



## Two new species of phlebotomine sand flies (Diptera: Psychodidae, Phlebotominae) from Quintana Roo, Mexico

SERGIO IBÁÑEZ-BERNAL<sup>1</sup>, EMIGDIO MAY-UC<sup>2</sup>, & EDUARDO A. REBOLLAR-TELLEZ<sup>3</sup>

<sup>1</sup>Instituto de Ecología, A. C. Red Ambiente y Sustentabilidad. Carretera antigua a Coatepec No. 351, El Haya, Xalapa, C.P. 91070, Veracruz, MÉXICO. E-mail: sergio.ibanez@inecol.edu.mx

<sup>2</sup>Museo de Zoología, El Colegio de la Frontera Sur Unidad Chetumal, Avenida Centenario km 5.5 Chetumal, Quintana Roo, CP. 77014, México. E-mail: emagyc1@yahoo.com.mx

<sup>3</sup>Laboratorio de Entomología Médica, Departamento de Zoología de Invertebrados, Facultad de Ciencias Biológicas, Unidad “B”, Universidad Autónoma de Nuevo León. Ciudad Universitaria, Apartado Postal 109-F, San Nicolás de los Garza, Nuevo León, C.P. 66457 México. E-mail: eddie\_the\_little@yahoo.com

### Abstract

Two new species of phlebotomine sand flies from Quintana Roo, Mexico are described and illustrated following the classification proposal of Galati (2003). *Pintomyia* (*Pifanomyia*) *itza* Ibáñez-Bernal, May-Uc and Rebollar-Tellez **sp. nov.**, is described based on four male specimens, whereas *Psathyromyia* (*Psathyromyia*) *maya* Ibáñez-Bernal, May-Uc and Rebollar-Tellez **sp. nov.**, is described based on seven female specimens. *Pintomyia* (*Pif.*) *itza* clearly belongs to the *verrucarum* series, and is the only species of this series known to occur outside South America. *Psathyromyia* (*Psa.*) *maya* belongs to the *lanei* series which was previously known only from Brazil and Paraguay.

**Key words:** Sand flies, Diptera, taxonomy

### Introduction

During the development of the project “Spatial variation of phlebotomine community structure in Quintana Roo, Mexico”, we collected seven female specimens of one undescribed species, and four male specimens of another undescribed species. In this report we describe these two new species following the classification proposal of Galati (2003). Galati (2003) raised many subgenera to generic status and regrouped some of the species treated by Young and Duncan (1994). Based on cladistic analysis of morphological characters Galati (1995) made a major contribution towards the systematic relationships of several phlebotomine supraspecific taxa. Galati’s proposal has received further support from more recent comparisons of ribosomal gene sequences (e.g., Beati *et al.* 2004).

### Material and methods

Collecting took place from January to April, 2008 at a number of localities considered representative of the State of Quintana Roo (i.e., evergreen forests that are at least 40 years old, as well as disturbed areas in which the forest was removed at least 10 years ago). Four Disney traps, 1 Shannon trap and 4 CDC miniature light traps were run from 18:00 to 22:00 hours over a period of 3 days at each locality. Specimens were cleared, dissected and permanently mounted on slides following the procedure outlined by Ibáñez-Bernal (2005). We follow the general morphological nomenclature of Quate and Vockeroth (1981), in accordance with McAlpine *et al.* (1981), however, we take into account some characters and terminology proposed by Galati (2003). Abbreviations used for genera and subgenera follow the proposal of Marcondes (2007). Specimens were

examined using a Nikon Eclipse 50i phase contrast microscope. Measurements were obtained using 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). Photomicrographs were captured with a Nikon Digital Sight DS-2Mv camera using NIS-Elements F 3.0, and later edited for clarity using Helicon Focus v. 4.75. Collector names abbreviations are as follows: ACMOA: Ana Cecilia Montes de Oca Aguilar, DML: David Moo Llanes; EMU: Emigdio May Uc. Repository collections are listed under material examined using the following acronyms: CAIM: Colección de Insectos con Importancia Médica del Instituto de Diagnóstico y Referencia Epidemiológicos (formerly known as ISET: Instituto de Salubridad y Enfermedades Tropicales), Secretaría de Salud, México, Distrito Federal, México; CLEM: Colección del laboratorio de Entomología Médica, Facultad de Ciencias Biológicas, Universidad Autónoma de Nuevo León, Monterrey, Nuevo León, México; IEXA: Colección de Insectos del Instituto de Ecología, A. C., Xalapa, Veracruz, México; MZCFS: Colección de Dípteros de el Museo Zoología de El Colegio de la Frontera Sur Unidad Chetumal, Quintana Roo, México.

## Results

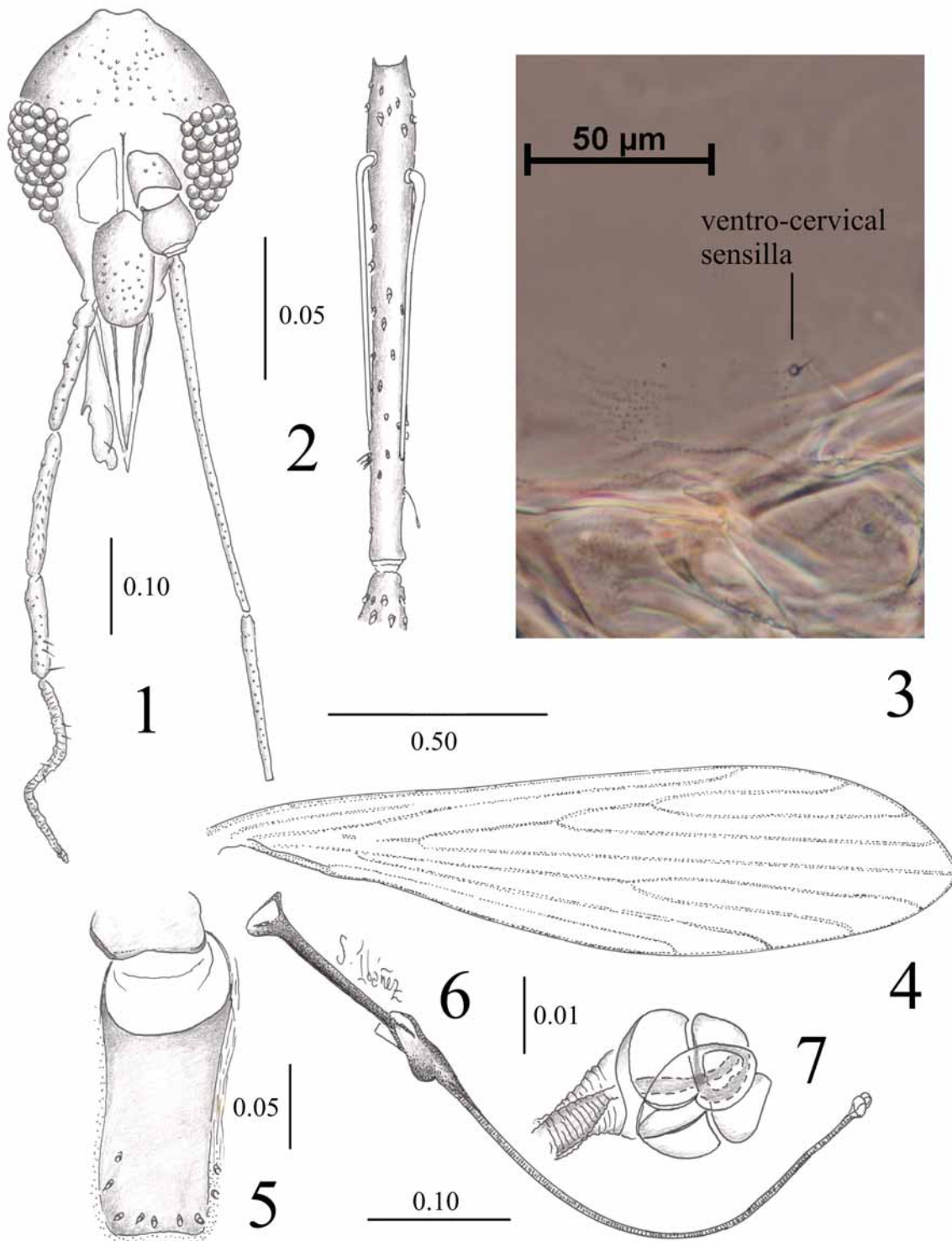
### *Pintomyia (Pifanomyia) itza* Ibáñez-Bernal, May-Uc, and Rebollar-Tellez sp. nov. (Figures 1–11)

Male. General body coloration not observed; body uniformly sclerotized. *Head*: pyriform in frontal view, vertex not enlarged; ratio of head length to width: 1.18; setae alveoli patches extending anteriorly at midline, meeting supraocular alveoli patches. Eyes small, slightly longer than the clypeus. Frons with intra-ocular sutures about 0.3 its width. Ratio of labrum length to head length: 0.53; ratio labrum length to flagellomere 1 length: 0.41; ratio of flagellomere 1 length to length of flagellomeres 2+3: 1.20 (Fig. 1). Ascoids simple, those of flagellomere 2 about 0.53 times as long as flagellomere, one terminating basal to sensory papilla, the other terminating at level of sensory papilla, both inserted at slightly different levels (Fig. 2); flagellomeres 2 and 3 with sensory papilla rosette-like. Palpal formula: 1.0: 3.8: 4.6: 3.6: 8.3 (Fig. 1). Newstead's scales numbering approximately 10, inserted at midpoint of medial margin of palpomere 3. Cibarium and pharynx unarmed. *Thorax*: with ventrocervical sensilla (Fig. 3); katapisternum with distinct pilosity on frontal margin; with 7 upper and 3 lower mesanepisternal setae. Wing about 3.9 times the width, delta positive (Fig. 4) but variable. *Abdomen*: sternite 2 about 1.91 longer than wide, with 4–5+ 4–5 distal setae (Fig. 5). *Terminalia*: Gonostylus with subterminal seta and 4 spines inserted as follows: one at apex, one at distal 0.20, one at mid-length, one at basal 0.25; gonocoxite with tuft of 16–20 setae inserted basally (Figs. 10, 11), with patch of about 20 thin and long persistent setae on apical half (Fig. 10); paramere simple, arched, with apex swollen, bearing two spiniform setae and few smaller setae ventrally, arm one third as wide as lateral lobe at middle, smooth, base broad, cylindrical, with patch of about seven prebasal setae (Figs. 8–10); ejaculatory ducts striated, about twice the length of apodeme + ejaculatory bulb (Fig. 6), with apices about two times as wide as duct diameter, greatly modified, each forming two shell-like structures partially superposed with those of the other duct (Figs. 7, 9); lateral lobe about 0.60 times the length of gonocoxite, narrowing at mid-length; cercus about as long as gonostylus and apically rounded (Fig. 10).

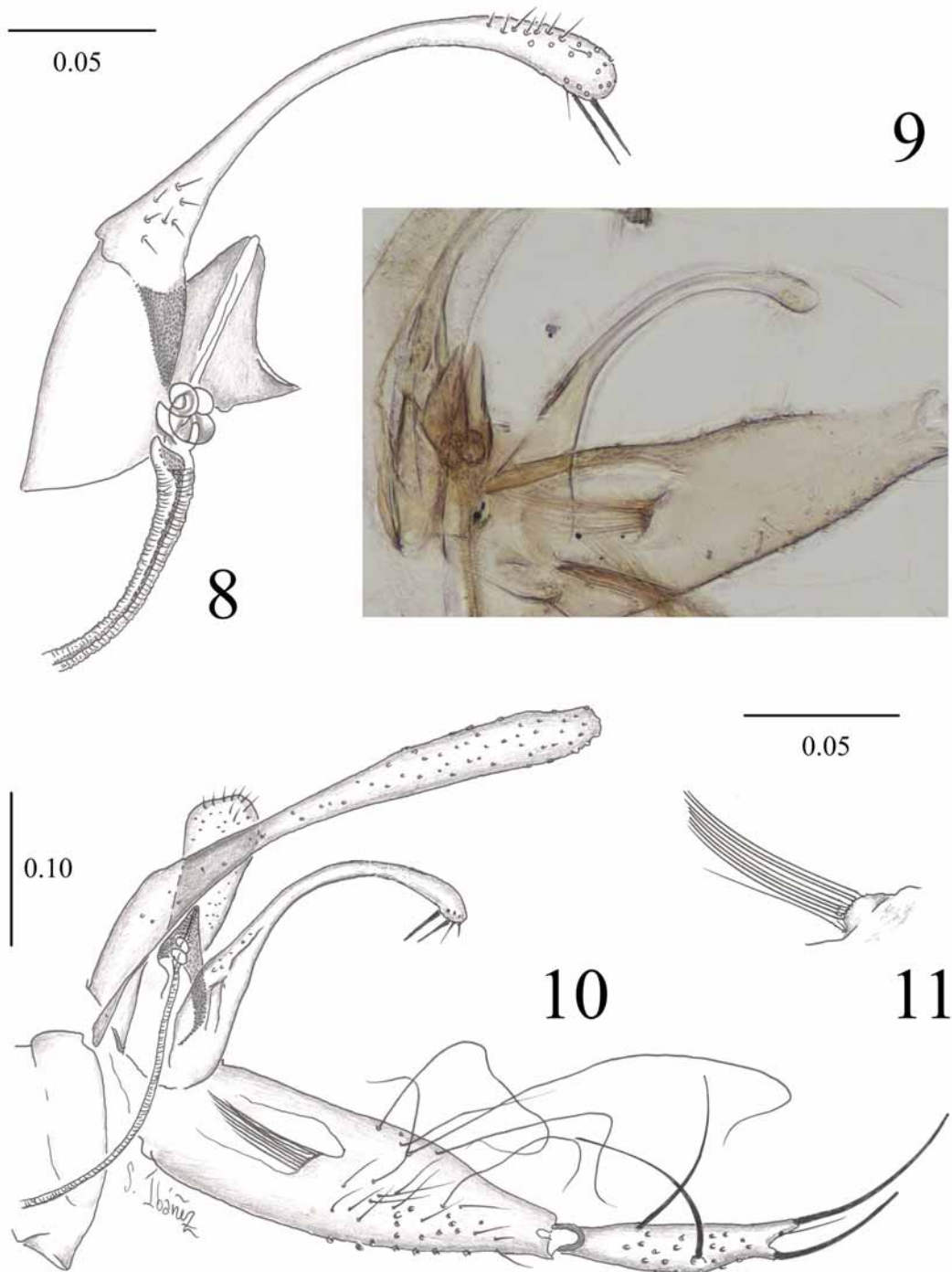
Measurements (mean  $\pm$  s. d. (interval), n=4 except when other number is indicated). Head height:  $0.323 \pm 0.005$  (0.32–0.33) n=3; head width:  $0.273 \pm 0.005$  (0.27–0.28) n=3; eye height:  $0.127 \pm 0.005$  (0.12–0.13); eye width:  $0.08 \pm 0.016$  (0.06–0.10); interocular distance:  $0.11 \pm 0.018$  (0.09–0.13); labrum length:  $0.175 \pm 0.005$  (0.17–0.18); flagellomere 1 length:  $0.41 \pm 0.014$  (0.39–0.42); flagellomere 2 length:  $0.178 \pm 0.002$  (0.175–0.180); flagellomere 3 length: 0.17; palpal segment 1 length:  $0.035 \pm 0.005$  (0.03–0.04); palpal segment 2 length:  $0.111 \pm 0.008$  (0.10–0.12); palpal segment 3 length:  $0.15 \pm 0.014$  (0.14–0.17) n=4; palpal segment 4 length:  $0.12 \pm 0.01$  (0.11–0.13); palpal segment 5 length:  $0.268 \pm 0.022$  (0.25–0.30); wing length:  $1.762 \pm 0.04$  (1.70–1.80); wing width:  $0.437 \pm 0.015$  (0.42–0.45); alpha length:  $0.40 \pm 0.068$  (0.30–0.44); beta length:  $0.245 \pm 0.058$  (0.20–0.33); gamma length:  $0.29 \pm 0.011$  (0.28–0.30); delta  $0.17 \pm 0.082$

(0.05–0.21); ejaculatory apodeme + bulb length:  $0.165 \pm 0.005$  (0.16–0.17); ejaculatory ducts length:  $0.387 \pm 0.026$  (0.35–0.41); gonocoxite length:  $0.305 \pm 0.017$  (0.29–0.33); gonostylus length:  $0.175 \pm 0.01$  (0.17–0.19); paramere length: 0.25; lateral lobe length:  $0.40 \pm 0.008$  (0.39–0.41); cercus length:  $0.195 \pm 0.005$  (0.19–0.20).

Female. Unknown.



**FIGURES 1–7.** *Pintomyia (Pifanomyia) itza* Ibáñez-Bernal, May-Uc, and Rebollar-Tellez **sp. nov.**, male. 1. Head, frontal view; right antenna and left palpus removed; 2. Flagellomere 2, showing ascoids and rosette-sensilla; 3. Microphotography of cervical area showing ventrocervical sensilla; 4. Wing; 5. Abdominal sternum 2; 6. apodeme, bulb, and ejaculatory ducts; 7. Detail of ejaculatory ducts apices. All measurements are expressed in millimeters, except Fig. 3.



**FIGURES 8–11.** *Pintomyia (Pifanomyia) itza* Ibáñez-Bernal, May-Uc, and Rebollar-Tellez **sp. nov.**, male. 8. Paramere, aedeagus, and apical portion of ejaculatory ducts; 9. Microphotography showing aedeagus, apical portion of ejaculatory ducts, paramere, basal portion of gonocoxite; 10. Complete male terminalia, lateral view; 11. Detail of basal tuft of gonocoxite. All measurements are expressed in millimeters.

**Type locality.** MEXICO, Quintana Roo, Municipality of Benito Juárez, Central Vallarta (20° 51' 54.4 N, 87° 03' 58.06 W).

**Material examined.** 4 males. Holotype male. MEXICO, Quintana Roo, Municipality of Benito Juárez, Central Vallarta (20° 51' 54.4 N, 87° 03' 58.06 W), 27-II-2008 EMU, CDC light trap (DP-10774, IEXA). Paratypes 3 males: MEXICO, Quintana Roo, Municipality of Benito Juárez, Central Vallarta, 27-II-2008 EMU, CDC light trap (DP-10771, 1 male, CLEM); Municipality of Lázaro Cárdenas, Solferino (21° 20' 47.4

N, 87° 24' 22.3 W), 24-II-2008, DML, CDC light trap (DP-10376, DP-10380, 2 males, MZCFS, and CAIM, respectively).

**Etymology.** This species is named *itza*, after the name given to the actual ethnic group and the language of the people living in southern Quintana Roo, Mexico, northern Belize, and Guatemala. The Itza descended from a Yucatecan Maya lineage the *Ah Itzá*, who dominated the Yucatan peninsula in the Post-classic period (Drew 1999).

**Comments.** According to the classification of Young and Duncan (1994), *Pi. (Pif.) itza* corresponds to the *verrucarum* species group and *verrucarum* series. This species somewhat resembles those species included in *Sciopemyia* Barretto, 1962, by the long flagellomere 1 that is longest than in the female, simple ascoids, palpomere 5 subequal to palpomeres 3+4, gonocoxite with persistent setae, gonostylus with four spines, and simple parameres. Nevertheless, *Pi. (Pif.) itza* has a gonostylus with subterminal setae and modified ejaculatory duct apices, which do not correspond to the diagnosis of subgenus *Sciopemyia*. Another similar species is the ungrouped *Lutzomyia ignacioi* Young, 1972, but it differs from *Pi. (Pif.) itza* by the absence of subterminal setae in the gonostylus, the gonocoxite basal setae tuft composition, the ejaculatory duct apex only slightly modified, short lateral lobe compared to gonocoxite length, and ascoids with short proximal spurs.

Considering the Galati's (2003) classification system, this species clearly is a member of tribe Phlebotomini Rondani, 1840, and subtribe Lutzomyiina Abonnenc and Leger, 1976, having palpal segment 2 as long as or slightly longer than 4, Newstead's scales located at middle or dispersed on the internal margin of palpal segment 3, flagellomere 3 with rosette-like sensillum, pharynx unarmed, male's flagellomere 1 with external ascoid somewhat distad as compared with internal ascoid, and female's cibarium with vertical teeth disposed in one or two transversal rows. This species does not correspond to *Sciopemyia*, because this taxon (considered as a genus) includes species without ventrocervical setae and males without subterminal setae in the gonostylus, both characteristics are present in *Pintomyia (Pifanomyia) itza*. Genus *Pintomyia* Costa Lima, 1932, as defined by Galati (2003), is characterized by having ventrocervical sensilla, and usually long pilosity on the frontal margin of katepisternum, in the male flagellomere 1 longer than 0.5X the head height, paramere simple without pointed protuberance in the ventral margin of preapical region, lateral lobe thinner than gonocoxite and with rounded apex, abdominal tergum VIII usually with strong setae, gonocoxite with strong longitudinal sclerotization on the basal portion of internal margin, gonostylus with subterminal setae, all characteristics present in *Pi. (Pif.) itza*. Within *Pintomyia*, the subgenus *Pifanomyia* Ortiz and Scorza, 1963, is characterized by females having the spermathecal common duct unsclerotized and as long or longer than one-half the length of furcal stem; however, there are no apparent male apomorphies. Seven series of species and three ungrouped species of *Pintomyia (Pifanomyia)* are recognized (Galati 2003), one of them, the *verrucarum* series (Fairchild, 1955) is characterized by the gonocoxite with basal and medial-apical persistent tufts of setae, gonostylus bearing 3–4 spines of which the internal one is situated basally, and ejaculatory ducts shorter than 5.0X the apodeme + bomb length in males, and by having small eyes slightly longer than the clypeus, all characteristics present in *Pi. (Pif.) itza*. Following this classification system, the *verrucarum* series is composed of *Pintomyia (Pifanomyia) andina* (Osorno, Osorno-Mesa, and Morales 1972), *Pi. (Pif.) aulari* (Feliciangeli, Ordoñez, and Manzanilla 1984), *Pi. (Pif.) cajamarcensis* (Galati, Cáceres, and Le Pont 1995), *Pi. (Pif.) columbiana* (Ristorcelli and Van Ty 1941), *Pi. (Pif.) deorsa* (Pérez, Ogasuku, Monje, and Young 1991), *Pi. (Pif.) disiuncta* (Morales, Osorno, and Osorno-Mesa 1974), *Pi. (Pif.) moralesi* (Young 1979), *Pi. (Pif.) verrucarum* (Townsend 1913) (Cazorla 1995; Galati 2003), and now *Pi. (Pif.) itza* **sp. nov.**

Diagnostic characteristics of *Pintomyia (Pif.) itza* are in general constant, but there are differences in the length of delta of the specimens studied; one specimen shows a short delta (0.05 mm), whereas the other three have long delta (0.23 mm).

It is important to note that all the previously known species of *Pintomyia (Pifanomyia)* series *verrucarum* are from northern South America, with records in Colombia, Peru and Venezuela (Cazorla 1995; Galati 2003). *Pintomyia (Pifanomyia) itza* is the only species of this series known to occur outside this region, with a discontinuous distribution to southeastern Mexico, as no other species of the series have yet been recorded in Central America.

***Psathyromyia (Psathyromyia) maya* Ibáñez-Bernal, May-Uc and Rebollar-Tellez sp. nov.**

(Figures 12–20)

Female. General body coloration not observed, thorax uniformly heavily sclerotized. *Head*: nearly rounded in frontal view, vertex not enlarged, ratio of head length to width: 1.04, setae alveoli patches extending anteriorly at midline, meeting supraocular alveoli patches. Frons without intra-ocular sutures. Eyes large, about twice the length of clypeus. Ratio of labrum length to head length: 0.60; ratio labrum length to flagellomere 1 length: 0.85; ratio of flagellomere 1 length to length of flagellomeres 2+3: 1.11 (Fig. 12). Ascoids (Figs. 15–17) with short basal projection, those of flagellomere 2 about 0.56 times as long as flagellomere, both ending after the level of the sensory papilla rosette-like, inserted slightly at different level (Fig. 16); flagellomere 3 with rosette-like sensillum (Fig. 16). Palpal formula: 1.0: 2.1: 3.5: 1.7: 3.3 (Fig. 12). Newstead's scales numbering approximately 20, sparse over the 0.75 distal-internal surface. Pharynx unarmed but with strong comb-rugosities. Cibarium with arch slightly sclerotized medially, pigment patch about 0.33 as wide as the cibarium, armed with about 16 teeth centrally, arranged in an irregular row of approximately 4 vertical teeth and 12 horizontal teeth, with a group of relatively small teeth laterally (Figs. 13–14). *Thorax*: without ventrocervical sensilla; pleura strongly sclerotized, as notum; katepisternum without distinct setae on frontal margin; with 10–14 upper and 4–5 lower mesanepisternal setae. Wings as long as 2.9 their width, delta very variable from 0.02 mm negative, to 0.04 mm positive (Fig. 18). *Abdomen*: sternite 2 as long as medial width, with lateral translucent spots at middle and 10–11+ 10–11 distal setae (Fig. 19). *Terminalia*: Spermathecal ducts striated, common duct as long as spermatheca, individual ducts are as long as 2.0X the common duct, common duct + individual duct as long as furcal stem; spermatheca striated, with a median constriction, wider apically; apical knob longer than wide, with a digital projection (Fig. 20).

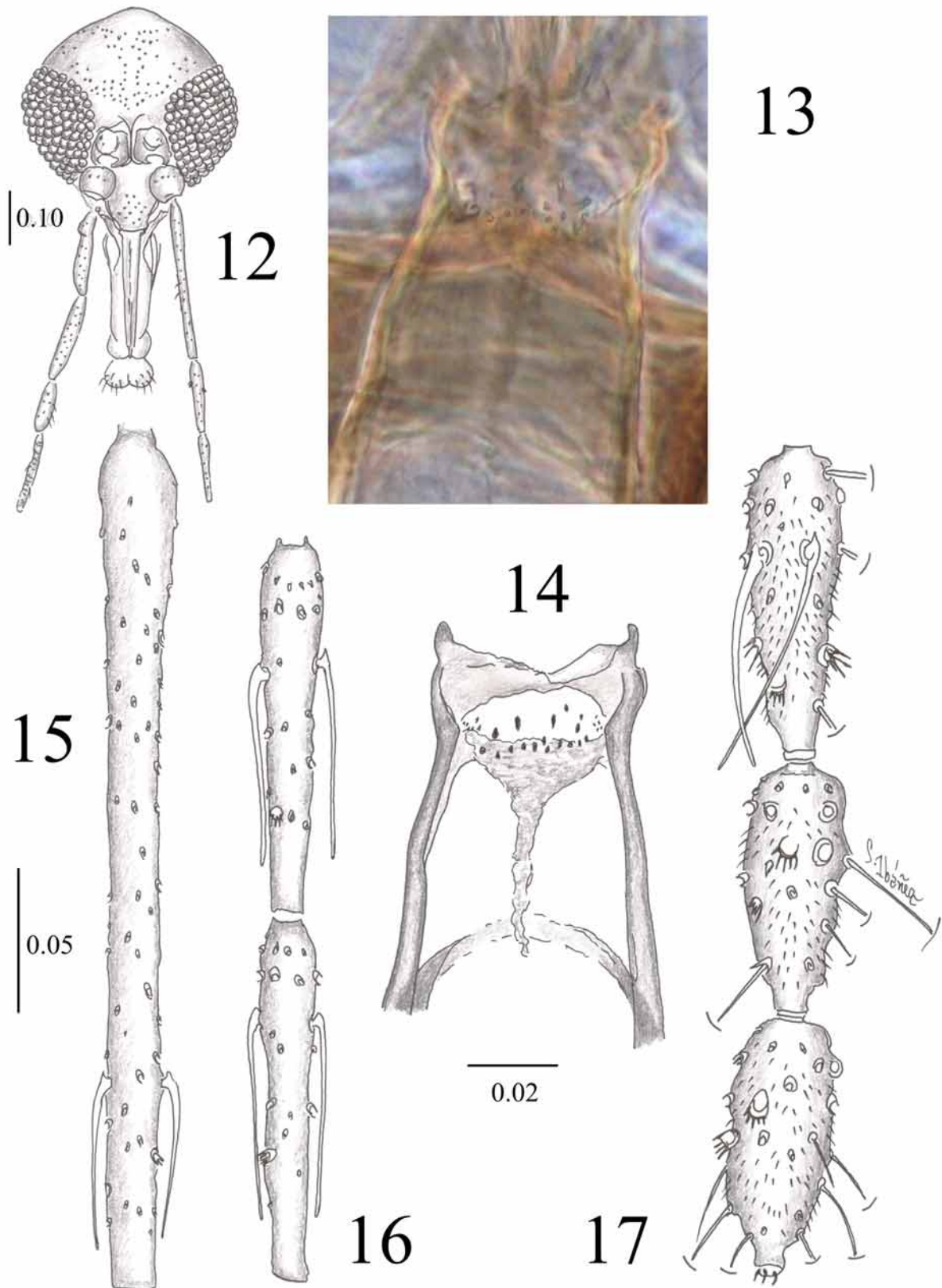
Measurements (mean s. d. (interval), n= number of measures). Head height: 0.416 0.016 (0.40–0.44) n=6; head width: 0.403 0.005 (0.40–0.41) n=6; interocular distance: 0.125 0.005 (0.12–0.13) n=7; labrum length: 0.258 0.012 (0.25–0.28) n=7; flagellomere 1 length: 0.284 0.009 (0.27–0.30) n=7; flagellomere 2 length: 0.128 0.006 (0.120–0.140) n=7; flagellomere 3 length: 0.118 0.006 (0.11–0.13) n=7; palpal segment 1 length: 0.045 0.005 (0.04–0.05) n=7; palpal segment 2 length: 0.112 0.004 (0.11–0.12) n=7; palpal segment 3 length: 0.17, n=7; palpal segment 4 length: 0.086 0.005 (0.08–0.09) n=7; palpal segment 5 length: 0.17 0.008 (0.16–0.18) n=7; wing length: 2.160 0.118 (1.92–2.22) n=6; wing width: 0.703 0.034 (0.67–0.76) n=6; alpha length: 0.373 0.028 (0.33–0.40) n=6; beta length: 0.336 0.028 (0.28–0.36) n=6; gamma length: 0.251 0.029 (0.21–0.29) n=6; delta 0.023 0.022 (0.02–0.04) n=6; sternum 2 length: 0.12–0.14, n=2; sternum 2 width: 0.13, n=1.

Male. Unknown.

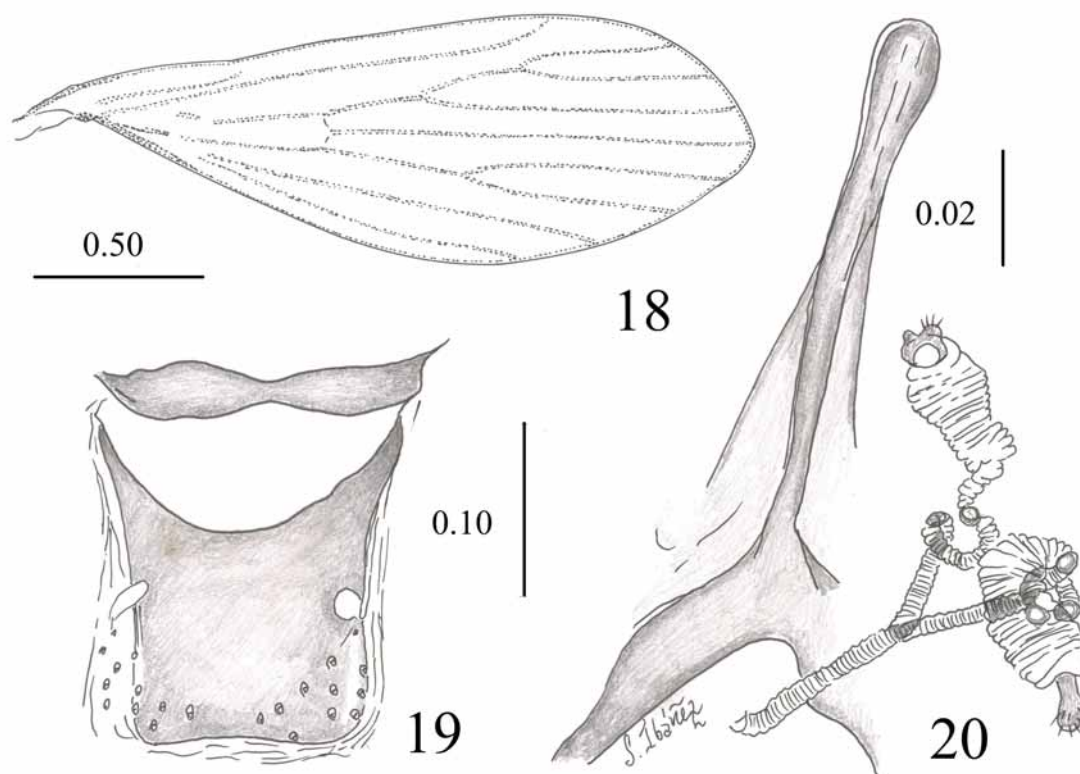
**Type locality.** MEXICO, Quintana Roo, Municipality of Othon P. Blanco, Altos de Sevilla.

**Material examined.** 7 females. Holotype female: MEXICO, Quintana Roo, Municipality of Othon P. Blanco, Altos de Sevilla (18° 50' 31.59 N, 88° 40' 1.5 W), 10-II-2008, EMU, Shannon trap 21:00 h, conserved vegetation (DP-9678, 1 female, IEXA). Paratypes 6 females: MEXICO, Quintana Roo, Municipality of Othon P. Blanco, Altos de Sevilla (18° 50' 31.59 N, 88° 40' 1.5 W), 9-II-2008, EMU, CDC light trap, conserved vegetation (DP-9525, 1 female, CAIM); 9-II-2008, DML, Shannon trap 20:00 h, perturbed vegetation; 10-II-2008 (DP-13979, 1 female, CLEM); Municipality of Solidaridad, Cobá (20° 29' 52.6 N, 87° 42' 35.3 W), 5-III-2008, ACOMOA, Shannon trap 19:00 h, conserved vegetation (DP-10992, 1 female, MZCFS); Municipality of Felipe Carrillo Puerto, Francisco I. Madero (20° 13' 01.4 N, 88° 02' 30.8 W), 27-III-2008, DML, CDC light trap, conserved vegetation (DP-13280, DP-13282, 2 females, CAIM, and CLEM, respectively); Petcacab (19° 14' 59.7 N, 88° 12' 35.6 W), 11-II-2008, EMU, Shannon trap 19:00 h, perturbed vegetation (DP- 9924, 1 female, MZCFS).

**Etymology.** This species is named *maya*, after the ancient civilization and the actual ethnic group and language of the people inhabiting the Mexican states of Yucatan, Campeche, Quintana Roo, Tabasco, and Chiapas, and the Central American countries Belize and Guatemala, as well as the western portions of Honduras and El Salvador (Schmidt *et al.* 1998).



**FIGURES 12–17.** *Psathyromyia (Psathyromyia) maya* Ibáñez-Bernal, May-Uc and Rebollar-Tellez **sp. nov.**, female. 12. Head, frontal view; right antenna and left palpus removed. 13. Microphotography of cibarial armature; 14. Cibarium; 15. Antennal flagellomere 1; 16. Antennal flagellomere 2 and 3; 17. Antennal three apical flagellomeres. All measurements are expressed in millimeters, Figs. 14 and 17 at the same scale, Figs. 15 and 16 at the same scale.



**FIGURES 18–20.** *Psathyromyia (Psathyromyia) maya* Ibáñez-Bernal, May-Uc and Rebollar-Tellez **sp. nov.**, female. 18. Wing. 19. Abdominal sternum 2; 20. Spermathecae, spermathecal ducts and furca. All measurements are expressed in millimeters.

**Comments.** Following the classification of Young and Duncan (1994), this species corresponds to *Lutzomyia (Psathyromyia)* or to the *aragoi* or *lanei* species groups, characterized by the ascoids with a proximal spur, palpomere 5 usually shorter than palpomeres 2+3+4, and longer than 0.5 the length of palpomere 3, female with an armed cibarium with 4 horizontal teeth, pharynx unarmed, and spermathecae smooth-walled, cylindrical with annulations. On the other hand, following the Galati's classification, the species here described has all the characteristics of the tribe Phlebotomini Rondani 1840, and subtribe Psychodopygina Galati 1995, because it does not have ventrocervical setae, palpomere 4 is shorter than palpomere 2, and the cibarium has horizontal teeth that are not easily distinguishable from the vertical teeth which are arranged in transversal rows. The species here described has all the diagnostic characteristics of the genus *Psathyromyia* Barretto 1962, by having ascoids with proximal spur long or short, and hind tarsomere 1 as long as the sum of 2–5. *Psathyromyia maya sp. nov.* is a member of subgenus *Psathyromyia* series *lanei* (*sensu* Galati 2003), because it does not have rosette-like sensilla in the flagellomeres 10–11, the palpomere 5 as long as 3, the ascoid proximal spur is rudimentary, annulated spermathecae, and individual ducts longer than common duct. The *lanei* series includes three species: *Psathyromyia (Psa.) lanei* (Barretto and Coutinho 1941) known to occur in Brazil and Paraguay, *Pa. (Psa.) pelsoni* (Sherlock and Alencar 1959) from Brazil, and *Pa. (Psa.) digitata* (Damasceno and Arouck 1950), also from Brazil; females of the first two species are indistinguishable and the female of *Pa. digitata* has not yet been described (Galati 2003).

*Psathyromyia maya sp. nov.*, is the first record of a species of the *lanei* series occurring outside South America, and the fifth Mexican species of the subgenus *Psathyromyia*. There is indirect evidence suggesting that *Pa. maya* females may have some degree of anthropophily as they were captured with a human-baited Shannon trap.



## Acknowledgements

This work was conducted under the Project “Determinación de zonas de riesgo de transmisión de Leishmaniasis mediante el análisis de la distribución geográfica de los insectos vectores y su capacidad vectorial, granted to Rebollar-Tellez by CONACYT FOMIX / Quintana Roo (QROO-2005-C01-19166). Ibáñez-Bernal was supported by the Project INECOL-2003010816. The authors appreciate the technical help of the students David Moo Llanes (UADY), and Ana Celia Montes de Oca Aguilar (ITC Conkal, Yucatán), and the technician María Teresa Suárez Landa (INECOL). Authors are indebted to Dr. Gregory R. Curler (Department of Entomology and Plant Pathology, Laboratory of Insect Systematics, Biodiversity, and Evolution, The University of Tennessee), who devoted much time and effort reviewing and correcting the manuscript draft; his help strikingly improves this report.

## References cited

- Beati, L., Cáceres, A.G., Lee, J.A. and Munstermann, L.E. (2004) Systematic relationships among *Lutzomyia* sand flies (Diptera: Psychodidae) of Peru and Colombia based on the analysis of 12S and 28S ribosomal DNA sequences. *International Journal of Parasitology*, 34, 225–234.
- Cazorla, D. (1995) Revisión del grupo *verrucarum* Theodor, 1965 (Diptera: Psychodidae, Phlebotominae). *Revista de Ecología Latino Americana*, 3(1–3), 51–56.
- Drew, D. (1999) *The Lost Chronicles of the Maya Kings*. Weidenfeld & Nicolson, London, 450 pp.
- Galati, E.A.B. (1995) Phylogenetic systematics of the Phlebotominae (Diptera: Psychodidae) with emphasis on American groups. *Boletín de la Dirección de Malariología y Saneamiento Ambiental*, 35 (supl. 1), 133–142.
- Galati, E.A.B. (2003) 2. Morfologia e Taxonomia, 2.1. Classificação de Phlebotominae, pp. 23-175. In: Rangel, E. F. and R. Lainson (Eds.). *Flebotomíneos do Brasil*. Ed. FIOCRUZ, Rio de Janeiro, Brazil, pp. 367.
- Ibáñez-Bernal, S. (2005) Phlebotominae (Diptera: Psychodidae) de México. V. Clave ilustrada para la identificación de machos de *Lutzomyia* França. *Folia Entomologica Mexicana*, 44(1), 49–66.
- Marcondes, C.B. (2007) A proposal of generic and subgeneric abbreviations for Phlebotomine sand flies (Diptera: Psychodidae: Phlebotominae) of the World. *The Entomological News*, 118(4), 351–356.
- McAlpine, J.F. (1981) Morphology and terminology— Adults, pp. 9–63. In: J. F. McAlpine, B. V. Peterson, G.E. Shewell, H.J. Teskey, J.R. Vockeroth, and D.M. Wood (Eds.) *Manual of Nearctic Diptera*, vol. 1. Research Branch Agriculture Canada Monograph, 27, 1–674.
- Quate, L.W., and Vockeroth, J.R. (1981) Psychodidae, pp. 293–300. In: J.F. McAlpine, B.V. Peterson, G.E. Shewell, H. J. Teskey, J.R. Vockeroth, and D.M. Wood (Eds.) *Manual of Nearctic Diptera*, vol. 1. Research Branch Agriculture Canada Monograph, 27, 1–674.
- Schmidt, P., M. de la Garza, and Nalda, E. (Coords.) (1998) *Los Mayas*. CNCA-INAH/Landucci Ed. Mexico-Italy, 541 pp.
- Young, D.G., and Duncan, M.A. (1994) Guide to the identification and geographic distribution of *Lutzomyia* sand flies in Mexico, the West Indies, Central and South America (Diptera: Psychodidae). *Memoirs of the American Entomological Institute*, 54, 1–881.