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Digitonthophagus gazella auctorum: an unfortunate case of mistaken identity for a widely introduced species (Coleoptera: Scarabaeidae: Scarabaeinae: Onthophagini)

FRANÇOIS GÉNIER[1] & ADRIAN L.V. DAVIS[2]

[1]*Research and Collections, Canadian Museum of Nature, PO Box 3443, Station D, Ottawa, Ontario, K1P 6P4, Canada.*
E-mail: fgenier@mus-nature.ca
[2]*Scarab Research Group, Department of Zoology and Entomology, University of Pretoria, P/B X20, Hatfield, 0028, South Africa*

At risk of committing entomological heresy, we question the identity of a dung-burying beetle species that originates from Africa and has been introduced first into Hawaii and subsequently to Australasia, North America, and South America (Fincher 1986; Edwards 2007; Noriega *et al*. 2010) for pasture improvement and biological control of dung-breeding flies (Waterhouse 1974; Bornemissza 1979). Under the name *Onthophagus gazella* (Fabricius 1787), it was the first species selected for introduction into Australia by the CSIRO Dung Beetle Project (Bornemissza 1976; Edwards 2007). Firstly, in 1968, a "tropical strain" was introduced from Hawaii where it had become established after introduction from Zimbabwe in 1957 (Markin & Yoshioka 1998). Later, after establishment of the CSIRO Dung Beetle Research Unit in Pretoria in 1970, a "cold" or "even rainfall strain" was introduced into Australia directly from South Africa (Bornemissza 1976) (even rainfall region = south coast of Eastern Cape). The species was subsequently introduced into the southern continental United States of America (Victoria County, Texas) from Hawaii (Montes de Oca & Halffter 1998) then elsewhere into southeastern and southwestern states from Hawaii and breeding colonies from Australia (Anderson & Loomis 1978). It has since expanded its range through Mexico, Central America, and the Caribbean to coastal Colombia (Kohlmann 1994; Noriega 2002; Noriega *et al*. 2006, 2011). Expansion of its range within central southern South America (Noriega *et al*. 2010) has been assisted by introductions into Brazil from the United States of America since the 1980s (Bianchin *et al*. 1998), and others into Venezuela and Chile (Vidaurre *et al*. 2008). More recently, it has been introduced into quarantine and field trials in New Zealand (Forgie *et al*. 2013) using individuals originating from the south coast of the Eastern Cape and Northwest Province of South Africa (S. Forgie, personal communication).

The currently valid name of *Digitonthophagus gazella* (Fabricius, 1787) (Fig. 1–2) reflects a history of transfer between genera and subgenera. Described as *Scarabaeus gazella*, the species was first transferred to the genus *Onthophagus* Latreille, 1802 as *Onthophagus gazella*, then to the subgenus *Digitonthophagus* Balthasar, 1959 as *Onthophagus* (*Digitonthophagus*) *gazella*. This subgenus has since been raised to generic status (Zunino 1981) yielding the species name, *Digitonthophagus gazella*, with six synonyms (Schoolmeesters 2015) variously described from an unstated locality, east India, Senegal, east Africa, and Madagascar (Fabricius 1787, 1798; Olivier 1789; Reiche 1840; d'Orbigny 1905). As a result it has been considered as one of the most widespread of scarabaeine taxa indigenous to pastures of tropical, subtropical, and warm temperate regions across Africa and the Middle East to the west of the Oriental region (Schoolmeesters 2015). The species has also been the subject of study or referenced in at least 1120 scientific publications or technical reports (Google Scholar 2016). However, detailed study has now revealed that the introduced species belongs to a species complex and is incorrectly named.

The purpose of this note is to reveal issues concerning the identity of the introduced species, as its worldwide distribution pattern is currently the subject of a comprehensive study outside of its native range. Such a study can only be useful if the identity of the taxon is resolved and its native distribution is known. As a courtesy to our colleagues, we are providing information on the taxonomic problem and native distribution pattern of the introduced species prior to publication of the formal taxonomic revision of the genus, which is has been submitted for publication by the senior author. This work will address the status of all the names included in the genus.

After studying over 11,000 specimens from the entire Afrotropical region and several countries outside of its native range (Australia, Brazil, Cuba, Dominican Republic, Fiji, Mexico, New Caledonia, Papua New Guinea, United States of America, Vanuatu) with populations that originate directly or indirectly from southern Africa, it must be concluded that

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the names that apply to the species introduced worldwide should be *Scarabaeus dorcas* Olivier, 1789, not *Scarabaeus gazella* Fabricius, 1787 [= *Digitonthophagus gazella*, *Onthophagus gazella*, or *Onthophagus (Digitonthophagus) gazella* auctorum].

FIGURE 1–2. *Digitonthophagus gazella* auctorum dorsal habitus (Mukambi Safari Lodge, Central Province, Zambia). 1. male; 2. Female

Scarabaeus dorcas [combined as *Digitonthophagus dorcas* (Fabricius) if it would be valid] was described from Madagascar. The type series of *Scarabaeus dorcas* could not be found (O. Montreuil, personal communication) and is here considered lost. However, Olivier's description and illustration correspond to a female of the single species of *Digitonthophagus* occurring in Madagascar that is also distributed from eastern South Africa across the savanna, grassland, or disturbed areas of southeastern Africa northwards to southern Kenya and Uganda, which correspond to the geographical origin of the introduced species. The presence of *D. dorcas* in Madagascar and the Comoro Islands is most likely due to the accidental introduction of the species through importation of cattle from the east coast of Africa about 1,000 years ago (Rahagalala *et al*. 2009). The widespread occurrence of the species in natural or disturbed open habitat within Madagascar and other areas of introduction (Doube 1991; Noriega *et al*. 2010) may reflect a slight bias to sandy clay loam compared to deep sand (ratio, 70:30) and a strong bias to grassland as opposed to open woodland or shaded habitat (ratio, 75:18:7) (Davis 1996, cited as *Digitonthophagus gazella*).

After studying Fabrician type material, we concur with previous authors (Gerstaecker 1873; Arrow 1931) that the names *Scarabaeus catta* Fabricius, 1787 and *Scarabaeus gazella* Fabricius refer to the same exclusively oriental species, with *S. catta* being the female and *S. gazella* being the male. Although Gerstaecker (1873) and Arrow (1931) correctly considered *S. gazella* as a synonym of *S. catta* based on the principle of priority, it should be noted, here, that prevailing usage will maintain *D. dorcas* (Olivier) as a synonym of *D. gazella* (Fabricius). Therefore, an application has been submitted to the International Commission on Zoological Nomenclature (1999) (case number 3722) to conserve the name *Scarabaeus gazella* Fabricius for the widely introduced species. A positive ruling is expected, soon, with wide support from the scientific community. To comply with article 82.1 of the International Code of Zoological Nomenclature, prevailing usage of the name *D. gazella* (Fabricius) must be maintained while the case to conserve the name is under consideration. We invite colleagues to comment on the case. Instructions are at http://iczn.org/content/instructions-comments.

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