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Studies on the Diversity of Butterflies in Railway Colony, Madurai

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ABSTRACT

Biodiversity offers several direct and indirect economic benefits to humankind. The butterfly fauna of the southern part of the Indian peninsula is very rich and diverse compared to other parts of the peninsula due to the availability of diverse habitats, a wide range of altitudinal gradients and associated microclimatic regimes. Of the many species diversity indices, the Shannon Index and Simpson's Index are most commonly used. A survey of Railway Colony, Madurai from March 2018 to August 2018 was conducted to identify the species of butterflies using transect method. The survey was carried out every fortnight for six months in the selected four locations which revealed the presence of twenty one species of butterflies belonging to four families. Shannon, Shannon Evenness and Simpson's indices of butterflies were calculated. Shannon and Simpson's indices of butterflies were the highest in quarter's area and the least in office area. Shannon Evenness index of butterflies showed the maximum in park area and minimum in office area. Shannon and Simpson's indices of butterflies were the highest in August 2018 and the least in March 2018. Shannon Evenness index of butterflies showed maximum in June and minimum in March 2018. This kind of work will help in maintaining Biodiversity Register for landscapes and to monitor the effect of climate change on butterflies.

Key words: Butterflies, diversity, shannon index, shannon evenness index, simpson's, microclimate

INTRODUCTION

Biodiversity is a measure of health of an ecosystem and it can be approached at gene, species and ecosystem levels. Butterflies are one of the most beautiful and colorful organisms present on earth. The presence of butterflies indicates health status of a particular terrestrial biotope and hence they occupy a vital position in ecosystem[1]. They are good indicators of environmental quality as they are sensitive to changes in the environment. Butterflies are the most admired and popular among the insects. They act as pollinators while some of their larvae act as agricultural pests[2].

The butterflies selectively visit the flowers and plants. There is a close relationship between butterflies and host plants[3]. It is influenced by the color, odor and the shape of the flowers. Butterflies and their larvae depend on specific host plants with specific foliage, nectar and pollen for their food. Thus, butterfly diversity depends on plant diversity. Land use pattern changes alter butterfly diversity and distribution[4]. Adult butterflies as opportunistic foragers used to visit a wide variety of flowers[5].

Lepidoptera (butterflies and moths) is the second largest order of Arthropods and its members are most easily identified, making them particularly useful for biodiversity survey[6]. The species richness and relative abundance of individuals are the noteworthy factors which develop the conservation status and enhance the biodiversity thus beneficial to the ecosystem[7]. The largest butterfly recorded in India is the Common Birdwing, *Troides helena* while the smallest is the Grass Jewel, *Freyeria trochilus putli*[8]. Many researchers have suggested that butterflies were studied as indirect measures of environmental variation because they were sensitive to local weather, climate and light levels[9]. Species richness has been used as a variable to help prioritize conservation efforts[10] and to measure biological responses to natural disturbance processes, human land use and alternative management actions at numerous spatial extents[11]. Hence the present work has been undertaken to record the number of individual butterflies and number of species in the selected locations every fortnight during the study period and to calculate biodiversity indices including Shannon's and Simpson's diversity indices in Railway Colony, Madurai.

MATERIALS AND METHODS

Study area: The study was conducted from March 2018 to August 2018 at Railway Colony in Madurai. The city of Madurai lies on the flat and fertile plain of the River Vaigai, which runs in the northwest-southeast direction through the city, dividing it into almost two equal halves. The climate of Madurai is tropical with the average annual temperature of 28.8°C and the rainfall of 840 mm.

The latitude of the Railway Colony at Madurai is N 9°55.2437' and the longitude is E 78°6.5902'. The Railway Colony is located with the GPS coordinates of 9.9249°N, 78.1066°E (Fig. 1). The Railway Colony is a residential area meant for the employees and their families of Southern Railways in Madurai, Tamil Nadu. A recreation center, living quarters for the employees, temple, church and a marriage hall are all located within the premises of the colony. The railway colony is strategically located, very near the Madurai Junction railway station. The colony also has an entry from the Karimedu market area, thus serving as a conduit for residents and non-residents alike who want to enter the Karimedu market and the surrounding areas from the Periyar bus stand. The study area was divided into five different locations namely office, park, church, red ground and quarters.

Survey of butterflies: The study was carried out for six months from March 2018 to August 2018. Regular monitoring

Fig. 1: Study Area-Railway colony, Madurai shown in Google road map

of the butterflies was carried out every fortnight by making transect counts and recording their number for the entire study period. The butterflies were observed from 9 to 11 am in the morning for six months. A visual survey was done during each sampling period. The butterflies were identified based on the wing pattern and the date of observation, number of species and individuals were recorded in the selected five locations. Total number of individuals of each species in the five different locations for each sampling was calculated.

Biodiversity indices: Shannon-Wiener Index, Shannon Evenness Index and Simpson's Index were calculated.

Shannon-wiener index: It was calculated in order to know the species diversity in different habitats based on the abundance of the species by the following formula[12].

$$H' = (P_i \ln P_i)$$

Where:

H' = Diversity index

P_i = Proportion of each species in the sample

$\ln P_i$ = Natural logarithm of this proportion

Shannon evenness index: It is calculated by dividing the Shannon diversity index by its maximum (h (m)). Therefore it varies between 0 and 1 and is relatively easy to interpret[12].

$$E = H/H_{(max)}$$

Simpson's index: Simpson's index has been measured by the given formula[13].

$$D = 1 - {}_{n}(n-1)N(N-10)$$

n = The total number of individuals of a particular species
N = The total number of individuals of all species

Statistical analysis: Two way analysis of variance (ANOVA) using MS Excel was carried out for the factors: Total number of butterflies, Total number of species, Shannon-Wiener index, Shannon Evenness index and Simpson's index with the variables, months and sites.

RESULTS AND DISCUSSION

Diversity of butterflies was studied in Railway colony, Madurai from March 2018 to August 2018. Totally twenty one species of butterflies were recorded belonging to four families. Total number of individuals of butterflies in six months is exhibited in Fig. 2. Total number of individuals showed maximum in June and minimum in July. Figure 3 shows the total number of individuals of butterflies in five selected areas. Quarter's area exhibited the maximum number of individuals whereas office and park areas showed the minimum number of individuals of butterflies. Figure 4 and 5 show the total number of species of butterflies in six months and in five sites.

Based on the data analysis, Shannon, Shannon evenness and Simpson's indices were calculated and exhibited in Table 1, 2 and 3 respectively. Shannon and Simpson's indices of butterflies were the highest in quarter's area and the least in office area. Shannon Evenness index of butterflies showed maximum in park area and minimum in office area. Shannon and Simpson's indices of butterflies were the highest in August and the least in March. Shannon Evenness index of butterflies showed maximum in June and minimum in March 2018. The Shannon-Wiener diversity index can be used to measure species richness and evenness and it is considered sensitive to the addition of rare species. It assumes that individuals were sampled in a random manner from a large population and all the species were represented in the sample. Shannon diversity is a very widely used index for comparing diversity between various habitats. The presence of one individual of a species is not necessarily indicative of the species being present in a large number. The Shannon-Wiener diversity index usually falls between 1.5 and 3.5 only and rarely does it surpass 4.5 to 4.6 which would indicate that the numbers of the individuals were evenly distributed between all the species. The Shannon evenness index

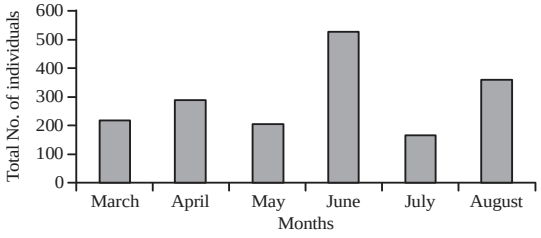

Fig. 2: Total number of butterflies observed in six months in Railway Colony, Madurai from March 2018 to August 2018

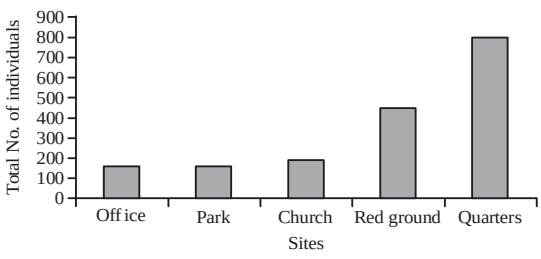

Fig. 3: Total number of butterflies observed in five sites in Railway Colony, Madurai from March 2018 to August 2018

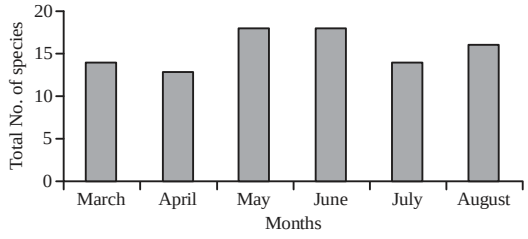

Fig. 4: Total number of species of butterflies observed in six months in Railway Colony, Madurai from March 2018 to August 2018

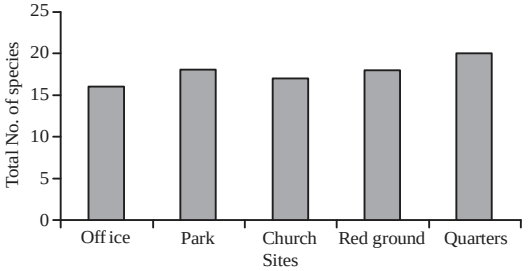

Fig. 5: Total number of species of butterflies observed in five sites in Railway Colony, Madurai from March 2018 to August 2018

Table 1: Shannon index calculated for butterflies observed in Railway Colony, Madurai from March 2018 to August 2018

		Office		Park		Church		Red ground		Quarters	
Sr. No.	Month	I	II	I	II	I	II	I	II	I	II
1.	March	0.69	1.88	0.63	1.03	1.03	1.70	1.59	1.03	1.89	1.68
2.	April	1.01	1.33	1.63	1.59	1.58	1.84	1.64	1.70	2.12	2.01
3.	May	1.27	1.42	2.04	1.51	1.97	1.67	1.76	1.28	1.78	1.60
4.	June	1.49	1.40	1.96	2.13	2.08	1.96	2.06	1.99	2.51	2.35
5.	July	1.33	1.14	1.56	1.59	0.69	1.95	1.70	1.81	2.24	2.01
6.	August	1.30	2.28	1.95	2.38	2.05	2.18	2.23	2.29	2.22	2.34

Table 2: Evenness index calculated for butterflies observed in Railway Colony, Madurai from March 2018 to August 2018

		Office		Park		Church		Red ground		Quarters	
Sr. No.	Month	I	II	I	II	I	II	I	II	I	II
1.	March	1.00	0.97	0.91	0.94	0.94	0.95	0.76	0.74	0.79	0.80
2.	April	0.92	0.96	0.91	0.99	0.88	0.88	0.79	0.81	0.88	0.84
3.	May	0.92	0.73	0.98	0.93	0.95	0.93	0.80	0.92	0.74	0.82
4.	June	0.68	0.78	0.94	0.96	0.94	0.94	0.86	0.86	0.88	0.89
5.	July	0.96	0.82	0.96	0.99	1.00	0.94	0.94	0.93	0.90	0.91
6.	August	0.81	0.91	0.88	0.92	0.89	0.87	0.89	0.89	0.86	0.84

Table 3: Simpson's index calculated for butterflies observed in Railway Colony, Madurai from March 2018 to August 2018

		Office		Park		Church		Red ground		Quarters	
Sr. No.	Month	I	II	I	II	I	II	I	II	I	II
1.	March	0	0	0	0	0	0	0	0	0.81	0.77
2.	April	0	0	0	0	0.81	0.85	0	0	0.87	0.83
3.	May	0	0.67	0	0.82	0.92	0	0	0	0.75	0
4.	June	0.66	0	0	0	0.90	0	0	0.84	0.90	0.89
5.	July	0	0.69	0	0.87	0	0	0.85	0.85	0.89	0.86
6.	August	0.70	0.90	0	0.92	0	0	0.87	0.88	0.87	0.11

Table 4: Two way analysis of variance (ANOVA) for the factor of butterflies with the variables, months and sites

Factors	Source of variation	SS	Df	MS	Calculated F value	Table value at 5% level	Level of significance
Total number of individuals	Months	7800.567	5	1560.113	4.255667	2.71089	Significant
	Sites	33938.47	4	8484.617	23.14428	2.866081	Significant
Total number of species	Months	155.2	5	31.04	9.679834	2.71089	Significant
	Sites	117.4667	4	29.36667	9.158004	2.866081	Significant

Table 5: Two way analysis of variance (ANOVA) for the Shannon Index, Shannon evenness index and Simpson's index of butterflies with the variables, months and sites

Factors	Source of variation	SS	Df	MS	Calculated F value	Table value at 5% level	Level of significance
Shannon index	Months	2.053217	5	0.410643	11.21313	2.71089	Significant
	Sites	1.320447	4	0.330112	9.014108	2.866081	Significant
Shannon evenness index	Months	0.08103	5	0.01606	1.440619	2.71089	Not Significant
	Sites	0.154053	4	0.038513	3.42361	2.866081	Significant
Simpson's index	Months	1.58448	5	0.316896	1.401166	2.71089	Not Significant
	Sites	2.32888	4	0.58222	2.574304	2.866081	Not Significant

provides information on area composition and richness. Simpson's index measures the probability that two individuals randomly selected from a sample will belong to the same species.

Table 4 shows the results of two way analysis of variance for the factors of butterflies with the variables, months and sites. Variations due to months and sites for both total number of individuals and species of butterflies were statistically significant at 5% level. Table 5 shows the results of two way analysis of variance for the Shannon Index, Shannon Evenness Index and Simpson's Index of butterflies with the variables, months and sites. Variations due to months and sites for Shannon index were statistically significant at 5% level. Variations due to months for Shannon Evenness were statistically not significant whereas variations due to sites were statistically significant at 5% level. Variations due to months and sites for Simpson's index were statistically not significant at 5% level.

The Alagar Hills reserve forest with its altitude of 830 m, harboured 101 species of butterflies and the lesser altitude did

not affect the distribution of butterflies[14]. Guiterez and Mimendez[15] suggested that the abundance of butterflies was not affected by altitude but related to the availability of food plants. Uniyal[16] made a similar observation, in a study at Himachal Pradesh, where there was negative correlation between butterfly species richness and elevation. There was high density of butterflies and plants at low and mid elevation forest in Sikkim[17]. Tew *et al.*[18] reported the relationship between habitat heterogeneity and species diversity.

Railway Colony is situated in the middle of the city but with much greenery and it could harbor twenty one species of butterflies. Disturbed forests usually have high diversity of insects. Studies carried out by Spitzer *et al.*[19] had shown that disturbed forest had high diversity of plants and more number of insects. The disturbed forest also led to the emergence of secondary vegetation namely *Lantana, Eupatorium, Mikanea* species that were good nectar source for butterflies[20]. Butterflies tend to show low diversity in natural forest but higher diversity in disturbed forest[21].

Nymphalidae was the dominant family in the present study and the predominance of Nymphalidae had been reported by earlier workers from Western Ghats[22-25]. Nymphalidae is always dominant in the tropical region as most species are polyphagous and many species of this family are strong and active fliers which help them to search for resources in large areas[26]. This would have resulted in the dominance of Nymphalidae in the study area.

The landscape structure of different sites had a fundamental influence on the distribution of population affecting insect demography[27]. The sites of each landscape will have different plant resources. Simonson *et al.*[28] had showed that plant resource is an essential factor for influencing the assemblage of butterfly population. Disturbed areas may be the only areas in forested landscape with sufficient light intensity for butterfly thermoregulation[29]. Diverse plant resources and effective mud puddling sites improved diversity of butterflies as reported by Simonson *et al.*[28].

Malabika[30] has reported less number of species due to habitat modification by pollution. The larval food plants and adult nectaring sources affect the distribution and abundance of individual species. Connel[31] suggested maximum diversity at sites that are disturbed at intermediate spatial or temporal scale, as disturbance disrupts the species competitive abilities to achieve dominance in the community while some disturbance permits less competitive species to co-exist. If disturbance was too frequent or too severe, only good dispersing or quickly maturing species remain.

There were butterflies which are opportunistic feeders and these butterflies were not seen exclusively in particular microhabitat and fly across greater distances[32]. Habitat selection in butterflies was related to the availability of food plants for larvae and adults[33]. Butterflies that were disturbance adaptable are seen in all biotopes and they may be local specialist, oligophagous and polyphagous[34]. Widely distributed species show tolerance to vegetation complex, share food resources and were of little conservation value[29]. Many butterflies were seen in all the sites and the presence of these species in all the sites correlated with that of Prasannakumar *et al.*[35], Thomas[36], Fox and Marrow[34] and Sptizer *et al.*[19]. These butterflies found in all the sites can be considered as polyphagous, tolerant to disturbance and they might have shared food resources.

The shrub and grass habitat had high population of common butterfly species with wide geographical range[35]. Brandle *et al.*[36] suggested that ubiquitous species inhabit wide geographical range and have tolerance to climatic conditions. In constant species, the larval development can take place in another patch or habitat type, as they can exploit wide variety of host plants. Warren *et al.*[37] also suggested that generalists were mobile and their development can take place in any habitat type.

CONCLUSION

The result of studies on the diversity of butterflies was of six months observations, twenty one species of butterflies were recorded belonging to four families. Shannon and Simpson's indices of butterflies were the highest in quarter's area and the least in office area. Shannon Evenness index of butterflies showed the maximum in park area and minimum in office area. Shannon and Simpson's indices of butterflies were the highest in August 2018 and the least in March 2018. Shannon Evenness index of butterflies showed maximum in June and minimum in March 2018.

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