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## **Biodiversity of butterflies from poonch division of Azad Kashmir, Pakistan**

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The adult butterflies were collected from 28 different localities from three districts of Poonch Division of Azad Kashmir. The localities visited were ten from district Bagh, ten from district Poonch, and eight from district Sudhnoti, throughout the summer season (April to October) from 1998 to 2001. A total of 32 species belonging to 3 families (5 Sub-Families), under 15 genera were identified from 28 localities. Out of these 32 species, 27 species in district Bagh, 28 species in district Poonch and 19 species in district Sudhnoti were identified. Relative abundance was calculated by using Maria's method. Diversity was calculated by using Shannon-Wiener's diversity index and Simpson's index. Richness was calculated by Margalef's and Menhinick's Indices and evenness was calculated by Shannon-Wiener's Equitability Index, Pielou's index and Nakamuras's RI index. The calculated values showed the lowest diversity from Nammanpura (Bagh), Topa and Paniola (Poonch), Palandari city (Sudhnoti), and the highest values of diversity indices were calculated from Sudhan Gali and Mongbajri (Bagh), Khaigalah (Poonch), and Azad Pattan (Sudhnoti), The fauna of the area under study in not well documented and this study is first attempt to explore the biodiversity of butterflies in the area and it will serve as a base line study of changes in the biodiversity of butterflies in future.

**Keywords:** Abundance, biodiversity, butterflies, diversity indices, evenness, equitability, richness, Poonch Division, Azad Kashmir, Pakistan.

### **Introduction**

Butterflies are regarded as the symbol of beauty and grace since the dawn of the time and are best known insects due to their diurnal habitats and are readily recognized by their bright colours, shapes and graceful flights, which give pleasure to everyone (Dal, 1978). Butterflies are found almost in every part of the world where ever the flowering plants are found, inhabiting even very high altitudes except Arctic, Antarctic and mountainous area which are

covered with perpetual snow and Glaciers (Hassan, 1997). Systematically the butterflies have been studied since 18<sup>th</sup> century and up till now 19,238 species have been documented worldwide (Heppner, 1998) and this number is increasing day by day (Gooden, 1977; Stokoe, 1974; Green and Huang, 1998) but the fauna of the area under study is not well documented with exception of a few attempts such as Doherty, (1886) and Rafi *et al.* (2000) and Khan *et al.* (2007). This paper reports on the first attempt at calculating the biodiversity of butterflies in a Part of the area known as Azad Kashmir. The aim of this study is to establish a base-line to underpin future long-term monitoring of butterflies in this area (Azad Kashmir) of Pakistan.

Azad Jammu and Kashmir is the librated part of the state of Jammu Kashmir. It has an area of 13397 sq Km and only 13% area is cultivated. It is situated between longitude 73-75 and latitude 39-37. Average rainfall is approximately 150 cm annually. The topography is mainly hilly and mountainous with valleys and plains in some places. The elevation ranges from 360 meters in the South to 6325 meters in the north. The snow line in winter is around 1200 meters above sea level while in summer it raises up to 3300 meters. The area is full of natural beauty with forest, fast flowing rivers and winding streams.

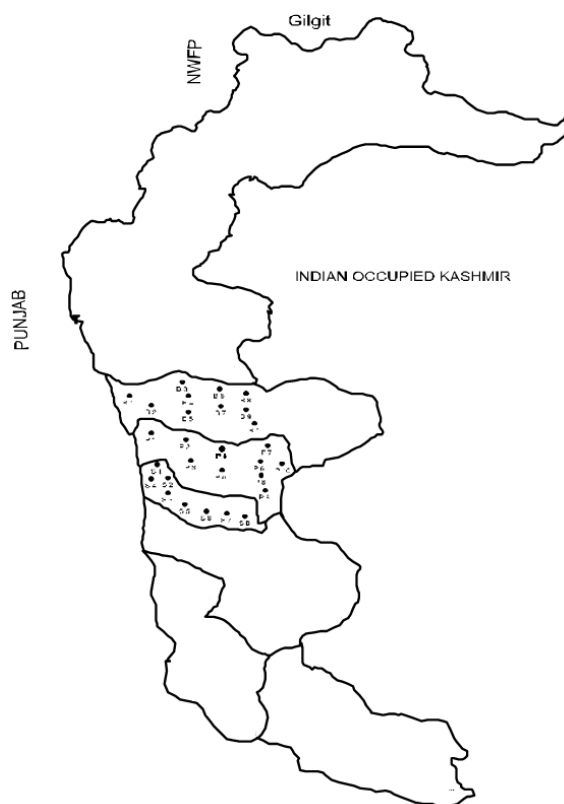
Azad Jammu and Kashmir consists of 3 divisions namely: Muzaffarabad, Poonch, and Mirpur. Muzzafarabad Division consists of districts Muzaffarabad, Neelum and Hatian Bala. Poonch Division consists of districts Bagh, Poonch, Haveli and Sudhnoti and Mir Pur Division consists of districts Kotli Mir Pur and Bhimber. (Fig. 1) The present study was conducted only in the Poonch Division of Azad Kashmir which at the time of study comprised of three districts namely: Bagh, Poonch and Sudhnoti.

District Bagh of Azad Kashmir is diverse climatic region starting from very hot areas like Bagh city, Numanpura and Mangbajri, during summer, to very cold areas like Dhirkot and Sudhangali, during winter. 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. Whereas on the whole this district has very cold winter and the most of the areas are included in snow zone. District Haveli (at the time of study it was the part of district Poonch) of Poonch Division comprises of diverse climatic parts. Few places like Hajira are hot during the summer. Some areas of the district could not be sampled due to unavailability of roads links. Sudhnoti is adjacent to district Poonch and climatically some places of district Sudhnoti are more or less the same as that of district Poonch like Nakka Bazar and Gorah but all the remaining 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 alpine trees are very patchy and dense vegetation is sparse. Most of the areas of district Sudhnoti are out of the snow zone.

### Materials and methods

The butterflies were collected from Poonch division of Azad Kashmir which comprises on three districts namely: Bagh, Poonch and Sudhnoti and the localities visited were ten from district Bagh, ten from district Poonch and eight from district Sudhnoti (Fig. 1). At the time of survey for the present study district Haveli was the part of district Poonch. Hence it was not treated as a separate district. However, some localities were sampled form district Poonch are now included in district Haveli.



**Fig. 1.** DOT Map of Districts Poonch, Bagh and Sudhnoti of Poonch Division (AJK)

***Selection of Localities:*** The localities were selected depending on the road links available and at least 10-15 kilometres apart from each other and the maximum area of each locality was covered during the sampling. All sorts of localities were selected such as grassy patches, grassy fields, field crops, orchards, residential areas, lawns of the houses, grazing fields, bushes, forests with high trees, valleys, mountain peaks and alpine free zones. The altitude of each locality was measured by using Altimeter and was compared with the altitude given in different maps.

***Collection:*** The localities were visited fortnightly, starting from mid March to the end of October (from 1998 to 2001). The butterflies were collected from each locality during the day time, starting from 9-30 am to 3-30 pm during the colder months and 9 am to 5 pm during the hotter months (May to August). Preferably the sunny days were chosen for collection but sometimes the specimens were also collected during the cloudy days. However, during the rainy days insects were not collected.

The specimens were collected by using the butterfly net with the bag made up of delicate cloth to minimize the damage to the wings of the butterflies. The specimens were collected by usual methods of collecting the butterflies that is the chasing the butterflies with net in hand. However, sometimes sweep nets with the bags made up of rugged cloth were also used to collect the butterflies sitting on the grasses, bushes, faeces and urine of the animals. From the grazing fields the specimens were collected from the excreta of the animals with the sweep nets.

***Preservation:*** Soon after collecting the butterflies were taken out of the bags of the nets and were killed by crushing (pinching) their thorax to kill them by suffocation. (Gullan and Cranston, 2004) and then were put in the jars. Relatively bigger specimens were put in the paper stamp envelopes and glassine envelopes to avoid the damage to the wings of the butterflies in the jars with other specimens. The collecting team stayed in the field from morning to evening covering the most of the area of the locality. After returning from the locality to the laboratory the specimens were stretched with the specially made non-corrosive insect pins stuck in to the foam board and after 24 hours they were preserved in the wooden entomological boxes with the naphthalene balls and camphor crystals in the boxes with the insects for further study. The collection, stretching, pinning, labelling and preservation methods for the study of butterflies were followed from Ross (1949), Methven *et al.* (1995), Carter *et al.* (1997), Uys and Urban (2006) and Gullan and Cranston (2010).

***Identification:*** The collected specimens were identified up to the species level by using the keys by Howell *et al.* (1998). Further expertise help for the

confirmation of identified species was sought from National Insect Museum, National Agricultural Research Centre, Islamabad, Pakistan.

**Storage:** The identified specimens were stored partly in the department of Entomology and partly in the National Insect Museum, National Agricultural Research Centre, Islamabad, Pakistan.

**Statistical Analysis:** The rank lists were prepared from each locality according to the maximum abundance with the help of which the diversity indices were calculated and the collective rank lists along with the lists of the taxa from each district were also prepared (Tables 3, 4). The list of sampled localities along with their altitude from each district is also given in Table I. The relative Abundance was calculated by the formula,  $R = n_i/N$ , where, “ $n_i$ ” is the number of individuals in “ith” species and “ $N$ ” is the total number of individuals in the sample. The relative percentage abundance of families, sub-families at division level and at district was calculated (Table 2). The relative percentage abundance of each species was also calculated (Table 4) by using the formula,  $RPA = n_i(100)/N$ , where, “ $n_i$ ” is the number of individuals in “ith” species and “ $N$ ” is the total number of individuals in the sample. The diversity was calculated by using Shannon-Wiener’s index (Shannon and Wiener, 1963) and Simpson’s index (Simpson, 1949). The richness was calculated by using Margalef’s index (Margalef, 1969) and Menhinick’s index (Menhinick, 1964) and evenness was calculated by using Shannon-Wiener’s Equitability index (Shannon and Wiener, 1963), Pieou’s index (Pielou, 1977) and Nakamura’s RI index Nakamura and Toshima, 1995, 1999).

The diversity was calculated by using Shannon-Weiner’s diversity index (Shannon and Wiener, 1963) Simpson’s index (Simpson, 1949). The form of the Shannon-Weiner index used is  $H = -\sum(p_i)\log_2 p_i$ , where, “ $p_i$ ” is the proportion within the sample of the number of the individuals of “ith” species and it is “ $n_i/N$ ”, where, “ $n_i$ ” 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:  $H = C\{\log_{10} N - 1/N \sum(n_r \log_{10} n_r)\}$ , where “ $N$ ” is the total number of the individuals, “ $n_r$ ” is the rank abundance in “ith” species “ $C$ ” is the conversion factor from  $\log_2$  to  $\log_{10}$ .

The Simpson’s index used is  $D = 1/\sum(p_i)^2$ , where, “ $p_i$ ” is the proportion of “ith” species and is calculated as “ $n_i/N$ ”, where, “ $n_i$ ” 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:  $D = \sum[n_i(n_i - 1)/N(N - 1)]$ , where, “ $n_i$ ” 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 diversity decreases. That’s why this index is usually expressed as  $1 - D$  or  $1/D$ .

**Table 1.** List of different sampled localities along with their altitude from three Districts of Poonch Division

S. No.	District Bagh		District Poonch		District Sudhnoti	
	Locality	Altitude	Locality	Altitude	Locality	Altitude
1	Dhirkot	5499 Ft.	Datot	6400 Ft.	Nakka Bazar	6100 Ft.
2	Chamyati	4719 Ft.	Paniola	4425 Ft.	Mong	5479 Ft.
3	Chamankot	4936 Ft.	Topa	6626 Ft.	Pattan Sher Khan	3500 Ft.
4	Arja	2607 Ft.	Singhola	5765 Ft.	Azad Pattan	3200 Ft.
5	Mong Bajri	3170 Ft.	Hussainkot	5999 Ft.	Gorah	4750 Ft.
6	Sudhan gali	7042 Ft.	Rawalakot city	5242 Ft.	Pallandri City	4750 Ft.
7	Hari gahl	3250 Ft.	Alisojal	5610 Ft.	Saundh	4400 Ft.
8	Bagh city	3670 Ft.	Khaigala	5747 Ft.	Baral	4300 Ft.
9	Naumanpura	3415 Ft.	Banjosa	6603 Ft.		
10	Paddar	3450 Ft.	Hajira	2920 Ft.		

**Table 2.** Relative Percentage Abundance of Families and Sub-Families of Butterflies recorded from three Districts of Poonch Division

Name of Family/Sub-Family	Poonch Division	District Poonch	District Bagh	District Sudhnoti
Family Pieridae	51.401	7.583	32.930	10.888
Sub-Family Pierinae	33.343	4.691	22.986	5.650
Sub-Family Coliadinae	18.058	2.891	9.9943	5.222
Family Papilionidae	16.022	1.888	6.196	7.937
Sub-Family Papilioninae	16.022	1.888	6.196	7.937
Family Nymphalidae	32.575	5.016	15.904	11.655
Sub-Family Nymphalinae	27.205	3.363	12.540	11.301
Sub-Family Satyrinae	5.370	1.652	3.363	0.354

**Table 3.** Collective Rank list of the butterfly Taxa recorded from three Districts of Poonch Division

Rank	Name of Taxa	Poonch Division	District Bagh	District Poonch	District Sudhnoti
1	<i>Pieris brassicae</i>	493	80	269	144
2	<i>Junonia orityha</i>	360	40	187	133
3	<i>Papilio machaon</i>	262	21	124	117
4	<i>Gonepteryx rahmni</i>	259	26	135	98
5	<i>Pieris canidia</i>	199	31	156	12
6	<i>Papilio demoleus</i>	183	29	64	90
7	<i>Pontia daplidice</i>	175	28	147	--
8	<i>Pieris ajaka</i>	156	--	131	25
9	<i>Argynnis kamala</i>	134	12	36	86
10	<i>Argynnis hyperbius</i>	122	11	33	78
11	<i>Eurema hecabe</i>	119	23	96	--
12	<i>Danaus genutia</i>	113	25	88	--
13	<i>Colias erate</i>	99	10	44	45

14	<i>Pontia chloridice</i>	96	20	76	--
15	<i>Junonia almans</i>	80	12	48	20
16	<i>Venessa cardui</i>	74	15	59	--
17	<i>Colias fieldi</i>	66	7	25	34
18	<i>Melitaea lukto</i>	47	10	37	--
19	<i>Papilio Polytes</i>	45	6	9	30
20	<i>Nepits hylas</i>	42	6	8	28
21	<i>Catopsila pyranthe</i>	39	9	30	--
22	<i>Junonia hierta</i>	38	--	--	38
23	<i>Parage schakara</i>	33	21	--	12
24	<i>Graphium cloanthus</i>	30	--	5	25
25	<i>Danaus chrysippus</i>	28	8	20	--
26	<i>Papilio polycitor</i>	23	8	8	7
27	<i>Vanessa polychloros</i>	20	8	12	--
28	<i>Eurema laeta</i>	18	18	--	--
29	<i>Catopsila crocale</i>	12	5	7	--
30	<i>Belenois aurota</i>	11	--	--	11
31	<i>Lethe verma</i>	8	2	6	--
32	<i>Phalantha phalantha</i>	5	--	5	--
Total					

**Table 4.** Rank list along with Relative Percentage Abundance of recorded butterfly Taxa from three Districts of Poonch Division

Rank	Name of Taxa	Poonch Division	District Poonch	District Bagh	District Sudhnoti
1	<i>Pieris brassicae</i>	14.54706	14.42359	16.29328	13.93998
2	<i>Junonia orityha</i>	10.6226	10.02681	8.14664	12.87512
3	<i>Papilio machaon</i>	7.730894	6.648794	4.276986	11.32623
4	<i>Gonepteryx rahmni</i>	7.642372	7.238606	5.295316	9.486931
5	<i>Pieris canidia</i>	5.871939	8.364611	6.313646	1.161665
6	<i>Papilio demoleus</i>	5.399823	3.431635	5.906314	8.712488
7	<i>Pontia daplidice</i>	5.163765	7.882038	5.702648	0
8	<i>Pieris ajaka</i>	4.603128	7.024129	0	2.420136
9	<i>Argynnis kamala</i>	3.953969	1.930295	2.443992	8.325266
10	<i>Argynnis hyperbius</i>	3.599882	1.769437	2.240326	7.550823
11	<i>Eurema hecabe</i>	3.51136	5.147453	4.684318	0
12	<i>Danaus genutia</i>	3.334317	4.718499	5.09165	0
13	<i>Colias erate</i>	2.921216	2.359249	2.03666	4.356244
14	<i>Pontia chloridice</i>	2.832694	4.075067	4.07332	0
15	<i>Junonia almans</i>	2.360578	2.573727	2.443992	1.936108
16	<i>Venessa cardui</i>	2.183535	3.163539	3.05499	0
17	<i>Colias fieldi</i>	1.947477	1.340483	1.425662	3.291384
18	<i>Melitaea lukto</i>	1.38684	1.983914	2.03666	0
19	<i>Papilio polytes</i>	1.327825	0.482574	1.221996	2.904163
20	<i>Nepits hylas</i>	1.239304	0.428954	1.221996	2.710552
21	<i>Catopsila pyranthe</i>	1.150782	1.608579	1.832994	0
22	<i>Junonia hierta</i>	1.121275	0	0	3.678606
23	<i>Parage schakara</i>	0.973739	0	4.276986	1.161665
24	<i>Graphium cloanthus</i>	0.885217	0.268097	0	2.420136

25	<i>Danaus Chrysippus</i>	0.826202	1.072386	1.629328	0
26	<i>Papilio polycitor</i>	0.678666	0.428954	1.629328	0.677638
27	<i>Vanessa polychloros</i>	0.590145	0.643432	1.629328	0
28	<i>Eurema laeta</i>	0.53113	0	3.665988	0
29	<i>Catopsila crocale</i>	0.354087	0.375335	1.01833	0
30	<i>Belenois aurota</i>	0.32458	0	0	1.06486
31	<i>Lethe verma</i>	0.236058	0.321716	0.407332	0
32	<i>Phalantha</i>				
	<i>phalantha</i>	14.54706	0.268097	0	0

The richness was calculated by using Margalef's index (Margalef, 1969) and Menhinick's Index (1964). 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 form of Menhinick's Index used during the present study is:  $R = S / \sqrt{N}$ , where, "S" is total number of the species and "N" is the total number of individuals.

The Evenness was calculated by using Shannon-Weiner's equitability Index (Shannon and Weiner, 1963), Pielou's Index (Pielou, 1977) and RI index (Nakamura and Toshima, 1995, 1999). The form of the Shannon's equitability used is:  $J = H / H^{\max}$ , where, "H" is the Shannon-Weiner'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 Pielou's index used is:  $E = H / \ln S$ , where "H" is the Shannon-Weiner's diversity index and "S" is the total number of species in the sample. The form of the Nakamura's RI 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 discussions

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 one of the major features of the animal communities. It is the number of species present and their numerical composition. Diversity is the niche time stability dependent (Bowman, *et al.*, 1971; McIntosh, 1967; Pielou, 1966, 1969, & 1975; McArthur, 1965; Kempton and Tailor, 1976; Kempton, 1979; Kempton and Wedderburn, 1978) which means if a large number of niches are present it will support higher diversity (Begon, *et al.*, 1966; Maguran; 1988; Rosenweig, 1995). Generally, homogeneous conditions yield low diversity where as heterogeneous conditions yield higher diversity (Sanders, 1978; Gray, 1980; Alatolo, 1981).



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 within the species (McArthur, 1965). The measure of diversity of the fauna will represent the number and the available niches present in that 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 (May, 1975; Gray, 1980).

During the present study diversity was calculated by using two indices, richness was calculated by using two indices and evenness was calculated by using three indices. The reason being using more than one index for calculating one attribute is that, in future the continuous monitoring will be carried out in this area and the long-term and short-term changes observed in the diversity of the fauna of the area can only be reliable if they are measured by using more than one index, otherwise the observed changes in the diversity measured by one index can be misleading because the changes in the values of only one index can be due to any other reason/factor as well.

The diversity in the present study is calculated by using two indices namely; Shannon-Wiener's diversity index and Simpson's index. The Shannon-Wiener's diversity index is distribution dependent and suffers least from criticism of validity in application of biological data (Gray, 1974; 1980; Hutcheson, 1970).

The calculated values of diversity indices from each district of division Poonch (Table 5) show that district Bagh yielded the highest values and district Sudhnoti yielded the lowest values.

The calculated values of Shannon's index at various localities of district Bagh ranged from 2.09 (at Naumanpura) to 3.60 (at Chammyati), while from remaining all the locations this index ranged from 2.86 (Bagh city) to 3.45 (Sudhangali) (Table 5).

The calculated values of Shannon's index at different localities of District Poonch ranged from 3.14 (Topa) to 34.36 (Khaigala). The lowest diversity was calculated from Topa (3.14), Hajira (3.16), Ali Sojal (3.19) and Paniola (3.21). The highest diversity was calculated from Rawalakot (4.01) and Khaigala (4.36). Remaining all the localities yielded the diversity of this index ranging from 3.40 (Singhola) to 3.99 (Hussain Kot), (Table 5). The calculated value of the Shannon's diversity index from District Sudhnoti ranged from 3.29 (Pallandri City) to 3.8 (Azad Pattan), remaining all the localities yielded diversity index values ranging from 3.41 (Saundh) to 3.79 (Mong), (Table 7).

The second index used for the measurement of diversity was the Simpson's diversity index. This index is sample size dependent and values decrease with the increase in sample size. Therefore, it's reciprocal from I-D or

1/D is usually used in ecological data. This ensures that the calculated values of index increase with increasing diversity (James and Shugart, 1970). The calculated values of Simpson's index at different localities of district Muzaffarabad ranged from 0.07 (Gari Dopatta) to 0.20 (Kohala) (Table 5). The values of Simpson index at different localities of district Bagh ranged from 0.07 at Mangbajri to 0.26 at Naumanpura, The calculated value of this index showed that abundance was not very high (Table 5). The calculated values of Simpson's index (D) at different localities of district Bagh ranged from 0.07 (Mangbajri) to 0.26 (Naumanpura). District Bagh of Azad Kashmir has very highly diverse flora. Some areas like Chammyati, Sudhangali and Dhirkot are densely rich with diverse flora and some areas have very patchy flora like Naumanpura, Arja and Mangbajri. The former areas support high diversity where as the latter areas support low diversity. The calculated values of Simpson's index "D" at different localities of district Poonch ranged from 0.03 (Khaigala) to 0.14 (Ali Sojal). The calculated values of 1-D ranged from 0.85 (Ali Sojal) to 0.96 (Khaigala). Similarly 1/D ranged from 6.87 (Ali Sojal) to 29.70 (Khaigala) (Table 5). 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 whereas; at Ali Sojal lower diversity was recorded. Due to difficult terrain it could not be sampled properly, otherwise this could be little higher than the calculated value. The calculated values of Simpson's index "D" at different localities of district Sudhnoti ranged from 0.07 (Azad Pattan) to 0.115 (Saundh). Similarly "1-D" ranged from 0.88 (Sudhnoti) - 0.927 (Azad Pattan) and 1/D ranged from 10.90 (Boral) - 13.71(Azad Pattan). It is indicates that the maximum richness was calculated from Azad Pattan.

**Table 5.** Calculated values of Diversity Indices (District wise) from three Districts of Poonch Division

S. No.	Name of Indices	Poonch Division	District Bagh	District Poonch	District Sudhnoti
1	Shannon-Wiener's Index	3.0169	3.0201	2.8836	2.6365
2	Simpson's Index	0.0649	0.0614	0.6988	0.0885
3	Margalef's Index	3.8138	4.1960	3.5851	2.5935
4	Menhinick's Index	0.5496	1.2184	0.64836	0.5911
5	Shannon's Equitability	0.6033	0.6351	0.5998	0.6206
6	Pielou's Index	0.8705	0.9163	0.8653	0.8954
7	Nakamura's Index	0.5320	0.5370	0.5380	0.5550

The richness was calculated by using Margalef's index and Menhenick's index. The calculated values of Marglef's index at different localities of district

Bagh ranged from 1.642 (Naumanpura) to 3.65 (Chammyati). Whereas, at all other localities the values of the index ranged from 2.03 to 3.10, which indicates that species richness was not very high (Table 5). The calculated values of Margalef's index at different places of district Poonch ranged from 2.48 (Hajira) to 4.57 (Datot). The obtained values of this index indicate 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 (Table 5). 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 Paltan Sher Khan, remaining all the stations showed more or less the same abundance (Table 5). The calculated values of Margalef's index from different localities of district Kotli ranged from 2.07 (Holar) to 2.55 (Fateh Pur). Remaining all the localities yielded the diversity values ranging from 2.21 to 2.52 indicating that richness was slightly higher at Fateh Pur & was slightly lower at Holar. The yielded values of this index from all the localities visited indicate that there was no any big difference in the richness of butterflies on different localities of this district.

The evenness was calculated by using Shannon-Wiener's equitability index, Pielou's index and Nakamura's RI index.

The calculated values of Shannon's equitability index at different localities of district Bagh ranged from 0.81 (Naumanpura) to 0.96 (Mongbajri), showing that the fauna was well distributed at all the stations of this district. The calculated values of Shannon's equitability index at different localities of district Poonch ranged from 0.737 (Topa) to 0.941 (Khaigala) (Table V). Shannon's equitability index's calculated from different sites of District Sudhnoti ranged from 0.83 (Palandri City) to 0.95 (Pattan Sher Khan) which showed that the butterflies distribution evenness at all the localities of this District is more or less the same. The calculated values of this index showed that butterflies are more or less equally distributed at all the places of District Sudhnoti because the calculated values did not show the much difference among the surveyed places.

The calculated values of Shannon-Wiener's diversity index very much coincide with the values of Shannon's equitability which means the evenness, richness and abundance of butterflies from all the localities of the sampled districts support normal distribution and none of the above sampled places showed disturbed communities of butterflies.

The second index used for the measurement of evenness was Pielou's index. The calculated values of this index from District Bagh ranged from 1.144 to 1.375.

The localities which show the highest values are Bagh city (1.375) whereas the lowest values 1.144 were calculated from Naumanpura. From district Poonch the highest values (1.258) were calculated from Banjosa and lowest values (1.015) were calculated from Topa. From district Sudhnoti the highest (1.337) values were calculated from Nakka Bazar and the lowest values (1.186) were calculated from Pallandri city.

The last index used for the measurement of evenness was R1 index of Nakamura (Nakamura & Toshima, 1995, 1999). The index shows the number of species and individuals in the sampled area. If the calculated values go near to 1 it indicates that higher number of species and individuals are recorded from the area. The calculated values RI index from different localities of district Bagh ranged from 0.05 (Dhirkot) to 0.70 (Nauman Pura). Remaining all the stations yielded the values between 0.06 and to 0.62. The calculated values of RI index from different localities of district Poonch ranged from 0.54 (Khaigala) to 0.58 (Hajira). Remaining all the stations yielded the values between 0.54 and 0.57. The calculated values of R1 index at different localities of district Sudhnoti ranged from 0.55 (Azad Pattan) to 0.64 (Baral).

The calculated values of all the indices used in this study concluded that various species of butterflies are normally distributed in all the districts of the area under study. The present study is the first study of this type in the area and provides baseline information on the diversity of mountainous butterflies in the area known as Poonch Division of Azad Kashmir. Therefore, it is very difficult to say whether any species are supported by the enriched flora or any species are endangered or at the verge of extinction. Therefore, it is suggested that the area under study should be continuously monitored to observe any changes in the diversity of butterflies, because the changes in the diversity can only be observed through continuous monitoring and comparing the data of every year.

With the help of continuous monitoring and study of other factors will enable us to establish relationship of the diversity and distribution of butterflies with other factors like: Vegetation-both natural forest & shrubs and manmade-orchards and cultivated crops, use of hazardous chemicals (Pesticides etc) and environmental changes-destruction of habitat etc. These areas need to be covered in future studies. Presence of predatory birds and pests etc are also important for future studies of butterfly's diversity of the area.

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