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Revision of the subgenus *Orphnus* (*Phornus*) (Coleoptera, Scarabaeidae, Orphninae)

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Abstract. The Afrotropical subgenus *Phornus* Paulian, 1948 of the genus *Orphnus* MacLeay, 1819 is revised and currently comprises six species. Four new species are described: *Orphnus renaudi* sp. nov., *Orphnus valeriae* sp. nov., *Orphnus ferrierei* sp. nov. and *Orphnus parastrangulatus* sp. nov. The subgenus is characterized by the coarse stridulatory field, sclerotized plate on the second abdominal sternite near plectrum, absence of the pronotal lateral processes in males, rounded apices of the parameres and endophallus without armature, although some of these characters differ in *O. giganteus* Paulian, 1948. Symphysocery is reported for the first time for members of the Orphninae. In *O. giganteus*, the majority of specimens have malformed antennomeres. Four of the six species of *Phornus* are brachypterous and all species except for *O. giganteus* are known only from males. A key to *Phornus* species and a map of their localities are provided.

Keywords. Brachyptery, flightlessness, stridulation, symphysocery, Afrotropical Region.

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Introduction

The scarab beetle genus *Orphnus* MacLeay, 1819 comprises over 100 species — about half of the species of the subfamily Orphninae Erichson (Paulian 1948; Petrovitz 1971; Frolov 2012). The great majority of *Orphnus* species occur in the Afrotropical Region. Paulian (1948) proposed a subgeneric classification of the genus with six subgenera, including the subgenus *Phornus* for two species, *O. strangulatus* Paulian, 1948 and *O. giganteus* Paulian, 1948, described in the same paper (Paulian 1948). The diagnostic characters of *Phornus* were the absence of prothoracic armature and the "simple" shape of the parameres.

Examination of material of Orphninae housed in European museums revealed additional specimens similar to *O. strangulatus* but belonging to four undescribed species. Because both diagnostic characters of *Phornus* proposed by Paulian (1948) are sex-dependent and highly homoplastic, and the former is also subject to reasonable allometric variation in *Orphnus*, we re-evaluated the characters of the subgenus and clarified its diagnosis and species composition.

Material and methods

The material used in this work is housed in the following organizations (curators in brackets):

BMNH = The Natural History Museum, London, UK (Maxwell Barclay)
IRSNB = Belgian Royal Institute of Natural Sciences, Bruxelles, Belgium (Alain Drumont)
MCSNG = Natural History Museum Giacomo Doria, Genova (Roberto Poggi)
MHNG = Natural History Museum, Geneva, Switzerland (Giulio Cuccodoro)
MNHN = National Museum of Natural History, Paris, France (Olivier Montreuil)
MRAC = Royal Museum for Central Africa, Tervuren, Belgium (Marc De Meyer)
ZMHUB = Museum of Natural History of Humboldt-Universität, Berlin, Germany (Johannes Frisch, Joachim Willers)

Specimens were prepared by standard methods used in entomological research. Genital structures were cleared in 10% KOH, rinsed in distilled water and either air dried or placed in glycerol. Photographs were taken with a Canon D100 camera equipped with an EF-S 60 macro lens and a Leica MZ9.5 stereo microscope equipped with a Leica DFC290 digital camera from dry specimens (habitus, aedeagus) or from specimens in glycerol. Partially focused serial images were combined in Helicon Focus software (Helicon Soft Ltd.) to produce completely focused images. Helicon Focus software was used with default settings and the number of stack images varied from 20–40. Minor stacking artefacts were not retouched, only general image enhancing (levels, background elimination and slight sharpening) was applied. The locality map was prepared with ArcGIS software (ESRI Inc.). Co-ordinates of the localities were taken from the specimen labels, if available, or from the NGA GEOnet Names Server (GNS, http://earth-info.nga.mil/gns/html/index.html). Labels of the type specimens are cited verbatim and separated by a slash (/); authors' comments are in square brackets ([]). The holotypes of the new species have additional labels "HOLOTYPUS Orphnus [species] Frolov & Akhmetova 2015"; paratypes have additional labels "PARATYPUS Orphnus [species] Frolov & Akhmetova 2015"

Results

Class Hexapoda Blainville, 1816
Order Coleoptera Linnaeus, 1758
Family Scarabaeidae Latreille,1802
Subfamily Orphninae Erichson, 1847
Genus *Orphnus* MacLeay, 1819

Subgenus ***Phornus*** Paulian, 1948

Phornus Paulian, 1948: 15.

Type species

Orphnus strangulatus Paulian, 1948 (original designation).

Diagnosis

Medium sized beetles (body length 10.0–14.5 mm). Colour uniformly brown to black. Dorsal surface of body more or less densely punctate, punctation of head and pronotum denser than of elytra. Elytra with flat to slightly convex intervals, first five to seven elytral striae more or less marked as slightly depressed lines. Head armature of males as short tubercle or transverse frontoclypeal carina. Pronotal disc of males slightly flattened anteromedially in some species. Stridulatory field in males with sparse coarse carinae, separated by ¼₀ to ⅓₀ length of stridulatory field in central ⅓rd (Figs 1K, 2I). Sides of abdominal sternite 2 with more or less developed accessory plate (Figs 1G, 2H). Parameres with rounded apices in dorsal view, without lateral teeth. Endophallus without sclerotized armature.

Composition

In the present work we treat the subgenus as comprising six species: two originally described by Paulian (1948) and four new species. Petrovitz (1971) described two further species in the subgenus *Phornus*, *O. planicollis* and *O. compactus*, although he noted that they had no similarity to *O. giganteus* and *O. strangulatus*. These species have genital and stridulatory structures more similar to those of *O. bicolor* (Fabricius, 1801), the type species of *Orphnus* (sensu stricto), and therefore we transfer them to the nominotypical subgenus.

Orphnus giganteus differs from other members of the subgenus in a number of characters (see description below) and its taxonomic position needs further clarification. Until additional comparative data are available, we follow Paulian (1948) and treat this species as a member of subgenus *Phornus*.

Distribution

Members of the subgenus *Phornus* are distributed in Equatorial Africa and the majority of species apparently have allopatric ranges. Most of the known localities are south of the Congo Depression, notably on the Lunda and Katanga plateaus and the Eastern Arc Mountains (Fig. 6).

Key to the subgenus *Phornus* (males):

1. Macropterous, humeral humps well developed (Fig. 1A) ……2
– Brachypterous, humeral humps feebly marked to indistinct (Fig. 3A) ……3

2. Pronotum as wide as elytra (Fig. 1M), densely punctate; head wide, frons convex and densely punctate (Fig. 1C–D); eyes small, feebly visible in dorsal view ……***O. giganteus*** Paulian, 1948
– Pronotum narrower than elytra (Fig. 1N), sparsely punctate on disc; head narrower, frons concave and sparsely punctate (Fig. 2C–D); eyes large ……***O. renaudi*** sp. nov.

3. Frontoclypeal process tubercle-shaped or horn-shaped, not sinuate medially (Figs 3B–C, 4H–I). Disc of pronotum somewhat flattened anteriorly; parameres more or less tapering apically (in lateral view) ……4
– Frontoclypeus with a low transverse keel, from ½ to almost whole head width (Fig. 5B–C, J–K); keel may be feebly sinuate medially; disc of pronotum more or less convex, not flattened anteriorly; parameres rounded apically (in lateral view)……5

4. Pronotum larger (Fig. 1P), more densely punctate, punctures on disc somewhat elongated (Fig. 3A); pronotum without longitudinal medial stria basally; frontoclypeal process horn-shaped; parameres more strongly sclerotized, with acute apices (in lateral view, Fig. 3D) ……***O. valeriae*** sp. nov.
– Pronotum smaller (Fig. 1O), more sparsely punctate with rounded punctures (Fig. 4A); pronotum with distinct medial longitudinal stria basally; frontoclypeal process tubercle-shaped; parameres less sclerotized, with angulate apices (in lateral view, Fig. 4F) ……***O. ferrierei*** sp. nov.

5. Frontoclypeus with a low transverse keel, almost as wide as frontoclypeus (Fig. 5B–C); anterior margin of clypeus somewhat rounded, keel-shaped; abdomen shorter and somewhat convex ventrally (in lateral view contour of abdominal sternites is somewhat rounded) …***O. parastrangulatus*** sp. nov.
– Frontoclypeus with a higher transverse keel, slightly sinuate medially, about half the length of frontoclypeus (Fig. 5J–K); anterior margin of clypeus somewhat rectangular, sharp; abdomen longer and almost flat (in lateral view contour of abdominal sternites is almost straight) …… ……***O. strangulatus*** Paulian, 1948

Orphnus* (*Phornus*) *giganteus Paulian, 1948
Figs 1A–M, 6

Diagnosis

Orphnus giganteus is easily distinguished from other *Phornus* species by the characteristic sculpture of the head and pronotum, small eyes, and parameres with excavations on the ventral side. From all species except for *O. renaudi* sp. nov. it also differs in having well developed wings.

Material examined

Holotype
ZAMBIA: ♂, with label "N.W. Rhodesia [Zambia]" (MNHN).

Paratype
DEMOCRATIC REPUBLIC OF CONGO: 1 ♀, Lulua, Kapanga, Oct. 1932, F.G. Overlaet (MRAC).

Additional material
DEMOCRATIC REPUBLIC OF CONGO: 5 ♂♂, Lulua, Sandoa, Nov. 1931, F.G. Overlaet (MRAC); 1 ♂, same locality, Oct.–Dec. 1932, F.G. Overlaet (MRAC); 3 ♂♂, 1 ♀, same locality, Oct. 1931, F.G. Overlaet (MRAC); 1 ♂, same locality, Dec. 1930, F.G. Overlaet (MRAC); 4 ♂♂, 2 ♀♀, same locality, 1 Nov. 1920, F.G. Overlaet (MRAC); 2 ♂♂, 2 ♀♀, Lulua, Kapanga, Sep. 1933, F.G. Overlaet (MNHN); same locality, Oct. 1933, F.G. Overlaet, 1 ♂, 7 ♀♀ (MRAC), 1 ♀ (MNHN); 3 ♂♂, 3 ♀♀, same locality, Oct. 1932, F.G. Overlaet (MRAC); 2 ♂♂, 3 ♀♀, same locality, Sep. 1932, F.G. Overlaet (MRAC); 1 ♀, same locality, Nov. 1933, F.G. Overlaet (MRAC); 1 ♂, 12 ♀♀, same locality, Nov. 1932, F.G. Overlaet (MRAC); 3 ♀♀, same locality, Dec. 1931, F.G. Overlaet (MRAC); 2 ♀♀, same locality, Dec. 1933, F.G. Overlaet (MRAC); 1 ♂, same locality, Dec. 1932, F.G. Overlaet (MRAC); Lulua, Tshibamba, Dec. 1931, F.G. Overlaet, 2 ♂♂, 2 ♀♀ (MRAC), 1 ♂ (MCSNG); 1 ♂, same locality, Mar. 1932, F.G. Overlaet (MRAC); 1 ♀, Katanga, Kafakumba, Dec. 1930, F.G. Overlaet (MRAC); 1 ♂, same locality, Oct. 1931, F.G. Overlaet (MRAC); 1 ♀, same locality, Dec. 1932, F.G. Overlaet (MRAC); 1 ♀, same locality, Oct. 1932, F.G. Overlaet (MRAC); 1 ♀, same locality, Jan. 1931, F.G. Overlaet (MRAC); 1 ♀, Katanga, Elisabethville [Lubumbashi], Nov. 1911, (MRAC); 1 ♂, Lulua, Tshibalaka, 9 Nov. 1933, F.G. Overlaet (MRAC); 1 ♀, same locality, Oct. 1933, F.G. Overlaet (MRAC); 2 ♀♀, same locality, Dec. 1933, F.G. Overlaet (MRAC); 2 ♂♂, Lulua, Lunkinda River, Sep. 1933, F.G. Overlaet (MRAC); 2 ♂♂, Luashi, Nov. 1938, F. Freyne (MRAC); 1 ♀, Sankuru, Gandajika, Dec. 1953, P. de Francquen (MRAC); 1 ♀, Kasai, Lula, 1958, A.J. Jobaert (MRAC); 1 ♂, Lulua, Katombe, 13 Nov. 1933, F.G. Overlaet (MNHN); 1 ♂, Lulua, Luiza River, 15 Oct. 1933 F.G. Overlaet (MRAC); 1 ♀, same locality, 16 Oct. 1933, F.G. Overlaet (MRAC); 1 ♂, Lomami, Kamina, 1931, R. Massart (MHNG); 1 ♂ and 2 ♀♀, Kaniama, 1931, R. Massart (MRAC); 1 ♂, Lulua, Kalani River [not traced], 14 Oct. 1933, F.G. Overlaet (MHNG). ZAMBIA: Abercorn [Mbala], 15 Dec. 1943, H.J. Bredo, 6 ♂♂, 2 ♂♂ (MRAC), 1 ♂ (IRSNB); 2 ♂♂, 1 ♀, same locality, 19 Jun. 1943, H.J. Bredo (MRAC); 1 ♂, same locality, Dec. 1943, H.J. Bredo (MRAC); 2 ♂♂, same locality, Nov. 1943, H.J. Bredo (MRAC); 1 ♀, Mpika, Jan. 1908, S. Neave (MRAC); 2 ♂♂, 1 ♀, with the same locality as holotype (MNHN).

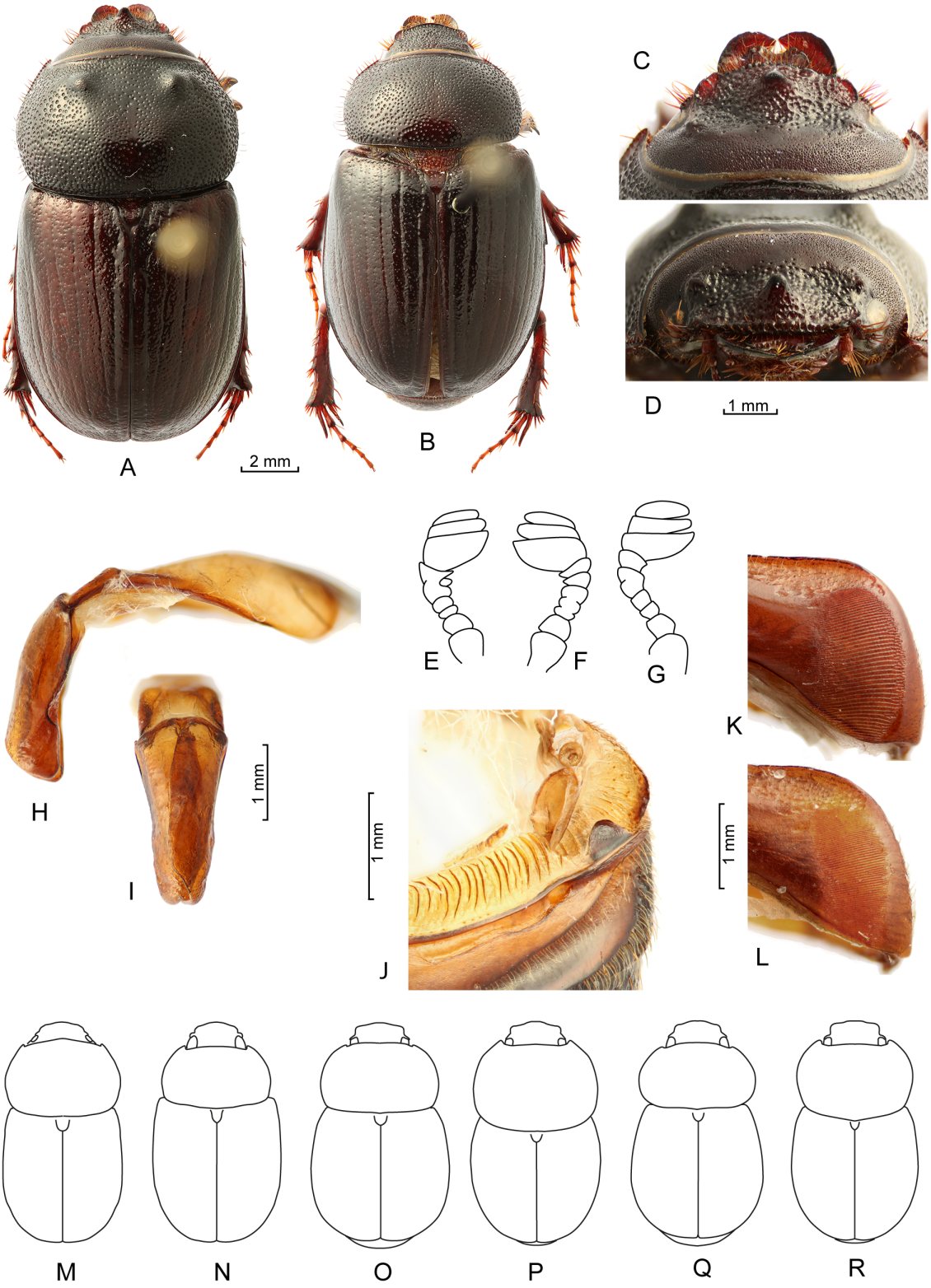

Fig. 1. — **A–M**. *Orphnus giganteus* Paulian, 1948. **A–B**. Habitus. **C–D**. Head in dorsal and apical view. **E–G**. Antennae. **H**. Aedeagus in lateral view. **I**. Parameres in dorsal view. **J**. Abdomen in dorsal view. **K–L**. Stridulatory field. **M**. Habitus. — **N**. *O. renaudi* sp. nov., holotype, habitus. — **O**. *O. ferrierei* sp. nov., holotype, habitus. — **P**. *O. valeriae* sp. nov., holotype, habitus. — **Q**. *O. parastrangulatus* sp. nov., holotype, habitus. — **R**. *O. strangulatus* Paulian, 1948, habitus. M–R = not to scale.

Description

Male (Fig. 1A)

Body length 10.0–14.5 mm. Colour uniformly brown to black.

Anterior margin of frontoclypeus slightly convex in middle, serrate and setose, without distinct border (Fig. 1C). Frontoclypeus with process near anterior margin, varying for conical tubercle to small horn (Fig. 1D). Eye tubercles more or less developed. Frontoclypeus rugose anteriorly up to eye tubercles, including base of frontoclypeal process, convex and finely but densely punctate behind eyes.

Eyes small: width about 1/15 distance between eyes in dorsal view. Antennae 10-segmented, with malformed segments. In the majority of specimens antennomeres 5 and 6 partly fused (Fig. 1G). In one specimen the malformations are asymmetrical: the left antenna has antennomeres 5–7 partly fused (Fig. 1E) while the right has antennomeres 3–5 partly fused (Fig. 1F).

Pronotum widely rounded laterally, as wide as elytra (Fig 1M). Anterior border wide, with somewhat undulate or serrate posterior margin. Basal border narrow, keel-shaped, separated from pronotal disc by deep groove with irregular punctation. Pronotal disc anteromedially flattened, with two distinct rounded tubercles in majority of specimens (Fig. 1A). Pronotum covered with dense rounded punctures.

Scutellum subtriangular, rounded apically, about 1/12 length of elytra.

Elytra 1.1 times longer than wide, with distinct humeral humps. Elytra widest in middle, lateral margins almost parallel in basal half. First seven striae feebly distinct as shallow grooves, somewhat shagreened in most specimens. Elytral intervals covered with relatively smaller punctures, much finer than those on pronotum.

Macropterous.

Stridulatory field: carinae separated by 1/39 length of field in central 1/3rd (Fig. 1K).

Abdominal sternite 8 medially longer than sternites 6 and 7 combined; sternite 6 about as long as sternite 7. Pygidium almost invisible from above, with slightly truncate apex. Plectrum triangular with rounded apex, wider than long (Fig. 1J). Lateral plate of second abdominal sternite is less distinct than in other *Phornus* species, situated more laterally and appears as sharp lateral edge of sternite.

Aedeagus with relatively long parameres (0.68 length of phallobase), somewhat angulate and rounded apically in dorsal and lateral view (Fig. 1H–I), with excavations on ventral side of parameres.

Female (Fig. 1B)

Female differs from the male in having a relatively smaller pronotum without tubercles, frontoclypeus uniformly densely punctured, without convexity and process, prothoracic spur, finer stridulatory area (carinae separated by 1/57 of field in central 1/3rd, Fig. 1L), smaller plectrum, less distinct abdominal lateral plate, and pygidium with rounded apex. Body length of examined specimens varies from 11.0–14.5 mm.

Distribution

O. giganteus is known from a number of localities chiefly on the Katanga Plateau (Fig. 6).

Orphnus* (*Phornus*) *renaudi sp. nov.
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Figs 1N, 2, 6

Diagnosis

Orphnus renaudi sp. nov. differs from the other macropterous *Phornus* species (*O. giganteus*) in having the pronotum relatively smaller and narrower than elytra, sparsely punctate disc of pronotum, narrower head with concave and sparsely punctate frons, and larger eyes.

Etymology

This species is named after Renaud Paulian.

Material examined

Holotype
NIGERIA: ♂, "Old Calabar [Calabar, Nigeria]" (MNHN).

Paratypes
NIGERIA: 2 ♂♂ with the same locality label as the holotype and "PARATYPUS Orphnus renaudi Frolov & Akhmetova 2015" (MNHN).

CAMEROON: 1 ♂, "Camaroons [probably foothills of Mount Cameroon]" (MNHN).

1 ♂ without locality labels (BMNH).

Description

Holotype (Fig. 2A)
Body length 13 mm. Colour uniformly dark brown.

Anterior margin of frontoclypeus slightly convex in middle, slightly sinuate beside medial convexity, rounded laterally, with a narrow border (Fig. 2C). Frontoclypeus with a low transverse bimodal process medially approximately in middle of a line connecting anterior margins of eyes and anterior margin of frontoclypeus (Fig. 2D). Frontoclypeus slightly concave behind process, punctate with rounded punctures separated by 1–3 puncture diameters in the anterior part and more sparsely behind the frontoclypeal process.

Eyes relatively large: width about ⅕ distance between eyes in dorsal view. Antennae 10-segmented, without malformed segments.

Pronotum widely rounded laterally, narrower than elytra (Fig. 1N). Anterior border wide, with smooth posterior margin. Basal border narrow, keel-shaped, separated from pronotal disc by a deep groove having a row of coarse elongated punctures. Pronotal disc anteromedially slightly flattened, punctate. Sides with coarser punctures than disc, rounded to somewhat elongated. Disc almost smooth in basal half, with minute punctation.

Scutellum subtriangular, narrowly rounded apically, about 1⁄11 length of elytra.

Elytra 1.1 times longer than wide, with distinct humeral humps, widest in middle, with lateral margins almost parallel in basal half. First five striae feebly distinct as shallow densely punctured grooves. Laterad of fifth elytral stria, punctation is more uniform with relatively dense, rounded punctures.

Macropterous.

Stridulatory field with carinae separated by 1⁄33 length of field in central 1⁄3rd (Fig. 2I).

Abdominal sternite 8 medially longer than sternites 6 and 7 combined; sternite 6 slightly shorter than sternite 7. Pygidium almost not visible from above, with rounded apex. Plectrum trapezoidal, slightly longer than wide (Fig. 2H). Lateral plate of second abdominal sternite well developed, sclerotized, about length of plectrum, with rounded apex.

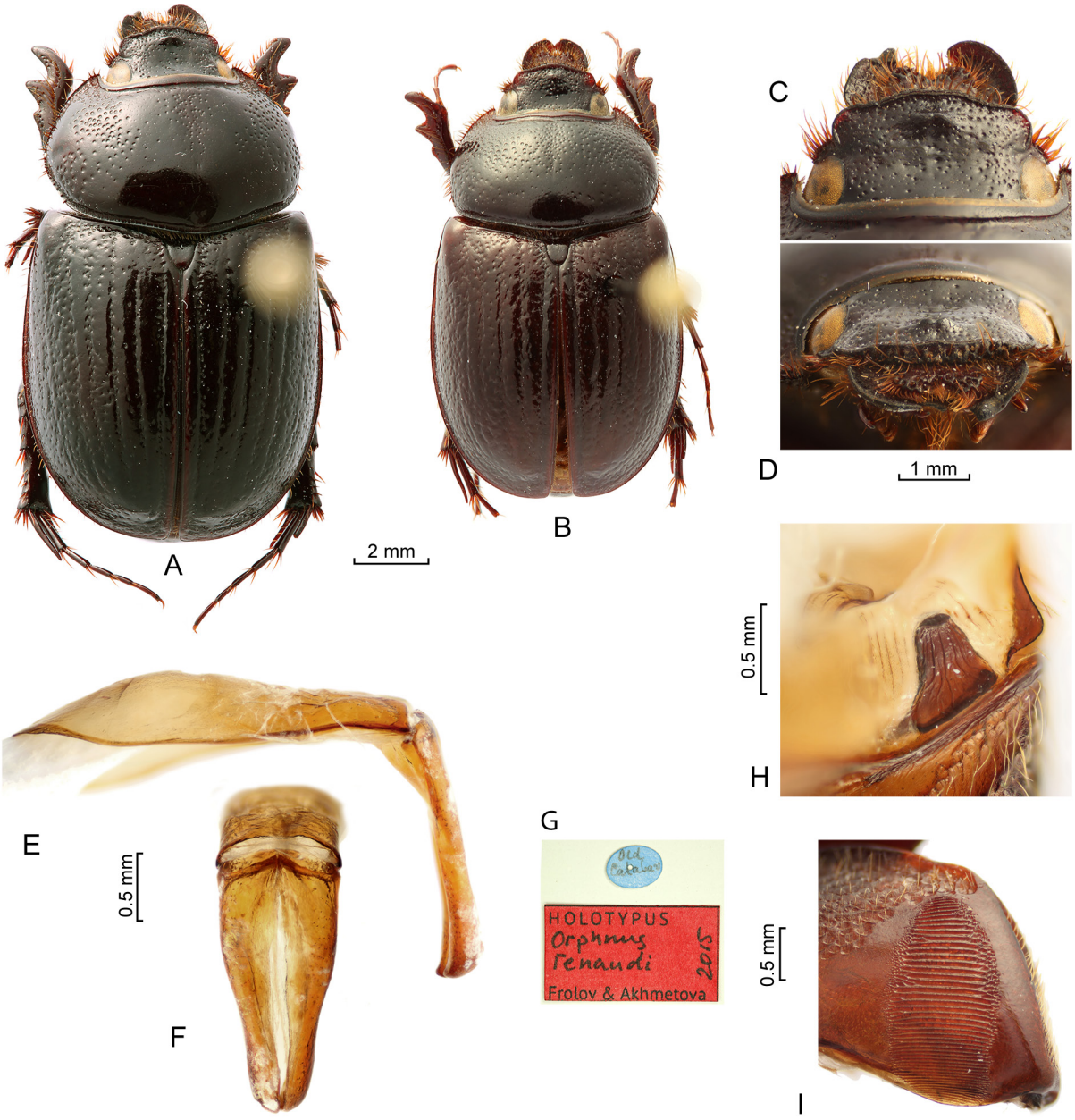

Fig. 2. *Orphnus renaudi* sp. nov. **A–B**. Habitus. **C–D**. Head in dorsal and apical view. **E**. Aedeagus in lateral view. **F**. Parameres in dorsal view. **G**. Labels of holotype. **H**. Abdomen in dorsal view. **I**. Stridulatory field. A, C–D, G. Holotype. B, E–F, H–I. Paratypes.

Aedeagus with relatively long parameres (0.65 length of phallobase, Fig. 2E–F), narrowly rounded apically in dorsal and lateral view, without excavations.

Female

Unknown.

Variation

Body length of the paratypes varies from 11.5–14.0 mm. In the smallest paratype the frontoclypeal process is feebly developed (Fig. 2B).

Distribution

The distribution and habitat of *O. renaudi* need further clarification. The only exact locality label, "Old Calabar" (modern town of Calabar, Nigeria) suggests that the holotype and two paratypes were collected in the coastal area near the Cross River estuary (Fig. 6). It is possible, however, that the specimens were collected inland of the town of Calabar, in the foothills of Western High Plateau. Another locality, "Camaroons", may refer to foothills of Mount Cameroon or the state of Cameroon.

Remarks

One paratype of *O. renaudi* sp. nov. from Calabar bears the label "Brachyorphnus ferrierei n. sp. R. Paulian det. / ALLOTYPE", and another specimen designated below as the holotype of *O. ferrierei* sp. nov., bears the label "Brachyorphnus ferrierei n.sp. R. Paulian det. / HOLOTYPE". Apparently Paulian considered the two specimens as conspecific and provisionally labelled them as a female and a male of a taxon he intended to describe, but his name "*Brachyorphnus ferrierei*" was not published.

Orphnus* (*Phornus*) *valeriae sp. nov.

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Figs 1P, 3, 6

Diagnosis

Orphnus valeriae sp. nov. is most similar to *O. ferrierei* sp. nov., but can be separated from it in having pronotum larger and more densely punctate with somewhat elongated punctures, no distinct median longitudinal stria basally on pronotum, frontoclypeal process horn-shaped, and more strongly sclerotized parameres with acute apices (in lateral view).

Etymology

We named this species after our daughter Valeria.

Material examined

Holotype

TANZANIA: ♂, "TANZANIA 200m Zaraninge Coastal Forest. Saadani N.P. 10 xi. 1994 Pitfall Trap University of DSM coll. / BMNH(E) 2010-91 / BMNH(E) #1031110 / Orphnus sp. S. Pokorný det 2011" (BMNH).

Paratypes

TANZANIA: 8 ♂♂ with the same locality label as the holotype; 4 ♂♂, "TANZANIA 200m Zaraninge Coastal Forest, Saadani N.P., S.Pools x-xi.1994 Pitfall Trap UDSM coll. / BMNH(E) 2012-92 / Orphnus sp. 2 S. Pokorný det. 2014" (BMNH); 7 ♂♂ "TANZANIA, Mbwebwe, Zaraninge, Saadani N.P., ix.-xi.1995, UDSM coll./ BMNH(E) 2013-71 / Orphnus sp.1 S. Pokorný det. 2015" (BMNH);

5 ♂♂, "TANZANIA 2005 Udzungwa Mts. UDSM coll." (BMNH); 1 ♂, "Mkatta Steppe [Tanzania] III.12" (ZMHUB).

Description

Holotype (Fig. 3A)

Body length 11.6 mm. Colour uniformly blackish brown.

Anterior margin of frontoclypeus slightly convex in the middle, slightly sinuate aside the medial convexity, rounded laterally, with a narrow border (Fig. 3B). Frontoclypeus with a trapezoidal transverse process medially approximately on the line connecting anterior margins canthi (Fig. 3C). Frontoclypeus finely punctate anteriad of the process and coarsely punctate with elongated punctures posteriad of the process.

Eyes relatively large: width about ⅕ the distance between eyes in dorsal view. Antennae 10-segmented, without malformed segments.

Pronotum widely rounded laterally, almost as wide as elytra, 1.4 times wider than length, 0.75 length of elytra (Fig. 1P). Anterior border wide, with smooth posterior margin. Basal border narrow, keel-shaped, separated from pronotal disc by a smooth groove. Pronotal disc anteromedially distinctly flattened and slightly concave. Surface of pronotum covered with dense, coarse, rounded to elongated punctures except for a V-shaped almost smooth and slightly convex area in the centre.

Scutellum subtriangular, narrowly rounded apically, about ⅓ the length of elytra.

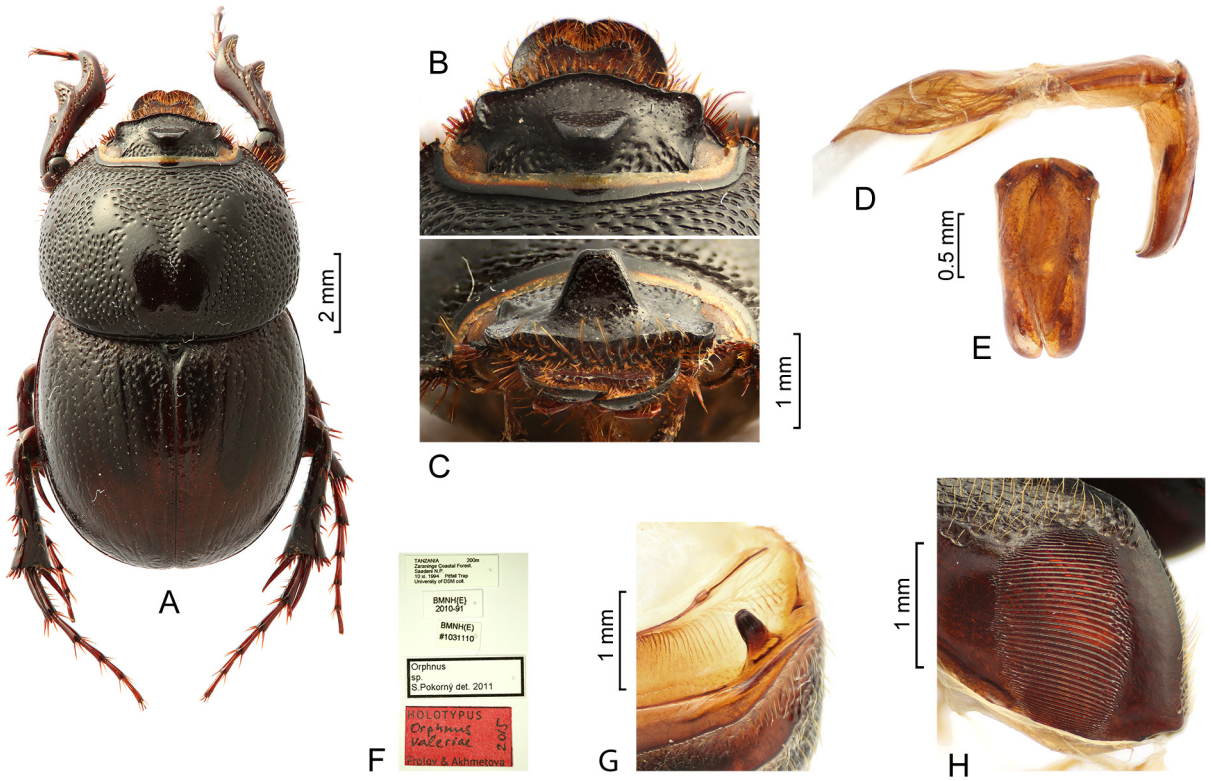

Fig. 3. *Orphnus valeriae* sp. nov. **A**. Habitus. **B–C**. Head in dorsal and apical view. **D**. Aedeagus in lateral view. **E**. Parameres in dorsal view. **F**. Labels of holotype. **G**. Abdomen in dorsal view. **H**. Stridulatory field. A–F. Holotype. G–H. Paratypes.

Elytra 1.07 times wider than long, without humeral humps. Elytra widest in basal ⅓, with widely rounded lateral margins. First five striae faintly visible as very shallow grooves, without rows of punctures. Elytra covered with rather sparse punctures becoming denser towards the base; sculpture of the base is rasp-shaped.

Brachypterous. Wings vestigial, narrow, about ⅔ the length of elytra.

Stridulatory field: carinae separated by 1⁄30 length of the field in central ⅓rd (Fig. 3H).

Abdominal sternite 8 medially longer than sternites 6 and 7 combined; sternites 6 and 7 approximately of the same length. Pygidium feebly visible from above. Plectrum trapezoidal, elongated (Fig. 3G). Lateral plate of the second abdominal sternite relatively small, shorter than plectrum, with acute apex.

Aedeagus with relatively long parameres (0.58 length of phallobase). Apices of the parameres widely rounded in dorsal view and acute, slightly curved downwards in lateral view, without excavations (Fig. 3D–E).

Female

Unknown.

Variation

Body length of paratypes varies from 11.0–12.5 mm. In one specimen, antennomeres 5 and 6 are partly fused. The variation in body size, shape and size of the frontoclypeal process and in the sculpture of the pronotum is notably small among the reasonably large type series.

Distribution

The species is known from three localities, two in the foothills of the Eastern Arc Mountains and one in coastal forest some 40 km inland (Fig. 6).

Orphnus* (*Phornus*) *ferrierei sp. nov.

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Figs 1O, 4, 6

Diagnosis

Orphnus ferrierei sp. nov. is most similar to *O. valeriae* sp. nov., but can be separated from it in having pronotum smaller and more sparsely punctate with rounded punctures, distinct medial longitudinal stria basally on pronotum, frontoclypeal process tubercle-shaped, and less sclerotized parameres with angulate apices (in lateral view).

Etymology

This species is named after Pierre-Alfred Ferrière, collector of the type series.

Material examined

Holotype

CENTRAL AFRICAN REPUBLIC: ♂, “MUSEUM PARIS CONGO FRANC. HAUTE-SANGA [South-Western Central African Republic] P. A. FERRIÈRE 106-97 / Brachyorphnus ferrierei n.sp. R. Paulian det. / HOLOTYPE” (MNHN).

Paratypes

CENTRAL AFRICAN REPUBLIC: 2 ♂♂ with the same locality label as the holotype (MNHN).

Description

Holotype (Fig. 4A)
Body length 14 mm. Colour uniformly brown.

Anterior margin of frontoclypeus slightly convex in middle, slightly sinuate each side of medial convexity, rounded laterally, with a narrow border (Fig. 4H–I). Frontoclypeus with conical, tubercle-shaped transverse process medially approximately in middle of line connecting anterior margins of eyes and anterior margin of frontoclypeus. Frontoclypeus somewhat rugose anteriad of process and coarsely punctate posteriad of process.

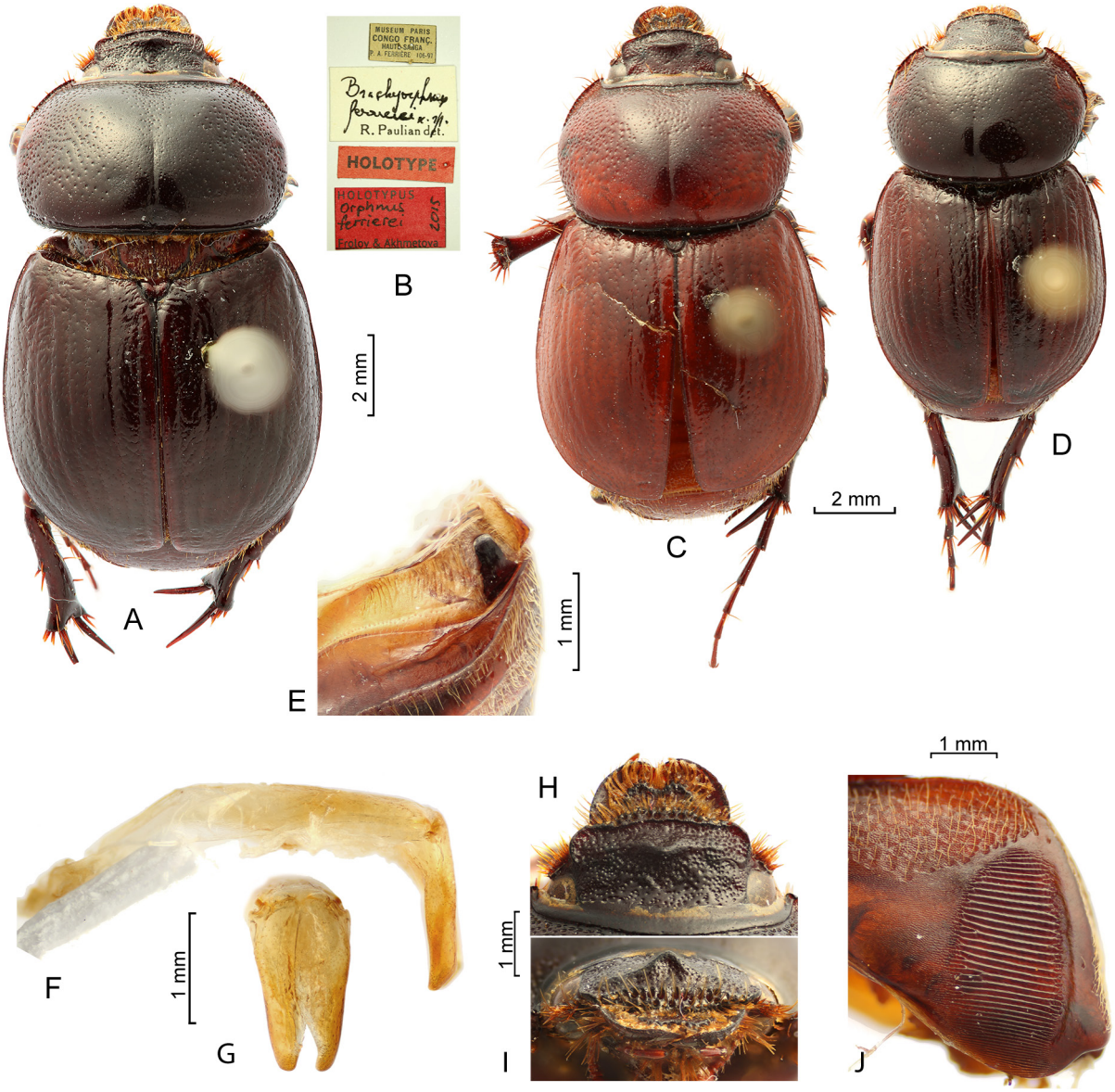

Fig. 4. *Orphnus ferrierei* sp. nov. **A**, **C–D**. Habitus. **B**. Labels of holotype. **E**. Abdomen in dorsal view. **F**. Aedeagus in lateral view. **G**. Parameres in dorsal view. **H–I**. Head in dorsal and apical view. **J**. Stridulatory field. A–B, F–I. Holotype. C–E. Paratypes.

Eyes relatively large: width about 1/5.6 distance between eyes in dorsal view. Antennae 10-segmented, without malformed segments.

Pronotum widely rounded laterally, almost as wide as elytra, 1.6 times wider than length, 0.55 length of elytra (Fig. 1O). Anterior border wide, with almost smooth posterior margin. Basal border narrow, keel-shaped, separated from pronotal disc by a smooth groove. Pronotal disc anteromedially slightly flattened. Surface of pronotum covered with double puncturation composed of large rounded and minute punctures; large punctures cover sides of pronotum and a smaller area anteromedially.

Scutellum rounded apically, about 1/16 length of elytra.

Elytra 1.08 times wider than long, with feeble marked humeral humps. Elytra widest approximately in middle, with widely rounded lateral margins. First six striae faintly visible as very shallow grooves, without distinct rows of punctures. Elytra covered with sparse punctures becoming slightly coarser towards base.

Brachypterous. Wings vestigial, narrow, about 2/3 length of elytra.

Stridulatory field: carinae separated by 1/30 length of field in central 1/3rd (Fig. 4J).

Abdominal sternite 8 medially slightly longer than sternites 6 and 7 combined; sternites 6 slightly longer than sternite 7. Pygidium visible from above, rounded apically. Plectrum trapezoidal, elongated (Fig. 4E). Lateral plate of second abdominal sternite relatively small, shorter than plectrum, with rounded apex.

Aedeagus with relatively long parameres (0.53 length of phallobase). Apices of parameres narrowly rounded in dorsal view and lateral view, without excavations (Fig. 4F–G).

Female

Unknown.

Variation

Paratypes (Fig. 4C–D) are lighter coloured than holotype, with smaller frontoclypeal processes. Body length 10.0 and 12.5 mm.

Distribution

O. ferrierei sp. nov. is known from Haute-Sangha, modern Mambéré-Kadéï prefecture of the Central African Republic (Fig. 6). The region is a low-elevation plateau and a transition zone between Northern Congolian forest-savannah mosaic and Northwestern Congolian lowland forests ecoregions.

Orphnus* (*Phornus*) *parastrangulatus sp. nov.

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Figs 1Q, 5A–H

Diagnosis

Orphnus parastrangulatus sp. nov. is most similar to *O. strangulatus* but can be separated from it in having a long transverse keel on frontoclypeus, relatively shorter pronotum and more rounded elytra, shorter and somewhat convex ventrally abdomen (in lateral view contour of abdominal sternites is somewhat curved).

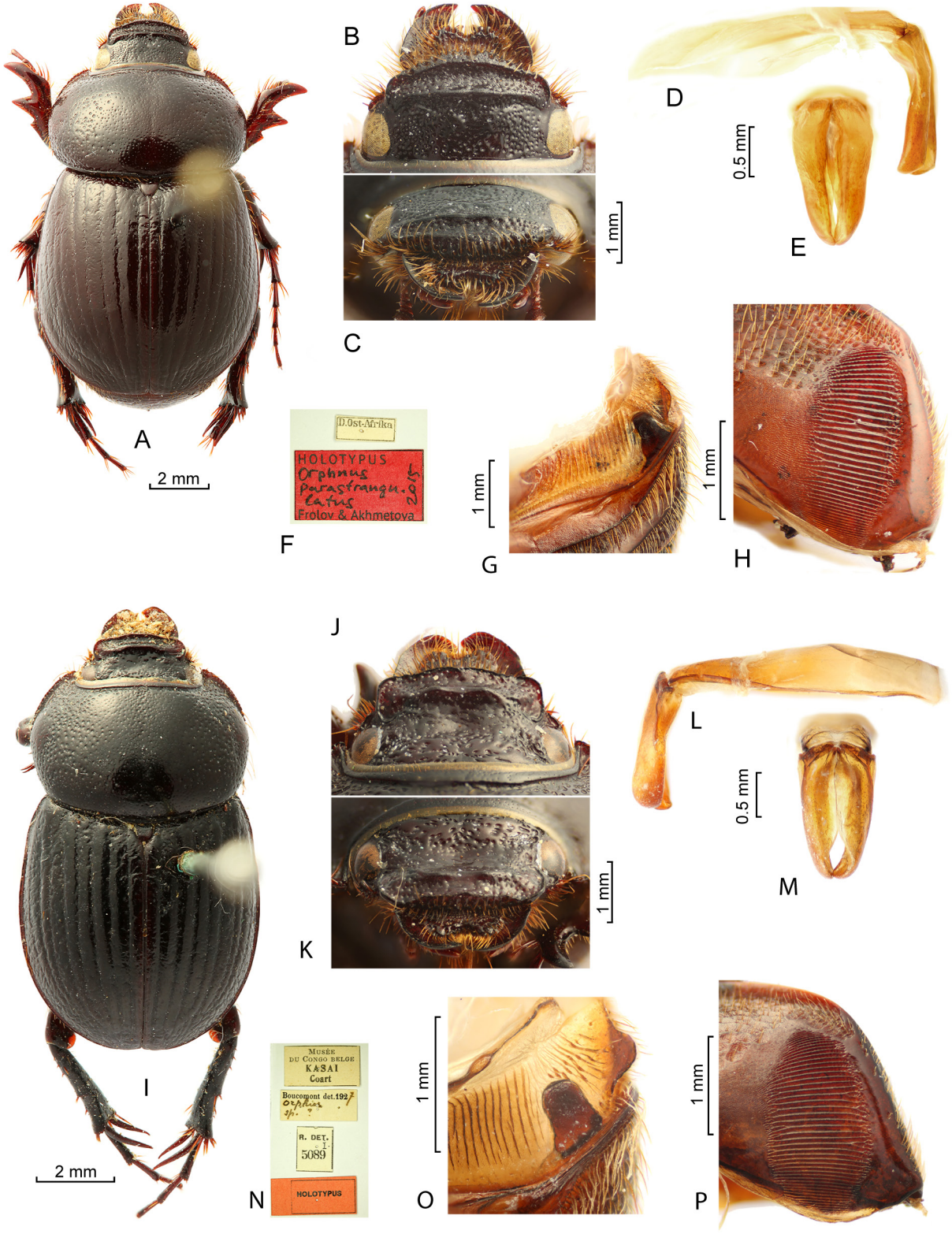

Fig. 5. — **A–H**. *O. parastrangulatus* sp. nov. **A**. Habitus. **B–C**. Head in dorsal and apical view. **D**. Aedeagus in lateral view. **E**. Parameres in dorsal view. **F**. Label of holotype. **G**. Abdomen in dorsal view. **H**. Stridulatory field. — **I–P**. *O. strangulatus* Paulian, 1948. **I**. Habitus. **J–K**. Head in dorsal and apical view. **L**. Aedeagus in lateral view. **M**. Parameres in dorsal view. **N**. Label of holotype. **O**. Abdomen in dorsal view. **P**. Stridulatory field. A–H, I, N. Holotypes.

Etymology

From Greek "παρά" and "strangulatus" for close relations with *O. strangulatus*.

Material examined

Holotype

TANZANIA: ♂, "D. Ost-Afrika [Tanzania]" (ZMHUB).

Description

Holotype (Fig. 5A)

Body length 12.5 mm. Colour uniformly dark brown.

Anterior margin of frontoclypeus convex, rounded laterally, with a keel-shaped border (Fig. 1B–C). Frontoclypeus with low transverse carina approximately on the line connecting anterior margins of canthi. Frontoclypeus densely punctate anteriad and posteriad of the carina.

Eyes relatively large: width about 1/5.5 the distance between eyes in dorsal view. Antennae 10-segmented, without malformed segments.

Pronotum widely rounded laterally, narrower than elytra, 1.8 times wider than length, 0.5 length of elytra (Fig. 1Q). Anterior border wide, with almost smooth posterior margin. Basal border narrow, keel-shaped, separated from pronotal disc by a smooth groove. Pronotal disc anteromedially slightly flattened. Surface of pronotum covered with double puncturation composed of large rounded and minute punctures; large punctures cover sides of the pronotum and area near anterior border.

Scutellum narrowly rounded apically, about 1/16 the length of elytra.

Elytra about as wide as long, with feeble marked humeral humps. Elytra widest approximately in the middle, with widely rounded lateral margins. First six striae faintly visible as very shallow grooves, without distinct rows of punctures. Elytra covered with sparse punctures becoming slightly coarser towards base.

Brachypterous. Wings vestigial, narrow, about 2/3 the length of elytra.

Stridulatory field: carinae separated by 1/30 length of the field in central 1/3rd (Fig. 5H).

Abdomen 1.4 times wider than long (measured in ventral view from anterolateral margins of sternite 2 to apex of pygidium). Abdominal sternite 8 medially about as long as sternites 5–7 combined; sternite 7 very narrow medially. Pygidium visible from above, with rounded apex. Plectrum trapezoidal, elongated, with widely rounded apex (Fig. 5G). Lateral plate of abdominal sternite relatively small, shorter than plectrum, with rounded apex.

Aedeagus with relatively long parameres (0.5 length of phallobase), without excavations. Apices of the parameres rounded in dorsal and lateral view (Fig 5D–E).

Female

Unknown.

Distribution

The only type specimen lacks precise information of the collecting locality except for a reference to "Deutsch Ostafrika", the area corresponding to modern Tanzania, Burundi and Rwanda.

Orphnus* (*Phornus*) *strangulatus Paulian, 1948
Figs 1R, 5I–P, 6

Diagnosis

Orphnus strangulatus is most similar to *O. parastrangulatus* sp. nov. but can be separated from it in having frontoclypeus with higher transverse keel, slightly sinuate medially, about half as long as frontoclypeus, and abdomen longer and almost flat (in lateral view contour of abdominal sternites is almost straight).

Material examined

Holotype

DEMOCRATIC REPUBLIC OF CONGO: ♂, "MUSÉE DU CONGO BELGE KASAI [Democratic Republic of Congo] Coart / Boucomont det. 1927 Orphnus sp. ? / R. DET. 5089 / HOLOTYPUS" (MRAC).

Other material examined

DEMOCRATIC REPUBLIC OF CONGO: 2 ♂♂, Kasai, Luebo, 1 Apr. 1959, F. Francois (MHNG); 1 ♂, same locality, Oct. 1959, F. Francois (MRAC); 1 ♂, same locality, Dec. 1958, F. Francois (MRAC); 1 ♂, Kondue (BMNH); 2 ♂♂, Sankuru, Bena Bendi, Jan. 1895, L. Cloetens (IRSNB); 2 ♂♂, Mukenge Pogga (ZMHUB).

ZAMBIA: 1 ♂, Madona, Dec. 1907, Sh. Neave (MNHN).

Description

Male (Fig. 5I)

Body length 10.5–13.5 mm. Colour uniformly dark brown to black.

Anterior margin of frontoclypeus feebly convex medially, rounded laterally, with a keel-shaped border (Fig. 5J– K). Frontoclypeus with low transverse carina slightly sinuate medially, about half as long as frontoclypeus, approximately on the line connecting anterior margins of canthi. Frontoclypeus concave and coarsely punctate posteriad of the carina.

Eyes relatively large: width about 1/5.3 the distance between eyes in dorsal view. Antennae 10-segmented, without malformed segments.

Pronotum widely rounded laterally, narrower than elytra, 1.5 times wider than length, 0.6 length of elytra (Fig. 1R). Anterior border wide, with almost smooth posterior margin. Basal border narrow, keel-shaped, separated from pronotal disc by a smooth groove. Pronotal disc anteromedially very slightly flattened. Surface of pronotum covered with double puncturation composed of large rounded and minute punctures; large punctures cover sides of the pronotum and area near anterior border.

Scutellum narrowly rounded apically, about 1/14 the length of elytra.

Elytra about slightly longer than wide, with feeble marked humeral humps. Elytra widest approximately in the middle, with less rounded lateral margins than in previous species. First six to eight striae faintly visible as shallow grooves, without distinct rows of punctures. Elytra covered with sparse punctures becoming denser laterally and towards base.

Brachypterous. Wings vestigial, narrow, about 2/3 the length of elytra.

Stridulatory field: carinae separated by 1/30 length of the field in central 1/3rd (Fig. 5P).

Abdomen 1.3 times wider than long (measured in ventral view from anterolateral margins of sternite 2 to apex of pygidium). Abdominal sternite 8 medially about as long as sternites 6–7 combined. Pygidium visible from above, rounded apically. Plectrum trapezoidal, elongated, almost rectangular, with widely rounded apex (Fig. 5O). Lateral plate of abdominal sternite relatively large, as long as plectrum, with rounded apex.

Aedeagus with relatively long parameres (0.5 length of phallobase) without excavations. Apices of the parameres rounded in dorsal view and lateral view (Fig. 5L–M).

Female

Unknown.

Variation

Except for body size and colour variation, examined specimens differ slightly in the shape of the frontoclypeal carina and the sculpture of the elytra and pronotum.

Distribution

O. strangulatus is known from a number of localities, chiefly on the Katanga Plateau (Fig. 6).

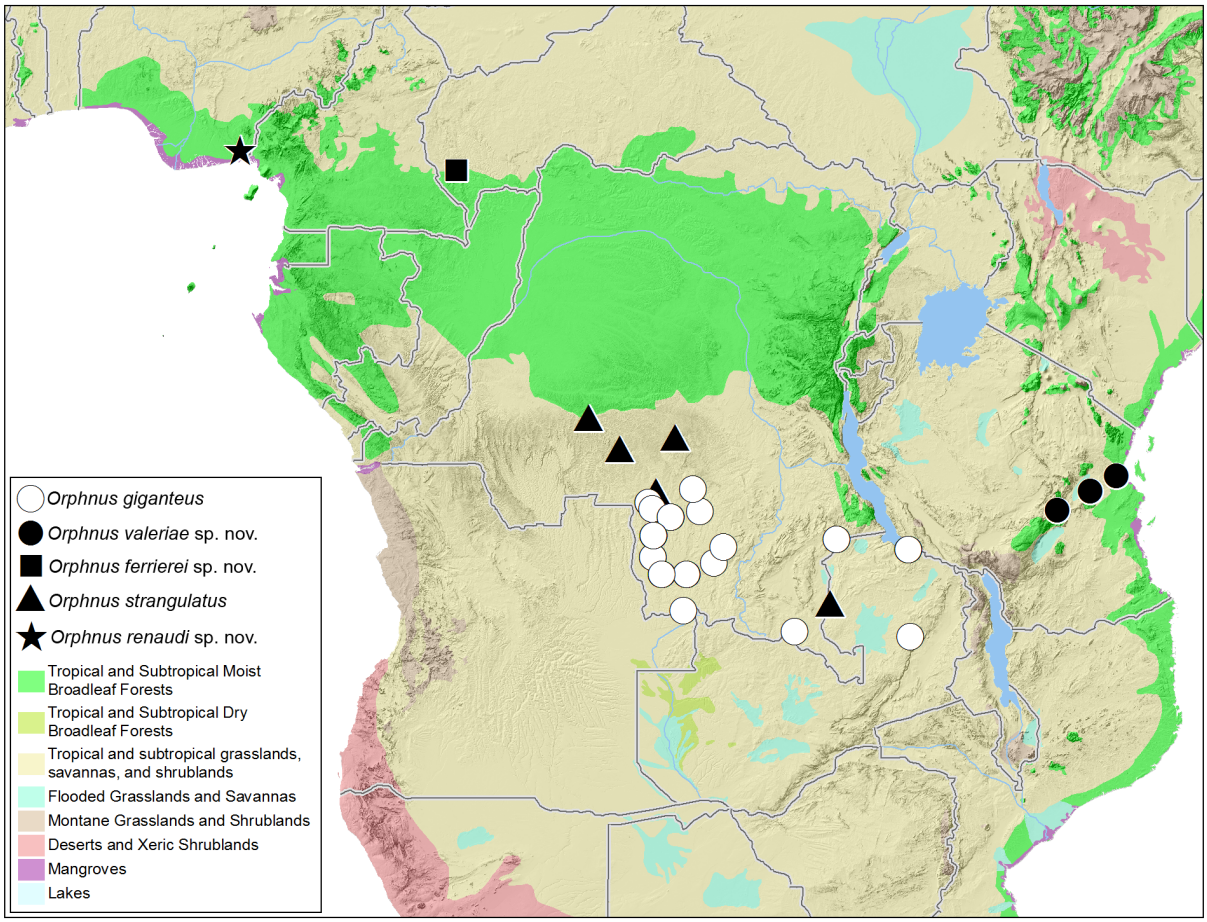

Fig. 6. *Orphnus* (*Phornus*) spp. Locality map. *Orphnus parastrangulatus* sp. nov. is not mapped, because there are no more or less precise locality data available for this species.

Discussion

Flightlessness

Wing reduction, resulting in inability to fly, is found in many scarab beetle taxa although the taxonomic and geographical patterns of this phenomenon are not always clear (Scholtz 2000). In *Orphnus*, a number of species were found to be brachypterous, having the wing rudiments about ⅔ the length of elytra (Frolov 2008, 2009; Frolov & Akhmetova 2015). Morphological characters of the examined flightless species suggest that flightlessness evolved a few times in different lineages of *Orphnus*, but flightlessness of the species of the subgenus *Phornus* is probably inherited from a common ancestor.

Stridulatory apparatus

The general type of the stridulatory apparatus of the members of *Phornus* is the same as in all other Orphninae, although there are some distinctive features. The stridulatory field in metacoxae consists of rather coarse and sparse carinae. Since only the central part of the field is apparently used to produce sound, for comparative purposes we counted the carinae of a central section, ⅓ the length of the field, and extrapolated the numbers to the length of the whole field. In all *Phornus* species except for *O. giganteus*, the numbers of carinae were about 30 per field. This is less than half as many as in most other Orphninae. In males of *O. giganteus* carinae are denser (40 carinae per field length), while in females they are denser still (about 60). It seems probable that beetles with different densities of stridulatory carinae may produce sounds of different frequencies. However, it is unclear if the sounds modulated via different structure of the stridulatory field play any role in interactions of the sexes or individuals of different species or only serve to repel predators. The low number of the carinae seems unrelated to flightlessness because approximately the same numbers were found in flightless (*O. valeriae* sp. nov., *O. ferrierei* sp. nov., *O. parastrangulatus* sp. nov., *O. strangulatus*) and flying (*O. renaudi* sp. nov.) species.

Another character found in *Phornus* is the more or less developed plates on the sides of abdominal sternite 2. These plates apparently originated from the flattened margin of the sternite. The initial stage of this character can be found in *O. giganteus* which has the margin of the sternite acute and heavily sclerotized (more so in males than in females), although it is carina-shaped rather than plate-shaped. In other species there is a distinct thin-walled plate, smooth on both sides. *In situ* the plates are situated above the dorsolateral margins of metacoxae. We think that these plates are part of the stridulatory apparatus, and may apparently serve to guide the abdomen during stridulatory friction.

Symphysocery

Symphysocery is a teratological fusion or, more correctly, incomplete separation during ontogenesis, of antennomeres (Balazuc 1948). Symphysoceries are found in many Coleoptera taxa, notably in Staphylinidae (Asiain & Márquez 2009), Cerambycidae, Chrysomelidae and Tenebrionidae (Ferreira 2015). In scarab beetles, symphysoceries are quite common in chafers ("Pleurosticti"). In species of several Sericinae genera, the number of antennomeres can be either nine or ten and this character is considered highly homoplastic and unsuitable for phylogenetic studies (Ahrens 2006). Krell (1992) reported symphysocery in over 90 percent of examined specimens of the African rhinoceros beetle *Temnorhynchus repandus* Burmeister (Dynastinae). However, in the Orphninae symphysocery was previously unknown. We found that the majority of specimens of *O. giganteus* have malformed antennae, mostly partly fused antennomeres 5 and 6. These figures correspond very well to the malformations found in *T. repandus* in terms of both the percentage of malformed specimens and the shape of the fused antennomeres. In *O. giganteus,* symphysocery is apparently sex-independent and may be asymmetrical (see description above). One case of symphysocery was also found in *O. valeriae* sp. nov. Thorough screening of the Orphninae for symphysocery has yet to be done, so it is unknown if this phenomenon is limited to the members of *Phornus*.

Biology and life style

There are no direct observations of feeding and nesting behaviour of the species of *Phornus*. It should be noted that all species of the subgenus except for *O. giganteus* are known only from males. It is probable that females of these species are also flightless and have a cryptic life style. Probably females do not leave soil and litter or only appear on the surface next to their burrows, and thus avoid falling into pitfall traps.

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