

Revision of the genus *Biterolfa* Schaus, 1928 (Mimallonoidea: Mimallonidae) with the descriptions of two new species

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Abstract: The mimallonid genus *Biterolfa* Schaus, 1928 is revised. We describe and figure the female of the type species, *B. althea* (Schaus), for the first time. We recognize two new species, *B. rana* sp. n. found in the western Amazon and eastern slopes of the Andean mountains from Venezuela, Colombia, Ecuador, Peru, Bolivia, and northern Brazil, and *B. tinalandia* sp. n. from Costa Rica, Panama, Colombia, and Ecuador (western slopes of the Andes). This revision increases the total number of known *Biterolfa* species from one to three.

Key words: Amazon rainforest, Andean Mountains, Neotropical, taxonomy

INTRODUCTION

Recent taxonomic studies of the Mimallonidae, the sole representative of the superfamily Mimallonoidea, have shown numerous genera to be more diverse than previously thought (for example see St Laurent & Dombroskie, 2016). Evidently, this superfamily contains more species than previously understood, and ongoing taxonomic and phylogenetic work will likely ultimately reveal many more.

Until now, *Biterolfa* Schaus, 1928 contained a single species previously reported from French Guiana (Schaus, 1905, 1928). Schaus (1928) placed this genus in the refuted subfamily Lacosominae based on the presence of a frenulum, which has been deemed a plesiomorphic character and thus not grounds for subfamilial classification (Pearson, 1951, 1984; Lemaire and Minet, 1998; Franclemont, 1973). Schaus (1928) described the frenulum of *Biterolfa* as being “not highly developed,” and we determined the frenulum to be absent or vestigial, thus it is not clear why Schaus placed this genus in the “frenulum present” subfamily.

This work is the first to figure the female of *Biterolfa* and the genitalia of both sexes. We also describe two additional new species: one from the western Amazon and eastern slopes of the Andes (Venezuela, Colombia, Ecuador, Peru, Bolivia, and Brazil) and another from southern Central America and the western slopes of the Andes (Costa Rica, Panama, Colombia, and Ecuador).

MATERIALS AND METHODS

Dissections were performed as in Lafontaine (2004). Morphological terminology follows Kristensen (2003). Genitalia from the Museum Witt, Munich, Germany are slide mounted, while the remaining preparations are kept in glycerol-filled microcentrifuge tubes to allow for three-dimensional examination of the structures. Specimens from the following collections were examined:

BME	Bohart Museum of Entomology, University of California, Davis, California, USA
CAC	Collection of Alexandre Cahurel, France
CDH	Collection Daniel Herbin, Garidech, France
CGCM	Collection Carlos G. C. Mielke, Curitiba, Paraná, Brazil
CGD	Collection of Guy Durand, France
CPC	Collection Philippe Collet, Caen, France (soon to be transferred to the MNHN)
MGCL	McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History, Gainesville, Florida, USA
MNHN	Muséum nationale d'Histoire naturelle, Paris, France
MNHU	Museum für Naturkunde der Humboldt-Universität zu Berlin, Germany
MNRJ	Museu Nacional, Rio de Janeiro, Rio de Janeiro, Brazil
MWM	Museum Witt, Munich, Germany
NHMUK	Natural History Museum, London, U.K.
NHRS	Entomological Collections, Swedish Museum of Natural History, Stockholm, Sweden
USNM	National Museum of Natural History [formerly United States National Museum], Washington, D.C., USA

The symbol ‡ is used to represent unavailable names in the text (Fletcher and Nye, 1982). Figures were manipulated with Adobe Photoshop CS4 (Adobe, 2008). Latitude and longitude data were obtained from Google Earth, when absent on specimen labels, and are provided below in material examined sections within brackets.

RESULTS

Biterolfa Schaus, 1928

Type species: *Cicinnus althea* Schaus, 1905: 326, by original designation in Schaus, 1928: 666.

Description: Male. *Head:* Eyes large, occupying more than two thirds area of head when viewed anteriorly; antenna bipectinate to tip, pectination reduced along distal quarter; labial palpus not extending beyond frons, three palpomeres. *Thorax:* Vestiture thick, usually darker along distal edge of scales demarcating prothoracic collar and tegulae. *Legs:* Vestiture similar to dorsum of thorax. Tibial spurs small, indistinct, almost entirely

clothed in scales. *Forewing dorsum*: Forewing length: 17–22 mm, wingspan: 34.5–44.0 mm. Elongated, triangular, apex falcate, outer margin concave below apex, convex mesally forming a point where CuA1 intersects margin. Ground color always reddish brown, ranging from more orange hued to deeper brown. Antemedial line absent. Postmedial line straight, sharply angled toward costa after passing Rs4. Submarginal area with dark gray to black shading along postmedial line reaching apex, shading broadest near tornus, gradually narrowing along length of postmedial line. Pair of diffuse, nearly parallel lines transversing wing from costa to postmedial line, upper line includes barely discernable, narrow discal mark within. Posterior edge of paired lines shaded darker brown than surrounding wing, anterior shading of same lines pale cream. Wing overall lightly stippled with broad, dark brown petiolate scales. *Forewing ventrum*: Similar to dorsum, but lighter in color, paired transverse lines nearly absent, faint discal mark present as simple askew line. *Hindwing dorsum*: Rounded, anal angle pronounced, markings simple, antemedial line absent, postmedial line smoothly curving, lunule-like marking present submarginally, marking meets postmedial line near anterior wing margin and smoothly curves away towards anal angle or just above it. *Hindwing ventrum*: As for hindwing dorsum, but lighter, postmedial lunule absent. Frenulum apparently absent or vestigial. *Venation*: Rather typical for Mimallonidae, essentially identical to *Cicinnus melsheimeri* (Harris, 1841) in Franclemont (1973). *Abdomen*: Elongated, usually extending beyond anal angle of hindwing. Narrow line of darker scales present ventro-laterally on either side of abdomen. Sternite VIII bears pair of fingerlike processes. *Genitalia*: Tegumen fused to vinculum. Vinculum rather squared, broad, slightly projected posteriorly. Uncus narrow, bird beak-like, projected posteriorly. Gnathos mesally unfused, separated into two large, heavily sclerotized arms of variable shape. Gnathos arms always elongated with apical fingerlike tip. Valves short, somewhat triangular, basally broad, distally narrowed. Each valve with elongated scale tufts tipped with darker brown scales. Juxta partially fused to phallus, encircling it, forming pair of lobe-like extensions, one situated on either side of phallus somewhat ventrally arranged. Sclerotized shaft of phallus very short, broad, angled downward, greatly broadened distally. Vesica narrow, roughly twice length of sclerotized shaft. **Female.** *Head*: Similar to male, but antennae smaller overall. *Thorax*: As in male. *Legs*: As in male. *Forewing dorsum*: Forewing length: 23.5–25.0 mm, wingspan: ~45–50 mm. As in male but broader, apex less falcate, postmedial line slightly convex. *Forewing ventrum*: Similar to dorsum, but lighter, paired transverse lines nearly absent, faint discal mark present as simple askew line. *Hindwing dorsum*: As in male but broader, anal angle less pronounced. *Hindwing ventrum*: As for hindwing dorsum, but lighter, postmedial lunule absent. Frenulum apparently absent. *Abdomen*: As in male but larger, more robust. Sternite VII with pair of thin sclerotized plates. Sternite VIII lacks paired process of male. *Genitalia*: Stout, apophyses anteriores longer than apophyses posteriores. Lamella postvaginalis broad, bowl-like. Tergite VIII variable, but always sclerotized, forming posteriorly directed structure. Papillae anales typical of Mimallonidae, but particularly broad. Ductus bursae well-sclerotized, broad,

matching width of lamella postvaginalis. Corpus bursae bag-like, roughly equal in size to that of remainder of female genitalia.

Diagnosis: *Biterolfa* is recognized by the consistently brown to red-brown coloration overall, and slightly elongated, apically falcate forewings which have a pair of distinctive white outlined streaks extending horizontally across the forewing towards the costa from the postmedial line. Male genitalia are recognized by the distally truncated valvae and the prominent gnathos, which is unfused, or weakly connected mesally, and separates into two large arms that vary in shape from species to species, but always display a distally narrowed, fingerlike process at the tip of each arm. The phallus is short, and very wide, appearing nearly as wide as long in some cases (viewed anteriorly), usually steeply curved downward, the juxta is affixed to the phallus and forms two lobes, one on either side of the phallus. Female genitalia have a very broad, bowl-like lamella postvaginalis, which at its base is narrower than the very broad, sclerotized ductus bursae. Tergite VIII is variously sclerotized in each species. The genus *Psychocampa* Grote & Robinson, 1866 display similar male genitalia, however, the valves are not so distinctly truncated distally, and the gnathos arms are broader, more triangular structures with more gradual narrowing distally, usually without the fingerlike process of *Biterolfa*. Additionally, no *Psychocampa* display the reddish brown coloration and horizontal streaks of the forewings.

Remarks: Considering the diagnostic characters given above, this unique genus should not be easily confused with any other in the family. *Biterolfa* is broadly distributed in southeastern Central America and throughout the Andes to Bolivia and western Amazonian regions of South America.

Key to species of *Biterolfa*.

1. Wing coloration light red-brown, forewing weakly concave (male) below apex, lighter region of forewing submarginal area not much wider than that of dark shading along postmedial line at tornus. Male genitalia with triangular valves (Figs 15a, 17a) not greatly narrowed distally forming a lobe (Fig. 18a). East of the Andean mountains.....2
-Wing coloration dark red-brown, forewing deeply concave (male) below apex, lighter region of forewing submarginal area noticeably wider than that of dark shading along postmedial line at tornus. Male genitalia with rounded valves that are highly narrowed distally forming a lobe (Fig. 18a). West of Andean mountains, also Costa Rica and Panama.....***B. tinalandia* sp. n.**
2. Male genitalia: gnathos arms with ventral mesal teeth along ridge and short, downwardly angled point distally (Fig. 19). Phallus thin (viewed laterally) and smoothly arcing (Fig. 15c). Female genitalia: tergite VIII weakly sclerotized, hardly forming posteriorly directed angle (Fig. 22b). Mostly eastern Amazonian.....***B. althea***
3. Male genitalia: gnathos arms usually lacking ventral mesal teeth, distal tip of processes with elongate fingerlike extension and small dorsal protuberance (Fig. 20). Phallus broad (viewed laterally) and short, not clearly arcing in shape,

basally angled backward (Fig 17c). Female genitalia: tergite VIII heavily sclerotized, indented mesally (Fig. 23b). Mostly western Amazonian and eastern Andes.....***B. rana* sp. n.**

***Biterolfa althea* (Schaus, 1905)**

Figs 1–2, 10, 15, 19, 22, 25

Cicinnus althea Schaus, 1905: 326

Biterolfa althea; Schaus, 1928: 666, fig. 88g, ♂

Biterolfa althea; Gaede, 1931: 15

Biterolfa althea; Becker, 1996: 19

Description: Male. *Head:* As for genus, coloration rusty red-brown. *Thorax:* As for genus, coloration as for head except darker scales along tegulae and prothoracic collar. *Legs:* As for genus, coloration essentially as for thorax dorsum but lighter. *Forewing dorsum:* Forewing length: 18–21 mm, avg. 18.9 mm, wingspan: 35–43 mm, n=17. Typical of genus, coloration light reddish brown, submarginal area narrow, only slightly wider than black shading along postmedial line at the tornus. *Forewing ventrum:* As for genus. *Hindwing dorsum:* Typical of genus, light reddish brown. *Hindwing ventrum:* As for hindwing dorsum, but lighter, postmedial lunule absent. *Abdomen:* As for genus but fingerlike processes of sternite VIII narrowly spaced, distally convergent. *Genitalia:* (Figs 15, 19) n=5. Vinculum rather squared or subsquared, broad, relatively thinly sclerotized. Uncus narrow, moderately bent mesally, tip squared. Gnathos unfused mesally with heavy sclerotization, though somewhat connected at base with strong membrane, separated into two large, heavily sclerotized arms with lateral ridge and sharply downturned apex which may be very sharp or blunt; ventral edge of gnathos arms convex mesally and lined with small, sharp teeth. Small teeth may also be present subapically dorsal to downturned tip. Valves short, triangular, basally broad, distally slightly narrowed. Juxta as for genus. Phallus short, broad viewed dorsally or ventrally, but thin laterally, angled downward distally, smoothly arcing in shape. Vesica as for genus. **Female.** *Head:* Similar to male, but antennae smaller overall. *Thorax:* As in male. *Legs:* As in male. *Forewing dorsum:* Forewing length: 25 mm, wingspan: 50 mm, n=1. As in male but broader, apex less falcate, postmedial line slightly convex. *Forewing ventrum:* As for genus. *Hindwing dorsum and ventrum:* As for genus. *Abdomen:* As for genus. *Genitalia:* (Fig. 22) n=1. Stout, apophyses anteriores slightly longer than apophyses posteriores. Lamella postvaginalis broad, bowl-like. Tergite VIII weakly sclerotized, forming posteriorly directed angle. Papillae anales broad, rather flat. Ductus bursae well-sclerotized, very broad, matching width of lamella postvaginalis. Corpus bursae bag-like, roughly equal in size to that of remainder of female genitalia.

Type: HOLOTYPE ♂. **FRENCH GUIANA:** St. Jean, Maroni, F. Guiana [5.402561°, -54.076601°] / *Perophora althea* type Schaus/ [holo]Type No. 8890 U.S.N.M./ USNM-Mimal: 1110/ Collection WmSchaus/ (USNM, examined). (Fig. 1).

Additional material examined: (18 ♂, 3 ♀ total) **FRENCH GUIANA: Saint-Laurent-du-Maroni:** 1 ♂, Mana River [5.618975°, -53.763343°]: V.1917, Acc. 6008 (CMNH). 1 ♂, St Laurent du Maroni [5.483882°, -54.02489°]: *B. althea* Schaus Topotype [not exactly topotypical], Collection Wm Schaus, USNM-Mimal: 2601, St Laurent diss.: 11-16:11 (USNM). **Cayenne:** 1 ♂, Dirt Road to Kaw, Camp Patawa [4.682705°, -52.513802°]: 25.III.2008, S. Kohll leg., BC-Her 2692 (CDH). 1 ♂, Dirt Road to Saut Leodate, km 12 [4.986073°, -52.588962°]: 12.II.1999, M. Laguerre leg., BC-Her 2943 (CDH). 3 ♂, Dirt Road Coralie, 4°29'07.43"N 52°23'49.40"W, 40m: 30.XI.2013 [2 ♂], 07.XII.2013 [1 ♂], D. Herbin leg., D. Herbin genitalia prep. ref. H1225 (CDH). 1 ♀, Road to Coralie, km 10 [4.655955°, -52.342242°]: XII.2010, A. Cahurel leg. (CAC). 2 ♂, Road Coralie, km 2: IX.1991, Exp. H. de Toulgoët., H. de Toulgoët, J. Navatte, P. Bleuzen, L. Sénécaux leg.; 11.VI.1993, L. & A. Sénécaux (MNHN). 1 ♂, Rte. forest of Coralie, km 2, 4°30'30"N, 52°22'30"W: 15.IX.1998, B. Hermier, G. Debaix, P. Thiaucourt leg. (MNHN). 1 ♂, Roura, road Coralie, km 2: 25.III.1992, P. Kindl leg., Muséum Paris don de Th. Kindl (MNHN). 1 ♂, Roura, environs de Coralie, road to Dégrad Corrèze, km 0.1: 2.III.1992, P. Kindl leg., Muséum Paris don de Th. Kindl (MNHN). 1 ♂, Roura, Road to Changement, km 6: 4.XII.1991, L. Sénécaux leg., coll. P. Kindl, Muséum Paris don de Th. Kindl (MNHN). 1 ♂, Roura, Road to Kaw, km 38: 10.III.1992, P. Kindl leg., coll. P. Kindl, Muséum Paris don de Th. Kindl (MNHN). 1 ♀, Petites Montagnes Tortue, RN 2 – km 95 [4.292914°, -52.130991°]: 18.V.2010, Greg

Lamarre leg. (CPC). 1 ♀, Dirt Road to Kaw, km 45 [4.514189°, -52.070314°]: 28.II.2006, D. Herbin, M. Laguerre leg., BC-Her 2944, D. Herbin genitalia prep. H600 (CDH). 1 ♂, Bélizon, km 8 [4.276285°, -52.643673°] (CGD). 2 ♂, Moyen Oyapock, Camopi, 100 m [3.166092°, -52.341383°]: 26.I.1990, 15.II.1991, BMNH(E) 2008-107, NHMUK010588032, NHMUK010588033, Genitalia vial NHMUK010402169 (NHMUK). **BRAZIL: Amazonas:** 1 ♂, Reserva Ducke, km 26 Manaus-Itacoatiara Highway [-3.072002°, -59.712633°]: 14.IV.1972, E.G., I. & E.A. Munroe [leg.], St Laurent diss.: 2-26-16:6 (CNC).

***Biterolfa* near *althea*: PERU: Amazonas:** 2 ♂, Bagua Chica, 1000 m [-5.650058°, -78.527362°]: X–XII.1998, via R. Marx ex. coll. Shintmeister [Schintmeister], genital preps 29.993, 30.814 (MWM).

Diagnosis: *Biterolfa althea* is recognizable by the narrow submarginal area, especially mesally along wing margin (distinguishing it from *B. tinalandia* sp. n. only), and narrow gnathos arms in the male genitalia which always bear distinct teeth along the pronounced ventral ridge of the arms. The gnathos projections are thus somewhat similar to those of *B. tinalandia*, but in *B. althea* the terminus of each projection is sharply downwardly angled with only a short point (Fig. 19), whereas in *B. tinalandia* the distal tips of the gnathos arms are narrower and more elongated (Fig. 21). The phallus is the thinnest (when viewed laterally) in the genus and intermediate in curvature between nearly uncurving *B. rana* sp. n. (Fig. 17c) and steeply curved *B. tinalandia* (Fig. 18c). Female genitalia of *B. althea* can be distinguished from those of both *B. rana* and *B. tinalandia* by the reduction of sclerotization of the tergite VIII (Fig. 22b), which is much more robust and well developed in the other two species (Figs 23b, 24a). *Biterolfa althea* female genitalia are also recognizable by the relatively small size of the corpus bursae and broadness of the lamella postvaginalis.

Distribution (Fig. 25): Most specimens examined of the type species of *Biterolfa* come from French Guiana as well as the central Amazon near Manaus, Amazonas, Brazil. See Remarks below regarding material from Peru.

Remarks: Schaus described “*Cicinnus althea*” from a single specimen as per the given catalogue number in the original description (Cat. No. 8890), which corresponds to the type located in the USNM. Prior to this work, *B. althea* was known only from the type locality in French Guiana, we thus report several new localities in French Guiana, as well as a new country record from Brazil. A dissection of two specimens from Amazonas, Peru in the MWM revealed genitalia characteristic of *B. althea*, though the forewing apex is more falcate in these specimens than *B. althea* from the eastern Amazon, thus we are not certain that these specimens represent *B. althea* or a cryptic taxon. We treat this population as near *B. althea* pending further information, considering the similarity of the genitalia, and we include figures of one of these specimens and its associated genitalia (Figs 3, 16). All other *Biterolfa* material that we have examined from Peru and the western Amazon display the clearly distinct genitalia of *B. rana*.

In addition to new collecting data, we figure the female and genitalia of both sexes of *B. althea* for the first time.



Figs 1–9. Adult male *Biterolfa*, a or no letter= dorsal, b= ventral. **1.** *B. althea* holotype, French Guiana, St. Jean du Maroni (USNM). **2.** *B. althea*, French Guiana, Moyen Oyapock, Camopi, 100 m (NHMUK). **3.** *B.* near *althea*, Peru, Amazonas, Bagua Chica, 1000 m (MWM). **4.** *B. rana* paratype, Brazil, Rondônia, Vilhena, 600 m (USNM). **5.** *B. rana* paratype, Ecuador, Morona-Santiago, San Carlos de Limón, 937 m (MWM). **6.** *B. rana* holotype, Ecuador, Sucumbíos, Lumbaquí, 850 m (MGCL). **7.** *B. tinalandia* paratype, Costa Rica, Cartago, Copal Reserve, 1050 m (CDH). **8.** *B. tinalandia* holotype, Ecuador, Pichincha, Santo Domingo, Tinalandia, 650 m (MGCL). **9.** *B. tinalandia* paratype, Ecuador, Azuay, Cochabamba-Pan de Azúcar, 3150 m (MWM). Scale bar: 1 cm.

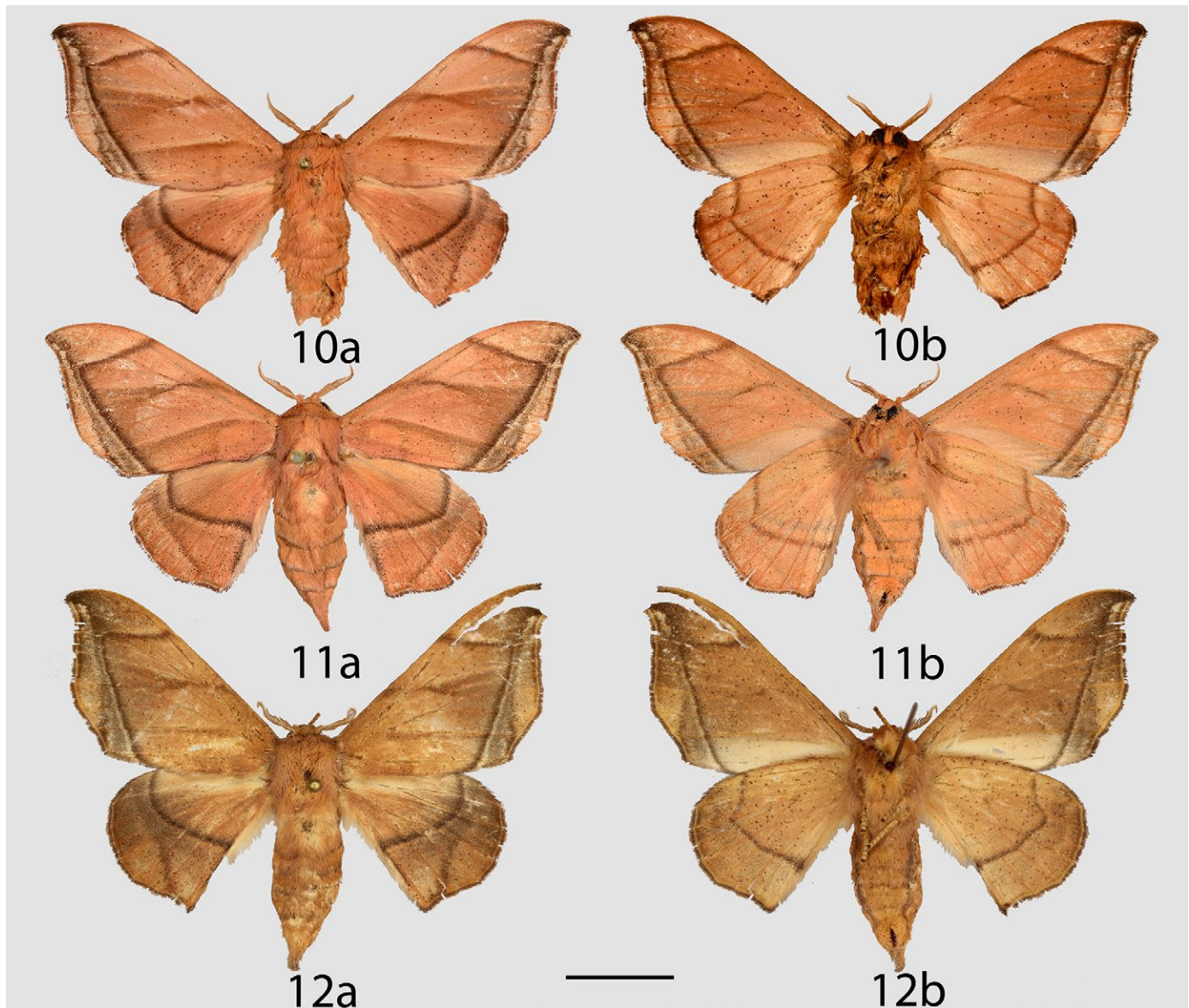
***Biterolfa rana* St Laurent, Giusti, & Herbin, new species**

Figs 4–6, 11, 13, 14, 17, 20, 23, 25

Biterolfa yupanqui†; Piñas, 2004: 36, figs 225 ♂, 226 ♀, **nomen nudum**
Biterolfa yupanqui†; Piñas, 2007, figs 228 ♂, 229 ♀, **nomen nudum**

Description: Male. *Head:* As for genus, coloration rusty red-brown. *Thorax:* As for genus, coloration as for head except darker scales along tegulae and prothoracic collar. *Legs:* As for genus, coloration essentially as for thorax dorsum but lighter. *Forewing dorsum:* Forewing length: 17–21 mm, avg. 19.2 mm, wingspan: 34.5–42.0 mm, n= 25. Typical of genus, coloration light reddish brown, submarginal area narrow. *Forewing ventrum:* Similar to dorsum, but lighter in color, paired transverse lines nearly absent. *Hindwing dorsum:*

Typical of genus, coloration light reddish brown. *Hindwing ventrum:* As for hindwing dorsum, but lighter, postmedial lunule absent. *Abdomen:* As for genus but fingerlike processes of sternite VIII widely spaced, about one third as wide as sternite. *Genitalia:* (Figs 17, 20) n= 16. Vinculum rather box-like, broad, relatively heavily sclerotized. Uncus narrow, weakly bent mesally, tip squared. Gnathos not mesally fused, separated into two large, heavily sclerotized arms with elongated downwardly angled fingerlike projection and smaller dorsal protuberance. Ventral edge of gnathos arms rarely bearing sharp teeth. Valves short, triangular, basally broad, distally slightly narrowed. Juxta partially fused to phallus, encircling it, forming pair of lobe-like extensions, one situated on either side of phallus. Phallus very short and broad when viewed dorsally, ventrally, and laterally, angled downward distally, backward basally. Vesica broad, roughly triangular and twice length of phallus. **Female.** *Head:* Similar to male, but antennae smaller overall. *Thorax:* As in male. *Legs:* As in male.



Figs 10–12. Adult female *Biterolfa*, a= dorsal, b= ventral. **10.** *B. althea*, French Guiana, Road to Kaw, km 45 (CDH). **11.** *B. rana* paratype, Ecuador, Napo, Road Pangayacu-Loreto, km 11, 1450 m (MNHN). **12.** *B. tinalandia* paratype, Ecuador, El Oro, 8 km NW of Piñas, 900 m (MWM). Scale bar: 1 cm.

Forewing dorsum: Forewing length: 24 mm, wingspan: 50 mm, n=1. As in male but broader, apex less falcate, postmedial line slightly convex. *Forewing ventrum:* Similar to dorsum, but lighter in color, paired transverse lines absent. *Hindwing dorsum:* As in male but broader, anal angle less pronounced. *Hindwing ventrum:* As for hindwing dorsum, but lighter, postmedial lunule absent. *Abdomen:* As for genus. *Genitalia:* (Fig. 23) n=1. Stout, apophyses anteriores slightly shorter than apophyses posteriores. Lamella postvaginalis broad, bowl-like, less heavily sclerotized mesally. Segment VIII strongly sclerotized, encircling papillae anales as dorsolateral ring, tergite VIII robust, thickly sclerotized, mesally indented. Ductus bursae well-sclerotized, very broad, matching width of lamella postvaginalis. Corpus bursae bag-like, larger overall than remainder of female genitalia. Papillae anales broad, rather flat.

Types: HOLOTYPE ♂. **ECUADOR: Sucumbios:** ECUADOR – Napo [*recte* Sucumbios], Lumbaquí, 850 m [-0.008228°, -77.427806°], 23 VII 1973, Coll Vénédictoff/ Venedictoff colln. Allyn Museum Acc. 1986-26/ St Laurent diss.: 11-16:13/ HOLOTYPE ♂ *Biterolfa rana* St Laurent, Giusti, & Herbin, 2017/ (MGCL). (Fig. 6).

Paratypes (37 ♂, 1 ♀ total). **COLOMBIA: Meta:** 1 ♂, Villavicencio, 400 m [4.150956°, -73.638619°]. Coll. Fassel [leg.], Joicey Coll., Brit. Mus. 1925–157, *Biterolfa althea* det. J.E. Chainey, 2003, Genital vials NHMUK010402172,

NHMUK010588472 (NHMUK). **VENEZUELA: Bolívar:** 1 ♂, Gran Sabana, Sierra Pacaraima, Río Surukun, 4°36.60'N, 61°25.77'W, 950 m: 21–23. VIII.2008, F. & Th. Greifenstein [leg.], genitalia prep. 29.994 (MWM). 2 ♂, Rte El Dorado to Sta. Elena, km 118, 1400 m [5.779357°, -61.684486°]: 7–20.XI.1990, P. Bleuzen leg., D. Herbin genitalia prep. H1276 (MNHN). **ECUADOR: Sucumbios:** 1 ♂, Lumbaquí, 850 m [-0.008228°, -77.427806°]: 13.VIII.1973, Coll Vénédictoff, Allyn Museum Acc. 1986-26 (MGCL). **Napo:** 2 ♂, Route Pangayacu to Loreto, km 11.4, 1350 m [-0.818452°, -77.744397°]: 21.VII.1993, J. Haxaire [leg.], BC-Her 2806, D. Herbin genitalia prep. H1226 (CDH); 16.VIII.1993, J. Haxaire leg. (MNHN). 1 ♀, Route Pangayacu to Loreto, km 11, 1450 m: 3.VIII.1990, D. Herbin & J. Haxaire leg., D. Herbin genitalia prep. H1296 (MNHN). 1 ♂, Route Pangayacu to Loreto, km 5, 1350 m: 18–21.VII.1988, D. Herbin & J. Haxaire leg. (MNHN). 1 ♂, Route Pangayacu to Loreto, km 36, 1150 m [-0.803059°, -77.533668°]: 8.VII.1990, D. Herbin & J. Haxaire leg. (MNHN). 3 ♂, Hollin, 0°42'46"S, 77°44'26"W, 1321 m: 8–9.XI.2011, IV. Siniaev & O. Romanov [leg.], genital prep. 29.998 (MWM). **Pastaza:** 1 ♂, 5 km N Mera, 1500 m [-1.41122°, -78.099727°]: 29.VII.1988, D. Herbin & J. Haxaire leg. (MNHN). **Morona Santiago:** 2 ♂, San Carlos de Limón, 3°11'32"S, 78°26'40"W, 937 m: 24.XI.2011, V. Siniaev & O. Romanov [leg.], genital prep. 30.000 (MWM). 2 ♂, Route Limón à Méndez, km 22.5, 800 m [-3.091045°, -78.402833°]: 2–4.VIII.1988, D. Herbin & J. Haxaire



Figs 13, 14. *Biterolfa rana* in nature, Ecuador, Orellana, Loreto (Photo courtesy of Pavel Kirillov, used with permission). **13.** Dorsal. **14.** Lateral.

leg. (MNHN). 1 ♂, Route Méndez à Morona, km 75, 600 m [-3.042749°, -78.121967°]; 14.VIII.1990, D. Herbin & J. Haxaire leg. (MNHN). **BRAZIL:** **Amazonas:** 10 ♂, Fonte Boa, [Amazonas] [-2.53703°, -66.155898°]: V.1906, VI.1906, VII.1906, IX.1906, X.1906, S. M. Klages leg., Rothschild Bequest BM 1939-1, NHMUK010588471 [Genitalia vial NHMUK010402171], NHMUK010588473 [Genitalia vial NHMUK010402170], additional genital vials NHMUK010402174, NHMUK010402175 (NHMUK). **Rondonia:** 1 ♂, Vilhena, 600 m [-12.720269°, -60.143056°]; 9.XII.1997, V.O. Becker leg., ex-Col. Becker 111446, St Laurent diss.: 11-16:12 (USNM). **PERU:** **Loreto:** 1 ♂, Iquitos, Ramirez leg., CGCM 32313 [number refers to CGCM coll. number and dissection number] (CGCM). **Huánuco:** 3 ♂, Yuyapichis, ACP Panguana, 9°36'S, 74°56'W, 220 m: IX.2013, H. Thöny [leg.], genitalia prep. 29.992 (MWM). 1 ♂, Yuyapichis, Farm Tropical, 9°37' S, 74°56' W, 210 m: VI.2013, A. Eichinger leg. (MWM). **BOLIVIA:** 1 ♂, North Yungas, 1000–1800 m: X/XI/XII.2008, Local collector., D. Herbin genital prep. H1224 (CDH). **La Paz:** 2 ♂, Rio Songo [Río Zongo], 700 m [-15.716667°, -67.683333°]: Coll. Fassl, NHRS-TOBI000001878 [dissected], 000001879 (NHRS). – All paratypes with the following yellow label: PARATYPE ♂/♀ *Biterolfa rana* St Laurent, Giusti, Herbin, 2017.

Additional material examined and literature records [not to be included in type series]: (11 ♂, 2 ♀ total) **ECUADOR:** **Sucumbios:** 1 ♂, Díaz de Pineda, 1600 m: 9.V.1997, I. Manzano [leg.] (Piñas, 2004). **Napo:** 1 ♂, Wildsumaco Biol. Stat., E. Slope of Andean Mountains, 0°40'17.2''S, 77°35'55.1''W, ~1400 m: 1–14.VIII.2016, Kawahara & Barber Labs *et al.* [leg.], DNA voucher number 40834 (MGCL, molecular collection). 1 ♀, Vía Cosanga-Tena, km 24, 1100 m: 31.VIII.2000, F. Piñas [leg.] (Piñas, 2004). **Orellana:** 1 ♂, Loreto: photograph examined courtesy of Pavel Kirillov, specimen not collected (Figs 13, 14). 7 ♂, Canton Loreto, Section 8 de Diciembre, Res. Biol. del Rio Bigal, 00°31.769'S, 77°25.445'W, 939 m: 27–31.X.2011, A.Y. Kawahara leg., DNA voucher numbers 05465, 05705, 05747, 06264, 06310, 12624 [genitalia examined], 12628 (MGCL, molecular collection). **PERU:** **Tumbes:** 1 ♂, [EI] Caucho, 800 m [-4.083374°, -80.799956°]: III–IV.1998, Claude Lemaire donation, Genital preparation C. Gibeaux 7988 (MNHN). **Puno:** 1 ♀, Carabaya, Río Huacamayo, 3100 ft [-13.621684°, -69.707893°]: VI.1904, dry season, G. Ockenden [leg.], HRP No. 1233, *B. althea* Schaus (MNRJ).

Etymology: The specific epithet is based on the Latin word for frog (*rana*), referring to the shape of the ventrally splayed male genitalia which is similar to the ventral side of a frog, such that the valves are the frog's hind legs, the massive gnathos arms the front legs, and the uncus a narrow head. The name is a noun in apposition.

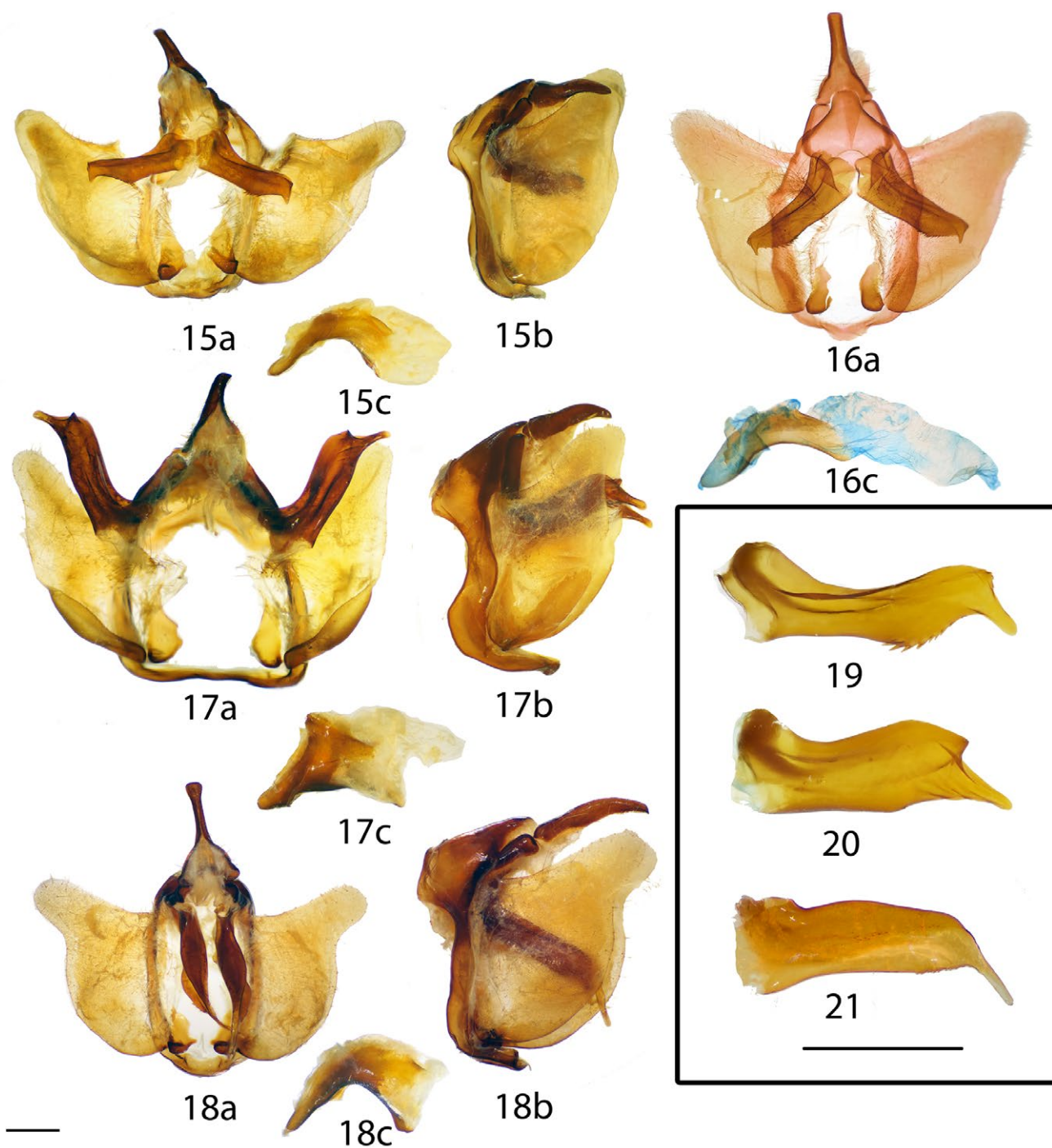
Diagnosis: Superficially, *B. rana* is identical to *B. althea*. The genitalia in both sexes, however, are very distinct when comparing these two species. Male: in *B. rana* the gnathos arms

are broader, with a smaller secondary protuberance dorsal to the usual fingerlike extension. Additionally, the phallus is broader and oddly shaped in *B. rana*, rather box-like with a backwardly angled base, in comparison with the narrow and evenly arcing phallus of *B. althea*. Female: genitalia of *B. rana* display a much more robust tergite VIII and larger corpus bursae than in *B. althea*, and thus are more similar to the genitalia of *B. tinalandia* sp. n. These two species can be distinguished by the steeper arches of the tergite VIII on either side of the mesal indentation in *B. tinalandia*, which are less pronounced in *B. rana*. Furthermore, the lamella postvaginalis is mesally unsclerotized in *B. rana*, but straight edged and fully sclerotized mesally in *B. tinalandia*.

Distribution (Fig. 25): *Biterolfa rana* is primarily an eastern Andes and western Amazonian species, found along the eastern slopes of the Andes mountains from Colombia south through Ecuador, Peru, and Bolivia, as well as the western Amazon rainforest in Venezuela, Brazil, and Peru. See remarks for information regarding a single specimen from northwestern Peru.

Remarks: Specimens that likely represent this new species were figured (figs 225, 226 and 228, 229) in the plates of Piñas (2004, 2007, respectively) with the unavailable name *Biterolfa yupanqui*‡; Piñas *nomen nudum* assigned by the author. As per information available in Thöny and Piñas (2015, 2017), all names proposed by Piñas in his works “Mariposas del Ecuador” are unavailable and must be regarded as *nomina nuda* since they do not satisfy Article 13.1.1 of the ICZN for a taxonomically available name (e. g. no description is provided) (see also St Laurent, *et al.* 2017).

We are currently uncertain as to whether or not *B. rana* and the externally indistinguishable *B. althea* are sympatric in the Amazon basin. It seems that *B. althea* is more commonly collected in the eastern Amazon, French Guiana and near Manaus, Amazonas, Brazil, whereas *B. rana* has only been found as far east as southern Venezuela. Most *B. rana* records come from moderate to low elevations along the eastern slopes

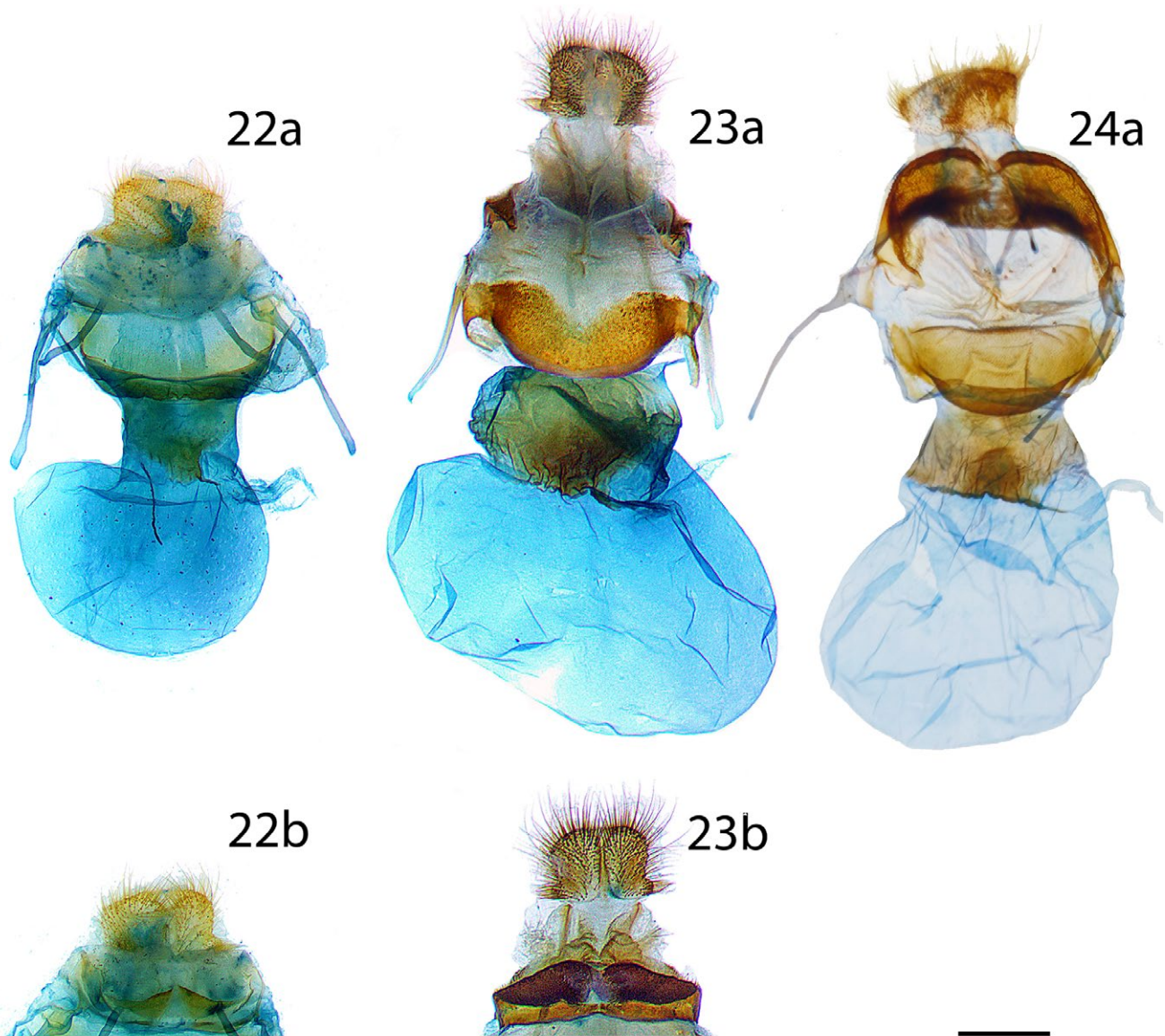


Figs 15–21. *Biterolfa* male genitalia, a= ventral, b=lateral, c= phallus. Inset displays excised right gnathos arm. **15.** *B. althea*, French Guiana, St. Laurent du Maroni, St Laurent diss.: 11-16:11 (USNM). **16.** *B. near althea*, Peru, Amazonas, Bagua Chica, 1000 m, MWM genitalia prep. 30.814 (MWM). **17.** *B. rana* holotype, Ecuador, Sucumbíos, Lumbaquí, 850 m, St Laurent diss.: 11-16:13 (MGCL). **18.** *B. tinalandia* holotype, Ecuador, Pichincha, Santo Domingo de los Colorados, Tinalandia, 650 m, St Laurent diss.: 11-16:14 (MGCL). **19.** *B. althea*, French Guiana, Moyen Oyapock, Camopi, 100 m, NHMUK genitalia prep. 010402169 (NHMUK). **20.** *B. rana* paratype, Colombia, Meta, Villavicencio, 400 m, NHMUK genitalia prep. 010402172 (NHMUK). **21.** *B. tinalandia* paratype, Ecuador, Pichincha, Tinalandia, 12 km SE Santo Domingo de los Colorados, 730 m, St Laurent diss.: 11-16:15 (USNM). Both scale bars: 1 mm.

of the Andean mountains, from Colombia south to Bolivia. However, as mentioned previously, two specimens from eastern Peru display genitalia matching those of *B. althea*. If this population is considered to be conspecific with *B. althea*, then it is likely that these two *Biterolfa* species are sympatric.

We located one specimen in the MNHN labeled from El

Caucho, Tumbes, Peru on the western side of the Andes in dry forests, for which external and male genital morphology are consistent with eastern Andean *B. rana*. The labels indicate that this specimen was donated to the MNHN by C. Lemaire, but with no indication of collector (and C. Lemaire himself never collected in Peru). Considering that we could not establish the



Figs 22–24. *Biterolfa* female genitalia, a= ventral, b= dorsal detail of tergite VIII. **22.** *B. althea*, French Guiana, Road to Kaw, km 45, D. Herbin genitalia prep. H600 (CDH). **23.** *B. rana* paratype, Ecuador, Napo, Road Pangayacu-Loreto, km 11, 1450 m, D. Herbin genitalia prep. H1296 (MNHN). **24.** *B. tinalandia* paratype, Ecuador, El Oro, 8 km NW of Piñas, 900 m, MWM genitalia prep. 29.996 [figured is a slide mount, thus both dorsal and ventral aspects are clearly visible] (MWM). Scale bar: 1 mm.

reliability of this specimen's labels, and the unlikelihood of *B. rana* occurring in both dry forests on the western side of the Andes and wet forests on the eastern side, this specimen is not included in the type series.

***Biterolfa tinalandia* St Laurent, Giusti, & Herbin, new species**

Figs 7–9, 12, 18, 21, 24, 25

Description: Male. *Head:* As for genus, but darker reddish brown. *Thorax:* As for genus, but darker reddish brown. *Legs:* As for genus. *Forewing dorsum:* Forewing length: 18–22 mm, avg. 20.4 mm, wingspan: 37–44 mm, n=7. Triangular, apex strongly falcate, outer margin deeply concave below apex, margin very convex mesally forming accentuated point where CuA1 intersects margin. Ground color deep reddish brown, maculation typical of genus but submarginal area particularly wide due to mesal point at CuA1, transverse parallel lines usually quite faint. *Forewing ventrum:* As for the genus. *Hindwing dorsum:* As for genus but dark reddish brown as for forewing. *Hindwing ventrum:* As for hindwing dorsum, but lighter, postmedial lunule

absent. *Abdomen:* As for genus but colored as for head and thorax. Finger-like processes of sternite VIII variably spaced but processes straight, not converging distally. *Genitalia:* (Figs 18, 21) n= 7. Vinculum ovoid, relatively narrowly sclerotized. Uncus very narrow, elongate, smoothly curving, unbent mesally, truncated distally, appearing clubbed apically. Gnathos not fused mesally with heavy sclerotization, though somewhat connected at base of arms with strong membrane, gnathos separated into two large, heavily sclerotized arms with thin, fragile, elongated downwardly angled projection distally, dorsally smoothly curving with no protuberances. Gnathos arms creased lengthwise appearing folded. Ventral edge of gnathos arms with minute, sharp teeth which may or may not be symmetrical in comparing each gnathos arm. Valves short, basally broad, rounded edge or convex, dorso-distally projected, distally forming small lobe. Juxta as for genus. Phallus short and broad, distinctly bent, base downwardly angled usually extending beyond ventral edge of distal end of phallus. Vesica broad, triangular, more than twice length of phallus. **Female.** *Head:* Similar to male, but antennae smaller overall. *Thorax:* As in male but lighter. *Legs:* As in male. *Forewing dorsum:* Forewing length: 23.5 mm, wingspan: ~45 mm, n=1. As in male but broader, apex less falcate, postmedial line slightly convex. Coloration lighter red-brown. *Forewing ventrum:* Similar to dorsum, paired transverse lines absent. *Hindwing dorsum:* As in male but broader, lighter red-brown. *Hindwing ventrum:* As for hindwing dorsum, but

lighter, postmedial lunule and shading absent. *Abdomen*: As in male but larger, more robust, coloration lighter red-brown. *Genitalia*: (Fig. 24) $n=1$. Stout, apophyses anteriores longer than apophyses posteriores. Lamella postvaginalis broad, bowl-like. Tergite VIII as thick, heavily sclerotized, broad plate, mesally indented separating two broad lateral lobes directed posteriorly. Papillae anales typical of genus, but particularly broad. Ductus bursae well-sclerotized, very broad, matching width of lamella postvaginalis near ostium widening slightly towards corpus bursae. Corpus bursae bag-like, roughly equal in size to that of remainder of female genitalia.

Types: **HOLOTYPE** ♂. **ECUADOR**: **Pichincha**: S. Dom. [Santo Domingo de los Colorados] Tinalandia, 650 m [-0.297505° , -79.051797°], 15-IX-1971, Coll. Vénédictoff/ Venedictoff colln., Allyn Museum, Acc. 1986-26/ St Laurent diss.: 11-16:14/ **HOLOTYPE** ♂ *Biterolfa tinalandia* St Laurent, Giusti, & Herbin, 2017/ (MGCL). (Fig. 8).

Paratypes (16 ♂, 1 ♀ total). **COSTA RICA**: **Cartago**: 3 ♂, Copal Reserve, $9^{\circ}47'2.21''N$, $83^{\circ}45'6.14''W$, 1050 m: 10.V.2010, D. Herbin & M. Laguerre leg., D. Herbin genitalia preps H1223, H1227 (CDH). **PANAMA**: **Chiriquí**: 1 ♂, Santa Fé National Park, Rd. Santa Fé to Guabal, 13 km, El Mirador, $8^{\circ}32'30.9''N$, $81^{\circ}09'27.7''W$, 780 m: 4-6.IX.2016, B. Vincent leg. (CDH). **COLOMBIA**: **Chocó**: 1 ♂, Bella Vista [recte Bojayá, 6.523602° , -76.974425°]: VIII.1927, W. Niepelt, Ziriau [leg.] (MNHU). **Nariño**: 1 ♂, "Zw. Tumaco u. Pasto" [between Tumaco and Pasto, 1.377363° , -77.97102°]: W. Niepelt G. [leg.] (MNHU). **ECUADOR**: **Pichincha**: 2 ♂, Santo Domingo [de los Colorados] [-0.297505° , -79.051797°]: 12.IV.1975, 3.XII.1975, Vénédictoff leg. (MGCL). 2 ♂, Hotel Tinalandia, S. of Santo Domingo de los Colorados: 6-11.V.1990, Jeffrey A. Smith [leg.] (BME). 1 ♂, Tinalandia, 12 km SE Santo Domingo [de los Colorados], $0^{\circ}17'S$, $79^{\circ}4'W$, 730 m: 20.III.1990, S.J. Weller, P. Batra, & M.J. Ryan [leg.], UV trap, USNM-Mimal: 2740, St Laurent diss.: 11-16:15 (USNM). 1 ♂, Tinalandia, 700 m: 5-10.XII.1993, J.B. Heppner [leg.] (MGCL). 1 ♂, Rio Pachijal, Los Bancos, $0^{\circ}04'06''N$, $78^{\circ}54'17''W$, 928 m: 3.III.2012, R. Brechlin & V. Sinyaev leg., genitalia prep. 29.999 (MWM). 1 ♂, Nono/Bancos, km. 37.5, 2385 m [-0.032276° , -78.717239°]: 19.V.1982, N. Vénédictoff leg. (MGCL). **El Oro**: 1 ♂, Road Piñas-Saracay, $3^{\circ}38'57''S$, $79^{\circ}45'15''W$, 850 m: 5.XII.2012, Sinyaev & Romanov leg., expedition Ron Brechlin, genitalia prep. 29.995 (MWM). 1 ♀, 8 km NW Piñas, $3^{\circ}38'53''S$, $79^{\circ}45'04''W$, 900 m: 15.IV.2012, R. Brechlin & V. Sinyaev leg., genitalia prep. 29.996 (MWM). **Azuay**: 1 ♂, Cochabamba-Pan de Agucar [Azúcar],

$2^{\circ}46'08''S$, $79^{\circ}26'20''W$, 3150 m: 12.XII.2012, Sinyaev & Romanov leg., expedition Ron Brechlin, genitalia prep. 29.997 (MWM).— All paratypes with the following yellow label: PARATYPE ♂/♀ *Biterolfa tinalandia* St Laurent, Giusti, Herbin, 2017.

Etymology: *Biterolfa tinalandia* is named for the type locality, and location where many paratypes were collected in Pichincha, Ecuador, namely the Hotel Tinalandia. The name is a noun in apposition.

Diagnosis: *Biterolfa tinalandia* is the most easily recognizable species of *Biterolfa*, identifiable by the dark red-brown coloration, the extreme outward point of forewing at CuA1 resulting in a particularly widened submarginal area, and by the male and female genitalia. The male genitalia display distally narrowed valves and distally elongated gnathos arms unlike those in either *B. althea* or *B. rana*. In *B. tinalandia* the tips of the gnathos arms extend as a narrow and fragile fingerlike projection that follow the smooth curvature of the overall shape of the gnathos arms. This distal projection is not sharply angled downward as in *B. althea* and lacks the dorsal protuberance of the overall more robust gnathos arms of *B. rana*. The female genitalia differ from those of *B. althea* by the width and bilobed appearance of tergite VIII, whereas in *B. althea* the same structure is reduced to a weakly sclerotized structure. The female genitalia are thus similar to those of *B. rana*, but with more accentuated arches on either side of the indentation of tergite VIII. *Biterolfa tinalandia* is the only *Biterolfa* species known from the western Andes of Colombia and Ecuador, and the sole member of the genus so far collected in Central America.

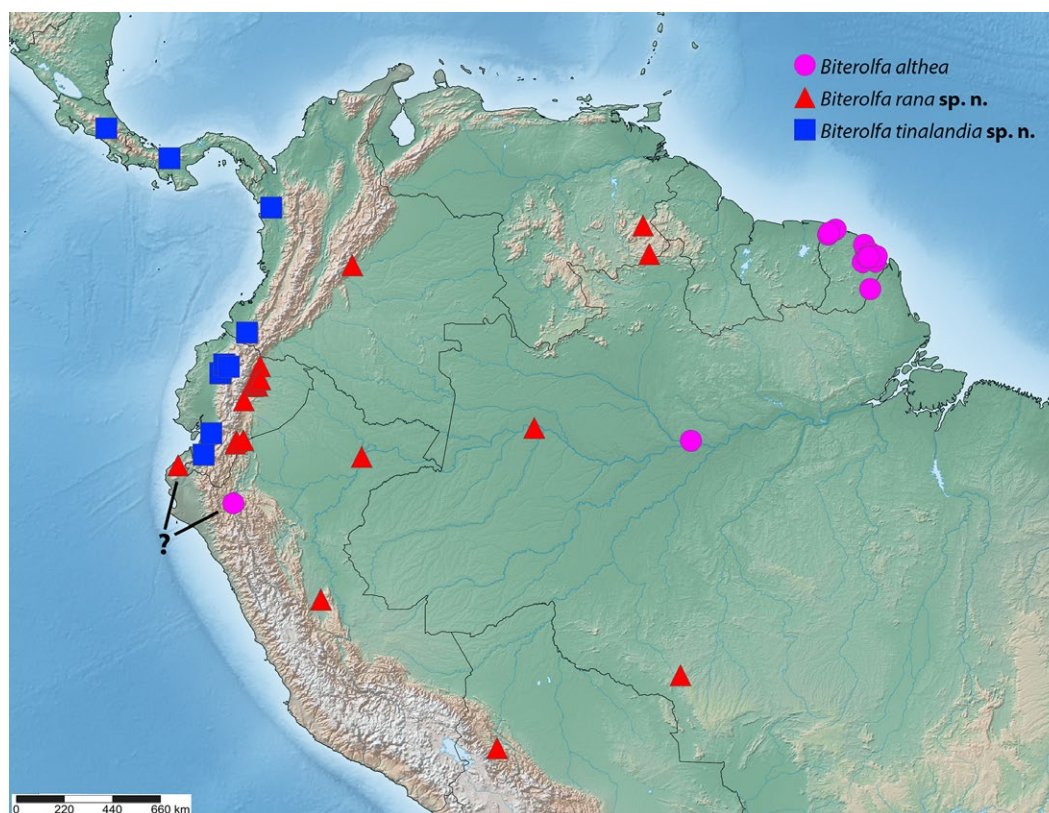


Fig. 25. Geographical distribution of *Biterolfa* within southern Central America and northwestern South America. Question mark signifies uncertain records.

Distribution (Fig. 25): This species is found from central Costa Rica, southeast to Panama, and along the Western Andes slopes of Colombia south to Ecuador from 700–3150 m.

Remarks: Although *B. althea* and *B. rana* are externally indistinguishable from each other, *B. tinalandia* is the most recognizable species in the genus considering the characters given in the diagnosis above. This is also the only species known from west of the Andean mountains (except for the single, questionable, previously mentioned record of *B. rana* from northwest Peru). We note a surprising range in elevation that this species inhabits, and question the accuracy of the data at the extreme high end of elevation that we report. Most records of *B. tinalandia* come from 700–1050 m, but one specimen in MGCL from 2385 m and one from MWM at 3150 m are much higher than any other record that we have found for this species. However, other Mimallonidae, particularly the genera *Lurama* Schaus, 1928 and *Ulmara* Schaus, 1928, have been reported from even higher elevations and thus these outliers may indeed be accurate (St Laurent, 2016). We have no reason to otherwise doubt the accuracy of the collectors of these specimens, and the given coordinates for the MWM specimen point to a locality with an elevation over 3000 m. Therefore, we must consider that *B. tinalandia* is potentially able to tolerate a great variation in elevation, because the external and genital characteristics are consistent across this elevational gradient.

Note added at proof stage: We were subsequently able to COI 'barcode' all three *Biterolfa* species, with the following results determined using tools available in the Barcode of Life Database (BOLD, <http://www.boldsystems.org/>): *B. tinalandia* [BC-Her 4999] is found sister to (*B. althea* [BC-Her 2692] + *B. rana* [BC-Her 2692]) with a 6.6% K2P (Kimura, 1980) distance from *B. althea* and a 5.8% distance from *B. rana*, whereas there is a 4.9% distance between sister taxa *B. rana* and *B. althea*.

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