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Assessment of Diversity Pattern of Butterfly Fauna in Chail Wildlife Sanctuary, Himachal Pradesh : An Appraisal for Conservation Management

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Abstract

The present study provides information on Habitat Preferences of Butterflies of Forests of Chail Wildlife Sanctuary for the first time. Chail Wildlife sanctuary located in Solan district of Himachal Pradesh has a wide forest cover and it owes its prime conservation value due to its biodiversity. Because data on bio-resources that are crucial to ecological functioning is scarce, the current study documented the species composition of butterfly fauna and seasonal trends in richness and abundance of butterflies in Chail Wildlife Sanctuary for future management and conservation. The study's goal was to identify priority conservation species, their seasonality, and this area's butterfly diversity potential. From February 2018 to January 2021, surveys were conducted in three different seasons. A total of 3590 butterfly species were found during three years of field Survey. These belonged to five families. 68 butterfly species of families i.e. Nymphalidae (32 species) followed by species), Lycaenidae (13 species), Pieridae (12), Papilionidae (8 species) and Hesperiidae (3 species) of the order Lepidoptera were found. Family Nymphalidae with a percent composition of 42% oftotal individuals was the most dominant taxonomic group among them.The results of the study indicated thatthe Chail Wildlife Sanctuary has a healthy environmental setup that accommodates rich butterfly diversity and different diversity indices showed high diversity in community structure. This study is likely to contribute towards the conservation of butterfly fauna in this area.

Introduction

The diurnally active butterflies are universally treasured for their often bright and colourful patterns. Butterflies are important pollinators and herbivores among insects (1), with a long history of co evolution with plants (2). They are an excellent subject for ecological studies of landscapes (3) and their importance as biotope quality indicators is becoming increasingly recognised because of their sensitivity to modest changes in micro-habitat (4). Butterflies as pollinators play an important role in the growth, maintenance, and expansion of flora in tropical areas where they are abundant and diverse (5). Many studies have highlighted the diversity of insects because they provide ecosystem services such as pollination andpest control, breakdown of nutrients, and conservation of species in the land and aquatic environments (6). Butterfly diversity observations offer information on differences in species richness and abundance in response to vegetation along the landscape and species interactions (7, 8). It is now widely accepted that biodiversity is being lost on a worldwide basis as a result of numerous anthropogenic activities (9,10). Insects are mostly used to assess forests for biological resource conservation (11,12). Butterflies are among the most diverse insects, making them suitable candidates for ecological research in the forests (13, 14). Many researchers have looked into the diversity, distribution, and relative abundance of insects from all throughout the country. However, just a few studies on the role of butterflies as flower visitors and pollinators in the Himalayan region have been done. However, no research has been done on Rhopalocera fauna in the selected wildlife sanctuary and the surrounding places. As a result, the current research was conducted to investigate the role of butterflies as flower visitors and pollinators in the Chail Wildlife Sanctuary. This study also intended to bring out any hitherto not recorded threatened taxa of butterfly from this natural preserve of wildlife in this part of south Asia.

Material and Methods

Sample Collection : Chail Wildlife Sanctuary was selected as the site for the present investigations. The Sanctuary having an area of 1020.32 ha is distributed across the altitudinal range between 900m-2275m amsl and lies in between 310 05' to 1075' N latitudes and 770 12' to 770 15' E longitudes. The study area was divided into 3 different altitudinal Sites. Transects were selected on each and every accessible aspect of the sanctuary during the years 2018-2021. Each year was divided into three seasons based on general observation on the climate. These were June to September (Monsoon), October to January (Postmonsoon) and from February to May (Premonsoon). Pollard Walk sampling method (15), was adopted and transects, each with 1000 x10 m^2 were selected at different habitats that were visited regularly. The information regarding the butterfly collected, temperature, rainfall, GPS coordinates and host plants was recorded.

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Identification of Butterfly Specimen : Collected butterflies were identified using field guides (16, 17, 18) and followed by their classification (19). All the butterfly specimens were collected, processed and preserved according to the method used by Wynter-Blyth (20). The collected butterfly specimens are maintained in the Forest Protection Division, HFRI Pathaghati, Shimla.

Statistical Analysis of data

Measurement of diversity : The diversity of species i.e. the number of different species that are represented in given habitat or community was calculated by using Shannon-Wiener diversity Index (21).

$$H = - \quad (Ni/N) \ln (Ni/N)$$

b. Measurement of species Evenness : Evenness Index was calculated as per Hill (22) which measures that how close in number different species exist in an environment.

$$J = H/ \ln S$$

c. Measurement of Species Richness : Margalef's Index (23) was used as a simple measure to calculate the number of different species represented in an ecological community.

Margalef's index (M) = (S-1) / ln N

Where, Ni = Number of individuals of species I, S=Total number of species, N=Total number of individuals of all the species, H=Index of diversity, ln = Natural logarithm, J is the Evenness index.

d. Measurement of relative abundance : Based on the relative abundance estimates, the Butterflies were classified according to (24) as follows : Abundant : >30%, Very Common : 20%-30%, Common : 10% - 20%, Frequent : 5%-10%, Occasional : 1%-5%, Rare : < 1%.

Results and Discussion

Species Richness, Abundance and Diversity : 68 butterfly species (Table-1) of families i.e. Nymphalidae (32 species) followed by species, Pieridae (12 species), Lycanidae (13), Papilionidae (8 species) and Hesperiidae (3 species) of the order Lepidoptera were observed and identified. The percentage composition of different butterfly families showed that the most dominant family was Nymphalidae that constituted 42% of total and lowest percent was of family Hesperiidae i.e 1% while the other three families i.e. Pieridae, Lycanidae and Papilionidae showed the percentage composition of 31%, 22% and 4%, respectively (Fig-1). The relative abundance of butterflies was calculated and among the total butterfly species found, 53% species were rare 42 % were frequent and 5% were rare (Fig-2). The cumulative number of families in different seasons (Fig-4) butterfly individuals in different months of the year has been shown in Fig 5. The richness indices of the butterfly fauna has been shown in the Table-3. The maximum number of individuals (526) was found in the premonsoon of year 2018-2019 and minimum number of individuals (275) was found in postmonsoon of the year 2020-2021 (Table-4). The number of butterfly individuals however remained high during the premonsoon and minimum during the postmonsoon. The species diversity was found to be maximum (1.54) in the postmonsoon of the year 2018-2019 and minimum (1.36) in the premonsoon of the year 2020-2021. Species richness was maximum (17.92) in the premonsoon of the year 2019-2020 and minimum (13.38) in the monsoon of year 2020-2021. The species evenness was more or less same during all the seasons, postmonsoon having a little higher value (0.95).The cumulative number of individuals in different seasons has been shown in Table-3. The maximum number of individuals was found in the premonsoon of every year and minimum numbers of individuals were found in postmonsoon.

The Relationship between Physical Factors and Butterfly Diversity : The value of correlation coefficient between the average temperature and the abundance of butterfly individuals during different months of the year is 0.5121. It can be interpreted that there is a moderate positive correlation between these variables, which means there is a tendency for high butterfly population with a rise in temperature and vice versa (25). However there was no correlation between the average rainfall and butterfly as the value of R was –0.801 (Weak negative correlation).

Conclusions

The decline in species diversity and abundance during the winter season is linked to habitat dryness and seasonal variations in microhabitat conditions. With the advent of dry conditions in December, the butterfly population began to fall in numbers. Many butterflies struggled during this dry season, owing to a lack of water, nectar, and fresh leaves. The highest abundance was noted in the months of April-May and after the rainy season in the months of September-October. Optimal light, temperature, and rainfall typically boost vegetation, favouring their abundance directly. However, because butterflies strive to time their emergence with fresh young leaves of their plants, peaks and troughs were observed in their population pattern. Since no earlier study in this area had been done by anyone, no comparison could be established, but the study did imply that more research and correct strategies are needed for long-term conservation in this area. It will also help researchers to create a baseline data that will be utilised by future researchers to design habitat conservation plans and

Table-1 : Distribution of Butterfly Species collected from the Chail Wildlife sanctuary.

Sr. No.	Species	Family	Latitude	Longitude	Altitude
1.	*Accraeaissoria*	Nymphalidae	30°57’23.81"N	77°11’8.43"E	2014
2.	*Aglaiscashmirensis*	Nymphalidae	30°59’23.64"N	77°12’26.06"E	2098
3.	*Argyreushyperbius*	Nymphalidae	30°57’9.26"N	77°10’26.81"E	1945
4.	*Athymaperius*	Nymphalidae	30°57’9.05"N	77°10’29.08"	1949
5.	*Auloceraswaha*	Nymphalidae	30°56’10.83"N	77°12’12.83"E	1908
6.	*Callerabiaananda*	Nymphalidae	30°57’21.85"N	77°11’11.93"E	2125
7.	*Cyestisthyodamas*	Nymphalidae	30°58’23.76"N	77°11’56.83"E	1917
8.	*Danauschrysippus*	Nymphalidae	30°57’20.95"N	77°11’15.49"E	2019
9.	*Dodona durga*	Nymphalidae	30°58’26.02"N	77°11’56.53"E	2111
10.	*Elymniashypermnestra*	Nymphalidae	30°57’32.96"N	77°13’37.04"E	2108
11.	*Elymniasundularis*	Nymphalidae	30°57’56.97"N	77°12’5.32"E	2147
12.	*Euploiaklugii*	Nymphalidae	30°59’23.76"N	77°12’25.65"E	2021
13.	*Euploiamulciber*	Nymphalidae	30°59’23.31"N	77°12’28.52"E	2099
14.	*Euploiasylvesterbarsim*	Nymphalidae	30°56’6.56"N	77°12’16.25"E	2125
15.	*Euthalialubentina*	Nymphalidae	30°57’32.15"N	77°13’46.92"E	2092
16.	*Fabricianaadippe*	Nymphalidae	30°59’23.27"N	77°12’28.49"E	2093
17.	*Issorialathonia*	Nymphalidae	30°56’13.85"N	77°12’9.02"E	2027
18.	*Junoniaiphita*	Nymphalidae	30°57’11.15"N	77°10’24.45"E	1962
19.	*Junonialimonias*	Nymphalidae	30°57’10.24"N	77°11’56.45"E	2020
20.	*Junoniaorithya*	Nymphalidae	30°57’19.80"N	77°11’15.27"E	2134
21.	*Kallima inachus*	Nymphalidae	30°58’28.24"N	77°11’56.32"E	2117
22.	*Kaniskacanace*	Nymphalidae	30°57’9.04"N	77°10’27.85"E	1949
23.	*Lassiomataschkara*	Nymphalidae	30°57’31.14"N	77°13’41.02"E	2100
24.	*Lethe naga*	Nymphalidae	30°59’20.89"N	77°12’26.43"E	2025
25.	*Lethe rohria*	Nymphalidae	30°59’22.22"N	77°12’28.42"E	2136
26.	*Libytheamyrrha*	Nymphalidae	30°58’40.61"N	77°12’6.15"E	2122
27.	*Melantislida*	Nymphalidae	30°59’24.04"N	77°12’25.78"E	2117
28.	*Neptisyerbhuryi*	Nymphalidae	30°58’32.62"N	77°11’58.96"E	2126
29.	*Pantoporiahardonea*	Nymphalidae	30°58’30.46"N	77°11’57.97"E	1917
30.	*Phalanthaphalantha*	Nymphalidae	30°57’59.76"N	77°12’6.66"E	2130
31.	*Vanessa carduii*	Nymphalidae	30°59’23.00"N	77°12’28.54"E	2018
32.	*Ariciaastrarche*	Lycanidae	30°59’20.81"N	77°12’26.58"E	2136
33.	*Atheneemolus*	Lycanidae	30°58’28.11"N	77°11’56.38"E	2014
34.	*Celastrinahueglii*	Lycanidae	30°59’19.24"N	77°12’26.14"E	2091
35.	*Celastrinamarginata*	Lycanidae	30°57’57.86"N	77°12’5.83"E	2147
36.	*Deudorixepijarbas*	Lycanidae	30°57’13.01"N	77°11’54.24"E	2027
37.	*Heliophorusandrocles*	Lycanidae	30°56’10.85"N	77°12’14.68"E	2013
38.	*Heliophorusepicles*	Lycanidae	30°59’24.04"N	77°12’25.78"E	2136
39.	*Loxuraatymnus*	Lycanidae	30°58’27.22"N	77°11’55.58"E	2111
40.	*Lycaenapavanna*	Lycanidae	30°56’10.79"N	77°12’13.48"E	2148
41.	*Lycaenaphlaeus*	Lycanidae	30°56’5.42"N	77°12’16.82"E	2117
42.	*Neozephirus duma*	Lycanidae	30°56’28.60"N	77°12’11.55"E	2008
43.	*Prosotusbhutea*	Lycanidae	30°56’26.09"N	77°12’13.67"E	1996
44.	*Zizzeriakarsandra*	Lycanidae	30°59’20.82"N	77°12’26.52"E	2111
45.	*Deliasbelladona*	Pieridae	30°59’23.97"N	77°12’27.99"E	2133
46.	*Aporiaagathon*	Pieridae	30°56’10.79"N	77°12’13.48"E	2024
47.	*Belenoisaurota*	Pieridae	30°59’21.14"N	77°12’27.32"E	2013
48.	*Catopsillapomona*	Pieridae	30°59’19.69"N	77°12’26.32"E	1898

Table-1 : Contd...

Sr. No.	Species	Family	Latitude	Longitude	Altitude
49.	*Coliasfieldii*	Pieridae	30°57’21.65"N	77°11’10.19"E	2111
50.	*Euremahecabe*	Pieridae	30°56’10.61"N	77°12’14.21"E	1897
51.	*Euremalaeta*	Pieridae	30°57’22.66"N	77°11’12.36"E	2034
52.	*Genopteryxrhamni*	Pieridae	30°58’42.04"N	77°12’9.96"E	2105
53.	*Pierisbrassicae*	Pieridae	30°58’4.28"N	77°12’7.74"E	2097
54.	*Pieris conidia*	Pieridae	30°56’14.08"N	77°12’9.96"E	1898
55.	*Pierisnapi*	Pieridae	30°57’21.21"N	77°11’7.86"E	2014
56.	*Pierisrapae*	Pieridae	30°59’23.95"N	77°12’25.72"E	2028
57.	*Pontiadaplidice*	Pieridae	30°59’21.61"N	77°12’28.09"E	2094
58.	*Atrophaneurapolyeuctes*	Papilionidae	30°56’14.22"N	77°12’9.83"E	2024
59.	*Graphiumsarpedon*	Papilionidae	30°59’22.26"N	77°12’28.40"E	2130
60.	*Papiliodemoleus*	Papilionidae	30°58’41.56"N	77°12’6.21"E	2117
61.	*Papiliomachaon*	Papilionidae	30°58’5.47"N	77°12’8.64"E	2098
62.	*Papilioparis*	Papilionidae	30°58’27.11"N	77°11’55.49"E	2013
63.	*Papiliopolyctor*	Papilionidae	30°59’19.11"N	77°12’26.07"E	2093
64.	*Papilioprotenor*	Papilionidae	30°57’10.95"N	77°10’31.00"E	1955
65.	*Parnassiushardwickii*	Papilionidae	30°56’32.84"N	77°12’11.29"E	2002
66.	*Celanorhinnusauritivitta*	Hesperidae	30°59’19.72"N	77°12’26.38"E	2132
67.	*Pelopedassubochracea*	Hesperidae	30°58’25.93"N	77°11’56.65"E	2019
68.	*Pseudocoladoniadandan*	Hesperidae	30°59’24.01"N	77°12’28.03"E	2019

Table-2 : Quantitative estimates of Species Diversity, Species Richness, and Species Evenness of butterfly families in Chail Wildlife Sanctuary.

Index	Nymphalidae	Pieridae	Lycanidae	Papilionidae	Hesperidae
Shannon’s Diversity	1.28	0.91	0.955	0.79	0.35
Margalef’s Richness	9.76	3.6	4.15	3.17	1.31
Jaccard Evenness	0.86	0.87	0.88	0.93	1.16

Table-3 : The seasonal diversity of the Butterfly species in different seasons of the Chail Wildlife sanctuary in the year 2018-2019, 2019-2020, 2020-2021.

Year	2018-2019			2019-2020			2020-2021		
Season	Species Diversity	Species Richness	Species Evenness	Species Diversity	Species Richness	Species Evenness	Species Diversity	Species Richness	Species Evenness
Premonsoon	1.41	14.7	0.88	1.47	17.92	0.87	1.42	15.1	0.88
Monsoon	1.43	13.99	0.91	1.45	14.81	0.91	1.36	13.4	0.88
Postmonsoon	1.54	16.7	0.94	140	14.85	0.89	1.487	14.8	0.95

Table-4 : The cumulative number of individuals in different seasons in Chail Wildlife Sanctuary sanctuary in the year 2018-2019, 2019-2020, 2020-2021.

Year/Season	2018-2019		2019-2020		2020-2021	
	N	S	N	S	S	N
Premonsoon	526	41	477	49	445	41
Monsoon	440	37	367	39	347	35
PostMonsoon	375	44	310	38	275	37

identify butterfly species that are sensitive to climate changes. As a result, efforts must be taken to maintain biodiversity by identifying hotspots and providing an environment that is conducive to their survival. The findings will aid future research into the status of the butterfly fauna, as well as conservation efforts in the Chail Wildlife Sanctuary.

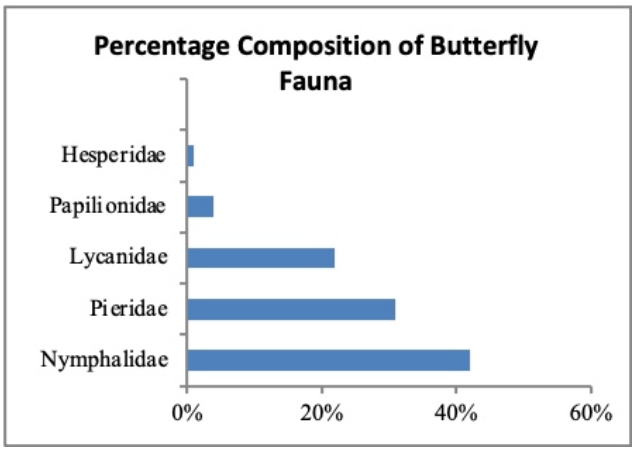

Fig-1 : The percentage composition of butterfly families in Chail wildlife Sanctuary.

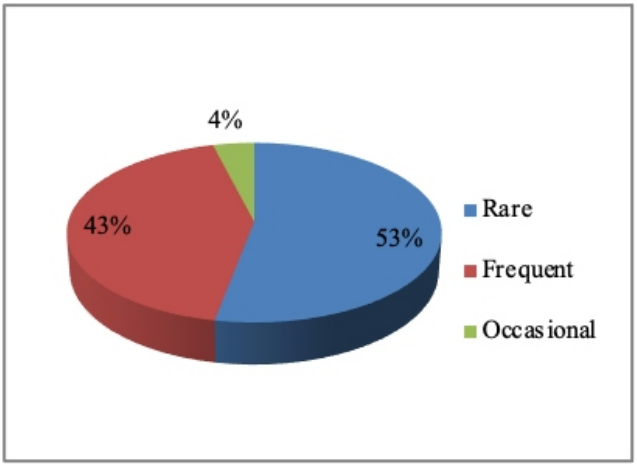

Fig-2 : Pie chart showing the relative abundance status of different species collected from Chail Wildlife Sanctuary.

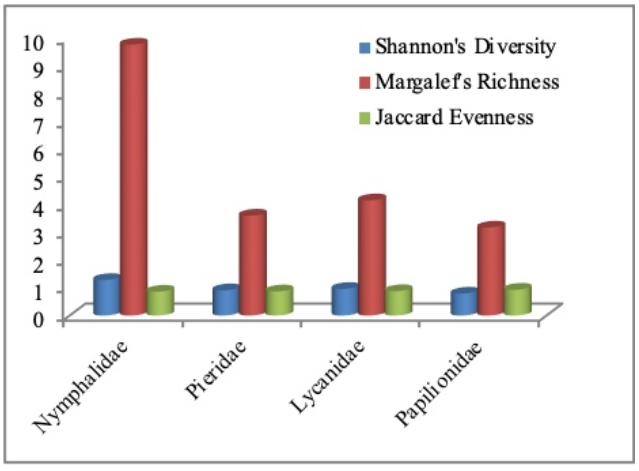

Fig-3 : Quantitative estimates of Species Diversity, Species Richness, and Species Evenness of butterfly families in Chail Wildlife Sanctuary.

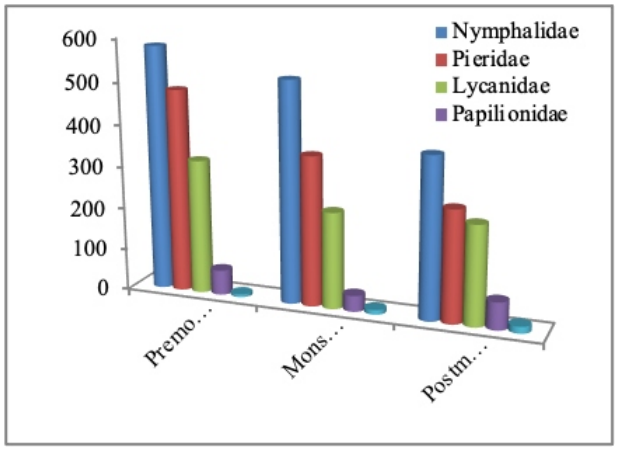

Fig-4 : The overall population trend of various families of Butterflies across seasons at different Seasons in Chail Wildlife Sanctuary.

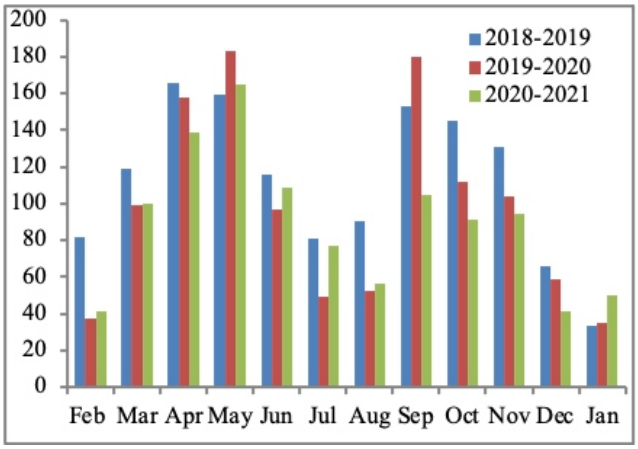

Fig-5 : Butterfly species number across different months at Chail Wildlife Sanctuary during the year 2018-2019, 2019-2020, 2020-2021.

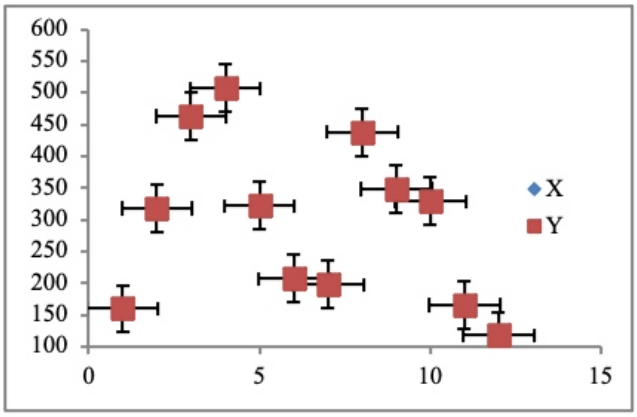

Fig-6 : A scatter graph showing the correlation between the average temperature and the population of butterfly species in different months of year.

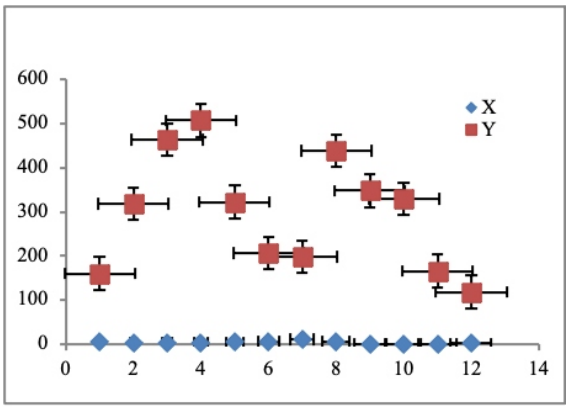

Fig-7 : A scatter graph showing the correlation between the average rainfall and the populationof butterfly species in different monthsof year.

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