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Sogalabana ochracea gen. et sp. nov. from Tsaratanana massif in northern Madagascar (Hemiptera: Fulgoromorpha: Flatidae)

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The paper describes a new flatid genus, *Sogalabana* gen. nov., and a new species *Sogalabana ochracea* sp. nov. from Madagascar. Illustrations of the female internal genital structures are provided.

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Keywords: planthoppers; Fulgoromorpha; Flatidae; Madagascar; taxonomy

Introduction

Madagascar is the fourth largest island and represents one of the world's top 12 "megadiversity" hotspots with high levels of taxonomic endemism and species diversity (Myers et al. 2000; Goodman and Benstead 2005). These can be partly explained by mountainous areas of the island, which serve as refugia, centres of clade origin and endemism (Boumans et al. 2007; Wollenberg et al. 2008). Madagascan mountains stretch from north to south across the island; there are three prominent highland massifs: Tsaratanana, Ankaratra and Andringitra.

Tsaratanana massif, located in the north, is the highest mountain range in the island, with the peak of Maromokotro rising to 2876 m. It is composed of volcanic granite and migmatite, characterized by steep slopes in the low-altitude parts, ending with a complex system of sharp crests culminating in a vast plateau. The massif is a very important source of water for the whole area and numerous rivers exist there, such as the Bemarivo, the Sambirano, the Ramena and the Mahavavy rivers. The area has one of the highest levels of endemicity in Madagascar. There are 20 mammal species, among them 11 lemurs, listed for the range and 94 bird species, of which 56 are endemic. The vegetation up to 2000 m is represented mainly by dense, humid evergreen forest with an abundance of trees 10–12 m high, lianas and palms. The area located between 2000 and 2200 m is characterized by dense bamboo forest and between 2200 and 2600 m by sclerophyllous montane forest. Grassy savannah, which occurs above 2600 m, is of human origin, having replaced the original montane bushland as a result of burning and livestock-grazing.

A new monotypic genus of Flatidae planthoppers from the Tsaratanana massif is described and illustrated here. The genus is placed in a monotypic subtribe that is endemic to Madagascar – Phaedolina Melichar, 1923 belonging to the tribe

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Nephesini Melichar, 1923. It is assumed that the subtribe should be raised to tribal level; however, to confirm this, further studies on Nephesini are required.

Material and methods

Material

The studied material comes from the entomological collections of the Muséum national d'Histoire naturelle (MNHN), Paris, France.

Preparations and illustration

The abdomens of the specimens examined were cut off and cleared for 30 min in a warm (50°C) 10% KOH solution with a few drops of black chlorazol (CAS No. 1937-37-7) for dyeing the ectodermic genital ducts based on the method introduced by Carayon (1969) and Bourgoin (1993). Dissections and cleaning of the genital structures were carried out in distilled water. Final observations and drawings were made in glycerol using a camera lucida attached to Olympus microscopes (SZH10 and BX50). The photographs of the habitus were taken using a stereoscopic microscope Leica MZ 16 with IC3D camera; images were produced using Synoptics Automontage software. The photographs of genital structures were taken using a light microscope Leica DM5500B with Leica DFC490 camera; final images were created using the Helicon 5.0 software and Adobe Photoshop. The scanning electron micrographs of uncoated specimens were taken in the Laboratory of Scanning Microscopy, MIZ PAS (Warsaw), using a scanning microscope HITACHI S-3400N under low-vacuum conditions.

Measurements and abbreviations

Proportions and measurements taken are listed with the abbreviations used in this study: Total length, measured (in dorsal view) from the apex of head to the apex of tegmina; A/B, width of vertex measured at the anterior margin/length of vertex at midline; C/E, width of frons at upper margin/length of frons at midline; D/E, maximum width of frons/length of frons at midline; F/B, length of pronotum in mid-line/length of vertex at midline; G/F, length of mesonotum/length of pronotum at midline; G/B + F, length of mesonotum/cumulative length of vertex and pronotum at midline; G/H, length of mesonotum at midline/width of mesonotum between lateral angles; I/J, length of tegmen measured from base to the apical margin in median portion/width of tegmen measured from the apex of clavus to the anterior margin.

The nomenclature of the male genitalia follows Bourgoin and Huang (1990) and for the female genitalia Bourgoin (1993). Vein nomenclature follows the interpretation proposed by Szwedo and Żyła (2009).

Taxonomy

Genus ***Sogalabana*** gen. nov.
(Figures 1–7)

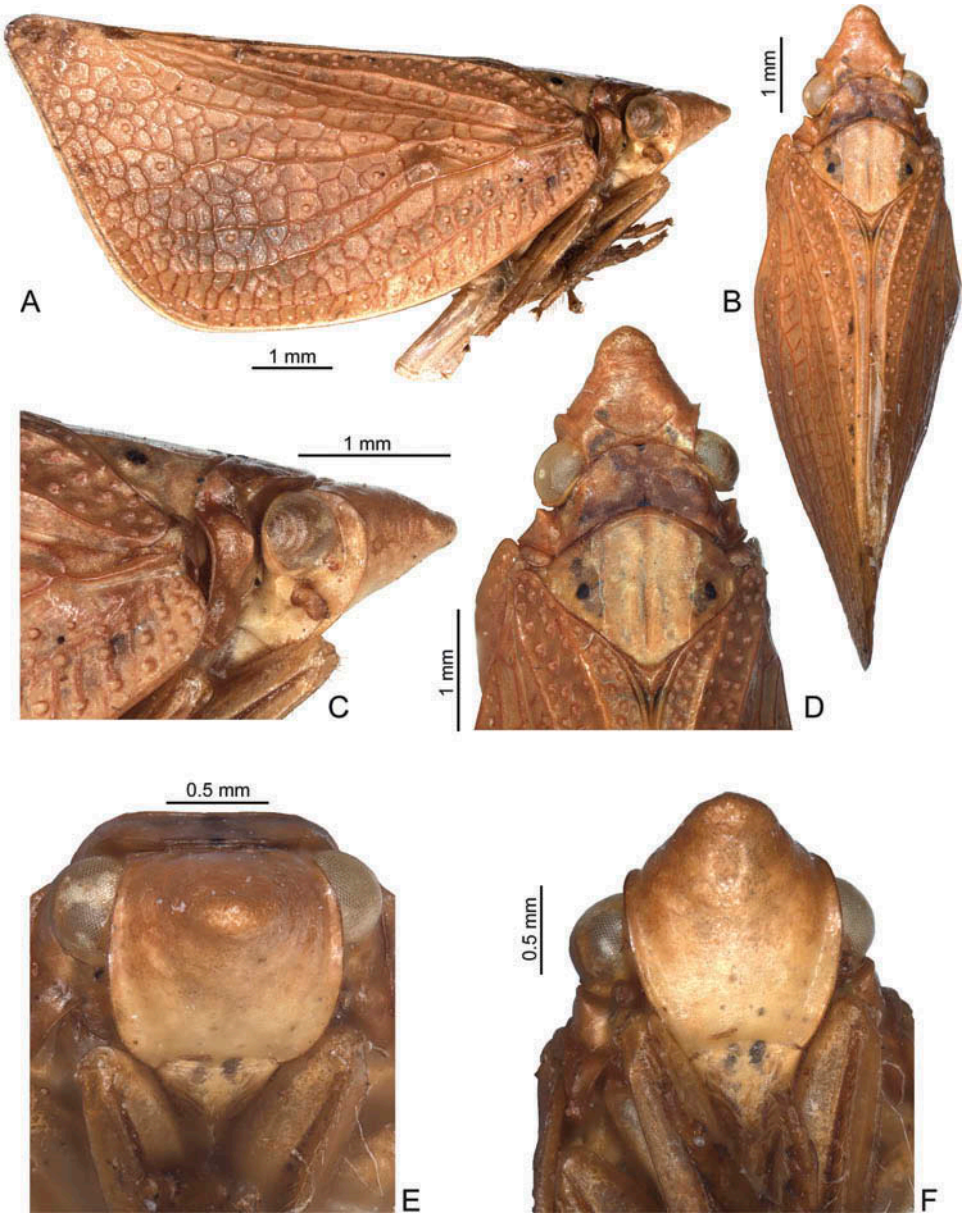

Figure 1. *Sogalabana ochracea* gen. et sp. nov., female: (A) habitus, lateral view; (B) same, dorsal view; (C) anterior part of body, lateral view; (D) same, dorsal view; (E) same, frontal view; (F) frons, frontal view.

Type species

Sogalabana ochracea sp. nov., here designated.

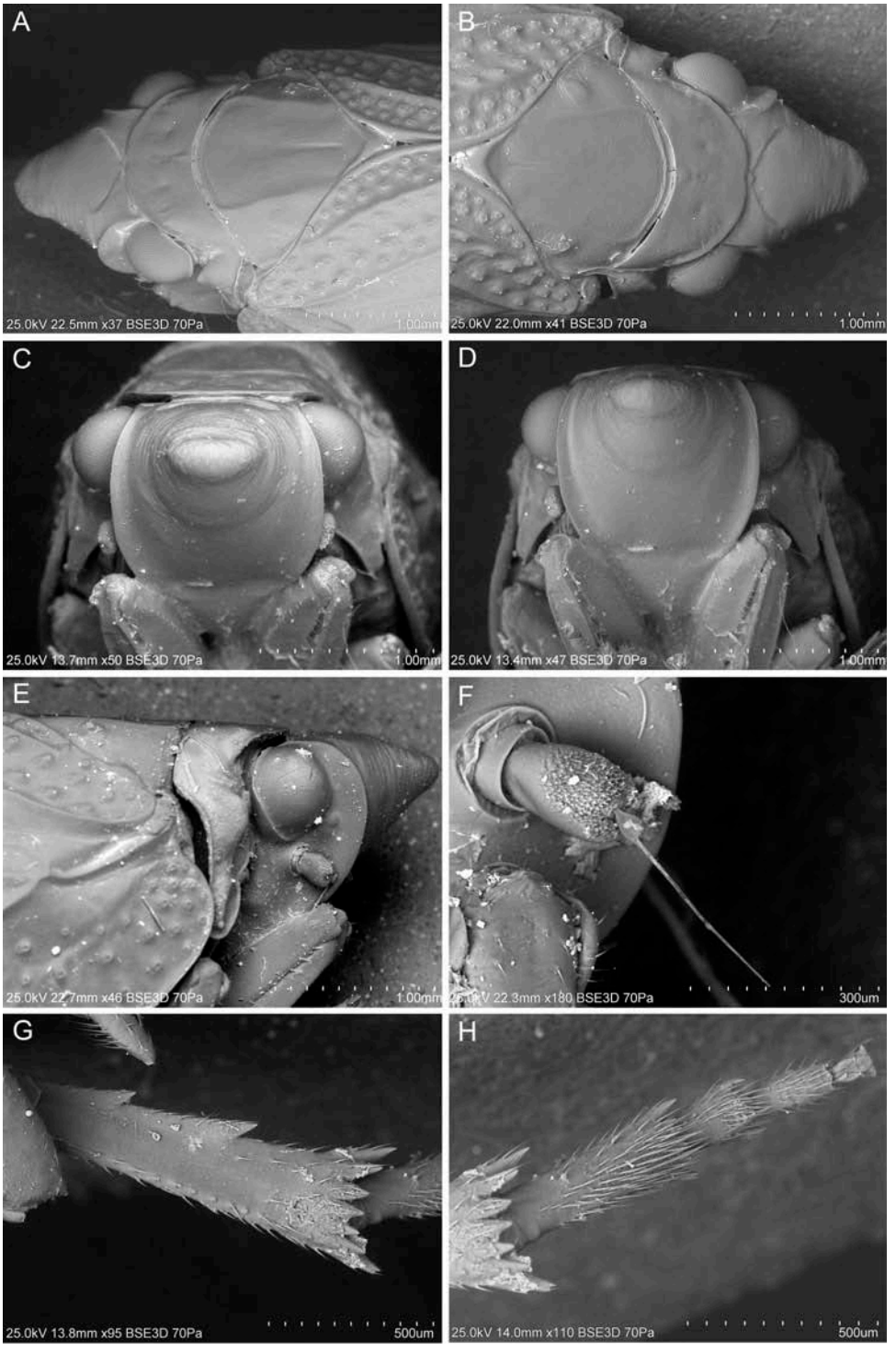

Figure 2. *Sogalabana ochracea* gen. et sp. nov., female: (A) anterior part of body, dorsolateral view; (B) same, dorsal view; (C) anterior part of body, frontal view; (D) frons, frontal view; (E) head and thorax, lateral view; (F) antenna; (G) hind tibia, ventral view; (H) hind tarsus, ventral view.

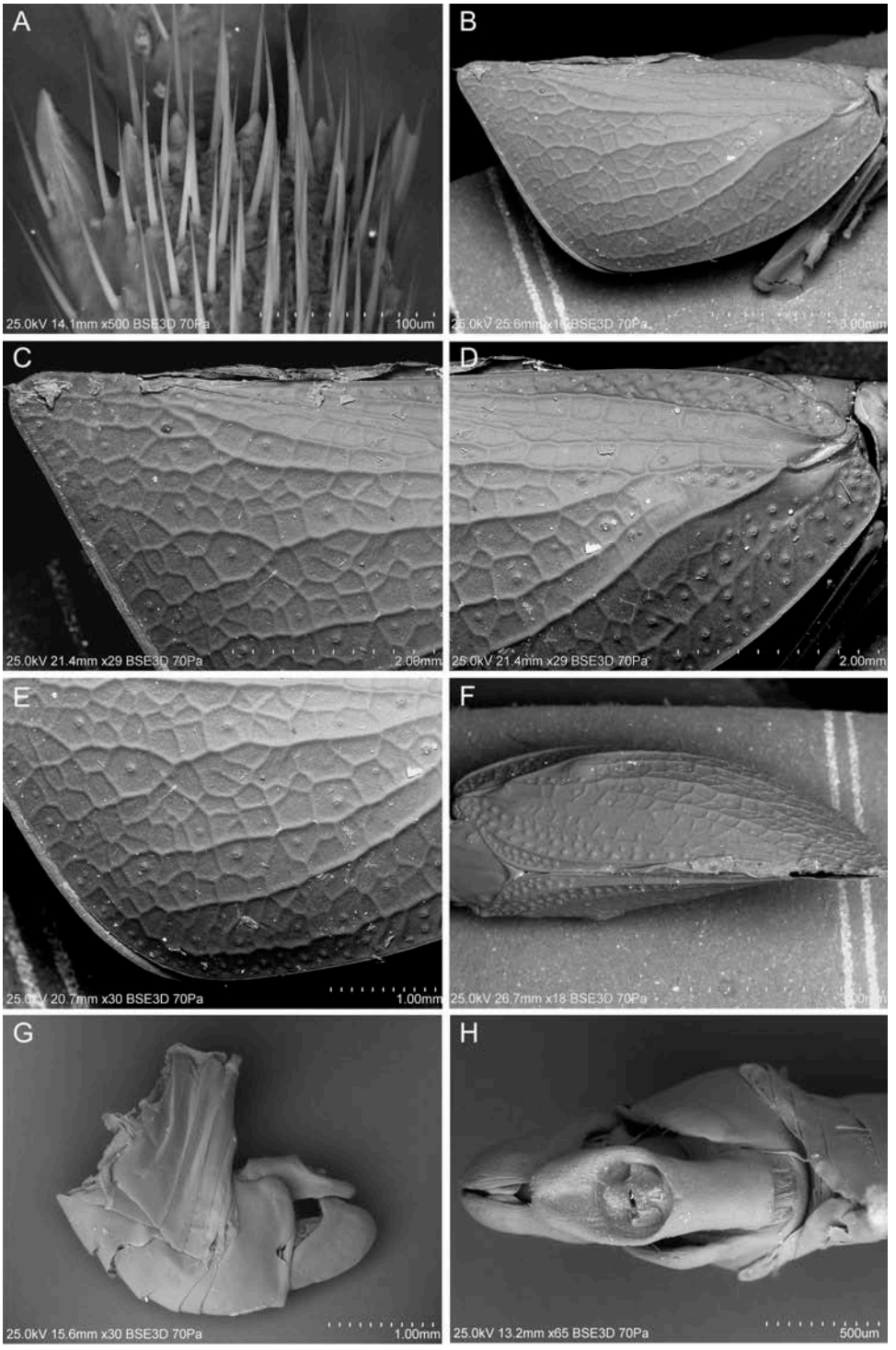

Figure 3. *Sogalabana ochracea* gen. et sp. nov. (A) female, anterior part of basitarsomere; (B) female, tegmen, dorsolateral view; (C) female, apical part of tegmen; (D) female, base of tegmen; (E) female, apical part of tegmen; (F) female, tegmina, dorsal view; (G) male, abdomen, lateral view; (H) male, anal tube, dorsal view.

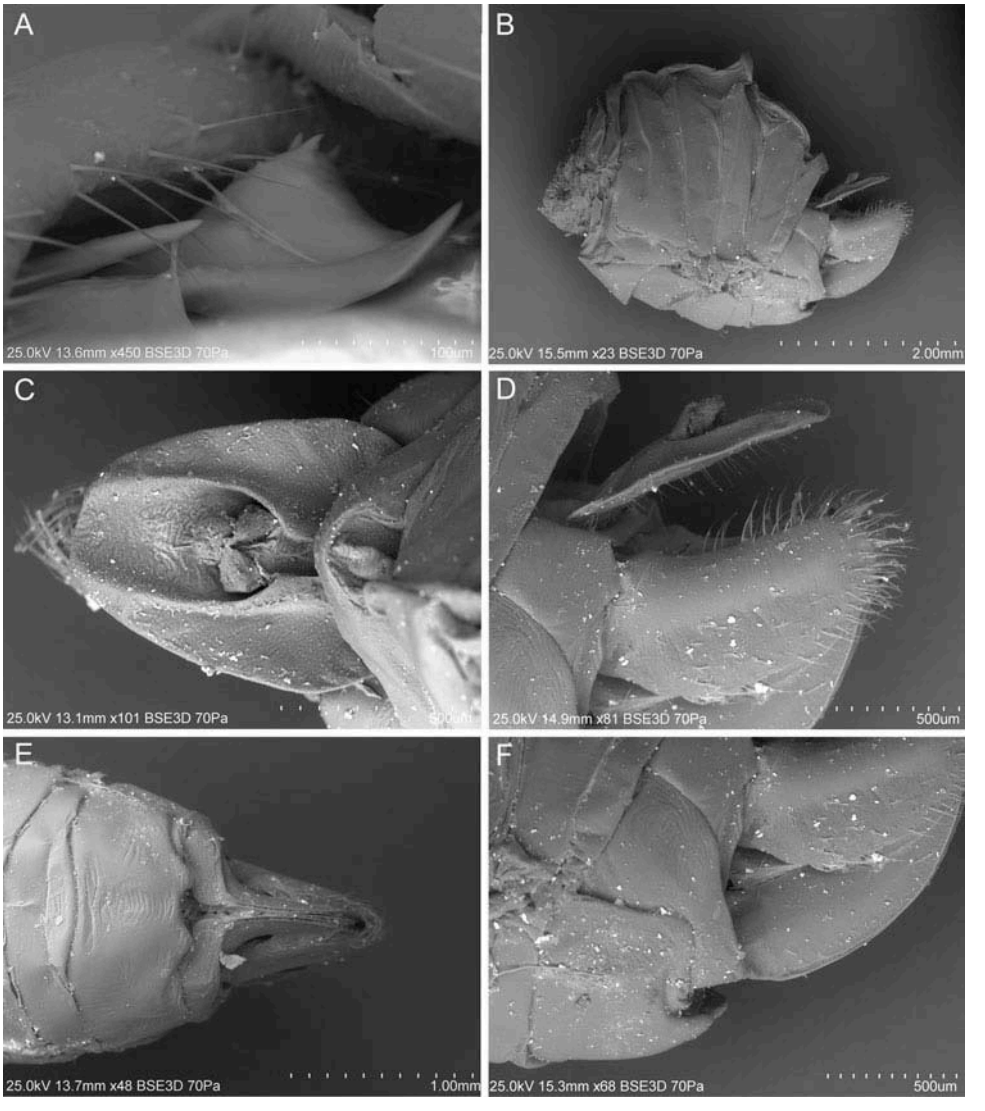

Figure 4. *Sogalabana ochracea* gen. et sp. nov. (A) male, aedeagus, basal lateral lobe; (B) female, abdomen, lateral view; (C) female, anal tube, dorsal view; (D) female, genital capsule, lateral view; (E) female, genital capsule, ventral view; (F) female, genital capsule, ventrolateral view.

Etymology

The generic name is a combination of the names Soga (after Pierre Soga, collector of the specimens representing a new genus) and Analabana (*locus typicus* of newly described species). Gender: feminine (Genetivus singularis: *Sogalabanae*)

Diagnosis

The genus *Sogalabana* is related to *Phaedolus* Karsch, 1890 (type species *Phaedolus quadripunctatus* Karsch, 1890) but differs by the following characters: frons with

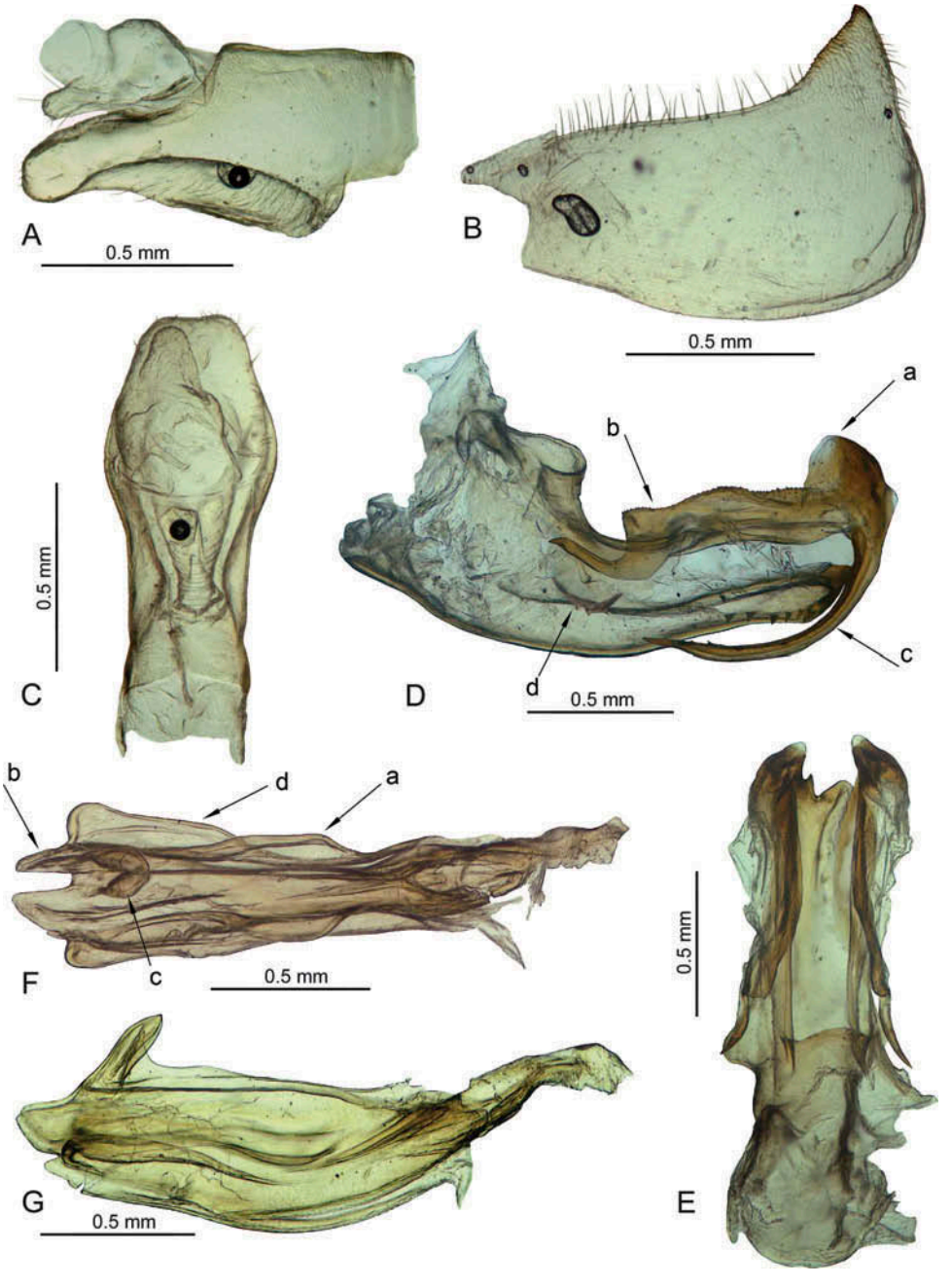

Figure 5. *Sogalabana ochracea* gen. et sp. nov., male: (A) anal tube, lateral view; (B) stylus, lateral view; (C) anal tube, dorsal view; (D) periandrium, lateral view (a, apical lobe; b, dorsal process; c, ventral process; d, lateral bulba); (E) same, dorsal view; (F) aedeagus, dorsal view (dorsal part: a – lateral lobe, b – apical lobe, c – vertical appendage; d – ventral part); (G) same, lateral view.

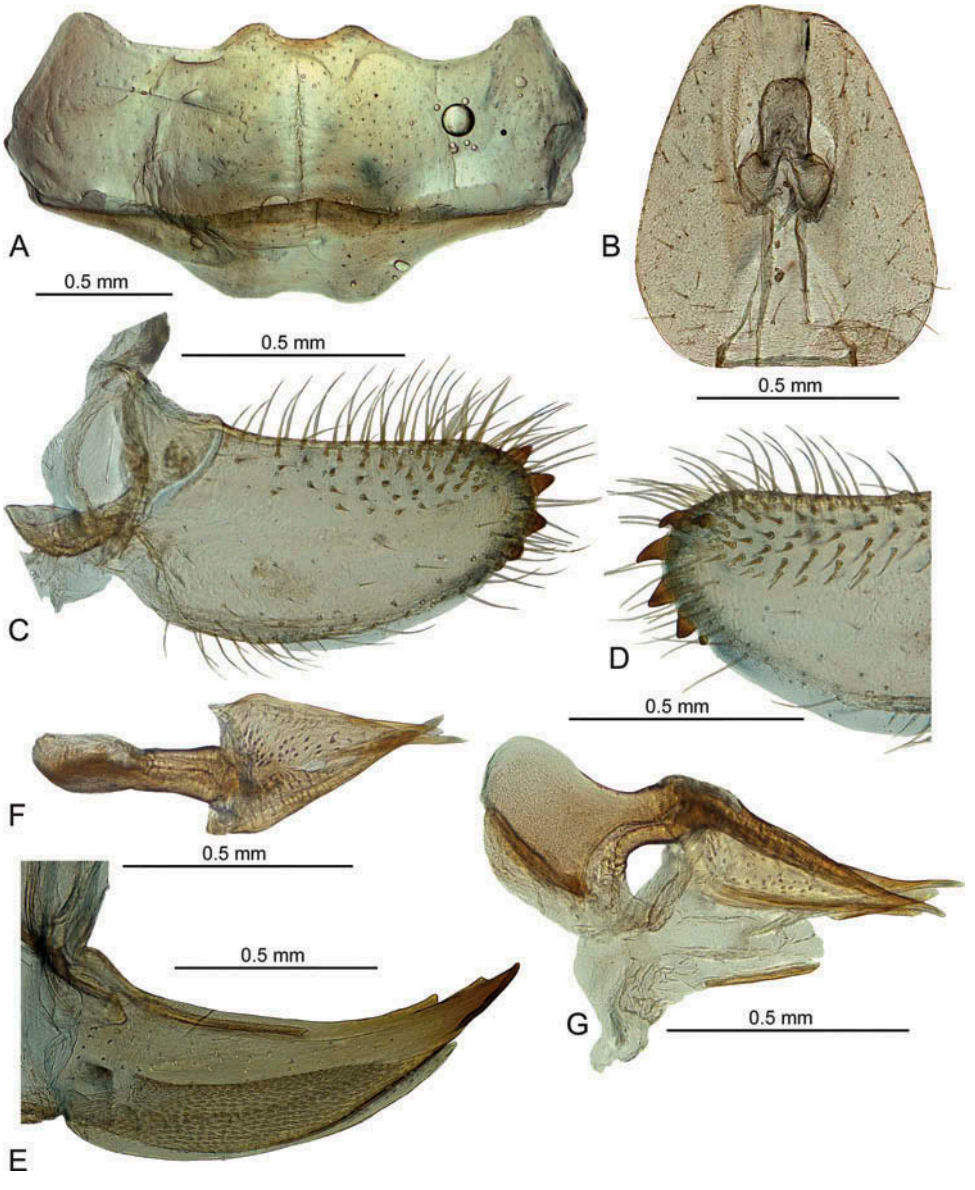

Figure 6. *Sogalabana ochracea* gen. et sp. nov., female: (A) pregenital sternite, ventral view; (B) anal tube, dorsal view; (C) gonoplac, lateral view; (D) apical part of gonoplac, internal view; (E) gonapophysis VIII, lateral view; (F) gonapophyses IX and gonospiculum bridge, dorsal view; (G) same, lateral view.

distinct protrusion in upper part (*Phaedolus* – frons convex); disc of frons without carinae (*Phaedolus* – disc of frons with three carinae); veins ScR + M arise as short common stem from basal cell (*Phaedolus* – veins ScR + M arise at the same point from basal cell).

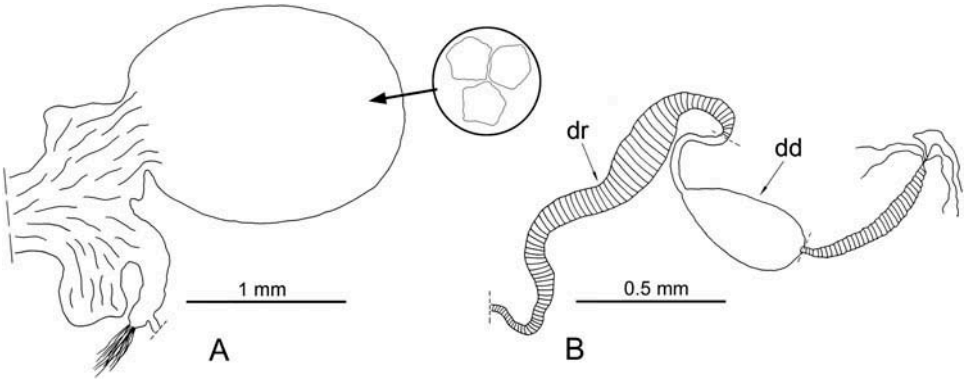

Figure 7. *Sogalabana ochracea* gen. et sp. nov., female: (A) bursa copulatrix; (B) spermatheca (dr, *ductus receptaculi*; dd, *diverticulum ductus*).

Description

Head. Head with compound eyes in dorsal view narrower than thorax, strongly prolonged (Figure 1B,D).

Vertex much wider than long at midline, medially partly covered by pronotum (Figures 1D; 2A,B). Anterior margin deeply concave, in form of elevated suture, laterally obsolete; posterior and lateral margins carinate. Disc of vertex without carinae, sensory structures and secretory pores.

Frons (Figures 1D; 2A,B) in upper part with distinct protrusion, in dorsal and lateral view triangular shape with bluntly rounded apex; upper surface flattened, placed at about same level as thorax. Lateral margins of frons carinate, in frontal view widest about level of antennae. Disc of frons (upper and frontal surface) without carinae, but with small sensory pits.

Compound eyes rounded, with small callus placed at lower-posterior margin. Ocelli present (Figure 2E). Antennal pedicel elongate, widest medially, with setae and plate organs placed apically and on upper surface (Figure 2F). Clypeus narrower than frons, without carinae (Figure 2C,D). Rostrum with apical segment distinctly shorter than subapical segment, apex reaching hind coxae.

Thorax. Pronotum distinctly longer than vertex at midline (Figures 1D; 2A,B); anterior and posterior margins arcuate. Pronotum posteriorly with extremely short median, incomplete carina (clearly visible in female) and median groove (clearly visible in male); disc of pronotum with lateral impressions and triangular postocular eminences.

Mesonotum triangular (Figures 1D; 2A,B); disc posteriorly with short median, groove; lateral carinae connected basally, running parallel reaching posterior margin; surface between lateral carinae almost flat, with two sensory pits; lateral parts of mesonotum with gibbosities.

Tegmen (Figures 1A; 3B–F) coriaceous and weakly convex, with clearly visible venation and bulla, without apical, subapical and nodal lines, with net of irregular transverse veinlets. Costal margin – basal half arcuate, apical part straight, costal angle widely rounded, posterior margin straight, sutural angle acute with rounded apex, postclaval sutural margin straight. Costal area narrower than costal cell, with

single, transverse veinlets, terminating a bit before end of clavus. Costal cell wider than costal area with net of transverse veinlets. Basal cell very long and narrow. Longitudinal veins ScR + M arise as short common stem from basal cell; ScR forking just before bulla into ScRA and RP; ScRA strongly elevated, forking into Sc and RA near posterior margin (Figure 3E); M fork before half of tegmen; Cu bifurcated before end of clavus. Claval veins PCu and A_1 fused before end of clavus, vein A_1 elevated; transverse veinlets between claval suture and Pcu. Tubercles on whole tegmen with concentration on costal area, costal cell, between basal Sc + R and M veins and on clavus between PCu-A_1.

Femora shorter than tibiae; hind tibia arcuate and partly flattened laterally with two lateral spines placed after midlength, apically with row of well-developed teeth (Figure 2G); basitarsomere as cumulative length of second and third tarsomeres with row of apical spines, second tarsomere with two lateral spines (Figures 2H; 3A).

Male genitalia. Anal tube (in lateral view, Figures 3G; 5A) massive, longer than wide; basal part distinctly wider than apical; anus placed about midlength. Anal tube (in dorsal view, Figures 3H; 5C) calyx-shaped, basal part narrower than apical part; anus placed about midlength.

Pygofer (in lateral view; Figure 3G) higher than wide, almost rectangular, dorsoposterior angle bluntly rounded and "elevated".

Genital styles (in lateral view; Figures 3G; 5B) longer than wide and bearing distinct, triangular capitulum; dorsal margin without concavity near base of capitulum; ventroposterior angle weakly projected.

Phallic complex. Periandrium – closed basally to about one-third length, remaining part open dorsally (Figure 5D,E). Dorsal part of periandrium apically with well-sclerotized, vertically oriented lobes and two large processes (dorsal and ventral) oriented basad; dorsal part, near base, with bulba with a few teeth (Figure 4A). Ventral part apically with three lobes; ventral surface with row of denticles. Aedeagus divided into dorsal and ventral parts (Figure 5F,G). Dorsal part with lateral lobes in median portion, apical part bilobate with median incision, subapically with vertical appendage. Ventral part apically widened with lateral lobes.

Female genitalia. Pregenital sternite massive, lateral lobes weakly separated (Figures 4E,F; 6A); anterior margin weakly concave, medially with sclerotized lobe (Figure 6A); posterior margin medially with two bluntly triangular lobes separated by shallow concavity.

Anal tube (in lateral view; Figure 4B,D) flattened, elongate and narrow, reaching end of gonoplac; anus placed about midlength; ventral surface with long setae. Anal tube (in dorsal view; Figures 4C; 6B) pear-shaped; anus placed about midlength.

Gonoplac unilobate, laterally flattened, elongate (Figures 4B,D; 6C); posterior margin rounded with single row of well-developed teeth (Figure 6D); narrow, membranous part placed alongside ventral margin, extending half of gonoplac; dorsal and ventral part externally with long setae, median portion of internal surface with short and thick setae.

Gonapophysis VIII sabre-shaped and laterally flattened, tapering apicad (Figures 4F; 6E); apical part of ventral margin folded externally, apical part of dorsal margin with two teeth. Endogonocoxal process a bit shorter than gonapophysis VIII, sabre-shaped with spiniferous microsculpture.

Gonapophyses IX and gonospiculum bridge as in Figure 6F,G.

Bursa copulatrix of single, elongately oval, huge pouch; cells clearly visible, without ornamentation (Figure 7A). Spermatheca well developed; *ductus receptaculi* longer than *diverticulum ductus* (Figure 7B).

Distribution

Madagascar: Mahajanga Province.

Sogalabana ochracea sp. nov.
(Figures 1–7)

Etymology

The specific epithet comes from the Latin *ochraceus*, meaning ochre coloured, and refers to the colouration of the species.

Diagnosis

See Diagnosis of the genus.

Description

Total length 0.80–0.92 cm.

Head. Vertex: proportion A/B = 8.66–11.66; posterior and lateral margins straight, lateral almost parallel; disc of vertex almost flat (Figures 1D; 2A,B). Frons: proportion C/E = 0.81–0.90; proportion D/E = 0.98–1.02; lateral margins of frons elevated and weakly arcuate. Clypeus in median portion weakly convex (Figures 1E,F; 2C,D).

Thorax. Pronotum: proportion F/B = 4.66–5.66; anterior margin with median shallow incision (Figures 1D; 2A,B). Mesonotum: proportion G/F = 0.97–1.02, proportion G/B + F = 2.35–2.40, proportion G/H = 0.80–0.96. Tegmina: proportion I/J = 2.21–2.43; vein Sc ending with one terminal, RA and RP with one or two terminals; vein M ending with eight (female) and ten (male) terminals; vein Cu with five or six terminals ending at postclaval margin (Figure 3B–F).

Hind tibia apically with seven teeth (Figure 2G,H); basitarsomere with six apical spines in formula 2 + 4 (lateral distinctly larger than internal) (Figures 2H; 3A); lateral spines of second tarsomere well developed, median lobe not exceeding level of spines (Figure 2H).

Male genitalia. Anal tube (in lateral view; Figures 3G; 5A) twice as long as wide; basal part rectangular, apical part tapered, apex rounded. Anal tube (in dorsal view; Figures 3H; 5B) with anterior and posterior margins almost straight. Pygofer (in lateral view; Figure 3G) with dorsal margin concave. Genital styles (in lateral view; Figures 3G; 5C) with ventral margin arcuate and dorsal margin almost straight.

Phallic complex. Dorsal part of periandrium: ventral process narrow, arcuate, with four small dorsal teeth; dorsal process longer and more massive than ventral process, with denticulate upper margin and horn-like apex. Ventral part of

periandrium: ventral surface with row of seven to nine denticles (Figure 5D,E). Aedeagus: dorsal part apically with deep rectangular incision (Figure 5G).

Female genitalia. Anal tube (in dorsal view; Figures 4C; 6B): anterior margin almost straight.

Gonoplac: posterior margin with row of five or six teeth (Figure 6C,D). Spermatheca: *ductus receptaculi* ribbed, long and widened subapically; *diverticulum ductus* smooth, basal part tubular, apical part elongated and widened apically in form of membranous bulla (Figure 7A,B).

Colouration. General colour ochre (yellow-reddish-brown), two black dots on lateral parts of pronotum.

Type material

Holotype, ♂: [Madagascar Nord, Rég. Tsaratanana, N.M. Mangidrano], [Analabana, IV-1964, 1640 m. P. Soga], [Museum Paris] – MNHN

Paratype, 1♀: the same locality labels as in Holotype – MNHN

Note: According to the literature, locality data of type-specimens seems to be incomplete and written incorrectly. The only work with the same locality data is that of Montreuil (2010); however, in many other papers the locality is cited as follow: Madagascar Nord, Région du Tsaratanana, N.O. de Mangindrano, Analabana, 10/20-IV-1964, 1640 m, P. Soga.

Distribution

Madagascar: Mahajanga Province, Sofia Region, Bealanana district, Mangidrano commune.

Discussion

Flatidae constitute one of the largest families within planthoppers (Fulgoromorpha: Hemiptera) with 1446 species described in 299 genera and 12 tribes distributed worldwide (Bourgoin 2014). Flatidae fauna of Madagascar presently consists of 17 genera with 39 species of Flatinae and 11 genera with 37 species of Flatoidinae (Świerczewski and Stroiński 2013). Despite a long history of observation and investigation, the state of knowledge of Madagascar's Flatidae is deeply unsatisfactory. Some of the worst investigated ecosystems are those occurring in mountainous areas, although their flatid fauna seems to be quite rich and diverse, with endemic species and genera restricted to particular mountain massifs. An example can be the representatives of the genus *Urana* Melichar, 1902 – *Urana paradoxa* Melichar, 1902 and *Urana unica* Stroiński et Świerczewski, 2012 – which are distributed across the north–south mountain ranges and related to the ecotone habitats of high-altitude montane forest (humid forest) and wooded grassland–bushland vegetation. Another species, *Madoxychara unicornis* Stroiński et Świerczewski, 2013 is confined to the western part of Madagascar and covers lowland and mountain populations, the former differs by reduced median process of periandrium. Both genera reveal disjunct distributions. As was shown for ants (Fisher and Girman 2000) and reptiles (Raxworthy and Nussbaum 1997), the current

distribution of montane species can be explained by the dynamic history of the island during the Pleistocene. During cooler periods, montane forest limits may have lowered, forming a continuous zone of montane forests between particular massifs (Burney 1997). Montane vicariance occurred when the climate warmed and montane populations became isolated on mountain tops. The newly described *Sogalabana ochracea* gen. et sp. nov. from Tsaratanana massif adds to the list of montane flatids and we predict that further research will reveal additional genera and species in the near future.

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