

Pictorial key to species of the genus *Ropalidia* Guérin-Méneville, 1831 (Hymenoptera, Vespidae) from China, with description of one new species

Jiang-Li Tan^{1,†}, Kees Van Achterberg^{2,‡}, Xue-Xin Chen^{3,§}

1 Key Laboratory of Resource Biology and Biotechnology in Western China (Northwest University), Ministry of Education; School of Life Sciences, Northwest University, 229 North Taibai Road, Xi'an, Shaanxi 710069, China **2** Naturalis Biodiversity Center, Dept. of Terrestrial Zoology, Postbox 9517, 2300 RA Leiden, the Netherlands **3** Institute of Insect Sciences, Zhejiang University, Zijingang Campus, Yuhangtang Road 866, Hangzhou 310058, China

† <http://zoobank.org/71A3B5FF-D605-4284-ACD9-94AF5FF134B0>

‡ <http://zoobank.org/D6374CF4-8F07-4FA8-8C55-9335FD19CECD>

§ <http://zoobank.org/0054AC5F-7F6D-4811-A560-90983889C861>

Corresponding author: Jiang-Li Tan (tanjl@nwu.edu.cn)

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Abstract

Twenty two species of the paper wasp genus *Ropalidia* Guérin-Méneville, 1831, are listed from China. Among them, *R. malaisei* van der Vecht, 1962, *R. cyathiformis* (Fabricius, 1804), *R. santoshae* Das & Gupta, 1989, *R. scitula* (Bingham, 1897), *R. obscura* Gusenleitner, 1996 and *R. ornaticeps* (Cameron, 1900) are new records from China. A new species, *R. parartifex* Tan & van Achterberg, is described. Their diagnostic characteristics are summarized in an illustrated key and 36 colourplates.

Keywords

Vespidae, Polistinae, *Ropalidia*, new records, new taxa

Introduction

The genus *Ropalidia* Guérin-Méneville, 1831 (Hymenoptera: Vespidae: Polistinae: Ropalidiini), is the only polistine genus that includes both independent- and swarm-founding species, so that their nests are highly variable: arboreal or in cavities, envelope present or not (Carpenter and Nguyen 2003, Wenzel 1998). The genus can be separated from the other genera of the Ropalidiini by having the pretegular carina and dorsal episternal groove absent, the metasoma bell-shaped with its first metasomal segment petiolate and the second segment covering more or less the following segments which telescope one by one (Carpenter and Nguyen 2003). It is one of the largest polistine genera with more than 180 species and is distributed in the greater part of the Old World with a tropical or subtropical climate. The distribution is centered in the Oriental region, extending westward via Yemen to the Afrotropical region and southward to the Australian region (Kojima and Carpenter 1997, Saito and Kojima 2005a, b, Kojima 2006, Blommers 2012). The faunas of continental Africa, Australia, and New Guinea have a large number of endemic species with 18, 24 and 40 *Ropalidia* species, respectively. Most extreme is the fauna of Madagascar: all 43 species are endemic to Madagascar (Carpenter and Madl 2009, Blommers 2012). Both the Indian subcontinent (26 species) and South-East Asia (about 60 species) are very speciose (Kojima 2006, Nguyen et al. 2006). Although several taxonomic studies of the genus exist, the Chinese fauna of *Ropalidia* is still very poorly studied (Bingham 1897, van der Vecht 1941, 1962, Cheesman 1952, Richards 1978, Das and Gupta 1989, Giordani Soika 1991, Kojima 1982, 1984, 1996a, b, 1999a, b, Kojima and Tano 1985, Kojima et al. 2002, 2005, 2007, Nguyen et al. 2006). To date, 13 valid species and subspecies of *Ropalidia* have been reported from China, based mainly on research and collections in areas other than continental China (Sonan 1935, van der Vecht 1941, 1962, Das and Gupta 1989, Kojima et al. 2007, 2011, Nguyen et al. 2006, Kojima 2006). Liu (1936–1937) included 3 species of *Ropalidia* in his catalogue of the Vespidae of China; Lee (1982, 1985) recorded 10 species and subspecies with an obsolete key which only distinguished species by their colour. During the following 30 years, no comprehensive and complete taxonomic studies on this large fauna have been made. During 2012–2013, the first author studied the taxonomy of Chinese Vespidae in Leiden (RMNH), Paris (MNHN) and Hangzhou (ZJUH). The result is a new illustrated key to 22 species of the genus *Ropalidia* from China. Six species are recorded from China for the first time and one new species is described. Distributional data are extracted from the literature as well as based on specimens examined during this study; three colour plates are added to enhance the chance of a correct identification.

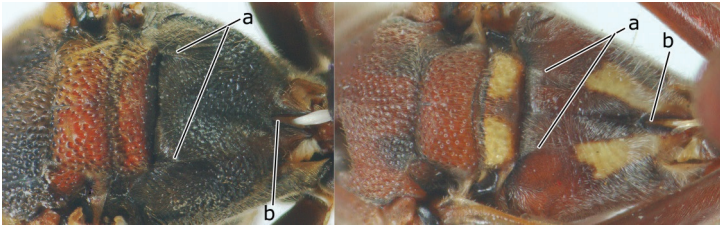
Material and methods

Some specimens were collected with interception traps (Li et al. 2012, Sheng et al. 2013), but most specimens were collected with a hand net. The examined specimens are preserved in the Zoological Collection of School of Life Sciences, Northwest University, Xi'an (NWUM); the Parasitic Hymenoptera Collection of Institute of Insect Sciences, Zhejiang University, Hangzhou (ZJUH); the General Station of Forest Pest Management, State Forestry Administration, Shenyang (GSFA), the Entomological Museum of Northwest A&F University, Yangling (NWAM); the Environment and Plant Protection Research Institute, Chinese Academy of Tropical Agriculture Sciences, Haikou (CATAS); the Taiwan Agriculture Research Institute, Taichung (TARI); the Naturalis Biodiversity Center, Leiden (RMNH); the Natural History Museum, London (BMNH); the Museum National d'Histoire Naturelle, Paris (MNHN); the Zoological Museum of the University of Copenhagen (ZMUC); the Senckenberg Deutsches Entomologisches Institut, Müncheberg (SDEI) and the Oberösterreichisches Landesmuseum (Linz).

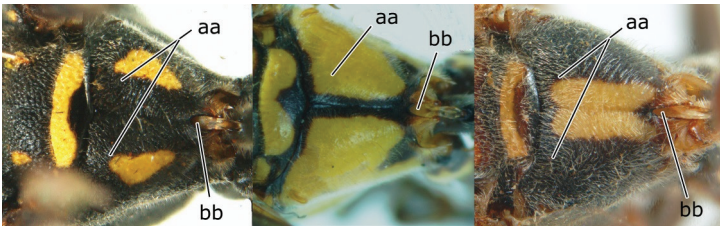
For the morphological and micro-sculpture terminology used in this paper see Kojima (1999c), Kojima et al. (2002, 2007) and Nguyen et al. (2006). An Olympus SZX 12 binocular microscope with analySIS Soft Imaging System software was used for the descriptions, measurements and photos.

Key to species of the genus *Ropalidia* from China

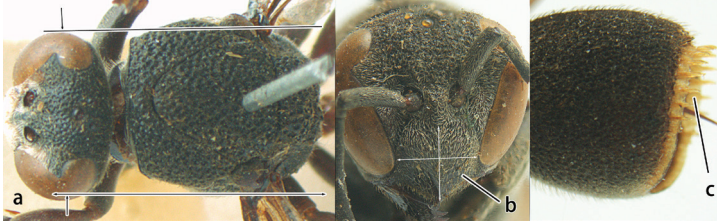
- 1 Propodeum with pair of raised vertical carinae anteriorly (a); propodeal orifice narrow, slit-like, acute above (b).....2



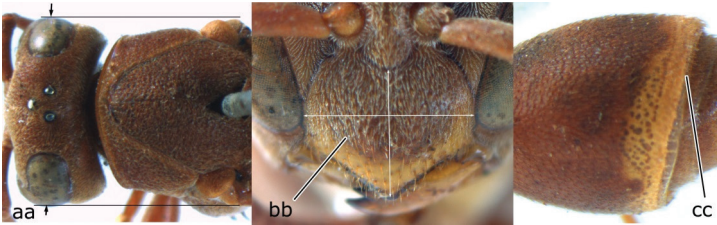
- Propodeum without pair of raised vertical carinae anteriorly (aa); propodeal orifice relatively broad, more or less rounded above (bb).....3



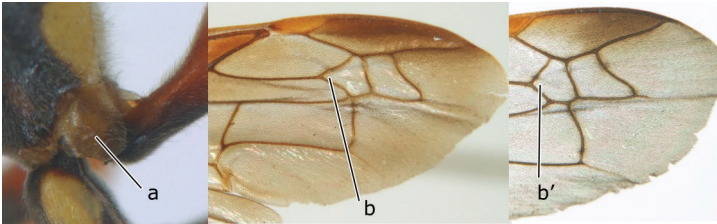
- 2 Head narrower than mesoscutum just in front of tegulae (a); clypeus slightly higher than wide, shiny and its dorsal half impunctate (b); apical margin of second metasomal tergite armed with a row of spines (c) *Ropalidia binghami* van der Vecht, 1941



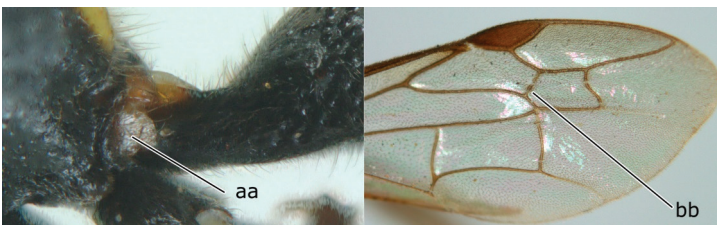
- Head wider than mesoscutum just in front of tegulae (aa); clypeus distinctly wider than high, dull and its dorsal half evenly punctate (bb); apical margin of second tergite simple (cc) *Ropalidia marginata* (Lepeletier, 1804)



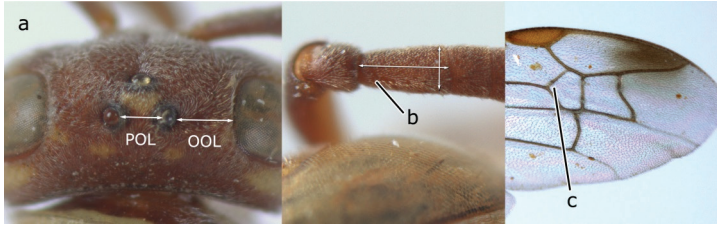
- 3 Propodeal valvula large, obscuring most of propodeal orifice in lateral view (a); basal angle of second submarginal cell less than (b) or equal to or slightly greater than 90°(b') 4



- Propodeal valvula medium-sized, most of propodeal orifice visible in lateral view (aa); basal angle of second submarginal cell greater than 90°(bb) 14



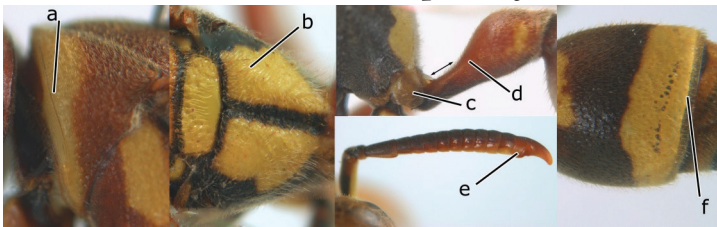
- 4 Length between ocellus and eye (OOL) less than twice as long as length between posterior ocelli (POL) (a); first flagellomere of female antenna comparatively short, less than $2.5\times$ as long as its apical width (b); basal angle of second submarginal cell $\geq 90^\circ$ (c) 5



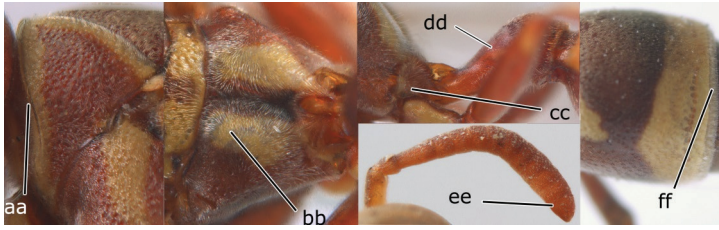
- OOL more than $2.5\times$ as long as POL (aa); first flagellomere of female antenna long, $3\times$ longer than its apical width (bb); basal angle of second submarginal cell distinctly less than 90° (cc) 6



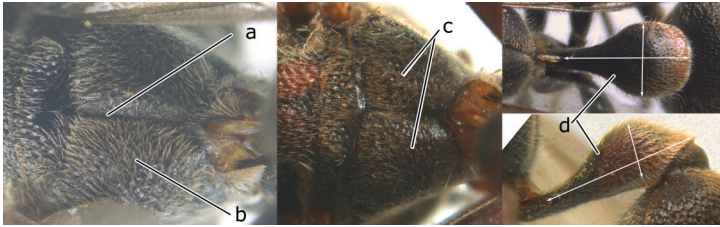
- 5 Pronotal carina nearly straight (a); propodeum distinctly obliquely striate (b); propodeal valvula large, nearly circular (c); first metasomal tergite comparatively long, with petiolus parallel-sided, widened part swollen submedially and narrowed near apical margin (d); second metasomal segment oblique apically, with tergite longer than sternite (e); male antenna with distinct tyloids, apical two thirds of apical flagellomere excavated and curved (f) *Ropalidia fasciata* (Fabricius, 1804)



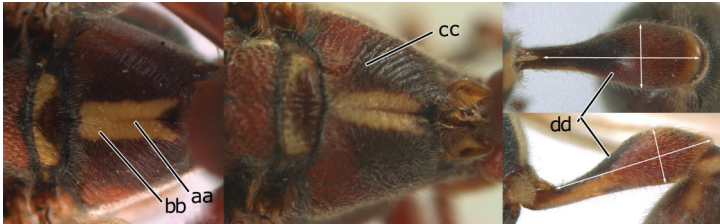
- Pronotal carina distinctly sinuate (aa); propodeum largely smooth (bb); propodeal valvula rounded triangular (cc); first tergite comparatively short, petiolus widened basally and apically, and widened part swollen up to apical margin (dd); second metasomal segment vertically cut off apically, with tergite about as long as sternite (ee); male antenna without tyloids and apical flagellomere normal (ff) *Ropalidia variegata* (Smith, 1852)



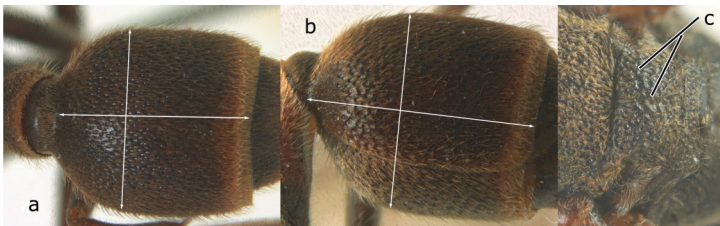
- 6 Propodeum reticulate-punctate, anteriorly with distinct median depression (a), yellow marks of propodeum absent (b), dorsal side of propodeum reticulate-punctate (c); first metasomal tergite less than twice as long as wide in dorsal view and less than 2.5× as long as high in lateral view (d) 7



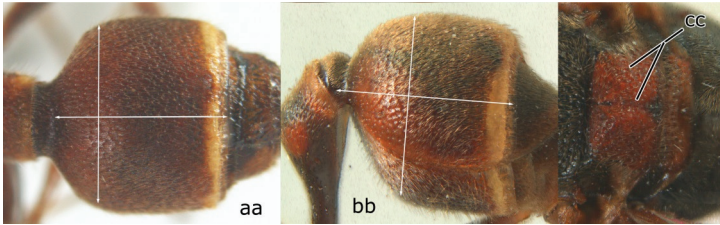
- Propodeum finely striate, barely depressed antero-medially or if depressed, only as fine median furrow (aa); propodeum with yellow marks confluent basally (bb); dorsal side of propodeum barely punctate, only finely transversely striate (cc); first tergite more than twice as long as wide in dorsal view and more than 2.5× as long as high in lateral view (dd) 9



- 7 Second metasomal tergite as wide as long in dorsal view (a); second segment longer than high in lateral view (b); scutellum black, slightly convex and without median furrow (c) ***Ropalidia santoshae* Das & Gupta, 1989, rec. n.**

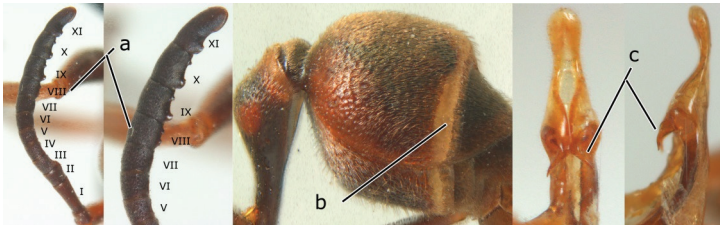


- Second tergite wider than long in dorsal view (aa); second segment as long as high in lateral view (bb); scutellum reddish brown, distinctly convex and with a longitudinal median furrow (cc)..... **8**



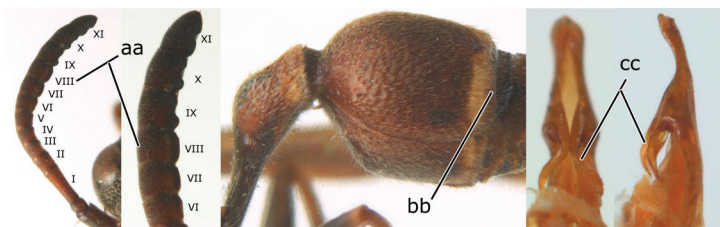
- 8** Apical flagellomere of male antenna long; carina of the 8th flagellomere (VIII) emarginate (a); second metasomal segment oblique apically, with sternite longer than tergite (b). Male: proximo-ventral margin of penis with a short hook, at most one fourth as long as penis valve (c).....

..... ***Ropalidia taiwana* Sonan, 1935**

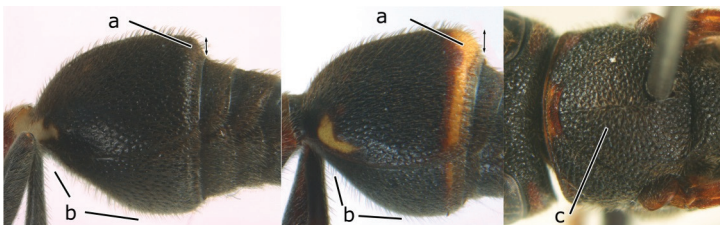


- Apical flagellomere of male antenna short; carina of the 8th flagellomere (VIII) not emarginate (aa); second metasomal segment vertical apically, with tergite about as long as sternite (bb); male genitalia: proximo-ventral margin of penis valve with a long hook, two thirds as long as penis valve (cc)

..... ***Ropalidia birmanica* van der Vecht, 1962**



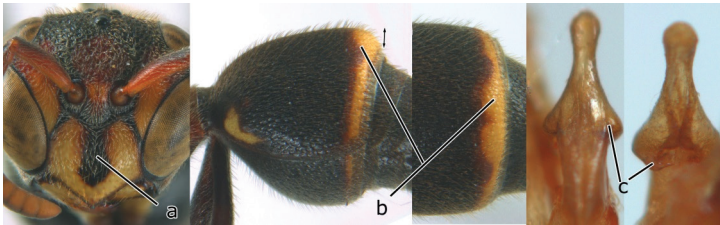
- 9** Preapical part of second tergite distinctly swollen (a); lateral profile of second sternite nearly straight anteriorly (b); mesoscutum entirely black (c)..... **10**



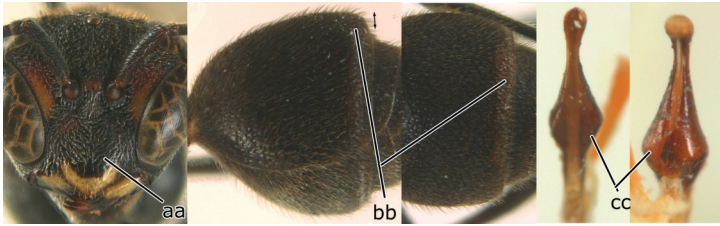
- Preapical part of second tergite flat (aa); lateral profile of second sternite evenly curved anteriorly (bb); colour of mesoscutum variable (cc) **11**



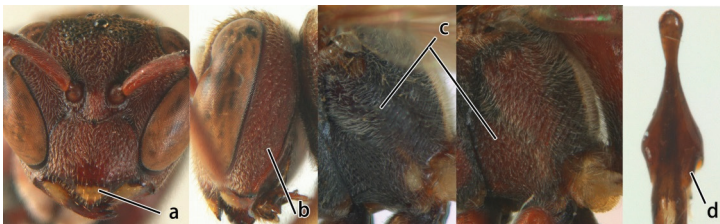
- 10 Female clypeus yellow with a black arrow-shaped mark (a); second tergite with yellow apical band and strongly swollen medio-dorsally in lateral view (b); male genitalia: proximal margin of penis abruptly contracted in dorsal view and with a large hook in ventral view (c).....
..... ***Ropalidia artifex* (de Saussure, 1854)**



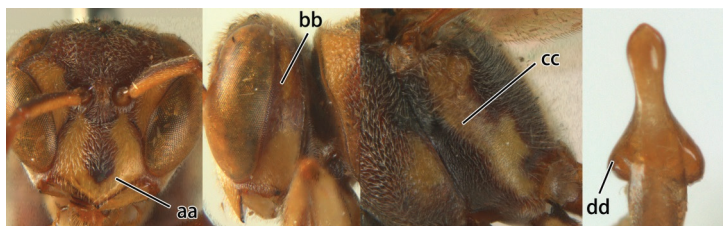
- Female clypeus largely black and apically yellow (aa); second tergite largely black and dorsally relatively weakly swollen in lateral view (bb); male genitalia: proximal margin of penis gradually contracted in dorsal view and with a comparatively small hook in ventral view (cc).....
..... ***Ropalidia parartifex* Tan & van Achterberg, sp. n.**



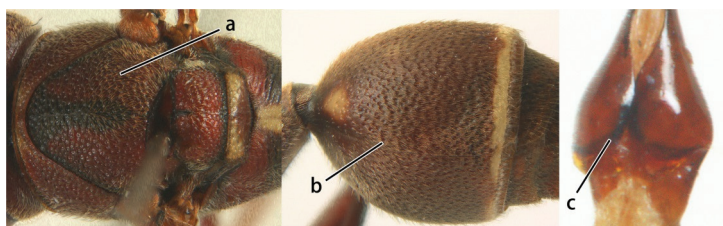
- 11 Female clypeus reddish or blackish brown and yellow apically (a); gena reticulate-punctate (b); metapleuron black or with reddish brown patch (c); male genitalia: proximo-dorsal margin of penis gradually contracted (d) **12**



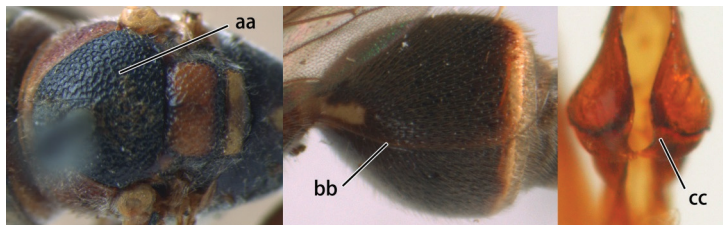
- Female clypeus yellow laterally (aa); gena finely punctate (bb); metapleuron generally with large yellow patch (cc); male genitalia: proximo-dorsal margin of penis abruptly contracted (dd) **13**



- 12 Mesoscutum with two separate reddish brown patches (a); tergite and sternite of second metasomal segment fused and suture indistinct except posteriorly (b); male genitalia: proximo-ventral margin of penis valve hardly projecting (c) *Ropalidia hongkongensis* (de Saussure, 1854)



- Mesoscutum entirely black (aa); tergite and sternite of second metasomal segment separated and suture complete (bb); male genitalia: proximo-ventral margin of penis valve with a distinct projection (cc) *Ropalidia rufocollaris* (Cameron, 1900)



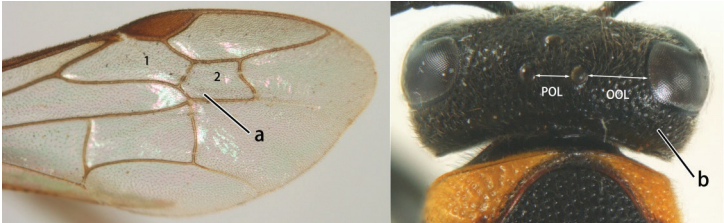
- 13 Metapleuron ventrally punctate (a); female clypeus reddish brown with two lateral yellow spots (b); first metasomal segment reddish brown baso-laterally, without yellow pattern basally (c); second sternite usually without yellow spots (d); male antenna comparatively robust and serrate (e); male genitalia: proximo-ventral margin of penis valve with a relatively sharp hook-like projection (f) *Ropalidia mathematica* (Smith, 1860)



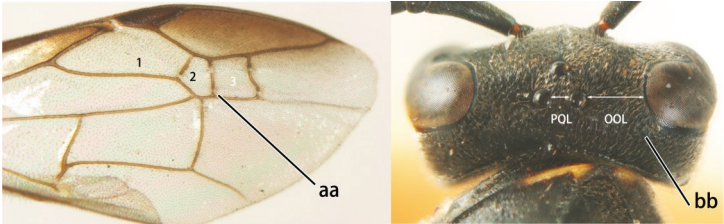
- Metapleuron ventrally smooth (aa); female clypeus yellow with a dark arrow-shaped mark medially (bb); first segment partly yellow baso-laterally (cc); second sternite usually with a pair of large yellow spots (dd); male antenna comparatively slender and hardly serrate (ee); proximo-ventral margin of penis valve evenly curved, without a hook-like projection (ff).....
..... *Ropalidia stigma* (Smith, 1858)



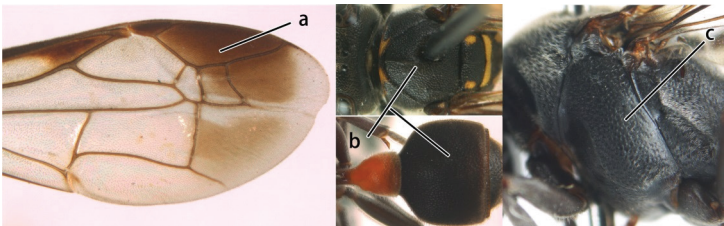
- 14 Fore wing with two submarginal cells (a); OOL at most twice as long as POL or shorter (b)*Ropalidia bicolorata* van der Vecht, 1962



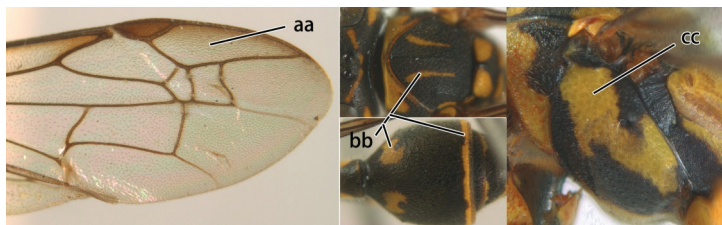
- Fore wing with three submarginal cells (aa); OOL at least 3 × as long as POL or longer (bb) 15



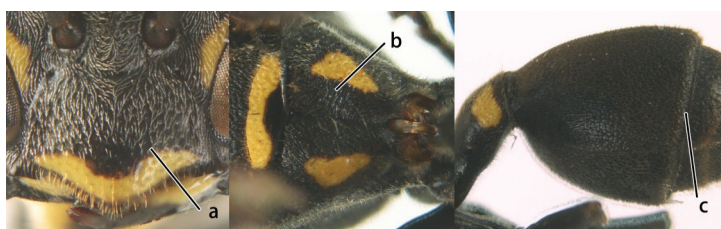
- 15 Length of body 10–11 mm (measured from head to end of second metasomal tergite); pterostigma blackish brown and marginal cell entirely dark brown (a); mesoscutum and second metasomal tergite entirely black (b); mesopleuron (except antero-ventrally) coarsely punctate (c) 16



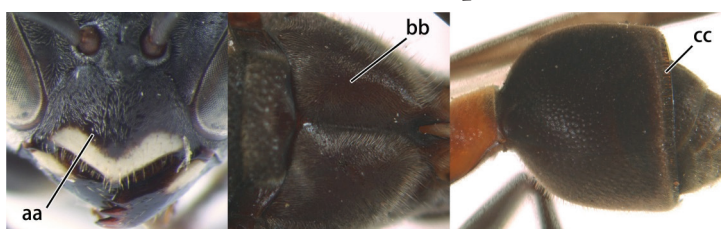
- Length of body 7–8 mm (measured from head to end of second metasomal tergite); pterostigma brown and ventral half of marginal cell subhyaline (aa, in *R. cyathiformis* anterior half of marginal cell subhyaline); mesoscutum generally with two yellow stripes and second tergite generally with pair of yellow spots and apical band (bb); mesopleuron weakly punctate (cc) **18**



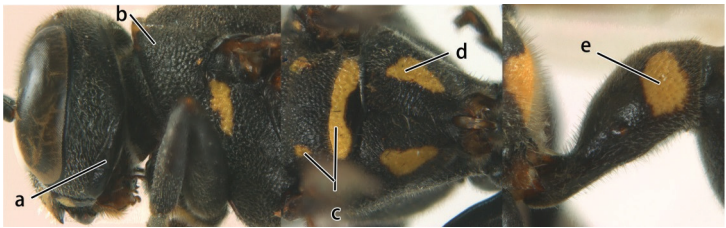
- 16 Female clypeus coarsely and densely punctate (a); propodeum dull and distinctly punctate-striate (b); first metasomal segment black with pair of apical spots (c); second metasomal segment somewhat oblique with sternite shorter than tergite (d)..... **17**



- Female clypeus finely punctate (aa); propodeum shiny and smooth, at most very finely striate (bb); first metasomal segment entirely orange (cc); second segment oblique with sternite distinctly larger than tergite (dd) ***Ropalidia sumatrae* (Weber, 1801)**



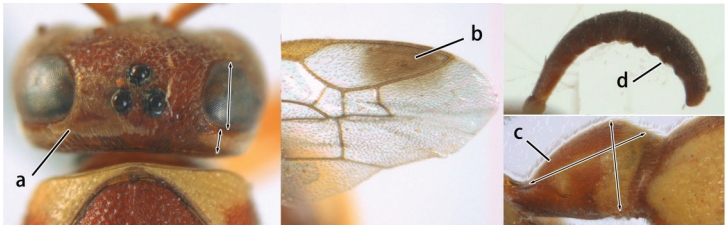
- 17 Ventral half of occipital carina strongly widened, its maximum width nearly one-third genal width (a); pronotum with two small yellow spots medio-dorsally (b); scutellum and metanotum black with yellow pattern (c); propodeum with pair of large yellow patches (d); subapical spots of first tergite yellow and large (e) ***Ropalidia obscura* Gusenleitner, 1996, rec. n.**



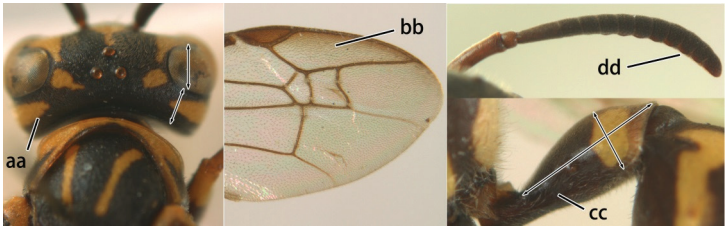
- Occipital carina hardly or not widened (aa); pronotum reddish brown medio-dorsally (bb); scutellum and metanotum reddish brown (cc); propodeum black (dd); apical spots of first tergite reddish brown and large (ee).....
.....*Ropalidia scitula* (Bingham, 1897), **rec. n.**



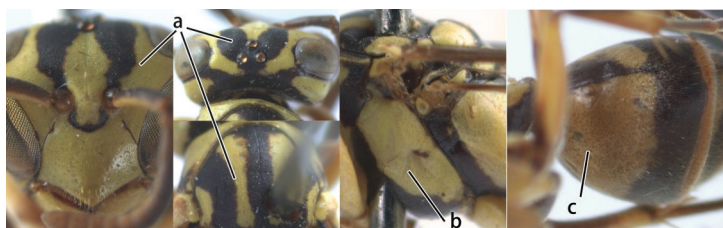
- 18 Head reddish brown and with yellow patches near its occipital carina, and temple distinctly shorter than eye in dorsal view (a); pterostigma pale brown and basal half of marginal cell subhyaline (b); first metasomal tergite strongly widened in lateral view, its length less than 1.5× its height (c); male: flagellum more or less serrate ventrally and terminal flagellomere weakly curved (d)
.....*Ropalidia cyathiformis* (Fabricius, 1804), **rec. n.**



- Head black with yellow spots and temple as long as eye in dorsal view (aa); pterostigma dark brown and posterior half of marginal cell subhyaline (bb); first metasomal tergite weakly widened in lateral view, its length more than 2.2× its height (cc); male: flagellum slightly serrate and terminal flagellomere bullet-shaped (dd)..... 19



- 19 Vertex, frons, mesoscutum and scutellum shiny, impunctate (a); mesopleuron largely yellow and without distinct coarse punctures (b); second metasomal sternum yellow on basal two-thirds (c) ***Ropalidia opifex* van der Vecht, 1962**



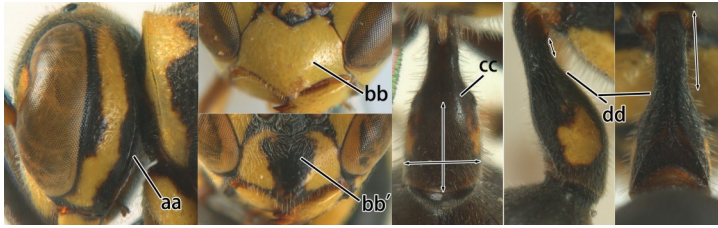
- Vertex, frons, mesoscutum and scutellum dull, finely punctulate with rather large, shallow, flat-bottomed punctures (aa); mesopleuron black with less extensive yellow pattern (bb, bb') and with distinct coarse punctures (bb, bb'); second metasomal sternite black with small yellow spots (cc), but more extensively yellow in *R. ornaticeps* (cc') **20**



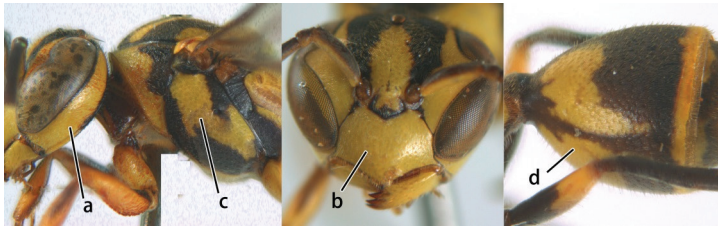
- 20 Occipital carina sinuate near middle level of eye (a); clypeus yellow with an isolated black medial spot (b); apical part of first metasomal tergite comparatively wide (beyond spiracle slightly wider than long) and spiracle invisible in dorsal view (c); basal slender part of first metasomal tergite rather short in lateral and ventral view, rising directly from posterior end of reception of propodeal suspensory ligament (d) ***Ropalidia flavopicta* Smith, 1857**



- Occipital carina evenly curved near middle level of eye (aa); clypeus entirely yellow (bb) or a large black spot (bb'); apical part of first metasomal tergite comparatively slender (beyond spiracle longer than wide or quadrate) and spiracle visible in dorsal view (cc); basal slender part of first metasomal tergite longer in lateral and ventral view, rising further away from propodeal suspensory ligament (dd) **21**



- 21 Gena yellow, except upper half of occipital carina black (a); clypeus entirely yellow (b); mesopleuron with extensive yellow pattern (c) as second sternite (d) ***Ropalidia ornaticeps* (Cameron, 1900), rec. n.**



- Gena mainly black anteriorly and posteriorly, but medially yellow (aa); clypeus with a large triangular black medial spot (bb); mesopleuron with restricted yellow pattern (cc); second sternite black except a narrow yellow band apically (dd) ***Ropalidia malaisei* van der Vecht, 1962, rec. n.**



Distribution records and taxonomic remarks

***Ropalidia artifex* (de Saussure, 1854), rec. n.**

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

Figure 1A

Icaria artifex de Saussure, 1854: 236. Type locality: Java.

Ropalidia artifex; Dover 1931: 257.

Ropalidia artifex artifex; van der Vecht 1941: 110.

Ropalidia artifex fuscata van der Vecht 1941: 136. Type locality: N. Sumatra.

Specimens examined. CHINA: 3 ♀ (NWUM), Yaoqu, Mengla, Yunnan, 28–30. ix.2010, JL Tan; 1 ♀ (NWUM), Longmen, Shangyong, Yunnan, 26.ix.2010, JL Tan; 1 ♀ (ZJUH), Jinghong Forestry Park, Yunnan, 31.vii.2003, J Lu (no. 20045916);

5 ♀ (ZJUH), Fugong, Yunnan, 24.viii.2003, Q Li (no. 20046662, -4, -6, -8, -70); 1 ♀ (ZJUH), Mt. Youle, Yunnan, 17.iv.1981, JH He (no. 811876); 1 ♀ (ZJUH), Shuangjiang, Yunnan, 21.iv.1981, coll. JH He (no. 813609); 2 ♀ + 8 ♂ (ZJUH), Tongzhong, Shiwandashan, Guangxi, 3.xii.2001, ZF Xu (no. 20029971–4, -77–79, -80–82). INDONESIA: 2 ♀ (RMNH), W. Java: Djampang Tengah, 1634, M Walsh; 1 ♂ (RMNH), Ujung Kulon, Tjidaon, Java, 29.xi.1951, AMR Wegner. VIETNAM: 1 ♀ (RMNH), S. Vietnam: Dak Lak, Chu Yang Sin N.P., 50 km S. Buon Ma Thuot, Krong K'Mar, 550–600 m, 23–25.x.2005, near rainforest, C van Achterberg & R de Vries; 1 ♀ (RMNH), id., but 590–840 m, 22–26.x.2005, Malaise traps 13–23; 1 ♂ (RMNH), N. Vietnam: Viet Try, Thuong Cuu, near Thanh Son, 20°59'N, 105°8'E, 350–400 m, 12–16.x.1999, R de Vries. MYANMAR: 8 ♀ + 1 ♂ (RMNH), S. Shan state, Burma, 1500 m, Taunggyi, 1.viii–13.x.1934, R Malaise.

Remarks. Some specimens have the apical margin of the second metasomal tergite flattened, not convex as in typical specimens. In the species *R. artifex*, there are two subspecies e.g. *R. a. artifex* and *R. a. fuscata* van der Vecht 1941. Up to date, no distinct morphological differences between them were found, and it is hard to formally treat them as two distinct species (van der Vecht 1962, Nguyen et al. 2006). The Chinese specimens belong all to *R. a. artifex*.

Distribution. China (Yunnan, Guangxi); Borneo; Java; Myanmar; Malay Peninsula; Sumatra; Vietnam (Kojima and Carpenter 1997 and updated to 2006, Nguyen et al. 2006).

***Ropalidia bicolorata* van der Vecht, 1962**

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

Figure 1B

Paraicaria bicolor Gribodo, 1892: 249 (preoccupied by *Ropalidia bicolor* (Smith 1865)).

Type locality: Myanmar (Chan Yoma).

Ropalidia bicolorata bicolorata van der Vecht, 1962: 38.

Ropalidia bicolorata parvula van der Vecht, 1962: 38, 39. Type locality: N. Borneo (Bettotan near Sandakan). Syn. by Nguyen et al. 2006.

Ropalidia bicolorata shiva Das & Gupta, 1984: 428 (nomen nudum); 1989: 153. Type locality: India (Tripura). Syn. by Kojima et al. 2007.

Specimens examined. 1 ♀ (RMNH), syntype of *P. bicolor*, Chan Yoma, with a red handwritten label: *Paraicaria bicolor* det. Gribodo. MYANMAR: 1 ♀ (RMNH), Burma, S. Shan States, 1500 m, Taunggyi, i.viii.–22.ix.1934, R Malaise. CHINA: 9 ♀ (NWUM), Longmen, Shangyong, Yunnan, 26–27.ix.2010, JL Tan; 2 ♀ (NWUM), Yaoqu, Mengla, Yunnan, 28–30.ix.2010, JL Tan; 1 ♀ (GSFA), Xishuangbanna, Wangtianshu, Yunnan, 23.iv.2002, SP Sun; 3 ♀ (ZJUH), Ruili, Yunnan, 29.iv.1981, JH He, no. 811457, 811458, 811458; 1 ♀ (ZJUH), Mengxiu, Ruili, Yunnan, 2–6.v.1981, JH He, no. 813071; 1 ♀ (ZJUH), Menglian, Yunnan, 19.iv.1981, JH He, no. 812639.

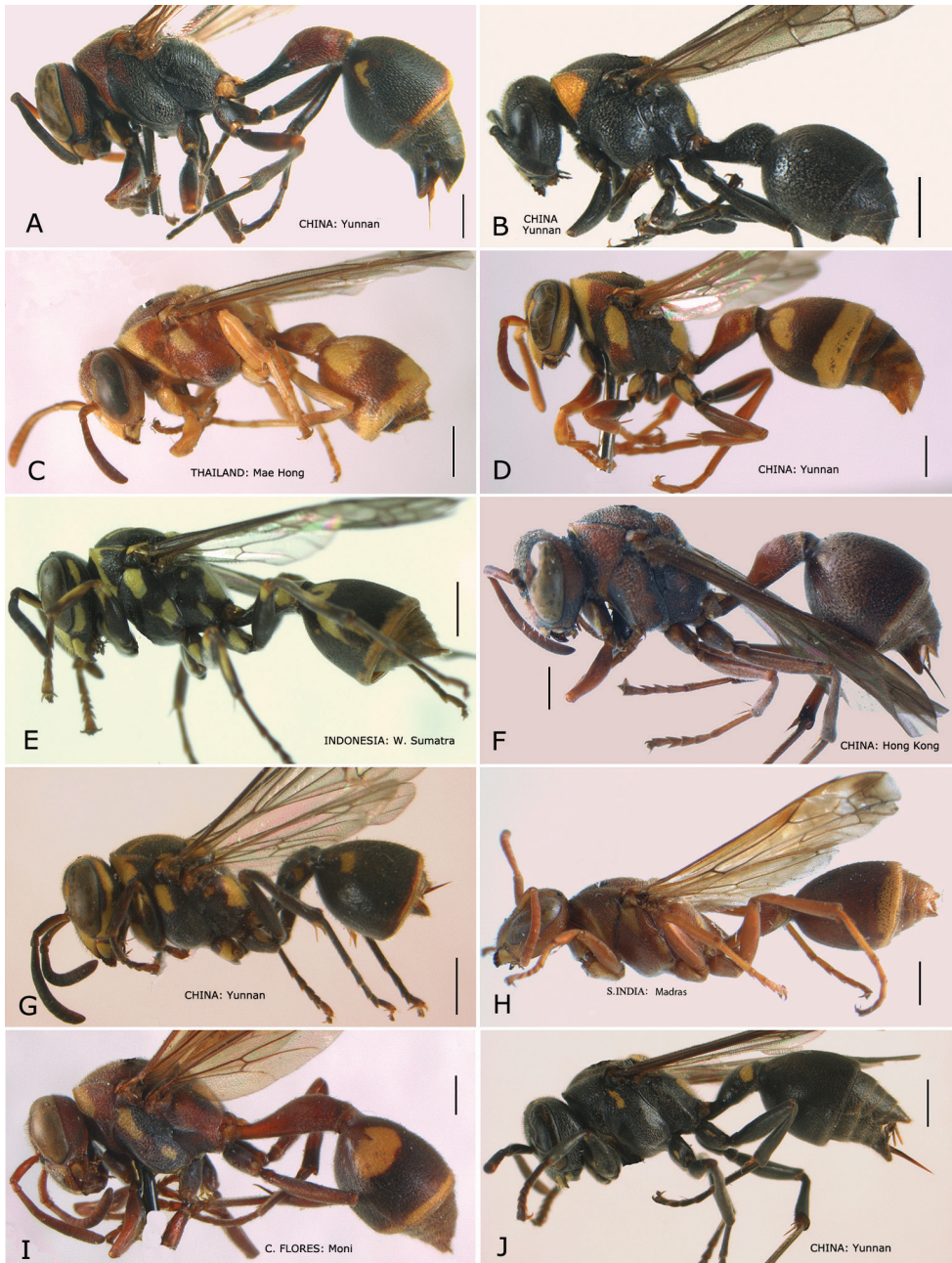


Figure 1. *Ropalidia* spp., habitus (♀). **A** *Ropalidia artifex* (de Saussure, 1854) **B** *Ropalidia bicolorata* van der Vecht, 1962 **C** *Ropalidia cyathiformis* (Fabricius, 1804) **D** *Ropalidia fasciata* (Fabricius, 1804) **E** *Ropalidia flavopicta* (Smith, 1857) **F** *Ropalidia hongkongensis* (de Saussure, 1854) **G** *Ropalidia malaisei* van der Vecht, 1962 **H** *Ropalidia marginata* (Lepeletier, 1793) **I** *Ropalidia mathematica* (Smith, 1860) **J** *Ropalidia obscura* Gusenleitner, 1996.

THAILAND: 1 ♀ (RMNH), Thailand, Doi Inthanon, 8.i.1958, Umesao. MALAYSIA: 1 ♀ (RMNH), N. Borneo: Bettotan, near Sandakan, 26.vii.1927 (paratype of *Ropalidia bicolorata parvula* van der Vecht, 1962).

Remarks. Among the specimens from China, there are two colour forms, *parvula* and the nominate species *bicolorata*.

Distribution. China (Yunnan); Borneo; India; Malaysia; Myanmar; Thailand; Vietnam. (Kojima and Carpenter 1997 and updated to 2006, Nguyen et al. 2006, Kojima et al. 2007).

***Ropalidia binghami* van der Vecht, 1941**

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

Icaria sumatrae; Bingham, 1897: 387 (misidentification).

Ropalidia binghami van der Vecht, 1941: 113. Type locality: Thailand (Siam).

Ropalidia binghami binghami; van der Vecht 1962: 8.

Ropalidia sumatrae sumatrae; Lee 1982: 88, 1985: 50.

Specimens examined. 1 ♀, Luang Prabang, Hat Thoun, Siam, 10. xi.1917, RV De Salvaza (holotype, BMNH) 1 ♂, Mergui, Tenasserim, May 1890, CT Bingham (allotype, BMNH). "This specimen bears a label in Bingham's handwriting: "*Icaria cotonata* White ♀").

Remarks. No specimens from China were available, but this species is included in the key because it has been listed for China by Lee (1982, 1985) as *Ropalidia* (*Anthreneida*) *sumatrae sumatrae* (Weber). Considering the description and illustration of Lee (1982, 1985), we agree with Kojima and Carpenter (1997) and Kojima (2006) that it most likely concerns *Ropalidia binghami* van der Vecht, 1941.

Distribution. China (Guangdong); Myanmar; Thailand. (Kojima and Carpenter 1997 and updated to 2006, Lee 1982, 1985).

***Ropalidia birmanica* van der Vecht, 1962**

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

Ropalidia taiwana birmanica van der Vecht, 1962: 23. Type locality: Myanmar.

Ropalidia birmanica: Kojima et al. 2007: 382.

Specimens examined. MYANMAR (specimens collected by R. Malaise are paratypes of *R. taiwana birmanica*): 1 ♂ + 1 ♀ (RMNH), S. Shan States, road 40 km. E. of Tannggyi, 25.ix.–13.x.1934, R Malaise; 2 ♀ (RMNH), Burma, S. Shan States, 1500 m, Tannggyi, 1.viii–22.ix.1934, R Malaise; 2 ♀ (RMNH), N. East Burma, Sadon, 1200 m, 28.vi–5.vii.1934, R Malaise; 1 ♀ (RMNH), Sukii, 75 km, E. of Mouimein,

Tenasserim, 600 m, 27–31.x.1934, R Malaise; 2 ♀ (RMNH), Nam Tamai valley, Upper Burma, 3000 ft, 27°42'N, 97°54'E, 26.viii.1938, R Kaulback, B.M. 1938–741. CHINA: 1 ♀ (ZJUH), West Mt. Tianmu, Lin'an, Zhejiang, vi.1994, no. 940007, JH He; 1 ♀ (ZJUH), Mt. Jiulong, Huishui, Guizhou, 11.vi.2010, JL Tan.

Distribution. China (Guizhou, Fujian, Zhejiang), Myanmar. (Kojima and Carpenter 1997 and updated to 2006, Kojima et al. 2007).

***Ropalidia cyathiformis* (Fabricius, 1804), rec. n.**

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

Figure 1C

Eumenes cyathiformis Fabricius, 1804: 289. Type locality: Java.

Ropalidia cyathiformis; van der Vecht 1941: 104.

Specimens examined. INDONESIA: 1 ♀ (RMNH), Java, Malang, 11.iv.1930, JG Betrem. CHINA: 1 ♀ (NWAM), Xishuangbanna, Mengla, Yunnan, 20.iv.1982, JR Zhou & SM Wang.

Distribution. China (Yunnan); Bali; India; Java; Lombok; Nepal; Malay Peninsula; Myanmar; Philippine Islands; Sumba, Sulawesi, Sri Lanka; Thailand; Vietnam. (Kojima and Carpenter 1997 and updated to 2006, Kojima et al. 2007).

***Ropalidia fasciata* (Fabricius, 1804)**

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

Figure 1D

Eumenes fasciata Fabricius, 1804: 290. Type locality: Java.

Polistes bioculata Fabricius, 1804: 278. Type locality: Nova Cambria.

Icaria picta de Saussure, 1854: 238. Type locality: India (Le Bengale).

Ropalidia fasciata; van der Vecht 1959: 245.

Specimens examined. 1 ♂ (ZMUC), with three handwritten labels “Lectotype, J.v.d.Vecht, 1957”, “*Ropalidia fasciata* (F.) ♂ = *picta* (Sauss.) det. v d Vecht, 1957”, “*E. fasciata*, O. Java”, and a red label: “Type”, ZMUC 00241458. CHINA: 2 ♀ (ZJUH), Songtao Reservoir, Hainan, 17.vii.2002, ZF Xu (no. 20029573–4); 2 ♂ + 7 ♀ (CATAS), Nada, Danzhou, Hainan, N 19°05'17", E109°34'50", 143 m; 1 ♀ (NWUM), Yaoqu, Mengla, Yunnan, 30.ix.2010, JL Tan; 1 ♂ (NWUM), Longmen, Shangyong, Yunnan, 27.ix.2010, JL Tan; 1 ♀ + 2 ♂ (ZJUH), Kaiyuan, Yunnan, v.1978, no. 780497, 780497, 780496, Y Huang; 1 ♀ (ZJUH), Kaiyuan, Yunnan, 1984, no. 841202, YC Liao; 1 ♀ (ZJUH), Longchuan, Yunnan, 1981, no. 814945, SL Tao; 1 ♀ (ZJUH), Yunjiang, Yunnan, 4.iv.1981, no. 811491, JH He; 1 ♀ (RMNH), Canton (=

Guangzhou); 1 ♀ (RMNH), Canton, 12.xi.1932; 2 ♀ (ZJUH), Fengkai, Guangdong, 16–18.v.1992, no. 921925, JH He; 1 ♀ (RMNH), Foochow (= Fuzhou), Kellogg; 2 ♂ (RMNH), Canton, 10.xi.1932, O Piel, no. 5.13.10.61, (with a handwritten label: “*Ropalidia variegata*, det. O Piel, 1935”); 4 ♀ (RMNH), N. Sanya, Gainan, Formosa, ii.1909, (labelled: *Ropalidia picta* Sauss., det. J v d Vecht '33); 8 ♀ (RMNH), Anping, Formosa, vii.1911, H Sauter (labelled: *Icaria bioculata*, det. Schulthess and *R. picta* (Sauss.), det. J v d Vecht, 1940); 2 ♀ (RMNH), Taihorin, Formosa, vii.1911, H Sauter, (labelled: *R. variegata*, det. Schulthess); 6 ♂ + 1 ♀ (RMNH), id., but 7.xii.1911; 4 ♂ (RMNH), id., but labelled “*Ropalidia picta* (Sauss.), det. J v d Vecht, 1940”; 1 ♂ (RMNH), Formosa, Taihorinsho, H Sauter; 1 ♂ (ZJUH), Longquan, Zhejiang, 20.vii.1965, no. 65053.6, JH He & DD Jin; 1 ♀, (ZJUH) Jingning, Zhejiang, vii.1994, no. 943782, SF Ye; 1 ♀ (ZJUH), Suichang, Zhejiang, 4. vii.1980, no. 833877; 1 ♀ (ZJUH), Mt. Jiulong, Suichang, Zhejiang, 18.vii.1994, no. 944048, JH He. MALAYSIA: 1 ♀ (RMNH), N. Borneo, Sabah, 6 km S of Nabawan, near old airstrip 116°.27'E, 5°.2'N, 400 m, 24.vi.1987, J Huisman.

Distribution. China (Fujian, Guangdong, Hainan, Hong Kong, Taiwan, Yunnan, Zhejiang); Bali; Bangka; Borneo; Flores; India; Java; Kariman Djava I.; Myanmar; Nepal; Nias; Malay Peninsula; Sumatra; Timor; Palawan; Ryukyu Islands; Philippines (Palawan); Sri Lanka; Thailand; Vietnam. (Kojima and Carpenter 1997 and updated to 2006, Kojima et al. 2007, Barthélémy 2008).

Ropalidia flavopicta (Smith, 1857)

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

Figure 1E

Icaria flavopicta Smith, 1857: 99. Type locality: Borneo.

Ropalidia flavopicta; Bequaert 1918: 246.

Ropalidia flavopicta flavopicta; van der Vecht 1962: 42.

Specimens examined. MALAYSIA: 1 ♂ (RMNH), S. Sabah, near Long Pa Sia, c 1010 m, 25.xi.–8.xii.1987, Mal. trap, C van Achterberg; 1 ♂ (RMNH), S. Sabah, Beaufort, 0°20'S 115°43'E, 1.iv.1987, Jvan Tol & J Huisman; 1 ♀ (RMNH), Sabah, Brumas NBT, 23–27.iv.1973, KM Guichard. INDONESIA: 1 ♀ (RMNH), W. Sumatra, Padangpanjang, 1.v.1988, 0°30'S, 100°26'E, R Hensen (labelled *Ropalidia flavopicta* (Smith, 1857) by J. Kojima in 1996).

Remarks. No specimens from China were available in the present study, but this species was reported from China by Liu (1936–37). Van der Vecht (1962) recognized eight subspecies of *Ropalidia flavopicta*. The identification characters of the species *R. flavopicta* were not well enough defined before Kojima (1982, 1996a) re-examined the eight subspecies and concluded that eight valid species are involved. Therefore, the presence in China needs reconfirmation.

Distribution. China (Hong Kong); Borneo; Malay Peninsula; Sumatra; Vietnam. (Liu 1936–37, van der Vecht 1962, Kojima 1996a, Kojima and Carpenter 1997 and updated to 2006, Nguyen et al. 2006).

***Ropalidia hongkongensis* (de Saussure, 1854)**

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

Figure 1F

Icaria hongkongensis de Saussure, 1854 : 239. Type locality: China (Hong Kong).

Ropalidia hongkongensis hongkongensis Das & Gupta, 1983: 418; Das and Gupta 1989: 111.

Ropalidia hongkongensis juncta van der Vecht, 1941: 141. Type locality: W. Java. Syn. by Nguyen et al. (2006).

Specimens examined. CHINA: 1 ♂ (BMNH), Hummocks, Hainan, 24.v.1936, G. Ros, (allotype of *R. hongkongensis*); 1 ♀ (BMNH), Hongkong Peak, c. 1300 ft, 14–17. ix.1937, Miss Hurford, B.M. 1938–426; 9 ♀ + 5 ♂ (NWUM, RMNH), Yaoqu, Mengla, Yunnan, 28, 30.ix.2010, JL Tan; 2 ♀ (ZJUH), Hongmao Village, Yuanmen, Baisha, Hainan, 29.iv.2010, J.L. Tan; 1 ♀ + 2 ♂ (GSFA), Quannan, Jiangxi, 27.xi. & 1.xii.2010, SC Li; 1 ♂ (ZJUH), Mt. Yunji, Xinfeng, Guangdong, 19.vi.2002, no. 20029072, ZF Xu; 1 ♀ (ZJUH), Chengjia, Yangshan, Guangdong, 25.vii.2002, no. 20029350, ZF Xu; 1 ♀ (ZJUH), Shaoguan, Guangdong, 12.ix.1992, no. 921802, JH He; 1 ♀ (ZJUH), Fengkai, Guangdong, v.1992, no. 924296, XX Chen.

Distribution. China (Guangdong, Hainan, Hong Kong, Jiangxi, Yunnan); Bangka; India; Java; Myanmar; Vietnam. (Kojima and Carpenter 1997 update to 2006, Nguyen et al. 2006, Kojima et al. 2007).

***Ropalidia malaisei* van der Vecht, 1962, rec. n.**

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

Figure 1G

Ropalidia malaisei van der Vecht, 1962: 42, 65; Das and Gupta 1983: 427; 1989: 113, 151; Gusenleitner 1996: 16; Kojima 1996a: 325, 328, 340. Type locality: Myanmar.

Specimens examined. MYANMAR: 4 ♂ (RMNH), N. East Burma: Sadon, 1200 m, 28.vi–5.vii.1934, R. Malaise (paratypes of *R. malaisei*). CHINA: 1 ♀ (NWUM), Longmen, Shangyong, Yunnan, 26.ix.2010, JL Tan; 20 ♀ (ZJUH, RMNH), Xishuangbanna Forestry Park, Yunan, 31.vii. 2003 (no. 20045871, -74, -76, -77–82 (-79 in RMNH), -84–91, -93, -95), Q Jiang.

Remarks. The yellow stripes of the mesoscutum are lacking in some individuals.

Distribution. China (Yunnan), Myanmar. (Kojima and Carpenter 1997 and updated to 2006).

***Ropalidia marginata* (Lepeletier, 1836)**

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

Figure 1H

Vespa ferruginea Fabricius, 1793: 280 (junior primary homonym of *Vespa ferruginea* Gmelin, 1790). Type locality: India.

Ropalidia ferruginea; Bequaert 1918: 247.

Epipona marginata Lepeletier, 1836: 541. Type locality: “Inde”.

Ropalidia marginata marginata; van der Vecht 1941: 109, 117.

Ropalidia marginata indica van der Vecht, 1941: 121 (replacement name for *Vespa ferruginea* Fabricius, 1793).

Ropalidia marginata sundaica van der Vecht, 1941: 122. Syn. by Nguyen et al. 2006.

Icaria jucunda Cameron, 1898: 46.

Ropalidia marginata jucunda (Cameron, 1898): van der Vecht 1941: 104. Syn. by Nguyen et al. 2006.

Specimens examined. VIETNAM: 1 ♀ (RMNH), S. Vietnam: Dak Lak, Chu Yang Sin N.P. 50 km S. Buon Ma Thuot, Krong K’Mar, 550–600 m, 23–25.x.2005, near rainforest, C van Achterberg & R de Vries; 1 ♂ (RMNH), S. Vietnam: Đông Nai, Cát Tien N.P., Head Quarters, 3.x.2005, at light, C van Achterberg & R de Vries. INDIA: 1 ♀ (RMNH), S. India, Madras State, Coimbatore, 1400 ft., v.1960, P Susai Nathan; 1 ♀ (RMNH), Madras, India; 1 ♂ (RMNH), India, Ajanda, 13.vii.1978, J Timor. INDONESIA: 1 ♀ + 1 ♂ (RMNH), Java, Malang, Kawi, iv.1933, JG Betrem. SRI LANKA: 1 ♂ (RMNH), Col. Dist., Colombo, 50 ft., museum gardens, 15.i.1977, KV Krombein & P Fernando.

Remarks. No specimens from China were available in the present study, but this species was reported from China by Lee (1982, 1985) as *Ropalidia* (*Anthreneida*) *ferruginea* (Fabricius). However, Lee’s (1982, 1985) description and illustration are far from sufficient to define the species. Barthélémy (2008) recorded it from Hong Kong.

Distribution. China (Guangdong, Hong Kong); Australia (Thursday Islands, Queensland); Bali; Bangka; Borneo; India; Java; Kariman Djawa I.; Lombok; Malay Peninsula; Mariana Islands; Myanmar; New Britain; New Guinea; Pakistan; Palau Islands; Philippine Islands; Sri Lanka; Sulawesi; Sumatra; Sumba; Sumbawa; Talud Islands; Tukang Besi Islands; Vietnam; Volcano Islands. (Lee 1982, 1985, Kojima and Carpenter 1997 and updated to 2006, Kojima et al. 2007, Barthélémy 2008).

***Ropalidia mathematica* (Smith, 1860)**

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

Figure 1I

Polybia mathematica Smith, 1860: 90. Type locality: Sulawesi (Makassar).

Ropalidia mathematica mathematica; van der Vecht, 1941: 110.

Ropalidia mathematica binotata van der Vecht, 1941: 131. Syn. by Kojima et al. (2005).

Icaria nigroplagiata Cameron, 1900: 498.

Ropalidia mathematica nigroplagiata; van der Vecht, 1941: 104. Syn. by Kojima et al. (2005).

Ropalidia mathematica sumbaensis van der Vecht, 1962: 20. Syn. by Kojima et al. (2005).

Specimens examined. INDONESIA: 1 ♀ (RMNH), W. Flores, Rana Mese, 1300 m, 21.xi.1949, Dr. Bühler & Dr. Sutter (labeled as *Ropalidia mathematica mathematica* Smith, van der Vecht in 1956); 1 ♀ (RMNH), Moni, C. Flores, Wolowaru, 11.xi.1949, Dr. Bühler & Dr. Sutter; 16 ♀ + 7 ♂ (RMNH), Timor, Wiencke; 5 ♂ (RMNH), Batavia [= Jakarta], v.1908, E Jacobson; 1 ♂ (RMNH), Java, Mt. Gede, Tapos, 800 m, viii.1933, J v d Vecht; 2 ♀ (RMNH), W. Java, Pelabuhan Ratu, 5–6.viii.1972, 0–50 m, J v d Vecht. SRI LANKA: 1 ♂ (RMNH), Col. Dist., Gamaha Botanic Garden, 28.i.1979, KV Krombein, PB Karunaratne, T Wijesinhe, S Siriwardane & T Gunawardane (labeled *Ropalidia marginata marginata* (Lep.) by van der Vecht in 1979).

Remarks. No specimens from China were available in the present study, but the species was reported from China (Hong Kong) by Barthélémy (2006, 2008). However, according to his pictures, at the base of the first metasomal tergum is a pair of distinct yellow lateral stripes as in typical *R. stigma*. Therefore, the presence in China needs reconfirmation, but its presence in Vietnam and Thailand indicates that this species may occur in southern China.

Distribution. ?China (Hong Kong), India, Thailand, Vietnam, Bangka, Sumatra, Java, Kariman Djava Isl., Bali, Lombok, Sumbawa, Flores, Sumba, Timor, Sulawesi. (Kojima and Carpenter 1997 and updated to 2006, Kojima et al. 2007).

***Ropalidia obscura* Gusenleitner, 1996, rec. n.**

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

Figure 1J

Ropalidia obscura Gusenleitner, 1996: 15; Kojima and van Achterberg 1997: 10. Type locality: Thailand.

Specimens examined. CHINA: 3 ♀ (NWUM), Mengla, Yaoqu, Yunnan, 27–30. ix.2010, JL Tan; 1 ♀ (NWUM), Longmen, Shangyong, Yunnan, 26.ix.2010, JL Tan; 1 ♀ (NWUM), Banna, Menglun, Yunnan, 5.x.2010, JL Tan. THAILAND: 1 ♀ (RMNH), 50 km SW Loei (17°20'N, 101°20'E), Phu Rua N. P., 14.vii.1986, R Hensen; (labeled *Ropalidia obscura* Gusenleitner, 1996, by J Kojima in 1996).

Distribution. China (Yunnan), Thailand. (Kojima and Carpenter 1997 and updated to 2006).

***Ropalidia opifex* van der Vecht, 1962**

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

Figure 2A

Ropalidia opifex van der Vecht, 1962: 42; Richards 1978: 128; Lee 1982: 86; 1985: 46, 51; Kojima 1996a: 325, 328. Type locality: Malaya (Penang).

Specimens examined. MALAYSIA: 1 ♀ (RMNH), Penang Hill, Penang, 2500 ft, 27.i.1959, H.T. Pagden (paratype of *R. opifex*). INDONESIA: 1 ♀ (RMNH), E. Borneo, Begen River, Tabang, 26.ix.1956, AMR Wegner.

Remarks. No specimens from China were available in the present study, but this species was reported from China by Lee (1982, 1985).

Distribution. China (Yunnan); Borneo; Malay Peninsula. (Kojima and Carpenter 1997 and updated to 2006).

***Ropalidia ornaticeps* (Cameron, 1900), rec. n.**

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

Figure 2B

Icaria ornaticeps Cameron, 1900: 496. Type locality: India.

Ropalidia flavopicta ornaticeps; van der Vecht 1962: 49.

Ropalidia ornaticeps; Yoshikawa et al. 1969: 167; Kojima 1996a: 325.

Specimens examined. CHINA: 1 ♀ (CATAS), Nada, Danzhou, Hainan, 19°5'17"N, 109°34'50"E, 143 m. VIETNAM: 46 ♀ + 1 ♂ (RMNH, IEBR), Đông Nai, Cát Tien N.P., Mal. traps, x.2005 & iv.–v.2007, C van Achterberg & R de Vries; 1 ♂ (RMNH), Thua Thien Hué, Phong Dién N.R., 23.iii. –6.iv.2001, Mal. traps 6–9, C van Achterberg & R de Vries. THAILAND: 3 ♀, (RMNH), Chiang Khan, 17.vii.1986, R Hensen, with a label "*Ropalidia ornaticeps* (Cameron, 1900), det. J Kojima, 1996".

Remarks. The clypeus is completely yellow, but sometimes with a small black spot; the occipital carina is variable, sometimes the carina is bent anteriorly as in *Ropalidia flavopicta*.

Distribution. China (Hainan); Cambodia; India, Malay Peninsula; Myanmar; Thailand; Vietnam. (Kojima and Carpenter 1997 and updated to 2006, Kojima et al. 2007).

***Ropalidia parartifex* Tan & van Achterberg, sp. n.**

<http://zoobank.org/F28CA4A3-0334-448E-B363-2AC1BB46DC0A>

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

Figures 2C, 3

Holotype. ♀ (NWUM), CHINA: Longmen, Shangyong, Yunnan, 27.ix.2010, JL Tan. **Paratypes:** 2 ♀ + 1 ♂ (NWUM, RMNH), same data as holotype; 1 ♀ (GSFA),

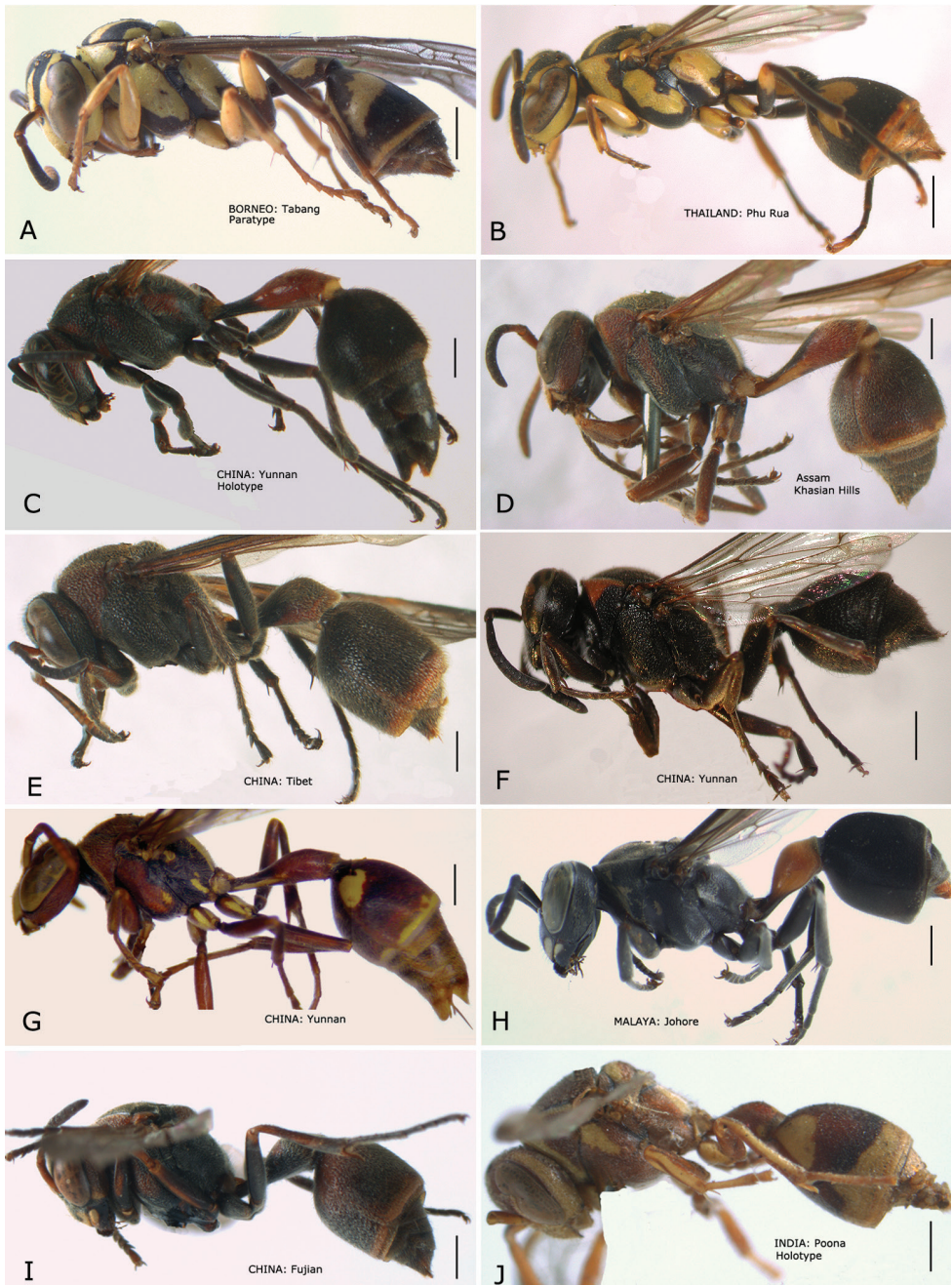


Figure 2. *Ropalidia* spp., habitus (♀). **A** *Ropalidia opifex* van der Vecht, 1962 **B** *Ropalidia ornateiceps* (Cameron, 1900) **C** *Ropalidia parartifex* Tan & van Achterberg, sp. n. (holotype) **D** *Ropalidia rufocollaris* (Cameron, 1900) **E** *Ropalidia santoshae* Das & Gupta, 1989 **F** *Ropalidia scitula* (Bingham, 1897) **G** *Ropalidia stigma* (Smith, 1858) **H** *Ropalidia sumatrae* (Weber, 1801) **I** *Ropalidia taiwana* Sonan, 1935 **J** *Ropalidia variegata* (Smith, 1852).

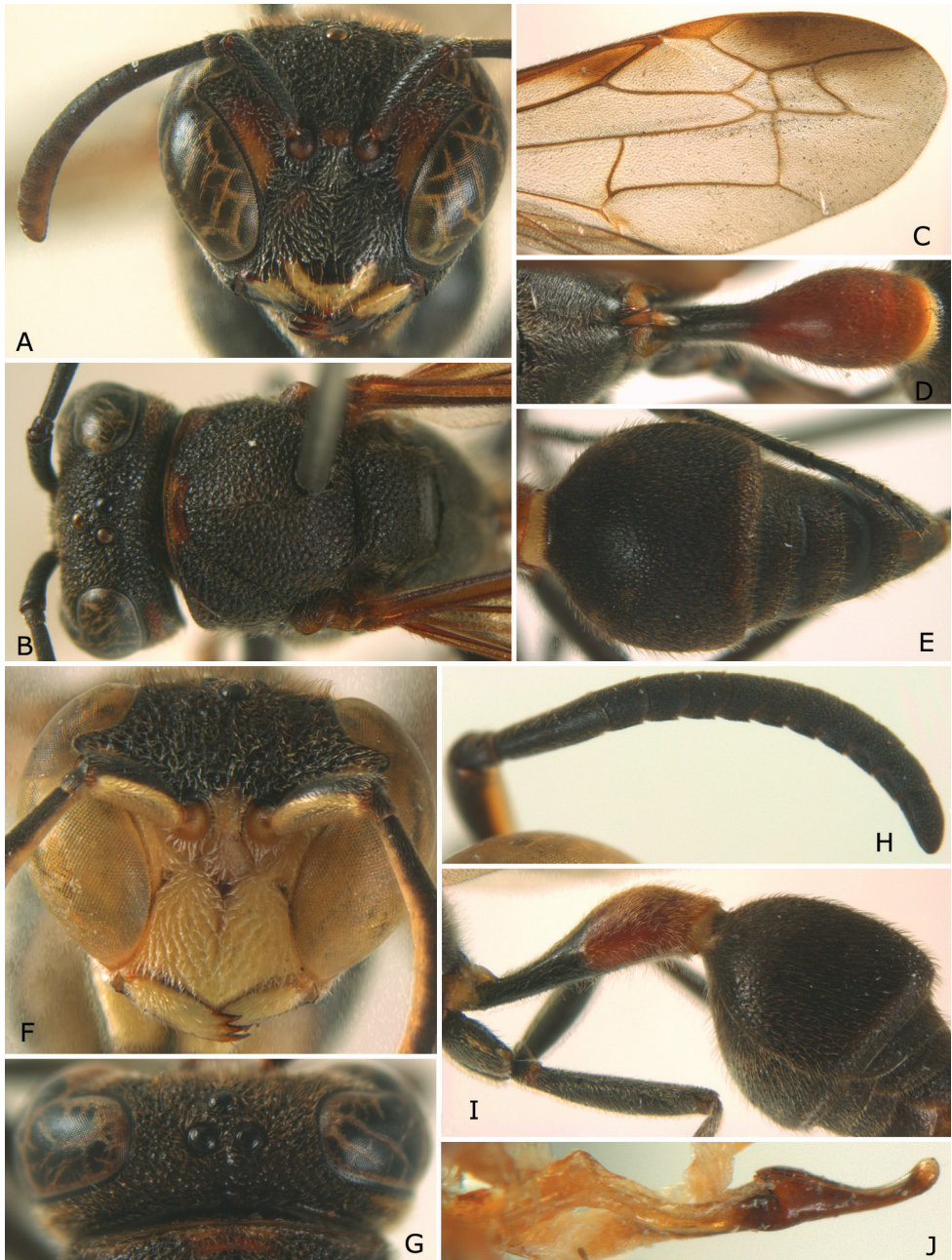


Figure 3. *Ropalidia parartifex* Tan & van Achterberg, sp. n. **A–E** Female (♀): **A** Head, frontal view **B** Head and mesosoma, dorsal view **C** Right fore wing **D** Propodeum and first metasomal segment, dorsal view **E** Second metasomal segment to the end, dorsal view **F–J** Male (♂): **F** Head, frontal view **G** Head, dorsal view **H** Right antenna **I** Metasomal, lateral view **J** Penis, lateral view.

Xishuangbanna, Wangtianshu, Yunnan, 610 m, 23.iv. 2002, SP Sun; 2 ♂ (ZJUH), Jinghong Forestry Park, Yunnan, 31.vii.2003, no. 20045919, 20045938, J Lu; 2 ♀ (ZJUH), Mt. Youle, Yunnan, 17.iv.1984, no. 811874, 811873, JH He; 1 ♀ + 2 ♂ (NWUM), Banna, Menglun Yunnan, 6.x.2010, JL Tan; 4 ♂ (NWUM), Yaoqu, Mengla, Yunnan, 28.ix.2010, JL Tan. THAILAND: 1 ♀ (RMNH), Chiang Dao, 19.1.1958, K. Yoshikawa (identified as *Ropalidia artifex* (Sauss.) var. by van der Vecht in 1960); 1 ♀ + 1 ♂ (RMNH), Siam, Chiangmai, 23.x.1922, F.4560, F.4571 (the female has the first tergite entirely black).

Diagnosis. The new species is similar to *R. artifex*, but differs as follows: clypeus of female largely black and apically yellow (yellow with a black arrow-shaped mark in *R. artifex*); second metasomal tergum entirely black and strongly swollen subapically (with yellow apical band apically and weakly swollen subapically); male genitalia: proximal margin of penis gradually contracted in dorsal view and with a comparatively small hook in ventral view (abruptly contracted in dorsal view and with a large hook in ventral view).

Description. ♀, length of body (head + mesosoma + metasomal segments I–II) 11–12 mm, fore wing 10.5–12 mm.

Head. Head in frontal view about $1.2 \times$ as wide as high; in dorsal view $2.2 \times$ as wide as long, straightly contract behind eye, emarginate posteriorly, about $1.1 \times$ as broad as mesonotum (including tegulae). Gena in lateral view about $0.7 \times$ as wide as eye; occipital carina present completely, slightly sinuate laterally (Fig. 2C). Posterior ocelli slightly closer to each other than to anterior ocellus; OOL (posterior ocellus-ocular distance):diameter of ocellus:POL (distance between the two posterior ocelli) = 10:4:3. Inner eye margins converging ventrally, about $1.25 \times$ further apart at vertex than at clypeus. Clypeus weakly convex, pointed apically, nearly $1.1 \times$ wider than high. Inter-antennal distance slightly shorter than antenna-ocular distance. Antenna about 4.0 mm long, gradually thickened apically; scape slightly curved, about $4.4 \times$ as long as its apical width; third article slightly more than $3.3 \times$ as long as its apical width, about as long as fourth, fifth and sixth articles combined; terminal article bullet-shaped, about $1.2 \times$ as long as its basal width (Fig. 3A).

Mesosoma. Mesosoma robust, in dorsal view about $1.4 \times$ as long as wide (Fig. 3B). Pronotum in dorsal view broadly and weakly rounded anteriorly, with lateral sides diverging posteriorly in straight lines; ventral corner gradually narrowed (Figs. 2C, 3B); pronotal carina raised entirely and sinuate laterally. Scutellum trapezoid, strongly convex. Posterior face of propodeum weakly convex, without median complete furrow, slightly depressed in front of orifice (Fig. 3D).

Metasoma. First segment elongate, about $3.5 \times$ as long as high, $2.5 \times$ as long as wide, weakly widening posteriorly from level slightly anterior to spiracle, widest at two thirds of its length and slightly contracted apically. Profile of second sternite in lateral view curved in anterior two thirds, with second tergite strongly swollen subapically (Fig. 3D, E).

Sculpture. Body covered with fine tomentum except in apical half of clypeus and with sparse setae. Clypeus, front, antero-ventral area of mesopleuron, metapleuron and sides of propodeum with scattered fine punctures; vertex, pronotum, mesoscutum,

scutellum and postero-dorsal area of mesopleuron reticulate-rugose; posterior face of propodeum densely striate; first metasomal tergite shiny, with fine and sparse punctures on anterior half, and dense punctures on its posterior half; second–sixth metasomal segments dull, with dense punctures.

Colour (Fig. 2C). Body black to blackish brown with irregular reddish brown patches on the following parts: upper half of clypeus, ventral part of ocular sinus, gena, pronotum, mesopleuron antero-dorsally and propodeum laterally, but clypeus apically, mandible basally, tegula, propodeum valve and basal narrow part of second metasomal segment yellowish brown; apical half of first metasomal segment reddish brown. Coxa basally with irregular small yellow stripes. Fore wing slightly brown tinged with pterostigma yellowish brown; marginal cell and median cell apically dark brown (Fig. 3C).

Male (Figs 3F–J). Similar to female but head more transverse, in frontal view about $1.25 \times$ as wide as high; in dorsal view $3.3 \times$ as wide as long, directly contracted behind eyes (Figs 3F, G). Antenna with 13 articles, third to terminal articles with slightly raised tyloids (Fig. 3H). Frons, clypeus, mandible, ventral antenna and antero-ventral area of mesopleuron yellow. Male genitalia (Fig. 3J): proximal margin of penis gradually contracted in dorsal view and curved slightly into a hook in ventral view.

Etymology. The species name is derived from “para” (Latin for “near”) and “artifex”, because it is similar to *Ropalidia artifex*.

Distribution. China (Yunnan); Thailand.

***Ropalidia rufocollaris* (Cameron, 1900)**

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

Figure 2D

Icaria rufocollaris Cameron, 1900: 497. Type locality: India (Khasia Hills).

Ropalidia rufocollaris rufocollaris; Das and Gupta 1983: 421; 1989: 125.

Ropalidia rufocollaris atrata van der Vecht, 1941: 139. Type locality: Thailand (Siam Doi Setep). Syn. by Nguyen et al. (2006).

Specimens examined. CHINA: 1 ♀ (RMNH), Tibet, Khamba Jong, F.A.M. INDIA: 1 ♀ + 1 ♂ (RMNH), Khasia Hills, Assam; 1 ♀ (RMNH), British Sikkim, 200 m, valley at Tista Bridge, 8–15.xii.1934, R Malaise; 1 ♀ (RMNH), E. Himalayas, Pashok, 2000 ft, Darjiling district, 11.vi.16, LC Hartless; 1 ♀ (RMNH), India, Lushai Hills, Miso district, Thingsat, 2000–3500 ft, 9–10.ix.1960, F Schmid. MYANMAR: 1 ♂ (RMNH), Burma: Washaung, 20 km, East of Myitkyina, c 200 m, 14.vii.1934, R Malaise; 1 ♀ (RMNH), Nord East Burma: Punkatang, road Sadon-Myitkyina, 8.vii.1934, R Malaise.

Remarks. Occipital carina is curved forward ventrally and the gena narrow ventrally; the propodeum has the yellow stripes merged, but are sometimes lacking.

Distribution. China (Tibet); India; Laos; Myanmar; Thailand; Vietnam. (Kojima and Carpenter 1997 and updated to 2006, Kojima et al. 2007).

***Ropalidia santoshae* Das & Gupta, 1989, rec. n.**

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

Figure 2E

Ropalidia santoshae Das & Gupta, 1983: 422. Nomen nudum.

Ropalidia santoshae Das & Gupta, 1989: 111, 123, 156; Kojima et al. 2007: 382. Type locality: India.

Specimens examined. INDIA: 1 ♀ (RMNH), Sikkim, Kambur, 3280 ft, 15.viii.1959, F. Schmid; 1 ♀ (RMNH), Assam, Div. Kamens, Bokhar, 2200–2500 ft, 28.v.1961, F. Schmid (both paratypes labelled “*Ropalidia santoshae* Das L. l., det. J v d Vecht, 1981). CHINA: 1 ♀ (NWUM), Motuo, Tibet, 29°19'37.5"N, 95°19'44.6"E, 15.viii.2011, HL Yang & JB Wang; 10 ♀ (NWUM), with same locality data, but 10.vii.2013, T Li.

Remarks. The specimens from China agree well with the examined paratypes from India.

Distribution. China (Tibet); India. (Kojima and Carpenter 1997 and updated to 2006, Kojima et al. 2007).

***Ropalidia scitula* (Bingham, 1897), rec. n.**

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

Figure 2F

Icaria scitula Bingham, 1897: 387. Type locality: India (Sikkam).

Ropalidia scitula: van der Vecht 1941: 110, 142; Das and Gupta 1983: 428; Das and Gupta 1989: 113, 152, 172; Kojima et al. 2007: 389.

Specimens examined. INDIA: 1 ♂ (RMNH), India, Kulara, Kumaon, 12000 ft, 4.viii.1958, F Schmid. MYANMAR: 1 ♀ (RMNH), Carin Chebá, Karen Hills, Kayin State, 900–1000 m, 5.viii.1988, L Fea. CHINA: 5 ♀ (ZJUH), Ruili, Yunnan, 1.v.1981, no. 812465, JH He.

Distribution. China (Yunnan); India; Myanmar; Thailand. (Kojima and Carpenter 1997 and updated to 2006, Kojima et al. 2007).

***Ropalidia stigma* (Smith, 1858)**

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

Figure 2G

Polybia stigma Smith, 1858: 114. Type locality: Borneo (Sarawak).

Icaria stigma; du Buysson 1913: 296.

Parapolybia stigma; von Schulthess 1913: 164.

Ropalidia stigma stigma; van der Vecht 1941: 110.

Ropalidia stigma nigrolineata van der Vecht, 1962: 18. Syn. by Nguyen et al. (2006).

Ropalidia stigma rufa van der Vecht, 1941: 130. Syn. by Nguyen et al. (2006).

Specimens examined. CHINA: 1 ♀ (ZJUH), Guishan, Heyuan, Guangdong, 18.v.2002, no. 20028494, ZF Xu; 1 ♀ (NWUM), Luofu, Huizhou, Guangdong, 250 m, 12.vii.2004, CT Zhang; 1 ♀ (ZJUH), Dongzhong, Fangcheng, Guangxi, 8.xii.2001, ZQ He; 1 ♀ (ZJUH), Baise, Guangxi, 2.vi.1982, no. 822126, JH He; 9 ♀ + 2 ♂ (NWUM), Yaoqu, Mengla, Yunnan, 27–30.ix.2010, JL Tan; 7 ♀ + 2 ♂ (NWUM), Longmen, Shangyong, Yunnan, 26–27.ix.2010, JL Tan; 1 ♀ (GSFA) Xishuangbanna, Wangtianshu, Yunnan, 610 m, 23.iv.2002, SP Sun; 1 ♀ (NWAM), Yaoqu, Mengla, Yunnan, 640 m, 6.v.1991, GC Liu & WZ Cai; 12 ♀ + 1 ♂ (NWUM), Beibeng, Motuo, Tibet, 10.viii.2011, HL Yang & JB Wang; 1 ♀ (NWUM), Motuo, Tibet, (29°19'37.5"N, 95°19'44.6"E), 15.viii.2011, HL Yang & JB Wang; 1 ♀ (ZJUH), Hongmao Village, Yuanmen, Baisha, Hainan, 29.iv.2010, JL Tan; 2 ♀ (ZJUH), Bawangling, Hainan, 19.viii.2000, no. 200104356, -67, ZF Xu; 1 ♀ (CATAS), Leguang Farm, Ledong, Hainan, 14.vii.2011, 18°37'0"N, 109°6'39"E, no. 07018, WJ Zhu; 4 ♀ + 2 ♂ (CATAS), Nada, Danzhou, Hainan, 19°05'17"N, 109°34'50"E, 143 m. INDONESIA: 2 ♀ + 2 ♂ (RMNH), Sumatra/Ind., viii-ix.1989, F. Moussault. VIETNAM: 5 ♀ (RMNH), S. Vietnam: Dak Lak, Chu Yang Sin N.P., Krong K'Mar, 550–610 m, 21–26.x.2005, C van Achterberg & R de Vries, (mesoscutum with a pair of narrow yellow stripes vaguely visible in the reddish brown mark); 1 ♀ (RMNH), S. Vietnam: Đông Nai, Cát Tien N.P., *Ficus* trail, Mal. traps, c 100 m, 9–30.iv.2007, MP Quy & NT Manh; 1 ♀ (RMNH), same data, but Botanical garden, Mal. traps 14–19, c 100 m, 14–20.v.2007, C van Achterberg & R de Vries; 1 ♀ (RMNH), same data, but c 100 m, 6.x.2005, Ecotrail, C van Achterberg & R de Vries (similar to Chinese specimens with small yellow spots on second tergite and sternite). MALAYSIA: 1 ♀ (RMNH), Penang Isl., Malaya, Batu Feringgi, 25.ii.1963, MA Liefstinck; 2 ♀ (RMNH), Perlis, Bukit Bingtang, Forest Res. (Kangar), 23.ii.1963, MA Liefstinck.

Remarks. Specimens from Tibet are slightly darker than those from Yunnan and the basal yellow marks of the second sternite are very small or lacking. Chinese specimens have the gena slightly wider and the first tergite longer than other specimens, 3.0–3.5 times as long as high with small yellow patches. Specimens from Vietnam and Malaysia have the first tergite shorter, about 2.9 times as long as high with large yellow patches.

Distribution. China (Hainan, Guangdong, Guangxi, Yunnan, Tibet); Bali; Borneo; India; Java; Malay Peninsula; Myanmar; Nepal; Philippine Islands; Sri Lanka; Sumatra; Thailand; Vietnam. (Kojima and Carpenter 1997 and updated to 2006, Nguyen et al. 2006, Kojima et al. 2007).

Ropalidia sumatrae (Weber, 1801)

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

Figure 2H

Vespa sumatrae Weber, 1801: 103. Type locality: Sumatra.

Icaria sumatrae; de Saussure 1854: 241.

Ropalidia sumatrae sumatrae van der Vecht, 1962: 35.

Ropalidia sumatrae lugubris van der Vecht, 1941: 104. Syn. by Kojima et al. (2007).

Icaria speciosa de Saussure, 1855: 374. Type locality: Sumatra. Syn. by van der Vecht (1941).

Specimens examined. CHINA: 1 ♀ (NWAM), Menglun, Yunnan, 19.v.1991, YL Wang & RG Tian; 1 ♀ (ZJUH), id., but 12.iv.1981, JH He, no. 811796; 2 ♀ (ZJUH), Sanchahe, Yunnan, 10.iv.1981, JH He, no. 811812; 1 ♀ (ZJUH), Mt. Youle, Yunnan, 17.iv.1981, JH He, no. 811873. MALAYSIA: 2 ♂ (RMNH), Sabah, Brumas, NBT, 23–27.i.1973, K.M. Guichard; 1 ♂ (RMNH), Borneo, Sarawak, trail Bario-Pa Lungan, 3°48'N, 115°34'E, 1100 m, 23.ii.1987, J Huisman; 1 ♀ (RMNH), SW. Sabah, near Long Pa Sia (West), c. 1200 m, 2–14.iv.1987, Mal. trap 7, C van Achterberg. INDONESIA: 1 ♀ (RMNH), N. Sumatra: Allas Valley, near Gumpang, 13.vi.1972, 3°48'N, 97°29'E, J Krikken; 2 ♀ (RMNH), N. Sumatra, Aceh, Ketamba, 400 m, iv.1995, Mal. trap, near edge rainforest, Y van Nierop & C van Achterberg.

Remarks. Lee (1982, 1985) used *R. speciosa* still as a valid species.

Distribution. China (Yunnan); Bangka; Borneo; India; Malaysia (Sabah, Sarawak) (rec. n.); Myanmar; Sumatra; Thailand; Vietnam. (Lee 1982, 1985, Kojima and Carpenter 1997 and updated to 2006, Kojima et al. 2007).

***Ropalidia taiwana* Sonan, 1935**

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

Figure 2I

Ropalidia taiwana Sonan, 1935: 199. Type locality: China (Taiwan: Shinchiku).

Ropalidia taiwana taiwana; Iwata 1976: 295; Lee 1982: 83, 92; 1985: 46, 52.

Ropalidia taiwana var. *koshunensis* Sonan, 1935: 199, type locality: China (Taiwan: Koshun). Syn. by Starr (1992).

Ropalidia taiwana koshunensis; Iwata 1969: 367.

Ropalidia formosana Kuo, in Kuo and Yeh 1987: 84, type locality: China (Taiwan: Wufeng). Syn. by Starr (1992).

Specimens examined. CHINA: Type material of *Ropalidia taiwana*, no. 90-96 in TARI: 1 ♀, Holotype, Shinchiku, Formosa 18.vii.1-30, J Sonan, K Miyake; paratypes: 1 ♀, id.; 1 ♀, Hassenzan, 23.x.1932, K Nomura; 1 ♂, Horisha, 2.xii.1916, T Shiraki; 1 ♀, Koshun, Formosa, 1918, iv.25–v.25. J Sonan, K Miyake, M Yoshino; 1 ♀, Urai, vii.1931, J Sonan; 1 ♀ (RMNH), Eassenzan, Formosa, 23.vi.1934, L Gressitt. Type material of *Ropalidia taiwana* var. *koshunensis* Sonan, 1935, confirmed by J Kojima & F Saito, 2010: 1 ♀, Holotype, Kuraru, 13.x.1926, J Sonan, “*Ropalidia taiwana* Sonan var. *formosensis* Sonan, DET. J SONAN. Type label, “97”; Paratypes: 6 ♀ + 5 ♂ with same data; 2 ♀, with same data but 14.x.1926; 1 ♀ “Koshun 1918.iv.25–v.25, J Sonan, K Miyake, M Yoshino; 1 ♂, Koushun, 25.iii.1930, T Shiraki”. 1 ♀ (RMNH), Rokki, Formosa, 20.v.1934, L Gressitt; 2 ♀ (RMNH), Kosempo, Formosa, 11.vii.1911, H Sauter; 2 ♀ (RMNH), Taihorin, Formosa, 10.v, H Sauter; 1 ♂ (RMNH), Taihorinsho, Formosa, H Sauter; 1 ♀ (RMNH), Ku-ling, Jiangxi, 13.ii.1935, O Piel; 1 ♀ (RMNH), Kuatun, Fujian, 27°40'N, 117°40'E, 2300 m, 14.iv.1938, LJ Klapperich; 1 ♀ (ZJUH), Mt. Baxian, Heiping, Taizhong, Taiwan, 24°11'N, 121°E, 4–5.vi.2011, P

Tang. MYANMAR: 2 ♀ (RMNH), Sadon, 1200 m, 28.vi.–5.vii.1934, R Malaise; 2 ♀ (RMNH), Taunggyi, S. Shan States, 1.viii.–22.ix.1934, R Malaise.

Distribution. China (Jiangxi, Fujian, Taiwan); Myanmar. (Kojima and Carpenter 1997 and updated to 2006)

***Ropalidia variegata* (Smith, 1852)**

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

Figure 2J

Epipona variegata Smith, 1852: 48. Type locality: India (Poona).

Icaria variegata; de Saussure 1854: 237.

Ropalidia variegata; Bequaert 1918: 247; van der Vecht 1941: 104; Kojima et al. 2007: 387.

Ropalidia variegata variegata; van der Vecht 1941: 112.

Icaria pendula Smith, 1857: 98. Type locality: India (Bareilly). Syn. by van der Vecht (1941).

Ropalidia pendula; Richards 1978: 58.

Specimens examined. INDIA: 1 ♀, Type, 60-15, E.I.C., with a handwritten label “*variegata* Type, Sm.”, Capt. F. Downes, BM Type 18.846, van der Vecht (1941) recorded it is Holotype, locality: Poona, India; 1 ♂, India, with a label: “*R. pendula* Smith” (BMNH); 1 ♀ (RMNH), India, Pinjore, (identified as *R. variegata* by Dover, 1921). PAKISTAN: 1 ♀ (RMNH), Karachi, 25.i.1934, R Malaise.

Remarks. No specimens from China were available, but the species is included in the key because it has been listed for China. Liu (1936–37) listed *Ropalidia variegata* (Smith) from China in his catalogue and *Ropalidia variegata variegata* (Smith) was reported from China by Lee (1982, 1985). However, considering that Lee (1982, 1985)’s description of the male antenna with its hooked terminal segment, we suspect misidentification of *R. variegata*.

Distribution. China; India; Malay Peninsula; Myanmar; Nepal; Pakistan; Sulawesi. (Kojima and Carpenter 1997 and updated to 2006).

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References

- Barthélémy C (2006) A new record for Hong Kong and China of a Polistine wasp of the genus *Ropalidia*: *Ropalidia mathematica* (Vespidae: Polistinae: Ropalidiini). Porcupine! 34: 8–10.
- Barthélémy C (2008) Provisional Guide to the Social Vespids of HongKong (Hymenoptera: Vespidae). (Online PDF, <http://insectahk.com>)
- Bequaert JC (1918) A revision of the Vespidae of the Belgian Congo based on the collection of the American Museum Congo expedition, with a list of Ethiopian diplopterous wasps. Bulletin of the American Museum of Natural History 39: 1–384.
- Bingham CT (1897) The fauna of British India including Ceylon and Burma. Hymenoptera, 1. Wasps and Bees. Taylor & Francis, London.
- Blommers LHM (2012) Taxonomy and natural history of 18 *Ropalidia* species (Hymenoptera, Vespidae) of Madagascar. Tijdschrift voor Entomologie 155: 133–192. doi: 10.1163/22119434-00002010
- Buysson R du (1913) Sur quelques Vespides (Hym.). Bulletin de la Société entomologique de France 1913: 296–299.
- Cameron P (1898) Hymenoptera Orientalia, or contributions to a knowledge of the Hymenoptera of the Oriental zoological region. Part VII. Memoirs and Proceedings of the Manchester Literary and Philosophical Society 42: 1–84, pl. 4.
- Cameron P (1900) Descriptions of new genera and species of Hymenoptera. Annals and Magazine of Natural History (7)6: 410–419, 495–506, 530–539. doi: 10.1080/00222930008678398
- Carpenter JM, Nguyen PLT (2003) Keys to the genera of social wasps of South-East Asia. Entomological Science 6: 183–192. doi: 10.1046/j.1343-8786.2003.00016.x
- Carpenter JM, Madl M (2009) A catalogue of the Vespidae of the Malagasy Subregion. (Insecta, Hymenoptera). Linzer biologische Beiträge 41/2: 1871–1935.
- Cheesman LE (1952) *Ropalidia* of Papuasia. Annals and Magazine of Natural History (12)5: 1–26. doi: 10.1080/00222935208654259
- Das BP, Gupta VK (1983) A catalogue of the families Stenogastridae and Vespidae from the Indian subregion (Hymenoptera: Vespidae). Oriental Insects 17: 395–464. doi: 10.1080/00305316.1983.10433698
- Das BP, Gupta VK (1989) The social wasps of India and the adjacent countries. Oriental Insects Monograph 11: 1–292.
- Dover C (1931) The vespidae in the Federated Malay State Museums. Journal of the Federated Malay State Museums 16: 251–260.
- Fabricius JCF (1793) Entomogica Systematica, vol 2, Hafniae.

- Fabricius JCF (1804) *Systema Piezatorum Secundum Ordines, Genera, Species Adiectis Synonymis, Locis, Observationibus, Descriptionibus*. Brunsvigae Arud Carolum Reichard.
- Gribodo G (1892) Contribuzioni imenotterologiche sopra alcune specie nuove o poco conosciute di Imenotteri Diplotteri. Nota IV (1). Bollettino della Società Entomologica Italiana 23: 242–300.
- Gusenleitner J (1996) Zwei neue Arten der Gattung *Ropalidia* Guérin-Ménéville aus der orientalischen Region (Hymenoptera, Vespidae). Linzer Biologische Beitrage 28: 15–21.
- Iwata K (1969) On the nidification of *Ropalidia* (*Anthreneida*) *taiwana kuoshunensis* Sonan in Formosa (Hymenoptera: Vespidae). Kontyû 37 (4): 367–372. [in Japanese]
- Iwata K (1976) Evolution of Instinct. Comparative Ethology of Hymenoptera. Amerind Publishing Co., New Delhi. [Japanese edn in 1971]
- Kojima J (1982) Taxonomic revision of the subgenus *Icarielia* of the genus *Ropalidia* (Vespidae) in the Philippines. Kontyû 50: 108–124.
- Kojima J (1984) *Ropalidia* wasps in the Philippines (Hymenoptera, Vespidae) (I) subgenus *Icariola*. Kontyû 52: 522–532.
- Kojima J (1996a) Taxonomy of the *Ropalidia flavopicta*-complex (Hymenoptera: Vespidae: Polistinae). Zoologische Mededelingen 70: 325–347.
- Kojima J (1996b) Reconsideration of the taxonomy of the *Ropalidia malayana*-complex (Hymenoptera: Vespidae: Polistinae). Zoologische Mededelingen 70: 349–359.
- Kojima J (1997) Subgeneric affiliation of *Ropalidia thailandia* Gusenleitner: a case showing ambiguity of the subgenera of *Ropalidia* Guérin-Ménéville (Hymenoptera: Vespidae: Polistinae). Zoologische Mededelingen 71: 57–61.
- Kojima J (1999a) A key to species and notes on distribution of the polistine genus *Ropalidia* Guérin-Ménéville, 1831 (Hymenoptera: Vespidae, Polistinae) in Australia. Entomological Science 2: 379–390.
- Kojima J (1999b) Taxonomic notes on Australian *Ropalidia* Guérin-Ménéville, 1831 (Hymenoptera: Vespidae, Polistinae). Entomological Science 2: 367–377.
- Kojima J (1999c) Male genitalia and antennae in an Old World paper wasp genus *Ropalidia* Guérin-Ménéville, 1831 (Insecta: Hymenoptera; Vespidae, Polistinae). Natural History Bulletin of Ibaraki University 3: 51–68.
- Kojima J (2001) *Ropalidia* wasps (Insecta: Hymenoptera; Vespidae, Polistinae) in New Guinea and its adjacent islands. (First part). Natural History Bulletin of Ibaraki University 5: 31–60.
- Kojima J (2006) Checklist and/or catalog of social wasps. <http://www.ipc.ibaraki.ac.jp/~jkrte/wasp/list.html>
- Kojima J, Carpenter JM (1997) Catalog of species in the polistine tribe Ropalidiini (Hymenoptera: Vespidae). American Museum Novitates 3199: 1–96.
- Kojima J, Achterberg C van (1997) Social wasps collected by Malaise trapping in Southeast Asia, with a note on relative abundance of swarm-founding species (Insecta: Hymenoptera: Vespidae). Natural History Bulletin of Ibaraki University 1: 1–13.
- Kojima J, Hartini S, Kahono S, Fujiyama N, Katakura H (2002) Males, mature larvae, and nests of *Ropalidia plebeja*, a nearly solitary paper wasp endemic to Sulawesi (Insecta: Hy-

- menoptera: Vespidae), with taxonomic notes on the *R. plebeja* group. Species Diversity 7: 1–28.
- Kojima J, Lambert K, Nguyen LTP, Saito F (2007) Taxonomic notes on the paper wasps of the genus *Ropalidia* in the Indian subcontinent (Hymenoptera: Vespidae). Entomological Science 10(4): 373–393. doi: 10.1111/j.1479-8298.2007.00237.x
- Kojima J, Saito F, Nguyen LPT (2011) On the species-group taxa of Taiwanese social wasps (Hymenoptera: Vespidae) described and/or treated by J. Sonan. Zootaxa 2920: 42–64.
- Kojima J, Saito F, Nguyen LPT, Ubaidillah R, Hartini S (2005) Taxonomy of social wasps of the polistine tribe Ropalidiini (Hymenoptera: Vespidae) in the eastern part of the Lesser Sunda Islands. Treubia 33: 165–180.
- Kojima J, Tano T (1985) *Ropalidia* wasps in the Philippines (Hymenoptera, Vespidae) (II) a new species from Palawan, with brief notes on the distribution of our species. Kontyû 53: 520–526.
- Kuo MC, Yeh WH (1987) Ecological studies on *Vespa*, *Polistes*, *Parapolybia* and *Ropalidia* (Study on Vespidae in Taiwan III). Journal of National Chiayi Institute of Agriculture 16: 77–104. [In Chinese with English summary]
- Lepeletier de St. Fargeau ALM (1836) Histoire Naturelle Des Insectes. Hyménoptères, 1. Roret's Suites à Buffon, Paris.
- Liu CL (1936–1937) A bibliographic and synonymic catalogue of the Vespidae of China, with a cross-referring index for the genera and species. Peking Natural History Bulletin, Vol. II, Part 3, 205–232.
- Li T, Sheng ML, Sun SP, Chen GF, Guo ZH (2012) Effect of the trap color on the capture of ichneumonids wasps (Hymenoptera). Revista Colombiana de Entomología 38(2): 338–342.
- Lee TS (1982) Hornets from agricultural regions of China (Hymenoptera: Vespoidea). Agriculture Publishing House, Beijing. [In Chinese]
- Lee TS (1985) Fauna of China Economical Insect (vol. 30). Vespoidea. China Science Press, Beijing. [In Chinese]
- Nguyen LTP, Kojima J, Saito F, Carpenter JM (2006) Vespidae (Hymenoptera) of Vietnam 3: Synoptic key to Vietnamese species of the polistine genus *Ropalidia*, with notes on taxonomy and distribution. Entomological Science 9(1): 93–107. doi: 10.1111/j.1479-8298.2006.00157.x
- Richards OW (1978) The Australian social wasps (Hymenoptera: Vespidae). Australian Journal of Zoology. Supplement series 61: 1–132.
- Saito F, Kojima J (2005a) Taxonomy and biogeography of Australian species of the *Ropalidia stigma* group and *R. variegata* group (Hymenoptera: Vespidae). Entomological Science 8: 179–188. doi: 10.1111/j.1479-8298.2005.00111.x
- Saito F, Kojima J (2005b) Colony cycle in the south-eastern coastal populations of *Ropalidia plebeiana*, the only *Ropalidia* wasp occurring in temperate Australia. Entomological Science 8: 263–275. doi: 10.1111/j.1479-8298.2005.00125.x
- Saussure H de (1853–1858) Études Sur la Famille Des Vésipides, Vol. 2. Monographie des Guêpes Sociales, ou de la Tribe de Vespiens. Masson, Paris, and Kessmann, Genève.

- Schulthess A von (1913) *Parapolybia* Saussure Vespidae sociales. Mitteilungen der Schweizerischen Entomologischen Gesellschaft 12: 152–164.
- Sheng ML, Sun SP, Ding DS, Luo JG (2013) Ichneumonid Fauna of Jiangxi (Hymenoptera: Ichneumonidae). Science Press, Beijing.
- Smith F (1852) Descriptions of some hymenopterous insects captured in India, with notes on their economy, by Ezra T. Downes, Esq., who presented them to the Honourable the East India Company. Annals and Magazine of Natural History (2)9: 44–50.
- Smith F (1857) Catalogue of Hymenopterous Insects in the Collection of the British Museum. Part 5. Vespidae. Taylor & Francis, London.
- Smith F (1858) Catalogue of the hymenopterous insects collected at Sarawak, Borneo; Mount Ophir, Malacca; and at Singapore, by A. R. Wallace. Journal of the Proceedings of the Linnean Society, Zoology 2: 42–130.
- Smith F (1860) Catalogue of the hymenopterous insects collected by A.R. Wallace in the Islands of Bachian, Kaisaa, Amboyna, Gilolo, and at Dory in New Guinea. Journal of the Proceedings of the Linnean Society, Zoology 5: 93–143.
- Smith F (1865) Description of New Species of Hymenopterous Insects from the Islands of Sumatra, Sula, Gilolo, Salwatty, and New Guinea, collected by Mr. A.R. Wallace. Journal of the Proceedings of the Linnean Society, Zoology 8: 61–94.
- Sonan J (1935) On the genus *Ropalidia* from Formosa and Okinawa (Hymenoptera: Vespidae). Transactions of the Natural History Society of Formosa 25(142): 199–202.
- Starr CK (1992) The social wasps (Hymenoptera: Vespidae) of Taiwan. Bulletin of the National Museum of Natural Science 3: 93–138.
- Vecht J van der (1941) The Indo-Australian species of the genus *Ropalidia* (= *Icaria*) (Hym., Vespidae) (first part). Treubia 18: 103–190.
- Vecht J van der (1962) The Indo-Australian species of the genus *Ropalidia* (*Icaria*) (Hymenoptera, Vespidae) (second part). Zoologische Verhandelingen 57: 1–72.
- Weber F (1801) Observationes Entomologicae, Continentes Novorum quae Condidit Generum Characteres, et Nuper Detectarum Specierum Descriptiones. Kiliae.
- Wenzel JW (1998) A generic key to the nests of hornets, yellowjackets, and paper wasps worldwide (Vespidae: Vespinae, Polistinae). American Museum Novitates 3224: 1–39.
- Yoshikawa K, Ohgushi R, Sakagami SF (1969) Preliminary report on entomology of the Osaka City University 5th Scientific Expedition to Southeast Asia 1966 – With descriptions of two new genera of stenogastrine wasps by J. Van der Vecht. Nature and Life in Southeast Asia 6: 153–182, pls. 1–75.

A new genus of Cletopsyllidae (Copepoda, Harpacticoida) from Gulf of Mexico

Hyun Woo Bang^{1,†}, Jeffrey G. Baguley^{1,‡}, Heejin Moon^{1,§}

¹ Department of Biology, University of Nevada Reno, Reno, Nevada 89557, USA

† <http://zoobank.org/6DDDB085-85C6-4D1E-9D38-9B0A94F9CFBB>

‡ <http://zoobank.org/7FE6B366-FC09-4648-9001-66BC0C5ECAB2>

§ <http://zoobank.org/23F9C67E-68A7-4FB3-AA0F-37808F881BD4>

Corresponding author: Jeffrey G. Baguley (baguley@unr.edu)

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Abstract

A new genus and new species of the family Cletopsyllidae Huys & Willems, 1989 from deep-sea sediment in the Gulf of Mexico, are reported and fully described and illustrated. The new genus *Pentacletopsyllus* (type species: *P. montagni* **sp. n.**) can be distinguished from the four known genera of the family by antennule segmentation, length ratio of first and second endopodal segments of P1, and armature pattern on P5 exopod. It also differs from its sister genera by the rostrum being bifid at the tip, third segment of the female antennule having a smooth posterior margin, the baseoendopod of P5 with biarticulate outer setophore bearing basal seta, and female caudal rami without lobate expansion. A revised key to species of the family Cletopsyllidae Huys & Willems, 1989 is provided.

Keywords

Harpacticoida, Cletopsyllidae, *Pentacletopsyllus* gen. n., meiofauna, Gulf of Mexico

Introduction

The Gulf of Mexico is a large semi-enclosed oceanic basin surrounded by the North American continent and the island of Cuba. The continental slope of the northern Gulf of Mexico is topographically complex and shows a high species diversity of benthic fauna (Haedrich et al. 2008). Baguley et al. (2006) estimated the harpacticoid species richness of the northern Gulf of Mexico to be approximately 2200 species with a maximum diversity found at mid-slope water depths of 1200–1500 m. Harpacticoid diversity in this area is thought to be maintained by both small scale heterogeneity and large scale food supply mechanisms (Baguley et al. 2006). In total, Baguley et al. (2006) recorded 696 species of benthic harpacticoids, belonging to 175 genera and 22 families.

The family Cletopsyllidae includes only four genera and 11 species, which are rare in marine benthic habitats (Boxshall and Halsey 2004). However, Cletopsyllidae does have a broad global distribution and has been found in the Indian Ocean (*Retrocalcar secundus* (Nicholls, 1945); *Cletopsyllus bacescui* Marcus, 1976; *Bathycletopsyllus hexarthra* Huys & Lee, 1999), the Pacific Ocean (*R. sagamiensis* (Itô, 1971); *Isocletopsyllus maximus* Song, Kim & Hwang, 2010), the Atlantic Ocean and the Caribbean Sea (*C. papillifer* Willey, 1935; *R. brattstroemi* (Geddes, 1981); *C. rotundifera* Fiers, 1986), and the Mediterranean Sea (*I. tertius* (Por, 1964); *I. quartus* (Soyer, 1966); *I. sardus* Addis, Floris & Carcupino, 2011).

The subfamily Normanellinae was elevated to family level by Huys and Willems (1989), and they established two subfamilies, the Normanellinae and Cletopsyllinae. Subsequently, Huys and Lee (1999) raised the subfamily to the family Cletopsyllidae and it was divided into four genera, the type genus *Cletopsyllus* Willey, 1935, and three new genera *Bathycletopsyllus*, *Isocletopsyllus* and *Retrocalcar*. At that time, they considered *Pseudocletopsyllus* Vervoort, 1964 to be a *genus inquirendum* in Cletopsyllidae because of the inadequate description of the type species *P. spiniger*, which was very similar to the copepodid V of *R. sagamiensis* (Itô, 1971).

During a recent deep-sea benthic survey to assess impacts of the Deepwater Horizon oil spill in the northern Gulf of Mexico, a new genus and species of Cletopsyllidae was collected. Recent investigations have uncovered significant benthic community impacts from the Deepwater Horizon (Montagna et al. 2013), stressing the need to more completely describe and understand the biodiversity and community structure of the region. Here, we describe the new genus and species based on the newly collected specimens and provide an updated key to genera and species of Cletopsyllidae.

Material and methods

Samples were collected from the northern Gulf of Mexico in May/June 2011 as part of the Deepwater Horizon Natural Resource Damage Assessment (NRDA) follow-up cruise aboard the *R/V Sarah Bordelon*. Sediments were sampled with an Osil multicorer and were fixed with buffered formalin and stained with Rose Bengal. Meiofauna was

extracted from sediments by Ludox isopycnic centrifugation (Burgess 2001). Harpacticoids were sorted and enumerated under a Leica S8APO dissecting microscope, and stored in 70% ethanol.

Specimens were dissected in lactic acid and the dissected parts were mounted on slides in lactophenol mounting medium. Preparations were sealed with transparent nail varnish. All drawings have been prepared using a camera lucida on a Leica DM 2500 differential interference contrast microscope. Specimens are deposited at the Smithsonian National Museum of Natural History.

The descriptive terminology is adopted from Huys et al. (1996). Abbreviations used in the text are: A1, antennule; A2, antenna; ae, aesthetasc; exp, exopod; enp, endopod; P1–P6, first to sixth thoracopod; exp (enp)-1 (2, 3) to denote the proximal (middle, distal) segment of a ramus. Scale bars in figures are indicated in μm .

Results

Order Harpacticoida Sars, 1903

Family Cletopsyllidae Huys & Willems, 1989

Pentacletopsyllus gen. n.

<http://zoobank.org/F4DAC7B8-1F8F-4F98-BEE7-8FD00EDDED7D>

<http://species-id.net/wiki/Pentacletopsyllus>

Diagnosis. Cletopsyllidae. Body elongated. Cephalothorax and other somites with numerous spinous processes at margin. Rostrum very prominent, triangular, with bifid tip in its apical portion, with pair of subapical sensilla. Genital and first abdominal somites completely fused forming double-somite. Anal operculum well developed. Caudal rami cylindrical, with 7 setae; setae I–II small, closely set; seta III subapical, setae IV–V bipinnate, seta V longest, seta VI bare, Seta VII tri-articulate at base. Sexual dimorphism in antennule, P2 endopod, P5 and P6.

Antennule 5-segmented in female, 7-segmented and subchirocer in male. Antenna 3-segmented, comprising coxa, allobasis and free endopodal segment; exopod 1-segmented with 2 setae. Mandible with biramous palp; basis with 3 pinnate setae; endopod with 1 lateral and 3 distal setae; exopod 1-segmented with 1 seta. Maxillule with strongly developed praecoxal arthrite, with 2 setae on anterior surface and 9 spines/ setae around distal margin; coxal endite with 1 seta and 1 spine; basis with 4 spines/ setae; endopod represented by 1 seta; exopod with 2 setae. Maxilla with 3 endites; allobasis drawn out into claw; endopod minute, bearing 3 setae. Maxilliped subchelate, with 3 pinnate setae; basis aetose; endopod drawn out into long, curved, pinnate claw with 1 long bare seta and 1 short accessory seta at base.

P1 basis with outer seta and inner spine; exopod 3-segmented, exp-1 with long outer spine, exp-2 with inner seta, exp-3 with 4 elements; endopod 2-segmented and prehensile, enp-1 as long as enp-2.

P2-P4 with outer spine or seta on basis. Exopods 3-segmented, exp-3 with 3 outer spines; endopod 2-segmented, enp-1 small, enp-2 elongate. Male P2-enp modified; inner apical seta fused to segment forming small apophysis. Armature formula:

| | Exopod | Endopod |
|----|---------|---------|
| P2 | 0.1.123 | 1.421 |
| P3 | 1.1.223 | 1.321 |
| P4 | 1.1.223 | 1.321 |

P5 of both sexes with separate baseoendopod and exopod. Basal seta on setophore; endopodal lobe triangular with 5 bipinnate setae in female and 3 bipinnate setae in male; exopod elongated with 5 setae in female and 4 setae in male. Male P6 asymmetrical, functional member represented by small plate, opposite member fused to genital somite; each leg with 1 bare seta.

Type and only species. *Pentacletopsyllus montagni* gen. et sp. n.

Etymology. The generic name is derived from the Greek *penta*, meaning five, and refers to the 5-segmented female antennule.

***Pentacletopsyllus montagni* sp. n.**

<http://zoobank.org/3CD1F4AE-9B8D-422F-A863-4683A3BA1EDC>

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

Figs 1–6

Type locality. Gulf of Mexico; 28°43.20'N, 88°20.68'W; depth 1590 m; mud.

Material examined. Holotype: 1♀ (USNM No: 1231418) dissected on 8 slides, from the type locality. Paratypes: 2♀♀ and 1♂ (USNM No's listed in order presented in text: 1231419, 1231420, 1231421) each dissected on 8, 4 and 9 slides respectively, and 10♀♀ and 10♂♂ (USNM No's for specimens in vials (female, male): 1231422, 1231423) in 70% ethanol, vial. Additional samples were deposited in the first author's collection. All from the type locality, collected by J. G. Baguley on May 2011.

Description. Female. Body (Fig. 1A) elongated. Total body length 1121 µm (n=10; range: 1022–1242 µm, measured from anterior margin of rostrum to posterior margin of caudal rami). Largest width measured at posterior margin of cephalic shield: 234 µm. Urosome narrower than prosome (Fig. 1A). Cephalothorax bell-shaped, with few tegumental sensilla; posterior and lateral margins irregularly serrated (Fig. 1D). Rostrum prominent, triangular; with a pair of sensilla near anterior margin, with bifid tip (Fig. 1E). Pedigerous somites with 1 pair of sensilla on dorsal surface, serrate posteriorly as cephalothorax; pleural areas well developed.

Urosome 5-segmented, comprising P5-bearing somite, genital double-somite and 3 free abdominal somites. All urosomites covered with small spinules dorsally and laterally. Urosomite with serrate posterior and posterolateral margin.

Genital double-somite (Fig. 4C), completely fused ventrally with original segmentation indicated by a transverse surface ridge dorsally and laterally. Genital field located

near anterior margin with gonopore and copulatory pore located in median depression. P6 with 1 bare seta on a small protuberance. Anal somite with well-developed rounded operculum bearing row of setules (Fig. 4D).

Caudal rami cylindrical, about 7 times as long as wide, each ramus with 7 setae: setae I-II small, closely set, seta III subapical, setae IV-V bipinnate, seta V longest, seta VI bare and small, seta VII tri-articulate at base; tube pore presented dorsally near proximal inner margin (Fig. 1F).

Antennule (Fig. 2A) 5-segmented, with well-developed sclerite around base of segment 1. Segment 1 short, with 2 long spinule rows and 1 seta. Segment 2 with 2 outer processes, distal one longer than proximal one, each one bearing one seta distally. Segment 3 longest, with smooth posterior margin. Armature formula: 1-[1], 2-[9], 3-[8 + (1 + ae)], 4-[3], 5-[7 + acrothek]. Apical acrothek consisting of a small aesthetasc fused basally to 2 bare setae.

Antenna (Fig. 2B) 3-segmented, comprising coxa, allobasis and free 1-segmented endopod. Coxa small with spinule row. Allobasis elongated; original segmentation marked by incomplete surface sutures; 2 groups of strong spinules on abexopodal margin; with a long distal abexopodal seta. Exopod small, 1-segmented; with 1 apical and 1 lateral seta. Endopod elongated, with spinules along inner margin; lateral armature consisting of 2 pinnate spines and a minute seta; distal armature consisting of 1 apically curved pinnate spine, 1 bipinnate seta and 3 geniculate setae, the outer-most basally fused to an additional short seta.

Labrum with spinular ornamentation and covered with densely packed setules as in Fig 2C.

Mandible (Fig. 2D) with large coxa bearing well-developed gnathobase, with 2 strong teeth, several multicuspidate teeth around distal margin and 1 pinnate spine at distal corner; spinules near base of palp. Palp biramous, basis with 3 pinnate setae; endopod with 1 lateral and 3 distal setae; exopod 1-segmented, with 1 apical seta.

Maxillule (Fig. 2E). Precoxa with few spinules near outer margin; arthrite strongly developed, with 2 surface setae and 9 apical spines and setae. Coxa with cylindrical endite bearing 1 naked seta, and 1 curved, pinnate spine. Basis with 2 setae and 1 bipinnate spine apically, and 1 pinnate seta along outer margin; with several spinules around inner distal margin and base of endopod. Endopod incorporated in basis and presented by 1 seta. Exopod 1-segmented, with 1 pinnate and 1 naked setae.

Maxilla (Fig. 2F). Syncoxa with 3 endites, each with a short row of spinules. Proximal endite small and with 1 strong pinnate spine. Middle endite produced into pectinate spine and with 2 setae. Distal endite with 3 pinnate setae. Allobasis drawn out into strong, slightly curved, distally pinnate claw, accessory armature consisting of 2 bare and 1 pinnate seta. Endopod small, with 3 naked setae.

Maxilliped (Fig. 2G) comprising syncoxa, basis, and 1-segmented endopod. Syncoxa with 3 plumose setae and several short rows of spinules. Basis with 1 longitudinal row of spinules along palmar margin. Endopodal segment produced into strong and distally pinnate curved claw; accessory armature consisting of 1 long naked seta and 1 small seta at base.

Swimming legs 1–4 (Fig. 3A, 3B, 3C, 4A) with wide intercoxal sclerite, biramous, endopods 2-segmented, exopods 3-segmented. Coxae and bases with row of spinules along outer margins as illustrated.

P1 (Fig. 3A). Coxa large, with inner and outer spinular rows. Basis with strong bipinnate seta on outer margin and bipinnate spine on inner distal surface; inner portion produced as a cylindrical pedestal for endopod. Endopod 2-segmented, prehensile; enp-1 as long as enp-2; enp-1 with one small seta on middle third of inner margin; enp-2 with 2 pinnate inner setae, and 1 pinnate spine and 1 geniculate seta distally. Exopod 3-segmented. Exp-1 and exp-2 with 1 pinnate spine; exp-2 with 1 inner seta; exp-3 with 2 geniculate distal setae and 2 strong spinulose outer spines.

P2–P4 (Figs 3B, 3C, 4A). Coxae and bases with spinular rows along outer margin and anterior surface. Basis wider than long, with pinnate spine (P2–P3) or bare seta (P4), each seta arising from a setophore. Each ramus consisting of 3-segmented exopod and 2-segmented endopod. Armature formula as in generic diagnosis.

P5 (Fig. 4B) with separate exopod and baseoendopod. Baseoendopod longer than wide, forming long biarticulate (not triarticulate) outer setophore bearing the basal seta. Endopodal lobe triangular, with 5 bipinnate setae. Exopod about three times as long as wide, with 1 inner, 1 distal and 3 outer pinnate setae.

Description. Male. Body (Fig. 5A). Male slightly smaller and more slender than in female. Body length 1075 μm (N=10; range: 1007–1132 μm , measured from anterior margin of rostrum to posterior margin of caudal rami). Largest width measured at P2-bearing thoracic somite: 196 μm . Sexual dimorphism in antennule, P2 endopod, P5 and P6.

Prosome (Fig. 5A) 4-segmented, comprising cephalothorax (bearing first pedigerous somite) and 3 free pedigerous somites. Posterior margin of cephalothorax and pedigerous somites with serrated process, with integumental sensilla. Rostrum as in female (Fig. 5B).

Urosome (Fig. 5C) 6-segmented, comprised of P5-bearing somite, genital somite, and 4 free abdominal somites. Urosomite with crenulate posterior margin dorsally and ventrally.

Antennule (Fig. 6A) 7-segmented; subchirocer with geniculation between segments 5 and 6. Segment 1 with 1 row of long spinules along outer distal margin. Segment 2 with 1 cylindrical process along posterior margin, with 1 seta apically. Segment 4 represented by a small sclerite along anterior margin. Segment 5 swollen with large bump along posterior margin. Segment 7 with triangular distal half. Armature formula: 1-[1], 2-[7], 3-[6], 4-[2], 5-[7 + 4 pinnate + 1 modified + (1 + ae)], 6-[3], 7-[7 + acrothek]. Apical acrothek consisting of 2 small naked setae.

P2 (Fig. 6E). Exopod as in female. Endopod modified, 2-segmented; enp-2 with 4 plumose inner setae; inner apical seta fused to segment forming short apophysis; outer apical seta shorter than female; outer seta reduced and presented by minute naked seta (Fig. 6F).

Fifth pair of legs (P5) (Fig. 6G) fused medially. Baseoendopod with outer setophore bearing the basal seta. Endopodal lobe with 1 inner and 2 distal bipinnate setae.

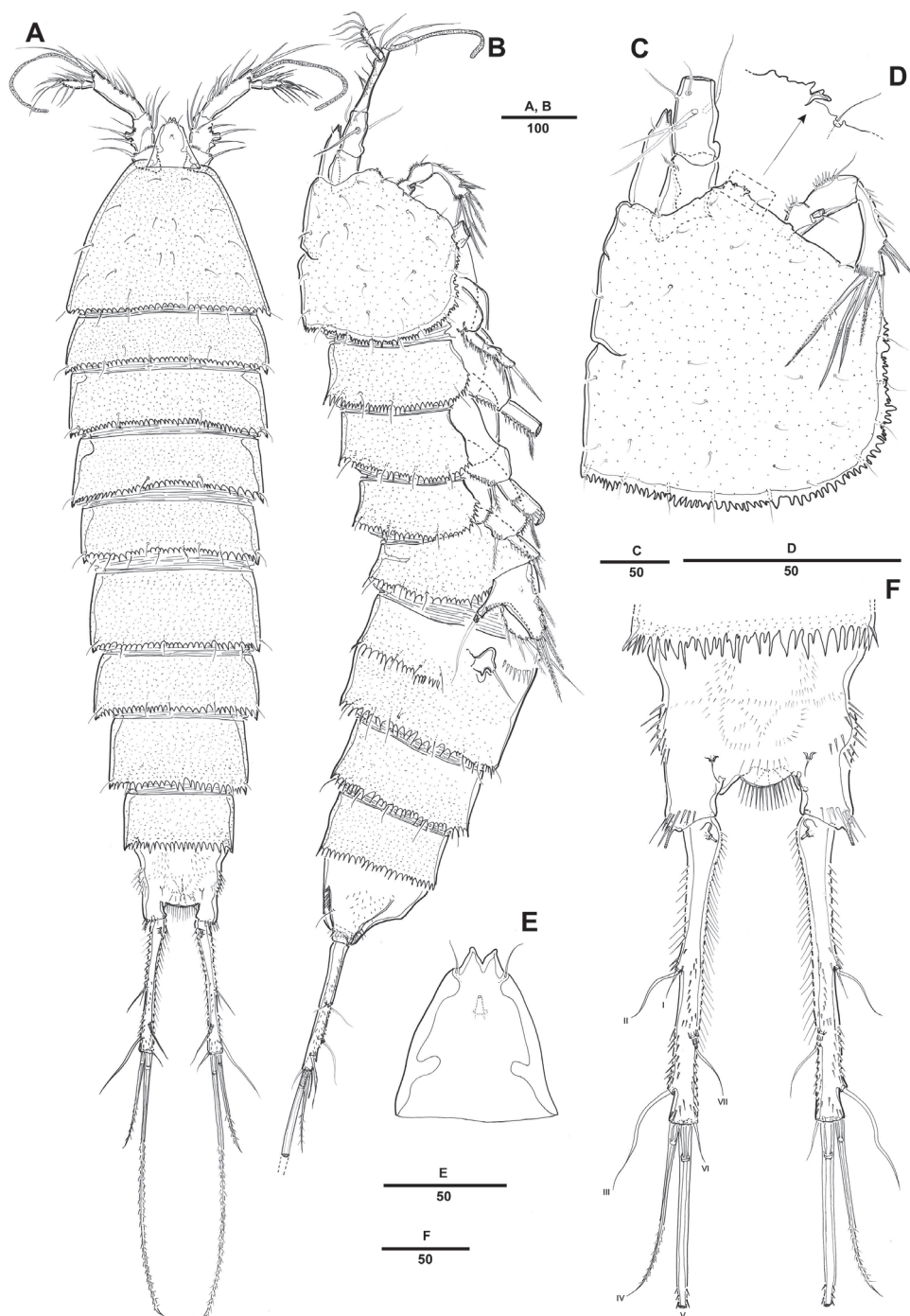


Figure 1. *Pentacleptopsyllus montagni* gen. et sp. n. female: **A** habitus, dorsal **B** habitus, lateral **C** cephalothorax, lateral **D** tooth-like process of cephalothorax lateral anterior margin **E** rostrum, dorsal **F** caudal ramus, dorsal.

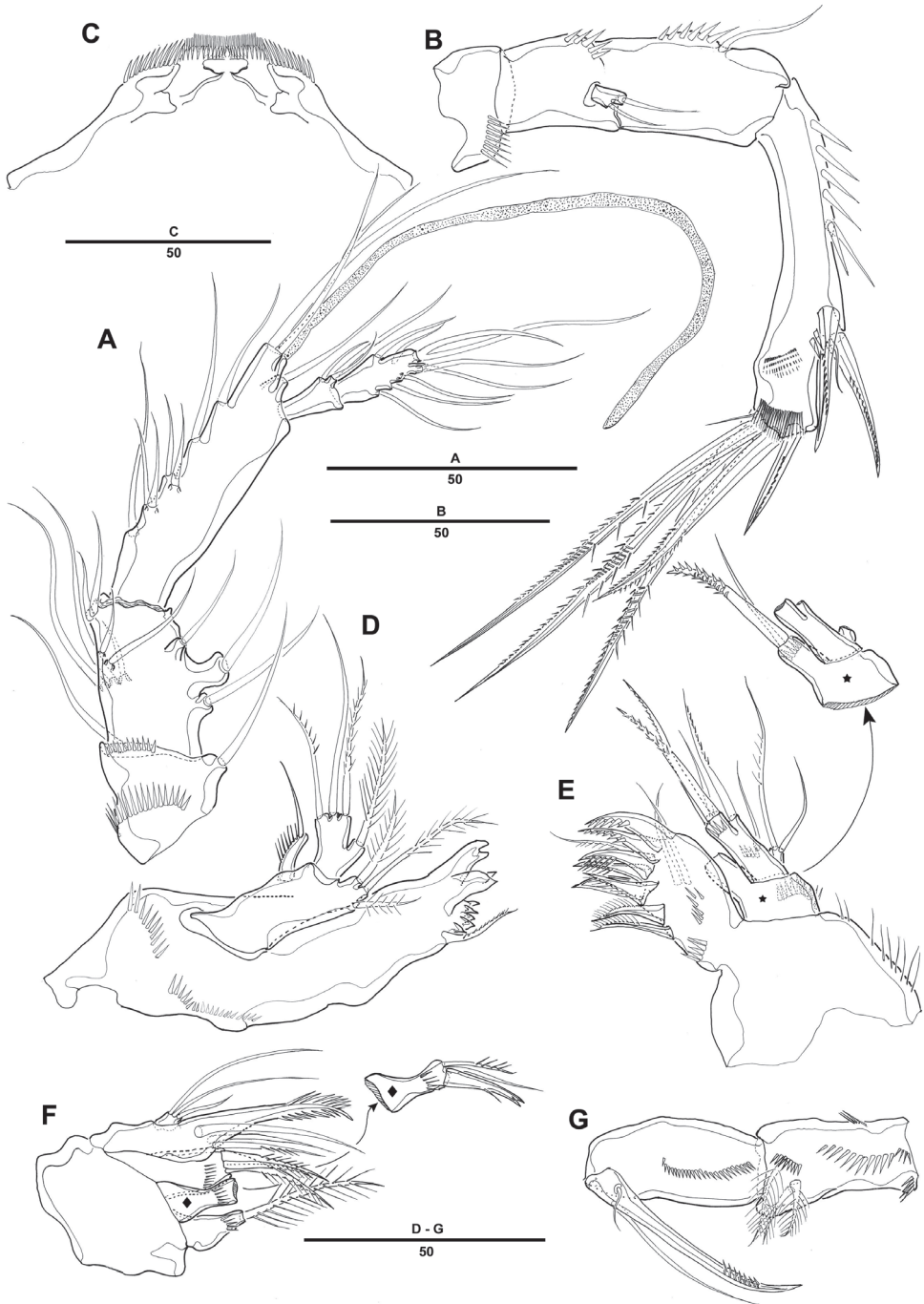


Figure 2. *Pentactetopsyllus montagni* gen. et sp. n. female: **A** antennule, dorsal **B** antenna, dorsal **C** labrum, posterior **D** mandible **E** maxillule (inset showing armature on coxa) **F** maxilla (inset showing armature on middle endite) **G** maxilliped.

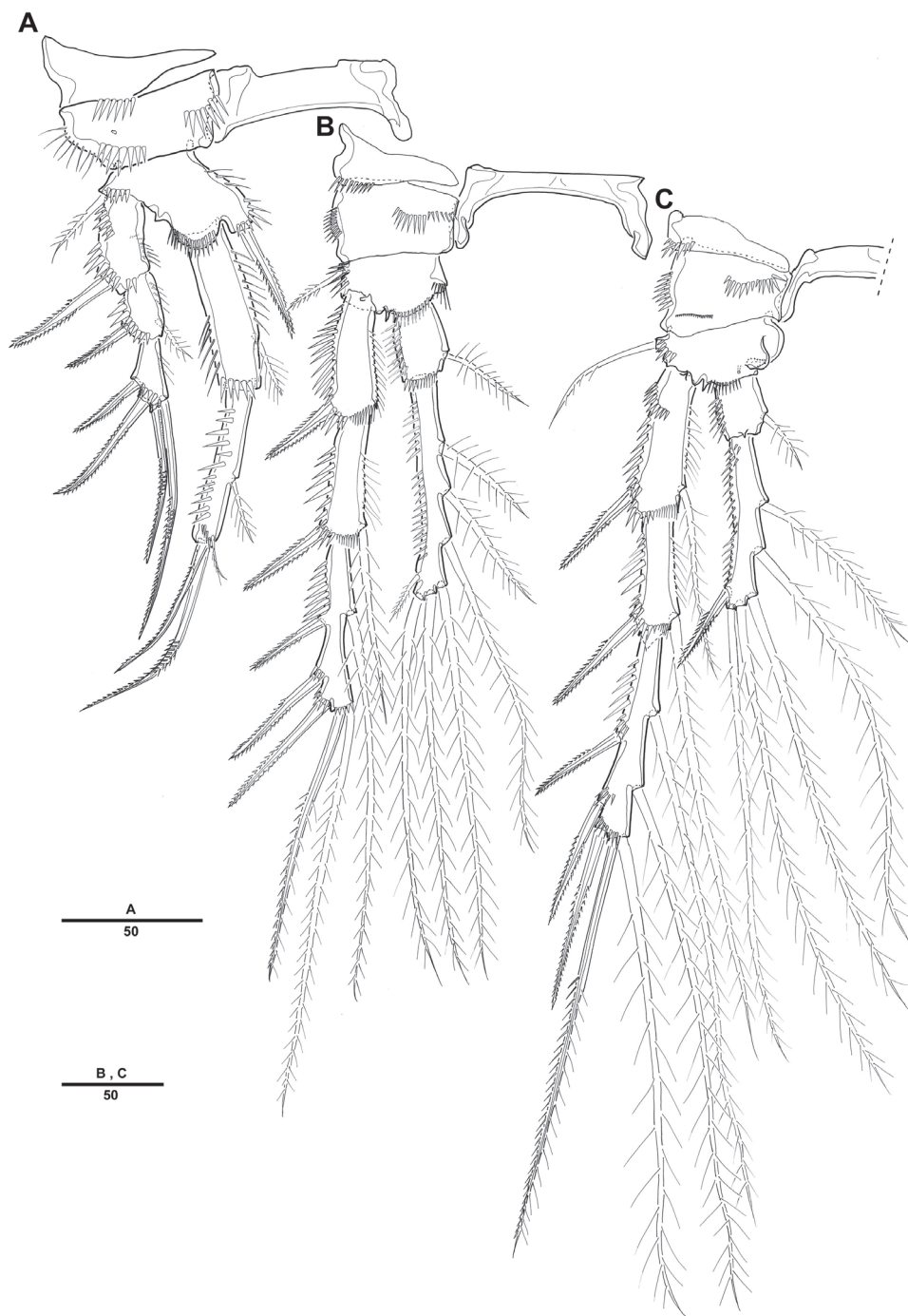


Figure 3. *Pentacletopsyllus montagni* gen. et sp. n. female: **A** P1, anterior **B** P2, anterior **C** P3, anterior.

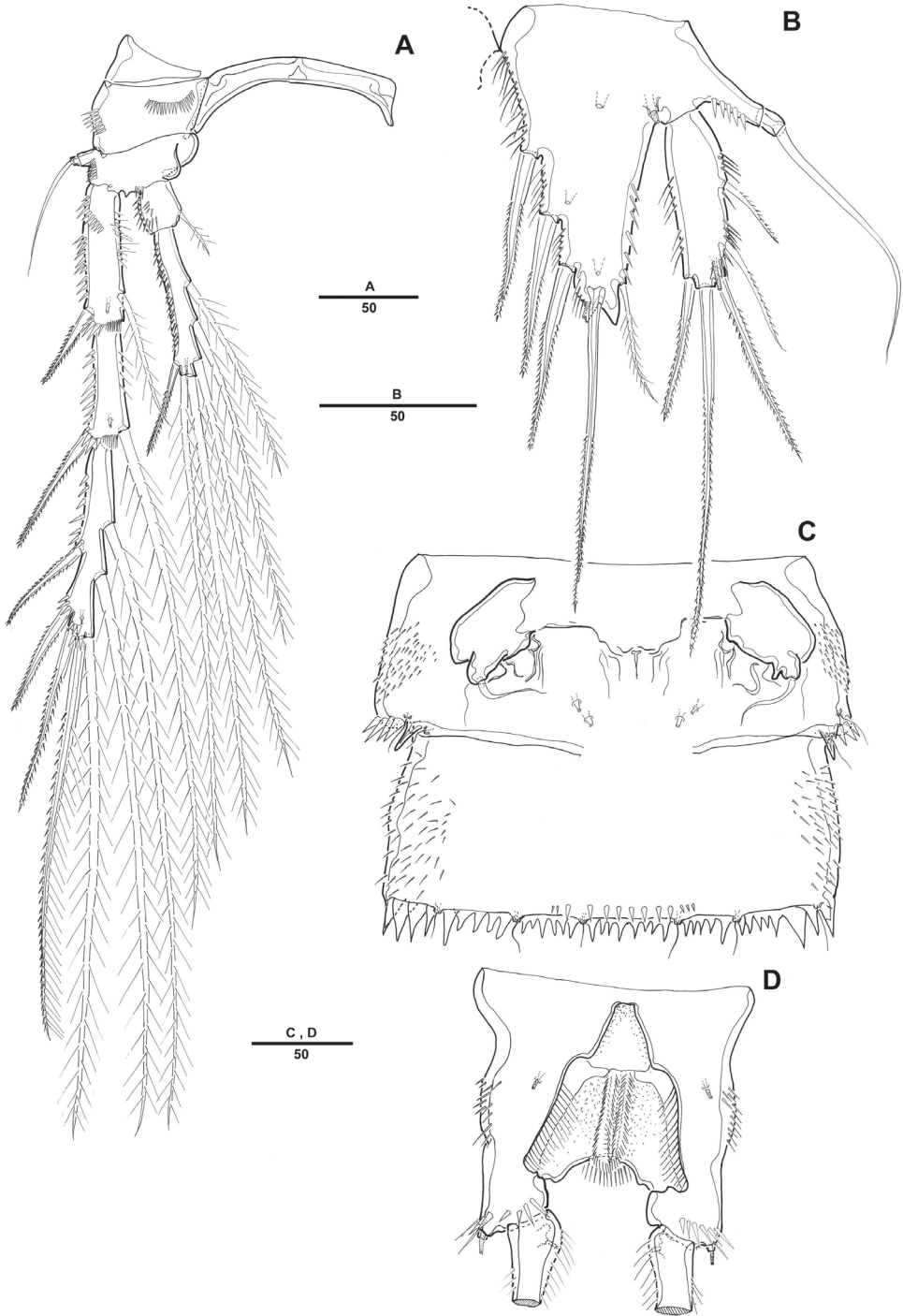


Figure 4. *Pentactetopsyllus montagni* gen. et sp. n. female: **A** P4, anterior **B** P5, anterior **C** genital field, ventral **D** anal somite, ventral.

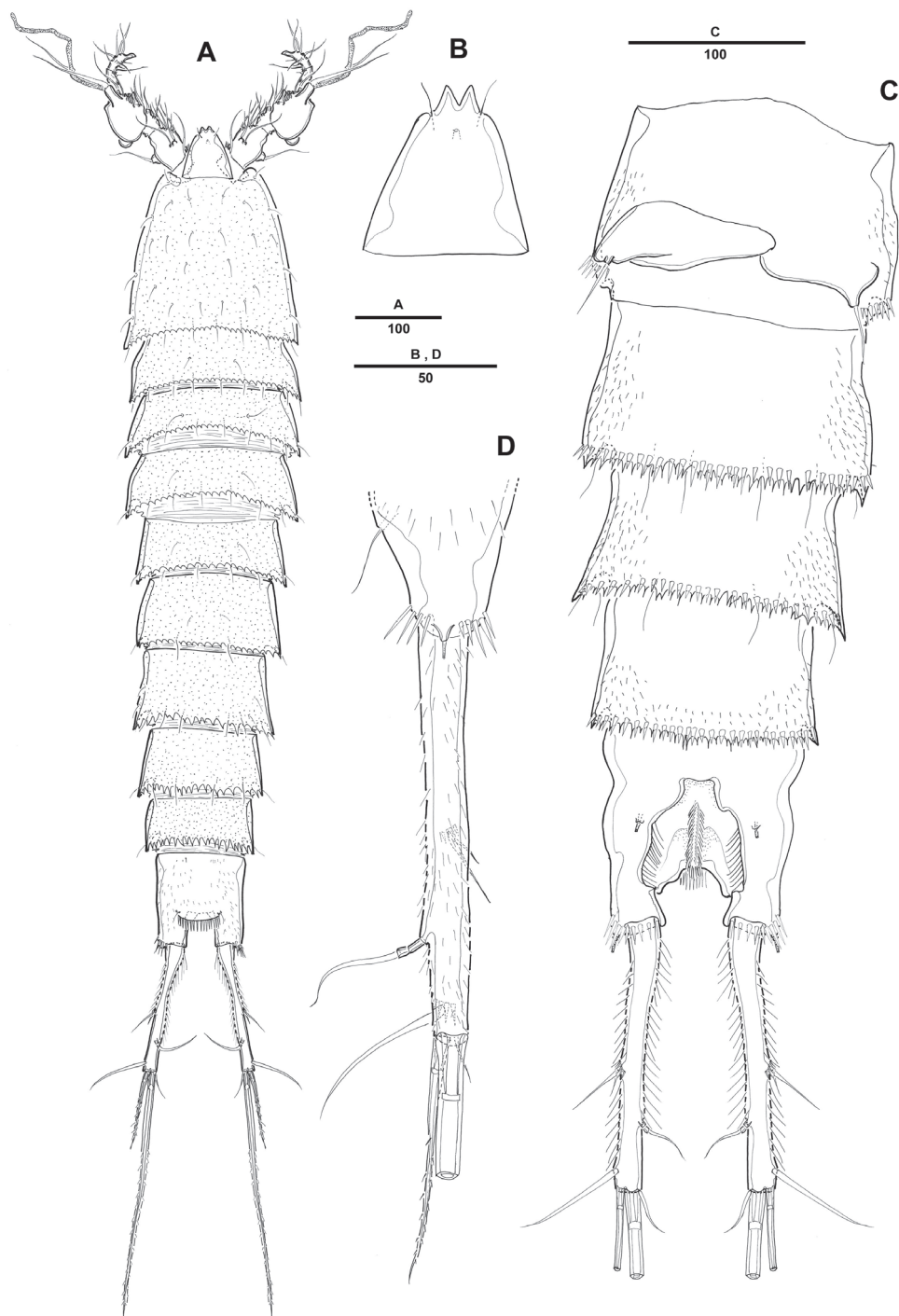


Figure 5. *Pentacleptopsyllus montagni* gen. et sp. n. male: **A** habitus, dorsal **B** rostrum, dorsal **C** Urosome (excluding P5-bearing somite), ventral **D** anal somite and left caudal rami, lateral.

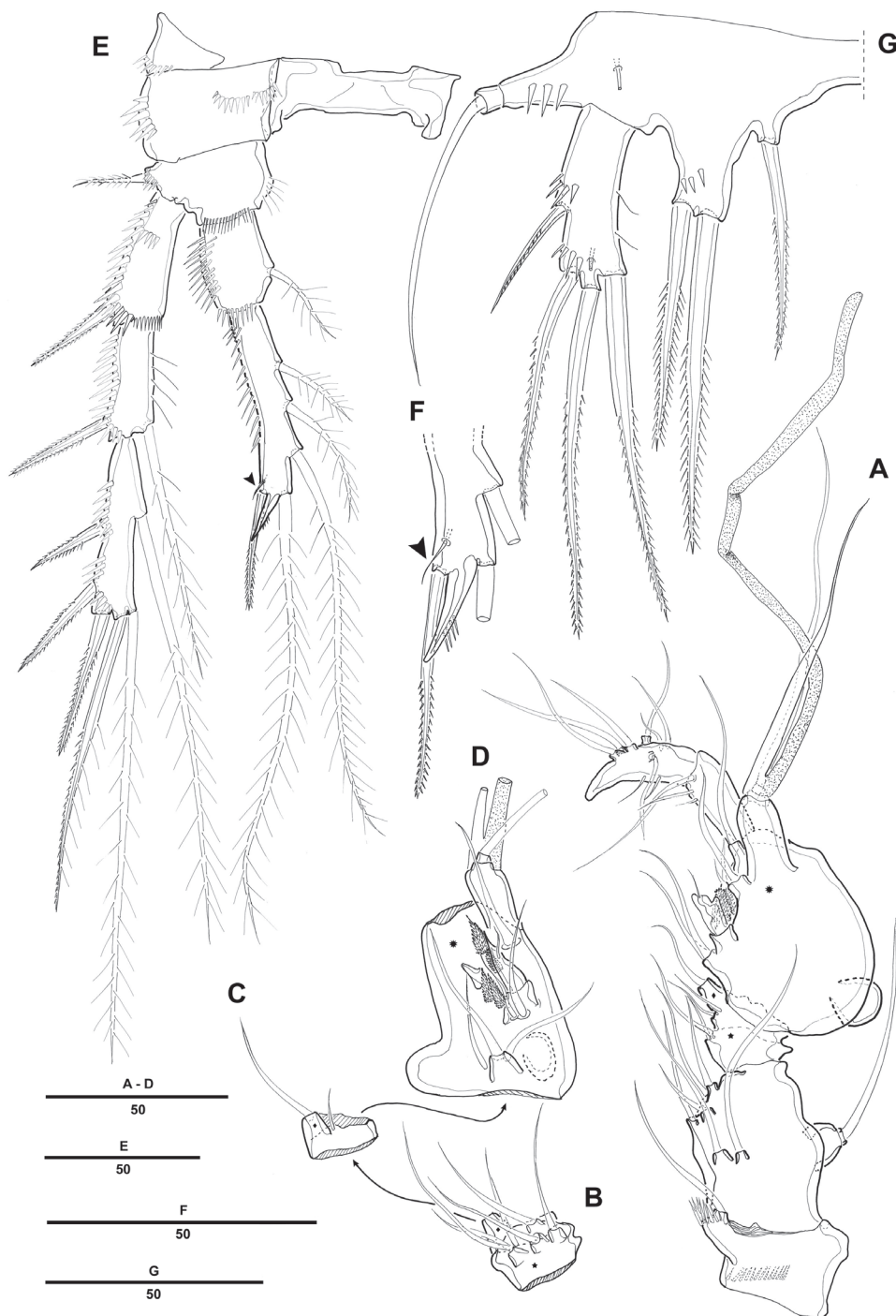


Figure 6. *Pentacletopsyllus montagni* gen. et sp. n. male: **A** antennule, ventral **B** third segment of antennule, anterior **C** fourth segment of antennule, anterior **D** fifth segment of antennule, anterior **E** P4, anterior **F** P4 endopod 3 (arrow indicating reduced outer seta), anterior **G** P5, anterior.

Exopod shorter than in female, about three times as long as wide, with 1 inner, 1 distal and 2 outer pinnate setae.

P6 (Fig. 5C) asymmetrical, bearing 1 naked seta on a cylindrical process.

Etymology. The species is named in honor of Dr. Paul Montagna, Endowed Chair for Ecosystem Studies and Modeling at the Harte Research Institute, Texas A&M University Corpus Christi. Dr. Montagna has had a long and distinguished career studying meiofauna, harpacticoid systematics, and marine ecosystem dynamics, particularly in the Gulf of Mexico.

Discussion

The subfamily Cletopsyllinae of the family Normanellidae was raised to familial rank by Huys and Lee (1999). They provided a new diagnosis and revised the genera of the family, and the family Cletopsyllidae was divided into four genera and nine species. Since then, two new species have been added by Song et al. (2010: *Isocletopsyllus maximus*) and Addis et al. (2011: *I. sardus*), the family Cletopsyllidae currently includes four genera and 11 species.

Huys and Lee (1999) provided the following morphological diagnosis of the family Cletopsyllidae: (1) body elongated, body somites well defined with dentate or crenulate posterior margins, (2) female antennule 4- or 6-segmented, posterior margin of second segment with two distinct conical processes, each bearing an apical seta; apical acrothek in both sexes represented by two setae only, (3) male antennule 7-segmented and typically subchirocerate with geniculation between segments 5 and 6; posterior margin of segment 2 with proximal spinous and distal cylindrical process, (4) antenna exopod 1-segmented and bisetose; endopod with 3 lateral and 6 distal element, (5) P1-P4 biramous with 3-segmented exopod and 2-segmented endopod, (6) baseoendopod of P5 with elongated, tri-articulate setophore, (7) the sexual dimorphism of P2 endopod is the most diagnostic character.

Pentacletopsyllus gen. n. is placed in the family Cletopsyllidae with the character sets of the presence of a crenulated posterior margin of body somite, posterior margin of female antennule second segment with 2 distinct conical processes, 1-segmented antenna exopod with 2 setae, armature formula of swimming legs, and P5 with separate exopod and baseoendopod in both sexes and baseoendopod with elongated basal seta. The new genus can be readily identified on the basis of the following three characters:

- 1) Antennule: The genus *Bathycletopsyllus* Huys & Lee, 1999 has a 6-segmented female antennule and the other genera - *Cletopsyllus* Willey, 1935, *Isocletopsyllus* Huys & Lee, 1999, and *Retrocalcar* Huys & Lee, 1999 - have a 4-segmented antennule. However, the new genus displays a 5-segmented female antennule. Generally the third segment of the antennule has a smooth posterior margin, but a crenulated posterior margin is presented in the genus *Cletopsyllus*. The new genus does not show any modifications as in the genus *Cletopsyllus*. Huys and Lee (1999)

mentioned that the second segment of the male antennule has 2 processes along the posterior margin, however the genus *Pentacletopsyllus* has only one process on the posterior margin of antennule, moreover the fifth segment has an additional swelling at the posterior margin.

- 2) Structure of P1: Normally in the family Cletopsyllidae, P1 exopod is 3-segmented, shorter than endopod; P1 endopod 2-segmented, prehensile, enp-1 at least twice as long as enp-2, and consists of an elongate proximal segment with 1 inner seta. The setation on exopod and endopod of P1 in the genus *Pentacletopsyllus* is the same as above, but the proximal and distal segment of P1 endopod are nearly equal in length.
- 3) P5: Huys and Lee (1999) mentioned that the baseoendopod of both sexes in the family Cletopsyllidae is characterized by an extremely long extension bearing the outer basal seta, and this setophore is typically tri-articulate. The P5 exopod has six setae in the female and 4–5 setae in the male except for *Cletopsyllus papillifer* Willey, 1935 with seven setae in the female. The new genus has long setophore but not extremely long, and the P5 baseoendopod has a bi-articulate outer setophore in both sexes, and the female P5 has only five setae on the exopod.

Currently, ten species of Cletopsyllidae are known from shallow and sublittoral marine habitats in India (*Retrocalcar secundus* (Nicholls, 1945); *Cletopsyllus bacescui* Marcus, 1976), in Far East Asia (*R. sagamiensis* (Itô, 1971); *Isocletopsyllus maximus* Song, Kim & Hwang, 2010), in northeastern America and in Caribbean (*C. papillifer* Willey, 1935; *R. brattstroemi* (Geddes, 1981); *C. rotundifera* Fiers, 1986), and in the Mediterranean (*I. tertius* (Por, 1964); *I. quartus* (Soyer, 1966); *I. sardus* Addis, Floris & Carcupino, 2011). Additionally, *Bathycletopsyllus hexarthra* was reported from deep-sea (depth of 460 m) in the Indian Ocean (Huys and Lee 1999), and new genus has been reported in muddy bottom from 1590 m depth in Gulf of Mexico. The family Cletopsyllidae is not common in the marine benthic environment but it is distributed widely throughout the world.

Together with newly described *P. montagni*, the 5 genera and 12 species currently recognized as valid in the family Cletopsyllidae can be identified with the specific key given below. It is amended from Huys and Lee (1999) and Wells (2007).

Key to genera and species of the family Cletopsyllidae

- | | | |
|---|--|--|
| 1 | Female antennule 6-segmented..... | <i>Bathycletopsyllus hexarthra</i> |
| – | Female antennule 5-segmented..... | <i>Pentacletopsyllus montagni</i> sp. n. |
| – | Female antennule 4 segmented | 2 |
| 2 | Third segment of female antennule with crenulate posterior margin; male fifth leg with 4 setae/spines on exopod..... | 3 |
| – | Third segment of female antennule with smooth posterior margin; male fifth leg with 5 setae/spines on exopod | 5 |

- 3 P5 endopodal lobe without (male) or with (female) short rounded terminal process; second endopodal segment of first leg with 1 inner seta; rostrum with rounded apex ***Cletopsyllus rotundifera***
- P5 endopodal lobe of both sexes with long curved terminal process; second endopodal segment of first leg with 2 inner setae; rostrum trifold or bifid at tip 4
- 4 Inner seta on first endopodal segment of leg 1 inserted at 55% of segment length; endopodal lobe of female fifth leg elongate, rectangular ... ***C. bacescui***
- Inner seta on first endopodal segment of leg 1 inserted at 66% of segment length; endopodal lobe of female fifth leg short, triangular ***C. papillifer***
- 5 Female caudal rami with outer proximal margin produced as a lobate expansion bearing a spur-like process posteriorly and secondary process dorsally 6
- Female caudal rami without lobate expansion; ramus markedly longer in male 8
- 6 Second endopodal segment of first leg with 1 inner seta... ***Retrocalcar secundus***
- Second endopodal segment of first leg with 2 inner setae 7
- 7 Caudal ramus 3.6 (male) and 6.5 (female) times as long as greatest width; outer spines on third exopodal segment of leg 3 modified in male ***R. brattstroemi***
- Caudal ramus 5.3 (male) and 9.0 (female) times as long as greatest width; outer spines on third exopodal segment of leg 3 not modified in male ***R. sagamiensis***
- 8 Caudal ramus less than 6 times as long as wide; rostrum trifold at tip 9
- Caudal ramus more than 7 times as long as wide; rostrum bifid at tip 10
- 9 First antennular segment without outer process; caudal ramus without expanded inner border ***Isocletopsyllus tertius***
- First antennular segment with outer process; caudal ramus with expanded inner border ***I. maximus***
- 10 Antennary exopod with 2 setae of equal length; distal margin of basis of leg 1 without spinous process between exopod and endopod ***I. quartus***
- Antennary exopod with 2 setae of different length; distal margin of basis of leg 1 with spinous process between exopod and endopod ***I. sardus***

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References

- Addis A, Floris A, Carpuccio M (2011) A new species of the genus *Isocletopsyllus* (Harpacticoida, Cletopsyllidae). *Meiofauna Marina* 19(1): 166–171.
- Baguley JG, Montagna PA, Lee W, Hyde LJ, Rowe GT (2006) Spatial and bathymetric trends in Harpacticoida (Copepoda) community structure in the Northern Gulf of Mexico deep-sea. *Journal of Experimental Marine Biology and Ecology* 330(1): 327–341. doi: 10.1016/j.jembe.2005.12.037
- Boxshall GA, Halsey SH (2004) An introduction to copepod diversity. Ray Society, London, 966 pp.
- Burgess R (2001) An improved protocol for separating meiofauna from sediments using colloidal silica sols. *Marine Ecology Progress Series* 214: 161–165. doi: 10.3354/meps214161
- Fiers F (1986) Harpacticoid copepods from the West Indian Islands: Laophontidae (Copepoda, Harpacticoida). *Bijdragen tot de Dierkunde* 56(1): 132–164.
- Geddes DC (1981) Marine biological investigations in the Bahamas 21. A new species of *Cletopsyllus* (Copepoda, Harpacticoida). *Sarsia* 66(4): 287–291.
- Haedrich RL, Devine JA, Kendall VJ (2008) Predictors of species richness in the deep-benthic fauna of the northern Gulf of Mexico. *Deep Sea Research Part II: Topical Studies in Oceanography* 55(24): 2650–2656. doi: 10.1016/j.dsr2.2008.09.003
- Huys R, Gee JM, Moore CG, Hamond R (1996) Marine and brackish water harpacticoid copepods part 1: keys and notes for identification of the species. The Linnean Society of London, London, 352 pp.
- Huys R, Lee W (1999) On the relationships of the Normanellidae and the recognition of *Cletopsyllidae* grad. nov. (Copepoda, Harpacticoida). *Zoologischer Anzeiger* 237(4): 267–290.
- Huys R, Willems K (1989) *Laophontopsis* Sars and the taxonomic concept of the Normanellinae (Copepoda: Harpacticoida): a revision. *Bijdragen tot de Dierkunde* 59(4): 203–277.
- Itô T (1971) A new species of the genus *Cletopsyllus* from Sagami Bay (Harpacticoida). *Annotationes Zoologicae Japonenses* 44(2): 117–124.
- Lee W, Montagna PA, Han MS (2003) Three new species of the genus *Normanella* Brady (Copepoda: Harpacticoida) from the Gulf of Mexico. *Journal of Natural History* 37(10): 1219–1245. doi: 10.1080/00222930110109064
- Marcus A (1976) Contributions to the study of the genus *Cletopsyllus* Willey 1935 (Copepoda, Harpacticoida) from the Indian Ocean. *Travaux du Muséum d'histoire naturelle "Grigore Antipa"* 17: 39–49.
- Montagna PA, Baguley JG, Cooksey C, Hartwell I, Hyde LJ, Kalke RD, Kracker LM, Reuscher M, Rhodes ACE (2013) Deep-sea benthic footprint of the Deepwater Horizon Blowout. *PLoS ONE* 8(8): e70540. doi: 10.1371/journal.pone.0070540

- Nicholls AG (1945) Marine Copepoda from Western Australia. III. Littoral harpacticoids from Port Denison. *Journal of the Royal Society of Western Australia* 29: 1–16.
- Por FD (1964) A study of the Levantine and Pontic Harpacticoida (Crustacea, Copepoda). *Zoologische Verhandelingen* 64: 1–128.
- Song SJ, Kim W, Hwang UW (2010) First record of the family Cletopsyllidae (Copepoda: Harpacticoida) from Korean waters, with description of a new species. *Animal Cells and Systems* 14(4): 351–360. doi: 10.1080/19768354.2010.525801
- Soyer J (1966) Copépodes Harpacticoides de Banyuls-sur-Mer. 3. Quelques formes du coralligène. *Vie Milieu* 17(1-B): 303–344.
- Vervoort W (1964) Free-living Copepoda from Ifaluk Atoll, in the Caroline Islands: with notes on related species. *Smithsonian Institution, Washington*, 431 pp.
- Wells JBJ (2007) An annotated checklist and keys to the species of Copepoda Harpacticoida (Crustacea). *Zootaxa* 1568: 1–872.
- Willey A (1935) IV.-Harpacticoid Copepoda from Bermuda.-Part II. *Journal of Natural History Series* 10, 15(85): 50–100.

Two new species of *Micrencaustes* Crotch, subgenus *Mimencaustes* Heller from China (Coleoptera, Erotylidae, Encaustini)

Zhao-Na Meng^{1,†}, Guo-Dong Ren^{2,‡}, Jing Li^{1,§}

1 College of Plant Protection, post-doctoral research center of Crop Science, Agricultural University of Hebei, Baoding, Hebei, 071002, P. R. China **2** College of Life Sciences, Hebei University, Baoding, Hebei 071002, P. R. China

[†] <http://zoobank.org/51A63F78-36EA-44C7-9AD7-D557B928535B>

[‡] <http://zoobank.org/B81DF29F-6D90-46B2-905C-D186FD3DA0DA>

[§] <http://zoobank.org/4D502438-AC7C-4067-9CE6-633487B95135>

Corresponding author: Jing Li (lijing1976416514@163.com)

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Abstract

Two new species *Micrencaustes* (*Mimencaustes*) *renshiae* **sp. n.** and *Micrencaustes* (*Mimencaustes*) *biomaculata* **sp. n.** are described and illustrated from China. A key to Chinese species of subgenus *Mimencaustes* Heller is provided.

Keywords

Coleoptera, Erotylidae, *Micrencaustes*, *Mimencaustes*, identification key, new species, China

Introduction

To date, only 2 subgenera of the genus *Micrencaustes* Crotch, 1876 are known (Crotch 1876; Heller 1918). One of the two subgenera, *Mimencaustes* was erected by Heller for *Micrencaustes dehaanii* (Castelnau, 1840), as the type species. It differs from *Micrencaustes* (s. str.) by the presence of mesocoxal lines. The subgenus *Mimencaustes* included

8 species worldwide (Castelnau 1840; Gorham 1883; Heller 1914; Heller 1918; Araki 1941; Chûjô and Chûjô 1989; Osawa and Chûjô 1990; Li and Ren 2006). They are mainly distributed in Asia. But *Micrencaustes* (*Mimencaustes*) *torquata* Gorham 1883 was originally stated to inhabit West Africa. Arrow (1925) pointed out this was probably a mistake in labeling the type specimen. The presence of this genus in West Africa is uncertain. Previously, only two species, *Micrencaustes* (*Mimencaustes*) *taiwana* Araki 1941 and *Micrencaustes* (*Mimencaustes*) *acridentata* Li & Ren, 2006, are known from China.

In this work, two new species of the subgenus *Mimencaustes* are described and illustrated: *Micrencaustes* (*Mimencaustes*) *renshiae* sp. n. from Hainan Province and *Micrencaustes* (*Mimencaustes*) *biomaculata* sp. n. from Yunnan Province, China. Two species, *Micrencaustes* (*Mimencaustes*) *dehaanii* (Castelnau, 1840) and *Micrencaustes* (*Mimencaustes*) *wunderlichi* Heller, 1918 are recorded from China for the first time.

Material and methods

The specimens examined in this paper were collected in a wide variety of woodland fungus, in crevices under bark or in other retreats by splitting and sifting. They were killed with ethyl acetate and dried. For an examination of the male or female genitalia, the abdominal segments were detached from the body after softening in hot water. Morphological figures were prepared using a Nikon SMZ1500 stereomicroscope; habitus photos were taken with a Nikon D7000 camera. All measurements are given in millimeters. The specimens treated in this study are deposited in the Museum of Hebei University (MHU), Hebei, P. R. China.

Morphological terminology predominantly follows Węgrzynowicz (1997) with changes according to Skelley and Leschen (2007).

The measurements of proportions are abbreviated as follows:

pl/pw – pronotum length/width ratio.

Taxonomy

Key to Chinese species of the subgenus *Mimencaustes*

- 1 Body entirely dark, without mark
.....*Micrencaustes* (*Mimencaustes*) *dehaanii* (New record to China)
- Body with marks..... 2
- 2 The marks on pronotum and elytron ... *Micrencaustes* (*Mimencaustes*) *taiwana*
- The marks only on pronotum or elytron 3
- 3 Pronotum with marks..... 4
- Elytron with marks 5
- 4 Head without orange mark, prosternal femoral lines surpassing the front edge of coxae *Micrencaustes* (*Mimencaustes*) *acridentata*

- Head with orange mark, prosternal femoral lines reaching the front edge of coxae..... *Micrencaustes (Mimencaustes) rensbiae* sp. n.
- 5 Basal mark of elytron smaller, without black spots near anterior border.....
..... *Micrencaustes (Mimencaustes) wunderlichi* (New record to China)
- Basal mark of elytron bigger, with 2 black spots near anterior border.....
..... *Micrencaustes (Mimencaustes) biomaculata* sp. n.

***Micrencaustes (Mimencaustes) rensbiae* sp. n.**

<http://zoobank.org/F3871C6A-063C-493E-B7EE-259047C1D12A>

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

Type material. Holotype. male, CHINA: Hainan Province, Baisha County, 19.2248°N, 109.4514°E, alt. 450 m, 27 May 2008, Yi-Bin Ba & Jun-Tong Lang leg. (MHU). Paratypes. 3 males, 4 females, same data as holotype (MHU).

Description. Body (Fig. 1) moderately elongate, length: 10.5–12.4mm, width: 4.1–4.5mm; widest at base of elytra, general color dark, slightly shining. Head with an irregular orange mark between eyes. Pronotum with two longitudinal, curved orange marks, each bearing a short branch in the middle.

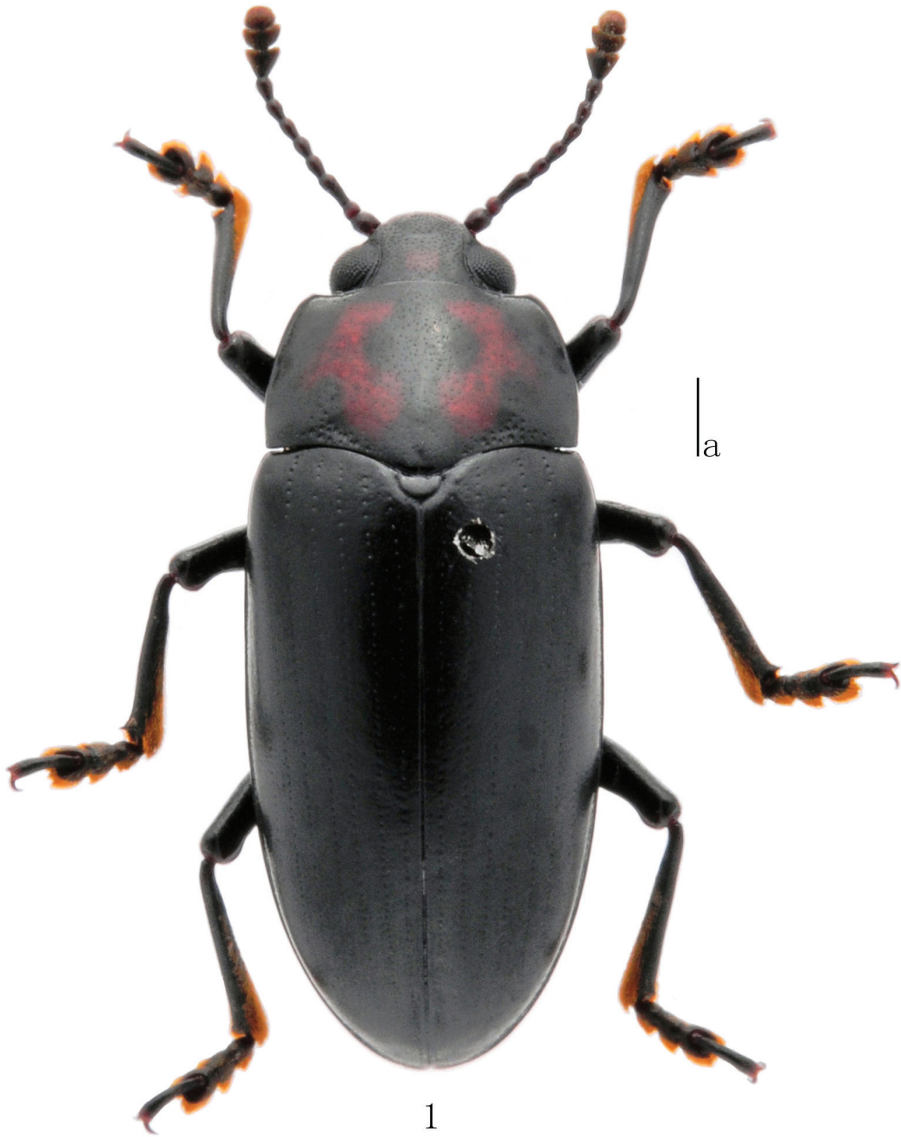
Head (Fig. 2) strongly and sparsely punctured on vertex, with ocular lines. Clypeus strongly and rather closely punctured, with anterior border feebly emarginate, with a fovea on each side of the base. Eyes large, moderately prominent laterally. Antennae (Fig. 3) extending posterior border of pronotum; antennomere III about 1.75 times as long as IV; antennomere IX asymmetrical, almost triangular; antennomere X bowl-shaped; antennomere XI hemispherical, narrower than antennomere X, slightly constricted in middle; relative lengths of antennomeres II–XI: 12: 35: 20: 19: 19: 19: 20: 18: 16: 19. Maxillary palp terminal segment triangular, sides rounded, nearly 2.7 times as wide as long. Mentum (Fig. 4) with plate triangular, sides concave, with coarse punctures and setae; submentum roughly punctured, with long golden setae.

Pronotum (Fig. 5) widest at base (pl/pw = 0.69–0.74); lateral margin slightly curved; pronotal anterior margin straight in the middle; basal margin weakly sinuate. Pronotum finely punctate, punctures evenly scattered; with a group of coarse punctures on each side of base area. Anterior angles projected; posterior angles nearly rectangular.

Prosternum (Fig. 6) coarsely and sparsely punctured on lateral areas, with some oblique rugae; an irregular depression in the middle of base area; surface with golden pubescence. Prosternal process triangular, strongly emarginated at apical border, produced into a blunt point at the base. Prosternal femoral lines almost straight, converging anteriorly and reaching the front edge of coxae.

Scutellum pentagonal, with fine and spare punctures.

Elytra widest near base, then gradually narrowing to apex. Each elytron with 8 striae; stria punctures stronger at basal part, gradually weakened apically and disappeared before extremity; intervals finely punctured and wrinkled.



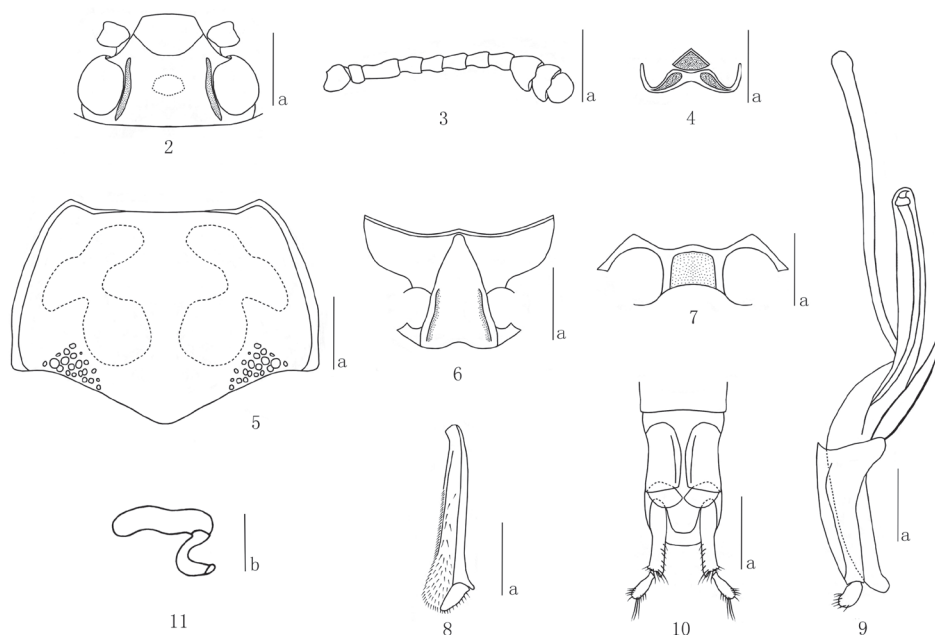
Figures 1. Habitus of *Micrencaustes (Mimencaustes) rensbiae* Scale: a = 1 mm.

Mesoventrite (Fig. 7) broad, with a median quadrate depression; mesocoxal lines short; sternum with fine and sparse punctures.

Mesotibia (Fig. 8) with outer edge of apex acutely toothed.

Male genitalia (Fig. 9) with median lobe weakly curved; narrowed to a point in lateral view; median strut about 1.31 times as long as median lobe.

Female genitalia (Fig. 10) with narrow styli at apex of coxite, and styli rounded apically, covered with setae at apex. Female spermatheca as in Fig. 11.



Figures 2–11. *Micrencaustes* (*Mimencaustes*) *renshiae* sp.n. **2** head **3** antenna **4** mentum **5** pronotum **6** prosternum **7** mesoventrite **8** mesotibia **9** aedeagus in lateral views **10** female genitalia in ventral view **11** female spermatheca Scale bars: **a** = 1mm, **b** = 0.5mm.

Distribution. Known only from the type locality (China: Hainan Province, Baisha County).

Diagnosis. *Micrencaustes* (*Mimencaustes*) *renshiae* is most similar to *Micrencaustes* (*Mimencaustes*) *acridentata* Li & Ren, 2006, due to the similar form and color pattern of pronotum. The new species can be distinguished from it by the head with orange mark; prosternum with an irregular depression in the middle of base area; prosternal femoral lines reaching the front edge of coxae. *Micrencaustes* (*Mimencaustes*) *acridentata* without orange mark on head; prosternum with a distinctly depressed in the middle; prosternal femoral lines surpassing the front edge of coxae.

Etymology. This species is named in honor of Mr. Guo-Dong Ren, teacher of author Jing Li, who helped a lot during our work.

***Micrencaustes* (*Mimencaustes*) *biomaculata* sp. n.**

<http://zoobank.org/B973810F-7181-4236-9605-ABFFC6E5B3B1>

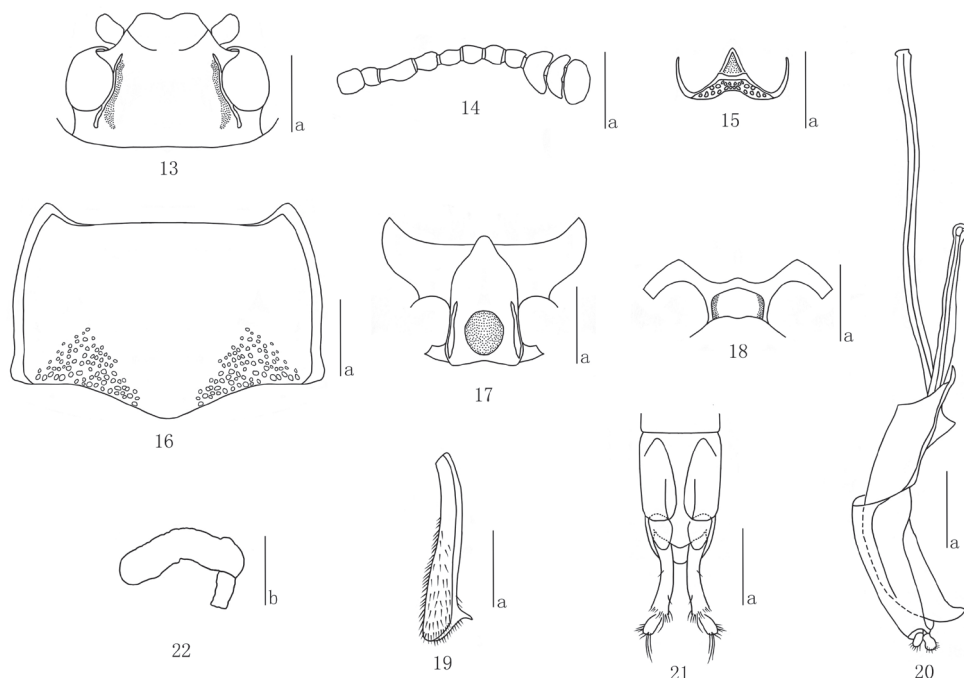
http://species-id.net/wiki/Micrencaustes_biomaculata

Type material. Holotype. male, CHINA: Yunnan Province, Eryuan County, 26.1111°N, 99.9510°E, alt. 1870 m, 17 August 2008, Ji-Shan Xu leg. (MHU). Paratypes. 3 males, 6 females, same data as holotype (MHU).



Figures 12. Habitus of *Micrencaustes* (*Mimencaustes*) *biomaculata* Scale: a = 1 mm.

Description. Body (Fig. 12) oblong oval, moderately convex, length: 10.8–12.5mm, width: 3.5–4.4mm; general color dark, moderately shining. Each elytron with 2 orange bands; anterior band reaching lateral and basal margins, leaving a



Figures 13–22. *Micrencaustes* (*Mimenaustes*) *biomaculata* sp. n. **13** head **14** antenna **15** mentum **16** pronotum **17** prosternum **18** mesoventrite **19** mesotibia **20** aedeagus in lateral views **21** female genitalia in ventral view **22** female spermatheca Scale bars: **a** = 1mm, **b** = 0.5mm.

black part at humerus, with 2 black spots near anterior border, with 4 teeth at posterior border; posterior band at four fifths length of elytron, extending from the striae I to near the lateral border, with 2 teeth at anterior border, with 3 teeth at posterior border.

Head (Fig. 13) sparsely punctured on vertex, closely at base, with ocular lines. Clypeus strongly and closely punctured, with anterior border feebly emarginate, with a fovea on each side of the base. Eyes large, rather prominent laterally. Antennae (Fig. 14) reaching basal 0.25 of pronotum; antennomere III about 1.69 times as long as IV; antennomere IX asymmetrical, almost triangular; antennomere X crescent-shaped; antennomere XI hemispherical, narrower than antennomere X, slightly constricted in middle; relative lengths of antennomeres II–XI: 12: 27: 16: 16: 17: 16: 14: 18: 13: 20. Maxillary palp terminal segment broadly triangular, nearly 3.2 times as wide as long. Mentum (Fig. 15) with plate triangular, sides concave, with rather coarse punctures and setae; submentum roughly punctured, with short golden setae.

Pronotum (Fig. 16) widest at middle ($pl/pw = 0.67–0.72$); sides almost parallel on posterior half and narrowing toward apex, strongly margined; anterior margin straight in the middle, margined behind eyes; basal margin weakly sinuate. Pronotum finely and sparsely punctuated, with a group of coarse punctures on each side of base area,

with punctate longitudinal median areas. Anterior angles projected; posterior angles nearly rectangular.

Prosternum (Fig. 17) coarsely and sparsely punctured on lateral areas, with some oblique rugae; an irregular depression in the middle of base area; surface with golden pubescence. Prosternal process triangular, strongly emarginated at apical border, produced into a blunt point at the base. Prosternal femoral lines converging anteriorly and reaching the front edge of coxae.

Scutellum nearly pentagonal, sparsely punctured.

Elytra widest at base, sides almost parallel at two thirds from base, then gradually narrowing to apex; striae punctures fine at basal part and disappeared before extremity; intervals finely punctured and distinctly wrinkled.

Mesoventrite (Fig. 18) broad, with a median pentagonal depression; mesocoxal lines moderate length; sparsely punctured.

Mesotibia (Fig. 19) with outer edge of apex acutely toothed.

Male genitalia (Fig. 20) with median lobe curved; narrowed to a hook at apex in lateral view; median strut about 1.43 times as long as median lobe.

Female genitalia (Fig. 21) with narrow styli at apex of coxite, and styli rounded apically, covered with setae at apex. Female spermatheca as in Fig. 22.

Distribution. Known only from the type locality (China: Yunnan Province, Eryuan County).

Diagnosis. The new species is most similar to *Micrencaustes* (*Mimencaustes*) *michioi* Osawa & Chûjô, 1990, but can be distinguished from it by body moderately shining; pronotum with anterior margin margined behind eyes, without impunctate longitudinal median areas; mesotibia with outer edge of apex acutely toothed. In *Micrencaustes* (*Mimencaustes*) *michioi*, the body fairly shining; pronotum with anterior margin immarginate, with impunctate longitudinal median areas; every tibia with outer edge of apex acutely toothed.

Etymology. The species is named with 2 black spots near anterior border of basal mark of elytron.

***Micrencaustes* (*Mimencaustes*) *dehaanii* (Castelnau, 1840) (New record to China)**
http://species-id.net/wiki/Micrencaustes_dehaanii

Engis dehaanii Castelnau, 1840: 15.

Encaustes dehaanii, Lacordaire 1842: 42.

Micrencaustes dehaanii, Crotch 1876: 572.

Micrencaustes (*Mimencaustes*) *dehaanii*, Heller 1918 (1920): 10.

Material examined. 1 female, CHINA: Yunnan Province, Lianghe County, 24.8070°N, 98.2949°E, 3 May 1957, Bong Faye Love leg.

Distribution. China (Yunnan), Java, Malaysia, Thailand, Singapore, Vietnam, Laos, India, Sikkim.

***Micrencaustes (Mimencaustes) wunderlichi* Heller, 1918 (New record to China)**

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

Micrencaustes (Mimencaustes) wunderlichi Heller, 1918 (1920): 23.

Micrencaustes wunderlichi, Arrow 1926: 254.

Material examined. 1 male, CHINA: Yunnan Province, Lushui County, 25.9667°N, 98.8167°E, 11 May 2004, Zi-Zhong Yang leg (MHU).

Distribution. China (Yunnan), Java, Indonesia.

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References

- Araki H (1941) On a new species of the genus *Micrencaustes* Crotch from Formosa (Coleoptera, Erotylidae). *Mushi* 14: 31–33.
- Arrow GJ (1925) Coleoptera. Clavicornia. Erotylidae, Languriidae and Endomychidae. In: Shipley AE, Scott H (Eds) *The Fauna of British India, including Ceylon and Burma*. Taylorand Francis, London, 1–416.
- Arrow GJ (1926) Fauna Sumatrensis. Endomychidae and Erotylidae. *Entomologische Mitteilungen* 15: 248–262.
- Chûjô M, Chûjô MT (1989) A catalog of the Erotylidae (Insecta, Coleoptera) from the Old World (excl. The Ethiopian Region). *Esakia* 28: 90–94.
- Crotch GR (1876) A revision of the Coleopterous Family Erotylidae. *Cistula Entomologica* 1: 359–572.
- Gorham HS (1883) Descriptions of new species of beetles belonging to the family Erotylidae. *Proceedings Zoological Society of London*, 75–76.
- Heller KM (1914) Neue papuanische Käfer. *Deutsche Entomologische Zeitschrift*, 305–306.
- Heller KM (1918) Beitrag zur Kenntnis der Erotyliden der indo-australischen Region mit besonderer Berücksichtigung der philippinischen Arten. *Archiv für Naturgeschichte* 84, A (8): 1–121.
- Lacordaire JT (1842) *Monographie des Erotyliens, Famille de l'Ordre des Coléoptères*. Roret, Paris, 1–543.
- Laporte [=de Castelnau] FLN (1840) *Histoire naturelle des Insectes Coléoptères, avec une introduction renfermant l'anatomie et la physiologie des animaux articulés, par M. Brullé. Histoire naturelle des Animaux Articulés: Annelidés, Crustacés, Arachnides, Myriapodes et Insectes*. Tome deuxième: 1–563.

- Li J, Ren GD (2006) Description of a new species of *Micrencaustes* (subgenus *Mimencaustes* Heller) (Coleoptera: Erotylidae: Encaustini) from China. *Zootaxa* 1176: 53–58.
- Osawa S, Chûjô M (1990) A new species of *Micrencaustes* (*Mimencaustes*) from Taiwan, Republic of China (Coleoptera, Erotylidae). *Esakia* 29: 69–71.
- Skelley PE, Leschen RAB (2007) Erotylinae (Insecta: Coleoptera: Cucujoidea: Erotylidae): taxonomy and biogeography. *Fauna of New Zealand* 59: 1–58.
- Węgrzynowicz P (1997) Redescription of two species from *Erotylus tectiformis* group (Coleoptera, Erotylidae, Erotylinae). *Annales Zoologici (Warszawa)* 47(1–2): 199–207.

A new species of the *Aenictus wroughtonii* group (Hymenoptera, Formicidae) from South-East China

Michael Staab^{1,†}

¹ Chair of Nature Conservation and Landscape Ecology, Institute of Earth and Environmental Sciences, University of Freiburg, Tennenbacherstraße 4, 79106 Freiburg, Germany

† <http://zoobank.org/42662938-64FB-4680-87DA-8D88AA9981C8>

Corresponding author: Michael Staab (michael.staab@nature.uni-freiburg.de)

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Abstract

A new species of army ant from the *Aenictus wroughtonii* group is described and illustrated based on the worker caste. *Aenictus gutianshanensis* Staab, **sp. n.** is known from a single colony collected in the subtropical mixed evergreen broad-leaved forest of the Gutianshan National Nature Reserve, South-East China. The new species is probably most closely related to *A. vieti* Jaitrong & Yamane, 2010 known from North Vietnam and Taiwan. It is suggested that the abundant records of *A. camposi* Wheeler & Chapman, 1925 from East and South-East China should be reevaluated, as they are probably *A. gutianshanensis* or *A. vieti* and not *A. camposi*, which is distributed in Sundaland, the Philippines, and the southernmost part of continental South-East Asia.

Keywords

Aenictinae, *Aenictus gutianshanensis*, army ants, species description, taxonomy

Introduction

The genus *Aenictus*, which is the only genus of the dorylomorph subfamily Aenictinae, is the largest genus of army ants. Army ants are characterized by several specialized morphological, behavioral, and ecological adaptations, such as a nomadic life style, highly specialized mating systems, and mass raiding for arthropod prey (Schneirla and

Reyes 1966, Gotwald 1995, Kronauer 2009). *Aenictus* is restricted to the tropical and subtropical regions of the Old World and Australia (Gotwald 1995). Almost all *Aenictus* species are specialized predators of other ants (e.g. Rościszewski and Maschwitz 1994, Hirose et al. 2000, Jaitrong and Yamane 2011), however they can also supplement their diet with plant-based resources (Staab in press).

Until now, 179 species (9 synonyms, 2 unavailable) and 30 subspecies (13 synonyms, 2 unavailable) have been validly described (AntCat 2014). Recently, Jaitrong and coworkers established 12 species groups based on the worker caste (Jaitrong and Yamane 2011), and comprehensively revised the Oriental and Australasian *Aenictus* fauna (Jaitrong and Yamane 2010, Jaitrong et al. 2010, Jaitrong and Yamane 2011, Wiwatwitaya and Jaitrong 2011, Jaitrong and Hashimoto 2012, Jaitrong and Yamane 2012, Jaitrong and Wiwatwitaya 2013, Jaitrong and Yamane 2013).

The *A. wroughtonii* species group has been revised in detail by Jaitrong et al. (2010). The group contains seven species in the Oriental and Australasian faunal region that can easily be separated from other conspecific *Aenictus* species by the combination of a yellowish and slender body, very long antennal scapes, and a rounded anterior clypeal margin bearing several denticles (Jaitrong et al. 2010, Jaitrong and Yamane 2011). In the present paper, a new species of the *A. wroughtonii* group from South-East China is described as new to science based on the worker caste.

Methods

All morphological observations were made with a Leica SD6 stereomicroscope. Measurements were taken with an ocular micrometer. Images were produced using a Keyence VHX2000 (Osaka, Japan) digital microscope.

The general worker terminology follows Jaitrong et al. (2010) and Jaitrong and Yamane (2011).

All measurements are expressed in millimeters. Abbreviations used for measurements and indices follow Jaitrong et al. (2010) and Jaitrong and Yamane (2011) and are:

| | |
|------------|--|
| CI | Cephalic index, $HW / HL \times 100$. |
| HL | Maximum head length in full-face view, measured from the anterior clypeal margin (excluding the projecting clypeal teeth) to the midpoint of a line drawn across the posterior margin of the head. |
| HW | Maximum head width in full face view. |
| ML | Mesosomal length measured from the point at which the pronotum meets the cervical shield to the posterior base of the metapleuron in profile. |
| MTL | Maximum length of mid tibia, excluding the proximal part of the articulation which is received into the distal end of the femur. |
| PL | Petiole length measured from the anterior margin of the peduncle to the posteriormost point of tergite. |
| SI | Scape index, $SL / HW \times 100$. |

- SL** Scape length excluding the basal constriction and condylar bulb.
TL Total length, measured roughly from the anterior margin of head to the tip of gaster in stretched specimens.

Depositories of type material

- CASC** California Academy of Science Collection, San Francisco, California, USA.
IZAS Insect Collection of the Institute of Zoology, Chinese Academy of Sciences, Beijing, China.
ZMBH Museum für Naturkunde, Berlin, Germany.

Results

Aenictus wroughtonii species group

Jaitrong et al. (2010) and Jaitrong and Yamane (2011) defined this species group as follows:

Head narrow; occipital margin lacking collar. Antenna long, consisting of 10 segments, with a strikingly long scape attaining or extending beyond posterolateral corner of head (but in one Vietnamese species the scape shorter, not reaching posterolateral corner of head). Anterior clypeal margin roundly convex with 5–10 denticles. Mandible triangular, with masticatory margin bearing 8–12 minute inconspicuous denticles in addition to large apical tooth with a sharp apex; basal margin of mandible lacking denticles. Frontal carina short; parafrenal ridge feeble and incomplete. Mesosoma narrow and elongate. Legs very slender. Subpetiolar process weakly developed or almost absent. Head and gaster entirely smooth and shiny. Nearly entire body clear yellow to yellowish brown; typhlata spot absent.

Aenictus gutianshanensis Staab, sp. n.

<http://zoobank.org/F14B8EED-1D2E-4931-A0AA-F3697502BEEF>

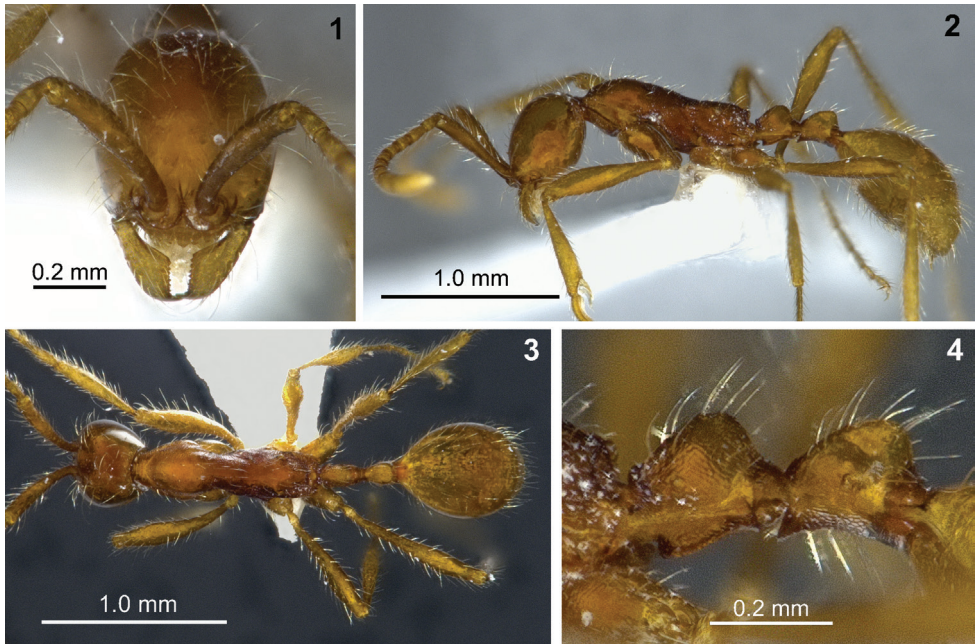
http://species-id.net/wiki/Aenictus_gutianshanensis

Figs 1–5

Holotype. Worker from China, Zhejiang Province, Gutianshan National Nature Reserve, ca. 30 km NW of Kaihua, 29°12'54"N / 118°7'18"E, ca. 250 m above sea level, 28.VI.2009, leg. Andreas Schuldt, label: "CSP26/SW7(2009)", deposited in IZAS.

Paratypes. Five workers, same data as holotype. Three deposited in IZAS; one each deposited in ZMBH and CASC. All type specimens were collected in a single pitfall trap in a secondary mixed evergreen broad-leaved forest.

Measurements and indices. **Holotype:** TL 3.30, HL 0.68, HW 0.63, SL 0.70, ML 1.17, MTL 0.75, PL 0.30, CI 93, SI 112.



Figures 1–4. *Aenictus gutianshanensis* sp. n. (holotype). **1** Head in full-face view **2** body in profile **3** body in dorsal view **4** propodeal junction petiole and postpetiole in profile.

Paratypes (n=5): TL 3.10–3.30, HL 0.69–0.75, HW 0.60–0.65, SL 0.65–0.70, ML 1.17–1.25, MTL 0.69–0.83, PL 0.29–0.31, CI 87–91, SI 104–113.

Worker description. Head in full-face view elliptical, slightly longer than broad, with convex sides and almost straight posterior margin of head. Antennal scape long, reaching posterior corner of head; antennal segments II–X each longer than broad; II as long as III, but longer than each of IV–VII; terminal segment (X) longer than each of II–IX; the last four segments forming an indistinct club. Frontal carina long, extending slightly beyond the posterior margin of antennal torulus. Clypeus short with its anterior margin slightly convex, bearing 7–8 bluntly rounded denticles. Mandible subtriangular, masticatory margin straight, with a large curved apical tooth which is followed by 9–10 minute teeth on masticatory margin. With mesosoma in profile, pronotum dorsally convex, not distinctly separated from mesonotum by a promesonotal suture. Propodeum slightly lower than promesonotum, its dorsal outline gently sloping posteriorly; propodeal junction angulate; declivity of propodeum straight in the dorsal part, concave in the ventral part when viewed in profile, encircled by a thin rim. Petiole in profile as long as high, its node convex dorsally. Subpetiolar process present, its ventral margin almost straight, bearing a thin rim below, anteroventral corner angulate. Postpetiole slightly longer than petiole, its node convex dorsally in profile; ventral postpetiolar process developed, angulate, bearing a thin rim below, slightly projecting over the posterior part of the petiole.

Head including mandible smooth and shiny; antennal scape punctate. Entire mesosoma finely reticulate, dorsal face of pronotum finely reticulate but shiny, reticulation



Figure 5. *Aenictus gutianshanensis* sp. n. (holotype), sculpture of pronotal dorsum.



Figure 6. Typical mixed evergreen broad-leaved forest at the type locality, the Gutianshan National Nature Reserve.

on mesopleuron, metapleuron and lateral face of propodeum finer than on pronotum, appearing almost punctate in magnification lower 64 \times . Entire petiole finely reticulate. Postpetiole finely reticulate, except the dorsum smooth and shiny. Gaster smooth and shiny. Coxae finely reticulate, femora densely punctate, tibiae sparsely punctate.

Body except anterior part of mesonotum with abundant standing hairs and interspersed short hairs; length of longest hairs on dorsa of head and pronotum 0.20–0.30 mm. Antennal scape and legs with abundant standing hairs. Head, mandible, gaster and legs yellowish brown. Mesosoma, antennal scape, petiole and postpetiole reddish brown.

Male and female are unknown.

Etymology. The scientific name is after the type locality, the Gutianshan National Nature Reserve (Fig. 6) in South-East China.

Distribution. South-East China; only known from the type series.

Ecology. No direct biological information is available. The type series was collected in a single pitfall trap in a secondary mixed evergreen broad-leaved forest. Thus, the species probably lives and forages on and in the leaf-litter preying on small ants of the subfamily Formicinae, as it has been previously reported for species in the *A. wroughtonii* group (Rościszewski and Maschwitz 1994, Jaitrong et al. 2010). Possible prey species of the genera *Prenolepis* and *Nylanderia* are common at the type locality (M. Staab, unpublished data).

Discussion

Aenictus is one of the most species-rich ant genera in China and worldwide (Guénard and Dunn 2012, AntCat 2014), and the present paper raises the number of described species to 180. However, several *Aenictus* species have been described based only on males. As males of *A. gutianshanensis* and many other *Aenictus* species are so far unknown, further collections supported by genetic work are needed in the future to clarify the relationship between male and worker based species names. Recently, the exhaustive reviews of Jaitrong and coworkers (Jaitrong and Yamane 2010, Jaitrong et al. 2010, Jaitrong and Yamane 2011, Wiwatwitaya and Jaitrong 2011, Jaitrong and Hashimoto 2012, Jaitrong and Yamane 2012, Jaitrong and Wiwatwitaya 2013, Jaitrong and Yamane 2013) provided detailed taxonomic and biogeographic information for the Oriental *Aenictus* fauna. Nevertheless, additional new species from the region have been described by various authors since these revisions (e.g. Jaitrong and Nur-Zati 2010, Bharti et al. 2012). Due to their highly specialized colony cycle which is characterized by reproduction through colony fission only (Gotwald 1995), most *Aenictus* species have a low dispersal potential and rather small and limited distribution ranges (e.g. Jaitrong et al. 2010, 2012, Jaitrong and Yamane 2013).

Aenictus gutianshanensis can be easily distinguished from all other species of the *A. wroughtonii* group by the pronotum, the petiole, and the side of the postpetiole completely finely reticulate (see Jaitrong et al. 2010 for detailed species descriptions including a key to the *A. wroughtonii* group; the same key is available online at http://www.antwiki.org/wiki/Key_to_Aenictus_wroughtonii_group_species). The new species is most similar to *A. vietii* Jaitrong & Yamane, 2010 and to *A. camposi* Wheeler & Chapman, 1925 but slightly larger in all measurements. In addition to having the pronotum and petiole completely finely reticulate, *A. gutianshanensis* can be easily distinguished from *A. vietii* and *A. camposi* by the following characters (characters for *A. vietii* and *A. camposi* are given in brackets, see Jaitrong et al. 2010): ventral margin of subpetiolar process almost straight (ventral margin convex), femora densely punctate (smooth and shiny in Jaitrong et al. 2010, but superficially and irregularly sculptured and shiny in

two paratypes examined by the reviewer), postpetiolar process more developed with a rim below (less developed, without ventral rim), and longest standing hairs on pronotal dorsum distinctly longer (maximal 0.13 mm).

In China, *A. camposi* has been recorded from several provinces in East and South-East China. (Guénard and Dunn 2012). However, *A. camposi* is a clearly tropical species whose distribution is restricted to Sundaland, the Philippines, and the southernmost part of continental South-East Asia (Jaitrong et al. 2010). Jaitrong and Yamane (in Jaitrong et al. 2010) described *A. vietii* from Taiwan and North Vietnam. The authors recommended treating the Chinese records of *A. camposi* as *A. vietii*, which is morphologically similar. However, *A. vietii* has not yet been recorded from mainland China. Thus, I also recommend reevaluating the Chinese *A. camposi* for their identity. The type locality of *A. gutianshanensis* is in the Zhejiang Province, and at least *A. camposi* specimens collected further north, e.g. in Anhui or Hubei, may be *A. gutianshanensis*.

There are probably several *Aenictus* species which still await discovery and description in the tropical and subtropical forests of the Oriental region. However, these forests are under high land-use pressure and are increasingly being cleared for agriculture (Gibbs et al. 2010, Miettinen et al. 2011, Hansen et al. 2013). As top predators, *Aenictus* and other army ants are sensitive to the negative effects of forest fragmentation and anthropogenic land use (Matsumoto et al. 2009). *Aenictus gutianshanensis* was discovered in South-East China, a region that was once covered by species rich subtropical forests which have largely been converted to timber plantations and to agricultural land (López-Pujol et al. 2006). The type locality, the Gutianshan National Nature Reserve (Brüelheide et al. 2011), despite being secondary forest, is one of the larger fragments of the historically wide ranging mixed evergreen broad-leaved forest in South-East China. These areas, as well as other secondary forest fragments in China and elsewhere probably contain several new ant species waiting to be discovered.

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References

AntCat. Available from: <http://www.antcat.org/catalog/429477> [accessed 3 March 2014]

- Bharti H, Wachkoo AA, Kumar R (2012) Two remarkable new species of *Aenictus* (Hymenoptera: Formicidae) from India. *Journal of Asia-Pacific Entomology* 15: 291–294. doi: 10.1016/j.aspen.2012.02.002
- Bruelheide H, Böhnke M, Both S, Fang T, Assmann T, Baruffol M, Bauhus J, Buscot F, Chen XY, Ding BY, Durka W, Erfmeier A, Fischer M, Geissler C, Guo DL, Guo LD, Härdtle W, He JS, Hector A, Kröber W, Kühn P, Lang AC, Nadrowski K, Pei KQ, Scherer-Lorenzen M, Shi XZ, Scholten T, Schuldt A, Trogisch S, von Oheimb G, Welk E, Wirth C, Wu YT, Yang XF, Zeng XQ, Zhang SR, Zhou HZ, Ma KP, Schmid B (2011) Community assembly during secondary forest succession in a Chinese subtropical forest. *Ecological Monographs* 81: 25–41. doi: 10.1890/09-2172.1
- Gibbs HK, Ruesch AS, Achard F, Clayton MK, Holmgren P, Ramankutty N, Foley JA (2010) Tropical forests were the primary sources of new agricultural land in the 1980s and 1990s. *Proceedings of the National Academy of Sciences of the United States of America* 107: 16732–16737. doi: 10.1073/pnas.0910275107
- Gotwald WHJ (1995) *Army ants: the biology of social predation*. Cornell University Press, Ithaca, NY, U.S.A. 320 pp.
- Guénard B, Dunn RR (2012) A checklist of the ants of China. *Zootaxa* 3558: 1–77.
- Hansen MC, Potapov PV, Moore R, Hancher M, Turubanova SA, Tyukavina A, Thau D, Stehman SV, Goetz SJ, Loveland TR, Kommareddy A, Egorov A, Chini L, Justice CO, Townshend JRG (2013) High-resolution global maps of 21st-century forest cover change. *Science* 342: 850–853. doi: 10.1126/science.1244693
- Hirosawa H, Higashi S, Maryati M (2000) Food habits of *Aenictus* army ants and their effects on the ant community in a rain forest of Borneo. *Insectes Sociaux* 47: 42–49. doi: 10.1007/s000400050007
- Jaitrong W, Hashimoto Y (2012) Revision of the *Aenictus minutulus* species group (Hymenoptera: Formicidae: Aenictinae) from Southeast Asia. *Zootaxa* 3426: 29–44.
- Jaitrong W, Nur-Zati MA (2010) A new species of the ant genus *Aenictus* (Hymenoptera: Formicidae: Aenictinae) from the Malay Peninsula. *Sociobiology* 56: 449–454.
- Jaitrong W, Wiwatwitaya D (2013) Two new species of the *Aenictus pachycerus* species group (Hymenoptera: Formicidae: Aenictinae) from Southeast Asia. *Raffles Bulletin of Zoology* 61: 97–102.
- Jaitrong W, Yamane S (2010) The army ant *Aenictus silvestrii* and its related species in Southeast Asia, with a description of a new species (Hymenoptera: Formicidae: Aenictinae). *Entomological Science* 13: 328–333. doi: 10.1111/j.1479-8298.2010.00385.x
- Jaitrong W, Yamane S (2011) Synopsis of *Aenictus* species groups and revision of the *A. currax* and *A. laeviceps* groups in the eastern Oriental, Indo-Australian, and Australasian regions (Hymenoptera: Formicidae: Aenictinae). *Zootaxa* 3128: 1–46.
- Jaitrong W, Yamane S (2012) Review of the Southeast Asian species of the *Aenictus javanus* and *Aenictus philippinensis* species groups (Hymenoptera, Formicidae, Aenictinae). *Zookeys* 193: 49–78. doi: 10.3897/zookeys.193.2768
- Jaitrong W, Yamane S (2013) The *Aenictus ceylonicus* species group (Hymenoptera, Formicidae, Aenictinae) from Southeast Asia. *Journal of Hymenoptera Research* 31: 165–233. doi: 10.3897/jhr.31.4274

- Jaitrong W, Yamane S, Tasen W (2012) A sibling species of *Aenictus dentatus* FOREL, 1911 (Hymenoptera: Formicidae) from continental Southeast Asia. *Myrmecological News* 16: 133–138.
- Jaitrong W, Yamane S, Wiwatwitaya D (2010) The army ant *Aenictus wroughtonii* (Hymenoptera, Formicidae, Aenictinae) and related species in the oriental region, with descriptions of two new species. *Japanese Journal of Systematic Entomology* 16: 33–46.
- Kronauer DJC (2009) Recent advances in army ant biology (Hymenoptera: Formicidae). *Myrmecological News* 12: 51–65.
- López-Pujol J, Zhang F-M, Ge S (2006) Plant biodiversity in China: richly varied, endangered, and in need of conservation. *Biodiversity and Conservation* 15: 3983–4026. doi: 10.1007/s10531-005-3015-2
- Matsumoto T, Itioka T, Yamane S, Momose K (2009) Traditional land use associated with swidden agriculture changes encounter rates of the top predator, the army ant, in Southeast Asian tropical rain forests. *Biodiversity and Conservation* 18: 3139–3151. doi: 10.1007/s10531-009-9632-4
- Miettinen J, Shi C, Liew SC (2011) Deforestation rates in insular Southeast Asia between 2000 and 2010. *Global Change Biology* 17: 2261–2270. doi: 10.1111/j.1365-2486.2011.02398.x
- Rościszewski M, Maschwitz U (1994) Prey specialization of army ants of the genus *Aenictus* in Malaysia. *Andrias* 13: 179–187.
- Schneirla TC, Reyes AY (1966) Raiding and related behaviour in two surface-adapted species of the Old World Doryline ant, *Aenictus*. *Animal Behavior* 14: 132–148. doi: 10.1016/S0003-3472(66)80022-2
- Staab M (in press) The first observation of honeydew foraging in army ants since 1933: *Aenictus hodgsoni* Forel, 1901 tending *Eutrichosiphum heterotrichum* (Raychaudhuri, 1956) in South-East China. *Asian Myrmecology*.
- Wiwatwitaya D, Jaitrong W (2011) The army ant *Aenictus hottai* (Hymenoptera: Formicidae: Aenictinae) and related species in Southeast Asia, with a description of a new species. *Sociobiology* 58: 557–565.
- Wheeler WM, Chapman JW (1925) The ants of the Philippine Islands. Part I, Dorylinae and Ponerinae. *Philippine Journal of Science* 28: 27–73.

Four new spider species of the family Theridiosomatidae (Arachnida, Araneae) from caves in Laos

Yucheng Lin^{1,†}, Shuqiang Li^{2,‡}, Peter Jäger^{3,§}

1 Key Laboratory of Bio-resources and Eco-environment (Ministry of Education), College of Life Sciences, Sichuan University, Chengdu, Sichuan 610064, China **2** Institute of Zoology, Chinese Academy of Sciences, Beijing 100101, China **3** Arachnology, Senckenberg Research Institute, Senckenberganlage 25, 60325 Frankfurt am Main, Germany

† <http://zoobank.org/A514B4E7-2F9F-42B5-82E9-60713ACE9943>

‡ <http://zoobank.org/0968F85E-881F-43FD-8E6A-BE570F9E334F>

§ <http://zoobank.org/A79CD670-BC87-4A1B-8EDF-B391514CCB2A>

Corresponding author: Peter Jäger (peter.jaeger@senckenberg.de)

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Abstract

Four new species of the spider family Theridiosomatidae are described from caves in Laos: *Alaria cavernicola* **sp. n.** (♂♀), *A. navicularis* **sp. n.**, (♂♀) *A. bicornis* **sp. n.** (♂♀), *Chthonopes thakekensis* **sp. n.** (♀). Diagnoses and illustrations for all new taxa are given. All holotypes are deposited in the Senckenberg Research Institute in Frankfurt am Main, Germany (SMF).

Keywords

Cave spiders, taxonomy, Araneoidea, Orbiculariae, Indochina, limestone karst

Introduction

Theridiosomatidae are small (usually ≤ 3 mm), widely distributed, and cryptozoic spiders, which can be found in damp, dark habitats (litter layer of forest or in caves) (Zhao and Li 2012). Coddington (1986) reviewed the genera of this family and proposed

synapomorphies based on a cladistic analysis, including the combination of following characters: a pair of pits on the anterior margin of sternum near the labial base (absent in *Chthonos* Coddington, 1986), partly fused spermathecae (separated in *Coddingtonia* Miller, Griswold & Yin, 2009), especially large male palps (except for *Menglunia* Zhao & Li, 2012), and a long trichobothrium dorsally on tibia IV. Subsequently, an increasing number of new species have been described from all over the world. For example, some species from Latin America have been reported by Lopez (1994, 1996), Rodrigues and Ott (2005) and Rodrigues and Lise (2008). Chinese Theridiosomatidae have been reported from Gaoligongshan, Yunnan (Miller et al. 2009), tropical rainforest in Hainan and Xishuangbanna of Yunnan, and in caves in Guangxi, Chongqing and Guizhou (Zhao and Li 2012; Dou and Lin 2012; Chen 2010; Zhu and Wang 1992; Song and Zhu 1994). Other species have been described from insular states or areas (Barrion and Litsinger 1995; Saaristo 1996; Zhang et al. 2006; Shinkai 2009). According to the latest data, 18 genera containing 101 known species are recorded worldwide (Platnick 2014).

The earliest report on Theridiosomatidae from the Indochinese Peninsula was published by Simon (1901), who described two species, *Andasta cyclosina* and *Theridiosoma nebulosum* from Malaysia. About one hundred years later, two new genera (*Chthonopes* and *Luangnam*) were established by Wunderlich (2011) to accommodate three new species (*C. cavernicolus*, *C. jaegeri* and *L. discobulbus*) discovered from caves in Laos. Insufficient sampling could not hide the rich species diversity of this region, and still more species are waiting to be found. In this paper, we provide detailed descriptions, illustrations and distribution data for four new species from Laos.

Material and Methods

Specimens were examined and measured under a Leica M205 C stereomicroscope. Further details were studied under an Olympus BX43 compound microscope. All drawings were made using a drawing tube attached to an Olympus BX43 compound microscope, and then inked on ink jet plotter paper. Copulatory organs of males and females were examined and illustrated after they have been dissected and detached from the spiders' bodies. Vulvae were treated in lactic acid before illustration. All embolic divisions and vulvae were illustrated after being embedded in Hoyer's Solution. Photos were taken with a Canon EOS 60D wide zoom digital camera (8.5 megapixels) mounted on an Olympus BX43 stereomicroscope. The images were montaged using Helicon Focus 3.10 software. All type specimens are preserved in 85% ethanol solution. All material was collected by Peter Jäger by hand. Material is deposited in Senckenberg Research Institute, Frankfurt, Germany (SMF) and in the Institute of Zoology, Chinese Academy of Sciences, Beijing, China (IZCAS).

All measurements were made in millimeters; altitude is given in meters (m). Leg measurements are given as: total length (femur, patella, tibia, metatarsus, tar-

sus). The terminology mostly follows Miller et al. (2009) and Zhao and Li (2012). Chaetotaxy of macrosetae is marked for dorsal (d), prolateral (p), retrolateral (r), and ventral (v) surfaces of legs. Metatarsal trichobothrium (Tm) is given as the ratio of the distance between the proximal margin of the metatarsus and the base of the trichobothrium divided by the total length of the metatarsus (Locket and Millidge 1953) and Tm value for each leg is given as Tm I, Tm II, Tm III, and Tm IV. The course of the duct system is illustrated as red line with a circle representing the copulatory opening and an arrow representing the fertilization duct pointing in direction of the Uterus externus.

Abbreviations used in the text: AME – anterior median eyes; DS – dorsal shield of prosoma; LE – lateral eyes; PME – posterior median eyes.

Taxonomy

Genus *Alaria* Zhao & Li, 2012

<http://species-id.net/wiki/Alaria> according to Lin et al. 2014

Type species. *Alaria chengguanensis* Zhao & Li, 2012 from China.

The genus was described in 2012 as monotypic (Zhao and Li 2012). The type species was known from Guizhou Province only from the type locality. Spiders were recorded in Xiniu Cave.

Alaria cavernicola sp. n.

<http://zoobank.org/87575CFC-446E-4846-9D28-E483E9DBC2A0>

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

Figs 1–4, 19

Material examined. LAOS: Bolikhamsay Province: Holotype: ♂ (SMF), Lak Sao, Tham Man Kone, 18°13.268'N, 104°48.765'E, altitude 501 m, inside cave, leg. 3 December 2012. Paratypes: 1 ♂, 2 ♀ (SMF), same data as holotype; **Khammouan Province:** 6 ♂ (SMF), 8.3 km NE of Thakek, Tham Noi, 17°26.655'N, 104°51.767'E, altitude 158 m, in foot cave, leg. 26 November 2012; 1 ♂ (IZCAS), 15 km N of Thakek, Ban Phônggam-Mai, 17°31.835'N, 104°46.582'E, altitude 144 m, limestone cave, quarry, leg. 25 November 2012; 1 ♂ (SMF), LAOS, 2.5 km WNW of Ban Tathot, entrance 17°37.897'N, 105°07.502'E, exit 17°37.994'N, 105°07.195'E, altitude 200 m, entrance area and in front of limestone cave, Tham Kamouk, leg. 30 April 2012; 2 ♀ (SMF, IZCAS), Thakek area, Ban Phônggam-Mai, 17°32.954'N, 104°48.754'E, altitude 180 m, limestone cave, Tham Phayat, leg. 29 April 2012; 1 ♀ (SMF), Boualapha District, Tham Nam, Lot Xe Bang Fai, 17°22'24.43"N, 105°50'39.36"E, altitude 190 m, in day, leg. 3–4 May 2012.

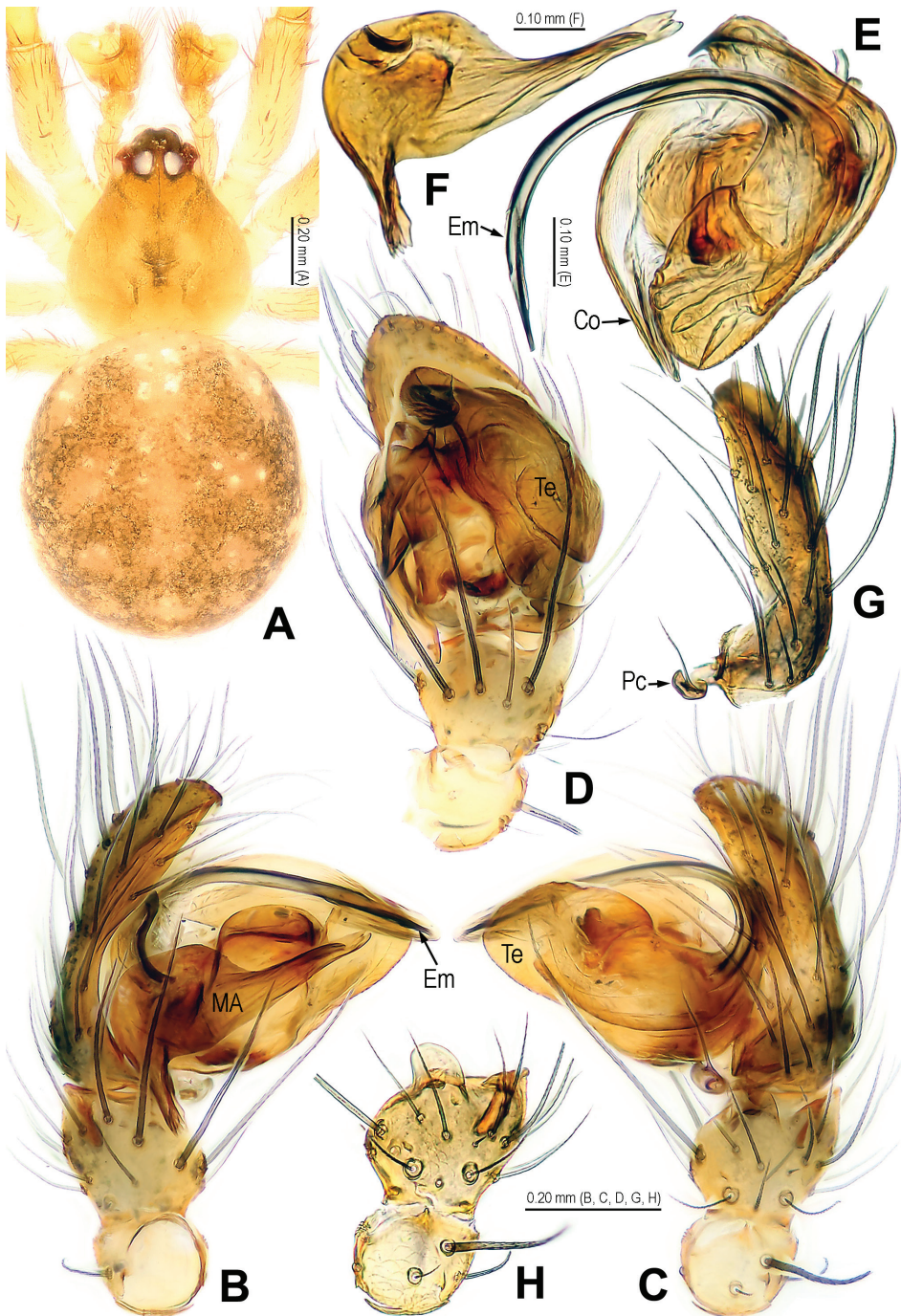


Figure 1. *Alaria cavernicola* sp. n., holotype male. **A** Habitus, dorsal **B** Palp, prolateral **C** Ditto, retrolateral **D** Ditto, ventral **E** bulb (median apophysis removed), distal **F** Median apophysis, prolateral **G** Cymbium, retrolateral **H** Palpal patella and tibia, retrolateral. Co = conductor; Em = embolus; MA = median apophysis; Pc = paracymbium; Te = tegulum.

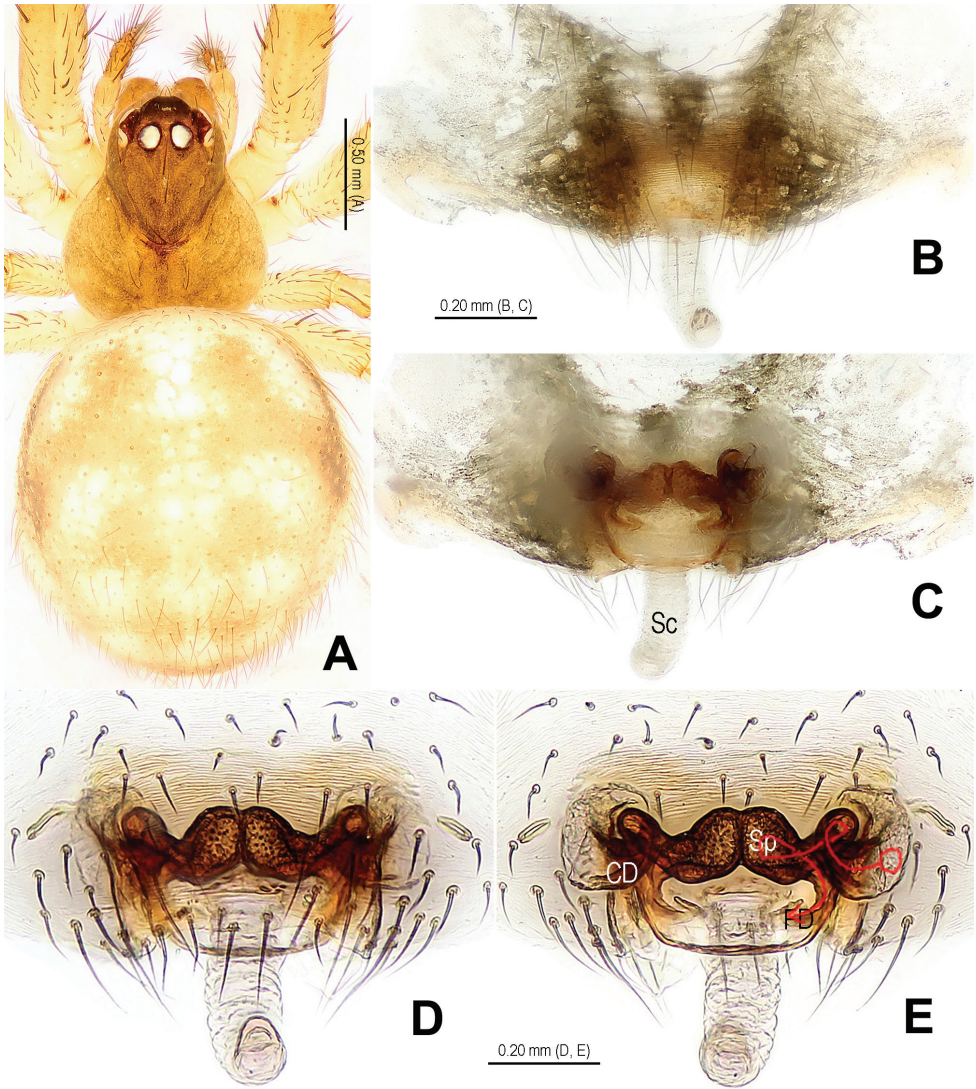


Figure 2. *Alaria cavernicola* sp. n., female paratype, from Tham Man Kone. **A** Habitus, dorsal **B** Epigyne, ventral **C** Epigyne, dorsal **D** Vulva (lactic acid-treated), ventral **E** Vulva, dorsal (red line showing course of duct system). CD = copulatory duct; FD = fertilization duct; Sc = scape; Sp = spermathecae.

Etymology. The specific epithet is derived from the Latin word “cavernicola” = “living in caves”, refers to that this species may mainly live in caves; adjective.

Diagnosis. This new species is similar to *A. chengguanensis* Zhao & Li, 2012 in the paracymbial shape (Figs 1D, 3C), most part of the long embolus embedded in conductor, the large median apophysis (Figs 1B–C, 3A–B), the scape protruding from beneath epigynal plate (Figs 2B–E, 4A–B), and the similar configurations of the vulva (Figs 2E, 4B). Males can be distinguished by the absence of tufted setae on the cym-

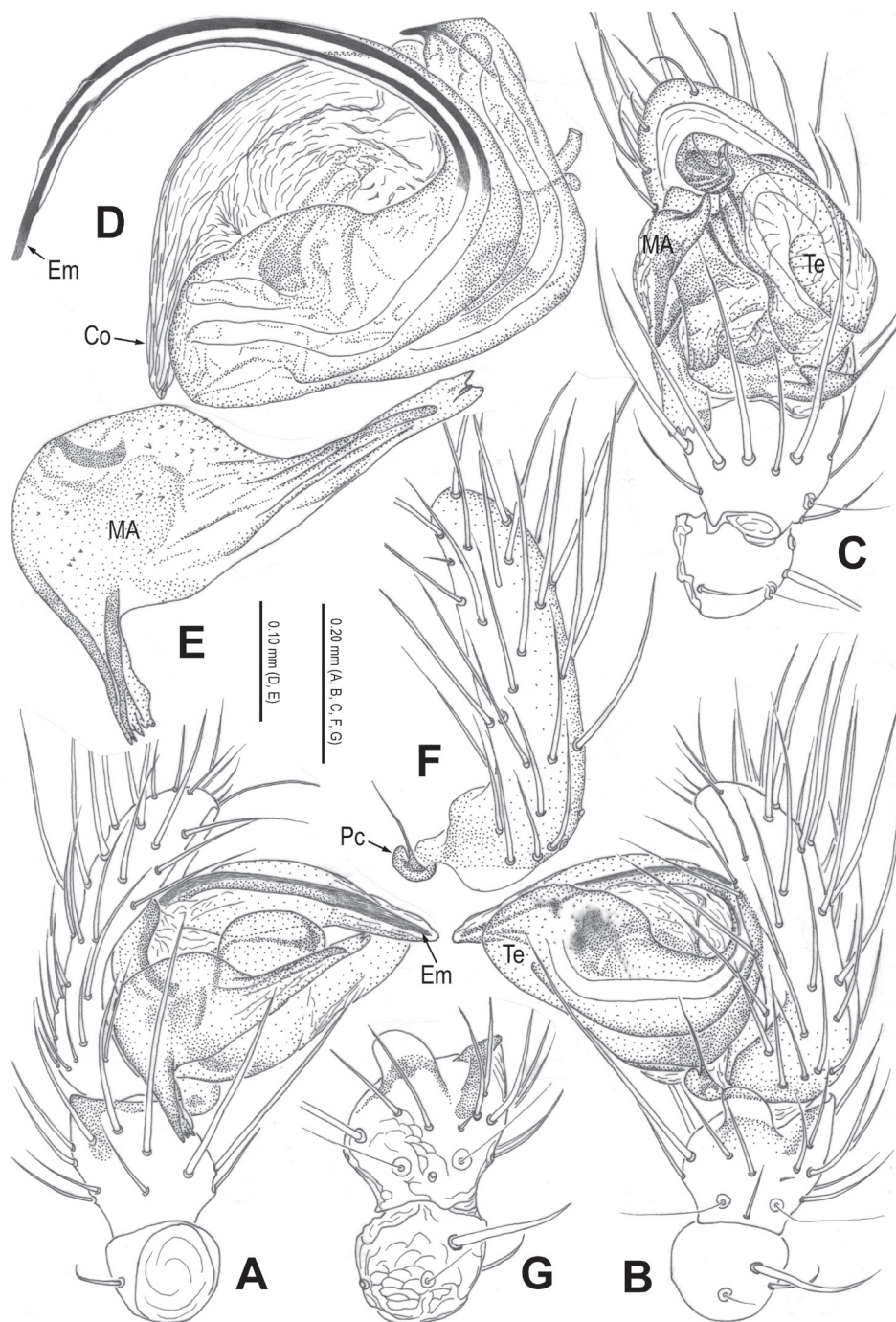


Figure 3. *Alaria cavernicola* sp. n., holotype male. **A** Palp, prolateral **B** Ditto, retrolateral **C** Ditto, ventral **D** bulb (median apophysis removed), apical **E** Median apophysis, prolateral **F** Cymbium, retrolateral **G** Palpal patella and tibia, retrolateral. Co = conductor; Em = embolus; MA = median apophysis; Pc = paracymbium; Te = tegulum.

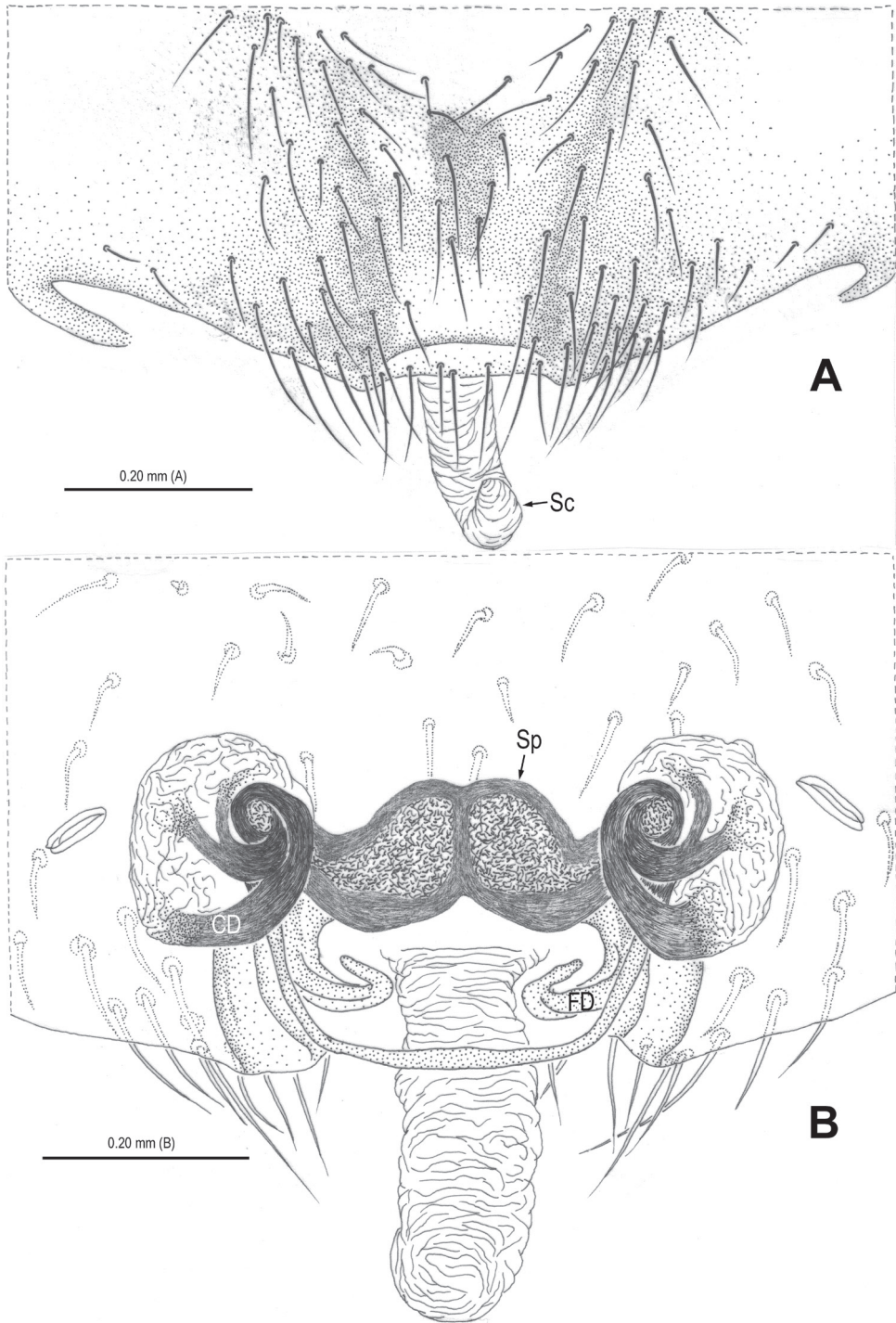


Figure 4. *Alaria cavernicola* sp. n., female paratype, from Tham Man Kone. **A** Epigyne, ventral **B** Vulva (lactic acid-treated), dorsal. CD = copulatory duct; FD = fertilization duct; Sc = scape; Sp = spermathecae.

bium (Figs 1G, 3F vs. Zhao and Li 2012: figs 1B, 1D, 3D), the different shape of the median apophysis (Figs 1F, 3E vs. Zhao and Li 2012: figs 1A, 3A, 5A), females by the long, narrow and membranous scape as well as by the large and wide spermathecae (Figs 2B–E, 4A–B vs. Zhao and Li 2012: figs 2A–B, 5C–D).

Description. Habitus as in Figs 1A, 2A. DS nearly pear-shaped, yellow, with grey pigment, cervical groove distinct, thoracic fovea present. Sternum yellow. Legs proximally pale yellow, distally yellow. Opisthosoma sub-spherical, grey in male, off-white in female, with white patches.

Male palp (Figs 1B–D, 3A–C): patella with strong macroseta and trichobothrium (Figs 1C, 1H, 3B, 3G). Tibia with 2 trichobothria and a lamellar process (Figs 1H, 3G). Paracymbium with a hooked basal process and a long distal spicula (Figs 1C–D, 1G, 3B–C, 3F). Tegulum smooth. Median apophysis large, surface with tiny grooves and aculei, proximal process short and serrated, distal process long and slightly furcated (Figs 1F, 3E). Most part of embolus embedded in sheath-like conductor (Figs 1B–D, 3A–C). Embolus long, bent, filiform (Figs 1E, 3D).

Female copulatory organ (Figs 2B–E, 4A–B): epigynal area with long setae. Scape long, membranous, rugose, distally bent, protruding from beneath epigynal posterior margin (Figs 2D, 4A). Spermathecae subovate, juxtaposed (Figs 2C, 2E, 4B). Copulatory ducts wide, starting from lateral corner of spermathecae (Fig. 4B), curl up to form a saccular structure at each side (Figs 2E, 4B). Fertilization ducts deriving from ventral surface of spermathecae, distally hooked (Fig. 4B).

Male: total length 1.52, DS 0.73 long, 0.60 wide, clypeus 0.16, sternum 0.39 long, 0.33 wide, coxae IV separated by their width, opisthosoma 0.82 long, 0.75 wide. PME separated by less than half their diameter. Macrosetae: leg I: femur d1, p1, r1, patella d2, tibia d2, p2, r1, v1, metatarsus d1, p1, r1; leg II: femur d1, r1, patella d2, tibia d2, p1, r1, metatarsus d1, r1; leg III: femur d1, patella d2, tibia r1, metatarsus d1, p1, r1; leg IV: femur d2, patella d2, tibia d2, p1, metatarsus d1, p1, r1. Metatarsal trichobothria: Tm I: 0.29; Tm II: 0.25; Tm III: 0.14. Leg measurements: I 2.02 (0.65, 0.28, 0.40, 0.41, 0.28); II 1.64 (0.51, 0.25, 0.32, 0.32, 0.24); III 1.14 (0.34, 0.19, 0.18, 0.23, 0.20); IV 1.48 (0.45, 0.22, 0.30, 0.29, 0.22).

Female (collected together with holotype, from Tham Man Kone): total length 2.65, DS 1.03 long, 0.99 wide, clypeus 0.18, sternum 0.62 long, 0.53 wide, coxae IV separated by their width, opisthosoma 1.67 long, 1.58 wide. PME separated by less than half their diameter. Macrosetae: leg I: femur d1, p1, r1, patella d2, tibia d2, p2, r1, v2, metatarsus p1, r1, v1; leg II: femur d1, r1, patella d2, tibia d2, p1, r1, v1, metatarsus p1, r1, v1; leg III: femur d1, patella d2, tibia d1, r1, metatarsus d1, p1, r1, v1; leg IV: femur d2, patella d2, tibia d2, p1, r1, v1, metatarsus p1, r1. Metatarsal trichobothria: Tm I: 0.27; Tm II: 0.27; Tm III: 0.16. Leg measurements: I 3.48 (1.18, 0.47, 0.71, 0.71, 0.41); II 2.92 (0.93, 0.42, 0.58, 0.60, 0.39); III 1.99 (0.59, 0.31, 0.34, 0.43, 0.32); IV 2.79 (0.93, 0.38, 0.56, 0.55, 0.37).

Variation. The total length ranges from 1.48 to 1.62 in males (n = 10) and from 2.38 to 2.70 in females (n = 5).

Distribution. See in Fig. 19.

***Alaria navicularis* sp. n.**

<http://zoobank.org/05825720-58CD-40F4-9FBE-4FBA4A97E5D1>

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

Figs 5–10, 19

Material examined. **LAOS: Khammouan Province:** Holotype: ♂ (SMF), 2.5 km WNW of Ban Tathot, entrance 17°37.897'N, 105°07.502'E, exit 17°37.994'N, 105°07.195'E, altitude 200 m, entrance area and in front of limestone cave, Tham Kamouk, leg. 30 April 2012. Paratypes: 2 ♀ (SMF), same data as holotype; 1 ♀ (SMF), 8.3 km NE of Thakek, Tham Noi, 17°26.655'N, 104°51.767'E, altitude 158 m, in foot cave, leg. 26 November 2012; 1 ♀ (IZCAS), 2.5 km WNW of Ban Tathot, entrance 17°37.897'N, 105°07.502'E, exit 17°37.994'N, 105°07.195'E, altitude 200 m, entrance area and inner parts of limestone cave, Tham Kamouk, leg. 26 April 2012.

Etymology. This specific name is derived from the Latin word “navicularis” = “shaped like a boat”, and refers to the shape of the median apophysis in the male palp; adjective.

Diagnosis. The most significant difference of this new species to *A. chengguanensis* (Zhao and Li 2012: figs 1A–D, 2A–B, 3A–D, 4A–B, 5A–B) and *A. cavernicola* sp. n. (Figs 1–4) is the navicular median apophysis in the male (Figs 5B, 6D, 8A, 9D), the triangular, weakly sclerotized scape and the nearly circular, juxtaposed spermathecae in the female (Figs 7B–D, 10A–C).

Description. Habitus see in Figs 5A, 7A. DS pear-shaped, yellow, eyes with black base, cervical groove distinct, sternum yellow. Legs yellow. Opisthosoma oval in male, pale yellow, dorsum with small sclerotized spots and a pair of black speckles; sub-spherical in female, pale, dorsum with white patches.

Male palp (Figs 5B–D, 8A–B, 9A): patella with strong macroseta (Figs 5C, 8B, 8E). Tibia with 3 trichobothria and lamellar process (Figs 5F, 8E). Paracymbium with basal hooked process and distal short spicula (Figs 5D–E, 8D, 9A). Tegulum medially smooth, marginally rugose (Figs 6A, 8C). Median apophysis especially large, navicular, surface with tiny aculei, proximal process short, distal process long and rugose (Figs 6D, 9D). Conductor chisel-shaped, distally slightly bent, longer than embolus, (Figs 6B–C, 9B–C). Embolus long, needle-shaped, sclerotized, distal part embedded in conductor, embolic tip not beyond distal end of conductor (Figs 6A–C, 8C, 9A–C).

Female copulatory organ (Figs 7B–D, 10A–C): epigynal area covered with long setae (Figs 7B, 10A, 10C). Scape large, triangular, basally rugose and contracted, apically weakly sclerotized, with small distal pocket, protruding from beneath epigynal posterior margin (Figs 7B–D, 10A–C). Spermathecae sub-circular, juxtaposed; lateral copulatory ducts coils oval, bent (Figs 7D, 10B). Copulatory ducts narrow, ending laterally margin in spermathecae (Figs 7D, 10B). Fertilization ducts short, triangular, arising ventro-laterally from spermathecae (Figs 7D, 10B).

Male: total length 2.31, DS 1.10 long, 0.93 wide, clypeus 0.17, sternum 0.55 long, 0.45 wide, coxae IV separated by their width, opisthosoma 1.31 long, 1.20 wide. PME separated by less than half their diameter. Macrosetae: leg I: femur d2, p1, r1, patella d2, tibia d2, p3, r1, v2, metatarsus d1, p1, r1, v1; leg II: femur d2, r1, patella d2, tibia

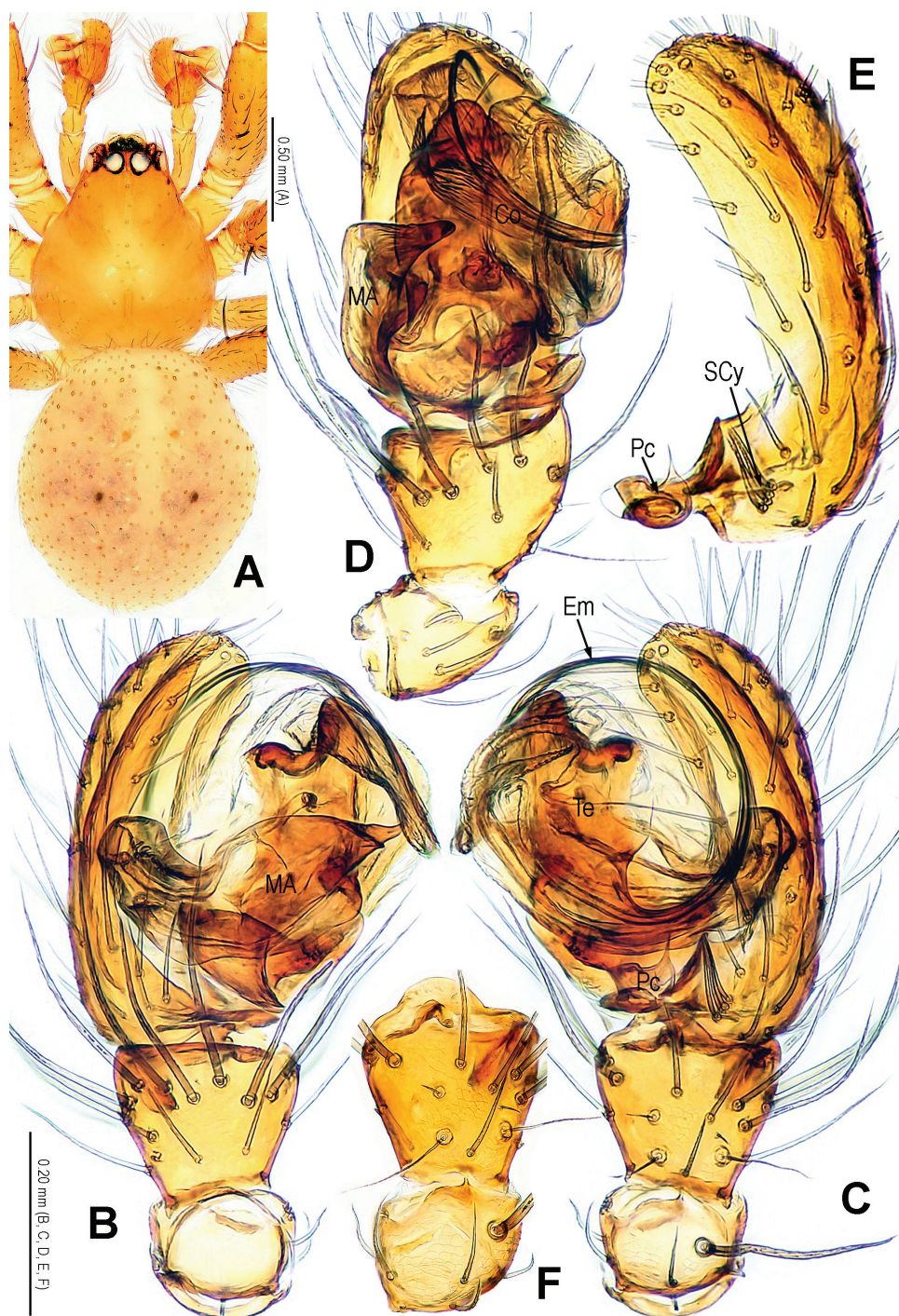


Figure 5. *Alaria navicularis* sp. n., holotype male. **A** Habitus, dorsal **B** Palp, prolateral **C** Ditto, retrolateral **D** Ditto, ventral **E** Cymbium, retrolateral **F** Palpal patella and tibia, retrolateral. Co = conductor; Em = embolus; MA = median apophysis; Pc = paracymbium; SCy = setae of cymbium; Te = tegulum.

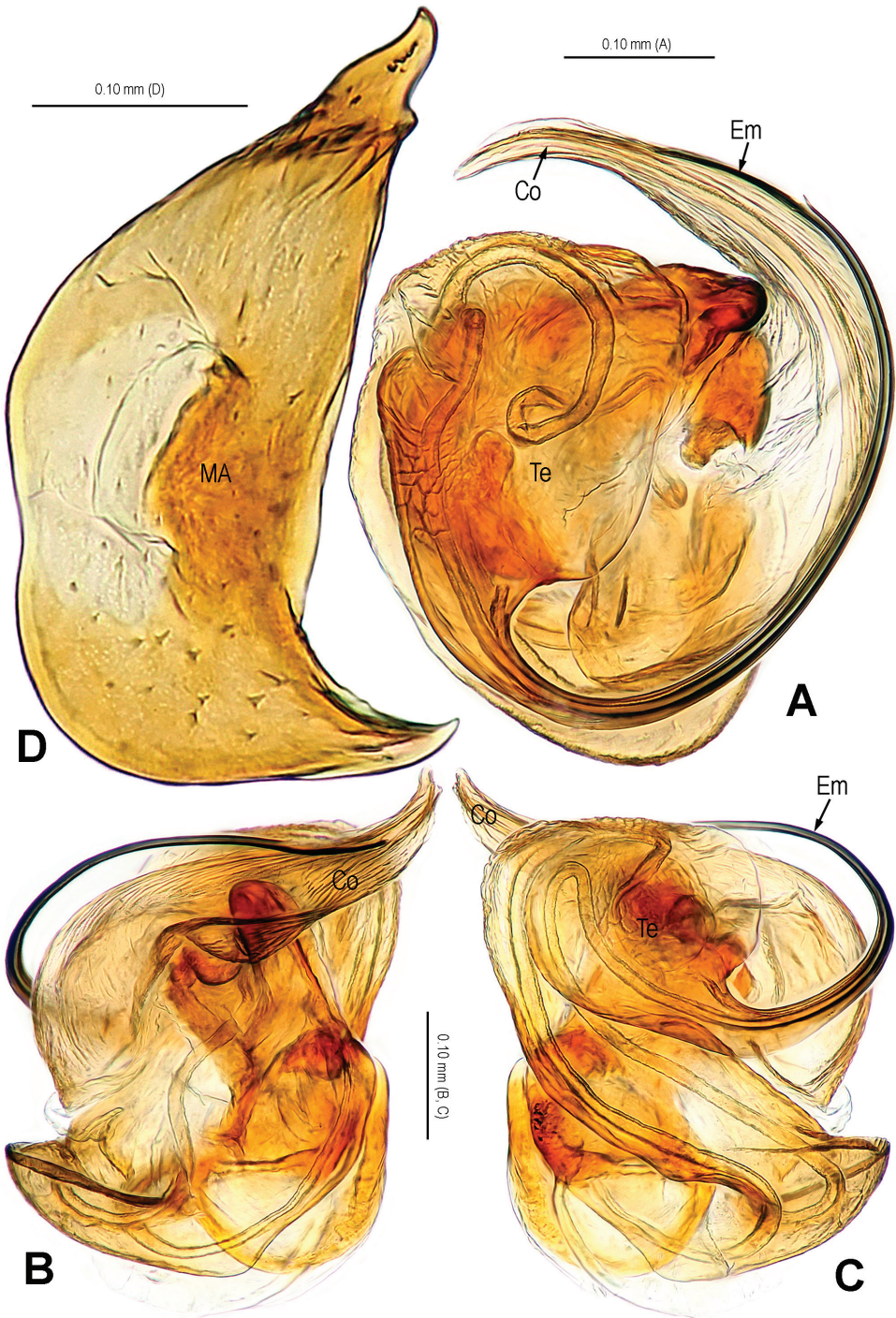


Figure 6. *Alaria navicularis* sp. n., male holotype. **A** Bulb (median apophysis removed), distal **B** Ditto, prolateral **C** Ditto, retrolateral **D** Median apophysis, prolateral. Co = conductor; Em = embolus; MA = median apophysis; Te = tegulum.

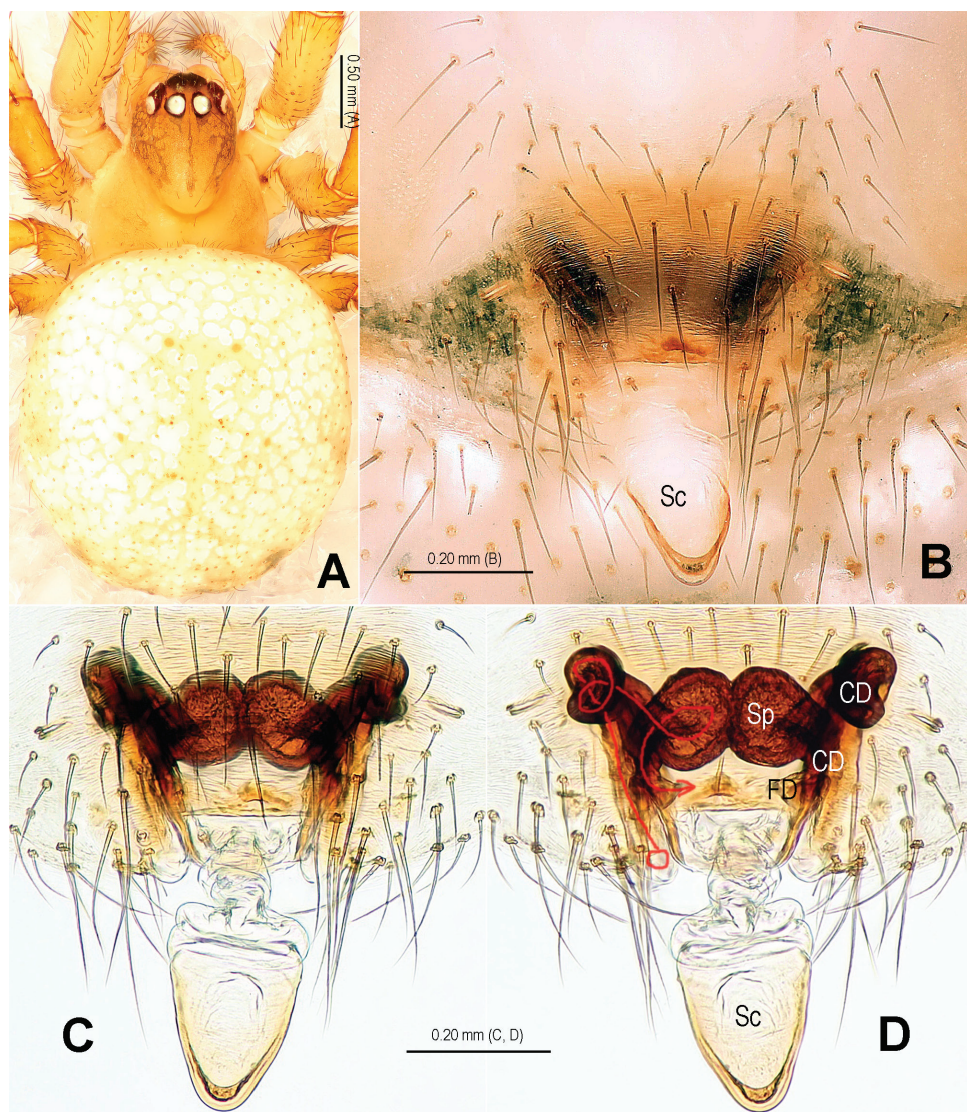


Figure 7. *Alaria navicularis* sp. n., female paratype, from Tham Kamouk. **A** Habitus, dorsal **B** Epigyne, ventral **C** Vulva (lactic acid-treated), ventral **D** Ditto, dorsal (red line showing course of duct system). CD = copulatory duct; FD = fertilization duct; Sc = scape; Sp = spermathecae.

d2, p1, r1, v1, metatarsus d2, r1, v1; leg III: femur d2, patella d2, tibia d2, p1, v1, metatarsus d1, p1, r1, v1; leg IV: femur d2, p1, patella d2, tibia d2, p1, r1, v1, metatarsus d1, p1, r1, v1. Metatarsal trichobothria: Tm I: 0.22; Tm II: 0.24; Tm III: 0.14. Leg measurements: I 3.34 (1.09, 0.45, 0.67, 0.69, 0.44); II 2.90 (0.93, 0.42, 0.57, 0.58, 0.40); III 2.16 (0.72, 0.32, 0.36, 0.43, 0.33); IV 2.65 (0.85, 0.37, 0.53, 0.55, 0.35).

Female (collected together with holotype): Total length 3.62, DS 1.24 long, 1.45 wide, clypeus 0.15, sternum 0.78 long, 0.68 wide, coxae IV separated by their width,

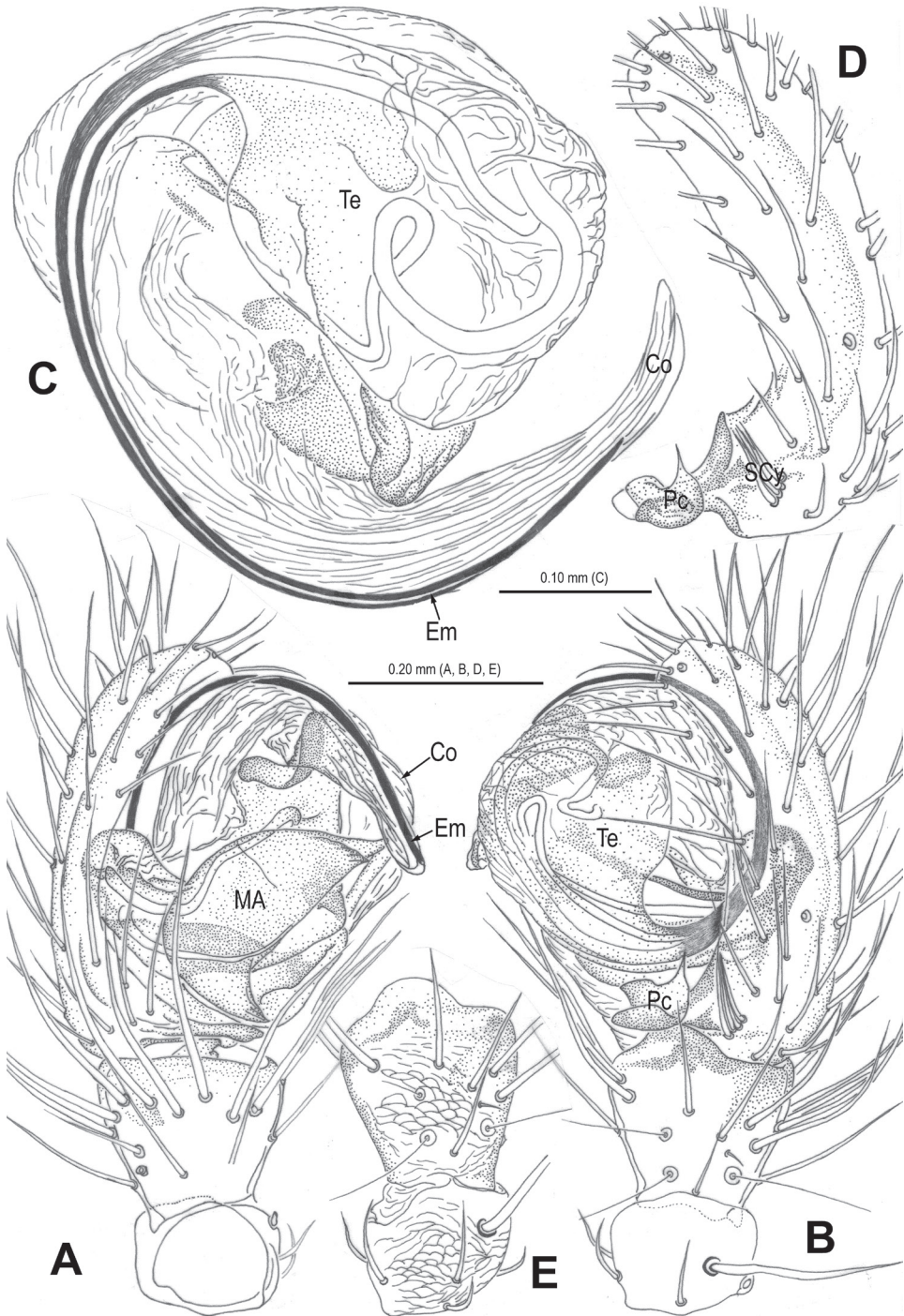


Figure 8. *Alaria navicularis* sp. n., holotype male. **A** Palp, prolateral **B** Ditto, retrolateral **C** Bulb (median apophysis removed), distal **D** Cymbium, retrolateral **E** Palpal patella and tibia, retrolateral. Co = conductor; Em = embolus; MA = median apophysis; Pc = paracymbium; SCy = setae of cymbium; Te = tegulum.

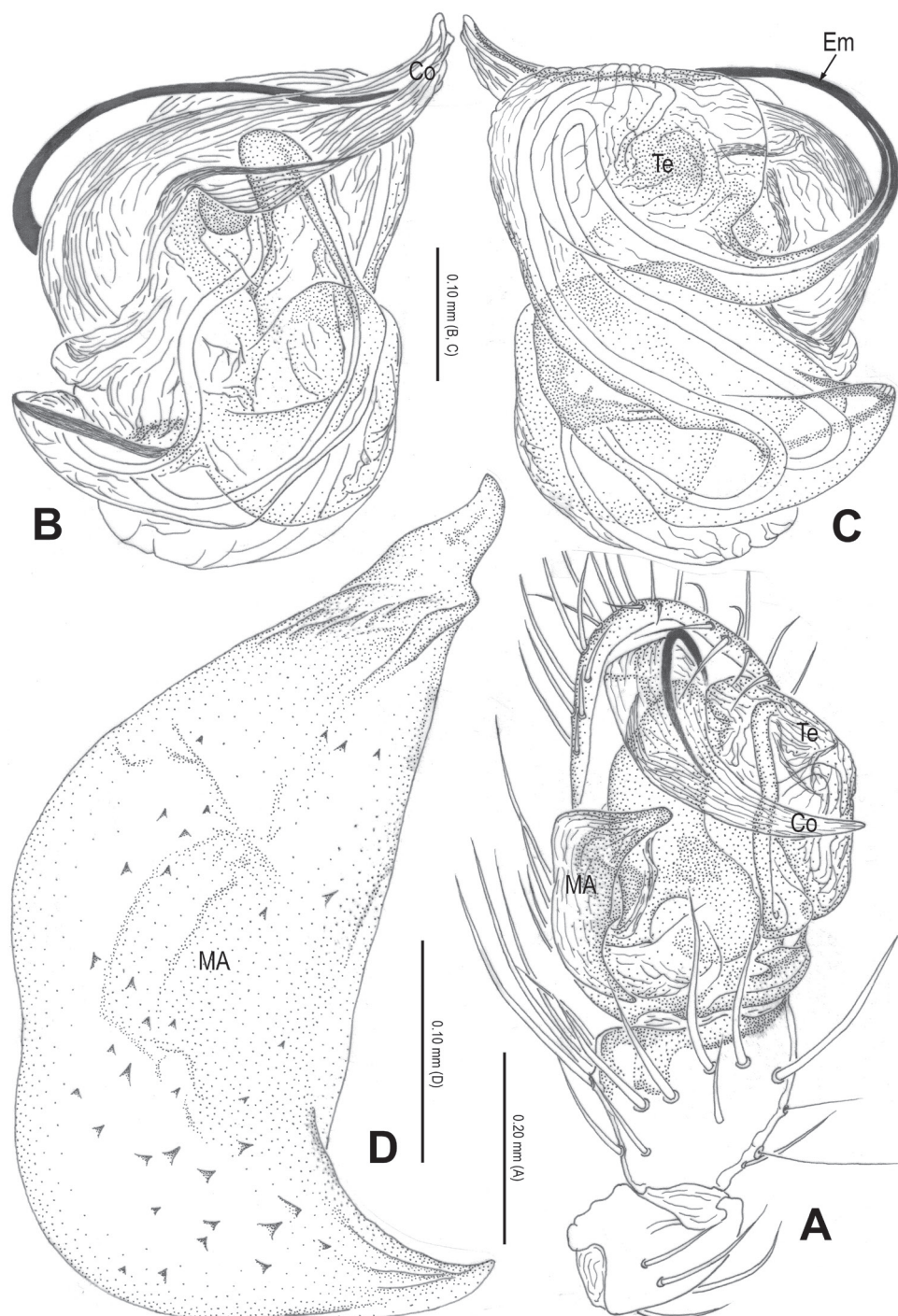


Figure 9. *Alaria navicularis* sp. n., holotype male. **A** Palp, ventral **B** Bulb (median apophysis removed), prolateral **C** Ditto, retrolateral **D** Median apophysis, prolateral. Co = conductor; Em = embolus; MA = median apophysis; Te = tegulum.

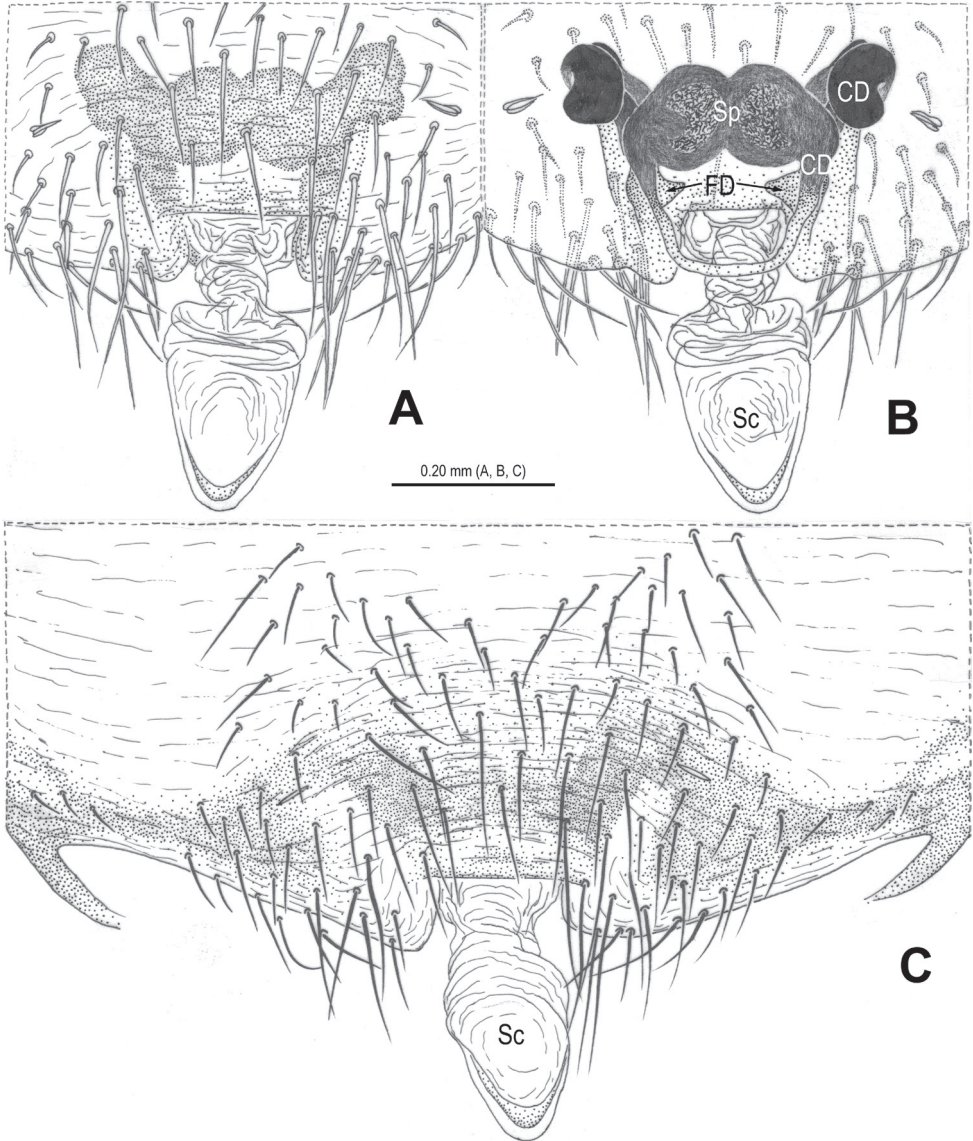


Figure 10. *Alaria navicularis* sp. n., female paratype, from Tham Kamouk. **A** Vulva (lactic acid-treated), ventral **B** Ditto, dorsal **C** Epigyne (untreated), ventral. CD = copulatory duct; FD = fertilization duct; Sc = scape; Sp = spermathecae.

opisthosoma 2.45 long, 2.35 wide. PME separated by less than half their diameter. Macrosetae: Leg I: femur d1, p1, r1, patella d2, tibia d2, p2, r1, v1, metatarsus p1, r1, v1; leg II: femur d2, r1, patella d2, tibia d2, p1, r1, v1, metatarsus p1, r1, v1; leg III: femur d1, v1, patella d2, tibia d2, p1, v1, metatarsus d1, p1, r1, v1; leg IV: femur d2, p1, patella d2, tibia d2, p1, r1, v1, metatarsus d1, p1, r1, v1. Metatarsal trichobothria: Tm I: 0.30; Tm II: 0.25; Tm III: 0.15. Leg measurements: I 4.46 (1.45, 0.61, 0.93,

0.88, 0.59); II 3.85 (1.20, 0.56, 0.78, 0.77, 0.54); III 2.83 (0.92, 0.42, 0.49, 0.54, 0.46); IV 3.54 (1.16, 0.52, 0.70, 0.69, 0.47).

Variation. The total length ranges from 3.42 to 3.70 in females (n = 4).

Distribution. See in Fig. 19.

***Alaria bicornis* sp. n.**

<http://zoobank.org/BA4F961C-149D-4C48-842B-C88A71DE3282>

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

Figs 11–16, 19

Material examined. LAOS: Vientiane Province: Vang Vieng: Holotype: ♂ (SMF), North of Ban Phoxay, 19°00.880'N, 102°25.902'E, altitude 280 m, Tham Kieo, in cave, leg. 2 December 2012. Paratypes: 2 ♂, 5 ♀ (SMF), with same data as for holotype; 2 ♂, 2 ♀ (SMF, IZCAS), cross Nam Song, 18°54.550'N, 102°26.527'E, altitude 270 m, Tham Xiang, in cave, leg. 3 December 2012; 5 ♀ (SMF), N of Ban Phoxay, 19°02.350'N, 102°25.423'E, altitude 256 m, Tham Hoi, in cave, leg., 3 December 2012; 3 ♀ (SMF), N of Ban Phoxay, 19°01.749'N, 102°25.954'E, altitude 290 m, Tham Phathao, in cave, leg. 3 December 2012.

Etymology. This specific name is derived from the Latin word “bicornis” = “with two horns”, referring to the median apophysis with a fingerlike and a hooked process in the male palp; used as an adjective.

Diagnosis. This new species and *A. chengguanensis* (Zhao and Li 2012: figs 1A–D, 2A–B, 3A–D, 4A–B, 5A–B) share the combination of the following features: tufted setae of cymbium (Figs 12E, 15E), especially large median apophysis (Figs 11B, 12D, 14A, 15D), and long embolus mostly enveloped by conductor in male, an utterly exposed scape protruding from beneath epigynal posterior margin and similar configurations of vulva in female, but the new species can be distinguished from the latter by the developed, strongly rugose tegulum (Figs 11C, 12C, 15C), the large median apophysis with 2 distal processes (Figs 12D, 14A, 15D) and the absence of a hooked process in paracymbium in male (Figs 12E, 15E), the oval median spermathecae (Figs 13C, E, 16B), the strongly sclerotized, long oval, lateral coils of copulatory duct (Figs 13E, 16B) and the narrow scape with two hoods in female (Figs 13C–E, 16A–C).

Description. Habitus see in Figs 11A, 13A. DS pear-shaped, brownish yellow, thoracic fovea black, with symmetric dark veins. Eyes with black bases. Cervical groove distinct. Sternum brown. Legs proximally yellow, distally dark yellow. Opisthosoma oval, dark, dorsum with a long, longitudinal white stripe and 3 pairs of white spots minishing in sequence.

Male palp (Figs 11B–D, 14A–C): patella with 1 strong macroseta (Figs 12F, 15F). Tibia with 3 trichobothria (Figs 12F, 15F). Paracymbium horn-shaped, proximally large, distally pointed (Figs 12E, 15E). Tegulum broad, strongly rugose and sclerotized (Figs 12A, 12C, 15A, 15C). Median apophysis very large, surface with tiny aculei, with one fingerlike and one hooked process (Figs 12D, 15D).

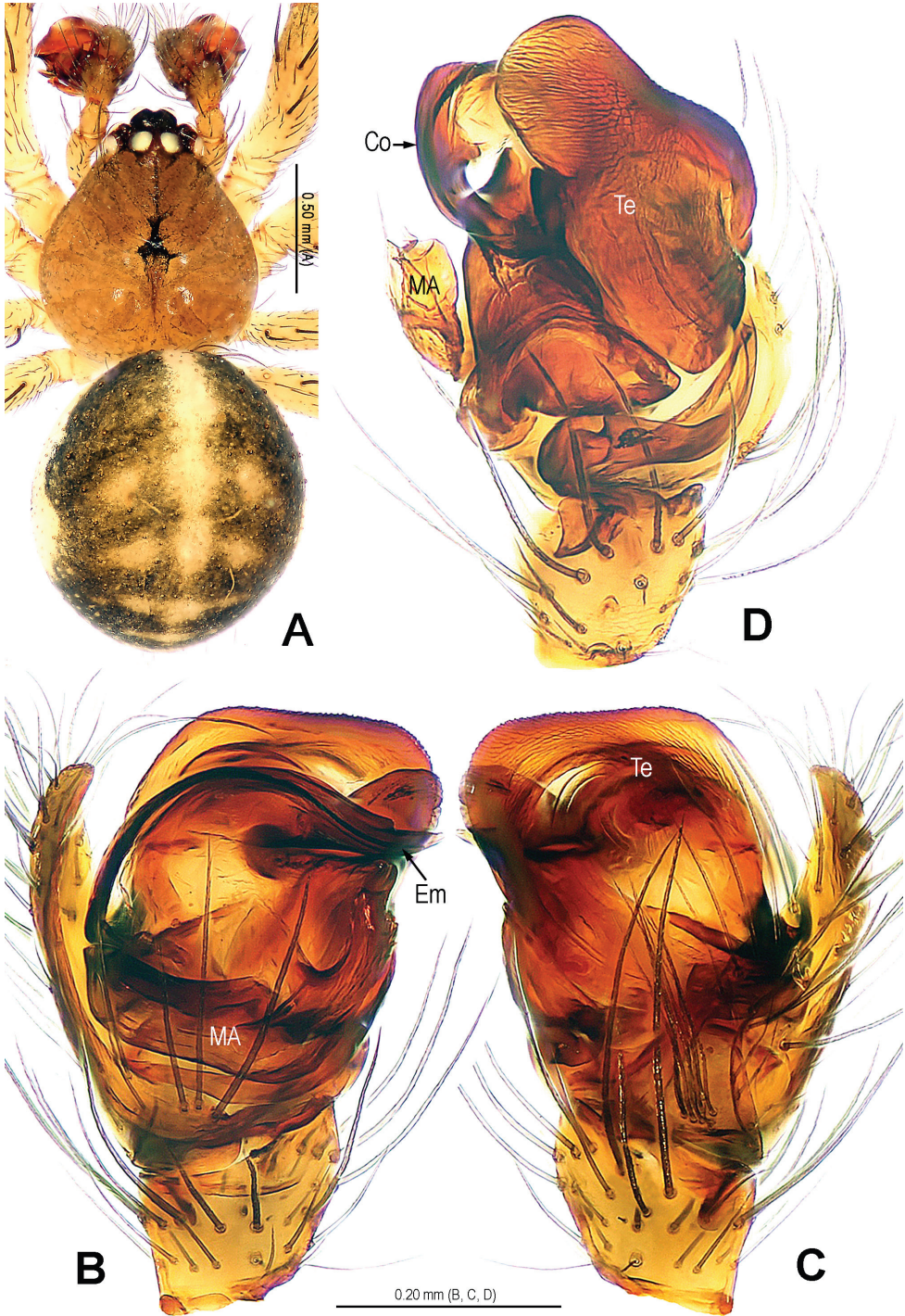


Figure 11. *Alaria bicornis* sp. n., holotype male. **A** Habitus, dorsal **B** Palp, prolateral **C** Ditto, retrolateral **D** Ditto, ventral. Co = conductor; Em = embolus; MA = median apophysis; Te = tegulum.

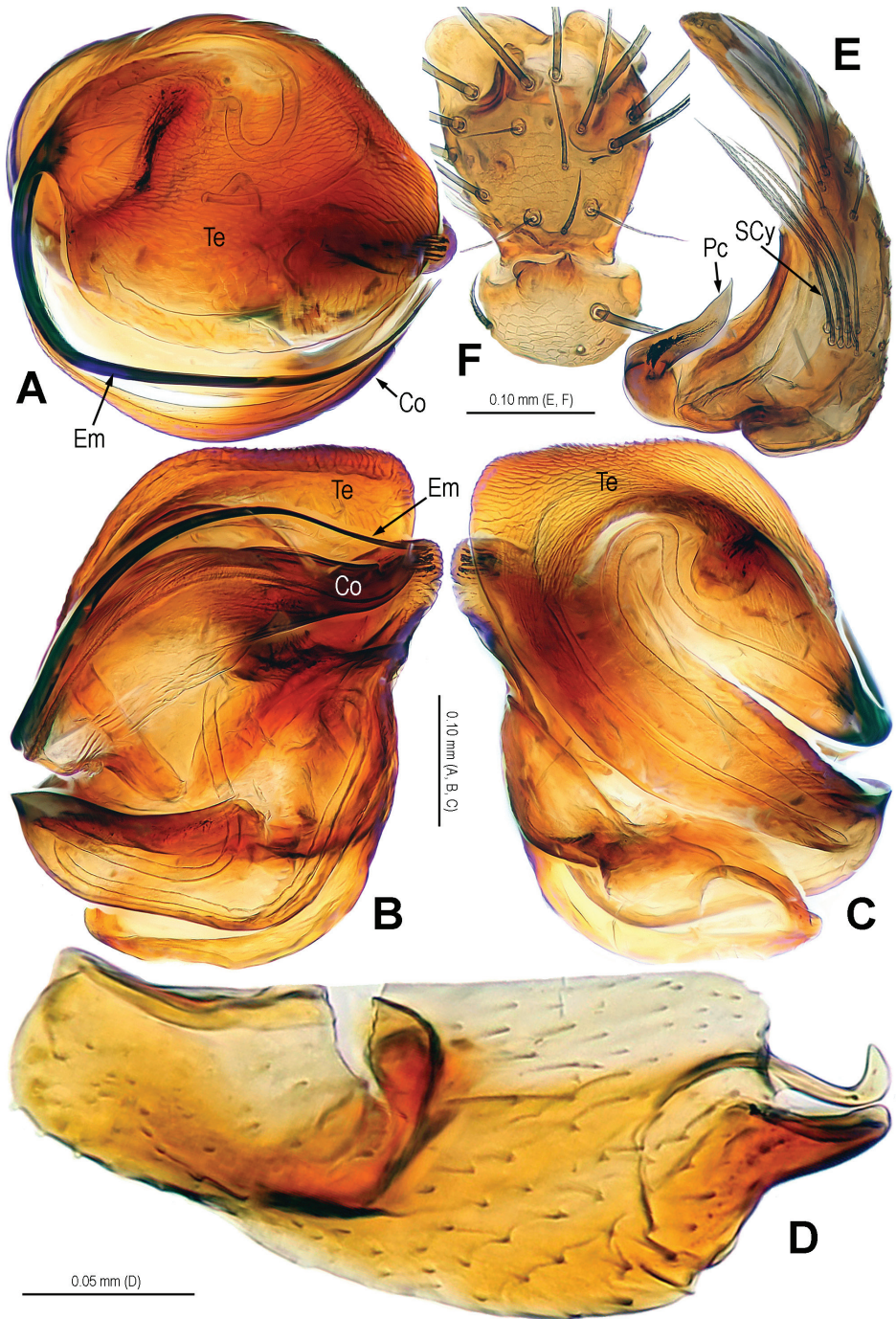


Figure 12. *Alaria bicornis* sp. n., holotype male. **A** Bulb (median apophysis removed), distal **B** Ditto, prolateral **C** Ditto, retrolateral **D** Median apophysis, prolateral **E** Cymbium, retrolateral **F** Palpal patella and tibia, ventral. Co = conductor; Em = embolus; Pc = paracymbium; SCy = setae of cymbium; Te = tegulum.

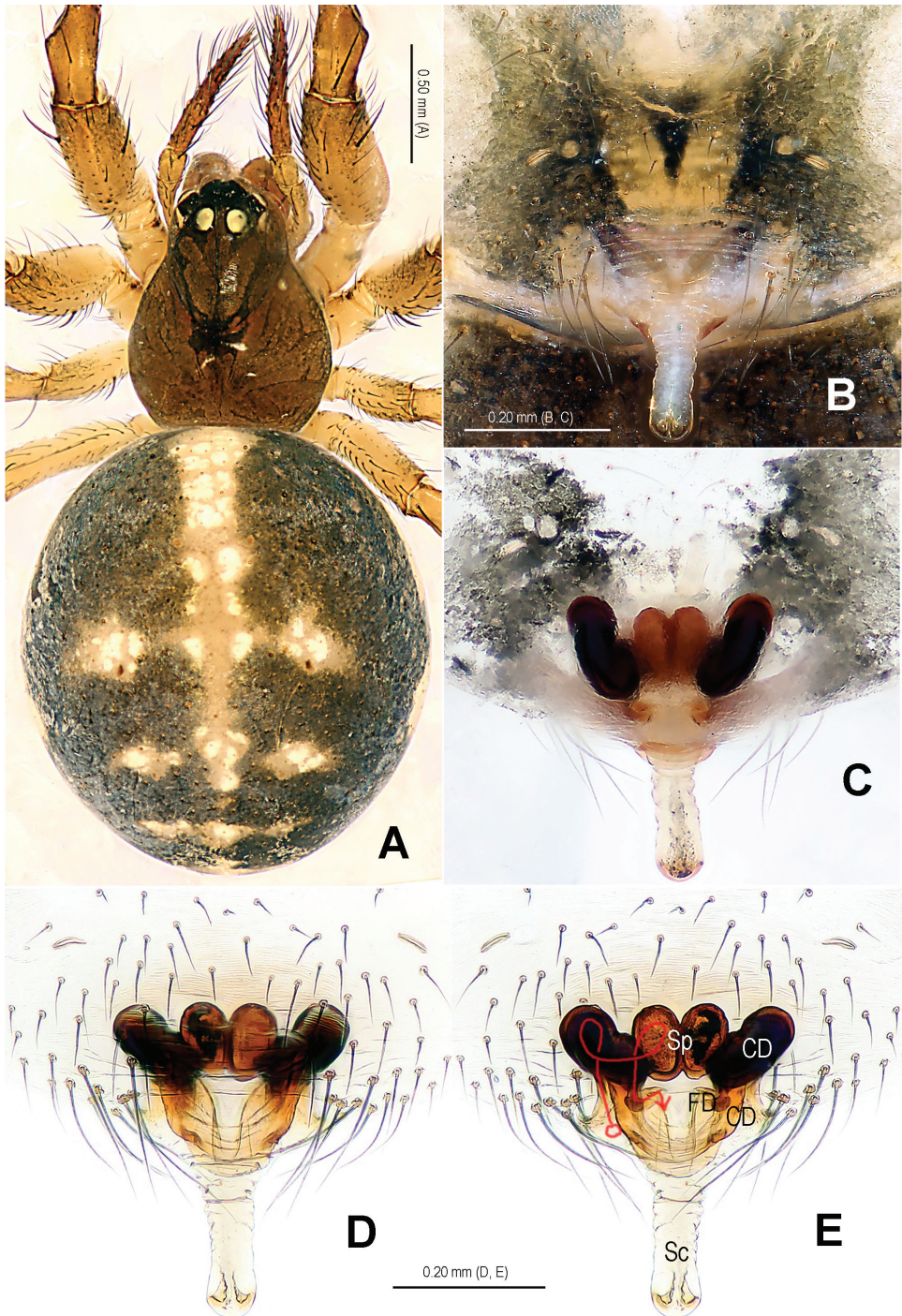


Figure 13. *Alaria bicornis* sp. n., female paratype, from Tham Kieo. **A** Habitus, dorsal **B** Epigyne, ventral **C** Vulva, dorsal **D** Epigyne (lactic acid-treated), ventral **E** Vulva, dorsal (red line showing course of duct system). CD = copulatory duct; FD = fertilization duct; Sc = scape; Sp = spermathecae.

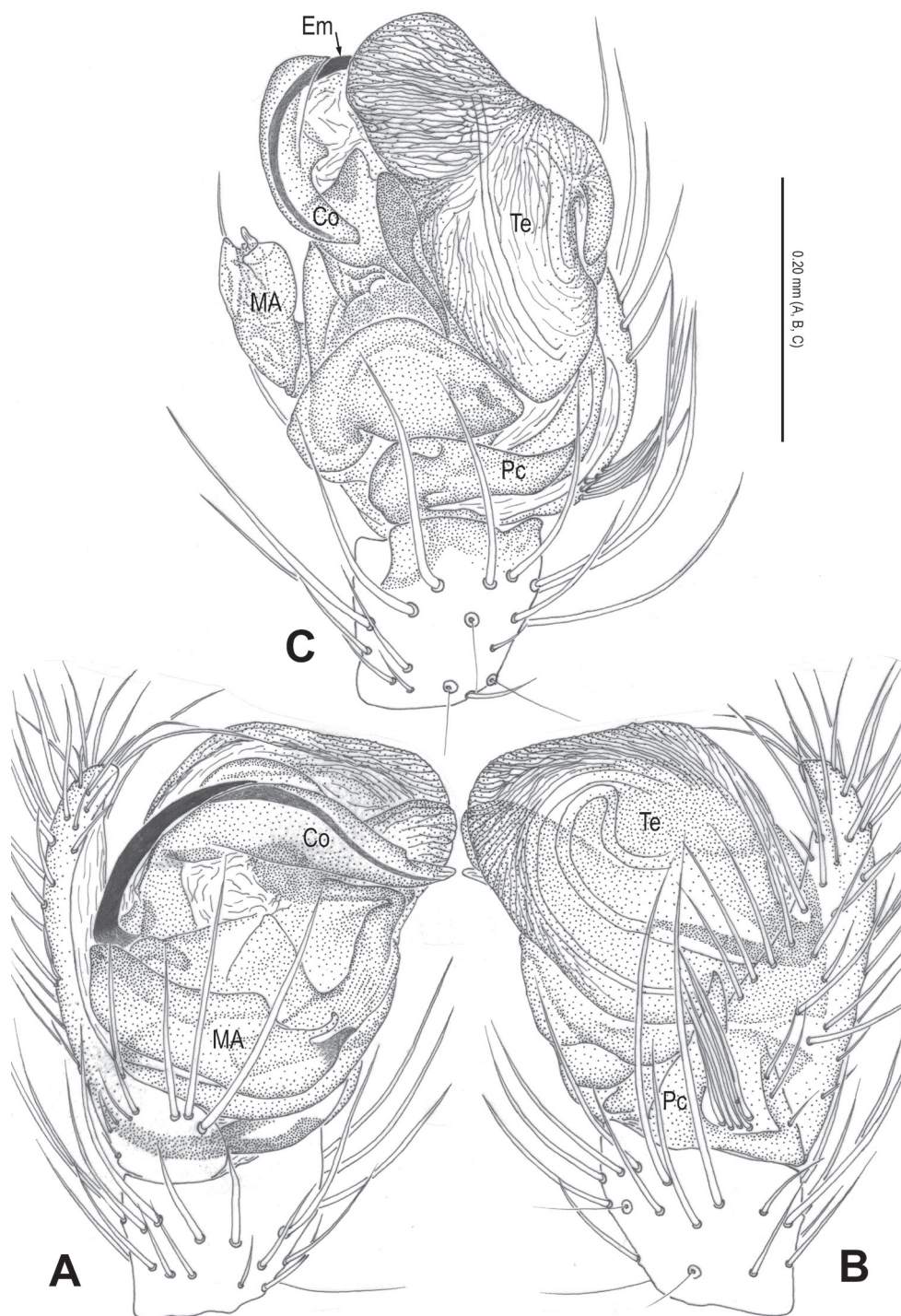


Figure 14. *Alaria bicornis* sp. n., holotype male. **A** Palp, prolateral **B** Ditto, retrolateral **C** Ditto, ventral. Co = conductor; Em = embolus; MA = median apophysis; Pc = paracymbium; Te = tegulum.

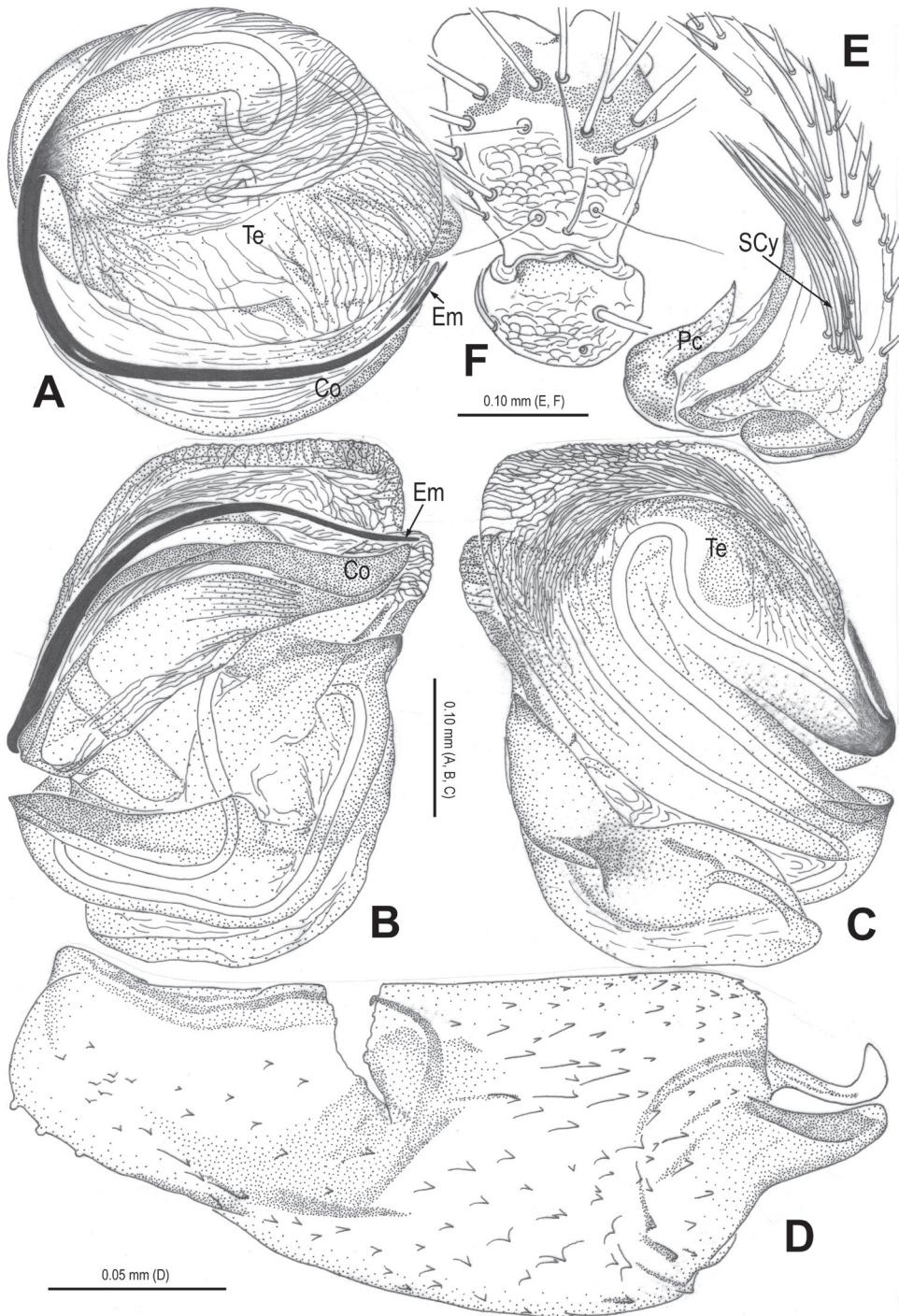


Figure 15. *Alaria bicornis* sp. n., holotype male. **A** Bulb (median apophysis removed), distal **B** Ditto, prolateral **C** Ditto, retrolateral **D** Median apophysis, prolateral **E** Cymbium, retrolateral **F** Palpal patella and tibia, ventral. Co = conductor; Em = embolus; Pc = paracymbium; SCy = setae of cymbium; Te = tegulum.

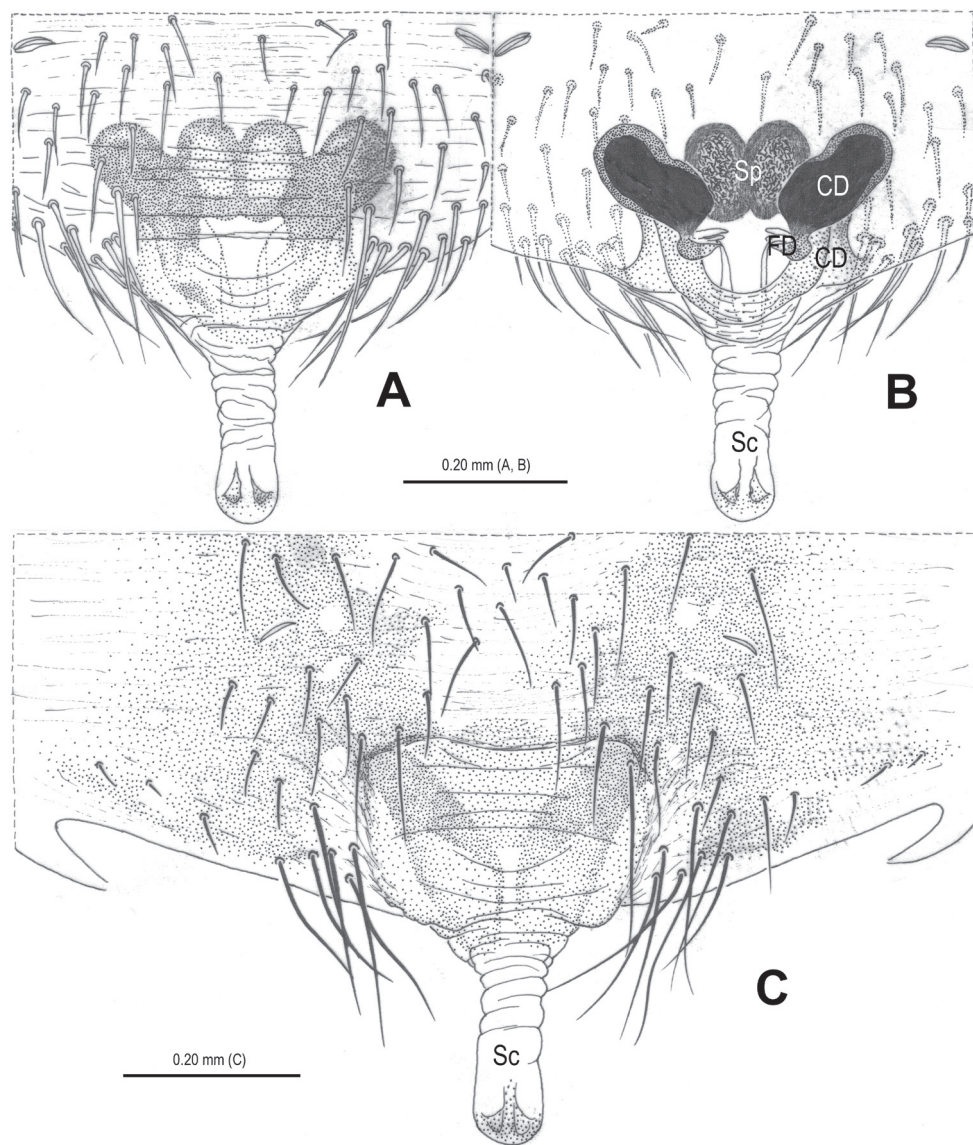


Figure 16. *Alaria bicornis* sp. n., female paratype, from Tham Kieo. **A** Epigyne (lactic acid-treated), ventral **B** Vulva (lactic acid-treated), dorsal **C** Epigyne (untreated), ventral. CD = copulatory duct; FD = fertilization duct; Sc = scape; Sp = spermathecae.

Conductor chisel-shaped, distinctly sclerotized, distally horn-shaped (Figs 11B, 11D, 12A, 14A, 14C, 15A). Embolus long, needle-shaped, sclerotized, most part embedded in conductor, embolic tip just on distal end of conductor (Figs 12A–B, 14A, 14C, 15A–B).

Female copulatory organ (Figs 13B–E, 16A–C): epigynal area covered with setae (Figs 13D, 16C). Scape long, fingerlike, rugose and membranous, distally weakly sclerotized, with 2 small hoods, extending from epigynal posterior margin (Figs 13B–C, 16A–C). Spermathecae oval, juxtaposed; lateral copulatory ducts strongly sclerotized, overlapping with dorsally posterolateral part of medial spermathecae (Figs 13C, 13E, 16B). Copulatory ducts wide, leading to posterolateral part of spermathecae (Figs 13E, 16B). Fertilization ducts short, arising posterolaterally from spermathecae (Figs 13E, 16B).

Male: Total length 2.01, DS 0.99 long, 0.78 wide, clypeus 0.15, sternum 0.60 long, 0.46 wide, coxae IV separated by their width, opisthosoma 1.09 long, 1.00 wide. PME separated by less than half their diameter. Macrosetae: Leg I: femur d2, p1, r1, patella d2, tibia d2, p2, r1, v2, metatarsus d1, r1, v1; leg II: femur d2, r1, patella d2, tibia d1, r1, v1, metatarsus d1, r1, v1; leg III: femur d2, patella d2, tibia p1, r1, v1, metatarsus d1, p1, r1; leg IV: femur d2, p1, patella d2, tibia d1, p1, r1, v1, metatarsus d1, p1, r1. Metatarsal trichobothria: Tm I: 0.24; Tm II: 0.24; Tm III: 0.09. Leg measurements: I 3.02 (0.97, 0.40, 0.66, 0.62, 0.37); II 2.44 (0.80, 0.35, 0.50, 0.46, 0.33); III 1.82 (0.56, 0.24, 0.34, 0.38, 0.30); IV 2.31 (0.73, 0.31, 0.48, 0.49, 0.30).

Female (collected together with holotype): total length 2.95, DS 1.10 long, 0.90 wide, clypeus 0.11, sternum 0.61 long, 0.47 wide, coxae IV separated by their width, opisthosoma 1.93 long, 1.75 wide. PME separated by about half their diameter. Macrosetae: Leg I: femur p1, r1, patella d2, tibia d2, p2, r1, v2, metatarsus p1, r2; leg II: femur d1, r1, patella d2, tibia d2, p1, r1, v1, metatarsus p1, r1, v1; leg III: femur d1, patella d2, tibia d1, r1, v1, metatarsus d1, p1, r1, v1; leg IV: patella d2, tibia d1, p1, r1, metatarsus p1, r1. Metatarsal trichobothria: Tm I: 0.26; Tm II: 0.23; Tm III: 0.12. Leg measurements: I 3.65 (1.20, 0.44, 0.80, 0.76, 0.45); II 2.99 (0.94, 0.40, 0.63, 0.60, 0.42); III 2.05 (0.61, 0.28, 0.39, 0.42, 0.35); IV 2.88 (0.90, 0.33, 0.65, 0.60, 0.40).

Variation. The total length ranges from 1.88 to 2.15 in males ($n = 5$) and from 2.73 to 3.20 in females ($n = 15$).

Distribution. See in Fig. 19.

Genus *Chthonopes* Wunderlich, 2011

<http://species-id.net/wiki/Chthonopes>

Type species. *Chthonopes jaegeri* Wunderlich, 2011 from Laos.

The genus was described in 2011 from two species recorded in Laos (Wunderlich 2011). The type species was known from Bolikhamsay Province from its type locality, *C. cavernicolus* Wunderlich, 2011 was recorded from Khammouan Province. Two additional females from Oudomxai Province were preliminary assigned to *Chthonopes* as well without describing them formally as new species. All spiders were recorded from caves.

***Chthonopes thakekensis* sp. n.**

<http://zoobank.org/92AA0D92-9434-414D-A86F-4596C0164644>

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

Figs 17–19

Material examined. LAOS: *Khammouan Province*: Holotype: ♀ (SMF), Thakek area, Ban Phôngam-Mai, 17°32.954'N, 104°48.754'E, altitude 180 m, Tham Phay-at, in limestone cave, leg. 25 November 2012.

Etymology. This specific name is taken from type locality; adjective.

Diagnosis. The new species is similar to *C. jaegeri* Wunderlich, 2011 (see Wunderlich 2011: 443, figs 18d–f) in the shape of epigyne and the configurations of vulva, but can be distinguished from it by the presence of translucent accessory spermathecae (Figs 17D–E, 18C; absent in *C. jaegeri*) and the large, semi-circular main spermathecae (Figs 17E, 18C; circular in *C. jaegeri*).

Description. Habitus see in Fig. 17A. DS yellow, pear-shaped, smooth; eyes small, with black base, AME contiguous, LE contiguous, anterior eye row recurved, posterior eye row procurved; sternum yellow, with sparse setae; legs yellow; opisthosoma spherical, covered with sparse long setae, setal base sclerotized.

Female copulatory organ (Figs 17C, 17E, 18C): epigyne large, with long setae in midline (Figs 17B, 18A); scape long, translucent, rugose, extending from posterior margin of epigynal plate, distal end weakly sclerotized (Fig. 17D); Spermathecae large, strongly sclerotized, separated by about 1.2 times their width (Fig. 17E); accessory spermathecae claviform, translucent (Fig. 17E); copulatory ducts wide, rugose, sclerotized, connected with posterior margin of main spermathecae (Figs 17E, 18C); fertilization ducts originating medio-posteriorly from main spermathecae, apical parts close to each other (Figs 17E, 18C).

Female: Total length 2.51, DS 0.89 long, 0.85 wide, clypeus 0.18, sternum 0.48 long, 0.49 wide, coxae IV separated by 0.97 time their width, opisthosoma 1.63 long, 1.60 wide. PME separated by about 1.5 times their diameter. Macrosetae: Leg I: patella d2, tibia d2, p2, r1, metatarsus d2, p5, r2, v2; leg II: patella d2, tibia d6, p3, r2, v3, metatarsus d2, p4, r2, v4; leg III: patella d2, tibia d2, p3, r3, v3, metatarsus d2, p6, r4, v6; leg IV: patella d2, tibia d3, p3, r4, metatarsus d3, p4, r3, v2. Metatarsal trichobothria: Tm I: 0.20; Tm II: 0.15; Tm III: 0.27. Leg measurements: I 3.83 (1.17, 0.49, 0.83, 0.79, 0.55); II 3.40 (1.03, 0.42, 0.74, 0.69, 0.52); III 2.56 (0.76, 0.34, 0.51, 0.54, 0.41); IV 3.03 (0.95, 0.36, 0.68, 0.62, 0.42).

Male unknown.

Distribution. See in Fig. 19.

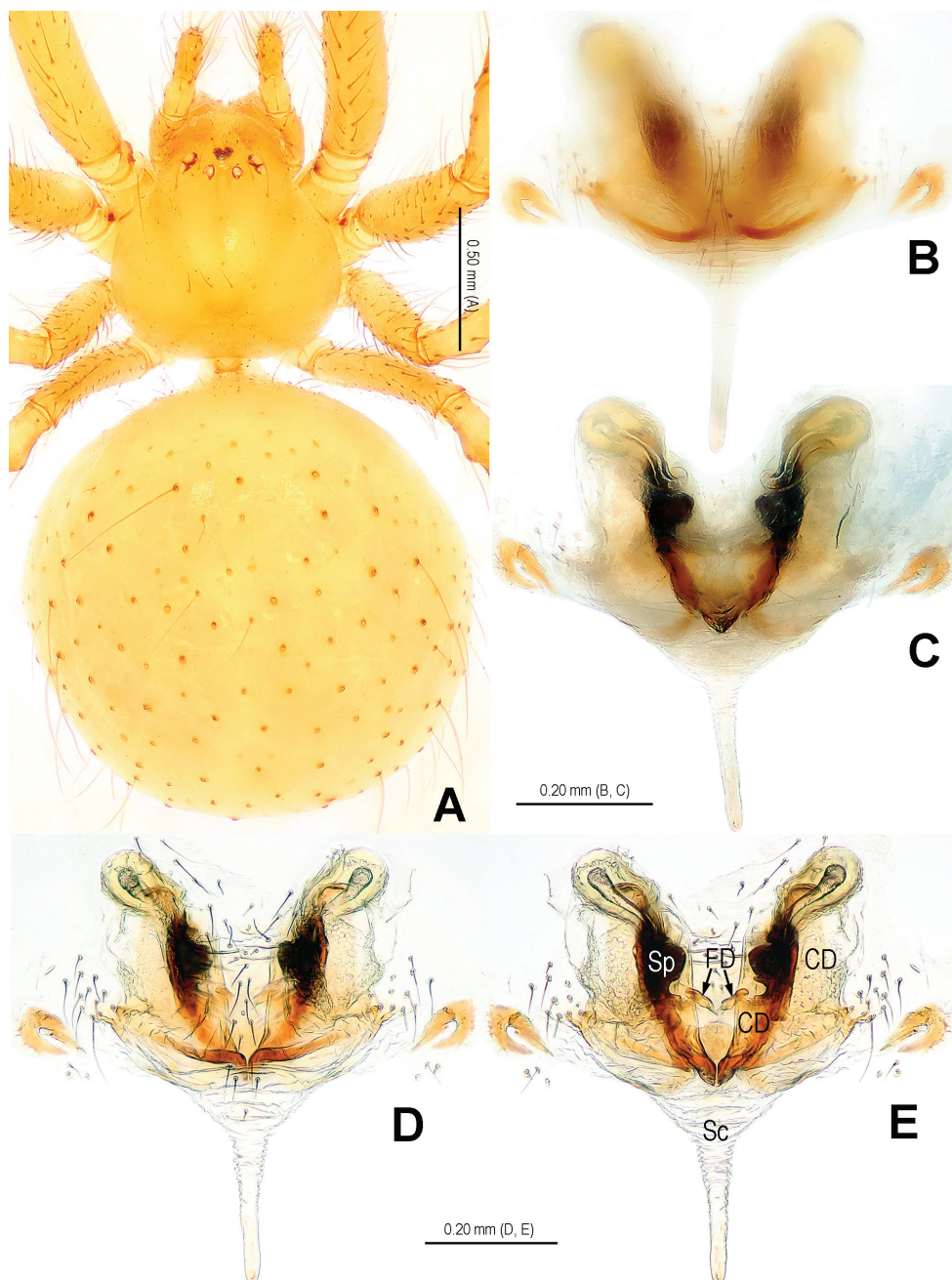


Figure 17. *Chthonopes thakekensis* sp. n., holotype female. **A** Habitus, dorsal **B** Epigyne (untreated), ventral **C** Vulva, dorsal **D** Epigyne (lactic acid-treated), ventral **E** Vulva, dorsal. CD = copulatory duct; FD = fertilization duct; Sc = scape; Sp = spermathecae.

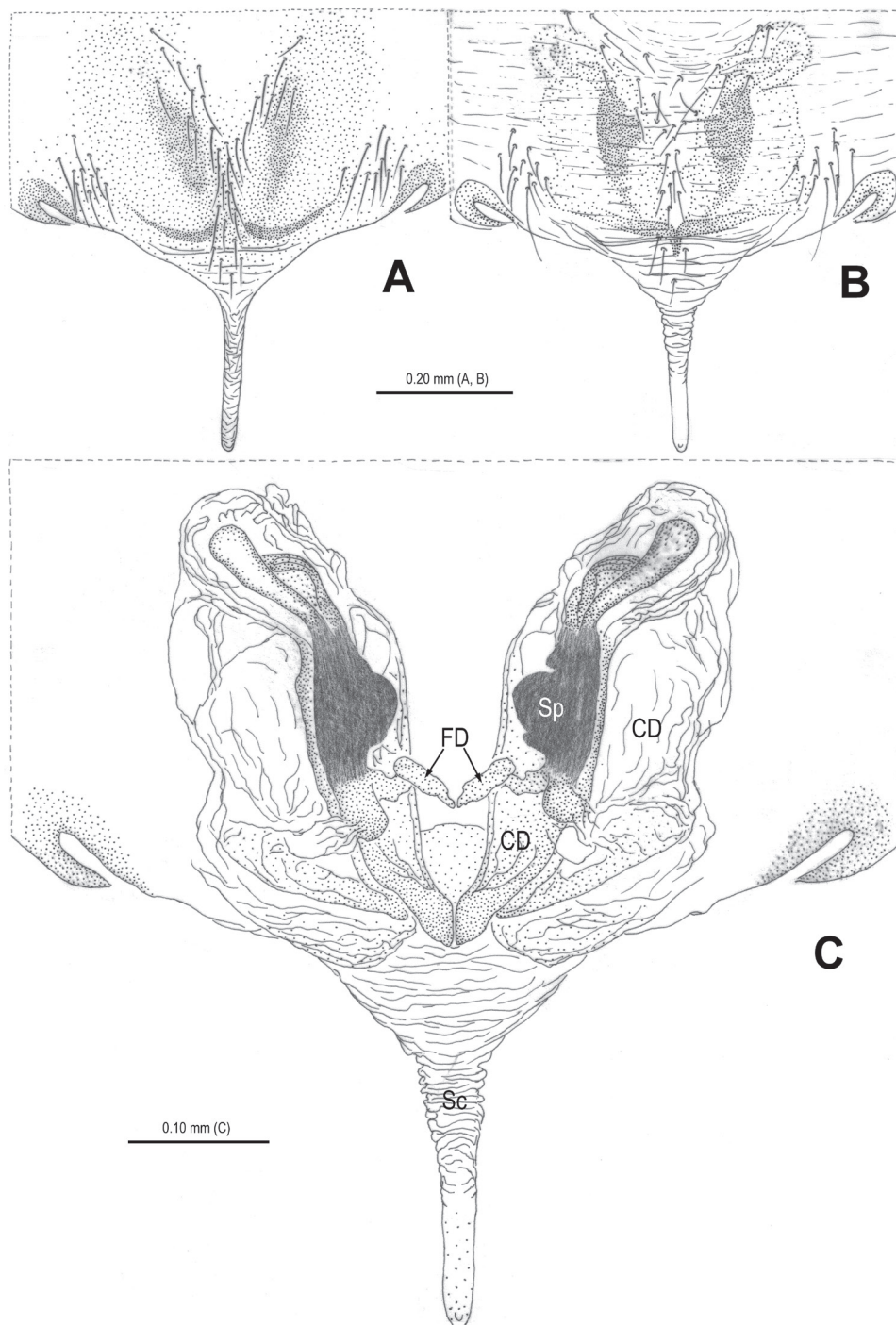


Figure 18. *Chthonopes thakekensis* sp. n., holotype female. **A** Epigyne (untreated), ventral **B** Ditto (lactic acid-treated), ventral **E** Vulva (lactic acid-treated), dorsal. CD = copulatory duct; FD = fertilization duct; Sc = scape; Sp = spermathecae.

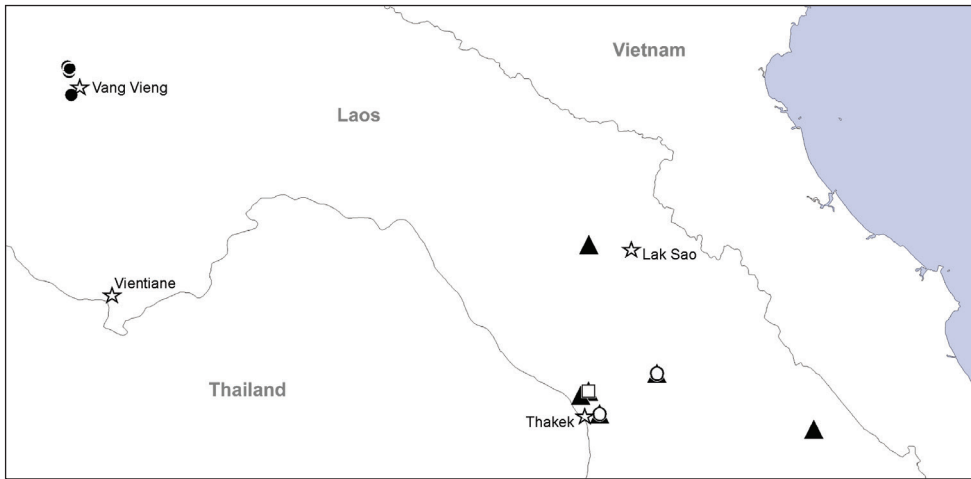


Figure 19. Records of four species of Theridiosomatidae from Laos. Filled triangles – *Alaria cavernicola* sp. n.; Open circles – *Alaria navicularis* sp. n.; Filled circles – *Alaria bicornis* sp. n.; Open square – *Chthonopes thakekensis* sp. n.; Stars — towns.

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References

- Barrion AT, Litsinger JA (1995) *Riceland Spiders of South and Southeast Asia*. CAB International, Wallingford, UK, xix + 700 pp.
- Brignoli PM (1981) Spiders from the Philippines IV. A new *Ogulnius* and notes on some other oriented and Japanese Theridiosomatidae (Araneae). *Acta Arachnologica* 30: 9–19. doi: 10.2476/asjaa.30.9
- Chen HM (2010) *Karstia*, a new genus of troglophilous Theridiosomatid (Araneae, Theridiosomatidae) from Southwestern China. *Guizhou Science* 28(4): 1–10.
- Coddington JA (1986) The genera of the spider family Theridiosomatidae. *Smithsonian Contributions to Zoology* 422: 1–96. doi: 10.5479/si.00810282.422
- Dou L, Lin Y (2012) Description of *Karstia cordata* sp. nov. (Araneae, Theridiosomatidae) from caves in Chongqing, China. *Acta Zootaxonomica Sinica* 37: 734–739.
- Lopez A (1994) *Ogulnius hayoti* n. sp. et autres araignées de la Martinique (Theridiosomatidae). *Bulletin de la Société des Sciences naturelle, Venette-Compiègne* 81: 7–15.

- Lopez A (1996) *Plato juberthiei* (Araneae: Theridiosomatidae), nouvelle araignée souterraine de la Guyana Française. Mémoires de biospéologie 23: 191–196.
- Miller JA, Griswold CE, Yin CM (2009) The symphytognathoid spiders of the Gaoligongshan, Yunnan, China (Araneae, Araneoidea): Systematics and diversity of micro-orbweavers. ZooKeys 11: 9–195. doi: 10.3897/zookeys.11.160-app.C.dt
- Platnick N (2014) The World Spider Catalog, version 14.5. American Museum of Natural History. <http://research.amnh.org/entomology/soiders/catalog/INTRO1.html> [accessed in January 12, 2014]
- Rodrigues ENL, Ott R (2005) Aranhas da família Theridiosomatidae: espécie nova e novas ocorrências no Brasil. Iheringia, Série Zoologia 95(4): 441–443. doi: 10.1590/S0073-47212005000400016
- Rodrigues ENL, Lise AA (2008) Description of two new species of *Naatlo* (Araneae: Theridiosomatidae) from Brazil. Revista Brasileira de Zoologia 25(2): 299–308. doi: 10.1590/S0101-81752008000200017
- Saaristo MJ (1996) Theridiosomatid spiders of the granitic islands of Seychelles. Phelsuma 4: 48–52.
- Shinkai E (2009) Two new species of the genera *Wendilgarda* and *Patu* from Japan (Araneae: Theridiosomatidae and Symphytognathidae). In: Ono H (Ed) The Spiders of Japan with keys to the families and genera and illustrations of the species. Tokai University Press, Kanagawa, 75–77.
- Simon E (1901) On the Arachnida collected during the Skeat expedition to the Malay Peninsula. Proceedings of the Zoological Society of London 1901(2): 45–84.
- Song DX, Zhu MS (1994) On some species of cave arachnids of China. In: Chen YY (Ed.) Sixtieth Anniversary of the Founding of China Zoological Society: Memorial Volume Dedicated to the Hundredth Anniversary of the Birthday of the Late Prof. Sisan Chen (Z Chen). China Science and Technology Press, Beijing, 35–46.
- Wunderlich J (2011) Extant and fossil spiders (Araneae). Beiträge zur Araneologie 6: 427–444.
- Zhang JX, Zhu MS, Tso IM (2006) First record of the family Theridiosomatidae from Taiwan, with description of a new species (Arachnida: Araneae). Bulletin of the British Arachnological Society 13: 265–266.
- Zhao Q, Li S (2012) Eleven new species of theridiosomatid spiders from southern China (Araneae, Theridiosomatidae). Zookeys 255: 1–48. doi: 10.3897/zookeys.255.3272
- Zhu MS, Wang WZ (1992) The spider family Theridiosomatidae first found in China, and with description of a new species (Araneae). Acta Arachnologica Sinica 1: 14–16.