of an IBD process. We estimated a matrix of genetic distances using the Kimura two-parameter (K2P) model (Kimura 1980) in MEGA, and a matrix of geographical distances based on individual pair comparisons. To estimate the role of IBB, we classified the sampling localities using two schemes: endorheic basin (no connection to the sea) or exorheic basin (connecting with the sea). The phenomenon of basin fragmentation isolates the aquatic organisms

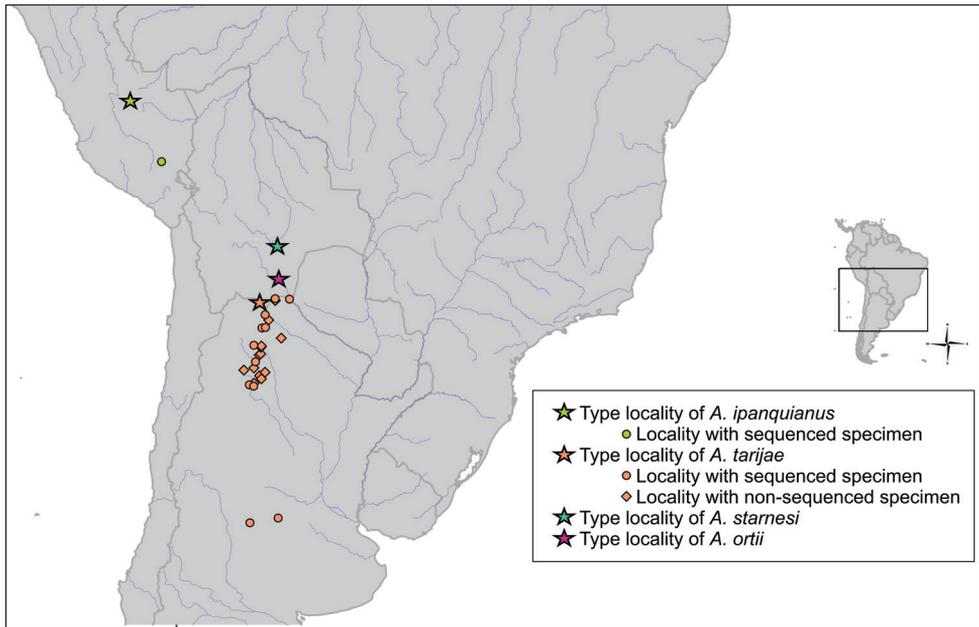


Figure 1. Map of the study area for the species of the genus *Acrobrycon*. Stars represent the type localities for each species; Circles the localities with sequenced specimens; and diamonds the localities without sequenced specimens.

that inhabit these rivers, resulting in an increase of the genetic diversity (Berry et al. 2019). If the time of isolation is long enough, it can result in population genetic differentiation within the species that has been fragmented. But if the time of isolation is even greater, it may eventually lead to allopatric speciation (Dias et al. 2013; Jardim de Queiroz et al. 2017; Briñoccoli et al. 2021). Finally, to assess whether the IBE is structuring the haplotype network of *Acrobrycon* species, we measured the altitude in meters above sea level for each site in which specimens of *Acrobrycon* were collected.

Diversity and divergence. Species delimitation analyses were conducted using the Automatic Barcode Gap Discovery (ABGD) method (Puillandre et al. 2012) and the BIN. For the ABGD, the *COI* alignment was uploaded to the online platform (<http://wwwabi.snv.jussieu.fr/public/abgd/abgdweb.html>) and run using two schemes: the default settings (Pmin = 0.001, Pmax = 0.1, Steps = 10, X relative gap width = 1.5, Nb bins = 20), and the Kimura distance models. The BIN was generated and downloaded for all 22 sequences available on the BOLD database. The BIN analysis clusters barcode sequences to create Operational Taxonomic Units (OTUs) that closely reflect species groupings. We computed the distance matrix of the K2P model (Kimura, 1980) using MEGA following the groups identified in the ABGD and BIN analyses. Finally, we explored whether the groups identified by the BIN and ABGD analyses were consistently supported by the ML analysis and the morphological characters (Tables 1, 2).

Table 1. Morphometric measurements of 30 specimens of *Acrobrycon tarijae*. Standard length (SL) is expressed in mm and all other measurements are expressed as a percentage of SL, except for head subunits which are expressed as percentages of the head length.

	Range	Mean \pm S.D.
Standard length (mm)	40.5–90	62.12 \pm 12.89
percent of SL		
Depth at dorsal-fin origin	11.8–30.5	16.99 \pm 5.21
Snout to dorsal-fin origin	22.8–47.8	33.4 \pm 6.71
Snout to pectoral-fin origin	10.5–20.9	15.16 \pm 2.71
Snout to pelvic-fin origin	20.6–45.3	28.81 \pm 6.66
Snout to anal-fin origin	26.4–59.7	39.05 \pm 8.92
Caudal peduncle depth	5–12	7.76 \pm 1.73
Caudal peduncle length	4.4–13	7.75 \pm 2.29
Pectoral-fin length	9–18.6	13.05 \pm 2.51
Pelvic-fin length	5.6–12.8	9.17 \pm 1.76
Dorsal-fin base length	4.2–11	7.45 \pm 2.02
Dorsal-fin height	8.6–18.3	13.14 \pm 2.57
Anal-fin base length	10–27.6	17.82 \pm 3.86
Anal-fin lobe length	12.8–33.7	21.91 \pm 4.63
Eye to dorsal-fin origin	18.3–40	26.99 \pm 5.81
Dorsal-fin origin to caudal-fin base	18.5–45.5	31.39 \pm 6.98
Head length	9.8–19.2	14.11 \pm 2.71
percent of HL		
Horizontal eye diameter	3–5.7	4.42 \pm 0.67
Least interorbital width	3–6.3	4.47 \pm 0.89

Table 2. Meristic data taken in 30 specimens of *A. tarijae*. *Data taken in 11 specimens.

Lateral line scales	51–60
Dorsal-fin rays	ii,8
Anal-fin rays	v-vi, 23–27
Pelvic-fin rays	i,6–7
Pectoral-fin rays	i,9–11
Maxillary teeth	6–11
*Vertebrae	37–39
*Pleural ribs	12–13

Morphological data remarks

Measurements rounded to the nearest 0.1 mm were made with digital calipers. Counts and measurements were conducted following previously standardized protocols (Fink and Weitzman 1974; Menezes and Weitzman 1990, 2009; Menezes et al. 2003). In order to standardize as much as possible our comparisons with previous studies examining all species in the genus *Acrobrycon*, measurements and counts were directly compared to those obtained by Arcila et al. (2013).

Meristic counts of 30 specimens are provided in the species description (See Tables 1, 2). Vertebral counts were taken from cleared and stained specimens (CFA-

IC-10058; Suppl. material 1: Fig. S3) prepared following the proposed procedures by Taylor and Van Dyke (1985) and dried skeletons (CFA-IC-9504 and CFA-IC-9505) ($N = 5$) and X-ray images of six specimens of the type series of *A. tarijae* (Holotype: ANSP 68775, paratypes ANSP 68776, and ANSP 68778). Vertebral counts of *A. ipanquianus* were performed from the holotype, ANSP 21114, and two paratypes, ANSP 21115. The number of vertebrae of the Weberian apparatus was quantified as four elements, and the first pre-ural center and the first fused ural of the caudal fin were counted as a single element.

Results

Molecular

Phylogenetic reconstruction and haplotype network. A total of 22 sequences from the original 24 specimens of *A. tarijae* processed were obtained and deposited in GenBank (accession numbers: MW940261-MW940282). *COI* sequences were also uploaded to BOLD under the project “COIPE Peces Argentinos”. Sequences of two specimens of *A. ipanquianus* from the Amazon Basin, Peru and 18 species from the genus *Hemibrycon* were obtained from GenBank for downstream phylogenetic comparisons. The Tamura-Nei model+G+I (TN93+G+I) was chosen as the best nucleotide substitution model under the BIC.

Our phylogenetic results supported the sister-group relationships between the species under study of the genera *Acrobrycon* and *Hemibrycon* with strong bootstrap support (Fig. 4A). The relationships within *Acrobrycon* under study resulted in two major clades, the first one including only the specimens of *A. ipanquianus*, and the second clade encompassing the 22 specimens of *A. tarijae* from La Plata River Basin.

We found a total of 11 different haplotypes in *A. tarijae* from La Plata Basin in Argentina, and one haplotype in *A. ipanquianus* from Peru (Fig. 4B). The haplotype network provided strong support differentiating lineages *A. ipanquianus* from *A. tarijae*. Interestingly, it also identified two haplotype groups among the specimens of *A. tarijae* that differ in their assigned BIN and in their distinctive geographic distribution (Fig. 4C). This result is consistent with the inferred phylogenetic tree (Fig. 4A), and the Mantel test that showed a significant correlation between geographic and genetic distances among the *A. tarijae* specimens ($p = 0.008$), indicating possibly an IBD process.

Regarding the type of basin (IBB), the sites located in the north of Argentina (Salta and Jujuy) are part of exorheic basins, while those sampling sites towards the centre-south of the country (Tucumán, Córdoba and San Luis) are part of endorheic-arheic basins (Fig. 4A). We also found the two groups of haplotypes separated from each other by eight mutations in the haplotype network colored according to BIN values (Fig. 4B). In terms of environment (IBE), altitudes in sampling sites spanned from 182 to 883 MASL.

Diversity and divergence. Three BINs were obtained for the genus *Acrobrycon*. The ACW0596 barcode was assigned to two specimens of *A. ipanquianus* from Peru. We found two barcodes (ACM2250, ADE4913) associated to *A. tarijae* in Argentina. The barcode

ACM2250 was assigned to seven specimens from Salí, Bermejo, Cuarto and Quinto rivers, southern and northern drainages in Argentina, while the barcode ADE4913 was found on nine individuals from Bermejo and Pilcomayo rivers, northern drainages from the same country. However, the ABGD analysis only reported two groups, one corresponding to the ACW0596 BIN and another corresponding to both ACM2250 and ADE4913 BINs together. The within-BIN distances were zero for the ACW0596 and 0.01% for both ACM2250 and for ADE4913. The between-BIN distances were 1.87% ACM2250–ADE4913; 4.2% ACW0596–ACM2250 and 4.1% for ACW0596–ADE4913.

Morphology

Acrobrycon Eigenmann & Pearson, 1924

Type species. *Tetragonopterus ipanquianus* Cope, 1877, by original description (Suppl. material 1: Fig. S1).

Acrobrycon tarijae Fowler, 1940

Figs 2, 3, Tables 1, 2, Suppl. material 1: Fig. S2

Acrobrycon tarijae Fowler, 1940:50 [Type locality: Lipeo River, branch of Bermejo River, Department of Tarija, Bolivia (currently the Lipeo River type locality was relocated to the province of Salta, Argentina)].

Amended diagnosis. *Acrobrycon tarijae* is distinguished from *A. ipanquianus* by the lower number of vertebrae [37 (1), 38 (3+holotype+3 paratypes), 39 (1+2 paratypes) vs. 41 (2 paratypes), 42 (holotype+2 paratypes)], and pleural ribs (12 (1 paratype), 13 (5+holotype+4paratypes) pairs vs. 14 (holotype+2 paratypes) pairs in the type series). *Acrobrycon tarijae* is distinguished from *A. starnesi* by the number of perforated scales of the lateral line [51 (1), 52 (1), 54 (4), 55 (2), 56 (1) 57 (7), 58 (5), 59 (7), 60 (2) vs. 61 to 66], and the number of horizontal-scale rows around the caudal peduncle (19 (12), 20 (9), 21 (9) vs. 22 to 26). *Acrobrycon tarijae* can be distinguished from *A. ortii* by the number of branched anal-fin rays [23 (3), 24 (9), 25 (10), 26 (7), 27 (1) vs. 19 to 21].

Description. The description of *A. tarijae* follows Arcila et al. (2013), including some adjustments to the ranges as indicated below. *Acrobrycon tarijae* is a characid of moderate size (can exceed 114 mm of standard length, SL), with an elongated body. Greater body depth in the sector behind the origin of the pectoral fins and before the dorsal-fin origin. Dorsal profile convex from the tip of the snout to the origin of the dorsal fin, slightly depressed along the nape, almost straight along the base of the dorsal fin and slightly concave along the caudal peduncle. Ventral profile convex. Dorsal-fin origin anteriorly than the origin of the anal fin. Rounded muzzle in lateral view.

Terminal mouth slightly upwards. Maxilla extending posteriorly beyond the vertical through the anterior margin of the orbit, but not reaching the vertical through the posterior border of the pupil. Posteroventral border of the maxilla convex and posterior margin

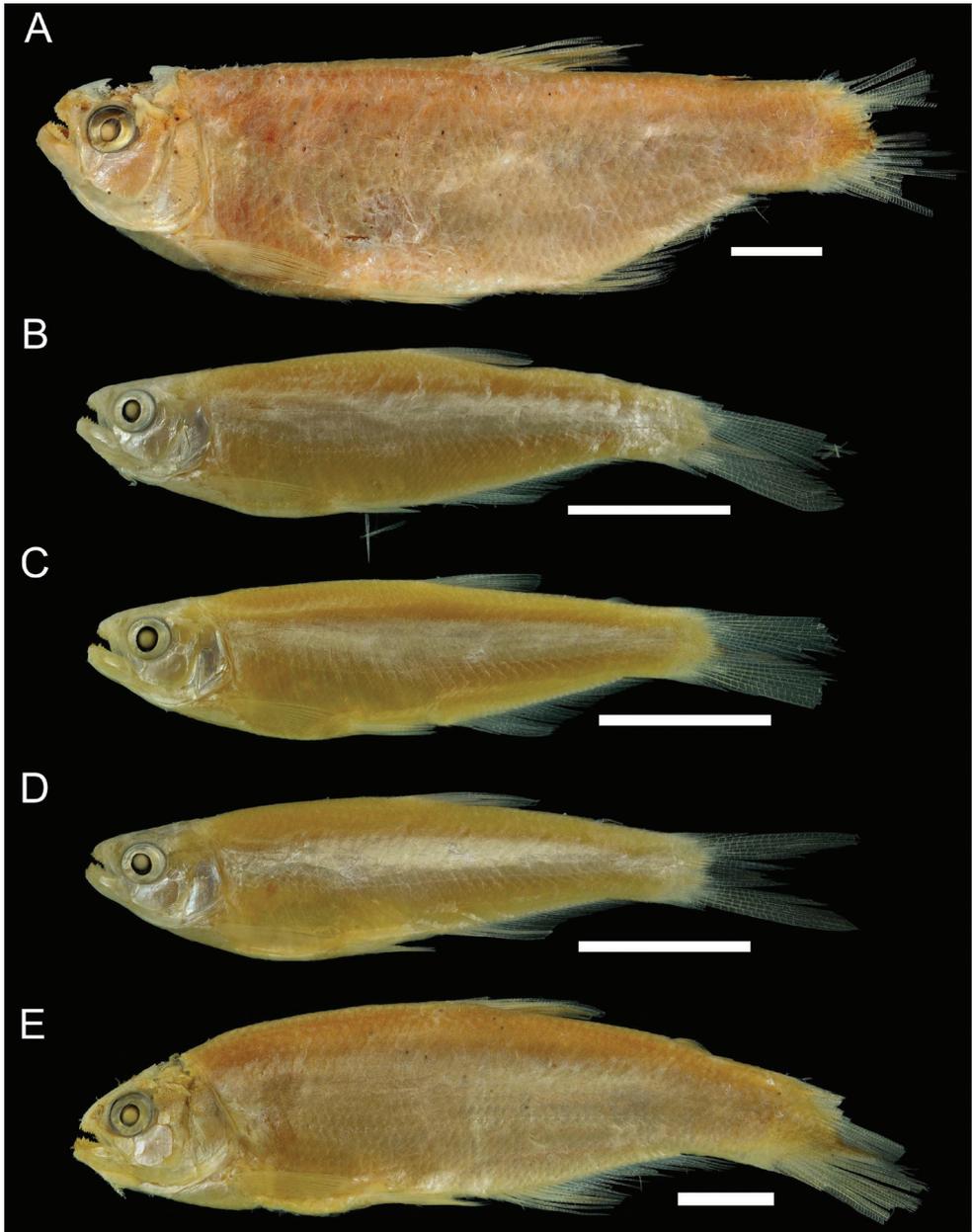


Figure 2. Pictures of the series types of *A. tarijae*. **A** holotype **B–E** paratypes. Scale represents 1 cm. Images from K. Luckenbill, courtesy Academy of Natural Sciences, Drexel University.

concave. Premaxillary teeth in two different rows, outside row with 4–5 teeth and internal row with 4 teeth. Larger teeth with five cusps; smaller teeth with three cusps. Maxillary teeth 6–11. Larger anterior maxillary teeth with 1–3 cusps, other smaller teeth with 1–2 cusps. Dentary with 4 large anterior teeth with 5 cusps, followed by 6–10 smaller teeth with 1–3 cusps.

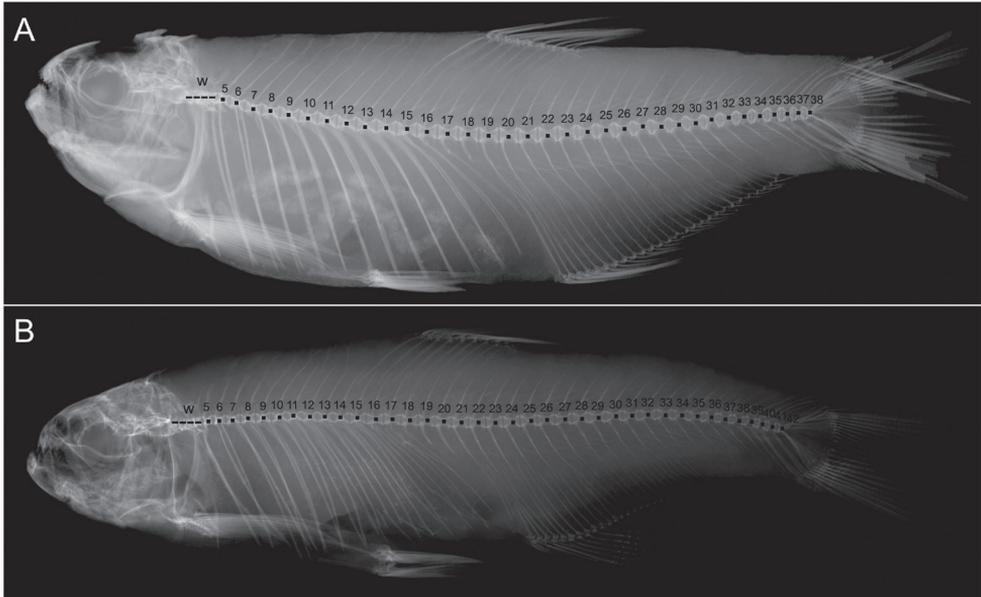


Figure 3. Count of vertebrae in holotypes of **A** *A. tarijae* and **B** *T. ipanquianus*. Abbreviation W represents the first four vertebrae of the Weber complex. Images from K. Luckenbill, courtesy Academy of Natural Sciences, Drexel University.

Tip of the pelvic fin does not reach the anal-fin origin, cycloid scales, with 4 to 8 rays along the exposed surface over most of the body and 14 to 17 rays on scales bordering the opening of the caudal pocket. Lateral line with 51–60 perforated scales. Predorsal scales 19–26. Horizontal-scale rows around caudal peduncle 19–21.

Dorsal-fin rays $ii+8$. Some specimens with posteriormost dorsal ray unbranched and others with a branched condition in this ray, although this is restricted to a very small part of its distal tip. Small adipose fin. Anal fin with $v,vi-23-26$. Pectoral fin with $i, 9-10$. Pelvic-fin rays $i, 7 (12), 8 (18)$. Caudal fin with two well differentiated lobes, with $i, 9-10$.

Sexual dimorphism. Mature males present a hypertrophied terminal caudal-fin squamation forming a caudal pocket and also have bony hooks on the anal, pelvic, and caudal-fin rays.

Coloration in live specimens. Gray ochre dorsal coloration from the nostrils to the caudal peduncle. Silvery flanks, paler at ventral section and with purplish-bluish reflection dorsally. A golden to greenish coloration bordering the lateral line. A silver wide band behind the humeral spot progressing distally to the end of the body, continuing with a marked black pigmentation in the medial rays of the caudal fin. Circum-orbital bones generally silver, the fifth and sixth infraorbitals may have purplish reflections. Operculum with conspicuous violet reflections, turning greenish above and ahead this bone. A conspicuous humeral dark spot vertically elongated. Pectoral and ventral fins whitish. The dorsal and adipose fins smoothly yellowish. The anal fin gray or yellowish usually with a whitish lower margin (Suppl. material 1: Fig. S2).

Coloration in alcohol. Preserved specimens, body brown, with darker dorsum. Humeral spot dark, with a well-defined upper part and a fainter lower expansion. In

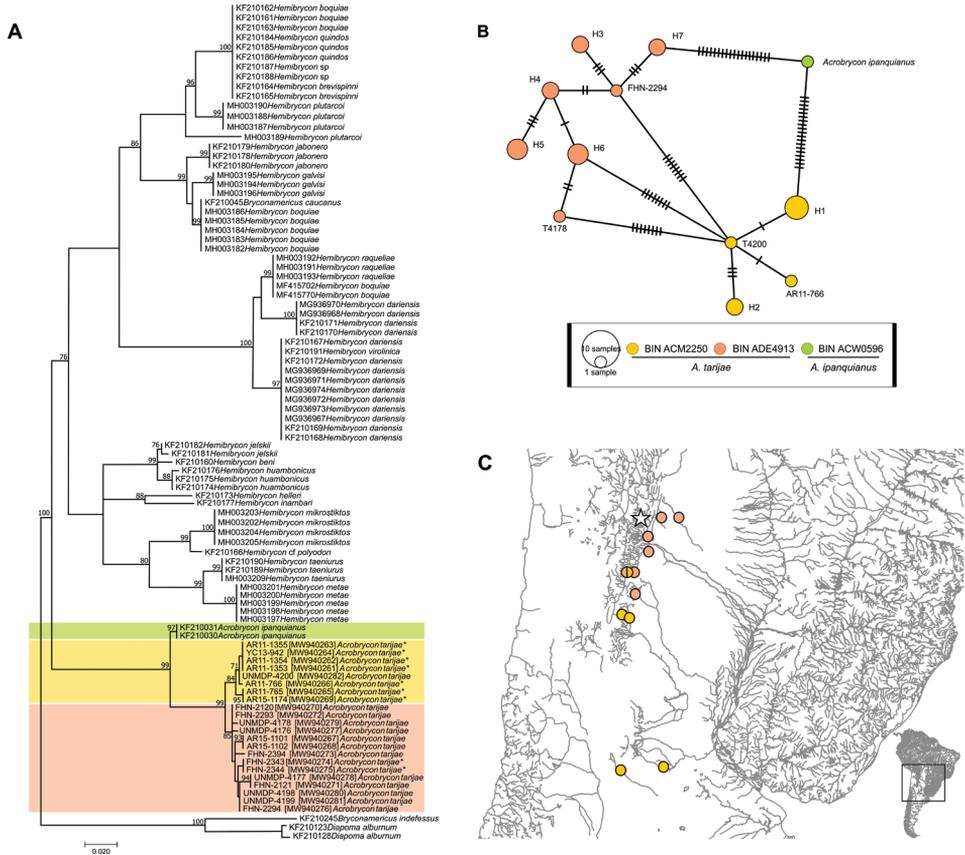


Figure 4. A Maximum likelihood tree of *Acrobrycon* based on 521 nucleotides of the mitochondrial gene *COI*. Bootstrap values are shown above the branches, values below 70 are not shown. Genbank access numbers are indicated for *A. tarijae*, and an asterisk indicates those that were sampled in endorheic basins **B** haplotype network, colored by three BINs groups **C** map with the sampling sites of the *A. tarijae* specimens.

many specimens the lower expansion of humeral spot absent. The lateral band dark, thin at the level of the humeral spot, and shortly wider until the distal end of the body. This band conspicuous in some specimens and very faint in others. The middle rays of the caudal fin black.

Discussion

Species diversity in *Acrobrycon*

Our study revealed a greater genetic diversity than expected for the genus *Acrobrycon* along La Plata River Basin as well as additional taxonomically informative morphological characters allowing the discrimination between two of its previously

synonymized species. Particularly, our results from an integrative analytical approach allows us to revalidate *A. tarijae*, which is distinguished from *A. ipanquianus* by the lower number of vertebrae and pleural ribs and a higher number of unbranched anal-fin rays. The genetic analyses, despite involving only one marker, showed two clear clades, one with samples identified as *A. ipanquianus* and the other as *A. tarijae*. The morphological traits of the specimens of *A. tarijae* showed clear differences from the two other species described for this genus, *A. ortii* and *A. starnesi* (Arcila et al. 2013) in the branched anal-fin rays and scales. Furthermore, the molecular analyses showed a conspicuous genetic structure within *A. tarijae* revealing the existence of two mitochondrial lineages. The BIN analyses assigned two different OTUs to these lineages which diverged by 1.87%. In fishes, *COI* sequences have traditionally been used to delimit species and a 2% paired divergence threshold has been proposed to discriminate interspecific from intraspecific genetic divergence (Ward et al. 2009; Ward 2012). However, the use of only this genetic criterion for taxonomic decision has been controversial. In *Hypostomus*, for example, it was shown that 82% of the sister-species pairs with well-defined morphology, showed genetic divergence values of less than 2% (Cardoso et al. 2019; Jardim de Queiroz et al. 2020; Cardoso et al. 2021). Despite our genetic results obtaining a distance close to 2% of differentiation, our examination of morphological characters did not find unequivocal characters for the description of a new species.

Genetic structure within *Acrobrycon tarijae*

Our results indicated that the distribution of *A. tarijae* is restricted to the western headwaters of La Plata Basin (Liotta 2022), including an important sector of the Chaco plain on the main channel of the Pilcomayo River and the dry Chaco sector of the Bermejo Basin in Formosa (Ringuelet et al. 1967). The geographic coverage of our samplings extends the distribution of *A. tarijae* to the Quinto River basin in San Luis, being the only record known for the province of San Luis and the southernmost documented report for this species (Cardoso et al. 2015). However, the abundance of this species is relatively low compared to the populations distributed in the Andean foothills or the Pampas mountains, also linked to landscapes of the foothills (Monasterio de Gonzo 2003; Mirande and Aguilera 2009). *Acrobrycon tarijae* is an abundant species in some endorheic basins such as the Itiyuro, the Horcones and the Urueña rivers (Monasterio de Gonzo 2003; Monasterio de Gonzo et al. 2006), and in the large arheic system of Mar Chiquita Lagoon Basin (Haro et al. 1991; Butí and Miquelarena 1995; Haro and Bistoni 1996). These endorheic basins are characterized by high diversity of endemic freshwater fishes (Miquelarena and Menni 1999). Briñoccoli et al. (2021) observed that the type (endorheic vs. exorheic) of basin played a predominant role in population structure (as well as the altitude at which the rivers were located) in *Jenynsia lineata*, a small ovoviviparous fish widely distributed throughout the La Plata Basin. As well as in *A. tarijae*, Briñoccoli et al. (2018) showed that the catfish *Rhamdella aymarae*, originally described from an endorheic basin, has a wider distribution.

Morphological variations in *Acrobrycon*

The morphological study by Arcila et al. (2013) characterized *A. ipanquianus* (including *A. tarijae* as its synonym) as a species with a relatively deep body, a trait that would significantly differentiate it from *A. ortii*. However, in the type series of this species (holotype and more than 33 paratypes) some individuals (see for instance Fig. 2 B–D) have a low body with proportions similar to those described for *A. ortii*. According to Arcila et al. (2013) the explanation for the lack of variation within the *Acrobrycon* species may be associated with the relatively homogeneous habitats occupied by these species and their moderate-sized geographic distributions. However, in the La Plata River Basin, a great morphological variation of body depth was observed in *A. tarijae*. No link was found between observed genetic differences and these morphological variations. In our survey, elongated, low and well-stylized bodies are observed in individuals that inhabit rivers with strong currents, sometimes linked to mountain formations or in the beds of large rivers, such as the Pilcomayo River. Morphological differences between populations of the same species could be due to the environmental conditions to which the fish are exposed. Due to the evident lack of diagnostic value of body depth to discriminate *Acrobrycon* species, the number of branched rays in the anal fin remains an important diagnostic character to differentiate *A. ortii* from other species (19–21 vs. 23–27 in *A. ipanquianus* and *A. tarijae*). Unfortunately, the molecular identity of *A. ortii* and *A. starnesi* could not be assessed in this study, but our results urge the inclusion of these species along with additional populations and markers of *Acrobrycon* in future studies to investigate their population structures and phylogenetic relationships as well as biogeographic and morphological patterns of diversification.

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Supplementary material I

Molecular and taxonomic evidence unmask hidden species diversity in the genus *Acrobrycon* (Characiformes, Characidae). Fig. S1–S3.

Authors: Yanina F. Briñocoli, Sergio Bogan, Dahiana Arcila, Juan J. Rosso, Ezequiel Mabragaña, Sergio M. Delpiani, Juan Martín Díaz de Astarloa, Yamila P. Cardoso

Data type: material, images

Explanation note: List of all Material examined, types of *T. ipanquianus*, living specimens of *Acrobrycon tarijae* and vertebrae count of two diaphanous specimens of *A. tarijae*. **Fig. S1.** Types of *T. ipanquianus*. **A, B** paratypes **C** holotype. The scale represents 1 cm. **Fig. S2.** Living specimen of *Acrobrycon tarijae*, **A** from Las Conchas River, Salta Argentina (CFA-IC-5557) **B, C** from Rosario River, Salta Argentina (CFA-IC-5017). **Fig. S3.** Vertebrae count of two diaphanous specimens of *A. tarijae* (CFA-IC-10058), Bermejo River basin, Argentina. The abbreviation *W* represents the first four vertebrae of the Weber complex. Scale bar: 1 cm.

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On the genus *Coccophagus* Westwood (Hymenoptera, Aphelinidae) from Xishuangbanna Rainforest. Contribution I: Two new species of the *Coccophagus varius* group, with an identification key and phylogenetic analysis

Yao-guang Qin¹, Hai-feng Chen¹, Cheng-de Li², Ye Chen¹

1 Hebei Key Laboratory of Animal Diversity, College of Life Science, Langfang Normal University, Langfang, 065000, China **2** School of Forestry, Northeast Forestry University, Harbin, 150040, China

Corresponding author: Ye Chen (chenye19890506@163.com)

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Abstract

Two new species belonging to the *varius* group of *Coccophagus*, *C. breviclavulus* **sp. nov.** and *C. perlucidus* **sp. nov.**, are described from Xishuangbanna Rainforest (China, Yunnan). *Coccophagus anchoroides* (Huang) and *C. yunnana* Wang, Huang & Polaszek are recorded. A tentative key to world species of this group is provided. Partial nuclear ribosomal 28S-D2 of these four species and other six species were sequenced and subjected to a phylogenetic analysis. Phylogeny of *C. varius* group is discussed.

Keywords

Chalcidoidea, Coccophaginae, parasitoid wasp, taxonomy

Introduction

In 2019 and 2020, we undertook extensive sampling and surveying of arthropods in the canopy of the Xishuangbanna Rainforest, and collected some specimens belonging to the genus *Coccophagus* Westwood. In the present paper, some of the specimens

within the *Coccophagus varius* group are studied, as the first contribution to the genus *Coccophagus* from Xishuangbanna Rainforest (Yunnan Province).

Coccophagus Westwood, 1833 is the second largest genus of Aphelinidae, and currently contains 271 valid species, of which 36 species are known from China (Chen and Li 2017; Noyes 2019; Wang et al. 2020). The females of *Coccophagus* are endoparasitoids of scale insects (Hemiptera: Coccoomorpha), mainly of soft scales (Coccidae) and rarely of mealybugs (Pseudococcidae); males are generally hyperparasitoids on other primary parasitoids, including conspecific females (Clausen 1978; Hayat 1988). Currently, *Coccophagus* is divided into three subgenera: *Dicoccophagus* Sugonjaev (1994), *Polycoccophagus* Sugonjaev (1976) and *Coccophagus s. str.* (Chen and Li 2017). According to Compere (1931), Annecke and Insley (1974), Hayat (1988, 1992, 1998) and Myartseva and Ruíz-Cancino (2005), eight species groups have been recognized under *Coccophagus s. str.*: *lycimnia*, *ochraceus*, *malthusi*, *pseudococci*, *varius*, *zebratus*, *tshirchii*, and *redini* groups.

The *Coccophagus varius* species group was proposed by Hayat (1988) for those species which were previously placed in the genus *Prococcophagus* Silvestri. The status of *Prococcophagus* was first queried by Hayat (1983), and he stated *Prococcophagus* did not merit a separate status and may ultimately be treated as a species group of *Coccophagus*. Later, Shafee et al. (1985) and Viggiani (1985) both supported the synonymy of *Prococcophagus* under *Coccophagus*. The *varius* group of *Coccophagus* can be recognised by the following combination of characters: scape flattened and expanded ventrally and less than 3.0× as long as wide (with some exceptions: not flattened and expanded, e.g. *Coccophagus perlucidus*, cf. Fig. 19); body with contrasting brown and silver-white areas; antennomeres with white and dark segments; fore wing with distinct infuscation (with some exceptions: fore wing uniformly hyaline), the infuscate area with dark brown setae, and the hyaline area with transparent setae. Apart from the above characters noted by most authors (Hayat 1988, 1998; Myartseva 2004; Wang et al. 2020), our specimens (n=19) have two small patches posterior to each posterior ocellus respectively. Wang et al (2020) conducted phylogenetic analysis to discuss the systematic status of this species group based on 28S-D2 rDNA sequences though only including two species of this species group.

Until the present study, *C. varius* species group included 24 species which were originally found in Palearctic (1 species), Oriental (12), Australian (4), Ethiopian (4) and Neotropical Regions (3) (Noyes 2019; Wang et al. 2020). Herein, two new species from Xishuangbanna Rainforest (Yunnan, China) are added to the Oriental region, *C. anchoroides* is newly reported from Yunnan Province, 28S-D2 rDNA of *C. yunnana* is sequenced for the first time and a key to all the known species in this group is provided. In addition, phylogenetic analyses including 12 online 28S-D2 rDNA sequences together with our *de novo* data, which represented five species groups of *Coccophagus*, were carried out to assess the systematic status.

Materials and methods

Morphological study

Samples were obtained using a pyrethroid fog generated from a thermal fogger (Swingfog SN50, Germany, Model 2610E, Series 3). Specimens were dissected and mounted in Canada Balsam on slides, following the method described by Noyes (1982). Specimens in ethanol and on slides were photographed and then the images were processed, following Chen and Chen (2021). Scale bars are 100 μm except where otherwise indicated. All specimens listed below are deposited in Langfang Normal University, Langfang, China.

Terminology follows the Hymenoptera Anatomy Consortium (2021). The following abbreviations are used in the text: C1–3, clavomeres 1–3; F1–3, funicle segments 1–3; Gt₁, Gt₂ etc., tergites 1, 2, etc. of gaster.

Abbreviations for depositories as follows

FAFU Fujian Agriculture and Forestry University, Fuzhou 350002, China;
LFNU Langfang Normal University, 065000, China.

DNA extraction, amplification, and sequencing

Genomic DNA extraction was from the entire body of female adults. The body was destroyed and performed using the DNeasy Blood & Tissue Kit (Qiagen GmbH, Hilden, Germany) following the manufacturer's protocols. The forward and reverse primers used for amplifying the D2 region of 28S rDNA gene were [F] 5'-CGT GTT GCT TGA TAG TGC AGC-3' and [R] 5'-TTG GTC CGT GTT TCA AGA CGG G-3' respectively (Campbell et al. 1994). The amplification program was: initial denaturation step at 95 °C for 5min, denaturation step at 95 °C for 30s, annealing for 45s at 58 °C, and extension at 72 °C for 1min, with 40 cycles being performed, and final extension at 72 °C for 5min. Each PCR product was subjected to electrophoresis on 1% agarose gel, and positive products were sequenced directly in both directions using BigDye v3.1 on an ABI 3730xl DNA Analyser (Applied Biosystems). Generated sequences were deposited in GenBank (accession numbers: OM095389–OM095398).

Phylogenetic analysis

To investigate the phylogenetic relationship between the *Coccophagus varius* group and other *Coccophagus* species, Bayesian inference (BI) and Maximum likelihood (ML) were used to reconstruct phylogenetic trees using 28S-D2 rDNA dataset. The dataset included 22 ingroups (12 online data and 10 produced data in this study), representing 22 species and 5 species groups of *Coccophagus*, and two 28S online sequences of the

- 6(5) Fore wing uniformly hyaline, without infuscated area (cf. fig. 91B in Huang 1994).....7
- Fore wing with infuscate area.....9
- 7(6) Flagellomeres more paler; except F1 basally, C1 and C2 dark.....*C. equifuniculatus* (Huang, 1994)
- Flagellomeres black.....8
- 8(7) Scape black, abdomen (as Compere 1936 noted) black and with a yellow band at base; ovipositor apparently not exerted.....*C. nympha* (Girault, 1915)
- Scape black but with base and apex yellow, abdomen black without yellow markings; ovipositor exerted..... *C. argentiscutellum* (Girault, 1915)
- 9(6) Fore wing with a conspicuous arched hyaline band at preapical area and infuscated apically (cf. fig. 6 in Compere 1936)*C. aurantifrons* (Compere, 1936)
- Forewing hyaline apically (Figs 5, 13, 29) and without that hyaline band 10
- 10(9) Fore wing with a basal hyaline area extending outward one half the length of the blade on the posterior part (as noted by Compere 1936).....*C. hispaniolae* (Dozier, 1932)
- Otherwise 11
- 11(10) Pedicel and F1 pale*C. mixtus* (Girault, 1915)
- Pedicel with pale and dark areas; F1 completely dark or with pale and dark areas..... 12
- 12(11) All flagellomeres dark or mostly dark only with F2, F3 and C1 having small pale areas dorsally 13
- Flagellomeres at least with one segment completely pale 14
- 13(12) Scape largely white on outer surface, black on both dorsal and ventral margins; axillae yellow, with fuscous median spot; legs white*C. tobiasi* Myartseva, 2004
- Scape (cf. fig. 6 in Annecke and Mynhardt 1979) largely brownish black on outer surface, pale dorsally and with a white curving lateral band; axillae dark brown; legs white with extensive dark markings.....*C. nesororum* (Annecke & Mynhardt, 1979)
- 14(12) F2 completely pale..... 15
- F2 with dark area..... 20
- 15(14) Mid lobe of mesoscutum with a dark anchor shaped patch (Figs 1, 25) 16
- Mid lobe of mesoscutum generally yellowish brown or brown, with dark or pale streaks..... 17
- 16(15) Scape with dorsal margin and a median band white (cf. Fig. 3), F1 largely dark brown, C3 pale; gaster with 4 dark brown bands on Gt_1 – Gt_4 . F1 slightly longer than wide, F2 1.2× as long as wide.... *C. anchoroides* (Huang, 1994)
- Scape with a hook-like white streak medially except the white dorsal margin (Fig. 27), F1 pale, C3 dark; gaster with 6 dark brown bands on Gt_1 – Gt_6 (Fig. 32). F1 1.3–1.5× as long as wide, F2 1.6–1.7× as long as wide*C. yunnana* Wang, Huang & Polaszek, 2020

- 17(15) Scape largely pale, with two dark broad streaks distally (Fig. 11)
 *C. breviclavulus* Chen & Li, sp. nov.
- Scape differently coloured, with more extensive dark area **18**
- 18(17) Scape extremely expanded, 1.87× as long as wide; mesoscutellum yellowish brown, with anterior margin and two dark patches (cf. fig. 89C in Huang 1994) on posterior half *C. dilatatus* (Huang, 1994)
- Scape more than 2.0× as long as wide; mesoscutellum without patches on posterior area **9**
- 19(18) Mid lobe of mesoscutum yellowish brown, F3 completely white; pedicel subequal to F1 in length; mesotibial spur slightly longer than corresponding basitarsus *C. pellucidus* (Huang, 1994)
- Mid lobe of mesoscutum orange brown to brown, with a brown median longitudinal streak, F3 with a brown irregular patch distally; pedicel obviously longer than F1 (cf. fig. 292 in Hayat 1998); mesotibial spur slightly shorter than corresponding basitarsus *C. zeyai* Hayat, 1998
- 20(14) F3 dark **21**
- F3 pale **23**
- 21(20) Fore wing with a hyaline area bearing transparent setae below basal half of marginal vein (cf. fig. 300 in Hayat 1998)
 *C. narendrani* Hayat & Zeya, 1993
- Fore wing infuscated below marginal vein **22**
- 22(21) Scape brown, and with dorsal margin and a median streak white (cf. fig. 71 in Hayat and Khan 2010); pronotum silvery white, mesally dark; mesoscutellum brown *C. fumadus* Hayat, 2010
- Scape white, and with dark margins; pronotum with collar brown, rest part sordid white; mesoscutellum reddish orange, and with two brown patches ...
 *C. nipponicus* (Ishihara, 1977)
- 23(20) F1 dark ventrally and fading to white above; pedicel slender, 2.0× as long as wide, obviously longer than F1 (cf. fig. 10 in Annecke and Mynhardt 1979)
 *C. eusaissetiae* Özdikmen, 2011
- F1 completely dark; pedicel less than 2.0× as long as wide, at most slightly longer than F1 **24**
- 24(23) F1 with ventral margin shortest among funicle segments, without sensillum (cf. fig. 2 in Hayat 1988) *C. srilankensis* Hayat, 1988
- F1 with ventral margin longest among funicle segments, with sensilla (cf. fig. 5 in Silvestri 1915 and figs 1, 13 in Annecke and Mynhardt 1979) **25**
- 25(24) Scape (cf. fig. 13 in Annecke and Mynhardt 1979) with two largely separated, dark streaks on outer surface; pedicel whitish with only ventral edge rather narrowly brown or blackish brown
 *C. probus* (Annecke & Mynhardt, 1979)
- Scape (cf. fig. 1 in Annecke and Mynhardt 1979) with extensively streak on outer surface, the dark streaks merging apically and basally; pedicel with ventral one half black, remainder pale *C. varius* (Silvestri, 1915)

Table 1. 28S-D2 rDNA of *Coccophagus* and outgroups used in this study.

Species	Group	GenBank Accession No.	Reference
S1 <i>C. yunnana</i>	<i>varius</i>	OM095389	This study
S2 <i>C. breviclavulus</i>	<i>varius</i>	OM095390	This study
S3 <i>C. longifasciatus</i>	<i>ochraceus</i>	OM095391	This study
S4 <i>C. chloropulvinariae</i>	<i>malthusi</i>	OM095392	This study
S5 <i>C. candidus</i>	<i>malthusi</i>	OM095393	This study
S6 <i>C. sp.</i>	<i>lycimnia</i>	OM095394	This study
S7 <i>C. sp.</i>	<i>pseudococci</i>	OM095395	This study
S8 <i>C. sp.</i>	<i>lycimnia</i>	OM095396	This study
S9 <i>C. perlucidus</i>	<i>varius</i>	OM095397	This study
S10 <i>C. anchoroides</i>	<i>varius</i>	OM095398	This study
<i>C. fumadus</i>	<i>varius</i>	MT677530.1	Wang et al. 2020
<i>C. bivittatus</i>	<i>ochraceus</i>	KY605784.1	Zhou et al. 2017
<i>C. ceroplastae</i>	<i>lycimnia</i>	KY605741.1	Zhou et al. 2017
<i>C. yoshidae</i>	<i>malthusi</i>	MH455871.1	Amouroux et al. 2019
<i>C. lycimnia</i>	<i>lycimnia</i>	KY605608.1	Zhou et al. 2017
<i>C. couperi</i>	<i>lycimnia</i>	HM856875.1	Rugman-Jones et al. 2011
<i>C. semicircularis</i>	<i>malthusi</i>	KY605779.1	Zhou et al. 2017
<i>C. scutellaris</i>	<i>malthusi</i>	JN623562.1	Munro et al. 2011
<i>C. ishiii</i>	<i>malthusi</i>	KY605777.1	Zhou et al. 2017
<i>C. nigricorpus</i>	<i>malthusi</i>	KY605646.1	Zhou et al. 2017
<i>C. bogoriensis</i>	<i>lycimnia</i>	KY605553.1	Zhou et al. 2017
<i>C. japonicus</i>	<i>lycimnia</i>	KY605542.1	Zhou et al. 2017
<i>Coccobius</i> sp. D1492	Outgroup	AY599373.1	Gillespie et al. 2005
<i>Coccobius</i> sp. D1387	Outgroup	AY599372.1	Gillespie et al. 2005

Coccophagus anchoroides (Huang)

Figs 1–8

Prococcophagus anchoroides Huang, 1994: 259. Holotype ♀, CHINA, FAFU, not examined.

Coccophagus anchoroides (Huang): Xu & Huang, 2004: 362; Wang et al. 2020: 1883.

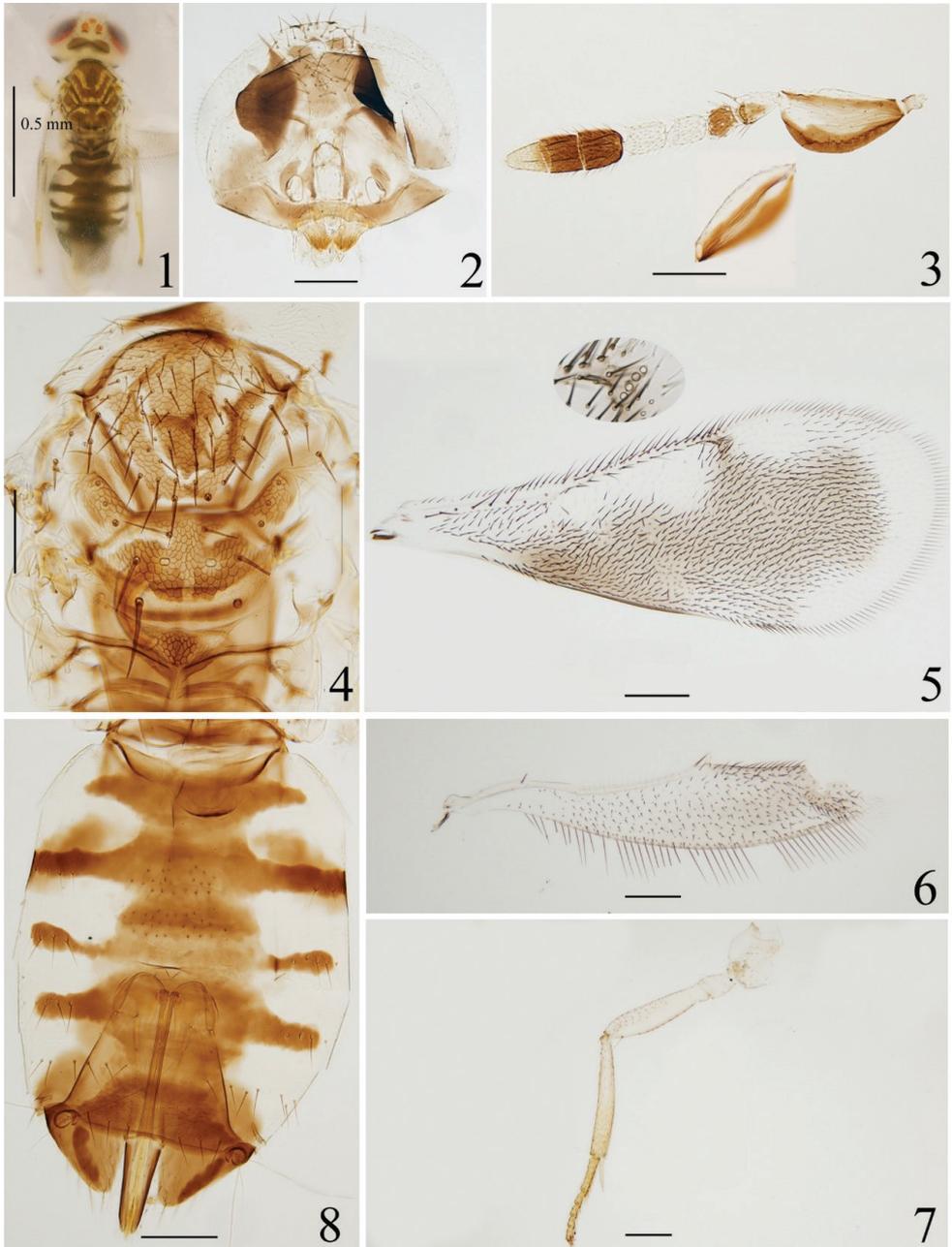
Material examined. 1♀ [on slide, C202007-1]; Yunnan Province; Xishuangbanna; Mengla County; Menglun Town; 21°54.24'N, 101°16'E; 541m a.s.l.; 13 May 2019; Z.-l. Bai, Z.-g. Chen, C. Wang, H. Yu leg.; LFNU. 1♀ [on slide, C202009-2]; Yunnan Province; Xishuangbanna; Mengla County; Menglun Town; 21°54.33'N, 101°16.78'E; 616m a.s.l.; 26 Apr. 2019; Z.-l. Bai, Z.-g. Chen, C. Wang, Y.-f. Tong, H. Yu leg.; LFNU. 1♀ [destroyed for DNA extraction]; Yunnan Province; Xishuangbanna; Mengla County; Menglun Town; 21°54.18'N, 101°16.71'E; 606m a.s.l.; 5 May. 2019; Z.-l. Bai, Z.-g. Chen, C. Wang, Y.-f. Tong, H. Yu leg.

Professor Jian Huang (FAFU) confirmed our identification. Our specimens agree well with the original description in Huang (1994). A minor difference should be noted: mesoscutellum (Figs 1, 4) of our specimens with two yellow curved stripes anteriorly like *C. yunnana*, but in the original description mesoscutellum without

yellow markings anteriorly (cf. fig. 90C in Huang 1994). Here we provided the digital images and DNA sequence for references.

Host. Unknown.

Distribution. China (Xishuangbanna of Yunnan Province [new record], Fujian).



Figures 1–8. *Coccophagus anchoroides* **1** body, dorsal view **2** head **3** antenna, inset shows the colour of outer surface of scape **4** mesosoma **5** fore wing **6** hind wing **7** mid leg **8** metasoma.

***Coccophagus breviclavulus* Chen & Li, sp. nov.**

<http://zoobank.org/AC0A2216-A462-4121-88FB-A3EE97B4FBDF>

Figs 9–16

Type material. Holotype: CHINA • ♀; Yunnan Province; Xishuangbanna; Mengla County; Menglun Town; 21°53.89'N, 101°16.72'E; 568 m a.s.l.; 22 May. 2019; Z.-l. Bai, Z.-g. Chen, C. Wang, H. Yu leg.; LFNU C202108-1 [on slide]. **Paratypes:** 4♀♀ [3♀♀ on slides, C202108-2–C202108-4; 1♀ destroyed for DNA extraction]; same data as holotype; LFNU.

Diagnosis. *Coccophagus breviclavulus* sp. nov. can be distinguished from females of other species in this genus by the following combination of characters: scape largely white, and with two broad and short dark streaks distally (Fig. 3); F2 and F3 white; mesosoma (Fig. 12) most brown, with two longitudinal yellow lines medially on mid lobe of mesoscutum; metasoma largely dark brown as in Figs 9, 16; F1–F3 with the same length; clavomeres obviously wider than funicle segments.

Description. Female. Length 0.7–0.9 mm; holotype 0.9 mm.

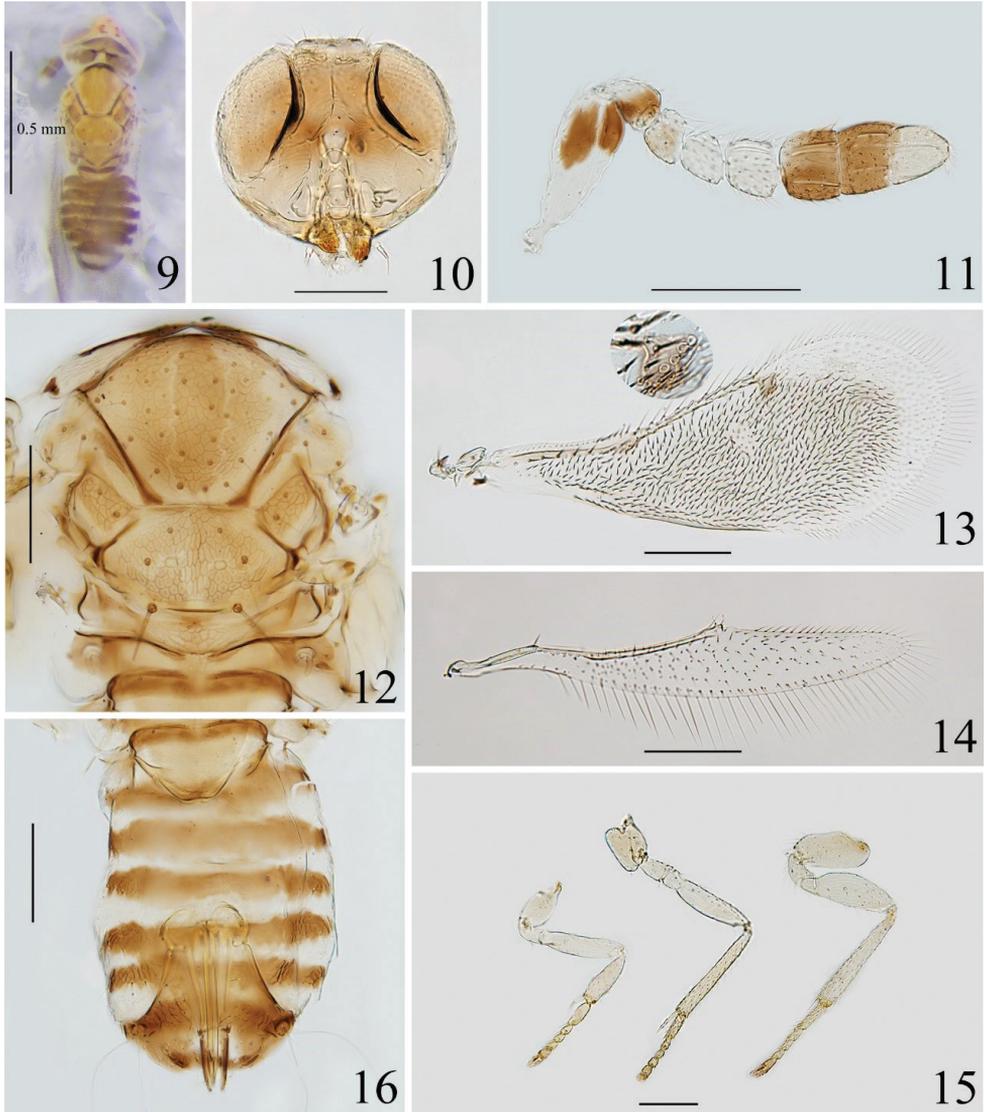
Colour. Head (Fig. 10), in frontal view, mostly white; in dorsal view, vertex yellow, ocelli red-brown, eyes pale red and with two small dark patches behind each posterior ocellus (Fig. 9). Occiput brown above foramen, and with two dark brown suboval patches lateral to foramen, the remaining parts of occiput white. Scape (Fig. 11) with a dark broad streak on distal half of outer surface and on apex of ventral surface each, remainder parts white; pedicel dark brown except dorsal margin white; F1 suffused with brown, F2 and F3 white, C1 and C2 dark brown, C3 yellowish white. Mandible brown. Pronotum dark medially and white laterally; mid lobe of mesoscutum (Fig. 12) mostly brown, with two longitudinal yellow line medially, lateral and posterior edges yellow; side lobe of mesoscutum largely yellow, with a brown patch anteriorly, and with interior edge dark; notaulus dark; axilla dark brown, with lateral edge yellow; mesoscutellum brown except yellow margins; metanotum brown; propodeum brown with anterior and posterior margins and lateral sides dark brown. Fore wing (Fig. 13) largely infuscated and hyaline apically, with stigma vein brown; hind wing (Fig. 14) hyaline. Legs (Fig. 15) pale, with last tarsi brown. Metasoma (Fig. 9) with petiole dark brown on anterior half part and yellow posteriorly; Gt_1 – Gt_5 largely dark brown and yellow on posterior margin of each tergite, Gt_6 and Gt_7 dark brown. Ovipositor with outer plates and third valvula dark brown. Ventral part of body generally pale.

Head (Fig. 10), in frontal view, 0.8–0.9× as high as wide. Ocellar triangle with apical angle almost right-angled. Mandible tridentate. Antenna (Fig. 11) with scape 2.0–2.6× as long as wide; pedicel 1.2–1.4× as long as wide, 1.4× length of F1; F1–F3 ventrally connected, F1 with ventral length 1.7× dorsal length, and as long as wide; F2 about same size as F1; F3 0.9–1.0× as long as wide, as long as but a little wider than F1 and F2; clava with the second septum oblique, 1.2–1.4× length of funicle, and obviously wider than funicle segment. F1 without longitudinal sensilla, other flagellomeres with the following number of longitudinal sensilla successively: 1, 2, 2, 2, 2.

Mesosoma (Fig. 12). Dorsum of mesosoma finely reticulate. Mid lobe of mesoscutum with approximately 40 setae, 0.8× as long as wide, 1.5× length of mesoscutellum;

each side lobe of the mesoscutum with 3 setae; each axilla with 3 setae; mesoscutellum $0.6\times$ as long as wide, with 3 pairs of setae. Distance between anterior pair of scutellar setae $0.5\times$ and $0.6\times$ that between median and posterior pair respectively. Placoid sensilla mesad of the median scutellar setae, and the distance between placoid sensilla about equal to that of anterior scutellar setae. Metanotum slightly longer than propodeum.

Wings. Fore wing (Fig. 13) $2.5\text{--}2.8\times$ as long as wide, marginal setae long and $0.15\times$ wing width. Costal cell $0.8\text{--}0.9\times$ length of marginal vein, bearing 1 row of setae and with the distal 6 setae long and coarse; submarginal vein with 6 setae; marginal



Figures 9–16. *Coccophagus breviclavulus* sp. nov. **9** body, dorsal view **10** head **11** antenna **12** mesosoma **13** fore wing **14** hind wing **15** legs, from left to right: fore-, mid- and hind-leg **16** metasoma.

vein with 9 long setae along anterior margin; postmarginal vein absent; stigmal vein (Fig. 13, inset) swollen posteriorly and with sensilla arranged in 1 line. Hind wing (Fig. 14) 5.5–6.6× as long as wide, with marginal setae 0.7–0.8× wing width.

Legs (Fig. 15). Mesotibial spur as long as corresponding basitarsus.

Metasoma (Fig. 16). Lateral sides of gaster, Gt₆, posterior of Gt₇ clearly reticulated. Setation of tergites on dorsal surface as followings: Gt₂ with 2 and 3 setae (short for 2+3) on left and right side respectively, Gt₃ 2 or 3+2, Gt₄ 3+3, Gt₅ 4+4 or 5+5, Gt₆ with 6 arranged in a line, Gt₇ with 8 setae arranged in two lines. Ovipositor originating from apex of Gt₃, 1.0–1.1× as long as mesotibia, and slightly exerted. Gt₇ 0.3× as long as wide. Second valvifer 1.9–2.0× as long as third valvula; the latter 1.1–1.3× as long as mesobasitarsus.

Male. Unknown.

Host. Unknown.

Etymology. The specific name refers to the scape with short streaks distally.

Distribution. China (Xishuangbanna of Yunnan Province).

Comments. This new species is similar to *C. anchoroides* but can be distinguished from the latter by the following characters: (1) scape largely white, and with two dark broad streaks distally (vs largely dark, with dorsal margin and a median streak white, cf. Fig. 5 and fig. 90A in Huang 1994); (2) mesoscutum without the anchor shaped patch (vs with, cf. Figs 1, 4); (3) Gt₁–Gt₅ with 5 brown transverse band (vs 4, cf. Fig. 8); (4) funicle segments equal in length, and each segment as long as wide (vs F1 shortest, F2 and F3 longer than wide); (5) fore wing with dark setae and without narrow hyaline area posterior to marginal vein (vs with a narrow hyaline area bearing fine pale setae, cf. Fig. 5); (6) ovipositor 1.0–1.1× as long as mesotibia (vs 1.3–1.6×).

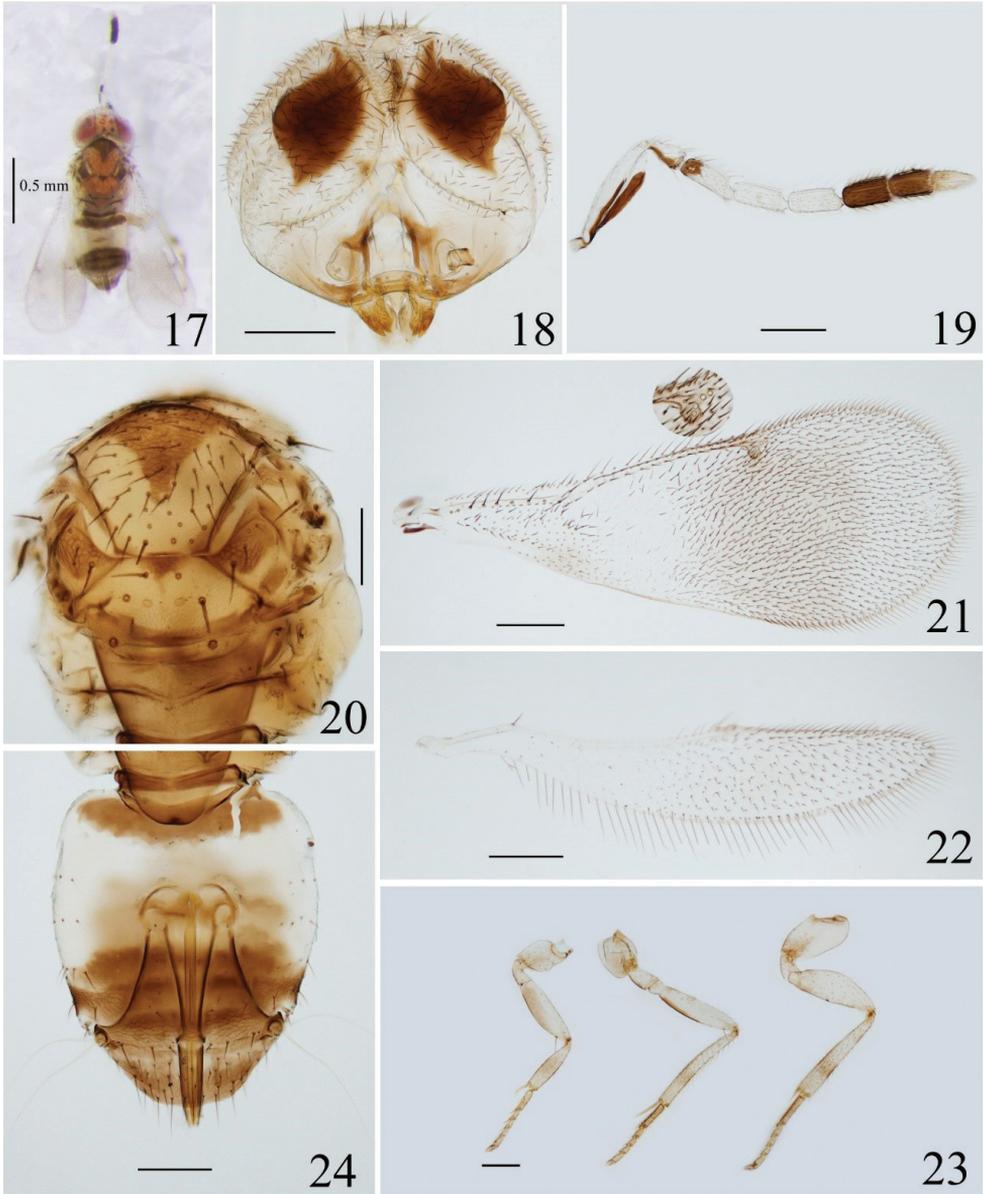
***Coccophagus perlucidus* Chen & Li, sp. nov.**

<http://zoobank.org/2AFFB554-C935-4079-BACD-977C8D598DE6>

Figs 17–24

Type material. Holotype: CHINA • ♀ [on slide, C202108-9]; Yunnan Province; Xishuangbanna; Mengla County; Menglun Town; 21°53.59'N, 101°17.29'E; 546 m a.s.l.; 4 May. 2019; Z.-l. Bai, Z.-g. Chen, C. Wang, Y.-f. Tong, H. Yu leg.; LFNU. **Paratypes:** 1 ♀ [on slide, C202012-1]; Yunnan Province; Xishuangbanna; Mengla County; Menglun Town; 21°54.33'N, 101°16.78'E; 616m a.s.l.; 26 Apr. 2019; Z.-l. Bai, Z.-g. Chen, C. Wang, Y.-f. Tong, H. Yu leg.; LFNU. 1 ♀ [destroyed for DNA extraction]; Yunnan Province; Xishuangbanna; Mengla County; Menglun Town; 21°54.18'N, 101°16.71'E; 606 m a.s.l.; 5 May. 2019; Z.-l. Bai, Z.-g. Chen, C. Wang, Y.-f. Tong, H. Yu leg.; LFNU.

Diagnosis. *Coccophagus perlucidus* sp. nov. can be distinguished from females of other species in this genus by the following combination of characters: scape (Fig. 19) slightly expanded, 3.1–3.3× as long as wide; fore wing infuscate posterior to stigmal vein, and with a hyaline area bearing sparse and transparent setae below basal half of marginal vein as in Fig. 21; the characteristic colour of mesosoma and metasoma as in Fig. 17.



Figures 17–24. *Coccophagus perlucidus* sp. nov. **17** body, dorsal view **18** head **19** antenna **20** mesosoma **21** fore wing **22** hind wing **23** legs, from left to right: fore-, mid- and hind-leg **24** metasoma.

Description. Female. Length 0.9–1.4 mm; holotype, 1.4 mm.

Colour. Head, in frontal view, mostly pale yellow, with mouth margin brown; in dorsal view, vertex orange, ocelli and eyes red, with two small dark patches behind each posterior ocellus (Fig. 17). Occiput suffused with brown above foramen, remainder pale yellow. Scape mostly white, and dark brown on ventral surface except distal one

fourth white and having a pale streak on dark area as in Fig. 19; pedicel white except dark ventrally; funicle white except basal one third of F1 dark, C1 and C2 dark, C3 pale brown. Mandible brown. Pronotum largely dark brown except lateral sides yellow; mid lobe of mesoscutum (Figs 17, 20) with a large dark patch on anterior part, the remaining part orange; side lobe and axilla largely dark except lateral sides yellow; mesoscutellum orange except brown posteriorly, and with a small brown inverted triangle anteriorly; metanotum and propodeum brown and with lateral sides paler. Fore wing (Fig. 21) with stigma vein brown, largely infuscated below stigma vein, and with a hyaline area bearing sparse and transparent setae below basal half of marginal vein; hind wing (Fig. 22) slightly infuscate in distal half. Legs (Fig. 23) mostly yellow and with brown parts as following: procoxa apically, profemur ventrally, protibia medially, mesocoxa largely, ventral margin of mesofemur except distal one third, mesotibia submedially, metacoxa apically, metatibia submedially, all tarsomeres. Metasoma (Fig. 24) with petiole, Gt_1 except posteriorly and Gt_5 – Gt_7 dark brown, Gt_7 pale brown anteriorly, Gt_2 to Gt_4 largely white except Gt_3 having a short brown band medially. Ovipositor dark brown.

Head (Fig. 18), in frontal view, $0.9\times$ as high as wide. Ocellar triangle with apical angle acute. Mandible with two teeth and a truncation. Antenna (Fig. 19) with scape 3.1 – $3.3\times$ as long as wide; pedicel 1.5 – $1.9\times$ as long as wide, $0.7\times$ length of F1; an anellus present between pedicel and F1; F1–F3 ventrally connected, F1 with ventral length a little longer than dorsal length, and 2.1 – $2.9\times$ as long as wide; F2 slightly shorter than F1, 2.0 – $2.3\times$ as long as wide; F3 nearly as long as F2, and $2.1\times$ as long as wide; clava $0.8\times$ length of funicle, and C1–C3 almost same in length, with C3 slightly narrower. Flagellomeres each with 2 longitudinal sensilla.

Mesosoma (Fig. 20). Dorsum of mesosoma finely reticulate, and with the sculpture more evident in dark areas. Mid lobe of mesoscutum bearing approximately 70 setae, and with anterior setae short and dense, $0.8\times$ as long as wide, $1.4\times$ as long as mesoscutellum; each side lobe of the mesoscutum with 3 setae; each axilla with 3 or 4 setae; mesoscutellum $0.6\times$ as long as wide, with 3 pairs of setae. Distance between anterior pair of scutellar setae $0.4\times$ and $0.3\times$ that between median and posterior pair respectively. Placoid sensilla mesad of the median scutellar setae, and the distance between placoid sensilla about equal to that of anterior scutellar setae. Metanotum as long as propodeum.

Wings. Fore wing (Fig. 21) 2.5 – $2.6\times$ as long as wide, marginal setae short. Costal cell 0.9 – $1.0\times$ length of marginal vein, bearing 1 row of setae; submarginal vein with 8 long setae; marginal vein with 13 setae along anterior margin; postmarginal vein absent; stigmal vein (Fig. 21, inset) swollen posteriorly and with sensilla arranged in 2 lines. Hind wing (Fig. 22) 5.1 – $5.9\times$ as long as wide, with marginal setae 0.4 – $0.5\times$ wing width.

Legs (Fig. 23). Mesotibial spur as long as corresponding basitarsus.

Metasoma (Fig. 24). Lateral sides of Gt_5 , Gt_6 and Gt_7 clearly imbricate reticulated on dorsal surface. Setation of tergites on dorsal surface as followings: Gt_2 with 3 setae on each side, Gt_3 and Gt_4 with 4 setae on each side respectively, Gt_5 and Gt_6 with 10

and 6 setae arranged in a line respectively, Gt_7 with 18 setae nearly arranged in 3 lines. Gt_7 0.3× as long as wide. Ovipositor originating from base of Gt_3 , 1.2× as long as mesotibia, and not or slightly exerted. Second valvifer 1.6–1.8× as long as third valvula; the latter 1.4–1.5× as long as mesobasitarsus.

Male. Unknown.

Host. Unknown.

Etymology. The specific name refers to this species having a hyaline area on the fore wing.

Distribution. China (Xishuangbanna of Yunnan Province).

Comments. Although *C. perlucidus* sp. nov. is very similar to *C. equifuniculatus* in having similar antenna and thorax, the new species differs from the latter by two unambiguous characters: (1) fore wing of *C. perlucidus* obviously with a hyaline area bearing sparse and transparent setae below basal half of marginal vein (vs without the hyaline area, and with setae of disc dark, cf. fig. 91B in Huang 1994); (2) colour of gaster is different. We examined all materials belonging to the *Coccophagus varius* group in hand, the colour of scape and gaster exhibit very little variation in conspecific individuals. *Coccophagus perlucidus* with Gt_1 except posteriorly and Gt_5 – Gt_7 dark brown, Gt_7 pale brown anteriorly, Gt_2 to Gt_4 largely white except Gt_3 having a short brown band medially as in Fig. 17 (vs Gt_1 with a broad brown band medially, Gt_2 and Gt_3 with short brown band medially, Gt_4 – Gt_7 mostly brown cf. fig. 91C in Huang 1994). This new species also resembles *C. lii* in having a similar colour of gaster and a hyaline area bearing fine setae below basal half of fore wing. It differs from the latter by the following combination of characters: (1) scape and pedicel with dark areas (vs completely white); (2) the dark patch on mid lobe of mesoscutum not touching the posterior margin of mesoscutum (vs touching cf. fig. 86A in Huang 1994); (3) mesoscutellum largely orange except brown anteriorly and posteriorly (vs with a large brown inverted T-shaped patch); (4) scape 3.1–3.3× as long as wide (vs 3.7×), pedicel 0.7× length of F1 (vs nearly as long as).

Coccophagus yunnana Wang, Huang & Polaszek

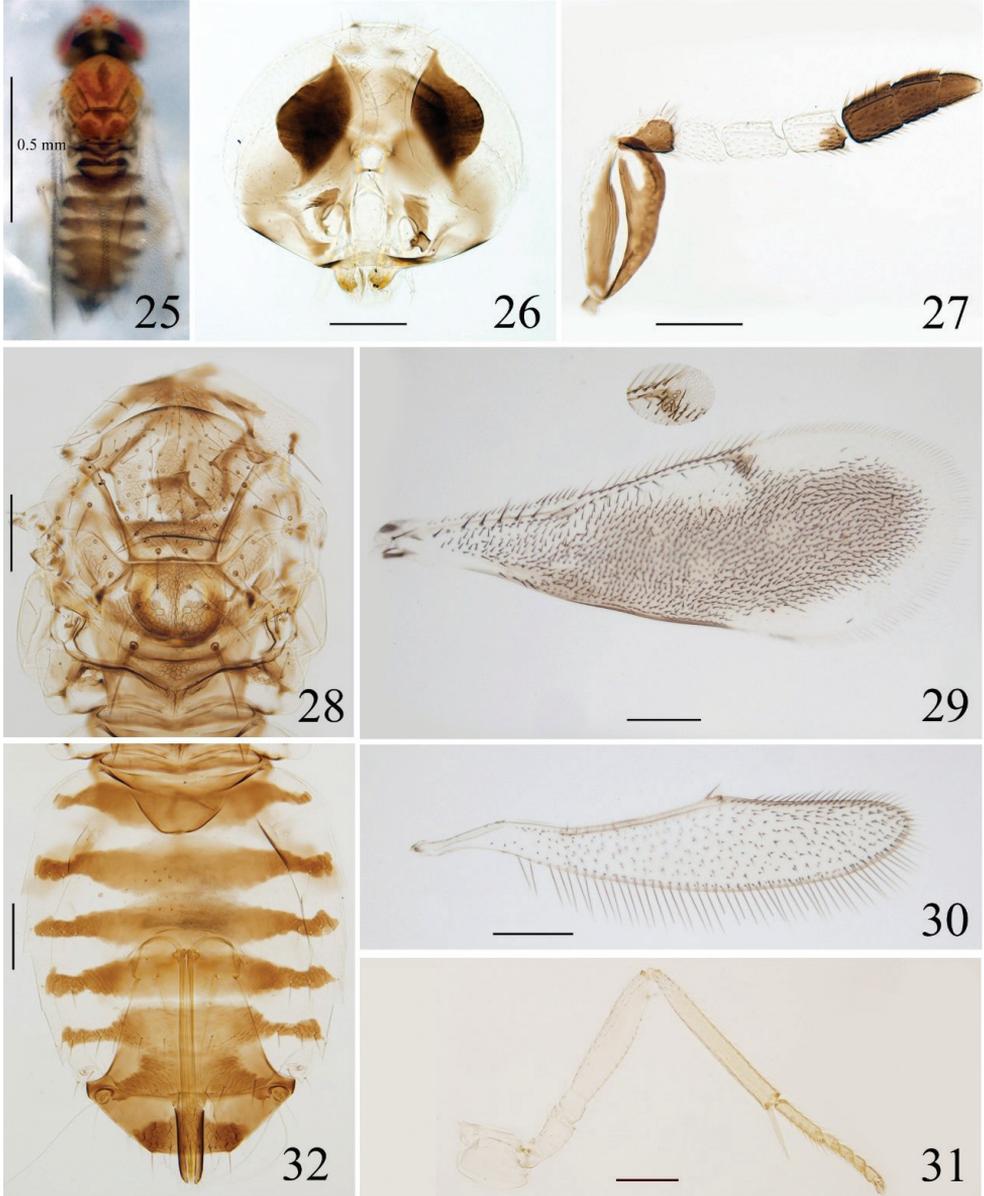
Figs 25–32

Coccophagus yunnana Wang, Huang & Polaszek, 2020: 1888. Holotype ♀, CHINA, FAFU, not examined.

Material examined. 1 ♀ [on slide, C202009-1]; Yunnan Province; Xishuangbanna; Mengla County; Menglun Town; 21°54.28'N, 101°16.75'E; 629 m a.s.l.; 25 Apr. 2019; Z.-l. Bai, Z.-g. Chen, Y.-j. Lin, C. Wang, H. Yu leg.; LFNU. 2 ♀♀ [1 ♀ on slide, C202009-3; 1 ♀ destroyed for DNA extraction]; Yunnan Province; Xishuangbanna; Mengla County; Menglun Town; 21°54.33'N, 101°16.78'E; 616 m a.s.l.; 26 Apr. 2019; Z.-l. Bai, Z.-g. Chen, C. Wang, Y.-f. Tong, H. Yu leg.; LFNU. 2 ♀♀ [on slides, C201911-1, C201911-2]; Yunnan Province; Xishuangbanna; Mengla County; Menglun Town; 21°54.34'N, 101°16.79'E; 618 m a.s.l.; 2 May. 2019; Z.-l. Bai, Z.-g. Chen, C. Wang, Y.-f. Tong, H. Yu leg.; LFNU.

Wang et al. (2020) provided abundant descriptions for this species based on a single female specimens reared from an unidentified coccid (Hemiptera, Coccidae) on *Kopsia fruticosa* (Ker). Here we provided some figures and DNA sequence for references.

Distribution. China (Xishuangbanna of Yunnan Province).



Figures 25–32. *Coccophagus yunnana* **25** body, dorsal view **26** head **27** antenna **28** mesosoma **29** fore wing **30** hind wing **31** mid leg **32** metasoma.

Phylogenetic analysis

Phylogenetic relationship between *Coccophagus varius* group and other *Coccophagus* species are shown in Fig. 33 and Suppl. material 1: Figs S1, S2. In this study, we provided 10 new 28S-D2 rDNA sequences of 10 species, representing 5 species groups as shown in Table 1. The *varius* group was found to be monophyletic in both BI and ML analysis with very strong support (PP=0.99; BS=91). Both resulting trees also lend support to the idea that *C. longifasciatus* + *C. bivittatus* (*ochraceus* group) serve as the sister group of *varius* group, which has been hinted at the analysis of Wang et al (2020). The 28S-D2 rDNA sequences between *C. longifasciatus* and *C. bivittatus* have no differences, these two species are very similar morphologically. They are maybe conspecific, which is first suspected by Hayat (1998). Our slide-mounted materials of *C. longifasciatus* agreed well with the original description. The material of *C. bivittatus* from Zhou (2017) need to be checked in the future to verify if it is a misidentification of *C. longifasciatus*, and if not, then other gene regions (e.g. COI sequence) should be more indicative to test the possibility of *C. bivittatus* as a synonym of *C. longifasciatus*. *Coccophagus varius* group and *C. ochraceus* group together form a monophyletic clade, being the sister group of the remaining *Coccophagus*. Though both resulting trees

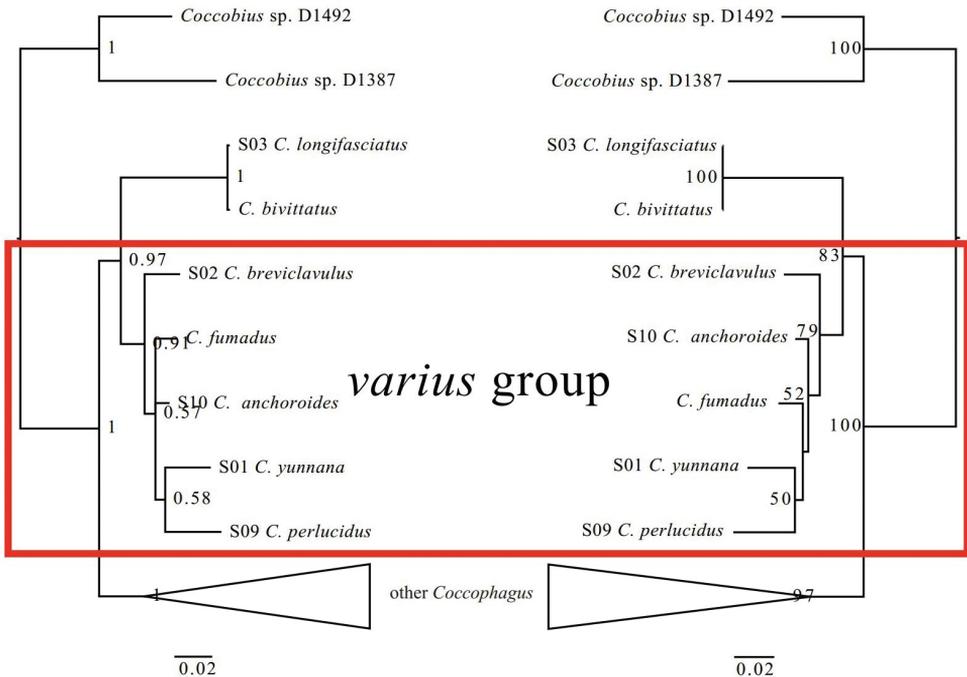


Figure 33. Phylogenetic trees constructed by Bayesian inference (BI) (left)/ Maximum likelihood (ML) (right) methods based on the 28S-D2 rDNA dataset. In the BI tree, all nodes of posterior probability (PP) value lower than 0.5 were shown as polytomy. In the ML three, all Branch support (BS) values lower than 50 were not shown. Detailed trees of both BI and ML were shown in Suppl. material 1: Figs S1, S2.

showed similar relationships between species groups, the relationships between species within groups were not fully resolved, which might be attributed to the conservative property of 28S rDNA. More species and genetic data of *Coccophagus* should be added to verify the monophyly of *varius* group and elucidate the relationships between *varius* group and other *Coccophagus* in the future.

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Supplementary material I

Figures S1, S2

Authors: Yao-guang Qin

Data type: phylogenetic, images

Explanation note: Phylogenetic trees constructed by Bayesian inference (BI)/ Maximum likelihood (ML) methods based on the 28S-D2 rDNA dataset.

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A review of the *Temnothorax anodontoides* species-group (Hymenoptera, Formicidae) from Greece

Sebastian Salata¹, Lech Borowiec¹

¹ University of Wrocław, Department of Biodiversity and Evolutionary Taxonomy, Myrmecological Laboratory, Przybyszewskiego 65, 51-148 Wrocław, Poland

Corresponding author: Sebastian Salata (sebastian.salata@uwr.edu.pl)

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Abstract

A review of the Greek members of the *Temnothorax anodontoides* species-group revealed three species new to science: *Temnothorax euboae* **sp. nov.** (Sterea Ellas, Euboea Island), *Temnothorax arkasi* **sp. nov.** (Peloponnese, Arcadia) and *Temnothorax parnonensis* **sp. nov.** (Peloponnese, Arcadia and Lakonia). The diagnoses of *Temnothorax ikarosi* Salata, Borowiec & Trichas, 2018 and *T. anodontoides* (Dlussky & Zabelin, 1985) are updated based of the new discoveries. Additionally, presence of the latter species in Greece is discussed and its distribution range revised. All members of the *anodontoides* species-group are associated with alpine and rocky habitats such as pastures and thermophilous forests. A dichotomous key to the *anodontoides* species-group from Greece is given.

Keywords

Myrmicinae, new species, *Temnothorax anodontoides* group, taxonomy

Introduction

The myrmicine genus *Temnothorax* Mayr, 1861, with 452 valid species and 36 valid subspecies, is one of the most speciose ant genera (Bolton 2021). Most of its members are distributed in the Northern Hemisphere, with diversity centers located in the

Mediterranean region, southern parts of the USA, and the Greater Antilles (Salata and Borowiec 2019; Bolton 2021; Prebus 2021). *Temnothorax* species occupy a wide range of habitats, including tropical rainforests, hot deserts and boreal forests. Members of this genus nest most often in small, preformed cavities, such as rock crevices, hollow dead twigs, and dry acorns. They nest also under moss on stones and directly in ground, occasionally under cracked bark on tree trunks (Prebus 2021). Among 285 Palaearctic taxa, which consist of 59% of all known *Temnothorax* species, nearly 200, i.e., ~40% of all *Temnothorax*, are known from the Mediterranean region (sensu Vigna Taglianti et al. 1999). Due to its diversity, the Mediterranean myrmecofauna has been recently a subject of thorough studies that were partially focused on this genus (Csösz et al. 2015, 2018; Radchenko et al. 2015; Salata and Borowiec 2015; Galkowski and Lebas 2016; Catarineu et al. 2017; Galkowski and Cagniant 2017; Sharaf et al. 2017; Salata et al. 2018; Salata and Borowiec 2019; Tinaut and Reyes-López 2020; Arcos González 2021), and resulted in the description of several species new to science.

The *Temnothorax anodontooides* species-group was for the very first time defined by Salata and Borowiec (2019) and referred to the Balkan species characterized by the following set of characters: 12-segmented antennae, darkened club, absence of metanotal groove, overall body coloration brown to almost black, propodeal spines absent or short with wide base, rounded or at most subangulate petiolar node in profile, and very strongly sculptured head and mesosomal surface. Overall, the morphological definition of the *anodontooides* species-group partly overlaps with the *korbi* species-group defined by Radchenko (1995). However, *T. anodontooides* was excluded from the *korbi* species-group because it was the only member with distinct head sculpture, dark body colouration and unique shape of the petiole. The remaining members of the *korbi* group, i.e., *T. korbi* (Emery, 1924), *T. caucasicus* (Arnoldi, 1977) (now junior synonym of *T. nadigi*), *T. anodonta* (Arnoldi, 1977), and *T. iranicus* (Radchenko, 1994), form a separate group more closely related to the *bulgaricus* group (sensu Salata and Borowiec 2019). In this new sense the *anodontooides* species-group covers species recorded from the Apennines, Balkans and Kopet Dag Mts at the border area between Iran and Turkmenistan. Based on the literature, the Balkans hosts only two species of the *anodontooides* group: *Temnothorax anodontooides* (Dlussky & Zabelin, 1985), described from Turkmenistan close to the Iranian border, and *Temnothorax ikarosi* Salata, Borowiec & Trichas, 2018, described from Crete. *Temnothorax anodontooides* was noted from subalpine meadows and its nests were located directly in the ground (Dlussky and Zabelin 1985). Whereas *T. ikarosi* was described recently from the Limnarakou Plateau on Crete. A single specimen of this species was collected on a shelter wall overgrown by blackberry bush (Salata et al. 2018).

Occurrence of members of the *anodontooides* species-group in Greece was for the first time suggested by Schulz et al. (2007). In the paper on Italian *Temnothorax*, the authors compared therein described *Temnothorax saxatilis* Schulz, Heinze & Pusch, 2007 with a Greek taxon collected in Arcadia, Peloponnese that was tentatively

identified as *Temnothorax anodontoidea*. By courtesy of Alex Radchenko (UASK, Kiev), Petr Werner (Prague), and Claude Lebas (Canohès), we had an opportunity to study a paratype specimen of *T. anodontoidea*, a series of specimens collected in Arcadia and identified by A. Schulz as *T. anodontoidea*, and other material collected from Greek mountains with characters of the *anodontoidea* species-group. Based on our research, we concluded that there are four Balkan species belonging to the *anodontoidea* species-group: *T. ikarosi* known from Crete (Salata et al. 2018), two species known from the Greek mainland: *Temnothorax arkasi* sp. nov. and *Temnothorax parnonensis* sp. nov., and *Temnothorax euboae* sp. nov., so far known only from Euboea Island. The literature records of *T. anodontoidea* from Greece (Schulz et al. 2007) should be assigned to *T. arkasi* sp. nov. and its presence in Europe is doubtful. Also, we consider *T. saxatilis* as a member of the *anodontoidea* species-group but due to its absence in Greece we did not include it in the review. However, when necessary, we included this species in the differential diagnoses of the species described as new to science. Below, we describe three species new to science, provide their photographs and a key to all members of the *anodontoidea* species-group known from Greece.

Materials and methods

Examined specimens are housed in the following collections

MHNG	Museum d'Historie Naturelle, Geneve, Switzerland;
MNHW-DBET	Museum of Natural History, University of Wrocław, in temporary deposit by Department of Biodiversity and Evolutionary Taxonomy, University of Wrocław, Poland;
PWC	private collection of Petr Werner, Prague, Czech Republic;
UASK	Institute of Zoology, National Academy of Sciences of Ukraine, Kiev.

Specimens were compared using standard methods of comparative morphology. All measurements were made in μm using a pin-holding stage, permitting rotations around X, Y, and Z axes. A Nikon SMZ18 stereomicroscope was used at a magnification of $\times 100$ for each character. Photographs were taken using a Nikon SMZ 1500 stereomicroscope, Nikon D5200 camera and Helicon Focus software. All given label data of type specimens are in original spelling, presented in square brackets; a vertical bar (|) separates data on different rows and double vertical bars (||) separate labels. Images of type specimens are available online on AntWeb (www.AntWeb.org) and are accessible using the unique identifying specimen codes provided in the description sections.

Pilosity inclination measurements follow Wilson (1955): adpressed ($0\text{--}5^\circ$) hairs run parallel, or nearly parallel to the body surface; decumbent hairs stand $10\text{--}15^\circ$; subdecumbent hair stands 30° ; suberect hairs stand $35\text{--}45^\circ$; and erect hairs stand more than 45° from the body surface. The surface sculpturing glossary follows Harris (1979).

Measurements

EL	eye length; measured along the maximum diameter of the eye;
EW	eye width; measured along the minimum diameter of the eye;
HL	head length; measured in straight line from mid-point of anterior clypeal margin to mid-point of posterior margin in full-face view (i.e., when both maximum head length in median line and maximum head width are positioned in visual plane);
HW	head width; measured in full-face view directly posterior of the eyes;
PEH	petiole height; measured in lateral view, the chord of ventral petiolar profile at node level is the reference line perpendicular to which the maximum height of petiole is measured (fig. 1D in Csősz et al. 2015);
PEL	petiole length; measured in lateral view, from anterior corner of subpetiolar process to dorsocaudal corner of caudal cylinder (fig. 3 in Csősz and Fisher 2015);
PNW	pronotum width; maximum width of pronotum in dorsal view;
PPH	postpetiole height; measured perpendicularly to a line defined by the linear section of the segment border between dorsal and ventral petiolar sclerite (fig. 1D in Csősz et al. 2015);
PPL	postpetiole length; maximum length of the postpetiole measured in lateral view perpendicular to the straight section of lateral postpetiolar margin (fig. 1D in Csősz et al. 2015);
PPW	postpetiole width; maximum width of postpetiole in dorsal view;
PSL	propodeal spine length; measured from the centre of the propodeal spiracle to the top of the propodeal spine;
PEW	petiole width; maximum width of petiole in dorsal view;
SDL	spiracle to declivity length; minimum distance from the centre of the propodeal spiracle to the propodeal declivity;
SL	scape length; maximum straight-line length of scape excluding the articular condyle;
WL	mesosoma length; measured as diagonal length from the anterior end of the neck shield to the posterior margin of the propodeal lobe.

Indices

CI	HW/HL;	MI	PNW/WL;
EI1	EW/EL;	PI	PEL/PEH;
EI2	EW/HL;	PPI	PPL/PPH;
SI1	SL/HL;	PSI	PSL/SDL.
SI2	SL/HW;		

Abbreviations

w. worker

Results

Synopsis of the *Temnothorax anodontoides* species-group known from Greece

Temnothorax arkasi sp. nov.

Temnothorax euboeae sp. nov.

Temnothorax ikarosi Salata, Borowiec & Trichas, 2018

Temnothorax parnonensis sp. nov.

Key to members of the *Temnothorax anodontoides* species-group known from Greece

- 1 Head with reduced sculpture, frons medially with long and narrow smooth or indistinctly punctate area (Fig. 15). Body predominantly yellowish brown (Figs 9, 10). Mountains of Peloponnese ***T. parnonensis* sp. nov.**
- Head strongly sculptured, distinctly reticulate (Figs 7, 8). Body predominantly brown to almost black (Figs 1, 2, 5, 6, 17, 18) **2**
- 2 Petiole with short peduncle (Fig. 6). Propodeal spines well marked, needle shaped (Fig. 6). Euboea ***T. euboeae* sp. nov.**
- Petiole with elongated peduncle (Figs 2, 18). Propodeal spines absent or short, in form of triangular denticle (Figs 2, 18) **3**
- 3 Petiole regularly rounded in profile, with shorter peduncle (Fig. 2), petiolar and postpetiolar dorsum with distinct irregular rugae; promesonotum with denser and thinner sculpture (Fig. 1). Peloponnese ***Temnothorax arkasi* sp. nov. (= *T. anodontoides* sensu Schulz et al. 2007)**
- Petiole subangulate in profile, with longer peduncle (Fig. 18), petiolar and postpetiolar dorsum reticulate, rugae absent, promesonotum with thicker and sparser sculpture (Fig. 17). Crete ***T. ikarosi* Salata, Borowiec & Trichas**

Species accounts

Note. Because of the partly reduced head sculpture, *Temnothorax parnonensis* doesn't entirely match the characteristics of the *anodontoides* species-group proposed by Salata and Borowiec (2019). However, because its habitat preferences and overall morphology match most of the characters associated with this group, we decided to include it in the revision. Based on that, the definition of the *anodontoides* species-group should be modified as follow: 12-segmented antennae, darkened club, absence of metanotal groove, overall body coloration from yellowish brown to almost black, propodeal spines absent or short with wide base, rounded or at most subangulate petiolar node in profile, very strongly sculptured mesosomal surface; head strongly sculptured or strongly sculptured with frons with diffused sculpture and sometimes medially with narrow smooth area.

***Temnothorax arkasi* sp. nov.**

<http://zoobank.org/23D7FD80-558A-47D9-832C-B797F46B4A6B>

Figs 1–3, 7, 19

Type material. *Holotype*: worker (CASENT4015000, pin), label: “Greece, Peloponnes | Prov. Arkadia | A. Schulz & K. Vock lgt. || Parnon, | 3 km W Sitena | 37°18'N, 22°36'E | 25.4.2000 1700 m || Collection L. Borowiec | Formicidae | LBC-GR02714” (MNHWD-BET). *Paratypes*: 3 workers (CASENT4015001–CASENT4015003): the same data as holotype; 5 workers (CASENT4015004–CASENT4015008): the same data as holotype + “Sample Nr. | AS1”; 8 workers (CASENT4015009–CASENT4015016): the same data as holotype + “Sample Nr. | AS2”; 6 workers (CASENT4015017–CASENT4015022): the same data as holotype + “Sample Nr. | AS3” (MHNG, MNHW-DBET, PW).

Type locality. Greece, Peloponnes Province, Parnon, 3 km W Sitena, 37.3/22.6, 1375 m a.s.l.

Differential diagnosis. *Temnothorax arkasi* differs from *T. parnonensis* and *T. anodontoides* in very dark body coloration, with head and mesosoma predominantly dark brown to black (pale brown to yellowish brown in both relatives) and more elongate head, i.e., 1.25–1.28 as long as wide (only 1.22 in both relatives); from *T. anodontoides* it differs additionally in more sculptured head with rugulocostulate frontal part of head (*T. anodontoides* has frons entirely rugulate); from *T. parnonensis* it additionally differs in reduced propodeal spines and lack of smooth patch on frons (*T. parnonensis* has small but well-marked triangular propodeal spines and its frons sculpture is reduced on the central part); from *T. euboeae* it differs in almost reduced propodeal spines that are in form of small angulation of very short triangular spines, shiny interspaces between head sculpture, and longer petiole with moderately elongate pedicel (*T. euboeae* has propodeal spines distinct and in form of small, short, needles, more dull head surface and very short pedicel); from *T. ikarosi* it differs in more elongate head, shorter petiolar peduncle, denser and thinner sculpture on promesonotal dorsum and smaller propodeal spines (*T. ikarosi* has less elongate head, longer petiolar peduncle, sparser and thicker promesonotal sculpture and bigger propodeal spines).

Description. Worker ($N = 10$): HL: 0.66 ± 0.03 (0.6–0.71); HW: 0.55 ± 0.03 (0.5–0.57); SL: 0.49 ± 0.03 (0.44–0.53); EL: 0.14 ± 0.01 (0.11–0.16); EW: 0.1 ± 0.01 (0.08–0.12); WL: 0.8 ± 0.06 (0.68–0.89); PSL: 0.12 ± 0.01 (0.11–0.13); SDL: 0.11 ± 0.01 (0.1–0.12); PEL: 0.29 ± 0.03 (0.24–0.34); PPL: 0.17 ± 0.01 (0.15–0.19); PEH: 0.2 ± 0.02 (0.17–0.23); PPH: 0.19 ± 0.01 (0.17–0.21); PNW: 0.39 ± 0.02 (0.36–0.42); PEW: 0.18 ± 0.01 (0.15–0.19); PPW: 0.22 ± 0.02 (0.2–0.24); CI: 1.2 ± 0.03 (1.18–1.25); SI1: 0.74 ± 0.03 (0.68–0.77); SI2: 0.9 ± 0.03 (0.82–0.94); MI: 0.49 ± 0.03 (0.45–0.54); EI1: 0.75 ± 0.06 (0.67–0.85); EI2: 0.16 ± 0.01 (0.13–0.17); PI: 1.43 ± 0.1 (1.26–1.59); PPI: 0.87 ± 0.04 (0.8–0.94); PSI: 1.1 ± 0.03 (1.08–1.18).

Colour. Head dark brown, mesosoma, petiole and postpetiole brown to brownish black, lateral sides of pronotum with indistinct brownish areas, gaster mostly brown only base of first segment slightly brighter, in the palest specimens mesosoma partly yellowish brown; scape yellowish to yellowish brown, funicle segments 1–8 yellowish, an-



Figures 1, 2. Holotype worker of *Temnothorax arkasi* sp. nov. **1** dorsal **2** lateral. Scale bar: 1 mm.

tennial club yellowish brown to dark brown, legs mostly yellowish to yellowish brown, femora medially darkened (Figs 1, 2). **Head.** Slightly elongate, 1.28 times as long as wide, sides below and above eyes gently convex, occipital corners regularly rounded, occipital margin of head straight (Figs 3, 7). Anterior margin of clypeus distinctly convex, medial notch absent. Eyes moderate, short oval, 1.2 times as long as wide. Antennal scape short, in lateral view slightly curved, 0.78 times as long as length of the head, in apex gradually widened, its base without tooth, funiculus long, club 3-segmented (Fig. 3). Surface of scape finely microreticulate, shiny, covered with thin, dense, decumbent to suberect setae. Funicle longer than scape, first segment 2.1 times as long as wide at apex, segments 2–7 short, rectangular. Mandibles rounded with thick and sparse striae, shiny. Clypeus with sharp median longitudinal keel and two keels laterally, area between keels microreticulate but shiny. Frontal carinae short, slightly extending beyond frontal lobes. Antennal fossa deep, with thin circular striae and dense microreticulation. Frontal lobes narrow, microreticulate with costulae (Fig. 7). Frons, gena, malar region, vertex and temples densely reticulate with shiny interspaces; frons, gena, area behind eyes, central part of vertex, occipital area with additional costulae, malar area with costulae partly interrupted. Whole surface of head appears shiny. Sides of head with very short and sparse adpressed pubescence, sides of frons, vertex and occipital area



Figures 3, 4. Head and antennae of holotype workers **3** *Temnothorax arkasi* sp. nov. **4** *Temnothorax euboae* sp. nov. Scale bars: 0.25 mm.

with erect, pale, short and thick setae (Figs 3, 7). **Mesosoma.** Elongate, approximately twice as long as wide, distinctly arched in profile. Metanotal groove absent. Pronotum convex on sides. Propodeal spines very short, in form of triangular denticles or small angulation (Fig. 2). Whole surface of mesosoma densely reticulate with shiny interspaces. Pronotal dorsum regulate, lateral sides of pronotum rugocostulate, mesonotal dorsum reticulocostulate, propodeum rugocostulate, area below spines microreticulate with few transverse costulae. Entire mesosoma with erect, pale, moderately long and thick setae (Figs 1, 2). **Petiole.** In lateral view, with moderately elongate peduncle, node low, with anterior face shallowly concave and dorsum regularly rounded, whole surface rugoreticulate. Dorsal surface with sparse, short, erect setae. **Postpetiole.** In lateral view regularly convex, sides rounded, on the whole surface reticulocostulate, surface appears less rugose than surface of petiole. Dorsal surface with sparse, moderately long, erect setae (Figs 1, 2). **Gaster.** Smooth and shiny, with erect, thin, pale setae (Figs 1, 2). **Legs.** Moderately elongate, femora swollen in the middle, tibiae widened from base to $\frac{3}{4}$ length, surface of legs covered with sparse, adpressed to decumbent hairs.

Etymology. The name is a noun in genitive case, dedicated to Arkás (ancient Greek: Ἀρκάς), a mythological hunter and King of ancient Arkadía (ancient Greek: Ἀρκάδία). His name was given to the recent Greek province Arcadia, Peloponnese, a terra typica for *Temnothorax arkasi*.

Biology. The type locality is placed in an alpine zone on the rocky northern slopes of Mt. Parnon overgrown with a young and sparse fir forest. The altitude indicated on the labels (1700 m) is most likely overestimated as the site indicated by the geographical coordinates given on the label gives the actual altitude of 1375 m.

***Temnothorax euboeae* sp. nov.**

<http://zoobank.org/7BF704E0-F549-4B81-8640-9FDE9F4FBDF6>

Figs 4–6, 8, 19

Type material. Holotype: worker (CASENT4015023, pin), label: “GREECE, Sterea Ellas | Euboea, Mt. Dirfi, 1030 m | 14 V 2017 | C. Lebas || Collection L. Borowiec | Formicidae | LBC-GR02765” (MNHW-DBET).

Typelocality. Greece, Sterea Ellas Province, Euboea, Mt. Dirfi, 38.61666/23.83333, 1030 m a.s.l.

Differential diagnosis. *Temnothorax euboeae* differs from *T. parnonensis* and *T. anodontoides* in very dark body coloration, with head and mesosoma predominantly dark brown to black (pale brown to yellowish brown in both relatives), more elongated head (1.25–1.28 times as long as wide vs 1.22 in both relatives), and costate frons with microreticulate interspaces (interspecies smooth in both relatives); from *T. saxatilis* it differs in very dark body coloration, with head and mesosoma predominantly dark brown to black, more coarse sculpture of mesosoma, petiole and postpetiole, and costate frons with microreticulate interspaces; from *T. anodontoides* it differs additionally in presence of propodeal spines; from *T. parnonensis* it differs additionally in shorter petiolar node; from *T. arkasi* it differs in presence of small, short, and needle



Figures 5, 6. Holotype worker of *Temnothorax euboeae* sp. nov. **5** dorsal **6** lateral. Scale bar: 1 mm.



Figures 7, 8. Head sculpture of holotype workers **7** *Temnothorax arkasi* sp. nov. **8** *Temnothorax euboeae* sp. nov.

shaped propodeal spines (in *T. arkasi* propodeal spines are in form of small angulation or very short triangular spines), and shorter petiole and pedicel; from *T. ikarosi* it differs in more elongated head, short petiolar peduncle, more rounded and sculptured petiole and postpetiole, lobes and short, needle shaped propodeal spines.

Description. Worker ($N = 1$): HL: 0.7; HW: 0.57; SL: 0.44; EL: 0.14; EW: 0.09; WL: 0.87; PSL: 0.15; SDL: 0.13; PEL: 0.3; PPL: 0.17; PEH: 0.2; PPH: 0.2; PNW: 0.41; PW: 0.17; PPW: 0.25; CI: 1.23; SI1: 0.63; SI2: 0.77; MI: 0.47; EI1: 0.64; EI2: 0.13; PI: 1.5; PPI: 0.85; PSI: 1.15.

Colour. Head, mesosoma, petiole and postpetiole black, sides of pronotum with indistinct brownish-black areas, gaster mostly dark brown only base of first segment slightly brighter, scape brown, funicle segments 1–8 yellowish brown, antennal club dark brown, legs mostly dark brown with yellowish-brown coxae and knee, and yellowish-brown tarsi (Figs 5, 6). **Head.** Slightly elongate, 1.25 times as long as wide, sides below and above eyes gently convex, occipital corners regularly rounded, occipital margin of head straight (Figs 4, 8). Anterior margin of clypeus distinctly convex, medial notch absent. Eyes moderate, short oval, 1.2 times as long as wide. Antennal scape short, in lateral view slightly curved, 0.74 times as long as length of the head, in apex gradually widened, its base without tooth, funiculus long, club 3-segmented (Fig. 4). Surface of scape finely microreticulate, shiny, covered with thin, dense, decumbent to suberect setae. Funicle longer than scape, first segment 2.2 times as long as wide at apex, segments 2–7 short, rectangular. Mandibles rounded with thick and sparse striae, shiny. Clypeus with sharp median longitudinal keel and two keels laterally, area between keels microreticulate but shiny. Frontal carinae short, slightly extending beyond frontal lobes. Antennal fossa deep, with thin circular striae and dense microreticulation. Frontal lobes narrow, microreticulate with costulae (Fig. 8). Frons, gena, malar region, vertex and temples densely reticulate with dull interspaces; frons and vertex medially, gena, and area behind eyes with additional costulae, sides of frons and malar area with additional interrupted costulae, on vertex costulae fading but reticulation tends to be more longitudinal, occipital area partly with additional costulae. Whole surface of head appears slightly dull. Sides of head with very short and sparse adpressed pubescence, sides of frons, vertex and occipital area with erect, pale, short and thick setae (Figs 4, 8). **Mesosoma.** Elongated, approximately twice as long as wide, slightly arched in profile. Metanotal groove absent. Pronotum convex on sides. Propodeal spines short, needle shaped, directed distinctly upward, base narrow, tips sharp (Fig. 6). Whole surface of mesosoma densely rugulate with shiny interspaces. Promesonotal dorsum rugulate but rugocostulate on lateral sides are more longitudinal, propodeum rugocostulate and only area between spines microreticulate. Entire mesosoma with erect, pale, moderately long and thick setae (Figs 5, 6). **Petiole.** In lateral view, with short peduncle, low node, with anterior face shallowly concave and dorsum regularly rounded, whole surface rugoreticulate. Dorsal surface with sparse, short, erect setae. **Postpetiole.** In lateral view regularly convex, sides rounded, on the whole surface reticulate, on sides with short costulae, surface appears less rugose than surface of petiole. Dorsal surface with sparse, moderately long, erect setae (Figs 5, 6). **Gaster.** Smooth and shiny, with erect, thin, pale setae (Figs 5, 6). **Legs.** Moderately elongate, femora swollen in the middle, tibiae widened from base to $\frac{3}{4}$ length, surface of legs covered with sparse, adpressed to decumbent hairs.

Etymology. The name is a noun in genitive case, dedicated to Euboea, a mythical Naiad nymph whose name was given to the island of Euboea, terra typica for *Temnothorax euboeae*.

Biology. Little known. The type locality is located in a mountainous area of Mt. Dirfi overgrown with Mediterranean oak forest.

Note. We decided to describe this species based on a single specimen because of a compilation of morphological characters that make it unique among all known Greek and eastern Mediterranean *Temnothorax* species. A morphologically similar species outside eastern Mediterranean is *T. saxatilis*, known from the alpine zone in the L'Aquila province in Italy. However, *T. euboeae* differs morphologically from *T. saxatilis* based on the set of characters mentioned above in the differential diagnosis.

***Temnothorax parnonensis* sp. nov.**

<http://zoobank.org/A2C4112E-A11F-4247-9325-3B0AB7BF477F>

Figs 9–11, 15, 19

Type material. **Holotype:** worker (CASENT4015024, pin), label: “Greece, Peloponnes | Prov. Arkadia | A. Schulz & K. Vock lgt. || Parnon, | 4 km WSW Kastanitsa | 37°17'N, 22°40'E | 22.4.2000 1200–1400 m || Collection L. Borowiec | Formicidae | LBC-GR02712” (MNHW-DBET). **Paratypes:** 3 workers (CASENT4015025–CASENT4015027): the same data as holotype; 6 workers (CASENT4015028–CASENT4015033): the same data as holotype + “Sample Nr. | AS7”; 5 paratype workers (CASENT4015034–CASENT4015038): “Greece, Peloponnes | Prov. Arkadia | A. Schulz & K. Vock lgt. || Parnon, | 3 km W Sitená | 37°18'N, 22°36'E | 25.4.2000 1700 m || Sample Nr. | AS8”; 2 workers (CASENT4015039–CASENT4015040): “Greece, Peloponnes | Prov. Arkadia | A. Schulz & K. Vock lgt. || Oros Melanon, | 10 km S Levidi | 37°38'N, 22°17'E | 27.4.2000 1700 m || Collection L. Borowiec | Formicidae | LBC-GR02713”; 6 workers (CASENT4015041–CASENT4015046): the same data except LBC label but + “Sample Nr. | AS5”; 6 workers (CASENT4015047–CASENT4015052): the same data except LBC label but + “Sample Nr. | AS6”; 5 workers (CASENT4015053–CASENT4015057): “Greece, Peloponnes | Prov. Lakonia | A. Schulz & K. Vock lgt. || Oros Taigetos, | 20 km SW Sparti | 36°58'N, 22°21'E | 29.4.2000 1800–2100 m || Sample Nr. | AS4” (MHNG, MNHW-DBET, PW).

Type locality. Greece, Peloponnes Province: Arcadia, Parnon, 4 km WSW Kastanitsa, 37.28333 / 22.66666, 550–600 m a.s.l (please see note below for altitude estimations).

Differential diagnosis. *Temnothorax parnonensis* well differs from other species of the *T. anodontoides* group in the reduced head sculpture, with presence of smooth or indistinctly microreticulate patch on the central part of frons, and brighter yellowish brown to brown body coloration (remaining members of the group have frons entirely sculptured and darker body coloration).

Description. Worker ($N = 20$): HL: 0.67 ± 0.04 (0.59–0.75); HW: 0.57 ± 0.04 (0.48–0.66); SL: 0.5 ± 0.04 (0.4–0.58); EL: 0.15 ± 0.02 (0.12–0.18); EW: 0.11 ± 0.01 (0.08–0.13); WL: 0.79 ± 0.07 (0.65–0.92); PSL: 0.12 ± 0.01 (0.09–0.15); SDL:



Figures 9, 10. Holotype worker of *Temnothorax parnonensis* sp. nov. **9** dorsal **10** lateral. Scale bar: 1 mm.

0.1 ± 0.01 (0.08–0.12); PEL: 0.3 ± 0.03 (0.25–0.37); PPL: 0.18 ± 0.02 (0.15–0.2); PEH: 0.22 ± 0.02 (0.19–0.26); PPH: 0.2 ± 0.02 (0.17–0.24); PNW: 0.41 ± 0.03 (0.33–0.46); PEW: 0.18 ± 0.02 (0.13–0.24); PPW: 0.24 ± 0.02 (0.2–0.28); CI: 1.17 ± 0.03 (1.11–1.23); SI1: 0.74 ± 0.03 (0.68–0.78); SI2: 0.86 ± 0.03 (0.81–0.93); MI: 0.52 ± 0.02 (0.5–0.56); EI1: 0.72 ± 0.06 (0.62–0.86); EI2: 0.16 ± 0.01 (0.14–0.18); PI: 1.37 ± 0.05 (1.27–1.48); PPI: 0.89 ± 0.08 (0.75–1.06); PSI: 1.19 ± 0.14 (1.08–1.67).

Colour. Head, mesosoma, petiole and postpetiole yellowish brown to brown, head usually slightly darker than mesosoma, gaster mostly yellowish brown only base of first segment slightly brighter, yellowish to rusty yellow; scape and funicle segments 1–8 yellow, antennal club darkened, yellowish brown to dark, legs mostly yellowish, femora medially darkened, yellowish brown (Figs 9, 10). **Head.** Slightly elongate, 1.22 times as long as wide, sides below and above eyes gently convex, occipital corners regularly rounded, occipital margin of head straight (Figs 11, 15). Anterior margin of clypeus distinctly convex, medial notch absent. Eyes moderate, short oval, 1.3 times as long as wide. Antennal scape short, in lateral view slightly curved, 0.69–0.72 times as long as length of the head, in apex gradually widened, its base without tooth, funiculus long, club 3-segmented (Fig. 11). Surface of scape microreticulate, shiny, covered with thin, dense, decumbent to suberect setae. Funicle longer than scape, first segment 2.2 times as long as wide at apex, segments 2–7 short, rectangular. Mandibles rounded with thick and



Figures 11, 12. Head and antennae of workers **11** *Temnothorax parnonensis* sp. nov., holotype
12 *Temnothorax anodontoides* Dlussky & Zabelin, 1985, paratype. Scale bars: 0.25 mm.

sparse striae, shiny. Clypeus without or with rudiment of median keel but with two keels laterally, area between keels smooth and shiny. Frontal carinae short, slightly extending beyond frontal lobes. Antennal fossa deep, with thin circular striae and diffused microreticulation. Frontal lobes narrow, indistinctly microreticulate with costulae (Fig. 11). Frons, gena, malar region, vertex and temples reticulate with shiny interspaces, frons medially smooth or with diffused sculpture, sometimes smooth patch reduced to a shiny line, rest of frons costulate; gena costulate, malar area rugulate, area behind eyes costulate, central part of vertex with less distinct rugulosocostulae, occipital area partially costulate. Whole surface of head appears shiny. Sides of head with very short and sparse adpressed pubescence, sides of frons, vertex and occipital area with erect, pale, short and thick setae (Figs 10, 11). **Mesosoma.** Elongate, approximately twice as long as wide, slightly arched in profile. Metanotal groove absent. Pronotum convex on sides. Propodeal spines very short, in form of triangular spines with sharp tip (Fig. 10). Whole surface of mesosoma densely reticulate with shiny interspaces, sometimes in the middle of mesonotum sculpture diffused and microreticulate. Pronotal dorsum rugulate, lateral sides of pronotum rugocostulate; mesonotal dorsum rugoreticulate, lateral sides rugocostulate; propodeum rugocostulate, area below spines rugomicroreticulate. Entire mesosoma with erect, pale, moderately long and thick setae (Figs 9, 10). **Petiole.** In lateral view, with moderately long peduncle, node low, regularly rounded, with anterior face distinctly concave, whole surface rugoreticulate. Dorsal surface with sparse, short, erect setae. **Postpetiole.** In lateral view regularly convex, sides rounded, on the whole surface rugoreticulate, surface appears less rugose than surface of petiole. Dorsal surface with sparse, moderately long, erect setae (Figs 1, 2). **Gaster.** Smooth and shiny, with erect, thin, pale setae (Figs 9, 10). **Legs.** Legs moderately elongate, femora swollen in the middle, tibiae widened from base to $\frac{3}{4}$ length, surface of legs covered with sparse, adpressed to decumbent hairs.

Etymology. The species name *parnonensis* is masculine and is a Latin singular adjective in the nominative case. The name refers to Parnon Massif, a terra typica for *T. parnonensis*.

Biology. Most of the collecting sites are located in mountainous areas overgrown by Mediterranean oak forest (the eastern slopes of Mt. Parnon), and young and sparse fir forest (rocky northern slopes of Mt. Parnon and Mt. Menalon). The site in Taygetos Mts is located in alpine area above the upper border of the forest zone.

Note. Based on the geographical coordinates given on the labels, latitudes for some of the collecting sites were overestimated. It applies to (label data vs altitude based on coordinates): Mt. Parnon (1200–1400 m vs 550–600 m), Mt Parnos (1700 m vs 1375 m), and Mt Menalon (1700 m vs 1450 m).

***Temnothorax anodontoides* (Dlussky & Zabelin, 1985)**

Figs 13, 14, 16

Leptothorax anodontoides Dlussky & Zabelin, 1985: 227, fig. 5 (w.)

Type material. *Paratype* (ANTWEB1008959). С. Забелин | Копет-Даг | Кара-су, 6.V.81 || 81-171 || Paratypus Leptoth. | anodontoides | Dlussky et Zabelin.

Differential diagnosis. *Temnothorax anodontoides* is the only member of the group with entirely absent propodeal spines. Additionally, it differs from *T. arkasi*, *T. euboae*, and *T. ikarosi* in strongly reduced sculpture on frons, and from *T. parnonensis* in lack of smooth notch on central frons.

Description. Dlussky and Zabelin (1985): 227.

Distribution. Kopet Dag, Turkmenistan.

Comments. Despite literature records noting *T. anodontoides* from Greece (Schulz et al. 2007), we consider its presence in this country as doubtful. By courtesy of Petr



Figures 13, 14. Paratype worker of *Temnothorax anodontoides* Dlussky & Zabelin, 1985. **13** dorsal **14** lateral. Scale bar: 1 mm.



Figures 15, 16. Head sculpture of workers **15** *Temnothorax parnonensis* sp. nov., holotype **16** *Temnothorax anodontoides* Dlussky & Zabelin, 1985, paratype.

Werner (Prague), we had an opportunity to study specimens collected from the site mentioned by Schulz et al. (2007) and compare them with a paratype of *T. anodontoides* and our Greek samples of members of the *anodontoides* species-group. As a result, we concluded that the samples mentioned in the above-mentioned publication should be assigned to *T. arkasi*. There is also a record of *T. anodontoides* from Sheikmosa in Iran (AntWeb.org, CFH000026). The photographs of this specimen certainly show a species belonging to the *anodontoides* species-group. However, its body coloration and presence of very small but distinct propodeal spines could indicate that it represents yet another undescribed species. In conclusion, the distribution of verified *T. anodontoides* is most likely restricted to Kopet Dag mountains in Turkmenistan.

Temnothorax ikarosi Salata, Borowiec & Trichas, 2018

Figs 17, 18

Temnothorax ikarosi Salata, Borowiec & Trichas, 2018: 781, figs 26–30 (w.)

Type material. *Holotype* (w.) (CASENT0845912): *Temnothorax* | *ikarosi* sp. nov. | HOLOTYPE || GREECE, Crete, Lasithi | Prov. Limnakarou Plateau | 1750 m 35°06'N, 25°28'E | 5.8.2000. M. Chatzaki (MNHW).

Differential diagnosis. *Temnothorax ikarosi* differs from *T. parnonensis* in entirely sculptured head and frons lacking smooth patches; from *T. euboae* it differs in elongated petiolar peduncle and triangular propodeal spines; from *T. anodontoides* it differs

in presence of distinct propodeal spines; from *T. arkasi* it differs in less elongate head, sparser and thicker promesonotal sculpture and bigger propodeal spines.

Description. Salata et al. (2018): 781.

Distribution. Limnkarou Plateau, Crete, Greece.



Figures 17, 18. Paratype worker of *Temnothorax ikarosi* Salata, Borowiec & Trichas, 2018. **17** dorsal **18** lateral. Scale bar: 1 mm.

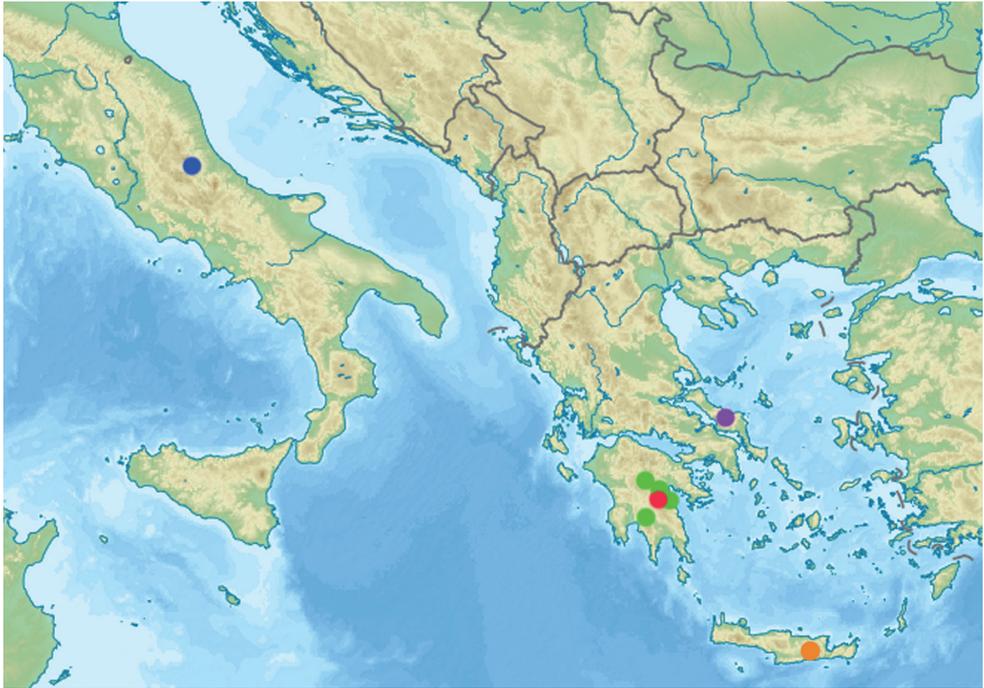


Figure 19. Distribution of members of the *Temnothorax anodontoides* species-group in Europe: *Temnothorax arkasi* (red circle), *T. euboae* (violet circle), *T. ikarosi* (orange circle), *T. parnonensis* (green circles) and *T. saxatilis* (blue circle).

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Revision of the genus *Arthrotus* Motschulsky, 1858 (Coleoptera, Chrysomelidae, Galerucinae) of Taiwan, with notes on color polymorphism

Chi-Feng Lee¹

¹ Applied Zoology Division, Taiwan Agricultural Research Institute, Taichung 413, Taiwan

Corresponding author: Chi-Feng Lee (chifeng@tari.gov.tw)

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Abstract

Seven species of *Arthrotus* are recognized and redescribed: *A. abdominalis* (Chûjô, 1962), *A. gressitti* Kimoto, 1969, *A. hirashimai* Kimoto, 1969, *A. fulvus* Chûjô, 1938, *A. saigusai* Kimoto, 1969, *A. tricolor* (Chûjô, 1965), and *A. testaceus* Gressitt & Kimoto, 1963. Also, two new species are described: *A. yuae* **sp. nov.** and *A. yangi* **sp. nov.** Three new synonyms are proposed: *Proegmena taiwana* Takizawa, 1978 **syn. nov.**, *Dercetina nakanei* Kimoto, 1969 **syn. nov.** and *A. shibatai* Kimoto, 1984 **syn. nov.** Lectotypes are designated for *A. fulvus* Chûjô, 1938 and *Dercestra abdominalis* Chûjô, 1962. Color polymorphism of each species is delimited base on more than 1800 specimens.

Keywords

Dercetina, food plant, leaf beetles, new species, new synonym, nomenclature, taxonomy

Introduction

The genus *Arthrotus* Motschulsky, 1858 includes 48 species from the Palearctic and Oriental regions (Nie et al. 2017). In Taiwan, Chûjô (1938, 1962, 1965) described three species: *A. fulvus* Chûjô, 1938; *A. abdominalis* (Chûjô, 1962); transferred from *Dercestra* by Kimoto (1965), and *A. tricolor* (Chûjô, 1965); transferred from *Dercetis* by Kimoto

(1969). Kimoto (1969, 1984) treated six species: *A. gressitti* Kimoto, 1969, *A. hirashimai* Kimoto, 1969, *A. saigusai* Kimoto, 1969, *A. nakanei* (Kimoto, 1969; transferred from *Dercetina* by Lee and Bezděk (2013)), *A. testaceus* Gressitt & Kimoto, 1963 (newly recorded by Kimoto (1969)), and *A. shibatai*, Kimoto, 1984. Takizawa (1978) described one species as *Proegmena taiwana* which was transferred to *Arthrotus* by Kimoto (1996). In total, ten species have been recorded or described from Taiwan previously (Table 1).

Arthrotus Motschulsky is similar to *Dercetina* Gressitt & Kimoto, 1963, with the following combination of shared characters: pronotum usually with one pair of lateral depressions, basal margin entirely marginate; closed anterior coxal cavity; elytra without setae; tibia of hind leg without one apical spine; first tarsomere of hind leg usually shorter than or subequal to combination of the rest; tarsal claws appendiculate. These genera differ from each other only by the structure of the male antennae: antennomere III is approximately twice as long as antennomere II in *Dercetina*, while antennomeres II and III are subequal in length in *Arthrotus*.

Most members of *Arthrotus* have similar shapes of male aedeagi and great color variation. Species boundaries are hard to determine without sufficient material. Fortunately, adults are collected easily by sweeping. More than 1800 specimens are available for study thanks to collecting efforts by members of the Taiwan Chrysomelid Research Team (TCRT), and borrowed material from several museums (see below).

Table 1. Taxonomic works on species of *Arthrotus* of Taiwan.

Reference	New species, new records, or nomenclatural acts
Chûjô 1938	<i>A. fulvus</i>
Chûjô 1962	<i>Dercestra abdominalis</i>
Chûjô 1965	<i>Dercetis tricolor</i>
Kimoto 1965	<i>A. abdominalis</i> (Chûjô, 1962) comb. nov. (transferred from <i>Dercestra</i>)
Kimoto 1969	<i>A. gressitti</i> , <i>A. hirashimai</i> , <i>A. saigusai</i> , <i>Dercetina nakanei</i> ; <i>A. testaceus</i> Gressitti & Kimoto, 1963 (new record); <i>A. tricolor</i> (Chûjô, 1965) comb. nov. (transferred from <i>Dercetis</i>)
Takizawa 1978	<i>Proegmena taiwana</i>
Kimoto 1984	<i>A. shibatai</i>
Kimoto 1996	<i>A. taiwanus</i> (Takizawa, 1978) comb. nov. (transferred from <i>Proegmena</i>)
Lee and Bezděk 2013	<i>A. nakanei</i> (Kimoto, 1969) comb. nov. (transferred from <i>Dercetina</i>)

Materials and methods

For taxonomic study, the abdomens of adults were separated from the forebodies and boiled in 10% KOH solution, followed by washing in distilled water to prepare genitalia for illustrations. The genitalia were then dissected from the abdomens, mounted on slides in glycerin, and studied and drawn using a Leica M165 stereomicroscope. For detailed examination, a Nikon ECLIPSE 50i microscope was used.

At least three sex pairs from each species were examined to delimit variability of diagnostic characters. For species collected from more than one locality or with color variations, at least one sex pair of specimens from each locality and color morph was

examined. Length was measured from the anterior margin of the eye to the elytral apex, and width at the greatest width of the elytra.

Specimens studied herein are deposited at the following institutes and collections:

BPBM	Bernice P. Bishop Museum, Hawaii, USA [James Boone];
CAS	California Academy of Sciences, California, USA [David H. Kavanaugh];
HTC	Haruo Takizawa private collection;
KMNH	Kitakyushu Museum of Natural History and Human History, Kitakyushu, Japan [Yūsuke Minoshima];
KUEC	Faculty of Agriculture, Kyushu University, Fukuoka, Japan [Osamu Tadauchi];
NMNS	National Museum of Natural Science, Taichung, Taiwan [Jing-Fu Tsai];
OMNH	Osaka Museum of Natural History, Osaka, Japan [Shigehiko Shiyake];
TARI	Applied Zoology Division, Taiwan Agricultural Research Institute, Taichung, Taiwan.

Precise label data are cited for all type specimens of described species; a double slash (//) divides the data on different labels and a single slash (/) divides the data in different rows. Other comments and remarks are in square brackets: [p] – preceding data are printed, [h] – preceding data are handwritten, [w] – white label, [y] – yellow label, [b] – blue label, and [r] – red label.

Taxonomy

Arthrotus abdominalis (Chûjô, 1962)

Figs 1A–C, 2, 3

Dercetis metallica: Chûjô 1935: 169 (nec Weise 1922); misidentification (Chûjô 1962)

Dercestra abdominalis Chûjô, 1962: 166; Chûjô 1965: 93 (additional records).

Arthrotus abdominalis: Kimoto, 1965 (transferred from *Decestra*); Kimoto 1969: 59 (additional records); Kimoto 1986: 58 (additional records); Kimoto 1989: 259 (additional records); Kimoto 1991: 16 (additional records).

Type series. *Lectotype* ♂ (TARI, here designated): “Hatonosawa (Chiuchihtse, 鳩之澤) / Mt. Taiheizan / 23.vii.1940 / FORMOSA / Col. M. CHUJO [p, w] // 2634 [p, w]”. Paralectotypes. 2♂, 1♀ (TARI), same holotype but with “2635–2637 [p, w]” respectively; 1♀ (TARI): “RAISYA (in Chaozhou, 潮州) / 30-VIII-1927 / J. Sonan [p, w] // 1910 [p, w]”; 2♀: “Formosa / Karenko (= Hualien, 花蓮), -19. / VII 20-VIII 4 / T. Okuni. [p, w] // 1911, 2155 [respectively, p, w]”; 1♂ (head detached, glued on another card) (TARI): “(明治) 41[h]年[p]4[h]月[p]20[h]日[p] (= 20.IV.1908) / Kuaru (= Kueitzychiao, 龜子角) [h, w, in Japanese] // Nitobe [p, w] // 2150 [p, w]”; 1♂ (TARI): “18/ IV 1910 / Kammon [h] (in Hualien, 花蓮) / Col. I. Nitobe [p, w] // 2151 [p, w]”; 1♂,

2♀ (TARI): “Formosa / Musha (= Wushe, 霧社), 1919. / V 18 – VI 15. / T. Okuni [p, w] // 2152–2154 [respectively, p, w]”; 1♂, 1♀ (TARI, with heads lost): “Takeyama (= Chushan, 竹山) / 17.IV.1928 / Coll. R. Takahashi [p, w] // 2156, 2157 [respectively, p, w]”; 1♀ (TARI): “KUSKUS (typed as Kusukusu in the original description, = Kaoshih, 高士) / 18.III.1930 / Col. T. Shiraki (typed wrongly as “R. Takahashi”) [p, w] // 2158 [p, w]”; 1♀ (TARI): “Taihorin (= Talin, 大林) / Formosa / H. Sauter, 1911 [p, w] // 7.VII. [p, w] // Dercetes [sic!] / *metallica* WEISE [h] / DET. M. CHUJO [p, b] // 2607 [p, w]”; 1♀ (TARI): “Kankau (Koshun (= Henchun, 恆春)) / Formosa / H. Sauter V. 1912 [p, w] // 7.IV. [p, w] // Dercetes [sic!] / *metallica* WEISE [h] / DET. M. CHUJO [p, b] // 2608 [p, w]”; 1♂ (TARI): “Kankau (Koshun (= Henchun, 恆春)) / Formosa / H. Sauter V.(22) (indicated in the original description). 1912 [p, w] // Dercetes [sic!] / *metallica* WEISE [h] / DET. M. CHUJO [p, b] // 2609 [p, w]”; 1♂ (TARI): “Kosempo (= Chiasien, 甲仙) / Formosa / H. Sauter 1912 [p, w] // 22.V. [p, w] // Dercetes [sic!] / *metallica* WEISE [h] / DET. M. CHUJO [p, b] // 2610 [p, w]”; 1♀ (TARI): “Shinsuiei [sic!] (Shinsuiei = Chinshuiying, 浸水營, typed as “Sinsuiei” in the original description) / 16.III.1926 / S. Issiki [p, w] // 2611 [p, w]”; 1♂ (only head, prothorax, and part of elytra and abdomen left, TARI): “Taihoku (= Taipei, 台北) / FORMOSA / 5.VII.1941/ T. KAGEYAMA [p, w] (this card was not shown in the original description) // KuSukusu (= Kaoshih, 高士) / 25.III.1926 / S. Issiki [p, w] // 2612 [p, w]”; 1♂, 2♀ (TARI): “URAI [h] (= Wulai, 烏來) / FORMOSA [p] / 28.III.1932 [h] / COL. M. CHUJO [p, w] // 2613–2615 [respectively, p, w]”; 2♀ (TARI): “Shiigao (= Maopu, 茅圃) Chikuto (= Chutung, 竹東) / SHINCHIKU / 27–30.VI.1934 (typed wrongly as “May 27 to 30, 1934” in the original description) Col. M. CHUJO [p, w] // 2616, 2617 [respectively, p, w]”; 1♀ (TARI): “KUARU [h] (= Kueitzuchiaio, 龜子角) / FORMOSA / 14.VI.1937 [h] / COL. M. CHUJO [p, w] // 2618 [p, w]”; 1♀ (TARI): “KUARU [h] (= Kueitzuchiaio, 龜子角) / FORMOSA / 15.VI.1937 (typed wrongly as “1938” in the original description) [h] / COL. M. CHUJO [p, w] // 2619 [p, w]”; 2♂, 1♀ (TARI): “RIMOGAN [h] (= Fushan, 福山) / FORMOSA [p] / 5.IV.1940 [h] / COL. M. CHUJO [p, w] // 2620–2622 [respectively, p, w]”; 1♂, 1♀ (TARI): “TYAKON [h] (扎亞孔, near Wulai, 烏來) / FORMOSA [P] / 5.IV.1940 [h] / COL. M. CHUJO [p, w] / 2623, 2624 [respectively, p, w]”; 2♂, 5♀ (TARI): “TIPON [h] (= Chihpen, 知本) / FORMOSA [p] / 13.VI.1940 [h] / COL. M. CHUJO [p, w] // 2625–2631 [respectively, p, w]”; 1♂ (TARI): “Hakurei (= Pailing, 白嶺) / Mt. Taiheizan / FORMOSA / 16.vii.1940 / Col. M. CHUJO [p, w] // 2632 [p, w]”; 1♂ (TARI): “Hatonosawa (= Chiuchihtse, 鳩之澤) / Mt. Taiheizan / 22.vii.1940 / FORMOSA / Col. M. CHUJO [p, w] // 2633 [p, w]”; 1♂, 1♀ (TARI): “Miharasi (= Chiencheng, 見晴) / Kubayan (= Kupaiyang, 古白楊) - / Karenio-tyo / FORMOSA / 16.viii.1940 / Col. M. CHUJO [p, w] // 2638, 2639 [respectively, p, w]”; 1♀ (TARI): “TAIWAN / HASSENZAN [p] (= Pahsienshan, 八仙山) / 4.VI.1942 [h] / A. MUTUURA [p, w] // 加保台 (Kahodai = Chiapaotai) – 黎明 (Reimei = Liming) [h, on the back of the same card] / 2640 [p, w]” 5♀ (TARI): “TIPON [h] (= Chihpen, 知本) / FORMOSA [p] / 8.V.1943 [h] / COL. M. CHUJO [p, w] // 2386, 2387, 2641–2643 [respectively, p, w]”. All specimens bear two additional cards: “CO / Type [p, w, circle label with yellow letters and border] // Dercetra / abdominalis / CHÛJÔ [h] / DET. M. CHUJO [p, w]”.

Other material. A total of 316 specimens was examined (Suppl. material 1).

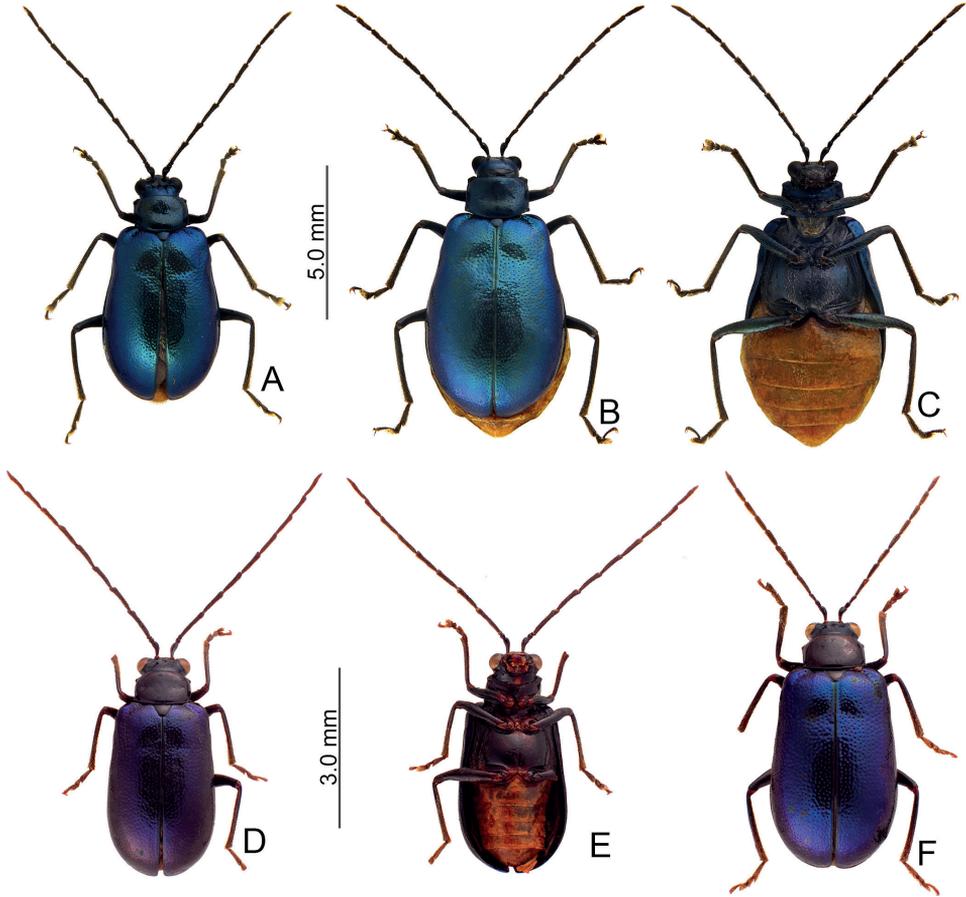


Figure 1. Habitus of *Arthrotus abdominalis* (Chûjô) and *A. gressitti* Kimoto **A** *A. abdominalis*, male, dorsal view **B** *A. abdominalis*, female, dorsal view **C** *A. abdominalis*, female, ventral view **D** *A. gressitti*, male, dorsal view **E** *A. gressitti*, male, ventral view **F** *A. gressitti*, female, dorsal view.

Diagnosis. Adults of *Arthrotus abdominalis* (Chûjô) (Fig. 1A–C) are similar to those of *A. gressitti* Kimoto (Fig. 1D–F), *A. hirashimai* Kimoto (Fig. 6A–C), and *A. yuae* sp. nov. (Fig. 6D–F) in possessing metallic blue elytra with a transverse depression at basal third (various elytra without transverse depression in other congeners), and straight lateral margins of the pronotum (rounded lateral margins of the pronotum in other congeners). Adults of this species is easily recognized by their metallic blue head, thorax, and legs (Fig. 1A–C) (black head, thorax, and legs in *A. gressitti* (Fig. 1D–F); yellowish brown head, thorax, and legs in *A. hirashimai* and *A. yuae* sp. nov. (Fig. 6)); and more slender antennae, anternomeres V–VIII $> 5.5 \times$ longer than wide ($< 5.5 \times$ longer than wide in other congeners), tectum of aedeagus covered with stout teeth (Fig. 2C) (covered with needle-shaped setae laterally in *A. gressitti* (Fig. 4C); covered with short needle-shape laterally and stout teeth apically in *A. hirashimai* (Fig. 7C)), apex of aedeagus curved (Fig. 2D) (apex of aedeagus recurved in *A. yuae* sp. nov. (Fig. 8D)), and widely separated

apices of gonocoxae (Fig. 2E) (narrowly separated apices of gonocoxae in other congeners (Figs 4E, 7E, 8E)).

Redescription. Color metallic blue, antennae and legs black, abdomen yellow (Fig. 1A–C). Pronotum with transverse depression behind middle; dull, with reticulate microsculpture; with sparse, fine punctures confused with a few coarse punctures; lateral margins straight; apical and basal margins slightly concave. Elytra with rounded lateral margins, widest at apical 1/3; disc shiny, without reticulate microsculpture, and with dense, coarse punctures, and transverse depression at basal 1/3.

Male. Length 6.2–7.6 mm, width 3.2–4.5 mm. Antennae filiform (Fig. 2B), antennomere III modified, much shorter than II, IV–VII apically widened, length ratios of antennomeres I–XI 1.0: 0.4: 0.2: 2.0: 1.9: 1.9: 1.9: 1.8: 1.7: 1.5: 1.8, length to width ratios of antennomeres I–XI 2.7: 1.3: 0.9: 5.3: 5.8: 5.8: 6.0: 6.3: 6.2: 5.9: 7.7. Pronotum 1.5–1.6 × wider than long. Elytra 1.4–1.5 × longer than wide. Aedeagus (Fig. 2C, D) extremely slender, ~ 7.7 × longer than wide, parallel-sided, basally widened, apex nar-

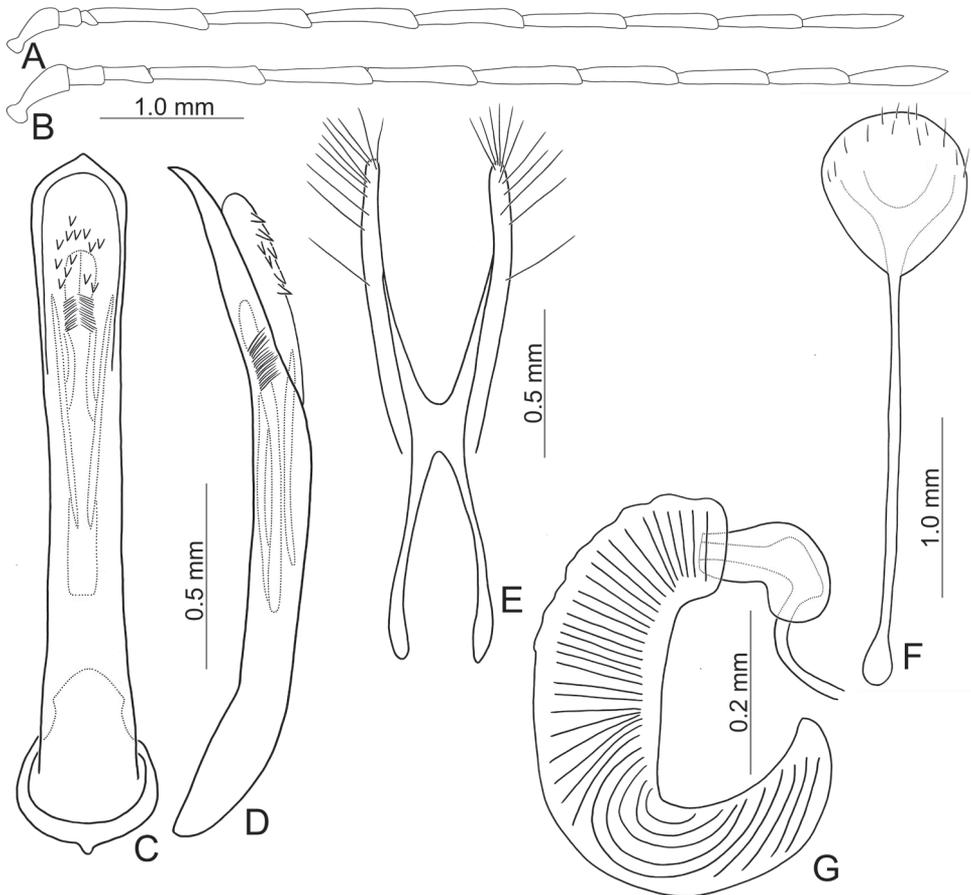


Figure 2. Diagnostic characters of *Arthrotus abdominalis* (Chùjò) **A** antenna, male **B** antenna, female **C** aedeagus, dorsal view **D** aedeagus, lateral view **E** gonocoxae **F** abdominal ventrite VIII **G** spermatheca.

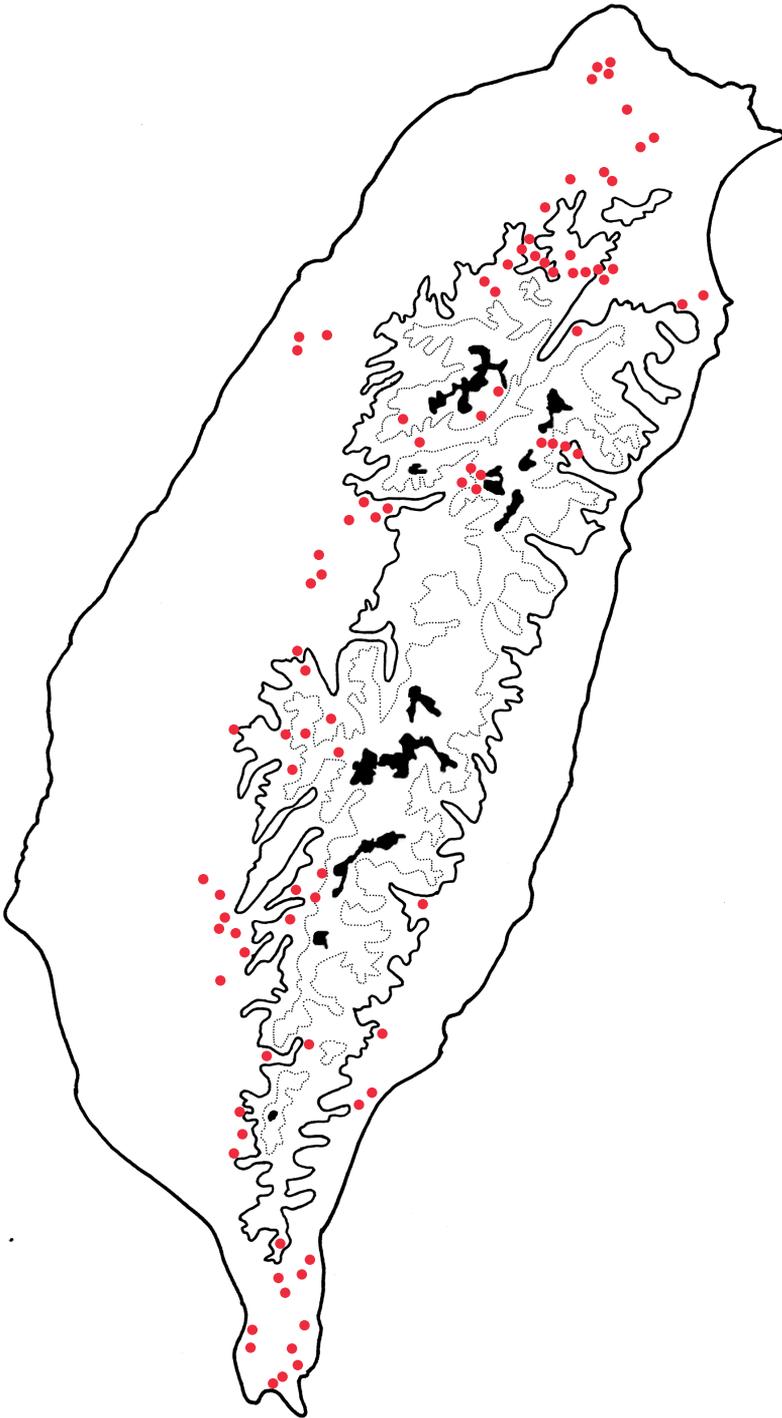


Figure 3. Distribution map of *Arthrotus abdominalis* (Chùjō), solid line: 1000 m, broken line: 2000 m, black areas: 3000 m.

rowly rounded; tectum membranous, with scattered small, stout setae; weakly curved in lateral view; primary endophallic sclerite elongate, $\sim 0.4 \times$ as long as aedeagus, bifurcate, with a cluster of dense setae near apex, deeply bifurcate from apical 1/3 to base; a pair of dorsal sclerites present, longitudinal and slender, $0.7 \times$ as long as primary sclerite.

Female. Length 7.8–9.2 mm, width 3.9–5.1 mm. Antennae similar to those of males, but antennomere III slightly longer than II in females (Fig. 2B), length ratios of antennomeres I–XI 1.0: 0.5: 0.6: 1.6: 1.6: 1.5: 1.5: 1.4: 1.3: 1.1: 1.4, length to width ratios of antennomeres I–XI 2.6: 1.9: 2.7: 5.9: 6.2: 5.9: 5.9: 5.7: 5.7: 5.0: 5.3. Pronotum $1.5 \times$ wider than long. Elytra 1.3 – $1.5 \times$ longer than wide. Ventricle VIII (Fig. 2F) weakly sclerotized laterally and apically, apical margin widely rounded, with scattered setae along lateral and apical margin, spiculum extremely slender. Receptacle of spermatheca (Fig. 2G) slightly swollen, undivided from pump; pump narrow and moderately curved, apex broadly rounded; sclerotized proximal spermathecal duct wide and short, shallowly projecting into receptaculum. Gonocoxae (Fig. 2E) narrowly connected at middle, $\sim 3.4 \times$ longer than wide, curved inwards at apical 1/3, with one long seta at apical 1/3, ten additional setae at apical areas.

Food plants. Adults feed on leaves of *Quercus glauca* var. *glauca* Thunb. (Fagaceae), *Hydrangea chinensis* Maxim. (Hydrangeaceae), *Persicaria chinensis* (L.) H. Gross (Polygonaceae), *Prunus campanulata* Maxim. (Rosaceae), *Zelkova serrata* (Thunb.) Makino (Ulmaceae), and *Debregeasia orientalis* C.J. Chen (Urticaceae).

Distribution. *Arthrotus abdominalis* is a common, widespread species in lowlands (below 1500 m) of Taiwan (Fig. 3).

Arthrotus gressitti Kimoto, 1969

Figs 1D–F, 4, 5

Arthrotus gressitti Kimoto, 1969: 61.

Types. Paratypes. 2♀ (BPBM): “FORMOSA / Hassenzan (= Pasienshan, 八仙山) / VI [p] 26 [h] 1934 / L. Gressitt [p, w] // L. Gressitt / Collection [p, w] // PARATOPOTYPE [p, b] // *Arthrotus* / *gressitti* / Kimoto, n. sp. [h, w]”. Holotype could be deposited at the BPBM but was not found.

Other material (n = 21). 1♂, 1♀ (BPBM), same data as paratypes; 3♂, 2♀ (BPBM), same but with “VI 24 1934”; 1♀ (KMNH), same locality, 29.V.1971, leg. K. Kamiya; Nantou: 2♂, 8♀ (HTC), Habonsan (合望山 = 北東眼山), 2.VIII.1985, leg. H. Takizawa; 1♂ (HTC), Hotsu (廬山, = Lushan), 6.VII.1983, leg. H. Takizawa; 3♀ (HTC), Nanshanchi (南山溪), 31.VII.1985, leg. H. Takizawa.

Diagnosis. Adults of *Arthrotus gressitti* Kimoto (Fig. 1D–F) are similar to those of *A. abdominalis* (Chùjò) (Fig. 1A–C), *A. hirashimai* Kimoto (Fig. 6A–C), and *A. yuae* sp. nov. (Fig. 6D–F) in possessing metallic blue elytra with a transverse depression at basal 1/3 (various elytra without transverse depression in other congeners), and straight lateral margins of the pronotum (rounded lateral margins of the pronotum in other congeners). Adults of this species is easily recognized by the black head, thorax, and legs

(Fig. 1D–F) (metallic blue head, thorax, and legs in *A. abdominalis* (Fig. 1A–C); yellowish brown head, thorax, and legs in *A. hirashimai* and *A. yuae* sp. nov. (Fig. 6)); and less slender antennae, antennomeres V–VIII $< 5.5 \times$ longer than wide ($> 5.5 \times$ longer than wide in *A. abdominalis*), tectum of aedeagus covered with needle-shaped setae laterally (Fig. 4C) (covered with stout teeth in *A. abdominalis* (Fig. 2C) and *A. yuae* sp. nov. (Fig. 8C)); covered with short needle-shape laterally and stout teeth apically in *A. hirashimai* (Fig. 7C)), apex of aedeagus curved (Fig. 4D) (apex of aedeagus recurved in *A. yuae* sp. nov. (Fig. 8D)), and narrowly separated apices of gonocoxae (Fig. 4E) (widely separated apices of gonocoxae in *A. abdominalis* (Fig. 2E)).

Redescription. Color blackish brown, elytra metallic blue, abdomen yellow (Fig. 1D–F). Pronotum with median transverse depression; dull, with reticulate micros-

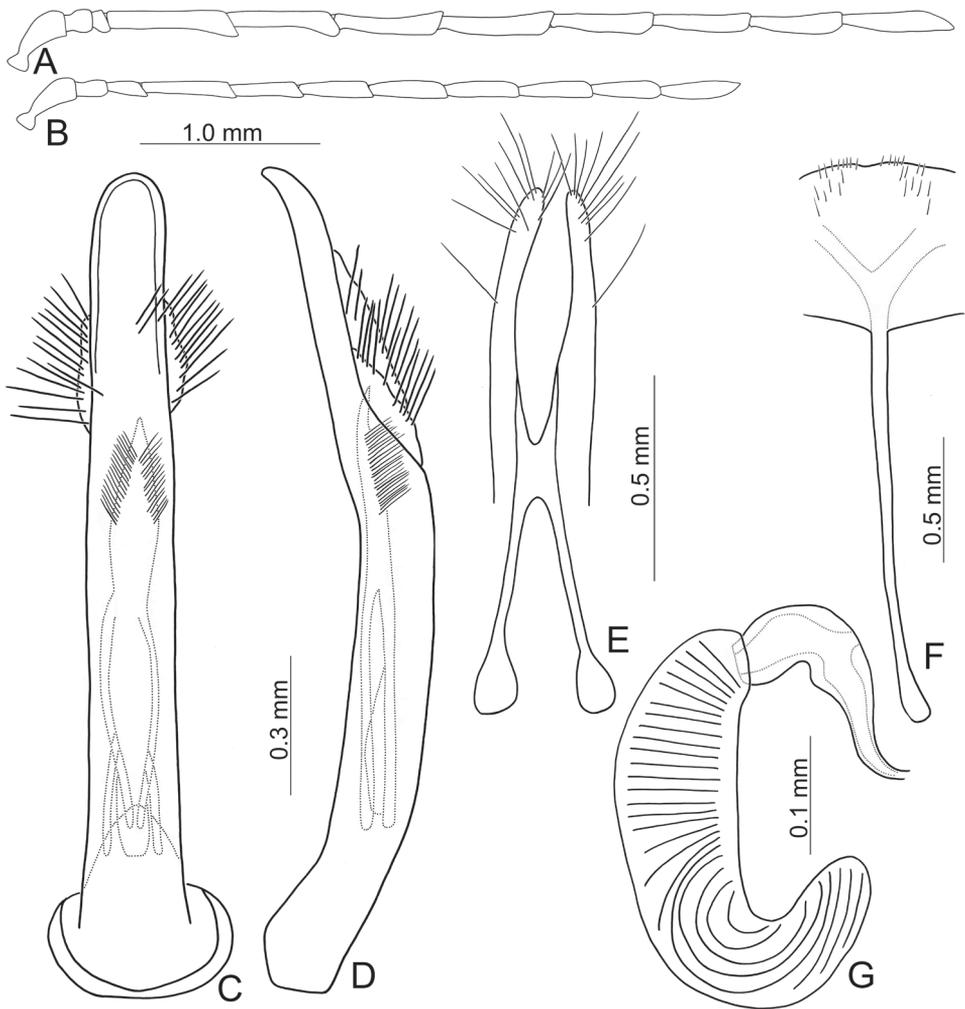


Figure 4. Diagnostic characters of *Arthrotus gressitti* Kimoto **A** antenna, male **B** antenna, female **C** Aedeagus, dorsal view **D** aedeagus, lateral view **E** gonocoxae **F** abdominal ventrite VIII **G** spermatheca.

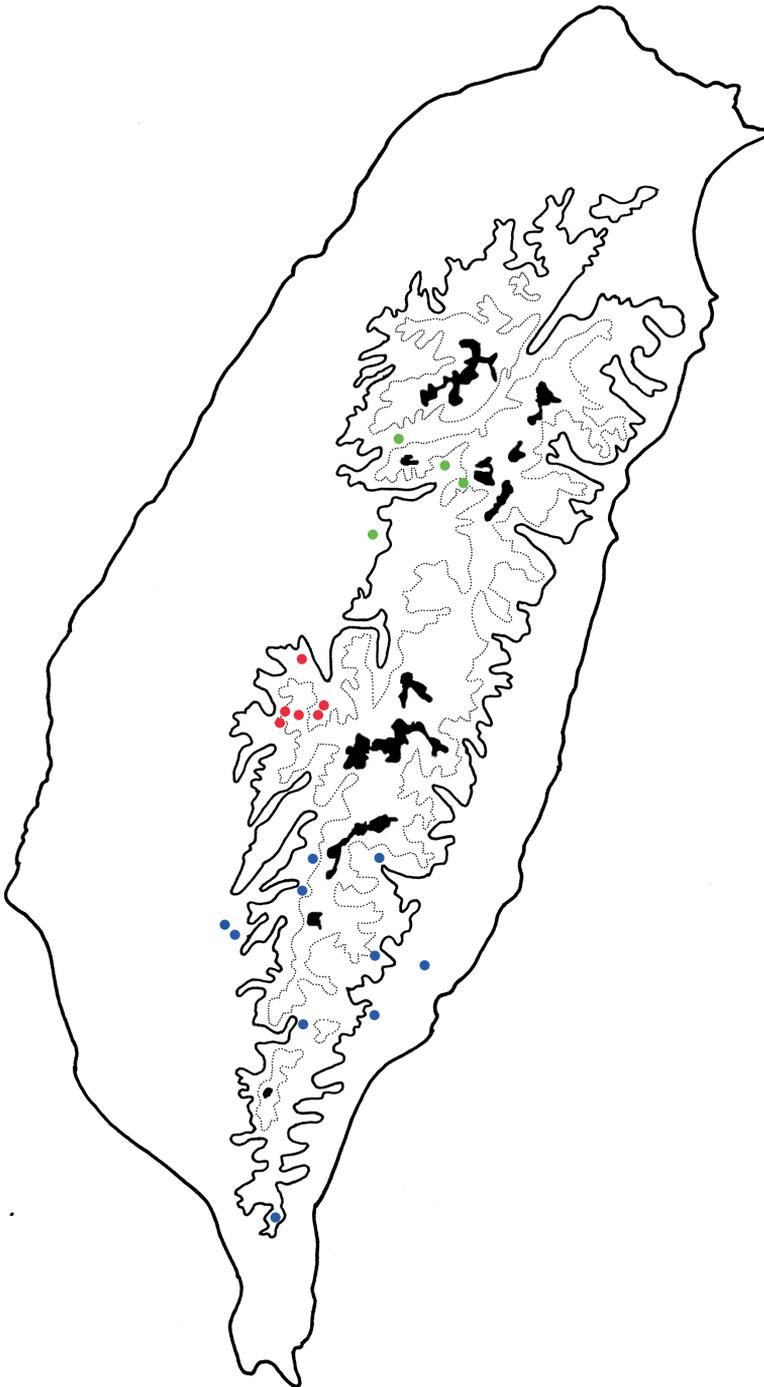


Figure 5. Distribution map of *Arthropus gressitti* Kimoto, *A. hirashimai* Kimoto, and *A. yuae* sp. nov., solid line: 1000 m, broken line: 2000 m, black areas: 3000 m. Key: green dots *A. gressitti*, red dots *A. hirashimai*, blue dots *A. yuae* sp. nov.

culpture; with sparse, fine punctures confused with a few coarse punctures; lateral margins straight, basally narrowed; apical and basal margins slightly concave. Elytra with rounded lateral margins, widest at apical 1/3; disc shiny, without reticulate microsculpture, and with dense, coarse punctures, and a feeble, transverse depression at basal 1/3.

Male. Length 5.9–6.6 mm, width 2.8–3.0 mm. Antennae filiform (Fig. 4A), antennomere III modified, much shorter than II, IV–VII apically widened, length ratios of antennomeres I–XI 1.0: 0.4: 0.2: 1.8: 1.6: 1.5: 1.6: 1.4: 1.4: 1.3: 1.6, length to width ratios of antennomeres I–XI 2.6: 1.1: 0.7: 4.6: 4.0: 4.2: 4.9: 4.6: 4.9: 4.6: 5.4. Pronotum 1.5 × wider than long. Elytra 1.6 × longer than wide. Aedeagus (Fig. 4C, D) extremely slender, ~ 9.6 × longer than wide, parallel-sided, slightly narrowed at apical 1/4, basally widened, apex widely rounded; tectum membranous, covered with needle-shaped setae laterally; weakly curved in lateral view, apex truncate; primary endophallic sclerite elongate, ~ 0.5 × as long as aedeagus, apex pointed, with a cluster of dense setae near apex, deeply bifurcate from middle to base; a pair of dorsal sclerites longitudinally and apically connected with primary sclerite.

Female. Length 7.4–7.9 mm, width 3.6 mm. Antennae (Fig. 4B) much shorter than in males, antennomere III slightly longer than II, length ratios of antennomeres I–XI 1.0: 0.4: 0.5: 1.3: 1.0: 1.0: 1.1: 1.1: 1.0: 1.0: 1.2, length to width ratios of antennomeres I–XI 3.0: 1.9: 2.2: 5.8: 4.4: 4.1: 4.6: 4.6: 4.2: 4.1: 4.8. Pronotum 1.5–1.6 × wider than long. Elytra 1.5–1.6 × longer than wide. Ventricle VIII (Fig. 4F) membranous, apically truncate with shallow median depression, with scattered long setae at sides and short setae along apical margin, spiculum extremely slender. Receptacle of spermatheca (Fig. 4G) slightly swollen, undivided from pump; pump narrow and moderately curved, apex broadly rounded; sclerotized proximal spermathecal duct wide and short, shallowly projecting into receptaculum. Gonocoxae (Fig. 4E) narrowly connected at middle, ~ 5.0 × longer than wide, curved inwards at apical 1/3, with one long seta at apical 1/3, and nine or ten additional setae at apical areas.

Food plants. Unknown.

Distribution. Adults have been collected from several localities of central Taiwan, including Pasienshan (八仙山) in Taichung county; Peitungyanshan (北東眼山), Lushan (廬山), and Nanshanchi (南山溪) in north Nantou county (Fig. 5).

Arthrotus hirashimai Kimoto, 1969

Figs 5, 6A–C, 7

Arthrotus hirashimai Kimoto, 1969: 60.

Proegmena taiwana Takizawa, 1978: 125. syn. nov.

Arthrotus taiwana: Kimoto 1996: 40 (transferred from *Proegmena*); Kimoto and Takizawa, 1997: 390 (catalogue).

Types. *Arthrotus hirashimai*. **Holotype** ♂ (KUEC): "(Taiwan) / 5–10 km S of Fen-chihu (奮起湖), Chiayi Hsien [p, w] // 11 [h] .iv.1965 / Y. Hirashima [p, w] // Japan-U. S. / Co-op. Sci. / Programme [p, y] // *Arthrotus* / *hirashimai* / Kimoto, n. sp. [h,

w] // HOLOTYPE [p, r]”. **Paratype:** 1♀ (KMNH), same data as holotype but with “PARATOPOTYPE [p, b]”.

Proegmena taiwana. The male holotype and one male paratype should be deposited at the Hokkaido University but were not found (Takemoto pers. comm., 23 Sept 2021). Two paratypes were deposited at the Takizawa’s private collection. 1♀

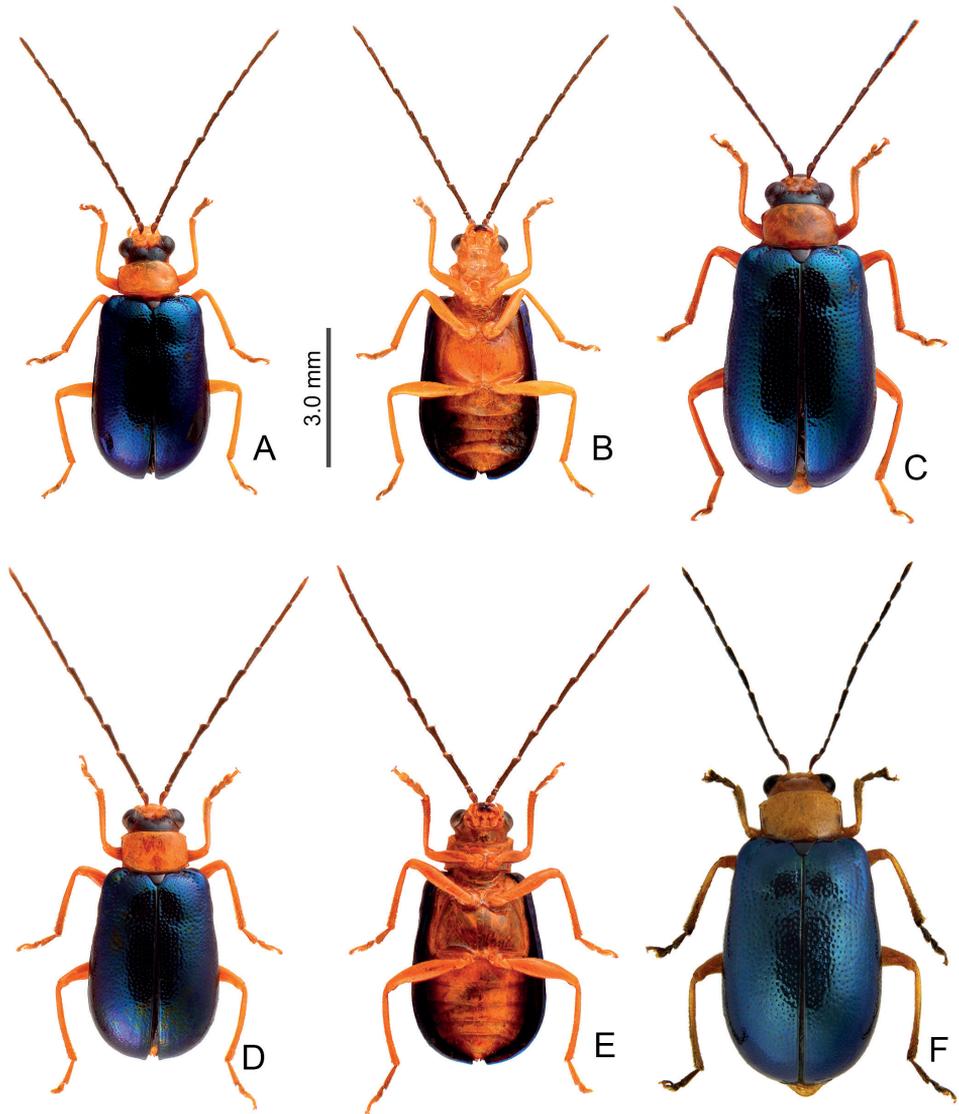


Figure 6. Habitus of *Arthrotus hirashimai* Kimoto and *A. yuae* sp. nov. **A** *A. hirashimai*, male, dorsal view **B** *A. hirashimai*, male, ventral view **C** *A. hirashimai*, female, dorsal view **D** *A. yuae* sp. nov., male, dorsal view **E** *A. yuae* sp. nov., male, ventral view **F** *A. yuae* sp. nov., female, dorsal view.

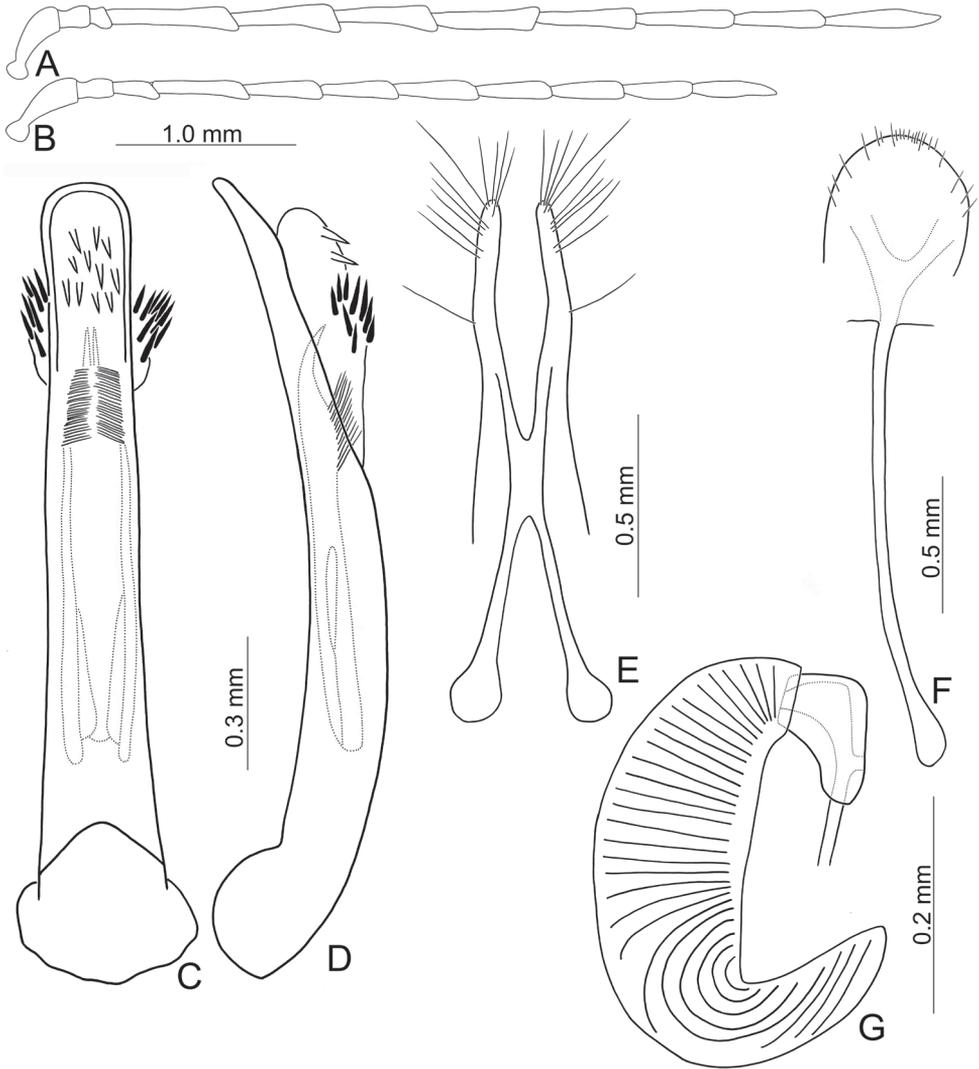


Figure 7. Diagnostic characters of *Arthrotus hirashimai* Kimoto **A** antenna, male **B** antenna, female **C** aedeagus, dorsal view **D** aedeagus, lateral view **E** gonocoxae **F** abdominal ventrite VIII **G** spermatheca.

(HTC): “Chitou (溪頭) Chu- / shan (竹山) Taiwan / 6–7.VII.1975 / H. Takizawa [p, w] // Paratype [h, red letter] // Proegmena / taiwana n. sp. [h] / para-T [h, red letters] 197[p]7.2[h] / Det. H. Takizawa [p, w] (on the back of the same card)”; 1♂ (HTC): “(male aedeagus glued on the card) // Chitou (溪頭) Chu- / shan (竹山) Taiwan / 6–7.VII.1975 / H. Takizawa [p, w] // PARATYPE (?) / Proegmena / taiwana [h, w] // 2021.X.15 / H. Takizawa / det. [p, w] (on the back of the same card). However, both paratypes should be females based on the original description (Takizawa 1978).

Other material ($n = 40$). TAIWAN. Chiayi: 3♂, 1♀ (TARI), Alishan (阿里山), 29.V.2016, leg. Y.-T. Chung; 3♂, 2♀ (TARI), same but with “leg. B.-X. Guo; 1♀ (TARI), Fenchiu (奮起湖), 25.V.1981, leg. K. Sasagawa; 3♀ (HTC), same locality, 11–12.VII.1981, leg. H. Takizawa; 1♀ (TARI), Tutzuhu trail (杜仔湖步道), 1.VI.2014, leg. W.-C. Liao; Nantou: 1♂ (TARI), Hsitou (溪頭), 15.VI.2011, leg. C.-F. Lee; 2♂ (TARI), Tungfu (同富), 9.VI.2009, leg. C.-F. Lee; 1♂, 3♀ (HTC), Tongpu (= Tungpu, 東埔), 5–10.VII.1977, leg. H. Takizawa; 2♀ (HTC), same but with “6–8.VII.1981”; 2♂, 6♀ (HTC), same but with “16–18.VII.1995”; 3♂, 5♀ (TARI), same locality, 19–23.VII.1982, leg. L. Y. Chou & T. Lin; 1♀ (TARI), same locality, 20–24.VI.1983, leg. K. C. Chou & C. Y. Wong.

Diagnosis. Adults of *Arthrotus hirashimai* Kimoto (Fig. 6A–C) are similar to those of *A. abdominalis* (Chûjô) (Fig. 1A–C), *A. gressitti* Kimoto (Fig. 1D–F), and *A. yuae* sp. nov. (Fig. 6D–F) in possessing metallic blue elytra with transverse depression at basal 1/3 (various elytra without transverse depression in other congeners), and straight lateral margins of the pronotum (rounded lateral margins of the pronotum in other congeners). Adults of *A. hirashimai* (Fig. 6A–C) and *A. yuae* sp. nov. (Fig. 6D–F) are recognized by their yellowish-brown heads, thoraces, and legs (metallic blue head, thorax, and legs in *A. abdominalis* (Fig. 1A–C); black head, thorax, and legs in *A. gressitti* (Fig. 1D–F)); and less slender antennae, antennomeres V–VIII < 5.5 × longer than wide (> 5.5 × longer than wide in *A. abdominalis*). Males of *A. hirashimai* are different from those of *A. yuae* sp. nov. by the tectum of the aedeagus being covered with short needle-shaped setae laterally and stout teeth apically (Fig. 7C) (covered with stout teeth in *A. yuae* sp. nov. (Fig. 8C)), and apex of aedeagus curved (Fig. 7D) (apex of aedeagus recurved in *A. yuae* sp. nov. (Fig. 8D)). In addition, both species are allopatric. Adults of *A. hirashimai* are found at mid-elevations (1000–2500 m) of central Taiwan while those of *A. yuae* sp. nov. are restricted to lowlands (below 1500 m) of southern Taiwan (Fig. 5).

Redescription. Body color yellowish brown, elytra metallic blue, antennae black, vertex darkened in most of individuals (Fig. 6A–C). Pronotum with median transverse depression; dull, with reticulate microsculpture; with sparse, fine punctures confused with a few coarse punctures; lateral margins straight, basally narrowed; apical and basal margins slightly concave. Elytra with rounded lateral margins, widest at apical 1/3, disc shiny, without reticulate microsculpture, and with dense, coarse punctures, with distinct transverse depression at basal 1/3.

Male. Length 5.6–6.4 mm, width 2.6–2.7 mm. Antennae filiform (Fig. 7A), antennomere III modified, much shorter than II, IV–VII apically widened, length ratios of antennomeres I–XI 1.0: 0.4: 0.3: 1.6: 1.4: 1.3: 1.4: 1.3: 1.3: 1.2: 1.5, length to width ratios of antennomeres I–XI 2.9: 1.6: 0.9: 4.8: 3.6: 3.8: 4.4: 4.5: 5.2: 5.4: 6.1. Pronotum 1.5–1.6 × wider than long. Elytra 1.6 × longer than wide. Aedeagus (Fig. 7C, D) extremely slender, ~ 10.2 × longer than wide, parallel-sided, slightly narrowed at apical 1/4, basally widened, apex widely rounded; tectum membranous, sides covered with densely, well-sclerotized, stout setae; weakly curved in lateral view, apex recurved; primary endophallic sclerite elongate, ~ 0.8 × as long as aedeagus, apex pointed, with a

cluster of dense setae near apex, deeply bifurcate from middle to base; a pair of dorsal sclerite longitudinal and apically connected with primary sclerite.

Female. Length 6.1–7.2 mm, width 2.8–3.4 mm. Antennae (Fig. 7B) much shorter than in males, antennomere III slightly longer than II, length ratios of antennomeres I–XI 1.0: 0.4: 0.5: 1.1: 1.0: 0.9: 1.0: 0.9: 0.9: 0.8: 1.0, length to width ratios of antennomeres I–XI 3.2: 1.9: 2.4: 5.1: 4.4: 4.2: 4.6: 4.3: 4.2: 4.1: 5.3. Pronotum 1.5–1.6 × wider than long. Elytra 1.6–1.7 × longer than wide. Ventricle VIII (Fig. 7F) membranous, apical widely rounded, with scattered long setae at sides and along apical margin, and dense short setae at apical margin; spiculum extremely slender. Receptacle of spermatheca (Fig. 7G) slightly swollen, undivided from pump; pump narrow and moderately curved, apex truncate; sclerotized proximal spermathecal duct wide and short, shallowly projecting into receptaculum. Gonocoxae (Fig. 7E) narrowly connected at middle, ~ 6.2 × longer than wide, curved inwards at apical 1/3, with one long seta at apical 1/3, nine additional setae at apical areas.

Food plants. Unknown.

Distribution. Adults are restricted to several localities at mid-elevations of central Taiwan, including Hsitou (溪頭), Tungfu (同富), and Tungpu (東埔) in south Nantou county; Alishan (阿里山), Fenchiu (奮起湖), and Tutzuhu trail (杜仔湖步道) in Chiayi county (Fig. 5).

***Arthrotus yuae* sp. nov.**

<http://zoobank.org/0F41557E-694E-4820-AEF8-2D77436D6D27>

Figs 5, 6D–F, 8

Type series (n = 160). **Holotype** ♂ (TARI): TAIWAN. Pingtung: Tahanshan (大漢山), 25.V.2013, leg. Y.-T. Chung. Paratypes. TAIWAN. Kaohsiung: 1♀ (TARI), Chungchihkuan (中之關), 13.X.2012, leg. L.-P. Hsu; 1♂ (KMNH), 溪南山 (= Shinanshan), 20.IV.1991, leg. W. Chen; 1♀ (TARI), Tona trail (多納林道), 13.X.2012, leg. W.-C. Liao; 2♂ (HTC), Wukongshan (五公山), 2.V.1996, leg. H. Takizawa; 1♀ (TARI), Wutai (霧台), 19.V.2009, leg. U. Ong; Pingtung: 1♀ (TARI), T(D)ahanshan (大漢山), 24.VI.2007, leg. C.-F. Lee; 2♂, 7♀ (TARI), same but with “18.VII.2007”; 4♂, 1♀ (TARI), same but with “25.V.2008”; 1♂ (TARI), same but with “4.IV.2009”; 16♂, 13♀ (TARI), same but with “6.VI.2012”; 2♂, 18♀ (TARI), same but with “19.VII.2012”; 2♀ (TARI), same locality, 18.VII.2007, leg. M.-H. Tsou; 2♀ (TARI), same but with “20.VII.2007”; 3♂, 6♀ (TARI), same but with “4.VII.2008”; 1♀ (TARI), same locality, 18.VII.2007, leg. S.-F. Yu; 2♀ (TARI), same but with “20.VII.2007”; 3♀ (TARI), same but with “4.VII.2008”; 1♀ (TARI), same locality, 18.V.2009, leg. M.-L. Jeng; 2♀ (TARI), same locality, 28.VI.2009, leg. Y(I).-T. Chung; 2♀ (TARI), same but with “14.VIII.2011”; 1♀ (TARI), same but with “6.VII.2012”; 1♀ (TARI), same but with “5.VIII.2012”; 1♂ (TARI), same but with “16.IV.2013”; 2♂ (TARI), same but with “24.IV.2013”; 4♂, 1♀ (TARI), same but with “5.V.2013”; 1♂ (TARI), same but with “10.V.2013”; 2♂, 5♀ (TARI), same but with 25.V.2013”; 1♂, 1♀ (TARI), same but

with “2.VI.2013”; 3♀ (TARI), same but with “2.VII.2013”; 3♀ (TARI), same but with “9–10.VII.2013”; 1♀ (TARI), same but with “30.VII.2013”; 5♂ (TARI), same but with “30.V.2014”; 1♂ (TARI), same but with “6.VI.2014”; 1♀ (TARI), same but with “17.VIII.2014”; 1♀ (TARI), same but with “14.IX.2014”; 1♀ (TARI), same but with “4.X.2014”; 1♀ (TARI), same but with “6.VI.2015”; 1♀ (TARI), same but with “29.VI.2018”; 5♀ (TARI), same locality, 14.VIII.2011, leg. Y.-T. Wang; 1♀ (TARI), same locality, 4–5.VI.2013, leg. K. Takahashi; 1♂, 3♀ (TARI), same locality, 29.VI.2013, leg. B.-X. Guo; 3♀ (TARI), same but with “3.VII.2013”; 2♀ (TARI), same locality, 13.VI.2015, leg. W.-C. Liao; 1♀ (TARI), same but with “28.VI.2015”; Taitung: 1♂ (TARI), Lichia (trail) (利嘉(林道)), 19.V.2009, leg. U. Ong; 1♀ (TARI), same locality, 15.VII.2014, leg. B.-X. Guo; 2♀ (TARI), same locality, 17.VII.2014, leg. W.-T. Wang; 2♀ (TARI), same locality, 25.VII.2015, leg. Y.-T. Chung, P.-H. Kuo (= B.-X. Guo) & S.-P. Wu; 2♀ (TARI), same locality, 1.VII.2016, leg. C.-C. Chen; 1♀ (TARI), same but with “leg. B.-X. Guo”; 1♀ (TARI), Liyuan (栗園), 23.VI.2010, leg. M.-H. Tsou; 1♂ (TARI), same locality, 19.VI.2013, leg. C.-F. Lee; 2♀ (TARI), Tulanshan (都蘭山), leg. S.-P. Wu; 1♀ (TARI), Yanping trail (延平林道), 5.VII.2016, leg. S.-P. Wu.

Diagnosis. Adults of *Arthrotus yuae* sp. nov. (Fig. 6D–F) are similar to those of *A. abdominalis* (Chûjô) (Fig. 1A–C), *A. gressitti* Kimoto (Fig. 1D–F), and *A. hirashimai* Kimoto (Fig. 6A–C) in possessing metallic blue elytra with a transverse depression at basal 1/3 (various elytra without transverse depression in other congeners), and straight lateral margins of the pronotum (rounded lateral margins of the pronotum in other congeners). Adults of *A. yuae* sp. nov. (Fig. 6D–F) and *A. hirashimai* (Fig. 6A–C) are recognized by their yellowish brown heads, thoraxes, and legs (metallic blue head, thorax, and legs in *A. abdominalis* (Fig. 1A–C); black head, thorax, and legs in *A. gressitti* (Fig. 1D–F)); and less slender antennae, antennomeres V–VIII < 5.5 × longer than wide (> 5.5 × longer than wide in *A. abdominalis*). Males of *A. yuae* sp. nov. differ from those of *A. hirashimai* by the tectum of the aedeagus being covered with stout teeth (Fig. 8C) (covered with short needle-shape laterally and stout teeth apically in *A. hirashimai* (Fig. 7C)), and apex of aedeagus recurved (Fig. 8D) (apex of aedeagus curved in *A. hirashimai* (Fig. 7D)). In addition, both species are allopatric. Adults of *A. yuae* sp. nov. are restricted to lowlands (below 1500 m) of south Taiwan while those of *A. hirashimai* are found at mid-elevations (1000–2500 m) of central Taiwan (Fig. 5).

Description. Color (Fig. 6D–F) yellowish brown, elytra metallic blue, antennae black, vertex darker in a few individuals. Pronotum with median transverse depression reduced, dull, with reticulate microsculpture; with sparse fine punctures confused with a few coarse punctures; lateral margins straight, basally narrowed; apical and basal margins slightly concave. Elytra with rounded lateral margins, widest at apical 1/3; disc shiny, without reticulate microsculpture, and with dense, coarse punctures, with distinct transverse depression at basal 1/3.

Male. Length 5.7–7.0 mm, width 2.8–3.4 mm. Antennae filiform (Fig. 8A), antennomere III modified, much shorter than II, IV–VII apically widened, length ratios of antennomeres I–XI 1.0: 0.4: 0.2: 1.8: 1.6: 1.6: 1.6: 1.5: 1.4: 1.4: 1.8, length to width

ratios of antennomeres I–XI 3.1: 1.3: 0.7: 4.8: 3.7: 4.3: 4.2: 5.1: 5.8: 5.8: 8.4. Pronotum 1.5–1.6 × wider than long. Elytra 1.5–1.6 × longer than wide. Aedeagus (Fig. 8C, D) extremely slender, ~ 8.8 × longer than wide, parallel-sided, slightly narrowed at apical 1/4, basally widened, apex widely rounded; tectum membranous, covered with dense, well-sclerotized, stout setae, and clustered elongate setae laterally; weakly curved in lateral view, apex narrowly rounded; primary endophallic sclerite elongate, ~ 0.5 × as long as aedeagus, apex pointed, with a cluster of dense setae near apex, deeply bifurcate from middle to base; a pair of dorsal sclerites longitudinally and apically connected with primary sclerite.

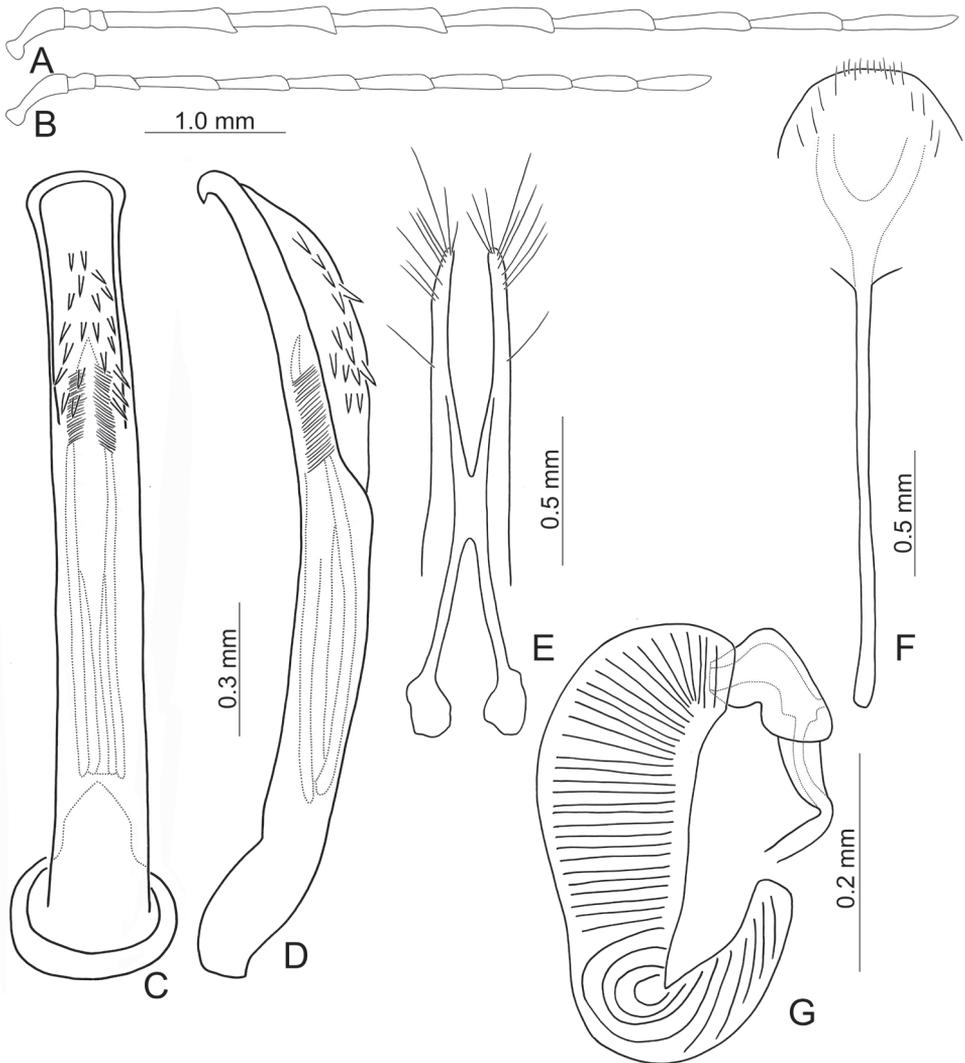


Figure 8. Diagnostic characters of *Arthrotus yuae* sp. nov. **A** antenna, male **B** antenna, female **C** aedeagus, dorsal view **D** aedeagus, lateral view **E** gonocoxae **F** abdominal ventrite VIII **G** spermatheca.

Female. Length 6.0–7.7 mm, width 3.3–3.9 mm. Antennae much shorter than in males, antennomere III a little longer than II (Fig. 4C), length ratios of antennomeres I–XI 1.0: 0.4: 0.6: 1.2: 1.0: 1.0: 1.1: 1.0: 1.0: 0.8: 1.1, length to width ratios of antennomeres I–XI 3.5: 1.7: 3.4: 6.3: 5.1: 4.8: 4.8: 4.6: 4.6: 4.1: 4.9. Pronotum 1.5 × wider than long. Elytra 1.5 × longer than wide. Ventricle VIII (Fig. 8F) membranous, apical margin widely rounded, with scattered long setae at sides and along apical margin, and dense, short setae at apical margin; spiculum extremely slender. Receptacle of spermatheca (Fig. 8G) slightly swollen, undivided from pump; pump narrow and moderately curved, apex broadly rounded; sclerotized proximal spermathecal duct wide and short, shallowly projecting into receptaculum. Gonocoxae (Fig. 8E) narrowly connected at middle, ~ 5.4 × longer than wide, curved inwards at apical 1/3, with one long seta at apical 1/3, ten additional setae at apical areas.

Food plants. Leaves of *Achyranthes bidentata* Blume (Amaranthaceae), and *Prunus phaeosticta* var. *phaeosticta* (Hance) Maxim. (Rosaceae).

Distribution. Adults are restricted to several localities at lowlands of southern Taiwan including Chungchihkuan (中之關), Shinanshan (溪南山), Tona trail (多納林道), and Wutai (霧台) in Kaohsiung county; Tahanshan (大漢山) in Pingtung county; Lichia trail (利嘉林道), Liyuan (栗園), Tulanshan (都蘭山), and Yanping trail (延平林道) in Taitung county (Fig. 5).

Etymology. Dedicated to Mrs Su-Fang Yu (余素芳) who was the first member of TCRT to collect specimens of this new species.

Arthrotus fulvus Chûjô, 1938

Figs 9–13

Arthrotus fulvus Chûjô, 1938: 139; Kimoto 1987: 190 (additional records); Kimoto 1989: 259 (additional records); Kimoto 1991: 16 (additional records).

Arthrotus testaceus: Kimoto 1969: 60 (part).

Dercetina nakanei Kimoto, 1969: 65. syn. nov.

Arthrotus nakanei: Lee and Bezděk 2013: 28 (transferred from *Dercetina*).

Types. *Arthrotus fulvus*. Lectotype ♀ (TARI) here designated for clarifying its species identity which was confused with *A. testaceus*, labeled: “ЧИПОН (= Chihpen, 知本) [h] / FORMOSA [p] / 25.III.1935 [h] / COL. M. CHUJO [p, w]”; CO / Type [p, w, circle label with yellow letters and yellow border] // *Arthrotus / fulvus / ЧЪЪЪ [h] / DET. M. CHUJO [p, w] // 1369 [p, w]*. Paralectotypes. 1 ♀ (TARI): “Formosa / Koshun (= Henschun, 恆春), 1918 / IV 25–V 25. / J. Sonan, [p, w] // CO / Type [p, w, circle label with yellow letters and yellow border] // *Arthrotus / fulvus / ЧЪЪЪ [h] / DET. M. CHUJO [p, w] // 2589 [p, w]*”; 1 ♂ (TARI, lacking head): “Formosa / Shinchiku (= Hsinchu, 新竹), -18 / VII 1–30, / J. Sonan, // CO / Type [p, w, circle label with yellow letters and yellow border] // *Arthrotus / fulvus / ЧЪЪЪ [h] / DET. M. CHUJO [p, w] // 1495 [p, w]*”

Dercetina nakanei. Types were studied by Lee and Bezděk (2013).

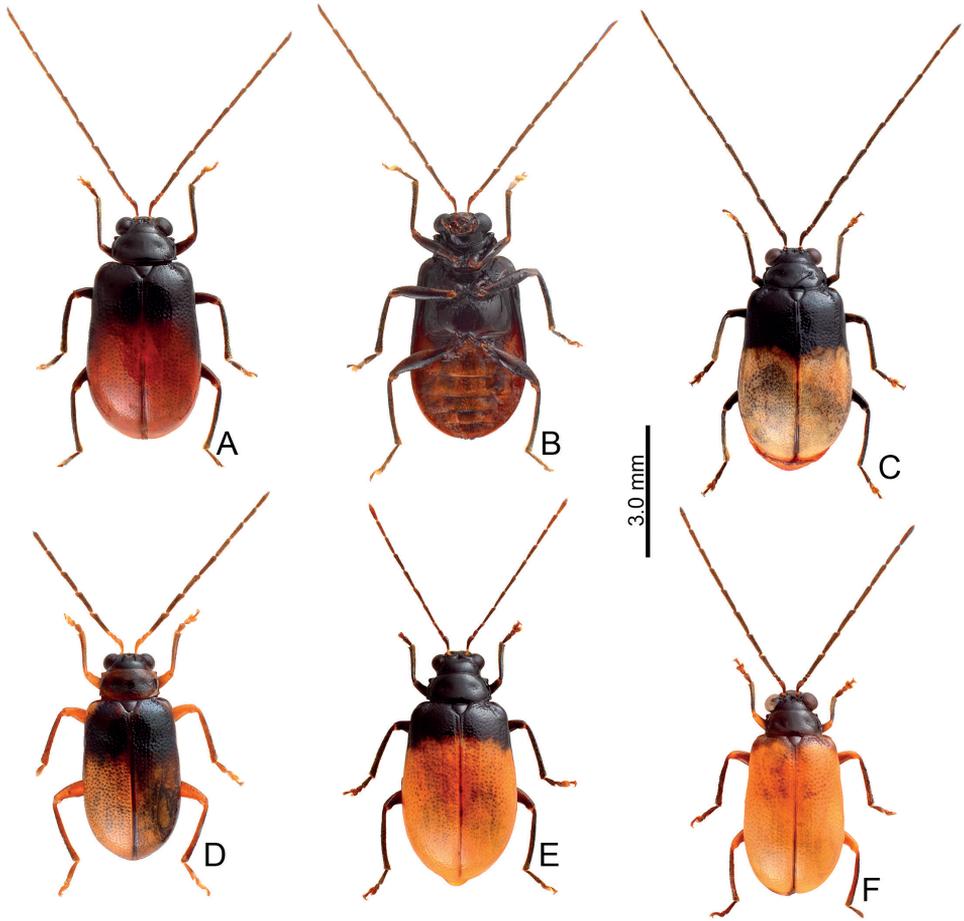


Figure 9. Habitus of *Arthrotus fulvus* Chûjô **A** collected from Kuanwu (觀霧), male, dorsal view **B** collected from Kuanwu (觀霧), male, ventral view **C** collected from Tzuchung (自忠), male, dorsal view **D** collected from Tungfu (同富), male, dorsal view **E** collected from Motien (摩天), female, dorsal view **F** collected from Motien (摩天), male, dorsal view.

Other material. A total of 603 specimens was examined (Suppl. material 2).

Diagnosis. Adults of *Arthrotus fulvus* Chûjô are similar to those of *A. tricolor* (Chûjô) in possessing rounded lateral margins of their pronota (straight lateral margins in *A. abdominalis* (Chûjô), *A. gressitti* Kimoto, *A. hirashimai* Kimoto, and *A. yuae* sp. nov.), the less transverse pronotum and elytra, $1.7\text{--}2.0 \times$ wider and long in pronotum and $1.5\text{--}1.6 \times$ longer than wide in elytra (more transverse pronotum and elytra, $2.1\text{--}2.2 \times$ wider and long and $1.4 \times$ longer than wide in elytra of *A. testaceus* Gressitt & Kimoto and *A. yangi* sp. nov.), the more transverse antennomere III in males, $0.7\text{--}0.8 \times$ longer than wide (Fig. 12A) (the less transverse antennomere III in males, $1.1 \times$ longer than wide in *A. saigusai* Kimoto (Fig. 16A)). Adults of *A. fulvus* (Figs 9–11) are different from those of *A. tricolor* in the absence of the characteristic color patterns of

A. tricolor (Fig. 19), tectum of aedeagus with one pair of apical tube-like processes and disc covered with scattered short setae (Fig. 12C, D) (without pairs of apical tube-like processes and disc covered with clustered stout setae in *A. tricolor* (Fig. 20C, D).

Redescription. Some color patterns characteristic and restricted to particular areas.

Form A (described as *A. nakanei*) (Fig. 9A, B): color black, abdomen and apical 2/3 of elytra reddish brown. **Form B** (Fig. 9C): similar to Form A, but reddish brown areas replaced with white ones; some with reddish brown head and pronotum (Fig. 9D); some specimens with black areas replaced with reddish brown; some specimens with yellowish brown legs, apical and basal areas of pronotum, one pair of yellow spots on humeral calli, sometimes surrounding scutellum, which is also yellow. **Form C** (Fig. 9E): similar to Form B, but white areas replaced with orange spots; some adults similar to Form C

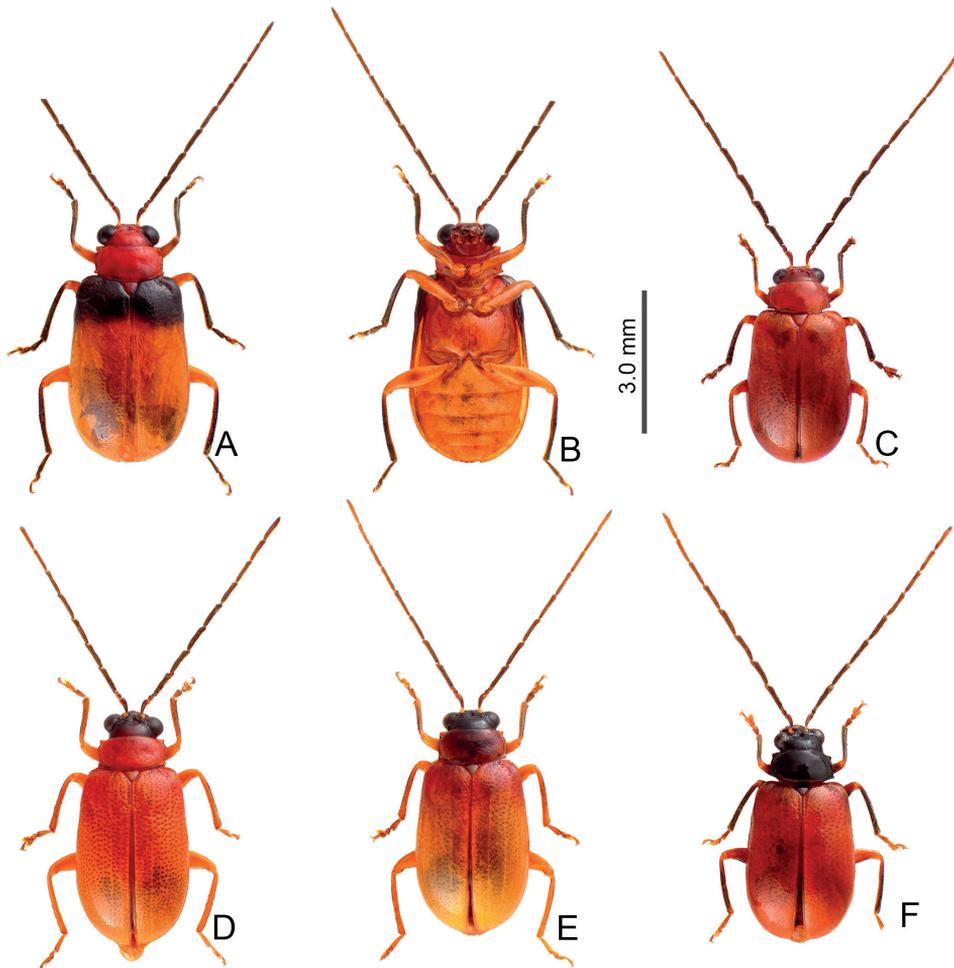


Figure 10. Habitus of *Arthrotus fulvus* Chûjô **A** collected from Liyuan (栗園), male, dorsal view **B** collected from Liyuan (栗園), male, ventral view **C** collected from Tengchih (藤枝), male, dorsal view **D** collected from Tahanshan (大漢山), male, dorsal view **E** collected from Tahanshan (大漢山), male, dorsal view **F** collected from Erhchituan (二集團), male, dorsal view.

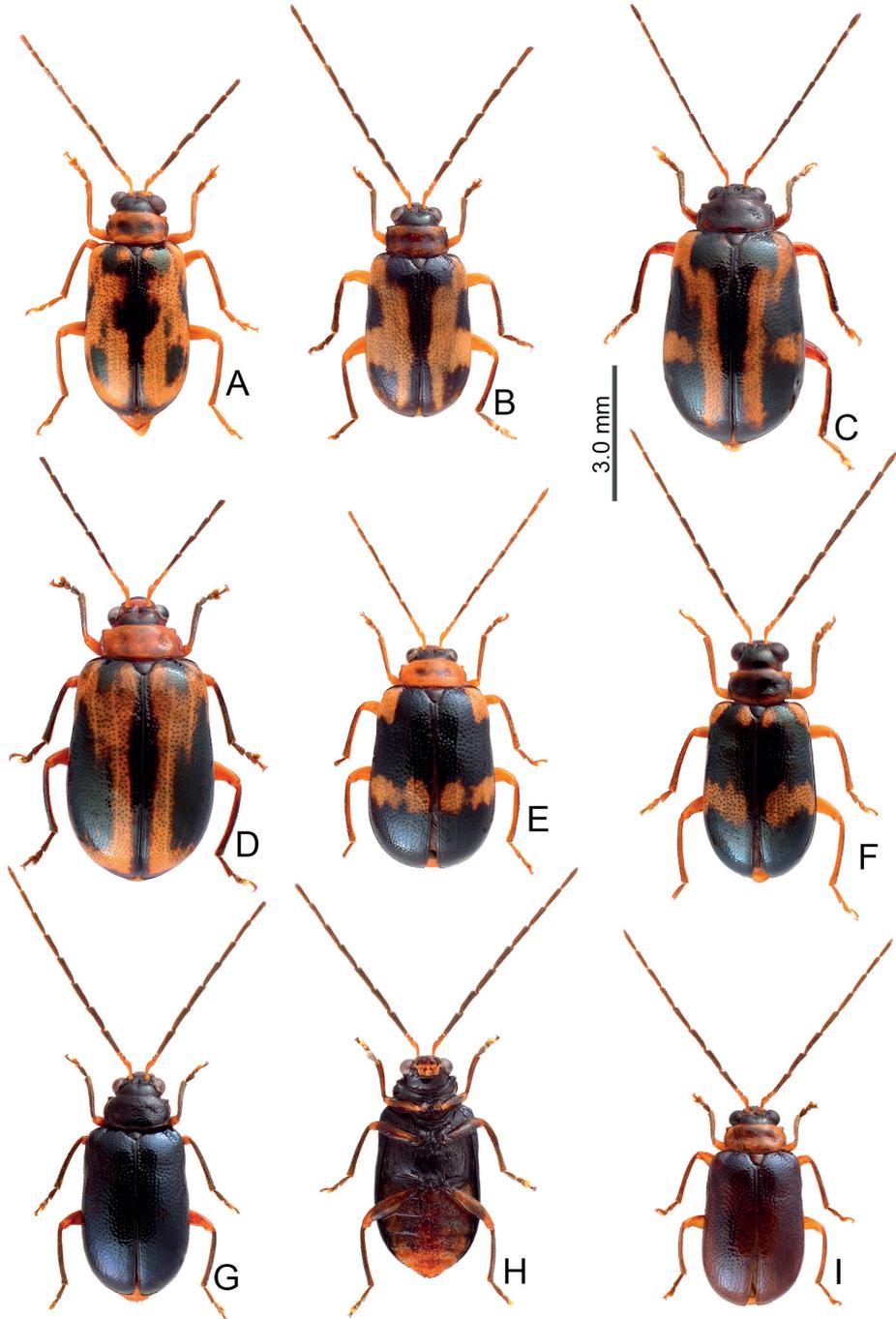


Figure 11. Habitus of *Arthrotus fulvus* Chûjô **A** collected from Motien (摩天), male, dorsal view **B** collected from Chenghsipao (鎮西堡), male, dorsal view **C** collected from Pilu (碧綠), female, dorsal view **D** collected from Taipingshan (太平山), female, dorsal view **E** collected from Wufeng (五峰), female, dorsal view **F** collected from Chungchihkuan (中之關), male, dorsal view **G** collected from Tsuifeng (翠峰), male, dorsal view **H** collected from Tsuifeng (翠峰), male, ventral view **I** collected from Meifeng (梅峰), male, dorsal view.

but with yellowish brown femora and almost entirely yellow elytra except basal area (Fig. 9F); some similar to Form C, but head, pronotum, and scutellum reddish brown, legs entirely black or yellow except tibiae and tarsi (Fig. 10A, B). **Yellowish or reddish brown elytra:** some adults with entirely yellow or reddish brown bodies except antenna (Fig. 10C); sometimes heads darker (Fig. 10D); some with dark head, pronotum dark brown centrally, elytra reddish brown basally (Fig. 10E); some adults with black heads, pronota, and scutella, and tibiae and tarsi darker (Fig. 10F). **Maculate or metallic blue elytra:** Pale individuals have dark brown vertex, blackish brown spots on sides of pronotum, some extending onto most of the pronotum, black stripes along lateral and basal margins of elytra, with additional dark spots near base, and near lateral margin at basal and basal 1/3, near suture at middle (Fig. 11A); sometimes dark spots near suture at

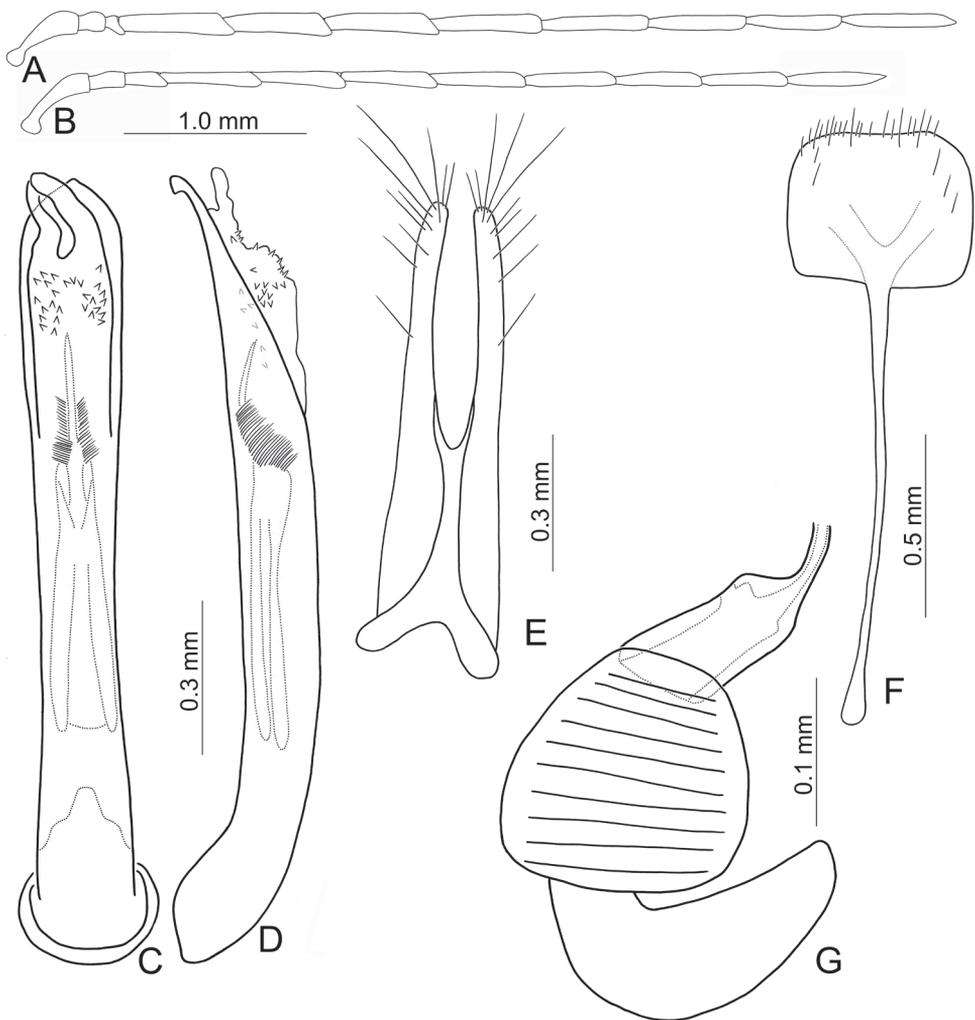


Figure 12. Diagnostic characters of *Arthrotus fulvus* Chûjô **A** antenna, male **B** antenna, female **C** aedeagus, dorsal view **D** aedeagus, lateral view **E** gonocoxae **F** abdominal ventrite VIII **G** spermatheca.

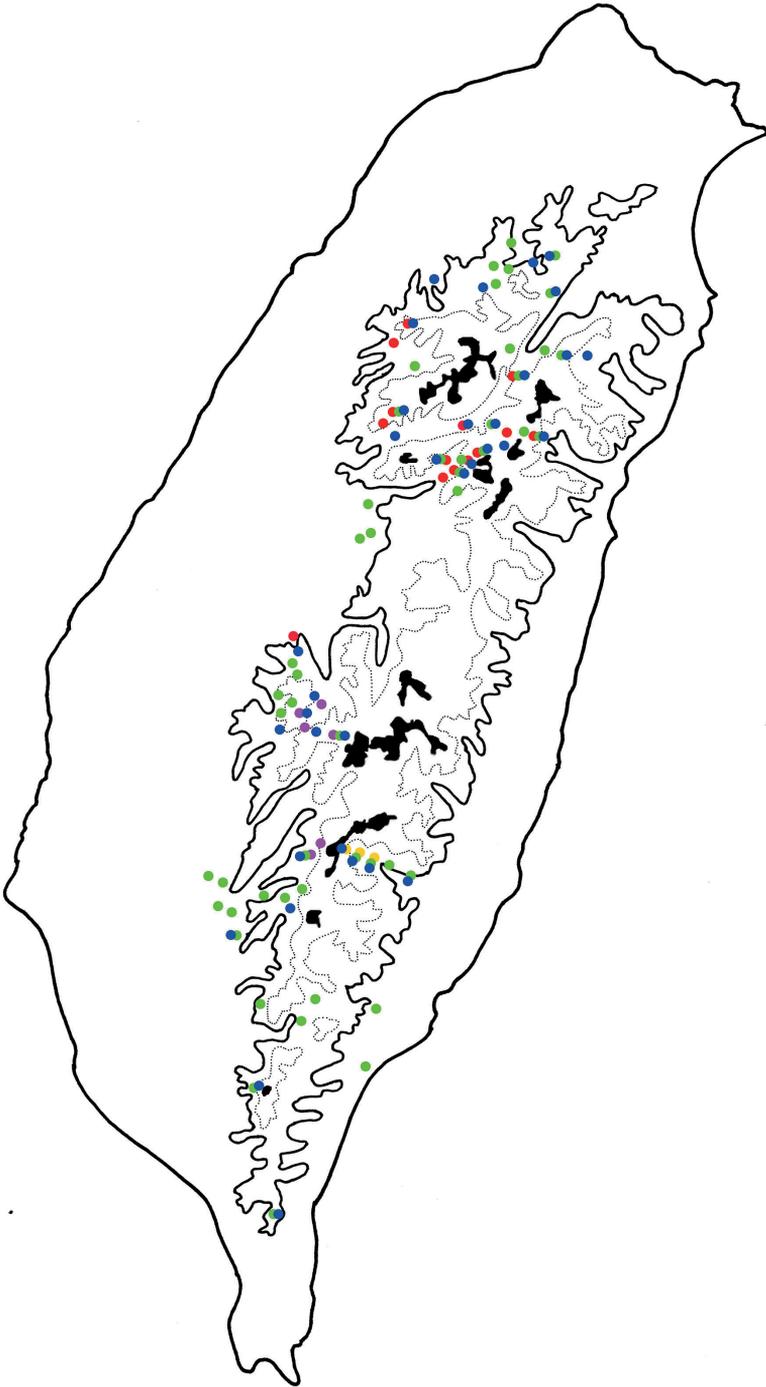


Figure 13. Distribution map of *Arthrotus fulvus* Chûjô; solid line: 1000 m, broken line: 2000 m, black areas: 3000 m. Key: red dots Form A, pink dots Form B, yellow dots Form C, green dots yellowish or reddish brown elytra, blue dots maculate or metallic blue elytra.

middle reduced and black stripes along suture widened (Fig. 11B); sometimes anterior and posterior spots at sides widened (Fig. 11C), some individuals with both (Fig. 11D). Dark individuals with metallic blue elytra with one or two pairs yellow spots along basal margin and transverse yellow stripes at middle (Fig. 11E, F). Some entirely metallic blue, but antennae (except three basal antennomeres) and legs blackish brown and abdomen yellow (Fig. 11G, H); some with yellowish brown bodies, but elytra entirely metallic blue; antennae except three basal antennomeres, tibiae, and tarsi dark or blackish brown (Fig. 11I). Pronotum with median transverse depression; shiny, without reticulate microsculpture; with sparse coarse punctures confused; lateral margins rounded, widest at middle; apical and basal margins slightly concave. Elytra parallel-sided; disc shiny, without reticulate microsculpture, and with dense, coarse punctures.

Male. Length 5.1–5.4 mm, width 2.5–2.8 mm. Antennae filiform (Fig. 12A), antennomere III shorter than II, IV–VII relatively wider, length ratios of antennomeres I–XI 1.0: 0.3: 0.2: 1.3: 1.3: 1.3: 1.4: 1.3: 1.2: 1.1: 1.4, length to width ratios of antennomeres I–XI 3.5: 1.4: 0.7: 4.5: 4.3: 4.8: 5.6: 7.2: 6.7: 6.4: 8.4. Pronotum 1.9–2.0 × wider than long. Elytra 1.5–1.6 × longer than wide. Aedeagus (Fig. 12C, D) extremely slender, ~ 10.8 × longer than wide, slightly narrowed medially; tectum membranous, covered with weakly sclerotized, tiny setae; weakly curved in lateral view, apex recurved; primary endophallic sclerite elongate, ~ 0.5 × as long as aedeagus, with a cluster of dense setae near apex; deeply bifurcate from middle to base.

Female. Length 5.4–6.3 mm, width 2.6–3.3 mm. Antennae (Fig. 12B) much more slender than in males, antennomere III slightly longer than II, length ratios of antennomeres I–XI 1.0: 0.4: 0.4: 1.2: 1.1: 1.1: 1.1: 1.1: 1.0: 1.0: 1.2, length to width ratios of antennomeres I–XI 4.2: 2.9: 2.4: 6.2: 5.6: 5.6: 6.2: 6.2: 6.3: 6.3: 6.8. Pronotum 1.7–1.9 × wider than long. Elytra 1.5–1.6 × longer than wide. Ventrite VIII (Fig. 12F) weakly sclerotized, apical margin truncate, with sparse, short setae along apical margin, and sparse, long setae in inner transverse row; spiculum extremely slender. Receptacle of spermatheca (Fig. 12G) strongly swollen, divided from pump; pump narrow and moderately curved, apex narrowly rounded; sclerotized proximal spermathecal duct wide and short, shallowly projecting into receptaculum. Gonocoxae (Fig. 12E) connected from base to middle, ~ 5.0 × longer than wide, curved inwards apically, with one short seta at apical 1/3, nine additional setae at apical areas.

Remarks. One specimen collected from Penpuchi (本部溪) was misidentified as *A. testaceus* by Kimoto (1969).

Host plants. Leaves of *Acer insulare* Hayata var. *caudatifolium* (Hayata) S.Y. Lu & Y.P. Yang (Sapindaceae), *Alnus formosana* (Burkill) Makino (Betulaceae), *Stachyurus himalaicus* Hook. f. & Thomson (Stachyuraceae), and *Persicaria chinensis* (L.) H. Gross (Polygonaceae).

Distribution. *Arthrotus fulvus* is widespread from lowlands to mid-elevations of Taiwan. Adult color forms A, B, and C are allopatric. Members of form A were collected from central Taiwan, including Hsinchu, Ilan, Hualien, north Nantou, and Taichung counties; color form B from southwest Taiwan, including south Nantou, Chiayi, and Kaoshiung counties; color form C from southeast Taiwan only, including

Taitung county. Most adults with yellowish or reddish brown elytra were collected from lowlands, while most adults with maculate or metallic blue elytra were from mid-elevations (Fig. 13).

***Arthrotus saigusai* Kimoto, 1969**

Figs 14–16, 17A, B, 18

Arthrotus saigusai Kimoto, 1969: 62; Kimoto 1987: 190 (additional records).

Arthrotus fulvus: Kimoto 1989: 259 (part).

Types. *Holotype* ♂ (KUEC): “[Formosa] / Tung-pu (東埔) / Tzu-chung (自忠) / 10.IV.1965 . T. Saigusa [h, w] // HOLOTYPE [p, r] // *Arthrotus* / *saigusai* / Kimoto, n. sp. [h, w]”. *Paratype*: 1♂ (KMNH): “(TAIWAN) / Tonp;ogoe (= Tungpu, 東埔) / 2500 m / Kagi-ken / 2. IV. 1967 / T. Shirozu [p, w] // *Arthrotus* / *saigusai* / Kimoto, n. sp. [h, w] // PARATYPE [p, b]”.

Other material. Yellowish brown form (n = 114): TAIWAN. Chiayi: 1♀ (HTC), 阿里山 (Alishan), 23–24.IV.1928, leg. Matsumura; 1♀ (KMNH), Yushan (玉山), 19.V.1981, leg. N. Ito; Hualien: 3♀ (HTC), Taruling (= Tayuling, 大禹嶺), 9.VII.1983, leg. H. Takizawa; 3♂ (NMNS), same locality, 25.VI.2008, leg. H.-H. Lin; Kaohsiung: 26♂, 11♀ (TARI), Kuanshan Wind Gap (關山啞口), 24.IX.2015, leg. C.-F. Lee; 4♂, 2♀ (TARI), same locality, 25.X.2015, leg. B.-X. Guo; 1♂, 4♀ (TARI), Tienchih (天池), 1.IV.2015, leg. C.-F. Lee; Nantou: 1♂ (TARI), Hohuanhsi trail (合歡溪步道), 15.V.2017, leg. J.-C. Chen; 3♂ (TARI), same (= Huakang, 華岡) but with “23.IV.2019”; 1♂, 3♀ (TARI), same but with “24.IV.2021”; 3♂, 1♀ (TARI), Kunyang (昆陽), 17.IV.2021, leg. W.-C. Liao; 1♂, 2♀ (NMNS), Nanhua (南華山), 6.V.1992, leg. W.-T. Yang & K.-W. Huang; 16♀ (TARI), Tatachia (塔塔加), 9.VI.2009, leg. T.-H. Lee; 2♂, 5♀ (TARI), same locality, 21.IX.2009, leg. C.-F. Lee; 11♂, 5♀ (TARI), same but with “leg. M.-H. Tsou”; 1♀ (TARI), same locality, 30.X.2009, leg. C.-F. Lee; 3♀ (TARI), same but with “13.V.2015”; Taichung: 1♂ (TARI), Hsuehshan (雪山), 26.VI.2017, leg. W.-B. Yeh.

Metallic blue form (n = 17): TAIWAN. Hualien: 2♀ (TARI), Malichiananshan (馬利加南山), 2.VI.2020, leg. J.-C. Chen; 1♀ (TARI), Mapolassushan (馬博拉斯山), 31.V.2020, leg. J.-C. Chen; 1♂ (TARI), Tayuling (大禹嶺), 12–15.IX.1980, leg. K. S. Lin & C. H. Wang; Nantou: 1♀ (KMNH), Hehuanshan (合歡山), 7.IX.1986, leg. K. baba; 1♀ (TARI), same locality, 23.VI.2018, leg. H.-F. Lu; 1♀ (NMNS), Hsiaofengko (小風口), 23.VI.–24.VIII.2009, leg. W.-T. Yang & K.-W. Huang; 1♂ (NMNS), same but with “24.IX.–22.X.2009”; 1♀ (TARI), Huakang (華岡), 24.IV.2019, leg. J.-C. Chen; 1♀ (HTC), Tsuifeng (翠峰), 20–21.VII.1995, leg. H. Takizawa; Taichung: 1♀ (TARI), Hsuehshan (雪山) 1.IV.2010, leg. W.-B. Yeh; 2♀ (TARI), same but with “7–8.IV.2011”; 1♀ (TARI), same but with “10.VI.2011”; 1♀ (TARI), same but with “8.X.2011”; 2♀ (TARI), same locality, 1.V.2012, leg. T.-H. Lee; Taitung: 1♀ (TARI), Hsiangyangshan (向陽山), 19.VI.2014, leg. J.-C. Chen; 1♂ (TARI), same but with “6.VIII.2015”.

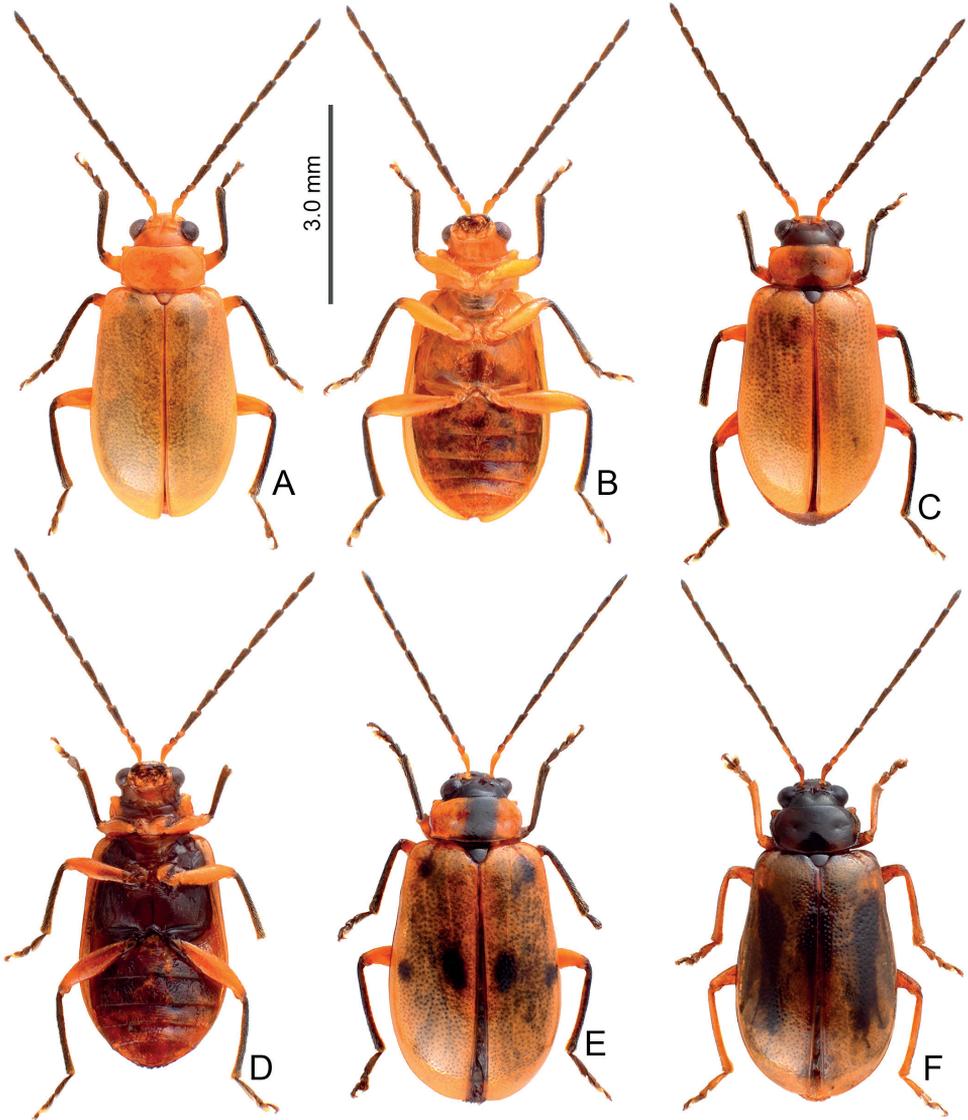


Figure 14. Habitus of *Arthrotus saigusai* Kimoto **A** collected from Kuanshan Wind Gap (關山啞口), male, dorsal view **B** collected from Kuanshan Wind Gap (關山啞口), male, ventral view **C** collected from Kuanshan Wind Gap (關山啞口), male, dorsal view **D** collected from Kuanshan Wind Gap (關山啞口), male, ventral view **E** collected from Tienchih (天池), female, dorsal view **F** collected from Huakang (華岡), female, dorsal view.

Diagnosis. Adults of *Arthrotus saigusai* Kimoto are similar to those of *A. tricolor* (Chûjô) and *A. fulvus* Chûjô in possessing rounded lateral margins of pronota (straight lateral margins of pronotum in *A. abdominalis* (Chûjô), *A. gressitti* Kimoto, *A. hirashimai* Kimoto, and *A. yuae* sp. nov.), the less transverse pronotum and elytra, 1.7–2.0 × wider and long in pronotum and 1.5–1.6 × longer than wide in elytra (the more transverse pronotum and elytra, 2.1–2.2 × wider and long and 1.4 × longer than wide in elytra

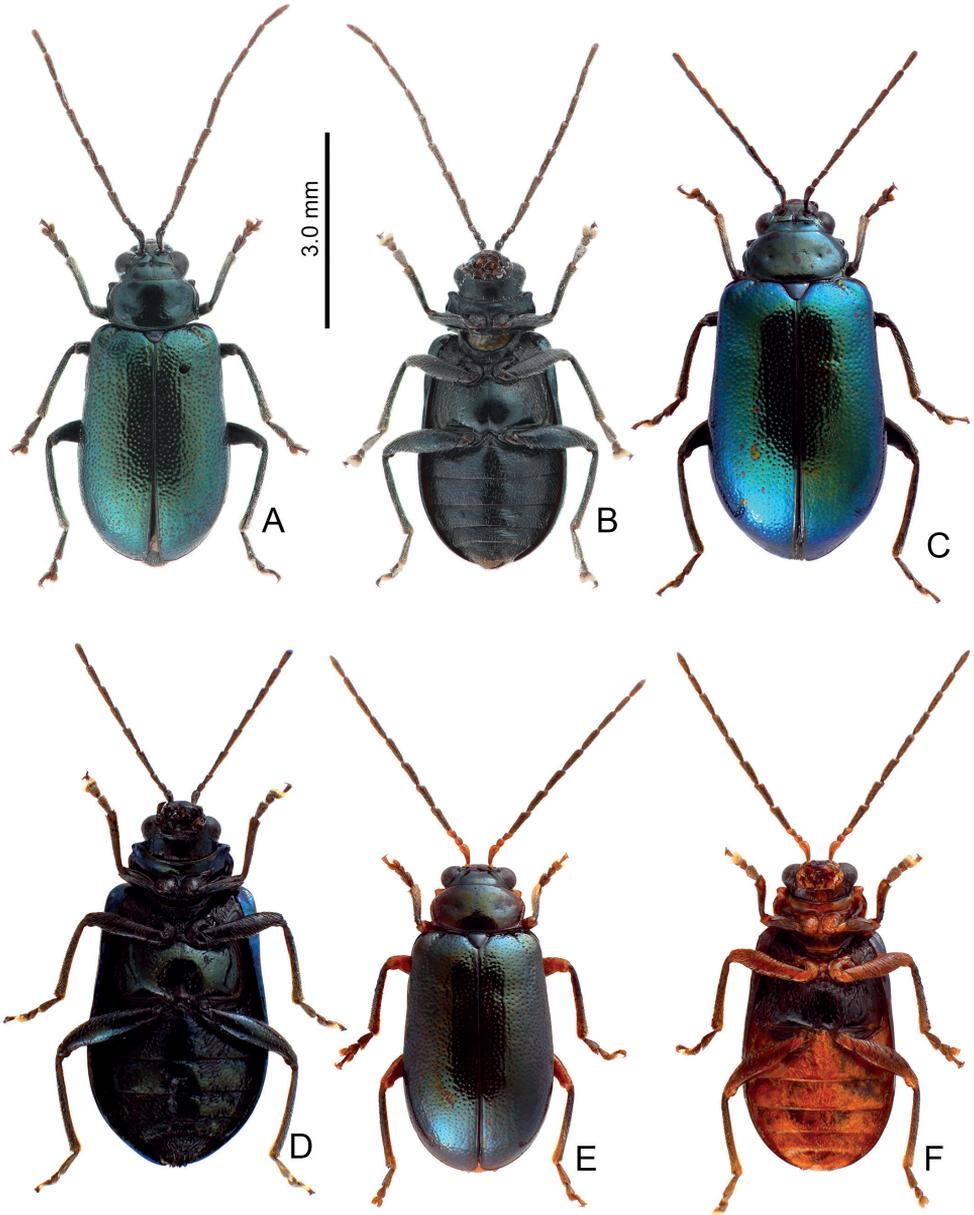


Figure 15. Habitus of *Arthrotus saigusai* Kimoto **A** collected from Hsiaofengko (小風口), male, dorsal view **B** collected from Hsiaofengko (小風口), male, ventral view **C** collected from Huakang (華岡), female, dorsal view **D** collected from Huakang (華岡), female, ventral view **E** collected from Hsiangyangshan (向陽山), male, dorsal view **F** collected from Hsiangyangshan (向陽山), male, ventral view.

of *A. testaceus* Gressitt & Kimoto and *A. yangi* sp. nov.). Adults of *A. saigusai* are different from those of *A. fulvus* and *A. tricolor* by the less transverse antennomere III in male, 1.1 × longer than wide (Fig. 16A) (the more transverse antennomere III

in male, $0.7\text{--}0.8 \times$ longer than wide in *A. fulvus* (Fig. 12A) and *A. tricolor* (Fig. 20A), the less slender antennae, antennomeres IV–VI $3.0\text{--}3.5 \times$ in male longer than wide and VII–XI in male and IV–XI in female $< 4.3 \times$ longer than wide (Fig. 16A, B) (more slender antennae, antennomeres IV–VI in male $> 3.7 \times$ longer than wide, VII–XI in male and IV–XI in female $> 4.3 \times$ longer than wide in *A. fulvus* (Fig. 12A, B) and *A. tricolor* (Fig. 20A, B), the slightly curved apex of aedeagus (Fig. 16D) (the recurved apex of aedeagus in *A. fulvus* (Fig. 12D) and *A. tricolor* (Fig. 20D)).

Redescription. Pale individuals have yellowish brown bodies with black antennae except antennomeres I, tibiae, and tarsi (Fig. 14A, B), some with vertex darker. Pronotum with median longitudinal wide black stripe from base to apex; scutellum black; thoracic ventrites blackish brown except hypomeron (Fig. 14C, D). Some similar to the previous form but differing in possessing three pairs of black spots on the

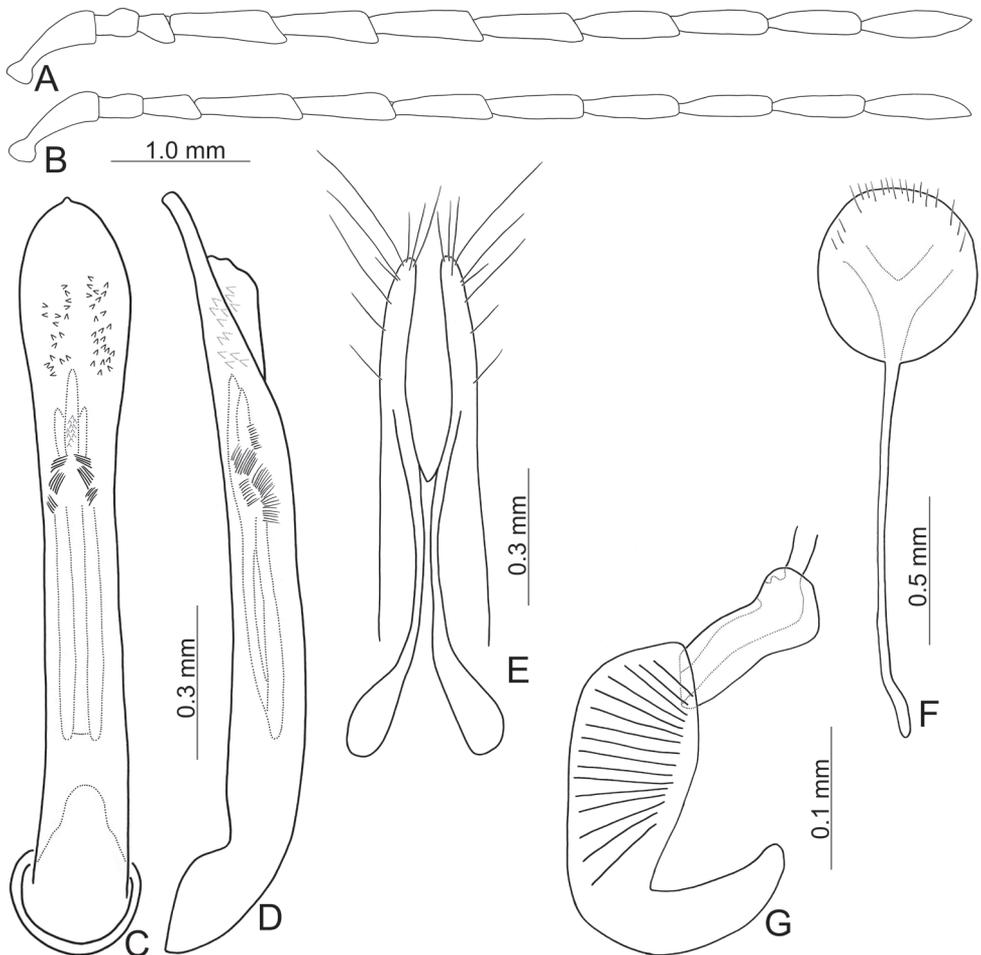


Figure 16. Diagnostic characters of *Arthrotus saigusai* Kimoto **A** antenna, male **B** antenna, female **C** aedeagus, dorsal view **D** aedeagus, lateral view **E** gonocoxae **F** abdominal ventrite VIII **G** spermatheca.

elytra: one pair near base, two pairs on the transverse line at middle (Fig. 14E); some with longitudinal black stripes instead of black spots (Fig. 14F). Metallic blue individuals occurring in alpine habitats with entirely metallic blue bodies (Fig. 15A–D). One individual with metallic elytra but with blackish brown body. Pronotum with median transverse depression; shiny, without reticulate microsculpture; with sparse, coarse, confused punctures; lateral margins rounded, widest at middle; apical and basal margins slightly concave. Elytra with rounded lateral margin, widest at apical 1/3; disc shiny, without reticulate microsculpture, and with dense, coarse punctures (Fig. 15E, F).

Male. Length 5.0–5.2 mm, width 2.4–2.5 mm. Antennae filiform (Fig. 16A), antennomere III less modified, shorter than II, IV–VII relatively wider, length ratios of antennomeres I–XI 1.0: 0.4: 0.3: 1.1: 1.0: 1.0: 1.0: 1.0: 0.9: 1.1, length to width ratios of antennomeres I–XI 3.2: 1.5: 1.1: 3.4: 3.0: 3.5: 3.7: 3.9: 4.2: 4.0: 4.3. Pronotum 1.9 × wider than long. Elytra 1.6 × longer than wide. Aedeagus (Fig. 7) extremely slender, ~ 11.3 × longer than wide, parallel-sided, slightly narrowed at apical 1/4, basally widened, apex narrowly rounded; tectum membranous, covered with weakly sclerotized, tiny setae; weakly curved in lateral view, apex curved and narrowly rounded; primary endophallic sclerite elongate, ~ 0.5 × as long as aedeagus, apex trilobed, with a cluster of dense setae near apex, and tiny teeth above clustered setae; deeply bifurcate from middle to base.



Figure 17. File photographs of *Arthrotus* species **A** adult of *Arthrotus saigusai* conceal under curled leaves of *Reynoutria japonica* **B** some adult come out from the curled leaves **C** blackened female of *A. tricolor* at Tahsuehshan (大雪山) **D** typical female of *A. tricolor* at the same locality.

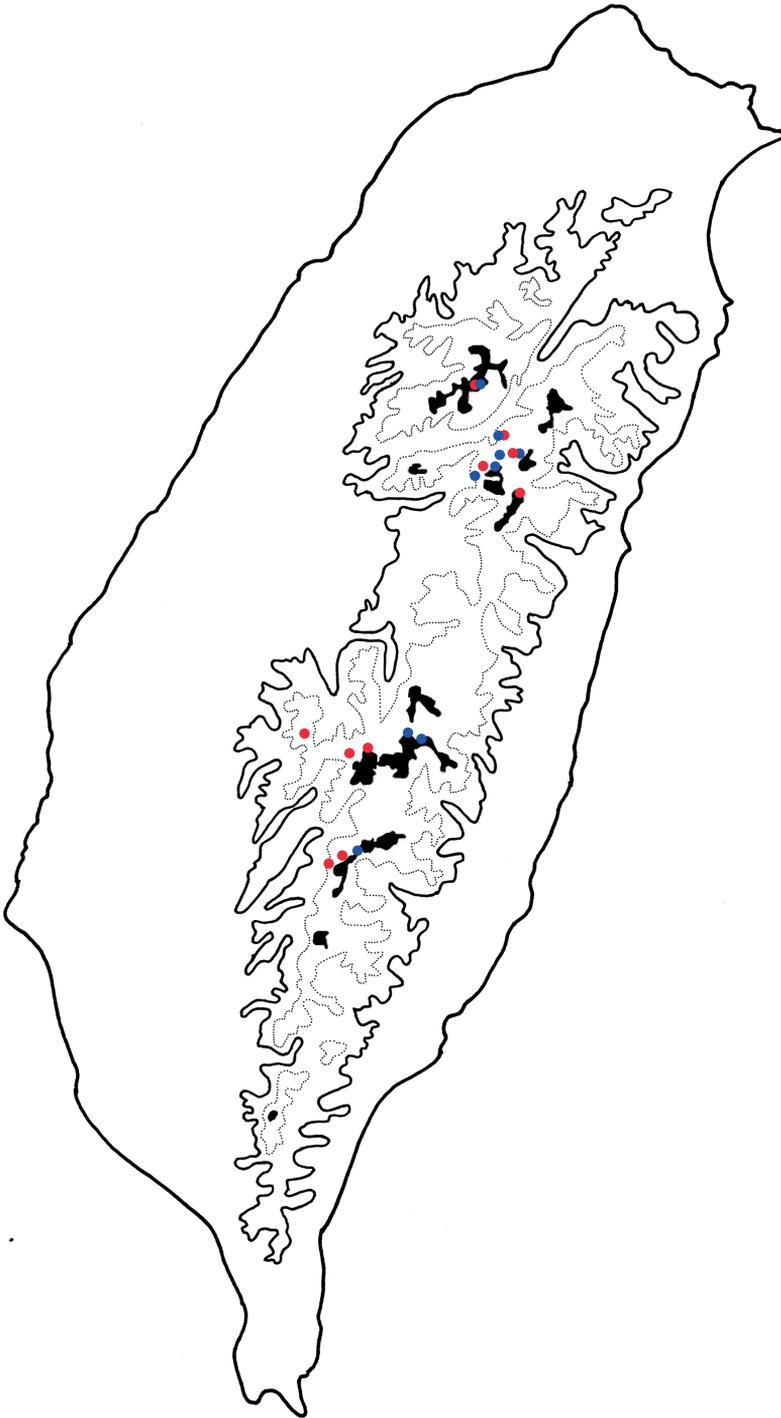


Figure 18. Distribution map of *Arthrotus saigusai* Kimoto; solid line: 1000 m, broken line: 2000 m, black areas: 3000 m. Key: red dots yellowish brown form, blue dots metallic blue form.

Female. Length 5.9–6.5 mm, width 3.0–3.3 mm. Antennae (Fig. 16B) much more slender than in males, antennomere III a little longer than II, length ratios of antennomeres I–XI 1.0: 0.4: 0.5: 1.0: 0.9: 0.9: 0.9: 0.9: 0.9: 1.0, length to width ratios of antennomeres I–XI 3.5: 1.8: 2.0: 4.1: 3.5: 3.8: 4.0: 3.9: 4.2: 4.2: 4.2. Pronotum 1.8 × wider than long. Elytra 1.6 × longer than wide. Ventricle VIII (Fig. 16F) weakly sclerotized, apical margin widely rounded, with sparse, short setae along apical margin, and sparse, long setae at inner transverse row; spiculum extremely slender. Receptacle of spermatheca (Fig. 16G) slightly swollen, divided from pump; pump narrow and moderately curved, apex narrowly rounded; sclerotized proximal spermathecal duct wide and short, shallowly projecting into receptaculum. Gonocoxae (Fig. 16E) connected at one point, ~ 5.0 × longer than wide, curved inwards apically, with one short seta at apical 1/3, eight additional setae at apical areas.

Food plants. Leaves of *Reynoutria japonica* Houtt. (Polygonaceae). Adults were found hiding inside the curled tender leaves of the food plants (Fig. 17A, B).

Remarks. One specimen collected from Ho Huan Shan (合歡山) by K. Baba was misidentified as *Arthrotus fulvus* by Kimoto (1989).

Distribution. Adults of *Arthrotus saigusai* Kimoto are widespread in high-elevations (above 2500 m) of Taiwan (Fig. 18).

Arthrotus tricolor (Chûjô, 1965)

Figs 17C, D, 19–21

Arthrotus fulvus Chûjô, 1938: 139 (part).

Dercetis tricolor Chûjô, 1965: 95.

Dercetina tricolor: Kimoto 1989: 280 (additional records).

Arthrotus tricolor: Kimoto 1969: 60 (transferred from *Dercetis*); Kimoto 1986: 58 (additional records); Kimoto 1991: 17 (additional records).

Types. Holotype ♀ (KUEC): “Rimogan (= Fushan, 福山) / FORMOSA / 10.VII.1961 / Coll. T. SHIROZU [h, w] // *Dercetis* / *tricolor* / CHÛJÔ, ♀ [h] / Det. M. CHUJO, 196[p]2[h, w]”.

Other material. A total of 299 specimens was examined (Suppl. material 3).

Diagnosis. Adults of *Arthrotus tricolor* (Chûjô) are similar to those of *A. fulvus* Chûjô in possessing rounded lateral margins of pronota (straight lateral margins of pronotum in *A. abdominalis* (Chûjô), *A. gressitti* Kimoto, *A. hirashimai* Kimoto, and *A. yuae* sp. nov.), the less transverse pronotum and elytra, 1.7–2.0 × wider and long in pronotum and 1.5–1.6 × longer than wide in elytra (more transverse pronotum and elytra, 2.1–2.2 × wider and long and 1.4 × longer than wide in elytra of *A. testaceus* Gressitt & Kimoto and *A. yangi* sp. nov.), a more transverse antennomere III in male, 0.7–0.8 × longer than wide (Fig. 20A) (less transverse antennomere III in male, 1.1 × longer than wide in *A. saigusai* Kimoto (Fig. 16A)). Adults of *A. tricolor* are different from those of *A. fulvus* (Figs 9–11) based on their characteristic color patterns (Fig. 19), tectum of aedeagus without pairs of apical tube-like processes and

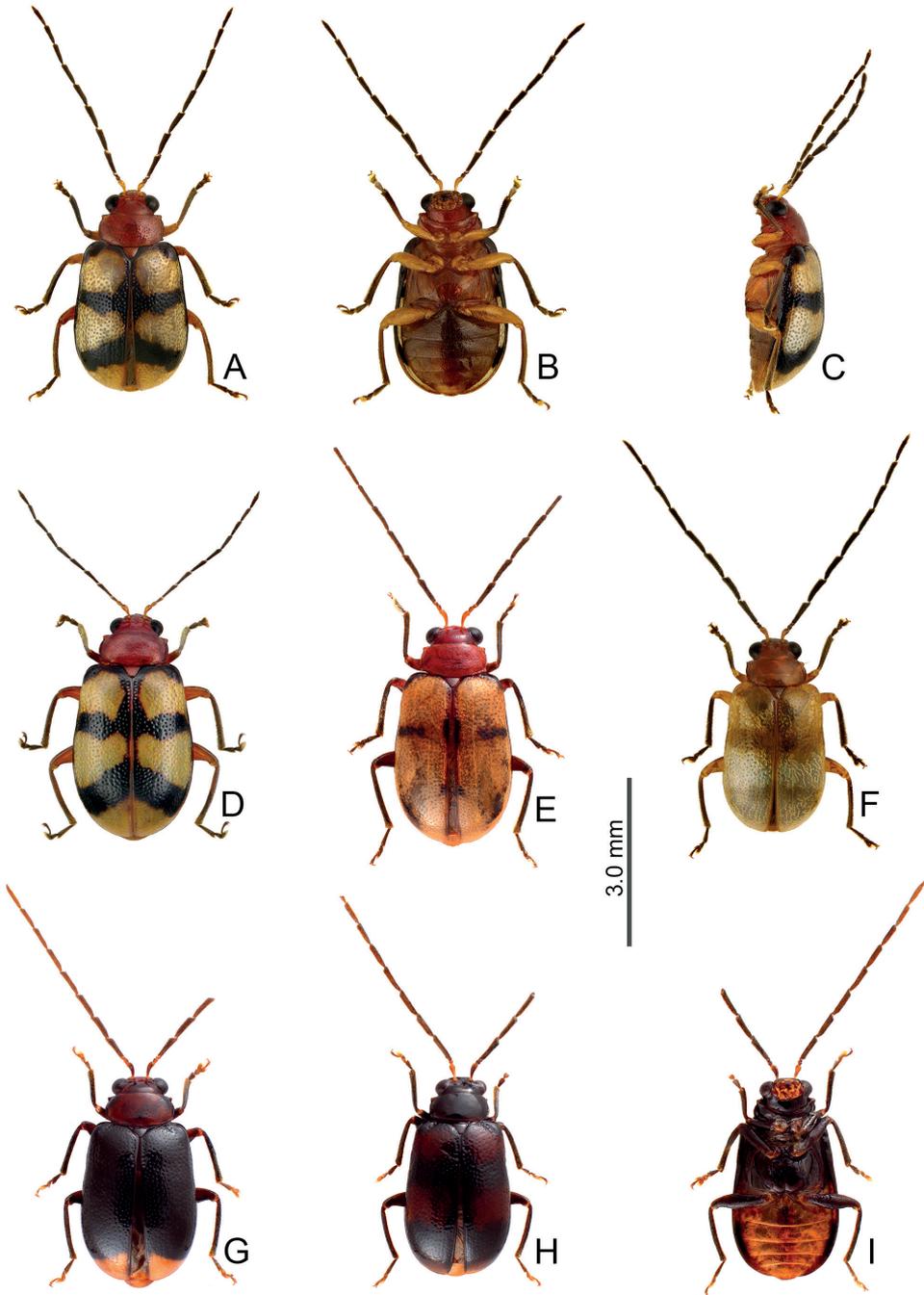


Figure 19. Habitus of *Arthrotus tricolor* (Chûjô) **A** collected from Chutzuhu (竹子湖), male, dorsal view **B** collected from Chutzuhu (竹子湖), male, ventral view **C** collected from Chutzuhu (竹子湖), male, lateral view **D** collected from Chutzuhu (竹子湖), female, dorsal view **E** collected from Junghua (榮華), male, dorsal view **F** collected from Wulai (烏來), male, dorsal view **G** collected from Lilungshan (里龍山), male, dorsal view **H** collected from Wushihkeng (烏石坑), male, dorsal view **I** ditto, ventral view.

disc covered with clustered stout setae (Fig. 20C, D) (with one pair of apical tube-like processes and disc covered with scattered short setae in *A. fulvus* (Fig. 12C, D)).

Redescription. Color yellowish brown; head, scutellum, and prothorax reddish brown, but antennae black; elytra with black stripes along basal margin, extending along entire suture, and lateral margins from base to apical 1/3, with two transverse black stripes at basal 1/3 and apical 1/3, legs black (Fig. 19A–D). Some specimens have reduced or paler black stripes on the elytra (Fig. 19E, F), some have black stripes expanding and the entire elytra black except apical 1/3 (Fig. 19G). Pronotum with median transverse depression reduced; shiny, without reticulate microsculpture; with sparse, coarse punctures confused; lateral margins rounded, widest at middle; apical

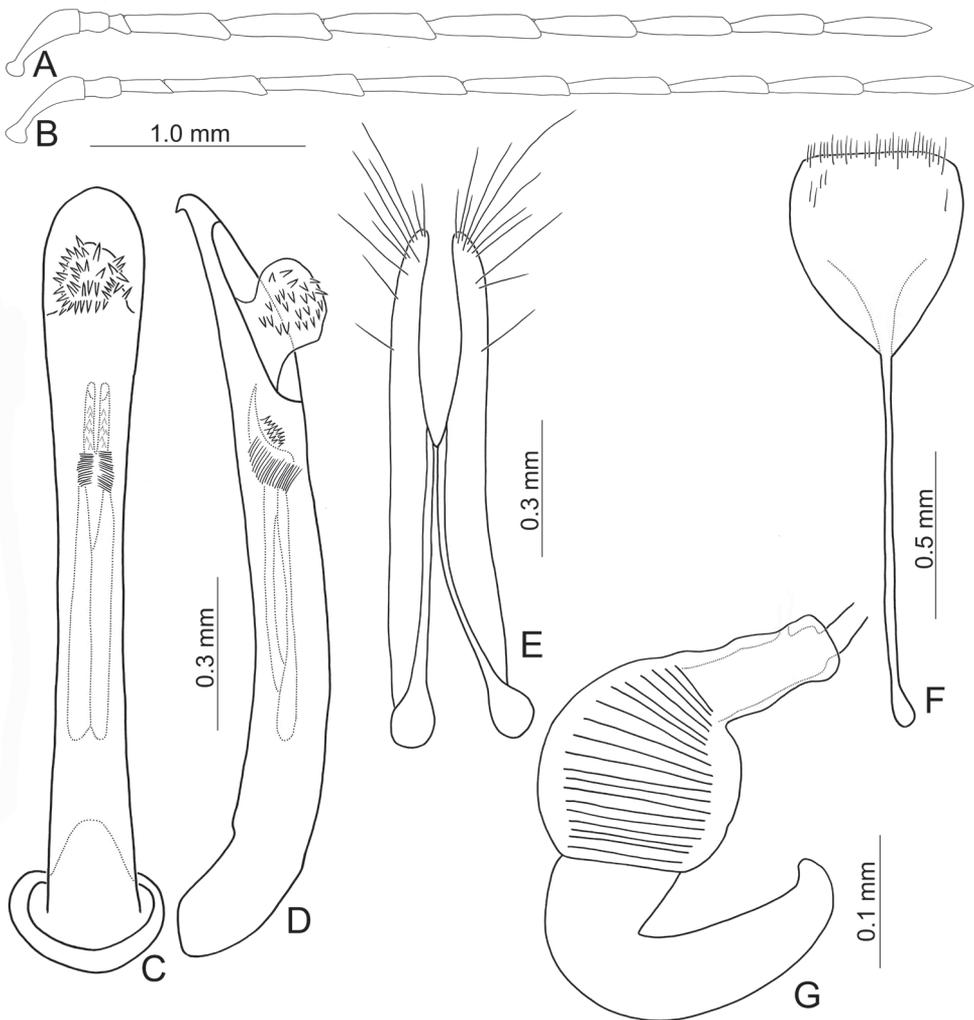


Figure 20. Diagnostic characters of *Arthrotus tricolor* (Chûjô) **A** antenna, male **B** antenna, female **C** aedeagus, dorsal view **D** aedeagus, lateral view **E** gonocoxae **F** abdominal ventrite VIII **G** spermatheca.

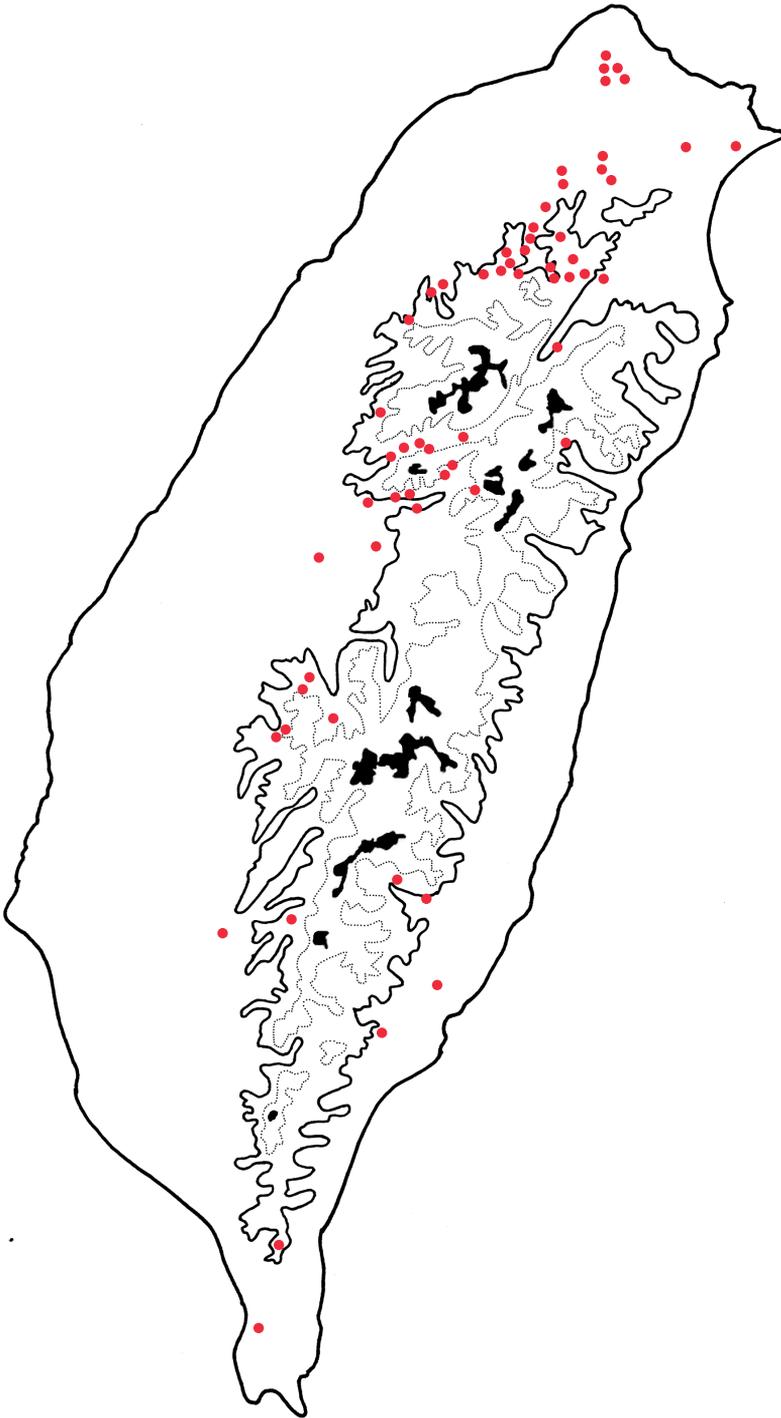


Figure 21. Distribution map of *Arthrotus tricolor* (Chùjō), solid line: 1000 m, broken line: 2000 m, black areas: 3000 m.

and basal margins slightly concave. Elytra parallel-sided, disc shiny, without reticulate microsculpture, and with dense, coarse punctures.

Male. Length 5.2–5.6 mm, width 2.4–2.8 mm. Antennae filiform (Fig. 20A), antennomere III modified, much shorter than II, IV–VII relatively wider, length ratios of antennomeres I–XI 1.0: 0.3: 0.2: 1.0: 1.1: 1.1: 1.2: 1.1: 1.0: 1.0: 1.2, length to width ratios of antennomeres I–XI 3.5: 1.5: 0.8: 3.7: 4.0: 4.0: 4.3: 4.7: 5.1: 4.8: 6.2. Pronotum 1.9–2.0 × wider than long. Elytra parallel-sided, 1.4–1.6 × longer than wide. Aedeagus (Fig. 20C, D) extremely slender, ~ 12.5 × longer than wide, parallel-sided, slightly narrowed at apical 1/4, basally widened, apex widely rounded; tectum membranous, strongly swollen, covered with densely, well-sclerotized, stout setae; weakly curved in lateral view, apex recurved; primary endophallic sclerite elongate, ~ 0.5 × as long as aedeagus, apex bifurcate, with a cluster of dense setae near apex, and tiny teeth above clustered setae; deeply bifurcate from middle to base.

Female. Length 5.4–6.4 mm, width 3.1–3.8 mm. Antennae (Fig. 20B) much slender than in males, antennomere III a little longer than II, length ratios of antennomeres I–XI 1.0: 0.4: 0.5: 1.0: 1.1: 1.1: 1.1: 1.1: 1.0: 1.2, length to width ratios of antennomeres I–XI 3.9: 1.9: 3.4: 5.1: 4.6: 5.7: 5.7: 5.6: 5.4: 5.3: 6.3. Pronotum 1.9–2.0 × wider than long. Elytra 1.4 × longer than wide. Ventricle VIII (Fig. 20F) weakly sclerotized, apically truncate, with dense, short setae along apical margin, and sparse, long setae at inner transverse line; spiculum extremely slender. Receptacle of spermatheca (Fig. 20G) strongly swollen, divided from pump; pump narrow and moderately curved, apex narrowly rounded; sclerotized proximal spermathecal duct wide and short, shallowly projecting into receptaculum. Gonocoxae (Fig. 20E) connected at middle at one point, ~ 5.2 × longer than wide, curved inwards at apical 1/3, with one long seta at apical 1/3, nine or ten additional setae at apical areas.

Variations. Some specimens collected from Tahsuehshan (大雪山) and nearby Wushihkeng (烏石坑) have a distinctive color form (Fig. 17C, D): body almost black except yellowish brown abdomen and yellow spots on the elytra, as typical form (Fig. 19H, I)

Remarks. Two types of *Arthrotus fulvus* [1♀ (TARI): “Formosa / Karenko (= Hualien, 花蓮), -19 / VII 20-VIII 4. / T. Okumi, // CO / Type [p, w, circle label with yellow letters and yellow border] // Arthrotus / fulvus / CHÛJÔ [h] / DET. M. CHUJO [p, w] // 2588 [p, w]” and 1♀ (TARI): “KUARU (= Kueitzuchiao, 龜子角) [h] / FORMOSA [p] / 12.VI.1937 [h] / COL. M. CHUJO [p, w]”; CO / Type [p, w, circle label with yellow letters and yellow border] // Arthrotus / fulvus / CHÛJÔ [h] / DET. M. CHUJO [p, w] // 1370 [p, w]”] are misidentified. They should belong to *A. tricolor*.

Food plants. Leaves of *Styrax formosanus* var. *formosanus* Matsum. (Styracaceae), *Cryptocarya chinensis* (Hance) Hemsl. (Lauraceae), and *Actinidia rufa* (Siebold & Zucc.) Planch. ex Miq. (Actinidiaceae).

Distribution. Adults of *Arthrotus tricolor* (ChÛjô) are widespread in lowlands (below 1500 m) of Taiwan. They are more common in northern Taiwan (Fig. 21).

***Arthrotus testaceus* Gressitt & Kimoto, 1963**

Figs 22, 23A–C, 24, 25

Arthrotus testaceus Gressitt & Kimoto, 1963: 702 (China); Kimoto 1969: 60 (Taiwan).*Arthrotus shibatai* Kimoto, 1984: 55 (Taiwan); Kimoto 1989: 259 (additional records);

Kimoto 1991: 16 (additional records). syn. nov.

Types. *Arthrotus testaceus*. **Paratypes.** 1♂ (KMNH): “W. HUPEH, China / Lichuan, Hsiaoho / VIII[p]-10-[h]1948 [p, w] // Gressitt & / Djou Collrs. [p, w] // Arthrotus / testaceus / G & K [h] / Gressitt & Kimoto det. 196[p]2 [p, w] // PARATYPE [p, b]”; 1♂ (KMNH): “CHINA, / W. HUPEH, / Sulho, Lichuan / IX-14-1948 [p, w] // Gressitt & / Djou Collrs. [p, w] // Arthrotus / testaceus / G & K [h] / Gressitt & Kimoto det. 196[p]2 [p, w] // PARATYPE [p, b]”; 1♂ (BPBM): “Suisapa, 1000 M. / Lichuan Distr. / W. Hupeh, China / VIII- [p] 21 [h] -48 [p, w] // J. L. Gressitt / Collector [p, w] // PARATYPE [p] / Arthrotus / testaceus [h] / Gressitt & Kimoto [p, y] // Arthrotus / testaceus / G & K [h] / Gressitt & Kimoto det. 196[p]2 [p, w]”; 1♀ (CAS), same but with “VIII- [p] 22 [h] -48 [p, w]”; 1♂ (CAS), same but with one additional card, labeled: “Ex / Liquidamo. / formosana [p, w]”; 1♀ (CAS), same but with “VIII- [p] 23 [h] -48 [p, w]”; 1♀ (CAS), same but with “VIII- [p] 25 [h] -48 [p, w]”; 1♂ (CAS), same but with “VIII- [p] 30 [h] -48 [p, w]”; 1♂ (BPBM): “FUKIEN, S. China / Chungah: Upper / Kuatun 1400 m. / T. C. Maa [p, w] // Apr.12.1943 [h, w] // PARATYPE [p] / Arthrotus / testaceus [h] / Gressitt & Kimoto [p, y] // Arthrotus / testaceus / G & K [h] / Gressitt & Kimoto det. 196[p]2 [p, w]”; 1♂ (CAS): “Mokansan China / Che Kiang Pr. [p] / IX-18-27 [h, w] // Mrs. Dora / E. Wright / Collector [p, w] // PARATYPE [p] / Arthrotus / testaceus [h] / Gressitt & Kimoto [p, y] // Arthrotus / testaceus / G & K [h] / Gressitt & Kimoto det. 196[p]2 [p, w]”.

Arthrotus shibatai. **Holotype** ♂ (OMNH): “NANSHANCHI (南山溪) / TAIWAN / 1.IV.1981 / F. KIMURA [p, y] // ♂ [p, w, with black border] // Arthrotus / shibatai / Kimoto [h, w] // HOLOTYPE [p, r]”. Paratypes: 1♀ (KMNH): “NANSHANCHI (南山溪) / TAIWAN / 31.III.1981 / F. KIMURA [p, y] // PHOTO [p, r]”; 1♂ (KMNH): “NANSHANCI [sic!] (南山溪) / TAIWAN / 3.IV.1971 / H. NOMURA [p, y] // ♂ [p, w, with black border]”; 1♀ (KMNH): “APR 9. 1967 / 松安 (= Sungan) / B-S. CHANG [h, w]”; 1♀ (KMNH): “(Taiwan) / Huanshan (環山) / Hsuehshan Mo (雪山山脈) / Taichung Hs. [p, w] // Jun [p] 1 [h] .1971 / K Kanmiya [p, w]”. Each paratype bears two additional labels: “Arthrotus / shibatai / Kimoto [h, w] // PARATYPE [p, b]”.

Other material. A total of 301 specimens was examined (Suppl. material 4).

Diagnosis. Adults of *Arthrotus testaceus* Gressitt & Kimoto (Figs 22, 23A–C) and *A. yangi* sp. nov. (Fig. 23D–F) are characterized by the more transverse pronotum and elytra, 2.1–2.2 × wider and long in pronotum and 1.4 × longer than wide in elytra (less transverse pronotum and elytra, 1.7–2.0 × wider and long in pronotum and 1.5–1.6 × longer than wide in elytra of others). Adults of *A. testaceus* (Figs 22, 23A–C) are different from *A. yangi* sp. nov. in lacking the characteristic color pattern of *A. yangi* sp. nov. (Fig. 23D–F); more slender antennae, antennomeres IV–VII 3.6–4.2 × longer than wide and VII–X 4.5–4.8 × longer than wide in males (Fig. 24A), IV–X > 4.0 × longer than

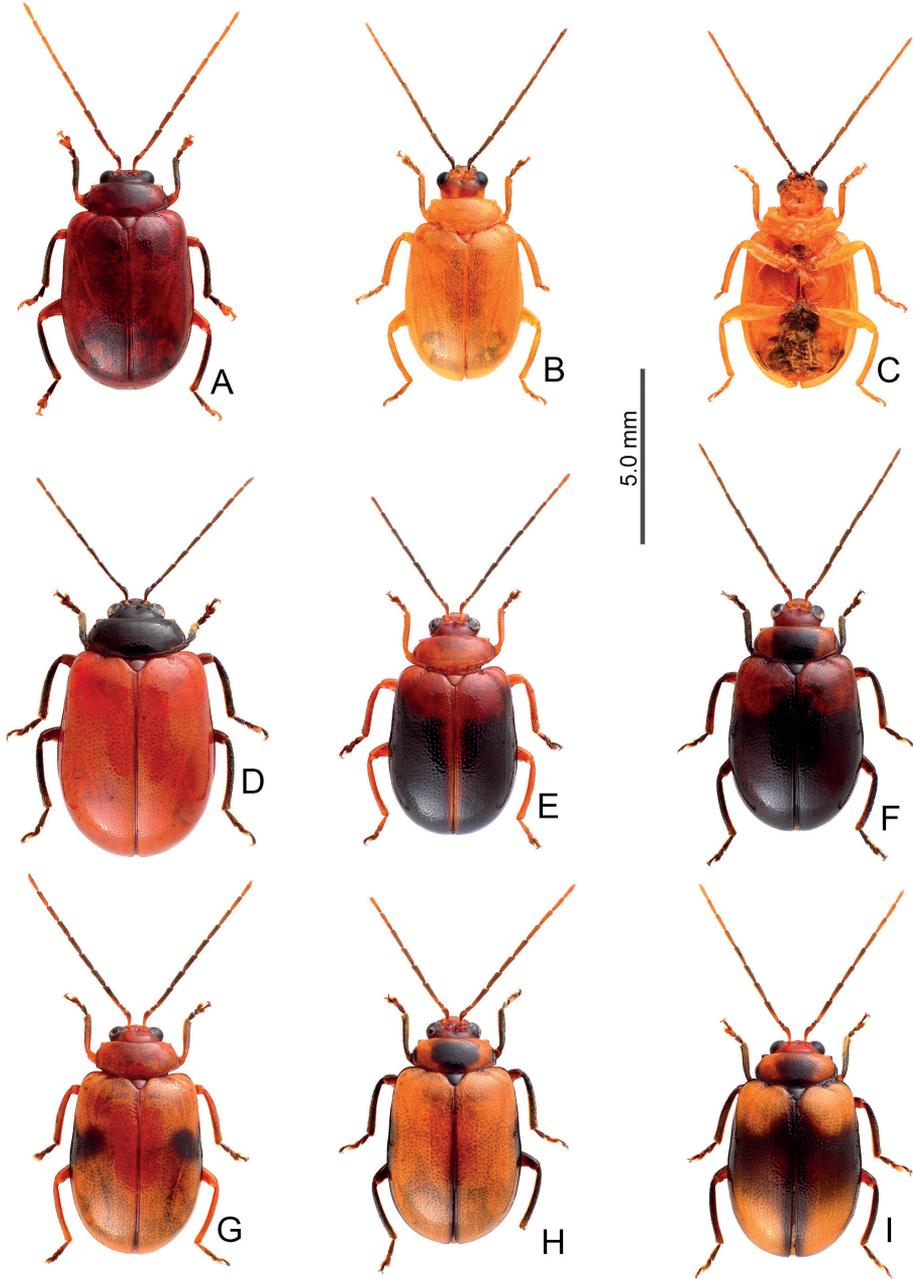


Figure 22. Habitus of *Arthrotus testaceus* Gressitt & Kimoto **A** collected from Tengchih (藤枝), male, dorsal view **B** collected from Peitawushan (北大武山), male, dorsal view **C** ditto, ventral view **D** collected from Tahanshan (大漢山), female, dorsal view **E** collected from Tahanshan (大漢山), male, dorsal view **F** collected from Tahanshan (大漢山), male, dorsal view **G** collected from Tahanshan (大漢山), male, dorsal view **H** collected from Tahanshan (大漢山), male, dorsal view **I** collected from Tahanshan (大漢山), male, dorsal view.

wide in females of *A. testaceus* (Fig. 24B) (less slender antennae, antennomeres IV–VII $2.9\text{--}3.1 \times$ longer than wide and VIII–X $3.4\text{--}3.7 \times$ longer than wide in males (Fig. 26A), IV–X $< 3.0 \times$ longer than wide in females of *A. yangi* sp. nov. (Fig. 26B)); more slender aedeagus, $11.3 \times$ longer than wide (Fig. 24C, D) (less slender aedeagus, $8.0 \times$ longer than wide in *A. yangi* sp. nov. (Fig. 26C, D)), tectum with clustered stout setae (Fig. 24A) (tectum with setae almost reduced in *A. yangi* sp. nov. (Fig. 26C)); slender gonocoxae, $4.8 \times$ longer than wide (Fig. 24E) (wide gonocoxae, $1.9 \times$ longer than wide in *A. yangi* sp. nov. (Fig. 26E)); and slightly swollen receptacle of spermathecal (Fig. 24G) (slender swollen receptacle of spermatheca in *A. yangi* sp. nov. (Fig. 26G)).

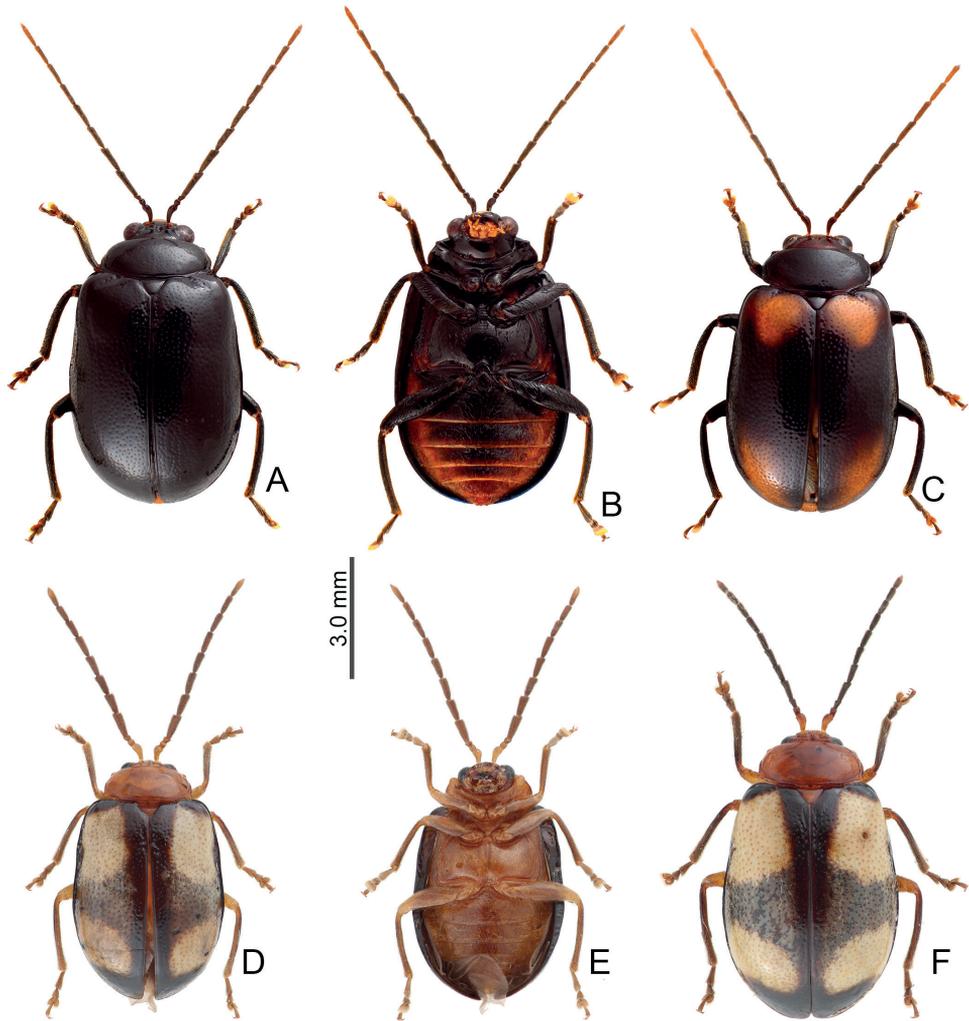


Figure 23. Habitus of *Arthrotus testaceus* Gressitt & Kimoto and *A. yangi* sp. nov. **A** *A. testaceus*, collected from Tahanshan (大漢山), male, dorsal view **B** *A. testaceus*, collected from Tahanshan (大漢山), male, ventral view **C** *A. testaceus*, collected from Tahanshan (大漢山), male, dorsal view **D** *A. yangi* sp. nov., collected from Hualuhsi (華綠溪), male, dorsal view **E** *A. yangi* sp. nov., collected from Hualuhsi (華綠溪), male, ventral view **F** *A. yangi* sp. nov., collected from Hualuhsi (華綠溪), female, dorsal view.

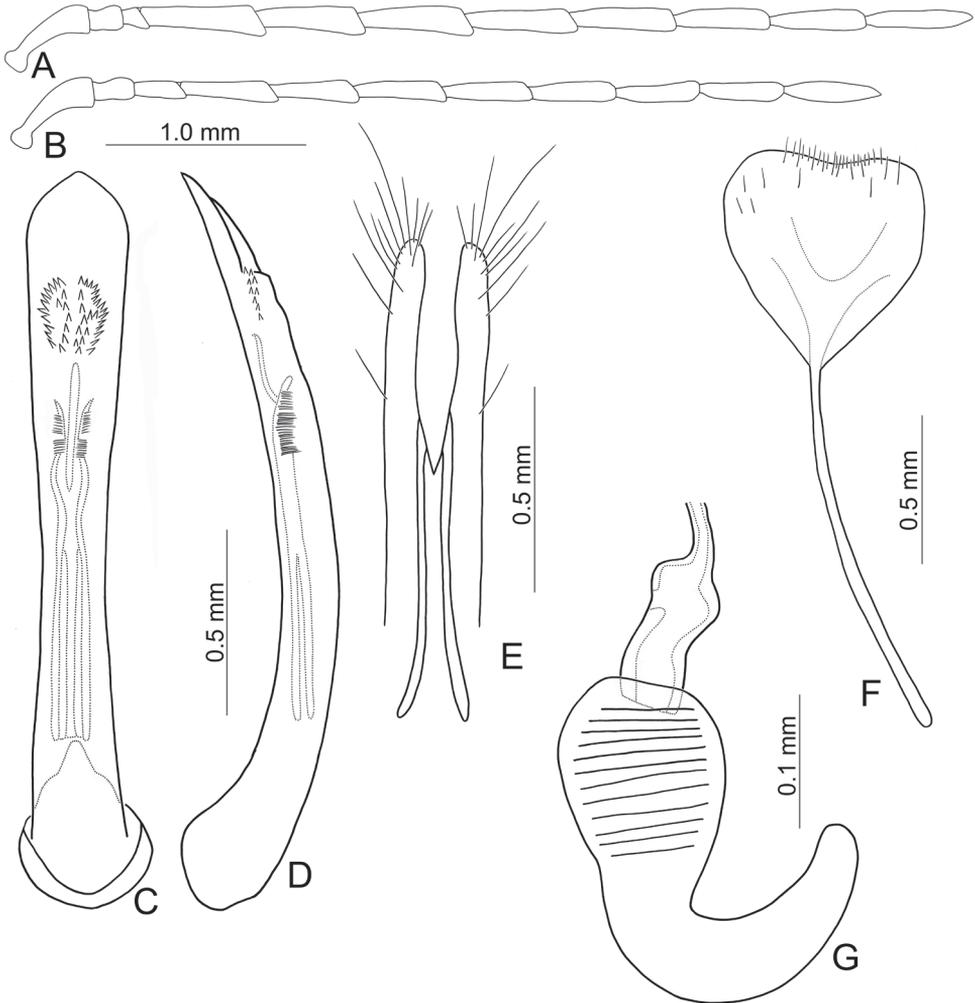


Figure 24. Diagnostic characters of *Arthrotus testaceus* Gressitt & Kimoto **A** antenna, male **B** antenna, female **C** aedeagus, dorsal view **D** aedeagus, lateral view **E** gonocoxae **F** abdominal ventrite VIII **G** spermatheca.

Redescription. Adults from China yellowish brown, but extremely variable in Taiwan, some similar to those of China (Fig. 22B, C) reddish brown with black antennae (except three basal antennomeres), tibiae, and tarsi (Fig. 22A); some with dark brown or black heads and pronota (Fig. 22D); some with black elytra but base and suture not darkened (Fig. 22E); some with base of elytra not darkened but pronotum with wide longitudinal black band (Fig. 22F); some with black lateral margin on elytra starting from basal 1/3, extending inwards at basal 1/3 (Fig. 22G); some with centrally darkened pronotum, elytra with black suture and lateral margin starting from basal 1/3, and black scutellum, and dark brown head (Fig. 22H); some similar to previous forms but with wide transverse dark band at basal 1/3 of elytra (Fig. 22I). Some with black body form with yellow abdomens (Fig. 23A, B); some with two additional, large, pale spots on elytra, one pair near base,

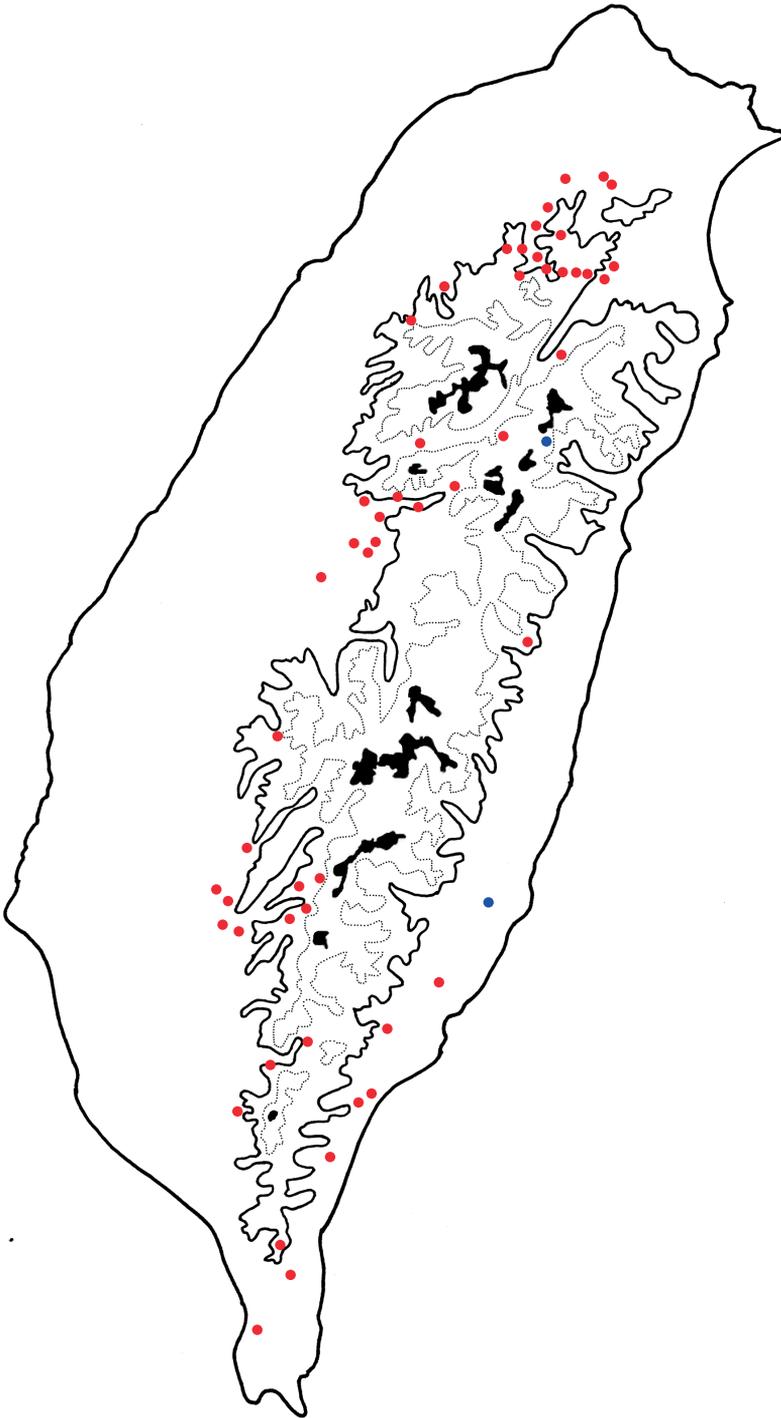


Figure 25. Distribution map of *Arthrotus testaceus* Gressitt & Kimoto and *A. yangi* sp. nov., solid line: 1000 m, broken line: 2000 m, black areas: 3000 m. Key: red dots *A. testaceus*, blue dots *A. yangi* sp. nov.

the other near apex (Fig. 23C). Pronotum without median transverse depression; shiny, without reticulate microsculpture; with sparse, coarse punctures confused; lateral margins rounded, widest at middle; apical and basal margins strongly concave. Elytra parallel-sided, disc shiny, without reticulate microsculpture, and with dense, coarse punctures.

Male. Length 6.5–7.1 mm, width 3.9–4.0 mm. Antennae filiform (Fig. 24A), antennomere III shorter than II, IV–VII relatively wider, length ratios of antennomeres I–XI 1.0: 0.4: 0.2: 1.3: 1.1: 1.2: 1.2: 1.1: 1.0: 1.0: 1.1, length to width ratios of antennomeres I–XI 3.4: 1.3: 0.9: 3.9: 3.6: 3.8: 4.2: 4.5: 4.5: 4.8: 6.0. Pronotum 2.2 × wider than long. Elytra 1.4 × longer than wide. Aedeagus (Fig. 24C, D) extremely slender, ~ 11.3 × longer than wide, slightly narrowed medially, basally widened, apex narrowly rounded; tectum membranous, covered with a pair of clusters of stout setae; moderately curved in lateral view, apex curved and acute; primary endophallic sclerite elongate, ~ 0.5 × as long as aedeagus, apex trilobed, with a cluster of dense setae near apex; deeply bifurcate from middle to base.

Female. Length 7.2–7.9 mm, width 4.3–4.4 mm. Antennae (Fig. 24B) much more slender than in males, antennomere III a little longer than II, length ratios of antennomeres I–XI 1.0: 0.4: 0.5: 0.9: 0.9: 0.9: 0.9: 0.9: 0.9: 0.9: 1.0, length to width ratios of antennomeres I–XI 3.5: 1.8: 2.6: 4.2: 4.0: 4.2: 4.4: 4.6: 4.5: 4.5: 4.6. Pronotum 2.2 × wider than long. Elytra 1.4 × longer than wide. Ventricle VIII (Fig. 24F) weakly sclerotized, with dense, short setae along apical margin, and sparse, long setae at inner transverse row; spiculum extremely slender. Receptacle of spermatheca (Fig. 24G) strongly swollen, divided from pump; pump narrow and moderately curved, apex narrowly rounded; sclerotized proximal spermathecal duct wide and short, shallowly projecting into receptaculum. Gonocoxae (Fig. 24E) connected at one point, ~ 4.8 × longer than wide, curved inwards apically, with one short seta at apical 1/3, nine or ten additional setae apically.

Food plants. Leaves of *Sapindus mukorossi* Gaertn. (Sapindaceae), *Acer insulare* Hayata var. *caudatifolium* (Hayata) S.Y. Lu & Y.P. Yang (Sapindaceae), *Acer albopurpurascens* Hayata (Sapindaceae), *Alniphyllum pterospermum* Matsum. (Styracaceae), *Alnus formosana* (Burkill) Makino (Betulaceae), and *Lithocarpus hancei* (Benth.) Rehder (Fagaceae).

Distribution. Adults of *Arthrotus testaceus* Gressitt & Kimoto are widespread in lowlands (below 1500 m) of Taiwan (Fig. 25).

Arthrotus yangi sp. nov.

<http://zoobank.org/CD028F70-32D7-4825-960B-AA39A8E78073>

Figs 23D–F, 25, 26

Type series ($n = 3$). **Holotype** ♂ (NMNS): TAIWAN. Hualien: Hualuhsi (華綠溪), 19.IV.-1.VI.2011, leg. W.-T. Yang & K. W. Huang, with Malaise trap. **Paratypes**. 1 ♀ (NMNS), same data as holotype; 1 ♀ (NMNS): TAIWAN. Taitung: Shinkangshan (新港山), 24.III.-19.V.2009, leg. W.-T. Yang & K. W. Huang, with Malaise trap.

Diagnosis. Adults of *Arthrotus yangi* sp. nov. (Fig. 23D–F) and *A. testaceus* Gressitt & Kimoto (Figs 22, 23A–C) are characterized by the more transverse pronotum and elytra, pronotum 2.1–2.2 × wider than long and elytra 1.4 × longer than wide

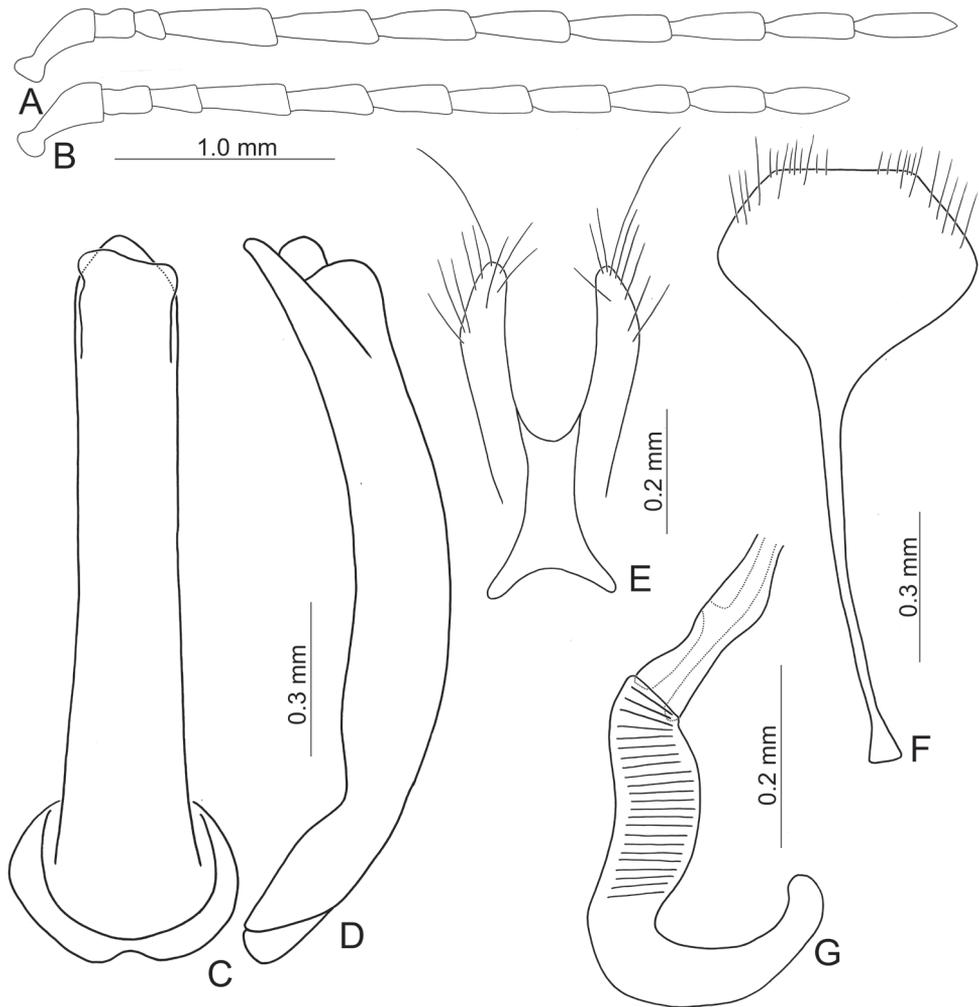


Figure 26. Diagnostic characters of *Arthrotus yangi* sp. nov. **A** antenna, male **B** antenna, female **C** aedeagus, dorsal view **D** aedeagus, lateral view **E** gonocoxae **F** abdominal ventrite VIII **G** spermatheca.

(less transverse pronotum and elytra, pronotum 1.7–2.0 × wider than long and elytra 1.5–1.6 × longer than wide in others). Adults of *A. yangi* sp. nov. are different from *A. testaceus* based on the characteristic color pattern (Fig. 23D–F) (lacking characteristic color pattern in *A. testaceus* (Figs 22, 23A–C)); less slender antennae, antennomeres IV–VII 2.9–3.1 × longer than wide, and VIII–X 3.4–3.7 × longer than wide in males (Fig. 26A), IV–X < 3.0 × longer than wide in females (Fig. 26B) (more slender antennae, antennomeres IV–VII 3.6–4.2 × longer than wide and VII–X 4.5–4.8 × longer than wide in males (Fig. 24A), IV–X > 4.0 × longer than wide in females of *A. yangi* sp. nov. (Fig. 24B)); less slender aedeagus, 8.0 × longer than wide (Fig. 26C) (more slender aedeagus, 11.3 × longer than wide in *A. yangi* sp. nov. (Fig. 24C)), tectum with setae almost reduced (tectum with clustered stout setae in *A. yangi* sp. nov.); wide gono-

coxae, $1.9 \times$ longer than wide (Fig. 26E) (slender gonocoxae, $4.8 \times$ longer than wide in *A. yangi* sp. nov. (Fig. 24E)); and slender receptacle of spermathecal (Fig. 26G) (slightly swollen swollen receptacle of spermatheca in *A. yangi* sp. nov. (Fig. 24G)).

Description. Color (Fig. 23D–F) yellowish brown, antennae black except two basal tarsomeres; tibiae and tarsi darkened; elytra black, with two pairs of large white spots near base and at apical $1/3$ respectively, areas mixed with white between anterior and posterior white spots. Pronotum without median transverse depression; shiny, without reticulate microsculpture; with sparse fine punctures; lateral margins rounded, widest at middle; apical margin strongly concave; basal margin truncate. Elytra with lateral margin slightly rounded, widest behind middle; disc without reticulate microsculpture, but with dense, coarse punctures.

Male. Length 5.5 mm, width 3.3 mm. Antennae filiform (Fig. 26A), antennomere III modified, much shorter than II, IV–VII much wider than others, length ratios of antennomeres I–XI 1.0: 0.4: 0.3: 1.2: 1.1: 1.1: 1.1: 1.1: 1.1: 1.0: 1.1, length to width ratios of antennomeres I–XI 2.6: 1.3: 0.9: 3.1: 2.9: 3.1: 3.0: 3.7: 3.5: 3.4: 4.5. Pronotum $2.2 \times$ wider than long. Elytra $1.4 \times$ longer than wide. Aedeagus (Fig. 26C, D) slender, $\sim 8.0 \times$ longer than wide, parallel-sided, apex widely rounded; tectum membranous, covered with extremely tiny and setae; moderately curved in lateral view, apex narrowly rounded; endophallic sclerites omitted.

Female. Length 6.7 mm, width 4.1 mm. Antennae (Fig. 26B) much shorter than in males, antennomere III subequal to II, IV–VI a little wider than others, length ratios of antennomeres I–XI 1.0: 0.5: 0.5: 0.9: 0.9: 0.8: 0.9: 0.8: 0.8: 0.8: 0.8, length to width ratios of antennomeres I–XI 2.2: 1.8: 1.7: 2.8: 2.6: 2.5: 2.1: 2.8: 2.9: 3.0: 3.3. Pronotum $2.1 \times$ wider than long. Elytra $1.4 \times$ longer than wide. Ventrite VIII (Fig. 4H) weakly sclerotized, apical margin truncate, with scattered long setae at sides, and several short setae at sides of apical margin; spiculum extremely slender. Receptacle of spermatheca (Fig. 26G) slightly swollen and slender, undivided from pump; pump slender and moderately curved, apex broadly rounded; sclerotized proximal spermathecal duct wide and long, shallowly projecting into receptaculum. Gonocoxae (Fig. 26E) basally connected from middle, $\sim 1.9 \times$ longer than wide, with one long seta at apex, nine additional setae at apical areas.

Food plants. Unknown.

Distribution. Adults are collected from only two localities in East Taiwan (Fig. 25).

Etymology. The specific name is dedicated to Mr Wan-Tsun Yang (楊萬琮) who collected type specimens using Malaise traps.

Key to Taiwanese species of *Arthrotus*

- 1 Lateral margins of pronotum straight; elytra metallic blue, with transverse depression at basal $1/3$ (Figs 1, 6) **2**
- Lateral margins of pronotum rounded; color patterns of elytra variable, without transverse depression (Figs 9–11, 14, 15, 22, 23) **5**
- 2 Head, pronotum, underside of thorax, and legs metallic blue (Fig. 1A–C)
..... *A. abdominalis* (Chûjô)
- Head, pronotum, underside of thorax, and legs blackish or yellowish brown (Figs 1D–F, 6) **3**

- 3 Head, pronotum, underside of thorax, and legs blackish brown (Fig. 1D–F) .
.....*A. gressitti* Kimoto
- Head, pronotum, underside of thorax, and legs yellowish brown (Fig. 6)4
- 4 Tectum of aedeagus covered with short needle-shape setae laterally and stout teeth apically, apex curved in lateral view (Fig. 7C, D); central Taiwan, including south Nantou, and Chiayi counties (Fig. 5)*A. hirashimai* Kimoto
- Tectum of aedeagus with scattered, stout setae, apex recurved in lateral view (Fig. 8C, D); south Taiwan, including Kaohsiung, Pingtung, and Taitung counties (Fig. 5).....*A. yuae* sp. nov.
- 5 Pronotum and elytra more transverse, pronotum 2.1–2.2 × wider than long and elytra 1.4 × longer than wide (Figs 22, 23).....6
- Pronotum and elytra less transverse, pronotum 1.7–2.0 × wider than and elytra 1.5–1.6 × longer than wide (Figs 9–11, 14, 15, 19)7
- 6 Color pattern of elytra characteristic (Fig. 23D–F); antennae less slender, antennomeres IV–VII 2.9–3.1 × longer than wide and VIII–X 3.4–3.7 × longer than wide in males (Fig. 26A), IV–X < 3.0 × longer than wide in females (Fig. 26B) *A. yangi* sp. nov.
- Color pattern on elytra variable but lacking above color pattern (Figs 22, 23A–C); antennae more slender, antennomeres IV–VII 3.6–4.2 × longer than wide and VII–X 4.5–4.8 × longer than wide in males (Fig. 24A), IV–X > 4.0 × longer than wide in females (Fig. 24B)*A. testaceus* Gressitt & Kimoto
- 7 Color pattern on elytra characteristic (Figs 14, 15); antennae less slender, antennomeres IV–VI 3.0–3.5 × longer than wide in male; VII–XI in male and IV–XI in female < 4.3 × longer than wide (Fig. 16A, B); antennomere III less transverse in male, 1.1 × longer than wide (Fig. 16A)*A. saigusai* Kimoto
- Color pattern on elytra variable but lacking above color pattern (Figs 9–11, 19); antennae more slender, antennomeres IV–VI > 3.7 × longer than wide in male, VII–XI in male and IV–XI in female > 4.3 × longer than wide (Figs 12A, B, 20A, B); antennomere III in male more transverse, 0.7–0.8 × longer than wide (Figs 12A, 20A) 8
- 8 Color pattern on elytra characteristic (Fig. 19); tectum of aedeagus without pairs of apical tube-like processes and disc covered with clustered stout setae (Fig. 20C, D)*A. tricolor* (Chûjô)
- Color pattern on elytra variable but lacking above color pattern (Figs 9–11); tectum of aedeagus with one pair of apical tube-like processes and disc covered with scattered short setae (Fig. 12C, D)*A. fulvus* Chûjô

Discussion

Taxonomic studies on *Arthrotus* species of Taiwan are difficult due to females being confused with those of *Dercetina* and the great variation of color patterns of most species. Taiwanese species of *Dercetina* were revised recently (Lee and Bezděk

2013) and every species of *Arthrotus* can be delimited with sufficient material now. Five *Arthrotus* species (*A. abdominalis* (Chùjò), *A. gressitti* Kimoto, *A. hirashimai* Kimoto, *A. yuae* sp. nov., and *A. yangi* sp. nov.) have characteristic and consistent adult color patterns with one exception, *A. hirashimai* Kimoto and *A. yuae* sp. nov., which are identical but allopatric. Color patterns of *A. tricolor* (Chùjò) and *A. saigusai* Kimoto are variable but characteristic within each species. Color patterns of the other two species, *A. testaceus* Gressitt & Kimoto and *A. fulvus* Chùjò, are extremely variable, but they can be identified by body shape. Therefore, all Taiwanese species of *Arthrotus* can be recognized by color patterns, geographic distributions, and body shapes.

Five *Arthrotus* species are widespread in Taiwan, *A. abdominalis*, *A. testaceus*, *A. saigusai*, *A. tricolor*, and *A. fulvus*. Of these, only *A. saigusai* is alpine. Populations of *Arthrotus gressitti*, *A. hirashimai*, *A. yuae* sp. nov., and *A. yangi* sp. nov. are localized and have similar color patterns and body shapes but allopatric distributions. In addition, one interesting phenomenon was noticed, the two bicolored patterns (black and white, black and red) of *A. fulvus* (Fig. 27A, C) have similar distributions as *Neochya nitidissima* (Chùjò, 1935), which also presents these two color forms (Lee 2020) (Fig. 27B, D). Could such a phenomenon result from convergent evolution and occur to other chrysomelids? This question requires further studies.

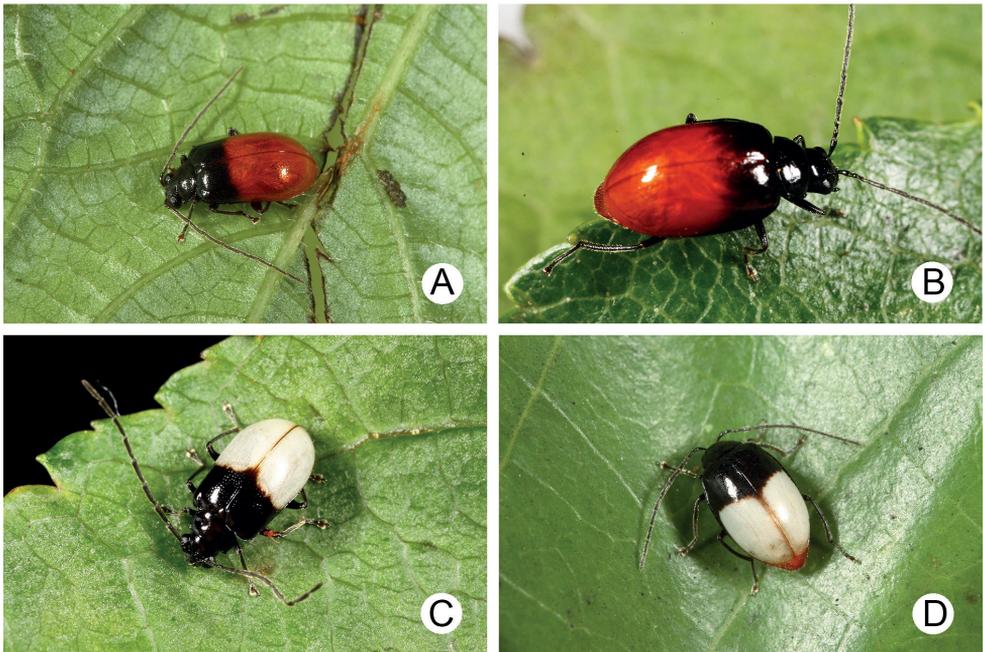


Figure 27. File photographs of *Arthrotus fulvus* Chùjò and *Neochya nitidissima* (Chùjò) **A** color form A of *A. fulvus* collected from Meifeng (梅峰) **B** similar color pattern of *N. nitidissima* collected from Kuanwu (觀霧) **C** color form B of *A. fulvus* collected from Tatchia (塔塔加) **D** similar color pattern of *N. nitidissima* collected from Tatchia (塔塔加)

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Supplementary material I

Arthrotus abdominalis (Chûjô, 1962)

Author: Chi-Feng Lee

Data type: docx file

Explanation note: *Arthrotus abdominalis* (Chûjô, 1962)

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Supplementary material 2

Arthrotus fulvus Chûjô, 1938

Author: Chi-Feng Lee

Data type: docx file

Explanation note: *Arthrotus fulvus* Chûjô, 1938

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Supplementary material 3

Arthrotus tricolor (Chûjô, 1965)

Author: Chi-Feng Lee

Data type: docx file

Explanation note: *Arthrotus tricolor* (Chûjô, 1965)

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Supplementary material 4

Arthrotus testaceus Gressitt & Kimoto, 1963

Author: Chi-Feng Lee

Data type: docx file

Explanation note: *Arthrotus testaceus* Gressitt & Kimoto, 1963

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