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RESEARCH ARTICLE

Sex pairing of three highly dimorphic Arctiinae (Lepidoptera: Erebiidae) females in French Guyana and description of three new species from Brazil

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Abstract: Following a general survey of the Neotropical Arctiinae using the so-called "barcoding" technique, three highly dimorphic females were identified and associated with their corresponding males. *Idalus larissa* Druce, 1890 **comb. rev.** is the male of *Idalus albescens* (Rothschild, 1909) **syn. nov.** *Euplesia sphingidea* (Perty, [1833]) is the male of *Delphyre varians* Hampson, 1901 **syn. nov.** and *Apiconoma opposita* (Walker, 1854) is the male of *Delphyre aclytioides* Hampson, 1901 **syn. nov.** Moreover two new species of the genus *Apiconoma* and one species of the genus *Glaucostola*, all collected in Brazil, are described: *Apiconoma witti* **sp. nov.**, *Apiconoma mojui* **sp. nov.** and *Glaucostola indagata* **sp. nov.** Several distances trees and pictures of all male (and one female) genitalia are provided. Distributions for all new species are discussed.

Key words: *Apiconoma, Euplesia, Idalus, Glaucostola*, Arctiinae, Phaegopterina, new species, dimorphic female, Brazil, French Guiana.

Introduction

Since a few years now, the so-called "barcoding" technique has been established as a very useful tool for the general classification and the discovery of cryptic species but always in association with more usual investigations such as habitus and genitalia observations and also taking into account some geographic considerations. In addition, barcoding allows to pair sexes and also to associate larval stages with adult stage. Nevertheless, up to now,

barcoding technique has been less extensively used for these purposes, at least in Lepidoptera.

On another hand, a large effort has been undertaken on the Lepidoptera fauna of the French Guiana either by several institutions or by a lot of private collectors resulting in several thousands of available sequences awaiting to be integrated in fundamental studies. A careful data mining of this huge collection of data has led to some preliminary surprising results mainly due to the pairing of highly dimorphic sexes. Some of these results are exposed below.

Material and methods

Adult genitalia were prepared by boiling abdomens during 15 minutes with 2 pellets of potash in 5 ml of water. After being washed with water and then alcohol, genitalia were photographed in natural position suspended in 95% alcohol, then types and museum specimens were mounted in Euparal, and remaining specimens were simply stored in glycerol. Photos were taken with a CoolPix 4500 Nikon camera attached to a trinocular Nikon stereomicroscope SMZ-10A. For genitalia pictures resolution was enhanced using focal planes fusion technique (3 to 6 planes were used generally) by the way of the free software CombineZM (http://www.hadleyweb.pwp.blueyonder.co.uk).

We had the opportunity to use analysis of short sequences of DNA corresponding to the COI mitochondrial gene. This gene is now routinely used for specific discrimination and identification (Hebert *et al.* 2003). The use of these sequences is currently known as "DNA barcoding". A project concerning Neotropical Arctiinae has been initiated within the framework of "ALL-LEPS BARCODE OF LIFE" (see website http://www.lepbarcoding.org) which objective is to archive the DNA barcodes of all known Lepidoptera. DNA was extracted, amplified and sequenced at the "Canadian Centre for DNA Barcoding" (CCDB) in Guelph, Ontario, starting from dry legs removed from specimens coming from different authors' collection. Details of various protocols have been described in Vaglia *et al*., (2008) and Decaëns & Rougerie (2008). These can be found on the website of CCDB (http:// http://www.ccdb.ca/resources.php). Finally we have in hand almost 23000 sequences of Arctiinae. In some cases, we provided also the BIN reference number which is a unique taxonomic unit that closely corresponds to a species. In a recent study of 1541 species of Canadian Noctuoidea, Zahiri *et al.* (2014) were able to affirm that BINs are a strong proxy for species, providing a pathway for a rapid, accurate estimation of animal diversity. Any people can use this BIN number to retrieve all data linked to this taxonomic unit, for instance by entering it on the web site: http://www.boldsystems.org.

The sequences were aligned and downloaded from BOLD (Table 1) and analyzed using MEGA6 (Tamura *et al*. 2013) for a cladistic analysis. Bootstrap values (Felsenstein, 1985) were used to estimate branch support: they were calculated in MEGA6 after 1000 random replications. Distance calculations were performed using the Kimura 2-parameter (K2P) method in MEGA6 (Kimura 1980) including all sites, with the pairwise deletion option and assuming both a homogeneous pattern of divergence among lineages and a uniform rate of substitutions among sites.

The Neighbour-Joining (NJ) distances-tree of *ca*. 23000 COI sequences represents more than 28 000 BIN which number can be compared to the 5500 - 6000 species known at present for the Neotropical Arctiinae. This constitutes a fairly good representation of the subfamily including numerous species representative of all tribes and subtribes.

Table 1. BOLD codes and GenBank references of the specimens used in the various NJ tree.

BOLD access code	GenBank reference	BOLD access code	GenBank reference
LNOU-0727	HQ989057	MILA 0129	GQ355777
BIOUG00735-D03	JN304158	BEVI1410	KX144859
NS-RR1343	JN262920	MILA 0104	KX144860
NS-RR1126	JN262902	MILA 2047	KX144861
NS-RR1830	JN262937	BEVI0591	KX144862
BC-INCT0508	HQ568195	MILA 1997	KX144857
CLV109810	HQ571798	MILA 2025	KX144863
MILA 2052	KX144864	MILA 1684	KX144866
MILA 2072	KX144865	BEVI1409	KX144858
MMZ1071	JX571158	BC-INCT0453	HQ568143

Repository abbreviations are as follows:

MNHN – Muséum National d'Histoire Naturelle, Paris, France.
BMNH – Natural History Museum, London, England, United Kingdom.
USNM – National Museum of Natural History, Smithsonian Institution, Washington, D.C., U. S. A.
UMO – University Museum, Oxford University, Oxford, England, UK.
MWM – Museum Witt, München, Germany.
MPEG – Museu Paraense Emilio Goeldi, Belém, Para, Brazil.
MLUH – Martin-Luther-Universitat, Wissenschaftsnbereich Zoologie, Halle, Germany.
UFPC – Universidade Federal do Paraná, Curitiba, Paraná, Brazil.
MZSP – Museu de Zoologia, Universidade de São Paulo, São Paulo, Brazil.
MLC – Personal collection of Michel Laguerre, 33850 Léognan, France.
BVC – Personal collection of Benoît Vincent, 31130 Quint-Fonsegrives, France.

Results

Sex pairing of *Idalus albescens* Rothschild, 1909

Idalus albescens (Rothschild, 1909) is a mysterious species seldom collected in French Guiana or Suriname and only as isolated females. Up to now no male has been collected which is strange as in the genus *Idalus* males are always largely easier to collect than females and moreover for all the species known from the Guianas shield the males are well identified. Two fresh females have been collected in September 2013 by Daniel Herbin and were thus successfully sequenced. The result was rather surprising as these two females sequences were found aligned with those of two males of *Eupseudosoma larissa* (Druce, 1890) from French Guiana and a strange female from Paraguay (see tree below, Fig. 1) and the resulting cluster was located very close to a large group containing *Idalus aleteria* (Schaus, 1905) (see Fig. 1) but also *Idalus tuisana* and the group *vitrea/intermedia* (data not shown).

Eupseudosoma larissa (Druce, 1890) was described initially by Druce (1890) from Santarem on the Amazon within the genus *Idalus* Walker, 1855. It was then transferred by Hampson (1901: 40) within the genus *Automolis* and then within the genus *Eupseudosoma* Grote, 1865 by Watson (1975: 74). In almost the same time, Rothschild (1909: 26) described

Eupseudosoma albescens from four females collected in Suriname and Guyana. Later Hampson (1920: 137) transferred this species to the genus *Automolis* and finally Watson (1975: 76) transferred it to the genus *Idalus*. The species *larissa* being described before *albescens* has priority and thus the name of the species will be *larissa* Druce, 1890.

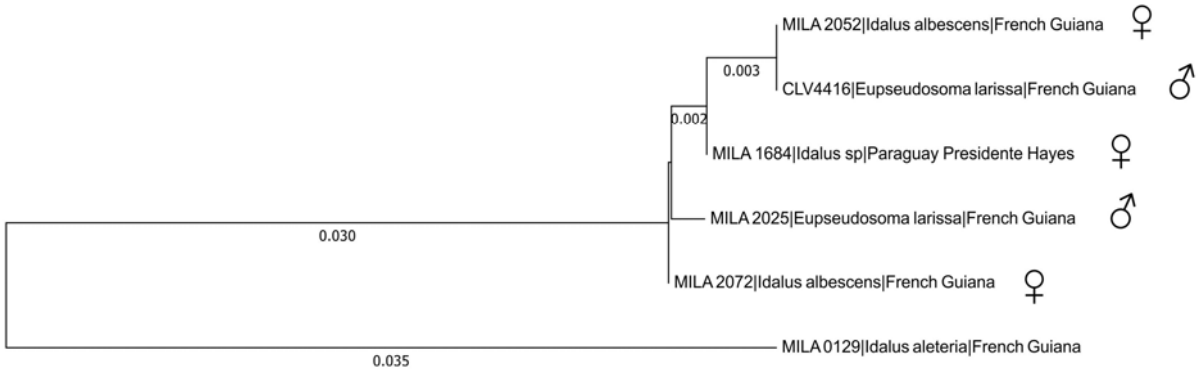

Figure 1. Neighbour-joining tree (Saitou & Neil 1987) for the 6 specimens of the studied groups. Distances in % are given below each branch (obtained with MEGA6, see Tamura *et al*. 2013).

Due to the vicinity with *Idalus aleteria*, the barcoding approach implies that this entity (*Eupsodosoma larissa*) must be transferred to the genus *Idalus*. Dissection of a male specimen indeed confirms this conclusion as can be seen on Figure 2 where the genitalia of *larissa* (Fig. 2A-B) are compared to those of *aleteria* (Fig. 2C-D) a well known member of the genus *Idalus*. Moreover these two genitalia are completely different of the male genitalia of authentic *Eupseudosoma* like *Eupseudosoma grandis* Rothschild, 1909 for instance (data not shown). In fact 125 years before barcoding, Druce (1890) was right and the species must be named *Idalus larissa* Druce, 1890 **comb. rev.**

Besides the four specimens from French Guiana we found in the same cluster a worn female which was very difficult to identify prior to the barcoding approach. This female was collected in Paraguay (Presidente Haye Province) by Ulf Drechsel. *Idalus larissa* is well distributed in Paraguay and the female found here with grey markings reminiscent of the male pattern on the forewings diverged noticeably from the females found in French Guiana (Fig. 3). There is an indistinct dark band along the anal border, the costal border is dusted with grey and there are three dark spots, one just below the end of cell, one preapical and one tiny at the upper end of cell. Nevertheless the sequence of this specimen is almost similar to the sequence found for the two females from French Guiana (difference = 0.14 %) and there is no doubt that these specimens are conspecific.

***Idalus larissa* Druce, 1890: 496 comb. rev.**

Type Locality. - [Brazil], [Pará], Santarém. - Type Specimen(s). - Lectotype male designated by Watson (1975: 74) (BMNH).

= *Eupseudosoma albescens* Rothschild, 1909: 26 **syn. nov.**

Type Locality. - Suriname, [Sipaliwini], Aroewarwa Creek, Maroewym Valley. - Type Specimen(s). - Lectotype female designated by Watson (1975: 76) (BMNH).

Material examined: FRENCH GUIANA. 1♂, Piste Coralie, 7-XII-2013, 40 m, 4.485° N 52.397° W, D. Herbin *leg*., Barcode Process ID ARCTD977-15, Sample ID MILA 2025;

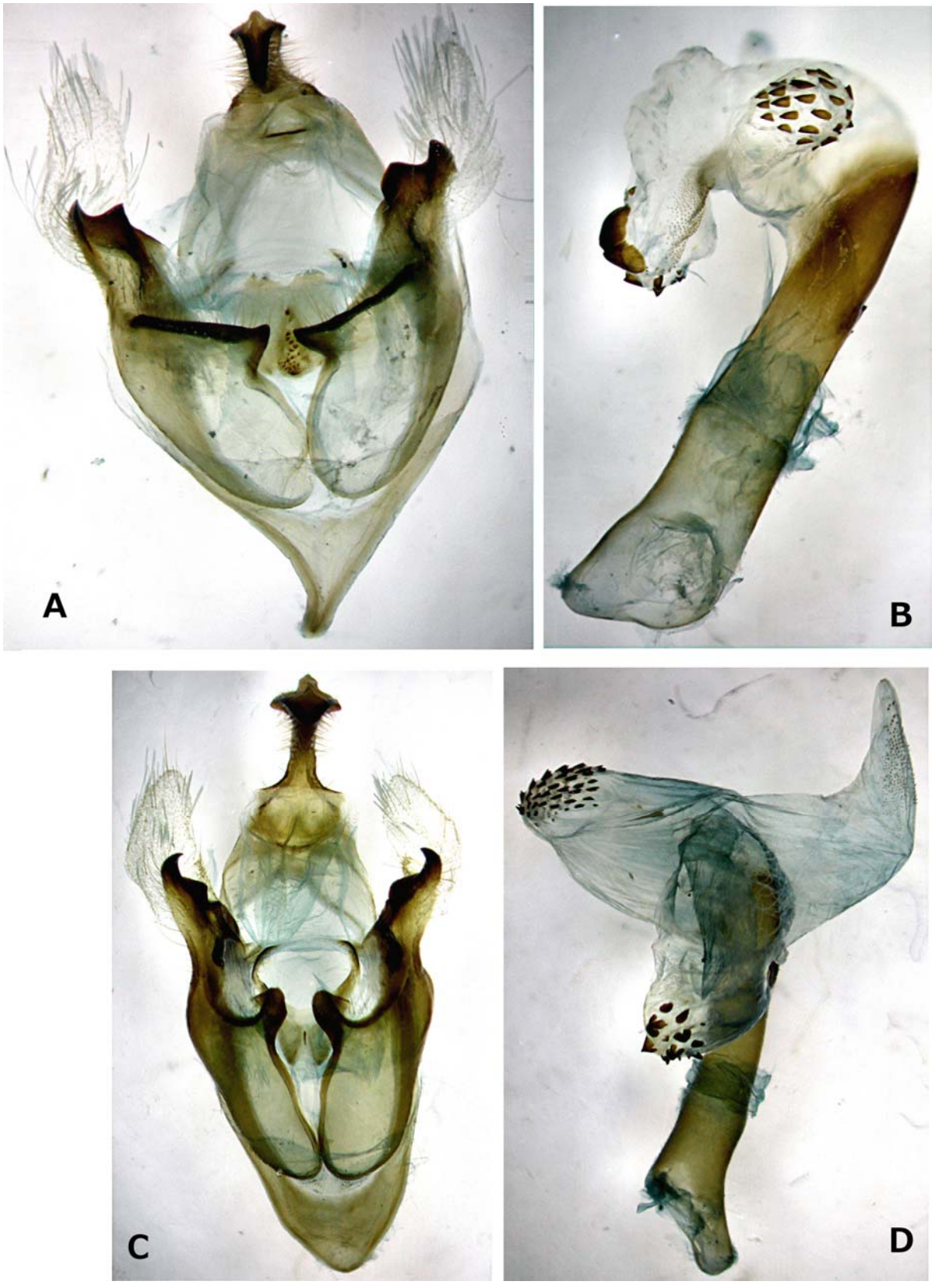

Figure 2. Male genitalia of *Idalus larissa* Druce, 1890 (**A-B**) and *Idalus aleteria* (Schaus, 1905) (**C-D**) from French Guiana. **A,** ventral view; **B,** penis with everted vesical; **C,** ventral view; **D,** penis with everted vesica.

Figure 3. Female of *Idalus larissa* Druce from Paraguay with barcode MILA 1684.

1♀, Piste de Kaw, PK 37.5, 28-IX-2013, 287 m, 4.548° N 52.146° W, D. Herbin *leg*., Barcode Process ID ARCTD1004-15, Sample ID MILA 2052; 1♀, Piste Montagne de Fer, 30-IX-2013, 88 m, 5.339° N 53.54° W, D. Herbin *leg*., Barcode Process ID ARCTD1024-15, Sample ID MILA 2072. All *in* MLC. 1♂, Nouragues Natural Reserve, Parare Field Station, 5-IX-2010, 24 m, 4.038° N 52.673° W, C. Lopez Vaamonde *leg*., Barcode Process ID LNOUD845-12, Sample ID CLV4416, *in* MNHN. PARAGUAY. 1♀, Presidente Hayes, Puerto Barbero, 13-II-2011, 60 m, 24.9167° S 57.3° W, U. Drechsel *leg*., Barcode Process ID ARCTD559-12, Sample ID MILA 1684, *in* MLC.

Remarks: The female of *I. larissa* is surprisingly similar (and so can be easily confused in the field) to the highly dimorphic female of *Senecauxia coraliae* Toulgoët, 1990 previously discovered with the help of the barcoding approach (Rougerie & Laguerre 2010). These two females are almost totally pure white as can be seen in Figure 4. The female of *S. coraliae* (Fig. 4D) is larger with the costa of forewings narrowly bordered with black and the coxae bright pink whereas the female of *I. larissa* (Fig. 4B) is entirely pure white but with the vertex yellow (as in the male). The general habitus of both species males are also presented in Figure 4A, C.

Sex pairing of *Euplesia sphingidea* (Perty, [1833]) and *Apiconoma opposita* (Walker, 1854)

Euplesia sphingidea was first described by Perty (1833) within the genus *Glaucopis* (in fact a Ctenuchina genus), then *Apiconoma opposita* was described by Walker (1854) within the genus *Euchromia* (in fact an *Euchromina* genus). Felder & Rogenhofer (1874) described *Euplesia vittigera* and *Euplesia ochrophila* to include them in the genus *Euplesia*.

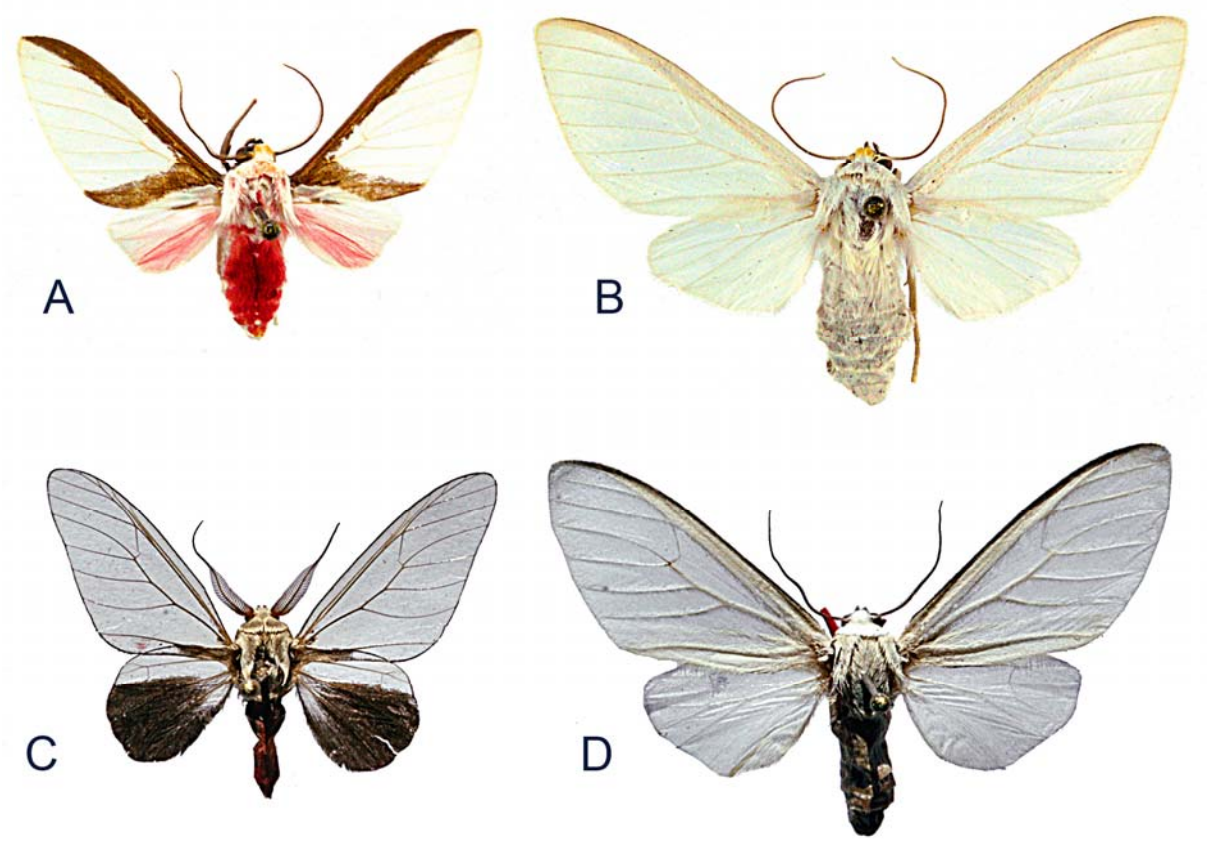

Figure 4. A pair adult of *Idalus larissa* Druce, 1890 (**A-B**) and *Senecauxia coraliae* Toulgoët, 1990 (**C-D**) from French Guiana, same scale. **A,** male; **B,** female; **C,** male; **D,** female.

These two species are respectively synonyms of *sphingidea* and *ochrophila* (Hampson 1901). So, these two species were included in the same genus, *i.e.*, *Euplesia* by Felder (1874). But, Butler (1876) was very likely unaware of the work of Felder (1874), thus transferred the sole *Euchromia opposita* Walker, 1854 within his new genus *Apiconoma* with some other species which were removed some times after leaving this monospecific genus. Then, Hampson (1901: 74) transferred these two species within the omnibus genus *Automolis* Hübner, 1819 and finally Travassos (1943: 456) reverted these two species to their previous genera, respectively.

In the general tree of the Neotropical Arctiinae, these two species (*E. sphingidea* and *A. opposita*) are found in a small but homogeneous and well isolated cluster close to the *Idalus* (*partim*) and the *Eupseudosoma* (*partim*) (see Fig. 10). *E. sphingidea* is isolated (minimum distance 8.2 %) from a group of three species encompassing, besides *A. opposita,* two unknown species from Brazil. The male genitalia of these last three species proved to be very similar with the same characteristic feature: symmetrical valvae with a clear notch located at their very basis near their junction, whereas *sphingidea* displays largely asymmetrical valvae without noticeable notch.

But the most unexpected discovery was to find aligned with *Euplesia sphingidea* (Fig. 5A) and *Apiconoma opposita* (Fig. 5C), the females of two well known Ctenuchina, namely *Delphyre varians* Hampson, 1901 (Fig. 5B) and *Delphyre aclytioides* Hampson, 1901 (Fig. 5D) respectively. These two species were described by Hampson (1901) on the same page (p.

Figure 5. Adults of *Euplesia sphingidea* (Perty, [1833]) (**A-B**) and *Apiconoma opposita* (Walker, 1854) (**C-D**) from French Guiana. **A,** male; **B**, female (*as Delphyre varians* Hampson, 1901); **C,** male; **D,** female (*as Delphyre aclytioides* Hampson, 1901).

174) from two unique female holotypes (still housed in Oxford). These species, though not really abundant, are evenly collected in French Guiana but up to now, it appears that no male has been collected since their description. It then appears that *Delphyre varians* Hampson, 1901 is the female of *Euplesia sphingidea* (Perty, [1833]) and that *Delphyre aclytioides* Hamspon, 1901 is the female of *Apiconoma opposita* (Walker, 1854). Moreover a careful study of the venation of male and female of these two species was unable to show the slightest differences between the four specimens (see Fig. 6) and it is very difficult to understand why the males were classified as Phaegopterina and the females as Ctenuchina. In fact, Butler (1876) had already published a perfect drawing of the venation of the genus *Apiconoma* (Butler, 1876, p. 433, *pl.* 29, *fig.* 22). Finally, the males being described largely before the females, they have priority.

Remarks: At this point we must discuss the status of a strange entity, *Aclytia apicalis* (Walker, 1854). This species was described originally within the genus *Euchromia* on a small series of 3 females collected by Bates in the Parà state (Brazil) and at least two of them are still present in BMNH. Kirby (1892: 170) transferred this species to the Phaegopterina genus *Apiconoma* which was essentially correct but Hampson (1901) moved it to the genus *Automolis* (always Phaegopterina) and finally Watson (1975: 95) transferred it to the Ctenuchina genus *Aclytia*. A careful examination of the series housed in BMNH proved it to be very similar to *Delphyre varians* except the forewing band which is slightly paler and narrower but *D. varians* is a variable species with specimens almost devoid of yellow band, see for instance the paratype labelled "ab. I" by Hampson (Type n° 178 in UMO) which is also the type of aberration *reducta* Draudt, 1915. These melanic forms are often common in French Guyana. For all these reasons we consider that *Aclytia apicalis* (Walker, 1854) is a

synonym of *Delphyre varians* Hampson, 1901 and in fact the female of *Euplesia sphingidea* (Perty, [1833]) which has priority.

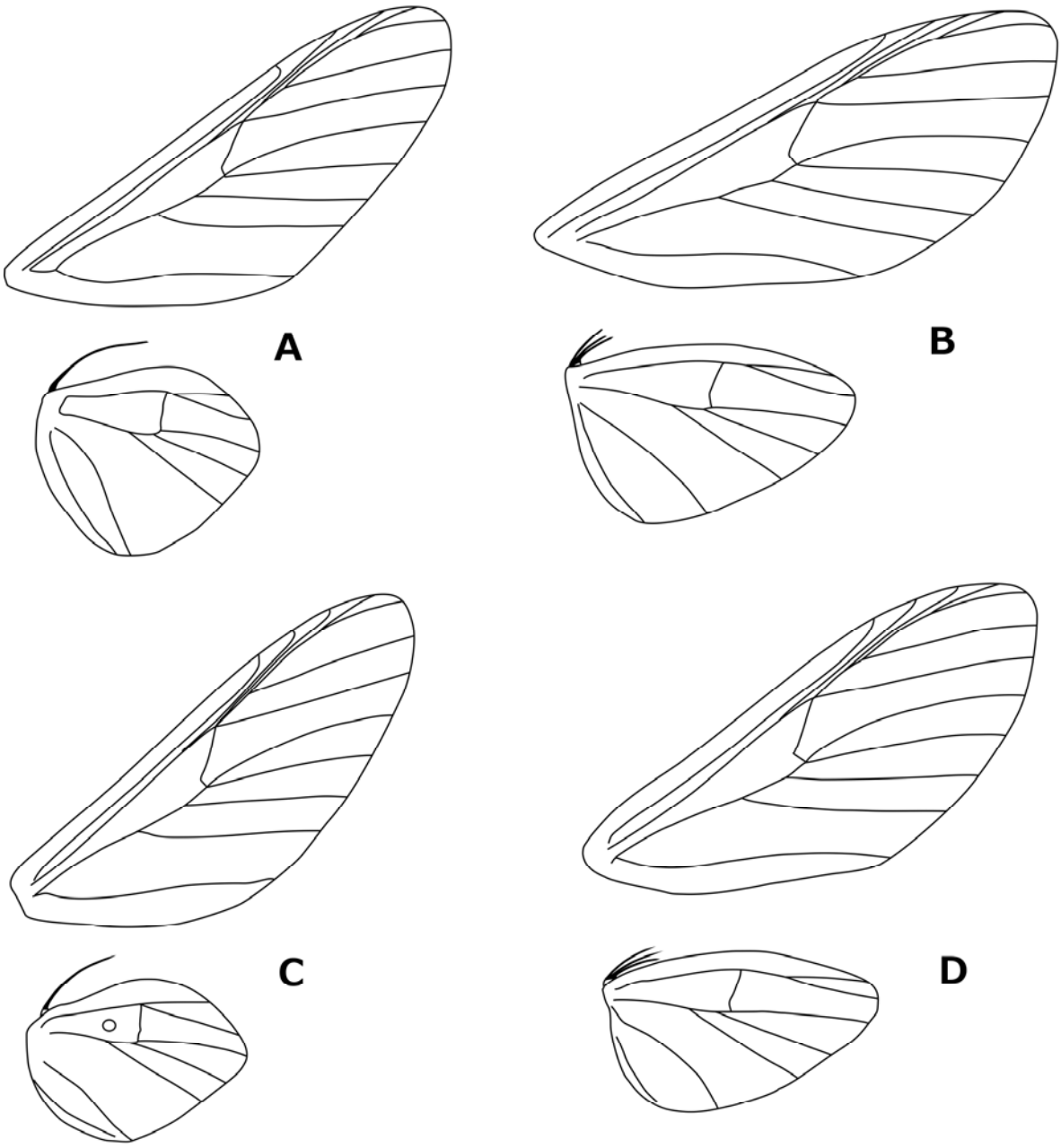

Figure 6. Wings venation of *Euplesia sphingidea* (Perty, [1833]) (**A-B**) and *Apiconoma opposita* (Walker, 1854) (**C-D**) from French Guiana. **A,** male and **B,** female (*as Delphyre varians* Hampson, 1901); **C,** male; **D,** female (*as Delphyre aclytioides* Hampson, 1901).

Euplesia Felder, 1874

Euplesia Felder, 1874: *pl.* 102, *figs* 9, 10.

Type species. - *Euplesia vittigera* Felder & Rogenhofer, 1874 by subsequent designation by Kirby (1892).

***Euplesia sphingidea* (Perty, [1833]): 158 (*Glaucopis*)**

Type Locality. - [Brazil], Rio Negro. -Type Specimen(s). - Undisclosed number of syntypes (?).

= *Euplesia vittigera* Felder & Rogenhofer, 1874: *pl.* 102, *fig.* 9. - Type locality: [Brazil], [Rio] Amazonas. - Type specimen: Lectotype male designated by Rothschild (1910: 20) (BMNH).

= *Delphyre varians* Hampson, 1901: 174 (*Delphyre*) **syn. nov.** - Type locality: [Brazil], Amazons. - Type specimen: Holotype female n°177 (UMO). Two infrasubspecific names are associated with this taxon: *Delphyre varians* ab. *reducta* Draudt, 1915: 166 and *Delphyre varians* ab. *reductivitta* Strand, 1920: 225.

= *Aclytia apicalis* (Walker, 1854): 261 (*Euchromia*) **syn. nov.** - Type locality: [Brazil], Parà. - Type specimen: three female syntypes (BMNH).

Material examined: FRENCH GUIANA. 1♂, Piste de Kaw, PK 38, 20-I-1996, M. Laguerre *leg*. 1♂, Piste de Kaw, PK 41, 25-I-1996, M. Laguerre *leg*. 2♂, Piste de Saut Léodate, PK 12, 12-II-1999, M. Laguerre *leg*. 4♂, Piste Paul Isnard, PK 57, 13-II-1999, M. Laguerre *leg*. 3♂, Piste du Dégrad Florian, PK 12, 29-VII-2001, M. Laguerre *leg*. 1♂, Piste Paul Isnard, PK 33, 4-VIII-2003, 5°44.622 N 53°57.432 W, M. Laguerre *leg*. 1♂, Piste Patagaï, PK 10, 2-III-2006, 40 m, 5°23.601 N 53°11.188 W, M. Laguerre *leg*. 1♂, Piste Apatou, layon PK 26, 1-X-2013, 126 m, 5°14'46" N 54°11'08" W, D. Herbin *leg*. 1♂, Piste St Elie, PK 10, 1-III-2006, 90 m, 5°17.874 N 53°09.018 W, M. Laguerre *leg*. + Barcode Process ID ARCTA104-07, Sample ID MILA 0104 & Gen. ML2495. 1♀, Barrage de Petit Saut, 27-VIII-1992, D. Morin *leg*. + Gen. ML2493. 2♀, Piste Apatou, layon PK 26, 1-X-20139, 126 m, 5°14'46" N 54°11'08" W, D. Herbin *leg*. + Barcode Process ID ARCTD999-15, Sample ID MILA 2047. 3♀, Piste Apatou, layon PK 26, 2-X-20139, 99 m, 5°14'46" N 54°11'52" W, D. Herbin *leg*. 1 ♀, Piste Patagaï, 9-X-2013, 58 m, 5°20'34" N 53°12'48" W, D. Herbin *leg*. All *in* MLC. 1♂, Réserve Naturelle de la Trinité, Roche Bénitier, 24-X-2008, 496 m, 4.61917° N 53.4089° W, A. Lévêque *leg*., Barcode Process ID ARCTB696-09, Sample ID BEVI0591, *in* BVC. 1♂, Nouragues, Inselberg Camp, 3-II-2011, 160 m, 4.088° N 52.681° W, MAS. Smith & R. Rougerie *leg*., Barcode Process ID LNOUF126-11, Sample ID NS-RR1126. 1♂, Nouragues, Inselberg Camp, 4-II-2011, 160 m, 4.088° N 52.681° W, MAS. Smith & R. Rougerie *leg*., Barcode Process ID LNOUF343-11, Sample ID NS-RR1343. All *in* MNHN.

Male genitalia (Fig. 7A-E): Uncus constricted medially in dorsal view, with a clear carina on each side and a small ridge on top, short and slightly bent ventrally in lateral view. Valvae largely asymmetrical just exceeding uncus, strongly sclerotized at the tip, the two distinctly narrowed in the middle, the left one strongly curved before the tip and the extremity largely spatulate, the right one straighter, the tip clearly spatulate and strongly wrinkled inside. No distinct notch at the basis but a slight concavity. Vinculum evenly rounded with a clear saccus. The anellus with a very long and robust process with a clubbed head covered with small teeth. Penis cylindrical, bent at 90° near its extremity, an obvious caecum penis, vesica smooth with one large lobe scobinated throughout.

***Apiconoma* Butler, 1876**

Apiconoma Butler, 1876: 422.

Type-species: *Euchromia opposita* Walker, 1854a, by original designation.

***Apiconoma opposita* (Walker, 1854): 260 (*Euchromia*)**

Type Locality. - Brazil. - Type Specimen. - Holotype male (BMNH).

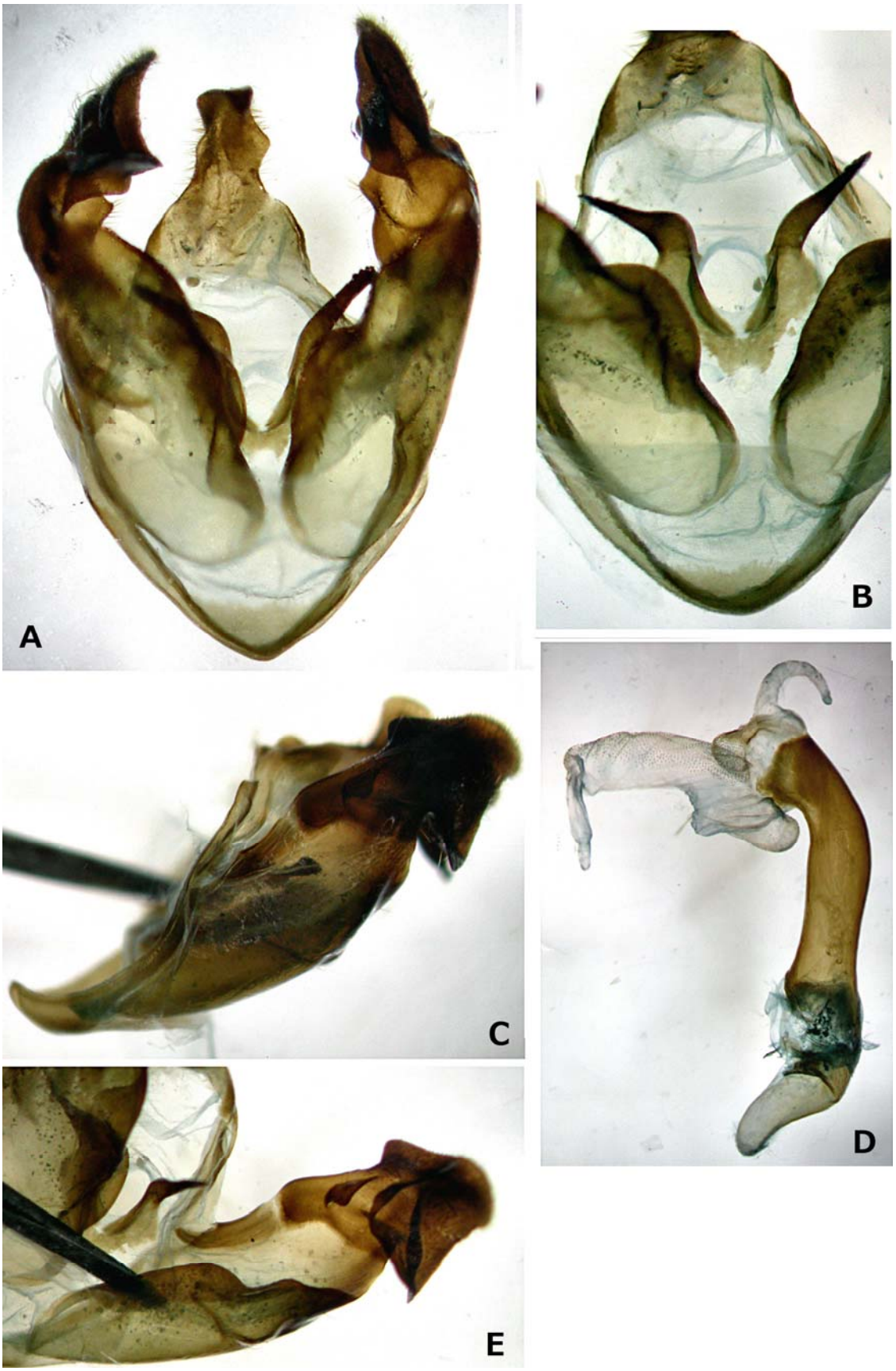

Figure 7. Male genitalia of *Euplesia sphingidea* from French Guiana. **A,** ventral view; **B,** detail of the anellus; **C,** lateral view; **D,** penis with everted vesical; **E,** detail on the valvae inside.

= *Euplesia ochrophila* Felder & Rogenhofer, 1874: *pl.* 102, *fig.* 10. - Type locality: [Brazil]. **-** Type specimen: Lectotype male designated by Rothschild (1910: 20) (BMNH), in fact Rothschild thought the type was a female but with doubt.
= *Delphyre aclytioides* Hampson, 1901: 174 (*Delphyre*) **syn. nov.** - Type locality: French Guiana, Cayenne. **-** Type specimen: Holotype female n°179 (UMO).

Material examined: FRENCH GUIANA. 5♂, Piste de Kaw, PK 38, 20-I-1996, M. Laguerre *leg*. 2♂, Piste de Kaw, PK 11, 23-I-1996, M. Laguerre *leg*. 1♂, Piste de Kaw, PK 36, 13-VIII-1994, M. Laguerre *leg*. 2♂, Piste de Saut Léodate, PK 12, 12-II-1999, M. Laguerre *leg*. + Gen. ML2494. 1 ♂ 1♀, Piste Paul Isnard, PK 57, 13-II-1999, M. Laguerre *leg*. 2♂, Piste Paul Isnard, PK 34, 28-VII-2001, M. Laguerre *leg*. 1 ♂, Piste de Kaw, PK 38, 10-II-1999, M. Laguerre *leg*. 1♂, Piste de Kaw, PK 37+3.3, 31-VII-2001, M. Laguerre *leg*. 1♂, Piste de Bélizon, PK 20+1, 28-VII-2003, 120 m, 4°17.613 N 52°24.385 W, M. Laguerre *leg*. 1♂, Piste Coralie, PK 5, I-2006, R. Souciou *leg*. 1♂, Piste de la Montagne de Fer, 30-IX-20139, 88 m, 5°20'21" N 53°32'22" W, D. Herbin *leg*. 3♀, Piste Apatou, layon PK 26, 1-X-20139, 126 m, 5°14'46" N 54°11'08" W, D. Herbin *leg*. + Barcode Process ID ARCTD949-15, Sample ID MILA 1997. 1♀, Piste Patagaï, 27-IX-2013, 47 m, 5°23'57" N 53°11'22" W, D. Herbin *leg*. 1♀, Piste de Kaw, PK 32+2.3, 2-VIII-2003, 240 m, 4°34.325 N 52°11.460 W, M. Laguerre *leg*. 1♀, Piste Patagaï, 7-IX-2013, 58 m, 5°20'34" N 53°12'48" W, D. Herbin *leg*. + Gen. ML2492. 1♀, Route d'Apatou, 05-X-2015, 99 m, 5°15'50.7" N 54°12'01.3" W, M. Laguerre *leg*. All *in* MLC. 1♂, Nouragues, Inselberg Camp, 9-II-2011, 160 m, 4.088° N 52.681° W, MAS. Smith & R. Rougerie *leg*., Barcode Process ID LNOUF8303-11, Sample ID NS-RR1830. 1♂, Nouragues Research Station, 20-I-2010, 300 m, 4.098° N 52.681° W, C. Lopez Vaamonde *leg*., Barcode Process ID LNOUB041-10, Sample ID CLV109810. 1♂, Nouragues Research Station, 23-I-2010, 300 m, 4.098° N 52.681° W, C. Lopez Vaamonde *leg*., Barcode Process ID LNOUB905-10, Sample ID LNOU-0727. 1♂, Nouragues Research Station, 8-IX-2010, 300 m, 4.098° N 52.681° W, C. Lopez Vaamonde *leg*., Barcode Process ID LNOUC982-10, Sample ID BIOUG00735-D03. All *in* MNHN. BRAZIL. 2♂, Rondonia, Vilhena, 3-4-XII-1994, 650 m, P. Boyer *leg*. + Gen. AS 2764b. All *in* MLC.

Male genitalia (Fig. 8A-E): Uncus subrectangular in dorsal view, with a clear carina on each side and a small ridge on top, long and slightly bent ventrally in lateral view. Valvae symmetrical largely exceeding uncus, distinctly narrowed in the middle, pointed and inwardly bent at the tip. A distinct notch at the basis with a smooth triangular tooth basally. Vinculum evenly rounded with a small saccus. The anellus with a long pointed, sclerotized and corrugated process on each side, the blunt tip pointing outside. Penis straight, cylindrical, an obvious caecum penis, vesica smooth with three lobes and slightly scobinated at the junction of the lobes with a sclerotized wrinkled area.

Remarks: One of the specimens collected in Rondonia exhibited a rather divergent habitus: the preapical transverse clear band is replaced by a line of three subquadrate dots (see Fig. 9). This specimen has been dissected by Hervé de Toulgoët under the reference AS2764b and the genitalia are identical to normal specimens.

Description of two new species of *Apiconoma* Felder, 1874 from Brazil

In the general Arctiinae tree, two other entities from Brazil were found within the *Euplesia/Apiconoma* cluster: an unknown species collected in the northern part of south-east Brazil (Espirito Santo and Minas Gerais states) and an unique specimen similar to *Apiconoma*

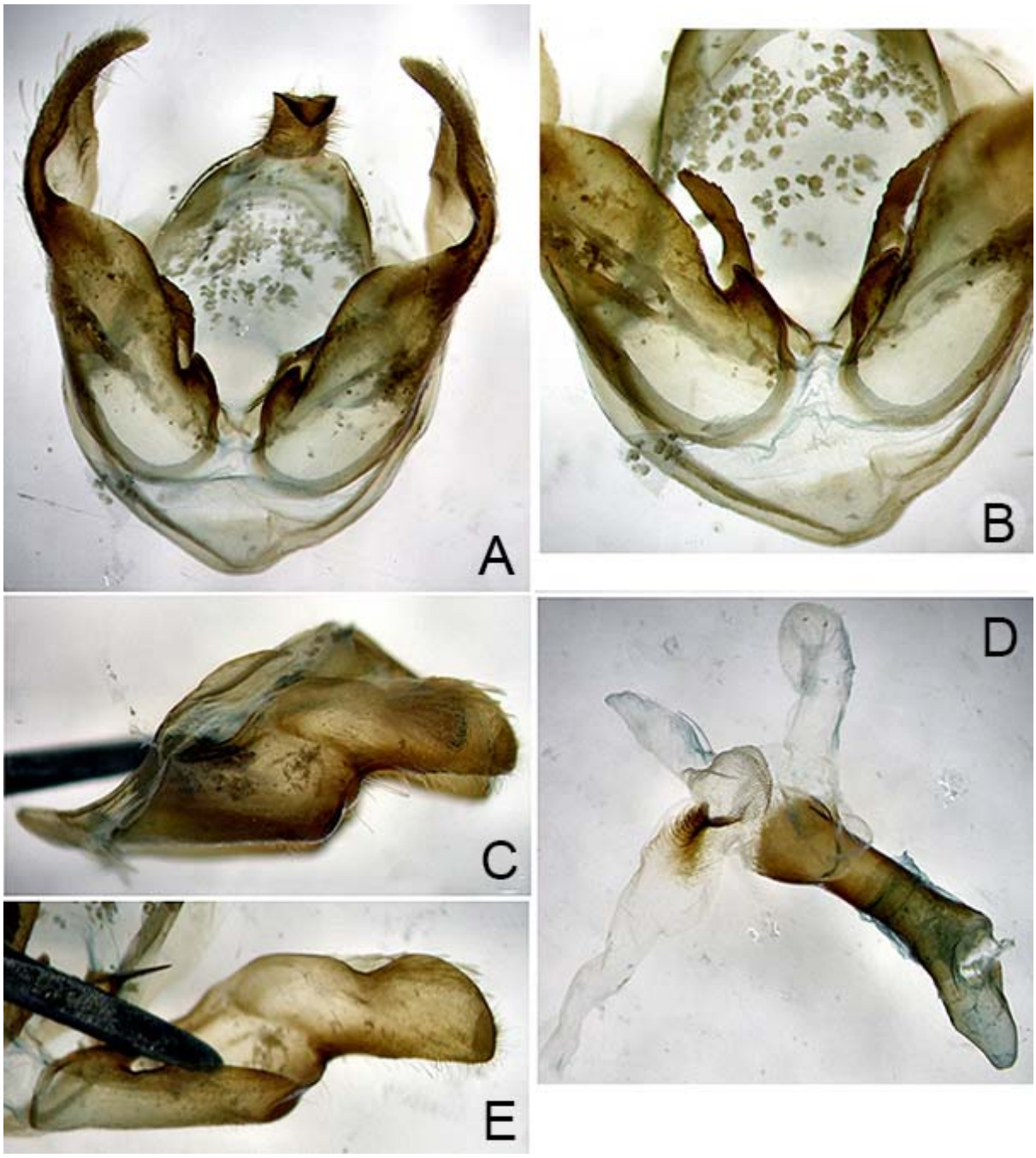

Figure 8. Male genitalia of *Apiconoma opposita* from French Guiana. **A,** left ventral view; **B,** detail of the anellus; **C,** left lateral view; **D,** penis with everted vesical; **E,** detail on the valvae inside.

opposita (Walker, 1854) and collected in Parà state a little bit south-east of Belém on the lower Amazon River (see Fig. 10, boxed specimens). The differences found in the COI gene (minimum 4.8 % with *Apiconoma opposita*) validate the creation of two new species, moreover all the nodes of the NJ distances tree are strongly supported. In turn, what is strange is the vicinity of the two new species (only 2.23 % for the COI gene) despite two clearly different habitus. In fact, one of the species is so close to *Apiconoma opposita* that it is very easy to confuse them.

Figure 9. Habitus on an aberrant male of *Apiconoma opposita* (Walker, 1854) from Brazil, Rondonia. **A,** dorsal view; **B,** ventral view.

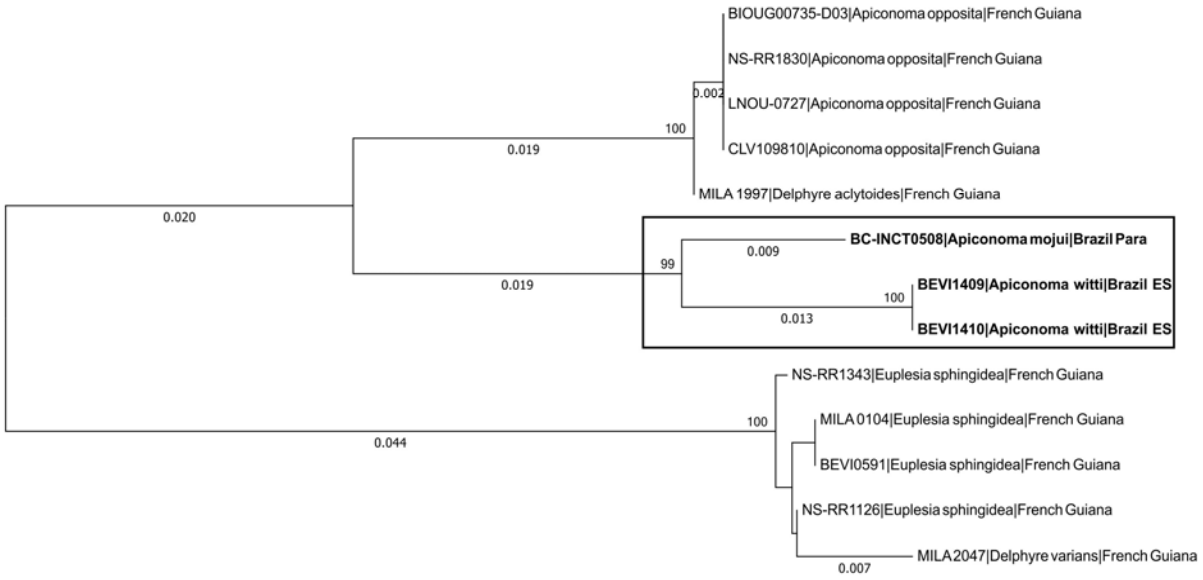

Figure 10. Neighbour-joining tree (Saitou & Neil, 1987) for the 13 specimens of the studied groups. The two new species from Brazil are boxed and in bold. Distances in % are given below each branch and bootstrap supports are given above each branch (only if larger than 70 %) (obtained with MEGA6, see Tamura *et al*. 2013).

***Apiconoma witti* sp. nov.** (BIN = ACG9549) (Fig. 11)

urn:lsid:zoobank.org:act:91ACFC29-E626-46F1-8069-D1508D25A765

Type material: Holotype: BRAZIL. 1♂, Minas Gerais, Potè, 15-VI-1996, ~500 m, 17.77° S - 41.83° W, H. Thöny *leg*., Gen. ML 2204, Barcode Process ID ARCTD104-11, Sample ID BEVI1409, *in* MWM. Paratypes: BRAZIL. 1♂, Minas Gerais, XI-1995, 300 m, T. Greffenstein *leg*., Barcode Process ID ARCTD105-11, Sample ID BEVI1410, *in* MWM. 1♀, Espírito Santo, Réserve Biologique Augusto Ruschi, Route Santa Teresa à Nova Lombardia, km 10, 816 m, 14-16-XI-2012, 19°53'21" N - S 40°32'41" W, Gen. ML2497, B. VINCENT *leg*., will be deposited in MZSP.

Description, holotype male (Fig. 11A-B)

Head. Antennae clearly bipectinated, dark grey. Palpi creamy-yellow. Head dark grey bordered frontally with yellow and with two small yellow triangles on collar. Patagias dark grey with a lateral yellow spot. Tegulae dark brown with a median yellow line. Thorax dark brown.

Legs. Coxae yellow very hairy. Legs light grey.

Forewing. Plain brown with the veins surlined with greyish-beige, lighter on the disk. A diffuse bluish-grey patch just below the end of cell. Below wings uniformly dark brown, with veins not contrasting except on the margin. A yellow patch at the basis.

Hindwing. Small and rounded, light yellow with a large black border, one third of the wing, with a slight indentation near the anal border. Below identical but the basal two-thirds yellowish-orange.

Abdomen. Above very hairy and bright yellow, last segments pure black with two metallic light-blue horizontal lines, anal tuft black. Below first half light yellow, then light yellow with a black posterior line, last segment and the anal tuft black.

Forewing length: 13 mm.

Figure 11. Habitus of *Apiconoma witti* **sp. nov.**, holotype, male (**A-B**) and paratype, female (**C-D**). **A,** dorsal view; **B,** ventral view; **C,** dorsal view; **D,** ventral view.

Male genitalia (Fig. 12A-E). Uncus subrectangular in dorsal view, with a clear carina on each side and a small ridge on top, long and slightly bent ventrally in lateral view. Valvae symmetrical largely exceeding uncus, distinctly narrowed in the middle, pointed and inwardly bent at the tip. A distinct notch at the basis with a clear corrugated tooth basally. Vinculum evenly rounded with a indistinct saccus. The anellus with a smooth pointed process on each side, the tip, sharp and acute, pointing outside. Penis straight, cylindrical, an obvious

caecum penis, vesica smooth and slightly scobinated at the junction of the lobes with a sclerotized wrinkled area.

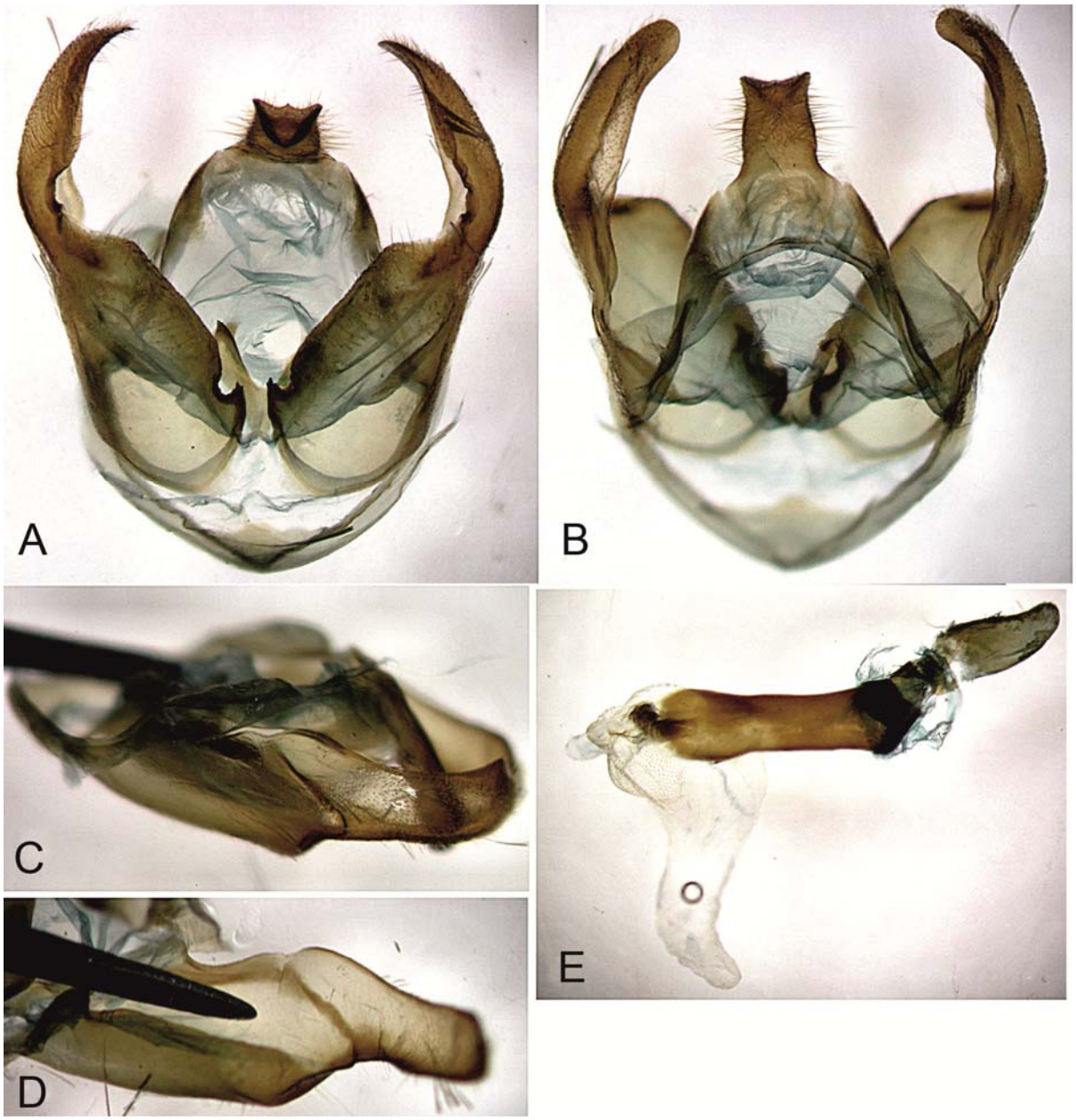

Figure 12. Male genitalia of the holotype of *Apiconoma witti* **sp. nov. A,** ventral view; **B,** dorsal view; **C,** lateral view; **D,** detail on the valva inside; **E,** penis with everted vesica.

Female (Fig. 11C-D)**:**

Head. Antennae just ciliate, dark grey, scape orange. Palpi yellowish-orange. Head orange. Patagias orange. Tegulae orange bordered internally with long brownish hairs. Thorax brownish.

Legs. Coxae brownish-yellow. Legs grey.

Forewing. Plain brown lighter than male with the veins surlined with greyish-beige, lighter on the disk. Below wings uniformly brown, with veins slightly contrasting yellowish-beige. A yellowish stripe above anal border.

Hindwing. Dull brownish-yellow with a brown diffuse border increasing from above anal angle to apex and then along costa, the anal border yellow. Below identical to the upperside.

Abdomen. Above very hairy and bright orange-yellow, a round black patch on the first and second segments, a black line distally on the 5th, the two last segments pure black, anal tuft black. Below dull yellowish-orange except the two last segments and the anal tuft black.

Forewing length: 16 mm.

Female genitalia (Fig. 13A-C). Antrum V-shaped, narrowed at the junction with ductus bursa. Ductus bursa as a long and flat sclerotized ribbon slightly twisted. Bursa copulatrix ovoid, smooth with two signa as small elliptic scobinate plates. An accessory bursa small, one third of the bursa copulatrix, joining on top near ductus bursa. Anterior apophyses short, posterior ones longer. Papillae analis subquadrate slightly concave on top. Pheromone glands long and largely twisted.

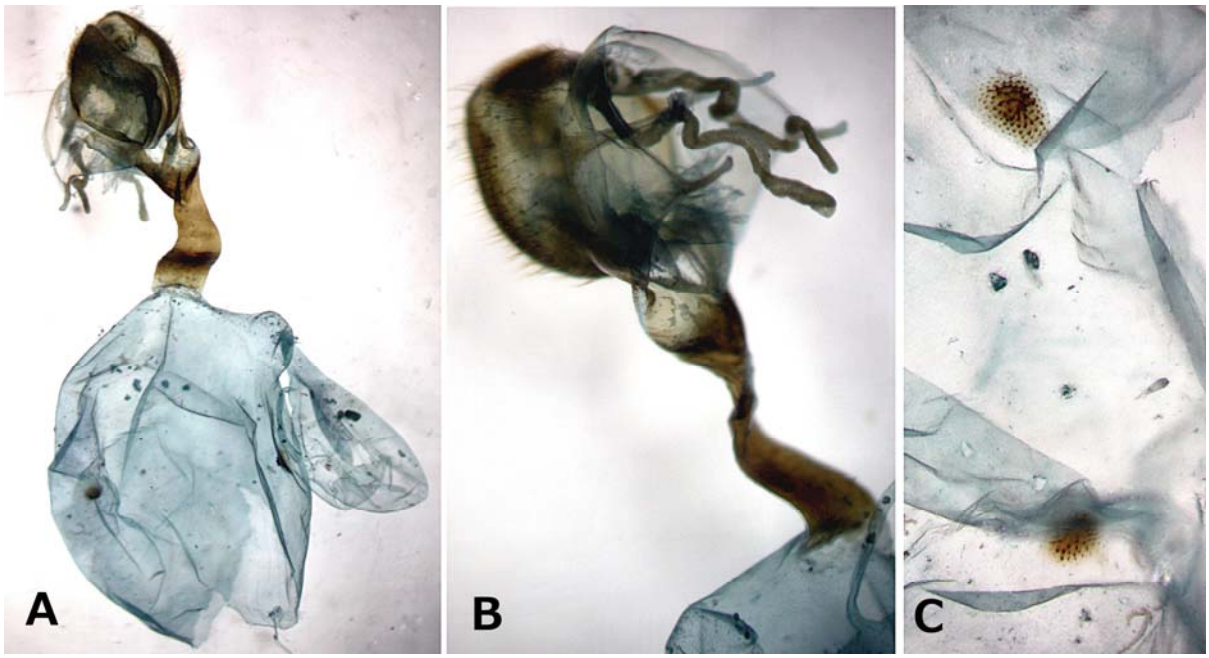

Figure 13. Female genitalia of a paratype of *Apiconoma witti* **sp. nov.**. **A,** general view; **B,** detail of the upper part lateral view; **C,** detail of the signa.

Etymology: Named in honor to Thomas Witt from Munchen for his tremendous contribution to the Neotropical fauna.

Distribution: Up to now, known only from two adjacent areas in Minas Gerais and Espirito Santo states in Brazil.
An easily identified species with a characteristic and divergent habitus, despite a close COI gene sequence. Its geographical area displays generally a high endemicity rate.

***Apiconoma mojui* sp. nov.** (BIN = AAM8430) (Fig. 14A-B)

urn:lsid:zoobank.org:act:D7B68807-27E2-48FB-BDEC-4D2539CEAB59

Type material: Holotype: BRAZIL. 1♂, Parà, Moju, Reserva de Floresta da EMBRAPA, 13-IV-2010, 19 m, 2.18° S - 48.8017° W, Gen. ML2268, T. Decaens *leg*., Barcode Process ID INCTA508-10, Sample ID BC-INCT0508, will be deposited in MPEG.

Description, holotype male

Head. Antennae clearly bipectinated, black, base of scape orange. Palpi yellow with a black lateral patch. Frons creamy-yellow bordered posteriorly with gray. Vertex hairy yellow with a central black patch. Patagias dark brownish-gray with a yellow orange central patch. Tegulae yellow-orange bordered by long dark-brown hairs. Thorax hairy brownish interspersed with yellow hairs.

Legs. Coxae yellowish-orange. Legs brownish with lines of yellow scales on felur and tinia.

Forewing. Dark brownish-gray with slightly contrasting yellowish veins. Two creamy-yellow, slightly translucent patches: the first one ovoid just below the end of cell, the second as a band almost perpendicular to the costa, just tapering before the termen. On the patches the veins are yellow. Below similar to upperside with a diffuse yellowish-beige patch at the basis of the wing.

Hindwing. Very reduced, yellowish-orange except a black border going from apex to anal angle and then following anal border on two thirds of its length. This border narrows near apex, becomes largely wider at the anal angle where it is covered by long yellow hairs. Below similar to upperside but the black border more diffuse and more covered by yellow hairs.

Abdomen. Above hairy and yellow. Anal tuft black, the two last segments black with steel-blue iridescence, preceding segment black only on the central part.

Forewing length: 12 mm.

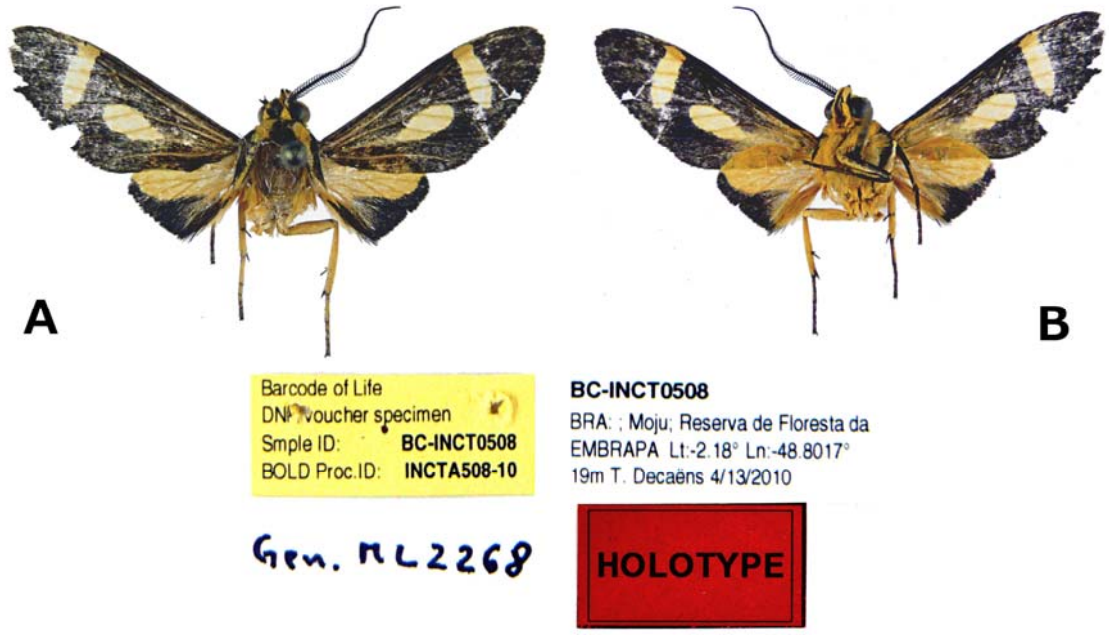

Figure 14. Holotype of *Apiconoma mojui* **sp. nov**. **A,** dorsal view; **B,** ventral view.

Male genitalia (Fig. 15A-E). Uncus subrectangular in dorsal view, with a clear carina on each side and a small ridge on top, long and perpendicular to tegumen in lateral view. Valvae symmetrical exceeding uncus, distinctly narrowed in the middle, pointed and inwardly bent at the tip. A distinct notch at the basis with a crenulate triangular tooth basally. Vinculum triangular with a small saccus. The anellus with a long pointed, sclerotized and corrugated process on each side, the acute tip pointing outside. In lateral view the valvae appear more rounded, more elongated and less tightened than in *Apiconoma opposita*. Penis straight, cylindrical, a long caecum penis, vesica smooth with three lobes and slightly scobinated at the junction of the lobes with a sclerotized wrinkled area.

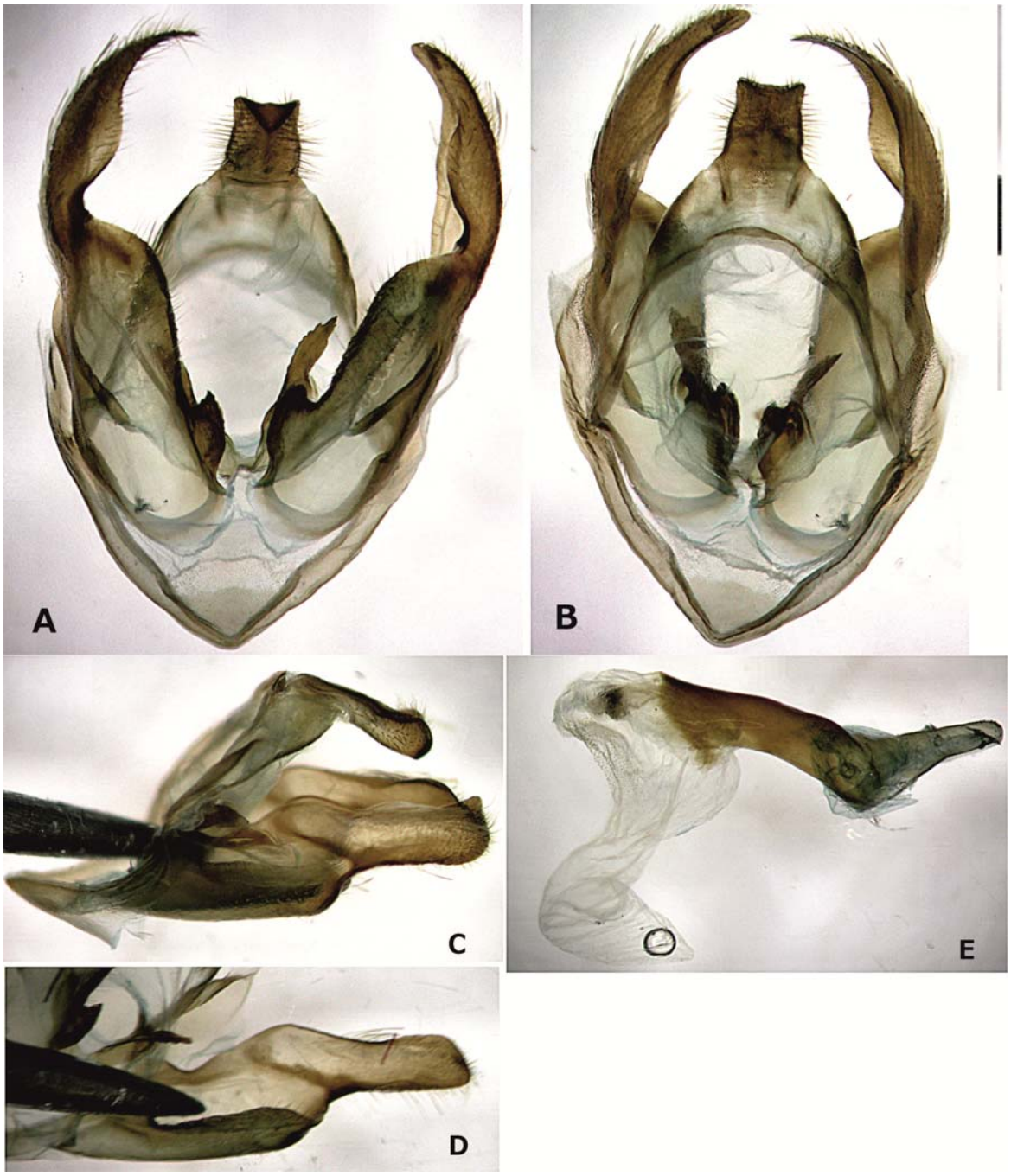

Figure 15. Male genitalia of the holotype of *Apiconoma mojui* **sp. nov. A,** ventral view; **B,** dorsal view; **C,** lateral view; **D,** detail on the valva inside; **E,** penis with everted vesica.

Female: Unknown.

Etymology: By reference to the locality of the unique specimen.

Distribution: Up to now, known only from the suburbs of Bélem and very likely from the low Amazon basin in Brazil.

Remarks: It is surprising to see how this species is similar to *Apiconoma opposita* (habitus and genitalia) despite a COI gene distance of at least 4.7 %. This large genetical difference between two apparently close geographical areas (Guianas Shield and Lower Amazon basin) seems in turn to be indicative of a habitat divergence deeper than previously thought: up to now species collected within the Guianas or on the lower Amazon banks were thought to be conspecific which is not exactly true. In a previous paper we already resurrected as *bona species, Pyrrostola subtussignata* Bryk, 1953 from Parà state wrongly synonymized with *Pyrrostola flavida* (Schaus, 1905) from French Guiana (Laguerre, 2015).

At the opposite and despite largely divergent habitus, this species exhibits a small COI gene difference (2.2 %) with *Apiconoma witti* **sp. nov.** The two geographical areas concerned are markedly different and there is no doubt that these species are not conspecific. Nevertheless a valid conclusion can be only reached if all available techniques are used: habitus, genitalia and molecular analysis.

Description of a new species of *Glaucostola* Hampson, 1901 from S.E. Brazil

Very recently we reviewed the genus *Glaucostola* Hampson, 1901 and we described a new species collected in the northern part of the Atlantic coast in Brazil: *Glaucostola acantha* Laguerre, 2015 from Espírito Santo, Augusto Ruschi Biological Reserve (Laguerre 2015). During this study we were aware of the presence of a second new species from the southern part of the same area (Paranà state). But this species was represented by an unique worn female which was sequenced but physically unavailable. Even if the habitus was very similar to *G. guttipalpis*, the distances with the three species of the *guttipalpis* group were high enough to justify a full species status for this entity: 3.4 % with *G. acantha* Laguerre, 2015, 4.4 % with *G. romula* (Druce, 1895) and 4.6 % with *G. guttipalpis* (Walker, 1856) (see distance NJ-tree in Fig. 16). It was thus necessary to study at least a male to confirm the novelty of this species. This was not an easy task, as this species proved to be scarce. After several unsuccessful attempts we finally could locate a small series of males in the personal collection of Jean-Aimé Cerda in Patawa (French Guiana). All these specimens were collected in Saõ Paulo state near the town of Jureia. Male dissection immediately confirms that this entity is indeed a new species with genitalia largely divergent not only from *Glaucostola acantha* Laguerre, 2015 but also from all the other species of the genus *Glaucostola*. This species will be described below under the name *Glaucostola indagata* **sp. nov.**

***Glaucostola indagata* sp. nov.** (Fig. 17A-B)

urn:lsid:zoobank.org:act:D01C96A0-9D72-4D0F-A847-9D4F7BEBC535

Type material: Holotype: BRAZIL. 1♂, Saõ Paulo, Jureia, PL, 3-5-II-1998, dissection Gen. ML 2510, will be deposited in UFPC. Paratypes : BRAZIL. 1♂, Saõ Paulo, Jureia, 3-5-II-1998. 1♂, Saõ Paulo, Jureia, PL, 28-29-V-1999. 1 ♂, Saõ Paulo, Dourado Bela Vista, XI-1999. *In* JACC. 1♀, Parana, Estrada da Graciosa, Santa Clara, 11-VI-2011, 72 m, 25.3999° S

48.8715° W, Barcode Process ID LEMMZ1071-12, Sample ID MMZ1071, M. Zenker *leg*., will be deposited *in* MZSP.

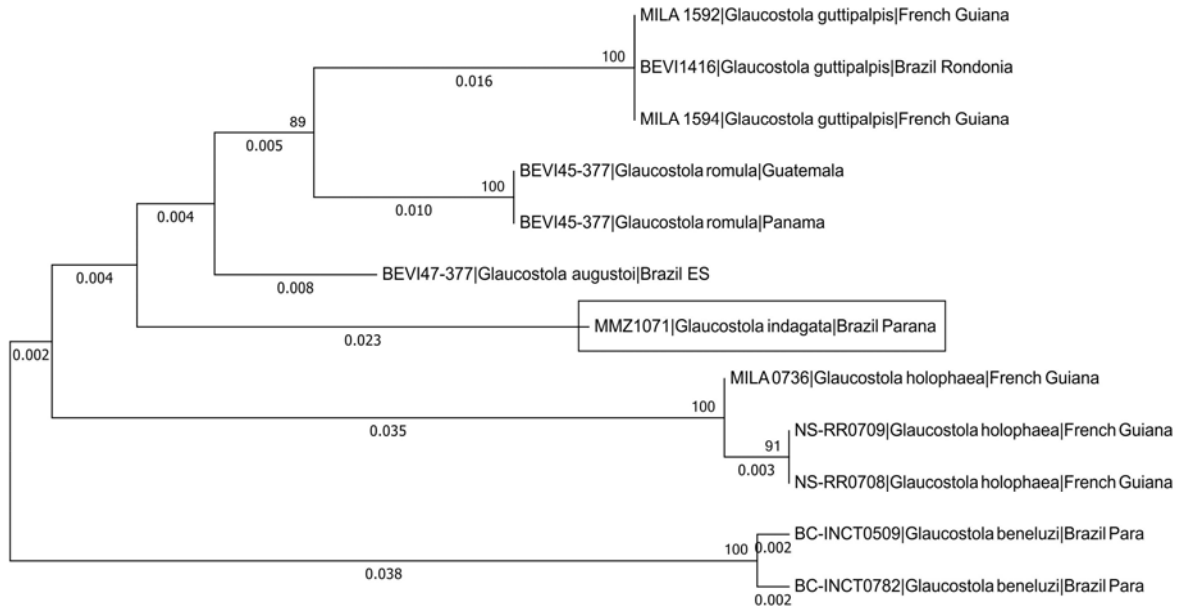

Figure 16. Neighbour-joining tree (Saitou & Neil, 1987) for the 12 specimens of the *Glaucostola* genus. The new species from Brazil is boxed. Distances in % are given below each branch and bootstrap supports are given above each branch (only if larger than 70 %) (obtained with MEGA6, see Tamura *et al*. 2013). Details for specimens can be found in a previous paper (see Laguerre 2015).

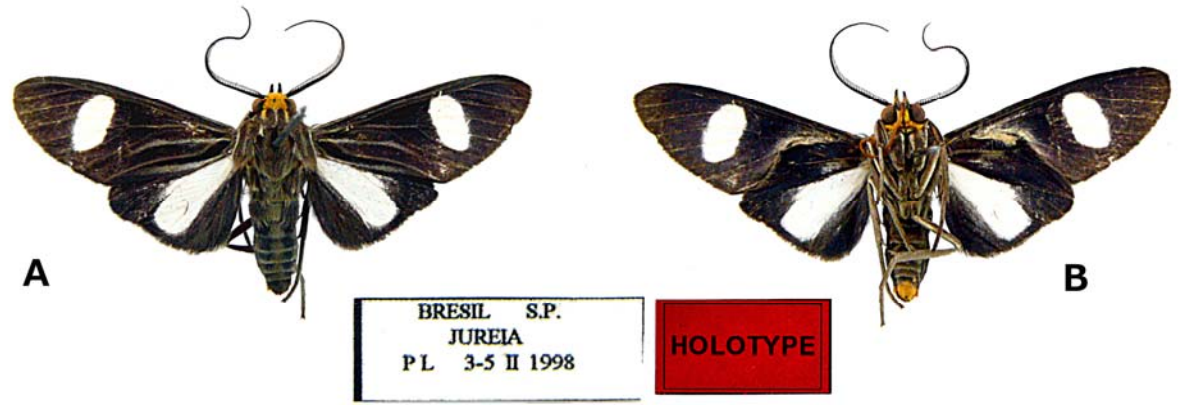

Figure 17. Holotype of *Glaucostola indagata* **sp. nov**. **A,** dorsal view; **B,** ventral view.

Description, holotype male

Head. Antennae clearly bipectinated, black, base of scape orange. Palpi dark brown, suffused with orange scales and with a black lateral patch. Frons orange, vertex orange with a black central dot. Collar very hairy and yellow below. Patagias brown with a thin median yellow line. Tegulae and thorax hairy and dark brown.

Legs. Uniform gray, surlined ventrally by brown on coxae, femur and tibia.

Forewing. Dark brownish-gray, almost black, with veins slightly contrasting in light gray, mainly on basis and disk. An ovoid pure white patch crosses the wing just after the end of cell but reaching neither the costa nor the termen. Below identical to upperside except a patch of dirty white hairs located in a pouch covered by the enlarged costa of the hindwings.

Hindwing. Uniform dark brownish-gray, almost black, with a subrectangular pure white patch located in the centre of the wing from the very basis to 1 mm before the termen, this patch is slightly enlarged distally. Below identical to upperside, the costa is largely lobed and covers the androconial pouch located on the forewings underside.

Abdomen. Dark gray almost black with a median light gray line. Below the anal tuft is bright orange.

Forewing length: 14 mm

Male genitalia (Fig. 18A-E). Genitalia almost cylindrical with valvae hardly able to open. The uncus is bifid, covered dorsally by a thin and ovoid expansion of the tegumen. The tegumen is protruding on each side at the uncus base with a long blade-shaped process with a distinct distal curvature and bordered ventrally with six strong spines. The valvae are weakly sclerotized, largely translucent, slightly concave dorsally with a spatulate extremity. The saccus is digitate and bent on the left in ventral view. Penis thin, cylindrical, caecum penis absent, vesica as a simple lobe with a scobinate area distally.

Female: Known but described only from a picture (see Fig. 19). Essentially similar to the male but with more rounded wings as usual within the *Glaucostola* genus. General colour very dark slate grey with an oval white preapical patch (similar to the male) on the forewing and a long and narrow white streak across cell from base to submarginal area on the hindwing. This patch noticeably narrower than in male. Remaining pattern similar to male.
Not available for dissection (*vide supra*).

Etymology: From the latin verb *indago* which means to hunt or to trace or track, because the male of this species was searched for with obstinacy during several months.

Distribution: For the moment, only a few specimens are known from a small area near the Atlantic Ocean in the São Paulo and Parana states in south-east Brazil.

Remarks: The four species of the group of *Glaucostola guttipalpis* exhibit an extremely homogeneous habitus, nevertheless the male genitalia are largely diagnostic and allow an unambiguous determination. The large differences found in the male genitalia are noticeable when compared to the not really extensive differences between the COI gene sequences: from 3.4 to 4.6 % between the four species.

It is interesting to have two different species along the Atlantic coast of Brazil, the two other species (*viz*. *guttipalpis* and *romula*) being mutually exclusive and with a more northern distribution. Only a few specimens of the two brazilian species (*acantha* Laguerre, 2015 and *indagata* **sp. nov.**) have been collected up to now and it will be interesting in the future to know their exact distribution range.

Acknowledgements

I wish to thank Paul Hebert (CCDB, Guelph, Canada) for access to the BOLD project and providing very efficient, competent and quick DNA barcoding, and Rodolphe Rougerie (Biodiversity Institute of Ontario, University of Guelph, Ontario, Canada) for his help and his

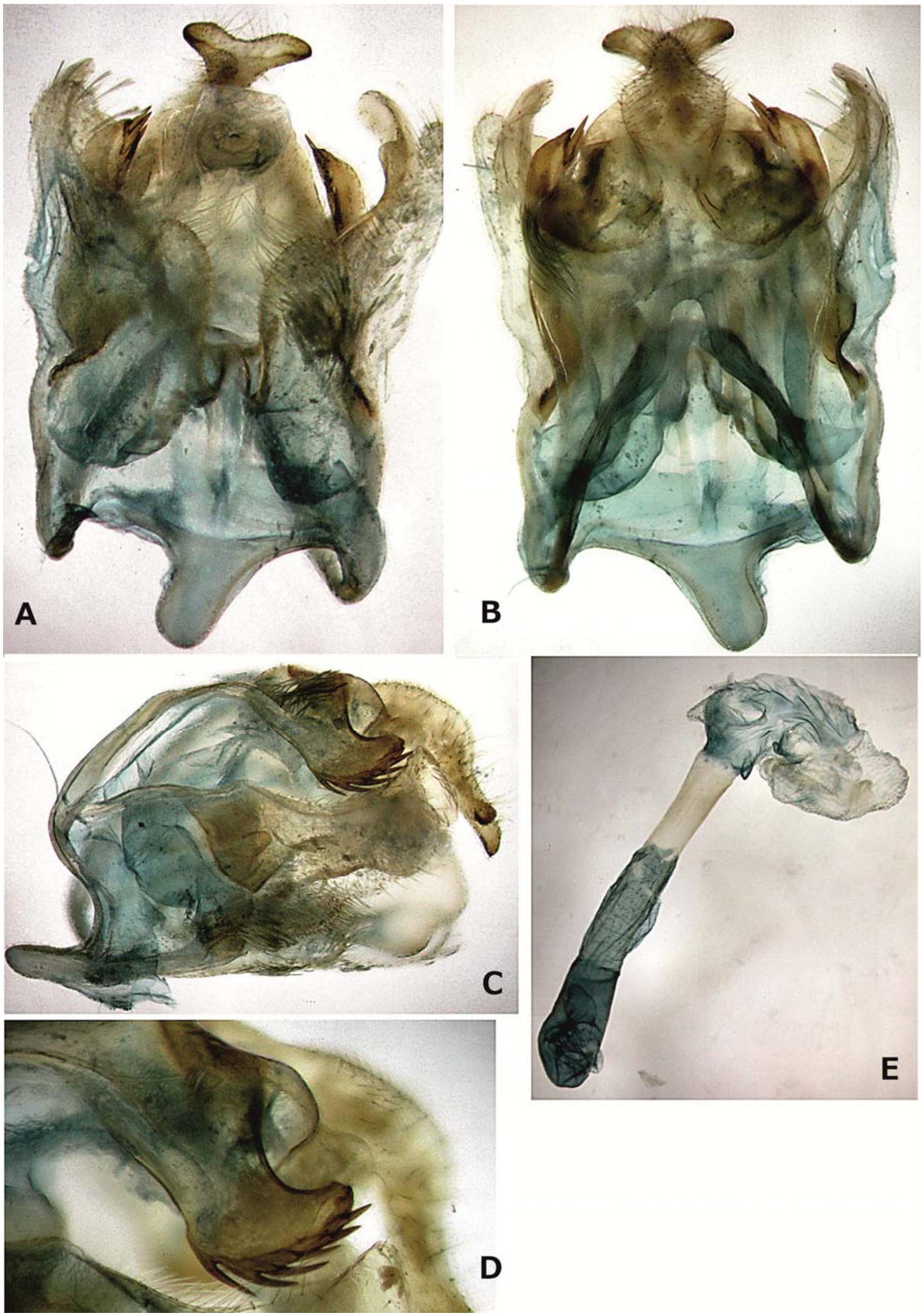

Figure 18. Male genitalia of the holotype of *Glaucostola indagata* **sp. nov. A,** ventral view; **B,** dorsal view; **C,** lateral view; **D,** detail of the processus of tegumen; **E,** penis with everted vesica.

Figure 19. Habitus of female paratype of the *Glaucostola indagata* **sp. nov**.

technical and scientific support in editing and compiling the hundreds of various sequences involved in the ARCT projects. All my thanks to Thomas Witt and Thomas Greifenstein (Munchen, Germany) for giving me access to their invaluable collection of Neotropical Arctiinae and for the loan of several very interesting species. I wish to thank Thibaud Decaëns for sharing his precious data from Brazil. DNA barcodes of some specimens were generated at the Institut de Recherche Criminelle de la Gendarmerie Nationale (France) with the precious help of Laetitia Cervantes and Benoit Vincent. All my thanks also to Jean-Aimé Cerda, Benoit Vincent, Daniel Herbin and Olivier Félis who collected several very interesting specimens. Finally I wish to thank Rodolphe Rougerie and Carlos Lopez Vaamonde (INRA, Nantes) for giving me access to their data.

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