

First species of *Inbiomyia* from the Atlantic Forest of Brazil (Diptera: Inbiomyiidae)

PAULA RAILE RICCARDI¹ AND DALTON DE SOUZA AMORIM²

ABSTRACT

We describe and illustrate *Inbiomyia azevedoi*, sp. nov., the first species of Inbiomyiidae known from the Atlantic Forest in southeastern Brazil. SEM photos show that the bifurcated labella have on their ventral face rows of scalelike rasping teeth that may be used to graze on green algae, as the gut content of some specimens suggest. A reanalysis of the phylogeny of the genus using *Australimyza mcalpineorum* as designated outgroup and including *I. azevedoi* shows that all four groups of species previously proposed for the genus are monophyletic if *I. anodonta* is removed from the *scoliostylus* group. *Inbiomyia anodonta* and *I. azevedoi* are here transferred to the *anemosyris* group. In our results with implied weight, *I. exul* is sister to a clade including all other species of the genus, while the *scoliostylus* group appears as sister to the clade (*mcalpineorum* group + *anemosyris* group).

INTRODUCTION

The monogeneric Neotropical acalyptrate family Inbiomyiidae was first described by Buck (2006) based on *Inbiomyia mcalpineorum* Buck from Costa Rica. The family was placed in the superfamily Carnoidea as sister to Australimyziidae by Buck (2006) based on a phylogenetic study of the relationships between carnoid families. Australimyziidae occur in Australia, New Zealand, and their nearby islands (Brake and Mathis, 2007), while Inbiomyiidae is Neotropical.

¹ Departamento de Entomologia, Museu Nacional do Rio de Janeiro, Universidade Federal do Rio de Janeiro, Brazil.

² Departamento de Biologia, Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto, Universidade de São Paulo, Brazil.

Inbiomyiidae is peculiar in having the posterior notopleural setae in a dorsal position, protruding eyes, head only with inner and outer vertical setae, one pair of inclinate fronto-orbitals, a typically very long arista, a strong subapical seta on the maxillary palpus, and both males and females without cerci (Buck, 2006).

Buck and Marshall (2006) later described 10 additional species, which extended the distribution of the family in the Neotropics with records for Colombia, Venezuela, Ecuador, Peru, Bolivia, and French Guiana. Buck and Marshall (2006) performed a cladistic analysis of the genus using morphological data. Their result show two major sister clades, in which they recognized four species groups—*exul*, *scoliostylus*, *mcalpineorum*, and *anemosyris*.

We here describe a new species of *Inbiomyia* from the Atlantic Forest based on males and females collected in southeastern Brazil. In our description, we include SEM images, illustrations, and a discussion of the phylogenetic relationships within the genus.

MATERIAL AND METHODS

Most of the material examined was collected along the Biota FAPERJ project. The holotype is deposited at the Museu Nacional do Rio de Janeiro, Rio de Janeiro, Brazil (MNRJ), while paratypes are deposited at the MNRJ, the Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (MZUSP), the Instituto Nacional de Pesquisas da Amazônia, Manaus, Brazil (INPA), and the Entomological Collection of the Universidade Federal do Espírito Santo (UFES). Part of the material initially studied was lost in the fire of the MNRJ that occurred on September 2, 2018 (Duarte, 2019). Fortunately, some of the specimens were in another lab and could be used as the formal type series.

Pictures were taken with LAS software and assembled in Helicon Focus 6. The terminalia were treated with KOH 10% at 40° C for 20 minutes, then neutralized in 1% acetic acid, and transferred to a microvial with glycerin. The wing and the antenna were mounted with Euparal between cover slips. Scanning electron micrographs (SEM) were obtained using a high vacuum JEOL JCM-6000. The morphological nomenclature follows Cumming and Wood (2017) and Buck and Marshall (2006).

In their phylogenetic study of the genus, Buck and Marshall (2006) used in the matrix a generalized “Australimyziidae” and an “ancestor” as terminals to root the analysis. The Australimyziidae had question marks for a number of characters of male and female terminalia. In this study, we used specimens of *Australimyza mcalpinei* Brake and Mathis to fill in some of the gaps on information about the generalized Australimyziidae, and we replaced it as a terminal in the matrix. We did not use an ancestor as a terminal and we rooted the analysis in *Australimyza*. We used Buck and Marshall’s (2006) original list of characters and data matrix to study the position of the Brazilian species within *Inbiomyia* and to reassess the relationships between the species of the genus, rooting the analysis in *A. mcalpinei* as the outgroup (table 1).

To understand the effects of the change of the outgroup and the addition of a new species, we ran the matrix including *Inbiomyia azevedoi*, sp. nov., using either Buck and Marshall’s (2006) Australimyziidae or *A. mcalpinei* as a terminal. We analyzed the data matrix using the

TABLE 1. Buck and Marshal's (2006) data matrix with the addition of *Inbiomyia azevedoi*, sp. nov., and with characters 11, 12, 19, 20, 22, 26, and 35 completed for *Australimyza mcalpinei*, replacing their generalized "Australimyzae." Sequence of terminals as in cladogram of figure 8C.

	1	11111	11112	22222	22223	33333
	12345	67890	12345	67890	12345	67890
<i>Australimyza mcalpinei</i>	00000	00000	1000-	---20	00000	?--00
<i>I. exul</i>	11110	00110	10100	00022	01100	01100
<i>I. scoliostylus</i>	00000	00000	01111	00011	11200	00101
<i>I. zeugodonta</i>	00000	00001	01111	00011	11200	00100
<i>I. mcalpineorum</i>	00001	00101	01110	00000	10011	00000
<i>I. empheres</i>	00001	00111	01110	00000	10011	00001
<i>I. azevedoi</i>	0000?	00000	00011	10001	21020	00000
<i>I. anodonta</i>	00?00	00001	01110	10001	21020	00001
<i>I. anemosyris</i>	11110	01010	00000	11000	20020	00011
<i>I. matamata</i>	10111	11010	00000	11000	20020	00001
<i>I. pterygion</i>	11111	11010	00000	11000	20020	02011
<i>I. acmophallus</i>	00101	01000	10000	11101	20010	12001
<i>I. regina</i>	10111	11010	10002	11101	20010	12001

TNT 1.1 software under equal-weight scheme (Goloboff et al., 2008) and $k = 3$ under implied weight, so characters with a higher level of incongruence would have a smaller effect on the construction of the backbone of the phylogeny. The construction of the data matrix and the trees was made with the software Winclada (Nixon, 1999).

The maps (fig. 9) were constructed using data from the literature (Buck, 2006; Buck and Marshall, 2006) for the known species within Google Earth, then edited in Adobe Illustrator CS.

TAXONOMY

Inbiomyia azevedoi, sp. nov.

Figures 1–7

DIAGNOSIS: Body entirely dark brown with brownish legs; proboscis with a pair of dark spots subapically in the prementum (fig. 1B); frontoclypeal membrane reaching dorsal part of lower facial ridge; second sector of the wing more than $2\times$ longer than the third sector; male terminalia with ventral epandrial process articulated and apically rounded; surstylus wider distally, bearing a regular row of stout setae; female abdominal tergite 7 not divided medially and not fused laterally to sternite 7.

MATERIAL EXAMINED: Holotype male BRAZIL, Rio de Janeiro, Itatiaia, PNI Complexo do Maromba, PNI-M2B, S22°26'07" W44°37'33.2" 1234 m; vi-vii.2015, Malaise trap, Azevedo & equipe. col. [MNRJ]. Paratypes: 7 ♂ and 17 ♀, same data as holotype [2 ♀ MNRJ]; 6 ♂ and 14 ♀ MZUSP; 1 ♂ and 1 ♀ INPA]; 1 ♀ BRAZIL, Espírito Santo, Divino de São Lourenço, Parque

Nacional do Caparaó, Trilha do Falcão, 1500 m, 20°24'30"S 41°47'06"W, 15-23.iii.2013, Malaise 21, C.O. Azevedo & F.B. Braga leg. [UFES].

DESCRIPTION: Body length, 1.75–1.8 mm. Wing length, 2.1–2.2 mm. *Head* (figs. 1, 2, 3A): Broad, dark brown except for yellowish proboscis and labella. Antenna brown, almost concolor with frons, lighter toward apex. First flagellomere with a small sensory pore at outer face opening to wider cavity inside (fig. 3A). Postocellar and inner occipital setae absent. Inner vertical seta almost as long as the single strong fronto-orbital seta, with four additional frontal orbit hairs. Ocellar plate with sparse microtrichia, ocellar setulae minute, proclinate. Eyes reddish brown, protruding, densely covered with interommatidial setae, ventroposterior area of eyes strongly emarginated. Facial sclerotization extending ventrally to lower facial ridge; frontoclypeal membrane reaching dorsal part of lower facial ridge. Vibrissal angle rounded, vibrissa strong, slightly longer than fronto-orbital seta, no subvibrissal hairs. Gena with several setulae, in addition to some longer setae along ventral margin, postgena large, extending into eye emargination. Maxillary palpus concolor, with a strong, long typical seta. Proboscis elongate, with two pairs of setae and a dark apical spot on prementum, labella bifid, inner face of labellum at each side covered with rows of scalelike rasping teeth. *Thorax* (figs. 1A, 3B, 4A): Dark brown. Scutum subquadrate, thoracic pleural sclerites concolor with scutum; anterior and posterior spiracles rounded, pilose. One smaller presutural and two very long postsutural dorsocentrals, a row of setulae anterior to the presutural dorsocentral, one setula between the presutural and anterior postsutural dorsocentrals and one setula between the two postsutural dorsocentrals; seven pairs of small acrostichal setae, not present posteriorly to level of transverse suture; one presutural and one postsutural supraalar setae; one postalar seta. Scutellum pilose, with one pair of small setae on disc surface, anteriorly to margin (subequal in length to acrostichal hairs), and one pair of very long converging marginal scutellar setae, crossing apically. Postpronotum almost indistinct with one postpronotal seta as long as the presutural supraalar seta. Proepimeron and proepisternum bare, anepisternum entirely covered with setulae, no strong seta present. Katepisternum with anteriorly inclined posterodorsal seta, some setae on ventroanterior half, and setulae. Meron high, only with some setulae on dorsal third, ventrally to posterior spiracle. Halter dark brown. *Leg* (figs. 1A, 4A): Caramel brown. Forecoxa protruding anteriorly, with four small laterobasal spines (fig. 4A); mid and hind coxa with a longer central seta; antero- and posteroventral rows of setae of forefemur slightly stronger and darker than remaining setulae, posteroventral row slightly stronger than anteroventral row in both sexes. First tarsomere of foreleg shorter than mid and hind first tarsomeres; first tarsomeres with a ventral fringe of orangish short setae. Tarsal claws elongate, no pulvillus. *Wing* (figs. 1A, 4B): Membrane hyaline, iridescent, veins brownish. Wing sectors Cs1/Cs2/Cs3/Cs4: 3; 12; 4; 2. Well-defined subcostal and humeral breaks, C extending to tip of M₁; setulae along C between apex of R₁ and R₂₊₃ well spaced, slightly longer and stouter than regular setae. Sc running close to R₁, not sclerotized on distal half. R₁ very short. R₂₊₃ long, ending on distal fifth of wing. R₄₊₅ ending almost at wing tip. M₁ ending close to wing apex, slightly curved posteriorly at tip. M₄ fading at tip, not reaching wing margin. CuA+CuP strong, not reaching wing margin, displaced anteriorly, close to wing margin; A₁ entirely absent. Cell dm narrow, separated from cell bm by rather oblique dm-m. Cell cua closed, convex distally. Anal lobe not

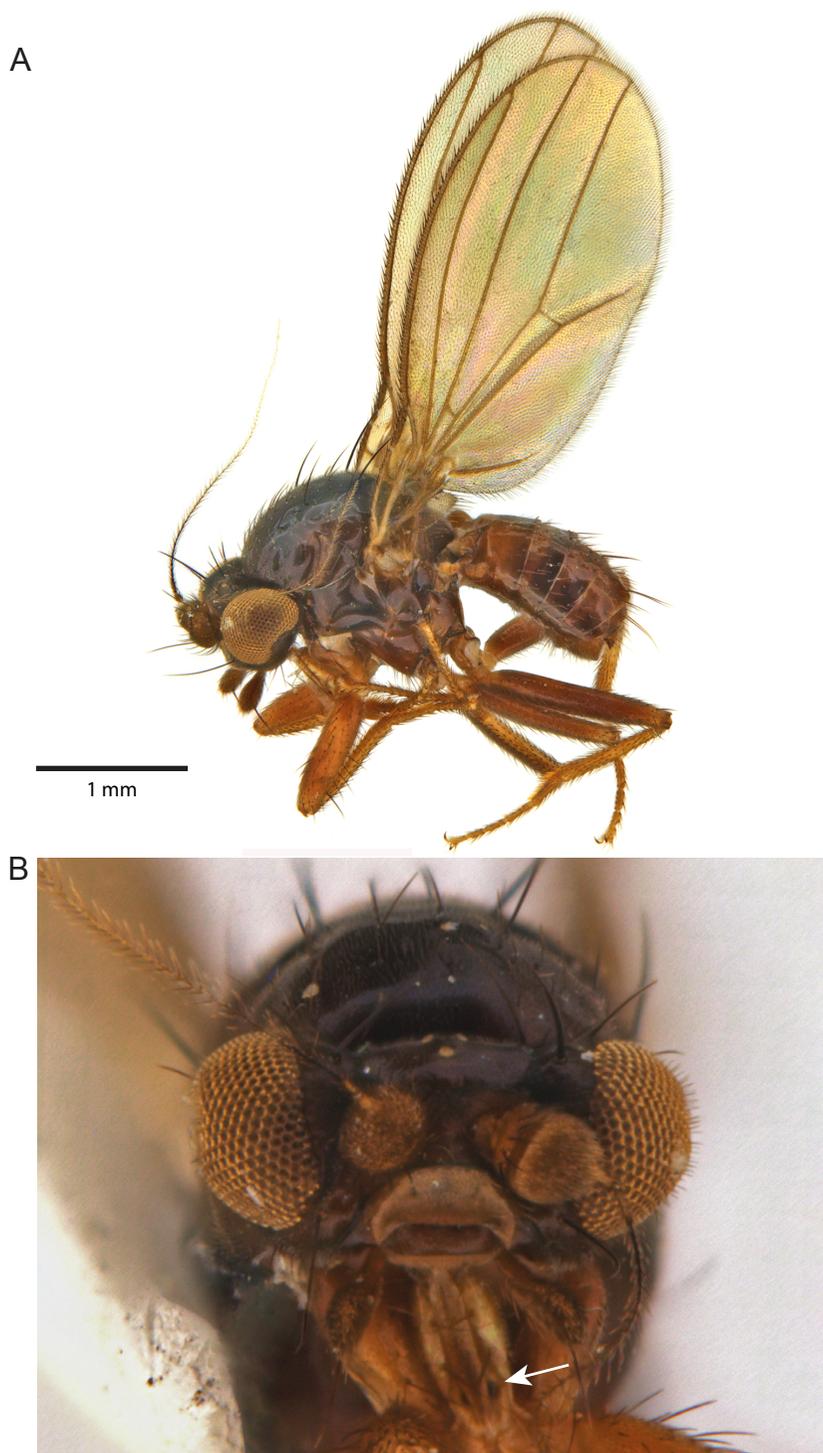


FIGURE 1. *Inbiomyia azevedoi*, sp. nov., female paratype. A, habitus. B, head in frontal view (arrow indicates black spot on prementum)

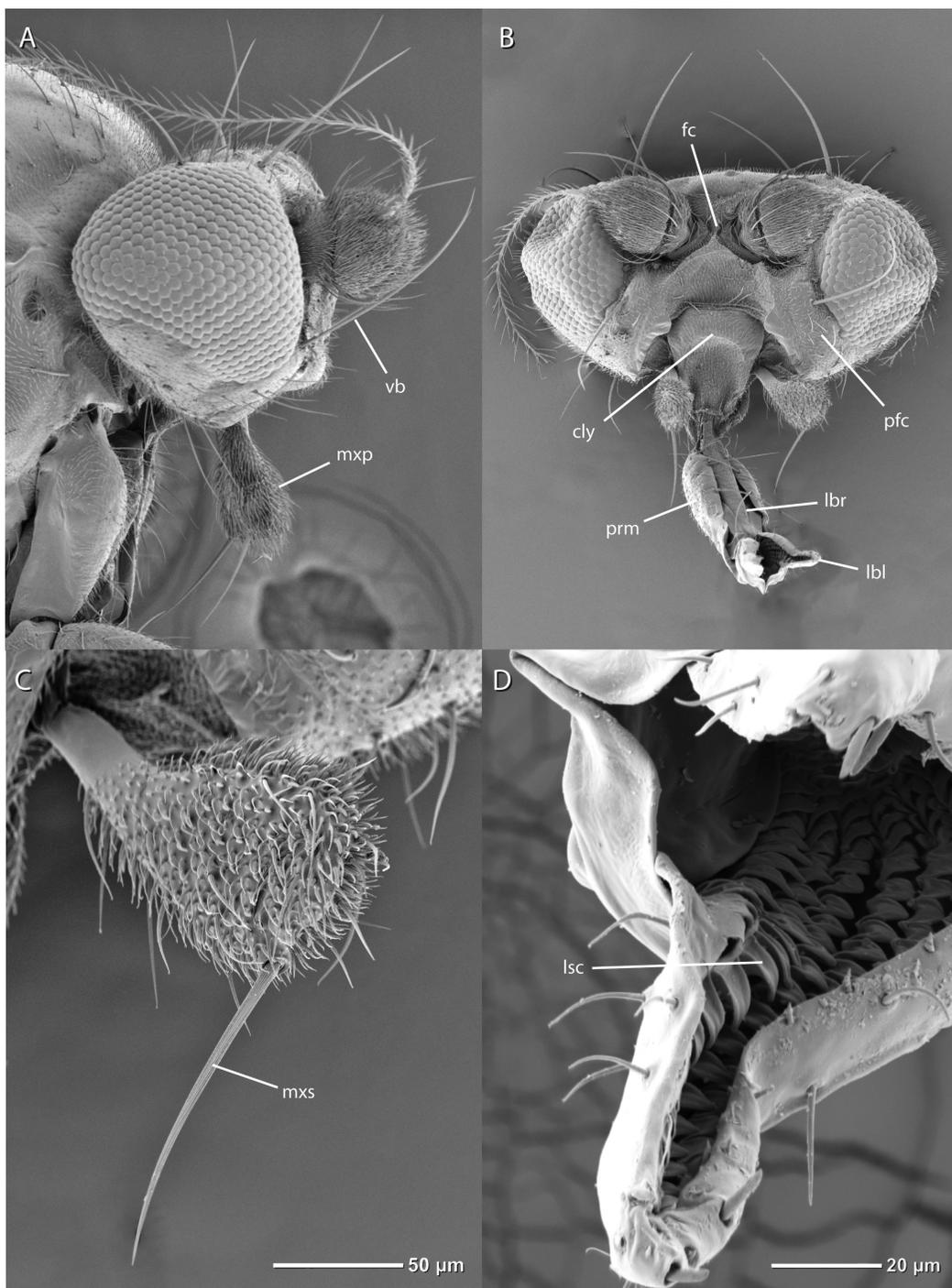


FIGURE 2. *Inbiomyia azevedoi*. **A**, head, lateral view, female paratype. **B**, head, frontal view, male paratype. **C**, maxillary palpus, female paratype. **D**, inner face of labella, male paratype. Abbreviations: **cly**, clypeus; **fc**, face; **lbl**, labium; **lbr**, labrum; **lsc**, labial scale; **mxp**, maxillary palpus; **mxs**, maxillary palpus seta; **pfc**, parafacialia; **prm**, prementum; **vb**, vibrissa.

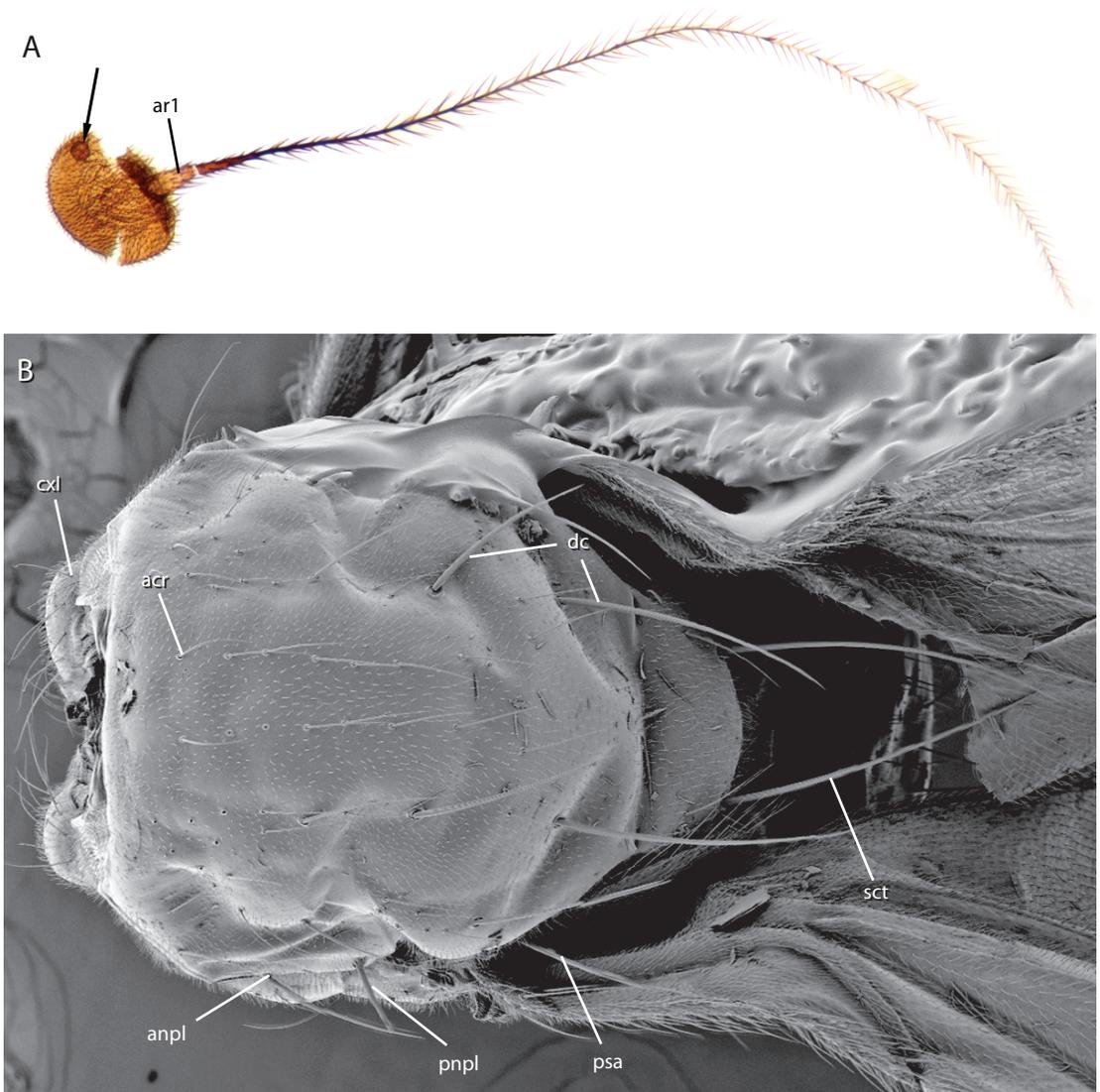


FIGURE 3. *Inbiomyia azevedoi* male paratype. **A**, antenna (arrow indicates the sensory pit). **B**, thorax, dorsal view. Abbreviations: **acr**, acrostichal setula; **anpl**, anterior notopleural seta; **ar1**, first aristomere; **cxl**, fore coxa; **dc**, dorsocentral seta; **pnpl**, posterior notopleural seta; **psa**, postsutural supralar seta; **sct**, apical scutellar seta.

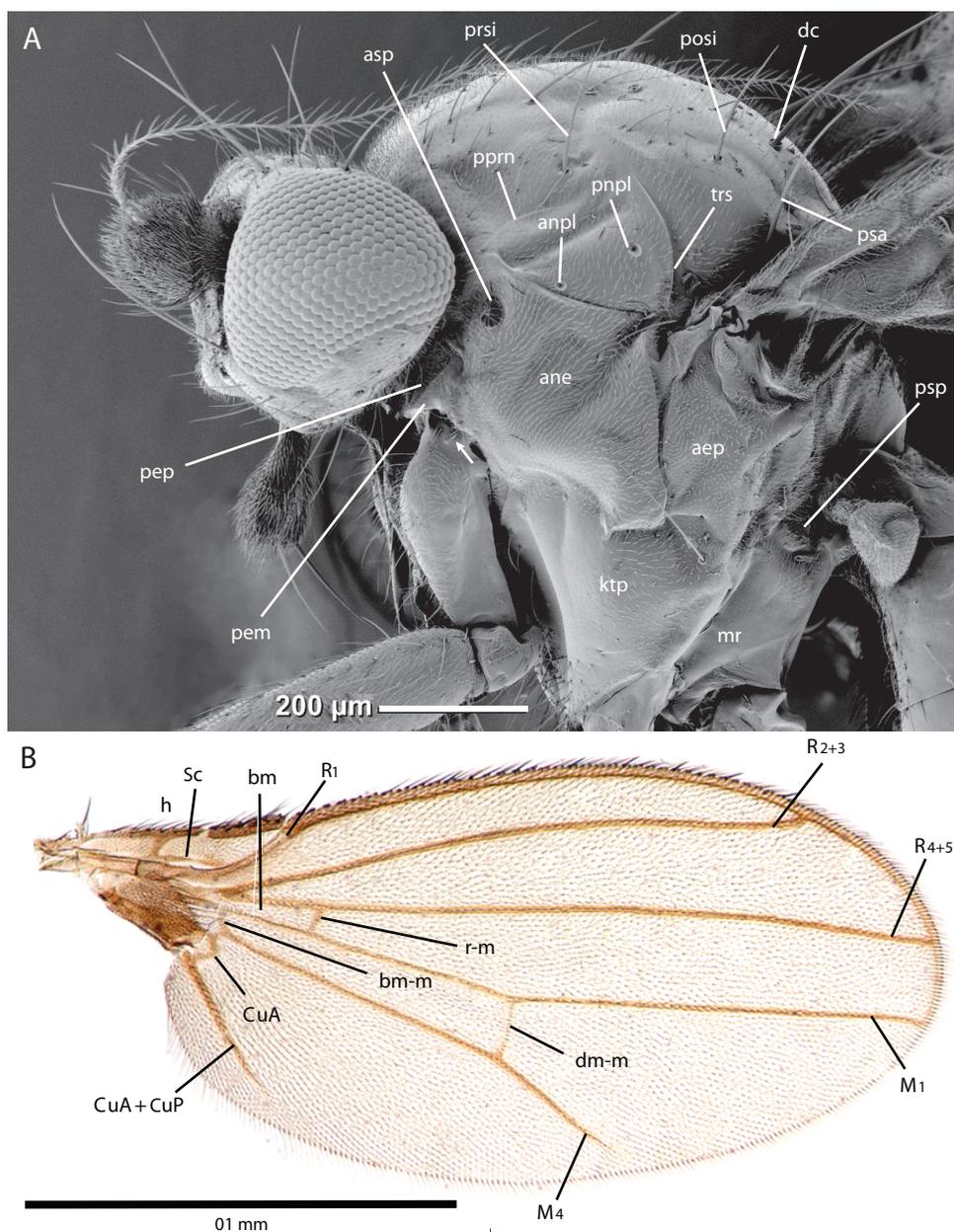


FIGURE 4. *Inbiomyia azevedoi*. **A**, thorax, lateral view, female paratype (arrow indicating four small latero-basal spines). **B**, wing. Abbreviations: **aep**, anepimeron; **ane**, anepisternum; **anpl**, anterior notopleural seta; **asp**, anterior spiracle; **bm**, basal medial cell; **bm-m**, basal medial crossvein; **CuA**, anterior branch of cubital vein; **CuA+CuP**, anterior branch of cubital vein + posterior branch of cubital vein; **dc**, dorsocentral seta; **dm-m**, discal medial crossvein; **h**, humeral crossvein; **ktp**, katepisternum; **M₁**, first branch of media; **M₄**, fourth branch of media; **mr**, meron; **pem**, proepimeron; **pep**, proepisternum; **pnpl**, posterior notopleural seta; **posi**, postsutural supraalar seta; **pprn**, postpronotal seta; **prsi**, presutural supra-alar seta; **psa**, postalar seta; **psp**, posterior spiracle; **R₁**, anterior branch of radius; **R₂₊₃**, second branch of radius; **R₄₊₅**, third branch of radius; **r-m**, radial medial crossvein; **Sc**, subcostal vein; **trs**, transverse suture.

prominent. *Abdomen*: Tergites shining brown, darker toward tip, terminalia brown. Tergites 1 and 2 fused, tergites much wider and well sclerotized than sternites 2–4. *Male terminalia* (figs. 5, 6): Synsternite 5+6+7 Y-shaped anteriorly, partially fused dorsally to sternite 8. Ring-shaped sclerite absent. Epandrium brown, elongated dorsoventrally, with posteroventral lobes paler, well developed; no anterodorsal apodemes developed; anteroventral process not fused to epandrium. Subanal plate continuous with epandrium. Perianal field elliptical dorsally, ventral margin clearly delimited from subanal plate. Surstylus brown, wider distally, with a regular row of stout setae along distal margin. Hypandrium connected to anteroventral margin of epandrium, with a long projection posteriorly. Postgonite short, brown, directed ventrally, with ca. 5 stout, peglike setae near apex and several small setulae. Epiphallus yellowish, slender, tip directed ventrodistally. Distiphallus short, microtrichose. *Female terminalia* (fig.7): Tergite 7 entire, laterally separate from sternite 7; tergite 8 without a dark brown apodeme, concolor with preceding tergites. Sternite 6 as wide as previous sternites, longer at lateral end, very short medially; sternite 7 evenly sclerotized. Ventral membrane internally at genital opening (possibly sternite 8) with rows of spines. Spermathecae weakly sclerotized, pale brown, slightly striate, central invagination at point of duct insertion.

ETYMOLOGY: The specific epithet of this species is given to honor Leonardo Henrique Gil Azevedo, Brazilian dipterist working at the Museu Nacional do Rio de Janeiro. He has collected most of the specimens of the type series and has provided an important contribution to the systematics of the Neotropical Simuliidae and some other nematocerous families.

COMMENTS: *Inbiomyia azevedoi* would run into couplet 8 of Buck and Marshall's (2006) key to the species of *Inbiomyia*, along with *I. mcalpineorum* and *I. empheres* Buck, if we consider the C2/C3 proportions, but it would run to *I. anodonta* if we consider the distribution of setae on the surstylus. The postgonite in *I. mcalpineorum* is directed anteriorly, in such a way that the subanal plate and the hind margin of the epandrium almost form a right angle in lateral view, while in *I. empheres* and *I. azevedoi* the postgonite is directed ventrally and the subanal plate and hind margin of the epandrium form an obtuse angle. *I. azevedoi* differs from *I. empheres* by having the abdominal tergite 7 of females not divided medially and is not fused laterally to sternite 7, along with the ventral epandrial process apically rounded in the male terminalia (acute in *I. empheres*). *Inbiomyia azevedoi* resembles *I. anodonta* in the shape of the surstylus and of the epiphallus, with which the ventral process is articulated. *Inbiomyia anodonta* possesses the second sector of the wing much shorter than *I. azevedoi* and also has an anterior apodeme on the epandrium, which is absent in the new species. Green algae were found in abdomen of one specimen analyzed during the dissection of the male terminalia, probably belonging to the gut content.

DISCUSSION

The species described here obviously fits in *Inbiomyia*. It shares with the remaining of the species of the genus distally bifid labella, a very conspicuous seta on the maxillary palpus, and an especially long arista. The fusion of sternites 5+6+7 forming an asymmetric, partly internal-

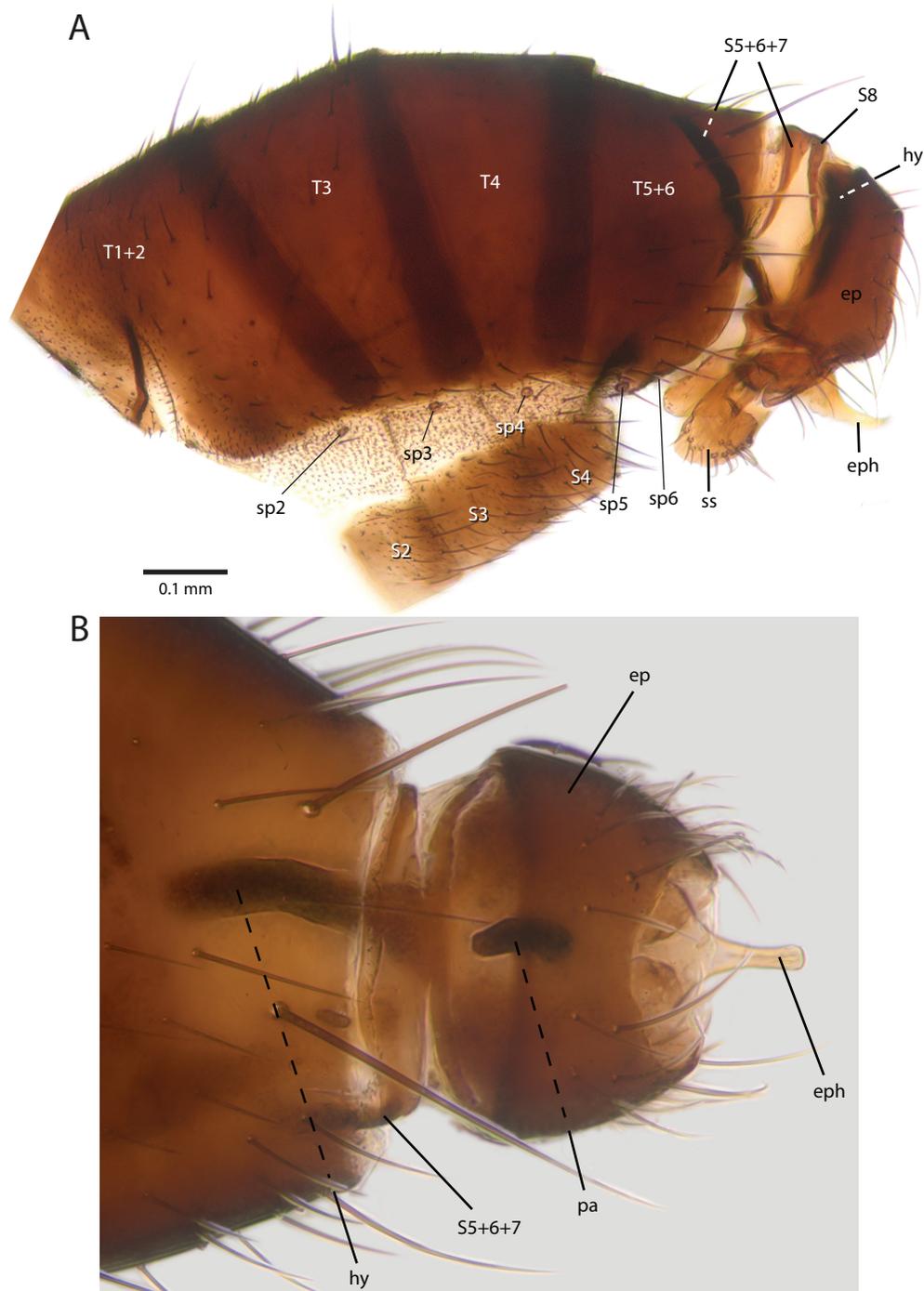


FIGURE 5. *Inbiomyia azevedoi*, male paratype. **A**, abdomen, lateral view. **B**, male terminalia, dorsal view. Abbreviations: **ep**, epandrium; **eph**, ephiphallus; **hy**, hypandrium; **pa**, phallapodeme; **S**, sternite; **ss**, surstylus; **sp**, spiracle; **T**, tergite.

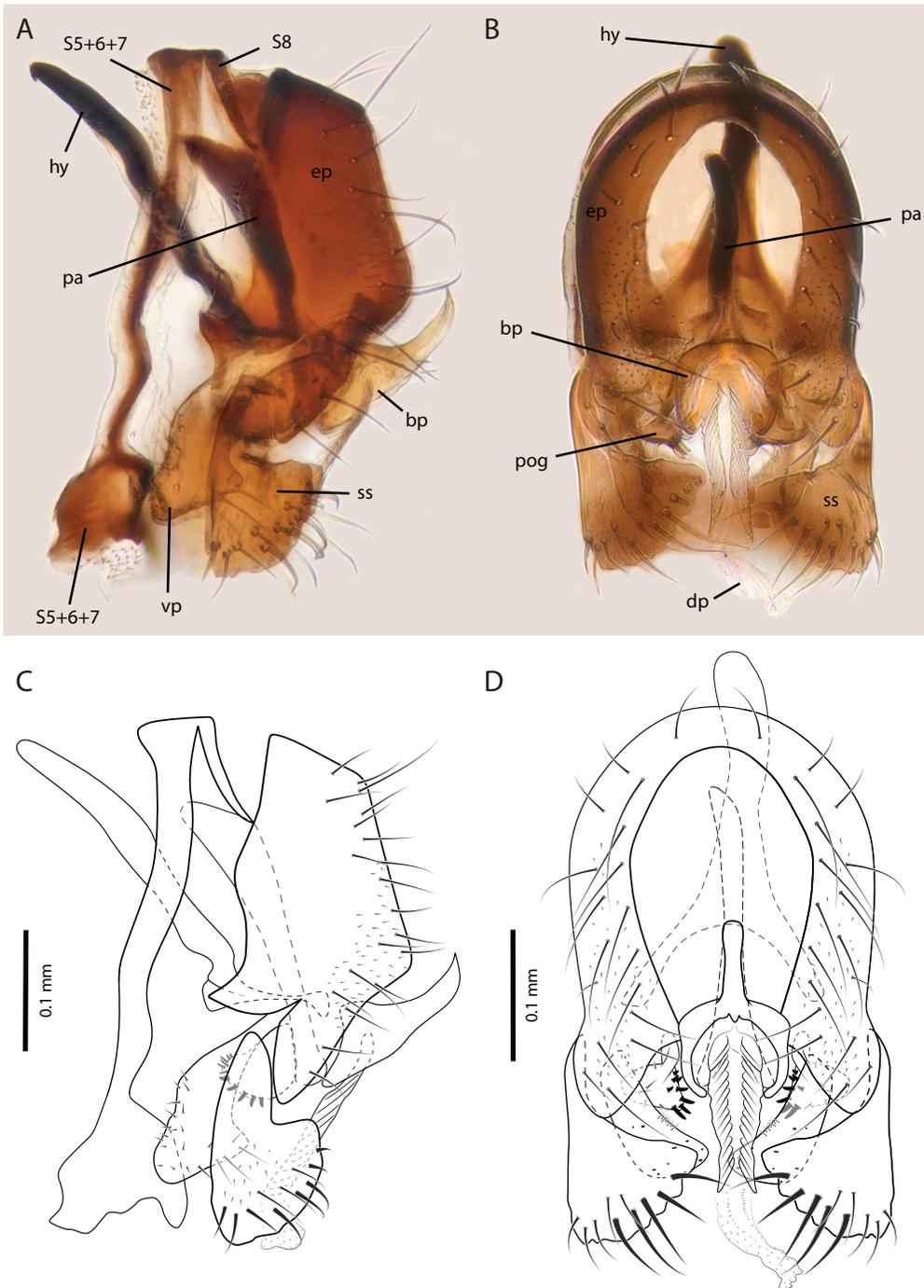


FIGURE 6. *Inbiomyia azevedoi*, male paratype, postabdomen. **A**, lateral view, dissected specimen. **B**, terminal view, dissected specimen. **C**, lateral view, illustration. **D**, dorsal view, illustration. Abbreviations: **bp**, basiphallus; **dp**, distiphallus; **ep**, epandrium; **hy**, hyandrium; **pa**, phallapodeme; **pog**, postgonite; **S**, sternite; **ss**, surstylus; **vp**, ventral process of epandrium.

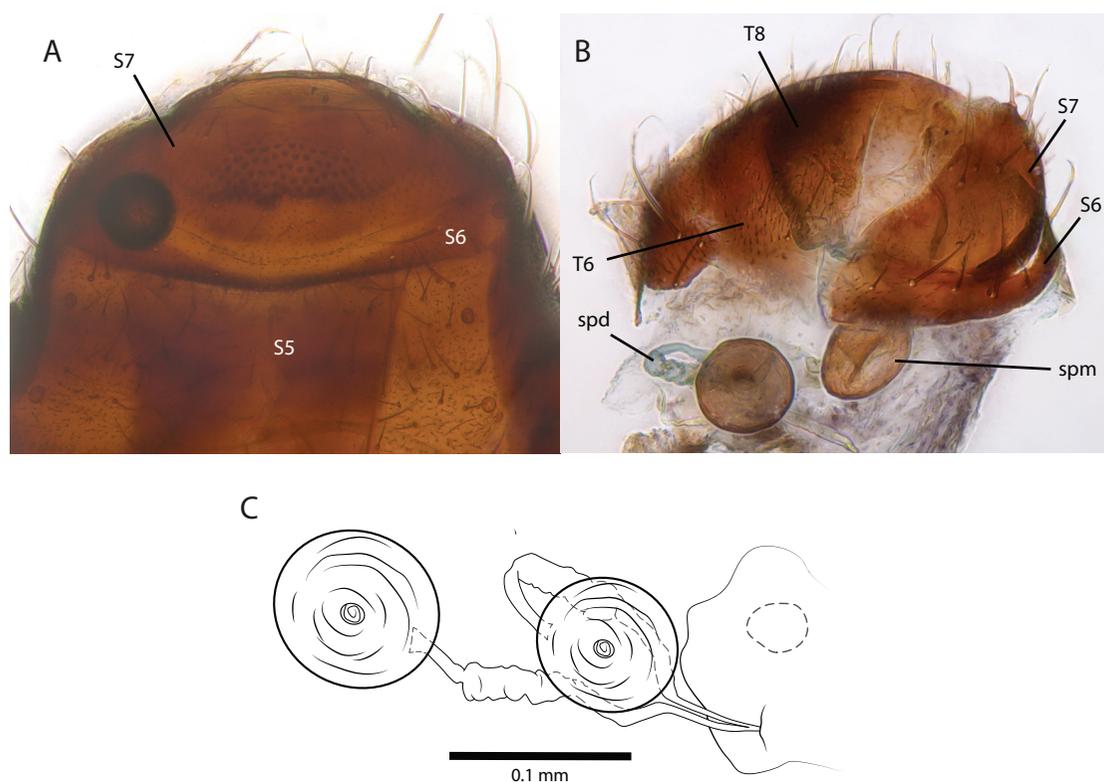


FIGURE 7. *Inbiomyia azevedoi*, female postabdomen. **A**, ventral view. **B**, ventrolateral view. **C**, illustration of the internal apparatus. Abbreviations: **S**, sternite; **spd**, spermathecal duct; **spm**, spermatheca; **T**, tergite.

ized structure in males and the absence of cerci in males and females are additional features of the terminalia in the Inbiomyiidae shared by *I. azevedoi*.

Our SEMs show that the labella have distally on the inner face six long rows of scalelike teeth, which are probably used to rasp the substrate. In some lauxaniids, the ventral surface of the labellum is adapted for fungal grazing (Broadhead, 1984), with teeth present along the pseudotracheal channels (Mello and Silva, 2006). The teeth of the labella found in *Inbiomyia azevedoi* (fig. 2D) differ in shape and position from those in lauxaniids and also from the pre-stomal teeth of calyptrates (Sukontason et al., 2005)—and represent obvious convergences. There are no field observation of adults feeding, nor an extensive study of the gut content of specimens in the family, but the observation of algae in the gut content of one of our specimens, as was also mentioned by Buck and Marshall (2006: 6), makes plausible an assumption that they graze wet surfaces to obtain algae for feeding.

In Buck's (2006) phylogenetic study of the Carnoidea, both most-parsimonious trees have the Inbiomyiidae as sister to the Australimyziidae, this clade sister to Carnidae. The group (Carnidae + (Australimyziidae + Inbiomyiidae)) came out as sister of a large clade of Carnoidea of which Chloropidae, Milichiidae, Cryptochaetidae, and Canacidae are members. The main features gathering Inbiomyiidae and Australimyziidae in their study are the reduced ptilinum,

presence of a basal extension on the hypandrium (named hypandrial apodeme), hypandrium rigidly connected to the epandrium along its ventral margin, and a short ovipositor (Buck, 2006). Brake and Mathis (2007) also cited the absence of a subepandrial sclerite as another feature shared by both families, but such a sclerite is extremely variable in carnoidea, so it should not be regarded as a reliable character.

Wiegmann et al.'s (2011) phylogeny based on molecular data placed the Inbiomyiidae and the Australimyziidae in entirely different positions. Inbiomyiidae appeared as sister of the Neminidae, a clade that is sister to (Aulacigastridae + Nerioidea), while Australimyziidae came out as sister of Xenasteiidae, in a clade also including, e.g., Asteiidae, Ropalomeridae, Neurochaetidae, and Clusiidae—rather far from the Carnoidea. In addition, their position for Inbiomyiidae and Australimyziidae contradicts other sources of information (e.g., Buck, 2006). Finally, their phylogeny is based on a limited taxon sampling, which may have affected the position of some of the terminals. The rapid radiation of Schizophora during the Tertiary could be a factor prejudicing the comprehension of the suprafamilial relationships of this clade (Wiegmann et al., 2011). A more recent analysis made by Keith Bayless et al. (2018) using a wider dataset also dismantled Carnoidea and recovered Australimyziidae and Asteiidae as sister groups; Inbiomyiidae, however, was not included in the taxonomic sampling. It is evident that the relationships of the members of the Carnoidea still have to be reassessed, but this is outside the scope of this paper and a study of the position of the Inbiomyiidae in the context of the Schizophora major clades is to be made elsewhere.

To determine the relationships among the species of *Inbiomyia* including the new species and to facilitate a comparison of our results with those of Buck and Marshall (2006), we removed the a priori “ancestor” as a terminal and instead used their “Australimyziidae” as a terminal and an *Australimyza* species as designated outgroup. Our reanalysis of Buck and Marshall's (2006) data matrix under equal weight including *I. azevedoi* and keeping their data for “Australimyziidae” as a terminal disrupted their *scoliostylus* group (fig. 8A). *Inbiomyia anodonta* Buck and Marshall moved out of the *scoliostylus* group and appeared as sister to a clade including (*I. mcalpineorum*, *I. empheres*, *I. scoliostylus*, and *I. zeugodonta*). In this case, *I. azevedoi* is sister to a clade including *I. anodonta* and its sister clade; *I. exul* keeps its position as sister of the group *anemosyris*.

In our equal-weight analysis including *I. azevedoi* but changing the data of “Australimyziidae” for data of *Australimyza mcalpinei*, *I. anodonta* was again excluded from the *scoliostylus* group (fig. 8B). In this tree, the *scoliostylus* group, the *mcalpineorum* group, the *anemosyris* group, *I. exul*, *I. azevedoi*, and *I. anodonta* are at the same level in a polytomy at the base of the phylogeny of the genus. Finally, running this last matrix using implied weight with $k = 3$ (fig. 8C), *E. exul* is sister to the remainder of the genus. In this larger clade, the *scoliostylus* group without *I. anodonta* is sister to a clade including the *mcalpineorum* group and (*I. anodonta* + (*I. azevedoi* + (*anemosyris* group))).

Indeed, the solution with $k = 3$ (fig. 8C) does not contradict the polytomy obtained with equal weight. We hence transfer *I. anodonta* to the *anemosyris* group, in which we also include *I. azevedoi*, based on the ventral process of the epandrium not being curved medially (char. 16:

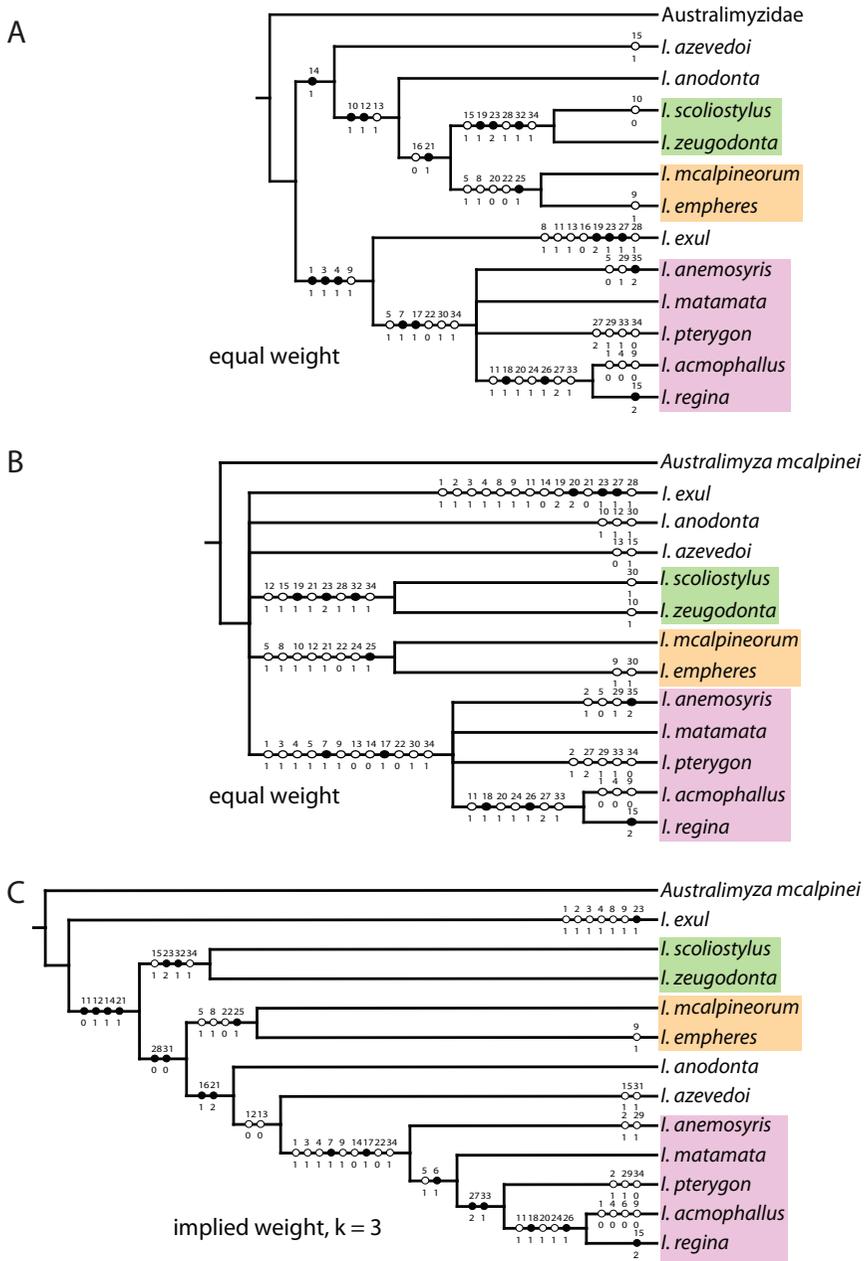


FIGURE 8. Phylogenetic analyses of Inbiomyiidae. **A**, strict consensus of Buck and Marshall's (2006) analysis under equal weights including *Inbiomyia azevedoi* and excluding the hypothetical ancestor (two most parsimonious trees with 74 steps, consistency index 0.58 and retention index 0.7). **B**, strict consensus of the extended matrix (table 1) analysis under equal weights (13 most-parsimonious trees with 77 steps, consistency index 0.55 and retention index 0.68). **C**, most parsimonious tree of the extended matrix under implied weighting ($k = 3$, consistency index 0.55 and retention index 0.68). The green squares represent the *scoliostylus* group except *I. anodonta*; the orange squares represent the *mcalpineorum* group; and the purple squares represent the *anemosyris* group of Buck and Marshall (2006).

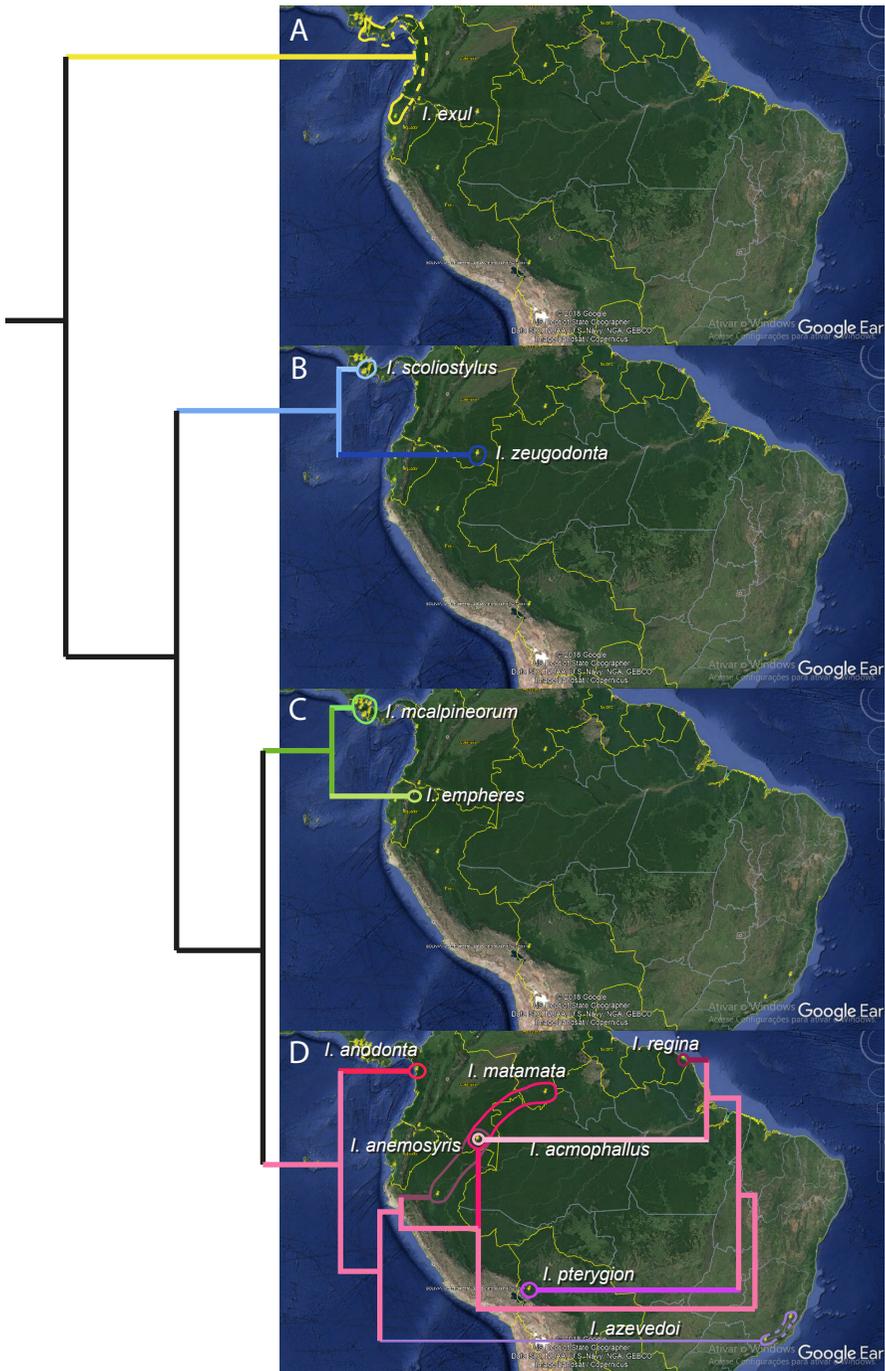


FIGURE 9. Distribution maps of the four species group of *Inbiomyia*. *I. anodontata* already transferred to the group *anemosyris* and *I. azevedoi* included in the same group. French Guyana occurrence of *I. zeugodonta* of Buck and Marshall (2006) was tentative and not included here. **A**, *Inbiomyia* group: *exul*. **B**, *Inbiomyia* group: *scoliostylus*. **C**, *Inbiomyia* group: *mcalpineorum*. **D**, *Inbiomyia* group: *anemosyris*. National boundaries in yellow; Brazilian states outlined in white.

state 1) and the apical portion of the surstylus greatly expanded (21: 2). This shows that the fusion of the ventral process to the epandrium (14: 0) and the absence of discal setae on the surstylus (22: 0) are plastic features that previously sustained the *anemosyris* group. There is very good support of the monophyly of the *anemosyris* group in its original delimitation and the connection of *I. anodonta* and *I. azevedoi* to the *anemosyris* group results in a clade still restricted to South America (fig. 9), as noted by Buck and Marshall (2006).

Overall, our study results in limited changes to Buck and Marshall's (2006) composition of the species groups. Basically, the species groups were confirmed to be monophyletic with the single exception of the position of *I. anodonta*. Missing data in the original matrix and the inclusion of an additional species in our matrix are probably responsible for the differences found.

It is apparently early to more fully understand the evolution of the family in the Neotropical region. Additional undescribed species are known from the Amazon basin (J.A. Rafael, personal commun.) and a larger taxon sample in the family may be soon available. Nevertheless, it is interesting to observe that the relationship found among *I. anodonta*, *I. azevedoi*, and the clade with the remaining species of the *anemosyris* group corresponds to an area cladogram that strictly correlates with the general pattern found for the Neotropical region (Amorim and Pires, 1996; Amorim, 2009) that has Central America–Mexico (with an extension west of the Andes in Colombia) sister to the Atlantic Forest, versus the Amazon Basin.

ACKNOWLEDGMENTS

We are grateful to Keith Bayless for providing the specimens of *Australimyza* examined and to two referees for their valuable contribution. The material was collected with the project Biota-RJ (200199) sponsored by FAPERJ. We acknowledge the Willi Hennig Society for having the TNT software available and updated. P.R.R. benefits from the financial support of a CNPq Protax II grant (#88887.176040/2018-00).

REFERENCES

- Amorim, D.S. 2009. Neotropical Diptera diversity: richness, patterns, and perspectives. *In* T. Pape, D. Bickel, and R. Meier (editors), *Diptera diversity: status, challenges and tools*: 69–95. London: Brill Academic Publishers.
- Amorim, D.S., and M.R.S. Pires. 1996. Neotropical biogeography and a method for maximum biodiversity estimation. *In* C.E.M. Bicudo and N.A. Menezes (editors), *Biodiversity in Brazil: a first approach*: 183–219. São Paulo: CNPq.
- Bayless, K.M., et al. 2018. A phylogenomic approach elucidates the early diverging acalyptate lineages of Schizophora. *In* A.H. Kirk-Spriggs and B.S. Muller (editors), *Abstracts volume, 9th International Congress of Dipterology, 25–30 November 2018, Windhoek, Namibia*: 23. Windhoek: International Congresses of Dipterology.
- Brake, I., and W.N. Mathis. 2007. Revision of the genus *Australimyza* Harrison (Diptera: Australimyziidae). *Systematic Entomology* 32 (2): 252–275.

- Broadhead, E.C. 1984. Adaptations for fungal grazing in Lauxaniid flies. *Journal of Natural History* 18: 639–649.
- Buck, M.A. 2006. New family and genus of acalyptrate flies from the Neotropical region, with a phylogenetic analysis of Carnoidea family relationships (Diptera, Schizophora). *Systematic Entomology* 31: 377–404.
- Buck, M., and S.A. Marshall. 2006. Revision of the Neotropical family Inbiomyiidae (Diptera, Schizophora). *Contributions in Science* 512: 1–30.
- Cumming, J.M., and D.M. Wood. 2017. Adult morphology and terminology. In A.H. Kirk-Spriggs and B.J. Sinclair (editors), *Manual of Afrotropical Diptera*, vol. 1. Suricata 4: 89–133. Pretoria: South African National Biodiversity Institute.
- Duarte, L.F.D. 2019. O Museu Nacional: ciência e educação numa história institucional brasileira. *Horizontes Antropológicos* 25 (53): 359–384.
- Goloboff, P.A., J.S. Farris, and K.C. Nixon. 2008. TNT, a free program for phylogenetic analysis. *Cladistics* 24: 1–13.
- Mello, R.L., and V.C. Silva. 2006. Morphological ultrastructure of the labellum in three Neotropical Lauxaniidae (Diptera, Muscomorpha). *Studia Dipterologica* 13: 397–403.
- Nixon, C.K. 1999. Winclada (Beta) ver. 0.9.9 Ithaca, NY: Published by the author.
- Sukontason, K.L., et al. 2005. Surface ultrastructure of prestomal teeth of some flies in the families Caliphoridae, Muscidae and Sarcophagidae. *Parasitology Research* 96 (6): 410–412.
- Wiegmann, B.M., et al. 2011. Episodic radiations in the fly tree of life. *Proceedings of the National Academy of Sciences of the United States of America* 108 (14): 5690–5695.

All issues of *Novitates* and *Bulletin* are available on the web (<http://digitallibrary.amnh.org/dspace>). Order printed copies on the web from:

<http://shop.amnh.org/a701/shop-by-category/books/scientific-publications.html>

or via standard mail from:

American Museum of Natural History—Scientific Publications
Central Park West at 79th Street
New York, NY 10024

Ⓢ This paper meets the requirements of ANSI/NISO Z39.48-1992 (permanence of paper).