

## A new synonymy in the *fidius* group of *Copris* Müller 1764 (Coleoptera: Scarabaeidae: Scarabaeinae) and a new species from the highland grasslands of South Africa

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### Abstract

The *fidius* group constitutes the basal clade in a phylogeny of the Afrotropical members of the genus, *Copris* Müller, 1764. In this paper we describe *Copris crassus* Deschodt and Davis as a new species in this group. We also demonstrate that the distributional function between two body dimensions (lateral horn length and mid-line elytron length) differs between *Copris fidius* (Olivier 1789) and *C. crassus*. *Copris bihamatus* Balthasar, 1965 is also a member of the *fidius* group. Nguyen-Phung (1988) suspected that it was a synonym of *C. fidius* (Olivier) so we compare specimens of similar body size and use the distributional function between body dimensions to demonstrate that *C. bihamatus* is indeed a synonym of *C. fidius*. We provide a key for all known valid species in the *fidius* group, except *C. serius* Nguyen-Phung, 1987.

**Key words:** Scarabaeidae, Scarabaeinae, New species, *Copris*, *crassus*, *fidius*, *bihamatus*, endemic, New synonym.

### Introduction

The group of species allied to *Copris fidius* (Olivier, 1789) (Nguyen-Phung 1987; 1988, Marchisio & Zunino 2012) forms the most basally-derived clade in a phylogeny of the Afrotropical members of the genus *Copris* Müller, 1764 (Cambefort & Nguyen-Phung 1996). These Afrotropical species have speciated in the forests, savannas, and highlands on the eastern side of the continent (seven species) with a single species distributed from west to northeast and east-central Africa (Nguyen-Phung 1987; 1988; Marchisio & Zunino 2012). In this paper we describe a new species of the group recorded primarily from high altitude grasslands along the eastern escarpment of South Africa. We also investigate the validity of *Copris bihamatus* Balthasar, 1965, described from a male holotype and two paratypes housed in the NMPC.

*Copris crassus* Davis and Deschodt n. sp. shows closest affinities to *C. fidius*, a species that is centred on forest patches, both along the eastern coastline of South Africa as far as the extreme south of Mozambique, and at higher altitude along the edge of the eastern escarpment in the north of its South African range. Other published records for *C. fidius* outside of South Africa (Nguyen-Phung 1988) probably represent old labeling errors.

As prominence of secondary sexual characters varies with body size and body size varies between species, as part of the description, we have used the relationship between lateral horn length and mid-line elytral length to demonstrate two parallel but separate scatters of data points for *C. fidius* and *C. crassus*. This is akin to the relationship between horn length and body size (thorax width) measured for *Onthophagus taurus* Schreber, 1759, which generated a sigmoidal distribution (Moczek & Emlen 1999).

In the case of *C. bihamatus*, Nguyen-Phung (1988) was unable to see the type specimens for her review of the *fidius* group but she suggested that it would likely be a synonym of *C. fidius*. In the plot of the horn length against elytral length, we demonstrate that *C. bihamatus* is close to *C. fidius* and distant from *C. crassus*. Furthermore, by comparing material of similar body size, we concur with Nguyen-Phung (1988) that *C. bihamatus* Balthasar is, indeed, a junior synonym of *C. fidius* (Olivier) so that, with the addition of *C. crassus*, the number of species in the *fidius* group remains at a total of eight.

## Materials and Methods

Males and females were separated by examining each specimen for the presence of an aedeagus. Using a jig, each pinned male specimen was then visually aligned to a standardized position and orientation in order to make lateral photographic images (Canon 500D camera body fitted with a Canon 100 mm macro lens set to manual focus) from which measurements were made (Fig. 1). Because the head, pronotum and elytra move in relation to one another, two images were made for each specimen, one for measuring elytral length and one for measuring horn length in side view. For measuring elytron length, the specimen was viewed from the side and tilted slightly until the elytral suture became entirely visible when the camera was triggered and the photograph stored for measurement. A measurement was then made from the anterior end of the left elytron along the margin to the posterior end. For measuring horn length, the specimen was tilted until the maximum visible horn area was seen and the second photograph was stored. The measurement was made from where the horn starts rising off the clypeus to the furthest tip of the horn. Each image had a gauge of known length to scale the images. Measurements were made using the program Analyzing Digital Images by John Pickle (Concord Academy; formerly, Museum of Science, Boston). Terminology for the male genitalia follows Medina *et al.* (2013).



**Figure 1.** Lateral view of *Copris fidius* (red lines indicate the positions where measurements of length for the horn and elytron were acquired).

Acronyms for depositories from which specimens were viewed and where types were deposited:

NMPC: Czech Republic, Prague, National Museum

SANC: South Africa, Pretoria, South African National Collection of Insects

TMSA: South Africa, Pretoria, Ditsong National Museum of Natural History

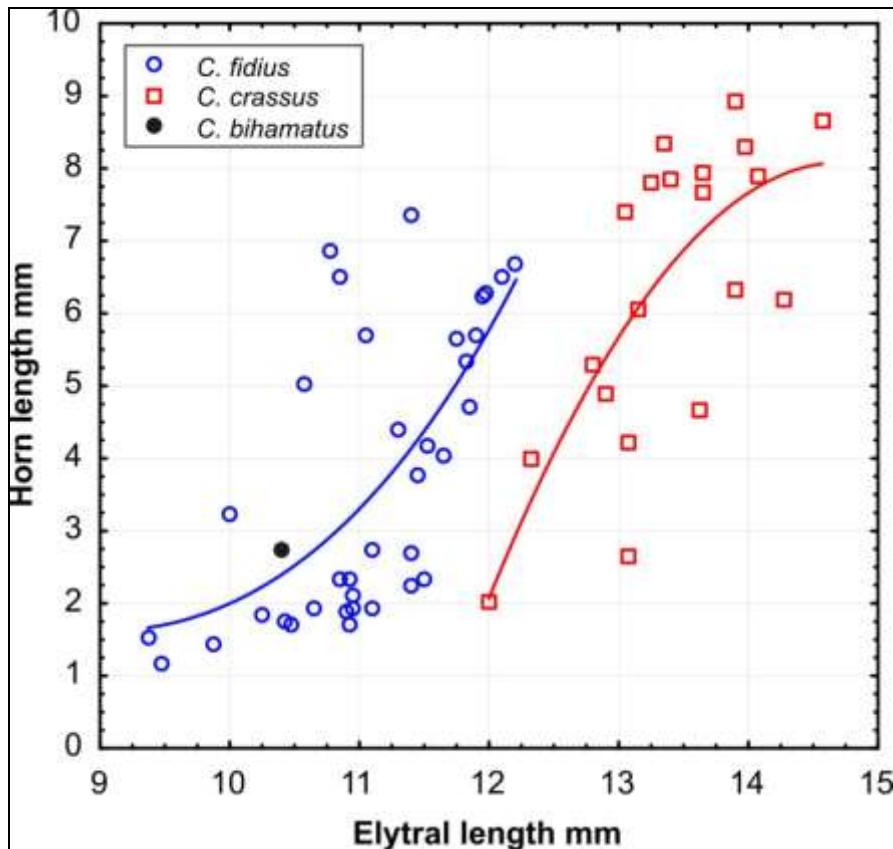
UPSA: South Africa, Pretoria, University of Pretoria

Locality labels are reported verbatim with authors' comments in square brackets.

### **Comparative graphs**

The relationship between lateral horn length and mid-line elytral length forms two separate scatters of data points for males, suggesting two different species (Fig 2). Whereas the data points for *C. crassus* are clearly separate from those for *C. fidius*, the single *C. bihamatus* data point is nested within those for *C. fidius*.

Curvilinear regression lines (negative exponential) were fitted to the data points for *C. fidius* and *C. crassus*. The failure to demonstrate sigmoid distributions may be related to sample size (absence of extreme major male *C. fidius* and extreme minor male *C. crassus*).



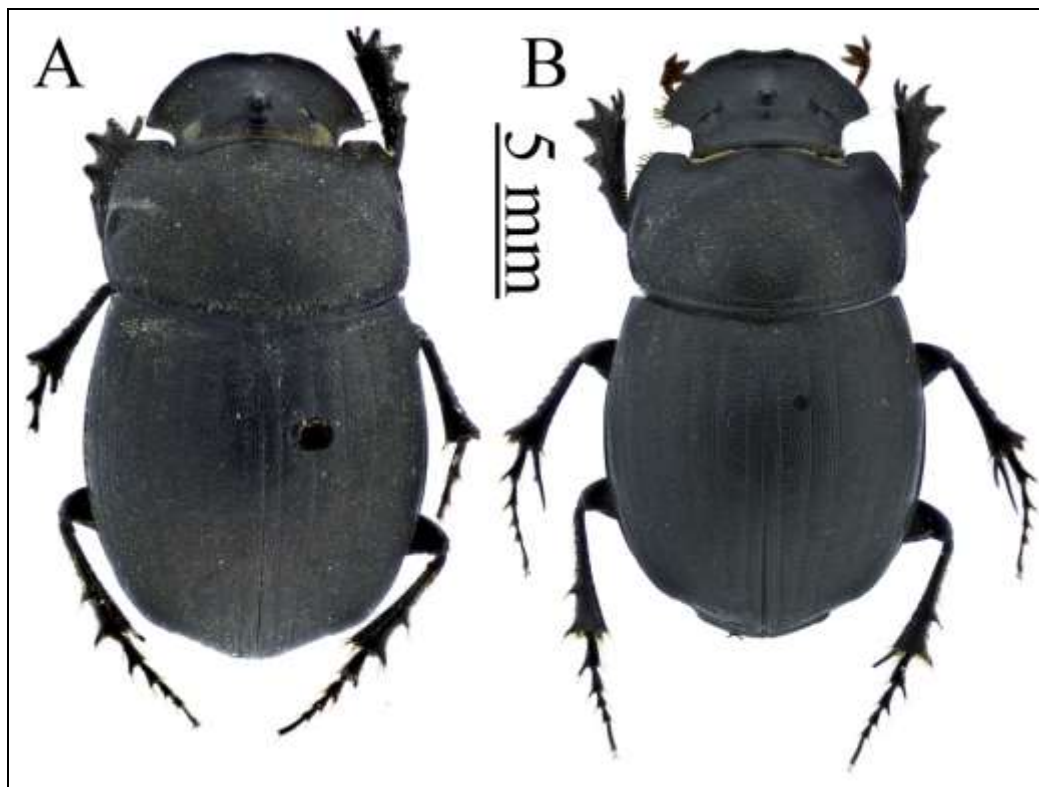
**Figure 2.** Graph showing horn length plotted against the length of elytral curvature for ■ *Copris crassus*, ○ *Copris fidius* and ● *Copris bihamatus* Holotype (regression lines = negative exponential).

### Synonymy

*Copris fidius* (Olivier, 1789) Figure 3 A, 4 C, E, 5.

*Copris bihamatus* Balthasar, 1965 **new synonym** Figure 3 B.

We have compared the habitus of the holotype male and two female paratypes of *C. bihamatus* with male and female specimens of *C. fidius*. Following the similarity of habitus (Fig 3 A, B), identical aedeagi, and similarity of the relationship between elytral length against horn length for male specimens (Fig 2), it is clear that *C. fidius* and *C. bihamatus* are the same species. Consequently *C. bihamatus* Balthasar, 1965, is, here, synonymized with *C. fidius* (Olivier, 1789).



**Figure 3.** Habitus of a male *C. fidius* (A) and the male *Copris bihamatus* holotype (B) of similar body size.

### New Species description

For easy comparison with Nguyen-Phung (1988), we conform to her style.

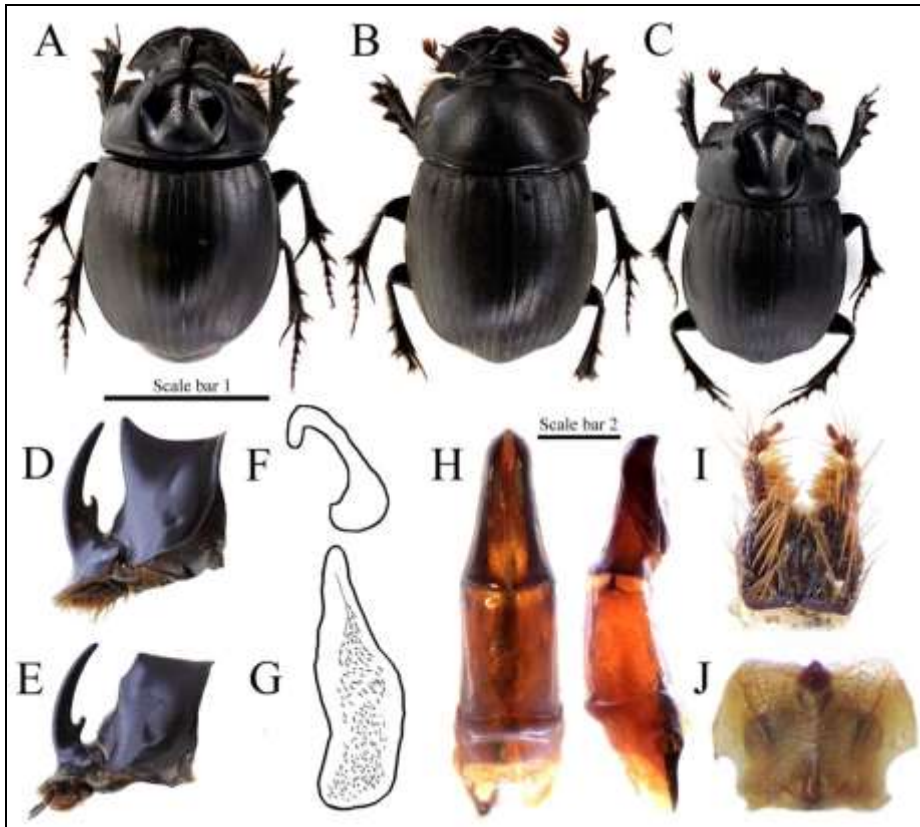
*Copris crassus* Deschodt and Davis Figure 4 A, B, D-H, 5.

**Diagnosis.** This species and *C. fidius* are the only species in the group with almost round eyes. However, this species can be separated from *C. fidius* by its larger size, the pronotal lateral lobes in major specimens ending with a single peak instead of two, and the male and female pronotal and elytral punctures being larger and closer together.

**Description.** Holotype: Length: 21.0 mm, long 12.4 mm at widest and 9.0 mm high.

Body somewhat squat, shiny black, glabrous dorsally.

Major male. **Head:** apical edge of clypeus slightly indented and with two small denticles, forming very shallow “v”; area behind clypeal horn and genae punctate; genal angle sharp; clypeal horn elongate and narrow, slightly curved backwards, sharp at apex, distal edge with a small hooked tooth at basal fourth. **Epipharynx:** anterior edge convex, median sensory setae dense and tight, forming a strongly sclerotized cone; sensory setae more or less in straight lines diverging anteriorly. **Labium:** apical edge with deep notch, median depression



**Figure 4.** Habitus of *C. crassus* (A) major male, (B) female and (C) *C. fidius* major male. Head and pronotum side profile of major males of (D) *C. crassus* and (E) *C. fidius*. Outlines of apical sclerites of the internal sack of aedeagus for *C. crassus*: (F) basal sclerite and (G) plate sclerite. (H) Aedeagus of *C. crassus*. *C. crassus*, (I) labium and (J) epipharynx. *C. fidius*. Scale bar 1 (10mm) for A - G and scale bar 2 (1mm) for H - J.

deep, almost one third as wide as labium at widest. **Prothorax:** median lateral indentation present, punctate laterally, with anterior median region smooth; anterior, outside angles obtuse, the lateral edges slightly curved; median excavation wide, somewhat concave, punctate anteriorly and smooth posteriorly, the prothoracic lobes significantly elevated with apices terminating in a single point, turned inward distally. **Elytra:** interstriae flat, finely punctate, punctation less than one puncture diameter apart, striae clearly visible. **Pygidium:** with dense punctation less than one puncture diameter apart. **Sterna:** meso-metasternal suture lines straight, forming obtuse, anteriorly-pointing angle medially; mesosternum somewhat rugose; on metasternum, meso-metasternal suture, posterior edge and area between coxae smooth; area outside of coxae punctate. **Legs:** protibial spur spatulate, slightly curved ventrally towards apex; profemora covered with dense hair; metatibiae with two thin spurs on distal outside edge; proximal spur is half the length of distally curving distal spur. **Male genitalia:** apices of parameres dorsally rounded with hooked ventral tip. The apical sclerites of the internal sack consist of the basal sclerite (“lamelle conique” in Nguyen Phung (1988)) that is bulbous at base and hooked at the tip; the elongate sclerite with long filaments that is typical of all *Copris* spp.; and of the plate sclerite with a file-like surface and ends that are twisted 90 degrees (Fig. 4E). **Length:** 18.0 to 21.0 mm.

**Variation.** *Minor males.* Size somewhat variable. Lateral lobes on pronotum range between half that of the major male to completely absent with between-lobe concave excavation becoming flat and less distinct. Clypeal horn ranges between one third of that in major males to only a small protrusion with distal basal tooth relatively smaller or absent.

*Females.* Similar to males, but with a much reduced clypeal horn or a slightly projecting point on the fronto-clypeal suture; the prothorax is very slightly excavated or flat and densely punctate medially.

**Etymology.** The name for this largest known species in the *fidius* group is the Latin word for “fat” reflecting the squat body shape.

**Type material examined.** Holotype: 1 m# Suikerbosrand Nat. Res., Gauteng, South Africa, 28°28-32'S 28°10-17'E, 12-13.xii.2001 1631-1930 m, Davis & Deschodt (TMSA).

Paratypes: 4 m# same data as holotype (2 UPSA, 1 TMSA, 1 SANC), 1 m# RSA: Kwazulu-Natal, Sani Pass, alt. 1747m, S29°37'37.57" E29°25'21.87", 21.ix.2003; Pitfall – Cattle dung, W.P. Stru[ü]mpher, A. Henning (UPSA), 3 m# RSA:NATAL, Giants Castle Res., 32.02S-19.13E [29.43°S 29.52°E] 250m [2500m] 15/17-XI-1985, AVEvans, CHScholtz, (UPSA), 1 f# Avontuur, E. CP, (23 kms S) [33.841°S 23.189°E] 2.IX.77, Sandy loam, Rocky hillside pasture with shrubs 570m C, A.L.V. Davis, (SANC), 1 f# QUEENSTOWN, CP (35 kms N) [31.669°S 26.708°E] 12.XI.74, I.D. Temby, (SANC), 1 m# S.Afr.; KWZ Natal, Lotheni Nat.Res. 29[°].26['] S - 29[°].31['] E, 27-30.3.2011; E-Y:3902, at light; 1497m, leg. Ruth Müller, (TMSA), 1 m# RSA, KZN, Lotheni, 29.44558[°]S/29.53784[°]E, 1718m, Grassland, 13 j[January] 2007, Site No. 107, Capture: Ground, MDTP No. 97353, [Michelle Hamer, Maluti Drakensberg transect project] and 1 m# same as previous but with MDTP No. 96745, (2 UPSA), 1 m# SOUTH AFRICA: MPU, Groenvally, 10km NE of Badplaas, 25°52'S, 30°46'E 04.ii.1995 S.H. Foord, (SANC), 6 m# Lotheni Nature Reserve, 29.44558°S 29.53784°E, 07-09.12.2014, 1700m, Grassland, C. Deschodt & A. Davis (4 UPSA, 2 NMPC).

### **Key to the species in the *fidius* group (translated and modified from Nguyen-Phung (1988))**

The key includes all species assigned to the *fidius* group, except *Copris serius* Nguyen-Phung 1987 which we were unable to examine

1 *Copris* species without two parallel lobes on the sides of the pronotum ... Most *Copris* groups

- *Copris* species with two parallel lobes on the sides of the pronotum in major males ... 2

2 Horn with one basal to median posterior denticle, internal margin of the eye rounded and row of piliferous punctures on the dorsal surface of hind femora comprising six points or less ... 3, *Copris fidius* group

- Horn with postero-apical denticles, internal margin of eye angular and single row of piliferous punctures on the dorsal surface of hind femora comprising more than ten points ... *Copris bootes* Klug 1855 group

3 Apical edge of clypeus not emarginate but slightly denticulate; epipharynx: sensory setae very fine. Male: prothoracic excavation narrow; genitalia, apical ends of parameres strongly elongated. Male and female of larger size (14.5 to 21.0 mm) ... 4

- Apical edge of clypeus emarginated, distinctly denticulate; epipharynx: sensory bristles thick. Male: prothoracic excavation broad; genitalia: apical ends of parameres slightly elongated. Male and female of smaller size (14-18 mm) ... 5

4 Apex of prothoracic lobes forming two peaks, apex blunt, proximal peak lower than distal peak, inner tooth on clypeal horn straight. Punctures on elytra small, about one puncture diameter apart, punctures on pronotum small and well separated, specimens tending to be more elongate and relatively smaller ... *fidius* (Olivier)

- Apex of prothoracic lobes forming a single peak, sharp at apex, inner tooth on clypeal horn curving forward. Punctures on elytra larger, less than one puncture diameter apart, punctures on pronotum large and close together, specimens tending to be squat and relatively larger ... *crassus* Deschodt and Davis

5 Male and female: front femora with ventral keels very close together, very dense elytral punctuation; epipharynx strongly convex in lateral anterior margins. Male: Tooth of cephalic horn near the base; prothoracic excavation strongly concave; genitalia, basal sclerite very small/thin and somewhat enlarged at the base. Female: A small tooth-like projection on frons ... *coriarius* Gillet

- Male and female: front femora with ventral carina well separated; elytral punctuation less dense; epipharynx to weakly convex anterior lateral edges. Male: Tooth of the cephalic horn near the middle of the horn; prothoracic excavation slightly concave; genitalia: basal sclerite sinuous strongly enlarged at the base. Female: no protruding tooth on head ... 6

6 Male and female: elytral striae with clear punctures; epipharynx with medium number of sensory bristles that are very elongated; labium: enlarged median depression; fore tibiae expanded, the second apical tooth highly developed. Male: apex of prothoracic lobes slightly serrated. Female: frontal projection (=ridge of frons) reduced and angular ... 7

- Male and female: elytral striae with shallower punctures; epipharynx with many sensory setae that are shorter; labium: narrow elongated central depression, fore tibia slightly expanded, the second apical tooth undifferentiated. Male: apex of prothoracic lobes not notched. Female: frontal projection (=ridge of frons) enlarged, somewhat rounded ... 8



7 Male and female: dense elytral punctuation. Male: broad prothoracic excavation at basal edge slightly concave, posterior punctuation deep; genitalia: dorsal edge angular at the apex of parameres. Female: pronotal punctuation deep ... *mesacanthus mesacanthus* Harold

- Male and female: sparser elytral punctuation. Male: prothoracic excavation close to basal edge clearly concave, posterior punctuation shallow; genitalia: dorsal edge rounded at apex of parameres. Female: pronotal punctuation less deep ... *mesacanthus transvaalensis* Nguyen-Phung

8 Male and female: rounded body; elytral punctuation deep; genae strongly projecting; epipharynx median sensory bristles sparser; labium: apical notch rounded, flared lobes. Male: pronotum with dense punctuation; genitalia: apex of parameres strongly curved, basal sclerite of the internal sac in the form of a stout hook. Female: front projection reduced pronotal punctuation dense ... *cambeforti* Nguyen-Phung.

- Male and female: elongate body; elytral punctuation shallow; genae slightly projecting; epipharynx: median sensory bristles are very close; labium: apical notch angular, acute lobes. Male: pronotum very slight or absent punctuation in the anterior region; genitalia: apex of parameres slightly curved, basal sclerite of the internal sac pointed at the proximal extremity. Female: frontal projection wide, less dense pronotal punctuation ... 9

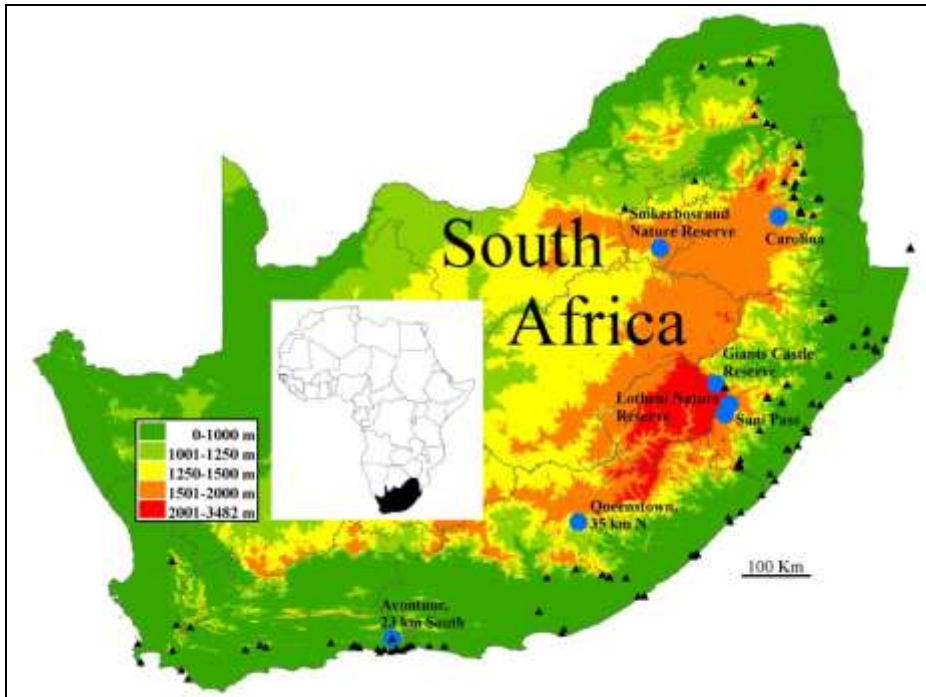
9 Male and female: strong genal punctuation; epipharynx: median sensory setae dense and tight; labium: very acute apical lobes. Male: pronotum with anterior area smooth, prothoracic excavation wide ... *vankhail vankhail* Nguyen-Phung

- Male and female: weak genal punctuation; epipharynx: median sensory setae less tight; labium: less acute apical lobes. Male: pronotum completely punctuated, prothoracic excavation narrow ... *vankhail genopunctatus* Nguyen-Phung

### Geographical ranges

*Copris crassus* Deschodt and Davis is endemic to South Africa (fig 5). Although it is found primarily in high altitude grasslands to the north, its southernmost occurrence lies at lower altitude in the cooler Eastern Cape. In Suikerbosrand Nature Reserve, it was recorded from south-facing, high altitude grassland at >1880 m but not in the surrounding, lower-lying, Highveld grasslands (1630-1690 m). In the Drakensberg at Lotheni Nature Reserve it has been collected in grassland at 1700m on south facing slopes amongst scattered *Protea sp.* trees. In the south, it has been recorded in a mountain valley of the Eastern Cape, south of Avontuur.

*Copris fidius* (Olivier 1789) is also virtually endemic to South Africa except for a marginal occurrence on the coastline of southeast Mozambique. It is found primarily in shade and forest patches. It shows a coastal distribution along the entire southern and eastern seaboard



**Figure 5.** Map indicating the location of the collecting sites of (●) *Copris crassus* and (▲) *C. fidius* specimens in Southern Africa.

of South Africa as well as along the edge of mountain blocks in the Western Cape and the lower edge of the eastern escarpment from the Eastern Cape to Limpopo Provinces.

### Acknowledgements

We thank Jiří Hájek (NMPC), Ruth Muller (TMSA) and Riaan Stals (SAMC) for the loan of specimens. Jiří Zidek, Prague, is thanked for obtaining the original images of *C. bihamatus* from NMPC and František Sládeček is thanked for conveying the loaned types to South Africa and back to NMPC. The two reviewers are thanked for invaluable comments on an earlier version of this paper. We wish to gratefully acknowledge the JRS Biodiversity Foundation for funding the project that led to the recognition of the taxonomic issues addressed in this paper. We thank Ezemvelo KZN Wildlife for the permit (No: OP 5434/2014) to collect at Lotheni Nature Reserve.

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