

**Taxonomy of some dung beetle taxa (Coleoptera: Scarabaeidae: Scarabaeinae) from arid south-west Africa.**

Some new dung beetles from south-west Africa.

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**Abstract**

In this paper we describe new taxa and discuss others previously described from arid south-west Africa. Descriptions are provided for a new monotypic genus (*Variuscorpis* Deschodt, Davis and Scholtz gen. n.) and three new species, *Variuscorpis erongoensis* Deschodt, Davis and Scholtz sp. n., *Namakwanus endroedyi* Deschodt, Davis and Scholtz, sp. n., and *Scarabaeus (Kheper) kalaharicus* Davis, Deschodt and Scholtz, sp. n. *Scarabaeus (Scarabaeus) hottentorum* Péringuey is examined and the validity of its name and type locality are discussed. The recently described *Scarabaeus (Kheper) namibicus* Krajcik 2006 is synonymised with *Scarabaeus (Kheper) cupreus* Castelnau 1840. Distribution records are provided for all cited taxa and closely related species are discussed.

## **Keywords**

Coleoptera; Scarabaeinae; Taxonomy; New; Genus; Species.

## **Introduction**

South-west Africa is rich in endemic dung beetle species (Scholtz et al. 2009). In drier regions, this endemism has been driven by responses to the increasingly arid conditions (Pickford & Senut 1999) that have overlain the regional geomorphology since the Miocene (Pickford & Senut 1999). Currently, there is a clear rainfall gradient from the arid west to the more mesic north-east. This ranges from less than 125 mm per year in the Namib Desert, to between 120 – 250 mm per year from the Nama Karoo to the Kalahari (Pickford & Senut 1999; Mucina & Rutherford 2006). Taxa from three arid areas within this region are considered in this paper.

### *Namibian Escarpment and Plateaux*

This area forms part of the Great African Escarpment and is characterised by inselbergs and escarpment mountain massifs. These comprise igneous formations of the Damaraland complex (Haapala et al. 2007) and a mixture of igneous and sedimentary Precambrian fold mountains forming the Naukluft Mountains (Korn & Martin 1959) and the Richtersveld complex (Frimmel et al. 2001). The mountains are surrounded by boulder fields as a consequence of erosion, which form ideal habitat for the Rock Hyrax (Hyracoidea: Procaviidae *Procavia capensis* (Pallas)).

This species is likely to have been present in the region since the middle Miocene (13-12 million years ago (MYA)) (Skinner & Chimimba 2005), which coincides with the postulated commencement of aridification in south-west Africa at about 15 MYA (Pickford & Senut 1999). The hyrax's communal toilets or dung middens have probably acted as a stable and regular supply of food and moisture for dung beetles living in increasingly arid environmental conditions. As a result, at least three genera (*Dicranocara* Frolov and Scholtz, *Byrrhidium* Harold, *Namakwanus* Scholtz & Howden) are now found exclusively in association with these middens (Deschodt et al. 2007). This paper describes a new genus and two new species from this hyrax-associated group.

#### *Namakwaland Hardeveld Bioregion*

This bioregion is part of the semi-desert Succulent Karoo Biome (Mucina & Rutherford 2006). It is situated on the uplands that lie along the escarpment, to the east and above the Namaqualand sandveld of the coastal plain, and extends from just south of Steinkopf [S29° 15' E17° 44'] in the north, almost to Bitterfontein [S31° 02' E18° 15'] in the south. The arid conditions were intensified by the uplift of the eastern escarpment around 15 MYA and again between 3-5 MYA (Haddon & McCarthy 2005). This latter event obstructed most rain from the east and may have driven more recent speciation events. This paper discusses the validity of labelling on the type material of *Scarabaeus* (*Scarabaeus*) *hottentorum* Péringuey and whether the range occupied by this probably recently-speciated taxon (see discussion below) might be restricted to the Namaqualand Hardeveld.

## *South-west Kalahari*

The southern Kalahari Basin has a probable origin in the late Cretaceous (Moore 1999; Moore & Larkin 2001). However, the deep sands of the region result from subsequent erosion and deposition by inward draining rivers after minor late Miocene (around 15 MYA) and major Pliocene (between 3 and 5 MYA) uplift in the east (Haddon & McCarthy 2005). Pleistocene aeolian reworking of these sands has led to dune development (Haddon & McCarthy 2005), particularly in the arid south-western region (Lawson & Thomas 2002). This paper describes a new *Scarabaeus* (*Kheper*) species that is probably endemic to these dunes. It also synonymises *S. (K.) namibicus* Krajcik 2006, recorded at the edge of the south-west Kalahari, with a widespread savanna species *S. (K.) cupreus* Castelnau 1840.

Labels are reported verbatim with authors' comments in square brackets. The type depositories are as follows: BMNH: England, London, The Natural History Museum; IRSNB: Belgium, Brussels, Institut Royal des Sciences Naturelles de Belgique; MNHN: France, Paris, Muséum National d'Histoire Naturelle; NMNW: Namibia, Windhoek, National Museum of Namibia; SAMC: South Africa, Cape Town, Iziko South African Museum; SANC: South Africa, Pretoria, South African National Collection of Insects; TMSA: South Africa, Pretoria, Transvaal Museum; and UPSA: South Africa, Pretoria, University of Pretoria Scarab Collection.

### **Description of new genus.**

*Genus: Variuscorpus* Deschodt, Davis and Scholtz, gen. n., Figs 1, 12

This genus keys out to couplet 22 in the key by Deschodt & Scholtz (2008). The following couplet will separate *Variuscorpis* Deschodt, Davis and Scholtz gen n from *Namakwanus* Scholtz and Howden:

- 22a. Elytra in dorsal view strongly convex to ovoid .....  
..... *Namakwanus* Scholtz and Howden  
— Elytra in dorsal view elongate.....  
..... *Variuscorpis* Deschodt, Davis and Scholtz gen n

Type-species: *Variuscorpis erongoensis* Deschodt, Davis and Scholtz sp. n.

*Diagnosis.* *Variuscorpis* is a flightless genus from the arid western parts of southern Africa. Compared to other flightless genera, it is interesting in that its pronotum is similar to that of *Byrrhidium*, while the elytra are close to those of *Dicranocara*, and the head and front tibiae compare well with *Namakwanus*. However, it has three front tibial teeth whereas the other genera have only two. *Variuscorpis* can be separated from *Namakwanus* by its much larger size and elongate elytra compared to the strongly convex to ovoid elytra of the smaller-bodied *Namakwanus*.

*Length.* ♀, 11.8mm x 7.5mm

*Head.* Clypeus with two upturned, reasonably well developed teeth and one smaller tooth medially on lower clypeal margin. Genae obtuse angled; genal suture distinct, slightly curving inward posteriorly. Entire dorsal ocular margin with ridge. Surface

with small granules; punctate with punctures irregular in size and shape anteriorly, becoming regular posteriorly.

*Pronotum.* Convex, lateral margins widening posteriorly, anterior margin sinuate. Surface granulate with small ovoid punctures and no associated setae. Punctures barely further apart than their diameter. Scutellum not visible.

*Elytra.* Elongate, transversely convex. Elytra fused and no humeral callus visible. Surface granulate. Interstriae faintly visible with irregular punctures. Punctures with very short setae. Setae mostly worn away.

*Sternum.* Meso- and metasternum fused, suture clearly visible, both widening anteriorly between middle coxa. Meso- and metasternum with very small granules. Mesosternum with small irregular punctures 2-3 times further apart than their diameter, metasternum with small irregular punctures 1-1.5 times further apart than their diameter.

*Pygidium.* Slightly convex, with small granules and irregular punctures 1-1.5 times further apart than wide.

*Fore tibia.* Outside lateral edge with three tibial teeth in anterior third, from there posteriorly up to last quarter with small denticles, denticles gradually smaller posteriorly. Carina running along ventral surface, terminating opposite anterior denticle. Ventral process at inside anterior margin curving down- and outward.

*Etymology.* The generic name is derived from the combination of the Latin words for various and body since the body appears to consist of a combination of body parts of other known genera. The gender is masculine.

## Description of new species

*Variuscorpis erongoensis* Deschodt, Davis and Scholtz, sp. n., Figs 1, 12

*Length. Holotype:* 11.8mm x 7.5mm

*Head.* With two upturned teeth and one small tooth medially on lower margin.

*Pronotum.* Surface granulate with ovoid punctures, mid longitudinal line without punctures from anterior- to posterior base of pronotum.

*Elytra.* Surface finely granulate (only visible under 64 x or stronger magnification). Interstriae only just visible and with irregular rows of shallow punctures.

*Sternum.* Punctate with punctures on mesosternum closer together and smaller than on metasternum.

*Pygidium.* Surface very finely granulate with punctures more than one puncture diameter apart. Punctures with associated setae.

*Fore tibia.* Outside margin anteriorly tridentate, thereafter serrated up to last quarter. Outside margin of tibia matte and inside shiny.

*Material examined. Holotype:* ♀ S.W.AFR., ErongoMT., Farm Amieb, 21.[°] 45[′] S - 15.[°] 39[′] E, 23.2.1975: E – Y:687, from under stones, legEndrödy &Schulze. (TMSA).

*Etymology.* The specific name is derived from the type locality.

*Discussion.* From its probable close relationships with the generic group comprising *Byrrhidium*, *Dicranocara* and *Namakwanus* (Sole & Scholtz unpublished data), it may be predicted that *Variuscorpis erongoensis* probably shows similar habits, including association with hyrax middens and their dung. There is a strong probability that the group is monophyletic (Sole & Scholtz unpublished data), that its members occur in similar rocky terrain, and that they are morphologically constrained by their similar ecological habits. Undoubtedly, more new species of

this relictual group will be found under similar environmental conditions In the absence of a comprehensive tribal revision *Variuscorpis* is provisionally placed in the existing polyphyletic tribe Canthonini like the other members of this group.

Figure 1.

*Genus: Namakwanus* Scholtz and Howden

Type-species: *Namakwanus irishi* Scholtz and Howden 1987 by original designation.

The genus *Namakwanus* currently consists of three described species, all from Namibia. These are: *Namakwanus irishi* Scholtz and Howden (described from Windhoek [S22°34' E17°04'] and Gobabeb [S23°33' E15°02']), *N. streyi* Frolov, (from Bullsport [16°22'E, 24°08'S]) and *N. davisii* Deschodt and Scholtz (from Hardap Dam [S24°29' E17°50']).

It seems that *Namakwanus* species are primarily separated between altitudinal blocks or isolated mountain ranges with catchment areas having a minor influence. However, speciation and distribution patterns are unclear given the limited available locality data. As these beetles are flightless and dependent on local and infrequently equitable environmental conditions, they may represent examples of –pocket speciation (Endrödy-Younga 1978). The collecting locality would thus be an excellent indicator of species' identity.

The type locality of *N. streyi* is probably in the Remhoogte Mountains to the east of the Tsondab river canyon where R. G. Strey's (collector of the holotype) farm, Buellsport, was located (Gunn and Codd 1981). Specimens collected from the Naukluft Mountains, west of the Tsondab river canyon belong to *N. endroedyi* sp.n.



A female specimen of a, possibly, fifth species was collected from the Erongo Mountains. However we chose not to describe it until male specimens are collected from that locality.

The specimen of *N. irishi* from –Gobabebll was probably collected further to the east in the Kuiseb canyon where suitable habitat for *Namakwanus* is found. The specimen compares well with the holotype but occurs at a different altitude and within a different catchment area. More specimens are required to determine whether or not it belongs to a further species of the genus.

Key to the species of *Namakwanus* Scholtz and Howden

- 1. Clypeal horns as long as or longer than distance between them.....  
..... *irishi* Scholtz and Howden
- Clypeal horns shorter than distance between them ..... 2
- 2. (1) Apices of aedeagus with rows of long setae, terminally not bending  
outwards..... *streyi* Frolov
- Apices of aedeagus without rows of long setae, terminally bending  
outwards..... 3
- 3. (2) Tip of parameres with two notches in frontal view (fig. 3 B1).....  
..... *endroedyi* Deschodt, Davis and Scholtz
- Tip of parameres without notches in frontal view (fig. 3 A1) .....  
..... *davisi* Deschodt and Scholtz

*Namakwanus endroedyi* Deschodt, Davis and Scholtz, sp. n., Figs 2, 3, 12

*Length. Holotype:* ♂ 7.9mm x 4.9mm.

*Head.* Clypeus with two teeth, fairly worn in holotype, notch between teeth more or less straight. One small tooth on lower margin of notch between dorsal teeth. Clypeogenal suture not evident, surface shallowly punctate.

*Pronotum.* Very convex, shallowly punctate, punctures closer together than diameter.

*Elytra.* Very convex; striae faintly punctate, punctures with very short associated setae.

*Sternum.* Meso - and metasternum fused, suture straight. Some faint punctures on meso - and metasternum, punctures smaller than distance between them.

*Pygidium.* Faintly punctate with punctures about as far apart as distance between them. Surface with micro-granules.

*Fore tibia.* Inner edge slightly sinuate with no denticles. Three denticles at outside distal edge, space between distal and middle denticle bigger than middle and last denticle. Spur short and spatulate.

*Paratypes and variability.* There is very little variation between specimens with ♀ slightly smaller than ♂.

*Material examined. Holotype:* ♂ Naukluft Mountains, S24.25763° E16.22925°, 2009.01.03. C. Deschodt. (NMNW). *Paratypes:* 2 ♀; S.W.Afr., Naukluft, Felseneck farm, 24[°].21['] S – 16[°].00['] E, 11.3.1975; E-Y:732a, groundtraps, 178day, Endrödy & Breytenb., groundtrap with banana bait. (TMSA), Naukluft Park Namibia, S24.02732° E16.15282°, 06.iii.2006 1160 m, C. Deschodt & A. Davis (UPSA).

*Etymology.* This species is named in honour of Dr. Sebastian Endrödy-Younga who collected the first specimen known to us, and whose lifetime collecting effort surpasses the imagination.

Figure 2.

Figure 3.

*Genus: Scarabaeus* Linnaeus

Type-species: *Scarabaeus sacer* Linnaeus 1758 by subsequent designation MacLeay 1821.

*Scarabaeus (Kheper) kalaharicus* Davis, Deschodt and Scholtz, sp. n., Figs 4, 5, 6, 7, 12

*Length. Holotype:* ♂ 31.7mm x 16.5mm.

*Head.* Surface fairly rugose with no granulation. No protrusion on clypeus. Front teeth evenly upturned with anterior half of teeth not rugose. Notch between innermost teeth rounded and notch between second pair sharp. Some short setae at posterior base. Antennae dark brown.

*Pronotum.* Granulate with granules not connected. Area between granules with micro granules (at 64x magnification). Middle lateral clear area forming a faint line, most evident in posterior second quarter.

*Elytra.* Feebly ribbed. Granules on interstriae with micro-granulation between. Striae not clearly discernible with the naked eye. Very short recurved tan setae spread sparsely over surface.

*Sternum*. Median longitudinal groove across metasternum, anterior third and lateral edges with setae, posterior two-thirds smooth.

*Pygidium*. Rugose with micro-granulation.

*Fore tibia*. Inside edge smooth with no protrusions or denticles, slightly curved inward. Outside margin with four teeth, proximal tooth smallest with protrusion at base.

*Aedeagus*. Right paramere at second third with triangular protrusion, otherwise symmetrical, distal tips angled anteriorly. Parameres narrowing distally. Tips of parameres round with a sharp point laterally. Paramere tips close together.

*Paratypes and variability*. Except for the variable size (22mm x 12mm for smallest to 31mm x 16mm for biggest in type series) there is very little variation in the type series. General colour of setae is dark brown to black.

*Material examined*. *Holotype*: ♂ Kgalagadi Transfrontier Park, Botswana, Site 1, 11-13.ii.2006, S26.40780° E20.70914° 895 m, B.P.Tshikae & C.M. Deschodt (TMSA). *Paratypes*: Botswana: Unsexed: 25, data same as holotype (5 TMSA, 5 SANC, 10 UPSA 5 MNHN), 11, same data as holotype but Site 2 S26.34255° E20.75092° 900 m (6 BMNH, 5 IRSNB), 3, same data as holotype but Site 3 S26.26294° E20.80314° 905 m (SAMC), 8, same data as holotype but collected 29-31.iii.2005 (5 SANC 3 SAMC), 2, South Africa: Farm: La Gratitude (3), S28.64108° E22.02656°, 9-11.iii.2004 1020m ALV. Davis & C. Deschodt (1 TMSA, 1UPSA).

*Distribution and relationships*. This species is centered on the arid dune fields of the south-western Kalahari that straddle the border of Namibia, Botswana and South Africa. Its distribution on deep dune sands may account for the habitus, which is somewhat more elongate than in other species of *Scarabaeus* (*Kheper*).

The aedeagus shows similarities to that of *Scarabaeus (Kheper) bonellii* MacLeay (see Davis 1986). However, the triangular protrusion in *S. (K.) bonellii* points downward and the distal tips of the parameres are clearly separated. *S. (K.) bonellii* is restricted to west coastal sands in the winter rainfall region of South Africa. The aedeagus differs from *Scarabaeus (Kheper) nigroaeneus* (Boheman) by having the triangular protrusion pointing more to the side and clearly separate from the right distal paramere tip whereas it is pointing downward and is connected to the right distal tip by a slight ridge in *S. (K.) nigroaeneus*. *S. (K.) nigroaeneus*' distribution extends throughout the moister lowland and mid-altitude wooded savannas in the southeast of Africa, including the savanna area between the southeast Kalahari and the western Highveld.

*Etymology.* The name is derived from the Kalahari on whose deep sands the species occurs.

Figure 4.

Figure 5.

Figure 6.

Figure 7.

*Scarabaeus (Scarabaeus) hottentorum* Péringuey. Figs 8, 9, 10, 12

Synonym: *Sebasteos procles* Kolbe, 1908 (Not examined)

The collections of the Iziko South African Museum contain a stand-alone aedeagus and three specimens considered to be the type material of *S. (S.) hottentorum* Péringuey 1901. One specimen bears a handwritten label inscribed –Scarabaeus hottentotus, type, Gg|| [apparently not in Péringuey’s handwriting], a red label inscribed –Type SAM / Ent 2642|| [= official SAM holotype label], a printed label inscribed –Holo-type.|| [faded red? = an A.J. Hesse label], and a handwritten label inscribed –Kimberley Per.||. The aedeagus bears a single handwritten label inscribed *Scarabaeus savignyi* hottentotus armature of ♂, which may have been used in a plate of the original article describing *S. (S.) hottentorum* (J. du G. Harrison pers. comm.). The other two specimens each bear a handwritten label inscribed –O’Okiep|| with further undeciphered writing, a printed orange label inscribed –PARA-TYPE|| [= A.J. Hesse labels], and a printed green label inscribed –Type SAM / Ent|| followed by either –2623|| or –5975||. Specimen –2643|| bears a handwritten label inscribed –Scarabaeus hottentorum Per.|| and specimen –5975||, a label inscribed –Scarabaeus hottentorum Per Cotypic material cf comp d with type (AJH)||.

The putative holotype has the distinction of bearing labels on which neither the species name, nor the collection locality, match the published name and type locality. We have examined a type specimen of *Scarabaeus (Scarabaeus) hottentotus* Macleay 1821 and concur with previous authors (zur Strassen 1967, Ferreira 1972) that it is a synonym of *Scarabaeus (Scarabaeus) suri* Hausman 1807, and quite different in appearance to *S. (S.) hottentorum* Péringuey 1901. The type bearing the *S. hottentotus* label is clearly similar in appearance to the paratypes from O’Okiep [Namaqualand] bearing the *S. hottentorum* labels. The putative

–holotypell specimen also matches material collected in Namaqualand on several different occasions between 1974 and 2009.

The published type locality of –Namaqualand: Barkly Westll and the locality information of the –paratypesll from O‘Okiep are consistent with a Namaqualand species range. However, we have been unable to locate either a settlement or a farm named, Barkly West, within this region. Furthermore, although the putative holotype specimen bears a label inscribed –Kimberleyll [S28° 44‘ E24° 45‘], which is close to the town of Barkly West (S28° 32‘ E24° 31‘), this area is distant from Namaqualand, and is well outside of the current known range of *S. (S.) hottentorum*. Although not conclusive evidence for absence, this species was not recorded in any one of seven dung beetle collections made in the Kimberley area during the 1970’s nor in one made near Barkly West. Available evidence from paratypes and recent collections, therefore, support Namaqualand as the most likely origin and range of the species.

*Distribution and relationships.* This species is centered on the upland part of Namaqualand (Namakwaland Hardeveld Bioregion) in the Succulent Karoo Biome (Mucina & Rutherford 2006) with species records at the edge of the Namaqualand Klipkoppe Shrubland and Namaqualand Heuweltjieveld in the north and the edge of the Namaqualand Klipkoppe Shrubland and Namaqualand Shale Shrubland in the south.

It shows close relationships to at least three species with distributions in other parts of South Africa. *Scarabaeus (Scarabaeus) rusticus* Boheman differs by lacking punctuation on the prothoracic disc and shows a distribution on koppies and hills around the northern edge of the Highveld from Northwest Province to KwaZulu-Natal. *Scarabaeus (Scarabaeus) spretus* Zur Strassen also lacks punctuation on the

prothoracic disc and is distributed on sandy soils in upland Fynbos or upland Karoo from the Cape of Good Hope Nature Reserve and Table Mountain to Sutherland (32° 23'S 20° 39'E). *Scarabaeus (Scarabaeus) savignyi* Macleay bears a protuberance on the posterior margin of the hind femora which is not present in the other three species. It shows a distribution in fynbos of the southern coastline from Caledon (34° 14'S 19° 25'E) to George (33° 57'S 22° 27'E).

Figure 8.

Figure 9.

Figure 10.

*Scarabaeus (Kheper) namibicus* Krajcik 2006. Fig 12

Krajcik 2006 described *Scarabaeus (Kheper) namibicus* based on three specimens from Namibia. He notes its proximity to *Scarabaeus (Kheper) cupreus* Castelnau 1840 but with the following variations: -The locality, non-metallic colour of dorsal side with non-lustrous elytral suture (in day light), not projected, rather obtuse teeth of anterior tibiae, and mainly shape of parameresll.

Figures 11 and 12 show the habitus of *S. (K.) cupreus* and distribution of both species with the type locality of *S. (K.) namibicus* clearly inside the known distribution of *S. (K.) cupreus*. *S. (K.) cupreus* is known to vary in colour. Furthermore, the obtuse teeth of the protibiae in *S. (K.) namibicus*, presumably, result from wear through burrowing activity. Although we did not have access to



either of the types it is clear from the description and images in Krajcik 2006 that this species is in fact *S. (K.) cupreus*. Thus, we synonymise *S. (K.) namibicus* with *S. (K.) cupreus*.

Figure 11.

Figure 12.

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**Figures:**

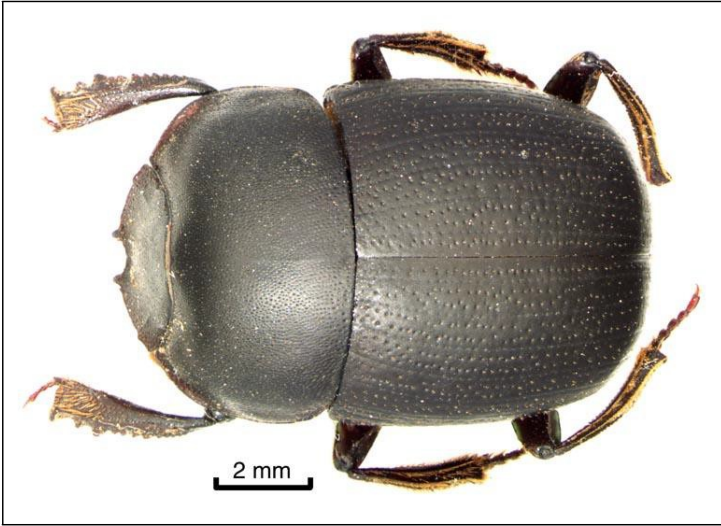


Fig. 1. Habitus of *Variuscorpis erongoensis* Deschodt, Davis and Scholtz.

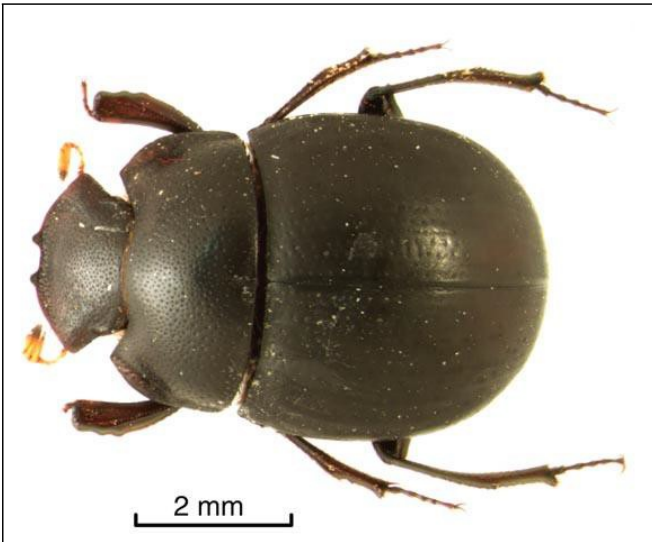


Fig. 2. Habitus of *Namakwanus endroedyi* Deschodt, Davis and Scholtz. ♀ paratype.

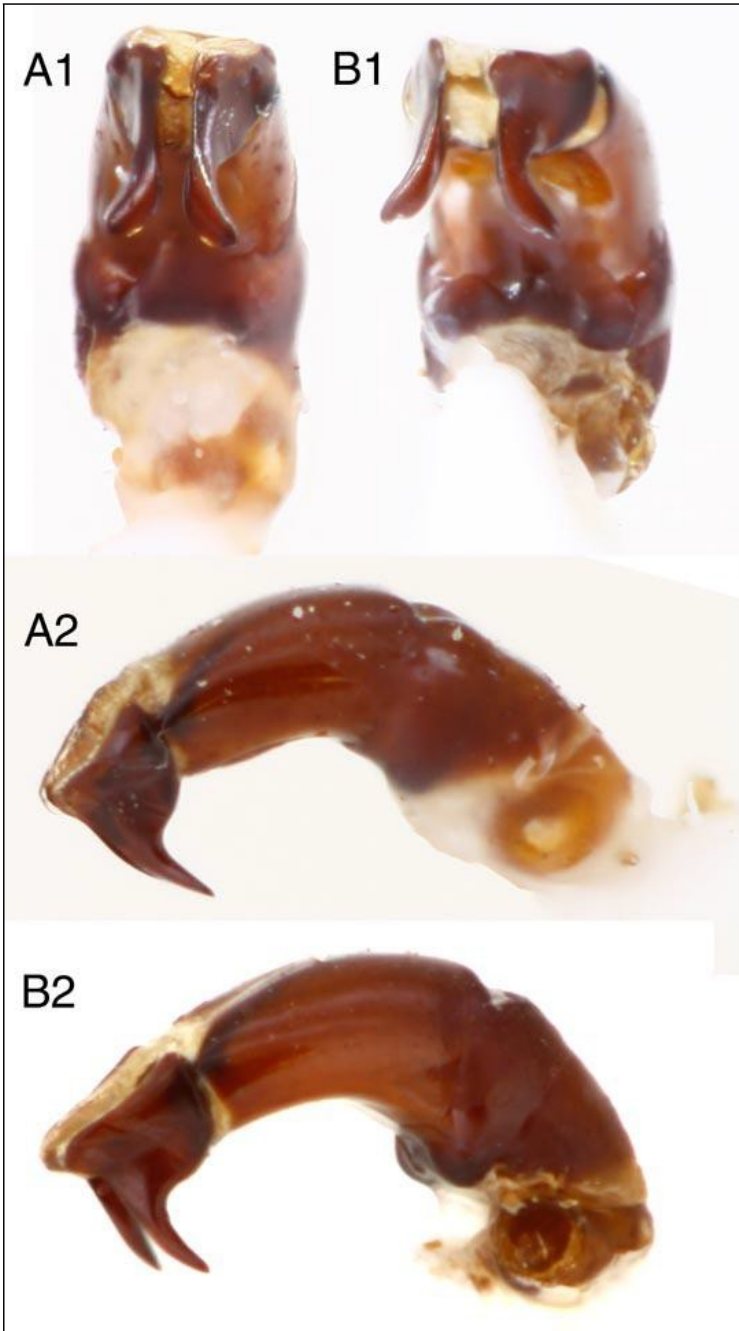


Fig. 3. Aedeagi of *Namakwanus davisi* Deschodt and Scholtz (A1 frontal A2 lateral) and *N. endroedyi* Deschodt, Davis and Scholtz (B1 frontal B2 lateral).

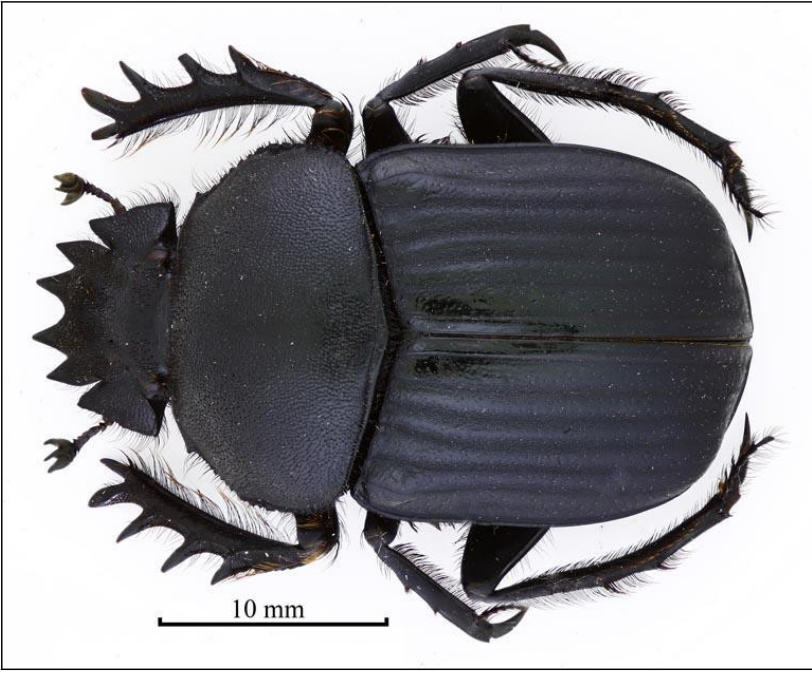


Fig. 4. Habitus of *Scarabaeus (Kheper) kalaharicus* Davis, Deschodt and Scholtz.

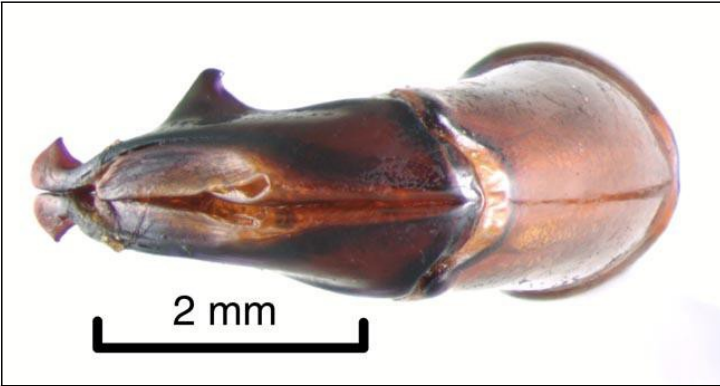


Fig. 5. Aedeagus of *Scarabaeus (Kheper) kalaharicus* Davis, Deschodt and Scholtz in dorsal view.

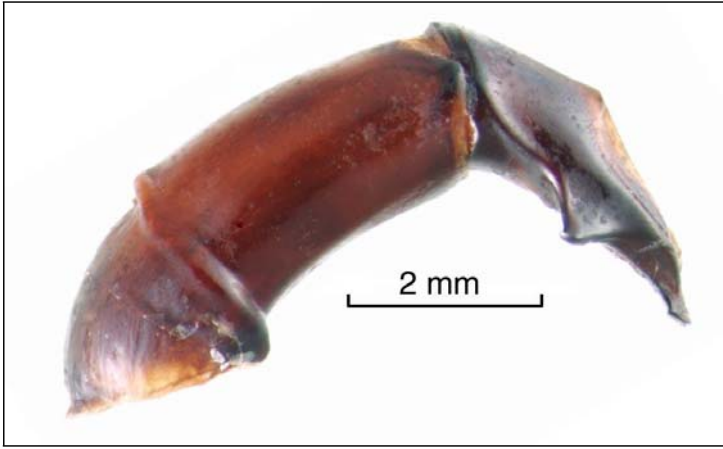


Fig. 6. Aedeagus of *Scarabaeus (Kheper) kalaharicus* Davis, Deschodt and Scholtz, lateral right view.



Fig. 7. Aedeagus of *Scarabaeus (Kheper) kalaharicus* Davis, Deschodt and Scholtz, lateral left view.



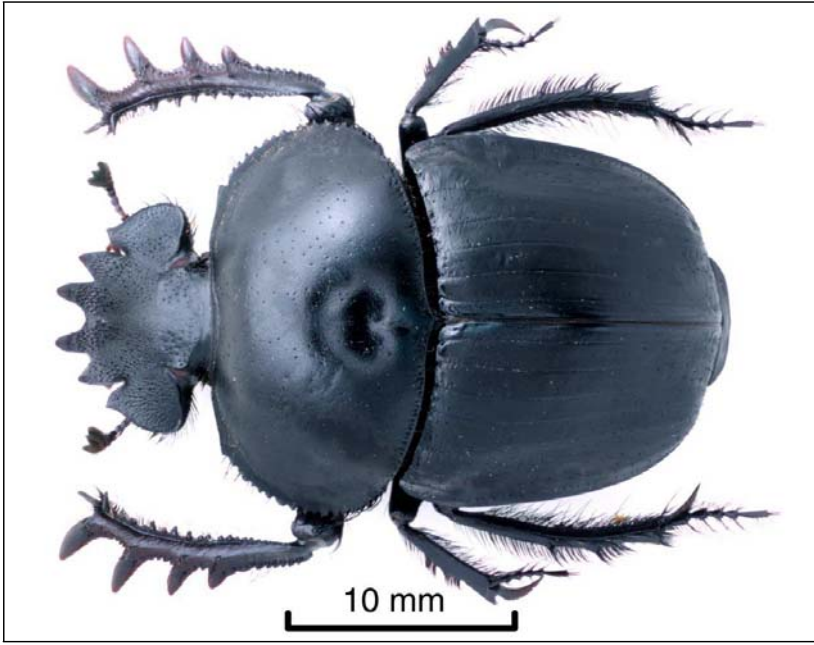


Fig. 8. Habitus of *Scarabaeus (Scarabaeus) hottentorum* Péringuey.

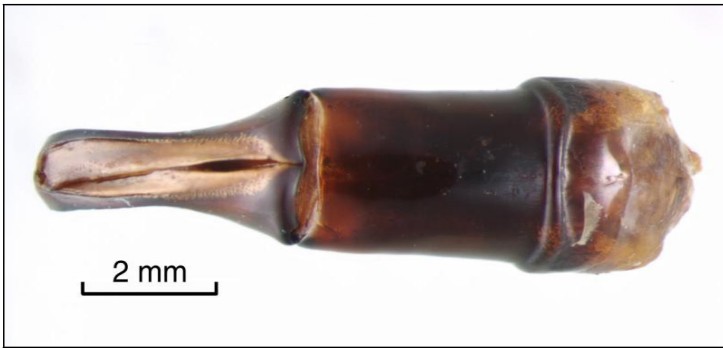


Fig. 9. Aedeagus of *Scarabaeus (Scarabaeus) hottentorum* Péringuey, dorsal view.

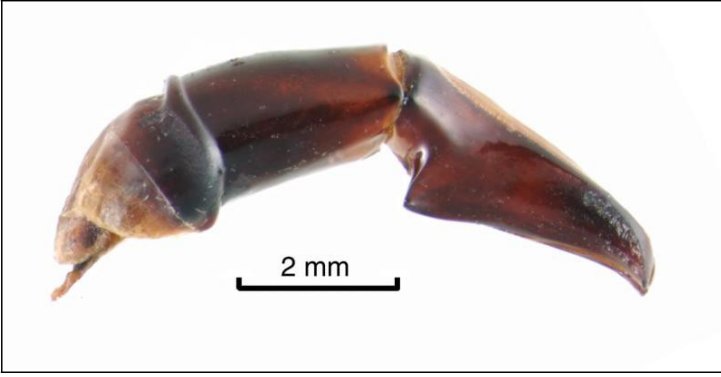


Fig.10. Aedeagus of *Scarabaeus (Scarabaeus) hottentorum* Péringuey, lateral right view.

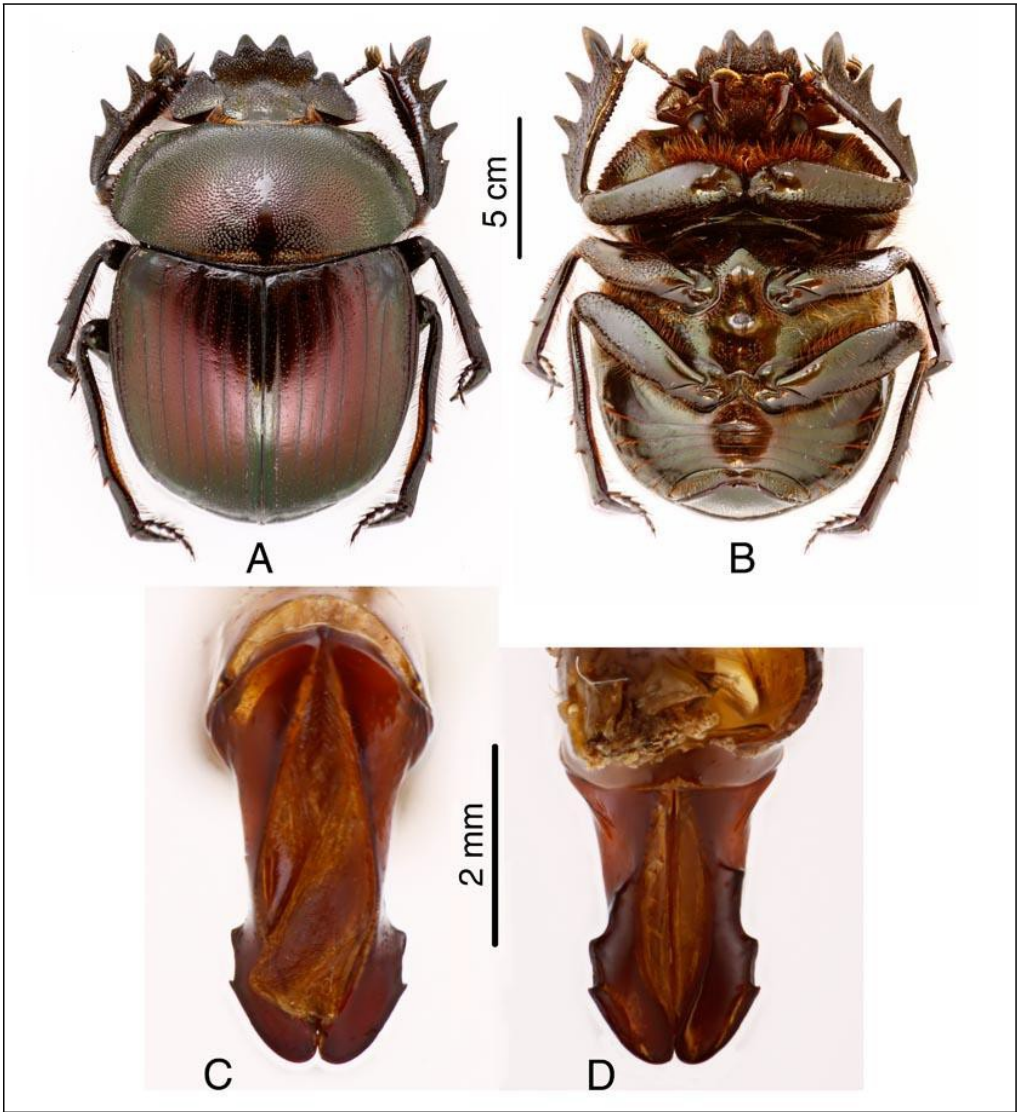
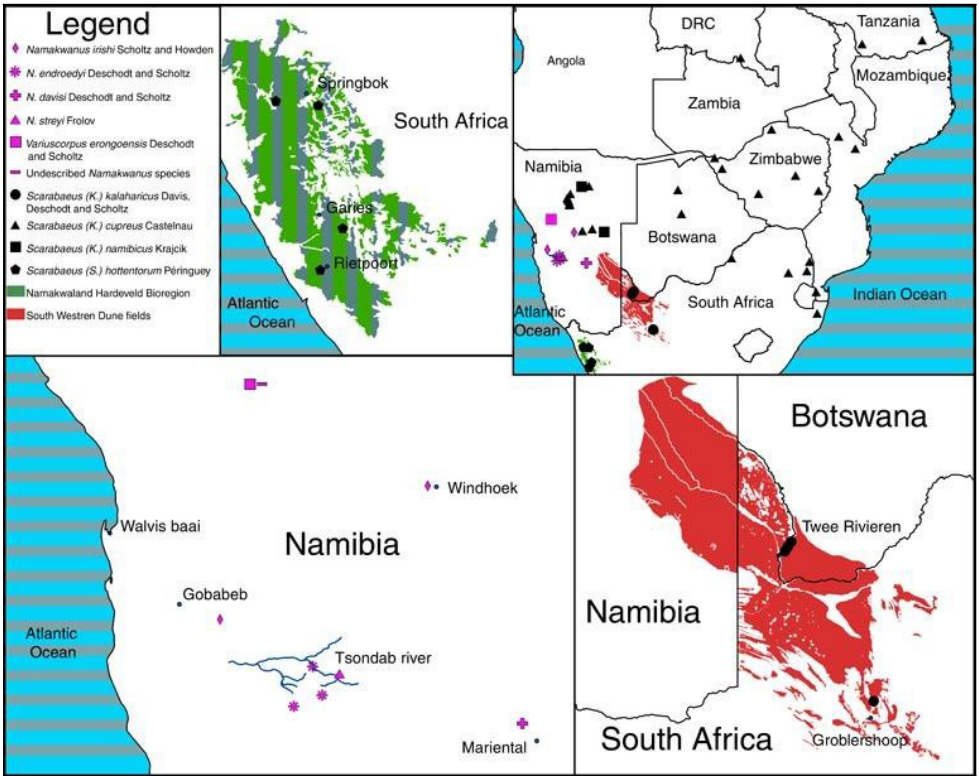


Fig. 11. Habitus (A dorsal, B ventral) and aedeagus (C dorsal, D ventral) of *S. (K.) cupreus* Castelnau. The illustrated specimen is from Kariba [S16.52335° E28.77482°], Zimbabwe, and housed in the Transvaal Museum and was determined by Dr. R. zur Strassen. The figure is in the same style as in Krajcik 2006.



**Fig. 12.** Map showing the type localities of the new and the apparent distribution of the species discussed in this paper. Note that no GIS soil map for Botswana was available and the extent of the dune fields in South Western Botswana was extrapolated from Google Earth.