

## Research article

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## Four new species of the Madagascan genus *Exphora* Signoret, 1860 (Auchenorrhyncha: Fulgoromorpha: Tropiduchidae: Elicini) with comments on some hitherto undescribed ultrastructural characters

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**Abstract.** Four new species of the Madagascan genus *Exphora* Signoret, 1860 (Hemiptera: Fulgoromorpha: Tropiduchidae) are described: *E. bourgoini* sp. nov., *E. kalalaoensis* sp. nov., *E. angustivenosa* sp. nov. and *E. robusta* sp. nov. Also, a new, green colour form of *E. linnavuorii* Junkiert, Walczak & Bourgoin, 2017 is presented. The male and female genitalia of the new species are illustrated. SEM photos of the head, antennae and their sensilla, legs, as well as the fore and hind wings are given. A number of structures, which were previously unknown or undescribed, are discussed, including the compound eye with trichoid sensilla, the sensory plate organ on the antennal pedicel surface, the fore and hind wings hamuli, the area of microtrichia at the costa posterior of the fore wing, the tegula, the postcubitus bulla, the third coxa with coxal protrusion and the spines of tibia. A distribution map of the newly described species and an illustrated key to all *Exphora* species are provided.

**Key words.** Planthoppers, insect genitalia, SEM, sensilla, wing morphology.

### INTRODUCTION

Madagascar is the fourth largest island in the world, remaining in relative isolation for about 88 million years, and over 90% of Malagasy wildlife is endemic (Vences et al. 2009). The state of knowledge of Madagascar's fauna improves each year and affects various groups of animals (e.g., Thalmann & Geissmann 2005; Couri et al. 2006; Olivieri et al. 2007; Glaw et al. 2012). This also applies to the quantity of newly described Hemiptera species, especially Heteroptera (e.g., Kment 2013; Bañaf et al. 2016; Chlond et al. 2016) and Fulgoromorpha (e.g., Stroiński et al. 2011; Constant 2014; Gnezdilov 2015; Gnezdilov & Bourgoin 2015; Junkiert & Walczak 2015; Junkiert et al. 2016; Świerczewski et al. 2016). The number of scientific expeditions has increased significantly, which allows to describe more and more new species of plants and animals. However, the rapidly progressing degradation of the island's natural habitats is reducing its biodiversity. Unfortunately, there is a concern that many of the species described as new taxa for science may no longer exist at all, because their habitats have been destroyed (Goodman & Benstead 2003).

Within the family Tropiduchidae Stål, 1866, Elicini Melichar, 1915 (37 genera, 139 species) is one of the

three tribes belonging to the subfamily Elicinae Melichar, 1915, next to Bucini Gnezdilov, Bartlett & Bourgoin, 2016 (two genera, four species) and Parathisciini Gnezdilov, 2013 (four genera, seven species) (Gnezdilov 2013; Gnezdilov et al. 2016; Bourgoin 2020). Previously, representatives of this tribe were placed within the Issidae Spinola, 1839 or Lophophidae Stål, 1866. In 1978, Fennah designated subtribes Elicina and Gaetuliina within Bladinini (Nogodinidae Melichar, 1898). Based on the morphology of genitalia, as well as the data provided by Urban & Cryan (2006), Gnezdilov (2007) transferred Gaetuliina Fennah, 1978, and it gained tribe status (Gaetuliini) within the Tropiduchidae. In 2013, Gnezdilov merged Elicina Melichar, 1915 with the Gaetuliini Fennah, 1978 and established the Elicini tribe.

Among the characteristics distinguishing the representatives of the tribe Elicini are hemispheric gonopods without teeth or with denticles, lateral spikes on the metatibia, as well as symmetrical spinulation on the second metatarsomere (Gnezdilov 2013; Gnezdilov et al. 2016). Elicini are found in the Americas, southern Africa, Madagascar, Asia, Australia and Oceania (Bourgoin 2020). Fossil records are known also from the areas of Europe (Szwedo & Stroiński 1999; Szwedo et al. 2019).

Currently, the Malagasy fauna of Tropiciduchidae is represented by 35 species (including four described in the present study). Until the mid-1960s, only 19 species of this family were known from Madagascar (of which ten from the subfamily Elicinae), including seven species of the genus *Exphora* Signoret, 1860: *E. guerinii* Signoret, 1860, *E. fumivenosa* (Jacobi, 1917), *E. longipennata* Lallemand, 1950, *E. succinae* Lallemand, 1950, *E. ifanadiensis* Synave, 1966, *E. perinetensis* Synave, 1966, and *E. similis* Synave, 1966. Over the past few years, one species of the genus *Chrysopuchus* Gnezdilov, 2013, one of *Bambomada* Gnezdilov, 2015 and six of *Bolitropis* Gnezdilov, 2013 (Gnezdilov 2013, 2015) have been described, followed by eight new species of the genus *Exphora*: *E. ambatolaonaensis*, *E. constanti*, *E. stroinskii* (Junkiart & Walczak 2015), *E. linnavuorii* (Junkiart et al. 2017), as well as *E. bourgoini* sp. nov., *E. kalalaoensis* sp. nov., *E. angustivenosa* sp. nov., and *E. robusta* sp. nov. (this study). Among the genera of the tribe Elicini, *Exphora* is now a rather speciose genus counting 15 species, including the four described here, ranking in third place in terms of species numbers within Elicini (after *Neaethus* Stål, 1861 and *Dictyssa* Melichar, 1906).

Examination of unidentified tropiduchid specimens in the collections of the Royal Belgian Institute of Natural Sciences in Brussel (Belgium) and the Royal Museum for Central Africa in Tervuren (Belgium) allowed the description of new species, as well as of the green colour form of *E. linnavuorii* Junkiert, Walczak & Bourgoïn, 2017. In addition, the use of scanning electron microscopy (SEM) allowed to study a number of structures, not yet known and described for this genus.

## MATERIALS AND METHODS

### Examination of the specimens

External structures were examined using a stereoscopic microscope Olympus SZX9. The genitalia were dissected after boiling the abdomen three times (about three minutes each time) in a 10% solution of potassium hydroxide (KOH). Then the pygofer and styles were separated from the abdomen and the aedeagus s.l. was extracted using thin forceps and a needle blade. After that, the aedeagus s.l. was placed in glycerine. The genitalia were examined using a light microscope Nikon Eclipse. Drawings were made using a camera lucida. Photographs were taken with a Canon Eos camera with extension rings. Wing venation nomenclature follows Bourgoïn et al. (2015). Quoting the labels of specimens: (/) is used to divide data on different rows on the label, (;) is used to divide data on different labels, ([ ]) is used for authors' comments.

### Institutional abbreviations

RBINS = Royal Belgian Institute of Natural Sciences, Brussels, Belgium  
 RMCA = Musée Royal de l'Afrique Centrale, Tervuren, Belgium

### Occurrence data and map preparation

All localities were georeferenced using Google Earth Pro 7.3.2.5776 (Google Inc. 2019, Mountain View, CA, USA) (coordinates for localities were collected in decimal degrees, datum: WGS84). The map was prepared in Quantum GIS 3.8 (QGIS Development Team 2019; <http://www.qgis.org>) using WGS84 datum and EPSG: 3395 (World Mercator).

## RESULTS

A key (Appendix I) to all known species of *Exphora* is presented. The authors of this article would like to emphasize that they claim that the species *E. longipennata* Lallemand, 1950 and *E. fumivenosa* (Jacobi, 1917) do not belong to the genus *Exphora*, but are included in this key as the genus has not been revised yet.

### Taxonomy

Class Insecta Linnaeus, 1758  
 Order Hemiptera Linnaeus, 1758  
 Family Tropiciduchidae Stål, 1866  
 Subfamily Elicinae Melichar, 1915  
 Tribe Elicini Melichar, 1915  
 Genus *Exphora* Signoret, 1860

***Exphora bourgoini* Junkiert & Walczak sp. nov.**  
 (Figs 1A, 2A, 3A, 5–6)

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### Material examined

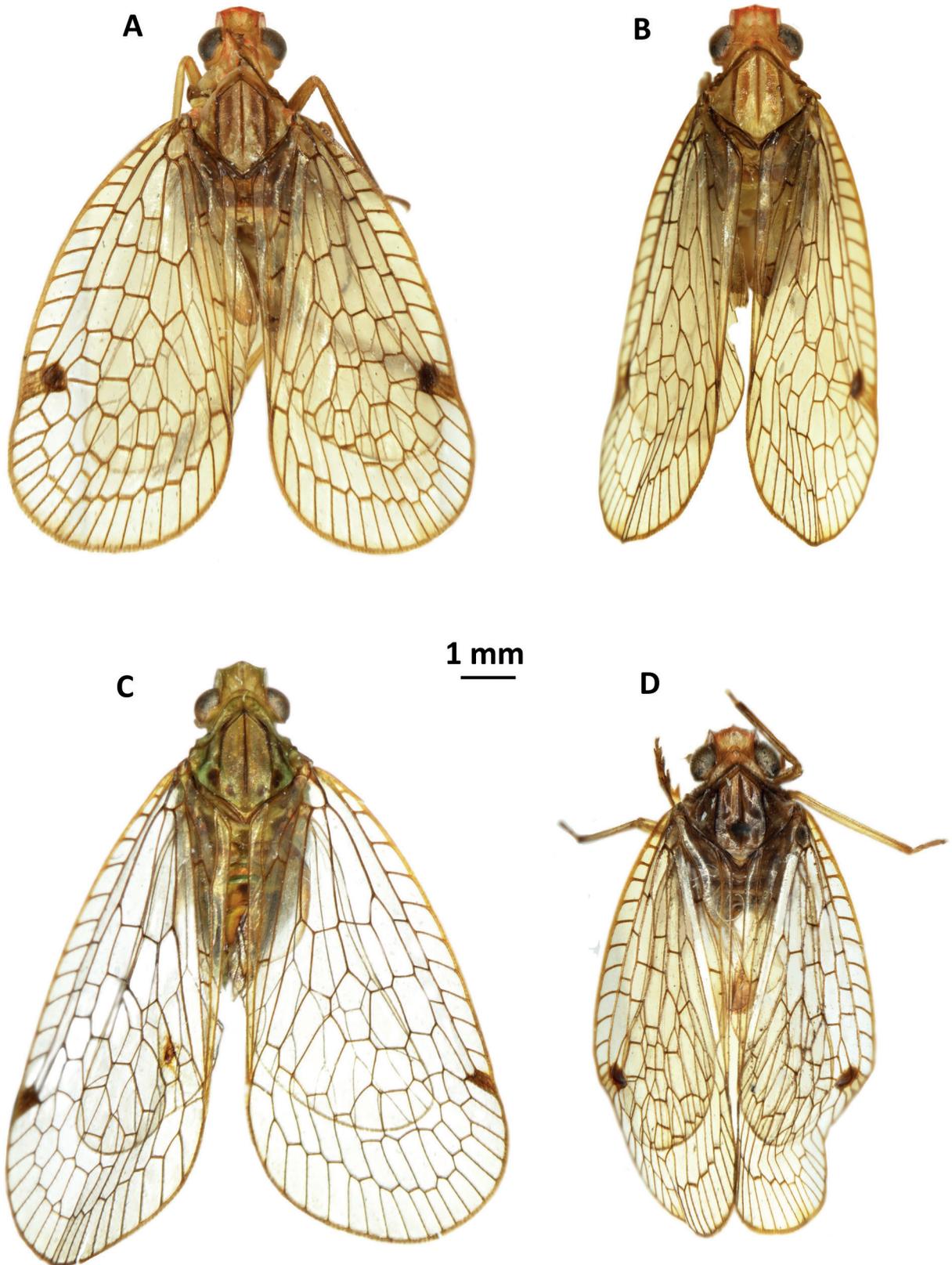
#### Holotype

1 ♂ / *Exphora bourgoini* sp. nov. / Junkiert & Walczak det. 2018 [red label]; Sahafanjana / Manambato / (Anove) [white label]; INSTITUT / SCIENTIFIQUE / MADAGASCAR [light green label]; Coll. R.I.Sc.N.B. [blue label] (RBINS).

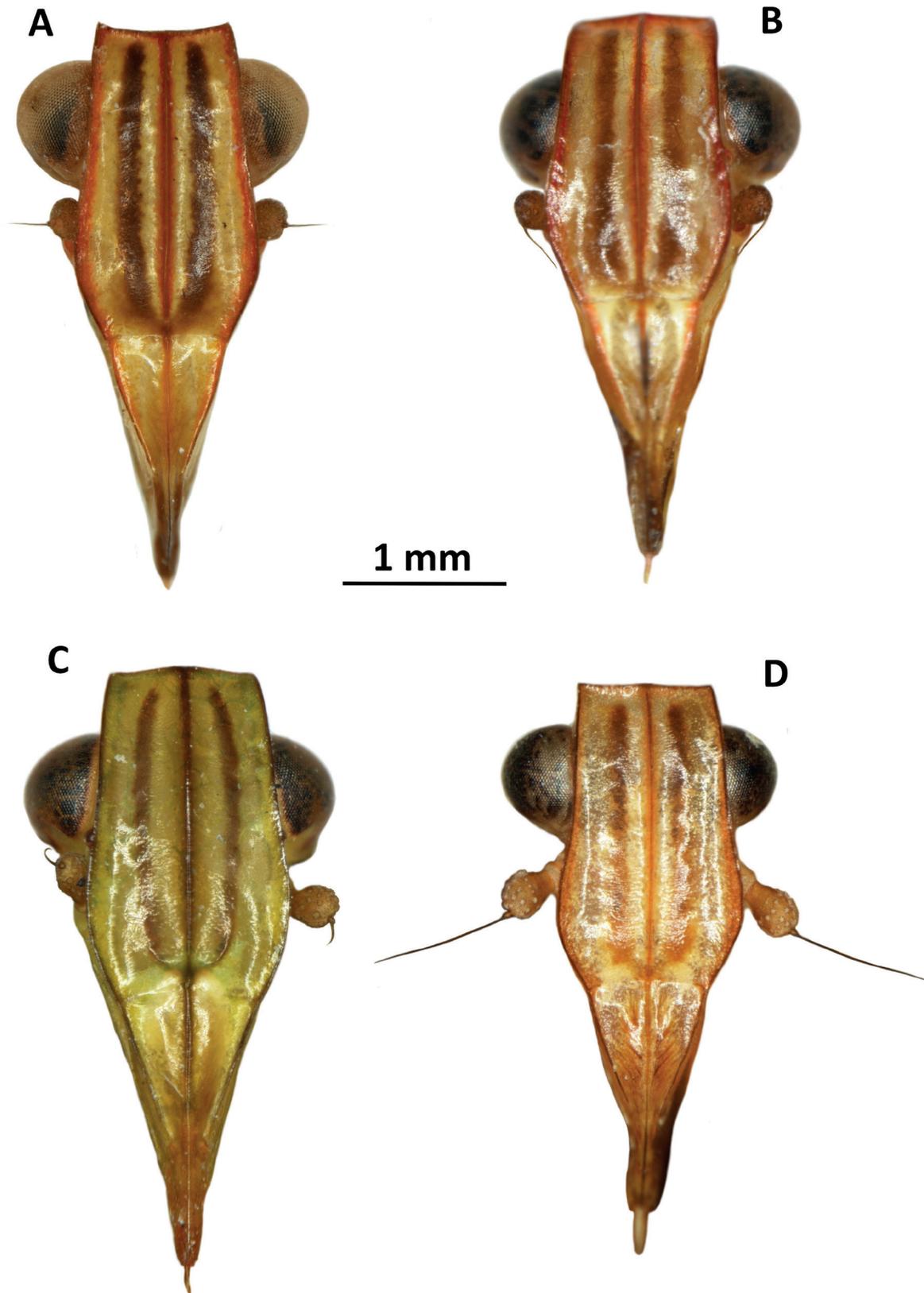
#### Paratypes

1 ♀ / *Exphora bourgoini* sp. nov. / Junkiert & Walczak det. 2018 [red label]; Sahafanjana / Manambato / (Anove) [white label]; INSTITUT / SCIENTIFIQUE / MADAGASCAR [light green label]; Coll. R.I.Sc.N.B. [blue label] (RBINS).

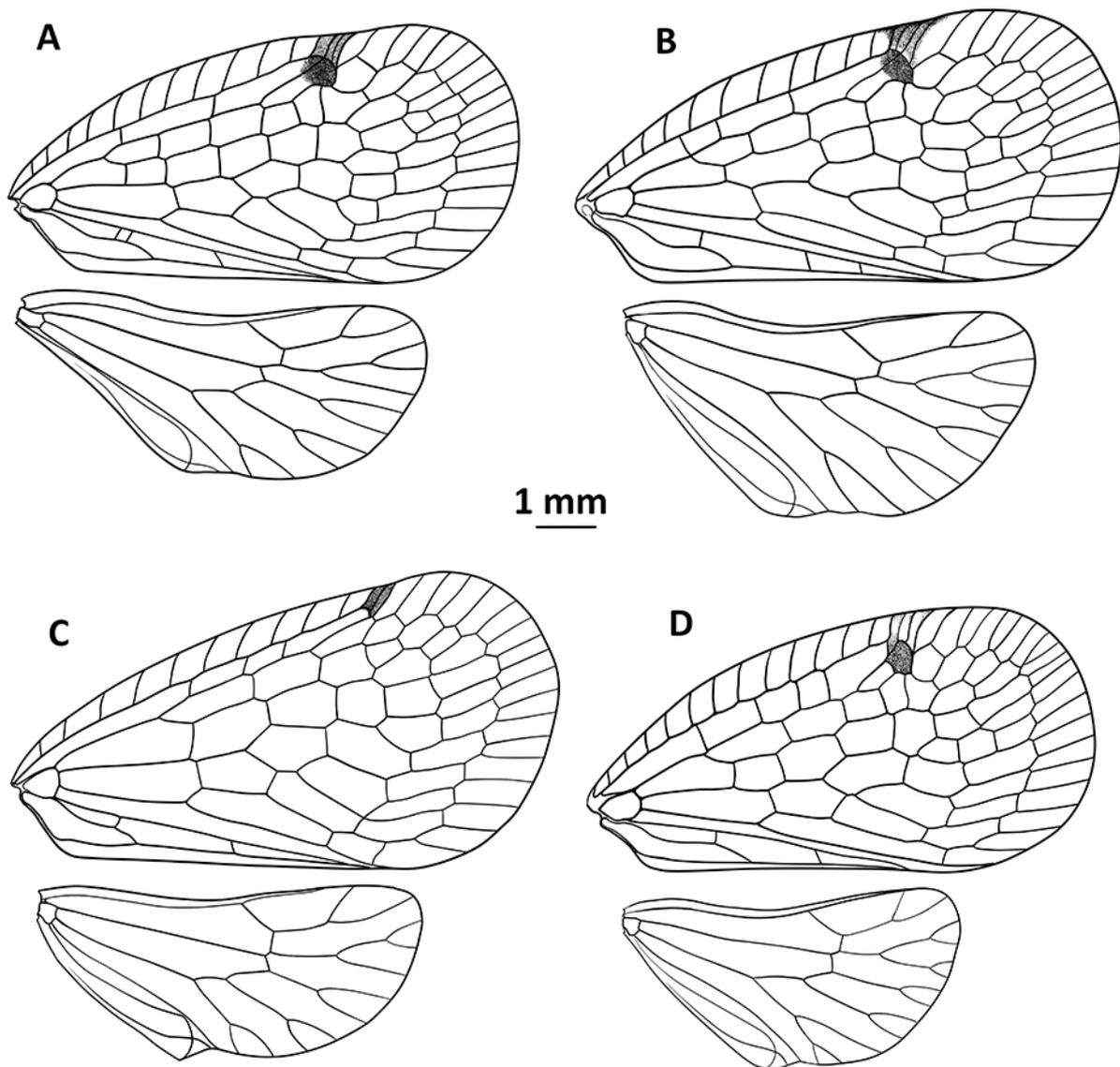
1 ♀ / *Exphora bourgoini* sp. nov. / Junkiert & Walczak det. 2018 [red label]; H. Synave det. 1956 / EXPHORA GUÉRINII [sic!] Signoret (hand written); Sahafanjana /



**Fig. 1.** Dorsal habitus of the newly described species. **A.** *Exphora bourgoini* sp. nov. **B.** *E. kalalaoensis* sp. nov. **C.** *E. angustivenosa* sp. nov. **D.** *E. robusta* sp. nov.



**Fig. 2.** Metope of the newly described species. **A.** *Exphora bourgoini* sp. nov. **B.** *E. kalalaoensis* sp. nov. **C.** *E. angustivenosa* sp. nov. **D.** *E. robusta* sp. nov.



**Fig. 3.** Fore wing and hind wing of the newly described species. **A.** *Exphora bourgoini* sp. nov. **B.** *E. kalalaoensis* sp. nov. **C.** *E. angustivenosa* sp. nov. **D.** *E. robusta* sp. nov.

Manambato / (Anove) [white label]; INSTITUT / SCIENTIFIQUE / MADAGASCAR [light green label]; Coll. R.I.Sc.N.B. [blue label] (RBINS).

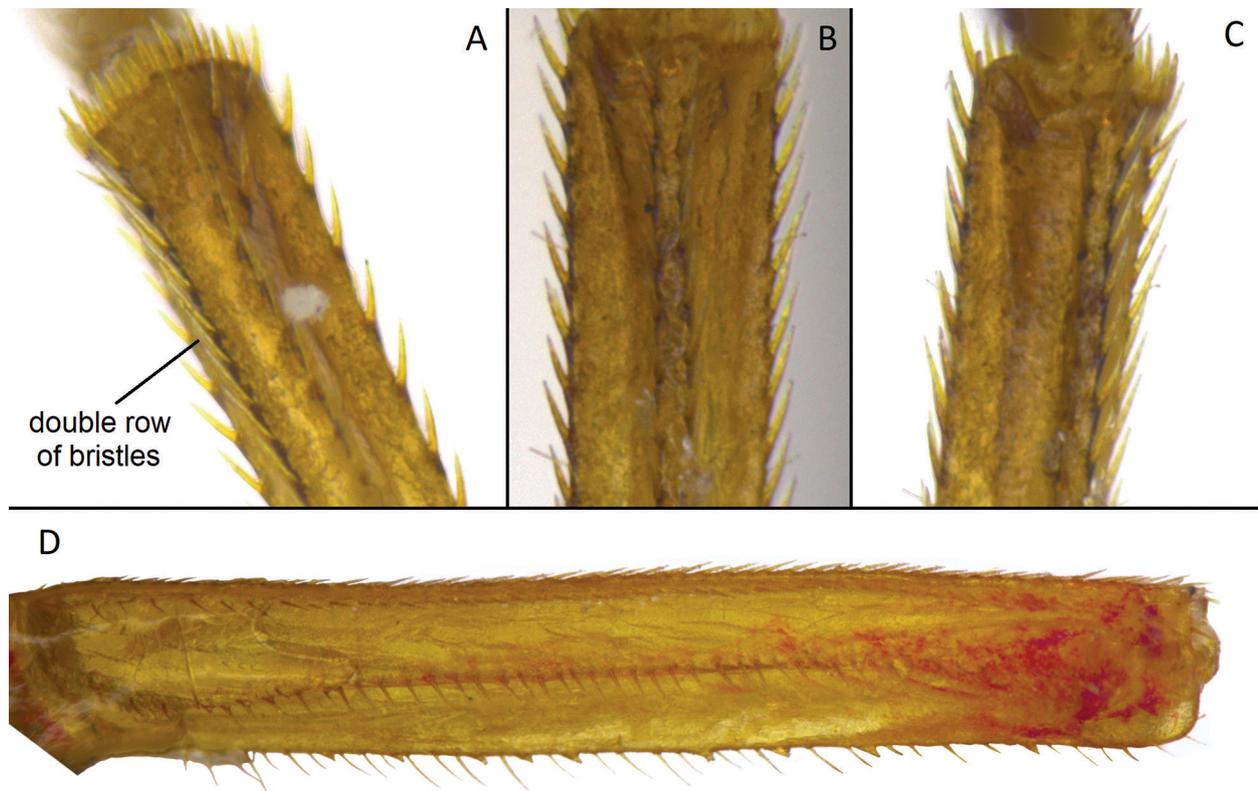
#### Description

Body length 10.8 mm.

**Head.** Metope twice as long as wide, lateral margins slightly arched and extended laterally at 3/4 in its lower part, then narrowing to metopoclypeal suture. Dorsal margin of metope weakly arched but distinctly concave. Median keel distinct, running through metope and metopoclypeal suture (Fig. 2A). Metopoclypeal suture elongate (about 1/4 shorter than metope), triangular. Lateral keels present and distinct. In lateral view, metope

is distinctly convex, whereas metopoclypeal suture almost straight but median keel in lateral view gently arches over surface of metopoclypeal suture, and it also protrudes above surface of metope, but in lateral view it is covered by also protruding lateral keels. Eyes round. Coryphe almost 1.5 times as wide as long (measured in the middle of the length), with anterior margin convex and distinctly angular and posterior margin distinctly arcuately concave.

**Pronotum and mesonotum.** Pronotum bluntly rounded anteriorly, distinctly concave posteriorly. Mesonotum weakly convex, with three parallel keels: median keel is in its anterior part joined to two slanting carina converging to each other almost at right angle and thus



**Fig. 4.** Various views of the protibia of *Exphora bourgoini* sp. nov. **A–C.** With double row of bristles highlighted. **D.** Profemur in dorsal view with small spines at inner margin.

forming an arrow-shaped structure. Both edges of arrow are joined to two lateral keels.

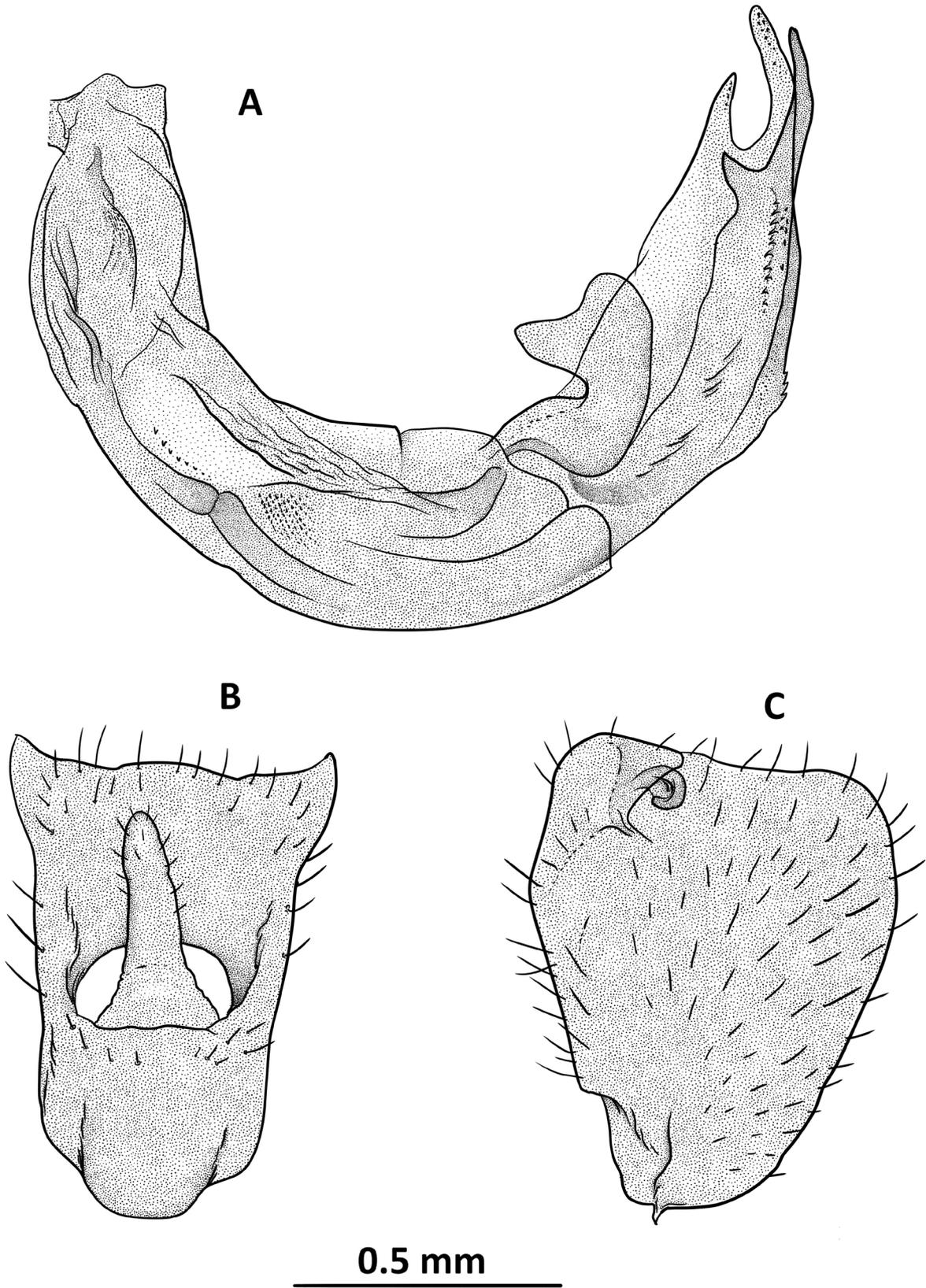
**Fore wings.** Clavus elongate, reaching almost 2/3 of the wing length, of hyperpterism type. Costal area well developed with 11 or 12 cells between CA and Pc+CP; ScP+R short, separating; RA two-branched; RP with at least 7 terminals; MP separating before nodal line; MP1+2 separating before nodal line, after the third terminal, clearly forked at the same level as stigma; MP3+4 separating, before nodal line; MP4 single, MP3 short, separating before nodal line, after the first terminal. CuA forking before nodal line and before MP; 3–4 transverse veins connecting CuP and PCu+A1 (more often one, sometimes two connecting CuP and PCu before joining with A1 and two or three veins connecting CuP and PCu+A1). A1 running parallel to posterior margin of clavus. Cubital cell twice as long, or even more, than postcostal cell, radial cell and median cell. Radial cell sometimes separated by a transverse vein. C1 based well before C2–C5; C2 and C4 in contact sharing MP margin. C1, C2, C3 and C4 of similar length, C5 about 2 times longer. Eighteen or nineteen apical cells. Stigma longitudinal and dark-brown, well visible, including 4 short veins running to edge of wing (Fig. 3A).

**Hind wings.** Well developed, 4/5 of the fore wings' length. Hyaline with brown veins. Almost twice long as wide in midline (ratio length to width: 2.2–2.4). Eleven apical cells (Fig. 3A).

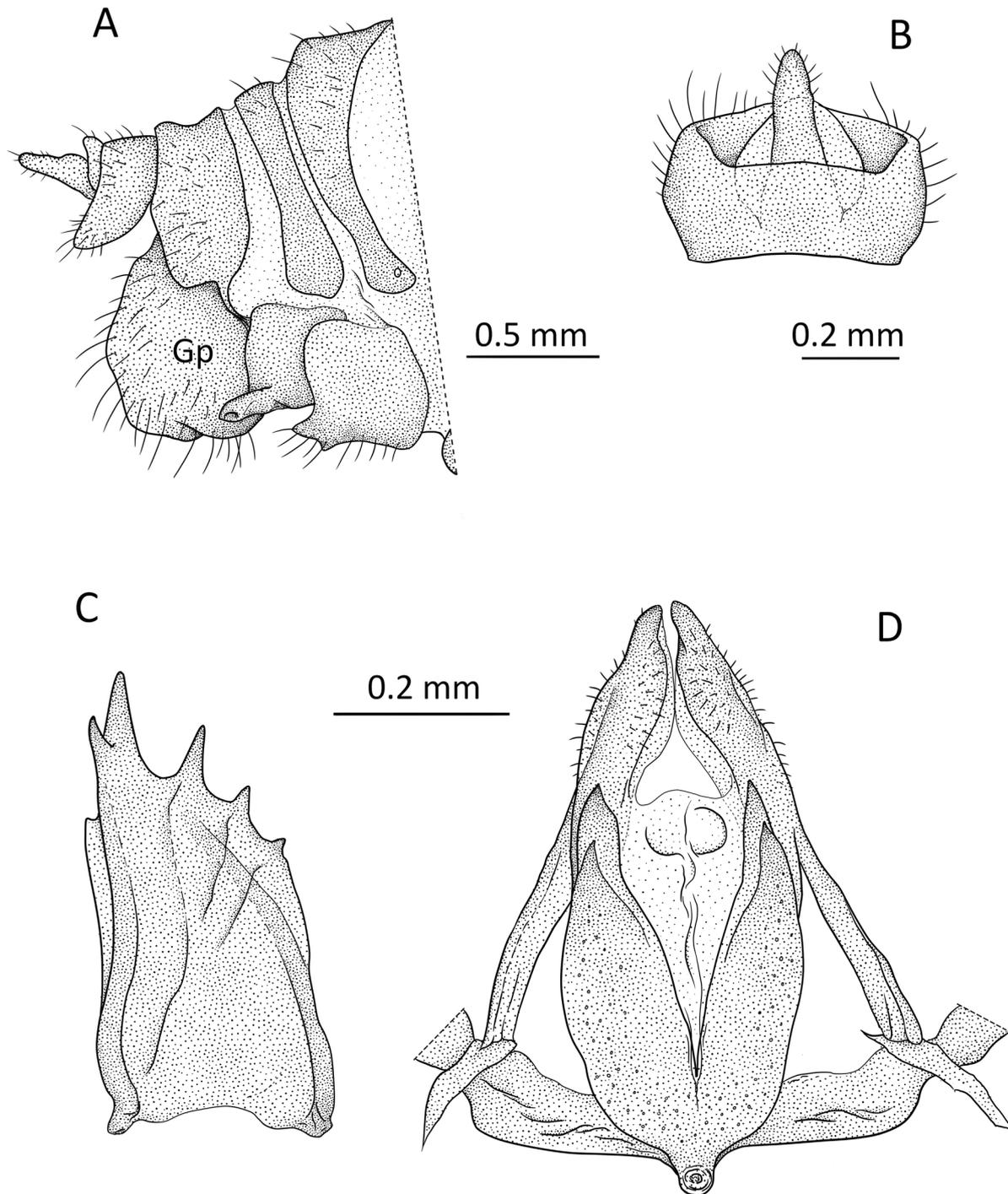
**Legs.** Prothoracic and mesothoracic legs: Femur about 2/3 of tibia length, irregular in cross-section, margins of femur covered with small bristles, inner margin bears small spines. Tibiae long and thin, trapezoidal in cross-section, margins covered with small bristles, lateral margins with double row of bristles (e.g., Fig. 4).

**Metathoracic legs.** Metafemur margins covered with small bristles. Metatibia twice as long as metafemur, triangular in cross-section with concave ventral side. Margins of metatibia covered with small, barely visible bristles. Lateral margin with four lateral spines, three of which are distinct and one is weakly visible. Metatibiotarsal formula 8/8/2.

**Colouration.** General colouration yellowish-brown, more contrastingly coloured than most species of this genus. Metope with keels distinctly red, between lateral and median keels red-brown stripes passing along the metope. Eyes slightly darker than background; ocelli with dark rim. Posterior margin of pronotum and mesonotum contoured by a distinct dark line, similar to all darkly



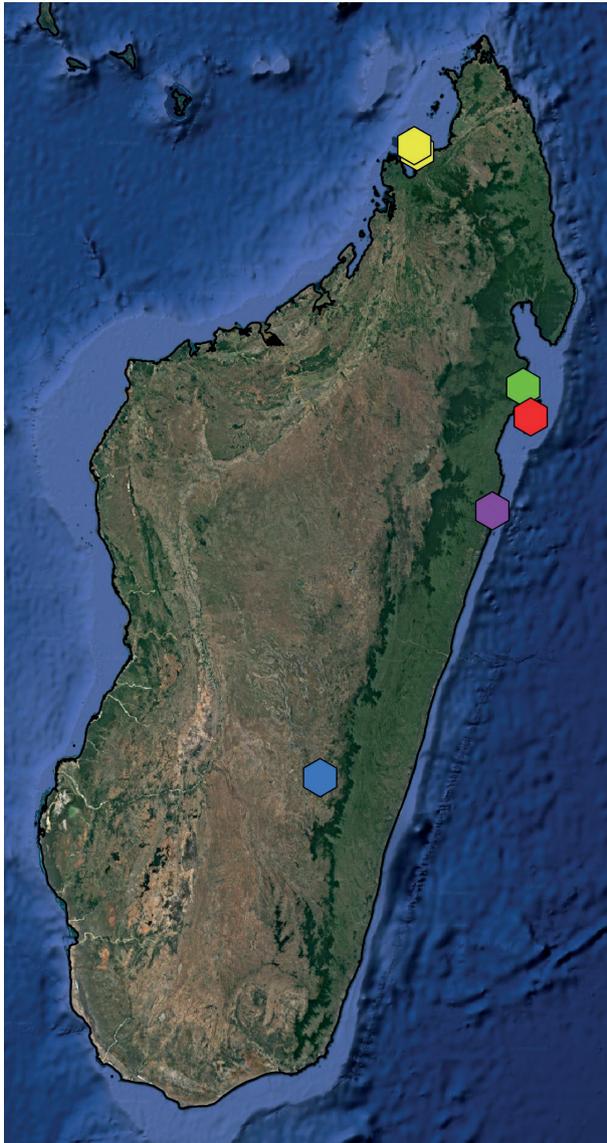
**Fig. 5.** Male genitalia of *Exphora bourgoini* sp. nov. **A.** Aedeagus, lateral view. **B.** Anal tube, dorsal view. **C.** Gonostyl, lateral view.



**Fig. 6.** Female genitalia of *Exphora bourgoini* sp. nov. **A.** Distal part of abdomen in lateral view. **B.** Anal tube, dorsal view. **C.** Gonapophyses VIII. **D.** Gonapophyses IX. Gp = gonoplac.

marked convex keels on the mesonotum. Lateral margins of tergites of abdomen brown. Wings hyaline with brown veins. Femur and tibia colouration uniform-yellowish-brown, spines of metatibia brown, darker than tibia, the sharp end of the spike is black. Prothoracic legs darker than meso- and metathoracic legs.

**Genitalia. Male.** Pygofer with hind margin convex. Aedeagus s.l. narrow, falcate in lateral view. Ventral phallobase overreaching half-length of aedeagus. Each dorso-lateral phallobase lobe with one long apical finger-shaped process bearing very small denticles. Subapical process smaller and slightly curved. Ventral



**Fig. 7.** Distribution of the newly described species and colour form on Madagascar. **Yellow.** *Exphora angustivenosa* sp. nov. **Green.** *E. bourgoini* sp. nov. **Red.** *E. kalalaoensis* sp. nov. **Purple.** *E. robusta* sp. nov. **Blue.** *E. linnavuorii* green colour form.

process (aedeagus s.s.) with inner part duck-head shaped, outer part elongated in distal part with finger-shaped apical process and smaller triangular subapical process (Fig. 5A). Anal tube rather robust, weakly narrowed basally and enlarged apically in dorsal view with two horn-like angles. Anal column elongate, about 0.5 times anal tube length (Fig. 5B). Gonostyle triangle-shaped with smooth roundish edges, lateral margin of gonostyle slightly concave; capitulum wide and folded, bearing subapical spiralling tooth on inner side (Fig. 5C).

*Female.* Endogonocoxal process well sclerotized with slightly rounded apex and delicate subapical indentation on the inner side. Gonoploc (third valvula) semi-circular

in lateral view with dorsal margin slightly convoluted innerly (Fig. 6A). Median part of sternite VII sinuous at ventral side with distinct acute incision in the middle. Genitalia with anal tube relatively short, broadly rounded in dorsal view (Fig. 6B). Gonapophyses VIII (first valvula) almost triangular, strongly sclerotized and bearing three teeth on dorsal margin, and one relatively large tooth with smaller subapical tooth (Fig. 6C). Gonapophyses VIII not visible externally, covered by gonoplocs. Gonapophyses IX (second valvular) well developed, sclerotized with apical ends not confluent, bearing very small quite abundant spikes, acute at apex (Fig. 6D).

**Measurements** (in mm, females in parentheses). Body length: – (10.80); head width (with eyes): 1.84 (1.80–1.97); metope length: 1.87 (2.02–2.08); metope width: 1.14 (1.22–1.25); metope length/metope width ratio: 1.64 (1.66–1.67); coryphe length: 0.38 (0.44–0.45); coryphe width: 0.77 (0.87–0.89); coryphe length/coryphe width ratio: 0.49 (0.50–0.51); fore wing length: 8.63 (8.64–8.73); fore wing width: 4.23 (4.44); mesonotum length: 2.02 (1.94–2.13); mesonotum width: 1.95 (2.11–2.29).

**Diagnosis.** *Exphora bourgoini* sp. nov. can be distinguished from other species by the pattern of dark-brown longitudinal stigma including four short veins running to edge of wing, metope with wide brown stripes, horned anal tube, shape of style, aedeagus and its processes.

**Etymology.** The name of this new species is dedicated to professor Thierry Bourgoïn, an excellent Fulgoromorphan specialist from the Institute of the Systematic Evolution and Biodiversity, National Museum of Natural History, Paris, France.

**Distribution.** Madagascar, Sahafanjana [16°32'28.9" S, 49°47'02.4" E] (Fig. 7).

***Exphora kalalaoensis* Junkiert & Walczak sp. nov.**  
(Figs 1B, 2B, 3B, 8–9)

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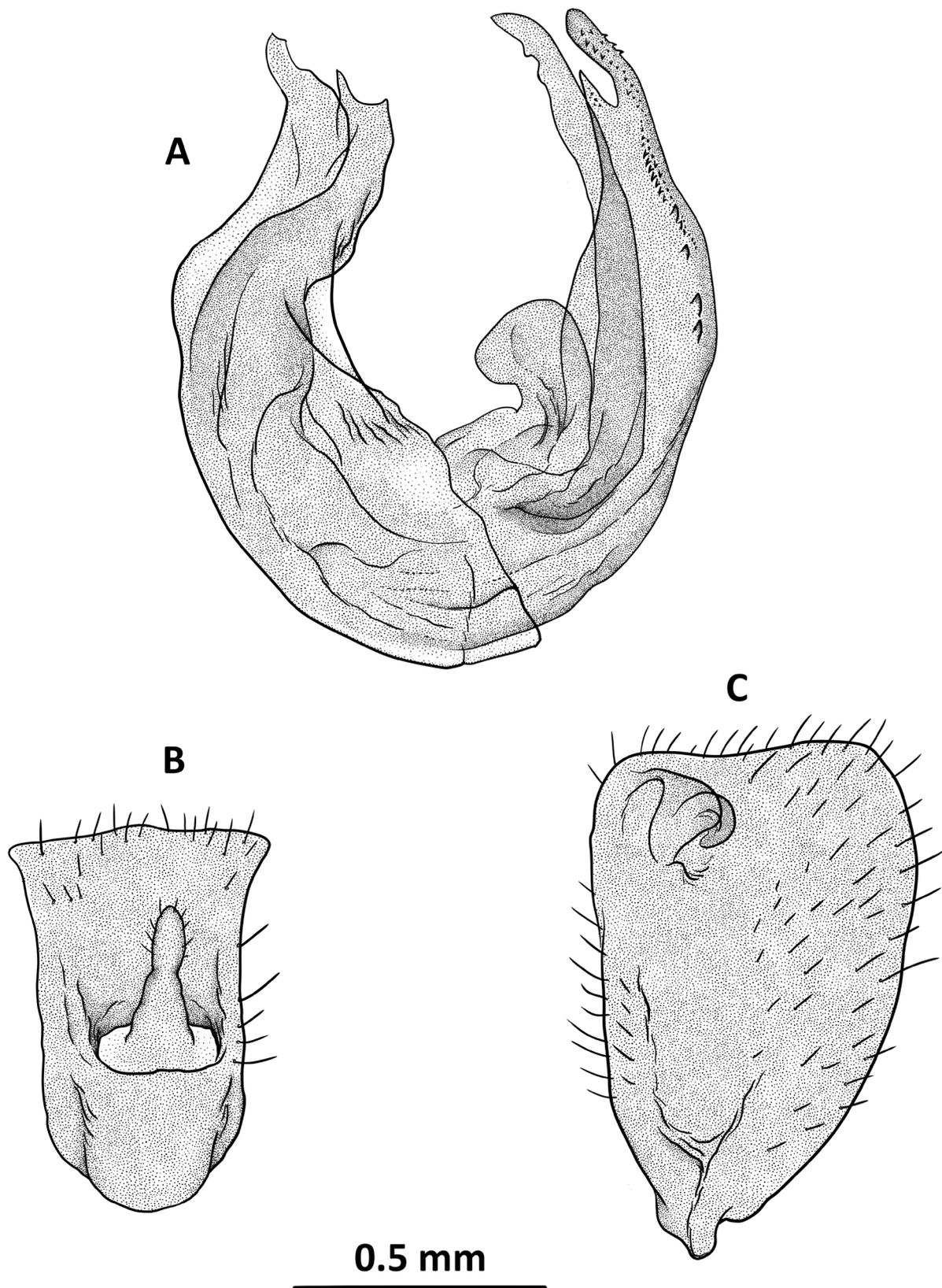
#### Material examined

##### Holotype

1 ♂ / *Exphora kalalaoensis* sp. nov. / Junkiert & Walczak det. 2018 [red label]; Ile Sainte Marie / forêt de Kalalao / III-60 Andria R. [white label]; INSTITUT / SCIENTIFIQUE / MADAGASCAR [light green label]; Coll. R.I.Sc.N.B. [blue label] (RBINS).

##### Paratypes

2 ♂♂, 1 ♀ / *Exphora kalalaoensis* sp. nov. / Junkiert & Walczak det. 2018 [red label]; Ile Sainte Marie / forêt de Kalalao / III-60 Andria R. [white label]; INSTITUT /



**Fig. 8.** Male genitalia of *Exphora kalalaoensis* sp. nov. **A.** Aedeagus, lateral view. **B.** Anal tube, dorsal view. **C.** gonostyl, lateral view.

SCIENTIFIQUE / MADAGASCAR [light green label];  
Coll. R.I.Sc.N.B. [blue label] (RBINS).

### Description

Body length 10.7–11.1 mm.

**Head.** Metope almost twice as long as wide, lateral margins slightly arched and extended laterally at level of 3/4 in its lower part, then narrowing to metopoclypeal suture. Dorsal margin of metope weakly arcuately but distinctly concave. Median keel distinct, running through metope and metopoclypeal suture (Fig. 2B). Metopoclypeal suture elongate (about 1/4 shorter than metope) and triangular. Lateral keels present and distinct. In lateral view, metope distinctly convex, whereas metopoclypeal suture almost straight, the median keel in lateral view gently arches over surface of metopoclypeal suture, and it also protrudes above surface of metope, but in lateral view it is almost all covered by also protruding lateral keels. Eyes not quite round (hind edge of the eye almost straight). Coryphe almost 1.5 times as wide as long, with anterior margin convex and strongly angular and posterior margin distinctly arcuately concave.

**Pronotum and mesonotum.** Pronotum bluntly rounded anteriorly, distinctly concave posteriorly. Mesonotum weakly convex, with three parallel keels: median keel is in its anterior part joined to two slanting lines converging to each other almost at right angle and thus forming an arrow-shaped structure. Both edges of arrow are joined to two lateral keels.

**Fore wings.** Clavus elongate, reaching almost 2/3 the length of the whole wing, of hyperpterism type. Costal area well developed with 12–15 cells between CA and Pc+CP; ScP+R short; RA two-branched; RP with 6–9 (mostly 7–8) terminals; MP separating before nodal line; MP1+2 separating before nodal line, 3–4 terminals (mostly 3), after the last terminal, clearly forked at the same level as stigma; MP3+4 separating before nodal line; with 1 terminal; MP4 single, MP3 short, with 1 terminal, separating before nodal line. CuA forking before nodal line and before MP; two or three transverse veins connecting CuP and PCu+A1 (one vein connecting CuP and PCu before joining with A1 and one or two connecting CuP and PCu+A1). A1 running parallel to posterior margin of clavus. Cubital cell at least twice as long as postcostal cell, radial cell and median cell. Radial cell separated by a transverse vein. C1 usually separated by a transverse vein. C1 based well before C2–C5; C2 and C4 in contact sharing MP margin. C1 longer than C2, C3 and C4, C5 about 2 times longer than C2, C3 and C4. Seventeen to twenty-one apical cells. Stigma well visible, including cell created by disjunction of ScP+RA (with dark brown spot within cell) and 4–5 short veins running to edge of wing (slightly paler cells) (Fig. 3B).

**Hind wings.** Well developed, 4/5 of the fore wings' length. Hyaline with brown veins. Almost twice long as wide in midline (ratio length to width: 2.2–2.4). Twelve apical cells (Fig. 3B).

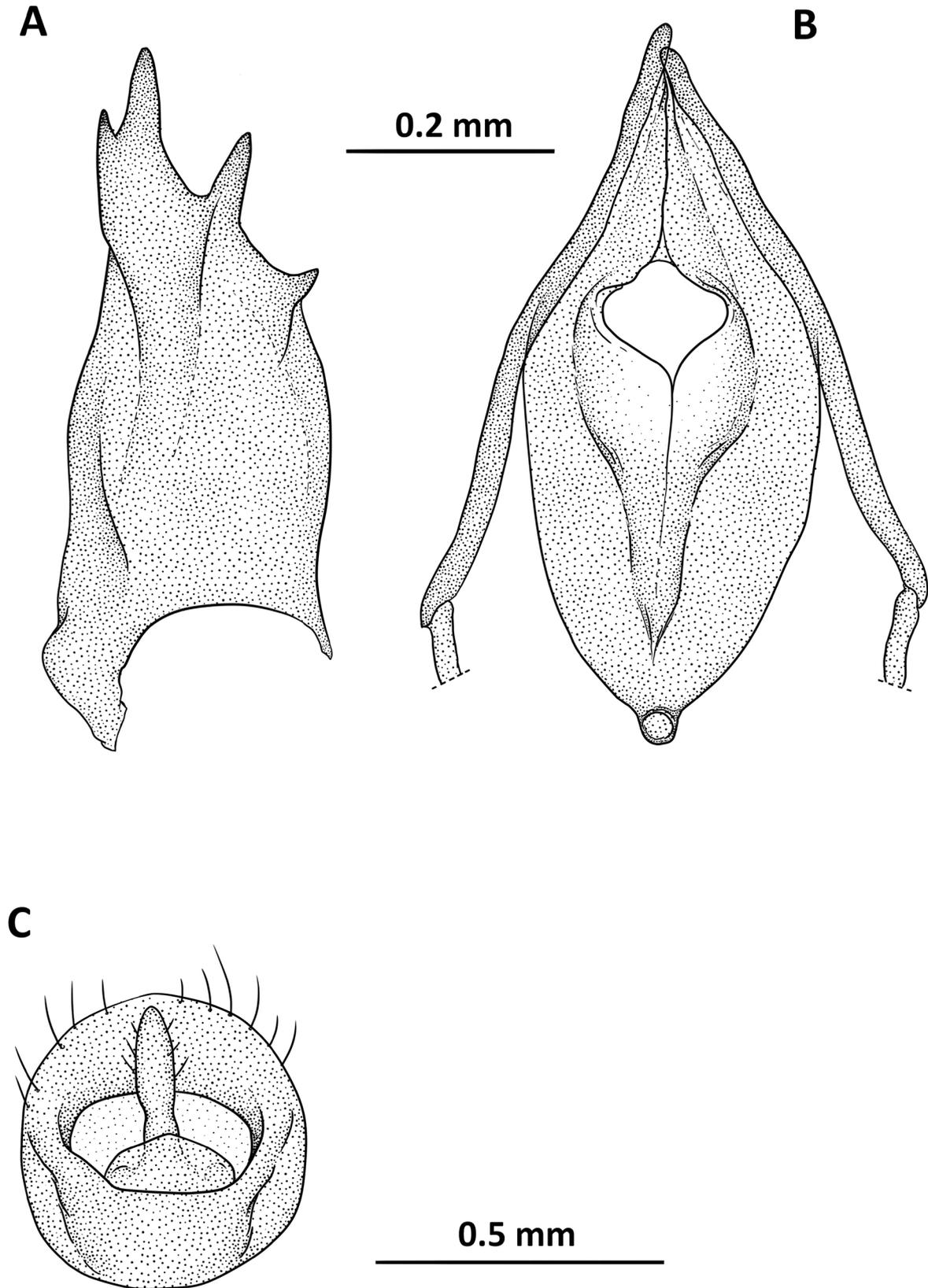
**Legs.** Prothoracic and mesothoracic legs: Femur about 2/3 of tibia length, irregular in cross-section, margins of femur covered with small bristles, inner margin bear small spines. Tibiae long and thin, trapezoidal in cross-section, margins covered with small bristles, lateral margins with double row of bristles.

**Metathoracic legs.** Metafemur margins covered with small bristles. Metatibia twice as long as metafemur, triangular in cross-section with concave ventral side. Margins of metatibia covered with small, barely visible bristles. Lateral margin with four lateral spines, three of which are distinct and one weakly visible. Metatibiotarsal formula 8/8/2.

**Colouration.** General colouration yellowish-brown. Metope with keels distinctly red, between lateral and median keels red-brown stripes passing (but thinner than in the previous species) along the metope. Eyes distinctly darker than background. Ocelli with delicate rim, blurred at the back. Posterior margin of pronotum and mesonotum contoured by a distinct dark line, similar to all darkly marked convex keels on mesonotum. Lateral margins of tergites of abdomen brown. Wings hyaline with brown veins. All legs in the same colour as the rest of the body. Femur and tibia colouration uniform yellowish-brown, spines brown, darker than tibia, the sharp end of the spike black.

**Genitalia. Male.** Pygofer with hind margin convex. Aedeagus s.l. U-shaped, robust (thick) in lateral view. Ventral phallobase reaching half-length of aedeagus. Each dorso-lateral phallobase lobe with one long apical finger-shaped process bearing abundant small denticles. Subapical process smaller and sharp ended. Aedeagus s.s. with inner part club-shaped, outer part lobate, narrow on the whole length, slightly sharpened with delicate indentation on its apical part (Fig. 8A). Anal tube rather robust, enlarged apically in dorsal view with slightly convex lateral margin in the middle; anal column short, about 0.43 times anal tube length (Fig. 8B). Gonostyle triangle-shaped (but slightly elongated) with smooth roundish edges, lateral margin of gonostyle slightly concave; capitulum wide and folded, bearing subapical spiralling tooth on inner side (Fig. 8C).

**Female.** Genitalia with anal tube relatively short, broadly rounded in dorsal view. Gonapophyses VIII (first valvula) rather triangular, elongated, strongly sclerotized and bearing two teeth on dorsal margin and one relatively large tooth, bearing smaller subapical tooth (Fig. 9A).



**Fig. 9.** Female genitalia of *Exphora kalalaoensis* sp. nov. **A.** Gonapophyses VIII. **B.** Gonapophyses IX. **C.** Anal tube, dorsal view.

Gonapophyses VIII not visible externally, covered by gonoplacs. Gonapophyses IX (second valvular) confluent with endogonocoxal processes forming triangular structure (Fig. 9B). Gonoplac (third valvula) semi-circular in lateral view (Fig. 9C). Median part of sternite VII with shallow roundish incision in the middle.

**Measurements (in mm, females in parentheses).** Body length: 10.13 (10.69–11.0); head width (with eyes): 1.81 (1.89–1.93); metope length: 1.93 (1.90–2.01); metope width: 1.10 (1.20–1.21); metope length/metope width ratio: 1.75 (1.58–1.66); coryphe length: 0.49 (0.44–0.48); coryphe width: 0.83 (0.89); coryphe length/coryphe width ratio: 0.49 (0.44–0.48); fore wing length: 8.34 (9.17–9.25); fore wing width: 3.77 (4.51–4.66); mesonotum length: 1.81 (1.88–1.97); mesonotum width: 2.01 (2.08–2.27).

**Diagnosis.** *Exphora kalalaoensis* sp. nov. can be distinguished from other species by a stigma which includes cell created by disjunction of ScP+RA (with dark brown spot within cell) and 4–5 short veins running to edge of wing, metope with wide brown stripes, anal tube with obtuse lateral margins, shape of style, aedeagus and its processes.

**Etymology.** The name of species is connected with place where specimens were collected, Kalalao Forest, Sainte Marie Island, Madagascar.

**Distribution.** Madagascar, Nosy Boraha (fr. Île Sainte-Marie), Kalalao Forest [16°55'32.1" S, 49°53'10.0" E] (Fig. 7).

***Exphora angustivenosa* Junkiert & Walczak sp. nov.**  
(Figs 1C, 2C, 3C, 10–11)

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#### Material examined

##### Holotype

1 ♂ / *Exphora angustivenosa* sp. nov. / Junkiert & Walczak det. 2018 [red label]; Madagascar / Nosy Komba [blue label]; Coll. R.I.Sc.N.B. [blue label] (RBINS).

##### Paratypes

1 ♂ / *Exphora angustivenosa* sp. nov. / Junkiert & Walczak det. 2018 [red label]; Coll. R.I.Sc.N.B. / Madagascar / Nossi-Be / Ex Coll. Le Moul't [green label] (RBINS);

1 ♀ / *Exphora angustivenosa* sp. nov. / Junkiert & Walczak det. 2018 [red label]; Coll. R.I.Sc.N.B. / Madagascar / Nosy Komba [blue label] (RBINS).

1 ♀ / *Exphora angustivenosa* sp. nov. / Junkiert & Walczak det. 2018 [red label]; Coll. R.I.Sc.N.B. [blue label]; INSTITUT / SCIENTIFIQUE / MADAGASCAR [white label]; Madagascar Sambirano / Nossi-Be / forêt de Lokobe / I-60 / Andria Robinson [white label] (RBINS).

#### Description

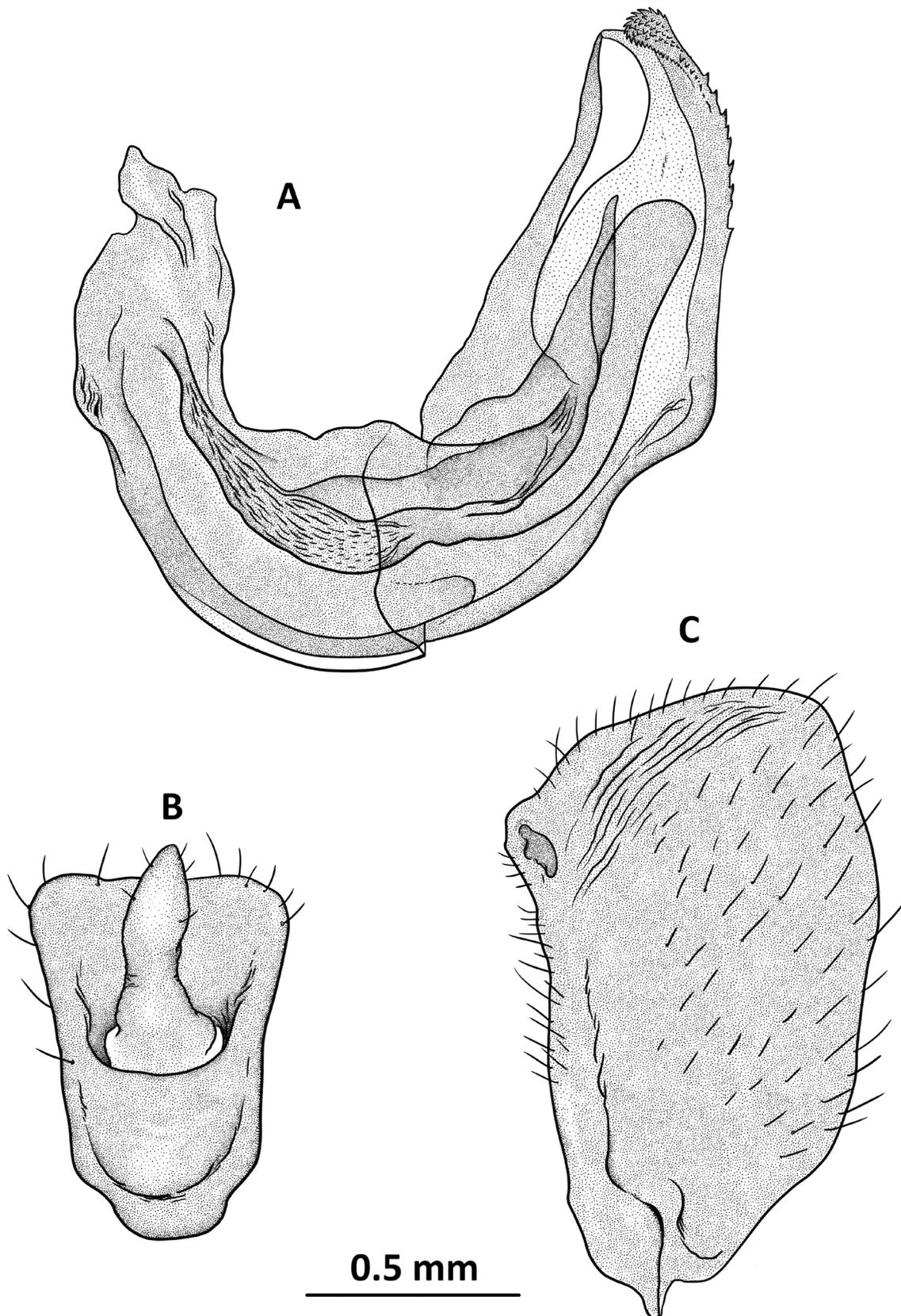
Body length 12.35–12.60 mm.

**Head.** Metope twice as long as wide, lateral margins slightly arched and extended laterally at level of 3/4 in its lower part, then narrowing to metopoclypeal suture. Dorsal margin of metope weakly arcuately but distinctly concave. Median keel distinct, running through metope and metopoclypeal suture (Fig. 2C). Metopoclypeal suture elongate (about 1/4 shorter than metope), triangular. Lateral keels present and distinct. In lateral view metope is distinctly convex, whereas metopoclypeal suture almost straight. Median keel in lateral view gently arches above the surface of the metopoclypeal suture and it also protrudes clearly above surface of metope, so that in lateral view it is still visible, and rather not covered by slightly protruding lateral keels. The eyes not quite round (hind edge of the eye almost straight). Coryphe almost 1.5 times as wide as long, with anterior margin strongly convex and strongly angular, and posterior margin distinctly and very arcuately concave.

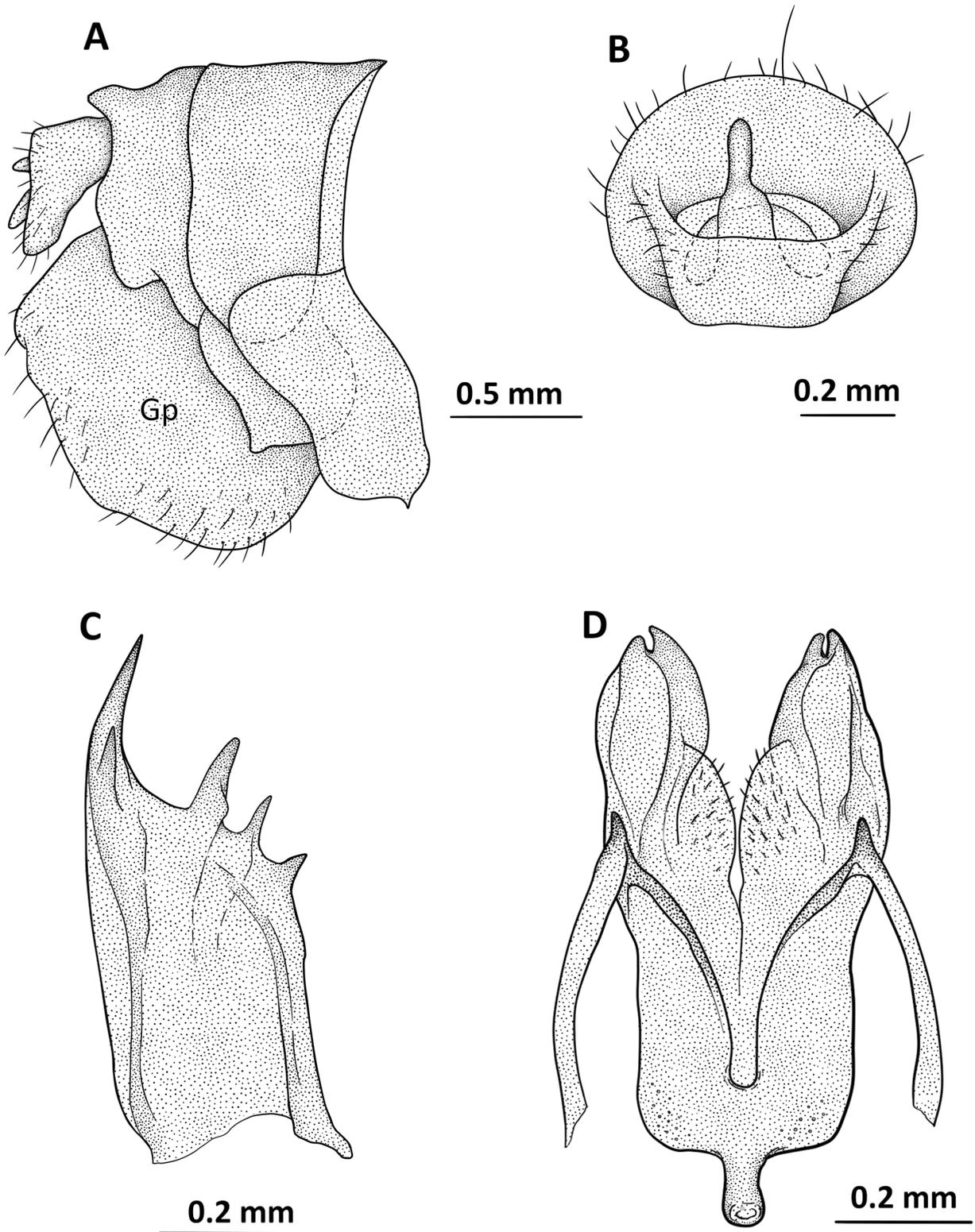
**Pronotum and mesonotum.** Pronotum bluntly rounded anteriorly, distinctly concave posteriorly. Mesonotum weakly convex, with three parallel keels: median keel is in its anterior part joined to two slanting lines converging to each other almost at right angle and thus forming an arrow-shaped structure. Both edges of arrow are joined to two lateral keels.

**Fore wings.** Clavus elongate, as long as 2/3 of whole wing length, of hyperpterism type. Costal area well developed with 10 or 11 cells between CA and Pc+CP; ScP+R short, separating; RA two-branched; RP with 5–7 terminals; MP separating before nodal line; MP1+2 separating before nodal line, after the third or fourth terminal, clearly forked at the same level as stigma; MP3+4 separating, before nodal line; MP4 single, MP3 short, separating before nodal line, after the first terminal. CuA forking before nodal line and before MP. Two or three transverse veins connecting CuP and PCu+A1 (one vein connecting CuP and PCu before joining with A1 and one or two connecting CuP and PCu+A1). A1 running parallel to posterior margin of clavus. Cubital cell at least twice as long as postcostal cell, radial cell and median cell. C1 based well before, C2, C3 and C4; C5 starts at a similar level as C1; C2 and C4 in contact sharing MP margin. C1, C2, C3 and C4 of similar length, C5 about 2 times longer. Eighteen to nineteen apical cells. Stigma longitudinal and brown, well visible, includes 3–4 (mostly 3) short veins running to edge of wing (Fig. 3C).

**Hind wings: Well developed, 4/5 of the fore wings' length.** Hyaline with brown veins. Almost twice long as wide in midline (ratio length to width: 2.2–2.4). Eleven apical cells (Fig. 3C).



**Fig. 10.** Male genitalia of *Exphora angustivenosa* sp. nov. A. Aedeagus, lateral view. B. Anal tube, dorsal view. C. Gonostyl, lateral view.



**Fig. 11.** Female genitalia of *Exphora angustivenosa* sp. nov. A. Distal part of abdomen in lateral view. B. Anal tube, dorsal view. C. Gonapophyses VIII. D. Gonapophyses IX. Gp = gonoplac.

**Legs.** Prothoracic and mesothoracic legs: Femur about 2/3 of tibia length, irregular in cross-section, margins of femur covered with small bristles, inner margin bear small spines. Tibiae long and thin, trapezoidal in cross-section, margins covered with small bristles, lateral margins with double row of bristles.

**Metathoracic legs: Metafemur margins covered with small bristles.** Metatibia twice as long as metafemur, triangular in cross-section with concave ventral side. Margins of metatibia covered with small, barely visible bristles. Lateral margin with four lateral spines, three of which are distinct and one is weakly visible. Metatibiotarsal formula 8/8/2.

**Colouration.** The species is paler than the previous one. General colouration ochre-lightbrown, metope with keels distinctly red, between lateral and median keels red-brown thin stripes passing (much thinner than the previous two species) passing along the metope. Eyes darker than background, almost black, ocelli with delicate rim, blurred at the back. Posterior margin of pronotum and mesonotum gently contoured by a very thin dark line, all convex keels on the mesonotum also darker than the background. Mesonotum at the proximal part with two small spots, with two larger irregular spots on each side, and at the distal part with two small but distinct spots. Lateral margins of tergites of abdomen light brown. Wings hyaline with red-brown veins. Legs ochre-lightbrown, metatibial spines of the same colour except for the tip that is black.

**Genitalia. Male.** Pygofer with hind margin convex. Aedeagus s.l. arched, robust in lateral view. Ventral phallobase not reaching half-length of aedeagus. Each dorso-lateral phallobase lobe with long fusiform process reaching the apex of aedeagus, apical process semi-circularly covered by abundant denticles, the lateral margin serrate, subapical process absent. Inner phallobase lobes spatulate, slightly curved, narrow on the base and wider on apices. Aedeagus s.s. long and fusiform (Fig. 10A). Anal tube rather robust, enlarged apically in dorsal view with concave lateral margin and roundish lateral margins. Anal column length about 0.54 times anal tube length (Fig. 10B). Gonostyle oval, elongated. Capitulum wide and folded, bearing subapical tooth on inner side (Fig. 10C).

**Female.** Endogonocoxal process, well developed, apical ends roundish, with well visible incision, inner margin strongly sclerotized. Gonoplac (third valvula) semi-circular in lateral view (Fig. 11A). Median part of sternite VII with distinct roundish incision in the middle. Genitalia with anal tube relatively short, broadly rounded in dorsal view (Fig. 11B). Gonapophyses VIII (first valvula) almost trapezoidal, elongated, strongly

sclerotized and bearing three teeth on dorsal margin and one large, long tooth, bearing smaller subapical tooth (Fig. 11C). Gonapophyses VIII not visible externally, covered by gonoplacs. Gonapophyses IX (second valvular) sclerotized, confluent with endogonocoxal processes (Fig. 11D).

**Measurements (in mm, females in parentheses).** Body length: 12.35 (12.60); head width (with eyes): 2.00 (1.93–2.00); metope length: 2.18 (1.84–2.14); metope width: 1.28 (1.27–1.30); metope length/metope width ratio: 1.70 (1.41–1.68); coryphe length: 0.68 (0.60–0.67); coryphe width: 0.98 (0.83–0.90); coryphe length/coryphe width ratio: 0.69 (0.72–0.74); fore wing length: 10.46 (10.17–10.99); fore wing width: 5.13 (4.78–5.32); mesonotum length: 2.40 (2.32–2.36); mesonotum width: 2.25 (2.12–2.15).

**Diagnosis.** *Exphora angustivenosa* sp. nov. can be distinguished by its size (it is bigger than other representatives of this genus), small brown longitudinal stigma which includes 3–4 (mostly 3) short veins running to edge of wing, metope with thin brown stripes, anal tube with roundish lateral margins, shape of style, aedeagus and its processes.

**Etymology.** The name of species refers to the thin veins on the fore wings.

**Distribution.** Madagascar, Nosy Ambariovalo, Nosy Komba [13°28'18.7" S, 48°20'54.2" E]; Nosy Be, Lokobe Forest [13°23'36.8" S, 48°18'42.4" E] (Fig. 7).

#### ***Exphora robusta* Junkiert & Walczak sp. nov.**

(Figs 1D, 2D, 3D, 12–13)

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#### **Material examined**

##### **Holotype**

1 ♂ / *Exphora robusta* sp. nov. / Junkiert & Walczak det. 2018 [red label]; Coll. Mus. Tervuren / Madagascar: Tamata / ve: Foul pointe XI- / 1995 A. Pauly [white label] (RMCA).

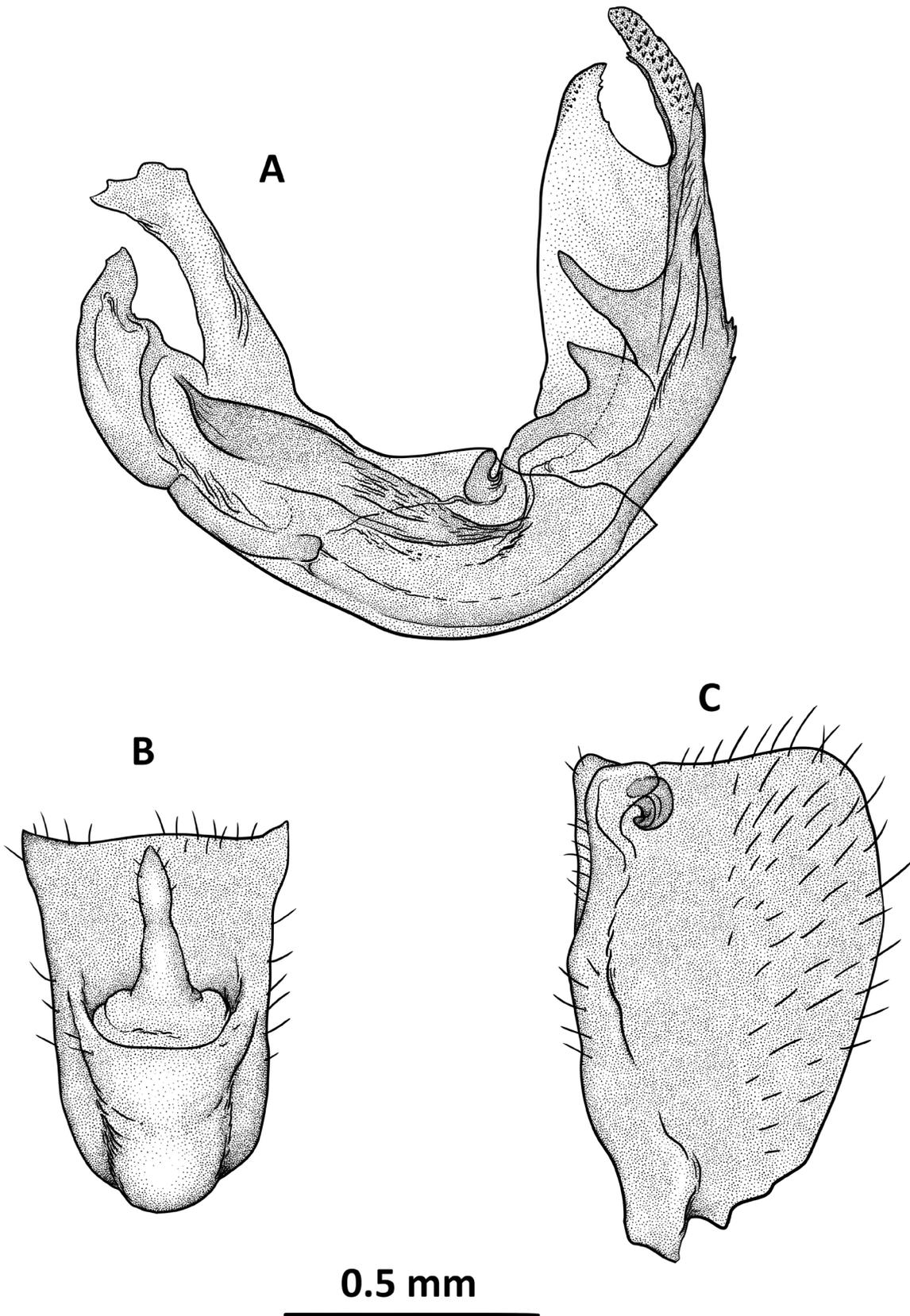
##### **Paratypes**

1 ♂, 2 ♀♀ / *Exphora robusta* sp. nov. / Junkiert & Walczak det. 2018 [red label]; Coll. Mus. Tervuren / Madagascar: Tamata / ve: Foul pointe XI- / 1995 A. Pauly [white label] (RMCA).

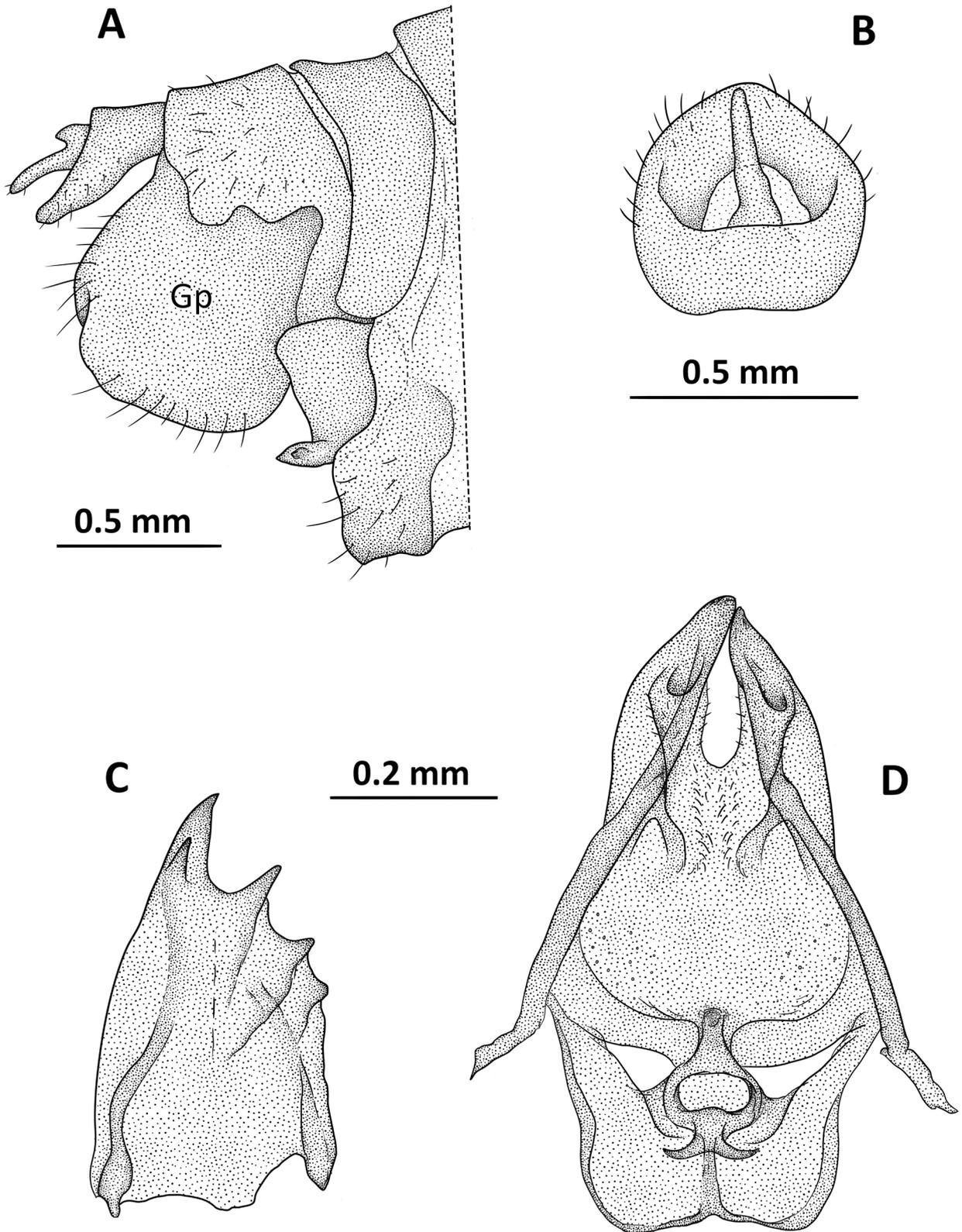
#### **Description**

Body length 9.5–10.25 mm.

**Head.** Metope twice as long as wide, lateral margins slightly arched and extended laterally at level 3/4 in its lower part, then narrowing to metopoclypeal suture. Dorsal margin of metope very weakly arcuately



**Fig. 12.** Male genitalia of *Exphora robusta* sp. nov. **A.** Aedeagus, lateral view. **B.** Anal tube, dorsal view. **C.** Gonostyl, lateral view.



**Fig. 13.** Female genitalia of *Exphora robusta* sp. nov. A. Distal part of abdomen in lateral view. B. Anal tube, dorsal view. C. Gonapophyses VIII. D. Gonapophyses IX. Gp = gonoplac.

concave (almost straight). Median keel distinct, running through metope and metopoclypeal suture (Fig. 2D). Metopoclypeal suture elongate, equal to 3/4 of the metope length, triangular. Lateral keels present and distinct. In lateral view, the metope is distinctly convex, whereas the metopoclypeal suture is almost straight. Median keel gently arches over surface of metopoclypeal suture and protrudes slightly above surface of the metope, bottom part is hidden by gently protruding lateral keels. The eyes rather round (hind edge of the eye almost straight). Coryphe almost 1.5 times as wide as long, with anterior margin convex and distinctly angular and posterior margin distinctly arcuately concave.

**Pronotum and mesonotum.** Pronotum bluntly rounded anteriorly, distinctly concave posteriorly. Mesonotum weakly convex, with three parallel keels: median keel is in its anterior part joined to two slanting lines converging to each other almost at right angle and thus forming an arrow-shaped structure. Both edges of arrow are joined to two lateral keels.

**Fore wings.** Clavus elongate, reaching almost 2/3 the length of the whole wing, of hyperpterism type. Costal area well developed with 13–14 cells between CA and Pc+CP; ScP+R short, separating; RA two-branched; RP with at least 8 terminals; MP separating before nodal line; MP1+2 separating before nodal line, 3–5 terminals (mostly 3), after the last terminal, clearly forked at the same level as stigma; MP3+4 separating, before nodal line; with 2–3 terminals (sometimes 1); MP4 single, MP3 short, with 1–2 terminals, separating before nodal line, after the last terminal. CuA forking before nodal line and before MP; two or three transverse veins connecting CuP and PCu+A1 (one vein connecting CuP and PCu before joining with A1 and one or two connecting CuP and PCu+A1). A1 running parallel to posterior margin of clavus. Cubital cell twice as long, or even more, than postcostal cell, radial cell and median cell. Radial cell separated by a transverse vein. C1 based well before C2–C5; C2 and C4 in contact sharing MP margin. C1 longer than C2, C3 and C4, C5 about 2 times longer than C2, C3 and C4. Nineteen to twenty one apical cells. Stigma well visible, includes cell created by disjunction of ScP+RA (with dark brown spot within cell) and 4 short veins running to edge of wing (slightly paler cells) (Fig. 3D).

**Hind wings.** Well developed, 4/5 of the fore wings' length. Hyaline with brown veins. Almost twice long as wide in midline (ratio length to width: 2.2–2.4). Thirteen apical cells (Fig. 3D).

**Legs.** Prothoracic and mesothoracic legs: Femur about 2/3 of tibia length, irregular in cross-section, margins of femur covered with small bristles, inner margin bear small spines. Tibiae long and thin, trapezoidal in cross-

section, margins covered with small bristles, lateral margins with double row of bristles.

**Metathoracic legs.** Metafemur margins covered with small bristles. Metatibia twice as long as metafemur, triangular in cross-section with concave ventral side. Margins of metatibia covered with small, barely visible bristles. Lateral margin with four lateral spines, three of which are distinct and one is weakly visible. Metatibiotarsal formula 8/8/2.

**Colouration.** General colouration brown, metope with keels distinctly red, between lateral and median keels red-brown thin stripes passing along the metope. Eyes darker than background, almost black, ocelli darker than background, without rim. The hind edge of the pronotum and mesonotum is contoured by a distinct dark line, similar like all dark marked convex keels on the mesonotum. Lateral margins of tergites of abdomen brown. Wings hyaline with brown veins. Legs brown like the rest of the body. Metatibial spines dark brown with black tip.

**Genitalia. Male.** Pygofer with hind margin convex. Aedeagus s.l. falcate in lateral view. Ventral phallobase overreaching half-length of aedeagus. Each dorso-lateral phallobase lobe with one long apical finger-shaped process bearing very small denticles. Subapical process smaller and slightly curved. Inner part of ventral process (aedeagus s.s.) short and robust, duck-head shaped, outer part finger-shaped with apical process and smaller triangular subapical well visible process (Fig. 12A). Anal tube rather robust, weakly narrowed basally and enlarged apically in dorsal view with two horn-like edges. Anal column elongated, about 0.5 times anal tube length (Fig. 12B). The dorsal and lateral margins of gonostyle form a right angle, ventral margin oval; capitulum folded, bearing subapical spiralling tooth on inner side (Fig. 12C).

**Female.** Endogonocoxal process, well sclerotized with slightly rounded apex. Gonoplac (third valvula) semi-circular in lateral view (Fig. 13A). Median part of sternite VII with distinct, wide triangular incision in the middle. Genitalia with anal tube relatively short, broadly rounded in dorsal view (Fig. 13B). Gonapophyses VIII (first valvula) rather short, almost trapezoidal, strongly sclerotized and bearing three short teeth on dorsal margin and one relatively large tooth, bearing smaller subapical tooth (Fig. 13C). Gonapophyses VIII not visible externally, covered by gonoplacs. Gonapophyses IX (second valvular) sclerotized, confluent with endogonocoxal processes, forming bell-mouthed immersion (Fig. 13D).

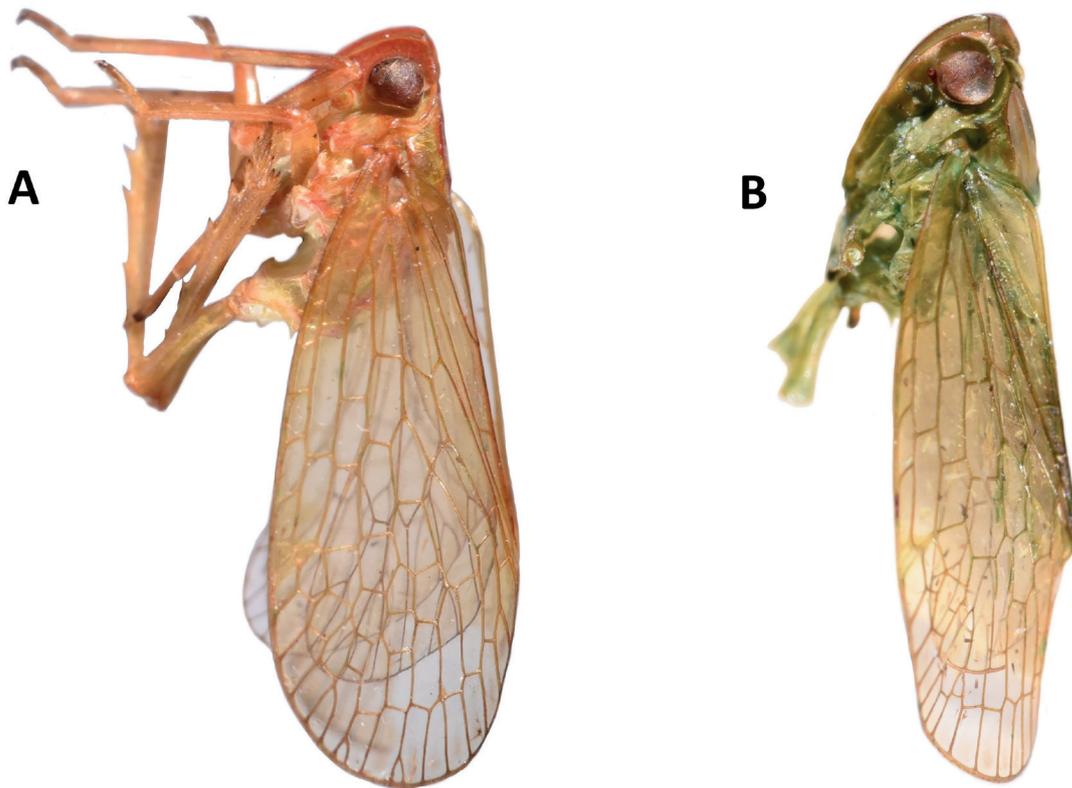


Fig. 14. *Exphora linnavuorii*. A. Lateral habitus. B. Green form of *E. linnavuorii*.

**Measurements** (in mm, females in parentheses). Body length: 9.48 (10.04–10.24); head width (with eyes): 1.73 (1.66–1.77); metope length: 1.90 (1.86–1.90); metope width: 0.98 (1.09–1.24); metope length/metope width ratio: 1.94 (1.50–1.74); coryphe length: 0.43 (0.44–0.49); coryphe width: 0.85 (0.82–0.92); coryphe length/coryphe width ratio: 0.50 (0.53–0.54); fore wing length: 8.52 (8.41–8.63); fore wing width: 4.26 (3.92–4.41); mesonotum length: 1.81 (1.96–2.02); mesonotum width: 2.17 (2.10–2.12).

**Diagnosis.** *Exphora robusta* sp. nov. can be distinguished by its size (it is smaller and more robust than other species of this genus), brown rounded stigma which includes four short veins running to edge of wing (colouration is slightly paler on those cells), metope with wide brown stripes, horned anal tube, shape of style, aedeagus and its processes.

**Etymology.** The name is given according to the robust appearance of the body of this species.

**Distribution.** Madagascar, Toamasina, Tamatava [18°08'05.0" S, 49°22'00.9" E] (Fig. 7).

***Exphora linnavuorii* – description of the new colour form** (Fig. 14)

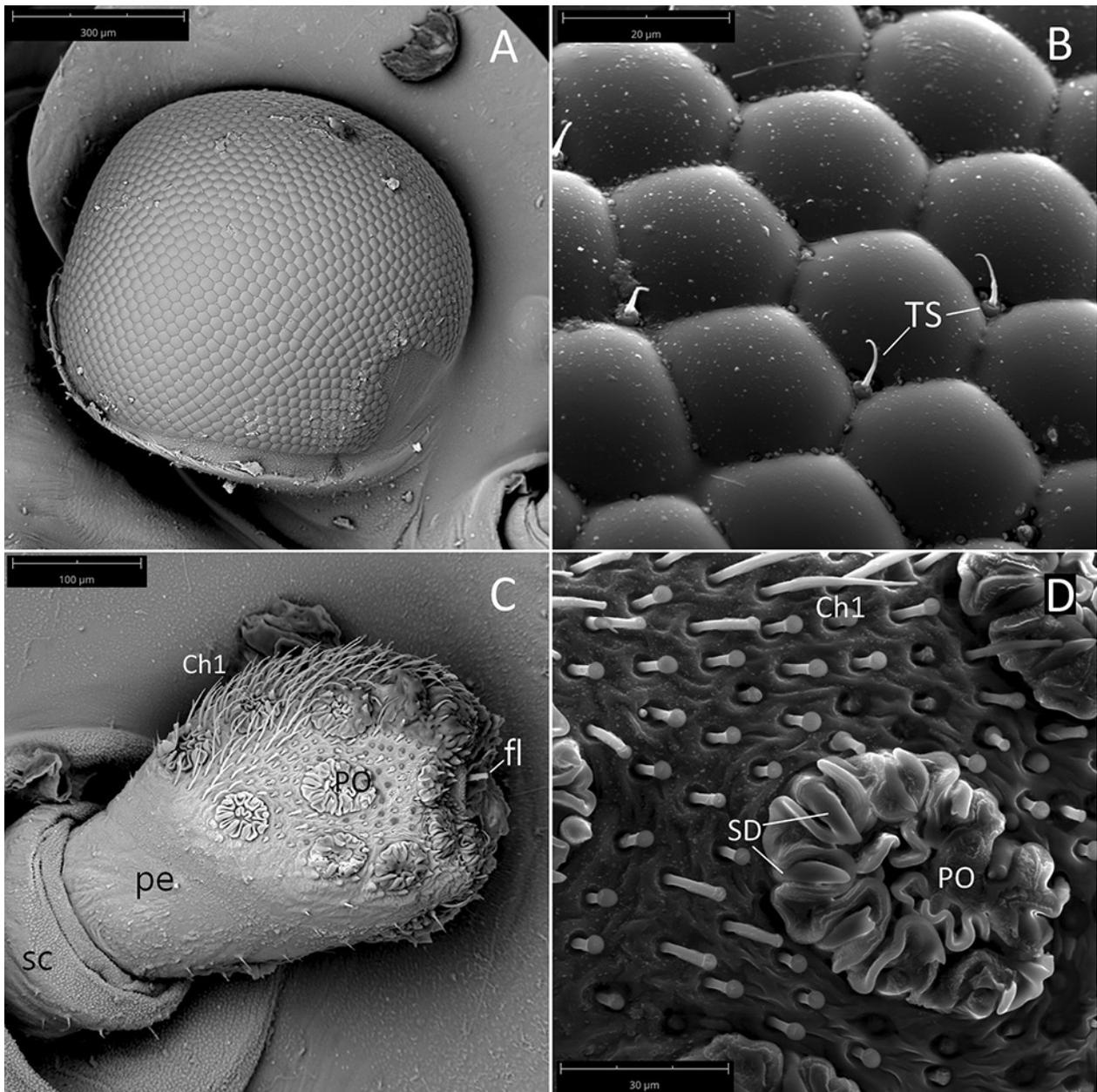
**Material examined**

1 ♂ / *Exphora linnavuorii* / Junkiert & Walczak det. 2018 [red label]; Coll. R.I.Sc.N.B. / Madagascar (2090m) / Plateau Soaindrana [blue label] (RBINS).

**Description**

Description consistent with the holotype of *Exphora linnavuorii* Junkiert, Walczak & Bourgoïn 2017. Unlike the type specimen whose body is ochre-light brown (metope with keels distinctly red), this form has a light green body throughout (metope with keels distinctly reddish). Wings hyaline, with green veins (veins of the type specimen are light brown). Legs of the type specimen are ochre-light brown (anterior and median legs with darker colour shade), while this form has light green legs with spikes on metatibiae in the same colour as the leg and the sharp end of the spike is black.

**Measurements** (in mm, only male). Body length: 9.63; head width (with eyes): 1.61; metope length: 1.72; metope width: 0.97; metope length/metope width ratio: 1.77; coryphe length: 0.47; coryphe width: 0.69; coryphe length/coryphe width ratio: 0.68; fore wing length:



**Fig. 15.** Scanning electron micrographs of *Exphora angustivenosa* sp. nov., male. **A.** Entire view of the compound eye. **B.** Trichoid sensilla (TS) between different ommatidia. **C.** Antenna, lateral view. **D.** Sensory plate organ on antennal pedicel surface. Ch1 = sensillum chaeticum type I; fl = flagellum; pe = pedicel; PO = plate organ; sc = scape; SD = sclerotized denticles. Scale bars: A = 300 µm; B = 20 µm; C = 100 µm; D = 30 µm.

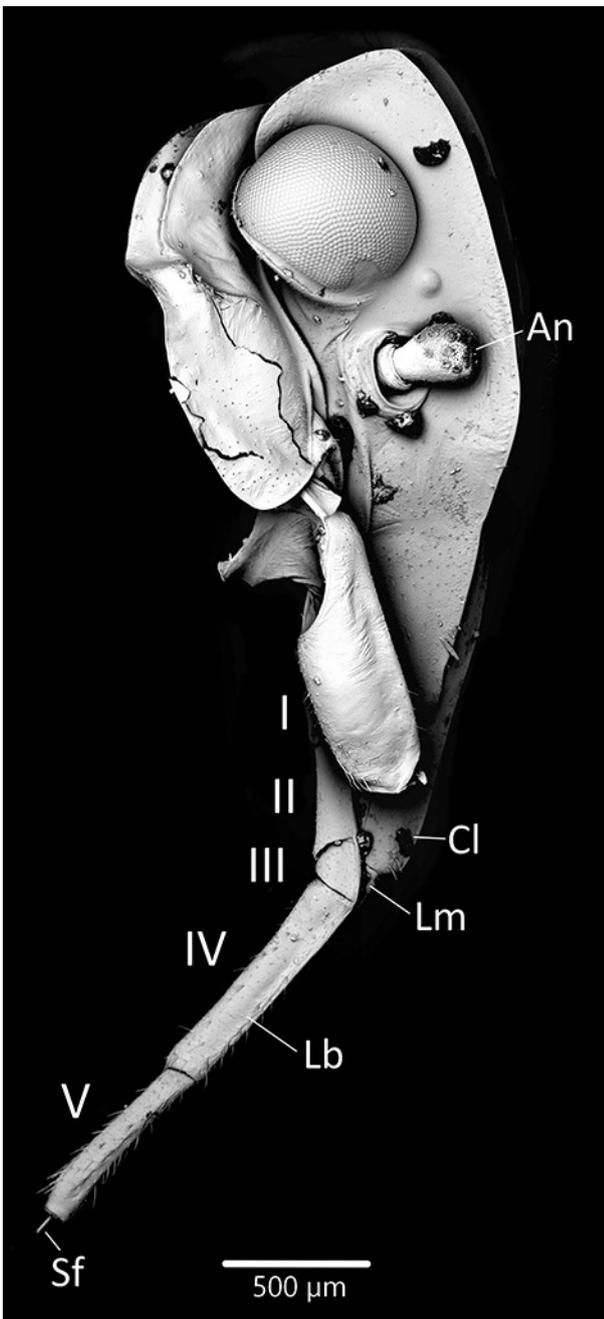
8.02; fore wing width: 3.43; mesonotum length: 1.90; mesonotum width: 2.10.

**Distribution.** Madagascar, Plateau Soaindrana [21°31'13.2" S, 47°02'18.6" E] (Fig. 7).

#### Ultrastructural characters

The terminology used for specific parts of the body and sensilla is taken from Bourgoïn and Deiss (1994), Brožek and Bourgoïn (2013) and Schubnel et al. (2019). The use of a scanning microscope allowed to visualize some in-

teresting structures that have not been presented for members of the genus *Exphora* so far. The images show what the compound eye looks like (Fig. 15A) and how trichoid sensilla are arranged on it (Fig. 15B). They are not evenly distributed and do not adhere to each ommatidium. The antennal pedicel is short and knobbed, with over a dozen sensory plate organs (Fig. 15C). Moreover, the antennae are covered with numerous sensilla chaetica type I, as well as shorter hairs with rounded ends (Fig. 15D). In figure 15C, the flagellum is broken at the base. Figure 16 shows the whole head in lateral view, with marked

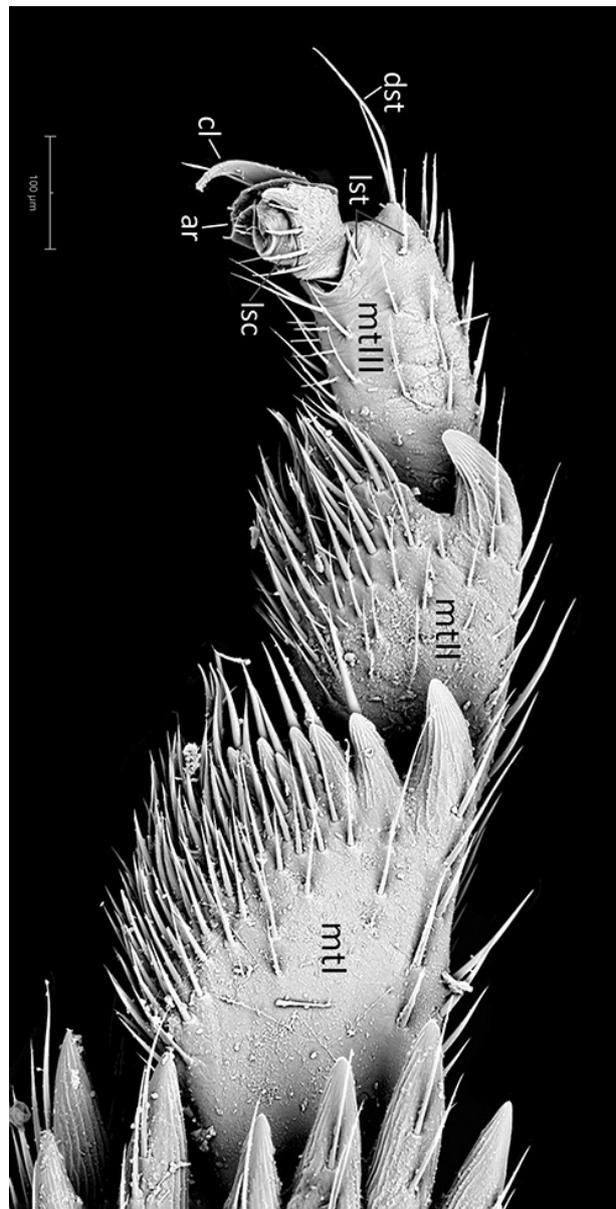


**Fig. 16.** SEM image of *Exphora angustivenosa* sp. nov., male. Head, lateral view. An = antenna; Cl = clypeus; Lb = labium; Lm = labrum; Sf = stylet fascicle; I–V = segments of labium.

structures, in particular the subsequent segments of the labium.

Each metatarsomere is covered with numerous, long trichobothria (Fig. 17). Distal margins of each metatarsomere bear spikes with longitudinal reticulation. Metatibiae are provided with distinct spines (4 or 5, depending on the species) and sensilla chaetica type II (Fig. 18).

Figure 19 presents the ventral surface of the fore wing with description of particular veins and cells, corresponding to the descriptions given above. The SEM images

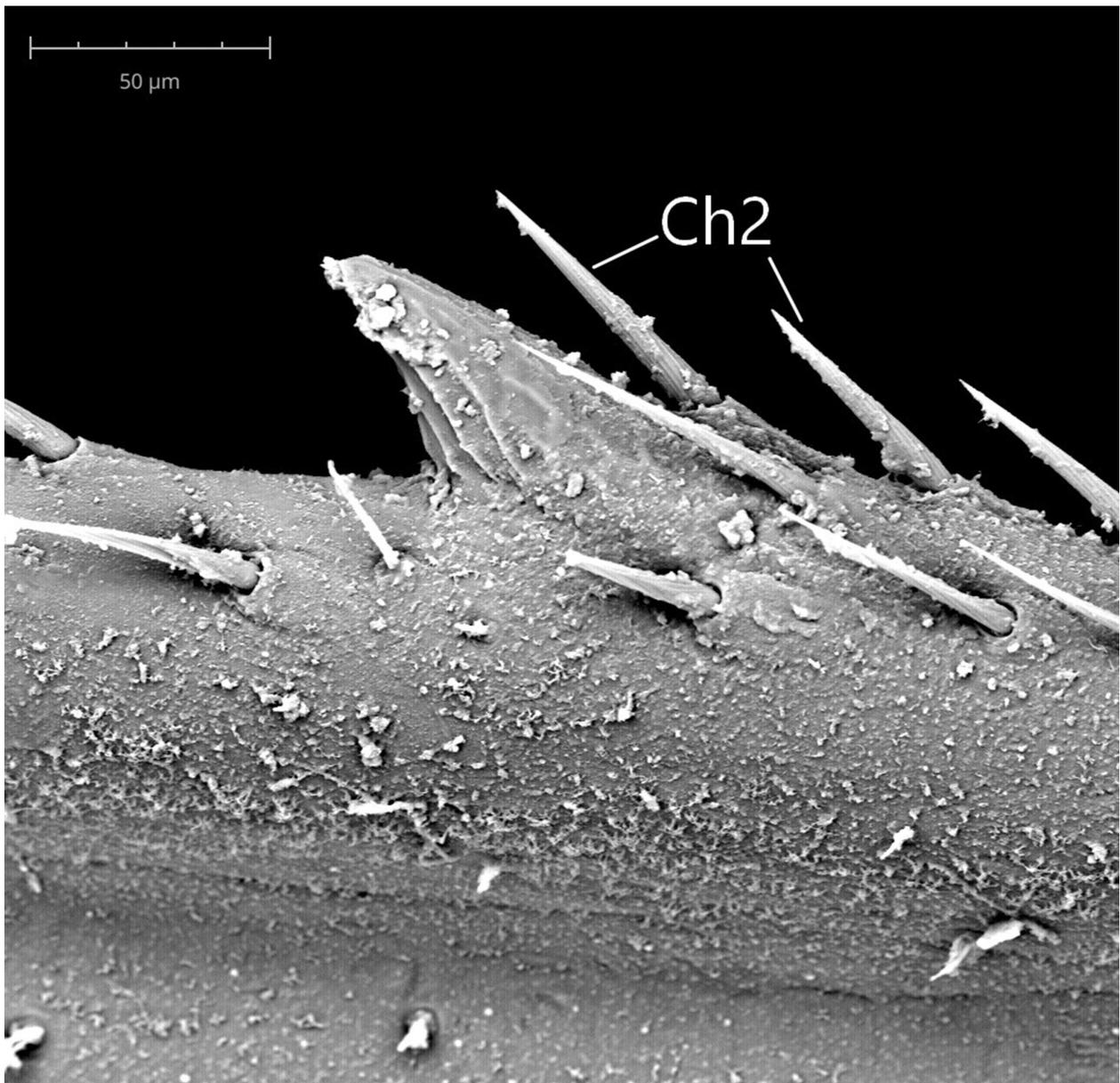


**Fig. 17.** SEM image of *Exphora angustivenosa* sp. nov., male. Tarsus of hind leg, lateral view. Abbreviations after Liang 2017: ar = arolium; cl = claw; dst = dorsal seta on tarsus; lsc = lateral seta on claw; lst = lateral seta on tarsus; mt I, II and III = metatarsomeres I, II, and III, respectively. Scale bar: 100 μm.

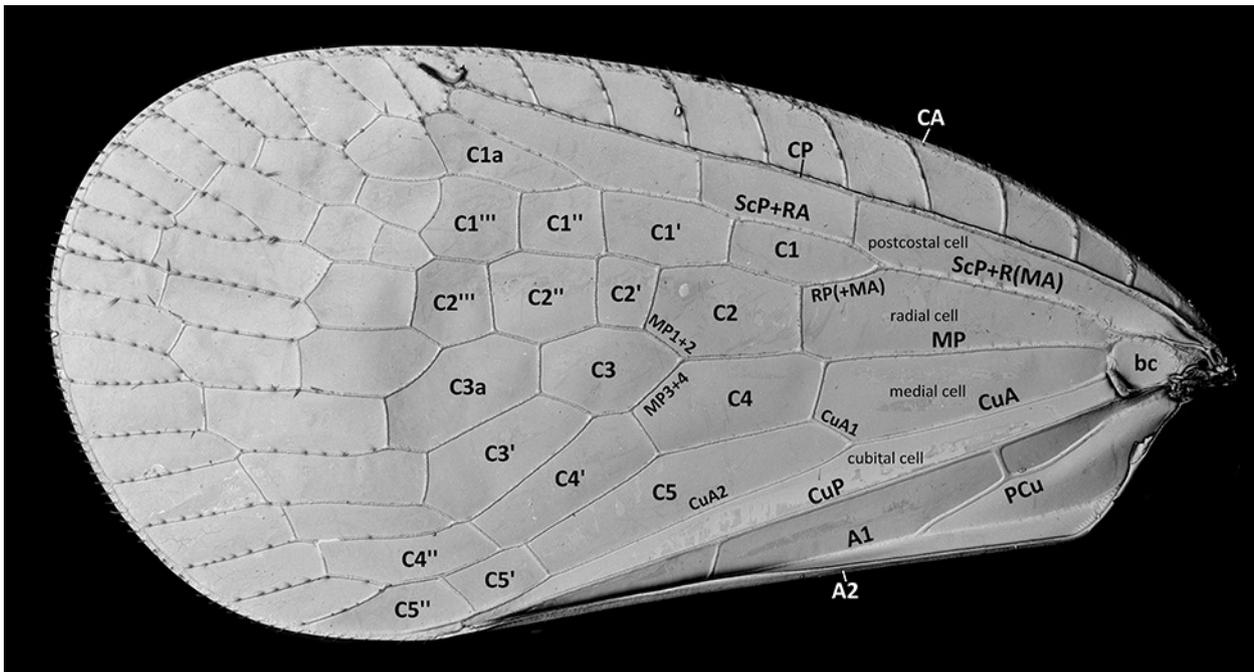
show that in this group of tropiduchids, the pterostigma is not a structural character, but corresponds to an area of pigmentation of certain cells and veins. On the ventral side of the fore wing, a micro-sculpture on the veins is noticeable, which may have a strengthening function (Fig. 20A,B). On the dorsal side of the fore wing, sensilla chaetica type II occur only on the margin of the wing, while on the ventral side they occur all over the margin and on the veins of the membrane (Fig. 20C,D). At the ventral side of the first anal vein (fore wing) campaniform sensilla (mechanoreceptors) and sensilla chaetica type I

are present (Fig. 20E–F). The area of microtrichia was found at the costa posterior vein of the fore wing (ventral side) (Fig. 21A–D). Examination of the area where the wing is attached to the body (Fig. 22A) showed that the thorax has a special depression where the postcubitus bulla (Fig. 22B) is hidden when the wings are folded on the body. In addition, the area of microtrichia at the mesopleuron has also been observed, and – while the wings are placed on the body – this area is in contact with the area of microtrichia at the costa posterior vein of the fore wing (Fig. 22C–D). Figure 23 presents how tegula and basal part of the wing look like, when the fore wing is placed on the body.

The hind wing is covered dorsally with sensilla chaetica type II on each vein (the jugal area was rolled up under the wing so it cannot be seen in the picture) (Fig. 24). The SEM pictures of both wings show the hamuli in *Exphora* that allow the wings of insects to remain connected in flight (Fig. 25). For members of the genus *Exphora*, the hamuli take the form of a fold at the edge of both wings. A higher magnification shows that the hamuli on the hind wing is covered with spines (Fig. 26A–B). A cuticular micro-sculpture of the fused veins (ScP+R+M) on the proximal part of the hind wing (Fig. 26C–D) was also observed.



**Fig. 18.** SEM image of *Exphora angustivenosa* sp. nov., male. Spine of tibia (hind leg), ventral view. Ch2 = sensillum chaeticum type II.

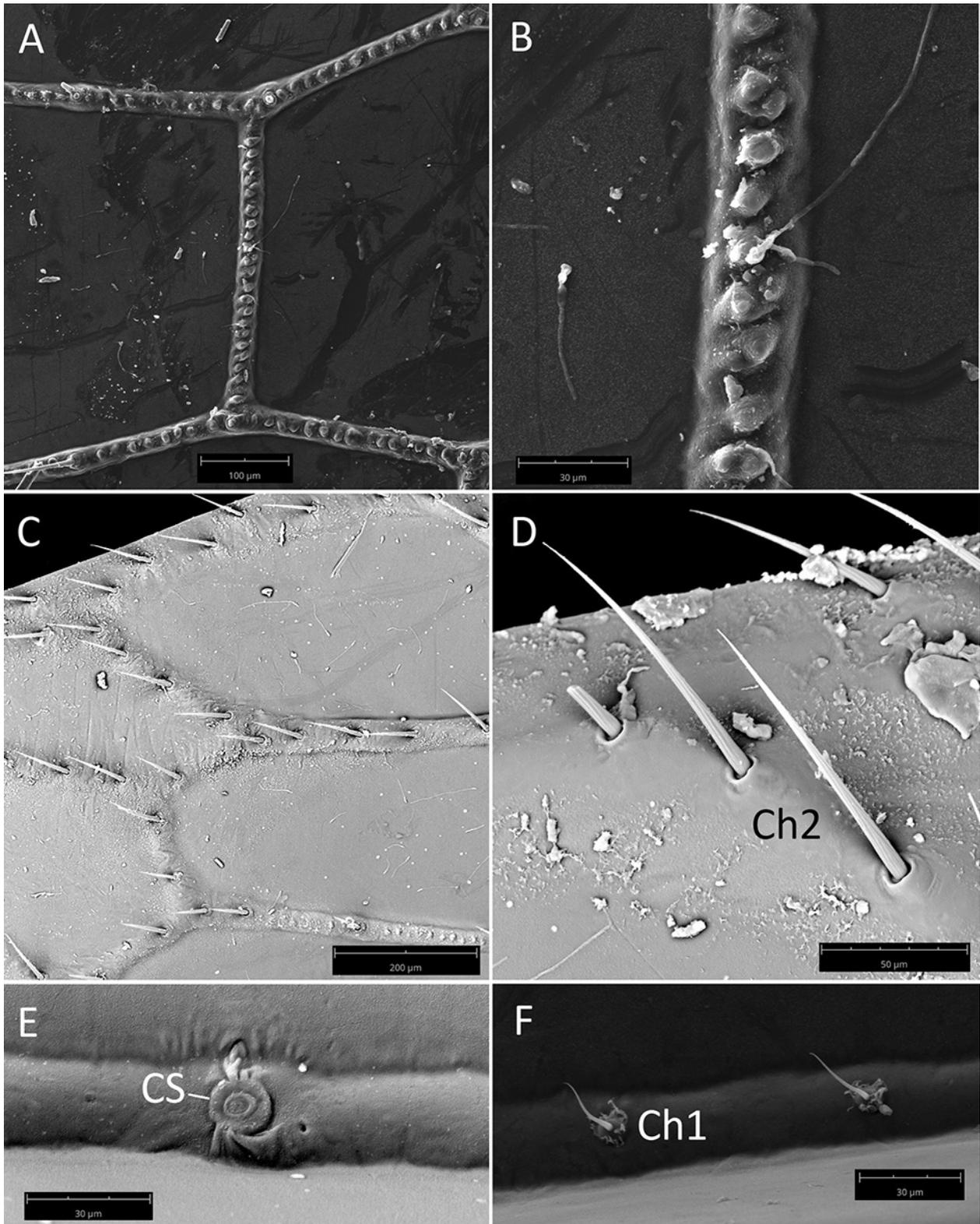


**Fig. 19.** SEM image of *Exphora angustivenosa* sp. nov., male. Fore wing, ventral view. A1 = first anal vein; A2 = second anal vein; bc = basal cubital; CA = costa anterior; CP = costa posterior; CuA = cubitus anterior; CuP = cubitus posterior; MP = media posterior; RP(+MA) = radius posteriori (+media anterior); ScP+R(MA) = subcosta posterior + radius (with media anterior); ScP+RA = subcosta posterior + radius anterior.

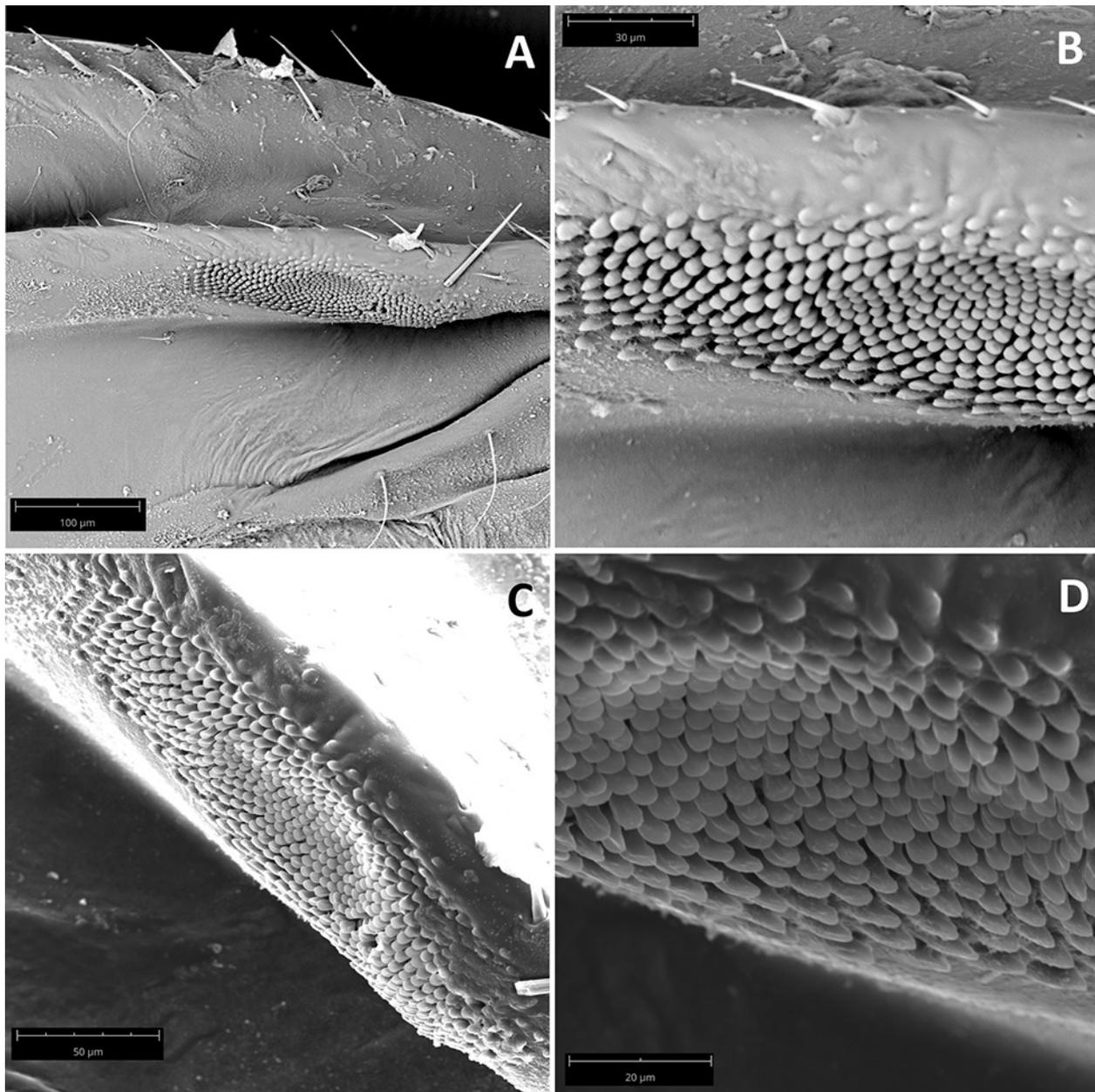
Each metacoxa presents a protrusion shaped as a spine (Fig. 27A–B). At higher magnification, a dense pad of microtrichia can be observed (Fig. 27C–D).

## REFERENCES

- Bañař P, Davranoglou LR, Chřond D (2016) A New species of *Henicocephaloides* from Eastern Madagascar (Hemiptera: Heteroptera: Reduviidae). *Entomologica Americana* 122 (1–2): 238–244
- Bourgoin T (2020) FLOW (Fulgoromorpha Lists on The Web): a world knowledge base dedicated to Fulgoromorpha. Version 8, updated [01.07.2020]. Online at <http://www.hemiptera-databases.org/flow/> [last accessed 27 Dec. 2020]
- Bourgoin T, Deiss V (1994) Sensory plate organs of the antenna in the Meenoplidae–Kinnaridae group (Hemiptera: Fulgoromorpha). *International Journal of Insect Morphology and Embryology* 23: 159–168
- Bourgoin T, Wang RR, Asche M, Hoch H, Soulier-Perkins A, Stroinski A, Yap S, Szwedo J (2015) From micropterism to hyperpterism: recognition strategy and standardized homology-driven terminology of the fore wing venation patterns in planthoppers (Hemiptera: Fulgoromorpha). *Zoomorphology* 134 (1): 63–77
- Brořek J, Bourgoin T (2013) Morphology and distribution of the external labial sensilla in Fulgoromorpha (Insecta: Hemiptera). *Zoomorphology* 132: 33–65
- Chřond D, Rédei D, Bañař P (2016) A new species of the Madagascar genus *Physoderoides* (Hemiptera: Heteroptera: Reduviidae: Physoderinae). *Entomologica Americana* 122 (1–2): 245–250
- Constant J (2014) Revision of the Malagasy lanternfly genus *Belbina* Stål, 1863, with two new species (Hemiptera: Fulgoromorpha: Fulgoridae). *European Journal of Taxonomy* 102: 1–37
- Couri MS, Pont AC, Penny ND (2006) Muscidae (Diptera) from Madagascar: identification keys, descriptions of new species, and new records. *Proceedings of the California Academy of Sciences* 57 (4): 799–923
- Davranoglou RL, Mortimer B, Taylor GK, Malenovský I (2019) On the morphology and possible function of two putative vibroacoustic mechanisms in derbid planthoppers (Hemiptera: Fulgoromorpha: Derbidae). *Arthropod Structure and Development* 52: 100880
- Fennah RG (1978) The higher classification of the Nogodiniidae (Homoptera, Fulgoroidea) with the description a new genus and species. *Entomologist's Monthly Magazine* 113: 113–119
- Glaw F, Köhler J, Townsend TM, Vences M (2012) Rivaling the World's Smallest Reptiles: Discovery of Miniaturized and Microendemic New Species of Leaf Chameleons (*Brookesia*) from Northern Madagascar. *PLoS One* 7(2): e31314. <https://doi.org/10.1371/journal.pone.0031314>
- Gnezdilov VM (2007) On the systematic position of the Bladinini Kirkaldy, Tonginae Kirkaldy, and Trienopinae Fennah (Homoptera, Fulgoroidea). *Zoosystematica Rossica* 15: 293–297
- Gnezdilov VM (2013) Contribution to the taxonomy of the family Tropiduchidae Stål (Hemiptera, Fulgoroidea) with description of two new tribes from Afrotropical Region. *Deutsche Entomologische Zeitschrift* 60 (2): 179–191
- Gnezdilov VM (2015) Madagascar Caliscelidae (Hemiptera, Fulgoroidea): Current Knowledge and Description of a New Genus and Species. *African Invertebrates* 56 (3): 739–746



**Fig. 20.** SEM image of *Exphora angustivenosa* sp. nov., male. **A–B.** Micro-sculpture on the veins of the fore wing. **C–D.** Sensilla chaetica type II occurring on the ventral side of the fore wing, mainly at distal part of the wing as well as costa anterior and costa posterior veins. **E.** Campaniform sensillum. **F.** Sensillum chaeticum type I, both at ventral side of the first anal vein (fore wing). Ch1 = sensillum chaeticum type I; Ch2 = sensillum chaeticum type II (after Wang et al. 2018); CS = campaniform sensillum.



**Fig. 21.** SEM image of *Exphora angustivenosa* sp. nov., male. **A–D.** Different views of the area of microtrichia at costa posterior (CP) of fore wing (ventral view).

Gnezdilov VM, Bartlett CR, Bourgoin T (2016) A new tribe of Tropicuchidae (Hemiptera:Fulgoroidea) with revision of the genus *Buca* and description of asymmetric hind leg spinulation. *Florida Entomologist* 99 (3): 406–416

Gnezdilov VM, Bourgoin T (2015) New Genera and New Species of the Tribe Elicini (Hemiptera: Fulgoroidea: Tropicuchidae) with Key to Tropicuchid Genera Known from Madagascar. *Annales Zoologici* 65 (4): 599–618

Goodman SM, Benstead JP (2003) *The Natural History of Madagascar*. University of Chicago Press, Chicago / London

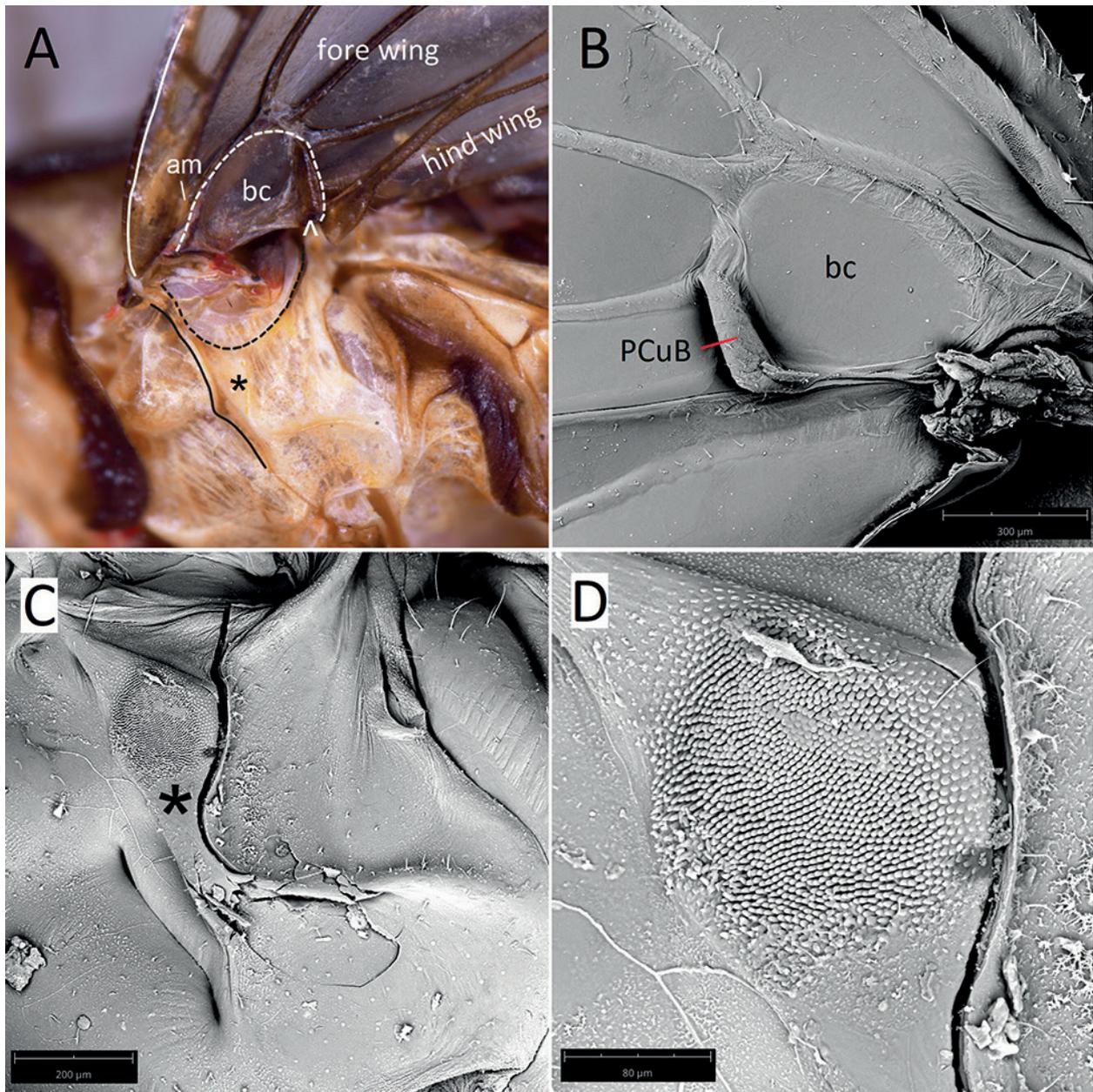
Jacobi A (1917) *Die Zikadenfauna Madagascars und der Comoren*. In: Jacobi A (ed) *Voeltzkow's Reise in Ostafrika Vol 3*. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart: 519–552

Junkiert Ł, Walczak M (2015) Three new species of the genus *Exphora* Signoret, 1860 (Hemiptera, Fulgoromorpha, Tropicuchidae) from Madagascar. *Zootaxa* 3926 (1): 129–136

Junkiert Ł, Walczak M, Bourgoin T (2017) A new species of the genus *Exphora* Signoret, 1860 from Madagascar (Hemiptera: Auchenorrhyncha: Fulgoromorpha: Tropicuchidae). *Entomologica Americana* 122 (3): 495–501

Kment P (2013) *Carduelicoris stehliki*, a new genus and species of Pentatomidae (Hemiptera: Heteroptera) from Madagascar. *Acta Musei Moraviae, Scientiae biologicae* 98 (2): 415–432

Lallemand V (1950) Contribution à l'étude des Homoptères de Madagascar. *Mémoires de l'Institut des Sciences de Madagascar (Series A)* 4 (1): 83–96



**Fig. 22.** Stereoscopic microscope and SEM images of *Exphora bourgoini* sp. nov. and *E. angustivenosa* sp. nov. **A.** Stereoscopic microscope image of the area where the wing is attached to the body (*E. bourgoini* sp. nov., male). Circumflex (^) indicates postcubitus bulla, i.e., the processus, which is located at the ventral side of fore wing, between cubitus anterior and cubitus posterior. \* indicates the area of microtrichia at mesopleuron. **B.** SEM image of processus at the ventral side of fore wing (*E. angustivenosa* sp. nov., male). **C.** SEM image of the area of microtrichia at mesopleuron. **D.** Area of microtrichia at higher magnification. am = area of microtrichia at costa posterior; bc = basal cubital; PCuB = postcubitus bulla.

Melichar L (1898) Monographie der Ricaniiden (Homoptera). Annalen des k.k. Naturhistorischen Hofmuseums 13: 197–359

Melichar L (1906) Monographie der Issiden. (Homoptera). Abhandlungen der K. K. Zoologisch-botanischen Gesellschaft in Wien 3: 1–327

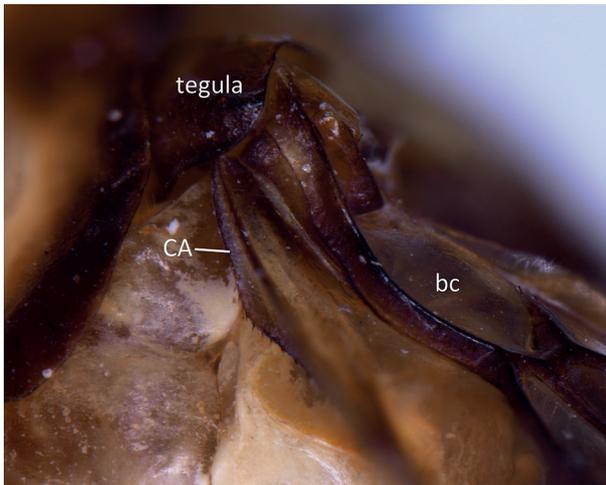
Melichar L (1915) Monographie der Lophopinen. Annales Historico-Naturales Musei Nationalis Hungarici 13: 337–385

Olivieri G, Zimmermann E, Randrianambinina B, Rasoloharjajaona S, Rakotondravony D, Guschanski K, Radespiel U

(2007) The ever-increasing diversity in mouse lemurs: Three new species in north and northwestern Madagascar. Molecular Phylogenetics and Evolution 43 (1): 309–327

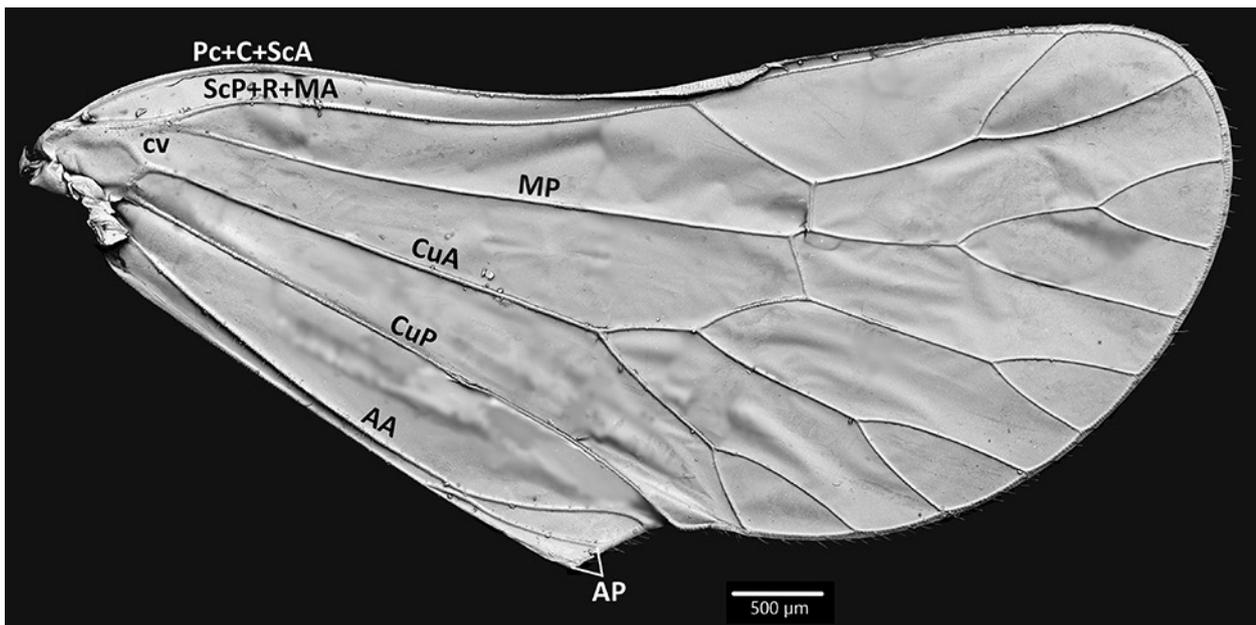
Schubnel T, Desutter-Grandcolas L, Legendre F, Prokop J, Mazurier A, Garrouste R, Grandcolas P, Nel A (2019) To be or not to be: postcubital vein in insects revealed by microtomography. Systematic Entomology 45 (2): 327–336

Signoret V (1860) Faune des hémiptères de Madagascar. 1ère partie. Homoptères. Annales de la Société Entomologique de France 3 (8): 177–206



**Fig. 23.** Stereoscopic microscope image of tegula and basal part of wing of *Exphora bourgoini* sp. nov., male. bc = basal cubital; CA = costa anterior.

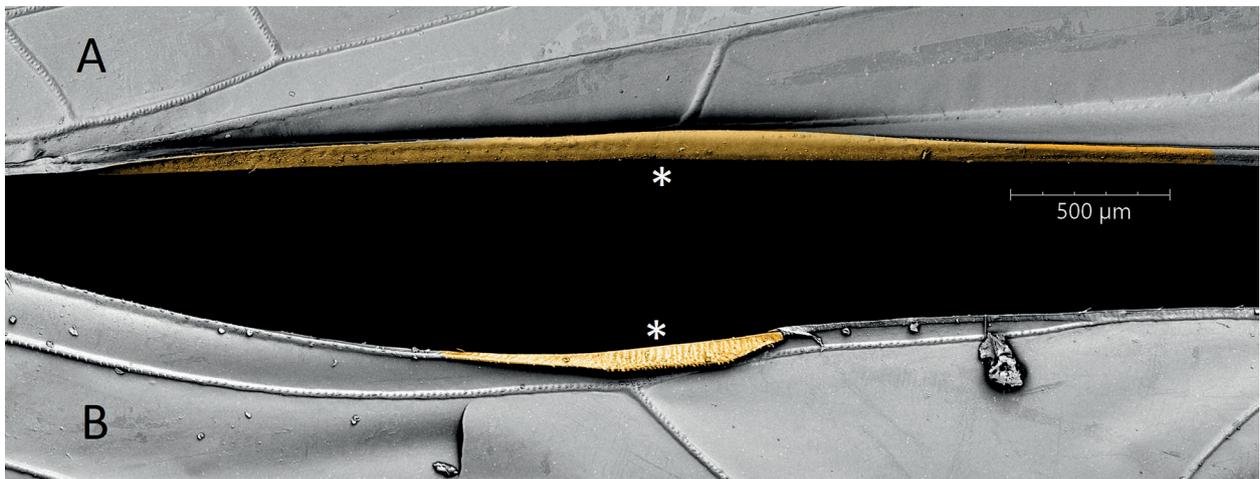
- Stroiński A, Gnezdilov VM, Bourgoïn T (2011) Sub-brachypterous Ricaniidae (Hemiptera: Fulgoromorpha) of Madagascar with morphological notes for these taxa. *Zootaxa* 3145: 1–70
- Świerczewski D, Bourgoïn T, Stroiński A (2016) Revision of the Madagascan genus *Paraflata* (Hemiptera: Fulgoromorpha: Flatidae), with notes on planthopper hosts parasitized by epipyropidae moths. *Annales Zoologici* 66 (1): 57–82
- Synave H (1966) Homoptères de Madagascar. *Verhandlungen der Naturforschenden Gesellschaft in Basel* 77: 55–75
- Szwedo A, Drohojowska J, Popov Y, Simon E, Wegierek P (2019) Aphids, true hoppers, jumping plant-lice, scale insects, true bugs and whiteflies (Insecta: Hemiptera) from the Insect Limestone (latest Eocene) of the Isle of Wight, UK. *Earth and Environmental Science Transactions of the Royal Society of Edinburgh* 1–66
- Szwedo J, Stroiński A (1999) Redescription of *Tritophania partruelis* Jacobi, 1938 from Eocene Baltic amber (Hemiptera: Nogodinidae). *Annales Zoologici Warszawa* 49 (3): 203–207
- Thalmann U, Geissmann T (2005) New species of woolly lemur *Avahi* (Primates: Lemuriformes) in Bemaraha (Central



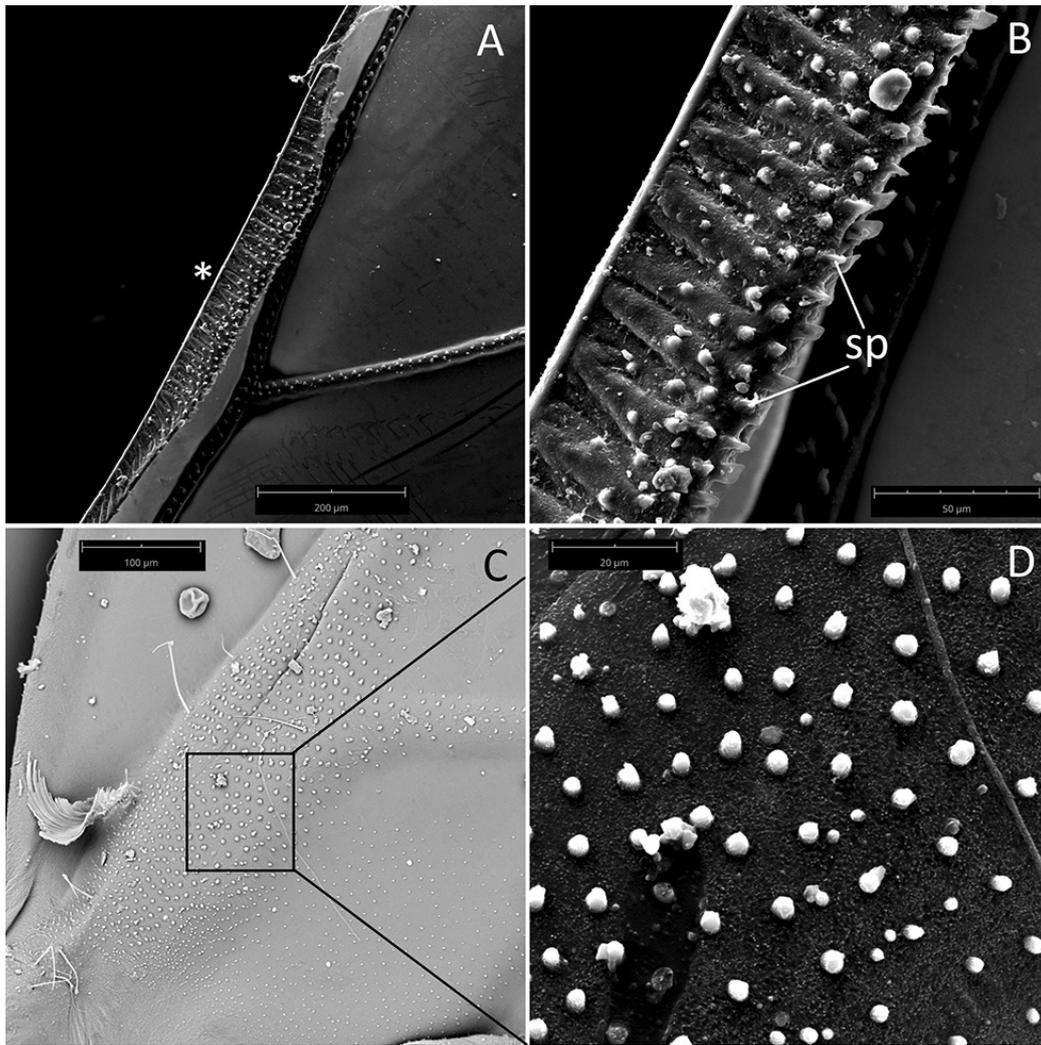
**Fig. 24.** SEM image of *Exphora angustivenosa* sp. nov., male. Hind wing, dorsal view. Abbreviation after Davranoglou et al. 2019: AA = anal anterior; AP = anal posterior; cv = cross-vein; CuA = cubitus anterior; CuP – cubitus posterior; MP = media posterior; Pc+C+ScA = postcubitus + costa + subcostal anterior; ScP+R+MA = subcosta posterior + radius + media anterior.

- Spinola M (1839) Essai sur les Fulgorelles, sous-tribu de la tribu des Cicadaïres, ordre des Rhyngotes. *Annales de la Société Entomologique de France* 8: 133–337
- Stål C (1861) Nova methodus familias quasdam Hemipterorum disponendi genera Issidarum synoptice disposita. *Ofversigt af Kongliga Svenska Vetenskaps-Akademiens Förhandlingar* 18: 195–212
- Stål C (1866) *Hemiptera Homoptera Latr. Hemiptera Africana* Vol 4. *Officina Norstedtiana, Stockholm, Sweden*

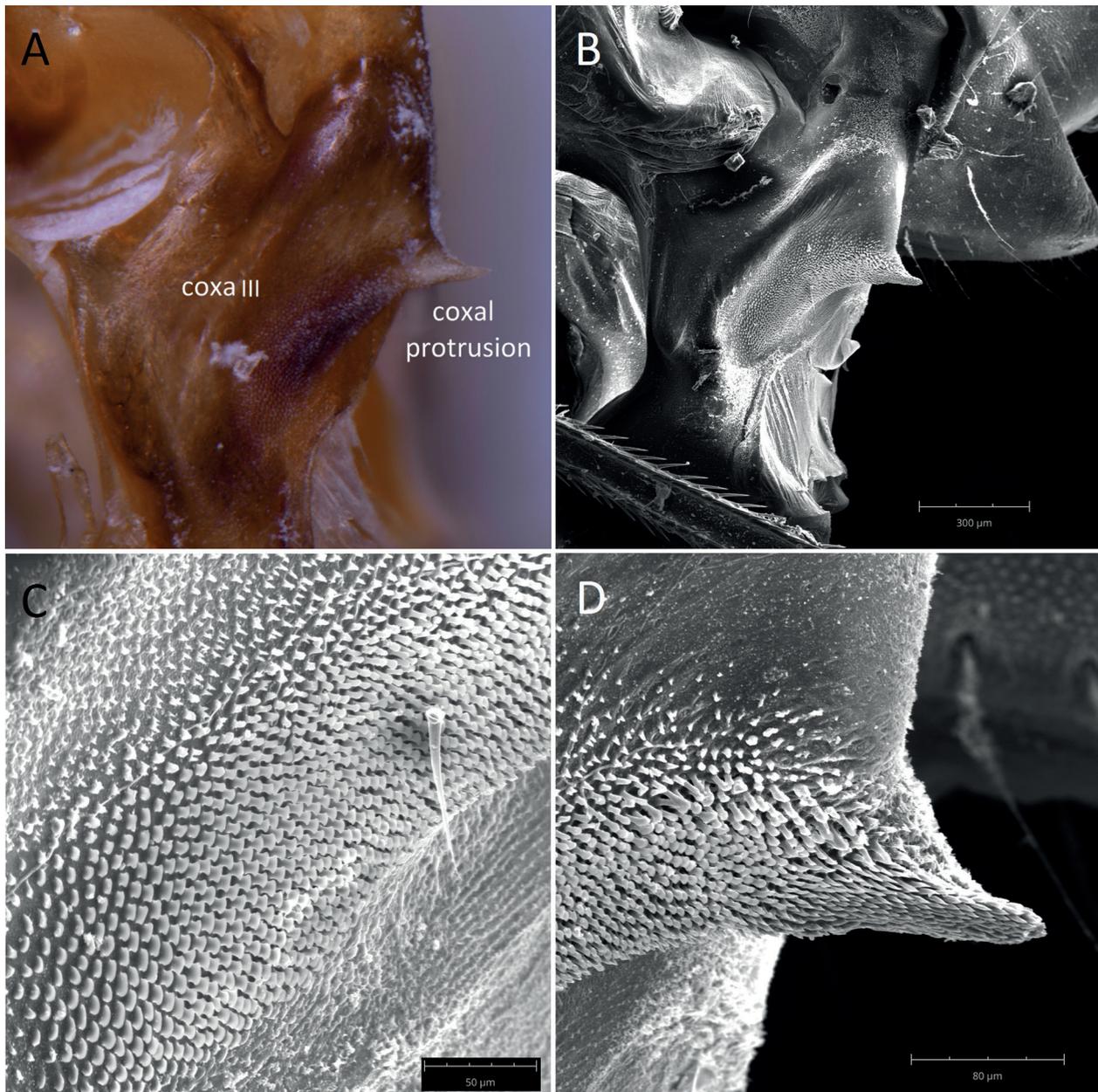
- Western Madagascar). *American Journal of Primatology* 67 (3): 371–376
- Urban JM, Cryan JR (2006) Evolution of the planthoppers (Insecta: Hemiptera: Fulgoroidea). *Molecular phylogenetics and evolution* 42: 556–572
- Vences M, Wollenberg KC, Vieites DR, Lees DC (2009) Madagascar as a model region of species diversification. *Trends in Ecology and Evolution* 24 (8): 456–465



**Fig. 25.** SEM image of *Exphora angustivenosa* sp. nov., male. **A.** Fore wing (ventral view). **B.** Hind wing (dorsal view) hamuli (\*), located along both wing margins.



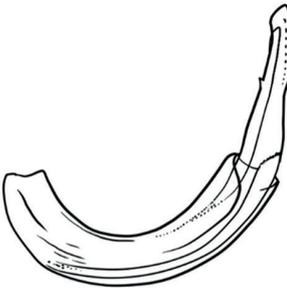
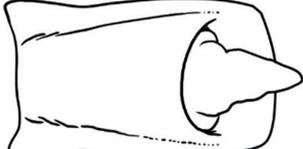
**Fig. 26.** SEM images of *Exphora angustivenosa* sp. nov., male. **A.** Hind wing (dorsal view) hamuli. **B.** Higher magnification view of hamuli with spines (sp). **C.** General view of the fused veins (ScP+R+M) on the proximal part of hind wing. **D.** Cuticular micro-sculpture of the fused veins on the proximal part of hind wing. ScP+R+M = subcosta posterior + radius + media; sp = spines.

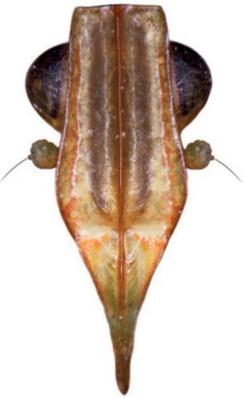
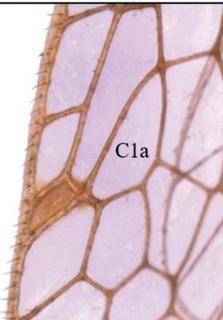
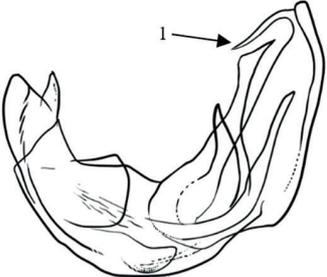
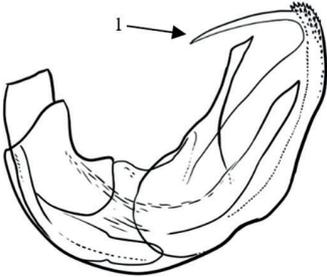
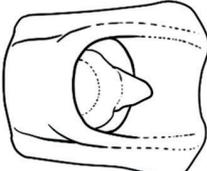
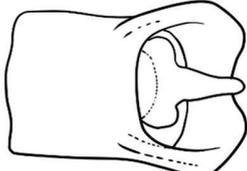
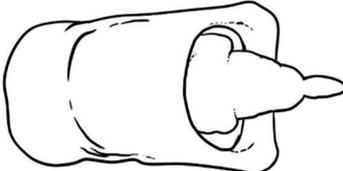


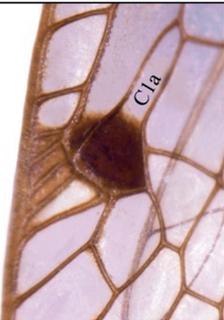
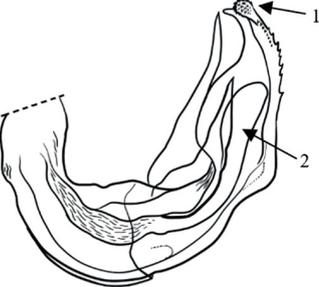
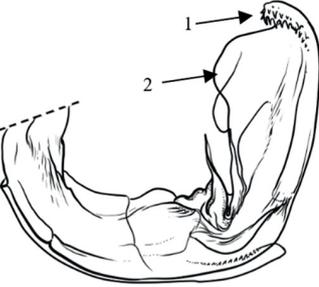
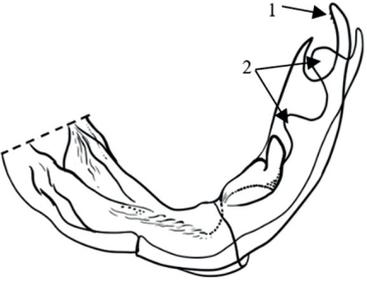
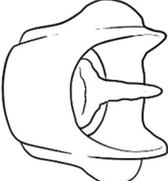
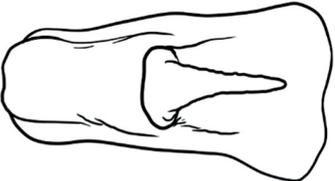
**Fig. 27.** Stereoscopic microscope and SEM images of *Exphora bourgoini* sp. nov. and *E. angustivenosa* sp. nov. **A.** Stereoscopic microscope image of the third coxa with coxal protrusion (*E. bourgoini* sp. nov., male). **B.** SEM image of the third coxa with coxal protrusion (*E. angustivenosa* sp. nov., male). **C–D.** The coxal protrusion at higher magnification, covered with densely packed microtrichia.

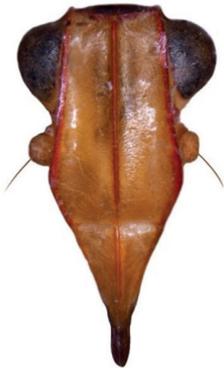
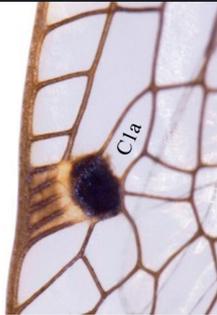
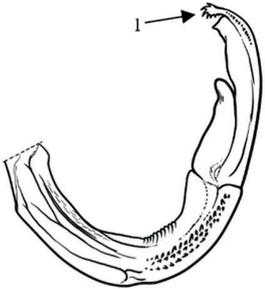
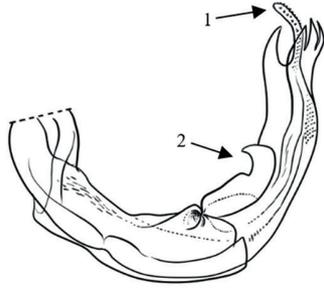
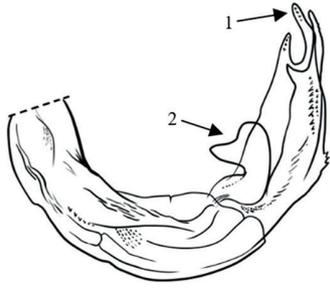
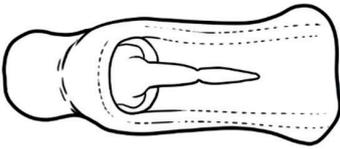
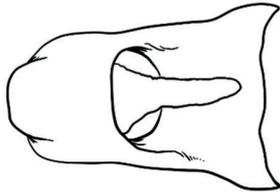
APPENDIX I.

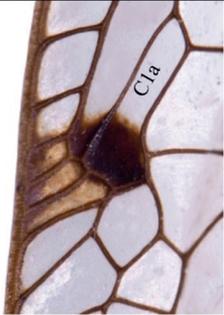
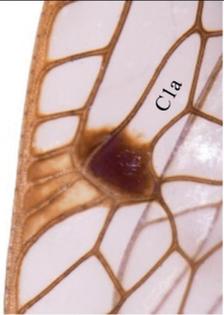
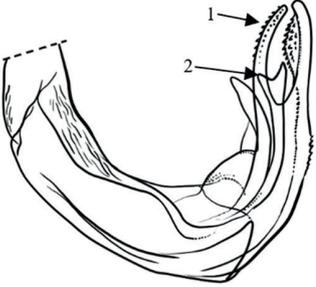
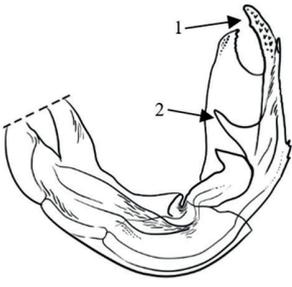
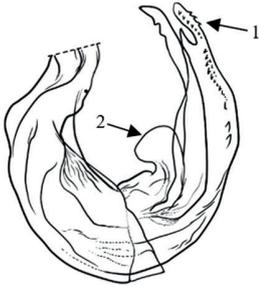
Key to the species of *Exphora*

	<i>Exphora longipennata</i>	<i>Exphora fumivenosa</i>	<i>Exphora perinetensis</i>
head	 Metope 2.5 times as long as wide	 Metope distinctly enlarged over clypeus at almost right angle, with two rows of black spots (between keels)	
pterostigma	 Pterostigma small, includes 1-3 cells, without distinct dark spot at cell C1a (cell C1a is missing)	 Pterostigma large, well visible, includes more than 3 cells, with distinct dark spot at cell C1a; fore wing with dark brown transvers veins	 Fore wing with dark brown transvers veins; pterostigma small, barely visible, includes 1-3 cells, without distinct dark spot at cell C1a
cells	Costal cells number – 7-8 Apical cells number – 16-17	Costal cells number – 8-9 Apical cells number – 15±1	Costal cells number – 9-10 Apical cells number – 17±1
aedeagus	unknown	unknown	 Aedeagus s.l. tubular, without appendages
anal tube	unknown	unknown	

	<i>Exphora similis</i>	<i>Exphora succinae</i>	<i>Exphora limnavuorii</i>
head			
pterostigma	 Pterostigma small, barely visible, includes 1-3 cells, without distinct dark spot at cell C1a	 Pterostigma small, barely visible, includes 1-3 cells, without distinct dark spot at cell C1a	 Pterostigma small, barely visible, includes 1-3 cells, without distinct dark spot at cell C1a
cells	Costal cells number – 10-11 Apical cells number – 17-19	Costal cells number – 8-10 Apical cells number – 14-17	Costal cells number – 7-8 Apical cells number – 15-17
aedeagus	 Apical part of aedeagus with long needle-like processes directed dorsally (1)	 Apical part of aedeagus with long needle-like processes directed dorsally (1)	 Lateral lobes without additional processes
anal tube			

	<i>Exphora angustivenosa</i>	<i>Exphora ifanadiensis</i>	<i>Exphora constanti</i>
head			
pterostigma	 Pterostigma small, barely visible, includes 1-3 cells, without distinct dark spot at cell C1a	 Pterostigma large, well visible, includes more than 3 cells, with distinct dark spot at cell C1a	 Pterostigma large, well visible, includes more than 3 cells, with distinct dark spot at cell C1a
cells	Costal cells number – 10-12 Apical cells number – 18±1	Costal cells number – 9-13 Apical cells number – 18-19	Costal cells number – 11-13 Apical cells number – 20-22
aedeagus	 Aedeagus s.l. well developed, lateral lobes with small spikes (1), inner lobes spatulate (2)	 Aedeagus s.l. well developed, lateral lobes with small spikes (1), inner lobes wide and spatulate (2)	 Apical part of lateral lobes with finger-like shaped processes (1), inner lobes with two bulges (2)
anal tube			

	<i>Exphora ambatolaonaensis</i>	<i>Exphora stroiński</i>	<i>Exphora bourgoini</i>
head			
pterostigma	 Pterostigma large, well visible, includes more than 3 cells, with distinct dark spot at cell C1a	 Pterostigma large, well visible, includes more than 3 cells, with distinct dark spot at cell C1a and paler stripe	 Pterostigma large, well visible, includes more than 3 cells, with distinct dark spot at cell C1a
cells	Costal cells number – 10-11 Apical cells number – 18-19	Costal cells number – 10-12 Apical cells number – 18-20	Costal cells number – 11±1 Apical cells number – 18±1
aedeagus	 Aedeagus s.l. narrow, apical part of lateral lobes with spiky ending (1)	 Apical part of lateral lobes with finger-like shaped processes (1), inner lobes without bulges; aedeagus s.s. claw-like shaped (2)	 Apical part of lateral lobes with finger-like shaped processes (1), inner lobes without bulges; aedeagus s.s. duck head-like shaped (2)
anal tube			

	<i>Exphora guerini</i>	<i>Exphora robusta</i>	<i>Exphora kalaloensis</i>
head			
pterostigma	 Pterostigma large, well visible, includes more than 3 cells, with distinct dark spot at cell C1a	 Pterostigma large, well visible, includes more than 3 cells, with distinct dark spot at cell C1a	 Pterostigma large, well visible, includes more than 3 cells, with distinct dark spot at cell C1a
cells	Costal cells number – 10-12 Apical cells number – 19±1	Costal cells number – 12-13 Apical cells number – 19-21	Costal cells number – 12-14 Apical cells number – 20±1
aedeagus	 Apical part of lateral and inner lobes with small spikes (1), inner lobes extended in apical part (2); apical process of aedeagus as long as subapical	 Apical part of lateral lobes with small spikes and finger-like shaped processes (1), inner lobes with distinct spiky process (2)	 Aedeagus s.l strongly falcate; apical part of lateral lobes with finger-like shaped processes (1); aedeagus s.s. robust and knobbed (2)
anal tube	