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Review of the genus *Anasta* Emeljanov (Hemiptera: Dictyopharidae: Hastini) from the Australasian region

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Abstract

The dictyopharid planthopper genus *Anasta* Emeljanov from the Australasian region is revised to include six species including a new one: *A. australiaca* (Lallemand, 1935) **comb. nov.** (North Australia), *A. lobosa* **sp. nov.** (Papua New Guinea), *A. minuta* (Lallemand, 1935) **comb. nov.** (Timor, Indonesia), *A. prognatha* (Distant, 1906) (North Australia, Papua New Guinea), *A. timorina* (Lallemand, 1935) (Timor, Indonesia), and *A. vitiensis* Emeljanov et Wilson, 2009 (Fiji). Descriptions or redescriptions of *A. australiaca*, *A. lobosa* sp. nov., and *A. prognatha* are provided together with dorsal habitus and structural illustrations of male genitalia. A key to the species of the genus and distribution map are provided. The biogeography of the genus is discussed.

Key words: Taxonomy, biogeography, new species, new combination, Australasian region

Introduction

The dictyopharid fauna of the Australasian region remains inadequately studied. Total number of 36 species in 17 genera/subgenera was mainly recorded in Australia, New Guinea, and those parts of Indonesia east of the Wallace Line (Fletcher 2009). This number of known species obviously represents only a small fraction of the actual diversity of the whole dictyopharid fauna considering the vast territory and various complex habitats of the Australasian region. Importantly, many of them lack standard revisionary studies, and monophyly of many genera and higher taxa never have been tested cladistically (Liang & Song 2012).

Within Dictyopharinae, the tribe Hastini Emeljanov is a small group containing six genera and no more than 15 species which are distributed in the Australasian region, and other three species in two genera restricted to the Neotropical region (Emeljanov 2008, 2011; Bourgoin 2013). The tribe is likely to be an unnatural group which needs be revised further in near future.

The genus *Anasta* was established by Emeljanov (2008) to comprise two species, *Dictyophara prognatha* Distant, 1906 (type species) from Queensland, Australia, and *Dictyophara timorina* (Lallemand, 1935) from Timor, Indonesia. Emeljanov & Wilson (2009) added the third species, *Anasta vitiensis* from Fiji, and first described and illustrated the male genitalia of the genus. *Anasta* was assigned in Hastini by Emeljanov (2008).

In the present paper, we transfer *Dictyophara australiaca* (Lallemand, 1935) and *Dictyophara minuta* (Lallemand, 1935) to *Anasta*, and describe a new species *Anasta lobosa* sp. nov. from Papua New Guinea. Photographs and descriptions (or redescriptions) of three species are provided together with structural illustrations of male genitalia for the first time. A distribution map and key to the species of the genus are provided.

Material and methods

The male genitalia were cleared in 10% KOH at room temperature for ca. 12 hours, rinsed in distilled H_2O, then transferred to glycerol for examination.

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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 Helicon Focus software, and improved with the Adobe Photoshop CS5 software.

The specimens studied in the course of this work are deposited in the following institutions whose names are abbreviated in the text as follows: American Museum of Natural History, New York, USA (AMNH), and Bernice Pauahi Bishop Museum, Honolulu, HI, USA (BPBM).

The morphological terminology used in this study follows Anufriev & Emeljanov (1988) for external morphology including venation of the forewings, Bourgoin & Huang (1990) for male genitalia.

Taxonomy

Family Dictyopharidae Spinola, 1839

Subfamily Dictyopharinae Spinola, 1839

Tribe Hastini Emeljanov, 1983

Genus *Anasta* Emeljanov, 2008

Anasta Emeljanov, 2008: 370**.**

Type species: *Dictyophara prognatha* Distant, 1906.

Diagnostic characters. General color viridescent or greenish-ochraceous, without colorful stripes on head and thorax; cephalic process gradually tapering to apex; vertex with lateral carinae prominent, gradually converging forwards, median carina only distinct at base; frons with lateral and intermediate carinae prominently ridged, nearly parallel from frontoclypeal suture to anterior margins of eyes and slightly narrowing toward apex, median carina distinct, but more or less weak apically; pronotum with median carina sharp and high, lateral carinae distinct but weakened in posterior part; mesonotum tricarinate, lateral carinae nearly parallel; forewings hyaline, stem of Sc+R and M about half as long as basal cell, stigmal area distinct; legs relatively short, fore femora not flattened and dilated; hind tibiae with 7 apical teeth; aedeagus with a pair of comparatively short endosomal processes; phallobase membranous and inflated apically, with paired lobes, without spines.

Description. General color viridescent in fresh specimens and greenish-ochraceous in dried ones.

Cephalic process (Figs 1, 2, 4, 7, 10, 13) in front of eyes short or moderately elongate and gradually tapering to apex. Vertex (Figs 1, 2, 4A, 7A, 10A, 13A) broadest at base, lateral carinae prominent, gradually converging forwards, with a bend-depression before eyes, apex more or less truncate, not acuminate; posterior margin ridged, angularly and broadly concave; median carina only distinct on a bulge at base. Frons (Figs 4B, 7B, 10B, 13B) elongate, lateral and intermediate carinae prominently ridged, nearly parallel from frontoclypeal suture to anterior margins of eyes and slightly narrowing toward apex; median carina distinct, more or less weak apically and maybe invisible at apex. Clypeus convex at middle, with distinct median carina. Rostrum short, reaching to hind coxae. Compound eyes oval and large. Ocelli relatively large, reddish. Antennae with very small scape; pedicel large and subglobose, with more than 50 distinct sensory plaque organs distributed over entire surface; flagellum long, setiform.

Pronotum (Figs 1, 2, 4A, 7A, 10A, 13A) distinctly shorter than mesonotum medially, narrow anteriorly, broad posteriorly; anterior margin centrally slightly arched, lateral marginal areas straight and sloping with two long longitudinal carinae on each side between eyes and tegulae, posterior margin arcuately concave; median carina sharp and high, with a big lateral pit on each side, lateral carinae distinct but weakened in posterior part. Mesonotum (Figs 1, 2, 4A, 7A, 10A, 13A) tricarinate, lateral carinae nearly parallel, slightly incurved anteriorly. Forewings (Fig. 3) hyaline, exceeding tip of abdomen, with ratio of length to width about 3:1; stem of Sc+R and M about half as long as basal cell; generally less netted veins on apical area, apical margin with 12–15 cells; stigmal area distinct, with 0–2 transverse veins. Legs relatively short, fore femora not flattened and dilated; hind tibiae with

4–5 (mainly 4) black-tipped lateral spines and 7 black-tipped apical teeth; hind tarsomeres I with 16–20 (mainly 16–17) and tarsomeres II with 11–16 (mainly 13) black-tipped apical teeth, respectively.

Male genitalia with pygofer (Figs 5A–C, 8A–C, 11A–C) very narrow, ventrally distinctly broader than dorsally, posterior margin somewhat convex in lateral view. Gonostyles (Figs 5D, 8D, 11D) symmetrical, base narrow, expanded towards apex, broadest subapically in lateral view; upper margin with a dorsally directed, black-tipped process at apex; outer upper edge with a ventrally directed, hook-like process near middle. Aedeagus (Figs 6, 9, 12) with a pair of comparatively short endosomal processes; phallobase membranous and inflated apically, with paired lobes, without spines. Segment X (Figs 5A, C, 8A, C, 11A, C) oblong, basal and apical ventral margins slightly protruded ventrad in lateral view; apical dorsal margin deeply excavated in dorsal view to accommodate anal style; anal style relatively large.

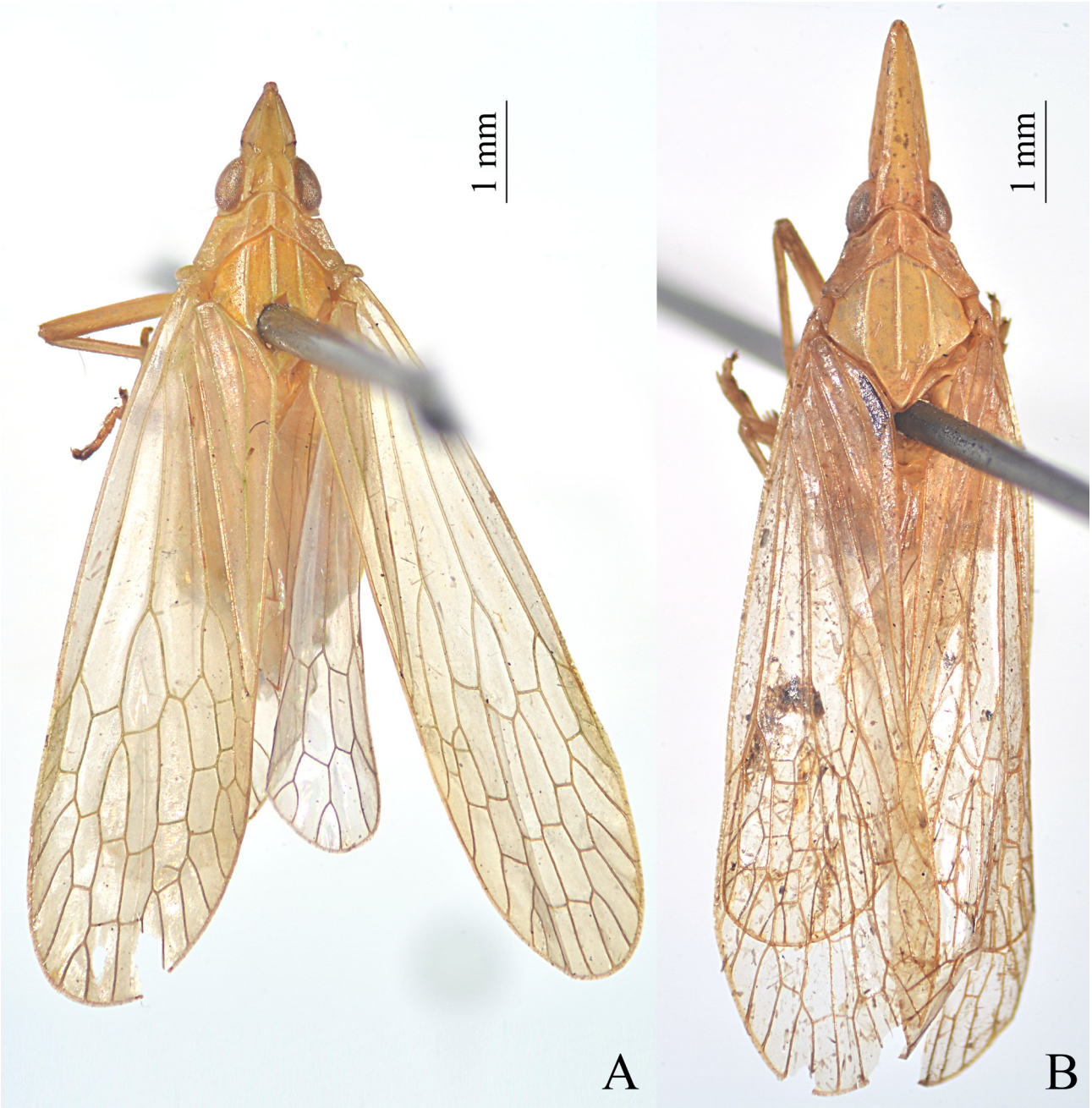

FIGURE 1. Dorsal habitus of *Anasta* species. A. *A. australiaca* (Lallemand) comb. nov., male; B. *A. lobosa* sp. nov., male.

FIGURE 2. Dorsal habitus of *Anasta* species. A. *A. prognatha* (Distant), male; B. *A. vitiensis* Emeljanov & Wilson, male.

Remarks. Externally, *Anasta* is very similar to *Dictyophara* s. str. Germar, 1833 in many morphological characters, but a long conjunct stem of Sc+R and M in the forewings and different female genitalia in *Anasta* make it be assigned to the tribe Hastini Emeljanov, 1983 (Emeljanov 2011). Geographically, *Anasta* is distributed in the Australasian region, while *Dictyophara* is restricted in the Palearctic region (Emeljanov 2004; Song & Liang 2008).

Anasta can be distinguished from Australasian genus *Articrius* Emeljanov, 2008 by the cephalic process relatively narrow, gradually tapering to apex; and the lateral carinae of mesonotum nearly parallel, not bifurcated.

Distribution. Australasian region.

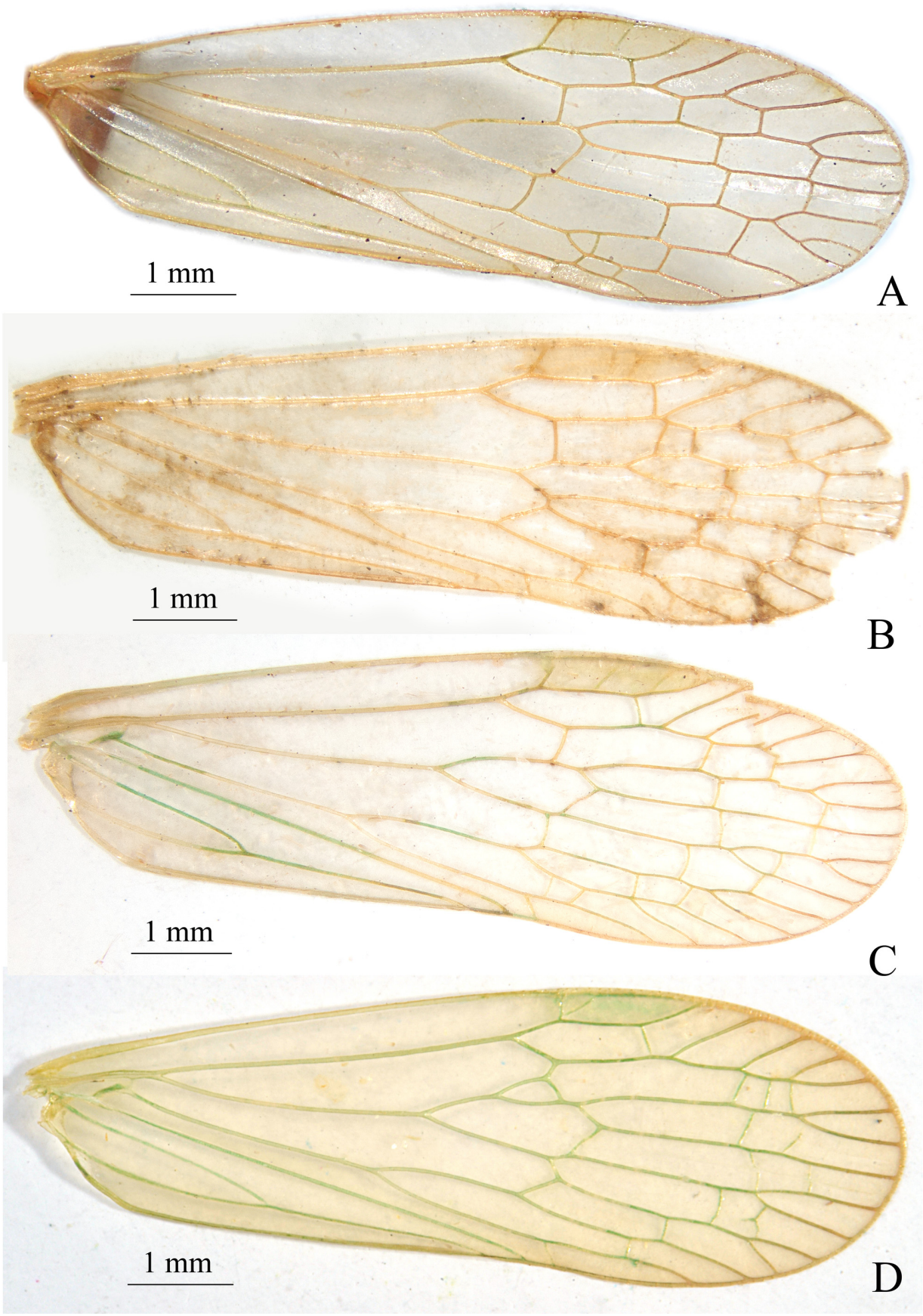

FIGURE 3. Forewing of *Anasta* species. *A. australiaca* (Lallemand) comb. nov.; B. *A. lobosa* sp. nov.; C. *A. prognatha* (Distant); D. *A. vitiensis* Emeljanov & Wilson.

Key to the species of the genus *Anasta* Emeljanov

1. Forewings with M vein first bifurcated to M1+2 and M3+4 veins distinctly beyond bifurcation of CuA, nearly abreast with Sc+R (Fig. 3B) . . . . . *A. lobosa* **sp. nov.**
- Forewings with M vein first bifurcated to M1+2 and M3+4 veins near bifurcation of CuA, distinctly ahead of Sc+R (Fig. 3A, C, D) 2
2. Cephalic process distinctly short, vertex with the ratio of length in central line to width in base (1.65–1.72):1 (Fig. 4A) . . . . . *A. australiaca (*Lallemand*)* comb. nov.
- Cephalic process long, vertex with the ratio of length in central line to width in base more than 2:1 3
3. Vertex with the ratio of length in central line to width in base (2.03–2.66):1. 4
- Vertex with the ratio of length in central line to width in base more than 3:1 5
4. Cephalic process distinctly long, nearly equally wide before and after contraction of vertex; aedeagus with ventrolateral lobes large and long (Fig. 10A) . . . . . *A. prognatha* (Distant)
- Cephalic process relatively short, narrower after contraction of vertex; aedeagus with ventrolateral lobes distinctly short and small (Fig. 13A) . . . . . *A. vitiensis* Emeljanov & Wilson
5. Cephalic process distinctly long; vertex with media carina long and prominent . . . . . *A. minuta* (Lallemand) comb. nov.
- Cephalic process relatively short; vertex with media carina short and weak . . . . . *A. timorina* (Lallemand)

Anasta australiaca (Lallemand, 1935) comb. nov.
(Figs 1A, 3A, 4–6)

Fulgora australiaca Lallemand, 1935: 674, Figs 16, 17.
Dictyophara australiaca (Lallemand): Metcalf, 1946: 149.

Redescription. Body length (from apex of cephalic process to tip of forewings): ♂ 9.9–10.5 mm; length of head: 1.4–1.6 mm; width of head (including eyes): 1.1–1.2 mm; length of forewings: 7.8–8.1 mm.

Cephalic process (Fig. 4A–C) in front of eyes distinctly short and upturned. Vertex (Fig. 4A) with the ratio of length in central line to width in base (1.65–1.72):1; median carina distinct and sharp between eyes. Frons (Fig. 4B) elongate, lateral and intermediate carinae ridged, median carina distinct, more or less weak apically and or lacking apically. Forewings (Fig. 3A) with stigmal area obscure viridescent, with 0–2 transverse veins.

Male genitalia with gonostyles (Fig. 5D) large and broad, apex with a small obtuse process; upper process elongate, slightly curved inwards, acute apically. Aedeagus (Fig. 6A–C) large and robust, dorsal part and bases of ventral and lateral parts on phallobase sclerotized and pigmented, the remainder membranous; dorsal part elongate, V-shaped apically, with a pair of small sclerotized apical processes, directed posteriorly in dorsal view, the base of processes membranous sac-like and inflated inwards; ventrolateral parts produced in a pair of large, sac-like and inflated lobes, transversely prolonged: rounded in middle and tapered at each end, dorsal end more or less sclerotized, directed posteriorly, ventral end elongated, incurved ventrally and crossed each other in ventral view; ventral part with a small lobe in middle under the ventrolateral lobes. Segment X (Fig. 5A) relatively broad and large, lateral margin somewhat diverging towards apex, with the ratio of length to width in base about 1.3:1 in dorsal view; ventral apical margin truncated and straight.

Material examined. AUSTRALIA: 2♂, North Queensland, Lockirbie, 14–17.VII.1948, L.J. Brass (Archbold Exped., AMNH).

Remarks. This species is externally similar to *A. vitiensis* Emeljanov & Wilson, but can be distinguished from the latter by the shorter cephalic process and the bigger ventrolateral lobes in aedeagus. See also the key for identification.

Distribution. Australia (North Queensland).

Anasta lobosa sp. nov.
(Figs 1B, 3B, 7–9)

Diagnosis. The new species is similar to *A. minuta* (Lallemand), but can be separated from the latter by the relatively short cephalic process, and the forewings with M vein first bifurcated to M_{1+2} and M_{3+4} nearly abreast with bifurcation of Sc+R, distinctly beyond CuA.

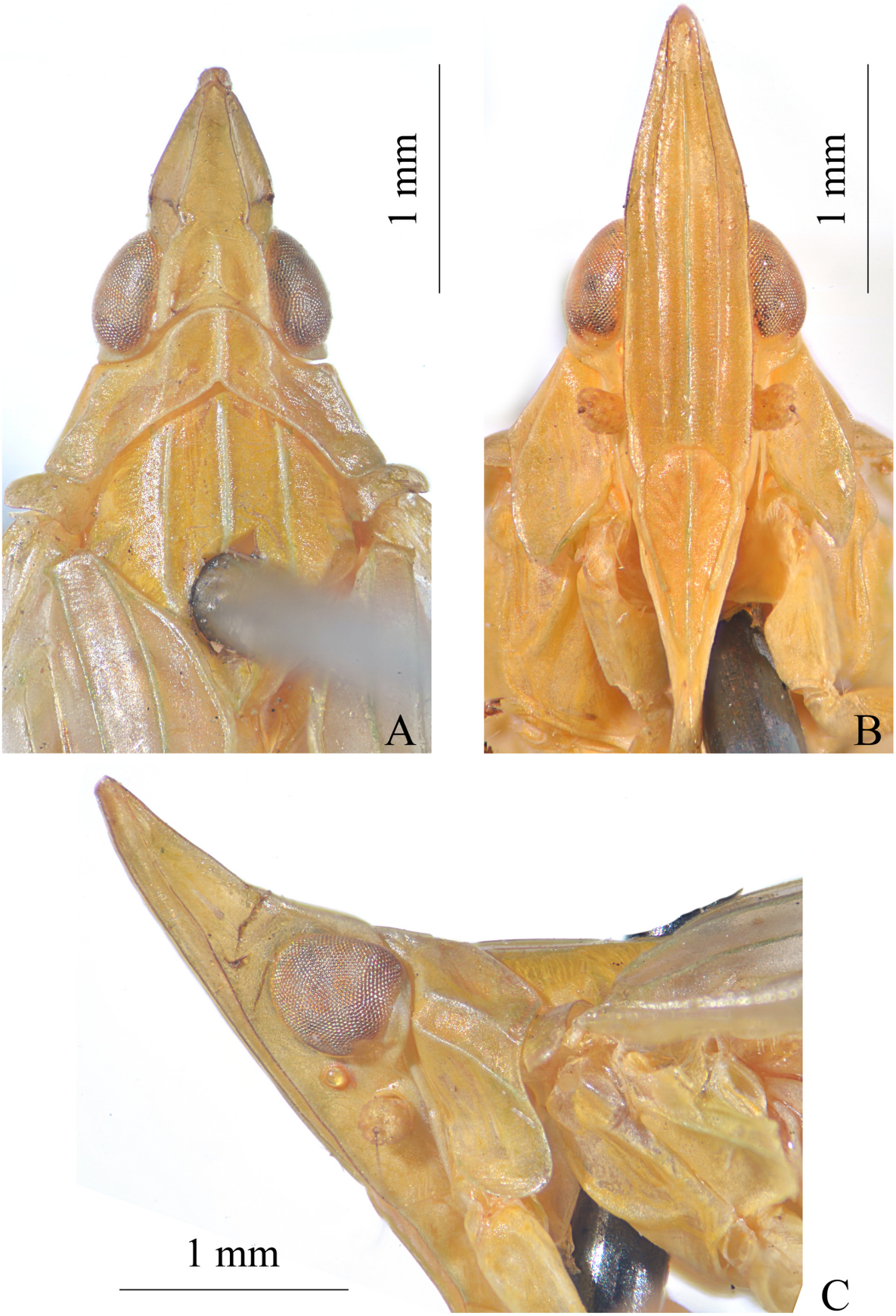

FIGURE 4. *A. australiaca* (Lallemand) comb. nov. A. head, pronotum and mesonotum, dorsal view; B. same, ventral view; C. same, lateral view.

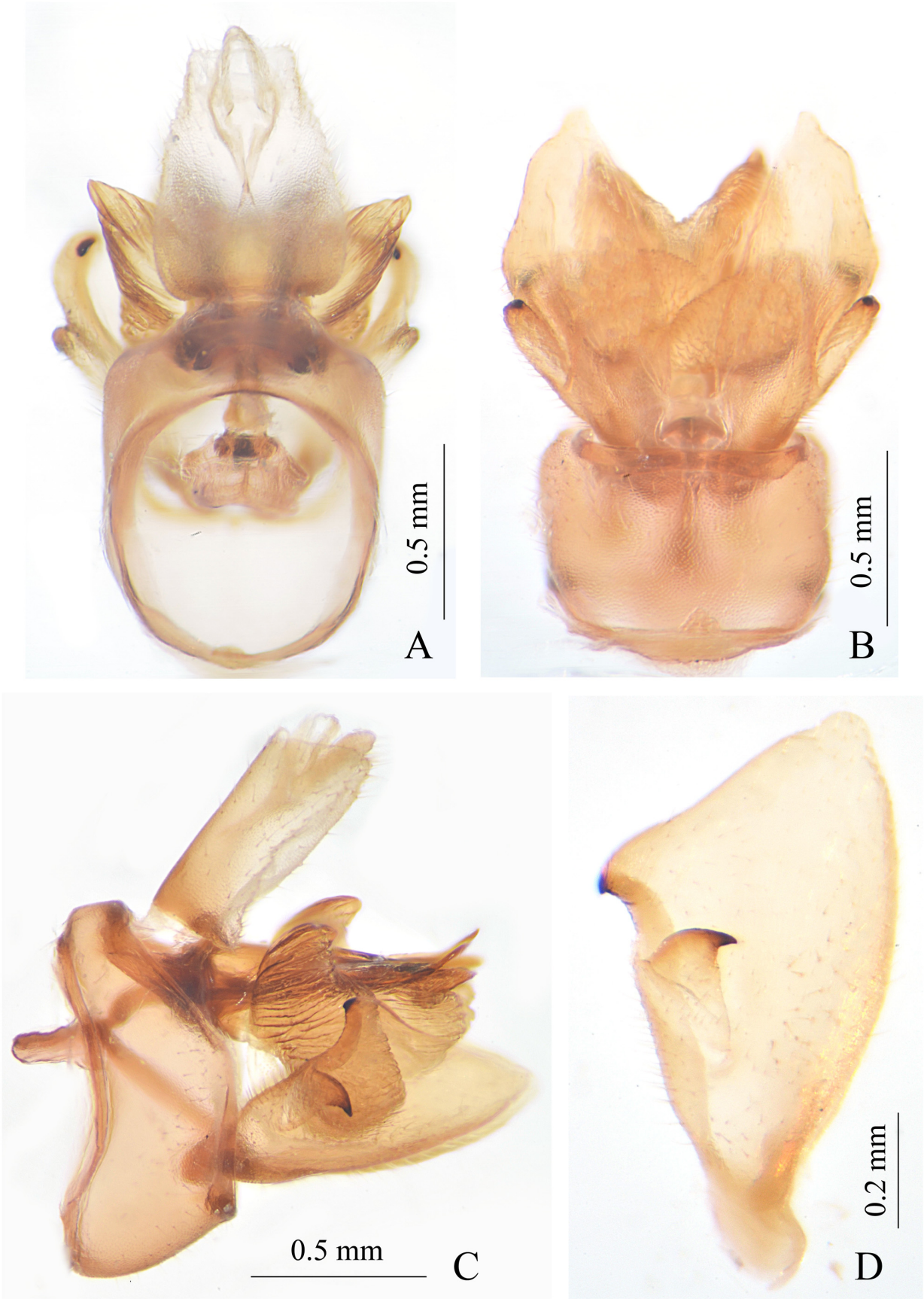

FIGURE 5. *A. australiaca* (Lallemand) comb. nov. A. genitalia of male, dorsal view; B. same, ventral view; C. same, lateral view; D. gonostyle, lateral view.

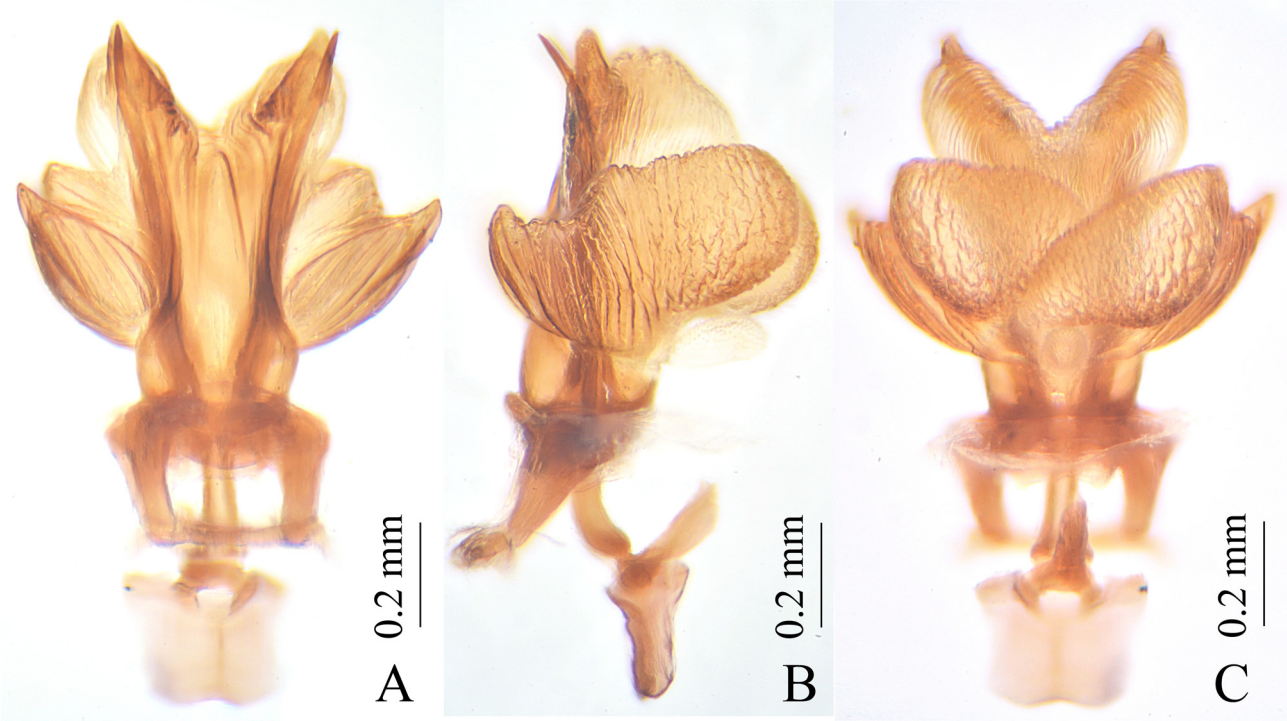

FIGURE 6. *A. australiaca* (Lallemand) comb. nov. A. aedeagus, dorsal view; B. same, lateral view; C. same, ventral view.

Description. Body length (from apex of cephalic process to tip of forewings): ♂ 11.5 mm; length of head: 2.4 mm; width of head (including eyes): 1.1 mm; length of forewings: 8.4 mm.

Cephalic process (Fig. 7A–C) in front of eyes distinctly elongate and slightly upturned. Vertex (Fig. 7A) with the ratio of length in central line to width in base 3.02:1; median carina only distinct between eyes. Frons (Fig. 7B) elongate, intermediate carinae nearly parallel, median carina distinct and complete. Forewings (Fig. 3B) with M vein first bifurcated to M_{1+2} and M_{3+4} veins near middle, nearly abreast with bifurcation of Sc+R, distinctly beyond CuA; stigmal area with 1 transverse veins.

Male genitalia with gonostyles (Fig. 8D) large and broad, apex with a small obtuse process; upper process prolonged, not incurved, acute apically. Aedeagus (Fig. 9A–C) large and broad, compressed dorsoventrally, bases of phallobase sclerotized and pigmented, the remainder membranous sac-like; dorsal lobes large, broad and inflated, more or less sclerotized, with a pair of small apical processes on each side, directed posteriorly in dorsal view; ventrolateral lobes small, flat and rounded at each end, dorsal end small, directed posteriorly, ventral end large, incurved ventrally and crossed in ventral view; ventral part with a small lobe in middle under ventrolateral lobes. Segment X (Fig. 8A) distinctly elongate, lateral margin nearly parallel, with the ratio of length to width in base about 2.1:1 in dorsal view; ventral apical margin conspicuously concave.

Material examined. Holotype ♂, **PAPUA NEW GUINEA:** SE Popondetta, 18 m, light trap, 30–15.VIII.1963, J. Sedlacek (BPBM).

Etymology. The name of this species is derived from the Greek "lobos", referring to its paired large, sac-like and inflated lobes in aedeagus.

Distribution. Papua New Guinea.

Anasta minuta (Lallemand, 1935) comb. nov.

Fulgora minuta Lallemand, 1935: 673, Figs 14, 15.
Dictyophara minuta (Lallemand): Metcalf, 1946: 167.

Remarks. According to Lallemand's description, *A. minuta* comb. nov. is very similar to *A. timorina* from Timor,

Indonesia. *A. minuta* comb. nov. can be distinguished from the latter by the longer cephalic process and a longer prominent media carina on vertex (Lallemand 1935). We didn't have chance to examine the both species

Distribution. Indonesia (Timor).

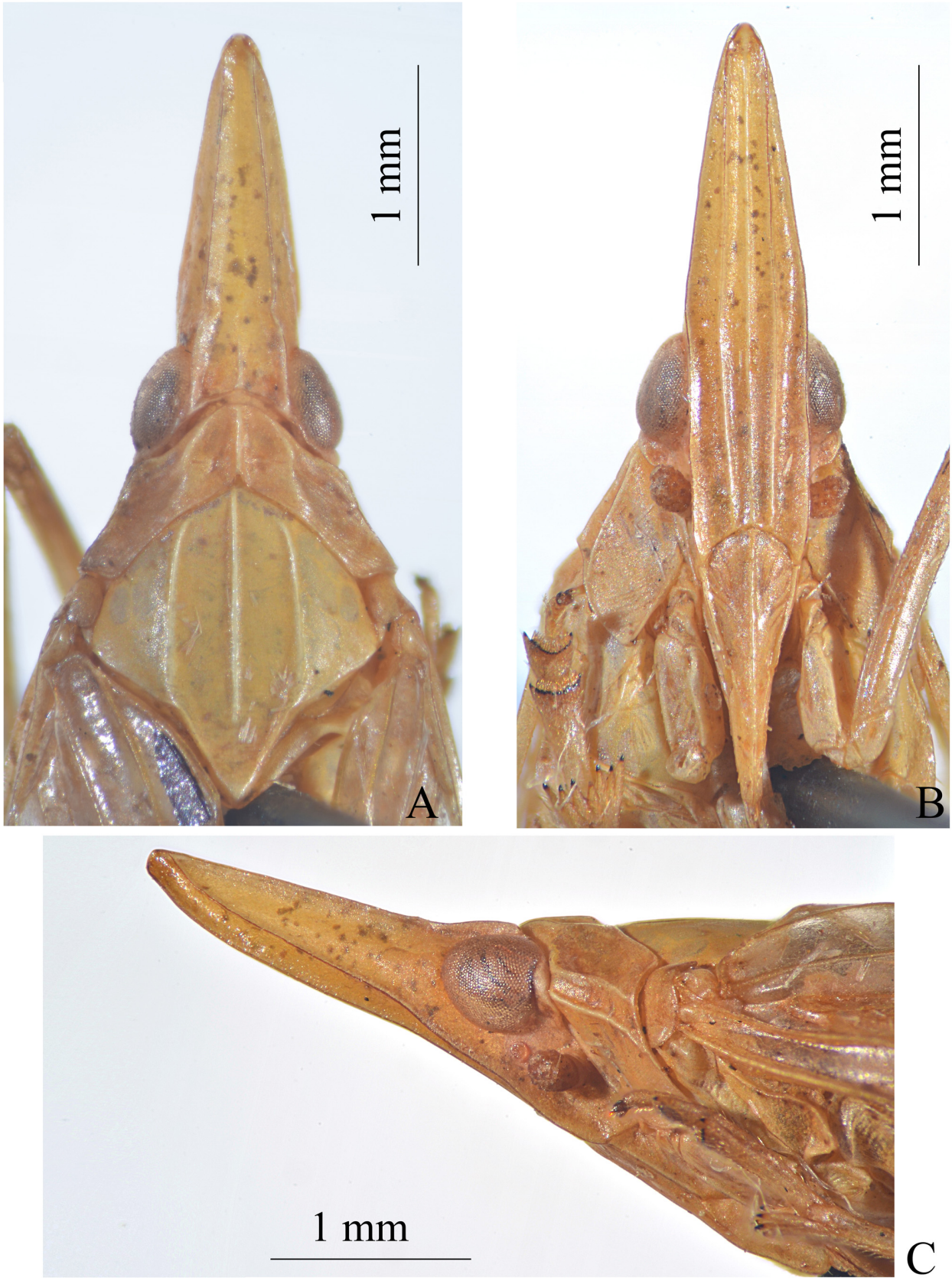

FIGURE 7. *A. lobosa* **sp. nov.** A. head, pronotum and mesonotum, dorsal view; B. same, ventral view; C. same, lateral view.

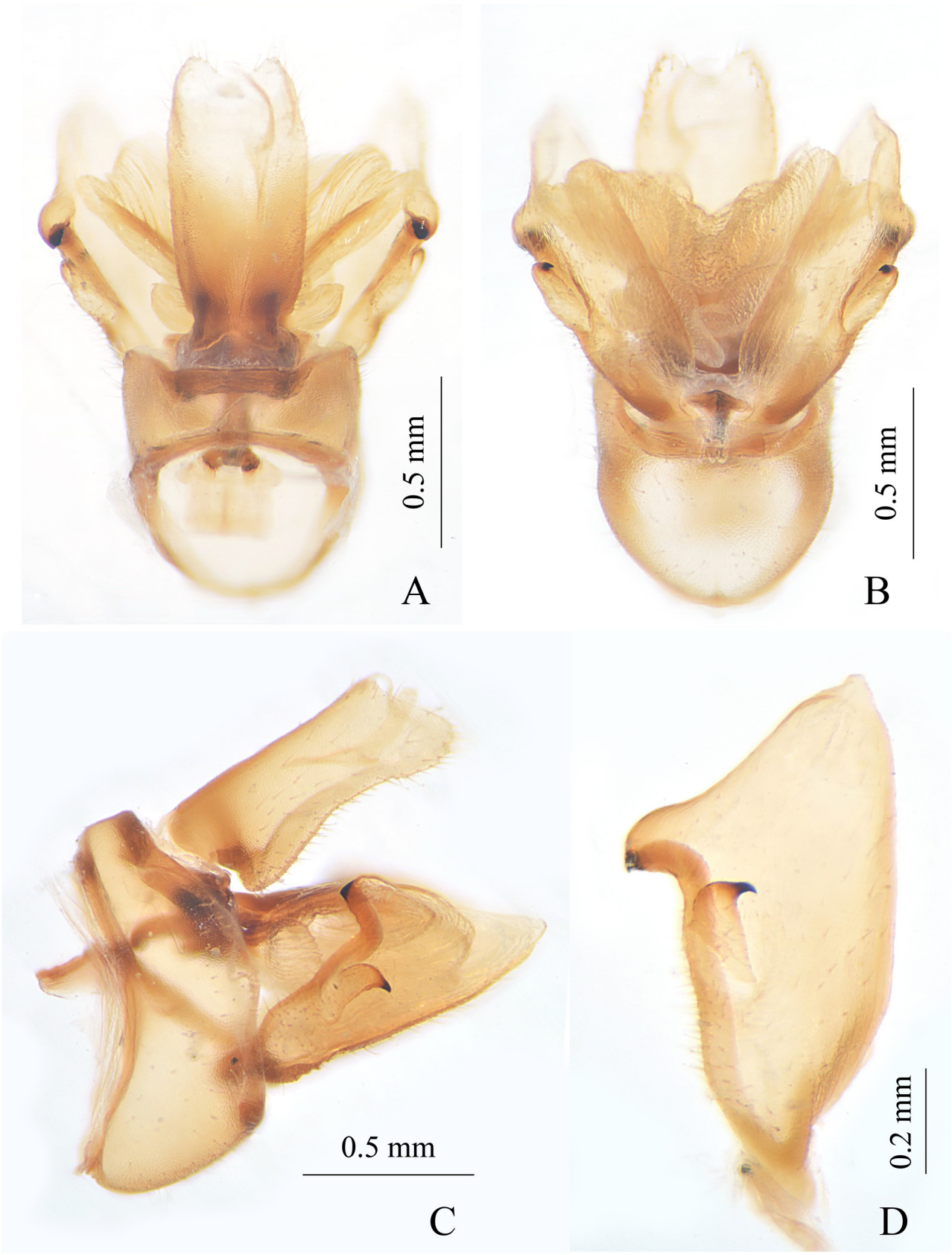

FIGURE 8. *A. lobosa* **sp. nov.** A. genitalia of male, dorsal view; B. same, ventral view; C. same, lateral view; D. gonostyle, lateral view.

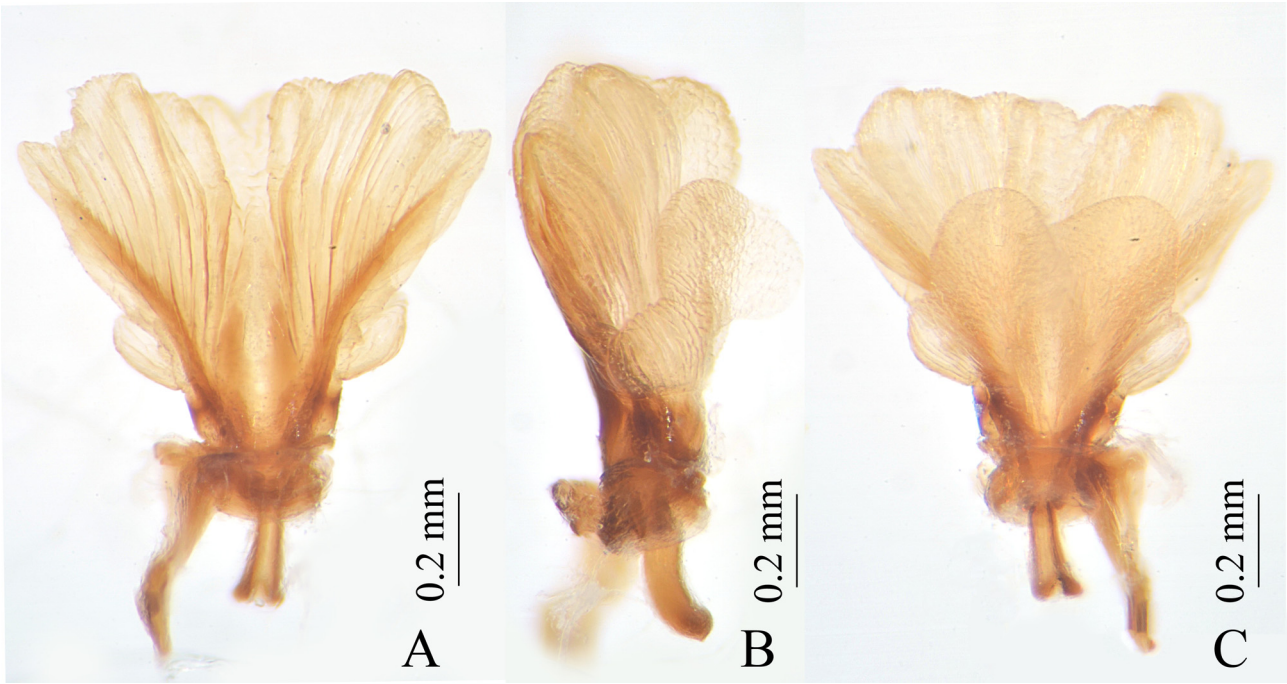

FIGURE 9. *A. lobosa* **sp. nov.** A. aedeagus, dorsal view; B. same, lateral view; C. same, ventral view.

Anasta prognatha (Distant, 1906)
(Figs 1C, 3C, 10–12)

Dictyophara prognatha Distant, 1906: 352; Melichar, 1912: 125; Metcalf, 1946: 174.
Anasta prognatha (Distant): Emeljanov, 2008: 371.

Redescription. Body length (from apex of cephalic process to tip of forewings): ♂ 10.8–11.9 mm; length of head: 2.0–2.1 mm; width of head (including eyes): 1.2–1.3 mm; length of forewings: 8.7–9.3 mm.

Cephalic process (Fig. 10A–C) in front of eyes moderately elongate and upturned. Vertex (Fig. 10A) with the ratio of length in central line to width in base (2.27–2.66):1; median carina distinct and sharp between eyes. Frons (Fig. 10B) elongate, lateral and intermediate carinae ridged, median carina distinct, more or less weak apically and maybe invisible at apex. Forewings (Fig. 3C) with stigmal area obscure viridescent, with 1–2 transverse veins.

Male genitalia with gonostyles (Fig. 11D) large and broad, apex slightly convex; upper process elongate, slightly curved inwards, acute apically. Aedeagus (Fig. 12A–C) very similar to *A. australiaca*, but ventrolateral lobes larger and longer, dorsal end directed dorsally, ventral end elongated, incurved ventrally and crossed each other in ventral view; ventral part with a small lobe in middle under the ventrolateral lobes. Segment X (Fig. 11A) relatively broad and large, lateral margin somewhat diverging towards apex, with the ratio of length to width in base about 1.4:1 in dorsal view; ventral apical margin conspicuously concave.

Material examined. AUSTRALIA: 2♂, North Queensland, Tozer Range, North Foot 400', 1–5.VII.1948, L.J. Brass (Archbold Exped., AMNH). **PAPUA NEW GUINEA:** 1♂, SE Weam, 9 m, light trap, 18.VI.1964, H. Clissold; 2♂, SE Moorhead [Morehead], 18 m, light trap, 4.VII.1965, H. Clissold (BPBM).

Remarks. The specimens from Papua New Guinea are distinctly smaller than those from North Queensland, Australia. The length of head is also shorter than that of Australia. They are maybe representing a subspecies of *A. prognatha*, but more specimens from Papua New Guinea need to be examined for confirmation.

Distribution. Australia (North Queensland), Papua New Guinea.

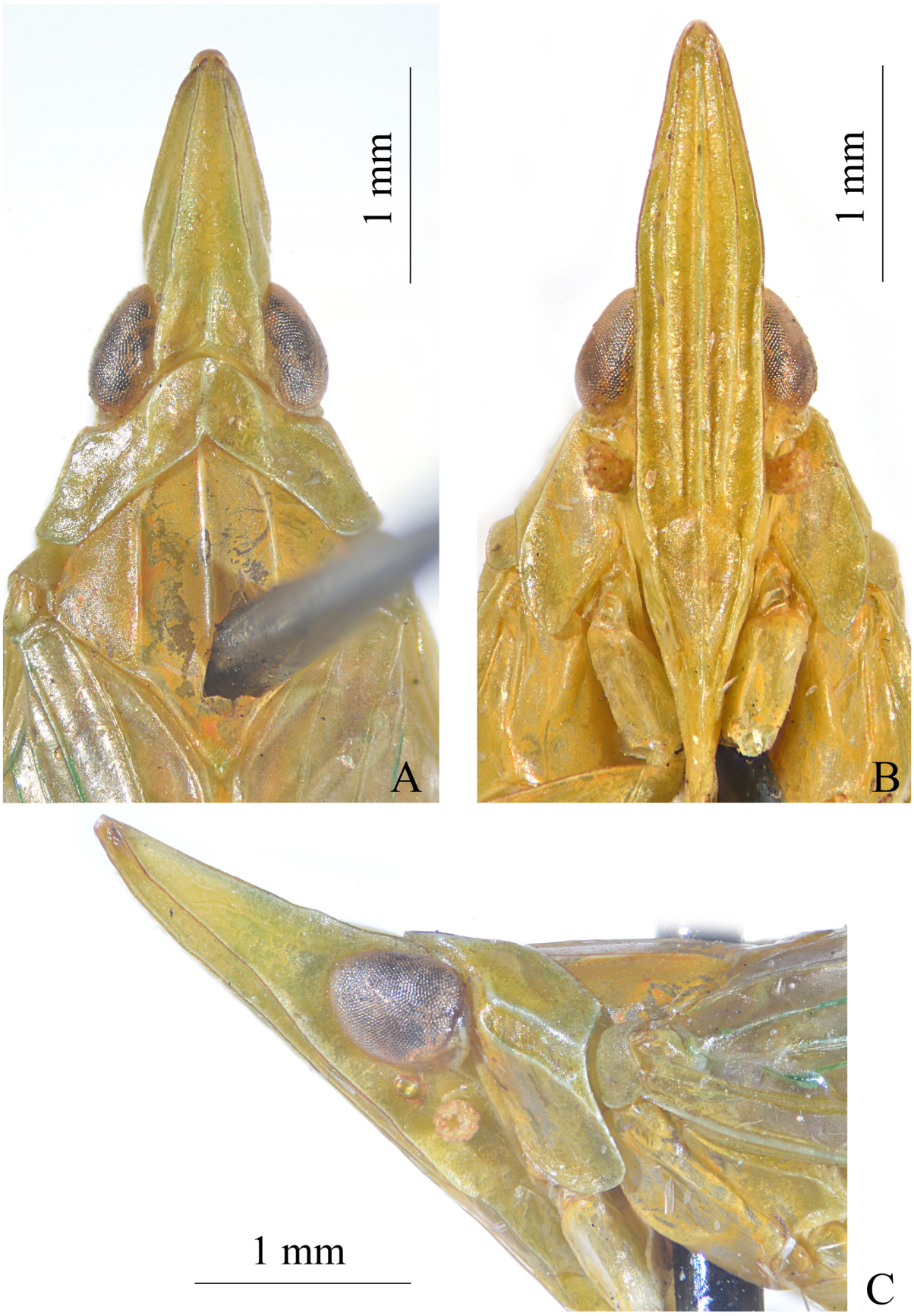

FIGURE 10. *A. prognatha* (Distant). A. head, pronotum and mesonotum, dorsal view; B. same, ventral view; C. same, lateral view.

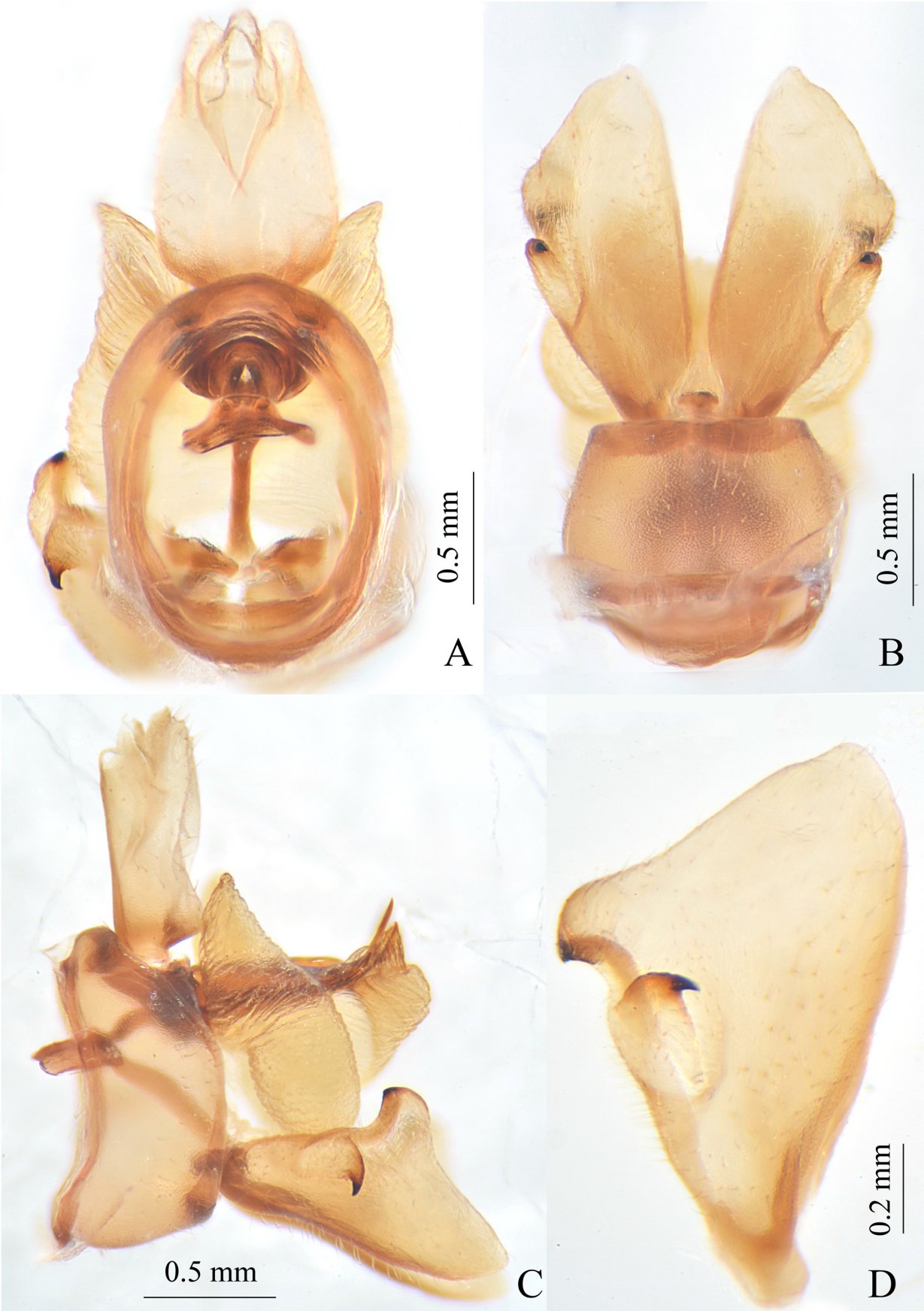

FIGURE 11. *A. prognatha* (Distant). A. genitalia of male, dorsal view; B. same, ventral view; C. same, lateral view; D. gonostyle, lateral view.

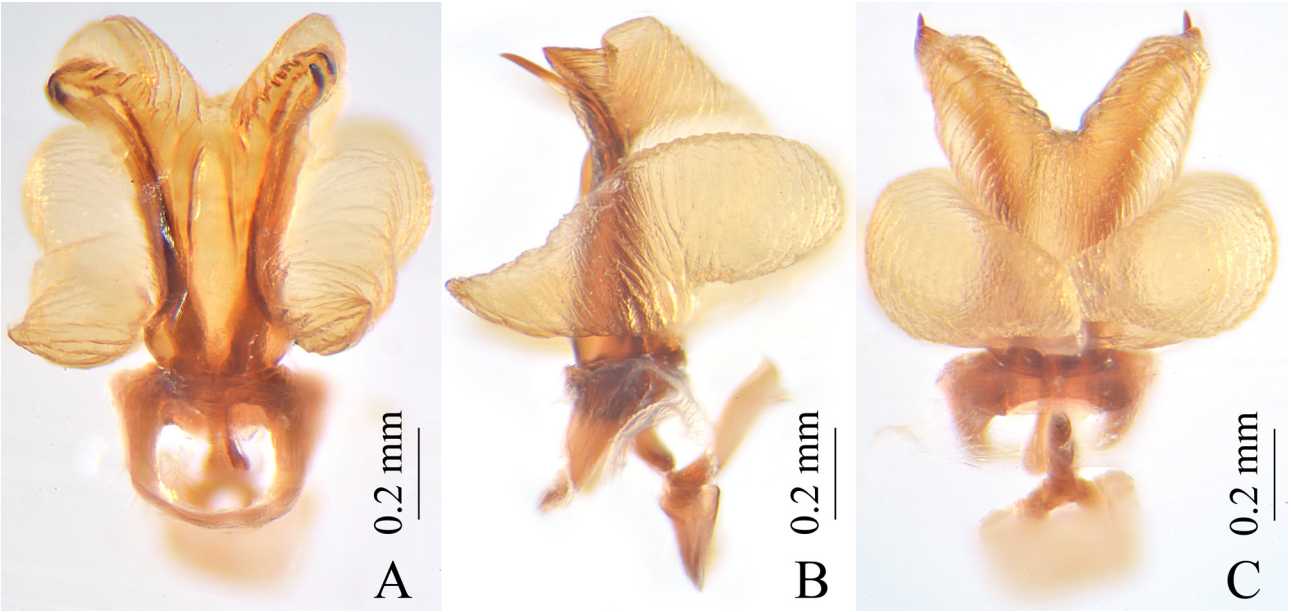

FIGURE 12. *A. prognatha* (Distant). A. aedeagus, dorsal view; B. same, lateral view; C. same, ventral view.

Anasta timorina (Lallemand, 1935)

Fulgora timorina Lallemand, 1935: 672, Figs 12, 13.
Dictyophara timorina (Lallemand): Metcalf, 1946: 179.
Anasta timorina (Lallemand): Emeljanov, 2008: 372.

Remarks. The species was transferred in *Anasta* by Emeljanov (2008). It is likely to be conspecific with *A. minuta* comb. nov., but it is not confirmed till the types of both species will be examined.

Distribution. Indonesia (Timor).

Anasta vitiensis Emeljanov et Wilson, 2009
(Figs 1D, 3D, 13)

Anasta vitiensis Emeljanov et Wilson, 2009: 36, Figs 1–12.

Material examined. FIJI: 1♂, Viti Levu, Tavua, 7.III.1963, C. M. Yoshimoto (BPBM); 1♂, Vanua Levu, Savusavu, 0–100 m, III.1973, N.L.H. Krauss; 1♂, Viti Levu, Nandi, 0–50 m, III.1981, N.L.H. Krauss (both in AMNH).

Remarks. The specimens examined in the present study are distinctly smaller (10.4–10.6 mm in males) than those described by Emeljanov & Wilson (2009). In Emeljanov & Wilson's material, the body length of *A. vitiensis* is 11.5–12.4 mm in males, and 13.7–13.8 mm in females.

Distribution. Fiji.

Discussion

The genus *Anasta*, as reviewed here, comprises six species which are distributed from western Timor, northern Australia, and Papua New Guinea, extending eastward to Fiji in the Australasian region (Fig. 14). This region can be regarded as the Oceanian realm which was one of newly defined zoogeographic realms (Holt *et al.* 2013). It was separated from the Australian realm and included New Guinea together with the Pacific Islands (Holt *et al.* 2013). Generally, the dictyopharid species are not supposed to possess the ability of long-distance dispersal, and they are

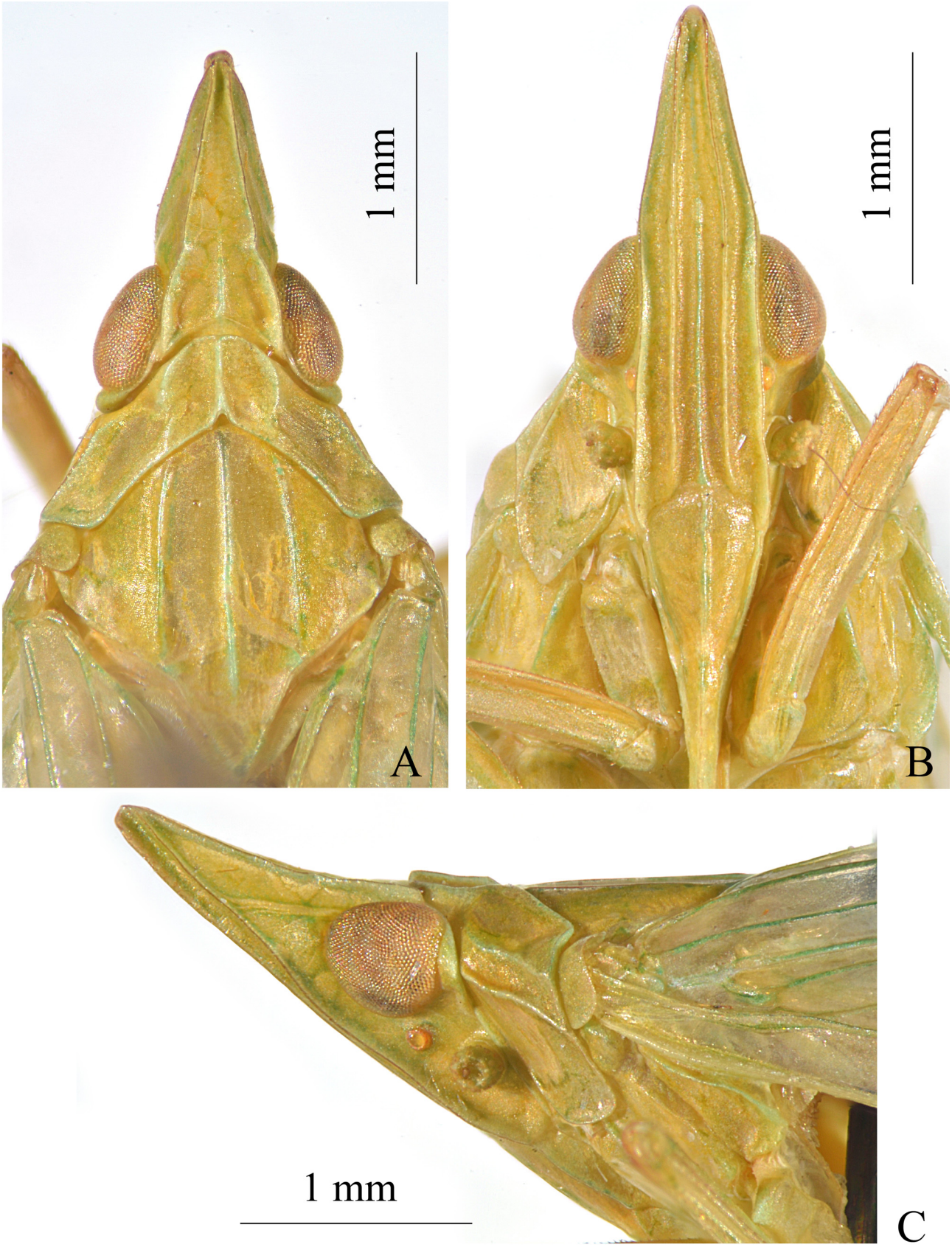

FIGURE 13. *A. vitiensis* Emeljanov & Wilson. A. head, pronotum and mesonotum, dorsal view; B. same, ventral view; C. same, lateral view.

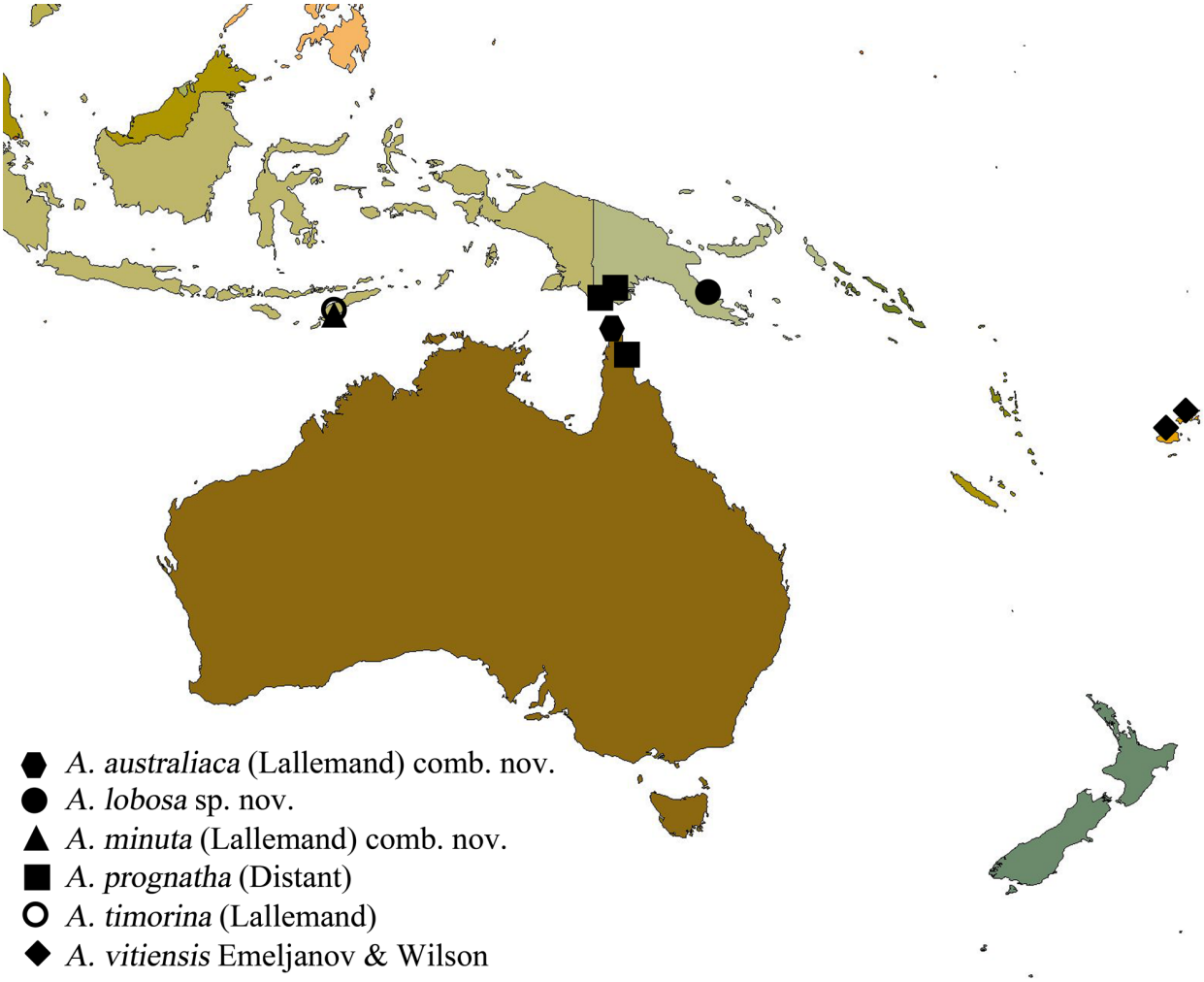

FIGURE 14. Geographic distribution of *Anasta* species.

practically absent from most of Pacific islands far away from the continent (Emeljanov & Wilson 2009). So the discovery of *A. vitiensis* from Fiji is quite enigmatic although the Fiji biota has been considered more typically as a mature continental ecosystem than a collection of small remote islands (Lucky & Sarnat 2010). Three hypotheses have been commonly resorted to explain the origins of Fiji's insular terrestrial assemblage (Lucky & Sarnat 2010). However, it is still difficult to guess how *Anasta* species colonized from Timor and New Guinea eastward to Fiji. Unlike other insect groups (Duffels & Turner 2002, Lucky & Sarnat 2010), we have been in the dark about the dictyopharid fauna in Bismark Archipelago, Solomon Islands and Vanuatu, even New Caledonia and Loyalty Islands which are rather rich in Fulgoromorpha (Fennah 1969).

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