DIVERSITY OF BUTTERFLIES IN HOLY CROSS COLLEGE CAMPUS, NAGERCOIL, INDIA.

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Abstract

A preliminary study on the diversity of butterflies was carried out in Holy Cross College campus, Nagercoil, Kanyakumari District, Tamilnadu, India from December 2016 to April 2017using line transect method. A total of 35 species of butterflies belonging to 29 genera, five families and 29 subfamilies were recorded, of which five species having protected status under the Indian Wildlife Act and IUCN schedule. Among the five families, family Nymphalidae represented with 10 genera and 12 species was the most dominant followed by Pieridae (7 genera and 9 species), Lycaenidae (7 genera and 7 species), Papilionidae (4 genera, 7 species) and Hesperiidae (1 genera and 1 species). Plain tiger, Plain sulphur, Common albatross, Psyche, Tiny grass blue and Mottled emigrant were found to be the dominant species. The value of Margalef's index, Simpson's index and Shannon Weiner index of diversity was, 6.282746, 0.943559 and 3.16285 respectively which indicates high species diversity of butterflies in the campus, which may be attributed to the presence of enormous host plants that provide a suitable nectar source and serves a breeding habitat to the butterflies.

Keywords: Biodiversity, Margalef's index, Simpson's index, Shannon Weiner index, species richness.

Introduction

Biological diversity is the base for upholding the ecosystem and the functional aspects of the species that provide goods and services for human well-being. Butterflies are suitable for diversity studies, as the taxonomy, geographic distribution and status of many species are relatively well known. Butterflies are important pollinators and bio-indicators (Suchitra and Sharif, 2005) which should be protected to conserve the biodiversity and environment (Aiswarya et al.,2014).

Observations on the butterfly diversity provide information about the variations in the species richness and the abundance shaped by the vegetation along the landscape (Ockinger et al., 2009) and the species interactions. There are 16,823 species of butterflies recorded from all over the world among them India has about 1501 species, 323 species in Tamilnadu and about 101 species were documented in Nagercoil, Kanyakumari district (Prasad, 2017).

Scientific study and documentation of Indian butterflies has been started in southern India, as early as in 1767. Then on many studies were carried out to evaluate the diversity of butterflies in different parts of India. Recent studies include the diversity of butterflies in Alagar hills situated in Tamil Nadu, India (Sharmila and Thatheyus, 2013), species richnesss and diversity of butterflies in and around Kumaun University, Nainital, Uttarakhand, India (Arya et al., 2014), diversity of butterflies in Assam University campus and its vicinity, Cachar District, Assam, India (Bora and Meitei, 2014), butterfly diversity in an urban garden Mumbai (Maharashtra) (Panse and Somani, 2017). The inner landscape of Holy Cross College campus is featured by lawns, well nurtured gardens, bushy plants and trees which serve as the store house of a wide variety of butterflies showing an excellent diversity. Hence an attempt was carried out to study the diversity of butterflies in our college campus (Holy Cross College, Nagercoil).

Materials and methods

This study is carried out in the campus of Holy Cross College (8º09'16.1''N 77º24'52.0''E) Nagercoil, Kanyakumari District, Tamilnadu from the month of December 2016 to April 2017.Butterflies were captured for identification using a simple compact net with a circular frame, a long handle and soft transparent net bag suitable for butterfly capture. Field visit to the campus was carried out regularly and the sample butterflies of different varieties were captured using the net, immobilized in a jar, fixed on a setting pith board with a groove and pinned them in proper configuration (Ambrose**,** 2004). After the specimen dries they were transferred to closed boxes provided with naphthalene balls to protect them from ants, lice and other insects. Finally the specimens were identified and labeled using the Key given in "The Butterflies of India" (Kehimkar, 2016). Photographic documentation was also done.

For quantifying the diversity of butterflies, five line transects were assigned in Holy Cross College Nagercoil campus. Weekly recording was done from 10 to 11.30 am, an ideal time for butterfly count around a radius of five meter from the observer covering either side, above and front (Kishor and Vierendra, 2014). The data was used for the study of density, abundance, frequency and Importance Value Index calculation and diversity index calculation (Dash, 1998; Sharma, 1999).

$$\text{Density (D)} = \frac{\text{Total number of individuals of the species in all the sampling units}}{\text{Total number of sampling units studied}}$$

$$\text{Relative Density (RD)} = \frac{\text{Density of the Species}}{\text{Total density of all the Species}} \text{x } 100$$

$$\text{Frequency \% (F)} = \frac{\text{Number of sampling units in which the species occured}}{\text{Total number of sampling units studied}} \text{x } 100$$

$$\text{Relative Frequency (RF)} = \frac{\text{Frequency of the species}}{\text{Total frequency of all the species}} \text{ x } 100$$

$$\text{Abundance (A)} = \frac{\text{Total number of individuals of the species in all the sampling units}}{\text{Number of sampling units in which species occured}}$$

$$\text{Relative Abundance (RA)} = \frac{\text{Abundance of the species}}{\text{Total abundance of all the species}} \text{ x } 100$$

$$\text{Importance Value Index (IVI)} = \text{Relative Density} + \text{Relative Frequency} + \text{Relative Abundance}$$

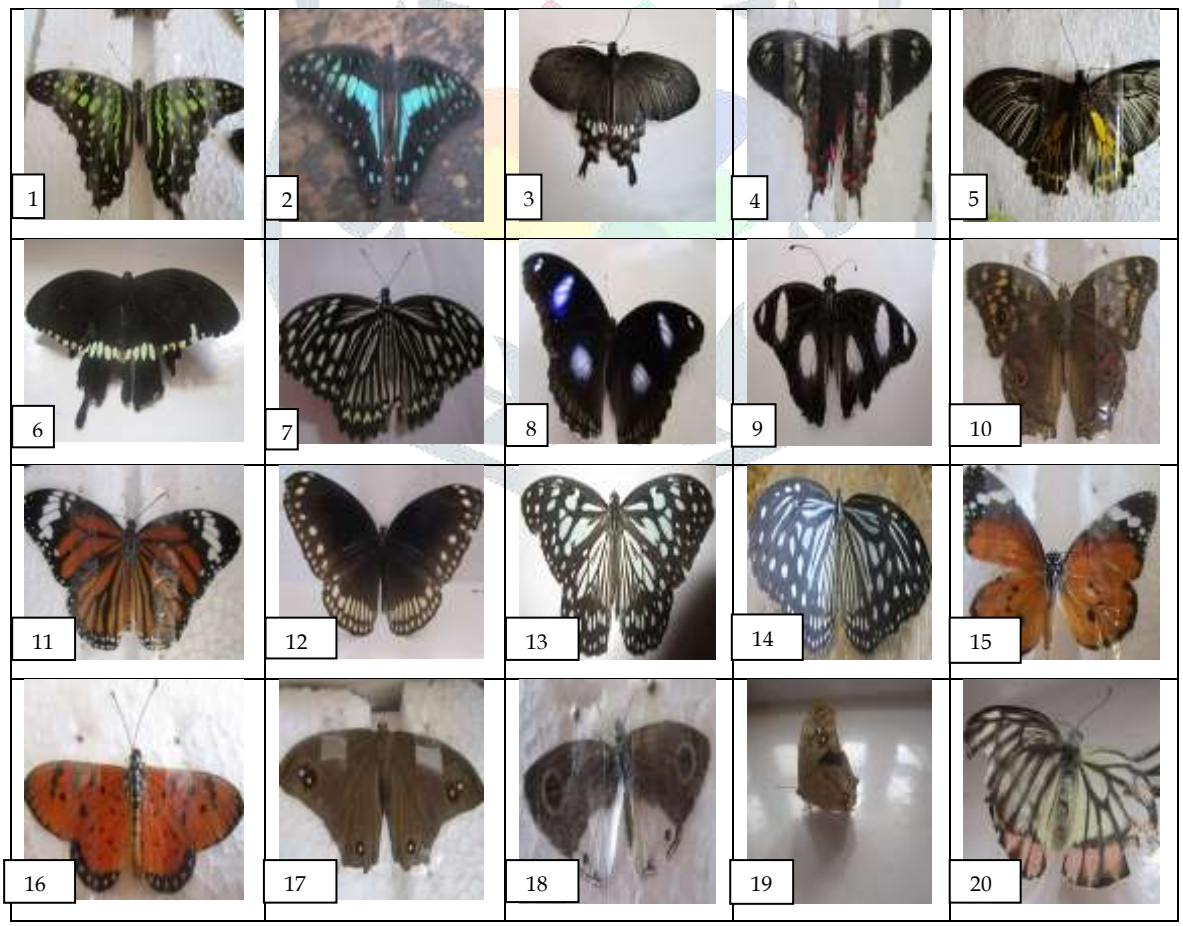
Species dominance was calculated using Margalef's Index D_{mg} = S-1/lnN. Where, S = the total number of species recorded, N = the total number of all species (Margalef, 1968).

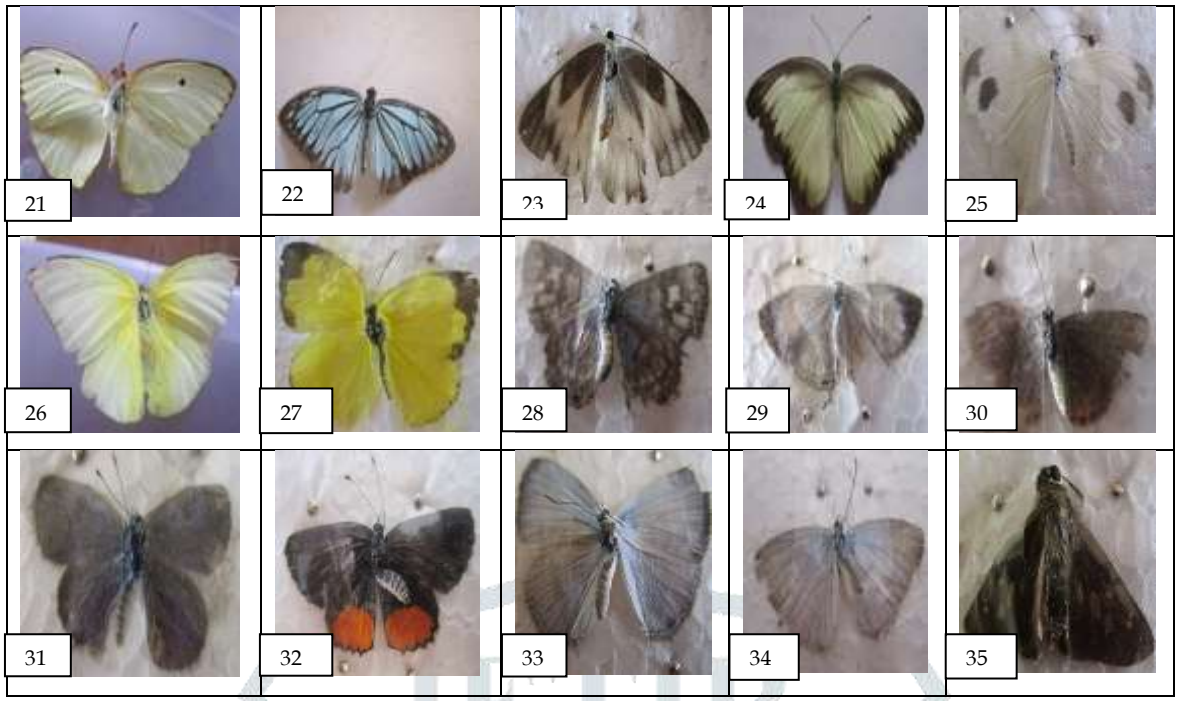
Species abundance and richness was calculated using Simpson's Index D = $\sum (pi)^2$ Simpson's index of diversity = 1- D (Simpson, 1949). Species diversity was also calculated using the Shannon – Weiner Index, H' = -$\sum$ Pi ln Pi. Where, Pi = the proportion of the i^{th} species in the total sample, ln = natural logarithm (Shannon-Weiner, 1949).

Results

During the systematic survey, a total of 35 species of butterfly belonging to 29 genera, five families and nine subfamilies were recorded from the study area during the study period (Plate 1 and Table 1).

Plate 1: Butterflies observed in Holy Cross College campus, Nagercoil during the study period





Si. no	Common name	Scientific name	Status	Si. no	Common name	Scientific name	Status
1	Tailed jay	*Graphiumagamemnon*	R	18	White four ring	*Ypthimaceylonica*	FC
2	Common jay	*Graphiumdoson*	R	19	Common evening brown	*Melnitisleda*	R
3	Common rose	*pachlioptaaristolochiae*	R	20	Common jezebel	*Delias eucharis*	FC
4	Crimson rose	*Pachliopta hector*	FC	21	Plain Sulphur	*Dercaslycorias*	C
5	Golden bird wing	*Triodes aeacus*	R	22	Indian wanderer	*Pareroniahippia*	R
6	Common Mormon	*Papiliopolytes*	R	23	Striped albatross	*Appiaslibythea*	R
7	Common mime	*Papilioclytia*	R	24	Common albatross	*Appiasalbina*	FC
8	Danaid egg fly	*Hypolimnusmisippus*	R	25	Psyche	*Leptosianina*	C
9	Great egg fly	*Hypolimnusbolina*	R	26	Mottled emigrant	*Catopsilia pomona*	C
10	Lemon pansy	*Junonialemonias*	R	27	Three spot yellow	*Euremablanda*	FC
11	Striped tiger	*Danausgenutia*	R	28	Zebra blue	*Tarucusplinius*	R
12	Common indian crow	*Euploea core*	R	29	Summer azure	*Celastrinaneglecta*	R
13	Blue tiger	*Tirumalalimniace*	R	30	Acmon blue	*Plebejusacmon*	FC
14	Glassy tiger	*Paranticaaglea*	R	31	Tiny grass blue	*Zizulahylax*	C

15	Plain tiger	*Danauschrysippus*	C	32	Indian red pierrot	*Talicadanyseus*	R
16	Tawny coaster	*Acraeaviolae*	FC	33	Eastern tailed blue	*Cupidocomyntus*	R
17	Common bush brown	*Mycalesisperseus*	R	34	Gram blue	*Euchrysopscnejus*	R
				35	Indian palm bob	*Suastusgremius*	R

Table 1: List of butterflies recorded from Holy Cross College campus, Nagercoil with status

R – rare, C- common, FC – fairly common,

Among the five families, family Nymphalidae represented with 10 genera and 12 species was the most abundant followed by Pieridae (7 genera and 9 species), Lycaenidae (7 genera and 7 species), Papilionidae (4 genera, 7 species) and Hesperiidae (1 genera and 1 species). The dominant and common species observed in the study area were *Catopsilia Pomona, Zizula hylax, Leptosia nina* and *Danaus chrysippus. Triodes aeacus* and *Pareronia hippie* were the rare species observed (Table 2).

Table 2: Number of species and individuals representing each Genus of the Subfamily and Family

Family	**Subfamily**	**Genus**	**Species**	**Total number of individuals**
Papilionidae	Papilioninae	*Graphium*	*agamemnon*	2
			doson	2
		Pachliopta	*aristolochiae*	3
			hector	3
		Triodes	*aeacus*	1
		Papilio	*polytes*	2
			clytia	2
Nymphalidae	Nymphalinae	*Hypolimnus*	*missipus*	2
			bolina	2
		Junonia	*lemonias*	1
	Danainae	*Danaus*	*genutia*	1
			chrysippus	5
		Euploea	*core*	4
		Tirumala	*limniace*	4
		Parantica	*aglea*	4

	Heliconinae	*Acraea*	*violae*	8
	Satyrinae	*Mycalesis*	*perseus*	2
		Melanitis	*leda*	2
		Ypthima	*ceylonica*	12
Pieridae	Pierinae	*Delias*	*eucharis*	8
		Dercas	*lycorias*	20
		Pareronia	*hippia*	1
		Appias	*libythea*	2
			albina	4
		Leptosia	*nina*	21
	Coliadinae	*Catopsilia*	*pomona*	23
		Eurema	*blanda*	6
Lycaenidae	Polyommatinae	*Tarucus*	*plinius*	5
		Celastrina	*neglecta*	4
		Plebejus	*acmon*	6
		Zizula	*hylax*	22
		Talicada	*nyseus*	2
		Cupido	*comyntas*	5
		Euchrysops	*cnejus*	4
Hesperiidae	Hesperiinae	*Suastus*	*gremius*	2

Representation from four subfamilies of the family Nymphalidae, two subfamilies of the family Pieridae and one subfamily each of family Papilionidae, Lycaenidae and Hesperiidae were recorded. More number of representations were observed from the subfamily Pierinae (64) of the family Pieridae followed by Polyommatinae (48) of the family Lycaenidae. Family Nymphalidae showed high species richness and Pieridae showed the highest number of individuals.

Plain Tiger, Plain Sulphur, Common Albatross, Psyche, Tiny Grass Blue and Mottled Emigrant were the dominant species. Striped Albatross, Common Jezebel, Tawny Coaster, Acmon Blue, White Four Ring and Common Grass Yellow were in medium level; Indian Wanderer, Striped Tiger and Golden Birdwing were the rare varieties; Plain Tiger, Psyche and Mottled Emigrant were recorded in all line transects; species richness was high in line transect 2 and number of butterflies were more in line transect 5 (Table 3).

Table 3: Variation in Density (D), Frequency % (F%), Abundance (A), Relative Density (RD), Relative Frequency (RF), Relative Abundance (RA) and Importance Value Index (IVI) of butterflies of Holy Cross College campus, Nagercoil.

Name of the Butterfly	Number of Butterflies in the Transects					Total	Number of Transects in which Species Occur	D	F %	A	RD	RF	RA	IVI
	1	2	3	4	5									
Tailed Jay	-	1	-	1	-	2	2	0.4	40	1	0.8928	2.1505	1.3365	4.3798
Common Jay	1	-	2	-	-	3	2	0.6	40	1.5	1.3393	2.1505	2.0048	5.4946
Common Rose	2	-	1	1	-	4	3	0.8	60	1.3	1.7857	3.2258	1.7910	6.8025
Crimson Rose	-	2	-	3	1	6	3	1.2	60	2	2.6786	3.2258	2.6731	**8.5775**
GoldenBird Wing	-	1	-	-	-	1	1	0.2	20	1	0.4464	1.0753	1.3365	2.8582
Common Mormon	1	2	-	-	-	3	2	0.6	40	1.5	1.3398	2.1505	2.0048	5.4951
Common Mime	-	1	-	-	1	2	2	0.4	40	1	0.8928	2.1505	1.3365	4.3798
DanaidEggfly	-	1	1	-	-	2	2	0.4	40	1	0.8928	2.1505	1.3365	4.3798
Great Eggfly	-	1	1	-	-	2	2	0.4	40	1	0.8928	2.1505	1.3365	4.3798
Lemon Pansy	-	-	-	-	2	2	1	0.4	20	2	0.8928	1.0753	2.6731	4.6412
Striped Tiger	-	1	-	-	-	1	1	0.2	20	1	0.4464	1.0753	1.3365	2.8582
Common Indian Crow	1	2	-	-	1	4	3	0.8	60	1.3	1.7857	3.2258	1.7910	6.8025
Blue Tiger	1	-	2	-	1	4	3	0.8	60	1.3	1.7857	3.2258	1.7910	6.8025
Glassy Tiger	-	1	-	2	1	4	3	0.8	60	1.3	1.7857	3.2258	1.7910	6.8025
Plain Tiger	5	4	3	3	2	17	**5**	3.4	100	3.4	7.5893	5.3763	4.5442	**17.5442**
Tawny Coaster	-	4	-	3	1	8	3	1.6	60	2.6	3.5714	3.2258	3.5686	**10.3658**
Common Bush Brown	1	-	-	1	-	2	2	0.4	40	1	0.8928	2.1505	1.3365	4.3798
Common Evening Brown	1	-	-	-	1	2	2	0.4	40	1	0.8928	2.1505	1.3365	4.3798
White Four Ring	-	1	-	-	11	12	2	2.4	40	6	5.3571	2.1505	8.0192	**15.5268**

Common Jezebel	2	-	3	2	1	8	4	1.6	80	2	3.5714	4.3011	2.6731	**10.5456**
Plain Sulphur	9	-	3	4	4	20	4	4	80	5	8.0928	4.3011	6.6827	**19.0766**
Indian Wanderer	-	-	-	1	-	1	1	0.2	20	1	0.4464	1.0753	1.3365	2.8582
Common Albatross	-	1	2	3	3	9	4	1.8	80	2.2	4.0178	4.3011	3.0072	**11.3261**
Striped Albatross	3	-	-	2	-	5	2	1	40	2.5	2.2321	2.1505	2.0048	6.3874
Psyche	3	6	2	3	7	21	**5**	4.2	100	4.2	9.375	5.3763	5.6135	**20.3648**
Mottled Emigrant	8	2	4	5	4	23	**5**	4.6	100	4.6	10.267	5.3763	6.1481	**21.7922**
Common Grass Yellow	3	1	-	-	2	6	3	1.2	60	2	2.6785	3.2258	2.6731	**8.5774**
Zebra Blue	-	-	-	2	3	5	2	1	40	2.5	2.2321	2.1505	2.0048	6.3874
Acmon Blue	3	-	-	-	3	6	2	1.2	40	3	2.6786	2.1505	4.0096	**8.8387**
Tiny Grass Blue	6	7	-	2	7	22	4	4.4	80	5.5	9.8214	4.3011	7.3510	**21.4735**
Indian Red Pierrot	-	1	-	-	1	2	2	0.4	40	1	0.8928	2.1505	1.3365	4.3798
Eastern Tailed Blue	-	2	-	-	3	5	2	1	40	2.5	2.2321	2.1505	2.0048	6.3874
Gram Blue	-	2	-	-	2	4	2	0.8	40	2	1.7857	2.1505	2.6731	6.6093
Summer Azure	-	1	-	1	2	4	3	0.8	60	1.3	1.7857	3.2258	1.7910	6.8025
Indian Palm Bob	-	1	-	-	1	2	2	0.4	40	1	0.8928	2.1505	1.3365	4.3798

Margalef's index value 6.282746, Simpson's index of diversity value 0.943559 and Shannon Weiner index value 3.16285 indicate high abundance and species diversity (Table 4) of butterflies.

Table - 4: Shannon-Weiner, Simpson's & Margalef's biodiversity index.

Sl. No	Name	Number	pi (ni/N)	$(pi)^2$	ln pi	pi. lnpi
1	Tailed Jay	2	0.008928571429	0.00007971938776	-4.718498871	-0.042129454
2	Common Jay	3	0.013392857	0.0001793686225	-4.313033763	-0.057763844
3	Common Rose	4	0.017857142	0.000318877551	-4.025351691	-0.071881276
4	Crimson Rose	6	0.026785714	0.0007174744898	-3.619886583	-0.096961246
5	GoldenBird Wing	1	0.004464285714	0.00001992984694	-5.411646052	-0.024159134

6	Common Mormon	3	0.013392857	0.0001793686225	-4.313033763	-0.057763844
7	Common Mime	2	0.008928571429	0.00007971938776	-4.718498871	-0.042129454
8	DanaidEggfly	2	0.008928571429	0.00007971938776	-4.718498871	-0.042129454
9	Great Eggfly	2	0.008928571429	0.00007971938776	-4.718498871	-0.042129454
10	Lemon Pansy	2	0.008928571429	0.00007971938776	-4.718498871	-0.042129454
11	Striped Tiger	1	0.004464285714	0.00001992984694	-5.411646052	-0.024159134
12	Common Indian Crow	4	0.017857142	0.000318877551	-4.025351691	-0.071881276
13	Blue Tiger	4	0.017857142	0.000318877551	-4.025351691	-0.071881276
14	Glassy Tiger	4	0.017857142	0.000318877551	-4.025351691	-0.071881276
15	Plain Tiger	17	0.075892857	0.005759725765	-2.578432708	-0.195684624
16	Tawny Coaster	8	0.035714285	0.001275510204	-3.33220451	-0.119007301
17	Common Bush Brown	2	0.008928571429	0.00007971938776	-4.718498871	-0.042129454
18	Common Evening Brown	2	0.008928571429	0.00007971938776	-4.718498871	-0.042129454
19	White Four Ring	12	0.053571428	0.002869897959	-2.926739402	-0.156789609
20	Common Jezebel	8	0.035714285	0.001275510204	-3.33220451	-0.119007301
21	Plain Sulphur	20	0.089285714	0.007971938776	-2.415913778	-0.215706586
22	Indian Wanderer	1	0.004464285714	0.00001992984694	-5.411646052	-0.024159134
23	Common Albatross	9	0.040178571	0.001614317602	-3.214421475	-0.129150861
24	Striped Albatross	5	0.022321428	0.0004982461735	-3.802208139	-0.084870715
25	Psyche	21	0.09375	0.0087890625	-2.367123614	-0.221917838
26	Mottled Emigrant	23	0.102678571	0.010542889	-2.276151836	-0.233712017
27	Three Spot Grass Yellow	6	0.026785714	0.0007174744890	-3.619886583	-0.096961246
28	Zebra Blue	5	0.022321428	0.0004982461735	-3.802208139	-0.084870715
29	Acmon Blue	6	0.026785714	0.0007174744890	-3.619886583	-0.096961246
30	Tiny Grass Blue	22	0.098214285	0.009646045918	-2.320603599	-0.227916423
31	Indian Red Pierrot	2	0.008928571429	0.00007971938776	-4.718498871	-0.042129454
32	Eastern Tailed Blue	5	0.022321428	0.0004982461735	-3.802208139	-0.084870715

33	Gram Blue	4	0.017857142	0.000318877551	-4.025351691	-0.071881276
34	Summer Azure	4	0.017857142	0.000318877551	-4.025351691	-0.071881276
35	Indian Palm Bob	2	0.008928571429	0.00007971938776	-4.718498871	-0.042129454
S = 35		**N = 224**		**∑(pi)² =0.056441**		**∑pi.lnpi =.16285**

Margalef's Biodiversity Index = (S – 1) /In N = 35–1/ ln224 = 34/5.411646052 = **6.282746446.**

Simpson's Index, D = **0.056441.** Simpson's Index of diversity = 1–D **=1-0.056441= 0.943559.**

Shannon Wiener Index, H'= - ∑ pi. ln pi = - **(-3.16285) = 3.16285.**

Among the 35 species recorded during the study, 5 species are found to be listed under the IUCN schedule: Crimson Rose and Danaid eggfly are in schedule I, Gram Blue in schedule II, Danaid eggfly and Common Indian Crow in schedule IV. Crimson Rose and Common Jezebel, which are endemic to Peninsular India, were found in our college campus.

Discussion

Butterfly species composition and their diversity patterns in Holy Cross College campus, Nagercoil have been analyzed in this study. Predominance of Nymphalidae was observed in the study area. Similar pattern was also reported by different researches (Tiple, 2012; Guptha et al., 2012; Murugesan et al., 2013). Members of the Nymphalidae were always dominant in the tropical region because most of the species are polyphagous in nature, consequently helping them to live in all the habitats. Additionally many species of this family are strong, active fliers that might help them in searching for resources in large areas (Eswaran and Pramod, 2005; Krishnakumar et al., 2008). A high proportion of Nymphalid species thus clearly indicates high host plant richness in the study area (Gunathilagaraj et al., 1998). Continuous observation suggests that the butterfly activity is at its peak in the month of March and April as there is plenty of food source available for their breeding cycles.

Presence of 35 species in the study area revealed that the area is under less degree of human stress. Mottled emigrant (Family: Pieridae) was recorded as the most abundant species and constituted 21.79% of the total recorded individuals of the butterflies. Tiny grass blue (Family: Lycaenidae) was recorded as the second abundant species constituting 21.47% and Psyche (Family: Pieridae) was the third dominant species and constituted 20.36% of the total butterflies recorded. On the other hand, Golden Birdwing (Family: Papilionidae) followed by Indian wanderer (Nymphalidae), Striped tiger (Family: Nymphalidae), were recorded as less abundant species during the study period. The preference of butterflies for particular habitats is associated with the availability of larval host plants and adult nectar plants (Aiswarya et al., 2014). Mottled emigrant was recorded as the most abundant species, and their host plant is *Cassia fistula* which is rich in our campus. Tiny grass blue was the second abundant species their host plant *Lantana*

camara is abundant in our campus. Psyche was the third dominant species and their host plant *Capparis separia* and *Capparis spinosa* are rich in our campus. Butterflies belonging to the family Hesperiidae are less seen due to their retiring habits. They keep to shady undergrowth and they are usually sighted inside the bushes. This might be the reason for the prevalence of only one species of Hesperiidae (Sharmila and Thatheyus, 2013).

As species richness and evenness increase, so diversity increases. Margalef's index is a measure of the number of species present for a given number of individuals. However it weighed towards species richness. It is used for comparison of the sites (Kocates, 1992) and takes only one component of diversity (species richness) into consideration reflecting sensitivity to sample size. The observed value of Margalef's index was 6.282746446, which means the college campus has high butterfly diversity. This may be due to the occurrence of more number and varieties of plants and low human intervention (Ravera, 2001).

Simpson's Diversity Index is a measure of diversity which takes into accounts both richness and evenness. While assessing the butterfly community of Holy Cross College campus during the entire study period, the Simpson index of diversity 0.943559 revealed high species richness in the College campus.

The Shannon diversity index (H') is an index that is commonly used to characterize species diversity, richness and evenness of the species present in a community (Melo, 2008). In biological communities, Shannon-Wiener diversity index varies from 0 to 5 and mainly falls between 1.5 and 3.5. According to this index, values less than 1 characterize heavily polluted condition, and values in the range of 1 to 2 are characteristics of moderate polluted condition, while the value above 3 signifies stable environmental conditions (Stub et al., 1970; Mason, 1988). In the present study, Shannon Wiener index of diversity (3.16285) indicated a marked richness and diversity of butterflies.

Among the 35 species recorded from the study area, five species of butterflies are included in the Wild Life Protection Act, 1972 as they are considered to be endangering. Out of these, the Crimson rose is found to be an important species in our campus. Other three species namely Gram blue, Common Indian crow and Danaid eggfly are also recorded in our campus in rare. The endemic varieties in Peninsular India, namely Danaid eggfly and common Jezebel are also present in our study area. Common jezebel is a fairly common species and Danaid eggfly is a rare species in the campus.

Conclusion

The butterfly diversity study within Holy Cross College campus, Nagercoil have generated a comprehensive baseline data, which will help in future assessment of biodiversity and any impact on the habitat of the present study area.

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