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Taxonomic revision of the Oriental genus *Metaurus* Stål (Hemiptera: Fulgoromorpha: Dictyopharidae), with description of a new species

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The Oriental planthopper genus *Metaurus* Stål, 1866 is revised to include the type species *Metaurus reticulatus* Stål, 1866, a new related species *Metaurus ramusitis* sp. nov. and an unnamed species. Photographs and descriptions of the species are provided together with structural illustrations of male and female genitalia.

Keywords: Dictyopharidae; taxonomy; revision; new species; Oriental Region

Introduction

The dictyopharid planthopper genus *Metaurus* was established by Stål in 1866 (Stål 1866a). Its type species *Metaurus reticulatus* was described by Stål (1866b) based on a single female specimen from Cambodia. Atkinson (1886) quoted Stål's description in his notes on Indian Rhynchota. Since Melichar (1912) redescribed and illustrated the genus and its species based on Stål's type specimen from Naturhistoriska Riksmuseet, Stockholm, Sweden, no further taxonomic work has been published.

Traditionally, the genus *Metaurus*, along with most other dictyopharid genera, was placed in Dictyopharinae Dictyopharini (Melichar 1912; Metcalf 1946). Recently, the genus was assigned from Dictyopharini to Orthopagini by Emeljanov (2011).

Based on comparison with type material and our critical review of the literature, *Metaurus* is revised to include the type species *M. reticulatus* Stål, a new species *Metaurus ramusitis* sp. nov., and an unnamed species, which are described and illustrated in this paper.

Materials and methods

The genitalia were cleared in 10% KOH at room temperature for *c*.12 hours, rinsed in distilled water, then transferred to glycerol for examination.

Morphological characters were observed with a Zeiss (Stemi SV II) optical stereomicroscope and illustrated with the aid of a drawing tube; measurements were made with the aid of an eyepiece micrometer.

The specimens studied in the course of this work are deposited in the following institutions whose names are abbreviated in the text as follows: BPBM, Bernice Pauahi Bishop Museum, Honolulu, HI, USA; CAS, California Academy of Sciences,

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San Francisco, CA, USA; NHRS Naturhistoriska Riksmuseet, Stockholm, Sweden; IZCAS, Zoological Museum, Institute of Zoology, Chinese Academy of Sciences, Beijing, China.

The morphological terminology used in this study follows Emeljanov (1988) for external morphology, Bourgoin (1997) and Szwedo & Żyła (2009) for venation of the forewings, Bourgoin and Huang (1990) for male genitalia, and Bourgoin (1993) for female genitalia.

Taxonomy

Subfamily **DICTYOPHARINAE** Spinola, 1839
Tribe **ORTHOPAGINI** Emeljanov, 1983
Genus ***Metaurus*** Stål, 1866

Metaurus Stål, 1866a: 151. Type species: *Metaurus reticulatus* Stål, 1866; by subsequent designation.

Metaurus Stål: Stål, 1866b: 391; Atkinson, 1886: 24; Melichar, 1912: 46; Metcalf, 1946: 38.

Diagnosis

Head in front of eyes strongly upturned, produced in a distinctly slender, straight process; vertex with median carina weakly ridged at base and lateral carinae abruptly constricted before eyes into a straight sulcate process; frons with median carina present but indistinct, sometimes absent in apical part, intermediate carinae before eyes slightly converging posteriorly and approaching to frontoclypeal suture; pronotum with median carina sharp and complete, intermediate carinae indistinct; mesonotum tricarinate, lateral carinae incurved anteriorly towards median carina; forewings hyaline, anterior margin distinctly expanded into a narrow, sclerotized costal area; M vein first branching to M_{1+2} and M_{3+4} veins near basal one-third, and then branching to dozens of accessory veins on apical two-thirds; numerous netted transverse veins among Sc+R, M and CuA veins on apical two-thirds; stigmal area distinctly elongate, with eight or nine cells; legs moderately elongate, fore femora more or less flattened and dilated, with a distinct spine near apex; hind tibiae with seven apical black-tipped spines; segment X (anal tube) of males distinctly broad, basal and apical ventral margins protruded ventrally; aedeagus with a pair of branched endosomal processes extended from phallotheca.

Description

Head (Figures 1; 2A–C; 4A–C) in front of eyes strongly upturned, produced in a distinctly slender, straight process. Vertex (Figures 1A–E; 2A; 4A) basally flat, nearly square; lateral carinae strongly ridged, abruptly constricted before eyes, curved upwardly into a straight sulcate process; posterior margin ridged and angularly concave at about 120°; median carina weakly ridged at base. Frons (Figures 2C; 4C) elongate and broad, but anterior portion with intermediate carinae distinctly narrowed

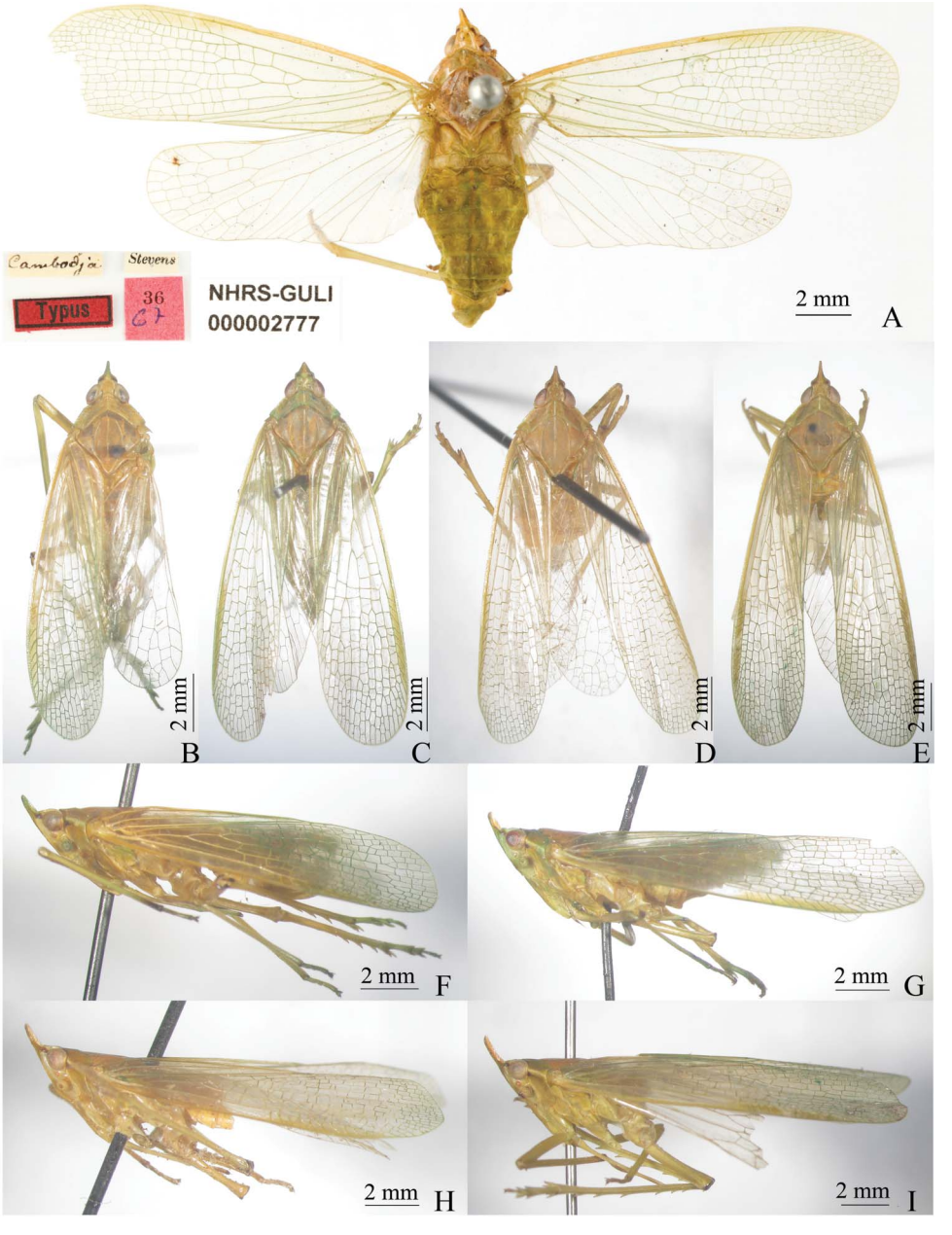

Figure 1. Habitus of *Metaurus* species (A–E, dorsal view; F–I, lateral view). (A) *Metaurus reticulatus* Stål, holotype, female; (B,F) *Metaurus ramusitis* sp. nov., holotype, male; (C,G) *Metaurus ramusitis* sp. nov., paratype, female; (D,H) *Metaurus reticulatus* Stål, non-type, male; (I) *Metaurus* indet. sp.

and protruded anteriorly and upwardly in ventral and lateral views (Figures 2B,C; 4B,C), so apical part of frons distinctly visible in dorsal view (Figures 2A; 4A); lateral carinae ridged, distinctly expanded outwards below antennae; posterior margin

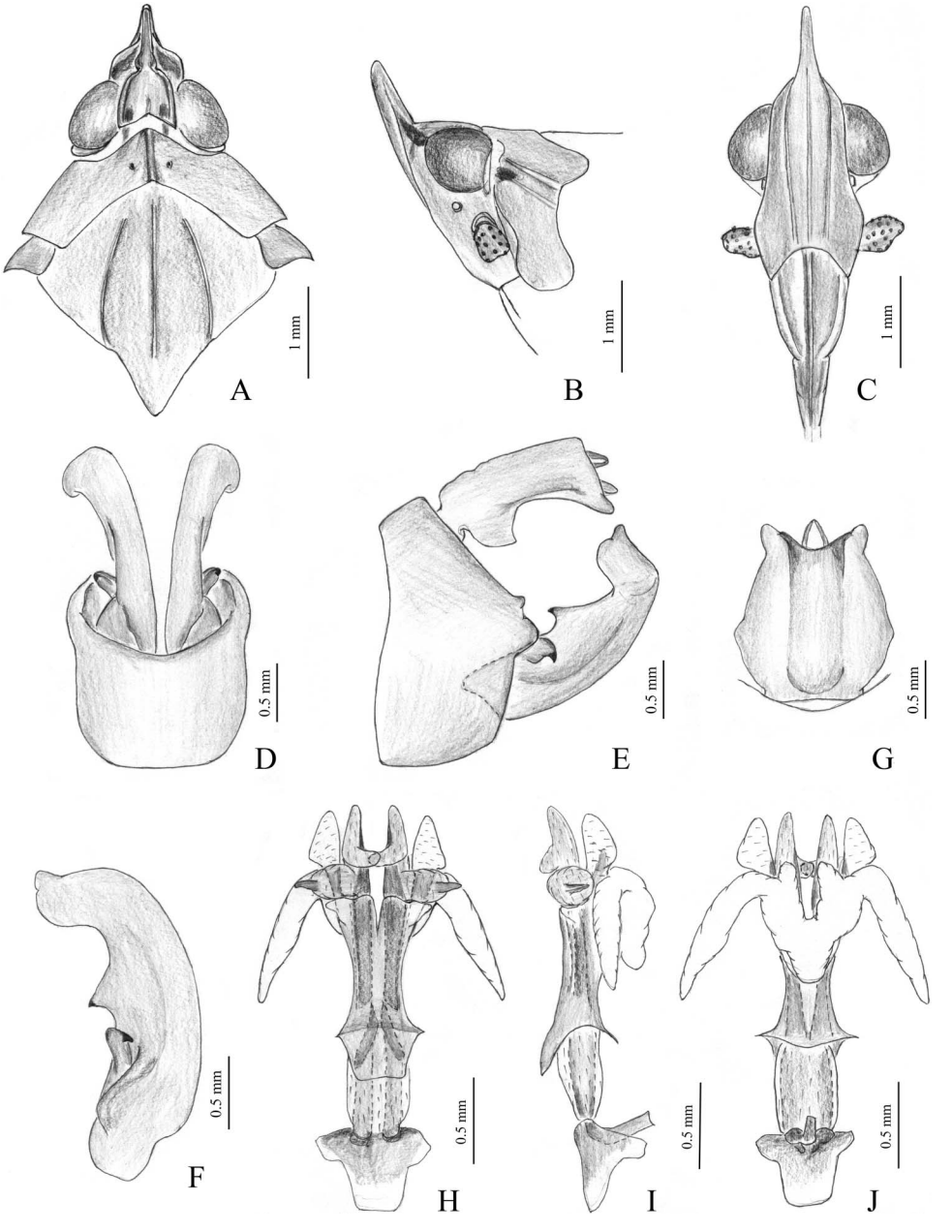

Figure 2. *Metaurus ramusitis* sp. nov. (A) Head, pronotum and mesonotum, dorsal view; (B) head and pronotum, lateral view; (C) head, ventral view; (D) pygofer and gonostyles, ventral view; (E) pygofer, gonostyles and segment X, lateral view; (F) gonostyles, lateral view; (G) segment X of male, dorsal view; (H) aedeagus, dorsal view; (I) aedeagus, lateral view; (J) aedeagus, ventral view.

concave deeply; median carina present but indistinct, sometimes absent in apical part; intermediate carinae before eyes slightly converging posteriorly and approaching to frontoclypeal suture. Postclypeus and anteclypeus strongly convex at middle, with distinct median carina. Rostrum long, reaching to abdominal sternite VI. Genae beyond the eyes strongly arched outwards, thence converging acuminately, so part of genae clearly visible in dorsal view (Figures 2A; 4A). Eyes oval and large. Ocelli relatively large, reddish. Antennae with very small scape; pedicel large and subglobose, with more than 50 distinct sensory plaque organs distributed over entire surface; flagellum long, setuliform.

Pronotum (Figures 1A–E; 2A; 4A) distinctly shorter than mesonotum medially, narrow anteriorly, broad posteriorly; anterior margin centrally slightly convex, lateral marginal areas straight and sloping with two longitudinal lateral carinae on each side between eyes and tegulae, lower lateral carina indistinct; posterior margin broadly concave at about 120°; median carina sharp and high, with a big lateral pit on each side, intermediate carinae indistinct. Mesonotum (Figures 1A–E; 2A; 4A) tricarinate, lateral carinae incurved anteriorly towards median carina. Forewings (Figures 1A–I; 3A) hyaline, much longer than tail of abdomen, nearly three times as long as broad; anterior margin distinctly expanded into a narrow, sclerotized costal area; costal cell without transverse veins, Sc+R forked apicad of claval veins junction; M vein first branching to M_{1+2} and M_{3+4} veins near basal one-third, and then branching to dozens of accessory veins on apical two-thirds; numerous netted transverse veins among Sc+R, M and CuA veins on apical two-thirds; apical cells 22–24; Pcu and A_1 veins fused into a short Pcu+A_1 vein at apical one-third of clavus; stigmal area distinctly elongate, with eight or nine cells. Hindwings (Figures 1A; 3B) hyaline, CuA vein first branching to CuA_1 and CuA_2 veins near middle, M and CuA_1 veins branching to several accessory on apical two-thirds, with several transverse veins; apical cells 12–14. Legs moderately elongate, fore femora more or less flattened and dilated, with a distinct spine near apex; hind tibiae with seven lateral black-tipped spines and seven apical black-tipped spines; hind tarsomeres I with 15–18 and tarsomeres II with 13–16 black-tipped apical spines.

Male genitalia. Pygofer distinctly wider ventrally than dorsally, dorsal margin slightly excavated to accommodate segment X. Segment X (anal tube) distinctly broad, basal and apical ventral margins protruded ventrally; apical dorsal margin slightly excavated in dorsal view (Figures 2G; 4G) to accommodate anal style; anal style short and small. Gonostyles symmetrical, nearly constant breadth in lateral view (Figures 2F; 4F); upper margin with a dorsally directed, black-tipped process at apex, outer upper edge with a ventrally directed, hook-like process near middle. Aedeagus with a pair of branched endosomal processes from phallotheca: the lower paired branches elongate and inflated, directed laterally, apex subacute and sclerotized; the middle ones short and small, directed inwards; the apical ones elongate, directed posteriorly. Phallobase basally sclerotized and pigmented, with paired membranous inflated apical lobes, without spines (Figures 2H–J; 4H–J).

Female genitalia. Segment X (anal tube) relatively small, broadest in middle, gradually narrowed towards apex in dorsal view (Figure 3C). Gonocoxae VIII (Figure 3D) with two endogonocoxal processes (GxP) membranous and flattened on endogonocoxal lobe (GxL): Gxp1 large and elongate, with a long sclerotized plate in it; Gxp2 smaller,

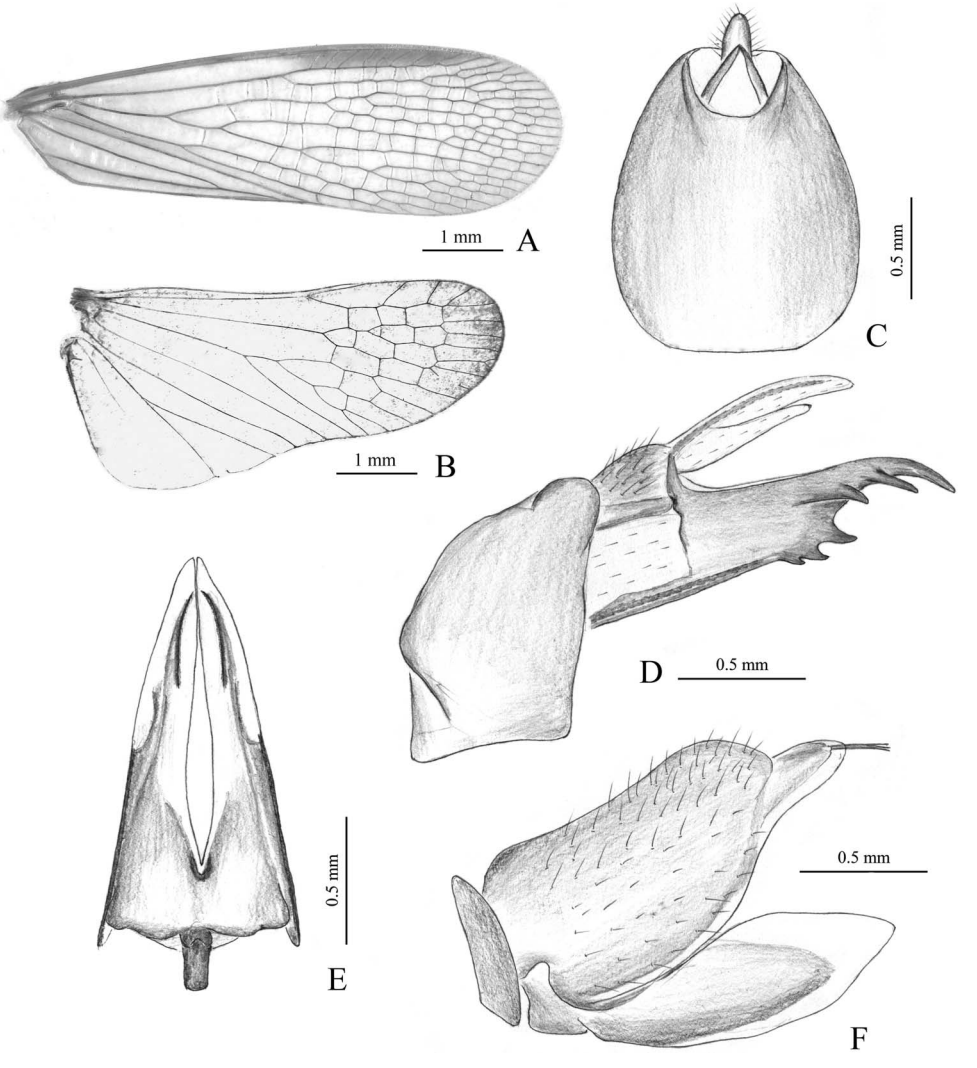

Figure 3. *Metaurus ramusitis* sp. nov. (A) Forewing; (B) hindwing; (C) segment X of female, dorsal view; (D) gonopophysis VIII, dorsolateral view; (E) gonopophysis IX, ventral view; (F) gonoplacs, ventrolateral view.

without sclerotized plate. Gonapophyses VIII (first valvulae, Figure 3D) with anterior connective lamina (ACL) large and sclerotized, with six teeth of varying sizes and shapes in lateral view (Figure 3D). Gonapophyses IX (second valvulae, Figure 3E) with posterior connective lamina (PCL) triangular, symmetrical in ventral view (Figure 3E), fused with the intergonocoxal plate (iGxp) at base; iGxp extended cephalad into the genital cavity forming the wall of the gonospiculum. Gonoplacs (third valvulae, Figure 3F) with three lobes: Gp1 and Gp2 homologous and fused basally; the lateral lobe (Gp1) large and moderately sclerotized, with four long setae at apex; the posterior lobe (Gp2) membranous, in which a long sclerotized plate is visible; the third process (Gp3) very small and membranous, sheltering behind Gp2.

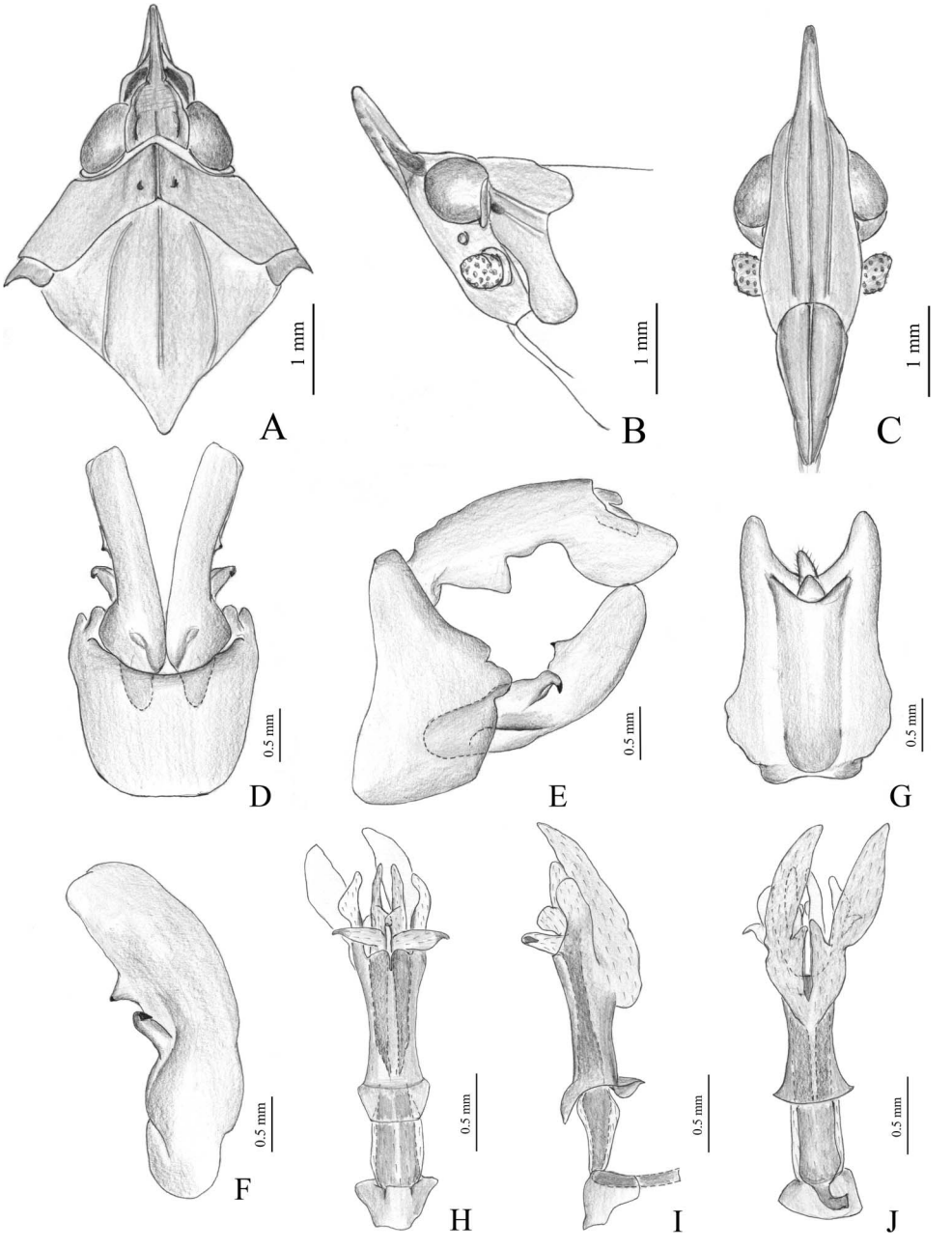

Figure 4. *Metaurus reticulatus* Stål. (A) Head, pronotum and mesonotum, dorsal view; (B) head and pronotum, lateral view; (C) head, ventral view; (D) pygofer and gonostyles, ventral view; (E) pygofer, gonostyles and segment X, lateral view; (F) gonostyles, lateral view; (G) segment X of male, dorsal view; (H) aedeagus, dorsal view; (I) aedeagus, lateral view; (J) aedeagus, ventral view.

Remarks

The genus *Metaurus* is externally similar to *Igava* Melichar, 1912 from South America for the head before eyes strongly upturned, produced in a distinctly slender, straight process. But *Igava* belongs to the tribe Lappidini Emeljanov for its Sc+R and M veins with a long common stem in the forewings (Emeljanov 2011).

Metaurus is similar to the Oriental genus *Dictyopharina* Melichar, 1903 in the tribe Orthopagini, but can be distinguished from the latter by the head in front of eyes strongly upturned, produced in a distinctly slender, straight process; the vertex with median carina only weakly ridged at base (median carina distinct and complete in *Dictyopharina*); the anterior margin of the forewings with narrow, sclerotized costal area; the hind tibiae with seven apical spines (eight in *Dictyopharina*); the aedeagus with a pair of branched endosomal processes; and the gonoplacs with a small third lobe (Song and Liang 2006).

In the genus *Metaurus*, the anterior margin of the forewings is distinctly expanded into a narrow, sclerotized costal area between Costa vein and anterior margin. This character is not present in other Oriental dictyopharid genera, but often exists in Tropiduchidae. M vein is first forked to M_{1+2} and M_{3+4} veins before CuA near basal one-third of corium, which is branched in succession to dozens of accessory veins on apical two-thirds of corium. There are numerous netted transverse veins among Sc+R, M and CuA veins on apical two-thirds of corium. The aedeagus possesses a pair of branched endosomal processes and the gonoplacs possess a small third lobe. The above characters may represent a series of autapomorphies in *Metaurus*, or may even represent a new tribe in Dictyopharinae.

Distribution

Oriental Region (Cambodia; Laos; southwestern China; Thailand).

Key to the species of the genus *Metaurus* Stål

1. Cephalic process in front of eyes distinctly longer than length from curved point to posterior margin of eyes, with the ratio about 1.4 : 1 in lateral view . . . . . *M.* indet. sp.
   Cephalic process in front of eyes a little shorter or as long as length from curved point to posterior margin of eyes in lateral view 2

2. Cephalic process in front of eyes a little shorter than length from curved point to posterior margin of eyes, with the ratio about 0.7–0.8 : 1 in lateral view; segment X of males distinctly short and small, with ratio of the longest length to width near base about 1.1 : 1 in dorsal view, apical ventral margins protruded ventrally into a short small process in lateral view; aedeagus with ventral outer apical lobes curved anteriorly in ventral view . . . . . *M. ramusitis* sp. nov.
   Cephalic process in front of eyes as long as length from curved point to posterior margin of eyes in lateral view; segment X of males distinctly large and elongate, with ratio of the longest length to width near base about 1.6 : 1 in dorsal view, apical ventral margins protruded ventrally into a large rounded process in lateral view; aedeagus with ventral outer apical lobes directed posteriorly in ventral view . . . . . *M. reticulatus* Stål

Metaurus ramusitis sp. nov.
(Figures 1B, C, F, G; 2; 3)

Description

Body length (from apex of cephalic process to tip of forewings): ♂ 13.5 mm, ♀ 14.6 mm; length of head (including two portions: the former is from apex of cephalic process to curved point, the latter is from curved point to posterior margin of eyes): ♂ (0.8 + 1.0) mm, ♀ (0.7 + 1.0) mm; width of head (including eyes): ♂ 1.7 mm, ♀ 1.7 mm; length of forewings: ♂ 10.9 mm, ♀ 12.1 mm.

General colour greenish ochraceous, apical part of cephalic process, a longitudinal spot before eyes on genae, a small anterior spot on lower lateral carina behind eyes on pronotum, apex of hind femora and base of hind tibiae black and shining; two small spots on basal vertex pale black.

Cephalic process in front of eyes strongly upturned (ascending at about 50°), a little shorter than length from curved point to posterior margin of eyes, with ratio about 0.7–0.8 : 1 in lateral view (Figures 1F,G; 2B). Forewings and hindwings as Figure 3(A,B). Hind tarsomeres I with 15–18 and tarsomeres II with 13–16 apical spines.

Male genitalia. Pygofer large and broad, ventrally distinctly wider than dorsally (about 2.1 : 1); posterior margin with two obtuse processes near middle in lateral view (Figure 2E), upper process distinctly smaller than lower one. Segment X (anal tube) distinctly short and small, with ratio of the longest length to width near base about 1.1 : 1 in dorsal view (Figure 2G); apical ventral margins protruded ventrally into a short small process in lateral view (Figure 2E). Gonostyles large and elongate, apical part distinctly prolonged and curved ventrally, apex with a small obtuse process in lateral view (Figure 2E,F); upper process short, acute apically. Aedeagus large and robust, bases of dorsal and lateral parts and most portion of ventral part on phallobase sclerotized and pigmented, the remainder membranous; dorsal part with a pair of small apical lobes, directed laterally in dorsal view (Figure 2H); lateral apical parts produced in a pair of long lobes, directed posteriorly in lateral view (Figure 2I); ventral part with two pairs of lobes: the inner two very small, directed posteriorly, the outer two distinctly large and elongate, curved anteriorly in ventral view (Figure 2J).

Female genitalia as in generic description (Figure 3C–F).

Material examined

Holotype. ♂, LAOS: Nongtevada, 18 September 1965, J. L. Gressitt (BPBM).

Paratypes. LAOS: 1♂, Paksong, 20 August 1965, native collector (BPBM); 1♀, CHINA: Yunnan, Baishiyan, 10 June 1953 (IZCAS).

Etymology

This new species name is derived from the Latin "*ramus*", refering to its paired branched endosomal processes in aedeagus.

Remarks

The new species is very similar to *M. reticulatus* Stål, but can be distinguished from the latter by the relatively shorter cephalic process in front of eyes; the forewings with relative fewer netted transverse veins among Sc+R, M and CuA veins on apical two-thirds; the segment X of males distinctly short and small, with ratio of the longest length to width near base about 1.1 : 1 in dorsal view, apical ventral margins protruded ventrally into a short small process in lateral view; the gonostyles distinctly prolonged and curved ventrally at apical part; and the aedeagus with ventral outer apical lobes curved anteriorly in ventral view.

Distribution

Laos; southwestern China (Yunnan).

Metaurus reticulatus Stål, 1866
(Figures 1A, D, H; 4)

Metaurus reticulatus Stål, 1866: 391. Holotype ♀, CAMBODIA (NHRS) [examined].

Metaurus reticulatus Stål: Atkinson, 1886: 24; Melichar, 1912: 47, Pl. II, figs. 5–7; Metcalf, 1946: 39.

Description

Body length (from apex of cephalic process to tip of forewings): ♂ 14.4 mm, ♀ 17.0 mm; length of head (including two portions: the former is from apex of cephalic process to curved point, the latter is from curved point to posterior margin of eyes): ♂ (1.0 + 1.0) mm, ♀ (1.1 + 1.2) mm; width of head (including eyes): ♂ 1.8 mm, ♀ 1.8 mm; length of forewings: ♂ 11.8 mm, ♀ 14.2 mm.

General colour greenish ochraceous, apical part of cephalic process, a longitudinal spot before eyes on genae, a small anterior spot on lower lateral carina behind eyes on pronotum, apex of hind femora and base of hind tibiae black and shining.

Cephalic process in front of eyes strongly upturned (ascending at about 45°), as long as length from curved point to posterior margin of eyes in lateral view (Figure 1B,H). Forewings and hindwings as Figure 1A. Hind tarsomeres I with 18 and tarsomeres II with 16 apical spines, respectively.

Male genitalia. Pygofer large and broad, ventrally distinctly wider than dorsally (about 3.9 : 1); posterior margin with two obtuse processes near middle in lateral view (Figure 4E), upper process slightly smaller than lower one. Segment X (anal tube) distinctly large and broad, with ratio of the longest length to width near base about 1.6 : 1 in dorsal view (Figure 4G); apical ventral margins protruded ventrally into a large rounded process in lateral view (Figure 4E). Gonostyles relatively small, apical part elongate and rounded in lateral view (Figure 4E,F); upper process short, acute apically. Aedeagus large and robust, bases of dorsal and lateral parts and most of ventral part on phallobase sclerotized and pigmented, the remainder membranous; dorsal part without lobe in dorsal view (Figure 4H); lateral apical parts

produced in a pair of long lobes, directed posteriorly in lateral view (Figure 4I); ventral part with two pairs of lobes: the inner two very small, directed posteriorly, the outer two distinctly large and elongate, directed posteriorly in ventral view (Figure 4J).

Type material examined

Holotype ♀ (NHRS-GULI 000002777), Cambodia, Stevens, [red label] Typus (NHRS).

Other material examined

1♂, LAOS: Sedone Province, Pakse, 31 May 1967, native collector (BPBM).

Remarks

Metaurus reticulatus was described from Cambodia based on a single female specimen, and was redescribed and illustrated in detail by Melichar (1912). Based on comparison with type specimen and our critical review of the literature, we definitely treat a male specimen from southern Laos as *M. reticulatus*.

Distribution

Cambodia; Laos.

Metaurus indet. sp.
(Figure 1E, I)

Description

Body length (from apex of cephalic process to tip of forewings): 16.3 mm; length of head (including two portions: the former is from apex of cephalic process to curved point, the latter is from curved point to posterior margin of eyes): (1.4 + 1.0) mm; width of head (including eyes): 1.8 mm; length of forewings: 13.1 mm.

General colour greenish ochraceous, apical part of cephalic process, a longitudinal spot before eyes on genae, a small anterior spot on lower lateral carina behind eyes on pronotum, apex of hind femora and base of hind tibiae black and shining.

Cephalic process in front of eyes strongly upturned (ascending at about 45°), distinctly longer than length from curved point to posterior margin of eyes, with ratio about 1.4 : 1 in lateral view (Figure 1I). Hind tarsomeres I with 18 and tarsomeres II with 16 apical spines, respectively.

Material examined

THAILAND: sex unknown (abdomen missing), 10 miles (16 km) north of Saraburi, 100 m, 21 July 1962, E. S. Ross and D. Q. Cavagnaro (CAS).

Remarks

The specimen can be easily distinguished from the other two *Metaurus* species by the distinctly longer cephalic process in front of eyes, longer than length from curved point to posterior margin of eyes, with the ratio about 1.4 : 1 in lateral view. Unfortunately, its abdomen was missing so that the specific status is unknown.

Distribution

Thailand.

Acknowledgments

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