DIVERSITY, COMPOSITION AND DISTRIBUTION OF DUNG BEETLE FAUNA IN CROPLANDS AND PASTURES OF JHELUM, PUNJAB, PAKISTAN

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ABSTRACT: Dung beetles as key biological indicators of habitat disturbance need to be explored from different locale with different topographical and vegetation characteristics. Species composition and abundance of dung beetle fauna in subtropical climatic conditions of cropland and pastures was explored during 2015-2016 from Jhelum, Punjab, Pakistan. The sampling was conducted fortnightly by hand picking and homogenized method from nine randomly selected sites within croplands and pastures. A total of 551 specimens were recorded which belonged to 15 species, 8 genera and 6 tribes. The data indicated that species belonging to two genera, *Onthophagus* and *Onitis* were more common (41.66 and 28.57 %) in pastures and croplands (35.71 and 27.78 %), respectively. Among the reported species, *Onitis excavatus* and *Onthophagus gazella* have shown greater abundance both in pastures (28.57 and 19.84 %) and croplands (27.78 and 15.87 %), respectively. The results indicated that both species richness and abundance was greater in the pastures (H′= 5.04) than croplands (H′= 4.44). The data depicted that relatively higher proportion (54.26 %) of the specimens were collected from pastures belonging to 15 species whereas lower proportion (45.74 %) of the specimens belonging to 12 species were recorded from croplands. The study indicated that pastures in the study area presented greater diversity and richness of species as compared to croplands.

Key words: *Onitis*, *Onthophagus*, Abundance and Richness.

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INTRODUCTION

The dung beetles taxonomic accounts, diversity and distribution have been studied for their significance in biodiversity conservation and environmental protection assessment. Scarabaeidae (Dung beetles) is an extensively studied group of insects having 7000 worldwide known species (Noureen *et al*., 2015a; Vaz-de-Mello, 2000). Phytophagus and coprophagus species of Scarabaeoidea contribute in burying and burrowing of dung in the soil thus performing important role of nutrient recycling, soil aeration, ameliorating soil properties and regulation of enteric parasites and dipteran pests breeding in the dung pats (Nasir *et al.*, 2016; Chandra and Gupta, 2013).

Gilbert Arrow's description of diversity and distribution regarding scarab beetle fauna of Pakistan and its cataloguing in the 2nd quarter of the 20th century have been reattempted and reconfirmed in the 1st two decades of 21st century (Abbas *et al.*, 2015; Ali *et al.*, 2015; Noureen *et al.*, 2015b; Ahmed and Ratcliffe, 2015; Siddiqui *et al.*, 2014). Much of the available resources of dung beetle fauna belong to the contributions made by Gilbert Arrow who explored the fauna of Scarabaeidae family published in three volumes but it is now old and outdated (Arrow, 1931). In the recent years, presence of several species of subfamily Scarabaeinae, previously unknown has been documented from various parts of the country (Noureen *et al*., 2015a; Abbas *et al*., 2015; Siddiqui *et al*., 2014). In the recent years, studies have been conducted to explore the dung beetle fauna from different parts of Pakistan (Ali *et al*., 2015; Siddiqui and Kamaluddin, 2011). Tillage practices, farm inputs, low mammalian diversity, availability of dung, fragmentations of land and texture of the soil are some of the key elements that determine comparative abundance of tunnelers and rollers (Noureen *et al*., 2015a). Distribution and diversity of dung beetle fauna depend greatly on the availability of cattle dung and the movement of cattle effectually redeploys nutrients (Nichols *et al*., 2008). Thus, the distribution, diversity and dynamics of dung beetles greatly depend on climatic conditions and edaphic factors in addition to dung associated with the dung beetle species (Nasir *et al.*, 2016). Intensive agriculture has resulted in the use of farm inputs like pesticides, herbicides and fertilizers which affect non target species ultimately disturbing ecosystem stability. The study was carried out to assess the dung beetle diversity and composition associated with croplands and pastures in Jhelum, Punjab, Pakistan.

MATERIALS AND METHODS

The research work was designed to explore the diversity and composition of dung beetles in selected habitats. Study area was located at the northern boundary of Punjab, Pakistan between latitude (32.9335 ^{o}N) and longitude (73.7207 ^{o}E) with humid subtropical climate. Sampling sites were selected from croplands and pastures within the study area based on availability of dung and proximity of both type of habitats. There were nine sampling places represented by both croplands and pastures as shown in Fig-1. The sampling was carried out from each selected site fortnightly from March 2015-February, 2016. Specimens were randomly collected from each study site by hand picking and homogenized method. In hand picking method, the dung pats were located in the pastures as well as croplands. The pats were overturned with a Hoe (Khurpa) and searched for the presence of dung beetles. Collected specimens were transferred in jars of two liter volume containing fresh dung placed soil layer and marked with the type of specimens to be placed and other information of the collection. In case of homogenize method, 2-4 days old dung pats were placed in the bucket containing water and stirred with the stick to make homogenize mixture. All the dung beetles floated on the surface of homogenize mixture were collected and placed in the respective collection jars.

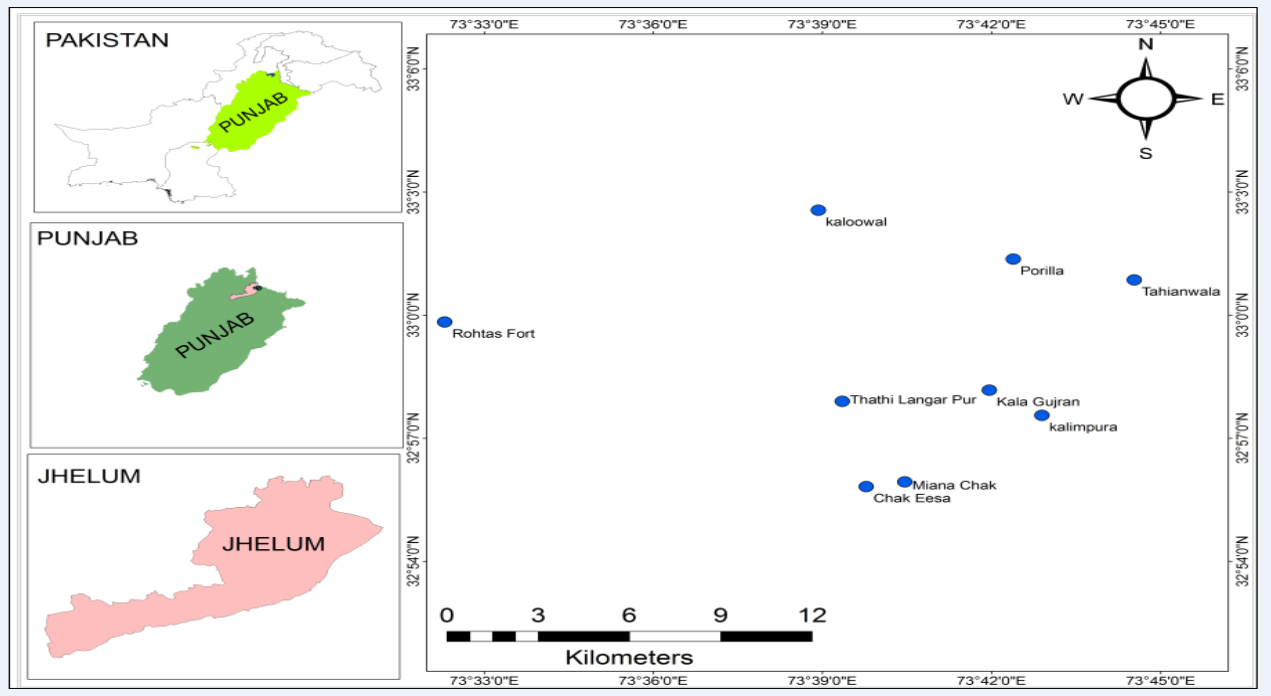

Figure 1: Map showing sampling sites in the study area Jhelum, Punjab, Pakistan during 2015-2016 Killing and preservation of specimens

Specimens collected were brought in the systematics and pest management laboratory, Department of Zoology, University of Gujrat. The specimens were killed using cyanide killing bottles. Specimens were preserved in insect collection boxes after identification with help of internet sources, recent works published and using identification keys (Nasir *et al.*, 2016; Noureen *et al.*, 2015a; Balthasar, 1963: Arrow, 1931).

Statistical analysis: Alpha diversity of recorded species was determined in each site (cropland and pasture). Data on the diversity and abundance of species was subjected to statistical analysis and indices were obtained (Magurran**,** 2004). Simpson's diversity index and Shannon-Wiener diversity indices were also obtained to explain the data.

RESULTS

Data on diversity of dung beetles in district Jhelum was analyzed by diversity indices and descriptive statistics. Data showed a total number of 551 specimens were recorded during the study period comprising of March 2015 to February, 2016 representing 15 species belonging to 6 tribes and 8 genera. Twelve (12) species belonging to the sub-family *Scarabaeinae* and three (3)

species from sub- family *Aphodiinae* were recorded from the study area.

Composition of species: Data on the abundance of species indicated higher abundance in pastures (54.26 %) with 15 species whereas croplands showed lower abundance (45.08 %) with 13 species (Table 1). Data indicated that maximum abundance belonged to only three species including common, less common and least common. Maximum number of species belonged to Scarabaeinae representing the seven (7) genera; *Onthophagus* (3 species), *Catharsius* (2 species), *Oniticellus* (1 species), *Helicopris* (2 species), *Onitis* (2 species), *Gymnopleurus* (1 species), *Chironitis* (1 species) and three (3) species belonged to family *Aphodinae*, named as *A. granarius, A. moestus and A. rufipes* (Table 1). Data collected from different sites representing pasture revealed presence of 15 species with higher abundance of *O. excavatus* (72) followed by *O. remosellus* (53) and *O. gazella* (50). Data collected from sites within croplands 13 species were captured showing and abundance of *O. excavatus* (75), *O. gazella* (48) and *O. brevidens* (40). Data depicted higher numbers of beetle assemblages in pastures as compared to croplands (Table 2).

Functional guilds: According to the nesting behavior, dung beetles are divided in to three major groups; Tunnelers, Dwellers and Rollers. Tunnelers were the most dominant group represented by six genera followed by Dwellers represented by *Aphodius* and Rollers represented by genus *Gymnopleurini* (Figure 2).

Species abundance and evenness: Species richness was expressed in terms of Shannon -Wiener diversity index for the pastures and cropland where different species were captured. The dung beetle species were collected form pasture areas characterized by the presence of cattle. Diversity and evenness values for pasture was (H = 5.04789; E = 0.02121), Croplands (H = 4.4411847, E = 0.0186604) indices show that pasture area is more diverse than the croplands and species were evenly distributed. Simpson's index values for *O. excavatus*, *O. brevidens* and *O. gazella* was (0.125), (0.075) and (0.82), respectively.

Table 1: Systematics of dung beetles recorded from the study area from Jhelum, Punjab, Pakistan during 2015-2016.

Family	Sub-family	Tribe	Genus	Species
Scarabaeidae	*Aphodiinae*	Aphodiini	*Aphodius*	*Aphodius granarius*
				Aphodius moestus
				Aphodius rufipes
	Scarabaeinae	Gymnopleurini	*Gymnopleurini*	*Gymnopleurus bicallosus*
		Coprini	*Heliocopris*	*Heliocopris Bucephalus*
				Heliocopris antenor
			Catharsius	*Catharsius sagax*
				Catharsius platypus
			Chironitis	*Chironitis hungaricus*
		Onitini	*Onitis*	*Onitis excavatus*
				Onitis brevidens
		Onthophagini	*Onthophagus*	*Onthophagus gazella*
				Onthophagus mopsus
				Onthophagus Taurus
		Oniticellini	*Oniticellus*	*Oniticellus pallipes*

Table 2: Relative abundance of species recorded from pasture and cropland from Jhelum, Punjab, Pakistan during 2015-2016.

	Pastures		Croplands	
Name of species	**Abundance (No.)**	**Composition (%)**	**Abundance (No.)**	**Composition (%)**
Aphodius granaries	20	07.94	17	06.75
Aphodius moestus	27	10.71	25	09.92
Aphodius rufipes	08	03.17	10	03.97
Catharsius pitherius	01	00.40	00	00.00
Catharsius platypus	01	00.40	00	00.00
Chironitis hungarius	35	13.89	15	05.95
Gymnopleurus biltallosus	12	04.76	8.0	03.17

Helicepus bucephalus	01	00.40	1.0	00.40
Helicopris antenor	01	00.40	00	00.00
Oniticellus cinctus	04	01.59	3.0	01.19
Oniticellus pallipes	12	04.76	13	05.16
Onitis excevatus	72	28.57	70	27.78
Onthophagus gazella	50	19.84	40	15.87
Onthophagus mopsus	02	00.79	2.0	00.79
Onthophagus remosellus	53	21.03	48	19.05
Total	**299**	**54.26**	**252**	**45.74**

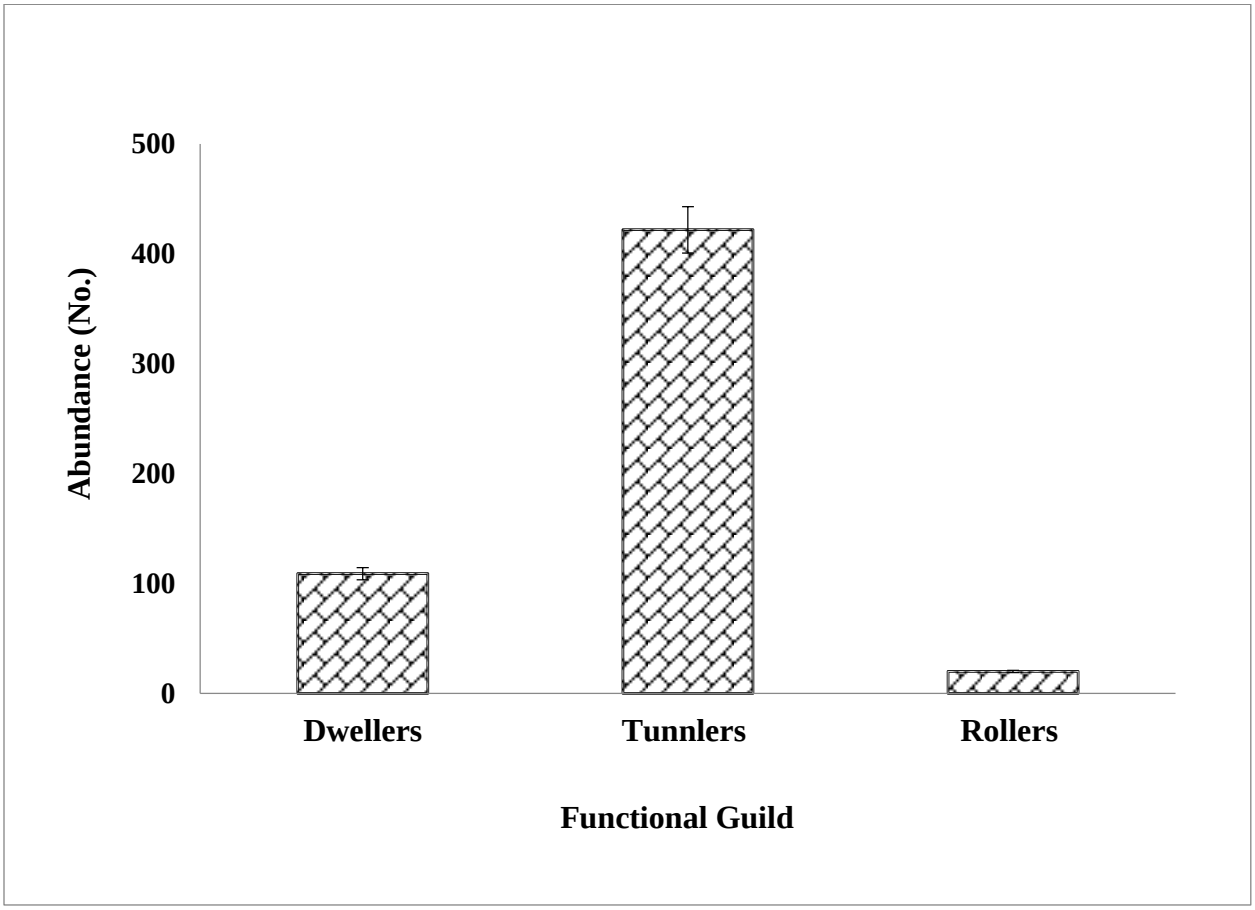

Figure 2: Number of specimens collected during the study pertaining to different functional guilds from Jhelum, Punjab, Pakistan during 2015-2016.

DISCUSSION

Similar patterns of species distribution in pastures were recorded in a study carried out in Barnawapara wildlife sanctuary (Chandra and Gupta, 2013). Variations in abundance of dung beetle species in croplands and pastures may be attributed to availability of dung pats, farming practices and soil conditions (Imura *et al*., 2014). Habitat modification due to agricultural practices may have resulted in reduced diversity in the croplands (Basto-Estrella *et al*., 2014).

Data depicted that dung beetles assemblages in two different habitats showed variations in abundance and richness patterns in pastures as compared to the croplands. Simpson Index value for richness was (0.034 that is close to zero) that elaborated that the more species present in the community thus greater the richness of the community in studied area. Simpson index value for evenness was calculated as 0.966 that represented the greater relative abundance in the community.

This type of dominance of tunnelers has also been reported from various studies in different regions of the world (Vinod and Sabu, 2007; Sabu *et al*., 2006; Andresen and Feer, 2005). The lower abundance of rollers and dwellers in the study area may be explained by examining the dominance of tunnelers exploiting fresh

dung disposing off in tunnels for their breeding activity (Sabu *et al*., 2006).

Abundance of *O. excavatus* and *O. gazella* in fresh dung pats may be attributed to their ability to locate fresh dung as compared to other species recorded from other guilds. Large portion of Tunnelers in the composition of dung beetle assemblages in the study area may be attributed to their ability to avoid the temporal overlap and competition between the members of the guild (Sabu *et al*., 2006). The species belonging to this category may show different behavior towards the exploitation of dung pats under given circumstances related to dung age thus providing opportunities for each other to harvest the food source efficiently (Sabu *et al*., 2006).

These result indicated that *O. excavatus* and *O. gazella* have high abundance in cropland as well as in pasture. Open fields in croplands may increase the rate of dung pats desiccation lowering the potential of telecoprids and endocoprids to exploit the resources (Sabu *et al*., 2006).

The value of the Shannon-Wiener Index was higher in the pasture (H'= 5.04) as compared to the cropland (H'= 4.44) that showed that the species diversity of dung beetles in the pastures was significantly higher than that in the cropland ($P < 0.05$). The study was designed to explore the diversity of dung beetles in pasture and cropland areas. Diversity indices including Shannon-Wiener Index and Simpson's Index revealed that the species richness was not significantly different in each habitat but data indicated variation in abundance of different habitats. Maximum species diversity was observed in pastures. Similar observations were reported; in most of the studies, with maximum numbers of species recorded from natural ecosystems supported by grazing animals providing sufficient dung pats (Horgan, 2005; Noureen *et al.,* 2015a).

The variations in the composition of dung beetles representing different functional guilds may attributed to their size as beetles having comparatively large size generally need greater food resources and have low reproductive rate (Thomas *et al*., 2016). The study provides an evidence for variations in dung beetle assemblages in croplands and pastures located adjacent to each other under prevailing conditions of temperature, humidity and topography.

Conclusion: The study revealed that dung beetle fauna was well distributed in the study area comprised of pastures and croplands with variations in species composition, abundance and diversity. Dung beetles showed higher diversity in pastures than in croplands with most common species belonged to two genera i.e. *Onitis* and *Onthophagus.*

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