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Systematic revision of the Oriental planthopper genus *Miasa* Distant (Hemiptera: Fulgoromorpha: Dictyopharidae), with description of a new genus from southern India

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Abstract

The dictyopharid planthopper genus *Miasa* Distant, 1906 (Orthopagini) is revised to include three known species, *M. producta* (Lethierry, 1888), *M. smaragdilinea* (Walker, 1857), and *M. wallacei* Muir, 1923, and two new species *M. borneensis* **sp.n.** and *M. nigromaculata* **sp.n.**, all distributed in Southeast Asia. The confusion regarding the taxonomy of *Miasa* species is clarified on the basis of a critical review and examination of historical material. Male genitalia of all species and fifth-instar nymph of *M. smaragdilinea* are described and illustrated for the first time. A new genus *Indomiasa* **gen.n.** which is closely related to *Miasa*, is also established for a single new species, *I. distanti* **sp.n.**, from southern India. A phylogenetic analysis based on morphological characters of adults was conducted to reconstruct the species-level phylogenetic relationships of *Miasa* and *Indomiasa*. The results show that the monophyly of *Miasa* and *Miasa* + *Indomiasa* is well supported. Keys to the genera of Orthopagini in the Oriental region and to the species of *Miasa* are provided.

Key words

New species, redescription, male genitalia, fifth-instar nymph, phylogeny, biogeography, taxonomy.

1. Introduction

The planthopper family Dictyopharidae is a moderately large family of Fulgoromorpha, containing more than 730 described species in 167 genera (Metcalf 1946; Song & Liang 2011a; Liang & Song 2012; Bourgoin 2014). Members of Dictyopharidae (Fig. 1) often can be recognized by their variably anteriorly produced head, although this character is not unique to Dictyopharidae within Fulgoromorpha (O'Brien 2002). It is widely accepted that this family is a sister clade of the lanternfly family Fulgoridae in the hypotheses of Fulgoromorpha phylogeny based on either morphological characters or DNA sequence data (Asche 1988; Emeljanov 1990; Bourgoin 1993; Yeh et al. 2005; Urban & Cryan 2007, 2009; Song & Liang 2013).

Dictyopharidae is widely distributed in most parts of the world, especially in tropical and subtropical regions such as South America, the Oriental region and the East Indies (Metcalf 1946). Members of this group are predominantly monocot-feeders, and a few are major agricultural pests on Poaceae (grasses), such as rice, maize,

Fig. 1. *Miasa* specimens. **A**: *M. borneensis* **sp.n.**, photographed by Dr. Arthur Anker at Danum Valley, Sabah, Borneo, Malaysia on 3 Feb. 2011. **B**: *M. wallacei*, photographed by Dennis Sim at Negeri Sembilan, Malaysia on 21 Apr. 2013.

and sugarcane (Wilson & O'Brien 1987; Wilson et al. 1994).

Traditionally, the family was separated into two subfamilies Dictyopharinae and Orgeriinae (Muir 1930; Metcalf 1946; Emeljanov 1980; Szwedo 2008). Dictyopharinae, distributed worldwide, comprises eleven extant tribes and two fossil tribes (Melichar 1912; Muir 1923, 1930; Metcalf 1946; Emeljanov 1979, 1983, 1997, 2008, 2011; Szwedo 2008). As in many other groups of Fulgoromorpha, quite a number of genera and higher taxa within Dictyopharinae still lack standard revisionary studies, and their monophyly has never been tested cladistically as well (Liang & Song 2012).

Within Dictyopharinae, the tribe Orthopagini Emeljanov is a relatively large group with 19 genera and more than 50 species mainly distributed in the Afrotropic and Oriental regions. Although there have been a continuing series of works emphasizing taxonomic revision of generic level within Orthopagini which were published (Liang & Song 2006; Song & Liang 2006a,b, 2007, 2011b, 2012a,b; Emeljanov 2008, 2011; Song et al. 2012), the phylogenetic relationships of most genera within Orthopagini are poorly understood (Song et al. in prep.).

The Oriental genus *Miasa* was established by Distant (1906) for a single species – *Elidiptera smaragdilinea* Walker, 1857, from Malacca (Malay Peninsula) – on the basis of the distinctly slender, straight and linear cephalic process, and narrow and long forewings. When describing *Miasa*, Distant (1906) stated that "this genus is allied to *Dictyopharoides* Fowl., from which it may be at once separated by the non-serrate anterior femora, a character omitted in Fowler's diagnosis." It was farther from the Neotropical genus *Elidiptera* Spinola, 1839 because the latter was moved into the family Achilidae.

Distant (1906) redescribed *M. smaragdilinea* (Walker) based on material from Myanmar (Burma) instead of Walker's type specimen. In the same year, Schmidt (1906) claimed that Distant's (1906) description was inaccurate and incomplete, giving as his reason that Distant's character 'green face with the central ridge testaceous' for *M. smaragdilinea* was not mentioned in Walker's (1857) description, and such an obvious feature, if present, could not possibly have been ignored by Walker (1857). Consequently, Schmidt (1906) described a new species, *M. rubrovittata*, for Distant's *smaragdilinea*, based on his own material from Sumatra and Java, which matched Distant's description of specimens with green frons.

In response to Schmidt's judgment, Distant (1916) declared that his description and illustration of *M. sma-*

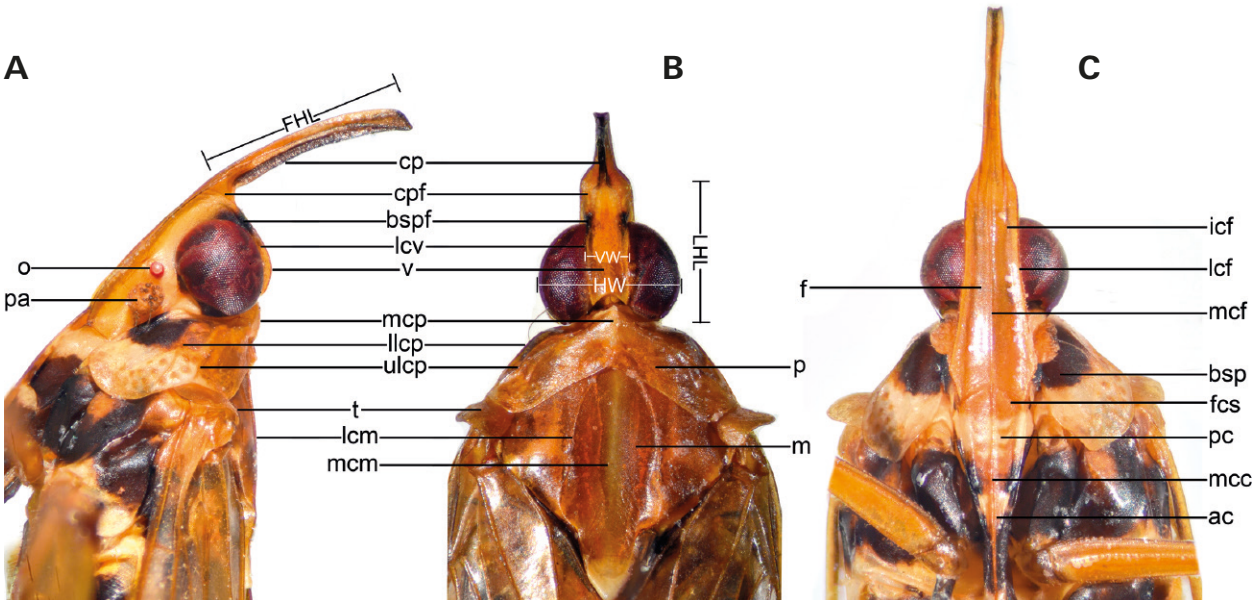

Fig. 2. Some measurements and terms regarding *Miasa*. **A–C**: Lateral, dorsal and ventral views of head, pronotum and mesonotum of *M. nigromaculata* **sp.n.** – **Abbreviations**: ac – anteclypeus; bsp – black spot on lateral area behind eyes of pronotum; bspf – black spot on preocular field; cp – cephalic process; cpf – carina in preocular field; f – frons; fcs – frontoclypeal suture; FHL – the former portion of head length; HW – head width; icf – intermediate carina of frons; lcf – lateral carina of frons; lcm – lateral carina of mesonotum; lcv –lateral carina of vertex; LHL – the latter portion of head length; llcp – lower lateral carina of pronotum; m – mesonotum; mcc – median carina of clypeus; mcf – median carina of frons; mcm – median carina of mesonotum; mcp – median carina of pronotum; o – ocellus; p – pronotum; pa – pedicel of antenna; pc – postclypeus; t – tegula; ulcp – upper lateral carina of pronotum; v – vertex; VW – vertex width.

ragdilinea from Burma agreed entirely with Walker's type in the British Museum, and proposed that *M. rubrovittata* from Sumatra and Java was a junior synonym of *M. smaragdilinea*. However, this action was not adopted by subsequent workers, such as Baker (1927), Schmidt (1928) and Metcalf (1946), although Schmidt (1928) did admit that he had misidentified his specimens as *M. smaragdilinea* and re-named them as *M. producta* (Lethierry) but at the same time, unaccountably retaining *M. rubrovittata* as a valid species. During the above period a fourth species, *Miasa wallacei* Muir, 1923, was described from southern Thailand (Muir 1923).

Based on an examination of most of the *Miasa* type specimens in the current work we not only confirm the synonymy of *M. rubrovittata* Schmidt with *M. smaragdilinea* (Walker), but also point out that Distant (1906) misidentified his specimens from Burma as *M. smaragdilinea* as they may belong to *M. wallacei* Muir.

Although there is a strong resemblance among the *Miasa* species, they can be distinguished by a combination of differences in body color and in the male genitalia (Figs. 15, 17), and they also differ in their distribution (Fig. 18). We accordingly revise the genus *Miasa* to include three known species, *M. producta*, *M. smaragdilinea*, and *M. wallacei*, and two new species, *M. borneensis* **sp.n.** and *M. nigromaculata* **sp.n.**, from Borneo. In addition, one new species, representing a new closely related genus, *Indomasia distanti* **gen.n.**, **sp.n.**, is described from southern India. A phylogenetic analysis based on morphological characters of adults was conducted to reconstruct the phylogeny of *Miasa* and *Indomasia*.

2. Materials and methods

2.1. Specimens and museums

Specimens examined were deposited in the following institutions whose names are abbreviated in the text as follows: **BMNH** Natural History Museum, London, UK; **BPBM** Bernice P. Bishop Museum, Honolulu, HI, USA; **IZCAS** Institute of Zoology, Chinese Academy of Sciences, Beijing, P.R. China; **MFNB** Museum für Naturkunde der Humboldt Universität, Berlin, Germany; **MIZPAS** Museum and Institute of Zoology, Polish Academy of Sciences, Warsaw, Poland; **MMBC** Moravian Museum, Brno, Czech Republic; **MZLU** Museum of Zoology, Lund University, Lund, Sweden; **SDEI** Senckenberg Deutsches Entomologisches Institut, Müncheberg, Germany; **SNSD** Senckenberg Naturhistorische Sammlungen Dresden, Dresden, Germany; and **USNM** National Museum of Natural History, Washington, DC, USA.

2.2. Terminology and techniques

The morphological terminology used in this study follows Anufriev & Emeljanov (1988) for general morphology (see Fig. 2), Bourgoin & Huang (1990) for

Table 1. Material for the phylogenetic analysis.

Genus	Species in analysis	Distribution
Dictyophara	*europaea* (L., 1767)	Palaearctic region
Putala	*rostrata* Melichar, 1903	Sri Lanka; southern India
Raivuna	*micida* Fennah, 1978	Vietnam; southern China
Centromeria	*longipennis* (Walker, 1851)	Philippines
Indomiasa **gen.n.**	*distanti* **sp.n.**	southern India
Leprota	*melichari* Fennah, 1963	Malaysia: Borneo; Indonesia: Sumatra
Metaurus	*reticulatus* Stål, 1866	Cambodia; Laos
Miasa	*borneensis* **sp.n.**	Malaysia: Borneo
Miasa	*nigromaculata* **sp.n.**	Malaysia: Borneo
Miasa	*producta* (Lethierry, 1888)	Indonesia: Java, Sumatra
Miasa	*smaragdilinea* (Walker, 1857)	Malaysia: Malay Peninsula; Indonesia: Java, Sipora, Siberut, North Pagi, Sumatra; Singapore
Miasa	*wallacei* Muir, 1923	China: Yunnan; Burma; Malaysia: Malay Peninsula; Vietnam; Thailand
Orthopagus	*lunulifer* Uhler, 1896	Japan; Korea; China; India; Sri Lanka; Southeast Asia
Saigona	*ussuriensis* (Lethierry, 1878)	Russia: Far East; Japan; Korea; northeastern China
Tenguna	*watanabei* Matsumura, 1910	southern China

male genitalia, and Bourgoin (1993) for female genitalia. The following abbreviations are used in the text. **BL**: body length (from apex of cephalic process to tip of forewings); **HL**: head length (including two portions: the former is from apex of cephalic process to constricted and curved part, and the latter is from curved part to base of eyes); **HW**: head width (including eyes); **VW**: vertex width; **FWL**: forewing length.

The postabdomina of specimens used for dissection were cleared in 10% KOH at room temperature for ca. 6–12 hours, rinsed in distilled H_2O, then transferred to H_2O with 10% glycerol for examination. Observations, measurements and photography were made under a compound optical stereomicroscope (Zeiss Discovery V12) equipped with a Nikon D7000 digital camera. Final images were compiled from multiple photographs using CombineZM Image Stacking Software, and improved with the Adobe Photoshop CS5 software. Morphological characters were observed and illustrated by a Zeiss (Stemi SV II) optical stereomicroscope with a drawing tube attached to the microscope.

We also compiled the species distribution data (geographic locations with longitudes and latitudes) associated with specimens or taken from the literature, which were then transferred into a geographic information system program (ArcView ver. 3.3) for the mapping process.

2.3. Taxon sampling

A cladistic analysis of morphological characters of adults was conducted, including all species of *Miasa* and *Indomiasa* and six species representing its putatively related genera within Orthopagini in the Oriental region. Three Dictyopharini species, *Dictyophara europaea* (L., 1767), *Putala rostrata* Melichar, 1903, and *Raivuna micida* Fennah, 1978, were chosen as outgroup taxa (Table 1).

3. Taxonomy

3.1. Tribe Orthopagini Emeljanov, 1983

Orthopagini Emeljanov, 1983: 306; Emeljanov 2011: 1024. **Type genus.** *Orthopagus* Uhler, 1896.

Distribution. The Old World.

Remarks. A total of 12 genera within Orthopagini are distributed in the Oriental region (*Saigona* Matsumura is also distributed in the eastern Palaearctic region). Most of them were revised or are in preparation by the first author and his collaborators in recent years (Liang & Song 2006; Song & Liang 2006a,b, 2007, 2011b, 2012a,b; Song et al. 2012; Song et al. in prep.), but a comprehensive systematic revision for this tribe in the world is still lacking. Here is a first provisional key to the genera of Orthopagini in the Oriental region provided in this paper.

3.2. Key to the genera of Orthopagini in the Oriental region

1 Forewings with M vein first bifurcating M_{1+2} and M_{3+4} near basal 1/3, which is branched in succession to a dozen accessory veins on apical 2/3; numerous netted crossveins among Sc+R, M and CuA on apical 2/3; aedeagus with a pair of branched endosomal processes ..... ***Metaurus*** Stål

1' Forewings with M vein first bifurcating near or beyond middle; fewer netted crossveins among Sc+R, M and CuA on apical 2/3; aedeagus with endosomal processes not bifurcate **2**

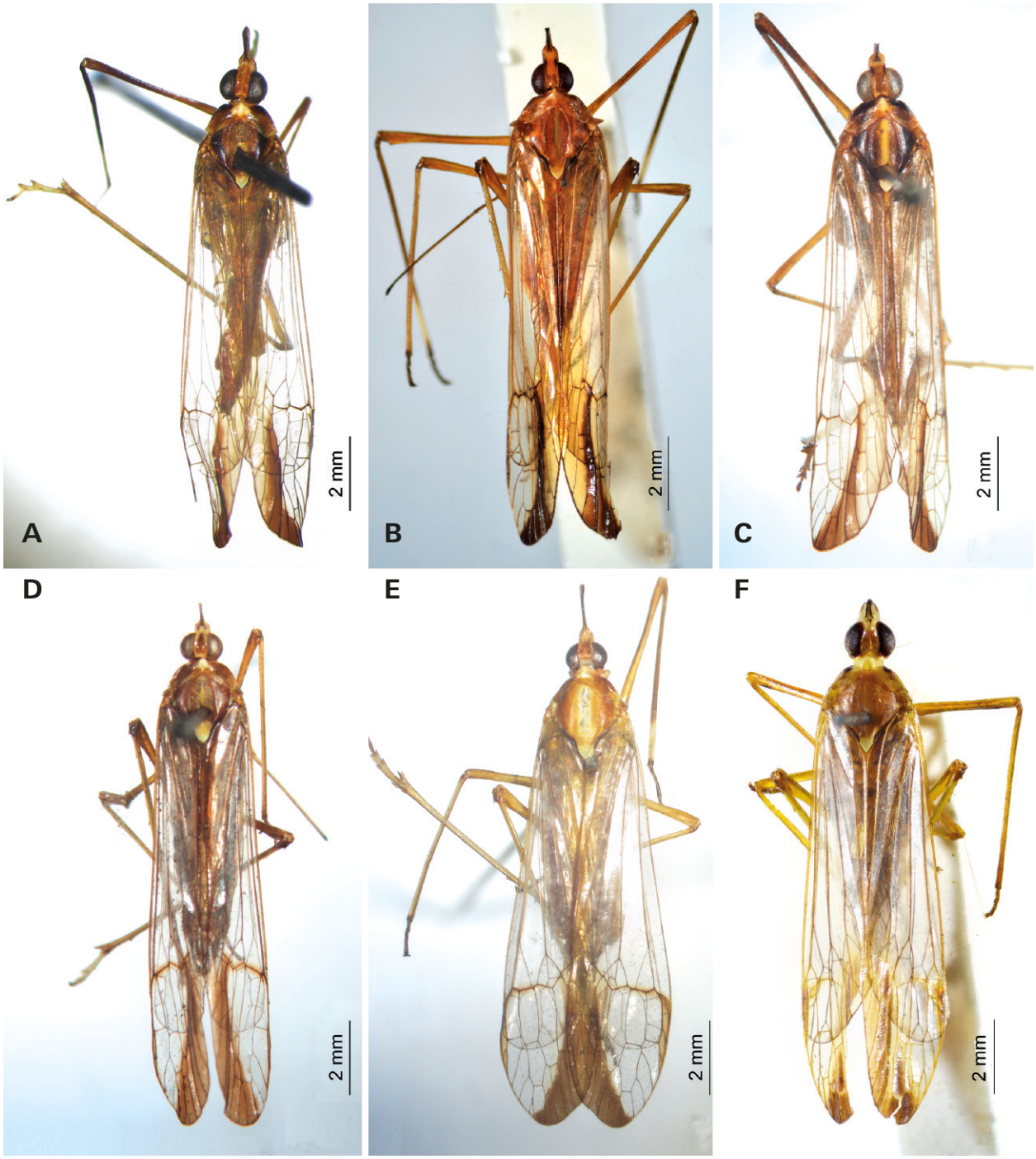

Fig. 3. *Miasa* and *Indomiasa*, dorsal habitus. **A**: *M. borneensis* **sp.n.**, male, northern Kalabakan, North Borneo, Malaysia. **B**: *M. nigromaculata* **sp.n.**, Sarawak, Malaysia. **C**: *M. producta*, male, Soekaranda, Sumatra, Indonesia. **D**: *M. smaragdilinea*, male, Soekaranda, Sumatra, Indonesia. **E**: *M. wallacei*, male, Xishuangbanna, Yunan, China. **F**: *I. distanti* **sp.n.**, male, Tenmalai, India.

2 Head produced into a robust and elongate cephalic process, little shorter to much longer than pronotum and mesonotum combined **3**

2' Head produced into a distinctly short or distinctly slender and straight cephalic process **5**

3 Fore femur flattened and dilated, with a distinct blunt spine near apex ..... ***Saigona*** Matsumura

3' Fore femur not flattened and dilated, with a small spine or not **4**

4 Cephalic process very robust, cylindrical; vertex with lateral carinae sub-parallel towards apex ..... ***Leprota*** Melichar

4' Cephalic process moderately robust, truncated cone shaped; vertex with lateral carinae convergent towards apex ..... ***Medeusa*** Emeljanov

5 Cephalic process distinctly slender and straight; forewings with crossveins forming a nodal line along Sc+R, M and CuA veins **6**

5' Cephalic process moderately robust, and distinctly shorter than pronotum and mesonotum combined;

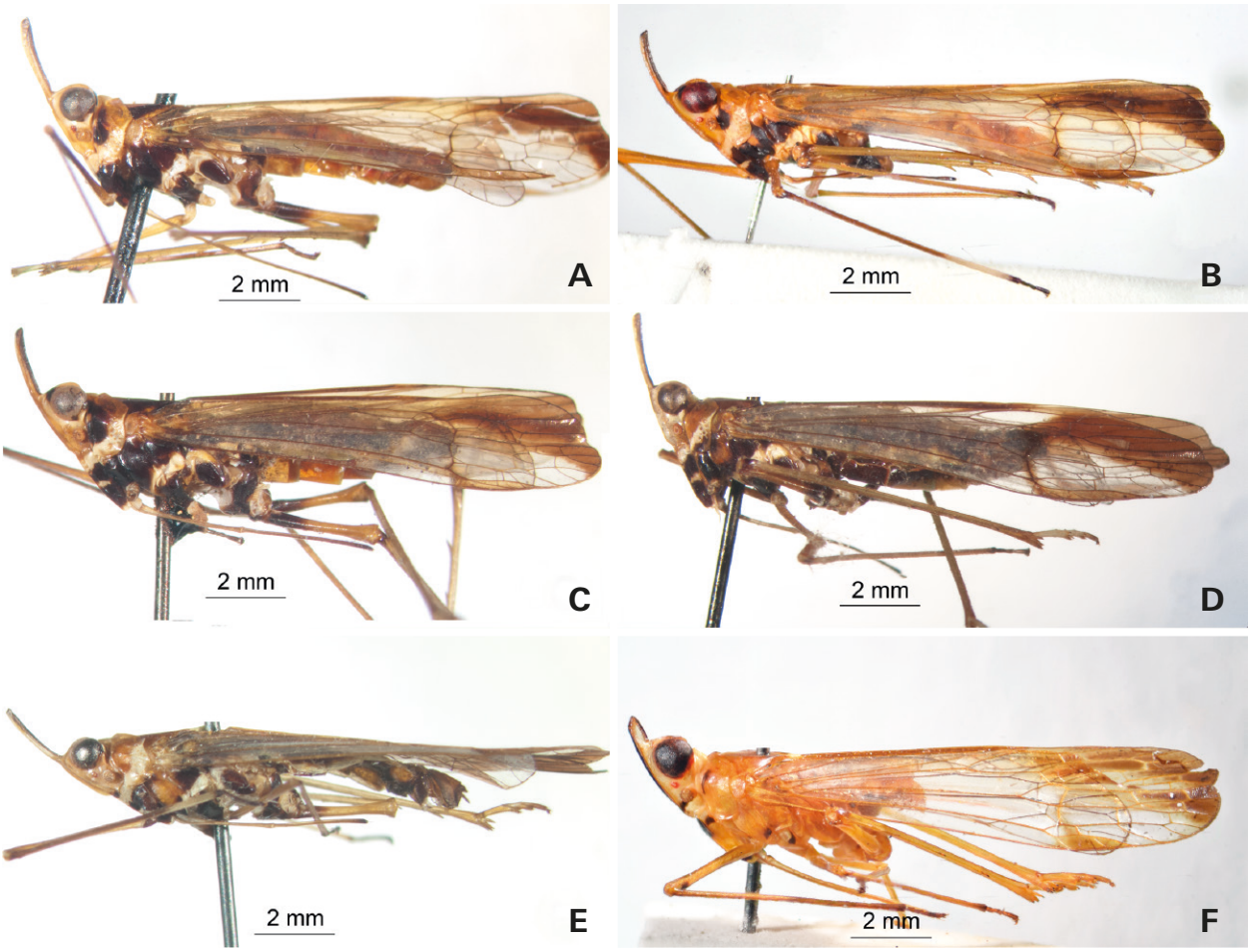

Fig. 4. *Miasa* and *Indomiasa*, lateral habitus. **A**: *M. borneensis* **sp.n. B**: *M. nigromaculata* **sp.n. C**: *M. producta*. **D**: *M. smaragdilinea*. **E**: *M. wallacei*. **F**: *I. distanti* **sp.n.**

forewings without nodal line **7**

6 Cephalic process distinctly slender and elongate; frons with median carina moderately ridged; fore femora with a distinct blunt spine near apex; hind tibiae with 6 apical teeth ..... ***Miasa*** Distant

6' Cephalic process more robust and shorter; frons with median carina robust and strongly produced; fore femora with a short small spine near apex; hind tibiae with 7 apical teeth ..... ***Indomiasa* gen.n.**

7 Forewings with a large crescent-shaped fuscous streak on posterior margin of apical part; fore femora flattened and dilated, with a distinct blunt spine near apex ..... ***Orthopagus*** Uhler

7' Forewings without above streak on posterior margin of apical part; fore femora not flattened and dilated, with a minute spine near apex or not **8**

8 Frons with median carina robust and strongly produced **9**

8' Frons with median carina moderately ridged **11**

9 Head gradually narrowed and acuminated to apex; hind tibiae with 6 apical teeth ..... ***Centromeria*** Stål

9' Head more or less truncate at apex; hind tibiae with 8 apical spines **10**

10 Frons with media carina broadly purplish-red, intermediate carinae approaching frontoclypeal suture ..... ***Truncatomeria*** Song & Liang

10' Frons with media carina virescent or ochraceous, intermediate carinae approaching posterior margin of eyes ..... ***Dictyotenguna*** Song & Liang

11 Vertex with lateral carinae before eyes gradually convergent and acuminated to apex ..... ***Tenguna*** Matsumura

11' Vertex with lateral carinae more or less truncate apically ..... ***Dictyopharina*** Melichar

3.3. *Miasa* Distant, 1906

Miasa Distant, 1906: 247; Schmidt 1906: 280; Melichar 1912: 37; Schmidt 1915: 348; Distant 1916: 28; Schmidt 1928: 129; Metcalf 1946: 34. **Type species.** *Elidiptera smaragdilinea* Walker, 1857; by original designation.

Putalamorpha Bierman, 1910: 9. **Type species.** *Stenocranus productus* Lethierry, 1888; by original designation. Synonymized by Melichar 1912: 79.

Diagnosis. Head in front of eyes distinctly upturned, produced into a laterally compressed, distinctly slender and

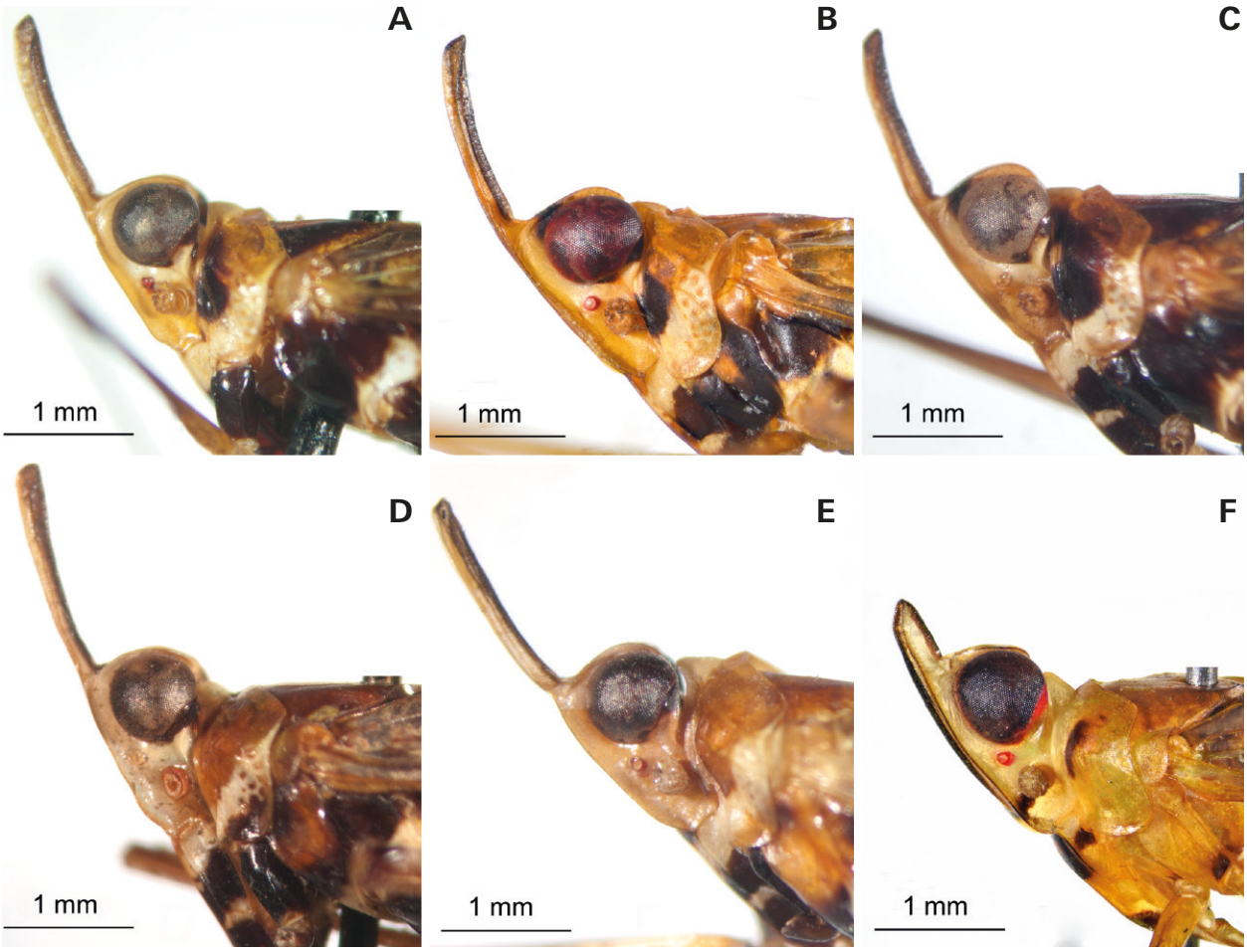

Fig. 5. *Miasa* and *Indomiasa*, head, pronotum and mesonotum, lateral view. **A**: *M. borneensis* **sp.n. B**: *M. nigromaculata* **sp.n. C**: *M. producta*. **D**: *M. smaragdilinea*. **E**: *M. wallacei* Muir, 1923. **F**: *I. distanti* **sp.n.**

straight linear process; vertex without media carina, lateral carinae parallel at base, abruptly strongly constricted and curved upwardly before eyes, very narrow and medially sulcate in remaining part; frons with lateral carinae distinctly expanded outwards below antennae, more or less convergent towards and abruptly strongly constricted before eyes, intermediate carinae beneath cephalic process very narrow and sulcate, approaching to anterior margin of eyes; rostrum very slender and long, reaching to apex of hind femora; pronotum centrally angularly convex and hood-like anteriorly, lateral anterior angles rounded, median carina sharp and high; mesonotum tricarinate with median carina generally too indistinct to be visible, lateral carinae incurved anteriorly towards median carina; forewings with dark streak on distal third of wing; crossveins very scarce, forming a nodal line along Sc+R, M and CuA veins at apical third; stigmal area clear, with 2–4 cells; fore femora with a distinct blunt spine near apex; hind tibiae with 6 black-tipped apical teeth; aedeagus with paired membranous inflated apical lobes, without spines.

Description of adults. ***Coloration***: General color in dried specimens ferruginous-brown, marked with pale green and black in dorsal habitus. Females slightly darker than males. Head with cephalic process black above, pale green or ochraceous beneath. Eyes fuscous or reddish brown. Postclypeus, anteclypeus and thorax beneath, black and white. Forewings hyaline, with venation and streak on distal third of wing dull ochraceous or fuscous. Legs ochraceous; coxae, trochanters and base of hind femora black; fore tibiae with a prominent subapical creamy-white annulation.

Head (Figs. 1, 2, 3A–E, 4A–E, 5A–E, 6A–E) produced in front of eyes and extended into a distinctly upturned and laterally compressed slender and straight linear process, which is medially sulcate above and beneath. Vertex (Figs. 2B, 3A–E) basally slightly convex medially, nearly rectangular, posterior surface in relation to pronotum elevated; lateral carinae parallel, strongly ridged at base, abruptly and strongly constricted and curved upwardly before eyes, very narrow and medially sulcate in remaining part, acuminate apically; posterior margin arcuate; median carina absent. Frons (Fig. 5A–E) elongate, anterior portion with intermediate carinae strongly narrowed and protruded anteriorly in ventral and lateral views (Figs. 5A–E, 6A–E), so apical part of frons distinctly visible in dorsal view (Figs. 2B, 3A–E); lateral carinae ridged, distinctly expanded outwards below antennae, more or less convergent towards and abruptly

Fig. 6. *Miasa* and *Indomiasa*, head and pronotum, ventral view. **A**: *M. borneensis* **sp.n. B**: *M. nigromaculata* **sp.n. C**: *M. producta*. **D**: *M. smaragdilinea*. **E**: *M. wallacei*. **F**: *I. distanti* **sp.n.**

strongly constricted before eyes; posterior margin widely concave; median carina slightly robust at basal half, more or less sharp in remainder; intermediate carinae beneath cephalic process very narrow and sulcate, and approaching to anterior margin of eyes. Postclypeus and anteclypeus (Fig. 6A–E) strongly convex at middle, with

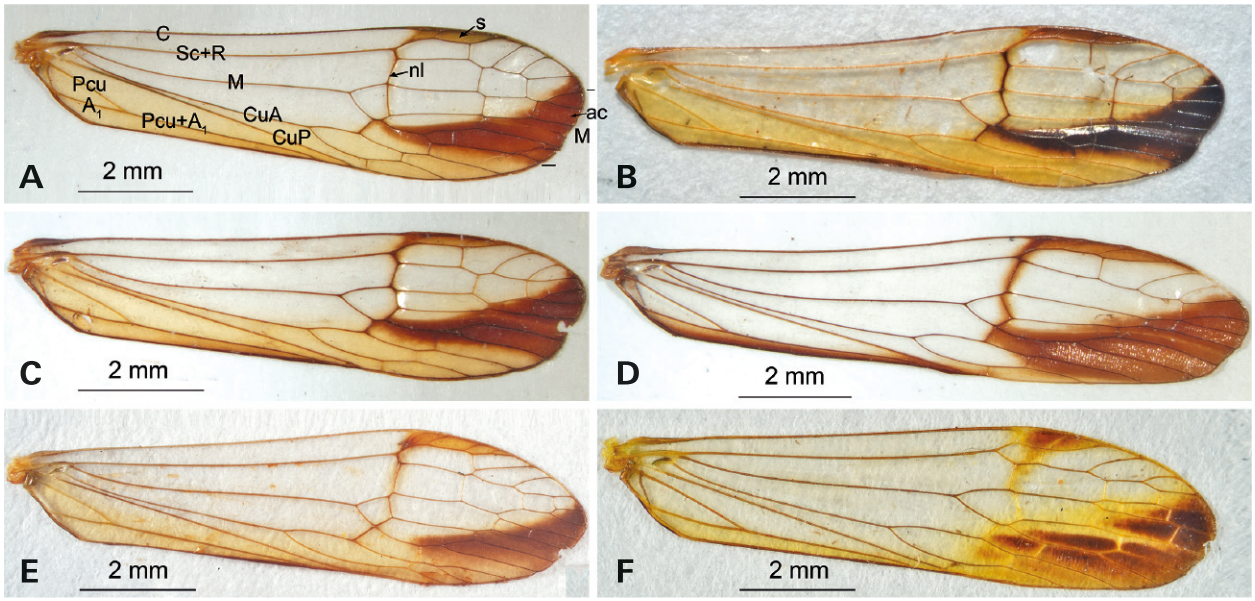

Fig. 7. *Miasa* and *Indomiasa*, forewing. **A**: *M. borneensis* **sp.n. B**: *M. nigromaculata* **sp.n. C**: *M. producta*. **D**: *M. smaragdilinea*. **E**: *M. wallacei*. **F**: *I. distanti* **sp.n.** – **Abbreviations**: ac – apical cell; nl – nodal line; s – stigmal area.

distinct median carina. Rostrum very slender and long, distal segment slightly longer than basal one, surpassing apex of hind femora. Compound eyes (Figs. 2A, 4A–E) large and round, callus postocularis forming a triangular process protruded posteriorly. Ocelli relatively large, reddish. Antennae (Fig. 5A–E) with very small scape; pedicel large and subglobose, with more than 40 distinct sensory plaque organs distributed over entire surface.

Thorax: Pronotum (Figs. 3A–E, 5A–E, 6A–E) distinctly shorter than mesonotum medially, anteriorly slightly narrower posteriorly; anterior margin centrally angularly protruded, forming a triangular central process; lateral marginal areas moderately laminate, their anterior angles rounded, with two lateral carinae on each side between eyes and tegulae; posterior margin widely concave; median carina sharp and high, with a big lateral pit on each side, intermediate carinae absent. Mesonotum (Fig. 3A–E) more or less convex, tricarinate; median carina generally too indistinct to be visible, lateral carinae incurved anteriorly towards median carina. Forewings (Fig. 7A–E) hyaline and elongate, much longer than abdomen; CuA vein first branched before Sc+R and M veins near middle; crossveins very scarce, forming a nodal line along Sc+R, M and CuA veins at apical 1/3; apical cells about 10–12; Pcu and A_1 veins fused into a long Pcu+A_1 vein at apical 1/6 in clavus; stigmal area clear, with 2–4 cells. Legs slender and elongate, fore femora elongate, with a distinct blunt spine near apex; hind femora relatively short, only about half the length of hind tibiae; hind tibiae with 5–8 black-tipped lateral spines (sometimes basal spines very small and obscure) and 6 black-tipped apical teeth; hind tarsomeres I with 7–9 and tarsomeres II with 7–9 black-tipped apical teeth, respectively.

Male genitalia with pygofer (Figs. 9A–C, 10A–C, 11A–C, 12A–C, 13A–C) distinctly longer ventrally than dorsally, dorsal margin slightly excavated to accommodate segment X (anal tube). Gonostyles symmetrical, with a rounded humped process subapically in lateral view (Figs. 9B, 10B, 11B, 12B, 13B); upper margin with an dorsally directed, black-tipped process at apex, outer upper edge with a ventrally directed, hook-like process near middle. Aedeagus (Figs. 9D–F, 10D–F, 11D–F, 12D–F, 13D–F) with a pair of sclerotized endosomal processes, abruptly curved anterolaterally at midlength, apical part gradually narrowed to acute. Phallobase basally sclerotized and pigmented, with paired membranous inflated apical lobes, without spines. Segment X (Figs. 9A–B, 10A–B, 11A–B, 12A–B, 13A–B) large and stout, expanded distally, ventral margin variably incurved; apical dorsal margin excavate in dorsal view (Fig. 9A, 10A, 11A, 12A, 13A) to accommodate anal style; anal style small.

Female genitalia with gonocoxae VIII with two endogonocoxal processes membranous and flattened on endogonocoxal lobe. Gonopophyses VIII with anterior connective lamina large and sclerotized, with seven teeth of varying sizes and shapes in lateral view (Fig. 13G). Gonopophyses IX with posterior connective lamina triangular, symmetrical, fused with the intergonocoxal plate at base. Gonoplacs with two lobes fused basally: the lateral lobe large and moderately sclerotized, with four long setae at apex; the posterior lobe membranous, in which a long sclerotized plate is visible. Segment X moderate and oval, anal style relatively big in dorsal view (Fig. 13H).

Description of fifth-instar nymphs. General habitus similar to adults, but wings undeveloped and body covered with numerous sensory pits. General color in dried specimens different to adults, ochraceous and pale ochraceous.

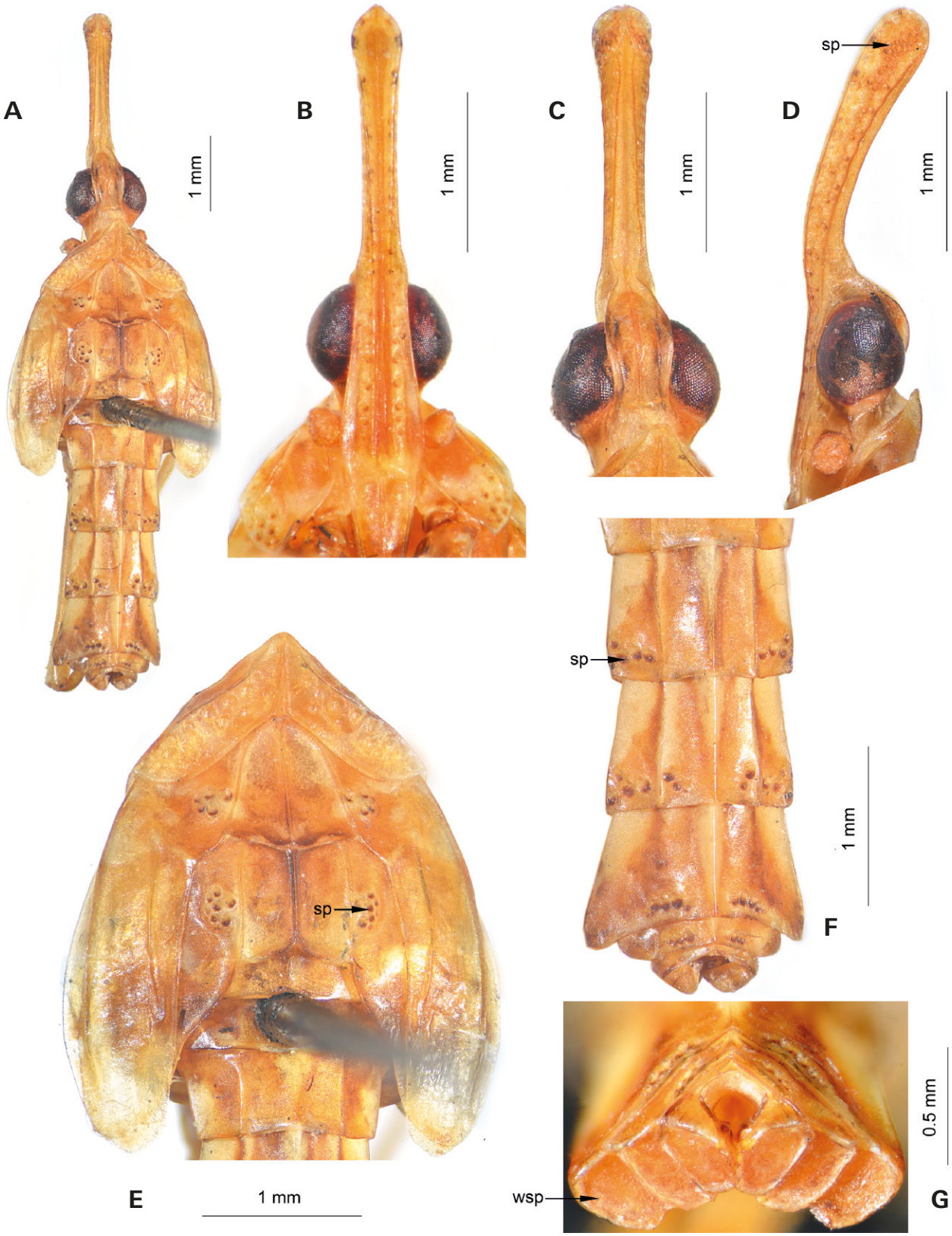

Fig. 8. Fifth-instar nymph of *Miasa smaragdilinea*. **A**: Dorsal habitus. **B**: Head and pronotum, ventral view. **C**: Head, dorsal view. **D**: Head, lateral view. **E**: Thorax, dorsal view. **F**: Abdomen, dorsal view. **G**: Abdominal tergites VI–VIII, caudal view, showing wax-secreting plates. – **Abbreviations**: sp – sensory pit; wsp – wax secreting plate.

Cephalic process (Fig. 8A–D) before eyes distinctly upturned, broader and more robust than adults, more or less compressed laterally. Vertex (Fig. 8C) basally arched, lateral margins strongly carinate, slightly convergent, abruptly constricted and curved upwardly before eyes, and medially sulcate in remainder; median

carina more or less obvious between eyes; anterior margin acuminate and posterior margin indistinct. Frons (Fig. 8B) elongate, expanded outwards below antennae, more or less convergent towards and slightly constricted before eyes; lateral areas (Fig. 8D) between lateral carinae and intermediate carinae distinctly broad, with more than 70 sensory pits from apex to base; intermediate carinae reaching to frontoclypeal suture, and median carina distinct and complete. Clypeus, rostrum and eyes (Fig. 8D) similar to adults, but ocelli absent.

Pronotum (Fig. 8E) with anterior margin centrally angularly convex, posterior margin widely concave; disc with about 18 sensory pits between median carina and upper lateral carinae, with 5–6 sensory pits between upper lateral carinae and lower lateral carinae, with 6 sensory pits on 6–7 on apical margin of ventral lobes, respectively. Mesonotum (Fig. 8E) with 5 sensory pits outside lateral carinae. Metanotum (Fig. 8E) with 7–8 sensory pits outside lateral carinae. Forewing pads (Fig. 8E) with 2 indistinct sensory pits in middle. Legs similar to adults, very elongate and slender.

Abdomen (Fig. 8F) 9-segmented, slender and elongate. Tergites II–V (Fig. 8A) with distinct median carina and intermediate carinae; tergites III–VI much longer than others; tergites IV–VII (Fig. 8F) with 0, 2, 5, and 4 sensory pits between median carina and intermediate carinae, 4, 4, 0, and 0 sensory pits between intermediate carinae and lateral carinae, and 14, 11, 5, and 0 pits on ventrolateral areas; tergites VII–IX very short and nearly covered by the former tergite, so the terminal more or less truncate; tergites VI–VII (Fig. 8G) with each pair of wax-secreting plates on posterolateral areas separated from rest of tergite by carina and directed posteriorly.

Distribution. Burma; Indonesia; Malaysia; China; Thailand; Vietnam.

Remarks. When describing the genus *Miasa*, DISTANT (1906) stated that "this genus is allied to *Dictyopharoides* Fowl., from which it may be at once separated by the non-serrate anterior femora, a character omitted in Fowler's diagnosis." Actually, *Dictyopharoides* Fowler, 1900 belongs to the tribe Nersiini Emeljanov for its forewing veins Sc+R and M with a long common stem (EMELJANOV 2011) and *Miasa* belongs in the tribe Orthopagini based on the following characters: forewings with Sc+R and M originated from basal cell without common stem; fore femora usually with a spine on ventral subapex; fore and middle tarsomeres I and II with a pair of acutellae; apical lobes of phallobase spineless or just with very short small spines; and structure of female genitalia.

Miasa can be easily distinguished from other genera in Orthopagini by the distinctly slender, straight and linear cephalic process, and forewings with a nodal line along Sc+R, M and CuA veins at apical 1/3. See also discussion under *Indomiasa* **gen.n.**

3.4. Key to the species of *Miasa* Distant

1 Frons below eyes including median carina uniformly dull ochraceous (Fig. 6A–C,E); pronotum with posterolateral corner pale yellow to ochraceous with or without dark spot behind eye (Figs. 5A–C,E, 6A–C,E); forewings posterior margin broadly dull ochraceous (Fig. 7A–C,E); aedeagus with two pairs of ventral lobes and a pair of dorsolateral lobes (Figs. 9D–F, 10D–F, 11D–F, 13D–F) **2**

1' Frons below eyes emerald green, with median carina testaceous (Fig. 6D) or if uniformly dull ochraceous medial carina darker; pronotum with lateroventral corner brown, without dark spot behind eye (Figs. 5D, 6D); forewings with inner margin of clavus narrowly dark brown (Fig. 7D); aedeagus with two pairs of ventral lobes, but without dorsolateral lobes (Fig. 12D–F); Southern Malay Peninsula, Sumatra and Java ..... ***M. smaragdilinea*** (Walker)

2 Male segment X broad basally, not hatchet-shaped in lateral view (Figs. 9B, 10B, 11B) **3**

2' Male segment X narrow basally, hatchet-shaped in lateral view (Fig. 13B); southwestern China, Southeast Asia to North Malay Peninsula ..... ***M. wallacei*** Muir

3 Preocular field with a blackish brown spot (Fig. 5B,C); male segment X with ventral margin weakly incurved in lateral view (Figs. 10B, 11B) **4**

3' Preocular field without blackish brown spot (Fig. 5A); male segment X with ventral margin distinctly incurved sub-basally in lateral view (Fig. 9B); Borneo ..... ***M. borneensis*** **sp.n.**

4 Upper process of gonostlyes distinctly broad at apex (Fig. 10B); basal ventral lobes of aedeagus distinctly short and small (Fig. 10E); male segment X with apical ventral margin distinctly produced in a long process in lateral view (Fig. 10B); Borneo ..... ***M. nigromaculata*** **sp.n.**

4' Upper process of gonostlyes not broad at apex (Fig. 11B); basal ventral lobes of aedeagus distinctly long (Fig. 11E); male segment X with ventral margin not protruded in lateral view (Fig. 11B); Sumatra and Java ..... ***M. producta*** (Lethierry)

3.5. *Miasa borneensis* sp.n.

Figs. 1A, 3A, 4A, 5A, 6A, 7A, 9

Miasa smaragdilinea (Walker): KIRKALDY 1913: 13 [error].

Material examined. Holotype ♂, **MALAYSIA, Sabah:** North Borneo (SE), Forest Camp, 19 km, N. of Kalabakan, 60 m, light trap, 29.x.1962, Y. Hirashima leg. (BPBM). — Paratypes. **MA-**

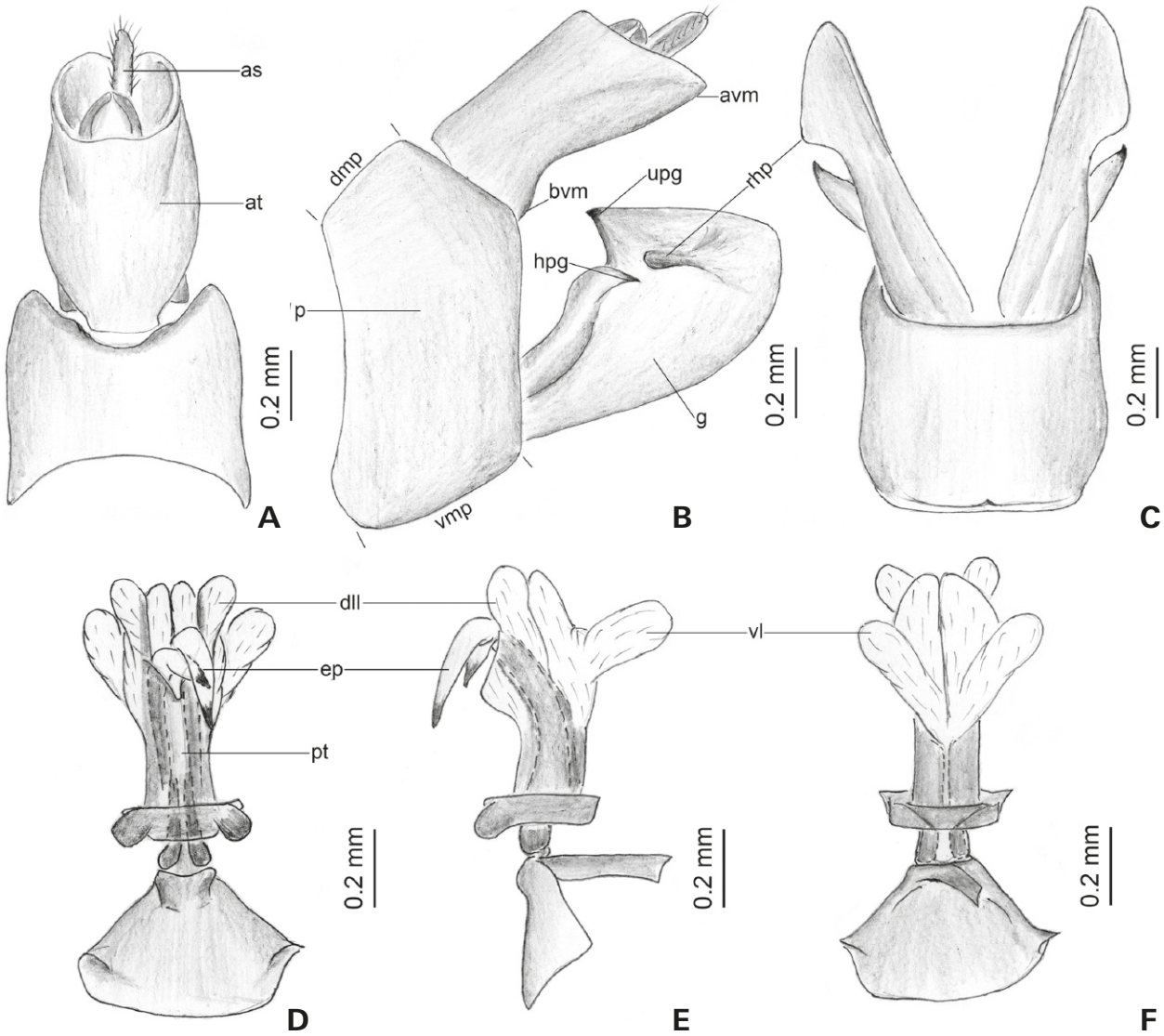

Fig. 9. *Miasa borneensis* **sp.n. A**: Male pygofer and segment X, dorsal view. **B**: Male postabdomen, lateral view. **C**: Male pygofer and gonostyles, ventral view. **D**: Aedeagus, dorsal view. **E**: Aedeagus, lateral view. **F**: Aedeagus, ventral view. – **Abbreviations**: as – anal style; at – anal tube (segment X); avm – apical ventral margin of segment X; bvm – basal ventral margin of segment X; dll – dorsolateral lobe on phallotheca; dmp – dorsal margin of pygofer in profile; ep – endosomal processes; g – gonostyle; hpg – hook-like process of gonostyle; p – pygofer; pt – phallotheca; rhp – rounded humped process of gonostyle; upg – upper process of gonostyle; vl – ventral lobe on phallotheca; vmp – ventral margin of pygofer in profile.

LAYSIA, Sabah: 1♂, North Borneo (SE), Forest Camp, 19 km, N. of Kalabakan, light trap, 27.x.1962, Y. Hirashima leg.; 1♂, Tenompok, 1460 m, Jesselton, 48 km E., 26–31.i.1959, T. C. Maa leg. (BPBM); 2♂♂, Sandakan, Baker leg. (USNM); **Sarawak:** 1♂ (MIZ 313185), 1♀ (MIZ 313186), Mt. Matang, 1012 ft., 10.xii.1909; *Miasa producta* Leth. [Schmidt's handwriting], Edm. Schmidt, determ. 1926 (MIZPAS); 2♂♂, Kuching, 21.ii.1899, 2. xi.1899 (BMNH); **'BORNEO':** 1♀ (abdomen missing), S.O. Borneo, Wahnes, V. Wolf. v. Schönberg leg.; *Miasa smaragdilinea* Walk.; 1♂, Mindai, 6.82 (MFNB).

Etymology. The species is named for its occurrence in Borneo.

Description. BL: ♂ 11.6–12.4 mm, ♀ 13.1 mm; HL: ♂ (1.6+1.0)–(1.8+1.0) mm, ♀ (1.6+1.0) mm; HW: ♂ 1.3 mm, ♀ 1.2 mm; VW: ♂ 0.3–0.4 mm, ♀ 0.4 mm; FWL: ♂ 9.1–9.9 mm, ♀ 10.0 mm.

General color ferruginous marked with pale green and blackish brown in dorsal habitus. Vertex between eyes and genae pale green or ochraceous, preocular field without blackish brown spot, frons below eyes including median carina and basal postclypeus uniformly dull ochraceous. Anterolateral marginal areas of pronotum behind eyes and lateral areas of mesonotum glossy blackish brown, sometimes just dull ochraceous on mesonotum (see Remarks); median carina, apical marginal areas of ventral lobes and posterior lateral angles of pronotum, and a broad median fascia to mesonotum pale green or pale ochraceous. Forewings with stigmal area and posterior margin broadly dull ochraceous, a large oblique triangular apical streak and a narrow streak along nodal line

fuscous; hind wings with an apical fuscous spot. Abdomen above and beneath testaceous mixed with fuscous, a broad central stripe and a lateral stripe on each side above pale green or ochraceous.

Cephalic process (Fig. 5A) in front of eyes relatively long, with the ratio of its length to basal length of vertex (from curved part to base of vertex) about (1.9–2.0) : 1. Frons (Fig. 6A) elongate. Forewings (Fig. 7A) with ratio of length to width about 3.7 : 1. Hind tibiae with 5–7 (mainly 6) lateral spines; hind tarsomeres I with 6–7 and tarsomeres II with 6–8 black-tipped apical teeth, respectively.

Male genitalia with pygofer (Fig. 9A–C) ventral to dorsal length (about 1.9 : 1); posterior margin dorsally more or less protruded in lateral view (Fig. 9B). Gonostyles relatively large, more or less expanded towards apex, broadest subapically in lateral view (Fig. 9B), apex rounded; upper process elongate, acute apically. Aedeagus (Fig. 9D–F) relatively small, with a pair of long endosomal processes extended posteriorly and curved dorsally; phallobase sclerotized and pigmented at lateral sides, membranous and moderately inflated dorsally and ventrally, with a pair of dorsolateral lobes directed posteriorly, and two pairs of ventral lobes, directed posteriorly and ventrally, respectively.

Segment X in lateral view with base ventral margin protruded ventrally at base and concaved in middle, so base is slightly narrower than apex and looks like broad in lateral view (Fig. 9B), with ratio of length to width near middle about 1.7 : 1 in dorsal view (Fig. 9A).

Distribution. Malaysia (Borneo).

Remarks. The new species is very similar to *M. producta*, but it can be distinguished from the latter by the preocular field usually without blackish brown spot, and male segment X with ventral margin strongly incurved sub-basally in profile. *M. smaragdilinea* described by Kirkaldy (1913) and two *M. producta* specimens mentioned by Schmidt (1928) from Borneo should belong to the new species.

Specimens from northwestern Borneo lack the blackish brown spots on the lateral areas of mesonotum having this area just dull ochraceous. However, there is no obvious difference of male genitalia between them.

3.6. *Miasa nigromaculata* sp.n.

Figs. 2, 3B, 4B, 5B, 6B, 7B, 10

Material examined. Holotype ♂, **MALAYSIA, Sarawak:** Gunong Mulu National Park, v–viii.1978, P.M. Hammond & J.E. Marshall leg., R.G.S. Expedition 1977–8, B.M. 1978–49 (BMNH). — Paratypes. **MALAYSIA, Sarawak:** 1♂, Gunong Mulu National Park, Long Pala base camp, ii–vii.1978, V.F. Eastop, R.G.S. Expedition 1977–8, B.M. 1978–411; 1♀, Gunong Mulu National Park, near base camp, 50–100m., v–viii.1978, P.M. Hammond & J.E. Marshall leg., R.G.S. Expedition 1977–8, B.M. 1978–49; 1♂, Baram, 18.vii.1920, J.C. Moulton leg.; **Sabah:** 1♂, 1♀, Jesselton, 4000', 9.iii.1968, P.J.L. Roche leg. (BMNH).

Etymology. This new species name is derived from the Latin combination of the prefix "nigro-" plus "maculate", referring to its black macula on the forewings.

Description. BL: ♂ 12.3–12.6 mm, ♀ 13.3 mm; HL: ♂ (1.5+0.9)–(1.8+1.0) mm, ♀ (1.8+1.0) mm; HW: ♂ 1.1–1.2 mm, ♀ 1.2 mm; VW: ♂ 0.3–0.4 mm, ♀ 0.4 mm; FWL: ♂ 9.9–10.4 mm, ♀ 10.9 mm.

General color similar to *M. producta*, ferruginous marked with pale green and blackish brown in dorsal habitus. Vertex between eyes and genae pale green or ochraceous, preocular field with blackish brown spot, frons below eyes including median carina and basal postclypeus uniformly dull ochraceous. Anterolateral marginal areas of pronotum behind eyes glossy blackish brown with spot just below lower lateral carina, lateral areas of mesonotum usually dull ochraceous; median carina, apical marginal areas of ventral lobes and posterior lateral angles of pronotum, and a broad median fascia to mesonotum pale green or pale ochraceous. Forewings with stigmal area and posterior margin broadly dull ochraceous, a large oblique triangular apical streak and a narrow streak along nodal line fuscous; hind wings with an apical fuscous spot. Abdomen above and beneath testaceous mixed with fuscous, a broad central stripe and a lateral stripe on each side above pale green or ochraceous.

Cephalic process (Fig. 5B) in front of eyes relatively long, with the ratio of its length to basal length of vertex (from curved part to base of vertex) about (1.9–2.0) : 1. Frons (Fig. 6B) elongate. Forewings (Fig. 7B) with ratio of length to width about 3.7 : 1. Hind tibiae with 6–8 lateral spines; hind tarsomeres I with 6–7 and tarsomeres II with 6–7 black-tipped apical teeth, respectively.

Male genitalia with pygofer (Fig. 10A–C) ventral to dorsal length (about 1.6 : 1); posterior margin more or less protruded dorsally in lateral view (Fig. 10B). Gonostyles relatively large, more or less expanded towards apex, broadest subapically in lateral view (Fig. 10B), apex rounded; upper process elongate and broad, acute apically. Aedeagus (Fig. 10D–F) relatively large, with a pair of long endosomal processes extended posteriorly and curved dorsally; phallobase sclerotized and pigmented at lateral sides, membranous and moderately inflated dorsally and ventrally, with a pair of dorsolateral lobes directed posteriorly, and two pairs of ventral lobes: apical paired large and elongate, directed posteriorly, and basal paired distinctly small, directed ventrally.

Segment X elongate in dorsal view (Fig. 10A), basal ventral margin protruded ventrally, so base is slightly narrower than apex and looks like broad in lateral view (Fig. 10B), and apical ventral margin distinctly produced in a long process, with ratio of length to width near middle about 2.1 : 1 in dorsal view (Fig. 10A).

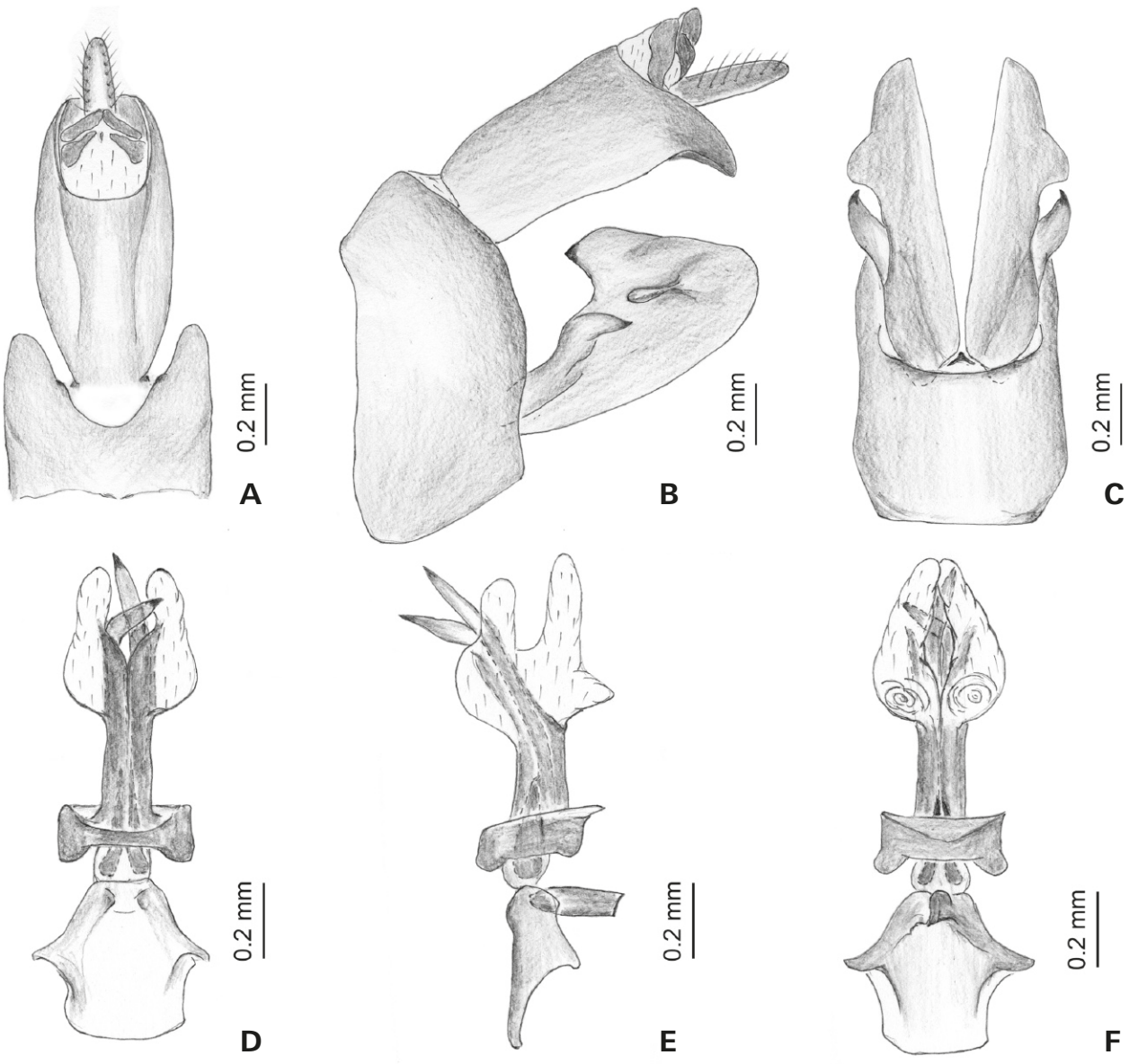

Fig. 10. *Miasa nigromaculata* **sp.n. A**: Male pygofer and segment X, dorsal view. **B**: Male postabdomen, lateral view. **C**: Male pygofer and gonostyles, ventral view. **D**: Aedeagus, dorsal view. **E**: Aedeagus, lateral view. **F**: Aedeagus, ventral view.

Distribution. Malaysia (Borneo).

Remarks. The new species is similar to *M. producta* in having a preocular spot but can be distinguished from the latter by the smaller spot just below the lateral carina of the pronotum, the upper process of gonostlyes distinctly broad at apex, the basal ventral lobes of aedeagus distinctly short and small and the male segment X with apical ventral margin distinctly produced in a long process in profile.

3.7. *Miasa producta* (Lethierry, 1888)

Figs. 3C, 4C, 5C, 6C, 7C, 11

Stenocranus productus Lethierry, 1888: 468.

Miasa smaragdilinea [nec Walker]: Schmidt, 1906: 280; Melichar 1912: 38.

Putalamorpha producta (Lethierry): Bierman 1910: 10.

Miasa producta (Lethierry): Schmidt 1928: 129; Metcalf 1946: 35.

Material examined. INDONESIA, **Sumatra:** 1♀, Soekaranda, H. Dohrn leg.; *Miasa smaragdilinea* [Schmidt's handwriting], Edm. Schmidt, determ. 1906 (MFNB); 2♂♂ (MIZ 313169–313170), 3♀♀ (MIZ 313171–313173), Soekaranda, i.1894, Dohrn leg.; *Miasa producta* Leth. [Schmidt's handwriting], Edm. Schmidt, determ. 1926; 1♂ (MIZ 313174), Liangagas, H. Dohrn leg.; *Miasa producta* Leth. [Schmidt's handwriting], Edm. Schmidt, determ. 1926; 3♂♂ (MIZ 313175–313177), 6♀♀ (MIZ 313178–313183), Soekaranda, H. Dohrn leg.; *Miasa producta* Leth. [Schmidt's handwriting], Edm. Schmidt, determ. 1926 ♀ (Mus. Zool. Polonicum, Warszawa, 12/45; MIZPAS); 2♀♀, Soekaranda, H. Dohrn leg.; *Miasa smaragdilinea* [Schmidt's handwriting], Edm. Schmidt,

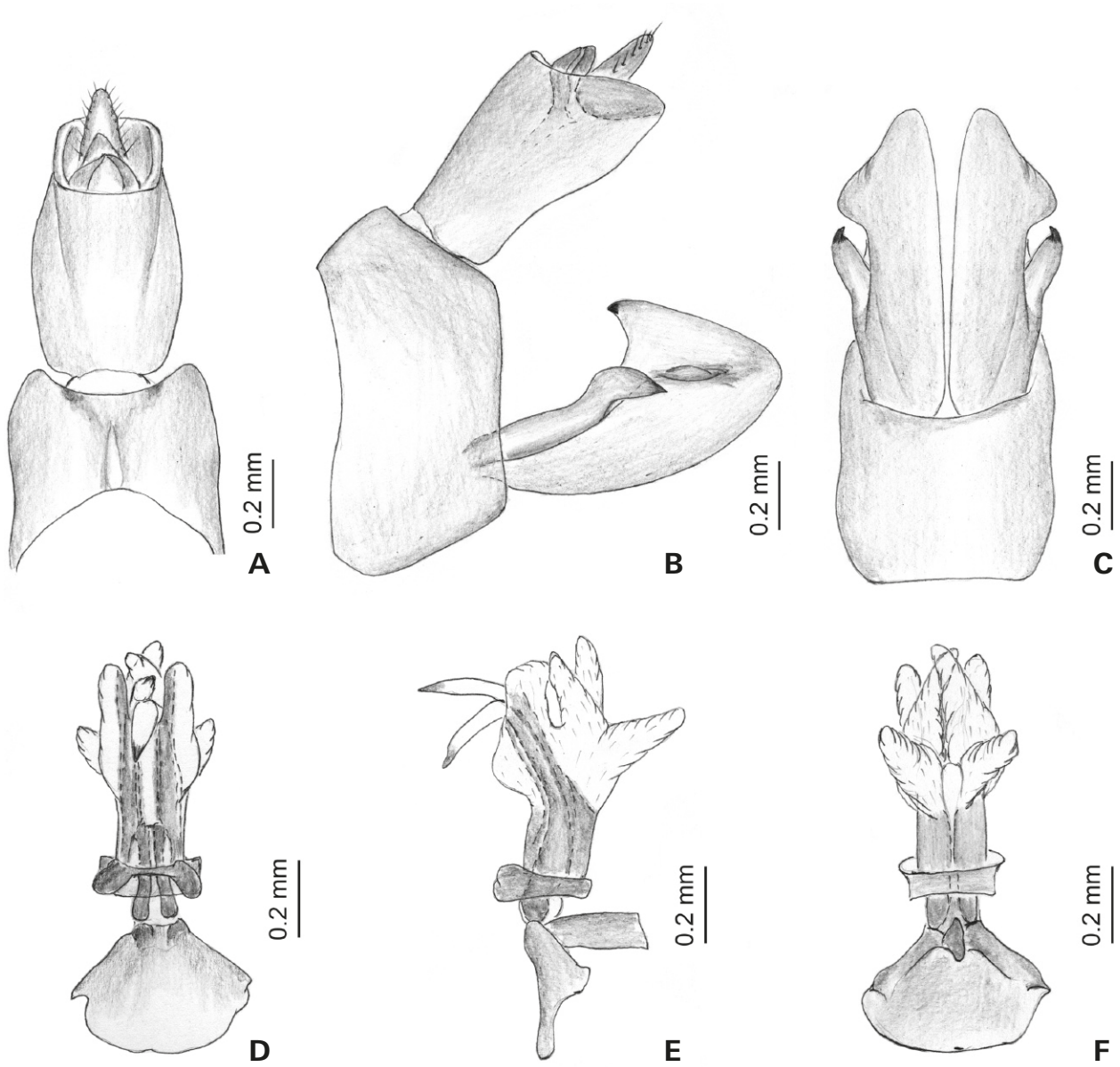

Fig. 11. *Miasa producta*. **A**: Male pygofer and segment X, dorsal view. **B**: Male postabdomen, lateral view. **C**: Male pygofer and gonostyles, ventral view. **D**: Aedeagus, dorsal view. **E**: Aedeagus, lateral view. **F**: Aedeagus, ventral view.

determ. 1906 (MMBC); 2♀♀, Soekaranda, H. Dohrn leg.; *Miasa smaragdilinea* [Schmidt's handwriting], Edm. Schmidt, determ. 1906 (SDEI); **Java:** 1♀ (MIZ 313184), K. Fruhstorfer leg.; *Miasa producta* Leth. [Schmidt's handwriting], Edm. Schmidt, determ. 1926 (Mus. Zool. Polonicum, Warszawa, 12/45; MIZPAS); 4♀♀, Tjimerang, Djampang, iii.1939, M. E. Walsh leg. (MZLU).

Redescription of adults. BL: ♂ 11.6–11.9 mm, ♀ 12.9–13.1 mm; HL: ♂ (1.4+0.9)–(1.6+1.1) mm, ♀ (1.6+1.0)–(1.7+1.1) mm; HW: ♂ 1.1–1.2 mm, ♀ 1.2–1.3 mm; VW: ♂ 0.3–0.4 mm, ♀ 0.4–0.5 mm; FWL: ♂ 9.0–9.2 mm, ♀ 9.9–10.1 mm.

Color as in *M. nigromaculata* (see also SCHMIDT 1906). Cephalic process (Fig. 5C) in front of eyes relatively short, with the ratio of its length to basal length of vertex (from curved part to base of vertex) about (1.8–1.9) : 1. Frons (Fig. 6C) elongate. Forewings (Fig. 7C) with ratio of length to width about 3.9 : 1. Hind tibiae with 5–7 (mainly 6) lateral spines; hind tarsomeres I with 7–9 and tarsomeres II with 7–9 black-tipped apical teeth, respectively.

Male genitalia with pygofer (Fig. 11A–C) ventral to dorsal length (about 1.9 : 1); posterior margin more or less protruded dorsally in lateral view (Fig. 11B). Gonostyles relatively large, more or less expanded towards apex, broadest subapically in lateral view (Fig. 11B), apex rounded; upper process elongate, acute apically. Aedeagus (Fig. 11D–F) relatively small, with a pair of long endosomal processes extended posteriorly and curved dorsally; phallobase sclerotized and pigmented at lateral sides, membranous and moderately inflated dorsally and ventrally, with a pair of dorsolateral lobes directed posteriorly, and two pairs of ventral lobes, directed posteriorly and ventrally, respectively.

Segment X large and stout, basal ventral margin protruded ventrally, so base is slightly narrower than apex

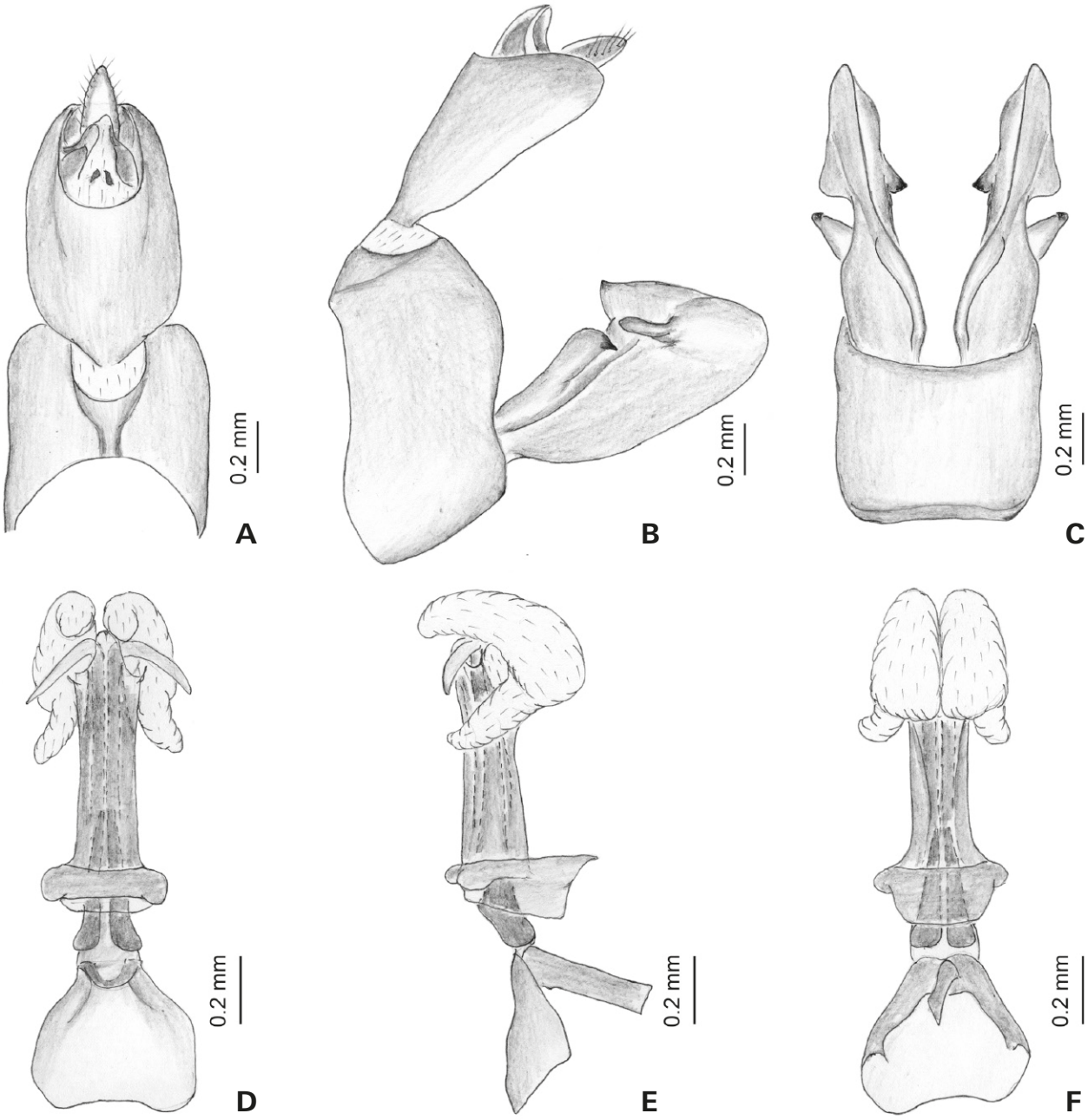

Fig. 12. *Miasa smaragdilinea*. **A**: Male pygofer and segment X, dorsal view. **B**: Male postabdomen, lateral view. **C**: Male pygofer and gonostyles, ventral view. **D**: Aedeagus, dorsal view. **E**: Aedeagus, lateral view. **F**: Aedeagus, ventral view.

and looks like broad in lateral view (Fig. 11B), with ratio of length to width near middle about 1.7 : 1 in dorsal view (Fig. 11A).

Distribution. Indonesia (Sumatra, Java).

Remarks. The species is very similar to *M. nigromaculatus* both species having a preocular spot (see Remarks under *nigromaculatus*). It can be easily distinguished from other *Miasa* species by the relatively short cephalic process and shape of the male segment X.

3.8. *Miasa smaragdilinea* (Walker, 1857)

Figs. 3D, 4D, 5D, 6D, 7D, 12

Elidiptera smaragdilinea Walker, 1857: 86.
Dictyophora [sic] *smaragdilinea* (Walker): Walker 1858: 318.
Helicoptera (?) *smaragdilinea* (Walker): Atkinson 1886: 37.
Miasa smaragdilinea (Walker): Distant 1906: 248; Schmidt 1906: 280 [error]; Melichar 1912: 38 [error]; Kirkaldy 1913: 13; Schmidt 1915: 34; Distant 1916: 28; Muir 1923: 561; Schmidt 1928: 129; Metcalf 1946: 36.

Miasa rubrovittata Schmidt, 1906: 284. Synonymised by Distant, 1916: 28.

Miasa rubrovittata (Schmidt): Melichar 1912: 38; Schmidt 1915: 34; Distant 1916: 28; Baker 1927: 32; Schmidt 1928: 129; Metcalf 1946: 35.

Type material examined. Syntype ♂ of *Elidiptera smaragdilinea* Walker, **MALAYSIA, Malay Peninsula:** Mt Ophir, Wallace (BMNH). — Holotype ♂ of *Miasa rubrovittata* Schmidt, 1906 (MIZ 313187), **INDONESIA**, **Sumatra:** Soekaranda, H. Dohrn leg., i.1894; Type [red label]; *Miasa rubrovittata* Schmidt [Schmidt's handwriting], Edm. Schmidt, determ. 1906 (Mus. Zool. Polonicum, Warszawa, 12/45; MIZPAS). — Allotype ♀ of *Miasa rubrovittata* Schmidt, 1906 (MIZ 313188), **INDONESIA**, **Sumatra:** Soekaranda, H. Dohrn leg. i.1894; Type [red label]; *Miasa rubrovittata* Schmidt [Schmidt's handwriting], Edm. Schmidt, determ. 1906 (Mus. Zool. Polonicum, Warszawa, 12/45; MIZPAS). — Paratypes of *Miasa rubrovittata* Schmidt, 1906: 3 males (MIZ 313189–313191), **INDONESIA**, **Sumatra:** Soekaranda, H. Dohrn leg. i.1894; Cotype [yellow label]; *Miasa rubrovittata* Schmidt [Schmidt's handwriting], ♂, Edm. Schmidt, determ. 1906; 3♂♂ (MIZ 313192, 313195), 4♀♀ (MIZ 313193, 313194, 313196, 313197) and 2 fifth instar nymphs (MIZ 313198, 313199), Soekaranda, H. Dohrn leg.; Cotype [yellow label]; *Miasa rubrovittata* [Schmidt's handwriting], Edm. Schmidt, determ. 1906 (Mus. Zool. Polonicum, Warszawa, 12/45; all MIZPAS); 1♀, Soekaranda, H. Dohrn leg.; *Miasa rubrovittata* [Schmidt's handwriting], Edm. Schmidt, determ. 1906; Type (MFNB). 1♀ (MIZ 313200); 1♂, 1♀, Soekaranda, H. Dohrn leg.; type [red label]; *Miasa rubrovittata* [Schmidt's handwriting], Edm. Schmidt, determ. 1906 (MMBC); 1♂, 1♀, Soekaranda, H. Dohrn leg.; type [red label]; *Miasa rubrovittata* [Schmidt's handwriting], Edm. Schmidt, determ. 1906 (SNSD); 1♀, Soekaranda, i.1894, H. Dohrn leg.; type [red label]; *Miasa rubrovittata* [Schmidt's handwriting], Edm. Schmidt, determ. 1906 (SDEI); **Java:** K. Fruhstorfer leg.; Cotype [yellow label]; *Miasa rubrovittata* Schmidt [Schmidt's handwriting], Edm. Schmidt, determ. 1906 (Mus. Zool. Polonicum, Warszawa, 12/45; MIZPAS).

Other material examined. MALAYSIA, Malay Peninsula: 1♀, Perak, Larut Hills, 500–2000', 22.vi.1938; 1♀, Perak, Batang Padang, Jor camp, 11.iii.1925, H.M. Pendlebury leg.; 1♂, 1♀, Selangor, 29.xii.1939 (BMNH). **INDONESIA**, **Sumatra:** 1♀, Ober Langkat, Deli, 1894, M. Ude. leg. (MFNB); **Mentawai Islands:** 1♀, Sipora I., 27.x.1924; 1♂, 4♀♀, Siberut I leg. (BMNH). 2♂♂, 1♀, Soekaranda, H. Dohrn leg.; *Miasa rubrovittata* [Schmidt's handwriting], Edm. Schmidt, determ. 1906 (SNSD).

Redescription of adults. BL: ♂ 14.7–15.1 mm, ♀ 15.7–15.9 mm; HL: ♂ (2.0+1.0)–(2.0+1.1) mm, ♀ (2.0+1.0)–(2.1+1.1) mm; HW: ♂ 1.3–1.4 mm, ♀ 1.2–1.3 mm; VW: ♂ 0.4 mm, ♀ 0.4–0.5 mm; FWL: ♂ 11.3–11.5 mm, ♀ 12.3–12.4 mm.

Frons below eyes emerald green with median carina broadly testaceous or dull ochraceous with median carina darker. Forewings with posterior margin of clavus, a long and broad stripe along the terminal part of posterior margin and a narrow streak along nodal line, fuscous. Cephalic process (Fig. 5D) in front of eyes relatively long, with the ratio of its length to basal length of vertex (from curved part to base of vertex) about 2.0 : 1. Frons (Fig. 6D) relatively short and broad. Forewings (Fig. 7D) elongate, with ratio of length to width about 4.3 : 1. Hind tibiae with 6–8 (mainly 7) lateral spines; hind tarsomeres I with 8–9 and tarsomeres II with 8–9 black-tipped apical teeth, respectively.

Male genitalia with pygofer (Fig. 12A–C) distinctly longer ventrally than dorsally (about 2.6 : 1); posterior margin distinctly protruded dorsally in lateral view (Fig. 12B). Gonostyles relatively large, more or less expanded towards apex, broadest subapically in lateral view (Fig. 12B), apex rounded; upper process elongate, acute apically. Aedeagus (Fig. 12D–F) distinctly elongate, with a pair of long endosomal processes extended posteriorly and curved laterally; phallobase elongate, sclerotized and pigmented at lateral sides, membranous and moderately inflated dorsally and ventrally, with two pairs of ventral lobes: upper pair robust, directed dorsally; lower pair relatively small, directed anterolaterally.

Segment X with basal ventral margin not protruded, gradually widening towards apex with base much narrower than apex in lateral view (Fig. 12B), with ratio of length to width near middle about 1.7 : 1 in dorsal view (Fig. 12A).

Description of fifth-instar nymphs. Body length (from apex of cephalic process to tip of abdomen: 8.6–9.1 mm; HL: (1.7+0.9)–(1.8+1.0) mm; HW: male 1.0–1.1 mm; VW: 0.4 mm.

Distribution. Indonesia (Sumatra, Java, Sipora, Siberut, and North Pagi), Malaysia (Malay Peninsula), Singapore.

Remarks. This species was originally described by Walker (1857) from an unknown number of specimens from 'Mt Ophir' collected by 'Wallace'. A single specimen (syntype) is present in the BMNH bearing this data and the registration number 68.4 referring to an entry in the museums register for 1868.4. The species can be easily distinguished from other *Miasa* species by the relatively larger body size, the emerald green frons with broadly testaceous median carina, the longer forewings with a broader stripe along the terminal part of posterior margin and the shape of the male genitalia.

3.9. *Miasa wallacei* Muir, 1923

Figs. 3E, 4E, 5E, 6E, 7E, 13

Miasa wallacei Muir, 1923: 561.

? *Miasa smaragdilinea* (Muir): Distant 1906: 248, fig. 108.

Miasa wallacei (Muir): Metcalf 1946: 36.

Type material examined. Holotype ♂, **THAILAND:** S. Thailand, Biserat, 24.x.1901 (BMNH).

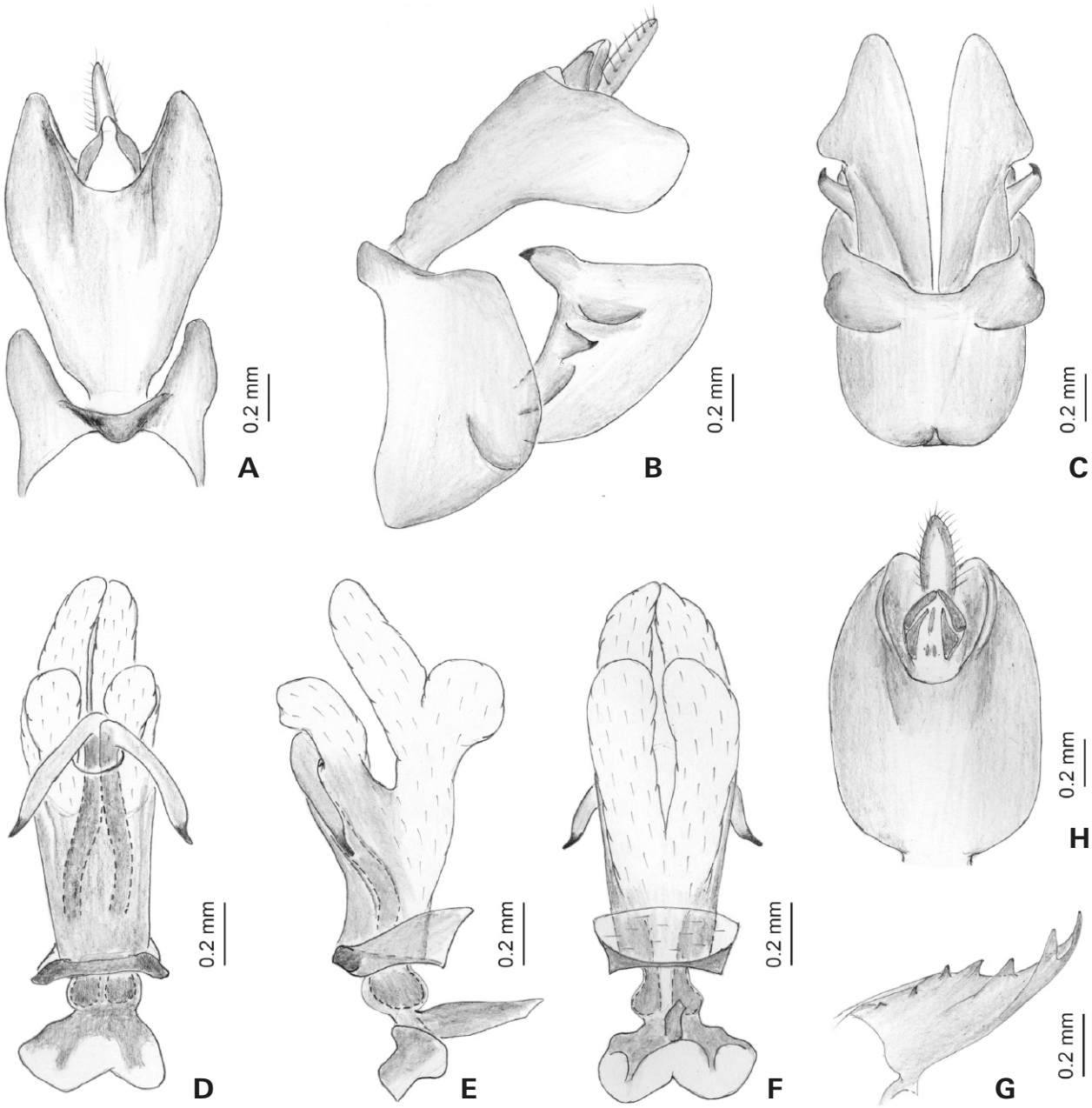

Fig. 13. *Miasa wallacei*. **A**: Male pygofer and segment X, dorsal view. **B**: Male postabdomen, lateral view. **C**: Male pygofer and gonostyles, ventral view. **D**: Aedeagus, dorsal view. **E**: Aedeagus, lateral view. **F**: Aedeagus, ventral view. **G**: Anterior connective lamina of female gonopophyses VIII. **H**: Female segment X, dorsal view.

Other material examined. CHINA, Yunnan: 3♂♂, 3♀♀, Xishuangbanna, Mengzhe, 870 m, 6.ix.1958, S.Y. Wang leg.; 1♂, Xishuangbanna, Xiaomengyang, 850 m, 4.ix.1957, S.Y. Wang leg.; 1♀, Mengla, 20.ix.1979, Y. Shang & G.Q. Liu leg.; 1 ♂, Mengla, 25.ix.1979, S.L. Liu leg.; 1 ♂, 1♀, Xishuangbanna, Menglun, 650 m, 25.vii.1959, S.F. Li leg. (IZCAS); **VIETNAM:** 1 ♂, Dilinh (Djiring), 27.ix–14.x.1960, C.M. Yoshimoto leg.; 1 ♂, Fyan, 900–1000 m, 11.vii–9.viii.1961, N.R. Spencer leg.; 1♀, Ap. Hung-Lam, 21 km, NW of Dilinh, 1100 m, 29.ix–5.x.1960, C.M. Yoshimoto leg. (BPBM); **BURMA:** 2♂♂, 1♀, Mergue, Distant leg.; **MALAYSIA, Malay Peninsula:** 8♂♂, 8♀♀, Pahang, various localities and dates; 1♂, 3♀♀, Selangor, various dates; **THAILAND:** 4♂♂, 3♀♀, same data as holotype (BMNH).

Redescription of adults. BL: ♂ 13.3–13.8 mm, ♀ 14.5–14.8 mm; HL: ♂ (1.8+0.9)–(1.8+1.0) mm, ♀ (1.8+1.0)–(2.0+1.0) mm; HW: ♂ 1.1–1.2 mm, ♀ 1.2–1.3 mm; VW: males 0.3–0.4 mm, ♀ 0.4–0.5 mm; FWL: ♂ 10.2–10.4 mm, ♀ 10.7–11.0 mm.

General color similar to *M. smaragdilinea*, ferruginous brown marked with pale green in dorsal habitus. Vertex between eyes, preocular field and genae pale green or ochraceous, frons below eyes including median carina uniformly dull ochraceous, base of postclypeus glossy blackish brown. Anterolateral marginal areas of pronotum behind eyes ferruginous brown or blackish brown, lateral areas of mesonotum ferruginous brown; median carina, apical marginal areas of ventral lobes and

posterior lateral angles of pronotum, and a broad median fascia to mesonotum pale green or pale ochraceous. Forewings and hindwings similar to *M. producta*. Abdomen above and beneath testaceous mixed with fuscous, a broad central stripe and a lateral stripe on each side above pale green or ochraceous.

Cephalic process (Fig. 5E) in front of eyes relatively short, with the ratio of its length to basal length of vertex (from curved part to base of vertex) about (2.3–2.4) : 1. Forewings (Fig. 7E) with ratio of length to width about 3.6 : 1. Hind tibiae with 5–6 (mainly 5) lateral spines; hind tarsomeres I with 8–9 and tarsomeres II with 8–9 black-tipped apical teeth, respectively.

Male genitalia with pygofer (Fig. 13A–C) much longer ventrally than dorsally (about 4.6 : 1); posterior margin distinctly protruded dorsally in lateral view (Fig. 13B); a pair of large rounded humped process on ventrolateral area (Fig. 13B,C). Gonostyles relatively large, more or less expanded towards apex, broadest subapically in lateral view (Fig. 13B), apex straight; upper process more elongate, acute apically. Aedeagus (Fig. 13D–F) relatively large, with a pair of long endosomal processes extended posteriorly and curved anteriorly; phallobase sclerotized and pigmented at lateral sides, membranous and moderately inflated dorsally and ventrally, with a pair of dorsal lobes directed posteriorly, and two pairs of ventral lobes: upper pair large and elongate, directed dorsally; lower pair relatively small and rounded.

Segment X steeply tectiform, with sides very long on apical half, ratio of length to width near middle about 1.4 : 1 in dorsal view (Fig. 13A); basal ventral margin not protruded, rapidly widening to apex beyond middle, so in lateral view (Fig. 13B) somewhat hatchet-shape, base much narrower than apex.

Distribution. China, Vietnam, Burma, Thailand.

Remarks. This species was originally described from a single male specimen from ‘Biserat, Siam, Malay States’. The male specimen bearing this data and labeled ‘holotype’ is presumed to be the type, there being four other males and three females with the same data present in the BMNH collection (see Material examined). The species can be easily separated from other *Miasa* species by the hatchet-shaped male segment X in lateral view (Fig. 13B), and also by the postclypeus basally being glossy blackish brown (Fig. 6E) and the male pygofer with a pair of large rounded humped processes on ventrolateral area (Fig. 13B–C).

As in *M. borneensis*, some variation of color pattern occurs in *M. wallacei.* The large glossy blackish brown spot on the pronotum behind the eye of the holotype and some other specimens is paler in some other topotypical specimens and the area is just ferruginous brown in specimens from Burma (3 specimens), Yunnan, China (13 specimens) and Vietnam (3 specimens). However, as all specimens have similar male genitalia they are considered conspecific.

The specimen from Burma (Tenasserim: Myitta) described and figured by Distant (1906) as *M. smaragdulinea* may be this species based on the three other *M. wallacei* specimens from Myanmar examined.

3.10. *Indomiasa* gen.n.

Type species. *Indomiasa distanti* **sp.n.**, by present designation and monotypy.

Etymology. The new generic name is a combination of the prefix “Indo-” (India) plus the generic name of its related group “Miasa”, gender: feminine.

Diagnosis. Cephalic process before eyes strongly upturned, gradually convergent anteriorly, more or less acuminate apically; vertex without media carina, lateral carinae parallel at base, abruptly strongly constricted and curved upwardly before eyes, more or less parallel anteriorly, acuminate apically; frons with median carina robust and strongly convex, intermediate carinae reaching middle margin of eyes; pronotum centrally angularly convex and hood-like anteriorly, lateral anterior angles rounded, median carina sharp and high; mesonotum tricarinate with median carina generally too indistinct to be visible, lateral carinae incurved anteriorly towards median carina; forewings with dark streak on distal third of wing; crossveins very scarce, forming a nodal line along Sc+R, M and CuA veins at apical third; stigmal area clear, with 2 cells; fore femora with a small spine near apex; hind tibiae with 7 apical black-tipped teeth; aedeagus with paired membranous inflated apical lobes, without spines.

Description. ***Head*** (Figs. 3F, 4F, 5F) produced in a short and slightly slender cephalic process. Vertex (Fig. 3F) basally slightly convex medially, slightly narrower than transverse diameter of eyes in dorsal view, posterior surface in relation to pronotum elevated; lateral margins sub-parallel at base, abruptly constricted and curved upwardly before eyes, more or less parallel anteriorly, acuminate apically; posterior margin arcuate; median carina absent. Frons (Fig. 6F) elongate, lateral margins carinate and nearly parallel, more or less expanded outwards below antennae, posterior margin widely concave; median carina robust and strongly produced, intermediate carinae obsoletely developed, slightly converging posteriorly and approaching to anterior margin of eyes. Postclypeus and anteclypeus (Fig. 6F) strongly convex at middle, median carina indistinct. Rostrum relatively short, distal segment slightly longer than basal one, reaching to middle of hind femora. Compound eyes (Fig. 6F) large and round, callus postocularis forming a small triangular process protruded posteriorly. Ocelli relatively large, reddish. Antennae (Fig. 6F) with very small scape; pedicel large and subglobose, with more than 40 distinct sensory plaque organs distributed over entire surface.

Thorax: Pronotum (Figs. 3F, 5F, 6F) distinctly shorter than mesonotum medially, anteriorly slightly narrower posteriorly; anterior margin centrally angularly convex, forming a long triangular central process; lateral marginal areas moderately laminate, their anterior angles rounded and distinctly convex, with two lateral carinae on each side between eyes and tegulae, but both carinae too obscure to be visible; posterior margin widely concave; median carina sharp and high, with a big lateral pit on each side, intermediate carinae absent. Mesonotum (Fig. 3F) more or less convex, tricarinate; median carina distinct, lateral carinae incurved anteriorly towards median carina. Forewings (Fig. 7F) hyaline and elongate, much longer than abdomen; CuA vein first branched before Sc+R and M veins near middle; crossveins very scarce, formed a nodal line along Sc+R, M and CuA veins at apical 1/3; apical cells about 10; Pcu and A_1 veins fused into a long Pcu+A_1 vein at apical 1/5 in clavus; stigmal area clear, with 2 cells. Legs moderately elongate, fore femora relatively short, with a small spine near apex; hind femora relatively short, only about half the length of hind tibiae; hind tibiae with 5–6 lateral black-tipped spines and 7 apical black-tipped apical teeth; hind tarsomeres I with 16–17 and tarsomeres II with 13–14 black-tipped apical teeth, respectively.

Male genitalia with pygofer (Fig. 14A–C) distinctly longer ventrally than dorsally, dorso-lateral margins strongly and angularly produced posteriorly in dorsal view (Fig. 14A). Gonostyles large and symmetrical, with a rounded humped process subapically in lateral view (Figs. 14B); upper margin with a long black-tipped process at apex, directed dorsally; outer upper edge with a ventrally directed, hook-like process near middle in lateral view (Fig. 14B). Aedeagus (Fig. 14D–F) with a pair of long sclerotized endosomal processes, abruptly curved laterally at midlength, apical part gradually narrowed distally to acute apex; phallobase basally sclerotized and pigmented, dorsal part mostly sclerotized and pigmented, with paired membranous lobes covering numerous small spines at apex. Segment X narrow and elongate, anal style small.

Female genitalia unknown.

Distribution. India.

Remarks. The new genus is externally similar to *Miasa*, but can be distinguished from the latter by the cephalic process more robust and shorter; the frons with median carina robust and strongly produced; the fore femora relatively short, with a short small spine near apex; the hind tibiae with 7 apical teeth; and hind tarsomeres I with 16–17 and tarsomeres II with 13–14 black-tipped apical teeth, respectively.

It can be distinguished from *Centromeria* Stål with a similar shaped cephalic process, by its more slender and elongate forewings with crossveins very scarce forming a nodal line along Sc+R, M and CuA veins at apical third and the hind tibiae with 7 apical teeth.

3.11. *Indomiasa distanti* sp.n.

Figs. 3F, 4F, 5F, 6F, 7F, 14

Material examined. Holotype ♂, **INDIA:** Tenmalai, 500–800', Travancore, S. India, 11–17.x.[19]38 (BMNH).

Etymology. This new species is named after William Lucas Distant, an excellent English entomologist in the Natural History Museum, London.

Description of adults. ♂, length (from apex of cephalic process to tip of forewings) 12.9 mm; HL (0.6+1.0) mm; HW 1.4 mm; VW 0.2 mm; FWL 10.4 mm.

General color greenish-ochraceous. Lateral carinae of vertex before eyes, median carina and area between lateral carinae, two big spots of frons below antennae, a large spot on postclypeus and apex of anteclypeus blackish brown. Compound eyes fuscous with posterior margin purplish-red; ocelli purplish-red. Pronotum with a small area behind eyes blackish brown; anterior central area with median carina, pale green. Mesonotum with median carina and apex, pale green. Forewings with stigmal area and a large oblique triangular apical streak fuscous, an obscure streak along nodal line, posterior margin of clavus, surrounding area of streak dull, and all crossveins pale ochraceous. Abdomen above and beneath greenish-ochraceous.

Male genitalia with pygofer relatively small, distinctly longer ventrally than dorsally (about 2.8 : 1), dorsal margin slightly excavated to accommodate segment X, dorso-lateral margins strongly and angularly produced posteriorly in dorsal view (Fig. 14A); posterior margin with two processes, directed posteriorly, near upper middle in lateral view (Fig. 14B), upper process rounded, lower process angular. Gonostyles with posterior margin nearly straight, with a rounded humped process subapically (Fig. 14B); upper margin with a long black-tipped process at apex, directed dorsally; outer upper edge with a ventrally directed, hook-like process near middle (Fig. 14B). Aedeagus (Fig. 14D–F) moderately stout, phallobase with a pair of small membranous lobes near subapex, directed laterally in dorsal view (Fig. 14D); ventral part with two pairs of large lobes: ventrolateral pair moderately large, directed posteriorly at apex in lateral view (Fig. 14E), ventral pair very elongate and large, protruded posteriorly and curved anteriorly, with numerous small spines at apex.

Segment X narrow and elongate, with ratio of length to width near middle about 2.2 : 1 in dorsal view (Fig. 14A); basal ventral margin not protruded, rapidly widening to apex beyond middle, so base much narrower than apex in lateral view (Fig. 14B); apical dorsal margin deeply excavate in dorsal view (Fig. 14A) to accommodate anal style; anal style small.

Distribution. Southern India.

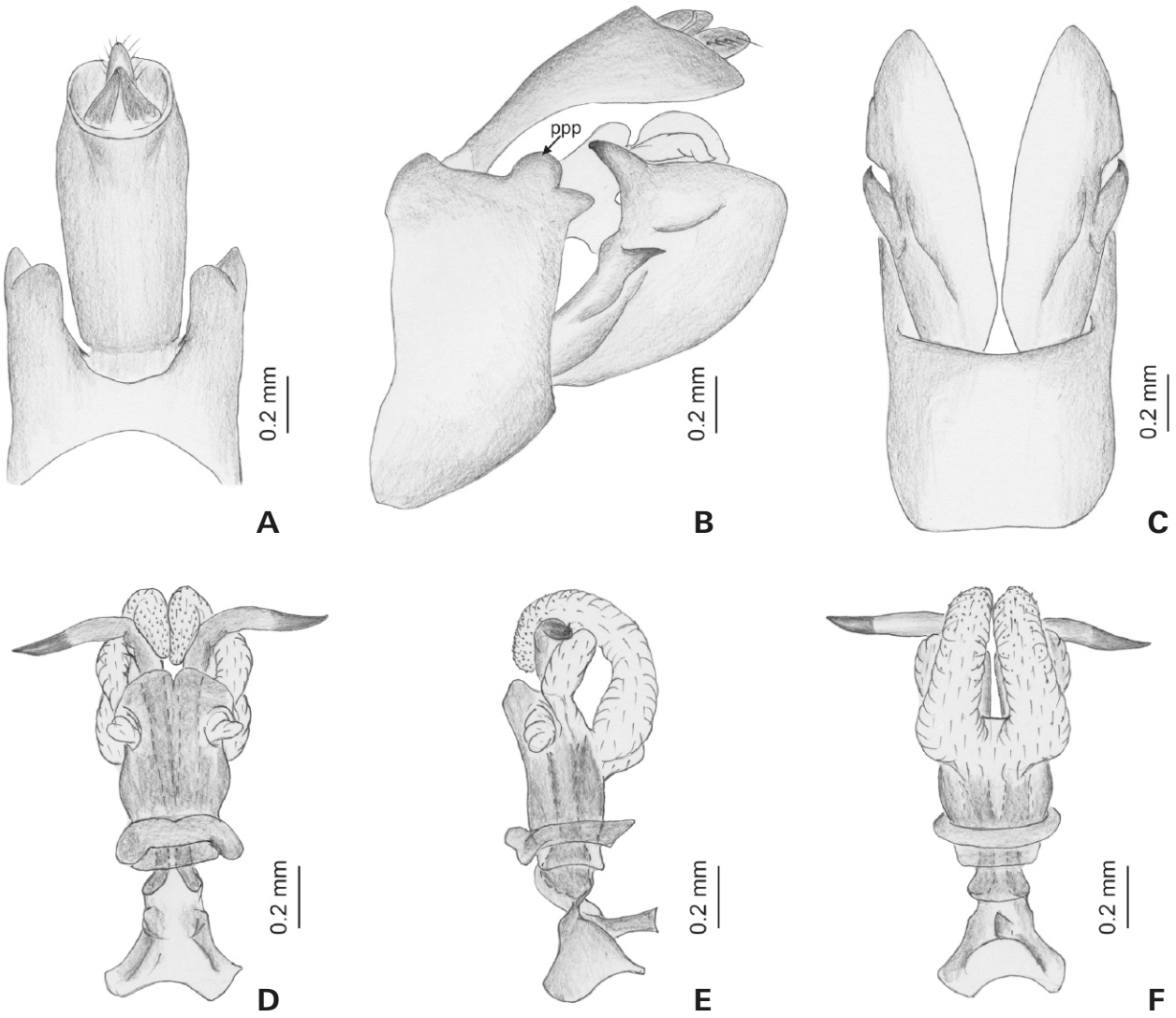

Fig. 14. *Indomiasa distanti* **sp.n. A**: Male pygofer and segment X, dorsal view. **B**: Male postabdomen, lateral view. **C**: Male pygofer and gonostyles, ventral view. **D**: Aedeagus, dorsal view. **E**: Aedeagus, lateral view. **F**: Aedeagus, ventral view. – **Abbreviation**: ppp – posterior process of pygofer.

4. Phylogenetic analysis of *Miasa* and *Indomiasa*

4.1. Characters

The data matrix (Table 2) was composed of 64 morphological characters from the coloration, head, thorax, and male postabdomen (including genitalia) of adults. All characters were equally weighted, and in all characters, states were treated as unordered. A dash (–) was entered in a matrix position if a character is not applicable to a taxon, and a question mark (?) was entered if the character condition was ambiguous or unexamined.

Coloration

0 Vertex, lateral carinae before eyes: [0] dull ochraceous; [1] black (Fig. 2A,B).

1 Frons, median carina: [0] ochraceous; [1] purplish-red (Fig. 6D); [2] black (Fig. 6F).

2 Frons, areas between intermediate carinae and lateral carinae: [0] ochraceous; [1] emerald green (Fig. 6D); [2] reddish ochraceous.

3 Base of postclypeus: [0] dull ochraceous (Fig. 6A–D); [1] blackish brown (Fig. 6E,F).

4 Cephalic process, preocular field (lateral area before eyes): [0] without spot; [1] with a black spot (Fig. 2A,B).

5 Pronotum, dark brown spots on lateral areas behind eyes: [0] absent; [1] present (Fig. 2C).

6 Forewings, fuscous streak on apical region: [0] absent; [1] present (Fig. 7).

7 Forewings, apical streak: [0] narrow, not exceeding CuA_1 posteriorly (Fig. 7A); [1] broad, exceeding CuA_2 posteriorly (Fig. 7D).

8 Forewings, apical streak: [0] approaching to nodal line anteriorly (Fig. 7A); [1] not approaching to nodal line anteriorly (Fig. 7E).

9 Forewings, dull ochraceous posterior margin: [0] narrow, not exceeding Pcu + A_1 (Fig. 7D, F); [1] broad, exceeding CuP (Fig. 7A–C,E).
10 Legs: [0] pale green, without spots; [1] brown with whitish stripes or spots (Fig. 1).
11 Abdominal segments III–VI: [0] pale green without spots or stripes; [1] dark brown with whitish spots or stripes (Fig. 1).

Head

12 Cephalic process before eyes: [0] robust; [1] distinctly slender (Fig. 5F); [2] very slender (Fig. 5A–E).
13 Cephalic process before eyes: [0] short, less or little longer than longitudinal diameter of eyes (Fig. 5F); [1] much longer (Fig. 5A–E).
14 Cephalic process before eyes: [0] unbent or slightly bent; [1] strongly bent (Fig. 5).
15 Cephalic process with a short oblique carina in preocular field: [0] absent; [1] present (Fig. 2A, B).
16 Vertex, width of posterior margin in relation to transverse diameter of eyes: [0] narrower (Fig. 2B); [1] nearly equal or little wider; [2] much wider.
17 Vertex, median carina: [0] absent; [1] present.
18 Vertex, median carina: [0] only distinct in base; [1] nearly completely distinct.
19 Vertex, apex: [0] broadly and angulately convex; [1] nearly acuminate.
20 Vertex, posterior margin: [0] broadly concave (Fig. 2B); [1] angularly concave (no more than 100°).
21 Vertex, posterior surface in relation to pronotum: [0] in the same plane; [1] in an elevated plane.
22 An apical carina between anterior margins of frons and vertex: [0] absent; [1] present.
23 Frons, median carina: [0] ridged; [1] robust and strongly convex (Fig. 6F).
24 Frons, intermediate carinae approaching to: [0] anterior margin or middle of eyes (Fig. 2C); [1] frontoclypeal suture.
25 Frons, lateral margins below the antennae: [0] nearly straight; [1] angularly convex (Fig. 2C).
26 Rostrum, apex: [0] reaching base to middle of hind femora; [1] reaching or surpassing apex of hind femora.
27 Rostrum, basal segment relative to distal one: [0] distinctly longer (no less than 1.2× as long as distal one); [1] nearly equal or slightly longer.

Thorax

28 Pronotum, lateral carinae: [0] absent; [1] present in basal third to half.
29 Pronotum, ventral lobes with a carina: [0] absent; [1] present.
30 Pronotum, anterior central margin: [0] arcuately convex; [1] angularly convex (Fig. 2B).
31 Pronotum, posterior margin: [0] broadly arcuately concave (Fig. 2B); [1] angularly concave (no more than 120°).
32 Pronotum, anterolateral angles: [0] angular; [1] rounded (Fig. 2B).
33 Mesonotum, lateral carinae: [0] gradually incurved; [1] nearly straight.
34 Mesonotum, lateral carinae: [0] parallel; [1] convergent.
35 Forewings, veins: [0] without setae; [1] with short setae.
36 Forewings, numbers of apical cells of M: [0] 4–5 (Fig. 7A); [1] ≥ 6.
37 Forewings, shape of stigmal area: [0] quadrangular; [1] elongate (Fig. 7A).
38 Forewings, nodal line: [0] absent; [1] present (Fig. 7A).
39 Forewings, ratio of length to width: [0] 3.0–3.5×; [1] 3.6–4.0×; [2] > 4.0×.
40 Fore and middle tarsomeres I and II, acutellae: [0] 2; [1] > 2.
41 Fore femora: [0] neither slender nor dilated; [1] slender and elongate; [2] flattened and dilated.
42 Fore femora, a small spine on ventral subapex: [0] absent; [1] present.
43 Fore femora, subapical spine: [0] small and acute; [1] large and blunt.
44 Hind femora and tibiae: [0] not slender and elongate; [1] slender and elongate.
45 Hind tibiae, number of apical teeth: [0] 6; [1] 7; [2] 8.
46 Hind tarsomeres I and II, number of apical teeth: [0] 7–13; [1] 14–20.

Male postabdomen

47 Pygofer (lateral view), ventral margin in relation to dorsal one: [0] < 1.5× (Fig. 9B); [1] 1.5–3.0× (Fig. 12B); [2] > 3.0× (Fig. 13B).
48 Pygofer (lateral view), posterior process: [0] absent; [1] present (Fig. 14B).
49 Pygofer, numbers of posterior process: [0] 1; [1] 2 (Fig. 14B).
50 Pygofer, poster margin if posterior process absent: [0] slightly protruded posteriorly (Fig. 9B); [1] distinctly protruded posteriorly (Fig. 12B).
51 Pygofer, a pair of rounded humped process on ventrolateral area: [0] absent; [1] present (Fig. 9B).
52 Gonostyles, upper process: [0] neither elongate nor broad; [1] elongate (Fig. 14B); [2] broad (Fig. 10B).
53 Aedeagus, apical membranous lobes of phallotheca: [0] with long spines; [1] with very short small spines or not.
54 Aedeagus, apical membranous lobes of phallotheca: [0] without spine; [1] with very short small spines.
55 Aedeagus, phallotheca with dorsolateral lobes: [0] present (Fig. 9D,E); [1] absent.
56 Aedeagus, lower ventral lobes of phallotheca: [0] short (Fig. 10E); [1] elongate (Fig. 14E).
57 Aedeagus, lower ventral lobes of phallotheca: [0] rounded (Fig. 9E); [1] pointed (Fig. 10E).
58 Aedeagus, endosomal processes: [0] short, just extended from phallotheca; [1] long, much extended from phallotheca (Fig. 9D,E).
59 Aedeagus, apex of endosomal processes: [0] acute (Fig. 9D,E); [1] obtuse.

Table 2. Character state matrix.

Characters → Taxa ↓	0000000000 0123456789	1111111111 0123456789	2222222222 0123456789	3333333333 0123456789	4444444444 0123456789	5555555555 0123456789	6666 0123
Dictyophara europaea	0000000---	0001001110	0010100111	0001001100	100-01110-	0000-0--10	1111
Putala rostrata	0020100---	0111110100	0100101000	1001001100	100-011110	-000-0--01	0110
Raivuna micida	0020000---	0001001110	0010100101	0001001000	100-011110	-000-11101	0000
Centromeria longipennis	0100--0---	0000011101	1101011000	1100101100	0110100110	-01101--10	1000
Indomiasa distanti **sp.n.**	1201011000	00101100-1	0101010100	1010100111	0010011111	-011101010	1210
Leprota melichari	0000001110	0000100210	0010100010	0000011100	0010020110	-011101010	0000
Metaurus reticulatus	0000110---	0020111101	0000111000	0000111100	0110011111	-00100111-	-311
Miasa borneensis **sp.n.**	1000011001	11211100-1	0100011100	1010100111	011110000-	0001001010	1001
Miasa nigromaculata **sp.n.**	1000111001	11211100-1	0100011100	1010100111	011110000-	0021000110	1211
Miasa producta	1000111001	11211100-1	0100011100	1010100111	011110000-	0001001110	1001
Miasa smaragdilinea	1110001100	11211100-1	0100011100	1010100112	011110010-	1001011110	1000
Miasa wallacei	1001?01011	11211100-1	0100011100	1010100111	011110020-	1111000010	1310
Orthopagus lunulifer	0000111100	1100001110	1010100100	1100101100	021101120-	101100--10	1000
Saigona ussuriensis	0000110---	1101002100	0110010010	0100111000	021102010-	100111--10	1001
Tenguna watanabei	0000000---	0000011111	1000110110	1000101100	0010020110	-01100--10	1000

60 Aedeagus, endosomal processes: [0] nearly straight; [1] curved in middle (Fig. 9D,E).

61 Segment X, shape (dorsal view): [0] oval; [1] truncate; [2] distinctly elongate (Fig. 14A); [3] irregular (Fig. 13A).

62 Segment X (lateral view), apical ventral margins: [0] not protruded; [1] protruded ventrally (Fig. 13A, B).

63 Segment X (lateral view), basal ventral margins: [0] not protruded; [1] protruded ventrally (Fig. 9A,B).

4.2. Character analysis

The cladistic analysis was conducted with WinClada ver. 1.00.08 (Nixon 1999, 2002) and implemented in NONA ver. 2.0 (Goloboff 2000). Phylogenetic relationships were reconstructed with a heuristic analysis by searching for the most parsimonious trees (MPTs) with 1000 maximum trees, 1000 replications and 10 starting trees per replication. Characters were selected to map the homoplasy/homology in the homoplasy setting dialog with any extra steps making it homoplasious. Bootstrap (Felsenstein 1985) and jackknife (Farris et al. 1996) values were used as support measures, and calculated in NONA for the hypothesised clades with 1000 replications.

4.3. Results

Analysis of the dataset (see Table 2) resulted in two MPTs with tree length = 162 steps, consistency index (CI) = 0.46, and retention index (RI) = 0.61. A strict consensus of both trees is shown in Fig. 15 and a reference tree selected from the two MPTs is presented in Fig. 16 with the more robust bootstrap/jackknife support values mapped onto it. According to the result of phylogenetic analysis, *Miasa* species make up a good monophylum, and the new genus *Indomiasa* can be considered as the sister group of it.

Clade 1 in Fig. 16 supports the monophyly of Orthopagini represented by *Miasa* and its seven putatively related genera all distributed in the Oriental region, which is defined phylogenetically by four unique synapomorphies with consistency index 1:33-0 (character 33, state 0), 40-0, 42-1, and 53-1. This clade is further defined by two unambiguous character changes: 46-0 and 52-1. It has 62% bootstrap and 68% jackknife values. The phylogenetic relationships among three genera *Leprota*, *Orthopagus*, and *Saigona* differ between the two MPTs, but the remaining four taxa form a series of successive sister taxa to *Miasa*.

The new genus *Indomiasa* and all *Miasa* species constitute clade 2 (also see Fig. 17), which is supported by six synapomorphies (0-1, 17-0, 32-1, 36-0, 38-1, and 39-1), and two homoplasious characters (6-1 and 16-0). *Indomiasa* **gen.n.** can be considered as the sister group of *Miasa*, which is supported by 88% bootstrap and 93% jackknife values.

The monophyly of *Miasa* (clade 3) is supported by 73% bootstrap and 77% jackknife values. It is supported by six unambiguous character changes: 10-1, 11-1, 13-1, 43-1, 44-1, and 48-0. Within *Miasa*, *M. wallacei* has the following one autapomorphy not present in other *Miasa* species: a pair of rounded humped process on ventrolateral area of pygofer (51-1). It can be regarded as the sister group of the remaining *Miasa* species (clade 4).

Clade 4 is grouped on two unambiguous character changes: 52-0 and 62-0. Within the clade, *M. smaragdilinea* is the sister group of remaining species (clade 5) although clade 4 has low bootstrap and jackknife values.

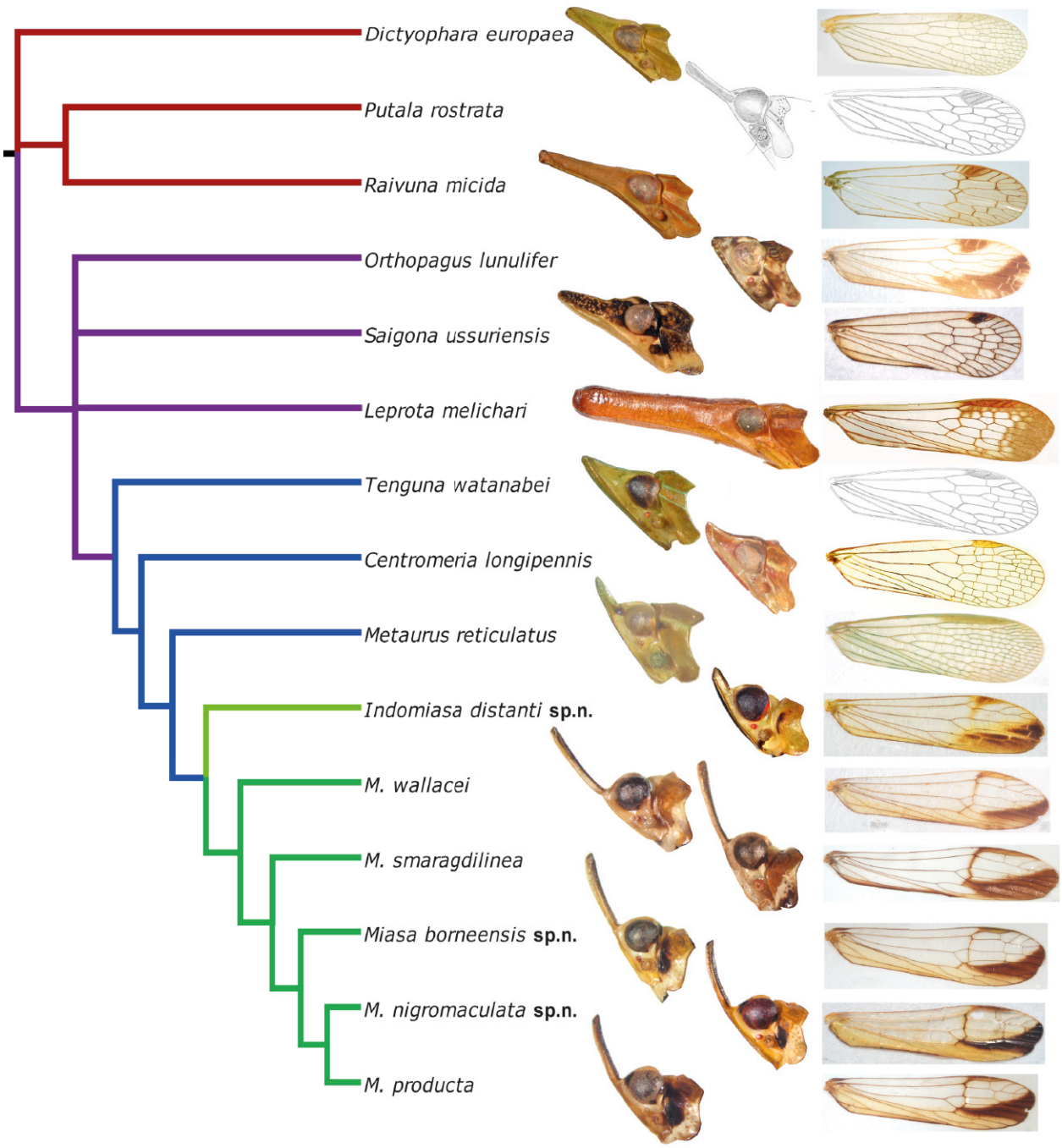

Fig. 15. Strict consensus of the two most parsimonious trees (tree length 171) for *Miasa*, *Indomiasa* and other representatives of Dictyopharinae. The head and pronotum (lateral view), and forewing are mapped onto the tree.

Clade 5 is supported by three unambiguous character changes: pygofer with ventral margin in relation to dorsal one < 1.5 × in lateral view (47-0); pygofer with posterior margin slightly protruded posteriorly (50-0), and basal ventral margins of segment X protruded (63-1). This clade has 54% bootstrap and 59% jackknife values.

Finally, *M. nigromaculata* **sp.n.** and *M. producta* share an unambiguous character change: preocular field of cephalic process with a black spot (4-1); this supports that they form a monophyletic group (clade 6).

5. Discussion

The range of *Miasa* includes the Indo-Chinese and Indo-Malayan subregions in the Oriental region, showing a typical sympatric distribution pattern (Fig. 18). The northernmost distribution of the genus is southern Yunnan, China, the easternmost reaches northeastern Borneo, and the southernmost extends to northern Java. Within

Fig. 16. Reference tree for *Miasa*, *Indomiasa* and other representatives of Dictyopharinae, with clade numbers (on nodes), selected from the two most parsimonious trees showing unambiguous characters supporting each clade (character number above and state number below) based on unambiguous optimisation. Characters were selected to map the homoplasy/homology with any extra steps making it homoplasious. Non-homoplasious characters with consistency index 1 are shown as filled rectangles, and homoplasious characters are shown as empty rectangles. The bootstrap (upper right corner of nodes) and jackknife (lower right corner of nodes) values are also shown if > 0.50.

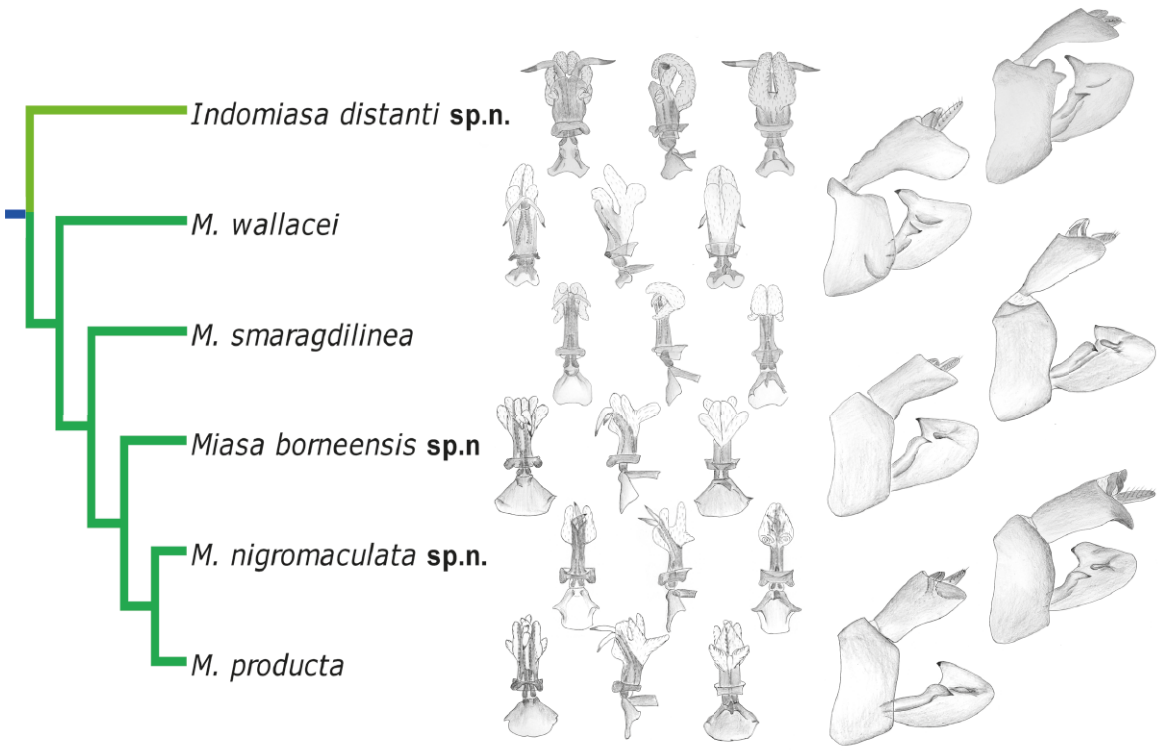

Fig. 17. Structure of the aedeagus, male pygofer, gonostyle, and segment X mapped onto the clade of *Indomiasa* **gen.n.** and *Miasa*.

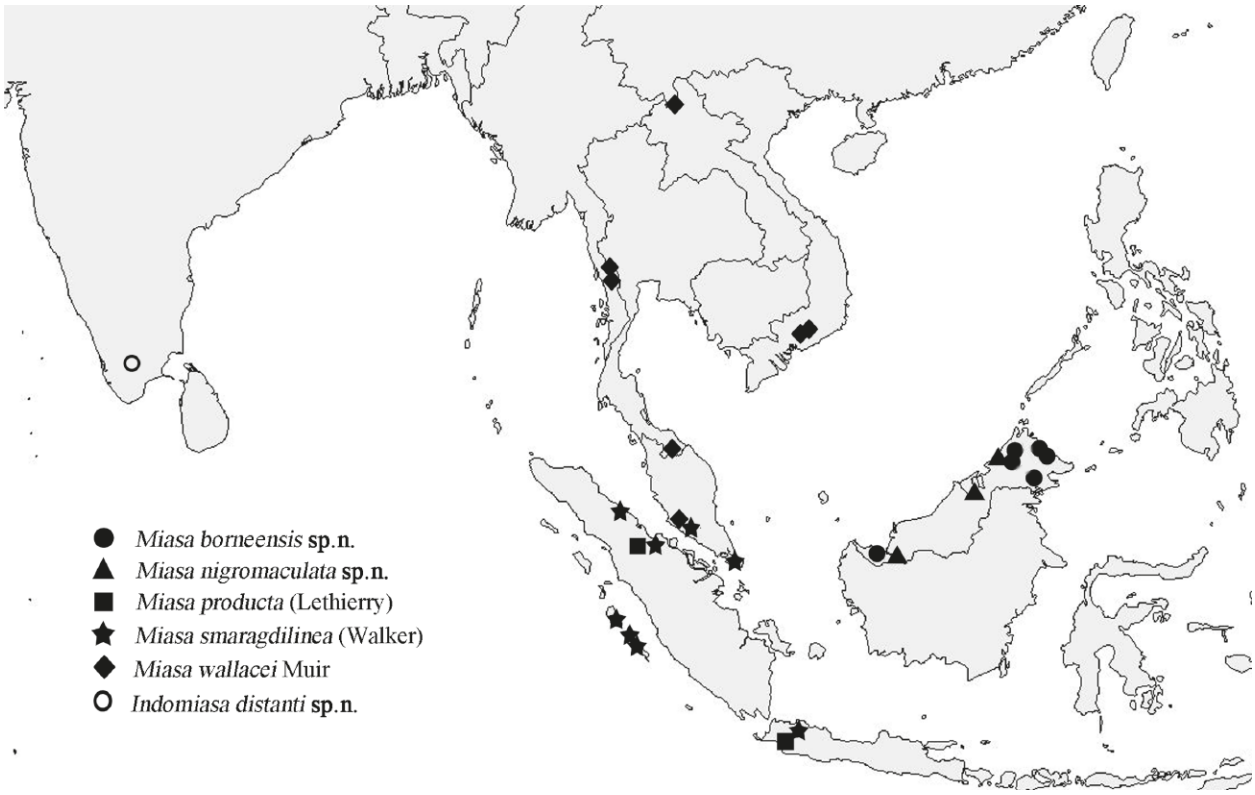

Fig. 18. Geographic distribution of the species of *Miasa* and *Indomiasa* **gen.n.**

Miasa, *M. wallacei* is widespread in Southeast Asia from southwestern China via Indochina to Malay Peninsula. *M. smaragdilinea* is widely distributed in Malay Peninsula, Sumatra, Mentawei Islands, and Java. The distribution ranges of the other species are relatively limited. *M. nigromaculata* **sp.n.** and *M. borneensis* **sp.n.** are restricted to northern Borneo, whereas *M. producta* occurs in Sumatra and Java. In contrast, the new monotypic genus *Indomiasa* is only found in southern India.

As a relatively small group, the distribution pattern displayed by *Miasa* is largely concordant with other dictyopharid groups, for example *Centromeria* and *Dictyomorpha* Melichar, 1912, but the species diversity in *Miasa* is not high. More new species and more potential distribution areas such as Lesser Sundas, the Philippines and the Moluccas, are expected to be found in future.

As fossils of *Miasa* and its related groups have never been found, it is difficult to trace the origin of this genus. Nevertheless, Liang (1998) assumed that many tropical cercopoid and fulgoriod groups in the Oriental region might have a Gondwanan origin followed by dispersal into Southeast Asia along with the collision of the Indian subcontinent with southern Eurasia at the beginning of Tertiary. Similarly, *Miasa* is likely to have an Indian origin from Gondwana because its sister group, *Indomiasa* **gen.n.**, occurs in southern India. The situation is similar in many dictyopharid groups in the Oriental region, such as *Centromeria* and *Dictyomorpha*, which possess similar distribution pattern and evolutionary history (Liang & Song 2012; Song et al. in prep.).

The diversification center of *Miasa* is possibly located in Sundaland, which has been considered as one of the eight hottest hotspots of global biodiversity (Myers et al. 2000). There have been masses of dictyopharid species possibly diversified in Sundaland, such as the genera *Centromeria*, *Leprota* and *Metaurus* within Orthopagini, suggesting this region could be considered as a center of speciation and diversification of Orthopagini (Song et al. 2012; Song & Liang 2012a; Song et al. in prep.). A future test or confirmation for the present phylogenetic and biogeographic inferences is expected to be developed and improved by more material, especially fossil and molecular data, allowing more accurate understanding of the origin and diversification of *Miasa* and other taxa.

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