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ECOSYSTEMS

New *Amydrostylus* Lamas, Falaschi & Evenhuis (Diptera, Mythicomyiidae, Psiloderoidinae) from the Brazilian semiarid region, with discussion on the unusual male terminalia of the genus

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Abstract: The studying material were recently collected with Malaise traps in Northeastern Brazil, and the authors found a new species of *Amydrostylus*, which represents the second known species of this endemic genus from the open/dry biomes of Brazil. The discovery results will provide more new diagnosis for the genus and allow a better knowledge of the male terminalia morphology, leading to a new interpretation of some of its structures. Male and female specimens are described and illustrated here.

Key words: biodiversity, Caatinga, micro bee flies, Neotropical, taxonomy.

INTRODUCTION

Amydrostylus Lamas, Falaschi & Evenhuis, 2015, was the first Psiloderoidinae genus found in South America. The hitherto monotypic genus of micro bee flies is characterized by the presence of a minute apical antennal stylus and by the equal length of the cells *br* and *bm* (Lamas et al. 2015).

The genus is placed in the subfamily Psiloderoidinae, defined by the short R_{2+3} vein, much shorter than R_{4+5} vein, ending free in the costa. The subfamily includes 11 genera (six fossils): *Acridophagus* Evenhuis, 1983, *Amydrostylus* Lamas, Falaschi & Evenhuis, 2015, *Borissovia*† Evenhuis, 2002, *Carmenelectra*† Evenhuis, 2002, *Eoacridophagus*† Myskowiak, Garrouste & Nel, 2016, *Onchopelma* Hesse, 1938, *Palaeoplatypygus*† Kovalev, 1985, *Procyrtosia*† Zaitzev, 1986, *Proplatypygus*† Hennig, 1969, *Psiloderoides* Hesse, 1967 and *Zzyzzarro* Evenhuis, 2022. The Jurassic fossil genus *Palaeoplatypygus* and the Cretaceous fossil genera *Borrisovia* and *Procyrtosia* make the Psiloderoidinae the oldest lineage in the family (Greathead & Evenhuis 2001).

The geographic records of the extant genera are known for the Afrotropical region (*Onchopelma* - seven species; *Psiloderoides* - two species), Australasian (*Acridophagus* - two species; *Zzyzzarro* – one species) and Neotropical (*Amydrostylus* – one species) (Evenhuis 2002b, Kirk-Spriggs & Evenhuis 2008, Lamas et al. 2015). By studying the material recently collected with Malaise traps installed in the Caatinga biome in the state of Pernambuco (Brazil), the authors were able to find the second Brazilian species of *Amydrostylus*. Photographs of the external morphology and detailed illustrations of the male and female terminalia of the new species, together with a new reformulated diagnosis for the genus, are included.

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MATERIALS AND METHODS

The specimens examined are deposited in the following institutions: Bernice Pauahi Bishop Museum – BPBM, Honolulu, Hawaii, USA; Museu de Zoologia da Universidade de São Paulo – MZUSP, São Paulo, Brazil and Coleção Zoológica do Maranhão – CZMA, Caxias, Maranhão, Brazil, preserved in absolute ethyl alcohol.

Male and female terminalia were dissected and macerated in 85% hot lactic acid (150°C) for about 25 minutes (Cumming 1992) and then examined on excavated slides in glycerin. After study and illustration, the dissected abdomens and terminalia were placed in microvials with glycerin. The left wing was detached from the paratype and mounted in permanent slide preparations in Entellan. Photographs were obtained using the Zeiss® Discovery V20 stereomicroscope with a Zeiss AxioCam Mrc5 camera attached, connected to a desktop computer through Zeiss AxioVs40 v. 4.8.2.0 software. Scanning electron micrographs (SEM) of the male paratype were taken with an SEM LEO440 (Carl Zeiss Microimaging GMBH, Göttingen, Germany). Image sequences were assembled in Helicon Focus 6.7.1 software, with some further editing in Adobe Photoshop. Illustrations of the terminalia were made using Adobe Illustrator® software, using the corresponding digital images. The map of the geographic distribution of the species was prepared using QGis 3.20.3 software. Morphological descriptive terminology follows Cumming & Wood (2017), and the term 'pseudo-surstylus', follows Evenhuis (2002a).

RESULTS

Amydrostylus Lamas, Falaschi & Evenhuis

Amydrostylus Lamas, Falaschi & Evenhuis 2015: 403. Type-species: *Amydrostylus triadicophallus* Lamas, Falaschi & Evenhuis 2015, by original designation.

Diagnosis. Antennae with minute apical stylus; inner margin of the compound eyes with a notched triangular area, above the level of base of the antennae, without ommatidia (Fig. 3a); vein *Sc* ending in *C*; cell *br* as long as cell *bm* (Fig. 1c); male genitalia well developed, 3/4 abdomen length; epandrium with long lateral process (Fig. 4); phallus slender and trifid (Fig. 4b) and spermatheca coiled (Fig. 5).

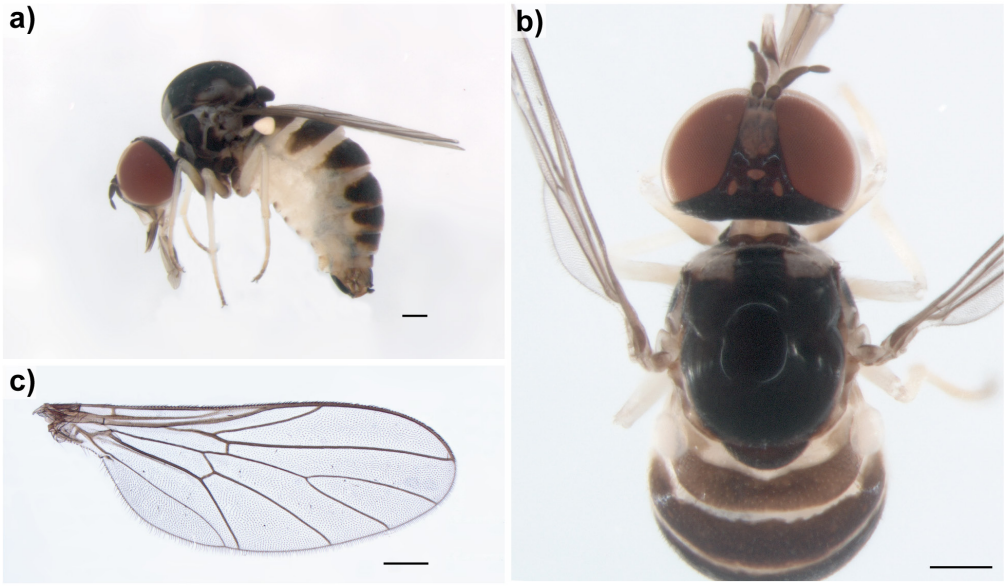

Figure 1. ***Amydrostylus martinsi*** **sp. nov., male. a) Habitus, lateral view (holotype). b) Thorax, dorsal view (holotype). c) Left wing, ventral view (paratype).**

Amydrostylus martinsi sp. nov.

ZooBank Life Science Identifier (LSID): urn:lsid:zoobank.org:act:738F56E2-5C54-4913-AFDB-71EF83AB845B

Diagnosis. Mesonotum and scutellum dark brown to black, shiny, with submedian antero-mesonotal triangular mark; tergites dark brown, shiny; pseudo-surstylus well developed, digitiform, stronger sclerotized than epandrium; phallus trifid, all with same length, extending along terminalia; sperm pump with apical collar umbrella-shaped.

Etymology. The species is named after Prof. Herbeson Martins (Universidade Federal do Vale do São Francisco) for his kind collaboration in collecting the studied material and also for donating it to the MZUSP collection.

Description. **Holotype male** (Fig. 1a). Body length: 2.96 mm. Wing: 1.81 mm length, 0.68 mm width. **Head** (Fig. 1a). slightly wider than long, eyes reddish dichoptic, well separated, evenly rounded in profile; ocellar triangle dark brown to black, shiny, sub-elliptical yellowish brown ocelli (Fig. 1b); frons yellow on ventral 1/2 and dark brown to black on dorsal 1/2, lightly widest at ocellar tubercle level, face yellow, bare; proboscis dark yellow to brown, surpassing oral margin by distance greater to head length (Fig. 1a); postcranium dark brown to black, shiny; antenna dark brown, entirely covered by microsetae (Figs. 3a-d); scape short, about 1/2 the length of pedicel, about 2× wider than long; pedicel rounded, 1/3 of first flagellomere length; first flagellomere cylindrical, length 2× its greatest width, with sensorial pits on outer lateral surface (Fig. 3c); second flagellomere digitiform, 3/4 the length of first flagellomere, apical stylus (Fig. 3b). **Thorax**. Mesonotum and scutellum (Figs. 1a-b) dark brown to black, shiny, covered with whitish minute setae; yellow markings on: postpronotal lobe, submedian antero-mesonotal triangular mark connected with postpronotal lobe, supra-alar area, postalar callus. Pleura (Fig. 1a) dark brown to black, shiny, with yellow markings on: proepimeron; anepisternal surround margin, dorsal margin of katepisternum, dorsal 1/3 of meron and

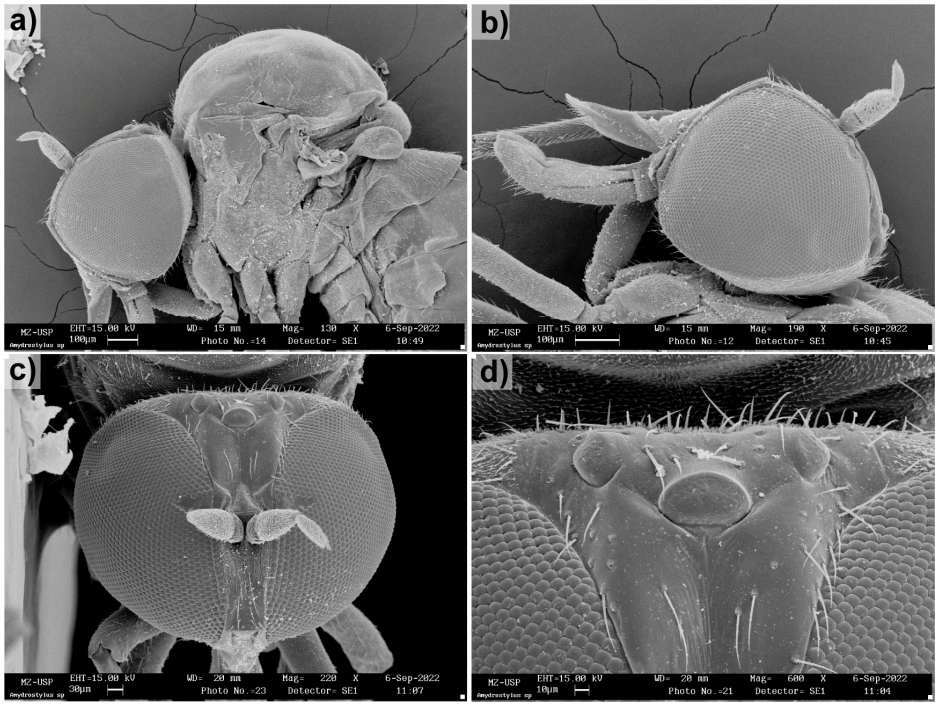

Figure 2. ***Amydrostylus martinsi*** **sp. nov., male paratype, SEM. a) Head and thorax, lateral view. b) Head, lateral view. c) Head, frontal view. d) Ocellar triangle.**

metakatepisternum. **Legs** (Fig. 1a). Coxae dark brown becoming lighter ventrally; fore and mid femur yellow with proximal 1/2 brown, hind femur entirely yellow; tibiae light yellow; tarsi yellow to dark yellow, third to fifth brown tarsomere. **Wing** (Fig. 1c). Elongate, 2.5× longer than wide; hyaline, with discrete maculation localized on cell *Sc*, covered with microsetae; veins brown, well sclerotized; vein *C* ending at the level of the end of R_{4+5}, with short macrosetae; *Sc* evanescent arriving in *C*; R_{4+5} slightly curved down towards the wing margin; M_1 straight to wing margin; M_2 slightly curved at wing margin; M_4 straight to wing margin; A_1 slightly sinuous to wing margin; A_2 almost inconspicuous; cell *cup* open at wing margin by width equal to *r-m* crossvein; fringe of hair on posterior margin. Alula reduced. Halter with stem dark yellow and knob whitish yellow. **Abdomen** (Figs. 1a-b). Tergites dark brown, shiny, covered with yellowish setae; pleural membrane whitish; sternites predominantly yellowish white, anterior margin brown sclerotized. **Terminalia** (Fig. 4). Light brown to dark brown. Epandrium with lobed dorsal margin and long lateral process extending to posterior margin of hypandrium, in lateral view (Fig. 4c); pseudo-surstylus digitiform, more strongly sclerotized than epandrium, with dark brown setae, in lateral view (Fig. 4c); cercus setose, weakly sclerotized, in dorsal view (Fig. 4a); gonocoxite + hypandrium complex elongated, posterior half medially convex, with sinuous lateral lobes, in dorsal and ventral view (Figs. 4a-b), presence of median orifice, in lateral view (Fig. 4c); anterior half fusiform, developed, in dorsal view (Fig. 4a), length proportional to lateral process of epandrium, in lateral view (Fig. 4c); gonostylus bulging on posterior margin, in dorsal view (Fig. 4a); gonocoxal apodeme with projections that unite posteriorly (Figs. 4b-c); ejaculatory apodeme dorsoventrally flattened, in lateral view (Fig. 4c), posterior region with rounded margin, in dorsal view (Fig. 4a); lateral ejaculatory process digitiform, reduced, in dorsal view (Fig. 4a); phallus slender and trifid, all with same length, extending along terminalia, phallus separated on anterior 1/3, in 2/3 get together and splits again at posterior extremity, in lateral view (Fig. 4c).

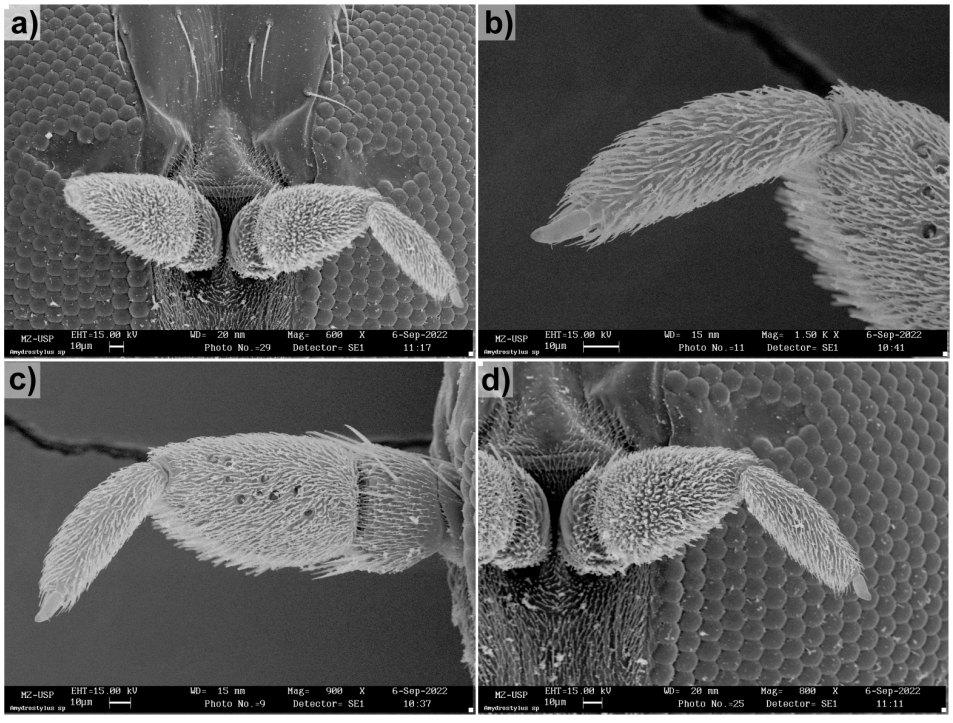

Figure 3. ***Amydrostylus martinsi*** **sp. nov., male paratype, SEM. a) Antenna. b) Second flagellomere, detail of stylus. c) Antenna, detail of the sensorial pits, outer lateral surface. d) Antenna, inner lateral surface.**

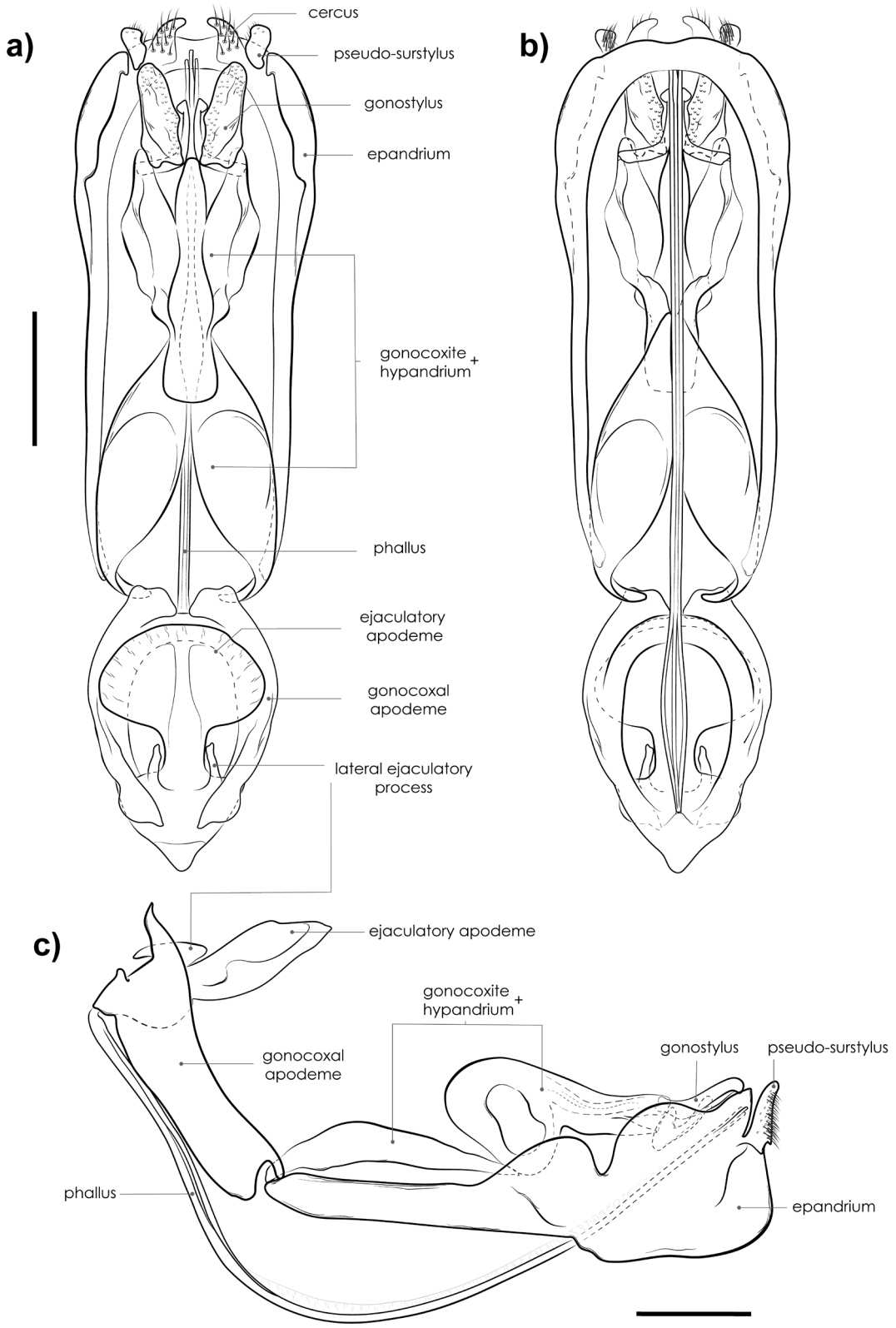

Figure 4. ***Amydrostylus martinsi*** **sp. nov., male terminalia, paratype. a) dorsal view. b) ventral view. c) lateral view. Scale 0.2 mm.**

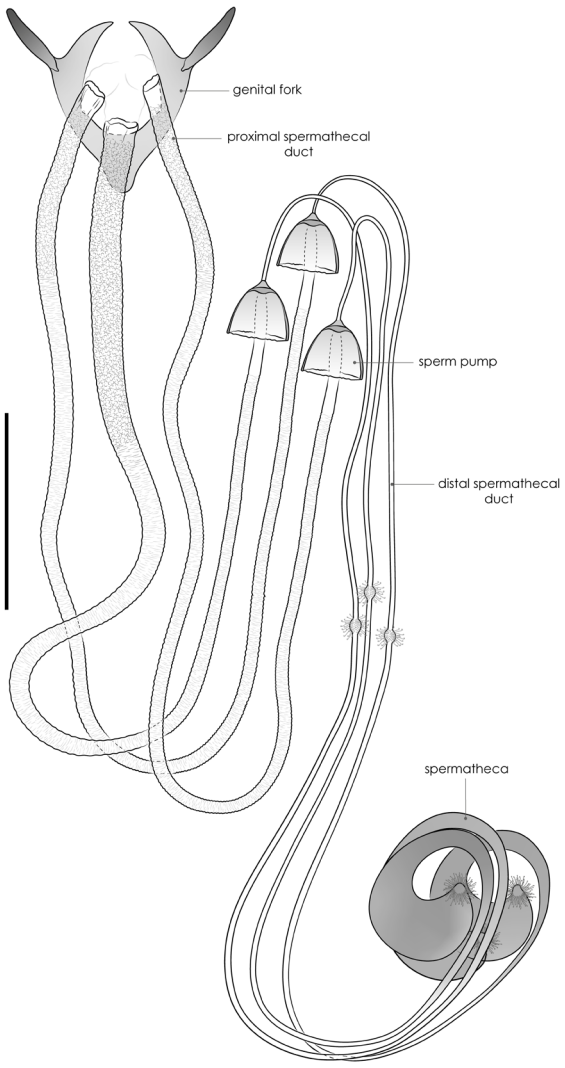

Figure 5. ***Amydrostylus martinsi*** **sp. nov., female terminalia, paratype. Scale 0.2 mm.**

Female. As in male. **Terminalia** (Fig. 5). Genital fork V-shaped, anterior margin arched with short projection, posterior margin bifurcate, inner arms convergent, outer arms divergent, longer and tapered toward apex, more sclerotized; common duct short, membranous; proximal spermathecal duct with length almost equivalent to length of the distal duct, wrinkled, central duct thicker than lateral ones; sperm pump with apical collar umbrella-shaped; distal spermathecal duct with length almost equivalent to proximal duct, striated, with elliptical swelling medially surrounded by minute, tangled, glandular trichomes; spermatheca coiled, gradually widening toward apex, sclerotized until point of union with duct spermatic distal, brown, with glandular trichomes at apex.

Variation. Measurements of males (n = 10): body length: 1.62–2.96 mm, wing: 1.43–1.81 mm length, 0.55–0.68 width. Measurements of females (n = 10): body length: 2.28–2.88 mm; wing: 1.55–1.72 mm length, 0.59–0.62 width. Thorax, mesonotum sometimes with yellow mark along the transverse suture. Pleura with yellow marking on dorsal 1/3 of katepisternum.

Geographical records. This species is known from the Brazilian state of Pernambuco (Fig. 6), in area of Caatinga Biome, semi-arid climate.

Type material. Holotype male deposited in MZUSP: Brazil, Pernambuco, Petrolina, UNIVASF – CCA, 9°19'19" S, 40°33'40" W, Malaise, 22.ii.2020, Martins, H.O.J. Paratypes. Same data as holotype (3♂, 3♀ BPBM; 2♂, 2♀ CZMA; 26♂, 47♀ MZUSP).

Remarks. *Amydrostylus martinsi* **sp. nov.** differs from *Amydrostylus triadicophallus* by having the notopleural and prescutellar area brown to dark brown (notopleural and prescutellar area yellowish white in *A. triadicophallus*); tergites mostly dark brown and shiny (tergites yellowish white with light brown spots in *A. triadicophallus*); pseudo-surstylus well developed, stronger sclerotized than epandrium, digitiform (pseudo-surstylus undeveloped, pointed in *A. triadicophallus*); trifid phallus of equal length to each other (central phallus more than 2× longer than lateral in *A. triadicophallus*); sperm pump with apical collar umbrella-shaped (sperm pump without apical collar in *A. triadicophallus*); sperm pump of equal length to each other (central sperm pump about 2× the length of lateral in *A. triadicophallus*).

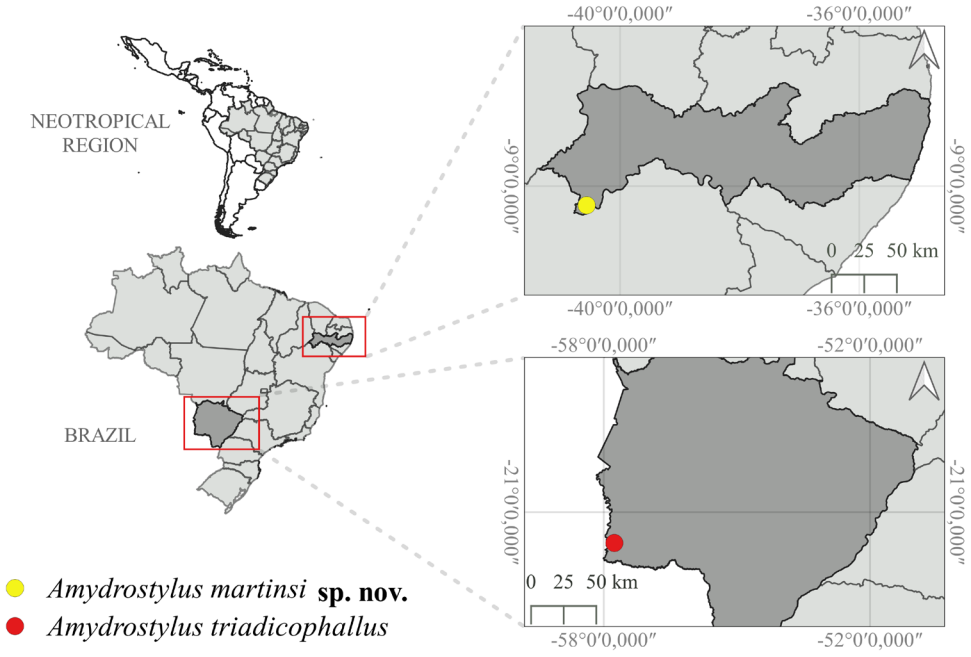

Figure 6. Geographical records of *Amydrostylus* known from Brazil.

DISCUSSION

Amydrostylus is an unusual genus of micro bee flies found in the Neotropical Region, and the discovery of its second species allowed us to refine the diagnosis presenting new diagnostic characters for the genus: inner margin of the compound eyes with a triangular notched area, above the level of base of antennae, without ommatidia; epandrium with long lateral process; phallus slender and trifid and spermatheca coiled. It was observed that the trifid pattern of phallus appears to be a generic character rather than something specific to *A. triadicophallus*, as Lamas et al. (2015) suspected, and despite the variation in the size of each of the three ducts (central phallus more than 2× longer than lateral phallus in *A. triadicophallus*, and equivalent length of all three phalli in *A. martinsi* **sp. nov.**). Comparative morphological study among the genera of Psiloderoidinae should be implemented in order to understand if the trifid condition of the phallus is synapomorphic at the subfamily or genus level.

The male terminalia of *Amydrostylus* is still remarkable by the presence of unusual morphological features, different from the Mythicomyiidae groundplan. The genus presents a gonocoxite + hypandrium complex, morphologically peculiar, making a clear delimitation difficult. In most groups, the hypandrium is absent, as observed by Yeates (1994). Another structure that draws attention is the pseudo-surstylus, which normally presents itself as a conspicuous pointed process in most groups, but in *Amydrostylus* this process is well developed and sclerotized, which seems to be articulated with the epandrium or, if not articulated, they are just separated by a much less sclerotized or even a membranous connection. In some species of the genus *Glabellula* Bezzi, 1902, it is also possible to observe a robust process (Evenhuis, person. comm).

These detailed morphological studies (mainly of the male and female terminalia) have enabled a better delimitation of the group, on a generic and specific level, as well as making possible the construction of new hypotheses of primary homology, which in the future will be able to be tested in a cladistic analysis approach (under development). This comparative study

also brought light to the peculiar morphology of the male terminalia and made it possible to better understand some of its structures, such as the gonocoxites that are united to the hypandrium; and what Lamas et al. (2015) named as the hypandrium that is, in fact, the gonocoxal apodeme.

Nothing is yet known about *Amydrostylus*' bionomy. Aspects such as life cycle, hosts and behavioral habits have not yet been observed. What we can infer, once again, is that the group seems to have a well-established niche in arid and semi-arid environments, where they are more commonly found, as already mentioned by Greathead & Evenhuis (2001) and Lamas et al. (2015), and now corroborated in this study since the type-locality is inserted in the Caatinga biome (strongly determined by the semi-arid climate). The disjunct distribution recorded for the *Amydrostylus* species in Brazil (Fig. 6), together with their above mentioned preference for arid or semi-arid environments, suggest that other species of the genus may be found through the dry diagonal of South America, which is still undersampled for the entomofauna in general. New collection efforts through these biomes (Caatinga, Cerrado and Chaco) should be organized in order to look for new *Amydrostylus* species.

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Author contributions

All authors contributed made critical revision and added intellectual content. Luanna Mendes prepared the manuscript; Carlos Lamas, Neal Evenhuis and Francisco Limeira-de-Oliveira contributed to analysis and interpretation of the data.