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A Checklist of Dung Beetles of Uttarakhand,
Western Himalaya, India

This paper presents an attempt to build a complete dataset of the dung beetles recorded from Uttarakhand with an updated checklist. All the available literature on the dung beetles from Uttarakhand was investigated to obtain data. Altogether 104 dung beetle species are known from Uttarakhand covering 20 sampling sites falling in different altitudinal zone.

Key words: Dung beetles., Himalaya, Biodiversity, Bio-indicator

Introduction

True dung beetles are the members of subfamily Scarabaeini within Scarabaediae family, which exclusively feed on dung and utilized dung for nesting also. The animals that produce the dung which is of interest to dung beetles fall into numerous taxonomic and feeding categories; vertebrate, invertebrate, omnivore, carnivore or herbivore, although the majority of dung beetles worldwide probably feed on mammalian herbivore dung (Scholtz *et al*., 2009). The dung beetles are important contributors in ecosystem functioning by providing important ecological services such as dung removal, secondary seed burial, nutrient cycling, soil aeration etc. The dung that is rapidly buried by beetles loses only 5-15% of its nitrogen, while volatilization results in the loss of 80% of nitrogen if dung remains on the soil surface (Gillard, 1967). Many cattle parasites and pest flies require a moist environment such as dung to complete their development. Burying dung and removing this habitat (dung pats) can reduce the density of these pests (Fincher, 1981). The dung beetles affected the survival and distribution of a portion of the seeds dispersed by other animals and their relative importance in shaping seed fate depended on seed and beetle size (Feer, 1999). The dung beetles play a significant ecological role; they may greatly increase the number of dispersed seeds that end up in locations where seed predation is low and germination potential is high. It is also possible to ask whether dung beetles are playing a significant evolutionary role in influencing seed characters (Shephard and Chapman, 1998). The dung removal rates are significantly and positively correlated with dung beetle species richness, which have significant effects on ecosystem functioning. The dung beetles exhibits short life cycle and they are sensitive to environmental heterogeneity and climate change. The synergistic effects of climate change (*e.g.* extension and severity of dry season) and direct human induced changes (*e.g.* habitat degradation, fragmentation) are known to affect their trophic networks and ecosystem services. Dung beetle abundance, richness, and body mass also show inter-annual variation in both undisturbed forest and modified habitats. The dung beetles was evaluated correlating the anthropogenic impacts and habitat recovery from disturbance with recent advances relating dung beetle sensitivity to disturbance to functional traits such as species body mass or size, nesting behavior, diet preference, and activity period (Beiroz *et al.,* 2016). Phylogeny biology, taxonomy, behavior ecology of dung beetles

Dung beetles are highly sensitive to disturbance and are vulnerable to deforestation and other changes in habitat and fauna. They can play an important as bio-indicator to predict the impacts of climate change, forest fragmentation and biodiversity losses.

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is well studied which is an essential element of any indicator taxa (Halffter and Favila, 1993). It is possible to analyze the environmental influences (climatic area, numbers of dung types) and major components of diversity (taxon richness, taxon diversity, functional composition) at different taxonomic levels (tribe, genus, species). Current global variation in taxon richness is correlated strongly to current biogeographical variation in the area of suitable climate at all three taxonomic levels (Davis and Scholtz, 2001). Dung beetles have high potency to be used as bioindicator (*i.e.* ecological indicator) in relation with their fidelity and specificity to a particular type of habitat (Shahabuddin *et al*., 2014) and also they valuable application in the monitoring of habitat integrity (McGeoh *et al.,* 2002). These combined proprieties make dung beetles valuable indicator of forest fragmentation and climate change. As a result they are now best-monitored group of insects in the world. Consequently dung beetles represent a well suited model to monitor the possible occurrence of shifts in species ranges, altitudinal distribution and biodiversity loss.

Uttarakhand is an Indian state on the southern slope of the Himalaya. It borders Tibet on the north and Nepal on the east. Most of the northern part of the state is covered by high Himalayan peaks and glaciers. This state ranges from subtropical forests at an elevation 200m to the alpine zone above 8000m. This variability in elevation range and climatic diversity supports a huge diversity of flora and fauna. This Himalayan state is under immense pressure due to recent wave of urbanization and global climate change (Wester *et al.,* 2019). Thus documentation of biodiversity prevailing in the state and prioritizing conservation areas are major challenges for policy mangers and conservationists. Spatial and temporal data sets are needed to provide a basis for understanding the species-habitat relationships; species range shift and distributional pattern. However the data in biodiversity repositories are still largely incomplete. Inclusive data information can help in understanding the impact of climate change and also to monitor the biodiversity loss at steady rate. Policy makers and conservationist can use these insights in order to prioritize the conservation area and efforts, management policies and decisions.

The Himalaya is one of the most vulnerable ecosystems to climate change. The impacts of extreme events are amplified in the fragile ecosystems of the Himalaya. There is critical need of conservation interventions for the documentation of biodiversity and digitization of all the described taxonomic groups. Dung beetles are excellent indicators of habitat degradation, biodiversity loss and important taxa for long term ecological monitoring. UNFCC, IPCC, MEA and CBD have a common target of biodiversity conservation, sustainable development and updated scientific knowledge for better understanding of climate change. This works aims to generate an updated checklist with synonymies and distributional maps for each recorded dung beetle species to build the systemic information to monitor the climate change and biodiversity loss.

For this work data was obtained from secondary sources such as published literature, annual reports, records, and archives (Arrow, 1931; Balthasar, 1963a and 1963b; Mittal, 1999; Mittal and Jain, 2015). Accuracy of secondary data was verified thorough cross-referencing with similar data from alternative sources. The recorded species have been arranged alphabetically giving their scientific names and synonyms wherever necessary. Gathered data has been georeferenced by using Google earth where coordinates were not explicitly reported by the authors. Doubtful or uncertain records were not included in the data set. Previous works (Arrow, 1931; Balthasar, 1963a and 1963b; Mittal, 1999; Mittal and Jain, 2015) lack new political boundaries framework therefore we have extracted the sampling locations, distributional record and rectified the sampling locations into the current state political boundary recognized by government of India. A current checklist of all the dung beetle species known to date from Uttarakhand with broad geographical locations and species-wise map has been generated. Names of districts where species occurred are given following the spelling adopted by the Indian government.

Results and Discussion

This updated checklist includes 104 species of dung beetles (Scarabaeidae: Scarabaeini) within seven tribes, 20 genera covering 20 locations falling in nine districts of Uttarakhand, India. Which is 25% of total dung beetle species recorded from India and 15% of world dung beetle species reported so far.

Subfamily Scarabaeinae has been classified into 12 tribes *viz*., Dichotomiini (40 genera and 750 species), Onitini (18 genera and 250 species), Phanaeini (12 genera and 150 species), Coprini (ten genera and 400 species), Oniticellini (15 genera and 180 species), Onthophagini (40 genera and 2200 species), Canthonini (120 genera and 800 species), Scarabaeini (three genera and 150 species), Gymnopleurini (four genera and 110 species), Eucraniini (four genera and 16 species), Eurysternini (single genus and 20 species) and Sisyphini (three genera and 60 species) (Hanski and Camefort, 1991; Scholtz *et al*., 2009) but Dichotomiini (Halffter and Matthews, 1966) were used as a tribe name but neither described or validated in any code compliant way, therefore the name is unavailable (Smith, 2006). Instead of this, Ateuchini is a validated tribe of dung beetles in the subfamily Scrabaeinae hence in this work we have also considered Ateuchini as a validated tribe.

Table 1: Checklist of dung beetles and their district wise distribution (Scarabaeinae: Scarabaeidae: Coleoptera) in Uttarakhand

	Taxon	Locality	Districts
		Family Scarabaeidae Latreille, 1802	
		Subfamily Scarabaeinae Latreille, 1802	
		Tribe Gymnopleurini Lacordaire, 1856	
		Genus *Allogymnopleurus* Janssens, 1940	
1.	*A. maculosus* (MacLeay, 1821)	Almora, Haridwar	HA, AL
		Genus ***Garreta*** Janssens, 1940	
2.	*G. dejeani* (Castelnau, 1840)	Mussoorie	DD
3.	*G. opacus* (Redtenbacher, 1848)	Almora, Berinag, Mussorie	AL, BA
4.	*G. ruficornis* (Motschulsky, 1854)	Mussoorie	DD
		Genus ***Gymnopleurus*** Illiger, 1803	
5.	*G. cyaneu*s (Fabricius, 1798)	Almora, Arakot, Chakrata, Haldwani	AL, DD, NA, UT
		Subgenus ***Metagymnopleurus*** Kabakov, 2006	
6.	*G.* (*M.*) *gemmatus* Harold, 1871	Haridwar, Rishikesh	DD, HA
7.	*G.* (*M.*) *parvus* (MacLeay, 1821)	Dehradun	DD
		Genus ***Paragymnopleurus*** Shipp, 1897	
8.	*P. sinuatusassamensis* (Waterhouse, 1890)	Jhajra, Dehradun	DD
		Tribe Sisyphini Mulsant, 1842	
		Genus *Sisyphus* Latreille, 1807	
9.	*S. neglectus* Gory, 1833	Chakrata, Dehradun, Haridwar, Mussoorie	DD, DD
		Tribe Ateuchini Laporte, 1840	
		Genus ***Delopleurus*** Erichson, 1847	
10.	*D. striatus* Arrow, 1931	Dehradun	DD
		Tribe Coprini Leach, 1815	
		Genus ***Copris*** Müller, 1764	
11.	*C. repertus* Walker, 1858	Chakrata, Dehradun	DD
12.	*C. sabinus* Gillet, 1910	Chakrata, Kausani, Mussorie, Nainital	AL, BA, DD, NA
13.	*C. sacontala* Redtenbacher, 1848	Almora, Kausani, Ranikhet,	AL, BA
14.	*C. sarpedon* Harold, 1868	Chakrata, Kausani, Mussoorie, Naintal, Ranikhet	AL, BA, DD, NA
		Genus ***Paracopris*** Balthasar, 1939	
15.	*P. surdus (*Arrow, 1931)	Chakrata, Haldwani, Kausani, Tanakpur	BA, CP, DD, NA
		Genus ***Catharsius*** Hope, 1837	
16.	*C. molossus* (Linnaeus, 1758)	Dehradun, Nainital	DD, NA
17.	*C. pithecius* (Fabricius, 1775)	Dehradun, Rishikesh	DD
18.	*C. sagax* (Quensel, 1806)	Dehradun	DD
		Tribe Oniticellini Kolbe, 1905	
		Genus ***Euoniticellus*** Janssens, 1953	
19.	*E. pallipes* (Fabricus, 1781)	Almora, Arakot, Chakrata, Dehradun, Jhajra	AL, DD, NA,UT
		Genus ***Liatongus*** Reitter, 1893	
20.	*L. gagatinus* (Hope, 1831)	Almora, Chakrata, Dehradun, Mussoorie, Mukteshwar	AL, DD, NA
21.	*L. mergacerus* (Hope, 1831)	Ranikhet	AL
22.	*L. phanaeoides* (Westwood, 1839)	Badrinath, Chakrata, Joshimath, Kasauni, Kedarnath, Mussoorie	BA, CL, DD, RP
23.	*L. vertagus* (Fabricius, 1798)	Kasauni, Mussoorie, Nanital	BA, DD, NA
		Genus ***Oniticellus*** Dejean, 1821	
24.	*O. cinctus* (Fabricius, 1775)	Almora, Dehradun, Haridwar, Mussorie, Nainital, Ranikhet, Rishikesh	AL, DD, HA, NA
		Genus ***Tibiodrepanus*** Krikken, 2009	
25.	*T. setosus* (Wiedemann, 1823)	Almora, Dehradun, Haldwani, Rishikesh	AL, DD, HA, NA
26.	*T. sinicus* (Harold, 1868)	Almora, Mussoorie, Nainital, Ranikhet	AL, DD, NA
		Genus ***Tiniocellus*** Péringuey, 1900	
27.	*T. spinipes* (Roth, 1851)	Almora, Mussoorie, Rishikesh	AL, DD
		Tribe **Onitini** Laporte, 1840	
		Genus ***Onitis*** Fabricius, 1798	
28.	*O. castaneus* Redtenbacher, 1848	Almora, Jhajra	AL, DD
29.	*O. excavates* Arrow, 1931	Dehradun, Haridwar, Mussoorie, Rishikesh	DD, HA
30.	*O. falcatus* (Wulfen, 1786)	Almora, Dehradun Haridwar, Mussoorie, Rishikesh	AL, DD, HA

	Taxon	Locality	Districts
31.	*O. lama* Lansberge, 1875	Almora	AL
32.	*O. philemon* Fabricius, 1801	Almora, Dehradun	AL, DD
33.	*O. subopacus* Arrow, 1931	Dehradun, Haridwar, Jhajra, Rishikesh	DD, HA
34.	*O. virens* Lansberge, 1875	Dehradun, Rishikesh	DD
	Tribe Onthophagini Burmeister, 1846		
	Genus ***Caccobius*** Thomson, 1859		
	Subgenus ***Caccobius*** Thomson, 1859		
35.	*C.* (*C.*) *denticollis* Harold, 1867	Almora, Chakrata, Kausani, Mussoorie	AL, BA, DD
	Subgenus ***Caccophilus*** Jekel, 1872		
36.	*C.* (*C.*) *diminutivus* Walker, 1858	Dehradun, Haridwar	DD, HA
37.	*C.* (*C.*) *himalayanus* Jekel, 1872	Chakrata	DD
38.	*C.* (*C.*) *indicus* Harold, 1867	Dehradun	DD
39.	*C.* (*C.*) *torticornis* Arrow, 1931	Dehradun	AL, DD
40.	*C.* (*C.*) *ultor* Sharp, 1875	Dehradun, Haldwani, Rishikesh	DD, DD
41.	*C.* (*C.*) *unicornis* (Fabricius, 1798)	Mussoorie	DD
42.	*C.* (*C.*) *vulcanus* (Fabricius, 1801)	Dehradun, Haldwani, Haridwar, Rishikesh	DD, HA, NA
	Genus ***Cleptocaccobius*** Cambefort, 1984		
43.	*C. inermis* (Arrow, 1931)	Almora	AL
	Genus ***Digitonthophagus*** Balthasar 1959		
44.	*D. bonasus* (Fabricius, 1775)	Dehradun, Haldwani, Haridwar, Rishikesh	DD, HA, NA
45.	*D. gazella* (Fabricius, 1787)	Haldwani, Rishikesh	DD, NA
	Genus ***Onthophagus*** Latreille, 1802		
46.	*O. agaricophilus* Arrow, 1931	Mussoorie, Ranikhet	AL, DD
	Subgenus ***Altonthophagus*** Kabakov 1990		
47.	*O.* (*A.*) *concolor* Sharp, 1878	Chakrata	DD
48.	*O.* (*A.*) *tibetanus* Arrow, 1907	Badrinath, Kedarnath	CL, RP
	Subgenus ***Colobonthophagus*** Balthasar, 1963		
49.	*O.* (*C.*) *aenescens* (Wiedemann, 1823)	Dehradun	DD
50.	*O.* (*C.*) *bengalensis* (Harold, 1886)	Dehradun	DD
51.	*O.* (*C.*) *dama* (Fabricius, 1798)	Almora, Dehradun, Jhajra	AL, DD
52.	*O.* (*C.*) *paliceps* Arrow, 1931	Dehradun	DD
53.	*O.*(*C.*) *quadridentatus* Fabricus, 1798	Dehradun, Haridwar	DD, HA
54.	*O.* (*C.*) *ramosellus* Bates, 1891	Dehradun, Haldwani, Haridwar, Jhajra, Ramgarh, Rishikesh	DD, HA, NA
55.	*O.* (*C.*) *ramosus* (Wiedemann, 1823)	Almora, Chakrata, Dehradun, Haldwani	AL, DD, NA
56.	*O.* (*C.*) *tragus* (Fabricius, 1792)	Dehradun	DD
57.	*O.* (*F.*) *amicus* (Gillet 1925)	Almora, Dehradun, Haldwani,	AL, DD, NA
58.	*O.* (*F.*) *lilliputanus* Lansberge, 1883	Mussoorie	DD
	Subgenus ***Gibbonthophagus*** Balthasar, 1963		
59.	*O.* (*G.*) *duporti* Boucomont, 1914	Dehradun	DD
60.	*O.* (*G.*) *luridipennis* Boheman, 1858	Chakrata, Dehradun	DD
61.	*O.* (*G.*) *nasalis* Arrow, 1931	Almora, Dehradun	AL, DD
	Subgenus ***Macronthophagus*** Ochi, 2003		
62.	*O.* (*M.*) *rubricollis* Hope, 1831	Mukteshwar	NA
	Subgenus ***Matashia*** Matsumura, 1938		
63.	*O.* (*M.*) *kuluensis* Bates, 1891	Almora, Chakrata, Mussoorie	AL, DD
	Subgenus ***Micronthophagus*** Balthasar, 1963		
64.	*O.* (*M.*) *hystrix* Boucomont, 1914	Dehradun	DD
	Subgenus ***Palaeonthophagus*** Zunino, 1979		
65.	*O.* (*P.*) *marginalis* (Gebler, 1817)	Arakot, Badrinath, Chakrata, Kedarnath, Mussoorie	CL, DD, RP, UT
	Subgenus ***Paraphaeneomorphus*** Balthasar, 1959		
66.	*O.* (*P.*) *bifasciatus* (Fabricius, 1781)	Dehradun	DD
67.	*O.* (*P.*) *vaulogeri* Boucomont, 1923	Dehradun	DD
	Subgenus ***Serrophorus*** Balthasar, 1963		
68.	*O.*(*S.*) *atropolitus* d'Orbigny, 1902	Dehradun	DD
69.	*O.* (*S.*) *sagittarius* (Fabricius, 1775)	Dehradun	DD
	Subgenus ***Sinonthophagus*** Kabakov, 2006		
70.	*O.* (*S.*) *productus* Arrow, 1907	Almora, Chakrata, Dehradun, Mussoorie, Ranikhet	AL, DD

	Taxon	Locality	Districts
		Subgenus ***Strandius*** Balthasar, 1963	
71.	*O.* (*S.*) *gagates* Hope, 1831	Chakrata, Mussoorie, Mukteshwar, Ranikhet	AL, DD, NA
		Subgenus ***Trichonthophagus*** Zunino, 1979	
72.	*O.* (*T.*) *tarandus* (Fabricius, 1792)	Dehradun	DD
		Onthophagus **incertaesedis**	
73.	*O. abreui* Arrow, 1931	Dehradun, Haldwani	DD, NA
74.	*O. arboreus* Arrow, 1931	Dehradun	DD
75.	*O. beesoni* Arrow, 1931	Jhajra, Haldwani	DD, NA
76.	*O. centricornis* (Fabricius, 1798)	Dehradun, Haridwar, Rishikesh	DD, HA
77.	*O. cervus* (Fabricius, 1798)	Dehradun	DD
78.	*O. circulifer* Arrow, 1931	Dehradun, Jhajra	DD
79.	*O. compactus* Arrow, 1933	Haldwani	NA
80.	*O. deflexicollis* Lansberge, 1883	Haldwani	NA
81.	*O. expansicornis* Bates, 1891	Dehradun, Mussoorie	DD
82.	*O. exquisitus* Arrow, 1931	Dehradun	DD
83.	*O. falsus* Gillet, 1925	Rishikesh, Haldwani, Haridwar	DD, HA, NA
84.	*O. fasciatus* Boucomont, 1914	Dehradun	DD
85.	*O. furcicollis* Arrow, 1931	Dehradun, Mussoorie	DD
86.	*O. furcillifer* Bates, 1891	Almora, Dehradun, Mussoorie, Nainital	AL, DD, NA
87.	*O. germanus* Gillet, 1927	Nainital	NA
88.	*O. gratus* Arrow, 1931	Dehradun	DD
89.	*O. griseosetosus* Arrow, 1931	Dehradun	DD
90.	*O. hamaticeps* Arrow, 1931	Jhajra	DD
91.	*O. kumaonensis* Arrow, 1931	Almora, Mussoorie, Nainital	AL, DD, NA
92.	*O. lapillus* Arrow, 1931	Dehradun, Shyamkhet	DD, NA
93.	*O. mirandus* Arrow, 1931	Almora	AL
94.	*O. mopsus* (Fabricius, 1792)	Almora, Haldwani, Haridwar, Jhajra, Rishikesh	AL, DD, HA, NA
95.	*O. necrophagus* Arrow, 1931	Jhajra	DD
96.	*O. orientalis* Harold,1868	Dehradun	DD
97.	*O. pacificus* Lansberge, 1885	Jhajra	DD
98.	*O. spinifex* (Fabricius, 1781)	Haldwani	NA
99.	*O. sternalis* Arrow, 1931	Dehradun	DD
100.	*O. unifasciatus* (Schaller, 1783)	Dehradun	DD
		Genus ***Parascatonomus*** Paulian, 1932	
101.	*P. quaestus* (Sharp, 1875)	Dehradun, Haridwar	DD, HA
		Genus ***Proagoderus*** Lansberge, 1883	
102.	*P. amplexus* (Sharp, 1875)	Dehradun	DD
103.	*P. pactolus* (Fabricius, 1787)	Dehradun	DD
		Genus ***Phalops*** Erichson, 1847	
104.	*P. divisus* Wiedemann, 1823	Dehradun	DD

In Uttarakhand, most dominant tribe is Onthophagini with seven genera and 70 species followed by Oniticellini with five genera and nine species, Coprini with three genera and nine species, Gymnopleurini with three genera and eight species while Onitini is represented by single genus and seven species, Ateuchini with single genus and single species, Sisyphini includes single genus and single species only.

Majority of species were recorded from Dehradun district, followed by Almora district. Champawat, Rudraprayag and Uttarkashi were very poor sampled districts with one or two records only (Fig. 2). No records exist for four districts *viz.* Pauri Garhwal, Pithoragarh, Tehri Garhwal and Udham Singh Nagar so these are the gap areas which need future interventions to complete the database for dung beetles of Uttarakhand.

उत्तराखण्ड, पश्चिमी हिमालय, भारत के डंग बीटल्स की जाँच सूची

मोना चौहान और वी.पी. उनियाल

सारांश

इस शोधपत्र में एक अद्यतन जाँचसूची के साथ उत्तराखण्ड से अभिलिखित डंग बीटल्स के एक पूर्ण आँकड़ासेट का निर्माण करने का प्रयास किया गया है। आँकड़े प्राप्त करने के लिए उत्तराखण्ड से डंग बीटल्स पर सभी उपलब्ध साहित्य की जाँच की गई। अलग-अलग ऊँचाईयों में आने वाले 20 सैम्पलिंग स्थलों को कवर करके उत्तराखण्ड से कुल मिलाकर 104 डंग बीटल्स प्रजाति ज्ञात हैं।

References

Arrow G.J. (1931). *The Fauna of British India including Ceylon and Burma*. Col. Lamell. III (Coprinae). Taylor and Francis, London, XII: pp.428.

Balthasar V. (1963a). *Monographie der Scarabaeidae und Aphodiidae der Palaearktischen und Orientalischen region. Verlag der Tschechoslowakischen Akademie der Wissenschaften,* Prag, pp. *617.*

Balthasar V. (1963b). *Monographie der Scarabaeidae und Aphodiidae der Palaearktischen und Orientalischen region*. Verlag der Tschechoslowakischen Akademie der Wissenschaften, Prag, pp 381.

Beiroz W., Slade M.E., Barlow J., Silveira M.J., Louzada J and Sayer E. (2016). Dung beetle community dynamics in undisturbed tropical forests: implications for ecological evaluations of land-use change. *Insect Conservation and Diversity.*

Davis A.J., Holloway J.D., Huijbregts H., Krikken J., Kirk-Spriggs A.H. and Sutton S.L. (2001). Dung beetles as indicators of change in the forests of northern Borneo. *Journal of Applied Ecology,* **38**: 593-616.

Davis A.L.V. and Scholtz C.H. (2001). Historical vs. ecological factors influencing global patterns of scarabaeine dung beetle diversity. *Diversity and Distributions,* **7:** 161-174.

Feer F. (1999). Effects of dung beetles (Scarabaeidae) on seeds dispersed by howler monkeys (*Alouatta seniculus*) in the French Guianan rain forest. *Journal of Tropical Ecology,* **15**: 129-142.

Fincher G.T. (1981). The potential value of dung beetles in pasture ecosystems. *Journal of the Georgia Entomological Society,* **16**: 301-316.

Gillard P. (1967). Coprophagous beetles in pasture ecosystems. *Journal of the Australian Institute of Agricultural Science*, **33**: 30-34.

Halffter G. and Favila M.E. (1993). The Scarabaeinae (Insecta: Coleoptera) an animal group for analyzing, inventorying and monitoring biodiversity in tropical rain forests and modified landscapes. *Biology International,* **27**: 15-21.

Halffter G. and Matthews E.G. (1966). The natural history of dung beetles of the subfamily Scarabaeinae (Coleoptera, Scarabaeidae). *Folia Entomologica, Mexicana,* **12-14**: 1-312.

Hanski I. and Cambefort Y. (1991a). Index of the genera in Scarabaeidae. Dung beetle ecology (ed. I. Hanski and Y. Cambefort), *Princeton University Press, Princeton,* pp. 465-473.

Kremen C., Merenlander A.M. and Murphy D.D. (1994). Ecological monitoring: a vital need for integrated conservation and development programs in the tropics. *Conservation Biology,* **8**: 388-397.

McGeoch M.A.,VanRensburg B.J. and Botes A. (2002). The verification and application of bioindicators: a case study of dung beetles in a savanna ecosystem. *Journal of Applied Ecology*, **39**: 661-672.

Mittal I.C. (1999). Annotated list of Scarab fauna (Scarabaeidae: Coleoptera) of Western Uttar Pradesh (India). *Annals of Entomology,* **17**(2): 25-43.

Mittal I.C. and Jain Rahul (2015). A checklist of Indian dung beetles (Coleoptera: Scarabaeidae). *Indian Journal of Entomology,* **77**(4): 383-404.

Nichols E., Spector S., Louzada J., Larsen T., Amezquitad S. and M.E. Favila M.E. (2008). Ecological functions and ecosystem services provided by (Scarabaeinae) dung beetles. *Biological Conservation*, **141**: 1461-1474.

Scholtz C.H., A.L.V. Davis and U. Kryger. (2009). Evolutionary biology and conservation of dung beetles. *Pensoft Publishers, Sofia, Bulgaria.*pp. 567.

Shahabuddin Hasanah U. and Elijonnahdi. (2014). Effectiveness of dung beetles as bioindicators of environmental changes in land-use gradient in Sulawesi, Indonesia. *Biotropia,* **21**(1): 48-58.

Shepherd V.E. and Chapman C.A. (1998). Dung beetles as secondary seed dispersers: impact on seed predation and germination. *Journal of Tropical Ecology,* **14**: 199-215.

Slade M.E., Mann J.D. and Lewis T.O. (2011). Biodiversity and ecosystem function of tropical forest dung beetles under contrasting logging regimes. *Biological Conservation,* **144**: 166-174.

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. *Coleopterists Society,* **5**: 144-204.

Wester P., Mishra A., Mukherji A. and Shrestha A.B. (2019). The Hindu Kush Himalaya Assessment-Mountains, Climate Change, Sustainability and People IN: Springer Nature Switzerland AG, Cham. pp. 638.