

ON SOME ECONOMICALLY IMPORTANT SCARAB BEETLES (COLEOPTERA : SCARABAEOIDEA) FROM GOMARDA WILDLIFE SANCTUARY, CHHATTISGARH

KAILASH CHANDRA*, JOYJIT GHOSH, AMITAVA MAJUMDER, SUMANA HALDER and DEVANSHU GUPTA

Zoological Survey of India, New Alipore, Kolkata

ABSTRACT : The paper reports the occurrence of 36 species of scarab beetles (Coleoptera : Scarabaeoidea) belonging to 20 genera, 8 subfamilies and 3 families, Scarabaeidae, Hybosoridae and Geotrupidae from Gomarda Wildlife Sanctuary, Chhattisgarh. Scarabaeidae is represented by 34 species while Geotrupidae and Hybosoridae include a single species each. *Bolbohamatum phallosum* Krikken, 1980 (Bolboceratinae) and *Adoretus versutus* Harold, 1869 (Rutelinae) have been recorded for the first time from the state. Based on their pattern of feeding, the scarab beetle fauna of Gomarda Wildlife Sanctuary can be classified into 2 major groups viz. dung beetles and chafers. It was found about 25 species feeding on dung and decaying matters while the other 9 species were collected from different leaves and flowers.

Key words : Taxonomy, Diversity, Distribution, Scarab beetles, India.

INTRODUCTION

Scarab beetles belong to the superfamily Scarabaeoidea comprising one of the major species rich superfamilies under order Coleoptera. The superfamily is divided into 12 families, 43 subfamilies, 118 tribes and 94 subtribes from the world (Smith, 2006) and currently includes approximately 37,268 species under 2498 genera worldwide (Krajcik, 2012). The beetles in the superfamily feed significantly on decaying matters, fungi, vegetables, fruits, pollens and dung etc. Based on their feeding habits the scarab beetles are mainly classified into two groups, first group feed on dung, decaying matters and vegetables is commonly termed as dung or coprophagous beetles and the second group which are also termed as white grubs are pest of major commercial crops; like sugarcane, acacia, ber, neem, rose and tamarind (Brownie, 1968; Kumara *et al.*, 2009 and Anitha *et al.*, 2006). The name dung beetles usually refer to the species especially belonging to the subfamilies, Scarabaeinae and Aphodiinae and the families Geotrupidae and Hybosoridae. The dung beetles are categorized into 3 major groups based on their nesting strategies, *i.e.* tunnellers, dwellers and rollers (Halffter and Matthews, 1966). By these activities, these dung beetles play vital roles in nutrient cycling, soil aeration (Mittal, 1993), secondary seed dispersal (Estrada and Estrada, 1991) and regulation of dung breeding dipteran pests (Borenmissza, 1970). It was estimated by Mittal and Yadav (1979) that about 80,000 tons of excreta carried out everyday into the soil by the dung beetles.

Arrow (1910, 1917, 1931) compiled the information on the Indian scarab beetle fauna in the form of Fauna of British India dealing with major subfamilies such as : Scarabaeinae, Rutelinae, Dynastinae, Cetoniinae and Euchirinae. Later major works include : Balthasar (1963a, 1963b, 1964), Kuijten (1978), Endrodi (1985), Gupta & Mittal (1987), Mittal (2005) and Sewak (2009). Whereas the fauna of Madhya Pradesh and Chhattisgarh have been mainly dealt by Chandra (2000,

2003), Chandra & Ahirwar (2007), Chandra & Singh (2010), Chandra & Gupta (2012a, 2012b, 2012c, 2012d, 2013a, 2013b), Chandra *et al.* (2015) and Ghosh *et al.* (2015). Chandra & Ahirwar (2007) reported 124 species/subspecies from Madhya Pradesh and Chhattisgarh states. Chandra and Gupta (2013a) illustrated the dung beetle fauna of Chhattisgarh, giving information about 52 species from the state. So far as the diversity in protected areas in the state is concerned, 52 species have been reported from Achanakmar-Amarkantak Biosphere reserve (Chandra and Gupta, 2012a), 43 species from Barnawapara Wildlife Sanctuary (Chandra and Gupta, 2013b), 22 from Kanger Valley National (Chandra *et al.*, 2012) and 20 species from Badalkhol Wildlife Sanctuary (Ghosh *et al.*, 2015). Chandra and Gupta (2012b) studied diversity and relative abundance of 26 species of chaffer beetles (Scarabaeidae) from Achanakmar-Amarkantak Biosphere Reserve. Chandra and Gupta (2012d, 2016) recently described 2 new species, *viz.* *Bolbohamatum achanakmarini* Chandra & Gupta and *Bolboceras bilaspuricans* Gupta & Chandra (Scarabaeidae : Geotrupidae) from Chhattisgarh.

Keeping in view the economic and ecological significance of these beetles to Chhattisgarh forest, surveys were conducted for evaluating their diversity in the Gomarda Wildlife Sanctuary and specimens were collected which resulted in the identification of 36 species.

MATERIALS AND METHODS

Gomarda Wildlife Sanctuary is situated in the district Raigarh, of the state of Chhattisgarh covering an area of 277.820 sq/km. The sanctuary having both flat and hilly areas, lies between latitude 21°30'24" N to longitude 83°06'47" E with an elevation of around 400 meters.

The beetle sampling was done in the months of May-

*Corresponding author (email : kailash611@rediffmail.com)

Received 02.03.2016

Accepted 22.05.2016

June, 2015. As the beetles are phototropic in nature, they were mostly captured by applying light trap using 160 watt mercury bulb as light source. They were also sampled from dung, decayed matters and foliage. They were preserved dry pinned and deposited in the National Zoological Collection of Zoological Survey of India, Kolkata. The specimens were identified using the literature Arrow (1910, 1917, 1931), Kuijten (1978), Balthasar (1963a, 1963b, 1964), Endrodi (1985) and Chandra & Gupta (2012c, 2013a, 2013c). The external male genitalia were also dissected and compared with the illustrations published by Gupta and Mittal (1987) for species confirmation.

RESULTS AND DISCUSSION

Altogether around 400 specimens of the scarab beetles were collected which yielded the identification of 36 species belonging to 20 genera, 8 subfamilies and 3 families, Scarabaeidae, Hybosoridae and Geotrupidae of superfamily Scarabaeoidea (Table.1). The family Scarabaeidae is represented by 34 species while a single species was collected each from Geotrupidae and Hybosoridae.

The family Scarabaeidae includes two significant groups, one that feeds exclusively on dung and decaying mat-

Table. 1 List of Scarab Beetles (Coleoptera : Scarabaeoidea) from Gomarda Wildlife Sanctuary, Chhattisgarh (36 species, 20 genera, 8 subfamilies and 3 families).

Order : Coleoptera Linnaeus, 1758 Suborder : Polyphaga Emery, 1886 Superfamily : Scarabaeoidea Latreille, 1802 Family : Scarabaeidae Latreille, 1802				
S.	Subfamily	Tribe	Species	Feeding strategy
Dung or Coprophagous Beetles				
1.	Scarabaeinae	Gymnopleurini	<i>Gymnopleurus (Gymnopleurus) cyaneus</i> (Fabricius)	Roller
2.	Scarabaeinae	Gymnopleurini	<i>Gymnopleurus (Metagymnopleurus) miliaris</i> (Fabricius)	Roller
3.	Scarabaeinae	Gymnopleurini	<i>Gymnopleurus (Metagymnopleurus) gemmatus</i> Harold	Roller
4.	Scarabaeinae	Coprini	<i>Heliocopris bucephalus</i> (Fabricius)	Tunneller
5.	Scarabaeinae	Coprini	<i>Catharsius pithecius</i> (Fabricius)	Tunneller
6.	Scarabaeinae	Coprini	<i>Catharsius molossus</i> (Linnaeus)	Tunneller
7.	Scarabaeinae	Coprini	<i>Catharsius sagax</i> (Quensel)	Tunneller
8.	Scarabaeinae	Onthophagini	<i>Caccobius (Caccophilus) unicornis</i> (Fabricius)	Tunneller
9.	Scarabaeinae	Onthophagini	<i>Digitonthophagus bonasus</i> (Fabricius)	Tunneller
10.	Scarabaeinae	Onthophagini	<i>Digitonthophagus gazella</i> (Fabricius)	Tunneller
11.	Scarabaeinae	Onthophagini	<i>Onthophagus (Proagoderus) pactolus</i> (Fabricius)	Tunneller
12.	Scarabaeinae	Onthophagini	<i>Onthophagus (Serrophorus) sagittarius</i> (Fabricius)	Tunneller
13.	Scarabaeinae	Onthophagini	<i>Onthophagus (Colobonthohagus) dama</i> (Fabricius)	Tunneller
14.	Scarabaeinae	Onthophagini	<i>Onthophagus (Colobonthohagus) ramosus</i> (Wiedemann)	Tunneller
15.	Scarabaeinae	Onthophagini	<i>Onthophagus (Colobonthohagus) hindu</i> Arrow	Tunneller
16.	Scarabaeinae	Onthophagini	<i>Onthophagus (Colobonthohagus) agnus</i> Gillet	Tunneller
17.	Scarabaeinae	Onthophagini	<i>Onthophagus quadridentatus</i> (Fabricius)	Tunneller
18.	Scarabaeinae	Onitini	<i>Onitis philemon</i> (Fabricius)	Tunneller
19.	Scarabaeinae	Onitini	<i>Onitis subopacus</i> (Arrow)	Tunneller
20.	Scarabaeinae	Oniticellini	<i>Oniticellus cinctus</i> (Fabricius)	Dweller
21.	Scarabaeinae	Oniticellini	<i>Tiniocellus spinipes</i> (Roth)	Dweller
22.	Aphodiinae	Aphodiini	<i>Aphodius (Calaphodius) moestus</i> (Fabricius)	Dweller
23.	Aphodiinae	Aphodiini	<i>Aphodius (Pharaphodius) crenatus</i> (Harold)	Dweller
Phytophagous Beetles (White Grubs)				
24.	Dynastinae	Pentodontini	<i>Dipelicus bidens</i> (Arrow)	Phytophagous
25.	Dynastinae	Pentodontini	<i>Heteronychus lioderes</i> (Redtenbacher)	Phytophagous
26.	Rutelinae	Anomalini	<i>Anomala biharensis</i> Arrow	Phytophagous
27.	Rutelinae	Anomalini	<i>Anomala dorsalis</i> (Fabricius)	Phytophagous
28.	Rutelinae	Anomalini	<i>Mimela macleayana</i> (Vigors)	Phytophagous
29.	Rutelinae	Anomalini	<i>Mimela inscripta</i> (Nonfried)	Phytophagous
30.	Rutelinae	Adoretini	<i>Adoretus stoliczkae</i> (Ohaus)	Phytophagous
31.	Rutelinae	Adoretini	<i>Adoretus versutus</i> (Harold)	Phytophagous
32.	Melolonthinae	Melolonthini	<i>Schizonycha ruficollis</i> (Fabricius)	Phytophagous
33.	Cetoniinae	Gymnetini	<i>Clinteria klugi</i> (Hope)	Phytophagous
34.	Cetoniinae	Cetoniini	<i>Gametis versicolor</i> (Fabricius)	Phytophagous
Family : Hybosoridae Erichson, 1847				
35.	Hybosorinae	-	<i>Phaeochrous emarginatus</i> (Laporte)	-
Family : Geotrupidae Latreille, 1802				
36.	Bolboceratinae	Bolboceratini	<i>Bolbohamatum phallosum</i> (Krikken)	-

ters are called as coprophagous or dung beetles while the second group is the beetle which feed foliage and flowers and are commonly termed as white grubs. Out of the total 36 species, 27 species in the subfamilies, Scarabaeinae and Aphodiinae and families Geotrupidae and Hybosoridae were collected from cow, buffalo, human, nilgai and dog dung.

The dung beetles include 3 major categories, Tunnelers, Rollers and Dwellers with some species to be keptocoprid in nature (Halffter and Matthews,1966). Tunnelers make vertical chambers under ground near the dung balls and bury their brood balls and make their nest whereas dwellers breed and live in dung pats itself. Rollers make rolls of dung balls and bury it underground for breeding and feeding purposes. In the survey, 16 species of dung beetles were found to be tunnelers, 4 were dwellers and 3 were rollers.

Gymnopleurus (G.) cyaneus, *G. (Metagymnopleurus) miliaris* and *G.(M.) gemmatus* (Gymnopleurini : Scarabaeinae) were observed carrying dung balls made from fresh cattle dung from one place to another. It was also observed that both male and female cooperate in making the dung balls. The rollers were found to be diurnal in nature and did not attract towards light. The species belonging to the genera; *Helicopriss*, *Catharsius*, *Copris* (Coprini), *Onthophagus*, *Caccobius*, *Digitonthophagus* (Onthophagini) and *Onitis* (Onitini) were tunnellers in nature. *Oniticellus cinctus*, *Tiniocellus spinipes* (Oniticellini), *Aphodius (C.) moestus* and *Aphodius (P.) crenatus* (Aphodiinae) were found in abundance in cow and buffalo dung as dwellers.

Recently Mittal (2005) reported decline in the population of dung beetles in northern India because of anthropogenic activities like disturbance to natural vegetation, deforestation, excessive human inhabitations (Favila and Halffter,1997). These beetles are treated as bioindicator to ecological environment (Halffter *et al.*,1992 and Halffter & Favila,1993) for being sensitive to environmental changes (Halffter & Matthews,1966 and Kadiri *et al.*,1997).

In the survey, 11 species were found to be phytophagous of which subfamily Rutelinae have the maximum number of species (6), Cetoninae (2), Dynastinae (2) and Melolonthinae (1) (Table.1). Taxonomically these phytophagous scarabs were referred to as Pleurosticti and they are considered as pests to major economical crops. Scarabs under subfamilies Dynastinae, Cetoninae and Rutelinae feed on the nector sap or pollens (Chandra and Gupta,2012b). Larvae of Melolonthinae, Rutelinae and Dynastinae are called as white grubs and are one of the most destructive soil insects, threatening and damaging the crop production (Pal,1977). Some scarabs in Cetoninae and Dynastinae consume soil humus and litter whereas Trichinae, Valginae and few Cetoninae resides in decay woods and debris of the trees (Sawada,1991).

Anomala biharensis and *Heteronychus lioderes* had been widely reported as a serious pest of sugarcane crop whereas, *Anomala dorsalis* is a destructive pest on Ber planta-

tion (Anitha *et al.*,2006). *Schizonycha ruficollis* feeds on *Cassia fistula*, acacia, ber, neem, rose and tamarind other dicotyledonous trees (Brownie,1968; Kumara *et al.*,2009 and Anitha *et al.*,2006) and *Vitis villifera* during night (Batra *et al.*,1973), *Clinteria klugi* causes damage to *Tectona grandis* (Beeson,1941) and *Gametis versicolor* (Fabricius) to rose and brinjal (Kumara *et al.*,2009). The larvae or grubs of these beetles feed on roots of the host plants, while the adult scarabs are found to be feeding on the leaves of other plants during the night (Pal,1977). The study also revealed two species new to the state fauna viz. *Bolbohamatum phallosum* Krikken,1980 (Bolboceratinae) and *Adoretus versutus* Harold,1869 (Rutelinae).

ACKNOWLEDGMENTS

The authors are thankful to Director, Zoological Survey of India for providing necessary facilities and encouragements. We are also thankful to Ministry of Environment Forests and Climate Change for providing funds to carry out the work. Thanks are also due to Chhattisgarh Forest Department for providing necessary permissions and support to carry out the present work.

REFERENCES

- Anitha, V. D. J.; Rogers, J. Wightman and A. Ward (2006). Distribution and abundance of white grubs (Coleoptera : Scarabaeidae) on groundnut in Southern India. *Crop Prot.*, **25** : 732-740.
- Arrow, G. J. (1910). *The Fauna of British India including Ceylon and Burma. Col. Lamell I* (Cetoniinae & Dynastinae). Taylor & Francis, London, **5(15)** : 1-322.
- Arrow, G. J. (1917). *The Fauna of British India including Ceylon and Burma. Col. Lamell II* (Rutelinae). Taylor & Francis, London, **5(13)** : 1-387.
- Arrow, G. J. (1931). *The Fauna of British India including Ceylon and Burma. Col. Lamell III* (Coprinae). Taylor & Francis, London, **12** : 1-428.
- Balthasar, V. (1963a). Monographie der Scarabaeidae und Aphodiidae der Palaearktischen und Orientalischen Region. (Coleoptera : Lamellicornia). *Verlag der Tschechoslowakischen Akademie der Wissenschaften Prag*, **1** : 1-391.
- Balthasar, V. (1963b). Monographie der Scarabaeidae und Aphodiidae der Palaearktischen und Orientalischen Region (Coleoptera : Lamellicornia). *Verlag der Tschechoslowakischen Akademie der Wissenschaften Prag*, **2** : 1-627.
- Balthasar, V. (1964). Monographie der Scarabaeidae und Aphodiidae der Palaearktischen und Orientalischen Region (Coleoptera : Lamellicornia). *Verlag der Tschechoslowakischen Akademie der Wissenschaften Prag*, **3** : 652.
- Batra, R. C., Bindra, O. S. and Sohi, B. S. (1973). New record of some chaffer beetles as pests of grapevine. *Indian J. Ent.*, **35(2)** : 177.
- Beeson, C. F. C. (1941). *The Ecology and Control of the Forest Insects of India and Neighboring Countries*, pp. 1-767.
- Borenmissza, G. F. (1970). Insectary studies on the control of dung

- breeding lies by the activity of dung beetle, *Onthophagus gazella* F. (Coleoptera : Scarabaeinae). *J. Aus. Ent. Soc.*, **9** : 31-41.
- Brownie, F. G. (1968). *Pests and Diseases of Forest Plantation Trees*. Clarendon Press, Oxford.
- Chandra, K. (2000). Inventory of scarabaeid beetles (Coleoptera) from Madhya Pradesh. *Zoo's Print Jour.*, **15(11)** : 359-362.
- Chandra, K. (2003). Insect biodiversity in Madhya Pradesh and Chhattisgarh. *Advancements in Insect Bio-diversity* (ed. Rajiv Gupta), *Agrobios (India)*, pp. 37-52 & 325-337.
- Chandra, K. and Ahirwar, S. C. (2007). Insecta : Coleoptera: Scarabaeidae. In : *Zoological Survey of India, Fauna of M.P.* (including C.G.), State Fauna Series, **15(1)** : 273-300.
- Chandra, K. and Gupta, D. (2012a). An Inventory of scarab beetles (Coleoptera : Scarabaeidae) of Achanakmar-Amarkantak Biosphere Reserve, Chhattisgarh. *I. J. Sci. Nat.*, **3(4)** : 886-891.
- Chandra, K. and Gupta, D. (2012b). Diversity and relative abundance of pleurosict Scarabaeidae (Coleoptera) in Achanakmar-Amarkantak Biosphere Reserve, Central India. *World J. Zool.*, **7(2)** : 147-154.
- Chandra, K. and Gupta, D. (2012c). Bolboceratine Scarabs of genera *Bolbohamatum* Krikken, 1980 and *Bolbogonium* Boucomont, 1911 (Coleoptera : Geotrupidae) from Central India. *Taprobanica*, **4(2)** : 69-76.
- Chandra, K. and Gupta, D. (2012d). *Bolbohamatum achanakmarini* sp. nov. (Coleoptera : Geotrupidae : Bolboceratinae) from Chhattisgarh. *J. Ent. Res.*, **36(4)** : 383-385
- Chandra, K. and Gupta, D. (2013a). Taxonomic studies on dung beetles (Coleoptera : Scarabaeidae, Geotrupidae, Hybosoridae) of Chhattisgarh. *Munis Ent. Zoo.*, **8(1)** : 331-360.
- Chandra, K. and Gupta, D. (2013b). Scarab beetles (Coleoptera : Scarabaeoidea) of Barnawapara Wildlife Sanctuary, Chhattisgarh. *J. Threat. Taxa*, **5(12)** : 4660-4671.
- Chandra, K. and Gupta, D. (2013c). Studies on rhinoceros beetles (Coleoptera : Scarabaeidae : Dynastinae) from Madhya Pradesh, Central India. *Colemania*, **34** : 1-9.
- Chandra, K. and Singh, S. P. (2010). Scarabaeid beetles (Coleoptera) of Achanakmar Wildlife Sanctuary, Chhattisgarh. *Nat. J. Life Sci.*, **7(1)** : 71-74.
- Chandra, K., Gupta, D. and Khan, S. (2012). Scarab beetles (Coleoptera : Scarabaeidae) of Kanger Valley National Park, Chhattisgarh. *J. Ecobiotechnology*, **4(2)** : 69-70
- Chandra, K.; Gupta, D. and Goel, S. C. (2015). On scarab beetles (Coleoptera : Scarabaeidae) from Sidhi district of Madhya Pradesh. *Uttar Pradesh J. Zool.*, **35(3)** : 235-243.
- Gupta, D. and Chandra, K. (2016). *Bolboceras bilaspuricans* (Coleoptera : Geotrupidae : Bolboceratinae), a new species from Chhattisgarh. *Zootaxa*, **4103(3)** : 295-300.
- Endrodi, S. (1985). *The Dynastinae of the World*. Publisher Dr. W. Junk. Dordrecht, **28** : 1-800.
- Estrada, A. and Estrada, R. C. (1991). Howler monkeys, dung beetles (Scarabaeidae) and seed dispersal : Ecological interactions in the tropical rainforest of Lostuxlas, Mexico. *J. Trop. Eco.*, **7** : 459-474.
- Favila, M. E. and Halffter, G. (1997). The use of indicator groups for measuring bio-diversity as related to community structure and function. *Acta Zool. Mex.*, **72** : 1-25.
- Ghosh, J., Majumder, A., Halder, S., Gupta, D. and Chandra, K. (2015). Scarab beetles (Coleoptera : Scarabaeidae) of Badalkhol Wildlife Sanctuary, Chhattisgarh. *Rec. Zool. Surv. India*, **115(4)** : 391-403.
- Gupta, A. K. and Mittal, I. C. (1987). Studies on the male genitalia of some Indian dung beetles (Coleoptera : Scarabaeidae : Scarabaeinae) and their taxonomic significance. *Y.E.S. Quarterly*, **4(3)** : 46-31.
- Halffter, G. and Matthews, E. G. (1966). The natural history of dung beetles of subfamily Scarabaeinae (Coleoptera, Scarabaeidae). *Folia Ento. Mex.*, **12-14** : 3-312.
- Halffter, G.; Favila, M. E. and Halffter, V. (1992). A comparative study of the structure of the scarab guild in Mexican tropical rain forest and derived ecosystems. *Folia Ento. Mex.*, **84** : 131-156.
- Halffter, G. and Favila, M. E. (1993). The Scarabaeinae (Insecta : Coleoptera) : An animal group for analyzing, inventorying and monitoring bio-diversity in tropical rainforest and modified landscapes. *Biology Int.*, **27** : 15-21.
- Kadiri, N.; Lobo, J. M. and Lumaret, J. P. (1997). Consequences of interactions between preferences and the quantity of trophic resources on coprophagous insect communities (Coleoptera : Scarabaeoidea). *Acta Oec.*, **18(2)** : 107-119.
- Krajcik, M. (2012). *Checklist of World Scarabaeoidea*. Animax. x-Supplement 5, p. 278.
- Kuijten, P. J. (1978). Revision of the Indo-Australian species of the genus *Phaeochrous* Castelnau, 1840 (Coleoptera : Scarabaeidae, Hybosorinae), with notes on the African species. *Zool. Verh.*, pp. 1-40.
- Kumara, M. S., Sankar, V. Sethuramana and A. Musthak (2009). Population dynamics of white grubs (Coleoptera: Scarabaeidae) in the rose environment of Northern Bangalore. *Ind. J. Sci. Tech.*, **2(1)** : 46-52.
- Larsen, T. (2004). *Dung beetle extinctions and ecological function*. <http://www.princeton.edu/kremen/trond.htm>.
- Mittal, I. C. (1993). Natural manuring and soil conditioning by dung beetles. *Trop. Eco.*, **34(2)** : 150-159.
- Mittal, I. C. (2005). Diversity and conservation status of dung beetles (Laparosticti : Scarabaeidae : Coleoptera) in North India. *Bull. Nat. Inst. Eco.*, **15** : 43-51.
- Mittal, I. C. and Yadav, P. S. (1979). Role of coprophagous beetles in nutrient cycling. *Geobios*, **6** : 70-73.
- Pal, S. K. (1977). *White grubs and their Management*. Central Arid Zone Research Institute. B. R. Chowdhri, Press Manager at Haryana Agricultural University Press, Hissa, pp. 1-42.
- Sawada, H. (1991). Morphological and phylogenetical study on the larvae of Pleuristict lammelicornia in Japan. *Tokyo Univ. Agri. Press*, p. 289.
- Sewak, R. (2009). Dung Beetles (Coleoptera : Scarabaeidae : Coprinae) of Rajasthan. *Records of the Zoological Survey of India, Occasional Paper*, **296** : 1-106.
- Smith, A. B. T. (2006). A review of the family-group names for the superfamily Scarabaeoidea (Coleoptera) with corrections to nomenclature and a current classification. *Coleopterist Society Monograph*, **5** : 144-204.