International Journal of Tropical Insect Science
https://doi.org/10.1007/s42690-020-00336-z

ORIGINAL RESEARCH ARTICLE

DNA barcode and phylogenetic analysis of dung beetles (Coleoptera: Scarabaeidae) from the Western Ghats biodiversity hotspot, India

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Received: 13 March 2020 / Accepted: 14 October 2020

Abstract

Dung beetles are diverse, cosmopolitan, and endemic to different biogeographic zones. But, their taxonomy and phylogeny is currently not well understood in the old-world tropics. Within the subfamily Scarabaeinae, *Onthophagus* is the most species rich and complex genus with 2189 species worldwide. India has approximately 400 species of dung beetles belonging to 30 genera. Based on morphology, the dung beetles of certain genera in Oriental and Afrotropical regions have been classified into Species Groups. Presently the genetic information of dung beetles of India is poorly represented in the databases, thus limiting knowledge on the phylogenetic relationships of the Indian fauna. In this study, we aimed to provide barcodes of 27 species belonging to *Onthophagus* and one species of *Onitis* and to examine whether the resulting phylogenetic tree complies with the Species Groups. Kimura 2 parameter model was used to measure genetic distance and Neighbour Joining method was used for the tree construction. The tree topology did not fully support the Species Groups of *Onthophagus* as other studies from the African region have noted. The DNA barcodes generated from this study can serve as a reference for future phylogenetic studies.

Keywords DNAbarcoding · Dung beetle · Mitochondrial DNA · *Onthophagus* · Taxonomy · Western Ghats

Introduction

Scarabaeid dung beetles are cosmopolitan insects performing vital functions of terrestrial ecosystems such as nutrient cycling and secondary seed dispersal (Davis and Scholtz 2001). They are considered as excellent ecological indicator species (McGeoch et al. 2002). The true dung beetles belonging to Scarabaeinae with 16 tribes are diverse and cosmopolitan in the world (Bouchard et al. 2011; Tarasov and Dimitrov 2016; Tarasov 2017; Davis et al. 2019). Among them, Onthophagini with 35 genera (Philips 2016) and *Onthophagus* Latreille 1802 with ca. 2189 species are the most diverse taxa (Schoolmeesters 2020). They are cosmopolitan (Emlen et al. 2005, Schoolmeesters 2020), but speciose in tropics (Hanski and Krikken 1991). Oriental region has about 600 species of *Onthophagus* (Tarasov and Solodovnikov 2011).

India has about 400 species of dung beetles, belonging to 30 genera and 9 tribes (Priyadarsanan et al. 2017). Among these, 194 species belonging to 29 genera have been reported from the Western Ghats biodiversity hotspot (Priyadarsanan et al. 2017), and 78 species have been recorded from the moist southern Western Ghats, in which 19 are endemic to the Western Ghats (Sabu et al. 2011). Yet, the dung beetles of India is underrepresented in global biogeography and phylogeny studies due to their poor representation in global databases (Monaghan et al. 2007; Breeschoten et al. 2016). This study is aimed to fill this critical gap by generating the DNA barcodes of dung beetle species belonging to *Onthophagus* and *Onitis* from the Western Ghats.

Onthophagus is considered to have a possible Afrotropical origin (Emlen et al. 2005; Monaghan et al. 2007; Tarasov and Solodovnikov 2011; Philips 2016) and subsequent range expansion to Palearctic and Oriental regions (Davis et al. 2002). A satisfactory classification of the innumerable species of this genus using morphological traits is highly challenging. Since the species are sexually dimorphic, it is not easy to find characters common to both (Arrow 1931). *Onthophagus* displays

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s42690-020-00336-z) contains supplementary material, which is available to authorized users.

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Published online: 28 October 2020