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Taxonomy and systematics

***Cratomorphus leoneli*: a new firefly from Mexico (Coleoptera: Lampyridae: Cratomorphini)**

***Cratomorphus leoneli*: una nueva especie de luciérnaga de México (Coleoptera: Lampyridae: Cratomorphini)**

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Abstract

Cratomorphus Motschulsky, 1853 includes 38 species restricted to the Neotropical region. Based on adult males from Mexico, *Cratomorphus leoneli* sp. nov. is herein described from the states of Oaxaca, Campeche and Chiapas. We place the new species in *Cratomorphus*' group IV, which includes species with the posterior border of sternite VIII medially produced. The new species can be distinguished from other species of the group IV by the clypeus subquadrate, posterior margin of pygidium bisinuate and posterior margin of sternite VIII with an apically obtuse median projection. Illustrations of habitus and diagnostic traits are provided, along with an identification key and a distribution map for the group IV species.

Keywords: Taxonomy; Firefly; Morphology; Neotropical region; Elateroidea

Resumen

Cratomorphus Motschulsky, 1853 incluye 38 especies restringidas a la región Neotropical. Con base en machos adultos de México, se describe *Cratomorphus leoneli* sp. nov., distribuida en los estados de Oaxaca, Campeche y Chiapas. Incluimos a la nueva especie en el grupo IV de *Cratomorphus*, que incluye especies con el borde posterior

del esternito VIII proyectada medialmente. La nueva especie se puede distinguir de otras del grupo IV por el clípeo subcuadrado, pygidium con margen posterior bisinuado y esternito VIII con un margen posterior con una proyección mediana apicalmente obtusa. Se proporcionan ilustraciones del hábito y caracteres diagnósticos, junto con una clave de identificación y un mapa de distribución de los machos de las especies del grupo IV.

Palabras clave: Taxonomía; Luciérnaga; Morfología; Región neotropical; Elateroidea

Introduction

Cratomorphus Motschulsky, 1853, the type-genus of Cratomorphini (Coleoptera: Lampyridae), comprises 38 species distributed in the Neotropical region, predominantly in South America (McDermott, 1964; Olivier, 1907; Silveira et al., 2019). *Cratomorphus* species are characterized by the pronotum anteriorly rounded, with 2 anterior vitreous spots, but most diagnostic traits refer to males, which have: head dorsally concave between the eyes, which are as wide as 2/3 head width; and abdomen with tergites laterally projected (Gorham, 1881; Green, 1959; Olivier, 1907). Females and larvae have been far less studied (but see Campos et al., 2018).

Olivier (1895) divided *Cratomorphus* into 4 groups, based on variations in sternite VIII, as follows: posterior margin bilobate with a medial filiform projection (group I); posterior margin sharply bilobate (group II); posterior margin gently bilobate, almost truncated (group III), and posterior margin medially projected (group IV).

Eleven species of *Cratomorphus* have been reported for Mexico, 5 belonging to group III (*C. picipennis* Gorham, 1881; *C. signativentris* Olivier, 1895; *C. anitae* Zaragoza-Caballero, 1996; *C. rodriguezae* Zaragoza-Caballero, 1996; *C. ramirezi* Zaragoza-Caballero, 1996) and 6 to group IV (*C. cossyphinus* (Perty, 1832); *C. hoffmannae* Zaragoza-Caballero, 1996; *C. ayalai* Zaragoza-Caballero, 1996; *C. huautlaensis* Zaragoza-Caballero, 1996; *C. halffteri* Zaragoza-Caballero, 2012; *C. limai* Zaragoza-Caballero et al., 2021). The species herein described as new, *Cratomorphus leoneli* sp. nov. is placed in group IV (Olivier, 1895).

Materials and methods

The study was based on 132 male specimens collected in the Mexican states of Oaxaca, Campeche and Chiapas, and deposited in the National Insect Collection (CNIN) at Institute of Biology, Universidad Nacional Autónoma de México (IB-UNAM). For classification, we followed McDermott (1966) and Martin et al. (2019). Overall terminology of genitalia structures follows Silveira et al. (2019), and terminology of wing venation follows Vaz

et al. (2021). Specimens were softened and clarified in a 10% potassium hydroxide (KOH) solution for 24 h at room temperature, subsequently the specimens were dissected, and the genital structures examined under a Leica EZ4HD stereoscopic microscope. The images and measurements were obtained in a Leica M165C stereomicroscope with a coupled with a DFC295 camera, and processed in the LAS version 4.2 software. Series of images were stacked and processed by the software Helicon Focus® version 5.3. The stacked images were edited in Adobe Lightroom® CC 2020 Software for light and contrast adjustment, and the plates edited using Adobe Photoshop® CC 2020. Distribution maps of the species were made using QGIS 3.10.9 (QGIS, 2020), combining original and previously published occurrence data obtained (Campos et al., 2018; Zaragoza-Caballero, 1996, 2012).

Description

Family Lampyridae Rafinesque, 1815
Subfamily Lampyrinae Rafinesque, 1815
Tribe Cratomorphini Green, 1959
Genus *Cratomorphus* Motschulsky, 1853
Cratomorphus leoneli sp. nov.

Figs. 1-41

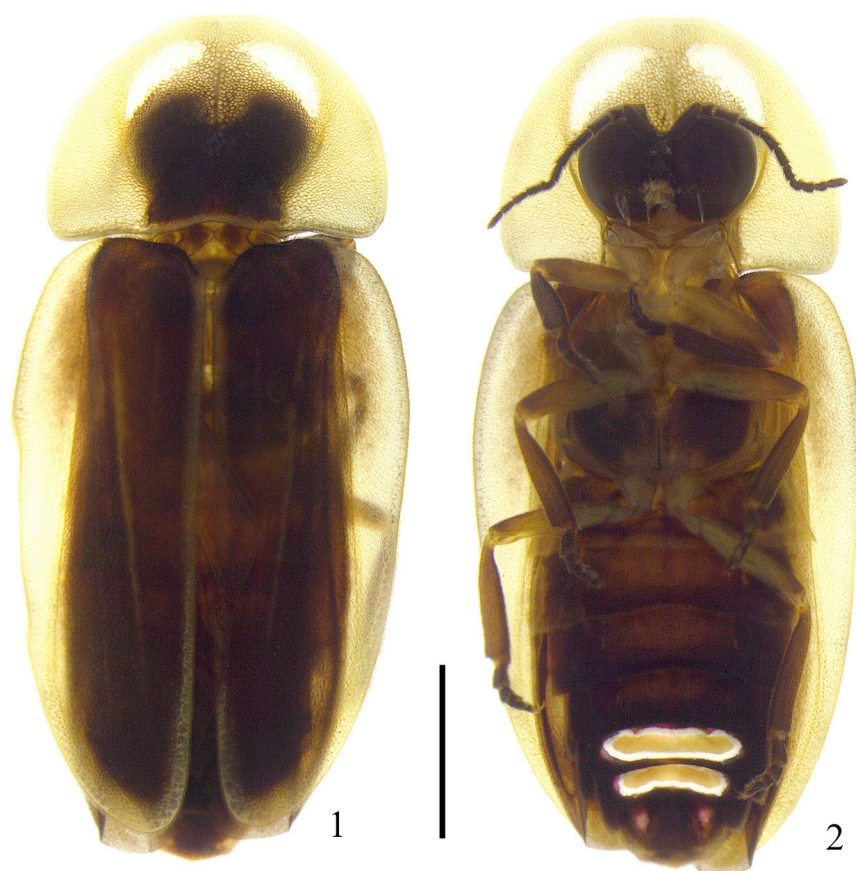
<http://zoobank.org/urn:lsid:zoobank.org:act:627EF888-7E8D-4A59-A083-896744E1EC6E>

Diagnosis. Body (Figs. 1, 2) overall yellow to yellowish-brown; clypeus subquadrate (Figs. 3, 6); elytron (Fig. 26) elliptical with 2 longitudinal keels, one extending along entire length of elytron, reaching 1/5 apical, and the other shorter, not reaching 1/2 of the elytron; pygidium with posterior margin bisinuate, sternite VIII with posterior margin with median projection apically obtuse.

Description. Male (holotype). Body length 11.7 mm, elliptical (Figs. 1, 2). Coloration, overall yellow to yellowish-brown (Figs. 1, 2). Antenna, fronto-clypeus and mouthparts (Figs. 3-9) yellowish-brown. Pronotum (Figs. 15-19) with brown disc, yellow lateral margins, anterior region with pair of parasagittal reniform vitreous spots. Scutellum (Fig. 25) yellowish-brown. Elytra (Fig. 26) yellowish-brown with 2 slender pale-yellow longitudinal keels. Legs and mesoventer dark brown to yellowish brown.

Abdominal sternites (Fig. 32) VI - VII entirely covered by yellow luminescent organs with whitish margins (Fig. 32). Sternite VIII (Fig. 34) brown with 2 pinkish points laterally. Pygidium (Fig. 33) dark brown with light brown side spots. Head, trapezoidal in dorsal view (Figs. 3-8). Eyes as wide as head width in dorsal and ventral views (Figs. 3, 4), surpassing head length in dorsal view (Figs. 3, 4); internal margin straight, divergent posteriad in dorsal view, curved ventrally posterior margin emarginate (Figs. 3, 4). Frons prominent (Figs. 5, 6), vertex concave, with 2 posterior parasagittal indentations (Figs. 3, 6) Antennal socket oblong, 2 times longer than wide; distance between sockets as wide as 0.1 times labral width (Fig. 6); antennifer process conspicuous (Fig. 6). Antennae (Fig. 9) 11-jointed, filiform, scape about 3 times longer than wide, 2.5 times longer than pedicel; pedicel almost as wide as long, 2 times shorter than antennomere III; antennomeres III - VIII 3.5 - 4 times longer than wide; IX - XI 3.5 - 4 times longer than wide. Fronto-clypeus (Fig. 6) semicircular, membranous. Clypeus (Figs. 3, 6) subquadrate, as wide as long, lateral margins parallel, anterior border straight, with bristles, and reaching almost length of clypeus. Labrum (Fig. 6) subtriangular, mobile, membranous. Mandible (Figs. 10, 11) stout basally, abruptly arcuate at apical 1/3, proximal region bearing a fringe of bristles, apex acute. Mentum membranous with bristles, divided sagittally. Submentum triangular divergent posteriad. Maxillary palp (Figs. 1-4) 4-segmented, IV > III < II > I, palpomeres I - III increasing in width apically; palpomere IV tapering apicad (fusiform); palpifer rectangular, well sclerotized; stipe oblong, with 1/3 apical covered by setae; galea bifurcated bearing dense fringe of bristles on inner margin; lacinia medially fused, internal margin with thick fringe of bristles. Labial palp 3-segmented, III > II = I; palpomere III securiform. Gular sutures indistinct; occiput (Figs. 7, 8) oblong, 1.3 times longer than wide. Tentorium (Figs. 12-14) long and slender, almost as high as 3/4 head high, slightly curved backwards. Thorax (Figs. 15-30) with pronotum (Figs. 15-19) semicircular, almost as wide as long; posterior angles rounded; posterior edge slightly sinuate with large median punctures; disc convex, about 2 times wider than long, trapezoidal, with punctured and setose sparser; lateral and anterior parts of pronotum expanded, lateral expansion variably declined in lateral view, as wide as disc, evenly and densely setose; anterior part 1.8 times longer than disc, with setae and punctured sparsely distributed. Hypomerone (Fig. 19) trapezoidal and protruded outwards anteriorly, 2.5 times longer than wide, posterior margin possessing an indentation. Prosternum (Fig. 16) with anterior margin slightly sinuate, with margins convergent outwards; prosternal process short, 1/6 of prosternum length in

ventral view; proendosternite acute. Mesoscutellum (Fig. 25) triangular, bristled and acute posteriad; Alinotum (Figs. 20-23) as long as wide, lateral margins slightly convergent posteriad, posterior margin lightly sinuate; allocrista distinct reaching anterior 1/3 of alinotum; prescutal ridge extending up to 1/3 of the metascutum length; scutum well developed, poorly sclerotized, reaching the posterior margin of alinotum; metascutellum glabrous; postnotal plate with posterior margin somewhat rounded, medially beveled, postnotal medial ridge conspicuous at posterior half; mesosternum weakly sclerotized, acute posteriad, attached to metasternum by a suture sclerotized and acuminate; mesoepimeron attached to metasternum by membrane; mesosternum/mesanepesternum suture inconspicuous; mesanepesternum/mesepimeron suture conspicuous; metasternum (Fig. 23) oblique and strongly depressed by mesocoxae, anterior medial keel prominent up to anterior one third, discrimen indistinct, lateral margins divergent posteriad up to lateral-most part of metacoxa, then convergent posteriad, posterior margin bisinuate; metendosternum (Fig. 21) spatulate, 2 times longer than wide, slightly emarginate anteriorly, with 2 lateral laminae as wide as 1/6 of the metasternum width, as wide as long. Elytra (Fig. 26) elliptical, 3 times longer than wide, slightly convex, with curved margins up to half its length, then convergent posteriad, surface with 2 splendor, longitudinal keels, inner extending along entire length of elytron, reaching 1/5 apical, other one shorter, not reaching 1/2 of the elytron. Hind wing (Fig. 27) well-developed, 2 times longer than wide, radial cell about 5 times wider than long, almost reaching anterior margin, costal row of setae inconspicuous; r4 twice as long as r3, CuA2 crossvein absent, MP-Cu crossvein present, RP + MP1+2 slightly shorter than r4 and almost reaching distal margin; AP3+4 lightly curved, J evanescent. Legs. Procoxae and mesocoxae (Figs. 28-30) elongate, tapering distally; femur slightly shorter than tibia, with sparse bristles; tibia densely setose, paired apical spurs present. Tarsomeres gradually expanded I > II > III < IV = V; tarsomere IV bilobed, densely setose, located inserted under tarsomere IV the V. Claws simple. Abdomen (Figs. 31-40) with tergites (Fig. 31) II - VII slightly emarginate (Fig. 31), posterior angles acute. Pygidium (Fig. 33) with anterior angles acute, lateral margins rounded, each 1/2 of posterior margin sinuate, median 1/3 with apex rounded. Sternites (Fig. 32) II - IX visible, sternites II - IV with acute posterior angles projected laterad, spiracles lateroventral not visible. Sternites VI - VII slightly emarginate posteromedially, each one bearing a single luminescent organ as large as sternites. Sternite VIII (Fig. 34) basally as wide as long, with anterior margin widely emarginate, posterior margin with a medially projected and apically obtuse; sternites



Figures 1-2. Habitus of *Cratomorphus leoneli* sp. nov. (Lampyridae: Cratomorphini) male. 1) Dorsal view; 2) ventral view. Scale bar: 3 mm.

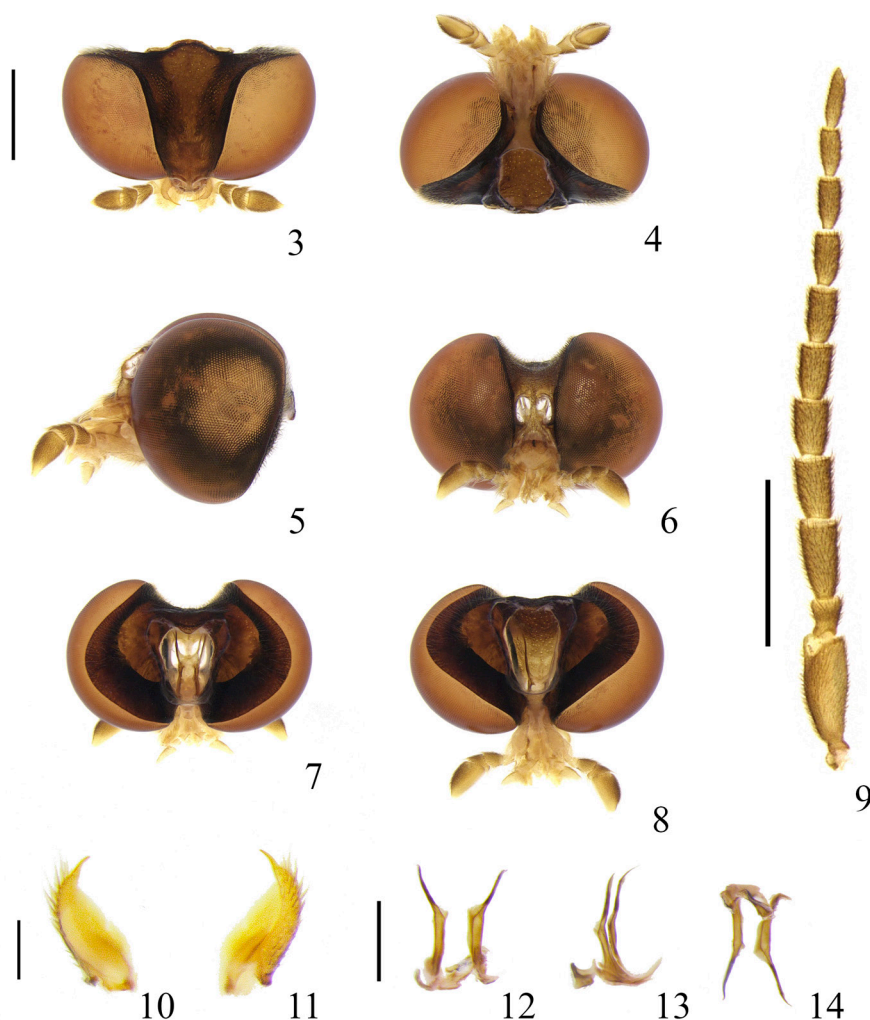
IX subtriangular (Fig. 35), translucent, overall poorly sclerotized except for the outline, with stria 1/3 distal medially transversal and emarginate; syntergite (Fig. 36) consisting of paired lateral plates convergent posteriorly, anterior margin emarginate. Genitalia. Aedeagus (Figs. 37-40) well-sclerotized, phallobase asymmetric with 1/3 rounded apical and lightly emarginate, projected dorsally. Parameres (Figs. 37-39) symmetric, longer than phallus, apically acute and curved ventrad, parameres margins with median anterodorsal margins fused to each other and extended anteriad, articulated to phallus dorsally and obtuse, ventral margins of parameres separated; phallus (Fig. 40) almost 5 times longer than wide, ventral plate with keels apically convergent, apex rounded and dorsally curved.

Taxonomic summary

Type material: ♂ holotype deposited at CNIN, labelled: "Mexico. Oaxaca: Parque Nacional Huatulco, Estación El

Sabatal (15°46'10.4" N, 96°11'40.6" W), 103 m, 04-nov-2005, S. Zaragoza col." // "UNAM-57561".

Other material examined: paratypes; 131 males, same locality and date as holotype UNAM-57541, 57543-57568, 57646-57650, 57653, 57662, 57665-57669, 57571, 57713; same locality, 05.11.2005 UNAM-57542, 55569-55570, 55572-55573, 55575-55582, 55671, 55714, 57610-57623, 57625-57628, 57630-57642, 57644-57645, 57651-57652, 57654, 57657-57658; same locality, 07.11.2005 UNAM-55624, 57629-57642, 57655. Collected at 15°46'19.7"N, 96°11'53.9"O, 29m, TL2, 05.IX.20, S. Zaragoza coll. UNAM-57574, 57585, 57593, same locality and date, F. Noguera coll. UNAM-50062, 57542, 57569, 57572-57573, 57584, 57586-57592, 57594-57599, 57600-57601, 57661, 57670, 57672-57674; same locality and date, E. Gonzalez coll. UNAM-57603, 57602-57605, 57607-57609, 57660. México. Chiapas, Villa Flores, 03-abr-2002, E. Pozo V.; México. Campeche Calakmul km.78 Escárcega-Xpuhil, 31-may-200, L. Cervantes & C.



Figures 3-14. Head structures and mouthparts of *Cratomorphus leoneli* sp. nov. (Lampyridae: Cratomorphini) male. 3-8) Head: 3) dorsal view; 4) ventral view; 5) lateral view; 6) frontal view; 7) posterior view; 8) occipital view. 9) antenna, lateral view. 10-11) Mandible: 10) dorsal view; 11) ventral view. 12-14) tentorium: 12) frontal view; 13) lateral view; 14) dorsal view. Scale bar: 3-8) 0.5 mm; 9) 1 mm; 10-11) 0.2 mm; 12-14) 0.5 mm.

Mayorga colls. UNAM-57324. Deposited in CNIN and INPA.

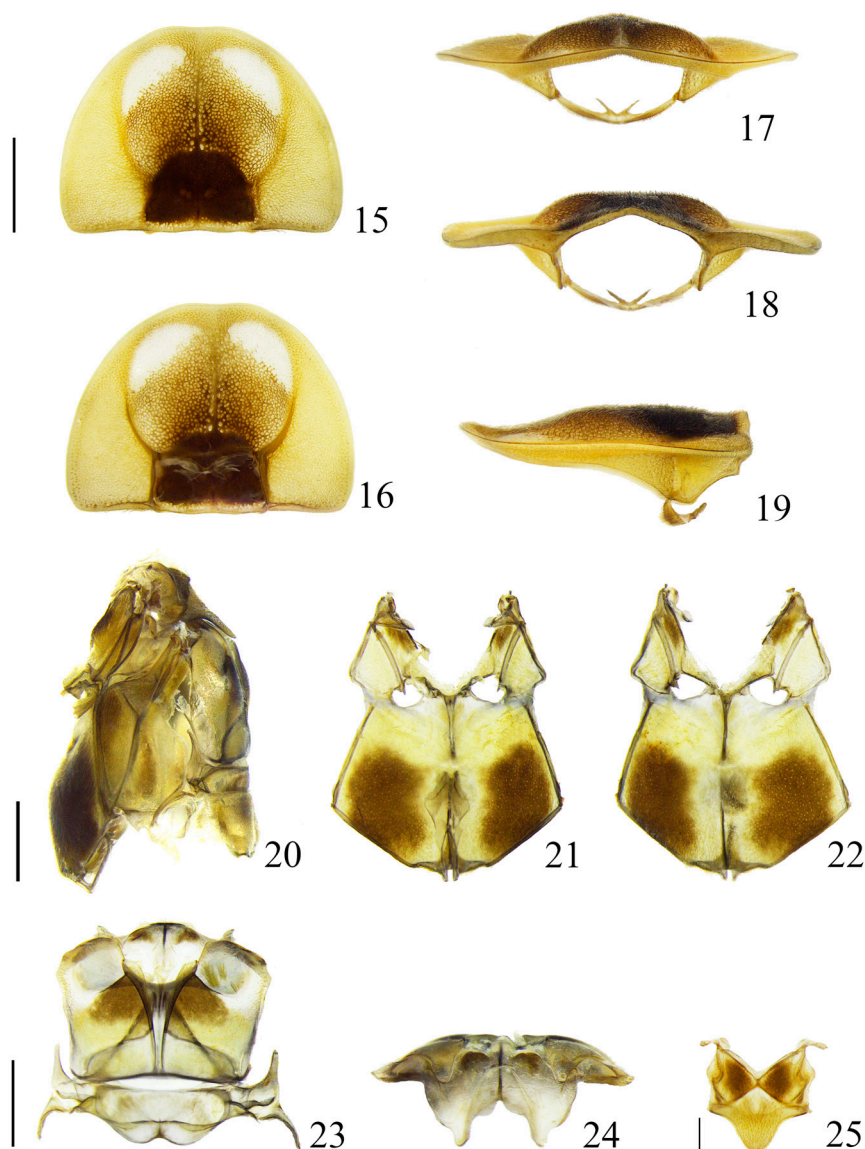
Female and immature stages: unknown.

Etymology: species dedicated to Martín Leonel Zurita García, an excellent student, teacher, colleague and friend, focused on the study of beetles of the Elateridae and Lampyridae families, as well as a passionate researcher in the field of forensic Entomology.

Distribution: the species is only known from the type material, which is from, Oaxaca, Campeche and Chiapas, México (Fig. 41).

Remarks

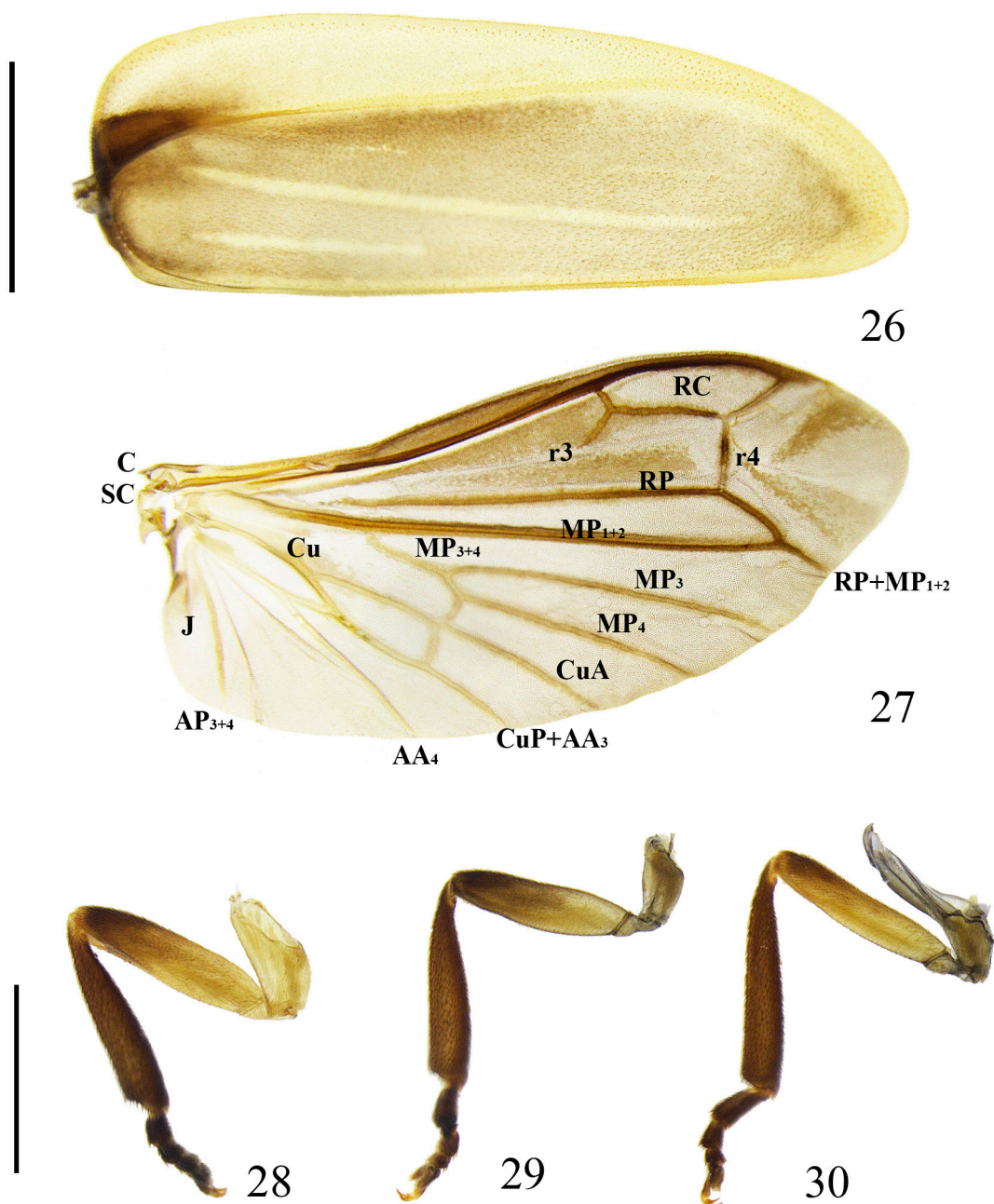
Cratomorphus leoneli sp. nov. is the 12th species of the genus in Mexico, and shares posterior border of sternite VIII produced into a median lobe with the other 6 species (*C. cossyphinus* (Perty, 1832); *C. hoffmannae* Zaragoza-Caballero, 1996; *C. ayalai* Zaragoza-Caballero, 1996; *C. huautlaensis* Zaragoza-Caballero, 1996; *C. halfferi* Zaragoza-Caballero, 2012) and *C. limai* Zaragoza-Caballero et al., 2021) of Olivier's group IV from Olivier (1885). The new species can be distinguished from all other species by the following combination of



Figures 15-25. Thorax of *Cratomorphus leoneli* sp. nov. (Lampyridae: Cratomorphini) male. 15-19) Prothorax: 15) dorsal view; 16) ventral view; 17) frontal view; 18) posterior view; 19) lateral view. 20) pterothorax, lateral view. 21-22) Metaendosternito: 21) ventral view; 22) dorsal view; 23-24) mesoendosternito: 23) dorsal view; 24) frontal view. 25) Mesoescutelo, dorsal view. Scale bar: 15-19) 2 mm; 20-24) 1 mm; 25) 0.5 mm.

characters: 1) smaller body size (body length, compared to 16.93 - 17.45 mm in *C. ayalai* and *C. hoffmannae*); 2) clypeus subquadrate (subcordiform in *C. ayalai*; clypeus semicircular in *C. hoffmannae* and *C. halffteri*; clypeus rectangular in *C. cossyphinus*; clypeus trapezoidal in *C. limai*); 3) pygidium with posterior margin bisinuate (trilobate in *C. halffteri*, with 2 parasagittal indentations

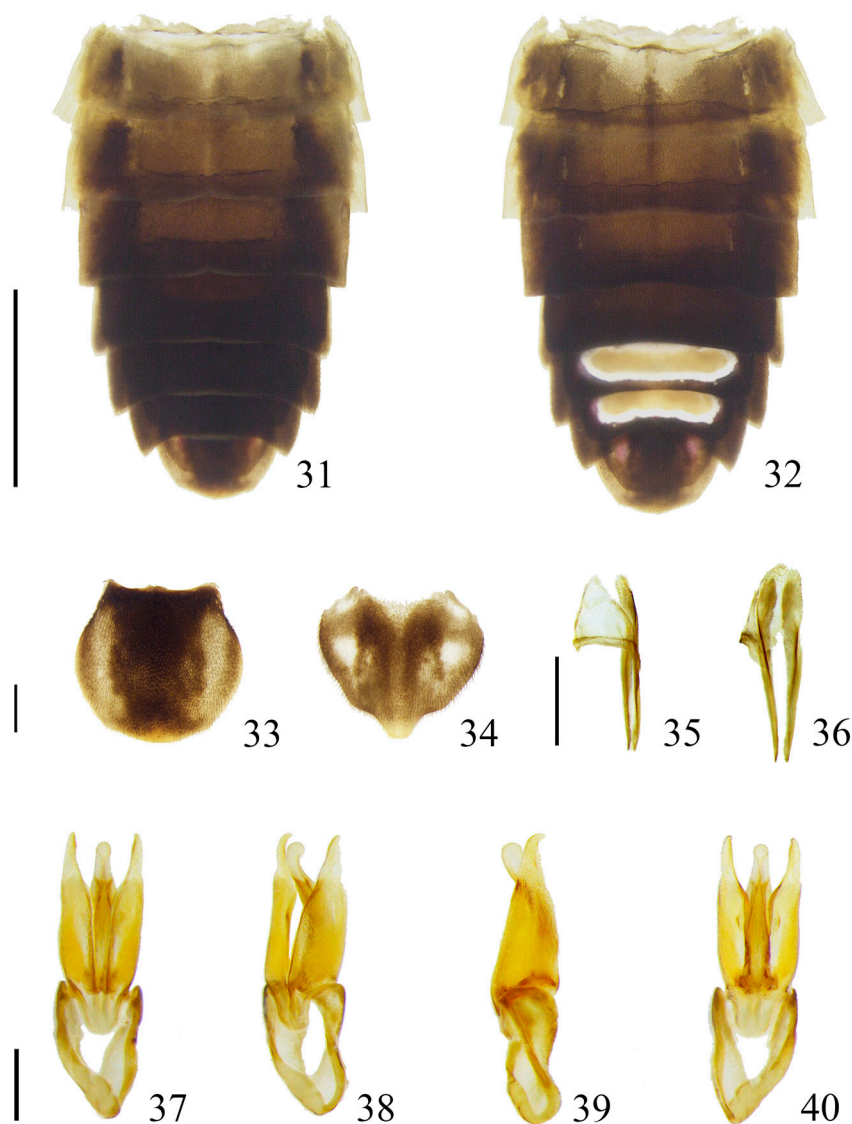
and central margin rounded in *C. cossyphinus*; rounded in *C. hoffmannae* and *C. huautlaensis*; truncate in *C. limai*); 4) sternite VIII with posterior margin with a median projection which is apically obtuse (with a median projection apically acute in *C. ayalai*, *C. huautlaensis*, *C. limai*; apically truncated in *C. halffteri*).



Figures 26-30. Wings and legs of *Cratomorphus leoneli* sp. nov. (Lampyridae: Cratomorphini) male. 26) Right elytron, ventral view; 27) right hind wing; 28) right foreleg; 29) right mid leg; 30) right hind leg. Scale bar: 26-27) 3mm; 28-30) 2mm. Abbreviations: AA-anal anterior vein; AP-anal posterior vein; C-costa; Cu-cubitus; CuA-cubitus anterior; CuP-cubitus posterior; J-julgum; MA-media anterior; MP-media posterior; r3- radial 3; r4- radial 4; RC-radial cell; RP-Radius posterior; Sc-subcosta. Scale bar: 26-27) 3 mm; 28-30) 2 mm.

Zaragoza-Caballero (1996) considered the possibility that *C. ayalai* should be part of a new group due to the presence of a unique trait: the sternite VIII with a trilobed posterior margin. However, Zaragoza-Caballero (2012)

did not formally propose a new group, but rather included *C. halfferi* in Group IV along with the *C. ayalai*, *C. hoffmannae* and *C. huautlaensis*.



Figures 31-40. Abdomen and genitalia of *Cratomorphus leoneli* sp. nov. (Lampyridae: Cratomorphini) male. 31-32) Abdomen: 31) dorsal view; 32) ventral view; 33) pygidium, dorsal view; 34) sternite VIII, ventral view; 35) sternite IX, ventral view; 36) syntergite, dorsal view. 37-40) Aedeagus: 37) dorsal view; 38) oblique view; 39) lateral view; 40) ventral view. Scale bar: 31-32) 3 mm; 33-34) 0.5 mm; 35-36) 1 mm; 37-40) 0.5 mm.

Group IV species seem to share similar Grinnelian niches, since they are in tropical humid and sub-humid areas commonly found in southern Mexico, Central and South America (Morrone, 2014; Fig. 41) and capable of exploiting a diversity of environments (Campos et al., 2018).

Our study, with an updated key to species and new distribution records, contributes to facilitating the identification of *Cratomorphus* species in Central America, indicates new traits (e.g., shape of terminalia), and is therefore an important step towards the revision of the whole genus.

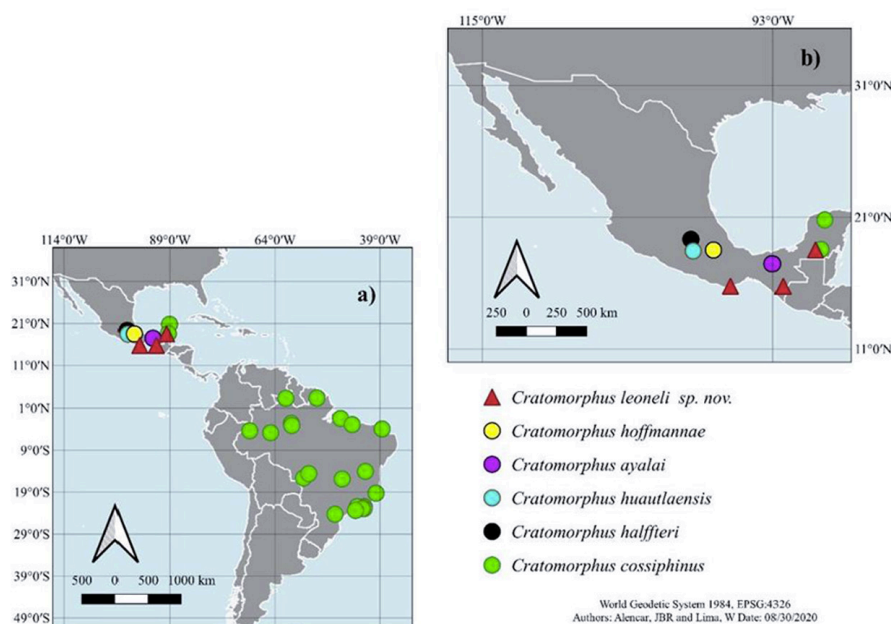


Figure 41. Current distribution of *Cratomorphus* species from group IV of Olivier (1885) to: a) Neotropical region, overview; b) Mexico.

Key to males of Mexican *Cratomorphus* belonging to the species group IV of Olivier (1895).

1. Sternite VI with lantern tripartite *C. cossiphinus* (Perty, 1830)
- 1'. Sternite VI with lantern entire 2
2. Pygidium with posterior margin rounded *C. huautlaensis* Zaragoza, 1996
- 2'. Pygidium with posterior margin trilobated or bisinuated 3
3. Posterior margin of sternite VIII with median projection apically truncated *C. halfferi* Zaragoza, 2012
- 3'. Posterior margin of sternite VIII with median projection apically acute or obtuse 4
4. Lateral margins of elytra subparallel *C. hoffmannae* Zaragoza, 1996
- 4'. Lateral margins of elytra rounded 5
5. Posterior margin of sternite VIII with median projection apically acute 6
- 5'. Posterior margin of sternite VIII with median projection apically obtuse; clypeus subquadrate; posterior margin of pygidium bisinuate *Cratomorphus leoneli* sp. nov.
6. Clypeus subcordate; posterior margin of pygidium trilobate *Cratomorphus ayalai* Zaragoza, 1996
- 6'. Clypeus trapezoidal; posterior margin of pygidium truncate *Cratomorphus limai* Zaragoza et al., 2021

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