

# Two New Species of the Spittlebug Genus *Ocoaxo* Fennah (Hemiptera: Cercopidae) from Mexico, and Keys for the Groups, Group Three, and First Subgroup

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## Keywords

*Ocoaxo* near *fowleri*, *Ocoaxo cardonai*, *O. sinai*, *O. varians*, *Pinus*, Mexico

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## Abstract

Insects of the family Cercopidae are known as spittlebugs or froghoppers and are represented by 62 genera in the Neotropical region. One of these genera is *Ocoaxo* Fennah, 1968 with 30 species. The most recent species to be accepted into this genus, *Ocoaxo costaricanus*, was described by Nast (Ann Zool 33:93–101, 1975). Herein, two new species of *Ocoaxo* from Mexico are described. One of these new species forms a complex together with *Ocoaxo assimilis* (Walker) and *Ocoaxo varians* (Stål). The complex has economic importance in the mountainous areas of the states of Puebla and Oaxaca because it attacks *Pinus* spp. and causes a disorder called “pine decline.” Additionally, dichotomous keys were designed to identify the *Ocoaxo* Fennah groups and also the species of the subgroup *bivittus*.

## Introduction

Insects of the family Cercopidae are known as spittlebugs or froghoppers and are represented by 62 genera in the Neotropical region (Carvalho & Webb 2005; Paladini & Cavichioli 2015). The *Ocoaxo* genus was created by Fennah (1968: 181) based on a review of the genus *Sphenorhina* Amyot & Serville by Nast (1950). This author named *O. lineatus* (Walker, 1858) as the type species. Later, Nast (1975: 99) added the new species *O. costaricanus*. Finally, Fennah (1979: 269) transferred the species *O. ferranti* to a new genus *Tunaima*. Fennah (1968: 181) described the genus *Ocoaxo* with the following characteristics: (1) head with the eyes two thirds as wide as the pronotum; (2) postclypeus laterally compressed, with median carina prominent, usually gradually widening toward base (front), also presenting strongly delimited lateral grooves (Paladini *et al* 2015); (3) rostrum reaching almost to mesotrochanters; (4) ocelli nearer to each other than to eyes and as near to each other as to hind margin of head; (5) antennae with

third segment short, more or less cylindrical or barrel-shaped, with arista longer than (third) segment; (6) pronotum with posterior margin very shallowly concave; (7) tegmina moderately long, nearly three times as long as broad, venation slightly prominent, reticulate distally; (8) posttibiae with two spines laterally and 10 to 11 teeth apically (crown of spines); (9) basal metatarsal segment usually with 7 to 8 teeth, sometimes alternating in two rows; (10) second segment with about 8 teeth; (11) wings with Cu<sub>1</sub> abruptly widening near base; (12) pygofer with two processes laterally on each side, the lower [distal] process rather larger than the upper; (13) subgenital plates each transversely convex, usually with parallel margins, truncate at apex and with an oblique ridge internally (a spine); (14) aedeagus more or less straight, usually with a pair of lobate or spinose processes apically and sometimes with a pair laterally near middle; (15) genital style (paramere) with a pigmented tooth at apex; (16) ovipositor with the first valvulae separating near base, each produced at base in a narrow lobe that reaches to middle line.

Nast (1950: 145) established 3 groups based on morphological characters of the genitalia as follows. The first group includes *O. panamensis* (Nast, 1950). The second group (*distans*) includes *O. distans* (Nast, 1950) and *O. cygnus* (Nast, 1950). The third group was subdivided into four subgroups as follows. The first subgroup has *O. bivittus* (Walker, 1958), *O. femoratus* (Nast, 1950), *O. inflexus* (Nast, 1950), *O. lineatus* (Walker, 1851), *O. nicaraguanus* (Nast, 1950), *O. punctus* (Nast, 1950), *O. quezaltanus* (Nast, 1950), *O. secundarius* (Nast, 1950), *O. septemnotatus* (Distant, 1878), *O. similis* (Walker, 1858), *O. assimilis* (Walker, 1858), *O. fowleri* (Lallemand, 1912), and *O. varians* (Stål, 1864). The second subgroup has *O. digitatus* (Nast, 1950), *O. relatus* (Nast, 1950), *O. insularis* (Lallemand, 1928), and *O. imperans sexnotata* (Fowler, 1897). The third subgroup has *O. tucurricae* (Lallemand, 1924) and *O. turpior* (Fowler, 1897). The fourth subgroup has only *O. nuptialis* (Stål, 1864). Lastly, Nast (1950: 146) did not assign the species *O. confusus* (Nast, 1950) and *O. tullia* (Distant, 1893) to any group. A total of 30 species are now recognized in the genus *Ocoaxo* (Nast 1950, 1975; Fennah 1979; Carvalho & Webb 2005).

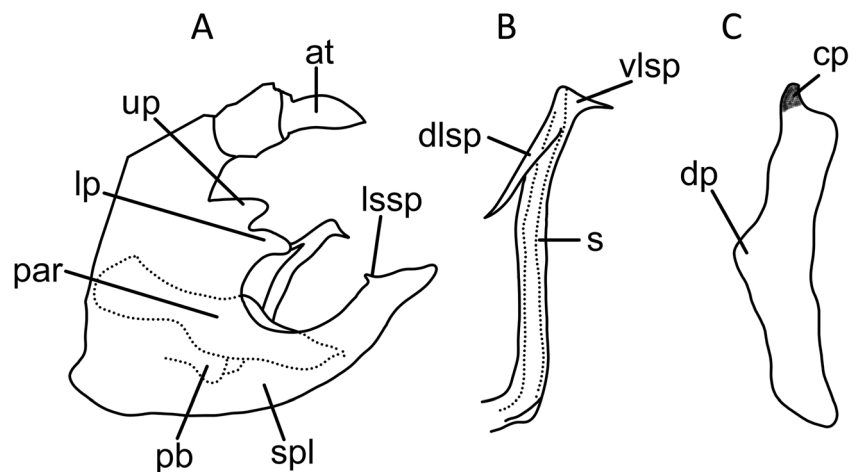
In the most recent phylogenetic study based on morphological characters conducted by Paladini *et al* (2015), four species, *O. panamensis*, *O. tucurricae*, *O. lineatus*, and *O. assimilis*, were found to be closely related to the genus *Maxantonia* (Schmidt) as a sister group. Since 1975, the genus *Ocoaxo* has not been reviewed nor had any new species added. Now, two new species of *Ocoaxo* from Mexico are described. In addition, binomial taxonomic keys are proposed to differentiate among the five groups, among the four subgroups of group three, and among the species of the first subgroup in group three. One of the new species forms a complex together with *O. assimilis* and *O. varians*. In the last few years, this complex has been of economic importance in the mountains of the States of Puebla and Oaxaca because of damage to *Pinus* spp., causing a disorder called “pine decline” (Castro-Valderrama *et al* 2017).

## Material and Methods

Insects associated with pines were collected in the state of Puebla, Mexico. Vouchers of a new species were deposited in the Colección de Insectos del Colegio de Posgraduados (CEAM) and the Colección Nacional de Insectos del Instituto de Biología de la Universidad Nacional Autónoma de México (CNIN). The two aforementioned insect collections were revised, as well as those from the following eight institutions: Instituto de Ecología, Xalapa (IEXA); Colección del Laboratorio de Parasitología Vegetal Universidad Autónoma del Estado de Morelos (CLPV); Colección de Artrópodos asociados a cultivos de la región del Soconusco, Chiapas, ECOSUR, Unidad Tapachula (CCFT); Colección Entomológica del Campus Tabasco, Colegio de Postgraduados (CECT); Colección Entomológica, Ciencias Agronómicas de Chiapas, Universidad Autónoma de Chiapas (CACH); ECOSUR unidad San Cristóbal de las Casas (CEFS); Colección Nacional de Insectos-Estación Biológica Trópicos Los Tuxtlas-UNAM (EBTLT), and the North Carolina State University Insect Collection, USA (NCSU).

The identifications were made based on available literature for the genus and species of *Ocoaxo* (Nast 1950, 1975; Fennah 1968, 1979) and on the male genitalia (Nast 1950, 1975; Carvalho & Webb 2005). The genitalia were detached from the abdomen and clarified in 10% KOH solution for 12–24 h. Afterwards, the KOH was neutralized with acetic acid and washed with distilled water. Finally, the genitalia were stored in microvials with glycerin. Genitalia photographs were taken with a Zeiss® SteREO Discovery, V20 and images captured with AxioCam IC-ZEN 2 lite software. In order to take the photographs of genitalia, the Valdez-Carrasco method was used, which consisted of applying a thin layer of hair gel (without bubbles) on the bottom surface of a 5-cm Petri dish. The sample was put into the appropriate position on the gel, covered with 70% alcohol, and the photographs were taken with transmitted light. Adult photographs were

**Fig 1** **A** Parts of male pygofer: phalobase (pb), anal tube (at), upper process of pygofer (up), lower process of pygofer (lp), lateral spine of the subgenital plate (lssp), paramere (par), subgenital plate (spl). **B** Parts of aedeagus: dorsolateral spines of aedeagus (dls), ventrolateral spines of aedeagus (vls), shaft (s). **C** Parts of paramere: claw of the paramere (cp), dorsal process (dp)



taken with a digital Olympus® E-620 camera attached to an Olympus SZX7 stereoscope and images captured with Olympus Studio 2.22 software. Images were stacked with Combine ZP free software and edited with GIMP 2.8.14 free software. The morphological terminology follows Nast (1950), Fennah (1968), and Hamilton (1977). To make the terminology match that of Paladini *et al* (2015) and Paladini & Cavichioli (2015), the processes located in the aedeagus were called the dorsolateral and ventrolateral spines (dlsps and vlsp); a pair of processes on the pygofer was called the upper process and lower process (up and lp) (Nast 1950); the acute process located in the subgenital plate was called the lateral spine of the subgenital plate (lssp); and the spine on the paramere was called the claw of the paramere (cp) (Fig 1). The taxonomic keys of the groups and subgroups were elaborated with the description by Nast (1950: 145) of the external and internal morphology of the pygofer, aedeagus, paramere, and subgenital plates of the adult male (Fig 1), as well as the color pattern of the tegmina. We considered that the species *O. confusus* and *O. tullia* each formed an independent group. The two new species were additionally described by their dorsal, lateral, and ventral view.

**Results**

*Key to the Groups of the Genus Ocoaxo Nast (1950)*

- 1 Parameres strongly curved, forming a right angle before the tip; subgenital plate broad and short, dilated apically.....Group one
- 1' Parameres not strongly curved, not forming a right angle; subgenital plate not dilated apically .....2
- 2(1') Parameres elongated and curved distally, they terminate with a claw that has two or more chitinized teeth; aedeagus very short, broad with a very thin apex .....Group two
- 2' Parameres short and less curved on their apex (Fig 1C); aedeagus long .....3
- 3(2') Aedeagus with one or two pairs of acute spines on its apex...Group three.....
- .....see key to the subgroups of group three
- 3' Aedeagus with a pair of processes on its tip .....4
- 4(3') Aedeagus with processes like butterfly wings on its apex .....Group four or *confusus*
- 4' Aedeagus with triangle-like processes, long lateral spines at base .....Group five or *tullia*

*Key to the Subgroups of Group Three Nast (1950)*

- 1 In lateral view, aedeagus more or less flattened along its entire length, with two pairs of opposite spines on its

- apex; the dorsolateral spines of aedeagus are longer than the ventrolateral spines (see Fig 1) ... First subgroup or *bivittus* .....2
- .....see key to the species of first subgroup
- 1' In lateral view, aedeagus not flattened along its entire length, with two pairs of dorsal spines or narrow compact processes on its apex.....2
- 2(1') Base of the aedeagus swollen, shaft with a short process on its ventral side; a pair of processes, on the sides of the apex, directed toward the dorsal side.....
- .....second subgroup
- 2' Base of the aedeagus swollen or not, the shaft without a short process on its ventral side, and the apex with two pairs of spines on its sides ..... 3
- 3(2') Base of the aedeagus not swollen, the shaft c-like, two pairs of dorsal spines directed down near the apex, one long and the other short, without a spine on its ventral side near the base.....third subgroup
- 3' Base of the aedeagus swollen, straight, flattened on the apex, with two pairs of dorsal spines, on apex, directed down, one long and the other short; one long and conspicuous spine on its ventral side near the base
- ..... fourth subgroup

*Key to the Species of First Subgroup Nast (1950)*

- 1 Aedeagus in lateral view, with s-shape .....2
- 1' Aedeagus in lateral view, with different shape.....3
- 2 (1) Aedeagus in lateral view, dlsps long, curve, reaching beyond the middle of the shaft. Tegmina with a small orange basal spot, after, a thin (faint) brown transverse line followed by thick orange transversal line, two orange longitudinal lines.....*Ocoaxo lineatus* (Walker)
- 2' Aedeagus in lateral view, dlsps short, curved, not reaching beyond the middle of the shaft. Tegmina with red basal spot, a narrow brown transverse line followed by a red transverse line, two red longitudinal lines .....*O. nicaraguanus* (Nast)
- 3 (1') Aedeagus in lateral view, the shaft straight .....4
- 3' Aedeagus in lateral view, the shaft not straight.....8
- 4(3) Aedeagus in lateral view, dlsps very curved towards the shaft. Tegmina semitransparent with a small orange basal spot, a brown transverse line followed by an orange transverse line. Two orange longitudinal lines, the upper one reaching the claval suture.....
- .....*O. inflexus* (Nast)
- 4' Aedeagus in lateral view, dlsps not curved towards the shaft ..... 5
- 5 (4') Aedeagus in ventral view, the apex of dlsps touching one another. Tegmina with light brown to dark brown background with eight orange spots .....*O. septemnotatus* (Distant)

- 5' Aedeagus in ventral view, the apex of dlsp not touching one another .....6
- 6(5') Aedeagus in ventral view, the apices of dlsp do not protrude from the shaft. Tegmina with a cream yellow basal spot, joined with two longitudinal lines of the same color, both lines reaching the apical third and joining distally, forming an ellipse.....*O. cardonai* Castro-Valderrama, Carvalho & Valdez-Carrasco n. sp.
- 6' Aedeagus in ventral view, the apices of dlsp protrude from the shaft .....7
- 7(6') Aedeagus in ventral view, the apices of dlsp parallel to the shaft. Tegmina with a large basal spot reddish-orange, extending obliquely one-third of tegmina, followed by two reddish-orange longitudinal lines, with a separation between them and the basal spot.....*O. sinai* Castro-Valderrama, Peck & Romero Nápoles n. sp.
- 7' Aedeagus in ventral view, the apices of dlsp directed outer of the shaft. Tegmina with a yellow-cream basal spot that crosses the Cu, it is joined by a trace to the straight yellow-cream longitudinal line; sometimes there are traces of an upper longitudinal line.....*O. fowleri* (Lallemand)
- 8(3') Aedeagus in lateral view, the distal third of shaft slightly curved .....9
- 8' Aedeagus in lateral view, the distal third of shaft not slightly curved .....11
- 9(8) Aedeagus in ventral view, shaft with the same width along its entire length. Tegmina with a large basal spot of light orange to reddish orange color, extending to a quarter of the tegmina, two thick orange longitudinal lines joined to the basal spot.....*O. bivittus* (Walker)
- 9' Aedeagus in ventral view, shaft slightly thinner toward the base .....10
- 10(9') Aedeagus in lateral view, dlsp straight and away to the shaft. Tegmina with a cream yellow basal spot joined to a cream yellow longitudinal line, ending as a poorly delineated "tjamata"<sup>1</sup>.....*O. assimilis* (Walker)
- 10' Aedeagus in lateral view, dlsp slightly curved towards the shaft. Tegmina with a cream yellow basal spot joined to a cream yellow longitudinal line, ending as a well-defined "tjamata".....*O. varians* (Stål)
- 11(8') Aedeagus in lateral view, shaft slightly arched. Tegmina with brown background, yellow-brown basal spot and a blackish transversal line, followed by a yellow-brown transverse line. Two yellow-brown longitudinal lines with a separation between them and the yellow-brown transverse line.....*O. similis* (Walker)
- 11' Aedeagus in lateral view, shaft slightly sinuous.....12
- 12(11') Aedeagus in ventral view, the tip of shaft wider than the base.....13
- 12' Aedeagus in ventral view, the base of shaft wider than the tip .....14
- 13(12) Aedeagus in lateral view, dlsp inserted at tip of shaft. Tegmina with a large basal spot red, extending obliquely one-third of tegmina, followed by two red longitudinal lines, with a separation between them and the basal spot .....*O. femoratus* (Nast)
- 13' Aedeagus in lateral view, dlsp inserted under the tip of shaft. Tegmina with a small orange or orange-reddish basal spot, a dark brown transversal line followed by an orange or orange-reddish transversal line. After, two longitudinal lines orange or orange-reddish. Sometimes, the brown transversal line is interrupted by a thin orange or orange-reddish line and Cu, this line joined with basal spot and the orange or orange-reddish transversal line.....*O. quezaltanus* (Nast)
- 14(12') Aedeagus in ventral view, dlsp with the apices close to and almost touching one another. Tegmina with a small yellowish basal spot, a thick darker transversal line followed by a yellowish transversal line. After, two longitudinal yellowish lines.....*O. secundarius* (Nast)
- 14' Aedeagus in ventral view, dlsp with the apices separated from one another. Tegmina semitransparent with an orange basal spot that cover one-third, two orange or orange-reddish thick longitudinal lines and joined with the basal spot. Those lines distally joined or not. A small black or dark brown spot near the costal margin. ....*O. punctus* (Nast)

*Ocoaxo cardonai* Castro-Valderrama, Carvalho & Valdez-Carrasco n. sp.

(Figs 2A–C and 3A–G)

Measurements: Male: width of the head in dorsal view ( $n = 12$ ),  $1.90 \pm 0.2$  mm. Length in lateral view ( $n = 12$ ),  $11.16 \pm 1.1$  mm.

Male: Dorsal view (Fig 2A). Head triangular and orange; compound eyes rounded and black; vertex rectangular, with a carina on the posterior margin; ocelli black, nearer to each other than to compound eye; tylus quadrangular and orange with a black carina; pronotum hexagonal without carina, it shows three colors varying by the area covered: (a) orange basal area, middle area with creamy yellow, and posterior area with a black or brown stripe, anterior part with two irregular darker depressions, one on each side, anterior margin straight and orange, lateroanterior margin straight and orange; (b) creamy yellow and black towards the humeral angle, lateroposterior margin slightly sinuous and black (predominant); or (c) light brown, posterior margin slightly grooved and black (predominant) or light brown; scutellum with four morphs, (i) black base and the rest orange, (ii) completely orange, (iii) black base, followed by orange, black, and the tip is orange, (iv) black base with orange tint and the rest orange. Lateral view (Fig 2B). Postclypeus orange, convex, with lateral carina, lateral grooves marked; pronotum not curved; tegmina narrow, basal spot creamy yellow,

<sup>1</sup> Tjamata is a cutting tool used in gardening

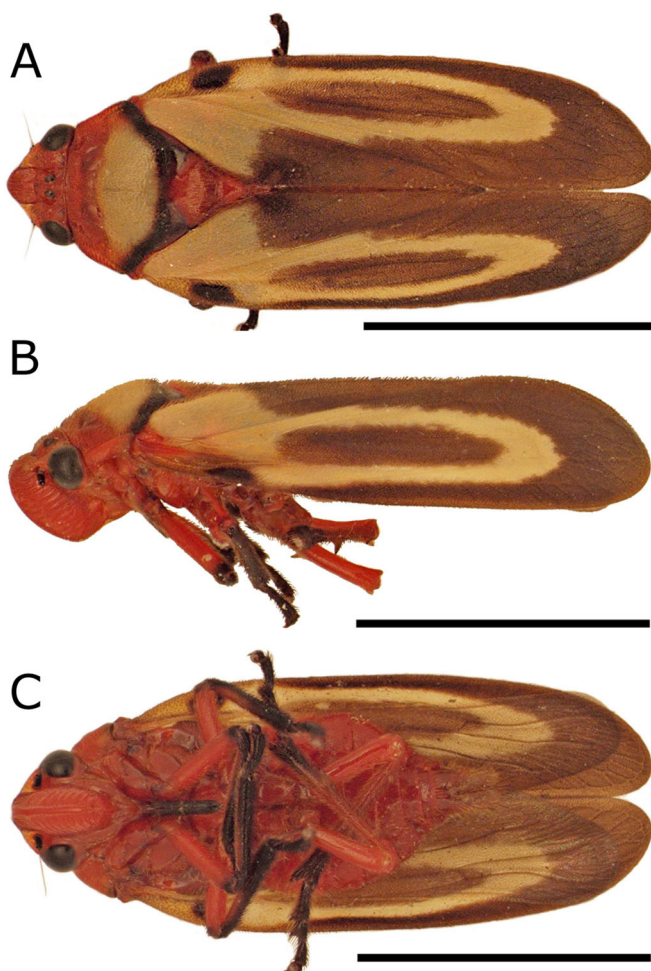
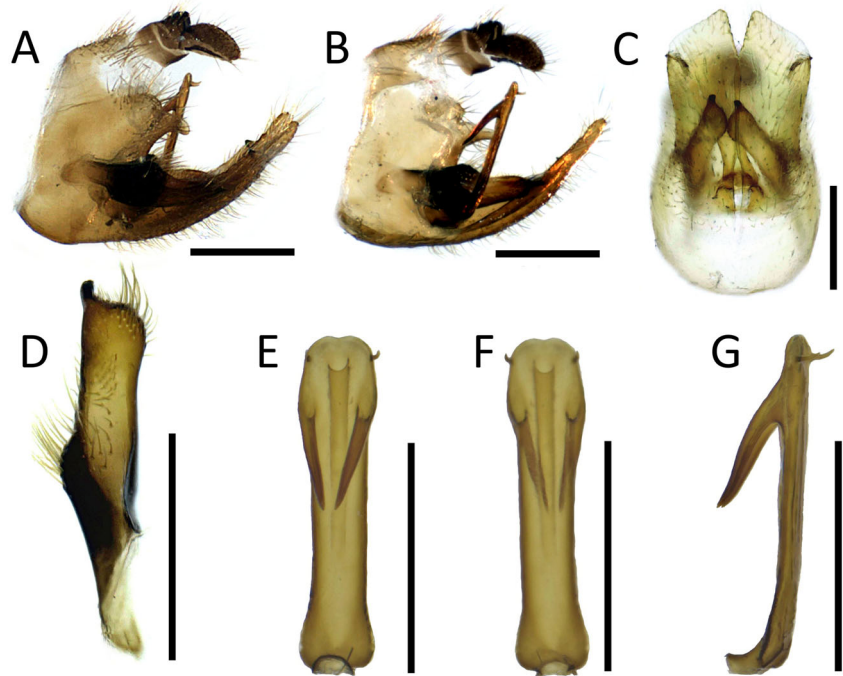


Fig 2 Adult of *Ocoaxo cardonai* n. sp.: **A** dorsal view; **B** lateral view; **C** ventral view. Scale bar = 5 mm

between the Cu and beyond half or near the tip of the scutellum, joined with two longitudinal lines of the same color, both lines reaching the final third and joined distally, forming an ellipsis surrounding a darker area, wing background dark brown or almost black; prominent apical reticulation of the tegmina venation and setae on both sides, the setae taking the color of where they are inserted; posterior wing transparent light brown, with light brown venation, and black setae on both sides. Ventral view (Fig 2C). Postclypeus compressed with a median carina, rostrum black and reaches to mesocoxae; antennae with scape and pedicel black, setae on pedicel scarce, flagellum auburn, basal body of the flagellum subcylindrical, smaller than the pedicel and with arista; thorax orange with small darker areas; prothoracic and mesothoracic legs with coxae, trochanters and femora orange, tibiae and tarsi black; metathoracic legs with coxae, trochanters and femora orange, tibiae orange and becoming gradually black towards their ends, tarsi black, tibiae with two lateral spines (spines black from the middle or upper third) and an apical crown of spines with two rows, basal spines on tibiae smaller than the apical spines, basal spine on tibiae the same size as the apical crown spines, distal spines on tibiae larger than apical crown spines,

basitarsus with two rows of spines covered by scarce setae. Abdomen orange with dark spots.

Genitalia. Pygofer lateral view (Fig 3A–B): two lateral processes between the anal tube and subgenital plates, upper process triangular, small, wide on base and directed toward anal tube, the lower process bigger than the upper one, narrow on base, straight, but distally rounded, the tip directed toward subgenital plates; subgenital plates tapering towards the apex, superior margin forming a semicircle that begins in the lower process, lateral spine of the subgenital plate directed toward anal tube. Subgenital plate ventral view (Fig 3C): short, wide, interior margins parallel but distally separated, exterior margins with a slight arch inward and lateral spine of the subgenital plate, truncate at apex, oblique and straight; paramere curved at middle and almost touches the other one, ends with an elongated chitinized claw. Paramere lateral view (Fig 3D): in the middle of the superior margin with reduced process, rounded and with many setae, ending with a chitinized claw projected toward or reaching the subgenital plate, inferior margin with a slight depression, ends like a ship's prow but more rounded, with several setae. Aedeagus: anterior view (Fig 3E); lateral margins straight, apex wider than the base, upper third with a



**Fig 3** Genitalia of male *Ocoaxo cardonai* n. sp.: **A** external lateral view; **B** internal lateral view. **C** Subgenital plates ventral view. **D** Paramere lateral view. Aedeagus: **E** anterior view; **F** posterior view; **G** Lateral view. Scale bar = 0.5 mm

pair of ventrolateral spines, short, straight but curved distally, projected outward and upward, a small depression near the gonophore, posterior view (Fig 3F); with a pair of dorsolateral spines, long, straight, projected into the shaft and downward, lateral view (Fig 3G); long, flattened, straight, upper third with two pairs of opposite spines, ventrolateral spines short, straight but the tips curved and directed upwards, inserted before the tip, forming a right angle with the shaft, dorsolateral spines directed downwards, long, thick at base, inserted below the ventrolateral spines, forming an acute angle with the axis, the gonophore with preapical position (Fig 3F–G).

**Female.** Dorsal view, width of the head ( $n = 10$ ),  $1.91 \pm 0.1$  mm. Lateral view, length ( $n = 10$ ),  $11.00 \pm 0.9$  mm. Similar to male, except that it is shorter in length.

**Distribution.** Mexico (Nuevo León, Coahuila, San Luis Potosí, Michoacán, Edo. de México, México City, Puebla, Oaxaca, and Querétaro).

**Host plants.** *Pinus pseudostrobus* Lindl, *Pinus patula* Schiede Ex Schltdl & Cham and *Pinus* sp. In addition, *Rubus* sp. (Castro-Valderrama *et al* 2017).

**Type Material:** MEXICO; ♂, Puebla, Acatlán, Tetela de Ocampo, 20/VII/2015, 1765 m, U. Castro-Valderrama, *Pinus pseudostrobus* Lil,  $19^{\circ} 51' 29.71''$  N,  $97^{\circ} 50' 01.87''$  W, (holotype, HOM-TIP-94, CNIN); ♀ Puebla, Acatlán, Tetela de Ocampo, 20/VII/2015, 1765 m, U. Castro-Valderrama, *Pinus pseudostrobus* Lil,  $19^{\circ} 51' 29.71''$  N,  $97^{\circ} 50' 01.87''$  W, (allotype, HOM-TIP-95, CNIN). Paratypes: Coahuila, Arteaga Km 7 W, La Carbonera, 23/VII/2014, 2010 m, L. Cervantes,  $25^{\circ} 27.494' N$ ,  $100^{\circ} 42.869' W$ , 4 ♀, 2 ♂ (CNIN); Estado de México, San Miguel Presa Necaxa, 1/VIII/1963, A. Ibarra, 1 ♂ (CNIN); México, D. F.

Pedregal de San Ángel, 26/IX/1972, T. Bravo,  $16^{\circ} 34' 5.48'' N$ ,  $96^{\circ} 55' 8.54'' W$ , 1 ♂ (CNIN); México, D. F. Reserva del Pedregal de San Ángel, Brecha 1, 2/IX/2006, 2250 m, M. Torres, 1 ♀, 1 ♂ (CNIN); Michoacán, Km 126 carr. Maravatio/Morelia, 16/XI/1987, R. Barba, 1 ♂ (CNIN); Nuevo León, Chipinque, 23/VI/1972, E. Barrera, 1 ♂ (CNIN); Oaxaca, 11 Km W de San Martín Lochila, 12/VII/2004, 1814 m, A. Delgado, C. Mayorga & S. Gámez,  $16^{\circ} 34' 5.48'' N$ ,  $96^{\circ} 55' 8.54'' W$ , 1 ♀, 1 ♂ (CNIN); Oaxaca, Mpio. Pluma Hidalgo, 17/VI/1982, L. Torres, 1 ♂ (CNIN); Querétaro, El Lobo Tres Lagunas km 2, 20/VIII/1998, H. Brailovsky & E. Barrera, 1 ♂ (CNIN); Querétaro, San Joaquín, Las Ranas, 16/X/1997, 2450 m, E. Barrera & H. Brailovsky,  $20^{\circ} 55' 28' N$ ,  $99^{\circ} 33' 53'' W$ , 11 ♀ (CNIN); Querétaro, San Joaquín de Las Ranas, 23/XII/1991, H. Brailovsky & Ka. Brailovsky, 1 ♀ (CNIN); Querétaro, Toluquilla, 2/VII/1999, H. Brailovsky,  $16^{\circ} 34' 5.48'' N$ ,  $96^{\circ} 55' 8.54'' W$ , 1 ♂ (CNIN); San Luis Potosí, Valle de los Fantasmas, 20/VIII/2008, 2283 m, H. Brailovsky & E. Barrera,  $22^{\circ} 03' 32'' N$ ,  $100^{\circ} 37' 16'' W$ , 1 ♀ (CNIN). Puebla, Acatlán, Tetela de Ocampo, 20/VII/2015, 1765 m, U. Castro-Valderrama, on *Pinus pseudostrobus* Lil,  $19^{\circ} 51' 29.71'' N$ ,  $97^{\circ} 50' 01.87'' W$ , 7 ♀, 13 ♂ (CEAM); Puebla, Acatlán, Tetela de Ocampo, 20/VII/2015, 1765 m, U. Castro-Valderrama, on *Pinus* sp.,  $19^{\circ} 51' 29.71'' N$ ,  $97^{\circ} 50' 01.87'' W$ , 3 ♂ (CEAM); Puebla, Acatlán, Tetela de Ocampo, 20/VII/2015, 1765 m, U. Castro-Valderrama, in sotobosque,  $19^{\circ} 51' 29.71'' N$ ,  $97^{\circ} 50' 01.87'' W$ , 5 ♀, 11 ♂ (CEAM); Puebla, Km 68 carr. fed. Zacatlán-Apizaco, Zacatlán, 10/VIII/2015, 2112 m, U. Castro-Valderrama, on *Pinus* sp.,  $19^{\circ} 54' 06.81'' N$ ,  $97^{\circ} 57' 31'' W$ , 7 ♀, 5 ♂ (CEAM); Puebla, Rancho Alegre, Tetela de Ocampo, 10/VIII/2015, 2270 m, U. Castro-Valderrama, on *P. patula* Schiede Ex Schltdl et Cham,  $19^{\circ} 50' 34'' N$ ,  $97^{\circ} 51' 22''$

W, 10 ♀, 27 ♂ (CEAM); San Luis Potosí, RN El Potosí, sitio 1, 1/IX/2017, E. Chamé, Trampa de Luz, 2 ♂ (CCFT).

**Etymology.** In honor of Cesar Cardona Mejia, a prominent Colombian entomologist.

**Diagnosis.** Tegmina narrow, basal spot creamy yellow between the Cu and beyond half or near the tip of the scutellum, joined with two longitudinal lines of the same color, both lines reach the final third and joined distally, forming an ellipsis surrounding a darker area, background wing dark brown or almost black, anterior costal border with a small black spot or dark brown or light brown, connected or not with the background color of the tegmina.

**Remarks.** *Ocoaxo cardonai* Castro-Valderrama, Carvalho & Valdez n. sp. was mentioned in Castro-Valderrama *et al* (2017) as *Ocoaxo* near *fowleri*. This species forms a complex with *O. assimilis* (Walker) and *O. varians* (Stål) that are pests of pines, and cause the disorder called "pine decline" (Castro-Valderrama *et al* 2017). *O. cardonai* is quite similar to *O. varians* (Stål, 1864) and *O. assimilis* (Walker, 1858). The main distinction is that in posterior view the dls in *O. cardonai* do not protrude from the shaft of the aedeagus; in *O. varians* and *O. assimilis*, they do (see Figs 16d and 15d by Nast (1950); Fig 172d by Carvalho & Webb (2005)). Also, in *O. cardonai*, the tegmina lines are joined and form an ellipse; *O. varians* and *O. assimilis* have a "tajamata"-shaped line (see Fig 3a by Nast (1950); Figs 464 and 672 by Carvalho & Webb (2005)). We only found specimens of *O. cardonai* in CNIN, CCFT and CEAM, but we know that at least two adult *O. cardonai* were collected from Cerro Chipique, Nuevo León and the specimens were determined because the curator (Dr. Mick Webb) from the British Museum of Natural History (BMNH) sent a photograph of them. The two aforementioned specimens are paratypes. Holotype, allotype and 20 paratypes with collection number HOM-TIP-96-115 are deposited at CNIN, 31 paratypes at CEAM, and 2 paratypes each at IEXA, CEFS, CEFT, MCTP (Brazil, Rio Grande do Sul, Porto Alegre, Museu de Ciências e Tecnologia da PUCRS), and UNCP (Universidad Nacional de Colombia-Palmira).

*Ocoaxo sinai* Castro-Valderrama, Peck & Romero Nápoles n. sp.

(Figs 4A–C, 5A–G)

**Measurements.** Male: width of the head in dorsal view ( $n = 1$ ), 2.12 mm. Length in lateral view, ( $n = 1$ ), 11.82 mm.

**Dorsal view** (Fig 4A). Head triangular and orange; compound eyes rounded and black; vertex rectangular, with a carina on the posterior margin; ocelli black and nearer to each other than to compound eye; tylus quadrangular and orange with a carina of the same color; pronotum orange, hexagonal without carina, anterior part with two irregular darker depressions, one on each side, anterior margin straight and orange, lateroanterior margin straight and orange, lateroposterior margin slightly sinuous and orange, posterior margin slightly grooved and orange; scutellum orange. Lateral view (Fig 4B). Postclypeus orange, convex, with

lateral carina, lateral grooves marked; pronotum not curved; tegmina narrow, with basal, widespread orange reddish spot, that begins at the level of the tip of the scutellum and is directed obliquely to the costal margin, extending one-third of the wing, then two reddish orange longitudinal lines separated from each other and from the basal spot; background of light brown and almost transparent wing, distally slightly darker, prominent apical reticulation of the tegmina venation and setae in both sides, the setae taking the color of where they are inserted; posterior wing transparent light orange, with venation orange dark, and setae on both sides orange. Ventral view (Fig 4C). Postclypeus compressed with a median carina; rostrum with first segment black and orange, the second black, reaching to the coxae; antennae with scape orange, pedicel black, basal body of the flagellum dark orange, setae on pedicel scarce, basal body of the flagellum subcylindrical, smaller than the pedicel, with arista; thorax dark orange; all legs with coxae, trochanters and femora orange, tibiae orange, black toward their ends, tarsi black, tibiae with two lateral spines (spines with black tips) and an apical crown of spines with two rows, basal spines on tibiae smaller than the apical spines, basal spines on tibiae the same size as the apical crown spines, distal spines on tibiae larger than apical crown spines, basitarsus with two rows of spines covered by scarce setae. Abdomen orange, a darker tone than the thorax.

**Genitalia.** Pygofer in lateral view (Fig 5A–B): two lateral processes between the anal tube and subgenital plates, upper process triangular, small, wide on base and directed toward the space between the anal tube and subgenital plates, the lower process bigger than the upper one, narrow on base, superior margin straight but distally rounded, the lower margin curved with the tip pointing toward the genital plates; subgenital plate nearly as wide in its entirety (sub-quadrangular), superior margin forming a semicircle that begins in the lower process, lateral spine of the subgenital plate directed toward anal tube. Subgenital plate ventral view (Fig 5C); short, wide, interior margins parallel but distally separated, exterior margins straight, lateral spine of the subgenital plate with a truncate apex, oblique and lightly sinuous; paramere curved at middle and almost touching the other one, ends with an elongated chitinized claw. Paramere in lateral view (Fig 5D); middle of the superior margin with reduced process, rounded (sensu Paladini *et al* 2015), with many setae, ending with a chitinized claw projected or reaching the subgenital plate, inferior margin with a slight curve, ends like a ship's prow and with several setae. Aedeagus: anterior view (Fig 5E); lateral margins becoming gradually narrow toward the middle of shaft, apex same width as the base, upper third with a pair of ventrolateral spines curved, directed upward, a small depression near the gonophore, posterior view (Fig 5F); with a pair of dorsolateral spines, long, thin, straight, parallel to the shaft and downward, lateral view (Fig 5G); long, flattened, straight, upper third with two pairs of opposite spines, ventrolateral spines short, straight,

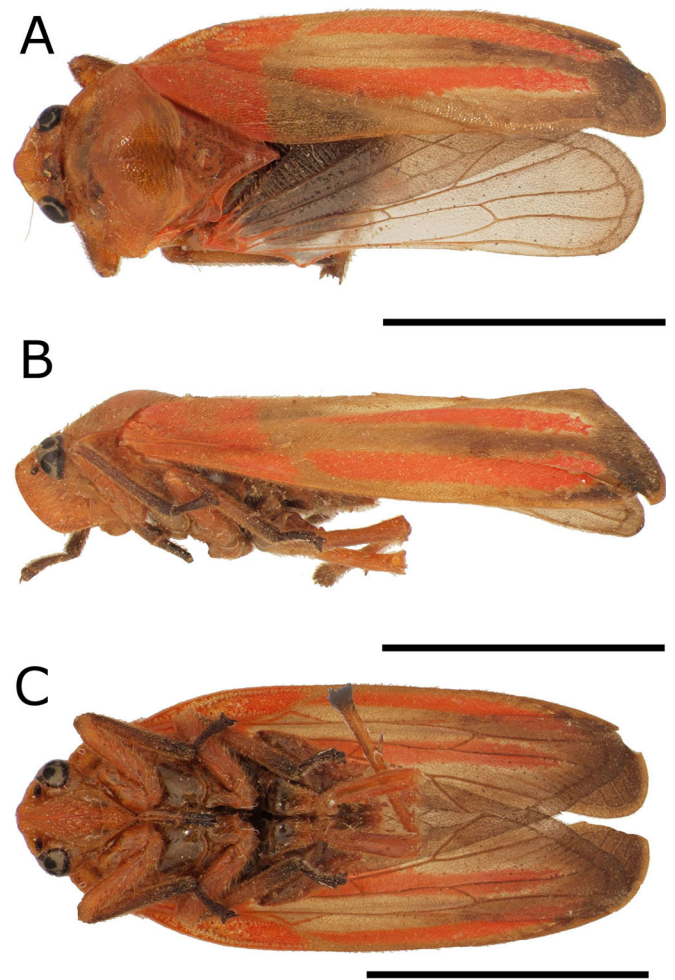


Fig 4 Adult of *Ocoaxo sinai* n. sp.: **A** dorsal view; **B** lateral view (reverse image); **C** ventral view (left tegmen was edited). Scale bar = 5 mm

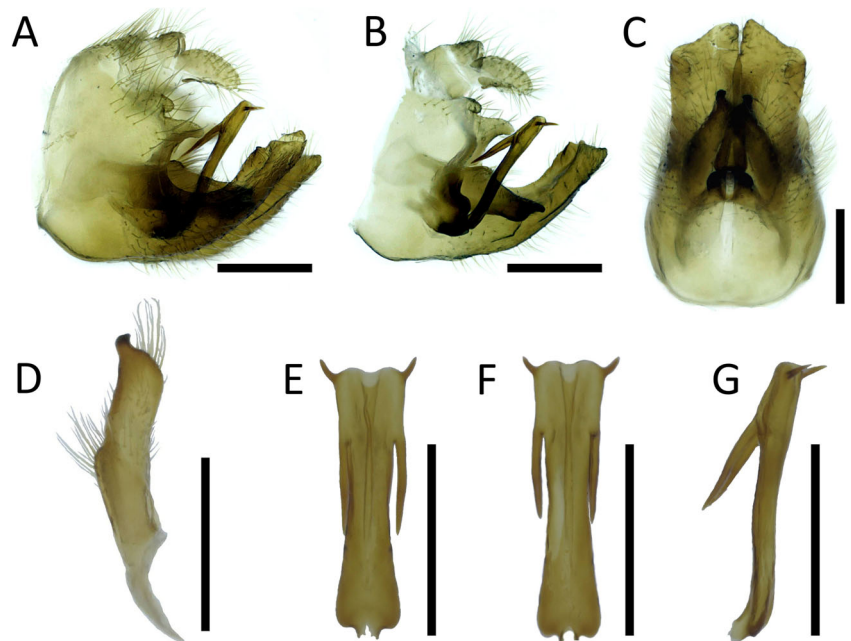


Fig 5 Genitalia of male *Ocoaxo sinai* n. sp.: **A** external lateral view; **B** internal lateral view. **C** Subgenital plates ventral view. **D** Paramere lateral view. Aedeagus: **E** anterior view; **F** posterior view; **G** lateral view. Scale bar = 0.5 mm



directed upward, inserted before the tip, forming an obtuse angle with the shaft; dorsolateral spines long, thin and slightly curved, inserted below the ventrolateral spines and forming an acute angle with the axis, projected downward; gonophore at apical position (Fig 5E–F).

Female. No female was revised, but by the features of genus, it is probably similar to male.

Distribution. Mexico (Oaxaca).

Type Material: México, Valle Nacional, Oaxaca, 31/V/1962, Alberto Ortiz, 1 ♂ (holotype, HOM-TIP-124, CNIN).

Etymology. The specific epithet is a noun in apposition to *Ocoaxo*, and is in honor of Sinai, wife of the first author.

Diagnosis. Tegmina narrow, basal spot widespread, orange reddish that begins at the level of the tip of the scutellum and directed obliquely to the costal margin, extending one third of the wing, then two reddish orange longitudinal lines separated from each other from the basal spot, background of light brown and almost transparent wing.

Remarks. *Ocoaxo sinai* Castro-Valderrama, Peck & Romero n. sp. has the same pattern of spots and lines as *O. femoratus* (Nast) (= *S. femorata*), but *O. sinai* has the color orange and *O. femoratus* has the color red (see description of *O. femoratus* by Nast (1950: 124); Fig 737 by Carvalho & Webb (2005)). Also, in lateral view, the shaft of aedeagus in *O. sinai* is straight and in *O. femoratus* it is slightly sinuous (see Fig 7d by Nast (1950: 125). Finally, in posterior view, the dlsps in *O. sinai* are parallel to shaft of the aedeagus, but in *O. femoratus* they do not protrude (see Fig 7e by Nast (1950: 125). No female is known but it probably has the same pattern as the male. At present, host plants are unknown, but the area where the holotype was collected is a transition between pine and deciduous forest.

## Discussion

The feeding habits of the Neotropical genus *Ocoaxo*, together with the Old World species *Haematoloma dorsatum* (Ahrens), could be a vestige of its ancestors from the early Jurassic, namely the extinct family Procercopidae (Cryan & Svenson 2010). The prevalent vegetation in that period were conifers and ferns (Diéguez 2003). Today, this feeding habit is causing economically relevant damage to conifers in Mexico, Italy and Spain (Roversi & Baccetti 1994, Cobos 1995, Castro *et al* 2017).

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**Nomenclature** Two new species of the spittlebug genus *Ocoaxo* Fennah (Hemiptera: Cercopidae) from Mexico, and keys for the groups, group three, and first subgroup (LSID urn:lsid:zoobank.org:pub:174C6444-67CB-44A7-9879-4B2B5E79C347).

*Ocoaxo cardonai* Castro-Valderrama, Ca 426 rvalho & Valdez-Carrasco n. sp. (LSID urn:lsid:zoobank.org:act:3752DDFB-53A5-4DC6-ABAA-2CEE3EDFF3Co)

*Ocoaxo sinai* Castro-Valderrama, Peck & Romero Nápoles n. sp. (LSID urn:lsid:zoobank.org:act:E8EBAD10-11EC-44C1-A993-A9C39B8C537F)

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