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A new species of planthopper in the genus *Paraphenice* (Hemiptera: Derbidae: Otiocerinae) from palms in eastern Madagascar

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Abstract

A survey of planthoppers associated with palms in Madagascar was initiated to assess putative vectors of a phytoplasma causing palm decline. Here a derbid collected from a Chinese fan palm (*Livistona chinensis*) is described as *Paraphenice fluctus* **sp. n.**, with supplemental molecular data for the cytochrome *c* oxidase subunit I (COI) gene, 18S rRNA gene, and D9–D10 expansion region of the 28S rRNA gene.

Key words: survey, biodiversity, taxonomy, phylogenetics

Résumé

Une étude des cicadelles associées aux palmiers à Madagascar a été initiée pour évaluer les insectes vecteurs putatifs d'un phytoplasme associé à un dépérissement des palmiers. Ici, un derbide collecté sur un palmier éventail chinois (Livistona chinensis) est décrit comme Paraphenice fluctus **sp. n.**, avec des données moléculaires additionnelles pour le gène codant pour la sous-unité I (COI) de la cytochrome c oxydase, le gène codant pour l'ARNr 18S, et la région du gène codant pour les segments d'expansion D9–D10 de l'ARNr 28S.

Mots clés: l' enquête, biodiversité, taxonomie, phylogénétique

Famintinana

Ny fikarohana mikasika ny fifandraisan'ny karazan—jorery amin'ny satrana (hazon-drofia) ao Madagasikara dia natao mba hahalanana ireo bakteria (phytoplasme) mety mitondra aretina ka mahatonga ny fihenan'ny satrana. Eto dia hita fa ny karazan-jorery (Derbidae) izay nalaina teny amin'ny karazana satrana *Livistona chinensis*, dia voasokajy ho *Paraphenice fluctus* **sp. n.**, izay manana angona molekiola fanampiny amin'ny foto-tarazo ao amin'ny zana-bondrona (COI) cytochrome c oxydase, ny fototarazo ARNr 18S, ary ny faritra fanitarana D9–D10 amin' ny fototarazo ARNr 28S.

Teny fototra: Fanadihadiana, Zavamananaina, Fisokajiana zavamanaina, Fisokajiana araka ny fototarazo

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Introduction

Recent survey efforts in the Neotropics focused on palms have resulted in the discovery of over 20 new species of planthoppers (primarily Cixiidae and Derbidae) (Bahder *et al.* 2023, Echavarria *et al.* 2023). The emphasis on palms is due to a renewed interest in the relationship between palm phytoplasmas and their vectors because of the emergence of lethal bronzing disease in Florida, U.S.A., around 2006 (Harrison *et al.* 2008). The high diversity of these planthopper families on palms has been noted previously (Lepesme 1947, Wilson 1987, 1988; Yap *et al.* 2015) along with their association with palms (e.g., Ball 1928). Recent efforts have focused primarily on Costa Rica, a region with high levels of biodiversity and where planthoppers remain insufficiently documented.

In 2016, a phytoplasma related to the one associated with Lethal Decline Tanzania (LDT) was found in coconut palms in Madagascar (Pilet *et al.* 2022). One derbid species, *Diastrombus mkurangai* has been found carrying the LDT associated phytoplasma (Mpunami *et al.* 2000), and transmission capacity of Coconut Lethal Yellowing for several derbid species has been evaluated in Ghana (Philippe *et al.*, 2008). With the discovery of a novel phytoplasma infecting palms and the high degree of diversity and endemism known from Madagascar, a new survey was initiated in January of 2023. In general, the reported palm diversity in Madagascar is approximately three times that of the entire African continent (Dransfield & Beentje 1995). Currently, there are around 210 species of palms known from Madagascar (Dransfield, *pers. comm.*) with 17 endemic genera (POWO 2023) and around 68 species in 18 genera known from the African continent (Goodman 2022). Conversely, only nine species of derbids are documented from Madagascar while there are approximately 400 species known from the African continent (Bourgoin 2023). Based on this, it is reasonable to hypothesize that the true diversity of derbids in Madagascar is far higher than heretofore reported.

Knowledge of the Madagascar Derbidae is very poor. So far, nine species of Derbidae are reported, all within the subfamily Otiocerinae belonging to three tribes have been recorded (Bourgoin 2023). These include four species in Aquaeliciini (*Ravola pennyi* Banaszkiewicz & Szwedo, 2005, *Razanus beniowskii* Banaszkiewicz & Szwedo, 2005, *Vizimbum constanti* Banaszkiewicz & Szwedo, 2005, and *V. lakandavaensis* Banaszkiewicz & Szwedo, 2005); two species in Phenicini (*Fescennia bivittata* (Coquerel, 1859), *Phenice bivittata* Coquerel, 1859), and three species in Zoraidini (*Raizoda signoreti* (Coquerel, 1859), *Teutberga anthracina* Jacobi, 1917, and *Zoraida fulgans* Muir, 1923).

During the expedition, a derbid was collected from the underside of a Chinese fan palm (*Livistona chinensis* (Jacq.) R. Br. ex Mart.) and Raffia palms (*Raphia farinifera*) and determined to be in the subfamily Otiocerinae. Based on the tribal criteria from Emeljanov (1996) and Banaszkiewicz & Szwedo (2005), the derbid was determined to belong to the tribe Kamendakini. Currently, the tribe Kamendakini is comprised of a single genus, *Kamendaka* Distant, 1906 with 79 species (including three subgenera, although many species remain unplaced to subgenus; Emeljanov 1996, Bourgoin 2023). The genus *Kamendaka* is widely distributed in the Old World tropics and broadly defined, with a high degree of variability in head structure, wing venation, and general terminalia characters. However, the novel taxon appears more similar to the genus *Paraphenice* Muir 1924 (with all species known only from the Afrotropical Region) in the tribe Phenicini. The Phenicini differ from the Kamendakini by the outer contour of the stridulatory plate on the hind wing (concave in Kamendakini, convex in Penicini). The general wing venation, the form of medioventral process of pygofer, and the presence of the subantennal processes are features that the novel taxon has that are more similar to *Paraphenice* than *Kamendaka*. Herein, the novel taxon is described with supplementary molecular data for the barcoding region of the cytochrome *c* oxidase subunit I (COI) gene, 18S rRNA gene, and D9–D10 expansion region of the 28S rRNA gene.

Materials and methods

Locality and Specimen Collection. Specimens were collected by sweeping palm foliage, aspirated, and then transferred directly to 95% ethanol. Specimens were collected with the permission of Hotel Feon'ny Ala (-18.947378, 48.418640) (Figs. 1 & 2) under permit N°254-22/MEDD/SG/DGGE/DAPRNE/SCBE.Re. Specimens were exported under permit number N°009N-EA01/MG23 and imported into the United States under permit number P526P-20-00214.

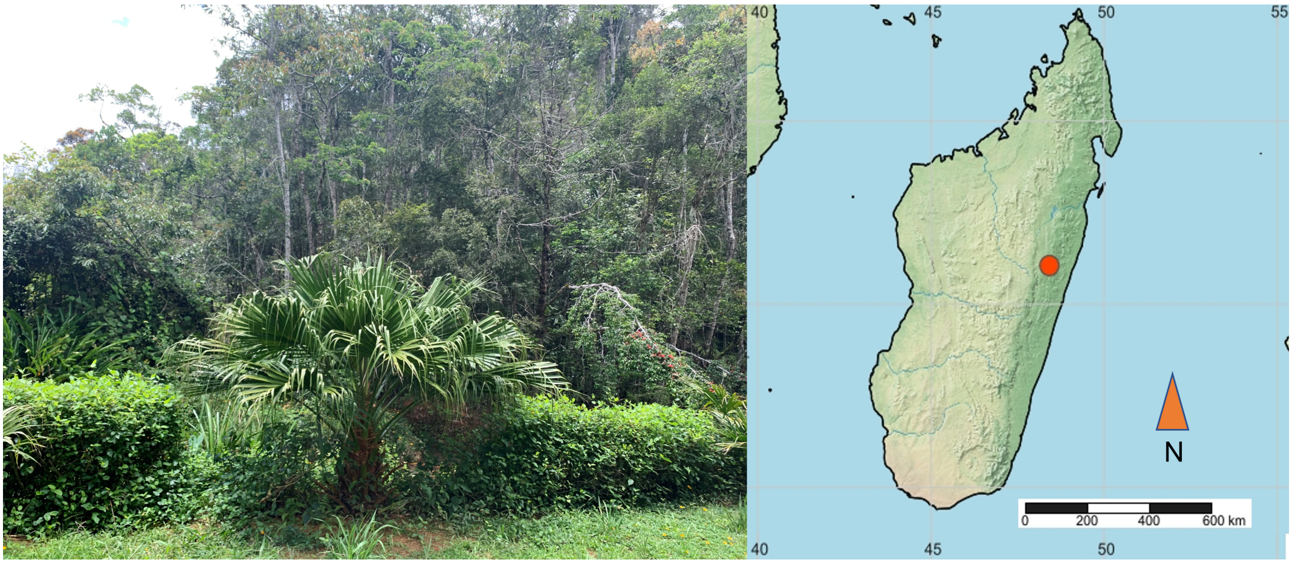

FIGURE 1. Habitat and locality of *Paraphenice fluctus* **sp. n.**

FIGURE 2. *Paraphenice fluctus* **sp. n.** *in vivo* on adult host plant.

Morphological terminology and identification. Morphological terminology generally follows that of Bartlett *et al*. (2014), except forewing venation following Bourgoin *et al*. (2015) and Stroiński (2020) and with male terminalia nomenclature modified after Bourgoin (1988) and Bourgoin & Huang (1990). Administrative divisions of Madagascar follow the results of the Malagasy constitutional referendum in 2007. New taxa are intended to be attributed to Bahder, Stroiński & Bartlett. Plant nomenclature followed the Tropicos database (https://www.tropicos.org; Tropicos 2023). The distribution map of the species was created using SimpleMappr (Shorthouse 2010).

Dissections and DNA Extraction. The male terminalia that was dissected for morphological examination 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. The cleared genitalia were then used for morphological characterization and photography.

PCR Parameters, Sequence Data, and Analysis. Primers to amplify COI, 18S, and 28S loci 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 (Promega, Madison, WI, USA), 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 both the COI and 18S loci separately as well as one based on concatenated data forming a consensus tree between COI and 18S with MEGA7 (Kumar *et al.* 2016).

TABLE 1. Primers used to amplify loci used for assessment of *Paraphenice fluctus* **sp. n.** and corresponding annealing temperatures and extension times.

Gene	Primer Name	Sequence (5'→3')	Annealing	Extension	Reference
COI	LCO1490	GGTCAACAAATCATAAAGATATTG	40˚C	1 min. 30 sec.	Folmer *et al.* 1994
	HCO2198	TCAGGGTGACCAAAAAATCA			
18S	18SFI	ACTGTCGATGGTAGGTTCTG	50˚C	2 min.	Bahder *et al.* 2019
	18SRI	GTCCGAAGACCTCACTAAA			
28S	V	GTAGCCAAATGCCTCGTCA	55˚C	1 min. 30 sec.	Cryan *et al.* 2000
	X	CACAATGATAGGAAGAGCC			

Taxon sampling. A preliminary phylogeny was constructed for the novel taxon. For the loci analyzed, data from Old World taxa were not available but Otiocerinae from tribes represented in both the Eastern and Western hemispheres were included. These were Otiocerini (*Shellenius serratus* Bahder & Bartlett 2023, *S. ballii* (McAtee 1923), *Sayiana sayi* (Ball 1902), *Cobacella palmensis* Bahder & Bartlett 2023), Patarini (*Patara vanduzei* Ball 1902, *P. cooki* Bahder & Bartlett 2021 and *Mula resonans* Ball 1928), and Sikaianini (*Sikaiana harti* (Metcalf 1923)). *Agoo xavieri* Bahder & Bartlett 2019 (Derbinae: Cenchreini) was used as a non-Otiocerinae group to root the phylogenetic trees. Accession numbers for all taxa included in the analysis are presented in Table 2.

TABLE 2. Representative Otiocerinae used for morphological and molecular comparisons with *Agoo xavieri* as subfamily outgroup (Derbinae).

	Locus		
Species	COI	18S	28S
Agoo xavieri	MK443068	MK443073	ORO50638
Paraphenice fluctus **sp. n.**	OR670336	OR670345	OR670346
Cobacella palmensis	ORO44883	ORO41765	ORO50628
Mula resonans	OQ473376	OQ519977	ORO50635
Patara cooki	MW332651	MW333024	ORO50634
Patara vanduzei	OQ473377	OQ519977	ORO50633
Sayiana sayi	ORO44884	ORO41766	ORO50632
Shellenius ballii	OQ473378	OQ519976	ORO50631
Shellenius serratus	OQ473380	OQ519974	ORO50629
Sikaiana harti	OR418165	OR419690	OR419689

Systematics

Family Derbidae Spinola, 1839

Subfamily Otiocerinae Muir, 1917

Tribe Phenicini Emeljanov, 1996

Amended diagnosis (modified from Emeljanov 1996). Frons narrow and elongate (but not closely approximate), projected in front of eyes, lateral margins foliate, bearing pits. Vertex trapezoidal, narrowing anteriorly, lateral margins foliate bearing pits, separated from frons by transverse carina. Antennae with scape very short, pedicle enlarged (ovate or elongated). Genae with subantennal crest (may be small). Eyes reniform, with emargination adjoining antennae (antennae situated below or behind eyes. Lateral ocelli present. Postclypeus elongated, with lateral and median carainae. Pronotum short, posterior margin broadly emarginated, tectate in dorsal view, anteriorly delinate in lateral view, with distinct median and lateral (between tegula and head) carinae. Mesonotum large, convex, tricarinate. Forewings with closed clavus and C5 (procubital) cell, sensory pits present on costal margin. Hindwings stridulatory plate with convex external margin, nodal line irregular. Hind tibia without lateral teeth, spinulation 4(1+5)–6–4/5; apex with large lateral tooth, separated by deep gap from row of 4 teeth, apex of lst tarsomere with 6 teeth, apex of 2nd tarsomere with 4–5 teeth.

Paraphenice fluctus Bahder, Stroiński & Bartlett, sp. n.

(Figures 2–6)

Type locality. Madagascar, Hotel Feon' ny Ala, Alaotra-Mangoro Region.

Diagnosis. Moderate-sized planthopper (~6.7 mm), general body color yellow to testaceous. Antennal pedicel large and bulbous. Wings transparent with median fuscous markings. Pygofer with large triangular projection of posterior margin in lateral view; medioventral process in ventral view strongly asymmetrical, left side round, invaginating at apex and right side projecting in irregularly sinuate process, slight more sclerotized on right side. Gonostyli with sclerotized process at midpoint angled ventrad on outer lateral sides. Aedeagus with multiple sclerotized processes with serrations at apex and highly complex endosoma, twisting and reaching base of aedeagal shaft.

Description. *Color*. General body color yellowish, darker dorsally, paler ventrally (Figs 2 & 3), abdominal terga reddish. Second segment of antennae white basally, yellow distally. Forewings transparent (veins mostly white), weakly embrowned medially bearing dark spot at subapically fork of MP_1 (Figs 3, 5).

FIGURE 3. Adult male habitus of *Paraphenice fluctus* **sp. n.**; (A) dorsal view and (B) lateral view; scale bar = 1mm.

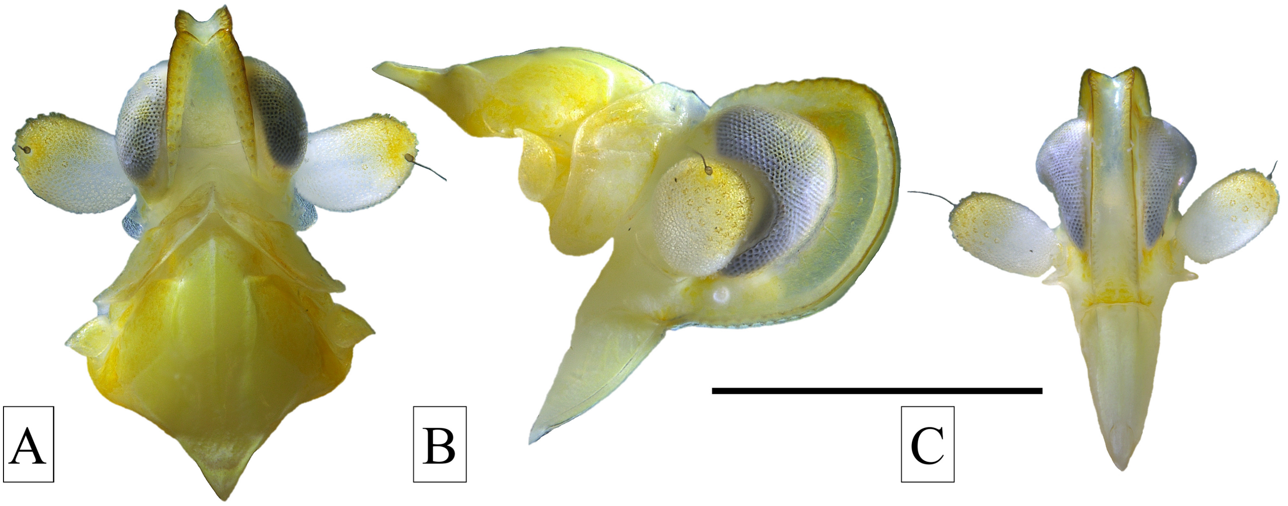

FIGURE 4. Adult male of *Paraphenice fluctus* **sp. n.**: (A) head, pronotum, and mesonotum in dorsal view, (B) head, pronotum, and mesonotum in lateral view, and (C) head in frontal view; scale bar = 1mm.

Structure. Body length (including wings) males: 6.6–6.7 mm (n = 11), females: 6.7–6.9 mm (n = 9). Head. In dorsal view, vertex elongated, approximately 3x long as wide, extending beyond eyes, lateral margins foliate, disc depressed, median carina absent; anterior margin strongly concave, posterior margin truncate, transverse carina present at fastigium, two complete rows of sensory pits along lateral margins, third incomplete row mesad (Fig.

4A). In lateral view, head rounded (vertex weakly inclined and convex, frons arched), extending moderately beyond eye margin, slightly angled at fastigium (at transverse carina); In frontal view, lateral margins of frons sub-parallel, single row of sensory pits along lateral margins extending from dorsal margin to clypeus (Fig. 4C). Frontoclypeal suture truncate, clypeus very elongately triangular. Eyes reniform in front of antennae. Lateral ocelli present, white, situated just below eye at posterior margin (Fig. 4B). Antennae with scape ring-like, pedicle segment large and bulbous bearing two differently sized sensory plaques, smaller plaques over entire surface in uniform distribution, larger clustered over the apical 1/3 of segment (Fig. 4). Subantennal genal crest present (arched along ventroposterior antennal margin), slightly surpassing basal margin of second antennal segment in frontal view (Fig. 4C).

Thorax. Pronotum tricarinate, in dorsal view with median carina and carinae at lateral margin (from dorsal view) between tegulae and head, anterior margin in dorsal view strongly convex, posterior margin broadly triangularly excised (Fig. 4A). Mesonotum in dorsal view tricarinate, median carina becoming obsolete posteriorly near scutellum, lateral carinae arising laterad, extending transversely, then abruptly angled (nearly 90°), then longitudinally (slightly sinuate), becoming obsolete before caudal margin (Fig. 4A); in lateral view, mesonotum humped (concave before upturned scutellum), bearing pair of crests near anterior margin of scutellum. Spinulation of hind tibia 5-6-5.

Forewing (Fig. 5) elongate, spatulate, approximately 2.5 times longer than broad (at greatest width), costal margin convex (bearing small pits near midlength), trailing margin expanded between claval apex and wing tip. Clavus closed (Pcu+A1 reaching wing margin well before CuP). Basal cell narrow and elongated; ScP+R+MP arising from leaving basal cell as common stem; MP forked after short common stem; RP forked from Sc+RA in basal third of wing just before fork of CuA, fork of MP$_{1+2}$ from MP$_{3+4}$ before claval apex. CuA anastomosing to form closed C5 (procubital) cell. Veins Pcu and A$_1$ fused just after claval midlength. Branching pattern RA 2-branched, RP 3-branched, MP 7-branched .

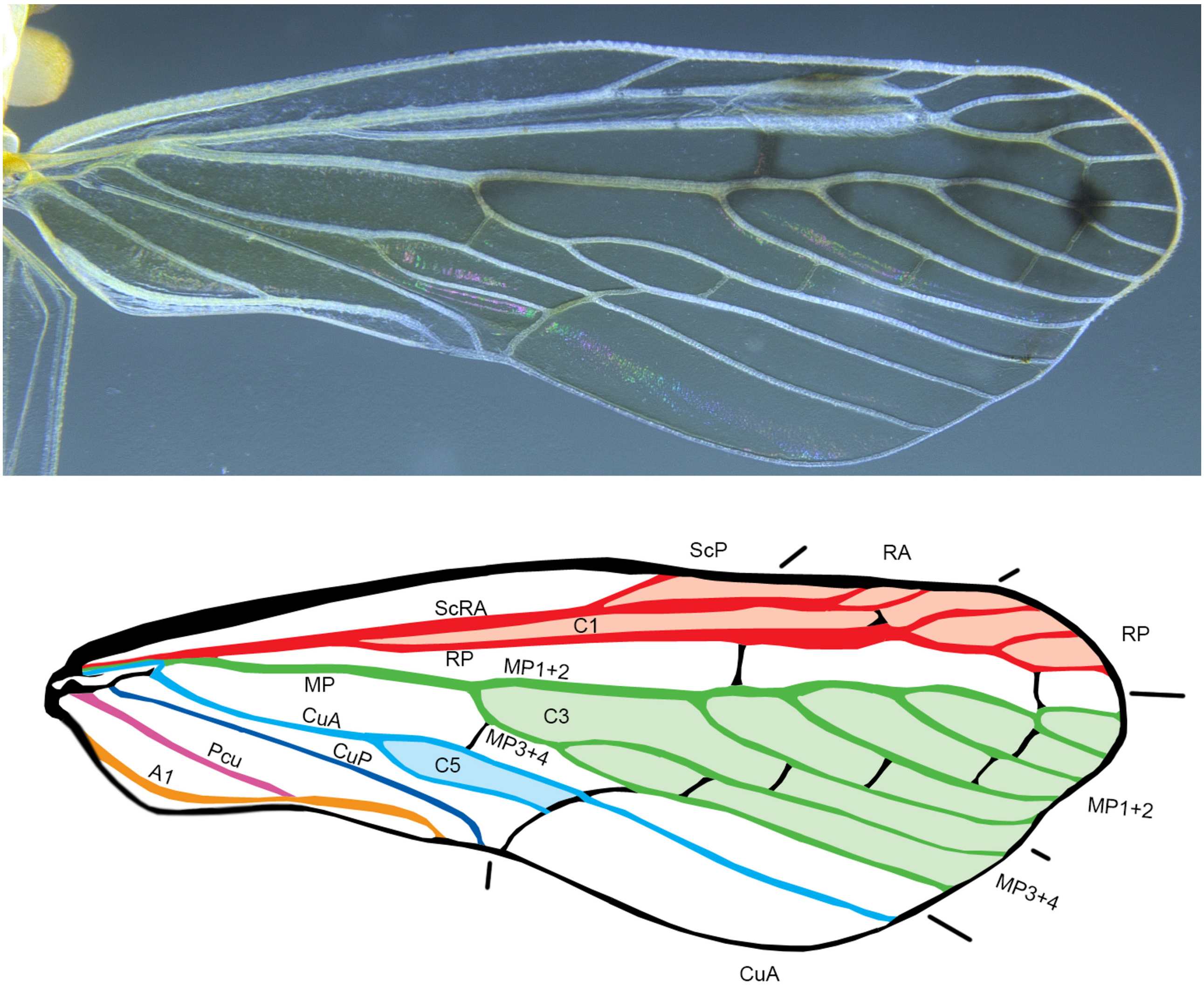

FIGURE 5. Forewing venation of *Paraphenice fluctus* **sp. n.**

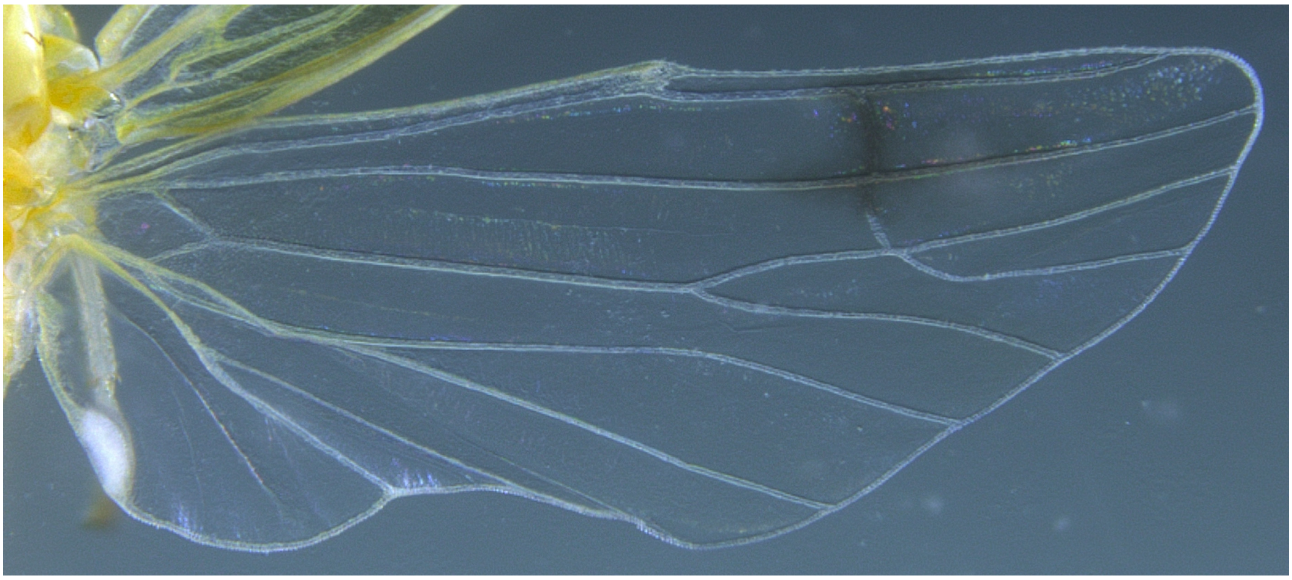

FIGURE 6. Hindwing venation of *Paraphenice fluctus* **sp. n.**

Hindwing (Fig. 6) almost as long as forewing with large basal cell. ScP+RA ending with single terminal about middle of costal margin; RP unbranched, MP single, CuA with 3 terminals, CuP single, Pcu single, A_1 with 2 terminals, A_2 single; stridulatory plate with outer margin weakly concave; crossveins r-m and m-cu at apical third of hindwing.

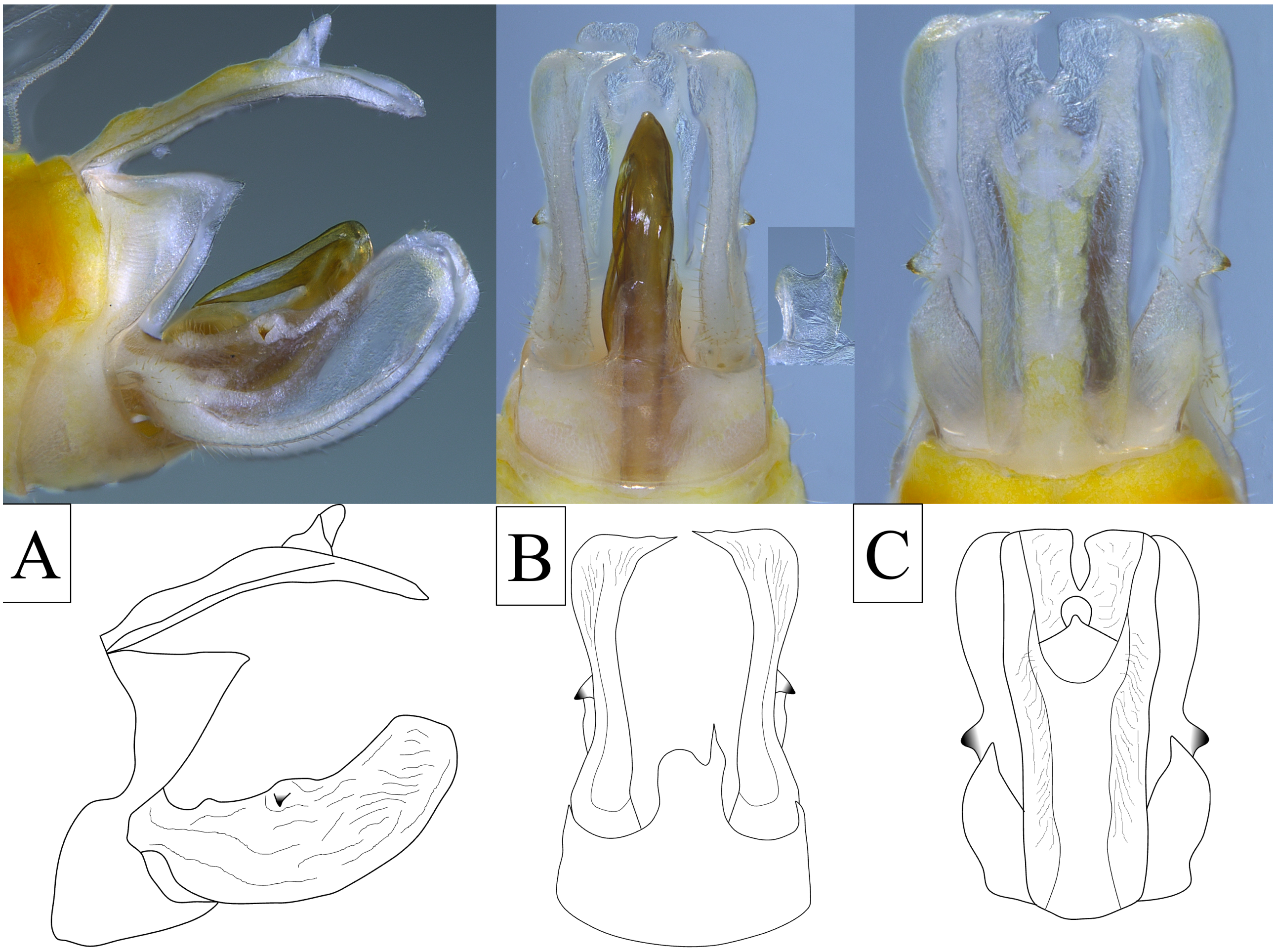

FIGURE 7. Male genitalia of *Paraphenice fluctus* **sp. n.**; (A) lateral view, (B) ventral view, and (C) dorsal view.

Genitalia. Pygofer in lateral view irregular, dorsal margin appearing to not reach dorsal margin, irregularly sinuate on anterior margin, lateral margins of pygofer opening bearing large, triangular lobes, constricted ventrally near midlength, expanded again to ventral margin (Fig. 7A); in ventral view, medioventral process strongly asymmetrical, longer than wide, broadest at base, left lateral margin apically rounded, right lateral apex bearing acuminate and irregularly sinuate process (Fig. 7B). Gonostyli in lateral view broadly and elongately spatulate, narrowest at base, irregularly sinuate on broadly concave dorsal margin bearing laterally projected sclerotized uncus at midpoint (Fig. 7C), ventral margin broadly convex, apex bluntly rounded (Fig. 7A); in ventral view, inner and outer margins sinuate, broad at base, constricting near midpoint, expanding subapically, apices truncated with elongate median points (Fig. 7B). Aedeagus complex, bilaterally asymmetrical, shaft simple bearing three large retrorse sclerotized processes arising near apex; the first process (A1) arises at apex on right lateral side slender dorsal spine (A1a; sinuate, curving slightly ventrad) and weakly sclerotized, transparent broad flange entrally (A1b); second process (A2) arising subapically on left lateral side near dorsal margin, robust, sinuate, apex finely serrate, nearly reaching apex of A1; third process (A3) arising subapically on left lateral side longer and more slender than A2, apex irregularly apically serrated (both dorsally and ventrally) curved slightly dorsad, (Fig. 8); endosoma large and complex with twisted and wavy lingulate appearance, reaching base of aedeagal shaft bearing three elongated sclerotized processes; one large process (E1) arising near base, curved dorsad, sfinely serrated dorsally in distal half, second process (E2) arising on left ventral margin near midpoint, sinute, not serrated; third process (E3) arising near E2, angled mesad, spatulate, angled dorsad (Fig. 8). Anal t in later view narrow, irregularly sinuate on dorsal margin, curved along ventral margin to elongated ventrocaudally directed apex, apex nearly reaching apex of gonostyli (Fig. 7A); in dorsal view, broad, quadrate, apex truncate, medially deeply notched (Fig. 7C).

Plant associations. *Livistona chinensis* (Jacq.) R. Br. ex Mart. and *Raphia* P. Beauv. (Arecales: Arecaceae).

Distribution. Central-eastern Madagascar (Alaotra-Mangoro Region, Anosibe An'ala District, Andasibe commune; Atsinanana Region, Toamasina II District, Mahavelona (Foulpointe) commune, Analalava Forest Reserve).

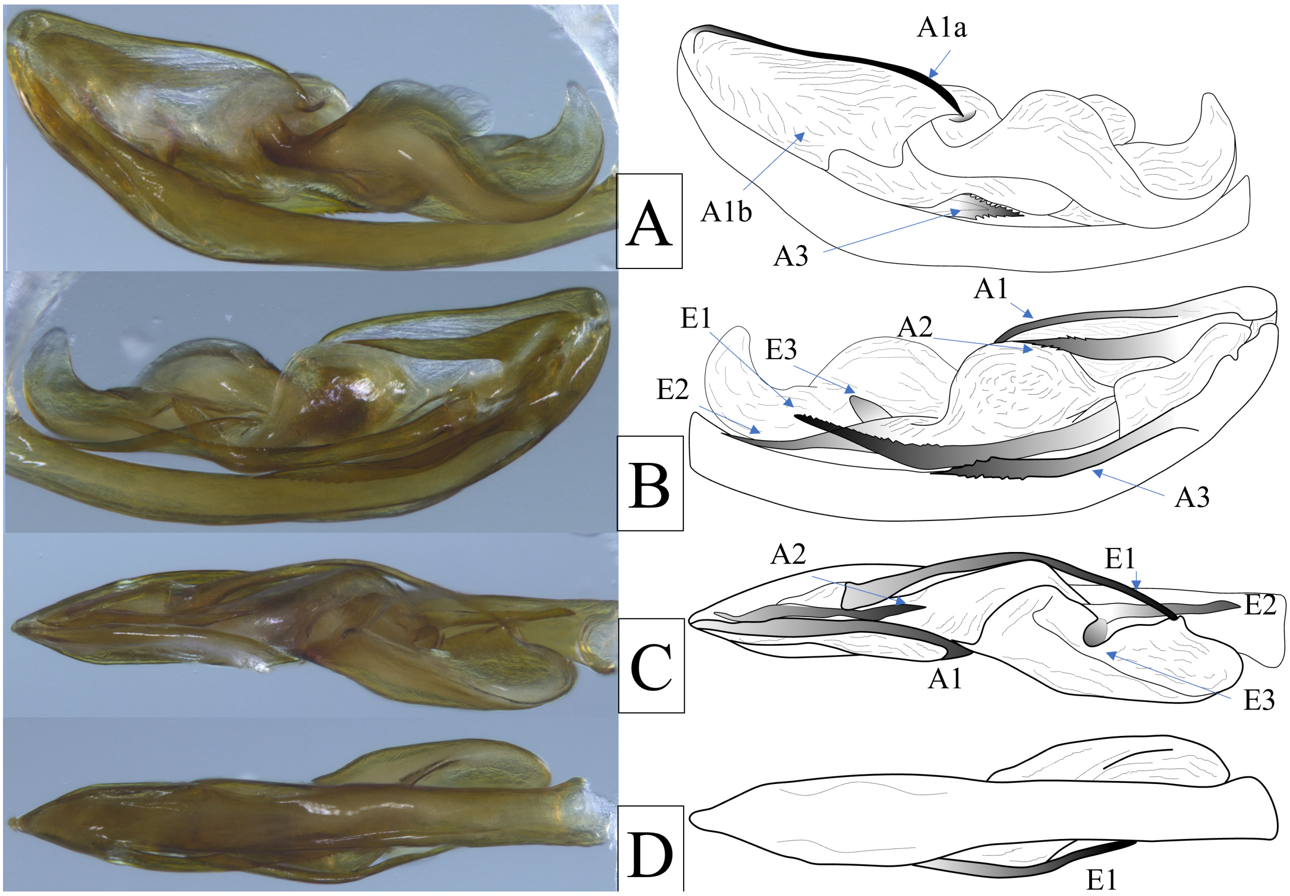

FIGURE 8. Aedeagus of *Paraphenice fluctus* **sp. n.**; (A) right lateral view, (B) left lateral view, (C) dorsal view and (D) ventral view.

Etymology. The specific name given, "*fluctus*" is Latin for 'wave' in reference to the large, wave-like appearance of the endosoma, and is intended as indeclinable.

Material examined. Holotype, male: "Madagascar, Alaotra-Mangoro, Andasibe / Hotel Feon'ny Ala / 26.I.2023, sweeping *Livistona* palm / Coll.: B.W.Bahder // Holotype / *Paraphenice fluctus* ♂ /" (FLREC). **Paratypes**: 8 males, 9 females same locality as holotype, FLREC; 2 males: "Madagascar, Atsinana, Analalava / Reserve lodge at entrance / 27.I.2023, sweeping *Raphia* palm / Coll.: B.W.Bahder" (FLREC).

Sequence Data. For the novel taxon, a 713 bp was generated for the barcoding region of COI, a 1,498 bp product for the 18S rRNA gene, and a 754 bp product for the D9–D10 region of 28S. All accession numbers are presented in Table 2.

TABLE 3. Biometric data for *Paraphenice fluctus* **sp. n.** (in mm)

	Male (*n*=11)		Female (*n*=9)	
Character	Range	Average ± SE	Range	Average ± SE
Body length, with wings	6.6–6.7	6.7 ± 0.0	6.7–6.9	6.8 ± 0.1
Body length, no wings	3.9–4.0	4.0 ± 0.0	5–5.2	5.1 ± 0.1
Forewing length	5.5–5.5	5.5 ± 0.0	5.7–5.7	5.7 ± 0.0
Vertex length	0.8–0.8	0.8 ± 0.0	0.8–0.8	0.8 ± 0.0
Vertex width, basal margin	0.3–0.3	0.3 ± 0.0	0.3–0.3	0.3 ± 0.0
Vertex width, distal margin	0.2–0.2	0.2 ± 0.0	0.2–0.2	0.2 ± 0.0
Pronotum length, midline	0.1–0.1	0.1 ± 0.0	0.1–0.1	0.1 ± 0.0
Mesonotum length, midline	1.1–1.1	1.1 ± 0.0	1.1–1.1	1.1 ± 0.0
Mesonotum width	1.0–1.0	1.0 ± 0.0	1.0–1.0	1.0 ± 0.0
Frons width, dorsal margin	0.2–0.2	0.2 ± 0.0	0.2–0.2	0.2 ± 0.0
Frons width, clypeal suture	0.2–0.2	0.2 ± 0.0	0.2–0.2	0.2 ± 0.0
Frons width, widest	0.2–0.2	0.2 ± 0.0	0.2–0.2	0.2 ± 0.0
Frons width, narrowest	0.2–0.2	0.2 ± 0.0	0.2–0.2	0.2 ± 0.0
Frons length, midline	1.0–1.1	1.1 ± 0.0	1.1–1.1	1.1 ± 0.0
Clypeus length	0.8–0.8	0.8 ± 0.0	0.8–0.8	0.8 ± 0.0

In the absence of molecular data from Phenicini and other Old World Otiocerinae, *Paraphenice fluctus* **sp. n.** resolved adjacent to *Shellenius* Ball with varying degrees of support for all loci as well as for the consensus tree based on all loci (Fig. 9). Bootstrap support in the COI tree was weak (<50), although support was stronger in the 18S tree (65) and 28S trees (84). The strongest bootstrap support (94) for placement of *P. fluctus* **sp. n.** next to *Shellenius* was observed from concatenated data for all three loci (Fig. 9D).

Remarks. While Old World taxa were not included and with a relatively small number of taxa analyzed, the closer apparent relationship of *Paraphenice fluctus* **sp. n.** to *Shellenius* (Otiocerini) than the relationship of *Shellenius* to *C. palmensis* and *S. sayi* (also Otiocerini), suggests that the monophyly of tribes in the Otiocerinae needs to be more clearly established. Of the species currently described in *Paraphenice*, there appears to be substantial variability in form of the anal segment, gonostyli, and medioventral process of the pygofer. In general, there appears to be a common pattern of the aedeagus among the described taxa; possessing a large, complex endosoma that is twisted with multiple lobes/projections.

Among Phenicini, *Paraphenice* appears to be the only genus with subantennal ridges. Among members of *Paraphenice*, the closest to *P. flucutus* **sp. n.** appears to be *P. arebiensis* Synave, 1973 (figs 389–392), but this species has dark forewings, a strongly downturned apex of the anal tube, more broadly spatulate gonostyli, and different sizes of processes on the right side of the aedeagus (Synave 1973 does not illustrate the pygofer or left side of aedeagus). The general forewing pattern appears similar among species of *Paraphenice* and while there likely exists variation in features of branching, crossvein positions, and cell morphology, the color pattern appears to vary from species to species (where it has been illustrated), and as such, *P. fulcutus* **sp. n.** appears to have a unique color pattern, in this case almost lacking a pattern some slightly fuscous areas but with a prominent, subapical black spot. Finally, while there are some species of *Paraphenice* with distinct and sometimes asymmetrical medioventral processes of the pygofer, the form observed in *P. flucutus* **sp. n.** diverges significantly from these other forms. Geographically, *P. mawae* Wilson, 1987 is the closest species to *P. flucutus* **sp. n.**, having been documented in Tanzania, however differs significantly in many features (Wilson 1987, figs 57–65). All other *Paraphenice* are known from western Africa.

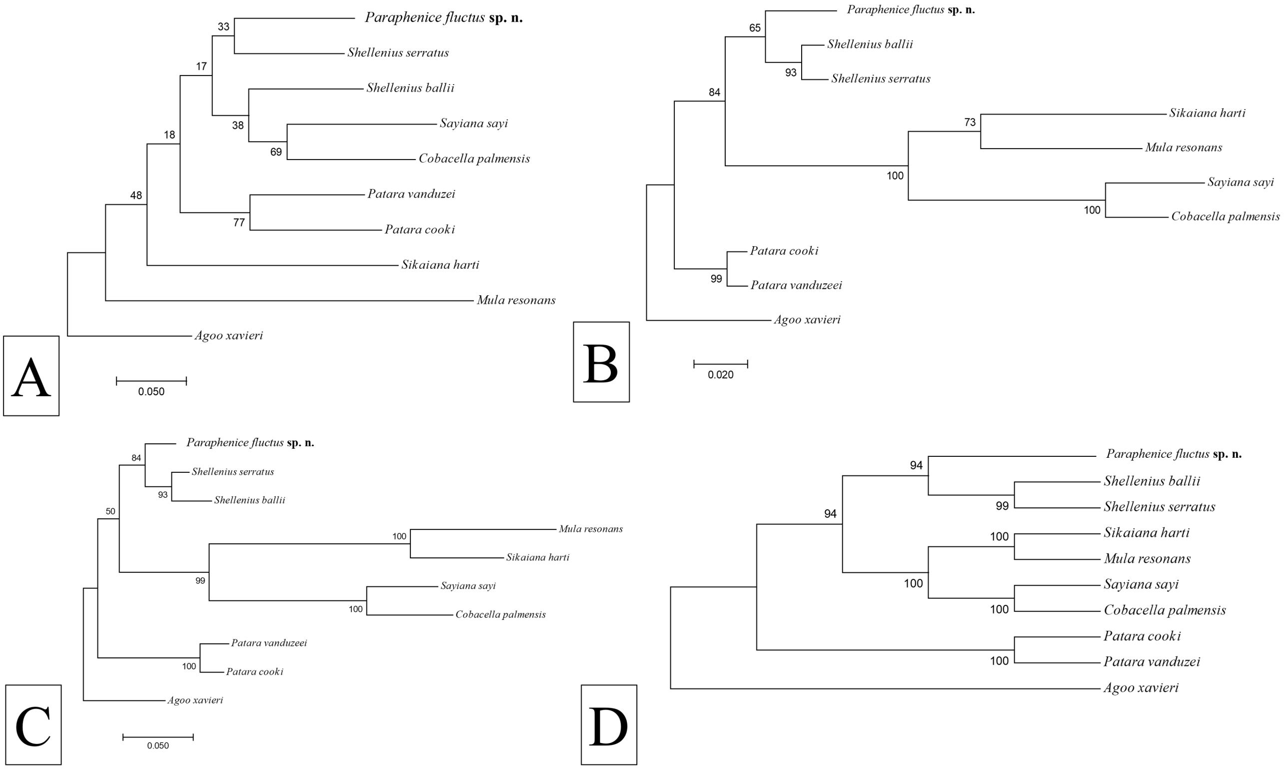

FIGURE 9. Maximum Likelihood trees (1,000 replicates) demonstrating the relationship of *Paraphenice fluctus* **sp. n.** relative to other available species; (A) COI, (B)18S, (C) 28S and (D) concatenated COI, 18S and 28S data, scale bar = percent nucleotide difference.

Discussion

The survey conducted in Madagascar was focused on palms because of interest in palm phytoplasma vectors in the region. From this survey, there remain several putative new species of planthoppers suggesting that there may be a potentially large number of new species of planthoppers that remain to be described from Madagascar, despite past efforts in the region (we count over 60 publications directly related to planthoppers from Madagascar).

There remains little molecular data from Old World Derbidae. These data presented here appear to call into question the monophyly of some tribes in the Otiocerinae. Although the conceptual basis for the classification of Derbidae seems well established (e.g., Emeljanov 1996, Emeljanov & Shcherbakov 2020), the classification remains to be investigated using quantitative phylogenetic tools.

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