



Assessment of the Diversity and Abundance of Butterfly Fauna in and around Choolanur Peafowl Sanctuary in Palakkad, Kerala, India

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

This study investigates the diversity and abundance of butterflies in two selected sites, Choolanur (protected area) and Pazhambalakkode (an area close to sanctuary) of Palakkad district of Kerala, India. The study was done only in and around the peafowl sanctuary and Choolanur forest premise and the diversity of butterfly was found to be a little high at Site 1(Choolanur), with Nymphalidae family being most abundant. The number of butterflies from the Papilionidae and Lycaenida family was recorded to be in less numbers as compare to the Nymphalidae. The diversity of butterflies at Site 2 (Pazhambalakkode) the diversity was almost similar to the diversity of Site 1, which may be due to the immigration of species. The butterflies were sampled by direct search method and photographs were identified with the help of keys and specialists. The species belonging to

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Nymphalidae family was seen to be high, followed by species of the Lycaenidae family, Pieridae family and the species of the Papilionidae family was recorded to be least. Our results not only confirm the importance of protected sites for protecting biodiversity within a particular area but also highlight their beneficial effects in their surroundings.

Keywords: Diversity; butterflies; abundance; pea fowl sanctuary; choolanur; nymphalidae; pazhambalakode.

1. INTRODUCTION

Among insects, butterflies play a significant role in both ecological and economical benefits to human beings. They enhance aesthetic value due to their diverse colour and actively involved in pollination thus help in seed setting of plants. Due to their aesthetic beauty and ecological significance, butterflies are systematically well studied throughout the world since the early 18th century and a total of 19,238 species have been documented till now [1]. They are considered as the good indicators of habitat quality including anthropogenic disturbances [2]. Due to their dependence on plants butterfly diversity may reflect overall plant diversity in the given area (Antony et al., 2016). The butterfly diversity is high in tropics compared to temperate regions of the world. Along with their rich diversity, their habitats ranges from greenlands to the sand deserts.

Butterflies belong to the Order Lepidoptera. Lepidopterans are regarded as one of the important component of biodiversity (New and Collins, 1991) and are the second largest order among insects made up of approximately 1,50,000 species so far known to literature. The Word Lepidoptera derived from the Latin word "Scaly wing" and the Greek word "lepidon" (scale) and "ptera" (wings) and are considered as a prominent feature of adult butterflies. Lepidopteran butterflies are characterized by broad wings covered with minute overlapping scales, which are usually brightly coloured. Hind wing and fore wings of Lepidopterans are either overlapped simply or are linked by a frenulum, jugum and their wings are covered by double layer of scales. Head of adult Lepidopterans usually bears long and coiled proboscis; formed from elongated maxillary galeae which they uses to feed on nectar; presence of large labial palps are also noticed; while other mouthparts are absent; except mandibles are present primitively in some groups (Cranston & Gully, 2009). Lepidopterans bears large compound eyes. Antennae are knobbed or clubbed in butterflies while it is pectinate in moths. Lepidoptera is

divided into Heterocera (moths) and Rhopalocera (butterflies) [3]. Butterflies are divided into 2 superfamilies viz., Papilionoidea constitutes 11,100 species and contains four families: Papilionidae (Swallowtails), Pieridae (whites and Yellows), Nymphalidae (Brush footed butterflies) and Lycaenidae (blues); whereas Hesperioidea constitutes 3,650 species in the world and consists of a single family of Hesperidae (Skippers) [4]. There are 16,823 species of butterflies recorded from all over the world among them 1501 species are recorded from India [5]. In India, the Western Ghats, are considered as one of the most diversified areas containing a wide variety of butterfly species due to the typical ecoclimatic and geographic features. Of the 334 species that have been recorded from Western Ghats, 37 species are endemic to the region and 316 species have been reported from Kerala [6]. This study was thus undertaken with the primary objective of sampling the butterfly species of Choolanur forest premise region.

The main objective of the study were:

1. To document the butterfly fauna of Choolanur forest premise region.
2. To compare the species variation in the 2 sites.
3. To estimate the relative abundance of species.

To analyze the species diversity and evenness and richness at two sites.

2. MATERIALS AND METHODS

The selected sites for the investigation were Choolanur and Pazhambalakkode which is 4 km distant from each other and situated in Palakkad district.

The study area were:

Site 1- Choolanur (10 42' 713" and 10 43'962" N and 76 27' 407" and 76 29' 899" E) is situated adjacent to peafowl sanctuary which is a part of Choolanur forest. Choolanur region is said to

have immense floral composition since it is a forest premise region. The region has over 337 species of flowering plants. The forest can be described as Moist Deciduous Forest. The dominant tree species are *Xylia xylocarpa* (Irul), *Terminalia paniculata* (Maruti), *Bombax ceiba* (Elavu), *Lannea coromandelica* (Kalayam), *Azadirachta indica* (Aryaveppu), *Alstonica scholaris* (Ezhilampala) etc and there are many shrubs and herbs in the area.

Site 2 Pazhambalakkode is 4 km away from Choolanur forest premise and is populated and disturbed region. The plants and tree species include *Cocus nucifera*, *Mangifera indica*, *Ixora coccinea*, *Musa sp*, *Pisum sativum*, *Anacardium occidentale*, *Psidium guajava*, *Murraya koenigii*.

Butterflies were surveyed once in 2 weeks from the sampling sites. Sampling of butterflies was conducted from January 2016 to June 2016. We used direct searching and observation method. In this study, the target species were observed visually and were photographed and documented from site 1 and site 2.

Identification: Identification of collected butterfly were done at KFRI Peechi, Thrissur. All scientific names followed in this study are in accordance with photographic guide to Butterflies of Kerala [7].

Diversity was assessed by Shannon and simpsons Index

Shannon diversity index, $H'(S) = -\sum p_i \ln p_i$

$H'(S)$ - Shannon diversity index

P_i - i / total number of samples

Simpsons diversity index, $D = 1 - \left[\sum n(n-1) \right] / [N(N-1)]$

D – Simpsons diversity index

n – total number of organisms of a particular species

N – total number of organisms of all species

Calculation of Species richness:

The species richness was calculated using Margalefs index.

Margalefs index = $(S-1) / \ln N$

S – total number of species, N – total number of individuals in samples, \ln – natural logarithm

Evenness of butterflies:

Evenness of butterflies was calculated by using the Pielous Evenness Index, which is defined as $J' = H'S / \ln S$ where S is the number of species present in Site and H' is the diversity index. The value of J ranges from 0 to 1. Lesser the variations in the communities between the species, the higher the value of J .

Butterflies observed were categorized into 3 groups based on their abundance during the period of study. Accordingly those species observed 40 to 50 % of the survey days were categorized as very common (VC), 30 to 20 % as common (C), below 20 % as rare (Mathew 2014).

3. RESULTS AND DISCUSSION

The present work was conducted as a preliminary assessment of diversity of butterflies in the 2 selected sites. During the sampling, a total of 25 species of butterflies belonging to 4 families have been recorded from the 2 selected sites (Table 1). The photographs of the observed butterflies have been given in Plate No: 2. Family Nymphalidae showed the maximum species richness, comprising of 10 species; followed by Family Lycaenidae (6), Family Pieridae (5), and Family Papilionidae (4) species.

Diversity of butterfly: The diversity of butterfly when compared in the 2 sites using Simpson index, Site 1 Choolanur (0.95) is said to be slightly more diverse than Site 2 Pazhambalakkode (0.94). And the Shannon index also revealed the same result. And this might be because of reasons like more host plant and different kinds of adult nectaring plants present there at Site 1 and also Site 1 (Choolanur) being highest in biologically controlled system and lower in polluted ecosystems. The present study deals with analyzing diversity (Table 5) of butterflies in 2 sites by using Simpsons index (Graph 3) and Shannon index (Graph 4). Species richness was also calculated using Margalefs index, and species richness is found to be more at Site 1 (3.5) than Site 2 (3.2).

This study investigates the diversity of butterfly in 2 selected sites Choolanur and Pazhambalakkode of Palakkad district and since, the peafowl sanctuary and Choolanur forest region are protected regions the study is done only in and around peafowl sanctuary and

Choolanur forest premise and the diversity of butterfly was found to be a little high at Site 1 choolanur, with Nymphalidae family being most species. The number of butterfly from Papilionidae and Lycaenida family was seen to be less. But at Site 2 Pazhambalakkode the diversity was almost similar to the diversity of Site 1 with only a variation of 0.01. And here, also the species belonging to Nymphalidae family was seen to be high followed by species of Lycaenidae family, Pieridae family and the species of Papilionidae family was seen to be least here. The variation in the diversity index of the 2 sites is less this might be because of migration which takes place since the 2 sites are at a close distance, apart from variation in host plants. Species richness of the 2 sites have been calculated and the Choolanur, Site 1(3.5) is seen to have higher species richness compared to Pazhambalakkode , Site 2 (3.2).

The abundance of grass yellow at both the sites would perhaps be attributed to their polyphagous nature and they are herb feeders. This might be one of their evolutionary advantages that makes them the commonest butterflies in the world. The species richness and abundance was lower in Site 2 than Site 1 where host plants are less when compared to Site 1 which is adjacent to forest region and this being less populated.

In the study, there were no representatives from Hesperidae, it may be partially due to sampling bias, since Hesperids are crepuscular habit ie ; they are active early in morning and to lesser extend in the evening , they are also active in the shade [8] .

Abundance of butterfly: A total of 293 individuals of butterflies belonging to 25 species and 4 families were recorded during the study period (Table 1). On the basis of number of collected species family Nymphalidae was the most dominant family with 10 species followed by Lycaenidae (6) ,Pieridae (5), and Papilionidae (4). Percent contribution of the abundance of individuals and number of species of different families of butterflies collected from study area are represented in (Table 4).

Family Nymphalidae was the most dominant family which constituted 40% of the total collected butterflies. *Neptias hylas* was the most dominant species of this family which constituted (21%) of total individuals of this family followed by *Acraea terpsicore* (15%) , *Tirumala limniace* (14.9%), *Melanitis leda* (14.1%), *Orsotriaena*

medus (8.9%), *Hypolimnas misippus* (8.2%), *Euploea core* and *Ariadne merione* (5.9%), *Mycalesis perseus* and *Danaid chrysippus* (3.7%).

Family Lycaenidae was the second most dominant family which constituted 24 % of the total collected butterflies. *Castalius rosimon* was the dominant species of this family which constituted 35% of total individuals of this family, followed by *Leptotis plinius* (25%), *Caleta decidia* (14.7%), *Zeltus etolus* (11.7%), *Talicauda nyseus* (7.3%), and *Rathinda amor* (5.8%). Family Pieridae was the third most abundant family which constituted 20% of the total recorded individuals of butterflies and represented by 5 species. *Eurema hecaba* was the dominant species of this family which constituted (33%) of total individuals of this family followed by *Leptosia nina* (22%), *Delias eucharis* and *Catopsilia pomona* (18%) and *Catopsiliapyranthe* (7%). Family Papilionidae was represented by 4 species and constituted 16% of total collected butterflies. *Atrophaneura hector* was the dominant species of this family which constituted 40% of the total individuals of this family followed by *Graphium nominus* (25%), *Papilio mormon* (18%) and *Papilio buddha* (14%).

Diversity studies at different sampling sites:

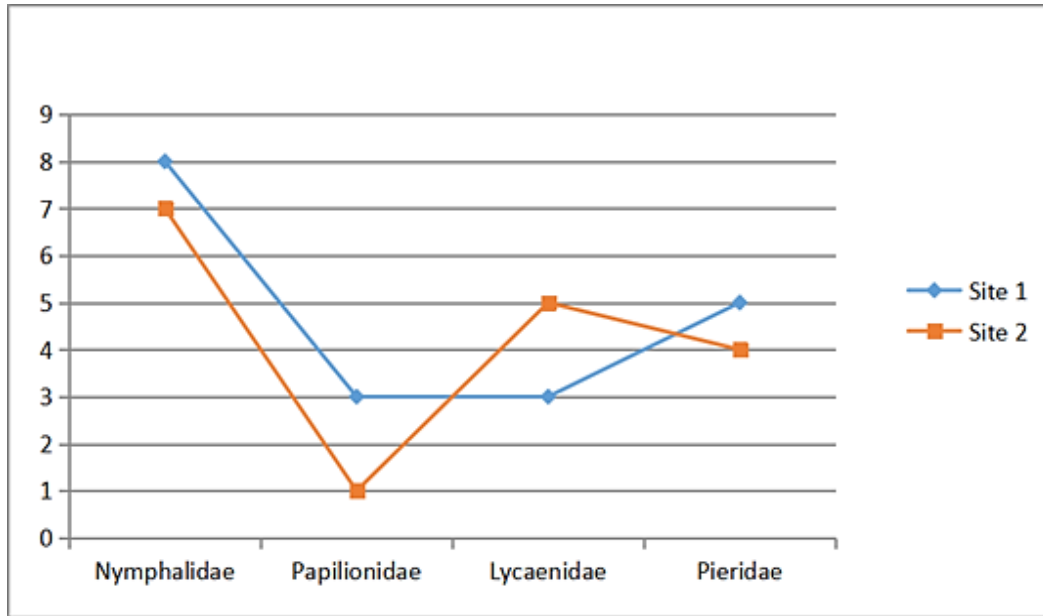
Out of the 334 species of Kerala, 37 endemic species of Western Ghats have been reported in earlier studies. Crimson rose collected in this study is a butterfly included in Schedule 1 of IWL (P) Act 1972. Common crow, Common evening brown, Malabar Banded Peacock in this study arGpea are endemic species. The common migratory species like Common emigrant, Mottled emigrant, Common crow, Plain tiger, Common jezebel, Tawny coster , Blue tiger etc had also been reported . *Papilio Buddha* which is endemic to Western Ghat has been reported. Some species like Angled pierrot, Fluffy tit, Spot sword tail and Malabar banded peacock are considered to be rare. This calls the need for conservation [9].

The study reveals that the study area provides favourable ecological conditions and habitat for butterflies. The highest number of species was recorded from Site 1 favouring the observation of Padhey et al. [10], Kunte ,[11] and Tiple et al. [12].

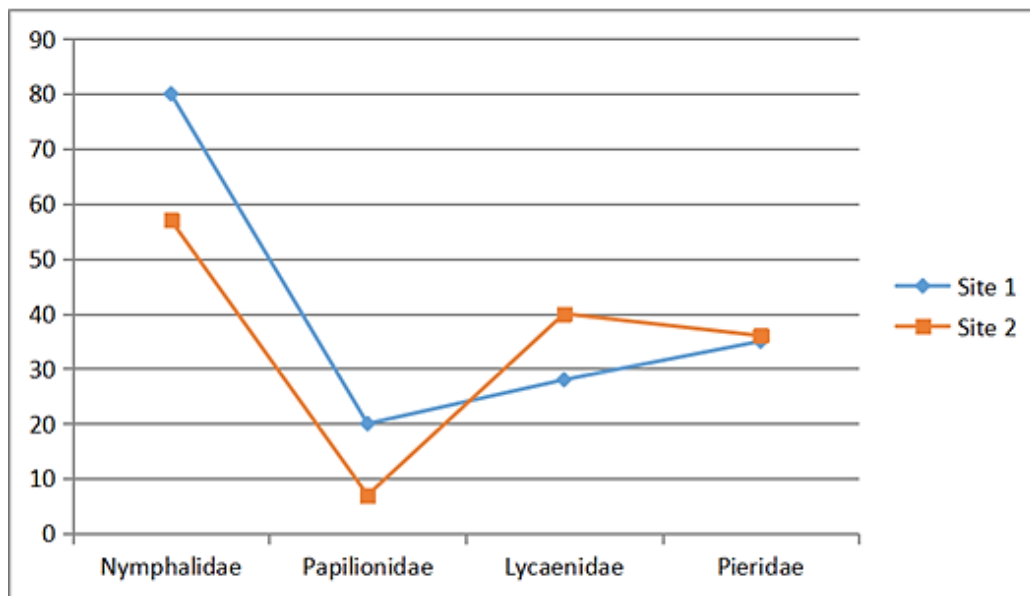
The butterflies have been found more in the protected areas than the nearby [9,13]. This includes improvements in management, the

allocation of funds towards targeted biodiversity support and enhanced monitoring [14], (Hochkirch et al., 2013; Hodge, Hauck, & Bonn, 2015), Potts et al. [15]. Furthermore, future management concepts need to consider a wider biodiversity context and should also take into account the mitigation of other potential drivers

such as climate change. With respect to butterflies (and many other organisms as well), this means, for example, a stronger consideration of the landscape context in conservation planning and management for heterogeneity of habitats across space and time [16,17,18,19,20].

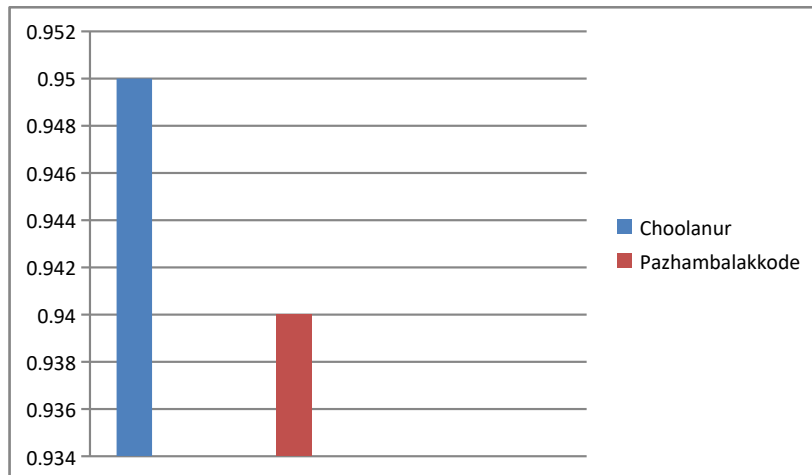


Graph 1. Family wise composition of butterfly species at Site 1 (Choolanur) and Site 2 (Pazhambalakkode)



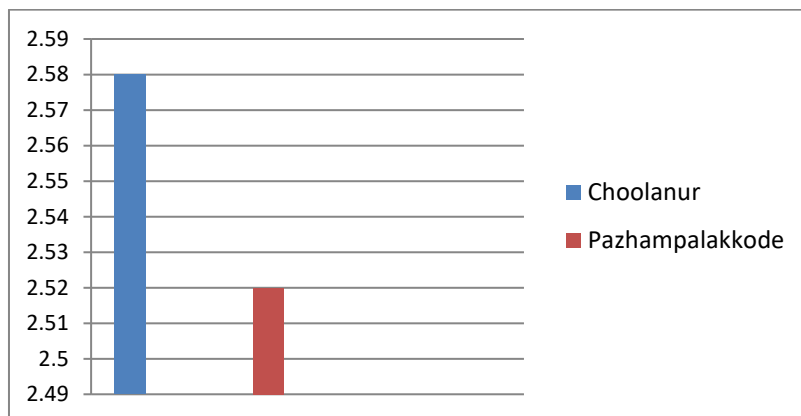
Graph 2. Total number of individuals sighted from Site 1 (Choolanur) and Site 2 (Pazhambalakkode)

Simpsons Diversity Index Graph:

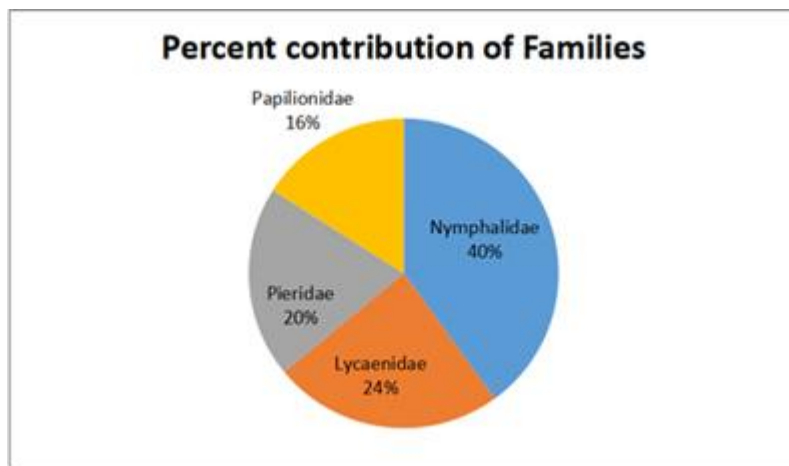


Graph 3. Diversity index at Site 1 and Site 2

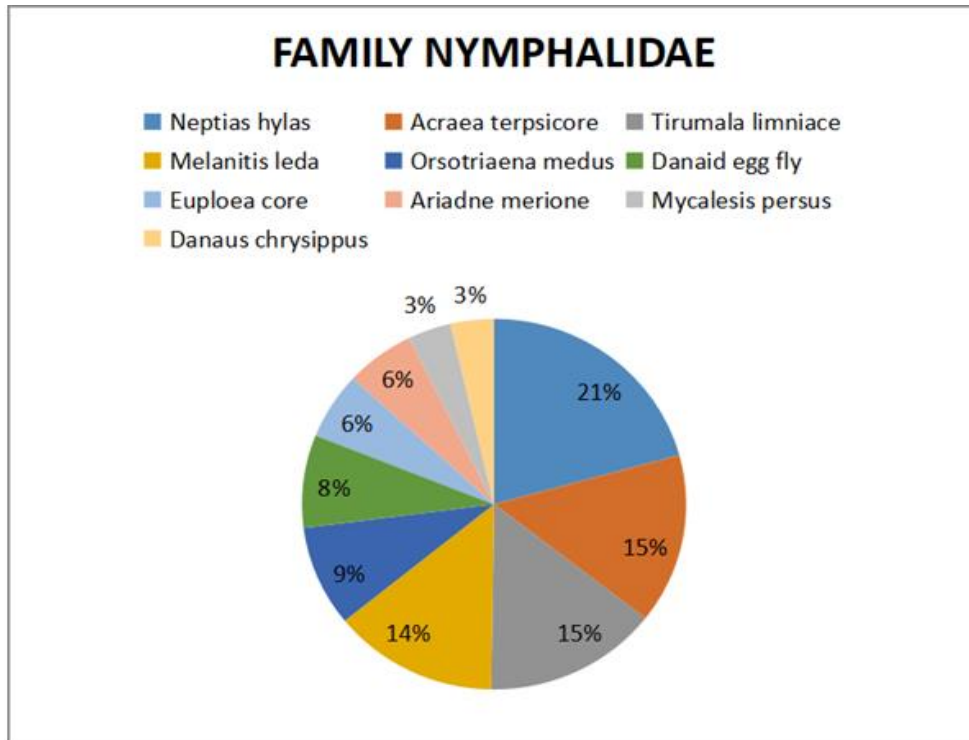
Shannon Diversity Index Graph:



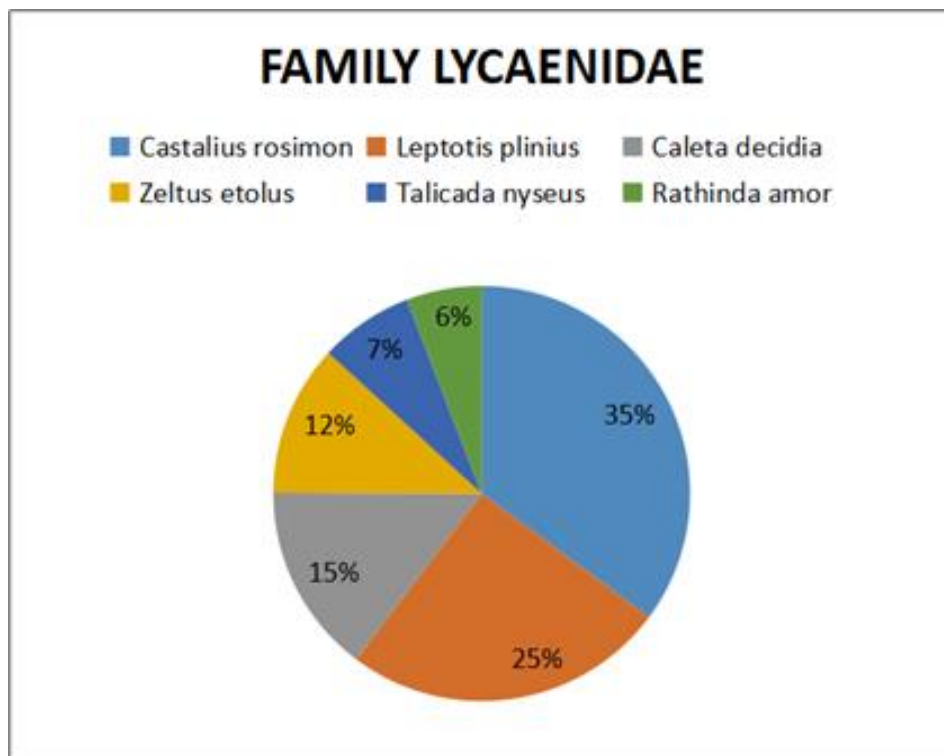
Graph 4. Showing diversity index at Site 1 and Site 2



Pie Chart 1. Representing Percent Contribution of Families



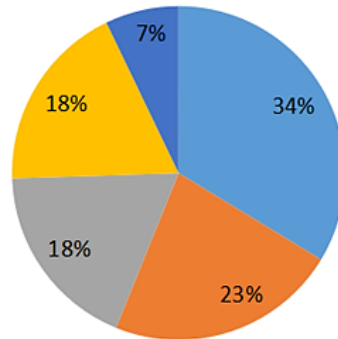
Pie chart 2. Pie chart representing percent contribution of family nymphalidae



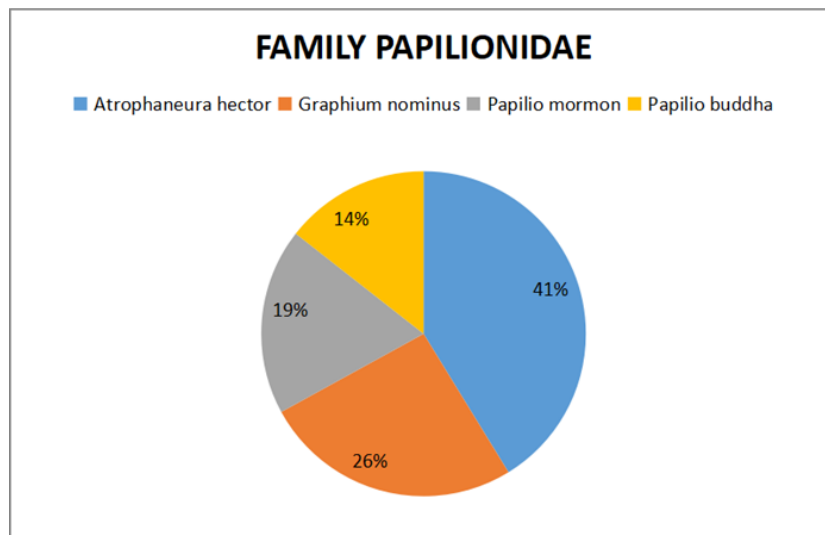
Pie chart 3. Pie chart representing percent contribution of family lycaenidae

FAMILY PIERIDAE

Eurema hecaba Leptosia nina Delias eucharis
Catopsilia pomona Catopsilia pyranthe



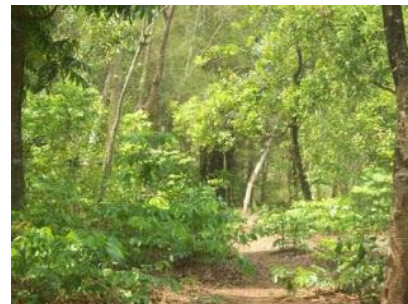
Pie chart 4. Pie chart representing percent contribution of family pieridae



Pie chart 5. Pie chart representing the percent contribution of family papilionidae



Choolanur (Site 1)



Pazhambalakkode (Site 2)

Plate 1. Palakkad



1. *Melanitis leda*



2. *Tirumala limniace*



3. *Danaus chrysippus*



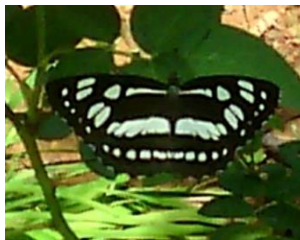
4. *Mycalesis persus*



5. *Ariadne merion*



6. *Hypolimnas missipus*



7. *Neptias hylas*



8. *Orsotriaena medus*



9. *Acraea terpsicore*



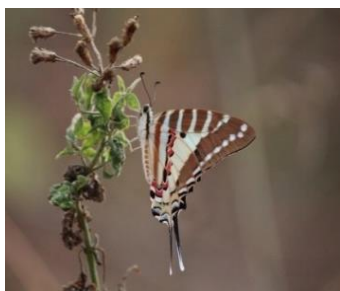
10. *Euploea core*



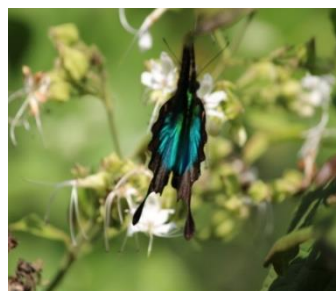
11. *Atrophaneura hector*



12. *Papilio polytes*



13. *Graphium nominus*



14. *Papilio buddha*



15. *Caleta decidia*



16. *Castalius rosimon*



17. *Zeltus etolus*



18. *Talicauda nyseus*



19. *Leptotis plinius*



20. *Rathinda amor*



21. *Eurema hecabe*



22. *Leptosia nina*



23. *Delias eucharis*



24. *Catopsilia pomona*



25. *Catopsilia pyranthe*

Plate 2. Collected butterflies from choolanur and pazhambalakkode

Table 1. List of butterflies recorded from the study are

SI no	Family name	Scientific name	Common name	Status	Relative abundance
01.	Nymphalidae	<i>Tirumala limniace</i>	Blue tiger	Migratory	Very Common
02.		<i>Mycalesis persus</i>	Common bush brown	-	Common
03.		<i>Ariadne merione</i>	Common castor	-	Common
04.		<i>Melanitis leda</i>	Common evening brown	Endemic	Very Common
05.		<i>Hypolimnas misippus</i>	Danaid egg fly	Schedule 1	Common
06.		<i>Neptias hylas</i>	Common sailor	-	Very Common
07.		<i>Orsotriaena medus</i>	Dark grass brown	-	Very Common
08.		<i>Acraea terpsicore</i>	Tawny coster	Migratory	Very Common
09.		<i>Danaus chrysippus</i>	Plain tiger	Migratory	Very Common
10.		<i>Euploea core</i>	Common Indian crow	Endemic, Migratory	Very Common
11.	Papilionidae	<i>Graphium nominus</i>	Spot sword tail	-	Rare
12.		<i>Atrophaneura hector</i>	Crimson rose	Schedule 1	Common
13.		<i>Papilio buddha</i>	Malabar banded peacock	Endemic, Schedule 2	Rare
14.		<i>Papilio mormon</i>	Common Mormon	-	Common
15.	Lycaenidae	<i>Rathinda amor</i>	Monkey puzzle	-	Common
16.		<i>Caleta decidia</i>	Angled pierrot	Migratory	Rare
17.		<i>Castalius rosimon</i>	Common pierrot	Schedule 1	Common
18.		<i>Zeltus etolus</i>	Fluffy tit	-	Rare
19.		<i>Talicauda nyseus</i>	Red pierrot	-	Common

Table 2. Species of butterflies recorded in Site 1 Choolanur pea folwl sanctuary

SI no	Family name	Species name	Visiting host plant	Total number of butterflies recorded
01.	Nymphalidae	<i>Melanitis leda</i>	<i>Caryota urens</i> , <i>Musa sp</i>	9
02.		<i>Hypolimnas misippus</i>	<i>Blainvillea rhomboidea</i>	11
03.		<i>Neptias hylas</i>	<i>Leucas aspera</i>	14
04.		<i>Orsotriaena medus</i>	<i>Tridas procumbens</i>	12
05.		<i>Danaus chrysippus</i>	<i>Catharanthus roseus</i>	5
06.		<i>Acraea terpsicore</i>	<i>Ixoracoccinea</i> , <i>Chysanthem coronarium</i>	8
07.		<i>Tirumala limniace</i>	<i>Pisum sativum</i> , <i>Hyptis suaveolens</i>	13
08.		<i>Euploea core</i>	<i>Crotalaria</i> , <i>Heliotropium</i>	8
09.	Papilionidae	<i>Atrophaneura hector</i>	<i>Ervatamia coronaria</i> , <i>Leucas aspera</i>	11
10.		<i>Papilio buddha</i>	<i>Citrus spp.</i>	4
11.	Lycaenidae	<i>Papilio polytes</i>	<i>Lantana camara</i> , <i>Ixora coccinea</i>	5
12.		<i>Castalius rosimon</i>	<i>Mimosa pudica</i> , <i>Leucas aspera</i>	12
13.		<i>Leptotis plinius</i>	<i>Medicago sativa</i>	12
14.		<i>Rathinda amor</i>	<i>Ixora spp.</i>	4
15.	Pieridae	<i>Eurema hecaba</i>	<i>Leucas aspera</i> , <i>Allamanda spp.</i>	9
16.		<i>Catopsilia pomona</i>	<i>Ixora coccinea</i> , <i>Glyricidia maculate</i>	7
17.		<i>Catopsilia pyranthe</i>	<i>Ixora spp.</i>	5
18.		<i>Delias eucharis</i>	<i>Hibiscus spp.</i> , <i>Ixora</i>	7
19.		<i>Leptosia nina</i>	<i>Luecas aspera</i> , <i>Nerium oleander</i>	7

Table 3. Species of butterfly recorded from site 2 Pazhambalakkode

Sl no	Family name	Species name	Visiting host plant	Number of butterfly	
01.	Nymphalidae	<i>Tirumala limniace</i>	<i>Pisum sativum</i> ,	7	
02.		<i>Mycalesis perseus</i>	<i>Hyptis suaveolens</i>	5	
03.		<i>Ariadne merione</i>	<i>Leucas aspera</i> , <i>Ervatamia coronaria</i>	8	
04.	Papilionidae	<i>Melanitis leda</i>	<i>Musa sp</i>	10	
05.		<i>Euploea core</i>	<i>Crotalaria</i>	5	
06.		<i>Acraea terpsicore</i>	<i>Ixora coccinea</i>	7	
07.		<i>Neptias hylas</i>	<i>Leucas aspera</i>	15	
08.		<i>Graphium nominus</i>	<i>Miliusa velutina</i>	7	
09.		Lycaenidae	<i>Caleta decidia</i>	<i>Leucas aspera</i> , <i>Mimosa pudica</i>	10
10.			<i>Castalius rosimon</i>	<i>Mimosa pudica</i>	12
11.			<i>Zeltus etolus</i>	-	8
12.			<i>Talicauda nyseus</i>	<i>Alternanthera sp</i>	5
13.			<i>Leptosius plinius</i>	<i>Medicago sativa</i>	5
14.		<i>Eurema hecaba</i>	<i>Leucas aspera</i>	15	
15.		<i>Leptosia nina</i>	<i>Leucas aspera</i>	9	
16.	Pieridae	<i>Catopsilia pomona</i>	<i>Ixora coccinea</i>	6	
17.		<i>Delias eucharis</i>	<i>Hibiscus spp</i> , <i>Ixora</i>	6	

Table 4. Relative abundance of different families of butterflies recorded from the study area in both Site 1 and Site 2

Sl no	Families	Total number of species in site 1&2	% of species	Total number of individuals in site 1&2	% of individuals
01.	Nymphalidae	10	40.00	134	44.66
02.	Papilionidae	4	16.00	27	9.00
03.	Pieridae	5	20.00	71	23.67
04.	Lycaenidae	6	24.00	68	22.67
	Total	25	100.00	300	100.00

Table 5. Diversity indices of butterflies in Choolanur and Pazhambalakkod

Sl no	Sites	No: of species	Total no: of butterfly	Simpsons Diversity index D	Evenness E	Shannon diversity index H ²	Evenness E	Species richness
01.	Choolanur	19	159	0.946	0.32	2.58	0.87	3.5
02.	Pazhambalakkode	16	134	0.934	0.33	2.52	0.89	3.2

Table 6. Distribution of butterflies in Choolanur and Pazhambalakkode

Sl no	Scientific name	Choolanur	Pazhambalakkode
01.	<i>Tirumala limniace</i>	+	+
02.	<i>Mycalesis perseus</i>	-	+
03.	<i>Ariadne merione</i>	-	+
04.	<i>Melanitis leda</i>	+	+
05.	<i>Hypolimnas misippus</i>	+	-
06.	<i>Neptias hylas</i>	+	+
07.	<i>Orsotriaena medus</i>	+	-
08.	<i>Acraea terpsicore</i>	+	+
09.	<i>Danaus chrysippus</i>	+	-
10.	<i>Euploea core</i>	+	+
11.	<i>Atrophaneura hector</i>	+	-
12.	<i>Graphium nominus</i>	-	+
13.	<i>Papilio buddha</i>	+	-
14.	<i>Papilio polytes</i>	+	-
15.	<i>Rathinda amor</i>	+	-
16.	<i>Caleta decidia</i>	-	+
17.	<i>Castalius rosimon</i>	+	+
18.	<i>Zeltus etolus</i>	-	+
19.	<i>Talicauda nyseus</i>	-	+
20.	<i>Leptotis plinius</i>	+	+
21.	<i>Eurema hecaba</i>	+	+
22.	<i>Leptosia nina</i>	+	+
23.	<i>Delias eucharis</i>	+	+
24.	<i>Catopsilia pomona</i>	+	+
25.	<i>Catopsilia pyranthe</i>	+	-

4. CONCLUSION

Mere legislations alone will not be helpful in conservation of the insect diversity present in various ecosystems. Active involvement by the community is one of the greatest resources available in managing biodiversity across all landscapes. Educating the community on the need for environmental conservation is very important to achieve the desired goals. Butterfly gardens and Butterfly houses have been proposed as ideal means for maintaining resident butterfly. Such an attempt of creating butterfly garden has been begun in the 'Choolanur Peafowl Sanctuary' which is close to Site1. As these living jewels form an essential part of the

ecosystem, no efforts can be spared in the attempt to conserve them.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Authors Sruthi MS and Lakshmi Devi Menon P hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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