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Monograph

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Revision of the genus *Callipia* Guenée, 1858 (Lepidoptera, Geometridae), with the description of 15 new taxa

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Abstract. The vividly coloured Neotropical genus *Callipia* Guenée (1858) (Lepidoptera Linnaeus, 1758, Geometridae (Leach, 1815), Larentiinae (Leach, 1815), Stamnodini Forbes, 1948) is revised and separated into four species groups, according to a provisional phylogeny based on Cytochrome Oxidase I (COI) gene data and morphology. Fourteen new species are described using COI data and morphology: a) in the *balteata* group: *C. fiedleri* sp. nov., *C. jakobi* sp. nov., *C. lamasi* sp. nov.; b) in the *vicinaria* group: *C. hausmanni* sp. nov., *C. walterfriedlii* sp. nov.; c) in the *parrhasiata* group: *C. augustae* sp. nov., *C. jonai* sp. nov., *C. karsholti* sp. nov., *C. levequei* sp. nov., *C. milleri* sp. nov., *C. sihvoneni* sp. nov., *C. wojtusiaki* sp. nov. and d) in the *constantinaria* group: *C. hiltae* sp. nov., *C. rougeriei* sp. nov. One new subspecies is described: *C. wojtusiaki septentrionalis* subsp. nov. Two species are revived from synonymy: *C. intermedia* Dognin, 1914 stat. rev. and *C. occulta* Warren, 1904 stat. rev. The taxon *hamaria* Sperry, 1951 is transferred from being a junior synonym of *C. constantinaria* Oberthür, 1881 to being a junior synonym of *C. occulta* stat. rev. The taxon *admirabilis* Warren, 1904 is confirmed as being a junior synonym of *C. paradisea* Thierry-Mieg, 1904. The taxon *languescens* Warren, 1904 is confirmed as being a junior synonym of *C. rosetta*, Thierry-Mieg, 1904 and the taxon *confluens* Warren, 1905 is confirmed as being a junior synonym of *C. balteata* Warren, 1905. The status of the remaining species is not changed: *C. aurata* Warren, 1904, *C. brenemanae* Sperry, 1951, *C. parrhasiata* Guenée, 1858, *C. flagrans* Warren, 1904, *C. fulvida* Warren, 1907 and *C. vicinaria* Dognin. All here recognised 26 species are illustrated and the available molecular genetic information of 25 species, including Barcode Index Numbers (BINs) for most of the taxa is provided. The almost threefold increase from 10 to 26 valid species shows that species richness of tropical moths is strongly underestimated even in relatively conspicuous taxa. *Callipia* occurs from medium to high elevations in wet parts of the tropical and subtropical Andes from Colombia to northern Argentina. The early stages and host plants are still unknown.

Keywords. *Callipia*, taxonomy, Andes, insect, Neotropics.

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Introduction

Guenée (1858) described *Callipia parrhasiata* Guenée, 1858 in a new monotypic genus and illustrated this remarkable, vividly pink coloured species. The type was eventually deposited in the Natural History

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Museum (London). The locality is (according to its label) given as "Bengale" – obviously an error, since all confirmed records of species of *Callipia* are from the wet tropical Andes. In this revision, all specimens assigned to *C. parrhasiata* have been collected in a very limited geographic range in the eastern Andes of Ecuador. Only 23 years later the second species of the genus – *C. constantinaria* (Oberthür, 1881) – was described (Oberthür 1881). Twelve further taxa were described between 1904 and 1914 by Thierry-Mieg (1904), Warren (1904, 1905, 1907) and Dognin (1913, 1914), and two by Sperry (1951), reflecting a typical temporal pattern and peak of taxonomic activity around 1900 also found in many other Neotropical geometrid taxa (Gaston *et al*. 1995; Brehm *et al.* 2011; Brehm 2015). In their catalogue of geometrid moths, Parsons *et al.* (1999) treated 15 of these 16 taxa; only the taxon *C. confluens* Warren, 1907 is not listed in the catalogue, it was originally described as a form of *Callipia balteata* Warren, 1905. Parsons *et al.* (1999) recognised ten valid taxa and five junior synonyms.

Whenever possible, this paper aims to integrate results from external morphology, genitalia morphology and molecular genetics, i.e., from "DNA barcoding" of the Cytochrome Oxidase I (COI) gene. COI barcoding allowed a reliable match between males and females in several cases and eased the sorting of difficult species complexes considerably. In the large majority of cases, molecular and morphological results were congruent, but in some cases, DNA barcoding produced splits in taxa that were morphologically otherwise not distinguishable. I generally followed DNA barcoding results and applied a 2% threshold for the separation of species with the exception of the *C. milleri* – *wojtusiaki* complex. Barcode Index Numbers (BINs) were assigned to each species when available, a system that has been established by the Barcode of Life Data Systems (www.boldsystems.org) (Ratnasingham & Hebert 2013). Twenty-one different BINs are assigned to species of *Callipia* in this paper, thus covering 75% of the valid species. In one species complex, I assigned two different BINs not to different species, but to geographically separated subspecies. The BIN system allows a quick and reliable assignment of DNA-barcoded specimens. This is particularly valuable in cryptic and difficult species complexes in poorly known faunas (Brehm *et al.* 2016). Assignment of DNA barcodes to described species was performed by careful comparison of type material with freshly collected material (Brehm 2015; Brehm *et al.* 2016), and all relevant types and vouchers are illustrated in this paper. DNA-barcoded material also includes six old specimens collected between 30 and 100 years ago in a couple of cases where no fresh material was available (Strutzenberger *et al.* 2012).

Most historical descriptions of *Callipia* consist of a few text lines only that describe external characters and the colour patterns of the moths. Today, the study of external and internal morphological characters in combination with genetic characters and colour illustrations provides far better opportunities for taxonomy than ever. However, the wealth of options to describe a new taxon also means a burden for taxonomic work, because the description of species could include the study and illustration of dozens, if not hundreds of characters. If these are met at high standards, descriptions will not only fare better than in the past, but unfortunately, also consume much more time. Given the severe and rapid loss of biodiversity and the need of sound taxonomic information, especially in tropical regions, I here choose a treatment that focuses on diagnostic characters, high resolution illustrations with standardized scale bars and standard gene sequences. On the other hand, I have decided to waive extensive and detailed descriptions of characters that are diagnostically not valuable and/or plesiomorphic (Forum Herbulot 2014; Brehm 2015).

Callipia is assigned to the geometrid subfamily Larentiinae (Parsons *et al.* 1999). Viidalepp (2011) confirmed this position and further assigned *Callipia* to the tribe Stamnodini Forbes, 1948. Besides a butterfly-like vertically folded resting position of the wings (also found in, e.g., *Hagnagora* Druce, 1885 and *Heterusia* Hübner, 1831, see Brehm 2015), the Stamnodini are characterised by certain structures of the male genitalia (Viidalepp 2011). The author states that the juxta is shield-shaped and has a specific ornamentation, and the valvae have a strong costal hair lock (Viidalepp 2011). The placement in the

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Larentiinae was also confirmed by recent molecular phylogenetic analyses (Sihvonen *et al.* 2011; Õunap *et al.* 2016). The tribe Stamnodini (as represented by *Callipia*) is sister to the tribe Erateini Guenée, 1858 (as Erateinidae) (as represented by '*Trocherateina*' *cachara*) (Sihvonen *et al.* 2011; Viidalepp 2011). However, due to incomplete taxon sampling, phylogenetic relationships of *Callipia* and other Stamnodini within the Larentiinae Duponchel, 1845 require further examination.

Material and methods

Moths were pinned and dissected following established techniques (e.g., Lafontaine 2004; Hünefeld *et al.* 2013). Genitalia slides were embedded in Euparal, stained with Chlorazol Black and digitised at least 10 weeks after production using an Olympus dotSlide system with 10 × magnification. Adult moths were photographed on a neutral grey background in raw format using a 60 mm Nikkor macro lens mounted on a Nikon D700 camera. Photos were adjusted and colour plates were mounted using Photoshop and InDesign software (Adobe Systems, San José, USA).

Sequencing of the barcode fragment of the COI gene was carried out at the Canadian Center for DNA barcoding in Guelph, Ontario. Barcode sequences were compared by nearest neighbour analyses (Kimura 2 parameter), as implemented on the Barcode of Life Data Systems website (Ratnasingham & Hebert 2007). The resulting tree represents preliminary hypotheses of taxa groupings and can form the basis of future phylogenetic work (Brehm 2015) (Fig. 1). For eight old specimens, a six fragments approach was performed that was originally developed for Sphingidae (Lees *et al.* 2011; Rougerie *et al.* 2012), but also successfully applied to Geometridae (Strutzenberger *et al.* 2012). Distribution maps display only such specimens with original coordinate data on their labels, or specimens labelled with localities that could be found with reasonable certainty, e.g., using Google Earth software. Localities were checked using Lamas (1976), and in correspondence with Gerardo Lamas (personal communication, Peru) and Sebastian Herzog (personal communication, Bolivia). In order to keep an overview and to allow easy tracking of specimens for later analyses, every specimen that was investigated and did not already possess a unique museum identification number was labelled with an individual number, ranging from "Callipia-gb 0001" to "Callipia-gb 0432" (abbreviated as C-0001 to C-0432). Individual numbers were not provided for some of the existing type specimens. Genitalia slides were produced for ca 130 specimens. They are labelled for example "Genitalia slide Gunnar Brehm 399" (abbreviated GS-399). Sampling locations are generally ordered from north to south.

Museum acronyms

AMNH = American Museum of Natural History, New York, USA
CMNH = Carnegie Museum of Natural History, Pittsburgh, USA
MfN = Museum für Naturkunde, Berlin, Germany
MNHN = Musée national d'Histoire naturelle, Paris, France
MTD = Museum für Tierkunde, Dresden, Germany
MUSM = Museo Nacional de Historia Natural, Lima, Peru
NHM = Natural History Museum, London, United Kingdom
PMJ = Phyletisches Museum, Jena, Germany
RCGB = Research Collection of Gunnar Brehm, Jena, Germany (all specimens will eventually be deposited in a public museum)
SMF = Senckenberg Museum Frankfurt, Germany
SMNS = Staatliches Museum für Naturkunde, Stuttgart, Germany
USNM = National Museum of Natural History, Washington D.C., USA
ZMUC = Zoological Museum, University of Copenhagen, Denmark
ZMUJ = Zoological Museum of the Jagiellonian University, Krakow, Poland
ZSM = Zoologische Staatssammlung, Munich, Germany (including the Herbulot collection)

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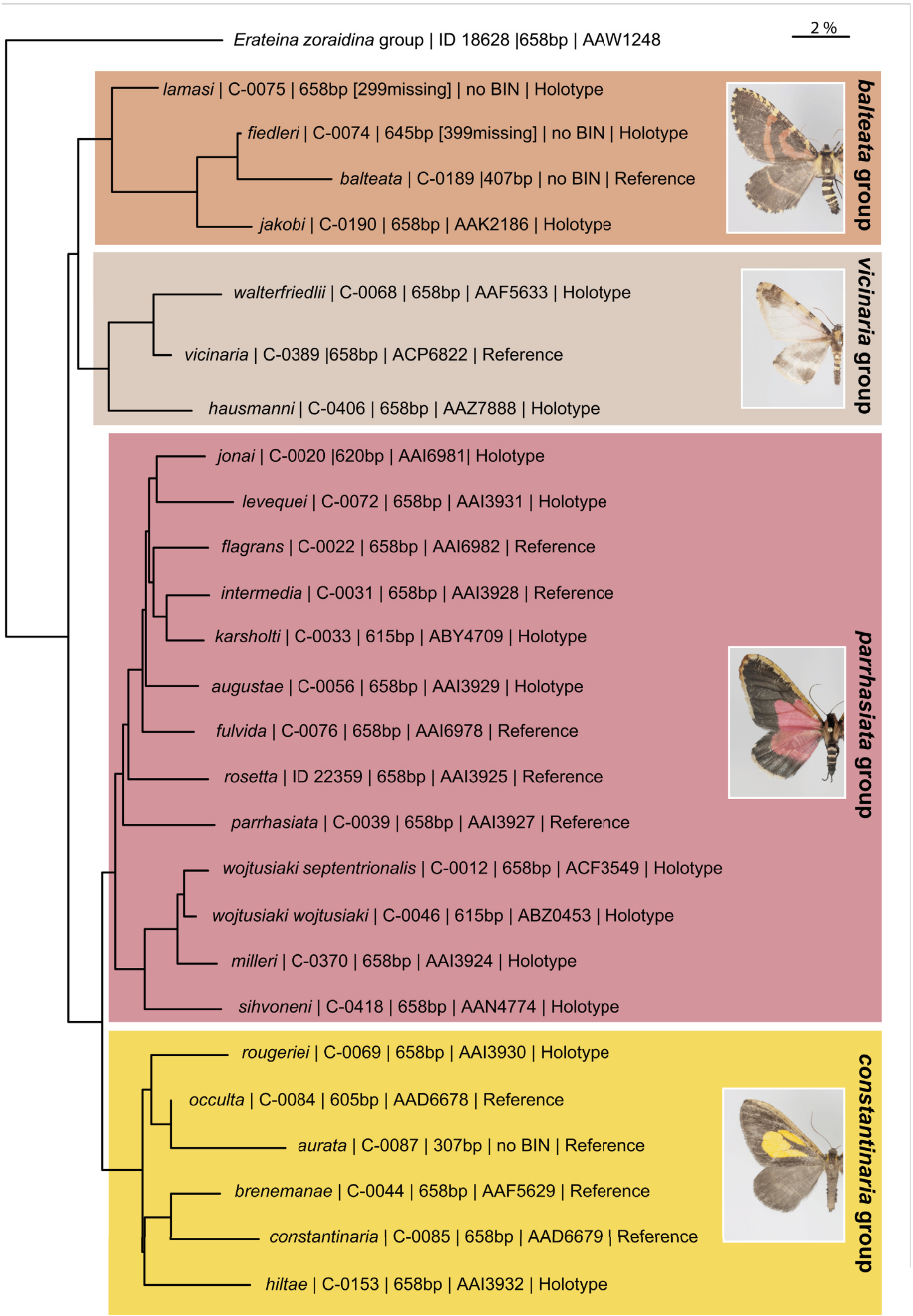

Fig. 1. Summary tree of the available molecular genetic data based on genetic COI barcodes using the Kimura 2 parameter implemented in BOLD systems. All valid species with the exception of *Callipia paradisea* Thierry-Mieg, 1904 are represented by the barcode data, either by type specimens or as reference specimens. The species name is followed by the individual identification number and the Barcode Index Number (BIN). A full tree is available in the supplementary material (Supplementary File 1).

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Localities are mostly quoted according to the original label, with my emendations between square brackets.

Results

In this paper, two taxa are revived from synonomy. With the addition of 15 new taxa, *Callipia* now comprises 26 valid species, one subspecies and 4 junior synonyms.

General short description

With its large size, typically shaped forewings and colourful wing patterns, *Callipia* forms a distinct group within the Neotropical Larentiinae that made assignment of newly described species to this genus easy. In contrast to most other Neotropical larentiin genera, all described species were originally assigned to the genus they are still assigned to. During visits to various museums holding Neotropical material, I have not come across species that need to be transferred to *Callipia*, either.

Compared to most other larentiines, *Callipia* are very large moths, with wing lengths ranging from ca 24 mm up to ca 32 mm. As a comparison, the three most species rich Neotropical genera *Eupithecia* Curtis, 1825, *Eois* Hübner, 1818 and *Psaliodes* Guenée, 1858 only reach wing lengths up to ca 13 to 14 mm.

Wings

Callipia are exceptionally colourful geometrids, most species possess wing patterns with large rosy-pink, yellow or red blotches on the wings. The function of these conspicuous colours is unknown, because the moths always rest with vertically folded wings, and their colourful patterns remain largely unseen, see Figs 135 and 137. They have this in common with related genera such as *Heterusia* Hübner, 1831, *Erateina* Doubleday, 1848 and *Hagnagora* Druce, 1885 (Brehm 2015). Many butterflies and other insects with striking colours during flight are well camouflaged when they rest. It is possible that that the conspicuous patterns are shown when the moths are disturbed, but this has not been observed so far. In other colourful Neotropical geometrid genera such as *Heterusia* and *Erateina* diurnal activity or activity at day and night was recorded (Brehm & Sullivan 2005). However, diurnal behaviour has so far to my knowledge not been documented in *Callipia*, but it is possible that the moths show their colours when disturbed, fly away and hide again well camouflaged.

Callipia can also be distinguished from other geometrids by their typically shaped forewings which are "higher than broad", i.e., the outer margin of the fore wing stretches longer than veins 1A+2A. While the fore wing pattern can vary considerably between species, the underside of the hindwings is rather uniform among most species of *Callipia*: with a dark brown background colour, they are ochreously striated in such a way that it resembles an irregular orb spider web. Similar striae also occur in the apical region of the underside of the fore wing – the only exception being *C. rougeriei* sp. nov. in which striae are completely reduced. Most species possess a cream white postmedial line on the underside of the hindwing, but it is largely reduced in the *constantinaria* group and widened to a large white blotch in *C. paradisea* Thierry-Mieg, 1904.

Colour

The ground colour in all species is dark to medium brown.

Head (illustrated by Viidalepp 2011)**, thorax and abdomen**

Appear not to possess particular characters that can be interpreted as an apomorphy of the genus. Head: proboscis, compound eyes and labial palpi are well developed, and the antennae are filiform in both sexes. Thorax: the tegulae are often light ochreous, contrasting with the dark brown scutum, the legs are usually

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brown. The tibia spur formula is 0–2–4 as found in most other Geometridae (Scoble 1992). Abdomen: tympanal organs are well developed. The colour of the abdomen in most species consists dorsally (and in some species also laterally) of alternate ochreous and brown rings in each segment, most prominently in the *balteata* group, but absent in several species, particularly in the *constantinaria* group.

Male genitalia

The valvae are broad and rounded, hemitranstilla (*sensu* Viidalepp 2011) are present, the juxta is shield shaped (Viidalepp 2011) and many species possess a spine-like process on the ventral margin of the valvae. The uncus is slender with a sharp or round apex, the sacculus is round. The aedeagus is enclosed in a sclerotized tube – the manica *sensu* Viidalepp (2011). The shape of the manica varies considerably between species.

Female genitalia

A signum is not visible on the corpus bursae, the lamella antevaginalis is small, sclerotised, often lunular; the ductus bursae is short, narrow and sclerotised; the ductus bursae is without sclerotisations, its shape varying from narrow and elongated to more roundish.

Preimaginal stages and host plants

Preimaginal stages and host plants are unknown.

Phylogenetic information summary

Figure 1 shows a summary tree with each DNA-barcoded species represented by one specimen per species. It visualizes similarities and differences in the COI gene between the different taxa and it was instrumental in differentiating four clades identified within *Callipia*. One species, *paradisea*, could not be reliably assigned to one of these clades. The four clades are subsequently treated as *balteata* group, *vicinaria* group, *constantinaria* group and *parrhasiata* group, named after the oldest available name in each of the clades. Table 1 provides an overview of all taxa, including available molecular genetic information and currently known distribution. Detailed information on all examined species can be found in Supplementary File 2. Further details for 150 specimens, including voucher images and molecular data, are publicly available in BOLD and can be accessed under https://doi.org/10.5883/DS-CALL2017

Distribution, habitats and behaviour

Specimens of *Callipia* were collected in Ecuador using blacklight and blacklight-blue tubes (Brehm & Axmacher 2005), and in Peru with a newly developed UV LED lamp (Brehm 2017). All specimens illustrated in Figs 131–139 were collected in this way and photographed either on the surface of the 'light tower', or in the vegetation next to the light source. Specimens of *Callipia* were often shy and escaped when they were disturbed. Figures 131 and 133, therefore, show benumbed specimens. Other investigated adult specimens have usually been collected with lamps as well, but in most cases this is not explicitly documented on the labels.

Figure 2 shows the distribution data of those specimens of *Callipia* with reliable locality information. In addition, a kml file (Supplementary File 3) allows to explore the distribution data in detail using Google Earth software. So far, examined specimens of *Callipia* have been collected in the Andes from Colombia (Boyacá, 5° N) to northern Argentina (Tucumán, 26° S). In Colombia and Ecuador, *Callipia* have been observed in both (wet) Cordilleras. However, further south, they are restricted to a narrow band along the Amazonian slopes of the Eastern Andes with wet montane forests, cloud forests and high elevation paramo and puna vegetation. Some of the habitats are illustrated in Figs 132, 136 and 138. *Callipia* appear to be restricted to humid areas, because none have been recorded in dry south western Ecuador, western Peru and Bolivia, or in Chile. Specimens of *Callipia* obtained from many museum

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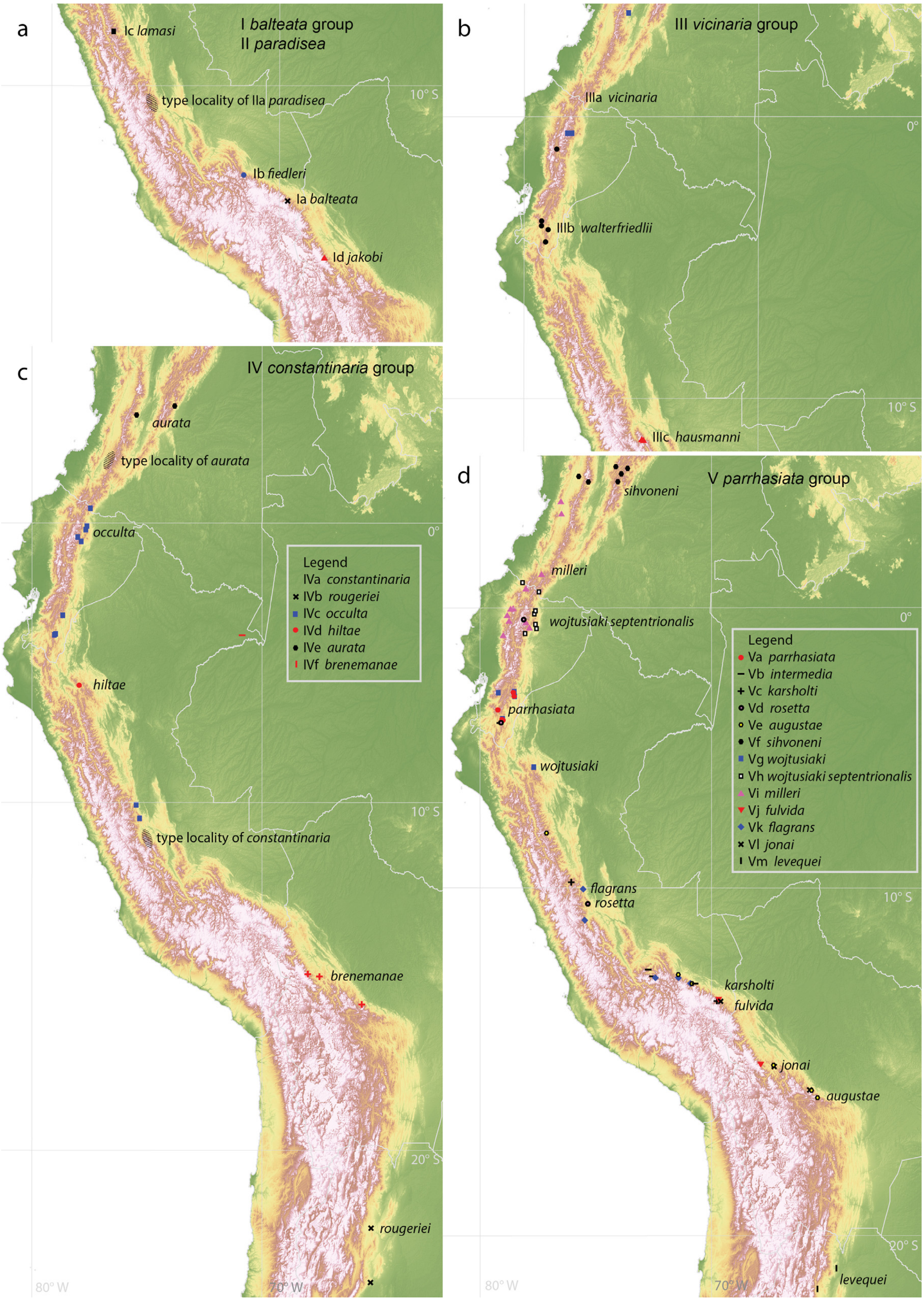

Fig. 2. Distribution maps. **A**. The *balteata* group and *Callipia paradisea* Thierry-Mieg, 1904. **B**. The *vicinaria* group. **C**. The *constantinaria* group. **D**. The *parrhasiata* group. More details can be retrieved from a Google Earth kml file (Supplementary File 3).

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Table 1 (continued on next page)**.** Overview of species of *Callipia* Guinée, 1858, available molecular genetic data, holotype depositories and coarse distribution data.

Nr	Taxon	COI information (base pairs)	BIN	Holotype *Callipia*-Nr.	Holotype depository	Distribution
I		***balteata* group**				**Central Peru to Bolivia**
Ia	*C. balteata* Warren, 1905	assigned, 407 bp	–		NHM	SE Peru (Puno)
	C. confluens Warren, 1907				NHM	
Ib	*C. fiedleri* sp. nov.	from holotype, 246 bp	–	C-0074	MUSM	SE Peru (Cusco)
Ic	*C. lamasi* sp. nov.	from holotype, 359 bp	–	C-0075	MUSM	Peru (San Martín)
Id	*C. jakobi* sp. nov.	from holotype, 658 bp	BOLD:AAK2186	C-0190	ZSM	Bolivia (La Paz)
II		**Not assigned**				**Central to SE Peru**
IIa	*C. paradisea* Thierry-Mieg, 1904	–	–		USNM	Central to SE Peru
	C. admirabilis Warren, 1904	–	–		NHM	
III		***vicinaria* group**				**Colombia to Central Peru**
IIIa	*C. vicinaria* Dognin, 1913	assigned, 658 bp	BOLD:ACP6822		USNM	Colombia to NE Ecuador
IIIb	*C. walterfriedlii* sp. nov.	from holotype, 658 bp	BOLD:AAF5633	C-0068	AMNH	Ecuador
IIIc	*C. hausmanni* sp. nov.	from holotype, 658 bp	BOLD:AAZ7888	C-0406	ZSM	Central Peru
IV		***constantinaria* group**				**Colombia to N Argentina**
IVa	*C. constantinaria* Oberthür, 1881	assigned, 658 bp	BOLD:AAD6679		NHM	Central to SE Peru
IVb	*C. rougeriei* sp. nov.	from holotype, 658 bp	BOLD:AAI3930	C-0192	AMNH	N Argentina
IVc	*C. occulta* Warren, 1904 stat. rev.	assigned, 658 bp	BOLD:AAI3932		NHM	Ecuador to Central Peru
	C. hamaria Sperry, 1951	–	–		AMNH	
IVd	*C. hiltae* sp. nov.	from holotype, 658 bp	BOLD:AAD6678	C-0054	ZSM	N Peru
IVe	*C. aurata* Warren, 1904	assigned, 397 bp	–		NHM	Colombia
IVf	*C. brenemanae* Sperry, 1951	assigned, 658 bp	BOLD:AAF5629		AMNH	Bolivia

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Nr	Taxon	COI information (base pairs)	BIN	Holotype *Callipia*-Nr.	Holotype depository	Distribution
V		***parrhasiata* group**				**Colombia to N Argentina**
Va	*C. parrhasiata* Guenée, 1858	assigned, 658 bp	BOLD:AAI3927		NHM	Ecuador
Vb	*C. intermedia* Dognin, 1914 stat. rev.	assigned, 658 bp	BOLD:AAI3928		USNM	SE Peru
Vc	*C. karsholti* sp. nov.	from holotype, 658 bp	BOLD:ABY4709	C-0033	ZMUC	SE Peru
Vd	*C. rosetta* Thierry-Mieg, 1904	assigned, 658 bp	BOLD:AAI3925		USNM	Ecuador to Central Peru
	C. languescens Warren, 1904	–	–		NHM	
Ve	*C. augustae* sp. nov.	from holotype, 658 bp	BOLD:AAI3929	C-0056	PMJ	S Ecuador to Bolivia
Vf	*C. sihvoneni* sp. nov.	from holotype, 658 bp	BOLD:AAN4774	C-0003	ZSM	Colombia
Vg	*C. wojtusiaki* sp. nov.	from holotype, 658 bp	BOLD:ABZ0453	C-0047	SMNS	S Ecuador to N Peru
Vh	*C. wojtusiaki septentrionalis* subsp. nov.	from holotype, 658 bp	BOLD:ACF3549	C-0016	CMNH	N Ecuador
Vi	*C. milleri* sp. nov.	from holotype, 658 bp	BOLD:AAI3924	C-0005	CMNH	S Colombia to N Ecuador
Vj	*C. fulvida* Warren, 1907	assigned, 658 bp	BOLD:AAI6978		NHM	SE Peru to Bolivia
Vk	*C. flagrans* Warren, 1904	assigned, 658 bp	BOLD:AAI6982		NHM	N to SE Peru
Vl	*C. jonai* sp. nov.	from holotype, 620 bp	BOLD:AAI6981	C-0020	ZSM	Bolivia
Vm	*C. levequei* sp. nov.	from holotype, 658 bp	BOLD:AAI3931	C-0071	MNHN	N Argentina
–		***Erateina zoraidina* group**				
–	*E. zoraidina*	no type specimen, 658 bp	BOLD:AAW12418			

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collections have not been sampled in northern Colombia and in Venezuela either, but this might reflect a sampling artifact. Many regions are still undersampled, such as large ranges of the Andes in northern and central Peru and in southern Bolivia. More sampling will certainly improve the knowledge of the distribution of *Callipia* and will inevitably reveal further undiscovered taxa. *Callipia* appears to be restricted to the Andes and is absent from Central America. It is a truly Andean taxon, similarly as, e.g., the *Acrotomodes clota* group (Ennominae Duponchel, 1845) (Brehm 2005). The most widely distributed clade is the *parrhasiata* group that ranges from Colombia to northern Argentina, with the highest species richness found in Peru. Similarly, widely distributed is the *constantinaria* group, but it has a smaller species richness. The other groups are geographically more restricted (Fig. 2).

Although there are records of *Callipia* from lowland tropical forests (e.g., 200 m in Madre de Dios, Peru and 450 m in Tena, Napo, Ecuador), these cases are exceptional and would need to be confirmed – mislabelling appears very likely. Most tropical species of *Callipia* are not found below 1500 m a.s.l. Some, such as species belonging to the *balteata* group, have only been recorded at elevations around or higher than 3000 m a.s.l.

The **balteata** *group*

The four known members of the *balteata* group possess two distinctive broad, deep rosy bands on the forewing; a pattern that is not found in other species of *Callipia*. The male valvae are round-shaped and do not possess the spine-like processes on the ventral margin that are present in all other groups of *Callipia*. The uncus is pointed. The aedeagi are bulkier than in other *Callipia*, the vesica is long and has a small series of cornuti. The species are restricted to high elevations in the wet eastern Peruvian and Bolivian Andes (observed: 1982–3450 m). All are represented by a single or very few specimens in museum collections only. Surprisingly, the *balteata* group consists of relatively many species, with small, but clear morphological differences besides supporting molecular information. One species was collected in Huánuco Province, Central Peru (*C. lamasi* sp. nov.), ca 850 km separated from the collection site of *C. fiedleri* sp. nov. (Peru, Cusco Province), separated by ca 250 km from the collection site of *C. balteata* (Peru, Puno Province) and separated by another ca 250 km from the collection site of *C. jakobi* sp. nov. (western Bolivia). The *balteata* group represents an example of an Andean high elevation clade with a large degree of local endemism. The females are still unknown.

Class Hexapoda Blainville, 1816
Order Lepidoptera Linnaeus, 1758
Superfamily Geometroidea Leach, 1815
Family Geometridae Leach, 1815
Subfamily Larentiinae Duponchel, 1845
Tribe Stamnodini Forbes, 1948
Genus *Callipia* Guenée, 1858

Callipia balteata Warren, 1905
Figs 3–5, 9–10

Callipia balteata confluens Warren, 1907: 243. (Fig. 5). **Syn. nov.**

No assigned BIN, but assigned 407 bp fragment.

Diagnosis

See the three other species of the group. COI-barcode: the observed distance to the genetically most similar species (*C. fiedleri* sp. nov.) is 3.3%.

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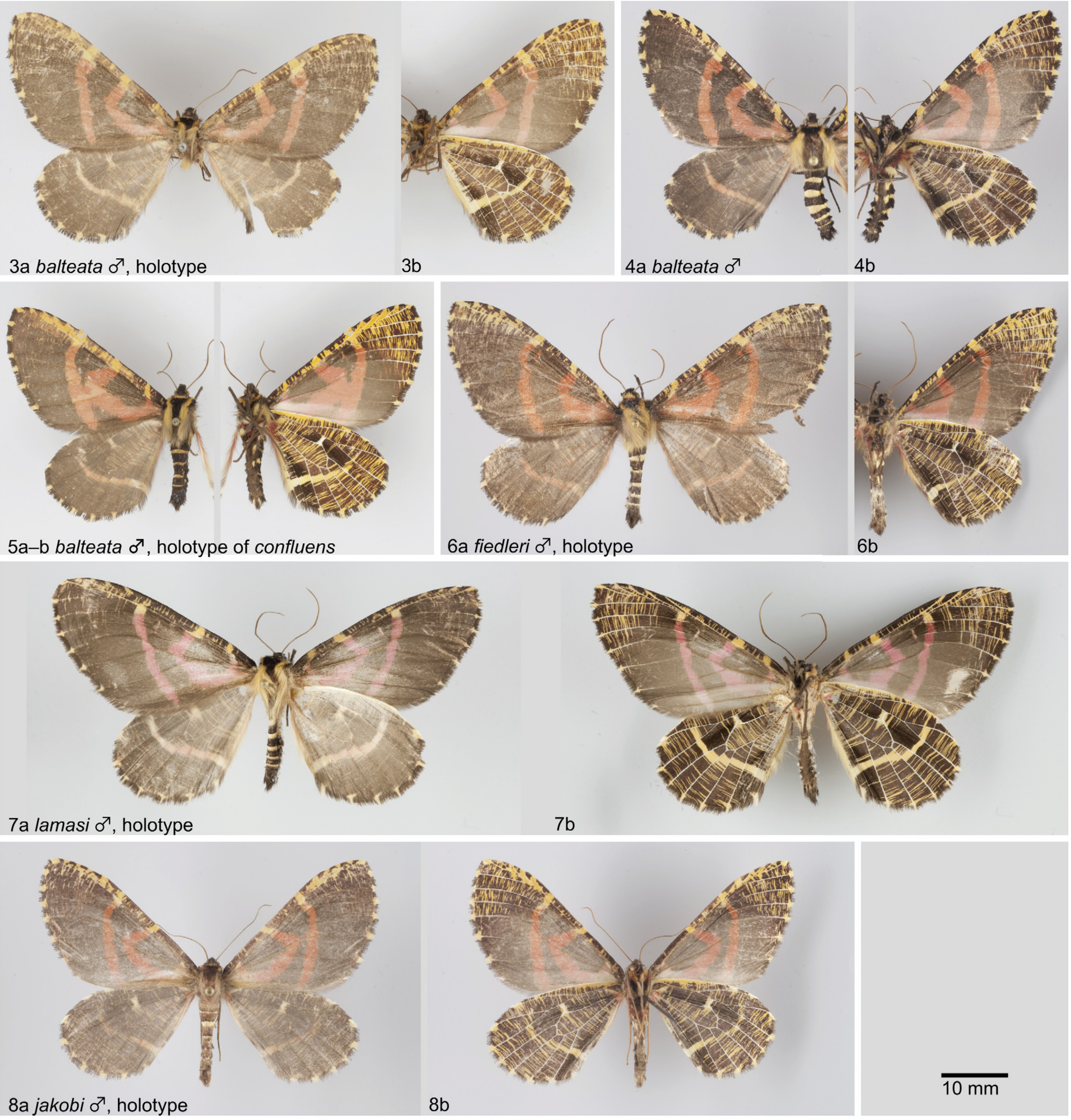
Type material

Holotype (Figs 3, 9)
PERU: ♂, south east Peru [Puno], Carabaya, Santo Domingo, 6500 ft [1982 m], Jan. 1902, dry season, [G.R.] Ockenden leg. (NHM).

Other type material
PERU: ♂, holotype of *balteata confluens* Warren, 1907 (Fig. 5), [Puno], Carabaya, Agualani, 9000 ft [2743 m], Mar. 1905, wet season, [G.R.] Ockenden leg. (NHM) [Originally as form].



Figs 3–8. Eight adult moths (a = dorsal view; b = ventral view). **3**. *Callipia balteata* Warren, 1905, ♂, holotype (NHM). **4**. *C. balteata* Warren, 1905, ♂ (C-0189, COI data). **5**. *C. balteata* Warren, 1905 (holotype of *C. confluens Warren, 1907*) (NHM). **6**. *C. fiedleri* sp. nov., ♂, holotype (C-0074, COI data). **7**. *C. lamasi* sp. nov., ♂, holotype (C-0074, COI data). **8**. *C. jakobi* sp. nov., ♂, holotype (C-0190, COI data).

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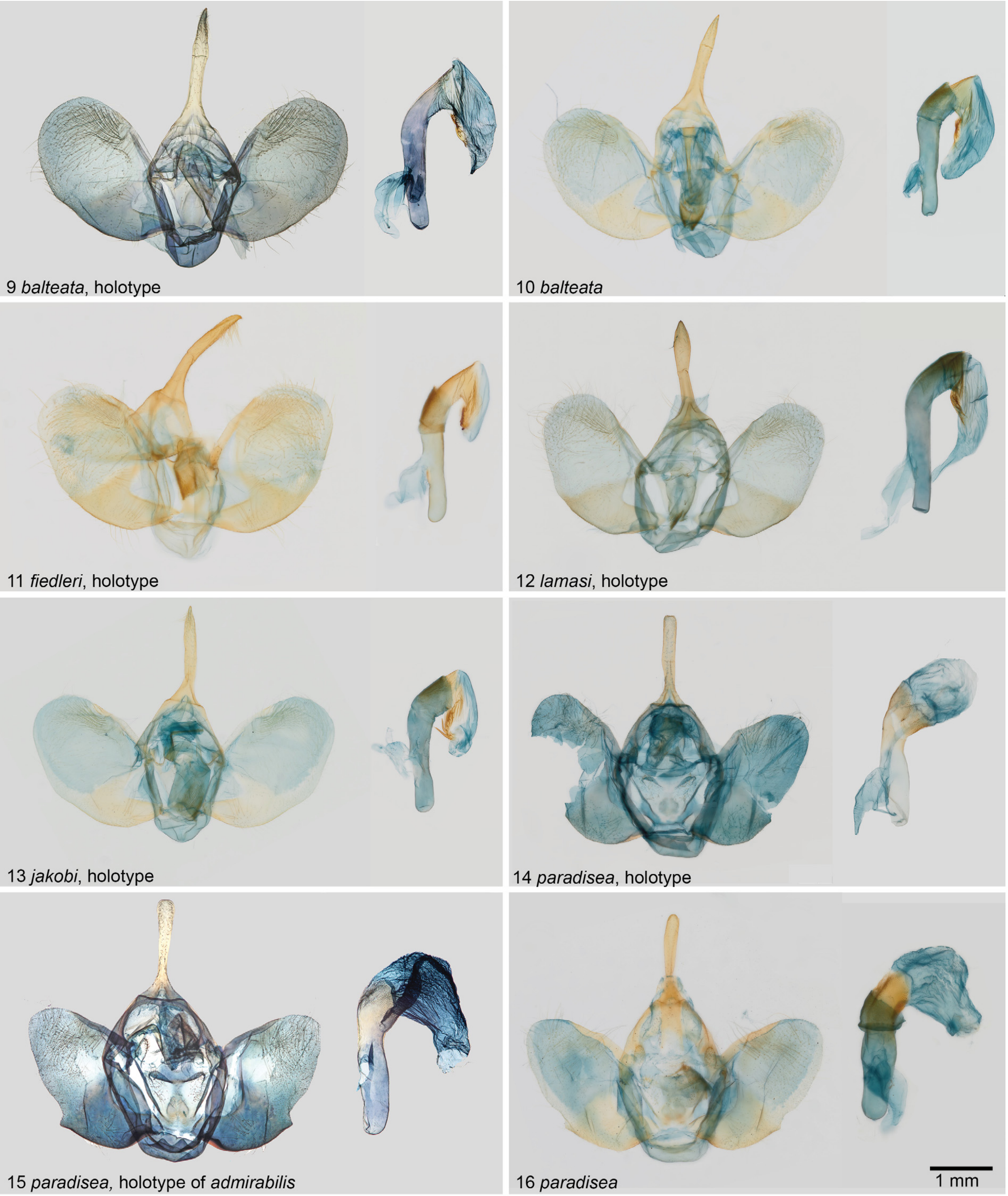

Figs 9–16. Male genitalia (left: valves, right: aedeagus). **9**. *Callipia balteata* Warren, 1905, holotype. **10**. *C. balteata* Warren, 1905 (C-0189, COI data). **11**. *C. fiedleri* sp. nov., holotype (C-0074, COI data). **12**. *C. lamasi* sp. nov., holotype (C-0075, COI data). **13**. *C. jakobi* sp. nov., holotype (C-0190, COI data) **14**. *C. paradisea* Thierry-Mieg, 1904, holotype (C-0194). **15**. *C. paradisea* Thierry-Mieg, 1904 (holotype of *C. admirabilis* Warren, 1904) (NHM). **16**. *C. paradisea* Thierry-Mieg, 1904.

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Other material examined

PERU: 1 ♂, Puno, 5 km E of Limbani, 3000 m (ZMUC) (C-0189 with GS-417, COI sequence: 407 bp, Figs 4, 10); 1 ♂, Carabaya, Agualani, 9000 ft [2743 m], Apr. 1905 (NHM) (C-0090).

Description

As illustrated. Female unknown.

Distribution

South eastern Andes of Peru, 2000–3000 m.

Callipia fiedleri sp. nov.

urn:lsid:zoobank.org:act:DBD4E060-1768-4EA1-970A-6A8651310369

Figs 6, 11

No assigned BIN but 246 bp fragments (399 bp gap).

Diagnosis

Similar to *C. balteata*, but the two bands on the forewing further apart, the cream white band on the hindwing underside is very narrow. Vesica of the aedeagus is shorter than in *C. balteata*. COI-barcode: the observed distance to the genetically most similar species (*C. balteata*) is 3.3%.

Etymology

The species is named in honour of Konrad Fiedler, Vienna, Austria.

Type material

Holotype (Figs 6, 11)

PERU: ♂, Cusco, Abra Acjanaco [13.201° S, 71.627° W], 3200–3450 m, 7 Jul. 1991, M. Medina leg. (MUSM) (C-0074 with GS-396, COI sequence: 246 bp [399 bp gap]).

Description

As illustrated. Only a single male is known.

Distribution

Only known from a single high-elevation locality in the south eastern Andes of Peru, 3200–3450 m, ca 250 km north-west of the collection sites of *C. balteata*.

Callipia lamasi sp. nov.

urn:lsid:zoobank.org:act:B6050BC5-F312-468D-87D0-1A90573BDB1E

Figs 7, 12

No assigned BIN, but holotype with COI 359 bp fragments [299 bp gap].

Diagnosis

The largest member of the *balteata* group, patterns strikingly contrasting, colour of the bands on the forewing upperside distinctly pink, and not red-brown as in the related species. The uncus is broader than in the other species. COI-barcode: the observed distance to the genetically most similar species (*C. jakobi* sp. nov.) is 6.0%.

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Etymology

The species is named in honour of Gerardo Lamas (MUSM), Lima, Peru.

Type material

Holotype (Figs 7, 12)
PERU: ♂, [San Martín], P.N. [Parque Nacional] Abiseo, Pampa del Cuy, 24 km NE of Pataz, [08.067° S, 77.236° W], 3380 m, 10 Aug. 1987, M. Romo leg. (MUSM) (C-0075 with GS, COI sequence 359 bp fragments (299 bp gap)).

Description

As illustrated. Only a single male is known.

Distribution

Only known from a single locality in the Central Eastern Andes of Peru, 3400 m, ca 850 km north west of the collection site of *C. fiedleri* sp. nov.

Callipia jakobi sp. nov.

urn:lsid:zoobank.org:act:3D00FE40-D169-4ED1-9CD8-B6424EF12955
Figs 8, 13

BIN (holotype): BOLD:AAK2186.

Diagnosis

The smallest species of the *balteata* group, relatively pale and less contrasting patterns of the wings than in the other species. The cornuti of the vesica are much longer than in the other species of the *balteata* group. COI-barcode: the observed distance to the genetically most similar species (*C. balteata*) is 4.3%.

Etymology

The species is named in honour of my son Jakob Brehm, Jena, Germany.

Type material

Holotype (Figs 8, 13)
BOLIVIA: ♂, [La Paz Department], Route La Paz-Rio Songo [Rio Zongo, ca 16.104° S, 68.065° W], 3300 m, 3 Mar. 1984, G. Lachaume and T. Porion leg. (ZSM) (C-0190 with GS-409, COI sequence 658 bp, BIN).

Description

As illustrated. Only a single male is known.

Distribution

Eastern Andes of W Bolivia, 3300 m a.s.l. Distance to the collection site of *C. balteata* is ca 250 km.

Without assignment to group

Callipia paradisea is known from a few specimens only. Wing patterns and structure of male genitalia not easily fitting into any of the other groups, but *vicinaria* group is possibly most closely related. Since no molecular data are available either, *C. paradisea* is provisionally treated separately.

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Callipia paradisea Thierry-Mieg, 1904
Figs 14–19

Callipia admirabilis Warren, 1904: 538 (confirmed junior synonym of *C. paradisea,* see Parsons *et al.* 1999) (Figs 15, 19).

No assigned BIN.

Diagnosis

Callipia paradisea is unmistakeable due to its unique mixed colour pattern of white, dark brown and extended rosy elements. The taxon *C. admirabilis* does not show any significant differences from the type specimen of *C. paradisea* and, therefore, remains in synonymy with *C. paradisea*. The other four species of the *vicinaria* group are smaller than *C. paradisea*. Male genitalia: a spine-like process on the ventral margin of the valvae is present, but short and blunt. The aedeagus is broader than in most other species, the manica is slightly bent, and the vesica does not possess cornuti.

Type material

Holotype (Figs 14, 17)
PERU: ♂, [Pasco], Huancabamba, 6000–10000 ft [1829–3048 m], 1903 (C-0194 with GS-291) (USNM).

Other type material
PERU: ♂, holotype of *C. admirabilis* Warren, 1904 (confirmed junior synonym of *C. paradisea*) (Figs 15, 19), Peru, [Pasco], Huancabamba, Cerro de Pasco, [E.] Böttger leg. (NHM).

Figs 17–19. Adult moths, ♂♂ (a = dorsal view; b = ventral view). **17**. *Callipia paradisea* Thierry-Mieg, 1904, holotype (C-0194). **18**. *C. paradisea* Thierry-Mieg, 1904 (C-0195). **19**. *C. paradisea* Thierry-Mieg, 1904 (holotype of *C. admirabils* Warren, 1904) (NHM).

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Other material examined

PERU: 1 ♂, [Pasco], Huancabamba, 6000–10000 ft [1829–3048 m] (NHM) (C-0196); 1 ♂, [Cusco], Paucartambo (ZMUC) (C-0063); 2 ♂♂[Puno, Carabaya], Agualani, 9000 ft (SMF) (C-0093 with GS-402; C-0195 with GS-413, Figs 16, 18).

Description

As illustrated. The female is unknown.

Distribution

Eastern Andes of central and south eastern Peru, 1800–3100 m.

Remarks

Only a few specimens of *C. paradisea* exist in collections. No recently collected material has been available for DNA barcoding and it failed in an old specimen.

The vicinaria *group*

This group comprises three species. The moths are on average smaller than members of the other groups. Wings are composed of cream white, ochreous, dark brown and rosé elements. The male valvae have more pronounced spine-like processes on the ventral margin than species of the other groups. The vesicae do not possess cornuti. All species show a pronounced sexual dimorphism that is possibly an apomorphy of the group. The females have a dark grey ground colour with ochreous patterns; the female of *C. hausmanni* sp. nov. more resembles those of the *parrhasiata* group. Females of this group are therefore illustrated on a separate plate. Species are distributed from Colombia to central Peru but not further in the south (Fig. 2b).

Callipia vicinaria Dognin, 1913
Figs 20–23, 30–31, 36, 39

Assigned BIN: BOLD:ACP6822.

Diagnosis

Callipia vicinaria is one of the smallest known species of *Callipia*. It is closely related to *C. walterfriedlii* sp. nov. The spine-like processes on the ventral margin of the valvae are relatively short and the uncus is narrower than in the other closely related species. Other diagnostic characters are discussed in those species. COI-barcode: the minimum observed distance to the genetically most similar species (*C. walterfriedlii* sp. nov.) is 3.3%.

Type material

Syntypes (Figs 20, 30)
COLOMBIA: 3 ♂, [Tolima], Monte Tolima, 3200 m, [A.H.] Fassl leg. (USNM). One syntype investigated and designated as **lectotype**: C-0197 with GS-292.

Other material examined

COLOMBIA: 3 ♂♂, same data as lectotype, Jan. 1910 (NHM, ZMUC) (C-0092; C-0198 with GS-411, Figs 21, 31; C-0199); 1 ♂, [Tolima], Nevado del Tolima, 2850 m (ZSM) (C-0389, COI sequence 658 bp, BIN, Fig. 22).

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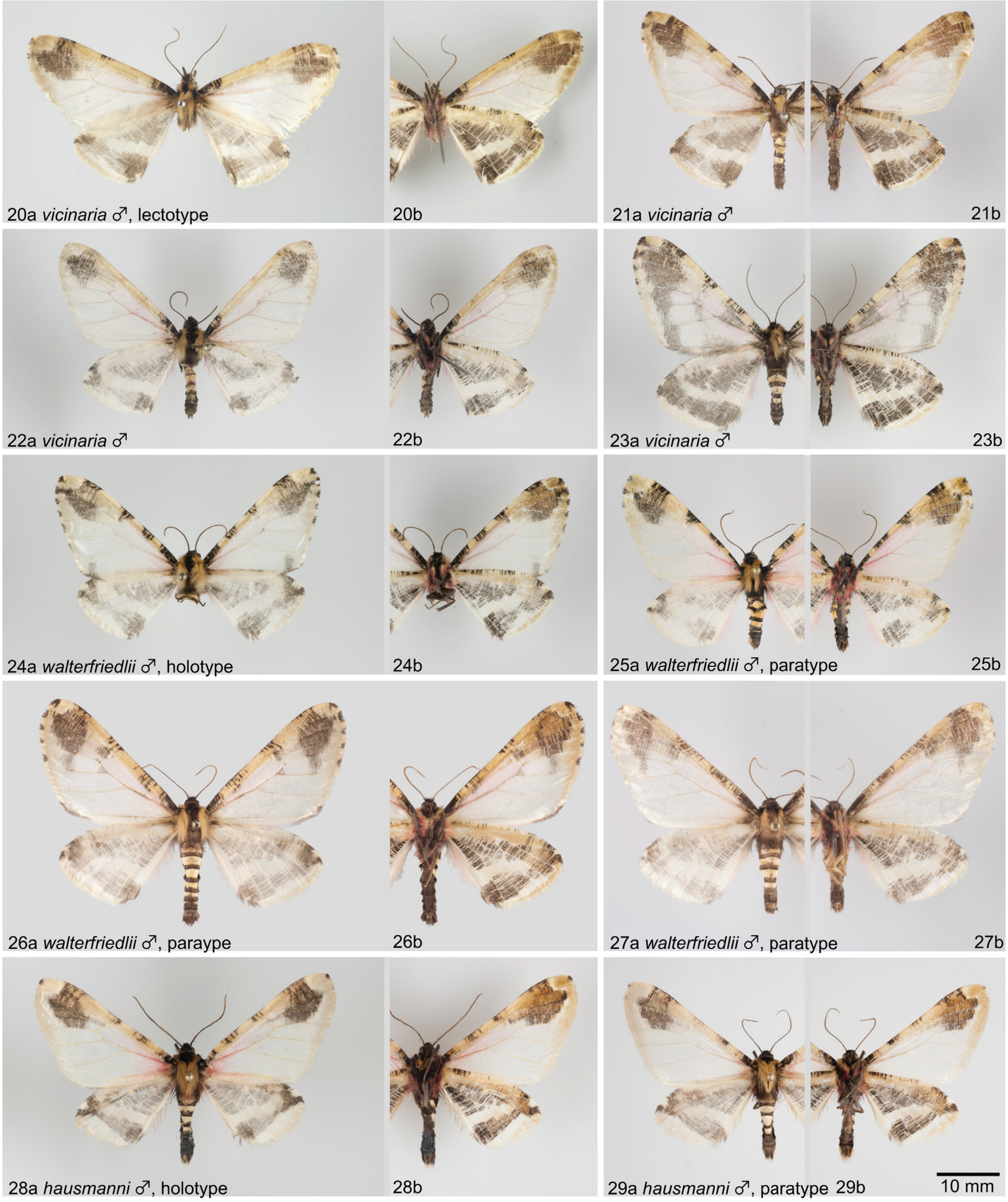

Figs 20–29. Adult moths, ♂♂ (a = dorsal view; b = ventral view). **20**. *Callipia vicinaria* Dognin, 1913, lectotype (C-0197). **21**. *C. vicinaria* Dognin, 1913 (C-0198). **22**. *C. vicinaria* Dognin, 1913 (C-0389, COI data). **23**. *C. vicinaria* Dognin, 1913 (C-0390, COI data). **24**. *C. walterfriedlii* sp. nov., holotype (C-0068, COI data). **25**. *C. walterfriedlii* sp. nov., paratype (ID 22342, COI data). **26**. *C. walterfriedlii* sp. nov., paratype (C-0065, COI data). **27**. *C. walterfriedlii* sp. nov., paratype (C-0207). **28**. *C. hausmanni* sp. nov., holotype (C-0406, COI data). **29**. *C. hausmanni* sp. nov., paratype (C-0413).

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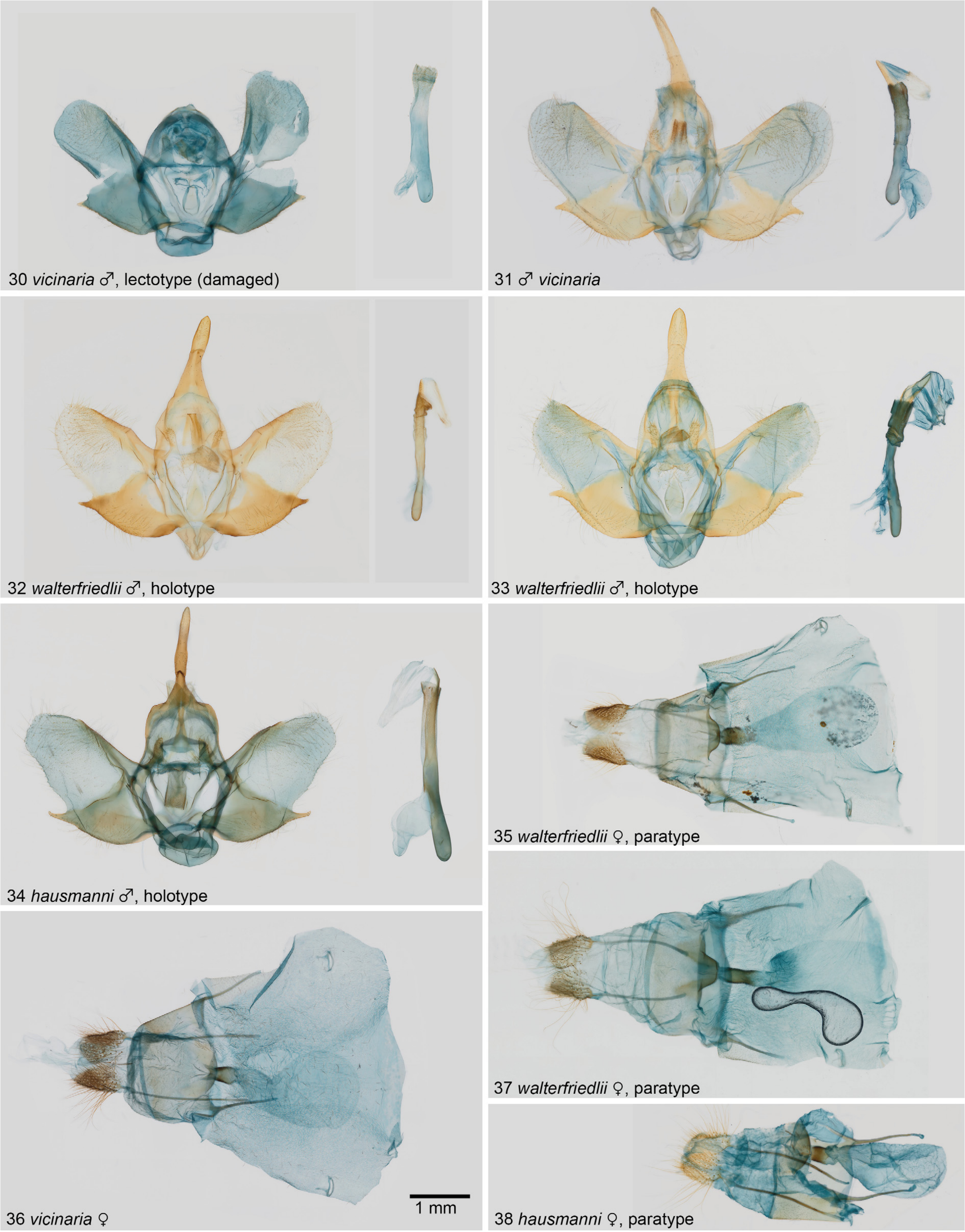

Figs 30–38. Male and female genitalia (left = valves; right = aedeagus). **30**. *Callipia vicinaria* Dognin, 1913, ♂, lectotype (C-0197). **31**. *C. vicinaria* Dognin, 1913, ♂ (C-0198). **32** *C. walterfriedlii* sp. nov., ♂, holotype (C-0068, COI data). **33**. *C. walterfriedlii* sp. nov., ♂, paratype (C-0065, COI data). **34**. *C. hausmanni* sp. nov., ♂, holotype (C-0406, COI data). **35**. *C. walterfriedlii*, ♀, paratype (ID 18948, COI data). **36**. *C. vicinaria*, ♀ (C-0393, COI data). **37**. *C. walterfriedlii*, ♀, paratype (C-0064, COI data). **38**. *C. hausmanni* sp. nov., ♀, paratype (C-0407, COI data).

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ECUADOR: 1 ♂, Napo, Papallacta, Rio San Pedro, 3010 m, 0.382° S, 78.124° W (RCGB) (C-0390, COI sequence 658 bp, BIN, Fig. 23); 1 ♂, 1 ♀, same data as previous (ZSM) (C-0391; C-0392); 1 ♀, same data as previous, but Cuyuja, 2525 m, 0.411° S, 78.022° W, (ZSM) (C-0393 with GS, COI sequence 547 bp (2 bp gap), BIN, Figs 36, 39)

Description

As illustrated. The extent of dark brown markings on the wings is more extended and pronounced in the Ecuadorian specimens (Fig. 23) than in the males from Colombia (Figs 20–22).

Distribution

Colombia, eastern Cordillera to north eastern Ecuador, 2500–3200 m.

Remarks

The female was unillustrated until now.

Callipia walterfriedlii sp. nov.

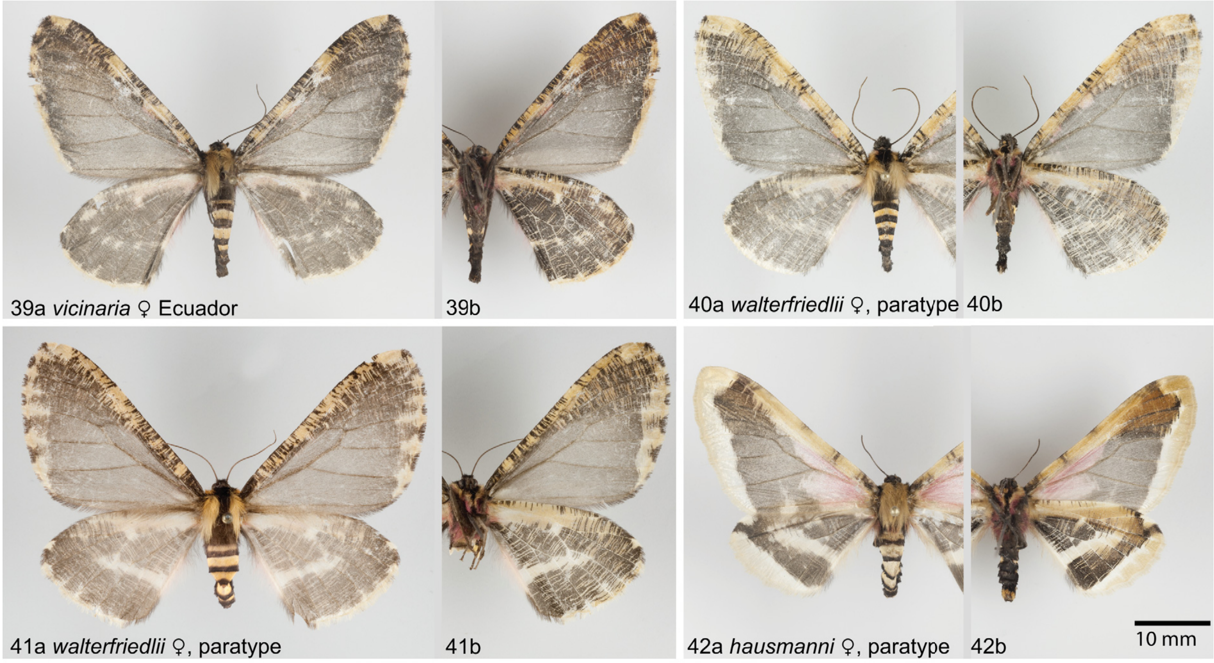
urn:lsid:zoobank.org:act:D1088620-C594-4A25-89F9-3C1F88F1814B

Figs 24–27, 32–33, 35, 37, 40–41, 132–134

BIN (holotype): BOLD:AAF5633.

Diagnosis

Callipia walterfriedlii sp. nov. has a similar wing shape and size like *C. vicinaria*. Diagnosis from *C. hausmanni* sp. nov., see there. Males tend to have a more contrasting pattern than *C. vicinaria*, particularly on the forewing costal area. The white transversal band on the hindwing is broader than in



Figs 39–42. Adult moths, ♀♀ (a = dorsal view; b = ventral view). **39**. *Callipia vicinaria* Dognin, 1913 (C-0393, COI data). **40**. *C. walterfriedlii* sp. nov., paratype (ID 18948, COI data). **41**. *C. walterfriedlii* sp. nov., paratype (C-0064, COI data). **42**. *C. hausmanni* sp. nov., paratype (C-0407, COI data).

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C. vicinaria. The females are very similar, but the extent of the ochreous colour in the forewing is larger. The uncus tends to be broader than in *C. vicinaria*. COI-barcode: the minimum observed distance to the genetically most similar species (*C. vicinaria*) is 3.3%.

Etymology

The species is named in honour of Walter Friedli, Schwarzenburg, Switzerland.

Type material

Holotype (Figs 24, 32)

ECUADOR: ♂, Loja [province], PN [Parque Nacional] Podocarpus, 04.115° S, 79.171° W, 2950 m, 11 Apr. 2000, S. Rab Green, M. Tapia leg. (AMNH) (C-0068 with GS-398, COI sequence 658 bp, BIN).

Paratypes

ECUADOR: 1 ♂ (Figs 27, 33), [Napo], km 48 de la route Salcedo-Rio Mulatos, [ca 1.033° S, 78.604° W], 3500 m, 5–6 Jan. 1975, C. Herbulot leg. (ZSM) (C-0065 with GS-421, COI sequence: 315 bp); 1♀, same data as previous (ZSM) (C-0064 with GS 419, COI sequence: 124 bp, Figs 37, 41); 4 ♂♂, same data as previous, but 7 Jan. [19]75, (ZSM, RCGB) (C-0204 with GS 097; C-0205 with GS-297; C-0207 (Fig. 27); C-0214); 5 ♂♂, 1 ♀, Cotopaxi, Rio Mulatos, 2200 m, 21 Mar. [19]71 (RCGB, PMJ, ZSM) (C-0208; C-0209 with GS 309; C-0210–0213); 2 ♂♂, Loja [province], 15 km N of Loja, road to Cuenca, disturbed forest and pastures, 3.825° S, 79.239° W, 2200 m, 25 Mar. 1993, Jan Hillman leg. (CMNH) (C-0066, COI sequence 658 bp, BIN; C-0067 with GS-309, COI sequence 658 bp, BIN); 1 ♂, Loja Province, Parque Nacional Podocarpus, Cajanuma, 4.114° S, 79.174° W, 2897 m, 26 Mar. 2011, L. Lehner and M. Adams leg. (RCGB) (ID 22342, COI sequence 658 bp, BIN, Fig. 25); 5 ♂♂, Loja [Province], 15 km N of Loja, road to Cuenca, 2200 m, 25 Mar. 1993, Jan Hillmann leg. (AMNH, CMNH, USNM) (C-0200 with GS-273; C-0201–0203; C-0215); 1 ♂, Loja [Province], Route Saraguro-Loja, 13 km N of San Lucas, 3130 m, 4 Mar. 1983, C. Lemaire and P. Thiaucourt leg. (ZSM) (C-0216); 1 ♀, Zamora-Chinchipe, Parque Nacional Podocarpus, Cerro Toledo, 4.386° S, 79.119° W, 2938 m, G. Brehm leg. (RCGB) (ID 18948 with GS, COI sequence 658 bp, BIN, Figs 35, 40); 3 ♂♂, same data as previous, but 4.380° S, 79.112° W, 3031 m, L. Möckel leg. (RCGB) (ID 18964, COI sequence 658 bp, BIN; ID 48464; ID 48465).

Distribution

Eastern Andes of Ecuador, 2200–3500 m.

Remarks

A living female is illustrated in Fig. 133, together with the habitat (Fig. 134).

Callipia hausmanni sp. nov.

urn:lsid:zoobank.org:act:2B092DCC-DA6D-420D-BF9E-BAC7073F34D6

Figs 28–29, 34, 38, 42

BIN (holotype): BOLD:AAZ7888.

Diagnosis

While males of *C. hausmanni* sp. nov. look rather similar as the other three species of the complex, the females are easily distinguished: only females of *C. hausmanni* sp. nov. possess broad cream white margins and a large pale rosy base of the forewing. The males have purely cream white fringes, a relatively intensive rosy basal area of the forewings and a more contrasting pattern of the hindwings than the related species. The male genitalia are characterised by a rectangular shape of the tegumen

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(rounded in the other species) and a narrower uncus. The spine-like processes of the valvae are long and slightly curved. COI-barcode: the minimum observed distance to the genetically most similar species (*C. vicinaria*) is 5.0%.

Etymology

The species is named in honour of Axel Hausmann (ZSM), Munich, a leading Geometridae expert in acknowledgment of his support for this study.

Type material

Holotype (Figs 28, 34)

PERU: ♂, Junín, near Calabaza village, 11.487° S, 74.888° W, 3350 m, 27 Jan. 2011, V. Sinyaev and A. Poleschuk leg. (ZSM) (C-0406 with GS, COI sequence 658 bp, BIN).

Paratypes

PERU: 1 ♀, same data as for holotype (ZSM) (C-0407 with GS, 658 bp, BIN, Figs 38, 42); 1 ♂, same data as for holotype (ZSM) (C-0408); 7 ♂♂, 1 ♀, same data as for holotype, but 11.493° S, 74.918° W, 3035 m, 29 Jan. 2011 (NHM, PMJ, RCGB, MUSM, ZSM) (C-0409–0412; C-0413, Fig. 29; C-0414–0416).

Description

As illustrated.

Distribution

Only known from high elevations in a small area of the Eastern Andes of central Peru, 3000–3400 m.

The constantinaria *group*

The six known members of the *constantinaria* group are easily recognised by their wing patterns: brown coloured with large deep yellow blotches on the forewing. Male valves are overall similar as in the *parrhasiata* group; the aedeagus is straight and slender without cornuti. The male genitalia within the group are rather similar and appear to be of little use for the diagnosis of species. *C. occulta* stat. rev. and *C. hiltae* sp. nov. form a cryptic species complex that can reliably only be distinguished by DNA barcoding. Species are distributed from Colombia to northern Argentina (Fig. 2c).

Callipia constantinaria Oberthür, 1881

Figs 43–44, 59

Assigned BIN: BOLD:AAD6679.

Diagnosis

The yellow blotch on the forewing is the smallest among all species of the *constantinaria* group. The male genitalia of the holotype are lost, but male genitalia are very similar among all species in the group. COI-barcode: the minimum observed distance to the genetically most similar species (*C. brenemanae*) is 3.9%. The most reliable identification method appears to be through DNA barcoding.

Type material

Holotype (Fig. 43)

PERU: ♂, [Junín?] Punamarca, 30 Jan. 1873, Constantin Jelski leg. (NHM). The genitalia are lost.

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Other material examined

PERU: 1 ♂, Cusco, Ollantaytambo-Quillabamba R[oa]d, km 158, [ca 13.148° S, 72.513° W], 2945 m (AMNH) (C-0085 with GS, COI sequence 658 bp, BIN, Figs 44, 59).

Description

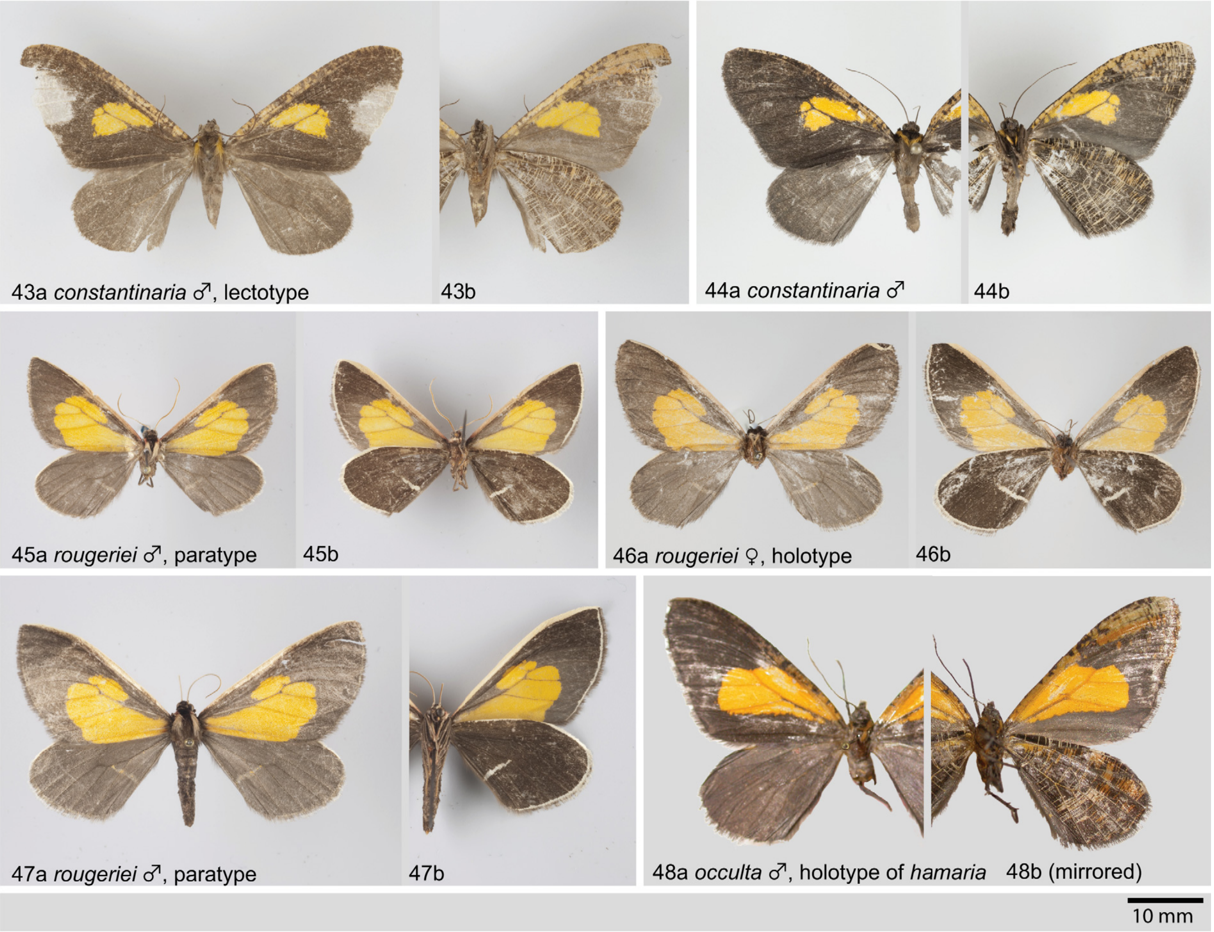
As illustrated. The female is unknown.

Distribution

Eastern Andes of central and south eastern Peru, 3000 m.

Remarks

Many museum specimens were identified as *C. constantinaria* but will often actually belong to *C. occulta* stat. rev. and other species. The female is unknown.



Figs 43–48. Adult moths (a = dorsal view; b = ventral view). **43**. *Callipia constantinaria* Oberthür, 1881, ♂, lectotype (NHM). **44**. *C. constantinaria* Oberthür, 1881, ♂ (C-0085, COI data). **45**. *C. rougeriei* sp. nov., ♂, paratype (C-0070, COI data). **46**. *C. rougeriei* sp. nov., ♀, holotype. **47**. *C. rougeriei* sp. nov., ♂, paratype (C-0192, COI data). **48**. *C. occulta* Warren, 1904 stat. rev., ♂, holotype of *C. hamaria* Sperry, 1951 (AMNH).

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Callipia rougeriei sp. nov.

urn:lsid:zoobank.org:act:CB1251FC-59DD-4945-8C06-D1C87834E903

Figs 45–47, 60, 123

BIN (holotype): BOLD:AAI3930.

Diagnosis

Unmistakable. Similar as other *constantinaria* group members, but striae on the underside of the wings completely reduced, and instead with dark brown ground colour (except for the yellow blotch). It has a light ochreous costa on forewing underside and a light ochreous marginal band on the underside of both wings. COI-barcode: the minimum observed distance to the genetically most similar species (*C. brenemanae*) is 4.7%.

Etymology

The species is named in honour of Rodolphe Rougerie, MNHN, Paris, France.

Type material

Holotype (Figs 46, 123)

ARGENTINA: ♀, Salta, Las Curtiembres, [ca 24.933° S, 65.333° W], 23–24 Feb. 1992, Luis P. Guzman leg. (AMNH) (C-0069 with GS-412, COI sequence 658 bp, BIN).

Paratypes

ARGENTINA: 2 ♂♂, Jujuy, Yala, [ca 24.183° S, 65.383° W], 1450 m, 20 Feb. 1955, J. Förster leg. (ZSM, RCGB) (C-0070 with GS-301, Figs 45, 60; C-0191); 1 ♂, Tucuman, Ciudad Universitaria, 800 m, 20 Feb. [19]59, J.F.G. Clarke leg. (AMNH) (C-0192, COI sequence 658 bp, BIN, Fig. 47); 1 ♂, Tucuman, R. Schreiter coll. (USNM) (C-0193).

Description

As illustrated.

Distribution

Eastern Andes of northern Argentina, 800–1500 m.

Callipia occulta Warren, 1904 stat. rev.

Figs 49–51, 61–62

Callipia hamaria Sperry, 1951: 161. (Fig. 48). **Syn. nov.**

Assigned BIN: BOLD:AAI3932.

Diagnosis

Callipia occulta stat. rev. was put into synonymy with *C. constantinaria* by Parsons *et al.* (1999), following Prout's catalogue in the British Museum (Natural History). However, the yellow blotch on the forewing is much more restricted in *C. constantinaria* than in *C. occulta* stat. rev., moreover, *C. constantinaria* appears to be a bit smaller than *C. occulta* stat. rev. The comparison of the genitalia is not possible since the final segments of the abdomen are missing in the holotype of *C. constantinaria*. Barcoding revealed two different BINs of *C. constantinaria*-like species from Peru. *C. occulta* stat. rev. and *C. hiltae* sp. nov. form a cryptic species complex, see *C. hiltae* sp. nov. COI-barcode: the minimum observed distance to the genetically most similar species (*C. aurata*) is 3.4%.

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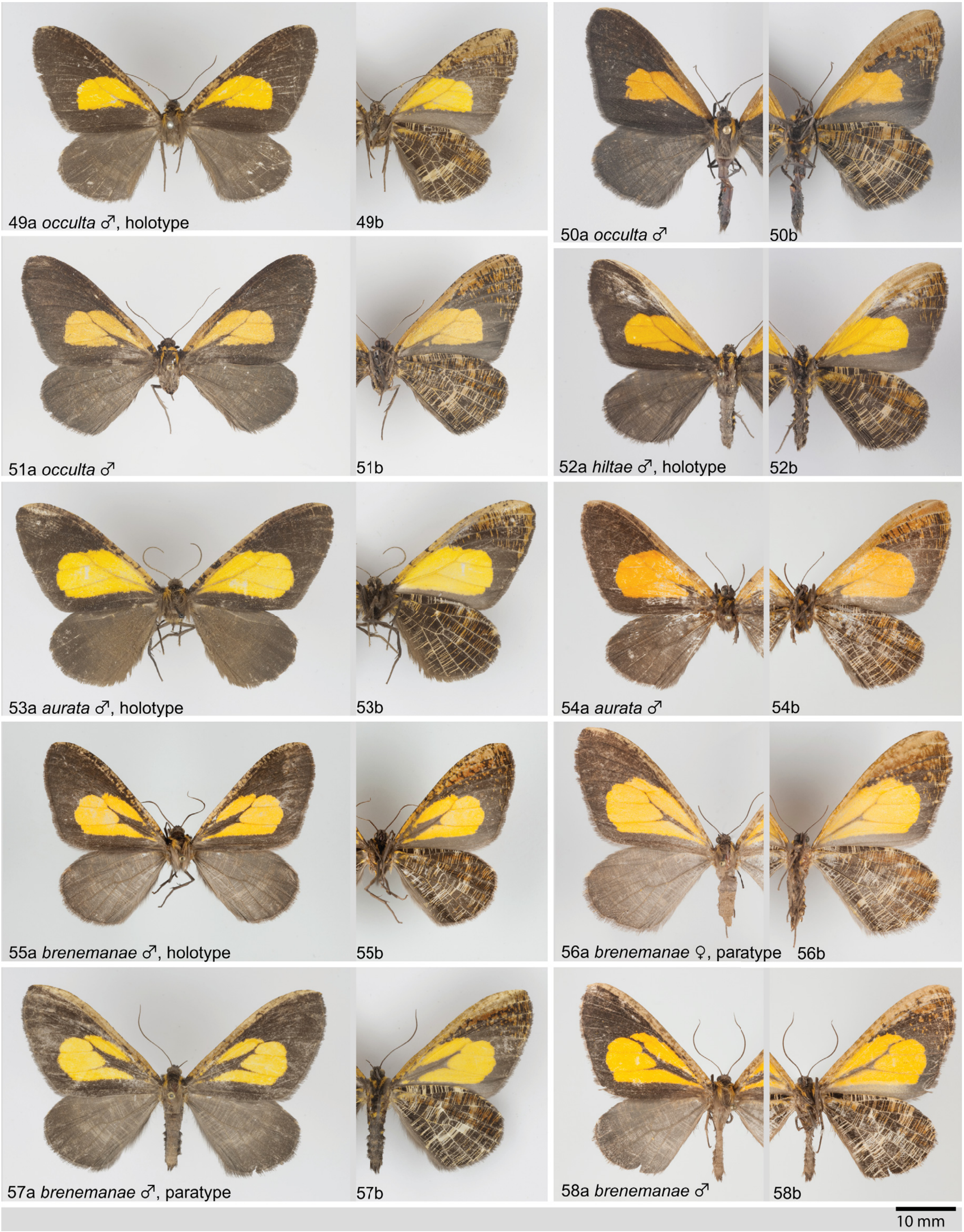

Figs 49–58. Adult moths (a = dorsal view; b = ventral view). **49**. *Callipia occulta* Warren, 1904 stat. rev., ♂, holotype (NHM). **50**. *C. occulta* Warren, 1904 stat. rev., ♂ (C-0159, COI data). **51**. *C. occulta* Warren, 1904 stat. rev., ♂ (C-0084, COI data). **52**. *C. hiltae* sp. nov., ♂, holotype (C-0153, COI data). **53**. *C. aurata* Warren, 1904, ♂, holotype (NHM). **54**. *C. aurata* Warren, 1904, ♂ (C-0087, COI data). **55**. *C. brenemanae* Sperry, 1951, ♂, holotype (C-0129). **56**. *C. brenemanae* Sperry, 1951, ♀, paratype (C-0130). **57**. *C. brenemanae* Sperry, 1951, ♂, paratype (NHM; C-0131). **58**. *C. brenemanae* Sperry, 1951, ♂ (C-0084, COI data).

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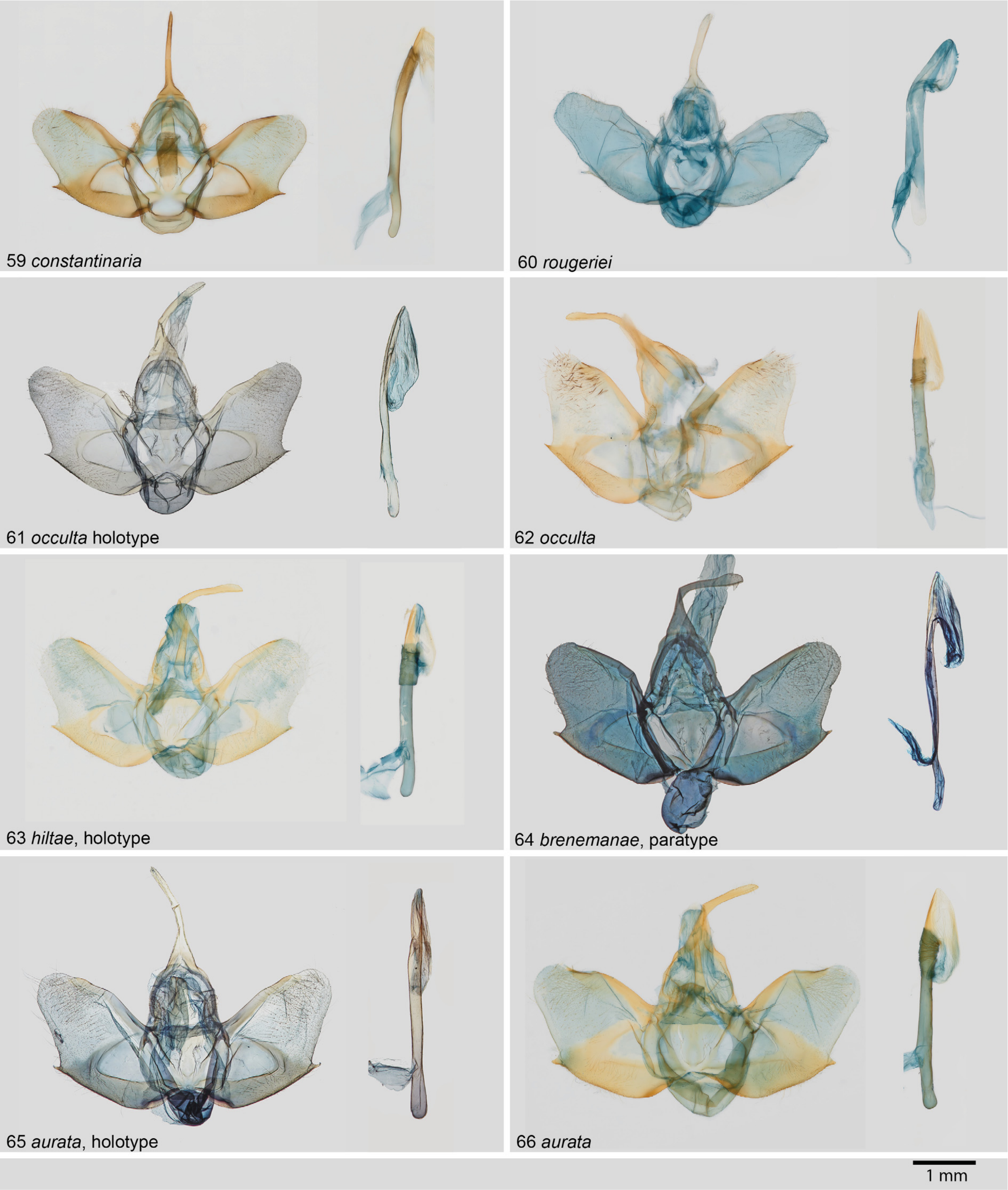

Figs 59–66. Male genitalia (left = valves; right = aedeagus). **59**. *Callipia constantinaria* Oberthür, 1881 (C-0085, COI data). **60**. *C. rougeriei* sp. nov., paratype (C-0070, COI data). **61**. *C. occulta* Warren, 1904 stat. rev., holotype (COI data). **62**. *C. occulta* Warren, 1904 stat. rev., (C-0084, COI data). **63**. *C. hiltae* sp. nov., holotype (C-0153, COI data). **64**. *C. brenemanae* Sperry, 1951, paratype (NHM). **65**. *C. aurata* Warren, 1904, holotype (NHM). **66**. *C. aurata* Warren, 1904 (C-0095, COI data).

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Type material

Holotype (Figs 49, 61)
PERU: ♂, [no further data available] (NHM).

Other type material (Fig. 48)
PERU: holotype of *hamaria* Sperry, 1951, [Junín] Satipo, May 1948, P. Paprzycki leg. (AMNH).

Other material examined

VENEZUELA: no further data (MFN) (C-0107) [doubtful since there are no records from Colombia].

ECUADOR: 1 ♂, Guayaquil (MFN) (C-0106) [doubtful because of the low elevation, far off any other record]; 2 ♂♂, Sucumbios, El Calvario, 2800 m, 7 Aug. 1996, G. Onore, E. Tapia, F. Salazar leg. (CMNH) (C-0082, COI sequence: 658 bp, BIN; C-0115); 15 ♂♂, [Napo] Route Baeza-Lumbaqui au Puente Azuela, 1530 m, 6–7 Feb. 1975, C. Herbulot leg. (ZSM, RCGB) (C-0117–0128, 0157; 0158; 0425); 2 ♂♂, Hacienda San Isidro (ZMUJ) (C-0045; 0116); 1 ♂, Napo, 10 km E of Papallacta, Hacienda Bosque on road Quito-Baeza, disturbed montane forest, 2600 m, 11 Nov. 1995, Jan Hillman leg. (AMNH) (C-0160, COI sequence: 658 bp, BIN); 1 ♂, Napo, Cordillera Guacamayos, Cedroyacu Canyon, pristine cedar forest, 2100 m, 8 Aug. 1996, Jan Hillman leg. (AMNH) (C-0161, COI sequence: 407 bp, BIN); 1 ♂, Napo, Cordillera Huacamayos, Estero Chico, virgin humid forest, 0.617° S, 77.850° W, 2650 m, 5 Aug. [19]96, J. Hillmann leg. (CMNH) (C-0084 with GS-391, COI sequence: 658 bp, BIN, Figs 50, 62); 1 ♂, Napo, Tena, 450 m [doubtful elevation, not considered for observed distribution], Aug. [19]56, J. Förster leg. (ZSM) (C-0152 with GS-092, COI sequence 307 bp); 1 ♂, Cañar, 10 m NW of Chiguinda, farms in tropical forest, 2000 m, 16 July 1994, Jan Hillman leg. (AMNH) (C-0159, COI sequence: 658 bp, BIN, Fig. 50); 1 ♂, Zamora-Chinchipe, 27 km NW of Zamora, 3.95° S, 79.05° W, 1550 m, 10 Jun. 1983, John E. Rawlins leg. (CMNH) (C-0083, COI barcode 307 bp); 1 ♂, Zamora-Chinchipe, Reserva Biológica San Francisco, 3.983° S, 79.086° W, 2290 m, 6 May 1999, D. Süßenbach leg. (SMNS) (C-0054 with GS-103, COI sequence: 658 bp, BIN); 1 ♂, same data as previous, but 3.986° S, 79.073° W, 2387 m, 12 May 1999, D. Süßenbach leg. (SMNS) (C-0053, COI sequence: 658 bp, BIN); 1 ♂, same data as previous, but Estación Biológica San Francisco, 3.971° S, 79.079° W, 1850 m, 2 July 2007, F. Bodner (RCGB) (C-0081, COI sequence: 658 bp, BIN).

PERU: 2 ♂♂, [Pasco], Quiroz (AMNH) (C-0113; 0155); 1 ♂, [Pasco], near Pozuzo, 1000 m, 6–7 May 1996 m, J. Grados leg (MUSM) (C-0086); 1 ♂, [Pasco], Oxapampa (AMNH) (C-0110); 2 ♂♂, [Pasco] Huancab[amba] (MNHN, ZMF) (C-0100; 0103; 0104); 1 ♂, [Pasco] Huancab[amba] Pasco de Cerro (NHM) (C-0102); 5 ♂♂, [Junín], Chanchamayo (MFN) (C-0101; 0105; 0109; 0112; 0156); 2 ♂♂, [Junín] Rio Negro, 24 May 1933 (MFN) (C-0108); 1 ♂, Cusco, Valle de Marcapata (MUSM) (C-0151).

Description

As illustrated.

Distribution

Eastern Andes of Ecuador and N and Central Peru, 1500–2800 m.

Remarks

The taxon *C. hamaria*, originally described as a form of *C. constantinaria* by Sperry (1951), actually very closely resembles *C. occulta* stat. rev.; both are from Peru. While Parsons *et al.*(1999) treated *C. hamaria* as a junior synonym of *C. constantinaria*, I treat it here as junior synonym of *C. occulta* stat. rev.

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Callipia hiltae sp. nov.

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Figs 52, 63

BIN (holotype): BOLD:AAD6678.

Diagnosis

Costa in *C. hiltae* sp. nov. largely without striae; on the contrary the holotype of *C. occulta* stat. rev. shows such striae as well as most of the 10 successfully DNA-barcoded specimens assigned to *C. occulta* stat. rev. The extent of the yellow blotch on the forewing appears to be rather variable, and the male genitalia do not offer reliable diagnostic characters either. So far, only two specimens can reliably be assigned to *C. hiltae* sp. nov., but it is possible that the species has a broader distribution. COI-barcode: the minimum observed distance to the genetically most similar species (*C. brenemanae*) is 5.0%, and it is 5.7% to *C. occulta* stat. rev.

Etymology

The species is named in honour of Nadine Hilt, Bayreuth, Germany who carried out a moth diversity study along a disturbance gradient in southern Ecuador.

Type material

Holotype (Figs 52, 63)

PERU: ♂, Amazonas, Pomacochas, 2200 m (ZSM) (C-0153 with GS-420, COI sequence 658 bp, BIN).

Paratypes

PERU: 1 ♂, same data as for holotype (ZSM) (C-0154, COI sequence 307 bp).

Description

As illustrated. The female is unknown.

Distribution

Eastern Andes of northern Peru, 2200 m.

Callipia aurata Warren, 1904

Figs 53–54, 65–66

No assigned BIN, but 307 bp COI fragment.

Diagnosis

The species with the largest yellow blotch. Only known from Colombia. COI-barcode: the minimum observed distance to the genetically most similar species (*C. occulta* stat. rev.) is 3.4%.

Type material

Holotype (Figs 53, 65)

COLOMBIA: ♂, [Cauca], Popayan, Lehmann leg. (NHM).

Other material examined

COLOMBIA: 1 ♂, Cundanimarca, Monterredondo, 1420 m (ZSM) (C-0087, COI sequence 307 bp, Fig. 54); 1 ♂, [Tolima], San Antonio, 5800 ft [1768 m] (NHM) (C-0098); 2 ♂♂, (AMNH) (C-0095, Fig. 66; C-0099).

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Description

As illustrated. The female is unknown.

Distribution

Colombia, western and eastern Cordillera, 1400–1800 m.

Callipia brenemanae Sperry, 1951
Figs 55–58, 64

Assigned BIN: BOLD:AAF5629.

Diagnosis

The base of forewing veins CuA_2, CuA_1 and often M_3 are covered with dark brown scales in *brenemanae*, particularly at the wing base. Only specimens of *C. occulta* stat. rev. show a similar pattern, but it is weaker and only true for vein CuA_2. COI-barcode: the minimum observed distance to the genetically most similar species (*C. constantinaria*) is 3.9%.

Type material

Holotype (Fig. 55)

BOLIVIA: ♂, [Cochabamba department], Yungas del Palmar, 2000 m, 15 Mar. 1949 (AMNH) (C-0129 with GS-302).

Paratypes

BOLIVIA: 8 ♂♂, 4 ♀♀, same locality as holotype [Cochabamba Department], Chapare (AMNH, NHM, private collections), among them one ♀ designated as allotype (C-0130 with GS, Fig. 56; and one ♂, C-0131, Fig. 57). Figure 64 shows the male genitalia of a paratype deposited in the NHM.

Other material examined

PERU: 3 ♂♂, [Puno, Oroya] La Oroya and [Puno], Rio Inambari, 3100 ft [945 m] (NHM, SMF) (C-0138; 0149; 0150).

BOLIVIA: 3 ♂♂, (SMF, MFN) (C-0134; 0135; 0137); 1 ♂, [La Paz Department], Coroico (Yungas), 2000 m [ca 16.189° S, 67.576° W], (MfN) (C-0094); 1 ♂, [La Paz Department], Songo [Rio Zongo, ca 16.104° S, 68.065° W] (MfN) (C-0139); 1 ♂, same locality data as previous, 750 m (CMNH) (C-0146); 4 ♂♂, La Paz Department, northern Yungas, road Ceranavi-Choroico, near Choro (ZSM) (C-0421–0424); 3 ♂♂,[Cochabamba Department], Chapare, San Jocinto, 2800 m (ZSM) (C-0088 with GS-389, COI sequence 658 bp, BIN; C-0132; 0133); 1 ♂, Cochabamba [Department], Via Cochabamba (ZMUJ) (C-0044, COI sequence 658 bp, BIN); 7 ♂♂, Cochabamba [department] (CMNH, RCGB) (C-0089, COI sequence 658 bp, BIN; C-0140–0145); 5 ♂♂, [Cochabamba Department], Yungas del Palmar, 1200–2000 m (AMNH, ZSM) (C-0136; 0147; 0148; 0388; 0426).

Description

As illustrated. The female is unknown.

Distribution

Eastern Andes of central to south eastern Peru and central Bolivia, 700–2800 m.

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The parrhasiata *group*

This group comprises most species; I acknowledge here 12 taxa at species level with one of them comprising two geographically separated subspecies (*C. wojtusiaki* sp. nov.). Most species have conspicuous rosy or pink wing bases, but in four species (distributed from central Peru to northern Argentina) the base colour is more intensive and ranges from orange to red. The rosy / pink species are distributed from Colombia to Bolivia. Unlike in the *vicinaria* group, there is no pronounced sexual dimorphism, but females are considerably larger than males. Unfortunately, the male genitalia only offer very limited diagnostic characters and DNA barcoding in combination with distributional data will sometimes be the only reliable way of distinguishing closely related species.

Callipia parrhasiata Guenée, 1858
Figs 67–69, 75, 124

Assigned BIN: BOLD:AAI3927.

Diagnosis

Probably has the most intense pink colouration of all members of the group, and the most extended dark brown area. *Callipia intermedia* stat. rev. on forewing upperside with a marginal ochreous blotch, this is only present on the underside in *parrhasiata*. The male vesica has a series of relatively long cornuti. The cream white margin of the underside of the hindwing is very narrow and considerably less pronounced than in related species. COI-barcode: the minimum observed distance to the genetically most similar species (*C. milleri* sp. nov. and *C. wojtusiaki septentrionalis* subsp. nov.) is 4.1%, respectively.

Type material

Holotype (Fig. 67)

COUNTRY UNKNOWN: ♀, ‘Bengale?’ [incorrect locality] (NHM). The last segments of the abdomen are lost. Eggs are visible in the dorsally open abdomen.

Other material examined

ECUADOR: 2 ♂♂, Napo, Route Baeza-Lumbaqui, at Puente Azuela, 1530 m (ZSM) (C-0281; 0282); 1 ♂, Napo, Yanayacu Biological Station, 5 km W of Cosanga on Cosanga-Rio Aliso R[oa]d, 2200 m (RCGB) (C-0355, COI sequence 307 bp); 1 ♂, Napo, Papallacta, Cuyuja, 0.421° S, 78.022° W, 2525 m (ZSM) (C-0405); 1 ♂, Morona-Santiago, W of General Plaza on road from Cuenca (Azuay Province) to Mendez, 2200–2400 m (AMNH) (C-0289); 2 ♂♂, Morona-Santiago, Rio Culebrillas, 34 km SE of Gualaceo, 2200 m (ZMUJ) (C-0028, COI sequence 658 bp, BIN; C-0288); 6 ♂♂, Morona-Santiago, road Gualaceo-Limon, east, 2200–2450 m (ZMUJ) (C-0038, COI sequence 658 bp, BIN; C-0039 with GS-422, COI sequence 658 bp, BIN, Figs 68, 75; C-0042, COI sequence 658 bp, BIN; C-0283; 0284); 1 ♀, Morona-Santiago, Road Gualaceo - Plan de Milagro, 2601 m (ZSM) (C-0431 with GS, Figs 69, 124); 1 ♂, same data as previous, but 2157 m (ZSM) (C-0417); 1 ♂, Loja [province], R[ou]te Saraguro-Loja, 13 km N of San Lucas (?), 3130 m (ZSM) (C-0286); 15 ♂♂, Zamora-Chinchipe, Reserva Biológica San Francisco, 1850–2677 m (RCGB, SMNS) (ID 6081; 6082; 6084; 18830, 22590; 44631; 48463; C-0025 / ID 6083; C-0026 / ID 6085 with GS-284; C-0027 / ID 6088 with GS-107; C-0050 / ID 6087; C-0051 / ID 55871 with GS-098; C-0052 / ID 25733 with GS-115; C-0080 / ID 17844; C-0287 / ID 6086; several of these with BIN).

Distribution

Eastern Cordillera of Ecuador, 1500–2700 m.

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Figs 67–74. Adult moths (a = dorsal view; b = ventral view). **67**. *Callipia parrhasiata* Guenée, 1858, ♀, holotype (NHM). **68**. *C. parrhasiata* Guenée, 1858, ♂ (C-0039, COI data). **69**. *C. parrhasiata* Guenée, 1858, ♀ (C-0431). **70**. *C. intermedia* Dognin, 1914 stat. rev., ♂ (C-0097). **71**. *C. intermedia* Dognin, 1914 stat. rev., ♂, lectotype (C-0327). **72**. *C. intermedia* Dognin, 1914 stat. rev., ♂ (C-0031, COI data). **73**. *C. karsholti* sp. nov., ♂, holotype (C-0033, COI data). **74**. *C. karsholti* sp. nov., ♂ (C-0349, COI data).

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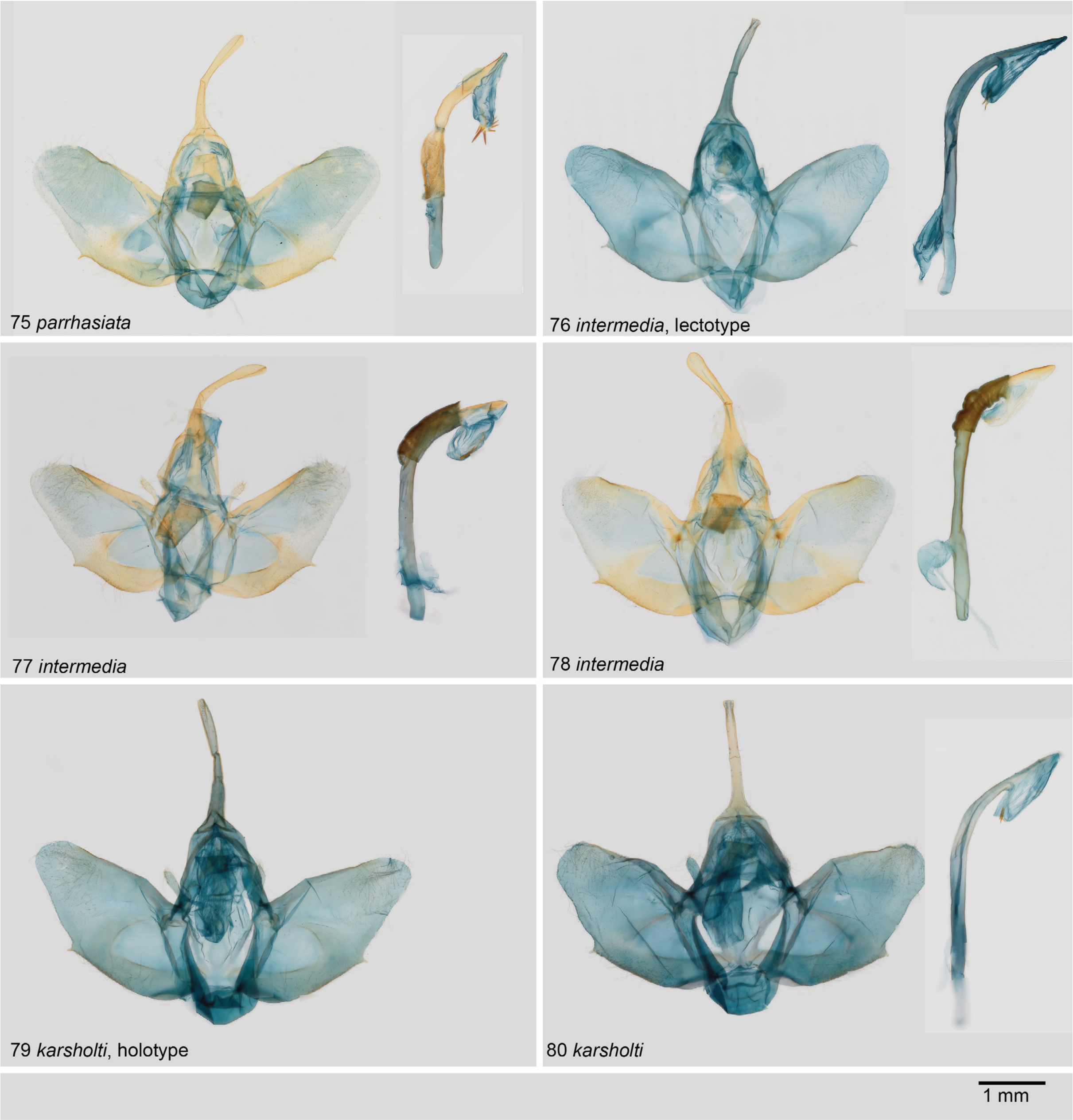
Callipia intermedia Dognin, 1914 stat. rev.
Figs 70–72, 76–78

Assigned BIN: BOLD:AAI3928.

Diagnosis

Ground colour a little bit less intense, less pink and more reddish than in *parrhasiata*. The cream white margin of the hindwing underside is broader than in *parrhasiata*. Light ochreous costal area of forewing



Figs 75–80. Male genitalia (left = valves; right = aedeagus). **75**. *Callipia parrhasiata* Guenée, 1858, ♂ (C-0039, COI data). **76**. *C. intermedia* Dognin, 1914 stat. rev., ♂, lectotype (C-0327). **77**. *C. intermedia* Dognin, 1914 stat. rev., ♂ (C-0031, COI data). **78**. *C. intermedia* Dognin, 1914 stat. rev., ♂ (C-0097). **79**. *C. karsholti* sp. nov., ♂, holotype (C-0033, COI data). **80**. *C. karsholti* sp. nov., ♂ (C-0349, COI data).

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upperside less extended than in *C. karsholti* sp. nov. COI-barcode: the minimum observed distance to the genetically most similar species (*C. jonai* sp. nov.) is 2.7%.

Type material

A series of 6 **syntypes** (males) from Ecuador, Loja; and Peru, [Puno], Carabaya, Limbari [correct: Limbani], and Agualani (USNM). These six specimens are not conspecific; the two Ecuadorian specimens (C-0019; C-0357) are assigned to *C. wojtusiaki* sp. nov. (see there). Specimens from Limbani were indicated by Dognin (1914) as 'type', and therefore a specimen from this locality is selected as **lectotype** (C-0327 with GS-296, Figs 71, 76; the other C-0329). Two specimens are from from Agualani (C-0328 with GS-283; C-0330).

Other material examined

PERU: 2 ♂♂, Cusco, Ollantaytambo-Quillabamba R[oa]d, km 158, 2945 m (AMNH) (C-0030 with GS-393, COI barcode 615 bp, BIN; C-0059, COI barcode 658 bp, BIN); 1 ♂, Cusco, Valle de Marcapata (USMSM) (C-0347); 1 ♂, Cusco, 8 km SW of Quillabamba, 1130 m (AMNH) (C-0018, COI sequence 464 bp, BIN); 2 ♂♂, [Cusco], Paucartambo (ZMUC) (C-0097 with GS-406, Figs 70, 78; C-0341); 3 ♂♂, Madre de Dios, Tambopata Preserve, Explorer's Inn, 200 m [probably wrong locality/elevation, not considered in distribution] (AMNH) (C-0031 with GS 407, COI sequence 658 bp, BIN, Figs 72, 77; C-0350; C-0351, COI sequence 307 bp); 1 ♂, Puno, 5 km E of Limbani, 3000 m (ZMUC) (C-0029, COI barcode 658 bp, BIN); 1 ♂, [Puno], Carabaya, Limbari [correct: Limbani] (MHNH) (C-0348); 15 ♂♂, [Puno], Carabaya, Agualani, 9000 ft (AMNH, PMJ, RCGB, SMF, ZSM) (C-0331–0346).

Distribution

Eastern Andes of south eastern Peru, 1100–3000 m.

Remarks

The species was described as subspecies of *C. parrhasiata*, but is clearly an independant species. The six syntypes belong to two different taxa (see above).

Callipia karsholti sp. nov.

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Figs 73–74, 79–80

BIN (holotype): BOLD:ABY4709.

Diagnosis

Most similar to *C. intermedia* stat. rev. (sympatric distribution), but ground colour light rosy with an extended light ochreous costal area on the forewing upperside. Similarly as in *C. intermedia* stat. rev., but different from *C. parrhasiata*, male aedeagus with a few small cornuti. COI-barcode: the minimum observed distance to the genetically most similar species (*C. intermedia* stat. rev.) is 2.8%.

Etymology

The species is named in honour of Ole Karsholt (ZMUC), Copenhagen, Denmark, who collected the type specimens in Peru.

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Type material

Holotype (Figs 73, 79)

PERU: ♂, Puno, 5 km E of Limbani, 3000 m, 14.125° S, 69.682° W, 28 Mar. 1987, O. Karsholt leg. (ZMUC) (C-0033 with GS-304, COI sequence 615 bp, BIN).

Paratypes

PERU: 1 ♂, Cusco, Cosñipata, 13.140° S, 71.584° W, 2240 m, 23. Aug. 2016, D. Bolt leg. (PMJ) (Pe-Geo-1162); 1 ♂, Cusco, Cosñipata, 13.140° S, 71.584° W, 2250 m, 23. Aug. 2016, M. Nuß leg. (MTD) (C-0477, Pe-Geo-1141).

Other material examined

PERU: 1 ♂, Huánuco, 15: 25 km NE of Huánuco, Cordillera Carpish, Pattytrail, 2500 m, 8–10 Nov. 1987, O. Karsholt leg. (ZMUC) (C-0349 with GS-323, COI sequence 251 bp, Figs 74, 80). Because of the different sampling location in central Peru, the assignment of this specimens to *karsholti* sp. nov. is provisional until more material can be examined.

Description

As illustrated.

Distribution

Eastern Andes of south eastern Peru, 2240–3000 m.

Callipia rosetta Thierry-Mieg, 1904

Figs 81–85, 88–92, 131–132

Callipia languescens Warren, 1904: 539 (confirmed junior synonym of *rosetta*, see Parsons *et al.* (1999) (Figs 82, 89)

Assigned BIN: BOLD:AAI3925.

Diagnosis

Callipia rosetta is usually a rather small species. Some large specimens are provisionally included in *C. rosetta* (same BIN), but might turn out as different species if more data on the life history of the taxa become available. The spine-like process on the ventral margin of the valvae is well developed and larger than in *augustae* sp. nov. COI-barcode: the minimum observed distance to the genetically most similar (but not similar looking) species (*C. fulvida*) is 4.4%.

Type material

Originally described with two male as **syntypes** from Peru, [Pasco], Huancabamba, 1903 (USNM). One of these males is designated as **lectotype** (C-0290 with GS-286, Figs 81, 88).

PERU: ♂, holotype of *C. languescens* Warren, 1904 (confirmed junior synonym of *rosetta*), [Pasco], Huancabamba, Cerro de Pasco, [E.] Böttger leg. (NHM) (Figs 82, 89).

Other material examined

ECUADOR: 9 ♂♂, Napo, Cordillera Huacamayos, Rio Cedroyacu, 00°37′ S, 77°51′ W [incorrect coordinates], 2100 m, 7 Aug. 1996, Jan Hillman leg. (CMNH, NHM, ZSM) (C-0010 with GS-312, COI sequence 556 bp, BIN; C-0011 with GS-416, COI sequence 603 bp, BIN, Figs 83, 92; C-0274

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with GS-287; C-0275–0280); 2 ♂♂, Loja province, Parque Nacional Podocarpus, Cajanuma, 04.114° S, 79.175° W, 2897 m, 26 Mar. 2011, L. Lehner and M. Adams leg. (PMJ, RCGB) (ID 22359 with GS, COI sequence 658 bp, BIN, Figs 84, 90; ID 22362 with GS, COI sequence 658 bp, BIN, Figs 85, 91); 1 ♂, same data as previous, but 2916 m, G. Brehm leg. (RCGB) (ID 22316, COI sequence 658

Figs 81–87. Adult moths (a = dorsal view; b = ventral view). **81**. *Callipia rosetta* Thierry-Mieg, 1904, ♂, lectotype (C-0290). **82**. *C. rosetta* Thierry-Mieg, 1904, ♂, holotype of *languescens* Warren, 1904 (NHM). **83**. *C. rosetta* Thierry-Mieg, 1904, ♂ (C-0011, COI data). **84**. *C. rosetta* Thierry-Mieg, 1904, ♂ (ID 22359, COI data). **85**. *C. rosetta* Thierry-Mieg, 1904, ♂ (ID 22362, COI data). **86**. *C. augustae* sp. nov., ♀, paratype (C-0432). **87**. *C. augustae* sp. nov., ♂, holotype (C-0056, COI data).

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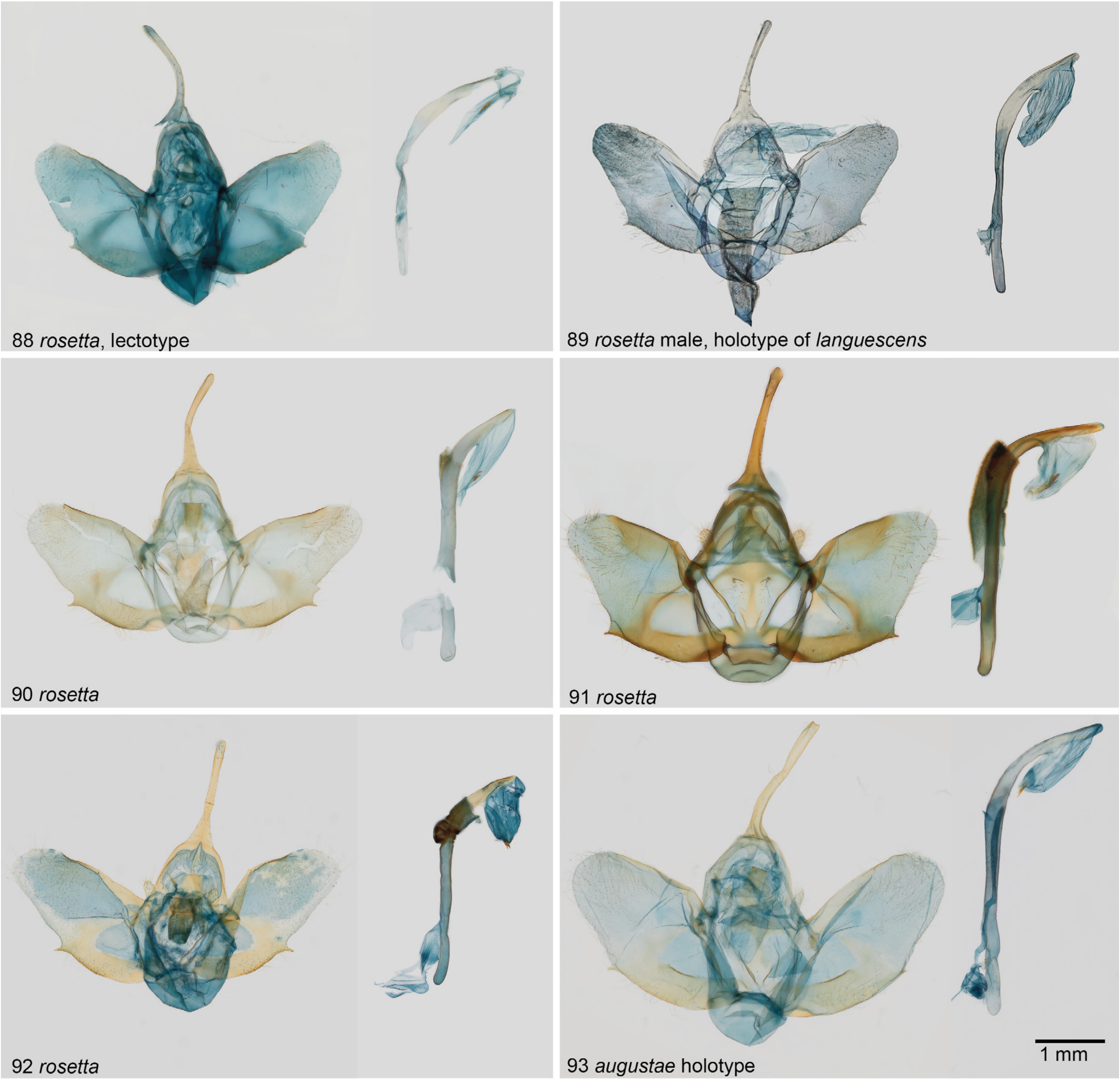
bp, BIN); 1 ♂, Zamora-Chinchipe, Reserva Biológica San Francisco, 03.995° S, 79.068° W, 2677 m, 31 Mar. 2011, G. Brehm leg. (RCGB) (ID 22580).

PERU: 1 ♂, [Huánuco or San Martín or western Loreto] Huallaga (USNM) (C-0292); 1 ♂, [Pasco], Huancabamba, 2000–3000 m (SMF) (C-0292); 1 ♂, [Pasco], Oxapampa (ZSM) (C-0032); 2 ♂♂, [Puno], Carabaya, Agualani (SMF, USNM) (C-0293 with GS-305, C-0296).

Description

Male as illustrated. Female unknown.



Figs 88–93. Male genitalia (left = valves; right = aedeagus). **88**. *Callipia rosetta* Thierry-Mieg, 1904, ♂, lectotype (C-0290). **89**. *C. rosetta* Thierry-Mieg, 1904 (holotype of *C. languescens* Warren, 1904), ♂, holotype (NHM). **90**. *C. rosetta* Thierry-Mieg, 1904, ♂ (ID 22359, COI data). **91**. *C. rosetta* Thierry-Mieg, 1904, ♂ (ID 22362, COI data). **92**. *C. rosetta* Thierry-Mieg, 1904, ♂ (C-0011, COI data). **93**. *C. augustae* sp. nov., ♂, holotype (C-0056, COI data).

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Distribution

Eastern Cordillera of Ecuador and Peru, 2100–3000 m.

Remarks

A living male is illustrated in Fig. 131 together with its habitat in Ecuador (Fig. 132).

Callipia augustae sp. nov.

urn:lsid:zoobank.org:act:53BC4DD0-6174-42B0-B754-0B244C9F3FA7
Figs 86–87, 93, 125, 135–137

Assigned BIN: BOLD:AAI3929.

Diagnosis

Callipia augustae sp. nov. is unique in having spotted wing pattern pattern elements, i.e., the fine light ochreous striae that are found in most other species of *Callipia* are mostly widened to small spots. The spine-like processes on the ventral margin of the valvae are very small. COI-barcode: the minimum observed distance to the genetically most similar (but not similar looking) species (*C. flagrans*) is 2.6%.

Etymology

The species is named in honour of Augusta Albrecht, Friedrichshafen, Germany.

Type material

Holotype (Figs 87, 93)

ECUADOR: ♂, Zamora-Chinchipe, Reserva Biológica San Francisco, 1921 m, 03.978° S, 79.083° W, N. Hilt and C. Ramenda leg. (PMJ) (ID 25732 / C-0056 with GS-316, COI sequence 658 bp, BIN).

Paratypes

ECUADOR: 5 ♂♂, Zamora-Chinchipe, Reserva Biológica San Francisco, 1921–2677 m (RCGB, SMNS) (C-0055 with GS-102, COI sequence 658 bp, BIN; C-0057 with GS R. Trusch 480, COI sequence 658 bp, BIN; C-0058 with GS-100, COI sequence 658 bp, BIN; ID 44632; ID 44633).

PERU: 1 ♂, [San Martín], P[arque] N[acional] Abiseo, Las Palmas, 2200 m (USMSM) (C-0060 with GS-315); 1 ♂, [Pasco], Huancabamba, 2000–3000 m (SMF) (C-0312); 2 ♂♂, [Pasco], Huancabamba, Cerro de Pasco, 6–10000 ft (NHM) (C-0295 with GS-281; C-0311); 1 ♂, [Junín], Chanchamayo (USNM) (C-0315 with GS-107); 1 ♂, [Junín], Chanchamayo, La Merced (AMNH) (C-0303); 2 ♂♂, [Ayacucho], Apurímac, Rio Piene (AMNH) (C-0305; 0306); 1 ♂, [Cusco], Paucartambo (ZMUC) (C-0302 with GS-289); 5 ♂♂, Cusco, Pillahuata, Cosñipata Valley, 2575–2600 m (AMNH, USMSM) (C-0048; 0049; 0162; 0169; 0170); 1 ♂, [Cusco], Cosñipata, 2200 m (ZSM) (C-0299); 1 ♂, Cusco, Cosñipata, 13.177° S, 71.581° W, 2680 m, 21. Aug. 2016, D. Bolt leg. (ID Pe-Geo-0128, C-0474, COI sequence 658 bp, BIN); 1 ♂, Cusco, Cosñipata, 13.141° S, 71.585° W, 2250 m, 23. Aug. 16, M. Nuß leg. (PMJ) (Pe-Geo-1142, C-0478, COI sequence 658 bp, BIN); 1 ♀, Cusco, Cosñipata, 13.140° S, 71.584° W, 2240 m, 23. Aug. 2016, D. Bolt leg. (PMJ) (Pe-Geo-1143, C-0479, COI sequence 658 bp, BIN); 1 ♂, Cusco, Cosñipata, 13.179° S, 71.582° W, 2770 m, 21. Aug. 2016, M. Nuß leg. (MTD) (Pe-Geo-1153); 1 ♂, Cusco, Cosñipata, 13.178° S, 71.582° W, 2770 m, 21. Aug. 2016, G. Brehm leg. (MTD) (Pe-Geo-1153); 4 ♂♂, Cusco, Cosñipata, 13.140° S, 71.584° W, 2240 m, 23. Aug. 2016, D. Bolt leg. (PMJ) (Pe-Geo-1154, 1158–1160); 2 ♂♂, Cusco, Cosñipata, 13.146° S, 71.586° W, 2284 m, 23. Aug. 2016, G. Brehm leg. (PMJ) (Pe-Geo-1155, 1156); 1 ♂, Cusco, Cosñipata, 13.157° S, 71.596° W, 2360 m, 25. Aug. 2016, J. Grados leg. (PMJ) (Pe-Geo-1161); 1 ♂, [Cusco], Torontoy, 7000 ft (USNM) (C-0304);

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3 ♂♂, [Puno], Carabaya, Rio Huacamaya (USNM) (C-0308–0310); 1 ♂, [Puno], Carabaya, Oconeque (USNM) (C-0307); 1 male Cusco, Valle de Marcapata (USMSM) (C-0061).

BOLIVIA: 1 ♂, [La Paz Department], Rio Tanampaya, [ca 16.30° S, 67.33° W] (MfN) (C-0320); 42 ♂♂, 1 ♀, Cochabamba [department] (CMNH, RCGB, PMJ) (♀ C-0432 with GS, Figs 86, 125; C-0326); 4 ♂♂, Cochabamba [Department], Chapare, Paracti, 2200 m (AMNH) (C-0062 with GS-099, COI sequence 658 bp, BIN; C-0300; 0319; 0321); 1 ♂, Cochabamba [Department], Incachaca (USNM) (C-0318); 1 ♂, [Cochabamba Department], Yungas de Arepucho, Sihuencas [Sehuencas, ca 17.504° S, 65.276° W], 2200–2500 m (ZSM) (C-0313 with GS-314); 3 ♂♂, [Cochabamba Department], Yungas del Palmar, 2000 m (AMNH, ZSM) (C-0314; 0316; 0317); 4 ♂♂, [Cochabamba Department], Yungas de Corani, 2500 m, [ca 17.221° S, 65.817° W], (ZSM) (C-0322–0325).

Description

Male and female as illustrated.

Distribution

Eastern Andes of southern Ecuador, Peru and Bolivia, 1900–3100 m.

Remarks

Two living males are illustrated in Figs 135 and 137. The conspicuous colours are only displayed when the moths are active. The habitat is shown in Fig. 136. It is remarkable that one of the apparently most common species of *Callipia* was undescribed until now.

Callipia sihvoneni sp. nov.

urn:lsid:zoobank.org:act:3FE12724-54E2-40FA-BAA5-69F6D10A1F4C

Figs 94–95, 102, 126

BIN (holotype): BOLD:AAN4774.

Diagnosis

Callipia sihvoneni sp. nov. is a medium sized species of *Callipia* that was identified as *C. parrhasiata* in many museum collections. The costal area of the forewing is conspicuously striated / spotted and the apical dark brown area is usually not divided as in *C. wojtusiaki* sp. nov. and *C. milleri* sp. nov. COI-barcode: the minimum observed distance to the genetically most similar species (*C. milleri* sp. nov.) is 4.1%. *Callipia sihvoneni* sp. nov. can most reliably be distinguished from the closely related *C. wojtusiaki septentrionalis* subsp. nov. and *C. milleri* sp. nov. by DNA-barcoding.

Etymology

The species is named in honour of Pasi Sihvonen, Veikkola, Finland.

Type material

Holotype (Figs 94, 102)

COLOMBIA: ♂, Cundanimarca, Vereda La Concepción, Bosque La Guajira, 2910 m, 04.793° N, 75.783° W, 9–12 Apr. 2014, R. Brechlin leg. (ZSM) (C-0418 with GS, COI sequence 658 bp, BIN).

Paratypes

COLOMBIA: 1 ♂, 1 ♀, same data as for holotype (ZSM) (C-0419; C-0420); 11 ♂♂, Bogotá, Le Moult leg. (PMJ, ZSM) (C-0003 with GS-110, COI sequence: 553 bp, BIN; C-0377; C-0378 with GS-385; C-0379; 0380; 0382; C-0383 with GS-096; C-0384; 0427; 0428); 1 ♂, same data as previous, but

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Figs 94–101. Adult moths (a = dorsal view; b = ventral view). **94**. *Callipia sihvoneni* sp. nov., ♂, holotype (C-0418, COI data). **95**. *C. sihvoneni* sp. nov., ♀, paratype (C-0396, COI data). **96**. *C. wojtusiaki wojtusiaki* sp. nov., ♂, holotype (C-0046, COI data). **97**. *C. wojtusiaki wojtusiaki* sp. nov., ♀, paratype (C-0040, COI data). **98**. *C. wojtusiaki septentrionalis* subsp. nov., ♂, holotype (C-0012, COI data). **99**. *C. wojtusiaki septentrionalis* subsp. nov., ♂, paratype (C-0013, COI data). **100**. *C. milleri* sp. nov., ♂, holotype (C-0370, COI data). **101**. *C. milleri* sp. nov., ♂, paratype (C-0008, COI data).

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3200 m (ZSM) (C-0091); 1 ♂, Choco près [near] Bogota (ZSM) (C-0373); 3 ♂♂, Pueblo Guasca, Bogota (USNM) (C-0385–0387); 2 ♂♂, Pacho, Ost Kord. [Eastern Cordillera], 2200 m (MFN, ZMUC) (C-0374; C-0375 with GS-303); 3 ♂♂, 1 ♀, Boyacá, Vereda Suralá, 2730 m (ZSM) (C-0394; 0395; 0396 with GS, Figs 95, 126; C-0397).

Other material examined

COLOMBIA: 1 ♂, Cauca, Jiminez, 1600 ft [488 m] [doubtful elevation, not considered for distribution] (ZSM) (C-0376); 5 ♂♂, Tolima, Nevado del Tolima, 2600–2850 m (ZSM) (C-0398–C-0402).

Figs 102–107. Male genitalia (left = valves; right = aedeagus). **102**. *Callipia sihvoneni* sp. nov., ♂, holotype (C-0418, COI data). **103**. *C. wojtusiaki wojtusiaki* sp. nov., ♂, holotype (C-0046, COI data). **104**. *C. wojtusiaki septentrionalis* subsp. nov., ♂, holotype (C-0012, COI data). **105**. *C. wojtusiaki septentrionalis* subsp. nov., ♂, paratype (C-0013, COI data). **106**. *C. milleri* sp. nov., ♂, holotype (C-0370, COI data). **107**. *C. milleri* sp. nov., ♂, paratype (C-0008, COI data).

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Description

Male and female as illustrated.

Distribution

Western and eastern Cordillera of central and southern Colombia, 2200–3200 m. It has the northernmost distribution of all species of *Callipia*. It seems not to occur sympatrically with *C. wojtusiaki septentrionalis* subsp. nov., and might therefore only be confused with the sympatrically occurring *C. milleri* sp. nov.

Callipia wojtusiaki wojtusiaki sp. nov.

urn:lsid:zoobank.org:act:CDF58F76-E4DD-4989-A38E-53C35604B241

Figs 96–97, 103, 127

BIN (holotype): BOLD:ABZ0453.

Diagnosis

Callipia wojtusiaki sp. nov. can reliably be separated from the subspecies *C. septentrionalis* subsp. nov. and from *C. milleri* sp. nov. by the geographical distribution and DNA barcoding only. The uncus of *C. milleri* sp. nov. tends to be narrower than in the more spatula-shaped uncus of *C. wojtusiaki* sp. nov. COI-barcode: the minimum observed distance to the subspecies *C. septentrionalis* subsp. nov. is 0.8%, and the minimum observed distance to *C. milleri* sp. nov. is 1.7%.

Etymology

The species is named in honour of Janusz Wojtusiak (deceased), Krakow, Poland.

Type material

Holotype (Figs 96, 103)

ECUADOR: ♂, Zamora-Chinchipe, Reserva Biológica San Francisco, early succession, 3.983° S, 79.857° W, 1913 m, 10 Mar. 2002, N. Hilt, K. Fiedler leg. (SMNS) (C-0046 / ID 25730 with GS, COI sequence 615 bp, BIN).

Paratypes

ECUADOR: 1 ♂, with same data as for holotype, but montane rainforest, 3.973° S, 79.075° W, 1973 m, 11 Mar. 2002 (PMJ) (C-0047 / ID 25729 with GS-113, COI sequence 589 bp, BIN); 1 ♂, same data as previous, but disturbed area, 1800 m, 3.972° S, 79.079° W, 1810 m, 4 Feb. 2013, L. Möckel leg. (RCGB) (ID 48462); 2 ♂♂, Loja surroundings, 1890 [sampling year] (USNM) (C-0019, COI sequence 658 bp (6 bp gap); C-0357), these two specimens are also **syntypes** of *intermedia* stat. rev., but are not conspecific with the **lectotype** of *intermedia* stat. rev. from Peru (see *C. intermedia* stat. rev.); 1 ♂, Morona-Santiago, Limon-Gualaceo Road, east, 3.024° S, 78.585° W, 2450 m, 20 Aug. 2003, R. Garlacz leg. (ZMUJ) (C-0034; COI sequence 658 bp, BIN); 5 ♂♂, with same data, but 3.024° S, 78.585° W, 2200 m, 30 Aug. 2003, J. Wojtusiak leg. (ZMUJ) (C-0035–0037; 0041; 0043; COI sequences 616–658 bp, all with BIN); 1 ♀, with same data (C-0040, figs. 97, 127); 2 ♂♂, Morona-Santiago, Rio Culebrillas, 34 km SE of Gualaceo, 3.133° S, 78.55° W, 2200 m, 22–23 Oct. 1987, Jan Hillman leg. (CMNH) (C-0014, COI sequence 658 bp, BIN; C-0354).

PERU: 1 ♂, Amazonas, Route Moyobamba à Jaén, km 77, [5.683° S, 77.717° W], 2000 m, 23 Sep. 2003, A. Lévêque leg. (MNHN) (C-0017 with GS-318, COI sequence 658 bp, BIN).

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Distribution

Eastern Andes of southern Ecuador and northern Peru: 1800–2600 m. It seems that *C. wojtusiaki* sp. nov. does not occur sympatrically with the subspecies *septentrionalis* subsp. nov., or with *milleri* sp. nov. or *sihvoneni* sp. nov.

Callipia wojtusiaki septentrionalis subsp. nov.

urn:lsid:zoobank.org:act:45B9DA19-B4BF-41F8-AED3-D17A4B45C356

Figs 98–99, 104–105

BIN (holotype): BOLD:ACF3549.

Diagnosis

Callipia wojtusiaki septentrionalis subsp. nov. can reliably be separated from the nominate form by the geographical distribution and DNA barcoding only. The uncus of *C. milleri* sp. nov. tends to be narrower than in the more spatula-shaped uncus of *C. wojtusiaki* sp. nov. COI-barcode: the minimum observed distance to the nominate species is 0.8%, and the minimum observed distance to *C. milleri* sp. nov. is 1.0%.

Etymology

This subspecies of *C. wojtusiaki* sp. nov. is distributed in the northern part of the species' range and thus named *septentrionalis* from Latin, meaning 'northern'.

Type material

Holotype (Figs 98, 104)

ECUADOR: ♂, Napo, South slopes of Cerro Sumaco, wet cloud/moss forest, 0.559° S, 77.626° W, 2950 m, 18 Nov. 1995, Jan Hillman leg. (CMNH) (C-0012 with GS, COI sequence 658 bp, BIN).

Paratypes

ECUADOR: 1 ♂, collection data as for holotype, but cloud forest, landslide, 0.600° S, 77.483° W, 2400 m, 4 Jul. [19]94 (CMNH) (C-0016 with GS-282, COI sequence 658 bp, BIN); 2 ♂♂, Napo, SE slope Reventador, subparamo at treeline, 0.085° S, 77.655° W, 3200 m, 6 Jul. 1994, Jan Hillman leg. (CMNH) (C-0013 with GS-414, COI sequence 658 bp, BIN, Figs 99, 105; C-0365); 1 ♂, Napo, El Salado, 78 km (road) E of Papallacta, 1310 m, 17 Jan. 1986, McKamey and Osborne leg. (AMNH) (C-0362, COI sequence 658 bp, BIN); 1 ♂, Napo, R[ou]te Cosanga–Tena, km 10, 2230 m, 15 Nov. 1983, C. Lemaire and N. Venedictoff leg. (ZSM) (C-0363 with GS-306, COI sequence 307 bp); 1 ♂, Sucumbios, El Calvario, 0.060° N, 77.483° W, 2800 m, 7 Aug. 1996, G. Onore, E. Tapia and F. Salazar leg. (CMNH) (C-0015, COI sequence 550 bp, BIN); 1 ♂, [Napo?], Route Baeza-Lumbaqui, at Puente Azuela, 1530 m, 6–7 Feb. 1975, C. Herbulot leg. (ZSM) (C-0364 with GS-106, COI sequence 307 bp).

Other material examined

ECUADOR: 1 ♂, Carchi, Chical, [0.933° N, 78.183° W], 1250 m (CMNH) (C-0367); 1 ♂, Napo, Rio Pucuno, 42 km SE of Baeza on road to Loreto, 0.708° S, 77.598° W, 1045 m (AMNH) (C-0164); 2 ♂♂, Napo, Cordillera Huacamayos, Rio Cedroyacu, 0.887° S, 78.077° W, 2100 m (CMNH, RCGB) (C-0009; 0368); 1 ♂, Napo, Cordillera Huacamayos, Estero Chico, 2650 m (CMNH) (C-0369); 2 ♂♂, [Napo], Tena, 450 m [doubtful locality / elevation] (ZSM) (C-0358; 0359).

Description

Male as illustrated. Female unknown.

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Distribution

Paratypes are exclusively from north eastern Ecuador, but further study of specimens from north western Ecuador is required.

Callipia milleri sp. nov.

urn:lsid:zoobank.org:act:CA8B2C53-C4C4-493E-988C-ABCAC06E649B
Figs 100–101, 106–107

BIN (holotype): BOLD:AAI3924.

Diagnosis

Closest relative of *C. wojtusiaki* sp. nov. and *C. wojtusiaki septentrionalis* subsp. nov. The geographical range overlaps with the latter. The male uncus is narrower than in *C. wojtusiaki* sp. nov. The wing patterns do not offer reliable diagnostic characters. COI-barcode: the minimum observed distance to *C. milleri* sp. nov. is 1.0%.

Etymology

The species is named in honour of James S. Miller (AMNH), USA.

Type material

Holotype (Figs 100, 106)

ECUADOR: ♂, Carchi, 35 km W of Tufino, west slope, 3120 m, 30 Nov. 1987, C. Young and R. Davidson leg. (CMNH) (C-0370 with GS-311, COI sequence 658 bp, BIN).

Paratypes

COLOMBIA: 1 ♂, [Valle del Cauca], Calí, 1000 m, 19 Aug. 1973 (RCGB) (C-0004 with GS-279, COI sequence 658 bp, BIN); 1 ♂, [Valle del Cauca], Calima Dam, [03.881° N, 76.558° W], 3000 ft [914 m], 15 Jan. 1985, J. Bolling Sullivan leg. (Bolling collection) (C-0001, COI sequence 566 bp (92 bp gap), BIN); 1 ♂, [Nariño Department] Pasto-Sandona, [ca 1.25° N, 77.38° W], 2000–2400 m, [no date], Werner Hopp leg. (ZSM) (C-0002 with GS-313, COI sequence 658 bp, BIN)

ECUADOR: 2 ♂♂, Cotopaxi, W of Pilalo, 1800 m, 9–10 Oct. 1977, L.E. Peña leg. (AMNH, PMJ) (C-0361 with GS-310, COI sequence 307 bp; C-0360); 2 ♂♂, Pichincha, Las Palmeras, 59 km W Quito, 8 km W of Chiriboga, 6400 ft [1951 m], 15 Oct. 1988, J.S. Miller leg. (AMNH) (C-0005 with GS-320, COI sequence 589 bp, BIN; C-0371, COI sequence 658 bp, BIN); 1 ♂, Pichincha, 26 km WNW Machachi, humid primary forest, 1900 m, 12 Nov. 1987, J. Rawlins, C. Young and R. Davidson leg. (CMNH) (C-0006, COI sequence 658 bp, BIN); 1 ♂, Napo, Hazienda Bosque on road Quito-Baeza, disturbed montane forest, 2600 m, 11 Nov. 1995, Jan Hillman leg. (NHM) (C-0007, COI sequence 658 bp, BIN); 1 ♂, Napo, 12.8 km SE of Papallacta on road Papallacta-Baeza, 2440 m, 30 May 1993, J.S. Miller leg. (AMNH) (C-0008 with GS-307, COI sequence 658 bp, BIN, Figs 101, 107).

Other material examined

COLOMBIA: 5 ♂♂, [Valle del Cauca], Calima Dam, [03.881° N, 76.558° W], 3000 ft [914 m], (Sullivan collection) (C-0163; 0165–0168); 1 ♂, [Cauca], Jiminez, 1600 ft [488 m] [doubtful elevation, not considered in observed distribution], (USNM) (C-0372); 1 male Cali (ZSM).

ECUADOR: 1 ♂, Carchi, La Alegria on road between La Bonita and Santa Barbara, 2700 m, 14 Sep. 1977 (AMNH) (C-0366); 1 ♂, Pichincha, Quito - Nanegalito, 37 km, 0.018° N, 78.615° W, 2094 m, 2 Nov. 2011 (ZSM) (C-0403); 1 ♂, Pichincha, Camping Bella Vista, 0.011° S, 78.688° W,

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2230 m, 27 Oct. 2011 (ZSM) (C-0404); 2 ♂♂, Pichincha, Tandayapa, 3,5 km S, (Bellavista Lodge), 00°03.70' N, 78°40.93' W [coordinates incorrect], 2310 m, 1–20 Nov. 2012 (ZSM) (C-0429, 0430).

Description

Male as illustrated. Female unknown.

Distribution

Western Cordillera of southern Colombia, western and eastern Cordillera of northern Ecuador, 900–2500 m.

Callipia fulvida Warren, 1907

Figs 108–109, 116–117, 128

Assigned BIN: BOLD:AAI6978.

Diagnosis

Among the four species with a yellow-red ground colour (in comparison with the deep rosy species around *C. parrhasiata*), *C. fulvida* tends to have the most yellowish colour, but this is not a fully reliable diagnostic feature. The extent of yellow (vs dark brown) is most extended in *C. fulvida* among the four species, and the yellow blotch always reaches the costa at about two thirds from the base, producing an isolated brown spot. Although this is also seen in some individuals of the other species, the combination of these characters in combination with the geographical distribution will usually allow to identify *C. fulvida* without DNA barcoding or dissection. COI-barcode: the minimum observed distance to the genetically most similar (but not similar looking) species (*C. rosetta*) is 4.4%.

Type material

Originally two **syntypes** (males) from Peru, [Puno], Carabaya, Agualani, 9000 ft [2743 m], Mar. 1905, wet season, [G.R.] Ockenden leg. (NHM). One male was selected as **lectotype** (Figs 108, 116).

Other material examined

PERU: 12 ♂♂, same collection data as for lectotype (AMNH, RCGB, SMF, ZSM) (C-0078; 0171; 0173; 0176–0184); 4 ♂♂, Puno, 5 km E of Limbani, 3000 m (ZMUC) (C-0076 with GS-293, COI sequence 658 bp, BIN; C-0077 with GS-303, COI sequence 658 bp, BIN; C-0174 with GS-450, COI sequence 307 bp, Figs 109, 117; C-0175).

BOLIVIA: 1 ♀, [La Paz Department], Cuesta von Cillutincara [Cerro de Sillutincara, ca 16.29° S, 67.90° W], 3000–3500 m (ZSM) (C-0172 with GS, Fig. 128).

Description

Male and female as illustrated.

Distribution

Eastern Andes of south eastern Peru and Bolivia, 2700–3000 m.

Callipia flagrans Warren, 1904

Figs 110–111, 118–119

Assigned BIN: BOLD:AAI6982.

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108a *fulvida* ♂, lectotype

108b

109a *fulvida* ♂

109b

110a *flagrans* ♂, lectotype

110b

111a *flagrans* ♂

111b

112a *jonai* ♂, holotype

112b

113a *jonai* ♀, paratype

113b

114a *levequei* ♂, holotype

114b

115a *levequei* ♀, paratype

115b

Figs 108–115. Adult moths (a = dorsal view; b = ventral view). **108**. *Callipia fulvida* Warren, 1907, ♂, lectotype (NHM). **109**. *C. fulvida* Warren, 1907, ♂ (C-0174, COI data). **110**. *C. flagrans* Warren, 1904, ♂, lectotype (NHM). **111**. *C. flagrans* Warren, 1904, ♂ (C-0022, COI data). **112**. *C. jonai* sp. nov., ♂, holotype (C-0020, COI data). **113**. *C. jonai* sp. nov., ♀, paratype (C-0217). **114**. *C. levequei* sp. nov., ♂, holotype (C-0073, COI data). **115**. *C. levequei*, ♀, paratype (C-0071, COI data).

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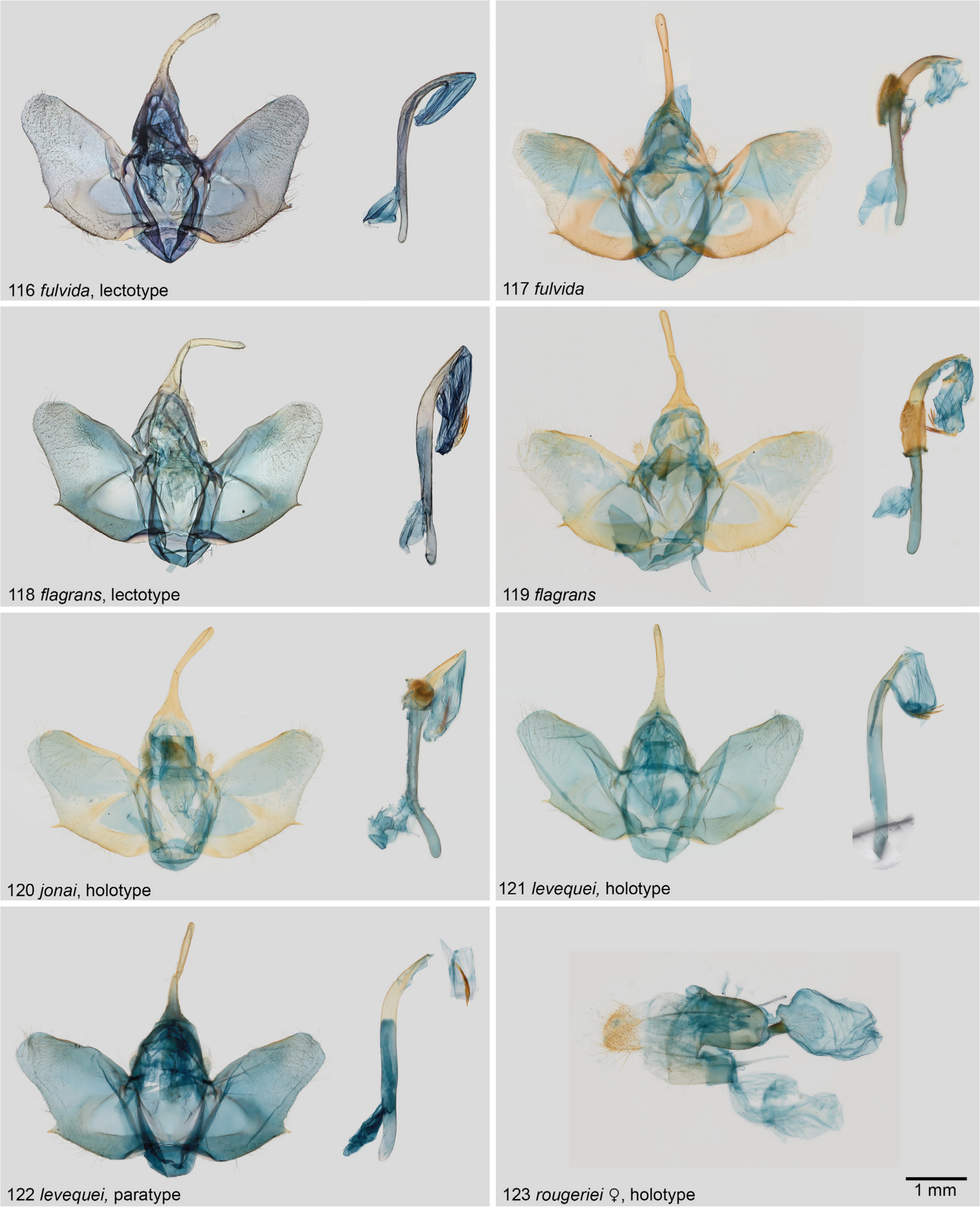

116 *fulvida*, lectotype

117 *fulvida*

118 *flagrans*, lectotype

119 *flagrans*

120 *jonai*, holotype

121 *levequei*, holotype

122 *levequei*, paratype

123 *rougeriei* ♀, holotype

Figs 116–123. Male genitalia (left = valves; right = aedeagus) and female genitalia. **116**. *Callipia fulvida* Warren, 1907, ♂, lectotype (NHM). **117**. *C. fulvida* Warren, 1907, ♂ (C-0174, COI data). **118**. *C. flagrans* Warren, 1904, ♂, lectotype (NHM). **119**. *C. flagrans* Warren, 1904, ♂ (C-0022, COI data). **120**. *C. jonai* sp. nov., ♂, holotype (C-0020, COI data). **121**. *C. levequei* sp. nov., ♂, holotype (C-0073, COI data). **122**. *C. levequei* sp. nov., ♂, paratype (C-0072, COI data). **123**. *C. rougeriei* sp. nov., ♀, holotype (C-0069, COI data).

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Diagnosis

The extent of dark brown colour is larger than in *C. fulvida*, see diagnosis in this species. *Callipia levequei* sp. nov. has a considerably more intense ground colour than *flagrans*. *Callipia flagrans* and *C. jonai* sp. nov. are very similar and can most reliably be distinguished by DNA-barcoding. The ground colour in *C. flagrans* is more yellow than in *C. jonai* sp. nov., and the species appear to be geographically separated (*C. flagrans* in Peru, *C. jonai* sp. nov. in Bolivia). COI-barcode: the minimum observed distance to the genetically most similar (but not similar looking) species (*C. augustae* sp. nov.) is 2.6%.

Type material

Originally 3 **syntypes** (males) from Peru, [Puno], River Inambari, 1000 m, July 1900, rainy season, Simons leg. (NHM). One of these males is designated as **lectotype** (Figs 110, 118).

Other material examined

PERU: 2 ♂♂, (MFN, MNHN) (C-0267, 0272); 1 ♂, [San Martín], Jepelacio (USNM) (C-0271); 3 ♂♂, [San Martín], Huallaga (USNM, ZSM) (C-0254; 0259; 0270); 1 ♂, [Huánuco] (SMNS) (C-0265); 1 ♂, [Pasco], Yanachaga [Parque nacional Yanachaga-Chemillén] (MfN) (C-0263); 1 ♂, [Pasco] Quiroz (AMNH) (C-0273 with GS-277); 1 ♂, [Pasco], Huancabamba, 6–10000 ft [1829–3048 m] (MNHN) (C-0268); 4 ♂♂, [Pasco], Huancabamba, Cerro de Pasco (NHM, SMF) (C-0253 with GS-156; C-0260 with GS-111; C-0261; 0264); 1 ♂, [Pasco], Huancabamba, 1000 m (MFN) (C-0252); 1 ♂, [Pasco], Pozuzo, 800 m (AMNH) (C-0256); 1 ♂, [Junín], Chanchamayo (MFN) (C-0266); 1 ♂, [Junín], Mina Pichita, 2100 m (MUSM) (C-0023); 1 ♂, [Junín], Tarma, 3000 m (AMNH) (C-0255); 1 ♂, Cusco, Vilcanota, 3000 m (SMF) (C-0262); 1 ♂, [Cusco], Machupicchu (AMNH) (C-0024 with GS-278, COI sequence 295 bp (148 bp gap)); 1 ♂, Cusco, Cosñipata, 2360 m, 13.157° S, 71.596° W (C-0475, Pe-Geo-0341, COI sequence 658 bp, BIN); 1 ♂, [Cusco], Valle de Marcapata (USMSM) (C-0269); 1 ♂, [Puno, Rio] Chirimayo (USNM) (C-0258); 1 ♂, Madre de Dios, Tambopata Reserve, Explorer's Inn, 12°51' S, 69°18' W, 200 m [doubtful record] (AMNH) (C-0022 with GS-415, COI sequence 658 bp, BIN, Figs 111, 119).

Distribution

Eastern Andes of Peru with records from the north to the south east, 800–3100 m.

Callipia jonai sp. nov.

urn:lsid:zoobank.org:act:E160FE45-8B84-4464-852B-05C52EFF4312
Figs 112–113, 120, 129

BIN (holotype): BOLD:AAI6981.

Diagnosis

Specimens of *C. jonai* sp. nov. were frequently assigned to *flagrans* in museum collections, but when seen in larger series, *C. jonai* sp. nov. has a deeper orange-red than *flagrans* which is more yellowish. See also diagnosis in *C. flagrans*. COI-barcode: the minimum observed distance to the genetically most similar (but not similar looking) species (*C. intermedia* stat. rev.) is 2.7%.

Etymology

The species is named in honour of my son Jona Brehm, Jena, Germany.

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Type material

Holotype (Figs 112, 120)
BOLIVIA: ♂, Cochabamba [Department], Chapare, 2000 m, Feb. 1995, G. Lachaume leg. (ZSM) (C-0020 with GS-410, COI sequence 620 bp, BIN).

Paratypes
BOLIVIA: 1 ♂, Cochabamba [Department], Yungas de Incachaca, 2100 m, 10 Feb. [19]59, R. Zischka leg. (ZSM) (C-0221 with GS-166, COI sequence 356 bp); 2 ♂♂, Cochabamba [Department], Incachaca (CMNH) (C-0231; 0232); 11 ♂♂, Cochabamba [Department], (CMNH, PMJ, NHM, RCGB) (C-0230; 0234; 0235; 0237–0242; C-0247 with GS-276; C-0248 with GS-290); 1 ♀, same data as previous (C-0217 with GS, Figs 113, 129).

Other material examined

BIOLIVIA: 1 ♂, La Paz [Department], Rio Tanampaya, [ca 16.30° , 67.33° W], (MfN) (C-0246); 1 ♂, [Cochabamba Department], Chapare (AMNH) (C-0228); 1 ♂,Cochabamba [Department] (CMNH) (C-0251); 1 ♂, Cochabamba [Department], El Palmar (AMNH) (C-0250); 8 ♂♂, Cochabamba [Department], Chapare (ZSM) (C-0219; 0220; 0223; 0226; 0229; 0233, 0243; 0244); 1 ♂,Tanamp.[aya] [ca 16.30° S, 67.33° W], (MfN) (C-0222); 1 ♂, Yungas de Corani, 2500 m (ZSM) (C-0224); 6 ♂♂, Yungas de Palmar, 1000 and 2000 m (AMNH, ZSM) (C-0206; 0225; 0227; 0236; 0245; 0249).

[ARGENTINA]: 1 ♂, Buenos Aires [location doubtful] (AMNH) (C-0218).

Distribution

Eastern Andes of western and central Bolivia, 1000–2000 m.

Callipia levequei sp. nov.

urn:lsid:zoobank.org:act:A290D0E4-627E-450A-8734-C4C8A20911D8

Figs 114–115, 121–122, 130

BIN (holotype): BOLD:AAI3931.

Diagnosis

Among all *Callipia* of the *parrhasiata* group, *C. levequei* sp. nov. has the deepest red colour. The holotype probably represents a chromatic abberation (Fig. 114), other males have the same appearance as the female illustrated in Fig. 115. *Callipia levequei* sp. nov. also tends to be smaller than *C. jonai* sp. nov. and *C. flagrans*, possibly the closest related species. The male genitalia do not offer clear diagnostic characters, when compared to *C. jonai* sp. nov. and *flagrans*. COI-barcode: the minimum observed distance to the genetically most similar (but not similar looking) species (*C. intermedia* stat. rev.) is 3.4%.

Etymology

The species is named in honour of Antoine Lévêque, Paris, France.

Type material

Holotype (Figs 114, 121)
ARGENTINA: ♂, Jujuy, Parc National Calilegua, Abra de Cañas, 1680 m, [ca 23.47° S, 64.55° W], [no date], P. Schmitt leg. (MNHN) (C-0073) with GS-298, COI sequence 658 bp, BIN).

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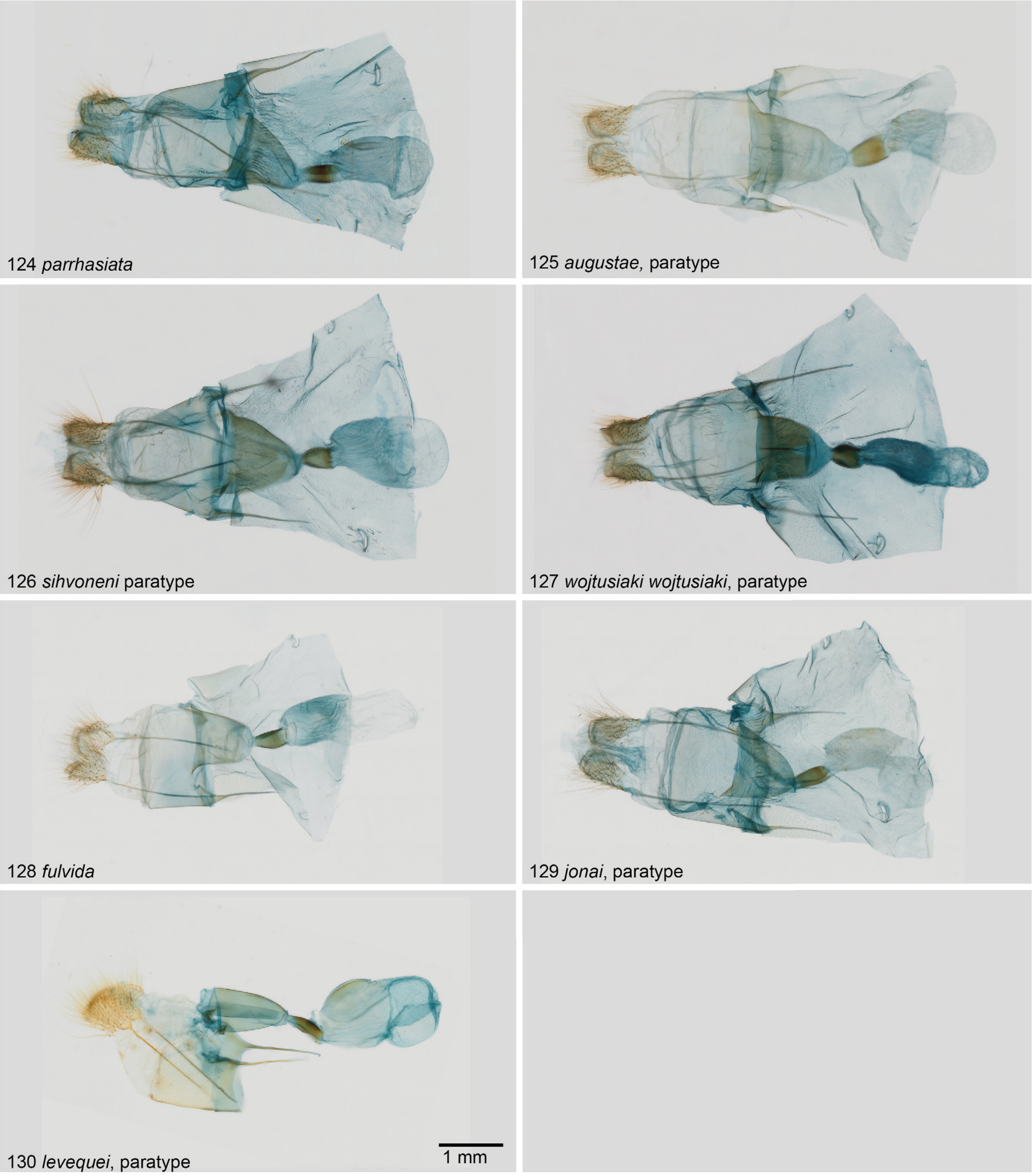
Paratypes

ARGENTINA: 1 ♂, same collection data as for holotype (C-0072 with GS-299, COI sequence 658 bp, BIN, Fig. 122) (MNHN); 1 ♀, same collection data as for holotype (C-0071 with GS-418, COI sequence 658 bp, BIN, Figs 115, 130); 2 ♂♂, Jujuy, Yala, 1450 m, 20 Feb. 1955, J. Förster leg. (PMJ, ZSM) (C-0185; 0187).



Figs 124–130. Female genitalia. **124**. *Callipia parrhasiata* Guenée, 1858, ♀ (C-0431). **125**. *C. augustae* sp. nov., ♀, paratype (C-0432). **126**. *C. sihvoneni* sp. nov., ♀, paratype (C-0396, COI data). **127**. *C. wojtusiaki wojtusiaki* sp. nov., ♀, paratype (C-0040, COI data). **128**. *C. fulvida* Warren, 1907, ♀, (C-0172). **129**. *C. jonai* sp. nov., ♀, paratype (C-0217). **130**. *C. levequei* sp. nov., ♀, paratype (C-0071).

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Figs 131–138. Living specimens and habitats. **131**. *Callipia rosetta* Thierry-Mieg, 1904, ♂, Ecuador, Loja province, Podocarpus National Park, Cajanuma, 2897 m, 26 Mar. 2011. The specimen was attracted to light and benumbed. **132**. Elfin forests are a habitat of *C. rosetta* Thierry-Mieg, 1904 and *C. walterfriedlii* sp. nov., Ecuador, Loja province, Podocarpus National Park, Cajanuma, 3000 m, 30 Jan. 2013. **133**. *C. walterfriedlii* sp. nov., ♀, Ecuador, Loja province, Podocarpus National Park, Cerro Toledo, 2938 m, 27. Feb. 2013. The specimen was attracted to light and benumbed. **134**. Habitat (elfin forest) of *C. walterfriedlii* sp. nov. at Cerro Toledo. **135**. *C. augustae* sp. nov., ♂, Peru, Cusco province, Wayqecha station, 2900 m, 26 Aug. 2016. The specimen was collected at night, trapped, photographed and released the next morning. **136**. Habitat of *C. augustae* sp. nov. and *Callipia* sp. near Wayqecha station. **137**. *C. augustae* sp. nov., ♂, Peru, Cusco province, road Wayqecha–Pillcopata, 2284 m, 23 Aug. 2016. The specimen was attracted to UV light and tried to take up fluid (see proboscis). **138**. *Callipia* sp. at Wayqecha station, 4 Sep. 2016. This specimen was attracted to UV light, but escaped into the vegetation when disturbed.

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Other material examined

BOLIVIA: 1 ♂, Cochabamba [Department], Chapare, Paracti (AMNH) (C-0021, COI sequence 554 bp (104 bp gap)); 1 ♂, [Cochabamba Department], Chapare, Incachaca (USNM) (C-0186); 1 ♂, Cochabamba [Department] (CMNH) (C-0188).

Distribution

Eastern Andes of northern Argentina and Bolivia, 1700 m.

Discussion

Remarkably, the number of species increased substantially even in a rather conspicuous moth taxon – from 10 to now 26 valid *Callipia* species. This shows that species richness of tropical moths can be strongly underestimated even in taxa that were regularly sampled and usually not overlooked. The situation in less conspicuous taxa is much worse: higher proportions of species still remain undescribed, and many species of small taxa (such as *Eupithecia* Curtis, 1825) still need to be sampled, because they are not represented in any museum collection. For example, Brehm *et al.* (2011) estimated the percentage of undescribed species in the Neotropical Larentiinae genus *Eois* Hübner, 1818 at 85%.

This revision is far from being perfect, but in my view the results represent a significant progress in the taxonomy of *Callipia* and a small step in the systematics of Geometridae. When I started working for this paper more than twelve years ago, I focused on morphological characters – and got stuck in a dead end. For example, specimens around *C. parrhasiata* appeared highly variable, but did they all belong to one single, widespread species? Unfortunately, male genitalia of *Callipia* did not advance the research much further. They mirrored the obvious differences between distantly related species (such as *C. balteata* and *C. fulvida*), but they were of little value in the discrimination of closely related taxa. DNA barcoding then boosted the process again. The new data provided many clear clusters, and this in turn allowed re-sorting of the material, and then patterns became visible that were much more convincing than the lumping before. One might argue that certain species splits are not sufficiently justified and, in some cases, only a single specimen was available for description. However, more data and new material can always shed more light into these matters in the future. If one, two or three of the new taxa will eventually turn out to be synonyms, then they will be – but in the meantime, there is now a framework available to build upon, and hypotheses that can be tested. It was important to me that as many specimens as possible (and all relevant types) are well illustrated in this paper, and that all molecular information and sampling data are well accessible and presented in the most transparent way, e.g., by providing a Google Earth kml file that allows to explore the distribution data in detail. Doubtlessly more species of *Callipia* will be discovered in the Andes in the future and, hopefully, much more biological knowledge will be gathered about these beautiful moths and their habitats will be valued and conserved.

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Electronic supplementary material

Supplementary File 1

Neighbour joining tree of all DNA barcoded *Callipia* specimens, generated in Boldsystems (pairwise distance, Bold aligner, Kimura 2 parameter)

Supplementary File 2

List of all examined *Callipia* specimens, including label data, and molecular information (BIN number, GenBank accession).

Supplementary File 3

Google Earth kml file with distribution data.

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