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BIODIVERSITY OF GROUND BEETLES (COLOEPTERA: CARABIDAE) IN UPPER SINDH PLAINS, PAKISTAN.

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ABSTRACT

Ecological diversity of Carabid beetles was conducted in plains of upper Sindh for the first-time during August 2018 to March 2019. The study was carried out at five sampling sites and adults were trapped with the help of light trap and pitfall trap. A total of 783 specimens belonging to six species was collected, among them 213 individuals and 6 species were captured at Khairpur, 159 individuals of 6 species were collected at Shikarpur, 146 individuals from 6 species were caught at Sukkur whereas 136 and 129 individuals of 6 species were trapped at Nausheroferoz and Moro respectively, most of species were found in muddy soils and agricultural fields in the months of July, August and September which coincided with humidity, temperature, vegetation, and greater number of crops in those months, the least abundant was found in barren and bushy fields in the months of December, January and February with low humidity, temperature and presence of flowering plants and larvae. Biodiversity was calculated using the Simpson Diversity Index and species evenness, the sites 1 and 5 had a large numerical value for homogeneity and i-e diversity (E, 0.91 and D, 5.5). The whole dominant structure of Carabid complex revealed two most dominant species *Calosoma auropunctuam* (Herbst 1874) and *Nesambloyps oreobious* (Broun 1893), and one least abundant species was *Harpalus suensoni* (Dejean 1829).

Key words: Carabid beetles, Biodiversity, Simpson diversity index, Plains, Upper Sindh.
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INTRODUCTION

Carbide is the largest beetle family in the order coleoptera with more than 40,000 species and 86 tribes (Johnson and Triplehorn, 2005). This family is explained by expanded accommodative success on the various ecological conditions came across and combated throughout the global scale. Carabids have cosmopolitan distribution and significant importance for the functioning of ecosystems (Brumwell *et al*., 1998). They are classical soil beetles persistently observed in sandy natural surrounding beneath stones and trash (Johnson and Triplehorn, 2005), however few groups dwell in trees and bushes (Erwin 2000). The basic biology and habitat requirements of nearly all species occurring in agricultural habitats are recognized. Each beetle species has specific requirements for soil type, moisture, pH and light exposure. They are very good indicators of habitat modification and environmental quality. Although most soil beetle's species are predators or scavengers, some are grain eaters (Lungren, 2005). Investigations on distributions and natural selection of carabid fauna in various habitats have enhanced our awareness regarding environmental and climes changes (Kerr *et al*., 2007); (Vaibhao *et al*., 2013). Ground beetle populations are influenced by crop sequencing and crop type. Most importantly, pesticides of all kinds reduce to varying degrees the number of species and specimens (Goulet, 2003). Carabids became a gist of investigations concerning with biologics and biogeographical traits such like their interactivity with physical and living components, their reproductive behavior, population structure and role as a pest control agent. Most of species coloration, abundance and richness have made Carabids favorite objects of inspections for many Carabidologist. The studies of Carabid beetles plays a vital role in establishment of various ecological theories (Lovei and Sunderland, 1996). The Carabid beetles assemblage or composition differs under various structural modifications of environ (Andersen and Levey, 2004), even maybe the more instructive practices for studying the faunal variation (Peneve, 1996). Species distribution models enable to estimate geographic extents of species and subsequent patterns of species richness and generate hypotheses regarding environmental factors determining these spatial patterns. Projected changes in climate can be used to predict future patterns of species distributions and richness (Staunton *et al.,* 2014). In the domain of natural sciences Species directory/ checklist are main tools for sorting out them; their diversity is directly related to any service oriented for species conservation. Present study was first time carried out on the fauna and ecological analysis of carabid communities of upper Sindh plains. The objective of this study was to gather information on the current status of the ground beetles and to characterize the assemblage (abundance, richness and diversity of species) in various habitats.

MATERIALS AND METHODS

Ground beetles were collected in 2018 and 2019 at five sites on the plains of the Upper Sindh ecoregion at various locations, with little difference in soil composition, availability of moisture, crops and vegetation over different months (Figure 1). The GPS coordinates (latitude, longitude and altitude) were measured using an on-line application at the Upper Sindh sampling station.

Site 1: Cropped area near (Khemtia) in Khairpur district (27.5256°N, 68.7551°E) at altitude 61 meters, this site is situated at 14 km south west of collecting site characterized by humid and vegetative soil and abundant cropping of wheat, cotton, sugarcane, and rice and vegetation. **Site 2:** Shikarpur with bushy land 25.2245°N, 68.2206 °E at altitude 13 m) and is located near Amrotat 18.4 km to (SALU) campus Shikarpur. The vegetable was represented spinach, turnip, mustard **Site 3:** Sukkur (27.713926° N,68.836899 °E at altitude 62 m). This site (aror) is at 4km from Sukkur city the sampled area was characterized by hard rocky with poor cultivations and arid soil (sampled area covered 200 km), area having poor vegetation and grasses. **Site 4:** Nausheroferoz (26.8463° N, 68.1253 °E and altitude 38 m) beside Behlani about 4 km, this area was part of plains with loamy and moist soil adjacent to many cultivated crops and vegetables, with wheat crop and other vegetables scattered over there. **Site 5:** Moro a location in Nausheroferoz (26.6684° N, 67.9941 °E, altitude 28 m) This site is located near muddy soil and near artificial channel flowing through, site is 5 km away from national highway. The described vegetation significantly was Triticum indicium (wheat, herbaceous plants, and scattered vegetables) from upper Sindh plains.

For the study survey of Carabid beetles was conducted in above five localities to collect adult ground beetles during (August 2018-March 2019) with the help of light trap, pit fall trap and hand-picking method, mostly nocturnal flying carabids were trapped at white light. While flightless were caught in pit fall traps, 10 pitfall containers were used per locality at 5 m, tomato ketchup and salt wine were used to make them attractive and visited fort nightly. The collected specimens were identified following different keys specially composed by Bei-bienko (1988) and preserved through standard method.

Fig. 1. showing light trap

Fig. 2. showing pit fall trap

Fig. 3. Carabid beetle

Fig. 4. showing hand picking

Fig.5& 6. showing collection site of ground beetles

Data analysis: For data analysis α-diversity (Simpson diversity indices) (Simpson 1949) was employed to calculate biological diversity within community or habitat. Species evenness was measured by the formula

$$E1/D = \frac{1}{\underline{D}}$$
$$S$$

To calculate Simpson diversity applied this formula (Simpson 1949).

$$D= \Sigma n\ (n-1)/N\ (N-1)$$

After calculating the D, the Simpson reciprocal index was measured i-e dividing D with 1, Simpson reciprocal index 1/D

Where: E1/D = Simpson's measure of Evenness

D= Simpson's diversity index

S= No: of species in a sample

The average population size was computed by dividing total number of individuals (N) with species number (S).

Ecological data: The data for climatic factors i-e humidity, temperature, cloudiness, rain fall was collected from regional Meteorological department Sindh. (Regional Agromet Centre Sukkur 2018-2019)

RESULTS AND DISCUSSION

During study period 783 Carabid specimens under 4 families belonging to 4 tribes and 4 genera were collected among them 213 (27%) individuals and 6 species were captured at Khairpur, 159 (20%) individuals of 6 species were collected at Shikarpur, 146 (18%) individuals for 6 species were caught at Sukkur whereas 136 (17%) and 129 (17%) individuals of 6 species were trapped at Nausheroferoz and Moro respectively, the sites varied in number of species but for ecological study 6 species are taken from each site and their pictures are mentioned in fig. (7a-7f).

Fig. 7. (a) *Calosoma auropunctuam* (b) *Calosoma scyophantum* (c) *Mecyclothorax cordicolis*

(d) *Harpalus erythropus* (e) *Harpalus suensoni,* (f) *Nesamblyops oreobius*

Fig.(7. a-f) showing photographs of species presented for biodiversity

Table 1. list of species of carabid beetles sampled from Sindh, plains during August 2018-March 2019

Species	Site.1	Site.2	Site.3	Site.4	Site.5
Calosoma auropunctuatumm	+	+	+	+	+
Calsoma sycophantum	+	+	+	+	+
Harpalus erythropus	+	+	+	+	+
Harpalus suensoni	+	+	+	+	+
Mecyclothorax cordicolis	+	+	+	+	+
Nesamblyops oreobius	+	+	+	+	+

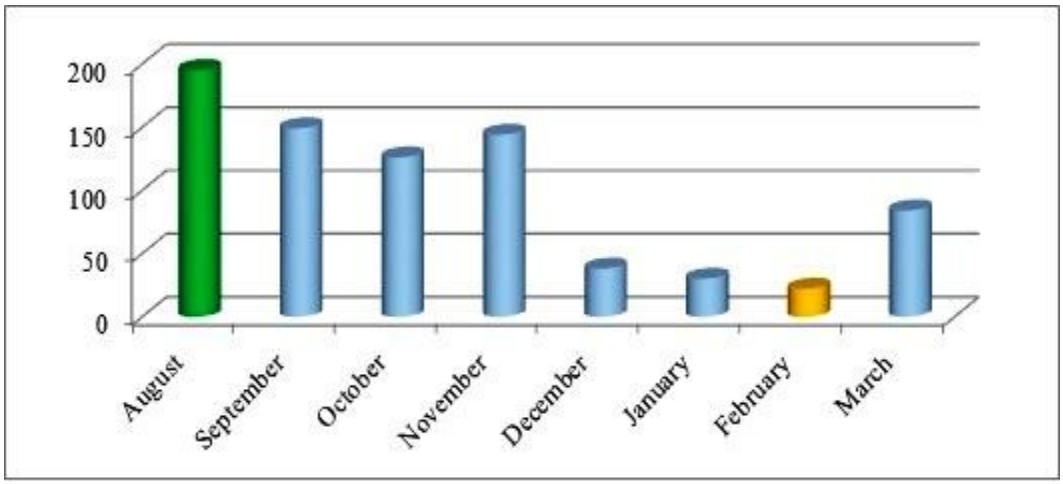

Fig. 8. Month wise collection of ground beetles collected during August 2018-March 2019

The scheme of sampled carabid species mentioned in Table 2., had obtained from traps at five sites (fig.9) presents 6 carabid species in 4 subfamilies, belonging to 4 tribes and 4 genera were identified. These tribes are Harpalini, Bembidinii, Mecylothoracini and Carabini of sub-families Harpalinae, Trichinae, Psydrinae and Carabinae respectively, tribe Harpalini and Carabini are rich with (33%) each with two species (*Harpalus erythropus*, *Harpalus suensoni*, and *Calosoma auropunctuatum*, *Calosoma scyophantum*) respectively, whereas Bembidinii and Mecyclothoracini (16%). each with only one species (*Nesamblyops orebious* and *Mecyclothorax cordicolis.*)

Table 2. Relative abundance of captured Carabid species in five different sites.

Species	Site.1	Site.2	Site.3	Site.4	Site.5
Calosoma auropunctuam	12.5%	39%	26.29%	26.47%	25.58%
Calsoma sycophantum	9.4%	20%	16%	18.3%	19.3%
Harpalus erythropus	25%	10.27%	11%	13.2%	15.5%
Harpalus suensoni	37%	15%	16%	14.7%	13.9%
Mecyclothorax cordicolis	25%	11.64%	20.65%	22%	19.3%
Nesamblyops oreobius	12.5%	3.42%	8.45%	7.35%	6.2%

The genera *Harpalus* (Latreille 1802) and *Calosoma* (Weber 1801) were represented each with two species that *Harpalus suensoni* (Degeer 1774) and *Harpalus erythropus* (Dejean, 1829), *Calosoma auropunctuatum* (Herbst 1874) and *Calosoma scyophantum* (Linnaeus 1758) and *Mecyclothorax* (Sharp 1903) and *Nesmblyops* (Broun 1893) were each depicted as one species. The relative abundance of Ground Beetles distribution is shown in Table 3. Among the sites, at Site 1 the resemblance is apprehended and ranges from 9.4% *Calosoma scyophantum* (Linnaeus 1758) to 37% *Harpalus suensoni* (Dejean 1829).

At Site 3, relative abundance was 8.4% for *Nesambloyps oreobious* (Broun 1893) and 26.29% for *Calosoma auropunctuatum* (Herbst 1874), whereas at Site 2, relative abundance was 3.4% for Nesambloyps oreobious (Broun 1893) and 39% for *Calosoma scyophantum* (Herbst 1874). The sites 4 and 5 exhibit relative abundance of 7.35% and 6.2% for *Nesambloyps oreobious* (Broun 1893) 26.47% and 25.58 for *Calosoma auropunctuatum* (Herbst 1874) respectively.

Comparatively site 1and site 5 (figure 10) are most diverse with (D=5.5) but site 1 is also with moderately high evenness (E=0.92) while site 5 with (E=0.91) evenness, site 4 is moderately less diverse as compared to site 1 and 5 with (D=5.2) but with less significant evenness value (E=0.877) whereas site 3 is more significant with both diversity (D=4.5) and higher evenness (E=0.757) while site 2 is least significant to site 3 as well as with remaining sites with diversity (D= 3.3) and evenness (E=0.561) whereas ground beetles relative abundance remarkably varied at all sites.

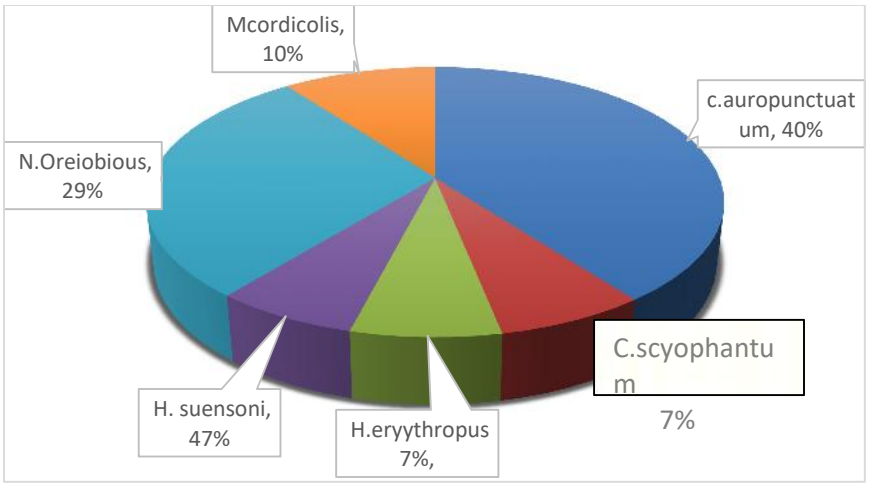

Fig. 9. Showing the dominancy species in studied localities.

Table 3. The number of sites shared by different species in upper Sindh plains.

Combination of sites	Number of species shared
Site 1-site-4 site-5	3
Site1-site 2	2
Site 1-site 2-site3	2
Site 1-site 3	1
Site 1-site 5	4
Site 4-site 5	1
Site 1-site 2-site 3-site 4-site 5	3

The number of species of family Carabidae captured and shared at all sites from upper Sindh plains are summarized in (Table 4). The top similarity was observed at sites 1 and site 5 with four species *Calosoma auropunctuatum* (Herbst 1874), *Harpalus suensoni* (Degeer 1774), *Harpalus erythropus* (Dejean 1829) and *Nesambloyps oreobious* (Broun 1893). Whereas species shared by sites 1, 2 and 3 were *Calosoma auropunctuatum* (Herbst 1874), *Harpalus suensoni* (Degeer 1774) and *Harpalus erythropus* (Dejean 1829). Only one species was common to sites 4 and 5 *Harpalus auropunctuatum* (Dejean, 1829), while *Harpalus suensoni* (Degeer 1774) was the most common species shared by all sites.

As a result, not all sites were (100%) rich, but the species captured at all 5 studied localities inhabit almost the same environmental conditions such as temperature, humidity and even agro-ecosystem because of that they share similar species, but the number of individuals varied.

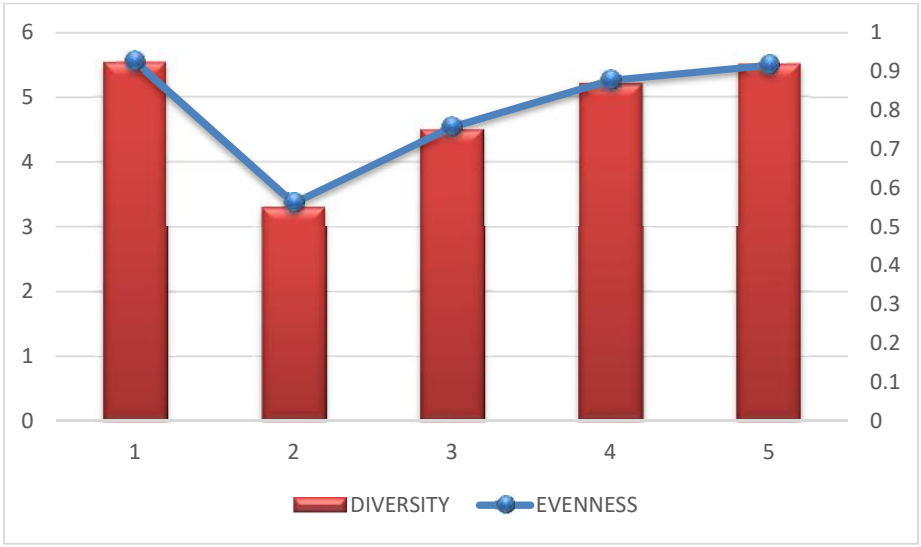

Fig. 10. Variation of Simpson diversity (D) and evenness diversity (E) indexes for Carabidae sampled form upper Sindh plains.

The present study focused on the biodiversity of ground beetles in the carabidae family with a large diversity of 6 species in 4 tribes and 4 genera. These tribes were generalist predator (predacious and granivore). The present study showed notable abundance of tribe Carabini and Harpalini due to presence of agricultural crops and vegetation at study sites, 2ndly they were abundant in the months of August and September as there is breeding season of carabids in spring and in June and July, they turned into adults so found abundantly. Most of areas of upper Sindh plains were frequently visited in July, August and September in the agricultural areas and urban areas with humid and sub-humid bioclimatic states and accounted as best type habitat. The investigations showed that *Calosoma auropunctuatum* and *Nesambloyps orebious* were more abundant in studied localities they have adapted a broad range of ecoclimatic conditions, so these species are stable species in ecosystem as mentioned in (figure 9).

Simpsons diversity was calculated with high values for species richness, evenness and diversity in localities 1 and 5 (D=5.5, E= 0.92), this coincided with humidity, temperature, vegetation and crops in those months were in greater number (fig.10).

The least abundant species of carabid beetles (*Harpalus suensoni*) was observed in the month of December, January and February because low humidity and temperature also the absence of non-flowering plants and larvae for predacious species.

The observations of (Hengveld 1980; Nimiela 1993; Ranio 2003; Balog *et al* 2011 and Teofilvoa 2015) are similar that number of species and specimens of each locality are different and low with poor vegetation, while highest value was recorded in muddy forest steppe area near moist soil. Different criterion (soil texture, soil condition, vegetable habitat and feeding habitat) effect on carabidae distribution. Further it has been observed that species richness, evenness and diversity decrease with environmental disturbances, Nimiele (2002). Moreover, urbanization and human activities interruptions are also affecting the habitat as well as prey of carabid beetles.

From Pakistan specially in Sindh Hashmi and Tasfeen (1994) and Rahim *et al*., (2013) from Kashmir described only the five species. Various attributes of species diversity declared that assemblages are significant among all explored study sites (Thelie 2012; Andersen 1978; Morases *et al*. 2013), this is due to their heterogeneity and variation in composition and structure of flora (consequently the litter composition and structure). The microhabitat availability and feeding resources are affected by local factors like humidity and temperature Barbosa *et al.* (2002). The results of Carabidae responses determines, habitat structure, disturbances and show their response to sensitive environment.

In conclusion the study revealed that *Calosoma auropunctuam* and *Nesambloyps oreobious* were dominant and stable species while *Harpalus suensoni* was least abundant species at study sites. The July, August and September were favourable months whereas, December, January and February were less favorable months with poor population. The greatest diversity was observed at sites 1 and 5 due to the variety of vegetation and cropland.

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