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Oficanthon Paulian, 1985, a junior synonym of *Lepanus* Balthasar, 1966 (Coleoptera: Scarabaeidae: Scarabaeinae), with redescription of *Lepanus mirabilis* (Paulian, 1985)

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Abstract

The monotypic genus *Oficanthon* Paulian, 1985 (Coleoptera: Scarabaeidae: Scarabaeinae) is treated as a junior synonym of the genus *Lepanus* Balthasar, 1966, and *L. mirabilis* (Paulian, 1985), **new combination** is proposed for *Oficanthon mirabilis* Paulian, 1985. Both morphological and molecular evidence support this synonymy. Morphological evidence further supports its placement within the *Lepanus ustulatus* species group. *Lepanus mirabilis* is redescribed.

Key words: Australasian endemic genera, Papua New Guinea, taxonomy

Introduction

Oficanthon, Paulian 1985 (Coleoptera: Scarabaeidae: Scarabaeinae) was established during a systematic revision of the 'canthonine' dung beetles of New Guinea from the Howden Collection (Paulian 1985). Two specimens previously identified as *Temnoplectron aeneolum* Lansberg, 1855 were described in a new monotypic genus and given the name *Oficanthon mirabilis* Paulian, 1985. The genus is currently considered endemic to Papua New Guinea and is only known from few specimens. Diagnostic characters listed by Paulian (1985) in the description include the presence of pseudepipleura, seven elytral striae and distinctly toothed claws.

Upon examination of a specimen identified as *Oficanthon,* inconsistencies between generic characters proposed by Paulian (1985) and the specimen itself were discovered. This specimen did not possess pseudepipleura, and superficial 8th striae were present along the flange-like dorsal edges of the epipleura. Four Australasian genera *Lepanus* Balthasar, 1966, *Sauvagesinella* Paulian, 1935, *Matthewsius* Gunter & Weir, 2017, and *Monteithocanthon* Gunter & Weir, 2017 share these features and can be further differentiated by protibial and pygidial arrangement, the presence/absence of trochantofemoral pits, proportions of metatarsomeres, and claw shape (Gunter & Weir 2017). These discoveries suggest that the specimen in question was either misidentified as *Oficanthon,* or that *Oficanthon* is a synonym of *Lepanus*.

Materials and methods

To verify the identity of the specimen identified as *Oficanthon,* high-resolution images of the holotype and paratype were obtained. Type images were compared to the original description of Paulian (1985), as well as the specimen in hand. Redescriptions follow the format for description of Australian *Lepanus* (Gunter & Weir 2019, 2021). Body length measurements were taken from the tip of the clypeal teeth to the posterior edge of the elytra. Width measurements were taken at the widest point. Label data is given verbatim with inside quotations with "|" to indicate line breaks and "||" to indicate information on reverse of label.

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Specimens examined are deposited in the following institutions:

CMNC: Canadian Museum of Nature (Ottawa, Ontario, Canada)
MNHN: Muséum National d'Histoire Naturelle (Paris, France)

In order to provide molecular data to support morphological hypotheses, the DNA from a recently collected specimen was extracted using non-destructive methods. The standard Qiagen DNeasy Tissue kit extraction protocol was modified to include tissue lysis overnight (~ 16 hours) and elution in two 100 uL aliquots. Following well-established molecular protocols for Australian dung beetles, we amplified the nuclear ribosomal region of 28S and 18S using the primers listed in Gunter & Weir (2017) and cycling conditions of Gunter *et al.* (2013). Additional markers, including cytochrome oxidase 1 (COI) were also attempted, but the region "Jerry-Pat" standardly used in Scarabaeinae analyses was unsuccessful. A shorter non-overlapping fragment generated using the primers LepF1 and MLepF1-rev (Brandon-Mong *et al.* 2015) was amplified. PCR products were purified with Exosap-IT and sent to the Genomics Core at Case Western Reserve University (Cleveland, Ohio, United States of America) for Sanger Sequencing. Raw sequences were trimmed and aligned using MAFFT (Katoh and Standley 2013) in Geneious (version 6.1.8; Biomatters, Auckland, New Zealand) with sequences (28S, 18S, 16S, COI) previously published in Gunter *et al.* (2019b) (see Table 1). A maximum likelihood topology was reconstructed using IQ-tree 1.6.12 (Nguyen *et al*. 2015) in which ModelFinder (Kalyaanamoorthy *et al.* 2017) was implemented and 1000 ultrafast bootstraps (Hoang *et al.* 2019) were used. The short COI fragment was not included in the phylogenetic analysis as the primers did overlap with the other sequences. However, all newly generated sequences (COI, 28S, 18S) are deposited on GenBank under the accession codes OM523102, OM522902, and OM522903.

Lepanus Balthasar, 1966

Lepanus Balthasar, 1966: 177. Type species: *Lepanus ovatus* Balthasar 1966 (by monotypy); Matthews 1974: 100, Gunter & Weir 2019: 41, Gunter *et al.* 2019a: 459.
Oficanthon Paulian, 1985: 227. Type species: *Oficanthon mirabilis* Paulian, 1985 (by monotypy); **new synonym**.

Comments. *Oficanthon* is a monotypic genus here treated as a synonym of *Lepanus.* For a generic description of *Lepanus* refer to Matthews (1974) and Gunter *et al.* (2019a).

Lepanus mirabilis (Paulian, 1985), new combination
Figs. 1–3.

Oficanthon mirabilis Paulian 1985: 228.

Type material examined. Holotype (1 ♂ CMNC). "PAPUA NEW GUINEA | 8km. SW Nadro, 650m. | Ofi Creek, O. Kukal | 15–18viii. 76, dng | lowlandRainforest" "H. & A.Howden | Collection" "HOLOTYPE" "Oficanthon mirabilis | n. g. n. sp | R. Paulian det." "Canadian Museum of | Musée canadien de la | NATURE | CMNEN 00011782" (Fig.2E). **Paratype (1 ♂ MNHN).** "PAPUA NEW GUINEA | 8km. SW Nadro, 650m. | Ofi Creek, O. Kukal | 15–18viii. 76, dng | lowlandRainforest" "H. & A.Howden | Collection" "PARATYPE" "Oficanthon | mirabilis | n.g. n.sp. | R. Paulian det." "MNHN, Paris | EC14839"

Additional material examined. (2 ♂ CMNC) "PAPUA NEW GUINEA | 8km. SW Nadro, 650m. | Ofi Creek, O. Kukal | 15–18.viii.76, dng | lowlandRainforest" "PARATYPE" "PARATYPE | Oficanthon | mirabilis | R. Paulian" "Canadian Museum of | Musée canadien de la | NATURE | CMNEN 00013051"; "PAPUA NEW GUNIEA: Western | Prov. P'nvana. CI RAP Survey | Camp 1. 05°29.5S 141°32.6E | 575 m. May 2013. T. Larsen || 05/28/13 | Trap 5" "OFICANTHON | MIRABILIS | PAUL. | Dét. F. Génier, 2017" "MUST BE | Lepanus NEAR | usulatus | det T.A. WEIR 2018" "COL3182".

Redescription. Head black medially and reddish brown apically. Prothorax and elytra black. Dorsal surface glabrous. Antennal clubs light brown. **Measurements.** Total length: 5.19 mm, elytral width 3.77 mm

Head. Width to length ratio 40:26. Surface smooth and nitid with very fine punctation. Broad U-shaped area between clypeal teeth that are upturned and strongly pointed. Margin of head completely bordered, rounded. Genal

angle slightly prominent, angulate at clypeogenal suture. Clypeofrontal margin with medial impression. Dorsal part of the eyes wide, separated by an interocular space approximately 6 times eye width. Eye canthus not dividing the eye. **Prothorax.** Pronotal surface smooth, nitid and very finely punctate. Pronotum anterior angles sharp, posterolateral corners distinct, lateral edges bordered. Basal edge rounded, with a fine margin medially, margin without punctures. Hypomeral surface reticulate, hypomeral striae absent. Pronotal width to length ratio 65:42. **Elytra.** Overall, strongly convex. Surface smooth, nitid and very finely punctate, with 8 superficial, impunctate striae. Sparse golden setae. Ratio of length of the elytra along suture to maximum elytral width 65:78. Wide reticulate epipleura. **Legs.** Reddish brown. Protibia with 3 teeth on outer edge, 1 small tooth at the base of the tarsus, and 1 small ventral tooth on the basal 1/3 (Fig. 2C–D); front edge truncate with a short, broad apical digit, apical spur absent; crenulate ridge on ventral surface; trochantofemoral pit absent. Mesotibia with a brush of golden setae apically on inner edge. Metatibia with inner edge finely crenulate, nearly straight. Metatarsus with 5 tarsomeres with 2nd tarsomere the longest; basal metatarsomere lobed on inner edge. Tufts of setae present on meso- and metatrochanters. Claws simple. **Abdomen.** Pygidium reticulate with a transverse fold extending from the lateral corners, and absent in the medial half; pygidial disc with a large, flat, ovate reticulate area that does not reach the fold basally; surface with long, fine setae. Abdominal ventrites reticulate for full width; ventrite 6 finely punctate. Suture between ventrites 5 and 6 weak. **Pterothorax.** Mesoventrite very finely reticulate, virtually impunctate, notched anteriorly. Medial lobe of metaventrite very finely reticulate and virtually impunctate, broadly margined between mesocoxae. Lateral lobes of metaventrite finely reticulate, finely punctate, punctures with fine setae. Mesometaventral suture arched. Metanepisternum reticulate.

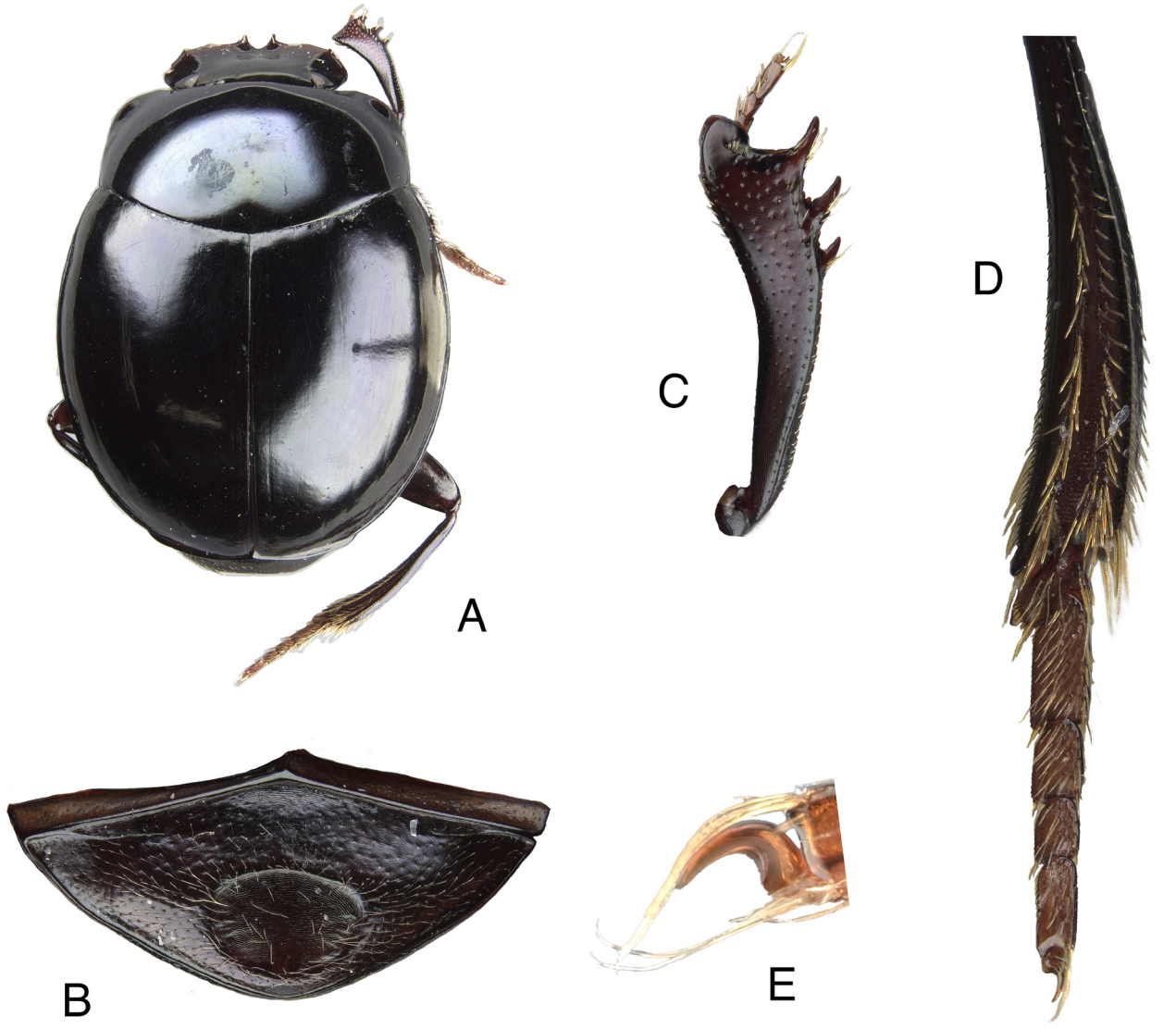

FIGURE 1. Holotype of *Lepanus mirabilis*. **A**, Dorsal habitus; **B**, pygidium; **C**, dorsal protibia; **D**, lateral metatibia; **E**, metatarsal claw. Images provided by F. Génier (CMNC).

TABLE 1. Specimens included in the phylogenetic analysis.

Genus	Species	Data Source	Identifier	COI	28s	**16s**	**18s**
Amphistomus	*complanatus*	Monaghan *et al.* 2007	NA	AY131436	AY131808	-	JN619228
Aptenocanthon	*wingar*	Gunter & Weir 2017;	COL1130	KY779776	KX986926	KX987061	KX987004
Boletoscapter	*cornutus*	Monaghan *et al.* 2007	NA	AY131632	AY131813	AY131441	JN619225
Canthonosoma	*castelnaui*	Monaghan *et al.* 2007	NA	AY131818	AY131638	AY131447	-
Cephalodesmius	*armiger*	Gunter *et al.* 2019b	COL3044	KY779825	KX986975	-	KX987043
Cephalodesmius	*laticollis*	Gunter & Weir 2017	COL3053	KY779830	KX986980	KX987091	KX987048
Coproecus	*hemisphaericus*	Monaghan *et al.* 2007	NA	AY131821	AY131641	AY131451	JN619177
Coptodactyla	*glabricollis*	Monaghan *et al.* 2007	NA	AY131863	AY131687	AY131496	JN619207
Demarziella	*mirifica*	Monaghan *et al.* 2007	NA	AY131872	AY131701	AY131512	-
Diorygopyx	*incomptus*	Gunter *et al.* 2016	COL2399	KF801955	KF802119	KF801791	-
Diorygopyx	*simpliciclunis*	Gunter *et al.* 2016	COL2396	KF801954	KF802118	KF801790	-
Endroedyolus	*paradoxus*	Monaghan *et al.* 2007	NA	GQ289981	GQ289752	GQ289701	-
Ignambia	*fasciculata*	Monaghan *et al.* 2007	NA	AY131834	AY131654	AY131463	JN619175
Lepanus	*australis*	Gunter & Weir 2017; Gunter *et al.* 2019b	COL1197	KY779779	KX986929	KX987064	KX987007
Lepanus	*globulus*	Gunter & Weir 2017	COL1136	KY779777	KX986927	KX987062	KX987005
Lepanus	*mirabilis*	current study	COL3182		OM522902		OM522903
Lepanus	*monteithi*	Gunter & Weir 2017	COL1451	KY779781	KX986931	KX987066	KX987012
Lepanus	*occidentalis*	Gunter & Weir 2017	COL964	KY779837	KX986988	KX987097	KX987056
Lepanus	*palumensis*	Gunter & Weir 2017	COL945	KY779834	KX986985	KX987094	KX987054
Lepanus	*parapisioniae*	Gunter & Weir 2017	COL775	KF801988	KF802151	KF801823	KX987051
Lepanus	*ustulatus*	Gunter & Weir 2017	COL1461	KY779785	KX986935	KX987070	KX987016
Lepanus	*vestitus*	Gunter & Weir 2017	COL1666	KY779792	KX986942	KX987076	KX987022
Lepanus	*villosus*	Gunter & Weir 2017	COL1123	KY779775	KX986925	KX987060	KX987003
Matthewsius	*penelopae*	Gunter & Weir 2017	COL1660	KY779789	KX986939	KX987073	KX987020
Matthewsius	*speewah*	Gunter & Weir 2017	COL3010	KY779809	KX986958	-	KX987026
Monoplistes	"sp. dgi1"	Monaghan et al. 2007	NA	AY131837	AY131658	AY131466	-
Monteithocanthon	*glaber*	Gunter & Weir 2017	COL1460	KY779784	KX986934	KX987069	KX987015

.....continued on the next page

TABLE 1. (Continued)

Genus	Species	Data Source	Identifier	COI	28s	**16s**	**18s**
Monteithocanthon	*paraarator*	Gunter & Weir 2017; Gunter *et al.* 2019b	COL1116	KY779773	KX986923	KX987059	KX987001
Odontoloma	*pusillum*	Monaghan *et al.* 2007	NA	AY131839	GQ289790	AY131469	-
Onthobium	*cooki*	Monaghan *et al.* 2007	NA	AY131841	AY131663	AY131471	JN619223
Outenikwanus	*tomentosus*	Monaghan *et al.* 2007	NA	GQ290023	GQ289798	GQ289748	-
Paronthobium	*simplex*	Monaghan *et al.* 2007	NA	AY131843	AY131665	AY131473	JN619173
Pseudignambia	"sp. dgi2"	Monaghan *et al.* 2007	NA	AY131846	AY131668	AY131476	-
Pseudonthobium	*fracticolloides*	Monaghan *et al.* 2007	NA	AY131847	AY131669	AY131477	JN619182
Psuedignambia	"NQ10"	Gunter & Weir 2017	COL3041	KY779824	KX986974	-	KX987042
Sauvagesinella	*becki*	Gunter *et al.* 2016; Gunter & Weir 2017	COL1220	KF801899	KF802066	KF801737	KX987010
Sauvagesinella	*monstrosa*	Gunter *et al.* 2016; Gunter & Weir 2017	COL1210	KF801898	KF802065	KF801736	KX987009
Temnoplectron	*finnigani*	Monaghan *et al.* 2007	NA	AY131851	AY131675	AY131483	JN619220
Tesserodon	*intricatum*	Gunter & Weir 2017	COL2436	KY779805	KX986954	-	-

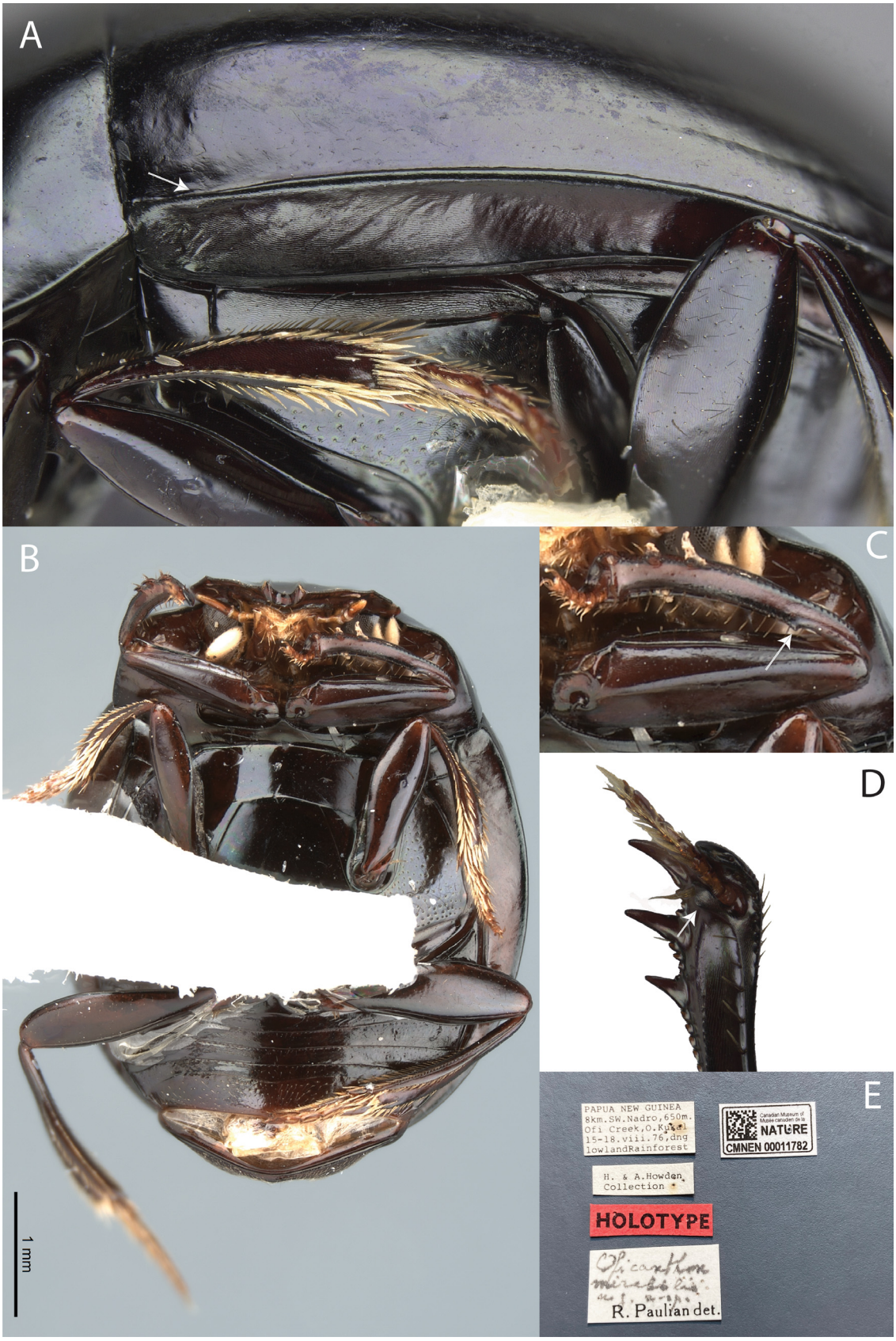

FIGURE 2. Holotype of *Lepanus mirabilis*. **A**, Lateral view of elytron, arrow points to superficial 8th stria that runs along flange like edge of elytron, dorsal to epipleuron; **B**, ventral habitus; **C**, ventral view of protibia, arrow points to small tooth; **D**, close up ventral view of protibial apex, arrow points to small tooth at base of the tarsus; **E**, labels. Images provided by F. Génier (CMNC).

Diagnosis. Can be diagnosed from most species of *Lepanus* by its large size, protibia with three teeth (Fig. 1C) and a small ventral tooth near base of the tarsus (Fig. 2D), the pygidial configuration with transverse fold, and large flat, ovoid reticulate area on the disc (Fig. 1B). *Lepanus mirabilis* can be diagnosed from other species in the *Lepanus ustulatus* species group by transverse fold on the pygidium being absent medially, and the depressed central area on the pygidal disc being distant from the transverse fold (Fig. 1B); presence of small tooth on ventral surface of the basal 1/3 of the protibia (Fig. 2C); and upturned clypeal teeth.

Geographic distribution. Papua New Guinea.

Remarks. The presence of a pygidial depression with a concave upper edge and transverse sinuate fold in conjunction with its larger size (5 mm), protibial ornamentation, and lack of hypomeral striae place this species within the informal *Lepanus ustulatus* species group (Gunter & Weir 2019), of which the Australian species were recently revised (Gunter & Weir 2021). This species will run to the *Lepanus ustulatus* species group at couplet 5 of Gunter & Weir (2019).

Paulian (1985) stated that he saw one other specimen from the same collecting event that he designated as a paratype and deposited in the MNHM. This specimen was located and confirmed to match the description given by Paulian (1985). An additional specimen labeled "Paratype" was also located in the CMNC. The species designation on the CMNC specimen is given by Paulian and the label data matches that of the holotype. It appears that this is an additional specimen Paulian examined but did not mention in the original description. The CMNC specimen is therefore not part of the type series.

The holotype is not dissected, but the shape of aedeagus of an examined specimen (CMNEN 00013051) (Fig. 3) bears a strong resemblance to the aedeagi of all other species in the *Lepanus ustulatus* species group. No female specimens were examined in this study; however, it is probable that females of *L. mirabilis* also share sexually dimorphic characters observed in other species in the *Lepanus ustulatus* species group including: protibial with apical spur arising from truncate front edge, apical digit absent; tooth on the underside of protibial smaller than in males; inner edge of metatibia not crenulate; mesotibia without a brush of setae apically (Gunter & Weir 2021).

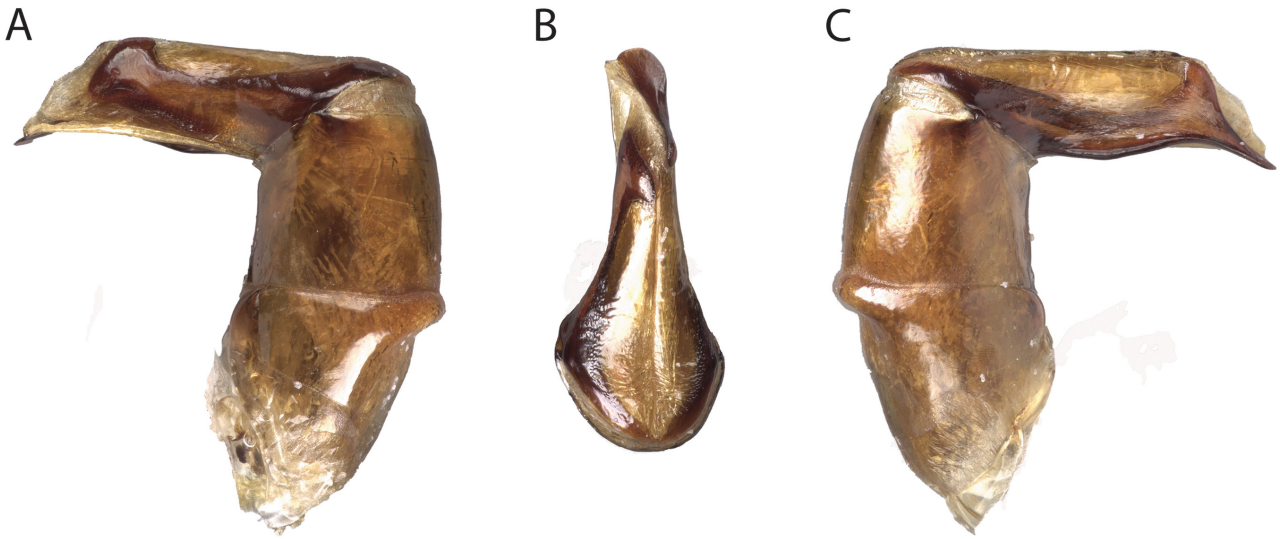

FIGURE 3. Aedeagus of *Lepanus mirabilis* (CMNEN 00013051). **A**, Left lateral view; **B**, dorsal view; **C**, right lateral view. Images provided by F. Génier (CMNC).

Phylogeny

The results of our phylogenetic reconstruction can be seen in Figure 4. The model GTR+F+I+G4 was found to best fit our data. The *Lepanus* clade, with *Lepanus mirabilis* nested within, is recovered as monophyletic with high support (98 BS). *Lepanus mirabilis* is recovered sister to *L. globulus* + *L. ustulatus* with moderate support (63 BS).

Discussion

Here, we treat *Oficanthon* as a synonym of *Lepanus* based on morphological and molecular evidence, and confirm the specimen that originally prompted our investigation was correctly identified. Paulian (1985) diagnosed *Oficanthon* from other Australasian genera (including *Lepanus*) by the presence of a wide pseudepipleuron and toothed claws. These characters are in disagreement with that of *Lepanus*, which is defined by the absence of pseudepipleuron, and with claws sometimes toothed (Matthews 1974). Upon examination of the holotype, however, it is clear that *Lepanus mirabilis* (Paulian, 1985) does not possess either character listed by Paulian (1985). Either there is confusion in homology of morphological terms or in our translation of "Élytres...., délimitant un large pseudéplipleure concave", or that Paulian may have mistaken the epipleuron for the pseudepipleuron. The *Dictionary of Insect Morphology* (Steinmann & Zombori 2012) defines the pseudepipleuron as "the outer margin of the abbreviate elytron in many Coleoptera that does not overlap with the pleuron". In Australasian endemic dung beetles, numerous genera, such as *Amphistomus* Lansberge, 1874, *Cephalodesmius* Westwood, 1841, *Mentophilus* Laporte, 1840, *Tesserodon* Hope, 1837, and *Pseudignambia* Paulian & Pluot-Sigwalt, 1984 possess distinct pseudepipleura, the abrupt deflection of the elytral surface in the same plane as the epipleura, marked by a sharp ridge, rounded fold or row of tubercles just outside of 7th striae. One or more, impressed or superficial striae are evident on the pseudepipleuron, the surface of which is usually similar to the main portion of the elytral disc. In this species, the pseudepipleuron is absent and the lateral edge of the elytron, is distinct (Fig. 2A). Paulian (1985) indicates there are seven striae present, however on close inspection it is evident a superficial 8th stria can be observed along the edge of the elytron, which could easily be missed (Fig. 2A). Paulian (1985) also considered the claws of *L. mirabilis* toothed. We disagree with this characterization and instead would consider the claws to be simple (Fig. 1E), although this is not clear without high magnification.

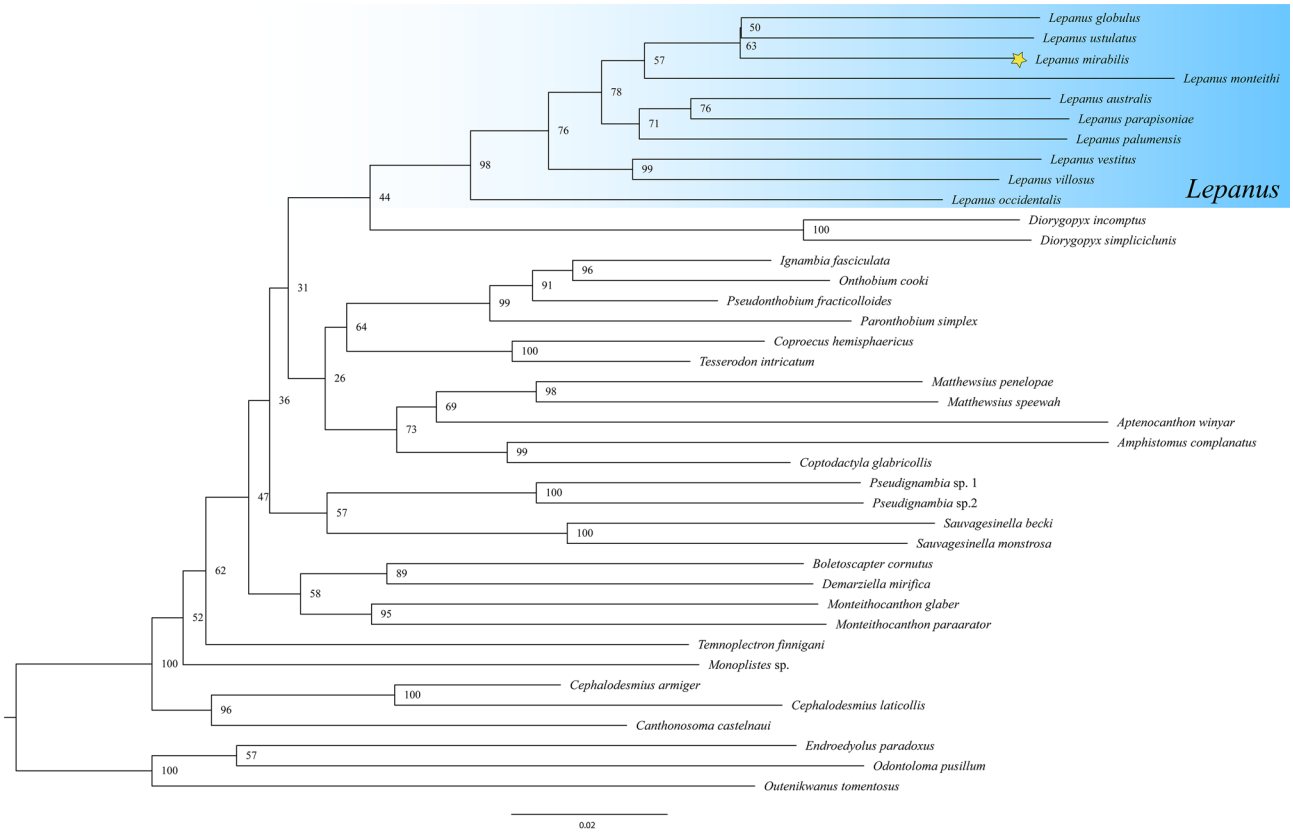

FIGURE 4. Phylogeny of Australasian endemic genera with the placement of *Lepanus mirabilis* within the genus *Lepanus* indicated by a star.

The ventrobasal protibial tooth observed in this species is not known in any other species of *Lepanus* (Fig. 2C). Our aim is to present a more natural and stable classification within Scarabaeinae and we believe this is a derived morphological character, and alone does not warrant generic separation. This is also supported by our

phylogenetic reconstruction that places *Lepanus mirabilis* within the genus *Lepanus*. Although sequencing is limited, the relationship within the *L. usutlatus* species group is supported (Fig. 4). Too few genes were sequenced to comment on the exact relationships of species, however additional work with increased gene coverage will help further resolve relationships and determine divergence of Australian and Papuan *Lepanus.*

Lepanus is the most species-rich genus in the Australasian endemic clade, with species known from Papua New Guinea and Australia. The incorporation of *L. mirabilis* into *Lepanus* increases its diversity in Papua New Guinea to include six species (Gunter *et al.* 2019a). While the type species of the genus, *L. ovatus* Balthasar, 1966 is only known from Papua New Guinea, the genus remains the most diverse in Australia.

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