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Four new species of the lanternfly genus *Zanna* Kirkaldy, 1902 from Cambodia and Vietnam (Hemiptera: Fulgoromorpha: Fulgoridae)

Jérôme CONSTANT [1,*] & Hong Thai PHAM [2,*]

[1]Royal Belgian Institute of Natural Sciences, O.D. Phylogeny and Taxonomy, Entomology, Vautier Street 29, B-1000 Brussels, Belgium.
[2]Mientrung Institute for Scientific Research, Vietnam National Museum of Nature, VAST, 321 Huynh Thuc Khang, Hue, Vietnam.
[2]Graduate School of Science and Technology, Vietnam Academy of Science and Technology, 18 Hoang Quoc Viet, Hanoi, Vietnam.

[*] corresponding authors: jerome.constant@naturalsciences.be; phamthai@vnmn.vast.vn

[1] urn:lsid:zoobank.org:author:6E6072A1-9415-4C8D-8E60-2504444DB290
[2] urn:lsid:zoobank.org:author:E34CB863-7E3B-4E8F-8738-B41C07D9F5F9

Abstract. Four new species of *Zanna* Kirkaldy, 1902 are described: two from Cambodia, *Z. chartieri* Constant sp. nov. from Tatai in Koh Kong Province and *Z. limbourgi* Constant sp. nov. from Phnom Aural Wildlife Sanctuary in Kampong Speu Province and Kbal Spean in Siem Reap Province, and two from Vietnam: *Z. bidoupana* sp. nov. from Bidoup-Nui Ba National Park in Lam Dong Province and *Z. kusamae* sp. nov. from Dong Nai Biosphere Reserve in Dong Nai Province. Illustrations of the holotypes and male genitalia, photographs of live specimens and nymphs, a distribution map and host plants records are provided. The type of *Zanna chinensis* (Distant, 1893) is also illustrated for comparison. The genus *Zanna* now contains 37 species.

Keywords. Fulgoroidea, Auchenorrhyncha, Dictyopharidae, Indochina.

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Introduction

The family Fulgoridae Latreille, 1807 contains the pantropical and subtropical lanternflies, the largest and most spectacular planthoppers represented by 142 genera and 769 species worldwide (Bourgoin 2024). Within this family, the subfamily Zanninae Metcalf, 1938 contains a single genus, *Zanna* Kirkaldy, 1902 which is widely distributed in both the Oriental and the Afrotropical regions (Lallemand 1959, 1963; Liang 2017, Bourgoin 2024). Only one other genus of Fulgoridae is shared between these two regions, O*malocephala* Spinola, 1839, which is widely distributed in the Afrotropics, but restricted to south India and Sri Lanka in Asia (Lallemand 1959, 1963; Bourgoin 2024). Among the 33 described species in *Zanna*, 22 are distributed in Africa, and 11 in the Oriental Region (Lallemand 1959, 1963,

1966; Liang 2017; Bourgoin 2024).The status of *Zanna* within the Fulgoridae has long been subject to a separate treatment: Metcalf (1938) erected the tribe Zannini Metcalf, 1938 to accommodate this single genus within the subfamily Fulgorinae Latreille, 1807, while later, Lallemand (1959) proposed to elevate the tribe Zannini to a subfamily on its own, the Zanninae Metcalf, 1938. Lallemand (1959) proposed a number of taxonomic changes within the Afrotropical species and gave a key to all species in this region (except for *Z. capensis* Lallemand, 1966, which he described later – Lallemand 1966) and in 1963, he provided an identification key to the 10 species from the Oriental Region (Lallemand 1963). Nagai & Porion (1996) listed only nine species of *Zanna* from the Oriental Region in their catalogue, *Z. pulmuncula* Distant, 1905, described from Java, appears to be missing. More recently, Liang (2017) reviewed the generic characters of the genus, discussed its monophyly, and added a new species from China, *Z. robusticephalica* Liang, 2017.

From a higher perspective, Emeljanov (1979) considered that *Zanna* was among the most ancient fulgorid lineages, a view confirmed by a recent molecular study by Wang *et al.* (2023) who found *Zanna* and *Dichoptera* Spinola, 1839 to be the most basal genera in the family Fulgoridae. Urban & Cryan (2009) suggested that *Zanna* should be excluded from the Fulgoridae following their phylogenetic analysis of the family based on five genetic loci (18S rDNA, 28S rDNA, histone 3, wingless, and cytochrome oxidase I). This view was developed by Emeljanov (2012) who considered that the Zanninae may be close to the Dichopterinae sensu lato, and might deserve to be placed together in a separate family, the Dichopteridae. A recent molecular phylogeny by Bucher *et al.* (2023) resulted in two different topologies: (Zanninae + (Dictyopharidae + other Fulgoridae)) under maximum likelihood analysis or ((Zanninae + Dictyopharidae) + Fulgoridae) under Bayesian analysis, leaving the issue unresolved. Hence, the Zanninae were kept in the family Fulgoridae.

Only one species of *Zanna*, *Z. chinensis* (Distant, 1893), was recorded from Vietnam, but no precise data was given (Nagai & Porion 1996) and this record was later repeated (Pham & Ta 2004; Pham 2011). From Cambodia, the genus *Zanna* was recently recorded based on photographs (Constant *et al.* 2016). The study of recent material of *Zanna* collected in the framework of the Global Taxonomy projects "A step further in the entomodiversity of Vietnam" and "A step further in the entomodiversity of Cambodia", revealed three closely related, undescribed species of *Zanna*, and a fourth one could be added through an efficient collaboration with Cambodia-based citizen-scientist Gerard Chartier, who also provided data on life-history.

The present paper aims to describe the four new species from Vietnam and Cambodia, provide a key to the species of these countries, and document the life-history of one of them.

Material and methods

The terminalia were cut with a needle blade from the abdomen of the fresh or relaxed specimens and boiled for about 20 minutes in a 10% solution of potassium hydroxide (KOH) at about 100°C. The organs were thoroughly rinsed in 70% ethanol and fine dissection was done with a needle blade for examination. The dissected organs were then placed in glycerine for preservation in a tube attached to the pin of the specimen. The measurements of the pygofer, anal tube and gonostylus of the male terminalia were taken as illustrated in Fig. 1.

The metatibiotarsal formula gives the number of spines on (side of metatibia) apex of metatibia/apex of first metatarsus/apex of second metatarsus. For example, the metatibiotarsal formula: (1) 6/4/2 represents 1 spine on the side of metatibia, 6 teeth on the apex of metatibia, 4 spines on the apex of first metatarsus, and 2 spines on the apex of second metatarsus. The morphological terminology mostly follows O'Brien & Wilson (1985); the terminology of the wings venation follows Bourgoin *et al.* (2015); the terminology of the cephalic carinae follows Liang (2017).

All the photographs were taken by JC, except otherwise stated in the corresponding captions. The photographs in the field were taken with a Sony DSC-H1 or a DSCH-300 camera. The photographs of the collection specimens were taken with a Canon EOS 700D camera with a Sigma DG Macro lens, these of the male terminalia with a Leica EZ4W stereo microscope with integrated camera, stacked with CombineZ software and optimized with Adobe Photoshop CS3. The distribution map was produced with SimpleMappr (Shorthouse 2010).

Abbreviations

Measurements

The measurements were taken as in Constant (2004) and the following abbreviations are used:

BF = maximum breadth of the frons
BH = breadth of head including eyes
BPrH = breadth of the cephalic process at half length
BTg = maximum breadth of the tegmen
LF = length of the frons in median line
LH = length of head in median line
LTg = maximum length of the tegmen
LT = total length (apex of head to apex of tegmina)

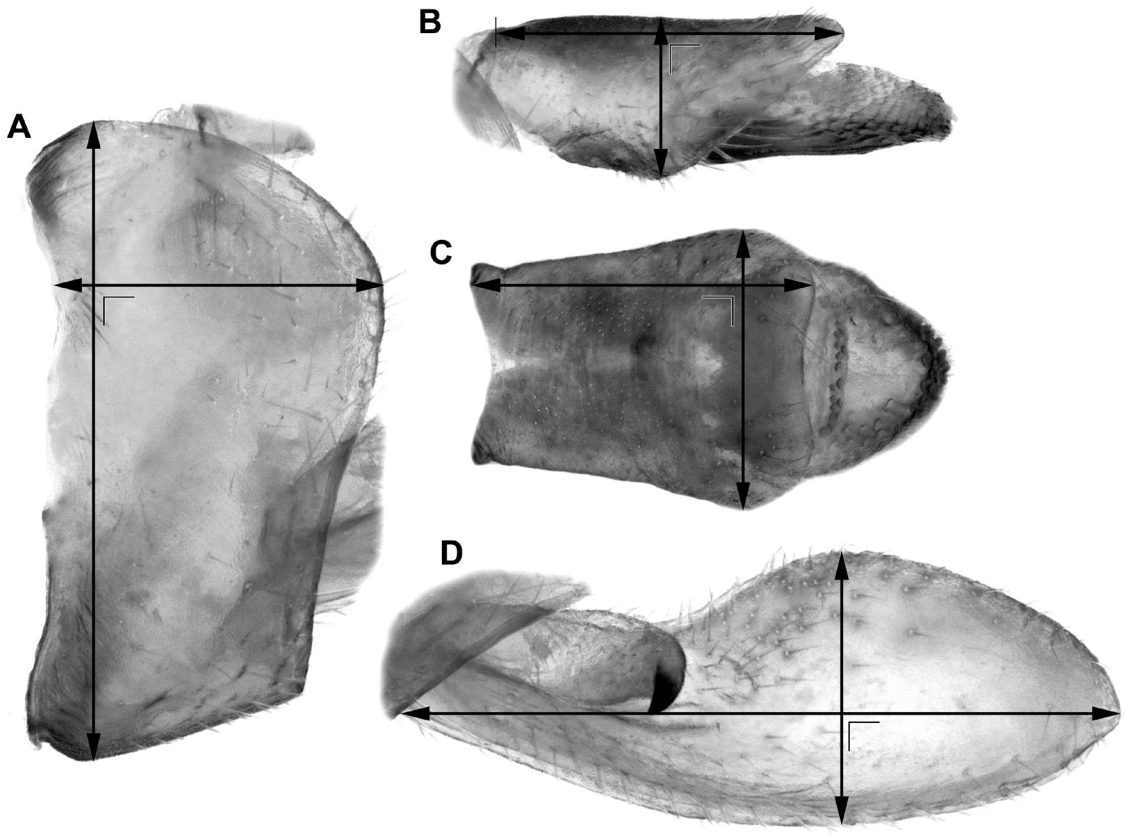

Fig. 1. Male terminalia of genus *Zanna* Kirkaldy, 1902, measurements. **A**. Pygofer, maximum height and length in lateral view. **B**. Anal tube, maximum length and height in lateral view. **C**. Anal tube, maximum length and width in dorsal view. **D**. Gonostylus, maximum length and height in lateral view.

Male terminalia

An = anal tube
dep = dorsal endosomal process
dpa = dorsal process of aedeagus
G = gonostylus
lhg = lateral hook of gonostylus
lpa = lateral process of aedeagus
lpg = lateral protrusion of gonostylus
Py = pygofer

Repositories

BMNH = The Natural History Museum, London, United Kingdom
RBINS = Royal Belgian Institute of Natural Sciences, Brussels, Belgium
RUPP-CEI = Royal University of Phnom Penh, Cambodian Entomology Initiatives, Phnom Penh, Cambodia
VNMN = Vietnam National Museum of Nature, Hanoi, Vietnam

Results

Taxonomy

Class Insecta Linnaeus, 1758
Order Hemiptera Linnaeus, 1758
Suborder Auchenorrhyncha Duméril, 1806
Infra-order Fulgoromorpha Evans, 1946
Superfamily Fulgoroidea Latreille, 1807
Family Fulgoridae Latreille, 1807
Subfamily Zanninae Lallemand, 1959
Tribe Zannini Metcalf, 1938

Genus ***Zanna*** Kirkaldy, 1902

Zanna Kirkaldy, 1902: 47. Type species: *Fulgora tenebrosa* Fabricius, 1775.

Zanna – Melichar 1903: 13. — Metcalf 1947: 246. — Lallemand 1959: 101; 1963: 90. — Nagai & Porion 1996: 27. — Urban & Cryan 2009. Replacement name for *Pyrops* Amyot & Audinet-Serville, 1843 nec *Pyrops* Spinola, 1839.
Pyrops – Amyot & Audinet-Serville 1843: 491. — Atkinson 1885: 139. — Distant 1906: 179.

Diagnosis

Species of the genus *Zanna* can be separated from the other genera of Fulgoridae by the combination of the following characters:

(1) General shape of body distinctly narrow, slender and elongate, usually pale brownish ochraceous, without colorful markings, usually densely and prominently spotted in black;

(2) Head distinctly produced into an elongate, often very long cephalic process, which can vary from as long as, to more than twice as long as pro- and mesonotum combined;

(3) Cephalic process relatively robust, projecting straight anteriorly, more or less hexagonal in cross-section, narrowing from base to apex, somewhat upturned at apex in lateral view (some Afrotropical species with apex clavate in lateral view);

(4) Vertex very elongate, lateral margins weakly ridged with carinae being slightly zigzagged, often with faint median carina;

(5) Frons distinctly elongate, with lateral margins weakly ridged with carinae being slightly zigzagged, with slightly zigzagged submedian carinae, carinae sometimes obsolete; median carina either absent or incomplete and very weakly marked;

(6) Antennae with pedicel relatively short, subbulbose, fully covered with sensory plaque organs over entire surface;

(7) Tegmina narrow and elongate, almost entirely reticulate, inner marginal areas overlapping at rest;

(8) Hind tibiae with 5–7 lateral spines;

(9) Gonoplacs of adult females with basal inner area strongly and densely pilose.

Note

The above diagnosis was modified from Liang (2017) as it was necessary to expand the definition of the genus in order to encompass many Afrotropical taxa, including the type species *Zanna tenebrosa* Fabricius, 1775.

Checklist of the species of *Zanna* from Cambodia and Vietnam

Zanna bidoupana sp. nov.
Zanna chartieri Constant sp. nov.
Zanna chinensis (Distant, 1893)
Zanna kusamae sp. nov.
Zanna limbourgi Constant sp. nov.

Zanna bidoupana sp. nov.
urn:lsid:zoobank.org:act:587A685F-A6C1-465F-A601-1C841D650B7B
Figs 2–5, 18A, E, I, 19A–B

Diagnosis

The species is closest to *Zanna chartieri* Constant sp. nov., *Z. kusamae* sp. nov. and *Z. limbourgi* Constant sp. nov., from which it can be separated by the following characters: basal portion of head (Fig. 2B, E–F) covered in dense, irregular, rather large, coarse, sometimes coalescent black pitting with few smaller pits (moderately large, rather well-spaced, black pitting in *Z. kusamae* – Fig. 12B, E–F; same but with 'background' of dense, very small black pitting in *Z. chartieri* and *Z. limbourgi* – Figs 6B, E–F, 15B, E–F); anal tube of male rather high in lateral view (Fig. 3A), about 1.60 times as long as high, with ventral angle in basal half (rather flattened dorsoventrally, 1.95–2.14 times as long as high in lateral view, with ventral angle at midlength in *Z. chartieri* and *Z. kusamae* – Figs 7A, 13A); pygofer of male in lateral view (Fig. 3A) with posterior margin sinuate, forming large, broadly rounded posterior lobe in dorsal half (posterior margin projecting into large posterior lobe angularly rounded in midheight in *Z. kusamae* – Fig. 13A; posterior margin projecting posteriad in dorsal ⅓, in large, apically rounded lobe forming nearly right angle in *Z. limbourgi* – Fig. 16A).

Etymology

The species epithet refers to the type location, Bidoup-Nui Ba National Park in Lam Dong Province, Highlands Vietnam.

Type material

Holotype

VIETNAM • 1 ♂; Lam Dong Province, Bidoup-Nui Ba National Park, Hon Giao station; 12°11′11.8″ N, 108°42′53.3″ E; 21–25 Jul. 2014; J. Constant and J. Bresseel leg.; GTI project; I.G.: 32.779; "Coll. I.R.Sc.N.B., Vietnam, Lam Dong prov., Bidoup-Nui Ba N.P., 12°26′ N, 108°30′ E, 21-25.VII.2014, Light trap, Leg. J. Constant & J. Bresseel, GTI Project, I.G.: 32.779"; RBINS.

Paratypes (12 ♂♂, 2 ♀♀)

VIETNAM • 8 ♂♂, 2 ♀♀; same collection data as for holotype; RBINS • 1 ♂; Lam Dong [Province], Bidoup-Nui Ba National Park; 4 Jun. 2013; [light trap]; [H.T. Pham leg.]; "VQG Bidup-Nui Ba, Lam Dong, 4/6/2013, VD"; VNMN • 1 ♂; [Lam Dong Province], Bidoup National Park; 13 Oct. 2016; T.T. Men leg.; VNMN_E 000009331; "Bidoup NP, LD, 13/10/2016, light, T.T. Men leg.", "VNMN_E 000 009 331"; VNMN • 1 ♂; same collection data as for preceding; VNMN_E 000009330; VNMN • 1 ♂; same collection data as for preceding; by net; T.T. Men and N.V. Dat leg.; VNMN_E 000009332; VNMN.

Description

Measurements and ratios. LT: ♂ (n=10): 41.0 mm (38.2–43.1), ♀ (n=2): 41.9–42.0 mm. LTg/BTg=3.48; LH/BH=4.0; LF/BF=5.3; BH/BPrH=2.2; LH/LT=0.35; wingspan (extrapolated): ♂: 52.8 mm (49.2–55.5), ♀: 54.0–54.1 mm.

Head (Fig. 2B, E–F). Strongly elongate, representing 35% of total length, gently and evenly narrowing towards apex; apex obliquely cut in lateral view and with incomplete, rim-shaped orange carina (missing in ventral portion); rather pale pinkish brown entirely covered in dense, irregular black pitting with smaller pits towards distal portion and majority of rather large, sometimes coalescent pits in basal portion. Lateral carinae of frons weakly zigzagged, more prominent towards apex, upcurved near apex and merging into a short dorsal carina reaching apex; lateral carinae of vertex merging with upcurved part of lateral carinae of frons; weakly marked, weakly zigzagged carina in middle portion of vertex, and some 'cross-carinae' between latter and lateral carinae of vertex. Labium pale brown, reaching mesocoxae.

Thorax (Fig. 2B, E–F). Pro- and mesonotum rather pale pinkish brown entirely covered in dense, irregular, strong black pitting with pits often larger than space between them and sometimes coalescent; median carina obsolete.

Tegmina (Fig. 2A, C–D). Strongly elongate and reticulate, pale pinkish brown, progressively paler, subhyaline towards apex, basal portion densely covered with minute pink spots; all surface irregularly covered in small to rather large black spots, mostly on veins, larger ones slightly protruding, large middle portion with very dense small spots; costal and postclaval margins subparallel, weakly diverging from base towards apex and curved at level of apex of clavus; apical margin rounded. Veins orange in large basal portion. Clavus open.

Venation. ScP+R forked in basal ⅓, MP forked more basally in basal ¼; CuA forked near apex of clavus; PCu and A1 fused near apex of clavus; PCu+A1 fused with postclaval margin at nodal line.

Hind wings (Fig. 2A, C). Subhyaline, milky white with veins slightly darker, vein PCu dark brown in basal half; postclaval margin weakly emarginate at A1 vein.

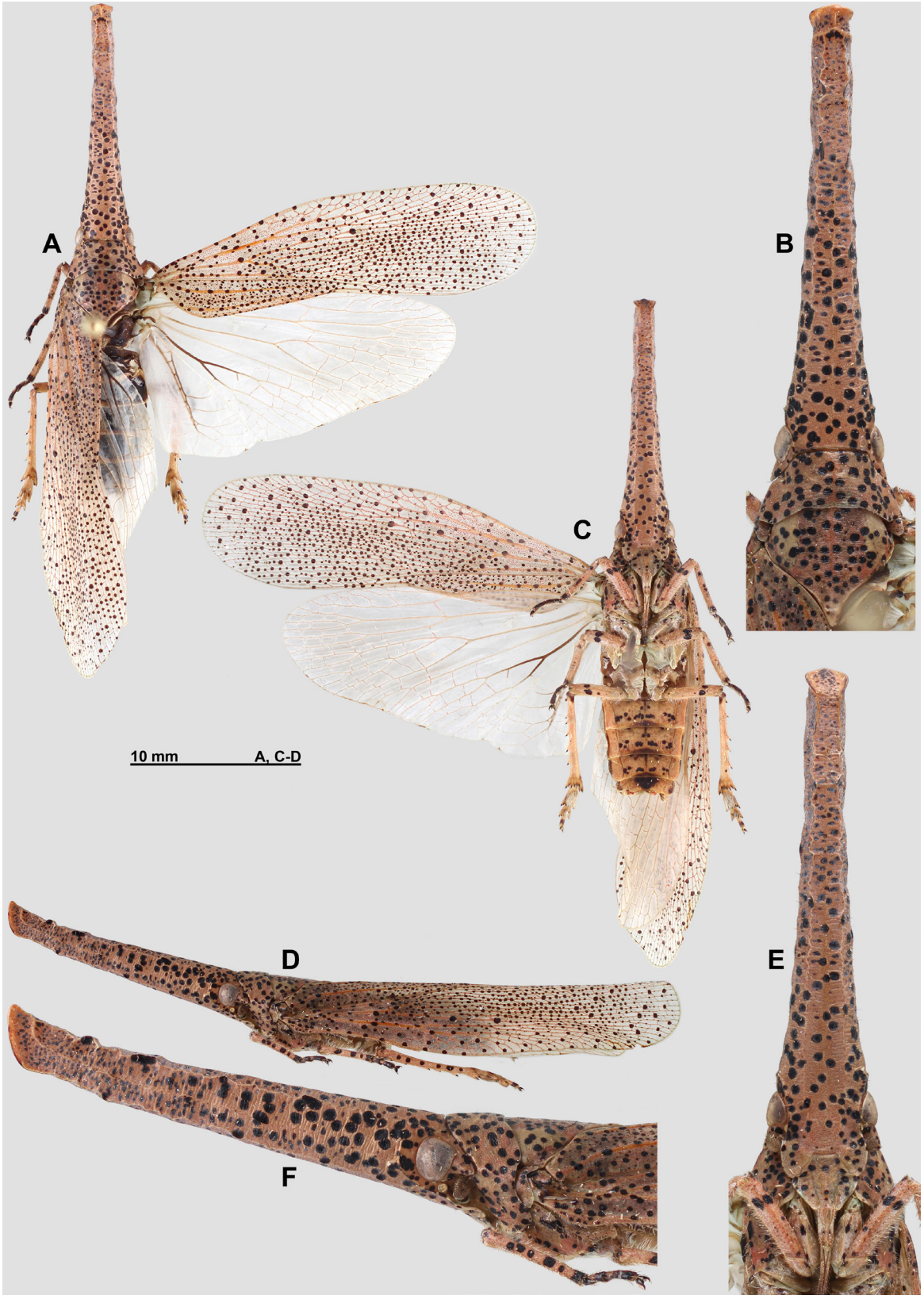

Fig. 2. *Zanna bidoupana* sp. nov., holotype, ♂ (RBINS). **A**. Habitus, dorsal view. **B**. Head and thorax, dorsal view. **C**. Habitus, ventral view. **D**. Habitus, lateral view. **E**. Head, ventral view. **F**. Head and thorax, lateral view.

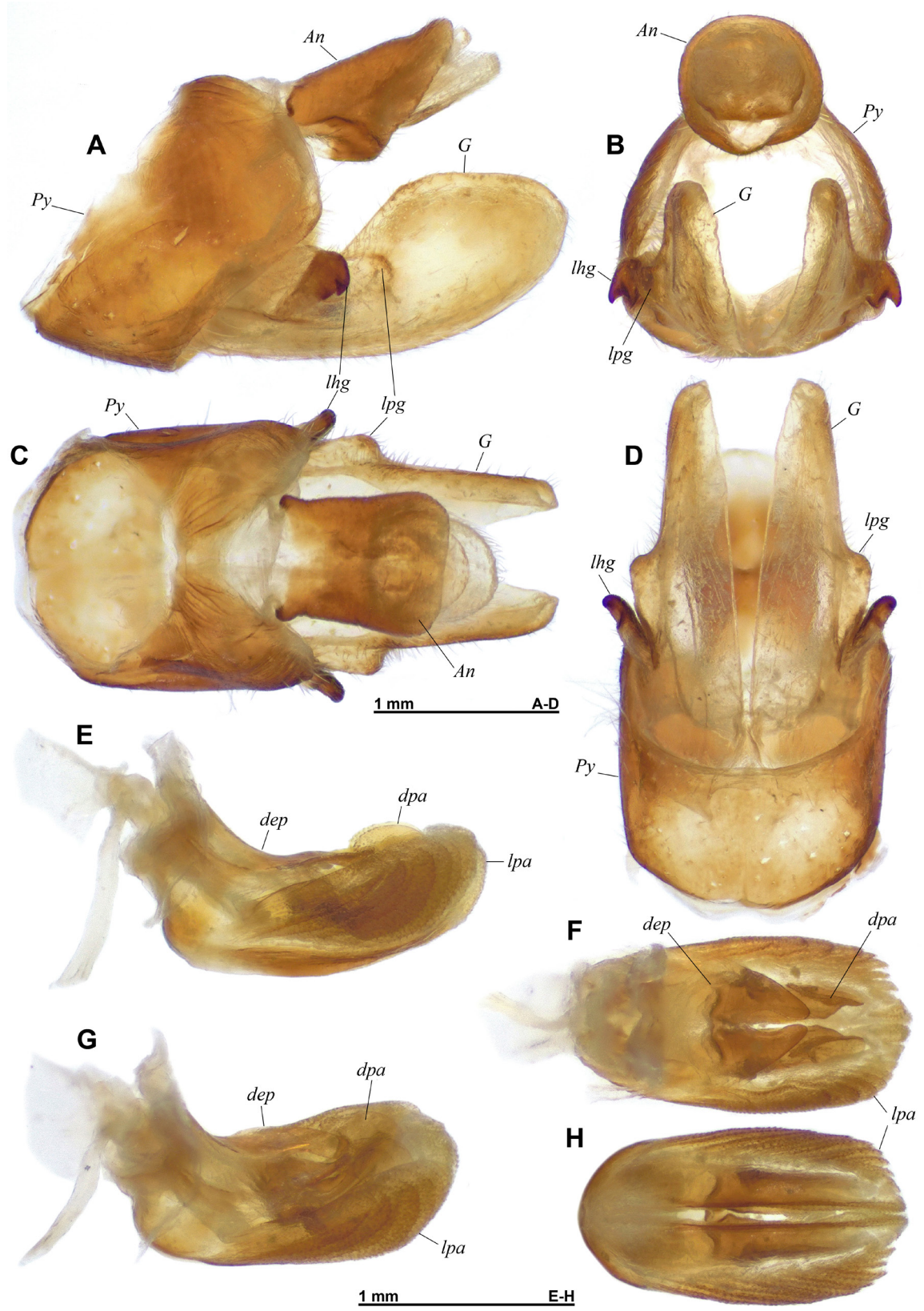

Fig. 3. *Zanna bidoupana* sp. nov., holotype, ♂ (RBINS), terminalia. **A–D**. Pygofer, anal tube and gonostyli. **A**. Left lateral view. **B**. Caudal view. **C**. Dorsal view. **D**. Ventral view. **E–H**. Aedeagus. **E**. Left lateral view. **F**. Dorsal view. **G**. Laterodorsal view. **H**. Ventral view. Abbreviations: see Material and methods.

Fig. 4. A–B. *Zanna bidoupana* sp. nov. at the light trap, Vietnam, Bidoup-Nui Ba National Park, 23 Jul. 2014. **A**. Dorsal view. **B**. Lateral view. **C**. Habitat of *Z. bidoupana* sp. nov. around Hon Giao station, 23 Jul. 2014.

Venation. ScP+R and MP forked at midlength; CuA forked slightly more basally then MP fork; PCu forked at basal ⅓; A1 forked close to base, $A1_2$ fused with A2 in distal portion and $A1_2$+A2 forked slightly before reaching postclaval margin. Numerous crossveins in large portion along apical and postclaval margins.

Legs (Fig. 2A, C–D). Pale pinkish brown, pilose, rather short and robust. Pro- and mesocoxae with some black markings; all femora with some small black spots and conspicuous ring in distal ⅓, formed from large, more or less coalescent, black spots; pro- and mesotibiae with some small black spots and with apex black; pro- and mesotarsi blackish brown; metatibiae brown basally with all spines apically black, 5–6 lateral spines and 8 apical spines; first metatarsomere with 11 apical spines ventrally; second metatarsomere with 9 apical spines ventrally; first and second metatarsomere with a dense pad of microsetae ventrally; third metatarsomere elongate with a blackish brown ring. Metatibiotarsal formula: (5–6) 8/11/9.

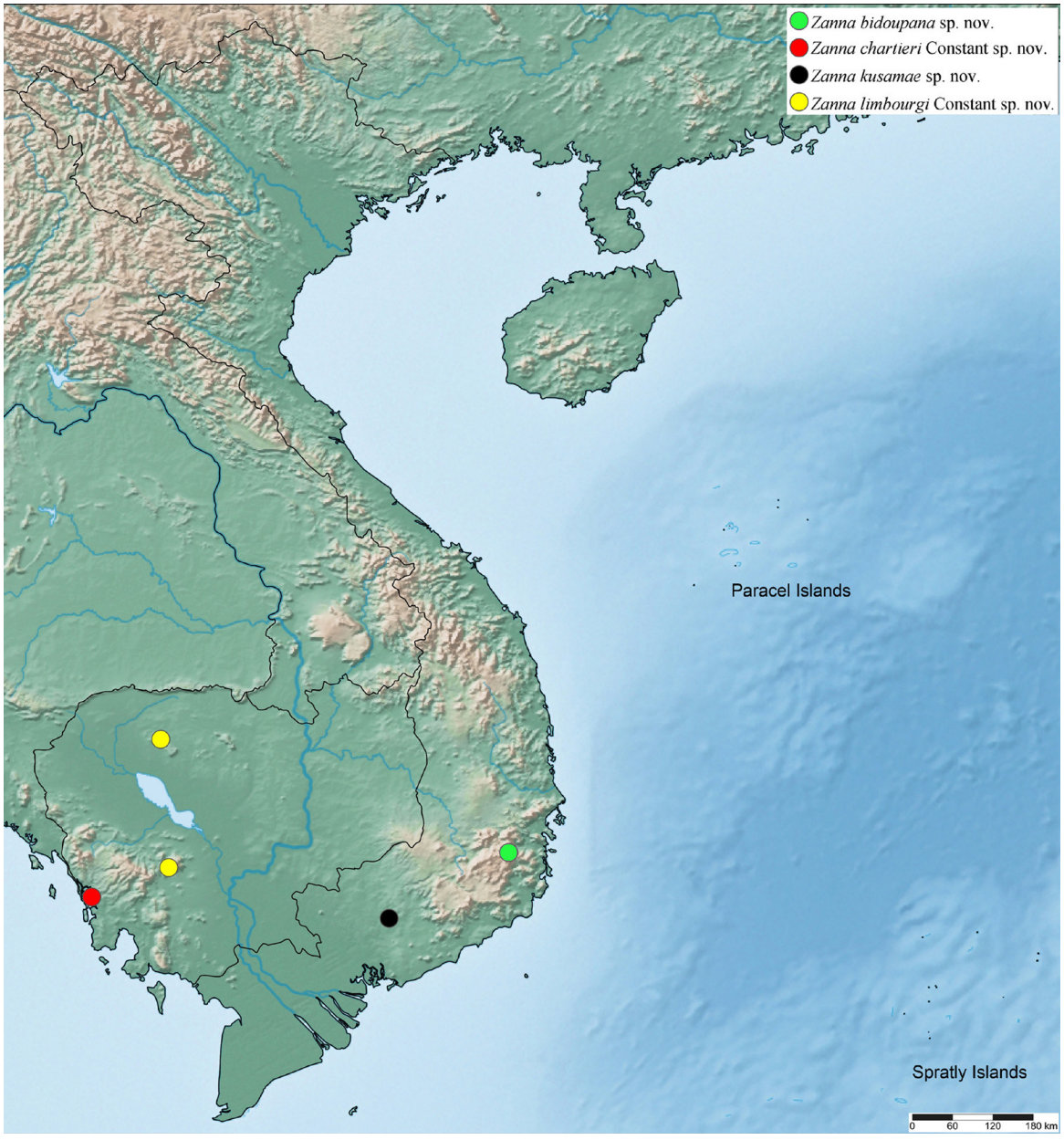

Fig. 5. *Zanna*, new spp. from Cambodia and Vietnam, distribution map.

Abdomen (Fig. 2A, C). Tergites smooth and shiny, blackish brown bordered with yellowish along posterior margin; sternites pale pinkish brown with transverse irregular row of strong black dots and rounded, brown marking along middle portion of posterior margin, except pregenital sternite with large subtriangular blackish brown marking in middle.

Male terminalia (Fig. 3). Pygofer (*Py* – Fig. 3A–D) about 1.77 times as high as long in lateral view, robust with posterior margin sinuate, forming large, broadly rounded posterior lobe in dorsal half; sides excavate in dorsal portion (visible in dorsal aspect, Fig. 3C). Anal tube (*An* – Fig. 3A–C) robust, 1.60 times as long as high and with ventral margin oblique in large posterior portion and angularly projecting in lateral view; 1.2 times as long as wide in dorsal view and with sides nearly straight, weakly diverging towards apex; more or less round in caudal view; epiproct and paraproct slightly supassing anal tube, rounded posteriorly in dorsal aspect. Gonostyli (*G* – Fig. 3A–D) elongate, 2.46 times as long as high; in lateral view, ventral margin broadly rounded and dorsal margin rather broadly rounded after lateral hook (*lhg*), apical margin rounded; lateral hook with basal portion projecting posterolaterad and apex strongly curved ventrad; in ventral view, lateral protrusion at about midlength, rather strongly and angularly marked. Aedeagus (Fig. 3E–H) rather robust with lateral processes (*lpa*) forming multiple lobes; dorsal process (*dpa*) moderately protruding dorsally in lateral view; dorsal endosomal process (*dep*) in dorsal view subtriangular with lateral margins weakly curved and median slit in distal portion.

Biology

The specimens were collected at a mercury vapour light trap at Hon Giao station in July (Fig. 4A–B). The habitat around was a clearing covered in grass, herbaceaous weeds and small bushes (Fig. 4C).

Distribution

Vietnam: Lam Dong Province (Fig. 5).

Zanna chartieri Constant sp. nov.
urn:lsid:zoobank.org:act:926CF853-E150-4282-984B-B99B17F1E37B
Figs 5–11, 18B, F, J, 19C–D

Diagnosis

The species is closest to *Zanna bidoupana* sp. nov., *Z. kusamae* sp. nov. and *Z. limbourgi* Constant sp. nov., from which it can be separated by the following characters: basal portion of head (Fig. 6B, E–F) covered in large, rather well-spaced, black pitting with 'background' of dense, very small black pitting (dense, irregular, rather large, coarse, sometimes coalescent black pitting in *Z. bidoupana* – Fig. 3B, E–F; moderately large, rather well-spaced, black pitting without 'background' of dense, very small black pitting in *Z. kusamae* – Fig. 12B, E–F); anal tube of male (Fig. 7A) rather flattened dorsoventrally, 2.14 times as long as high in lateral view and with ventral angle at midlength (rather high in lateral view, 1.60–1.65 times as long as high, with ventral angle in basal half in *Z. bidoupana* and *Z. limbourgi* – Figs 3A, 16A); pygofer of male in lateral view (Fig. 7A) with posterior margin moderately sinuate, forming a large, broadly rounded posterior lobe in dorsal half (posterior margin projecting into a large posterior lobe angularly rounded in midheight in *Z. kusamae* – Fig. 13A; posterior margin projecting posteriad in dorsal ⅓, in large, apically rounded lobe forming nearly right angle in *Z. limbourgi* – Fig. 16A).

Etymology

The species epithet is a patronym dedicated to Mr Gerard "Gee" Chartier (Tatai, Cambodia) who collected the type series and documented the biology of the species, in acknowledgment of his enthusiastic involvement in the progress of the knowledge of the Cambodian entomofauna.

Type material

Holotype

CAMBODIA • 1 ♂; Koh Kong Province, Tatai; 11°35′13″ N, 103°05′50″ E; 18 Jan.–2 Feb. 2017; day time collecting; G. Chartier leg.; I.G.: 33.551; "Coll. I.R.Sc.N.B., Cambodia, Koh Kong prov., Tatai, 11°35′13″ N, 103°05′50″ E, 18.I-2.II.2017, day collecting, leg. G. Chartier, I.G.: 33.551"; RBINS.

Paratypes

CAMBODIA • 3 ♂♂, 4 ♀♀; same collection data as for holotype; RBINS • 1 ♂,1 ♀; same collection data as for holotype; RUPP.

Additional material examined

CAMBODIA • 6 nymphs; same collection data as for holotype; RBINS.

Description

Measurements and ratios. LT: ♂ (n=4): 40.8 mm (38.4–41.8); ♀ (n=4): 41.8 (39.7–43.2). LTg/BTg=3.8; LH/BH=4.8; LF/BF=6.0; BH/BPrH=2.2; LH/LT=0.41; wingspan (extrapolated): ♂: 48.0 mm (45.2–49.3), ♀: 49.3 mm (46.8–50.9).

Head (Fig. 6B, E–F). Strongly elongate, representing 41% of total length, gently and evenly narrowing towards apex with apical ⅓ more or less parallel-sided in dorsal view; apex slightly widening, then obliquely cut in lateral view and with incomplete, rim-shaped orange carina (missing in ventral portion); rather pale greyish brown entirely covered in dense, irregular black pitting with smaller pits on all surface and some dispersed, moderately large, not or very rarely coalescent pits in basal ⅔; some larger black pustules on side, with always 2–5 along carina of vertex. Lateral carinae of frons moderate, weakly zigzagged, more prominent towards apex, upcurved near apex and merging into a short dorsal carina reaching apex; lateral carinae of vertex moderate, merging with upcurved part of lateral carinae of frons; median carina of vertex obsolete. Labium pale brown, reaching mesocoxae.

Thorax (Fig. 6B, E–F). Pro- and mesonotum rather pale greyish brown entirely covered in dense, irregular, moderate black pitting with pits smaller than space between them and not (or very rarely) coalescent; median carina obsolete.

Tegmina (Fig. 6A, C–D). Strongly elongate and reticulate, pale greyish brown, with more or less conspicuous, oblique brown band at basal ⅓, not extending on clavus; all surface irregularly covered in small to moderately large black spots, mostly on veins, larger ones slightly protruding; costal and postclaval margins subparallel, weakly diverging from base towards level of apex of clavus, then curved and weakly tapering towards apex; apical margin rounded. Main veins yellowish orange in basal portion. Clavus open.

Venation. ScP+R forked in basal ⅓, MP forked more basally in basal ¼; CuA forked near apex of clavus; PCu and A1 fused near apex of clavus; PCu+A1 fused with postclaval margin at nodal line.

Hind wings (Fig. 6A, C). Subhyaline, milky white with veins slightly darker, vein PCu pale brown in basal half; postclaval margin emarginate at A1 vein.

Venation. ScP+R and MP forked at midlength; CuA forked slightly more basally then MP fork; PCu forked at basal ⅓; A1 forked close to base, $A1_2$ fused with A2 in large distal portion and $A1_2$+A2 forked slightly before reaching postclaval margin. Numerous crossveins in large portion along apical and postclaval margins.

Fig. 6. *Zanna chartieri* Constant sp. nov., holotype, ♂ (RBINS). **A**. Habitus dorsal view. **B**. Head and thorax, dorsal view. **C**. Habitus, ventral view. **D**. Habitus, lateral view. **E**. Head, ventral view. **F**. Head and thorax, lateral view.

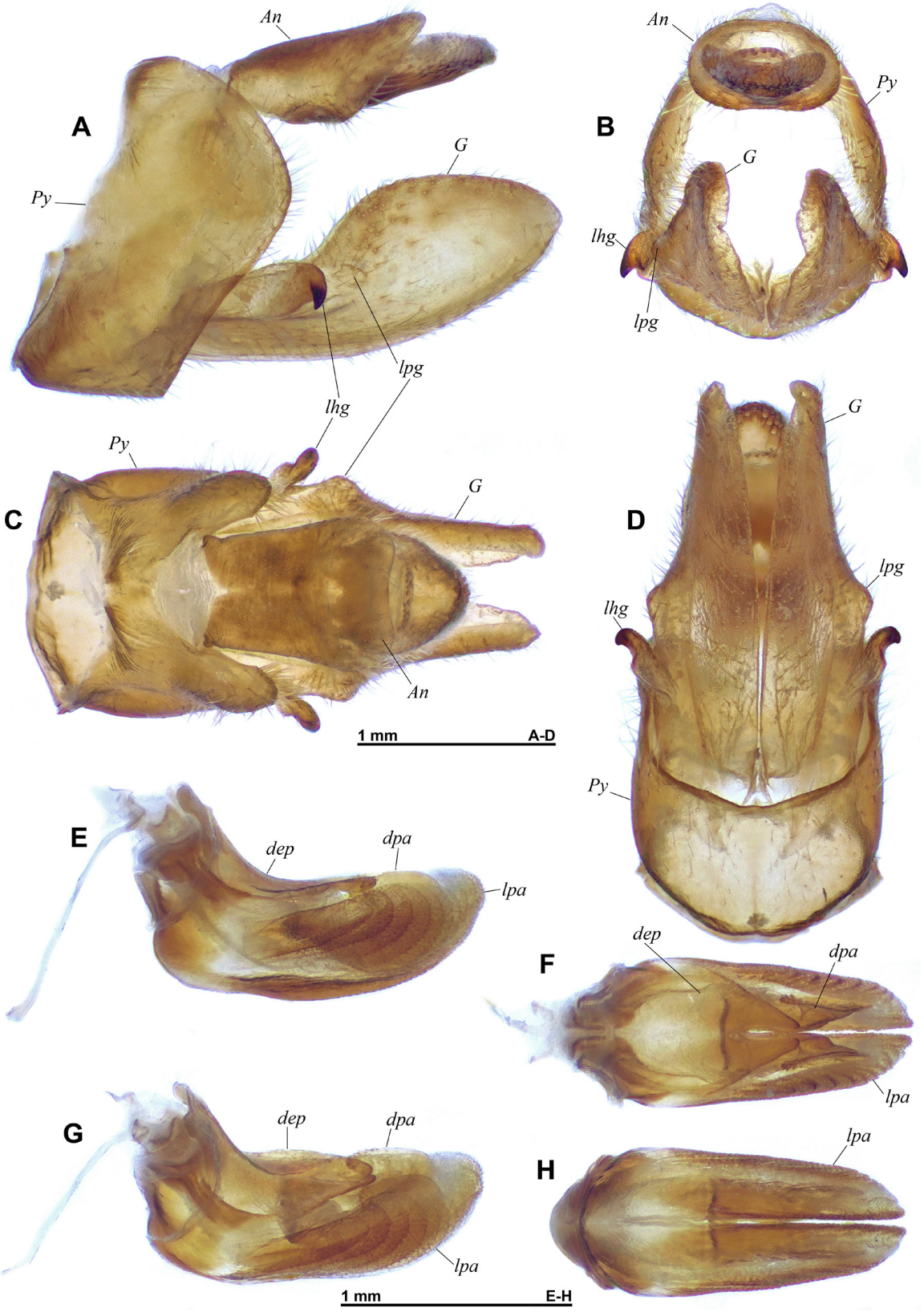

Fig. 7. *Zanna chartieri* Constant sp. nov., holotype, ♂ (RBINS), terminalia. **A–D**. Pygofer, anal tube and gonostyli. **A**. Left lateral view. **B**. Caudal view. **C**. Dorsal view. **D**. Ventral view. **E–H**. Aedeagus. **E**. Left lateral view. **F**. Dorsal view. **G**. Laterodorsal view. **H**. Ventral view. Abbreviations: see Materials and methods.

Fig. 8. *Zanna chartieri* Constant sp. nov., nymph. **A**. Habitus dorsal view. **B**. Habitus, ventral view. **C**. Habitus, lateral view.

Fig. 9. *Zanna chartieri* Constant sp. nov., in nature in Tatai, Cambodia (photographs © G. Chartier). **A**. Adult on *Desmodium* sp., 20 Jan. 2017. **B**. Adult on unidentified plant, 17 Jan. 2017. **C**. Adult on *Melastoma sanguineum*, lateral view, 17 Jan. 2017. **D**. Habitat, position of nymphs marked with red arrows, 20 Jan. 2017.

Fig. 10. *Zanna chartieri* Constant sp. nov., nymphs in nature in Tatai, Cambodia, on *Desmodium* sp. (photographs © G. Chartier). **A–B**. 4th instar nymphs. **A**. Laterodorsal view, 18 Jan. 2017. **B**. Lateral view, 20 Jan. 2017. **C–D**. 5th instar nymphs, 17 Jan. 2017. **C**. Lateral view. **D**. Dorsal view. **E–F**. Groups of nymphs. **E**. On vertical twig, 20 Jan. 2017. **F**. On creeping twig close to ground, 19 Jan. 2019.

Legs (Fig. 6A, C–D). Pale greyish stramineous, pilose, rather short and robust. Pro- and mesocoxae with some small black markings; all femora with few small to minute black spots and conspicuous black spots aligned in a ring in distal ⅓, sometimes coalescent; pro- and mesotibiae with some small black spots, regularly in basal ¼, and with apex brown; pro- and mesotarsi with segments darker apically; metatibiae weakly brown basally with all spines apically black, 5–6 lateral spines and 8 apical spines; first metatarsomere with 11–15 apical spines ventrally; second metatarsomere with 9–10 apical spines ventrally; first and second metatarsomere with a dense pad of microsetae ventrally; third metatarsomere elongate with a subapical blackish brown ring. Metatibiotarsal formula: (5–6) 8/11–15/9–10.

Abdomen (Fig. 6A, C). Tergites smooth and shiny, yellowish brown; sternites (except pregenital one) yellowish brown with irregular small black dots.

Male terminalia (Fig. 7). Pygofer (*Py* – Fig. 7A–D) about 1.96 times as high as long in lateral view, robust with posterior margin sinuate, forming a large posterior lobe in dorsal half; lobe broadly rounded; sides rather strongly excavate in dorsal portion (visible in dorsal aspect, Fig. 7C). Anal tube (*An* – Fig. 7A–C) robust, relatively flattened, 2.14 times as long as high and with ventral margin oblique in distal half and weakly angular in midlength in lateral view; 1.24 times as long as wide, with sides diverging towards apex and with apical margin incurved in dorsal view; oval in caudal view; epiproct and paraproct rather strongly supassing anal tube, rounded posteriorly in dorsal aspect. Gonostyli (*G* – Fig. 7A–D) elongate, 2.62 times as long as high; in lateral view, ventral margin broadly rounded and dorsal margin rather broadly rounded after lateral hook (*lhg*) but more strongly rounded at about midlength, apical margin rather narrowly rounded; lateral hook with basal portion projecting posterolaterad and apex strongly curved lateroventrad; in ventral view, lateral protrusion at about midlength, rather strongly marked and with posterior angle curved. Aedeagus (Fig. 7E–H) rather elongate with lateral processes (*lpa*) forming multiple lobes; dorsal process (*dpa*) weakly protruding dorsally in lateral view; dorsal endosomal process (*dep*) in dorsal view subtriangular with lateral margins nearly straight and median slit in distal portion.

Nymph (fifth instar – Figs 8, 10A–D)

Head (Figs 8A–C, 10A–D). Pale grey, strongly elongate, representing nearly half of total length, flattened dorsally and with well-marked longitudinal carinae; evenly tapering towards apex; apex slightly dilated, obliquely truncate, and with incomplete, rim-shaped orange carina (missing in ventral portion); carinae with protruding black spots, black spots limited to distal portion on lateral carinae of vertex; some black spots around eyes and on clypeus; minute tubercles between lateral and sublateral carinae of frons, more densely grouped towards base and towards apex. Lateral carinae of frons upcurved near apex and merging into a short dorsal carina reaching apex; lateral carinae of vertex merging with upcurved part of lateral carinae of frons. Labium pale brown with apex dark brown, reaching mesocoxae.

Thorax (Fig. 8A, C). Pale grey with irregular, rather wide, laterodorsal black stripe extending on pronotum and basal portion of mesonotum. Pronotum with anterior margin projecting cephalad, largely covering base of head, and with numerous minute tubercles on lateral fields and lateroventral lobes; two subparallel, sinuate lateral carinae, ventral one not visible in dorsal aspect. Mesonotum about 1.75 times as long as pronotum, with black spot in middle of well-marked peridiscal carinae, group of minute tubercles in lateral fields and longitudinal brown marking on buds of tegmina; buds of tegmina reaching apex of buds of hind wings. Metanotum about as long as pronotum, with two black spots on dorsolateral carinae and group of minute tubercles in lateral fields.

Legs (Fig. 8A–C). Pale grey, pilose, rather short and robust. Coxae with some small black markings; metacoxae with gear-shaped structures. Pro- and mesofemora with more or less coalescent black spots aligned in a ring in distal ⅓. Pro- and mesotibiae with 3 evenly spaced, more or less complete black rings, with first one at basal ¼ and last one at apex. Pro- and mesotarsi black with basal half of apical segment

pale grey. Metafemora with irregular black ring at distal ⅓ and more or less coalescent black spots in basal portion. Metatibiae dorsally with narrow, irregular blackish brown stripe at basal ⅓; ventrally with basal dark brown marking and black spots in distal half; laterally with irregular black spots; 5 lateral and 8 apical spines tipped with blackish brown. Metatarsi pale grey with apical half of last segment black; first metatarsomere with 9 apical spines ventrally; second metatarsomere with 8–9 apical spines ventrally; first and second metatarsomere with a dense pad of microsetae ventrally. Metatibiotarsal formula: (5) 8/9/8–9.

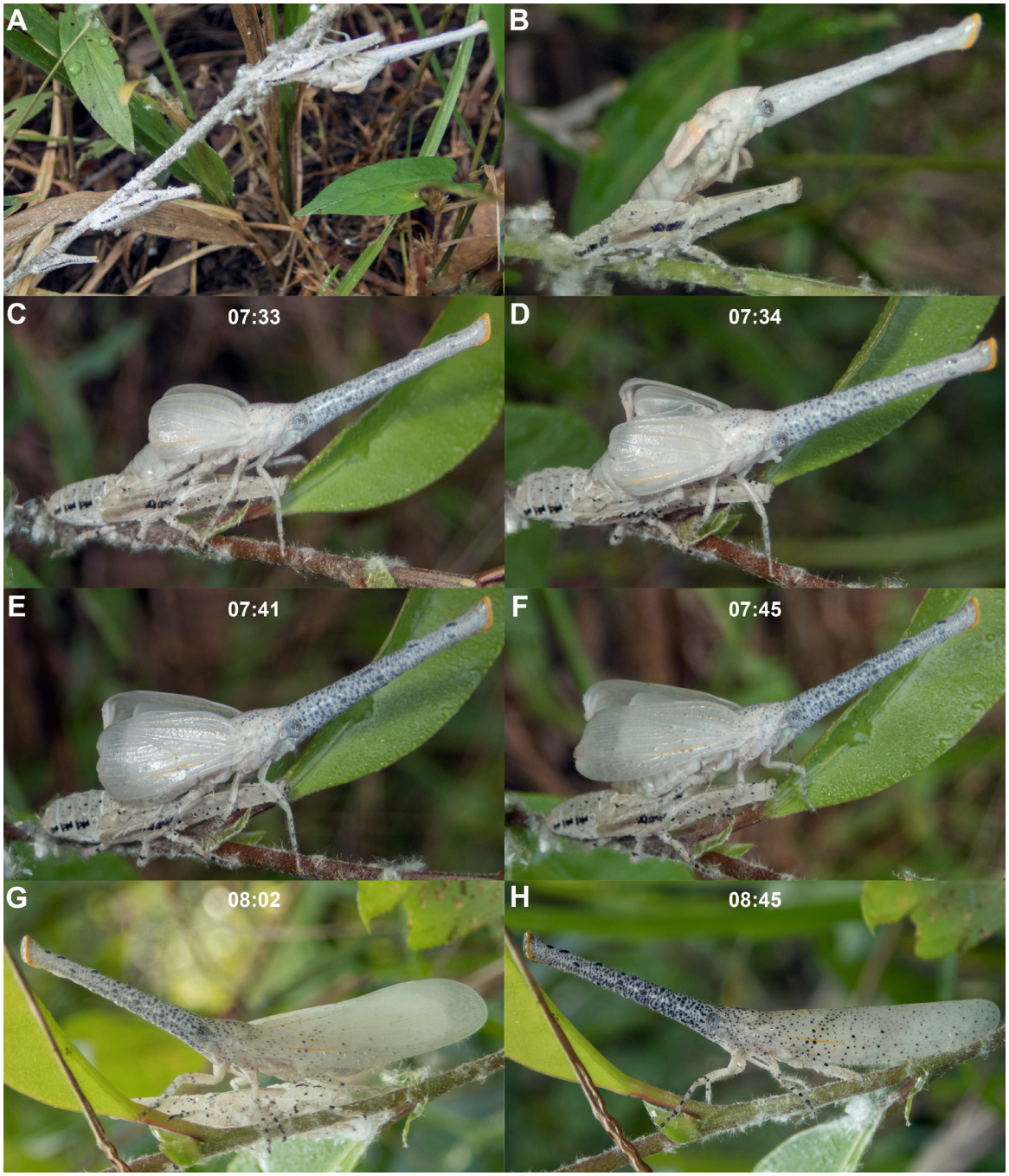

Fig. 11. *Zanna chartieri* Constant sp. nov., emerging adult in nature in Tatai, Cambodia, on *Desmodium* sp. (photographs © G. Chartier). **A**. Emerging adult with 4th and 5th instar nymphs, 18 Jan. 2017. **B**. 18 Jan. 2017. **C–H**. Time lapse of final moult of the same specimen, 18 Jan. 2017.

Abdomen (Fig. 8A–C). Pale grey. Tergites short and wide, with some small black spots in middle portion and curved black line on sides forming a zigzagged pattern not reaching apex; longitudinal ridge in lateral portion, not reaching anterior and posterior margins; groups of minute tubercles in posterolateral portion of visible segments. Sternites with some small black dots.

Biology

In 2017, between 17 January and 25 March, many specimens, nymphs and adults, were observed in Tatai, Koh Kong Province, Cambodia (G. Chartier, pers. com., Jan.–Feb. 2017), in a clearing covered in grass and other herbaceous plants at Rainbow Lodge. They were present in high density (Fig. 9D), with up to 40 nymphs at different stages, four emerging adults and two adults, counted in an area aproximatively 1 × 1.5 m on 18 January 2017. The very cryptic nymphs were all feeding on an unidentified species of creeping Fabaceae in the genus *Desmodium* Desv., leaving some characteristic white wax deposits on the stems they were sitting on (Fig. 10). The last instar nymphs seemed to move to more vertical stems before their final moult (Figs 9A–B, 11), even often climbing on different plant species like, for example, a newly emerged adult on the Melastomataceae, *Melastoma sanguineum* Sims (Fig. 9C) but no nymph was observed feeding on this plant. The adults seemed to move to other plants which were not found, and they were never seen feeding on *Desmodium*.

More specimens were recorded (photographed) by G.C., always at the same place in Tatai: on 1st November 2012, an adult in a bathroom at night, presumably attracted to light; on 20 February and 25 March 2014, one adult each time in a house, the latter at night time, presumably attracted to light; 2–4 August 2017, several nymphs on *Desmodium* sp.; 7–24 March 2018, several adults and nymphs on *Desmodium* sp.; 1 June 2018, one adult on *Melastoma* sp.; 2–4 March 2019, several adults and nymphs on *Desmodium* sp.; 27 December 2019–25 February 2020, several adults and nymphs on *Desmodium* sp.

Distribution

Cambodia: Koh Kong Province (Fig. 5).

Zanna kusamae sp. ***nov.***

urn:lsid:zoobank.org:act:326E30DE-9BB4-481E-B1D3-ABCBDCDCAF79

Figs 5, 12–14, 18C, G, K, 19E–F

Diagnosis

The species is closest to *Zanna bidoupana* sp. nov., *Z. chartieri* Constant sp. nov., and *Z. limbourgi* Constant sp. nov., from which it can be separated by the following characters: basal portion of head (Fig. 12B, E–F) covered in moderately large, rather well-spaced, black pitting without 'background' of dense, very small black pitting (dense, irregular, rather large, coarse, sometimes coalescent black pitting in *Z. bidoupana* – Fig. 3B, E–F; moderately large, rather well-spaced, black pitting with 'background' of dense, very small black pitting in *Z. chartieri* and *Z. limbourgi* – Figs 7B, E–F, 16B, E–F); anal tube of male (Fig. 13A) rather flattened dorsoventrally, 1.95 times as long as high in lateral view and with ventral angle at midlength (rather high in lateral view, 1.60–1.65 times as long as high, with ventral angle in basal half in *Z. bidoupana* and *Z. limbourgi* – Figs 3A, 16A); pygofer of male in lateral view (Fig. 13A) with posterior margin projecting into a large posterior lobe angularly rounded in midheight (posterior margin sinuate, forming a large, broadly rounded posterior lobe in dorsal half in *Z. kusamae* and *Z. chartieri* – Figs 3A, 7A; posterior margin projecting posteriad in dorsal ⅓, in large, apically rounded lobe forming nearly right angle in *Z. limbourgi* – Fig. 16A).

Etymology

The species epithet is a patronym dedicated to the famous Japanese artist Mrs Yayoi Kusama (1929–), whose artwork, extensively covered in dots, is reminiscent of the pattern on the body and tegmina of *Zanna* species.

Type material

Holotype

VIETNAM • 1 ♂; Vietnam, Dong Nai Biosphere Reserve; 11°18′ N, 107°06′ E; 25 Jun.–6 Jul. 2012; day time collecting; J. Constant and J. Bresseel leg.; I.G.: 32.161; "Coll. I.R.Sc.N.B., Vietnam, Dong Nai Biosphere Res., 11°18′ N, 107°06′ E, 25.VI-6.VII.2012, day collecting, Leg. J. Constant & J. Bresseel, I.G.: 32.161"; RBINS.

Description

Measurements and ratios. LT: ♂ (n = 1): 38.0 mm. LTg/BTg = 3.25; LH/BH = 4.2; LF/BF = 5.9; BH/BPrH = 2.4; LH/LT = 0.39; wingspan (extrapolated): ♂: 45.2 mm.

Head (Fig. 12B, E–F). Strongly elongate, representing 39% of total length, gently and evenly narrowing towards apex with apical ⅓ more or less parallel-sided in dorsal view; apex weakly widening, obliquely cut in lateral view and with incomplete, rim-shaped orange carina (missing in ventral portion); pale pinkish brown with irregular, moderately large, rather well-spaced, black pitting, more dense in basal half, especially on sides, and with very minute pits towards distal portion; some larger black pustules on side, along carina of vertex. Lateral carinae of frons weakly zigzagged, distinct towards apex, upcurved near apex and merging into a short dorsal carina reaching apex; lateral carinae of vertex distinct towards apex, merging with upcurved part of lateral carinae of frons; median carina of vertex obsolete. Labium yellowish brown, reaching mesocoxae.

Thorax (Fig. 12B, E–F). Pro- and mesonotum pale pinkish brown irregularly covered in small black pitting with pits much smaller than space between them (on average); median carina obsolete.

Tegmina (Fig. 12A, C–D). Strongly elongate and reticulate, pale (subhyaline) pinkish brown, moderately densely covered in minute to small black spots, mostly on veins, 3 slightly larger ones; costal and postclaval margins subparallel, weakly diverging from base towards apex and curved at level of apex of clavus; apical margin rounded. Veins yellowish in large basal portion. Clavus open.

Venation. ScP+R forked in basal ⅓, MP forked more basally in basal ¼; CuA forked near apex of clavus; PCu and A1 fused near apex of clavus; PCu+A1 fused with postclaval margin at nodal line.

Hind wings (Fig. 12A, C). Subhyaline, milky white with veins slightly darker, vein PCu dark brown in basal half; postclaval margin weakly emarginate at A1 vein, and infuscate along vein CuP.

Venation. ScP+R and MP forked at distal ⅓; CuA forked slightly more basally then MP fork; PCu forked at basal ⅓; A1 forked close to base, $A1_2$ fused with A2 rather close to base and $A1_2$+A2 forked slightly before reaching postclaval margin. Numerous crossveins in large portion along apical and postclaval margins.

Legs (Fig. 12A, C–D). Pale pinkish stramineous, pilose, rather short and robust. Pro- and mesocoxae with few small black markings; all femora with few small to minute black spots, sometimes absent, and conspicuous black spots aligned in a ring in distal ⅓, sometimes coalescent; pro- and mesotibiae with dark brown spots in basal ¼, and with apex brownish; pro- and mesotarsi with segments blackish brown apically; metatibiae weakly brown basally with all spines apically blackish brown, 4–5 lateral spines

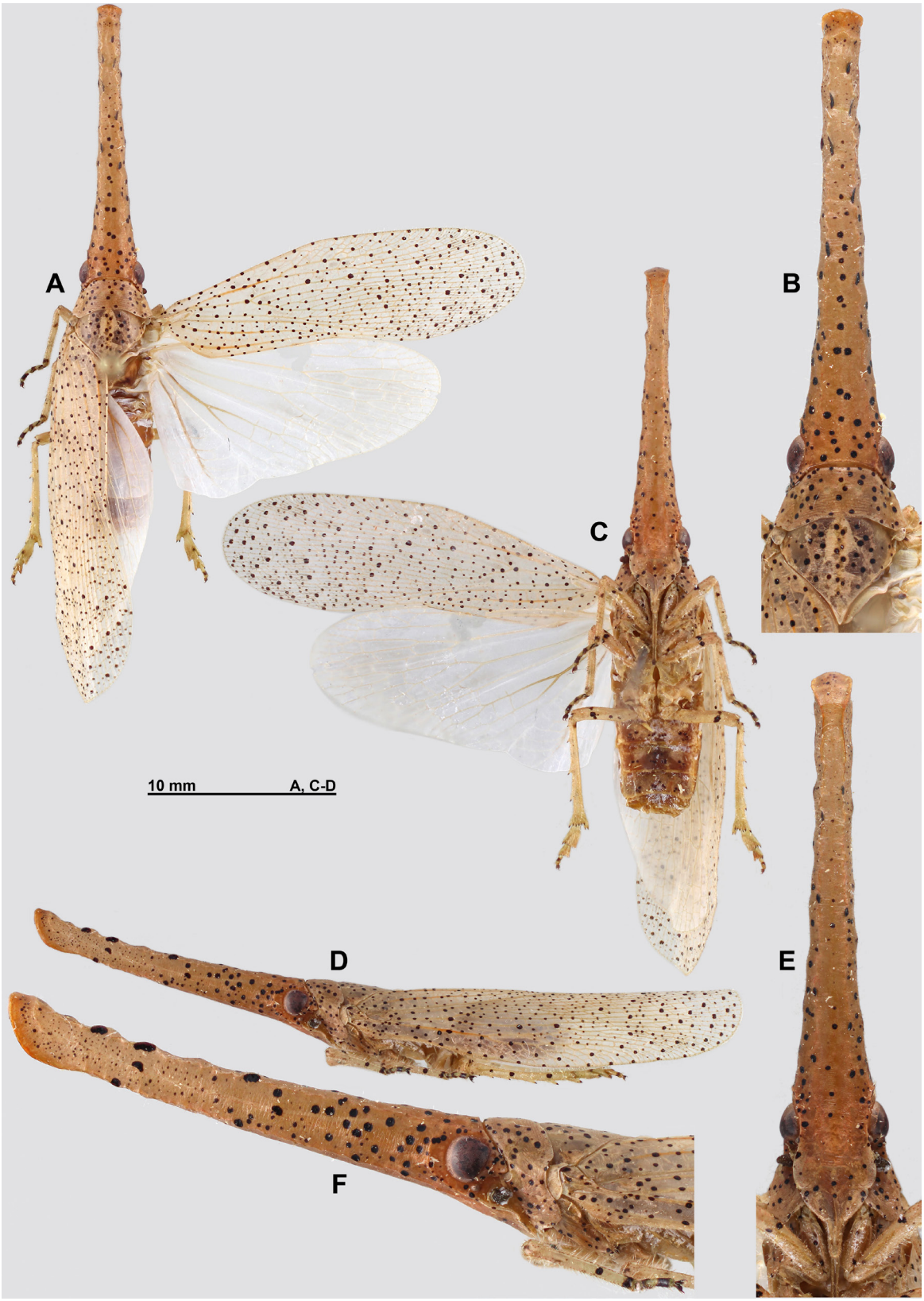

Fig. 12. *Zanna kusamae* sp. nov., holotype, ♂ (RBINS). **A**. Habitus dorsal view. **B**. Head and thorax, dorsal view. **C**. Habitus, ventral view. **D**. Habitus, lateral view. **E**. Head, ventral view. **F**. Head and thorax, lateral view.

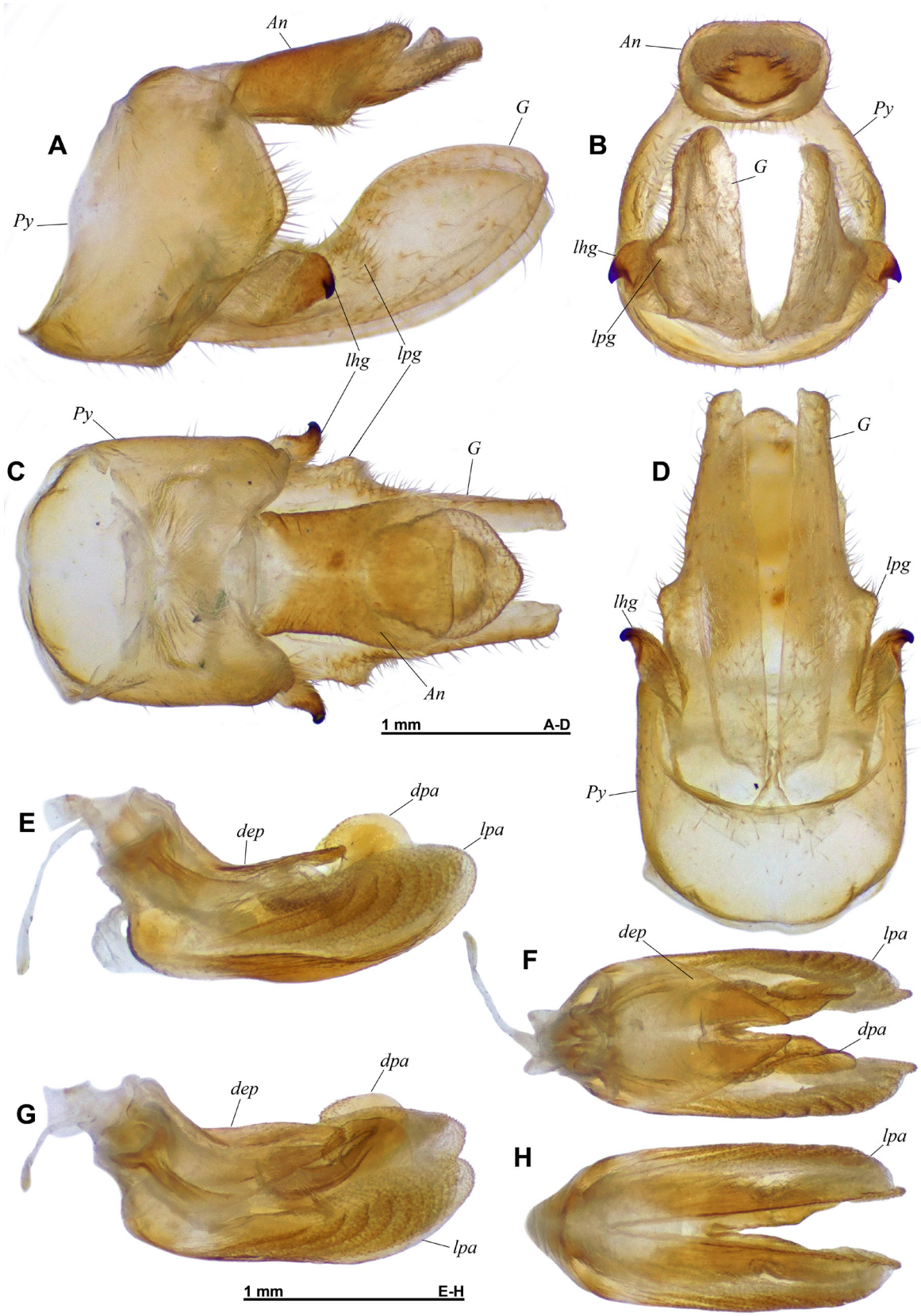

Fig. 13. *Zanna kusamae* sp. nov., holotype, ♂ (RBINS), terminalia. **A–D**. Pygofer, anal tube and gonostyli. **A**. Left lateral view. **B**. Caudal view. **C**. Dorsal view. **D**. Ventral view. **E–H**. Aedeagus. **E**. Left lateral view. **F**. Dorsal view. **G**. Laterodorsal view. **H**. Ventral view. Abbreviations: see Materials and methods.

and 8 apical spines; first metatarsomere with 11–13 apical spines ventrally; second metatarsomere with 9 apical spines ventrally; first and second metatarsomere with a dense pad of microsetae ventrally; third metatarsomere elongate with a subapical blackish brown ring. Metatibiotarsal formula: (4–5) 8/11–13/9.

Abdomen (Fig. 12A, C). Tergites smooth and shiny, yellowish brown; sternites (except pregenital one) yellowish brown with irregular small black dots more or less aligned into a transverse row.

Fig. 14. *Zanna kusamae* sp. nov., holotype, ♂, in nature, Dong Nai Biosphere Reserve, Vietnam, 3 Jul. 2012. **A**. Habitus lateral view. **B**. Habitus, dorsal view. **C**. Habitat.

Male terminalia (Fig. 13). Pygofer (*Py* – Fig. 13A–D) about 1.51 times as high as long in lateral view, robust with posterior margin projecting posteriorly into a large posterior lobe in midheight; lobe angularly rounded; sides weakly excavate in dorsal portion (visible in dorsal aspect, Fig. 13C). Anal tube (*An* – Fig. 3A–C) robust, 1.95 times as long as high and with ventral margin oblique in distal half and angularly projecting at a wide angle in lateral view; 1.26 times as long as wide in dorsal view, with lateral margins slightly diverging towards apex and apical margin bisinuate, weakly excavate in middle portion; suboval, more or less flattened dorsally, in caudal view; epiproct and paraproct strongly surpassing anal tube, angularly rounded posteriorly in dorsal aspect. Gonostyli (*G* – Fig. 13A–D) elongate, 2.82 times as long as high; in lateral view, ventral margin broadly rounded and dorsal margin rather broadly rounded after lateral hook (*lhg*), apical margin rounded; lateral hook with basal portion projecting posterolaterad and dorsal hump in middle portion, and apex strongly curved lateroventrad; in ventral view, lateral protrusion at about midlength, rather strongly and angularly marked. Aedeagus (Fig. 13E–H) rather elongate with lateral processes (*lpa*) forming multiple lobes; dorsal process (*dpa*) strongly protruding dorsally in lateral view; dorsal endosomal process (*dep*) in dorsal view subtriangular with lateral margins very weakly curved (nearly straight) and rather wide median slit in distal portion.

Biology

The holotype (Fig. 14A–B) was collected sitting on a leaf of a short plant along a gravel road near the clearing around the station in Dong Nai (Fig. 14C).

Distribution

Vietnam: Dong Nai Province (Fig. 5).

Zanna limbourgi Constant sp. nov.
urn:lsid:zoobank.org:act:CDC2CFD0-B1E8-4DA2-8114-5F4BD37D8782
Figs 5, 15–17, 18D, H, L, 19G–H

Diagnosis

The species is closest to *Zanna bidoupana* sp. nov., *Z. chartieri* Constant sp. nov., and *Z. kusamae* sp. nov., from which it can be separated by the following characters: basal portion of head (Fig. 16B, E–F) covered in moderately large, rather well-spaced, black pitting with 'background' of dense, very small black pitting (dense, irregular, rather large, coarse, sometimes coalescent black pitting in *Z. bidoupana* – Fig. 3B, E–F; moderately large, rather well-spaced, black pitting without 'background' of dense, very small black pitting in *Z. kusamae* – Fig. 12B, E–F); anal tube of male rather high in lateral view (Fig. 16A), about 1.65 times as long as high, with ventral angle in basal half (rather flattened dorsoventrally, 1.95–2.14 times as long as high in lateral view, with ventral angle at midlength in *Z. chartieri* and *Z. kusamae* – Figs 7A, 13A); pygofer of male in lateral view (Fig. 16A) with posterior margin projecting posteriad in dorsal ⅓, in large, apically rounded lobe forming nearly right angle (posterior margin projecting into a large posterior lobe angularly rounded in midheight in *Z. kusamae* – Fig. 13A; posterior margin moderately sinuate, forming a large, broadly rounded posterior lobe in dorsal half in *Z. bidoupana* and *Z. limbourgi* – Figs 3A, 16A).

Etymology

The species epithet is a patronym dedicated to my great (although still a bit fat, see Constant 2008) colleague Pol Limbourg (RBINS) who spotted the type specimens on a tree trunk in Phnom Aural Wildlife Sanctuary.

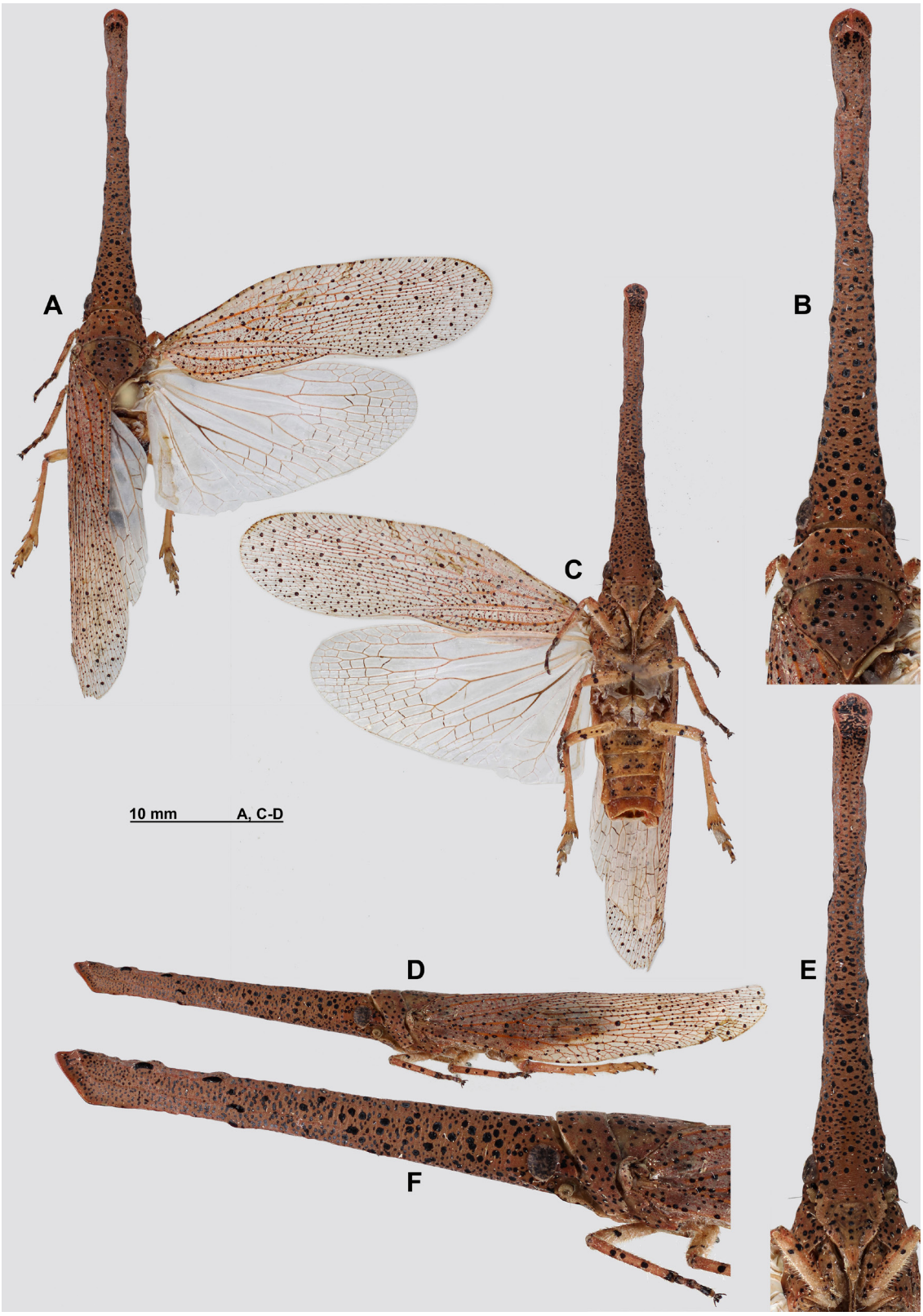

Fig. 15. *Zanna limbourgi* Constant sp. nov., holotype, ♂ (RBINS). **A**. Habitus dorsal view. **B**. Head and thorax, dorsal view. **C**. Habitus, ventral view. **D**. Habitus, lateral view. **E**. Head, ventral view. **F**. Head and thorax, lateral view.

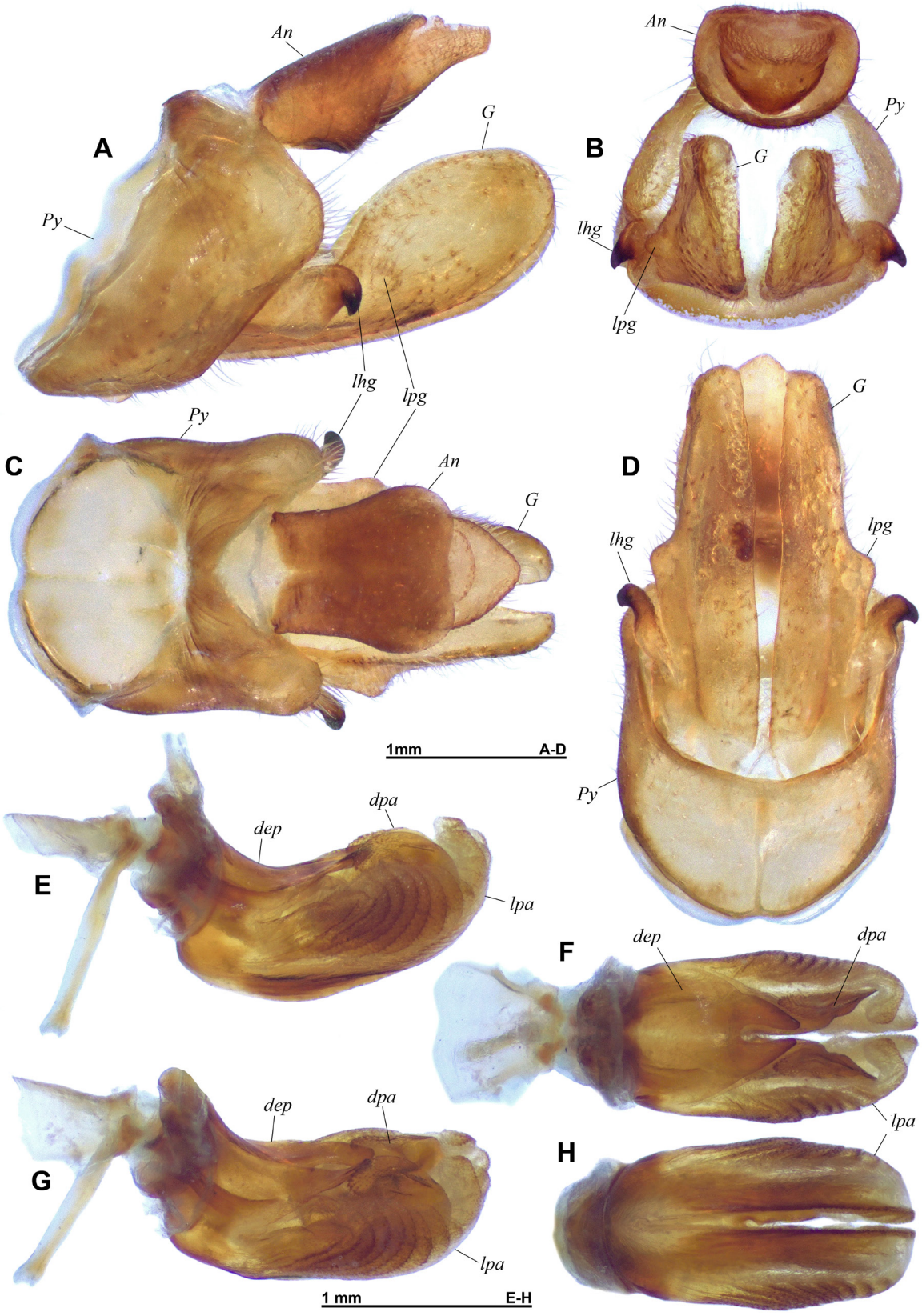

Fig. 16. *Zanna limbourgi* Constant sp. nov., holotype, ♂ (RBINS), terminalia. **A–D**. Pygofer, anal tube and gonostyli. **A**. Left lateral view. **B**. Caudal view. **C**. Dorsal view. **D**. Ventral view. **E–H**. Aedeagus. **E**. Left lateral view. **F**. Dorsal view. **G**. Laterodorsal view. **H**. Ventral view. Abbreviations: see Materials and methods.

Type material

Holotype

CAMBODIA • 1 ♂; Kampong Speu Province, Phnom Aural Wildlife Sanctuary, near Srea Ken Village; 11°59′ N, 104°08′ E; 10–14 May 2018; 200–400 m a.s.l.; GTI Project; J. Constant & P. Limbourg leg.; I.G.: 33.732; "Coll. I.R.Sc.N.B., Cambodia, Kampong Speu prov., Phnom Aural W.S., nr Srea Ken Vill., 10-14.v.2018, 200–400 m, 11°59′ N, 104°08′ E, GTI Project, Leg. J. Constant and P. Limbourg, I.G.: 33.732"; RBINS.

Paratypes

CAMBODIA • 1 ♂; same collection data as for holotype; RBINS • 1 ♂,1 ♀; Siem Reap Province, Kbal Spean; [13°42′30″ N, 104°01′32″ E]; light trap; 28 May 2005; I. Var and P. Grootaert leg.; "Coll. I.R.Sc.N.B., Cambodia (Siem Reap prov), Kbal Spean, Light Trap, 28.V.2005, Leg. Var & Grootaert"; RBINS.

Description

Measurements and ratios. LT: ♂ (n=2): 43.5–46.8 mm. LTg/BTg=3.3; LH/BH=5.1; LF/BF=5.3; BH/BPrH=2.56; LH/LT=0.43; wingspan (extrapolated): ♂: 44.8 mm (41.6–47), ♀: 45.9 mm.

Head (Fig. 15B, E–F). Strongly elongate, representing 43% of total length, gently and evenly narrowing towards apex with apical 1/2 more or less parallel-sided in dorsal view; apex weakly widening, then obliquely cut in lateral view and with incomplete, rim-shaped orange carina (missing in ventral portion); pinkish brown densely covered in irregular very small black pitting, with some moderately larger pits mostly in basal half on sides and vertex and rarely coalescent; some slightly larger black pustules on side in distal portion, with always 2–3 along carina of vertex. Lateral carinae of frons indistinct in basal half, then nearly straight and slightly prominent towards apex, upcurved near apex and merging into a short dorsal carina reaching apex; lateral carinae of vertex indistinct in basal half, then rather weak and zigzagged, merging with upcurved part of lateral carinae of frons; median carina of vertex weakly marked in distal ⅓. Labium pale brown, reaching mesocoxae.

Thorax (Fig. 15B, E–F). Pro- and mesonotum pinkish brown entirely covered in moderately dense, irregular, moderate black pitting with pits mostly smaller than space between them and rarely coalescent; median carina obsolete.

Tegmina (Fig. 15A, C–D). Strongly elongate and reticulate, pale pinkish brown, progressively paler, subhyaline towards apex, basal portion densely covered with minute dark red spots; all surface irregularly covered in small to moderately large black spots, mostly on veins, larger ones slightly protruding; costal and postclaval margins subparallel, weakly diverging from base towards apex and curved at level of apex of clavus; apical margin rounded. Veins orange in large basal portion. Clavus open.

Venation. ScP+R forked in basal ⅓, MP forked more basally in basal ¼; CuA forked near apex of clavus; PCu and A1 fused near apex of clavus; PCu+A1 fused with postclaval margin at nodal line.

Hind wings (Fig. 15A, C). Subhyaline, milky white with veins slightly darker, tinged with reddish brown; vein PCu brown in basal half; postclaval margin emarginate at A1 vein.

Venation. ScP+R and MP forked beyond midlength; CuA forked slightly more basally then MP fork; PCu forked at basal ⅓; A1 forked rather close to base, $A1_2$ fused with A2 in distal portion and $A1_2$+A2 forked slightly before reaching postclaval margin. Numerous crossveins in large portion along apical and postclaval margins.

Fig. 17. *Zanna limbourgi* Constant sp. nov., holotype, ♂, in nature in Phnom Aural Wildlife Sanctuary, Cambodia, 12 May 2018. **A**. Habitus, lateral view. **B**. Habitus, dorsal view. **C**. Habitat.

Legs (Fig. 15A, C–D). Pinkish stramineous, pilose, rather short and robust. Pro- and mesocoxae with some black markings; all femora with small to minute black spots and conspicuous black spots aligned in a ring in distal ⅓, rarely coalescent; pro- and mesotibiae with some small black spots (some arranged into irregular ring in basal ¼), and with apex brown; pro- and mesotarsi with segments darker apically; metatibiae weakly brown basally with all spines apically black, 4–5 lateral spines and 8 apical spines; first metatarsomere with 11–14 apical spines ventrally; second metatarsomere with 10 apical spines

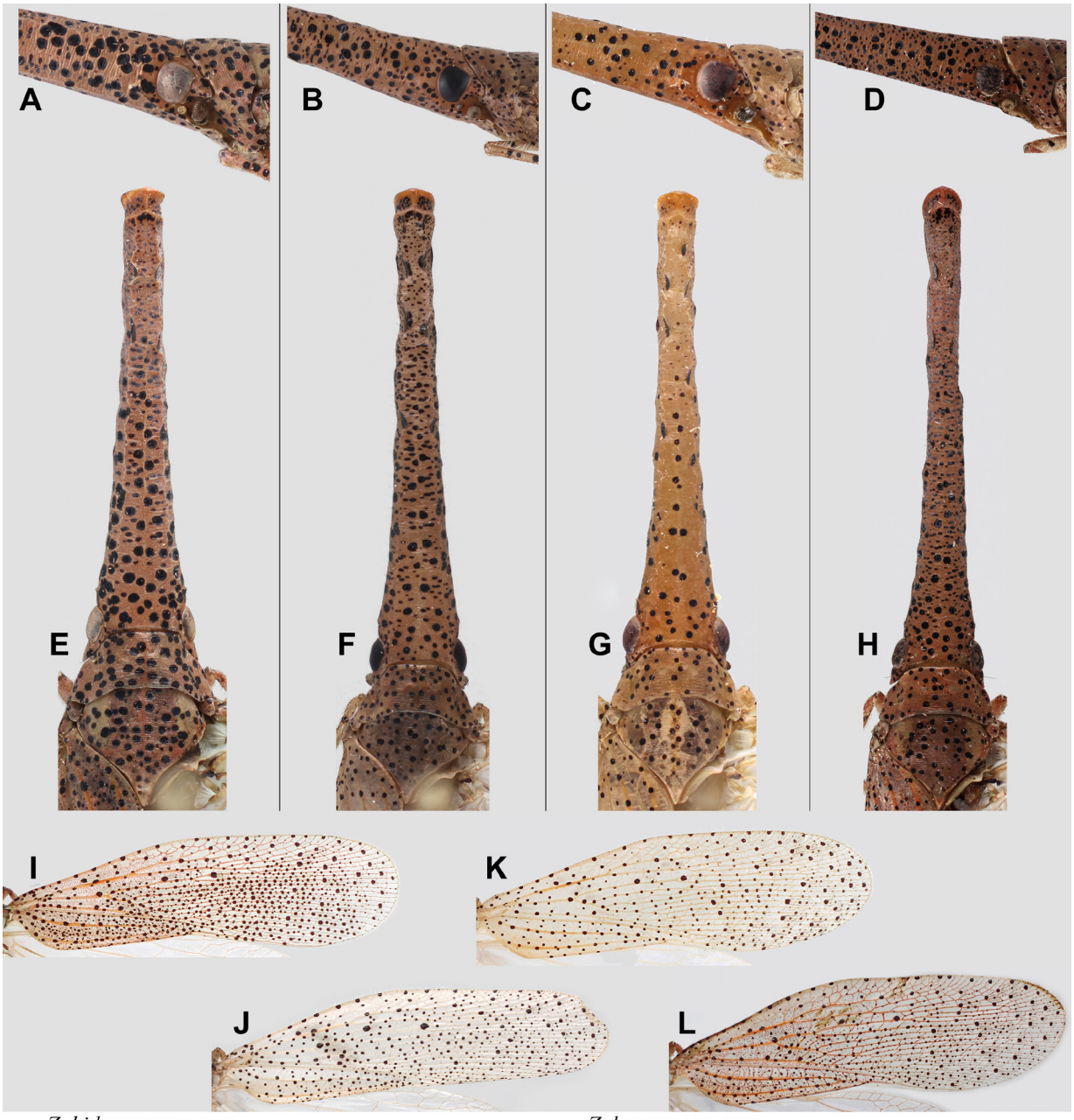

Fig. 18. *Zanna*, new spp. from Cambodia and Vietnam, key characters. **A–D**. Prothotax and basal half of head, lateral view. **E–H**. Head and thorax, dorsal view. **I–L**. Right tegmen. **A, E, I**. *Z. bidoupana* sp. nov. **B, F, J**. Z. *chartieri* Constant sp. nov. **C, G, K.** *Z. kusamae* sp. nov. **D, H, L**. *Z. limbourgi* Constant sp. nov., (not to scale).

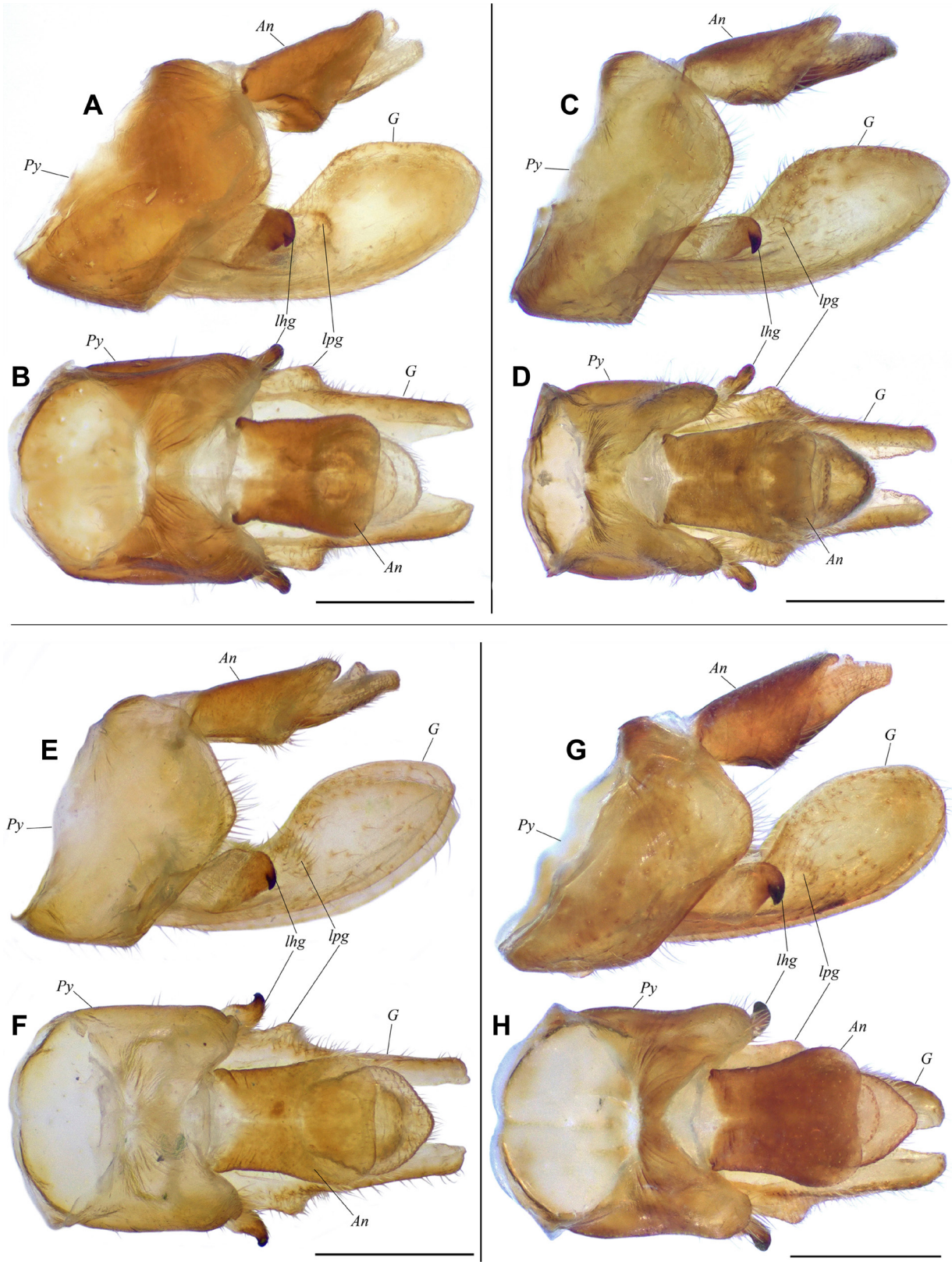

Fig. 19. *Zanna*, new spp. from Cambodia and Vietnam, key characters of pygofer, anal tube and gonostyli. **A, C, E, G**. Lateral view. **B, D, F, H**. Dorsal view. **A–B**. *Z. bidoupana* sp. nov. **C–D**. *Z. chartieri* Constant sp. nov. **E–F**. *Z. kusamae* sp. nov. **G–H**. *Z. limbourgi* Constant sp. nov. (scale bars = 1 mm). Abbreviations: see Materials and methods.

ventrally; first and second metatarsomere with a dense pad of microsetae ventrally; third metatarsomere elongate with a subapical blackish brown ring. Metatibiotarsal formula: (4–5) 8/11–14/10.

Abdomen (Fig. 15A, C). Tergites smooth, segments blackish brown with more or less developed marking at posterior angles, and posterior margin, yellowish; sternites (except pregenital one) yellowish brown with irregular small black dots arranged in two groups in middle portion, and two groups on side of each segment, often with two black dots anteriorly to middle groups.

Male terminalia (Fig. 16). Pygofer (*Py* – Fig. 16A–D) about 1.69 times as high as long in lateral view, robust with posterior margin projecting posteriad in dorsal ⅓, in large, apically rounded lobe forming nearly right angle; sides weakly excavate in dorsal portion (to observe in dorsal aspect, Fig. 16C). Anal tube (*An* – Fig. 16A–C) robust, moderately flattened, 1.65 times as long as high and with ventral margin oblique in distal half and moderately angular before midlength in lateral view; in dorsal view, 1.08 times as long as wide, with sides sinuate, subparallel in basal portion, then roundly diverging towards apex, forming rounded posterior angles and with apical margin incurved; suboval in caudal view, flattened dorsally; epiproct and paraproct rather strongly surpassing anal tube, subtriangular and rounded posteriorly in dorsal aspect. Gonostyli (*G* – Fig. 16A–D) elongate, 2.58 times as long as high; in lateral view, ventral margin broadly rounded and dorsal margin rather broadly rounded after lateral hook (*lhg*), apical margin rather broadly rounded; lateral hook with basal portion projecting posterolaterad and apex strongly curved lateroventrad; in ventral view, lateral protrusion at about midlength, rather strongly, angularly marked and with posterior angle curved. Aedeagus (Fig. 16E–H) moderately elongate with lateral processes (*lpa*) forming multiple lobes; dorsal process (*dpa*) weakly protruding dorsally in lateral view; dorsal endosomal process (*dep*) in dorsal view subtriangular with lateral margins nearly straight and rather wide median slit in distal portion.

Biology

The specimens from Siem Reap were attracted to a light trap in a strongly anthropized area while those from Phnom Aural were found sitting on the trunk of an unidentified tree (Fig. 17A–B) about 1.5 m above the ground in rather heavily disturbed secondary forest (Fig. 17C).

Distribution

Cambodia: Kampong Speu and Siem Reap provinces (Fig. 5).

Identification key to the species of Zanna from Cambodia and Vietnam

1. Smaller, wingspan up to 55 mm, usually less than 50 mm; cephalic process exceeding 1.3 times as long as abdomen 2
– Larger, wingspan 60–65 mm; cephalic process less than 1.3 times as long as abdomen (Fig. 20A–B) ..... ***Z. chinensis*** (Distant, 1893)

2. Anal tube of male rather flattened dorsoventrally, 1.95–2.14 times as long as high in lateral view; ventral angle of anal tube at midlength (Fig. 19C, E) 3
– Anal tube of male rather high, 1.60–1.65 times as long as high in lateral view; ventral angle of anal tube before midlength (Fig. 19A, G) 4

3. Pygofer with posterior margin projecting into a large rounded posterior lobe in dorsal half (Fig. 19C) and with sides rather strongly excavate in dorsal portion (Fig. 19D); basal portion of head covered in dense, irregular black pitting with smaller pits and some dispersed, moderately large, not or very rarely coalescent pits (Fig. 18B, F); tegmina more elongate, 3.80 times as long as wide (Fig. 18J) .. .. ***Z. chartieri*** Constant sp. nov.

– Pygofer with posterior margin projecting into a large posterior lobe angularly rounded in midheight (Fig. 19E) and with sides weakly excavate in dorsal portion (Fig. 19F); basal portion of head with irregular, moderately large, rather well-spaced, black pitting but without 'background' of smaller pits (Fig. 18C, G); tegmina less elongate, 3.25 times as long as wide (Fig. 18K) ..... ***Z. kusamae*** sp. nov.

4. Pygofer in lateral view with posterior margin sinuate, forming a large, broadly rounded posterior lobe in dorsal half (Fig. 19A); anal tube in dorsal view 1.2 times as long as wide and with sides nearly straight, weakly diverging towards apex (Fig. 19B); basal portion of head covered in dense, irregular, rather large, coarse, sometimes coalescent black pitting with few smaller pits (Fig. 18A, E) ..... ***Z. bidoupana*** sp. nov.

– Pygofer in lateral view with posterior margin projecting posteriad in dorsal ⅓, in large, apically rounded lobe forming nearly right angle (Fig. 19G); anal tube in dorsal view 1.08 times as long as wide, with sides roundly diverging towards apex (Fig. 19H); basal portion of head densely covered in irregular, very small black pitting, with some moderately larger pits, rarely coalescent (Fig. 18D, H) ..... ***Z. limbourgi*** Constant sp. nov.

Fig. 20. *Zanna chinensis* (Distant, 1893), syntype, ♀ (BMNH). **A**. Dorsal view. **B**. Lateral view. **C**. Labels (photograph by D. Rendon-Mera, © The Trustees of the Natural History Museum, London).

Other species examined for this study

Zanna chinensis (Distant, 1893)

Fig. 20

Pyrops chinensis Distant, 1893: 444 (in key), 448 (description).

Pyrops distanti Schmidt, 1911: 163 (described). Synonymized by Lallemand (1963: 93).

Zanna chinensis – Metcalf 1947: 249 (catalogued, transferred to *Zanna*).

Material examined

Syntype (examined from photographs)

CHINA • 1 ♀; Chia Hou Ho; 1700 ft; Leech leg.; Distant coll. 1911–383; NHMUK015981678; BMNH.

Note

Compared to the syntype (Fig. 19), it appears that the specimen illustrated as *Zanna chinensis* in Liang (2017: fig. 1) is probably misidentified, and might represent an undescribed species.

Discussion

The hypothesis of a monophyletic genus *Zanna* Kirkaldy, 1902 as proposed by Liang (2017), was not tested and was not supported by a morphological or molecular analyses. On the contrary, examination of the species within *Zanna* shows that some of them obviously group together based on some important morphological characters. These groups are further supported by their zoogeographical distribution and might be shown to represent separate genera in the future. For example, a large size, a subcylindrical cephalic process and completely brown hind wings will group the Afrotropical *Z. tenebrosa* (Fabricius, 1775) and its synonyms, subspecies and "forms"; a large size and a large cephalic process with prominent lateral teeth group the Oriental species, *Z. nobilis* (Westwood, 1838), *Z. servillei* (Spinola, 1839), *Z. terminalis* (Gerstaecker, 1895), and allies, while a moderately large size, an apically clavate and upcurved cephalic process combined with largely brown hind wings group the Afrotropical species *Z. clavaticeps* (Karsch, 1890) and *Z. turrita* (Gerstaecker, 1895), to name just a few (see illustrations available in Lallemand 1959; Nagai & Porion 1996). The two keys to the Afrotropical and Oriental species, respectively, as proposed by Lallemand (1959, 1963), remain difficult to use and might be misleading in the absence of a full revision of the genus, which must include the male genitalia characters. Such a revision will also allow an accurate assessment of the actual distribution of the species.

At a higher phylogenetic level, the precise placement of the Zanninae within the (Dictyopharidae + Fulgoridae) group remains uncertain, despite several studies based on morphological and/or molecular data (Emeljanov 1979, 2012, 2013; Urban & Cryan 2009; Bucher *et al.* 2023; Wang *et al.* 2023). More generally, the current subfamilies and tribes of Fulgoridae are widely considered as non-monophyletic taxa, being poorly defined on a small set of characters, mostly morphological features of the head, and requiring a completely revised classification (Urban & Cryan 2009; Bucher *et al.* 2023).

Two species of *Zanna* are now recorded from Cambodia (*Z. chartieri* Constant sp. nov. and *Z. limbourgi* Constant sp. nov.) and three from Vietnam (*Z. chinensis*, *Z. bidoupana* sp. nov. and *Z. kusamae* sp. nov.); as a comparison, three species are currently known from Thailand: *Z. chinensis*, *Z. dalyi* Distant, 1905 and *Z. nobilis* (Westwood, 1838) (Liang 2017), while the genus has not yet been recorded from Laos (Bourgoin 2024).

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