Article

Environmental and soil gradient effects on biodiversity of butterflies in Khyber Pakhtunkhwa, Pakistan

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Abstract

The natural territory disturbance, losses, and degradation are real and alarming threats to the ecosystem. The population of butterflies remains arbitrary in prairie residuals and linear range habitats. Such environments are low, isolated, and sub-quality than intact prairies—biodiversity losses associated with ecosystems regulating services and supporting services. Therefore, the present study was conducted on environmental variables and soil gradient and its effects on butterfly colonies in tehsil Tangi, Charsadda, Khyber Pakhtunkhwa, Pakistan. A total of 506 specimens of butterflies and soil samples were collected from different localities randomly. Butterflies were collected with aerial nets, searching, and picking method, and taken to the laboratory for identification and recording concerning each location every two weeks from August 2014 to May 2015. The similarity index among individuals was 246 (47%), while among species 45.5 (8.62%) and *Catopsilia pyranthe* were at (35/122; 14/30; 7/14; 6.91/24.11) position, similarly in dissimilarity index, *Catopsilia ponoma* was at (58/122; 19/30; 9/14; 11.460/24.11) position. The density revealed that the *Danauas chrysippus* was the most abundant species 122/506. Similarly, among environmental gradients, silt associated considerably with pH, wilting point (Wp), field capacity (Fc), bulk density (Bd), saturated hydraulic conductivity (Shy) and available water (Aw) ($p\approx0.000$), sand with pH, Wp, Fc and Bd ($p\approx0.000$), pH with Wp, Fc and Bd ($p\approx0.000$), Wp with Fc, Bd, and Aw ($p\approx0.000$), Fc with Bd and Aw ($p\approx0.000$). We concluded that low latitude and altitude, excessive amounts of insecticides and pesticides show a significant impact on butterflies' diversity.

Keywords environmental gradients; butterflies; relative frequency; biodiversity; Pakistan.

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1 Introduction

Soil is a multi-component and multifunctional network that affects arable ecosystems by interfering with the abiotic environment activities of various soil-dwelling species. These are critical for environmental processes that decompose organic material into nutrients, stabilize the soil through the formation of aggregates, and promote plant development (Neher and Barbercheck, 2019). Soil fertility has a significant indirect effect on defoliator output and associated detriment to the tree. It influences the nutritional benefit of the foliage and the development of protective compounds by host trees (Kosunen et al., 2017). The loss and degradation of natural resources are significant obstacles to conserving natural habitats by variability (Olivier et al., 2016). Habitat degradation and fragmentation decreased the plant's, insect's species diversity, increased air and soil pollution, and reduced water quality (McKinney, 2002). Thereduction of natural habitat and urban developmenthas a detrimental effect on biodiversity. The urbanized impact on terrestrial invertebrates like carabid beetles from the loss of habitat and deforestation were carefully studied. There is no equally consistent trend for other indicators of diversity and population structure (Clark et al., 2007). Decadence and grassland fragmentation have led to significant population deterioration, range contractions around the world (Krauss et al., 2010; Stefanescu et al., 2010; Forister et al., 2010; Swengel et al., 2010). The conversion of the indigenous tallgrass meadow ecosystem developed into row crop farming for the past 150 years is considered one of the fastest and complete environmental transformations in human history, with considerable declines in the population of Prairie Butterfly in North America and Europe (Samson and Knopf, 1994; Mutel, 2007; Swengel et al., 2010; Stefanescu et al., 2010; Forister et al., 2010). Butterflies are deliberate as indicator species. They have numerous functional roles that sustain ecosystems and the resources provided from that place (Bonebrake et al., 2010); besides pollination, butterflies and plants often interlinked in several activities, making ecological stability harder to preserve (Bonebrake et al., 2010). The population of butterflies remains arbitrary in prairie residuals (Davis et al., 2007; Vogel et al., 2007; Davis et al., 2008), linear range habitats along with crop fields, fence rows, roadsides and waterways (Ries et al., 2001; Reeder et al., 2005; Davros et al., 2006). However, such grassland environments are low, isolated, and sub-quality than intact prairies. In the absence of any substantial reforms in current agricultural practices, similar habitat conditions for butterflies will likely continue in the area into the future (Myers et al., 2012).

Global awareness about biodiversity loss presented by the International Union for Conservation of Nature (IUCN) updated 71,576 species. Where most species both terrestrial and freshwater were in its Red Lists of Threatened Species, of which 860 are extinct, and 21,286 are threatened, with 4,286 considered to be critically endangered (Pimm et al., 2014; IUCN, 2015). These species decline impacts the community composition and significantly affect the ecosystem (Newbold et al., 2015). The biodiversity losses associated with ecosystems regulating (e.g. regulation, floods, diseases, waste, and water quality), social (e.g. recreation, aesthetic enjoyment) and supporting services (e.g. soil formation, photosynthesis, and nutrient cycling) (Millennium Ecosystem Assessment, 2005). The protection of native species is gradually being undertaken, sufficient (Cancelliere et al., 2007) for environmental purposes (Thomson et al., 2007). The protected areas and sanctuaries should be protected from social pressure to escalate suitable territories (Olivier et al., 2016). Due to climate changing and territory dilapidation, the distribution of species is becoming incredibly complex (Pradervand et al., 2014; Khan et al., 2019). The sympathy of species richness and their circulation are very delicate to climate (Sykes et al., 2005; Haroon et al., 2013) and territory deficiency (Donald et al., 2001; Hewison et al., 2002). Species are predictable to retort separately due to these changes and prove the differences among the taxa, ecological traits, and environmental changes (Sykes et al., 2005; Syphard and Franklin, 2009; Haroon et al., 2020; Ali et al., 2019). Land degradation, floods and urbanization changes (Pradervand et al., 2014) are real threats to biodiversity (Olivier et al., 2016).

Butterflies have a high aesthetic and commercial value as a pollinator and environmental indicator. The degree of diversity depends on whether a species is adaptable to a microhabitat. The dimension of population size and diversity of the species is the most significant biological elements of an ecosystem (Kumar et al., 2013; Gaurav et al., 2009). Butterfly larvae play a vital role in the function of ecosystems, including nutrient cycling and bio-conservation (Bonebrake et al., 2010). Such variations between butterfly groups probably indicate the difference in the life cycles of the insects. Their larvae are mostly involved in the host plant, while adults are dependent on flowering juices. For some species, the larval forms and host plants have been identified, but there is no evidence of overwintering or diapause strategies (Despland et al., 2012). Butterfly individuals are found worldwide, even in very high altitudes of the mountains covered with perpetual snow and glaciers (except Antarctica), wherever flowering plants occur (Haroon et al., 2020). The assessment of butterflies and plant species richness in a unit area determined nature conservation strategy (Van Halder et al., 2008; Farhat et al., 2014) and provided the trophic nature of the butterflies an essential element defining the diversity pattern (Mukherjee et al., 2019). The richness of species conserved biodiversity and associated with natural and anthropogenic species productivity (Thomson et al., 2007; Khan et al., 2019). Biodiversity losses and changes in ecosystem functioning are due to anthropogenic nitrogen deposition (Dutton et al., 2007) from agriculture activities, traffic, and industry (Wallis de Vries and Swaay, 2013). Butterfly species assemblages are considerably different depending on the vegetation and land use pattern (Sagwe et al., 2015). The plant and butterfly communications are life-threatening to understand the health, productivity, and calibre strategy for conserving an environment (Ferrer-Paris et al., 2013). The present study aims to set up how ecological traits (pH, soil, and soil ingredients) affect butterfly species richness and alignment, provide a baseline for the distribution of butterfly species richness, landscape changes, and vegetativevariables.

2 Materials and Methods

2.1 Study sites

The present study was carried out at Charsadda, Khyber Pakhtunkhwa (KP), Pakistan, an area of 428,239 (urban 33,012 and rural 395227) km^2 consisting of fertile soil (Fig. 1). The study area was divided into eight main sites (union council) and 40 subsites (villages). Collection of such sites was rendered after on-site visits, ArcGIS (https://desktop.arcgis.com/en/arcmap/) by the United States of America, and land use planning map before the start of the sampling analysis. The area has natural flux and water channels from the mountains; therefore, all tracks have unique fauna and flora.

2.2 Sampling period and time

The butterfly species were observed and sampled from 40 study sites (Table 1) through daytime (9:00 hours) to afternoon (15:00 hours) and follow the standard protocol (Pollard, 1977; Pollard and Yates, 1993; Arispe et al., 1993; Durell et al., 1994; Donald et al., 2001), during ten months.

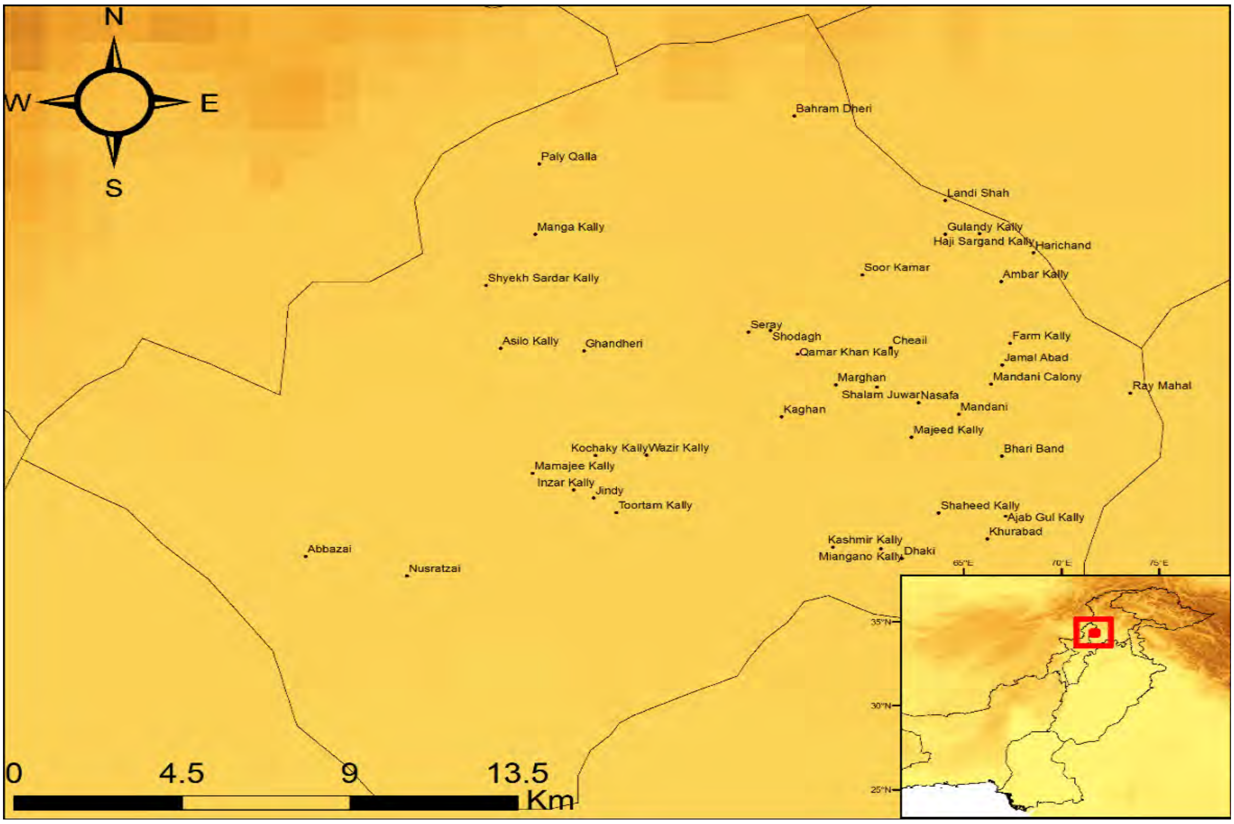


Fig. 1 Map of survey area in tehsil Tangi, Khyber Pakhtunkhwa, Pakistan.

Table 1 The main location and site names where butterfly species and soil samples were collected with their latitude, longitude and elevation (m) of tehsil Tangi.

SNo	Main locations	Sub-sites	Latitude	Longitude	Elevation (m)
1	Koaz Bahram Dheri	Haji Sargand Kally	34°23'46.24"N	71°47'31.50"E	419
		Landi Shah	34°24'19.94"N	71°47'10.21"E	426
		Gulandy Kally	34°23'45.64"N	71°.47'01.54"E	415
		Soor Kamar	34°23'04.59"N	71°45'49.69"E	413
		Paly Qalla	34°24'56.63"N	71°41'09.07"E	444
		Bahram Dheri	34°25'45.07"N	71°44'50.38"E	463
2	Dhaki	Dhaki	34°18'17.77"N	71°46'23.89"E	372
		Miangano Kally	34°18'27.62"N	71°46'05.61"E	375
		Khurabad	34°18'37.76"N	71°47'38.11"E	371
		Ajab Gul Kally	34°19'00.58"N	71°47'53.81"E	376
		Shaheed Kally	34°19'03.77"N	71°46'55.92"E	378
		Kashmir Kally	34°18'29.31"N	71°45'24.17"E	371
3	Ghandheri	Ghandheri	34°21'47.48"N	71°41'47.76"E	384
		Asilo Kally	34°21'50.17"N	71°40'35.59"E	401
		Shyekh Sardar Kally	34°22'53.88"N	71°40'22.99"E	414
		Manga Kally	34°23'45.53"N	71°41'05.46"E	413
4	d n a	Harichand	34°23'26.70"N	71°48'18.25E	407

		Ray Mahal	34°21'05.04"N	71°49'42.30"E	387
		Jamal Abad	34°21'33.54"N	71°47'50.91"E	397
		Farm Kally	34°21'55.42"N	71°47'57.97"E	400
		MandaniCalony	34°21'13.86"N	71°47'41.31"E	391
		Ambar Kally	34°22'57.79"N	71°47"49.96"E	410
5	HisaraNehri	Wazir Kally	34°20'02.24"N	71°42'42.33"E	376
		Mamajee Kally	34°19'43.79"N	71°41'03.38"E	374
		Kochaky Kally	34°20'01.86"N	71°41'57.91"E	372
		Inzar Kally	34°19'27.13"N	71°41'38.95"E	395
		Toortam Kally	34°19'04.03"N	71°42'16.08"E	363
		Jindy	34°19'19.05"N	71°41'56.18"E	362
6	Mandani	Mandani	34°20'43.76"N	71°47'13.37"E	398
		Nasafa	34°20'55.42"N	71°46'38.28"N	400
		ShalamJuwar	34°21'11.21"N	71°46'02.07"E	404
		Majeed Kally	34°20'20.32"N	71°46'32.33"E	393
		Bhari Band	34°20'01.44"N	71°47'50.70"E	392
		Kaghan	34°20'40.91"N	71°44'39.42"E	399
7	Shodagh	Shodagh	34°22'08.43"N	71°44"29.82"E	413
		Marghan	34°21'13.49"N	71°45'26.78"E	403

2.3 Butterflies sampling techniques

Butterflies have been randomly collected with slight modification according to the "Pollard Walk" method (Pollard, 1977; Pollard and Yates, 1993). Thoracic compression (squeezing between the thorax and head) and chloroform to kill the collected butterflies and wax envelopes was used for storage and appropriately marked with collection date and sites (Stork et al., 2003). The gap between the two areas was 2-5 km, as described by (Pradervand et al., 2014; Mukherjee et al., 2015). The butterfly species were identified according to morphological keys and already identified species at the National Insects Museum (NIM), National Agriculture Research Centre (NARC) Islamabad.

2.4 Environmental variables and analysis

We collected soil samples from 40 study sites and put them into biodegradable sheets for further analysis. Environmental variables were selected based on field observations, findings of latitude and ecological variables such as elevation (Ele), slope, aspect and occurrence (Occnce) (Harris et al., 2012). Besides, soil properties suchas soil type (clay, silt, sand and class), the composition of soil pH, OM%, Lime%, N%, P(mg/kg), K(mg/kg), wilting point (Wp), field capacity (Fc), bulk density (Bd), saturation (Saturtn), Sat. hydraulic conduct (Shy) and available water (Aw) exhibit shown to influence density (Miao et al., 2018). Data from soil type were used to categorize the soil moistures of each site and classified based on the soil clay content. Water holding capacity (scored as one high humidity and 0 low water holding capacity) set out in the Australian Soil Classification (ASC) and Great Soil Group guidelines (GSG) (Raymond, 2016). The soil samples have been analyzed at Mingora Swat Agriculture Research Station (MSARS) and used an online soil texture calculator (https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2_054167) and soil texture triangle hydraulic properties calculator (https://resources.hwb.wales.gov.uk/VTC/env-sci/module2/soils/soilwatr.htm).

2.5 Statistical analysis

Taxa S is used to identify the existence of butterfly species in the locality (Kremen, 1994; Hall and Harvey, 2002); Individuals N is considered as total numbers of species in the locality (Pollard, 1977; Fermon et al., 2005); and Dominance D describes the density/unit number of species (Spitzer et al., 1993; Barlow, 1994). Simpson 1-D, measures probability among individuals randomly/sample belonging to the same species (Simpson, 1949; Gracy et al., 2016). Shannon H diversity index calculates the rarity and commonness of species in a community (<1.5 low diversity, 1.5> and <2.5 medium variety, >2.5 high diversity) (Shannon and Weiner, 1963; Blair, 1999; Arya and Dayakrishna, 2014). Evenness e^H/S refers to determining the diversity index to quantify how equal the community is numerically (Adeduntan, 2009; Sethy et al., 2014; Dwari et al., 2017). Brillouin HB index measures the diversity of a collection instead of the Shannon Index (when sample randomness cannot be guaranteed) (Magurran, 1988; Tsafack et al., 2020). Menhinick D demonstrates the species richness/sample and number of species divided by the square root of the number of individuals/samples to calculate the Menhinick D index (Kinako, 1983; Camargo, 1992). Margalef diversity index d is a species richness S of biodiversity/area and is strongly dependent on the sampling size (Margalef, 1969). Equitability J measures the equitability of compares observed Shannon-Wiener index against the distribution of individuals between the observed species, which would maximize diversity (Kalapanida-Kantartzi et al., 2010; Guptha et al., 2014). Moreover, Fisher alpha assumes that the abundance of species follows the log series distribution (Schulte et al., 2005; Chen and Shen, 2017). The Chao 1 estimates the number of species/communities mostly counts the number of missing species (it gives more weight to the low abundance species) (Rodríguez-Ramos et al., 2014; Chao et al., 2014). Similarity and dissimilarity indexes calculate the species according to the population of individuals and make their relationship among individuals. All the statistical analyses were carried out in Past3 and XLSTAT software.

3 Results

In total, 506 specimens of butterflies from 40 sites represent three families, including Nymphalidae (252/506), Pieridae (217/506) and Papilionidae (37/506), 18 genera and 23 species. The collected species were identified as *Catopsilia ponoma*, *C. pyranthe*, *Colias fieldii*, *Eurema hecabe*, *C. erate*, *Pieris canidia*, *Colotis etrida*, *Belonias aurota*, *Danauas chrysippus*, *Tirumala liminniace*, *Junonia almana*, *Argyreus hyperbius*, *Vanesa indica*, *Junonia hierta*, *J. orytha*, *Hipparchia parisatis*, *Lethe confuse*, *Ariadne merione*, *Caynthia cardui*, *Neptis mahendra*, *Euthalia garuda*, *Papilio demoleus* and *P. polytes*. Butterfly communities showed a high turnover in the distribution of species; thus, we compared the group distribution between individuals with an abundance of estimator similarity index. We grouped individuals using single-link cluster analysis and presented the result in a dendrogram by population similarity. The dendrogram is showing the relationship between changes in the butterfly group and changes in the dominant individuals. Similarly, the relationship and similarities between the species are shown in Fig. 2.

The similarity index of individuals classified into absolute class 246 (47%), between-class 282 (53%), species-level and positions of *C. pyranthe* is (35/122; 14/30; 7/14; 6.91/24.11) in class 1, *C. etrida* is in class 2 (4/122; 5/30; 2/14; 0.79/24.11) and *T. liminniace* (3/122; 5/30; 2/14; 0.59/24.11) in class 3. In the similarity index, the predominant species were *C. pyranthe* and *C. etrida*.

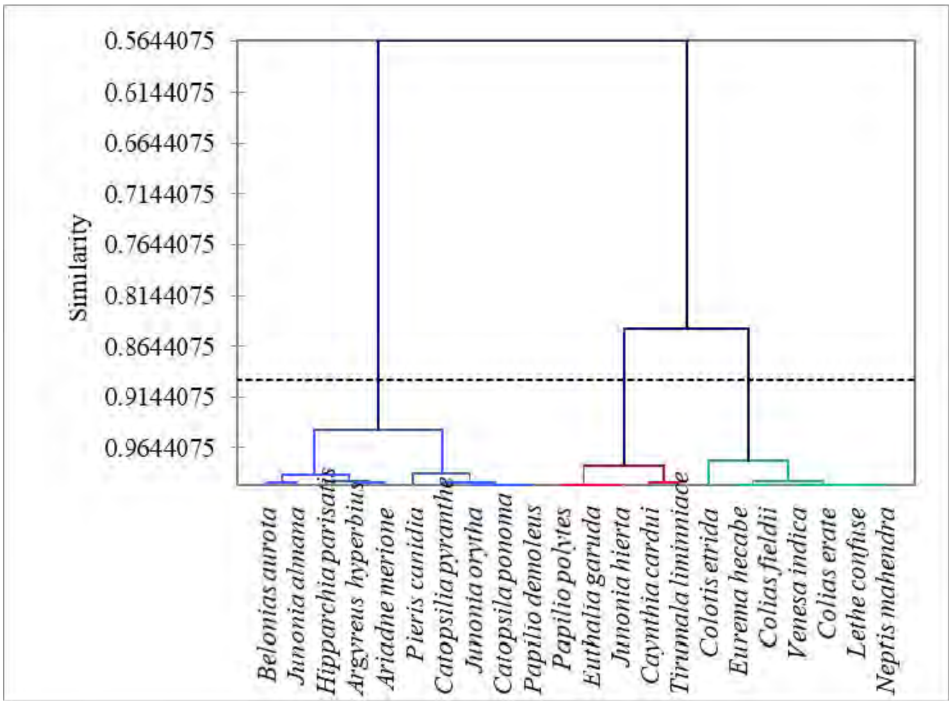


Fig. 2 Cluster analysis of butterflies species, the figure represents the quantity of similarity index among individuals.

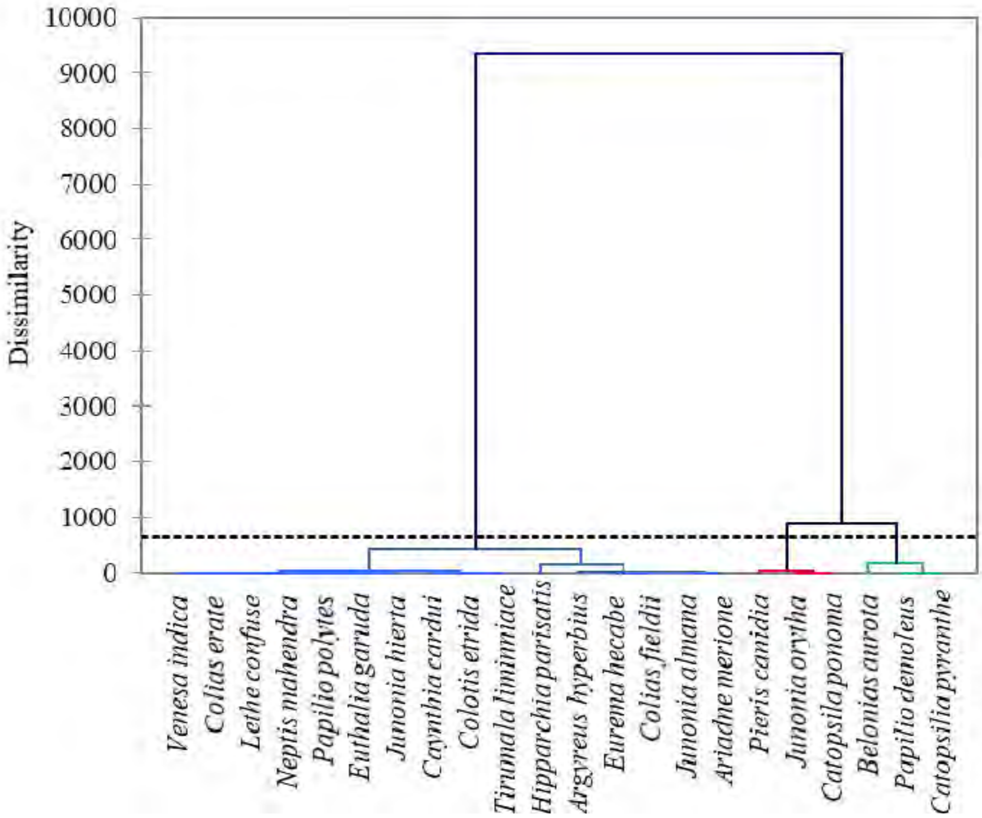


Fig. 3 Dissimilarity index represents the species quantity among the individuals.

The dissimilarity index differentiates the quantity and relationship among the butterfly individual's population in figure 3. The absolute class 45.5 (8.62%) and between-class 482.5 (91.38%), *C. ponoma* is (58/122; 19/30; 9/14; 11.460/24.11) in class 1, *C. pyranthe* at (35/122; 15/30; 7/14; 6/24.11) in class 2 and *C. etrida*in class 3 (4/122; 5/30; 2/14; 0.709/24.11) position.

In SDC, the highest density among species was *D. chrysippus* 122/506, followed by their frequency 30 and relative frequency 14. The minimum fauna of *E. garuda*, *J. hierta* and *P. polytes* species showing low and their densities were 1, frequencies two and relative frequencies 1, respectively (Fig. 4).

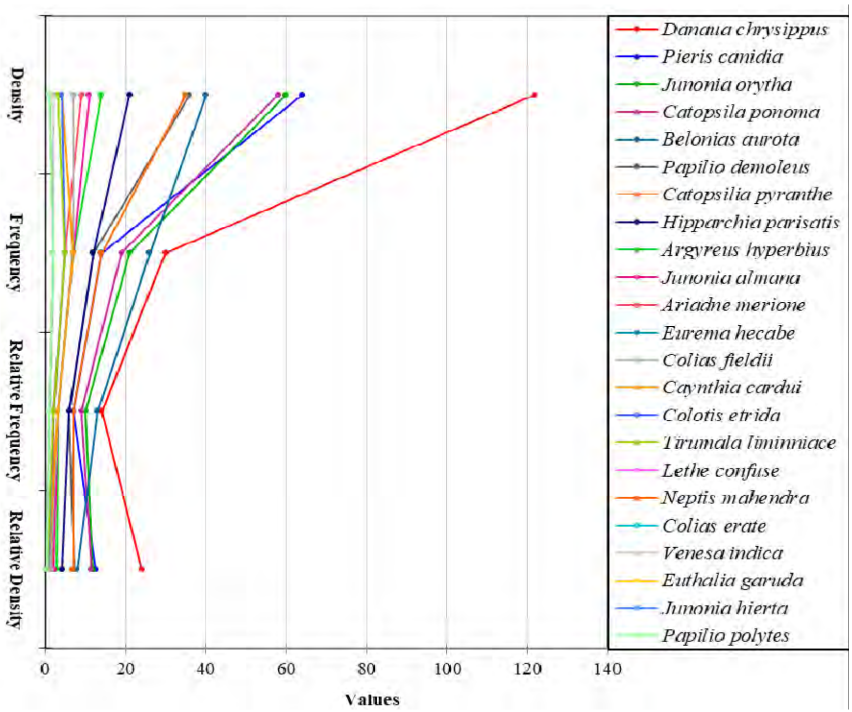


Fig. 4 The Semantic Differential Chart (SDC) of species shows their density, frequency and relative frequency. Each colour represents a specific species and their number of individuals.

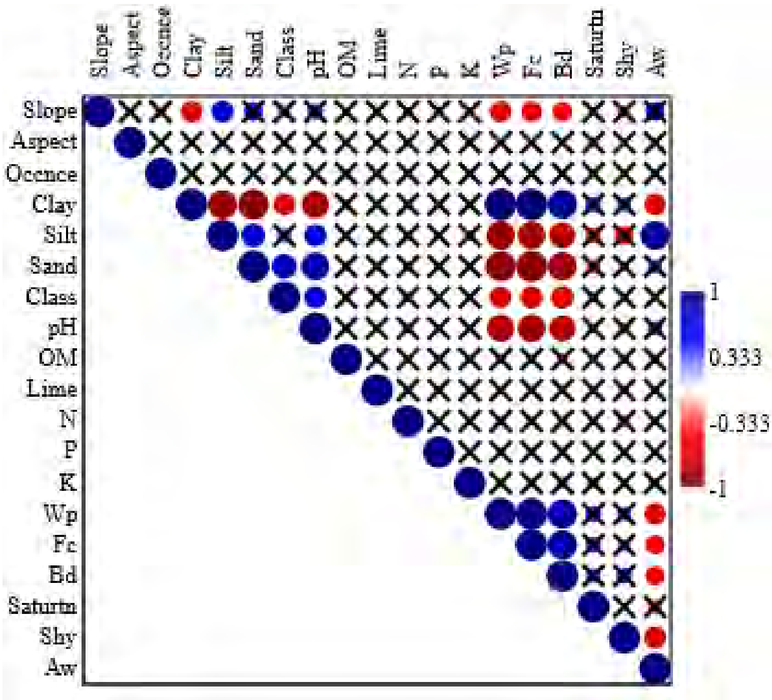
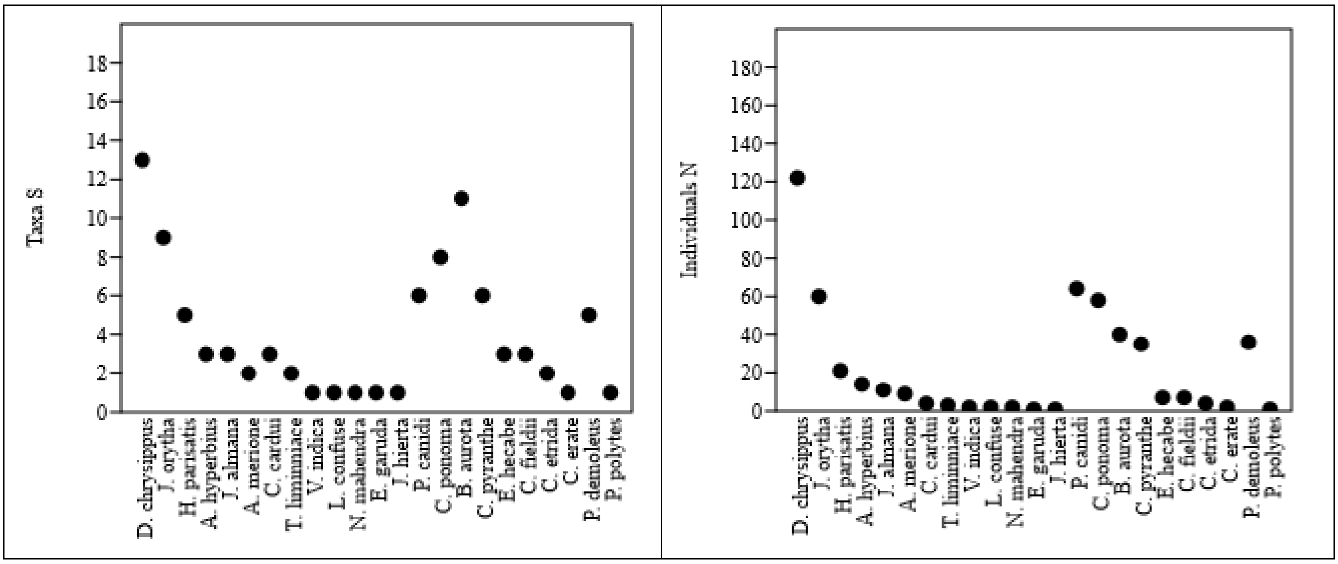
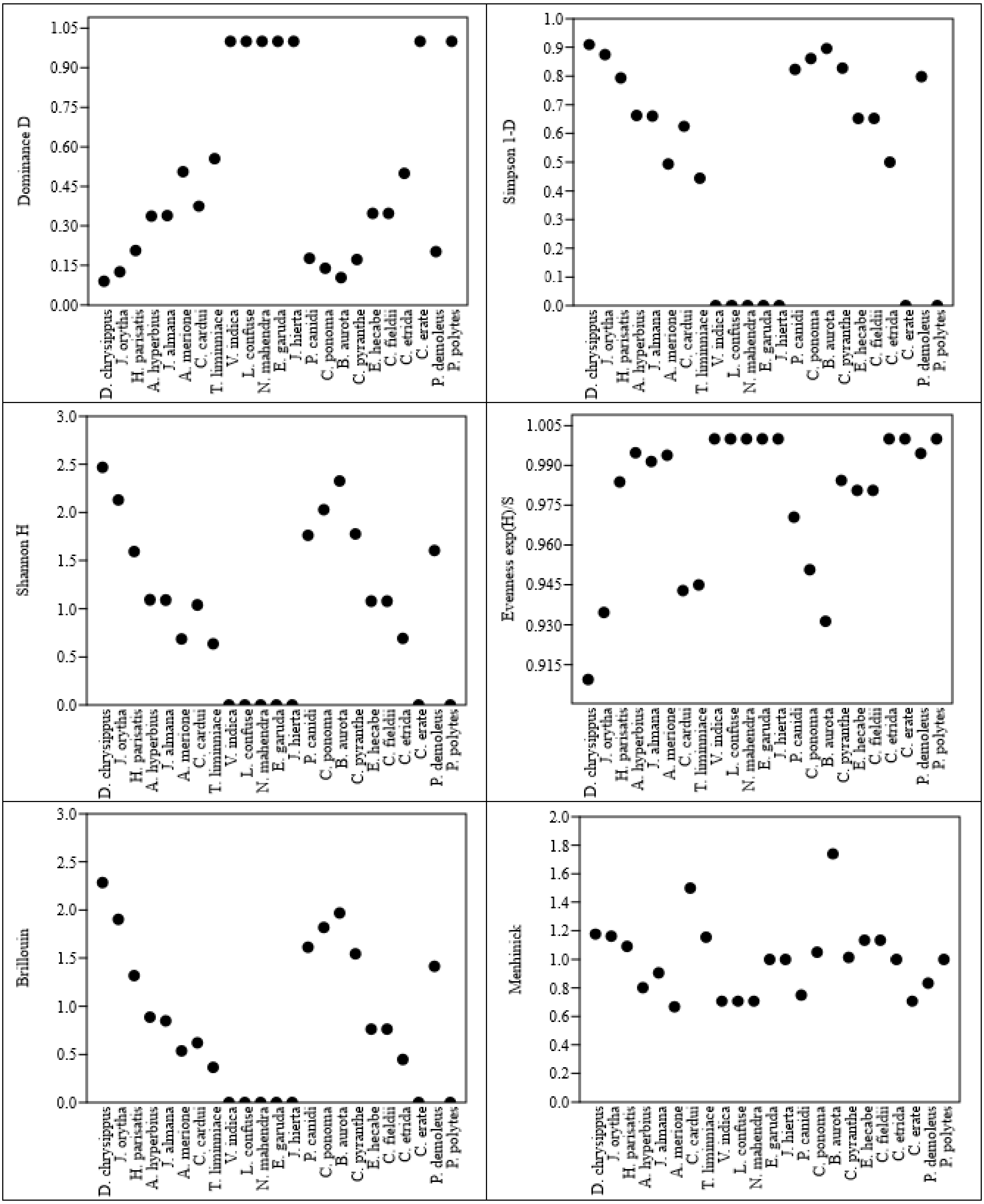


Fig. 5 Inter-correlation of the environmental gradient.

The inter-correlation differences between environmental gradients revealed that the elevation positively correlated with aspect and lime ($p \approx 0.000^{***}$). Altitude distribution of an insect species regulated with maximum population size at optimum levels and population density declining at altitudes above and below optimum can presume its environmental tolerances. Abundant species interactions cause essential variations in life-history that change simple climatic effects. Thus, the pattern of population density of a specific species represents increasing host plant phenology, quality, and density as well as variability in the species and predator populations. Slope correlated with clay, silt, sand, wilting point, field capacity, bulk density, and available water ($p \approx 0.000^{***}$), and with pH ($p < 0.005^{*}$). The importance of soil-based plant water is crucial for rapid growth and productivity to forecast a potential increase in global warming and summer drought. Therefore, the inhibition of photosynthesis and transpiration eventually affects plant growth—productivity under severe conditions of soil water scarcity during the growing year. Clay correlated with silt, sand, class, pH, wilting point, field capacity ($p \approx 0.000^{***}$), but they associated with saturation ($p \approx 0.00^{**}$). These organic substances help to improve soil structure, the bioavailability of nutrients and mineral particles. The high availability of pH effects on soil, therefore, is having an alternative impact on crop productivity. Silt correlated with sand, pH, wilting point, field capacity, bulk density, saturation, sat. hydraulic conduct and available water ($p \approx 0.000^{***}$), sand show correlation with class, pH, wilting point, field capacity, bulk density ($p \approx 0.000^{***}$), class correlated with pH, wilting point, field capacity and bulk density ($p \approx 0.000^{***}$), correlation of pH with the wilting point, field capacity and bulk density ($p \approx 0.000^{***}$), wilting point correlated with field capacity, bulk density ($p \approx 0.000^{***}$), and saturation ($p < 0.005^{**}$), field capacity with bulk density ($p \approx 0.000^{***}$) and bulk density with sat. hydraulic conduct ($p < 0.006^{**}$) and available water ($p < 0.000^{***}$), saturation with available water ($p < 0.01^{*}$) and sat. hydraulic conduct correlation with available water ($p \approx 0.000^{***}$) (Fig. 5). The correlation was carried out through Past3 and estimate the linear (Pearson) with ($p \approx 0.000^{***}$) significance level.





Dominance D
0.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
Simpson 1-D
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Shannon H
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Evenness exp(H)/S
0.915
0.930
0.945
0.960
0.975
0.990
1.005
Brillouin
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Menhinick
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
D. chrysippus
J. orytha
H. parisatis
A. hyperbius
J. almana
A. merione
C. cardui
T. limniace
V. indica
L. confuse
N. mahendra
E. garuda
J. hierta
P. canidi
C. ponoma
B. aurota
C. pyranthe
E. hecabe
C. fieldii
C. etrida
C. erate
P. demoleus
P. polytes

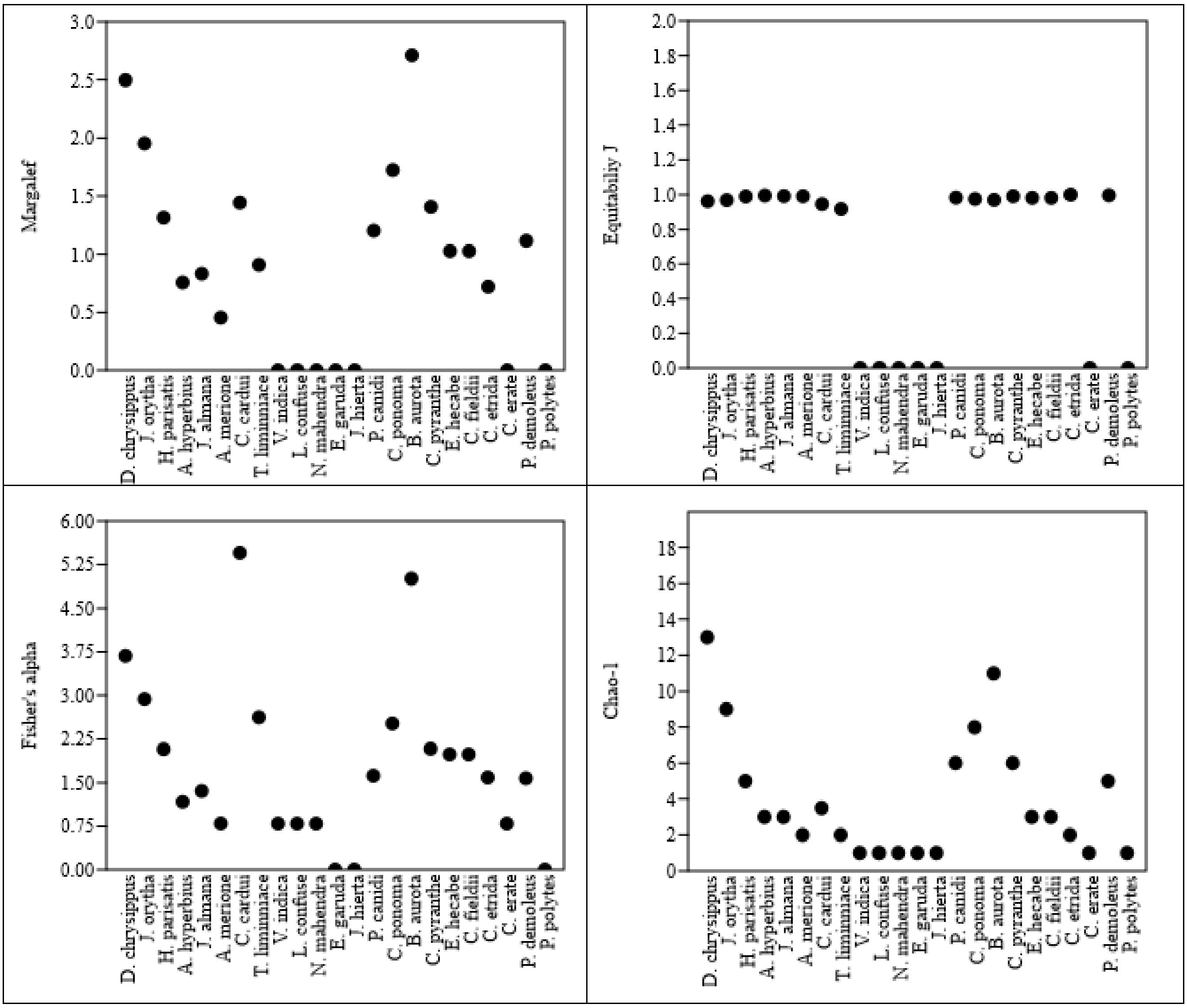


Fig. 6 The rank list of biodiversity of butterfly species in tehsil Tangi.

Biodiversity rank list of butterflies was represented in (Fig. 6), where *D. chrysippus* (13/91) proven high Taxa S followed by *B. aurota* (11/91), and the high number of specie (Individuals N) was (*D. chrysippus*,122/506). Density per unit area (Dominance D) of species shown that *D. chrysippus* (0.09/11.52) and *B. aurota* (0.10/11.52). The total probability (Simpson 1-D) was 11.48 of them *D. chrysippus* represents high (0.91/11.48) probability, whereas high the Simpson 1-D (1/0), the possibility will be considered lower, while 0 represents infinite diversity. Besides, the rarity and commonness (Shannon H) of species/community was *D. chrysippus* (2.5/23.1), *B. aurota* (2.3/23.1), *J. orytha* (2.1/23.1) and *C. ponoma* (2.0/23.1). Moreover, the maximum of the reported taxa show that the community is relatively even (Evenness e^H/S); the calculated data and variables revealed that the distribution of species was mostly present where the soil was fertile.

4 Discussion

The grassland ecosystem is characterized by three main management types: plant species composition, the segregating impact of grazing, and the two management regimes (Fiedler et al., 2017). Moreover, earlier scientists reported the diversity of foliage, foliage height diversity, habitat diversity, structural heterogeneity, vegetation heterogeneity, spatial heterogeneity, habitat complexity, structural complexity, spatial complexity, architectural complexity and vegetation complexity (Loos et al., 2016). Our study is based on the effects of soil gradient on butterfly biodiversity, where soil content affects butterfly diversity.The study area had a smaller number of plants, herbs, and shrubs, where the study area was attached to the foothill of the Suliman mountain ranges due to less rainfall. The results show that soil ingredient directly or indirectly affects flora and fauna of the study area.

Earlier researchers studied the mountain, desert, and temporal ecosystem and suggested to protect the slope of the region through vegetation covering (Dutton et al., 2007; Walker et al., 2010). This statement continued by our study and reported soil sample ingredients from 40 subsites of the study area. The slope significantly correlated with clay, silt, sand, wilting point, field capacity, bulk density and available water ($p \approx 0.000^{***}$), with pH ($p<0.005^{*}$), followed by class ($p<0.04^{*}$) and sat. hydraulic conduct ($p<0.03^{*}$). The covering of the slope with plantation and vegetation protects the original shape because of the significant flow of water barren soil. Robinson et al., (2018) reported that temperature and environmental variables, including pH, moisture, carbon and nitrogen, were not correlated. Our results revealed that pH was significantly ($p \approx 0.000^{***}$) correlated with clay, silt, sand, wilting point, field capacity, class, and bulk density.The soil content plays an essential role in plant growth, of which impacts come to support the fauna of butterflies in the study area. Loos et al. (2016) reported a total of 19,878 butterfly specimens belonging to 112 species. The collected individuals are *Colias alfacariensis*, *Minois dryas, Aphantopus hyperantus*, *Pieris rapae*, *Everes argiades*, *Coenonympha glycerion, Leptidea sinapis, Melanargia galathea, Coenonympha pamphilus*, *Maniola jurtina, Polyommatus icarus*, and *Plebeius argus covered* 85% (12/112 species) of the total area. From the present study, we concluded that some species had a well-observed abundance of the area. A total of 5219 specimens belonging to 229 species was reported after examination of the past disturbance of human and their effects on butterfly biodiversity (Williams 2011; Wallis de Vries and Swaay 2013; Whitworth et al., 2016). During the observation and collection, different traps were used to collect butterflies, including fish baited traps 3127/5219 (60%) and banana-baited traps 2092/5219 (40%). Our results showed that 506 specimens were collected belonging to 3 families, 18 genera and 23 species. The maximum species belong to the family Nymphalidae (252/506, 50%), followed by Pieridae (217/100, 43%) and family Papilionidae (37/100, 7%). Moreover, *D. chrysippus* covered 24% diversity of the study area, indicating that the vegetation and environmental factors were more favourable for the species. Haroon et al. (2013) surveyed and identified the distribution of butterflies in Union Council Koaz Bahram Dheri, Khyber Pakhtunkhwa, Pakistan and collected a total of 232 individuals from 12 localities. Moreover, the identified individuals belonged to 3 families, 11 genera and 13 species. Furthermore, family Nymphalidae comprised the most significant individuals, 49% followed by Pieridae 37% and 14% of Papilionidae. Here we also reported 506 individuals belonging to 23 species, 18 genera and three families. Therefore, from both studies, we concluded that the study areas had the same environmental conditions and soil ingredients. Elanchezhyan et al. (2012) recorded 19 genera and 23 species belonging to 8 families. While from the present study, only three families with 18 genera and 23 species. Similarly, both study areas were differentiated with significant differences local population of tehsil Tangi had used unnecessary pesticide to prevent the pest from agricultural land, which severely destroyed the butterfly fauna and caused acidity to the fields. The semi-natural habitats in the urban area, including gardens and parks (Donald et al., 2001; Haroon et al., 2013; Pradervand et al., 2014; Pinkard 2017). These are the selected areas which have butterfly species; whenever human disturb the respective sites, the species will move away from the disturbed sites. As a result, in the present study, selected sites are mainlyrural and few urban areas focus on vegetation sites. In the whole study, we found a distinct striking behaviour among butterflies in urban areas. These butterflies were aggressive to take the juices from the plants. The previous study suggests that in an urban area, the saviour condition occurs when species cannot find their food and habitats niches (Di Mauro et al., 2007); Williams 2011; Khan et al., 2019b). This condition neveroccured in our study area because the metropolitan study area is less populated and has flowering plants. The most common species in the study are *D. chrysippus, P. demoleus, C. ponoma* and *C. pyranthe*.

5 Conclusions and Recommendations

The present study concluded that the low latitude and altitude area both affected butterfly diversity. Farmers are advised to use insecticides, pesticides, and fertilizer properly because they cause acidity to the soil and affect the crop quality and quantity withal destroys the fauna of the butterfly as well. The protection of land and biodiversity of insects is the responsibility of the Biodiversity Action Plan (BAP) Pakistan, Ministry of Environment, Local Government and Rural Development.

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