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ECOLOGY DIVERSITY AND CONSERVATION STATUS OF DUNG BEETLES (SCARAABAEIDAE) OF CHHATTISGARH , INDIA

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ABSTRACT

Dung beetles are a universally distributed insect group, which is highly diversified in tropical forests and savannas and area member of the family Scarabaeidae of insect's largest order Coleoptera. Adults feed on the soup of the dung. The beetles mostly feed on the micro-organism - rich liquid component of mammalian dung and use the more fibrous material to brood their grubs. Dung beetles are increasingly used as a study taxonboth as bio-indicators of environmental change. For breeding, the adult female beetles roll a perfectly round ball of dung and take it to a special nesting place underground and lay their eggs on it so that the larvae can feed on the dung. The objective of the present survey is focused on the assessment of the diversity and abundance of dung beetles and conservation priorities in the study area. The study on diversity of dung beetles species of Chhattisgarh state were conducted for one year (Augest 2020 to July 2021). Total of 47 dung beetles species under the family Scarabaeidae, belonging to 18 genera, 10 tribes and 3 subfamilies were found.This field work represent 20 species that are widely spread, out of those twelve species are common, seven species found in Occasional and eight species are Rare . These beetle species are an important part of food chain and are good bio-indicators for evaluation of habitat change and variations in landscape structures. The Chhattisgarh state is in between 80° 15' to 84° 24' E and 17° 46' to 24° 5 N. It is covered by dense forest and hills. The dung beetles deliver important ecosystem services such as nutrient cycling, waste removal, seed dispersal, and by removing dung from the surface, the flies and parasites that breed in dung are not prominent. Burrowing, aerating and mixing the soil increases its nutrient content as well as improves the water holding capacity of the soil. Hence, dung beetles have been widely used as bio-indicators of environmental quality.

(Key words: Dung beetle, ecology, conservation, Chhattisgarh)

INTRODUCTION

Dung beetles are feed on feces. Dung beetles live in many habitats, including deserts, grasslands and savannas, farmlands, and native and planted forests. They are highly influenced by the environmental context, and do not prefer extremely cold or dry weather. Dung beetles use the dung of warm-blooded herbivores for everything. They are attracted to fresh dung via volatiles (meaning, the smell). Adults feed on the soup of the dung ((Michela, 2016).The incisor lobe of the mandibles of the adult is flattened and fringed for handling soft food, and the particulate components of the food are filtered out before being ingested. For breeding, the beetles roll a perfectly round ball of dung and take it in a special nesting place underground and lay their eggs on it so that the larvae can feed on the dung (Ueda, 2015).The dung of an herbivore can differ in terms of size and moisture consistency, depending on the plant species consumed, rainfall, etc. Dung beetles are a globally distributed insect group, with their high diversity in tropical forests and savannas and are member of family Scarabaeidae of insect's the largest order Coleoptera. The beetles mostly feed on the micro-organism rich liquid component of mammalian dung and use the more fibrous material to brood their larvae (Yadav and Painkra, 2021). Dung beetles, in the insect families Scarabaeidae and Geotrupidae, are an important group of insects associated with the decomposition of animal manure around the world. 47 dung beetle species, belonging to 18 genera and three subfamilies of the family Scarabaeidae were recorded from the Chhattisgarh state through this 1 year field study .

This research will help to produce a Checklist of subfamily Scarabaeinae of Chhattisgarh , India.This research will rove data and inventory of the species from Chhattisgarh. Present study help to provide us the taxonomic studies on Coleoptera: Scarabaeidae. It will facilitate the identification of dung beetle diversity and distribution of Chhattisgarh also.

Study area

Chhattisgarh is the tenth largest state of India, constituted on 1st November, 2000 and occupying a total

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area of 135,000 sq. km. with its capital at Raipur.Geographical location of Chhattisgarh state is between 80° 15' to 84° 24' E and 17° 46' to 24° 5 N. It is covered by dense forest and hills. The total forest area of the state is 59,772 sq. km. (44 %). The climate of Chhattisgarh state is mainly tropical, humid and sub-humid. Chhattisgarh can be divided into three distinct regions Northern region, the Central plains region and Southern region. There are 3 national parks, 11 wildlife sanctuaries and one biosphere reserve covering about an area of 6615 sq. km. Being 3rd largest forest cover in India, the state covers about of 13% forests with its area of about 59772 sq. km. Scarabaeidae is one of the largest orders of class Insectaor Hexapoda and they are cosmopolitan in distribution. Chhattisgarh is a heavily forested state in central India known for its temples and waterfalls. A perusal of literature on the diversity of dung beetles of Central India (Madhya Pradesh and Chhattisgarh) revealed that there are very few reports on the taxonomic studies and distribution of dung beetles in the state, of Chhattisgarh. Keeping in view, the present work was aimed to prepare the identification keys and reports on the distribution and diversity of these beetles from the state.

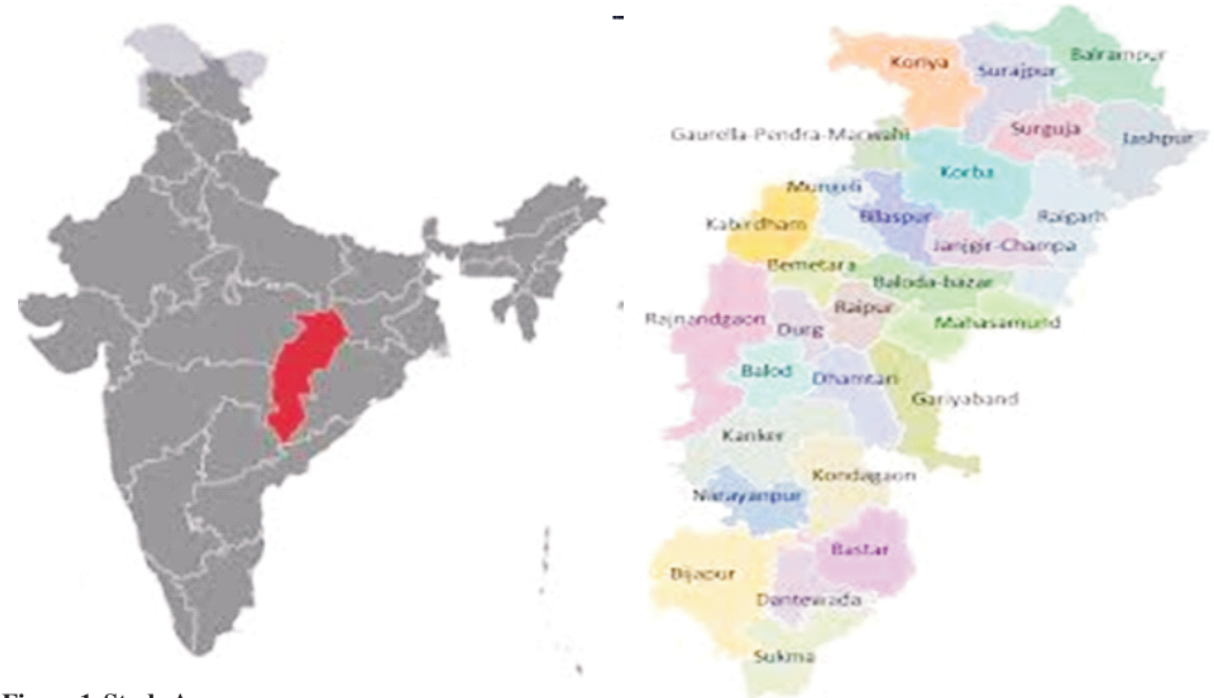

Figure 1. Study Area

MATERIALS AND METHODS

Point and Shoot Digital Cameras by Nikon

It was used for study. It expand the boundaries of everyday photography with the 16-megapixel COOLPIX B500, fitted with a high performance 40x optical zoom and 80x Dynamic Fine Zoom. A point-and-shoot camera, also known as compact camera, is a Still Camera designed primarily for simple operation.

GPS Navigation Machine

GPS Navigation Machine Garmin eTrex20x with 240 x 320 display pixels used for study.A GPS navigation device, GPS receiver, or simply GPS is a device that is capable of receiving information from GPS satellites and then to calculate the device's geographical position. Using suitable software, the device may display the position on a map, and it may offer directions.. A GPS device can retrieve from the GPS system location and time information in all weather conditions, anywhere on or near the Earth.

Field based methodology

The dung beetles were observed and recorded directly in the field. A combination of direct search technique and opportunistic sighting methods were applied for the present study which were conducted for one year (August 2020 to July 2021) to record dung beetles diversity and abundance. Observations were made at a frequency of twice a month for each study area ofdifferent habitat types. Direct sampling method is inducted for the dung beetles abundance study. The Observations were made between 06.30 hr and 16.30 hr during periods of good weather (no heavy rain or strong winds). This timing was found ideal based on preliminary observations done during different times of the day in the study sites. Dung beetles were photographed using digital camera 16-megapixel COOLPIX B500, fitted with a high performance 40x optical zoom and 80x Dynamic Fine Zoom and identified using suitable keys. Appropriate precautions were taken to ensure that the size, shape and colour, present on the wings. Photographs were preserved for taxonomic documentation. During each sampling, efforts were made to list the encounter frequencies of different dung beetles species from different sampling sites.

Figure 2.Collection of dung beetle by hand picking technique

Laboratory based methodology

Collected the dead specimens and photographs which were taken into the laboratory of Zoological Survey of India, Kolkata. Then the collected specimens, and photograps were examined very carefully. The study were based on the inherent peculiarities, both external, internal character. Through the microscopic and visualized observation, I observed the morphological variation among the individuals. The similarities and dissimilarities also observed among the specimen. These similarities and dissimilarities helps to do the taxonomic studies, properly. .The shape , size length were also measured. The presence and richness of the beetles, indicate the ecological condition of the study sites. Beside this I have also examined how the density of dung beetles co-related with environmental condition, if any kind of morphological abnormalities found that also docketed. Different types of abnormalities in antennae, abdomen and appendages were also examined and docketed properly. Several types of anatomical abnormalities also docketed which provided a solid data. The coloration and stain along with body painting also noticed. Any kind of morphological variation found among the specimen that indicate the geographical distribution of the dung beetles. Special types of coloration, painting, and abnormalities indicated the variation among the individuals according to the environmental changes.

RESULTS AND DISCUSSION

Studies on the diversity of dung beetles species in Chhattisgarh state were conducted for one year (August 2020 to September 2021).Forty seven dung beetles species, belonging to eighteen genera and three subfamilies of the family Scarabaeidae were found . This field work represent twenty species were vide spread, twelves species were common, seven species found in occasional and 8 species were rare . The field study showed most of the dung beetles active throughout the year but in the Monsoon and the Post Monsoon season, few members were more active monsoon represent 20 number of species, post monsoon 14 species and 18 species observed in summer and 16 species in winter. The observed dung beetles were categorized under four groups on the basis of their abundance in the study area as **W - Wide spread** (75-100 sightings), **C - Common** (50-75 sightings), **O - Occasional** (25-50 sightings), **R - Rare** (1-25 sightings),) and depicted as conservation status (Table 1). One complete year was divided into four seasons , (1) summer (March to May), (2) monsoon (June to August), (3) post-monsoon (September to November), and (4) winter (December to February). Data of same season for the two successive years were accumulated for season wise analysis of the data. The data analysis was carried out using Microsoft Office Excel, 2010.

Gibrán Sánchez-Hernández *et al.* (2020) testified that biodiversity monitoring in natural protected areas represents an integral component to assess its performance and provide the information necessary for effective management . In this sense, The dung beetles of the subfamily Scarabaeinae (Coleoptera: Scarabaeidae) are a group of insects with a wide global distribution, finding representatives on all con- tinents (except Antarctica), but whose diversity is mainly concentrated in the tropi- cal and subtropical regions . The ecological functions in which these beetles are involved provide valuable ecosystem services, such as secondary seed dispersal, nutrient cycle and biological control of pests, among others. According to Yadav and Painkra (2021) different authors have indicated that these arthropods are organisms sensitive to structural changes in habitats caused by disturbances, exhibiting drastic permutations in their development and distribution in the modi- fied landscapes . Due to the great variety of ecological functions in which they intervene , their ability to respond in the short term to forest fragmentation, its developed correlation and direct dependence on the presence of mammals in the forest. According to Pokhrel *et al.* (2020) dung beetle introduction programmes were designed to accelerate exotic livestock dung degradation and to control dung breeding pestiferous ûies and livestock parasites. The introduction programmes provided exotic dung beetle species with an opportunity to cross natural barriers and spread beyond their native range. There are no reports that explain what probable adaptation mechanisms enable particular dung beetle species to be the most successful invader. Here we identify the morphological, biological, physiological, ecological and behavioural attributes of the four most widespread and successful dung beetle species in introduced areas on a global scale in relation to the assumption that these species are different from other exotic and native dung beetles.Raine and Slade (2019) reported that dung beetles are increasingly used as a study taxon—both as bioindicators of environmental change, and as a model system for exploring ecosystem functioning. The advantages of this focal taxon approach are many; dung beetles are abundant in a wide range of terrestrial

ecosystems, speciose, straightforward to sample, respond to environmental gradients and can be easily manipulated to explore species-functioning relationships. However, there remain large gaps in our understanding of the relationship between dung beetles and the mammals they rely on for dung. Here we review the literature, showing that despite an increase in the study of dung beetles linked to ecosystem functioning and to habitat and land use change, there has been little research into their associations with mammals. Jugovic *et al.*(2018) said that the role of semi–natural grasslands and livestock in sustaining dung beetle communities (Coleoptera, Scara- baeoidea) in sub–Mediterranean areas of Slovenia. Through these roles, they help establish and sustain other ground living invertebrate communities. Coprophagous Scarabaeoidea may be used as bio- indicators . According to Michela Costa Batista *et al*. (2016) dung beetles have been widely used as bioindicators of environmental quality. Here, we assessed the influence of land use and seasonality on patterns of species richness and abundance of dung beetles in northeastern Brazil. Dung beetles were sampled in five different land uses (cassava, eucalyptus, alley cropping, young fallows and old fallows) in the dry and rainy seasons, using pitfall traps baited with fresh cow manure. Seasonality strongly influenced the dung beetle assemblage with a higher number of species and individuals being collected during the rainy season. Species richness was influenced by land use only in the rainy period. Additionally, except for eucalyptus, all land uses supported high dung beetle diversity during the rainy season. The comprehension that natural areas alone are not enough to sustain biodiversity has led to an increasing focus on agricultural areas to species conservation. "According to Chandra and Gupta (2013) dung beetles are a globally distributed insect group, with their high diversity in tropical forests and savannas and are member of family Scarabaeidae of insect's largest order Coleoptera. The beetles mostly feed on the micro-organism rich liquid component of mammalian dung and use the more fibrous material to brood their larvae . Based on their nesting strategies dung beetles are broadly classified into three functional groups *viz.,* rollers (telocoprid), tunnelers (paracoprid) and dwellers (endocoprid). Rollers form balls from a dung pat, which are rolled away and buried in the ground for feeding and breeding while tunnelers make underground vertical chambers in close proximity to the dung pat and construct their nest using the dung from pat whereas dwellers breed in dung pats .Pedro Giovâni da Silva*et al.* (2011) testified that dung beetles (Coleoptera: Scarabaeidae: Scarabaeinae) of two non- native habitats in Bagé, Rio Grande do Sul, Brazil. Beetles were collected with the use of pitfall traps with various kinds of bait and without bait, from Sept. to Dec. 2006. In total, 264 beetles belonging to 5 tribes, 7 genera, and 13 species were captured. Onthophagus aff. *Hirculus mannerheim,Canthon lividus* Blanchard, *C. bispinus* (Germar), and *C. podagricus* Harold were the most abundant species. These habitats seem to have influenced the Scarabaeinae fauna, giving support only to common species native to the region with generalist eating habits. Most of the captured species were represented by rollers.Federico Escobar (2004) reported that in a montane region of Colombia, the diversity and composition of the dung beetle (Scarabaeinae) assemblages were sampled and analyzed in natural and anthropogenic habitats: primary forest, secondary forest, pasture and crop land. The total number of species per habitat was similar (between 10 species in cropland and 13 in secondary forest). According to Kaushik and Nirmalkar (2020) inventory completeness was over 90%, except for cropland where over 82% of the true species richness was recorded. Greater numbers of species and individuals were found in primary forest than in secondary forest and pasture five per cent of all individuals were captured in cropland, where the number of species was similar to that recorded for secondary forest.These are the graphical representation of the Abundance, Species diversity, and seasonal variation.

Checklist of dung beetle species

Sr. No.	Dung beetles species	Genera	Tribe	Subfamilies	Conservation Status	Seasonal Variation
1.	*Orphnus impressus*	Orphnus	Orphnini	Orphninae	W	S,M.PM,W
2.	*Orphnus parvus*	Orphnus	Orphnini	Orphninae	W	S ,W
3.	*Aphodius moestus*	Aphodius	Aphodiini	Aphodiinae	W	S,M.PM,W
4.	*Aphodius crenatus*	Aphodius	Aphodiini	Aphodiinae		S,M.PM,W
5.	*Rhyssemus germanus*	Rhyssemus	Psammodiini	Aphodiinae	W	S,M.PM,W
6.	*Scarabaeus* (*Kheper*) *sanctus*	Scarabaeus	Scarabaeini	Scarabaeinae	R	S,M.PM,W
7.	*Sisyphus* (*Sisyphus*) *longipes*	Sisyphus	Sisyphini	Scarabaeinae	R	S,M.
8.	*Sisyphus* (*Sisyphus*) *neglectus*	Sisyphus	Sisyphini	Scarabaeinae	C	M.PM,
9.	*Gymnopleurus* (*Metagymno pleurus*) *gemmatus*	Gymnopleurus	Gymnopleurini	Scarabaeinae	O	S,M.PM,

10.	*Gymnopleurus* (*Gymnopleurus*) *cyaneus*	Gymnopleurus	Gymnopleurini	Scarabaeinae	C	S,M.PM,W
11.	*Gymnopleurus* (*Metagymnopleurus*) *miliaris*	Gymnopleurus	Gymnopleurini	Scarabaeinae	O	W
12.	*Paragymnopleurus sinuatus*	Paragymnopleurus	Gymnopleurini	Scarabaeinae	R	S,M.PM,W
13.	*Garreta mundus*	Garreta	Gymnopleurini	Scarabaeinae	O	S,M.PM,W
14.	*Garretadejeani*	Garreta	Gymnopleurini	Scarabaeinae	W	S,M.PM,W
15.	*Heliocopris bucephalus*	Heliocopris	Coprini	Scarabaeinae	C	S,M.PM,W
16.	*Catharsius* (*Catharsius*) *pithecius*	Catharsius	Coprini	Scarabaeinae	W	W
17.	*Catharsius* (*Catharsius*) *molossus*	Catharsius	Coprini	Scarabaeinae	C	S,M.PM,W
18.	*Catharsius* (*Catharsius*) *sagax*	Catharsius	Coprini	Scarabaeinae	R	S,M.
19.	*Copris* (*Copris*) *carinicus*	Copris	Coprini	Scarabaeinae	O	M.PM,
20.	*Copris* (*Copris*) *repertus*	Copris	Coprini	Scarabaeinae	R	S,M.PM,W
21.	*Copris* (*Paracopris*) *imitans*	Copris	Coprini	Scarabaeinae	R	S,M.
22.	*Copris*(*Paracopris*) *surdus*	Copris	Coprini	Scarabaeinae	W	S,M.
23.	*Caccobius* (*Caccophilus*) *unicornis*	Caccobius	Onthophagini	Scarabaeinae	W	S,M.PM,W
24.	*Phalopsdivisus*	Phalops	Onthophagini	Scarabaeinae	W	PM.W
25.	*Onthophagus* (*Onthophagus*) *spinifex*	Onthophagus	Onthophagini	Scarabaeinae		S,M.PM,W
26.	*Onthophagus* (*Onthophagus*) *griseosetosus*	Onthophagus	Onthophagini	Scarabaeinae	W	S,M.PM
27.	*Onthophagus* (*Onthophagus*) *igneus*	Onthophagus	Onthophagini	Scarabaeinae	O	M.PM
28.	*Onthophagus* (*Proagoderus*) *pactolus*	Onthophagus	Onthophagini	Scarabaeinae	W	M.PM,
29.	*Onthophagus* (*Onthophagus*) *ramosellus*	Onthophagus	Onthophagini	Scarabaeinae	W	S,M.PM,W
30.	*Onthophagus* (*Digitonthophagus*) *bonasus*	Onthophagus	Onthophagini	Scarabaeinae	C	S,M.PM
31.	*Onthophagus* (*Digitonthophagus*) *gazelle*	Onthophagus	Onthophagini	Scarabaeinae	R	S,M.PM
32.	*Onthophagus* (*Onthophagus*) *ramosus*	Onthophagus	Onthophagini	Scarabaeinae	W	PM,W

33. *Onthophagus (Onthophagus) abreui*	Onthophagus	Onthophagini	Scarabaeinae	R	M.PM
34. *Onthophagus (Serrophorus) sagittarius*	Onthophagus	Onthophagini	Scarabaeinae	W	S,M.PM,W
35. *Onthophagus (Onthophagus) dama*	Onthophagus	Onthophagini	Scarabaeinae	W	PM,W
36. *Onthophagus (Onthophagus) quadridentatus*	Onthophagus	Onthophagini	Scarabaeinae	W	S,M.PM,W
37. *Onthophagus (Colobonthophagus) hindu*	Onthophagus	Onthophagini	Scarabaeinae	R	M.PM,
38. *Onthophagus (Onthophagus) armatus*	Onthophagus	Onthophagini	Scarabaeinae	R	S,M.PM,W
39. *Onthophagus (Onthophagus) agnus*	Onthophagus	Onthophagini	Scarabaeinae	C	S,M.PM,W
40. *Onthophagus (Onthophagus) unifasciatus*	Onthophagus	Onthophagini	Scarabaeinae	C	W
41. *Onthophagus (Onthophagus) cervus*	Onthophagus	Onthophagini	Scarabaeinae	R	S,M.PM,W
42. *Onthophagus (Onthophagus) ludio*	Onthophagus	Onthophagini	Scarabaeinae	O	S,M.PM,W
43. *Onitis philemon*	Onitis	Onitini	Scarabaeinae	W	S,M.PM,
44. *Onitis subopacus*	Onitis	Onitini	Scarabaeinae	C	S,M.PM,W
45. *Oniticellus cinctus*	Oniticellus	Onitini	Scarabaeinae	C	S,M.PM,W
46. *Tiniocellus spinipes*	Tiniocellus	Onitini	Scarabaeinae	W	S,M.PM,W
47. *Drepanocerus setosus*	Drepanocerus	Onitini	Scarabaeinae	O	S,M.PM,W

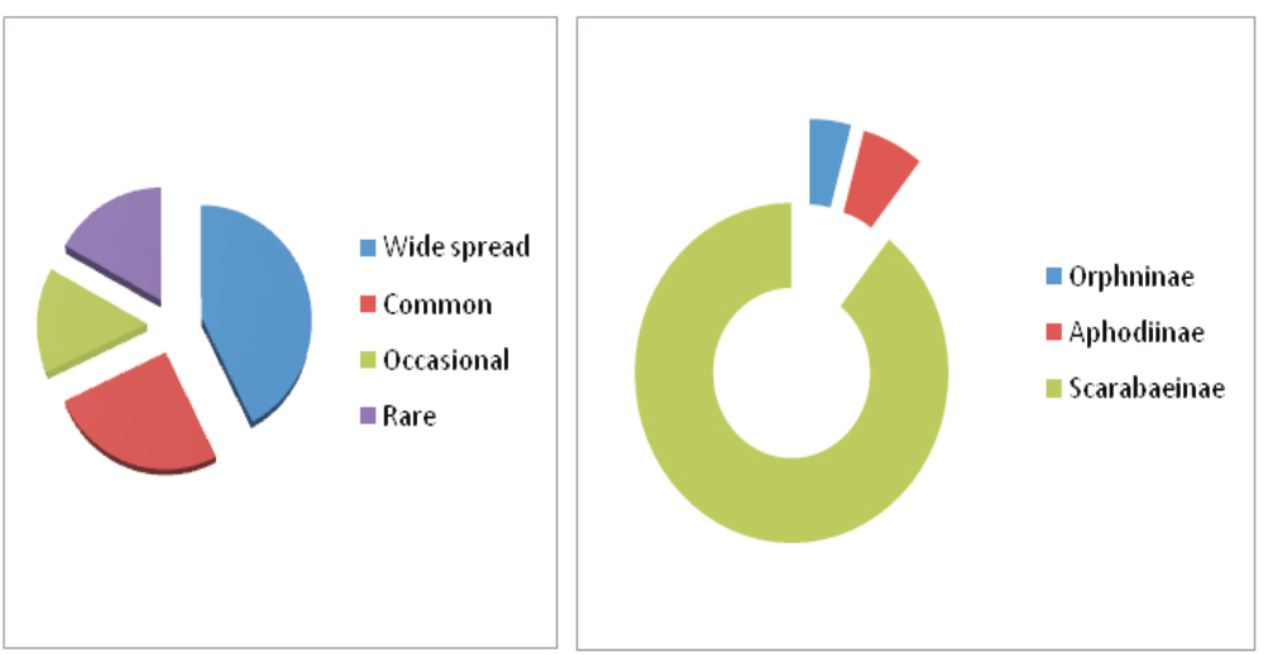

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Figure 3 (a) . Graphical representation of the seasonal variation of dung beetles species of Chhattisgarh

Figure 3 (b). Graphical representation of the family -wise variation of dung beetles species of Chhattisgarh

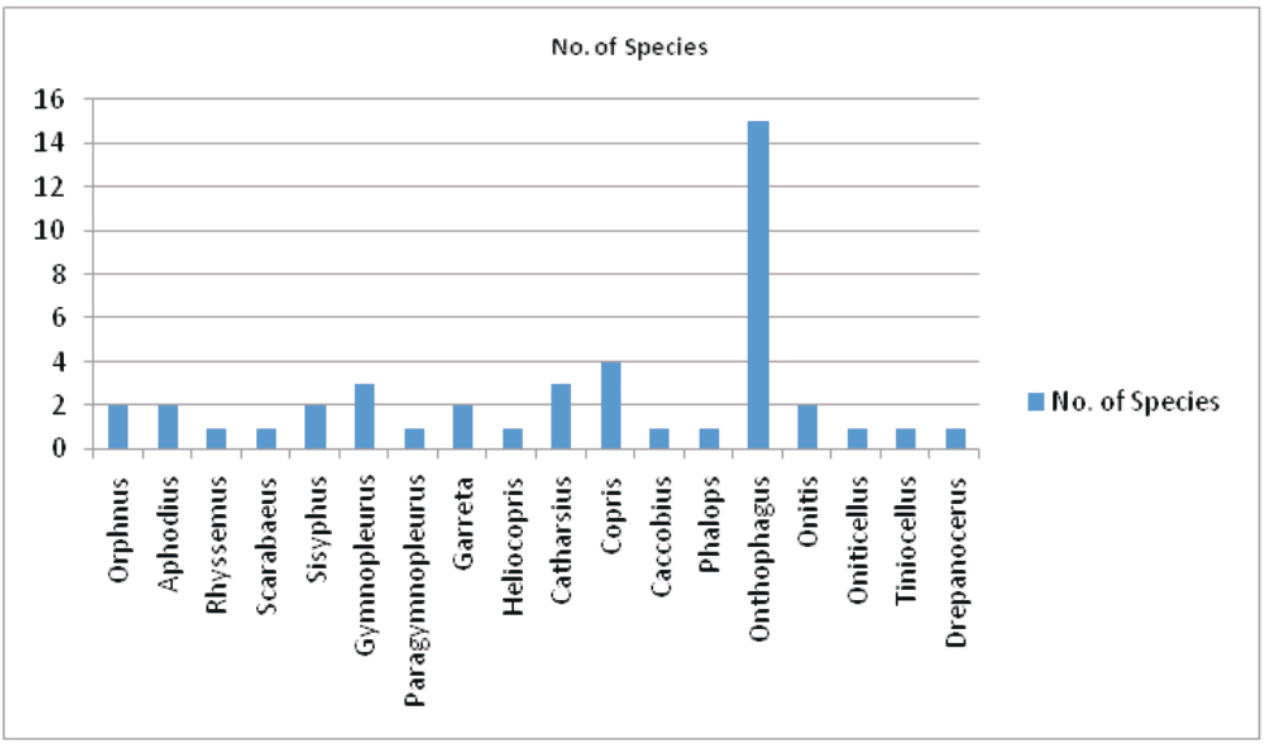

Figure 4 . Number of species contain in each genera of dung beetles species

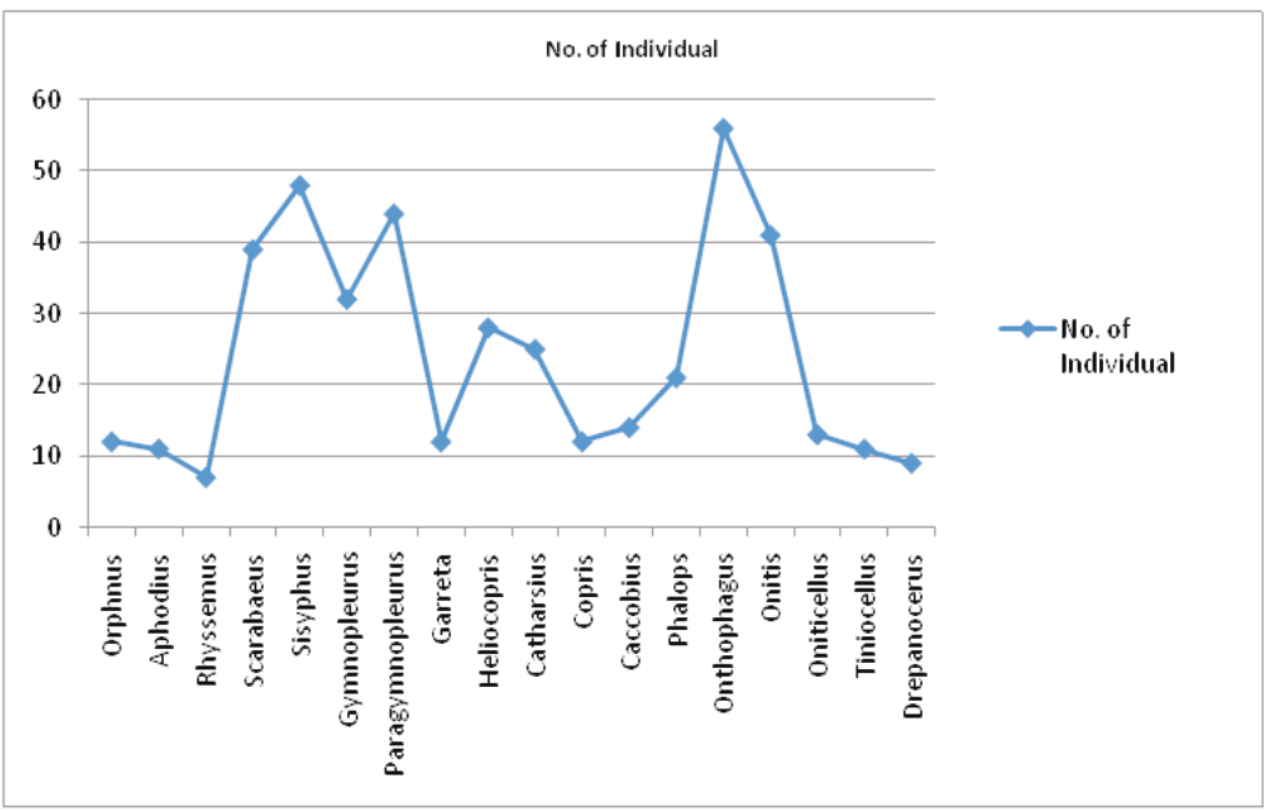

Figure 5. Number of individual contain in each genera of dung beetles species

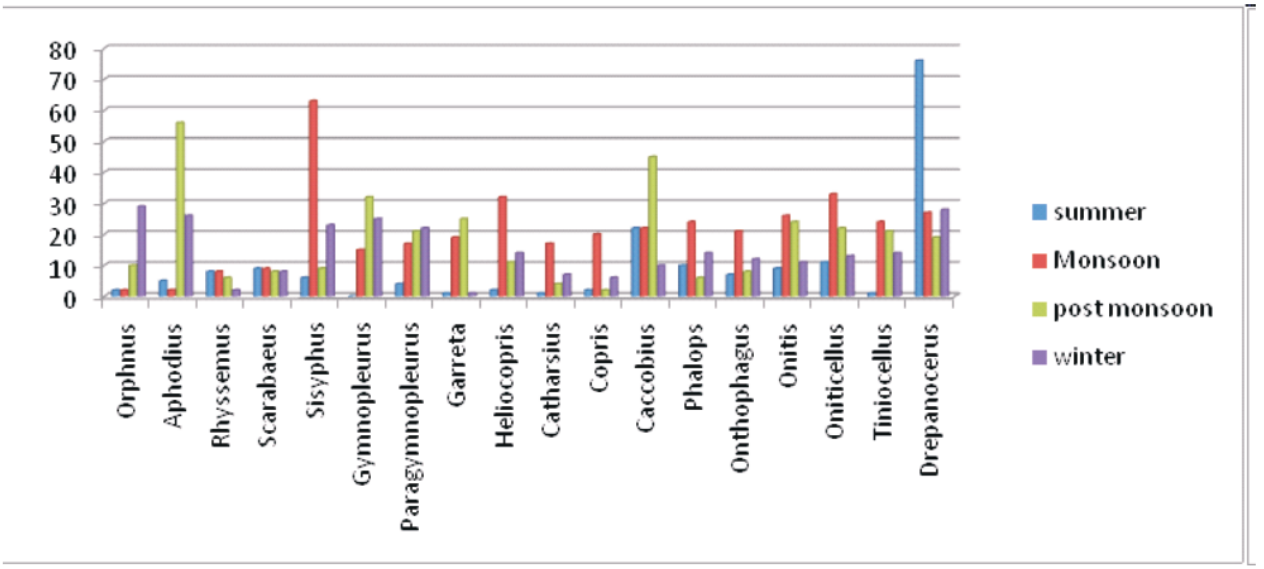

Figure 6. Graphical representation of the seasonal variation of dung beetles species of Chhattisgarh

Dung beetles are one of the most important assemblages of insects that act as biodiversity indicators as well as natures' gardeners. Owing to habitat destruction for developmental activities in urban environment and unscientific management of natural resources, many of our dung beetles are fast disappearing and at present, their survival is under threat. The presence of high number of bio-indicator species represents the unpolluted and healthy environment. Conservation of the natural resources may be helpful for the survival of many of the dung beetles species. To protect the diversity, proper conservation strategies may be followed. The survey was undertaken only for one year. Further samplings are necessary to confirm the dung beetles species diversity and also richness. In fact, the study area may be with some endemic and protected species. Therefore, more research on the region's biodiversity is needed, covering more research sites, to generate awareness among local residents and government officials about the need of protecting wildlife and their habitats.

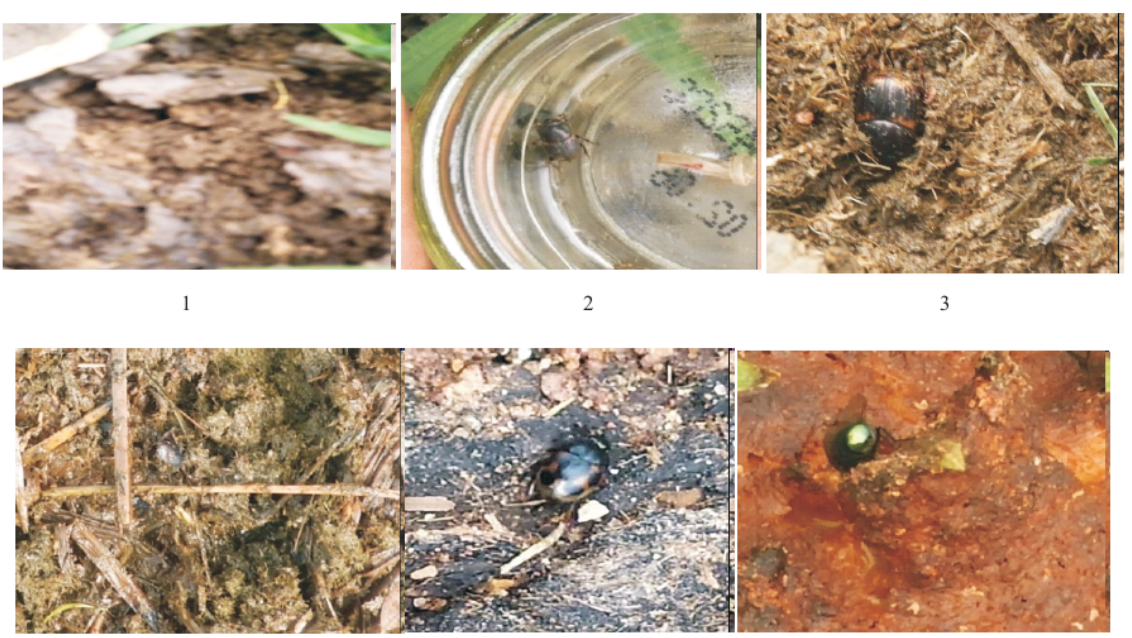

Figure 1.Lerve, 2*Onthophagusbonasus*, 3. *Onthophagusludio*,4.*Onthophagusagnus* 5.*Onthophagus ramosellus*6. *Onthophaguspactolus*

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