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SHORT COMMUNICATION

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SHORT COMMUNICATION

Diversity pattern of butterfly communities (Lepidoptera) in different habitat types of Nahan, Himachal Pradesh, India

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Abstract: Diversity and similarity of butterfly communities were assessed in three different habitat types in the mountains of Nahan, Himachal Pradesh, from May 2012 to April 2013. A total of 75 species and five families were reported. Proportion of species was highest in deciduous dry forest (49%), followed by *Shorea* (Saal) forest (34%), and *Pinus* (Cheer) forest (17%). Family Pieridae was dominant followed by Nymphalidae in all three habitat types. Cluster analysis revealed that Cheer forest stood out clearly from Dry and Saal forest which represents the different species composition. We found significant differences in butterfly diversity in the three forest types based on Shannon index, Simpson dominance index, and Buzas & Gibson's evenness. These differences may be attributable to variations in host and nectar plant distribution. Of the habitats surveyed, dry deciduous forest appeared to be the most suitable for butterfly conservation.

Keywords: Butterfly, diversity index, species composition, western Himalaya.

Insect diversity is influenced by available vegetation (DeVries 1992). The diversity of some moths and beetles are high in natural forests and low in secondary forests (Morse et al. 1988; Barlow & Woiwod 1989), but butterfly diversity has been found to usually be low in natural forests, moderate in disturbed forests and high in moderately disturbed forests (Blair & Launer 1997; Schulze et al. 2004) or near forest banks (Vu 2008, 2009).

Asian forests are under intense pressure from deforestation and forest degradation (Achard et al. 2002), which can have large effects on biodiversity. Climate change is another factor affecting biodiversity (Stange & Ayres 2010). Lepidoptera (moths and butterflies) are considered bioindicator species because of their sensitivity to climate change (Ronkay 2004). For example, recently some butterflies have shifted their distribution northwards in Europe and North America (Parmesan 1996; Parmesan et al. 1999; Sparks et al. 2007), and local species compositions have also been affected by climate change (Woiwod 1997).

Tropical butterfly assemblages have been observed to be largely dependent on closed-canopy forests (Collins & Morris 1985; Sutton & Collins 1991), which have a rich variety of vegetation (Erhardt 1985; Thomas & Mallorie 1985; Viejo 1989; Lawton et al. 1998). Such studies are important for determining patterns of tropical insect diversity in forest ecosystems (Brown 1991; DeVries et al. 1997). Various studies have been performed in Himachal Pradesh in order to document the diversity of butterflies on regional basis (Uniyal & Mathur 1998; Singh 2008; Arora et al. 2009; Bhardwaj & Uniyal 2009; Kumar 2009; Chandel et al. 2014). So far, no study has been performed to document the variation in butterfly diversity among

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different habitat types of Nahan, Himachal Pradesh. Therefore, the present study documented the seasonal (pre-monsoon, monsoon, post-monsoon, pre-winter, winter, and post-winter) variation of butterfly diversity among three different habitat types.

Material and Methods

Study was conducted in the three different forest types of Nahan town (30.55°N, 77.3°E) located in Sirmaur district of Himachal Pradesh with an elevation of 895 m. Nahan is situated in the Shivalik hills of western Himalaya. The town is surrounded by different forest patches, we conducted our study in *Shorea* (Saal) forest (30.554°N 77.293°E), deciduous dry forest (30.567°N 77.2852°E), and *Pinus* (Cheer) forest (30.563°N 77.314°E) (Figure 1).

Butterfly surveys were conducted from 8000 h to 1000 h and 1300 h to 1500 h in the afternoon, twice a month from May 2012 to April 2013. Butterflies were observed and identified in the field using a guide by Smetacek (2016) and doubtful species were collected using the sweep net method, identified & released immediately. We divided the data sets into six seasons: pre-monsoon (May–June), monsoon (June–July), post-monsoon (August–September), pre-winter (October–November), winter (December–January) and post-winter (February–March). Species diversity was calculated using:

Shannon index (Magurran 1988)

$H' = -\sum pi \ln pi$. (1)

pi= the proportion of the i^{th} species in the total sample.

Simpson dominance index (D)

D= sum$((n_i/n)^2)$ where n_i is number of individuals of taxon i,

and Buzas & Gibson's evenness= e^H/S

where H is the Shannon diversity index and S is the number of species.

Comparisons of butterfly species composition among different forest types was estimated using single linkage cluster analysis based on Bray-Curtis similarity.

Results and Discussion

Seventy-five species of butterflies were recorded (Table 1). In dry deciduous forest, species from five families were recorded: Pieridae (46%), Nymphalidae

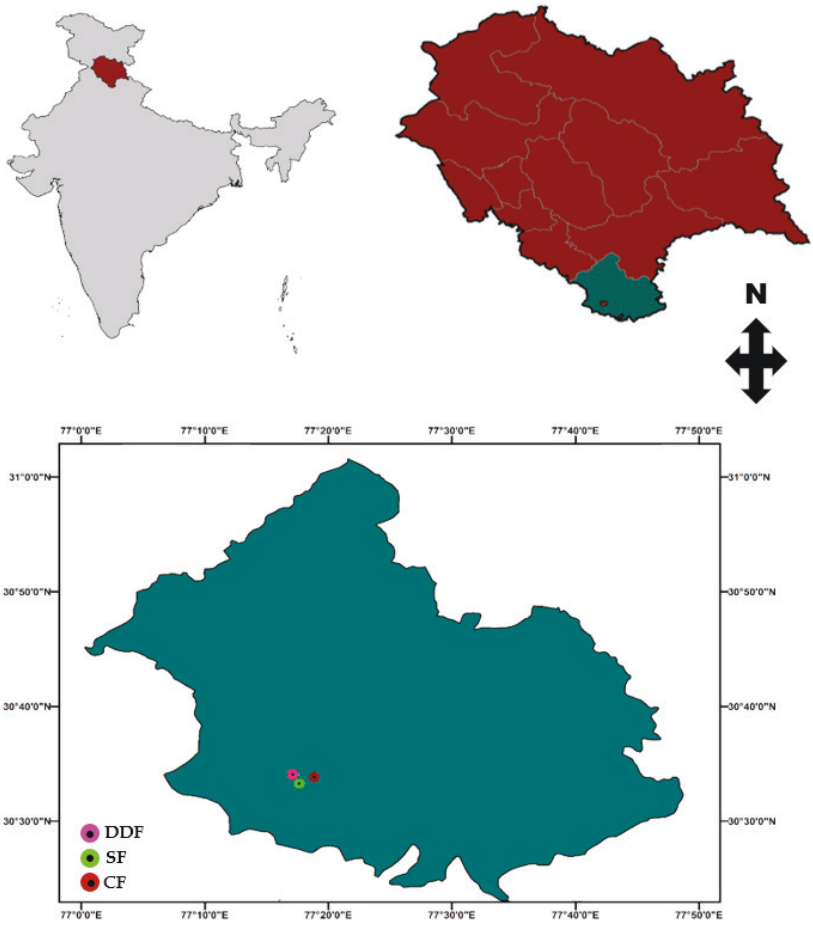

Figure 1. The three different habitat sites of Nahan town of Himachal Pradesh.

Table 1. Butterfly species reported in different forest types. DDF—Dry deciduous forest | SF—Saal forest | CF—Cheer Forest of Nahan.

	Family	Scientific name	Common name	DDF	SF	CF
1	Hesperiidae	*Sarangesa dasahara* (Moore, [1866])	Common Small Flat	4	18	7
2		*Suastus gremius* (Fabricius, 1798)	Oriental Palm Bob	1	0	0
3		*Pelopidas mathias* (Fabricius, 1798)	Small Branded Swift	1	0	0
4		*Pelopidas sinensis* (Mabille, 1877)	Chinese Branded Swift	0	3	0
5		*Notocrypta feisthamelii* (Boisduval, 1832)	Spotted Demon	4	7	0
6		*Taractrocera danna* (Moore, 1865)	White-Spotted Grass Dart	4	1	0
7		*Ochlodes brahma* (Moore, 1878)	Grey-Branded Darter	7	0	0
8	Lycaenidae	*Zizeeria karsandra* (Moore, 1865)	Dark Grass Blue	15	11	14
9		*Zizula hylax* (Fabricius, 1775)	Tiny Grass Blue	7	0	0
10		*Pseudozizeeria maha* (Kollar, [1844])	Pale Grass Blue	48	16	6
11		*Heliophorus sena* (Kollar, [1844])	Sorrel Sapphire	93	58	12
12		*Zizina otis* (Fabricius, 1787)	Lesser Grass Blue	28	20	11
13		*Lampides boeticus* (Linnaeus, 1767)	Pea Blue	65	59	1
14		*Acytolepis puspa* (Horsfield, [1828])	Common Hedge Blue	19	11	6
15		*Euchrysops cnejus* (Fabricius, 1798)	Gram Blue	5	0	0
16		*Arhopala rama* (Kollar, [1844])	Dark Oakblue	1	0	0
17		*Cyrestis thyodamas* Doyère, [1840]	Common Map	0	14	0
18		*Chilades pandava* (Horsfield, [1829])	Plains Cupid	3	11	4
19		*Talicada nyseus* (Guérin-Méneville, 1843)	Red Pierrot	2	2	0
20		*Leptotes plinius* (Fabricius, 1793)	Zebra Blue	1	1	0
21		*Castalius rosimon* (Fabricius, 1775)	Common Pierrot	3	0	0
22		*Catochrysops strabo* (Fabricius, 1793)	Forget-Me-Not	0	0	1
23		*Rapala selira* (Moore, 1874)	Himalayan Red Flash	1	0	0
24	Nymphalidae	*Tirumala limniace* (Cramer, [1775])	Blue Tiger	2	0	0
25		*Phalanta phalantha* (Drury, [1773])	Common Leopard	38	36	12
26		*Neptis hylas* (Linnaeus, 1758)	Common Sailer	24	10	20
27		*Aglais caschmirensis* (Kollar, [1844])	Indian Tortoiseshell	4	0	0
28		*Danaus chrysippus* Linnaeus, 1758	Plain Tiger	6	5	11
29		*Danaus genutia* Cramer, 1779	Common Tiger	6	0	2
30		*Danaus genutia* (Cramer, [1779])	Striped Tiger	9	0	0
31		*Parantica aglea* (Stoll, [1782])	Glassy Tiger	6	5	0
32		*Tirumala septentrionis* (Butler, 1874)	Dark Blue Tiger	1	0	0
33		*Junonia lemonias* (Linnaeus, 1758)	Lemon Pansy	156	145	20
34		*Junonia hierta* (Fabricius, 1798)	Yellow Pansy	3	6	0
35		*Junonia iphita* (Cramer, [1779])	Chocolate Pansy	18	29	12
36		*Vanessa indica* (Herbst, 1794)	Indian Red Admiral	12	3	0
37		*Kaniska canace* (Linnaeus, 1763)	Blue Admiral	0	2	0
38		*Vanessa cardui* (Linnaeus, 1758)	Painted Lady	13	4	0
39		*Kallima inachus* (Doyère, [1840])	Orange Oakleaf	1	0	0
40		*Ideopsis similis* (Linnaeus, 1758)	Blue Glassy Tiger	2	3	4
41		*Symphaedra nais* (Forster, 1771)	Baronet	0	8	0
42		*Mycalesis perseus* Fabricius, 1775	Common Bushbrown	2	1	1
43		*Melanitis leda* (Linnaeus, 1758)	Evening Bushbrown	2	0	0
44		*Melanitis phedima* (Cramer, [1780])	Dark Evening Brown	0	0	3

	Family	Scientific name	Common name	DDF	SF	CF
45		*Lethe rohria* (Fabricius, 1787)	Common Treebrown	2	0	0
46		*Melanitis leda* (Linnaeus, 1758)	Common Evening Brown	1	0	0
47		*Hypolimnas bolina* (Linnaeus, 1758)	Great Eggfly	5	4	0
48		*Junonia hierta* (Fabricius, 1798)	Yellow Pansy	1	0	0
49		*Euthalia aconthea* (Cramer, [1777])	Common Baron	4	0	0
50		*Hypolimnas misippus* (Linnaeus, 1764)	Danaid Eggfly	2	2	0
51		*Ypthima asterope* (Klug, 1832)	Common Three Ring	7	0	0
52	Nymphalidae	*Ypthima baldus* (Fabricius, 1775)	Common Five Ring	4	0	0
53		*Papilio polytes* Linnaeus, 1758	Common Mormon	81	34	48
54		*Euploea core* (Cramer, [1780])	Common Crow	14	4	0
55		*Euploea mulciber* (Cramer, [1777])	Striped Blue Crow	2	2	0
56		*Ariadne ariadne* (Linnaeus, 1763)	Angled Castor	26	11	0
57		*Ariadne merione* (Cramer, [1777])	Common Castor	21	11	4
58		*Lethe confusa* Aurivillius, [1898]	Banded Treebrown	0	0	3
59		*Lasiommata schakra* (Kollar, [1844])	Common Wall	1	0	0
60		*Pachliopta aristolochiae* (Fabricius, 1775)	Common Rose	0	4	0
61	Papilionidae	*Papilio demoleus* Linnaeus, 1758	Lime Swallowtail	39	18	0
62		*Graphium nomius* (Esper, 1799)	Spot Swordtail	2	2	0
63		*Catopsilia pomona* (Fabricius, 1775)	Lemon Emigrant	188	186	119
64		*Eurema hecabe* (Linnaeus, 1758)	Common Grass Yellow	98	67	44
65		*Eurema brigitta* (Stoll, [1780])	Small Grass Yellow	30	23	9
66		*Cepora nerissa* (Fabricius, 1775)	Common Gull	88	5	0
67		*Delias belladonna* (Fabricius, 1793)	Hill Jezebel	0	2	0
68		*Pieris rapae* Linnaeus, 1758	Small Cabbage White	209	94	84
69	Pieridae	*Catopsilia pyranthe* (Linnaeus, 1758)	Mottled Emigrant	83	82	56
70		*Belenois aurota* (Fabricius, 1793)	Pioneer	13	4	0
71		*Pontia daplidice* (Linnaeus, 1758)	Bath White	2	0	0
72		*Eurema laeta* (Boisduval, 1836)	Spotless Grass Yellow	1	17	5
73		*Eurema blanda* (Boisduval, 1836)	Three Spot Grass Yellow	1	0	0
74		*Delias eucharis* (Drury, 1773)	Indian Jezebel	0	0	0
75		*Pieris brassicae* (Linnaeus, 1758)	Large Cabbage White	2	0	0

(31%), Lycaenidae (19%), Papilionidae (2.7%), and Hesperiidae (1.4%). Pieridae were also dominant in Saal forest (45%), followed by Nymphalidae (31%), Lycaenidae (19%), Hesperiidae (2.7%), and Papilionidae (2.3%). Pieridae were also dominant in Cheer forest (61%) followed by Nymphalidae (27%), Lycaenidae (11%), and Hesperiidae (1.4%); no Papilionidae were recorded from Cheer forest.

The composition of butterfly communities in different habitat types is summarized in Figure 2. Comparisons indicate that Cheer forest had a markedly different species composition than dry deciduous and Saal forests, while the latter two showed similar species composition.

Shannon index in DDF ranged from 1.772 to 3.182 (Mean= 2.50 ± Sd 0.48), in SF from 1.435 to 3.065 (mean= 2.27 ± sd 0.57) and in CF from 0.8902 to 2.538 (mean= 1.75 ± sd 0.61) (Table 2, Figure 3). Diversity analysis for dominance in DDF ranged from 0.05334 to 0.2588 (mean= 0.12 ± sd 0.07), in SF from 0.05853 to 0.3208 (mean= 0.15 ± sd 0.09) and in CF from 0.09383 to 0.5542 (mean= 0.24 ± sd 0.16) (Table 3, Figure 4). Diversity analysis for evenness in DDF ranged from 0.4895 to 0.8237 (mean= 0.59 ± sd 0.12), in SF from 0.525 to 0.8608 (mean= 0.63 ± sd 0.15) and in CF from 0.4871 to 0.8742 (mean= 0.73 ± sd 0.14) (Table 4, Figure 5).

Species distribution governs the local assemblages (Ranta & Tiainen 1982). In this study, we documented

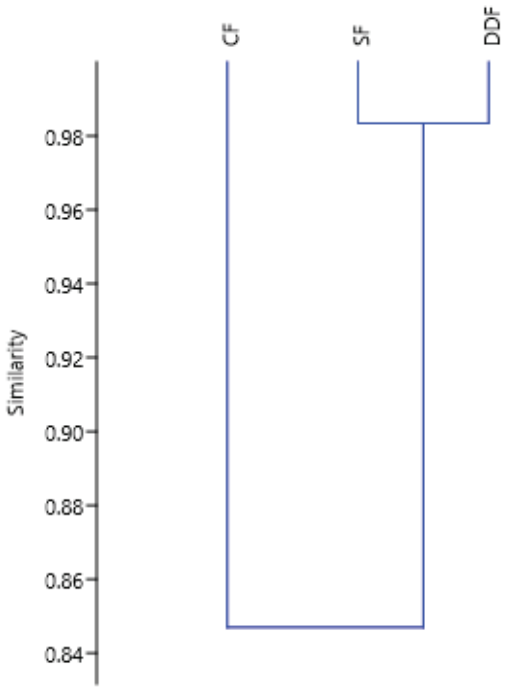

Figure 2. Similarity of species composition of butterfly families among different habitat types.

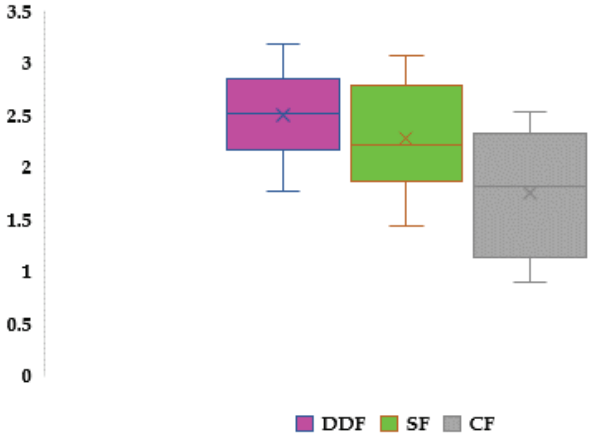

Figure 3. Box plot representing the difference of Shannon index between the forest types.

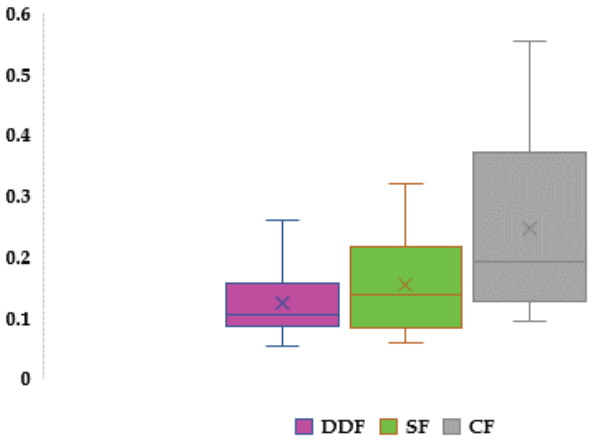

Figure 4. Box plot representing the difference of Simpson dominance index between the forest types.

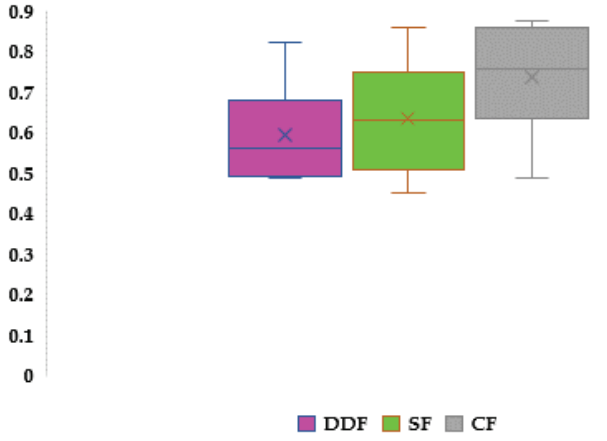

Figure 5. Box plot representing the difference of Buzas & Gibson's evenness index between the forest types.

the highest species diversity in DDF, followed by SF and CF. The habitat specificity of butterfly species is linked to the availability of host plants (Sarkar et al. 2011; Majumder et al. 2013), and in the present study species composition indicates the presence of host and nectar plants in particular areas and habitats. Family Pieridae was found dominant in all three forested habitats followed by Nymphalidae. Sarkar et al. (2011) also reported that the dominancy of Pieridae species correlates with the distribution of host plant species. On the other hand, high diversity of Nymphalidae directly indicates the high richness of host plants (Majumder et al. 2013). Nymphalidae species have a polyphagous nature, which allows them to inhabit vast habitats.

Bray-Curtis single linkage cluster analysis based on the similarity value revealed the percentage similarity between DDF and SF with a linkage of 99 % whereas CF has different species composition. We predicted that the *Pinus roxburghii* is the dominant plant species in cheer forest, which is why it has the lowest butterfly species diversity. Among all the habitats surveyed, the dry deciduous forest signified the most suitable habitat for butterfly diversity, which might be because of the habitat richness having the preferable nectar and host plant species.

Table 2. Two way ANOVA For Shannon diversty Index between seasons and forest type.

Source of variation	SS	Df	MS	F	P-value	F crit
Forest type	1.757115	2	0.878557	46.02805	9.03E-06	4.102821
Season	4.471064	5	0.894213	46.84824	1.28E-06	3.325835
Error	0.190874	10	0.019087			
Total	6.419053	17				

Tale 3. Two way ANOVA For Simpson's dominance index between seasons and forest type.

Source of variation	SS	df	MS	F	P-value	F crit
Forest type	0.049197	2	0.024598	8.719129	0.00643	4.102821
Season	0.178656	5	0.035731	12.66528	0.000462	3.325835
Error	0.028212	10	0.002821			
Total	0.256064	17				

Table 4. Two way ANOVA For Buzas & Gibson's evenness index between seasons and forest type.

Source of variation	SS	df	MS	F	P-value	F crit
Forest type	0.064756	2	0.032378	7.591687	0.009873	4.102821
Season	0.241155	5	0.048231	11.30879	0.000736	3.325835
Error	0.042649	10	0.004265			
Total	0.34856	17				

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