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Diversity and Bio-Ecological Assets of the Northwest Himalayan Butterflies in Nalagarh Valley of Himachal Pradesh

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Abstract: ***Butterflies diversity in Himachal Pradesh is very rich and diversified, primarily due to varied climatic conditions ranging from tropical in the foothills to arctic environment in the Trans-Himalayan region. Nalagarh Valley falls in the sub-tropical zone of the Shiwalik hills and supports large scale horticulture and agriculture crops. Butterflies studies carried out in Nalagarh valley, during different seasons of the years 2005-2009 revealed the presence of 62 species of insects belonging to 46 genera and 8 families. During the course of present studies it was observed that Nymphalidae, represented by 16 species, spread over 10 genera was the largest family followed by Pieridae (14 species), Satyridae (11), Papilionidae (9) and Lycaenidae & Danaidae (4 each). Moreover, it was interesting to note that two families of butterflies viz., Erycinidae and Hesperiidae were represented by two species each. Analysis of seasonal variation in the diversity of butterflies in different habitat of the valley revealed that maximum diversity has been recorded during pre and post monsoon periods. First peak in diversity (45 and 39 species) was recorded in spring season (April-May) and during monsoon season (July-September) when 39 and47 species of butterflies were collected. On the contrary, minimum diversity (9 and 3 species) was seen during winter months of December and January respectively. Present study of diversity and seasonal fluctuation contributes to the requirements of conservation and monitoring for climate change. As butterflies are very good bio-indicators of any disturbance in the ecosystem. So, studies on their diversity, status, seasonal fluctuation etc. shall be of great use in monitoring changes in an ecosystem especially due to habitat degradation, deforestation and organic and inorganic pollution.***

Keywords: Nalagarh Valley, Nymphalidae, Seasonal Variation and Butterflies

1. Introduction

Insects are the most dominant creatures on this earth. The Insects are believed to have appeared on this planet in the Devonian period, some 200 million years ago and since then survived the glacial periods and evolved into myriad forms. Lepidoptera, one of the highly specialized insect order, which includes butterflies and months that show total metamorphosis and pass through egg, larva, pupa and adult stages. Butterflies have always been a subject of fascination to mankind and they are considered as one of the best-known species of insects. These are most easily recognizable of all the other insects and second in number in their universal popularity after birds. Because of their charming colour patterns and most interesting phenomenon of mimicry and migration, these evoke curiosity and fondness among all the people on the earth, particularly among children, naturalists and scientists. They are good pollinators of many agricultural and horticultural crops. The adults visit flowers for nectar, while some of the male species congregate on damp or moist places near streams. Some of the species are attracted in large number over ripe fruits, animal dung and bird-droppings, etc., while majority of butterflies are found in sheltered and shaded areas; several others occur in open ground, among bushes and over tree tops. Due to their population size and palatability, major species of this group are indispensible food of many birds and reptiles present in grassland and forest ecosystems. Their role in the maintenance of ecological balance is beyond doubt. Many species of butterflies are also serious pests of crops.

2. Previous Study

The insect fauna of India is vast. The diversity and bioecological study on insects in India were initiated with the arrival of the European traders, missionaries and rulers largely from middle of the 18th century. Insects became one of the subjects of interest with the establishment of Royal Asiatic Society of Bengal. In an old estimate, Lefroy and Howlett (1909) in the monumental book 'Indian Insect Life' reported 25,700 Indian species. Studies of Beeson (1941) "An epitome to the National History of Insects" and "Ecology and control of forest insects in India and the neighboring countries" are excellent work from the South Asian region. Beeson (1941) estimated 40,000 Indian species. Roonwal (1954) opined that insects constitute two-third of the total fauna in India and comprise nearly 1, 00,000 species, of which about half remains yet to be studied. Varshney (1997) has reported 589 families and 51450 species of insects from India. In a recent estimate Alfred *et al*., (1998) estimated 59353 species of insects from India belonging to 619 families. Moreover, until the publication of first account of Indian butterflies in 1857 in their 'Catalogue of the Lepidoptera in the Museum of East India Company,' little attention was paid to Indian butterflies, though these butterflies have attracted the attention of some researchers (Talbot, 1939). The earliest comprehensive work on butterfly diversity of Indian subcontinent was Moore's 'Lepidoptera of Ceylon,' the first volume of which appeared in 1881. In 1882, Lionel de Niceville and Major GFL Marshall published the first volume of 'The butterflies of India, Burma and Ceylon, followed by the second in 1890. Many investigators have studied the diversity, distribution, relative abundance,

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taxonomy and ecology of butterflies from different parts of the country (Evans, 1932; Talbot, 1939; Wynter- Blyth, 1982; Alfred *et al*., 1998; Alfred, 2005; Thakur *et al.,* 2006), but only a few studies have been conducted on biosystematics and ecology of butterflies from the Himalayan region (Mani, 1986; Mehta *et al.,* 2002; Mehta *et al.,* 2003; Arora *et al*., 1995, 2005). However, a little has been done to survey the insect fauna from Himachal Pradesh (Uniyal and Mathur, 1998; Mehta *et al.,* 2002; Singh, 2007; Kumar, 2009; Sharma and Kumar, 2015). Keeping in view the above account, present studies were conducted to fill up the gap in our knowledge about diversity and bio-ecological assets of butterfly in the Nalagarh valley of Himachal Pradesh and to update the account of maximum number of species in a short span of time.

3. Study Area and Methodology

The comprehensive diversity and bio-ecological studies were conducted on various aspects of butterfly fauna in Nalagarh valley in Solan district of Himachal Pradesh from 2005 to 2009. Nalagarh valley is situated at 31° 02′ North latitude and 76° 43′ East longitude at an altitude of 350m in the Shiwalik hills region of the state. Various natural ecosystems/ habitats like crop fields, forests, grasslands, streams, human habitations, etc. were selected for the study. The butterfly specimens collected by various methods like hand picking, beating, sweeping, trapping, night trap and aerial netting were then killed in a killing bottle. After killing, specimens were removed from bottle within half an hour to avoid any damage to colouration and then pinned, identified, preserved and labelled (Arora, 1990). The identification was also done with the help of local keys and authenticated by taxonomists of Indian Agricultural Research Institute, New Delhi; Forest Research Institute, Dehradun and Zoological Survey of India, Kolkata.The identified collections were stored in insect cabinets having good quality drawers. The naphthalene powder was also put in the grooves of the drawers. The cotton balls soaked in the mixture of camphor and carbolic acid, in the ratio of 1:3 were put in each corner of the drawers. For interpretation, the data were recorded on separate data sheets during different seasons, different habitat types, climatic zones, etc. and each list was kept independent of the other.

4. Results and Discussion

The estimates within Lepidoptera from the Indian sub-continent reveal that the group comprises over 15,000 species and many more subspecies distributed over 84 families and 18 superfamilies (Alfred et al., 1998). There are about 1500 species of butterflies in India (Alfred et al., 1998). The presence of butterfly species at a particular habitat depends on a wide range of factors, of which the availability of food and climatic conditions are the most important. Butterflies show distinct pattern of habitat utilization. The nature of vegetation is an important factor, which determines the dependence and survival of a species on a particular habitat. Being highly sensitive to environmental changes, they are now being used as indicators of environmental quality and also reflect the health of an ecosystem. The present diversity and bio-ecological studies carried out on the Northwest Himalayan butterflies in Nalagarh valley of Himachal Pradesh during different seasons of the years revealed the presence of 62 species of insects belonging to 46 genera and 8 families. During the course of present studies it was observed that Nymphalidae, represented by 16 species, spread over 10 genera was the largest family followed by Pieridae (14 species), Satyridae (11), Papilionidae (9) and Lycaenidae & Danaidae (4 each). Moreover, it was interesting to note that two families of butterflies viz., Erycinidae and Hesperiidae were represented by two species each (Table 1; Figure 1). The most diversely distributed species included *Papilio demoleus demoleus, Parnassius hardwickei hardwickei, Pieris brassicae nepalensis, Colias erate erate* etc. whereas, *Chilasa clytia clytia, Dallacha hyagriva, Orinoma damaris, Precis* hierta etc. were less represented species (Table 1).

Further, the percent composition studies of butterfly fauna show that Nymphalidae represented by 26% species, was the largest family followed by Pieridae 23 % species , Satyridae 18% species, Papilionidae 15% species, Lycaenidae and Danaidae 6% species each, 4% species each and two families of butterflies viz., Erycinidae and Hesperiidae were represented by 3% species each (Table 1; Figure 2). Similarly, Shields (1989) has reported 6440 species of Nymphalidae from the world, which reduced to 3562, on excluding subfamilies Danainae, Satyrininae and Colininae from the family. Moreover, Nymphalidae is the largest family represented with nearly one-third of the known butterfly species of the world. From the Indian region, Varshney (1986) has shown 232 species of this family. Rose and Sidhu (2001) have listed 21 species of this family in the Punjab. Similarly, Arora *et al.* (2005) has enlisted this family as the largest family with 56 species in Himachal Pradesh.

Analysis of seasonal variation in the diversity of butterflies in different habitat of the valley revealed that maximum diversity has been recorded during pre and post monsoon periods. First peak in diversity 45 and 39 species were recorded in spring season (April-May) and during Monsoon season (July-September) when 39 and 47 species of butterflies were collected. During these periods species like *Papilio protenor protenor, Papilio polyctor polyctor, Papilio machanon asiatica, Graphium cloanthus cloanthus, Pontia daplidice moorei, Colias erate erate, Aulocera padma padma, Precis almana,* and *Vanessa cashmirensis* were recorded in different study areas. On the contrary, minimum diversity (9 and 3 species) was seen during winter months of December and January respectively (Table 1; Figure 3). Butterfly species namely *Papilio demoleus demoleus, Parnassius hardwickei hardwickei, Pieris brassicae nepalensis, Colias erate erate, Vanessa indica, Phalanta phalantha* and *Libythea myrrha* were collected from study sites during these months. But, there were some species namely *Parnassius hardwickei hardwickei, Pieris brassicae nepalensis, Colias erate erate* and *Libythea myrrha* which were recorded in all the seasons of the year (Table 1). Similar types of seasonal studies pertaining to butterfly diversity of different areas have been conducted by a number of workers like Vats and Mittal (1983) who reported the species and seasonal diversity of insects in a tropical deciduous forests; Gadagkar *et el.* (1990) studied the diversity of insects in the plantation and the natural forests of Uttar Kannad district of Karnataka; Holloway *et al.* (1992)

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reported alpha diversity value for insects in Mulu forests, Danum area of Sabah, East Malaysia; Pollard *et al*., (1993) studied the changes in the butterfly numbers in Britain and the Netherlands during 1990-91; Spitzer *et al*. (1997) reported a higher diversity of butterflies from the gaps, made by illegal lopping in an Indo-China mountain rain forest as compared to the closed forest in the same area; Singh (2007) studied the seasonal variation in the butterfly diversity in Shiwalik hills of Punjab.

Table 1: Diversity and monthly distribution of the Northwest Himalayan Butterflies in Nalagarh Valley of Himachal Pradesh

S.No.	Taxon	January	February	March	April	May	June	July	August	September	October	November	December
	Family: Papilionidae	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	*Polydorus philoxenus philoxenus* (Gray)			+	+	+	+	+	+	+			
2	*Chilasa agester govindra* (Moore)			+		+				+	+	+	
3	*Chilasa clytia clytia* (Linnaeus)			+		+							
4	*Papilio protenor protenor* Cramer			+	+	+	+	+					
5	*Papilio polyctor polyctor* Boisduval			+	+	+	+	+	+	+	+		
6	*Papilio demoleus demoleus* Linnaeus				+	+	+	+	+	+	+	+	+
7	*Papilio machanon asiatica* Menetries			+	+	+	+	+					
8	*Graphium cloanthus cloanthus* (Westwood)				+	+	+	+	+	+	+	+	
9	*Parnassius hardwickei hardwickei* Gray			+	+	+	+	+	+	+	+	+	+
	Family: Pieridae												
10	*Leptosia nina nina* (Fabricius)						+	+	+	+			
11	*Metaporia agathoni phryxe* (Boisduval)					+	+	+		+			
12	*Delias eucharis* (Drury)						+	+	+	+			
13	*Anaphaeis aurota aurota* (Fabricius)				+			+					
14	*Pieris brassicae nepalensis* (Doubleday)		+	+	+	+	+	+	+	+	+	+	+
15	*Pontia daplidice moorei* (Rober)				+	+	+	+	+	+	+		
16	*Ixias marianne* (Cramer)							+	+	+	+		
17	*Ixias pyrene kausala* Moore							+	+	+	+		
18	*Catopsilia crocale* (Cramer)							+	+	+	+		
19	*Catopsilia pyranthe pyranthe*(Linnaeus)							+	+	+	+		
20	*Gonepteryx rhamni nepalensis* Doubleday						+	+	+	+	+		
21	*Eurema hecabe fimbriata* (Wallace)					+	+	+	+	+	+	+	+
22	*Colias erate erate* (Esper)		+	+	+	+	+	+	+	+	+	+	+
23	*Colias electo fieldi* Menetries								+	+	+		
	Family: Danaidae												
24	*Danaus genutia* (Cramer)				+				+	+	+	+	
25	*Parantica aglea melanoides* Moore				+				+	+	+	+	
26	*Euploea core core* (Cramer)				+				+	+	+	+	
27	*Euploea mulciber mulciber* (Cramer)		+	+	+				+	+	+		
	Family: Satyridae												
28	*Mycalesis perseus blasius* (Fabricius)		+	+	+	+	+	+	+	+	+		
29	*Zophoessa maitrya maitrya* (de Niceville)							+	+	+	+		
30	*Lethe rohria rohria* (Fabricius)				+	+	+	+					
31	*Lethe confusa confusa* Aurivillius				+	+	+	+		+			
32	*Lethe insane insane* (Kollar)		+		+	+	+	+		+			
33	*Rhaphicera moorei moorei* Butler							+	+	+	+		
34	*Orinoma damaris* Gray								+	+			
35	*Aulocera padma padma* (Kollar)		+		+	+	+	+		+	+		
36	*Callerebia scanda scanda* (Kollar)					+	+			+	+	+	
37	*Dallacha hyagriva* (Moore)								+	+			
38	*Melanitis leda ismene* (Cramer)		+		+					+			
	Family: Nymphalidae												
39	*Neptis mahendra* Moore				+					+		+	
40	*Hypolimnas bolina* (Linnaeus)				+				+	+	+		+
41	*Kallima inachus* (Boisduval)				+	+	+						
42	*Precis hierta* (Fabricius)				+					+			
43	*Precis orithya* (Linnaeus)				+				+	+	+	+	
44	*Precis almana* (Linnaeus)		+	+	+	+	+	+		+	+	+	
45	*Precis atlites* (Linnaeus)	+			+	+	+	+			+	+	
46	*Precis iphita* (Linnaeus)				+	+	+	+		+	+	+	

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S.No.	Taxon (Contd…….. Table 1)	1	2	3	4	5	6	7	8	9	10	11	12
47	*Vanessa indica* (Herbst)				+	+	+	+	+	+		+	+
48	*Vanessa cashmirensis* Kollar		+		+	+	+	+					
49	*Argynnis childreni* Gray		+		+	+	+	+					
50	*Argynnis kamala* Moore		+		+	+			+	+		+	
51	*Phalanta phalantha* (Drury)		+	+	+	+	+			+	+	+	+
52	*Diagora persimilis* (Westwood)		+	+	+	+	+						
53	*Auzakia danava* (Moore)		+	+	+	+							
54	*Argyreus hyperbius* (Johanssen)	+	+	+	+								
	Family: Erycinidae												
55	*Libythea myrrha* Godart	+	+		+	+	+			+	+	+	+
56	*Dodona durga* (Kollar)			+	+	+	+			+	+		
	Family: Lycaenidae												
57	*Castalius rosimon* (Fabricius)			+	+	+	+	+	+	+			
58	*Pseudozizeeria maha* (Kollar)				+	+	+	+	+	+			
59	*Euchysops pandava* (Horsefield)				+	+	+	+	+				
60	*Catochrysops strabo* (Fabricius)		+		+	+	+	+	+	+		+	
	Family: Hesperiidae												
61	*Suastus gremius* (Fabricius)		+	+	+	+	+	+					
62	*Caprona ransonnetti* (Felder)		+	+	+	+	+	+					

Note: + = presence of butterfly species

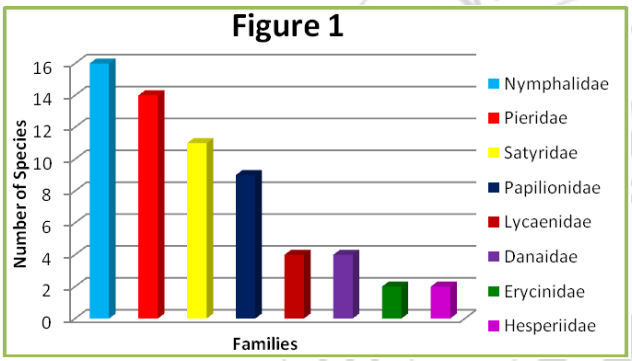


Figure 1: Diversity of the Northwest Himalayan Butterflies families in Nalagarh Valley of Himachal Pradesh

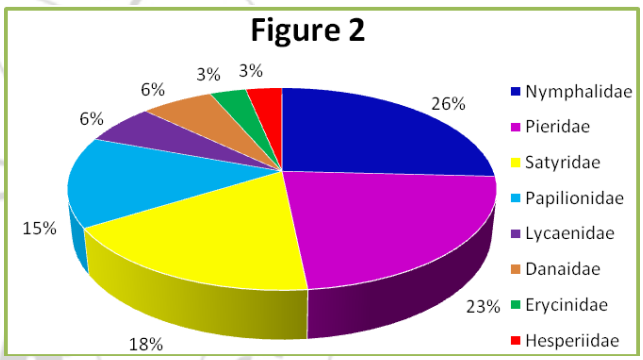


Figure 2: Showing the percent composition of the Northwest Himalayan Butterflies families in Nalagarh Valley

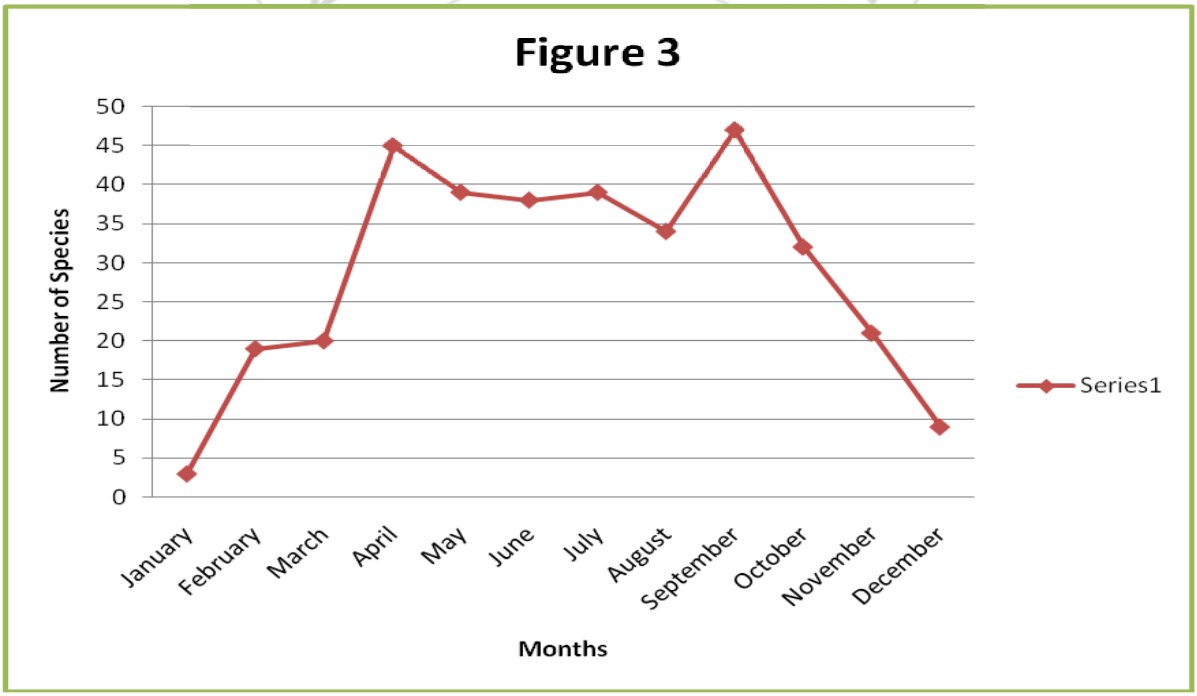


Figure 3: Showing the Seasonal fluctuation of the Northwest Himalayan butterfly fauna in Nalagarh Valley

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The study provided a benchmark and reliable database for future taxonomic studies. The study of diversity and seasonal fluctuation contributes to the requirements of conservation and monitoring for climate change. Thus, it is evident that by laying particular emphasis on the biosystematics and ecology and their profitable use for identification of genera and species has justified the scope of present study. As butterflies are very good bio indicators of any disturbance in the ecosystem. So, studies on their diversity, status, seasonal fluctuation etc. shall be of great use in monitoring changes in an ecosystem. In spite of important contribution, it is desired that more intensive and repeated surveys in the poorly surveyed and virgin areas should be conducted to have new information. It is hoped that present contribution will provide a model for further studies in this field.

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