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Three new species, a synonymy and taxonomic notes on southern African members of the dung beetle genera *Scarabaeus s. str.* Linnaeus, 1758 and *Escarabaeus* Zídek & Pokorný, 2011 (Scarabaeidae: Scarabaeinae)

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ABSTRACT

Three new species are described in the dung beetle genera *Scarabaeus s. str.* L., 1758, and *Escarabaeus* Zídek & Pokorný, 2011. Two comprise, *Scarabaeus karae sp. nov.* and *Escarabaeus remii sp. nov.* and are novelties. The third comprises *Scarabaeus geminogalenus sp. nov.*, which describes a new species previously misidentified by Péringuey in 1901 and involved in a false synonymy by Janssens (1940). Notes are provided on the type specimen of *Scarabaeus galenus*. A close relative, *Scarabaeus vicinus* is recorded for the first time. *Scarabaeus natalensis* is synonymized with *Scarabaeus basuto*. Relationships and validity of a further five species are discussed: *Scarabaeus convexus* with *S. spretus* and *S. rusticus; S. ebenus* with *S. interstitialis*. The type specimen of *Scarabaeus rixosus* is also discussed *galenus*. Distribution maps are provided for the new species and those in the *S. galenus* species complex.

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Endemic; Scarabaeidae; new species; lost species found; new synonymy

Introduction

Recent classification history of the dung beetle tribe Scarabaeini is complex. Forgie et al. (2005) reduced the number of Afrotropical genera in the tribe to only two by retaining *Pachylomera* Griffith & Pidgeon, 1831, and synonymizing all other genera with *Scarabaeus* Linnaeus, 1758. Three genera were made full synonyms of *Scarabaeus* (*Neateuchus* Gillet, 1911; *Drepanopodus* Janssens, 1940; *Mnematium* Macleay, 1821). Three were reduced from generic to subgeneric level (*Pachysoma* Macleay, 1821; *Sceliages* Westwood, 1837; *Kheper* Janssens, 1940). However, *Scarabaeolus* Balthasar, 1965, was revalidated as a subgenus of *Scarabaeus*.

Subsequently, all Afrotropical subgenera except *Sceliages* have been revalidated as full genera (*Pachysoma* by Forgie et al. 2006; *Kheper* by Ziani and Gudenzi 2012) or raised to generic level (*Scarabaeolus* by Moretto 2016). *Sceliages* remains a subgenus of *Scarabaeus*, but would also deserve revalidation at generic level on molecular, morphological and behavioural grounds (Deschodt et al. 2015).

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Further recent changes have been made to the Afrotropical fauna. Moretto (2016) revalidates the old taxon, *Parateuchus* Shipp, 1895, at generic level. Although *Mnematium* has also been revalidated at generic level (Ziani and Gudenzi 2012), an Angolan species formerly classified in *Mnematium* had been previously transferred to a new subgenus of *Scarabaeus* as *Pachylosoma* (Zídek and Pokorný 2008).

The recent revision of the tribe Scarabaeini in the Mediterranean Basin (Ziani and Gudenzi 2012) has established or raised further names to generic level (*Ateuchetus* Bedel 1892; *Escarabaeus* Zídek & Pokorný, 2011). As several Afrotropical species are cited in this revision, and one of these belongs to *Escarabaeus* (*E. satyrus* (Boheman, 1860)), it suggests that the Southern African species currently classified under *Scarabaeus s. str.* would benefit from a similar revision. In the interim, all species described or discussed, here, are cited as species of *Scarabaeus s. str.* except for one new species, which is a close relative of *E. satyrus*.

Original descriptions are provided for two of the new species. *Scarabaeus karae sp. nov.* is close to *S. funebris* (Boheman, 1857) and is known from a single northwest Highveld locality in South Africa. Although *Escarabaeus remii sp. nov.* is a close relative of *E. satyrus* (Boheman 1860), it is, on average, smaller-bodied, with a distribution centred on alluvial soils of the Okavango Delta and Makgadikgadi Pan in Botswana.

Recent work suggests that museum specimens previously identified as *Scarabaeus galenus* Westwood, 1847, actually comprise three closely-related species. These are *S. galenus* Westwood; the newly rediscovered *S. vicinus* Janssens, 1940; and the misidentified *S. geminogalenus sp. nov.* that was previously cited as *Scarabaeus westwoodi* Von Harold, 1869, *sensu* Péringuey, 1901. We discuss the confused history of the species complex, revise the alpha taxonomy with a new description of *Scarabaeus geminogalenus sp. nov.*, and provide distribution maps for the three species.

Relationships and validity of a further eight species are discussed. *Scarabaeus natalensis* Zur Strassen, 1962, is synonymized with *Scarabaeus basuto* Zur Strassen, 1962, on the basis that diagnostic characters represent a cline from northeast to southwest across the southeast highlands of southern Africa. Further investigation is required on the validity and distribution patterns of a further three very closely related species: *Scarabaeus convexus* (Hausmann, 1807), *S. spretus* Zur Strassen, 1962 and *S. rusticus* (Boheman, 1857). *Scarabaeus spretus* and *S. convexus* are described as differing from one another although they may share the same southwest Cape type locality. *Scarabaeus convexus* is often used as the name for moist highland individuals occurring far to the northeast where they show only slight differences to *S. rusticus* in drier, lower localities. *Scarabaeus ebenus* (Klug, 1855) and *S. interstitialis* (Boheman, 1857) are also close relatives. Although *S. interstitialis* shows a cline in body size and density of pronotal punctation from southwest to northeast across northern South Africa, at the northeast limits of its range, separation from the east coastal *S. ebenus* would be justified on the basis of the differing size of punctures in less-densely punctate individuals of both species with possible additional differences in soil associations. Finally, the recent rediscovery of the type specimen of *Scarabaeus rixosus* Péringuey, 1901, is reported.

The colour images were made using a Canon 500D camera body mounted with a Canon 100 mm macro lens and those of the aedeagi using a Leica M165 C microscope and a Leica DMC 2900 digital camera. Image stacking was done using the Helicon remote and Helicon focus software packages. Label data are reported verbatim with authors' comments in square brackets.

The following institutions contributed to the study.
IRSNB: Belgium, Bruxelles, Royal Belgian Institute of Natural Sciences
NHRS: Sweden, Stockholm, Naturhistoriska Riksmuseet
MNHN: France, Paris, Muséum National d'Histoire Naturelle
SANC: South Africa, Pretoria, South African National Collection of Insects
TMSA: South Africa, Pretoria, Ditsong National Museum of Natural History
UPSA: South Africa, Pretoria, University of Pretoria
ZMHB: Germany, Berlin, Museum für Naturkunde

Scarabaeus galenus westwood complex – history and revision

Scarabaeus galenus Westwood, 1847, was described as *Scarabaeus* (*Sebasteos*) *galenus* Westwood, 1847, from 'Africa meridionali, between 25° and 26° degrees south lat. and 27° and 28° degrees east long.' [Primarily North West Province, South Africa]. Subsequently several synonyms were described: *Ateuchus* (*Actinophorus*) *paradoxus* Boheman, 1857; from 'prope fluvium Limpopo' [near the Limpopo River] (synonymized by Péringuey, 1901) and *Sebasteos adelphus* Kolbe, 1895 from 'River Mkatta, Usagara' [eastern central Tanzania] (synonymized by Zur Strassen, 1967).

A further synonym of *S. galenus* Westwood was added by Péringuey, 1901 who misidentified a species that he believed to be *Scarabaeus westwoodi* Von Harold (1869) [described as *Scarabaeus* (*Ateuchus*) *westwoodi* Von Harold (1869) from 'Africa austr. inter.']. Although he later reinstated it as a valid species (but still erroneously as *Scarabaeus westwoodi* Von Harold (1869)), his description (Péringuey 1908) differs from that of Von Harold, 1869 for the true *S. westwoodi*. This misidentified species is actually *Scarabaeus geminogalenus sp. nov* that is described below. This misidentification explains why Péringuey (1901) follows his description of *S. galenus* Westwood with that of *Scarabaeus laticeps* Péringuey, 1901, which is currently an accepted synonym (Janssens 1940) of the true *S. westwoodi* Von Harold (1869).

In the redescription of his misidentified *S. westwoodi* Harold, Péringuey (1908) mentions that he saw one specimen amongst some *S. galenus* Westwood from the Z[S]outpansberg. This could only be a specimen of *Scarabaeus geminogalenus sp. nov*. This provides strong support for the misidentification as *S. westwoodi* Harold shows a highland distribution along the central and northeast Drakensberg escarpment.

Subsequently, Janssens, 1940 again, synonymized Peringuey's misidentified *S. westwoodi* (=*Scarabaeus geminogalenus sp. nov*.) with *S. galenus* Westwood [cited as a synonym under *S. galenus*: 'Sebasteos Westwoodi PERINGUEY (non HAROLD), Trans. s. Afr. Phil. Soc., XIII, 1908, p. 555 (nov. syn.)'], an erroneous decision that was followed by all subsequent authors.

Although we have been unable to locate type material for the misidentified *S. westwoodi* Harold, the description in Péringuey (1908) corresponds very well with that for a species that occurs on coastal sands of northeast South Africa, southeast Mozambique and along the Limpopo river valley. This new species is not a synonym of *S. galenus* Westwood but a very close relative that would require a new name (*Scarabaeus geminogalenus sp. nov*.) as *S. westwoodi* is unavailable.

Scarabaeus geminogalenus **Davis and Deschodt** sp. nov.
(Figures 1, 2, 4 and 5)

Scarabaeus (*Sebasteos*) *westwoodi sensu*; Péringuey, 1908: 555 nec; Von Harold (1869): 95

Specimens examined: Holotype: ♂ ST. LUCIA ESTUARY, Natal. 19.V.78, G. F. Bornemissza, COLS22344. (SANC).

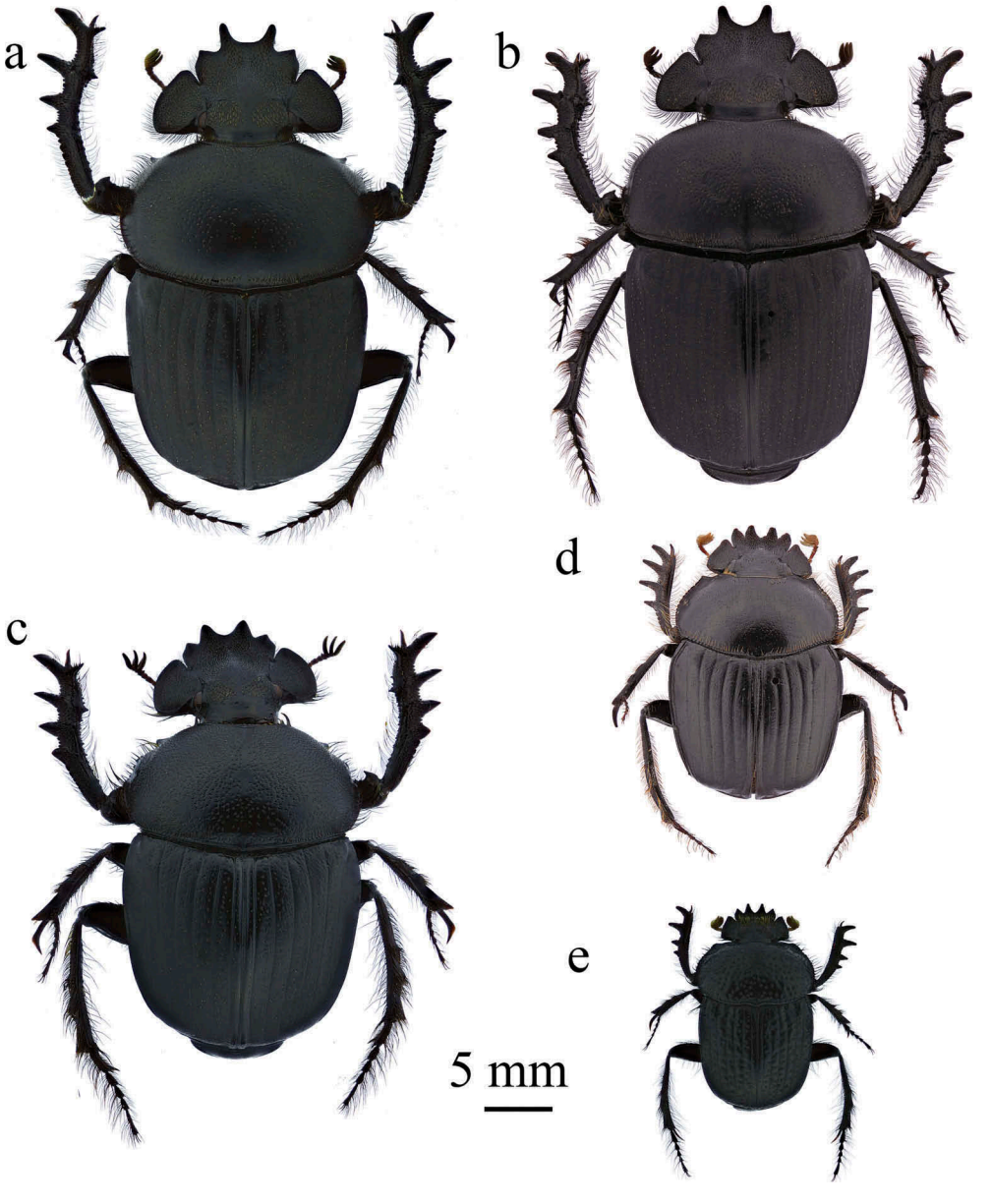

Figure 1. Habitus images of *Scarabaeus galenus* Westwood (A) *Scarabaeus vicinus* Janssens (B), *Scarabaeus geminogalenus* Davis and Deschodt sp. nov. (C), *Escarabaeus remii* Davis and Deschodt sp. nov. (D) and *Scarabaeus karae* Davis and Deschodt sp. nov. (E).

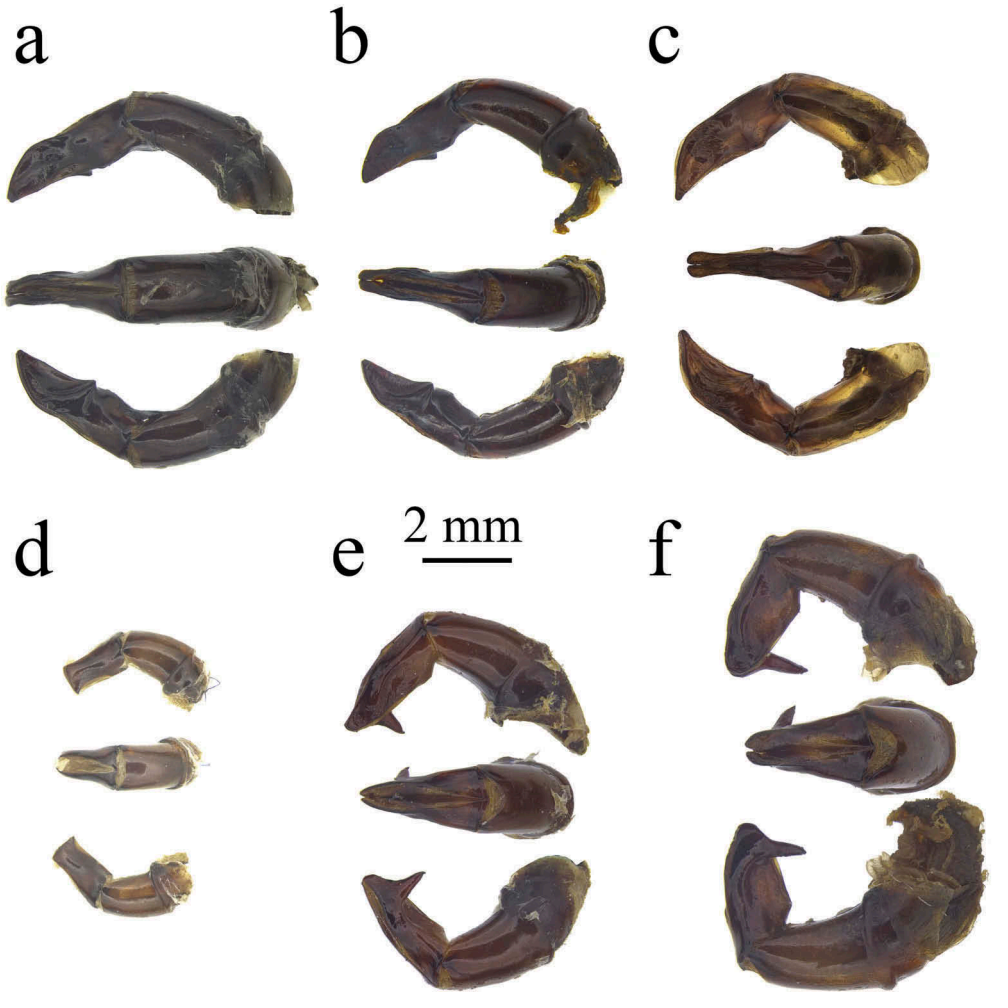

Figure 2. Aedeagi of *Scarabaeus galenus* Westwood (A) *Scarabaeus vicinus* Janssens (B), *Scarabaeus geminogalenus* Davis and Deschodt sp. nov. (C), *Scarabaeus karae* Davis and Deschodt sp. nov. (D), *Escarabaeus remii* Davis and Deschodt sp. nov. (E) and *Escarabaeus satyrus* Boheman (F). All aedeagi are shown right (top), frontal (middle) and left (bottom) view.

Paratypes one spec, S. Afr; Kruger Nat Pk, Punda Maria, 22.41 S – 31.01 E, 3.2.1994; E – Y: 2977, elephant dung, leg. Endrödy-Younga (TMSA), two spec, S. Afr; KrugerNat. Pk, Malonga sands, 22.38 S – 31.17 E, 8.2.1994: E – Y: 2986, on red sand, Endrödy-Younga (TMSA), one spec, Masemola ♂ – 6:03., 4593 (TMSA), one spec, S. Afr; KrugerNat. Pk, Pumbe sands, 24.12 S – 31.55 E, 22.11.1994: E – Y: 3063, ground-traps.60 days, Endrödy.Bellamy, groundtrap with faece bait (TMSA), five spec, ST. LUCIA ESTUARY, Natal. 26.VIII.78, G. F. Bornemissza, two with COLS22352, one with COLS22346 one with COLS22345 and one with COLS22348 (SANC), five spec, ST. LUCIA ESTUARY, Natal. 19.V.78, G. F. Bornemissza, three with COLS22343 and two with COLS22344 (SANC), four spec, SOUTH AFRICA: KZN, Tembe Elephant Park, 27° 01'S 32°24'E, 24–27.i.,1996, BJ van Rensburg, pitfall trap: elephant dung, COLS28131

(SANC), one spec, SOUTH AFRICA, NTL, St Lucia Nat.Park, 28.[°]22[′]S 32.[°]25[′]E, G Bernon, COLS23082 (SANC), two spec, SOUTH AFRICA: LIMP, Greater Kuduland, Safaris, E of Tshipise, 22°38′28″S 30°18′50″E, 08–16.iv.2007 SARCA, COLS23080 (SANC), one spec, SOUTH AFRICA, Tvl, D'Nyala Nat. Res., Ellisras District, 23.[°]45[′]S 27.[°]49[′]E, 10–14.xi.1986, V.M.Uys, COLS23081 (SANC), one spec, SOUTH AFRICA, Tvl, D'Nyala Nat. Res., Ellisras District, 23.[°]45[′]S 27.[°]49[′]E, 10–14.xi.1986, B.Grobbelaar, COLS23081 (SANC), one spec, NDUMU G.R., Natal, 25.X.73, Tribe & Temby, COLS00177 (SANC), PAFURI, KNP, (24 kms S – Maohai Pan), 25.III.73, I.D. Temby, COLS22349 (SANC), FOMOTHINI PAN, N. Natal 8.X.80, E. Klingelhoefer, COLS22350 (SANC), one spec, SOUTH AFRICA, NATAL, Cape Vidal, 28.[°]10[′]S, 32.[°]32[′]E. 13.i.1981, I.M.Millar, COLS23012 (SANC), one spec, HLUHLUWE, Natal, (15 km S) 31.X.78, Bornemissza & Aschenborn, COLS22347 (SANC), two spec (one spec gold coated for SEM imaging), Tembe Elephant park, Kwazulu-Natal, 27°01′S 32°24′E, 24–29.I.1996, B. J. Van Rensburg (UPSA), one spec, Tembe Elephant park, KZN, South Africa, 27°01′S 32° 24′E, 26–27.VII.1995, B. J. Van Rensburg (UPSA), one spec, Tembe Elephant park, KZN, South Africa, 27°01′S 32°24′E, 17.iii.1995, B. J. Van Rensburg (UPSA), three spec, Soutpansberg, Limpopo, S22.9157°E29.68756°, 3–4.ii.2009, L. J. Niemand (UPSA).

Diagnosis. This species is similar to *S. galenus*, but can easily be separated by the much denser punctation on the pronotum.

Description: Large beetle, completely black.

Body size of holotype: Head capsule length 9.3 mm, combined length of pronotum and elytra over midline 23.5 mm, widest width over elytra 16.1 mm, height 11.8 mm.

Head: Surface completely rugose, without granulation. No projection on dorsal surface of clypeus. Clypeal teeth slightly upturned, with anterior fourth of teeth smooth. Notch between two median clypeal teeth rounded; notch between first and second obtuse angled. Median two teeth protruding forward, with a downward pointing spine on each; a third downward pointing spine just under notch of median teeth present. Vertex slightly convex. Antennae dark brown to black.

Pronotum: Punctate, with large, sometimes irregular, punctures almost contiguous. Surface between punctures very finely shagreened. Thin medial line present, withoutpunctures and not always traversing pronotum. Sometimes small lateral clear area at anterior half adjacent to medial line present. Lateral margins punctate, with punctures at anterolateral angle elongated and arranged in sub-parallel downward pointing lines. Anterior margin smooth ending with sharp triangular protrusion.

Protibia: Outside margin with four teeth in distal two thirds, proximal tooth smallest. Margin between teeth serrate and somewhat crenulate in first third. Inside margin serrate, with dark long setae that are evenly spaced. Denticle on inside margin opposite third

protibial tooth pointing upward at almost 90 degrees, and fourth protibial tooth pointing forward at about 45 degrees.

Elytra: Slightly ribbed. Interstriae shagreened, with small widespread punctures. Striae clearly discernible with the naked eye, with small, regular punctures visible only from 20x magnification.

Sterna: Clear median longitudinal groove over meta- and mesosternum, forming deep foveae on meta- and mesosternum. Meta- and mesosternum with setigerous punctures. Mesosternum sloping at about 45 degrees anteriorly.

Pygidium: Wrinkled with small irregular punctures far apart.

Aedeagus: See Figure 2(C)

Variability: There is very little morphological variation between the specimens except for the variable size (smallest and largest specimens in type series: head capsule length 8.4–12.0 mm, combined length of pronotum and elytra over midline 20.3–28.3 mm, widest width over elytra 14.1–20.0 mm, height 9.8–13.6 mm.).

Etymology: The species' long association and incorporation with *S. galenus* is echoed by renaming it as the twin of *S. galenus*

Distribution: This species occurs on the coastal sand plains of eastern South Africa and southern Mozambique, extending inland along the Limpopo River valley.

Type specimens of *Scarabaeus galenus* Westwood, 1847, *Scarabaeus westwoodi* (Von Harold, 1869) and *Scarabaeus vicinus* Janssens, 1940 Figures 1, 2, 5 and 6

Zídek and Pokorný (2004); listed the holotype specimen of *Scarabaeus galenus* Westwood, 1847; as being deposited in the Natural History Museum, London, but it could not be located after an extensive search by Mr Malcolm Kerley, recently retired curator in the Coleoptera Section. Mr Darren Mann, Head of Life Collections at the Oxford University Museum of Natural History, also unsuccessfully searched the Hope Collection. The holotype could not be traced and is believed to be lost.

The type of *Scarabaeus westwoodi* Von Harold (1869); is listed (Zídek and Pokorný 2004) as being in the Muséum National d'Histoire Naturelle, Paris. Janssens (1940, p. 46) reported to have examined this type, and noted that it is in the Oberthür Collection in the MNHN. It is, however, also presumed lost since it could not be found after an extensive search by the current curator, Dr Antoine Mantilleri.

Article 75.2 of the ICZN (1999) states that 'A neotype is not to be designated as an end in itself, or as a matter of curatorial routine, and any such neotype designation is invalid'. Both these species are well known and without any taxonomic or nomenclatural

complications other than those resolved in the present paper. Hence we do not designate neotypes for the two abovementioned species.

During preparation for this paper, specimens believed to be *S. galenus* were placed next to each other and subtle differences were observed between individuals from the drier Kalahari and the moister savannah areas of southern Africa. Characterization of the Kalahari individuals corresponded well with the description of *Scarabaeus vicinus* Janssens, 1940. However, two extensive searches in the MNHN by Dr Antoine Mantilleri also failed to locate the type specimen. Although we could not compare our specimens with type material, we are confident that we have rediscovered a species for which there have been no records since its description in 1940. There is a history of previous misidentification since specimens of *S. vicinus* in the SANC and TMSA were found among those determined as *S. galenus* by zur Strassen in 1993. Some published data also appear to reflect misidentifications, e.g. from Burghersdorp (sic) [S30.996° E26.328°], Kimberley [S28.728° E24.749°], Prieska [S29.670° E22.745°] (Péringuey 1901), Twee Rivieren [S20.611° E26.470°] (Ferreira 1959), from the Waterberg plateau [S20.652° E22.146°] (Delatour 2008) and in extensive survey data from the Northern Cape (Davis et al. 2008).

Scarabaeus vicinus can be easily distinguished from the morphologically similar *S. galenus* by the more velutinous appearance of the elytra and pronotum compared to the more shiny *S. galenus*. The fore tibiae of *S. vicinus* are also more inwardly curved than those of *S. galenus*. See Figure 4 for SEM images of the elytra and pronota of both species. Locality records show that *S. galenus* is widespread in the drier savannah of south-eastern Africa with a range extending north-eastwards to southern Tanzania whereas the newly rediscovered, close relative, *S. vicinus* is Kalahari-centred in the drier, sandy areas of south western Africa (Figure 2).

Again with reference to Article 75.2 (ICZN 1999), we refrain from defining a neotype for *S. vicinus* because it is relatively easy to identify and the original type specimen might still be found.

Type specimen of *Scarabaeus rixosus* Péringuey 1901

As the type specimen of *Scarabaeus rixosus* Péringuey, 1901:50, is not listed in the holdings of the Iziko South African Museum where the majority of Péringuey's type specimens are housed, it is likely to have been deposited in his personal collection (R. Stals pers. comm.). Péringuey's private collection was acquired by the UPSA and subsequently donated to the SANC (Cochrane 2006). We propose that a specimen recently found amongst undetermined Scarabaeinae material in the SANC is the type specimen of *S. rixosus* (Figure 3 A–C) as it conforms to the original description. It also differs from all other known *Scarabaeus* species, including *Scarabaeus zambesianus* Péringuey, 1901, and its putative closest relative *Scarabaeus proboscideus* (Guérin-Méneville 1844) (Figure 3(D)), which is the only other *Scarabaeus* species known to bear a spur on the mentum. Although the locality label on the re-discovered specimen ('Upper Limpopo') is in Péringuey's handwriting (R. Stals pers. comm.), it differs from the published type locality for *S. rixosus* ('Southern Rhodesia (Middle Limpopo)') However, it is known that Péringuey seldom published labels verbatim (R. Stals pers. comm.) Thus, we propose that the rediscovered specimen is the holotype of *Scarabaeus rixosus* Péringuey, 1901. It is curated in the SANC, with accession numbers COLS23260 and TYPH02071. No other specimens of this species are known.

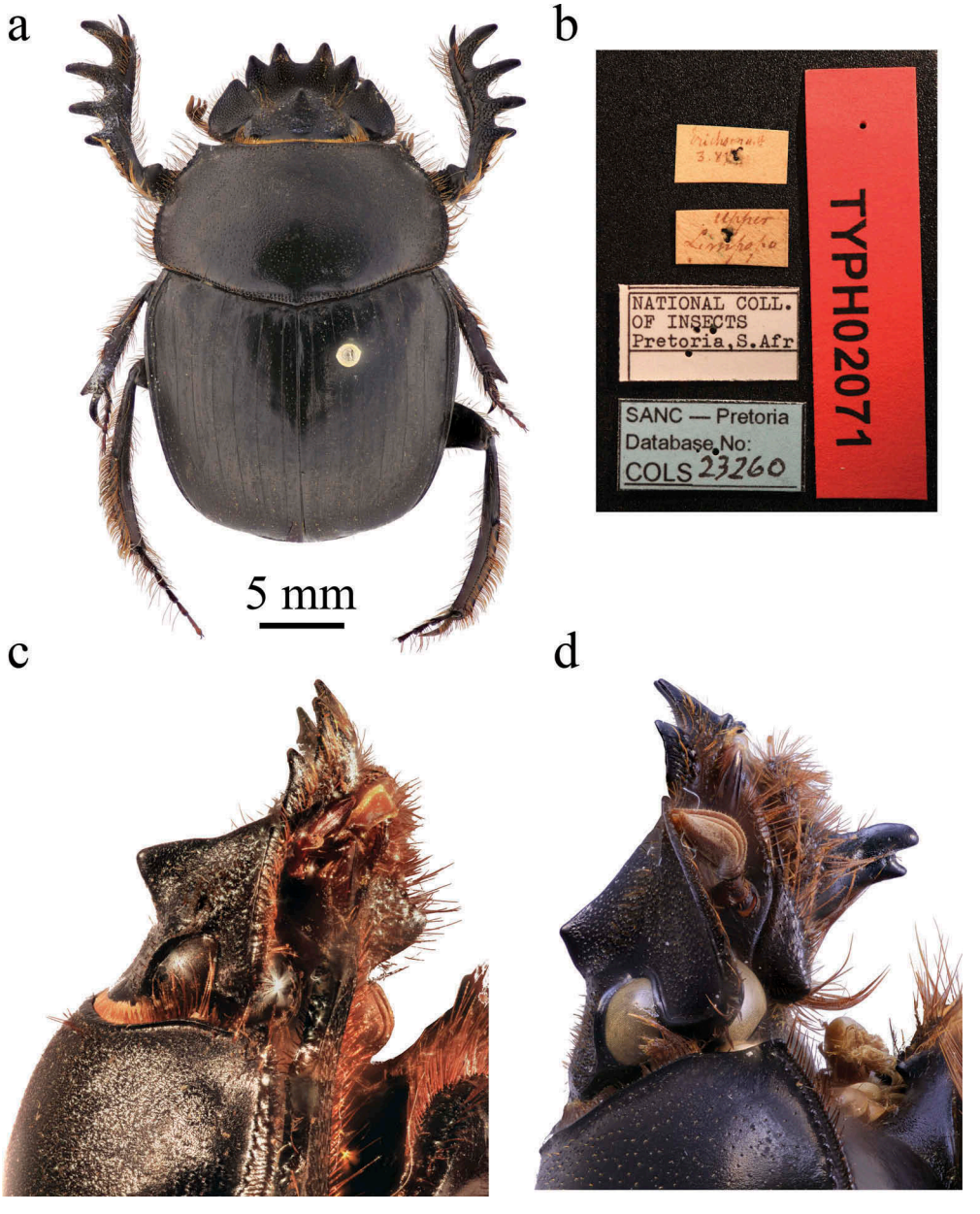

Figure 3. Habitus of the type of *Scarabaeus rixosus* Péringuey (A) and the labels (B) associated with the specimen. The spur on the mentum for *S. rixosus* (C) and *Scarabaeus proboscideus* (Guérin-Méneville) (D).

Descriptions of new species

Scarabaeus karae Davis and Deschodt sp. nov.

Figures 1, 2 and 6

Specimens examined Holotype: ♂ Abe Bailey NR, Gauteng, S26°17′-21′ E027°16′-18′, 1496 m-1544 m, 09–10.xii.2002. A Davis. (TMSA). Paratypes: three spec same as holotype, (one SANC, one TMSA, one UPSA).

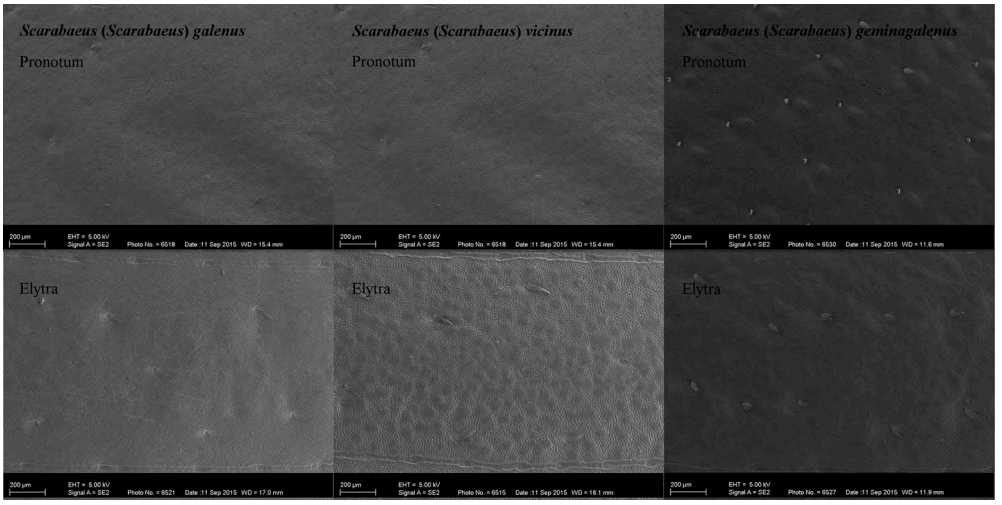

Figure 4. SEM micrographs showing the sculpture of *Scarabaeus galenus* Westwood, *Scarabaeus vicinus* Janssens and *Scarabaeus geminogalenus* Davis and Deschodt sp. nov.

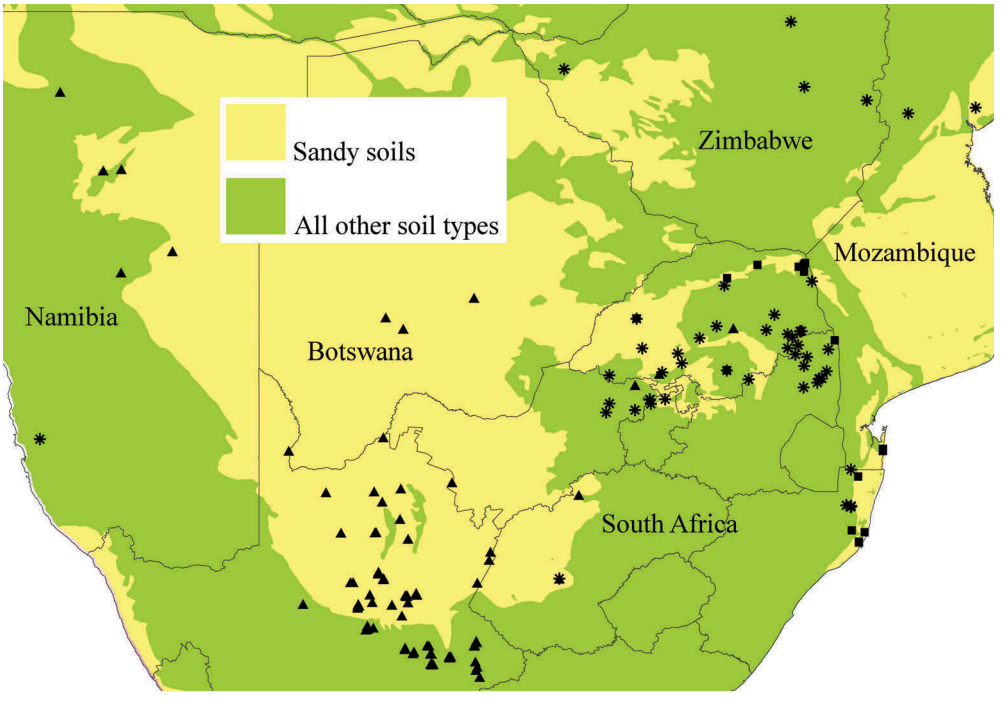

Figure 5. Map showing the known distribution of *Scarabaeus galenus* Westwood (✳) (the type localities of *Ateuchus* (*Actinophorus*) *paradoxus* Boheman, and *Sebasteos adelphus* Kolbe, are not shown here), *Scarabaeus vicinus* Janssens (▲) and *Scarabaeus geminogalenus* Davis and Deschodt (■). Note that the record for *Scarabaeus galenus* in Namibia and the two easterly records for *Scarabaeus vicinus* are seen as errors.

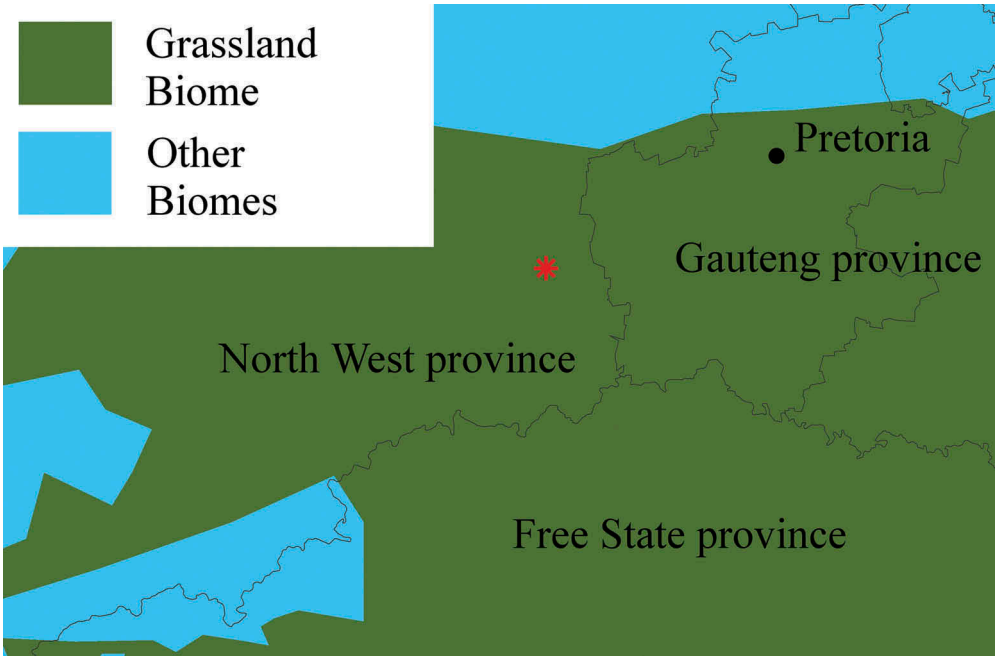

Figure 6. Map showing the collection locality of *Scarabaeus karae* Davis and Deschodt sp. nov. (✳).

Etymology: This species is named in honour of Kara, the only daughter of CD.

Description: Medium sized beetle, completely black except for tan brown coloured setae on ventral side.

Body size of holotype: Head capsule length 4.0 mm, combined length of pronotum and elytra over midline 11.9 mm, widest width over elytra 8.1 mm, height 5.6 mm.

Head: Frons punctate, clypeus rugose. No projection on dorsal or ventral surface of clypeus. Clypeal teeth slightly upturned, with anterior apices of teeth smooth. Notch between median clypeal teeth and between first and second clypeal teeth right angled. Vertex slightly convex. Antennae black.

Pronotum: Punctate with irregularly spaced punctures that are sometimes far apart and sometimes contiguous. Surfaces between punctures smooth. Row of irregular punctures on posterior margin. Lateral margins crenulate.

Protibia: Inside margin smooth, with dark setae of irregular length and uneven spacing. No tooth at distal inside end. Outside margin with four teeth in distal four fifths, proximal tooth smallest. Serrate between teeth and crenulate in first fifth.

Elytra: Ribbed. Shagreened on interstriae with irregularly spaced big punctures that are far apart. Punctures sometimes touch outside margin of interstriae. Striae acutely edged and distinct to the naked eye with small punctures close together giving a stippled appearance.

Sterna: Shallow and indistinct median longitudinal groove over meta- and mesosternum, area next to groove smooth. Otherwise meso and metasternum with long thin tan brown setae and small and close together punctures. Mesosternum strongly inclined at about 90 degrees anteriorly.

Pygidium: Smooth with very few large irregular punctures.

Aedeagus: See Figure 2(D).

Variability: Except for the variable size (smallest and largest specimens in type series: head capsule length 3.5–5.1 mm, combined length of pronotum and elytra over midline 10.5–13.1 mm, widest width over elytra 7.0–9.0 mm, height 5.0–6.1 mm.), there is very little variation between the specimens.

Diagnosis: This new species keys out to *Scarabaeus funebris* in Zur Strassen (1967), but can easily be separated from this allied species, which sometimes overlaps in distribution and habitat, by having larger punctures on the pronotum and clear and round punctures on the elytra. The parameres of the aedeagus are basally slightly more concave for *S. karae* than for *S. funebris*. The serrations on the inside front tibiae are reduced to small round scallops to almost smooth as opposed to *S. funebris*. It is also generally smaller than *S. funebris*. We have seen images of the type specimen of *Scarabaeus funebris pretoriensis* Janssens, 1940 (IRSNB) and compared it with images of the type specimen of *Scarabaeus funebris* Boheman, 1857; in the NHRS and confirm the synonymy of *S. funebris pretoriensis* with *S. funebris* as proposed by Zur Strassen, 1967 even though the pronotal punctation is less pronounced in the subspecies.

Distribution: This species is probably restricted to the high grassland of central South Africa.

***Escarabaeus remii* Davis and Deschodt** sp. nov.
(Figure 1, 2 and 7)

Specimens examined Holotype: ♂ Botswana, Okavango, Thamalakane riv., P. Reavell, XII.1973. (TMSA) Paratypes: two ♀ Tau Lodge Botswana., S20.42679° E24.52141°, 20. xii.2003 Light, C.Deschodt&L.Niemand. (UPSA), one ♂ spec and ten spec unsexed same as holotype, (TMSA), one ♂ spec and one spec unsexed, Namibia;Rundu Distr., 17 km E Rundu 1059 m, 17.[°]51[′] S – 19.[°]54[′] E, 14.3.2006;E-Y:3722, light trap, leg Ruth Müller (TMSA), one spec unsexed, Botswana, Kasane, groundtraps, 1–19.9.85;Beyleveld (TMSA), one spec unsexed, Kwandu River,WestCaprivi, SE 1723Cd, 14-XI-1979, C. H. Scholtz COLS2073 (SANC), one spec unsexed, 20 km N MAUN, BOTSWANA, SE 1923, Dc, 16-I-1978, Holm, Jacobs, Kirsten, Scholtz, COLS23072 (SANC), one spec unsexed BOTSWANA, Makgadikgadi Pans, Res, Khumaga, 20.[°]26[′]S 24.[°]35[′]E, 04.xii.1980, P. Reavell, COLS23074 (SANC), one spec unsexed, BOTSWANA, Sepupa, SE 18 22 Ca 5–6.I.1985, University of Pretoria, Dept. Entomology Tour '85, COLS22492 (SANC), one spec unsexed,

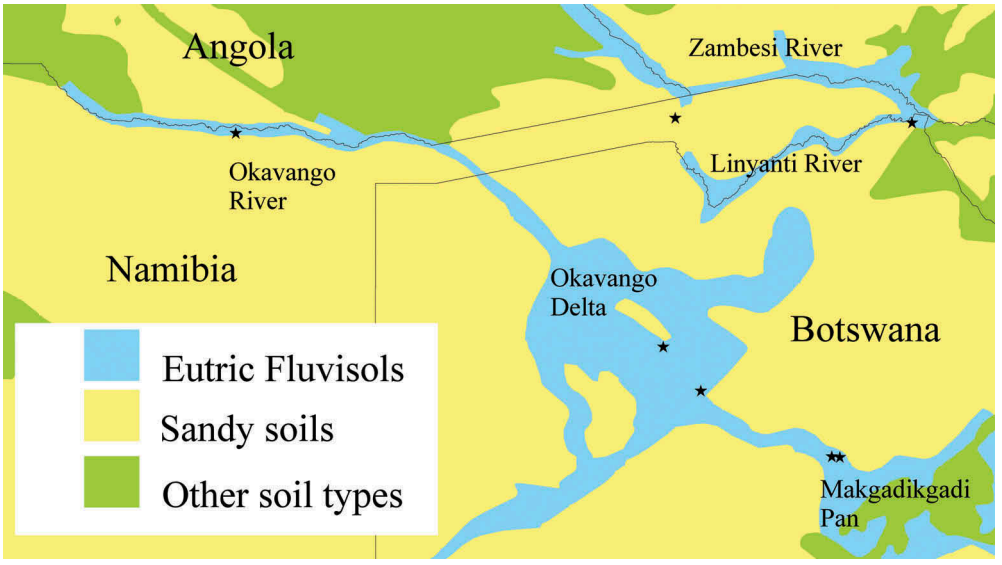

Figure 7. Map showing the type localities of *Escarabaeus remii* Davis and Deschodt sp. nov. (⋆).

MAUN. Botswana, (16kms N) 18.I.78, Grey sand, Open, Mopane Woodland, C (Bait), H. H. Aschenborn, COLS08770 (SANC).

Etymology: This species is named in honour of Remi the only son of CD.

Description: Large beetle, black.

Body size of holotype: Head capsule length 5.4 mm, combined length of pronotum and elytra over midline 15.3 mm, widest width over elytra 12.1 mm, height 8.0 mm.

Head: Surface anteriorly rugose, without granulation. Rugosity changes to punctures posterioriad. No projection on dorsal or ventral surface of clypeus. Clypeal teeth slightly upturned with anterior half of teeth smooth. Notch between innermost clypeal teeth rounded; notch between first and second clypeal teeth right angled. Vertex slightly convex. Antennae tan brown.

Pronotum: Punctate with punctures far apart, extending to margins. Setae in punctures very short and only seen under at least 60x magnification. Surfaces between punctures with microgranules. Single row of punctures on posterior margin.

Protibia: Inside margin smooth with dark long setae evenly spaced. Outside margin with four teeth in distal three quarters, proximal tooth smallest. Fine serrations all along inside margin and between teeth.

Elytra: Ribbed. Shagreened on interstriae. Striae clearly discernible with the naked eye. Margin between striae and interstriae well defined. Interstriae without setae.

Sterna: Median longitudinal groove over meta- and mesosternum, deepening to form a fovea on each of the sterna. Mesosternum with long thin setae. Mesosternum sloping at about 45 degrees anteriorly. Metasternum smooth.

Pygidium: Shagreened with small irregular punctures far apart.

Aedeagus: See Figure 2(E). Although very similar to that of *Escarabaeus satyrus* Boheman, 1860 (Figure 2(F)), it is generally more slender and the spike is broader.

Variability: Some size variation is observed (smallest and largest specimens in type series: head capsule length 5.0–6.5 mm, combined length of pronotum and elytra over midline 14.7–18.9 mm, widest width over elytra 11.2–14.2 mm, height 7.1–9.2 mm.). The ribbing in some specimens is not as clear.

Diagnosis: This new species keys out to *E. satyrus* in Zur Strassen, 1967. The elytra are however strongly ribbed. The punctures on the pronotum are also much further apart.

Distribution: This species has a distribution following the Okavango and Zambezi River floodplains of north western Botswana, extending northwards into the Caprivi Strip of Namibia and possibly into southern Angola and Zambia.

New synonymy

Scarabaeus basuto zur Strassen, 1962: 350
Scarabaeus natalensis zur Strassen, 1962: 352 syn. n.

Zur Strassen (1962) used various characters for separating *S. basuto* and *S. natalensis*. These comprised the depth of the elytral striae, the size of the punctures on the striae and interstriae, the granulation of the elytra, the sculpture of the basal margin on the prothorax (see Figure 8), and the shape of the aedeagi. During data basing, a larger number of specimens was available to be studied than in the 1960's. These individuals showed a mosaic of the characteristics cited by zur Strassen (Table 1). In the table, we note that one character form a cline (sculpture of posterior lateral margin of prothoracic disc) and that three instances of individual variation occur at end points on the cline but are considered as only intraspecific variation. We, thus, formally synonymise *Scarabaeus natalensis* Zur Strassen, 1962; syn. n. with *Scarabaeus basuto*, 1962. *Scarabaeus basuto*, 1962 is selected as the senior synonym under the Principle of the First Reviser (Article 24.2, ICZN, 1999).

Species requiring further investigation

Relationships and validity of *Scarabaeus convexus* (Hausmann, 1807), *Scarabaeus spretus* Zur Strassen, 1962 and *Scarabaeus rusticus* (Boheman, 1857) require further investigation. They are currently considered as close relatives showing combined distributions from the southwest Cape along the southeast seaboard to uplands and highlands of northeast South Africa, where, *S. convexus* is found on cool moist highlands and

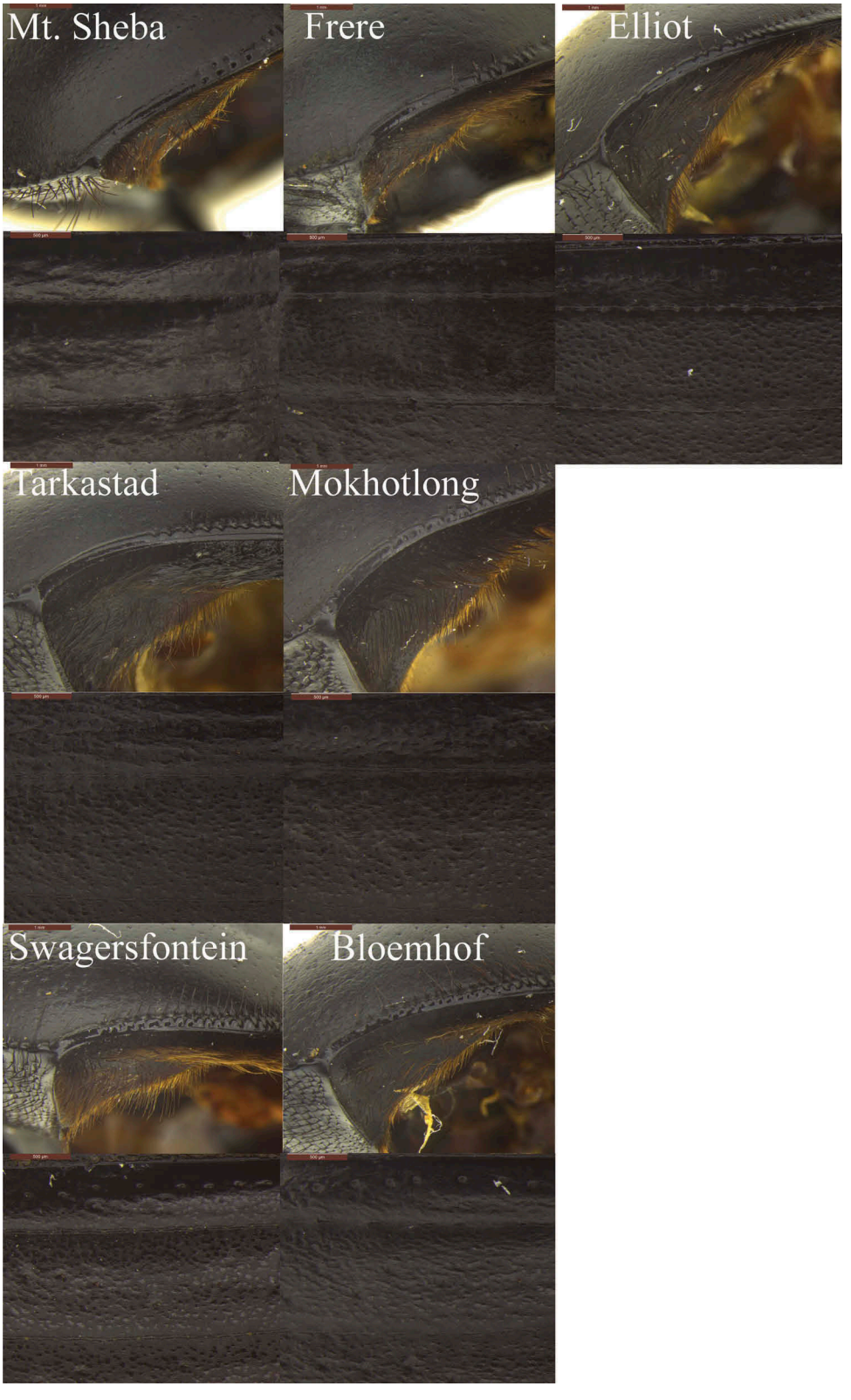

Figure 8. Images of *S. basuto* showing the length and sculpture of the basal line on the prothorax together with elytral sculpture.

Table 1. Specimens from various localities over the known range of *S. natalensis* and *S. basuto* and their characters.

	Depth of stria on elytra	Size of the punctures of the striae vs interstriae	Micro-granulation of elytra	Length of line and sculpture of posterior lateral margin on prothoracic disc	Aedeagus
Mt Sheba (S24.899° E30.692°)	Incised	Same/same	Smooth	Long and smooth	Same for all
Frere (S28.883° E29.766°)	Shallow	Same/same	Granular	Long and smooth	Same for all
Elliot (S31.333° E27.850°)	Shallow	Same/same	Granular	Long and smooth	Same for all
Mokhotlong (S29.287° E29.060°)	Shallow	Same/same	Granular	Medium with scalloping	Same for all
Tarkastad (S32.017° E26.267°)	Shallow	Same/same	Granular	Medium with scalloping	Same for all
Swagersfontein (S30.509° E24.445°) **and Bloemhof** (S30.935° E22.546°)	Slightly incised	Same/same	Granular	Very short with scalloping	Same for all

S. rusticus on drier warmer uplands. However, there may be some discrepancy between distribution pattern and type localities for *S. convexus* and *S. spretus*, which are distributed primarily on southwest winter rainfall uplands and the southern seaboard of South Africa.

Scarabaeus spretus was described from Table Mountain Zur Strassen (1967), and although the type locality of *S. convexus* is not cited, it may be assumed to also be from the Western Cape as it was described by Hausmann (1807) together with *Scarabaeus suri, Scarabaeus rugosus, Onthophagus giraffa* and *Onthophagus minutus*, which are all southwest or southern Cape endemics. However, the species that is currently identified as *Scarabaeus convexus* has a South African distribution that lies well to the east and northeast of the likely type locality. The type material that Hausmann used for the description of this species is in Europe and could not be traced. Therefore, it is currently not possible to resolve questions on the relationships between the type of *S. convexus*, northeast populations identified as *S. convexus*, and those of *S. spretus*.

The possibility that *Scarabaeus spretus* is a synonym of *Scarabaeus convexus*, and that the inland species is undescribed, requires investigation. However, pending further morphological or molecular study we have made no recommendations for changes to the alpha taxonomy. At present, Zur Strassen (1967) separates *S. spretus* by the presence of small punctures on the base of the pronotum that are absent in *S. convexus* and *S. rusticus*, a species that was described from 'Caffraria' (Boheman 1857). *Scarabaeus rusticus* is separated by the yellow antennae and irregular size of the inside front tibial teeth compared to the dark antennae and regular size of small teeth on the inside margin of the front tibiae in *S. convexus* (zur Strassen, 1967).

Relationships and validity of *Scarabaeus ebenus* Klug, 1855; and *Scarabaeus interstitialis* Boheman, 1857; have also been investigated. Clines from larger to smaller-bodied and denser to sparser punctation occur from the northern edge of the Highveld grasslands to lowland savannah. However, it is currently considered that smaller-bodied, more sparsely punctate inland savannah populations may be separated from eastern lowland and east coastal populations on the basis of larger (*S. interstitialis*) versus very small punctures (*S. ebenus*). Further investigation is justified.

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References

Balthasar V. 1965. Eine neue Undergattung und neue Arten der Familie Scarabaeidae (Col). (121. Beitrag zur Kenntnis der Scarabaeoidea). Acta entomologica bohemoslovaca. 62:14–23.

Bedel L. 1892. Révision des *Scarabaeus* paléarctiques. L'Abeille. 27:281–288.

Boheman CH. 1857. Insecta Caffraria annis 1838-1845 a J.A.Wahlberg collecta amici auxilios sultus descripsit. Coleoptera Officina Norstedtiana. Holmiae. 2:1–395.

Boheman CH. 1860. Coleoptera sammlade af J.A. Wahlberg i sydvestra Afrika. Öfvers. Vetenskapsakad. Förh. Stockholm.

Cochrane M 2006. Natural History Collections Division: terrestrial Invertebrate Collection. Collection Management Manual; [cited 2016 Jan 22]. Available from: http://www.iziko.org.za/images/uploads/iziko_entomology_manual.pdf

Davis ALV, Scholtz CH, Deschodt C. 2008. Multi-scale determinants of dung beetle assemblage structure across abiotic gradients of the Kalahari-Nama Karoo ecotone, South Africa. J Biogeogr. 35:1465–1480.

Delatour T. 2008. Presence of *Scarabaeus galenus* (Westwood 1847) in the savannah nearby the Waterberg Plateau in Namibia. Lambillionea. 108:329–337.

Deschodt CM, Davis ALV, Scholtz CH. 2015. Status changes, new synonymies, key and descriptions of seven new species in the subgenus *Scarabaeus* (*Scarabaeolus*) Balthasar 1965 (Coleoptera: Scarabaeidae: Scarabaeinae). Zootaxa. 3931:505–527.

Ferreira MC. 1959. A contribution to the study of the Coleoptera from the Kalahari Gemsbok National Park (Scarabaeidae, Buprestidae, Cerambycidae): I. Koedoe Afr Protected Area Conserv Sci. 2:77–86.

Forgie SA, Kryger U, Bloomer P, Scholtz CH. 2006. Evolutionary relationships among the Scarabaeini (Coleoptera: Scarabaeidae) based on combined molecular and morphological data. Mol Phylogenet Evol. 40:662–678.

Forgie SA, Philips TK, Scholtz CH. 2005. Evolution of the Scarabaeini (Scarabaeidae: scarabaeinae). Syst Entomol. 30:60–96.

Gillet JJE. 1911. Coprides nouveaux de la région orientale et remarques synonymiques. Annales de la Société entomologique de Belgique. 55:313–314.
Griffith E, Pidgeon, E. 1831. The Class Insecta arranged by the Baron Cuvier, with Supplementary Additions to each Order. Notices of New Genera and Species by G. Gray. In: Griffith, E. et al., editors. The Animal Kingdom arranged in conformity with its Organisation by the Baron Cuvier, with Supplementary Additions to each Order. Vol. 14. London: Whittaker, Treacher & Co; 570 pp., 102 plates. [dated 1832].
Guérin-Méneville FE. 1844. Iconographie du Règne Animal de G. Cuvier. Part 7. Insectes. Paris: Ballière (1829-1844). 7:1–576.
Hausmann JFL. 1807. Beiträge zur Insektenfauna des Vorgebirges der guten Hoffnung Magazin für Insektenkunde. K. Illiger, Braunschweig. 6:229–267.
ICZN. 1999. International Code of Zoological Nomenclature. 4th ed. London: The International Trust for Zoological Nomenclature; p. 306.
Janssens A. 1940. Monographie des *Scarabaeus* et genres voisins. Verhandelingen Koninklijk Natuurhistorisch Museum Belgie. Brussels. 2:1–81.
Klug JCF. 1855. Diagnosen der neuer Coleopteren aus Mossambique Berichten der Königlich-Preussischen Akademie der Wissenschaften. Berlin. 20:643–660.
Kolbe HJ. 1895. Beiträge zur Kenntniss der Mistkafer, Lamellicornia Onthophila. Stettiner Entomologische Zeitung. Stettin. 56:329–345.
Linnaeus C. 1758. Systema naturae per regna tria naturae secundum classes, ordines, genera, species cum characteribus, differentiis, synonymis, locis. Holmiae: Salvii; p. 824.
Macleay WS. 1821. Horae entomologicae, or essays on the annulose animals. London: Bagster; 524 pp.
Moretto P. 2016. Description d'une nouvelle espèce de *Scarabaeolus* Balthasar, 1965, d'Afrique de l'Ouest (Coleoptera, Scarabaeidae). Catharsius La Revue. 13:8–23.
Péringuey L. 1901. Descriptive catalogue of the Coleoptera of South Africa Transactions of the South African Philosophical Society. Cape Town (1900). 12:1–563.
Péringuey L. 1908. Descriptive catalogue of the Coleoptera of South Africa. Additions and corrections Transactions of the South African Philosophical Society. Cape Town (1907). 13:547–752.
Shipp JW. 1895. A revised classification of the genus Ateuchus. The Entomologist. 28:218–221.
Von Harold E. 1869. Diagnosen neuer Coprophagen. Coleopterologische Hefte. 5:95–104.
Westwood JO. 1837. Characters and descriptions of some new coleopterous insects belonging to the family of sacred beetles. Proceedings of the Zoological Society. 5:12–13.
Westwood JO. 1847. Characters of various new groups and species among the Coprophagous Lamellicorn Beetles Transactions of the Entomological Society. London. 4:225–232.
Ziani S, Gudenzi I. 2012. Commenti sulla sistematica generica degli Scarabaeini del bacino del Mediterraneo con una chiave dicotomica per il loro riconoscimento (Insecta Coleoptera Scarabaeidae: scarabaeinae). Quaderno Di Studi E Notizie Di Storia Naturale Della Romagna. 36:115–158.
Zídek J, Pokorný S. 2004. Checklist of the genus *Scarabaeus* Linné. Animma.X. 5:1–30.
Zídek J, Pokorný S. 2008. Illustrated keys to Palearctic *Scarabaeus* Linné (Scarabaeidae). Animma.X. 27:1–27.
Zídek J, Pokorný S. 2011. Replacement name for a subgenus of Scarabaeus Linné, and remarks on Scarabaeus isidis (Scarabaeidae: Scarabaeinae: Scarabaeini). Klapalekiana. 47: 89–90.
Zur Strassen R. 1962. Beschreibung einiger neuer oder verkannter südafrikanischer *Scarabaeus*-Arten Senckenbergiana biologica. 43:339–357.
Zur Strassen R. 1967. Arten-Übersicht der Gattung *Scarabaeus* Linnaeus (Scarabaeidae) mit besonderer Berücksichtigung der äthiopischen Formen. Ent Blätter. 63:129–173.