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Review of the genus *Tinissa* Walker, 1864 (Lepidoptera, Tineidae, Scardiinae) from China, with description of five new species

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Abstract
The genus *Tinissa* Walker is reviewed for China. Seven species are recognized, of which *T. apicimaculata* **sp. n.**, *T. conchata* **sp. n.**, *T. connata* **sp. n.**, *T. leguminella* **sp. n.** and *T. spirella* **sp. n.** are described as new; and *T. insularia* Robinson, 1976 is newly recorded from China. Photographs of the adults and illustrations of the genitalia are given. A key to all the known Chinese species and a distribution map of *Tinissa* in China are included.

Keywords
Lepidoptera, Tineidae, *Tinissa*, new species, China

Introduction

The genus *Tinissa* was established by Walker (1864) with *T. torvella* Walker, 1864 as the type species. It was once included in the subfamily Tinissinae, which was established by Gozmány and Vári (1973) for *Tinissa* and *Leptozancla* Meyrick, 1920. Robinson (1976) revised the Tinissinae on a worldwide basis, including 32 *Tinissa* species. Subsequently, Robinson (1981) described two more species from New Guinea and Borneo, and proposed a phylogenetic classification for *Tinissa*. Robinson (1986) synonymized Tinissinae with the subfamily Scardiinae. Following this treatment, Robinson and Tuck (1998) described one species from Brunei; and Robinson (2008) elevated the subspecies *Tinissa torvella mysorensis* Robinson, 1976 to species level. Currently, *Tinissa* comprises 36 named species, 14 of which are described from the Australian Region, 17 from the Oriental Region and five from the Afrotropical Region (Meyrick 1910, 1916, 1917, 1926, 1927, 1928, 1932; Gozmány and Vári 1973; Robinson 1976, 1981, 2008; Zagulajev 1972; Robinson and Tuck 1998).

Prior to this study, *T. indica* Robinson, 1976 was recorded in Taiwan (Robinson 1976), but none were recorded from Mainland China. The aim of the present paper is to review *Tinissa* in China, describe five new species, and record one species as new for the Chinese fauna. The distribution of *Tinissa* in China is shown by map (Fig. 1).

Material and methods

The specimens examined were collected using light traps. Morphological terms in the descriptions follow Robinson (1976). Whole body dissections were carried out following the methods described by Lee and Brown (2006), and genitalia dissection and mounting methods follow Li (2002). Photographs of adults were taken with a Nikon D300, and the genitalia were photographed with an Olympus C7070WZ digital camera. All the studied specimens, including the types, are deposited in the Insect Collection, College of Life Sciences, Nankai University, Tianjin, China.

Taxonomic accounts

Tinissa Walker, 1864

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

Tinissa Walker, 1864: 780. Type-species: *Tinissa torvella* Walker, 1864: 780, by monotypy.
Polymnestra Meyrick, 1927: 331. Type species: *Polymnestra perilithas* Meyrick, 1927: 331, by monotypy. [Synonymized by Gozmány and Vári 1973: 85.]

Generic characters. Medium to large tineid moths.

Head (Figs 2–3): Vertex and frons white of various shade, usually mixed with grayish brown scales (Fig. 2a). Compound eye large (Fig. 3a). Antenna about 0.5× length of forewing; scape with pecten more than 10 bristles; flagellum with elongate cilia (Fig. 3b). Labial palpus segmental ratio 1:2:2 (Fig. 3c), second segment with a few bristles and dense tuft, third segment upturned to about 60° (Fig. 2b). Maxillary palpus (Fig. 3d) with three to five segments.

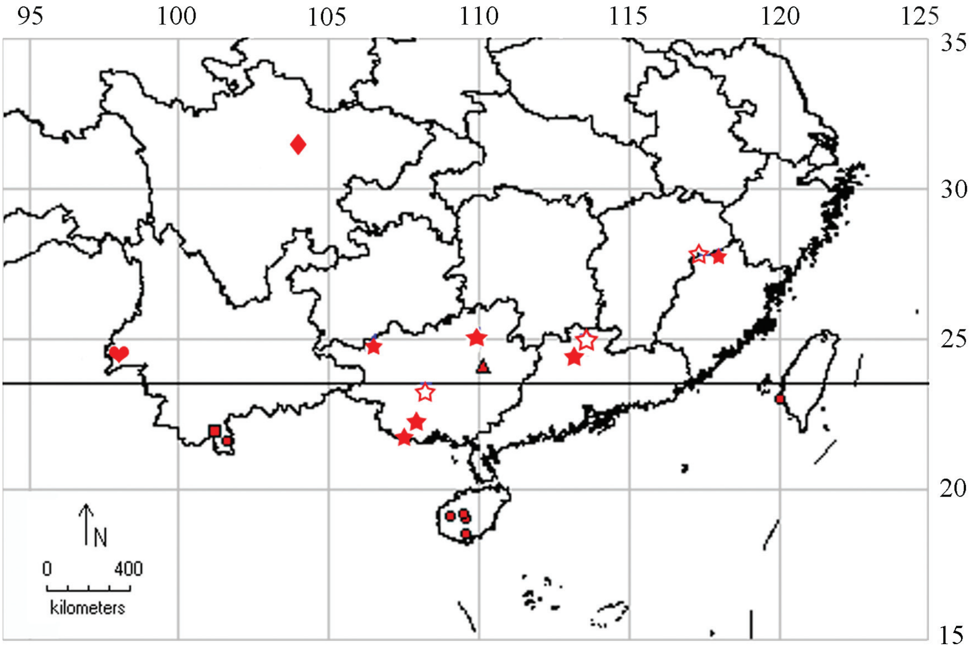
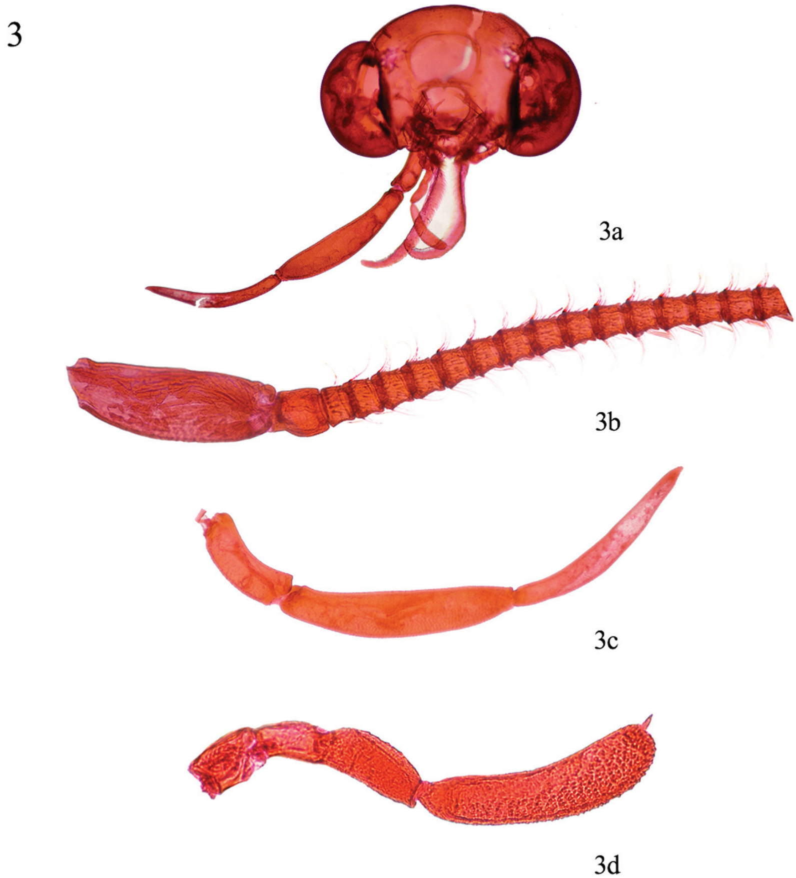


Figure 1. Distribution of Chinese *Tinissa* spp. ● *T. indica* Robinson, 1976 ■ *T. insularia* Robinson, 1976 ▲ *T. apicimaculata* sp. n. ★ *T. conchata* sp. n. ☆ *T. leguminella* sp. n. ♥ *T. connata* sp. n. ♦ *T. spirella* sp. n.

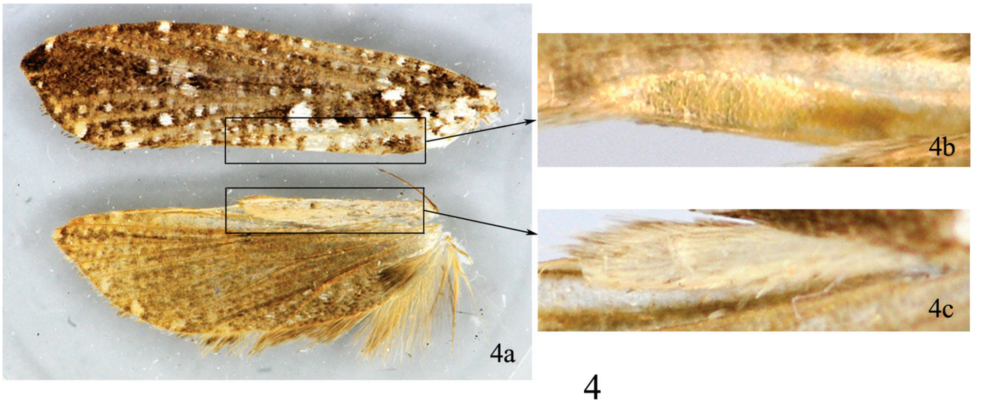
Forewing (Figs 4–5): Index 0.25–0.30, somewhat rectangular, with termen slightly concave inward, or lanceovate, with termen obliquely blunt; color brown in general, with a purplish sheen, with scattered white dots (Fig. 4a); M absent or with weak trace in cell, R_5 to costa or apex or just on to termen (R_5 to costa near apex in all the seven Chinese species), R_4 and R_5 separate, stalked or completely fused (Fig. 5); with elongate oval patch of small, flat, ovate scales on ventral surface between A_{1+2} and dorsum (Fig. 4b). Hindwing (Figs 4–5) index 0.3–0.35, costa with distal half slightly concave; grayish brown, shining purplish; with a patch of rough, pale scales opposite forewing patch, anterior to $Sc+R_1$ (Fig. 4c); all veins present (Fig. 5), M stem usually present, branched or not, weak or conspicuous. Male frenulum with one slender bristle, female frenulum with two or three bristles (female frenulum with two bristles in all Chinese species). Legs yellowish white to white; mid tibia usually with a brown spot at base and two oblique brown bands on outer surface; hind leg elongate, tibia bearing large tufts of erect scales at apex.

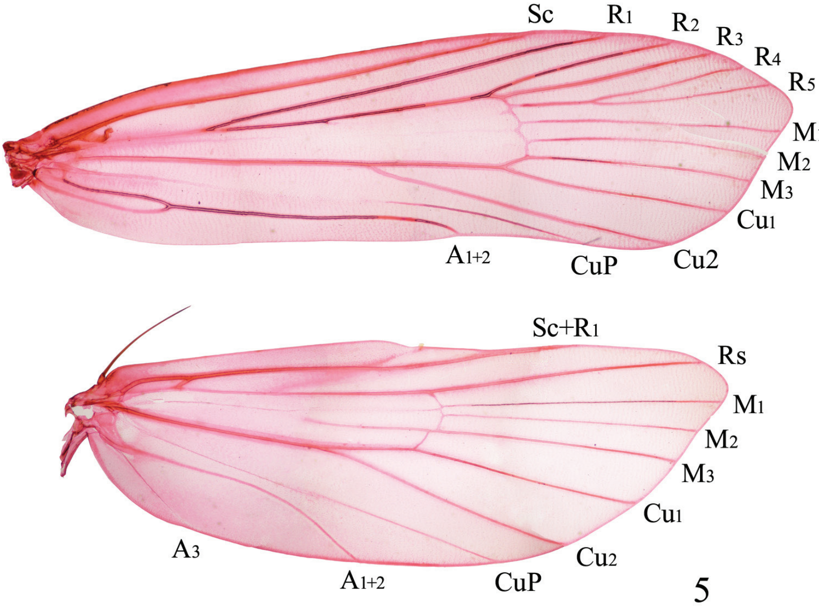
Abdomen (Fig. 6): Second sternite elongate, twice length of other sternites, with sclerotized eyepatch-shaped trace on anterior half, with small tuft of forward-directed setae medially (Fig. 6a); corema present or absent in eighth segment in male, eighth sternite with (Fig. 6b) or without (Fig. 6c) processes; corethrogyne present or absent in seventh segment in female. Male genitalia (Fig. 7) with tegumen and gnathos absent; uncus bilobate, being a pair of lobes of highly interspecific



Figures 2–3. Head structure of *Tinissa indica* Robinson, ♂. **2** Head with scales: **2a** dorsal view **2b** lateral view **3** Head scales removed: **3a** head, slide No. NKYLL012 **3b** antenna **3c** labial palpus **3d** maxillary palpus.

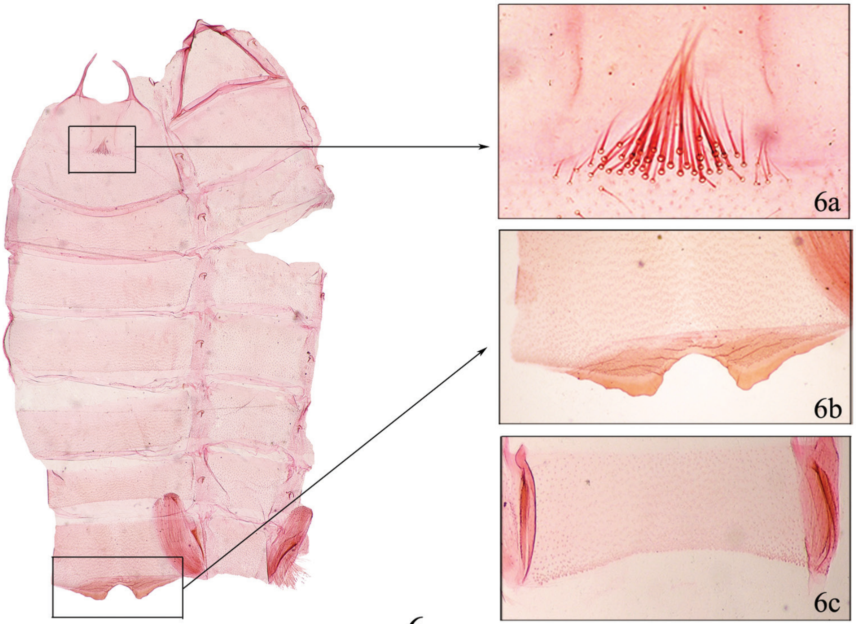
diversity attached to vinculum by membrane or fused with vinculum; subscaphium elongate and conspicuous, diagnostic at species level; saccus broad and triangular, or slightly narrow and rodlike; juxta large, closely appressed to valva, diversely





Figures 4–5. Wings of *Tinissa indica* Robinson, ♂. **4** Wings and patches: **4a** wings **4b** oval patch **4c** rough scale patch **5** Venation, slide No. NKYLL012.

modified; valva usually short and conical; a pair of variously shaped processes arising from membrane between valva and juxta; labides present, dorsal to aedeagus, usually a pair of lobes, sometimes fused. Aedeagus of various shape and size, with or without carina, cornuti absent. Female genitalia with variously shaped eighth sternite, usually ventrally protuberant; ostium similarly diverse; antrum usually present, often divided by a narrow, oblique membranous ring at point of junction with ductus seminalis; ductus bursae usually with transverse, regular constrictions. Corpus bursae with or without signum.



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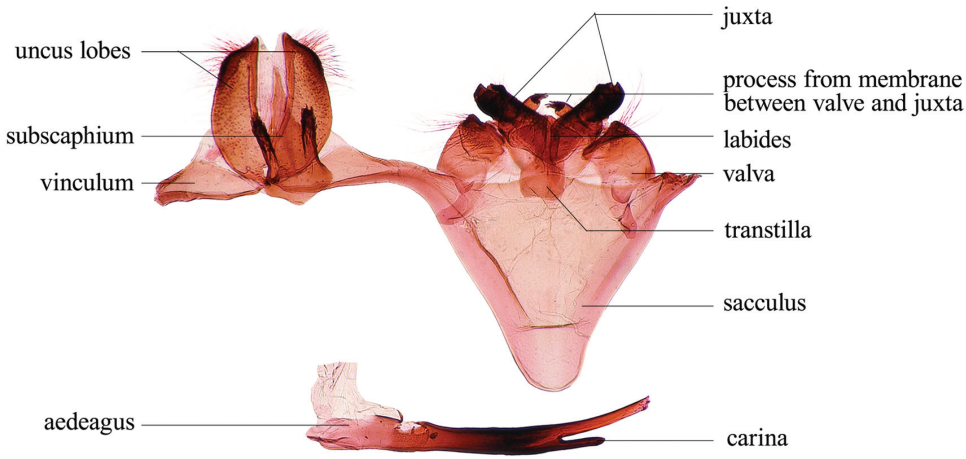

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Figures 6–7. Male abdomen of *Tinissa indica* Robinson. **6** Pregenital abdomen: **6a** setae on second sternite **6b–6c** eighth sternite **7** male genitalia (**6a–b, 7** slide No. NKYLL012; **6c** *Tinissa connata* sp. n., slide No. YLL11167).

Diagnosis. Members of *Tinissa* are medium to large sized robust tineid moths that can be easily recognized by having an elongate, brown-colored forewing with purple sheen and patterned with faint white dots; the hind legs are elongate and bear large tufts of erect scales at tibia apex; the male genitalia are characterized by the bilobate uncus, and the enlarged juxta being a pair of processes, forming a complex with the valva. *Tinissa* shares the above characters with *Leptozancla*, but differs from *Leptozancla* by the antenna about 0.5× length of forewing, the forewing with elongate oval patch of small, flat, ovate scales, the hindwing with patch of rough, pale scales opposite to the forewing patch; the male genitalia with reduced valva, and the labides present as a pair of lobes. In *Leptozancla*, the antenna is as long as the forewing, the forewing lacks the ovate patch, the hindwing lacks the patch opposite to the forewing patch, the valva is absent, the labides are present as elongate, posteriorly directed spines in the male genitalia.

Biology. One species was reared from fungus on bamboo (Robinson 1976).

Distribution. Afrotropical, Oriental and Australian regions, as far east as the Solomon Islands, and as far south as Queensland (Robinson 1986).

Remarks. Robinson (1976) described that the maxillary palpus has three or five segments. Our whole body dissection of *T. indica* shows that the maxillary palpus has four segments in this species (Fig. 3d).

Key to Chinese *Tinissa* species based on males

(Excluding *T. apicimaculata* sp. n. of which the male is unknown)

1 Wingspan > 15.0 mm; first hind tarsal segment with smooth scales **2**

– Wingspan < 15.0 mm; first hind tarsal segment with rough, raised scales (Fig. 11) .... ***T. connata* sp. n.**

2 Saccus broad, triangular; transtilla present; aedeagus stout, with carina **3**

– Saccus elongate, rodlike; transtilla absent; aedeagus slender, without carina **5**

3 Forewing scattered with conspicuous white spots throughout, arranged regularly along margins as well as between veins; transtilla inverted peach-shaped; aedeagus complete dorsally and ventrally **4**

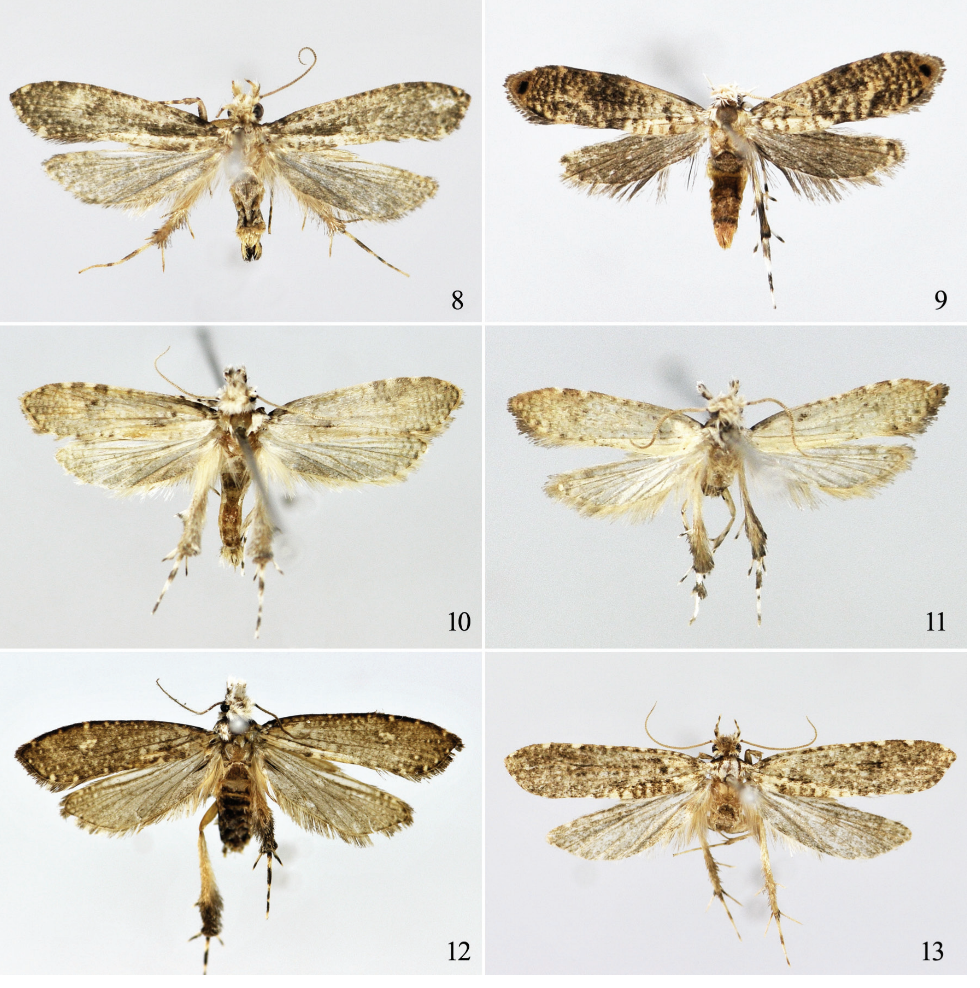
– Forewing diffused with irregular ochreous white dots forming indistinct transverse striae (Fig. 8); transtilla being two small, sclerotized plates; aedeagus dorsally complete, ventrally with narrow slit from apex to middle (Fig. 14) .... ***T. insularia***

4 Uncus lobe crescent; subscaphium triangular; juxta fist-shaped (Fig. 7) .... ***T. indica***

– Uncus lobe beanpod-shaped; subscaphium bifurcate posteriorly; juxta horn-shaped (Fig. 17) .... ***T. leguminella* sp. n.**

5 Uncus lobe ovate, with shallow pocket posterolaterally; subscaphium clubbed, with elongate setae posteriorly; juxta rectangular in basal 2/3, scallop-shaped in distal 1/3; valva flask-shaped; aedeagus clubbed, straight, with a row of small spinules (Fig. 15) .... ***T. conchata* sp. n.**

– Uncus lobe L-shaped, with slender hornlike thorn at apex; subscaphium bullet-like, with slender fingerlike process on each side; juxta spiral; valva pyramidical; aedeagus needlelike, curved dorsad, without spinule (Fig. 18)... ***T. spirella* sp. n.**



Figures 8–13. Adults of *Tinissa* spp. **8** *T. insularia* Robinson, male **9** *T. apicimaculata* sp. n., holotype, female **10** *T. conchata* sp. n., holotype, male **11** *T. connata* sp. n., holotype, male **12** *T. leguminella* sp. n., holotype, male **13** *T. spirella* sp. n., holotype, male.

Key to Chinese *Tinissa* species based on females

(Excluding *T. leguminella* sp. n. and *T. spirella* sp. n., of which the females are unknown)

1 Wingspan > 15.0 mm; first hind tarsal segment with rough, raised scales.... **2**

– Wingspan < 15.0 mm; first hind tarsal segment with smooth scales............ **3**

2 Forewing with an ovate, large, blackish brown spot near apex (Fig. 9); corethrogyne present .... ***T. apicimaculata* sp. n.**

– Forewing without spot near apex (Fig. 11); corethrogyne absent.................. .... ***T. connata* sp. n.**

3 Posterior margin of eighth tergite deeply concave at middle........................ **4**

– Posterior margin of eighth tergite slightly sinuate (Fig. 19) .... ***T. indica***

4 Antrum almost as long as sternite, junction with ductus seminalis at 2/3; ductus bursae with conspicuously coarse transverse constrictions (Fig. 21) ... . ***T. conchata* sp. n.**

– Antrum shorter than sternite, junction with ductus seminalis at one-half, ductus bursae with very fine transverse constrictions (Robinson 1976: Fig. 87) .... ***T. insularia***

Tinissa indica Robinson, 1976

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

Figs 1–7, 19

Tinissa indica Robinson, 1976: 282.

Material examined. CHINA, Hainan Province: 1 ♀, Mt. Diaoluo (18°28'N, 109°31'E), 940 m, 31.v.2007, leg. Zhiwei Zhang and Weichun Li, genitalia slide No. ZL09028; 1 ♂, Mt. Yingge (19°01'N, 109°33'E), 30.ix.2011, leg. Bingbing Hu, genitalia slide No. YLL11135m, YLL11135w; 1 ♂, Nancha River, Mt. Bawang (19°04'N, 109°02'E), 600 m, 9.vi.2007, leg. Zhiwei Zhang and Weichun Li; 2 ♂♂, East first Protection Station, Mt. Bawang, 650 m, 7.iv.2008, leg. Bingbing Hu and Haiyan Bai, genitalia slide No. NKYLL012; 1 ♂, East Administration, Mt. Bawang, 8.v.2011, leg. Dandan Zhang and Lifeng Yang; 1 ♂, Mt. Wuzhi (18°46'N, 109°30'E), 650 m, 15.v.2007, leg. Zhiwei Zhang and Weichun Li; 2 ♂♂, Mt. Limu (19°09'N, 109°28'E), 5.v.2011, leg. Dandan Zhang and Lijun Yang. **Yunnan Province:** 1 ♂, Bubang (21°36'N, 101°35'E), Mengla, 650 m, 25.vii.2008, leg. Yingdang Ren, genitalia slide No. XYL05049.

Diagnosis. Adult (Figs 2–5) with wingspan 24.0–28.0 mm in male, 30.0 mm in female. *Tinissa indica* can be easily recognized from its congeners by the male genitalia having a pair of crescent-shaped uncus lobes, the triangular subscaphium with wide, fingerlike process posterolaterally, and the fist-shaped juxta (Figs 6–7), and by the female genitalia having the eighth sternite ventrally protuberant and the hemispherical antrum (Fig. 19).

Distribution. China (Hainan, Yunnan, Taiwan), India, Sikkim, Bhutan.

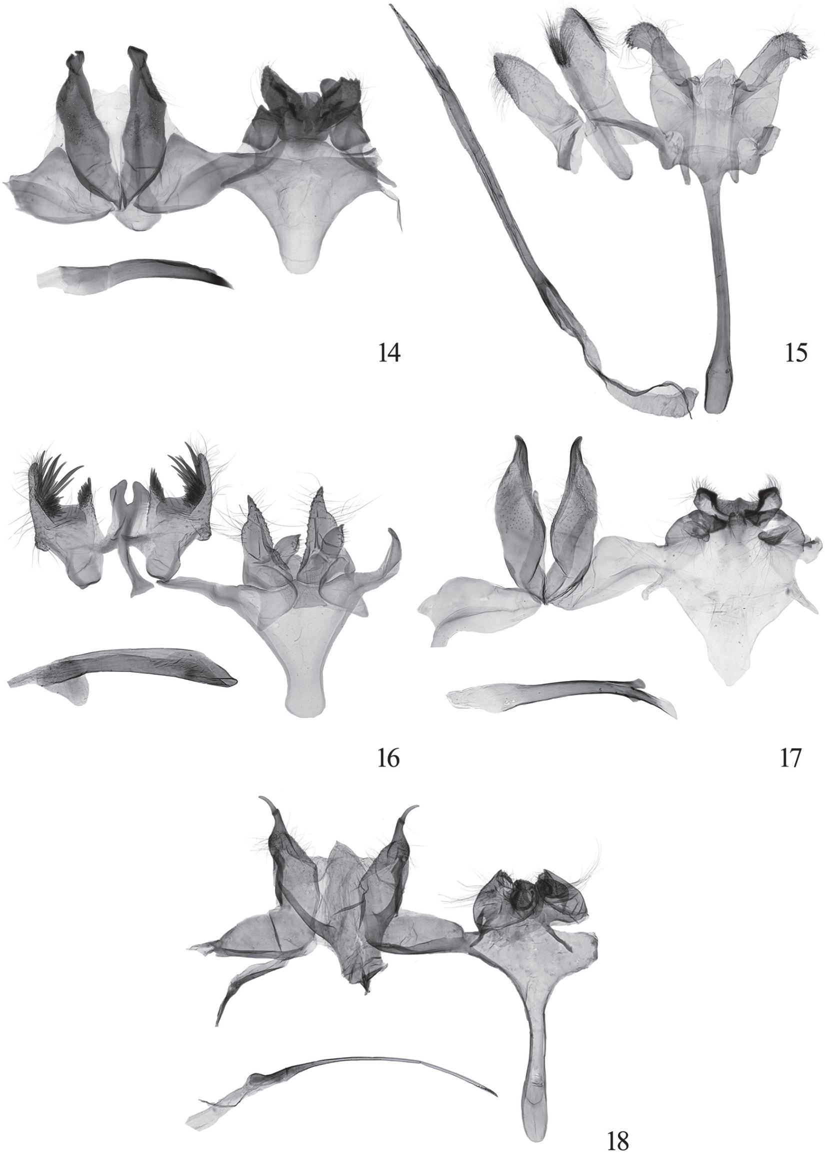
Tinissa insularia Robinson, 1976

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

Figs 1, 8, 14

Tinissa insularia Robinson, 1976: 285; Robinson, 1981: 371.

Material examined. CHINA, **Yunnan Province:** 1 ♂, Baka Village, Menglun Town (21°56'N, 101°15E), Mengla County, 620 m, 6.VIII.2010, leg. Yinghui Sun and Lixia Li, genitalia slide No. YLL11138.


14 15 16 17 18

Figures 14–18. Male genitalia of *Tinissa* spp. **14** *T. insularia* Robinson, slide No. YLL11138 **15** *T. conchata* sp. n., paratype, slide No. YLL10196 **16** *T. connata* sp. n., paratype, slide No. YLL11167 **17** *T. leguminella* sp. n., paratype, slide No. XYL05048 **18** *T. spirella* sp. n., holotype, slide No. XYL05050.

Diagnosis. Adult (Fig. 8) with male wingspan 17.0 mm. *Tinissa insularia* is close to *T. spirella* sp. n., but differs as noted in the description of the new species.

Distribution. China (Yunnan), Malaysia, Borneo, Indonesia (Sumatra, Java, Celebes, Moluccas), Philippines (Luzon, Mindanao, Palawan, Balabac, Tawi Tawi), New Guinea (Papua, Karkar I., New Britain), Solomon Is.

Notes. This species is recorded for the first time in China.

Tinissa apicimaculata **sp. n.**
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http://species-id.net/wiki/Tinissa_apicimaculata
Figs 1, 9, 20

Type material. Holotype ♀ – **CHINA, Guangxi Zhuang Autonomous Region:** Jinxiu County (24°08'N, 110°11'E), 550 m, 15.IV.2002, leg. Shulian Hao and Huaijun Xue, genitalia slide No. YLL11136.

Diagnosis. The new species is a distinctive species: the forewing markings are diagnostic, with an ovate, large, blackish brown spot near apex. It is small-sized as *Tinissa connata* sp. n., but can be easily recognized by the superficial characters.

Description. Adult (Fig. 9): Wingspan 12.0 mm in female. Vertex and frons creamy white. Antenna with scape and pecten white, pecten about 10–20 bristles; flagellum yellowish white. Labial palpus creamy white, second segment and tuft yellowish brown on outer surface. Thorax and tegula creamy white, anterior margin dark brown. Forewing index 0.27, lanceovate, apex protruded roundly, termen oblique; ground color creamy white on basal 1/3, yellowish brown on distal 2/3, gradually darker to apex, shining copperish violet; patterned with indistinct, faint transverse striae, with large, blackish brown ovate spot near apex; M absent in cell, R_4 and R_5 separated; fringe brown, pale yellowish brown at middle, forming a line parallel with pale yellowish brown basal line. Hindwing index 0.3; grayish brown, yellowish brown near apex, shining copperish violet; M stem conspicuous, not branched; fringe yellowish brown. Legs dominantly creamy white; fore femur with narrow, blackish brown spot on ventral surface, tibia blackish brown on outer surface, tarsus with fifth segment dark brown; mid tibia distally with oblique dark brown band on outer surface, spurs with oblique black band before apex, tarsus with middle portion of first and second segments dark brown, lighter on inner surface; hind tibial tuft creamy white on basal half, blackish brown on distal half, spurs with oblique blackish bands before apex, tarsus with basal half of first segment grayish brown, with rough, raised scales on dorsal surface, second and third segments blackish brown.

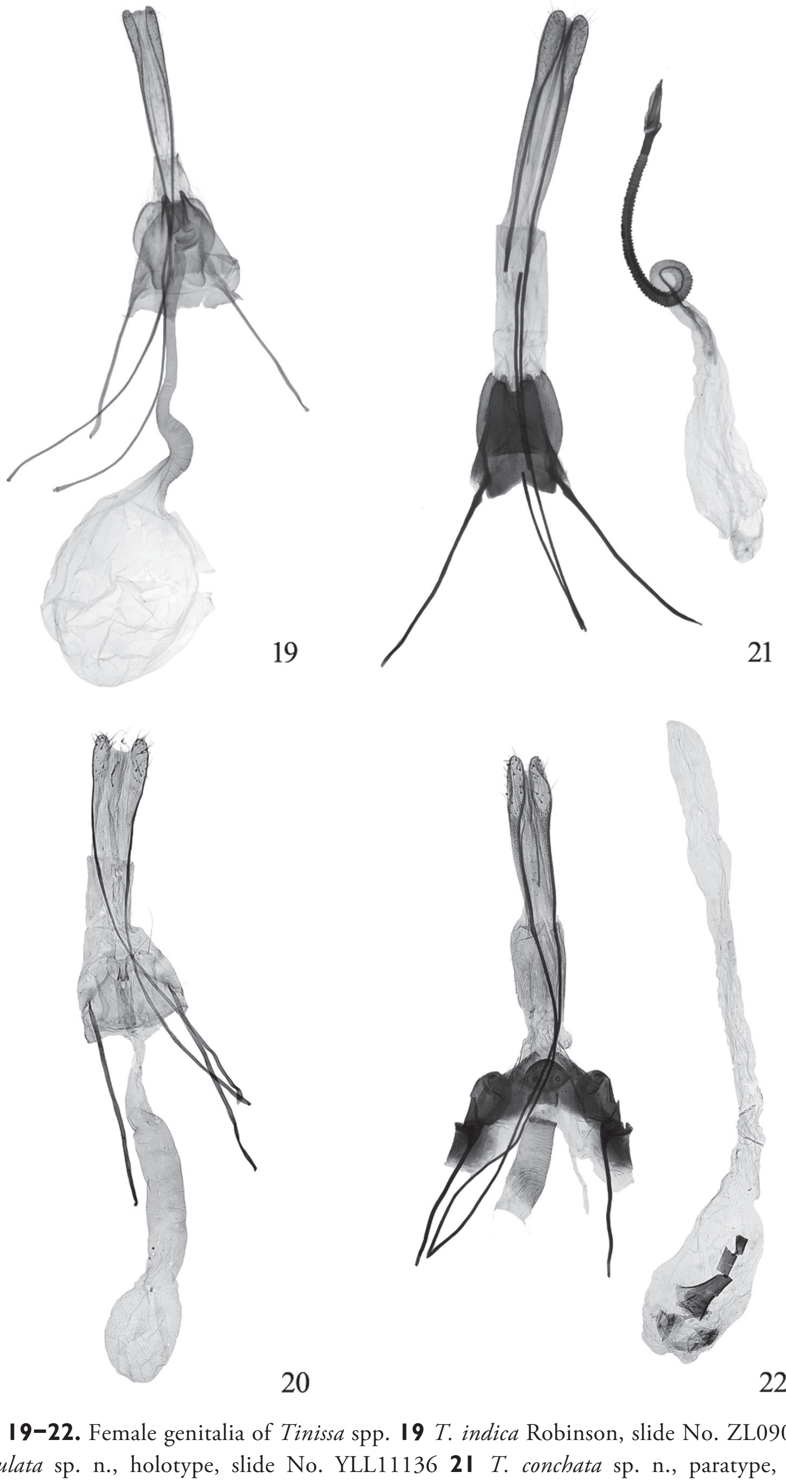
Male. Unknown.

Female genitalia (Fig. 20). Corethrogyne present in seventh segment. Eighth tergite rectangular, with sparse long setae on posterior margin; sternite hemicyclic, ventrally protuberant in short, tubular shape, with a pair of small, setose, mastoid processes at middle on posterior margin. Apophysis anterior 0.5× length of apophysis posterior. Ostium situated at middle of eighth sternite on posterior margin. Antrum absent; ductus bursae 3.5× length of corpus bursae, posterior 1/4 narrow, anterior 3/4 broader, 2.0× width of posterior 1/4. Corpus bursae ovate, without signum.

Distribution. China (Guangxi).

Etymology. The specific name is derived from the Latin prefix *apici-* (= apex) and *maculatus* (= macula), referring to the ovate, blackish brown spot near apex of forewing.

Remarks. In Tineidae, new species are usually described on the basis of male specimens. However, *Tinissa* is an exception. Among the 36 nominal species, seven are based



Figures 19–22. Female genitalia of *Tinissa* spp. **19** *T. indica* Robinson, slide No. ZL09028 **20** *T. apicimaculata* sp. n., holotype, slide No. YLL11136 **21** *T. conchata* sp. n., paratype, slide No. YLL11140 **22** *T. connata* sp. n., paratype, slide No. YLL11137.

on both male and female, 14 on male and 15 on female only. As there is no sexual dimorphism in this genus, *Tinissa apicimaculata* sp. n. is distinctive from other species – most likely also in the male – by the forewing having an ovate blackish spot near apex.

Tinissa conchata sp. n.

urn:lsid:zoobank.org:act:1A49EDE3-1411-45DB-99AA-EF22FBA1201E
http://species-id.net/wiki/Tinissa_conchata
Figs 1, 10, 15, 21

Type material. Holotype ♂ – **CHINA**, **Fujian Province:** Mt. Wuyi (27°45'N, 118°02'E), 740 m, 25.vii.2008, leg. Weichun Li, Yongling Sun and Haiyan Bai. Paratypes: 2 ♂♂, same data as holotype except dated 27.vii.2008. **Guangdong Province:**1 ♂, Nanling Mt. Babao (24°24'N, 113°08'E), 1070 m, 23.viii.2010, leg. Shulian Hao, genitalia slide No. YLL10196. **Guangxi Zhuang Autonomous Region:** 1 ♂, Qinmucun, Yongfu County (24°58'N, 109°58'E), 160 m, 1.v.2008, leg. Hui Zhen and Li Zhang; 1 ♂, Yachang Forest, Leye County (24°47'N, 106°33'E), 910 m, 28.vii.2004, leg. Jiasheng Xu, genitalia slide No. MYH11089; 1 ♀, Dongzhong Forest (21°37'N, 107°32'E), Fangchenggang City, 370 m, 9.iv.2002, leg. Shulian Hao and Huaijun Xue, genitalia slide No. YLL11140; 1 ♂, Hongqi Forest, Shangsi County (22°09'N, 107°59'E), 260 m, 2.IV.2002, leg. Shulian Hao and Huaijun Xue.

Diagnosis. The new species is similar to *T. amboinensis* Robinson, 1976, *T. cinerascens* Meyrick, 1910 and *T. distracta* Meyrick, 1916 in the forewing having fine transverse striae; the ovate uncus lobe with shallow pocket posterolaterally, the clubbed subscaphium setose posteriorly, the rodlike saccus expanded anteriorly, and the slender aedeagus in male genitalia; and the antrum divided by a membranous ring at point of junction with ductus seminalis in the female genitalia. However, the shapes of the valva, the juxta and the aedeagus in the male genitalia are different among the four species: in the new species, the valva is flask-shaped, the juxta is rectangular basally and scallop-shaped distally, with dentation on posterior margin, and the aedeagus has small spinules; in *T. amboinensis*, the valva is triangular, the juxta is roundly lobe-shaped, with smooth margins, the aedeagus lacks the carina or spinule (Robinson 1976, Fig. 46); in *T. cinerascens*, the valva is triangular, the juxta is somewhat triangular, with smooth margins, the aedeagus lacks carina or spinule (Robinson 1976, Fig. 48); in *T. distracta*, the valva is triangular, the juxta has two small conical projections on inner surface, the aedeagus bears two small carinae before apex (Robinson 1976, Fig. 45). Besides, the structures of the eighth segment, the position of the membranous ring on the antrum and the shape of the antrum in the female genitalia are also different among the four species.

Description. Adult (Fig. 10): Wingspan 16.0–20.0 mm in male, 22.0 mm in female. Vertex yellowish white; frons with creamy white scales directed forward, tinged with dark brown scales laterally. Antenna with scape and pecten white, pecten more than 20 bristles; flagellum ochreous white, first segment dark brown above. Labial palpus creamy white; second segment and tuft blackish brown above, mixed with black scales on outer surface and distal half of inner surface; third segment with oblique, blackish brown band near middle. Thorax and tegula creamy white, anterior margin dark brown. Forewing index 0.25, subrectangular, apex bluntly rounded, termen oblique; ground color yellowish white to yellowish brown, shining bluish violet, scattered with unconspicuous, transverse, fine grayish brown striae, with large dark brown spot at distal 3/5 and 2/3 of costa as well as at basal 1/4 near fold; M absent in cell, R_4 and R_5 separated; fringe brown. Hindwing index 0.32; pale grayish brown, shining bluish violet, distal 1/5 with faint, grayish brown striae; all veins present, M stem distinct in cell, branched at middle; fringe yellowish brown. Legs creamy white; fore femur with narrow, blackish brown spot on ventral surface, tibia blackish brown on outer surface, first segment of tarsus with large, blackish spot on outer surface, third and fourth segments mixed with dark brown; mid tibia with three broad oblique dark brown bands on outer surface, spurs with oblique dark brown band before apex, first to fourth segments of tarsus with large, blackish brown spot on outer surface; hind tibial tuft pale yellowish brown, forming two pale grayish brown clusters, blackish and shining purple at apex, tarsus and spurs of same pattern with mid leg.

Male genitalia (Fig. 15). Corema present; eighth sternite slightly convex at middle on posterior margin. Uncus lobe ovate, heavily sclerotized, with long setae on dorsal surface; apex pointed, setose, with shallow pocket posterolaterally. Subscaphium clubbed, 0.6× length of saccus, anterior 4/5 smooth, posterior 1/5 with elongate setae. Saccus elongate, rodlike, expanded anteriorly. Juxta heavily sclerotized, each lobe rectangular in basal 2/3, scallop-shaped in distal 1/3, with dentation and fine setae on posterior margin. Valva flask-shaped, basal 3/5 about 2.0× width of distal 2/5; process from membrane between valva and juxta papillary, with short setae on posterior margin. Transtilla absent. Labides with anterior 4/5 slender, posterior 1/5 umbrella-shaped. Aedeagus slender, clubbed, 1.4× length of saccus, straight, pointed at apex, complete ventrally and dorsally, with a row of 6 or 7 small spinules.

Female genitalia (Fig. 21). Corethrogyne present in seventh segment. Eighth tergite shield-shaped, with sparse short setae, lateral margins slightly concave at anterior 1/3, anterior margin concave at middle, anterolateral side protruding triangularly, posterior margin incised, deeply concave at middle, forming a pair of small papillary lateral processes; sternite tapered, posterior margin concave at middle, forming two overlapped plates, between two plates with a tubular chunnel. Ostium at middle of middle concavity on posterior margin of eighth sternite. Apophysis anterior 0.3× length of apophysis posterior. Antrum heavily sclerotized, divided at posterior 2/3 by a narrow, oblique membranous ring at point of junction with ductus seminalis, posterior 2/3 broader and less sclerotized than anterior 1/3; ductus bursae pipe-shaped, with coarse, transverse, regular constrictions, posterior 4/5 slightly sclerotized, anterior 1/5 slightly expanded and incurvate. Corpus bursae as long as ductus bursae, without signum.

Distribution. China (Fujian, Guangdong, Guangxi).

Etymology. The specific name is derived from the Latin *conchatus* (= conchoidal), referring to the scallop-shaped distal half of the juxta.

***Tinissa connata* sp. n.**
urn:lsid:zoobank.org:act:F528F4DB-C10C-470B-A2DA-B95CD21E454B
http://species-id.net/wiki/Tinissa_connata
Figs 1, 6c, 11, 16, 22

Type material. Holotype ♂ – **CHINA**, **Fujian Province:** Guadun (27°44'N, 117°38'E), Mt. Wuyi, 1100 m, 29.VII.2008, leg. Weichun Li, Yongling Sun and Haiyan Bai, genitalia slide No. XYL08114. Paratypes: **Guangdong Province:** 1 ♂, Nanling, Shaoguan City (24°48'N, 113°35'E), 22–28.VI.2008, leg. Liusheng Chen, genitalia slide No. YLL11167. **Guangxi Zhuang Autonomous Region:** 1 ♀, Mt. Daming (23°09'N, 108°16'E), Nanning City, 1200 m, 5.VIII.2011, leg. Shulian Hao and Yinghui Sun, genitalia slide No. YLL11137.

Diagnosis. The new species can be easily recognized by the small-sized body and the rough, raised scales on the first hind tarsal segment. These characters are also present in *T. apicimaculata* sp. n., but the forewing of *T. apicimaculata* sp. n. is darker in color, and has an ovate blackish brown spot near apex that is absent in *T. connata* sp. n.

Description. Adult (Fig. 11): Wingspan 12.5 mm. Vertex and frons ochreous white, tinged with grayish brown around antenna. Antenna with scape and pecten ochreous white, pecten more than 20 bristles; flagellum yellowish brown, first segment with blackish brown above. Labial palpus white, second segment and tuft blackish brown above, mixed with blackish brown on distal half of inner surface and on outer surface, third segment with oblique, blackish brown band before apex. Thorax and tegula white, anterior margin dark brown. Forewing index 0.26, lanceolate, apex protruded triangularly; ground color pale yellowish brown, gradually darker from base to apex, shining bluish violet, with scattered dark brown dots throughout, concentrated from costal 1/4 to dorsal 1/6, forming a discontinuous oblique stria; costal margin with conspicuous creamy white dot at distal 1/3 and 1/4; M with weak trace in cell, R_4 and R_5 separated; fringe brown. Hindwing index 0.32; yellowish brown, shining bluish violet; M stem conspicuous in cell, branched at middle; fringe pale yellowish brown. Legs ochreous white; fore coxa and femur mixed with brown on ventral surface, tibia blackish brown ventrally, tarsus with first segment on outer surface as well as fourth and fifth segments blackish brown; mid tibia with blackish brown spot at base, with a narrow, blackish brown band at middle, with an oblique dark brown band before apex, spurs with oblique dark band before apex, first segment of tarsus with blackish brown spot at base and middle, fourth segment dark brown; hind tibial tuft pale yellowish brown, distal scales with dark brown tips, tarsus with first segment dark brown on distal half, bearing rough, raised scales on dorsal surface, second segment with small blackish brown dot near base dorsally, fourth segment dark brown.

Male genitalia (Fig. 16). Corema present; eighth sternite straight on posterior margin. Uncus lobe deeply emarginated posteriorly, forming two processes: inner process short, bears stub spiculas; outer process 2.5× length of inner one, with spiculas varying in length, pectinated; with a large rounded flap arising from near posterior margin. Subscaphium cheliform, anterior 3/4 slender, slightly curved ventrad, posterior 1/3 broadened, with deeply U-shaped concavity at middle on posterior margin. Saccus broad triangular, narrowed anteriorly, rounded apically. Juxta sclerotized, each lobe triangular, pointed at apex, serrate along inner margin. Valva fully fused with juxta; process from membrane between valva and juxta foliole-shaped, bearing a small apical process and some short setae before apex. Transtilla trapezoidal, fully fused with labides. Labides peach-shaped. Aedeagus stout, as long as saccus, broadened to flared apex, slightly curved ventrad, ventrally complete, with large, triangular flap at base, dorsally with a deep cleft, without carina or spinule.

Female genitalia (Fig. 22). Corethrogyne absent, with deciduous setae on posterior margin of seventh segment. Eighth tergite semicircularly concave on anterior margin, and forming rounded plate posterolaterally, with a few short setae on posterior margin; eighth sternite semicircularly concave on anterior margin, forming semicylindrical plate anterolaterally extending to tergite, attached with apophysis posterior, setose and slightly concave at middle on posterior margin, with ovate ventral protuberance on ventral margin of ostium. Apophysis anterior 0.3× length of apophysis posterior. Antrum short, divided at posterior 2/3 by a membranous ring at point of junction with ductus seminalis on right; ductus bursae 3.0× length of corpus bursae, posterior 1/5 with transverse constrictions, anterior 4/5 smooth. Corpus bursae pear-shaped, with large, heavily sclerotized, inverted funnel-shaped signum.

Distribution. China (Fujian, Guangdong, Guangxi).

Etymology. The specific name is derived from the Latin *connatus* (= connate), referring to the fusion of the juxta and valva.

Remarks. The single female specimen was not collected in the same locality as the male specimens, but it has the same forewing patterns as the males do, and its first hind tarsal segment has the rough, raised scales, which are characteristic for this species. The rough, raised scales on the first hind tarsal segment are also present in *T. apicimaculata* sp. n. and *T. spaniastra* Meyrick, 1932, but the forewing of *T. apicimaculata* sp. n. has an ovate blackish brown spot near apex, and the members of *T. spaniastra* are larger in size (25 mm in male, 20–27 mm in female (Robinson 1976)). In addition, the genitalia structures of the above mentioned species are also different.

Tinissa leguminella **sp. n.**

urn:lsid:zoobank.org:act:D9425924-508D-475F-B2A6-A21B746E84DC
http://species-id.net/wiki/Tinissa_leguminella
Figs 1, 12, 17

Type material. Holotype ♂ – **CHINA**, **Yunnan Province:** Rare Botanical Garden, Ruili (24°00'N, 97°50'E), 1000 m, 5.VIII.2005, leg. Yingdang Ren, genitalia slide No. YLL11139. Paratype: ♂, same data as holotype except dated 7.VIII.2005, genitalia slide No. XYL05048.

Diagnosis. *Tinissa leguminella* sp. n. is similar to *T. indica* in having a similar forewing pattern, a broad and triangular saccus and a short and conical valva in the male genitalia. However, the new species can be recognized from the latter by the beanpod-shaped uncus lobe, the bifurcate subscaphium, the horn-shaped juxta, the process from the membrane between the valva and the juxta with basal 3/5 nearly parallel dorso-ventrally, widended at distal 2/5, then narrowed to melanised and setose apex, and the aedeagus with short carina in the male genitalia. In *T. indica*, the uncus lobe is crescent, the subscaphium is triangular, the juxta is fist-shaped, the process from the membrane between the valva and the juxta is fingerlike, and the aedeagus has long carina in the male genitalia.

Description. Adult (Fig. 12): Male wingspan 16.5–19.0 mm. Vertex ochreous yellow, tinged with blackish brown near eyes; frons ochreous yellow, with blackish brown scales laterally. Antenna with scape and pecten ochreous white, pecten more than 20 bristles; flagellum yellowish brown, first two segments blackish brown above. Labial palpus creamy white; second segment brown on outer surface, mixed with creamy white at middle and apex, tuft black; third segment with dark brown spot at base and distal 1/3 on outer surface. Thorax ochreous white, posterior 1/3 grayish brown; tegula creamy white, anterior 1/3 dark brown, posterior 1/3 mixed with yellowish brown. Forewing index 0.25, rectangular, apex protruded triangularly, termen slightly concave inward at about anterior 1/3; ground color brown, shining dark purplish, scattered with conspicuous white spots throughout, regularly arranged along margins as well as between veins, more white spots concentrated in basal 1/5, near fold and at upper angle of cell; M absent in cell, R_4 and R_5 separated; fringe brown. Hindwing index 0.32; pale grayish brown, shining dark purplish, with small pale dots apically; M stem conspicuous in cell, branched at middle; fringe yellowish brown. Fore leg yellowish brown, femur with narrow, dark brown spot on ventral surface, tibia blackish brown, tarsus blackish brown except apex of first segment as well as fifth segment ochreous white; mid leg ochreous yellow, tibia with three oblique, blackish brown bands on outer surface, broader near apex, shorter spur with oblique blackish brown band on outer surface, longer spur yellowish brown on outer surface, tarsus with first segment dark brown at base and middle, third and fourth segments dark brown; hind leg pale yellowish brown, tibia ochreous white at basal 2/3 ventrally, tuft dark grayish brown, forming two clusters at spurs, spurs ochreous white ventrally, dark brown dorsally but yellowish at apex, first segment of tarsus ochreous white ventrally, with dark brown spot at base on outer surface, with large, dark brown spot from basal 1/3 to before apex on outer surface, other tarsal segments yellowish brown ventrally, third and fourth segments blackish brown dorsally.

Male genitalia (Fig. 17). Corema present; eighth sternite straight on posterior margin. Uncus lobe beanpod-shaped, hornlike and heavily sclerotized, sparsely setose on distal half, with shallow pocket distally. Subscaphium fused anteriorly, bifurcate from 1/4, forming long band-shaped lobe on each side, gradually narrowed to blunt apex. Saccus broad triangular. Juxta heavily sclerotized, each lobe stout, narrow basally, dilated distally; apex straight, setose, and melanised; basally fused and protruded ventrad, forming a plate with a vertical ridge at middle. Valva short, conical, apex narrowly rounded, with long distal setae; process from membrane between valva and juxta with basal 3/5 nearly parallel dorso-ventrally, widended at distal 2/5, then narrowed to melanised and setose apex. Transtilla broad, inverted peach-shaped. Labides concave at middle on posterior margin, with mastoid process posterolaterally. Aedeagus stout, clubbed, 1.5× length of saccus, gently curved dorsad, complete dorsally and ventrally, with a short carina arising from distal 1/4 ventrally.

Female. Unknown.

Distribution. China (Yunnan).

Etymology. The specific name is derived from the Latin *legumin-* (= legume) and the postfix *-ellus*, referring to the beanpod-shaped uncus lobe.

Tinissa spirella sp. n.

urn:lsid:zoobank.org:act:151565EB-709E-4628-AAD4-81CCDE40A961
http://species-id.net/wiki/Tinissa_spirella
Figs 1, 13, 18

Type material: Holotype ♂ – **CHINA**, **Sichuan Province:** Wolong Nature Reserves (31°01'N, 103°10'E), 1900 m, 7.VIII.2004, leg. Yingdang Ren, genitalia slide No. XYL05050.

Diagnosis. The new species is similar to *T. conchata* sp. n. by having an elongate, rodlike saccus and a slender aedeagus. It can be recognized from the latter by the L-shaped uncus lobe with an apical thorn, the subovate subscaphium with slender fingerlike process on each side, the spiral juxta, the pyramidical valva, and the needlelike aedeagus curved dorsad, without spinule. In *T. conchata* sp. n., the uncus lobe is ovate, with shallow pocket posterolaterally; the subscaphium is clubbed, with elongate setae posteriorly, the juxta is rectangular in basal 2/3 and scallop-shaped in distal 1/3, the valva is flask-shaped, and the clubbed aedeagus is straight, with a row of small spinules.

Description. Adult (Fig. 13): Male wingspan 20.0 mm. Vertex ochreous yellow, posterior margin ochreous white; frons ochreous white, tinged with ochreous yellow. Antenna with scape and pecten ochreous white, pecten about 10–20 bristles; flagellum pale yellowish brown, first segment blackish brown above. Labial palpus with first and second segments creamy white on inner surface, dark brown mixed yellowish brown on outer surface; third segment ochreous yellow, with yellowish brown spot at base and before apex on outer surface. Thorax creamy white mixed with dark grayish brown scales; tegula with anterior half dark grayish brown, posterior half creamy white but pale gray at middle. Forewing index 0.27, rectangular, apex protruded triangularly, termen slightly concave inward at about 2/5; yellowish brown mixed with grayish brown, shining bluish violet, with scattered faint white dots, large and conspicuous at base, along costa, termen and dorsum; M absent in cell, R_4 and R_5 separated. Hindwing index 0.32; grayish brown, shining bluish violet; M stem conspicuous in cell, branched at middle; fringe pale grayish brown. Legs yellowish brown; fore femur dark brown on ventral surface, tarsus with first segment blackish brown on outer surface, with faint dark brown spots on outer surface of second to fifth segments; mid tibia with blackish brown spot at base, with one narrow, blackish brown band at middle, with one broad, oblique, dark brown band before apex on outer surface, tarsus with small, blackish brown spot at base and middle on outer surface of first segment; hind tibial tuft pale yellowish brown, blackish brown before apex on outer surface, tarsus with first segment dark brown at base and apex on dorsal surface, with long, fine scales dorsally, third segment dark brown dorsally.

Male genitalia (Fig. 18). Corema present; eighth sternite straight on posterior margin. Uncus lobe L-shaped, widely spaced to each other, completely fused with vinculum; distal half setose dorsally, with a large apical thorn. Subscaphium bulletlike, with a pair of small and narrow triangular protuberances at middle on anterior margin, with a slender fingerlike process arising from anterior 2/5 of each side, 0.5× length of subscaphium. Saccus rodlike. Juxta heavily sclerotized, each lobe spiral, with long setae ventrally, fused on inner margin. Valva short, heavily sclerotized, more or less triangular, apex pointed, dorsal margin with long setae; process from membrane between valva and juxta mastoid, with short setae at apex. Transtilla absent. Labides small, triangular, heavily sclerotized. Aedeagus very slender, needlelike, 1.2× length of saccus, curved dorsad, complete dorsally and ventrally, roundly protruded at base ventrally, without carina or spinule.

Female. Unknown.

Distribution. China (Sichuan).

Etymology. The specific name is derived from the Latin *spirellus* (= spiral), referring to the small, spiral, whorl-shaped juxta.

Discussion

The genus *Tinissa* is unique among the 30 genera of the subfamily Scardiinae. It is highly diagnostic by the hind legs bearing large tufts of erect scales at apex of the tibia. Based on this character, we assign five new species to this genus.

As all the nominal species were well described and illustrated by previous taxonomists (Robinson 1976, 1981; Robinson and Tuck 1998; Gozmány and Vári 1973; Zagulajev 1972), we examined only the holotypes of *T. araucariae* Robinson, 1976, *T. bakeri* Robinson, 1976, *T. insignis* Zagulajev, 1972, *T. parallela* Robinson, 1976, *T. polysema* Zagulajev, 1972) as well as the paratype of *T. insularia* Robinson, 1976 that were available during this study. Besides, the shape of valva+juxta complex and the uncus lobes in the male genitalia as well as the eighth sternite and the ostium in the female genitalia are highly diverse among species, which makes the species identification more effective.

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RESEARCH ARTICLE

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Forever in the dark: the cave-dwelling azooxanthellate reef coral *Leptoseris troglodyta* sp. n. (Scleractinia, Agariciidae)

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Abstract

The coral species *Leptoseris troglodyta* **sp. n.** (Scleractinia, Agariciidae) is described as new to science. It is the first known azooxanthellate shallow-water agariciid and is recorded from the ceilings of caves at 5-35 m depth in West Pacific coral reefs. The corals have monocentric cup-shaped calices. They may become colonial through extramural budding from the basal coenosteum, which may cause adjacent calices to fuse. The size, shape and habitat of *L. troglodyta* are unique compared to other *Leptoseris* species, many of which have been recorded from mesophotic depths. The absence of zooxanthellae indicates that it may survive well in darkness, but endolithic algae in some corals indicate that they may be able to get some light. The presence of menianes on the septal sides, which may help to absorb light at greater depths in zooxanthellate corals, have no obvious adaptive relevance in the new species and could have been inherited from ancestral species that perhaps were zooxanthellate. The new species may be azooxanthellate as derived through the loss of zooxanthellae, which would be a reversal in *Leptoseris* phylogeny.

Keywords

Cavernicolous, colonial, dwarfism, extramural budding, monocentric, skiophilous, solitary, troglobiotic

Introduction

Reef-dwelling species of the genus *Leptoseris* Milne-Edwards and Haime, 1849 (Scleractinia: Agariciidae) consist of foliaceous corals that are common in poorly illuminated environments, such as the deepest parts of reef slopes and vertical rocky walls with crevices, caves, tunnels and overhangs (Dinesen 1980, 1982, 1983; Waheed and Hoeksema in press). They are considered skiophilous (shade-loving) or cavernicolous, i.e., living in caves (Dinesen 1982, 1983). Because they appear to show more preference for dark habitats than many other reef corals, *Leptoseris* species constitute an important component of zooxanthellate scleractinian coral communities at mesophotic depths (30–150 m) (Kahng and Kelley 2007, Chan et al. 2009, Bare et al. 2010, Bongaerts et al. 2010, Kahng et al. 2010, Rooney et al. 2010, Dinesen et al. 2012). They may even occur deeper, with records of 153 and 165 m by *Leptoseris hawaiiensis* Vaughan, 1907, in the Pacific Ocean (Maragos and Jokiel 1986, Kahng and Maragos 2006), and 145 m by *L. fragilis* Milne Edwards and Haime, 1849, in the Red Sea (Fricke and Schuhmacher 1983, Fricke et al. 1987, Kaiser et al. 1993).

Because some *Leptoseris* species inhabit deep and poorly accessible habitats, they may not all be well known. An example is the recently discovered *L. kalayaanensis* Licuanan & Aliño, 2009, which so far has only been recorded from rocky substrates at 13–28 m depth in the South China Sea basin (Licuanan and Aliño 2009, Hoeksema et al. 2010). It shows a distinct brown and white coloured pattern on its upper surface, consisting of areas that are either with or without zooxanthellae.

The Agariciidae were not known to include true deep-sea species but according to recent phylogenetic studies, the solitary attached deep-water coral *Dactylotrochus cervicornis* (Moseley, 1881), which was originally classified with the Caryophylliidae, is also a member of the Agariciidae (Kitahara et al. 2010, 2012). This species has a recorded depth range of 73–852 m, is therefore considered ahermatypic and probably azooxanthellate (for terminology see Schuhmacher and Zibrowius 1985, Cairns and Kitahara 2012). It is monocentric and has smooth-edged septa that bear 2–5 elongate ridges (menianes or latera), which are considered characteristic for the Agariciidae (Kitahara et al. 2010, 2012).

Because *D. cervicornis* is predomintly from deep water, it is considered the first known extant azooxanthellate agariciid. *D. cervicornis* holds a basal position in a recent phylogeny reconstruction of extant Agariciidae and because extinct solitary agariciids from the Middle Cretaceous were also solitary, it is assumed that the ancestor of the Agariciidae, which nowadays predominantly consist of colonial and zooxanthellate species, was also solitary and azooxanthellate (Kitahara et al. 2012).

In the present paper a new agariciid coral species is described that is entirely azooxanthellate and dwells on ceilings of caves in steep reef slopes and walls. No co-occurrence with any zooxanthellate scleractinians was observed. Although its calices are relatively small, cup-shaped and predominantly monocentric, it resembles species of *Leptoseris*, which otherwise is known to consist of zooxanthellate species with polycentric ("circumoral") calices (Wells 1956). It is furthermore unique among extant reef-dwelling Agariciidae because it is modular (colonial) through extramural budding by growing new calices from a basal coenosteum, which eventually may fuse. It has been found in the western Pacific, including eastern Indonesia, central Philippines, Papua New Guinea, Palau and Guam. Most of its presently known distribution range overlaps with the centre of maximum marine species richness, the so-called Coral Triangle (Hoeksema 2007).

Methods

Specimens were observed, photographed and collected while diving with the help of SCUBA. All specimens were encountered below 5 m depth on the ceilings of caves inside steep reef slopes and walls, usually in areas with limestone outcrops. The caves measured one to several meters in width and several meters in length, enabling easy access and maneuvering for observations. Use of an underwater torch was indispensable to locate the corals. Collected specimens were soaked in fresh water or in sodium hypochlorite solution for cleaning. They were deposited in the Coelenterata collection (RMNH Coel.) of Naturalis Biodiversity Center, Leiden (formerly known as Rijksmuseum van Natuurlijke Historie). Specimens from Cebu were already available in the RMNH collection before they were photographed and collected for the present research. SEM photographs were taken with a Jeol 6480LV electron microscope operated at 10 kV.

Systematic section

Order Scleractinia Bourne, 1905
Family Agariciidae Gray, 1847
Genus *Leptoseris* Milne Edwards & Haime, 1849

***Leptoseris troglodyta* sp. n.**
urn:lsid:zoobank.org:act:DB802B45-E18D-4F55-9D23-5401660DD94E
http://species-id.net/wiki/Leptoseris_troglodyta
Figures 1–8

Leptoseris sp. Hoeksema and Van Ofwegen 2004.

Type material. Holotype. RMNH Coel. 40138 (1 specimen, dry, Figure 3a), **Palau**, W of Ulong Island (Rattakadokoru Island), W off barrier reef, 07°18'40"N, 134°13'30"E, Tsey's tunnel ceiling at 32 m depth, 28 July 2002, coll. B.W. Hoeksema. Paratypes: RMNH Coel. 40139 (15 specimens, dry), same collection data (Figures 2d, 3b–d).

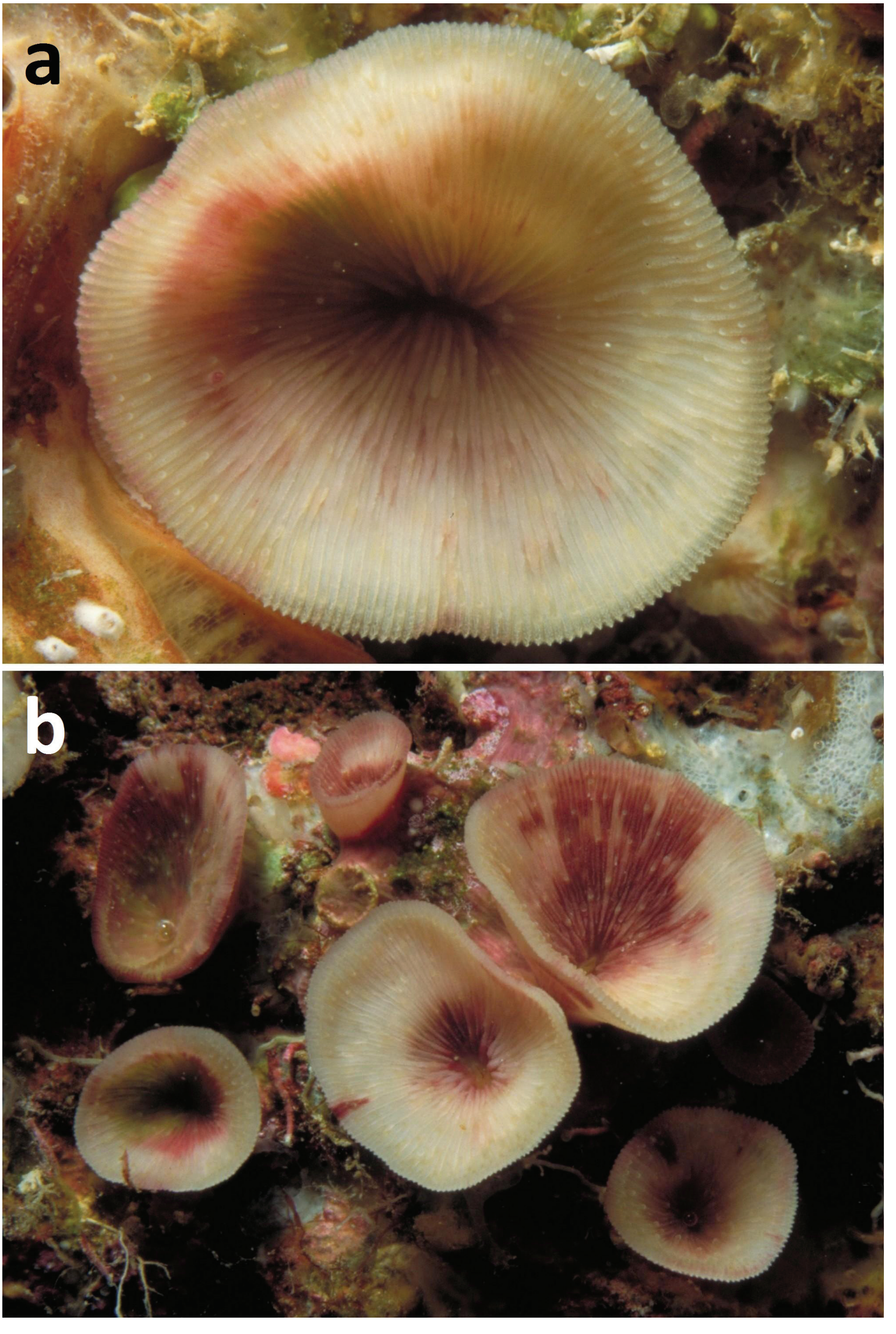

Figure 1. Living specimens of *Leptoseris troglodyta* sp. n. **a** Philippines, Cebu Strait, W of Bohol, NW of Cabilao Island, 10–30 m depth (7 November 1999) **b** Indonesia, NE Kalimantan, Berau Islands, S of Derawan Island, 7–10 m depth (4 October 2003).

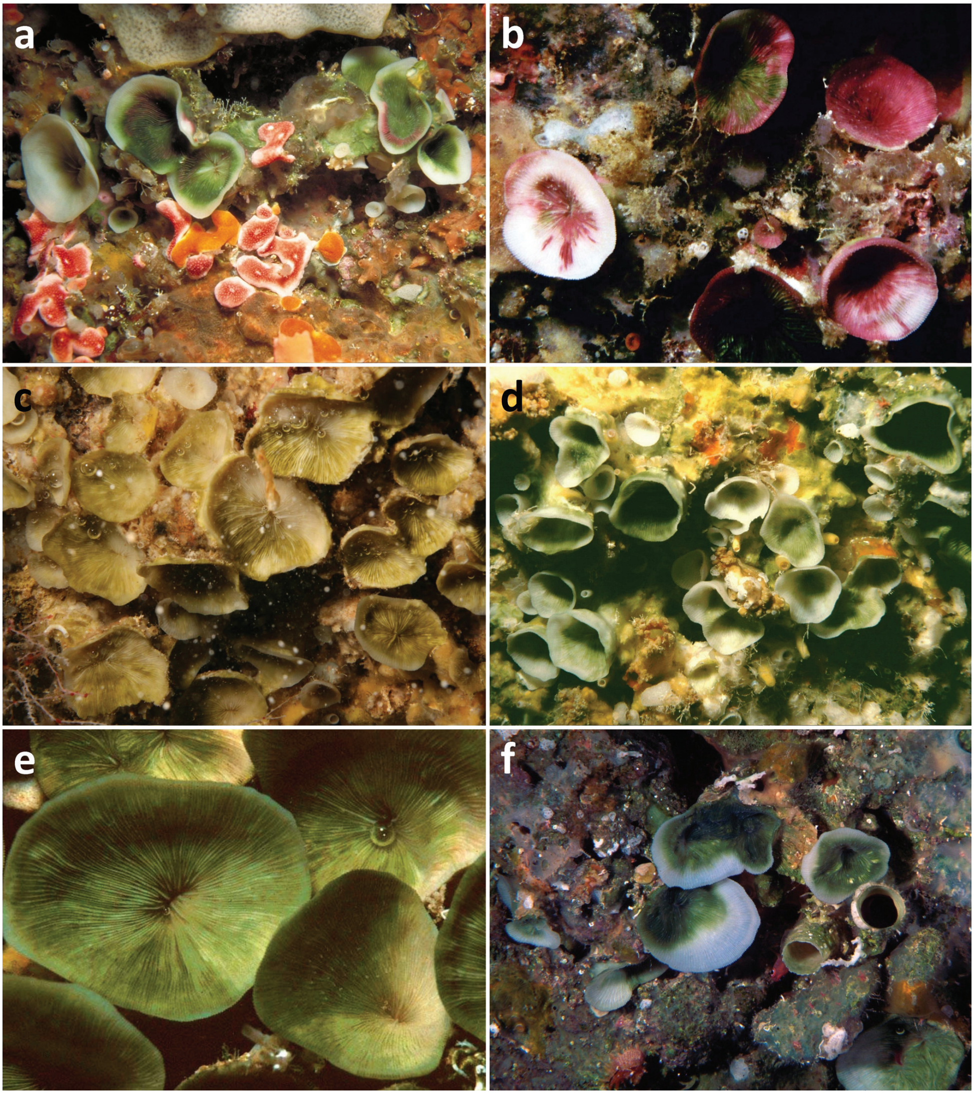

Figure 2. Living specimens of *Leptoseris troglodyta* sp. n. **a** Philippines, Cebu Strait, W of Bohol, NW of Cabilao Island, 10–30 m depth (7 November 1999) **b** Indonesia, Tukang Besi Islands (Wakatobi), Binongko, 20 m depth (10 May 2003) **c** Indonesia, North Sulawesi, S of Bunaken Island, 17 m depth (19 December 2008; photo B.T. Reijnen) **d** Palau, W of Ulong Island (Rattakadokoru Island), W off barrier reef, 32 m depth (28 July 2002) **e** Papua New Guinea, Misima Island, 6–10 m depth (31 May 1998; photo G. Paulay) **f** Guam, Blue Hole, 35 m depth (1 June 2000; photo G. Paulay).

Other material examined. Philippines. RMNH Coel. 24187 (3 specimens, dry), RMNH Coel 24195 (36 specimens, dry), Cebu Strait, W of Bohol, NW side of Cabilao Island, 09°53'12"N, 123°45'32"E, vertical wall with caves,10–30 m depth, 7 and 17 November 1999, coll. B.W. Hoeksema (Figures 1a, 2a, 7, 8). RMNH Coel. 40151 (2 specimens, dry), Philippines, Cebu, Mactan Island, Lapu-Lapu City, Marigondon

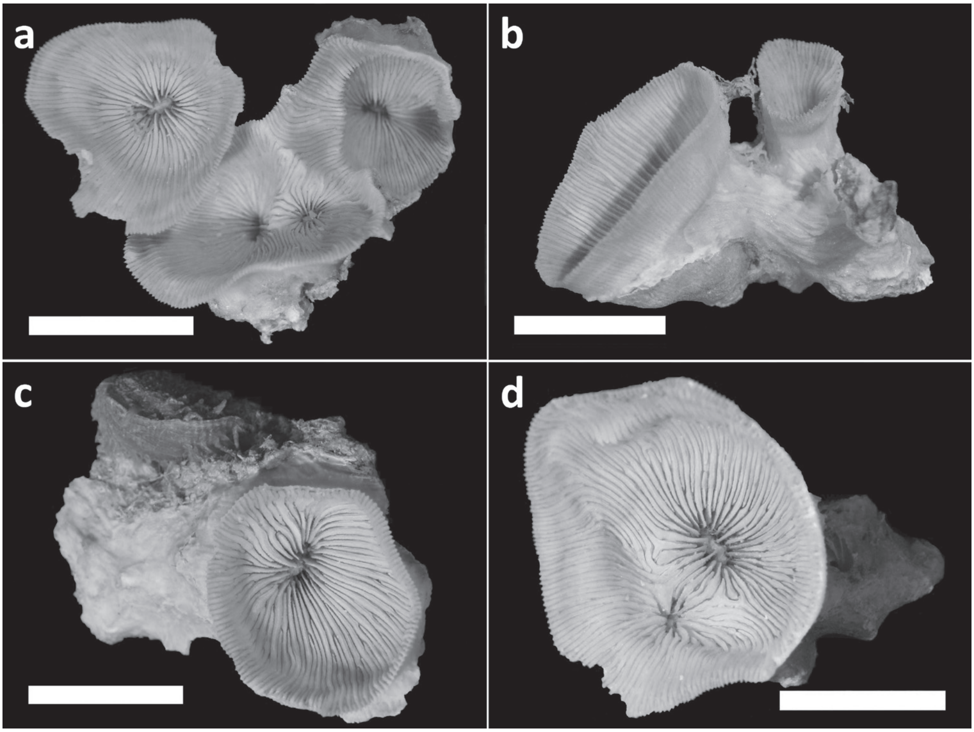

Figure 3. Holotype (RMNH Coel. 40138) and three paratypes (RMNH Coel. 40139) of *Leptoseris troglodyta* sp. n. from Palau. Scale bars: 1 cm. **a** Holotype consists of four calices: one (most left) has fused mid-height its calyx with two totally fused calices (centre), while another (right) has fused only with its corallum margin to those at the centre and the rest of its calyx has remained separate **b** Paratype: two separate calyces **c** Paratype: single calyx **d** Paratype: two fused calices. Scale bars: 1 cm.

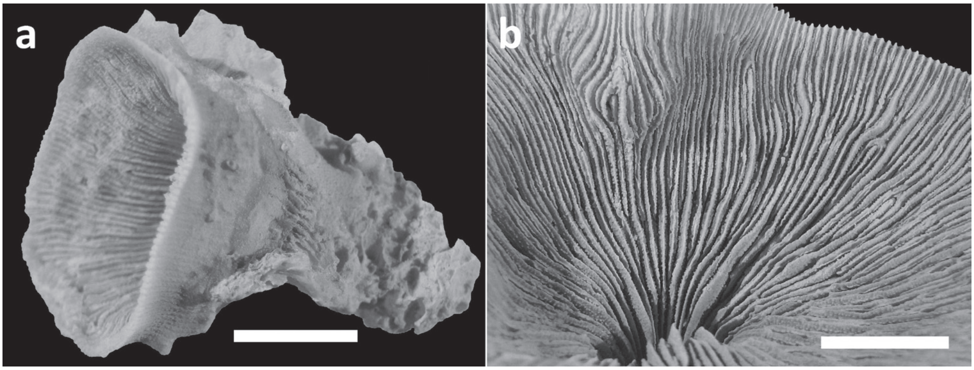

Figure 4. Specimens of *Leptoseris troglodyta* sp. n. from Indonesia, Wakatobi (RMNH Coel. 40152) **a** Single specimen from the side showing cup-shaped calyx shape and costae with fine granular spines (scale bar: 1 cm) **b** Close-up of large calyx showing septa with wide menianes along their sides (see Figure 5; scale bar: 5 mm).

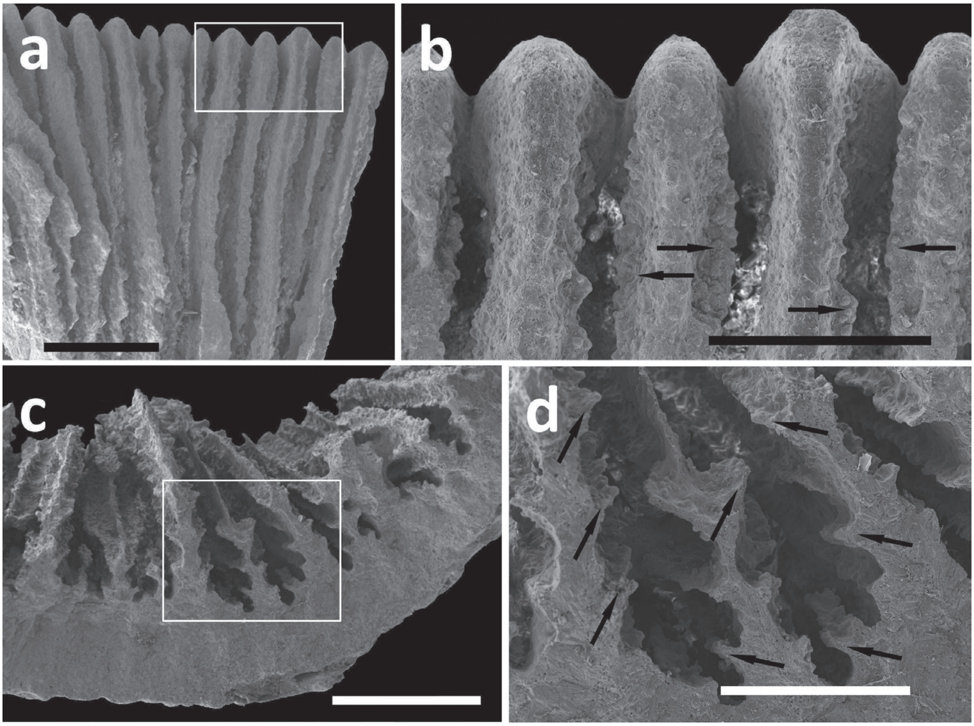

Figure 5. SEM photographs of *Leptoseris troglodyta* sp. n. from Wakatobi, Indonesia (RMNH Coel. 40152). **a** Upper side of septa showing wide menianes (scale bar: 1 mm; insert: Figure 5b) **b** Close-up (insert) of Figure 5a (arrows: menianes; scale bar: 0.5 mm) **c** Cross-section of septa showing multiple menianes along their sides (scale bar: 0.5 mm; insert: Figure 5d) **d** Close-up (insert) of Figure 5c (arrows: menianes; scale bar: 0.5 mm).

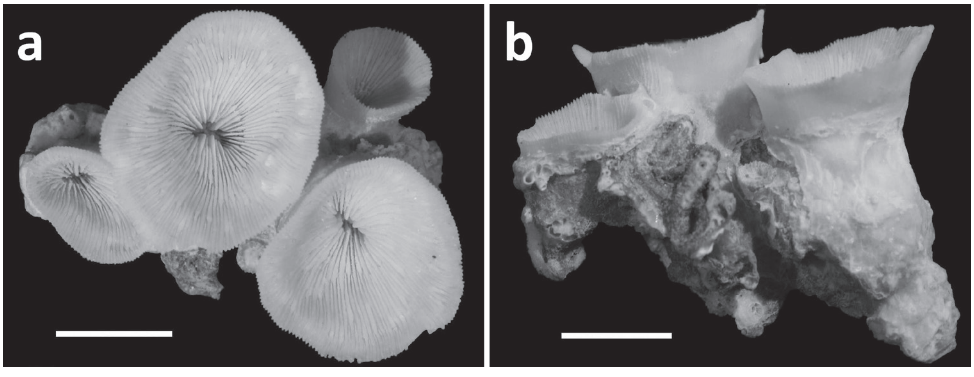

Figure 6. Specimens of *Leptoseris troglodyta* sp. n. from the Philippines, Cebu, Mactan Island, (RMNH Coel. 40151). Scale bars: 1 cm. **a** Upper side of a specimen showing four separate calices **b** Three calices that are partly fused at their sides.

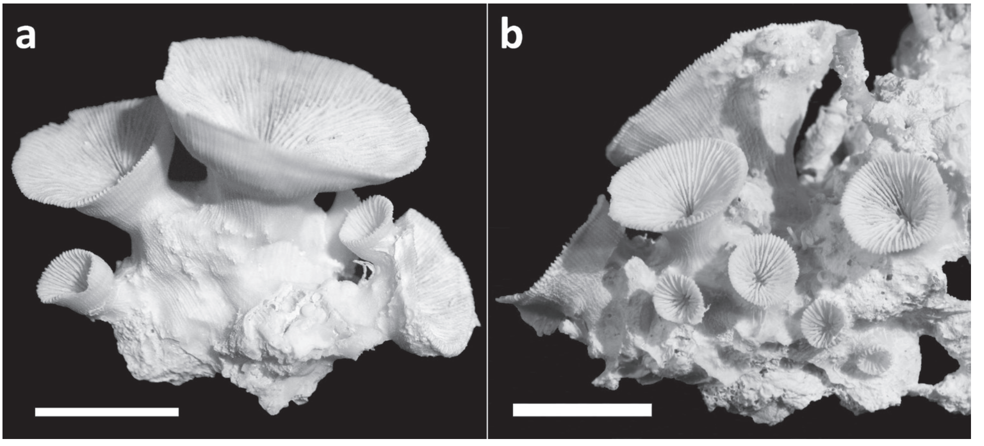

Figure 7. Specimens of *Leptoseris troglodyta* sp. n. from the Philippines, W of Bohol, NW side of Cabilao Island (RMNH Coel 24195). Scale bars: 1 cm. **a** Cluster of calices formed by extra-calicular budding showing costae with small granular spines **b** Idem.

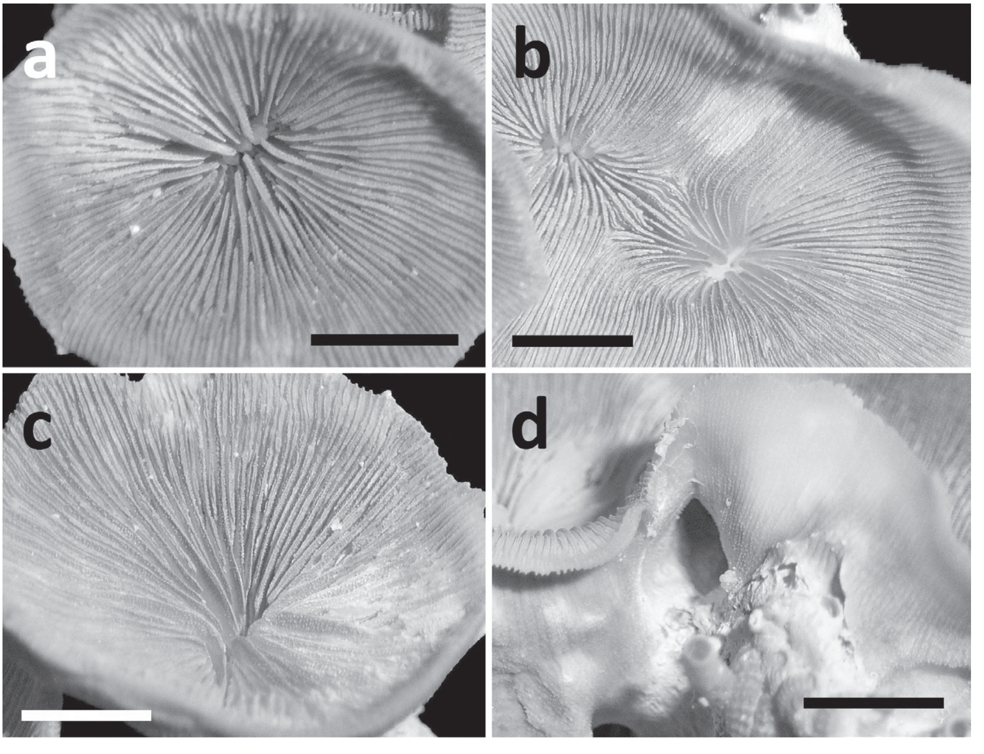

Figure 8. Specimens of *Leptoseris troglodyta* sp. n. from the Philippines, W of Bohol, NW side of Cabilao Island (RMNH Coel 24195). Scale bars: 5 mm **a** Single calyx from above, showing nearly solid columella in the fossa **b** Two totally fused monocentric calices showing, each with its own fossa **c** Upper side of calyx showing clearly visible granulation on septal sides **d** Calyx showing solid corallum wall covered by costae with fine granular spines.

Cave, 10°15'33"N, 123°59'07"E, ceiling of cave at 25-30 m depth, May 1981, coll. M.B. Best (Figure 6). **Indonesia.** RMNH Coel. 40152 (7 specimens, dry), Tukang Besi Islands (Wakatobi), Binongko, SW Bay, 05°59'47"S, 124°02'55"E, cave in steep wall 20 m depth, 10 May 2003, coll. B.W. Hoeksema (Figures 2b, 4–5). RMNH Coel. 40150 (25 specimens, ethanol), Tukang Besi Islands (Wakatobi), NE Hoga Island, 05°28'S, 123°47'E, cave in steep reef slope 5 m depth, 12 July 2011, coll. B.W. Hoeksema. RMNH Coel. 40137 (2 specimens, ethanol), North Sulawesi, South of Bunaken Island, Alung Banua village, 01°37'07"N, 124°45'30"E, tunnel in reef wall 17 m depth, 19 December 2008, coll. B.T. Reijnen and S.E.T van der Meij (Figure 2c).

Additional photographic records: Indonesia, NE Kalimantan, Berau Islands, S of Derawan Island, jetty Derawan Dive Resort, 02°17'03"N, 118°14'49"E, ceiling of caves, 7–10 m deep (4 October 2003; Figure 1b). **Papua New Guinea**, Off SE point, Misima Island, Pt. Ebola, 6–10 m depth (31 May 1998; Figure 2e). **Guam**, Blue Hole, 35 m depth (1 June 2000; Figure 2f).

Description. Corallum attached and solitary or colonial by budding from basal coenosteum (Figures 3–4, 6–8). Calices predominantly monocentric, very thin, cup-shaped to foliaceous, height < 15 mm, outline irregularly circular, Ø < 30 mm (Figures 1–4, 6–8). They are usually separate from each other above the interconnecting basal plate (Figures 3b, 6, 7), but can also be fused at their margins or lateral sides (Figures 3a, 8b). Corallum wall massive. Costae equal and well defined, with small spiny protuberances (Figures 4a, 7a, 8d). Septa approximately equal in size, with smooth upper edges and parallel ridges (menianes) on their sides (Figures 3, 5, 8). Septal sides may show evenly distributed granulations where menianes are absent (Figures 8b–c). Columella nearly solid (Figures 3a, 3c–d, 8a–b). Living animals azooxanthellate; corals are white, or partly green or red (Figures 1–2), owing to the presence of endolithic algae (Kühl and Polerecky 2008).

Diagnosis. Corals cave-dwelling, azooxanthellate. Calices small, cup-shaped, monocentric or fused, forming buds at basal coenosteum.

Etymology. The epithet *troglodyta* (noun) means cave dweller in Latin, derived from ancient Greek for "one who dwells in holes".

Distribution. Records are from coral reefs, usually in areas with limestone outcrops: Indonesia (East Kalimantan, North Sulawesi, Southeast Sulawesi), the central Philippines (Cebu, Bohol), Palau, eastern Papua New Guinea, and the Marianas (Guam) (Figure 9).

Discussion

Systematics

Leptoseris troglodyta sp. n. has a habitat and growth form unlike any other known *Leptoseris*; its corals are cavernicolous and azooxanthellate, and have small, monocentric calices that may multiply by extramural budding and fuse. Other *Leptoseris* species are

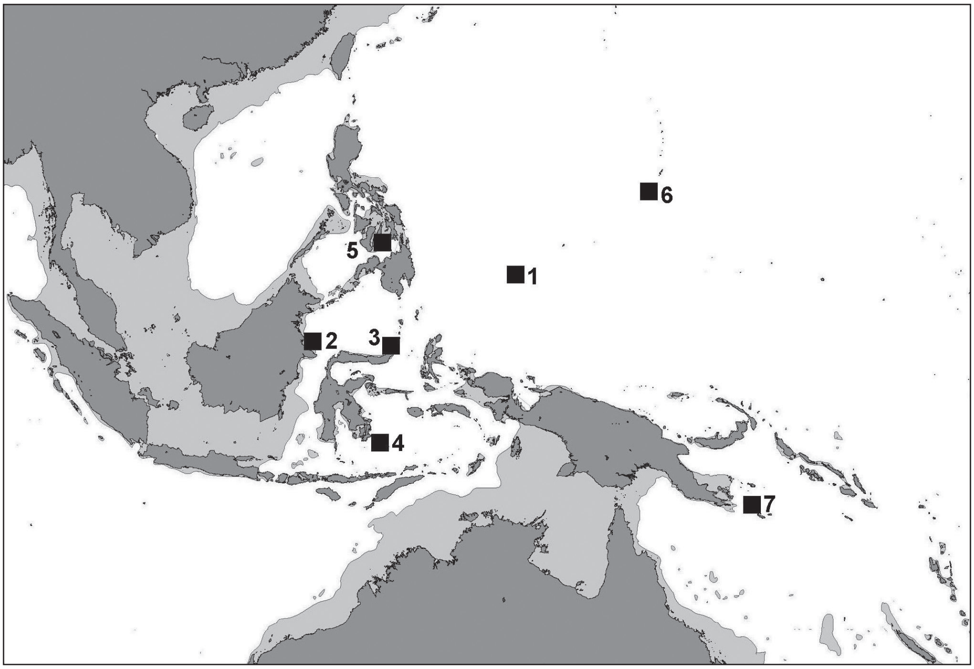

Figure 9. Distribution map of *Leptoseris troglodyta* sp. n. showing records at (**1**) Palau, (**2**) East Kalimantan, (**3**) North Sulawesi, (**4**) Wakatobi, (**5**) Bohol, (**6**) Guam, (**7**), eastern Papua New Guinea.

polycentric by circumoral and marginal budding (Dinesen 1980, Veron and Pichon 1980, Veron 2000, Licuanan and Aliño 2009). All congeneric species are larger, which may be related to their symbiosis with zooxanthellae. Polycentric species are usually bigger than close relatives with monocentric calices, as demonstrated for mushroom corals (Hoeksema 1991b, Gittenberger et al. 2011).

The new species lacks pigments of its own, like many cavernicolous (= troglobiotic) animals. Although there are no zooxanthellae in its soft tissue, it usually contains green or red shade-adapted endolithic cyanobacteria imbedded in the skeleton, which have also been reported from *Leptoseris fragilis* Milne-Edwards and Haime, 1849 (Schlichter et al. 1997).

Dinesen (1983) mentions the occurrence of "numerous *Leptoseris* cf. *scabra* (G. Hodgson, M. Ross, pers. comm.)", which were observed in 1981 on the ceiling inside the large Marigondon Cave (Mactan Island, Cebu), the Philippines. They were found "further back in the cave, in gloomier conditions" than the cave entrance at ca 30 m depth. It is likely that this record pertains to specimens of the new species. Two corals of the present study were collected at that site in 1981 and were available for study in the RMNH collection in Leiden. These specimens confirm that the new species was present at that locality at that time. Museum collections may indeed help to retrieve information on the earlier occurrence of coral species that have not been recorded before (Van der Meij et al. 2010, Hoeksema et al. 2011, Van der Meij and Visser 2011). However, without field observations it would not have been possible to know that the new species lacks zooxanthellae.

Despite its unique small monocentric corallites and lack of zooxanthellae, the new species is classified with *Leptoseris* because of similarly shaped septa and costae, and by its thin, cup-shaped or foliaceous coralla somewhat resembling those of *L. fragilis*. The latter species features corals that can be monocentric, but its calices grow larger (Ø > 50 mm) and may eventually form secondary stomata by intracalicular, circumoral budding. Other extinct agariciid genera predominantly consist of encrusting and massive, polystomatous species (Wells 1954, Veron 2000).

Support from molecular analyses (Stefani et al. in prep) would be needed to justify the position of the new species in a separate genus instead of *Leptoseris*. In that case, it could be appropriate to classify it with *Trochoseris* Milne Edwards & Haime, 1849, an extinct genus (Mid Cretaceous – Oligocene) consisting of corals that are solitary, attached and turbinate or trochoid (Wells 1956). However, molecular analyses cannot support such a transition because no live material is available of this genus.

The corals have a basic growth form like that of *Cladopsammia gracilis* (Milne Edwards and Haime 1848) (Dendrophylliidae), i.e., by extramural budding from the basal coenosteum (see Cairns 1991). They are not distinctly reptoid as described for some *Rhizopsammia* species of the same family (Cairns and Zibrowius 1997) because there are no clear basal costate stolons involved. Extramural budding is also shown by fossils of the extinct genus *Brachyphyllia* Reuss, 1854 (Agariciidae), which has thick, low plocoid corallites (Wells 1956) instead of the thin cup-shaped corallites shown by the new species. Compared to the extant solitary agariciid deep-water species *Dactylotrochus cervicornis* (see Wells 1954, Cairns 1999, Kitahara et al. 2012, Cairns and Kitahara 2012), *L. troglodyta* differs by the capacity to become colonial and by having a circular corallum outline instead of a periphery with thecal extensions. Only a few specimens of *D. cervicornis* are known to show an 'aberrant' tendency for coloniality (Kitahara et al. 2012).

Evolution of symbiosis with zooxanthellae

Leptoseris troglodyta is the first extant shallow-water agariciid known known to be reef-dwelling and azooxanthellate. The extinct agariciid genera, *Trochoseris* Milne Edwards & Haime, 1849 and *Vaughanoseris* Wells, 1934, also consists of monocentric species; the first being attached and turbinate or trochoid, and the second being free-living and discoid (Wells 1956). According to Kitahara et al. (2012) they could have been azooxanthellate because the extant *Dactylotrochus cervicornis*, which shows a basal position in the phylogeny reconstruction of the Agariciidae, is considered both azooxanthellate and monocentric. However, the phylogenetic positions of the two extinct taxa are unknown and although they share a (supposedly plesiosmorph) solitary growth form with *Dactylotrochus*, this does not necessarily imply that they are phylogenetically closely related to each other. For example, several phylogenetic lineages within the reef-dwelling mushroom coral family Fungiidae show an evolution from monocentric to polycentric zooxanthellate corals, implying that not all monocentric fungiid species are directly related to each other (Hoeksema 1989, 1991b, Gittenberger et al. 2011, Benzoni et al. 2012).

Coincidently, the Fungiidae show many examples of solitary free-living species that resemble the extinct *Vaughanoseris*. So, regarding their lifestyle, *Vaughanoseris* species could be reef-dwelling and zooxanthellate as well. Moreover, the attached, monocentric dendrophylliid *Balanophyllia europaea* (Risso, 1826) is an example of a single zooxanthellate species (Schuhmacher and Zibrowius 1985) among a majority of congeners without zooaxanthellae (Cairns et al. 1999). Its growth form resembles that of *Trochoseris*, for which the absence of zooxanthellae may therefore perhaps be less certain. Nevertheless, a solitary growth form, an old fossil record, and a possible ancestral position in the phylogeny may not be sufficient to predict whether an extinct coral taxon may have been azooxanthellate. Its habitat (especially depth) may be more indicative, especially if species were shallow reef-dwellers.

The deep-water species *Dactylotrochus cervicornis* and the cave-dweller *Leptoseris troglodyta* posses parallel ridges on the sides of their septa, which are called menianes (Kitahara et al. 2010, 2012). These are probably the same structures (compare Figure 5, Kitahara et al. 2012 figure 2, and Kahng et al. 2012 figure 9) that help zooxanthellate *Leptoseris* corals to absorb sunlight more efficiently at greater depths (Kahng et al. 2012). The bathymetric records of *D. cervicornis* (Kitahara et al. 2012) partly coincide with depth ranges of zooxanthellate *Leptoseris* species (see Dinesen et al. 2012). Depth may therefore not always be indicative for the absence of zooxanthellae.

All live specimens of *L. troglodyta*, which were observed in their habitat (Figures 1–2), were clearly azooxanthellate by lacking a brown colour, like completely bleached corals (Hoeksema 1991a, Hoeksema and Matthews 2011). In the case of dredged deep sea corals in collections, which are either dry or being preserved in ethanol, pigments of any present zooaxanthellae might have dissolved, which makes it difficult to see whether they were present. If *D. cervicornis* corals lack zooxanthellae, like those of *Leptoseris troglodyta*, the presence of menianes at least suggests that their ancestors might have been zooxanthellate and that the loss of zooxanthellae may be an evolutionary novelty related to life in deep water or in caves. Consequently, ancestral agariciids, along with *Trochoseris* and *Vaughanoseris*, were perhaps also zooxanthellate like many modern monocentric zooxanthellate reef corals in illuminated habitats. On the other hand, a preceding presence of menianes in agariciid corals may also have facilitated the development of symbiosis with zooxanthellae, which implies that early agariciids may have been azooxanthellate as suggested by Kitahara et al. (2012), presenting a "chicken or the egg" causality dilemma.

The deep-water species *Dactylotrochus cervicornis* and the cave-dweller *Leptoseris troglodyta* both live in dark environments. The latter has been observed to be azooxanthellate in caves at various localities. *D. cervicornis* specimens may have to be examined for the absence of zooxanthellae to be sure that this species is always azooxanthellate. If so, its menianes have no use in connection to light absorption, like in *L. troglodyta*. *L. troglodyta* shows that the evolutionary relation between scleractinian reef corals and their algal symbionts is not fixed and that it may be difficult to deduct such a relation based on coral growth forms and their possible position in phylogeny reconstructions, especially if no molecular data can be obtained, as is the case for fossil corals. According to a recent molecular study, coloniality may have become lost at least six times and symbiosis with zooxanthellae at least three times in the phylogeny of the Scleractinia (Barbeitos et al. 2010). However, these numbers are based on a subset of species and may have to be revised if additional species are involved (see Gittenberger et al. 2011).

Eco-morphological considerations

Leptoseris troglodyta sp. n. is the first reef-dwelling agariciid coral without zooxanthellae. As a small cave-dwelling species it can live without sunlight. It has not been observed to co-occur with any zooxanthellate scleractinians (only azooxanthellate species), although in small and poorly illuminated cavities a variety of zooxanthellate scleractinians can be discerned (Dinesen 1983). Other *Leptoseris* species are zooxanthellate and most of them are able to live on deep, poorly illuminated reefs or rocky substrates. Therefore, from an evolutionary perspective, the new species may have lost the capacity to live in symbiosis with zooxanthellae and it may have obtained a smaller corallum size (dwarfism). By their small and thin corolla the corals have little weight. Consequently, with their wide basal plate they may not easily break off from their substrate, which consist of porous limestone cave ceilings where settlement space is limited. Without zooxanthellae, they may not easily reach large sizes, whatsoever. Owing to its modular growth form a *L. troglodyta* coral may risk losing a few expendable calices while other *Leptoseris* corals may harm and lose their entire corallum in unfavourable conditions. Other examples of zooxanthellae loss in relation to a cavernicolous lifestyle are so far unknown among scleractinian families. However, among shallow-water brachycnemic zoanthids an undescribed cave-dwelling *Palythoa* species has been recorded that also lacks zooxanthellae, while its congeners are known to be zooxanthellate (Reimer 2010).

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RESEARCH ARTICLE

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First record of the ant subfamily Aenictinae (Hymenoptera, Formicidae) from Saudi Arabia, with the description of a new species

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Abstract

The ant subfamily Aenictinae is recorded for the first time from the Kingdom of Saudi Arabia and for the second time from the Arabian Peninsula. A new species *Aenictus arabicus* **sp. n.**, is described from the worker caste. *Aenictus arabicus* belongs to the *A. wroughtonii*-group and appears to be most closely related to *A. rhodiensis* Menozzi, but can be easily distinguished from the latter by the following characters: overall smaller size; cephalic index (head width/head length) small; occipital corners in lateral view rounded; antennal scape when laid back surpassing approximately two-thirds of head length; funicular segments 2–8 each at least 2× as long as broad; subpetiolar process well developed; petiole and postpetiole distinctly imbricate; gaster and clypeus entirely yellow, teeth of mandibles reddish- brown. *Aenictus arabicus* was collected from leaf litter, next to a tree of *Psidium guajava* L. The new species also is similar to *A. sagei* and *A. wroughtonii*. Affinities and a key to related species of the species group are given.

Keywords

Aenictus, taxonomy, Arabian Peninsula, Saudi Arabia, Al Sarawat Mountains, ants, Palaearctic region

Introduction

The subfamily Aenictinae Emery, 1901, was elevated to the rank of subfamily by Bolton (1990), and includes a single genus, *Aenictus* Schuckard, 1840. The genus presently has 177 species and subspecific forms (Bolton 2012), distributed through the East Mediterranean, Afrotropical, Oriental, Indo-Australian, and Australian regions (Gotwald 1995, Brown 2000, Aktaç et al. 2004, and Jaitrong and Yamane 2012). Most of the species are tropical (Brown 2000), with terrestrial habitats, foraging in soil, leaf litter, most of the Southeast Asian species forage on the ground, and some on trees (e.g., Hirosawa et al. 2000) and hunting other ant species and termites (Gotwald 1995, Rosciszewski and Maschwitz 1994).

The subfamily Aenictinae is characterized by having:- a waist of two segments, with the spiracle of the postpetiole set behind the midlength of the tergite; all gastral spiracles circular; and the first gastral segment with a narrow, neck-like constriction behind the articulation with the postpetiole, 8-10 antennal segments, the frontal lobes reduced with the antennal sockets completely exposed, and the promesonotal suture absent (Bolton 1994). Species of *Aenictus* are generally small, monomorphic and yellow to dark brown. Members of the *Aenictus wroughtonii*-group share the following characters (Jaitrong et al. 2010): head narrow; posterior margin of head lacking collar; antennae long, 10-segmented; with long scape reaching or surpassing posterolateral corners of head; anterior clypeal margin bearing 5-10 denticles; mandibles subtriangular, with masticatory margin bearing 8-12 minute teeth in addition to a large apical tooth with a sharp apex; frontal carinae short; mesosoma narrow and elongate; legs thin and long; head entirely smooth and shiny; almost entire body clear yellow to yellowish brown.

Since Wilson's (1964) revision, several authors have published taxonomic papers dealing with particular areas or species groups, e.g., Zhou (2001) (South China), Shattuck (2008) (Australia), Terayama (2009) (Taiwan), Zettel and Sorger (2010) (Borneo and the Philippines), Jaitrong and Yamane (2012) (Southeast Asia), and Bharti et al. (2012) (India). A catalogue of the 35 known Afrotropical members can be accessed on the website of Taylor (2012), with photographs also on Fisher's Antweb.org (2012).

Ten species of *Aenictus* have been reported from the Palaearctic, nine of which are distributed in the Southwestern part of the region, Morocco in the west to Afghanistan in the east (Aktaç et al. 2004). Country records include *A. rhodiensis* from Greece (Menozzi 1936), Turkey (Aktaç et al. 2004), Iran (Radchenko and Alipanah, 2004) and Israel (Kugler 1988); *A. fuscovarius fuscovarius* Gerstäcker, *A. fuscovarius sagittarius* Santschi and *A. hamifer* Emery from Egypt (Sharaf 2006); and, an unidentified species from Yemen (Collingwood and van Harten 2001). The *A. wroughtonii*-group was revised for the Oriental and Indo-Australian regions (Jaitrong et al. 2010) giving seven species. The new species, *A. arabicus* belongs to this species group with resemblance to *A. sagei* and *A. wroughtonii* described by Forel from India.

Here the subfamily Aenictinae is recorded for the first time from Saudi Arabia and for the second time from the Arabian Peninsula. A new species, *A. arabicus* sp. n., is described based on the worker caste. The queen and male are unknown. A key to the related species within the *A. wroughtonii*-group is given.

Materials and methods

The following abbreviations are used for particular morphological features and metrics:

TL Total length; the outstretched body length from the mandibular apex to the gastral apex.
HW Head width; the maximum width of the head in full-face view.
HL Head length; the maximum length of the head, excluding the mandibles.
CI Cephalic index (HW × 100/HL).
SL Scape length, excluding condylar bulb.
SI Scape index (SL × 100/HW).
ML Mesosoma length; the length of the mesosoma in lateral view, from the point at which the pronotum meets the cervical shield to the posterior base of the propodeal lobes or teeth.
PRW Pronotal width; the maximum pronotal width in dorsal view.
PL Petiole length; the maximum length of petiole measured in dorsal view, from the anterior margin to the posterior margin.
PW Petiole width; the maximum petiolar width measured in dorsal view.
PPL Postpetiole length; the maximum postpetiolar length measured in dorsal view.
PPW Postpetiole width; the maximum postpetiolar width measured in dorsal view.

All measurements are expressed in millimeters. Images were taken with a scanning electron microscope ((SEM) JSM-6380 LA).

Depositories of type material

BMNH Natural History Museum, London, United Kingdom.
CASC California Academy of Science Collection, San Francisco, California, USA.
KSMA King Saud Museum of Arthropods, King Saud University, Riyadh, Kingdom of Saudi Arabia (Holotype depository).
MCZC Museum of Comparative Zoology, Harvard University, Cambridge, MA, USA.
MHNG Muséum d'Histoire Naturelle, Geneva, Switzerland.
NHMB Naturhistorisches Museum, Basel, Switzerland.
SEMC Division of Entomology (Snow Entomological Collections), University of Kansas Natural History Museum, Lawrence, Kansas, USA.
WMLC World Museum Liverpool, Liverpool, United Kingdom.

Results

Aenictus arabicus **Sharaf & Aldawood, sp. n.**
urn:lsid:zoobank.org:act:347C091D-1E98-4765-AEF5-10C4CACE8DDE
http://species-id.net/wiki/Aenictus_arabicus
Figs 1–12

Holotype worker. Saudi Arabia, Al Baha-Mukhwah Aqaba RD,19.IV.2012, 20.00000°N,41.43758°E, 1300 m, 19.IV.2012 (*M. R. Sharaf leg.*); deposited in the KSMA.

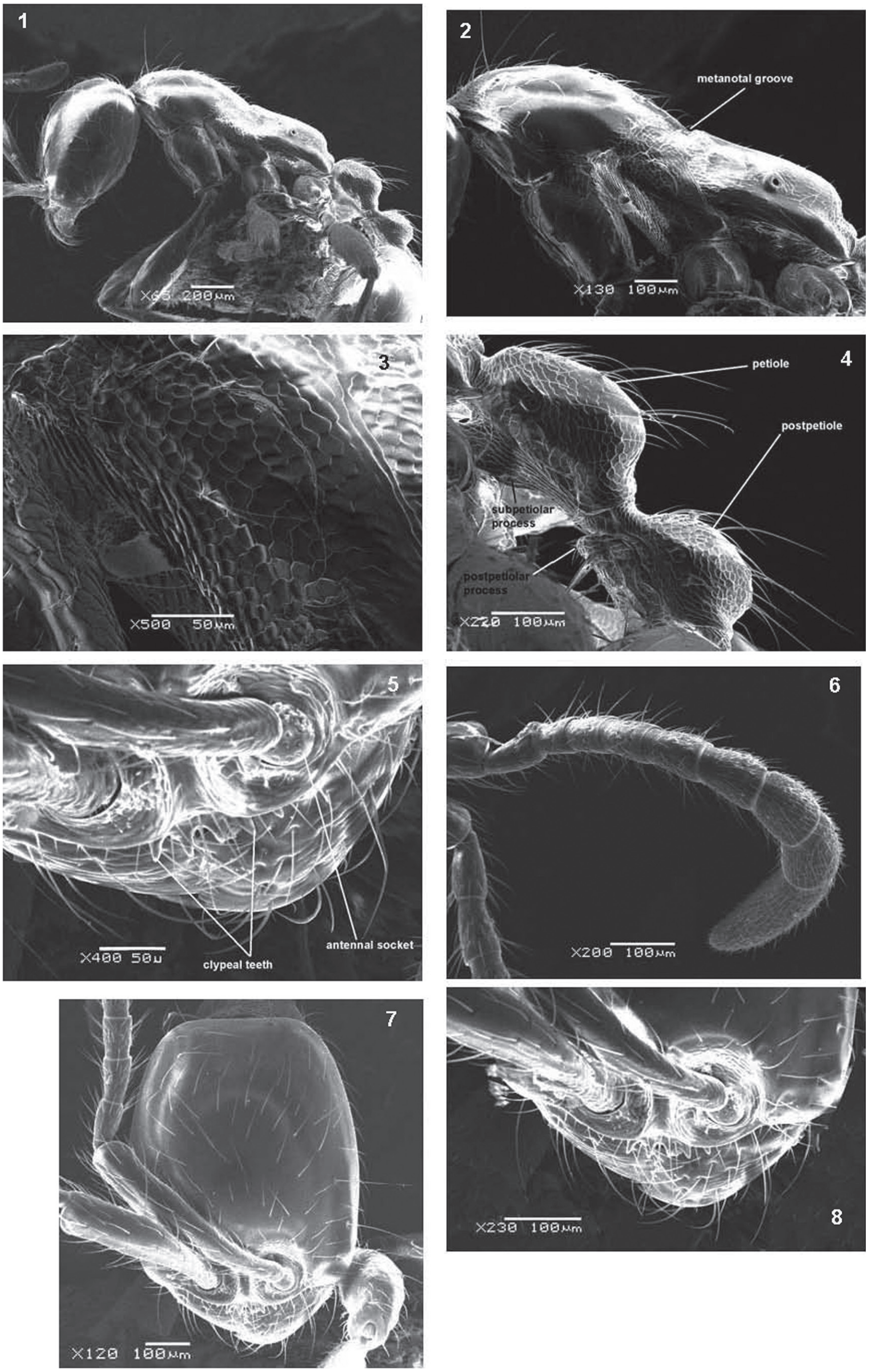
Paratype workers. 21 workers, same data as holotype; 1 deposited in **MHNG** (Dr Bernhard Merz); 1 deposited in **NHMB** (Mrs. Isabelle Zürcher-Pfander); 2 deposited in **CASC** (Dr Brian Fisher); 2 deposited in **MCZC** (Prof. E. O. Wilson); 2 deposited in **SEMC** (Prof. Michael S. Engel); 1 deposited in **WMLC** (Mr. Tony Hunter), 1 deposited in **BMNH** (Mr. Barry Bolton); the remaining specimens in **KSMA** (M. R. Sharaf).

Measurements. Holotype: TL 3.0, HL 0.65, HW 0.52, SL 0.50, PRW 0.35, ML 0.95, PL 0.22, PW 0.15, PPL 0.17, PPW 0.15. Indices: SI 96, CI 80.

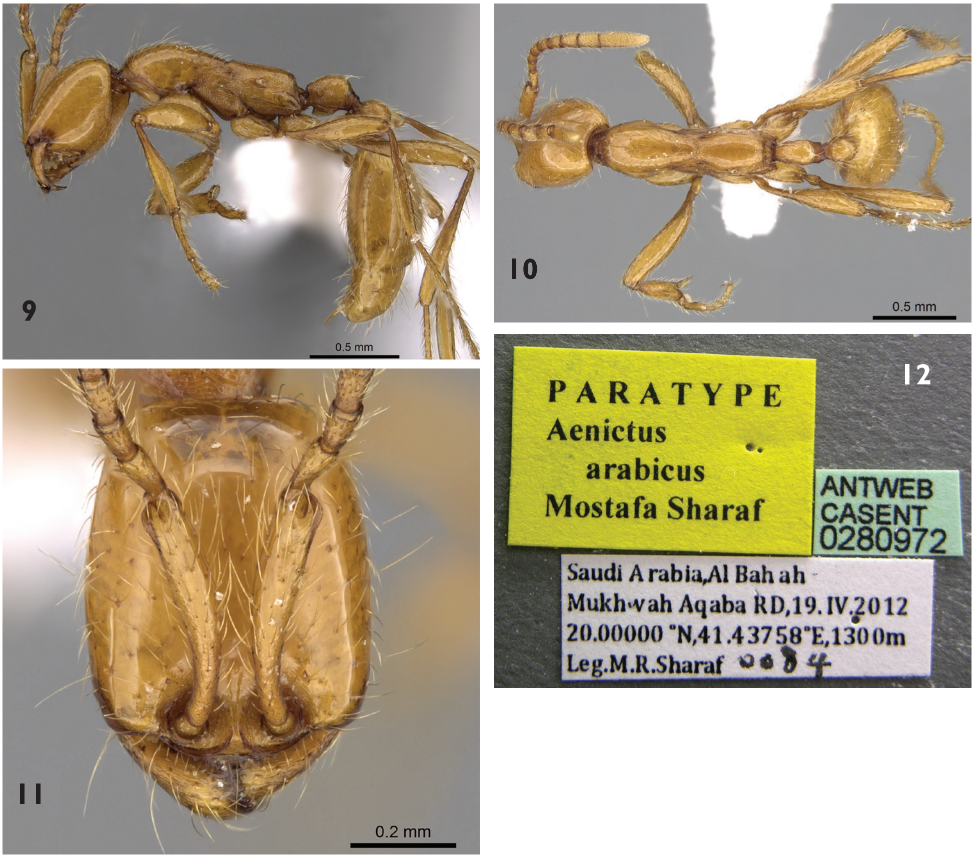
Paratypes. TL 2.75-3.12, HL 0.60-0.72, HW 0.42-0.55, SL 0.40-0.52, PRW 0.20-0.35, ML 0.77-1.00, PL 0.22-0.27, PW 0.12-0.15, PPL 0.15-0.20, PPW 0.12-0.17. Indices: SI 77-104, CI 70-92. (n=11).

Description of worker. Head entirely smooth and shining. In full-face view head distinctly longer than broad, with convex sides and nearly straight posterior margin; occipital corners in lateral view rounded; anterior clypeal margin with six small denticles; masticatory margin of mandibles armed with a large apical tooth followed by five smaller subequal teeth and a relatively larger basal tooth; when laid back, antennal scapes surpassing about two thirds of head length; all funicular segments at least twice as long as broad; terminal funicular segment about 2.5 × as long as the proceeding segment; mandibles dull with longitudinal striations; whole head dorsum and antennae with stiff scattered long hairs. Mesosoma in dorsal view broader anteriorly than posteriorly; promesonotum in profile distinctly convex, bearing many pairs of hairs; metanotal groove distinct; mesopleuron faintly but distinctly imbricate; propodeum bare or in some individuals with very sparse decumbent pubescence; propodeal dorsum long, about 4× as long as declivity; propodeum in profile slightly lower than promesonotum and almost flat dorsally; propodeal junction rounded. Petiole longer than broad in dorsal view with node clearly convex in lateral view; subpetiolar process triangular with convex ventral margin and blunt anteriorly. Postpetiole distinctly smaller than petiole, its node roundly convex, and its anteroventral edge sharp and bearing many hairs; both petiole and postpetiole distinctly imbricate and equipped dorsally with several pairs of backward directed long hairs. Gaster smooth and shining with abundant pairs of hairs. Color uniformly yellow.

Etymology. This species is named after the type locality.



Figures 1–8. SEM of *Aenictus arabicus* sp. n. paratype **1** body in profile **2** mesosoma in profile **3** imbricate sculpture of mesopleuron **4** petiole and postpetiole in profile **5** antennal sockets and anterior clypeal margin **6** antenna **7** head in full-face view **8** anterior part of head.



Figures 9–12. Automontage of *Aenictus arabicus* sp. n. paratype **9** body in profile **10** body in dorsal view **11** head in full-face view **12** label. (CASENT0280972).

Discussion

Affinities. *Aenictus arabicus* is similar to *A. rhodiensis* Menozzi, 1936 from Greece; and *A. sagei* and *A. wroughtonii* described by Forel from India. All the three species are members of the *A. wroughtonii*-group as defined by Jaitrong et al. (2010) and sharing the following characters: head narrow, entirely smooth and shining; occipital margin lacking collar; antennae long, 10-segmented; anterior clypeal margin convex, rounded, with 5–10 denticles; mandibles subtriangular, with masticatory margin bearing 8–12 minute teeth in addition to a large apical tooth with a sharpe apex; mesosoma narrow and elongate; subpetiolar process weakly developed or almost absent; body clear yellow to yellowish brown.

Comparing *A. arabicus* with *A. rhodiensis*, both species have a similar general morphology, notably the shape of the mesosoma, petiole and postpetiole, a similar body pilosity; also both have a peculiar subpetiolar process which is somewhat wide and blunt anteriorly and the anterior clypeal margin is equipped with six small denticles. From the more accurate description in Aktaç et al. (2004), *A. arabicus* can be separated readily from *A. rhodiensis*. The former has a small relatively long, narrow head

(HL 0.60-0.72, HW 0.42-0.55, CI 70-92) and long scapes, when laid back surpassing about two-thirds of the head length (SI 77-104) while the latter has a shorter head (HL 1.23, HW 1.02) and shorter scapes, which just surpass the midpoint of the head. *Aenictus arabicus* has a nearly straight posterior margin of the head whereas it is weakly concave in *A. rhodiensis.* The funicular segments 2-8 are at least twice as long as broad in the former, while they are as long as broad in the latter. *Aenictus arabicus* has an entirely yellow clypeus and reddish-brown mandibular teeth while the sides of the clypeus and mandibular teeth are reddish brown in *A. rhodiensis*. The gaster of *A. arabicus* is entirely yellow, whereas in *A. rhodiensis*, the middle of the third gastral tergite has two longitudinal brownish lines which diverge forward, sometimes reducing to small points. *Aenictus dlusskyi* Arnoldi, known only from the type series from Armenia, also resembles *A. arabicus* but is of a similar size to *rhodiensis* (Aktaç et al. 2004).

Comparing *A. arabicus* with the Asian species *A. sagei* (CASENT0281958) and *A. wroughtonii* (lectotype images are given in Jaitrong et al. 2010: 35), *A. arabicus* has the anterior clypeal margin bearing six small denticles; *A. sagei* has 9-10 denticles; whereas *A. wroughtonii* has 8-10 denticles. In addition, *A. arabicus* has the subpetiolar process well developed, triangular, with convex ventral margin and blunt anteriorly and body pilosity fewer and shorter; *A. sagei* has a weakly developed subpetiolar process, with its ventral outline nearly straight; its anteroventral corners obtusely angulate and body pilosity distinctly long and abundant (length of the longest pronotal hair 0.20–0.25 mm, Jaitrong et al. 2010); whereas *A. wroughtonii* has an undeveloped subpetiolar process, with its ventral outline feebly convex and without anterior angle and relatively sparse standing hairs which are shorter than in *A. sagei*.

Habitat and biology

Al-Baha Province is divided by massive and steep rocky mountains into the lowland coastal plain to the west, known as "Tihama", and the mountainous area ranging 1500 - 2450 m above sea level to the east, known as "Al-Sarat or Al-Sarah" which forms part of Al-Sarawat Mountains. The type locality (Fig. 13) is a small farm at the beginning of a narrow valley isolated between the mountains and the plain with a few native shrubs and trees at 1300 m. The farm is planted with *Annona squamosa* L. (Annonaceae), *Prunus persica* (L.), *P. Amigdalus* (Mill.) (Rosaceae), *Psidium guajava* L. (Family: Myrtaceae), *Zea mays* ssp. *mays* L. (Family: Poaceae), in addition to banana, and mango. The new species was found foraging on the ground under leaf litter and next to a tree of *Psidium guajava* L. The soil, at the time of collection was well saturated through irrigation and accumulation of organic matter.

The climate in Al-Baha Province is greatly influenced by its varying topography. It is generally moderate in summer and cold in winter with average temperatures ranging between 12–23 °C. In Tihama, the climate is hot in summer, warm in spring and mild in winter, with humidity ranging between 52%–67%, and a rainfall less than 100 mm annually. While in the mountainous area, Al-Sarah, The climate is greatly different from

Figure 13. Type locality, Al Bahah, Mukhwah Aqaba RD. (photo M. R. Sharaf).

that in Tihama although they are separated by no more than 30 km. The weather is cooler in summer and winter due to its high altitude. Al-Sarah is exposed to the formation of clouds and fog, and this often happens in winter because of air masses coming from the Red Sea, accompanied by thunderstorms. In spring and summer, the climate is mild and pleasant. Also, rainfall is higher with falls in the range of 229–581 mm. The average rain falls throughout the whole province is 100–250 mm annually

Collingwood and van Harten (2001) recorded Aenictinae for the first time from the Arabian Peninsula based on an unidentified species, from workers collected in Yemen among leaf litter of banana plantations in Khamis Bani Sa'd and Lahj. The diagnostic characters given for this species indicate a similarity in general habitus to *A. arabicus* but in two characters mentioned by them, a broadly emarginate head and unique crenulation of the anterior clypeal border, their species disagrees with the present new species. Future collecting in Yemen is needed to clarify the status of this taxon.

The presence of an *Aenictus* species in the Southwestern part of Saudi Arabia is not surprising as the area is regarded as being Afrotropical (Bodenheimer 1937; Nayman 1972; Sharaf et al. 2012; El-Hawagry et al. unpubl. data), and it is likely that more Afrotropical ants are awaiting discovery in the area.

Despite the Afrotropical nature of the type locality we found it important to give a key to the closely related species in the *A. wroughtonii*-group.

Key to species of the *Aenictus wroughtonii*-group related to *A. arabicus* based on worker

1	Subpetiolar process almost absent, anteroventrally not angulate (India) .... ***wroughtonii***
–	Subpetiolar process present, its anteroventral corners angulate **2**
2	Anterior clypeal margin bearing 9-10 denticles; subpetiolar process weakly developed (India) .... ***sagei***
–	Anterior clypeal margin bearing six denticles; subpetiolar process well developed **3**
3	Funicular segments 2–8 as long as broad; middle of third gastral tergite with two longitudinal brownish lines, sometimes reducing to small points; scapes when laid back just surpass the midpoint of head (Greece) ....***rhodiensis***
–	Funicular segments 2–8 at least twice as long as broad; gaster entirely yellow; scapes when laid back surpassing about two-thirds of head length (Saudi Arabia) .... ***arabicus* sp. n.**

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RESEARCH ARTICLE

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A new genus of the tribe Issini (Hemiptera, Fulgoromorpha, Issidae) from China

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Abstract

Macrodarumoides petalinus, a new genus and species of Issidae (Hemiptera) are described based on specimens from Yunnan and Guangxi, China.

Keywords

Taxonomy, Fulgoromorpha, *Macrodaruma*, new species

Introduction

Issidae are small insects (about 5mm to 20 mm) generally with a stocky body and usually brownish in color, few bright; and some have pronounced maculae. Issid planthoppers and ladybirds exhibit considerable similarity in general especially in the stocky body form. Issids are all plant feeders, with both nymphs and adults intaking phloem fluid from young branches and sometimes roots. Feeding of issids can result in the yellowing of plant foliage. At high population, issids can seriously affect plant growth (personal observation). Although they often have developed wings, some of them like to crawl and jump in shrubs, rather than to fly (personal observation). The family includes 973 species in 155 genera (Gnezdilov 2010).

Gnezdilov (2009) considered that the presence of the trilobed hind wing was an insufficient character for defining the tribe Thioniini, and therefore treated Thioniini Melichar, 1906 as a junior synonym of Issini Spinola, 1839. According to Gnezdilov (2003a, 2009), the subfamily Issinae consists of four tribes: Hemisphaeriini Melichar; Parahiraciini Cheng & Yang; Issini Spinola and Colpopterini Gnezdilov. In the present paper, a new genus and species, *Macrodarumoides petalinus* gen. et sp. n., from China is described and illustrated. Based on the hemispherical body, the claval suture on tegmen, the trilobed hind wings and the not-dilated legs, *Macrodarumoides* gen. n. is placed in the tribe Issini, which has the only species *Macrodarumoides petalinus* sp. n. from China.

Materials and methods

The terminology of the head, body and male genitalia follows Chan and Yang (1994), and the terminology of the female genitalia follows Gnezdilov (2003b). The genital segments of the examined specimens were macerated in 10% KOH and observed in glycerin jelly using a Leica MZ125 stereomicroscope. Photographs of the specimens were made using a Nikon SMZ1500 stereomicroscope with a Q-image CCD. Images were produced using the software Synoptics Automontage. All the specimens studied are deposited in the Entomological Museum of Northwest Agriculture and Forestry University of (NWAFU) or the College of Life Sciences, Nankai University (NKU), as indicated.

***Macrodarumoides* gen. n.**

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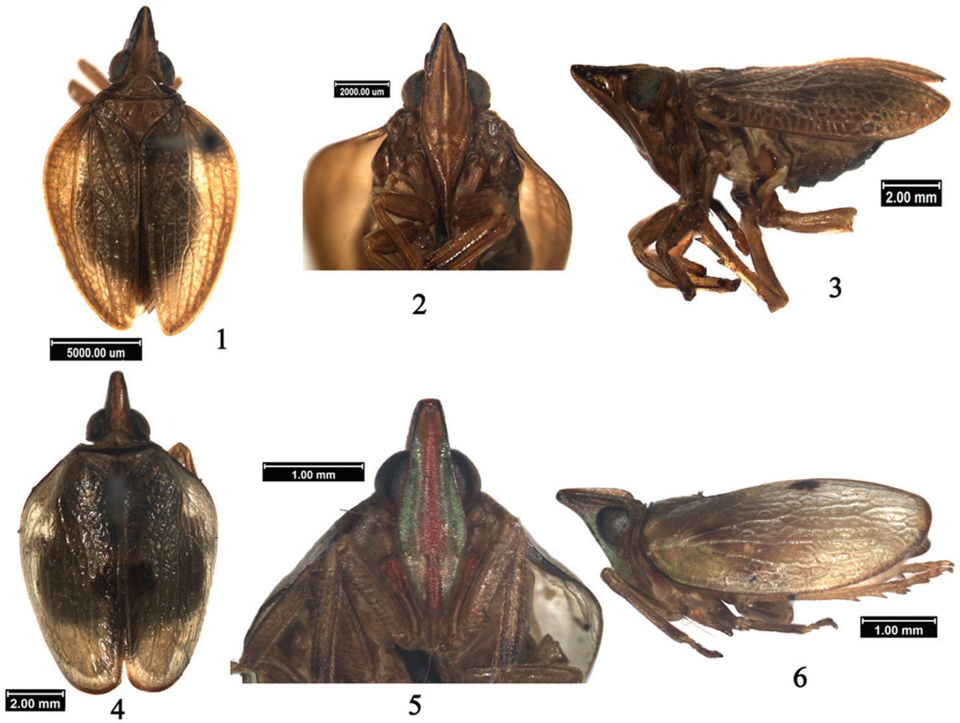
http://species-id.net/wiki/Macrodarumoides

Type species. *Macrodarumoides petalinus* sp. n.

Description. Head (including eyes) distinctly narrower than pronotum (Fig. 1). Vertex long and horizontal, approximately triangular, disc depressed, with 2 depressions near hind margin; anteriorly strongly angularly convex and posteriorly slightly angularly concave, lateral margins carinate; width at apex distinctly shorter than length in midline (Fig. 1). In dorsal view, vertex and frons extending far beyond eyes (Fig. 1). Ocelli present. Frons long and nearly triangular, disc obviously elevated, median carina present (Fig. 2); in lateral view frons curved towards apex (Fig. 3). Clypeus elevated with central carina, situated the same plane as frons (Fig. 2). Rostrum long, reaching to hind-trochanter. Pronotum short laterally, anterior margin convex and arched, posterior margin horizontal to slightly convex; disc elevated with pits (Fig. 1). Mesonotum nearly triangular, with 2 pits along lateral margins; disc slightly elevated, with or without carina (Fig. 1). Tegmen (Figs 1, 3, 7) leathery and approxi-



Figures 1–6. *Macrodarumoides petalinus* sp. n., male **1** Holotype, dorsal view **2** Holotype, head, ventral view **3** Holotype, lateral view; *Macrodaruma pertinax* Fennah, male: **4** Dorsal view **5** Head, ventral view **6** Lateral view.

mately elliptical, claval suture present; longitudinal veins prominent, between them with a number of obscure veinlets, rendering the whole surface faintly reticulate. Wing (Fig. 8) large, veins distinct and netlike, longer than half of tegmen, apically forming 3 lobes. Legs (Fig. 3) relatively long, not dilated; lateral margin of hind tibia with 2 teeth. Spinal formula of hind leg (5-6)- 11-2, indicating number of spines at apex of hind tibia and tarsomeres I and II.

Male genitalia symmetrical; anal segment (Fig. 10) in dorsal view longer than greatest width; pygofer (Fig. 9) without spines; aedeagus (Figs 11-13) tubular, symmetrical and shallowly U-shaped, divided distally into a dorsal and ventral lobe, the latter sometimes split, a pair of elongate lateral lobes and a pair of spiniform processes lying ventrolaterally and directed either cephalad or caudad. Genital style (Fig. 9) subtrianglar, apical margin curved and arched, basal margin convex near apex and dorsal margin produced into a single process.

Female genitalia with anal segment (Fig. 15) in dorsal view elliptical, length nearly equal to the widest part. Apex of endogonocoxal process without lobe and anterior connective lamina of gonapophyse VIII with 3 teeth in lateral group. First valvula (Fig. 14) with teeth, ninth tergum and third valvula subquadrate. Pregenital sternite (Fig. 16) with apical margin convex at mid.

Diagnosis. This genus is similar to *Eusarima* Yang, 1994 according to body shape and trilobed wings, but can be differentiated by the following characteristics: 1) vertex long, approximately triangular, the latter with vertex short and subquadrangular; 2) wings narrow, netlike and anal lobe rudimentary, the latter, wings broad, longitudinal veins distinct with little cross veins, and anal lobe developed.

This genus resembles *Macrodaruma* Fennah, 1978 (Figs 4–6), but can be distinguished from the latter by: 1) lateral margins of vertex and anterior margin of pronotum not carinated, the latter, distinctly and foliately carinated; 2) tegmen with claval suture present, the latter, claval suture absent; 3) wing trilobed, the latter, not bilobed.

Etymology. This generic name "-oides" from Greece suffix refers to the resemblance of this genus to *Macrodaruma* Fennah. The gender is masculine.

Distribution. China (Guangxi, Yunnan).

Macrodarumoides petalinus sp. n.

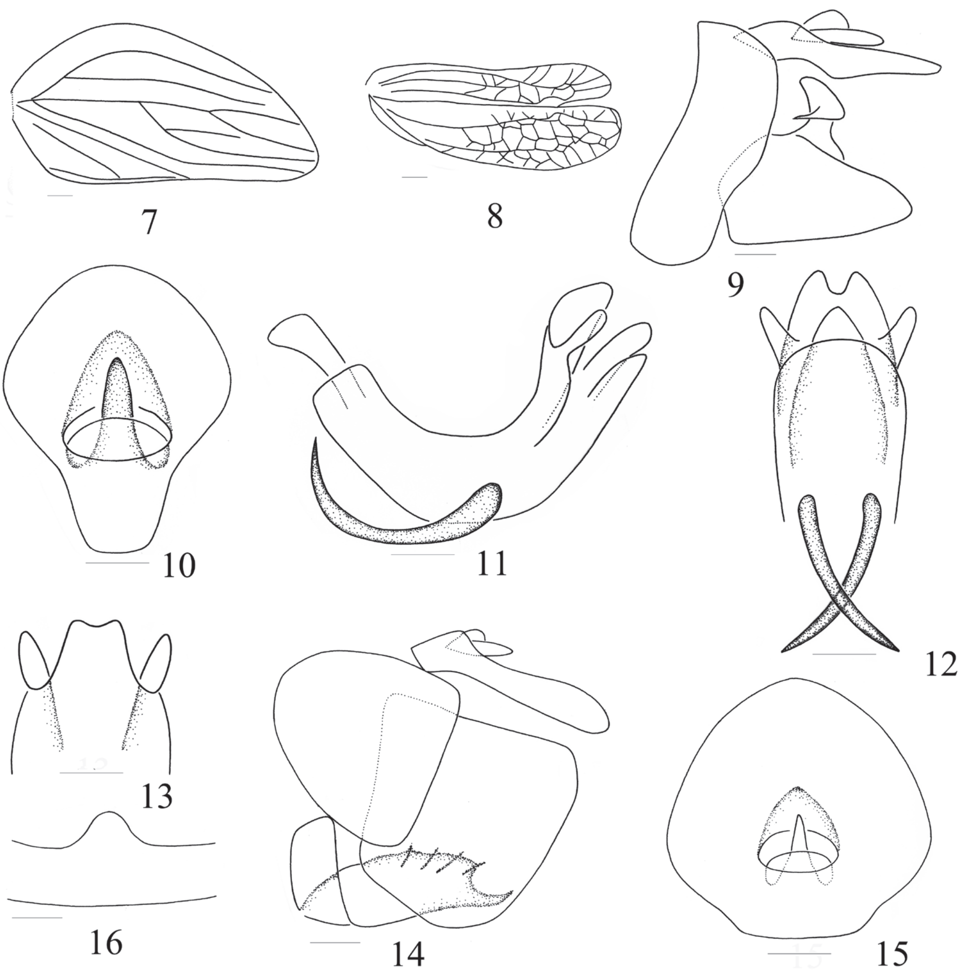
urn:lsid:zoobank.org:act:6D96BEEB-3639-41BC-88EA-43A0FD893343
http://species-id.net/wiki/Macrodarumoides_petalinus
Figs 1–3, 7–16

Description. Length, male (including tegmen): 8.1mm, length of tegmen: 6.0mm; female (including tegmen): 8.3mm, length of tegmen: 6.1mm.

Body brown (Fig. 1). Vertex with disc brown and lateral margins black. Eyes black brown. Frons brown with median carina paler and lateral margin black at apical half. Clypeus brown, rostrum pale brown. Pronotum, mesonotum, tegmen and legs brown; wing dark brown. Abdomen ventrally and dorsally brown, disc dark brown.

Vertex long and horizontal, approximately triangular, disc depressed, with 2 depressions near hind margin (Fig. 1); vertex 1.8× wider at apex than length in midline. Frons with disc distinctly elevated, with median carina (Fig. 2); oblique between median carina and lateral margin, frons curved towards apex in lateral view (Fig. 3), 1.1× wider at widest part than at base, 2.8× longer in midline than at widest part. Frontoclypeal suture nearly straight (Fig. 2). Thorax (Fig.1): disc of pronotum with 2 pits; mesonotum short and broad, greatest width 1.7× medial length. Tegmen 2.5× longer than widest part; Sc long, reaching beyond midlength; Sc and R forked near apex, M 4-branched, Cu not forked, claval suture only reaching to middle of sutural margin (Figs 1, 3, 7). Wing 0.7× length of tegmen, veins distinctly reticulate (Fig. 8). Spinal formula of hind leg 11-(5-6)-2.

Male genitalia. Anal segment in dorsal view (Fig. 10) distinctly longer than greatest width apically, apical margin strongly convex, lateral margin strongly divergent from base to apex, anal tube situated near middle; in lateral view ventral margin convex at midlength, nearly truncate in distal half (Fig. 9). Pygofer in lateral view with hind margin evenly convex near middle and slightly convex at base (Fig. 9). Phallus in profile shallowly curved with 2 long spiniform processes directed cephalad at midlength. Aedeagus in profile with apex bifurcated (Fig. 11); dorsal lobe (Figs 11, 13) in dorsal



Figures 7–16. *Macrodarumoides petalinus* sp. n. **7** Tegmen **8** Wing **9** Male genitalia, left side **10** Male anal segment, dorsal view **11** Aedeagus, lateral view **12** Apex of aedeagus, ventral view **13** Apex of dorsal lobe, dorsal view **14** Female genitalia, left side **15** Female anal segment, dorsal view **16** Pregenital sternite, ventral view. Scale bars = 1.0 mm (Figs 7–8), 0.5 mm (Figs 9–16)

view tri-lobed near apex, with apical margin slightly concave at mid, lateral margins curved downward and encasing lateral and ventral lobe; lateral lobes in lateral view divided and tapered into fingers (Fig. 11); ventral lobe with apical margin convex and arched at mid, and lateroapical angle rounded in ventral view (Fig. 12). Genital styles in lateral view nearly triangular, apical margin curved and arched, dorsal margin produced into one large process near apex; base of process acuminate and apex obtusely rounded in caudal view (Fig. 9).

Female genitalia. Anal segment in dorsal view (Fig. 15) slightly longer than greatest width with lateral margins convex, apical margin convex and arched, anal tube situated at basal half; in lateral view ventral margin concave at base, nearly truncate in distal half (Fig. 14). Ovipositor with anterior connective lamina of gonapophyse VIII curved dorsally, with 5 nearly parallel spines; tooth near lateral margin larger. Gonoplac stout, strongly convex and subquadrate, with apical margin polished (Fig. 14). Pregenital sternite with apical margin distinctly convex at midlength (Fig. 16).

Material examined. *Holotype*, male, China: Yunnan, Mt. Baoshan, 1900m, 20 November 1999, coll. Qin Daozheng (NWAFU). *Paratypes*, one male, one female, China: Guangxi, Leye, Tonglelinchang, 15 September 1980, coll. Lu Junsheng (NWAFU); one female China: Guangxi, Leye, Yachangyanpeng, 24 September 1980, coll. Lu Junsheng (NWAFU); one female, same data as holotype (NWAFU); two males, one female, China: Yunnan, Mt. Baoshan, 22 August 1979, coll. Cui Jianxin (NKU).

Remarks. This species can be differentiated from *Eusarima contorta* Yang, 1994 by the following characteristics: 1) vertex long, approximately triangular, the latter with vertex short and subquadrangular; 2) frons only with median carina, the latter with median and lateral carinae; 3) wings narrow, netlike and anal lobe rudimentary, the latter, wings broad, longitudinal veins distinct with little cross veins, and anal lobe developed.

This species resembles *Macrodaruma pertinax* Fennah, 1978 (Figs 4-6) in shape, but differs from the latter in the following characteristics: 1) lateral margins of vertex and lateral margins of pronotum not elevated, the latter with lateral margins of vertex and lateral margins of pronotum elevated foliately, 2) claval suture present, the latter without claval suture, 3) wing with 3 lobes, the latter with wing not split.

Etymology. The specific name is derived from the Latin word “petalinus”, referring to the dorsal lobe of aedeagus being concave with the lateral margin distinctly reflected as a petal.

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RESEARCH ARTICLE

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A review of the genus *Megapulvinaria* Young (Hemiptera, Coccoidea, Coccidae) from China, with a description of a new species

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Abstract

Prior to this study, only *Megapulvinaria maxima* (Green) was known from China. However, a new species *M. beihaiensis* Wang & Feng, **sp. n.** is described below and *M. maxima* is redescribed. A key is provided for the five species now placed in this genus.

Keywords

Hemiptera, Coccoidea, soft scale, taxonomy, China

Introduction

Soft scale or Coccidae is the third largest family after Diaspididae and Pseudococcidae within the superfamily Coccoidea (Ben-Dov 2012). Soft scale insects have a world-wide distribution and many of them are important pests on agricultural and horticultural crops and amenity plantings (Henderson and Hodgson 2005). China has a fauna of soft scale insects with a total of at least 125 species belonging to 46 genera (Tang 1991, Tao 1999, Wu 1999, Martin and Lau 2011). Some species that occur in China, such as *Ceroplastes rubens* and *C. japonicus*, can cause deformation or death of plants shoots and lead to great economic losses due to their feeding. However, some species present in China can be considered beneficial, such as *Ericerus pela*, whose wax provides an important raw material for many industries (Tang 1991).

The genus *Megapulvinaria* was erected by Young (1982), with *Pulvinaria maxima* Green, 1904 as its type species, and belongs to the tribe Pulvinariini, subfamily Coccinae. Three more species *M. burkilli* (Green, 1908), *M. orientalis* (Reyne, 1963) and *M. maskelli* (Olliff, 1891) have been subsequently added (Avasthi and Shafee 1991, Ben-Dov 1993, Hodgson 1994).

Previously, only *M. maxima* was known from China but a new species has now been discovered. The adult female of *M. maxima* is redescribed, the adult female of the new species *M. beihaiensis* Wang & Feng sp. n. is described and a key is provided for separation of the five species now known in this genus.

Materials and methods

Specimens were slide mounted using the method recommended by Hodgson and Henderson (2000). The morphological terminology of the mounted specimens used in the descriptions mainly follows Hodgson (1994). Characters were examined under a Nikon microscope. Illustrations were drawn from mounted adult female specimens, with the dorsum depicted on the left side and the venter on the right side, and with enlargements of important characters shown around the main illustration. All measurements were given in micrometers (μm) or millimeters (mm).

All specimens are deposited in the Entomological Museum of Northwest A & F University, Yangling, Shaanxi, China (NWAFU).

Checklist of known species of the genus *Megapulvinaria* Young

Megapulvinaria maxima (Green, 1904); China (Guangxi, Yunnan, Taiwan), Thailand, India, Indonesia, Philippines, Sri Lanka, Vietnam, Papua New Guinea, Chuuk Islands.
Megapulvinaria burkilli (Green, 1908); India.
Megapulvinaria orientalis (Reyne, 1963); Thailand.
Megapulvinaria maskelli (Olliff, 1891); Australia.
Megapulvinaria beihaiensis sp. n.; China (Guangxi).

Taxonomy

Genus *Megapulvinaria* Young, 1982

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

Megapulvinaria Young, 1982: 162. Type species: *Pulvinaria maxima* Green, 1904. By original designation and monotype.

Generic diagnosis. Adult female. Body elongate oval to broad oval; stigmatic clefts distinct. **Dorsum.** Dorsal setae spinose or conical. Dorsal submarginal tubercles absent. Preopercular pores present or absent. Dorsal tubular ducts present or absent. Eyespots generally displaced onto dorsum (marginal on *M. maxima*). Anal plates together quadrate, each plate with 2 spinose and/or truncate setae along inner margin, a similar seta on apex and a spinose seta present in discal position (possibly on outer margin of *M. maskelli*). Anal ring with 6 setae. **Margin.** Marginal setae stout, apex truncate or bidentate, and with 2 types present, one shorter and broader than other (about same length and one slightly broader than other both in *M. maskelli* and *M. beihaiensis*); broader setae on head and posterior margins of abdomen (0–3 broader setae present between two stigmatic clefts in *M. beihaiensis*). Stigmatic clefts deep or shallow, each with 3–12 stigmatic spines. **Venter.** Antennae 7–9 (mostly 8) segmented. Legs well-developed, each with a tibio-tarsal articulation and an articulatory sclerosis, each claw with a denticle on the widest part. Pregenital setae 2 pairs. Spiracular disc-pores each mainly with 5 loculi. Pregenital disc-pores each mainly with 10 loculi, restricted to abdominal segments. Ventral tubular ducts of three types, with a submarginal band of small tubular ducts; median area of head, thorax, and anterior 1–3 abdominal segments with large ducts each with both outer and inner ductules broad or stout (anterior submargin and all median area in *M. maskelli*); posterior abdominal segments of moderately tubular ducts.

Distribution. Oriental and Australian regions.

Key to all adult females of *Megapulvinaria*

1	Dermal areolations absent	***M. burkilli*** **(Green)**
–	Dermal areolations present	**2**
2	Anal plates with dorsal reticulations	**3**
–	Anal plates without dorsal reticulations	**4**
3	With only 3 stigmatic spines in each stigmatic cleft	***M. maskelli*** **(Olliff)**
–	With more than 3 stigmatic spines in each stigmatic cleft	***M. beihaiensis*** **sp. n.**
4	With only 1 pair of interantennal setae present; all of lateral stigmatic spines about same length	***M. orientalis*** **(Reyne)**
–	With 2–5 pairs of interantennal setae present; not all of lateral stigmatic spines about same length	***M. maxima*** **(Green)**

Megapulvinaria maxima (Green, 1904)

http://species-id.net/wiki/Megapulvinaria_maxima
Figure 1

Pulvinaria maxima Green, 1904: 206.
Pulvinaria thespesiae Green, 1909: 259. Syn. by Takahashi 1935: 10.
Eriochiton formosae Takahashi, 1929: 64. Syn. by Takahashi 1935: 10.
Megapulvinaria maxima (Green), Young 1982: 162.

Material examined. 5 adult females, CHINA, Yunnan, Jingdong, 18. x. 1976 on Pigeonpea (*Cajanus cajan* (L.) Millsp., Leguminosae), Xiao-Ze Chen (NWAFU).

Note. The measurements are based on all 5 specimens.

Diagnosis. Adult female. Mounted material. Body elongate oval, about 4.2–6.2 mm long and 2.7–3.8 mm wide. Anal cleft approximately 1/7 of the body length. Stigmatic clefts deep.

Dorsum. Derm membranous. Dermal areolations well developed, each with 1 or 2 dorsal microducts. Dorsal setae conical, with a well-developed basal socket, each 8–16 µm long, scattered throughout. Dorsal simple pores each with a slightly sclerotized margin, randomly distributed. Dorsal microducts each with a very short outer ductule and a longer, fairly broad inner filamentous ductule, sparsely located in dorsal areaolations. Dorsal tubular ducts each with a short outer ductule and a fine inner ductule with a minute terminal gland, sparsely distributed. Preopercular pores absent. Anal plates together quadrate; posterior margin slightly longer than anterior margin, outer angle slightly obtuse; each plate with a large cylindrical seta in discal position, each 34–50 µm long, a large spatulate seta apically, each 52–64 µm long, and with 2 spinose and/or spatulate setae along posterior 1/3rd of inner margin, each 40–56 µm long. Anogenital fold with 1 pair of long setae and 1 pair of short setae along anterior margin and 2 or 3 pairs lateral margin. Anal ring subcircular, with 2 or 3 rows of translucent pores and 6 anal ring setae. Eyespots present some way onto dorsum, each 80–96 µm wide.

Margin. Marginal setae of 2 types: 1) large and stout setae, each 17–38 µm long, with nearly parallel sides, and with either a truncate or a bifid apex, all with well-developed basal sockets, each socket with 1 or 2 small pores; with 96–110 setae between anterior clefts, 36–46 setae on each side between stigmatic clefts, and 84–98 setae between each posterior stigmatic cleft and anal cleft; and 2) quite broad and short setae, each 14–24 µm long, with parallel sides and a truncate, flattened apex, and with a larger basal socket about twice as broad as that of type 1), each socket with 3–8 small pores; latter type of marginal setae only distributed on anterior and posterior ends, with 16–22 setae anteriorly on head and prothorax, 5–12 setae on either side of abdomen near anal cleft. Stigmatic clefts deep; stigmatic spines bluntly spinose and mostly straight, with 4–8 spines in each anterior cleft and 5–10 in each posterior cleft; length of each 42–96 µm, with median 1–3 spines much longer than the lateral spines.

Venter. Derm membranous. Antennae 8 segmented, each 505–586 µm long; third segment longest; with 2 pairs of long setae and 1–3 pairs of short interantennal setae. Clypeolabral shield 198–232 µm long, 205–240 µm wide; labium 90–106 µm long, 113–144 µm wide. Legs well-developed, each with a tibio-tarsal articulation and articulatory sclerosis; claws with a denticle on widest part, claw digitules broad and expanded apically, tarsal digitules slender, knobbed and longer than claw digitules; trochanter+femur 239–405 µm, tibia 180–245 µm and tarsus 96–122 µm. With 2 pairs of long pregenital setae present in both segments VI & VII; submarginal setae present in a single row; other setae slender, each 4–10 µm long, quite sparsely distributed. Spiracles normal, spiracular disc-pores each with 5 loculi, present in a broad band between stigmatic cleft and each spiracle. Pregenital disc-pores each mainly with

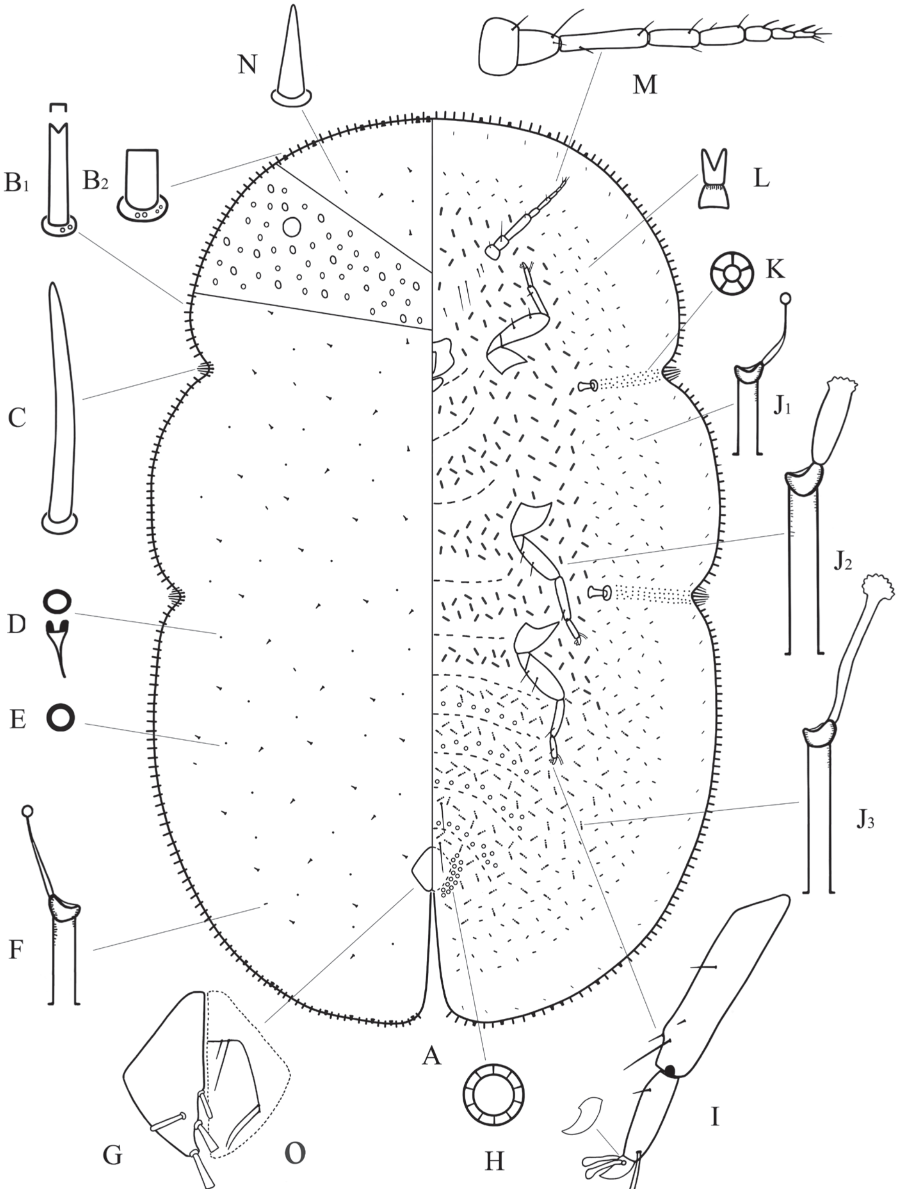

Figure 1. Adult female of *M. maxima* Green, **A** body derm **B1, B2** two kinds of marginal setae **C** stigmatic spine **D** dorsal microduct **E** dorsal pore **F** dorsal tubular duct **G** anal plates **O** ano-genital fold **H** pregenital disc-pore **I** tibio-tarsus of hind leg **J1, J2, J3** ventral tubular ducts **K** spiracle disc-pore **L** ventral microduct **M** antenna **N** dorsal seta.

10 loculi, present around the vulva and on posterior 4 abdominal segments. Ventral microducts scattered. Ventral tubular ducts of 3 types present: 1) a duct with a short outer ductule and a fine inner filament, with a minute terminal gland, present in a

complete submarginal band; 2) a duct with outer and inner ductules both broad and with a well-developed terminal gland, present medially on head, thorax and anterior 1 or 2 abdominal segments; and 3) a duct with a moderately long outer ductule and a thin inner ductule slightly longer than outer ductule, with a flower-shaped terminal gland, present medially on posterior abdominal segments and extending and mingling with marginal band of type 1) ducts.

Distribution. China (Guangxi, Yunnan, Taiwan), Thailand, India, Indonesia, Philippines, Sri Lanka, Vietnam, Papua New Guinea, Chuuk Islands.

Comments. Since Green (1904) originally described *M. maxima*, it had been described and illustrated by many authors, such as Green (1904, 1909), Takahashi (1929), Tang (1991), Hodgson (1994). Our observations agree well with these in descriptions in most respects. Tang (1991) and Hodgson (1994) pointed out the presence of dorsal areolations and denticles on widest part of claws, which Green (1909) and Takahashi (1929) failed to observe respectively. The outer angles of anal plates were obtuse or broadly rounded rather than at a right-angle, as shown by Hodgson (1994). We have confirmed the occurrence of dorsal areolations and denticles, and the outer angles are slightly obtuse in our examined specimens. Moreover, Hodgson (1994) described four types of dorsal pores, but we just observed just two types.

This species is close to *M. burkilli* (Green) (data from Green, 1908), but it can be distinguished from the latter by the following features (character states of *M. burkilli* in brackets): (1) the much larger body size in comparison to the latter (4 mm long, 2 mm wide); and (2) with well-developed dermal areolations present (absent).

Megapulvinaria beihaiensis Wang & Feng, sp. n.

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http://species-id.net/wiki/Megapulvinaria_beihaiensis
Figure 2

Material examined. Holotype: adult female. CHINA, Guangxi, Beihai, Haibin Park. 26. vii. 2010, on *Cinnamomum* sp., (Lauraceae), Bin Zhang (NWAFU)

Paratypes. 3 adult females, the data same as holotype.

Note. The measurements are based on all 4 specimens.

Description. Adult female. Unmounted material. Adult female yellowish brown or dark brown, elongate oval and with a longitudinal dorsal ridge in dorsal straight median area (materials examined were all immersed in 75% ethanol, and the ovisac was not seen). The specimens collected on the lamina of the host plant.

Mounted material. Body elongate oval, about 2.1–3.2 mm long, 1.3–1.7 mm wide. Anal cleft approximately 1/8 of the body length. Stigmatic clefts deep.

Dorsum. Derm membranous. Dermal areolations well-developed, each with a dorsal microduct. Dorsal setae conical, with a well-developed basal socket, each 6–11 μm long, scattered throughout. Dorsal simple pores each with a slightly sclerotized margin, randomly distributed. Dorsal microducts each with a very short outer duct-

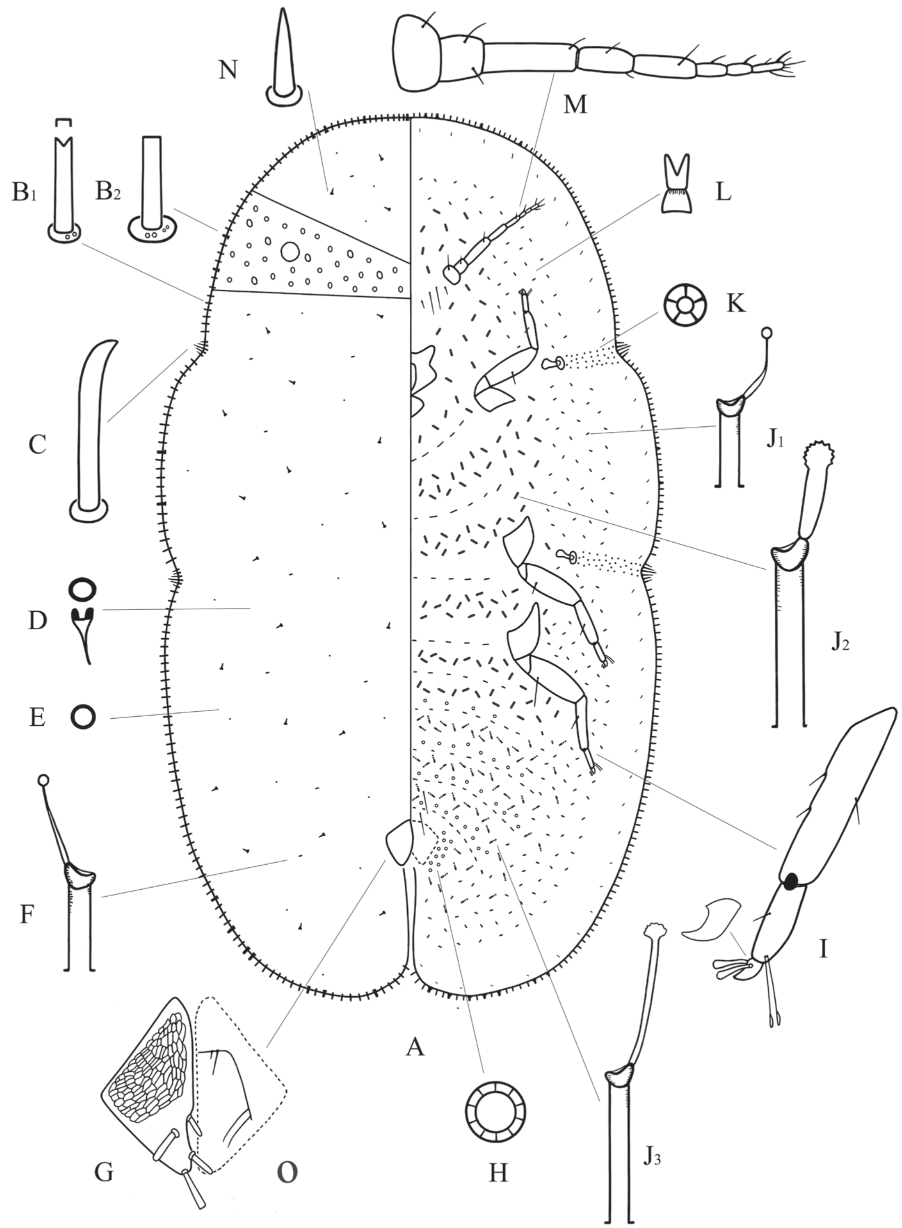

Figure 2. Adult female of *M. beihaiensis* sp. n., **A** body derm **B1, B2** two kinds of marginal setae **C** stigmatic spine **D** dorsal microduct **E** dorsal pore **F** dorsal tubular duct **G** anal plates **O** ano-genital fold **H** pregenital disc-pore **I** tibio-tarsus of hind leg **J1, J2, J3** ventral tubular ducts **K** spiracle disc-pore **L** ventral microduct **M** antenna **N** dorsal seta.

ule and a long, fairly broad inner filamentous ductule, sparsely located in each dorsal areaolation. Dorsal tubular ducts each with a short outer ductule and a fine inner ductule with a minute terminal gland, sparsely distributed. Preopercular pores absent.

Anal plates together quadrate, dorsal surface with reticulations on anterior two-thirds; posterior margin subequal to or slightly longer than anterior margin, outer angle a right-angle; each plate with a blunt spinose seta in discal position, each 34–42 µm long, a large spinose or spatulate seta apically, each 48–54 µm long, and with 2 spinose setae along posterior 1/3rd of the inner margin, each 32–44 µm long, length of plates 146–167 µm, width of single plate 74–88 µm. Ano-genital fold with 1 pair of long setae and 1 pair of short setae along anterior margin and 2 or 3 pairs lateral margin. Anal ring subcircular, with 2 or 3 rows of translucent pores and 6 anal ring setae. Eyespots present some way onto dorsum, each 42–60 µm wide.

Margin. Marginal setae of 2 types: 1) stout setae, each 18–30 µm long; each seta with nearly parallel sides and with either a truncate or a bifid apex, all with well-developed basal sockets, each socket with 1 or 2 small pores; with 101–111 setae between anterior clefts, 34–42 setae on each side between stigmatic clefts, and 74–85 setae between each posterior stigmatic cleft and anal cleft; 2) quite strong setae, subequal in length with type 1) but slightly broader; each seta with parallel sides, with a truncate and flattened apex, and with a large basal socket about twice as broad as that of type 1), each socket with 2–8 small pores; with 10–16 setae anteriorly on head and prothorax, 0–3 setae between stigmatic clefts, and 4–10 setae on either side of abdomen near anal cleft. Stigmatic clefts deep; stigmatic spines bluntly spinose and mainly curved apically, with 4 or 5 spines in each anterior cleft and 5–8 spines in each posterior cleft; length of each 34–62 µm, and the median 1–3 spines longer than the lateral spines.

Venter. Derm membranous. Antennae 8 segmented, each 346–378 µm long, the third segment longest; with 2 pairs of long setae and 2 or 3 pairs of short interantennal setae. Clypeolabral shield 138–160 µm long, 160–172 µm wide; labium 96–112 µm long, 84–112 µm wide. Legs well-developed, each with a tibio-tarsal articulation and articulatory sclerosis; claws with a denticle on widest part, claw digitules both broad and expanded apically; tarsal digitules slender, knobbed and longer than claw digitules; trochanter+femur 212–245 µm, tibia 136–188 µm and tarsus 54–75 µm. With 2 pairs of long pregenital setae present in both segments VI & VII; submarginal setae present in a single row; other setae slender, 6–20 µm long, quite sparsely distributed. Spiracles normal; spiracular disc-pores each mainly with 5 loculi, present in a broad band between stigmatic cleft and each spiracle. Pregenital disc-pores each mainly with 10 loculi, present around the vulva and on posterior 5 abdominal segments but becoming progressively less frequent anteriorly. Ventral microducts scattered. Ventral tubular ducts of 3 types present: 1) a duct with a short outer ductule and a fine inner filament with a minute terminal gland, present in a complete submarginal band; 2) a duct with a broad outer ductule, a stout inner ductule (as broad as outer ductule in some specimens) and with a well-developed terminal gland, present medially on thorax and anterior abdominal segments; and 3) a duct with a moderately long outer ductule, a thin inner ductule slightly longer than outer ductule, with a flower-shaped terminal gland, present medially on posterior abdominal segments and extending and mingling with marginal band of type 1) ducts.

Distribution. China (Guangxi).

Etymology. The specific epithet is taken from the type locality Beihai.

Comments. This new species resembles *M. maskelli* (Olliff) (data from Qin and Gullan 1992) in having: (1) dorsal reticulations on the anal plates, and (2) 2 types of marginal setae of about same length. However, *M. beihaiensis* can be distinguished by following features (character states of *M. maskelli* in brackets): (1) more than 3 stigmatic spines in each stigmatic cleft (only 3); (2) having dorsal tubular ducts (absent); (3) lacking preopercular pores (present); (4) eyespots displaced onto the dorsum (on the margin); and (5) the marginal setae of much broader basal socket often present between stigmatic clefts (absent).

M. maskelli, currently only known from the Australian region, is the only non-Oriental species in this genus and has some distinctive characteristics within *Megapulvinaria*. It differs from other species in having: (1) only 3 stigmatic spines in each stigmatic cleft; (2) eyespots located on margin; and (3) the discal setae possibly on outer margin of anal plates.

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Dental morphology of the Lesser Bamboo Rat, *Cannomys badius* (Rodentia, Spalacidae)

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Abstract

Cannomys and *Rhizomys* are the sole living genera of the tribe Rhizomyini (Rhizomyinae, Spalacidae, Rodentia), known in the fossil record since the Late Miocene. The dental morphology of fossil Rhizomyini has been described in detail but until recently such descriptions were unavailable for extant species. A detailed account of the morphology and dental wear pattern of the cheek teeth of *C. badius* is provided here based on the examination of museum specimens. Three stages of wear are recognized. *Cannomys* shares with *Rhizomys* the synapomorphy of having a mesolophid that is a long continuation of the protoconid on the first lower molar. There are significant differences between these taxa, such as the much smaller size of the cheek teeth and the trilophodont dental pattern of the M2, M3, and m2 in *Cannomys*.

Keywords

Rhizomyinae, Rhizomyini, *Cannomys*, dental wear pattern

Introduction

The subfamily Rhizomyinae (Spalacidae, Rodentia) is known in the fossil record since the Oligocene. It is represented by three modern genera: the Asian bamboo rats *Rhizomys* (a trispecific genus) and *Cannomys* (monospecific) and the African mole rats *Tachyoryctes*. The latter genus is considered bispecific by some authors (Missone 1971, Rahm 1980, Bucher 1982, Corbet and Hill 1991, Beolchini and Corti 2004), but this may be an underestimation of true diversity (Allen 1939, Ellerman 1941, Musser and Carleton 1993, 2005). The Asian bamboo rats belong to the tribe Rhizomyini, whereas *Tachyoryctes* is the only extant representative of the Tachyoryctini (Flynn 2009; López-Antoñanzas et al. in press). The lesser bamboo rat *Cannomys badius* ranges from eastern Nepal, through northeast India, Bhutan, southeastern Bangladesh, Myanmar, south China, northwest Vietnam, Thailand and Cambodia (Musser and Carleton 2005). It is known to live in a wide variety of habitats, from bamboo forest to cultivated land and other modified areas (IUCN 2010).

Cannomys badius was originally named as *Rhizomys badius* by Hodgson (1841; p. 60) on the basis of a male specimen obtained "some miles north of the great valley" of Nepal. The type specimen is BMNH 1843.1.12.61 (skin and skull) (P. Jenkins, pers. comm. 2012). Thomas (1915a) created the new genus *Cannomys* for which he took *Rhizomys badius* as type, but in which he also included two other species: *C. castaneus* (Blyth 1843) and *C. minor* (Gray 1842). Thomas (1915b) later described another species of *Cannomys*, *C. pater*, and split *C. castaneus* into two subspecies (*C. castaneus castaneus* and *C. castaneus plumbescens*). Later, Gyldenstolpe (1916) described a new subspecies of *Cannomys minor* (*C. minor lönnbergi*). All these taxa are currently regarded as synonyms of *C. badius* (Musser and Carleton 2005).

The dental morphology of all living Rhizomyinae other than *Cannomys badius*, has been described in detail recently (*Tachyoryctes*; López-Antoñanzas 2012) or are in the process thereof (*Rhizomys*). The aim of the present work is to provide an in-depth description of the dental morphology of *Cannomys*.

Material and methods

All the specimens of *Cannomys badius* housed in the Laboratoire de Zoologie-Mammifères et Oiseaux of the Muséum national d'Histoire naturelle, Paris, France (MNHN) and in the Institut für Systematische Zoologie-Zoologische Sammlung of the Museum für Naturkunde, Berlin, Germany (ZMB) have been examined. MNHN individuals come from Thailand and Nepal, whereas those at ZMB are from Myanmar.

First, second, and third lower molars are designated as m1, m2, and m3, respectively, and first, second, and third upper molars as M1, M2, and M3, respectively. The terminology used in the tooth descriptions follows the rodent dental terminology of Flynn (1982) with some adjustments (see Fig. 1).

Dental morphology and wear pattern

Incisors of *Cannomys badius* are strongly proodont, flattened anteriorly, lack major ornamentation and have the enamel pigmented orange.

The upper molars of *Cannomys badius* show unilateral hypsodonty, with crowns higher lingually than labially. M1 has four roots, the anterolabial one being the

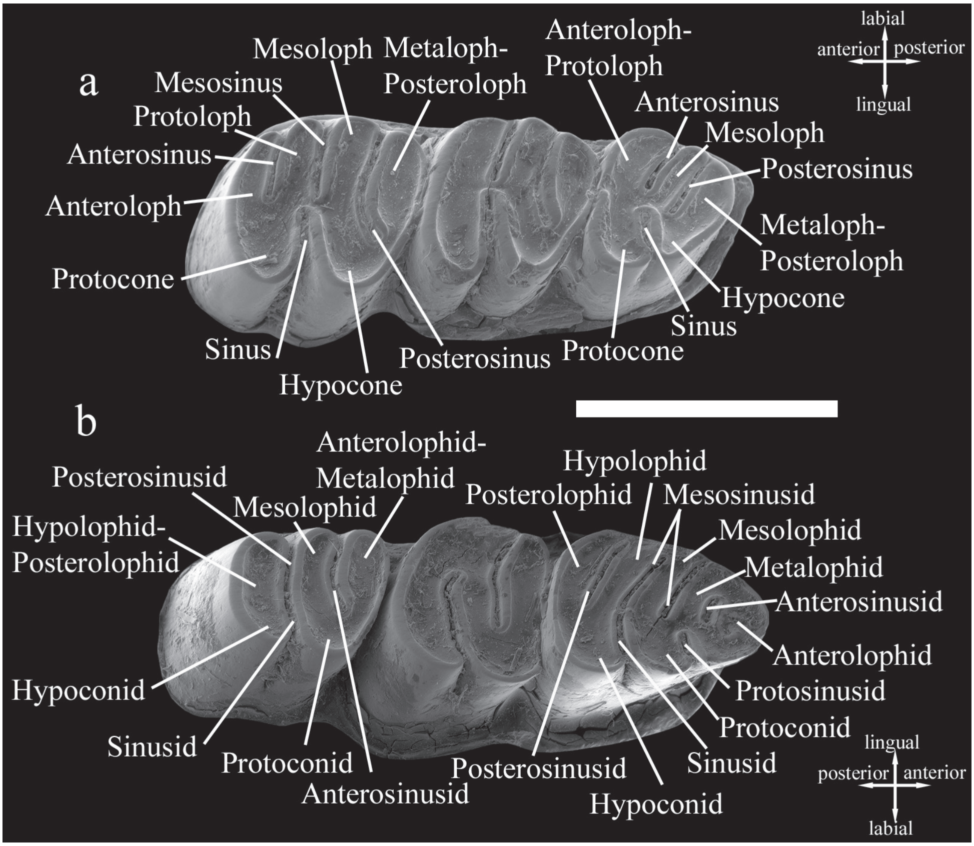

Figure 1. Dental terminology used in this paper. *Cannomys badius*. **a** Left upper cheek teeth **b** Right lower cheek teeth. Scale bar equals 5 mm.

most developed. Its occlusal outline is square. In early wear (e.g., MNHN C.G. 2000-271; Fig. 2a), it has four transverse lophs (anteroloph, protoloph, mesoloph, and metaloph-posteroloph) and all labial and lingual sinuses are open. In later wear (e.g., ZMB 44769 and MNHN C.G. 2000-761; Fig. 2b–c), the number of lophs is reduced to three as the anteroloph and protoloph combine and join at the margin of the tooth, isolating two transversely elongated enamel lakes, whereas the lingual sinus remains open. The latter, narrow and short, is directed toward the middle enamel lake. The connection between the anterior and posterior parts of the tooth persists through wear.

The occlusal outline of M2 is square, with its posterior side more reduced than the anterior one. This tooth is much shorter than M1. In early wear (e.g., MNHN C.G. 1860-382; Fig. 2a), it has three transverse lophs (anteroloph-protoloph, mesoloph, and metaloph-posteroloph). The sinus is directed toward the anterosinus. All reentrants remain open. After moderate wear (e.g., ZMB 44769, Fig. 2b), the sinus becomes narrower and the anterosinus and posterosinus are closed-off, isolating two enamel lakes. Late in wear (e.g., MNHN C.G. 2000-761; Fig. 2c), the morphology

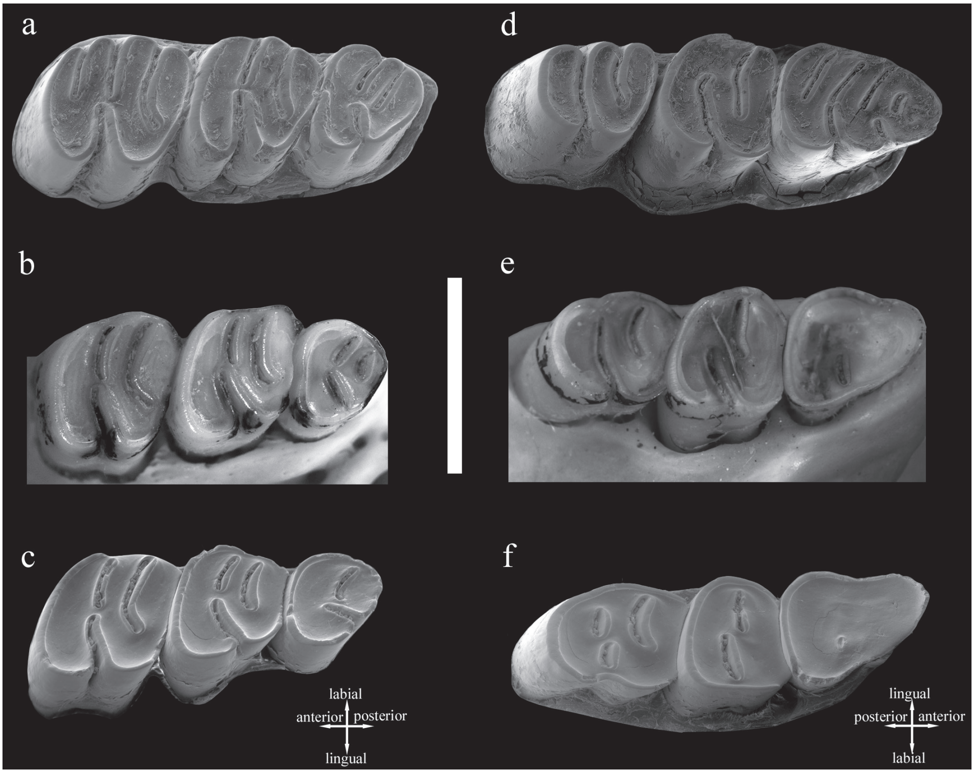

Figure 2. Dental wear pattern in *Cannomys badius*. **a–c** Upper molars: **a** Stage of wear 1, juvenile individual, left maxilla with M1-M3 in occlusal view (MNHN C.G. 1860-382) **b** Stage of wear 2, left maxilla with M1-M3 (ZMB 44769) **c** Stage of wear 3, left maxilla with M1-M3 in occlusal view (MNHN C.G. 2000-761). **d–f** Lower molars: **d** Stage of wear 1, juvenile individual, right hemimandible with m1-m3 in occlusal view (MNHN C.G. 1860-382), **e** Stage of wear 2, right hemimandible with m1-m3 in occlusal (ZMB 44768) **f** Stage of wear 3, left hemimandible with m1-m3 in occlusal (reversed) (MNHN C.G. 2000-761). Scale bar equals 5 mm.

of M2 is quite similar to that in the previous wear stage. However, the posterior part of the tooth becomes more reduced and, even though the lingual sinus remains open, it turns out to be more anterolabially directed due to the labial displacement of the hypocone. The connection between the anterior and posterior parts of the tooth persists through wear.

Cannomys has a reduced M3. In early wear (e.g., MNHN C.G. 1860-382; Fig. 2a), it is morphologically similar to M2 but with its posterior part smaller due to the more labial position of the hypocone. This tooth is trilophodont, with anteroloph-protoloph, mesoloph, and metaloph-posteroloph. After moderate wear (e.g., ZMB 44769; Fig. 2b), the anteroloph-protoloph is nearly connected to the mesoloph and the metaloph-posteroloph joins the mesoloph, isolating a labial circular enamel lake. The hypocone is much more labially displaced and the sinus much more anterolabially oriented. Therefore, the posterior part of the tooth becomes much reduced. In late wear (e.g., MNHN C.G. 2000-761; Fig. 2c), the first and second lophs combine and the anterior enamel lake disappears. At this stage of wear only a labial enamel lake persists and the hypocone is located on the posterior margin of the tooth.

The lower molars are lower crowned than the upper molars. As for the lower jaw bone, the mandibular foramen is located well caudal to the posterior margin of m3 (a little dorsal to m3, at the level of the tip of the coronoid process), whereas the mental foramen is situated rostrally to the anterior border of m1 (approximately on the midline of the dentary).

The occlusal outline of m1 is triangular, with its anterior part much narrower than its posterior. In early wear (e.g., MNHN C.G. 1860-382; Fig. 2d), it shows a pentalophodont dental pattern with anterolophid, metalophid, mesolophid, hypolophid, and posterolophid. The metalophid joins lingually the anterolophid and labially the protoconid, isolating a small and oval anterior enamel lake. The mesolophid is a long continuation of the protoconid. The anterior part of the tooth is isolated from the rest of the crown by a long sinusid. The latter results from the junction of the sinusid (or labial reentrant) with the mesosinusid (or middle labial reentrant). All lophids join the lingual margin of the tooth, isolating four transversely elongated enamel lakes. The m1 shows two open labial sinusids (protosinusid and sinusid). After moderate wear (e.g., ZMB 44768; Fig. 2e), all reentrants are closed-off, the protosinusid disappears, and the anterior part of the tooth is deprived of any enamel lake. However, two enamel lakes persist posteriorly. In late wear (e.g., MNHN C.G. 2000-761; Fig. 2f), the occlusal surface is completely flat and generally devoid of enamel lakes although a tiny and circular posterolabially located enamel lake may persist. The enamel has disappeared from the anterior border of the tooth, but it persists posteriorly.

The m2 has four roots, the posterior ones being the most developed. Its occlusal outline is square and it is anteroposteriorly compressed. In early wear (e.g., MNHN C.G. 1860-382, Fig. 2d); this tooth has three lophs (anterolophid-metalophid, mesolophid, and hypolophid-posterolophid). The mesolophid is short and joins labially the anterior lophid (through the protoconid) and lingually the posterior one. The sole lingual reentrant is closed-off, isolating a labial enamel lake, which is elongated. The narrow and posterolingually directed sinusid is open. After moderate wear (e.g., ZMB 44768, Fig. 2e); the morphology of the tooth is similar to that of the preceding stage. In late wear (e.g., MNHN C.G. 2000-761; Fig. 2f), the sinusid is closed off and the tooth shows both a labial and a lingual enamel lake. The anterior side of the tooth loses the enamel.

In early wear (e.g., MNHN C.G. 1860-382; Fig. 2d), m3 has three lophids (anterolophid-metalophid, mesolophid, and hypolophid-posterolophid). The first lophid joins the second one through the protoconid. The posterior lophid is isolated from the rest of the crown by a long reentrant. At this stage of wear, all reentrants are open. After moderate wear (e.g., ZMB 44768, Fig. 2e), the lingual reentrants are closed-off. The tooth has an elongate anterior enamel lake and a long sinusid. In late wear (e.g., MNHN C.G. 2000-761; Fig. 2f), the lingual reentrant is closed-off, isolating two enamel lakes, and the anterior enamel lake persists.

Conclusion

The examination of the cheek teeth in various specimens of *Cannomys badius* has allowed determining the changes undergone by the dental pattern during wear. Three fundamental stages of wear have been recognized.

As postulated by Flynn (1990), modern and extinct rhizomyines are united by dental features that include lophodonty, high crowned teeth, a strong wear gradient decreasing from first to last molar, junction between the metalophid and the anterolophid or the protoconid on the lower molars, and isolation of enamel lakes. In addition, *Cannomys* shares with *Rhizomys*, the other extant representative of the tribe Rhizomyini, the synapomorphy of having on the m1 a mesolophid that is a long continuation of the protoconid. However, *Cannomys badius* is much smaller than all the extant species of *Rhizomys* and exhibits the particularity of a trilophodont dental pattern on m2, M2, and M3, whereas it is tetralophodont in *Rhizomys*.

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Taxonomic notes on the *Macrocheilus* Hope (Coleoptera, Carabidae, Helluonini) from Oriental Region, with description of one new species from the Philippines

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Abstract
Taxonomic notes, together with illustrated characters, on the oriental species of the genus *Macrocheilus* Hope, 1838 (Carabidae, Helluonini) are provided. One new species, *Macrocheilus deuvie* **sp. n.** is described from the Philippines. A key to all species of *Macrocheilus* in the Oriental Region is also provided.

Keywords
Coleoptera, Carabidae, Helluonini, *Macrocheilus*, Oriental Region, new species

Introduction

The genus *Macrocheilus* Hope, 1838 is composed of Oriental, Palaearctic and Ethiopian species (Csiki 1932, Reichardt 1974). In total, fifty-six species of the genus are reported, among them, thirty-five species in the Ethiopian Region, nineteen in Oriental Region, and only two in Palaearctic Region (Lorenz 2005, Hůrka 2003, Zhao and Tian 2010).

For the Oriental *Macrocheilus*, Heller (1900) gave a table of ten species. But of them, two (*dorsalis* Klug and *scapularis* Klug) are actually African species, one (*distactus* Wiedemann) belongs to the genus *Creagris*, and one (*tripustulatus* Fairmaire) is a species of *Pheropsophus*. Andrewes (1920) dealt with ten Oriental species of the genus. Jedlička (1963) treated the East Asian *Macrocheilus* species and mentioned only five species. Park et al. (2006) listed six species from Vietnam. Zhao and Tian (2010) described seven new species and gave a key to Chinese species.

The aim of this paper is to provide taxonomic notes on all Oriental species of *Macrocheilus* by means of checking most of the type materials and a few other materials. As a result of the study, the examined materials are preserved in the Museum National d'Histoire Naturelle, Paris, France (MNHN). One new species of *Macrocheilus* from the Philippines is described. In addition, a distribution map of the genus in the Oriental Region is provided.

Materials and methods

Materials for this study were dry mounted specimens. Dissection of specimens was done following the standard technique described by Lindroth (1974). Observations and measurements were made under stereo microscope (Leica, MZ125) and ocular microscope (Wild M5).

Abbreviations for the collections in which the type materials are deposited as follows:

LMN Leiden Museum, the Netherlands
MDSG Museum Dresden, Saxony, Germany
MGI Museum Genoa, Italy
MNHN Museum National d'Histoire Naturelle, Paris, France
NHML Natural History Museum, London, the U.K.
NMP National Museum Prague, Czech Republic
SCAU South China Agricultural University, Guangzhou, China
SNSD Staatliches Naturhist. Sammlungen Museum für Tierkund, Dresden, Germany
ZMUC Zoological Museum University of Copenhagen, Copenhagen, Denmark

Taxonomic treatment

Genus *Macrocheilus* Hope, 1838
http://species-id.net/wiki/Macrocheilus

Macrocheilus Hope, 1838: 166. Type species: *Macrocheilus bensoni* Hope, 1838. Jeannel, 1949: 1041. Zhao & Tian, 2010:4.
Acanthogenius Reiche, 1842: 334. Type species: *Helluo impictus* Wiedemann, 1823.

Generic diagnosis. Medium sized (length from 8.0 to 17.0 mm), elongate, whole body coarsely punctuate and pubescent, except for labrum and middle region of ventral side of head. Head with two supraorbital setae on each side; ligula fairly wide, deeply impressed beneath at sides of base; mentum deeply emarginated, with a long and slender tooth; palpi varied in form; labrum extraordinarily or well developed; mandibles dorsally covered by labrum or not covered; antennae stout and flat, densely pubescent from antennomere 5. Pronotum truncate-cordiform or quadrate, basal margin more or less produced backwards in middle; lateral margin with two setae, one just before middle, and the other at hind angle. Elytra with deep striae and setiferous pores; intervals slightly or rather convex, interval 8 usually wide. Metepisterna elongate and very narrow in all species. Tarsomere 4 emarginate. Wings fully developed. No externally visible sexual dimorphic characters present. Median lobe of aedeagus varied in form. Parameres of aedeagus quite similar, elongate, the left one larger than the right one.

Differences with other genera of Helluonini in the Oriental Region. *Macrocheilus* spp., with larger body size, simple 4th tarsomeres, and non-securiform labial palpomere are distinctly different from *Colfax* spp. (smaller body size, securiform labial palpomere) and *Creagris* spp. (bilobed 4th tarsomere; smaller body size). Functional wings and the occurrence of a long spiniform median tooth of mentum of *Macrocheilus* distinguish them from *Omphra* spp. (which are brachypterous and have a short median tooth of the mentum).

Generic range. Oriental Region (China, Vietnam, Laos, Cambodia, Myanmar, India, Sri Lanka, the Philippines, Malaysia and Indonesia), Palaearctic Region (Pakistan, Syria, Asia Minor), Ethiopian Region (Ethiopia, Tanzania, Uganda, Senegal, Guinea, Guinea-Bissau, Sierra Leone, Togo, Nigeria, Central Africa, Cameroon, Gabon, Congo, Zimbabwe, Angola, South Africa, Madagascar).

Key to species of Oriental *Macrocheilus*

1	Elytra without spots	**2**
–	Elytra spotted	**3**
2	Head and pronotum red; ligula with apical outer angles rounded; apex of lateral lobes of mentum fairly acute (Fig. 9); labrum with apical margin not sinuate (Fig. 1). Length 6.5 mm	***M. bicolor*** **Andrewes**
–	Whole body piceous; ligula with apical outer angles rectangular; apex of lateral lobes of mentum rounded (Fig. 10); labrum with apical margin plurisinuate (Fig. 2). Length 15.0 mm	***M. impictus*** **(Wiedemann)**
3	Maxillary palpomere 4 not flattened and dilated, lateral lobes of mentum rounded on outer margin, mandibles not exposed, lateral margin of labrum rounded, front margin of clypeus not or slightly emarginate in middle, elytron with one or two spots	**4**
–	Maxillary palpomere 4 strongly flattened and dilated, lateral lobes of mentum sinuate behind middle or on anterior one-third, mandibles exposed, lateral margin of labrum distinctly sinuate on anterior one-third, front margin of clypeus deeply and widely emarginate in middle, elytron with one spot	**16**

4 Elytron with one spot **5**
– Elytron with two spots **10**
5 Labrum with anterior setae distinctly on upper surface margin **6**
– Labrum with anterior setae close to or on the apical margin **8**
6 Labrum with apex narrow (Fig. 3); mentum with median tooth stout and wide, strongly sinuate at middle of lateral margins (Fig. 11). Length 25.0 mm .... ***M. immanis* Andrewes**
– Labrum with apex wide; mentum with median tooth slender, almost straight at sides 7
7 Elytral spot transverse and almost rectangular (Fig. 46); median tooth of mentum with four or five setae (Fig. 12). Length 16.0 mm .... ***M. niger* Andrewes**
– Elytral spot cruciform (Fig. 47); median tooth of mentum with two setae. Length 14.5 mm .... ***M. asteriscus* (White)**
8 Elytral spot rounded, maxillary palpomere 4 roundly elongate; anterior setae of labrum close to apical margin. Length 12.5–14.0 mm .... ***M. vitalisi* Andrewes**
– Elytral spot oblong, maxillary palpomere 4 short and stout (Fig. 21); anterior setae of labrum along or on apical margin **9**
9 Elytral spot covering intervals 3–7, anterior seta of labrum on apical margin (Fig. 5). Length 13.0 mm .... ***M. binotatus* Andrewes**
– Elytral spot covering intervals 2–7, anterior seta of labrum along apical margin. Length 10.0 mm .... ***M. macromaculatus* Louwerens**
10 Labrum with anterior setae on apical margin; ligula thickened at apex **11**
– Labrum with anterior setae beneath apex; ligula thin at apex **13**
11 Labrum with apex wide; mentum with median tooth sinuate near apex on lateral margin, lateral lobes obtuse at apex. Length 15.5–17.0 mm .... ***M. gigas* Zhao & Tian**
– Labrum with apex pointed; mentum with median tooth not sinuate on lateral margin, lateral lobes sharp at apex **12**
12 Body length 11.7–11.0 mm; elytral spots smaller (Fig. 51); labrum exceptionaly convex on anterior portion which results apex can not be seen; maxillary palpomere 4 strongly and roundly dilated on anterior half portion .... ***M. parvimaculatus* Zhao & Tian**
– Body length 12.0–12.5 mm; elytral spots larger (Fig. 52); labrum normally convex, apex visible (Fig. 6); maxillary palpomere 4 slightly dilated (Fig. 22) .... ***M. tripustulatus* (Dejean)**
13 Maxillary palpomere 4 strongly dilated **14**
– Maxillary palpomere 4 not or slightly dilated **15**
14 Head and pronotum reddish brown (Fig. 53); labrum relatively long; pronotum elongate; tibiae testaceous. Length 8.4 mm..... ***M. chaudoiri* Andrewes**
– Head and pronotum black; labrum short (Fig. 7); pronotum wide; tibiae black. Length 8.0 mm .... ***M. nigrotibialis* Heller**

15 Maxillary palpomere 4 slightly dilated; labrum not recurved at apex; clypeus with irregular setae on middle. Length 15.0 mm..............***M. bensoni* Hope**

– Maxillary palpomere 4 not dilated (Fig. 24); labrum curved at anterior part (Fig. 8); clypeus almost glabrous on middle. Length 9.5 mm ....***M. deuvie* sp. n.**

16 Elytral spots large (1.5~2.2 mm), nearly rectangular **17**

– Elytral spots small (1.3~1.4 mm), not rectangular.................................... **19**

17 Color brown; labrum with only three pairs of labral setae, apex pointed rounded; mandibles obtuse at apices; median tooth of mentum with lateral margin not sinuate. Length 10.8 mm.............***M. fuscipennis* Zhao & Tian**

– Color black; labrum with four pairs of labral setae, apex widely rounded; mandibles sharp at apices; median tooth of mentum with lateral margin sinuate... **18**

18 Labrum with additional setae located between the anterior and intermediate setae (Fig. 8 in Zhao & Tian, 2010); median tooth of mentum with lateral margin sinuate in middle; mandibles less sharp at apices. Length 12.3–12.5 mm...***M. solidipalpis* Zhao & Tian**

– Labrum with additional setae located before the anterior setae (Fig. 9 in Zhao & Tian, 2010); median tooth of mentum with lateral margin sinuate on anterior one-third; mandibles sharper at apices. Length 11.0 mm.................... ....***M. cheni* Zhao & Tian**

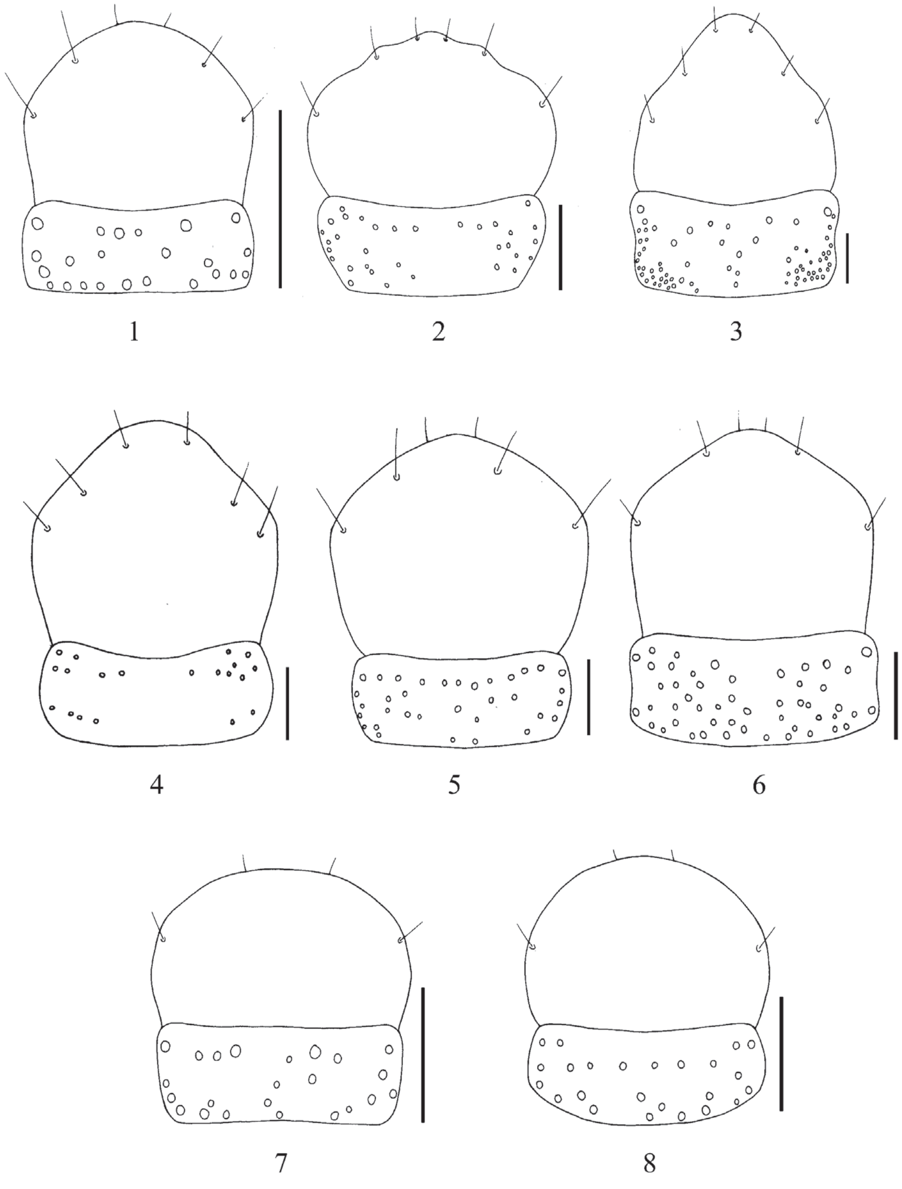
19 Labrum with anterior and intermediate setae distance from each other, apex pointed rounded (Fig. 10 in Zhao & Tian, 2010); mandibles sharp at apices; median tooth of mentum sharp at apex; pronotum almost quadrate. Length 12.1 mm...***M. quadratus* Zhao & Tian**

– Labrum with anterior and intermediate setae closed each other, apex widely rounded (Fig. 11 in Zhao & Tian, 2010); mandibles obtuse at apices; median tooth of mentum strongly obtuse at apex; pronotum nearly cordiform. Length 11.7 mm...***M. sinuatilabris* Zhao & Tian**

***Macrocheilus bicolor* Andrewes, 1920**
http://species-id.net/wiki/Macrocheilus_bicolor
Figs 1, 9, 17, 37, 43

Macrocheilus bicolor Andrewes, 1920: 503; Andrewes, 1930: 206; Csiki, 1932: 1573; Lorenz, 2005: 512. Type locality: India (Bombay: Belgaum), deposited in NHML.

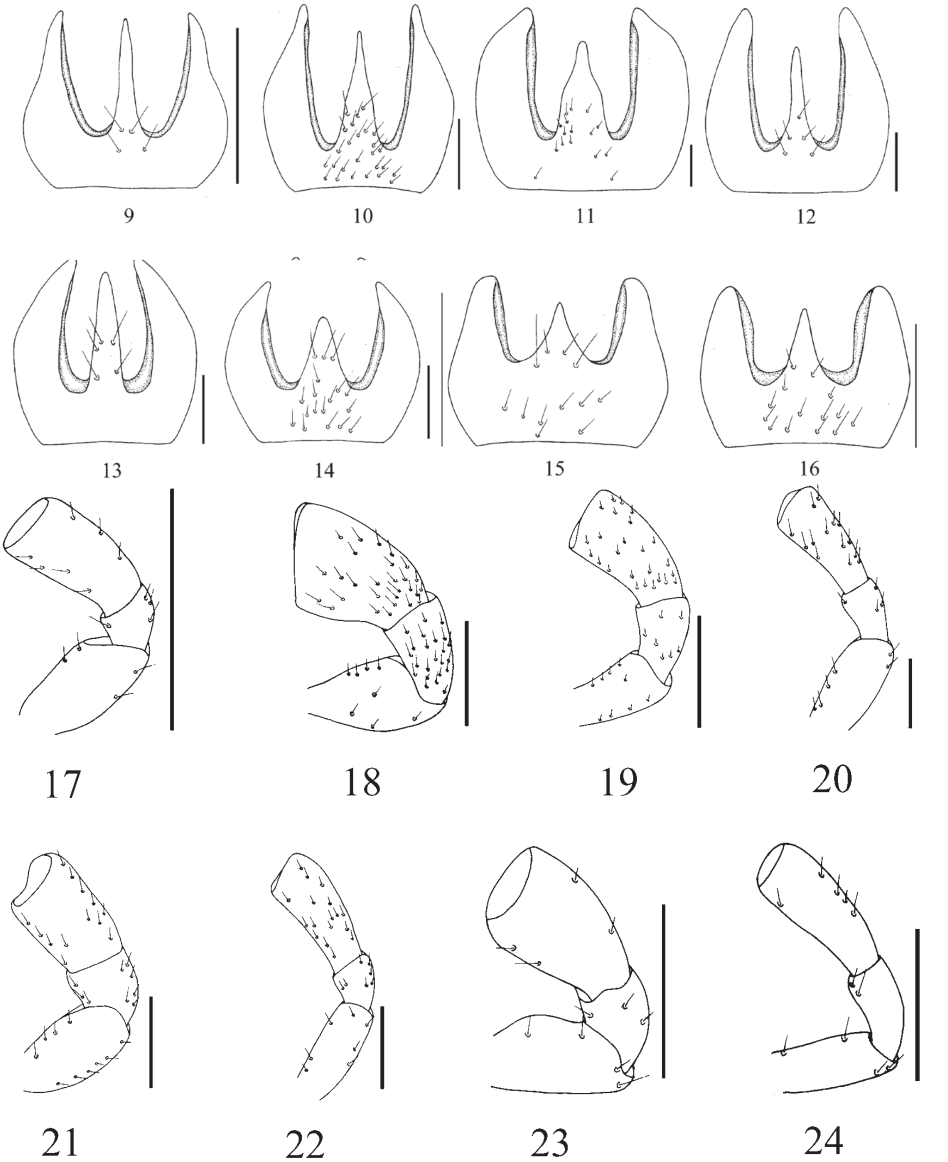
Diagnosis. Length 6.3–6.5 mm, width 2.5 mm. Head and prothorax red; elytra black or sometimes bluish black. Labrum (Fig. 1) semicircular in front, shortly depressed towards base, front pair of setae small and closely placed along the front margin, intermediate one at a distance from margin; ligula rectangular, with a wide and deep median impression, a pair of setae at a distance form apex depressed at base; apex truncate, outer apical angles rounded; mentum (Fig. 9) glabrous at base,



Figures 1–8. Labrum and clypeus of *Macrocheilus* (dorsal view): **1** *M. bicolor* (holotype) **2** *M. impictus* (male) **3** *M. immanis* (holotype) **4** *M. niger* (holotype) **5** *M. binotatus* (female) **6** *M. tripustulatus* (holotype) **7** *M. nigrotibialis* (holotype) **8** *M. deuvie* (holotype). Scale bar: 0.5 mm.

both tooth and lobes elongate, slender and sharp at apex; tooth almost as long as lobes, two pairs of setae on base; lobes sinuate at a distance from apex along outer margin; maxillary palpi (Fig. 17) not dilated. Elytra without spots.

Female genitalia. Gonocoxite short, stout, inner margin arcuate and not sinuate, apex short and sharp (Fig. 37).



Figures 9–24. Mentum and Left maxillary palpi of *Macrocheilus* (ventral view): **9, 17** *M. bicolor* (holotype) **10, 18** *M. impictus* (male) **11, 19** *M. immanis* (holotype) **12, 20** *M. niger* (holotype) **13, 21** *M. binotatus* (female) **14, 22** *M. tripustulatus* (holotype) **15, 23** *M. nigrotibialis* (holotype) **16, 24** *M. deuvie* (holotype). Scale bar: 0.5 mm.

Remarks. This species is allied to the next species, *M. impictus* (Wiedemann). Both differ from other species in the absence of elytral spot.

Materials examined. Holotype: 1 female, labeled "Kaoeqaoe, 740, Type, *Macrochilus bicolor* Type Andr., H. E. Andrewes det.; H. E. Andrewes Coll. B. M. 1945–97.;

Macrochilus bicolor Andrewes, 1920", deposited in NHML. 1 ex, sex unknown (the abdomen missing), labeled "Bangalore, Chikkangalur, Taboourel, 1900; *Macrocheilus bicolor* Andrewes, H. E. Andrewes det.", deposited in MNHN.

Distribution. India.

Macrocheilus impictus (Wiedemann, 1823)

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

Figs 2, 10, 18, 25, 26, 38, 44

Helluo impictus Wiedemann, 1823: 49. Dejean, 1825: 287; Reiche, 1842: 335; Heller, 1900: 3; Andrewes, 1920: 503; 1921: 168; Csiki, 1932: 1574; Lorenz, 2005: 512. Type locality: India, deposited in ZMUC.

Diagnosis. Length 14.5-15.0 mm, width 5.0-5.5 mm. Black. Labrum (Fig. 2) with front margin rounded and bisinuate, three pairs of setae close to margin, and front two pairs on sinuated area; mandibles slightly obtuse at apex; mentum (Fig. 10) irregularly setose in basal half, both tooth and lobes elongate and sharp at apex, tooth slightly shorter than lobes; maxillary palpomere 4 (Fig. 18) cylindrical and gradually dilated toward apex, rounded and obliquely truncate at apex. Elytra without spots.

Male genitalia. Median lobe dilated on dorsal side in middle partion, sinuate on ventral side; apical lamella elongate, not sinuate near apex, rounded at apex (Figs 25–26).

Female genitalia. Gonocoxite slender, five setae on dorsal surface, sharp at apex (Fig. 38).

Remarks. Similar to *M. bicolor* without elytral spots, distinctly differs by larger size, body black, sinuate front margin of labrum and plurisetose mental tooth.

Materials examined. 1 male, labeled "Indes Orientales, M^{ts} Kodeicanel, J. Castets 1886"; 1 male, "India, Bangalore. P.S. Nathan, 1936"; 1 male, "Punjab Baddia (Indes Angl.); G. Babault Avril 1914"; 1 male, "S. India, Medungadu, P.S. Nathan. 1936"; 3 males, "Java", "Ex-Musaeo Chaudoir from Coll. Dejean"; 1 female, "Java", "Ex-Musaeo Mniszech from Coll. Dejean". All deposited in MNHN.

Distribution. India (East India) and Indonesia (Java).

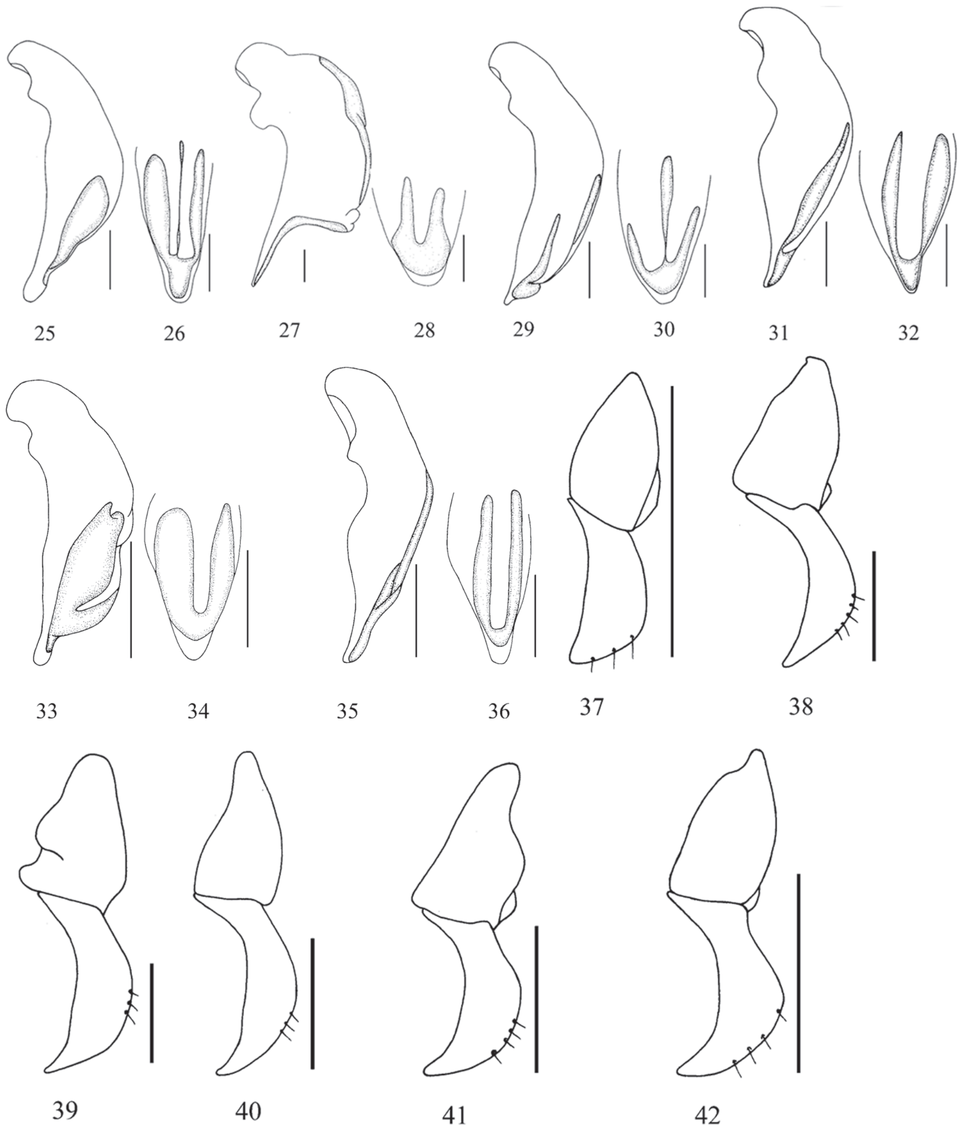
Macrocheilus immanis Andrewes, 1920

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

Figs 3, 11, 19, 27, 28, 45

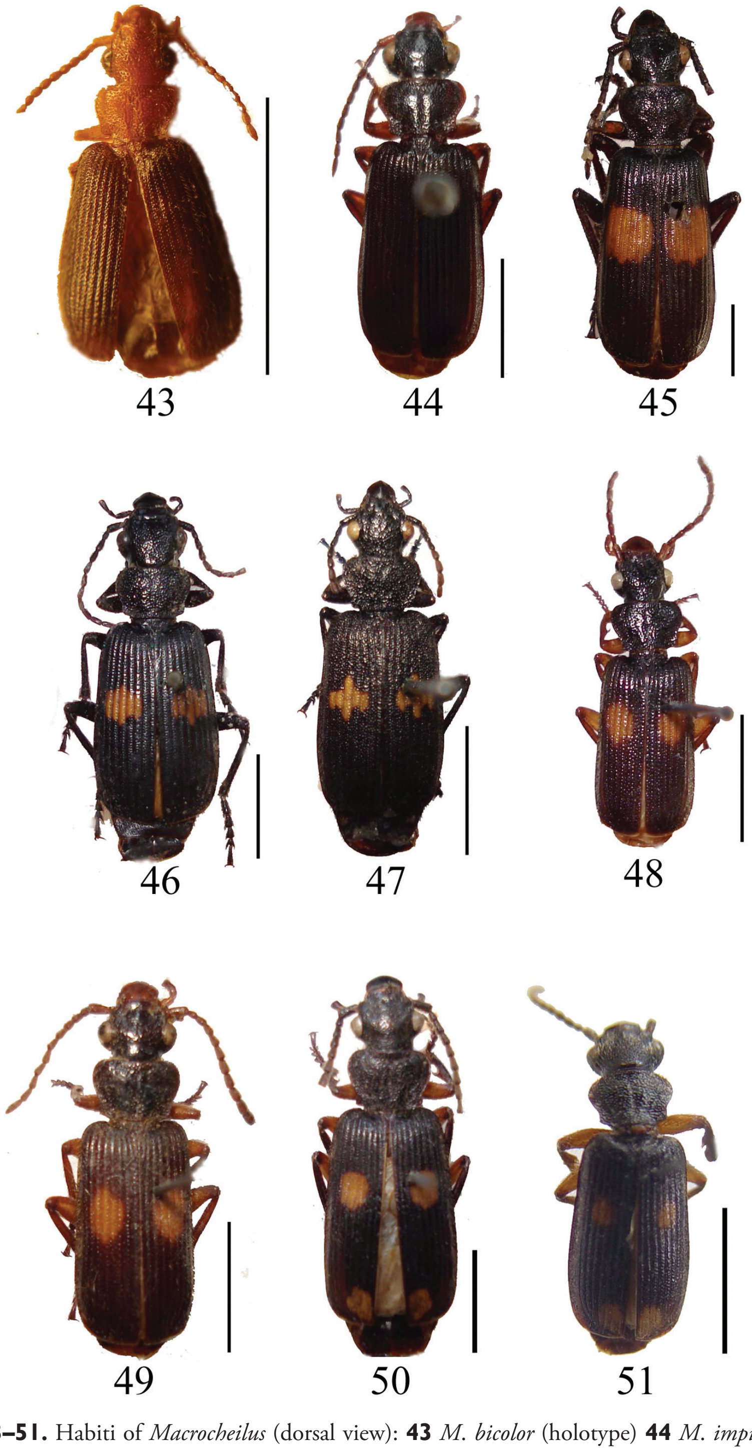
Macrocheilus immanis Andrewes, 1920: 498. Csiki, 1932: 1574; Jedlička, 1963: 469; Lorenz, 2005: 512. Type locality: Myanmar (Taung-ngu), deposited in NHML.

Diagnosis. Length 24.7 mm, width 8.3 mm. Labrum (Fig. 3) elongate, three pairs of equidistant setae on upper surface near margin; ligula thickened, apex slightly



Figures 25–42. Aedeagus of *Macrocheilus* (left lateral and dorsal view) and Left gonopods of female genitalia (dorsal view): **25, 26, 38** *M. impictus* **27, 28** *M. immanis* (holotype) **29, 30, 39** *M. niger* **31, 32, 41** *M. tripustulatus* **33, 34, 42** *M. nigrotibialis* (holotype) **35, 36** *M. deuvie* (holotype) **37** *M. bicolor* (holotype) **40** *M. binotatus*. Scale bar: 0.5 mm.

narrowed, slightly emarginate in middle of front margin, deeply depressed near apex to form a median channel, with five pairs of setae along sides, hollowed out above with a median carina; mentum (Fig. 11) with both tooth and lobes stout, tooth shorter than lobes, contracted after middle, irregularly setose on ventral surface on basal half; maxillary palpomere 4 (Fig. 19) dilated, densely setose; labial



Figures 43–51. Habiti of *Macrocheilus* (dorsal view): **43** *M. bicolor* (holotype) **44** *M. impictus* (male) **45** *M. immanis* (holotype) **46** *M. niger* (holotype) **47** *M. asteriscus* (male) **48** *M. vitalisi* (holotype) **49** *M. binotatus* (female) **50** *M. gigas* (holotype) **51** *M. parvimaculatus* (holotype).

palpomere 4 dilated, palpomere 3 not dilated inwards. Elytal spots nearly square, large, near the middle, cover intervals 2–7.

Male genitalia. Median lobe of aedeagus strongly dilated and stout, strongly sinuate near paramere, straight towards apex, apical lamera elongate and narrowed at apex (Figs 27–28).

Remarks. This species is similar to *M. niger* and *M. asteriscus* in having anterior setae of labrum obviously on upper surface, but differs from the other two species by the large and almost square elytral spots and stout median tooth of mentum.

Materials examined. 1 male, the holotype, labeled "Toungoo; Type; *Macrochilus immanis*, Type, Andr., H. E. Andrewes det.; *Macrochilus immanis* Andrewes, 1920", deposited in NHML.

Distribution. Myanmar.

Macrocheilus niger Andrewes, 1920

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

Figs 4, 12, 20, 29, 30, 39, 46

Macrocheilus niger Andrewes, 1920: 499. Csiki, 1932: 1574; Lorenz, 2005: 512. Type locality: India (Nilgiri Hills), deposited in NHML.

Diagnosis. Length 16.0–16.3 mm, width 6.0–6.2 mm. Labrum (Fig. 4) convex, with a short furrow on each side of base, narrowed and pointed in front, with three pairs of setae away from the margin; ligula thickened, apex truncate towards sides, apical margin slightly emarginate, deeply depressed towards base, with a small median impression near apex; mentum (Fig. 12) glabrous at base; median tooth shorter than lobes, rather narrow and with apex rather pointed, two pairs of setae at basal area; lateral lobes obtuse at apex. Palpi (Fig. 20) not dilated. Elytral spots transverse, close to the middle of interval 5, covering intervals 3–7.

Male genitalia. Median lobe stout, apical lamella short and round at apex (Figs 29– 30).

Female genitalia. Gonocoxite subapically dilated, three setae on dorsal surface, sharp at apex (Fig. 39).

Remarks. Similar to *M. asteriscus*, but differs with the tooth of mentum plurisetose and elytral spot not cruciform.

Materials examined. 1 female, the holotype, labeled "type, 11, H. L. Andrewes, Nilgiri Hills, H. E. Andrewes Coll., B.M. 1945–97.; *Macrochilus niger* Type-, Andr., H. E. Andrewes det.; *Macrochilus niger* Andrewes, 1920", deposited in NHML. 1 male and 1 female, "Dehra-Dun 1940-45, Kumaon Himalaya, Liesenfeldt leg.", deposited in MNHN.

Distribution. India (Nilgiri Hills, Malabar, Madras and Bombay) and Sri Lanka.

Macrocheilus asteriscus White, 1844

http://species-id.net/wiki/Macrocheilus_asteriscus
Fig. 47

Macrocheilus asteriscus White, 1844: 422; Bates, 1892: 389; Andrewes, 1919: 180; 1920: 500;1924: 470; 1930: 206; Csiki, 1932: 1573; Wu, 1937: 188; Jedlička, 1963: 470; Hůrka, 2003:407; Lorenz, 2005: 512; Zhao & Tian, 2010: 6. Type locality: China (Hongkong), deposited in NHML.

Planetes crucifer Redtenbacher, 1867: 4. Type locality: China (Hongkong), deposited in NHML.

Remarks. *M. asteriscus* differs from other species in having cruciform elytral spots, the slender median tooth of mentum and the narrow apex of ligula.

Materials examined. 2 males, 1 female, "Hongkong" (MNHN); 2 males, "Hainan, Oct. 1979, Shaoming Zhuo leg." (SCAU); 2 males, "Guangdong: Zhanjiang, Jul. 1982" (SCAU); 1 male, 1 female, "Guangdong: Zhanjiang, May, 1983" (SCAU). 1 male, 1 female, "Annam, Phuc-Son, Nov. to Dec., H, Fruhstorfer", Central Vietnam (MNHN); 1 male, "Tonkin, P. Lemée, 1903–1906", North Vietnam (MNHN); 1 male, "Laos. Mouhot" and "Janson Acq. 1884" (MNHN); 2 males, "Java, Preanger", Indonesia (MNHN); 1 female, "Nilgherries" and "Ex. Musaeo H. W. Bates, 1892", India (MNHN).

Distribution. China, Vietnam, Laos, Myanmar, Indonesia and India.

Macrocheilus vitalisi Andrewes, 1920

http://species-id.net/wiki/Macrocheilus_vitalisi
Fig. 48

Macrocheilus vitalisi Andrewes, 1920: 500; Andrewes, 1930: 208; Csiki, 1932: 1575; Wu, 1937:188; Jedlička, 1963: 470; Hůrka, 2003: 407; Lorenz, 2005: 512; Zhao & Tian, 2010: 7.

Remarks. *M. vitalisi* is similar to *M. binotatus* from Sumatra, but as stated by Andrewes (1931), *M. binotatus* differs from *M. vitalisi* by "the dark colour, the elytral spot oblong and red; the upper surface generally is more coarsely and less densely punctuate, the genae are contracted more sharply to the neck, the sides of the prothorax are less sinuate behind, the elytral intervals more convex, with punctuation along the side more widely spaced and coarser". In addition, according to our examination, the anterior seta of the labrum is closer to the apical margin in *M. vitalisi* than in *M. binotatus* and the 4th maxillary palpomere is cylindrically dilated in *M. vitalisi*.

Materials examined. 1 female, the holotype, "China, Bowring 63·47*, 986 27/2/53" (NHML); 1 female, "Tonkin, Région de Hoa-Binh", "Muséum Paris, 1932, A. de Cooman" (MNHN).

Distribution. China, Laos, Vietnam, Borneo.

Macrocheilus binotatus **Andrewes, 1931**

http://species-id.net/wiki/Macrocheilus_binotatus
Figs 5, 13, 21, 40, 49

Macrocheilus binotutats Andrewes, 1931: 68. Csiki, 1932: 1573; Lorenz, 2005: 512. Type locality: Indonesia (Sumatra), deposited in LMN.

Diagnosis. Length 14.0 mm, width 4.8 mm. Labrum (Fig. 5) with apex rounded and pointed, front setae on apical margin; mandibles covered by the labrum, sharp at apex; mentum (Fig. 13) glabrous at base, median tooth nearly as long as lobes, about five setae at basal half; maxillary palpomere 4 (Fig. 21) cylindrically dilated, labial palpomere 4 flat and dilated, labial palpomere 3 dilated inwards; ligula wide and rectangular, apical margin straight, with a wide median impression beneath apex, a seta on either side near apex. Elytral spots large and oblong, covering intervals 3–7 in the middle.

Female genitalia. Gonocoxite elongate, three setae on dorsal margin, sparsely setose on ventral surface; apex sharp (Fig. 40).

Remarks. This species is similar to *M. macromaculatus* having elytral spots oblong; and it differs from *M. macromaculatus* in having the anterior setae of labrum on the apical margin.

Materials examined. 1 female, "Paggar Alam, Sumatra, J. Bouchaud", deposited in MNHN.

Distribution. Indonesia (Sumatra).

Macrocheilus macromaculatus **Louwerens, 1949**

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

Macrocheilus macromaculatus Louwerens, 1949: 51. Lorenz, 2005: 512. Type Locality: Indonesia (Java), deposited in LMN.

Diagnosis. Length 10.0 mm, width 3.0 mm. Labrum large, semicircular anteriorly, with a flat depression on each sides, setae running along the sides in two small furrows; palpi short and stout, truncate at apex; mentum with a long, narrow, sharp median tooth, lateral lobes a little longer. Elytral spots oblong and covers intervals 2–7.

The above description is after Louwerens (1949).

Remarks. This species is similar to *M. binotatus*, but the former is smaller in size and has the sides of elytra gently rounded behind, in contrast to the larger size and more sharply rounded hind region of elytra in *M. macromaculatus*.

Distribution. Indonesia (Java).

***Macrocheilus gigas* Zhao & Tian, 2010**
http://species-id.net/wiki/Macrocheilus_gigas
Fig. 50

Macrocheilus gigas Zhao & Tian, 2010: 8. Type Locality: China (Guangdong), deposited in SCAU.

Remarks. *M. gigas* is similar to *M. parvimaculatus* and *M. tripustulatus* in having anterior seta of the labrum on the apical margin and the ligula thickened at apex which distinguishes these three species from other species with two spots on each elytron. But *M. gigas* differs from the other two species by wide apex of labrum and having median tooth of mentum sinuate near apex on lateral margin.

Materials examined. 1 male, the holotype, Guangdong: Zhanjiang, Jun.1983, deposited in SCAU; 1 male, Guangdong: Zhanjiang, Oct.1982, Zhichang Tan leg., deposited in SCAU; 2 males, Guangdong: Zhanjiang, July 1982, deposited in SCAU and MNHN.

Distribution. China (Guangdong: Zhanjiang).

***Macrocheilus parvimaculatus* Zhao & Tian, 2010**
http://species-id.net/wiki/Macrocheilus_parvimaculatus
Fig. 51

Macrocheilus parvimaculatus Zhao & Tian, 2010: 9. Type Locality: China (Guangxi), deposited in SCAU.

Remarks. This species is easily distinguished from other species of *Macrocheilus* by its strongly convex labrum, maxillary palpomere 4 dilated in apical half and with small spots on elytra.

Materials examined. 1 male, the holotype, Guangxi: Liuzhou: Luzhai, 26 May 1980, Shaozhou Ruan leg.; 1 male, same data as holotype. All specimens deposited in SCAU.

Distribution. China (Guangxi).

***Macrocheilus tripustulatus* (Dejean, 1825)**
http://species-id.net/wiki/Macrocheilus_tripustulatus
Figs 6, 14, 22, 31, 32, 41, 52

Helluo tripustulatus Dejean, 1825: 286 (syn. in Reiche, 1842: 334). Reiche, 1842: 334; Chaudoir, 1872: 212; Heller, 1900: 3; Andrewes, 1919: 124; Andrewes, 1920: 501; Csiki, 1932: 1575; Lorenz, 2005: 512. Type locality: Indonesia (Java), deposited in MNHN.

Diagnosis. Length 12.0–12.5 mm, width 4.0–4.3 mm. Labrum (Fig. 6) strongly convex on anterior part, rounded and pointed in front, front seta on apical margin, intermediate one on upper surface close to margin; mandibles sharp at apex; mentum (Fig.

14) irregular and densely setose, both tooth and lobes stout, tooth shorter than lobes, densely setose at basal half; palpi slender, palpomere 4 (Fig. 22) not dilated, densely setose, rounded and truncate at apex, labial palpomere 3 not dilated, bisetose inside; ligula strongly thickened and dilated, deeply depressed at sides, apex rounded, slightly emarginate in middle with a seta on either side. Elytra with two pairs of spots, front spot rounded, covering intervals 3–7 in the middle, hind spot close to apical inner angles, nearly rectangular, covering intervals 1–5; apex roundly truncate.

Male genitalia. Median lobe dilated in the middle ventrally, apical lamella long, wide and round at apex (Figs 31–32).

Female genitalia: Gonocoxite slender, setose on ventral surface, three setae on dorsal side, apex sharp (Fig. 41).

Remarks. *M. tripustulatus* can be distinguished from *M. parvimaculatus* by the slender maxillary palpomere 4, greater convexity of labrum and larger elytral spots.

Materials examined. 1 female, the holotype, "*tripustulatus* Dejean (non Fabr.), Java, Coll. Dejean, 3-*pustulatus* Wiedemann (*Helluo*). Fabr. (Brachinus), Western, Ex-Musaeo Chaudoir"; 1 male, "Java merid., 1500, 1891, H. Fruhstorfer."; 1 male, " Java", "Ex-Musaeo Mniszech"; 1 female, "Carin Chebà, 900-1100 m, L. Fea, V Xii-88; Ex-Musaeo H.W.Bates 1892". All specimens deposited in MNHN.

Distribution. Myanmar and Indonesia (Java).

Macrocheilus chaudoiri Andrewes, 1919

http://species-id.net/wiki/Macrocheilus_chaudoiri
Fig. 53

Macrocheilus chaudoiri Andrewes, 1919: 130; 1920: 502; 1924: 470; 1930: 207; Csiki, 1932: 1573; Jedlička, 1963: 470; Lorenz, 2005: 512; Zhao & Tian, 2010: 11. Type Locality: India, deposited in MNHN.

Acanthogenius trimaculatus sensu Chaudoir, 1872: 171 (non Oliver). Type Locality: India (Decan), deposited in MNHN.

Macrocheilus ruficollis Heller, 1923: 296; Andrewes, 1926: 258. Type Locality: Philippines (Luzon), deposited in MDSG.

Remarks. *M. chaudoiri*, *M. nigrotibialis*, *M. bensoni* and *M. deuvie* are similar in having the anterior seta of the labrum beneath the apex and two pairs of elytral spots. This species is distinct from the other three species in having the head and pronotum reddish brown and maxillary palpomere 4 strongly dilated.

Materials examined. 1 female, the holotype, "Ex-Musaeo Chaudoir; Macrocheilus Chaudoiri Andr., H.S. Andrewes det.; 3-maculatus Chaud., Deccan, Coll. Jeakes" (MNHN); 1 male, "Maissour, Sakrabail, IX 1897" (MNHN); 1 female, "Museum Paris, Cochinchine, Harmand 1872" (MNHN); 1 female, "Java" and "Museum Paris, Lakhon, Harmand 1878" (MNHN); 1 female, "Insl. Phiip." and "Thorey" (MNHN).

Distribution. China (Macao), Cambodia, Laos, Vietnam, the Philippines, Indonesia (Sumatra) and India.

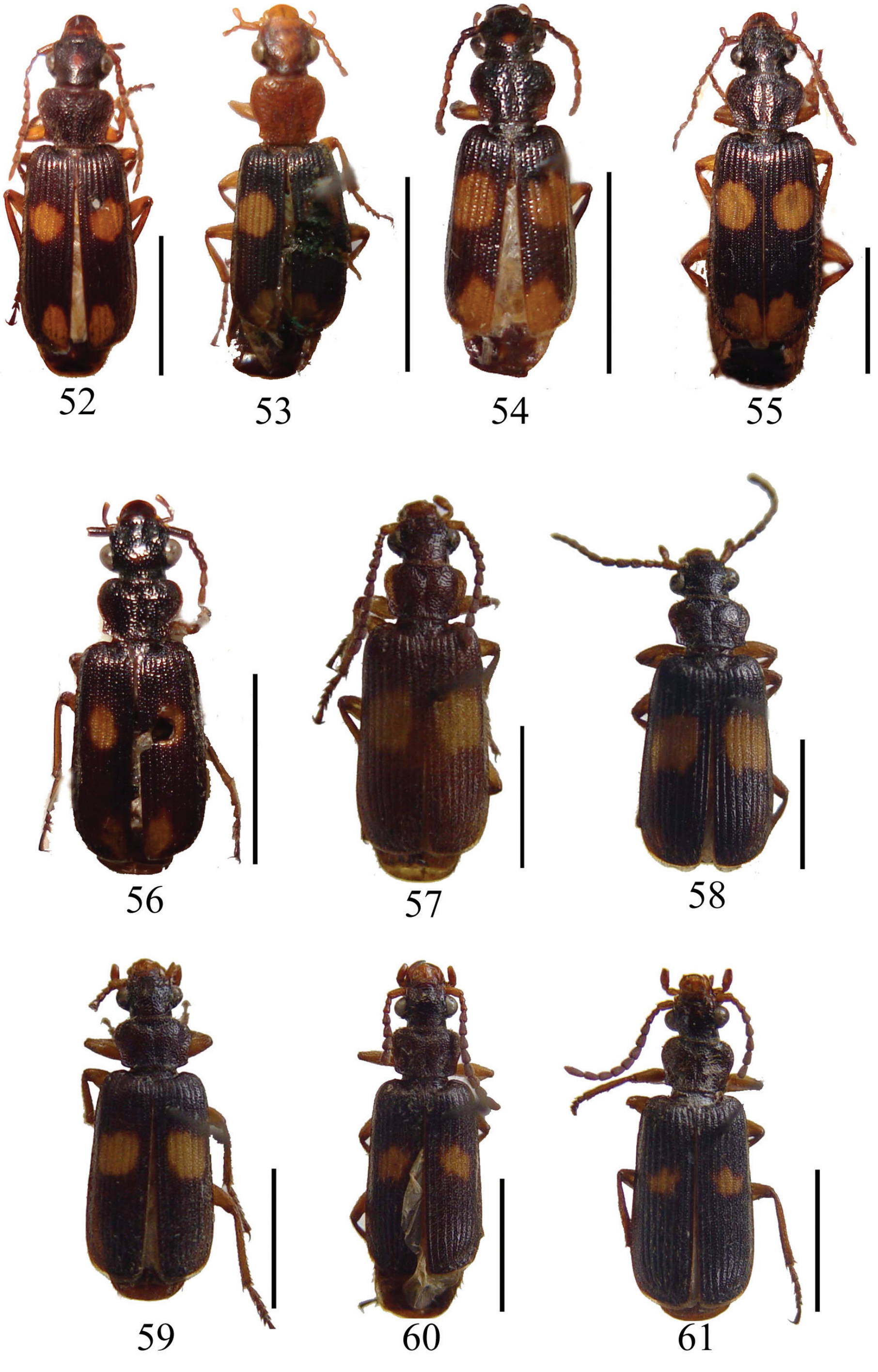


Figure 52–61. 52 *M. tripustulatus* (holotype) **53** *M. chaudoiri* (holotype) **54** *M. nigrotibialis* (holotype) **55** *M. bensoni* (male) **56** *M. deuvie* (holotype) **57** *M. fuscipennis* (holotype) **58** *M. solidipalpis* (holotype) **59** *M. cheni* (holotype) **60** *M. quadratus* (holotype) **61** *M. sinuatilabris* (holotype). Scale bar: 5.0 mm.

Macrocheilus nigrotibialis **Heller, 1900**

http://species-id.net/wiki/Macrocheilus_nigrotibialis
Figs 7, 15, 23, 33, 34, 42, 54

Macrochilus nigrotibialis Heller, 1900: 2. Andrewes, 1920: 497; Csiki, 1932: 1574; Lorenz, 2005: 512. Type locality: Indonesia (Sulawesi), deposited in MDSG.

Diagnosis. Length 8.0–10.1 mm, width 3.0–3.5 mm. Labrum (Fig. 7) convex, arcuate at apex, front setae beneath apex, intermediate one on apical margin, hind one close to middle margin; mandibles sharp at apex; mentum (Fig. 15) setose at base; median tooth triangular and shorter than lobes, with two pairs of setae at base; lobes obtuse at apex; maxillary palpomere 4 (Fig. 23) roundly dilated, labial palpomere 4 triangular in shape and dilated, 3 not dilated and bisetose on inner sides; ligula thickened, apical margin arcuate inwards, deeply depressed at sides, with a median impression close to apex, outer apical angles rounded, with a seta on either of median impression close to apex. Elytra with front spot large, just before middle, almost rounded, covering intervals 3–7 and extended to small part of 2 and 8; hind spot on inner angles, more or less triangular, covering intervals 1–5.

Male genitalia. Median lobe slender, apical lamella round (Figs 33–34).

Female genitalia. Gonocoxite slender, arcuate, with three or four setae on dorsal side, apex slightly obtuse (Fig. 42).

Remarks. This species differs from following two species in having the tibiae black, maxillary palpomere 4 more dilated, the median lobe of male genitalia stouter and the apical lamella more rounded.

Materials examined. 1 male, the holotype, "typus!", "Drs. Sarasin N. Celebes Panot-Maimang", "12623", "Staatl. Museum fur Tierkunde. Dresden", deposited in SNSD. 1 female, labeled "Nord Borneo Mont Kina Balu 5-8, 1903, John Waterstradt; *Macrochilus nigrotibialis* Heller, det. Andrewes", deposited in MNHN.

Distribution. Indonesia (Sumatra, Malaysia and Sulawesi).

Macrocheilus bensoni **Hope, 1838**

http://species-id.net/wiki/Macrocheilus_bensoni
Fig. 55

Macrocheilus bensoni Hope, 1838: 166; Chaudoir, 1872: 212; Bates, 1892: 389; Heller, 1900: 3; Andrewes, 1919: 176, 202; Hůrka, 2003: 407; Lorenz, 2005: 512: Zhao & Tian, 2010: 10. Type locality: India, deposited in NHML.

Carabus trimaculatus Olivier, 1790: 347 (non Villers, 1789); Andrewes, 1919: 129, 176; 1920: 502; 1930, 208; Csiki, 1932: 1574; Wu, 1937: 188; Jedlička, 1963: 470. Type locality: China, deposited in NHML.

Helluo quadrimaculata Guérin-Méneville, 1840: 38; Chaudoir, 1872: 212. Type locality: India, deposited in MNHN.

Helluo tripustulata sensu Guérin-Méneville, 1843: 34 (non Dejean, 1825); Andrewes, 1923: 460. Type locality: China, deposited in MNHN.

Macrocheilus quadripustulatus Schmidt-Göbel, 1846: 65. Type locality: Myanmar, deposited in NMP.

Acanthogenius infuscatus Bates 1892, 389; Andrewes, 1920: 493. Type locality: Myanmar (Bhamo), deposited in MGI.

Remarks. This species can be distinguished from *M. chaudoiri* by the black head and pronotum and from *M. nigrobibialis* by the slender maxillary palpomere 4.

Materials examined. 1 male, "North China, 1884, Janson" (MNHN); 1 male, "North India, Coll. Benson, Ex-Musaeo H.W. Bates, 1892" (MNHN); 1 male, "Ind. Angl., Coimbatore Dt, Siruveni, VI. 1937" (MNHN); 1 female, "Ind. Angl., Mysore" (MNHN); 1 male, "Guangdong: Zhanjiang, Oct.1982, Zhichang Tan leg." (SCAU); 2 males, "Guangdong: Yingde, 27 Mar.2003, Danyang Zhao leg." (SCAU and MNHN); 1 male, Guangxi, Dec.1983" (SCAU); 1 male, "Yunnan: Jinghong, Jul. 1985" (SCAU); 1 female, "Hainan: Diaoluoshan, 26 Nov.1963" (SCAU).

Distribution. China (Fujian, Jiangxi, Guangdong, Guangxi, Guizhou, Yunnan, Hongkong, Hainan), Laos, Vietnam, Myanmar, India and Sri Lanka.

Macrocheilus deuvie sp. n.

urn:lsid:zoobank.org:act:0181841F-FB7C-4A7D-9612-AB0BFEAD91F3
http://species-id.net/wiki/Macrocheilus_deuvie
Figs 8, 16, 24, 35, 36, 56

Description. Length 9.5 mm, width 3.5 mm.

Black; ligula, antennomeres 1-4, a spot on vertex, lateral margin of pronotum and legs reddish brown; sides of ligula, palpi, antennomeres 5-11 and elytral spots brown.

Head convex; neck short and punctate on dorsal surface; frontoclypeal sulcus faint, frontal foveae short and shallow; clypeus with apical margin truncate, two setae on each side of apical outer angels, a row of 6 setae along apical margin, irregularly setose basally on each side; labrum (Fig. 8) convex anteriorly, apical margin rounded, front setae beneath near apex, middle one just on apical margin, hind one close to middle margin; mandibles covered by labrum, sharp at apex; mentum (Fig. 16) irregularly setose and punctate at base, median tooth triangular and shorter than lobes, with a pair of setae at base, lobes obtuse at apex; maxillary palpi (Fig. 24) not dilated, labial palpomere 3 with two setae on inner side; ligula thickened, apex deeply and widely emarginated in middle.

Pronotum flat; widest before middle; faint median line, median and apical impression distinct, basal foveae deep; lateral margin round in front, strongly sinuate near base; hind angles nearly rectangular, with a small obtuse tooth and an emargination before tooth.

Elytra flat, striae with large, close punctures and setae; intervals convex, with two rows of regular punctures and setae, interval 8 wider than others and densely and irregularly punctate and setose; spots small, front spot rounded, just before middle, covering intervals 3–6, hind spot rhombic, on inner apical angles, covering intervals 1–5.

Male genitalia. Median lobe dilated in middle on ventral margin; apical lamella elongated, rounded at apex (Figs 35–36).

Remarks. This species is very similar to *M. bensoni*, but differs by it's smaller size, curved labrum at anterior part, clypeus glabrous on middle, pronotum with lateral margin strongly sinuate near base, and male genitalia dilated on ventral margin.

Type material. 1 male, the holotype, "Philippines, Bohol. Ch. Semper", deposited in MNHN.

Etymology. This species is named in honor of Dr. Thierry Deuve (MNHN), a well known carabidologist.

Distribution. The Philippines.

Macrocheilus fuscipennis Zhao & Tian, 2010

http://species-id.net/wiki/Macrocheilus_fuscipennis
Fig. 57

Macrocheilus fuscipennis Zhao & Tian, 2010: 12. Type locality: China (Guangxi), deposited in SCAU.

Remarks. This species is similar to *M. solidipalpis* and *M. cheni* in having the larger elytral spots, but easily distinguishable from them by the labrum without additional setae, mandibles obtuse at apex, median tooth of mentum with lateral margin not sinuate and body brownish.

Materials examined. 1 male, the holotype, "Guangxi: Napo, 10 Oct.1970, by light trap".

Distribution. China (Guangxi: Napo).

Macrocheilus solidipalpis Zhao & Tian, 2010

http://species-id.net/wiki/Macrocheilus_solidipalpis
Fig. 58

Macrocheilus solidipalpis Zhao & Tian, 2010: 13. Type locality: China (Guangxi), deposited in SCAU.

Remarks. This species is similar to *M. cheni* but easily distinguishable from the latter by the presence of additional setae between the anterior and anterior setae, the median tooth of the mentum with sinuate lateral margins in middle (sinuate on apical one-third in *M. cheni*), the median lobe larger, and the apical lamella long and narrowed towards apex.

Materials examined. 1 male, the holotype, "Guangxi: Dibei, Oct.1980, Xiuzhen Mao leg., by light trap".

Distribution. China (Guangxi: Dibei).

Macrocheilus cheni Zhao & Tian, 2010

http://species-id.net/wiki/Macrocheilus_cheni
Fig. 59

Macrocheilus cheni Zhao & Tian, 2010: 14. Type locality: China (Guangxi), deposited in SCAU.

Remarks. This species is similar to *M. solidipalpis* and the differences from the latter were mentioned above.

Materials examined. 1 male, the holotype,"Guangxi: Tengxian, Oct.1980".

Distribution. China (Guangxi: Tengxian).

Macrocheilus quadratus Zhao & Tian, 2010

http://species-id.net/wiki/Macrocheilus_quadratus
Fig. 60

Macrocheilus quadratus Zhao & Tian, 2010: 16. Type locality: China (Guangxi), deposited in SCAU.

Remarks. This species is easily distinguished from other species by the shape of pronotum.

Materials examined. 1 male, the holotype, labeled "Guangxi: Cangwu, 1980, in paddy field".

Distribution. China (Guangxi: Cangwu).

Macrocheilus sinuatilabris Zhao & Tian, 2010

http://species-id.net/wiki/Macrocheilus_sinuatilabris
Fig. 61

Macrocheilus sinuatilabris Zhao & Tian, 2010: 17. Type locality: China (Guangxi), deposited in SCAU.

Remarks. *M. sinuatilabris* is similar to *M. quadratus* in having three pairs of setae on the labrum and small elytral spots. However, it differs from *M. quadratus* in having smaller elytral spots, the median tooth of the mentum obtuse at its apex, the rounded apex of the labrum, the close positioning of front and intermediate labral setae, and the slender median lobe of the aedeagus.

Materials examined. 1 male, the holotype, labeled "Guangxi: Fenghuangcheng, Sep.1981, by light trap".

Distribution. China (Guangxi: Fenghuangcheng).

Distribution of *Macrocheilus* in the Oriental Region

The zoogeographical pattern of *Macrocheilus* is illustrated in Figure 62. Most species are distributed in limited small areas, but three are widespread, occurring in many countries: *M. asteriscus* in China, Vietnam, Laos, Myanmar, Indonesia and India; *M. chaudoiri* in China, Cambodia, Laos, Vietnam, the Philippines, Sumatra and India; and *M. bensoni* in China, Laos, Vietnam, Myanmar, India and Sri Lanka. At present the *Macrocheilus* faunas of Thailand and Nepal remain unknown.

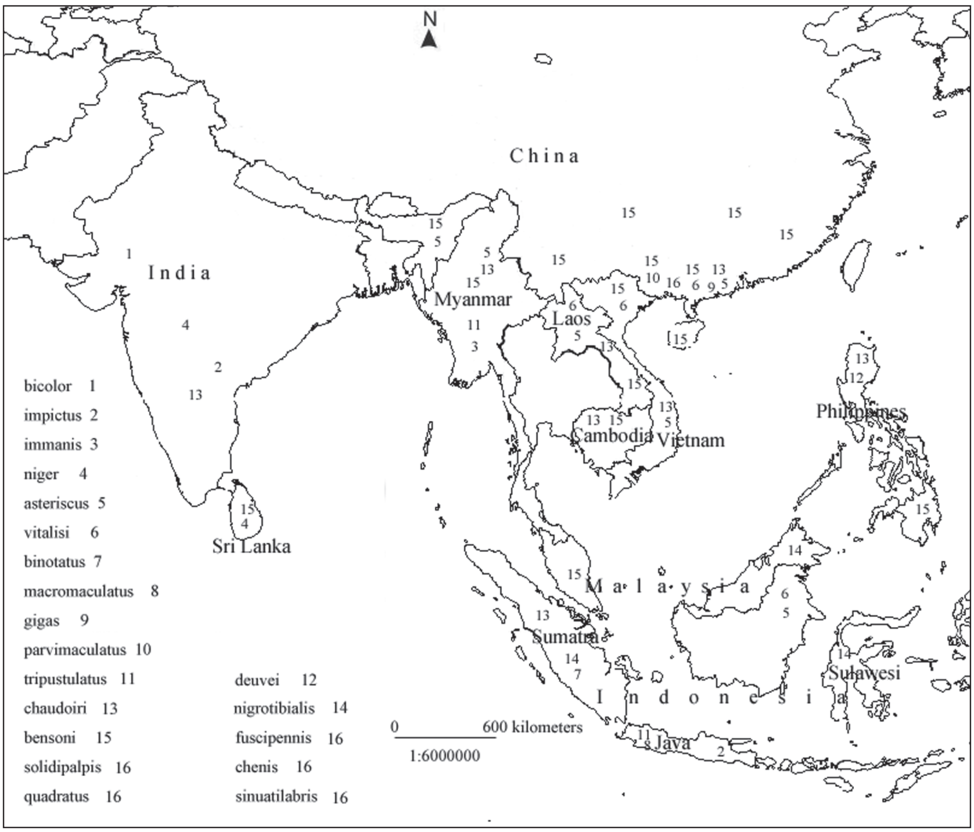


Figure 62. Distribution map of *Macrocheilus* in the Oriental Region.

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