ASSESSMENT OF BUTTERFLIES IN A MONTANE TEMPERATE FOREST OF ALLAIN-DUHAINGAN CATCHMENT IN KULLU, HIMACHAL PRADESH, INDIA – PROPOSED HYDROELECTRIC PROJECT SITE

MANISH BHARDWAJ AND V. P. UNIYAL

Wildlife Institute of India,
Chandrabani, Dehra Dun (Uttarakhand).

Introduction

Himachal Pradesh, situated in the Western Himalayan zone, is well known for its water resources *viz.*, streams, waterfalls and rivers etc. which are being highly exploited for generation of electricity. Such activities in fragile landscape of Himalayas are leading to habitat fragmentation and habitat destruction. This may lead to extinction of species even before their exploration. Human modification of the landscape has resulted in marked reduction in global biodiversity (Cincotta *et al.,* 2000; Collier *et al.,* 2005). As many butterfly species are very sensitive and responsive to anthropogenic disturbance, they are largely considered as indicators for nature conservation purposes (Robbins and Opler, 1997). Studies on butterflies of Western Himalaya were mostly restricted to the identification of butterfly species, information on altitudinal records and investigation on migration patterns (Mani, 1986). Butterfly diversity and distribution in four habitat types of Allain-Duhaingan (streams) catchment where a hydroelectric power station is proposed, have been assessed in this paper. An attempt to compare the diversity and richness across different habitat types and analyzed the possible effect of habitat on species occurrence has also been made.

Study Area

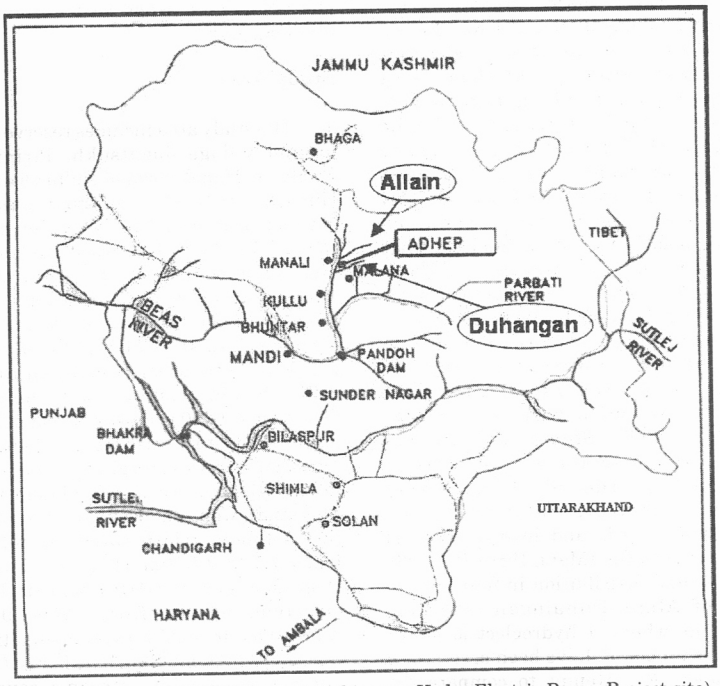
The study area includes reserve forest around village Jagatsukh, Pirini and Hamta in Manali town of Kullu District of Himachal Pradesh. The study area lies between latitude 32° 21' N and longitudes 77° 11' - 77° 22' E. The two streams Allain and Duhaingan bisect the area. Allain stream is formed by Hamta and Patroi streams which originate at elevations of 4,680 m amsl and 4,800 m amsl respectively in Great Himalayan ranges, while, Duhaingan stream originates at an elevation of 4,400 m amsl from Chandratal glacier. The two streams are joined by several tributaries and glaciers before they fall into the Beas river near Manali Town. The study was conducted in and around these streams which covers an altitude from 1,700-2,800m (Fig. 1). Human Degraded Forest (HDF) was at lower elevation, starting from 1,700-1,900m. Alpine Pastures (AP) covering an altitude from 2,500-2,800m, Blue Pine Forest (BPF) patches were along streams covering

altitude from 1,700-2,200m while Deodar Forest (DF) falls between 2,100-2,400m.

Vegetation

The study area falls in Biotic Province 2A (North-West Himalaya) of Biogeographic zone of Himalayas (Rodgers and Panwar, 1988). The forest type is montane temperate forest (Dhaliwal and Sharma, 1999). This was further classified into nearly pure Deodar Forest (DF), riverside Blue Pine Forest (BPF), lush green Alpine Pastures (AP) and Human Degraded Forest (HDF). The dominant tree species were *Aesculus indica, Cedrus deodara, Pinus wallichiana, Acer caesium, Acer acuminatum, Taxus wallichiana, Taxus semecarpifolia, Picea smithiana, Juglans regia* etc. While *Berberis* spp., *Princepia utilis, Rosa macrophylla, Canabis* spp., *Salix denticulata* were the main shrub species. Common herb species were *Viola canescens, Chenopodium album, Torilis japonica, Carex cruciata, Poa annua, Polygala abyssinica, Stellaria media, Phleum himalacium* etc.

Fig. 1



Map of study area (ADHEP: Allain-Duhiangan Hydro Electric Power Project site).

Methodology

The survey was conducted in October 2005. After an initial reconnaissance survey the area was broadly classified into four major habitat types (Dhaliwal and Sharma, 1999). In each habitat type three transects (800m - 1,500 m) were laid (Table 1). Each transect was repeated two times. Due to steep undulating terrain and topographic constraint time constrained search was performed for hill transects to record abundance of butterflies.

Butterflies are most active during bright sunlight (Pollard and Yates, 1993). Transects were walked between 9:00 and 12:00 hrs depending upon the weather. Butterflies within 5m on either side of transect were recorded. The duration of sampling for each transect was between 60 and 120 minutes. This effort difference in time was because of terrain and topographic features. The butterflies which were difficult to identify in flight were captured by using sweep-net, identified and released. The butterflies were identified using Wynter-Blynth (1957), Haribal (1992), Evans (1932), Mani (1986) and Kunte (2000). The doubt about presence of specific butterfly species in particular habitat and elevation was resolved after discussion with other lepidopterists.

Data analysis : To estimate species richness in different habitats Estimate Software Version 7.5 (Colwell, 2005) was used. To compare the diversity assemblages across habitats Simpson's index of diversity (1/D) (Magguran, 1988) was calculated. One way ANOVA was used to see whether different habitats differ significantly in their species richness and abundance. Bray-Curtis cluster analysis (Single link) was used to see the extent of similarity in species composition between habitats.

Table 1

Survey details, butterfly richness, abundance and diversity for the four habitats using hill transects.

Habitat	BPF	DF	AP	HDF
Mean Transect length (m)	1033.3 (n=6)	1100 (n=6)	1000 (n=6)	866.6 (n=6)
Mean time spend on each transect (min)	39.16	40	45	50
Observed species richness	22	14	23	30
Abundance	66	33	333	353
Unique species	4	2	1	2
Simpson's (1/D)	14.3	13.2	10.169	11.323
Estimated richness (Chao1)	25.5 ± 3.66	17.75 ± 4.21	26 ± 4.18	30.5 ± 1.08
% completeness	86%	79%	88%	98%

Habitats:
BPF = Blue Pine Forest; DF = Deodar Forest; AP= Alpine Pastures; HDF = Human Degraded Forest)

Results and Discussion

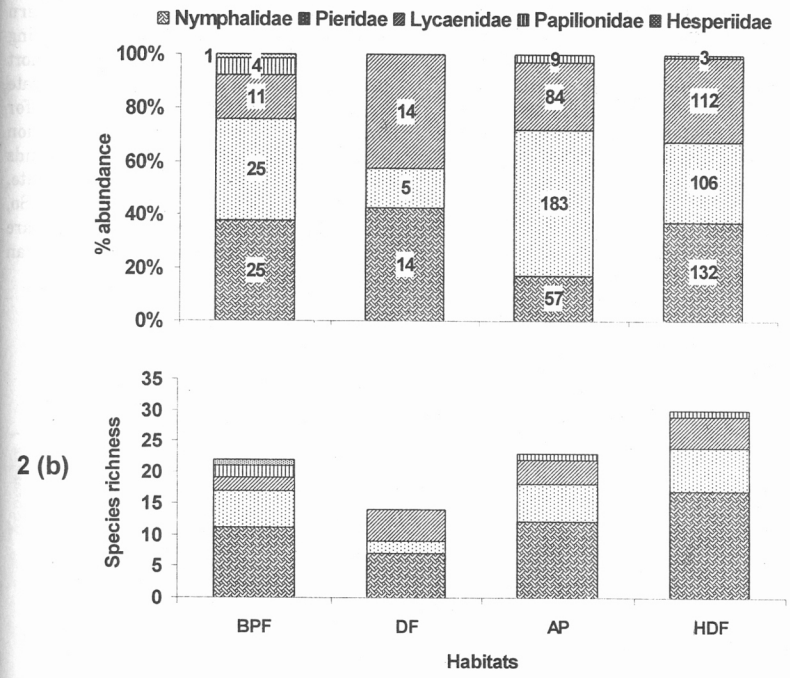
Butterfly composition and distribution : An effort of 24 km and 17 h encountered a total of 785 individual butterflies of 40 species under 26 genera and five families (Table 1 and Appendix1) across four habitat types during the survey. A total of 30 species of butterflies were detected in HDF, 23 species in AP, 22 species were detected in BPF and only 14 species in DF (Table 1). Three (7.5% of total richness) of the total 40 species were common to all four habitats. The HDF showed highest species richness (30) and abundance (353) which can be attributed to the fact that this site had *Cedrus deodara* and *Juglans regia* trees (with relatively high disturbance activities e.g., logging, cutting etc.), apple orchards (in stage of mature fruiting), seasonal ornamental flowers, livestock dung and water availability making the habitat more complex in terms of resources. Thus, this increase in the observed species richness in HDF can be attributed to the open canopy (due to logging), resource rich microhabitat and vegetation associated with it (Devy and Davidar, 2001; Spitzer *et al.*, 1993; Bowman *et al.*, 1990). HDF was around 1700-1900 amsl elevation and sampling was conducted at the transition of rainy and onset of winter season. So, one more reason can be given to explain the higher observed richness in HDF that the butterflies might be coming to the lower elevation (higher temperature) as there was lower temperature at all other three sites as found in other regions (Haribal, 1992).

Species richness and abundance from each of the following butterfly families were recorded as Nymphalidae 21 spp., Pieridae 8 spp., Lycaenidae 8 spp., Papilionidae 2 spp. and Hesperiidae only 1 species. Pieridae was found to be the most abundant family with 319 individuals followed by Nymphalids (228), Lycaenids (221), Papilionids (16) and Hesperiids (1) (Figs. 2a, b). BPF and DF were most undisturbed habitats of the study area. The highest number of unique species were recorded in BPF (4) followed by DF (2), HDF (1) and AP also with two species (Table 1 and Appendix 1). Under the wildlife protection act, 1972 only two species (Common Crow and Striped Blue Crow) recorded in study area are listed in schedule IV of the Wildlife Protection Act, 1972 (as amended upto 2003) 2005.

The one way ANOVA for species richness ($F = 4.06$ $P = 0.001$) and abundance ($F = 2.71$ $P = 0.003$) showed that both species richness and abundance differ significantly across habitats. Results of cluster analysis (Fig. 3) showed that butterfly composition of AP was found to be most similar to HDF (55.39%) forming a single cluster while, BPF and DF were found forming another cluster with 28.28% similarity. This cluster formation is based on species composition and abundance similarity. Habitat BPF and DF showed similarity in butterfly composition as these habitats are quite undisturbed, dense and both were on steep slopes

Species richness estimation : All levels of Species richness were calculated according to Chao1 estimates of species richness, as this estimator is generally agreed to be used for inventory completeness values (Sorenson *et al.*, 2002; Scharff *et al.*, 2003). Per cent completeness giving the ratio between observed and estimated richness. The result of inventory completeness shows that we were able to sample 98% of estimated butterfly richness in HDF

Fig. 2



Percentage abundance (a) and species richness (b) of different butterfly families across four habitats.

*Absolute values are also provided in each box 2(a).

(Table 1). 14% of estimated butterfly richness species in BPF, 21% in DF and 12% in AP is missing. In other words, the community structure of habitat HDF was dominated by more number of common species. It was not possible to sample average 16% of estimated diversity in three habitats e.g. BPF, DF and AP. This could be because of overall small sampling period of 24 days in all habitats.

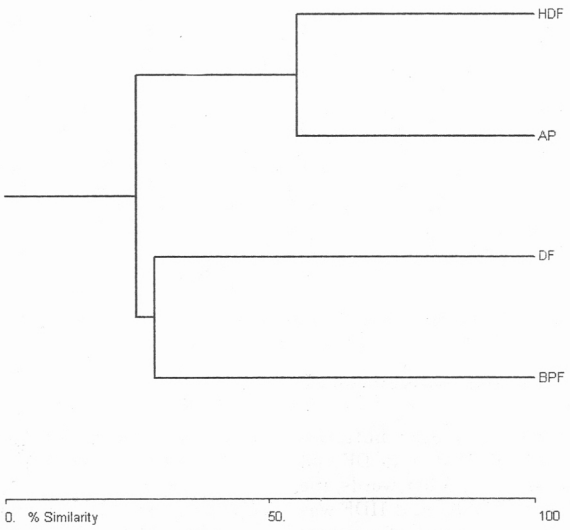
Species diversity : The Simpson's index of diversity (1/D) was calculated to estimate α-diversity of butterfly species across habitats (Table 1). AP showed (10.16) most diverse assemblage of butterflies followed

by HDF (11.32), BPF (14.30), and DF (13.20). Though in AP species richness was 23 species with an abundance of 333 but only 3 species (Common Emigrant, Common Brimstone and Large Hedge Blue) accounted for 47% of total abundance. Same in case of HDF which shows highest observed richness (30) and abundance (353) but only one species Large Hedge Blue accounted for 23% of the total abundance.

Conclusion

There are about 415 species of butterflies known to occur in the Western Himalayas (Wynter-Blyth, 1957). Forty species that make 10% of the known butterfly diversity from Western Himalayan landscape were found during this survey in a small area in a short duration. Thus these montane temperate forests provide good habitats for butterflies. It is important to mention here that the butterfly fauna depends mainly on the floristic elements, climate, rainfall, temperature in Himalaya. So, these high altitude temperate forests are important for conservation of Himalayan biodiversity.

Fig. 3



Dendrogram based on cluster analysis (Bray-Curtis) of 6 transects (in each habitat) and 43 butterfly species for the four habitat types based on abundance similarity matrix. The between-sample measurement of similarity was 'Linkage Distance'.

Appendix 1

List of Butterflies species recorded during survey in different habitats and their status in WPA, 1972. Unique species (found only in one habitat) are marked as.*

Sl. No.	Common name	Scientific name	BPF	DF	AP	HDF	WPA Status (Schedule)
1	2	3	4	5	6	7	8
Papilionidae							
1	Great Windmill	*Atrophaneura dasarada* Moore	+	-	+	-	--
2	Common Blue-Bottle	*Graphium sarpedon* Linnaeus	+	-	-	+	--
Pieridae							
3	Pioneer	*Anaphaeis aurota* Fabricius	+	+	-	+	--
4	Common Emigrant	*Catopsilia pomona* Fabricius	+	-	+	+	--
5	Dark Clouded Yellow	*Colias electo fieldii* Menetries	-	-	+	+	--
6	Hill Jezebel	*Delias belladonna* Fabricius	+*	-	-	-	--
7	Common Brimstone	*Gonepatrix rhamni* Latreille	+	-	+	+	--
8	Large Cabbage White	*Peiris brassica* Linnaeus	+	-	+	+	--
9	Indian Cabbage White	*Pieris canidia indica* Linnaeus	+	-	+	+	--
10	Lofty Bath White	*Pontia callidice* Moore	-	+	+	+	--
Nymphalidae							
11	Large Silverstripe	*Argynnis childreni* Gray	+	+	-	-	--
12	Indian Fritillary	*Argynnis hyperbius* Linnaeus	-	-	+	+	--
13	Queen of Spain Fritillary	*Argynnis lathonia* Linnaeus	-	+	+	+	--
14	Plain Tiger	*Danaus chrysippus* Linnaeus	+	-	+	+	--
15	Common Tiger	*Danaus genutia* Cramer	-	-	+	+	--
16	Common Punch	*Dodona durga* Kollar	+*	-	-	-	--
17	Mountain Argus	*Erebia shallada* Lang	-	-	+*	-	--

Contd...

1	2	3	4	5	6	7	8
18	Common Crow	*Euploea core* Cramer	+	-	+	+	IV
19	Striped Blue Crow	*Euploea mulciber* Cramer	-	-	-	+*	IV
20	Chocolate Pansy	*Junonia iphita* Linnaeus	+	-	+	+	--
21	Blue Pansy	*Junonia orithyia* Linnaeus	-	-	+	+	--
22	Common Beak	*Libythea lepita* Morre	+	+	-	-	--
23	Common Sailer	*Neptis hylas* Moore	+	-	+	+	--
24	Yerburis Sailer	*Neptis yerburii* Butler	-	+	+	+	--
25	Common Wall	*Parage schakra* Kollar	-	+	-	+	--
26	Glassy Tiger	*Parantica aglea* Stoll	+	-	+	+	--
27	Red Admiral	*Vanessa indica* Herbst	+	-	-	+	--
28	Blue Admiral	*Vanessa canace* Linnaeus	-	+	-	+	--
29	Indian Tortoiseshell	*Vanessa kaschmirensis* Kollar	+	+	+	+	--
30	Himalayan Five-Ring	*Ypthima sakra* Moore	+	-	-	+	--
31	Common Four-Ring	*Ypthima hubenri* Kirby	-	-	-	+*	--
Lycaenidae							
32	Large Hedge Blue	*Celastrina huegelli* Moore	+	+	+	+	--
33	Western Blue Sapphire	*Heliophorus bakeri* Evans	-	+*	-	-	--
34	Eastern Blue Sapphire	*Heliophorus oda* Hewitson	+*	-	-	-	--
35	Sorrel Sapphire	*Heliophorus sena* Kollar	-	+	-	+	--
36	Common Pea blue	*Lampides boeticus* Linnaeus	-	-	+	+	--
37	Green Copper	*Lycaena kasyapa* Moore	-	+*	-	-	--
38	White Bordered Copper	*Lycaena pavana* Kollar	-	+	+	+	--
39	Common Copper	*Lycaena phalaeas* Linnaeus	-	-	+	+	--
Hesperiidae							
40	Himalayan Grass Dark Dart	*Taractrocera danna* Moore	+*	-	-	-	--

Acknowledgement

The authors are thankful to World Pheasant Association-India for providing financial support for conducting the study.

SUMMARY

40 species of butterflies, under 26 genera and 5 families were recorded from four habitat types of Allain-Duhaingan (streams) catchment, where a hydroelectric power station is proposed. Results from diversity indices and ANOVA showed that the butterfly species richness (F = 4.06, P = 0.001) and abundance (F = 2.71, P = 0.003) varied in different habitats. Species richness and abundance was higher along disturbed habitat (logging, project activities etc.) while, rarity was restricted to the most undisturbed habitats of the study area.

Key words **: Butterfly diversity, Species richness, Montane temperate forest, Kullu, Himachal Pradesh.**

कुल्लू हिमाचल प्रदेश, भारत के अल्लैन–दुहैंगान जलग्रहण क्षेत्र के पर्वतीय समशीतोष्ण वन की तितलियों का आंकलन – प्रस्तावित पन बिजली परियोजना स्थल

मनीष भारद्वाज व वी०पी० उनियाल

सारांश

अल्लैन–दुहैंगन (जल धाराओं) के जलग्रहण क्षेत्र के चार प्राकृतावास प्ररूपों से 5 वंशों की 26 प्रजातियों में पड़ती 40 तितली जातियां आलेखित की गई हैं, जहां एक पनबिजली केन्द्र बनाना प्रस्तावित किया गया है। विविधता निर्देशांक और एनोवा से मिले परिणामें ने दिखाया है कि यहां की तितली सम्पन्नता (एफ=4.06, पी=0.001) और प्रचुरता (एफ=2.71, पी=0.003) तक विभिन्न प्राकृतावासों में मिलती है। जातिगत सम्पन्नता और प्रचुरता विक्षुब्ध हुए प्राकृतावास (लट्ठे बनाना, परियोजना कार्यक्रम चलाना आदि) में ज्यादा रही जबकि उनकी दुर्लभता अधीत क्षेत्र के अविक्षुब्ध रहे प्राकृतावासों में ही सीमित रही पाई गई।

References

Bowman, D.M.J.S., J.C.Z. Woinarski, D.P.A. Sands, A. Wells and V.J. McShane (1990). Slash-and-burn agriculture in the wet coastal lowlands of Papua New Guinea: response of birds, butterflies and reptiles. *J. Biogeography,* **17**: 227-239.

Cincotta, P.R., J. Wisnewski and R. Engelman (2000). Human population in the biodiversity hotspots. *Nature,* **404**: 990-992.

Collier, N., D.A. Mackay, K. Benkendorff, A.D. Austin and S.M. Carthew (2005). Butterfly communities in South Australian urban reserves: Estimating abundance and diversity using the Pollard walk. *Austral. Ecol.,* **31**: 282-290.

Colwell, R.K. (2005). *EstimateS: Statistical estimation of species richness and shared species from samples*. Version 7.5. User's Guide and application. http://purl.oclc.org/estimates

Devy, M.S. and P. Davidar (2001). Response of wet forest butterflies to selective logging in Kalakad-Mundanthurai Tiger Reserve: Implications for conservation. *Curr. Sci.,* **80**(3): 400-405.

Dhaliwal, D.S. and M. Sharma (1999). *Flora of Kullu District (Himachal Pradesh).* Bishen Singh Mahendra Pal Singh, Dehra Dun. 744 pp.

Evans, W.H. (1932). *The Identification of Indian Butterflies* (2nd edn.). Bombay Natural History Society, Bombay. 464 pp.

Haribal, M. (1992). *The Butterflies of Sikkim Himalaya and their natural history.* Sikkim. Nature Conservation Foundation, Gangtok. 217 pp.

Kunte, K. (2000). *India - A lifescape: Butterflies of Peninsular India.* University Press, Hyderabad. 254 pp.

Magurran, A.E. (1988). *Ecological diversity and its measurement.* Princeton University Press, Princeton, NJ. 179 pp.

Mani, M.S. (1986). *Butterflies of the Himalaya.* Oxford and IBH Publishing Co., New Delhi, 181pp.

Pollard, E. and T.J. Yates (1993). *Monitoring Butterflies for Ecology and Conservation.* Chapman and Hall, London, Xiii + 274 pp.

Robbins, R.K. and P.A. Opler (1997). Butterfly diversity and a preliminary comparison with bird and mammal diversity. *Biodiversity II. Understanding and Protecting our Biological Resources* (Reduka-Kudla, M.L., E.D. Wilson and E.O. Wilson, eds). Joseph Henry Press, Washington DC. pp. 69-82.

Rodgers, W.A. and H.S. Panwar (1988). *Planning a wildlife protected area network in India* Vol. I. Wildlife Institute of India, Dehra Dun. 339 pp.

Scharff, N., J.A. Coddington, C.E. Griswold, G. Hormiga and P.P. Bjorn (2003). When to quit estimating spider richness in a northern European deciduous forest. *J. Arachnology,* **31**: 246-273.

Sorensen, L.L., J.A. Coddington and N. Scharff (2002). Inventorying and estimating sub canopy spider diversity using semiquantitative sampling methods in an afromontane forest. *Environmental Entomology,* **31** : 319-330.

Spitzer, K., V. Novotny, M. Tonner and J. Leps (1993). Habitat preferences, distribution and seasonality of the butterflies (Lepidoptera, Papilionoidea) in a montane tropical rain forest, Vietnam. *J Biogeography,* **20**: 109-121.

WPA (2005). *The Wildlife Protection Act, 1972 (as amended upto 2003).* Wildlife Trust of India, New Delhi, Natraj Publishers, Dehra Dun.

Wynter-Blyth, M.A. (1957). *Butterflies of the Indian Region.* Bombay Natural History Society, Bombay. 523 pp.