



A new species of planthopper from Costa Rica in the genus *Oropuna* from palms in lowland tropical rainforest

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Abstract

The derbid genus *Oropuna* is a small taxon of Neotropical planthoppers in the tribe Cenchreini comprised of three species. Recent survey work on palms for planthoppers in Costa Rica resulted in the discovery of a fourth species, *Oropuna halo* **sp. n.** In this study the new species is described and a key to the four species is provided along with sequence data for the cytochrome *c* oxidase subunit I (COI) and 18S rRNA gene for the novel taxon.

Key words: planthopper, palm, phylogeny, taxonomy, Costa Rica

Resumen

El género *Oropuna*, perteneciente a la familia Derbidae, es un pequeño taxón de chicharritas neotropicales de la tribu Cenchreini, el cual está compuesto por tres especies. Durante una reciente investigación de campo de chicharritas en palmeras en Costa Rica, se descubrió una cuarta especie: *Oropuna halo* **sp. n.** En este documento se describe la nueva especie y se proporciona una clave para las cuatro especies, así como los datos de secuencia para la subunidad I del citocromo *c* oxidasa (COI) y el gen 18S rRNA para el nuevo taxón.

Palabras clave: chicharritas, palmeras, filogenia, taxonomía, Costa Rica

Introduction

The genus *Oropuna* Fennah is a taxon of derbid planthopper (Derbidae: Derbinae: Cenchreini) that until recently was comprised of a single species, *O. minutiana* (Caldwell). This species was described from Guatemala and Mexico (Chiapas) as *Phaciocephalus minutianus* Caldwell 1944. Two more species were recently added to the genus by Bahder *et al.* (2021a) with *Oropuna orba* (Stål) (from Brazil), transferred from *Phaciocephalus* Kirkaldy, and *Oropuna fusca* (Metcalf) (From Panama) transferred from *Herpis* Stål. Members of *Oropuna* are ‘cixiid-like’ derbids with tectiform wings and a pronotal paradiscal regions forming foliate, cup-like fossae behind the antennae. *Oropuna* is moderately robust among Cenchreini, approximately 3–6 mm (with wings), with broad frons (weakly concave) that lacks the median carina found in *Herpis*.

The genus *Oropuna* was established by Fennah (1952: 136–137) based on the shape of the vertex (“...distinctly

broader than long in middle, apically transverse; lateral margins broadly explanate and beset with sensory pits...”), the frons (“...frons only slightly more than twice as long as broad; disc not depressed, ecarinate, lateral margins not elevated...”) and the shape of the medioventral process (“...large subquadrate or trapezoidal medioventral process...”). In the keys to the Cenchreini by both Fennah (1952) and O’Brien (1982) these features were used to contrast *Oropuna* with those of *Herpis* Stål. The genus *Herpis* is contrasted with *Oropuna* in (Fennah 1952: 128) as having a “vertex as long as broad or longer than broad”; frons medially carinate and the “medioventral process [of the pygofer] triangular”. This last feature may be misleading as it appears that *Oropuna* has a notably broader medioventral process of the pygofer than *Herpis* (e.g., Caldwell 1944, plate 1 fig. 2C).

At present, there is no molecular data available for *Oropuna*, which makes it more difficult to assess its relationship among the Cenchreini from the New World. Superficially, *Oropuna* most closely resembles *Herpis* based on head morphology, being the only two genera with a ‘broad’ frons.

Recent survey efforts in the Neotropics have yielded many novel taxa within the Derbidae and Cixiidae closely associated with palms. As part of this survey, an expedition in June of 2019 resulted in the collection of what was identified in the field as a derbid planthopper from a variety of palm seedlings at La Selva Biological Station in Costa Rica, and subsequently determined to belong to *Oropuna* and represent a new species. Herein we describe the novel taxon, provide molecular sequence data for the COI and 18S loci, and present some discussion of genus-level diagnostic features of *Oropuna* relative to other New World Cenchreini.

Materials and methods

Locality and Specimen Collection. Individuals of the novel taxon were collected by sweep netting trailside palms, aspirated and were immediately transferred to 95% ethanol. Specimens were collected (permit no. SINAC-ACTo-GASPPNI-016-2018) at La Selva Biological Station, Heredia province, Costa Rica (10.431269, -84.005961), and exported under permit number DGVS-256-2018 to the U.S.A. under permit number P526-170201-001. All specimens collected were measured, photographed and dissected using a Leica M205 C stereoscope. Images of specimens and all features photographed were generated using the LAS Core Software v4.12. Voucher specimens, including primary types, are stored at the University of Florida—Fort Lauderdale Research and Education Center (FLREC) in Davie, FL, U.S.A and the Florida State Collection of Arthropods (FSCA) in Gainesville, FL, U.S.A.

Morphological Terminology and Identification. Morphological terminology generally follows that of Bartlett *et al.* (2014), except forewing venation following Bourgoïn *et al.* (2015) and with male terminalia nomenclature modified after Bourgoïn (1988) and Bourgoïn & Huang (1990).

Dissections and DNA Extraction. The terminalia that were dissected also served as the source of tissue for DNA extraction. The terminal end of the abdomens was removed and placed directly into a solution of tissue lysis buffer (buffer ATL) and proteinase K (180 µl ATL and 20 µl proteinase K) from the DNeasy® Blood and Tissue Kit (Qiagen). The abdomen was left to lyse for 24 hours at 56°C. Following lysis, eluate was transferred to a new 1.5 ml microcentrifuge tube and DNA extraction proceeded as per the manufacturer’s instructions. The terminalia were then immersed in 200 µl of buffer ATL and 200 µl of buffer AL from the same kit and placed at 95°C for 24 hours to remove fat, wax, and residual tissue.

PCR Parameters, Sequence Data, and Analysis. To obtain COI sequence data, DNA template from specimens was amplified using the primers TY-J-1460 (5’-TACAATTTATCGCCTAAACTTCAGCC-3’) (Simon *et al.* 1994) and HCO2198 (5’-TCAGGGTGACCAAAAAATCA-3’) (Folmer *et al.* 1994). To obtain 18S sequence data, the primers developed by Bahder *et al.* (2019) were used and are as follows; forward primer 18SF (5’-ACTGTCGATGGTAGGTTCTG-3’), reverse primer 18SR (5’-GTCCGAAGACCTCACTAAA-3’). PCR reactions contained 5x GoTaq Flexi Buffer, 25 mM MgCl₂, 10 mM dNTP’s, 10 mM of each primer, 10% PVP-40, and 2.5U GoTaq Flexi DNA Polymerase, 2 µl DNA template, and sterile dH₂O to a final volume of 25 µL. Thermal cycling conditions for COI were as follows: 2 min initial denaturation at 95°C, followed by 35 cycles of 30 sec denaturation at 95°C, 30 sec annealing at 40°C, 1 min 30 sec extension at 72°C, followed by a 5 min extension at 72°C. Thermal cycling conditions for 18S were as follows: 2 min initial denaturation at 95°C, followed by 35 cycles of 30 sec denaturation at 95°C, 30 sec annealing at 55°C, 2 min extension at 72°C, followed by a 5 min extension at 72°C. PCR products of the appropriate size were purified using the Exo-SAP-IT™ PCR Product Cleanup Reagent (ThermoFisher Scientific, Waltham, Massachusetts, USA). Purified PCR product was quantified using a NanoDropLite spectrophotometer

(ThermoFisher Scientific, Waltham, Massachusetts, USA) and sequenced using the SeqStudio Genetic Analyzer (ThermoFisher). Contiguous files were assembled using DNA Baser (Version 4.36) (Heracle BioSoft SRL, Pitesti, Romania), aligned using Clustal W as part of the package MEGA7 (Kumar *et al.* 2016). A matrix of pairwise differences using number of differences among COI and 18S was calculated with MEGA7 (Kumar *et al.* 2016). The bootstrap method was used for variance estimation at 1,000 replicates and using the p-distance model. A Maximum Likelihood tree was generated using the Bootstrap method at 1,000 replicates based on the Tamura-Nei model for concatenated COI and 18S data to yield a consensus tree.

Taxon sampling. For both the COI and 18S loci, DNA sequence data was used from eight species of *Omolicna* Fennah, four species of *Agoo* Bahder & Bartlett, two species of *Tico* Bahder & Bartlett, *Anchimothon dubia* (Caldwell), *Cenchrea dorsalis* Westwood, *Herpis soros* Bahder & Bartlett and *Neocenchrea heidemanni* (Ball) to generate a consensus tree (Table 1).

For morphological characterization of the genus, we obtained photos of the type specimen of *Oropuna minutianus* Caldwell (from the Smithsonian Institution, Washington, DC; USNM), the type specimen of *Oropuna orba* Stål (Swedish Natural History Museum, Stockholm Sweden, NHRS), and the type specimen of *Syntames fuscus* Metcalf (Harvard Museum of Comparative Zoology, Cambridge, MA; MCZC).

TABLE 1. Taxa used for constructing phylogeny based on the COI and 18S genes and performing pairwise comparisons.

Species	GenBank Accession No.	
	COI	18S
<i>Agoo beani</i>	MT413388	MT415403
<i>Agoo dahliana</i>	MN496467	MH472754
<i>Agoo luzdenia</i>	MT085818	MN999709
<i>Agoo xavieri</i>	MK443068	MK443073
<i>Anchimothon dubia</i>	MN496470	MN474755
<i>Anotia firebugia</i>	MT084365	MT945942
<i>Cenchrea dorsalis</i>	MT413387	MN472756
<i>Herpis soros</i>	MT085817	MT415405
<i>Neocenchrea heidemanni</i>	MN496473	MT415406
<i>Omolicna brunnea</i>	MK443070	MK443071
<i>Omolicna cubana</i>	MT413386	MT415404
<i>Omolicna joi</i>	KF472312	MN472753
<i>Omolicna latens</i>	MN496472	MN472757
<i>Omolicna mariajoseae</i>	MT422534	MT424915
<i>Omolicna puertana</i>	MN496468	MN472751
<i>Omolicna tarco</i>	MT422533	MT424914
<i>Omolicna triata</i>	MK443069	MK443072
<i>Tico emmettcarri</i>	MT085816	MT526036
<i>Tico pseudosoroius</i>	MT997938	MT526037

Systematics

Family Derbidae Spinola 1839

Subfamily Derbinae Spinola 1839

Tribe Cenchreini Muir 1913

Genus *Oropuna* Fennah 1952

Type species: *Oropuna minutianus* Caldwell, 1944: 102.

Amended Diagnosis. Relatively large and robust among Cenchreini, measuring approximately 3.8–5.5 mm in length, including wings. Wings tectiform in repose, distinctly exceeding abdomen. Vertex broad, nearly trapezoidal (anterior margin transverse to weakly convex, posterior margin concave), nearly 2x as broad at posterior margin as long at midline; lateral margins keeled (“explanate”, Fennah 1952: 136), converging anteriorly (slightly broader at apex); transverse carinae at fastigium faintly indicated. Pits present on lateral margins of vertex and frons, varying in size and distinctness, in 2+ rows. Frons broad, elongate, weakly concave, lateral margins keeled, slightly diverging to widest point approaching frontoclypeal suture; medium carina of frons absent, frontoclypeal margin straight. Clypeus elongate triangular, median carina evident, in lateral view in approximately same plane as frons. Genae without subantennal process. Antennae short, pedicel spheroid, about as long as wide.

Pronotum narrow, declinate (posterior margin raised), anterior margin convex, posteriorly broadly concave or v-shaped, broadening laterally; paranotal region foliate, forming large foveae posterior to the antennae (a tribal feature). Mesonotum tricarinate, carinae nearly reaching posterior margin, scutellum faintly discontinuous with scutum (not separated by groove). Lateral teeth absent on tibiae. In clavus of forewing, combined vein Pcu+A1 fusing with CuP, with the composite vein reaching wing margin near icu crossvein; C5 cell (formed by forked CuA) closed by crossvein (not anastomosing CuA, viz. Emeljanov 1996: 74); RP usually 5-branched (4 in *O. orba*).

Terminalia mostly bilaterally symmetrical, except aedeagus asymmetrical. Pygofer in lateral view narrow, strap-like, arched (caudal margin convex, anterior margin concave), ventral margin broadly expanded; in ventral view, medioventral process very broad, subquadrate, apex truncate to broadly triangular. Gonostyli elongate, narrow (relative to *Herpis*), distally enlarged with a twisted appearance, bearing a thumb-like process on dorsal surface and in ventral view two large medially directed processes. Aedeagus symmetrical or asymmetrical, shaft bearing dorsolateral keels and apical or subapical processes, endosoma complex with a variety of sclerotized processes. Anal tube length highly variable.

Distribution. Mexico (Chiapas); Guatemala; Costa Rica; Southeast Brazil (Rio de Janeiro); Bolivia (Cochabamba).

Etymology. Fennah (1952) did not specify an origin of the genus name ‘*Oropuna*’, and the derivation of the term does not appear obvious. The name may have come from the Oropuna River in Trinidad (or the town of Oropuna) but there is no connection with that place. Possibly the name is derived from the Greek term ‘*oros*’, or the Latin term ‘*orias*’, meaning mountain or hill, plus a form of the Latin verb ‘*punio*’ (punish). *Oropuna* is treated as masculine.

Remarks. This genus appears to be most similar to *Herpis* in general appearance, especially the broad frons. In *Herpis* the frons appears to be flat, parallel sided and bearing a median carina, in *Oropuna* the frons is weakly convex, lacking the median carina and the lateral margins diverging ventrally. The vertex in both genera are trapezoidal, but in *Oropuna* it is about 2x as wide at base as long at midline, whereas in *Herpis* the vertex is longer in midline. In male genitalia, the medioventral process is large, broad and subquadrate (unique among New World Cenchreini), whereas in *Herpis* it is subconical, usually taller than broad. Among species examined so far, *Herpis* has broad, spatulate gonostyli with a single medially directed process in ventral view; whereas *Oropuna* is narrow, with two medial processes in ventral view. In the forewing, *Oropuna* has 4–5 branches of the RP, and *Herpis* apparently has 6-branches, at least among the species examined, the species that we have examined so far in *Herpis* are all pallid in coloration relative to *Oropuna*.

The only genus, other than *Herpis*, whose head structure may approach that of *Oropuna* are some of the members of *Omolicna* Fennah. However, in this genus, the frons is more distinctly convex (and enlarged near the frontoclypeal border), and the medioventral process of the pygofer is not nearly as broad.

Key to species of *Oropuna*

1. Body uniformly brown (Fig. 7), wings evenly suffused with fuscus (except near apices of Sc and RA along costal margin); most veins near wing apex reddish (up to crossvein or fork); Brazil *O. orba*
- 1.’ Body paler, and/or wing not evenly suffused with fuscus (Fig. 1); apical wing veins not reddish, only wing margin and imme-

- diately adjacent veins; Mesoamerica 2
2. Medioventral lobe of male pygofer (ventral view) distinctly longer than wide, elongate-ovoid; gonostyli, in ventral view, with medial margin smooth, lacking medially directed lobes (Metcalf 1938, plate 20); Panama *O. fusca*
- 2.7 Medioventral lobe of male broad and about as wide as tall (ventral view), roughly quadrate; gonostyli in ventral view with 2 pairs of medial projections 3
3. Apex of the medioventral lobe of male pygofer with broadly acute apex (Fig. 4B); anal tube subequal in length to gonostyli, apically broad; Costa Rica *O. halo* sp. n.
- 3.7 Apex of the medioventral lobe of male pygofer truncate; anal tube much shorter than gonostyli (Caldwell 1944, plate I, figs 2B, 2C); Guatemala, Mexico (Chiapas) *O. minutiana*

Oropuna halo sp. n.

(Figures 1–6)

Type locality. Costa Rica, Heredia, La Selva Biological Station.

Diagnosis. General body color brown, abdomen darker, wings infusate, veins paler, marginal vein on wing apex reddish. Medioventral process of pygofer broad and spade-shaped, aedeagus bilaterally asymmetrical with complex arrangement of processes; anal tube elongate, in lateral view narrow basally with ventro-distal margin expanded into large truncate projections.

Description. *Color.* General body color yellow-brown, head and prothorax testaceous, clypeus light brown, mesonotum darker brown in anterior 2/3, with posterior 1/3 lighter brown, with paler carinae, give the appearance of a median vitta; abdominal tergites and sternites dark brown (Fig. 1A & 1B). Forewing fuscous, veins white, dark patches in cells along leading margin, in the areola postica near apex of clavus, and between the Pcu and A1 veins in the clavus.

Structure. Head. Head in lateral view with fastigium rounded (Fig. 2C) flattened on face, receding to fronto-clypeal suture and clypeus. Vertex broad, trapezoidal (expanded slightly distally), medially concave, wider at base than long at midline (ratio 1.95:1 Fig. 2B), anterior margin nearly transverse (weakly convex), lateral margins sinuate, weakly foliate bearing 2+ rows of irregularly sized (mostly large) and arranged pits; posterior margin concave. In frontal view, vertex appearing weakly medially produced, transverse carina at fastigium obscure. Frons wide, lateral margins straight and slightly diverging ventrad, widest near frontoclypeal suture (Fig. 2A), irregularly sized wax-producing pits on vertex (Fig. 2B) and frons on lateral margins arranged in 2+ irregular rows; disc of frons weakly convex, lacking median carina, bearing minute scattered pits (Fig. 2A). Frontoclypeal suture straight, clypeus elongate triangular (lateral margins straight and uniformly converging ventrad), median carina present. Antennae short, scape very short, pedicel spheroid, about as tall as wide, greatly overtopped by foliation of pronotal paradiscal region. Lateral ocelli absent (indicated by small whitish marking). Rostrum exceeding hind coxae, apical segment over 2x as long as wind.

Thorax. Pronotum, in dorsal view, very short at midline (less than half length vertex at midline), broadened laterally, anterior margin convexly rounded, posterior margin deeply concave; median carina evident, laterally, paradiscal region strongly foliate forming semicircular fossae, partially surrounding antennae; lateral margins in frontal view rounded (Fig. 2A). Mesonotum rhomboid, slightly wider than long, tricarinate, lateral carinae diffuse, arching mesad at midpoint, diverging posteriorly, not reaching posterior margin; median carina evident anteriorly, obsolete posteriorly (Fig. 2B); scutellum contiguous with scutum.

Forewing with large tubercles along Sc+R and Pcu (Fig. 3), claval apex near midlength (Pcu joined with A1 just before composite vein joins with CuP—clavus open—composite vein reaching wing margin at icu crossvein); fork Sc+PA from RP and fork of CuA both at basal third of wing (prior to Pcu+A1 fusion); C5 cell closed by icu crossvein (CuA not anastomosing to form closed ‘procubital cell’ *sensu* Emeljanov 1996; vein branching pattern RA two-branched, RP two-branched, MP five-branched, CuA two-branched. Tibiae of legs lacking lateral teeth, spinulation of hindleg 6-7-8.

Terminalia. Pygofer in lateral view narrow, strap-like, narrowed dorsally, broadly expanded expanding ventrally margins irregularly sinuate, concave on anterior margin and convex posteriorly (Fig. 4A); in ventral view, medioventral process large, at base, almost as wide as pygofer, spade-shaped, lateral margins converging to approximately midpoint, angled to near parallel-sided then abruptly converging to broadly pointed apex (Fig. 4B). Gonostyli in lateral view very irregularly sinuate on dorsal and ventral margin, with large, curved expansion on dorsal margin past midpoint subtended by pale expansion bearing small, sclerotized curved spine directed caudad (Fig.

4A); distal expansion comprised of curled gonostylus margin, distally expanding to apex (Fig. 4A); in ventral view, medial margin of gonostyli with two medial projections each, proximal projection in basal third (near level of apex of medioventral lobe of pygofer), ovoid and rounded at apex (directed mediocaudad), distal pair at distal 2/3rd level, triangular and sharply pointed bearing ventral sclerotized ridge (Fig. 4B); gonostyli apices rounded, caudomedially directed. Aedeagus bilaterally asymmetrical (Fig. 5), shaft nearly straight (upturned basally), bearing complex series of sclerotized ridges and a pair of apical retrorse processes, left process (Fig. 6, A2) about 2/3 twice length of right process (A1), A1 curved distad, A2 curved dorsolaterally. Endosoma large, retrorse and complex, bearing six pairs of processes (E1–E12), first pair arising near shaft apex, resting lateral of A1 & A2 (E1 & E2), angled anteriorly, slender, curved slight ventrodistad, E1 exceeding E2, E1 exceeding A2 (but not A1), E2 just shorter than A2; second pair (E3 & E4) arising near base of E1 & E2, situated lateral of aedeagal shaft, slender and elongate (about 2/3 length of shaft), apex of E3 slightly curved dorsad, apex of E4 curved ventrad; third pair (E5 & E6) forming apices of broad, flat weakly sclerotized central strap-like region, E5 shorter and curved slightly dorsad, E6 longer, curved ventrad and twisted; fourth pair (E7 & E8) situated lateral aspect of central strap-like region, arising lateroventrally (Figs. 6A, B), E8 shorter and arising just proximad of E7, both curved dorsolaterally; the fifth pair (E9 & E10) arising ventrad of large central region, long, strongly sclerotized, intertwined, E9 strongly curved dorsad (just exceeding apex of endosoma), E10 strongly curved lateroventrad; sixth pair of processes (E11 & E12) arising on ventral margin of aedeagus, small, robust, curved dorsad, not extending beyond apex of aedeagus. Anal tube in lateral view elongate (subequal to gonostyli in length), narrow basally, distally expanded, irregularly sinuate on ventral margin (Fig. 4A); in dorsal view lateral margins of proximal portion sinuate, roughly parallel-sided, distally expanded just before anal column (paraproct) forming pair of weakly asymmetrical lateral lobes (Fig. 4C).



FIGURE 1. Adult male habitus of *Oropuna halo* sp. n.; (A) lateral view and (B) dorsal view, scale = 1 mm.

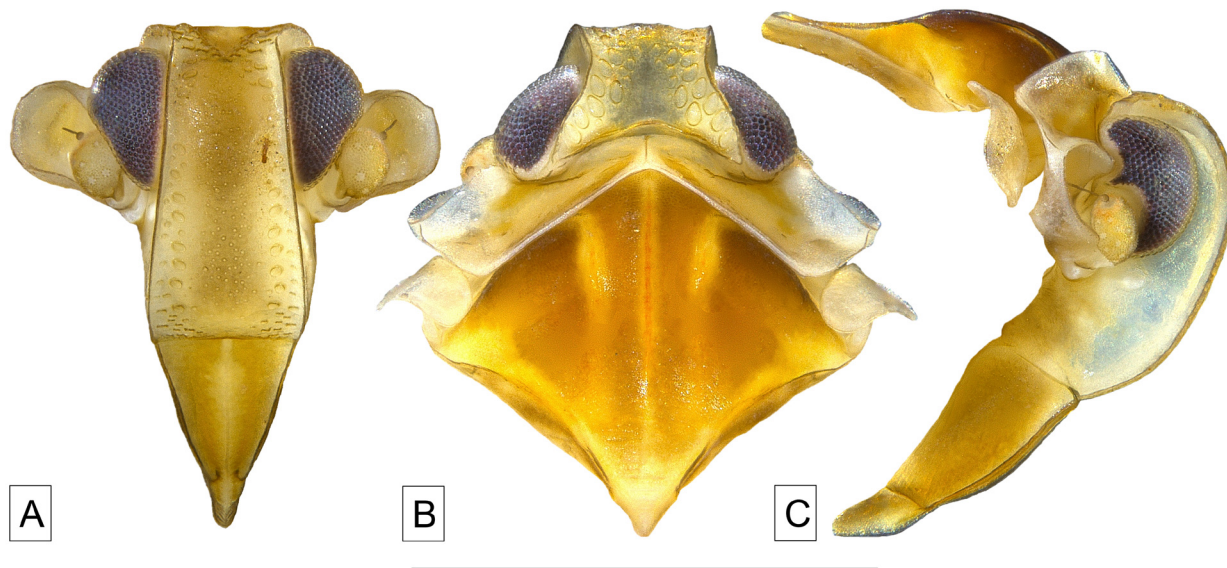


FIGURE 2. Adult *Oropuna halo* sp. n.; (A) head and pronotum frontal view, (B) head, pronotum, and mesonotum dorsal view, and (C) head, pronotum, and mesonotum lateral view; scale = 1 mm.

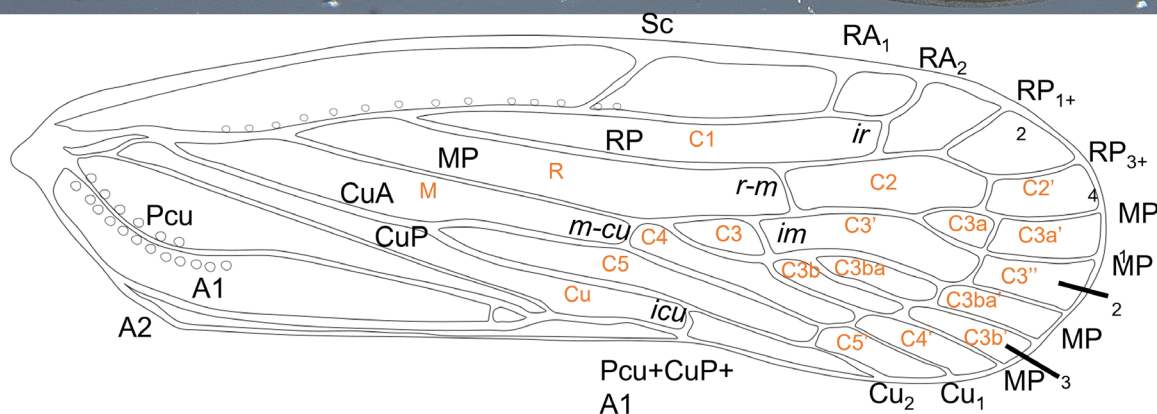
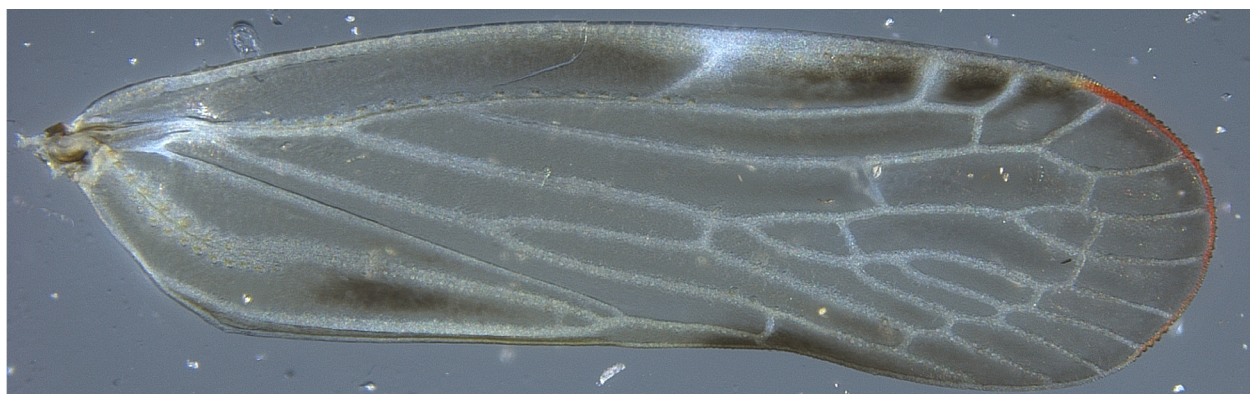


FIGURE 3. Forewing venation of *Oropuna halo* sp. n.; black = vein, italics = crossvein, orange = cell.

Plant associations. Palms (Arecaceae). Collected by sweeping palm seedlings in understory of primary rainforest (approximately 70 m above sea level).

Distribution. Costa Rica (Heredia Province)

Etymology. The specific name is given in reference to the video game ‘Halo’ due to the resemblance of the aedeagus to the ‘needler’ from the game.

Material examined. Holotype male, “Costa Rica, Heredia Pr. / La Selva Biological Station / 21.VI.2019 / Coll.: B.W. Bahder, sweeping palms / Holotype *Oropuna halo* ♂” (FLREC). Paratypes: 2 males, 3 females, same data as holotype (FSCA).

TABLE 2. Biometric data for *Oropuna halo* sp. n.

Character	Male		Female	
	Range	Average \pm SE	Range	Average \pm SE
Body length, with wings	3.80–3.84	3.83 \pm 0.01	3.94–3.95	3.94 \pm 0.01
Body length, no wings	2.56–2.59	2.58 \pm 0.02	2.7–2.72	2.71 \pm 0.01
Forewing length	3.26–3.28	3.27 \pm 0.01	3.41–3.50	3.43 \pm 0.04
Vertex length	0.19–0.19	0.19 \pm 0.00	0.21–0.21	0.21 \pm 0.00
Vertex width, basal margin	0.37–0.37	0.37 \pm 0.00	0.42–0.42	0.42 \pm 0.00
Vertex width, distal margin	0.21–0.21	0.21 \pm 0.00	0.24–0.25	0.24 \pm 0.01
Pronotum length, midline	0.09–0.09	0.09 \pm 0.00	0.12–0.12	0.12 \pm 0.00
Mesonotum length, midline	0.70–0.70	0.70 \pm 0.00	0.90–0.90	0.90 \pm 0.00
Mesonotum width	0.81–0.81	0.81 \pm 0.00	0.91–0.91	0.91 \pm 0.00
Frons width, dorsal margin	0.24–0.24	0.24 \pm 0.00	0.26–0.26	0.26 \pm 0.00
Frons width, clypeal suture	0.29–0.29	0.29 \pm 0.00	0.31–0.31	0.31 \pm 0.00
Frons width, widest	0.32–0.32	0.32 \pm 0.00	0.34–0.34	0.34 \pm 0.00
Frons width, narrowest	0.24–0.24	0.24 \pm 0.00	0.25–0.25	0.25 \pm 0.00
Frons length, midline	0.57–0.57	0.57 \pm 0.00	0.59–0.59	0.59 \pm 0.00
Clypeus length	0.34–0.34	0.34 \pm 0.00	0.36–0.36	0.36 \pm 0.00

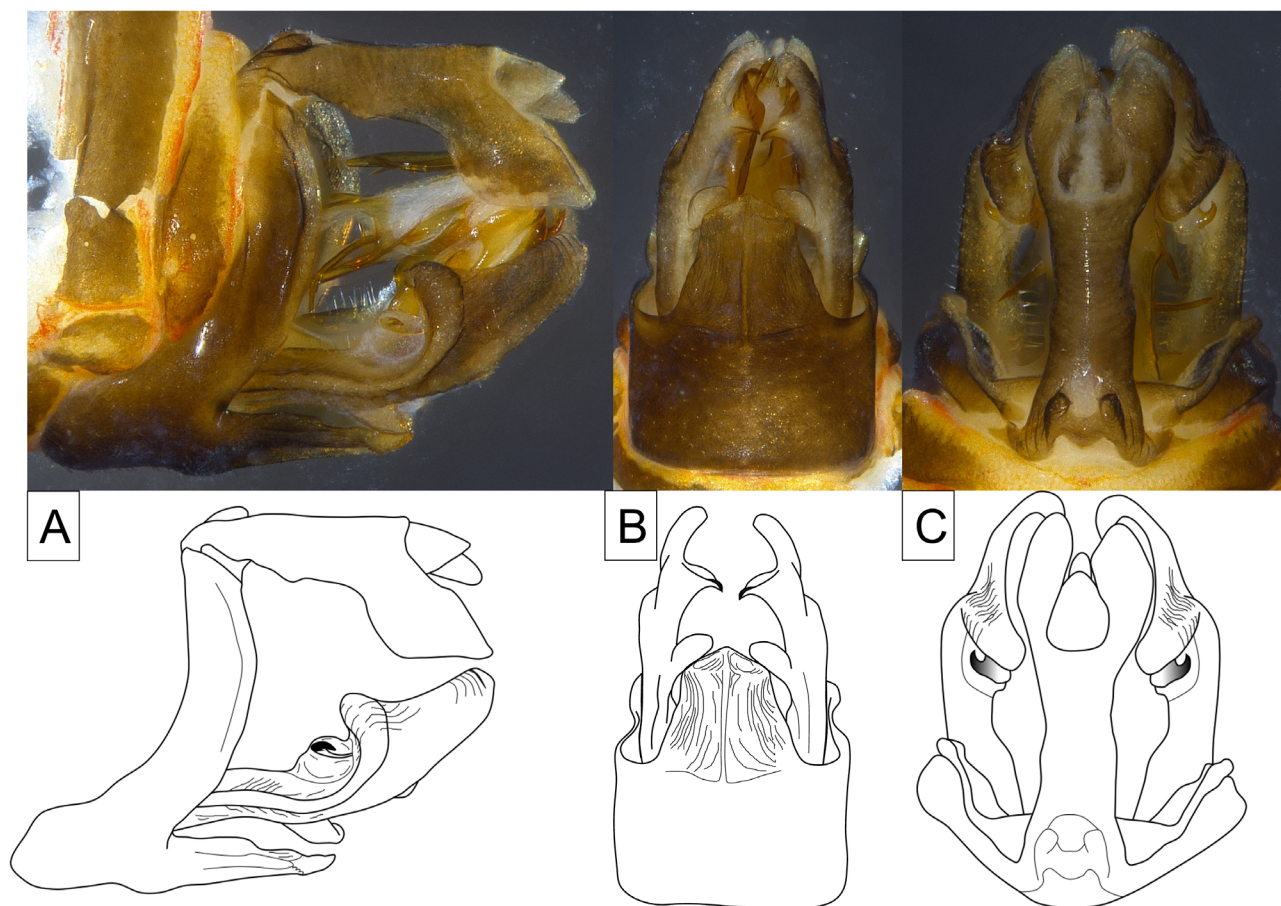


FIGURE 4. Male *Oropuna halo* sp. n. terminalia; (A) lateral view, (B) ventral view, and (C) dorsal view.

Other species examined. *Oropuna orba* (Fig. 8)—“Brasil // Typus // NHRS-GULI / 000041829”. *Oropuna minutiana* (Fig. 9)—“M.F.892 / B. Esperanza / XII-14-25Guat. // Phaciocephalus / Holotype / minutianus // JS-Caldwell / Collection / 1959”. *Oropuna fusca* (Fig. 10)—“Canal Zone: / Barro, / Colorado. / 19-VI 1924. / N. Banks. // M. C. Z. / Type / 22245 // Syntames / fusca / Det. Z.P.M. Met. // MCZ-ENT / 00022245”.

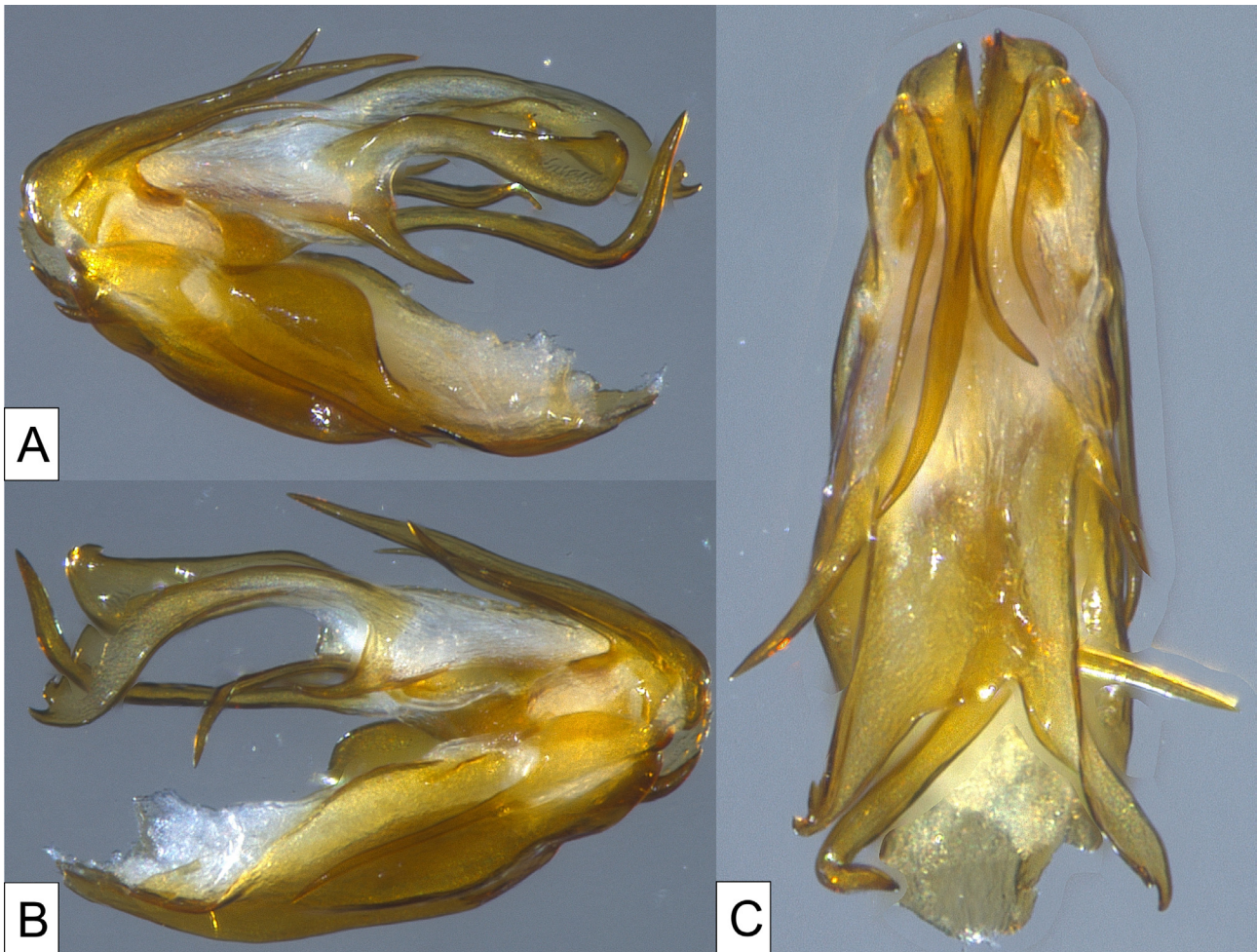


FIGURE 5. Aedeagus of *Oropuna halo* sp. n.; (A) right lateral view, (B) left lateral view, and (C) dorsal view.

Sequence data. For the COI locus, a 636 bp product was generated (GenBank Accession No. MZ836006) and for the 18S locus, a 1,363 bp product was generated (GenBank Accession No. MZ828126). Based on the phylogenetic analysis for COI, 18S, and the consensus tree, *Oropuna halo* sp. n. resolves closest to the genus *Herpis* (Fig. 7). The level of variability observed between *O. halo* sp. n. and *Herpis* (4.4%) is consistent with genus-level variability for 18S based on the pairwise comparison (Table 3). For the taxa analyzed, the average variability among genera was 5.9% (± 3.6). The average variability among species in the same genus is less than 1% for 18S (Table 3).

Remarks. *Oropuna halo* sp. n. can be diagnosed from *O. minutiana* most readily by the terminalia, especially that medioventral process of *O. halo* is broad, with a broadly triangular apex (broad and truncate in *O. minutiana*, elongately oval in *O. fusca*, males not known for *O. orba*), the anal tube is elongate and distally broad (short in *O. minutiana*, elongate but not as broad in *O. fusca*). The aedeagus in *O. halo* sp. n. is bilaterally asymmetrical and has a complex assortment of processes (fewer in *O. minutiana*, not yet examined in other species). For *Oropuna minutiana*, both Caldwell 1944 and Fennah 1952 both state that the aedeagus is symmetrical. *O. halo* sp. n. also has a reddish margin at the apex of the wing (absent in *O. minutiana*).

The terminalia of *Oropuna orba* are not described (and the type specimen is a female), however, that species is more deeply colored—with the wings almost entirely deep fuscus—with the distal wing margin and some veins reddish.

While material for the other species of *Oropuna* were not available for sequence analysis, the morphological characters described by Caldwell (1944) and Fennah (1952) support the placement of *Oropuna halo* sp. n. within *Oropuna*; based on the general form of the medioventral process of the pygofer, parameres, and shape of the frons. The size of the anal segment which in *O. minutiana* it is documented as being exceptionally small whereas *Oropuna halo* sp. n. has a relatively large anal segment, indicating that the size of the anal segment is not a useful genus level feature as stated by Fennah (1952). Furthermore, sequence analysis places the novel taxon sister to *Herpis* and not within any other cenchreine genus available for analysis.

The genus *Oropuna* appears closest to *Herpis* based on general morphology and based on DNA sequence analyses. The distinguishing characters for *Oropuna* (relative to *Herpis*) are lacking the median carina on the frons that is present in *Herpis* and the presence of two pairs of projections on the inner margins of the parameres in ventral view, whereas *Herpis* only has one pair.

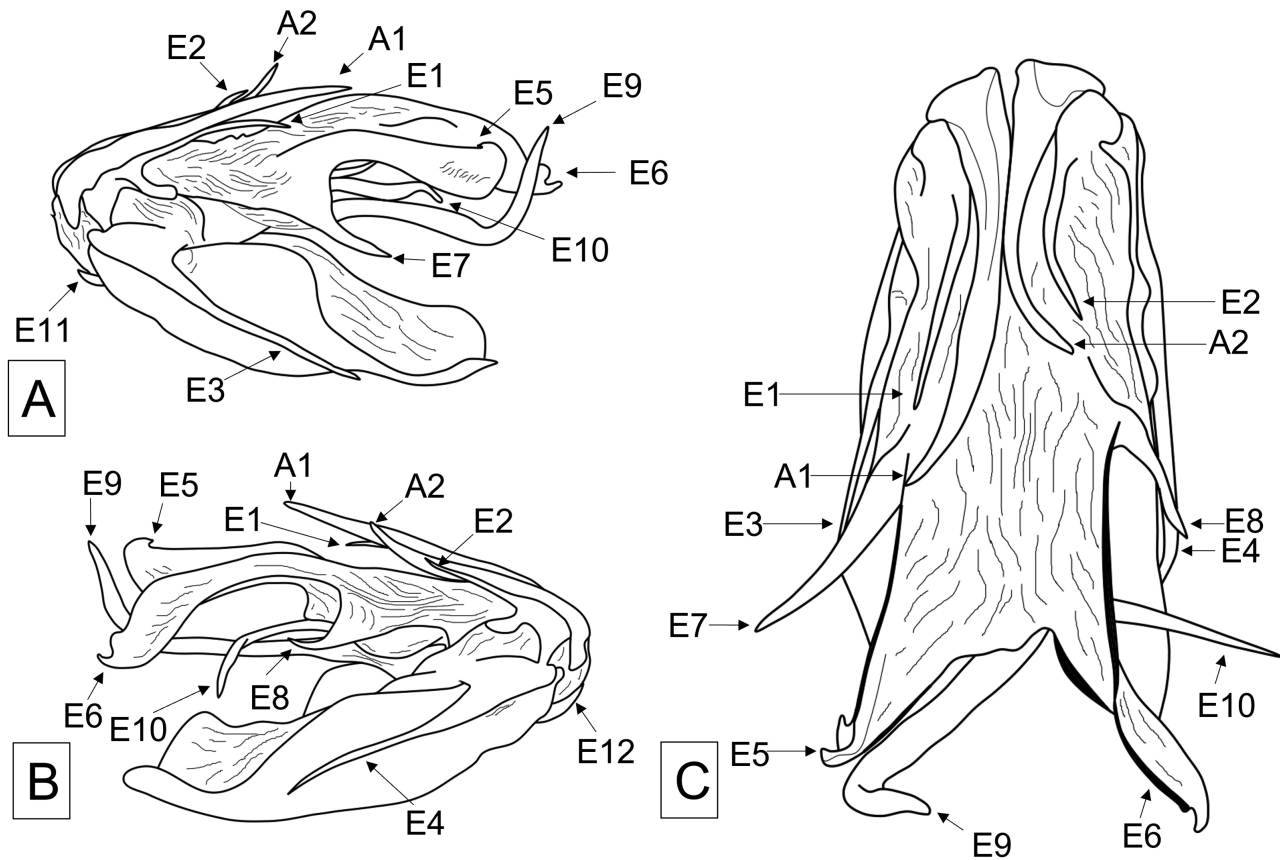


FIGURE 6. Line art for the aedeagus of *Oropuna halo* sp. n.; (A) right lateral view, (B) left lateral view, and (C) dorsal view, E = endosoma structures, A = aedeagal structures.

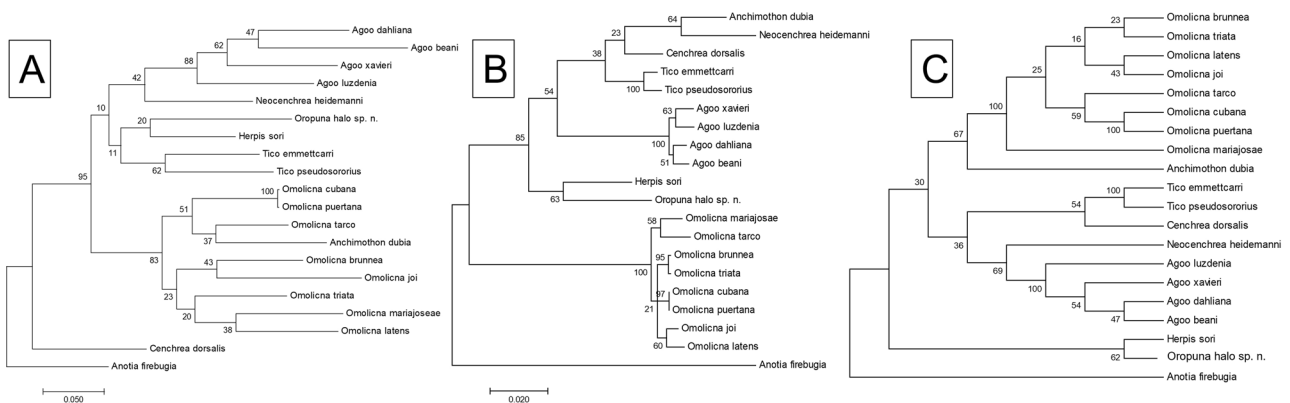


FIGURE 7. Maximum Likelihood phylogenetic trees (1,000 replicates) for currently available cenchreine planthoppers with *Anotia firebugia* as outgroup; (A) COI, (B) 18S, and (C) bootstrap consensus tree for concatenated COI and 18S data.

TABLE 3. Pairwise comparison for the 18S gene based on 1,000 bootstrap replications using the p-distance method; numbers on bottom left=percent difference, numbers in upper right=standard error.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 <i>Oropuna halo sp. n.</i>		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
2 <i>Herpis soros</i>	0.04		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
3 <i>Agoo xavieri</i>	0.07	0.06		0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4 <i>Agoo dahliana</i>	0.07	0.06	0.01		0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
5 <i>Agoo luzdenia</i>	0.07	0.06	0.01	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
6 <i>Omoligna brunnea</i>	0.09	0.08	0.09	0.09	0.09		0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
7 <i>Omoligna cubana</i>	0.09	0.08	0.10	0.09	0.10	0.01		0.00	0.01	0.01	0.01	0.01	0.01	0.01
8 <i>Omoligna triata</i>	0.09	0.08	0.09	0.09	0.09	0.00	0.01		0.01	0.01	0.01	0.01	0.01	0.01
9 <i>Cenchrea dorsalis</i>	0.05	0.05	0.06	0.06	0.06	0.09	0.09	0.09		0.00	0.01	0.01	0.01	0.01
10 <i>Anchimothon dubia</i>	0.06	0.06	0.07	0.06	0.07	0.09	0.09	0.09	0.04		0.01	0.01	0.01	0.01
11 <i>Neocenchrea heidemanni</i>	0.07	0.06	0.05	0.05	0.05	0.09	0.09	0.09	0.04	0.04		0.01	0.01	0.01
12 <i>Tico emmettcarri</i>	0.05	0.05	0.05	0.05	0.05	0.09	0.09	0.09	0.03	0.05	0.06		0.00	0.01
13 <i>Tico pseudosororius</i>	0.05	0.05	0.05	0.06	0.05	0.09	0.09	0.09	0.03	0.05	0.06	0.01		0.01
14 <i>Anotia firebugia</i>	0.13	0.12	0.13	0.13	0.13	0.14	0.14	0.14	0.12	0.12	0.13	0.14	0.14	

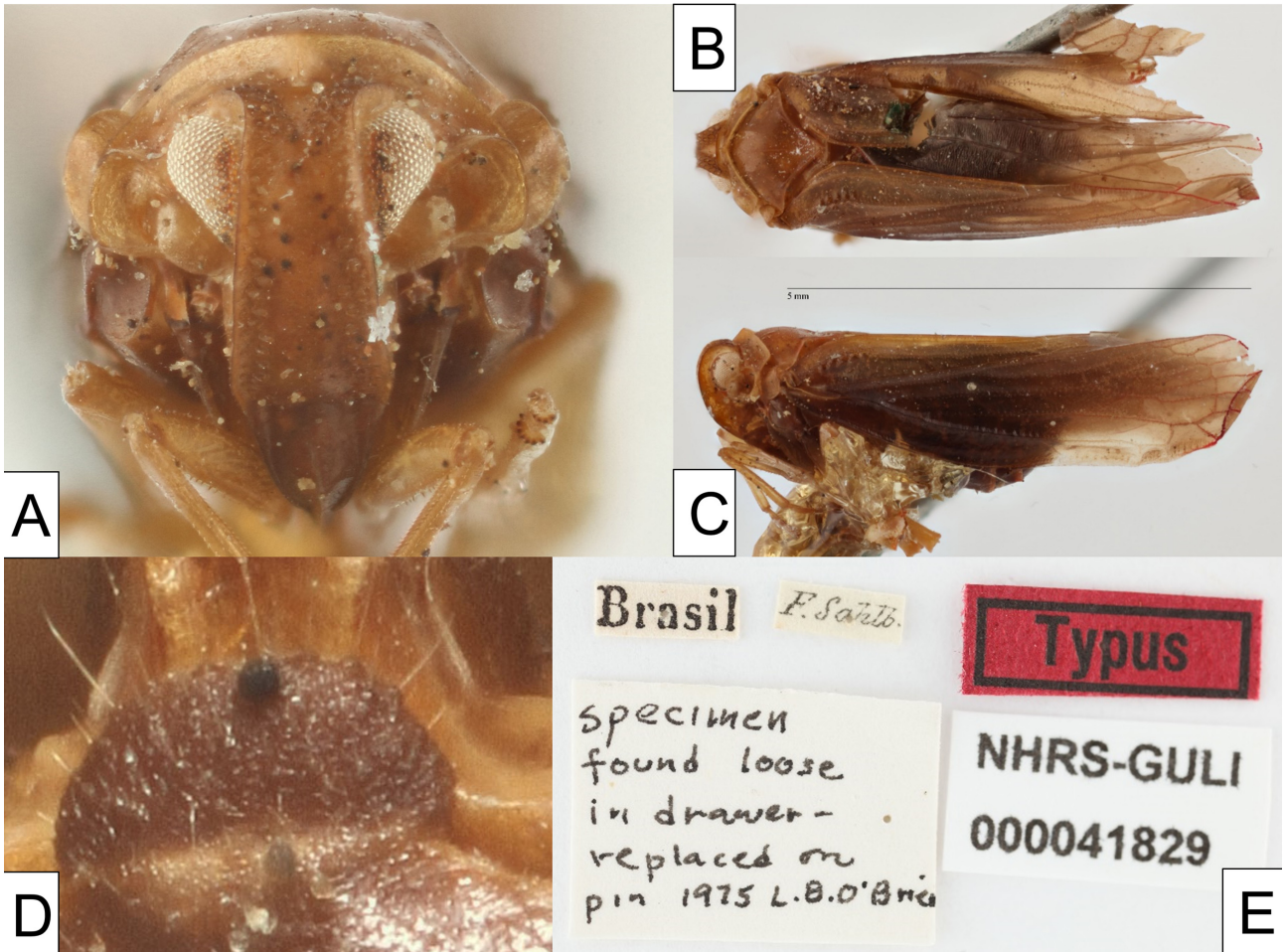


FIGURE 8. Holotype of *Phaciocephalus orba* (now *Oropuna orba*); (A) frontal view of head, (B) dorsal view of body, (C) lateral view of body, (D) female pregenital plate, and (E) labels.

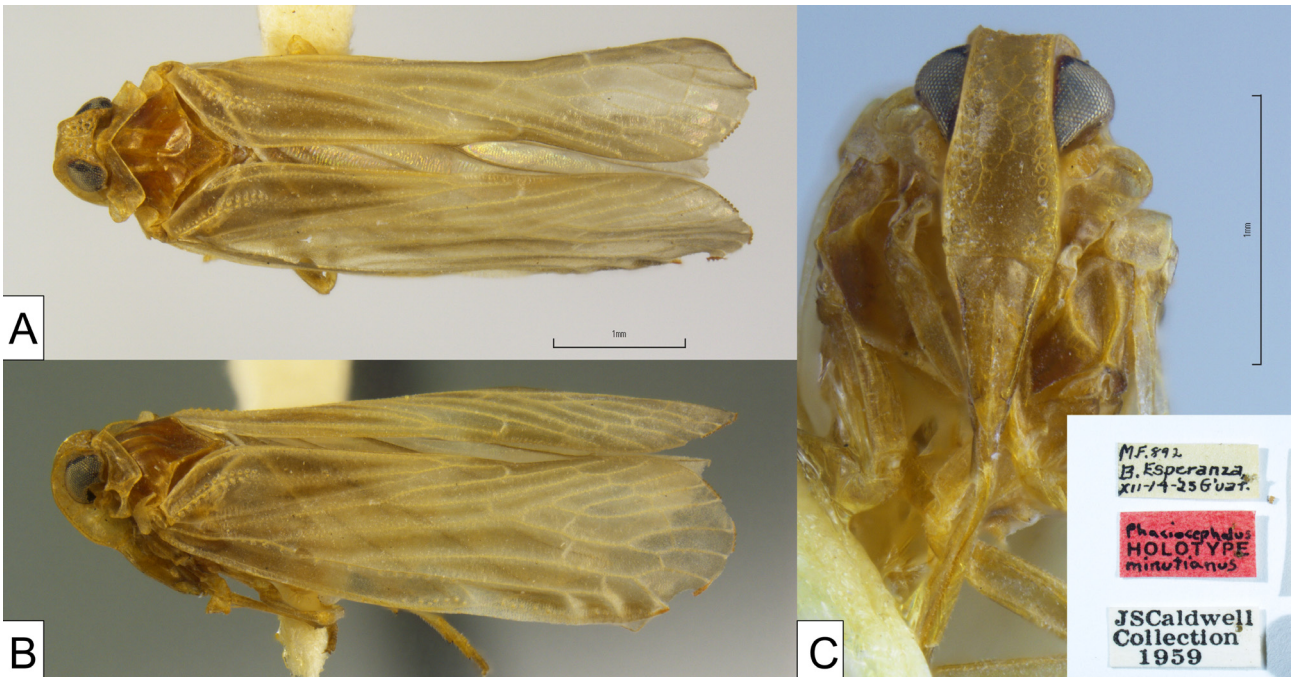


FIGURE 9. Holotype of *Oropuna minutiana*; (A) dorsal view, (B) lateral view and (C) frontal view of head.



FIGURE 10. Holotype of *Oropuna fusca*; (A) head frontal view, (B) lateral view, (C) dorsal view and (D) ventral view of male terminalia (Harvard University, Cambridge MA; ©President and Fellows of Harvard College, used by permission).

Discussion

The discovery of a species of *Oropuna* associated with palms indicates that about half of the new World Cenchreini have palm associates, viz. *Agoo* (Bahder *et al.* 2019), *Herpis* (Bahder *et al.* in review), *Omolicna* (Wilson *et al.* 2014), *Tico* (Bahder *et al.* 2020) and *Oropuna* (this work). The remaining New World cenchreine genera (*Anchimothon* Fennah, *Cenanges* Fennah, *Cenchrea* Westwood, *Contigucephalus* Caldwell, *Neocenchrea* Metcalf, and *Persis* Stål) have not yet been encountered directly associated with palms. We exclude *Phaciocephalus* Kirkaldy in this list because we believe the genus to be entirely Old World (See Bahder *et al.* 2021).

The new sequence data from *Oropuna* helps provide insight into the phylogeny of the Cenchreini. The concatenated COI and 18S data indicate that *Herpis* + *Oropuna* represent a clade that is sister to the remaining Cenchreini. The presence of *Herpis* near the base of the tree might be expected as the absence of a median carina of the frons is derived in derbids (Emeljanov 1996, Emeljanov & Shcherbakov 2020). Possibly, within the Cenchreini, the more derived taxa possess a more narrowed frons (e.g., the concave disc of frons and vertex). The phylogenetic relationships among the Cenchreini will require additional molecular data to stabilize the tree backbone, additional taxon sampling, and possibly additional outgroups - such as *Cedochrusa* Emeljanov or *Cedochrea* Emeljanov, within the Cedochreini, reputed to be closely related to the Cenchreini (Emeljanov 1996, Emeljanov & Shcherbakov 2020). Also, the question of the relationships between New World and Old World Cenchreini remains to be addressed.

Based on currently recognized morphological characters that appear consistent for *Oropuna*, the movement of other taxa into *Oropuna* has brought the genus to four species; *O. halo* **sp. n.**, *O. minutiana*, *O. orba*, and *O. fusca*. In future survey efforts, fresh male specimens of *O. minutiana*, *O. orba*, and *O. serrata* will be sought to further establish the genetic variability of the genus and test phylogenetic trends discussed in this study.

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