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The immature stages of *Phylloicus lituratus* (Trichoptera: Calamoceratidae) with new records of *Phylloicus* and *Banyallarga* species in northwestern Argentina and southern Bolivia

PAOLA A. RUEDA MARTÍN
Facultad de Ciencias Naturales e Instituto Miguel Lillo, Instituto de Biodiversidad Neotropical (IBN). CONICET. Miguel Lillo 206, CP4000, San Miguel de Tucumán, Tucumán, Argentina. E-mail: paolamartinzoo@yahoo.com.ar

Abstract

Phylloicus lituratus Banks 1920 larva and pupa were associated. It is a new record for Argentina and represents the most austral record for the species. New records of other Calamoceratidae species are provided also from northwestern Argentina and southern Bolivia. *Banyallarga* (*B.*) *argentinica* Flint 1983 is recorded for the first time for Bolivia; *B.* (*B.*) *loxana* (Navás 1934) and *B* .(*B.*) *yungensis* Flint 1983 are both newly recorded from Salta province in northwestern Argentina. Illustrations of male genitalia of all species and of immature stages of *P. lituratus* are included. Presence of a *Banyallarga* larva in a leaf case suggests a need to change some larval keys used to identify the two endemic genera of Neotropical Calamoceratidae.

Key words: adult-larva association, biology, caddisflies, new localities, Neotropics

Introduction

The Calamoceratidae family is cosmopolitan and contains over 187 described species (Holzenthal *et al*. 2011). There are eight extant genera: *Anisocentropus* McLachlan (1863); *Phylloicus* Müller (1880); *Banyallarga* Navás (1916); *Ganonema* McLachlan (1866); *Ascalaphomerus* Walker (1852); *Calamoceras* Brauer (1865); *Georgium* Fischer (1964); and *Heteroplectron* McLachlan (1871) (Prather 2003, 2004; Holzenthal *et al*. 2007). The only fossil genus in the family contains one species: *Palaeocentropus placidus* Sukatsheva & Jarzembowski 2001. *Banyallarga* and *Phylloicus* are the endemic Neotropical genera of this family, with 17 and 54 species described, respectively. Both genera were reviewed by Prather (2003, 2004).

The genus *Phylloicus* has 54 described species and is the largest calamoceratid genus in the new world (Prather 2003). The adults are active during the day, and usually are not collected in light traps. Adults of many species are brightly or dramatically colored, with bold patterns formed by white, gold, and orange setae, or by clear, sometimes iridescent membrane. These wing patterns are diagnostic; therefore, adults of *Phylloicus* should be collected in clean, dry cyanide jars, handled carefully (to avoid rubbing hairs off the wings), and mounted on pins (Prather 2003). In northwestern Argentina and southern Bolivia there are 3 recorded species of *Phylloicus*: *P. angustior* Ulmer 1905, *P. bicarinatus* Prather 2003, and *P. cressae* Prather 2003. Immature stages of only three species of *Phylloicus* have been associated with their identifiable adult stages: *P. bromeliarum* Müller 1880, *P. abdominalis* (Ulmer 1905) and *P. camargoi* Quinteiro & Calor 2011 (Ulmer 1955; Huamantinco *et al.* 2005; Quinteiro *et al.* 2011).

Banyallarga has been divided into 2 subgenera: *Banyallarga* Navás (1916) and *Histricoverpa* Prather (2004). In northwestern Argentina and southern Bolivia there are 4 recorded species of *Banyallarga*: *B. argentinica* Flint 1983, *B. loxana* (Navás 1934), *B. penai* Prather 2004 and *B. yungensis* Flint 1983. The immature stages of *B. argentinica* were described by Flint and Angrisano (1985), and this is the only species in the genus for which immature stages have been associated with identifiable adults.

The differences between *Banyallarga* and *Phylloicus* larvae were given by Flint and Angrisano (1985). Unlike

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other calamoceratid genera, which exclusively use plant material in their cases, the larvae of *Banyallarga* build tubular cases primarily of mineral fragments with some plant material incorporated (Prather 2004). The cases of *Phylloicus* are flat, made with leaf fragments, sometimes with a single oval fragment dorsally and another ventrally, in other species a series of overlapping fragments are used dorsally and ventrally (Flint & Angrisano 1985). However, Flint and Angrisano (1985) reported an unidentified species of *Banyallarga* larva from Argentina, Bolivia and Ecuador, in a leaf case identical to those of *Phylloicus*. Despite that observation, the kind of case-building material has been used to distinguish the genera of Calamoceratidae in larval keys and other publications (Angrisano & Korob 2001; Posada-García 2003; Springer 2006; Angrisano & Sganga 2009).

The overall scope of this paper is to update the knowledge of the Calamoceratidae from northwestern Argentina and Bolivia.

Material and methods

Immature and adult specimens of Calamoceratidae were collected in the field. The adult material of *Banyallarga* was collected with light traps or with entomological nets. Immature material was removed from the streams with strainers or by exploration of stream substrates. Biological material was fixed in 75% ethanol. The genitalia of adult males were cleared in a 10% solution of NaOH and then neutralized with phenol. The cleared genitalia of *B. argentinica*, *B. loxana*, *B. yungensis* and *P. lituratus* were mounted in glycerin for observation and illustration. The 4 species were identified by comparing them with type material reviewed from the United States National Museum of Natural History (NMNH), Washington, District of Columbia, U.S.A.

The immature stages of *P. lituratus* were associated using the metamorphotype method (Vorhies 1909; Milne 1938; Ross 1944; Wiggins 1996). Larval sclerites were associated with the larvae collected in the same lot. The larva and pupa were illustrated using a stereomicroscope with camera lucida attached.

All material examined is preserved in 75% ethyl alcohol and deposited in the Collection of the Instituto de Biodiversidad Neotropical (IBN), Tucumán, Argentina, unless indicated otherwise. Some specimens are in the United States National Museum of Natural History, Smithsonian Institution, Washington, District of Columbia, U.S.A. (NMNH).

Terminology used for adults follows that of Prather (2003, 2004) and for immature stages follows that of Wiggins (1996).

Taxonomy

Phylloicus lituratus Banks
(Figs 1–3)

Phylloicus lituratus Banks 1920: 350 [Type locality: Colombia, Mariquito; MCZ; male]. —Flint 1967: 19 [male]. —Denning *et al*. 1983:182 [redescription]. — Prather 2003 [redescription of male and female; review of the genus].
Phylloicus "species 1" Flint 1991: 98.
Phylloicus priapulus Denning & Hogue 1983 in Denning *et al.* 1983: 187 [Type locality: Costa Rica, Puntarenas Province, 1.8 miles west of Rincón, Osa Peninsula; Natural History Museum of Los Angeles County, Los Angeles, California, U.S.A.]; Prather 2003 [Synonym, review of the genus].

This species exhibits a range of minor variation across its geographic distribution and within populations. Prather (2003) decided to treat all specimens as a single species, with the types of *P. lituratus* and *P. priapulus* representing extremes of morphology for tergum X and its processes and other specimens representing intermediate variations between these morphotypes.

Phylloicus lituratus is distinguished by the wing pattern (Fig. 109 from Prather 2003), the lack of abdominal coremata, and preanal appendages longer than tergum X.

Two identical metamorphotypes where collected in Salta province (Argentina), no morphological variations could be found. Material from the NMNH was reviewed and the same variations discussed by Prather were observed. Metamorphotypes (Milne 1938) do not have fully developed wings, then, the wing pattern of specimens from Salta province is not available

The species was identified as *P. lituratus*, with both metamorphotypes showing in the male genitalia examples of variations observed by Prather. A short description of the male genitalia is included to record variations that the individuals show in northwestern Argentina.

Male genitalia (Fig. 1). Corematic structures absent, terga III–V unmodified. Sternum VII with short, acute anteromesal process. Sternum VIII enclosing base of sternum IX (Fig. 9A from Prather 2003); ventral posteromesal process notched, notch deep and oval (Fig. 1A). Tergum IX without mesal ridge. Preanal appendages slightly longer than tergum X, enlarged apically, bearing long setae (Figs 1B, C: pa). Tergum X without basal lobes; basodorsal process short, digitate and down-curved (Figs 1B, C: dp); basolateral processes slender, nearly as long as basodorsal process (Figs 1B, C: lp); apex of tergum X, in lateral view, rounded; in dorsal view, truncate, slightly elongate (Figs 1B, C: tx). Inferior appendages short, each with basal segment cylindrical; harpago rounded in ventral view (Fig. 1D); in lateral view, harpago acute and triangular (Fig. 1B: ia) with many apical small, strongly curved setae (peg-setae of Prather 2003). Phallobase curved ventrad, with membranous discoidal endotheca and internal ejaculatory duct visible; phallotremal sclerites not distinguishable (Fig. 1E).

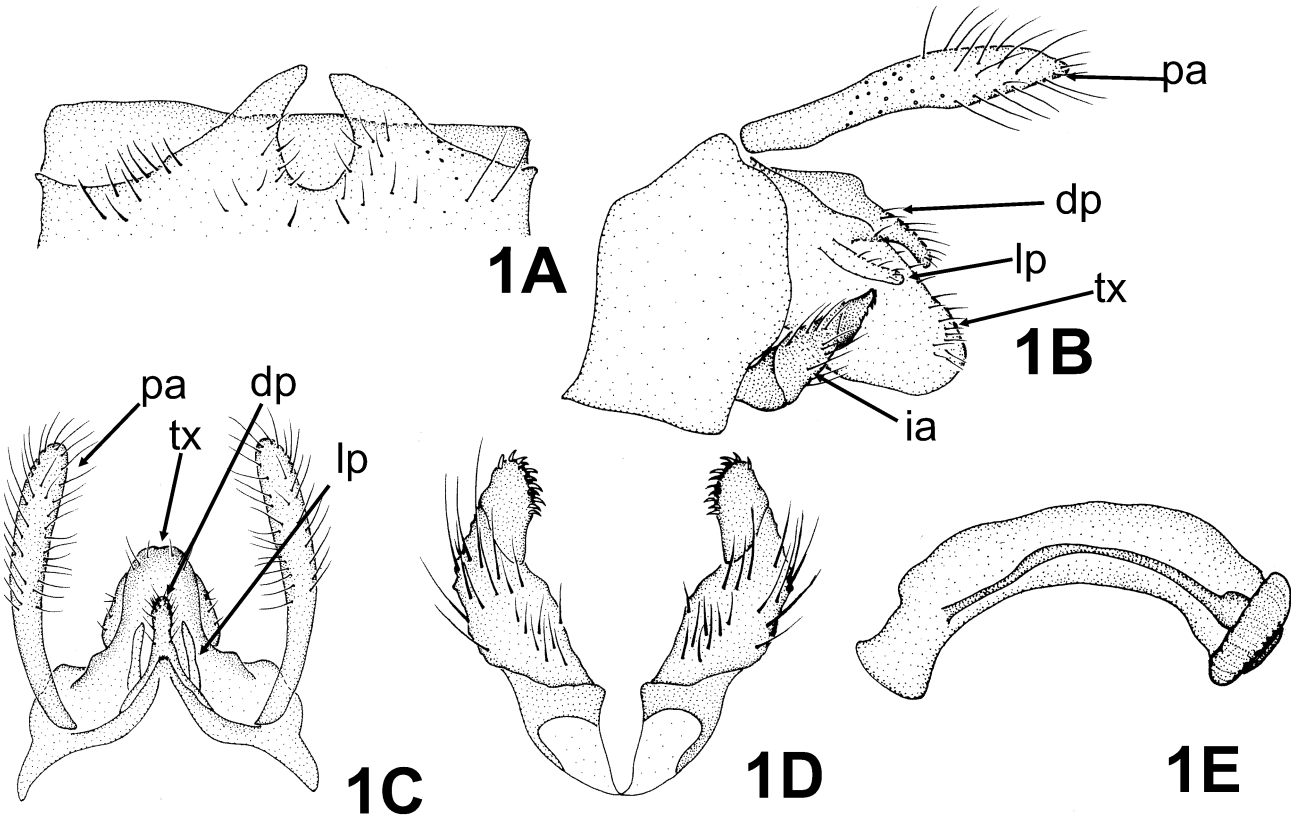

FIGURE 1. *Phylloicus lituratus* Banks 1920, adult male. A, sternum VIII; B, genitalia, left lateral; C, genitalia, dorsal; D, inferior appendages, ventral; E, phallic apparatus, left lateral. pa = preanal appendages; dp = basodorsal process; ia = inferior appendage; lp = basolateral process; tx = tergum X.

5th instar larva (Fig. 2). Total length 13 mm (N=7).

Head: Dark brown, with smooth surface, muscle scars light brown with pattern as in Figs 2A, B, C. Labrum with yellowish anterolateral brushes. Ventral apotome triangular and short, not reaching posterior margin of head (Fig. 2B).

Thorax: Pronotum light brown, with pale muscle scars (Fig. 2D). Anterior margin of pronotum bearing 3 pairs of long setae and minor yellowish setae; anterolateral corners elongate in pair of strong sclerotized hooks; posterior margin of pronotum dark (Fig. 2D). Mesonotum with pair of central irregular large sclerites with anteromedial margins strongly sclerotized and sunken, posterior margins not clearly delimited (Fig. 2E). Lateral sclerites (*sa*3 sclerites) of mesonotum small, setose and irregular. Metanotum completely membranous. Shape and chaetotaxy of thoracic legs I–III as in Fig. 2F.

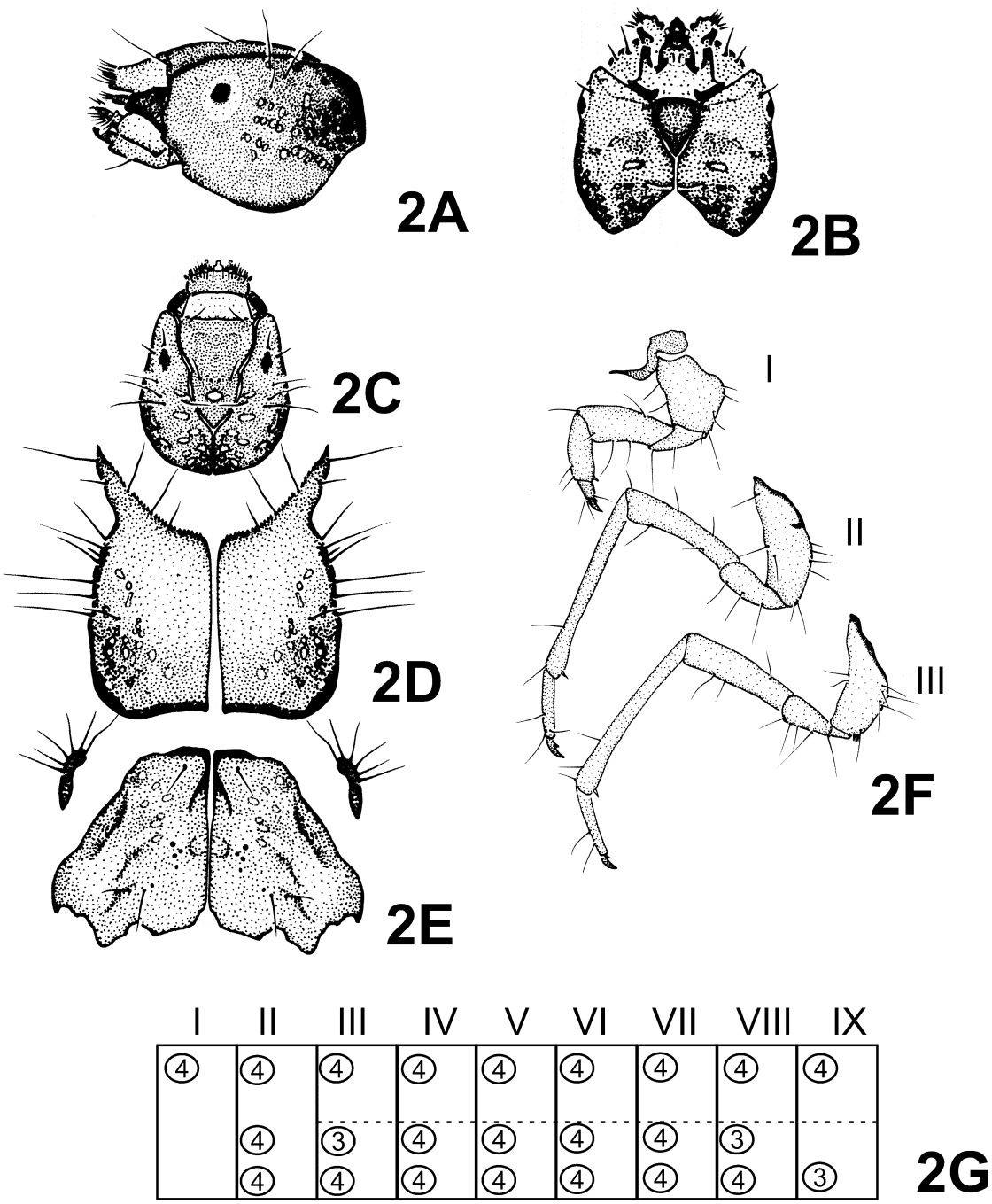

FIGURE 2. *Phylloicus lituratus* Banks 1920, larva. A, head, left lateral; B, head, ventral; C, head, dorsal; D, pronotum, dorsal; E, mesonotum, dorsal; F, thoracic legs I, II, III; G, distribution pattern of abdominal gills.

Abdomen: Abdominal segment with gills each having 3 or 4 filaments and distributed as in Fig. 2G.

Larval case. Oval, made with leaves, consisting of dorsal and ventral halves fastened together along edges and enclosing central chamber closed at posterior end (Fig. 5A).

Pupa (Fig. 3). Total length: 13 mm (n=2). General color yellowish brown.

Head: Antennae each with stout scape, pedicel cylindrical (Fig. 3A). Mandibles well-developed, symmetrically curved mesad, each four times as long as basal width, with internal margin finely serrated (Fig. 3B).

Thorax: Pronotum narrow. Mesonotum wide. Metanotum small.

Abdomen: Lateral line of setae on each side extending from anterior margin of segment IV to VIII, curving ventrally on segment VIII and touching at ventral midline (Fig. 3A). Abdominal segment I with pair of transverse, narrowly rectangular, hook plates near posterior margin, with small teeth directed anterad, and with pair of small

round sclerotized plates on posterior margin each bearing two teeth directed posterad (Fig. 3C: I). Abdominal segment II without hook plates (Fig. 3C: II). Abdominal segments III to VIII each with pair of elliptical anterior hook plates, each with two teeth directed posterad (Fig. 3C: III–VIII). Abdominal segment V bearing pair of oval posterior hook plates, with teeth directed anterad (Fig. 3C: V). Abdominal gills each having 3 or 4 filaments and distributed as in Figure 3D.

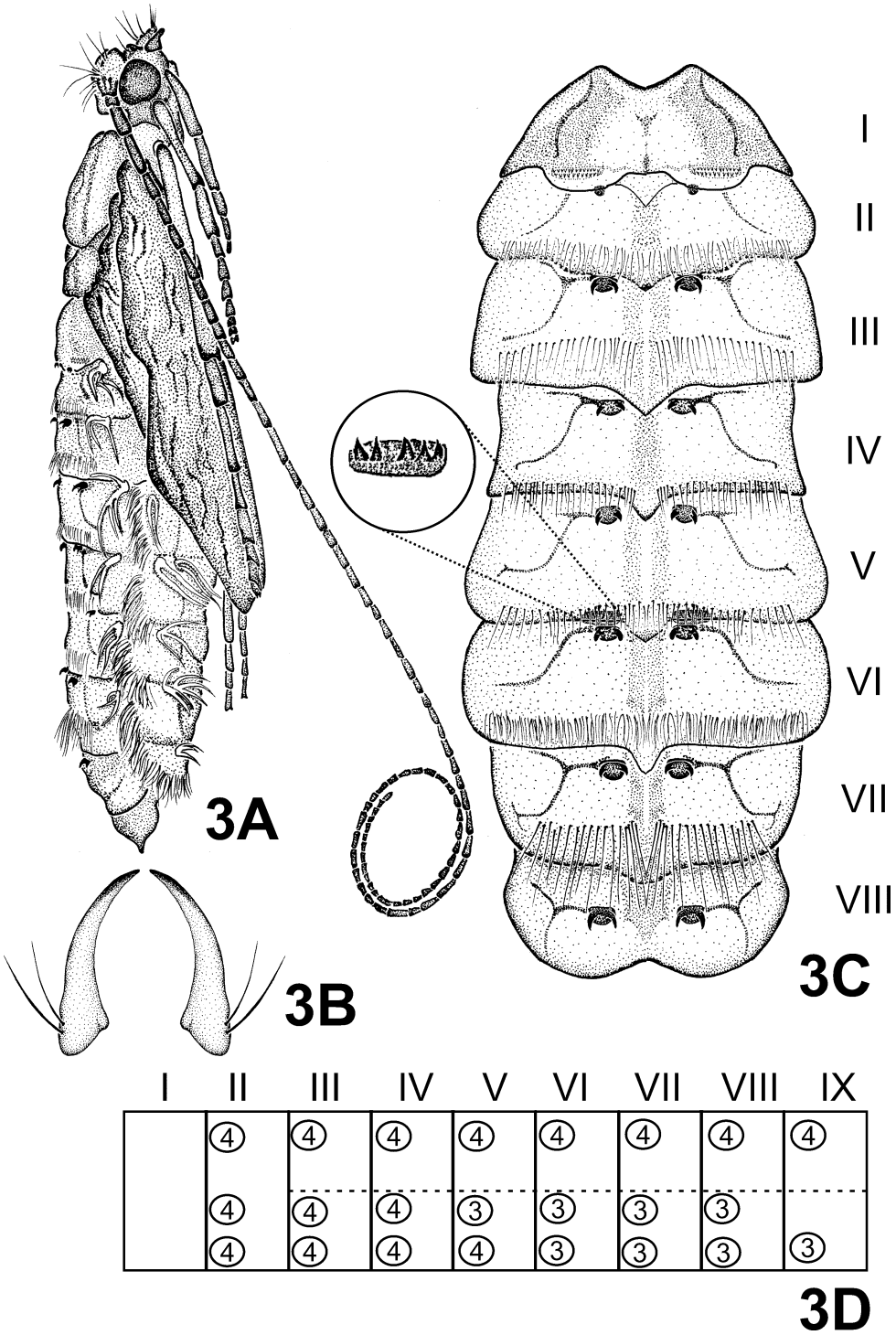

FIGURE 3. *Phylloicus lituratus* Banks 1920, pupa. A, habitus, right lateral; B, mandibles, ventral; C, abdomen, dorsal; D, distribution pattern of abdominal gills.

Biological notes: Larvae of this species were collected in slowly running water and pools of a stream from Salta province in northwestern Argentina. They were collected with a strainer from deposition microhabitats with accumulations of fallen leaves. The leaves used on the larval cases are the same as those on the bottom of the

stream. Therefore, the larvae are camouflaged in the microhabitats where they live and can be differentiated from regular leaves only by watching their almost imperceptible movements.

Distribution. Argentina (Salta, new country record), Colombia, Costa Rica, Nicaragua, Panamá, Venezuela.

Material examined. ARGENTINA: Salta: Sta. Victoria, Lipeo, A° Los Naranjos, S22°25´47", W64°44´20", 1109 m, 13.xi.2004, P. Rueda Martín col., 2 male metamorphotypes, 7 larvae, 4 pupae. **COSTA RICA:** Alajuela, Reserva Forestal San Ramón, Río Sal Lorencito, and trbs., 10.216N, 84607 W, 13–16.vi.1988, 980 m, C.M. & O.S. Flint, R.W. Holzenthal cols., NMNH, 1 male. **ECUADOR: Napo:** puerto Orellana, Río Tiputini, 38°02´00¨N, 76°08´54¨W, 12–26.viii.1999, W.N. Mathis col., NMNH, 1 male. **PANAMA: Coclé:** Taboga, Taboga Island, 1.ii.1912, Busck, NMNH, 1 male. Darien: Río Tuir at Río Pucuro, 16–17.ii.1985, J. Luton, NMNH, 1 male.

Banyallarga argentinica Flint
(Fig. 4A)

Banyallarga argentinica Flint 1983: 77 [Type locality: Argentina: Pcia. Salta, Cañada la Gotera, Rt. 59, km 23.5, 16–7 Oct 1973, O.S. Flint, Jr. USNM Type 100550; MNMH; male]; Flint & Angrisano 1985 [larva, pupa, biology]; Prather 2004: 13 [redescription of male and female; review of the genus].

The association of the female of this species was tentative (Prather 2004). The adult male can be differentiated from other species by the apex of tergum X which is truncated (Fig. 4A: tx). The immature stages of *Banyallarga argentinica* were associated by Flint and Angrisano (1985); this is still the only species of *Banyallarga* for which the larva has been associated and described. In their paper, some biological aspects of the larva were considered and differences with *Phylloicus* were reviewed. In this paper, this species is recorded for the first time from Bolivia.

Distribution. Argentina (Catamarca, Jujuy, Tucumán, Salta, Formosa), **Bolivia (New country record)**, Perú.

Material examined. Holotype: **ARGENTINA: SALTA:** ruta 59. Km 23.5, Cañada La Gotera, 16–17.x.1973, O. S. Flint Jr. col., N° 100550, NMNH; **ARGENTINA: Catamarca:** Guayamba, Río El Durazno, 8.xi.2000, S28°21´05”, W65°25´53”, 668 m, Fernández *et al*., 1 male **Salta:** Santa Victoria, Lipeo, A° Los Naranjos, S22°25´47", W64°44´20", 1109 m, 13.xi.2004, P. Rueda Martín col., 1 male; Finca Jakúlica, Aº1, S22º41´01”, W64º30´40”, 630 m, 14.xii.1999, E. Domínguez, F. Romero & V. Manzo cols., 1 larva; Río Conchas, 14.viii.1997, S. Cohen col., 5 larvae. **Tucumán:** Río Reartes, 29.x.1999, Vertientes, 2 males. **BOLIVIA: Tarija:** Río Carachimayu, S21°18´28,6”, W64°43´29,6”, 2241 m, 24.iii.2006, Rueda Martín & Nieto cols., 1 male.

Banyallarga loxana (Navás)
(Fig. 4B)

Phylloicus loxana Navás 1934: 173 [Type locality: Ecuador: Poujade, 1909; Museum National d'Histoire Naturelle, Paris; male]; Flint, 1983: 77 [to *Banyallarga*]; 1996: 424 [distribution]; Prather 2004 [redescription of male and female; review of the genus].

This species is the largest in the genus; size is sufficient to separate it from other species of the genus. The apex of tergum X is narrow and notched (Fig. 4B: tx), which is another diagnostic character of the species. The female was associated by Prather (2004) by having characteristics of color, proportion and size similar to those of the male. The larva and pupa have not yet been associated and described. This species is newly recorded from Salta province in northwestern Argentina.

Distribution. Argentina (Tucumán, **Salta new record**), Bolivia, Ecuador, Perú.

Material examined. ARGENTINA: Salta: Sta. Victoria, Los Toldos, Río Huaico Grande, S22°16´44", W64°42´39", 1645 m, 11.xi.2004, P. Rueda Martín col., 1 male. **PERU: Cuzco:** Paucartambo, E. Buenos Aires, Km 135, 2150 m, 13°08´S, 71°33´W, 28–29.viii.1989, N.E. Adams col., at UV light, NMNH, 1 female. **ECUADOR: Azuay:** Río Llaviuco, 301 Km, 16 km W Cuenca, 18.ix.1990, O.S. Flint, Jr. col., NMNH, 1 male.

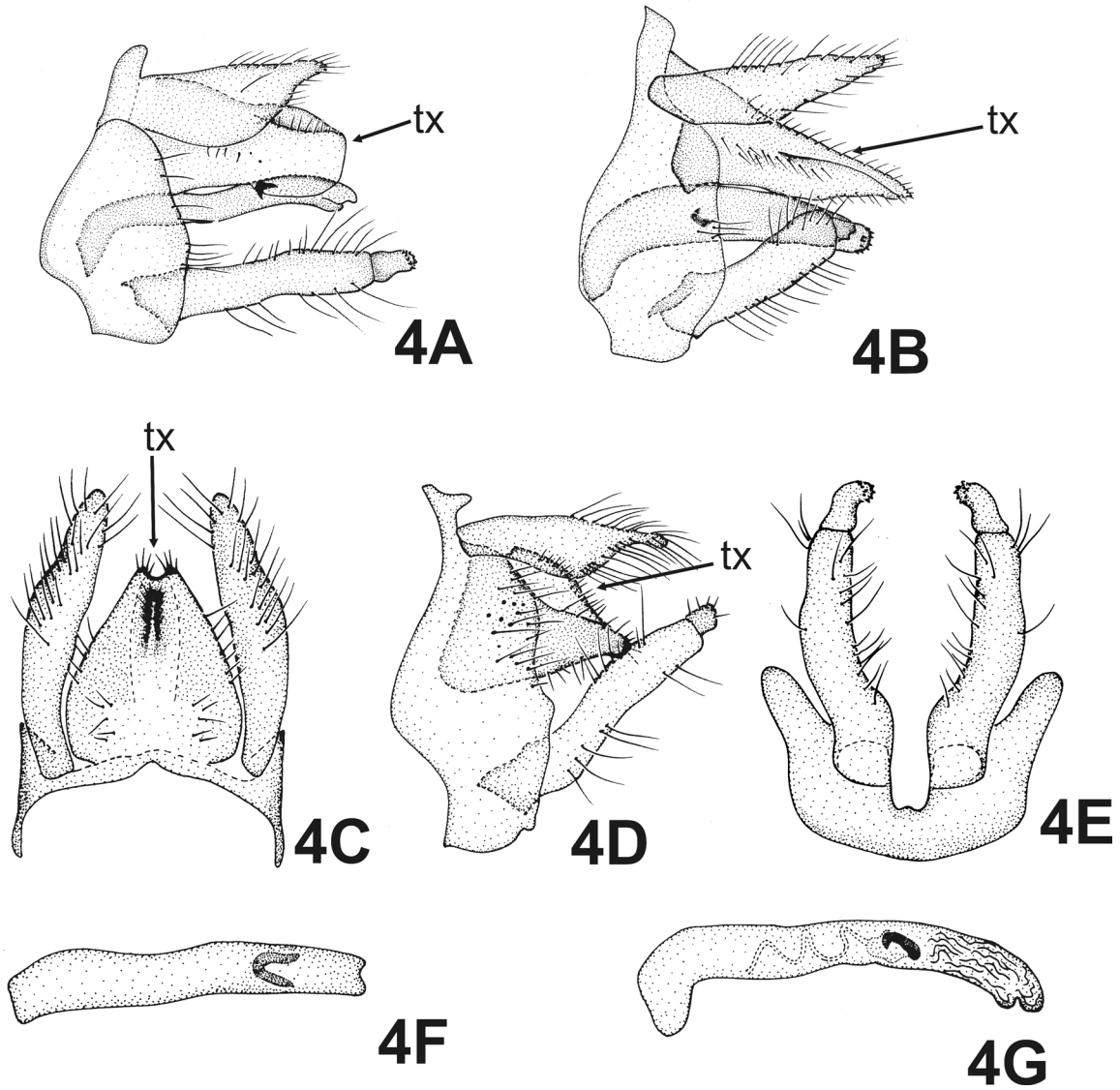

FIGURE 4. *Banyallarga* spp. recorded from northwestern Argentina and southern Bolivia, males. A, *Banyallarga argentinica* Flint 1983, genitalia, left lateral. B, *Banyallarga loxana* (Navás 1934), genitalia, left lateral. C–G, *Banyallarga yungensis* Flint 1983: C, genitalia, dorsal; D, genitalia, left lateral; E, inferior appendages, ventral; F, phallic apparatus, dorsal; G, phallic apparatus, left lateral. tx = tergum X.

Banyallarga yungensis **Flint**
(Fig. 4C–G)

Banyallarga yungensis Flint 1983: 79 [Type locality: Argentina, Pcia. Tucumán, Horco Molle, near Tucumán, 19 Jan 1966, L.S. Stange, USNM Type 100551; NMNH; male]; Prather 2004 [redescription of male and female; review of the genus].
Ganonema vicarium Martynov 1912: 7 [incorrect description of male].

This species has tergum X with an acute apex and a high dorsal ridge (Fig. 4D: tx). The female was associated by the similar general color and proportion, being slightly larger than the male. The immature stages of this species remain unknown. The new record of this species is from Salta province in northwestern Argentina.

Distibution. Argentina (**Salta new record**, Tucumán) Bolivia, Perú, Venezuela.

Material examined. Paratype: **PERU:** 2450 m, Machu Pichu, 16–18.x.1981, D & M. Davis cols., NMNH, 1 male; **ARGENTINA: Salta:** Santa Victoria, Lipeo, 1109 m, 13.xi.2004, Trampa de Luz, E. Domínguez, F. Romero & P. Rueda Martín cols., 2 males; A° Los Naranjos, S22°25´47", W64°44´20", 1109 m, 13.xi.2004, P. Rueda Martín col., 1 male.

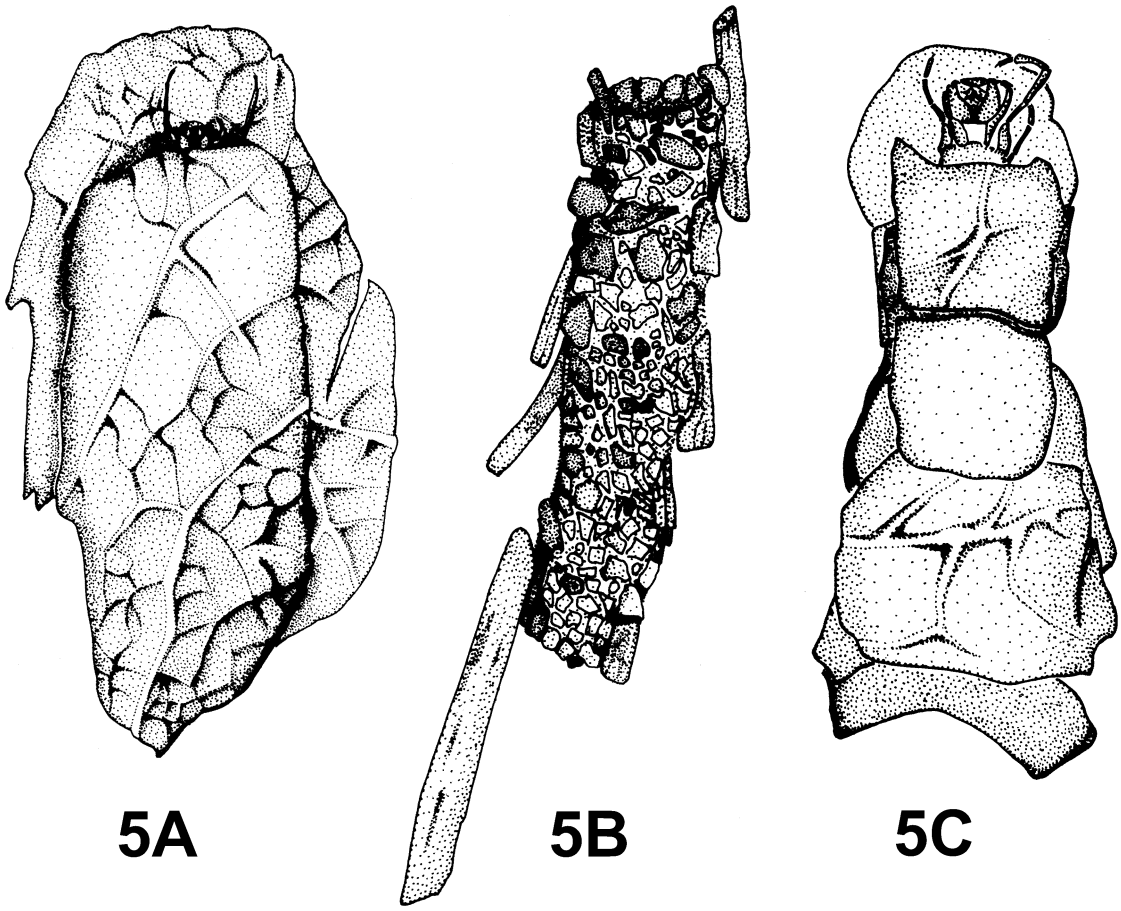

FIGURE 5. Calamoceratidae, larval cases. A, *Phylloicus lituratus* Banks 1920. B, *Banyallarga argentinica* Flint 1983. C, *Banyallarga* sp.

Discussion

There are three recorded species of *Banyallarga* in northwestern Argentina and southern Bolivia: *B. argentinica*, *B. loxana* and *B. yungensis*. Only the larva of *B. argentinica* has been associated and described. The genus *Phylloicus* is represented in this area by four species: *P. angustior, P. bicarinatus, P. cressae* and now *P. lituratus*. The larva of *P. lituratus* is now the fourth species associated and described in the genus.

According to Flint and Angrisano (1985): "The cases of both genera are generally distinguishable from each other. *Phylloicus* makes a flat case of leaf fragments, sometimes a single oval fragment dorsally and another ventrally, in other species a series of overlapping fragments is used dorsally and ventrally. In *Banyallarga* the case is most frequently made of small rock fragments or large sand grains, but often small plant fragments are substituted" and "The case of an unidentified species from Argentina, Bolivia and Ecuador, however, is identical to that of *Phylloicus*."

Nevertheless, in several identification keys the character of case-building material has been used to differentiate the larvae of the two genera (Angrisano & Korob 2001; Posada-García 2003; Springer 2006; Angrisano & Sganga 2009). Cases of *P. lituratus* (Fig. 5A), *B. argentinica* (Fig. 5B) and the case of an unassociated species of *Banyallarga* (Fig. 5C) from Salta province, in northwestern Argentina (*B.* sp.) are shown in Fig. 5. The minor differences between the cases of *P. lituratus* and *B.* sp. could introduce some erroneous identification of larval material. For this reason, I suggest that the material used for construction of cases by larvae of *Phylloicus* and *Banyallarga* should not constitute a strong character to differentiate them. The following identification key is proposed to identify the larvae of Calamoceratidae from South America to genus, following the key of Angrisano and Sganga (2009), but suppressing the case-construction-material character.

Key to the larvae of Neotropical Calamoceratidae genera

1. Ventral apotome long, reaching occipital foramen; anterior margin of pronotum with more than 12 setae; trochanter of each thoracic leg III with brush of short setae; abdominal gills each with no more than 3 filaments . . . . . *Banyallarga*
- Ventral apotome short, triangular, not reaching occipital foramen; anterior margin of pronotum with 6 setae; trochanter of each thoracic leg III without brush of short setae, chaetotaxy regular; abdominal gills each with 3 or 4 filaments. . . . . *Phylloicus*

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