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A remarkable new genus of Atalophlebiinae (Ephemeroptera: Leptophlebiidae) from the Neotropics

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Abstract

An unusual species of Leptophlebiidae is described based on males, females, and nymphs from Rio de Janeiro State, Brazil. As a consequence of its distinct characteristics on all stages, a new genus is established. The new genus can be distinguished from other South American Leptophlebiid genera mostly by: *Adults*: vein MA of fore wings asymmetrical; hind wings with costal projection well developed, Sc ending at cross vein near costal projection; tarsal claws dissimilar, one blunt other acute; projections of styliger plate forming two well developed lobes with rounded apex, ventrally obstructing view of the penes; penes fused on basal half, each lobe with a ventral furrow and a long and slender spine directed anteriorly. *Nymphs*: Head prognathous, wider than labrum; labrum with prominent median emargination, with three subtle crenulations; body flattened; hind wings pads present; tarsal claws with over 20 denticles, subapical denticle much larger than remaining denticles; gills long and narrow, present on abdominal segments I–VII; posterolateral projections present on abdominal segments VIII–IX. Phylogenetic analyses conducted based on a previously published data matrix that included other South America leptophlebiid genera placed *Poranga nessimiani* gen. nov. et sp. nov. as sister to *Bessierus* + *Perissophlebioides*. In most analyses this clade was recovered within the *Farrodes* complex. Nymphs of the new taxa are particularly similar to *Bessierus*, whereas adults share the very acute costal projection on hind wings seen in non-dipterous members of the *Farrodes* complex.

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Keywords: Atlantic rainforest; Brazil; *Poranga nessimiani*; Rio de Janeiro State

1. Introduction

The South American fauna of Ephemeroptera is marked by high generic and specific endemism, particularly regard-

ing the families Caenidae, Baetidae and Leptophlebiidae (Domínguez et al., 2006). The most dominant group, Leptophlebiidae, has its highest species diversity occurring in the Neotropics, with 35% of all species known in the family (Pescador, 1997; Barber-James et al., 2008).

Numerous recently collected specimens of Leptophlebiidae from the State of Rio de Janeiro, municipality Nova Friburgo, show distinguishing characteristics both as nymphs and adults. As a consequence, a new genus is established to

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include this undescribed species. Comments on its biology and phylogenetic placement are also provided.

1.1. *Poranga* gen. nov. Gonçalves & Da-Silva

Male imago (Figs. 1–13): Length: body 4.0–5.0 mm; fore wings 4.8–5.3 mm; hind wings 0.8–1.0 mm. Cerci over 4.0 mm and terminal filament about 7.0 mm (both broken off or missing in most specimens).

Head (Fig. 13): Male eyes; dorsal portion large, turbinate, contiguous on vertex.

Wings (Figs. 1 and 2): Fore wings usually with 3, though varying from 2 to 5, faint cross veins basal and 7–11 distal to bullae; third cross vein usually near bullae; fork of vein MA asymmetrical, fork of vein MP symmetrical; two intercalaries between CuA and CuP free at base. Costal projection of hind wings very acute, well developed; Sc ending at cross vein near end of projection.

Legs (Fig. 6): Male fore leg with five tarsal segments. Tarsal claws dissimilar, one blunt other acute.

Genitalia (Figs. 3–5): Each forceps inserted into a different socket; forceps three-segmented; first segment long; second and third segments short, similar in length. Posterior margin of styliger plate strongly projected, forming two lobes that ventrally obstruct the view of penes. In lateral view, lobes of styliger plate projected ventrally at apex. Penes fused on basal

half, each lobe with a ventral furrow and a long and slender spine directed anteriorly. Apical third of penes constricted, near insertion of the spines.

Variations: Fore wing cross veins of certain imagos, or even from one wing to another on the same individual, very faint and difficult to observe, at times appearing to be absent.

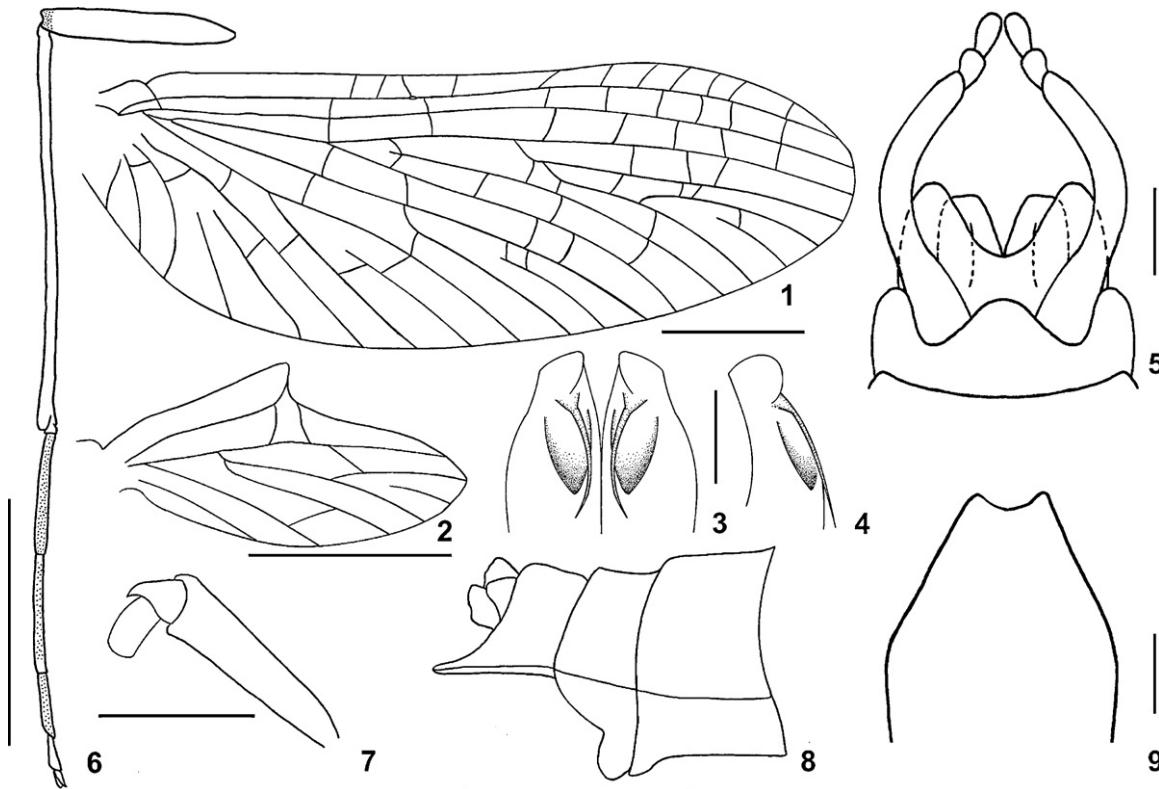
Female imago (Figs. 8 and 9): Length: body 3.1–3.7 mm; fore wings 4.4–5.0 mm; hind wings 0.7–0.8 mm. Caudal filaments missing.

Females similar to male. Sternum IX slightly clefted (Fig. 9).

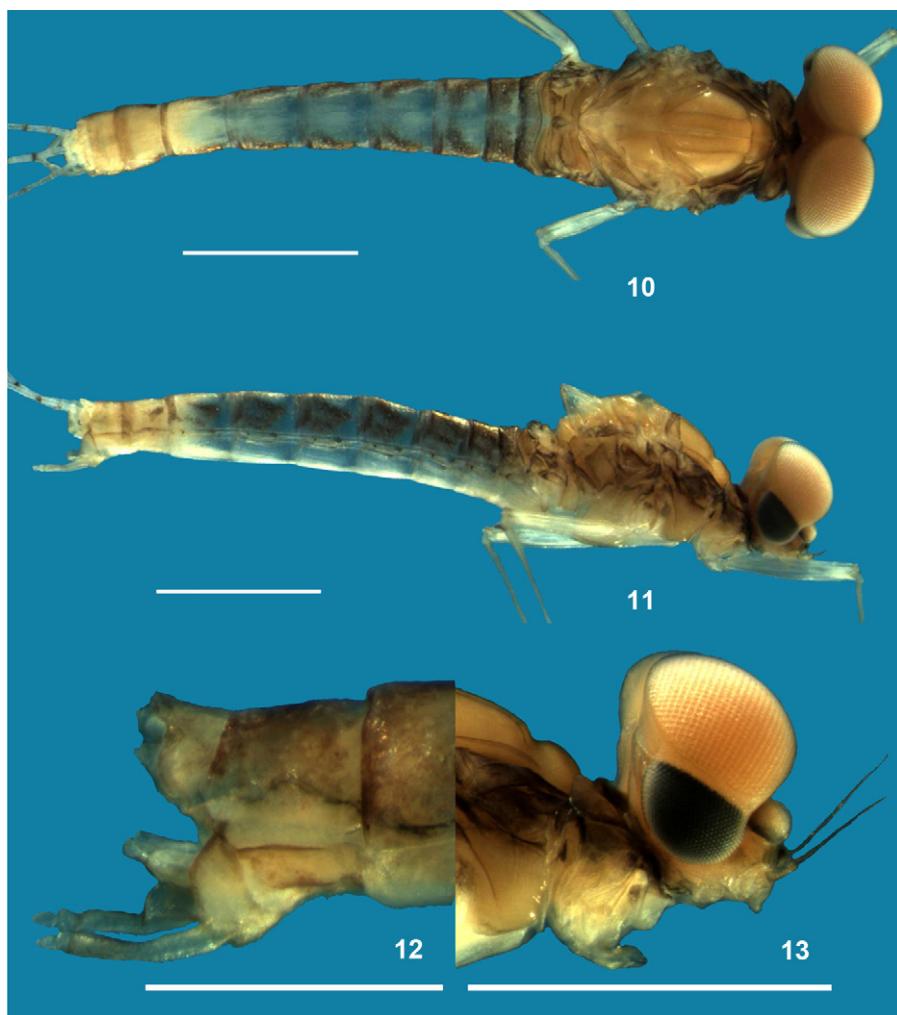
Variations: A structure similar to an ovipositor was found on female imagos (Fig. 8), but absent in female subimagos. As all females collected had already laid eggs and oviposition could not be observed, it is difficult to assure if such structure is, in fact, an ovipositor.

Mature nymph (Figs. 14–31): Length: 3.3–4.5 mm body. Caudal filaments over 5.0 mm (broken off). Body flattened.

Head (Figs. 14–24): Head prognathous. Antennae/head ratio 1.8. Labrum somewhat wider than clypeus; with two rows of submarginal simple setae, distal row with short setae and basal row with long setae. Labrum with rounded margins and bordered by short simple setae except on anterolateral margin; several setae scattered on dorsal surface; labrum strongly emarginated medially with margins rounded; possessing three subtle crenulations. Outer margin of mandibles angled with shallow depression on apical third. Inner mar-



Figs. 1–9. *Poranga nessimiani* gen. nov. et sp. nov. Male imago: 1 – forewing; 2 – hind wing; 3 – penes detail, ventral view; 4 – penes detail, lateral view; 5 – genitalia, ventral view; 6 – foreleg; 7 – tarsal claw. Female imago: 8 – abdomen, lateral view; 9 – sternum IX, ventral view (scale: Figs. 1 and 6: 1.0 mm; Figs. 2, 7 and 8: 0.5 mm; Figs. 3–5 and 9: 0.1 mm).



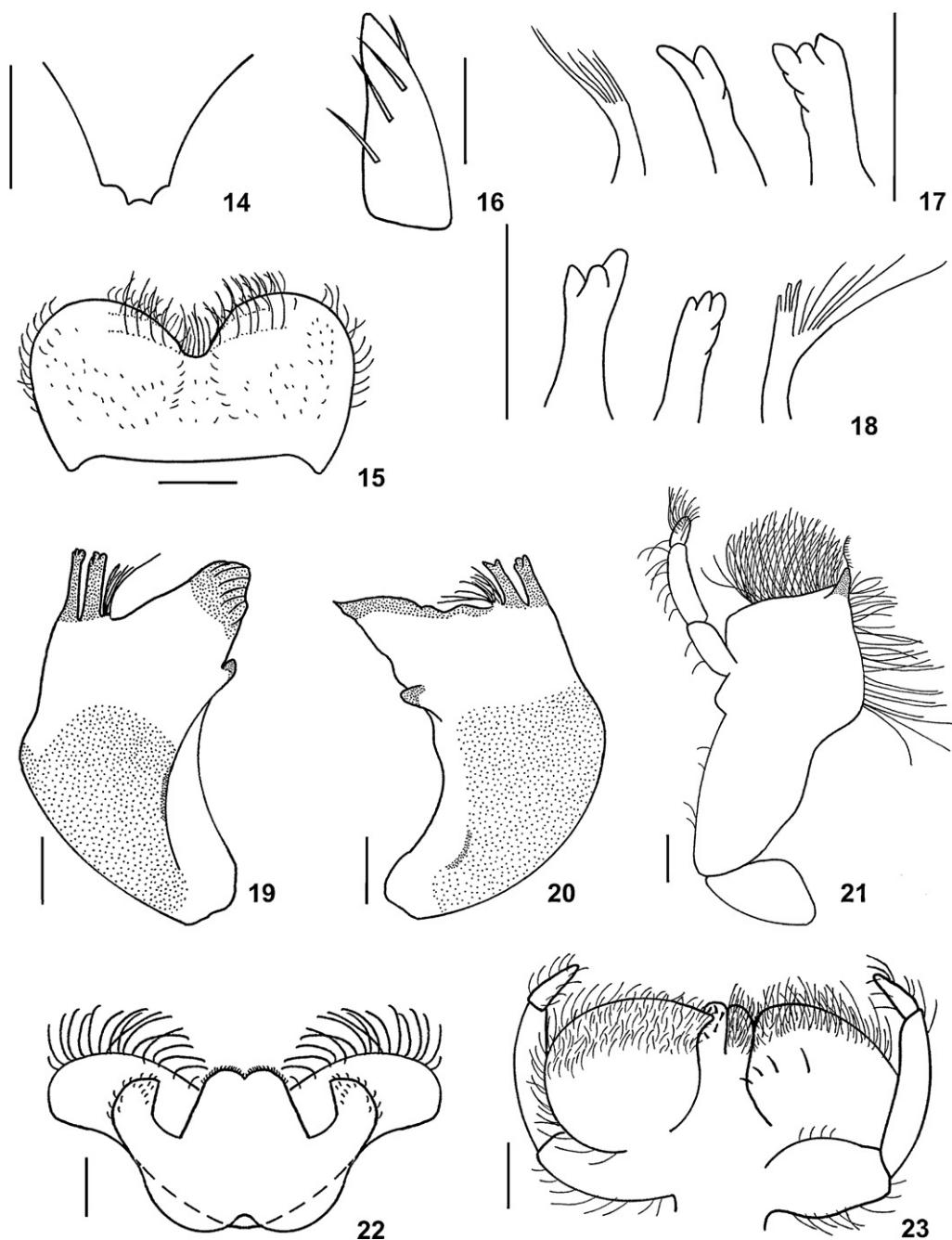
Figs. 10–13. *Poranga nessimiani* gen. nov. et sp. nov. Male imago: 10 – dorsal view; 11 – lateral view; 12 – genitalia, lateral view; 13 – head, lateral view (scale: 1.0 mm except Fig. 8: 0.5 mm).

gin of right mandible with row of long simple setae below molars; prostheca formed by thin setae; three apical denticles on outer incisors and two on inner incisors. Left mandible with three apical denticles on both incisors, inner margin of outer incisors crenulated; prostheca formed by thick setae on inner region and thin setae on outer region. Apical margin of maxillae with dense row of long setae with one distinct pectinated seta lateroapically; an apical anteromedially directed denticle on apex of inner margin; inner margin of maxillae with row of long simple setae on apical half; first segment of maxillary palpi bearing few long simple setae on outer margin; second segment with few long simple setae on both margins; third segment densely covered by long simple setae. Hypopharynx with subtle median cleft on lingua possessing short simple setae; lateral projections short and wide, with short simple setae on apex; inner margin of superlingua with row of simple long setae. Labium ventrally with glossa covered by long simple setae, as well as, wide marginal band on apex of paraglossa; lateral margins of paraglossa with fewer setae; paraglossa with median row of few long simple setae.

First segment of labial palpi with simple setae on inner and outer margins, setae longer on outer margin; second segment with few long simple setae on outer margin; third segment with few simple setae on both margins and few strong setae oblique to segment. Labium dorsally possessing strong setae on glossa; paraglossa equally covered by simple setae except for marginal band on apex, with denser row of setae.

Thorax: Hind wing pads present.

Legs (Figs. 27 and 29–31): Fore legs: Coxae with three long stout bristles on dorsal surface; outer margin of femora with scattered clavate and simple setae on distal 2/3 and spine-like setae on basal 1/3; inner margin bearing very short spine-like setae; some stout bristles scattered on row submarginal to inner margin; dorsal surface of femora with long stout bristles scattered on apical half. Inner margin of tibia with row of spine-like setae more densely focused apically; outer margin with very few simple setae; tarsi with very few simple setae and some scattered spine-like setae on inner margin; tarsal claws with over 20 denticles, increasing in size toward apex, subapical denticle bigger and wider than subsequent denti-

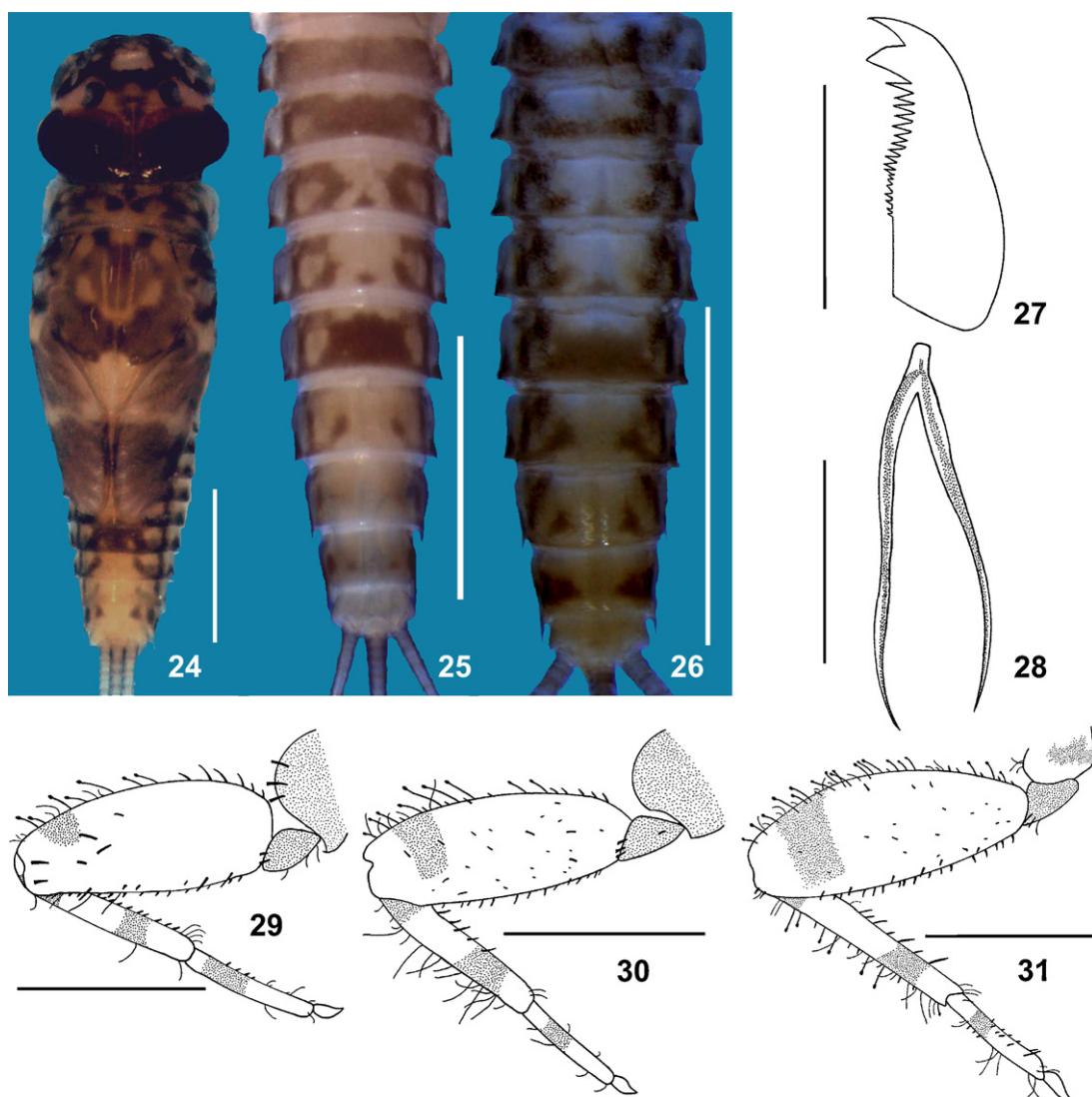


Figs. 14–23. *Poranga nessimiani* gen. nov. et sp. nov. Mature nymph: 14 – detail of the anterior margin of labrum, dorsal view; 15 – labrum, dorsal view; 16 – segment III of labial palpi; 17 – right mandible detail; 18 – left mandible detail; 19 – left maxilla, dorsal view; 20 – right maxilla, dorsal view; 21 – maxillae, dorsal view; 22 – hypopharynx, dorsal view; 23 – labium, left: dorsal view and right: ventral view (scale: 0.1 mm except Figs. 14 and 16: 0.05 mm).

cles. Mid legs: Outer margin of femora with small spine-like setae and clavate setae scattered throughout margin and simple setae present on apical half; inner margin with row of spine-like setae; dorsal surface of femora with short and long stout bristles; outer margin of tibia with simple setae and inner margin with spine-like setae; tarsi with simple setae. Hind legs: Outer margin of femora with several clavate setae and fewer spine-like and simple setae; inner margin with row of strong spine-like setae; dorsal surface with scattered short

stout bristles, longer stout bristles near inner margin; inner margin of tibia bordered by strong spine-like setae more densely focused apically; outer margin with very few simple setae and several clavate setae; tarsi with simple setae, inner margin with spine-like setae.

Abdomen (Figs. 24–26 and 28): Posterolateral spines present on segments VIII and IX. Gills present on segments I–VII; gills long and narrow, ventral and dorsal lamellae similar in size, trachea of gills not branched.



Figs. 24–31. *Poranga nessimiani* gen. nov. et sp. nov. Mature nymph: 24 – overall aspect; 25 and 26 – abdominal color patterns variations; 27 – tarsal claw; 27 – gill; 28 – foreleg; 30 – mid leg; 31 – hind leg (scale: Figs. 24–26: 1.0 mm; Fig. 27: 0.1 mm; Figs. 28–31: 0.5 mm).

1.2. Diagnosis

Imago: (1) Male eyes turbinate and contiguous on vertex (Figs. 10 and 13); (2) vein MA of fore wings asymmetrical (Fig. 1); (3) hind wings present; (4) costal projection of hind wings well developed with Sc ending at cross vein near costal projection (Fig. 2); (5) tarsal claws dissimilar, one blunt other acute (Fig. 7); (6) styliger plate projections forming two well developed lobes with rounded apex ventrally obstructing view of the penes (Fig. 5); (7) apex of lobes of styliger plate projected ventrally, in lateral view (Fig. 12); (8) penes fused on basal half, each lobe with a ventral furrow and a long and slender spine directed anteriorly (Figs. 3 and 4); (9) apical third of penes constricted, near insertion of the spines (Figs. 3, 4 and 12); (10) forceps sockets separated (Fig. 5).

Nymph: (1) Head prognathous (Fig. 24); (2) head wider than labrum; (3) labrum with prominent median emargination, possessing three subtle crenulations (Figs. 14 and 15);

(4) body flattened (Fig. 24); (5) hind wings pads present; (6) tarsal claws with over 20 denticles, subapical denticle much larger than remaining denticles (Fig. 27); (7) gills present on abdominal segments I–VII, long and narrow (Fig. 28); (8) posterolateral projections present on abdominal segments VIII–IX (Figs. 25 and 26).

Etymology: “*Poranga*” a tupi-guarani word meaning “beautiful”.

2. *Poranga nessimiani* sp. nov. Gonçalves & Da-Silva

Male imago (Figs. 1–13): General coloration light brown, abdomen translucent white with reddish dark brown markings. Wings hyaline.

Head (Fig. 13): Area between eyes and ocelli light brown. Anterior margin of head whitish. Ocelli whitish brown, sur-

rounded by blackish brown ring. Upper portion of turbinated eyes orange. Base of antennae and scape whitish; pedicel light brown; flagella washed with brown on basal half and whitish on distal half.

Thorax (Figs. 10 and 11): Margins of pronotum dark brown; pronotum light brown with elevated median dark brown line; pronotum washed by dark brown. Mesonotum light brown; posterior area whitish. Metanotum light brown shaded by dark brown. Sterna whitish; mesosternum yellowish light brown laterally.

Wings: Membrane hyaline; veins whitish; apex of wing membrane between Sc and R1 whitish; base of C, Sc and R1 light brown; anal margin of fore wings dark brown.

Legs (Fig. 6): General coloration whitish. Femora of all legs possessing an apical light brown mark. Tarsal segments II–IV of fore legs faintly washed with dark brown. Femora of hind legs shaded with dark brown.

Abdomen (Figs. 10 and 11): General coloration translucent white; posterior margin of terga light brown. First tergum shaded by reddish dark brown; second tergum almost completely shaded by reddish dark brown except at anterior margin; terga III–VII with a pair of lateral and sub-lateral stripes, curved inwards, stripes reddish dark brown; tergum VIII with only one pair of sub-lateral stripes; terga III–VI translucent whitish; terga VII–IX yellowish light brown; tergum X whitish. Sterna translucent white; sterna VII–IX yellowish light brown, sometimes suffused with white.

Genitalia: Forceps and penes yellowish light brown. Caudal filaments whitish, basally with dark brown annulations.

Variations: Certain specimens showed metasternum white and wider white markings on abdominal sterna, sometimes extending to terga. Apart from apical light brown markings on femora, coloration was very faint and some individuals did not present the described color pattern, with whitish legs. In some individuals, abdominal stripes were found to be dark brown, without reddish pigmentation.

Female imago: Similar to male.

Mature nymph (Figs. 14–31): General coloration light or yellowish brown with several brown markings.

Head (Figs. 14–24): Head brown. Ocelli black; area between eyes and lateral ocelli yellowish brown. Area in front of median ocelli light brown; a pair of yellowish brown spots on at each side of this area. Eyes black; turbinated portion dark reddish brown. Base of antennae brown; scape and pedicel faint brown; flagellum yellowish brown. Labrum brown, setae whitish. Basal 2/3 of mandibles brown, apical 1/3 whitish; incisors and molars light brown; notch basal to molars and a small region of inner margin dark brown. Maxilla whitish with whitish setae, setae on apical margin of maxilla brown. Hypopharynx whitish with light brown setae. Labium whitish with whitish setae.

Thorax (Fig. 24): Pronotum and mesonotum light brown washed with brown. Wings pads brown, with transversal median line yellowish brown. Metanotum and sterna yellowish brown.

Legs (Figs. 29–31): Legs whitish yellow trochanters and coxae shaded with brown. Femora with a subapical brown marking. Tibia with a subapical and a sub-basal brown band. Tarsi with a sub-basal brown band.

Abdomen (Figs. 25 and 26): Terga I–VIII yellowish brown shaded with brown; terga shaded in such way to form one pair of lateral yellowish brown marks on terga III–VIII and rarely on tergum IX. Color pattern variable, usually with terga I–III almost completely shaded with brown; terga IV–V less shaded, occasionally forming a median yellowish brown “X” shaped marking; tergum VI always strongly suffused with brown, possessing a dark brown median maculae. Sterna yellowish brown. Gills whitish gray with trachea purplish. Caudal filaments whitish yellow with brown annulations at joints; joints with row of setae.

Variations (Figs. 25 and 26): Some individuals showed different grades of shading within abdominal terga color pattern. Sometimes, shading on terga I–III was such that yellowish markings were not apparent. In addition, brown markings on terga VII–VIII were occasionally fainted, but not enough to form the lateral yellowish marks. Regardless of the variations described, tergum VI was always strongly suffused with brown.

2.1. Diagnosis

Imago: (1) Turbinated portion of male's eyes orange (Fig. 13); (2) abdominal color pattern as in Figs. 10 and 11; (3) genitalia as in Figs. 3–5.

Nymph: (1) Legs color pattern as in Figs. 29–31; (2) body general coloration as in Fig. 24; (3) abdominal color pattern variable, as in Figs. 25 and 26.

As specific diagnostic characters are difficult to establish on monotypic genera, the diagnosis of the species herein described will only be properly defined after the description of new species of the genus.

Etymology: Named in honor of J.L. Nessimian, a great entomologist and friend, who first taught us about aquatic insects and their environment.

Type-material: Holotype: Brazil, RJ, Nova Friburgo, Rio Bonito de Lumiar, Rio Bonito, 803 m, 22°13'47.6"S 42°08'04.7"W, 30.X.2009, Gonçalves, I.C. leg. 1 male imago (DZRJ1597). Paratypes: Brasil, RJ, Nova Friburgo: same data as holotype, 9 imagos and 2 nymphs (DZRJ1598, DZRJ1600, DZRJ1602); same data as holotype except Cardoso-Costa, G. leg. 2 nymphs (DZRJ1604); same data as holotype except 31.X.2009, 21 nymphs (DZRJ1601, DZRJ1603, DZRJ1605); same data as holotype except 03.IV.2009, 4 imagos (DZRJ1599); Rio Bonito de Lumiar, Afluente do Rio Bonito, 792 m, 22°24'27.7"S 42°25'05.1"W, 29.X.2009, 2 imagos and 2 nymphs (DZRJ1606, DZRJ1607, DZRJ1608); Estrada Galdinópolis-Lumiar, Rio Bonito, 786 m, 22°24'46.5"S 42°24'13.3"W, 07.III.2009, Gonçalves, I.C. leg. 14 nymphs (DZRJ1609); same data except Alecrim, V.P. leg. 1 nymph (DZRJ1610); Lumiar, Toca da Onça, Rio Bonito, 608 m,

22°24'05.6"S 42°19'17.8"W, 05.III.2009, Gonçalves, I.C. leg. 12 imagos (DZR1611J); Rio Bonito de Lumiar, Ramalhete, Rio Bonito, 656 m, 22°24'38.5"S 42°20'40.7"W, 06.III.2009, Gonçalves, I.C. leg. 16 imagos and 1 nymph (DZRJ1612 and DZRJ1613); Lumiar, Encontro dos Rios, Rio Macaé, 515 m, 22°23'37.1"S 42°18'20.6"W, 08.III.2009, Gonçalves, I.C. leg. 1 male imago (DZRJ1614); Macaé de Cima, Rio Macaé, 935 m, 22°24'46"S 42°31'16.2"W, 12.IX.2008, Alecrim, V.P. leg. 32 imagos (DZRJ1615, DZRJ1618, DZRJ1619, DZRJ1620); same data except 11.IX.2008, 1 nymph (DZRJ1622); same data except 13.IX.2008, 15 imagos (DZRJ1624); same data except 14.IX.2008, 10 imagos (DZRJ1617 and DZRJ1621); same data except 30.XI.2008, Santos, A.P.M. & Sampaio, B.H. leg. 1 subimago (DZRJ1623); same data except 01.XII.2009, Gonçalves, I.C. leg. 3 imagos (DZRJ1616); Macaé de Cima, Rio Macaé, 977 m, 22°25'30.6"S 42°32'00.7"W, 13.IX.2008, 1 imago (DZRJ1625).

Biology: Nymphs were found mainly on gravel areas of streams and under rocks and pebbles, always in moderate or fast current. Adults were collected at light traps.

Life cycle associations: Two male nymphs were reared to adult stage. Females were collected from the same swarms at light traps, and were associated to males by color pattern and wing venation.

3. Discussion

A recent phylogeny by Domínguez (2009) regarding two-winged genera of Atalophlebiinae from South America has found two independent losses of the hind wings: in *Hagenulopsis*–*Askola* lineage and *Perissophlebioides*–*Bessierus* lineage. This phylogeny also recovered the *Hermanella* and *Farrodes* complexes as sister-groups (respectively, clades T and P from Domínguez, 2009). A reanalysis of Domínguez' (2009) data matrix (subset polymorphisms treated as full polymorphisms) using PAUP* (Swofford, 2001) emulating PeeWee (pset goloboff=yes gpeewee=yes) recovered 12 most parsimonious trees ($L=188$, $CI=0.48$, $RI=0.81$, $RC=0.39$), of which the strict consensus was very similar to the single tree found by the author. Differences lied in three polytomies recovered: clades C, M, and R of Domínguez (2009). A new data matrix was constructed by coding morphological characters of *Poranga* and the previously unknown male imago of *Perissophlebioides* (Nascimento et al., in press) into Domínguez' (2009) data matrix. This new data matrix is available upon request to the senior author. Analysis of the new data matrix using implied weighting ($k=2$, 6 most parsimonious trees, $L=192$, $CI=0.47$, $RI=0.80$, $RC=0.38$) (Goloboff, 1993) and equal weights (48 most parsimonious trees, $L=192$, $CI=0.47$, $RI=0.80$, $RC=0.38$) were conducted. *Poranga* was always recovered as sister to *Bessierus* + *Perissophlebioides* with 65% non-parametric bootstrap support, Bremer support of 1 (equal weights), and

relative Bremer support of 53 (implied weighting). Absolute and relative Bremer supports were calculated using TNT (Goloboff et al., 2008). Unambiguous synapomorphies shared by these three genera are median hood in labrum cleft and absence of setae on inner margin of maxillary palp II (characters 5 and 18 of Domínguez, 2009), resulting in *Bessierus* + *Perissophlebioides* being now supported only by the medioapical denticle on tarsal claw larger than remaining denticles. In 36 of the equal weights and all most parsimonious trees of the implied weights analyses the clade *Poranga* + (*Bessierus* + *Perissophlebioides*) was recovered within the *Farrodes* complex with 43% bootstrap support (equal weights), forming a sister clade to *Homothraulus* + *Simothraulopsis* (supported by having the lateral margins of labrum rounded, with widest part on apical 2/3). However, in the remainder 12 most parsimonious trees of the equal weights analysis, the clade *Poranga* + (*Bessierus* + *Perissophlebioides*) was recovered as sister to the *Hermanella* complex with 29% bootstrap support and no unambiguous synapomorphy.

Male imagos of *P. nessimiani* gen. nov. et sp. nov. are similar to those of the *Hermanella* complex due to the projected posterior margin of the styliger plate and penes with spines directed anteriorly. This resemblance occurs particularly with *Traverella* since both genera have two projections on the styliger plate with rounded apex and base much wider than seen in others genera of the *Hermanella* complex. Nevertheless, *P. nessimiani* gen. nov. et sp. nov. differs from the species of this complex and other Leptophlebiidae by possessing styliger plate projections so developed (wide and long) that obstruct the ventral view of the penes. On the other hand, the very acute costal projection of hind wings is a trait shared with the non-dipterous adults of the *Farrodes* complex and was found to support the complex monophyly by Domínguez (2009) as well as in the present analysis. Regarding the nymphs, *P. nessimiani* gen. nov. et sp. nov. is similar to *Bessierus* in having lateral margins of labrum rounded, widest on apical 2/3, setae on inner margin of maxillary palp II absent, posterolateral projections on abdomen present on segments VIII–IX, and particularly because of the deep emargination on the labrum.

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