

Diversity and Distribution of Lepidopteran Butterflies in Kota District, Rajasthan

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DOI: 10.5281/zenodo.4724377

Abstract

Understanding the standing point of biodiversity is an integral part of studying habitat ecology in the arena of the applied ecology and conservation biology. Considering this, a study was conducted to understand the biodiversity of the single species, i.e. Lepidoptera in four different sites of Kota district. Four distinct habitat fragmentation sites, Chambal Garden, Ganesh Udhyan, Industrial Area and agriculture land were selected to understand the diversity and distribution of lepidopteran butterfly. As this group of butterfly is considered as "umbrella taxa", detailed study of its assemblages could be directly correlated with the changes in microclimates in the selected regions. Therefore, diversity of the Lepidoptera was calculated by Simpson's index of diversity and Shannon-Weiner Index. Among these four areas, Chambal Garden and Ganesh Udhyan are dominated with the Lepidoptera whereas, decline in abundance could be observed remaining two areas. This study indicated a rich and diverse butterfly habitat in the selected survey area, which could be served as a future referral for measuring and monitoring biological diversity.

Keywords: Lepidoptera, butterfly, biodiversity, conservation, species richness

1. Introduction:

In this present era of climate change, study of biodiversity and its associated consequences is much in demand to combat "crisis-orientated" habitat loss. (1) Habitat loss and degradation remain the main causes of biodiversity loss and species extinctions across the world (1) New strategies are required to be implemented for the protection of species in the selected habitat for long-term high conservation interest. (2,3) How precisely spatial and temporal processes can affect the biodiversity patterns is still a big challenge in the contemporary ecology (4). Detailed inventory of the available flora and fauna of the selected sites must be documented in this regards in order to maintain and monitoring the species richness and evenness. Since diversity and/or variability mostly influence the three domains of ecology, i.e., within the species, between the species and between the ecosystems, in-depth study must be carried out in terms of species composition, richness, evenness and interactions (5-9).

Insects, particularly the lepidopteran butterflies are considered as an ecological indicator in diverse ecological processes such as nutrient cycling, seed dispersal, pollination, predation or parasitism and pest control. (11) We hereby considered the lepidopteran butterflies for our study as it is known as flagship species for the biodiversity study. It is also observed that over the past decades, many reports showed the decrease in population of the *Lepidoptera* species due to unprecedented environmental hazards like climate change, deforestation, habitat fragmentation and loss, and pesticides and pollution. These negative attributes inevitably showed negative effect on the natural ecosystem. Therefore analyses of the biodiversity of *Lepidoptera* are essential in terms of seasonal changes and habitat fragmentation in order to conserve the micro-ecosystem.

The objective of this study is to determine the diversity and abundance of the insect fauna, *Lepidoptera* species at four

selected areas of Kota District to maintain and monitoring the conservation ecosystem.

2. Material and Methods:

Sampling was carried out in the four selected regions of Kota District in Rajasthan, India (25.2138° N, 75.8648° E).

S-1: Chambal Garden, S-2: Ganesh Udhyan, S-3: Industrial Area, S-4: Agriculture land

Within a group, sampling effort was identical on all plots (standardized by time, number of samples, or number of individuals sampled).

Since very beginning, biodiversity is one of the primary interests of ecologists but quantifying the species diversity of ecological communities is really difficult. During the statistical sampling, two statistical components were for our study, i.e., no of different classes of insects such as species, genera, families, different habitats and distribution of classes among different aspects such as a relative abundance of individuals of different taxa or relative site of habitat that falls into different habitat types. Only lepidopteran species was considered for the present study. Biodiversity of the selected fauna was estimated by Species Richness, Simpson's Indices, Shannon-Weiner Index and Species Evenness.

$$(H) = - \sum P_i \log_n P_i$$

Where
$$P_i = \frac{\text{No. of Individual of one species}}{\text{Total of no. of all individuals (one site only)}}$$

Simpson Index

Species richness which is represented by the number of species and proportion of each species estimates the Simpson Index. This index accounts for the best way for which species is most abundant.

$$\text{Simpson Index (D)} = \sum (P_i)^2$$

Simpson's Index (D) conveys the probability that two randomly selected individuals will belong to the common species.

Dominance Index

The pattern of relative abundance of species determines the dominance component of diversity. In this study, the relative dominance of Lepidoptera order in habitat was calculated by the dominance index by using the formula:

$$\text{Relative Dominance} = \frac{n_i}{N} \times 100$$

[n_i : Number of butterflies in the i th order, N : Total number of butterflies collected during the study period]

Pielou's index of Species Evenness

This index determines the evenness of species abundance is complimentary to the diversity index. It explains how the individual of various species is distributed in the community.

$$\text{Evenness Index} = \frac{H}{\text{Log} S}$$

[H : Shannon Weiner Diversity Index, S : Total number of Species]

Species Richness(S)

Species richness is measured by counting of number of species in a community. Apart from species richness other indices are also required to estimate different attributes of populations.

Margalef's Index of Species Richness(S)

Margalef's index is a simplest and most useful measure of species diversity. The number of species at a site, in a region or in a collection is called as species richness.

$$\text{Species Richness} = \frac{(S-1)}{\text{Log} N}$$

[S : Total number of species, and N : Total number of individuals of all species]

Shannon-Weiner diversity index (H)

Shannon-Weiner Index accounts for species richness and proportion of each species within the sampling Site. This index was used for the study of the diversity of species. Shannon-Weiner index is formulated as follows:

2. Results and Discussion:

Kota in the biodiversity point of view can be considered as a place for high lepidopteran abundance in terms of diversified community with evenly distributed species. This provides equilibrium to the mentioned community and other organisms interacting with them both directly or indirectly. Further, the results indicate that in S-1 and S-2 region, the abundance of the butterfly is observed to be remarkable.

The number of species and the proportion of each species account by Simpson Index is represented by symbol D. This index indicates the probability of two randomly chosen individuals which belong

to the same species. If the value of Simpson index is closer to one which means two randomly chosen individuals will be of the same species then it represents low biodiversity. If the percentage of individuals in each species within a community is nearly equal. A lower value of Simpson index indicates higher biodiversity.

The observation indicated that the biodiversity of butterflies was high in the case of S-4 which is followed by S-1 and S-3 as shown in Figure 1. The diversity of butterflies was low in agriculture site S-2 and industrial area S-3. Simpson index 'D' account for the species richness (the number of species) and the proportion of Simpson Index (D) of Butterflies of Different Sites of Kota District.

Sites	Lepidoptera
S-1	0.883
S-2	0.087
S-3	0.186
S-4	0.095

Table1. Simpson Index (D) of Butterflies in Different Sites of Kota District

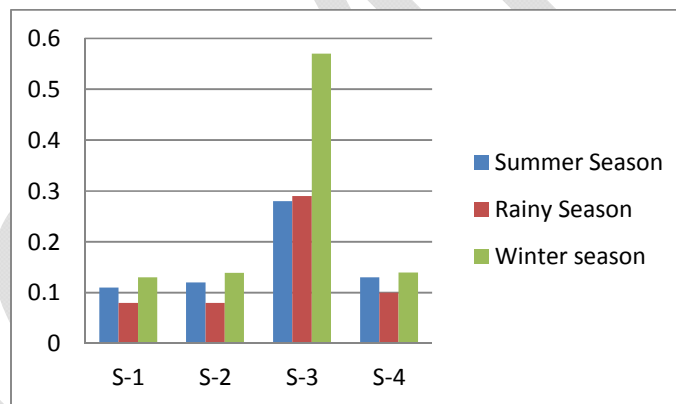


Figure 1: Simpson Index (D) of Butterflies of Different Sites of Kota District in different seasons.

S-1 (Chambal Garden), S-2 (Ganesh Udhyan), S-3(Industrial Area), S-4(Agriculture Land)

Shannon Weiner Diversity Index

The measure of the likelihood that the next individuals will be the same species as the previous sample is represented by Shannon Weiner diversity index. Two quantifiable measures like species richness and species evenness combine to determine Shannon Weiner index. The diversity value 'H' ranges from 0 to 4 to 7 which indicates low community complexity to high community

complexity respectively. So it indicates the measure of order or disorder within a particular system.

The observations indicated a very low value of H-1.33 in Site-3 and a high value of H-2.45 in site S-4 (Table 2). Again diversity was high in the rainy season for butterflies compared to the winter season and summer season as shown in Figure 2.

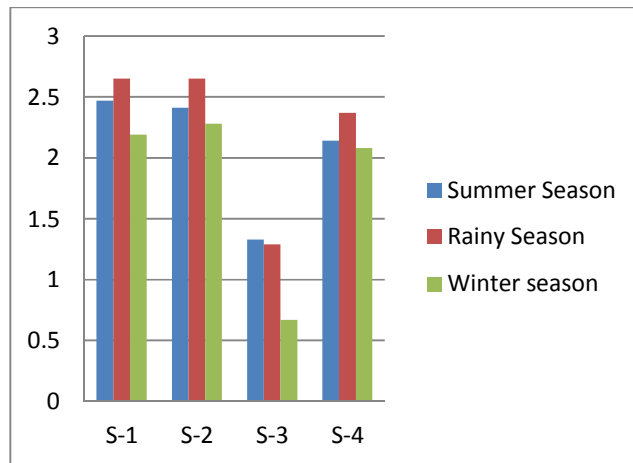


Figure 2: Shannon-Weiner Index of Special Richness of butterflies of different seasons

Marglef^s Index of Species Richness:

Species richness is the actual number of species in a population. The highest species richness was in site S-4 (S 3.22). The sites S-1

(S = 3.07) and S-4 (S = 2.92) also had nearly equal species richness to site S4. S-3 had the lowest value 2 of S 0.97 as shown in Table 3. Species was greater for these orders in the wet season compared to the dry season (Figure 3).

Sites	Lepidoptera
S-1	2.601
S-2	2.629
S-3	1.809
S-4	2.554

Table 2. Shannon-Weiner Index (D) of Butterflies of Different Sites of Kota District

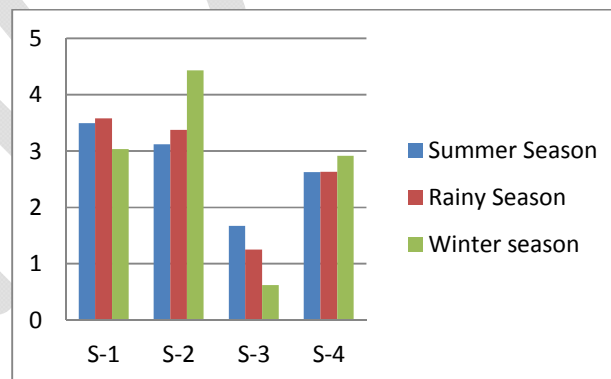


Figure 3. Margalef's Index of Species Richness of butterflies in different seasons

Pielou's Index of Special Richness

The uniform pattern of distribution of species in an ecological system is represented by Evenness Index. Evenness is considered one when there are similar proportions of all species but when some rare and some common species are found with dissimilarity then the value of evenness increases.

Site-3 and S-2 had the highest and lowest evenness index of 0.96 and 0.68 respectively (Table 4). All the other 2 sites had nearby similar species evenness. This concludes that the species that exist in site-3 were uniformly distributed while species were unevenly distributed in the agro-ecosystem of site-2.

Sites	Lepidoptera
S-1	0.826
S-2	0.677
S-3	0.804
S-4	0.960

Table 4. Pielou’s Index of Species Richness of Butterflies

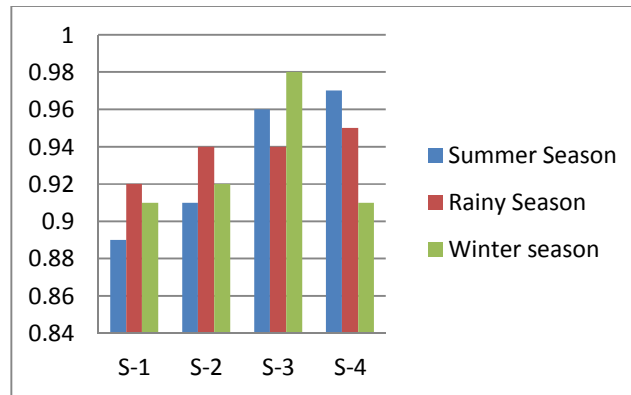


Figure 4. Pielou’s Index of Species Richness of Butterflies in different seasons

Site	Simpson Index	Shannon-Weiner Index	Margalef's Index	Pielou's Index
S-1	0.883	2.601	3.163	0.9
S-2	0.087	2.629	3.014	0.928
S-3	0.186	1.809	0.971	1.305
S-4	0.095	2.554	2.349	1.028

S-1 (Chambal Garden), S-2 (Ganesh Udhyan), S-3 (Industrial Area), S-4 (Agriculture Land)

Table 5. Diversity Indices of Butterflies in Different sites of Kota District

4.

Conclusion:

Present study reveals a good number of lepidopteran population at survey sites of Kota, Rajasthan, even in different seasons. This might be correlated to the fact that Kota region has good amount of light due to longer day periods, and sufficient amount of water resources. This therefore supports their activities and accounts for their successful thriving here. From our study, among the four sites, From the result obtained, the lowest diversity was found in the industrial area while the highest diversity was present in the parks of the Kota district. The high conservation rate was found in the sampling sites; S-1 and S-2 areas. However, extensive care should be taken in the industrial area because of the maximum anthropogenic disturbances and lesser availability of diversified feeding habitats. Our current study might provide an opportunity

to estimate the overall species richness of lepidopteran fauna in Kota District; which could be a baseline to gain further insight into butterfly management and its conservation

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