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A new species of *Omolicna* (Hemiptera: Auchenorrhyncha: Fulgoroidea: Derbidae) from coconut palm in Costa Rica and new country records for *Omolicna brunnea* and *Omolicna triata*

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Abstract

An ongoing survey for novel phytoplasmas and viruses that affect palms (Arecaceae) is being conducted in Costa Rica along with potential vectors. During that survey, a new species of derbid planthopper (Hemiptera: Fulgoroidea) in the genus *Omolicna* Fennah was detected from Heredia and Limón State and is here described as *Omolicna xavieri* sp. n. This new taxon was first found on declining coconut palms (*Cocos nucifera*) and subsequently on healthy coconut palms in Tortuguero National Park. Also, two additional species of *Omolicna*, *O. brunnea* and *O. triata*, were collected on coconut in the same habitat and represent new country records. There are no previously published records of *Omolicna* from Costa Rica. Sequence data for the cytochrome c oxidase subunit I (COI) and the 18S ribosomal RNA gene were obtained. In addition, novel 18S primers specific to auchenorrhynchan insects were developed and presented. The molecular data show high pairwise distances between *O. xavieri* sp. n. and other *Omolicna* species (24% to 31% and 10% using COI and 18S, respectively). Based on both morphological and sequence data, we erect and briefly describe the new subgenus *Agoo* for the new species to reflect the observed differences. A checklist of *Omolicna* species is presented.

Key words: Derbidae, Cenchreini, new species, Costa Rica, planthopper, survey, genetic diversity

Resumen

En Costa Rica se está llevando a cabo una investigación para detectar nuevos fitoplasmas y virus, así como sus posibles vectores, que afectan a las palmas (Arecaceae). Durante este estudio se descubrió una nueva especie de saltador de plantas perteneciente a la familia Derbidae (Hemiptera: Fulgoroidea) del género *Omolicna* Fennah en las provincias de Heredia y Limón y se describe aquí como *Omolicna xavieri* sp. n. Este nuevo taxón fue encontrado en cocoteras enfermas (*Cocos nucifera*) y, posteriormente, en cocoteras saludables en el Parque Nacional Tortuguero. Además, dos especies adicionales de *Omolicna*, *O. brunnea* y *O. triata*, fueron colectadas en cocoteras en el mismo hábitat y representan nuevos registros

para el país. No hay registros publicados de *Omolicna* para Costa Rica previos a este estudio. Se obtuvieron datos de secuencia para el citocromo c oxidasa de la subunidad I (COI) y para el gen del ARN ribosómico 18S. Además, se desarrollaron y se presentan en esta investigación nuevos iniciadores 18S específicos para insectos pertenecientes al suborden auchenorrhyncha.

Los datos moleculares muestran altas distancias entre pares de *O. xavieri* sp. n. y otras especies de *Omolicna* (del 24% al 31% y del 10% usando COI y 18S, respectivamente). Basándonos en las diferencias observadas entre los datos morfológicos y de secuencia, establecimos y describimos brevemente el nuevo subgénero *Agoo* para la nueva especie. Se presenta una lista de verificación para *Omolicna*.

Palabras clave: Derbidae, Cenchreini, nueva especie, Costa Rica, salta plantas, investigación, diversidad genética

Introduction

The derbid planthopper genus *Omolicna* Fennah is of concern as a potential vector of phytoplasmas in palms (e.g., Halbert *et al.* 2014, Silva *et al.* 2018). The genus is in the tribe Cenchreini, subfamily Derbinae (Fennah 1952, Emeljanov 1995), and consists of 21 species (O'Brien 1982, Halbert *et al.* 2014, Bourgoïn 2018). Halbert *et al.* (2014) provided a review of the genus including critical literature. A checklist of the currently described species and known distributions is provided in Table 1. The Cenchreini are 'cixiid-like' derbids (i.e., not highly modified), recognized by a foliate paranotal region of the pronotum that partially subtends the antennae, pits on the postcubital vein of the clavus and lateral pits on the vertex (O'Brien 1982, Emeljanov 1995, Halbert *et al.* 2014). Keys to the tribes of Derbidae were presented by Fennah (1952) and Emeljanov (1995), although these sources differ in tribal composition and definition. Keys to genera within Cenchreini are found in Fennah (1952) and revised by O'Brien (1982) for New World genera. Both Fennah (1952) and O'Brien (1982) included taxa subsequently removed from Cenchreini by Emeljanov (1992, 1995).

The most recent species described in *Omolicna* was *O. joi* Wilson, Halbert & Bextine (Halbert *et al.* 2014). This species was discovered in Florida on two native palm species—the cabbage palm (*Sabal palmetto* (Walter) Lodd. ex Schult. & Schult. f.) and the saw palmetto (*Serenoa repens* (W. Bartram) Small). *Omolicna joi* is considered a potential vector of the 16SrIV-D phytoplasma, the causal agent of lethal bronzing disease (LBD), also known as Texas Phoenix Palm Decline (TPPD) and Date Palm Lethal Decline (DPLD), as it was discovered investigating vectors for this disease (Harrison *et al.* 2008). Additionally, phytoplasmas belonging to the lethal yellowing group (16SrIV) were isolated from derbids in Jamaica (Brown *et al.* 2006). While evidence is lacking that derbids are competent vectors of 16SrIV phytoplasmas, the finding of this group of phytoplasmas in individuals from Jamaica and Florida has elicited concern over their ability to transmit these pathogens. Interestingly, little information is available on the life history of the genus *Omolicna*, and the cenchrini by extension. Detailed observations on behavior of species in the genus *Dawnarioides* and *Neodawnaria* are provided by O'Brien (1982) but there are no documents detailing factors such as oviposition, larval habits, life history, and host range. Given the diversity and economic potential of this group, these details would be valuable additions to future studies.

In 2017, a survey of declining palms was initiated to identify new phytoplasmas or expand host ranges of known 16SrIV subgroups in Costa Rica. In addition to sampling palms for phytoplasma, planthoppers found associated with declining palms were also collected. At one of the field sites with declining coconut palms (*Cocos nucifera* L.), planthoppers were found on the underside of the palm foliage and in the field, tentatively identified as derbids. Herein we describe this species as a new species of the genus *Omolicna* from Costa Rica. In addition, we report other species of *Omolicna* found in Costa Rica during these surveys. Molecular barcode data for cytochrome oxidase c subunit I (COI) and 18S data are provided for this new species as well as for other species reported herein.

Materials and methods

Locality and Specimen Collection. Individuals were aspirated from both declining palms and nearby healthy palms and were immediately transferred to 95% ethanol. Specimens were collected (permit no. SINAC-ACTo-GASPPNI-016-2018) near La Virgen de Sarapiquí, Heredia province, Costa Rica (10.422617, -84.123497) on

private property. Permission was obtained by the owner prior to sampling. Specimens were exported under permit number DGVS-256-2018 and imported into 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. The live image (Fig. 1) was taken by Stephen Cresswell using a Canon EOS 5D Mark II camera with a Canon 180 mm macro lens on an unknown plant. 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. Labels for type material printed with Country/Province/nearest location/collector/date/host//.

TABLE 1. Checklist of currently described *Omolicina* species with reported distribution.

Species	Distribution	References
<i>Omolicina anastomosis</i> (Caldwell, 1944)	Guatemala	Caldwell 1944, O'Brien 1982
<i>Omolicina brunnea</i> (McAtee, 1924)	Mexico (Vera Cruz), Panama, Guatemala	McAtee 1924, Caldwell 1994, Metcalf 1945, O'Brien 1982
<i>Omolicina cocoana</i> Rodriguez-Leon & Hidalgo-Gato, 2005	Cuba	Rodriguez-Leon & Hidalgo-Gato 2005
<i>Omolicina cubana</i> (Myers, 1926)	Cuba, Jamaica ¹ , Puerto Rico ²	Metcalf 1945, Fennah 1952, O'Brien 1982
<i>Omolicina dominicana</i> Fennah, 1952	Dominica	Fennah 1952, O'Brien 1982
<i>Omolicina dubia</i> (Caldwell, 1944)	Mexico (Chiapas)	Caldwell 1944
<i>Omolicina fulva</i> (Van Duzee, 1909)	Cuba, Panama ¹ , USA: FL	Metcalf 1945, Wilson & McPherson 1980a, O'Brien 1982, Bartlett <i>et al.</i> 2014, Halbert <i>et al.</i> 2014
<i>Omolicina joi</i> Wilson, Halbert & Bextine, 2014	USA: FL	Halbert <i>et al.</i> 2014
<i>Omolicina latens</i> Fennah, 1952	Trinidad	Fennah 1952, O'Brien 1982,
<i>Omolicina mcateei</i> (Dozier, 1928)	USA: FL, GA, MS, NC, TN	Caldwell 1944, Metcalf 1945, Wray 1967, Wilson & McPherson 1980a, O'Brien 1982, Gonzon <i>et al.</i> 2007, Bartlett <i>et al.</i> 2014, Halbert <i>et al.</i> 2014
<i>Omolicina nero</i> Fennah, 1971	Cayman Islands	Fennah 1971, O'Brien 1982
<i>Omolicina nigripennis</i> (Caldwell, 1944)	Mexico (Chiapas, Michoacán, Oaxaca, San Luis Potosi, Sinaloa, Vera Cruz), Guatemala, Brazil (Sergipe)	Caldwell 1944, O'Brien 1982, Bartlett <i>et al.</i> 2014, Silva <i>et al.</i> 2018
<i>Omolicina n. flavipennis</i> (Caldwell, 1944)	USA: TX, Mexico (Chiapas, Oaxaca, San Luis Potosi, Sinaloa, Vera Cruz), Guatemala	Caldwell 1944, O'Brien 1982
<i>Omolicina proxima</i> Fennah, 1945—type species	Trinidad, Venezuela	Fennah 1945, 1952; O'Brien 1982
<i>Omolicina puertana</i> Caldwell, 1951	Puerto Rico, Vieques Island, Virgin Islands (St. Thomas)	Caldwell & Martorell 1951, O'Brien 1982
<i>Omolicina puncta</i> (Caldwell, 1944)	Mexico (San Luis Potosi, Tamaulipas, Vera Cruz)	Caldwell 1944, O'Brien 1982
<i>Omolicina quadrispinosa</i> (Caldwell, 1944)	Mexico (Chiapas), Guatemala	Caldwell 1944, O'Brien 1982
<i>Omolicina rubrimarginata</i> Fennah, 1945	Trinidad	Fennah 1945, O'Brien 1982
<i>Omolicina tarco</i> Fennah, 1971	Cayman Islands	Fennah 1971, O'Brien 1982
<i>Omolicina texana</i> (Caldwell, 1944)	USA: TX	Caldwell 1944, O'Brien 1982, Bartlett <i>et al.</i> 2014

.....continued on the next page

TABLE 1. (Continued)

Species	Distribution	References
<i>Omolicna triata</i> (Caldwell, 1944)	Belize	Caldwell 1944, O'Brien 1982
<i>Omolicna uhleri</i> (Ball, 1902)	USA: AL, DC, GA, IL, KS, MD, MO, MS, NC, NJ, NY, OH, TN, VA; CAN: ON	Caldwell 1944, Metcalf 1945, Wilson & McPherson 1980a, O'Brien 1982, Paiero <i>et al.</i> 2003, Benton & McCreadie 2009, Bartlett <i>et al.</i> 2014

¹Needs verification²Reported as error by Caldwell & Martorell 1951

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

Dissections and DNA Extraction. The male genitalia that were dissected also served as the source of tissue for DNA extraction. The terminal end of the abdomens with genitalia were 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 genitalia were 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 genitalia 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. The cleared genitalia was then used for morphological characterization and photography.

**FIGURE 1.** *Omolicna xavieri* sp. n. by Stephen Cresswell (used by permission) at Monteverde, Costa Rica.

PCR Parameters and Sequence Data. To obtain COI sequence data, DNA template from specimens was amplified using the primers LCO1490 (5'-GGTCAACAAATCATAAAGATATTG-3') and HCO2198 (5'-TCAGGGTGACCAAAAAAATCA-3') (Folmer *et al.* 1994). To obtain 18S sequence data, custom primers were designed from data available in GenBank that represent 14 different families (Table 2). The resulting primer sequences were named 18S/Forward (5'-ACTGTCGATGGTAGGTTCTG-3') and 18S/Reverse (5'-GTCCGAAGACCTCACTAAA-3') and allowed for the amplification of a 1,493 bp product. PCR reactions

contained 5x GoTaQ Flexi Buffer, 25 mM MgCl₂, 10 mM dNTP's, 10 mM of each primer (for both COI and 18S reactions), 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: 5 min initial denaturation at 95°C, followed by 40 cycles of 1 min denaturation at 95°C, 30 sec annealing at 55°C, 1 min extension at 72°C, followed by a 5 min extension at 72°C. Thermal cycling conditions for 18S were as follows: 5 min initial denaturation at 95°C, followed by 40 cycles of 1 min denaturation at 95°C, 30 sec annealing at 59°C, 2 min extension at 72°C, followed by a 5 min extension at 72°C. All products were run on a 1.5% agarose gel stained with 1% GelRed (Biotium, Fremont, California, USA). 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 sent for sequencing at Eurofins Scientific (Louisville, KY, USA). Contiguous files were assembled using DNA Baser (Version 4.36) (Heracle BioSoft SRL, Pitesti, Romania), aligned using ClustalW as part of the package MEGA7 (Kumar *et al.* 2016). A matrix of pairwise differences using number of differences among COI and 18S haplotypes were calculated with MEGA7 (Kumar *et al.* 2016).

TABLE 2. GenBank accessions used for the development of novel primers for amplification of the 18S gene in auchenorrhynchan insects.

Family	Species	Accession No.	Reference
Acanaloniidae	<i>Bulldolonia depressa</i> Melichar, 1901	DQ532503	Urban and Cryan 2006
Achilidae	<i>Spino</i> sp.	DQ532508	Urban and Cryan 2006
Achilixiidae	<i>Bebaiotes</i> sp.	DQ532509	Urban and Cryan 2006
Caliscelidae	<i>Bruchomorpha</i> sp.	DQ532544	Urban and Cryan 2006
Cixiidae	<i>Pintalia alta</i> Osborn, 1935	AY744804	Urban and Cryan 2006
Delphacidae	<i>Megamelus distinctus</i> Metcalf, 1923	DQ532513	Urban and Cryan 2006
Derbidae	<i>Omolicna joi</i> Wilson, Halbert & Bextine, 2014	DQ532519	Urban and Cryan 2006
Dictyophatridae	<i>Scolops sulcipes</i> Say, 1825	DQ532522	Urban and Cryan 2006
Flatidae	<i>Siphanta</i> sp.	DQ532538	Urban and Cryan 2006
Fulgoridae	<i>Penthicodes pulchella</i> Guérin-Méneville, 1838	DQ532541	Urban and Cryan 2006
Issidae	<i>Thionia argo</i> Fennah, 1949	DQ532543	Urban and Cryan 2006
Kinnaridae	<i>Quilessa maculata</i> Fennah, 1942	DQ532552	Urban and Cryan 2006
Nogodinidae	<i>Biolleyana costalis</i> Fowler, 1900	DQ532558	Urban and Cryan 2006
Tropiduchidae	<i>Tangia viridis</i> Walker, 1851	DQ532569	Urban and Cryan 2006

Systematics

Family Derbidae Spinola 1839

Subfamily Derbinae Spinola 1839

Tribe Cenchreini Muir 1913

Genus *Omolicna* Fennah 1945

Type Species: *Omolicna proxima* Fennah, 1945:440.

Amended Diagnosis. The members of this genus can be separated from similar cenchreine derbids by the relatively broad vertex with pit-like sensoria bordering the lateral margins (these pits were given as a tribal feature in Emeljanov (1995). Vertex wider than long (midline less than 2x as long as broad at widest part), medially concave, with the lateral margins diverging caudally. Frons moderately compressed, elongate, narrowed between

eyes, without a longitudinal median carina, lateral margins foliately keeled. A scroll-like extension of the lateral aspect of the pronotum partially surrounds and subtends the base of the antennae forming antennal fossae (a tribal feature). Forewings with pits on postcubitus in clavus (a tribal feature), clavus closed (combined Pcu + A1 reaching CuP), extending beyond midlength of forewing. The male pygofer with a median ventral process, phallosoma (periandrium) with terminal flagellum (endosoma) folded anterodorsally with an asymmetrical arrangement of spines.

Remarks. The key to genera for Cenchreini presented in O'Brien (1982), modified from Fennah (1952), used (in part) features of the forewing venation for recognition of genera. However, review of available diagrams of wing venation for *Omolicna* (e.g., Caldwell & Martorell 1951, Fennah 1971), specimens of North American *Omolicna* species, and a wing photograph of the type species, *Omolicna proxima* Fennah, suggests that forewing features may be heterogeneous and not entirely reliable for genus-level diagnostics.

Subgenus *Agoo* Bahder & Bartlett subg. n.

(Figs 2–6)

Type species: *Omolicna (Agoo) xavieri* Bahder & Bartlett **sp. n.**

Diagnosis. Frons narrower and paranota more strongly foliate than subgenus *Omolicna*. Ventral lobe of pygofer (ventral view) broad, distally attenuating to rounded apex. Aedeagus and endosoma nearly bilaterally symmetrical. Segment 10 elongate, ventrally sinuate (lacking convexity found in most *Omolicna s.s.*).

Remarks. The composition of subgenus *Agoo* **subg. n.** is limited to *Omolicna xavieri* for the time being. At present, not all taxa of *Omolicna* are available for consideration of subgeneric status—this task is considered beyond our current scope and intended for future work. The erection of the new subgenus *Agoo* for *Omolicna xavieri* **sp. n.** is supported by molecular evidence (see below) that places this species as an outlier relative to *O. uhleri* (Ball), *O. joi*, *O. triata* (Caldwell) and *O. brunnea* (McAtee).

Etymology. The subgenus name was picked after the lead author asked his four-month-old daughter what name he should choose. Her response was to blow a raspberry, followed by 'agoo'. Due to the difficulty in spelling the sound of a raspberry, the latter was selected as the subgenus name.

Omolicna (Agoo) xavieri Bahder & Bartlett **sp. n.**

Type locality. La Virgen de Sarapiquí, Heredia, Costa Rica.

Diagnosis. Male pygofer with median ventral process broad near base, attenuating distally to broadly rounded apex (lateral teeth lacking). Segment 10 (= "anal tube") in lateral view elongate, caudal portion elongate, narrow, and ventrally sinuate, apex acute and distinctly downcurved; in dorsal view, deeply notched on caudal aspect. Phallosoma with lateral elongate, acuminate tooth on each side near base; apex with 4 elongate processes on each side, 2 pair at apex, 2 pair subapically, in addition to a complex endosoma.

Description. *Color.* General body color yellowish-brown to orange; face deep orange above frontoclypeal suture and beneath antennae, lateral carinae of front and vertex darker. Mesonotum diffusely infusate with orange. Wings, faintly yellowish, strong veins darkened, middle regions of remigium darkened so that in dorsal view wings appear to bear a dark vitta. Dorsum of abdomen orangish, aedeagus appearing dark brown within paler terminalia.

Structure. Body length males: 5.6–6.2 mm ($n = 9$) with wings; females: 8.0–8.2 mm ($n = 9$) with wings and males: 3.3–3.8 mm without wings; females: 4.2–4.7 mm without wings. **Head.** Anterior margin of head, in lateral view, rounded (Fig. 3C). Vertex deeply concave posteriorly, notched distally (Fig. 3B), broadest near base, tapering distally; lateral margins decidedly keeled, bearing 2 (somewhat irregular) rows of sensorial pits, disc depressed, without distinct carinae. Transverse apical carina separating vertex from frons absent. Vertex length males: 0.3–0.4 mm; females: 0.4–0.5 mm. Vertex width at hind margin males: 0.19–0.24 mm; females: 0.30–0.34 mm. Vertex width at distal margin males: 0.06–0.07 mm; females: 0.08–0.09 mm. Frons with lateral carinae strongly keeled, narrowest between compound eyes, diverging slightly ventral to become parallel between ocelli and frontoclypeal suture (Fig. 3A); sensorial pits next to each carina for entire length, carinae absent on disc of frons. Frons length males: 0.65–0.77 mm; females: 0.94–0.98 mm. Frons dorsal width males: 0.11–0.17 mm; females: 0.19–0.22 mm. Frons frontoclypeal margin width, males: 0.19–0.25 mm; females: 0.26–0.30 mm. Clypeus with lateral carinae keeled, sensorial pits absent, converging near midlength to labrum. Clypeus length males: 0.39–0.56 mm; females: 0.58–0.60 mm.

Thorax. Pronotum short, anterior margin following contours of posterior margin of head (Fig. 3B; convex, anteriorly truncate behind vertex, narrowed behind eyes); posterior margin weakly concave; paranotal regions strongly foliate (Figs 3A–C), in lateral view forming deep fossae, forming posterior cup for the antennae, partially surrounding eyes both dorsad and ventrad. Pronotum length at midline males: 0.19–0.24 mm; females: 0.33–0.36 mm. Mesonotum appearing slightly elevated in lateral view (Figs 2A, 3C), in dorsal view with 3 subparallel longitudinal carinae, indistinctly reaching posterior margin. Mesonotum length at midline males: 0.75–0.91 mm; females: 1.00–1.04 mm. Mesonotum width males: 1.02–1.11 mm; females: 1.40–1.47 mm.

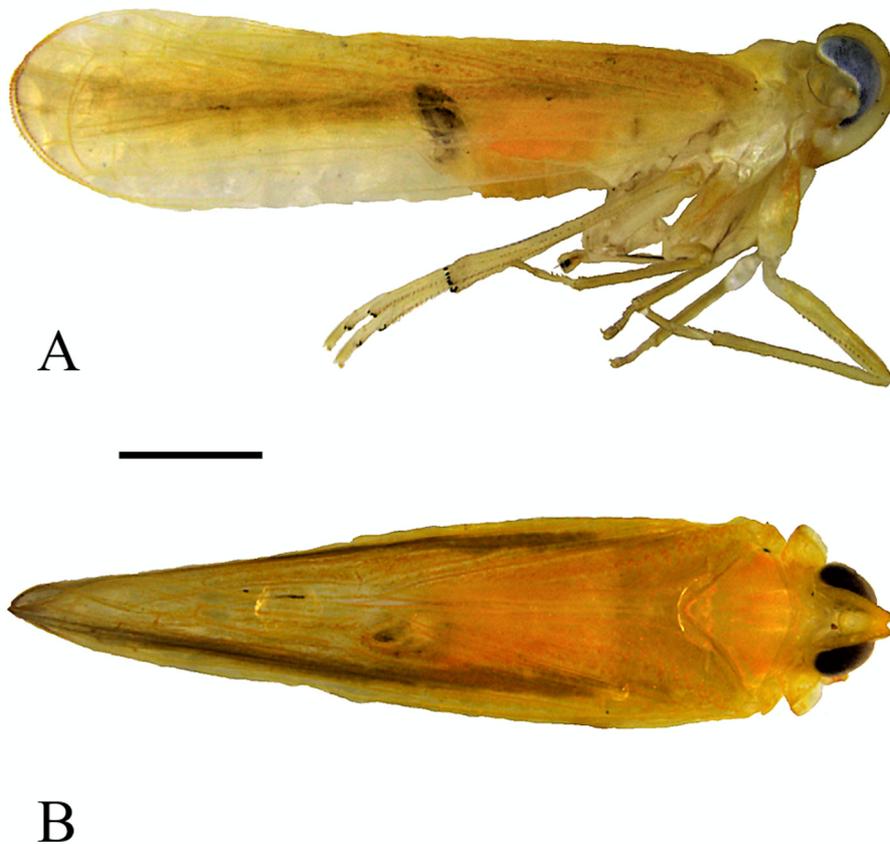


FIGURE 2. Adult male habitus *Omolicna xavieri* sp. n.; A. body lateral view and B. body dorsal view (B), scale = 1mm.

Forewing (Fig. 6) with a row of sensory pits along basal 2/3rd of Sc+R (nearly to fork of Sc) and basal half of postcubitus. Forks of R and CuA veins at approximately the same level, both well proximad of the claval apex. Claval apex just beyond midpoint of wing, fork of M just distad of claval apex; R 3-branched, M 4-branched and CuA 3-branched. The junction of the Pcu+A1 occurs in the distal half of the wing (A1 closely approximated to the trailing margin of the clavus). Forewing length males: 4.9–5.9 mm; females: 5.7–6.9 mm.

Terminalia. Pygofer, in lateral view, narrow, distal and proximal margins sinuate (Fig. 4A); broadest ventrally. In ventral view, ventral opening of pygofer bearing a rounded lobe (Fig. 4B), widest at base and attenuating distally to rounded apex. Gonostyli (\approx parameres), in ventral view, broadest ventrally, nearly meeting medially at base, then abruptly narrowed with large, rounded tooth just past midlength, slightly hooked medially at apex; in lateral view,

dorsal and ventral margin sinuate, concave and narrowest in basal third, broadened distally to broadly rounded apex, dorsal projection absent. Phallotheca with lateral pair of large subbasal acuminate teeth, one each on left and right sides (Fig. 5A, B); apex with pair of very long retrorse processes on both left and right side, and elongate subapical retrorse processes, the most distal very broad at base, strongly narrowed to acuminate apex, proximal process connected near base of previous, sinuate and asymmetrical on left and right sides. Endosoma complex, retrorse, bearing additional projections and asymmetrical 3-dimensional structures, but appearing to have 2 dorsal flattened projections, 2 ventral flattened processes, and two elongate ventral spines. Segment 10 (= “anal tube”), in lateral view (Fig. 4A), elongate, caudally narrow and sinuate, apex curved downward with acute apex; in caudal view, deeply notched (Fig. 4C).

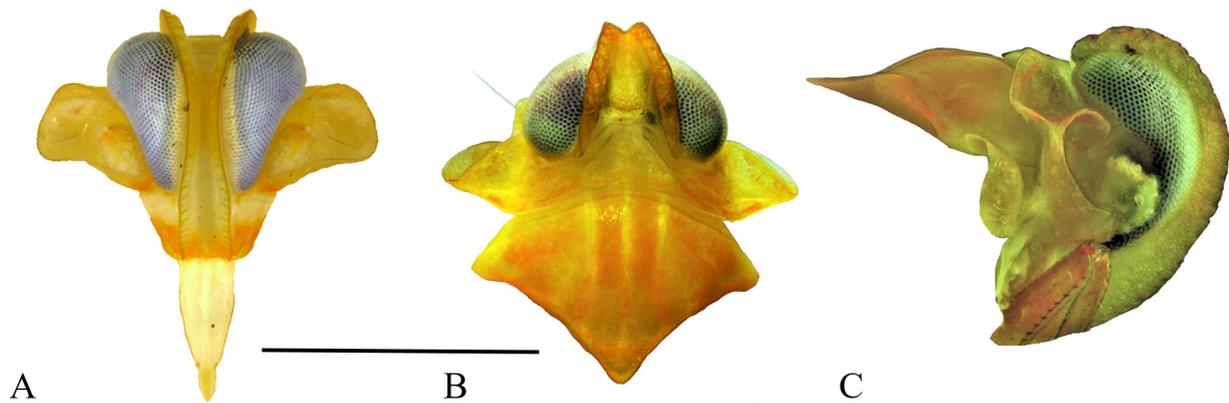


FIGURE 3. Adult male *Omolicna xavieri* sp. n.; A. head frontal view, B. head, pronotum and mesonotum dorsal view, C. head, pronotum and mesonotum lateral view, scale=1mm.

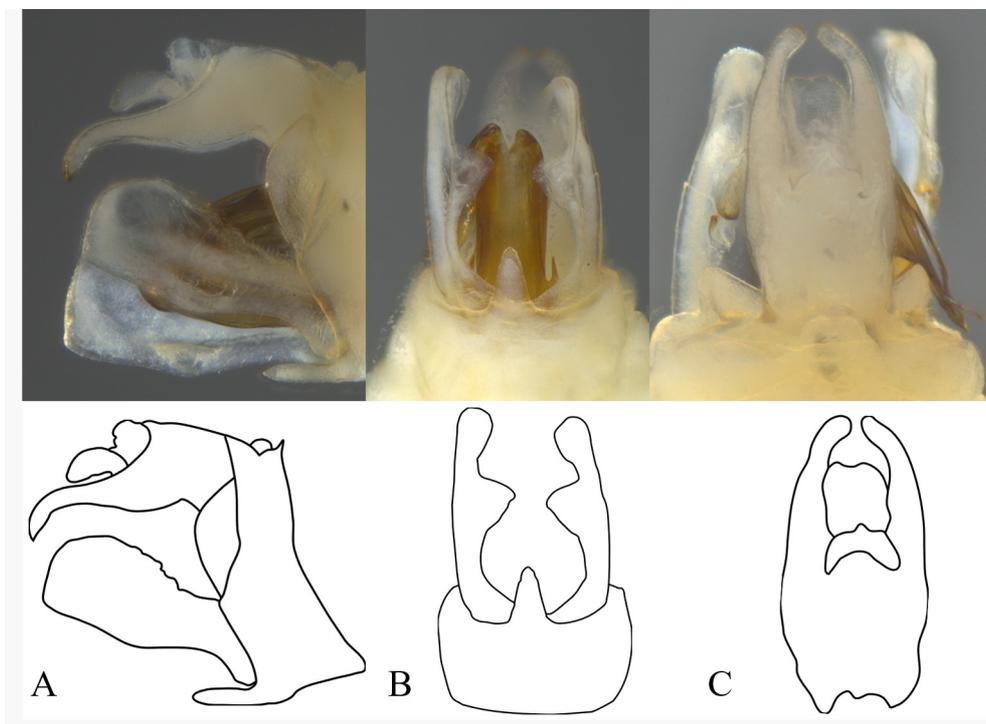


FIGURE 4. Male terminalia of *Omolicna xavieri* sp. n.; A. lateral view, B. ventral view, and C. dorsal view.

Plant associations. Coconut palm (*Cocos nucifera*), Arecaceae.

Distribution. Costa Rica (Heredia, Tortugeuro).

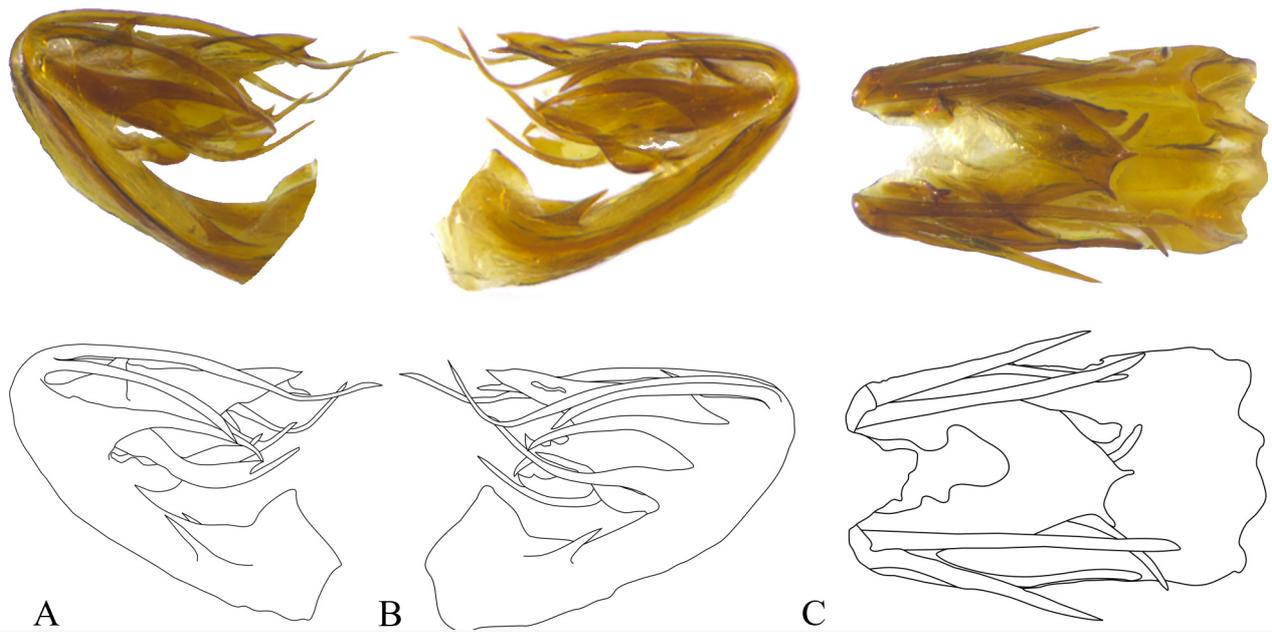


FIGURE 5. Aedeagus of adult male *Omolicna xavieri* sp. n.; A. right lateral view, B. left lateral view, and C. dorsal view.

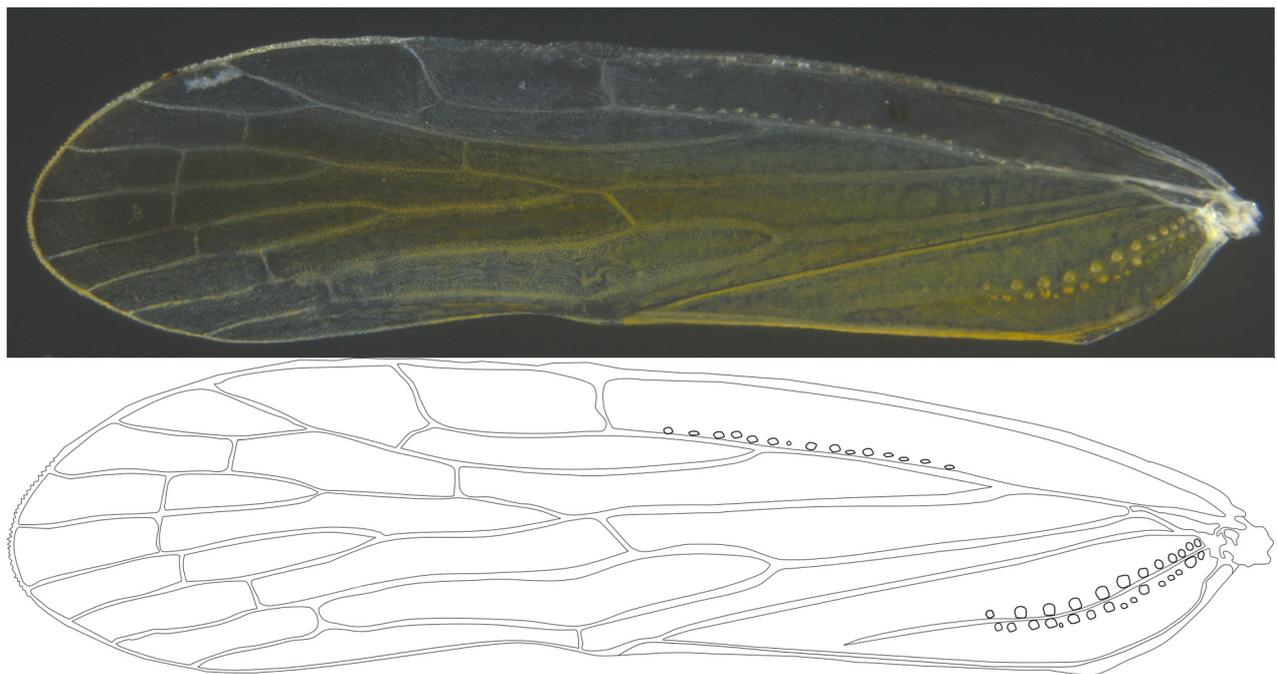


FIGURE 6. *Omolicna xavieri* sp. n., forewing venation.

Etymology. The specific name given is a reference to first name of the lead authors first born son, Xavier Jacques Bahder.

Material examined. Holotype male “Costa Rica, Heredia / La Virgen de Sarapiquí / Brian W. Bahder; 11 May 2018 / aspirated from coconut // Holotype/*Omolicna/xavieri*” (FSCA); Paratypes, Tortuguero [12 May 2018] (9 males, 10 females, FLREC and FSCA).

Sequence Data. A total of 703 bp of the COI gene was sequenced for *O. xavieri* and submitted to GenBank (Accession No. MK443068). In addition, 703 bp of the COI gene were sequenced for *O. triata* (Accession No. MK443069) and *O. brunnea* (Accession No. MK443070). For the region sequenced, no other *Omolicna* species

were represented in BLAST hits, with the closest match being *Kallitaxila sinica* (Walker) (MG099955) (Tropiduchidae) at 99% query coverage and 82% similarity. *Omolicna joi* is present in GenBank (Accession No. KF472312) while *O. fulva* (CNCHG1424-12.COI-5P) and *O. uhleri* (CNCHG1197-12.COI-5P) were both present in the Barcode of Life Database (BOLD). All sequences were aligned and compared to assess variability among the currently available *Omolicna* for the region that does overlap among all sequences. For the COI sequences available, pairwise genetic distance values comparing percent nucleotide difference ranges from 24.4% to 31.1% between *O. xavieri* sp. n. and the other species included (Table 3). Among *O. triata*, *O. brunnea*, *O. joi*, and *O. uhleri* there was between 14.4% and 19.5% variation for the region analyzed (Table 3). Finally, *O. fulva* differed by between 24.4% and 30.4% from all other species in the study (Table 3).

TABLE 3. Pairwise comparisons based on percent difference of different species of *Omolicna* using the COI barcoding region based on the bootstrap method at 1000 replicates; lower left side=percent difference, upper right corner=standard error.

Species No.	Species	1	2	3	4	5	6
1	<i>O. xavieri</i>	-	0.025	0.025	0.022	0.023	0.028
2	<i>O. triata</i>	0.259	-	0.017	0.023	0.015	0.019
3	<i>O. brunnea</i>	0.271	0.146	-	0.024	0.018	0.019
4	<i>O. fulva</i>	0.244	0.248	0.257	-	0.023	0.026
5	<i>O. uhleri</i>	0.242	0.144	0.173	0.264	-	0.019
6	<i>O. joi</i>	0.311	0.184	0.195	0.304	0.174	-

A total of 1,493 bps for the 18S gene was sequenced for *O. xavieri* (Accession No. MK443073) in addition to *O. brunnea* (Accession No. MK443071), *O. triata* (Accession No. MK443072), and *O. joi* (Accession No.). Overall, *O. xavieri* differed by about 10.6% from the other species of *Omolicna* (Table 4) whereas among *O. joi*, *O. brunnea*, and *O. triata*, there was between 0.1% to 0.9% of pairwise differences (Table 4).

Remarks. *Omolicna xavieri* sp. n. is unusual among *Omolicna* species in possessing a patterned face (beneath the antennae and along the frontoclypeal margin, the faint pattern on the dorsum of the thorax and on the wings). It is also unusual in that the ventral margin of the anal tube lacks the convexity found commonly (but not uniformly) in the genus. The new species also appears to differ qualitatively from many congeners in that the paranotal regions of the pronota are more expansively foliate, and the frons more narrowed than most of the available congeners.

The aedeagus in the new species is also distinct compared to other *Omolicna* species in that the spines are more elongate and slender. Additionally, the aedeagus in the new species is noticeably more symmetrical than that observed in other members of the genus.

TABLE 4. Pairwise distance comparisons of different species of *Omolicna* using the 18S gene based on the bootstrap method at 1000 replicates; lower left side=percent difference, upper right corner=standard error.

No.	Species	1	2	3	4
1	<i>O. xavieri</i>	-	0.013	0.014	0.014
2	<i>O. brunnea</i>	0.105	-	0.001	0.002
3	<i>O. triata</i>	0.107	0.001	-	0.003
4	<i>O. joi</i>	0.108	0.007	0.009	-

Other *Omolicna* species collected

Omolicna brunnea—Costa Rica, Heredia / La Virgen de Sarapiquí / Brian W. Bahder; 11 May 2018 / aspirated from coconut (1 male, 1 female). Previously reported from Mexico (Veracruz), Panama, Guatemala (McAtee 1924, Caldwell 1944) (Figure 7).

Omolicna triata—Costa Rica, Heredia / La Virgen de Sarapiquí / Brian W. Bahder; 13 May 2018 / aspirated from coconut (8 males, 6 females). Previously reported from Belize (Caldwell 1944) (Figure 8).



FIGURE 7. Adult male of *Omolicna brunnea*, A. lateral habitus, B. dorsal habitus, C. dorsal view of aedeagus, D. left lateral view of aedeagus, and E. right lateral view of aedeagus, scale = 1mm.



FIGURE 8. Adult male of *Omolicna triata*, A. lateral habitus, B. dorsal habitus, C. dorsal view of aedeagus, D. left lateral view of aedeagus, and E. right lateral view of aedeagus, scale = 1mm.

Discussion

While *Omolicna* is known from specimen collections from some Mesoamerican countries (Mexico, Belize, Costa Rica, Panama), records of the genus from Costa Rica have not been previously published. Here, we report for the first time three species of *Omolicna* from Costa Rica, including a new species, all of which are associated with coconut near La Virgen de Sarapiquí, Heredia province. This report is the beginning of documentation of the diversity and distribution of *Omolicna*, and the Fulgoroidea in general, throughout Costa Rica as part of the ongoing survey work for palm phytoplasmas and their potential vectors.

The genera of Cenchreini most similar to *Omolicna* are *Anchimothon* Fennah, *Cenanges* Fennah, *Neocenchrea* Metcalf, *Phaciocephalus* Kirkaldy, and possibly *Cenchrea* Westwood. *Neocenchrea* (five species, Nearctic, Mesoamerica, Trinidad) lacks the medial process on the venter of the pygofer (present in *Anchimothon* and *Cenanges*). *Anchimothon* (monotypic, reported from Guyana), has the frons along the midline 3x as long as wide (~2x in *Omolicna*). *Cenchrea* species often have a few distinctive dark spots on the wings and modestly patterned bodies; they differ from *Omolicna* by having a ‘short’ Sc cell (“though not invariably”; Fennah 1952: 128), pronotum with an elevated disc bounded by sinuate carinae, and frons separated from the vertex by a fine transverse carina. *Cenanges* (one species, Dominica) has an elevated disc on the pronotum bound by sinuate carinae. *Phaciocephalus* consists of 28 species, mostly from Oceania and Indomalaysia, except for three species from Brazil. Photos of primary types of the Brazilian species (from the Swedish Natural History Museum, Stockholm) suggest a heterogeneous group, belonging to other New World cenchreine genera (as opposed to *Phaciocephalus*).

Differences between *Omolicna xavieri* and other *Omolicna* impelled us to consider morphological features of this and morphologically similar Cenchreini. While we concluded that *Omolicna* was the most appropriate placement of the new species, heterogeneity within *Omolicna* prompted use of molecular tools to aid our investigation. We found large differences in 18S sequences between *Omolicna xavieri* and all of the other members of the genus we analyzed (here represented by *O. brunnea*, *O. triata* and *O. joi*). While members of *Omolicna sensu stricto* differed on average by about 0.56% among species for the 18S region, the difference of *Omolicna xavieri* to other *Omolicna* was about 10%. Considering the high genetic differences and the significant morphological discrepancies, the data support a genus-level difference for *Omolicna xavieri* compared to the other *Omolicna* species we analyzed, however additional molecular and morphological data will need to be examined for more species of *Omolicna sensu stricto* as well as species from closely related genera.

Omolicna xavieri differs from *Omolicna proxima* in some features of wing venation, and doubtfully conforms to features associated with the genus by Fennah (1945), and within keys by Fennah (1952) and O’Brien (1982). Presumed forewing features characteristic of the genus *Omolicna* are the elongate subcostal cell (extending basad of claval apex), Sc+R fork basad of Cu1 fork (latter about level with claval apex), first M fork about level with claval apex, apex of clavus distad of middle of forewing. These features occur in *O. proxima*, but vary among other *Omolicna* species. Additionally, we have examined other species (viz., *O. fulva* (Van Duzee), and *O. texana* (Caldwell) in which the forewing venational features are more similar to those of the new species than to *O. proxima*, suggesting (at minimum) that forewing venational features for the genus may be more heterogeneous than previously suggested and deserve further scrutiny.

There has been no modern synthetic revision of *Omolicna*, or related Cenchreini, and morphological evidence that *Omolicna* as currently comprised is monophyletic, while indicative, is not conclusive. Of course, a revision of *Omolicna*, testing its monophyly, examining morphological variation and reviewing inadequately described species would be desirable, but is beyond our current purview. Because of the potential importance of these species as palm phytoplasma vectors, a part of this work is developing a robust molecular database for *Omolicna* species. This will serve in describing new species, refining recognition of described species (including females), establishing a baseline for testing genus monophyly and establishing genus limits for *Omolicna* and other Cenchreini with quantitative tools. The molecular database will also provide an additional mechanism—aside from morphology—for new species discovery.

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