

## Comparison with a syntype of *Kheper cupreus* (Laporte de Castelnau, 1840) confirms that *Kheper namibicus* Krajcik, 2006 is a synonym

CHRISTIAN M. DESCHODT & ADRIAN L.V. DAVIS

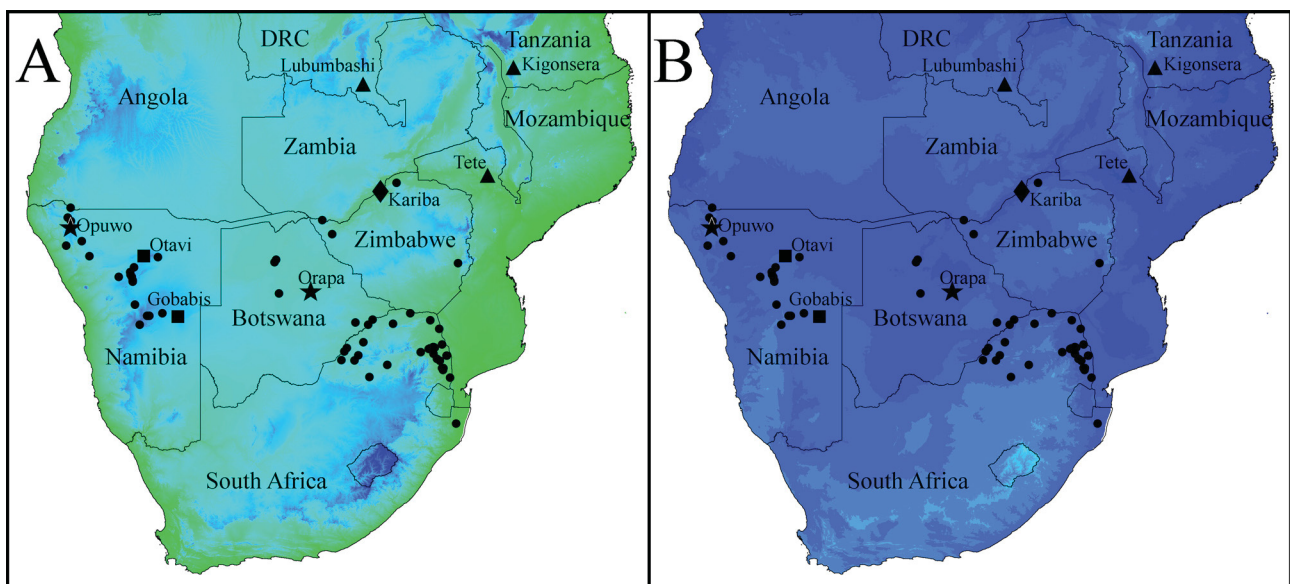
Department of Zoology & Entomology, University of Pretoria, Private Bag X20, Hatfield, 0028 South Africa.

✉ cdeschodt@zoology.up.ac.za; 🌐 https://orcid.org/0000-0002-3886-1813

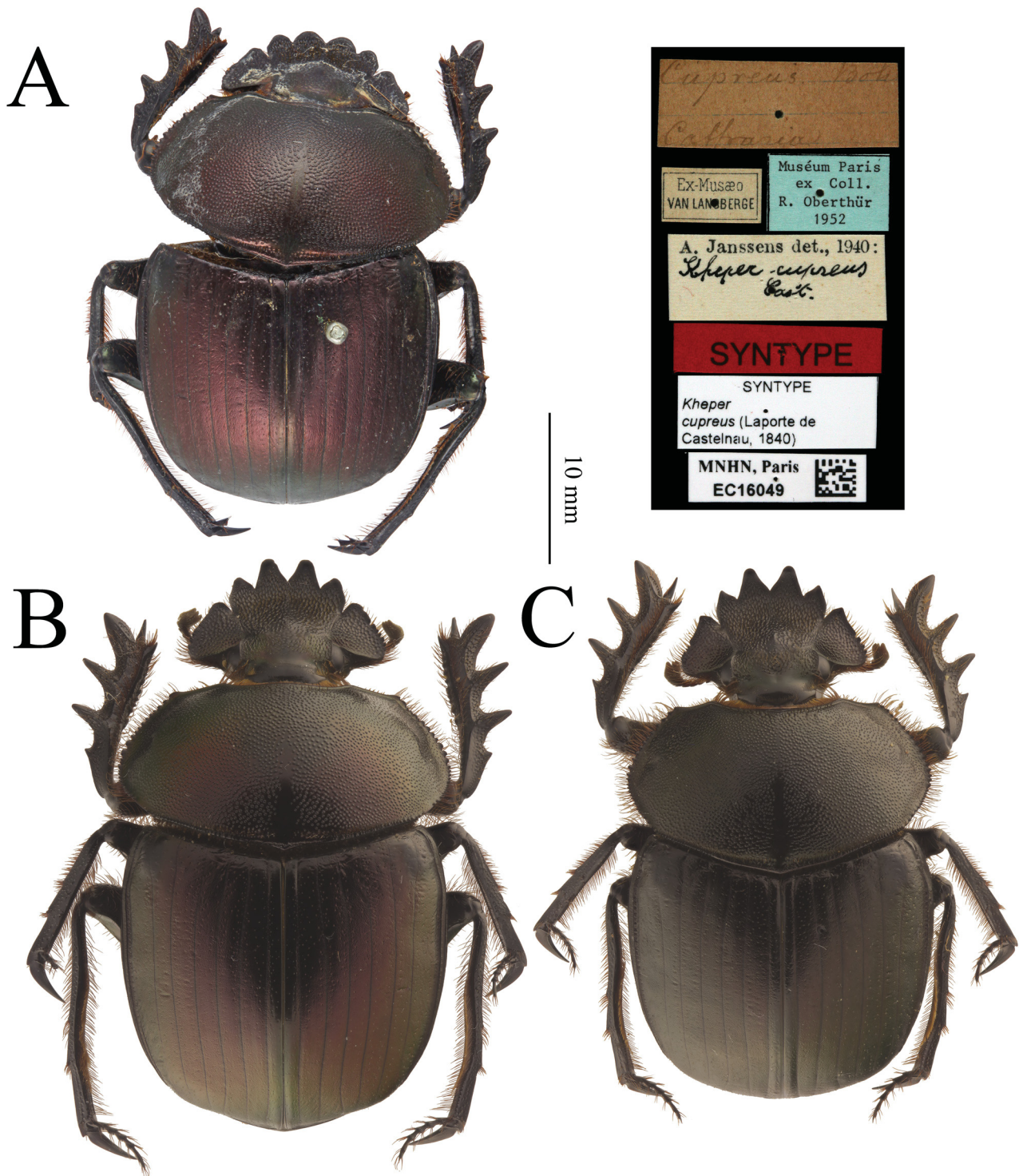
✉ adrian.davis@up.ac.za

Following its original description, *Kheper namibicus* Krajcik, 2006, was synonymized with *Kheper cupreus* (Laporte de Castelnau, 1840) by Deschodt *et al.* (2011) but later re-erected as a valid species or subspecies (Krajcik 2020). This paper discusses the evidence for validity versus synonymy and provides further support that *Kheper namibicus* is, indeed, a junior subjective synonym of *Kheper cupreus*.

The description of *Kheper namibicus* was based on three specimens, the holotype and a paratype from near Gobabis [S22.45° E18.97°] and a paratype from near Otavi [S19.63° E17.33°] in Namibia (Fig. 1). According to Krajcik (2006), *K. namibicus* is close to *K. cupreus* (Fig. 2) but differs from it in (1) geographical distribution, (2) the “non-metallic colour of [the] dorsal side”, (3) the “non-lustrous elytral suture (in day light)”, (4) the darker colour than *K. cupreus*, (5) denticles of the front tibiae that are “not projected, rather obtuse” and (6) the shape of the parameres. Although the present authors have been unable to examine the holotype of *K. namibicus*, the photographs in Krajcik (2006) are sufficiently clear for comparisons with other specimens.



**FIGURE 1.** Maps of southern Africa showing the known distribution of *Kheper cupreus* (Laporte de Castelnau, 1840) with the type localities of *Kheper namibicus* Krajcik, 2006 (black squares), Kariba specimen (Deschodt *et al.* 2011) (black diamond) and the localities of the photographed Opuwo and Orapa specimens (black stars). Old but non-validated reports (Ferreira 1972) suggest a distribution extending northwards to southern Congo (DRC) (Lubumbashi), southern Tanzania (Kigonsera) and central Mozambique (Tete) (black triangles). However, the Congo and Tanzania records, especially, need to be validated since a close relative, *Kheper rolciki* Pokorný & Zidek, 2015, occurs nearby in Ruaha National Park, Tanzania. A, showing the altitude with darker blue indicating higher and darker green indicating lower altitudes; B, showing the average temperature with lighter blue indicating cooler and darker blue indicating higher average temperatures. Temperature and altitude data is from Fick & Hijmans (2017).



**FIGURE 2.** Habitus of *Kheper cupreus* (Laporte de Castelnau, 1840). A, worn syntype and label; B, unworn cupreous specimen of *K. cupreus* from Orapa, Botswana; C, unworn darker coloured specimen of *K. cupreus* from Opuwo, Namibia. Light conditions for the Orapa and Opuwo specimens were exactly the same. All specimens are pictured at the same scale.

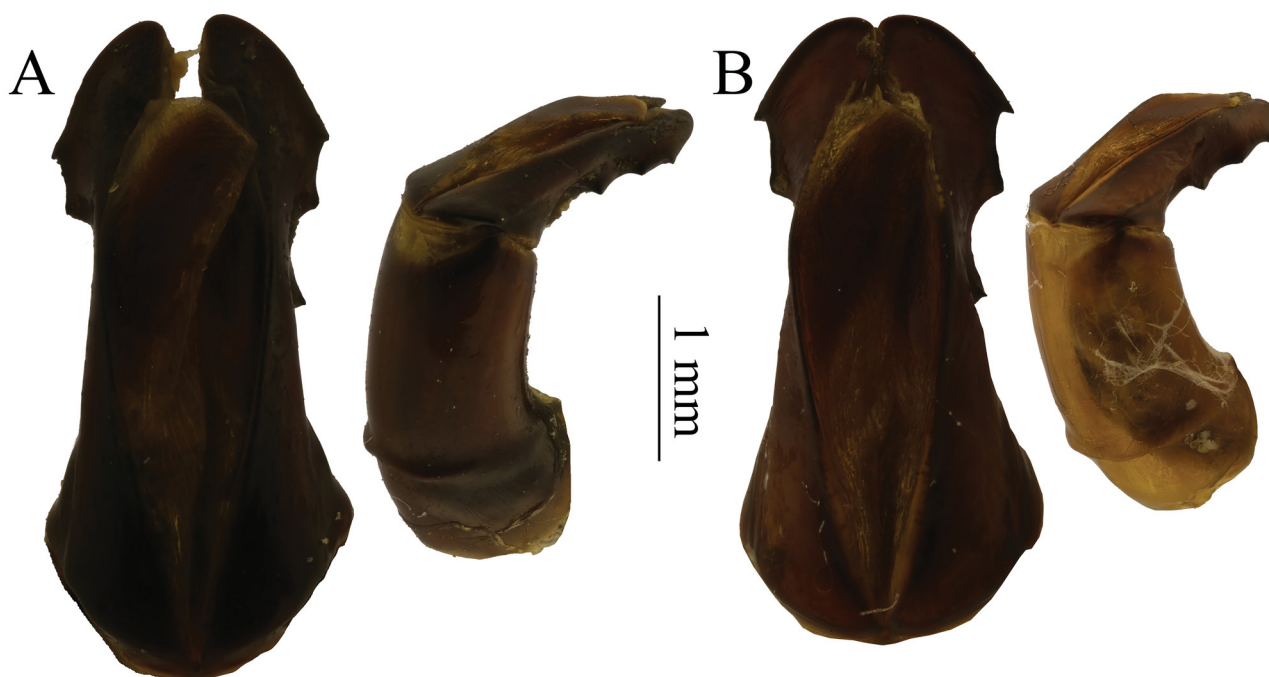
The synonymy of *K. namibicus* with *K. cupreus* (Deschodt *et al.* 2011) was based on a reference collection containing individuals identified as *K. cupreus* from more than 15 localities across northern Namibia and more than 30 localities to the east (Figs 1A, 1B). Deschodt *et al.* (2011) observed that Gobabis and Otavi fell well within the known range of *K. cupreus* and that northern Namibian specimens were darker than the cupreous individuals found further east. With regards to type material of *K. namibicus*, they also explained that the “not projected” or “obtuse” condition of denticles on the front tibiae resulted from wear during soil excavation. Furthermore, the aedeagus of the holotype was comparable to a



cupreous specimen from Kariba, Zimbabwe (16°31' S, 28°46' E) determined as *K. cupreus* by Richard zur Strassen, a specialist in the tribe Scarabaeini.

Subsequently, at the end of a paper dealing primarily with insects in famous artworks of ancient Egypt, Krajcik (2020) provided a seven line re-evaluation of *K. namibicus* and, again, elevated it to valid species or subspecies status. As regards this re-evaluation, an English translation from Czech follows in inverted commas (Google translation services, 27 May 2022): “In 2006, a description of a new species of the genus *Kheper* from Namibia was published, which was named *Kheper namibicus* (Krajcik 2006, *Animma.x*, 14: 21). Deschodt *et al.* (2011) synonymized this species with *cupreus*. Apparently *K. cupreus*, as imagined by Deschodt and his colleagues, is in fact different from what was described by Laporte de Castelnau in 1840, and therefore *K. namibicus* should be recognized by a valid taxon (species or subspecies)”.

Notably, Deschodt *et al.* (2011) was published without our having examined type specimens of *Kheper cupreus* or photographs of types. This has now been rectified by an examination of photographs of a syntype habitus sent from the Muséum national d'Histoire naturelle in Paris. The specimen should be considered a syntype (Fig. 2A) as it is unclear if Laporte de Castelnau's original description was based on a single or multiple individuals. However, staff of the museum have been unable to locate other specimens that might belong to a type series. As *Kheper* species show little, external, sexual dimorphism, dissection by museum staff has shown that the syntype is a female.



**FIGURE 3.** Aedeagi of *Kheper cupreus* (Laporte de Castelnau, 1840) in dorsal and dorso-lateral view. A, aedeagus extracted from a cupreous specimen of *K. cupreus* from Orapa, Botswana; B, aedeagus extracted from a dark specimen of *K. cupreus* from Opuwo, Namibia.

We have compared the habitus image of the female *Caffraria* syntype (cupreous with worn tibial and clypeal dentition) with that of the male *K. namibicus* holotype from Namibia (dark with a cupreous sheen and worn tibial/clypeal dentition) (Krajcik 2006, 2020), that of the male *K. cupreus* specimen from Kariba in Zimbabwe (cupreous with unworn fore tibial/clypeal dentition) (Deschodt *et al.* 2011) and those of male specimens that we determined as *K. cupreus* comprising a dark specimen with unworn fore tibial/clypeal dentition from 20km south of Opuwo (S18.2027° E13.81305°) in Namibia as well as a cupreous specimen with unworn tibial/clypeal dentition from Orapa to the east in Botswana. All images show close similarities. Therefore, this comparison suggests that, contrary to Krajcik (2020), we have correctly understood the identity of *K. cupreus* as originally described in only twelve, half-column lines (78 words) by Laporte de Castelnau (1840). Furthermore, images of the aedeagi extracted from the Opuwo (dark), Orapa (cupreous), Kariba (cupreous) and *K. namibicus* holotype (dark with cupreous sheen) specimens (Krajcik 2006; Deschodt *et al.* 2011, Fig. 3) are clearly identical. Therefore, after a consideration of (1) the close similarity between the habitus of the five compared specimens representing the two colour varieties (*K. cupreus* syntype, *K. namibicus* holotype, Namibia, Botswana and Zimbabwe *K. cupreus*), (2) the identical aedeagi from *K. namibicus* and three western and eastern specimens identified as *K. cupreus*

and (3) the identical aedeagi from dark worn (*K. namibicus*) and dark unworn (*K. cupreus*) specimens from Namibia, we confirm the synonymy of *Kheper namibicus* Krajcik, 2006, with *Kheper cupreus* (Laporte de Castelnau, 1840).

It is well known that dung beetles with metallic colouration may vary in perceived hue from cupreous to green to blue according differences in micro-structure of the exoskeleton, which absorbs or reflects different wavelengths of visible light (Neville & Caveney 1969; Brink *et al.* 2007). In local populations of *Gymnopleurus humanus* Macleay, 1821, such colour differences are correlated with differences in seasonal temperatures across a geographical gradient (Davis *et al.* 2008). Furthermore, some metallic coloured species have black varieties, often with a greenish or cupreous sheen, that may represent the addition of melanic pigmentation to the exoskeleton in some cooler parts of their geographical range, *e.g.* melanic *Kheper nigroaeneus* (Boheman, 1857) from uplands in the Southern African interior compared to cupreous individuals from the adjacent, hot, lowland, coastal plain (personal observation of ALVD, CMD). *Allogymnopleurus splendidus* (Bertoloni, 1849) and *K. cupreus* are other such species represented, respectively, by black or darker varieties in the highlands (Fig. 1A) of northern Namibia compared to cupreous or green individuals in the hotter or lower (Fig. 1B) regions to the east. In many genera, there was an historical trend to provide names at the level of subspecies or variety for such colour variants of particular species. However, many names listed by the Catalogue of Life (Schoolmeesters 2022) show that, in the present day, they are recognized as synonyms of those species.

## Acknowledgements

The authors wish to thank Christophe Rivier and Antoine Mantilleri of the Muséum national d'Histoire naturelle for locating the syntype of *K. cupreus* and sending photographic images. The examined and pictured specimens are from the University of Pretoria collection (Opuwo) and the private collection of CMD (Orapa). The authors also thank Aleš Bezděk and the reviewers for their invaluable input to improve this work.

## References

- Brink, D.J., van der Berg, N.G., Prinsloo, L.C. & Hodgkinson, I.J. (2007) Unusual coloration in scarabaeid beetles. *Journal of Physics D: Applied Physics*, 40, 2189–2196.  
<https://doi.org/10.1088/0022-3727/40/7/050>
- Davis, A.L.V., Brink, D.J., Scholtz, C.H., Prinsloo, L.C. & Deschodt, C.M. (2008) Functional implications of temperature-correlated colour polymorphism in an iridescent, scarabaeine dung beetle. *Ecological Entomology*, 33, 771–779.  
<https://doi.org/10.1111/j.1365-2311.2008.01033.x>
- Deschodt, C.M., Davis, A.L.V. & Scholtz, C.H. (2011) New dung beetle taxa from arid south-western Africa. *Insect Systematics and Evolution*, 42, 277–294.  
<https://doi.org/10.1163/187631211X568173>
- Ferreira, M.C. (1972) Os escarabídeos de África (sul do Sáara). *Revista de Entomologia de Moçambique*, 11, 5–1088.
- Fick, S.E. & Hijmans, R.J. (2017) WorldClim 2: new 1km spatial resolution climate surfaces for global land areas. *International Journal of Climatology*, 37 (12), 4302–4315.  
<https://doi.org/10.1002/joc.5086>
- Krajcik, M. (2006) New species of *Kheper* Janssens from Namibia. *Animma.x*, 14, 19–23.
- Krajcik, M. (2020) Hmyz jako předloha význačných uměleckých děl (speciální výběr). I. Posvátní brouci starověkého Egypta. Insects in famous artworks (special selection). I. Sacred beetles of ancient Egypt. *Animma.x*, 82, 1–20.
- Laporte de Castelnau, F.L. (1840) *Histoire naturelle des Insectes Coléoptères. Histoire naturelle des Animaux articulés, Annelides, Crustacés, Arachnides, Myriapodes et Insectes. Vol. 2.* P. Duménil, Paris, 565 pp.  
<https://doi.org/10.5962/bhl.title.35290>
- Neville, A.C. & Caveney, S. (1969) Scarabaeid beetle exocuticle as an optical analogue of cholesteric liquid crystals. *Biological Reviews*, 4, 531–62.  
<https://doi.org/10.1111/j.1469-185X.1969.tb00611.x>
- Schoolmeesters, P. (2022) World Scarabaeidae Database. In: Bánki, O., Roskov, Y., Döring, M., Ower, G., Vandepitte, L., Hobern, D., Remsen, D., Schalk, P., DeWalt, R. E., Keping, M., Miller, J., Orrell, T., Aalbu, R., Adlard, R., Adriaenssens, E. M., Aedo, C., Aesch, E., Akkari, N., Alfenas-Zerbini, P. *et al.*, *Catalogue of Life Checklist. Version 2022-05-02*. Available from: <https://www.catalogueoflife.org/data/dataset/1027> (accessed 31 May 2022)  
<https://doi.org/10.48580/dfpn-38g>