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Diversity and abundance of scarab beetles (*Coleoptera: Scarabaeidae*) in Jhunjhunu district of Rajasthan, India

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Abstract
A total of 46 species belonging to 30 genera under 8 subfamilies of the family *Scarabaeidae* were recorded from January 2021 to December 2022 from four study sites selected in the Jhunjhunu district. The most abundant subfamily Scarabaeinae was comprised of the highest number of species (16 species), followed by Aphodiinae (8 species), Melolonthinae (6 species), Dynastinae and Cetoninae (5 species each), Rutelinae (4 species), Hybosorinae, and Eremazinae (1 species each). As compared to the number of individuals, again Scarabaeinae was the most abundant subfamily (29.90% of the total individuals), followed by Dynastinae (18.57%), Melolonthinae (17.60%), Cetoninae (12.54%), Aphodiinae (9.56%), Rutelinae (8.34%), Hybosorinae (2.80%), Eremazinae (0.66%). The present study indicates a great diversity of Scarab beetles in the study area and provides preliminary data for future works.

Keywords: Diversity, abundance, *Scarabaeidae*, scarab beetles, Jhunjhunu

Introduction

The *Scarabaeidae* family, commonly known as scarab beetles or dung beetles, is a fascinating and diverse group of insects belonging to the order Coleoptera. With over 30,000 described species, they represent one of the biggest and most widespread families of beetles on Earth. Scarab beetles are record in a broad range of habitats across the globe, with their highest diversity occurring in tropical regions. They play essential ecological roles, particularly in the decomposition and recycling of organic matter. Many species are associated with dung, using it either as a food source or for breeding purposes. The family *Scarabaeidae* contains many species of dung beetles, fruit, and flower chafers, shining leaf chafers that feed on fruits, flowers, leaves, decayed plant materials and animal dung (Chandra and Gupta, 2012; Dadmal and Khadakkar, 2014; Franzini *et al*., 2016) [17, 19]. Dung beetles contribute major ecological services like nutrient recyclers, decomposers and increase fertility of soil (Nichols *et al*., 2008; Noriega *et al*., 2018) [36, 37]. Adults of the Melolonthinae and Rutelinae subfamily are leaf feeders, whereas adults of Cetoniinae feed on fruits and flowers.

Jessop (1986) [27] studied the Dung Beetles and Chafers and gave a key for identification of British Insects. Mowlavi *et al*., (2008) [34] have found a total of 15 scarab beetle fauna belonging to 9 genera in Ardabil Province, North West Iran. Gavrilovic and Curcic (2010**)** [21] enlisted a total of 178 species of family *Scarabaeidae*, 83 genera and 7 subfamilies from Serbia. Liberal *et al*., (2011) [33] recorded 13 species of dung beetle diversity from the Brazilian semi-arid ecosystem. Shahabuddin (2010) [43] studied diversity of dung beetles in habitat of Lore Lindu National Park, Indonesia and collected 24 dung beetle species related to 3 genera viz., *Onthophagus*, *Aphodius* and *Camponotus*.

Kakkar (2010) [28] studied seasonal distribution and prevalence of 29 species of dung beetles in three subfamilies (Hybosorinae, Aphodiinae and Scarabaeinae) from Kurukshetra, Haryana. Similarly, Jain and Mittal (2012) [26] revealed diversity and species composition of 33 dung beetle species of 16 genera related to three subfamilies viz., Scarabaeinae, Aphodiinae and Hybosorinae from Haryana, India.

Chandra and Gupta (2013a) [13] reported diversity and abundance of 52 dung beetle species related to 22 genera under 3 families viz. *Scarabaeidae*, Geotrupidae and Hybosoridae from Chhattisgarh. Similarly, Chandra and Gupta (2013b) [14] described 43 scarab beetle species associated with 25 genera under two families viz., Hybosoridae and *Scarabaeidae* from Barnawapara Wildlife Sanctuary, Chhattisgarh, India. David and Petr (2013) [18] have revealed 29 species of aphodiinae subfamily from Goa, Maharashtra, and Rajasthan (India). Bhawane *et al*., (2014) [6] recorded a total of 26 species of dung beetles of Scarabaeinae subfamily from Sindhudurg district, Maharashtra, India. Gupta *et al*., (2014) [24] updated 61 scarab beetle species related to 30 genera under 7 subfamilies from Madhya Pradesh. Pathania *et al*., (2015) [39] described diversity and seasonality of 56 phytophagous scarab beetle species related to 20 genera under four subfamilies viz., Melolonthinae (29 species in 10 genera), Rutelinae (19 species in 5 genera), Cetoniinae (6 species in 4 genera) and Dynastinae (2 species) in different landscapes from Himachal Pradesh. Chandra *et al*., (2015) [15] found 53 species of scarab beetle associated with 27 genera under 6 sub families from Madhya Pradesh, India.

Abdel-Dayem *et al*., (2016) [1] studied diversity and abundance of 22 dung beetle species belonging to 9 genera at a natural reserve within Hyper-Arid Ecosystem of Arabian Peninsula. Karimpumkala and Priyadarsanan (2016) [29] reported 13 dung beetle species attracted to unconventional resources from different parts of India. Jagdale and Magdum (2017) [25] noted 24 coleopteran species related to three families viz., *Scarabaeidae*, *Geotrupidae* and *Hybosoridae* were reported from Maharashtra. Patole (2018) found 33 scarab beetle species belonging to 8 families from Dhulia district, Maharashtra. Patole (2019) [40] studied diversity and seasonality of 15

species of dung beetles belong to 14 genera 5 subfamilies viz., Scarabaeinae, Rutelinae, Melolonthinae, Dynastinae and Cetoniinae from Sakri tahsil, Dhulia district Maharashtra. Bhattacharyya *et al.*, (2017) [8] reported 44 scarab beetle species belonging to 21 genera under 6 subfamilies viz., Melolonthinae, Rutelinae, Dynastinae, Cetoniinae, Scarabaeinae and Geotrupidae from Assam. Bajad *et al*., (2017) [5] provided distribution pattern of 13 scarab beetle species of subfamily Melolonthinae under five genera *viz*., *Holotrichia*, *Sophrops*, *Schizonycha*, *Leucopholis* and *Amiridiba* from Maharastra. Aparna *et al*., (2018) [3] revealed structural composition and diversity of 56 scarab species in different ecosystems of South Karnataka. Among them, 34 species belonged to phytophagous and 22 species related to non-phytophagous groups. Latha and Sabu (2018) [32] collected 34 dung beetle species related to 11 genera and 7 tribes from Nelliampathi in South Western Ghats, India.

Kharel *et al*., (2020) [30] during a survey approximately 78 scarab species were reported, and among them 22 were *Onthophagus* species. *Onthophagus* species were newly recorded from the Nadia district, of which 12 were newly recorded from West Bengal. Ghosh *et al*., (2021) [23] prepared a checklist of 52 scarab beetle species related to 22 genera, 13 tribes and 5 subfamilies of *Scarabaeidae* from Tripura, India. New records of 14 dung beetle species belonging to 5 genera were documented from Pothohar Plateau of Punjab, Pakistan by Ali *et al*., (2015) [2]. Novais et al., (2016) [38] studied 39 species of dung beetle and related among 15 genera diversity in a tropical dry forest, Brazil. Frizzas *et al*., (2020) [20] studied 8 species of scarab beetle belonging to 7 genera and four tribes of Scarabaeinae viz. Ateuchini, Dichotomiini, Eurystenini and Phanaeini in an urvan fragment of Cerrado in Central Brazil. Naveena *et al*., (2021) [35] studied the diversity of 17 species of white grubs belonging to 9 genera of Melolonthinae and Rutelinae in Dakshina Kannada district, Karnataka, India.

Material and Methods

Jhunjhunu district (Photo Plate- 1), located between latitudes 27°38' to 28°31' North and longitudes 75°02' to 76°06' East, covers a geographical area of 5,926 sq. km. The region experiences extreme temperatures, reaching up to 48°C in the summer and dropping below 0°C in the winter. The district's altitude ranges from 312 to 368 meters above sea level. Rainfall in the area varies between 350 and 500 mm, predominantly occurring during the monsoon season from July to September.

For the present study, four sampling sites were selected: agricultural lands (Site-A), plains dominated by grasses and herbs (Site-B), rocky areas (Site-C), and water body banks (Site-D). The geographic coordinates for these sites are as follows: Site-A is located at 28°19'N, 75°31'E; Site-B at 27°89'N, 75°01'E; Site-C at 28°02'N, 75°63'E; and Site-D at 27°65'N, 75°41'E. Field surveys were conducted from January 2021 to December 2022 at the chosen sites, with sampling carried out once a month during both morning and evening hours throughout the study period.

Scarab beetles were collected using sweep nets, hand picking, and light traps. After collection, the beetles were transported to the laboratory at the Department of Zoology, SRRM Govt. College, Jhunjhunu. The specimens were then pinned, stretched, and dried before being preserved in insect boxes with Paradichlorobenzene. The collected beetles were identified to the species level using a Stereo Zoom Binocular Microscope (Magnus MSZ-Bi), following taxonomic keys by Arrow (1931) [4]; Scholtz *et al*., (1999) [44]; Sewak (2015) [42]; Vaz-de-Mello *et al*., (2011) [44]; Chandra *et al*., (2020) [16]. The Scarab beetles were also photographed for future reference.

Jhunjhunu Study Area

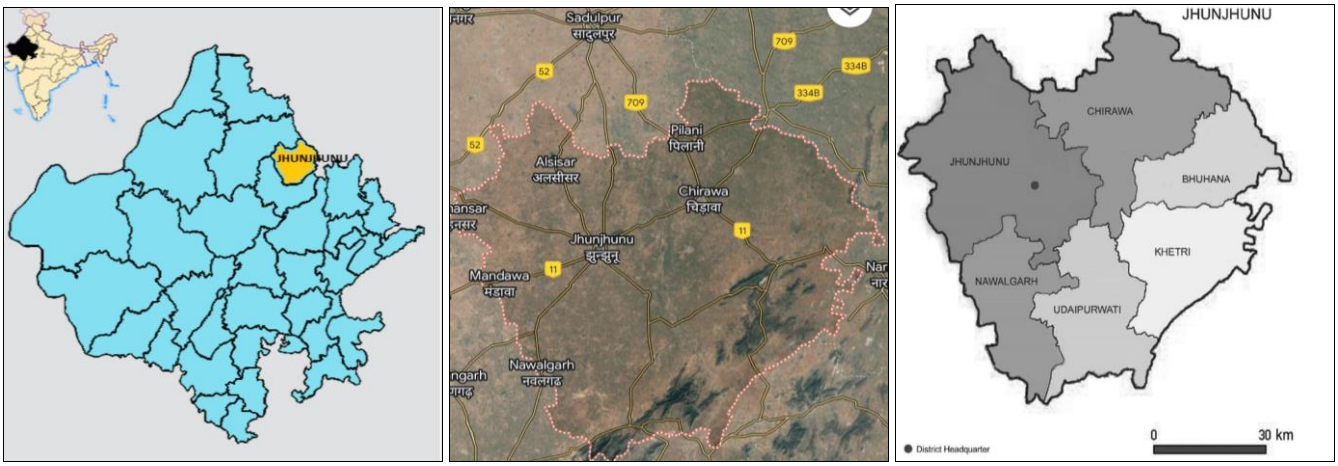

Photo Plate 1: Jhunjhunu district selected as study area

Result

A total of 46 species belonging to 30 genera under 8 subfamilies of the family *Scarabaeidae* were recorded from January 2021 to December 2022 from four study sites selected in the Jhunjhunu district. As evident from species richness and abundance of different subfamilies (Table 1&2), subfamily Scarabaeinae was comprised of the highest number of species (16 species), followed by Aphodiinae (8 species), Melolonthinae (6 species), Dynastinae and Cetoninae (5 species each), Rutelinae (4 species), Hybosorinae, and Eremazinae (1 species each) (Figure 1). As compared to the number of individuals, again Scarabaeinae was the most abundant subfamily (29.90% of the total individuals), followed by Dynastinae (18.57%), Melolonthinae (17.60%), Cetoninae (12.54%), Aphodiinae (9.56%), Rutelinae (8.34%), Hybosorinae (2.80%), Eremazinae (0.66%) (Figure 1).

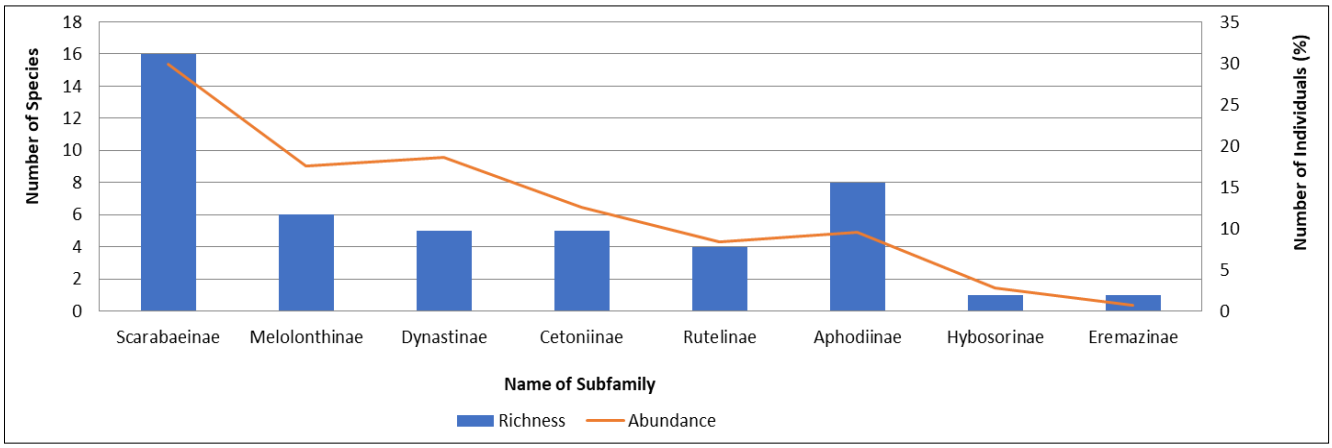

Fig 1: Species richness and abundance of *Scarabaeidae* family in the study area from January 2021 to December 2022.

During the first year of study, maximum number of species belonged to the subfamily Scarabaeinae constituting 15 species, followed by Aphodiinae (8 species), Melolonthinae (6 species), Dynastinae, and Cetoninae (5 species each), Rutelinae (4 species), Hybosorinae, and Eremazinae (1 species each) (Table 2). On the other hand, maximum number of individuals belonged to the subfamily *Scarabaeidae* which constituted 30.88% of the total individuals, followed by Melolonthinae (18.26%), Dynastinae (18.02%), Cetoninae (12.62%), Aphodiinae (9.61%), Rutelinae (6.97%), Hybosorinae (3%), and Eremazinae (0.60%). During the second year of study, maximum number of species belonged to the subfamily Scarabaeinae constituting 14 species, followed by Aphodiinae (8 species), Melolonthinae (6 species), Dynastinae, and Cetoninae (5 species each), Rutelinae (4 species), Hybosorinae, and Eremazinae (1 species each) (Table 2). On the other hand, maximum number of individuals belonged to the subfamily *Scarabaeidae* which constituted 28.28% of the total individuals, followed by Dynastinae (19.13%), Melolonthinae (16.91%), Cetoninae (12.46%), Rutelinae (9.75%), Aphodiinae (9.50%), Hybosorinae (2.59%), and Eremazinae (0.74%).

Table 1: Coleopteran insect fauna recorded from different study sites selected in the Jhunjhunu district from January 2021 to December 2022

S.No.	Family	Subfamily	*Species name*
1	*Scarabaeidae*	Scarabaeinae	*Onthophagus taurus*
2			*Onthophagus vladimiri*
3			*Onthophagus tweedensis*
4			*Onthophagus mopsus*
5			*Onthophagus* sp.
6			*Onthophagus falsus*
7			*Digitonthophagus gazella*
8			*Euonthophagus crocatus*
9			*Catharsius calaharicus*
10			*Catharsius philus*
11			*Catharsius pithecius*
12			*Catharsius molossus*
13			*Onitis alexis*
14			*Heliocopris hamadryas*
15			*Gymnopleurus miliaris*
16			*Euoniticellus intermedius*
17		Melolonthinae	*Anoxia villosa*
18			*Phyllophaga elenans*
19			*Phyllophaga vertula*
20			*Serica brunna*
21			*Maladera castanea*
22			*Diplotaxis* sp.
23			*Diplotaxis* sp.
24		Dynastinae	*Cyclocephala borealis*
25			*Cyclocephala lurida*
26			*Pentodon algerinus*
27			*Heteronychus arator*
28			*Oryctes rhinoceros*
29		Cetoniinae	*Euphoria aestuosa*
30			*Euphoria sepulcralis*
31			*Protaetia alboguttata*
32			*Protaetia aurichalcea*
33			*Gametis versicolor*

34		Rutelinae	*Adoretus sinicus*
35			*Adoretus versutus*
36			*Anoplognathus* sp.
37			*Anomala* sp.
38		Aphodiinae	*Aphodius prodromus*
39			*Aphodius* sp.
40			*Aphodius biguttatus*
41			*Aphodius pusillus*
42			*Aphodius sphacelatus*
43			*Neocalaphodius moestus*
44			*Rhyssemus germanus*
45		Hybosorinae	*Hybosorus illigeri*
46		Eremazinae	*Eremazus cribratus*

Table 2: Species richness and abundance of different subfamilies under the family *Scarabaeidae* recorded from the study area from January 2021 to December 2022

Scarabaeidae	**2021**		**2022**		**2021-22**	
	Richness	**Abundance**	**Richness**	**Abundance**	**Richness**	**Abundance**
Scarabaeinae	15	257	14	234	16	491
Melolonthinae	6	152	6	137	6	289
Dynastinae	5	150	5	155	5	305
Cetoninae	5	105	5	101	5	206
Rutelinae	4	58	4	79	4	137
Aphodiinae	8	80	8	77	8	157
Hybosorinae	1	25	1	21	1	46
Eremazinae	1	5	1	6	1	11
Total	45	832	44	810	46	1642

Discussion

In the present study, 46 species related to 30 genera under 8 subfamilies viz., Scarabaeinae, Melolonthinae, Dynastinae, Cetoniinae, Rutelinae, Aphodiinae, Hybosorinae and Eremazinae of scarab beetles were reported, constituting about 1.85% of the total known species from India (Krajcik, 2012) [31]. The results of the present study on Scarab beetles are in accordance with several studies across the globe. Jessop (1986) [27] studied the Dung Beetles and Chafers and gave a key for identification of British Insects. Chandra and Gupta (2012b) [10] reported diversity and seasonality of 52 scarab beetle species related to 24 genera under 5 subfamilies in Achanakmar-Amarkantak Biosphere Reserve, Chhattisgarh. Similarly, Chandra and Gupta (2013b) [14] described 43 scarab beetle species related to 25 genera under two families viz., Hybosoridae and *Scarabaeidae* from Barnawapara Wildlife Sanctuary, Chhattisgarh, India. However, as compared to present study, Gupta *et al*., (2014) [24] updated 61 scarab beetle species related to 30 genera under 7 subfamilies from Madhya Pradesh. Similar to the present reported species of scarab beetles, Chandra *et al*., (2015) [15] enlisted 53 scarab beetle species related to 27 genera under 6 sub families from Madhya Pradesh, India. Similarly, Pathania *et al*., (2015) [39] described diversity and seasonality and found 56 phytophagous scarab beetle species related to 20 genera under four subfamilies viz., Melolonthinae (29 species in 10 genera), Rutelinae (19 species in 5 genera), Cetoniinae (6 species in 4 genera) and Dynastinae (2 species) in different landscapes from Himachal Pradesh.

The results of the present study are quite comparable with the study by Bhawane *et al*., (2012) [7] who explored 29 scarab beetle species belonging to 21 genera under 4 subfamilies of family *Scarabaeidae* from Northern Western Ghats of Kolhapur district, Maharashtra, India. Mowlavi *et al*., (2008) [34] found a total of 15 scarab beetle fauna belonging to 9 genera from Ardabil Province, North West Iran. However, Frizzas *et al*., (2020) [20] studied 8 species of scarab beetle belonging to 7 genera and four tribes of Scarabaeinae viz., Ateuchini, Dichotomiini, Eurystenini and Phanaeini in an urvan fragment of Cerrado in Central Brazil. However, Gavrilovic and Curcic (2010**)** [21] enlisted quite a high number, 178 species of family *Scarabaeidae* related to 83 genera and 7 subfamilies from Serbia.

However, Bhawane *et al*., (2014) [6] reported 26 dung beetle species of Scarabaeinae subfamily from Sindhudurg district, Maharashtra, India. Similarly, Chandra and Gupta (2012a) [9] studied enlisted 26 species only of dung beetles related to 12 genera under 2 subfamilies viz., Scarabaeinae and Aphodiinae from Singhori Wildlife Sanctuary, Madhya Pradesh, India. In recent, these results are comparable with the studies by Karimpumkala and Priyadarsanan (2016) [29] who reported 13 dung beetle species attracted to unconventional resources from different parts of India. Ghazanfar *et al*., (2017) [22] also recorded 15 dung beetle species related to 8 genera from croplands and pastures of Jhelum, Punjab, Pakistan. However, from Nelliyampathy in South Western Ghats, India. Consonantly, Latha and Sabu (2018) [32] collected 34 dung beetle species belonging to 11 genera and 7 tribes. Similarly, Novais *et al*., (2016) [38] studied 39 species of dung beetle and related to 15 genera from a tropical dry forest, Brazil. However, Liberal *et al*., (2011) [33] recorded 13 dung beetle species from the Brazilian semi-arid ecosystem. In accordance with the present study, Shahabuddin (2010) [43] collected 24 dung beetle species related to 3 genera viz., *Onthophagus*, *Aphodius* and *Camponotus* from Indonesia.

Analogously, Chandra and Gupta (2012d) [12] reported 26 scarab beetle species related to 13 genera of 4 subfamilies viz., Rutelinae, Melolonthinae, Dynastinae, Cetoniinae from Achanakmar-Amarkantak Biosphere Reserve, Chhattisgarh. However, Chandra and Gupta (2012c) [11] documented only 5 species of scarab beetle belonging to two genera viz., *Bolbohamatum* and *Bolbogonium* from Central India

(Madhya Pradesh and Chhattisgarh). Diversity of 24 coleopteran species related to three families viz., *Scarabaeidae*, *Geotrupidae* and *Hybosoridae* were also reported from Maharashtra (Jagdale and Magdum, 2017) [25]. At par to the present study, Bhattacharyya *et al*., (2017) [8] reported 44 scarab beetle species belonging to 21 genera under 6 subfamilies viz., Melolonthinae, Rutelinae, Dynastinae, Cetoniinae, Scarabaeinae and Geotrupidae from Assam. Similarly, Aparna *et al*., (2018) [3] revealed structural composition and diversity of 56 scarab species from different ecosystems of South Karnataka. Among them, 34 species belonged to phytophagous and 22 species were related to non-phytophagous groups. Recently, Frizzas *et al*., (2020) [20] enlisted 8 scarab beetle species related to 7 genera and four tribes of Scarabaeinae viz., Ateuchini, Dichotomiini, Eurystenini and Phanaeini from an urvan fragment of Cerrado in Central Brazil. Similarly, Naveena *et al*., (2021) [35] documented diversity of 17 species of white grubs belonging to 9 genera of Melolonthinae and Rutelinae from Dakshina Kannada district, Karnataka, India.

Conclusion

The *Scarabaeidae* family, comprising a wide variety of dung beetles, flower chafers, and scarabs, exhibited notable diversity and abundance across the varied landscapes of Jhunjhunu district of Rajasthan. Studies indicated that the distribution and abundance of *Scarabaeidae* were closely linked to factors such as soil type, vegetation cover, and availability of organic matter, especially dung, which many species depended on for reproduction and sustenance. Despite the harsh climatic conditions of the Thar Desert and surrounding areas, certain scarab beetles evolved remarkable adaptations that enabled them to thrive. Continued research and conservation efforts were considered essential to better understand their ecological roles, especially in nutrient recycling and soil aeration, and to ensure the preservation of the scarab beetles in study area.

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