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A new species of planthopper in the genus *Platocerella* (Hemiptera: Auchenorrhyncha: Derbidae) from palms in Costa Rica, a key to the genus and an updated molecular phylogeny of available New World Otiocerinae

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Abstract

The genus *Platocerella* is a monotypic otiocerine genus (Derbidae: Otiocerinae: Otiocerini) reported from Guyana. A new species of *Platocerella* associated with palms is herein described from Costa Rica. Molecular data for the barcoding region cytochrome *c* oxidase subunit I (COI), 18S rRNA gene, and D9-D10 expansion region of the 28S rRNA gene is provided to produce a preliminary phylogenetic tree including the new species and related taxa to place the new species relative to other otiocerine planthoppers.

Key Words: taxonomy, phylogeny, biodiversity, systematics, survey

Resumen

El género *Platocerella* es un género monotípico de otiocerine (Derbidae: Otiocerinae: Otiocerini) reportado en Guyana. En este documento, se describe una nueva especie de *Platocerella* asociada a palmeras en Costa Rica. Se proporcionan datos moleculares para la región del código de barras de la subunidad I del gen del citocromo c oxidasa (COI), el gen 18S ARNr y la región de expansión D9-D10 del gen 28S ARNr, con el fin de elaborar un árbol filogenético preliminar que incluya la nueva especie y los taxones relacionados, para así ubicar a la nueva especie en relación con otras chicharritas del género otiocerine.

Palabras Clave: taxonomía, filogenis, biodiversidad, sistemática, encuesta

Introduction

The genus *Platocerella* Fennah, 1952 is a monotypic genus established as a segregate out of *Platocera* Muir, 1913 (Fennah 1952). At the time, *Platocera* consisted of five species, two from Indonesia (*P. annulipes* Muir, 1913, the type species, and *P. nigrifrons* Muir 1913), one from Taiwan (*P. albipennis* Muir 1915) one from South Africa (*P.*

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africana Muir 1928) and *P. rubicunda* Muir, 1918, from Guyana (Metcalf 1945). *Platocera albipennis* has since been transferred to *Pepleuca* Emeljanov, 1999, *Platocera calypso* Fennah, 1956 described from Palau, *Platocera demariste* Fennah, 1970 described from the Solomon Islands, and *Platocera achilles* (Fennah 1956) from Palau transferred into the genus from *Heronax* Kirkaldy, 1906 (Fennah 1956, 1970, 1971, Emeljanov 1999, Bourgoin 2024).

Platocerella was established for the Guyanian species *Platocera rubicunda*. Fennah (1952) distinguished *Platocerella* by the frons (lateral view) closely following the anterior margin of the eyes instead of being strongly produced as in *Platocera* (e.g. Muir 1913, pl. 2, fig. 9). Other diagnostic features given are that *Platocerella* has 'five sectors' of the media in the forewing and the vertex was short and 'not ascending (i.e., in lateral view, the profile of the head was not inclined from the posterior to anterior margin of the head), versus four sectors (Muir 1913, pl. 3, fig. 3) and with the head inclined (Fennah 1952). Fennah (1952) distinguished *Platocerella* from *Platonax* Metcalf, 1938 with the latter having the frons semicircular profile (e.g., Bartlett & Hoch 2023, fig 5f), the antennae flattened (e.g., Bartlett & Hoch 2023, fig 4), and the laterodorsal angles of the pygofer not being produced (Bartlett & Hoch 2023, fig 4a, vs produced in *Platocerella,* viz. Fennah 1952, fig. 35c).

Here we describe a second species of *Platocerella* collected on palms along trails at La Selva Biological Station, Costa Rica. The novel taxon is described with supplemental molecular data to evaluate its relationship among other available otiocerine planthoppers. A key to the species of *Platocerella* is provided.

Materials and Methods

Locality and specimen collection. Individuals of the novel taxon were swept from palms along trails and were immediately transferred to 95% ethanol. Specimens were collected (permit no. SINAC-ACTo-GASPPNI-016-2018) at La Selva Biological Station from 20-V-2018 to 22-V-2018, 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 were photographed and generated using the LAS Core Software v4.12. Voucher specimens, including primary types of the new species, are deposited at the University of Florida—Fort Lauderdale Research and Education Center (FLREC) in Davie, FL, U.S.A.

Morphological terminology and identification. Morphological terminology generally follows that of Bartlett *et al*. (2014), except forewing venation following Bourgoin *et al*. (2015) and with male terminalia nomenclature modified after Bourgoin (1988) and Bourgoin & Huang (1990). New taxa are intended to be attributed to Bahder & Bartlett.

Dissections and DNA extraction. The male terminalia that was dissected for morphological examination was photographed and subsequently 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.

PCR parameters, sequence data, and analysis. Primers used to amplify the barcoding region (5' half) of the cytochrome *c* oxidase subunit I (COI) gene, 18S rRNA gene and D9-D10 expansion region of 28S are presented in Table 1. PCR reactions contained 5x GoTaq Flexi Buffer, 25 mM $MgCl_2$, 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 dH_20 to a final volume of 25 µL. Thermal cycling conditions were as follows: 2 min initial denaturation at 95°C, followed by 35 cycles of 30-sec denaturation at 95°C, 30-sec annealing, extension at 72°C, followed by a 5 min extension at 72°C. Annealing temperatures and extension times for corresponding primers/loci are presented in Table 1. PCR product was run on a 2% agarose gel stained with GelRed (Biotium) amplicons of the appropriate size and were purified using the Exo-SAP-IT™ PCR Product Cleanup Reagent (ThermoFisher Scientific, Waltham, Massachusetts, USA). The purified PCR product was quantified using a NanoDropLite spectrophotometer (ThermoFisher Scientific, Waltham, Massachusetts, USA) and sent for sequencing at Eurofins Scientific (Louisville, KY, USA). Contiguous files were assembled using DNA Baser (Version 4.36) (Heracle BioSoft SRL, Pitesti, Romania), and aligned using Clustal*W* as part of the package MEGA7 (Kumar *et al.* 2016). Maximum Likelihood trees were generated using the

Bootstrap method at 1,000 replicates based on the Tamura-Nei model for all loci separately as well as one based on concatenated data forming a consensus tree on concatenated COI, 18S and 28S sequence data using MEGA7 (Kumar *et al.* 2016).

TABLE 1. Primers used to amplify loci used for assessment of *Shellenius serratus* **sp. nov.** and corresponding annealing temperatures and extension times.

Primer Name	Gene	Sequence (5'→3')	Annealing	Extension	Reference
LCO1490	COI	GGTCAACAAATCATAAAGATATTG	40˚C	1 min. 30	Folmer *et*
HCO2198		TCAGGGTGACCAAAAAAATCA		sec.	*al.* 1994
18SACDN_F1	18S	AGAGGGAGCCTGAGAAACG	60˚C	1 min. 45	Bahder *et*
18SACDN_R1		GGGCAGGGACGTAATCAAC		sec.	*al.* 2023
V/Forward	28S	GTAGCCAAATGCCTCGTCA	55°C	1 min. 30	Cryan *et al.*
X/Reverse		CACAATGATAGGAAGAGCC		sec.	2000

Taxon sampling. Molecular sampling consisted of 8 genera and 12 species of Otiocerinae, rooted by *Omolicna* Fennah (Derbinae: Cenchreini) (Table 2). The Otiocerinae consists of five genera and eight species of Otiocerini (2 species of *Anotia* Kirby, *Cobacella palmensis* Bahder & Bartlett, *Sayiana sayi* (Ball), three species of *Shellenius* Ball, and the new species of *Platocerella*), two genera and species of Sikianini (*Mula resonans* Ball and *Sikaiana harti* (Metcalf)), one genus (*Patara* Westwood) and two species of Patarini. There was no molecular data attributed to *Platocerella* in GenBank or BOLD.

TABLE 2. Representative Otiocerinae used for molecular comparisons with *Platocerella sordida* **sp. nov.**; *Omolicna joi* as subfamily outgroup (Derbinae).

	Locus		
Species	COI	18S	28S
Anotia cerebro	OR418164	OR419691	OR050637
Anotia firebugia	MT084365	MT945942	OR050636
Cobacella palmensis	OR044883	OR041765	OR050628
Mula resonans	OQ473376	OQ519977	OR050635
Omolicna joi	KF472312	MN472753	PP379272
Patara cooki	MW332651	MW333024	OR050634
Patara vanduzei	OQ473377	OQ519977	OR050633
Platocerella sordida **sp. nov.**	PP693304	PP693427	PP693428
Sayiana sayi	OR044884	OR041766	OR050632
Shellenius ballii	OQ473378	OQ519976	OR050631
Shellenius schellenbergii	OQ473379	OQ519975	OR050630
Shellenius serratus	OQ473380	OQ519974	OR050629
Sikaiana harti	OR418165	OR419691	OR419689

Systematics

Family Derbidae Spinola 1839

Subfamily Otiocerinae Muir 1917

Tribe Otiocerini Muir 1917

Genus *Platocerella* Fennah, 1952

Type species: *Platocera rubicundum* Muir, 1918 by original designation (spelling corrected to *Platocera rubicunda* in Metcalf 1945: 195).

Species composition

Platocerella rubicunda (Muir, 1918) (Fig. 35 in Fennah 1952)—Guyana.
Platocerella sordida **sp. nov.**—Costa Rica

Amended diagnosis (revised from Fennah 1952). Vertex small (in dorsal view), triangular; face with lateral carinae of frons closely appressed, frontoclypeal suture slightly convex; in lateral view head rounded, following the anterior margin of eyes. Eyes reniform, not deeply excavate. Antennae elongated, well exceeding anterior margin of head, antennal appendage absent; scape very short, pedicle elongated (surpassing anterior margin of head), subcylidrical, flagellum inserted apically. apically. Pronotum very narrow medially (in dorsal view), broadened laterally, posterior margin deeply angulately excavate. Mesonotum (lateral view) moderately convex, tricarinate. Forewing elongate, spatulate; composite vein ScP+R+MP forming common stem distad of basal cell, RP+MP forked from SC+RA a little basad of fusion of Pcu+A1 in clavus; RP forked from MP near wing midlength; composite vein Pcu+A1 reaching CuP before wing margin; branching pattern RA 2-branched, RP 3-branched, MP 8-branched, and CuA 2-branched, anastomosed to form closed C5 (procubital) cell. Pygofer with laterodorsal margin angulately produced, medioventral process present or absent. Gonostyli rather elongate, subspatulate, with shallow, dorsal lobe basally with many robust setae and more distal short, stout curved spines. Anal segment of male (lateral view) elongate, narrow, distally downcurved.

FIGURE 1. Habitat and locality of *Platocerella sordida* **sp. nov.**

***Platocerella sordida* Bahder & Bartlett sp. nov.**
(Figures 2–6)

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

Diagnosis. Medium-sized planthopper, body pale with light brown wash, wings transparent with fuscous mottling. Basal quarter of forewing costal vein bearing conspicuous sensory pits (appearing serrate). Lateral margin of pygofer bearing large dorsolateral projection, medioventral process absent. Gonostyli strongly sinuate on inner margin, distal sinuation appearing "beak-like", basal sinuation rounded. Aedeagus simple with complex flagellum bearing three large processes arising along dorsal margin and single, small process arising on right lateral side.

Description. *Color*. General body color ivory-white with extensive light brown wash, carinae and posterior margin of mesonotum pale; wings transparent, veins white, irregular fuscous mottling.

FIGURE 2. Adult male habitus of *Platocerella sordida* **sp. nov.**; A) dorsal view and B) lateral view; scale bar = 1 mm.

Structure. Body length (including wings) males: 6.5 mm (n = 3) (Table 3). Head. In dorsal view, much narrower than pronotum. Vertex short (Fig. 3A, about as long at midlength as wide at posterior margin), roughly elongately triangular; anterior margin rounded with distinct median inflection, posterior margin deeply concave (Fig. 3A) lateral margins of vertex foliate (disc depressed) and sinuate, anteriorly converging, bearing sensory pits;; in lateral view, vertex rounded, raised slightly above head, fastigium rounded to frons, becoming linear near anterior to eye, curved at frontoclypeal suture (Fig. 3B); in frontal view, lateral margins of frons contiguous from at dorsal margin to just above frontoclypeal suture, bearing row of sensory pits (Fig. 3C). Eyes round, emarginate near antennae; ocelli

absent. Antennae (Fig. 3) elongate, extending beyond margin of head; scape short, ringlike; pedicle subcylindrical (somewhat laterally compressed near midlength), antennal appendage absent, flagellum setaceous with bulbous base, arising apically.

TABLE 3. Biometric data for *Platocerella sordida* **sp. nov.** (in mm)

Character	Male (*n*=3)
Body length with wings	6.71
Body length without wings	2.82
Forewing length	5.92
Vertex length	0.25
Vertex width—basal	0.26
Vertex width—distal	0.18
Pronotum length—midline	0.02
Mesonotum length—midline	0.80
Mesonotum width	0.94
Frons length	0.75
Frons width—dorsal	0.10
Frons width—frontoclypeal	0.22
Clypeus length	0.63

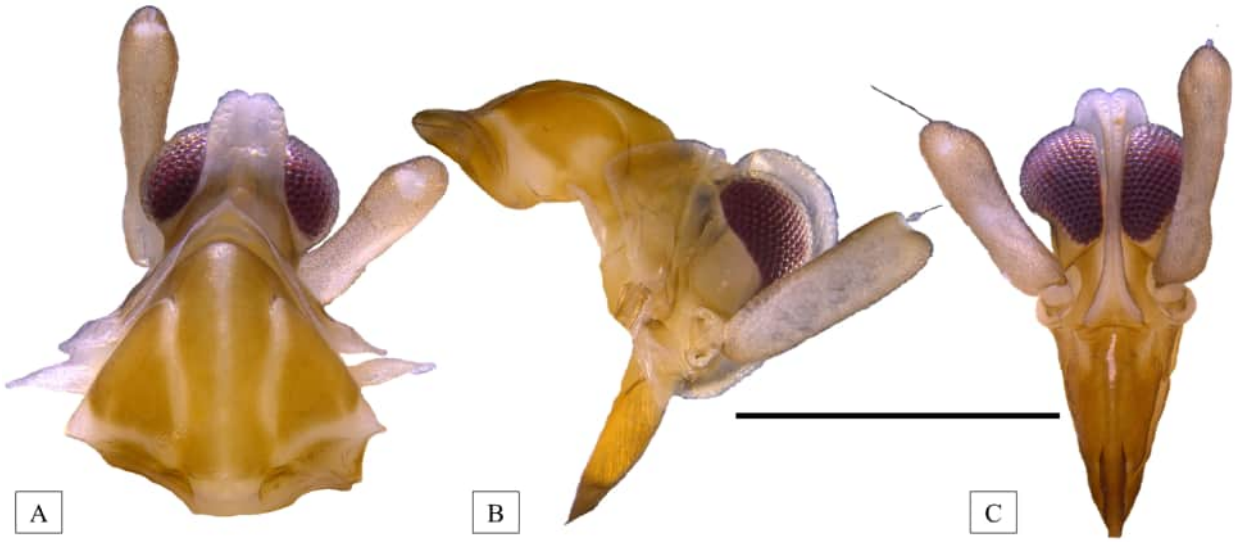

FIGURE 3. Adult male of *Platocerella sordida* **sp. nov.**; A) dorsal view of head, pronotum and mesonotum, B) lateral view of head, pronotum and mesonotum and C) frontal view of head; scale bar = 1 mm.

Thorax. Pronotum in dorsal view very narrow medially (wider laterally), anterior margin strongly convex, posterior margin deeply concave, lateral margins flared anteriorly, irregularly sinuate (Fig. 3A); in lateral view, medially inclined anteriorly (Fig. 3B); paradiscal region widest near tegula, narrowing ventrad to rounded apex near level of antennae. Mesonotum tricarinate (dorsal view, Fig. 3A), median carina nearly obsolete, lateral carinae arising on lateral margins, sinuate and converging posteriorly to nearly meet posterior margin; in lateral view (Fig. 3B), moderately arched.

Forewing spatulate, bearing row of large, spinose tubercles on basal ¼ of costal vein; composite vein Sc+R+M extending in proximal quarter of remigium, then Sc+RA branched from RP+MP; RP branching from MP near wing midpoint (at level of SC fork from RA); inclavus Pcu fusing with A1 in distal quarter, with composite vein reaching CuP before wing margin (clavus open); branches of CuA anastomosing to form closed C5 (procubital) cell; branching pattern RA 2-branched, RP 3-branched, MP-branched, CuA 2-branched.

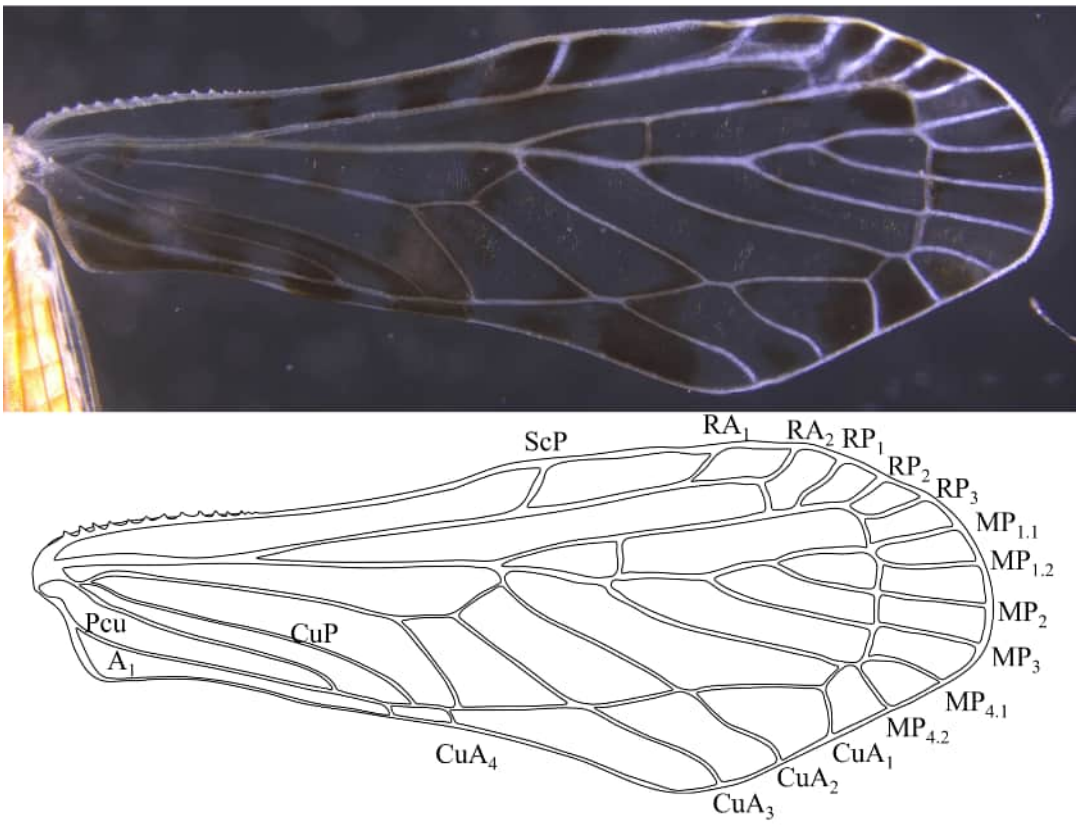

FIGURE 4. Forewing venation of *Platocerella sordida* **sp. nov.**; black text = vein and italic text = crossvein.

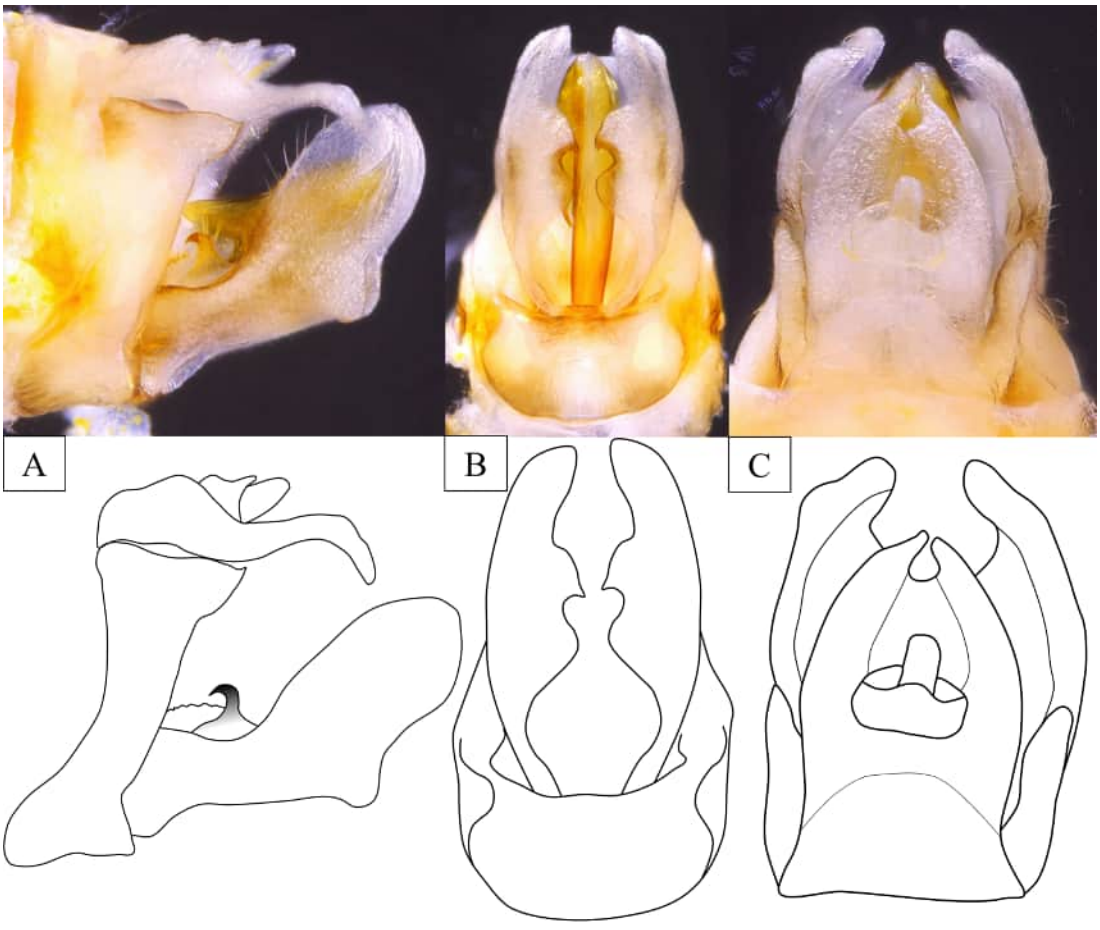

FIGURE 5. Adult male genitalia of *Platocerella sordida* **sp. nov.**; A) left lateral view, B) ventral view, and C) dorsal view.

Terminalia. Pygofer in lateral view narrow, widest subdorsally, narrowing ventrally, somewhat expanded at ventral margin; anterior margin concave, posterior margin diagonally linear except expanded slightly at ventral margin and strong subtriangular projection at laterodorsal margin (Fig. 5A). Gonostyli in lateral view elongated (exceeding anal tube) and spatulate, widest distally, constricted proximally, angled upward near midlength (bearing ventral knob at angle); apices rounded; dorsal margin concave, proximal bearing two processes, a dorsal setose lobe and more distal stout curved spine (Fig. 5A); in ventral view, outer margins smoothly arched, inner margins strongly sinuate, narrowest basally, expanding into large bilobed flange,, proximal lobe rounded, distal lobe appearing beak-like; apex acutely rounded (Fig. 5B). Aedegus simple, shaft upcurved, terete, devoid of ornamentation; endosome large and retrorse, bearing four processes; first process (E1) arising apically at midpoint on dorsal surface, angled (from dorsal view, Fig. 6C) to right lateral side, lobed basally, distally more sclerotized, gently curved mesad; second process (E2) a short spine arising at midpoint of left side (dorsal view) just ventral to E1; third process (E3) a small spine arising on right lateral side (dorsal view) just before base of E2; forth process (E4) arising from base of endosoma, forming large lobe, dorsally curved spine at apex. Anal segment in lateral view (Fig. 5A) narrow, of moderate length, not exceeding gonostyli, dorsal and ventral margins strongly sinuate, distally arched ventrad, apex acute; in dorsal view (Fig. 5C), anal tube broad, laterally rounded, apex emarginate; paraproct short and conical.

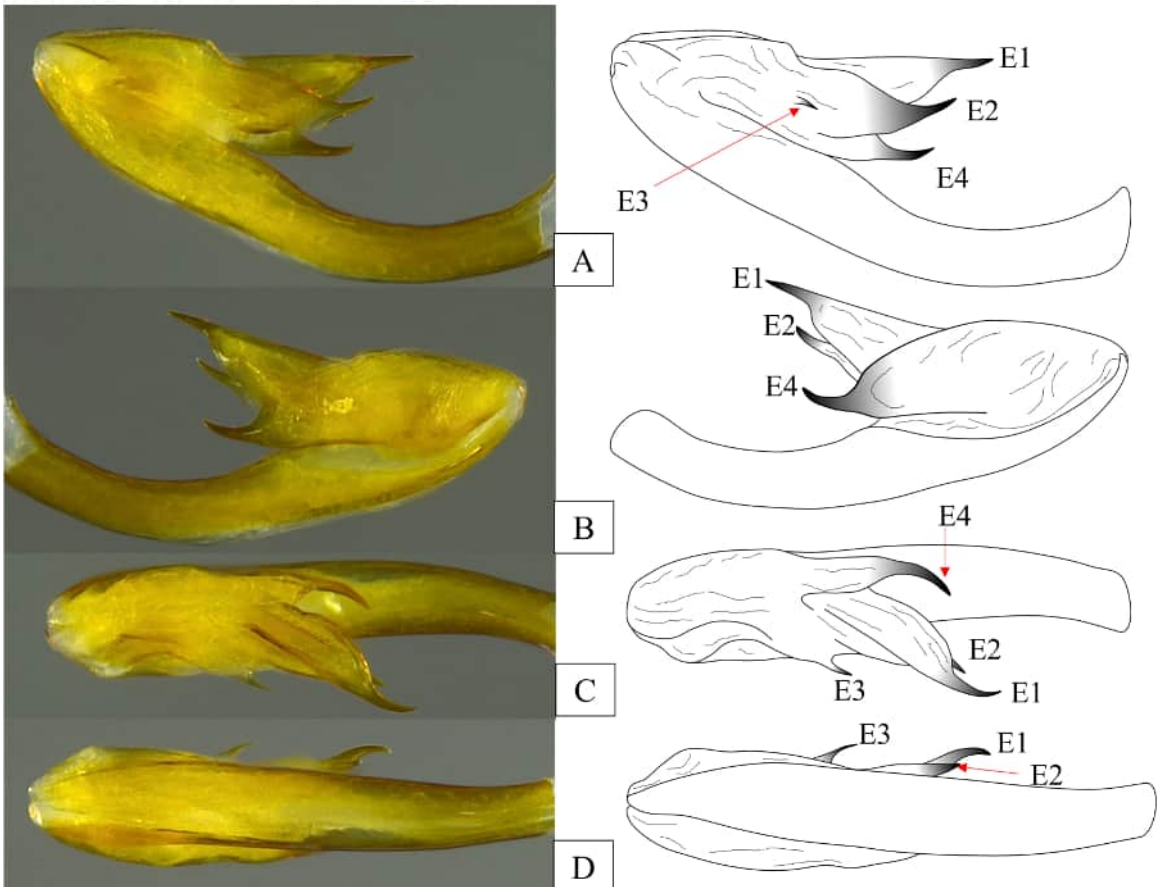

FIGURE 6. Aedeagus of *Platocerella sordida* **sp. nov.**; A) right lateral view, B) left lateral view, C) dorsal view, and D) ventral view.

Plant associations. *Asterogyne martiana* (H. Wendl.) H. Wendl. ex Hemsl. (Arecaceae).

Distribution. Heredia Province, Costa Rica.

Etymology. The specific name comes from the modern Latin word "*sordidus*" (dirty, filty), with the feminine termination *-a,* a reference to the dirty appearance of the species from the brown wash over the body and fuscous mottling of the wings.

Material examined. Holotype male "Costa Rica, Heredia Pr. / La Selva Biological Station / 12.V.2018, sweeping palms / Coll.: B.W.Bahder // Holotype / *Platocerella sordida* ♂ /" (FLREC); Paratypes same as holotype (2 males, FLREC).

Sequence Data. For *Platocerella sordida* **sp. nov.**, a 569 bp product was generated for the COI gene, a 1,096 bp product was generated for the 18S gene and an 802 bp product was generated for the 28S gene. All GenBank accession numbers for taxa included in the molecular analyses are presented in Table 2. While sequence data was not available for *P. rubicunda* for comparison, *Platocerella sordada* **sp. nov.** resolved outside of all currently available otiocerine genera for all loci with varying degrees of support. For the 18S locus, there was moderate bootstrap support (68) for placement of *Platocerella sordida* **sp. nov.** adjacent to *Shellenius* and *Patara* (Fig. 7A) whereas *Platocerella sordida* **sp. nov.** resolved adjacent to *Sikaiana harti* and *Mula resonans* with strong bootstrap support (96) based on the 28S locus (Fig. 7B). Weak bootstrap support (70 and less) was seen at all nodes for the COI gene (Fig. 7C). The consensus tree showed strong bootstrap support (90) for placement of *Platocerella sordida* **sp. nov.** outside, but adjacent to, the clade formed by *Anotia* Kirby*, Sayiana* Ball, *Cobacella* Fennah, *Mula* Ball and *Sikaiana* Distant (Fig. 7D).

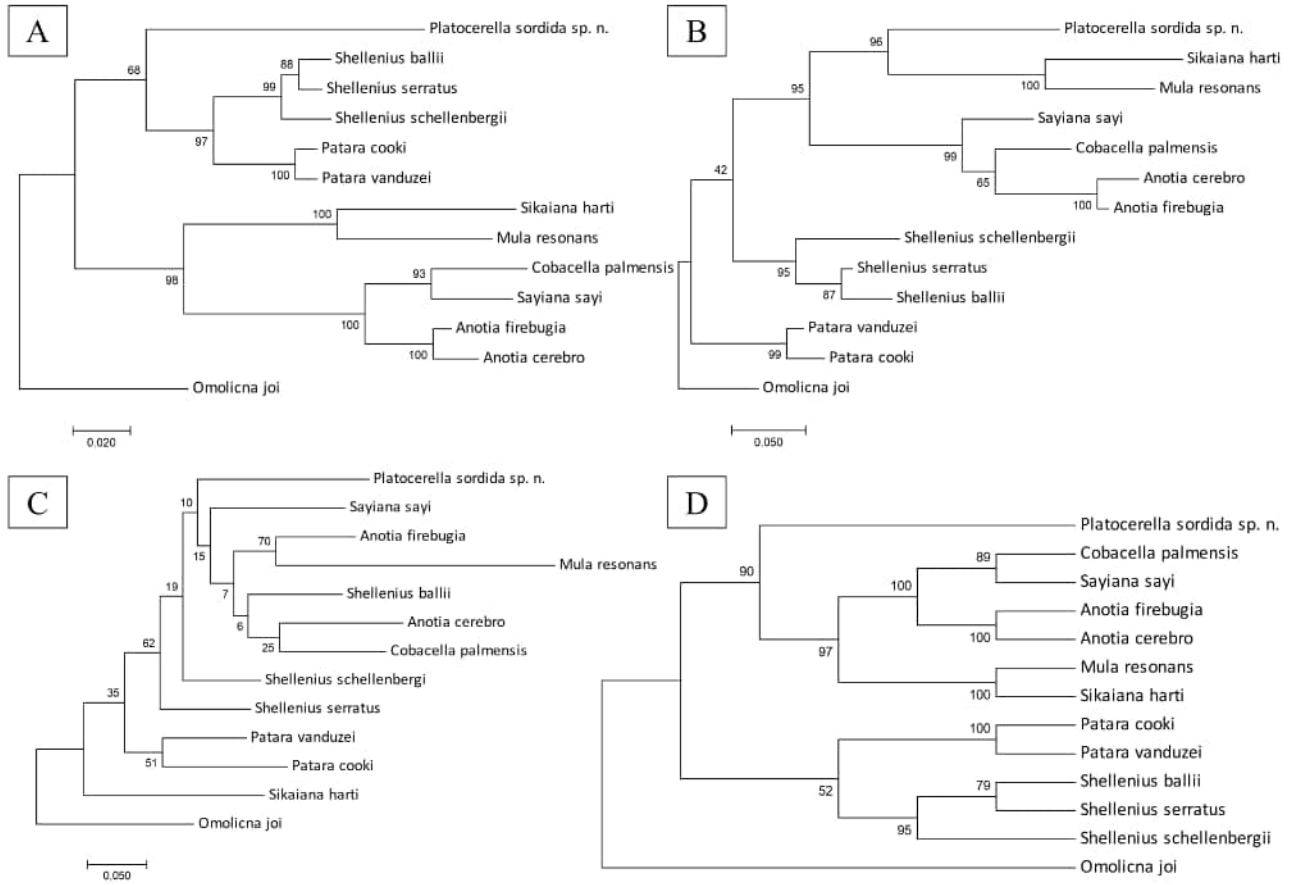

FIGURE 7. Maximum Likelihood phylogenetic trees based on 1000 replicates; A) 18S rRNA, B) D9-D10 expansion region of 28S rRNA, C) 5' region of COI, and D) consensus tree for concatenated sequence data for all three loci; scale bar = percent nucleotide difference.

Remarks. The novel taxon appears to fit the genus *Platocerella* overall. Some possible discrepancies between the new species and Fennah's (1952) description of *Platocerella* are that *P. rubicunda* appears to have more cylindrical antennae, possesses a medioventral lobe of the pygofer and *P. rubicunda* is described as fuscous with a red suffusion. It may also be meaningful that *P. rubicunda* is from northern South America instead of Mesoamerica. However, other features seem aligned between the two genea including the shape of the head, the lack of antennal appendage, and the male terminalia (viz. Fennah 1953, fig. 35), including the shape of the pygofer, gonostyli, aedeagus and anal tube, all appear similar between the two species and appear to support placement in the genus *Platocerella* rather erect a new genus. If molecular data from the type species could be obtained, this would provide a good test for the placement of the new species. An observation on iNaturalist (https://www.inaturalist.org/observations/214428017) appears to show a female specimen of *P. rubicunda* from French Guiana. While the head and antennae appear similar in form to *P. sordida* **sp. nov.**, the wings are substantially narrower in the specimen on iNaturalist. While

it is possible the novel taxon could be placed in a new genus, the similarities in terminalia to the description and similarities to the head and antennae of the specimen online (assuming the specimen on iNaturalist is *P. rubicunda*) and the lack of molecular comparisons, the genus *Platocerella* seemed the most appropriate genus for placement at this time.

The general habitus of *P. sordida* **sp. nov.** does appear more similar to the *Anotia*/*Sayiana*/*Cobacella*/*Mula*/*Sikaiana* group than it does to *Shellenius* or *Patara* so the phylogenies in general reflect this. However, while testing tribal features is beyond the scope of this study, the current status of Otiocerini appears polyphyletic and needs significant revision.

Key to species of *Platocerella* (males)

1. Body fuscous with red suffusion, fuscous forewings, medioventral process of pygofer present; British Guyana . . *P. rubicunda*
- Paler species with light brown wash, mottled wings; medioventral process of pygofer abset; Costa Rica . . *P. sordida* **sp. nov.**

Discussion

The discovery of a new species of derbid in a previously unrepresented genus in many taxonomic or phylogenetic studies is extremely valuable in that will allow to be generating a more accurate assessment of the tribal classification in the otiocerinae. Furthermore, the discovery of another species of derbid associated with palms further highlights the unique relationship between this group of insects and palms. Future efforts should seek to better characterize these more obscure genera (such as *Kubilaya*, *Labicerus*, and *Platonax*) and certainly provide molecular data to help further understand the diversity and evolution of this group of insects.

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