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Three new Mexican species of the endemic Athysanini leafhopper genus *Devolana* DeLong (Hemiptera: Cicadellidae) from the tropical dry forest

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ABSTRACT

Three new species of the endemic leafhopper genus *Devolana* are described based from Sierra de Tuxcacuesco (Jalisco), Iguala and Zincauro (Guerrero), Mexico. Overall habitus and genital characteristics are extensively illustrated. A map of the known distribution and habitat images are included. A key to known species of *Devolana* is provided. The studied area and biodiversity implications for arboreal leafhoppers are discussed.

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KEYWORDS

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Introduction

Deltocephalinae is the largest subfamily of cicadellids (Hemiptera: Auchenorrhyncha: Cicadellidae), comprising approximately 6350 described species distributed worldwide. The tribe Athysanini, one of the 38 recognised deltocephaline tribes, comprises 262 genera, of which 126 are present in the New World (Oman 1949; Linnavuori 1959; Oman et al. 1990; Dmitriev 2003; Zanol 2008; Zahniser and Dietrich 2013).

Due to its position on the transition zone between Nearctic and Neotropical region, the diversity mosaic of vegetation zones and abrupt orography, Mexico is home to a diverse fauna of athysanine leafhoppers with 27 apparently endemic genera known, e.g. *Mexicananus* DeLong, 1944; *Renonus* DeLong, 1959; *Usanus* DeLong, 1947; and *Jaacunga* Nielson, 1988 (Linnavuori 1959; Zahniser and Dietrich 2013). However, innumerable species are awaiting collection in remote and unexplored places.

Athysanini includes the Mexican leafhopper genus *Devolana* described by DeLong (1967) based on a single species, *D. hemicycla*, collected from Iguala, Guerrero. Since

DeLong erected the genus and species, there have been no further reports on *Devolana*, and its ecology has remained unknown. The material reviewed become from the Sierra de Tuxcacuesco of Mexico collected by C. H. Dietrich (University of Illinois) and his team in 2012 and, in addition, recent fieldwork by authors with a special interest in the same area and a deep review of type series of *D. hemicycla*. Given the need to highlight entomofauna and provide new knowledge about Mexican leafhoppers, herein we describe three new species of *Devolana* restricted to the tropical dry forest of Mexico.

Materials and methods

Study area

The Sierra de Tuxcacuesco region (19°42'21.6"N, 104°04'14.7"W, 900 m) is mainly covered by dense areas of tropical dry forest (Figure 5(a–c)). The methodology used follow light trap designed for monitoring leafhopper biodiversity of the Sierra Madre del Sur (SMSr) by JAPE. The studied area is characterised by tropical dry forest in low lands and *Quercus* forest in highlands with intercalated valleys of grasslands, with average annual precipitation of 914 mm and temperatures of 32°C for summer and 9°C during winter. The studied region is located on a small part of the Pacific Lowlands province in the transition zone between two biogeographic provinces in Mexico, the Transmexican Volcanic Belt (TVB) and SMSr.

Collecting, specimen preparation and terminology

Specimens collected were trapped using a light trap positioned at the base of trees to capture individuals. Specimens taken were preserved in 95% ethanol. The material studied is housed at the Illinois Natural History Survey, Champaign, Illinois, USA (INHS), Colección de Auchenorrhyncha de Jorge Adilson Pinedo Escatel, Mexico (CAJAPE), and C.A. Triplehorn Insect Collection, Columbus, Ohio, USA (OSUC).

The abdomen of males was cleared with hot 10% KOH, rinsed with water mixed with alcohol at different concentrations and stored in glycerine. Habitus images were taken using a Nikon digital camera. External and internal genital structures were visualised and examined through a Carl Zeiss Stemi 2000c stereoscopic-microscope coupled to a camera lucida where illustrations were drawn. Subsequently, drawings were digitised and vectorised with Adobe Illustrator® and edited in Adobe Photoshop®. Measurements were obtained using an electronic vernier.

Taxonomic criteria and terminology follow mainly Dietrich (2005), Rakitov (1998) and Kramer (1950).

Systematics

Family **CICADELLIDAE** Latreille, 1825
Subfamily **DELTOCEPHALINAE** Dallas, 1870
Devolana DeLong, 1967
Devolana DeLong, 1967: 22.

Type species

Devolana hemicycla DeLong, 1967, p. 23, original description.

Distribution

Endemic to Mexico, reported from the following states: Guerrero (Iguala de la Independencia and Zincauro) and Jalisco (Sierra de Tuxcacuesco), [Figure 4](#).

Diagnosis

Devolana is easily distinguished from other similar genera of Athysanini by the following combination of characteristics: (1) head very short with anterior and posterior margins of crown parallel; (2) face with arcuate black line extended from midline laterad through ocelli and along border of frontoclypeus; (3) pronotum with pair of large black spots; (4) pygofer without processes; and (5) aedeagus with a set of apical processes.

Morphology

Moderately robust leafhoppers with overall appearance yellowish with black spots on crown and pronotum. Crown rounded, paralleled to posterior margin. Transition of crown to face angled, shagreen. Ocellocular area parallel and wide. Ocelli slightly below margin of head, distance to adjacent eye approximately 2x ocellar diameter. Frontoclypeus wide, lateral frontal sutures reaching ocellus, fine setae laterad frontal suture. Anteclypeus widening apically, apex curved slightly surpassing natural curve of genae. Lorum subequal than anteclypeus near base. Genae incised laterad. Pronotum weakly produced medially, laterad margins carinate, yellowish with a symmetrical pair of large black spots and a paired diffuse pale-brown line between them. Scutellum broad. Forewing macropterous, translucent with black-brown colour on vein-scheme or yellowish pigmentation near the base of clavus, appendix restricted to anal margin, apex rounded, apical and antepical cells large, Cs–Pcu crossvein absent, Pcu–A1 crossvein only presented in *D. tuxcacuensis*. Front femur AM1 near mid-height of apex, long; IC long, thin; row AV small. Front tibia dorsal macrosetal formula (AD+PD) 1 + 4, PV small stout setae. Hind femur macrosetal formula 2 + 2 + 1.

Pygofer broad, short, square or pointed, without processes, long and small stout macrosetae near apex, basolateral cleft present. Segment tenth small, broad, well-sclerotised with membranous tip. Valve and subgenital plates free articulated to pygofer. Valve rounded and slightly produced. Subgenital plate triangular, uniseriate laterad with robust and fine setae. Connective Y-shaped, stem short. Style slender, basal and preapical lobe weakly developed with setae on posterad margin, apophysis short and curved mesad, apex truncate. Aedeagus curved dorsad, aedeagal shaft with lateral flanges devolved or not, two or three pairs of apical processes. Aedeagal base without processes. Gonoduct sclerotised. Gonophore subapical on ventral surface.

Remarks

DeLong (1967) compared this taxon to *Exitianus* and *Spinulana*, which differ by combinations of genital structures and external features. *Exitianus* was included in tribe Chiasmini by Zahniser and Dietrich (2013); members of this tribe have a tapering or parallel-sided anteclypeus and an aedeagus hinged at the base. *Spinulana* and *Devolana*, both of which are currently placed in Athysanini differ in general body colour and in the structure of the male pygofer and aedeagus.

Species of *Devolana*

Devolana hemicycla DeLong, 1967: 23

Devolana tuxcacuensis Pinedo-Escatel and Aguilar-Pérez, **sp. nov.**

Devolana youajla Pinedo-Escatel, **sp. nov.**

Devolana xajxayakamej Pinedo-Escatel, **sp. nov.**

Key to the species of *Devolana*

1. Aedeagus with two pairs of apical processes. 2
Aedeagus with three pairs of apical processes 3
2. Forewing yellowish on clavus; aedeagus without lateral flanges and apical processes directed anterodorsad *tuxcacuensis* Pinedo-Escatel and Aguilar-Pérez, **sp. nov.**
Forewing translucent; aedeagus with lateral flanges developed and apical processes directed dorsad and anteromesad *youajla* Pinedo-Escatel, **sp. nov.**
3. Flanges somewhat straight in ventrad view; posterad margin of flanges produced at midwidth *hemicycla* DeLong
Flanges declivous in ventrad view; posterad margin of flanges not produced and continuous *xajxayakamej* Pinedo-Escatel, **sp. nov.**

Devolana tuxcacuensis* Pinedo-Escatel and Aguilar-Pérez, **sp. nov.*

(Figures 1–3)

Description

Measurements. Length male 5 mm, and female unknown.

Male morphology. Overall colour light-yellowish dorsally with white venter (Figures 1–2). Crown with black transverse band at apex extended laterally onto face, and pair of tiny black spots next to eyes (Figures 1(a) and 2). Face with upper-half yellowish and lower half white. Frontoclypeal and anteclypeal margins marked with black band extended dorsad over ocelli to midline, multiple black transverse bands over frontoclypeal surface and anteclypeus with one dark-brown medial vertical line. Gena and lorum white with diffuse black, yellow and brown minute spots (Figure 1(b)). Forewing translucent over almost entire surface except with patches of yellowish opaque pigment near base of clavus and veins C, M, CuP and A dark brown (Figure 1(c)). Legs white with black stripes along tibiae and across front femur.

Female. Unknown.

Male genitalia. Pygofer broad with macrosetae mixed with small setae beyond mid-length (Figure 3(a–b)). Valve slightly projected and rounded, articulated with pygofer and subgenital plates (Figure 3(c)). Plate extended to apex of pygofer, with mix of fine and stout long setae along lateral margin (Figure 3(d)). Style slender with basal and preapical lobe weakly developed, apophysis slender and slightly curved mesad (Figure 3(h)). Connective Y-form (Figure 3(i)). Aedeagus robust, short and curved with two long pairs of apical processes directed anterodorsad (Figure 3(e–g)).

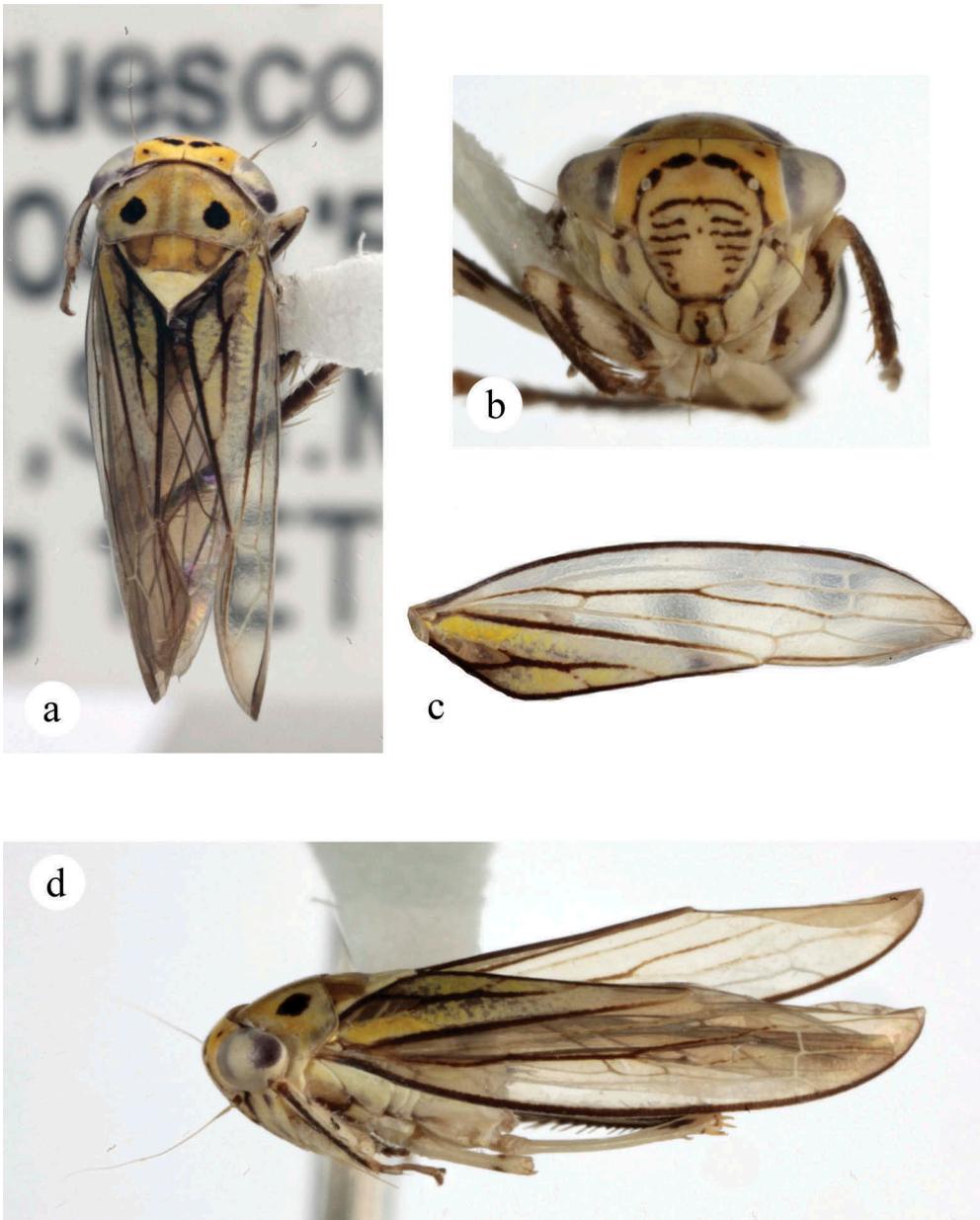


Figure 1. *Devolana tuxcacuensis* Pinedo-Escatel and Aguilar-Pérez, sp. nov., holotype male: (a) habitus, dorsal; (b) habitus, face; (c) right forewing, dorsal; (d) habitus, lateral.

Immature stages. Unknown.

Type locality. Sierra de Tuxcacuesco, Jalisco (Mexico), [Figure 4](#).

Seasonality. This species occurs between September and October.



Figure 2. *Devolana tuxcacuensis* Pinedo-Escatel and Aguilar-Pérez, sp. nov.

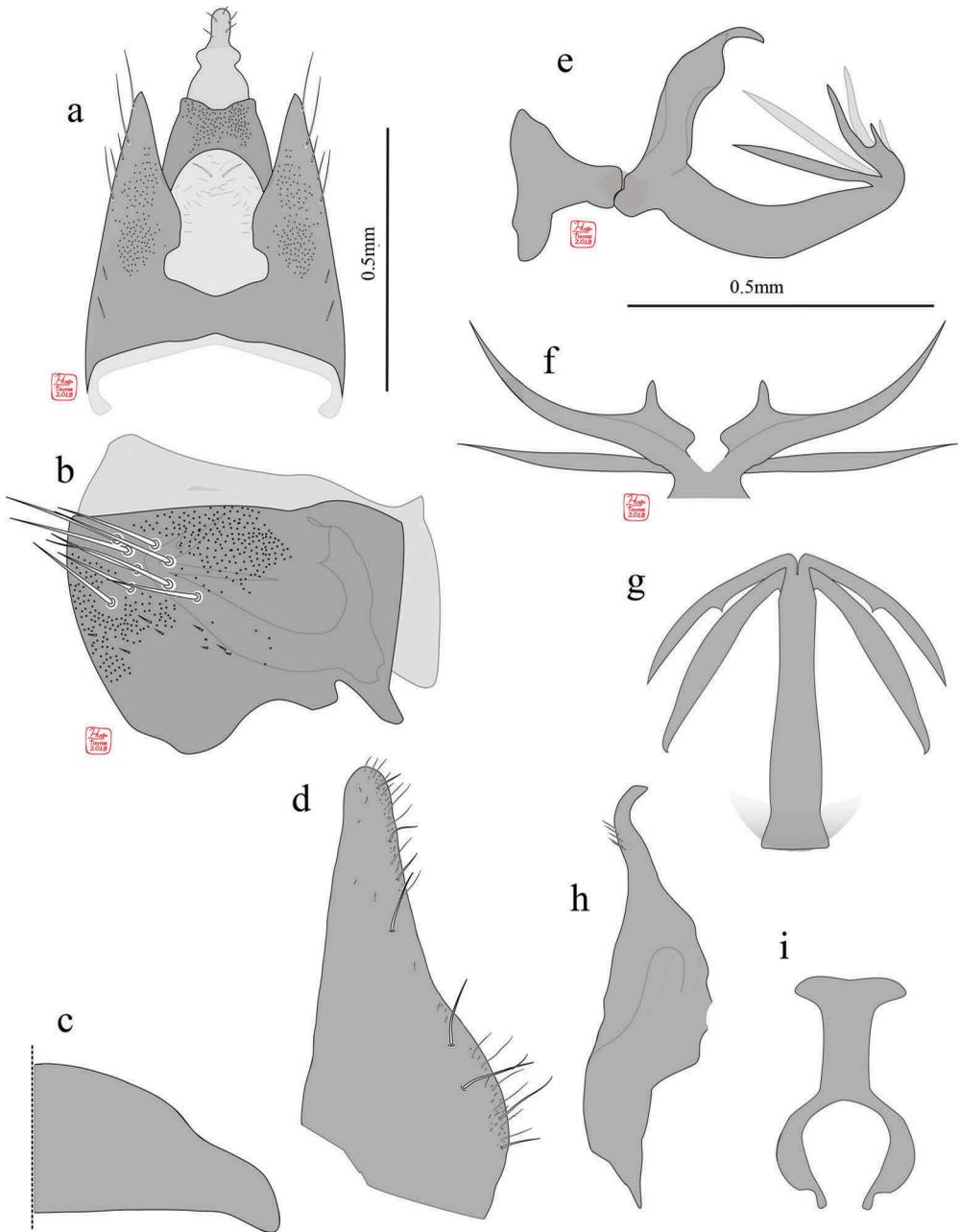


Figure 3. *Devolana tuxcacuensis* Pinedo-Escatel and Aguilar-Pérez, sp. nov., holotype male genitalia: (a) pygofer, dorsal; (b) pygofer, lateral; (c) valve, ventral; (d) subgenital plate, ventral; (e) aedeagus, lateral; (f) apex of aedeagus, caudal; (g) aedeagus, ventral; (h) left style, dorsal; (i) connective, dorsal.

Etymology. The species epithet refers to the type locality.

Type material. Holotype male (INHS) – MEXICO: Jalisco, 13 km ESE Tuxcacuesco 900 m, 19°40'6"N 104°1'53"W, 13 October 2001, S. H. McKamey et al. Colls., fogging 1

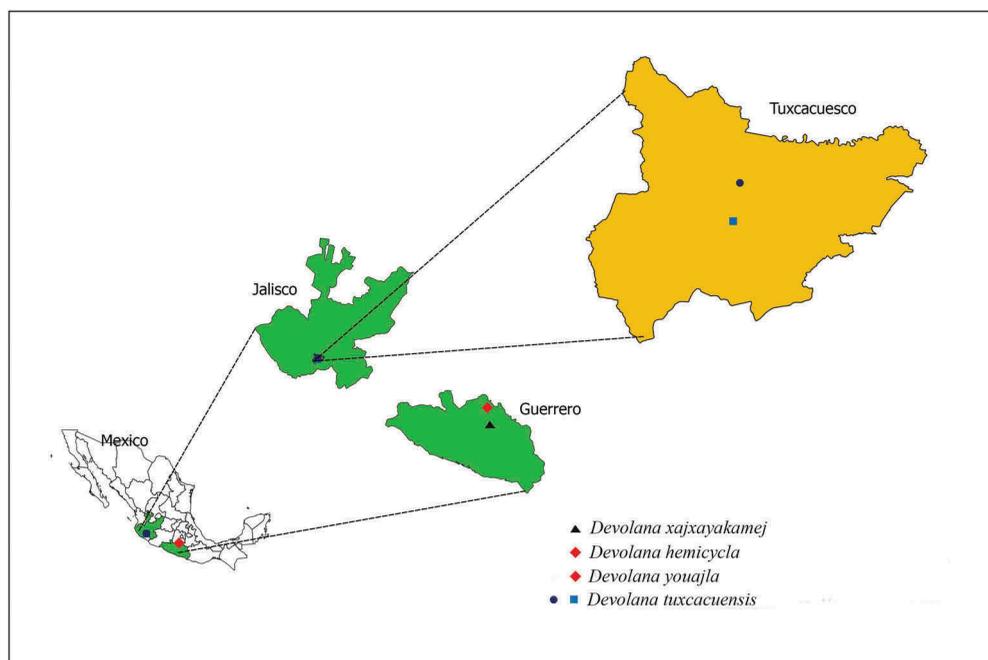


Figure 4. Map of distribution of the genus *Devolana* in Mexico.

E-T. Paratype male (CAJAPE) – MEXICO: Jalisco, Región Sierra de Amula, Municipio Tuxcacuesco, Sierra de Tuxcacuesco a 5.5 km del pueblo Tuxcacuesco, 19°42'02.1"N 104°01'41.6" W, 864 m. 08 de septiembre de 2018. Vegetación BTC. J. A. Pinedo-Escatel Col. Trampa de Luz [MEXJAL88].

Remarks. This species is similar in dorsal appearance to *D. youajla*, but *D. tuxcacuensis* differs in lacking lateral flanges on the aedeagal shaft (Figure 3(f–g)).

***Devolana youajla* Pinedo-Escatel, sp. nov.**
(Figures 6 and 7)

Description

Measurements. Length male 5.9 mm, female unknown.

Male morphology. Overall colour brown-yellowish. Crown short, paralleled to anterior margin with two pairs of black spots, one next to midline and second next to eyes (Figure 6(a)). Face yellowish. Frontoclypeal and anteclypeal margins marked with black band extended dorsad over ocelli and almost connecting to midline, multiple black transverse bands over frontoclypeal surface presented and anteclypeus longitudinally brown marked. Lorum yellowish. Gena mostly yellowish with a brown line running from eye corner towards midlength of lorum and diffuse black spot around maxillary sensillum (Figure 6(b)). Pronotum, anterior half gold-yellowish with posterior area white.

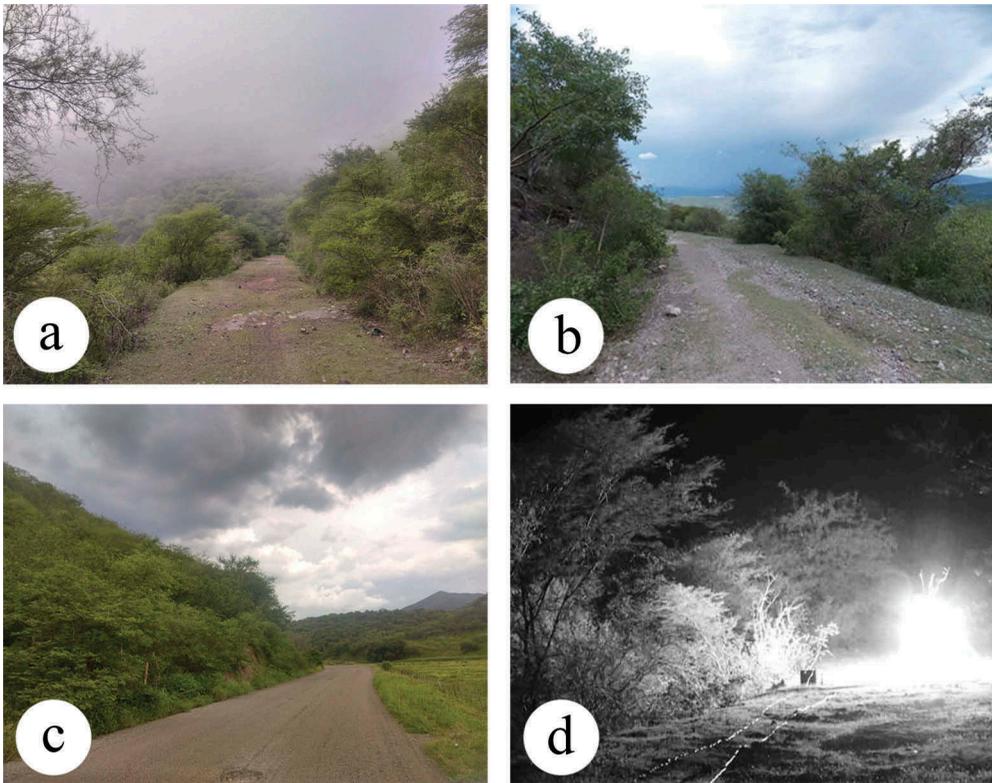


Figure 5. *Devolana tuxcacuensis* Pinedo-Escatel and Aguilar-Pérez, sp. nov., site of habitat and collection. (a–c) Area covered by tropical dry forest at sampled site; (d) position and functionality of light trap used during the collections in the site (photo by GRJ).

Forewing translucent with dark-brown pigment on C, M, CuA, Cs, Pcu and A veins (Figure 6(c)). Legs yellowish with black stripes along tibiae and front femur.

Female. Unknown.

Male genitalia. Pygofer broad with stout macrosetae distributed near midlength towards posterad margin (Figure 7(a–b)). Valve medially produced, articulated with pygofer and subgenital plates (Figure 7(c)). Plate thin, length similar to posterad margin of pygofer, few small fine and stout setae along lateral margin (Figure 7(d)). Style slender with posterad lobes weakly developed, apophysis short and curved (Figure 7(h)). Connective Y-form (Figure 3(i)). Aedeagus robust, short and apex pointed with broad lateral flanges developed with two apical processes; one emerging of distant flange corner directed dorsad and second arising near apex on ventral surface running ventromesad until midlength of aedeagal shaft, cylindrical (Figure 7(e–g)).

Immature stages. Unknown.

Type locality. Iguala de la Independencia, Guerrero (Mexico), Figure 4.

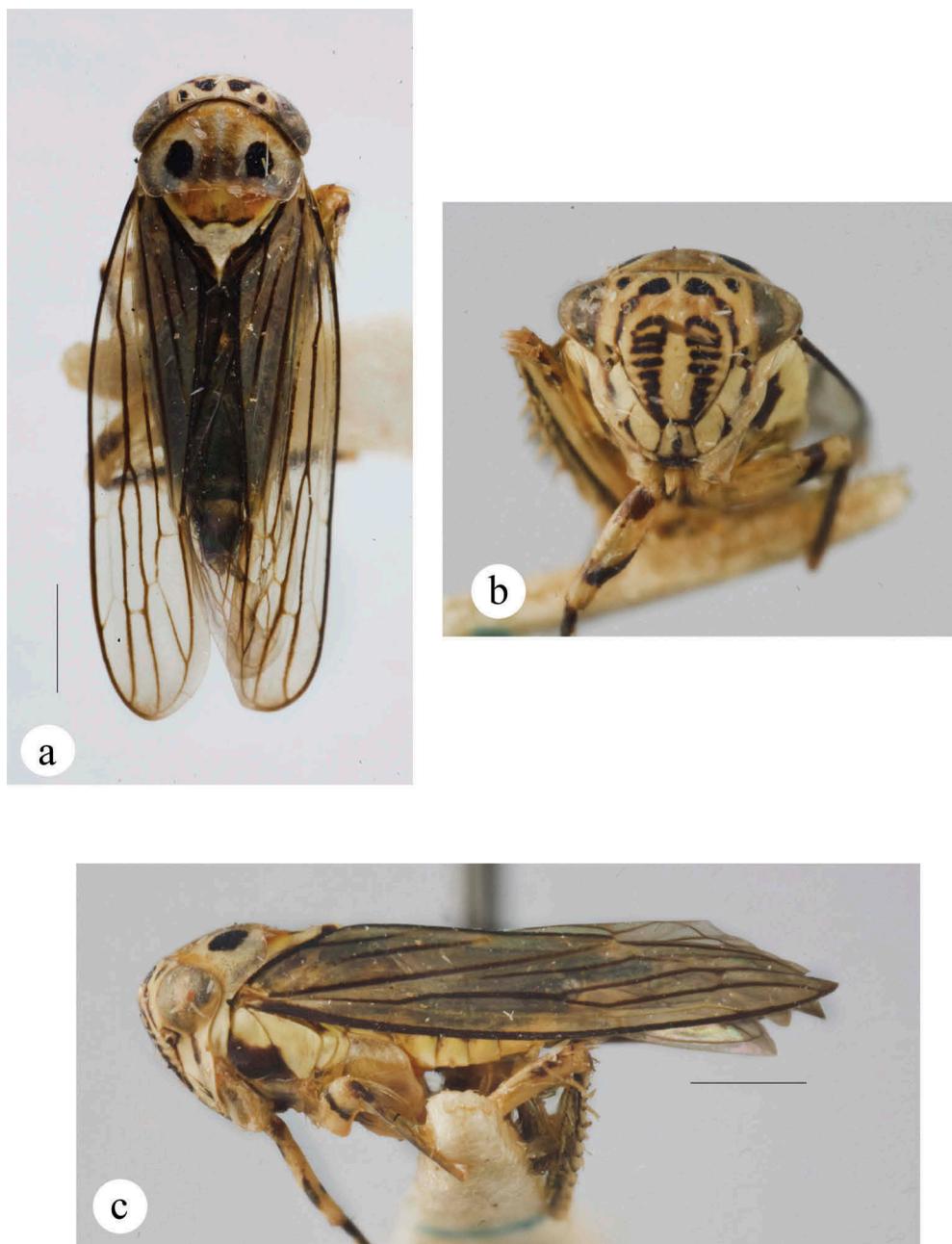


Figure 6. *Devolana youajla* Pinedo-Escatel, sp. nov., holotype male: (a) habitus, dorsal; (b) habitus, face; (c) habitus, lateral.

Seasonality. This species occurs in October.

Etymology. The species epithet derives from the Náhuatl word Iguala, meaning to the type locality.

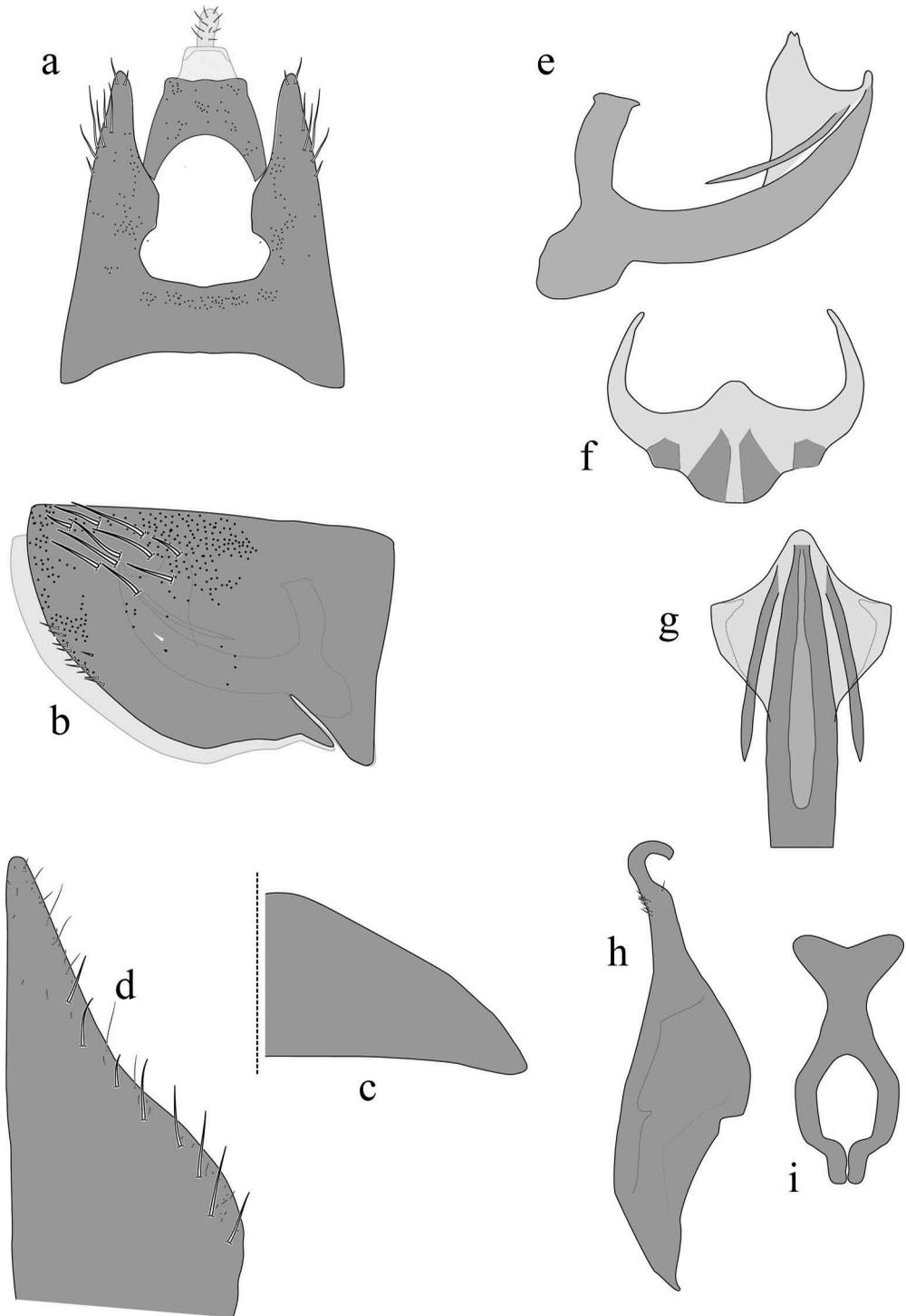


Figure 7. *Devolana youajla* Pinedo-Escatel, sp. nov., holotype male genitalia: (a) pygofer, dorsal; (b) pygofer, lateral; (c) valve, ventral; (d) subgenital plate, ventral; (e) aedeagus, lateral; (f) apex of aedeagus, caudal; (g) aedeagus, ventral; (h) left style, dorsal; (i) connective, dorsal.

Type material. Holotype male (OSUC) – MEXICO: Guerrero, Iguala, IX–11–1939, D. M. DeLong Collection, D. M. DeLong Coll. #OSUC 356605. Paratype 2 males (OSUC) – MEXICO: Guerrero, Iguala, IX–11–1939, D. M. DeLong Collection, D. M. DeLong Coll. #OSUC 356606 and 356607, respectively.

Note: all specimens examined were previously designated as paratypes of *Devolana hemycicla* DeLong by DeLong (1967).

Remarks. *Devolana youajla* differs from other species in having an aedeagus with flanges developed and two pairs of apical processes (Figure 7(f–g)).

***Devolana xajxayakamej* Pinedo-Escatel, sp. nov.**
(Figures 8 and 9)

Description

Measurements. Length male 5.2 mm, female unknown.

Male morphology. Overall colour light-yellowish (Figure 8(a–b)). Crown yellowish with black transverse band at apex and pair of black spots next to eyes (Figure 8(a)). Face entire yellowish. Frontoclypeal and anteclypeal sides unmarked, several black transverse bands over frontoclypeal surface and anteclypeus yellowish. Gena and lorum yellowish, unmarked (Figure 8(b)). Pronotum brown-yellowish with a symmetrical pair of black spots with a paired diffuse pale-brown line between them. Forewing translucent with dark-brown pigment on C, M, CuA, Cs, Pcu and A veins (Figure 8(c)). Legs brown with black stripe along front tibia.

Female. Unknown.

Male genitalia. Pygofer somewhat conical with macrosetae on posterior half (Figure 7(a–b)). Valve projected articulated with pygofer and plates (Figure 9(c)). Plate extended near to apex of pygofer with row of long and stout setae beside fine long setae on lateral margin (Figure 9(d)). Style slender with lobes weakly developed, apophysis short and curved mesad (Figure 9(h)). Connective Y-form (Figure 9(i)). Aedeagus robust, short, apex pointed and flanges developed with three pairs of apical processes; two processes emerging from flanges on dorsal surface directed dorsad and anterad, respectively; third process arising close from apex on ventral surface, long surpassing midlength of aedeagal shaft and subapically expanded (Figure 9(e–g)).

Immature stages. Unknown.

Type locality. Zincauro, Guerrero (Mexico), Figure 4.

Seasonality. This species occurs in October.

Etymology. The species epithet derives from the Náhuatl word mask, in allusion to its black markings of the crown

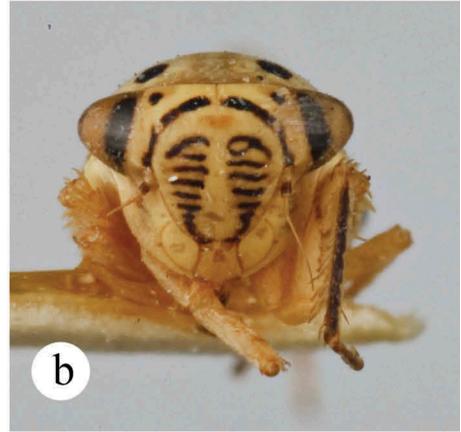


Figure 8. *Devolana xajxayakamej* Pinedo-Escatel, sp. nov., holotype male: (a) habitus, dorsal; (b) habitus, face; (c) habitus, lateral.

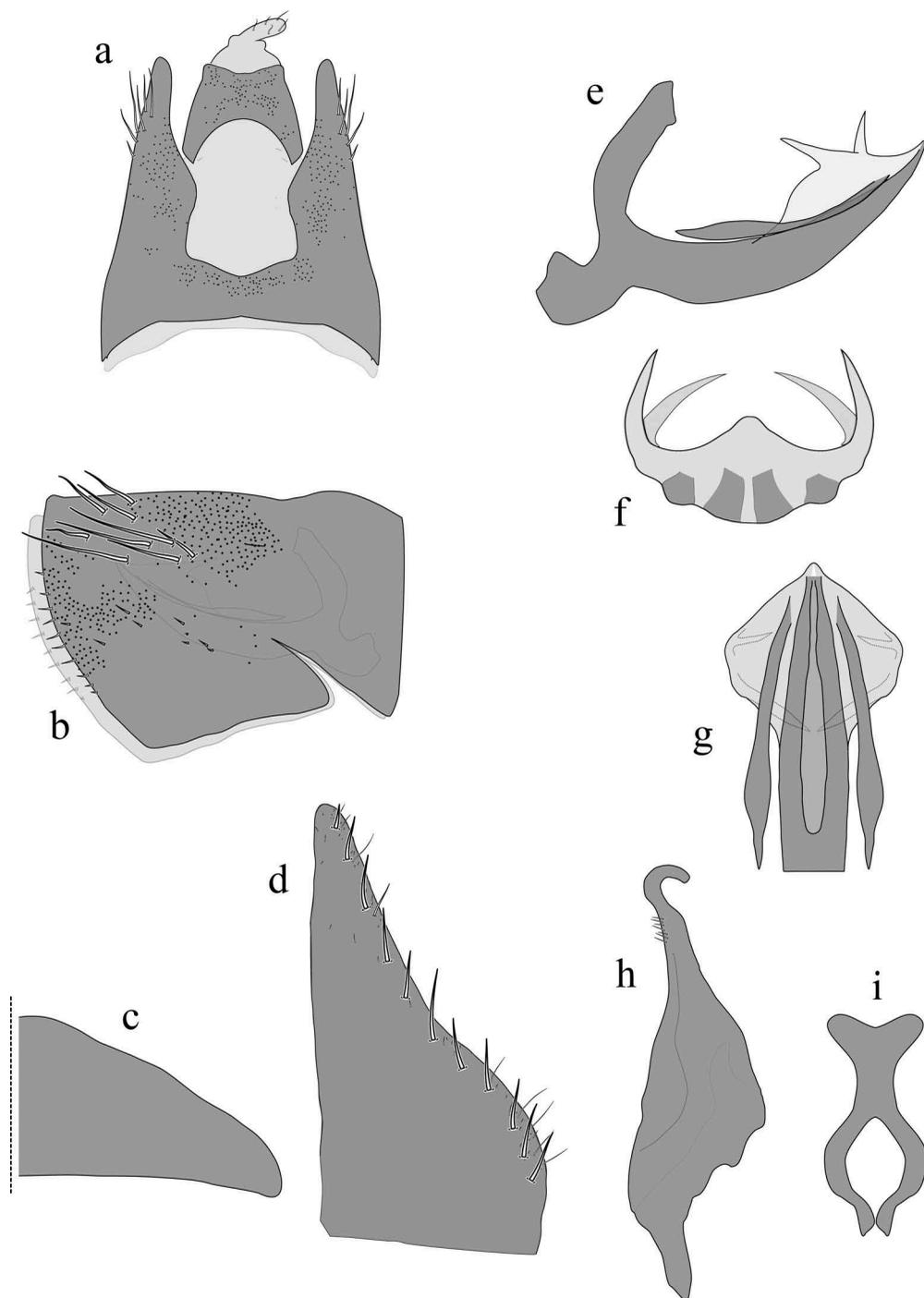


Figure 9. *Devolana xajxayakamej* Pinedo-Escatel, sp. nov., holotype male genitalia: (a) pygofer, dorsal; (b) pygofer, lateral; (c) valve, ventral; (d) subgenital plate, ventral; (e) aedeagus, lateral; (f) apex of aedeagus, caudal; (g) aedeagus, ventral; (h) left style, dorsal; (i) connective, dorsal.

Type material. Holotype male (OSUC) – MEXICO: Guerrero, Zincauro, IX–2–1930, J. Parra Coll., D. M. DeLong Collection. #OSUC 356604.

Note: Paratype previously designated to *Devolana hemicycla*

Remarks. This species is very similar in external appearance to *D. hemicycla* species but differs in lacking lobes on the posterior margin of the aedeagal flanges (Figure 9(f–g)).

***Devolana hemicycla* DeLong, 1967**

Devolana hemicycla DeLong, 1967: 23
(Figure 10)

Distribution known

Iguala de la Independencia, Guerrero (Mexico), Figure 4.

Measurements

Length male 6 mm, female unknown.

Material examined

Holotype male (OSUC) – MEXICO: Guerrero, Iguala, X–25–1941, DeLong, Good, Caldwell and Plummer Colls. E-103. D. M. DeLong Collection. #OSUC 209432.

Remarks

Label data from the only previously dissected specimen in the DeLong collection at Ohio State University, labelled as the holotype of this species, was misquoted in DeLong's (1967) publication. This specimen is unquestionably the holotype because DeLong (1967) illustrated the male genitalia with his original description and none of the paratypes were dissected. The label data published with the original description instead apply to three of the four specimens labelled as paratypes. DeLong's type series of *D. hemicycla* includes two additional undescribed species. Study of the entire type series of five specimens indicates that the specimen originally labelled as the holotype is the only representative of *D. hemicycla* species, whereas other specimens in the type series belong to the species *D. youajla* and *D. xajxayakamej*, described as new above.

Discussion

The west region of Jalisco harbours a diverse flora and fauna and forms a transition zone between 2 of the 14 major biogeographic provinces recognised for Mexico by Morrone et al. (2017). The SMSr and the TVB rest in part the Pacific Lowlands province (PL), the location of Sierra de Tuxcacuesco. Along the SMSr, TVB and PL provinces is found an ecosystem with multiple vegetation zones including as grasslands, oak/pine forest, tropical dry forest and montane cloud forest. The studied area includes one Natural Biosphere Reserve, Sierra de Manantlán (part of SMSr), which forms a bridge among these ecosystems of native-vegetation. Sierra de Tuxcacuesco exhibits physical characteristics that favour great diversity of cicadellids, one of these attributes is an extension of 253 m² of isolated

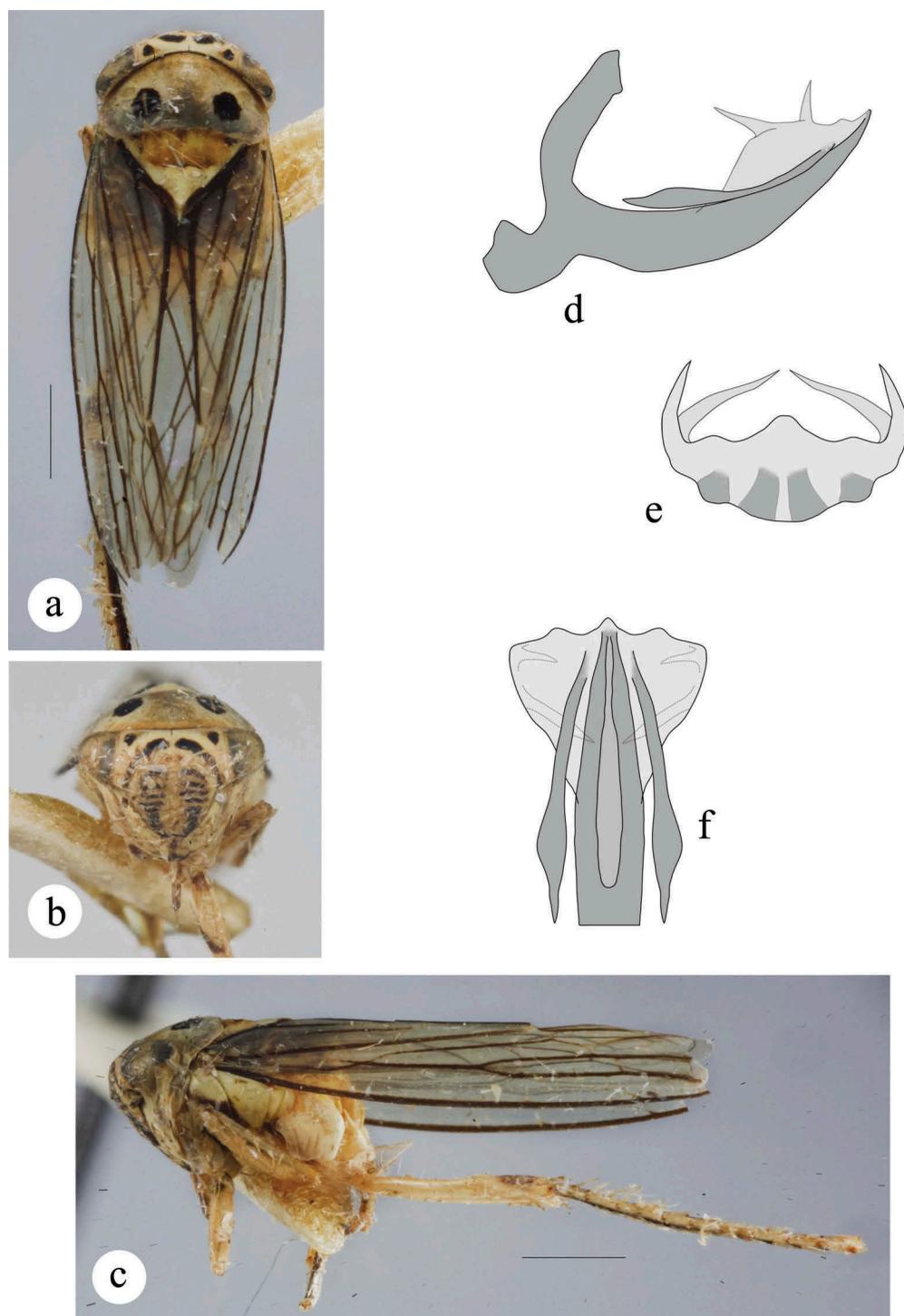


Figure 10. *Devolana hemicycla* DeLong, 1967, holotype male: (a) habitus, dorsal; (b) habitus, face; (c) habitus, lateral; (d) aedeagus, lateral; (e) apex of aedeagus, caudal; (f) aedeagus, ventral.

patches of preserved vegetation with a gradient of conditions ranging 980–600 masl with intermediate hilly areas and valleys facilitating the movement of herbivore insects. These habitats have yielded several new leafhopper species, including the ones described here.

Little is known about biology of genus *Devolana* and other similar leafhoppers of tribe Athysanini, of which *D. tuxcacuensis* represents the northwesternmost record of the genus, occupying a transitional zone between tropical dry forest to oak/pine forest and cloud forest. In contrast, the type-species, *D. hemicycla*, inhabits the south-central tropical dry forest of Mexico in the state of Guerrero with different flora and far from high elevation vegetation zones. The type locality of the latter species, Iguala, and surrounding areas needs further investigation to determine the habitat and host plants of the numerous apparently endemic athysanine taxa described by DeLong.

Devolana tuxcacuensis seems to be an arboreal leafhopper based on the collection method used and personal observations by the authors during fieldwork. The light trap used was set up below trees, oriented towards the canopy (Figure 5(d)), and during previous fieldwork in 2012, one sample was collected from trees in the same area studied.

Areas adjacent to the type locality are scarcely sampled. Medium-size forests of similar content at Sierra Madre del Sur and also in Sierra de Tuxcacuesco could harbour a significant diversity of uncommon genera of Deltocephalinae. Further data on the new species treated and others recently collected species will provide information useful for management and conservation of these habitats. Unfortunately, the expansion of human activities in threatened forests has led to the ongoing degradation of those. Thus, additional data on endemic leafhopper diversity are urgently needed to inform conservation decision-making.

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Rosario Pérez and Guadalupe Aguilar's family kindly hosted us, provided transportation during fieldwork and aided in essential communication with people at Tuxcacuesco town. Guillermo Rodríguez-Juárez shared photos and supported our fieldwork. Hugo Fierros-López helped with some drawings. Christopher Dietrich (INHS) helped with suggestions to improve the earlier manuscript. Curator Luciana Musetti (OSUC) facilitated loan of specimens examined and expressed the need to clarify this misunderstanding of type series labels. The second author is very grateful to Mildred Torres, Kevin Missael, Jorge Mario, Josefina Escatel and Axel Cristobal for comments, advice and space provided during the development of the manuscript. Diego Yassir (Universidad de Guadalajara, CUCSH), Higinio Cruz and Emmanuel Valerio (San Juan Totolcintla, Guerrero) helped with Náhuatl grammar of the species names. We also thank Rosaura Torres-Moreno, Iskra Mariana Becerra-Chiron, Laura Izascum Pérez-Valencia and Gustavo Moya-Raygoza (Universidad de Guadalajara, CUCBA, Laboratorio de Ecología de Insectos) for additional comments.

Disclosure statement

No potential conflict of interest was reported by the authors.

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