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Additions and corrections to the systematics of mayfly species assigned to the genus *Callibaetis* Eaton 1881 (Ephemeroptera: Baetidae) from South America

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Abstract

Due to historical taxonomic impediments, species of *Callibaetis* Eaton are difficult to identify. Recent studies have attempted to resolve this problem, although many species still lack complete descriptions; nymphs of several species remain undetermined; and type specimens are lost or poorly known. Given these hindrances, the aim of this study is to review some of the type specimens of *Callibaetis* from South America. This review provides a series of taxonomic additions and corrections supported by improved morphological evaluations, illustrations and photographs of *Callibaetis camposi* Navás, *C.* (*Abaetetuba*) *capixaba* Cruz, Salles & Hamada, *C. gregarius* Navás, *C.* (*C.*) *guttatus* Navás, *C. jaffueli* Navás, *C.* (*C.*) *jocosus* Navás, *C. nigrivenosus* Banks, *C.* (*A.*) *pollens* Needham & Murphy, *C.* (*C.*) *radiatus* Navás, *C.* (*A.*) *sellacki* (Weyenbergh), *C. stictogaster* Navás, *C.* (*C.*) *viviparus* Needham & Murphy, *C.* (*C.*) *willineri* Navás, and *C.* (*C.*) *zonalis* Navás. From among these species, *C. stictogaster* and *C. jaffueli* are revalidated; *C. nigrivenosus* and *C. gregarius* are designated as *nomina dubia*; *C.* (*C.*) *fluminensis* Cruz, Salles & Hamada is proposed as a junior subjective synonym of *C.* (*C.*) *zonalis*; and *C. gloriosus* Navás is proposed as a junior subjective synonym of *C.* (*A.*) *sellacki* (Weyenbergh). Lectotypes are designated for *C. camposi, C. jaffueli*, *C.* (*C.*) *radiatus* and *C. stictogaster.*

Key words: aquatic insects, mayfly, types, taxonomy

Introduction

During the earliest periods of research on mayfly diversity, European naturalists described a large number of species from the New World (Pescador *et al.* 2001, Domínguez & Dos Santos 2014), often writing long monographs covering a vast quantity of taxa, which were described and illustrated according to the knowledge and technology available during this period. As the full diversity of New World taxa was still unclear, and neither individual nor population-level variability was recognized, many of the descriptions were based on weak arguments and/or dubious characteristics (*e.g.* Banks 1900, 1918; Eaton 1871, 1881, 1883; Navás, 1930b; Needham & Murphy 1924; Pictet 1843–1845).

One of these early naturalists was Longinos Navás, who described 26 species of *Callibaetis* Eaton 1881 based on imagoes and subimagoes, some of which were in very poor condition, and in many cases, information about the type locality was lacking (Alba-Tercedor & Peters 1986; Domínguez 1989; Gillies 1990). Alba-Tercedor & Peters (1986) and Domínguez (1989) partly resolved this problem by providing more detailed information on the type specimens. Subsequently, Gillies (1990) evaluated the type specimens from South America and concluded that, in many cases, the observed variation was due to differences between males and females, as well as the inclusion of subimagoes of the same species, reducing the number of valid species to eight.

More recently, a number of studies have attempted to update the available knowledge on the diversity of *Callibaetis*, especially in South America, in particular by rearing nymphs in the field to identify the imagoes (Da-Silva 1991; Salles *et al.* 2003; Nieto 2008; Nieto & Cruz 2013; Cruz *et al.* 2009; Cruz *et al.* 2014). Despite these

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efforts, the identification of many species is still hampered by the deficiencies of the original descriptions, including inadequate illustrations, undetermined nymphs, and the lack of any systematic re-evaluation of the type specimens. All these factors hamper the description of new species and discovery of new records, as well as the development of reliable biogeographic and phylogenetic hypotheses.

Given the difficulties of discriminating many of the South American *Callibaetis* species, the objective of this study is to review some of the type specimens.

Material and methods

The descriptions presented here follow the standardized method proposed by Hubbard (1995), with the aid of the DELTA (DEscription Language for TAxonomy) open software (Dallwitz 1980) (*e.g.* Cruz *et al.* 2011; Salles *et al.* 2011). Photographs were taken using a stereoscopic ZEISS Stemi 2000–C microscope or a Nikon CoolPix 5700 camera. The photographs were combined using the open CombineZ5 software, and the final illustrations were prepared according to Coleman (2006).

The symbols "I" and "N" in known stages mean "imago" and "nymph", respectively. To indicate the gender, we used the universal symbols, ♀ for female and ♂ for male.

Diagnostic characteristics of species were constructed based on the cladistic study of Cruz *et al.* 2016.

The material examined in the present study is housed in the following institutions: the Invertebrate Collection of the Instituto Nacional de Pesquisas da Amazônia, Manaus, Brazil (INPA); Coleção Zoológica do Norte Capixaba da Universidade Federal do Espírito Santo, Brazil (CZNC); Museo de Zoología de Barcelona, Spain (MZB); the Natural History Museum, United Kingdom (NHM); Museum National d'Histoire Natural in Paris, France (MNHN); Museo de Zoologia de La Plata, Argentina (MZLP); Senckenberg Deutsches Entomologisches Institut Müncheberg, Germany (Senckenberg); Museum of Comparative Zoology, Harvard University, United States of America (MCZ-ENT); and the Insect Collection at the Department of Entomology, Cornell University, United States of America.

Results

Callibaetis camposi Navás 1930

(Figs. 1A–1G)

Callibaetis camposi Navás 1930d: 19; Gillies 1990: 22; Domínguez *et al.* 2006: 112.

Known stages: I♀

Diagnosis. Female imago: 1) forewing with pigmented C, Sc and R_1 areas (Fig. 1B); 2) thick and black cross veins in C and Sc areas (Fig. 1F); 3) marginal intercalary veins single; 4) hind wing hyaline (Fig. 1G); 5) hind wing with thick cross veins; 6) hind wing with quadrangular costal process; 7) hind wing with intercalary marginal veins (Fig. 1G); 8) body covered with brown spots (Figs. 1B–1E); 9) anterolateral spot on abdominal terga and sterna present (Figs. 1C and 1E).

Redescription. Female imago: Head (Fig. 1E). Light brown, covered with brownish spots; compound eyes black. Antenna with brown scape apically; pedicel dark brown apically. **Thorax** (Fig. 1F)**.** Covered with brownish spots, metascutellar protuberance rounded. Leg III, anterior surface covered with brownish spots; tibia light brown, with one dark brown mark at base and another at apex; tarsi light brown, each segment brown apically. Wings. Forewing (Fig. 1B) with pigmented C and Sc areas; some areas of Radial 1 pigmented; veins light brown; thick and black cross veins in C, Sc and R_1 areas; stigmatic area with six cross veins touching Sc vein; marginal intercalary veins single; length of each intercalary vein 0.47 × distance between adjacent longitudinal veins; length of forewing about 2.4 × width. Hind wing (Fig. 1G) hyaline, with 13 cross veins; one to three intercalary marginal veins; costal process quadrangular. **Abdomen** (Figs. 1B–1E). Terga. Yellowish, covered with brown spots, brown medially, forming longitudinal pale line; one spot anterolaterally. Sterna. Yellowish, covered with brown spots, with one mark anterolaterally. Caudal filaments lost.

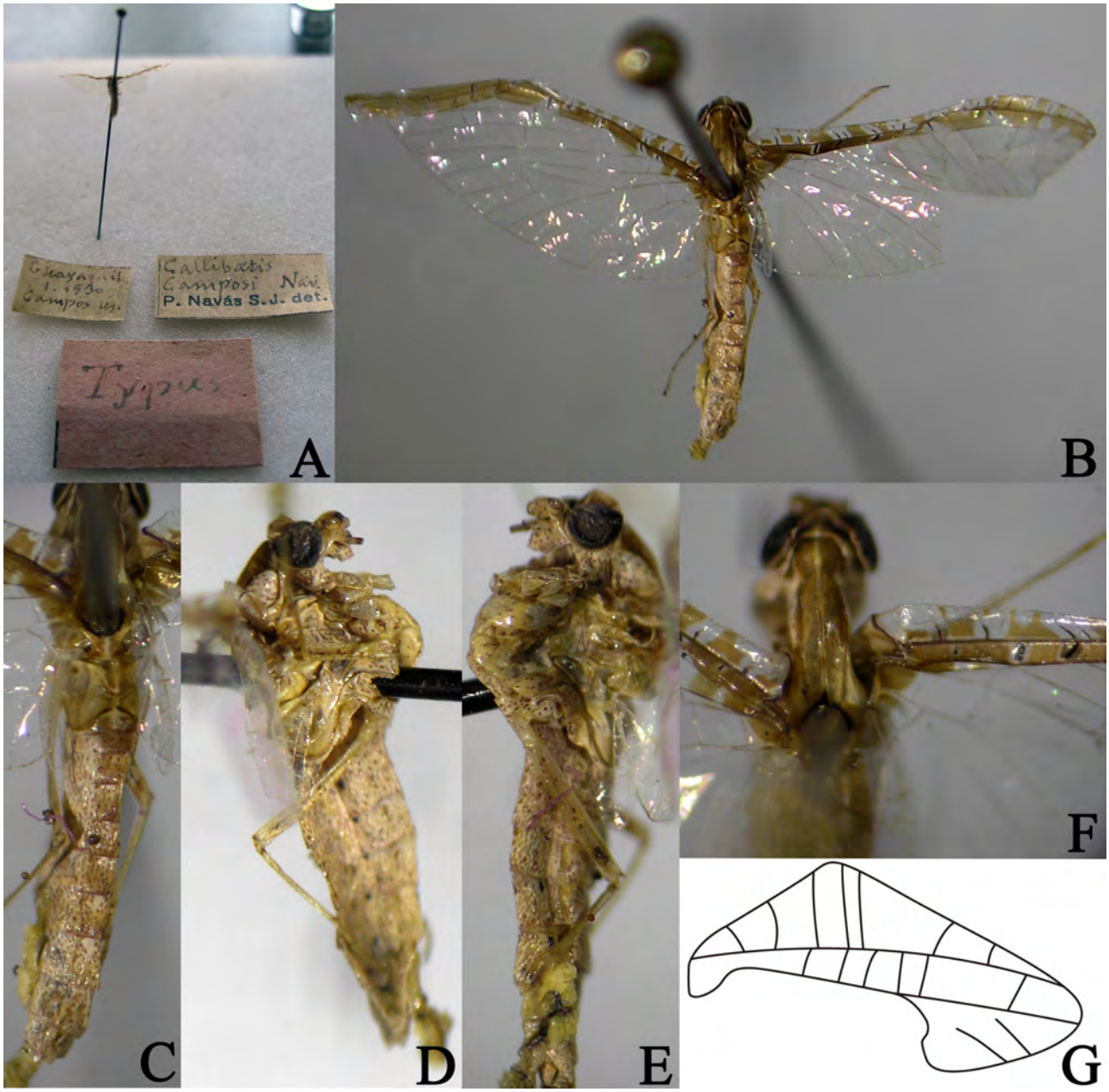

FIGURE 1. *Callibaetis camposi* female imago (lectotype). A. labels; B. dorsal view; C. detail of abdomen; D. detail of body in lateral view; E. detail of body in lateral view; F. detail of wing base; G. drawing of hind wing.

Comments. The only known specimen is in very poor condition; however, it is easy to observe the black and thick cross veins in the C, Sc and R_1 areas, which are conspicuous but not exclusive to this species (also present in *C.* (*C.*) *radiatus* and *C. viviparus*). A number of characteristics are shared by these three species, such as anterolateral spots on the abdominal terga and sterna; pigmented C, Sc and R_1 areas; hind wing with many thick cross veins; hind wing with quadrangular costal process; and abdomen covered with spots.

Based on re-evaluation of the morphology, we cannot distinguish between the female imagoes of *C. camposi, C.* (*C.*) *radiatus* and *C. viviparus*. Synonymizations are not proposed, because the delimitations of species are better investigated when nymphs and male imagoes are studied (see Cruz *et al.* 2016). Only *C.* (*C.*) *radiatus* is described based also on nymphs and male imago. In order to avoid unnecessary taxonomic acts, we consider it prudent to await the discovery and description of the unknown stages of *C. viviparus* and *C. camposi* before making any taxonomic hypotheses.

Although the species of the genus *Callibaetis* have a history of vague type locales, the collection of new specimens at the type locale of *C. viviparus* is achievable, and also of *C. camposi*, but with less probability.

We designate the unique known specimen of *C. camposi* as the lectotype.

Material examined. *Callibaetis camposi*, female imago (lectotype by present designation, dry), ECUADOR, Guayaquil, i.1930, Campos leg, nº 75–5308, MZB.

Distribution. Ecuador: Guayaquil.

Callibaetis (*Abaetetuba*) *capixaba* Cruz, Salles & Hamada 2009

(Figs. 2A–2G)

Callibaetis capixaba Cruz, Salles & Hamada 2009: 31; Cruz *et al.* 2014:11.

Known stages: I♀♂, N

Diagnosis. Male imago: 1) dorsal portion of turbinate eyes oval (Fig. 2A); 2) dorsal portion of turbinate eyes in lateral view without constriction; 3) dorsal portion of turbinate eyes stalk height 0.9 × height of dorsal portion; 4) turbinate portion of compound eyes (in lateral view) with anterior and posterior margins divergent; 5) forewing hyaline (Fig. 29 in Cruz *et al.* 2009); 6) marginal intercalary veins paired (Fig. 29 in Cruz *et al.* 2009); 7) hind wing hyaline (Fig. 30 in Cruz *et al.* 2009); 8) costal process of hind wing rounded (Fig. 30 in Cruz *et al.* 2009); 9) marginal intercalary veins on hind wing absent (Fig. 30 in Cruz *et al.* 2009); 10) abdominal sterna with pair of medioanterior and medioposterior sigilla weak pigmented (Fig. 2B); 11) abdominal sterna light brown with many red spots and two red marks, one lateral and other sublateral on anterior margin (Fig. 2B); 12) forceps segment I wide at base (Fig. 2F); 13) forceps segment III oval (Fig. 2F).

Female imago: 1) forewing hyaline (Fig. 33 in Cruz *et al.* 2009); 2) marginal intercalary veins paired (Fig. 33 in Cruz *et al.* 2009); 3) hind wing hyaline (Fig. 34 in Cruz *et al.* 2009); 4) costal process of hind wing rounded (Fig. 34 in Cruz *et al.* 2009); 5) marginal intercalary veins on hind wing absent (Fig. 34 in Cruz *et al.* 2009); 6) abdominal sterna with pair of medioanterior and medioposterior sigilla weak pigmented (Fig. 2D); 7) abdominal sterna reddish brown with many red spots and two red marks, one lateral and other sublateral on anterior margin (Fig. 2D).

Mature nymph: 1) distal margin of labrum medially with long, fine and apically bifid setae (Fig. 2G); 2) maxillary palp reaching apex of galea-lacinia (Fig. 41B in Cruz *et al.* 2009); 3) two rows of setae on basal part of inner-dorsal row of maxilla; 4) paraglossa subrectangular with apex truncated (Fig. 42A in Cruz *et al.* 2009); 5) paraglossa with three tufts of fine and simple; 6) metanotum with spines; 7) foretarsus anterior surface without spine-like setae (Fig. 43A in Cruz *et al.* 2009); 8) hind claw with minute denticles (Fig. 44B in Cruz *et al.* 2009).

Comments. Many species of the genus *Callibaetis* have a history of poor, inaccurate, or even absent, illustrations. In order to maximize the possibility of a reliable identification, here we present photographs of the complete dorsal and ventral habitus of the male and female imagoes (Figs. 2A–2D), a photograph of the ventral view of the male genitalia, mounted on a slide (Fig. 2F), photographs of the dorsal habitus of the nymphal exuviae (Fig. 2E) and a detailed illustration of the labrum (dorsal and ventral views) (Fig. 2G). For more, see morphological comments under *C.* (*A.*) *pollens*.

Material examined. *Callibaetis capixaba*, female imago with corresponding nymphal exuviae (holotype), BRAZIL, Espírito Santo, Santa Teresa, 19º52’30.9” S/ 40º32’07.4” W, pool, sand, 26.x.2008, F.F. Salles coll., INPA; one male imago (reared), 20 nymphs, BRAZIL, Espírito Santo State, Santa Teresa Municipality, 19º 52' 30.9" S/ 40º 32' 07.4' 'W, pool, sand, 26.x.2008, F.F. Salles coll., CZNC; one male imago and one female imago (both reared), Espírito Santo, Santa Teresa, Reserva Biológica Augusto Ruschi, 19º55’30.1” S/ 40º33’21.9” W, pool, sand, 26.ii.2009, F.F. Salles coll., INPA; one female imago, Santa Catarina, Vargem Bonita, 26°53’48.27” S/ 51°42'12.24” W, 2005, E. Raimundi coll., CZNC.

Distribution. Brazil: Espírito Santo; Santa Catarina.

Callibaetis gregarius Navás 1930 *nomen dubium*

(Figs. 3A–3G)

Callibaetis gregarius Navás 1930a: 72; Gillies 1990: 24; Domínguez *et al.* 2006: 113; Cruz *et al.* 2014: 29.

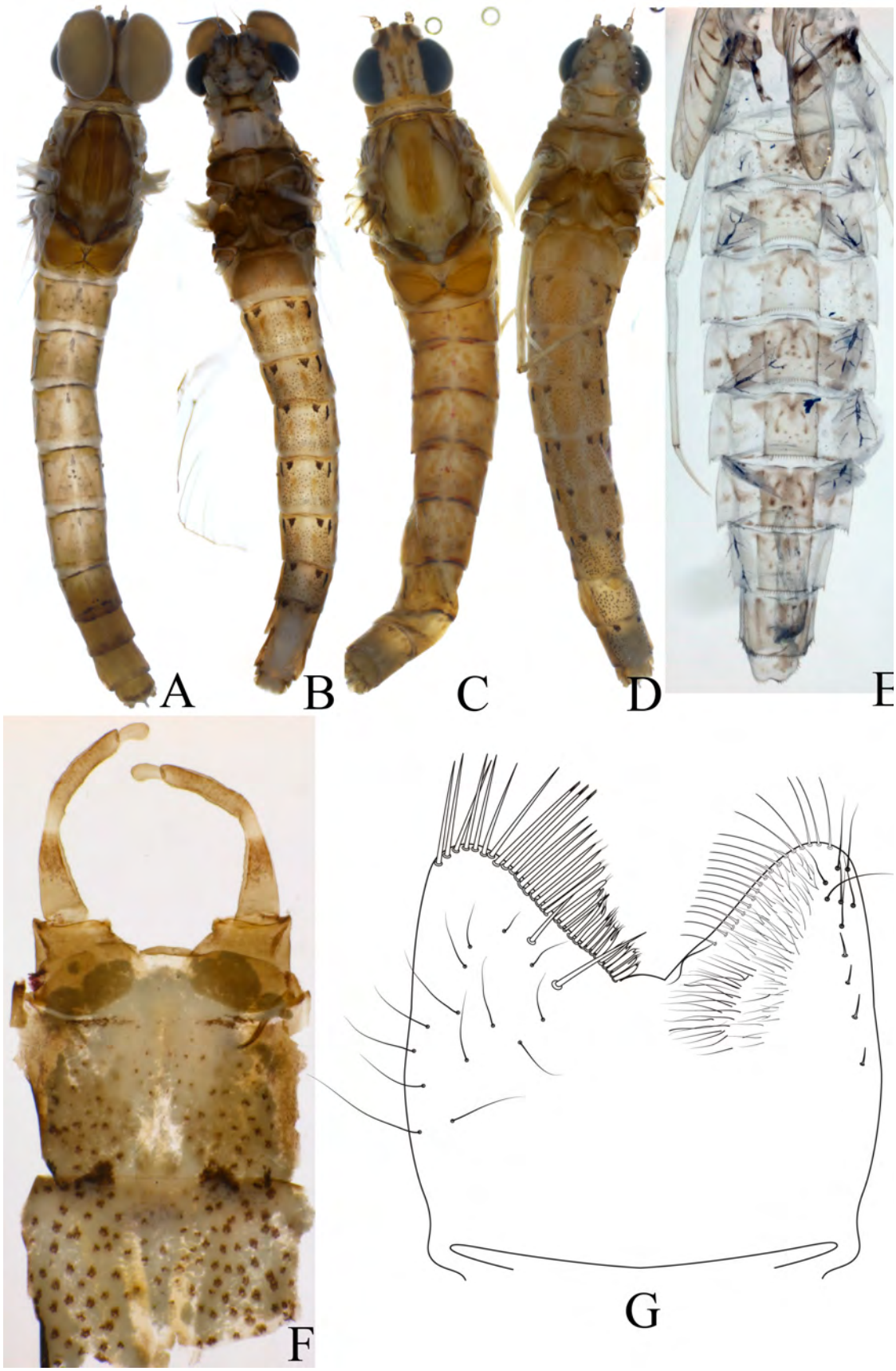

FIGURE 2. *Callibaetis* (*Abaetetuba*) *capixaba* imagoes and nymphs. A. dorsal view of male imago; B. ventral view of male imago; C. dorsal view of male imago; D. ventral view of male imago; E. abdomen of nymphal exuvia; F. genitalia; G. labrum (from nymphal exuvia of holotype) (left d.v., right v.v.).

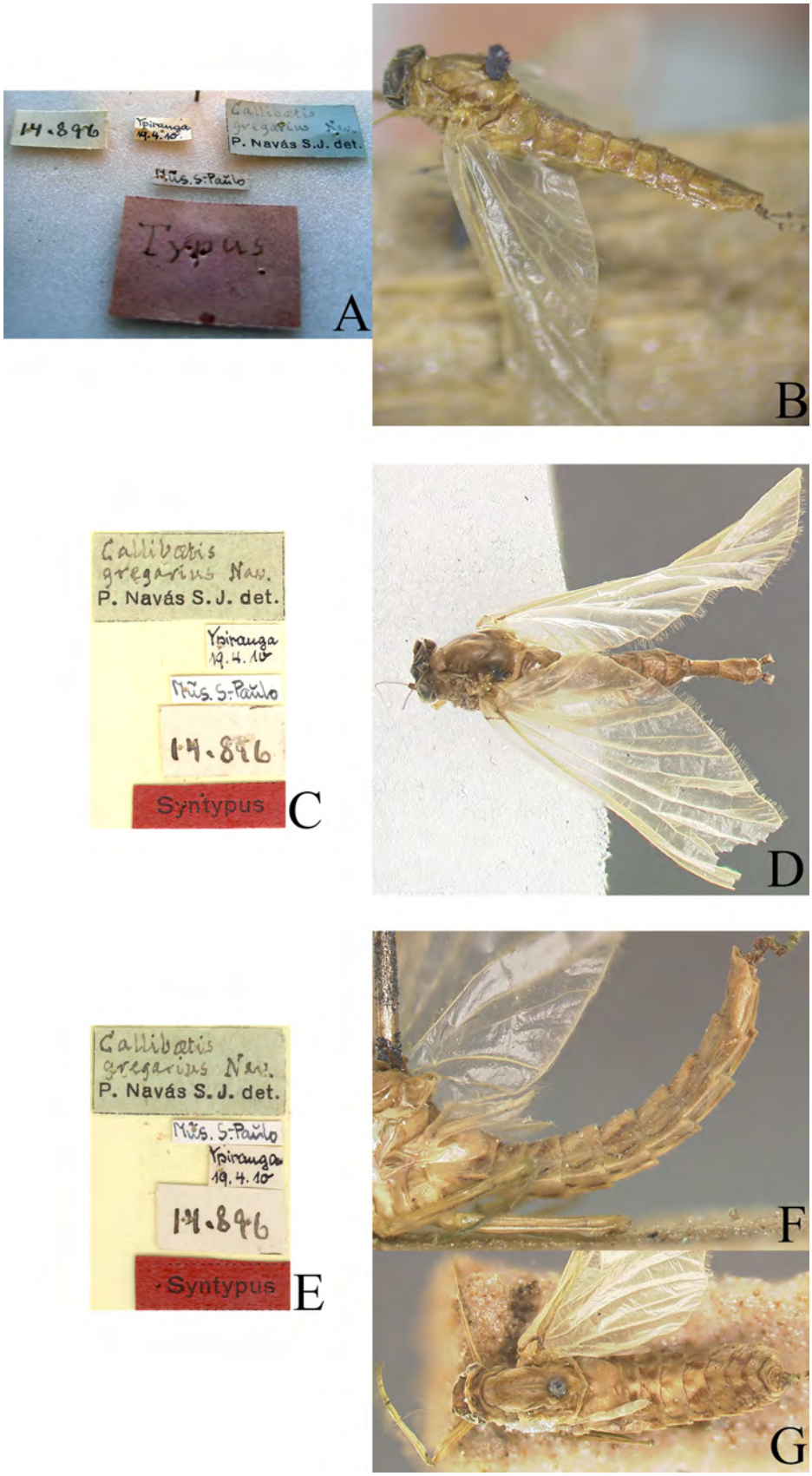

FIGURE 3. *Callibaetis gregarius* ***nomen dubium*** imagoes (types). A. labels (MZB); B. dorsolateral view of male subimago (MZB); C. labels (Senckenberg); D. dorsal view of male subimago (Senckenberg); E. labels (Senckenberg); F. detail of abdomen in lateral view (Senckenberg); G. dorsal view of male subimago (Senckenberg).

Known stages. I♂

Comments. The specimen studied at the Museu de Zoología de Barcelona (Figs. 3A and 3B) is not a male imago, as indicated by Gillies (1990), but rather a male subimago in very poor condition. Other specimens are available in the Senckenberg Deutsches Entomologisches Institut Müncheberg (Figs. 3C–3G), but they are also male subimagoes in poor condition. Even if additional specimens of this species could be obtained, the inadequate description, the very poor condition of the type and the vagueness of the type locality would probably minimize the possibility of a reliable identification. Based on our re-evaluation of the morphological and other evidence, we propose that *Callibaetis gregarius* be classified as a *nomen dubium*.

Material examined. *Callibaetis gregarius*, male subimago (labeled as type) and one male subimago, BRAZIL, Ypiranga, 19.iv.1910, MZB; three male subimagoes (labeled as syntypes) same data, Senckenberg.

Distribution. Brazil: São Paulo.

Callibaetis (*Callibaetis*) *guttatus* Navás 1915

(Figs. 4A–5D)

Callibaetis guttatus Navás 1915b: 120; Gillies 1990: 25; Da-Silva 1991: 346; Domínguez *et al.* 2006: 113; Nieto 2008: 232; Salles *et al.* 2010: 302; Lima *et al.* 2012: 306; Cruz *et al.* 2014: 30, Angeli *et al.* 2015: 199.
Callibaetis apicatus Navás 1917: 189. (syn. by Gillies 1990)
Callibaetis bruchius Navás 1920b: 55. (syn. by Gillies 1990)
Callibaetis zonatus Navás 1929: 224. (syn. by Gillies 1990)

Known stages. I♀♂, N

Diagnosis. Male imago: 1) dorsal portion of turbinate eyes oval; 2) dorsal portion of turbinate eyes in lateral view without constriction; 3) dorsal portion of turbinate eyes stalk height 1.9× height of dorsal portion; 4) turbinate portion of compound eyes (in lateral view) with anterior and posterior margins divergent; 3) forewing hyaline or with C, Sc, R_1 and posterior margin areas with large marks; 4) marginal intercalary veins paired; 5) hind wing hyaline or with basal mark; 6) costal process of hind wing rounded; 7) marginal intercalary veins on hind wing present; 8) abdominal terga III, V and VII with lateral marks; 9) abdominal sterna with pair of medioanterior and medioposterior sigilla without pigment; 10) forceps segment I wide at base; 11) forceps segment III oval.

Female imago: 1) forewing at least with C, Sc, R_1 and posterior margin areas with marks, maximal degree of pigmentation with seven complete and transversal bands (Fig. 5C); 2) marginal intercalary veins paired (Fig. 5C); 3) hind wing hyaline or with marks at base and middle (Fig. 5D); 4) costal process of hind wing rounded; 5) marginal intercalary veins on hind wing present (Fig. 5D); 6) abdominal terga II, III, V and VII with inverted V mark laterally (Fig. 5A); 6) abdominal sterna with pair of medioanterior and medioposterior sigilla without pigment (Fig. 5B); 7) abdominal terga and sterna with few or without spots (Figs. 5A and 5B); 8) abdominal sterna medially on anterior margin without one large spot (Figs. 5A and 5B); 9) abdominal terga without medial longitudinal mark (Figs. 5A and 5B).

Mature nymph: 1) maxillary palp subequal in length than galea-lacinia; 2) below maxillary palp insertion on outer margin without tuft of robust spine-like setae (Fig. 29 in Nieto 2008); 3) paraglossa with row of spine-like setae on ventral surface (Fig. 30 in Nieto 2008); 4) segment III of labial apically rounded (Fig. 30 in Nieto 2008); 5) metanotum without spines; 6) foretarsus anterior surface without spine-like setae; 7) mid and hind claw denticles smaller than foreclaw denticles (Fig. 33 in Nieto 2008).

Comments. Nieto (2008) described variation in the fore- and hind wings of this species.

In the present work, the specimens illustrated in Figures 20, 21a, 21b, 23, 24a and 24b in Nieto (2008) were examined. We conclude that they belong to *C.* (*A.*) *fasciatus* based on having forewing with three or four transverse bands of pigmentation, apical band transverse to posterior margin (see also Cruz *et al.* 2014 and comments for *C.* (*A.*) *sellacki* herein).

Callibaetis (*C.*) *guttatus* is similar to *C*. (*C.*) *zonalis*, *C*. (*C.*) *willineri* and *C*. (*C.*) *jocosus*. All four species share an inverted "V" mark on female abdominal terga III, V and VII and variable pigmentation on the female forewings. The female imago of *C.* (*C.*) *guttatus* can be differentiated from *C*. (*C.*) *jocosus* by the abdominal terga and sterna having few or no spots (Figs. 5A and 5B); from *C*. (*C.*) *willineri* by the abdominal sterna lacking one large spot medially, on the anterior margins (Figs. 5A and 5B); and from *C*. (*C.*) *zonalis* by abdominal terga without medial longitudinal mark (Figs. 5A and 5B).

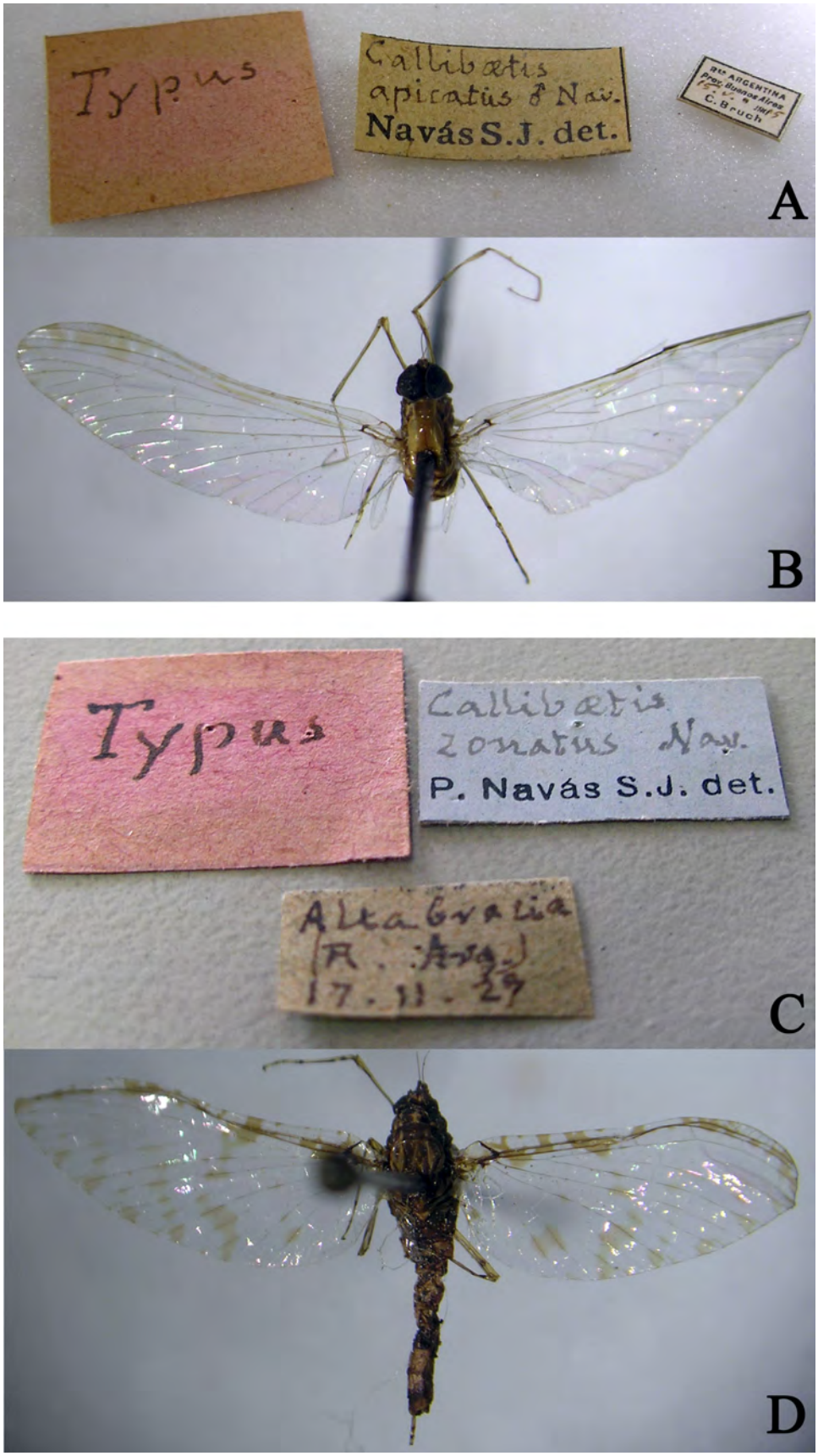

FIGURE 4. *Callibaetis* (*Callibaetis*) *guttatus* imagoes. A. labels of *C. apicatus* (type, MZB); B. dorsal view of male imago of *C. apicatus* (type, MZB); C. labels of *C. zonatus* (type, MZB); D. dorsal view of female imago of *C. zonatus* (type, MZB).

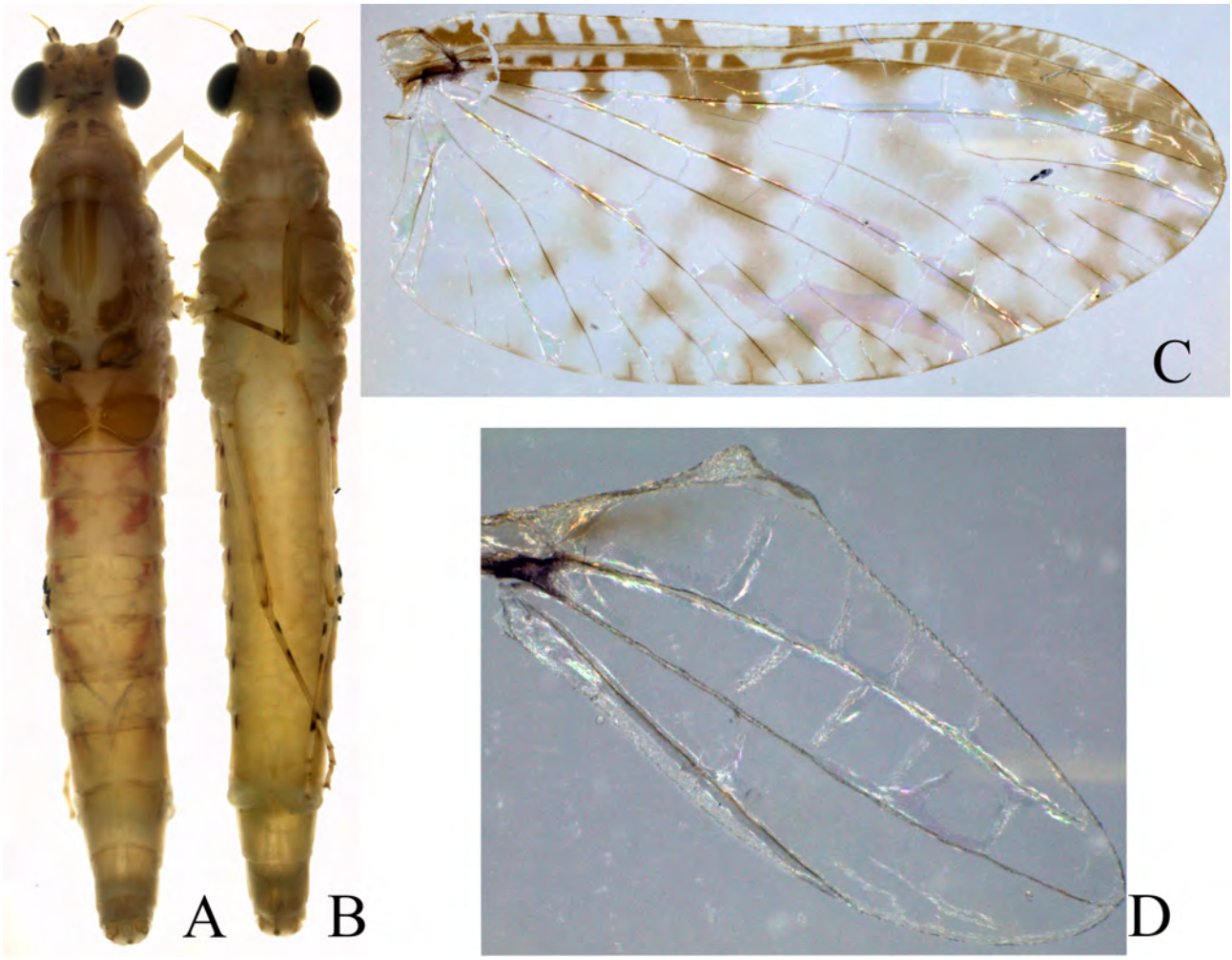

FIGURE 5. *Callibaetis* (*Callibaetis*) *guttatus* female imago. A. dorsal view; B. ventral view; C. forewing; D. hind wing.

We present figures of the types of the two synonymized species (Figs. 4A–4D) and newly collected specimens from Brazil (Figures 5A–5D).

The specimens studied by Navás (1915b) from Prov. de Buenos Aires, Argentina, were not found, thus a lectotype was not designated.

Material examined. Male imago (type of *Callibaetis apicatus*), ARGENTINA, Buenos Aires, 15.v.1915, MZB; one female imago (type of *Callibaetis zonatus*), ARGENTINA, Alta Gracia, 17.ii.1929, MZB; one female imago (*Callibaetis guttatus*), ARGENTINA, Alta Gracia, 27.vi.1926, C. Brush det., MZB; one nymph, ARGENTINA: Tucumán, Depto. Tafí Viejo, Raco (km 19), A8 Palangana, 24.xi.2001, C. Molineri coll.; one female imago reared, BRAZIL, Espírito Santo state, São Mateus, Rio São Mateus, 02.x.2007, F. F. Salles coll., INPA.

Distribution. Argentina: Tucumán; Misiones; Buenos Aires; Alta Gracia. Brazil: Ceará; Espirito Santo; Rio de Janeiro; Pernambuco.

Callibaetis jaffueli* Navás 1918 *revalidated species

(Figs. 6A–6E)

Callibaetis jaffueli Navás 1918: 214; Gillies 1990: 25; Domínguez *et al.* 2006: 115 (previously syn. with *C. jocosus* by Gillies 1990)

Known stages. I♂.

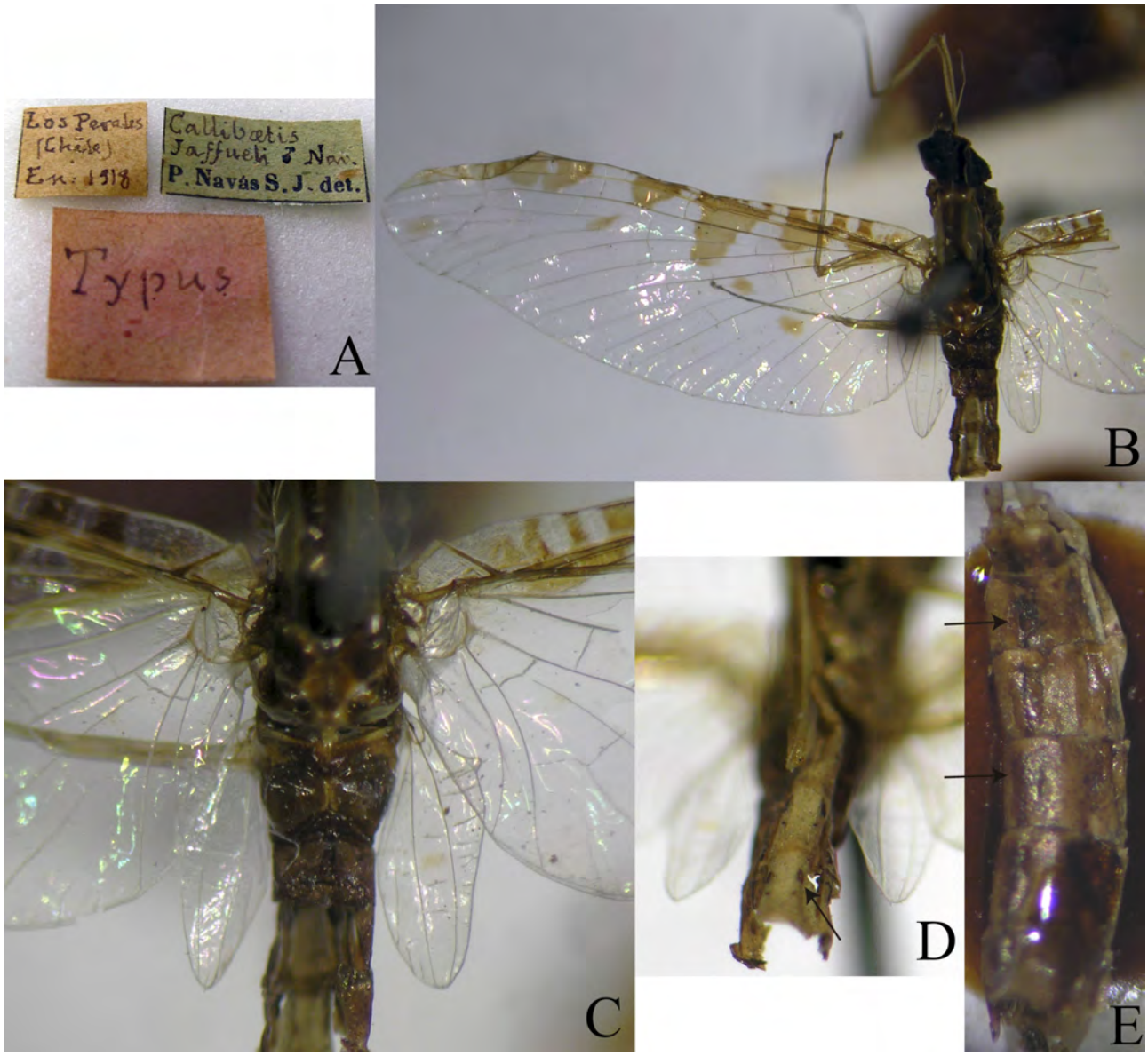

FIGURE 6. *Callibaetis jaffueli* ***revalidated species*** male imago (lectotype). A. labels; B. details of forewing and half of body; C. detail of forewing base and hind wing; D. detail of abdomen in ventral view (black arrow indicate the strong pigmented medioanterior and medioposterior sigilla); E. detail of abdomen in dorsal view (black arrow indicate the longitudinal mark).

Diagnosis. Male imago: 1) forewing with pigmentation overlapping R_1 in five regions, overlapping radial sector medially, without forming complete bands (Fig. 6B); 2) marginal intercalary veins paired (Fig. 6B); 3) hind wing with small brown mark at middle (Fig. 6C); 4) hind wing with pointed costal process (Fig. 6C); 5) marginal intercalary veins on hind wing present (Fig. 6C); 6) abdominal terga brown, with few spots and dark longitudinal mark at middle (Fig. 6E); 7) abdominal terga III, V and VI without lateral inverted V mark; 8) abdominal sterna covered with spots (Fig. 6D); 9) abdominal sterna with strong pigmented medioanterior and medioposterior sigilla (Fig. 6D).

Redescription. Male imago. Length: body, 6.5 mm; forewing, 7 mm; cerci 8.6 mm. **Head**. Compound eyes with brown turbinate portion. Antenna with brown scape, pedicel and flagellum. **Thorax.** Anteronotal protuberance brown medially; posterior scutal protuberance and scutellum brown. Anteronotal and metascutellar protuberance rounded. Legs: Tibia I with brown marks apically. Wings. Forewing with pigmented C and Sc areas, overlapping R1 in five regions, third region overlapping Radial sector (Fig. 6B); veins light brown; marginal intercalary veins paired; length of each intercalary vein 0.7 × distance between adjacent longitudinal veins; length of forewing about 2.6 × width. Hind wing with small brown mark at middle (Fig. 6C); costal process pointed; three

marginal intercalary veins. **Abdomen.** Terga. Brown, with some spots and dark longitudinal mark in middle (Fig. 6E); terga III, V and VI without lateral inverted V mark. Sterna. Light brown, covered with spots and with well pigmented medioanterior and medioposterior sigilla (Fig. 6D). Genitalia. Forceps light brown and badly damaged.

Comments. *Callibaetis jaffueli* ***revalidated species*** can be differentiated from *C.* (*C.*) *jocosus, C*. (*C.*) *zonalis*, *C*. (*C.*) *willineri* and *C.* (*C.*) *guttatus* by the abdominal sterna medially, on anterior margin, without one large spot (in contrast to *C*. (*C.*) *willineri*); marginal intercalary veins on hind wing present (in contrast to *C*. (*C.*) *zonalis*); terga III, V and VI without lateral inverted V mark (Fig. 6E) (in contrast to *C.* (*C.*) *guttatus* and *C.* (*C.*) *jocosus*); and the forewing with pigmentation overlapping R_1 in five regions, overlapping radial sector medially, without forming complete bands (Fig. 6B) (in contrast to *C.* (*C.*) *jocosus*).

Based on the re-evaluation of the morphological evidence, we propose the revalidation of *Callibaetis jaffueli* ***revalidated species*** Navás and designate the unique known specimen as lectotype.

Material examined. *Callibaetis jaffueli*, male imago (lectotype by present designation, dry), CHILE, Los Perales, Marga-Marga, i.1918, P. Jaffuel coll., MZB.

Distribution. Chile: Marga-Marga.

Callibaetis (*Callibaetis*) *jocosus* Navás 1912

(Figs. 7A–7B)

Callibaetis jocosa Navás 1912: 195. (name emended by Ulmer 1920)
Callibaetis jocosus Ulmer 1920: 126; Gillies 1990: 26; Domínguez *et al.* 2006: 115; Cruz *et al.* 2014: 40.
Callibaetis spegazzinus Navás 1920c: 36. (syn. by Gillies 1990)
Callibaetis rimatus Navás 1933: 113. (syn. by Gillies 1990)

Known stages. I♀♂, N.

Diagnosis. Male imago: 1) dorsal portion of turbinate eyes oval (Fig. 7A); 2) dorsal portion of turbinate eyes in lateral view without constriction; 3) dorsal portion of turbinate eyes stalk height 1.9 × height of dorsal portion; 4) turbinate portion of compound eyes (in lateral view) with anterior and posterior margins subparallel; 5) forewing with three transversal bands on apical third, base without pigmentation (Fig. 111 in Cruz *et al.* 2014); 6) marginal intercalary veins paired (Fig. 111 in Cruz *et al.* 2014); 7) hind wing hyaline (Fig. 112 in Cruz *et al.* 2014); 8) costal process of hind wing rounded (Fig. 112 in Cruz *et al.* 2014); 9) marginal intercalary veins on hind wing present (Fig. 112 in Cruz *et al.* 2014); 10) abdominal terga covered with spots and terga III, V and VII with lateral, inverted V mark (Fig. 7A); 11) abdominal sterna covered with spots and with one anterolateral mark (Fig. 7B); 12) abdominal sterna with pair of medioanterior and medioposterior sigilla weakly pigmented (Fig. 7B); 13) forceps segment I wide at base (Fig. 110 in Cruz *et al.* 2014); 14) forceps segment III oval (Fig. 110 in Cruz *et al.* 2014).

Female imago: 1) forewing with pigment in C and Sc areas, overpassing R_1, and after R_2 pigmentation lighter (Fig. 114 in Cruz *et al.* 2014); 2) marginal intercalary veins paired (Fig. 114 in Cruz *et al.* 2014); 3) hind wing with mark near costal process (Fig. 115 in Cruz *et al.* 2014); 4) costal process of hind wing rounded (Fig. 1151 in Cruz *et al.* 2014); 5) marginal intercalary veins on hind wing present (Fig. 115 in Cruz *et al.* 2014); 6) abdominal terga covered with spots, medially with longitudinal mark, and terga III, V and VII with lateral inverted V mark (Fig. 113 in Cruz *et al.* 2014); 7) abdominal sterna covered with spots (Fig. 116 in Cruz *et al.* 2014); 8) abdominal sterna with pair of medioanterior sigilla and medioposterior sigilla weak pigmented (Fig. 116 in Cruz *et al.* 2014); 9) abdominal sterna medially, on anterior margin, without one large spot.

Mature nymph: 1) maxillary palp subequal in length of galea-lacinia (Fig. 122 in Cruz *et al.* 2014); 2) below maxillary palp insertion on outer margin with tuft of robust spine-like setae (Fig. 122 in Cruz *et al.* 2014); 3) paraglossa with row of spine-like setae on ventral surface (Fig. 123 in Cruz *et al.* 2014); 4) segment III of labium apically rounded (Fig. 123 in Cruz *et al.* 2014); 5) metanotum without spines; 6) foretarsus anterior surface without spine-like setae; 7) hind claw denticles smaller than foreclaw denticles (Fig. 125D in Cruz *et al.* 2014).

Comments. The female imago of *C*. (*C.*) *jocosus* is similar to *C*. (*C.*) *zonalis*, *C*. (*C.*) *willineri* and *C.* (*C.*) *guttatus* (see *C.* (*C.*) *guttatus* comments). The female imago of *C*. (*C.*) *jocosus* can be differentiated from these three species by the abdominal sterna covered with spots (Fig. 116 in Cruz *et al.* 2014) (in contrast to *C.* (*C.*) *guttatus*); abdominal sterna medially, on anterior margin, without one large spot (in contrast to *C*. (*C.*) *willineri*); and marginal intercalary veins on hind wing present (in contrast to *C*. (*C.*) *zonalis*).

FIGURE 7. *Callibaetis* (*Callibaetis*) *jocosus* male imago. A. dorsal view (black arrow indicate the lateral inverted V mark); B. ventral view.

Callibaetis jaffueli Navás 1918 and *Callibaetis stictogaster* Navás 1915, previouly considered synonyms of *C.* (*C.*) *jocosus* by Gillies (1990), have here their species status revalidated. For the diagnoses, redescriptions and comments, see their respective species sections.

The specimens studied by Navás (1912) from São Paulo, Brazil, were not found, thus the lectotype was not designated.

Material examined. Female imago (reared), two male imagoes (reared), BRAZIL, São Paulo, Jundiaí, Serra do Japií, Lake near two houses, 23º14'15.1" S/ 046º56' 26.2" W, 14.vii.2009, 1043 m, P. Brito coll., INPA; female imago, photograph of the type of *Callibaetis stictogaster,* ARGENTINA, Buenos Aires, 15.x.1913, Museo de Ciencias Naturales de La Plata, C. Bruch coll.; one male imago, BRAZIL, São Paulo, i.1915, L. Navás det., MZB; one female imago (type of *Callibaetis spegazzinus*), PARAGUAY, Asunción, 10.x.1919, Spegazinni coll., L. Navás det., MZB; one female imago reared, BRAZIL, Santa Catarina state, Dionisio Cerqueira, Linha Toldo, Cachoeira do Toldo, 26º18'11.4" S/ 53º37'01.6" W, 649 m alt., 14–15.ix.2011, P.V. Cruz, R. Boldrini, N. Hamada and A. M. O. Pes cols., INPA; one female imago, BRAZIL, Paraná state, Balsas Novas, Rio Pomba, 25º26'29.8" S/ 49º44'40.5" W, 911 m alt., 11.ix.2011, P.V. Cruz, R. Boldrini, N. Hamada and A. M. O. Pes cols., INPA.

Distribution. Argentina: Buenos Aires. Brazil: São Paulo; Mato Grosso do Sul; Santa Catarina; Paraná. Paraguay: Asunción.

Callibaetis nigrivenosus* Banks 1918 *nomen dubium
(Figs. 8A–8E)

Callibaetis nigrivenosa Banks 1918: 11 (name emended by McCafferty 1996)
Callibaetis nigrivenosus McCafferty 1996: 231; Domínguez *et al.* 2006: 115.

Known stages. I♀.

Comments. We studied the type specimen from photographs (Figs. 8A–8E). It is fragile, badly damaged and lacks the hind wings. The only reliable structure is the forewing, which allowed us to identify the specimen to the family level (Baetidae). The absence of hind wings in the type specimen and its description lead us to believe that these structures were always absent. The manuscript is very brief and is not illustrated. The type locality presented in the manuscript and shown on the label is not precise, referring to a broad geographical area. Even if additional specimens of this species were collected, there would be little possibility of a reliable identification using the types or the original description. Based on the lack of information in the description, the damaged type and the improbability of assigning specimens to this species, we propose *Callibaetis nigrivenosus* Banks as a *nomen dubium*.

FIGURE 8. *Callibaetis nigrivenosus* ***nomen dubium*** female imago (holotype). A. labels (Harvard); B. lateral view of head and thorax; C. lateral view of abdomen; D. left forewing; E. right forewing.

Material examined. *Callibaetis nigrivenosa*, male imago (type), Ecuador, Huigar, 4,500 ft., 17 June, H. S. Parish coll., Museum of Comparative Zoology, Harvard University, MCZ-ENT 00010057.

Distribution. Ecuador: Huigar

Callibaetis (*Abaetetuba*) *pollens* Needham & Murphy 1924

(Figs. 9A–10H)

Callibaetis pollens Needham & Murphy 1924: 51; Nieto 2008: 235; Domínguez *et al.* 2006: 116; Boldrini *et al.* 2012: 92; Lima *et al.* 2012: 306; Cruz *et al.* 2014: 56; Boldrini & Cruz, 2014: 4.

Known stages. I♀♂, N.

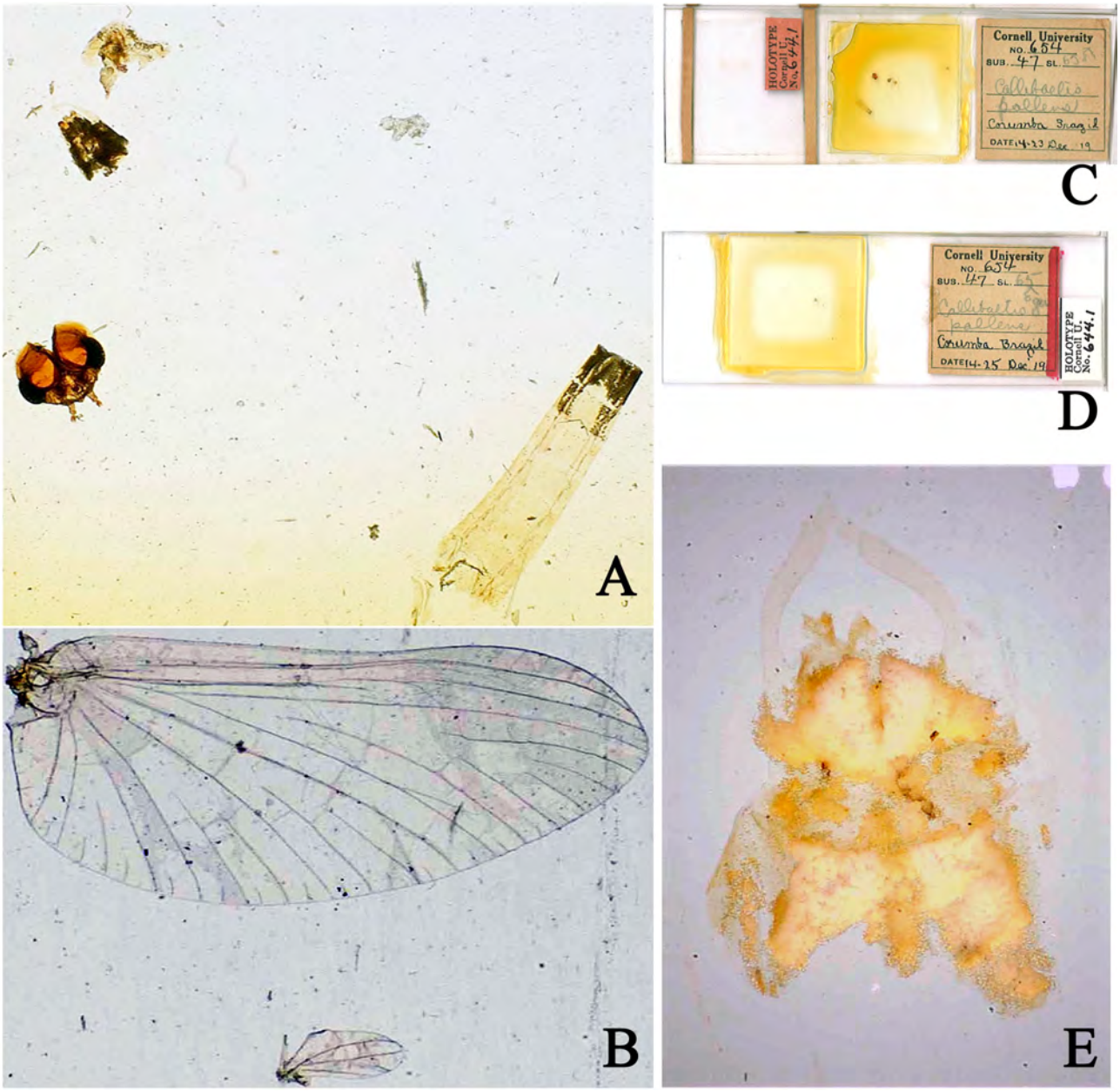

FIGURE 9. *Callibaetis* (*Abaetetuba*) *pollens* male imago (holotype). A. head, abdomen and genitalia on slide; B. forewing and hind wing on slide; C. slide and label; D. slide and label; E. detail of genitalia.

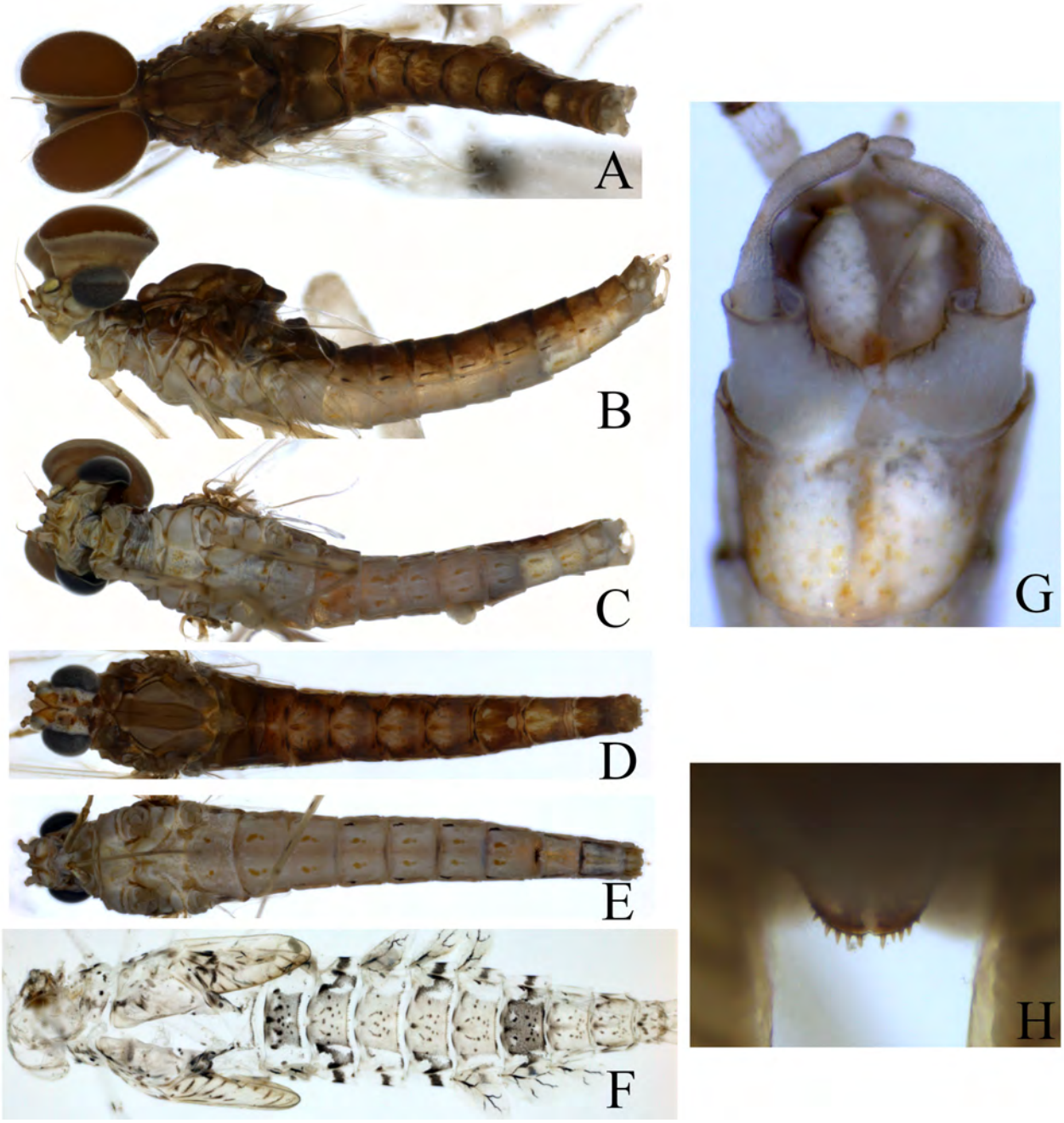

FIGURE 10. *Callibaetis* (*Abaetetuba*) *pollens* imagoes and nymphs. A. dorsal view of male; B. lateral view of male; C. ventral view of male; D. dorsal view of female; E. ventral view of female; F. dorsal view of nymphal exuvia; G. genitalia; H. detail of metanotum.

Diagnosis. Male imago: 1) dorsal portion of turbinate eyes oval (Figs. 9A, 10A); 2) dorsal portion of turbinate eyes in lateral view with constriction (Fig. 10B); 3) dorsal portion of turbinate eyes stalk height 1.3 × height of dorsal portion (Fig. 10B); 4) turbinate portion of compound eyes (in lateral view) with anterior and posterior margins divergent; 5) forewing hyaline (Fig. 9B); 6) marginal intercalary veins single (Fig. 9B); 7) hind wing hyaline (Fig. 9B); 8) costal process of hind wing rounded (Fig. 9B); 9) marginal intercalary veins on hind wing present; 10) abdominal terga on anterior margin with a transversal mark of pigment (Fig. 10A); 11) abdominal sterna with pair of medioanterior and medioposterior sigilla weak pigmented (Fig. 10C); 12) abdominal sterna with black anterolateral mark (Fig. 10C); 13) forceps segment I wide at base, with setae on inner margin (Figs. 9E, 10G); 14) forceps segment III oval (Figs. 9E, 10G).

Female imago: 1) head with a Y mark (Fig. 10D); 2) forewings hyaline (Fig. 161 in Cruz *et al.* 2014); 3)

marginal intercalary veins single (Fig. 161 in Cruz *et al.* 2014); 4) hind wing hyaline (Fig. 162 in Cruz *et al.* 2014); 5) costal process of hind wing rounded (Fig. 162 in Cruz *et al.* 2014); 6) marginal intercalary veins on hind wing present (Fig. 162 in Cruz *et al.* 2014); 7) abdominal terga reddish brown (Fig. 10D); 8) abdominal sterna with pair of medioanterior and medioposterior sigilla weak pigmented (Fig. 10E); 9) abdominal sterna II to IX with black mark (Fig. 10E).

Mature nymph: 1) distal margin of labrum, medially with row of long and bifid setae (Fig. 43B in Nieto 2008); 2) maxillary palp 1.5 × length of galea-lacinia (Fig. 47 in Nieto 2008); 3) crown of galea-lacinia with three rows of setae; 4) paraglossa with rounded apex (Fig. 48A in Nieto 2008); 5) paraglossa with one tuft of fine and simple setae; 6) metanotum with spines (Fig. 10H); 7) foretarsus anterior surface without spine-like setae (Fig. 49 in Nieto 2008); 8) hind claw with minute denticles (Fig. 51 in Nieto 2008).

Comments. Cruz *et al.* (2009, 2014) differentiate *C.* (*A.*) *pollens* and *C.* (*A.*) *capixaba* by the setae on the femur of the nymph (trifid setae absent on the femur of *C.* (*A.*) *pollens*). We studied the same specimens analyzed by Cruz *et al.* (2009, 2014) and some of those analyzed by Nieto (2008), and observed trifid setae on the femur of *C.* (*A.*) *pollens*. However, the nymphs of both species can be differentiated by the shape of the apex of paraglossa, being round in *C.* (*A.*) *pollens* (Fig. 48A in Nieto 2008) and truncate in *C.* (*A.*) *capixaba* (Fig. 42A in Cruz *et al.* 2009); and by the number of tufts of fine and simple setae on the apex of the paraglossa, having one in *C.* (*A.*) *pollens* and three in *C.* (*A.*) *capixaba*.

We present figures of the holotype (Figs. 9A–9E) and more recently collected specimens assigned to *C.* (*A.*) *pollens* (Figs. 10A–10H) from Brazil.

Material examined. *Callibaetis pollens*, photographs of the slide of the male imago (holotype), BRAZIL, Mato Grosso do Sul, Corumbá, 14.xii.1919, Cornell University, nº 644; two female imagoes, ARGENTINA, Acheral, Tucumán, Aranillas River, Cruce RP 38, 366 m, 27º06'59.9" S/65º27'43.9" W, 13.ix.2007, C. Nieto and C. Molineri cols., CZNC; five nymphs, ARGENTINA, Acheral, Tucumán, Aranillas River, Cruce RP 38, 366 m, 27º06'59.9" S/ 65º27'43.9" W, 28.vii.2006, C. Nieto and C. Molineri cols., CZNC; one female imago, one male imago, eight nymphs, BRAZIL, Lajeado River, BR010, under the bridge, Maranhão, 06°04'15.6" S/ 47°22'56.6" W, 21.vii.2010, N. Hamada, P.V. Cruz and R. Boldrini cols., INPA; two male imagoes, five nymphs, BRAZIL, Maranhão, Riachão, Riacho Cocal, Cachoeira Santa Bárbara, 07º13'46.2" S/ 46º27'24.6" W, 23.vii.2010, N. Hamada, P.V. Cruz & R. Boldrini cols., INPA; two female imagoes, BRAZIL, Maranhão, Farinha River, BR010, under the bridge, 06°31'47.3" S/ 47°28'11.4" W, 22.vii.2010, N. Hamada, P.V. Cruz & R. Boldrini cols., INPA; five male imagoes, seven female imagoes, 12 nymphs, BRAZIL, Ceará, Jaburu River, Ubajara, Distrito da Cachoeira do Boi Morto, 03°52'36.2" S/41°0.1'0.08" W, 26.vii.2010, N. Hamada, P.V. Cruz & R. Boldrini cols., INPA; four nymphs, BRAZIL, Brejinho, near Posto Cachoeira, Bahia, Correntina, 13°43'53.5" S/45°23'38.1" W, 08.viii.2010, N. Hamada, R. B. Querino & R. Boldrini cols., INPA; eight nymphs, BRAZIL, Bahia, Côcos, Formoso River, highway to Mambaí municipality, 14°40'00.6" S/45°49'32.3" W, 11.viii.2010, N. Hamada, R. B. Querino & R. Boldrini cols., INPA; five nymphs, 2 female and 1 male (reared), BRAZIL, Mato Grosso do Sul, Bonito, Balneário municipal de Jardim Rio Prata, 21°25'04.3" S/ 56°23'24.0" W, 15/iii/2012, P. V. Cruz coll., INPA.

Distribution. Argentina: Tucumán. Brazil: Ceará; Bahia; Goiás; Maranhão; Mato Grosso do Sul; Pernambuco; Piauí; Rondônia; Roraima.

Callibaetis (*Callibaetis*) *radiatus* Navás 1920

(Figs. 11A–14D)

Callibaetis radiatus Navás 1920a: 132; Gillies 1990: 26; Salles *et al.* 2003: 13; Domínguez *et al.* 2006: 116; Cruz *et al.* 2014: 58; García 2014: 41; Lima *et al.* 2016: 214; Vinasco-Mondragón & Zúñiga 2016: 92.
Callibaetis venulosus Navás 1933: 114. (syn. by Gillies 1990)

Known stages. I♀♂, **N**.

Diagnosis. Male imago: 1) dorsal portion of turbinate eye oval (Fig. 21 in Salles *et al.* 2003); 2) dorsal portion of turbinate eyes without constriction; 3) height of dorsal portion of turbinate eye stalk 0.85 × height of dorsal portion; 4) turbinate portion of compound eyes (in lateral view) with divergent anterior and posterior margins; 5) forewings hyaline (Fig. 167 in Cruz *et al.* 2014); 6) thick cross veins in C and Sc areas (Fig. 167 in Cruz *et al.*

2014); 7) marginal intercalary vein single (Fig. 167 in Cruz *et al.* 2014); 8) hind wing hyaline (Fig. 168 in Cruz *et al.* 2014); 9) hind wing with quadrangular costal process (Fig. 168 in Cruz *et al.* 2014); 10) hind wing with thick cross veins (Fig. 168 in Cruz *et al.* 2014); 11) marginal intercalary veins present on hind wing (Fig. 168 in Cruz *et al.* 2014); 12) abdominal terga with black mark anterolaterally (Fig. 169 in Cruz *et al.* 2014); 13) abdominal sterna with a weakly pigmented medioanterior and medioposterior sigilla (Fig. 172 in Cruz *et al.* 2014); 14) segment I of forceps wide at base (Fig. 166 in Cruz *et al.* 2014); 15) segment III of forceps truncated apex (Fig. 166 in Cruz *et al.* 2014).

Female imago: 1) forewing with brown pigmented C, Sc and R1 areas, extending beyond R1 but not forming bands (Fig. 11C); 2) forewing with thick and black cross veins in C and Sc areas (Fig. 11B); 3) marginal intercalary veins single (Fig. 11C); 4) hind wing hyaline (Fig. 171 in Cruz *et al.* 2014); 5) hind wing with quadrangular costal process (Fig. 171 in Cruz *et al.* 2014); 6) marginal intercalary veins on hind wing present (Fig. 171 in Cruz *et al.* 2014); 7) hind wing with thick cross veins (Fig. 171 in Cruz *et al.* 2014); 8) abdomen with brown spots; 9) anterolateral spot on abdominal terga and sterna present (Figs. 169 and 172 in Cruz *et al.* 2014); 10) abdominal sterna with a weakly pigmented medioanterior and medioposterior sigilla (Fig. 172 in Cruz *et al.* 2014).

Mature nymph: 1) maxillary palp 1.2 × length of galea-lacinia (Fig. 12F); 2) tuft of robust spine-like setae below insertion of maxillary palp absent (Fig. 12F); 3) ventral surface of paraglossa with row of spine-like setae (Fig. 12G); 4) segment III of labial palp rounded apically (Fig. 12G); 5) metanotum without spines; 6) anterior surface of foretarsus without spine-like setae (Fig. 13A).

Redescription. **Mature nymph:** Length: body, 7.2–8.0 mm; broken cerci and terminal filament (n=1). **Head**. Coloration: faded in alcohol. Turbinate portion of male compound eyes yellowish brown. Antenna with small spines and fine, simple setae (Fig. 12A). Labrum (Fig. 12B) maximum length about 1.4 × maximum width; anterolateral margins with long spine-like setae; distal margin with spine-like setae medially; dorsal surface with many, long, fine and simple setae; distal margin with one row of fine spine-like setae ventrally; ventral surface with short, spine-like setae near lateral margin. Right mandible (Fig. 12C) with 4 + 3 denticles; margin between prostheca and mola convex; basal half with short, fine, simple setae and pores scattered over dorsal surface. Left mandible (Fig. 12D) with 4 + 2 denticles; margin between prostheca and mola straight; basal half with short, fine and simple setae and pores scattered over dorsal surface. Hypopharynx (Fig. 12E). Lingua with lobe covered with small simple setae; short, fine and simple setae scattered over distal margin of superlingua. Maxilla (Fig. 12F). Medial protuberance of galea with 1+ 3 spine-like setae. Maxillary palp short, 1.2 × length of galea-lacinia; palp segment II 1.2 × length of segment I; outer margin of segment I scattered with long, fine, simple setae; inner margin of segment II with few spine-like setae. Labium (Fig. 12G). Glossa subequal in length to paraglossa; inner margin with 11 spine-like setae; apex with 3 – 5 long spine-like setae; outer margin with row of long spine-like setae; dorsal surface with one row of long spine-like setae near outer margin and one tuft of setae at apex. Paraglossa. Ventral surface with one row of fine and simple setae; dorsal surface with three rows of long spine-like setae. Labial palp with segment I 1.1 × length of segments II and III combined; segment I covered with micropores; inner and outer margin of segment II with six spine-like setae; dorsal surface with row of six short spine-like setae; segment III with rounded apex. **Thorax.** Foreleg (Figs. 13A). Ratio of foreleg segments 0.9:1:0.6:0.3. Forefemur. Length about 4.0 × maximum width; dorsal margin with row of short, spine-like setae; apex with two robust spine-like setae; length of setae about 0.1 × maximum width of femur; anterior surface near dorsal margin with one row of spine-like setae. Tibia. One row of short spine-like setae ventrally; anterior surface with few fine and simple setae. Tarsus. Anterior and posterior surface without spine-like setae. Tarsal claw 0.5 × length of tarsus (Figs. 13B). Femur of hind leg without trifid setae; tarsal claw with small denticles (Fig. 13C). **Abdomen.** Terga. Posterior margin with regular spines (Fig. 14A). Sterna. Surface with fine, simple setae. Paraproct (Fig. 14B) with 24 marginal spines; surface with micropores and short, fine, simple setae. Cercus and terminal filament at base as in Figures 14C and 14D respectively.

Comments. The female imagoes of *C.* (*C.*) *radiatus*, *C. viviparus* and *C. camposi* are similar and could not be distinguished based on re-evaluation of the morphological evidence. However, as stated in the comments of *C. camposi*, the type locality of *C. viviparus* can be accessed and new specimens can be collected in the future.

García (2014) recorded *C.* (*Callibaetis*) *radiatus* in Venezuela based on reared specimens (female, male and its nymphal exuviae). Taking into account the similarity between *C.* (*C.*) *radiatus*, *C. viviparus* and *C. camposi* and, in order to enable the comparisons to confirm this record, we re-describe and present new diagnosis and illustrations of the nymph described by Salles *et al.* (2003), as well figures of the specimen originally described by Navás (1920), here designated as lectotype (Figs. 11A–11D).

FIGURE 11. *Callibaetis* (*Callibaetis*) *radiatus* female imago (lectotype). A. labels; B. detail of anterior margin of forewing; C. forewing; D. dorsal view of body and wings.

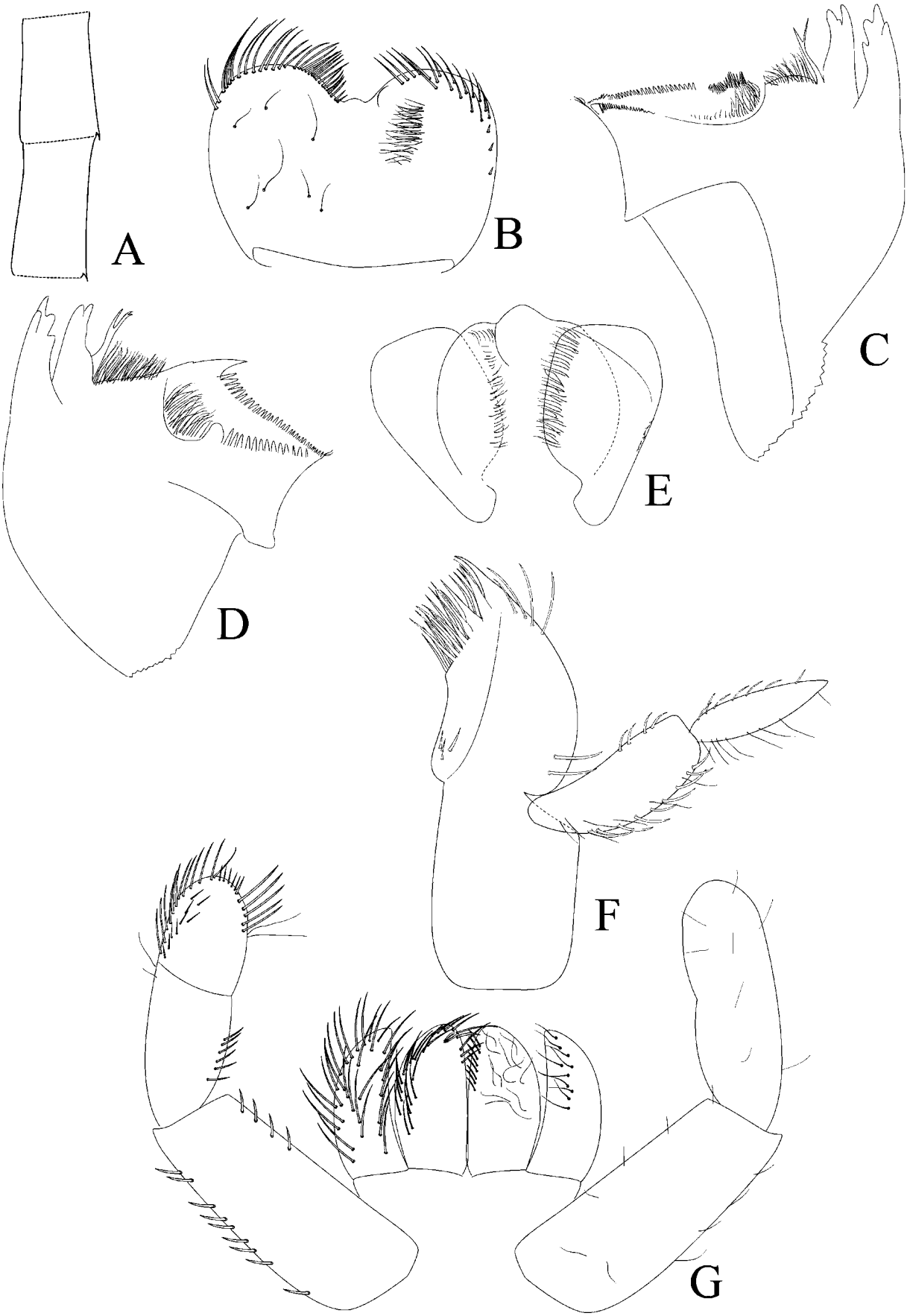

FIGURE 12. *Callibaetis* (*Callibaetis*) *radiatus* nymphs. A. antenna; B. labrum (left d.v., right v.v); C. right mandible; D. left mandible; E. hypopharynx; F. maxilla; G. labium (left d.v., right v.v.).

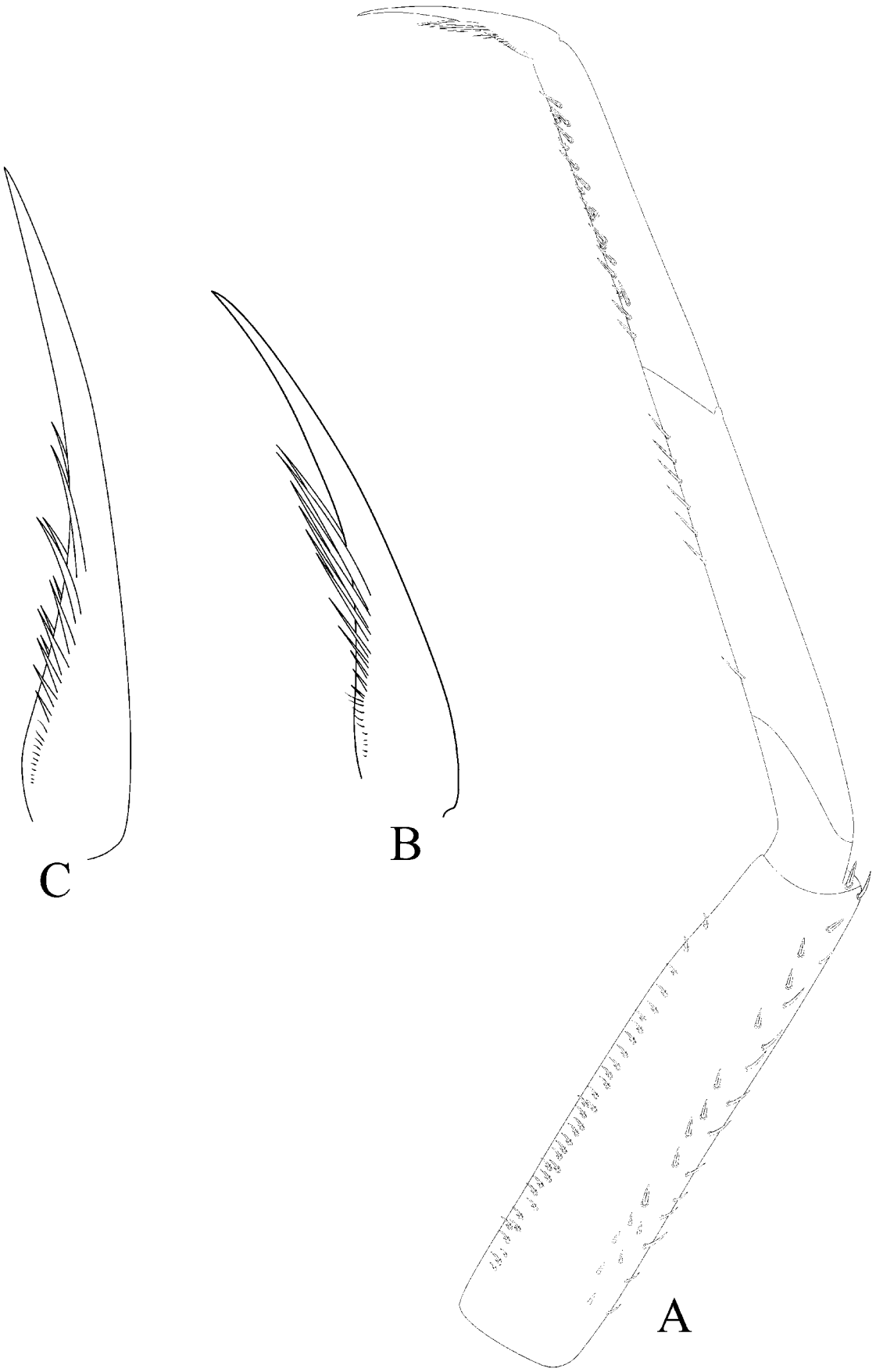

FIGURE 13. *Callibaetis* (*Callibaetis*) *radiatus* nymphs. A. foreleg; B. foreclaw; C. hind claw.

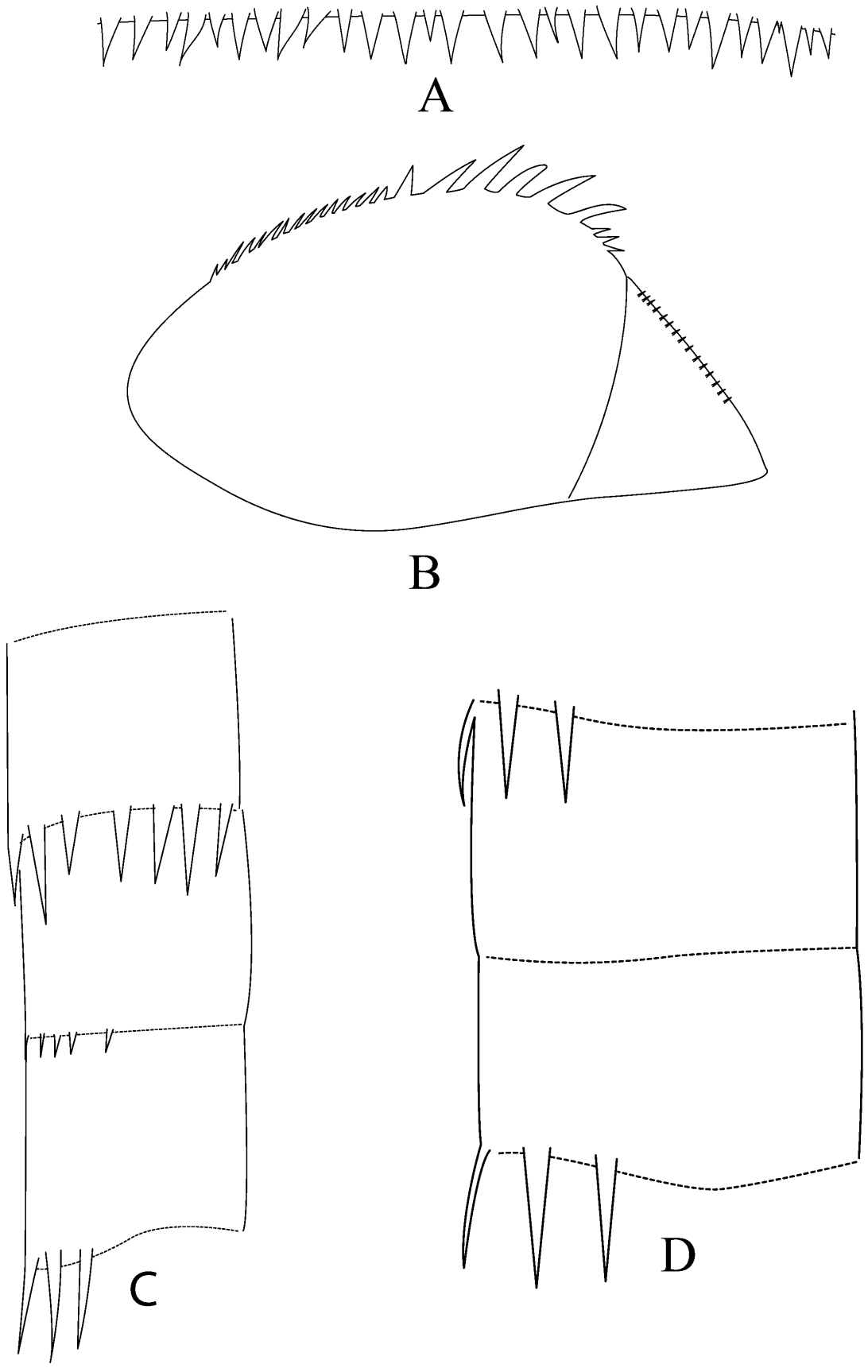

FIGURE 14. *Callibaetis* (*Callibaetis*) *radiatus* nymphs. A. posterior margin of terga IV; B. paraproct; C. cercus; D. terminal filament.

Recently, Lima *et al.* (2016) and Vinasco-Mondragón & Zúñiga (2016) recorded *C.* (*C.*) *radiatus* respectively from Bahia state (Brazil) and Colombia, all based on female imagoes. Taking into account the morphological evidence here presented, both 2016 records of *C. radiatus* could be applicable to *C. viviparus* or *C. camposi*. Associations between stages should be made in order to confirm or refute these records.

Material examined. *Callibaetis radiatus*, photographs of one female imago (lectotype by present designation), Argentina, Santa Fé, 1.iii.1918, MNHN; one female imago, Argentina, Formosa, Reserva EL, Bagual, xi-2004, Serochi coll.; one female imago, Paraguay, Asunción, 15.x.1919, MZB; male imago, female imago (reared) and two nymphs, BRAZIL, Minas Gerais, Viçosa, Ranário—Universidade Federal de Viçosa, 27.i.1997, E.R. Silva coll.

Distribution. Argentina: Santa Fé. Paraguay: Asunción. Brazil: Bahia; Minas Gerais.

***Callibaetis* (*Abaetetuba*) *sellacki* (Weyenbergh 1883)**

(Figs. 15A–16B)

Cloe sellacki Weyenbergh 1883: 164. (comb. by Eaton 1883)
Cloe lorentzii Weyenbergh 1883: 167. (syn. by Gillies 1990)
Callibaetis sellacki Eaton 1883: 198; Gillies 1990: 27; Nieto 2008: 237; Domínguez *et al.* 2006: 116; Cruz *et al.* 2014: 60.
Callibaetis trifasciatus (partim) Navás 1915b: 120. (misidentification, the name is not syn. Gillies 1990; McCafferty 1996)
Callibaetis fasciatus Ulmer 1921: 246. (misidentification, the name is not syn. Gillies 1990)
Callibaetis lineatus Navás 1932: 82. (syn. by Gillies 1990)
Baetis gloriosus Navás 1923: 2. **syn. nov.**
Callibaetis gloriosus Navás 1930b: 360. **syn. nov.** (comb. by Navás 1930b)

FIGURE 15. *Callibaetis* (*Abaetetuba*) *sellacki* nymphs. A. dorsal view; B. ventral view.

FIGURE 16. *Callibaetis gloriosus* female subimago **syn. nov.** (holotype). A. label of type; B. dorsal view.

Known stages. I♀♂, N

Diagnosis. Male imago: 1) dorsal portion of turbinate eyes oval (Fig. 173 in Cruz *et al.* 2014); 2) dorsal portion of turbinate eyes in lateral view without constriction; 3) dorsal portion of turbinate eyes stalk height 0.21 × height of dorsal portion; 4) turbinate portion of compound eyes (in lateral view) with anterior and posterior margins divergent; 5) forewing with two brown bands, apical band parallel to posterior margin (Fig. 176 in Cruz *et al.* 2014); 6) marginal intercalary veins paired (Fig. 176 in Cruz *et al.* 2014); 7) hind wing with small marks of pigmentation (Fig. 177 in Cruz *et al.* 2014); 8) costal process of hind wing pointed (Fig. 177 in Cruz *et al.* 2014); 9) marginal intercalary veins on hind wing present (Fig. 177 in Cruz *et al.* 2014); 10) abdominal sterna with pair of medioanterior and medioposterior sigilla strongly pigmented; 11) abdominal sterna washed with red spots and with one anterolateral mark; 12) forceps segment I wide at base (Fig. 175 in Cruz *et al.* 2014); 13) forceps segment III elongate (Fig. 175 in Cruz *et al.* 2014).

Female imago: 1) forewing with two bands, apical band parallel to posterior margin (Fig. 179 in Cruz *et al.* 2014); 2) marginal intercalary veins paired (Fig. 179 in Cruz *et al.* 2014); 3) hind wing with small marks of pigmentation (Fig. 180 in Cruz *et al.* 2014); 4) costal process of hind wing pointed (Fig. 180 in Cruz *et al.* 2014); 5) marginal intercalary veins on hind wing present (Fig. 180 in Cruz *et al.* 2014); 6) abdomen covered by red spots (Figs. 178 and 181 in Cruz *et al.* 2014); 7) abdominal sterna with pair of medioanterior and medioposterior sigilla strongly pigmented (Fig. 181 in Cruz *et al.* 2014).

Mature nymph: 1) distal margin of labrum medially with simple spine-setae (Fig. 61B in Nieto 2008); 2) maxillary palp 1.5 × the length of galea-lacinia (Fig. 65 in Nieto 2008); 3) crown of galea-lacinia with two rows of setae; 4) paraglossa with rounded apex (Fig. 66A in Nieto 2008); 5) paraglossa with one tuft of fine and simple setae on apex; 6) metanotum with spines; 7) foretarsus anterior surface with spine-like setae (Fig. 67 in Nieto 2008); 8) hind claw denticles smaller than foreclaw denticles (Fig. 69 in Nieto 2008).

Comments. Until now, *C. gloriosus* is considered to be a junior synonym of *Callibaetis* (*A.*) *fasciatus*. After studying the type of *C. gloriosus*, we observed that the most conspicuous diagnostic character of *C.* (*A.*) *sellacki* is present in *C. gloriosus*: an apical band on the female forewing, parallel to the posterior margin. Thereby, *C. gloriosus* is proposed here as junior synonym of *C.* (*A.*) *sellacki*. The type specimens of *C. gloriosus* possess damaged forewings (Fig. 16B), but the apical band is visible and comparable with those presented by Cruz *et al.* (2014: Figs. 27D, 27G).

We present figures of the dorsal and ventral habitus of the nymphs of *C.* (*A.*) *sellacki* (Figs. 15A–15B) and the type of *C. gloriosus* (Figs. 16A–16B).

Material examined. *Callibaetis gloriosus,* female subimago (type), CHILE, Marga-Marga, Ian 1919, MZB; *Callibaetis lineatus,* female imago (type), CHILE, Marga Marga, iii.1931, MZB; *Callibaetis trifasciatus,* male imago (type), ARGENTINA, Prov. Buenos Aires, C. Bruch coll., MZB; two nymphs (one mounted on slides), ARGENTINA, Buenos Aires, Tandil, A◦ Quequén Chico, 6.i.1983, E. Domínguez coll., INPA; one male subimago, BRAZIL, Rio Grande do Sul state, Pelotas municipality, 10.xi.1959, Biezanko, M.1960-3, NHM.

Distribution. Argentina: Bueno Aires. Chile: Marga-Marga. Brazil: Rio Grande do Sul; São Paulo.

Callibaetis stictogaster Navás 1915 *revalidated species*

(Figs. 17A–18E)

Callibaetis stictogaster Navás 1915b: 121; Gillies 1990: 28. (previously syn. with *C. jocosus* by Gillies 1990)

Known stages. I♀♂.

Diagnosis. Male imago: 1) costal margin of forewing with pigmentation extending beyond R_1 and less intense after R_2 (Fig. 17D); 2) marginal intercalary veins paired (Fig. 17D); 3) hind wing with pointed costal process; 4) marginal intercalary veins present on hind wing.

Female imago: 1) forewing completely brown (Figs. 17F, 18C, 18D); 2) marginal intercalary veins paired (Figs. 17F, 18C, 18D); 3) hind wing with brown marks (Fig. 18E); 4) hind wing with pointed costal process (Fig. 18E); 5) marginal intercalary veins on hind wing present (Fig. 18E); 6) abdominal terga and sterna covered with brown spots (Figs. 17B and 18A); 7) abdominal terga with longitudinal mark medially, near anterior margin; 8) anterior margin of terga II–IX with one pale triangle, inside of it with spots (Fig. 18A); 8) abdominal sterna with pigmented medioanterior and medioposterior sigilla (Fig. 18B); 9) abdominal sterna with two large brown marks on anterior margin, one medially and other anterolaterally (Fig. 18B).

Redescription. Female imago: Head. Yellowish with red "M" mark (Fig. 18A). **Thorax.** Anteronotal protuberance rounded. Metascutellar protuberance pointed. Wings. Forewing completely brown, with hyaline cross veins (Figs. 18C and 18D); stigmatic area with 12 cross veins touching Sc vein; marginal intercalaries paired; length of each intercalary vein 0.9 × distance between adjacent longitudinal veins; length of forewing about 2.8× width. Hind wing (Fig. 18E) with some brown marks; with two intercalary marginal veins; costal process pointed. **Abdomen.** Terga (Fig. 18A) with longitudinal mark medially, near anterior margin, and small light brown spots; anterior margins of terga II-IX each with one white triangular mark, inside with spots. Sterna (Fig. 18B) covered with reddish spots; with one longitudinal line medially; two large brown marks medially and anterolaterally, medial mark formed by spots. Caudal filaments light brown, segments brown at base and apex.

Comments. The female imago of *C. stictogaster* ***revalidated species*** can be distinguished from *C.* (*C.*) *jocosus*, *C.* (*C.*) *zonalis*, *C.* (*C.*) *willineri*, *C.* (*C.*) *guttatus* and *C.* (*A.*) *dominguezi*, as well other species of the genus, by the following characteristics: forewing completely brown (Figs. 17F, 18C, 18D); marginal intercalary veins on hind wing present (Fig. 18E); abdominal terga and sterna covered with brown spots (Figs. 17B and 18A); anterior margin of terga II–IX with one white triangular mark, inside of it with brown spots (Fig. 18A); and abdominal sterna with two large brown marks on anterior margin, one medially and other anterolaterally (Fig. 18B).

Based on the re-evaluation of the morphological evidence, we propose the revalidation of *Callibaetis stictogaster* ***revalidated species*** and designate the female imago housed in MZLP as lectotype (Figs. 17A and 17B), the male imago housed in MZLP as paralectotype (Figs. 17C and 17D) and the female imago housed in MZB as paralectotype (Figs. 17E and 17F).

Females collected from Brazil possess egg–nymph development inside their abdomens, indicating a possible ovoviviparous mode of reproduction.

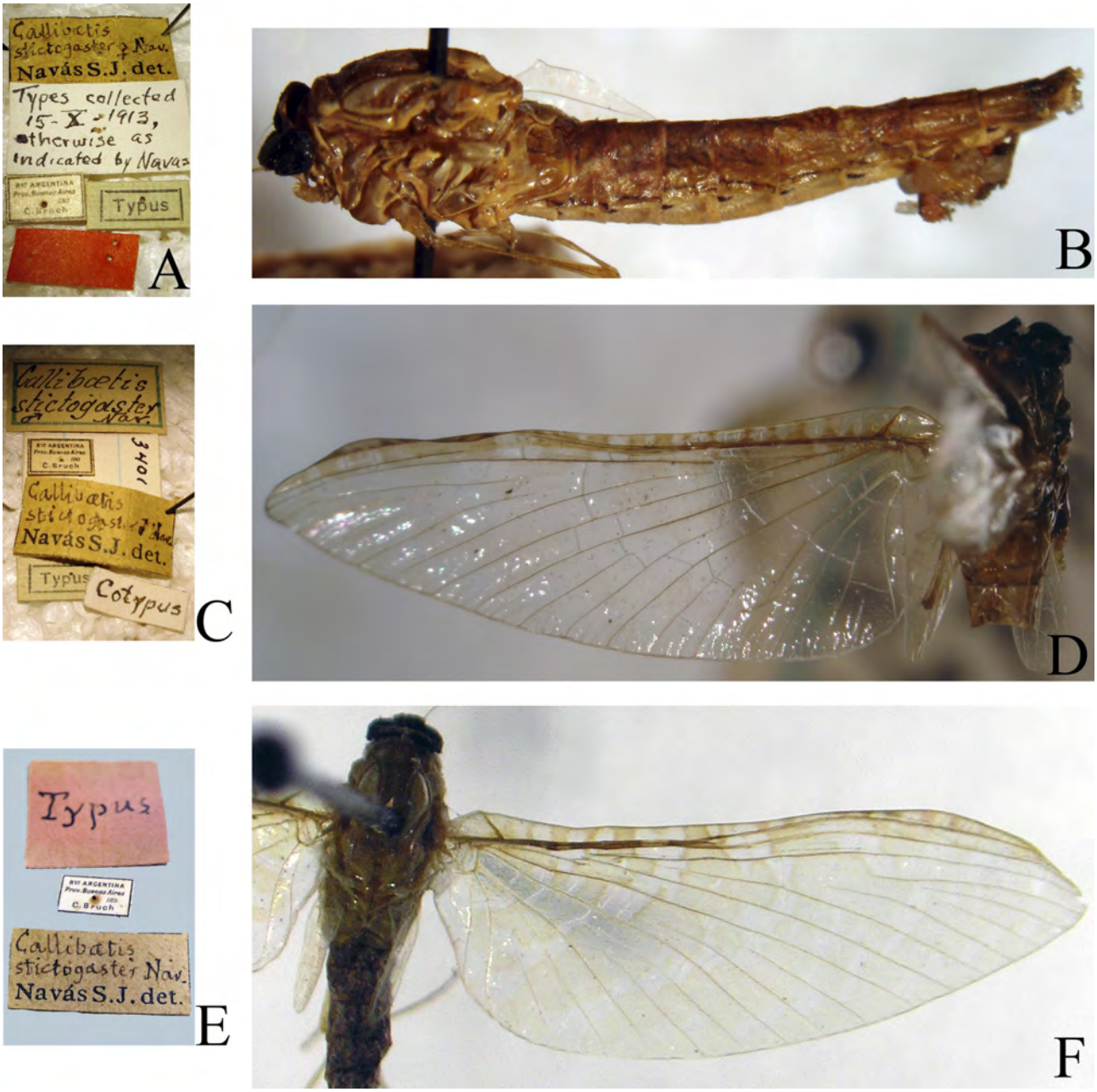

FIGURE 17. *Callibaetis stictogaster* ***revalidated species*** male and female imagoes (lectotypes). A. labels (MLP); B. dorsolateral view of female (MLP); C. labels (MLP); D. dorsal view of the forewing of the male imago (paralectotype) (MLP); E. labels (MZB); F. dorsal view of the forewing of the female imago (paralectotype) (MZB).

Material examined. *Callibaetis stictogaster*, one female (lectotype by present designation), ARGENTINA, Prov. de Buenos Aires, 15.x.1913, C. Bruch coll., MZLP. *Callibaetis stictogaster*, one male imago (paralectotype by present designation), ARGENTINA, Prov. de Buenos Aires, 15.x.1913, C. Bruch coll., MZLP. *Callibaetis stictogaster,* one female imago (paralectotype by present designation), ARGENTINA, Prov. de Buenos Aires, 15.x.1913, C. Bruch coll., MZB. Four female imagoes, BRAZIL, Rio Grande do Sul state, Bossoroca, Barra do

Angico, Piratini River, 112m alt., 28°032'06.2" S / 54°057'29.9" W, light trap, 20.x.2013-03.xi.2013, A. M. O. Pes coll., INPA.

Distribution. Argentina: Prov. Buenos Aires, Brazil: Rio Grande do Sul state.

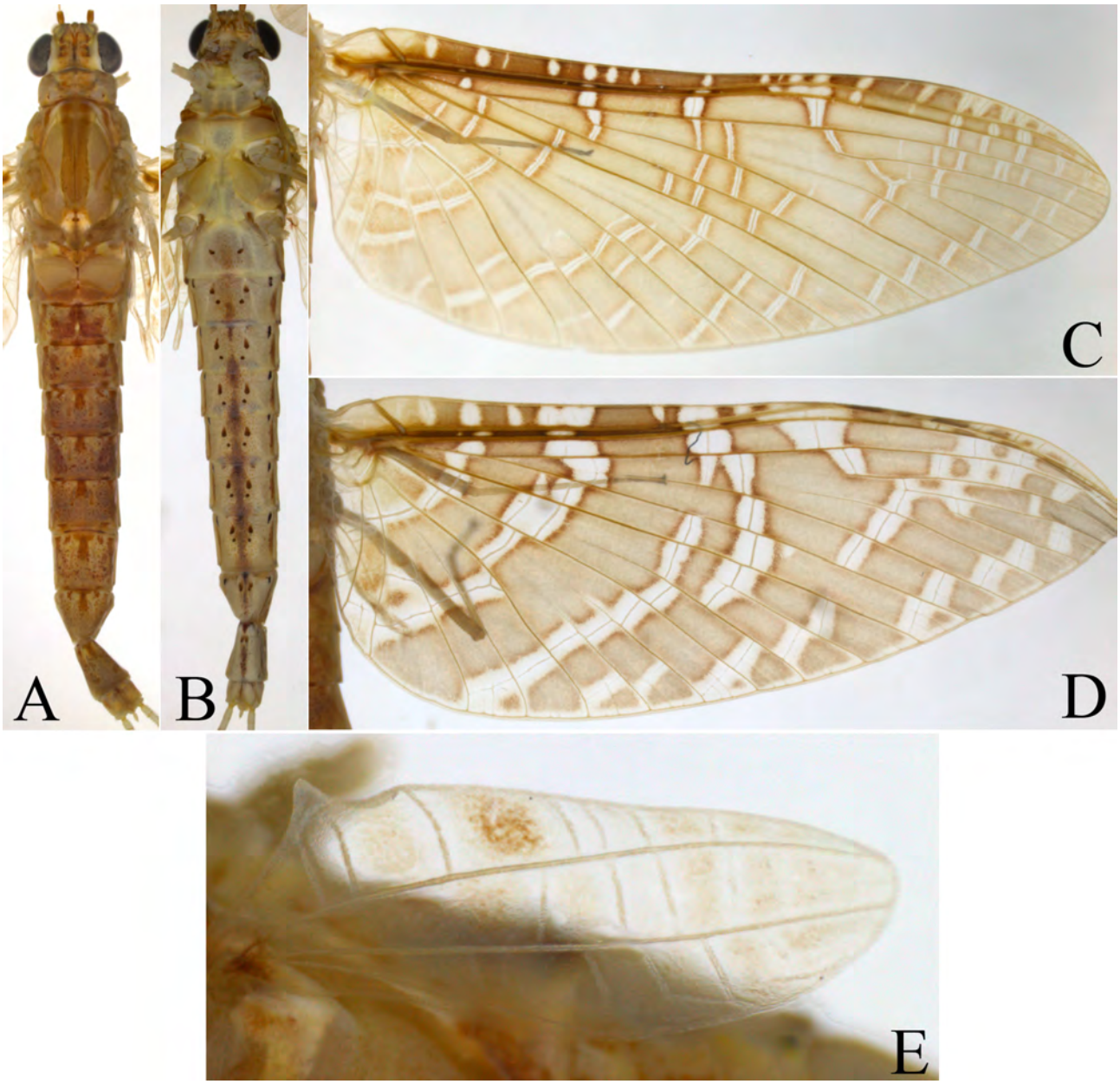

FIGURE 18. *Callibaetis stictogaster* ***revalidated species*** female imago. A. dorsal view; B. ventral view; C. forewing; D. forewing variation; E. hind wing.

Callibaetis viviparus Needham & Murphy 1924

(Figs. 19A–19C)

Callibaetis viviparus Needham and Murphy 1924: 50; Domínguez *et al.* 2006, p. 117; Cruz *et al.* 2014: 62; Vinasco-Mondragón & Zúñiga 2016: 93.

Known stages. I♀

Diagnosis. Female imago: 1) forewing with pigmented C, Sc and R_1 areas, extending beyond R_1 but not forming bands (Fig. 19C); 2) forewing with thick cross veins in C and Sc areas (Fig. 19C); 3) marginal intercalary veins single (Fig. 19C); 4) hind wing with one intercalary marginal vein (Fig. 19C); 5) hind wing with

quadrangular costal process; 6) body covered with brown spots (Fig. 19B); 7) anterolateral spots on abdominal terga and sterna present (Fig. 19B).

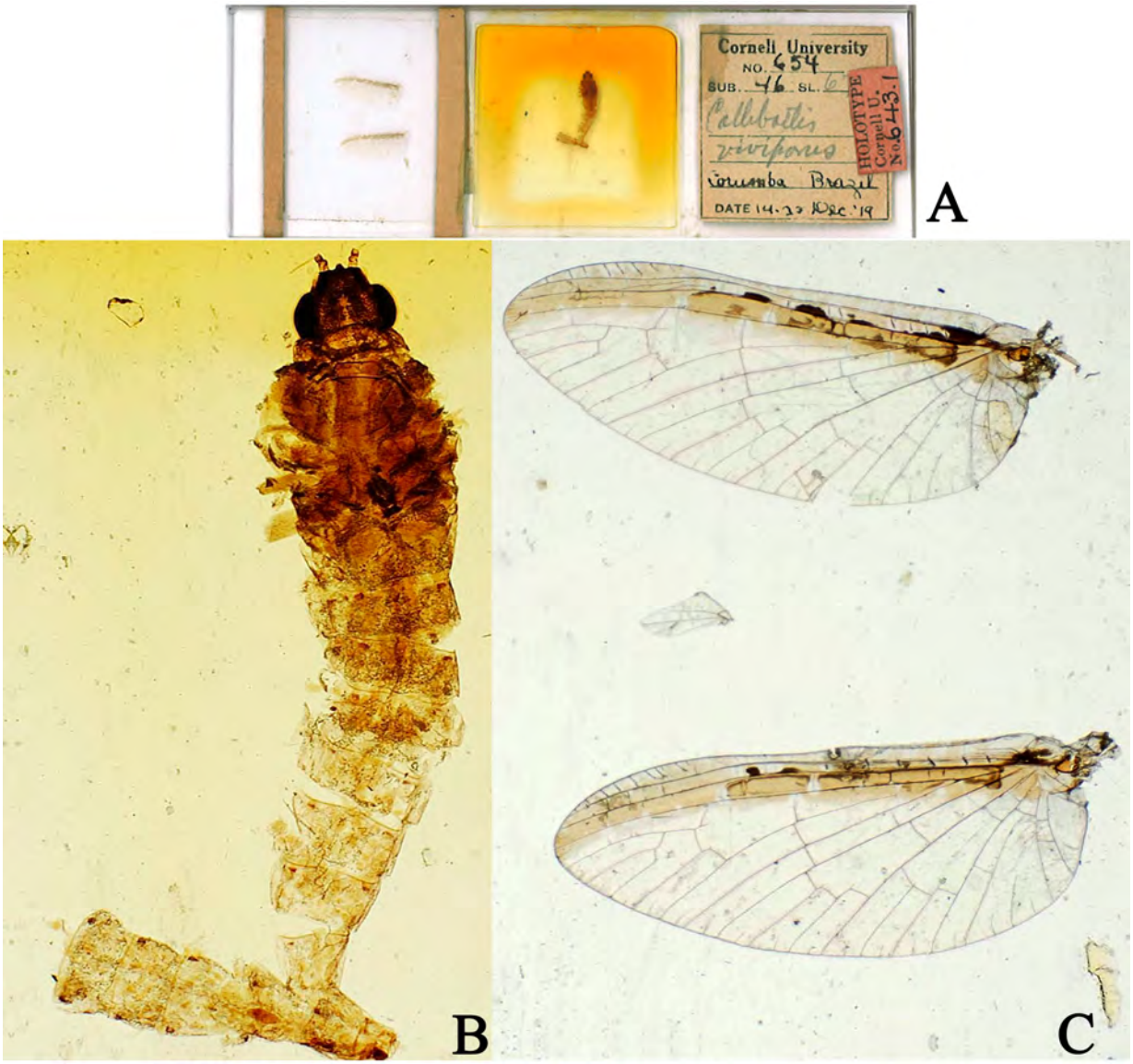

FIGURE 19. *Callibaetis viviparus* female imago (holotype). A. label; B. dorsal view of body; C. wings.

Complementary description. Female imago: Thorax. Covered with brownish spots. Wings. Forewing (Fig. 19C) pigmentation extending beyond R_1 but not forming bands; veins light brown; C, Sc and R_1 areas with thick cross veins; stigmatic area with 2–3 cross veins touching and 3–4 not touching subcostal vein; marginal intercalary veins single; length of each intercalary vein 0.41 × distance between adjacent longitudinal veins; length of forewing about 2.4 × width. Hind wing hyaline (Fig. 19C) and with 14 cross veins; one intercalary marginal vein present. **Abdomen.** Terga covered with brown spots, with spot anterolaterally (Fig. 19B). Sterna with spot anterolaterally (Fig. 19B). Caudal filaments lost.

Comments. Vinasco-Mondragón & Zúñiga (2016) recorded *C. viviparus* and *C.* (*C.*) *radiatus* in Colombia based on female imagoes. The morphological evidence to differentiate both species was the shape of the costal process of the hind wing (round in *C. viviparus* and truncante or quadrangular in *C.* (*C.*) *radiatus*). Studying the holotype of *C. viviparus* (mounted on a slide), we observed that one peak of the costal process is turned inward, appearing to be rounded. Thus, the morphological evidence presented by Vinasco-Mondragón & Zúñiga (2016) and Cruz *et al.* (2014) is not corroborated, not allowing the differentiation of both species. Taking into account the new evidence, association between stages should be made in order to confirm or refute the records from Colombia.

Material examined. *Callibaetis viviparus,* female imago (holotype, slide), Brazil, Mato Grosso state, Corumbá municipality, 14.xii.1919, Cornell University nº 643.

Distribution. Brazil: Mato Grosso do Sul.

Callibaetis (*Callibaetis*) *willineri* Navás 1933

(Figs. 20A–21I)

Callibaetis willineri Navás 1933: 115; Gillies 1990: 30; Domínguez *et al.* 2006: 117; Nieto 2008: 240; Cruz *et al.* 2014: 63.
Callibaetis alegre Traver 1944: 45. (syn. by Gillies 1990)

Known stages. I♀♂, N

Diagnosis. Male imago: 1) dorsal portion of turbinate eyes oval (Fig. 20H); 2) dorsal portion of turbinate eyes in lateral view without constriction; 3) dorsal portion of turbinate eyes stalk height 0.75 × height of dorsal portion; 4) turbinate portion of compound eyes (in lateral view) with anterior and posterior margins divergent; 5) forewing hyaline (Fig. 21G); 6) marginal intercalary veins paired (Fig. 21G); 7) hind wing hyaline (Fig. 21H); 8) costal process of hind wing rounded; 9) marginal intercalary veins on hind wing absent (Fig. 21H); 10) abdominal terga VII – X darker (Fig. 20H); 11) abdominal sterna covered with spots, all sterna with one medial mark on anterior margin (Fig. 20G); 12) abdominal sterna with pair of medioanterior and medioposterior sigilla weak pigmented (Fig. 20G); 13) forceps segment I wide at base (Fig. 21I); 14) forceps segment III oval (Fig. 21I).

Female imago: 1) forewing with C and Sc areas pigmented overpassing R_1, after R_2 pigmentation with large degree of intensity (Figs. 21A, 21C, 21E); 2) marginal intercalary veins paired (Figs. 21A, 21C, 21E); 3) hind wing usually with one brown mark near costal process (Figs. 21B, 21D); 4) costal process of hind wing rounded (Figs. 21B, 21D); 5) marginal intercalary veins on hind wing absent (Figs. 21B, 21D, 21F); 6) abdominal terga I –VIII with anterolateral spot, terga II – IX with medial longitudinal mark, terga III, V and VII laterally with inverted V mark (Figs. 20A, 20C, 20E); 7) abdominal sterna covered with spots, with one medial mark on anterior margin (Figs. 20B, 20D, 20F); 8) abdominal terga with medial longitudinal mark (Figs. 20B, 20D, 20F).

Mature nymph: 1) maxillary palp shorter than apex of galea-lacinia (Fig. 80 in Nieto 2008); 2) below maxillary palp insertion on outer margin without tuft of robust spine-like setae (Fig. 80 in Nieto 2008); 3) paraglossa with row of spine-like setae on ventral surface (Fig. 81 in Nieto 2008); 4) segment III of labial palp apically rounded (Fig. 81 in Nieto 2008); 5) metanotum without spines; 6) foretarsus anterior surface without spine-like setae (Fig. 82 in Nieto 2008); 7) hind claw denticles smaller than foreclaw denticles (Fig. 84 in Nieto 2008).

Comments. The nymphs of *C.* (*C.*) *willineri* and *C.* (*C.*) *zonalis* are similar, but they can be differentiated by the length of the maxillary palp, which is shorter than the galea-lacinia in *C.* (*C.*) *willineri* and longer in *C.* (*C.*) *zonalis*. Cruz *et al.* (2014) equivocally presented a female *C.* (*C.*) *willineri* labeled as *C.* (*C.*) *guttatus* (see more comments about similar species and its differentiation in *C.* (*C.*) *guttatus* and *C*. (*C.*) *jocosus*).

We present photographs of the female imago and male imago (Figs. 20A–20H).

The specimens studied by Navás (1915) from San Miguel, Buenos Aires, Argentina, were not found, thus a lectotype was not designated.

Material examined. One female imago, URUGUAY, San Gregorio, Ar. Orillo Rio Uruguay, 29.xi.1959, A. Mesa y San Martin, C. S. Carbonell coll., MZB; one nymph and one female imago, URUGUAY, Flores, Ruta 14, Km 235, Gruta del Palacio, 16.v.2009, E. Morelli and C. Molineri cols.; one female imago, ARGENTINA, La Plata city, light of living room, N. Hamada coll., INPA; two females and one male imago, BRAZIL, Rio Grande do Sul, Pelotas, 14.vi.2011, INPA; four female reared, BRAZIL, Santa Catarina, Iraní - Ponte Serrada (Lake next to Gas station), BR 282, 26º18'11.4" S/ 53º37'01.6" W, 649 m alt.,17.ix.2011, P.V. Cruz and N. Hamada cols., INPA; one female reared, BRAZIL, lake in Valcir Rodrigues farm, Derrubadas, 27º16'52.4" S/ 53º49'17.0" W, 29.ix.2011, 429m, P.V. Cruz and R. Boldrini cols., INPA; one male and female reared, BRAZIL, Rio Grande do Sul, Balneário das fontes, lake next to swimming pool, Derrubadas, 27º15'28.4" S/ 53º52'33.4" W, 29.ix.2011, 421 m. alt., P.V. Cruz and R. Boldrini cols., INPA; one female reared, BRAZIL, Paraná, PR 170,estrada de terra, Rondon farm, General Carneiro Pedra, 26º21'28.8" S/ 51º22'21.5" W, 04.x.2011, 1059 m. alt., P.V. Cruz and R. Boldrini cols., INPA.

Distribution. Argentina: Buenos Aires. Brazil: Paraná; Santa Catarina; Rio Grande do Sul. Uruguay: Flores.

FIGURE 20. *Callibaetis* (*Callibaetis*) *willineri* female imago variation and male imago. A. dorsal view of a female from Argentina; B. ventral view of a female from Argentina; C. dorsal view of a female from Brazil; D. ventral view of a female from Brazil; E. dorsal view of a female from Brazil; F. ventral view of a female from Brazil; G. dorsal view of a male from Brazil; H. ventral view of a male from Brazil.

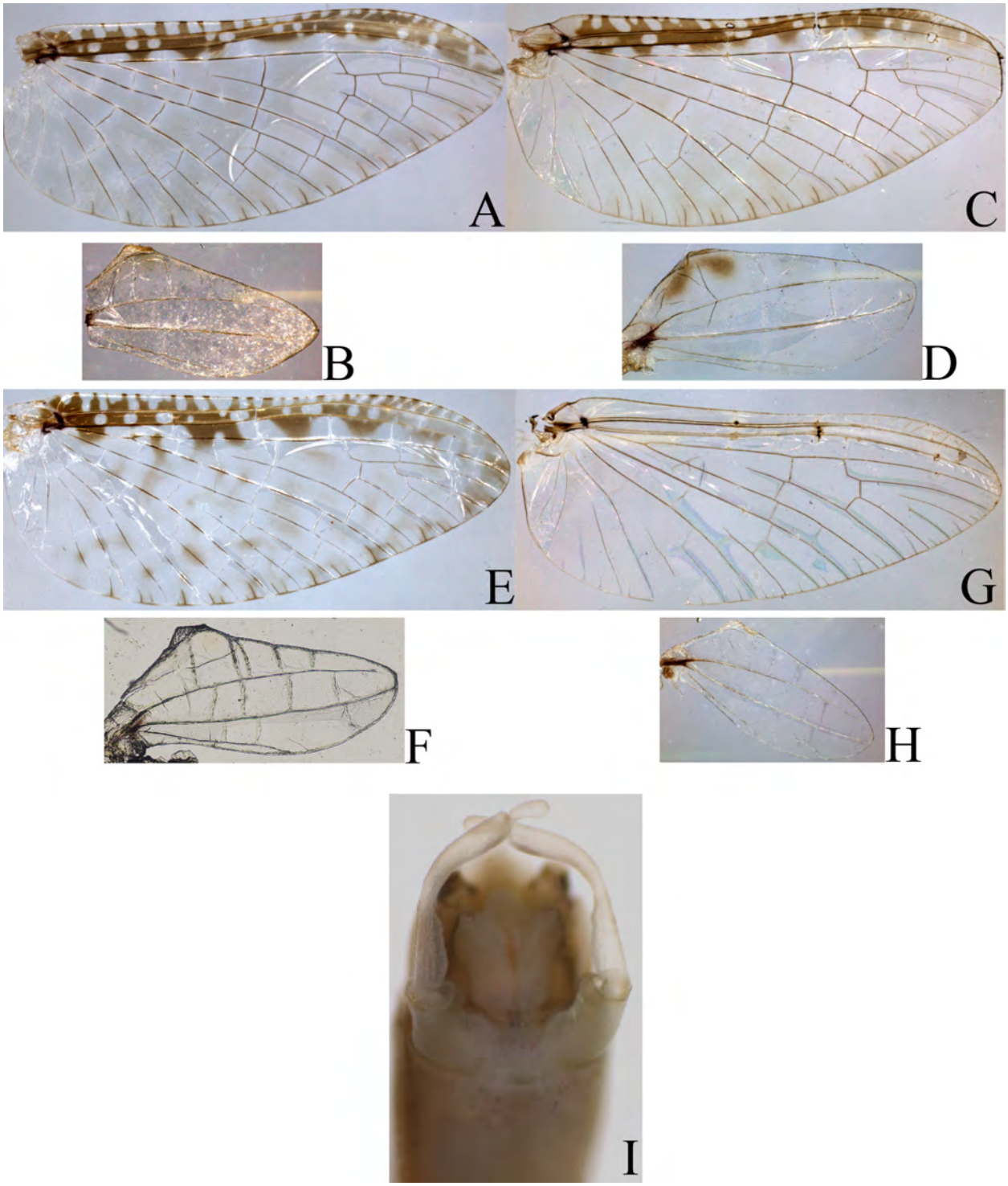

FIGURE 21. *Callibaetis* (*Callibaetis*) *willineri* variation of the wings and male genitalia. A. forewing of a female from Argentina; B. hind wing of a female from Argentina; C. forewing of a female from Brazil; D. hind wing of a female from Brazil; E. forewing of a female from Brazil; F. hind wing of a female from Brazil; G. forewing of a male from Brazil; H. hind wing of a male from Brazil; I. genitalia of a male from Brazil.

***Callibaetis* (*Callibaetis*) *zonalis* Navás 1915**

(Figs. 22A–22E)

Callibaetis zonalis Navás 1915a: 13; Gillies 1990: 31; Domínguez *et al.* 2006: 117; Cruz *et al.* 2014: 63.
Callibaetis vitreus Navás 1915b: 121 (syn. by Gillies 1990)

Callibaetis vitreus Navás, 1919: 81 (syn. with *C. vitreus* Navás 1915 by Hubbard & Edmunds 1977; note that this is a hom. syn.)
Baetis opacus Navás 1915a: 12. (syn. by Gillies 1990)
Callibaetis sobrius Navás 1916: 61. (syn. by Gillies 1990)
Baetis virellus Navás 1915b: 119. (syn. by Gillies 1990)
Callibaetis apertus Navás 1917: 190. (syn. by Gillies 1990)
Callibaetis depressus Navás 1922: 59. (syn. by Gillies 1990)
Callibaetis amoenus Navás 1930c: 131. (syn. by Gillies 1990)
Callibaetis fluminensis Cruz, Salles & Hamada 2009 **syn. nov.**

Known stages. I♀♂, N

Diagnosis. Male imago: 1) dorsal portion of turbinate eyes oval (Fig. 1 in Cruz *et al.* 2009); 2) dorsal portion of turbinate eyes in lateral view with constriction; 3) dorsal portion of turbinate eyes stalk height 2.6 × height of dorsal portion; 4) turbinate portion of compound eyes (in lateral view) with anterior and posterior margins divergent; 5) forewing with brownish stigmatic area and small brownish spots along costal vein (Fig. 3 in Cruz *et al.* 2009); 6) marginal intercalary veins paired (Fig. 3 in Cruz *et al.* 2009); 7) hind wing hyaline (Fig. 4A in Cruz *et al.* 2009); 8) costal process of hind wing rounded (Fig. 4B in Cruz *et al.* 2009); 9) marginal intercalary veins on hind wing absent (Fig. 4B in Cruz *et al.* 2009); 10) abdominal terga III, V and VII laterally with inverted V mark; 11) abdominal sterna covered with spots and with pair of medioanterior and medioposterior sigilla weak pigmented; 12) forceps segment I wide at base (Fig. 5 in Cruz *et al.* 2009); 13) forceps segment III oval (Fig. 5 in Cruz *et al.* 2009).

Female imago: 1) forewing with C and Sc areas pigmented overlapping R_1, after R_2 with lighter pigmentation (Fig. 7 in Cruz *et al.* 2009); 2) marginal intercalary veins paired (Fig. 7 in Cruz *et al.* 2009); 3) hind wing with brown mark near costar process (Fig. 8A in Cruz *et al.* 2009); 4) costal process of hind wing rounded (Fig. 8B in Cruz *et al.* 2009); 5) marginal intercalary veins on hind wing absent (Fig. 8B in Cruz *et al.* 2009); 6) abdominal terga III, V and VII laterally with inverted V mark (Fig. 6 in Cruz *et al.* 2009); 7) abdominal sterna covered by spots (Fig. 9 in Cruz *et al.* 2009); 8) abdominal terga with medial longitudinal mark (Figs. 22B–22D); 9) abdominal sterna medially, on anterior margin, without one large spot.

Mature nymph: 1) maxillary palp 1.3 × the length of galea-lacinia (Fig. 15 in Cruz *et al.* 2009); 2) below maxillary palp insertion on outer margin with tuft of robust spine-like setae (Fig. 15 in Cruz *et al.* 2009); 3) paraglossa with row of spine-like setae on ventral surface (Fig. 16A in Cruz *et al.* 2009); 4) segment III of labial apically rounded (Fig. 16A in Cruz *et al.* 2009); 5) metanotum without spines; 6) foretarsus anterior surface without spine-like setae (Fig. 17A in Cruz *et al.* 2009); 7) hind claw denticles smaller than foreclaw denticles (Fig. 18E in Cruz *et al.* 2009).

Comments. After analyzing the types, it is clear that the pigmentation pattern and morphology of *C.* (*C.*) *fluminensis* are identical to those of *C.* (*C.*) *zonalis*. Both species possess forewings with C and Sc areas pigmented overlapping R_1, after R_2 with lighter pigmentation (Fig. 7 in Cruz *et al.* 2009); marginal intercalary veins paired (Fig. 7 in Cruz *et al.* 2009); costal processes of hind wings rounded (Fig. 8B in Cruz *et al.* 2009); marginal intercalary veins on hind wings absent (Fig. 8B in Cruz *et al.* 2009); abdominal terga III, V and VII laterally with inverted V marks (Figs. 22C–22E and Fig. 6 in Cruz *et al.* 2009); abdominal sterna covered by spots (Figs. 22C–22E and Fig. 9 in Cruz *et al.* 2009); abdominal terga with medial longitudinal marks (Figs. 22B–22D); 9) abdominal sterna medially, on anterior margin, without one large spot. Thereby, *C.* (*C.*) *fluminensis* is considered a junior synonym of *C.* (*C.*) *zonalis*.

The specimen studied by Navás (1915) from La Plata, Argentina, is damaged, and we analyzed it only through photographs. Further studies are necessary to determinate if the specimen should be designated as lectotype or if a neotype should be designated.

Material examined. *Callibaetis apertus,* female subimago (type), ARGENTINA, Prov. Buenos Aires, 4.x.1915, C. Bruch coll., MZB; *Callibaetis vitreus*, male subimago (type) ARGENTINA, La Plata, 12.iv.1915, MZB; *Callibaetis depressus,* female subimago (type), ARGENTINA, Santiago del Esterno, 1920, MZB; *Callibaetis zonalis,* photograph of female imago (type), ARGENTINA, La Plata, iii.1913, C. Bruch coll., MZLP; one female imago, BRAZIL, São Paulo, i.1926, MZB; one female imago, ARGENTINA, Buenos Aires, 6.x.1915, C. Bruch coll., MZB; *Callibaetis fluminensis,* female imago (holotype), one nymph and one male imago (paratypes), BRAZIL, Rio de Janeiro state, Nova Friburgo Municipality, Lumiar, 22º23’ 27.2” S/42º 20’ 03.6” W, 3rd order tributary of the Rio Bonito, pool, v.2008, M.R. Souza coll., INPA.

FIGURE 22. *Callibaetis* (*Callibaetis*) *zonalis* female imago (MZB). A. label; B. dorsal view; C. detail of abdomen in dorsal view; D. detail of abdomen in dorsal view; E. detail of abdomen in lateral view.

Distribution. Argentina: Buenos Aires; La Plata; Santiago del Esterno. Brazil: São Paulo; Rio de Janeiro. Paraguay: Rio Paraguay. Uruguay: Maldonado.

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