ZooKeys 290: 1–19 (2013)
doi: 10.3897/zookeys.290.5114
www.zookeys.org

RESEARCH ARTICLE

A peer-reviewed open-access journal
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A review of the Western Australian keeled millipede genus *Boreohesperus* (Diplopoda, Polydesmida, Paradoxosomatidae)

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Academic editor: *R. Mesibov* | Received 12 March 2013 | Accepted 21 March 2013 | Published 16 April 2013

urn:lsid:zoobank.org:pub:C7747A4A-DB5E-4B84-8D18-634662BB0A0C

Citation: Car CA, Harvey MS (2013) A review of the Western Australian keeled millipede genus *Boreohesperus* (Diplopoda, Polydesmida, Paradoxosomatidae). ZooKeys 290: 1–19. doi: 10.3897/zookeys.290.5114

Abstract

A taxonomic review of the endemic Western Australian millipede genus *Boreohesperus* Shear is presented in which six species are recognized: the type species, *B. capensis* Shear, 1992, from North-West Cape, one new species, *B. dubitalis*, from Barrow Island and four more new species from the Pilbara region, *B. curiosus*, *B. delicatus*, *B. furcosus* and *B. undulatus*. All six species have highly localized distributions, consistent with being short-range endemics. The nomenclature of the branches of the male gonopod is revised.

Keywords

Morphology, new species, taxonomy, short-range endemics, biodiversity

Introduction

All native Australian keeled or flat-backed millipedes (Polydesmida: Paradoxosomatidae) belong to the subfamily Australiosomatinae, distinguishable from other subfamilies by the presence of a tubercle (adenostyle) arising near the base and on the medial surface of the femur of the first leg of the male. All but one (*Mjoebergodesmus* Verhoeff, 1924) Australian genera conform to this definition (Jeekel 1979) and usually the male first leg is incrassate and bears an obvious, well-developed tubercle.

In Western Australia, the described species of paradoxosomatids fall into five genera: *Antichiropus* Attems, 1911, *Boreohesperus* Shear, 1992, *Helicopodosoma* Verhoeff, 1924, *Hoplatessara* Verhoeff, 1928, and *Stygiochiropus* Humphreys & Shear, 1993 (Attems 1911; Humphreys and Shear 1993; Rowe and Sierwald 2006; Shear 1992; Shear and Humphreys 1996; Verhoeff 1924). A single species of *Hoplatessara* has been recorded from just one locality in Western Australia: the occurrence of this genus in the state remains in doubt and will be discussed in detail in a forthcoming paper on the millipedes of the Great Western Woodlands area of Western Australia (Car and Harvey, unpublished data). Shear (1992) described the genus *Boreohesperus* and its first known species*, B. capensis,* based on specimens from Cape Range in Western Australia, where it was collected from cave entrances. He pointed out that these specimens were not modified for cave life but that they merely "found conditions of the caves congenial" (p 777). The genus was tentatively assigned to the tribe Australiosomatini by Shear (1992) on the basis of the structure of the gonopod. He suggested that the presence of only two acropodite branches in *Boreohesperus* implied a relationship with several eastern and southern Australian genera that have confidently been assigned to the Australiosomatini. At this stage, there is no further evidence suggesting that the placement of *Boreohesperus* in the Australiosomatini should be revised and the genus is, therefore, still considered the only confirmed representative of the tribe in Western Australia, with the other Western Australian genera, except *Hoplatessara,* assigned to the tribe Antichiropodini.

There is no standardized terminology for the description of paradoxosomatid gonopods which may be highly modified across different taxa (Jorgensen and Sierwald 2010) and authors over the years have used a number of different terms for the same structures (Rowe and Sierwald 2006). In the majority of publications, these terms have also implied that the various structures of a gonopod are homologous with those of the podomeres of a walking leg, but there has been no research to confirm this suggestion (Mesibov 2005). Shear (1992) described the gonopod of *B. capensis* as having a short femorite leading into two branches: the long slender solenomerite bearing the sperm canal, and the shorter rod-like tibiotarsus. Jeekel (1968) identified the tibiotarsus as a process arising on the posterior surface of the gonopod, separate from the solenomerite. In *Boreohesperus*, the structure Shear labeled the tibiotarsus appears to arise on the

antero-lateral surface of the acropodite, but he believed this was due to the coiling of the gonopod.

In this paper, we redescribe the genus and describe a new species of *Boreohesperus* from Barrow Island that extends the limits of the genus. We also report on four additional new paradoxosomatid species from the Pilbara region of Western Australia (Figure 9). In this paper, they are described and have been included in the genus *Boreohesperus* as they share the same basic gonopod structure with *B. capensis,* but, in the light of these new discoveries, the labelling of the gonopod branches has become difficult. As for *B. capensis,* each of these new species has a gonopod that splits into two main branches from a short femorite. We have labeled one branch of the gonopod, the solenomere (S) which is the branch that carries the sperm canal, and was referred to as the solenomerite by Shear (1992). The other branch is called the non-seminiferous branch (NSB) here, and is measured from the centre of the solenomere base (bs) to the tip of that branch. The NSB appears to be an extension of the femorite and seems to be the equivalent of that branch labeled the tibiotarsus by Shear. In this paper, the femorite (F) is measured from the solenomere base (bs) to the distal edge of the prefemur (PF). Other structures which make up the acropodite are referred to only as processes to avoid confusion. Thus, the processes found at the tip of the solenomere are labeled solenomere tip processes (stp); any process on the main body of the solenomere is called a solenomere process (sp); the pointed process arising on the NSB is labeled the 'nsbp', and a separate process arising posteriorly from the base of the gonopod in some species is tagged the 'pp'. This last process is a tibiotarsus in the sense used by Jeekel (1968) but has not been named as such in this paper.

Material and methods

All of the specimens examined for this study are preserved in 75% ethanol, and are lodged in the Western Australian Museum, Perth (WAM). The specimens of the new species described from the Pilbara region were collected during a joint Department of Environment and Conservation and Western Australian Museum survey of the region, as outlined by George et al. (2009).

The specimens were examined with Leica MZ6 and MZ16A stereo microscopes and the images were generated with a Leica MZ16A automontage imaging system using Leica Application Suite Version 3.7.0 software. Images of whole specimens and their dorsal views were captured first. The left gonopod from each specimen was then removed and a set of images of the gonopod from four different orientations (posterior, anterior, medial and lateral) was captured. Descriptions were compiled with the software package DELTA (Dallwitz 1999) and the map was generated with ArcMap version 9.3.1 (ESRI Inc.)

Taxonomy

Order Polydesmida Pocock, 1887
Suborder Strongylosomatidea Brölemann, 1916
Family Paradoxosomatidae Daday, 1889
Subfamily Australiosomatinae Brölemann, 1916
Tribe Australiosomatini Brölemann, 1916
Genus *Boreohesperus* Shear, 1992

***Boreohesperus* Shear, 1992: 778**
http://species-id.net/wiki/Boreohesperus

Type species. *Boreohesperus capensis* Shear, 1992, by original designation.

Diagnosis. Four other genera of australiosomatines, apart from *Boreohesperus*, possess gonopods that are divided into two main branches, namely *Dicladosoma* Brölemann, 1913, *Dicladosomella* Jeekel, 1982, *Oncocladosoma* Jeekel, 1985 and *Somethus* Chamberlin, 1920. *Boreohesperus* may be distinguished from the other genera by the two main branches of its gonopod arising from a relatively short but distinct femorite (e.g. Fig. 3E). In *Dicladosoma*, the two thick squat gonopod branches arise from the prefemur, while in the other three genera, the gonopod is split into the two main branches much more deeply than in *Boreohesperus*, almost to the acropodite base.

Description. Modified from Shear (1992). Twenty body segments, each smooth and unsculptured, with distinct waist between prozonite and metazonite. Transverse sternal cross-impressions deeper than longitudinal. Paranota, if present, small, poorly developed. Normal pore formula. Legs and antennae with no remarkable features. Gonopod with coxa relatively broad and robust; prefemur sub-globose; femorite length approximately one-quarter to one-third of acropodite length; remainder of gonopod split into two branches, a long, slender, slightly undulating seminiferous branch with curving tip, and a shorter, more upright, pointed branch, often with an additional process near its tip.

***Boreohesperus capensis* Shear, 1992**
http://species-id.net/wiki/Boreohesperus_capensis
Figs 1A, 2, 9

Boreohesperus capensis Shear, 1992: 779, fig. 1.

Type material. Holotype male: Cave 324, Cape Range, Western Australia, Australia, 22°22'34"S, 113°51'25"E, 27 August 1989, M. East (WAM T23659; original number WAM 91/1408).

Paratypes: 1 female, same data as holotype (WAM T23660; original number WAM 91/1409); 2 males, same data as holotype except Cave 203 22°26’14"S, 113°54’39"E, 19 July 1989, W.F. Humphreys (WAM T23661-T23662; original

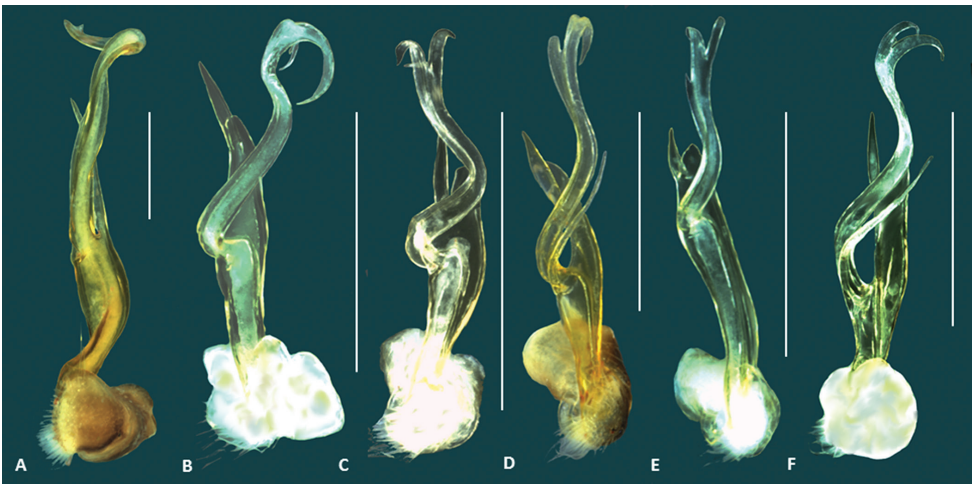

Figure 1. Size comparison of the left gonopod (posterior view), of six *Boreohesperus* species: **A** *B. capensis* Shear, 1992 **B** *B. curiosus* sp. n. **C** *B. delicatus* sp. n. **D** *B. dubitalis* sp. n. **E** *B. furcosus* sp. n. **F** *B. undulatus* sp. n. Scale bars = 0.5 mm.

numbers WAM 91/1410-1411). Other paratypes, lodged in the Australian Museum (Sydney), the American Museum of Natural History (New York) and the Zoologische Museum (Amsterdam) were not examined for this study.

Other material examined. Australia: ***Western Australia:*** Cape Range, 21°55'S, 114°04'E, May 1965, A. Saar, 1♂, 1♀ (WAM T44397); Cape Range, top of range, S. of Shot-hole canyon (#3243), 22°02'S, 114°01'E, by hand, 26 July 1967, W.F. Humphreys, 1♂ (WAM T71462); East coast plain, 21°57'S, 114°07'E, by hand, 28 July 1993, W.F. Humphreys, R.D. Brooks, 1♀ (WAM T71463); Cape Range, cave C-111, Breakdown Maze, 21°55'08"S, 114°00'17"E, 5 July 1989, R. Wood, M. East, 1♀ (WAM T71464); Cape Range, cave C-111, Breakdown Maze, 21°55'08"S, 114°00'17"E, 5 July 1989, R. Wood, M. East, 1♀ (WAM T71469); Cape Range area, WAWA Bore 43, cave C-499, 21°56'S, 114°06'E, by hand, 7 July 1993, R.D. Brooks 1 juvenile (WAM T71470); Cape Range area, on damp soil near cave C-499 (WAWA Bore 43 Cave), 21°56'S, 114°06'E, by hand, 19 May 1993, W.F. Humphreys, R.D. Brooks, 1♂, 2♀, 17 juveniles (WAM T71471); N-W Cape Peninsula, cave C-21 (#3346), 22°14'S, 113°58'E, 10 July 1989, A. Humphreys, R. Wood, 1♀ (WAM T71472); N-W Cape Peninsula, cave C-21 (#3348), 22°14'S, 113°58'E, 10 July 1989, A. Humphreys, R. Wood, 1♀ (WAM T71473); Cape Range area, 4 m outside cave, C-118 (#399), 22°09'S, 113°59'E, pitfall traps, 23 July 1989, E.C. Pryor, 1♂ (WAM T71474); Cape Range area, outside cave, C-118 (#320), 22°09'S, 113°59'E, wet pitfall traps, 27 July 1989, E.C. Pryor, 1♂, 1♀ (WAM T71475); Cape Range area, cave C-15, 22°13'S, 113°59'E, 13 August 1992, W.F. Humphreys, R.D. Brooks, R. L'Heureux, 1♀ (WAM T71476); Cape Range area, cave C-222, 21°56'S, 114°06'E, by hand, 10 August 1992, W.F. Humphreys, R.D. Brooks, 1♂, 1♀ (WAM T71477); N-W Cape Peninsula, cave C-232 (#4092), 21°56'S, 114°05'E, 10 July 1989, E. Bowra, 1♂ (WAM T71478); N-W Cape Peninsula, cave C-18 (#3544),

Figure 2. *Boreohesperus capensis* Shear, 1992. **A–B** Male (WAM T44397) habitus: **A** lateral view **B** dorsal view **C–F** Male (WAM T44397) left gonopod: **C** posterior view **D** anterior view **E** medial view **F** lateral view. **bs** solenomere base **C** coxa **F** femur **NSB** non-seminiferous branch **PF** prefemur **S** solenomere. Scale bars: **A–B** = 2 mm; **C–F** = 0.5 mm.

22°05'S, 114°00'E, 26 June 1989, B. Vine, M.S. Harvey, R.D. Brooks, 1♀ (WAM T71479); N-W Cape Peninsula, outside cave C-161 (#3065), 22°13'S, 113°58'E, 2 August 1989, E. Pryor, M. East, 1♀ (WAM T71480); N-W Cave Peninsula, cave C-222 (#3869), 21°56'S, 114°06'E, 3 June 1989, A.J. Humphreys, 1♂ (WAM T71481); N-W Cape Peninsula, cave C-177 (#3988), 22°06'S, 113°58'E, 7 July 1989, M. East, R. Wood 1♀ (WAM T71482); N-W Cape Peninsula, cave C-203 (#2623), 22°26'S, 113°55'E, 19 July 1989, B. Jones, 2♀, 1 juvenile (WAM T71483); N-W Cape Peninsula, near cave C-201 (#425), 22°10'S, 113°58'E, 19 June 1990, D. Brooks, 1♂ (WAM T71484); data lost, presumably Cape Range area, 1♀ (WAM T71485); N-W Cape Peninsula, cave C-162 (#3960), 22°09'S, 114°00'E, 20 June 1989, M.S. Harvey, 1♂ (WAM T71486); N-W Cape Peninsula, cave C-68 (#4238), 22°06'S, 113°59'E, 26 June 1989, R. Wood, 1♂ (WAM T71487); N-W Cape Peninsula, cave C-328 (#3098), 22°01'S, 113°56'E, 28 August 1989, M. East, 1♂ (WAM T71488); N-W Cape Peninsula, cave C-107 (#3267), 22°07'S, 114°00'E, 30 June 1989, B. Vine, E. Bowra, 1 juvenile (WAM T71489); N-W

Cape Peninsula, Well #2, Charles Knife Road (#381), 22°06'S, 113°59'E, attracted by ants on track, 3 June 1990, J.M. Waldock, 1♀ (WAM T71490).

Diagnosis. *Boreohesperus capensis* is considerably larger than other species of the genus, measuring approximately 20 mm in length, and 2 mm in mid-body width (Figs 2A–B). Additionally, the solenomere of the gonopod is twisted and undivided at its tip, unlike those of other species, and the non-seminiferous branch of the gonopod in *B. capensis* lacks the extra process seen in all other species (Figs 1A, 2C–F).

Description. *Holotype male*: See Shear (1992).

Distribution. This species is restricted to the Cape Range region of Western Australia (Fig. 9).

***Boreohesperus curiosus* sp. n.**
urn:lsid:zoobank.org:act:E0E61D2E-4BE0-463B-91AB-E9F3DB5219A3
http://species-id.net/wiki/Boreohesperus_curiosus
Figs 1B, 3, 9

Type material. Holotype male: 14.5 km NNW. of Mt Elvire, Pilbara Biological Survey site OYE07, Western Australia, Australia, 21°42'39"S, 116°45'57"E, ethylene glycol pitfall traps, 2 October 2005–21 May 2006, CALM Pilbara Survey (WAM T124633).

Paratype: 1 female, same data as holotype (WAM T126116).

Etymology. This species is named for the shape of the gonopod that is markedly different from those of the other species (*curiosus*, Latin, adjective, odd, different).

Diagnosis. *Boreohesperus curiosus* sp. n. has an easily recognizable gonopod in which the solenomere, when seen in medial or lateral view, curves in an arc (Figs 3E, F) and ends in two large claw-like processes (Fig. 3D). This species also bears two, small, spine-like processes situated at the tip of the solenomere (Fig. 3E).

Description. *Holotype male*: Body approximately 7 mm long; mid-body ring approximately 1 mm wide dorsally, with distinct waist between prozonite and metazonite; legs of moderate length, approximately equal to length of 1 to 2 mid-body rings. Colour bleached by alcohol. Paranota on all but first few body rings small. Sternites, other than those of fifth body ring, with no noticeable features. Anterior spiracles at mid-body flat circular. Antennae distinctly clavate, of moderate length, extending approximately to first body ring behind collum (to body segment 2), antennomeres relatively robust (Figs 3A, B). Gonopod long, extending at least to fifth body ring; coxa (C) much broader than acropodite and approximately 2× as long as broad; prefemur (PF) short, sub-globose; femorite (F) short, one-quarter to one-third length of acropodite, slightly narrower at base, then broadening; non-seminiferous branch (NSB) broadest at solenomere base, then narrowing to form blunt finger shape; process on medial surface of NSB (nsbp) sharply pointed, arising close to NSB tip, and slightly shorter (approximately two-thirds length) than NSB, extending well beyond rounded branch tip; solenomere (S) relatively long and slender, arising midway between NSB tip and prefemur, basal third curving away from NSB and tip curving back towards gonopod midline to form definite arc;

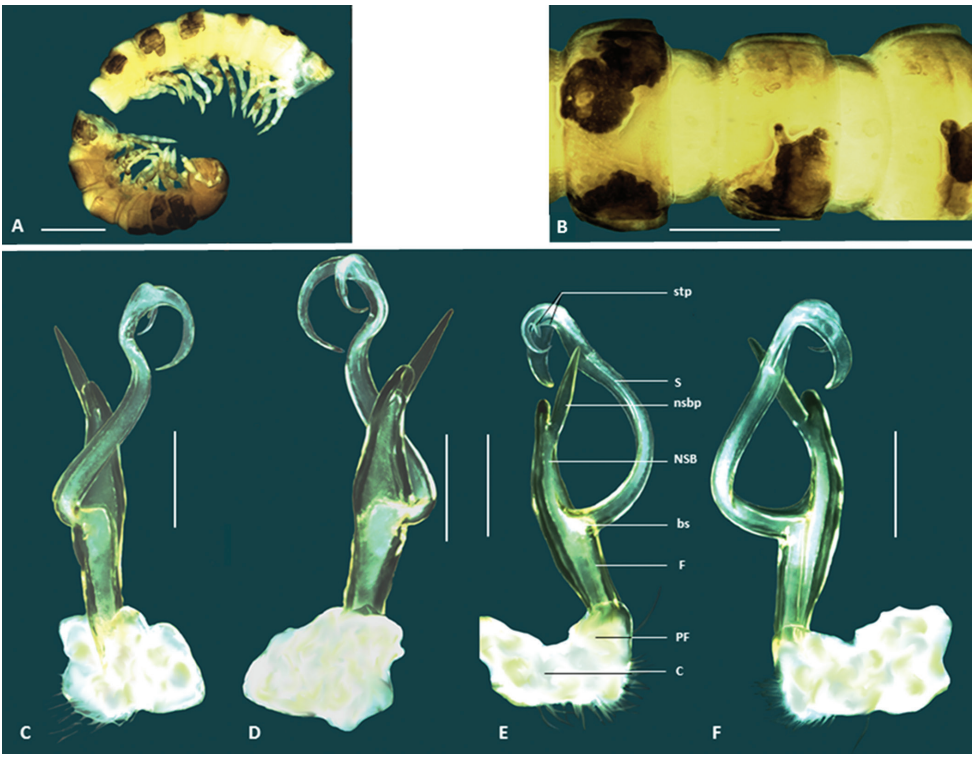

Figure 3. *Boreohesperus curiosus* sp. n. **A–B** Holotype male (WAM T124633) habitus: **A**, lateral view **B** dorsal view **C–F** Holotype male left gonopod: **C** posterior view **D** anterior view **E** medial view **F** lateral view. **bs** solenomere base **C** coxa **F** femur **NSB** non-seminiferous branch **nsbp** non-seminiferous branch process **PF** prefemur **S** solenomere **stp** solenomere tip process. Scale bars: **A** = 1 mm; **B** = 0.5 mm; **C–F** = 0.2 mm.

solenomere tip divided into two, main pointed claw like forks, with two small spine-like processes (stp) occurring at base of shorter fork when viewed medially; solenomere process (sp) absent; separate posterior process (pp) absent (Figs 1B, 3C–F).

Female: similar to male, except for genitalic features.

Distribution. This species in known only from two specimens found at Mt Elvire in the Pilbara region (Fig. 9).

***Boreohesperus delicatus* sp. n.**
urn:lsid:zoobank.org:act:69CC2421-755B-4EA1-B1C1-363DEB55E796
http://species-id.net/wiki/Boreohesperus_delicatus
Figs 1C, 4, 9

Type material. Holotype male: 6 km SE. of Marda Pool, Pilbara Biological Survey site DRW10, Western Australia, Australia, 21°04'11.8"S, 116°12'15.5"E, May 2004, CALM Pilbara Survey (WAM T76070).

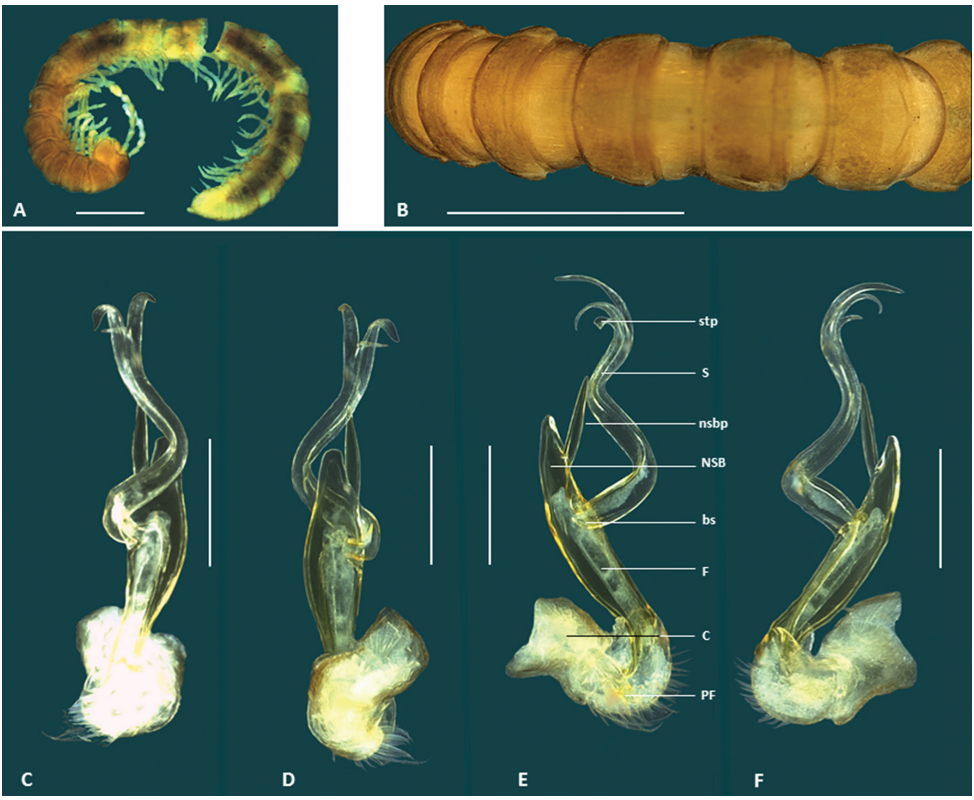

Figure 4. *Boreohesperus delicatus* sp. n. **A–B** Holotype male (WAM T76070) habitus: **A** lateral view **B** dorsal view **C–F** Holotype male left gonopod: **C** posterior view **D** anterior view **E** medial view **F** lateral view. **bs** solenomere base **C** coxa **F** femur **NSB** non-seminiferous branch **nsbp** non-seminiferous branch process **PF** prefemur **S** solenomere **stp** solenomere tip process. Scale bars: **A** = 1 mm; **B** = 1 mm; **C–F** = 0.2 mm.

Paratypes: 1 male, 1 female and 1 immature male, same data as holotype (WAM T126117); 1 male (gonopod only), 11 km ESE. of Marda Pool, Pilbara Biological Survey site DRW07, Western Australia, Australia, 21°03'20.4"S, 116°15'06"E, May 2004, CALM Pilbara Survey (WAM T76065).

Etymology. This species is named for its tiny size and delicate gonopods (*delicatus*, Latin, adjective, dainty).

Diagnosis. This species is most similar to *Boreohesperus undulatus* sp. n. but the gonopods of the two species differ in the following ways: (1) in *B. delicatus* sp. n. the femorite and non-seminiferous branch (NSB) together form a relatively narrow boat shape (Figs 4E, F) whereas in *B. undulatus* sp. n. they form a much broader spindle-shaped branch when viewed medially or laterally (Figs 8E, F); (2) the base of the solenomere of *B. delicatus* sp. n. arises approximately midway between the tip of the NSB and the distal end of the prefemur (Figs 4C–F), whereas that of *B. undulatus* sp. n. arises closer to the prefemur (Figs 8C, F); and (3) *B. delicatus* sp. n. does not possess a posterior process (Fig. 4C), as in *B. undulatus* sp. n. (Fig. 8C).

Description. *Holotype male*: Body approximately 7 mm long; mid-body ring approximately 0.75 mm wide dorsally with distinct waist between prozonite and metazonite; legs of moderate length, approximately equal to length of 1 to 2 mid-body rings. Colour bleached by alcohol. Paranota on all but first few body rings small. Sternites, other than those of fifth body ring, with no noticeable features. Anterior spiracles at mid-body flat circular. Antennae distinctly clavate, of moderate length, extending approximately to first body ring behind collum (to body segment 2), antennomeres relatively robust (Figs 4A, B). Gonopod of medium length, extending to posterior edge of fifth body ring; coxa (C) much broader than acropodite and approximately 2× as long as broad; prefemur (PF) short, sub-globose; femorite (F) short, one-quarter to one-third length of acropodite, noticeably narrower at base, then broadening; non-seminiferous branch (NSB) broadest at solenomere base then narrowing to form roughly triangular shape with broadly rounded tip; process on medial surface of NSB (nsbp) slender, arising approximately midway between NSB tip and base of solenomere (bs), similar in length to NSB, extending well beyond branch tip; solenomere (S) relatively long and slender, arising midway between NSB tip and prefemur, forming a distinct 'S' shape when viewed in any orientation; solenomere tip divided into two, main pointed ribbon-like forks, with third small spine-like process (stp) seemingly arising between main forks; solenomere process (sp) absent; separate posterior process (pp) absent (Figs 1C, 4C–F).

Female: Similar to male, except for genitalic features.

Distribution. This species is known only from the locality of Marda Pool in the Pilbara Region (Fig. 9) where it was found co-occurring with *B. undulatus* sp. n..

***Boreohesperus dubitalis* sp. n.**

urn:lsid:zoobank.org:act:0D0F45E5-7CB3-435E-9F83-D45D8B4F9B73
http://species-id.net/wiki/Boreohesperus_dubitalis
Figs 1D, 5, 6, 9

Type material. Holotype male: Barrow Island, WSW. of Latitude Point, Western Australia, Australia, 20°46'51"S, 115°26'28"E, mostly limestone and rocks, little soil, 11 August 2002, S. Slack-Smith (WAM T57637).

Paratypes: 2 males and 3 females, Barrow Island, 500m E. of Base, Western Australia, Australia, 20°49'02.0"S, 115°23'24.4"E, dry pitfall trap, 26 March 2012, R. Teale (WAM T126126).

Other material examined. Australia: ***Western Australia:*** **Barrow Island:** current airport, helicopter hangar, site N05b, 20°51'50"S, 115°24'23"E, Winkler sac, 1 May 2007, S. Callan, K. Edward, 1♂, 1♀, 1 juvenile (WAM T56353); old administration building, site N23, 20°49'09"S, 115°23'40"E, Winkler sac, 1 May 2007, S. Callan, K. Edwards, 2♀, 3 juveniles (WAM T56354); 20°48'S, 115°24'E, by hand, 31 March 1971, Burbidge, Butler, 1♂, 1 unidentified remains (WAM T73900); 4.5 km N. of Chevron Texaco Camp (NR B21), 20°47'14"S, 115°26'41"E, 8 March-20 May 2006, BIOTA, 1♀ (WAM T83026); Gorgon project, footprint plot GP5,

Figure 5. *Boreohesperus dubitalis* sp. n., living male (WAM T126113) (approx. 10 mm long) on Barrow Island. Image courtesy of K. Cullen.

20°46'59"S, 115°27'03"E, Winkler sac on high limestone flats, 15 March 2006, S. Callan, R. Graham, 4♂, 1♀, 1 juvenile (WAM T121015); Gorgon project, footprint GP7, 20°47'51"S, 115°26'27"E, Winkler sac on limestone ridge to drainage line, 15 March 2006, S. Callan, R. Graham, 1♂ (WAM T121016); Gorgon project, footprint plot CC2, 20°49'02"S, 115°26'24"E, wet pitfall traps on low limestone flats, 10-15 March 2006, S. Callan, R. Graham, 12♂, 1♀ (WAM T121017); Gorgon project, footprint plot GP9, 20°47'59"S, 115°27'00"E, Winkler sac on low limestone ridge, 15 March 2006, S. Callan, R. Graham, 3♂, 2♀, 10 juveniles, (WAM T121018); Gorgon project, footprint plot GP7, 20°47'51"S, 115°26'27"E, wet pitfall traps on limestone ridge to drainage line, 10–15 March 2006, S. Callan, R. Graham, 2♂ (WAM T121019); Gorgon project, footprint plot GP4, 20°47'03"S, 115°27'33"E, Winkler sac on low limestone flats, 15 March 2006, S. Callan, R. Graham, 1♀, 3 juveniles (WAM T121020); Gorgon project, footprint plot GP5, 20°46'59"S, 115°27'03"E, wet pitfall traps on high limestone flats, 10–15 March 2006, S. Callan, R. Graham, 1♂ (WAM T121021); Gorgon project, site 105, 20°48'08"S, 115°26'48"E, Winkler sac, 17 May 2005, S. Callan et al., 1♂, 1 juvenile (WAM T121022); future construction village, 20°49'00"S, 115°26'16"E, wet pitfall traps 17-22 May 2005, S. Callan et al., 1♂ (WAM T121023); Gorgon project, footprint plot GP9, 20°47'59"S, 115°27'00"E, wet pitfall traps on low limestone ridge, 10–15 March 2006, S. Callan, R. Graham, 2♀ (WAM T121024); Gorgon project, footprint plot CC1, 20°49'01"S, 115°26'15"E, wet pitfall traps on valley flats, 10-15 March 2006, S. Callan, R. Graham, 3♂ (WAM T121025); Gorgon project, footprint plot CC2, 20°49'02"S, 115°26'24"E, Winkler sac on low limestone flats, 15 March 2006, S. Callan, R. Graham, 1♂, 1♀, 15 juveniles (WAM T121026); old rubbish dump, 20°47'51"S, 115°20'55"E, Winkler sac

on 17 May 2005, S. Callan et al., 1♂ (WAM T121027); Gorgon project, footprint plot CC2, 20°49'02"S, 115°26'24"E, hand collected on low limestone flats, 15 March 2006, S. Callan, R. Graham, 1♀ (WAM T121028); site 22, 20°47'12"S, 115°27'17"E, hand collected, 17 May 2005, S. Callan et al., 2♀ (WAM T121029); Chevron Texaco camp, 20°49'43"S, 115°26'36"E, hand sorted litter, 7 May 2005, S. Callan et al., 1♂ (WAM T121030); 500m E. of Base, 20°49'02.0"S, 115°23'24.4"E, dry pitfall trap, 26 March 2012, R. Teale, 1♂ (WAM T123094); Quarantine Interception from Barrow Island, WAPET Landing, offices, 20°45'29"S, 115°28'19"E, by hand on path between vegetation and building, 8 January 2013, K. Cullen, 1♂ (WAM T126113).

Etymology. This species is named for the fact that, as the first new species of *Boreohesperus* to be discovered, there was initial difficulty in deciding on a genus in which to place it (*dubitalis*, Latin, adjective, to be doubted).

Diagnosis. This species differs from the four other new species because it is noticeably larger, although it is smaller than *B. capensis*. In common with *B. furcosus* sp. n. and *B. undulatus* sp. n., this species carries a process on the main body of the solenomere of the gonopod, but unlike the other species, this process is long and finger-like, extending almost to the solenomere tip (Fig. 6E).

Description. *Holotype male*: body approximately 10 mm long; mid-body ring approximately 1.2 mm wide dorsally with distinct waist between prozonite and metazonite; legs of moderate length, approximately equal to the length of 1 to 2 mid-body rings. Colour dark brown overall and legs with coloration similar to that of body. Paranota on all but first few body rings small. Sternites, other than those of the fifth body ring, with no noticeable features. Anterior spiracles at mid-body flat circular. Antennae less obviously clavate, fifth and sixth antennomeres only slightly wider than proximal ones, long, extending beyond body segment 2, antennomeres relatively slender (Figs 5, 6A, B). Gonopod long, extending at least to fifth body ring; coxa (C) much broader than acropodite and approximately 2x as long as broad; prefemur (PF) short, sub-globose; femorite (F) short, one-quarter to one-third length of acropodite, slightly narrower at base, then broadening; non-seminiferous branch (NSB) broadest at solenomere base then narrowing to form pointed finger-like shape; process on medial surface of NSB (nsbp) pointed, arising closer to NSB tip than to solenomere base (bs), and much shorter than NSB; solenomere (S) relatively long and slender, arising midway between NSB tip and prefemur, basal third curving away from NSB and tip curving back towards gonopod midline to form loose arc; solenomere tip divided into two, main pointed ribbon like forks; solenomere process (sp) present, long, finger-like and extending almost to solenomere tip; separate posterior process (pp) arising near solenomere base, long, slender, pointed and approximately half solenomere length (Figs 1D, 6C–F).

Female. Similar to male, except for genitalic features.

Distribution. *Boreohesperus dubitalis* sp. n. is endemic to Barrow Island where it is widespread and abundant (Fig. 9). However, due to its restricted distribution of less than 100 km^2, it clearly represents a short-range endemic species.

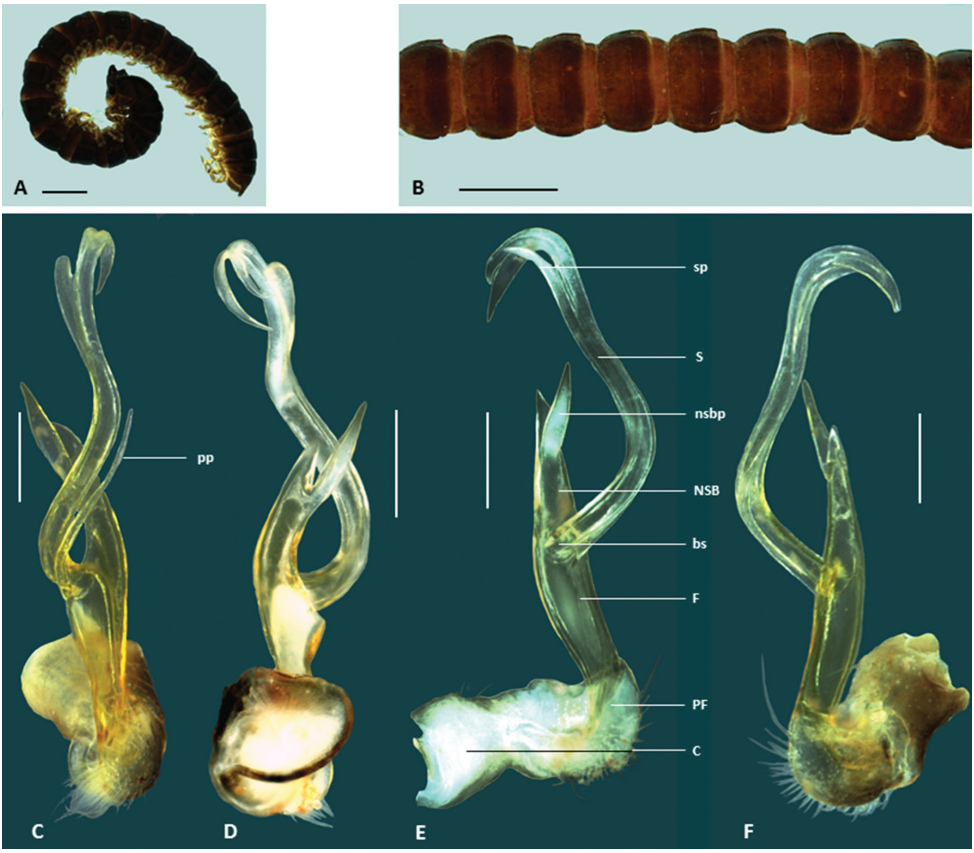

Figure 6. *Boreohesperus dubitalis* sp. n. **A** Male (WAM T123094) habitus, lateral view **B** Holotype male (WAM T57637) habitus, dorsal view **C–F** Holotype male left gonopod: **C** posterior view **D** anterior view **E** medial view **F** lateral view. **bs** solenomere base **C** coxa **F** femur **NSB** non-seminiferous branch **nsbp** non-seminiferous branch process **PF** prefemur **pp** posterior process **S** solenomere **sp** solenomere process. Scale bars: **A** = 1 mm; **B** = 1 mm; **C–F** = 0.2 mm.

***Boreohesperus furcosus* sp. n.**
urn:lsid:zoobank.org:act:7D64C1AD-1856-420D-BE41-D32E7074B38E
http://species-id.net/wiki/Boreohesperus_furcosus
Figs 1E, 7, 9

Type material. Holotype male: 9.5 km S. of Mt Minnie, Pilbara Biological Survey site WYW04, Western Australia, Australia, 22°11'19.1"S, 115°33'13.2"E, May 2004, CALM Pilbara Survey (WAM T76078).

Paratypes: 4 males and 4 females, same data as holotype (WAM T126118).

Etymology. This species is named for the solenomere of the gonopod that is more branched than those of other species (*furcosus*, Latin, adjective, full of forks).

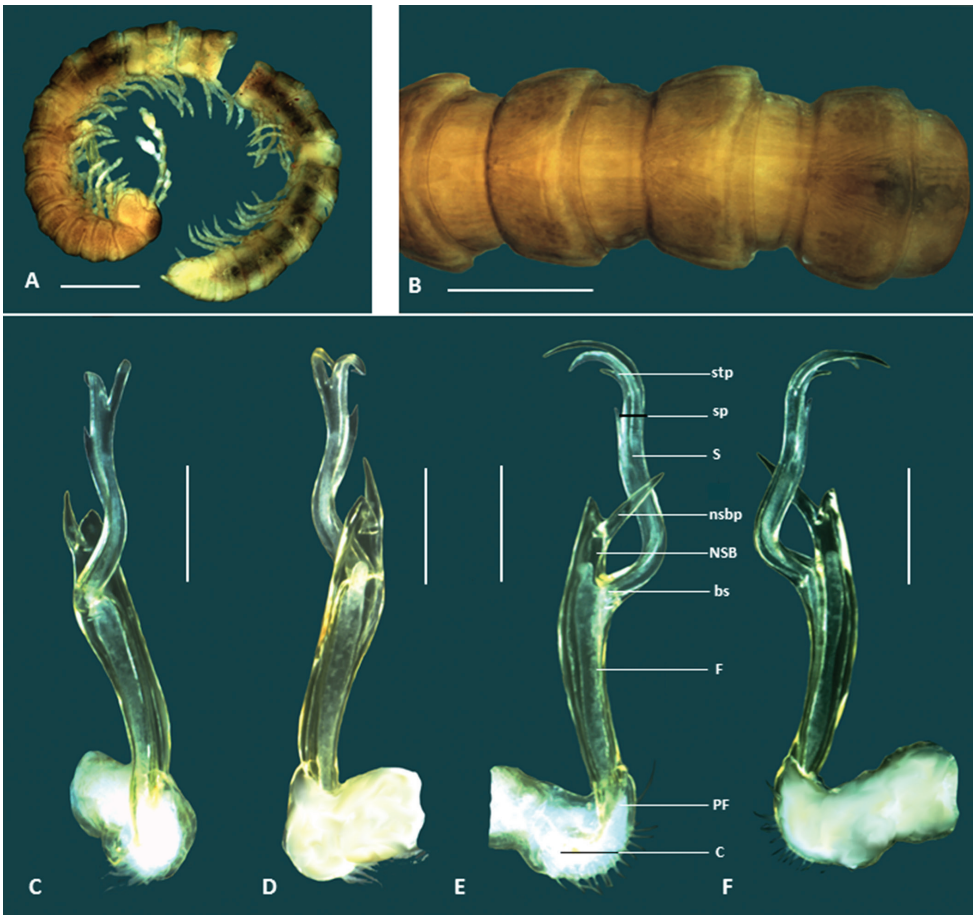

Figure 7. *Boreohesperus furcosus* sp. n. **A–B** Holotype male (WAM T76078) habitus: **A** lateral view **B** dorsal view **C–F** Holotype male left gonopod: **C** posterior view **D** anterior view **E** medial view **F** lateral view. **bs** solenomere base **C** coxa **F** femur **NSB** non-seminiferous branch **nsbp** non-seminiferous branch process **PF** prefemur **S** solenomere **sp** solenomere process **stp** solenomere tip process. Scale bars: **A** = 1 mm; **B** = 0.5 mm; **C–F** = 0.2 mm.

Diagnosis. This species may be distinguished from the other small species of *Boreohesperus* found in the Pilbara by the more upright solenomere and the presence of two processes on the solenomere of the gonopod which are also found in *B. curiosus* sp. n. and *B. undulatus* sp. n.. In *B. curiosus* sp. n., however, these processes arise at the solenomere tip (Fig. 3E) while in *B. furcosus* sp. n. and *B. undulatus* sp. n., one process is situated near the solenomere tip and the other occurs approximately one third along the solenomere length from the tip (Figs 7E, 8E). Most importantly, *B. furcosus* sp. n. lacks the posterior process of *B. undulatus* sp. n., and has a noticeably long femorite compared with all the other species.

Description. *Holotype male:* body approximately 8 mm long; mid-body ring approximately 0.75 mm wide dorsally, with distinct waist between prozonite and meta-

zonite; legs of moderate length, approximately equal to the length of 1 to 2 mid-body rings. Colour bleached by alcohol. Paranota on all but first few body rings small. Sternites, other than those of fifth body ring, with no noticeable features. Anterior spiracles at mid-body flat circular. Antennae distinctly clavate, long, extending well beyond body segment 2, antennomeres relatively robust (Figs 7A, B).Gonopod long, extending at least to fifth body ring; coxa (C) much broader than acropodite and approximately 2x as long as broad; prefemur (PF) short, sub-globose; femorite approximately half acropodite length, slightly narrower at base, then broadening; non-seminiferous branch (NSB) short, broad with pointed tip; process on medial surface of NSB (nsbp) sharply pointed, arising close to NSB tip, longer than NSB, extending well beyond branch tip; solenomere (S) relatively slender and upright, arising closer to NSB tip than to prefemur;. solenomere tip divided into two, main pointed ribbon like forks, with third small spine like process (stp) arising at base of main forks; solenomere process (sp) present, short; separate posterior process (pp) absent (Figs 1E, 7C-F).

Female: Similar to male, except for genitalic features.

Distribution. This species had been found from only one locality, Mt Minnie, in the Pilbara region of Western Australia (Figure 9).

***Boreohesperus undulatus* sp. n.**
urn:lsid:zoobank.org:act:90586ED4-0AAD-4173-A958-D16655A5B3CA
http://species-id.net/wiki/Boreohesperus_undulatus
Figs 1F, 8, 9

Type material. Holotype male: 3.5 km N. of Karratha Station, Pilbara Biological Survey site DRW05, Western Australia, Australia, 20°51'14.1"S, 116°40'07.9"E, May 2004, CALM Pilbara Survey (WAM T76056).

Paratypes: 4 males, 1 female and 1 juvenile, same data as holotype (WAM T126119); 1 male and 1 female, 11 km ESE. of Marda Pool, Pilbara Biological Survey site DRW07, Western Australia, Australia, 21°03'20.4"S, 116°15'06"E, May 2004, CALM Pilbara Survey (WAM T76072).

Etymology. This species is named for the shape of the gonopods (*undulatus*, Latin, adjective, wavy).

Diagnosis. This species is similar to *B. delicatus* sp. n., but the gonopod is slightly larger and the shape of the non- seminiferous branch and femorite together is much broader (spindle shaped) than that of *B. delicatus* (Fig. 8F). In addition, the gonopod of *B. undulatus* sp. n. carries a posterior process (Fig. 8C), lacking in *B. delicatus* sp. n.. The presence of a posterior process also distinguishes this species from *B. furcosus* sp. n., although *B. dubitalis* sp. n. also carries this posterior process. *B. undulatus* sp. n. is, however, much smaller than *B. dubitalis* sp. n., and the solenomere process found on the male gonopod of *B. undulatus* sp. n., while present (Fig. 8E), as it is in *B. dubitalis* sp. n., is much shorter than the relatively long finger-like solenomere process found on *B. dubitalis* sp. n. (Fig. 6E).

Figure 8. *Boreohesperus undulatus* sp. n. **A–B** Holotype male (WAM T76056) habitus: **A** lateral view **B** dorsal view **C–F** Holotype male left gonopod: **C** posterior view **D** anterior view **E** medial view **F** lateral view. **bs** solenomere base **C** coxa **F** femur **NSB** non-seminiferous branch **nsbp** non-seminiferous branch process **PF** prefemur **pp** posterior process **S** solenomere **sp** solenomere process **stp** solenomere tip process. Scale bars: **A** = 1 mm; **B** = 0.5 mm; **C–F** = 0.2 mm.

Description. *Holotype male*: body approximately 7 mm long; mid-body ring approximately 0.75 mm wide dorsally with distinct waist between prozonite and metazonite; legs of moderate length, approximately equal to length of 1 to 2 mid-body rings. Colour bleached by alcohol. Paranota on all but first few body rings small. Sternites, other than those of fifth body ring, with no noticeable features. Anterior spiracles at mid-body flat circular. Antennae distinctly clavate, of moderate length, extending approximately to first body ring behind collum (to body segment 2), antennomeres relatively robust. Gonopod long, extending at least to fifth body ring; coxa (C*)* much broader than acropodite, and approximately 2× as long as broad; prefemur (PF) short, sub-globose; femorite (F) short, one-quarter to one-third length of acropodite; noticeably narrower at base, then broadening; non-seminiferous branch (NSB) noticeably broadest at solenomere base then narrowing to form broad spindle shape with pointed

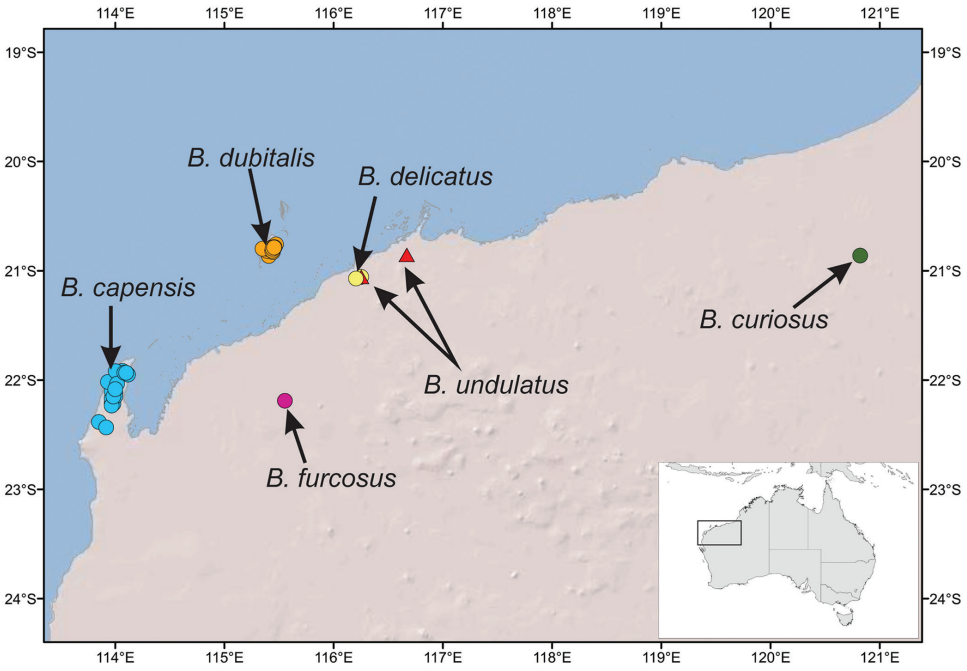

Figure 9. Map of the Pilbara region of north-western Australia showing distributions of *Boreohesperus* species.

tip; process on medial surface of NSB (nsbp) pointed, arising closer to NSB tip than to solenomere base (sb), and much shorter than NSB, extending just beyond branch tip; solenomere (S) relatively long and slender, arising closer to prefemur than to NSB tip, forming distinct 'S' shape when viewed in any orientation; solenomere tip divided into two, main pointed ribbon like forks, with third small spine-like process (stp) appearing to arise between main forks solenomere process (sp) present, short; separate posterior process (pp) arising near bs, long, slender, pointed and approximately half solenomere length.

Female: Similar to male, except for genitalic features.

Distribution. This species has been collected from two localities in the Pilbara: Karratha Station and Marda Pool, situated ca. 50 km apart (Fig 9).

Discussion

With few exceptions, paradoxosomatid millipede species in Australia are considered to be short-range endemics, defined by Harvey (2002) as species with natural distributions of less than 10,000 square kilometres. Most maintain very small ranges, well below Harvey's threshold, for example, species of the genus *Dicladosomella* in south-western New South Wales (Car 2012) and nearly all species of the genus *Antichiropus* in Western Australia (Attems 1911). The genus *Boreohesperus* is confined to Western

Australia and, at present, has been found only in a relatively small area of the semi-arid region of that state between latitudes 20°30'S and 22°30'S (Fig. 9). Extensive terrestrial invertebrate surveys have been carried out in Cape Range and the Pilbara region as well as on Barrow Island, and it appears that each paradoxosomatid species, including those of the genus *Boreohesperus*, has a very limited range, with *B. dubitalis* sp. n. being endemic to Barrow Island. *Boreohesperus delicatus* sp. n. and *B. undulatus* sp. n. are sympatric, both occurring at Marda Pool in the Pilbara and *B. curiosus* sp. n. and *B. furcosus* sp. n. have each been found at single localities. The rarity of specimens in the collection of the Western Australian Museum, apart from the two species from the intensively sampled Barrow Island and Cape Range caves, suggests that *Boreohesperus* species are rarely active on the surface, and may only emerge from the soil after heavy rains.

Acknowledgements

Stephen White of BHP Billiton Pty Ltd and Paul West of Cliffs Natural Resources facilitated the funding for this study for which we are extremely grateful. We wish to thank the staff of the Department of Environment and Conservation, Western Australia, in particular Brad Durrant and Nadine Guthrie, for access to the Pilbara Biological Survey collection. Thanks are due also to Julianne Waldock for laboratory assistance and to Karen Cullen for permission to use the photograph in Figure 5. CAC wishes to thank Michael Rix for assistance in preparing the manuscript and we both thank Sergei Golovatch and an anonymous reviewer for suggestions on improving the paper.

References

Attems CG (1911) Myriopoda exkl. Scolopendridae. In: Michaelsen W, Hartmeyer R (Eds) Die Fauna Südwest-Australiens. Ergebnisse der Hamburger südwest-australischen Forschungsreise 1905. Gustav Fisher, Jena, 3(6), 147–204.

Car CA (2012) Millipede communities in south-eastern Australia: systematics, biogeography and short range endemism. Charles Sturt University, Albury, New South Wales, Australia.

Dallwitz MJ, Paine, TA, Zurcher, EJ (1999) User's guide to the DELTA Editor. http://delta-intkey.com

George AS, McKenzie NL, Doughty P (2009) A Biodiversity Survey of the Pilbara Region of Western Australia, 2002–2007. Records of the Western Australian Museum, Supplement 78.

Harvey MS (2002) Short-range endemism among the Australian fauna: some examples from non-marine environments. Invertebrate Systematics 16: 557–570. doi: 10.1071/IS02009

Humphreys WF, Shear WA (1993) Troglobitic millipedes (Diplopoda: Paradoxosomatidae) from semi-arid Cape Range, Western Australia: systematics and biology. Invertebrate Taxonomy 7: 173–195. doi: 10.1071/IT9930173

Jeekel CAW (1968) On the classification and geographical distribution of the family Paradoxosomatidae (Diplopoda, Polydesmida). CAW Jeekel, Amsterdam, 162 pp.

Jeekel CAW (1979) Notes on the classification of some little known Australian paradoxosomatid genera (Diplopoda, Polydesmida). Journal of Natural History 13: 649–658. doi: 10.1080/00222937900770481

Jorgensen MC, Sierwald P (2010) Review of the Caribbean pyrgodesmid genus *Docodesmus* Cook with notes on potentially related genera (Diplopoda, Polydesmida, Pyrgodesmidae). International Journal of Myriapodology 3: 25–50. doi: 10.1163/187525410X12578602960461

Mesibov R (2005) A new genus of millipede (Diplopoda: Polydesmida: Dalodesmidae) from Tasmania with a pseudo-articulated gonopod telopodite. Zootaxa 1064: 39–49.

Rowe M, Sierwald P (2006) Morphological and systematic study of the tribe Australiosomatini (Diplopoda: Polydesmida: Paradoxosomatidea: Paradoxosomatidae) and a revision of the genus *Australiosoma* Brölemann. Invertebrate Systematics 20: 527–556. doi: 10.1071/IS05034

Shear WA (1992) A new genus and two new species of millipedes from the Cape Range, Western Australia (Diplopoda, Polydesmida, Paradoxosomatidae). Records of the Western Australian Museum 15: 777–784.

Shear WA, Humphreys WF (1996) A new *Stygiochiropus* from a North West Cape (Western Australia) coastal plain cave (Diplopoda: Polydesmida: Paradoxosomatidae). Records of the Western Australian Museum 17: 447–449.

Verhoeff KW (1924) Results of Dr. E. Mjöberg's Swedish Scientific Expeditions to Australia 1910-1913. 34. Myriapoda: Diplopoda. Arkiv för Zoologi 16: 1–142.

ZooKeys 290: 21–30 (2013)
doi: 10.3897/zookeys.290.4568
www.zookeys.org

RESEARCH ARTICLE

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Two new species of *Neoperla* (Plecoptera, Perlidae) from China

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Academic editor: *C. Geraci* | Received 24 December 2012 | Accepted 28 March 2013 | Published 16 April 2013

urn:lsid:zoobank.org:pub:1DE1E464-DA28-4A76-A1D2-D1B0E7D13AD2

Citation: Li W-H, Wang G-Q, Qin X-F (2013) Two new species of *Neoperla* (Plecoptera, Perlidae) from China. ZooKeys 290: 21–30. doi: 10.3897/zookeys.290.4568

Abstract

Two species of the genus *Neoperla* from China are described as new: *Neoperla furcostyla* **sp. n.**, and *N. similidella* **sp. n.** The new species are compared to similar taxa.

Keywords

Plecoptera, Perlidae, *Neoperla*, new species, China

Introduction

The stonefly genus *Neoperla* belongs to the family Perlidae and it is the most speciose genus within the subfamily Perlinae (DeWalt et al. 2012). It is distinguished from other genera of the subfamily by two close located ocelli, and by the abdominal tergum 7 with lobe-like processes and aedeagal tube variously armed with spines or spiny lobes (Sivec et al. 1988). There are up to 68 known species in China described by Chu (1929), Du (1999, 2000a, b), Du and Sivec (2004, 2005), Du and Wang (2005, 2007), Du et al. (1999), Du et al. (2001), Sivec and Zwick (1987), Wu (1935, 1938,

1948, 1962, 1973), Wu and Claassen (1934), Yang and Yang (1990, 1991), Yang and Yang (1992, 1993, 1995a, b, 1996, 1998), Li et al. (2011), Li et al. (2011), Li and Wang (2011), Li et al. (2012) and Li et al. (2012).

In the present paper, we describe two additional species as new to science: *Neoperla furcostyla* sp. n., and *N. similidella* sp. n. from Guangxi autonomous region and Fujian Province, respectively. All types, including paratypes, are deposited in the Entomological Museum of China Agricultural University (CAU). Aedeagi were everted using the cold maceration technique of Zwick (1983).

Taxonomy

***Neoperla furcostyla* Li & Qin, sp. n.**
urn:lsid:zoobank.org:act:757404FC-9474-4C97-AAF2-36DB91DB9525
http://species-id.net/wiki/Neoperla_furcostyla
Figs 1–2

Type material. Holotype: male, China: Guangxi autonomous region, Nanning City, Wuming County, Mt. Damingshan, 23.4047N, 108.4772E, 9 Aug. 2011, Zhang Ting–Ting. Paratypes: 5 males, same data as holotype.

Description. Male. Forewing length 16.6–16.9 mm. General body color brownish. Distance between ocelli about as wide as diameter of ocellus. Head slightly wider than pronotum, lateral margins and M-line pale, a large medial portion brown with area between ocelli and a triangular patch on frons darker (Fig. 1A); compound eyes dark; antennae brown. Pronotum pale brown with medial portion brown (Fig. 1A); wing membrane subhyaline, veins brown; legs evenly brown. Abdomen brown, hemiterga darker.

Terminalia. Tergum 7 process forming a sclerotized, upraised plateau, covered with many small sensilla basiconica (Figs 1B, 2A). Tergum 8 with a recurved quadrate process bearing small spines at distal margin. Tergum 9 without sensilla patches. Hemitergal processes of tergum 10 short and slightly curved (Figs 1B, 2A). Aedeagal tube very long and almost straight, but bearing a pale bifurcate structure with common stem located subapically (Figs 1C, 2B); dorsal surface heavily sclerotized and membraneous areas on ventral surface gradually enlarged toward tip of the tube. Aedeagal sac very short, about one fifth as long as tube, triangular in shape; with granules around sac apex and several dorsoapical spines and patch of smaller ventroapical spines (Fig. 2B).

Female. Unknown.

Etymology. The specific epithet refers to the subapical fork of the aedeagal tube.

Distribution. China (Guangxi).

Diagnosis. The male of *N. furcostyla* is characterized by an elongate, almost straight aedeagal tube bearing a subapical fork with common stem. The aedeagal sac is triangular in shape and barely one fifth as long as tube; several dorsoapical spines and patch of

Figure 1. *Neoperla furcostyla* Li and Qin, sp. n. (male). **A** Head and pronotum, dorsal view **B** Terminalia, dorsal view **C** Aedeagus, lateral view.

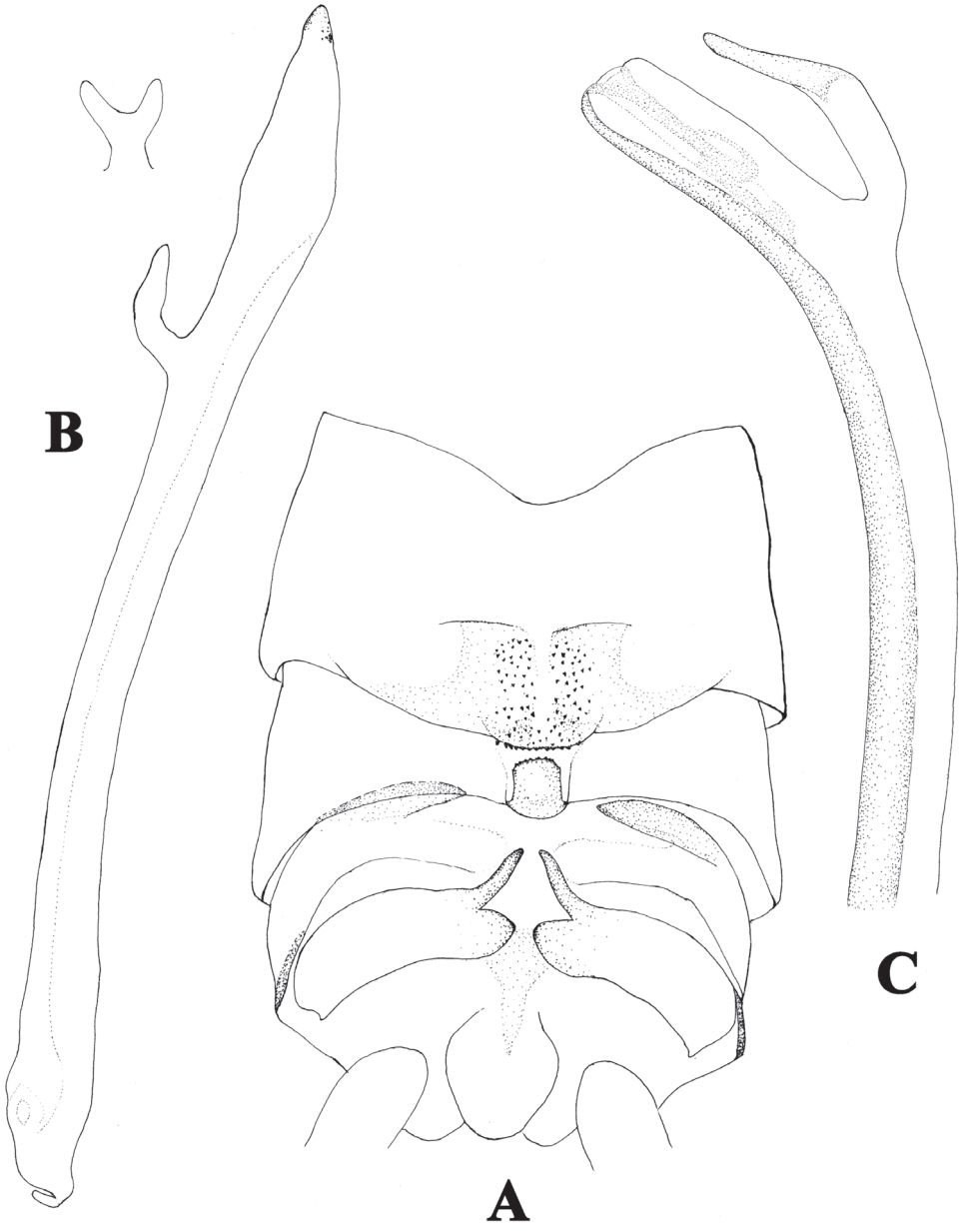

Figure 2. A–C *Neoperla furcostyla* Li and Qin, sp. n. (male). **A** Terminalia, dorsal view **B** Aedeagus, lateral view **C** Aedeagus of *Neoperla forcipata* Yang and Yang, lateral view.

smaller ventroapical spines are present at apex (Figs 1C, 2B). The type of the aedeagus of the new species is also found in *N. forcipata* Yang & Yang, 1992 known from Mt. Wulingshan of Hunan Province of China, but the aedeagus of this species is different. In *N. forcipata* (Fig. 2C), the aedeagal tube is more robust and has an obtuse curve

near the subapical fork, and the fork is much larger than that of *N. furcostyla.* The sac of *N. forcipata* though not everted, has an evident lateral flap subapically that is absent on the sac found in *N. furcostyla*. The new species is assigned to the Diehli subgroup of the Montivaga species group (Zwick 1983).

Notes. The holotype of *N. forcipata* Yang and Yang is apparently damaged at the base of the aedeagal tube, very possibly due to an overlooking of this elongate type of tube during the course of dissection. In this case, it is safe to cut the abdominal at the fifth or preceding segments in order to keep this kind of tube intact after dissection.

***Neoperla similidella* Li & Wang, sp. n.**
urn:lsid:zoobank.org:act:2549F9C7-9FEF-4BF6-B044-783CA798F6F5
http://species-id.net/wiki/Neoperla_similidella
Figs 3–4

Type material. Holotype: male, China: Fujian Province, Mt. Wuyishan, Kekao Station, 735 m, 27.7478N, 117.6831E, light trap, 12 Jul. 2009, Shi Li and Liu Xiao-Yan. Paratypes: 2 males, same data as holotype.

Description. Male. Forewing length 12.6–12.8. General body color dark brown. Distance between ocelli ca. 1.5X as wide as diameter of ocellus. Head slightly wider than pronotum, with a large black ocellar patch barely touching the compound eyes and a black trapezoidal patch on frons (Fig. 3A); compound eyes dark; antennae dark brown. Pronotum dark brown with pale brown to brown lateral margins (Fig. 3A); wing membrane pale brown, veins dark; legs yellow, basal third of tibiae darker. Abdomen dark brown, terminalia darker. Cerci dark except 1st segment brown.

Terminalia. Process of tergum 7 large, rounded and upraised, mostly covered with sparse sensilla basiconica but margined with denser sensilla basiconica patches (Fig. 3B). Tergum 8 with an upcurved tongue-shaped process, fringed with small distal spines. Tergum 9 without sensilla patches. Hemitergal processes of tergum 10 slightly curved medially (Figs 3B, 4D). Aedeagal tube darkly sclerotized, slender and mostly straight but with a gradual dorsoapical curve, dorsal surface heavily sclerotized, with many spinules on dorsal surface (Fig. 3C). Aedeagal sac about half as long as tube and gradually curved ventrad; along dorsoapical surface with a patch of small and median sized spines, and two rows of large stout spines apically (ca. 7 spines) (Figs 3E, 4A); mostly ventral and lateral surfaces of apical half of sac with small spines (Figs 3D, 4C); apex of the sac with several medium sized spines (Figs 4B).

Female. Unknown.

Etymology. The specific epithet refers to the great similarity to the species *N. idella* Stark and Sivec, 2008.

Distribution. China (Fujian Province).

Diagnosis. This species is characterized by its dark body color and the head with a large black ocellar patch barely touching the compound eyes and a black trapezoidal patch on frons. The aedeagal sac has a patch of small and medium sized spines, and

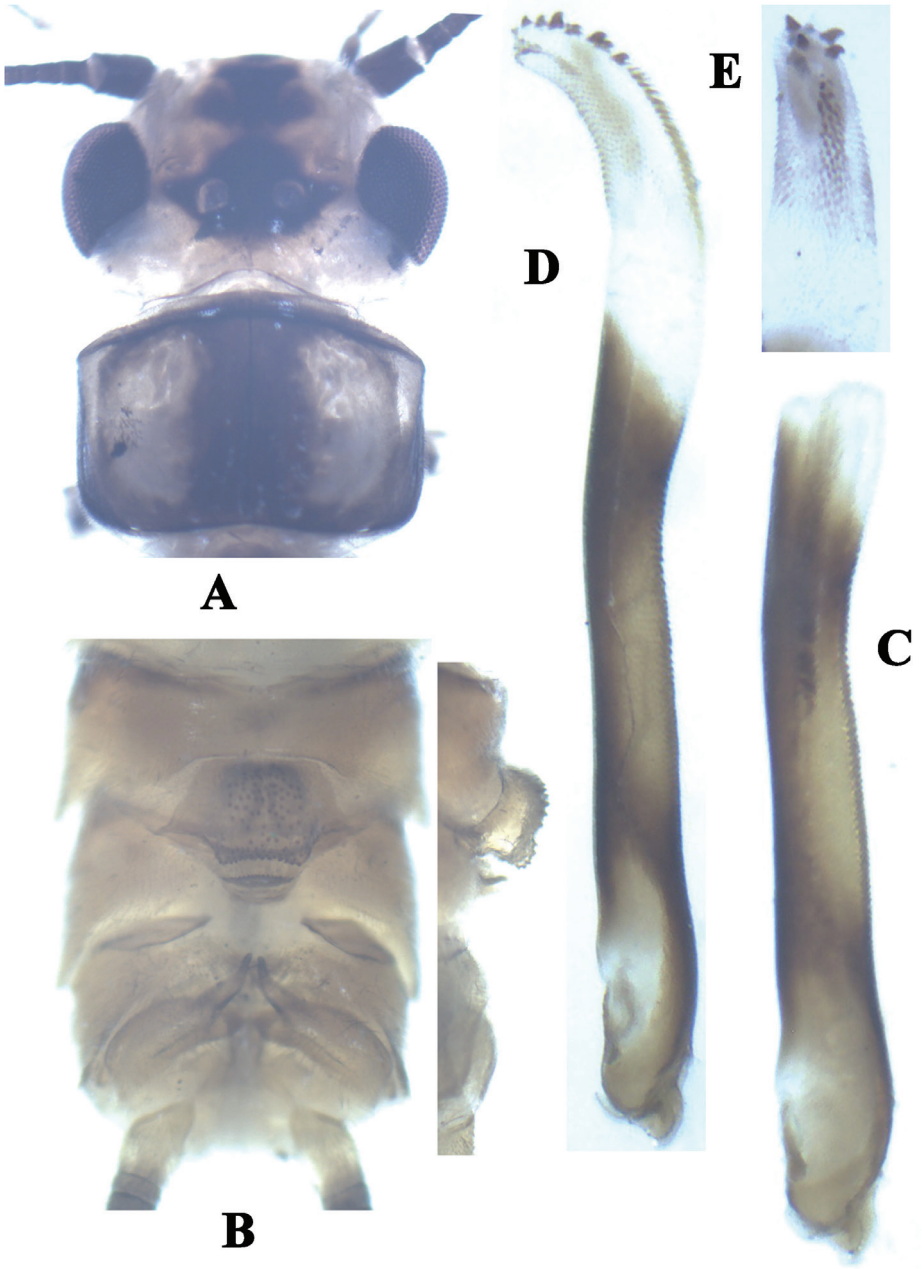

Figure 3. *Neoperla similidella* Li and Wang, sp. n. (male). **A** Head and pronotum, dorsal view **B** Terminalia, dorsal view **C** Aedeagus before eversion, lateral view **D** Aedeagus, lateral view **E** Aedeagal sac, dorsal view.

two rows of large stout spines that range from mid length to the apex of the dorsal surface (ca. 7); ventral and lateral surfaces of the apical half of the sac have small spines and the apex of the sac has several medium-sized spines. The aedeagus of the

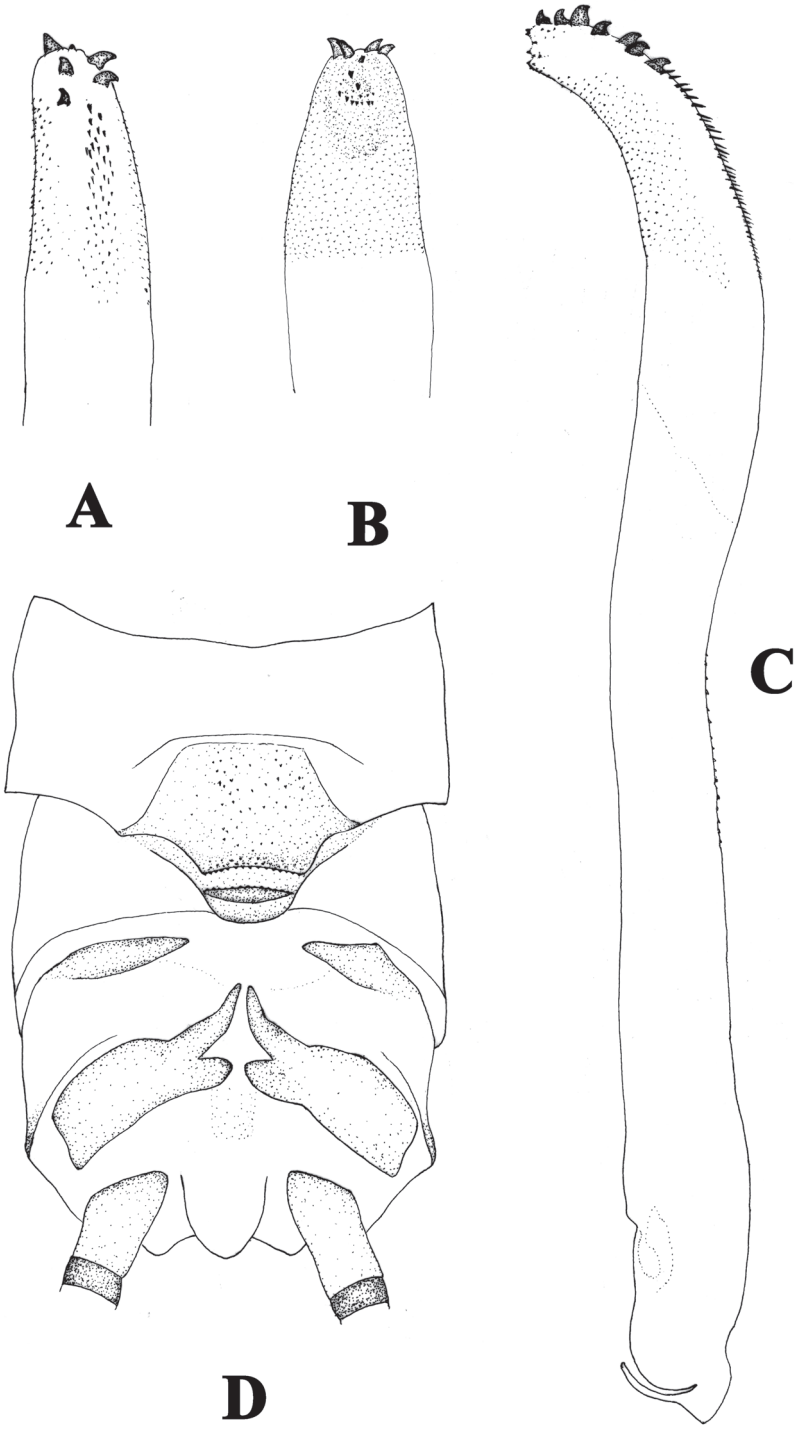

Figure 4. *Neoperla similidella* Li and Wang, sp. n. (male). **A** Aedeagal sac, dorsal view **B** Aedeagal sac, ventral view **C** Aedeagus, lateral view **D** Terminalia, dorsal view.

new species is very similar to that of *N. idella*, however in that species the aedeagal tube lacks a subtle dorsoapical curve and the sac is more strongly curved ventrad (Stark and Sivec 2008, Figs 36–37). In addition, the aedeagal sac of *N. idella* lacks a ventroapical patch of small spines and also lacks medium sized spines. Both species bear similar patches of large spines on the dorsoapical margin of the sac but in the new species the ventrolateral patch of small and medium spines is located nearer the sac apex than in *N. idella*.

Acknowledgments

We acknowledge the partial support of our research by the National Natural Science Foundation of China (No. 31000977).

References

Chu Y-T (1929) Descriptions of four new species and one new genus of stone-flies in the family Perlidae from Hangchow. The China Journal 10: 88–92.

DeWalt RE, Neu-Becker U, Stueber G (2012) Plecoptera Species File Online. Version 1.0/4.1. [12/16/2012] http://Plecoptera.SpeciesFile.org

Du Y-Z (1999) Plecoptera. In: Huang BK (Ed.) Fauna of Insects in Fujian Province of China. Vol. 3. Fujian Science and Technology Publishing house, Fuzhou, Fujian, 301–335.

Du Y-Z (2000a) *Neoperla magisterchoui*, a new species of the genus *Neoperla* Needham (Plecoptera: Perlidae) from China. In: Zhang YL (Ed.) Systematic and faunistic research on Chinese insects. Proceedings of the 5th National Congress of Insect Taxonomy. China Agriculture Press, Beijing, 1–3.

Du Y-Z (2000b) Two new species of the genus *Neoperla* Needham (Plecoptera: Perlidae: Perlinae) from Guizhou, China. Entomotaxonomia 22: 1–5.

Du Y-Z, Sivec I (2004) Plecoptera: Perlidae, Nemouridae, Leuctridae. *In*: Yang XK (Ed.), Insects from Mt. Shiwandashan area of Guangxi. China forestry Publishing House, Beijing, 39–45.

Du Y-Z, Sivec I (2005) Plecoptera. In: Yang XK (Ed.) Insect Fauna of Middle-west Qinling Range and South Mountains of Gansu Province. Science Press, Beijing, 38–54.

Du Y-Z, Wang Z-J (2005) Plecoptera: Leuctridae, Nemouridae, Perlidae and Peltoperlidae. In: Yang MF, Jin DC (Eds) Insects from Dashahe Nature Reserve of Guizhou. Guizhou People Press, Guiyang, Guizhou, 51–57.

Du YZ, Sivec I, He J-H (1999) A checklist of the Chinese species of the family Perlidae (Plecoptera: Perloidea). Acta Entomologica Slovenica 7: 59–67.

Du Y-Z, Wang Z-J (2007) Nemouridae and Perlidae. In: Li ZZ, Yang MF, Jin DC (Eds) Insects from Mountain Leigongshan Landscape of Guizhou. Guizhou Science and Technology Publishing house, Guiyang, Guizhou, 84–90.

Du Y-Z, Sivec I, Zhao M-S (2001) Plecoptera. In: Wu H, Pan CW (Eds) Insects of Tianmushan National Nature Reserve. Science Press, Beijing, 69–80.

Li W-H, Wang R-F (2011) A new species of *Neoperla* (Plecoptera: Perlidae) from China. Entomological News 122: 261–264.

Li W-H, Wang H-L, Lu W-Y (2011) Species of the genus *Neoperla* (Plecoptera: Perlidae) from Henan, China. Zootaxa 2735: 57–63. doi: 10.3157/021.122.0308

Li W-H, Wang G-Q, Lu W-Y (2012) Species of *Neoperla* (Plecoptera: Perlidae) from Hubei, China. Zootaxa 3478: 32–37.

Li W-H, Wang G-Q, Li W-L, Murányi D (2012) Review of *Neoperla* (Plecoptera: Perlidae) from Guangdong Province of China. Zootaxa 3597: 15–24.

Li W-H, Wu L-M, Zhang H-R (2011) A new species of the genus *Neoperla* (Plecoptera: Perlidae) from Henan, China. Acta Zootaxonomica Sinica 36: 33–35.

Sivec I, Zwick P (1987) Some *Neoperla* (Plecoptera) from Taiwan. Beiträge zur Entomologie 37: 391–405.

Sivec I, Stark BP, Uchida S (1988) Synopsis of the world genera of Perlinae (Plecoptera: Perlidae). Scopolia 16: 1–66.

Stark BP, Sivec I (2008) New species and records of *Neoperla* (Plecoptera: Perlidae) from Vietnam. Illiesia 4: 19–54.

Wu C-F (1935) Aquatic insects of China. Article XXI. New species of stoneflies from East and South China. (Order Plecoptera). Peking Natural History Bulletin 9: 227–243.

Wu C-F (1938) Plecopterorum sinensium: A monograph of stoneflies of China (Order Plecoptera). Yenching University, 225 pp.

Wu C-F (1948) Fourth supplement to the stoneflies of China (Order Plecoptera). Peking Natural History Bulletin 17: 75–82.

Wu C-F (1962) Results of the Zoologico-Botanical expedition to Southwest China, 1955–1957 (Plecoptera). Acta Entomologica Sinica 11 (Supplement): 139–153.

Wu C-F (1973) New species of Chinese stoneflies (Order Plecoptera). Acta Entomologica Sinica 16: 97–118.

Wu C-F, Claassen PW (1934) Aquatic insects of China. Article XXI. New species of Chinese stoneflies. (Order Plecoptera). Peking Natural History Bulletin 9: 111–129.

Yang C-K, Yang D (1990) New and little-known species of Plecoptera from Guizhou Province (I). Guizhou Science 8: 1–4.

Yang C-K, Yang D (1991) New and little-known species of Plecoptera from Guizhou Province (II). Guizhou Science 9: 48–50.

Yang D, Yang C-K (1992) Plecoptera: Perlidae. In: Huang FS (Ed.) Insects of Wuling Mountains area, Southwestern China. Science Press, Beijing, 62–64.

Yang D, Yang C-K (1993) New and little-known species of Plecoptera from Guizhou Province (III). Entomotaxonomia 15: 235–238.

Yang D, Yang C-K (1995a) Three new species of Plecoptera from Hainan Province. Acta Agriculture Universitatis Pekinensis 21: 223–225.

Yang, D, Yang C-K (1995b) Plecoptera: Perlidae. In: Wu H (Ed.) Insects of Baishanzu Mountain, Eastern China. China Forestry Publishing House, Beijing, 59–60.

Yang D, Yang C-K (1996) Four new species of Plecoptera from Nei Mongol. Journal of China Agricultural University 1: 115–118.

Yang D, Yang C-K (1998) Plecoptera: Styloperlidae, Perlidae and Leuctridae. In: Wu H (Ed) Insects of Longwangshan. China Forestry Publishing House, Beijing, 40–46.

Zwick P (1983) The *Neoperla* of Sumatra and Java (Indonesia) (Plecoptera: Perlidae). Spixiana 6: 167–204.

ZooKeys 290: 31–38 (2013)
doi: 10.3897/zookeys.390.4811
www.zookeys.org

REVIEW ARTICLE

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New synonymies and new combinations of Muscidae from China (Diptera, Muscoidea)

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Academic editor: *P. Cerretti* | Received 3 February 2013 | Accepted 29 March 2013 | Published 16 April 2013

Citation: Wang M-F (2013) New synonymies and new combinations of Muscidae from China (Diptera, Muscoidea). ZooKeys 290: 31–38. doi: 10.3897/zookeys.290.4811

Abstract

New synonymies and new combinations are proposed, based mainly on the study of type materials. They are as follows: *Helina sarmentosa* Fang & Fan, 1993 = *H. dianica* Qian & Feng, 2005, **syn. n.**; *Helina dianxiia* Xue and Li, 2002 = *H. aureolicolorata* Feng & Xue, 2002, **syn. n.**; *Myospila lenticeps* (Thomson, 1869) = *H. magnimaculata* Feng, 1995, **syn. n.**; *Spilogona angulisurstyla* (Xue & Xiang, 1998), **comb. n.**; *Spilogona apicicauda* (Xue, Wang & Tong, 2003), **comb. n.**; *Hebecnema arcuatiabdomina* (Feng & Fan, 2001), **comb. n.**

Keywords

New synonymies, new combinations, *Helina*, *Myospila*, *Spilogona*, *Hebecnema*, Muscidae

Introduction

The genus *Helina* Robineau-Desvoidy, 1830 is the second largest genus in the dipteran family Muscidae. It occurs in all zoogeographic regions of the world and comprises over 520 species (Pont 1980, 1986, Carvalho et al. 2005, Wang et al. 2008). According to present data, over 230 species of *Helina* have been found in China (Xue and Chao 1998, Xue et al. 2005, Wang et al. 2004, 2005a, 2005b, 2006a, 2006b, 2008). Early taxonomists, like Stein (1907, 1915), studied *Helina* from Taiwan and Northwest China, which formed the basis for further research on this genus in the Chinese fauna. Further impetus was provided by Emden's (1965) work on Muscidae for the Fauna of India series. The major references dealing with Chinese *Helina* are Hennig

(1957–1958), Ma (1981), Xue and Wang (1982), Fang et al. (1986), Pont (1986), Wu (1989), Xue et al. (2005) and Wang et al. (2004, 2005a, 2005b, 2006a, 2006b, 2008).

Helina includes so many species that it is an intimidating task to undertake research on, or even to identify the species correctly. Furthermore, many specialists consider that *Helina* is a ''catch-all'' repository for species that cannot be assigned elsewhere (Hennig 1965, Wang et al. 2008). The genus needs to be fully revised. In this paper, new synonymies and new combinations are proposed, based mainly on the study of type materials.

Material and methods

This study has been based on materials from the following museums:

IESNU	Institute of Entomology, Shenyang Normal University, Shenyang, Liaoning Province, China
IMEAMMS	Institute of Microbiology and Epidemiology, Academy of Military Medical Sciences, Beijing, China
IZCAS	Institute of Zoology, Chinese Academy of Sciences, Beijing, China
SEMCAS	Shanghai Entomological Museum, Chinese Academy of Sciences, Shanghai, China

Morphological terms follow McAlpine (1981), except the "postpedicel" and "prealar setae" follows Stuckenberg (1999) and Fan (1992), respectively. Absolute measurements are used for body length in millimeters (mm). The following abbreviations are used in this article: ***acr***: acrostichal setae; ***dc***: dorsocentral setae; ***ia***: intra-alar setae; ***pra***: prealar setae; ***ad***: anterodorsal setae; ***av***: anteroventral setae; ***p***: posterior setae and ***pv***: posteroventral setae.

Taxonomy

***Helina sarmentosa* Fang & Fan, 1993**
http://species-id.net/wiki/Helina_sarmentosa

Helina sarmentosa Fang & Fan, 1993: 1239; Xue and Chao 1998: 2283; Wang et al. 2004: 297; Xue et al. 2005: 40; Xue and Wang 2006: 178.
Helina dianica Qian & Feng, 2005: 260. **Syn. n.**

Redescription. MALE. Body length 8.5–9.5mm. Eye with dense and long hairs; frons about 1.3–2.0 times as wide as the width of anterior ocellus; frontal setae reaching ocellar triangle; fronto-orbital plate and parafacial with silveryish-grey pollinosity; parafacial bare, about 1.5–2.0 times as wide as postpedicel; antenna black, postpedicel about

2.6–3.0 times as long as broad, about 1.8 times as long as pedicel, arista plumose, the longest hair about equal or slightly longer than postpedicel width; gena and postgena with black hairs, gena with 5 rows of subvibrissal setae in anterior margin, genal height about 2/5 times of eye height; proboscis stout, prementum about 2.0 times as long as height; palpus black, slightly flat in distal half. Thorax ground-color black, scutum with four dark vittae in posterior view, ***acr*** 0+1, 9 rows of irregular fine setae between two ***dc*** rows, ***dc*** 2+4, ***ia*** 0+2, ***pra*** absent; anepisternum with hairs around anepisternal setae, meron with hairs around the lower margin of posterior spiracle, scutellum with black hairs in the lateral margin; basisternum, proepisternum, anepimeron, katepimeron bare; katepisternal setae 2+2, spiracles dark brown. Wing hyaline, brownish, with heavier color in the basal part and around veins; costal spine inconspicuous, radial node bare; veins R_{4+5} and M conspicuously diverging distally, crossveins r-m and dm-cu lightly clouded, crossvein m-m sinuate; calypteres yellowish; halteres brownish-yellow. Legs black; fore tibia with 2–4 ***p***; basal half of mid femur with row of 8–10 ***pv*** (stout towards distally), distal half with 2 or 3 slender setae, mid tibia with 1 or 2 ***ad*** and 6 or 7 developed ***p***, the length of longest seta about 3/5 of width of tibia; hind coxa bare on rear surface, hind femur with 5–7 strong setae on distal half, hind tibia with 7–10 ***av***, 3–5 developed ***ad*** and 6–9 ***p***. Abdomen ground-color black, with dense greyish-blue pollinosity, tergites 2 to 4 with one large dark lateral patch on each side, tergites 4 and 5 with posterior marginal setae, tergite 5 with irregular discal setae, sternite 1 with hairs.

FEMALE. Unknown.

Remarks. Both *Helina sarmentosa* and *H. dianica* can be easily separated from the other *Helina* species by mid and hind tibiae with very long and stout setae. Having examined the holotypes of both nominal species, we were unable to find differences justifying their separation, which has led us to consider all the examined specimens to be conspecific. Therefore, we synonymized *H. dianica* under *H. sarmentosa*.

Material studied. Holotype of *Helina sarmentosa*, ♂: China: Yunnan, Deqin, Mt. Meili, alt. 4,300–4,680m a.s.l., 29.VII.1982, Coll. H.C. Cai (IZCAS); paratype of *H. sarmentosa*, ♂: China: Yunnan, Deqin, Mt. Meili, alt. 4,300–4,680m a.s.l., 28.VII.1982, Coll. X.Z. Zhang (SEMCAS). Holotype of *Helina dianica*, ♂: China: Yunnan, Deqin, alt. 2,400m a.s.l., 29.VII.1991, Coll. unknown (IMEAMMS).

Distribution. China (Yunnan).

Helina dianxiia **Xue & Li, 2002**

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

Helina dianxiia Xue & Li, 2002: 78; Xue et al. 2005: 39; Xue and Wang 2006: 173.
Helina aureolicolorata Feng & Xue, 2002: 261; Xue et al. 2005: 39; Xue and Wang 2006: 172. **Syn. n.**

Remarks. The holotype of *H. dianxiia* is almost identical to *H. aureolicolorata*. The only difference between these two species is that the body color of *H. dianxiia* is darker

than *H. aureolicolorata*. *Helina dianxiia* and *H. aureolicolorata* are synonymized here because the two holotypes of these two nominal species characters are surprisingly consistent and genitalia are identical. Therefore, we synonymized *H. aureolicolorata* under *H. dianxiia*.

Material studied. Holotype of *H. dianxiia*, ♂: China: Yunnan, Lushui, alt. 2,000m a.s.l., 26.V.1992, Coll. F.H. Li (IESNU). Holotype of *H. aureolicolorata*, ♂: China: Sichuan, Ya'an, Mt. Zhougong, alt. 1,700m a.s.l., 24.VI.1985, Coll. Y. Feng (IMEAMMS).

Distribution. China (Sichuan, Yunnan).

***Myospila lenticeps* (Thomson, 1869)**
http://species-id.net/wiki/Myospila_lenticeps

Helina magnimaculata Feng in Deng and Feng, 1995: 140; Xue et al. 2005: 39; Xue and Wang 2006: 176. **Syn. n.**

Remarks. There are more than fifty species of the genus *Myospila* found in China. The species *magnimaculata*, previously assigned to *Helina*, is in my opinion a *Myospila* due to the following characters: vein M distinctly curved forward at tip; cerci slender and the morphology of genitalia. At the same time, I consider it to be a synonym of *M. lenticeps* for these other reasons: scutum with 4 ***dc***; costal spine short but distinct; most part of thorax brown with dense light yellow pollinosity and vein R_{4+5} with fine hairs on the basal part in ventral view. Consequently, *H. magnimaculata* is a new subjective junior synonym of *M. lenticeps*.

Distribution. China (Guangdong, Guizhou, Hunan, Sichuan, Taiwan, Yunnan); Japan; Sri Lanka; India; Indonesia; Malaysia; Philippines; Thailand; Nepal; Kiribati (Christmas Island); Madagascar; Principe.

***Spilogona angulisurstyla* (Xue & Xiang, 1998), comb. n.**
http://species-id.net/wiki/Spilogona_angulisurstyla

Helina angulisurstyla Xue & Xiang in Xue and Chao 1998: 1126; Xue et al. 2005: 45; Xue and Wang 2006: 171.

Material studied. Paratype, ♂: China: Xinjiang, Dong Kunlun, Kaerdong, alt. 4,300m a.s.l., 11.VII.1984, Coll. C.Q. Xiang (IESNU); paratype, ♂: China: Xinjiang, Hejing, alt. 3,000–3,500m a.s.l., 31.VII.1958, Coll. C.Q. Li (IZCAS).

Remarks. *Helina angulisurstyla* was described by Xue and Xiang in Xue and Chao (1998) and can be easily distinguished from other *Helina* species by the slightly shortened arista, ***pra*** absent, katepisternal setae 1+1, veins R_{4+5} and M not diverging distally, abdomen with trapezoid patches, sternite 1 bare, sternite 5 broad and short, cerci long

and distal sharped, surstyli not expanded distally but sharp in lateral view. However, these diagnostic characters are practically identical with the generic characters of *Spilogona*. Our analysis of the paratypes of *H. angulisurstyla* revealed a similar external morphology; especially the male genital structures with species in the genus *Spilogona*. Consequently, we suggest the following new combination: *Spilogona angulisurstyla*.

Distribution. China (Xinjiang).

***Spilogona apicicauda* (Xue, Wang & Tong, 2003), comb. n.**
http://species-id.net/wiki/Spilogona_apicicauda

Helina apicicauda Xue, Wang & Tong, 2003: 754; Xue and Wang 2006: 171.

Material studied. Holotype, ♂: China: Qinghai, Yushu, Batang, alt. 4,200–4,500m a.s.l., 15.VI.1964, Coll. S.Y. Wang (IZCAS).

Remarks. Diagnostic characteristics (arista short; ***pra*** absent; katepisternal setae 1+2; costa with distinct comb-like rows on the front margin, vein m-m straight; mid tibia with 2 ***ad*** and 2 ***p***; tergites 3 and 4 with one pair dark patches, sternite1 bare; surstyli slender, the lateral margin of cerci curved in distal half, apical of cerci sharp, sternite 5 broad and short) of the holotype indicate that it belongs to *Spilogona*.

Distribution. China (Qinghai).

***Hebecnema arcuatiabdomina* (Feng & Fan, 2001), comb. n.**
http://species-id.net/wiki/Hebecnema_arcuatiabdomina

Helina arcuatiabdomina Feng & Fan, 2001: 188; Xue et al. 2005: 47; Xue and Wang 2006: 171.

Description. (Translated from Feng and Fan 2001.) MALE. Body length about 7.0mm. Eye bare, upper part slightly flattened, facets obviously expanded on anterior margin in upper part, frons at its narrowest point about 1/3 of the width of anterior ocellus, lower half of fronto-orbital plate with 3 frontal setae; ocelli mound-like; parafacial about half as wide as postpedicel; antennal scape and pedicel black, brown distally, postpedicel 2.5 times as long as broad, arista short plumose, the longest hairs slightly shorter than half of postpedicel width; face distally slightly raised, upper part with a flat facial ridge; gena and postgena with black hairs, front gena with subvibrissal setae into 2 rows, genal height about 1/10 of the eye height; prementum about as long as high; palpus dark. Thorax with thin greyish blue pollinosity, scutum without distinct longitudinal stripes, ***acr*** 3+5 (prescutellar ***acr*** short), ***dc*** 2+4, ***ia*** 0+2, ***pra*** absent; lateral and lower margins of scutellum bare; basisternum, notopleuron, meron, katepimeron and metanepisternum bare; spiracle dark brown, half-open; proepisternal setae 2, proepimeral setae 2, katepisternal setae 1+2. Tegula blackish-brown, basicosta brownish-yellow, costal spine incon-

spicuous; node of Rs bare, crossveins without a cloudy appearance, veins R_{4+5} and M slightly diverging in distal part; calypteres brownish, halteres dark redish-brown. Coxae and trochanters brownish-yellow; femora and tibiae brownish-yellow, tarsi black, distal part of tarsi with yellow rings; fore tibia without ***p***; basal third of mid femur with 4 ***pv*** (short and stout distally), mid tibia with 3 ***p***, distally with 1 ***p***; hind coxa bare on posterior surface, hind femur with complete rows of ***av*** and ***p***, 1 ***av*** distally. Abdomen slightly dark yellow, with thin pollinosity, without distinct stripes and round patches, syntergite 1+2, tergites 3 and 4 with narrow posterior marginal stripes, tergites 3 to 5 with median marginal setae; tergite 6 and sternite 1 bare, sternites 2 and 3 square-shaped.

FEMALE. Unknown.

Remarks. The genus *Hebecnema* Schnabl, 1889 resembles the genus *Helina* but differs from it by the following characters: abdomen always without paired spots; fronto-orbital plate narrow, always narrower than antenna width; head in lateral view slightly flat on upper part; surstyli always slender.

According to the original descriptions and illustrations of *H. arcuatiabdomina* given by Feng and Fan (2001), we can confirm that this species belongs to *Hebecnema.*

Distribution. China (Sichuan).

Acknowledgements

I'm very grateful to Mr. Yan Feng (*The Center for Disease Control and Prevention of Ya'an Municipal, Sichuan Province, China*), who gave me invaluable help and extend my heartfelt gratitude to Drs. Jie Wu, Wei-bing Zhu and Xian-wei Liu (*Shanghai Entomological Museum, Chinese Academy of Sciences, Shanghai, China*); Prof. Ge-xia Qiao, Prof. Jun Chen, and Dr. Li-li Zhang (*Institute of Zoology, Chinese Academy of Sciences, Beijing, China*); Prof. Rong-man Xu (*Institute of Microbiology and Epidemiology, Academy of Military Medical Sciences, Beijing, China*) who gave us invaluable help with this study. I'm also extremely thankful to two anonymous reviewers for their constructive comments on the manuscript and Ms. April Gloury (University of Melbourne, Melbourne, Australia) for her assistance in proofreading of the manuscript. This study is supported by the National Nature Science Foundation of China (Grants No. 31071957, No. 31272347 and No. 30770252).

References

de Carvalho CJB, Couri MS, Pont AC, Pamplona D, Lopes SM (2005) A Catalogue of the Muscidae (Diptera) of the Neotropical Region. Zootaxa 860: 1–282.

Deng AX, Feng Y (1995) Three new species of genus *Helina* from Sichuan, China (Diptera: Muscidae). Sichuan Journal of Zoology 14(4): 139–142.

Emden FI van (1965) The Fauna of India and the adjacent countries. Diptera, 7, Muscidae, part 1. Government of India, Delhi, 647 pp.

Fan ZD (1992) Key to the common flies of China, second edition. Science Press, Beijing, 992 pp.

Fang JM, Fan ZD (1993) Diptera: Muscidae I. II. In Chen SX (Ed.) Insects of Hengduan Mountains. Volume 2. Science press, Beijing, 1220–1270.

Fang JM, Fan ZD, Li R, Deng XA (1986) Notes on some new species of Phaoniinae from Western China, (Diptera: Muscidae). Contributions from Shanghai Institute of Entomology 6: 237–245.

Feng Y, Fan ZD (2001) Two new species of the genus *Helina* (Muscidae) with a further description of *Scathophaga chinensis* Malloch (Scathophagidae) (Diptera) from Sichuan, China. Entomotaxonomia 23(3): 187–192.

Feng Y, Xue WQ (2002) Five new species of the genus *Helina* (Diptera: Muscidae) from Sichuan, China. Entomotaxonomia 24(4): 261–268.

Hennig W (1957–1958) Muscidae. In: Lindner E (Ed.) Die Fliegen der palaearktischen Region, 63b, Stuttgart: Schweizerbart, 145–232.

Hennig W (1965) Vorarbeiten zu einem phylogenetischen System der Muscidae (Diptera: Cyclorrhapha). Stuttgarter Beiträge zur Naturkunde 141: 1–100.

Ma ZY (1981) Descriptions of five new species of Muscidae from Liaoning, China (Diptera: Muscidae). Acta Zootaxonomica Sinica 6(3): 300–307.

McAlpine JF (1981) Morphology and terminology–adults. In: McAlpine JF, Peterson BV, Shewell GE, Teskey HJ, Vockeroth JR, Wood DM (Eds) Manual of Nearctic Diptera, Vol. 1. Research Branch, Agriculture Canada Monograph, 27, Ottawa, 9–63.

Pont AC (1980) Family Muscidae. In: Crosskey RW (Ed.) Catalogue of the Diptera of the Afrotropical Region. British Museum (Natural History), London, 721–761.

Pont AC (1986) Family Muscidae. In: Soós Á and L Papp (Eds.) Catalogue of Palaearctic Diptera. Vol. 11. Scathophagidae-Hypodermatidae. Akadémiai Kiadó, Budapest, 57–215.

Qian WP, Feng Y (2005) Three new species of the genus *Helina* from China (Diptera: Muscidae). Chinese Journal of Vector Biology and Control 16(40): 258–260.

Robineau-Desvoidy AJB (1830) Essai sur les Myodaires. Mémoires présentés par divers Savants à l'Académie Royale des Sciences de l'Institut de France, 2: 1–813.

Stein P (1907) Zur Kenntnis der Dipteren von Central-Asien. II. Cyclorrhapha schizophora schizometopa. Die von Roborowsky und Kozlov in der Mongolei und Tibet gesammelten Anthomyiiden. Ezhegodnik Zoologicheskago Muzeya 12 (3): 318–372.

Stein P (1915) H. Sauter's Formosa-Ausbeute, Anthomyidae (Diptera). Supplementa Entomological 4: 13–56.

Stuckenberg BR (1999) Antennal evolution in the Brachycera (Diptera), with a reassessment of terminology relating to the flagellum. Studia dipterologica 6(1): 33–48.

Thomson CG (1869) 6. Diptera. Species nova descripsit. In Kongliga svenska Vetensk Akademiens Handlingar. Kongliga svenska fregatten Eugenies resa omkring jorden 2(1): 523–563.

Wang MF, Wang RR, Xue WQ (2006a) A review of the *H. obtusipennis* species-group of the genus *Helina* R.-D. (Diptera: Muscidae) from the Palaearctic and Oriental regions, with the description of one new species. Zootaxa 1137: 63–68.

Wang MF, Wang RR, Xue WQ (2006b) A review of the *quadrum* species group of *Helina* Robineau-Desvoidy (Diptera: Muscidae) from China. Oriental Insects, 40: 171–178. doi: 10.1080/00305316.2006.10417469

Wang MF, Xue WQ, Wang RR, Zhang D (2005a) A review of the *hirsutitibia* species-group of the genus *Helina* Robineau-Desvoidy (Diptera: Muscidae) from China, with the description of one new species. The pan-pacific Entomologist 81(3/4): 114–121.

Wang MF, Xue WQ, Wang RR, Zhang D (2005b) Notes on *Helina laxifrons* species-group of the genus *Helina* R.-D. from China (Diptera: Muscidae). Chinese Journal of Vector Biology and Control 16(6): 416–417.

Wang MF, Xue WQ, Zhang D (2004) Notes on *annosa* species-group of *Helina* R.-D. (Diptera: Muscidae) in China. Entomologia Sinica 11(4): 293–301.

Wang MF, Zhang D, Wang RR (2008) Two new species of the genus *Helina* Robineau-Desvoidy (Diptera: Muscidae) from China with revised diagnosis on the Chinese species. Annales de la socciété entomologique de France (Nouvelle série) 44(2): 87–106.

Wu JW (1989) Five new species of the genus *Helina* from Gansu, China (Diptera: Muscidae). Entomotaxonomia 11(4): 323–332.

Xue WQ, Chao CM (1998) Flies of China. Vol. 1. Liaoning Science and Technology Press, Shenyang, 1365pp.

Xue WQ, Feng Y, Tong YF (2005) A taxonomic study on *Helina* R.-D. (Diptera: Muscidae) from China. Oriental Insects 39: 35–62. doi: 10.1080/00305316.2005.10417417

Xue WQ, Li FH (2002) Three new species of the genus *Helina* from Yunnan, China (Diptera: Muscidae). Acta Entomologica Sinica 45(S1): 78–80.

Xue WQ, Wang MF (1982) A new species of the genus *Helina* from Shanxi, China (Diptera: Muscidae). Entomotaxonomia 4(1/2): 15–17.

Xue WQ, Wang MF (2006) Flies of the Qinghai-Xizang Plateau (Insecta: Diptera). Science press, Beijing, 336 pp.

Xue WQ, Wang MF, Tong YF (2003) Four new species of the genus *Helina* R.-D. from Qinghai, China (Diptera, Muscidae). Acta Zootaxonomica Sinica 28(4): 754–758.

ZooKeys 290: 39–54 (2013)
doi: 10.3897/zookeys.290.4696
www.zookeys.org

RESEARCH ARTICLE

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Three new species of *Bolbochromus* Boucomont (Coleoptera, Geotrupidae, Bolboceratinae) from Southeast Asia

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Academic editor: *A. Frolov* | Received 17 January 2013 | Accepted 27 March 2013 | Published 16 April 2013

urn:lsid:zoobank.org:pub:25C31E44-8F34-448E-907B-C7162B4C69D4

Citation: Li C-L, Yang P-S, Krikken J, Wang C-C (2013) Three new species of *Bolbochromus* Boucomont (Coleoptera, Geotrupidae, Bolboceratinae) from Southeast Asia. ZooKeys 290: 39–54. doi: 10.3897/zookeys.290.4696

Abstract

Three new species of the Oriental bolboceratine genus *Bolbochromus* Boucomont 1909, *Bolbochromus minutus* Li and Krikken, **sp. n.** (Thailand), *Bolbochromus nomurai* Li and Krikken, **sp. n.** (Vietnam), and *Bolbochromus malayensis* Li and Krikken, **sp. n.** (Malaysia), are described from continental Southeast Asia with diagnoses, distributions, remarks and illustrations. The genus is discussed with emphasis on continental Southeast Asia. A key to species known from Indochina and Malay Penisula is presented. An annotated checklist of *Bolbochromus* species is presented.

Keywords

Bolbochromus, new species, Geotrupidae, Bolboceratinae, Southeast Asia

Introduction

The bolboceratine genus *Bolbochromus* Boucomont, 1909, is an Oriental genus that has a wide range and occurs eastward from Himalayan India and Sri Lanka to Southeast Asia, southern China, the Greater Sunda Islands, Philippines, Taiwan and its neighboring islands. A total of 19 species are currently known including three new species described here. Species of *Bolbochromus* inhabit forests, and the genus as here conceived is the most diverse bolboceratine group in Asia and it has never been systematically reviewed. For those species in Indochina, Paulian (1945) first diagnosed and recorded two species, *B. laetus* (Westwood, 1852) and *B. plagiatus* (Westwood, 1848), that were originally described from north India and Ceylon (presently Sri Lanka), respectively. We have examined a number of specimens looking like *B. laetus* from Thailand and Vietnam. But Paulian's record of *B. plagiatus* in our view was based on misidentified specimens of the species described later (*B. lao* Keith , 2012 from Laos and *B. masumotoi* Ochi, Kon and Kawahara, 2011 from Cambodia), or to one of our new species described below. Paulian's material was not traced and the type of *B. laetus* is probably lost. Actually, specimens of *Bolbochromus* are not numerous in museum collections, probably due to inappropriate collecting methods. It is likely that the number of known *Bolbochromus* species will increase in the future when appropriate collecting methods are used.

Within the Bolboceratinae, adults of *Bolbochromus* are small (5.8–13.0 mm in length), glossy dorsally, pronotal midline indented, and body usually bicolored with brownish yellow or reddish brown markings on the surface of the pronotum and elytron which may inter/intraspecifically vary in number, size, and shape. The bicolored markings in *Bolbochromus* species, a character state that is rarely found in bolboceratine beetles, indicates a link with the genus *Bolbocerosoma* Schaeffer. However, the males of *Bolbochromus* lack tubercles on their pronotum as in the genus *Bolbocerosoma* (instead having an indented midline and/or transverse carina).

In this paper, we will improve the descriptions of generic characters based on Li et al. (2008), particularly those of the male genitalia (e.g., median lobe) which are of taxonomic and phylogenetic importance. Additionally, we provide an annotated checklist of the genus with the descriptions of three new species from Indochina and the Malay Peninsula, respectively.

Materials and methods

All specimens used in this study were obtained on loan from the museums (names of curators are in acknowledgments) which are indicated in the type information of new species.

Specimens were studied and photographed using a Leica M205C stereo microscope with either a LED5000 MCI or HDI illuminator and a Canon 7D digital camera body. The measurements of specimens, preparation of aedeagus, and external morphological terms used in this paper follow Li et al. (2008). For those of the male genital structures, we employ the terms by D'Hotman and Scholtz (1990).

Systematics

Checklist of the genus *Bolbochromus* Boucomont

1. ***Bolbochromus catenatus* (Lansberge, 1886)**
Bolboceras catenatum Lansberge 1886: 135. Original combination.
Distribution. Sumatra (exact locality unknown); Borneo (exact locality unknown); Brunei (Boucomont 1914); Java (Boucomont 1914).

2. ***Bolbochromus celebensis* Boucomont, 1914**
Bolbochromus celebensis Boucomont 1914: 347. Original combination.
Distribution. Celebes (type locality: Toli-Toli).

3. ***Bolbochromus hirokawai* Ochi, Kon & Kawahara, 2010**
Bolbochromus hirokawai Ochi, Kon and Kawahara 2010: 97. Original combination.
Distribution. Negros Is. (type locality: Mt. Canla-on, Philippines).

4. ***Bolbochromus laetus* (Westwood, 1852)**
Bolboceras laetus Westwood 1852: 27. Original combination.
Distribution. Sri Lanka (exact locality unknown); Vietnam; Laos; S. China (Guizhou) (Paulian 1945, see our comment in introduction).

5. ***Bolbochromus lao* Keith, 2012**
Bolbochromus lao Keith 2012: 7. Original combination.
Distribution. Laos (type locality: Mt. Phou Sane, Khouang Province).

6. ***Bolbochromus lineatus* (Westwood, 1848)**
Bolboceras lineatus Westwood 1848: 356. Original combination.
Distribution. Sri Lanka (exact locality unknown).

7. ***Bolbochromus ludekingi* (Lansberge, 1886)**
Bolboceras ludekingi Lansberge 1886: 134. Original combination.
Distribution. Sumatra (exact locality unknown); Java (Boucomont 1914).

8. ***Bolbochromus malayensis* Li & Krikken sp. n.**
Distribution. Malay Peninsula (type locality: Ulu Gombak, Selangor State, Malaysia).

9. ***Bolbochromus masumotoi* Ochi, Kon & Kawahara, 2011**
Bolbochromus masumotoi Ochi, Kon & Kawahara 2011: 155. Original combination.
Distribution. Cambodia (type locality: Kbal Spean, Siem Reap).

10. ***Bolbochromus minutus* Li & Krikken sp. n.**
Distribution. Thailand (type locality: Khao Yai National Park, Nakhon Nayok Province).

11. ***Bolbochromus niger*** **Pouillaude, 1914**
Bolbochromus niger Pouillaude, 1914: 144. Original combination.
Distribution. Java (exact locality unknown).

12. ***Bolbochromus nigerrimus*** **(Westwood, 1852)**
Bolboceras nigerrimus Westwood 1852: 26. Original combination.
Distribution. N. India (Landour, Uttarakhand Province).

13. ***Bolbochromus nigriceps*** **(Wiedemann, 1823)**
Scarabaeus nigriceps Wiedemann 1823: 8. Original combination.
Bolboceras sumatranus Lansberge 1886: 135. Synonymized by Boucomont (1914: 347).
Distribution. Java (exact locality unknown); Sumatra (Boucomont 1914).

14. ***Bolbochromus nomurai*** **Li & Krikken sp. n.**
Distribution. N. Vietnam (type locality: Deo Pha Din, Son La Province).

15. ***Bolbochromus plagiatus*** **(Westwood, 1852)**
Bolboceras plagiatus Westwood 1852: 27. Original combination.
Distribution. N. India (type locality: Landour, Uttarakhand Province); Vietnam; Laos (Paulian 1945, see our comment in introduction).

16. ***Bolbochromus posticalis*** **(Westwood, 1852)**
Bolboceras posticalis Westwood 1852: 27. Original combination.
Distribution. Nothern (?) India (exact locality unknown).

17. ***Bolbochromus ryukyuensis*** **Masumoto, 1984**
Bolbochromus ryukyuensis Masumoto 1984: 168. Original combination.
Distribution. Taiwan; Iriomote and Ishigaki islands (type locality: Omotodake), S. W. Japan.

18. ***Bolbochromus sulcicollis*** **(Wiedemann, 1819)**
Scarabaeus sulcicollis Wiedemann 1819: 161. Original combination.
Distribution. Java (exact locality unknown).

19. ***Bolbochromus walshi*** **Pouillaude, 1914**
Bolbochromus walshi Pouillaude, 1914: 143. Original combination.
Distribution. Java (type locality: Soekaboemi and Toegoe).

Genus *Bolbochromus* Boucomont, 1909
http://species-id.net/wiki/Bolbochromus

Bolbochromus Boucomont 1909: 117. Type species: *Bolboceras laetus* Westwood, 1852, by subsequent designation (Paulian 1945).

Description. The following generic description is primarily based on the examination of continental *Bolbochromus* species. Length 5.8–13.0 mm. Dorsum glossy, color black to dark reddish brown, usually with brownish yellow or reddish brown markings on surface of pronotum and elytron varying in number, size and shape inter/intraspecifically. *Head:* Surface overall coarsely punctate. Clypeus with anterior border transversely arcuate or subtrapezoid with lateral border rounded; anterior margin unarmed or with tubercles/horns varying in number (1 or 3) and size. Frontal horn small to reduced. Antennal club with first antennomere mostly glabrous and polished on inner side; club ovoid in shape, apparently decreased in size apically, club segments slightly curved outwardly. Eye small in dorsal view, canthus broadened, rounded at anterior margin, entirely dividing eye into dorsal and ventral parts, ventral part larger than dorsal part. *Thorax:* Pronotum unarmed or with small anterior discal quadrituberculate carina; surface unevenly punctate, punctures usually large, deeply impressed at sides; form generally widest at middle, disc vaulted, apical declivity steep or gradually declined anteriorly; midline usually distinctly indented and punctate; lateral fovea poorly to moderately developed; anterior margin evenly arcuate; basal margin not beaded at middle. Middle coxae narrowly separated by metasternal process. *Elytron:* With 7 or 5 punctate striae between suture and humeral umbone, first stria curving along side of scutellum and reaching elytral base with first interval tapering basally; stria 5 not reaching base of elytron or vanishing together with stria 2 when intervals 2, 3 and 5, 6 fused completely; disc with 7, 5 or 3 impunctate intervals between suture and humeral umbone, longitudinally convex in varying degree, interval 2 usually more flat and narrower than others, interval 5 and 6 fused at base. *Legs:* Protibia with 6–10 contiguous teeth on outer margin. *Male genitalia:* Overall unevenly sclerotized, complex. Parameres symmetrically elongate or capsule-like in shape, membranous or well sclerotized laterally with median membranous parts, usually longer than basal piece, surface sparsely punctate, glabrous or setose with varying length of setae, apex usually rounded, in some species curved ventrally. Median lobe well developed, degree of sclerotization usually stronger than parameres, mostly trilobate and significantly varying in shape by species, trilobate median lobe consisting of dorsal sclerite and paired lateral sclerites articulated by paired supporting sclerites at base, lateral sclerites connected laterobasally to parameres. Internal sac embedded in median lobe, unarmed and hardly visible. Temones paired, tapered apically with articulation to base of median lobe, greatly varying in length, shape and degree of sclerotization interspecifically. Basal piece unevenly sclerotized, apical portion usually asymmetrical in shape. Genital capsule well developed.

Remarks. *Bolbochromus* species shows little sexual dimorphism as compared with species of *Bolbelasmus* and *Bolbocerosoma*. The latter two genera have their major sexual dimorphisms in the frontal and pronotal protrusions. In contrast, the shape of frontal and pronotal protrusions in *Bolbochromus* species is identical between males and females. Both sexes in *Bolbochromus* species have slight morphological differences in the anterior margin of the labrum, the secondary punctures on the pronotal disc, and the apical tooth of the protibia, thus making it difficult to separate males and females.

Key to males of *Bolbochromus* species occurring in Indochina and the Malay Peninsula

1 Body length larger than 7.9 mm **2**
– Body length smaller than 7.1 mm **4**
2 Head with frontal horn; apical part of pronotal disc steep when viewed laterally 3
– Head without frontal horn but with a weakly transverse convexity at base of vertex; disc of pronotum smoothly declined anteriorly when viewed laterally ..... ***B. lao* Keith**
3 Frontal horn situated at middle between eyes, pronotum with yellowish triangle-shaped markings on each side, midline shallowly indented; elytral marking rounded in shape ..... ***B. masumotoi* Ochi, Kon & Kawahara**
– Frontal horn situated at middle between canthi; pronotum entirely brownish yellow with anterior slightly quadrituberculate carina, midline hardly indented or absent; elytra entirely brownish yellow or black, or disc surrounded by blackish markings ..... ***B. laetus* (Westwood)**
4 Body length smaller than 5.8 mm; clypeal apex rounded; punctures of pronotal midline shallow and sparse ..... ***B. minutus* Li & Krikken, sp. n.**
– Body length larger than 6.8 mm; punctures of pronotal midline coarse and dense 5
5 Anterior margin of clypeus with a small, weakly-developed convexity at middle; vertex with an inconspicuous conical convexity at middle of base ..... ***B. nomurai* Li & Krikken, sp. n.**
– Anterior margin of clypeus completely beaded; vertex with an inconspicuous transverse carina at middle of base ..... ***B. malayensis* Li & Krikken, sp. n.**

***Bolbochromus minutus* Li & Krikken, sp. n.**
urn:lsid:zoobank.org:act:DBDAFF0E-EF40-4C98-91C6-D460D136F56C
http://species-id.net/wiki/Bolbochromus_minutus
Figs 1, 5, 7, 13–14,19

Holotype male. THAILAND: Nakhon Nayok Prov.// Khao Yai Nat. Park., ca 700 m// 29. ix.–6. x. 1984// Karsholt, Lomholdt & Nielsen leg.//Zool. Mus., Copenha-

gen (deposited at the Universitetes Zoologiske Museum, Copenhagen, Denmark). The holotype (pinned) having both protarsi and right metatarsus broken.

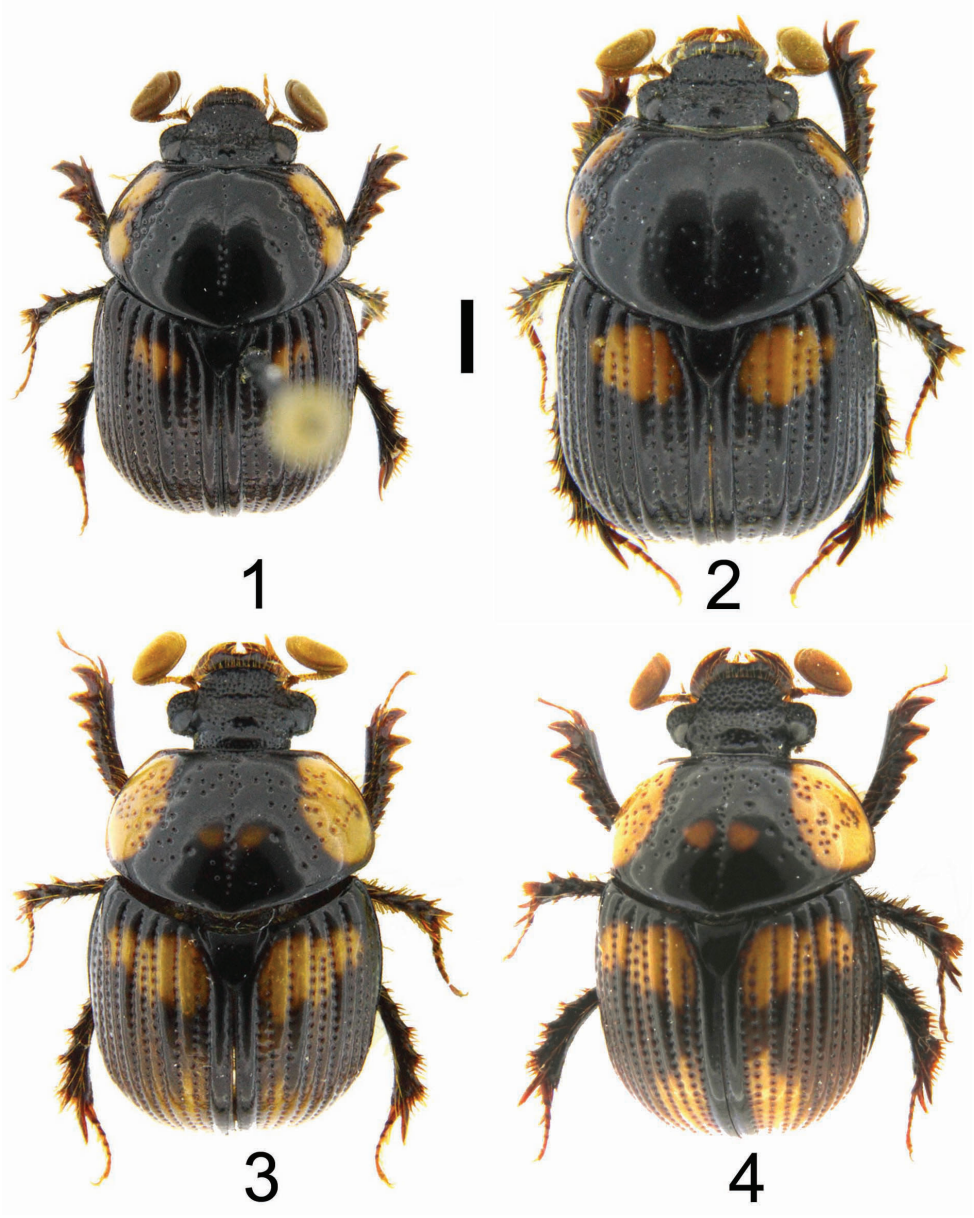
Type locality. Central Thailand: Nakhon Nayok Province, Khao Yai National Park, 14°26'N, 101°22'E (Fig. 23).

Description. Holotype Male (Figs 1, 5, 7). Body length 5.8 mm; greatest width 3.5 mm. Form ovate, sides subparallel. Dorsum black with lateral margins of pronotum and elytron reddish black; irregular-shaped brownish orange markings located on sides of pronotum with exception of fovea (Fig. 7); size of elytral markings small, shape transversally irregular, across base of intervals 3–7, marking of interval 7 barely visible, (Fig. 1). *Head*: Labrum with anterior margin feebly triangularly concave centrally, sides notched. Clypeal apex rounded (Fig. 5), anterior margin beaded, surface coarsely punctate, punctures unevenly distributed, confluent or separated by less than 1 puncture diameter. Clypeofrontal suture absent. Vertex transversely, weakly convex at middle of base, punctures on surface more shallowly developed than those on clypeus, sparsely distributed. *Thorax*: Outline of pronotum generally rounded, surface coarsely punctate at center of lateral side of disc, with surrounding part impunctate, except for fovea; midline moderately indented, with shallow and inconspicuous punctures; both sides of midline and area in front of elytral base impunctate (Fig. 7); disc gradually declined anteriorly when viewed laterally (Fig. 7). Metasternal process poorly developed, narrowly separating middle coxae with anterior margin beaded. Scutellum with scattered secondary punctures, slightly longer than wide medially. *Elytron*: With 7 striae between suture and humeral umbone, stria 2 interrupted by stria 1 not reaching base, stria 5 terminating at basal one-ninth; interval 4 more convex and wider than others at basal one-fifth, interval 2, 5, and 6 less convex than others (Figs 1, 7). *Legs:* Protibia with 10 distinct teeth on outer margin, apical 3 teeth protruding, tip of apical tooth sharp and curved outwardly. *Male genitalia*: Length 1.6 mm. Parameres (Figs 13–14, 19) capsule-like, swollen overall when viewed laterally, weakly sclerotized laterally with medial and apical parts membranous; surface sparsely punctate, glabrous; longer in length than basal piece. Median lobe (Figs 13–14) trilobate; apex of dorsal sclerite largely swollen, shape rectangular; lateral sclerites downcurved (Fig. 19) with apex rounded swollen, more sclerotized and slightly shorter than dorsal sclerite; supporting sclerites elongate-oval. Internal sac invisible. Temones strongly sclerotized basally, shortly thickened to half of basal piece (Fig. 13). Basal piece with apical portion asymmetrical.

Female. Unknown.

Etymology. The specific name is the Latin *minutus* which refers to the smallest body size of species currently known within *Bolbochromus*.

Diagnosis. *Bolbochromus minutus* is similar to *B. plagiatus*, but it can be distinguished based on the following combination of characteristics: smaller in body size (*B. plagiatus* larger, body length approximately 6.3 mm); punctures of pronotal midline shallow and sparsely distributed (densely coarse rugopunctures in *B. plagiatus*); elytral markings small across base of intervals 3-7 (large, across from stria 1 to epipleuron in *B. plagiatus*); tip of protibial apical tooth sharp and elongate (obtuse and not elongate in *B. plagiatus*).



Figures 1–4. Dorsal habitus of *Bolbochromus* spp. **1** *B. minutus* sp. n., holotype male **2** *B. nomurai* sp. n., holotype male **3** *B. malayensis* sp. n., holotype male **4** *B. malayensis* sp. n., paratype female. Scale bar = 1.0 mm.

Remarks. Compared with other males in *Bolbochromus* species, *B. minutus* can be easily separated from other similar species by the smaller body size, form of the elytral markings, and the punctures of the pronotal midline. In addition, the characteristics of the male genitalia are diagnostic.

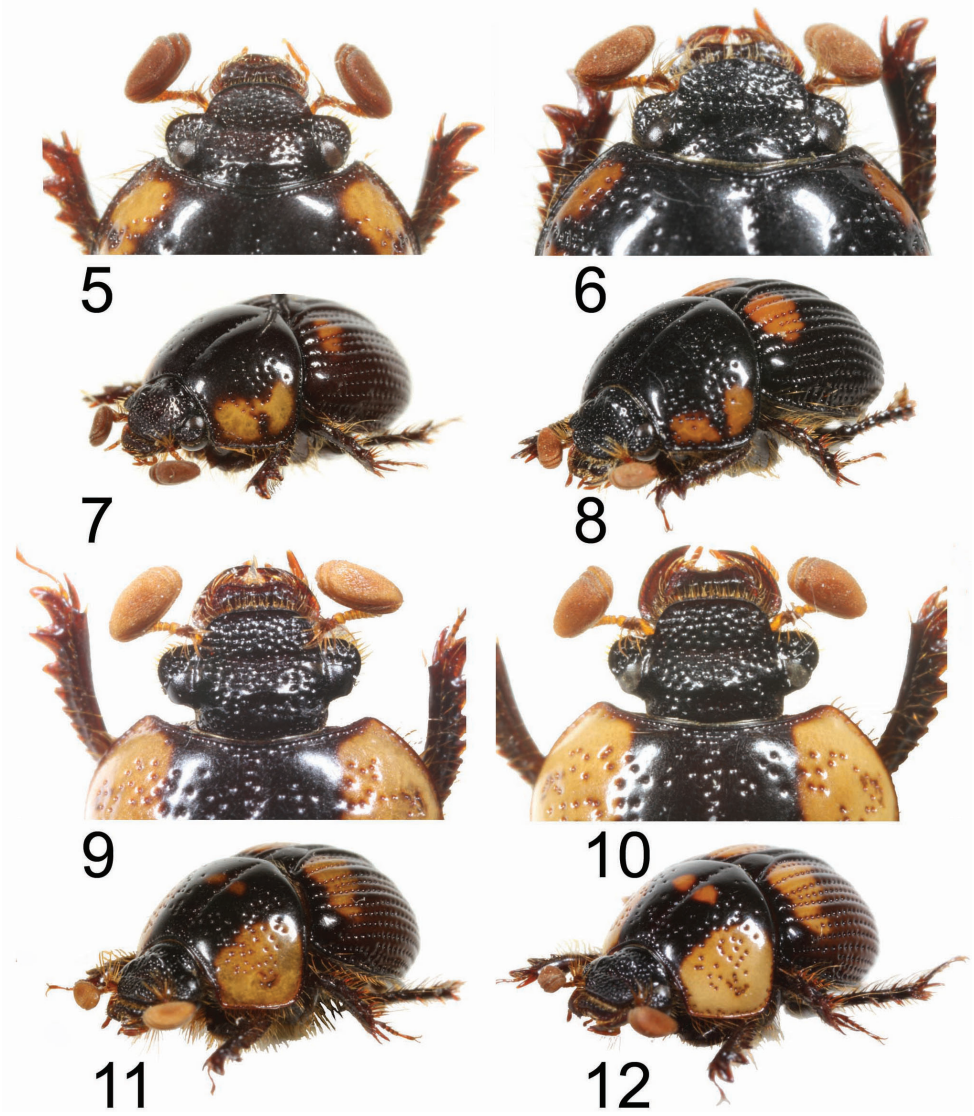
***Bolbochromus nomurai* Li & Krikken, sp. n.**
urn:lsid:zoobank.org:act:C0238EA6-41A8-4C65-BA14-BEAAA4DF697C
http://species-id.net/wiki/Bolbochromus_nomurai
Figs 2, 6, 8, 15–16, 20

Holotype male. The holotype is glued to a paper point and labeled: VIETNAM: Deo Pha Din (1000–1400m), Son La Prov.// [N. VIETNAM]// 24. VI. 1997// S. Nomura leg. (deposited at the National Museum of Nature and Science, Tokyo, Japan).

Type locality. Northern Vietnam: Son La Province, Deo Pha Din, 21°70'N, 103°50'E (Fig. 23).

Description. Holotype male (Fig. 2, 6, 8). Body length 7.1 mm; greatest width 4.1 mm. Form elongate-subovate, sides parallel. Dorsum black, with margins of head, pronotum, and elytron reddish black; isolated brownish orange markings located on each corner of pronotum, shape irregular, subequal in size (Fig. 8); elytral markings across base of striae 1-6 and interval 7, shape transversely rounded (Fig. 2). *Head*: Labrum with anterior margin feebly triangularly concave centrally, sides notched. Clypeal apex subtrapezoidal (Fig. 6), anterior margin beaded with a small, weakly-developed convexity at middle, surface smooth, coarsely punctate in uneven distribution, confluent or separated by less than 1 puncture diameter. Clypeofrontal suture absent. Vertex with inconspicuous conical convexity at middle of base with apex rounded, punctures on surface shallower and sparser than those on clypeus. *Thorax*: Outline of pronotum rounded, surface coarsely punctate along side of disc, less dense toward mid-disc; midline moderately indented with shallow and inconspicuous punctures; both sides of midline and area in front of elytral base impunctate with five smaller punctures at anterior end of midline (Fig. 6); disc gradually declined anteriorly when viewed laterally (Fig. 8). Metasternal process poorly developed, narrowly separating middle coxae with anterior margin beaded. Scutellum with scattered secondary punctures, slightly longer than wide medially. *Elytron*: With 7 striae between suture and humeral umbone, stria 2 interrupted by stria 1 not reaching base, stria 5 terminating at basal one-ninth; interval 4 more convex and wider than others at basal one-fifth, interval 2, 5, and 6 less convex than others (Figs 2, 8). *Legs:* Protibia with 10 distinct teeth on outer margin, apical 3 teeth protruding, tip of apical tooth downcurved. *Male genitalia*: Length 1.9 mm. Parameres (Figs 15–16) elongate, dorsal surface concave at basal half when viewed laterally, dorsal margin slightly declined at apical one-third anteriorly (Fig. 20), well sclerotized laterally with medial and apical parts membranous, surface sparsely punctate, glabrous; subequal in length to basal piece. Median lobe (Figs 15–16) trilobate; dorsal sclerite thumb-like with apex slightly swelling; lateral sclerites shorter than dorsal sclerite, broadly crescent-shaped, inwardly curved slightly with tip sharp and highly sclerotized; supporting sclerites L-shaped with central part more sclerotized than lateral side. Internal sac embedded in median lobe. Temones moderately sclerotized, thin and elongate to apical one-third of basal piece (Fig. 15). Basal piece with apical part asymmetrical.

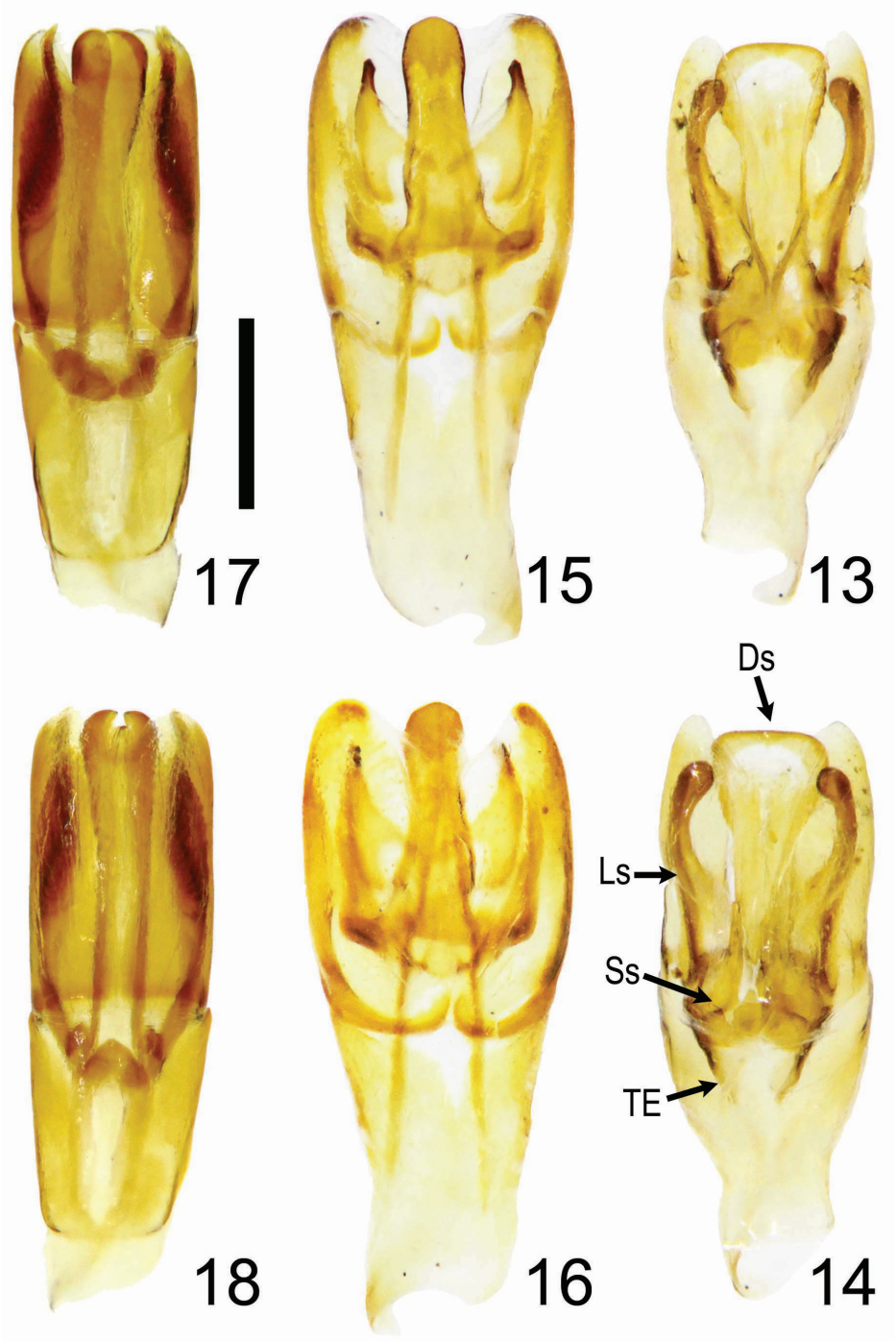
Female. Unknown.



Figures 5–12. Dorsal view of head and left oblique view of *Bolbochromus* spp. **5, 7** *B. minutus* sp. n., holotype male **6, 8** *B. nomurai* sp. n., holotype male **9, 11** *B. malayensis* sp. n., holotype male **10, 12** *B. malayensis* sp. n., paratype female.

Etymology. *Bolbochromus nomurai* is named after Dr. Shûhei Nomura of the National Museum of Nature and Science, Tokyo, who has always assisted C.-L. Li's visits to the scarab collections of the museum.

Diagnosis. *Bolbochromus nomurai* is similar to *B. plagiatus*, but it can be distinguished based on the following combination of characteristics: larger in body size (smaller in *B. plagiatus*); clypeal apex subtrapezoidal (rounded in *B. plagiatus*); anterior margin of clypeus with a small, weakly-developed convexity at middle; (anterior



Figures 13–18. Male genitalia of *Bolbochromus* spp. **13–14** *B. minutus* sp. n. **15–16** *B. nomurai* sp. n. **17–18** *B. malayensis* sp. n. **13, 15, 17** dorsal view; **14, 16, 18** ventral view. Ds, dorsal sclerite; Ls, lateral sclerite; Ss, supporting sclerite; TE, temones. Scale bar= 0.5 mm.

margin simply beaded in *B. plagiatus*); vertex with an inconspicuous conical convexity at middle of base (weakly convex in *B. plagiatus*); outline of pronotum rounded (transverse in *B. plagiatus*); punctures of pronotal midline shallow and inconspicuous (coarsely rugopunctate in *B. plagiatus*); pronotal markings separated on each corner (connected in *B. plagiatus*); elytral markings across base of striae 1–6 and interval 7 (across from stria 1 to epipleuron in *B. plagiatus*).

Remarks. Boucomont and Gillet (1921) and Paulian (1945) listed and diagnosed two *Bolbochromus* species (*B. laetus* and *B. plagiatus*) from Vietnam and neighboring areas which were originally recorded from Sri Lanka and northern India. Yet, we were not able to access the material studied by Paulian, and so we cannot be sure of the identity of specimens that he used. Considering the similarity of *B. plagiatus* to *B. nomurai* and other species occurring in Indochina, it is reasonable to assume that the identifications of Paulian are incorrect as it is unlikely he compared their male genitalia. To solve this problem it is necessary to re-examine the relevant specimens.

Bolbochromus malayensis Li & Krikken, sp. n.

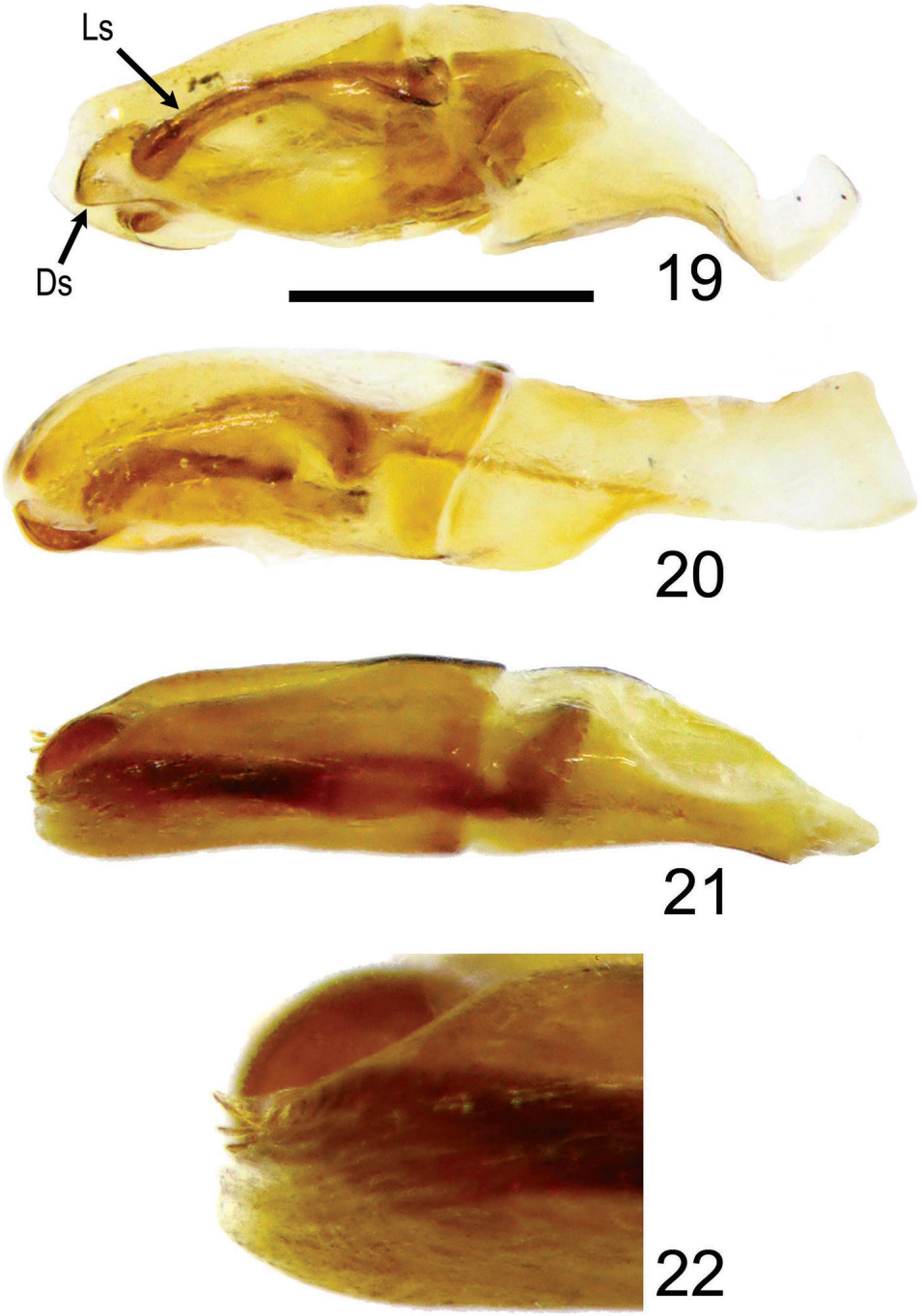
urn:lsid:zoobank.org:act:BE6D04EE-CA30-4BF4-923C-E6260488D63E
http://species-id.net/wiki/Bolbochromus_malayensis
Figs 3–4, 9–12, 17–18, 21–22

Holotype male. The holotype is glued to a paper point and labeled: MALAYSIA: Selangor// Ulu Gombak// 21. V.–3. VI. 2003// Maruyama M. (FIT) (deposited at the National Museum of Nature and Science, Tokyo, Japan).

Paratype. 1 female, with the same collecting data as the holotype.

Type locality. Western Malaysia: Selangor State, Ulu Gombak, 3°35'N, 101°78'E (Fig. 23).

Description. Holotype male (Figs 3, 9, 11). Body length 6.8 mm; greatest width 3.8 mm. Form ovate, sides subparallel. Dorsum of head, pronotum, interval 1 (sutural interval), and base of elytron black with elytral striae and remaining intervals brownish black to yellowish brown; round, brownish yellow markings located on lateral third of pronotum, 2 additional minor marking at sides of basal one-third of midline (Fig. 11); elytral markings across base of striae 1–8 and interval 9, shape transversely irregular (Fig. 3). *Head:* Labrum with anterior margin feebly triangularly concave centrally, sides notched. Clypeal apex trapezoidal with lateral border rounded (Fig. 9), anterior margin beaded, surface rugosely punctate, confluent or separated by less than 1 puncture diameter. Clypeofrontal suture absent. Vertex with an inconspicuous convexity of carina at middle of base, coarse punctures on surface same as those on clypeus, moderately distributed. *Thorax*: Outline of pronotum transverse, surface coarsely punctate along side of disc, moderately dense; midline moderately indented with well-defined, coarse punctures; area in front of elytral base impunctate with coarse punctures at anterior one-third of sides of midline (Fig. 9); disc gradually declined anteriorly when viewed laterally (Fig. 11). Metasternal process poorly developed, narrowly separating



Figures 19–22. Lateral view of male genitalia of *Bolbochromus* spp. **19** *B. minutus* sp. n. **20** *B. nomurai* sp. n. **21** *B. malayensis* sp. n. **22** ditto, tip of genitalia. Ds, dorsal sclerite; Ls, lateral sclerite. Scale bar = 0.5 mm for figures **19–21**.

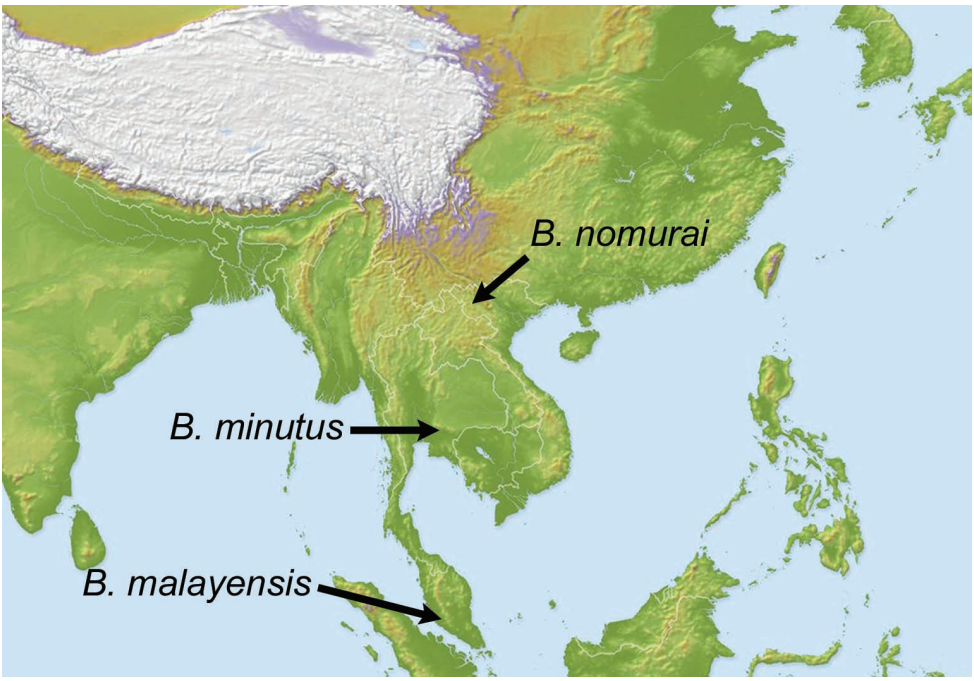


Figure 23. Distribution of the new *Bolbochromus* species.

middle coxae with anterior margin beaded. Scutellum slightly longer than wide medially, surface with 5 coarse punctures and scattered secondary punctures,. *Elytron*: With 7 striae between suture and humeral umbone, stria 2 interrupted by stria 1 not reaching base, stria 5 terminating at basal one-ninth; width of interval 3 and 4 same at basal one-fifth with interval 2, 5 and 6 less convex than others (Figs 3, 11). *Legs:* Protibia with 10 distinct teeth on outer margin, apical 3 teeth protruding, tip of apical tooth curved outwardly. *Male genitalia*: Length 1.7 mm. Parameres (Figs 17–18) elongate, dorsal margin slightly declined at basal one-fifth, becoming more declivous at apical one-fourth (Fig. 21), well sclerotized laterally with apical part membranous, surface almost impunctate, glabrous; subequal in length to basal piece. Median lobe (Figs 17–18) trilobate; dorsal sclerite vertically bilobed with apex notched; lateral sclerites elongate, equal in length to dorsal sclerite, overall highly sclerotized, apex tufted with 4 robust setae (Fig. 22); supporting sclerites kidney-shaped, evenly sclerotized. Internal sac embedded in median lobe. Temones membranous, thin and elongate to apex of basal piece (Fig. 17). Basal piece with apical portion asymmetrical.

Paratype female (Fig. 4, 10, 12). Similar to holotype male with minor differences of lighter body color, secondary punctures on pronotum and scutellum, smaller eyes, larger brownish yellow marking of elytra and robust protibial teeth.

Diagnosis. *Bolbochromus malayensis* is similar to *B. masumotoi*, but it can be distinguished based on the following combination of characteristics: smaller in body size

(*B. masumotoi* with larger; body length >8.0 mm); clypeal apex trapezoidal (rounded in *B. masumotoi*); vertex with an inconspicuous carina at middle of base (a tubercle at center of frontal disc in *B. masumotoi*); pronotal marking rounded (triangular in *B. masumotoi*); punctures on pronotum coarse and moderately dense (fine and sparse in *B. masumotoi*); pronotum smoothly declined anteriorly (steeply declined in *B. masumotoi*); elytral striae coarsely punctate (finely punctate in *B. masumotoi*); elytral intervals varying in degree of convexity (evenly convex in *B. masumotoi*); elytral markings across interval 2–9, transversely irregular (markings across intervals 4–8, shape rounded in *B. masumotoi*); dorsal sclerite of median lobe widened (narrow in *B. masumotoi*).

Etymology. *Bolbochromus malayensis* is the first species of the genus described from the Malay Peninsula, and the species epithet is derived from its locality.

Remarks. The holotype and paratype of *Bolbochromus malayensis* were collected by a flight interception trap, which is an effective method for collecting *Bolbochromus* adults. A series of papers by Hanski and Krikken (1991), Davis (2000), Davis et al. (2001), and Li et al. (2008) demonstrated that flight interception traps are highly effective for collecting forest-dwelling bolboceratine scarabs.

Acknowledgments

We are grateful to Alexey Solodovnikov (Zoological Museum of the University of Copenhagen, Copenhagen, Denmark) and Shûhei Nomura (National Museum of Nature and Science, Tokyo, Japan) for lending valuable specimens used in this work and for their long-term assistance to C.-L. Li. We also thank Denis Keith (Muséum d'Histoire Naturelle et de Préhistoire, Chartres, France) for providing valuable photographs of the type of *Bolboceras plagiatus*. Special thanks to Brett C. Ratcliffe (University of Nebraska State Museum, UNSM, Nebraska, USA) for reviewing the manuscript. This study was supported by NSC grants NSC101-2621-M-002-020 to P.-S. Yang and NSC101-2311-B-030-001 to C.-C. Wang as well the NTU Experimental Forest grant 102-B-02 to C.-L. Li.

References

Boucomont A (1909) Notes sur quelques sous-genres de *Bolboceras* [Col.,] et description d'un sous-genre nouveau. Bulletin de la Société Entomologique de France 10: 116–118.

Boucomont A (1914) Les coprophages de l'Archipel Malais. Annales de la Société Entomologique de France 83: 238–350.

Boucomont A, Gillet J (1921) Faune entomologique de l'Indochine française. Fasc. 4. Fam. Scarabaeidae. Laparosticti (Coléoptères). Portail, Saigon, Vietnam, 76 pp.

Davis AJ (2000) Does reduced-impact logging help preserve biodiversity in tropical rainforest? A case study from Borneo using dung beetles (Coleoptera: Scarabaeoidea) as indicators. Enviromental Entomology 29: 467–475. doi: 10.1603/0046-225X-29.3.467

Davis AJ, Holloway JD, Huijbregts H, Krikken J, Kirk-Spriggs AH, Sutton SL (2001) Dung beetles as indicators of changes in the forests of northern Borneo. Journal of Applied Ecology 30: 593–616. doi: 10.1046/j.1365-2664.2001.00619.x

D'Hotman D, Scholtz CH (1990) Phylogenetic significance of the structure of the external male genitalia in the Scarabaeoidea (Coleoptera). Entomology Memoir 77: 1–51.

Hanski I, Krikken J (1991) Dung beetles in tropical forests in south-east Asia. In: Hanski I, Cambefort Y (Eds) Dung Beetle Ecology. Princeton University Press, Princeton, 179–197.

Keith D (2012) Description de deux nouvelles espèces de Scarabaeoidea d'Asie (Coleoptera, Melonthodidae, Bolboceratidae). Nouvelle Revue d'Entomologie (NS) 28: 3–10.

Lansberge JW van (1886) Description de quelques Scarabaeides des Indes Neerlandais appartenant au Musée de Leyde. Notes from the Leyden Museum 8: 131–137.

Li CL, Wang CC, Masumoto K, Ochi T, Yang PS (2008) Review of the tribe Bolboceratini s.l. from Taiwan (Coleoptera: Scarabaeoidea: Geotrupidae) with a key to the Eurasian genera. Annals of the Entomological Society of America 101: 474–490. doi: 10.1603/0013-8746(2008)101[474:ROTTBS]2.0.CO;2

Ochi T, Kon M, Kawahara M (2010) A new species of *Bolbochromus* from the Philippines (Coleoptera, Scarabaeidae). Kogane 11: 97–99.

Ochi T, Kon M, Kawahara M (2011) Four new taxa of Scarabaeoidea (Coleoptera) from Southeast Asia. Special publication of the Japanese Society of Scarabaeoidology 1: 153–162.

Paulian R (1945) Faune de l'Empire Français III Coléoptères Scarabéides de l'Indochine. Première partie. Librairie Larose, Paris, 227 pp.

Pouillaude I (1914) *Bolbochromus Walshi* et *B. niger*. Nouvelles espèces de Bolbocerini (Col. Scarabeidae). Insecta (Rennes, France) 1914: 143–145.

Westwood JO (1848) Descriptions of some new or imperfectly known species of *Bolboceras*. The Annals and Magazine of Natural History 2(2): 353–358.

Westwood JO (1852) Descriptions of some new or imperfectly known species of *Bolboceras* Kirby. Transactions of the Linnean Society of London 21(1):19–30. doi: 10.1111/j.1096-3642.1852.tb00496.x

Wiedemann CRW (1819) Neue Käfer aus Bengalen und Java. Zoologisches Magazin 1: 157–183.

Wiedemann CRW (1823) Zweihundert neue Käfer von Java, Bengalen und den Vorgebirgen der Guten Hoffnung. Zoologisches Magazin 2(1): 1–133.

ZooKeys 290: 55–73 (2013)
doi: 10.3897/zookeys.290.4781
www.zookeys.org

RESEARCH ARTICLE

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Chinese species of the genus *Aptesis* Förster (Hymenoptera, Ichneumonidae) parasitizing sawflies, with descriptions of three new species and a key to species

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Academic editor: *G. Broad* | Received 29 January 2013 | Accepted 29 March 2013 | Published 16 April 2013

urn:lsid:zoobank.org:pub:F2504E82-AE1A-4911-BA76-D98E49CF1118

Citation: Li T, Sheng M-L, Sun S-P (2013) Chinese species of the genus *Aptesis* Förster (Hymenoptera, Ichneumonidae) parasitizing sawflies, with descriptions of three new species and a key to species. ZooKeys 290: 55–73. doi: 10.3897/zookeys.290.4781

Abstract

Six species of the genus *Aptesis* Förster 1850 belonging to the tribe Hemigastrini of the subfamily Cryptinae (Hymenoptera, Ichneumonidae) are reported from China. Three of them, *A. elongata* Li & Sheng, **sp. n.**, *A. melana* Li & Sheng, **sp. n.** and *A. nigricoxa* Li & Sheng, **sp. n.** reared from sawflies in China, are new to science. The biology of *A. melana* is described. A key to the species of *Aptesis* known from China is provided.

Keywords

Aptesis, Hymenoptera, parasitoid, Cryptinae, Diprionidae, Tenthredinidae, *Neodiprion huizeensis*, *Diprion jingyuanensis*, *Pristiphora erichsonii*, biology

Introduction

Aptesis Förster 1850, belonging to the subfamily Cryptinae of Ichneumonidae (Hymenoptera), comprises 70 described species, of which five are known from the Oriental region, 16 from the Nearctic, one from the Afrotropical, eight from the Eastern Palaearctic and 42 from the Western Palaearctic (two of them are found across the Palaearctic) (Yu et al. 2012).

Known hosts of *Aptesis* species that have been reliably reared are sawflies of the families Argidae, Diprionidae and Tenthredinidae (Carl 1976; Babendreier 2000; Herz and Heitland 2005; Sawoniewicz 2008; Kasparyan and Kopelke 2009). They parasitize sawfly cocoons (Townes 1970) and are idiobiont ectoparasitoids of larvae and prepupae.

Three species of *Aptesis* Förster have been known in China: *A. albibasalis* (Uchida, 1930), parasitizing *Arge pagana* (Panzer) (Hymenoptera, Argidae), found in Shandong Province (Wang and Sheng 2006); *A. corniculata* Sheng 2003, parasitizing *Nematus* sp. (Hymenoptera, Tenthredinidae), found in Gansu Province (Sheng and Wu 2003); *A. grandis* Sheng 1998, parasitizing *Diprion jingyuanensis* Xiao & Zhang and *Neodiprion fengningensis* Xiao & Zhou (Hymenoptera, Diprionidae), found in Gansu, Liaoning and Shanxi Provinces (Sheng et al. 1998; Sheng and Chen 2001). In this article, three new species of *Aptesis* parasitizing sawflies are reported.

Materials and methods

Cocoons of sawflies were collected under the naturally heavily infested trees in Weining County (26°54'N, 104°13'E, elevation 2000 to 2200 m), Guizhou Province (Li et al. 2012). The forest stand is mainly *Pinus armandii* Franch., *P. yunnanensis* Franch. and some shrubs.

Pingheliang (33°26'N, 108°28'E, elevation 2000 to 2100 m), Shaanxi Province. The main forest is *Larix principis-rupprechtii* Mayr and shrubs. Jialing River (34°13'N, 106°55'E, elevation 1450 to 1600 m), Shaanxi Province. The forest stand is composed of mixed deciduous angiosperms and evergreen conifers, mainly *Larix principis-rupprechtii*, *Pinus tabulaeformis* Carr., and some shrubs.

Liupan Mountains (36°10'N, 106°27'E, elevation 1600 to 1800 m), Ningxia Hui Autonomous Region. The forest stand is composed of mixed deciduous angiosperms and evergreen conifers, mainly *Larix principis-rupprechtii*, *Pinus tabulaeformis*, *Hippophae rhamnoides* L., *Elaeagnus angustifolia* L. and some shrubs.

Hasi Mountains (37°01'N, 104°22'E, elevation 2200 to 2400 m), Gansu Province. The forest stand is mainly *Pinus tabulaeformis* and shrubs. Maiji Mountains (34°21'N, 105°60'E, elevation 1400 to 1500 m), Gansu Province. The main forest is *Larix principis-rupprechtii* and shrubs.

The cocoons were stored individually in glass tubes (100 mm long and 15 mm in diameter) with a piece of filter paper dipped in distilled water in order to

prevent desiccation and plugged with absorbent cotton. Cocoons of *Neodiprion huizeensis* Xiao & Zhou (Hymenoptera, Diprionidae) were maintained at 23 ± 1 °C with 60 % to 70 % relative humidity and 14 hours to 10 hours light and dark photoperiod. Cocoons of other sawflies were maintained at room temperature. All cocoons were checked daily for sawflies and parasitoid emergence. Emerged parasitoid larvae and pupae were kept in glass tubes at the same temperature until adult emergence. After emergence of sawflies and parasitoids was complete, all remaining cocoons were dissected and their condition (i.e. status of sawflies, and parasitism) was recorded.

Aptesis pallidinervis (Cameron, 1904) was described from India, and there are no host records (Cameron 1904). We were not able to examine specimens of *A. pallidinervis* and we have compared it to our new species based on the original description.

Images of whole insects were taken using a CANON Power Shot A650 IS. Other images were taken using a Cool SNAP 3CCD attached to a Zeiss Discovery V8 Stereomicroscope and captured with QCapture Pro version 5.1. Morphological terminology is based on Gauld (1991). Wing vein nomenclature and terminology based on Mason (1986, 1990).

Type specimens are deposited in the Insect Museum, General Station of Forest Pest Management (GSFPM), State Forestry Administration, P. R. China.

Terminology

Postocellar line: the shortest distance between the lateral ocelli. Ocular-ocellar line: the shortest distance between the lateral ocellus and the margin of the compound eye. Wing veins referred to in the text are shown on Fig. 9.

Descriptions

Genus *Aptesis* Förster, 1850
http://species-id.net/wiki/Aptesis

Aptesis Förster 1850. Archiv für Naturgeschichte. 16(1): 71. Type species: *Ichneumon sudeticus* Gravenhorst, 1815. Designated by Viereck 1914.

Diagnosis. Clypeus weakly to rather strongly convex in lateral review, apex truncate or broadly and gently convex, sometimes faintly concave and sometimes with a median tooth. Mandible of moderate length, its lower tooth the same size as upper tooth or sometimes slightly smaller, rarely slightly larger. Tyloids linear to elliptic or subcircular, on about 5 segments, beginning on flagellomeres 9, 10, or 11. Epomia absent or rudimentary. Mesoscutum rather weakly convex. Notaulus vestigial or reaching as much as 0.3 of distance to scutellum. Sternaulus distinct over more than

0.5 of mesopleuron, its end pointing to lower hind corner of mesopleuron. Juxtacoxal carina complete and strong. Propodeum of moderate length to short, with or without weak apophyses. Costula usually present in males, usually incomplete or absent in females, but sometimes absent in males and sometimes complete and strong in females. Propodeal spiracle circular or short elliptic. Areolet pentagonal, moderate size. Median dorsal carinae of first tergum usually weak and reaching about to the spiracle, rarely longer and stronger. Dorsolateral part of postpetiole usually carinate between spiracle and apex, or rarely rounded. Ovipositor sheath about 0.35 times as long as fore wing. Ovipositor straight, tip usually elongate sagittate but sometimes shorter, teeth on lower valve weak, oblique, separated into a basal and an apical series (Townes 1970).

Key to species of *Aptesis* known in China

1 Vein 2rs-m parallel or almost parallel with vein 3rs-m (Figs 31, 34) **2**

– Vein 2rs-m obviously anteriorly convergent with vein 3rs-m (Figs 9, 18).... **3**

2 Face approximately 2.8 times as wide as long. Mandible teeth of equal length. Postocellar line about 1.3 times as long as ocular-ocellar line. Ovipositor sheath about 0.6 times as long as hind tibia. Metasoma black (Fig. 34) .... ***A. grandis* Sheng**

– Face approximately 2.0 to 2.1 times as wide as long (Fig. 24). Upper tooth slightly longer than lower tooth. Postocellar line about 1.5 times as long as ocular-ocellar line. Ovipositor sheath about 0.7 times as long as hind tibia. Apical portion of first and second to third terga entirely reddish brown (Fig. 30)..... ***A. nigricoxa* Li & Sheng, sp. n.**

3 Face and frons black (Fig. 11)..... **4**

– Inner orbits of frons with yellowish white flecks, inner orbits of face with or without yellowish white flecks (Fig. 4)..... **5**

4 Malar space about 1.4 times as long as basal width of mandible. Postocellar line about 1.4 times as long as ocular-ocellar line (Fig. 13). First tergum about 1.3 times as long as apical width. Basal portion of hind tibia dark reddish brown (Fig. 10) ..... ***A. melana* Li & Sheng, sp. n.**

– Malar space about 0.9 times as long as basal width of mandible. Postocellar line about equal with ocular-ocellar line. First tergum about 1.7 times as long as apical width. Basal portion of hind tibia white (Fig. 32) .... ***A. albibasalis* (Uchida)**

5 Face approximately 1.7 times as wide as long (Fig. 2). Vein 2-Cu approximately 2.3 times as long as 2cu-a. Hind wing vein 1-cu about 4.0 times as long as cu-a (Fig. 9). First tergum about 1.5 times as long as apical width .... ***A. elongata* Li & Sheng, sp. n.**

– Face approximately 2.0 times as wide as long. Vein 2-Cu approximately 1.5 times as long as 2cu-a. Hind wing vein 1-cu about 1.5 times as long as cu-a. First tergum about 1.2 times as long as apical width ... ***A. corniculata* Sheng**

***Aptesis elongata* Li & Sheng, sp. n.**
urn:lsid:zoobank.org:act:C71C2353-32C7-4DB2-AF95-6538294B184A
http://species-id.net/wiki/Aptesis_elongata
Figures 1–9

Etymology. The name of the new species is based on the elongate area superomedia.

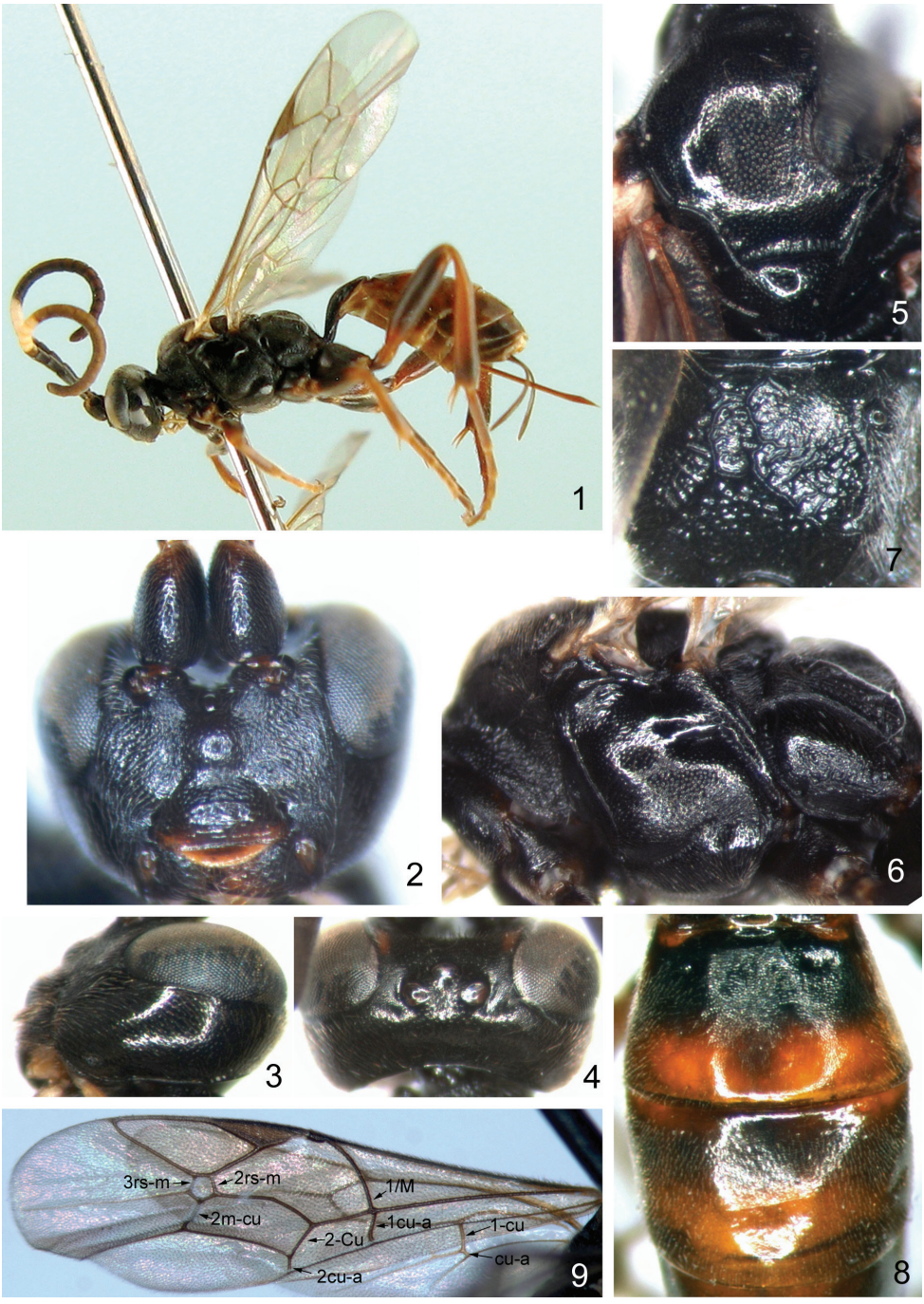
Types. *Holotype*, female, CHINA: Jialing River, Shaanxi Province, 18 May 2010, 2025m, leg. Tao Li. *Paratypes*: 2 females, CHINA: Pingheliang, Shaanxi Province, 29 October 2009, leg. Tao Li; 1 female, CHINA: Pingheliang, Shaanxi Province, 6 April 2010, leg. Tao Li; 1 female, CHINA: Jialing River, Shaanxi Province, 10 May 2010, 2025m, leg. Tao Li. All specimens reared from *Pristiphora erichsonii*, except one female from *Pristiphora xibei* in Pingheliang on 6 April 2010.

Diagnosis. Clypeus about 1.6 times as wide as long. Malar space approximately 1.3 times as long as basal width of mandible. Postocellar line approximately 1.6 times as long as ocular-ocellar line. Antenna with 21 to 23 flagellomeres. Vein 2-Cu approximately 2.3 times as long as 2cu-a. Hind wing vein 1-cu about 4.0 times as long as cu-a. First tergum about 1.5 times as long as apical width. Ovipositor sheath about 0.7 times as long as hind tibia.

Description. Female (Fig. 1). Body length 5.0 to 7.0 mm. Fore wing length 4.0 to 6.0 mm.

Head. Face (Fig. 2) about 1.7 times as wide as long, with fine leathery granulose texture and evenly dense punctures; centrally convex; upper margin concave, with a small median protuberance. Clypeus evenly convex, about 1.6 times as wide as long; basally with texture as face, with weak transverse wrinkles; subapex smooth; apical margin flat. Mandible with dense punctures, upper tooth slightly longer than lower tooth. Malar space with fine granulose texture, approximately 1.3 times as long as basal width of mandible. Gena (Fig. 3) smooth with dense fine punctures; median portion weak convex. Ocellar triangle medially with dense fine punctures; remainder of vertex with fine granulose texture (Fig. 4). Postocellar line approximately 1.6 times as long as ocular-ocellar line. Upper portion of frons flat with fine granulose texture; lower portion concave with fine leathery texture. Antenna with 21 to 23 flagellomeres, ratio of length from first to fifth flagellomeres: 7.0:8.0:6.5:5.5:5.0. Occipital carina complete.

Mesosoma. Pronotum anteriorly with fine wrinkles and dense punctures; medially with fine oblique wrinkles and fine punctures; upper posterior portion smooth, with fine granulose texture and dense fine punctures. Mesoscutum (Fig. 5) weakly convex, smooth with evenly dense punctures. Notaulus evident approximately on anterior half of mesoscutum. Scutellum evenly convex, smooth with dense fine punctures. Postscutellum transverse, with texture as scutellum. Median portion of mesopleuron (Fig. 6) weakly convex, smooth with evenly fine punctures; lower portion flat, with irregular fine wrinkles and dense fine punctures. Epicnemial carina distinct, approximately reaching subalar ridge; lower portion of subalar ridge weakly concave, with fine transverse wrinkles. Sternaulus distinct, reaching margin of mesopleuron,



Figures 1–9. *Aptesis elongata* Li & Sheng, sp. n. Holotype. Female. **1** Body, lateral view **2** Head, anterior view **3** Head, lateral view **4** Head, dorsal view **5** Mesoscutum **6** Mesopleuron **7** Propodeum **8** Terga 2 to 3, dorsal view **9** Fore wing.

apically ventral to ventral-posterior corner of mesopleuron. Speculum big, smooth and shiny. Scrobe with strong groove. Metapleuron weakly convex; upper portion smooth with densely fine punctures, lower portion with irregular wrinkles. Juxtacoxal area with fine granulose texture. Juxtacoxal carina and submetapleural carina complete. Legs robust. Ratio of length of hind tarsomeres 1:2:3:4:5 is 19.0:9.0:6.5:4.0:7.0. Fore wing (Fig. 9) with vein 1cu-a opposite or slightly proximal or distal to 1/M. Vein 3rs-m anteriorly convergent with 2rs-m. Vein 2m-cu meets areolet at about mid-point of cell. Vein 2-Cu approximately 2.3 times as long as 2cu-a. Hind wing vein 1-cu about 4.0 times as long as cu-a. Propodeum (Fig. 7) weakly convex. Area basalis an inverse trapezium, small. Area superomedia elongate, approximately 1.3 times as long as wide, with distinct transverse wrinkles, central portion weakly concave. Costula connecting area superomedia at its middle. Posterior transverse carina of propodeum strong. Area petiolaris weakly sloping, with irregular transverse wrinkles. Area externa with fine granulose texture. Area dentipara with irregular oblique wrinkles. Propodeal spiracle circular, moderately large, near pleural carina, located at anterior 0.2 of propodeum.

Metasoma. First tergum about 1.5 times as long as apical width, with fine leathery texture, smooth. Median dorsal carinae distinct, extending beyond spiracle. Dorsolateral and ventrolateral carinae complete. Spiracle circular, very small, located at apical 0.3 times of first tergum. Second tergum (Fig. 8) approximately 0.7 times as long as apical width, with fine granulose texture; centrally with weak wrinkles. Thyridia present. Third tergum about 0.6 times as long as basal width, with texture as first tergum; basally polished. Fourth to eighth terga with texture as third tergum. Ovipositor sheath about 0.7 times as long as hind tibia. Ovipositor straight and slender, apical portion sharp, with nodus. Apical portion of lower valve with weak ridges.

Color (Fig. 1)**.** Black, except the following. Flecks of inner orbits on frons yellowish brown with some reddish. Maxillary and labial palpi, apical half of fifth and sixth to ninth flagellomeres, tegula laterally, wing base, yellow. Fore leg (coxa, trochanters, most of femur, blackish brown), mid leg (coxa, trochanters, most of femur, blackish brown), hind leg (coxa, first trochanter, most of femur, apical portion of tibia, blackish brown), yellowish brown with some reddish. Apical half of second tergum, thyridia, third tergum (medially dark reddish brown), base of fourth tergum, reddish brown. Wing membrane brownish hyaline. Veins, pterostigma, blackish brown.

Male. Unknown.

Hosts. *Pristiphora erichsonii*, *P. xibei* (Hymenoptera: Tenthredinidae).

Host plant. *Larix principis-rupprechtii* (Pinaceae).

Biology. The mature larva forms a cocoon inside the host's cocoon and outside the body of the host larva.

Remarks. This new species is similar to *Aptesis corniculata* Sheng 2003, but can be distinguished from the latter by the following combination of characters: face approximately 1.7 times as wide as long; fore wing vein 2-Cu approximately 2.3 times as long as 2cu-a; hind wing vein 1-cu about 4.0 times as long as cu-a; first tergum about 1.5

times as long as apical width. *Aptesis corniculata*: face approximately 2.0 times as wide as long; fore wing vein 2-Cu approximately 1.5 times as long as 2cu-a; hind wing vein 1-cu about 1.5 times as long as cu-a; first tergum about 1.2 times as long as apical width.

Aptesis melana Li & Sheng, sp. n.

urn:lsid:zoobank.org:act:D0C50573-9CFC-42F4-BAA6-A81B2BF11705
http://species-id.net/wiki/Aptesis_melana
Figures 10–18

Etymology. The name of the new species is based on the black body color.

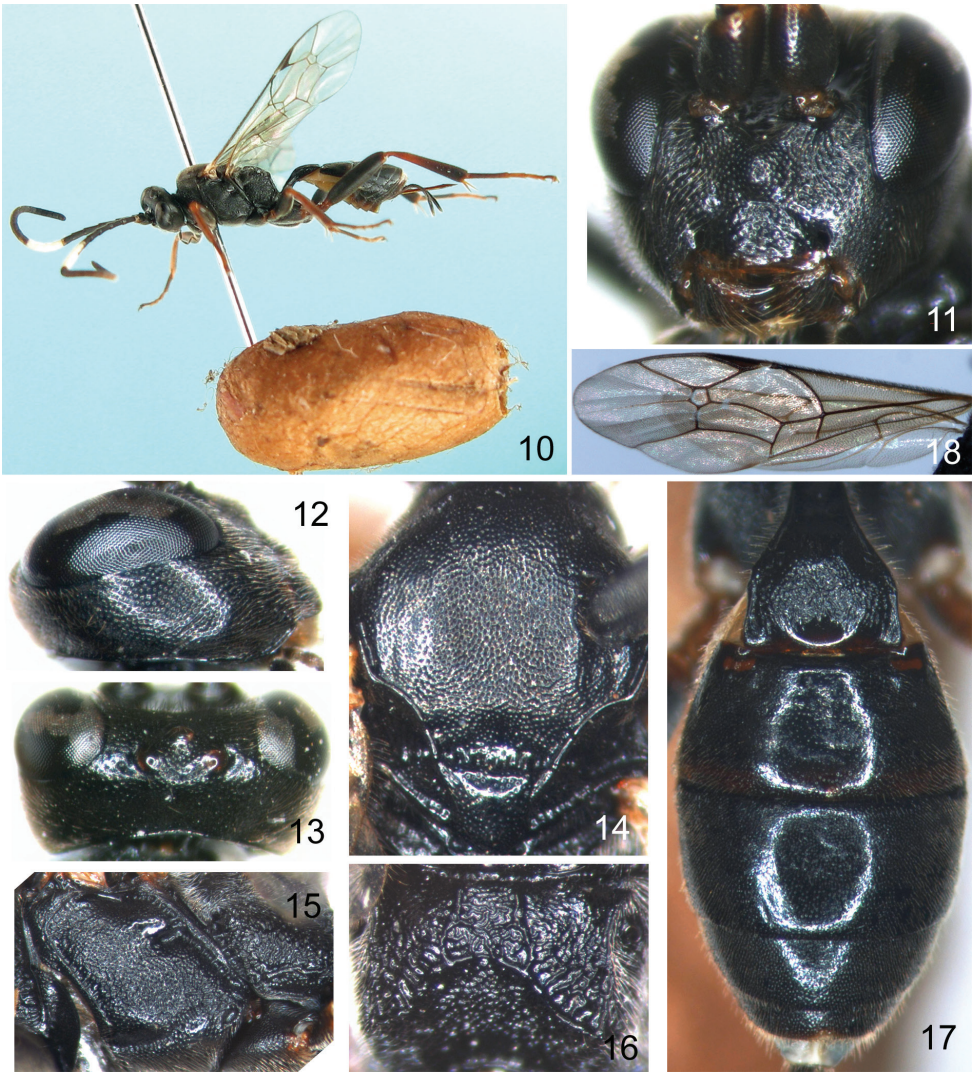
Types. *Holotype*, female, CHINA: Weining County, Guizhou Province, 20 February 2012, leg. Mao-Ling Sheng. *Paratypes*: 2 females, CHINA: Jialing River, Shaanxi Province, 8 May 2010, 2025m, leg. Tao Li; 2 females, CHINA: Pingheliang, Shaanxi Province, 16 to 24 May 2010, leg. Tao Li; 6 females, CHINA: Maiji Mountains, Gansu Province, 8 to 24 May 2010, leg. Tao Li; 35 females and 15 males, CHINA: Liupan Mountains, Ningxia Hui Autonomous Region, 8 May to 1 August 2011, leg. Tao Li; 337 females and 199 males, CHINA: Weining County, Guizhou Province, 17 February to 3 April 2012, leg. Tao Li, Mao-Ling Sheng; 11 females and 5 males, CHINA: Liupan Mountains, Ningxia Hui Autonomous Region, 17 to 23 May 2012, leg. Tao Li. All specimens reared from *Pristiphora erichsonii* in Jialingjiang River, Pingheliang, Maiji Mountains and Liupan Mountains, except one reared from *Neodiprion huizeensis* in Weining County, Guizhou Province.

Diagnosis. Clypeus approximately 1.7 times as wide as long. Mandible teeth about equal in length. Malar space approximately 1.4 times as long as basal width of mandible. Postocellar line approximately 1.4 times as long as ocular-ocellar line. Antenna with 25 flagellomeres. Fore wing with vein 1cu-a opposite 1/M; Vein 2-Cu approximately 1.5 times as long as 2cu-a. First tergum about 1.3 times as long as apical width. Ovipositor sheath about 0.8 times as long as hind tibia.

Description. Female (Fig. 10). Body length 6.0 to 9.0 mm. Fore wing length 5.0 to 7.0 mm.

Head. Face (Fig. 11) about 2.7 times as wide as long, with dense fine punctures; centrally convex, punctures smaller than on remainder of face; upper margin concave. Clypeus approximately 1.7 times as wide as long; basally with dense fine punctures; apically with weak wrinkles; apical margin flat. Mandible with dense punctures, teeth approximately equal in length. Malar space with fine leathery texture, approximately 1.4 times as long as basal width of mandible. Gena (Fig. 12) with evenly dense punctures. Vertex (Fig. 13) with texture as gena. Outside of ocellar triangle with sparse punctures. Postocellar line approximately 1.4 times as long as ocular-ocellar line. Frons with evenly dense punctures, basally smooth. Antenna with 25 flagellomeres, ratio of length from first to fifth flagellomeres: 12.0:11.0:10.0:9.0:7.0. Occipital carina complete.

Mesosoma. Pronotum anteriorly with weak wrinkles; medially with short transverse wrinkles; with dense punctures dorso-posteriorly. Mesoscutum (Fig. 14) flat,



Figures 10–18. *Aptesis melana* Li & Sheng, sp. n. Holotype. Female. **10** Body, lateral view **11** Head, anterior view **12** Head, lateral view **13** Head, dorsal view **14** Mesoscutum **15** Mesopleuron **16** Propodeum **17** Metasoma, dorsal view **18** Fore wing.

with dense punctures. Notaulus present anteriorly. Scutellum with punctures sparser than on mesoscutum. Postscutellum transverse, smooth. Mesopleuron (Fig. 15) with texture as mesoscutum, with irregular wrinkles. Epicnemial carina strong, reaching subalar ridge. Sternaulus distinct, reaching hind margin of mesopleuron, apically ventral to ventral-posterior corner of mesopleuron. Scrobe with strong groove. Metapleuron with texture as mesopleuron. Juxtacoxal carina incomplete. Submetapleural carina complete. Legs robust. Ratio of length of hind tarsomeres 1:2:3:4:5 is 13.0:5.0:4.0:2.0:4.0. Fore wing (Fig. 18) with vein 1cu-a opposite 1/M. Vein 3rs-m

anteriorly convergent with 2rs-m. Areolet receiving vein 2m-cu approximately at its middle. Vein 2-Cu approximately 1.5 times as long as 2cu-a. Hind wing vein 1-cu about 4.0 times as long as cu-a. Propodeum (Fig. 16) weakly convex. Anterior transverse carina absent. Areas basalis and superomedia combined, with irregular wrinkles. Areas externa and dentipara combined; basal portion with sparse punctures and weak wrinkles; apically with irregular short wrinkles. Posterior transverse carina strong. Area petiolaris sloping, with irregular wrinkles; medially weakly concave. Propodeal apophysis distinct. Propodeal spiracle approximately circular, located at anterior 0.2 of propodeum.

Metasoma (Fig. 17)**.** First tergum about 1.3 times as long as apical width, apically with weak wrinkles. Median dorsal carinae distinct, basally parallel. Dorsolateral and ventrolateral carinae complete. Spiracle circular, small, located at apical 0.3 of first tergum. Second tergum approximately 0.5 times as long as apical width, smooth. Third to eighth terga with texture as second tergum. Ovipositor sheath about 0.8 times as long as hind tibia. Ovipositor strong, straight, apically sharp. Apical portion of lower valve with 2 ridges.

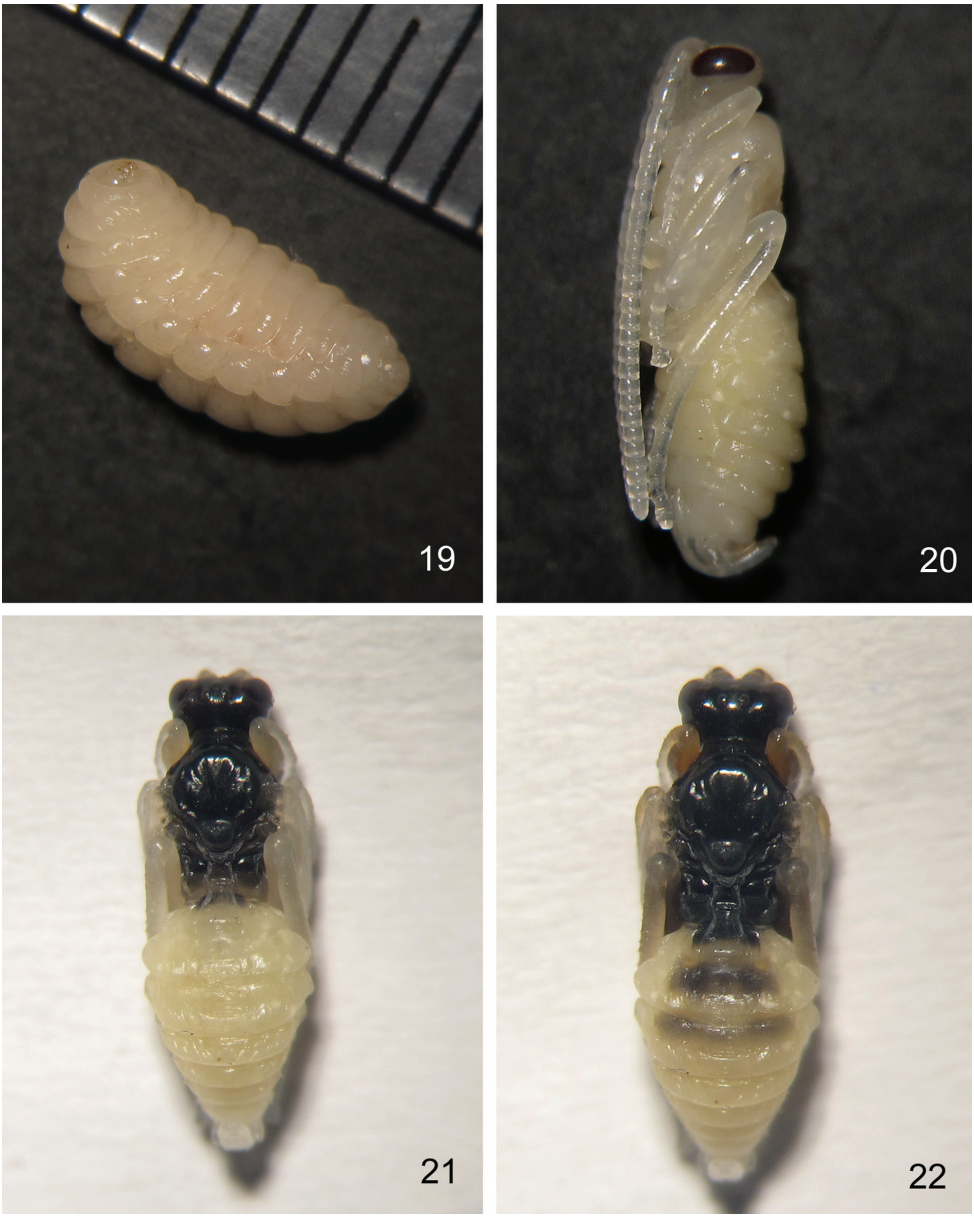
Color (Fig. 10)**.** Black, except the following. Sixth to ninth (base of tenth) flagellomeres, wing base, yellowish white. Apical portion of clypeus, mandible (basally and teeth, blackish brown), fore leg (part of coxa black; first trochanter, femur laterally, blackish brown), mid leg (coxa, femur, blackish brown), hind leg (coxa, femur, tibia apically, first tarsomere, blackish brown), reddish brown. Maxillary and labial palpi, pterostigma, veins, blackish brown. Wing membrane brownish hyaline.

Male. Body length 7.0 to 8.0 mm. Fore wing length 5.0 to 7.0 mm. Body black. Face, clypeus, mandible (teeth black), maxillary and labial palpi, wing base, yellowish white. Fore leg (most of coxa, trochanters, second to forth tarsomeres, yellowish white; fifth tarsomere brown), mid leg (part of coxa, trochanters, second to fourth tarsomeres, yellowish white; most of femur blackish brown; most of first and fifth tarsomeres, brown), hind leg (coxa, trochanters, femur, most of tibia, blackish brown; first and fifth tarsomeres basally brown; Apex of first and second to fourth tarsomeres, yellowish white), reddish brown.

Hosts. *Neodiprion huizeensis* (Hymenoptera: Diprionidae), *Pristiphora erichsonii* (Hymenoptera: Tenthredinidae).

Host plants. *Pinus armandi*, *Larix principis-rupprechtii* (Pinaceae).

Biology. The mature larva of *A. melana* forms a cocoon outside the body of the *N. huizeensis* larva and inside the cocoon of the host. The mature larva of *A. melana* is cream-colored (Fig. 19). The pupa changes continuously as development continues. The young pupa is cream-colored, the compound eyes light red. After three days, the compound eyes change to dark red (Fig. 20). Two days later, the head and mesosoma are blackish brown (Fig. 21). After two days, the head and mesosoma change to black; the first and second terga blackish brown, third to eighth terga brown (Fig. 22); the basal portion of flagellomeres brown, median portion yellowish white and apical portion yellowish brown. The mature pupa is the same color as the adult. Of 537 *A. melana* reared from *N. huizeensis*, the female to male ratio was 1.7: 1. The average parasitism



Figures 19–22. *Aptesis melana* Li & Sheng, sp. n. **19** Larva. **20, 21, 22** Pupa.

rate of *N. huizeensis* by *A. melana* was 8.7%. Adults of *A. melana* emerged between 17th February to 12th March under laboratory conditions.

Remarks. This new species is similar to *Aptesis albibasalis* (Uchida, 1930) but can be distinguished from the latter by the following combination of characters: malar space about 1.4 times as long as basal width of mandible; postocellar line about 1.4 times as long as ocular-ocellar line; first tergum about 1.3 times as long as apical width;

hind tibia basally dark reddish brown. *Aptesis albibasalis*: malar space about 0.9 times as long as basal width of mandible; postocellar line about equal with ocular-ocellar line; first tergum about 1.7 times as long as apical width; hind tibia basally white.

Aptesis nigricoxa Li & Sheng, sp. n.

urn:lsid:zoobank.org:act:89FF2D20-D0A2-41B4-AC95-64CA314F48B2
http://species-id.net/wiki/Aptesis_nigricoxa
Figures 23–31

Etymology. The name of the new species is based on the black coxae.

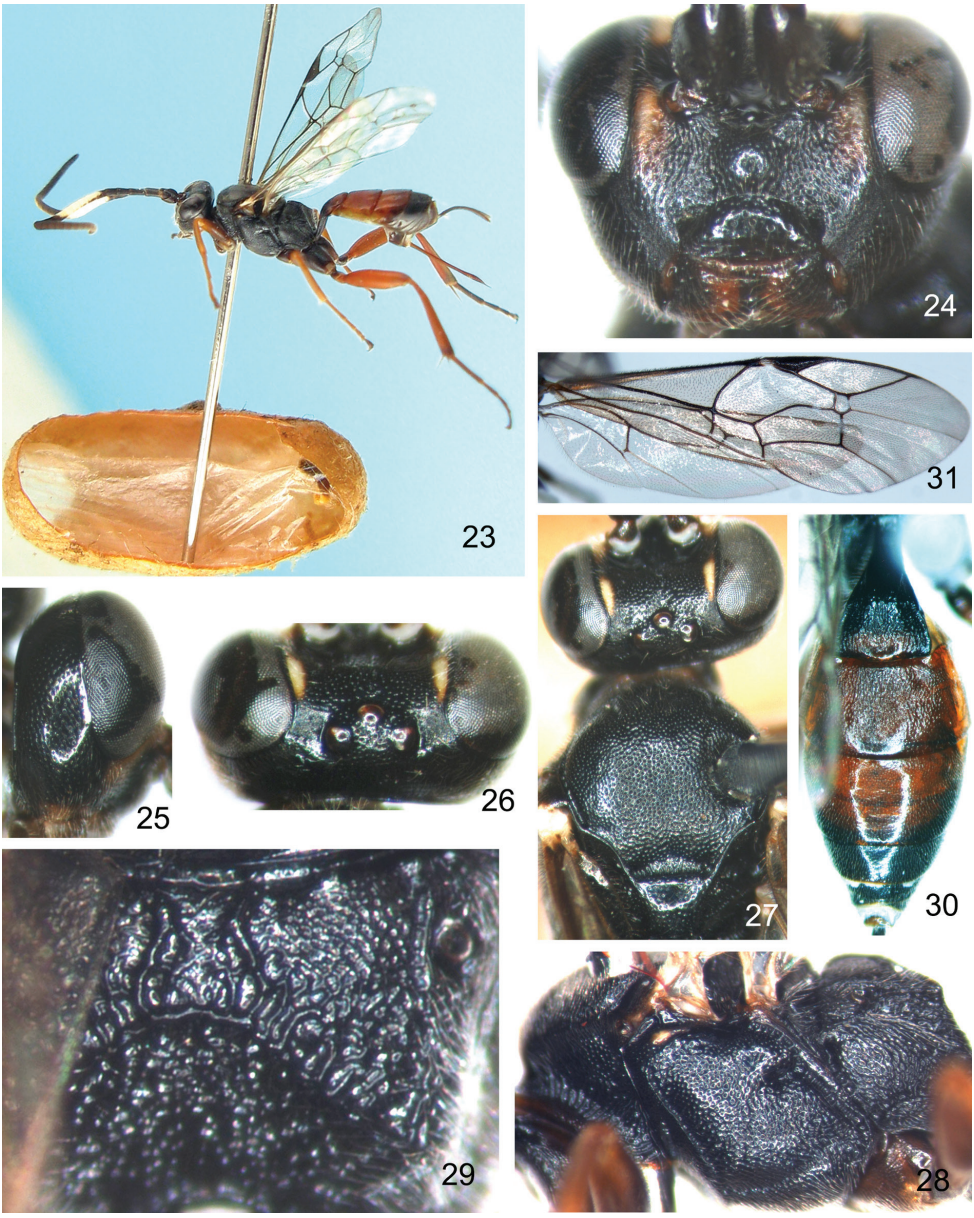
Types. *Holotype*, female, CHINA: Weining County, Guizhou Province, 26 February 2012, leg. Mao-Ling Sheng. *Paratype*: 1 female, CHINA: Weining County, Guizhou Province, 1 March 2012, leg. Tao Li. Both specimens reared from *Neodiprion huizeensis*.

Diagnosis. Clypeus about 1.9 to 2.0 times as wide as long. Malar space approximately 1.2 to 1.4 times as long as basal width of mandible. Postocellar line approximately 1.5 times as long as ocular-ocellar line. Antenna with 30 to 31 flagellomeres. Fore wing vein 3rs-m almost parallel with 2rs-m. Vein 2-Cu approximately 1.5 times as long as 2cu-a. First tergum about 1.5 times as long as apical width. Ovipositor sheath about 0.7 times as long as hind tibia.

Description. Female (Fig. 23). Body length 6.0 to 8.5 mm. Fore wing length 6.0 to 7.0 mm.

Head. Face (Fig. 24) about 2.0 to 2.1 times as wide as long, with short brown setae and dense punctures; centrally weakly convex, punctures sparser than remainder of face; face orbits granulose with sparse punctures. Epistomal suture distinct. Clypeus about 1.9 to 2.0 times as wide as long, with sparse punctures; basally evenly convex; apically flat, with transverse wrinkles, apical margin distinct. Mandible strong, with dense fine punctures; upper tooth slightly longer than lower tooth. Malar space with fine granulose texture, approximately 1.2 to 1.4 times as long as basal width of mandible. Gena (Fig. 25) smooth, with dense fine punctures; centrally weakly convex. Ocellar triangle densely punctate; outside of ocellar triangle with fine leathery texture and sparse fine punctures (Fig. 26). Postocellar line about 1.5 times as long as ocular-ocellar line. Frons densely punctate, medially weak transverse convexity, evenly concave ventrally, smooth with weak wrinkles; orbits of frons with sparse punctures. Antenna with 30 to 31 flagellomeres, ratio of length from first to fifth flagellomeres: 7.0:8.0:7.0:6.0:5.0. Occipital carina complete.

Mesosoma. Pronotum anteriorly with weak wrinkles and fine punctures; medially with weak transverse wrinkles; with dense punctures dorso-posteriorly. Mesoscutum (Fig. 27) weakly convex, with texture as upper posterior of pronotum, punctures relatively coarse. Notaulus distinct. Punctures of scutellum sparser than on mesoscutum. Postscutellum transverse, with sparse fine punctures. Mesopleuron (Fig. 28) flat, with texture as mesoscutum. Epicnemial carina distinct, reaching subalar ridge. Sternaulus reaching hind margin of mesopleuron, apically ventral to ventral-posterior corner of



Figures 23–31. *Aptesis nigricoxa* Li & Sheng, sp. n. Holotype. Female. **23** Body, lateral view **24** Head, anterior view **25** Head, lateral view **26** Head, dorsal view **27** Mesoscutum **28** Mesopleuron **29** Propodeum **30** Metasoma, dorsal view **31** Fore wing.

mesopleuron. Speculum small. Scrobe with strong groove. Metapleuron with texture as mesopleuron, ventrally with irregular wrinkles. Juxtacoxal carina distinct. Leg robust. Ratio of length of hind tarsomeres 1:2:3:4:5 is 21.0:10.0:6.0:4.0:6.0. Fore wing (Fig. 31) with vein 1cu-a opposite 1/M. Vein 3rs-m almost parallel with 2rs-m. Areolet re-

ceiving vein 2m-cu approximately at its middle. Vein 2-Cu approximately 1.5 times as long as 2cu-a. Hind wing vein 1-cu about 4.0 times as long as cu-a. Propodeum (Fig. 29) with irregular wrinkles. Anterior transverse carina absent. Posterior transverse carina strong. Areas basalis and superomedia combined, with irregular wrinkles. Area petiolaris sloping. Propodeal spiracle almost circular, located at anterior 0.2 of propodeum.

Metasoma (Fig. 30)**.** First tergum about 1.5 times as long as apical width, smooth with weak wrinkles. Median dorsal carinae distinct, almost parallel. Dorsolateral and ventrolateral carinae complete. Spiracle circular, small, located at apical 0.3 of first tergum. Second tergum about 0.6 times as long as apical width, mostly with fine longitudinal wrinkles, apically smooth with fine punctures. Third to eighth terga shiny, densely punctate. Ovipositor sheath about 0.7 times as long as hind tibia. Ovipositor straight, strong, with small nodus, apically sharp.

Color (Fig. 23)**.** Black, except the following. Face orbits, flecks of inner orbits on frons, wing base, fifth flagellomere apically and sixth to tenth, eleventh basally, yellowish white. Mandible (basally and teeth, blackish brown), apical margin of first tergum, second to third terga, fourth tergum (apically blackish brown), reddish brown. Fore leg (coxa blackish brown with reddish brown, trochanters blackish brown), mid leg (coxa, trochanters, blackish brown), hind leg (coxa, first trochanter, tibia apically, tarsomeres, blackish brown), red. Wing membrane brownish hyaline. Pterostigma and veins blackish brown.

Male. Unknown.

Host. *Neodiprion huizeensis* (Hymenoptera: Diprionidae).

Host plant. *Pinus armandi* (Pinaceae).

Biology. Adults of *A. nigricoxa* emerged from overwintering cocoons of *N. huizeensis*.

Remarks. Based on the original description, this new species is similar to *Aptesis pallidinervis* (Cameron, 1904) but can be distinguished from the latter by the following combination of characters: apical portion of fifth and sixth to tenth and basal portion of eleventh flagellomeres, yellowish white; mandible teeth blackish brown; pterostigma blackish brown; metasoma black; postpetiole with weak wrinkles. *Aptesis pallidinervis*: eighth to thirteenth flagellomeres white; mandible teeth rufo-testaceous; pterostigma pale yellow; apex of first, second to third terga ferruginous, seventh to eighth terga white; Base of postpetiole with strong longitudinal wrinkles.

Aptesis albibasalis (Uchida, 1930)

http://species-id.net/wiki/Aptesis_albibasalis
Figure 32

Plectocryptus albibasalis Uchida, 1930. Journal of the Faculty of Agriculture, Hokkaido Imperial University, 25(4): 327.

Specimens examined. 1 female, CHINA: Jinan, Shandong Province, 7 October 2004, leg. Mao-Ling Sheng. 10 females and 4 males, CHINA: Jinan, Shandong Province, 21 to 26 December 2004, leg. Nan-Xi Wang, Mao-Ling Sheng. 6 females, CHINA:

Figure 32. *Aptesis albibasalis* (Uchida, 1930). Female. Body, lateral view.

Zhongmu County, Henan Province, 4 to 14 April 2011, leg. Tao Li. All specimens reared from *Arge pagana* (Panzer).

Host. *Arge pagana* (Hymenoptera: Argidae).

Host plant. *Rosa chinensis* Jacq. (Rosaceae).

Distribution. China (Henan, Shandong), Korea, Japan, Russia (Wang and Sheng 2006; Yu et al. 2012).

***Aptesis corniculata* Sheng, 2003**
http://species-id.net/wiki/Aptesis_corniculata
Figure 33

Aptesis corniculata Sheng, 2003. Entomotaxonomia, 25(2): 148.

Specimens examined. 3 females and 1 male, CHINA: Tianshui, Gansu Province, 26 March to 4 April 2001, leg. Xing-Yu Wu. All specimens reared from *Nematus* sp. (Sheng and Wu 2003).

Figure 33. *Aptesis corniculata* Sheng, 2003. Female. Body, lateral view.

Host. *Nematus* sp. (Hymenoptera: Tenthredinidae).
Host plant. *Salix* sp. (Salicaceae).
Distribution. China (Gansu).

***Aptesis grandis* Sheng, 1998**
http://species-id.net/wiki/Aptesis_grandis
Figure 34

Aptesis grandis Sheng, 1998. Acta Entomologica Sinica, 41(3): 316.

Specimens examined. 1 female and 2 males, CHINA: Qinyuan, Shanxi Province, 13 June 1994, leg. Mao-Ling Sheng. 11 females and 38 males, CHINA: Qinyuan, Shanxi Province, 20 June 1995, leg. Guo-Fa Chen, Qing-He Zhang, reared from *Diprion jingyuanensis* (Sheng and Chen 2001). 6 females and 2 males, CHINA: Hasi Mountains, Gansu Province, 4 to 30 June 2010, leg. Tao Li, reared from *Diprion jingyuanensis*. 130 females and 101 males, CHINA: Weining County, Guizhou Province, 19 February to 30 March 2012, leg. Tao Li, Mao-Ling Sheng, reared from *N. huizeensis*.

Figure 34. *Aptesis grandis* Sheng, 1998. Female. Body, lateral view.

Hosts. *Diprion jingyuanensis*, *Neodiprion fengningensis* (Sheng and Chen 2001), *N. huizeensis* (Hymenoptera: Diprionidae).

Host plants. *Pinus tabulaeformis*, *P. armandi*, *Picea crassifolia* Kom. (Pinaceae).

Distribution. China (Gansu, Guizhou, Liaoning, Shanxi) (Yu et al. 2012).

Biology. The mature larva of *A. grandis* forms a cocoon outside the body of the *N. huizeensis* larva and inside the cocoon of the host. Of 231 adults of *A. grandis* that emerged from cocoons of *N. huizeensis*, the female to male ratio was 1.2: 1. The average parasitism rate of *N. huizeensis* by *A. grandis* was 3.8%. Adults of *A. grandis* emerged between 20th February to 9th March under laboratory conditions.

Acknowledgements

The authors are deeply grateful to Dr Gavin Broad (Department of Life Sciences, the Natural History Museum, London, UK) and two anonymous referees for their criticism and important suggestions. The authors also wish to thank Dr. Dicky S. K. Yu (Canadian National Collection, Ottawa, Canada) for presenting valuable materials. This research was supported by the National Natural Science Foundation of P. R. China (NSFC, No.30872035, No.31110103062).

References

Babendreier D (2000) Life history of *Aptesis nigrocincta* (Hymenoptera: Ichneumonidae) a cocoon parasitoid of the apple sawfly, *Hoplocampa testudina* (Hymenoptera: Tenthredinidae). Bulletin of Entomological Research 90(4): 291–297. doi: 10.1017/S0007485300000419

Cameron P (1904) Descriptions of new species of Cryptinae from the Khasia Hills, Assam. Transactions of the Royal Entomological Society of London 52: 103–122. doi: 10.1111/j.1365-2311.1904.tb02740.x

Carl KP (1976) The natural enemies of the pear-slug, *Caliroa cerasi* (L.) (Hym., Tenthredinidae), in Europe. Zeitschrift für Angewandte Entomologie 80(1/4): 138–161.

Förster A (1850) Monographie der Gattung *Pezomachus*, Grav. Archiv für Naturgeschichte 16(1): 49–232.

Gauld ID (1991) The Ichneumonidae of Costa Rica, 1. Introduction, keys to subfamilies, and keys to the species of the lower Pimpliform subfamilies Rhyssinae, Poemeniinae, Acaenitinae and Cylloceriinae. Memoirs of the American Entomological Institute 47: 1–589.

Herz A, Heitland W (2005) Species diversity and niche separation of cocoon parasitoids in different forest types with endemic populations of their host, the common pine sawfly *Diprin pini* (Hymenoptera: Diprionidae). European Journal of Entomology 102: 217–224.

Kasparyan DR, Kopelke JP (2009) Taxonomic review and key to European ichneumon flies (Hymenoptera, Ichneumonidae), parasitoids of gall-forming sawflies of the genera *Pontania* Costa, *Phyllocolpa* Benson, and *Euura* Newman (Hymenoptera, Tenthredinidae) on willows: Part I. Entomological Review 89(8): 933–957. doi: 10.1134/S0013873809080089

Li T, Sheng ML, Sun SP (2012) Species of the genus *Lamachus* Förster (Hymenoptera, Ichneumonidae) parasitizing diprionid sawflies (Hymenoptera, Diprionidae) with descriptions of two new species and a key to Chinese species. ZooKeys 249: 37–49. doi: 10.3897/zookeys.249.4069

Mason WRM (1986) Standard drawing conventions and definitions for venational and other features of wings of Hymenoptera. Proceedings of the Entomological Society of Washington 88: 1–7.

Mason WRM (1990) Cubitus posterior in Hymenoptera. Proceedings of the Entomological Society of Washington 92: 93–97.

Sawoniewicz J (2008) Hosts of the world Aptesini (Hymenoptera, Ichneumonidae, Cryptinae). Wyd. Mantis, Olsztyn, 13–25.

Sheng ML, Chen GF (2001) Ichneumonidae parasitzing sawflies from China (Hymenoptera). Entomofauna 22(21): 413–420.

Sheng ML, Wu XY (2003) A new species of genus *Aptesis* (Hymenoptera: Ichneumonidae) parasitizing *Nematus* sp. from China. Entomotaxonomia 25(2): 148–150.

Sheng ML, Zhang QH, Chen GF (1998) A new species of genus *Aptesis* parasitic on *Diprion jingyuanensis* (Hymenoptera: Ichneumonidae, Diprionidae). Acta Entomologica Sinica 41(3): 316–318.

Townes H (1970) The genera of Ichneumonidae. Part 2. Memoirs of the American Entomological Institute 12: 1–537.

Uchida T (1930) Fuenfter Beitrag zur Ichneumoniden-Fauna Japans. Journal of the Faculty of Agriculture, Hokkaido University 25(4): 299–347.

Viereck HL (1914) Type species of the genera of Ichneumon flies. United States National Museum Bulletin 83: 1–186. doi: 10.5479/si.03629236.83.1

Wang XN, Sheng ML (2006) Chinese species of genus *Aptesis* Förster (Hymenoptera: Ichneumonidae) parasitizing sawfly. Entomotaxonomia 28(1): 75–76.

Yu DS, van Achterberg C, Horstmann K (2012) Taxapad 2012 – World Ichneumonoidae 2011. Taxonomy, Biology, Morphology and Distribution. On USB Flash drive. Ottawa, Ontario, Canada. http://www.taxapad.com