Biodiversity of White Grub, (Coleoptera: Scaraeidae) in Semi-Arid Agro-Ecosystem of Rajasthan

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ABSTRACT

White grubs are the major insect pests of cultivated plants in semi arid agro-ecosystem of Rajasthan. It is important to understand diversity, abundance and distribution of scarabaeid beetles for planning effective pest management programme. The experimental data were collected from 9nine locations in 3three different ecosystems in Kharif season of year 2019. Species identification revealed that there was total 9nine species were recorded from 18885 specimens collected. The identified species were belongs under 2two subfamilies of Scarabaeidae family. Maximum specimens were collected in the month of July from selected sites. When species diversity was compared among different locations, it was found that Shannon Wiener diversity index varied from 1.235 to 1.095 which1.095, which indicates that species were less diverse but frequently present. . The present study can be used to formulate the integrated pest management strategies based on most abundance and diverse scarabaeids in semi-arid agro-ecosystem of Rajasthan.

INTRODUCTION

Scarabaeidae is the largest family of the order Coleoptera, and cosmopolitan in distribution with immense species richness and ecological importance. Beetles belong to this family attack to all types of plants as well as processed fibers and grains. Scavengers of this also play a crucial role in decomposition of organic nutrient. Scarabaeidae come into two main groups, one group including Coprinae, Aphodiinae, Geotrupinae and Troginae which are saprophagousTroginae, which are saprophagous, or fungus feeders and form another group 'Laprosticti'. The second group includes the subfamilies Melolonthinae, Rutelinae, Dynastinae and Cetoniinae which are mostly phytophagous. In world fauna of scarabaeids exceeds 30,000 species ((Mittal, 2000). Maximum numbers occur in the tropical areas, particularly in the African and Oriental regions. The family Scarabaeidae represents about 2,500 species from the Indian sub-continent from which the majority of the phytophagous scarabs belong to and the economically most important sub families include Melolonthinae, Rutelinae, Dynastinae and Cetoniinae. Grub stages of scarabaeidae are fleshy, white and the body is curved in 'C' form (Raodeo *et al*, 1987). Grubs stages are most destructive and troublesome soil insects in many areas of the world. White grubs are pests of national importance and cause extensive damage to field crops and fruit trees in India (Mehta *et al*, 2010).White grubs are dominant in certain endemic pockets of the states Rajasthan, Uttar Pradesh, Gujarat, Maharashtra and Karnataka. Adult beetles active during May-June and feed on the foliage parts of different fruit and forest trees (Mehta *et al*, 2008). Changes in biotic fauna and flora of natural habitats due to climate change and human interference in natural ecosystem has necessitated the need to have an inventory of species richness in an ecosystem. SoTherefore, the present study was undertaken to investigate the species diversity and abundance of scarabaeids in semi-arid agro-ecosystem of Rajasthan.

MATERIALS AND METHODS

Materials required during the study were net, vials containing 70% alcohol and 4% formalin for preservations, plastic containers for temporary storage. Polythene bags for storing plant material for rearing purpose. A survey was carried out to find the scarabeid beetles and their host in the natural environment in the year 2019. The beetles were emerged after first shower of monsoon during evening; observations on the host range were made from 7.00 pm to 11.00 pm in the sampling site at selected locations (Table 1). Light traps were used for collection of the beetles from shelter plants and beetles collected were brought to the laboratory for further studies.

Study area

Cultivated area of different tehsil of Jaipur, Sikar and Nagour districts of Rajasthan, India were selected for installation of light traps (Table 2) and representative sites of different district were selected. The average annual rainfall was recorded from 500 to 550 mm. Temperature range during summer, winter and rainy season ranges from 30ºC to 48ºC, 2ºC to 29ºC and 25ºC to 39ºC, respectively. Soil was sandy loam to sandy soil and plant diversity, and good vegetative cover and harbors vegetation types ranging from seasonal grasses, herbs and climbers to perennial herbs, shrubs and trees. Rainy

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season enjoys most greenery in the study region. The sampling was carried out during July to August,August 2019. Light trap data were collected daily and total counts were pooled for per month population. Adult beetles belonging to Scarabaeidae were sorted from samples. All specimens were preserved and identified to species level using taxonomic keys (Omkar and Bind 1996 and Omkar 2000) and cross checked with the help of specimens in the national museum at RARI, Durgapura, Jaipur.

Table 1: Locations of biodiversity and seasonality ofscarabaeid beetles

Study sites	Locations	Latitude DM	Longitude DM	Elevation m (asl)
Jaipur	Durgapura	26^0 51 N	75^0 47 E	390
	Bobas			
	Chomu			
	Jobner			
Sikar	Palsana	27^0 56 N	74^0 59 E	361
	Fatehpur			
	Regus			
Nagaur	Molasar	27^0 31 N	74^0 75 E	352
	Nagour			

Statistical analysis Diversity indices
Study of different diversity indices were calculated to understand the diversity of insect community in space and time.
Alpha diversity
 Numbers of species observed per site were considered as alpha diversity. Richness (number of species), abundance (number of individuals) and four indices were used to access species diversity of the area. Diversity indices were based on all the information recorded during study period from each site by using the following indices (Krebs, 2001) .
Species richness (S): Number of species in a habitat
Species diversity index :
Common species richness index is based on the total number of species (S) and the total number of individuals of all species (N) in a habitat. Margalef's richness index: was calculated by given formula of Margalef (1968)
Da = (S-1)/loge N
Da= Margalef's richness index
Shannon-Wiener diversity index (H^1): This index (Shannon and Weiner, 1963) was used to determine species diversity
H^1 = "n_1/N ln n_i/N
Species evenness index (E): Was calculated as per Pielou (1975) EI = H^1/ ln N
Species dominance index (D) : Was calculated as per Simpson (1949).
Shannon index

$H^1 = -\sum_{i=1}^{s}(p_i)(\log_2 p_i)$
Simpson's index of diversity
$D = 1 - \sum_{i=1}^{s}(p_i)_2$
Simpson's reciprocal index= 1/D
where
H'= Shannon diversity index
pi= Number of total sample to the ith species.
S= Number of species.
$\sum$= Sum from species 1 to species S
D= Simpson's index of diversity.
N= Total number of organisms.
n= Percentage cover of a species
J'= Evenness of allotof of individuals from the species.
Hmax= Maximum species diversity (H') = $\log_2 S$
Diversity dominance was drawn to assess the changes in abundance in each species from each locality. Properties and merit of each index has been discussed in details (Kempton 1979; Routledge 1979; Koleff *et al* 2003; Magurran 1988 & Magurran 2004). A combination of indices, measure species richness, diversity and evenness are more important for the purpose ((Donald *et al*, 2004).

RESULTS AND DISCUSSION
Species distribution is important strategy for species specific management options. Previous reports provide list of scarab fauna in north India (Sreedevi *et al*, 2017). Geographical variations united with cropping pattern differences contribute to composition of species complex of an area. ThereforeTherefore, the present study, document the white grub species diversity and distribution pattern in the arid region of Rajasthan, India. Surveys conducted in Jaipur, Sikar and Nagour district of Rajasthan. The diversity indices assume that individuals are randomly sampled from infinitely large population. The Shannon index (H') explains the evenness of the abundance of species, while the Simpson's index of diversity (D) is less sensitive to species richness, but more sensitive to the most abundant species (Price 2004; Wilson and M 1988; Whittaker 1965; Chao 2004; Choudhary *et al* 2014). Pielou's evenness index (J') explains the evenness of allotment of individuals of different the species (Donald *et al*, 2004).
Total 9 species were recorded during the study period under 2 subfamilies of family Scarabaeidae .Scarabaeidae. The beetles collected during the study area were shown in different places. The details of beetles captured shown in Table 2 . The Scarabaeidae collected from three locations are listed in Table 2 . A total of 18885 specimens representing 9 different species of Scarabaeidae beetles were collected from different locations fromof Rajasthan. The identified species belong to subfamily Melolonthinae represented 6 species from the present study area. These are Holotrichia consanguinea, Holotrichia serrata, Maladera insanabilis, Maladera carninata, M. species and Schizonicha spp. The most important genera of the Melolonthinae family are Holotrichia, Apogonia, Maladera, and Leucopholis (Beeson 1941; Nair 2007; Butani 1979).

In another subfamily Rutelinae are Anomala bengalensis, and A. dimidiata are polyphagus white grubs and dangerous pests of agricultural and horticultural crops. Present finding are supported by Sreedevi *et al* (2017) . In Rajasthan, H. consanguinea and M. insanabilis, are the predominant species and serious pests of groundnut, bajra and jowar. Predominant species may be correlated with the cropping pattern to a large extent. The dominance of species and the richness of species varied from year to year and locality to locality (Table 3).

Table 2: Scarabaeid beetles species captured across the region

Species	Total number of individual captured			Mean no. of individual
	Jaipur	Sikar	Nagour	
H. consanguinea	1903	3530	2345	2593
H. serrata	34	67	41	47
Maladera carninata	1097	610	910	872
Maladera insanabillis	2654	2634	2525	2604
M. species	23	0	0	8
Schizonicha sp	13	43	16	24
Anomala bengalensis	149	189	0	212
A. dimidiata	14	32	26	24
Pachyrrhinadoretus frontatus	30	0	0	10
Total number of species	9	7	6	7
Total number of individual	5917	7105	5863	6295

The overall diversity of scarabaeid beetles in Rajasthan, observed by light trap catches. In Jaipur, the Simpson's index of diversity (D = 0.660) was highest followed by Nagour (D = 0.630) and lowest was recorded at Sikar (D = 0.607). Simpson's index of diversity (S^1 = 0.3396) was recorded at Jaipur and highest at Sikar (S^1 = 0.3924). The Simpson's reciprocal index was maximum at Jaipur (RS = 2.945) and minimum at Sikar (RS = 2.548). Maximum Simpson's reciprocal index and minimum Simpson's index at Jaipur indicated that scarabaeid community at Jaipur consisted of maximum number of species with similar abundance (Table 4). The similar trend was also observed at Sikar and Nagour. At Nagour the species richness was found lower than the Jaipur. Jaipur found the highest Shannon index (H^1 = 1.235) and lowest was recorded at Sikar (H^1 = 1.093).

Table 3: Quantitative characteristic ofScarabaeid beetles species in agro ecosystem of the Rajasthan region

Species	Jaipur		Sikar		Nagour		Rajasthan	
	RF	RA	RF	RA	RF	RA	RF	RA
H. consanguinea	32.16	9.99	49.68	18.54	40.00	12.31	41.18	13.61
H. serrata	0.57	0.20	0.94	0.40	0.70	00.24	0.75	0.28
Maladera carninata	18.54	5.76	8.59	3.20	15.52	4.78	13.85	4.58
Maladera insanabilis	44.85	13.94	37.07	13.83	43.07	13.26	41.37	13.67
M. species	0.39	0.27	0.00	0.00	0.00	00.00	0.12	0.09
Schizonicha sp	0.22	0.08	0.61	0.25	0.27	00.09	0.38	0.14
Anomala bengalensis	2.52	1.01	2.66	1.28	0.00	00.00	1.78	0.76
A. dimidiata	0.24	0.11	0.45	0.25	0.44	00.20	0.38	0.27
Pachyrrhinadoretus frontatus	0.51	0.47	0.00	0.00	0.00	00.00	0.01	0.15

These values for Shannon index evenness index showed poor species richness, with least evenness in relative abundance of different species. Scarabeids community at Sikar was least diverse. This least diversity in Sikar may be due to associated cropping pattern. This unevenness of scarabaeid community was mainly found due to the dominance of H. consanguinea, which comprised of more than 40% of total beetle catch in light traps. The Shannon index was maximum (H′ = 1.235) at Jaipur and Evenness index 0.562 suggested maximum abundance of scarabaeid beetles species at Jaipur. There exists of a local variation among the different scarabaeid beetles, but the evenness was found high. A community dominated by few species is considered less diverse than one with a high species richness and evenness (Dhoj *et al*, 2009). There was a considerable variation in the diversity of scarabaeid beetles across locations with observation reported by several workers in the past (Chandel *et al* 1994; Anonymous 2008 & Anonymous 2010). Variation in beetle diversity may be due to variation in seasonality, vegetation, crops sown, altitudeand altitude and soil type. Therefore, the present study results are discussed with species-specific integrated pest management

strategies should formulate for most abundance and diverse scarabaeids in semi-arid agro-ecosystem of Rajasthan.

Table 4: Parameters of abundance ofScarabaeid beetles in agro ecosystem of the Rajasthan region

Regions	Diversity Indices							
	N	S	H^1	Da	E	D	S^1	RS
Jaipur	5917	9	1.235	0.9211	0.562	0.6604	0.3396	2.945
Sikar	7105	7	1.122	0.6765	0.627	0.6076	0.3924	2.548
Nagour	5863	6	1.093	0.5763	0.610	0.6305	0.3695	2.706

N= Total number of individuals, S= Numbers of species, H^1=Shannon –Wiener diversity index, Da= Margalef's richness index, D=Dominance index, E= Evenness index, S^1=Simpson index, RS=Reciprocal Simpson index

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