

**Research article**

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**Revision of the lanternfly genus *Limois* Stål, 1863  
(Hemiptera: Fulgoromorpha: Fulgoridae)  
with description of a new species from China**

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**Abstract.** All extant species of the planthopper genus *Limois* Stål (Hemiptera: Fulgoromorpha: Fulgoridae) were studied. One new species, *Limois sordida* sp. nov., is described and illustrated from China. Six known species are re-described and photos and illustrations of male genitalia are provided. A key to all extant species of this genus is also given.

**Keywords.** Auchenorrhyncha, Fulgoroidea, key, taxonomy, distribution.

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## Introduction

The lanternfly genus *Limois* belongs to the Aphaeninae within the family Fulgoridae (Hemiptera: Fulgoromorpha) and is distributed in the southeastern part of the Palaearctic and the northern part of the Oriental regions, most species were found in the Sino-Japanese realm. Described by Stål (1863) with *Lystra westwoodii* Hope, 1843 as its type species, this genus is currently represented by nine species. This includes seven extant species, *Limois bifasciatus* Ollenbach, 1928, *L. chagyabensis* Chou & Lu, 1981, *L. emelianovi* Oshanin, 1908, *L. guangxiensis* Chou & Wang, 1985, *L. hunanensis* Chou & Wang, 1985, *L. kikuchii* Kato, 1932 and *L. westwoodii*, plus two extinct species, *L. pardalis* Zhang, 1989 and *L. shanwangensis* (Hong, 1979) (Bourgoin 2019).

China possesses the richest species diversity of this genus worldwide, comprising six extant species and the two extinct species to date (Metcalf 1947; Lallemand 1963; Chou & Lu 1981; Chou *et al.* 1985a, 1985b; Nagai & Porion 1996). This paper adds one new species to the genus from China and re-describes and illustrates the other known extant species insofar as the morphological characters, especially the male genitalia, remained unclear to date. A distribution map and an identification key to all species in this genus are also provided.

## Material and methods

Dry pinned and mounted specimens were used for the descriptions and illustrations. External morphology was observed under a stereoscopic microscope and characters were measured with an ocular micrometer. Genital segments of the examined specimens were macerated in 10% NaOH and illustrated from preparations in glycerin using a light microscope. Habitus photos were taken using the Scientific Digital micrography system equipped with an Auto-Montage imaging system and QIMAGING Retiga 4000R digital camera (CCD). Multiple photographs were then compiled into final images.

Body measurements are from apex of vertex to tip of abdomen (female body length not including the extension for mating or spawning). All measurements are in millimeters (mm). The morphological terminology used in this study follows Anufriev & Emeljanov (1988) except for the venation of the forewing, which follows Bourgoïn *et al.* (2015) and the male genitalia that follows Bourgoïn (1987). The standardized terminology used for zoogeographic regions of the world follows Holt *et al.* (2013).

## Collection acronyms

- CAU = China Agricultural University, Beijing, China  
FSAG = University of Liège, Gembloux Agro-Bio Technologies, Gembloux, Belgium  
IZCAS = Institute of Zoology, Chinese Academy of Sciences, Beijing, China  
FRI-NFIC = Forest Research Institute, National Forest Insect Collection (FRI-NFIC), Dehradun, India  
NWFU = Entomological Museum, Northwest A&F University, Yangling, Shaanxi, China  
OUMNH = Oxford University Museum of Natural History, Oxford, UK  
RBINS = Royal Belgian Institute of Natural Sciences, Brussels, Belgium

## Results

Class Insecta Linnaeus, 1758  
Order Hemiptera Linnaeus, 1758  
Suborder Auchenorrhyncha Duméril, 1806  
  Infraorder Fulgoromorpha Evans, 1946  
    Superfamily Fulgoroidea Latreille, 1807  
      Family Fulgoridae Latreille, 1807  
        Subfamily Aphaeninae Blanchard, 1847  
          Tribe Limoisini Lallemand, 1963

Genus *Limois* Stål, 1863

*Limois* Stål, 1863: 230. Type species: *L. westwoodii* (Hope, 1843).

*Limois* – Metcalf 1947: 170. — Lallemand 1963: 54. — Chou & Lu 1981: 221. — Chou *et al.* 1985a: 30. — Chou *et al.* 1985b: 108. — Nagai & Porion 1996: 22.

**Re-description**

HEAD (including eyes). Much narrower than pronotum (Figs 8B, 9B). Vertex slightly produced in front of eyes, vertex about 2 times as broad as an eye, medially with reflexed protuberance (Fig. 9B, H). Pronotum almost twice as broad as vertex, with deeply impressed point at each side of median carina, each lateral area with one rounded dark spot behind eyes, lateral carinae sinuate. Mesonotum tricarinate in disc, median carina straight, intermediate carinae curved, reaching posterior margin (Figs 8B, 9B). Frons distinctly narrower from fronto-clypeal suture to apex, lateral margins carinate, medially with 2 or 3 longitudinal carinae; clypeus narrower and shorter than frons, labium elongate, median carina on clypeus (Figs 4C, 9D). Tegmina elongate, slightly broadened distad with the maximum width near apex, apically obliquely rounded, venation reticulate, tegmina hyperpterous, much longer than hindwing (Fig. 9A). Hindwing posterior margin indented at PCu level, apical cell and clavus venation reticulate (Fig. 8A). Metatibiae with 4–7 lateral spines (Fig. 9E).

MALE GENITALIA. Pygofer symmetrical, narrow and subquadrangular in lateral view, ventrally longer than dorsally, ventrocaudal angle slightly produced caudad (Fig. 10A). Anal tube subtriangular in lateral view, in dorsal view gradually broadened distad, apical margin concave; epiproct and paraproct separated in lateral view, in dorsal view epiproct short and broad, paraproct slender, surpassing the end of anal tube (Fig. 10A, C). Gonostyli subtriangular or oval in lateral view, submedially with a hook-shaped process near dorsal side, in ventral view the styles connect only at base (Fig. 10A, B). Aedeagus reduced, membranous endosoma with a dorsal pair of lobes surrounding a ventral pair of lobes and the sclerotized endosomal processes, the endosomal processes paired, apical portion exposed and curved dorsad in lateral view, terminally inflated (Fig. 10D–F).

**Distribution**

China (northeast China, Shanxi, Shaanxi, Hebei, Beijing, Gansu, Ningxia, Xizang, Hunan, Sichuan, Guangxi, Fujian, Taiwan), Japan, Korea, Russia, Bangladesh, India, Myanmar (Fig. 16).

**Remarks**

Lallemand (1963) established the tribe Limoisini belonging to the subfamily Aphaeninae Blanchard, 1847 and assigned *Limois*, together with four other genera (*Bloeteanella* Lallemand, 1963, *Erilla* Distant, 1906, *Hellerides* Lallemand, 1963 which was synonymized with *Zophiuma* Fennah, 1955 by Liang (1995) in the family Lophopidae, and *Neolieftinckana* Lallemand, 1963) to this tribe. Nagai & Porion (1996) recorded seven genera (*Bloeteanella*, *Erilla*, *Limois*, *Neolieftinckana*, *Nisax* Fennah, 1977, *Saramel* Fennah, 1977 and *Ombro* Fennah, 1977) in Limoisini. The genus *Limois* differs from the other six genera in the tribe by the hindwings bicolored (red or yellow in basal part and hyaline apically) rather than concolorous over entire length. *Limois* also differs from *Neolieftinckana* by the tegmina hyaline in apical half (entirely opaque in *Neolieftinckana*). From *Ombro* it differs by the phallobase having 4 paired lobes (with 5 paired lobes in *Ombro*). From *Erilla* and *Nisax* it differs by the cephalic process of vertex slanting upwards to backwards, flattened on the vertex (cephalic process of vertex reduced in *Erilla* and forming a granular mass in middle of vertex in *Nisax*). From *Bloeteanella* it differs by the frons having 2 or 3 smooth longitudinal carinae (wrinkled and grooved carinae in *Bloeteanella*).

***Limois chagyabensis* Chou & Lu, 1981**

Figs 1, 14A–D

*Limois chagyabensis* Chou & Lu, 1981: 221.

*Limois chagyabensis* – Chou *et al.* 1985b: 109.



**Fig. 1.** *Limois chagyabensis* Chou & Lu, 1981. A–G. Holotype, adult female. A. Dorsal view. B. Ventral view. C. Left lateral view. D. Head and thorax, dorsal view. E–F. Face. G. Head and thorax, left lateral view (showing reflexed protuberance of the vertex). H–L. NWAUFU HO088523, male genitalia. H. Left lateral view. I. Gonostylus, ventral view. J. Anal tube, dorsal view. K. Aedeagus and gonostylus, dorsal view. L. Aedeagus, ventral view. M. Labels of the holotype. Scale bars: H = 1.0 mm; I–L = 0.5 mm.

**Diagnosis**

(1) Frons medially with 3 longitudinal carinae, median carina tinier, all not reaching fronto-clypeal suture (Fig. 1E–F), cephalic process of vertex moderate in length, reaching posterior margin of vertex (Fig. 1D, G); (2) pronotum red-brown with one longitudinal broken band on each side of median carina, blackish brown, mesonotum yellow, with 3 pairs of dark patches along anterior margin and one dark triangular patch on each lateral area, with one large irregular patch on each side of median carina (Fig. 1D); (3) tegmina with a transverse irregular dark brown band on basal  $\frac{2}{5}$  (not reaching posterior margin) and orange-yellow on costal area and basal half followed by some brown patches and spots on hyaline area (Fig. 1A–C); hindwings reddish yellow on basal half (red in fresh specimens), the apical half hyaline (Fig. 1A–B); (4) abdominal segment dark, posterior margin testaceous (Fig. 1A).

**Material examined****Holotype**

CHINA • ♀ (see Figs 1A–G, 14A–D); Xizang, Chaya, Jitang; alt. 3200 m; 15 Sep. 1976; Xue-zhong Zhang leg.; NWAUFU.

**Allotype**

CHINA • ♀; same data as for holotype; NWAUFU.

**Additional material**

CHINA • 1 ♂; Shaanxi, Baliguan; 16 Aug. 1983; De-jin Zhao leg.; NWAUFU HO088523 • 1 ♀; Shaanxi, Zhenba; 5 Oct. 1981; collector unknown; NWAUFU HO088514 • 1 ♀; Sichuan, Wolong Nature Reserve; alt. 1940 m; 25 Nov. 1982; Jian-guo Yang leg.; NWAUFU HO088508 • 1 ♀; Shaanxi, Liuba; Aug. 1980; Yan-hua Wei leg.; NWAUFU HO088518.

**Description**

MEASUREMENTS. Body length: ♀ 9.8–12 mm; ♂ 9.2 mm. Wingspan: ♀ 39.6–44.7 mm; ♂ 34.8 mm.

MALE GENITALIA. Pygofer in profile with ventral margin straight, laterocaudal margin slightly convex (Figs 1H, 14A). Anal tube moderate in length, ventral margin slightly concave in basal  $\frac{2}{3}$ , apical margin truncate, intersected with dorsal margin at almost right angle in lateral view, epiproct acutely angled apically in dorsal view (Figs 1H, J, 14A). Gonostyli subtriangular, apically almost straight in lateral view (Figs 1H, 14A). Endosomal processes sclerotized, about 3.5 times as long as sheath, apical half exposed, inflexed and inflated at apex (Figs 1K–L, 14C–D). Connective linear (Fig. 14A). Tectiductus unrecognizable in lateral view.

**Distribution**

China (Xizang, Shaanxi, Sichuan).

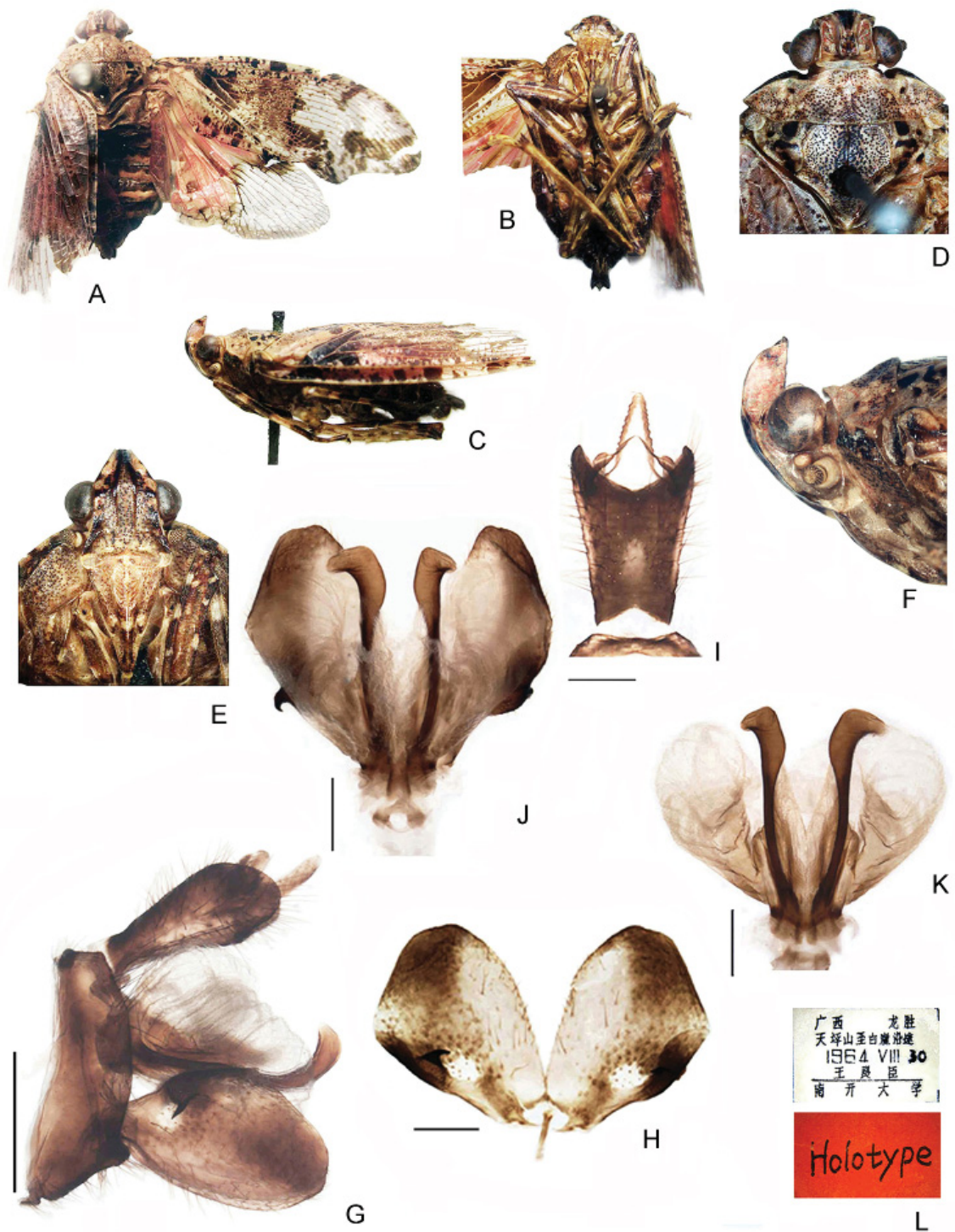
**Remarks**

When listing the type specimens of this species, Chou & Lu (1981) stated that the holotype was male but in fact it is a female.

*Limois guangxiensis* Chou & Wang, 1985  
Figs 2, 14E–H

*Limois guangxiensis* Chou & Wang, in Chou *et al.* 1985a: 31.

*Limois guangxiensis* – Chou *et al.* 1985b: 111.



**Fig. 2.** *Limois guangxiensis* Chou & Wang, 1985. A–F. Holotype, female. A. Adult, dorsal view. B. Adult, ventral view. C. Adult, left lateral view. D. Head and thorax, dorsal view. E. Face. F. Head and thorax, left lateral view (showing reflexed protuberance of the vertex). G–K. NWAUFU HO088509, male genitalia. G. Left lateral view. H. Gonostylus, ventral view. I. Anal tube, dorsal view. J. Aedeagus and gonostylus, dorsal view. K. Aedeagus, ventral view. L. Labels of the holotype. Scale bars: G = 1.0 mm; H–K = 0.5 mm.

**Diagnosis**

(1) Frons with two longitudinal carinae (Fig. 2E), cephalic process of vertex relatively long, surpassing posterior margin of vertex but not reaching the middle of pronotum (Fig. 2C–D, F); (2) pronotum and mesonotum rusty brown, pronotum covered with numerous dark spots centrally and posteriorly, mesonotum covered with numerous dark spots on disc, with 4 irregular dark patches near each posterolateral angle (Fig. 2D); (3) tegmina with basal  $\frac{3}{5}$  and costal area pale reddish brown, apical  $\frac{2}{5}$  hyaline with a broad brown stripe obliquely extending to the apical angle (Fig. 2A, C); hindwings red on basal  $\frac{2}{3}$  and hyaline on remaining area, between them with a sinuate brownish fascia (Fig. 2A); (4) abdomen sordid orange, anterior margin dark brown on each tergite (Fig. 2A).

**Material examined****Holotype**

CHINA • ♀ (see Figs 2A–F, 14E–H); Guangxi, Longsheng; 30 Aug. 1964; Liang-chen Wang leg.; NWAUFU HO088505.

**Additional material**

CHINA • 1 ♂; Fujian, Taiwu; 15 Aug. 1982; Xiang-dong Ye leg.; NWAUFU HO088509.

**Description**

MEASUREMENTS. Body length: ♀ (holotype of *L. guangxiensis*) 15.9 mm; ♂ 11.5 mm. Wingspan. ♀ (holotype of *L. guangxiensis*) 50.2 mm; ♂ 47.4 mm.

MALE GENITALIA. Pygofer in profile with ventral margin slightly concave, laterocaudal margin slightly convex (Figs 2G, 14E). Anal tube long, apical margin rounded, intersection with dorsal margin at obtuse angle in lateral view, epiproct obtusely angled apically in dorsal view (Figs 2G, I, 14E). Gonostyli oval, widest in middle in lateral view, (Figs 2G, 14E). Endosomal processes sclerotized over entire length, about 6.0 times as long as sheath, apical  $\frac{3}{5}$  exposed, terminally inflated and hook-shaped (Figs 2J–K, 14G–H). Connective rod-like, sclerotized. Tectiductus large in lateral view, rectangular (Figs 2G, 14E).

**Distribution**

China (Guangxi, Fujian).

***Limois hunanensis* Chou & Wang, 1985**

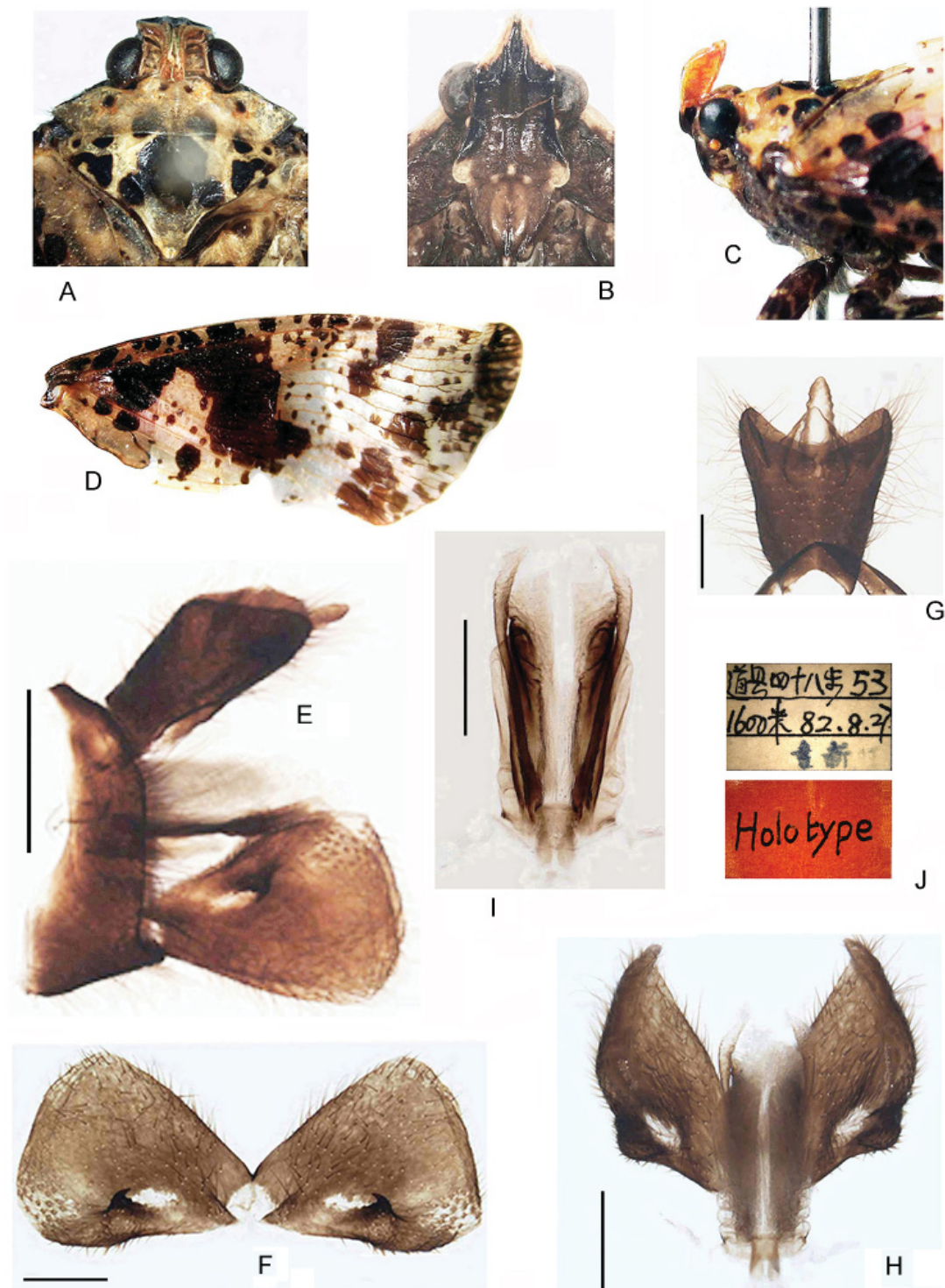
Figs 3, 14I–L

*Limois hunanensis* Chou & Wang, in Chou *et al.* 1985a: 30.

*Limois hunanensis* – Chou *et al.* 1985b: 110.

**Diagnosis**

(1) Frons with 2 longitudinal carinae (Fig. 3B), cephalic process of vertex long, surpassing anterior margin of pronotum (Fig. 3A, C); (2) pronotum and mesonotum creamy yellow, pronotum with 2 dark spots anteriorly, mesonotum with 3 pairs of dark patches along anterior margin and the middle pair covered by pronotum, one large irregular patch on each side of median carina, each lateral area with 1 large irregular patch (Fig. 3A); (3) tegmina with a transverse irregular dark brown band on basal  $\frac{2}{5}$  (not reaching posterior margin) and reddish on basal  $\frac{2}{5}$  and costal area followed by some brown patches and spots in apical half (Fig. 3D); hindwings red on basal half and hyaline on apical half, between them a sinuate blackish brown fascia; and (4) abdominal tergites yellowish brown, anterior margin black-brown on each tergite, sternites dark brown.



**Fig. 3.** *Limois hunanensis* Chou & Wang, 1985, holotype, adult male. **A.** Head and thorax, dorsal view. **B.** Face. **C.** Head and thorax, left lateral view (showing reflexed protuberance of the vertex). **D.** Forewing. **E–I.** Male genitalia. **E.** Left lateral view. **F.** Gonostylus, ventral view. **G.** Anal tube, dorsal view. **H.** Aedeagus and gonostylus, dorsal view. **I.** Aedeagus, ventral view. **J.** Labels. Scale bars: E = 1.0 mm; F–I = 0.5 mm.



### Material examined

#### Holotype

CHINA • ♂ (see Figs 3, 14I–L); Hunan, Daoxian, alt. 1600 m; 27 Aug. 1982; Xin-wang Tong leg.; NWAUFU HO088511.

### Description

MEASUREMENTS. Body length (from the original description of Chou *et al.* 1985a): ♂ (holotype) 9 mm. Wingspan: ♂ (holotype) 40 mm.

MALE GENITALIA. Pygofer in profile with ventral and laterocaudal margins almost straight (Figs 3E, 14I). Anal tube moderate, apical margin truncate, intersection with dorsal margin at obtuse angle in lateral view, epiproct acutely angled apically in dorsal view (Figs 3E, G, 14I). Gonostyli triangular in outline, widest near apex, apically almost truncate in middle (Figs 3E–F, 14I–J). Endosomal processes mostly sclerotized, about 5.0 times as long as sheath, apical  $\frac{1}{3}$  exposed, slightly inflexed and inflated (Figs 3H–I, 14K–L). Connective unrecognizable. Tectiductus small, unrecognizable more or less.

### Distribution

China (Hunan).

### *Limois kikuchii* Kato, 1932

Figs 4–5, 14M–Q

*Limois kikuchii* Kato, 1932: 225.

*Limois kikuchii* – Chou *et al.* 1985a: 30. — Chou *et al.* 1985b: 108.

### Diagnosis

(1) Frons medially with 3 longitudinal carinae, the median carina tinier, all not reaching fronto-clypeal suture (Fig. 4C), cephalic process of vertex moderate in length, not reaching posterior margin of vertex (Fig. 4B, E); (2) pronotum brown with one longitudinal broken band on each side of median carina, blackish brown; mesonotum covered with numerous dark spots on disc, with 3 pairs of dark patches along anterior margin and one dark triangular patch on each lateral area (Fig. 4B); (3) tegmina with a transverse irregular dark brown band on basal  $\frac{2}{3}$  (extending to posterior margin) and reddish yellow on costal area and basal  $\frac{1}{3}$  followed by some brown patches and spots in apical half on hyaline area (Fig. 4A, D, F); hindwings red orange on basal half and hyaline on apical half (Fig. 4A, D); (4) abdominal tergite brown except anterior margin dark on each segment, sternites dark (Fig. 4A).

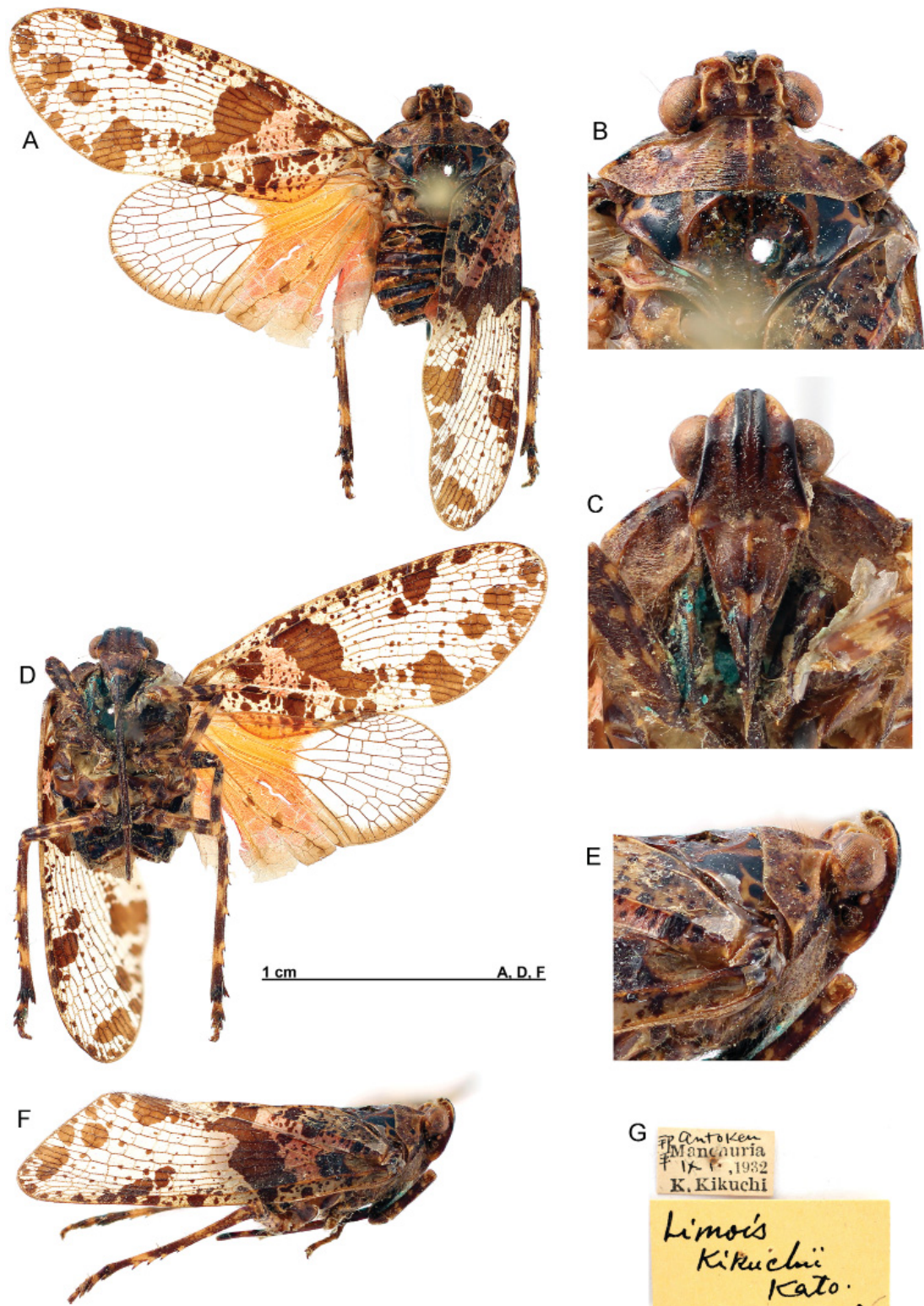
### Material examined

CHINA • 1 ♂ (see Figs 4–5, 14M–Q); Manchuria; 1 Sep. 1932; K. Kikuchi leg.; RBINS • 1 ♀; Mukden; 3 Sept. 1928; FSAG • 1 ♂, 2 ♀♀; Shaanxi, Tongchuan; Sep. 1980; Yun-zhou Jiang & Da-xin Chen leg.; NWAUFU.

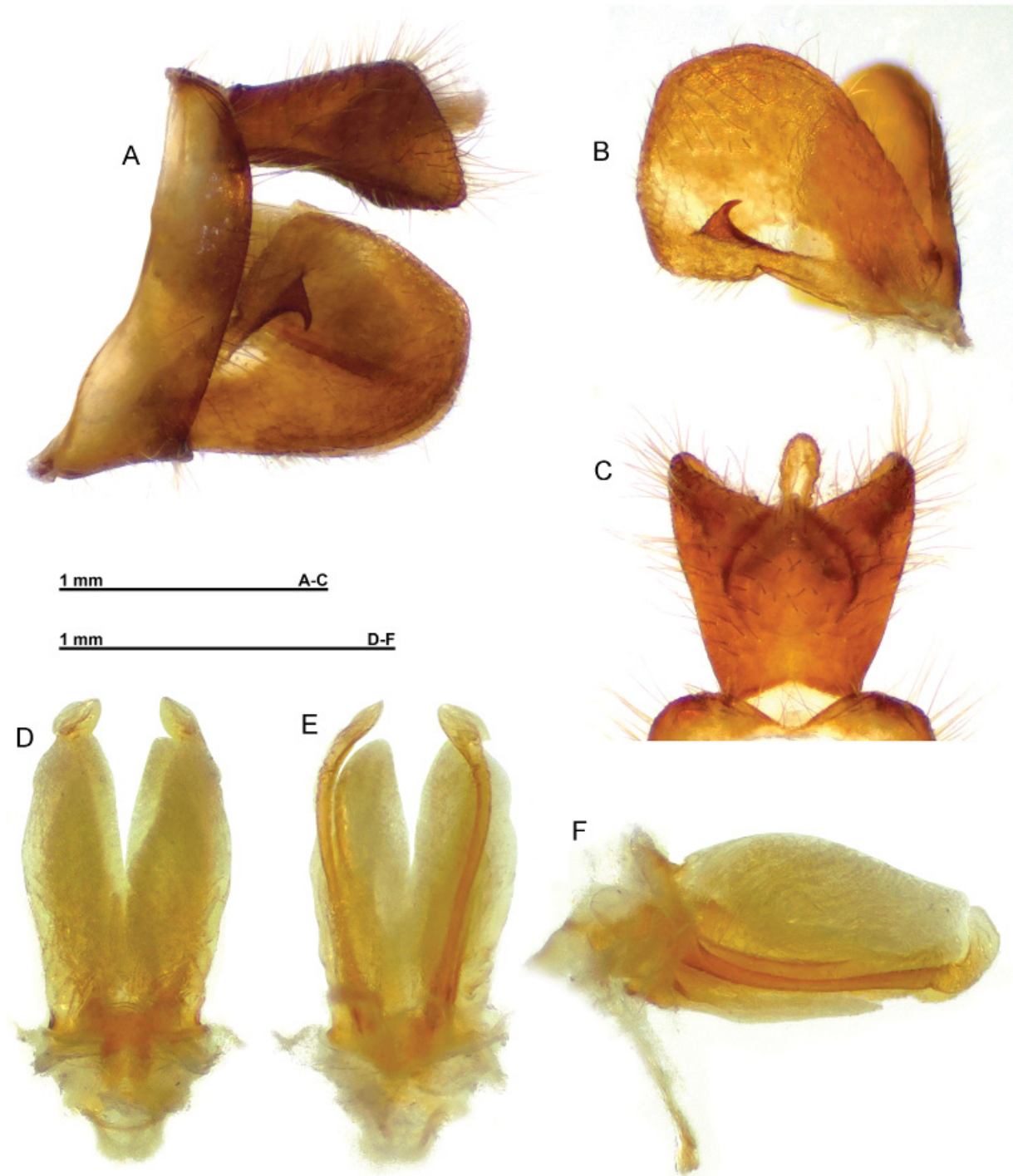
### Description

MEASUREMENTS. Body length: ♀ 9.5–10.5 mm; ♂ 9.4–10 mm. Wingspan: ♀ 37.6–40.5 mm; ♂ 32.5–34.4 mm.

MALE GENITALIA. Laterocaudal margin of pygofer slightly convex (Figs 5A, 14M). Anal tube moderate, apical margin truncate, intersected with dorsal margin at almost right angle in lateral view, epiproct acutely angled apically in dorsal view (Figs 5A, C, 14M). Gonostyli elongate, subtriangular in lateral



**Fig. 4.** *Limois kikuchii* Kato, 1932, Manchuria, K. Kikuchi leg., RBINS, adult male. **A.** Dorsal view. **B.** Head and thorax, dorsal view. **C.** Face. **D.** Ventral view. **E.** Head and thorax, right lateral view (showing reflexed protuberance of the vertex). **F.** Right lateral view. **G.** Labels. Photographs by J. Constant.



**Fig. 5.** *Limois kikuchii* Kato, 1932, Manchuria, K. Kikuchi leg., RBINS, male genitalia. **A.** Left lateral view (except phallic complex). **B.** Gonostylus. **C.** Anal tube, dorsal view. **D.** Aedeagus, dorsal view. **E.** Aedeagus, ventral view. **F.** Aedeagus, left lateral view. Photographs by J. Constant.

view, apically rounded (Figs 5A, B, 14M, N). Endosomal processes about 5.0 times as long as sheath, apical 1/3 exposed, apically sinuate and inflated (Figs 5D–F, 14O–Q). Connective and tectiductus unrecognizable.

### Distribution

China [northern China (Kato 1932, 1933), Shaanxi, Beijing (Liang 2005)], Korea (Kato 1933; Metcalf 1947).

### *Limois sordida* sp. nov.

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Figs 6–7, 15A–D

### Diagnosis

(1) Frons with 3 longitudinal carinae (Fig. 6E); (2) tegmina with along irregular stripe, sinuately extending to anal angle (Fig. 6A–C); (3) gonostyli almost equilateral in lateral view; (4) hindwings pale yellow in basal  $\frac{2}{5}$ , medially without fascia (Fig. 6A–B).

### Etymology

The specific epithet alludes to the sordid color of the clypeus.

### Type material

#### Holotype

CHINA • ♂; Shanxi, Ningwu, Mt. Luyashan; 25 Oct. 2011; Ai-ping Dong leg.; NWAUFU.

#### Paratypes

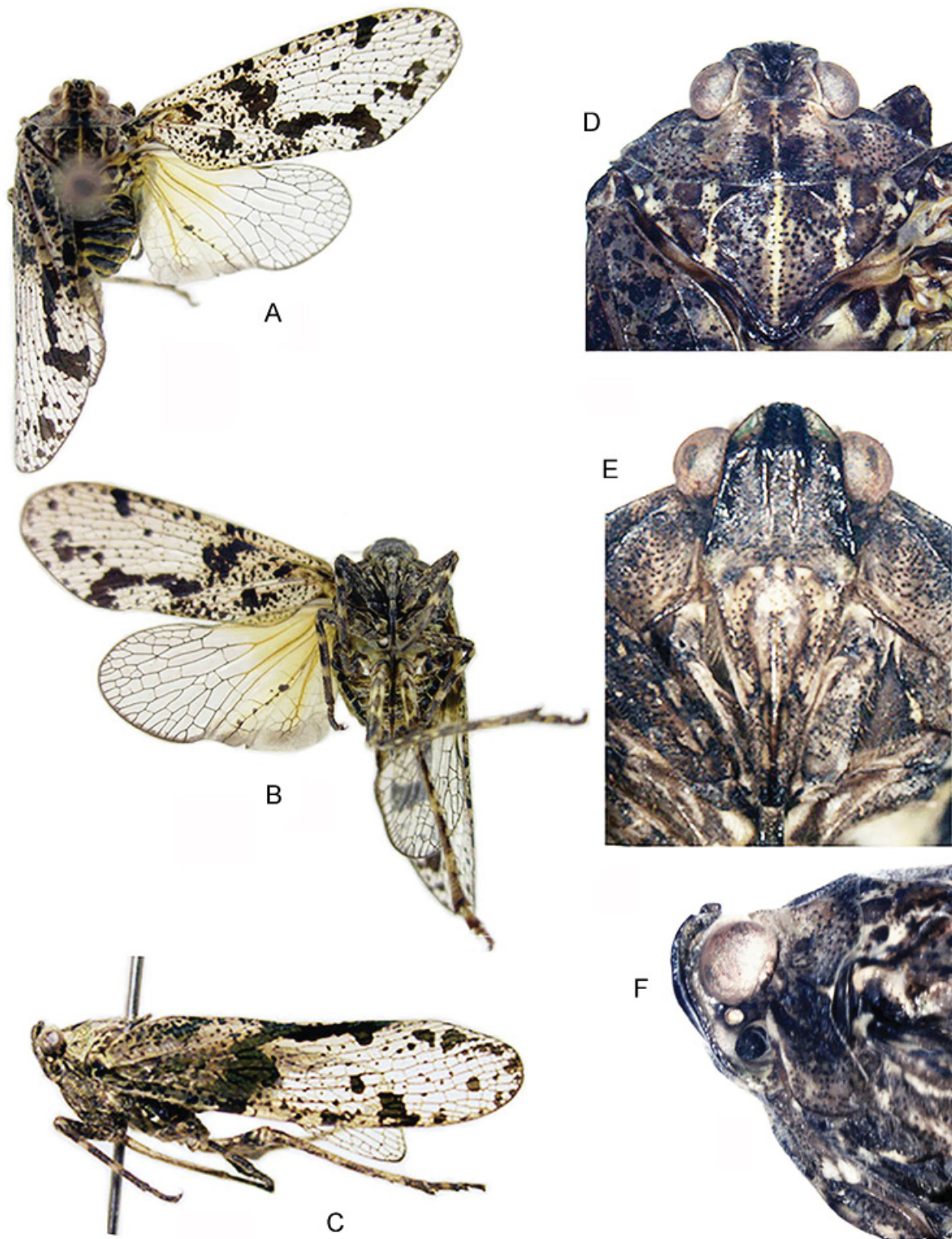
CHINA • 4 ♂♂, 2 ♀♀; same data as holotype; NWAUFU • 2 ♀♀; Beijing, Mt. Baihuashan, Huang Tuo village; 9 Sep. 1960; Fa-sheng Li leg.; CAU • 1 ♂; Beijing, Mt. Baihuashan, Huang Tuo village; 7 Sep. 1960; Ji-kun Yang leg.; CAU • 1 ♂; Beijing, Mt. Baihuashan; 5 Sep. 1961; Fa-sheng Li leg.; CAU • 1 ♂; Hebei, Mt. Xiaowutaishan; 3 Aug. 2011; Jian Yao leg.; IZCAS IOZ(E)2058877 • 1 ♂; Hebei, Mt. Xiaowutaishan; 4 Aug. 2011; Jian Yao leg.; IZCAS IOZ(E)2058878 • 1 ♀; Hebei, Mt. Xiaowutaishan; 3 Aug. 2011; Jian Yao leg.; IZCAS IOZ(E)2058876.

### Description

MEASUREMENTS. Body length: ♀ 10.6–11.4 mm; ♂ 9.2–10.2 mm. Wingspan: ♀ 35.7–36.5 mm; ♂ 31.5–32.7 mm.

HEAD. Including eyes distinctly narrower than pronotum (about 1: 1.7) (Fig. 6D). Vertex quadrangular, about 2 times as broad as an eye, lateral and posterior margins carinate, median carina obscure; cephalic process flattened, not reaching posterior margin of vertex (Fig. 6D, F). Frons medially with 3 longitudinal carinae, the median carina tinier, all not reaching fronto-clypeal suture; clypeus sordid, narrower and shorter than frons, labium elongate, reaching the end of abdomen, median carina on clypeus (Fig. 6E).

THORAX. Thorax macular covered with numerous dark spots, pronotum about 1.6 times as long as vertex in dorsal view, with one longitudinal broken band on each side of median carina, black (Fig. 6D); mesonotum with 3 pairs of dark patches along anterior margin and one dark triangular patch on each lateral area (Fig. 6D).



**Fig. 6.** *Limois sordida* sp. nov., Shanxi, Ningwu, Mt. Luyashan, Ai-ping Dong leg., NWFU, adult male. **A.** Dorsal view. **B.** Ventral view. **C.** Left lateral view. **D.** Head and thorax, dorsal view. **E.** Face. **F.** Head and thorax, left lateral view (showing reflexed protuberance of the vertex).

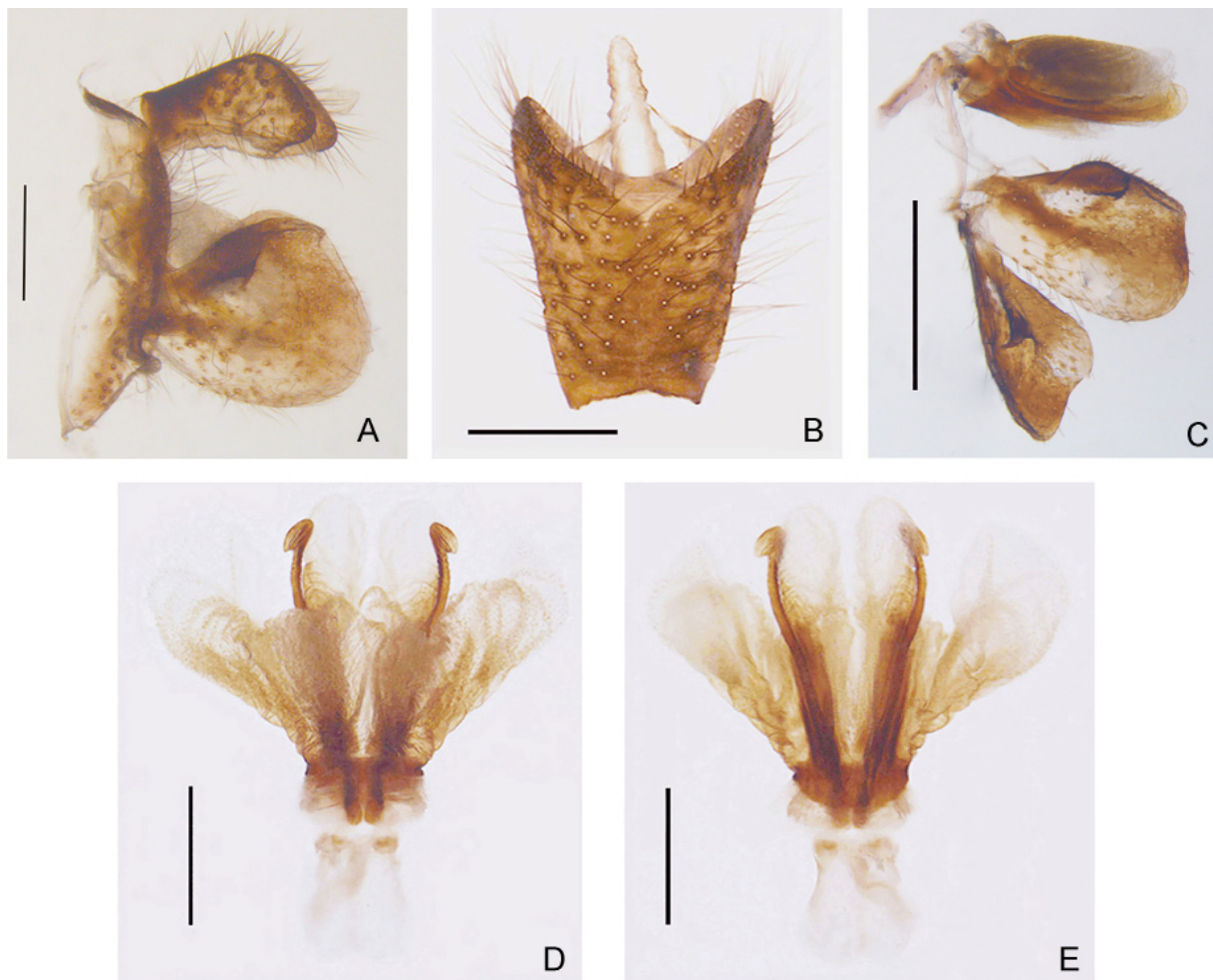
TEGMINA. Brownish yellow on basal  $\frac{2}{3}$  and costal area, with narrow irregular stripe from costal area, extending to anal angle; remaining area of tegmina hyaline with some dark markings, veins ochre brown, about 2.7 times as long as maximum broad (Fig. 6A–C).

HINDWINGS. Pale yellow on basal  $\frac{2}{3}$ , with 4–5 black spots arranged in one oblique row, apical  $\frac{3}{5}$  of hindwings hyaline with a brown band along suture margin (Fig. 6A–B).

LEG. Brown with black rings and stripes. Metatibiae with 5–8 lateral and 6–7 apical spines.

ABDOMEN. Tergites black, posterior margin ochre yellow on each segment (Fig. 6A).

MALE GENITALIA. Pygofer in profile with ventral margin straight, laterocaudal margin slightly convex (Figs 7A, 15A). Anal tube moderate, in lateral aspect reaching level of end of genital plates, ventral margin slightly concave in basal  $\frac{2}{3}$ , apical margin truncate, intersecting with dorsal margin at obtuse angle, epiproct right-angled apically, paraproct slender in dorsal view (Figs 7A–B, 15A). Gonostyli subtriangular in lateral view, rounded apically, apical margin straight in middle, in ventral view plates connected in basal  $\frac{1}{5}$  (Figs 7A, C, 15A–B). Aedeagus reduced, membranous endosoma with a dorsal



**Fig. 7.** *Limois sordida* sp. nov., Shanxi, Ningwu, Mt. Luyashan, Ai-ping Dong leg., NWAFU, male genitalia. **A.** Left lateral view. **B.** Anal tube, dorsal view. **C.** Aedeagus and gonostylus. **D.** Aedeagus, dorsal view. **E.** Aedeagus, ventral view. Scale bars = 0.5 mm.

pair of lobes surrounding a ventral pair of lobes and the sclerotized endosomal processes; the endosomal processes sclerotized over entire length, about 4.0 times as long as sheath, apical  $\frac{1}{3}$  exposed and terminally inflated (Fig. 7C–E, 15C–D). Connective rod-like. Tectiductus large, in lateral view subrectangular, in dorsal view broad, apically rounded and distinctly concave medially (Figs 7C–E, 15A).

### Distribution

China (Shanxi; Hebei, Beijing).

### Remarks

*Limois sordida* sp. nov. is similar to *L. bifasciatus*, *L. emelianovi* and *L. kikuchii*, but differs from *L. bifasciatus* by the frons having three longitudinal carinae (Fig. 6E) (with two longitudinal carina in *L. bifasciatus*); from *L. emelianovi* and *L. kikuchii* it differs by the irregular stripe on tegmina long, sinuately extending to anal angle (Fig. 6A–C) (irregular stripe short and straight, not extending to anal angle in *L. emelianovi* and *L. kikuchii*). Furthermore, it differs from *L. kikuchii* by the gonostyli being almost equilateral in lateral view (Figs 7A, 15A–B) (elongate in *L. kikuchii*); from *L. emelianovi* it differs from the basal  $\frac{2}{5}$  of hindwings pale yellow in both sexes, medially without fascia (Fig. 6A–B) (base of hindwings yellow in male but red in female and medially with a blackish brown fascia in *L. emelianovi*).

### *Limois westwoodii* (Hope, 1843) Figs 8–10, 15E–I

*Lystra westwoodii* Hope, 1843: 133.

*Limois westwoodii* – Stål 1863: 231. — Distant 1906: 200. — Metcalf 1947: 170. — Lallemand 1963: 55. — Nagai & Porion 1996: 22.

### Diagnosis

(1) Frons with 2 longitudinal carinae (Figs 8D, 9D, F), cephalic process of vertex of moderate length, not surpassing anterior margin of pronotum (Figs 8B, F, 9B, H); (2) pronotum and mesonotum olivaceous, pronotum with one longitudinal broken black band on each side of median carina; mesonotum with 3 pairs of dark patches along anterior margin and one irregular patch on each lateral side (Figs 8B, 9B); (3) tegmina with a transverse irregular reddish brown band on basal half and ochraceous on costal area and basal  $\frac{1}{3}$  followed by some brown patches and spots in apical half on hyaline area (Figs 8A, C, E, 9A, E, G); hindwings sanguineous on basal  $\frac{3}{5}$  and hyaline on the apical  $\frac{2}{5}$ , between them a sinuate brown fascia (Figs 8A, C, 9A, E); and (4) abdomen dark, posterior margin whitish on each segment (Figs 8A, 9A).

### Material examined

#### Holotype

BANGLADESH • ♀ (see Fig. 9A–H); Frederick John Parry leg.; OUMNH.

#### Additional material

MYANMAR • 1 ♂; Nat Ma Taung; Oct. 2003; 2000 m; local collector leg.; RBINS (see Figs 8 A–F, 10A–F, 15E–I).

CHINA • 1 ♀; Maku; 20 Nov. 1973; Yun-xing Gan leg.; NWFU HO088506 • 1 ♀; locality unknown; 21 Dec. 1973; Yun-xing Gan leg.; NWFU HO088507.

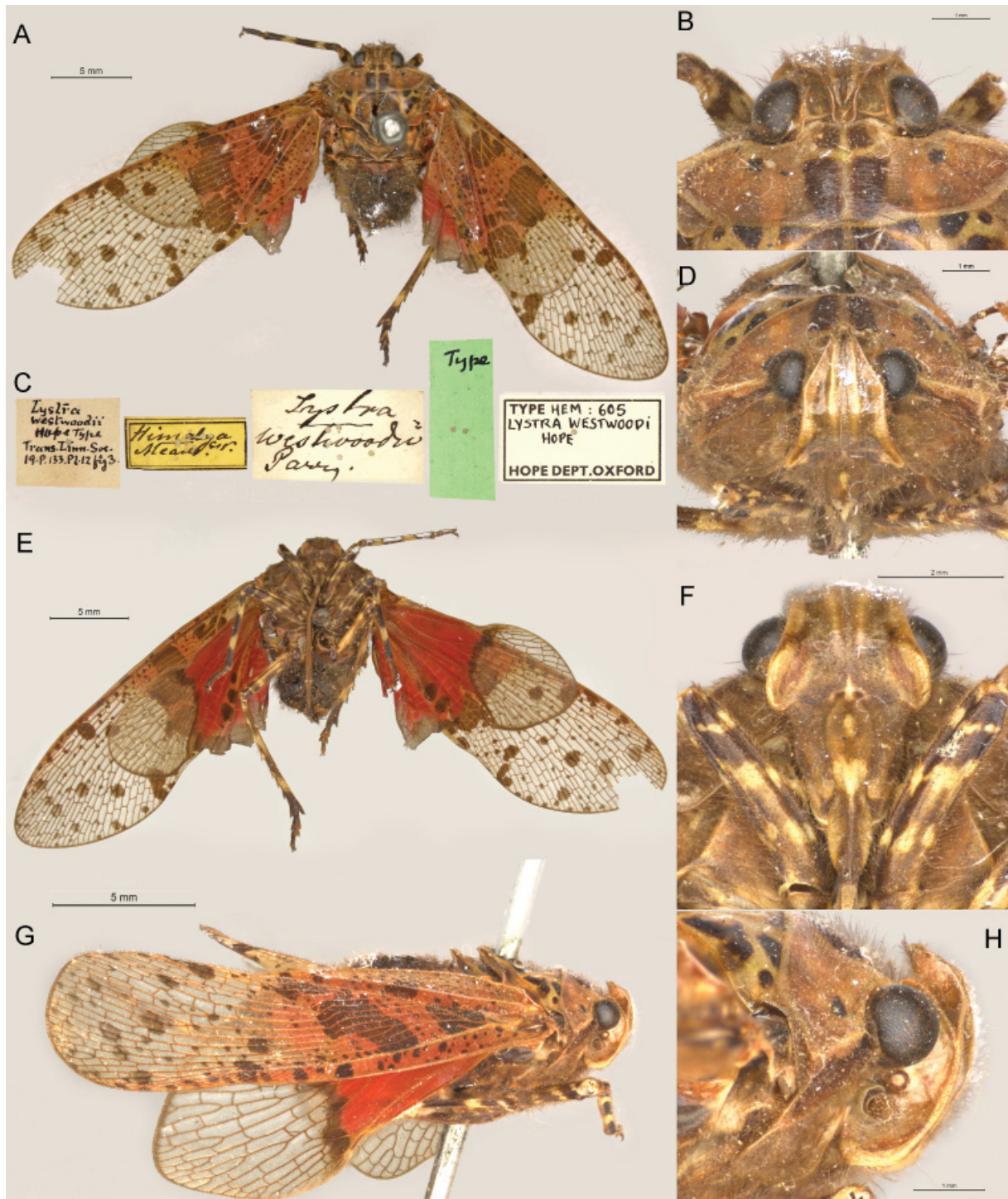
### Description

MEASUREMENTS. Body length: ♀ 12.5–12.6 mm; ♂ 12.4 mm. Wingspan: ♀ 47.5–48.4 mm; ♂ 47 mm.



**Fig. 8.** *Limois westwoodii* (Hope, 1843), Myanmar, Nat Ma Taung, RBINS, adult male. **A.** Dorsal view. **B.** Head and thorax, dorsal view. **C.** Ventral view. **D.** Face. **E.** Left lateral view. **F.** Head and thorax, left lateral view (showing reflexed protuberance of the vertex). Photographs by J. Constant.



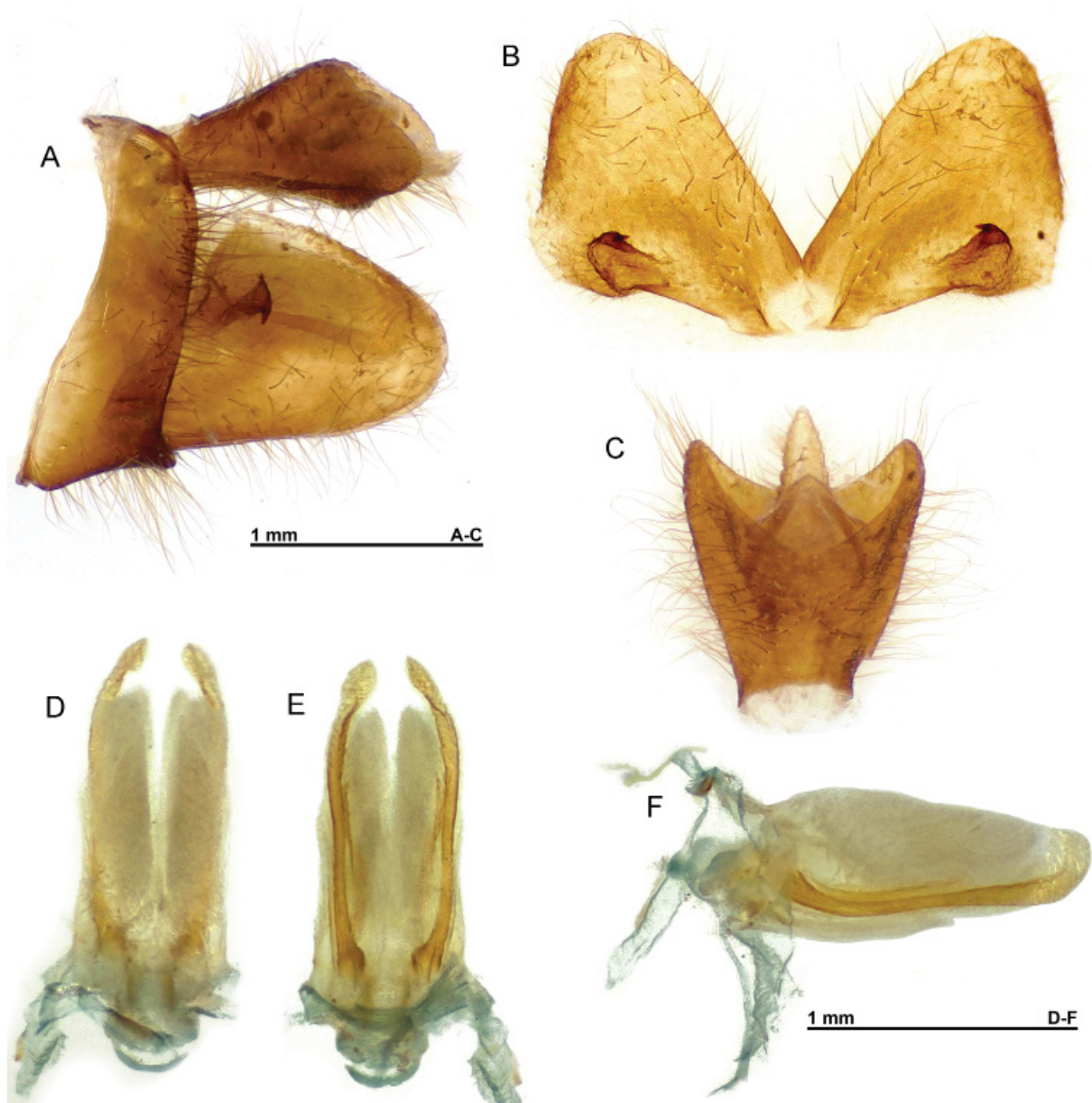


**Fig. 9.** *Limois westwoodii* (Hope, 1843) holotype, adult female. **A.** Dorsal view. **B.** Head and thorax, dorsal view. **C.** Labels. **D, F.** Face. **E.** Ventral view. **G.** Right lateral view. **H.** Head and thorax, right lateral view (showing reflexed protuberance of the vertex). Photographs by K. Child.

MALE GENITALIA. Pygofer in profile with ventral margin slightly concave; laterocaudal margin slightly convex (Figs 10A, 15E). Anal tube moderate, apical margin truncate, intersection with dorsal margin at obtuse angle in lateral view, epiproct acutely angled apically, paraproct long, subulate in dorsal view (Figs 10A, C, 15E). Gonostyli subtriangular, apically rounded in lateral view (Figs 10A, 15E). Endosomal processes about 5.0 times as long as sheath, apical  $\frac{1}{3}$  exposed, apically sinuate and inflated (Figs 10D–F, 15G–I). Tectiductus unrecognizable in lateral view.

### Distribution

China (Xizang), Bangladesh (Hope 1843).



**Fig. 10.** *Limois westwoodii* (Hope, 1843), Myanmar, Nat Ma Taung, RBINS, male genitalia. **A.** Left lateral view (except phallic complex). **B.** Gonostylus, ventral view. **C.** Anal tube, dorsal view. **D–F.** Aedeagus. **D.** Dorsal view. **E.** Ventral view. **F.** Left lateral view. Photographs by J. Constant.



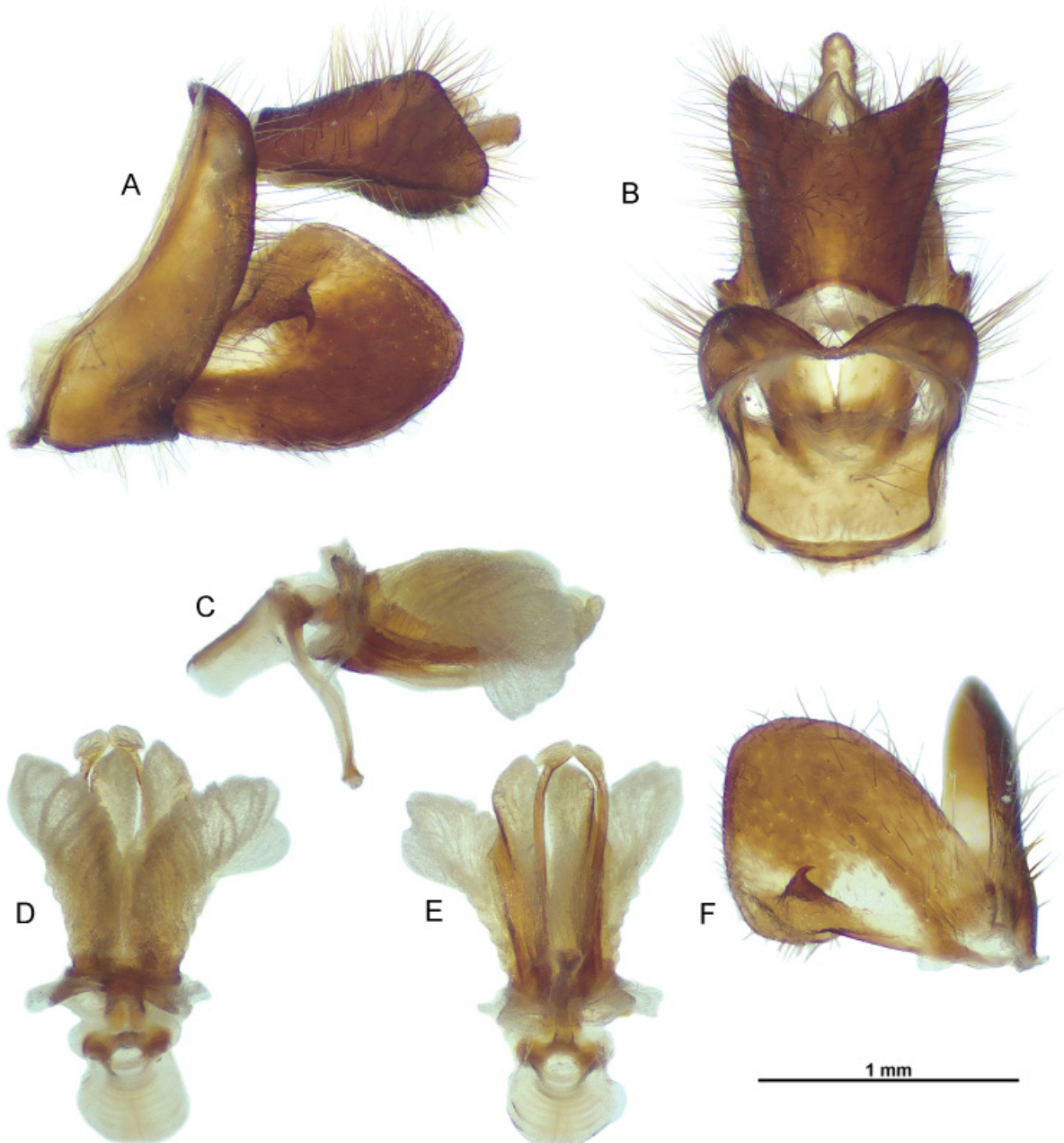
**Fig. 11.** *Limois emelianovi* Oshanin, 1908, Vladivostok, Anufriev leg., RBINS, adult male. **A.** Dorsal view. **B.** Head and thorax, dorsal view. **C.** Adult, ventral view. **D.** Face. **E.** Left lateral view. **F.** Head and thorax, left lateral view (showing reflexed protuberance of the vertex). Photographs by J. Constant.

*Limois emelianovi* Oshanin, 1908  
Figs 11–12, 15J–N

*Limois emelianovi* Oshanin, 1908: 468.

**Material examined**

RUSSIA • 1 ♂ (Figs 11–12, 15J–N); Vladivostok; Aug. 1967; Anufriev leg.; RBINS • 1 ♂; Primorsky Krai; 8 Sept. 1961; J. Vilbaste leg.; FSAG.



**Fig. 12.** *Limois emelianovi* Oshanin, 1908, Vladivostok, Anufriev leg., RBINS, male genitalia. **A.** Left lateral view (except phallic complex). **B.** Anal tube, dorsal view. **C–E.** Aedeagus. **C.** Left lateral view. **D.** Dorsal view. **E.** Ventral view. **F.** Gonostylus. Photographs by J. Constant.

## Description

MEASUREMENTS. Body length: ♂ 9 mm. Wingspan: ♂ 33 mm.

MALE GENITALIA. Pygofer with ventral margin sinuate in lateral view; posterior margin in lateral view slightly convex, emarginate on ventral  $\frac{1}{6}$ ; in dorsal view deeply, roundly emarginate posteriorly (Figs 12A, 15J). Anal tube massive, in lateral view reaching level of apex of gonostyli, ventral margin sinuate, apical margin obliquely truncate, intersecting with dorsal margin at obtuse angle, in dorsal view, widening from base to apex, 1.36 times broader at apex than long in median line, apical margin roundly emarginate in dorsal view; epiproct right-angled apically, paraproct slender in dorsal view (Figs 12A–B, 15J). Gonostyli subtriangular in lateral view, rounded apically, apical margin straight in middle, in ventral view gonostyli connected in basal  $\frac{1}{5}$ , lateral tooth slender, directed posteroventrally, then curved ventrally towards apex (Figs 12A, F, 15J–K). Endosomal processes sclerotized over entire length, about 4.0 times as long as sheath, apical  $\frac{1}{3}$  exposed and terminally membranous and inflated (Figs 12C–E, 15L–N). Connective rod-like. Tectiductus large, in lateral view subrectangular, in dorsal view broad, apically rounded and distinctly concave ventrally (Figs 12C–E, 15L–N).

## Distribution

China (Gansu, Dongbei), Russia (Oshanin 1908; Anufriev 2009), Korea (Doi 1932a, 1932b; Kwon & Huh 2001).

*Limois bifasciatus* Ollenbach, 1928

Fig. 13

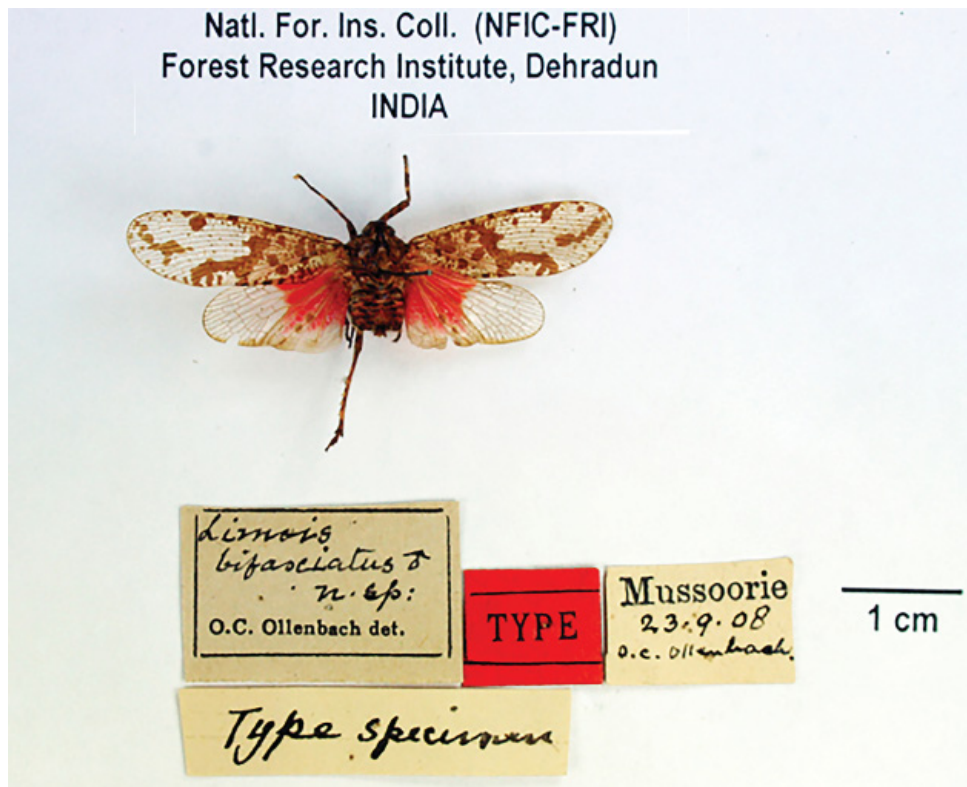


Fig. 13. *Limois bifasciatus* Ollenbach, 1928, holotype, adult male.

*Limois bifasciatus* Ollenbach, 1928: 281.

### Material examined from photograph

INDIA • 1 ♂, holotype of *Limois bifasciatus* (see Fig. 13); Mussoorie United Provinces; O.C. Ollenbach leg.; O.C. Ollenbach det.; FRI-NFIC.

### Distribution

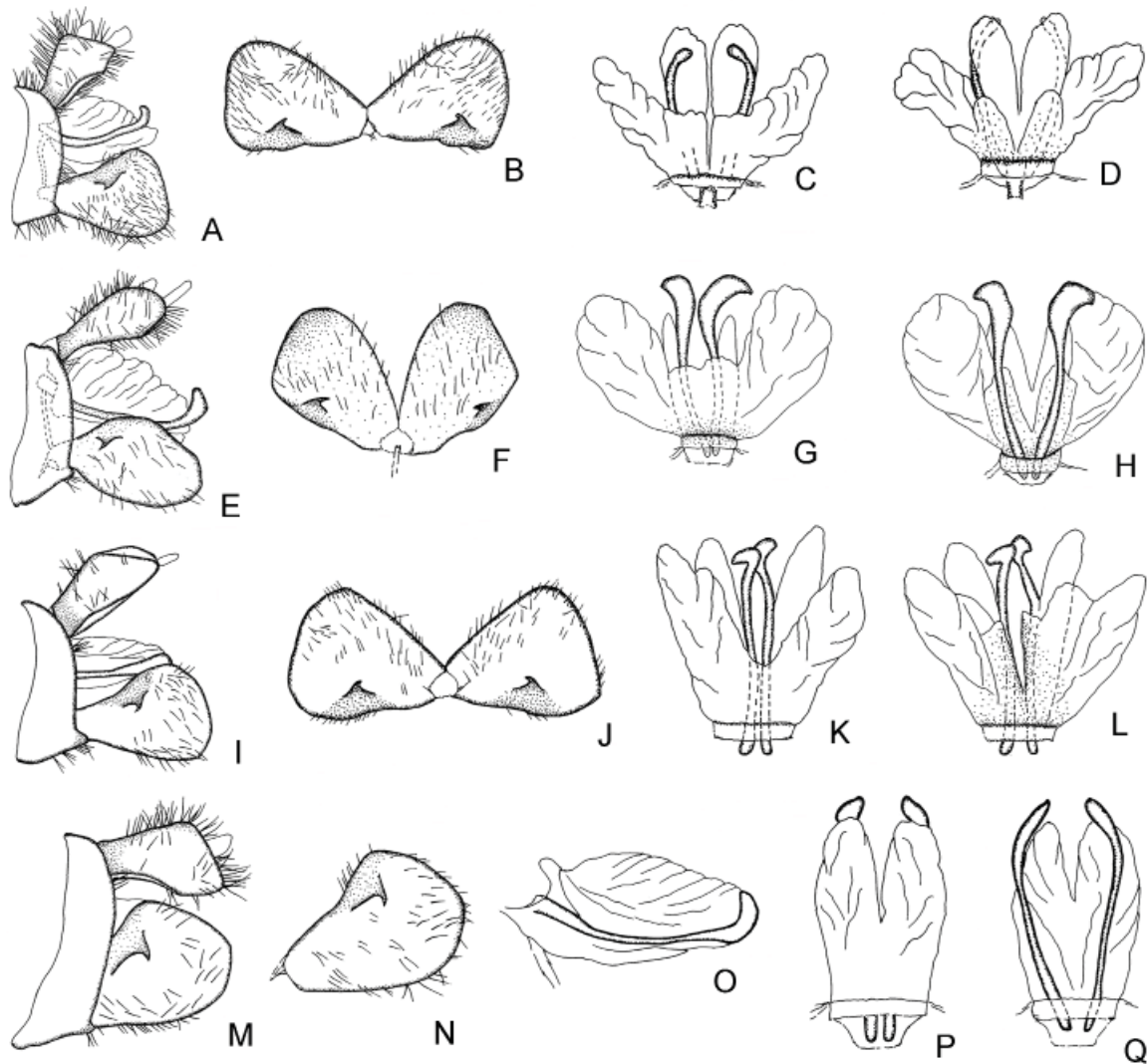
India.

### Key to species of the genus *Limois* Stål, 1863

1. Frons with 3 longitudinal carinae (Figs 1E–F, 4C, 6E, 11D) ..... 2  
– Frons with 2 longitudinal carinae (Figs 2E, 3B, 8D, 9D–F) ..... 5
2. Pronotum with one dark irregular patch along the posterior margin on each lateral area (Fig. 11B); base of hindwings yellow in male and red in female (Fig. 11A, C) ..... *L. emelianovi* Oshanin, 1908  
– Pronotum without one dark irregular patch along the posterior margin on each lateral area (Figs 1D, 4B, 6D); base of hindwings concolorous in both sexes (Figs 1A–B, 4A, D, 6A–B) ..... 3
3. Pronotum brown (Fig. 4B); genital styles distinctly elongate, subtriangular in lateral view (Fig. 5A–B) ..... *L. kikuchii* Kato, 1932  
– Pronotum purplish red or dark brown (Figs 1D, 6D); genital styles short, almost equilateral in lateral view (Figs 1H, 7A, C) ..... 4
4. Pronotum purplish red (Fig. 1D); thorax sparsely covered with few dark spots (Fig. 1D); irregular stripe in tegmina short and straight, not extending to anal angle (Fig. 1A–C); apical half of endosomal processes exposed (Figs 1K–L, 14C–D) ..... *L. chagyabensis* Chou & Lu, 1981  
– Pronotum dark brown (Fig. 6D); thorax densely covered with numerous dark spots (Fig. 6D); irregular stripe in tegmina long, sinuately extending to anal angle (Fig. 6A–C); apical 1/3 of endosomal processes exposed (Figs 7D–E, 15C–D) ..... *L. sordida* sp. nov.
5. Thorax densely covered with numerous dark spots (Fig. 2D); tegmina submedially without broad irregular band (Fig. 2A) ..... *L. guangxiensis* Chou & Wang, 1985  
– Thorax with dark spots sparse or not (Figs 3A, 8B, 9B); tegmina submedially with broad irregular band (Figs 3D, 8A, C, E, 9A, G) ..... 6
6. Pronotum with 2 dark spots anteriorly, without one longitudinal broken black band on each side of median carina (Fig. 3A) ..... *L. hunanensis* Chou & Wang, 1985  
– Pronotum without dark spots anteriorly, with one longitudinal broken black band on each side of median carina (Figs 8B, 9B) ..... 7
7. Tegmina with an oblique narrow fascia from apex to disc ..... *L. bifasciatus* Ollenbach, 1928  
– Tegmina without an oblique narrow fascia from apex to disc (Figs 8A, C, E, 9A, G) .....  
..... *L. westwoodii* (Hope, 1843)

## Discussion

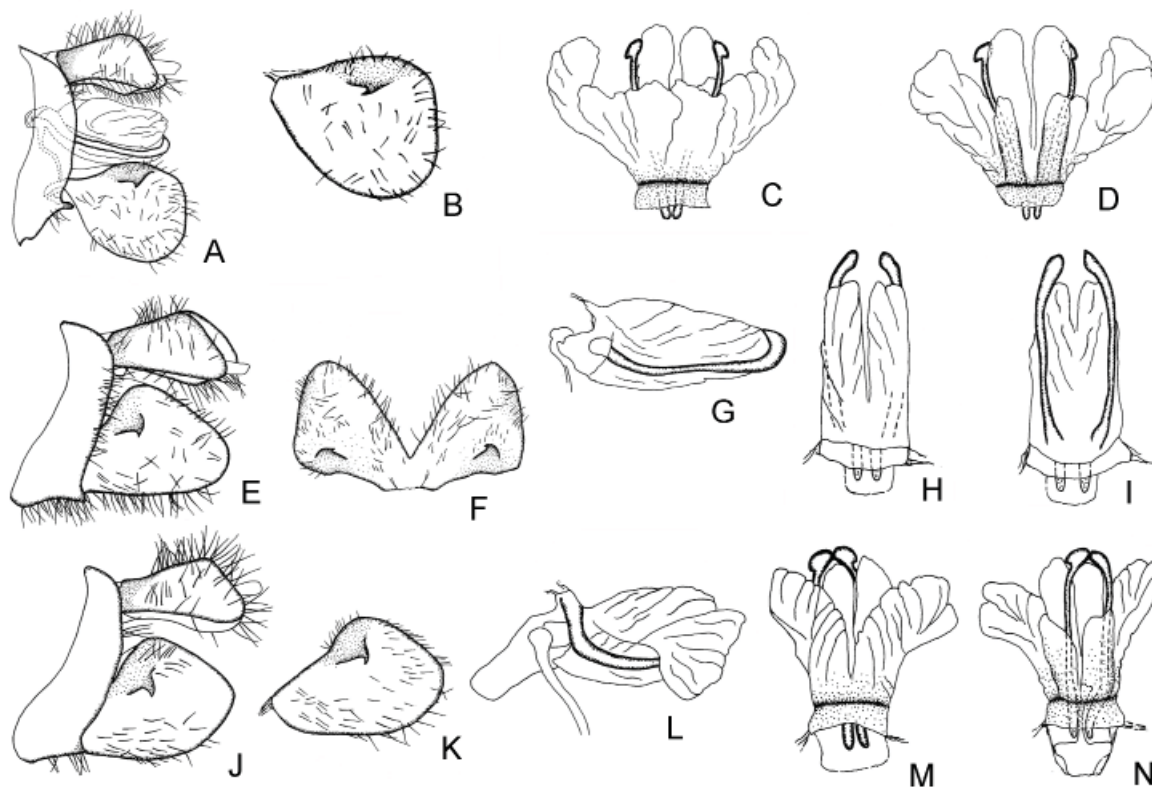
External morphological characters were generally used for species identification in this genus, however, male genitalia characters of most *Limois* species remain poorly understood so far, making identification of species in this genus difficult. For example, three previously described species, *L. kikuchii*, *L. westwoodii* and *L. bifasciatus* look similar in external morphology. In this study, we only secured the photo of the male holotype of *L. bifasciatus*; It was not sufficient to confirm the status or propose synonym(s) here, but we provide photographs and hand drawings of male genitalia of several species after checking actual type specimens, with the intent of providing further information toward the taxonomy of this



**Fig. 14.** Male genitalia. **A–D.** *Limois chagyabensis* Chou & Lu, 1981, NWAUFU HO088523. **A.** Left lateral view. **B.** Gonostylus, ventral view. **C.** Aedeagus, dorsal view. **D.** Aedeagus, ventral view. – **E–H.** *Limois guangxiensis* Chou & Wang, 1985, NWAUFU HO088509. **E.** Left lateral view. **F.** Gonostylus, ventral view. **G.** Aedeagus, dorsal view. **H.** Aedeagus, ventral view. – **I–L.** *Limois hunanensis* Chou & Wang, 1985, NWAUFU HO088511. **I.** Left lateral view. **J.** Gonostylus, ventral view. **K.** Aedeagus, dorsal view. **L.** Aedeagus, ventral view. – **M–Q.** *Limois kikuchii* Kato, 1932, Manchuria, K. Kikuchi leg., RBINS. **M.** Left lateral view. **N.** Gonostylus, left lateral view. **O.** Aedeagus, left lateral view. **P.** Aedeagus, dorsal view. **Q.** Aedeagus, ventral view.

genus. Some drawings of male genitalia of the *Limois* species look similar at first sight, for example, the Figs 14A, E, I, M and Figs 15A, E, J. However, the pygofer in lateral view, particularly the angles produced by anal tube apically and dorsally, the shape of gonostyli, and the features of apical part of the endosomal processes are specific in each species, making them useful for identifying the species of this genus.

Although Urban & Cryan (2009) investigated the phylogeny of Fulgoridae based on DNA nucleotide sequence data, only one species, *Neolieftinckana fuscata* (Guérin-Méneville, 1838) from Papua New Guinea, was selected as an example of the tribe Limoisini (in Aphaeninae). Results show *Neolieftinckana fuscata* has a closer relationship with *Birdantis blötei* Lallemand, 1959 (in Poiocerini within the subfamily Poiocerinae). The samples from the Old World are rather limited and most fulgorid subfamilies and tribes from existing classifications of Fulgoridae were non-monophyletic in Urban & Cryan's (2009) investigation (including Aphaeninae and Poiocerini in Poiocerinae). Hence the analysis of Urban & Cryan (2009) cannot be used to discuss the status of Limoisini, as well as the phylogenetic relationships within *Limois* and with other genera of the family. The genus *Limois* appears mainly distributed in the Sino-Japanese realm and crossed the frontier into the tropical area for only three species: *L. westwoodii*, *L. guangxiensis* and *L. hunanensis*. China possesses the richest species diversity of this genus now;



**Fig. 15.** Male genitalia. A–D. *Limois sordida* sp. nov., Shanxi, Ningwu, Mt. Luyashan, Ai-ping Dong leg., NWAFU. A. Left lateral view. B. Gonostylus, left lateral view. C. Aedeagus, dorsal view. D. Aedeagus, ventral view. – E–I. *Limois westwoodii* (Hope, 1843), Myanmar, Nat Ma Taung, RBINS. E. Left lateral view. F. Gonostylus, ventral view. G. Aedeagus, left lateral view. H. Aedeagus, dorsal view. I. Aedeagus, ventral view. – J–N. *Limois emelianovi* Oshanin, 1908, Vladivostok, Anufriev leg., RBINS. J. Left lateral view. K. Gonostylus, left lateral view. L. Aedeagus, left lateral view. M. Aedeagus, dorsal view. N. Aedeagus, ventral view.



our recent collecting in Chinese fauna also show that *Limois* species are widespread in this area and more species need to be described in future studies. Moreover, we suggest more information, including molecular and morphological studies, as well as host plants investigations, will be helpful for better understanding the classification and evolution of *Limois*.

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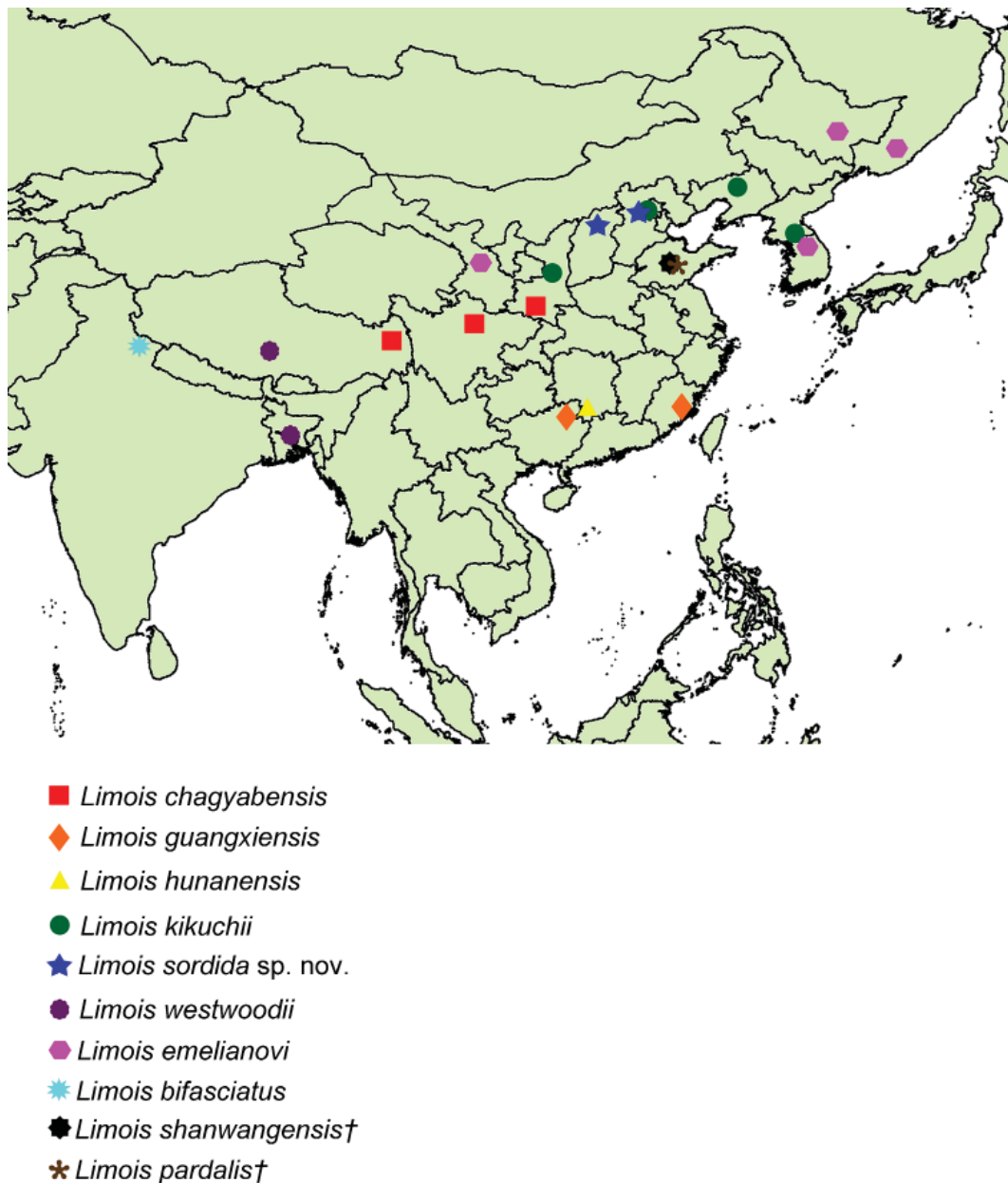


Fig. 16. Distribution map for species of *Limois* Stal, 1863.

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