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Study on faunal diversity of butterflies in Triveni Mahadev (Himachal Pradesh)

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Abstract
In this study butterflies were used as a means of assessing biodiversity restoration at Triveni Mahadev area. Butterflies were used as indicator species because of their high sensitivity in ecosystem alteration. The study was done in three different areas, namely the dam site, diversion site and power house sites. Butterfly sweep nets and Butterfly traps baited were used for capturing butterflies. Besides, monitoring was also an indicator about the trend being followed by insects group as a whole. The diversity of butterflies was lowest at diversion site during monsoon season and highest during post monsoon season at power house site. In this study butterflies were used in assessing hydroelectric project sites recommended for aesthetic, education purposes and further studies on organisms. Biodiversity index of butterfly species has been updated from different hydroelectric project sites. The statistical data of seasonal abundance and diversity index of butterfly species have been discussed.

Keywords: butterfly, diversity, seasonal abundance

1. Introduction
Himachal Pradesh Power Cooperation is planning to set up Triveni Mahadev Hydro Electric Project in Kangra and Mandi districts of Himachal Pradesh across river Beas in Beri village. The focus on conservation of biodiversity has recently received attention. Various studies and protocols have been proposed to test the apropos patterns of biodiversity [3, 8, 17]. Earlier authors have classified a hierarchical composition of different level of organizations as well as groups of taxonomically related species to test the patterns of biodiversity conservation [13]. Certain insects were used to identify the state or changes in a landscape [4]. The use of indicator taxa in conservation efforts from pollution control to biodiversity has been the focus of attention [5]. Butterflies were found to be a potentially useful indicator of biodiversity, a significant predictor of the richness of birds, lichens and plants but not a good indicator of soil biodiversity. The main objective of the study was to assess biodiversity health of Triveni Mahadev by using butterflies as indicator species. In India two species of butterflies have shown change in their distribution range, recently. The Red Pierrot, *Talicada nyseus nauseous* (Lycaenidae) a species restricted to Peninsular India has now colonized the lower West Himalayan foothills and Shiwaliks in northern India [10]. While another species, the Brown Gorgon, *Meandrusa lachinus* (Fruhstorfer) Syn. *M. gyas* (Papilionidae), which had distribution restricted to north-east India and eastern Himalayas up to Sikkim has also now established itself in Kedarnath Musk Deer Reserve in Garhwal, the western Himalayas [13]. There is now ample evidence of the ecological impacts of recent climate change, from polar terrestrial to tropical marine environments. The responses of both flora and fauna span an array of ecosystems and organizational hierarchies, from the species to the community levels. Despite continued uncertainty as to community and ecosystem trajectories under global change, our review exposes a coherent pattern of ecological change across systems. Although we are only at an early stage in the projected trends of global warming, ecological responses to recent climate change are already clearly [14]. Diversity among the high-elevation-specialist butterflies is beginning to fall as temperatures become uncomfortably warm for them. As already stated butterflies are particularly sensitive to climate and are important bio-indicators of climate change. They are good biological indicators of environmental variation and are easily noticed as they are diurnal, flying around during sunshine, attractive, conspicuous; more easily identified group as compared to others; taxonomically track able with most species described and recognizable; have short generations and are widespread and diverse. They are also good biological indicators of environmental quality as they are sensitive and directly affected by any

alteration in their habitats, atmosphere, local weather, temperature and micro-climate [9, 15, 16]. Butterflies are excellent indicators of the effects of climate change on the wildlife.

2. Materials and Methods

The study was carried out at Triveni Mahadev Power House sites across river Beas during 2013-14. Three survey sites. (DMS: Indicating Area of Dam Site; DVS: Indicating Areas of Diversion Site; PWH: Indicating Areas of Powerhouse site) were selected as representatives of the habitat type in the study area. Collection, preservation and storage of specimens of butterflies were done. Two types of butterfly traps were used, the sweep nets and butterfly traps. Identification of butterfly fauna was carried out with the help of literature or through comparison with national reference collections being housed at Entomological Museums of I.A.R.I., New Delhi and F.R.I., Dehradun. Dissection of imagos for the study of genitalia, identification and characterization of new species of butterfly, was carried out.

2.1 Methodology for analyzing biodiversity

1 Regular marked trails in all habitat types were made during collection period. All butterfly species sighted were collected, identified and recorded. Identifications were confirmed from different national museum and literature. The year, in this part of the world is divided into four seasons based on general observation on the climate. The first wet season from mid June to mid September receives scanty rainfall through the monsoon. The next three months from September to November are dry, relatively cooler months and receives scanty showers. The months from December to March constitute winter interrupted by rain and heavy snow. Some of high altitude areas remain separated from rest of the world due to heavy snow. Three months from April to June were hot and humid with scanty rainfall. Since sampling efforts in the four seasons was unequal and all specimens collected over each of the month was pooled together for analysis, only relative estimates of the abundance was possible. The mean relative abundance values of all the counts in each habitat were calculated for the different species in the four seasons. Differences between the means across the habitats were tested to determine any habitat preference by the butterflies.

2 Transect counts were made to monitor butterfly populations. Three transect, each with 1000x10m^2 were selected at different habitats. Each of the transect was

2.2 Data analysis

a. Differentiation diversity (beta diversity)

The beta diversity was estimated using similarity coefficients as a measure of how different or similar a range of habitats or samples are in terms of variety of species found in them. Though several indices exist, Shannon-Wiener index was used for the present study.

3. Results and Discussion

Butterfly traps and sweep net gave the total 331 individuals from three survey sites. DMS: Indicating Area of Dam Site; DVS: Indicating Areas of Diversion Site; PWH: Indicating Areas of Powerhouse site. 10 species were found during pre-monsoon season (H= -2.14, C=0.13); 9 species were found during monsoon season (H= -2.11, C=0.13); 7 species during post- monsoon season (H= -1.83, C=0.17) from dam site (Table 1-3).

Table 1: Triveni Mahadev pre monsoon dam site

S. No.	Name of the Species	P	Q	Abundance	Density/sq.m.	Frequency%	(ni/n)=Pi	H	C
1	*Actolepis puspa*	8	2	4	2.67	66.67	0.19	-0.31	0.03
2	*Aulocera swaha*	6	3	2	2	100.00	0.14	-0.27	0.02
3	*Catopsilia pomona*	3	3	1	1	100.00	0.07	-0.19	0.00
4	*Eurema brigitta*	1	1	1	0.33	33.33	0.02	-0.09	0.00
5	*Graphium sarpedon luctatius*	2	2	1	0.67	66.67	0.05	-0.14	0.00
6	*Mycalesis francisca*	3	3	1	1	100.00	0.07	-0.19	0.00
7	*Neptis hylas*	4	2	2	1.33	66.67	0.09	-0.22	0.01
8	*Papilio polytes*	3	2	1.5	1	66.67	0.07	-0.19	0.00
9	*Pieris brassicae*	9	3	3	3	100.00	0.21	-0.33	0.04
10	*Rapala manea*	4	3	1.33	1.33	100.00	0.09	-0.22	0.01
		43	24					**-2.14**	**0.13**

Table 2: Triveni Mahadev monsoon dam site

S. No.	Name of the Species	P	Q	Abundance	Density/ sq.m.	Frequency%	(ni/n)=Pi	H	C
1	*Actolepis puspa*	10	3	3.33	3.33	100.00	0.13	-0.26	0.02
2	*Aulocera swaha*	15	3	5	5	100.00	0.19	-0.32	0.04
3	*Catopsilia pomona*	5	1	5	1.67	33.33	0.06	-0.18	0.00
4	*Eurema brigitta*	8	3	2.67	2.67	100.00	0.10	-0.23	0.01
5	*Graphium sarpedon luctatius*	11	3	3.67	3.67	100.00	0.14	-0.28	0.02
6	*Neptis hylas*	8	2	4	2.67	66.67	0.10	-0.23	0.01
7	*Papilio polytes*	6	3	2	2	100.00	0.08	-0.20	0.01
8	*Pieris brassicae*	12	3	4	4	100.00	0.15	-0.29	0.02
9	*Rapala manea*	3	2	1.5	1	66.67	0.04	-0.13	0.00
10		78	23					**-2.11**	**0.13**

Table 3: Triveni Mahadev post monsoon dam site

S. No.	Name of the Species	P	Q	Abundance	Density/ sq.m.	Frequency%	(ni/n)=Pi	H	C
1	*Actolepis puspa*	6	3	2	2	100	0.25	-0.35	0.06
2	*Catopsilia pomona*	3	3	1	1	100	0.125	-0.26	0.02
3	*Graphium sarpedon luctatius*	4	2	2	1.33	66.67	0.17	-0.30	0.03
4	*Neptis hylas*	2	2	1	0.67	66.67	0.08	-0.21	0.01
5	*Papilio polytes*	3	3	1	1	100	0.13	-0.26	0.02
6	*Pieris brassicae*	1	1	1	0.33	33.33	0.04	-0.13	0.00
7	*Rapala manea*	5	2	2.5	1.67	66.67	0.21	-0.33	0.04
8		24	16					**-1.83**	**0.17**

8 species were found during pre-monsoon season (H= -1.93, C=0.16); 11 species were found during monsoon season (H= -2.23, C=0.11); 7 species during post-monsoon season (H= -1.91, C=0.15) from diversion site (Table 4-6).

Table 4: Triveni Mahadev pre monsoon diversion site

S. No.	Name of the Species	P	Q	Abundance	Density/ sq.m.	Frequency%	(ni/n)=Pi	H	C
1	*Candida canis*	6	3	2	2	100	0.24	-0.34	0.06
2	*Catopsilia pomona*	3	3	1	1	100	0.12	-0.25	0.01
3	*Colias erate (esper)*	4	2	2	1.33	66.67	0.16	-0.29	0.03
4	*Eurema laeta*	1	1	1	0.33	33.33	0.04	-0.13	0.00
5	*Gonepteryx rhamni*	5	2	2.5	1.67	66.67	0.2	-0.32	0.04
6	*Graphium sarpedon luctatius*	2	2	1	0.67	66.67	0.08	-0.20	0.01
7	*Heliophorus sena*	1	1	1	0.33	33.33	0.04	-0.13	0.00
8	*Lycaena phleas*	3	3	1	1	100	0.12	-0.25	0.01
9		25	17					**-1.93**	**0.16**

Table 5: Triveni Mahadev monsoon diversion site

S. No.	Name of the Species	P	Q	Abundance	Density/ sq.m.	Frequency%	(ni/n)=Pi	H	C
1	*Argynnis* sp.	2	2	1	0.67	66.67	0.03	-0.11	0.00
2	*Ariadne ariadne*	3	2	1.5	1	66.67	0.05	-0.14	0.00
3	*Candida canis*	9	3	3	3	100.00	0.14	-0.27	0.02
4	*Catopsilia pomona*	5	1	5	1.67	33.33	0.08	-0.20	0.01
5	*Colias erate (esper)*	6	3	2	2	100.00	0.09	-0.22	s
6	*Eurema laeta*	12	3	4	4	100.00	0.18	-0.31	0.03
7	*Gonepteryx rhamni*	4	3	1.33	1.33	100.00	0.06	-0.17	0.00
8	*Graphium sarpedon luctatius*	11	3	3.67	3.67	100.00	0.17	-0.30	0.03
9	*Heliophorus sena*	3	2	1.5	1	66.67	0.05	-0.14	0.00
10	*Lycaena phleas*	9	3	3	3	100.00	0.14	-0.27	0.02
	Papilio demoleus	2	1	2	0.67	33.33	0.03	-0.11	0.00
		66	26					**-2.23**	**0.11**

Table 6: Triveni Mahadev post monsoon diversion site

S. No.	Name of the Species	P	Q	Abundance	Density/ sq.m.	Frequency%	(ni/n)=Pi	H	C
1	*Ariadne ariadne*	4	2	2	1.33	66.67	0.14	-0.28	0.02
2	*Catopsilia pomona*	3	3	1	1	100.00	0.11	-0.24	0.01
3	*Gonepteryx rhamni*	6	3	2	2	100.00	0.21	-0.33	0.05
4	*Graphium sarpedon luctatius*	4	2	2	1.33	66.67	0.14	-0.28	0.02
5	*Heliophorus sena*	3	2	1.5	1	66.67	0.11	-0.24	0.01
6	*Lycaena phleas*	3	3	1	1	100.00	0.11	-0.24	0.01
7	*Papilio demoleus*	5	3	1.67	1.67	100.00	0.18	-0.31	0.03
8		28	18					**-1.91**	**0.15**

6 species were found during pre-monsoon season (H= -1.72, C=0.19); 6 species during monsoon season (H= -1.72, C=0.19); 3 species during post-monsoon season (H= -1.09, C=0.34) from power house site (Table 7-9).

Table 7: Triveni mahadev pre monsoon power house site

S. No.	Name of the Species	P	Q	Abundance	Density/ sq.m.	Frequency%	(ni/n)=Pi	H	C
1	*Catopsilia pomona*	3	3	1	1	100	0.19	-0.31	0.04
2	*Colias erate (esper)*	4	2	2	1.33	66.67	0.25	-0.35	0.06
3	*Erabia nirmala*	3	2	1.5	1	66.67	0.19	-0.31	0.04
4	*Eurema brigitta*	1	1	1	0.33	33.33	0.06	-0.17	0.00
5	*Graphium sarpedon luctatius*	2	2	1	0.67	66.67	0.13	-0.26	0.02
6	*Mycalesis francisca*	3	3	1	1	100	0.19	-0.31	0.04
7		16	13					**-1.72**	**0.19**

Table 8: Triveni Mahadev monsoon power house site

S. No.	Name of the Species	P	Q	Abundance	Density/ sq.m.	Frequency%	(ni/n)=Pi	H	C
1	*Ariadne ariadne*	3	2	1.5	1	66.67	0.075	-0.19	0.01
2	*Catopsilia pomona*	5	1	5	1.67	33.33	0.125	-0.26	0.02
3	*Colias erate (esper)*	6	3	2	2	100	0.15	-0.28	0.02
4	*Erabia nirmala*	7	3	2.33	2.33	100	0.175	-0.31	0.03
5	*Eurema brigitta*	8	3	2.67	2.67	100	0.2	-0.32	0.04
6	*Graphium sarpedon luctatius*	11	3	3.67	3.67	100	0.275	-0.36	0.08
7		40	15					**-1.72**	**0.19**

Table 9: Triveni Mahadev post monsoon power house site

S. No.	Name of the Species	P	Q	Abundance	Density/ sq.m.	Frequency%	(ni/n)=Pi	H	C
1	*Ariadne ariadne*	4	2	2	1.33	66.67	0.36	-0.37	0.13
2	*Catopsilia pomona*	3	3	1	1	100.00	0.27	-0.35	0.07
3	*Graphium sarpedon luctatius*	4	2	2	1.33	66.67	0.36	-0.37	0.13
4		11	7					**-1.09**	**0.34**

The insect habitat must supply the needs throughout its life time [12]. These needs will comprise, at the very least, food and Suitable climatic conditions, and may also include shelter from disturbance and natural enemies. The effect of land-use changes on insects can be studied at three levels; on individual species, on the composition of species in a habitat or on simplified measures of the overall structure of the assemblage, such as species richness, diversity or biomass. Large butterfly like *Papilio* sp were observed to migrate over long distance than small sized species. Some studies have shown that, certain level of disturbance can be beneficial to butterflies, thus increasing the abundance of butterflies [10]. This suggests that, the Triveni Mahadev area can be upgraded to favourable microclimate disturbance for butterflies. However some studies have showed different cases on the variation of butterfly's diversity for disturbed area [7]. For instance, the study revealed that difference in disturbance did not cause difference in species diversity due to understory vegetation cover. Butterflies play a keystone species role in the ecosystems by pollination and completion of food chain [1].

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