Pakistan J. Zool., vol. 52(3), pp 835-841, 2020. **DOI**: https://dx.doi.org/10.17582/journal.pjz/20190326090338

Biodiversity of Butterflies in Tangi Charsadda, Khyber Pakhtunkhwa, Pakistan

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ABSTRACT

During study biodiversity of butterflies is explored in Tangi, Charsadda, Khyber Pakhtunkhwa, Pakistan. A total of 506 specimens collected out of which 252/506 were belonging to family Nymphalidae, 217/506 from family Pieridae, family Papilionidae represented only 37/506 individuals. With their abundance *Danauas chrysippus* (F130, F314 and D3 24.11), followed by *Junonia orytha* (F121, F310 and D3 11.86), while *Papilio polytes*, *Junonia hierta* and *Euthalia garuda* showed minimum (F12, F 31 and D3 0.2) of each species. The Shannon diversity (H') is high in union council (UC) Koaz Bahram Dheri (H'= 6.05) followed by UC Dhaki (H'= 4.38), while Simpson diversity (1/D) is more significant in UC Koaz Bahram Dheri (1/D= 0.1), and Ghandheri (1/D= 0.14). While the minimum Simpson diversity (1/D) recorded from UC Tangi (1/D= 0.41) and UC Hisara Nehri (1/D= 0.31). The maximum individuals were collected from UC Koaz Bahram Dheri (n=144/506), followed by UC Mandani (n=73/506), while the minimum species individuals collected from UC Shodagh (n=32/506) followed by UC Tangi (n=35/506). The present biodiversity study showed that the study area is rich in butterfly species with a different verity of species. More contemplations are rendering urban reserves imperative for worldwide preservation endeavours. Generally, urban areas frequently emerged close conspicuous landforms, for example, soak slopes or important waterways and protect their flora and fauna of the study area.

Article Information
Received 26 March 2019
Revised 29 May 2019
Accepted 11 June 2019
Available online 17 February 2020

Authors' Contribution
Haroon, YM and ZK designed the study. FP, MAR, and WS executed experimental work and analyzed the data. XS helped in preparation of the manuscript. LX supervised the work.

Key words
Butterflies, Biodiversity, Tangi, Khyber Pakhtunkhwa, Pakistan.

INTRODUCTION

The diversity of insect communities depends upon the types of land, local climates, vegetation, altitude and human interferences in the ecosystem (Hassan, 1997). Larvae of butterflies feed on leaves of plants for their survival (Shah *et al.,* 2016), and hence their distribution depends upon the accessibility of their host plants (Arya, 2014). They are highly sensitive and are easily affected by the ecological changes and variations in the plant community structure (Blair, 1999). Many species are strictly seasonal and prefer only particular set of habitat (Kunte, 1997). A slight change in their habitat may lead to either their migration or disappearance (Blair, 1999; Kunte, 2000; Mennechez *et al.,* 2003).

However, throughout the world, many studies have been conducted in recent years, and many different habitats have been investigated about butterfly diversity (Schneider, 2003) including Pakistan. Hassan (1997) reported biogeography and diversity of butterflies of Northeast Himalaya, *i.e.* Gilgit, Hunza-Nagar, Astor and Chilas. Khan *et al.* (2000) studied the distribution and diversity of genus *Papilio* in Rawalpindi and Islamabad. Abbas *et al.* (2002) reported taxonomy and distribution of butterflies of the Skardu, Gilgit-Baltistan. Khan *et al.* (2004) studied the diversity of butterflies from District Muzaffarabad, Azad Kashmir. Tayyab *et al.* (2006) reported the biodiversity of butterflies from Agro-forest area of Bahawalpur. Smith *et al.* (2007) reported butterflies from Hunza Region Northern Pakistan and adjacent Pakistan. Khan *et al.* (2007) reported biodiversity of butterflies from Districts Kotli, Mirpur and Bhimber, Azad Kashmir, Pakistan. Munir *et al.* (2007) reported the distribution and diversity of swallowtail butterflies from Karachi. Perveen (2012) reported the distribution of butterflies from Kohat. Khan *et al.* (2014) studied the biodiversity of butterflies from Poonch Division of Azad Kashmir. Mal *et al.* (2014) reported the diversity of Pieridae butterflies from Jamshoro District, Sindh. Through the current work, the first-time biodiversity of butterflies reported from Tangi, Charsadda

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0030-9923/2020/0003-0835 $ 9.00/0

and a baseline data on biodiversity of butterflies of the study area.

MATERIALS AND METHODS

The specimens were collected from UC Koaz Bahram Dheri, UC Harichand, UC Mandani, UC Shodagh, UC Dhaki, UC Hisara Nehri, UC Ghandheri and UC Tangi. All localities were visited fortnightly from August 2014 to May 2015. The butterflies collected from each locality with the help of aerial nets and searching and picking methods. The collected specimens were taken to the laboratory for identification and then recorded with reference to each locality. The species diversity was calculated by the following indices:

Shannon diversity index (H')

The Shannon diversity index assumes that individuals of each species randomly sampled from an effectively infinite population. It was calculated from the following equation:

$$H' = - \Sigma pi \ln pi$$

Where, Pi indicates the individuals belonging to the (i^{th}) species (proportional).

Shannon's index considers the evenness of the abundances of species. It is also possible to calculate a separate measure of Evenness:

$$E = H' / H_{max} = H' / \ln S$$

As with H' this evenness measure assumes that all species in the community account for in the sample, and H_{max} is the maximum diversity (when all species are equally abundant) (Shannon and Wiener, 1963).

Simpson's index (1/D)

Simpson's index (1/D) is referred to as a dominance measure because it weighted towards the abundance of the most prevalent species. It calculates the probability of any two individuals drawn at random from an infinitely large community belonging to different species as:

$$1/D = \Sigma\left(\frac{ni(ni-1)}{N(N-1)}\right)$$

Where, ni is the proportion of individuals in the i^{th} species. To calculate the index, the formula appropriate to finite community use: where ni is the number of individuals in the i^{th} species and N is the total number of individuals. As D increases, diversity decreases, and Simpson's index is therefore usually expressed as 1- D or 1/D. Simpson's index is heavily weighted towards the most abundant species in the sample while being less sensitive to species richness (Simpson, 1949).

Evenness or Shannon's equitability index (E)

Shannon's equitability index measures the evenness of species abundance, is complementary diversity index concept indicates how the individuals of various species distribute in the community.

$$E = H/\log(S)$$

Where, H is the Shannon-Weiner index of diversity (Shannon and Wiener, 1963).

Species richness index (d)

Species richness index (d) was calculated using the formula given:

$$d = S/\sqrt{N}$$

Where, N is the total number of individuals summed over all species (Margalef, 1969).

Frequency F_1

To determine the frequency in a stand was taken by the following formula:

$$F1 = \frac{S}{N} \times 100$$

Where, S is the occurrence of species in a stand and N is the total numbers of the stand taken.

Margalef's index (R)

The richness will calculate by using Margalef's index and Menhinick's Index. The form of the Margalef's index used will be:

$$d=S-1/\log_e N$$

Where, S is the number of species and N is the total number of individuals. The form of Menhinick's Index use during the present study:

$$R= S/\sqrt{N}$$

Where, S is the total number of the species and N is the total number of individuals (Margalef, 1969; Pielou, 1977).

RESULTS AND DISCUSSION

The study was conducted first time on butterfly fauna of Tangi, Charsadda, Khyber Pakhtunkhwa, Pakistan. During survey 506 specimens of butterflies were collected, identified specimens belonging to 3 families, *i.e.* Family Nymphalidae (252/506), Pieridae (217/506) and family Papilionidae (37/506) and 18 genera. Table I shows the list of collected species. The study area is mostly plain from east to west, situated 45° from the north to south. The latitude, longitude, elevation (ft) and elevation (m) recorded along with collected specimens. It has been observed that the low and high latitude or longitude affect the distributions of butterflies Table III.

The frequency (F1), relative frequency (F3) and relative density (D3) of different species were also calculated. Among the species *D. chrysippus* showed the highest ratios followed by *Junonia orytha*, *Papilio polytes*, *Junonia hierta* and *Euthalia garuda* (Table I).

Table I.- The collected butterfly's species with density, frequency, relative frequency and relative density from Tangi, Charsadda, Khyber Pakhtunkhwa, Pakistan, during August 2014-May 2015.

Species	Density (D)	Frequency (F1)	Relative frequency (F3)	Relative density (D3)
Family: Pieridae				
Pieris canidia	64	14	7	12.65
Catopsilia ponoma	58	19	9	11.46
Belonias aurota	40	26	13	7.91
Catopsilia pyranthe	35	14	7	6.91
Eurema hecabe	7	7	3	1.38
Colias fieldii	7	7	3	1.38
Colotis etrida	4	5	2	0.79
Colias erate	2	2	1	0.4
Family: Nymphalidae				
Danauas chrysippus	122	30	14	24.11
Junonia orytha	60	21	10	11.86
Hipparchia parisatis	21	12	6	4.15
Argyreus hyperbius	14	7	3	2.76
Junonia almana	11	7	3	2.17
Ariadne merione	9	5	2	1.78
Caynthia cardui	4	7	3	0.79
Tirumala liminniace	3	5	2	0.59
Lethe confuse	2	2	1	0.4
Neptis mahendra	2	2	1	0.4
Vanesa indica	2	2	1	0.4
Euthalia garuda	1	2	1	0.2
Junonia hierta	1	2	1	0.2
Family: Papilionidae				
Papilio demoleus	36	12	6	7.11
Papilio polytes	1	2	1	0.2
Total ΣN	506	212	100	100

Different scientists worked on the biodiversity of butterfly fauna in Pakistan. Khan *et al.* (2007) explored the biodiversity of Poonch Division, Districts Kotli, Mirpur and Bhimber of Azad Kashmir, Pakistan. They analysed Shannon Wiener's diversity index (Shannon and Wiener, 1963), and calculated values of this index at District Kotli ranged from 2.145 (Dongi) to 3.29 (Sarsawa), followed by 3.2 (Holar, Kotli city, Fateh Pur and Khuiretta). From Mirpur the lowest values yielded at Khari Sharif (3.135), and highest values 3.75 at Mirpur City and Islam Garh (3.70), whereas at all remaining stations the values yielded between 3.2 (Mangla) and 3.60 (Afzal Pur); in District Bhimber it ranged between 3.75 (Berhing) and 2.97 (Barnala). However, from the present study Shannon Diversity (H') is high in UC Koaz Bahram Dheri (H'= 6.05) followed by UC Dhaki (H'= 4.38) and UC Ghandheri (H'= 2.03) and the minimum (H') were calculated from UC Hisara Nehri (H'= 0.39) and UC Harichand (H'= 0.55). Therefore, both study areas were entirely different from each other, due to the collection period and the environmental factors.

Khan *et al.* (2014) calculated the values of Shannon's Index at various localities of District Bagh which ranged from 2.09 (Naumanpura) to 3.60 (Chammyati), while in all the remaining locations this index ranged from 2.86 (Bagh city) to 3.45 (Sudhangali); in District Poonch calculated values 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). All the remaining localities yielded the diversity of this index ranging from 3.40 (Singhola) to 3.99 (Hussain Kot). The calculated value of Shannon's Diversity index from District Sudhnoti ranged from 3.29 (Pallandri City) to 3.8 (Azad Pattan), all the remaining localities yielded diversity index values ranging from 3.41 (Saundh) to 3.79 (Mong). Although, from the present study Shannon Diversity (H') is high in UC Koaz Bahram Dheri (H'= 6.05), and the minimum (H') in UC Hisara Nehri (H'= 0.39) and UC Harichand (H'= 0.55) (Table II). The butterflies calculated value is well distributed almost at all the localities of the study area of Tehsil Tangi. Conversely, the more compactly vegetated locations generated faintly multiple diversity values, and unfertile and less vegetated areas retained marginally lower diversity values.

Several workers have worked on the distribution and documentation of butterflies in KPK, Pakistan. Shah *et al.* (2001) first time explored and reported ten species of butterfly from Kohat, they reported ten species belong to only family Pieridae from 7 different localities. During the present research, similar species of family Pieridae was also recorded from Tehsil Tangi, which shows the great resemblance in both areas. The diversity of butterfly fauna of Buner, KPK, Pakistan, explored and reported a total of 450 specimens; however, all specimens were belonging to family Pieridae (Naz *et al.,* 2001). While, in the present study, most of the specimens belonged to family Nymphalidae followed by family Pieridae. However, there was the greatest difference between both areas. Furthermore, Buner area mostly hilly and Tangi is a plain area. However, from the butterfly fauna of Kohat, a total of 21 species were collected which belong to 3 families (Perveen and Ahmad, 2012). Therefore, from Tehsil Tangi reported the same families but the percentage of the families were different in both areas because of the climatic conditions

Table II.- The collected butterfly's species diversities, richness and their density in different localities of the Tangi, Charsadda, Khyber Pakhtunkhwa, Pakistan, during August 2014-May 2015.

S No	Name of place	Density	Richness (d)	Maturity index	Simpson diversity (1/D)	Shannon diversity (H')	Shannon equitability (E)	Margalef's index (R)
1	UC Koaz Bahram Dheri	144	1.42	28.47	0.1	6.05	2.14	3.22
2	UC Shodagh	32	1.06	5.33	0.19	1.86	1.04	3.32
3	UC Mandani	73	0.94	9.13	0.19	0.82	0.39	3.76
4	UC Dhaki	54	0.95	7.71	0.26	4.38	2.25	3.46
5	UC Hisara Nehri	56	0.67	11	0.31	0.39	0.24	2.29
6	UC Tangi	35	0.84	7	0.41	0.73	0.45	2.6
7	UC Ghandheri	63	0.63	7.88	0.14	2.03	0.98	3.89
8	UC Harichand	49	0.71	32	0.25	0.55	0.34	2.37

Table III.- The collective rank list along with the list of Taxa collected from different localities of Tangi, Charsadda, Khyber Pakhtunkhwa, Pakistan, during August 2014-May 2015.

Rank	Name of Taxa	Abundance	UC Koaz Bahram Dheri	UC Shodagh	UC Mandani	UC Dhaki	UC Hisara Nehri	UC Tangi	UC Ghandheri	UC Harichand
	Family: Pieridae									
2	*Pieris canidia*	64	16	6	19	23	-	-	-	-
4	*Catopsilia ponoma*	58	13	8	14	5	6	5	7	-
5	*Belonias aurota*	40	11	3	2	-	8	2	5	9
6	*Catopsilia pyranthe*	35	13	6	5	5	-	-	6	-
12	*Eurema hecabe*	7	-	-	2	5	-	-	-	-
13	*Colias fieldii*	7	4	-	-	-	-	-	3	-
15	*Colotis etrida*	4	4	-	-	-	-	-	-	-
19	*Colias erate*	2	-	-	-	2	-	-	-	-
	Family: Nymphalidae									
1	*Danauas chrysippus*	122	33	4	12	-	21	20	13	19
3	*Junonia orytha*	60	12	-	-	-	20	-	16	12
8	*Hipparchia parisatis*	21	12	-	4	-	-	-	-	5
9	*Argyreus hyperbius*	14	9	-	-	-	-	-	5	-
10	*Junonia almana*	11	-	4	-	7	-	-	-	-
11	*Ariadne merione*	9	5	-	-	-	-	-	-	4
14	*Caynthia cardui*	4	4	-	-	-	-	-	-	-
16	*Tirumala liminniace*	3	-	1	-	-	-	2	-	-
17	*Lethe confuse*	2	2	-	-	-	-	-	-	-
18	*Neptis mahendra*	2	2	-	-	-	-	-	-	-
20	*Vanesa indica*	2	2	-	-	-	-	-	-	-
21	*Euthalia garuda*	1	1	-	-	-	-	-	-	-
22	*Junonia hierta*	1	-	-	-	-	1	-	-	-
	Family: Papilionidae									
7	*Papilio demoleus*	36	-	-	15	7	-	6	8	-
23	*Papilio polytes*	1	1	-	-	-	-	-	-	-
	Total individuals	ΣN=506	N=144	N=32	N=73	N=54	N=56	N=35	N=63	N=49

and vegetation. Moreover, on the basis of identification and distribution of butterflies, a survey was conducted at UC Koaz Bahram Dheri, KP, Pakistan and collected a total of 232 specimens from 12 localities (Haroon *et al.,* 2013). Moreover, the identified specimens of butterflies belonging to 13 species, 11 genera and three families. Family Nymphalidae comprised the most significant number of butterflies 49% followed by Pieridae 37% and 14% of Papilionidae. However, the similar families reported from the present research, and family Nymphalidae covered 49.8%, Pieridae 42.89% and Papilionidae 7.31%. Although, both study areas having the same type of cultivation land, climatic condition and flora. The butterflies of Kohat, KPK, explored the second time

for identification and distribution and collected 21 species belonged to 3 families and six subfamilies from Kohat, KPK (Perveen, 2012). Additionally, two subfamilies of Nymphalidae: Nymphalinae covered 28% and Satyrinae 5% species. Furthermore, family Pieridae including three subfamilies, *viz*., Pierinae covered 24%, Coliaclinae 5% and Coliadinae 28%. While the family Papilionidae including only one subfamily, Papilioninae covered 10% species. However, in present study, reported 3 families; Nymphalidae and their subfamilies are: Danainae 25%; Nymphalinae 6%; Vespidae 12%; Satyrinae 4%; Biblidinae 2%; Trogidae 1 % and Limenitidinae 1%; Pieridae: Coliadinae 21%; Pierinae 21% and Papilionidae: Papilioninae 7% (Table III). Moreover, the Tehsil Tangi flora and fauna is mostly dominant as compared to Kohat due to intensive agricultural land.

CONCLUSION

During present study, a total of 506 specimens were collected from 8 localities: Union Council Koaz Bahram Dheri: 29% > Mandani: 14% > Ghandheri: 12% > Dhaki: 11% = Hisara Nehri: 11% > Harichand: 10% > Tangi: 7% and Shodagh: 6%. Family Nymphalidae contributed the maximum number of specimens (252/506) followed by Pieridae (217/506) and minimum specimens recorded of family Papilionidae (37/506). Furthermore, proper protective measures should take in attention to minimising the natural habitat loss, as butterfly fauna is dependent upon perfect environmental conditions.

ACKNOWLEDGEMENT

The authors acknowledge Department of Zoology, Shaheed Benazir Bhutto University, Main Campus, Sheringal, Dir Upper, Khyber Pakhtunkhwa, Pakistan for providing laboratory facilities.

Statement of conflict of interest

The authors declare no conflict interest.

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