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ARTICLE

New species of *Sycorax* (Diptera: Psychodidae) from the Brazilian Amazon

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Abstract. Moth flies of the subfamily Sycoracinae have been associated with anurans. Females of some species have been found feeding on the blood of these vertebrates. Here we describe a new species of the genus *Sycorax* Curtis from a preserved site of Amazon Forest in the city of Manaus, Amazonas, Brazil, with one male specimen collected in the dorsum of the frog *Anomaloglossus stepheni* (Martins).

Keywords. Taxonomy, New taxa, Hematophagous, Neotropics.

INTRODUCTION

Among the Psychodidae, the subfamily Sycoracinae comprehend a group of moth flies which adult of some species have been collected in association with anurans (Desportes, 1942; Bravo & Salazar-Valenzuela, 2009; Curler *et al.,* 2015; Ježek *et al.,* 2015). These associations showed evidence of females feeding on blood of these vertebrates and males with an aggregation behaviour, possibly to mate. This subfamily has 55 current species described (Bravo *et al.,* 2023; Faé *et al.,* 2023), distributed in four genera: *Sycorax* Curtis, 1839, with 43 known species, *Parasycorax* Duckhouse, 1972, with six described species, *Falsosycorax* Bravo & Araújo, 2023, with five species, and the monospecific *Aposycorax* Duckhouse, 1972. In the Neotropics, 12 species of *Sycorax* have been described (Bravo *et al.,* 2023). Here we describe a new species from central Amazonia and discuss its possible association with the frog *Anomaloglossus stepheni* (Martins, 1989).

MATERIAL AND METHODS

All specimens were collected in the grids used for long term ecological studies of two forested areas of the municipality of Manaus, Amazonas, Brazil: *Reserva Florestal Adolpho Ducke* and *Fazenda Experimental da UFAM*. The codes L3 3500 and NS01/100 indicate specific points on those grids which coordinates are 02°56′28.4″S, 59°56′10.4″W and 02°39′40.9″S, 60°03′49.8″W, respectively. Specimens were collected using Malaise (one male and one female) and CDC light traps (three males and one female), except for one male that was manually collected while resting on top of the frog *Anomaloglossus stepheni*. Specimens were preserved in alcohol 70%. They were mounted using the following methodology: diaphanization in KOH 10% at 50°C for approximately 3 hours, and immersion in the following solutions for 10 minutes each: water, 10% acetic acid, distilled water, 70% alcohol, absolute alcohol, clove oil and 5 minutes in butyl acetate, and finally slide mounted using Canadian balsam. Photomicrographs were captured using a Leica DM5500 B optical microscope, with Leica DFC295 camera and the z-stacking function included in Leica Application Suite LAS V3.6 digital imaging software. The specimens will be deposited at the Entomological Collection of the *Instituto Nacional de Pesquisas da Amazônia* (INPA), Manaus, Amazonas, Brazil, and at the Entomological Collection Prof. Johann Becker of the *Museu de Zoologia da Universidade Estadual de Feira de Santana,* Feira de Santana, Bahia, Brazil (MZFS). General morphology follows Cumming & Wood (2017) with specifications for the family of Kvifte & Wagner (2017).

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RESULTS

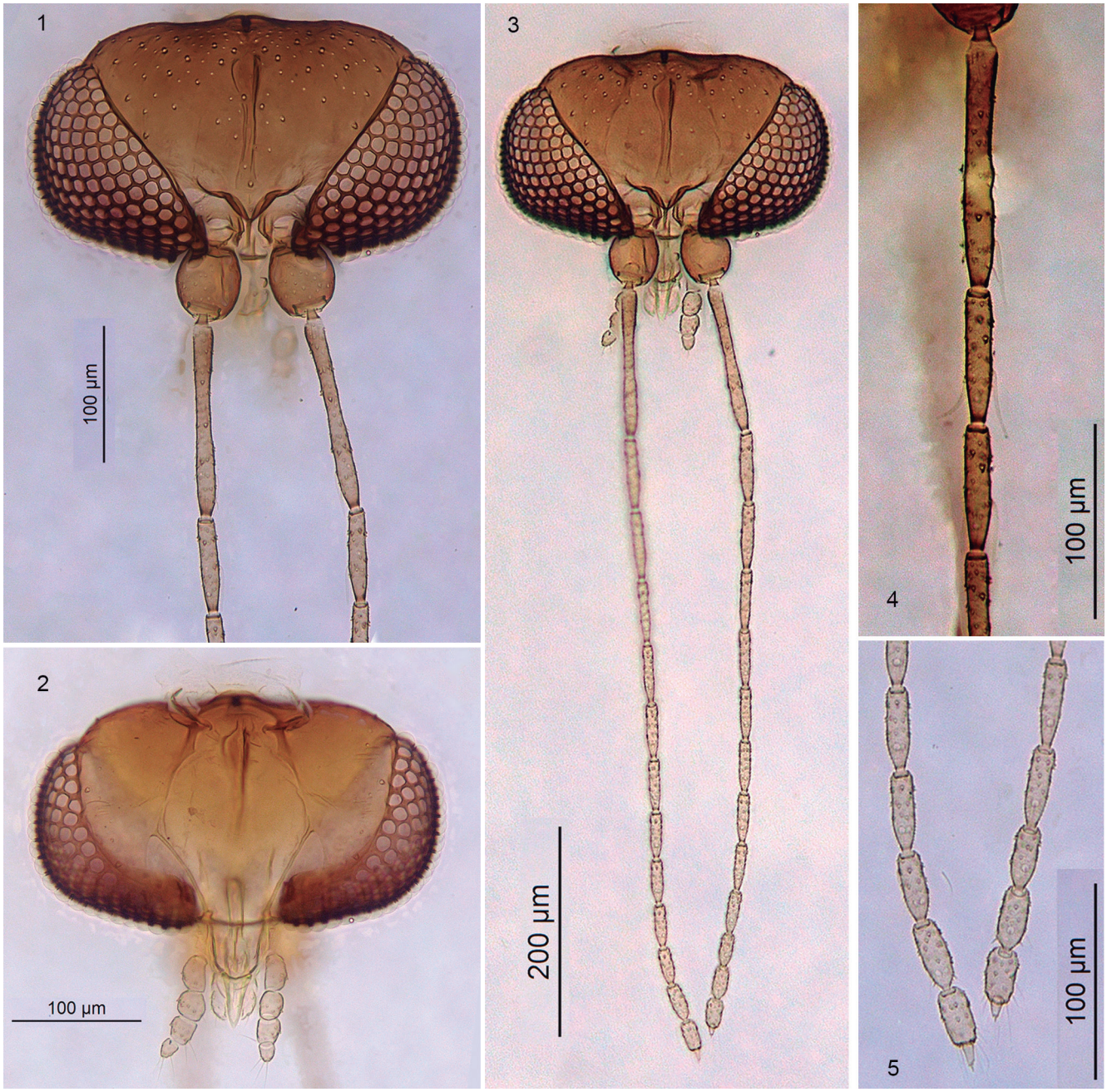
Taxonomy

Sycorax manauara Cordeiro & Bravo sp. nov. Figs. 1-18

Diagnosis: The new species can be differentiated from all other *Sycorax* by the combination of the following characteristics: gonocoxite with long bristle inserted subapically, on internal surface; gonostyle with apical spine and without subapical setae; paramere with an external convex and robust main structure, bearing one dorsal and one ventral subapical long setae, and a medial hooked branch; aedeagus bifid, developed in two long and sinuous genital filaments.

Etymology: The epithet 'manauara' is a noun in apposition, referring to the gentilic used for people born in the city of Manaus.

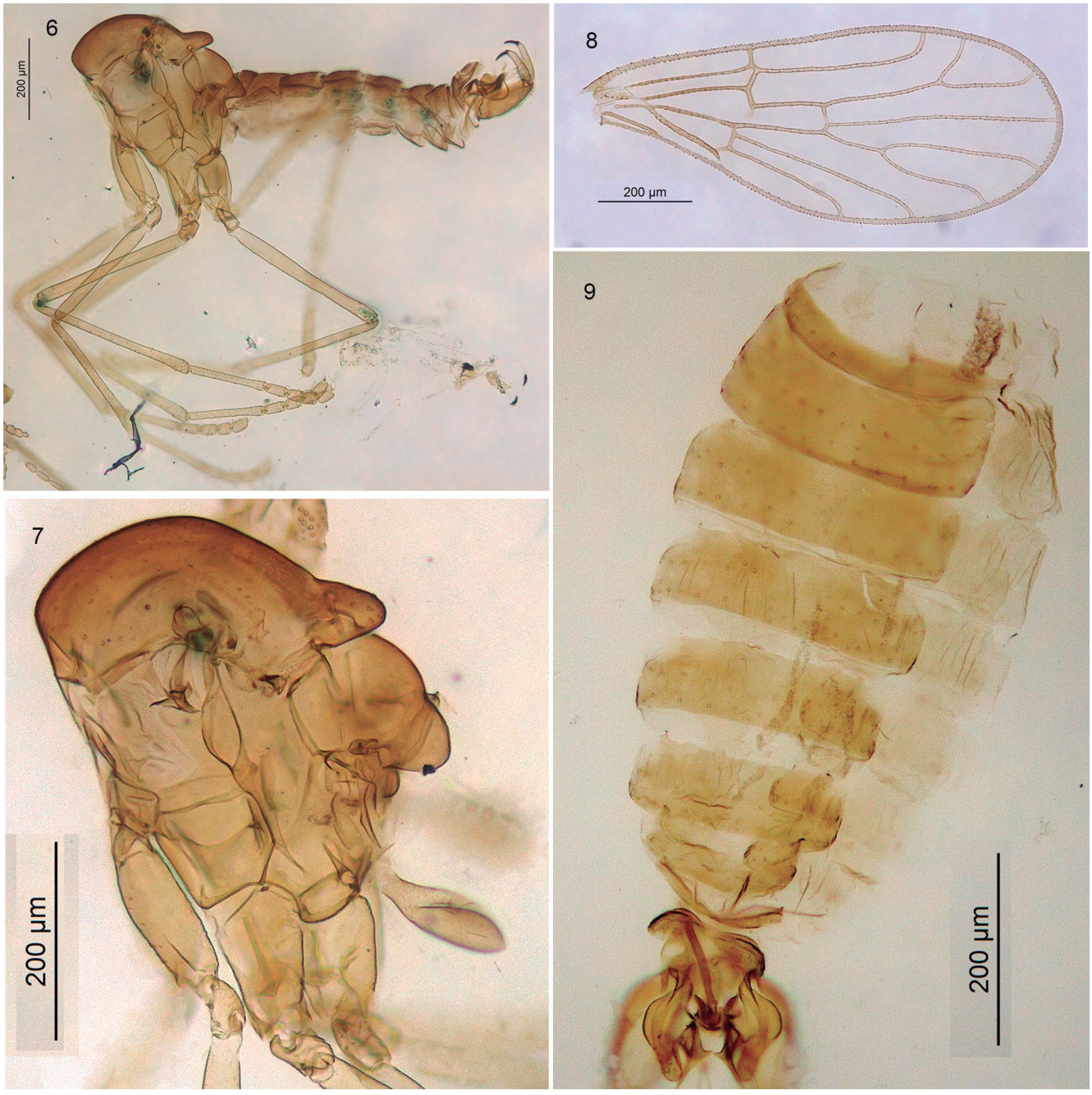
Material examined: Holotype ♂ Brazil, AM, Manaus, Reserva [Florestal Adolpho] Ducke, L3 3500 [-2.941228, -59.936225], ponto 1, Malaise 24:00 h, x.2014, col. Samuel Azevedo (INPA). Paratypes: 1♀ Brazil, AM, Manaus, Reserva [Florestal Adolpho] Ducke, L3 3500 [-2.941228, -59.936225], ponto 1, Malaise 72:00 h, x.2014, col. Samuel Azevedo (INPA); 1♂ Brazil, AM, Manaus, 04.v.2019, captured on the dorsum of *Anomaloglossus stepheni,* col. Ramires, A. (INPA); 3♂ Brazil, AM, Manaus, Fazenda [Experimental] da UFAM, NS01/100 [-2.661359, -60.063842], [cdc trap], 14.vii.2019, col. Ramires, A.C. (1 INPA, 2 MZFS); 1♀ Brazil, AM, Manaus, Fazenda



Figures 1-5. *Sycorax manauara* **sp. nov.**, male head. (1) Anterior view. (2) Posterior view. (3) Head and complete antennae. (4) Detail of flagellomeres 1-3 with ascoids. (5) Detail of apical flagellomeres.

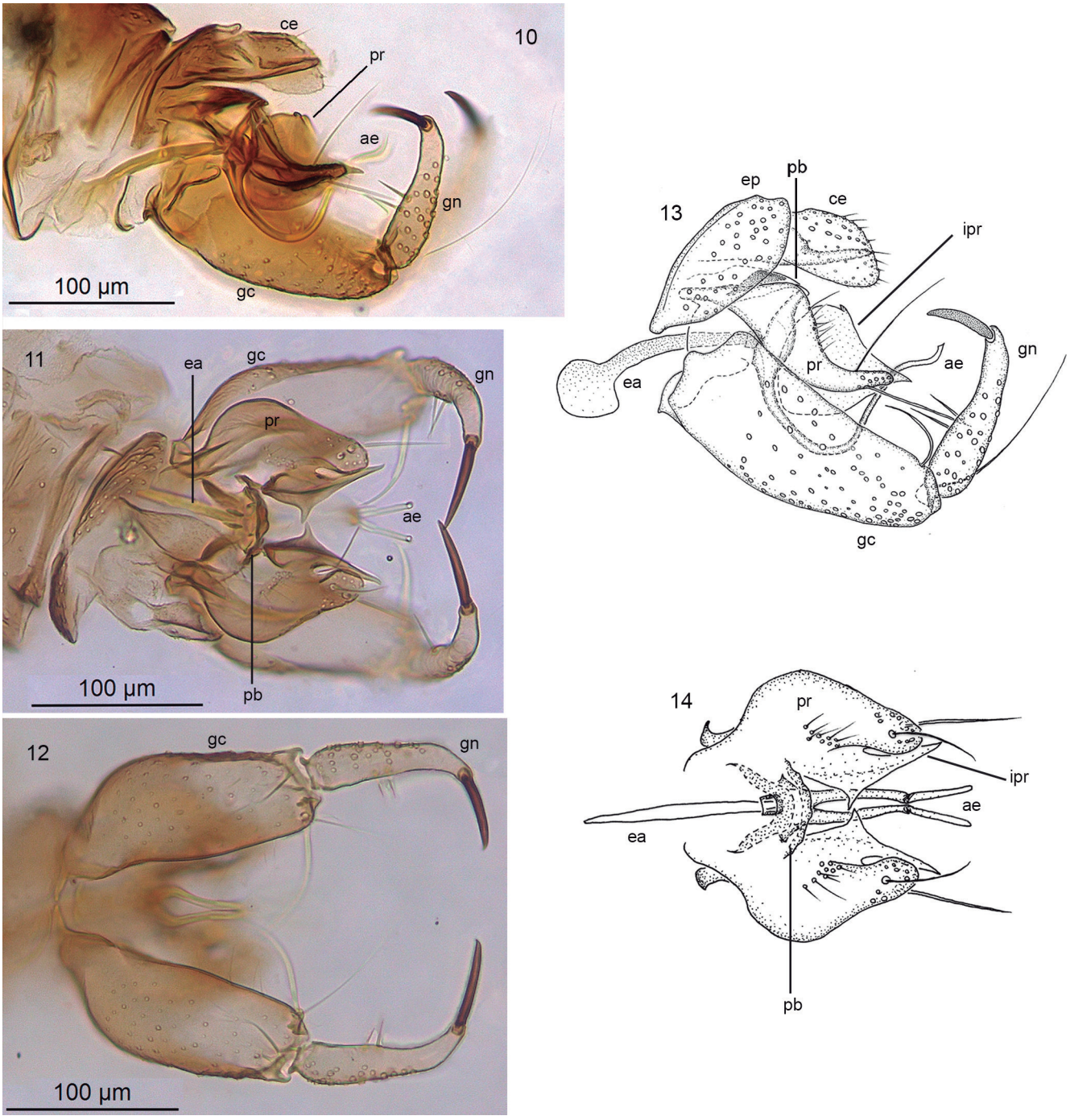
[Experimental] da UFAM, NS01/100-60 [-2.661359, -60.063842], [cdc trap], 28.iv.2019, CDC, col. Ramires, A.C. (MZFS).

Description: Male. Head (Figs. 1-3) ellipsoid in frontal view, 1.5x broader than long (to the tip of clipeus); eyes rounded, minimum interocular distance above insertion of antennae 9.2x diameter of ommatidium (Fig. 1). Antenna (Figs. 3-5): scape broader than long; pedicel sub-spherical, 2.7x longer then scape; flagellum with 13 flagellomeres cylindrical and tapered; flagellomere I 2.2x longer than flagellomere II, other flagellomeres progressively shorter; ascoids (Fig. 4) paired, digitiforms, inserted on each side of flagellomeres I-III, extending beyond apex of flagellomeres; last flagellomere with small cylindrical apiculum (Fig. 5), ornamented with one apical spine, around 0.5 times smaller than flagellomere; distal extremity of flagellomere XIII bearing several bristles longer than apiculum. Palpus with four segments (Fig. 2), total length 0.7 times length of flagellomere I; second segment with a cluster of Newstead sensilla on medial surface; relative length of palpus segments: 1.0: 0.8: 0.7: 0.5. Thorax (Figs. 6-7). Scutum, scutellum, wing veins, halteres and legs pilose; pleura without setae. Wing length 0.97 mm, 2.35x larger than width (Fig. 8); apex rounded; Sc reaching C; R_{2+3} and R_2 parallel to R_1, ratio of distance of R_2-R_1/R_2-R_3 0.5; R_{4+5} terminating at apex; vein r-m short; m-m present; M_4 reaching wing margin just after the level of r-m; CuA short, not reaching margin of wing. Knobs of halteres ovoid, with scales sparsely and homogeneously distributed and with one (sometimes 2) setiform seta on its apical half. Abdomen (Fig. 9). Tergites 1 and 7



Figures 6-9. *Sycorax manauara* **sp. nov.**, male body. (6) Lateral view. (7) Thorax, lateral view. (8) Wing. (9) Abdomen, dorsal view.

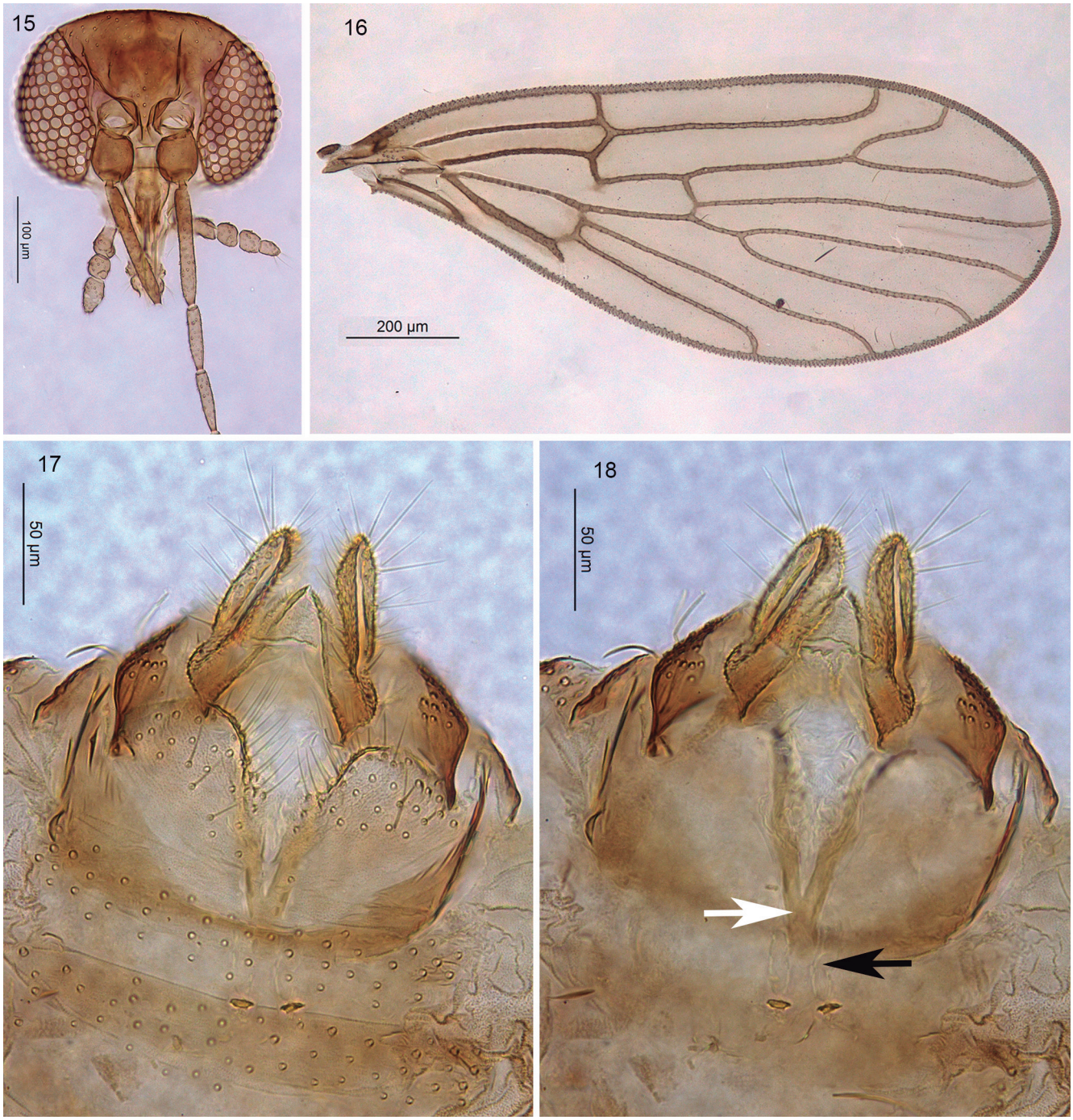
with a single row of setae, tergites 2-6 with two rows of setae, tergite 8 narrow and without setae. Terminalia: epandrium pilose; cercus longer than broad in dorsal view, with setae inserted on its posterior 1/3, mostly medially; hypoproct ending near the same level of cerci, with rounded micropilose apex (Fig. 10). Gonocoxite cylindrical (Figs. 10-13), 2.5x longer than broad, long bristle inserted subapically, on internal surface; gonostyle slender, 0.7 length of gonocoxite, curved inward near apex, subterminal bristle absent; apical thick bristle (spine), 0.49x length of gonostyle. Paramere robust (Figs. 10-11, 13-14), narrowing at base, with two parts, an external convex and robust main structure, 1.8x longer than broad and a medial hooked branch; external robust part of paramere with a group of short setae dorsally and another group of short setae on rounded apex, from where arise two long setae, one dorsal and one ventral. Dorsally, parameres are united by the dorsomedian process of the paramere [= parameral bridge (pb)], which has a V-shaped sclerotized area ventrally. Aedeagus bifid, developed in two long and sinuous genital filaments, base expanded, articulating with the parameral bridge dorsally (Fig. 13); ejaculatory apodeme with approximately the same length as paramere (Fig. 13).



Figures 10-14. *Sycorax manauara* **sp. nov.**, male Terminalia. (10) Lateral view. (11) Dorsal view. (12) Ventral view. (13) Detailed drawing of lateral view. (14) Detail of aedeagal complex. Abbreviations: ae = aedeagus; ce = cercus; ea = ejaculatory apodeme; ep = epandrium; gc = gonocoxite; gn = gonostyle; ipr = internal branch of paramere; pb = parameral bridge; pr = paramere.

Female. Similar to male, except for the following: Head (Fig. 15) 1.25 times broader than long; eyes rounded, discrete groove close to insertion of the antenna, interocular distance 10 times diameter of ommatidium. Palp segment 2 with a cluster of Newstead sensilla on medial surface. Cibarium with one pair or inconspicuous spines. Antennae with one ascoid inserted on inner side on flagellomeres I-IV, ascoids more discrete than in males. Wing (Fig. 16) similar to that of male, except for length 1.69 mm, 3.18 times longer than width, R_1 reaching wing margin beyond level of R_{2+3} fork, R_2 converging to R_1 on basal third then diverging from it apically, M_3 surpassing level of R_{2+3} fork, M_4 reaching wing margin at level of M_{1+2} fork. Tergite 8 and sternite 8 without bristles. Sternite 8 with two pilose lobes (Fig. 17); tergite 9 sub-rectangular and pilose; cercus longer than broad in dorso-ventral view; hypoproct with apex rounded and micropilose. Sternite 9 (genital fork) well sclerotized, 2 times longer than greatest width (Fig. 18); spermathecal duct slightly sinuous, terminating in sclerotized button, which gives way to an amorphous tenuous sac (Fig. 18).

Discussion: The sinuous shape of genital filaments of the aedeagus seen in the new species is unique, although it resembles those of the five *Falsosycorax* species, which are known from the Andes of Ecuador and Colombia.



Figures 15-18. *Sycorax manauara* **sp. nov.**, female. (15) Head, anterior view. (16) Wing. (17) Apex of abdomen, ventral view. (18) Genital fork (white arrow) and sphermathecal ducts (black arrow).

However, the new species lacks the median dorsal process of the aedeagus, that can be found in these five species, and lacks, too, the two or three long basal spines in the gonostylus present in the Andean species. Instead, it has two spiniform setae, not developed as spines. A long subapical seta, near de apical spine, is present in most species of *Sycorax,* but it is absent in the new species, as well as in *F. andicola* (Young, 1979) and *F. trispinosa* (Young, 1979). A long bristle in the gonocoxite as described to the new species is only observed in three other species of the genus, *Sycorax bravoi* Santos, Ferreira & Falqueto, 2011, *Sycorax longispinosa* Bravo, 2007, and *Sycorax malayensis* Quate, 1962.

The number and disposition of spines on the gonostyli is an important character for Sycoracinae species diagnosis. Along with *Sycorax manauara* **sp. nov.**, other nine Neotropical species of *Sycorax* (*S. longispinosa, S. confusa* Bravo, Rocha & Santos, 2010, *S. bahiensis* Bravo, 2003, *S. cariacicaensis* Santos & Bravo, 2009, *S. tuberculata* Santos, Bravo & Falqueto, 2013, *S. assimilis* Barretto, 1956, *S. espiritosantensis* Santos & Bravo, 2009, *S. bravoi* and *S. canaanensis* Santos, Bravo & Falqueto, 2013) have also only an apical spine on each gonostylus, but their distally bifid aedeagus are not developed in long genital filaments as seen in the new species. *Sycorax longispinosa* and *S. confusa* are also easily differentiated from the new species by the long and strong setae near the paramere apex, measuring twice the length of the paramere. In the new species the paramere has two long setae near its apex, one on the dorsal and one on the ventral surface of the paramere, both shorter than the length of the paramere. *Sycorax canaanensis* have one long and one short setae near the apex of the paramere, but both on the dorsal surface. The other six neotropical species of *Sycorax* have only a single long setae or no long setae at all on the paramere. Also, the overall shape of the paramere is unique for all these species.

Although we did not test for the identification of DNA samples of vertebrate blood in the female specimens, one male of the new species was collected in the dorsum of the frog *Anomaloglossus stepheni.* A single male specimen does not confirm an association but given our current knowledge, it is expected that species of Sycoracinae can be associated with anurans. Bravo & Salazar-Valenzuela (2009) reported the presence of many males (in majority) and females of *Falsosycorax wampukrum* (Bravo & Salazar-Valenzuela, 2009) on the dorsum of the frog *Atelopus* sp. in Ecuador and suggested the behavior of aggregation of males to mate. Ježek *et al.* (2015) reported aggregation of males of two species of *Sycorax* on two frog species in Brunei and Curler *et al.* (2015) showed that the females of *Aposycorax chilensis* (Tonnoir, 1929) prefer to feed on the blood of species of frogs. We believe that males of *Sycorax manauara* **sp. nov.** may have a similar behavior and encourages new field expeditions to confirm and better understand what would be the first association in Brazil between a Sycoracinae and an anuran species.

AUTHORS' CONTRIBUTIONS: DPC: Conceptualization, Visualization, writing – original draft; ACR, DPC, FB: Investigation, Resouces; DPC, FB: formal analysis, writing – review & editing. All authors actively participated in the discussion of the results, they reviewed and approved the final version of the paper.

CONFLICTS OF INTEREST: Authors declare there are no conflicts of interest.

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