



RESEARCH ARTICLE

Description of two new species Pericopini from Guatemala and critical review of some recent nomenclature changes in the genus *Dysschema* Hübner (Lepidoptera: Erebiidae: Arctiinae: Pericopini)

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Abstract: Two new species of Pericopini (Erebiidae, Arctiinae) are described from Guatemala: *Gnophaela baileyi* **sp. nov.** and *Dysschema faustinoi* **sp. nov.** Detailed species descriptions are based upon morphological and molecular characters as well as distributional data. Analyses of the CO1 locus (a 658 nucleotide sequence commonly referred to as a barcode) in 397 individuals of the genus *Dysschema* Hübner reveal that many taxonomic changes recently proposed by V. O. Becker are not supported by molecular data. *Dysschema* appears not to be a genus of wide ranging species but rather a complex of more localized species that require redefinition using more detailed morphological, molecular, and ecological data.

Key words: Arctiinae, Pericopini, Neotropical fauna, *Dysschema*, *Gnophaela*, molecular phylogeny, biogeography.

Introduction

On September 15th 2013 Vitor O. Becker published an important contribution to the nomenclature of Pericopini (mainly the genus *Dysschema* Hübner, 1818) with the descriptions of 3 new species from the northern part of central America (2 from Guatemala

and 1 from Mexico) (Becker, 2013). Hereafter two weeks, Vincent & Laguerre (2013a) published a large contribution, accepted on August 22nd, with more than 100 recombination for the Neotropical Arctiinae. Of these, *Hypocrita celina* (Boisduval, 1870), *Dysschema leda* (Druce, 1884), *Dysschema ultima* (Hering, 1926), *Isostola superba* Druce, 1885 are redundant and so unjustified with respect to Becker (2013). Within these recombination, there are several concern in the Pericopini. Even if we agree with a lot of the recombination made by Becker (2013), several discrepancies remain and need either to be discussed or corrected. Moreover, the three new species descriptions were very short and published without any pictures which may render their identifications questionable. The types are not deposited in a main collection but they remain in the author's private collection. In the following, we will discuss or correct some of the recombinations made by Becker (2013) for the genus *Dysschema*. But the first part will be devoted to the description of two new species of Pericopini coming from Guatemala which are clearly linked to the taxa previously described by Becker. In order to do that we will also provide pictures for two of the Becker's new species and we will also transfer one of these species from *Josiomorpha* Felder, 1874 to the genus *Gnophaela* Walker, 1854.

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.

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 Arctiidae has been initiated within the framework of "ALL-LEPS BARCODE OF LIFE" (see website 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 author's 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://www.dnabarcoding.ca/page/research/protocols>). Finally we have in hand almost 11000 sequences of Arctiinae including 397 sequences for the sole *Dysschema* genus. In some cases, we provided also the BIN reference number which is a unique taxonomic unit that closely corresponds to a species. 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/index.php/Public_BarcodeIndexNumber_Home.

The sequences were aligned and downloaded from BOLD and analyzed using MEGA5 (Tamura *et al.* 2007) for a cladistics analysis. Bootstrap values (Felsenstein 1985) were used to estimate branch support: they were calculated in MEGA5 after 1000 random replications. Distance calculations were performed using the Kimura 2-parameter (K2P) method in MEGA5 (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 phylogenetic tree of 11000 COI sequences represents 2407 species 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. A perusal of this tree shows that the classical threshold of 2 % to distinguish between species (Hebert *et al.* 2003) is perfectly valid and has been used several times with success (see for instance Vincent & Laguerre 2013b; Vincent *et al.* 2009; Laguerre 2009). In some cases noticeable differences in habitus and genitalia were found with differences as low as 1.5-2%.

Repository abbreviations are as follows:

MNHN: Muséum National d'Histoire Naturelle, Paris, France.

BMNH: British Museum (Natural History), London, England, UK. (now Natural History Museum, London)

UVGC: Universidad del Valle Collection of Arthropods, Guatemala City, Guatemala

LACM: Natural History Museum of Los Angeles County, Los Angeles, California, USA.

MWM: Museum Witt, Munchen, Germany.

UFPC: Universidade Federal do Paraná, Curitiba, Paraná, Brazil.

Coll. Michel Laguerre: Personal collection of Michel Laguerre, 33850 Léognan, France.

JMS: José Monzón Sierra private collection.

Coll. Benoit Vincent: personal collection of Benoit Vincent, 1 rue Roger Rameau, 93110 Rosny sous Bois, France

Results

Descriptions of new Pericopini species

***Gnophaela baileyi* Laguerre & Monzon sp. nov.** (Figure 1B)

urn:lsid:zoobank.org:act:A7DB16CD-4B4F-4994-99FE-CF44A59F37BD

Diagnosis: A spectacular species with jet-black forewings with one narrow yellow band: first longitudinal and then abruptly bended upwards subapically, the color becoming then very pale yellow. Hind wings mainly bright yellow with jet-black border. It can be distinguished from the very similar species *G. cathetozosta* (Figure 1A) by the front wing yellow band continuous (not divided in two lines) and slightly larger size. It can also be separated from all black and yellow species of the genus *Josiomorpha* by the presence of the vertical preapical part of the longitudinal band, invariably absent in all known *Josiomorpha* species.

Type material: Holotype: 1♂, Guatemala, 9-10.V.2002, 2450 m, Todos Santos, Villa Alicia, Huehuetenango, C. Bailey *leg.*, dissection Gen. ML1605, housed in MNHN Paris.

Paratypes: 5♂, Guatemala, 1-4.V.2009, 2566 m, Cerro Pinalon, El Progreso, 15°05'02.69" N; 89°56'33.96" W, all J. Monzon *leg.* Two specimens have been barcoded: reference MILA1453 and 1454 (BIN = ABY7655). All *in coll.* M. Laguerre. 1♂, Guatemala, Huehuetenango, carretera Bulej a Yalambojoch, 10.X.1999, 1900 m. In Coll. Monzón & Bailey. 1♂, Guatemala, Huehuetenango, Barillas, Ixcansan, 1600 m, VII.2000, In Coll. Monzón & Bailey. 1♂, Guatemala, Huehuetenango, Todos Santos, Villa Alicia, 2450 m, 9-10.V.2002, In Coll. A. Bailey. 1♂, Guatemala, 24.V.2011, 1990 m, San Mateo Ixtatán, 2 km north of Bulej, Cloud forest, 15°57'38.70" N; 91°34'09.26" W, Huehuetenango, Col. Camposeco & Monzón. 2♂, Guatemala, same data except 18.VIII.2010; 1♂, Guatemala, same data except 14.V.2010. 12♂, Guatemala, 1.V.2009, 2568 m, El Progreso, Cerro

Pinalon, Cabañas, 15°05'02.69" N; 89°56'33.96" W, Col. Monzón & Camposeco. 5♂, Guatemala, same data except 15.V.2010, Col. J. Monzón, B. Sutton, G. Steck & P. Skelley. Paratypes deposited in JMS and UVGC. 1 ♂, Guatemala, VI-VII.2001, 2460 m, Alta Verapaz, Coban, Chicacnab, Quetzal reservation, J.-P. Rudloff *leg.*, in MWM.

COI Sequence of one of the paratype:

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ACTTTATATTTTATTTTTGGGATTTGAGCAGGTATAGTAGGAACTTCTCTAAGACTGTTAATTTCGAG
CAGAATTAGGAACCCAGGTTCAATTAATTGGAGATGATCAAATTTATAATACTATTGTTACAGCAC
ATGCTTTTATTATAATTTTTTTTATAGTTATACCTATTATAAATTGGAGGATTTGGTAATTGATTAATT
CCTTTAATATTAGGGGCCCCCGATATAGCATTCCCCCGAATAAATAATATAAGTTTTTGATTACTTC
CCCCTCAATCACTTTATTAATTTCAAGAAGAATAGTAGAAAATGGAGCAGGTACAGGATGAACA
GTTTATCCCCCACTTTCATCTAATATTGCCCATAGAGGAAGATCTGTTGACTTAGCTATTTTTTCAC
TACATCTAGCAGGAATTCCTCTATTTTAGGAGCTATTAATTTTATTACTACAATTATTAATATACG
ATTAATAGGTAAACATTGATCAAATACCTTTATTATTGAGCTGTTGGAATTACTGCATTTTTTA
TTACTTTTTCATTACCTGTTTTAGCAGGAGCTATTACTATATTATTAAGTACCGAAATTTAAATA
CATCTTTTTTTGACCCAGCAGGAGGAGGAGATCCAATTTTATATCAACATTTA
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Habitat: All the specimens collected are from the humid forests on the northern slopes of the Guatemala Mountains. *Gnophaela cathetozosta* (Becker, 2013) occurs only in the southern humid forests of the mountains.

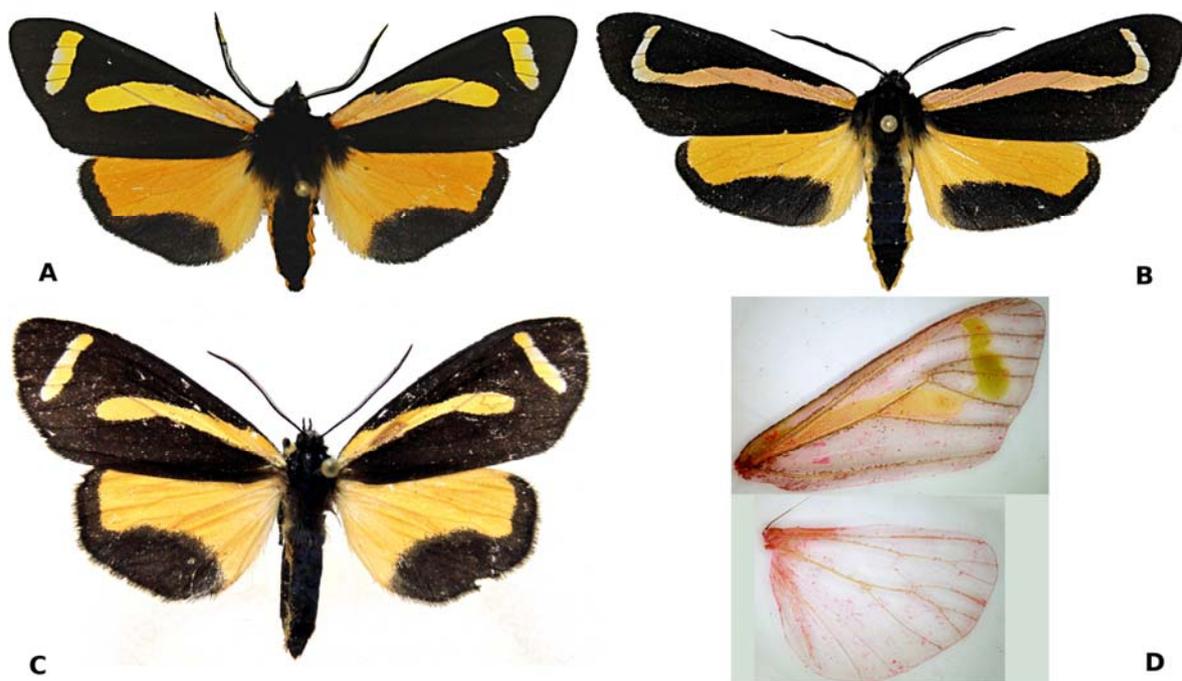


Figure 1. Adults of *Gnophaela cathetozosta* Becker and *Gnophaela baileyi* Laguerre & Monzon **sp. nov.** **A**, Male of *Gnophaela cathetozosta* Becker from type locality; **B**, holotype of *Gnophaela baileyi* Laguerre & Monzon **sp. nov.** **C**, picture of the first female specimen of *Gnophaela cathetozosta* Becker; **D**, venation of a male specimen of *Gnophaela cathetozosta* Becker.

Description

Male. Antenna bipectinate, black. Head, patagias, pterygodes and thorax black and very hairy. The head, frons and scape of antenna interspersed with white hairs. Eyes finely bordered with white hairs. A yellow patch on each side of the thorax. A thin line of pale yellow hairs between head and thorax. Palpi black with the two first segments covered below

by long pale yellow hairs. Underside with the coxae of the first pair of legs largely yellow, the two other pairs being white. Femurs of the legs covered underside by a line of pure white hairs, tibia dark grey interspersed with white hairs, tarsi black. Last tibia pairs with two pairs of spines covered with black and white hairs, intermediate tibia pairs with one pair of spines covered with black and white hairs. Upperside of abdomen black with a yellow band on each side and a deep metallic blue hue, underside dark grey with some white hairs distally on each segment. The first segment is covered by very long yellow hairs on upperside and each side. Dorsal surface: forewings elongated pure black with one narrow yellow band first longitudinal and then abruptly bended upwards subapically, the color becoming then very pale yellow almost whitish. The basal half of this band exhibits an oily appearance due to the presence of reddish-brown scales visible at higher magnification. A pure white spot at the very basis of the wing. Hindwings lemon yellow with a black border narrow toward the apex then widening abruptly from the middle of termen to anal angle where it stops just before the angle.

Ventral surface similar to the dorsal surface.

Male Genitalia (Figures 2E-I). Uncus triangular in ventral view, the tip curved downward and pointed. Tegumen in lateral view largely and abruptly rounded after the uncus (less rounded and with a smooth transition after uncus in *G. cathetozosta*). Valvae narrow and in lateral view bended upward in the terminal third (they are wider and straight in *G. cathetozosta*). Juxta with a rounded apex (triangular-shaped in *G. cathetozosta*). Saccus very long and triangular, largely bended dorsally in the terminal half (slightly bended in *G. cathetozosta*). Penis long and narrow, the vesica with two slightly scobinated lobes, one straight, conical and ventral, the second sharply bent backwards. See figures 2A-D for genitalia of *G. cathetozosta* (Becker, 2013).

Forewing length: 20-22 mm (n=5) compared to 20-21 mm (n=14) for *G. cathetozosta*. Female unknown.

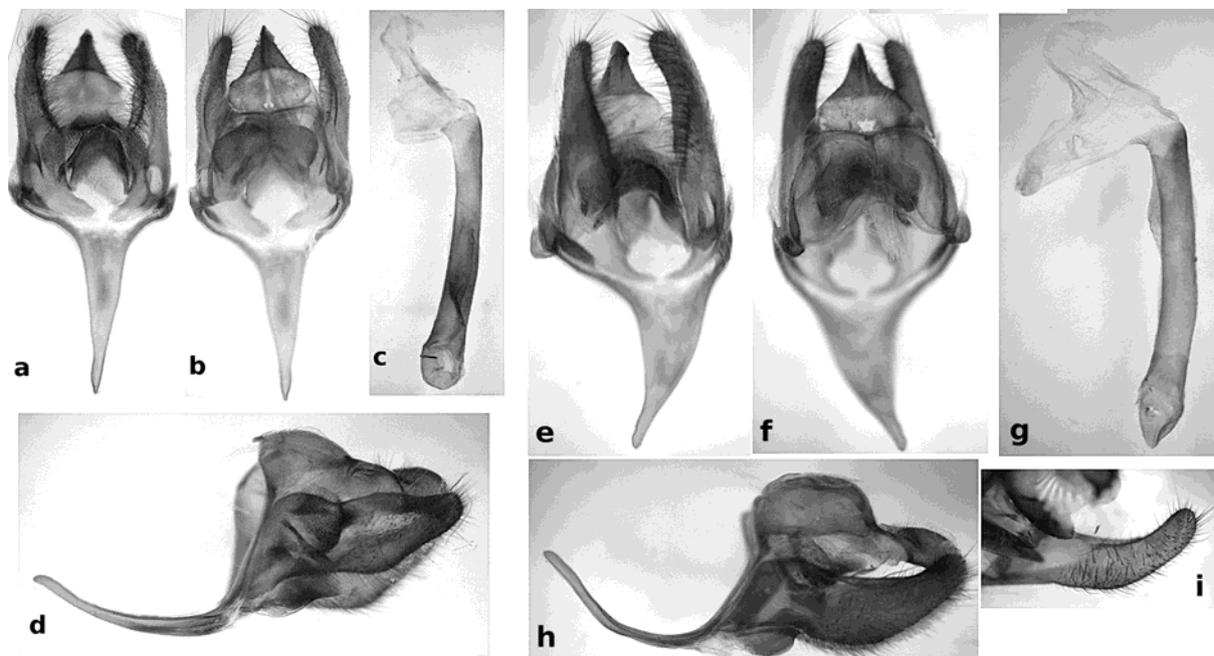


Figure 2. Genitalia of *Gnophaela cathetozosta* Becker and *Gnopahela baileyi* Laguerre & Monzon **sp. nov.** **A–D**, *Gnophaela cathetozosta* Becker; **A**, ventral view; **B**, dorsal view; **C**, penis with devaginated vesica; **D**, lateral view; **E–I**, genitalia of the holotype of *Gnopahela baileyi* Laguerre & Monzon **sp. nov.**; **E**, ventral view; **F**, dorsal view; **G**, penis with devaginated vesica; **H**, lateral view; **I**, internal view of one valva. All views unmounted in natural position.

Etymology: Named in honor of Anna Cristina Bailey, who discovered the first specimen in Guatemala.

Remarks: The genus *Josiomorpha* has been created by Felder in 1874 to receive the species *longivitta* Felder, 1874 (Felder *et al.* 1874, Pl. 104, fig. 12) which is in fact a junior synonym of *penetrata* (Walker, 1865) originally described within the genus *Josia* Hübner, [1819], but this last genus belongs in fact to the Dioptidae family. Until the paper of Becker (2013), *Josiomorpha* contained the unique species *penetrata* (Walker, 1865) (= *longivitta* Felder, 1874). The species described by Becker (2013), *J. cathetozosta*, is indeed reminiscent of *penetrata* mainly by its bright yellow drawings on a jet black background. It seems to be an inhabitant of the high altitudes within cold and humid biotopes on the Pacific slope of the Central Cordillera. We collected two consecutive nights in May 2007 in the type locality at 2460 m and the species was so abundant that it was extremely strange to think this species was new! In fact we were so surprised that venation was studied in order to dismiss a Dioptidae species (M2 is not equidistant of M1 and M3, see Figure 1D). The COI sequence was established for two specimens and the difference between them and a male specimen of *Josiomorpha penetrata* was 7.1%, which is a high value. In order to identify this species we consult in 2008 the large collection of Hervé de Toulgoët housed in MNHN but without any result. Nevertheless we found an unique specimen of a very close but distinct species collected by Cristina Bailey in May 2002 at 2450 m in the province of Huehuetenango (Atlantic slope), see Figure 1B. After contact with our friend José Monzon, we received a small series of identical males from the same area confirming the presence of a new species close to *J. cathetozosta*. Hereafter we sequenced two fresh males and the distance between the two taxa is from 2.2 to 2.7%.

Even if these species are indeed reminiscent of *Josiomorpha* the shape of the drawings is different, there is a transverse subapical band in the two new species, absent in all *Josiomorpha* which in turn exhibit only a long and narrow yellow band from basis to termen on the forewings. Moreover the forewings are obviously larger than the long and narrow wings of *Josiomorpha*. We send the 4 sequences through the taxonomy browser of the BOLD project, *i.e.*, we align them with the full tree containing at least 800.000 Lepidoptera sequences. We obtained finally the following partial tree (see Figure 3) in which it is clear that the two new species cluster perfectly within the genus *Gnophaela* Walker, 1854, close but distinct from the genus *Josiomorpha* (the distance between the two new *Gnophaela* and *Josiomorpha penetrata* is between 7.3 and 7.8%). Moreover, the studied venation is identical to the one of *Gnophaela epicharis* and conform to the genus *Gnophaela*: R3 present on forewings (absent in *Josiomorpha*) and on hindwings, CuA1 anastomosed with M3, and CuA2 closest to CuA1 (see Figure 1D). In fact the two genera are extremely similar either from molecular data or from the genitalia features and after further studies of several new species pending description, they may be considered in the future only as subgenera. In this case *Gnophaela* will have priority. But for the moment, our new species is described within the genus *Gnophaela* under the name *Gnophaela baileyi* **sp. nov.** and the species described by Becker is transferred also to the same genus: *Gnophaela cathetozosta* (Becker, 2013) **comb. nov.**

Material examined for *Gnophaela cathetozosta* Becker 2013

14♂, Guatemala, Quetzaltenango, Fuentes Georginas, 9 & 10.V.2007, 2460 m, 14°45'00.66" N; 91°28'49.13" W, M. Laguerre *leg.* Two specimens have been barcoded: reference MILA0519 and 0964 (BIN = AAI7889) and one has been dissected reference Gen. ML1484. All *in coll.* M. Laguerre. 1♀, Guatemala, Sacatépéquez, NE slope of volcan Acatenango, 19-20.V.1979, 2000 m, 14°32' N - 90°51' W, Peter Hubbell *leg.*, *in* LACM.

Up to now the female was unknown but Julian Donahue found one specimen housed in LACM. The specimen was collected in the same area as all other known specimens: on the slopes of volcan Acatenango close to the city of Antigua (see Figure 1C). It is slightly different from the male: all wings are shorter and more rounded than male, the general coloration is duller and lighter and the anal black indentation of the hindwing border is largely more pronounced than in male.

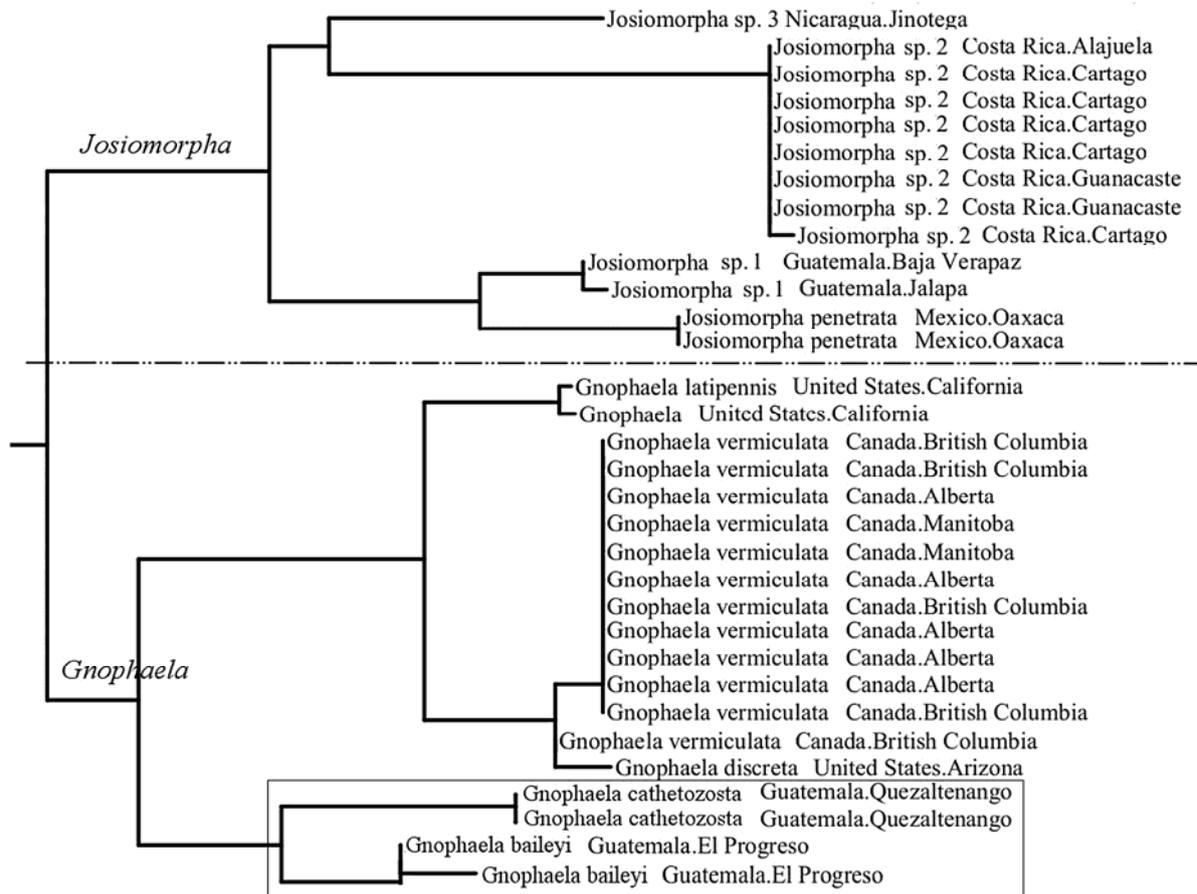


Figure 3. General tree of the *Gnophaela* Walker and *Josiomorpha* Felder genera, the two new species are in the boxed area.

***Dysschema faustinoi* Laguerre & Monzon sp. nov.** (Figures 5D-F)

urn:lsid:zoobank.org:act:5976E597-6DA2-4B98-8945-87399DAEB381

Diagnosis: Generally speaking a smaller and duller species than the similar *Dysschema intermedium* Becker, 2013. The red areas are largely reduced and the female is orange yellow and not pale rosy red. It is easy to differentiate this species from the closely allied *D. magdala* (Boisduval, 1870) by the largely hyaline forewing in male (basal half black in *D. magdala*), the conspicuous black patch at the end of the hindwing cell (absent in *D. magdala*) and the conspicuous yellow patches on the collar which are present in *D. magdala* and largely reduced in the new species.

Type material: Holotype: 1♂, Guatemala, Quetzaltenango, Fuentes Georginas, 9-10.V.2007, 2460 m, 14°45'00.66" N; 91°28'49.13" W, M. Laguerre *leg.* (white printed label) / Gen. ML1481 (white hand-written label) / MILA0514 (yellow printed label) / HOLOTYPE

(red printed label); BOLD access code ARCTA795-07/MILA0514 (BIN = AAB4229), deposited in MNHN, Paris. **Paratypes:** 7♂, all same data as holotype, two male specimens have been sequenced, BOLD access code: ARCTA825-07/MILA0544 & ARCTA826-07/MILA0545. All M. Laguerre leg. In coll. M. Laguerre. 1♂, 1♀, Guatemala, Quetzaltenango, Zunil, Fuentes Georginas, 2478 m, on the parking lot, 2.VII.2008, José Monzón leg. In coll. UVGC. 1♂, 1♀, Guatemala, Quetzaltenango, Zunil, Fuentes Georginas, 2400 m, 24-25-VIII-2001, José Monzón leg. In coll. A. C. Bailey & José Monzón. 2♂, 1♀, Guatemala, Jalapa, Pino Dulce, 2.VI.2009, 2380 m, 14°32'09.88" N; 90°09'17.39" W, J. Monzón leg. The female specimen has been sequenced, BOLD access code: ARCTC874-11/MILA1336. In coll. M. Laguerre. 2♂, Guatemala, Sacatepéquez, Cerro Alux, 2200 m, 10.V.2001. In Coll. J. Monzón. 1♂, Guatemala, Sacatepéquez, San Cristobal El Bajo, Finca El Pilar, 2000 m, 14°32'03.11 N 90°41'35.59 W, 12.VI.2009. In Coll. J. Monzón & B. Sutton. 1♂, Guatemala, Sacatepéquez, Antigua Guatemala, 1600 m, 26.IV.2000. In Coll. A. Bailey & J. Monzón. 1♂, Guatemala, Suchitepéquez, Santa Barbara, Ref. Quetzal UVG, 1600m, 29.III.2009. 14°32'30.42" N; 91°11'50.29" W. In Coll. Camposeco & Monzón. 2♂, Guatemala, Sololá, Santa Lucia Uatlán, 2499 m, Corazón del Bosque, 9.VIII.2009. 14°47'27.17" N; 91°15'47.76" W. In Coll. José Monzón. 2♂, Guatemala, Chimaltenango, Tecpan, 2700 m, 29.V.2008. 14°49'11.2" N; 91°00'24.7" W, J. Touroult leg. in B. Vincent Coll. 1♂, Guatemala, Chimaltenango, Tecpan, 2700 m, 06.VI.2008. 14°49'11.2" N 91°00'24.7" W, J. Touroult leg. BEVI 1221, in B. Vincent Coll. 1♂, Guatemala, Chimaltenango, Tecpan, 2700 m, 06.VI.2008. 14°49'11.2" N 91°00'24.7" W, J. Touroult leg. in B. Vincent Coll.

COI Sequence of the holotype:

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ACATTATATTTTATTTTGGGATTGAGCTGGGATAGTAGGAACCTCCCTAAGATTATTAATTCGAG
CGGAATTAGGTAACCCCTGGTCTTTAATTGGTGATGATCAAATTTATAATACTATTGTAACAGCCC
ATGCTTTTATTATAATTTTTTTTATGGTGATACCTATTATAAATTGGTGGATTTGGAAATTGATTAGTT
CCTTTAATGTTAGGGGCCCTGATATAGCTTTCCCCGAATAAATAATATAAGCTTCTGATTATTAC
CCCCATCTCTTACCTTATTAATTTCAAGAAGAGTTGTAGAAAATGGAGCAGGAAGCTGGTTGAACAG
TTTACCCCTCTTTTCATCTAATATCGCTCATAGAGGAAGATCTGTTGACTTAGCTATTTTCTCCCTT
CATTTAGCTGGTATTTTCATCTATTTTGGGGGCTATTAACCTCATTACTACAATTATTAACATACGAT
TAAATAGTTTAAACATTTGATCAAATACCTTTATTTGTTTGGAGCTGTTGGAATTACAGCATTTTTATT
ATTACTCTCCCTTCTGTTTTAGCTGGTGCTATTACTATATTATTAAGTATCGAAATTTAAATACTT
CATTTTTTGATCCTGCGGGGGGGGAGATCCAATTCCTTTATCAACACTTA
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Habitat: An inhabitant of the volcanic chain and the central highlands south of the Motagua river whereas *D. intermedium* seems to be confined to the central highlands north of the Motagua river (see map below).

Description

Male. Antenna bipectinate, black. Head black, frons covered by long dark grey hairs, some white hairs at the basis of antenna. Pterygodes black with one large lateral pale yellow spot, this spot formed outside by a rounded patch half white and half yellow and inside by a line of yellow hairs. Thorax black covered by long dark brown hairs. Below the thorax is covered by very long dark brown hairs mixed with yellow hairs on the coxae. Palpi dark grey, the two first segments covered with long dark brown hairs. Legs black very hairy, the femurs covered with long yellow hairs below, tarsi dark grey with some light grey scales, tarsi dark grey largely mixed with white below. Anterior pair of tibiae with one spine, the two last pairs with two spines. Abdomen red upperside and bright yellow underside, the two colors separated by a black lateral line, the yellow color is interrupted by a black line at the end of each segment.

The first segments covered by long dark brown hairs. A large median black band on the upperside, the last segment distally half black. The anal tuft russet orange.

Dorsal surface: clear almost transparent forewings with contrasting black veins. A whitish yellow spot at the very basis of the forewings with a dull red tiny dot on top. Forewings transparent, one oval black spot in the middle of the cell and a large quadrangular one at the end. The costa is narrowly dark from basis to the first spot and then in contact with the spot at the end of the cell. Apex largely dark grey leaving 3 clear spots distad to the cell spot. Border of the termen dark grey first narrow then increasing in width up to the tornus. Three quarters of the anal border with a rectangular dark grey band leaving the whole tornus completely clear. Hindwings clear, almost transparent with an elongated black spot at the end of cell, costa dull grey, termen with a narrow dark-grey border from apex to just before anal angle. Inside this border and in the center of each space, a pure white triangular spot finely bordered by a black line. Basad to the grey border a dull dark-red band internally lined with black and limited to the anal half of the termen. Sometimes this band is obsolete. The anal border is covered by dark grey hairs.

Ventral surface similar to dorsal surface but the dark markings with a brownish-red suffusion.

Forewing length: 26-32 mm (n=8) compared to 31-35 mm (n=9) for *D. intermedium*.

Male Genitalia: as usual within the whole genus *Dysschema*, male genitalia are deceptively similar and not very conclusive and those of *D. faustinoi* are difficult to differentiate from those of *Dysschema intermedium* Becker, 2013. Uncus subrectangular, very short, socii long, slender, slightly bent ventrally, with a pointed tip. Juxta oval. Valvae splitted into two distinct parts: a dorsal expansion slender and incurved with a sharp and slightly sclerotized end and a ventral expansion more straight, pointed and covered with long hairs. Sacculus almost absent. Aedeagus curved with an elongated S shape (almost straight in *D. intermedium*), the devaginated vesica displays a single rounded and slightly scobinated lobe bearing at the base an elongated highly sclerotized bar which is also present in *D. intermedium*.

Female. Antenna thin, black. Head, pterygodes, thorax as in male. Palpi dark brown, the two first segments covered with long dark brown hairs. Legs as in the male with the tibia spines slightly shorter. Abdomen as in the male with the median black line comparatively narrower. The anal tuft dull red admixed with black scales.

Dorsal surface: drawings similar to male but the wings are scaled. A whitish yellow spot at the very basis of the forewings with a dull red tiny dot on top. Forewings with the basal half up to the first spot in the cell greyish brown slightly clearer in the centre, the postmedian transparent area dusted with a central brownish-grey suffusion. Hindwings translucent pale orange yellow with a pinkish cast with an elongated black spot at the end of cell, costa dull grey, termen with a narrow dark-grey border from apex to just before anal angle. Inside this border and in the center of each space, a pure white triangular spot finely bordered by a black line. Basad to the grey border a light orange-red band internally lined with black going from anal angle to apex. The anal border is covered by dark grey hairs.

Ventral surface similar to dorsal surface but the dark markings with a brownish-red suffusion.

Forewing length: 33 mm (n=1) compared to 36-38 mm (n=3) for *D. intermedium*.

Etymology: Named after Faustino René Camposeco who collected a large number of specimens in Guatemala including several new species.

Distribution: The distribution of the two pairs of sister species (*Gnophaela cathetozosta/baileyi* and *Dysschema intermedium/faustinoi*) has been plotted on a Guatemala map (see Figure 6). It is then clear that the two slopes of the central highlands (at least at high altitudes) are different biogeographic areas with a high exclusive endemism. This has already been shown by Schuster *et al.* (2000) who have studied the endemism of the Passalidae family (Coleoptera) in the cloud forests of Guatemala. In fact starting around 1800/2000 m species found either on the Atlantic or on the Pacific slopes of the central highlands are very likely to be considered as fully endemic species.

Remarks: The genus *Dysschema* was created by Hübner in 1818 to receive his species *hypoxantha* described from Surinam. This is a large, extremely complex and heterogeneous genus largely in need of revision and encompassing at least 95 species of which 53 were classified *sensu lato* in the catalogue of Watson & Goodger (1986). The situation is further complicated by a very large sexual dimorphism and a noticeable difficulty to correctly associate sexes. In fact several pairs of male and female are described under two different names. Within the BOLD project we got an access to 397 barcodes of *Dysschema*. Following this large study, it seems that the situation is largely intricate in Central America mainly for two groups, namely the *magdala* and the *lycaste* groups. The two representative species: *i.e.*, *D. magdala* (Boisduval, 1870) from Guatemala and *D. lycaste* (Klug, 1836) from Mexico were in fact described on females making things really complex. Nevertheless, the *magdala* group is well characterized by conspicuous yellow spots on the lateral part of the pterygodes which are absent in the *lycaste* group. The species described by Becker (2013) under the name *D. intermedium* Becker, 2013 is part of the *magdala* group. The type was collected on the central highlands near Purulha and the species is common in the Quetzal's Biotope (Baja Verapaz) but also in the sierras of Zacapa and El Progreso departments (Cerro Monos and Cerro Piñalon). The species was also collected at high altitudes on the pacific slope namely at Fuentes Georginas and also in the San Marcos department but as a smaller and greyish form. We have collected this second entity at Fuentes Georginas where it is common but it was also collected in Jalapa, Zacatepéquez, Suchitepéquez and Sololà departments always at high altitude (between 1600 and 2500 m). All specimens are indeed smaller and duller compared to their counterparts collected on the central highlands. We have sequenced 12 specimens collected in Nicaragua and Guatemala with 7 specimens of *magdala* (see Table 1 for details), 2 of *D. intermedium* and 3 of the second entity (see below). It then appears clearly that the distance between the two entities collected either on the pacific or the central highlands in Guatemala (*i.e.*, 2.6%) is high enough to consider them as separate species (Figure 4). Moreover this result is corroborated by constant differences in the habitus and slight but noticeable differences in the genitalia, thus we decide to describe this second entity as a new species *Dysschema faustinoi* Laguerre & Monzon **sp. nov.**

Table 1. Data for *Dysschema magdala* (Boisduval) specimens used in the phylogenetic analysis.

Code	BOLD access code	Collecting data	Country, Province
MILA1132	ARCTC102-09	16.IV.2004	Nicaragua, Rio San Juan
MILA1133	ARCTC103-09	4.VIII.2000	Nicaragua, Rio San Juan
MILA0556	ARCTA837-07	16.V.2007	Guatemala, Izabal
MILA0550	ARCTA831-07	16.V.2007	Guatemala, Izabal
MILA0513	ARCTA794-07	18.V.2007	Guatemala, Izabal
MILA0158	ARCTA158-07	07.VIII.2002	Nicaragua, Granada
MILA0158	ARCTA158-07	4.VIII.2000	Nicaragua, Rio San Juan

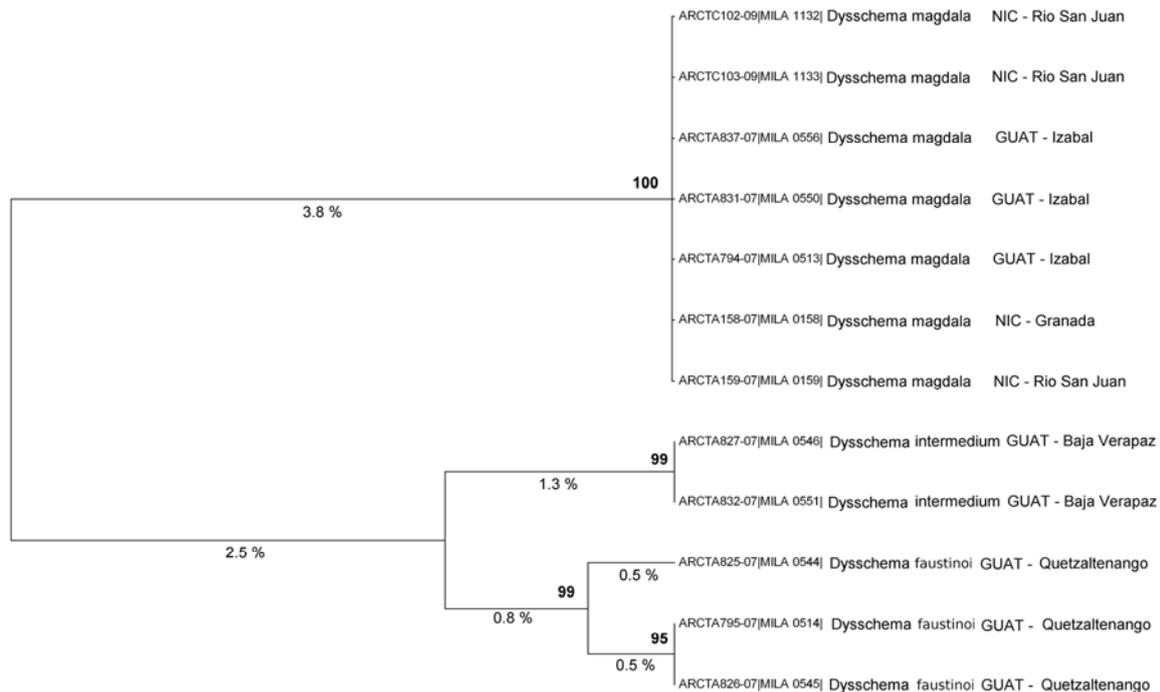


Figure 4. Neighbor-Joining Tree (Saitou & Neil, 1987) for the 12 specimens of the *Dysschema magdala* group from Central America. Distances in % are given below each branch and bootstrap supports are given above each branch (in bold case) (obtained with MEGA5, see Tamura *et al.* 2007).

Material examined for *Dysschema intermedium* Becker, 2013 (Figures 5A-C)

1♂, Guatemala, Zacapa, Cerro Monos, 1.3.VI.2009, 2250 m, 15°06'57.48" N; 89°41'07.48" W, J. Monzon *leg.* (white printed label) / MILA1329 (yellow printed label); BOLD access code ARCTC867-11/MILA1329, will be deposited in MNHN, Paris. 6♂, Guatemala, Baja Verapaz, Biotopo del Queltzal, Hotel Ranchitos, 14 & 23.VI.2007, 1680 m, 15°12'57.19" N; 91°13'10.53" W, M. Laguerre *leg.* two male specimens have been bar-coded, BOLD access code: ARCTA832-07/MILA 0551 & ARCTA827-07/MILA 0546. 1♂, 1♀, Guatemala, Baja Verapaz, Biotopo del Queltzal, Hotel Ranchitos, 11.VI.2009, 1650 m, 15°12'57.19" N; 91°13'10.53" W, J. Monzon *leg.* The male has been dissected, Gen. ML2040 and the female has been bar-coded, BOLD access code ARCTC871-11/MILA1333. 1♂, Guatemala, Zacapa, San Lorenzo Road, 30-IX-2008, 1800 m, 15°03' N; 89°40' W, J. Monzon *leg.* 1♂, Guatemala, El Progreso, Cerro Piñalon, 13.V.2010, 2566 m, 15°05'02.76" N; 89°56'34.00" W, J. Monzon *leg.* 2♀, Guatemala, Zacapa, Cerro Monos, 1-3.VI.2009 & 20.V.2010, 2250 m, 15°06'57.48" N; 89°41'07.48" W, J. Monzon *leg.* The second female has been dissected, Gen. ML2041. All *in coll.* M. Laguerre.

Discussion

Critical review of the taxonomic changes within the genus of the *Dysschema*

The 397 COI sequences obtained for the genus *Dysschema* represent 66 species which can be compared to the 93 actually known species for the whole genus. Moreover, this fairly good representation of the genus aligns entirely within an unique and very homogeneous cluster located at one extremity of the global Arctiinae tree of 11000 sequences. The closest neighbors are the genera *Chetone* Boisduval, 1870, *Hypocrita* Hübner, [1807] and the

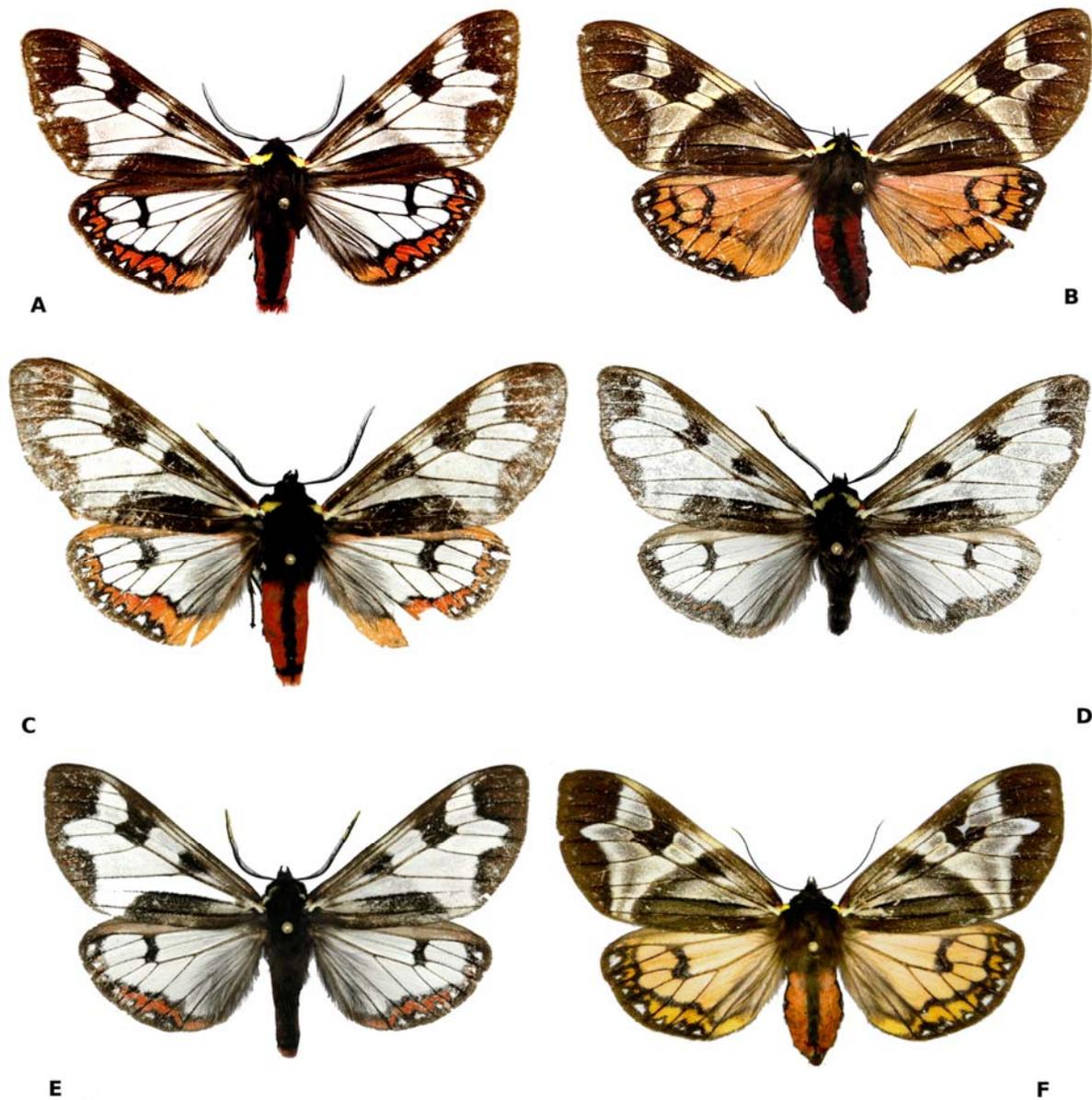


Figure 5. Adults of *Dysschema intermedium* Becker and *Dysschema faustinoi* Laguerre & Monzon sp. nov. **A–C**, *Dysschema intermedium* Becker; **A**, habitus of a male; **B**, habitus of a female; **C**, habitus of one extreme form; **D–F**, *Dysschema faustinoi* Laguerre & Monzon sp. nov. **D**, habitus of one extreme paratype; **E**, habitus of the holotype; **F**, habitus of the female paratype.

complex *Gnophaela/Josiomorpha* (see above), all typical Pericopini. All the *Dysschema* species represented by several sequences appear extremely homogeneous with an overall intra-cluster variation lower than 0.3-0.5%, the inter-cluster distances being always at least 2%. In addition, all of them can be differentiated morphologically after careful examination (habitus, genitalia). This leads to the conclusion that the classical 2% threshold is always valid for *Dysschema*. Thus the molecular data approach appears to be a valuable and complementary tool to target the problematic issues. Moreover it is the best tool to elucidate the sex pairing in complex situations.

In his paper Becker (2013) questionably synonymized a large number of species but without presenting any compelling data to support his decisions: no detailed genitalic figures,

no real distributional data, habitat or food plant information, no molecular or valid genetic data. Thus and even if some of his conclusions are accepted some of them should be regarded as speculative until each complex has been more thoroughly investigated.

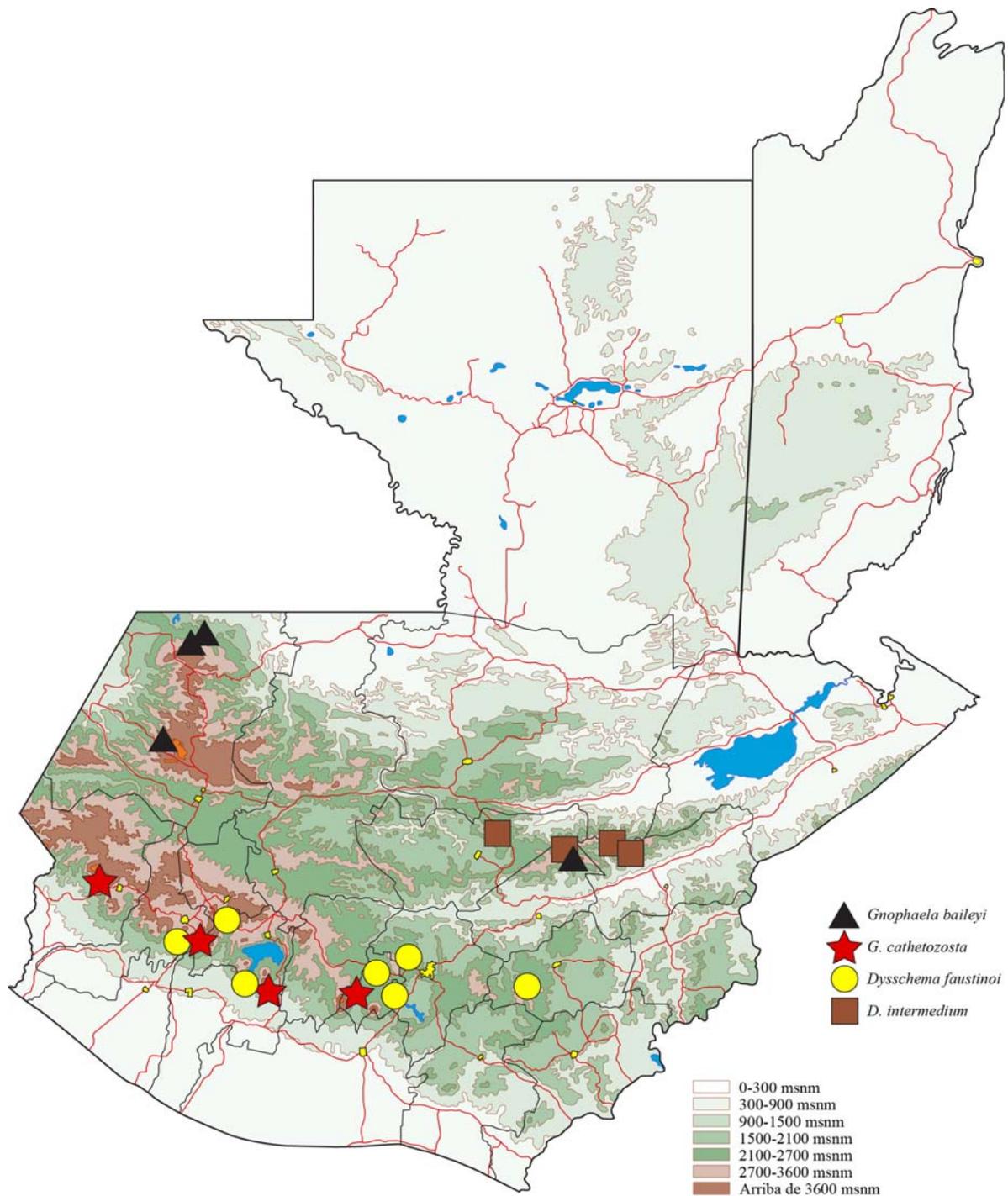


Figure 6. Distribution map of *Dysschema intermedium/faustinoi* and *Gnophaela cathetozosta/baileyi*.

In the following part we will discuss thoroughly some of his most controversial decisions using the molecular approach as a complementary analytical tool.

Dysschema amphissa/vestalis: in the paper of Becker (2013) *D. amphissa* (Geyer, 1832), *fenestrata* (Walker, 1855) and *D. vestalis* (Butler, 1871) were synonymized under the

name *D. amphissa*. *Dysschema amphissa* was originally described on an orange female whereas *D. fenestrata* and *D. vestalis* were described on two pure white males. However, there are series of immatures reared by Travassos at the MZSP that confirm the association of the orange female with at least one white male. Indeed the two males are very close but in the catalogue of Watson & Goodger (1986) they are considered as distinct. We had access to 7 sequences of specimens coming from south-east Brazil (Parana) and Argentina (Misiones) including one female similar to *D. amphissa*. They split clearly into two different groups distant by about 3.5% (4 sequences on one side BIN = AAV6466 and three on the second BIN = AAP4031) and so it seems that there are really two different species. Moreover the female clusters nicely within one group (BIN = AAV6466). The main problem is that the type of *D. amphissa* Geyer, 1832 is presumably lost and so it is very difficult to identify accurately this species. We can associate this female with one group of males but we are not sure that it represents really *D. amphissa*. So, for the moment, the association of females with the two different species remains open and further studies are needed. Moreover as the Geyer's taxon has priority it is impossible to take any decision of synonymy. Moreover, Becker (2013) fixed the "holotype" condition for *D. vestalis*, but there is no evidence of monotype, so a lectotype should have been designed. Finally we decided to maintain the current status for *Dysschema amphissa*, *D. vestalis* and *D. fenestrata*: *Dysschema amphissa* (Geyer, 1832) **stat. rev.**; *Dysschema vestalis* (Butler, 1871) **stat. rev.**; *Dysschema fenestrata* (Walker, 1855) **stat. rev.**

In the same publication by Becker (2013) *D. imitata* (Druce, 1910) and *D. titan* (Druce, 1910) are synonymized with *Dysschema arema* (Boisduval, 1870). In fact *D. imitata* and *D. titan* were described in the same paper by Druce (1910) and author being perfectly aware of the similarity with *D. arema* as he gave details on the main differences between the two species. *Dysschema imitata* is described from 10 males and 1 female, all collected from Peru between 1000 and 3300 m, a supplementary male collected in Brazil may not be conspecific. This also invalidates the fixed condition of holotype, established by Becker (2013). When Druce (1910) described *titan* on a unique female, he had in hand a female of *imitata* and so he decided to describe *titan* as new and different from *imitata*. In fact in the series in BNHM there are at least 3 females of *imitata* (including the original one) and they are extremely homogeneous and largely different from the holotype (and the 3 other females) of *titan* housed in the same drawer, mainly the background color which is brownish-yellow for *imitata* and greyish for *titan*. Moreover in *imitata* the large black spot at the end of the forewing cell is not linked to the dark marginal border of the wing whereas it is clearly linked below to the marginal border in *titan*. The median black transverse band has a very different shape in *imitata* and *titan*. Finally the subapical clear band of the forewing almost reaches the termen with a horizontal orientation in *imitata*, whereas it is oblique and far from the termen in *titan*. On the other hand *arema* has been described by Boisduval on an unique male coming from Nicaragua and he added he had also an other male coming from Venezuela, but the type housed in BMNH bears a label claiming Colombia so cannot be from the original series! Moreover the two original specimens were not found in the drawer. Nevertheless *arema* is well characterized by a very large and obvious black transverse median band on the forewings, which is present neither in *titan* nor in *imitata*. Moreover the bands of spots on the abdomen are vivid yellow in *arema* but bluish-gray in *imitata* and dull greenish-yellow in *titan*. Finally, *arema* is an inhabitant of Central America and the Pacific slope of South America (Occidente) and so cannot be synonymized with 2 species only present of the Atlantic slope of the Andes. So, we think it is wise to leave the nomenclature unchanged for these 3 species and maintain their status of full species: *Dysschema titan* (Druce, 1910) **stat. rev.**; *Dysschema imitata* (Druce, 1910) **stat. rev.**

Dysschema marianme/howardi (= *thetis*): In the paper of Becker (2013) and even if the author considers that there is only one species, he maintains finally the two species separated because they have been considered as distinct in the past (sic !). We have sequenced 10 specimens: 5 from Mexico (Michoacan, Jalisco and Sinaloa), 3 from Guatemala (Baja Verapaz and Suchitépéquez) and 2 from Nicaragua (Jinotega and Madriz). There are finally 2 groups of sequences with *D. howardi* (Edwards, 1887) on one side (Mexico) and *D. marianme* (Geyer, 1838) on the other (Guatemala and Nicaragua), the distance between these 2 groups is around 7.5%, which means widely separated species even if the genitalia are not conclusive. In this case we confirm that *D. marianme* and *D. howardi* are really largely distinct species and must be treated as such.

Dysschema viuda/joiceyi: These two species are synonymized by Becker (2013) without any explanation. *D. viuda* (Schaus, 1910) is described from Costa Rica (female holotype in USNM) and *D. joiceyi* (Dognin, 1923) is described from Bogotá (Colombia, female holotype in USNM). *D. viuda* has been reared by David Janzen in Guanacaste (Costa Rica) but not *D. joiceyi*. Indeed, the two types and all the series collected either in central America or on the pacific slope of south America are extremely similar but we have sequenced 3 specimens from western Ecuador (Pichincha, Esmeraldas), 1 specimen from Panama, 3 specimens from Guatemala (Izabal), 2 specimens from Costa Rica (Limon and Guanacaste) and we have seen almost 60 sequences from Costa Rica (Guanacaste and Alajuela) and the conclusion is clear: there are 2 sequences, one in central America and one in south America which differ by at least 4%, *i.e.*, the two species *D. viuda* and *D. joiceyi* seems to be valid and except new data cannot be considered as synonyms and we maintain their status of separate species: *Dysschema joiceyi* (Dognin, 1923) **stat. rev.**

Dysschema thyridina/talboti: in the paper of Becker (2013), *D. thyridina* (Butler, 1871) is synonymized with *D. talboti* (Dognin, 1922) along with *D. mosera* (Druce, 1907), *D. sylvia* (Druce, 1910), *D. damon* (Druce, 1910) and *D. grassator* (Hering, 1925). We have sequenced 4 specimens of *D. talboti* coming from western Ecuador (Cotopaxi and Pichincha). They cluster nicely within a very homogeneous group (BIN = AAE8234) and far from the other similar groups (from 2.5 to 4.2% and up to 9.3%) like *D. thyridina*, *D. mosera*, *D. grassator*. Moreover, *D. talboti* is from Rio Cauca *i.e.*, the extreme west of Colombia and then cannot be considered as a synonym of an amazonian species like *D. thyridina*! In fact, *D. thyridina* and *D. talboti* belongs to two distinct complexes. *Dysschema thyridina* is related to *mosera/moseroides/grassator* complex and on the other hand, *D. talboti* is morphologically related to *D. nigrivenata* (Hering, 1925) complex. The difference between the two complexes are that the species associated to *mosera/moseroides/thyridina* have cornuti on the vesica and the species associated to *talboti/nigrivenata* do not have. Finally, the group located on the amazonian slope of the Andes appear to be very complex and divided into at least 5 (maybe 7) species. Among these species it is extremely difficult to identify all these entities with the known taxa as *D. mosera*, *D. damon*, *D. sylvia*, *D. thyridina* or *D. grassator*. In fact, the number of entities recognized in our partial tree is already larger than the number of available names and so synonymizing all these species seems to be rather premature and further studies are urgently needed and so we maintain their current status of separate species: *Dysschema damon* (Druce, 1910) **stat. rev.**; *Dysschema grassator* (Hering, 1925) **stat. rev.**; *Dysschema mosera* (Druce, 1907) **stat. rev.** = *Dysschema sylvia* (Druce, 1910) **stat. rev.**; *Dysschema talboti* (Dognin, 1922) **stat. rev.**

Dysschema hilara/hilarina: these two entities are inhabitants of the southeastern part of Brazil and some adjacent areas. Large series of material belonging to the forms associated to this complex, involving *D. hilara* (Weymer, 1895), *D. hilarina* (Weymer, 1915) and *D. schadei* (Schaus, 1927), all of them collected at the same locality are deposited at the Federal

University of Curitiba (UFPC). They are largely similar species with the color of hindwings in the males ranging from yellowish to pinkish-red, the females being largely dimorphic. We got 4 sequences from southeastern Brazil (Parana) and northern Argentina (Misiones) with 3 males with pinkish-red hindwings and 1 male with yellowish-orange hindwings. There is a clear difference between the two colored forms by about 4% which can be considered as a large value (BIN = ABV8199 and AAI8836). So it seems that to classify all forms as synonyms is rather premature and it is wise to maintain the *status quo* until new data appear and so we maintain their status of separate species: *Dysschema hilarina* (Weymer, 1914) **stat. rev.** (subsp. *hilarina* (Weymer, 1914) = *Dysschema biformis* (Schaus, 1901a), subsp. *fulva* (Weymer, 1914))

Group of *Dysschema eurocilia*: in his paper Becker (2013) puts into synonymy at least 25 species and various forms under the oldest available name, *i.e.*, *D. eurocilia* Cramer, 1777. This is a rather unusual procedure because the consequence is the presence of only one very variable species with an extremely large distribution, in fact going from Guatemala to Paraguay from north to south, from the Pacific coast to the Guyanas and the coastal Maranhao from west to east and from sea level on the Atlantic coast to around 2500 m on the pacific slope of the Andes. Taking into consideration only the genital morphology, at least 4 species can be recognized: *D. molesta* (Hering, 1925), *D. eurocilia*, *D. aorsa* (Boisduval, 1870) and *D. bivittata* (Walker, 1854). We have sequenced more than 60 specimens in this very complex group and even if it is very difficult to get fresh specimens for all the species involved we reach the conclusion that at the opposite of the Becker's paper there is in fact a large number of very stable species, all with a very localized distribution. For instance *D. bivittata* (Walker, 1854) from Venezuela (2 males and 1 female, see Figure 7A) forms a very homogeneous group at a distance of 2.4% of the closest relatives (BIN = AAF6152). *Dysschema molesta* (Hering, 1925) (Colombia, Antioquia) is perfectly isolated at a minimum distance of 4.4% of the nearest neighbor (BIN = AAZ2663) (see Figure 7B). There is a complex cluster (BIN = AAF6152) encompassing specimens from south Bolivia (Tarija) and Argentina (Misiones) with females identical to *D. staudingeri* (Druce, 1910).

For *D. eurocilia* itself, the species seems to be from Surinam but the type is lost and an accurate identification is problematic as the figure in Cramer is very poor. Nevertheless some specimens have been collected in the Guyanas and the Maranhao and the only female we have seen (from Maranhao) compares fairly with the Cramer's picture. One male associated with this female has been sequenced and clusters with a small group of males from Paraguay (BIN = ABY9942) at a distance from 1.7 to 2.3% to the "*D. staudingeri*" cluster.

Finally the most problematic group is *D. aorsa* (Boisduval, 1870). In fact we received three years ago from Alex Bic a picture of a very strange bipartite gynandromorph with a right side similar to a male of *D. leucophaea* (Walker, 1854) and a left side similar to a female of *D. aorsa* (see Figure 7C). The main problem is that *D. leucophaea* is a well known species with a slightly divergent black and red female but, up to now, not associated at all with *D. aorsa*.

After sequencing more than 20 specimens including males and females of *D. leucophaea* (Guatemala, Nicaragua, Costa Rica), *D. cerialis* (Druce, 1884) (Panama and Costa Rica), females of *D. aorsa* (Guatemala and Nicaragua) and *D. lucretia* (Butler, 1875) (Panama) we concluded that we have in fact at least 4 different entities. Two of them exhibit males similar to *D. leucophaea* but with very divergent females and the two other forms exhibit males similar to *D. cerialis* also with very different females.

For the *D. leucophaea* group, one species has a female of the *D. aorsa* type (BIN = AAE8233) (the gynandromorph is very likely this entity, Figure 7D) and the second species

has a dimorphic female, either of the *D. lucretia* type or of the classical *D. leucophaea* female type (BIN = AAB3210, Figure 7E). For the moment it seems that *D. lucretia* is present in Panama whereas *D. leucophaea* is present in Costa Rica but sequences are identical. The distance between these two species is at least 4%.

We have also the same situation for *D. cerialis* with a classical *D. cerialis* entity in Costa Rica (BIN = ACF2551, Figure 7F) and a second entity present in Panama with a male similar to *D. cerialis* but a female similar to *D. leonina* (BIN = AAP8202, Figure 7G), but in this case the difference between these two entities is low (0.85 %). The localization observed for the different entities is maybe a consequence of the poor sampling and is perhaps not conclusive.

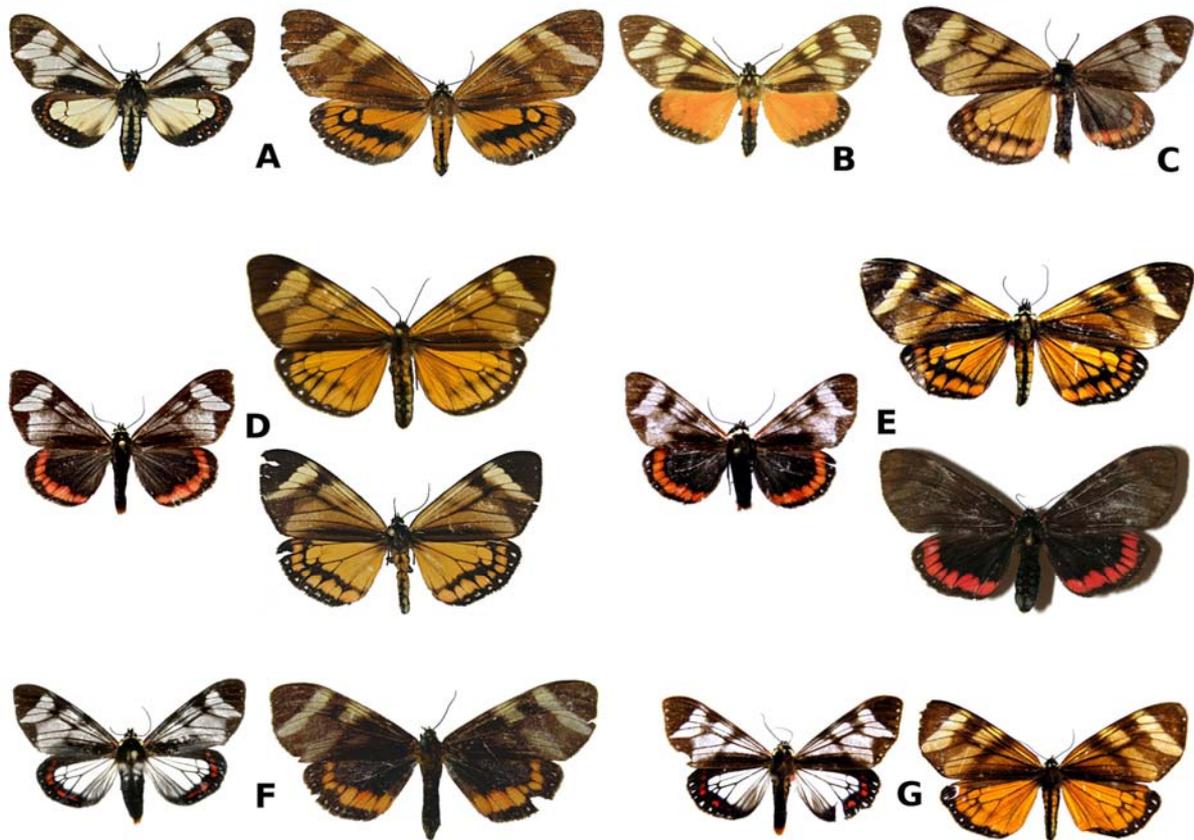


Figure 7. Adults of *Dysschema* Hübner. **A**, a pair of *D. bivittata* (Walker) from Venezuela; **B**, a male of *D. molesta* (Hering) from Antioquia (Colombia); **C**, a gynandromorph with a *D. aorsa* (Boisduval) left female part and a *D. leucophaea* (Walker) right male part; **D**, the *D. aorsa* (Boisduval) BIN entity AAE8233; **E**, the *D. leucophaea* (Walker) BIN entity AAB3210 with the classical form of femelle; **F**, the classical *D. cerialis* (Druce) pair BIN entity ACF2551; **G**, the BIN entity AAP8202 with a female similar to *D. leonina* (Butler).

The conclusion, here also, is that the situation is extremely complex and unless further deep studies it is wise to leave the nomenclature unchanged, moreover the exact identity of *europilia* which is the oldest available name is at best uncertain. So it is necessary to come back to the *status quo ante* in this group and maintain the current status of separate species for the whole entities concerned: *Dysschema anadema* (Druce, 1907) **stat. rev.**; *Dysschema aorsa* (Boisduval, 1870) **stat. rev.**; *Dysschema bivittata* (Walker, 1854) **stat. rev.** (=

Dysschema disjuncta (Walker, 1856) **stat. rev.**); *Dysschema daphne* (Druce, 1885) bona species **stat. rev.**; *Dysschema flavimedia* (Monte, 1933) **stat. rev.**; *Dysschema fulgorata* (Butler, 1871) **stat. rev.**; *Dysschema hypoxantha* Hübner, 1818 **stat. rev.** (= *Dysschema sibylla* (Butler, 1873) **stat. rev.**, subsp. *unxia* (Druce, 1910) **stat. rev.**); *Dysschema leonina* (Butler, 1872) **stat. rev.**; *Dysschema leptoptera* (Perty, [1833]) **stat. rev.**; *Dysschema molesta* (Hering, 1925) bona species **stat. rev.**; *Dysschema nigrivenata* (Hering, 1925) **stat. rev.**; *Dysschema parviplaga* (Hering, 1926) **stat. rev.**; *Dysschema postflava* (Hering, 1926) **stat. rev.**

In fact and at the opposite of what was thought up to now, the molecular genetic approach shows that the genus *Dysschema* is not constituted by an exaggerated number of species but simply by a large number of very stable and highly localized species and not by a very small number of variable and widely distributed species. For instance, it appears that there is not a single Pericopini in common between Guatemala and Costa Rica and even in a small country like Guatemala there is a large difference between the Atlantic and the Pacific slopes on the mountainous system (at least at high altitudes). The necessary review of the *Dysschema* genus must involve molecular phylogeny and immature studies in order to get completion. A very large number of new species are always pending description and the accurate pairing of all species will be a very hard task.

Acknowledgements

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