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Habitat preferences of butterflies of conifer forests of water catchment sanctuary Shimla, Himachal Pradesh

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Abstract

The present study provides information on Habitat Preferences of Butterflies of Conifer Forests of Water Catchment Sanctuary of Shimla, Himachal Pradesh for the first time. As a part of the biodiversity impact assessment, a survey was carried out to study the butterfly diversity. The aim of the study was to identify species of conservation priority, their seasonality and to know the butterfly diversity potential of the area. Surveys were carried out during three different seasons (pre-monsoon, monsoon, post-monsoon from Feb 2017 to Jan 2018. Pollard walk method was used to assess the diversity. Total 755 individuals belonging to 31 species of 5 families were recorded and maximum numbers of individuals (268) were recorded during Pre-monsoon (Feb-May). The results of present study revealed that maximum number of species belonged to family Nymphalidae (12 species), followed by Lycanidae (8 species), Pieridae (7 species), Hesperidae (2 species) and Papilionidae (2 species). Percentage composition of each family revealed that Nymphalidae constituted around (41%) of the total butterfly fauna, followed by Lycanidae (37%), Pieridae (18%) Papilionidae (2%), Hesperiidae (2% each). Species diversity, evenness and species richness was calculated by Shannon-Weiner Diversity index, Jaccard Evenness index and Margalef's Richness index. Species diversity was found highest in Nymphalidae (1.06) and lowest in family Papilionidae (0.28); evenness was highest in family Nymphalidae (4.43) and lowest in Hesperidae (0.81). Similarly species richness was highest in family Nymphalidae (0.42) and lowest in Hesperidae (0.24). From the conservation point of view the study area is undisturbed forest, rich in flora and fauna species and the findings suggested that it holds a rich and unique diversity of butterflies. Such studies on monitoring the butterfly diversity and abundance offer valuable information on their population dynamics. Large scale study on ecologically important species is required to fully explore the area thus a detailed study of butterfly fauna in these areas is in progress to conclude comprehensive information on habitat preferences of Butterflies.

Keywords: butterflies, conservation, diversity, species, nymphalidae

Introduction

Among the insects butterflies are the most taxonomically studied groups, and have attained reasonable attention worldwide [1]. Due to their diurnal habitats, easily recognized morphology and their smooth flight behavior they have become a centre of attraction for everyone [2]. The diversity of color patterns on the wings of butterflies has caught the attention of evolutionary biologists for more than a century [3]. Butterflies have nearly global distribution, present on every continent except Antarctica [4]. Research studies have proved that many of butterfly species are seasonal and prefer a particular habitat. They are pollinators which ensure reproduction and survival of plants that are used by other organisms as a food source. From various experiments it has been found that, increase of species richness and species assemblage have been augmented to 47% in a wild state when butterflies were used as indicators which indicates a healthy habitat for all kinds of animals [5]. The order Lepidoptera is probably one of the most suitable groups for most quantitative comparisons between various insect fauna for many reasons [6] especially their abundance, species richness, response to climate and vegetation and relatively advanced taxonomy. Biologists have worked for more than hundred years on butterflies keeping in view their economic importance. Our nation is known to be very rich in species diversity and the Lepidoptera alone from the Indian sub-continent revealed that this order comprises over 15,000 species [7] and nearly 1500 species of butterflies are reported [8]. It is now a well-established fact that biodiversity or 'the variability of life' [9] is being eroded on a global scale due to various anthropogenic activities [10, 11].

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Insects are mainly useful in the evaluation of forests for biological resource conservation [12, 13]. Among the diversity of insects, butterflies are ideal subjects for ecological study in the forests [14, 15]. Biological diversity is the base for upholding the ecosystems and the functional aspects of the species that provide goods and services for human well-being [16]. Although India has a rich butterfly fauna, but due to various reasons such as habitat destruction, overpopulation, overexploitation, pollution and threats due to global climate change [17] use of pesticides and weedicides and illegal collection for trade, many species have become very rare and some are on the verge of extinction. There has been significant decline in the status of biodiversity which is mainly due to human activities [18]. Biodiversity is one of the important cornerstones of sustainable development and represents biological wealth of a nation but the world is facing its greatest ever biodiversity crisis and diversity in the living world is staggering, therefore it needs to be conserved and it would have been impossible to deal with enormous diversity if such a significant data is not timely documented and classified. Hence the entire gradient needs conservation attention for the preservation of rich and unique butterflies in ecosystem. Therefore, the current study is designed to find out the diversity and distribution of butterflies to provide a base for other researchers because of abrupt climatic changes and urbanization.

Materials and Methods
(a) Study site
The present study was carried out in Water Catchment Sanctuary, Shimla, Himachal Pradesh which has an area about 11 sq Km with an altitude ranging from 1900 m to 2620 m above mean sea level (amsl). The latitude and longitude of the Sanctuary is 31°05'12"N to 31°07'11"N and 77°12'54"E to 77°16'04"E respectively. Mean annual rainfall is 1600 mm and temperature ranges from 4°C to 32°C. This undisturbed forest area is considered as one of the wealthiest storehouses of Himalayan flora and has a rich collection of flora and fauna having a vast forest cover. The vegetation consists predominately of temperate coniferous forest, dominated by Deodar mixed with Oak and patches of Chir Pine. This area has been selected to study the butterfly diversity, abundance, seasonal occurrence, habitat preference and conservation status.

1. Methodology for analyzing biodiversity and Taxonomy
Regular marked trails in all habitat types were made during collection period. All butterfly species sighted were identified and recorded [19, 20]. Identifications were confirmed through literature. The year was divided into three seasons i.e. Pre Monsoon, Monsoon and post Monsoon. Transect counts were made to monitor butterfly populations. Different transects with 1000 x10 m^2 were selected. Each of the transect was visited at least twice in a month. Butterfly specimens were collected for identification, details of habitat and other activities like mud puddling and basking was recorded. Since sampling efforts in the all seasons were unequal and all specimens collected and sighted over each of the month have been pooled together for analysis, only relative estimate of the abundance is possible. Based on the relative abundance estimates, the Butterflies have been classified according to Rajasekhar [21-24] as follows:
1. Abundant: >30%
2. Very Common: 20% - 30%
3. Common: 10% - 20%
4. Frequent: 5% - 10%
5. Occasional: 1% - 5%
6. Rare: < 1%.

(b) Collection and preservation of specimen
Butterflies were collected by using Pollard walk method [25, 26]. A sweep net was used to trap the butterfly fauna appearing at the sites. The transect in each site was sampled twice a month in the morning when butterflies were active. Butterfly species seen within the range of 2.5m to each side and 5m in front and above were trapped using an improvised sweep net and released after proper identification. All the captured butterflies that were not identified in the field were put in specimen bottles. To collect the butterflies, killing jars were used which had been thoroughly fumigated with 8-10 drops of ethyl acetate. After making sure that the specimen is dead it was pinned vertically in the middle of thorax. Method of Arora [27] was used with necessary modifications for the stretching of specimen which were kept at safe place to allow the proper drying and preserved in fumigated insect storage boxes.

(c) Identification of butterflies
The butterfly species were identified from relevant literature [28-36] and their comparison with reference collection housed at Forest Research Institute (F.R.I.), Dehradun.

(d) Diversity analysis
(i) Shannon-Wiener diversity Index: The species diversity was calculated following Shannon Wiener diversity Index [37].

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

i=1 Where Ni = Number of individuals of species i and N= Total number of individuals of all the species.

(ii) Jaccard Evenness index: Evenness Index was calculated using the method of Hill [38].

$$E = H/ \ln S$$

Where S= Total number of species, N= Total number of individuals of all the species, H = Index of diversity.

(iii) Margalef's Index: Margalef's index was used as a simple measure of species richness [39].

$$\text{Margalef's index} = (S-1) / \ln$$

Where S = Total number of species, N = Total number of individual in sample, ln = Natural logarithm

Results and Discussion
Percentage composition of each family revealed that Nymphalidae constituted around (41%) of the total butterfly fauna, followed by Lycanidae (37%), Pieridae (18%) Papilionidae (2%), Hesperiidae (2% each) as shown in Fig1. As we can see in Table 2, species diversity was found highest in Nymphalidae (1.06) and lowest in family Papilionidae (0.28); evenness was highest in family Nymphalidae (4.43) and lowest in Hesperidae (0.81). Similarly species richness was highest in family Nymphalidae (0.42) and lowest in Hesperidae (0.24). During the one year study a total of 755

individuals belonging to 5 families of the order Lepidoptera were recorded and maximum numbers of individuals (268) were recorded during Pre-monsoon (Feb-May) and minimum (190) during the post monsoon. Seasonal abundance showed that butterflies belonging to family Papilionidae, Pieridae and nymphalidae were on the wing throughout the year whereas most of the organims of the family Hesperidae were observed during the months of May to November) and that of lycanidae during April to July and in January as shown in Fig.1. Out, of total 31 species found 2 were classified as abundant (>30%), 6 very common (20-30%), 7 common (10-20%), 3 frequent (5-10%), 8 occasional (1-5%) and 5 were rare (<1%) as shown in Table 1.Similar studies conducted by some workers[40] in Balh valley of Mandi (H.P) revealed that this area has diverse butterfly species and it was observed that the family Pieridae represented by 9 species was the most dominant followed by Nymphalidae. Related study pertaining to biosystematics, ecology and diversity of butterflies in western Himalayas [41] revealed the presence of 107 species of butterflies belonging to 73 genera and family wise analyses revealed that family Nymphalidae dominated the diversity. Present outcomes are in accordance with studies which were carried out in Sub alpine forests of Western Himalayas (Himachal Pradesh) 298 specimens of Butterflies belonging to 69 species dominated by family Nymphalidae [42] were recorded. 105 species of butterflies were reported in Solan

belonging to 5 families. In a study on the diversity of butterfly in the Sub-Alpine area of Chanshal valley, Himachal Pradesh, the presence of 47 species of butterflies belonging to family Nymphalidae (10 species), family Pieridae (9 species), Lycaenidae (8 species) and Papilionidae (20 species) out of which the family Nymphalidae was most dominating followed by family Pieridae, Lycaenidae and Papilionidae respectively [44] and suggested that such areas should be continuously surveyed and monitored to add new taxa to the existing biodiversity. The review on the status of the work on diversity indicated that a lot of hard work has been carried out by lot of workers on different aspects of butterflies of the world including India as well as in the state Himachal Pradesh but no work on butterfly diversity has been carried out by any of the workers in the selected study sites. The study reflects the baseline information on the butterflies of Water catchment Sanctuary. Since no previous work has been done by any worker in this area no comparison could be done but the study suggested that more studies and proper strategies are needed for sustainable conservation in this area. It will also help in developing baseline information which can be utilised by future workers in changing climatic conditions to develop habitat conservation strategy and identify butterfly species which are sensitive to climate change. Efforts are therefore required to conserve this biodiversity to identify the hot spots and to create proper environment for their survival.

Table 1: Checklist of Butterfly species collected from Chail Water Catchment Sanctuary of Shimla, Himachal Pradesh

S. No.	Scientific name	Common Name	Relative abundance	Family
1.	*Argyreus hyperbius*	The Indian Fritillary	R	Nymphalidae
2.	*Junonia hierta*	The Yellow Pansy	O	Nymphalidae
3.	*Lethe naga*	Naga Tree Brown	O	Nymphalidae
4.	*Phalantha phalantha*	The Common Leopard	O	Nymphalidae
5.	*Issoria lathonia*	Queen Of Spain Fritillary	O	Nymphalidae
6.	*Callerabia ananda*	Ringed Argus	C	Nymphalidae
7.	*Danaus chrysippus*	Plain Tiger	F	Nymphalidae
8.	*Aglais cashmirensis*	Small Tortoise Shell	C	Nymphalidae
9.	*Lassiomata schkara*	Common Wall	VC	Nymphalidae
10.	*Vanessa carduii*	Painted Lady	O	Nymphalidae
11.	*Fabriciana adippe*	High Brown Fritillary	R	Nymphalidae
12.	*Athyma jina*	Bhutan Sergeant	C	Nymphalidae
13.	*Lycaena phlaeus*	Common Copper	VC	Lycanidae
14.	*Heliophorus epicles*	Purple Sapphire	VC	Lycanidae
15.	*Athene emolus*	The Ciliate Blue	C	Lycanidae
16.	*Zizzeria karsandra*	Dark Glass Blue	VC	Lycanidae
17.	*Polyommatus icarus*	Common Blue	C	Lycanidae
18.	*Celastrina lavendularis*	The Plain Hedge Blue	O	Lycanidae
19.	*Aricia astrarche*	Orange Bordered Argus	R	Lycanidae
20.	*Eurema hecabe*	Common Grass Yellow	O	Pieridae
21.	*Genopteryx rhamnii*	Common Brimstone	VC	Pieridae
22.	*Colias fieldii*	Darl Clouded Yellow	C	Pieridae
23.	*Pieris rapae*	Cabbage White	C	Pieridae
24.	*Pieris brassicae*	Large Cabbage White	VC	Pieridae
25.	*Delias belladonna*	The Hill Jezebel	O	Pieridae
26.	*Belenois aorota*	Pioneer White	F	Pieridae
27.	*Aporia agathion*	Great Blackvein	F	Pieridae
28.	*Celanorhinus auritivitta*	Dark Yellow Banded Flat	A	Hesperidae
29.	*Potanthus dara*	Himalayan Dart	A	Hesperidae
30.	*Atrophaneura polyeuctes*	Common Windmill	R	Papilionidae
31	*Papilio machaon*	Common Yellow Swallowtail	R	Papilionidae

Table 2: Table showing the Butterfly Diversity, Richness and Evenness index of studied area

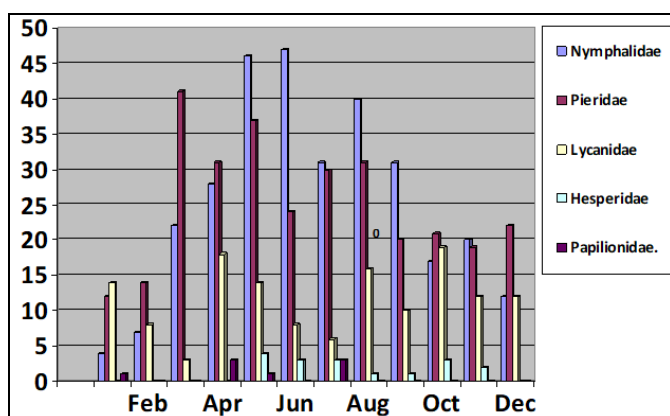| Family	No. of species	Species Diversity	Species Evenness	Species richness
Nymphalidae	12	1.06	4.43	0.42
Pieridae	8	0.78	2.84	0.31
Lycanidae	7	0.77	2.79	0.35
Hesperidae	2	0.30	0.81	0.24
Papilionidae	2	0.28	1.11	0.31

Fig 1: Seasonal abundandance of butterfly Families

Conclusion

The present study provides a description of butterfly diversity in Water Catchment Sanctuary of Shimla, Himachal Pradesh. The presence of 31 species of butterflies in just one small sanctuary suggests that the water catchment sanctuary is likely to be a very important habitat. The chances of disturbances in natural habitats appears to be less although it is a very popular center of tourism. The present study will help in updating the the data of butterfly distribution in the above area and in designing further field and research studies in such habitats. Further studies regarding host food plant and larval development are in progress that will be helpful in conservation of butterfly fauna and a baseline data will be available for the Entomologists. Studies are also required to examine the effects of on going anthropogenic activities on species diversity of butterflies.

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