

A new fossil species of Phlebotominae sand fly from Miocene amber of Chiapas, Mexico (Diptera: Psychodidae)

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Abstract The male of *Pintomyia (Pifanomyia) bolontikui* sp. nov., from the Miocene Mexican amber deposits of Simojovel, Chiapas, is described. This is the second fossil phlebotomine sand fly described from Mexico. Morphological differences between fossil and extant species of American phlebotomine sand flies are discussed.

Keywords Mexican amber · Phlebotomine · *Pintomyia*

Kurzfassung *Pintomyia (Pifanomyia) bolontikui* sp. nov. aus dem Miozänen Mexikanischen Bernstein von Simojovel, Chiapas wird beschrieben. Dies ist die zweite beschriebene fossile Phlebotomine aus Mexiko. Morphologische Unterschiede zwischen fossilen und rezenten Arten der amerikanischen Phlebotominae werden diskutiert.

Schlüsselwörter Mexikanischer Bernstein · Phlebotomine · *Pintomyia*

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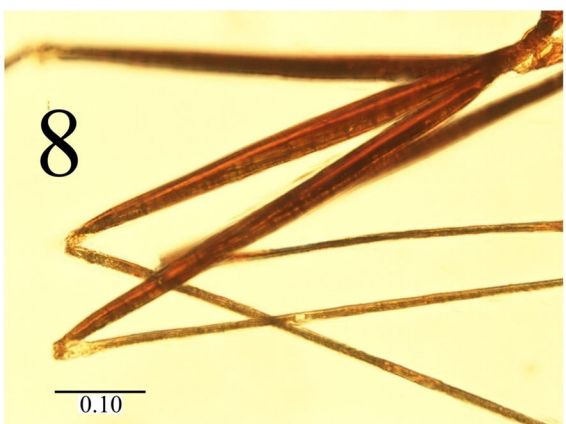
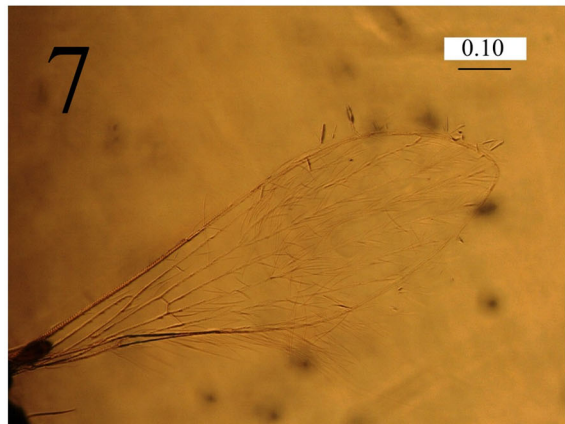
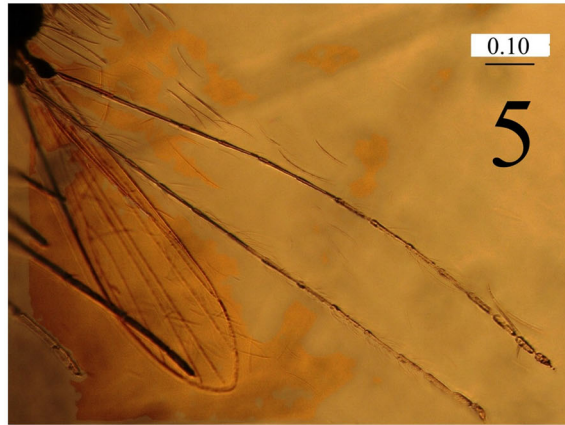
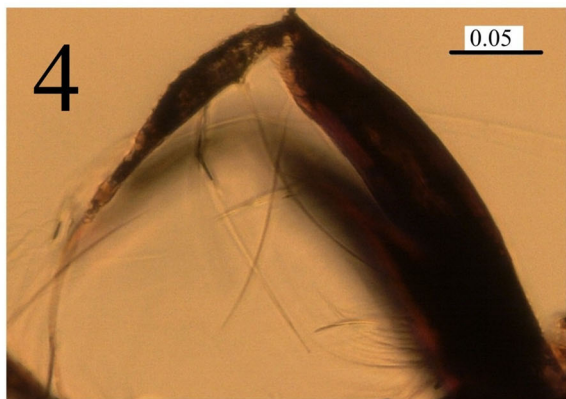
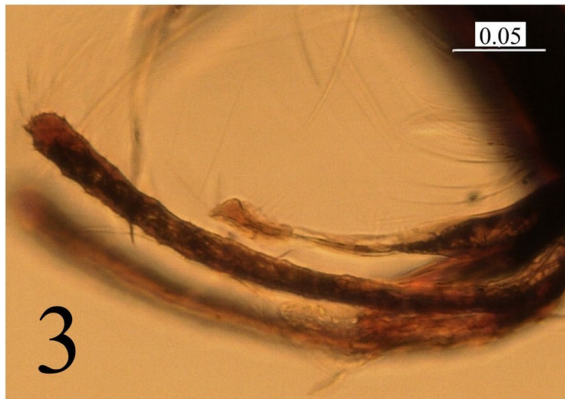
Introduction

Phlebotominae is one of the six subfamilies of Psychodidae, with more than 800 species described worldwide (Wagner 2009; Curler and Moulton 2012). Due to their medical and veterinary importance, it is the best studied group of psychodids, as their females are hematophagous and involved in the transmission of pathogens, principally those that produce all clinical types of leishmaniasis (Young and Arias 1991). Nevertheless, their taxonomy is controversial and much discussed. Rohdendorf (1964) as well as Abonnenc (1976) and Williams (1993) gave them family rank, whereas they were treated as a subfamily of Psychodidae including six genera of Phlebotominae according to Lewis et al. (1977) and Young and Duncan (1994), as a subfamily including 24 genera according to Artemiev (1991), and as a subfamily including 31 genera according to Galati (2003).

Psychodidae are known from the Lower Jurassic (An-sorge 1994; Krzeminski 2003) and probably from the upper Triassic (Blagoderov et al. 2007).

The oldest records of phlebotomine-like species from amber are from the Lower Cretaceous deposits of France (Perrichot et al. 2007), Spain (Declòs et al. 2007) and Lebanon (Azar et al. 1999), although the placement of some of these species into the Phlebotominae still is a matter of debate (Lukashevich 2003). Furthermore, two species of *Phlebotomites* from Lebanese amber (Hennig 1972) and *Palaeomyia burmitis* from Burmese amber (Poinar 2004) show evidence of blood-sucking habits that, in addition to other morphologic characteristics, support their inclusion in Phlebotominae.

From the Eocene, two genera, *Phlebotomiella* and *Sergentomyia*, are known from Baltic amber (Andrade Filho and Brazil 2003) and one more from Indian amber



◀ **Fig. 1** Photographs of *Pintomyia* (*Pintomyia*) *bolontikui* sp. nov. (holotype, male, Mx 351.3). **1** General view; **2** body close-up; **3** detail of paramere, lateral lobe and cercus; **4** detail of gonopod; **5** antennae; **6** head and its appendages; **7** wing; **8** detail of hind femora. Scales in millimeters

described as *Phlebotoiella* by Solórzano Kraemer and Wagner (2009).

From the New World, 16 fossil species are described to date from the Miocene Dominican and Mexican amber deposits. These correspond to the genus *Lutzomyia* França (sensu Young and Duncan 1994) or to genera *Micropygomyia* Barretto (3 spp.), *Pintomyia* Costa Lima (12 spp.), and *Psathyromyia* Barretto (1 sp.) (sensu Galati 2003), (Poinar 2008; Andrade Filho et al. 2009a; Andrade Filho et al. 2009b).

From the Mexican amber deposit of Simojovel de Alende, Chiapas, which is dated to the Miocene age (20 Ma) (Solórzano Kraemer 2007), only the phlebotomine sand fly *Micropygomyia* (*Sauromyia*) *paterna* Quate, 1963 sensu Galati (2003), described as *Phlebotomus paternus*, has been recorded. In this report the second species of phlebotomine sand fly from the Simojovel amber is described based on morphological characteristics of a male specimen.

Materials and methods

The piece of amber containing the specimen was polished to form a cube, measuring 7.5×5.2 (principal surface) $\times 3.3$ mm (proof). The specimen was examined using a Nikon Eclipse 50i microscope. Measurements were obtained with an ocular micrometer and are given in millimeters. Drawings were rendered with the aid of a Nikon Y-IDT drawing tube and digitally processed with Corel Photo Paint X3 (Version 13). Microphotographs were captured with a Nikon Digital Sight DS-2Mv camera using NIS-Elements F 3.2 and later edited for clarity using Helicon Focus v. 4.75.

Morphological terminology is in accordance with Young and Duncan (1994) and Galati (2003). We follow the phylogenetic classification proposed by Galati (1995, 2003), but the equivalent nomenclature according to Young and Duncan (1994) is included for reference. Abbreviations for genera and subgenera names follow the proposed system of Marcondes (2007).

Systematic palaeontology

Family Psychodidae Newman
Psychodidae Newman 1834: 388; 1835, 185–254 (as Psychodites).

Subfamily Phlebotominae Rondani
Phlebotominae Rondani, 1840: 10, 12 (as Flebotomidae).
Tribe Phlebotomini Rondani
Phlebotomini Rondani, 1840: 12.
Subtribe Lutzomyiina Abonnenc and Leger

Lutzomyiinae Abonnenc and Leger, 1976: 357 (as subfamily of Phlebotomidae, as they considered it a distinct family separated from Psychodidae). Type genus: *Lutzomyia* França, 1921.

Lutzomyiina Abonnenc and Leger: as subtribe sensu Galati 2003, 34.

Genus *Pintomyia* Costa Lima
Phlebotomus, subgenus *Pintomyia* Costa Lima, 1932: 44.
Type species: *Phlebotomus fischeri* Pinto.

Phlebotomus, species group *triacanthus*, series *fischeri*: Fairchild, 1955: 194.

Lutzomyia, subgenus *Pintomyia* Costa Lima: Barretto, 1962: 92;

Lutzomyia species group *Verrucarum* Theodor, 1965: 183; Lewis et al., 1977: 325; Martins et al., 1978: 124 (in part); Young and Duncan, 1994: 171.

Pintomyia Costa Lima: Forattini, 1971: 103 (in part); Forattini, 1973: 497 (in part); Artemiev, 1991: 73; Galati, 2003: 37.

Subgenus *Pifanomyia* Ortiz and Scorza (=species group *Verrucarum* Theodor, sensu Young and Duncan 1994)

Pifanomyia Ortiz and Scorza, 1963. Type species: *Flebotomus serranus* Damasceno and Arouck; Galati, 2003: 37.

Pintomyia (*Pifanomyia*) *bolontikui* sp. nov.
(Figs. 1, 2).

Diagnosis

The specimen can be clearly distinguished from other *Pintomyia* by: palpus with segment 5 larger than segments 3 + 4, hind femur without longitudinal row of short spines, male terminalia with a patch of persistent setae on basal half, gonostylus with subterminal setae and four large spiniform setae inserted at different levels, paramere long, simple, and truncate.

Description

Holotype, male, Mx 351.3. Body length 1.55 mm, coloration dark brown, with mesonotum and pleura concolours, abdomen slightly paler.

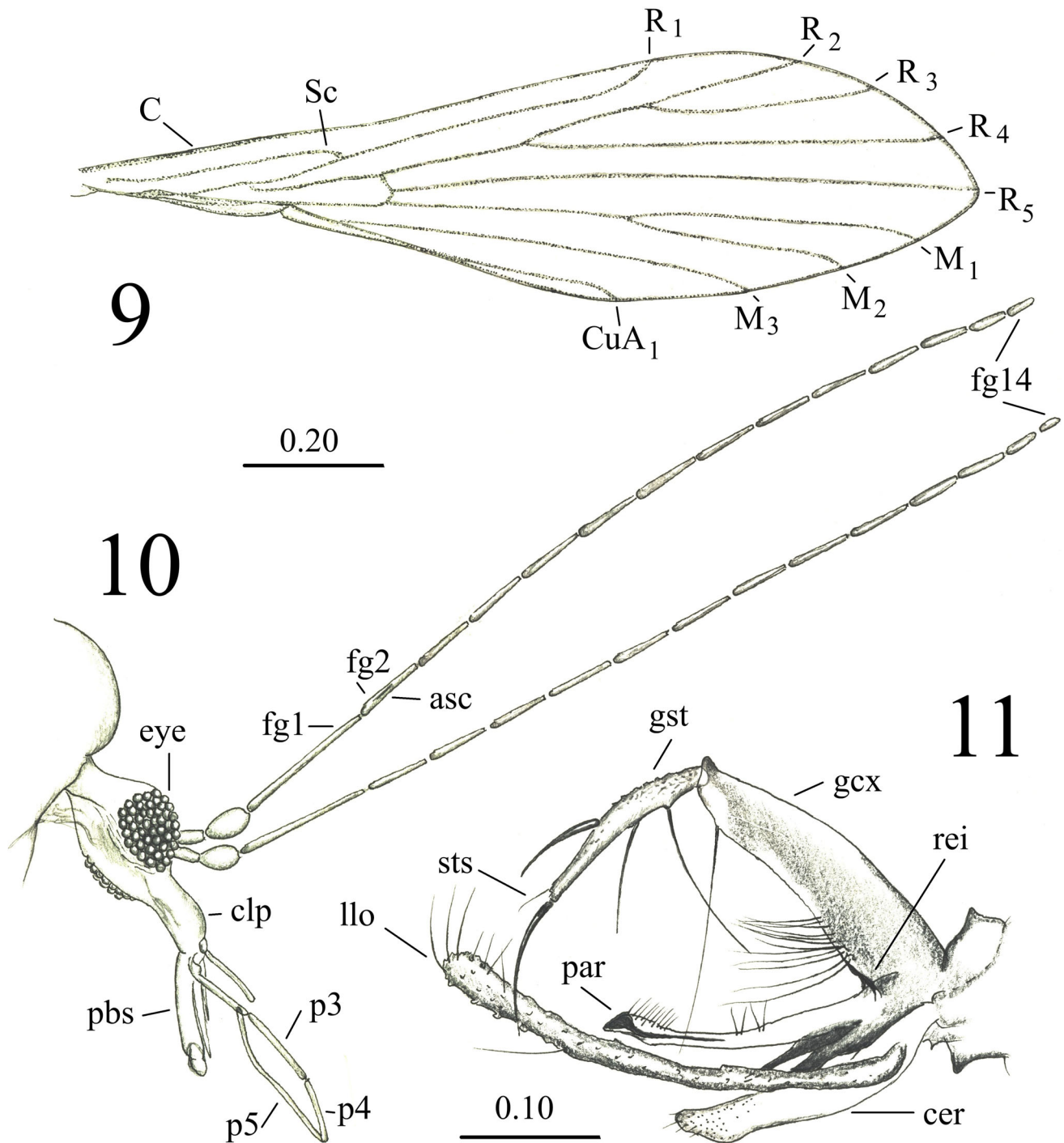


Fig. 2 Drawings of *Pintomyia (Pintomyia) bolontikui* sp. nov. (holotype, male, Mx 351.3); **9** wing; **10** head and appendages; **11** male terminalia, lateral. Abbreviators: *asc* ascoid, *der* cercus, *clp* clypeus, *eye* eye, *fg1*–*fg2*, *fg14* flagellomeres 1, 2, and 14,

respectively, *gcx* gonocoxite, *gst* gonostylus, *llo* lateral lobe, *par* paramere, *pbs* proboscis, *p3*–*p5* palpal segments 3, 4, and 5, respectively, *rei* reinforcement of gonocoxite, *sts* subterminal seta. Figs. **9** and **10** same scale. Scales in millimeters

Head oblique extended forwards and laid on its side, length from vertex to apex of clypeus 0.325 mm, clypeus 0.11 mm, length of proboscis 0.175 mm; palpus length: 0.635 mm; palpomere proportions: 1.0: 4.0: 5.0: 3.6: 11.8 (in mm: 0.025: 0.1: 0.125: 0.09: 0.295); palpus segment five

longer than the sum of 3 + 4, but shorter than 2 + 3 + 4. Labrum–epipharynx reaching middle of palpomere 3 and nearly the apex of flagellomere 1. Antenna with flagellomere 1 as long as 1.17 the length of labium, scape (0.045 mm) nearly as long as pedicel (0.055 mm), flagellum

with 14 flagellomeres with a total length of 1.375 mm; length of flagellomeres 1–3: 0.205: 0.112: 0.102 mm. Ascoids difficult to recognize, simple, and reaching the middle of the flagellomere. Cervical sensilla not seen.

Thorax dark and somewhat collapsed, obscuring external characters. Legs without special characters. Front leg lengths: coxa: 0.275 mm, trochanter: 0.030 mm, femur: 0.620 mm, tibia: 0.53 mm, tarsomere 1: 0.325 mm, tarsomere 2: 0.190 mm, tarsomere 3: 0.130 mm, tarsomere 4: 0.115 mm, tarsomere 5: 0.080 mm; midleg lengths: coxa: 0.270 mm, trochanter: 0.065 mm, femur: 0.550 mm, tibia: 0.690 mm, tarsomere 1: 0.410 mm, tarsomere 2: 0.205 mm, tarsomere 3: 0.135 mm, tarsomere 4: 0.115 mm, tarsomere 5: 0.080 mm; hindleg lengths: coxa: 0.270 mm, trochanter: 0.080 mm, femur: 0.645 mm, tibia: 0.880 mm, tarsomere 1: 0.485 mm, tarsomere 2: 0.225 mm, tarsomere 3: 0.145 mm, tarsomere 4: 0.130 mm, tarsomere 5: 0.085 mm. Wing somewhat turned at base; length: 1.310 mm, width: 0.365 mm, relation length/width: 3.5 mm; Sc not branched, ending in R_1 ; Rs four branched, all branches complete and ending on wing margin; R_1 (0.775 mm) slightly shorter than R_5 (0.840 mm), and Rs (0.187 mm) shorter than R_{2+3+4} (0.220 mm); vein R_2 (0.220 mm) and R_3 (0.340 mm) longer than R_{2+3} (0.160 mm), R_5 straight (0.845 mm), vein M_{1+2} from level of vein r–m to branch (0.295 mm) shorter than M_1 (0.490 mm) and M_2 (0.395 mm), CuA_1 and CuA_2 ending beyond level of R_{2+3} and R_{2+3+4} branches, respectively; wing values: α : 0.775 mm, β : 0.175 mm, δ : 0.075 mm, γ : 0.225 mm; wing ratio values: β/α : 0.225 mm, γ/α : 0.290 mm, δ/β : 0.428 mm, β/γ : 0.777 mm.

Abdomen extended, seven pregenital segments visible without special characters; terminalia with gonostylus (0.135 mm) as long as half the length of gonocoxite (0.265 mm), bearing one subterminal seta and four spiniform setae all arranged at different levels, one apical, which is long and thick, one preapical as thick but slightly shorter than the apical originating at middle of the distance between the apical and the prebasal spiniform setae, one prebasal spiniform seta thin and as long as the preapical originating at middle between basal and preapical spiniform setae, and one basal spiniform seta, which is the longest, as thin as the prebasal one, originating at middle between the base of gonostylus and the origin of the prebasal spiniform seta; gonocoxite with sclerotized reinforcement at base and with long, evenly spaced, perennial setae over its basal half, and longer preapical setae on ventral margin; paramere (0.215 mm) shorter than gonocoxite, simple, without dorsal protuberances, but with a broad, truncate, apparently reinforced apex, with a group of short ventral pilosity on the apical fifth, and a ventral group of few larger setae at middle; lateral lobes very long (0.320 mm) and slender (0.015 mm at middle); ejaculatory

apodeme and pump not seen, but filaments with unmodified apex; cercus long (0.175 mm) reaching about middle of lateral lobes.

Etymology

From the Mayan language, *Bolontikú*, the generic name given to the nine gods of the underworld, according to the Mayan cosmogony myth as expressed in the *Chilam Balam of Chumayel* (Médiz Bolio, A. [Transl.] 1985).

Material examined

Holotype, male: Early Middle Miocene age amber from Simojovel, Chiapas, Mexico. The specimen belongs to the collection of the Staatliches Museum für Naturkunde, Schloss Rosenstein, Stuttgart, Germany (SMNS). The inventory number of the specimen is Mx 351.3

Remarks

The new species described here shares with *Trichopygomyia* Barretto the lack of a condensed basal tuft on the gonocoxite but the presence of numerous spaced persistent setae, the gonostylus with four spiniform setae inserted at different levels and subterminal setae present, and the lateral lobe longer than the gonocoxite, but it differs in having a simple paramere in contrast to the complex bifurcate or trifurcate paramere of that group. The new species is included in the genus *Pintomyia* because of: the antenna with flagellomere 1 usually longer than 0.5 the length of head, flagellomeres with simple ascoids, gonostylus with one apical spiniform seta and with subterminal setae, paramere simple, lateral lobe narrower than gonocoxite with rounded apex, and gonocoxite with sclerotized reinforcement at the base. Further, the hind femur does not have spines in the subgenus *Pifanomyia*. Galati (2003) recognized seven series of species of this subgenus. *Pintomyia* (*Pifanomyia*) *bolontikui* sp. nov. probably corresponds to the series *townsendi*, because the gonocoxite has a patch of setae on the basal half of the structure and gonostylus with four spiniform setae, the basal seta isolated. However, characteristics of the ejaculatory ducts, sensorial papillae of the flagellomeres, and coloration of the thoracic sclerites were all impossible to observe.

As compared with the extant species of the *Pintomyia* (*Pifanomyia*) series *townsendi*, *Pi.* (*Pif.*) *bolontikui* sp. nov. is similar to *Pi. spinicrassa* (Morales et al. 1969), by the apical spiniform setae of the gonostylus, which is evidently thicker than the other three, but differs in not having the notch in the preapical dorsal margin of the apical setae, by

having a more dispersed patch of setae in the gonocoxite, and a considerably longer lateral lobe as compared with the paramere and gonocoxite lengths. *Pintomyia nadiae* (Felicangeli, Arredondo, and Ward 1992), and *Pi. amilcari* (Arredondo 1984), differ by the presence of a dorsal hump in the basal third of the paramere. *Pi. torvida* (Young, Morales, and Ferro, in: Young and Duncan 1994), differs in the strongly arched paramere and the condensed basal tuft on the gonocoxite. *Pi. longiflocosa* (Osorno-Mesa et al. 1970), *Pi. youngi* (Felicangeli and Murillo, in: Murillo and Zeledón 1985), *Pi. quasitownsendi* (Osorno, Osorno-Mesa, and Morales-Alarcon 1972), *Pi. townsendi* (Ortiz 1959), and *Pi. sauroida* (Osorno-Mesa, Morales-Alarcon, and Osorno 1972), differ in the condensed basal tuft on the gonocoxite and the position of the spiniform setae of the gonostylus, which are equally separated from each other in *Pi. bolontikui*. An overview of Recent *Pintomyia* (*Pifanomyia*) can be found in Young and Duncan (1994), Cazorla (1995) and Galati (2003).

To date, 16 fossil sand fly species have been described from the New World (Andrade Filho et al. 2009a; Andrade Filho et al. 2009b), almost all from the Miocene Dominican amber deposits with the exception of *Micropygomyia paterina* (Quate 1963) from Mexican amber. Of these, 12 species belong to the genus *Pintomyia* (sensu Galati 2003), with 6 of those having 4 spiniform setae on the gonostylus, like the new species described in the present work. *Pintomyia falcaorum* Brazil and Andrade Filho, 2002, *Pi. paleotownsendi* Andrade Filho, Falcão, Galati, and Brazil, 2006, and *Pi. paleotrichia* Andrade Filho, Brazil, Falcão, and Galati, 2007, differ from *Pi. bolontikui* sp. nov. by having a spiniform seta in the dorsal margin of the basal third of the paramere. *Pintomyia dominicana* Andrade Filho, Galati, and Brazil, 2008, differs from the new species by having two basal spiniform setae on the surstylus originating at the same level, and a long, thin and arched paramere. *Pi. killickorum* Andrade Filho, Falcão, and Brazil, 2004, has a dorsal lobe in the paramere, and *Pi. filipalpis* Peñalver, and Grimaldi, 2005, has an elbowed paramere and a different distribution of the spiniform setae on the gonostylus.

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