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## Biodiversity of Butterflies from Districts Poonch and Sudhnoti, Azad Kashmir

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**Abstract:** The adult butterflies were collected from ten localities of district Poonch and eight localities of district Sudhnoti through out the summer season of (April to October) 2000. A total of 29 species belonging to 5 families from district Rawalakot and 21 species belonging to 5 families were collected from district Sudhnoti. Biodiversity was calculated by using Shannon-Wiener diversity index, Shannon's equitability, Margalef's index, Simpson's index and RI index. The calculated values of diversity indices showed that from district Rawalakot the highest diversity was obtained from Khaigala and lowest diversity was obtained from Topa and Paniola. From district Sudhnoti the highest diversity was calculated from Azad Pattan and the lowest diversity was calculated from Pallandri city.

**Key words:** Biodiversity indices, butterflies, richness, abundance, equitability

### INTRODUCTION

Butterflies are the most abundant group of insects on the earth which are recognizable among the general public and science due to their beautiful colors and graceful flight<sup>[1]</sup>. The butterflies are found in every part of the world wherever the flowering plants are found<sup>[2]</sup> inhabiting even very high altitude, Arctic, Antarctic, mountains covered with perpetual snow and glaciers<sup>[3]</sup>.

Systematically the butterflies are being studied since 18th century and up till now 4500 species have been documented from the world but the fauna of the area under study was completely unexplored<sup>[4-7]</sup> and it is the first attempt to explore the butterfly fauna and to calculate the distributional diversity which will be continuously monitored with the passage of the time in this area of the world.

District Poonch of Azad Kashmir is one of the most beautiful pieces of land due to the green vegetation, very high alpine trees and the flowering plants of all kinds. The climate of the district is not very diverse. Only a few places like Hajira are hot during the summer, where as on the whole this district has very cold winter and the most of the areas are included in snow zone. Some areas of the district could not be sampled due to unavailability of roads links.

District Sudhnoti is adjacent to district Poonch and climatically some places of district Sudhnoti are more or less the same like Nakka Bazar and Gorah but remaining all the places from district Sudhnoti are very hot during the summer and mild during the winter. The vegetation of this

district is also very different from that of district Poonch. In this district, small bushes and shrubs are very abundant, where as high trees are very patchy and dense vegetation is sparse.

Therefore, the present study aims at the bio-diversity of butterflies in the Poonch and Sudhnoti districts of Azad Kashmir.

### MATERIALS AND METHODS

The butterflies were collected from ten localities of district Poonch namely: Datot, Paniola, Topa, Singhola, Hussain Kot, Ali Sojal, Khaigala, Banjonsa and Hajira and eight localities from district Sudhnoti namely: Azad Pattan, Baral, Pallandri city, Nakka Bazar, Pattan Sher Khan, Mong, Gorah and Saundh (Fig. 1).

The localities were visited fortnightly through out the summer season, from mid March to the end of October 2000. In this way the whole summer season was completed. The specimens were preserved in the polythene bags and brought to the laboratory and later on identified to the species level with the help of available literature<sup>[8,9]</sup>. The rank lists were prepared from each locality according to the maximum abundance with the help of which the diversity indices were calculated and two collective rank lists were also prepared (Table 3 and 4).

The diversity was calculated by using diversity indices namely: Shannon-Wiener's diversity index<sup>[10]</sup>, along with its equitability component, Margalef's index<sup>[11,12]</sup>, Simpson's index<sup>[13]</sup> and RI index<sup>[14,15]</sup>.

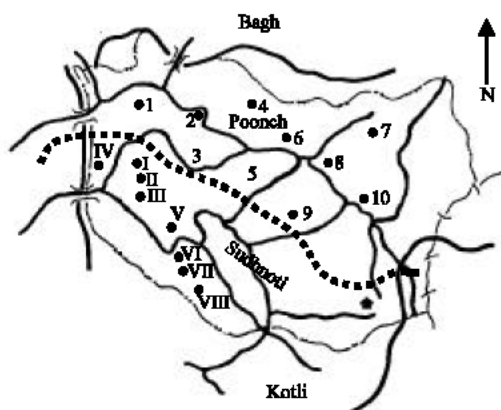


Fig. 1: Map of districts Poonch and Sudhnoti showing the sampled places

Sampled places of district Poonch

- |                |              |
|----------------|--------------|
| 1. Datot       | 6. Rawalakot |
| 2. Paniola     | 7. Ali Sojal |
| 3. Topa        | 8. Khaigala  |
| 4. Singola     | 9. Banjonsa  |
| 5. Hussain Kot | 10. Hajira   |

Sampled places of district Sudhnoti

- |                       |                    |
|-----------------------|--------------------|
| I. Nakka Bazaar       | V. Gorah           |
| II. Mong              | VI. Pallandri city |
| III. Pattan Sher Khan | VII. Saundh        |
| IV. Azad Pattan       | VIII. Baral        |

The form of the Shannon-Wiener index used is  $H = -\sum \{(pi) \log_2 pi\}$ , where, pi is the proportion with in the sample of the number of the individuals of ith species and it is  $ni/N$ , where, ni is the number of individuals in ith species and N is the total number of individuals. But the, form of the index used in the present study is:  $H = C \{ \log_{10} N - 1/N \sum (nr \log_{10} nr) \}$ , where N is the total number of the individuals, nr is the rank abundance in ith species C is the conversion factor from  $\log_2$  to  $\log_{10}$ .

The form of the Shannon's equitability used is:  $J = H/H_{max}$ , where, H is the Shannon-Wiener's diversity index and  $H_{max}$  is the  $\log_2$  of S, where, S is the total number of species in the sample.

The form of the Margalef's index used is:  $d = S - 1/\log_e N$ . Where, S is the number of species and N is the total number of individuals.

The Simpson's index used is  $D = 1/\sum (pi)^2$ , where, pi is the proportion of ith species and is calculated as  $ni/N$ , where, ni is the total number of individuals in the ith species and N is the total number of individuals in the sample but the form of the index used in the present study is:  $D = \sum [ni \{ni - 1 / N(N - 1)\}]$ , where, ni is the

number of individuals in ith species and N is the total number of individuals in the sample. This index gives the species abundance and is denoted by D. As the D increases the diversity decreases. That's why this index is usually expressed as  $1 - D$  or  $1/D$ .

The last index used is RI index. The form of the index used is  $RI = \sum Ri / S(M - 1)$ , where S is the number of investigated species of insects, M is the number of rank of abundance (0,1,2,3,...M-1) and Ri is the rank value of ith species in the sample.

RESULTS AND DISCUSSION

Diversity is the central theme of ecology and its measures are frequently seen as the indicators of the wellbeing of the ecological system. As the diversity is hard to define, similarly, it is difficult to calculate because the collection of data and their processing is a time taking and tedious job. However, it is the major feature of the animal communities. It is the number of species present and their numerical composition. Diversity is the niche time stability dependent, which means if a large number of niches are present; it will support higher diversity<sup>[6-18]</sup>. Generally, homogeneous conditions yield low diversity where as heterogeneous conditions yield higher diversity<sup>[9-21]</sup>. Diversity indices are a measure of a way in which individuals in an ecological community are distributed among species.

A co-efficient of diversity is a convenient way of demonstrating the variety of species present in a habitat or a sample and the abundance of individuals with in the species. The measure of diversity of the fauna will represent the number and the available niches present in the environment. If niche heterogeneity is great, it will support a more diverse fauna and thus will result in a higher co-efficient or index of diversity<sup>[22]</sup>.

The first index used in the present study is Shannon-Wiener's diversity index. This index is distribution dependent and suffers least from criticism of validity in application of biological data<sup>[23]</sup>.

The calculated values of this index at different localities of district Poonch ranged from 3.145 (Topa) to 4.366 (Khaigala). The lowest diversity was calculated from Topa (3.145), Hajira (3.167), Ali Sojal (3.192) and Paniola (3.217). The highest diversity was calculated from Rawalakot (4.012) and Khaigala (4.366). Remaining all the stations yielded the diversity of this index ranging from 3.405 (Singhola) to 3.991 (Hussain Kot) (Table 1). The calculated values of the shannon's diversity index from district Sudhnoti ranged from 3.29 (Plandri City) -3.81 (Azad Pattan), remaining all the stations yield diversity index values from 3.41 (Saundh) to 3.79 (Mong) (Table 2).

Table 1: Calculated values of diversity indices from different localities of Poonch, Azad Kashmir

Name of places	Shannon-Wiener index (H')	Shannon's equitability (J')	Margalef's index (d)	Simpson's index (D)	Simpson's index (1-D)	Simpson's index (1/D)	RI index
Datot	3.70	0.84	4.57	0.088	0.91	11.28	0.547
Paniola	3.21	0.83	3.37	0.139	0.86	7.15	0.571
Topa	3.14	0.73	4.02	0.125	0.87	7.93	0.552
Singhola	3.40	0.81	3.57	0.109	0.89	9.12	0.555
Hussain Kot	3.99	0.87	4.11	0.061	0.93	16.19	0.541
Rawalakot	4.01	0.88	4.11	0.069	0.03	14.26	0.543
Ali Sojal	3.19	0.76	3.58	0.145	0.85	6.87	0.555
Khaigala	4.36	0.04	4.43	0.033	0.96	29.70	0.540
Banjosa	3.77	0.88	3.47	0.075	0.92	13.25	0.552
Hajira	3.16	0.86	2.48	0.120	0.88	8.33	0.583

Table 2: Calculated values of diversity indices from different localities of Sudhnoti, Azad Kashmir

Name of places	Shannon-Wiener index (H')	Shannon's equitability (J)	Margalef's index (d)	Simpson's index (D)	Simpson's index 1-D	Simpson's index 1/D	RI index
Nakka Bazar	3.53	0.93	2.85	0.08	0.91	11.70	0.57
Mong	3.79	0.91	3.23	0.07	0.92	13.56	0.55
Pattan Sher Khan	3.69	0.94	2.60	0.07	0.92	13.24	0.57
Azad Pattan	3.81	0.90	4.03	0.07	0.92	13.71	0.55
Gorah	3.73	0.90	3.87	0.07	0.92	12.89	0.55
Pallandri City	3.29	0.83	2.63	0.09	0.90	10.91	0.56
Saundh	3.41	0.86	3.22	0.11	0.88	8.68	0.56
Baral	3.48	0.89	3.43	0.09	0.90	10.90	0.64

Table 3: The collective rank list along with the lists of Taxa collected from different localities of district Poonch, Azad Kashmir

Name of Taxa	Total abundance	Datot	Topa	Rawalakot	Khaigala	Hussain Kot	Banjosa	Paniola	Ali Sojal	Singhola	Hajira
<i>Pieris brassicae</i>	269	19	25	39	13	25	27	21	40	31	29
<i>Junonia orithya</i>	187	13	19	31	9	19	21	13	32	19	11
<i>Pieris canidia</i>	156	11	15	21	13	20	19	9	19	15	14
<i>Pontia daplidice</i>	147	9	14	19	7	29	22	6	13	17	11
<i>Pieris rapae</i>	131	7	-	22	9	31	23	-	3	21	15
<i>Papilio philoxenus</i>	124	6	3	21	21	20	25	-	-	15	13
<i>Gonopteryx rhamni</i>	135	-	17	17	15	23	19	5	11	13	15
<i>Eurema hecabe</i>	96	9	7	15	12	19	21	-	-	5	8
<i>Danucus gemutia</i>	88	3	2	10	23	27	13	1	2	3	4
<i>Pontia collicida</i>	76	1	3	14	21	23	9	3	-	2	-
<i>Papilio demoleus</i>	64	-	3	9	13	17	12	-	10	-	-
<i>Venessa cardui</i>	59	1	-	7	15	18	7	3	5	2	1
<i>Precis almanace</i>	48	-	1	6	17	13	6	-	3	-	2
<i>Colias erate</i>	44	-	-	9	11	18	3	-	2	1	-
<i>Argynnis kamala</i>	36	-	2	8	12	10	4	-	-	-	-
<i>Melanites leda</i>	37	-	3	8	14	6	2	-	1	2	1
<i>Argynnis hyperbuis</i>	33	-	-	9	13	4	-	2	3	2	-
<i>Catopsila pyranthe</i>	30	3	2	5	14	3	1	2	-	-	-
<i>Colias electo</i>	25	2	2	7	9	2	-	1	-	2	-
<i>Danucus chrysippus</i>	20	1	3	4	5	4	-	1	2	-	-
<i>Colias fieldi</i>	14	-	2	4	3	2	-	1	2	-	-
<i>Vanessa polychloros</i>	12	-	-	3	5	4	-	-	-	-	-
<i>Papilio Polytes</i>	9	2	1	2	3	-	-	-	1	-	-
<i>Papilio polyctor</i>	8	1	-	2	-	3	-	1	-	1	-
<i>Nepits hylas</i>	8	1	2	-	1	-	2	-	1	-	1
<i>Catopsila florella</i>	7	2	1	1	-	-	1	1	-	1	-
<i>Lethe rolhia</i>	6	1	1	1	1	-	1	-	1	-	-
<i>Phalantha phalantha</i>	5	1	-	1	-	1	-	1	-	1	-
<i>Graphium cloanthus</i>	5	-	1	-	1	1	-	1	-	1	-
$\Sigma N=1879$		93	129	295	280	342	238	72	151	154	125

The stations like Topa and Khaigala yielded the lowest diversity because at these stations the vegetation is sparse and the flowering plants are very scanty which attract less number of insects towards them. More over high trees are also less abundant which provide less favorable habitat to the butterflies.

The localities which yielded higher diversity (Rawalakot and Hussain Kot) have very dense vegetation and abundant flowering plants and high trees which provide very favorable habitat to the butterflies. Their larvae can easily find the host plants and the dense vegetation provide excellent shelter to the adult

Table 4: The collective rank list along with the lists of Taxa from different localities of district Sudhnoti, Azad Kashmir

Name of taxa	Abundance	Pattan Sher Khan	Mong	Naka Bazar	Pallandari	Saundh	Azad Pattan	Baral	Gorah
<i>Pieris brassica</i>	144	19	29	11	26	24	13	10	12
<i>Junonia orithya</i>	133	16	25	13	28	20	11	11	9
<i>Papilio phioxemus</i>	117	23	14	10	31	12	9	7	11
<i>Genotery xrhamni</i>	98	21	16	12	25	9	7	3	5
<i>Papilo demoleus</i>	90	26	17	-	35	3	2	-	7
<i>Argymnis kamala</i>	86	18	11	10	32	2	-	5	8
<i>Argymnis hyperbuis</i>	78	15	9	8	36	-	3	2	5
<i>Catopsila pomana</i>	60	19	7	5	20	3	2	-	4
<i>Colias erate</i>	45	-	16	-	14	6	7	2	-
<i>Precis hierta</i>	38	11	6	3	10	2	4	-	2
<i>Colias electo</i>	34	16	-	2	-	6	7	3	-
<i>Papilio polytes</i>	30	13	5	-	6	-	-	4	2
<i>Neptis machendra</i>	28	-	11	8	-	-	6	-	3
<i>Graphium cloanthus</i>	25	6	-	-	5	4	5	4	1
<i>Pieris rapae</i>	25	7	6	-	-	5	3	-	4
<i>Junonia hierta</i>	20	-	7	6	2	-	1	4	-
<i>Papilio machaon</i>	17	-	5	-	5	3	1	1	2
<i>Pararage schakra</i>	12	4	-	3	-	2	1	1	1
<i>Pieris canidia</i>	12	-	3	2	-	3	2	1	1
<i>Anaphacis aurota</i>	11	1	2	-	3	1	2	1	1
<i>Papilio polyvector</i>	7	-	1	2	1	-	1	-	2
	ΣN= 1110	215	190	95	279	105	87	59	80

butterflies, particularly during the summer. The calculated values of this index showed that butterflies are more or less equally distributed at all the stations of district Sudhnoti because the calculated values did not show the much difference among the station (Table 2).

Shannon's equitability component ranged from 0.737 (Topa) to 0.941 (Khaigala), indicating that the lowest equitability was calculated from Topa and the highest diversity was calculated from Khaigala. Both the values indicate that the butterfly fauna is more or less evenly distributed at all the localities of district Poonch. The calculated values of this index showed that the distribution of butterflies at all the stations of this district is even (Table 1). Shannon's equitability calculated from district Sudhnoti ranged from 0.83 (Pallandri City) to 0.95 (Pattan Sher Khan) which showed that the butterflies evenness at all the stations of this district is more or less the same.

Third index used was Margalef's index which ranged from 2.485 (Hajira) to 4.570 (Datot). This index indicates that the species richness was slightly higher at the localities like Datot, Topa, Hussain Kot, Rawalakot and Khaigala, where as it was slightly lower at Singhola, Paniola, Ali Sojal and Banjonsa. The calculated values of Margalef's index at different localities of district Sudhnoti ranged from 2.60 (Pattan Sher Khan) to 4.03 (Azad Pattan), indicating that butterflies are more abundant at Azad Pattan and less abundant at Pattan Sher Khan, remaining all the stations showed more or less the same abundance (Table 2).

These calculated values coincide with those of Shannon-Wiener's diversity index and its equitability component.

The fourth index used was Simpson's index. This index gives the species abundance and denoted by D. As D increases diversity decreases and the Simpson's index is usually expressed as 1-D or 1/D. This index is heavily weighted towards the most abundant species and being less sensitive to species richness<sup>[19]</sup>.

The calculated values of Simpson's index D ranged from 0.0336 (Khaigala) to 0.145 (Ali Sojal). The calculated values of 1-D ranged from 0.854 (Ali Sojal) to 0.968 (Khaigala). Similarly 1/D ranged from 6.872 (Ali Sojal) to 29.703 (Khaigala).

This index showed that the lowest abundance was obtained from Ali Sojal and the highest abundance was obtained from Khaigala. The flora of the Khaigala is densely rich which supported high diversity where as, at Ali Sojal lower diversity was due to reason that the difficult terrain could not be sampled properly. The calculated values of Simpson's index D ranged from 0.07 (Azad Pattan) to 0.115 (Saundh). Similarly 1-D ranged from 0.88 (Saundh) to 0.927 (Azad Pattan) and 1/D ranged from 10.90 (Boral) to 13.71 (Azad Pattan). It is indicating that maximum richness was calculated from Azad Pattan.

The last index used was RI index which ranged from 0.541 to 0.583 which indicates that the distribution of the butterflies at the localities of this district is more or less same. The calculated values of RI index ranged from 0.55 (Azad Pattan) to 0.64 (Baral). This index showed that butterflies at all the stations of district Sudhnoti are more or less equally distributed.

District Poonch of Azad Kashmir is mostly very cold during the winter and temperature falls down sub-zero and during the summer the weather remains mild. All the locations sampled more or less the same climatic

conditions except with little variations. District Sudhnoti of Azad Kashmir is mostly hot during the summer where temperature goes to 37-40°C at stations like Azad Pattan, Baral, Pattan Sher Khan and Saundh but some areas like Gorah the summer is not very hot where as the winter is very cold. Despite this variation in the climate the flora of district is not very diverse, that's why the distributions of the butterflies in the district is not adversely effected by the flora.

All the indices used concluded that the butterflies are normally distributed in the area under study. Neither any species are reported to be highly supported by enriched flora nor were any species reported to be threatened to become extinct.

The present study is the first of this type of study in the area. Therefore, it is very difficult to say whether the diversity of the butterflies in the area is increasing or decreasing. Therefore, it is suggested that the area under the study should be continuously monitored to observe any changes in the diversity of butterflies, because the changes in the diversity can only observed through continuous monitoring and comparing the data of every year.

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