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A new species of *Telmatoscopus* Eaton, 1904 (Diptera: Psychodidae) from Mexico with morphological and molecular data

Una nueva especie de *Telmatoscopus* Eaton, 1904 (Diptera: Psychodidae) de México con datos morfológicos y moleculares

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ABSTRACT

This publication documents the first geographical record of an extant species of the genus *Telmatoscopus* Eaton, 1904 in Mexico, based on material collected in the state of Veracruz. The species is described as new to science, and this study presents the mitochondrial cytochrome c oxidase subunit I (COI) DNA barcodes and a consensus sequence for the newly described taxon.

Keywords: Psychodinae; new geographic record; integrative taxonomy; COI barcode; mothflies**.**

RESUMEN

Esta publicación documenta el primer registro geográfico de una especie existente del género *Telmatoscopus* Eaton, 1904 en México, con base en material recolectado en el estado de Veracruz. La especie se describe como nueva para la ciencia, y este estudio presenta los códigos de barras de ADN del gen mitocondrial citocromo c oxidasa subunidad I (COI), así como una secuencia consenso, para el taxón recientemente descrito.

Palabras clave: Psychodinae; nuevo registro; taxonomía integrativa; COI barcode; moscas polilla.

Globally, the family Psychodidae is a species-rich yet comparatively understudied group, with over 3,500 species formally described (Galati and Rodrigues 2023). Nevertheless, vast geographic regions remain faunistically unexplored (Jaume-Schinkel and Kolter 2025), and the true diversity of the family is expected to exceed 20,000 species (Wagner and Ibáñez-Bernal 2009).

In Mexico, the family is represented by four out of six subfamilies, namely Bruchomyiinae, Phlebotominae, Psychodinae, and Trichomyiinae (Ibáñez-Bernal and Durán-Luz 2022). Historically, research in the country has focused predominantly on Phlebotominae due to their epidemiological relevance, while knowledge of the remaining subfamilies remains fragmentary. The foundational works of Ibáñez-Bernal (2000, 2008) and Ibáñez-Bernal and Durán-Luz (2022) significantly advanced our understanding of the Mexican fauna, and more than 100 species of Psychodidae are currently known from the country (Ibáñez-Bernal and Durán-Luz 2022; Ibáñez-Bernal 2025, 2026).

Within the Mexican fauna, only a single fossil species of *Telmatoscopus* Eaton, 1904 has been reported, *Telmatoscopus hurdi* Quate, 1963, and no extant representatives of the genus have been documented to date.

The present study documents the first extant species of *Telmatoscopus* from Mexico and provides the first DNA barcodes and a consensus sequence for the species. It also includes illustrations and photographs to discuss morphological characters in comparison with closely related species. This contribution broadens the known diversity of Mexican Psychodidae and underscores the need for continued faunistic and integrative taxonomic research in the region.

MATERIAL AND METHODS

All specimens were collected by Rafael Ojeda Flores using Malaise traps. All metadata associated with the specimens is available in the BOLD dataset (DS-TCONMX). Each specimen is uniquely referenced by its sample ID (e.g., BIOUG89230-C06). The examined material is hosted at the Centre for Biodiversity Genomics (CBG), type material will be deposited at Colección Nacional de Insectos, Instituto de Biología, Universidad Nacional Autónoma de México (CNIN).

DNA extraction, PCR amplification, and sequencing were performed according to standard protocols from the CBG at the University of Guelph (available at: https://biodiversitygenomics.net/resources/sampling-protocols/). Sequences were uploaded to BOLD, where Barcode Index Numbers (BINs) were assigned via the RESL algorithm

(Ratnasingham and Hebert 2013).

Consensus sequence was generated from all available COI reads by aligning them using MUSCLE (Edgar 2004) as implemented in the msa package for R (Bodenhofer et al. 2015). Alignment columns containing more than 50% gaps were removed before consensus construction. A majority-rule consensus sequence was then produced using functions from the Biostrings package (Pagès et al. 2024), applying IUPAC ambiguity codes where multiple bases were equally frequent.

Images were obtained using a digital microscope Keyence model VHX-7000 and processed through focus stacking. Illustrations were initially prepared using a drawing tube attached to a Leitz SM-LUX microscope and subsequently refined digitally using Clip Studio Paint and Adobe Photoshop.

The selected specimens were slide-mounted in Euparal following the protocol detailed by Jaume-Schinkel et al. (2024).

Terminology. Description largely follows Cumming and Wood (2017). However, consistent with Kvifte and Wagner (2017), the lobe of the epandrium (sometimes referred to as cercopods, surstyli, or hypopods) is here referred to as the epandrial appendage.

For consistency in the male terminalia, the hypandrium is treated as the ventral-most structure and the epandrium as the dorsal-most, as though genital rotation had not occurred. Under this convention, "ventral" refers to the hypandrium or the direction toward it, while "dorsal" refers to the epandrium or the direction toward it.

RESULTS

Taxonomic account.

Genus *Telmatoscopus* Eaton, 1904

Telmatoscopus Eaton, 1904: 58. Type species: *Pericoma advena* Eaton, 1893, by designation of Quate (1965).
Sciria Enderlein, 1935: 247. Type species: *Pericoma advena* Eaton, 1893, by original designation (see Kvifte 2014).
Krivosheinoscopus Ježek, 2001: 57. Type species: *Telmatoscopus ussuricus* (Ježek, 2001) (see Jaume-Schinkel et al. 2022).

Etymology. Eaton (1904) does not explicitly state the etymology of the genus; however, I infer it to be derived from the Greek words τέλμα (telma) meaning marsh or swamp and σκοπός (skopós) meaning observer, referring to the association of the genus with marshy or wet habitats. Gender masculine.

Important references. Quate (1965) [type designation]; Duckhouse (1978) [discussion of "telmatoscopoid" genera]; Ježek 1989 [discussion]; Bravo et al. (2011) [description of new species]; Kvifte (2014) [discussion on nomenclature and synonymy]; Jaume-Schinkel et al. (2022) [discussion of synonyms and European species].

Telmatoscopus mexicanus sp. nov.

(Figures 1-16)
http://zoobank.org/68F76522-DDD8-4F1E-942C-AF-36D0E6F60F

Examined material: Holotype. 1 ♂; MEXICO – Veracruz, Tlapacoyan, Centro de Enseñanza, Investigación y Extensión en Ganadería Tropical (CEIEGT, FMVZ-UNAM), km 5.5 de la carretera federal Martínez de la Torre, C.P. 93650; 20.032° N, 97.106° W; alt. 122 m.a.s.l. 25 Oct. 2017; BIOUG91599-C01. **Paratypes:** 1 ♂; same data as for holotype except: 07 Jun. 2017; BIOUG44971-G04 • 1 ♀; same data as for preceding except: 05 Jul. 2017; BIOUG89599-H02 • 2 ♂; same data as for preceding except BIOUG88585-A08, BIOUG89599-C07 • 1 ♀; same data as for preceding except 08 Nov. 2017; BIOUG90208-E09 • 1 ♀; same data as for preceding except 09 May. 2018; BIOUG66721-B01 • 1 ♂; same data as for preceding except 09 May. 2018; BIOUG66717-C02 • 1 ♂; same data as for preceding except 16 Aug. 2017; BIOUG89198-B04 • 1 ♀; same data as for preceding except 17 Jan. 2018; BIOUG66704-E01 (♀) • 3 ♀; same data as for preceding except 19 Jul. 2017; BIOUG88915-F10, BIOUG88917-D11, BIOUG89866-F08 • 1 ♀; same data as for preceding except 25 Oct. 2017; BIOUG91601-A08 • 2 ♀; same data as for preceding except 30 Aug. 2017; BIOUG89286-B04, BIOUG89295-H08 • 1 ♂; same data as for preceding except 30 Aug. 2017; BIOUG89298-G03

Other material examined (Ethanol-preserved specimens): 3 (unknown sex); same data as for holotype except: 07 Jun. 2017; BIOUG44901-A08, BIOUG44902-F03, BIOUG44905-F10 • 1 (unknown sex); same data as for preceding except 28 Jun. 2017; BIOUG45033-E02 •1 (unknown sex); same data as for preceding except 03 Jan. 2018; BIOUG90419-B06 • 1 ♀; same data as for preceding BIOUG90416-H04 • 3 ♂; same data as for preceding BIOUG90416-B11, BIOUG90417-G03, BIOUG90418-H04 • 1 (unknown sex); same data as for preceding except 05 Jul. 2017; BIOUG88588-D10 • 1 ♂; same data as for preceding except 05 Jul. 2017; BIOUG89601-A01 • 1 ♀; same data as for preceding except 06 Dec. 2017; BIOUG90409-B05 • 5 ♀; same data as for preceding except 08 Nov. 2017; BIOUG90358-A04, BIOUG90364-D10, BIOUG90366-A10, BIOUG90370-A09, BIOUG90378-H06 • 10 ♂; same data as for preceding except 08 Nov. 2017; BIOUG90356-B06, BIOUG90357-E01, BIOUG90361-E03, BIOUG90369-G03, BIOUG90371-C02, BIOUG90377-C03,BIOUG90379-E06,BIOUG90379-F12, BIOUG90381-C05, BIOUG90386-B03 • 1 ♀; same data as for preceding except 11 Apr. 2018; BIOUG91941-D08 • 1 ♂; same data as for preceding except 11 Apr. 2018; BIOUG91939-C06 • 1 ♀; same data as for preceding except 11 Oct. 2017; BIOUG90337-A12 • 1 ♂; same data as for preceding except 11 Oct. 2017; BIOUG89327-B06 • 1 ♂; same data as for preceding except 13 Sep. 2017; BIOUG90175-E03 • 1 ♀; same data as for preceding ex-

cept 14 Feb. 2018; BIOUG81879-A12 • 2 ♂; same data as for preceding except 14 Feb. 2018; BIOUG81876-D09, BIOUG81881-A07 • 1 (unknown sex); same data as for preceding except 19 Jul. 2017; BIOUG89870-D12 • 2 ♀; same data as for preceding except 19 Jul. 2017; BIOUG88914-D03, BIOUG89859-G04 • 5 ♂; same data as for preceding except 19 Jul. 2017; BIOUG88924-F11, BIOUG89858-A10, BIOUG89860-A02, BIOUG89861-A06, BIOUG89875-A01 • 9 ♂; same data as for preceding except 20 Dec. 2017; BIOUG89230-C06, BIOUG89231-D03,-BIOUG89231-G01, BIOUG89232-B06, -BIOUG89234-C06, BIOUG89235-G03, -BIOUG89236-D12, BIOUG89236-E08, BIOUG89244-B10 • 7 ♀; same data as for preceding except 22 Nov. 2017; BIOUG66161-E04, BIOUG66174-B01,-BIOUG66174-E09, BIOUG66181-B11, BIOUG66182-B12, BIOUG66185-E03, BIOUG66188-B07 • 2 ♂; same data as for preceding except 22 Nov. 2017; BIOUG66176-G09, BIOUG66187-C10 • 3 ♂; same data as for preceding except 25 Oct. 2017; BIOUG91598-D12, BIOUG91603-C11, BIOUG91616-A07 • 1 ♀; same data as for preceding except 28 Mar. 2018; BIOUG91934-D09 • 1 ♀; same data as for preceding except 30 Aug. 2017; BIOUG89315-A02 • 1 ♂; same data as for preceding except 27 Sep. 2017; BIOUG66145-B10.

Differential diagnosis. *Telmatoscopus mexicanus* **sp. nov.** is similar to *Telmatoscopus congruus* Quate, 1996, both can be differentiated by the following characters of the male: the aedeagal complex in *Telmatoscopus mexicanus* **sp. nov.** presents a shield-shaped sclerite on ventral surface (ventral to the aedeagal sheath), this sclerite is absent in *T. congruus* (see Quate, 1996: fig. 14h); the gonocoxal apodemes form a U-shaped band that extends below the aedeagus, band without spicules (gonocoxal apodeme forming a prominent arch below the aedeagus with spicules on the arch on *T. congruus*). Females of both species can be distinguished by the shape of the subgenital plate being medially constricted in *T. mexicanus* **sp. nov.** (medial constriction less prominent in *T. congruus,* see Quate, 1996: fig. 14i); subgenital plate length about two times its width (subgenital plate length about 1.5 times its width in *T. congruus*); the apex of the subgenital plate with a strong concavity at middle (the apex of the subgenital plate with shallow concavity in *T. congruus,* see Quate, 1996: fig. 14i).

Description. Male: Head (Figs. 1, 7) eye bridge with 4 (sometimes 5) facet rows at the widest part, separated by 1.5 facet diameters; interocular suture present, shaped as an inverted wide U, without anterior spur; frons patch undivided, with 3-4 irregular rows extending up to the interocular suture. Antenna with 16 segments (Fig. 7); scape cylindrical, about 1.5 times longer than the spherical pedicel; 14 slightly asymmetrical and nodiform flagellomeres, each with a pair of digitiform ascoids (Figs. 2, 8); apical flagellomere with digitiform apiculus (Figs. 2, 8). Palpus four-segmented (Figs. 1, 3), extending towards the antennal flagellomere 5, palpal segments cylindrical, last palpal segment corrugated; palpal segments proportion: 1.0:1.4:1.3:1.5. Labella bulbous, with 5-6 setae arranged in two rows on the exterior margin.

Thorax without allurement organs. Coxae with three to five rows of alveoli. Wing length about 2.2 times its width; wing membrane hyaline; subcostal vein extending beyond the origin of R_1, with broaden apex as in Fig. 9, ending at the same level as origin of R_5; Radial and medial forks almost the same level with medial fork slightly basal; R_5 ending beyond wing apex; CuA and ending at wing margin at the level of medial fork.

Terminalia. Hypandrium band-like (Fig. 5); gonocoxites cylindrical; gonostyli cylindrical and evenly narrowing towards the pointed apex; ejaculatory apodeme slender, digitiform, longer than the aedeagal complex (Figs. 5-6, 10-11); aedeagal complex symmetrical in ventral view (Figs. 5-6, 10-11), with a sclerotized heart-shaped sclerite at the apex; with a tongue-shaped aedeagal sheath dorsal to the aedeagal complex; gonocoxal apodemes band-like, forming a strong U-shaped band that extends below the aedeagus, band without spicules; the aedeagal complex in lateral view (Figs. 4, 12) appears to be linked with the aedeagal sheath, the ejaculatory apodeme and linked to the hypandrium and epandrium; epandrium rectangular, slightly wider than its length, with two apertures; epandrial appendages cylindrical, with 10-12 apical tenacula; epiproct and hypoproct tongue shaped and covered in micropilosity.

Female (Figs.13-16). Like male except for the following characteristics: eye bridge with 4 facet rows; the subgenital plate (sternite 8) longer than its width, covered in setulae and medially constricted, resulting in an hourglass-shaped outline (Figs. 14, 15); the anterior margin is straight, and the posterior margin is divided into two lobes by a U-shaped concavity in the middle. The cerci are about 1.5 times longer than the subgenital plate; the genital chamber is symmetrical as in Fig. 14.

Etymology. The species name *mexicanus* is an adjective referring to Mexico, the country where the species was collected.

Genetics. 84 specimens were successfully sequenced, forming a single BIN (BOLD:ADX7807) within the BOLD database. The average uncorrected pairwise distance is 1.22%, with a maximum of 2.56%. The Distance to Nearest Neighbor in BOLD is 9.38 % (BOLD:ADA8979).

Consensus sequence:

ATTATATTTTATTTTTGGAAGTTGAGCTAGAATAG-TTGGAACTTCACTAAGTATTATTATTCGTACAGA-ATTAGGTCATCCTGGGTCTTTAATTGGGAATGAC-CAAATTTATAACACAATTGTAACAGCTCATGCCT-TTGTAATAATTTTTTTTATAGTAATACCTATTATAA-TTGGAGGATTTGGTAATTGATTGGTTCCTTTAATA-TTAGGGGCCCCTGATATAGCTTTCCCTCGAATAA-ATAATTTAAGTTTTTGACTTTTACCCCCTTCTATA-TTATTATTATTAAATAGATCAATAGTAGATACAG-GAGCCGGGACAGGTTGAACAGTTTACCCCCCTC-

TTTCTAATATTATTGCTCATGGAGGGCCCTCCGTT-GATTTAGCAATTTTTTCATTACATTTAGCCGGGA-TTTCATCAATTTTGGGGGCTGTAAATTTTATTAC-TACAATTATTAATATACGATCGCCAGGAATTACTT-TTGATCGAATACCTTTATTTGTATGATCAGTATTTA-TTACTGCCGTTCTATTACTTCTTTCATTGCCTGTAT-TAGCTGGAGCCATTACCATACTATTAACAGATCG-TAATTTAAATACTTCATTTTTTGACCCTGCCGGGG-GAGGAGACCCTATTTTATATCAACACTTAT

Remarks. Males of *Telmatoscopus mexicanus* **sp. nov.** are very similar to males of *T. congruus* and although no specimens of the latter were examined the male terminalia can be separated based on Quate's illustrations (see Quate, 1996: fig. 14h). Likewise, the overall shape of the female subgenital plate can be differentiated from Quate's original drawing (see Quate 1996: fig. 14i).

DISCUSSION

Within the family Psychodidae, the genus *Telmatoscopus* Eaton has long been regarded as taxonomically unstable due to inconsistent interpretations of its type species and unclear relationships among historically described taxa (Kvifte 2014; Ježek 1989; Bravo et al. 2011; Jaume-Schinkel et al. 2022). These inconsistencies have persisted for decades and continue to affect the placement of numerous species, particularly those from the Neotropical region (Bravo et al. 2011). For example, the recent revision by Kvifte (2014) excluded Neotropical species traditionally assigned to *Telmatoscopus*, leaving them without adequate allocation to other genera.

Early attempts to define the genus further contributed to the confusion. Ježek (1989) considered *Telmatoscopus* to be a probable polyphyletic assemblage, suggesting that many species currently included in the genus may in fact belong to undescribed genera. In his proposed diagnosis, Ježek relied on *Pericoma morula* Eaton, 1893 (now recognized as *Seoda morula* following Kvifte (2014)) as the type species of *Telmatoscopus*. Based on this concept, he included 27 Holarctic species; however, he did not address the taxonomic placement of other species historically classified under the genus.

Further complication followed in Ježek's (2001) diagnostic table of "telmatoscopoid" genera, which included *Lepiseodina*, *Sciria* (= *Telmatoscopus*), *Iranotelmatoscopus*, *Krivosheinoscopus* (= *Telmatoscopus*), and *Telmatoscopus* auctt. (= *Seoda*). Despite this effort at clarification, Ježek continued to treat species belonging to *Seoda* as *Telmatoscopus*, and conversely placed species of *Telmatoscopus* under *Sciria*. These inconsistencies were later resolved by Kvifte (2014) and have since been revisited by Jaume-Schinkel et al. (2022), who further discussed the diagnostic characters of the genus *Telmatoscopus* with a focus on European species.

Recognizing these long-standing issues, Bravo et al. (2014) proposed a new genus as an initial step toward resolving the taxonomic confusion surrounding *Telmatoscopus* and related genera in the American continent (Bravo et al. 2014). However, more recent work by Viera et al. (2024) emphasizes that a comprehensive revision of Neotropical species remains necessary to establish clear boundaries among the different genera in the region.

The species described herein is assigned to the genus *Telmatoscopus* following the diagnoses of Kvifte (2014) and Jaume-Schinkel *et al*. (2022), based on the following characters: frons and clypeus separated and not protruding beyond the eye margin; flagellomeres asymmetrically nodiform, bearing paired digitiform ascoids; flagellomere 14 with an elongated apiculus; wing veins R2+3 not connected to R4; ejaculatory apodeme narrow in ventral view; and aedeagal complex symmetrical.

However, certain features do not conform to the published diagnosis, including the termination of wing vein R_5 beyond the wing apex (rather than at the apex) and the presence of two apertures in the epandrium (instead of a single aperture). Despite these discrepancies, the species is provisionally placed within *Telmatoscopus* pending further studies to clarify the status and delimitation of closely related species and genera. Considering these persistent challenges, integrative approaches combining both morphological and molecular data offer a promising path toward resolving long-standing taxonomic ambiguities within Psychodidae. DNA barcoding can provide evidence for delimiting species, detecting cryptic diversity, and clarifying relationships that remain obscured when relying solely on morphology. Molecular data can also strengthen sex associations by validating conspecificity between males and females collected sympatrically (Cordeiro et al. 2023), reducing the risk of misassociation in regions where multiple closely related species coexist. Moreover, integrative frameworks can reveal previously undocumented lineages in under-sampled or newly surveyed geographic areas, thereby improving our understanding of species distributions and informing future revisions of Neotropical Psychodinae (Jaume-Schinkel and Kolter 2025).

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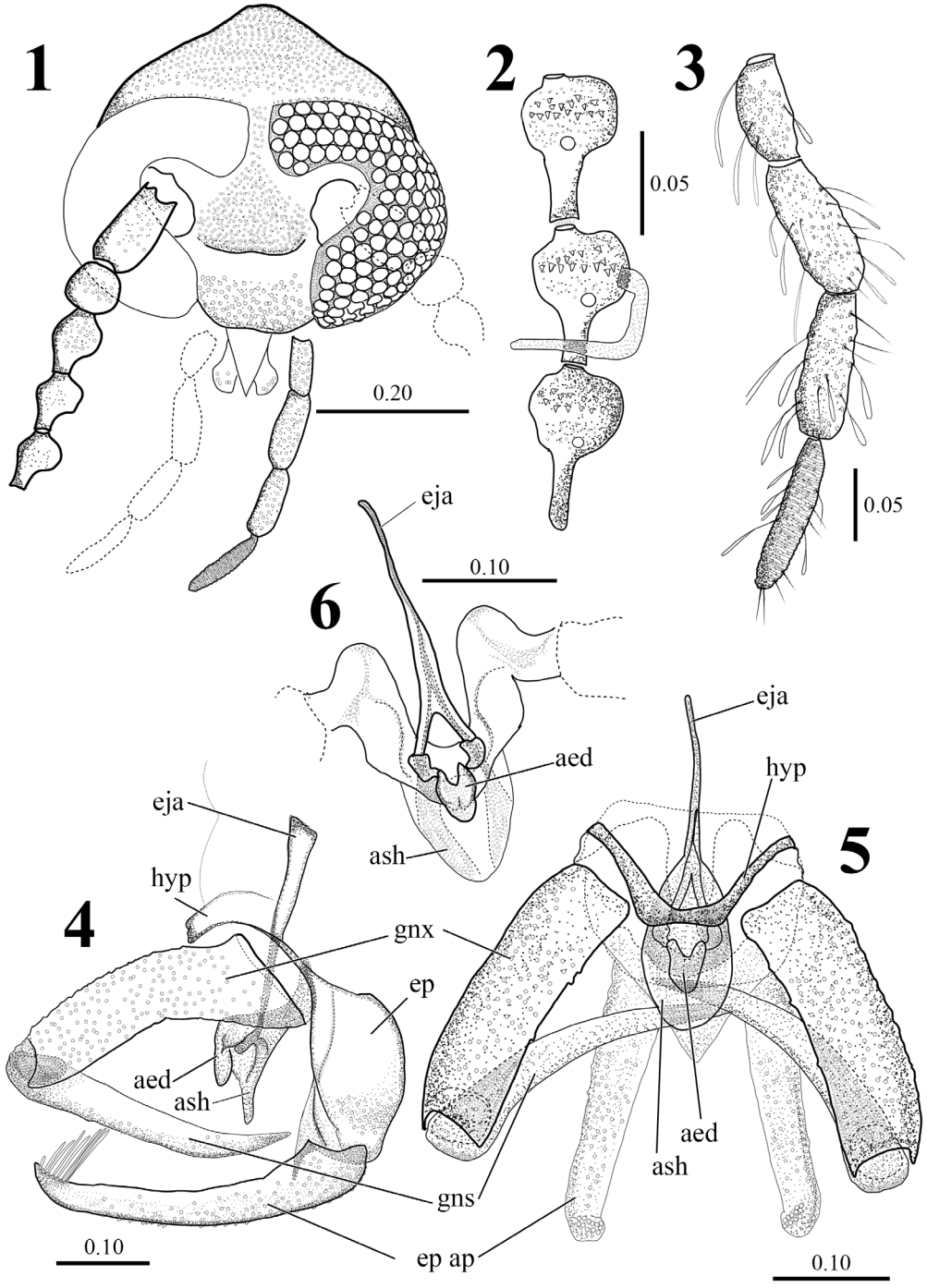
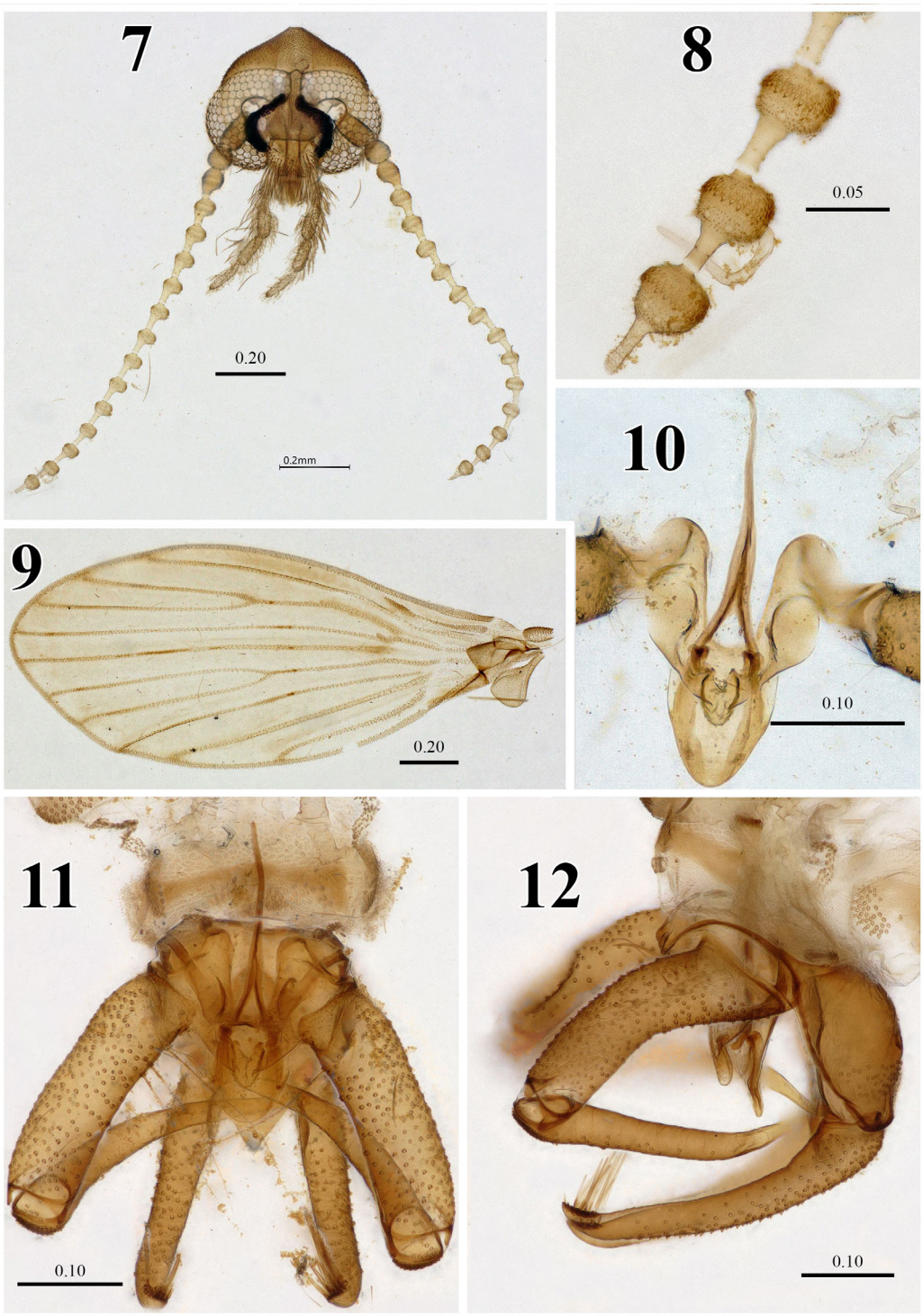
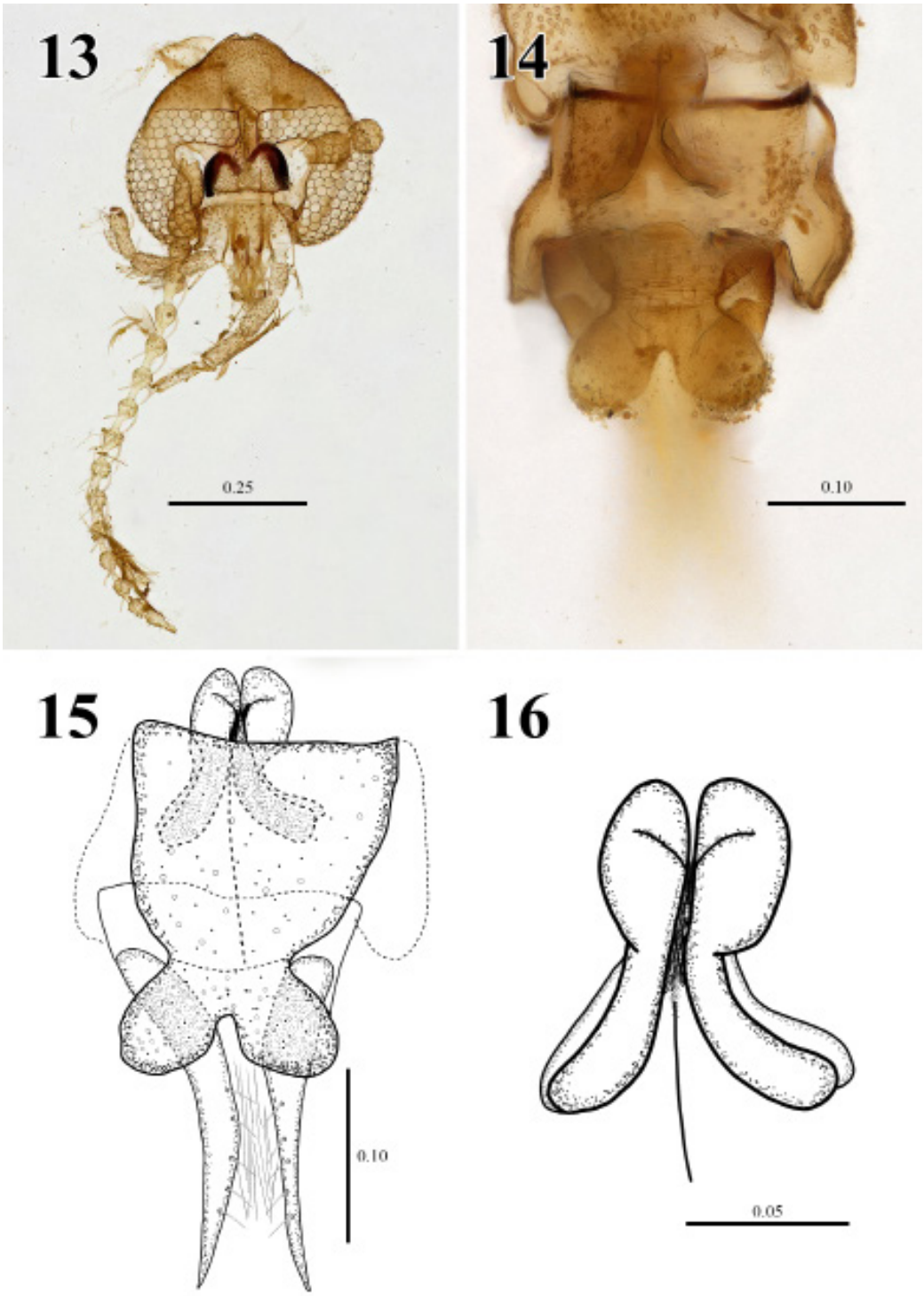


Figures 1-6. *Telmatoscopus mexicanus* sp. nov., male. Figures 1-3 (BIOUG91599-C01), Figure 4 (BIOUG44971-G04), Figure 5 (BIOUG89599-C07), Figure 6 (BIOUG88585-A08). 1) Head (frontal view). 2) apical flagellomeres of antennae. 3) Palpal segments. 4) terminalia (lateral view). 5) terminalia (ventral view). 6) Aedeagal complex (ventral view). Abbreviations: aed: aedeagus; ash: aedeagal sheath; ep: epandrium; ep ap: epandrial appendages; hyp: hypandrium; eja: ejaculatory apodeme; gnx: gonocoxites; gns: gonostyli. All scales are in millimeters.



Figures 7-12. *Telmatoscopus mexicanus* sp. nov., male. Figures 7-8 (BIOUG91599-C01), Figures 9 and 12 (BIOUG44971-G04), Figure 10 (BIOUG88585-A08), Figure 11 (BIOUG89599-C07).7) Head (frontal view). 8) Apical flagellomeres of antennae. 9) wing. 10) Aedeagal complex (ventral view). 11) Terminalia (ventral view). 12) Terminalia (lateral view). All scales are in millimeters.



Figures 13-16. *Telmatoscopus mexicanus* sp. nov., female. Figure 13 (BIOUG66704-E01), Figures 14-16 (BIOUG66721-B01). 13) Head (frontal view). 14) Terminalia. 15) Terminalia line drawing. 16) Genital chamber. All scales are in millimeters.

