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Original Article

Seasonal abundance and distribution of dragonflies in upper Siran valley of District Mansehra Pakistan

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Abstract

Present study was conducted to study seasonal abundance and distribution of dragonflies in upper Siran valley district Mansehra Pakistan. To collect data, eleven localities were visited for three consecutive years (2016-2018). Results come up with a sum of 300 specimens identified under three families, eight genera and twenty species. Highest seasonal abundance recorded during summer and spring were 80.67% and 13.33% respectively while minimum 6.00% was recorded during early autumn. Dominant species observed were, *Orthetrum chrysis* (14.00%), followed by *O. gluacum* (12.00%), *Palpoleura sexmaculata sexmaculata* (11.33%) and *O. cancellatum cancellatum* (8.00%). However the highest population of dragonflies was found in Munda Gucha with a percentage of 11.33 followed by Jabbar (11.00%) and Sachan (9.67%). The lowest populations were recorded in Suham (6.00%), Dadar (7.67%) and Jabori (7.67%). The surveyed valley showed diverse Anisopterous fauna and thus further extensive surveys are recommended that can come up with more important species from the area.

Keywords: dragonfly, diversity, distribution, Mansehra, Pakistan.

Abundância sazonal e distribuição de libélulas no vale superior de Siran, distrito de Mansehra, Paquistão

Resumo

O presente estudo foi realizado para verificar a abundância sazonal e a distribuição de libélulas no vale superior de Siran, distrito de Mansehra, Paquistão. Para a coleta de dados, 11 localidades foram visitadas por três anos consecutivos (2016-2018). Os resultados apresentaram uma soma de 300 espécimes identificados em três famílias, 8 gêneros e 20 espécies. A maior abundância sazonal registrada durante o verão e a primavera foi de 80,67% e 13,33%, respectivamente, enquanto o mínimo de 6% foi registrado no início do outono. As espécies dominantes observadas foram Orthetrum chrysis (14%), seguido por O. gluacum (12%), Palpoleura sexmaculata sexmaculata (11,33%) e O. cancellatum cancellatum (8%). No entanto, a maior população de libélulas foi encontrada em Munda Gucha (11,33%), seguida por Jabbar (11%) e Sachan (9,67%). As populações mais baixas foram registradas em Suham (6%), Dadar (7,67%) e Jabori (7,67%). O vale pesquisado mostrou fauna Anisopterous diversificada, e, portanto, recomenda-se a realização de mais pesquisas que possam apresentar mais espécies importantes da área.

Palavras-chave: libélula, diversidade, distribuição, Mansehra, Paquistão.

1. Introduction

Dragonflies (Odonata) are well known bio-control agents and environmental indicators that are commonly found in running as well as standing freshwater bodies (Rafi et al., 2009). They possess slender abdomen, large eyes, short antennae and long wings (Dijkstra and Lewington, 2006). They are important predators of serious insect pests of crops, fruits and vegetables (Zia et al., 2008). Their larvae are also voracious predators and consume mosquito larvae and other small crustaceans in large numbers (Din et al., 2013; Bhatti et al., 2013).

Besides this, Odonata themselves may also be a significant prey of birds, fishes and few invertebrates thereby playing an important component in food chain of these organisms (Chaudhry, 2010). According to Zia et al. (2011a) more than 6500 species of Odonata have been described so far all over the world. However odonate fauna of Pakistan is less explored with a record of only 121 species (Chaudhry, 2010; Zia, 2010; Zia et al., 2009a; Akhtar et al., 2014; Din, 2012). Pakistan is far behind from its neighboring countries as well e.g., India has a known odonate fauns of 500 species, Srilanka reflect 120 species while from Nepal 180 species of Odonates have been reported (Zia et al., 2011b). Previously Laidlaw (1915) and Fraser (1934) reported Odonata of subcontinent, Kanth (1985), Khaliq et al. (1992), Yousuf et al. (2000) studied Odonata of different districts of Kashmir valley. Khaliq and Siddique (1995) and Khaliq et al. (1994) studied odonates of Poonch district of Kashmir valley. Last known country wide surveys exploring country's Odonate fauna were carried out by Zia (2010) and Chaudhry (2010). Yet few short studies were conducted by various workers like Din (2012), Bhatti et al. (2013), Akhtar et al. (2014), Rauf et al. (2011), Seyab et al. (2015), Rehman et al. (2015), Ullah (1994) and Adnan (2010). It is important to mention that in all above studies only faunistics of Odonata were studied with no information collected for their seasonal abundance. Also the area under Hazara division was badly neglected and very minimum information is thus available for the inhabiting Odonate fauna. In view of this, present study was designed to study seasonal abundance and distribution of dragonflies in Siren valley of district Mansehra.

2. Materials and Methods

2.1. Sampling area

Eleven localities were surveyed during summer season of three consecutive years (2012-2014) in upper Siren valley. The localities were selected on the basis of variables that are important in influencing the distribution of dragonflies as stated by Clark and Samways (1996). The localities visited were, Suham (L1), Dadar (L2), Bella (L3), Jabori (L4), Sachan (L5), Kodhar (L6), Nawaz abad (L7), Jabbar (L8), Deuvili (L9) Munda Gucha (L10) and Chajja (L11).

2.2. Collection of samples

For sampling, methods of Zia (2010) and Wahizatul-Afzan Jullia and Amirrudin (2006) with minor additions were followed. Collected specimens were brought to Zoology Department, Hazara University Mansehra for pinning and mounting.

2.3. Identification of specimens

Preserved specimens were sent to National Insect Museum, National Agriculture Research Centre (NARC) Islamabad for taxonomic identification. All identified specimens were deposited in Zoological Museum, Department of Zoology, Hazara University Mansehra for future studies.

2.4. Morphometric measurements

Measurements of fore and hind wings, abdomen, superior and inferior anal appendages were done by Divider and Scale method (Zia, 2010).

2.5. Statistical analyses

Statistical analyses of morphometric parameters were done using statistica-7 and environmental variables were estimated through Canoco5 software. The abundance of the various species on the basis of seasons, localities and species richness were represented by histograms using computer program "Excel" version 2010.

3. Results

As a whole 300 specimens were identified under three families eight genera and twenty species. Family Aeshnidae represented single genus and species i.e. *Anax immaculifrons* while Gomophidae comes up with three genera and five species. Under family Libellulidae, six genera and 14 species were recorded. Data was recorded for three seasons viz., spring (March-May), summer (June–September) and autumn (October and November). Figure 1 represent seasonal abundance, which was maximum during summer (80.66%) in three sequent years at all localities, while the lowest population recorded during autumn (6.00%) at each locality. As a whole 300 specimens were recorded among which 242 were recorded during Sumer, 40 in spring and 18 during autumn. Possible reason for higher seasonal abundance observed during Summer is, that the area (siren valley) is surrounded at all of its sides by high mountains that receives snowfall in winters that feeds streams and rivers as the summers approaches. These water bodies act as common breeding points for the dragonflies and support their biology and life cycle,

Species abundance was calculated for all the recorded species (Figure 2). Among these *O. chrysis* (14.00) dominated followed by *O.gluacum* (12.00%), *Palpoleura sexmaculata sexmaculata* (11.33%) and *O. cancellatum cancellatum* (8.00%), respectively. While lowest abundance was observed for *Anormogomphus heteropterus (*0.67%)

Richness for all recorded species was also calculated and shown in Table 1, It is evident that the highest

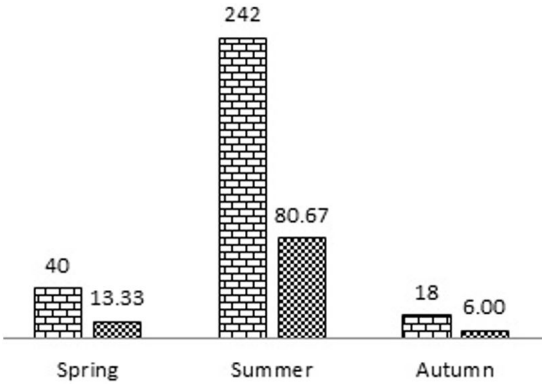

Figure 1. Seasonal abundance of dragonflies in different localities of upper Siran valley District Mansehra during 2016-2018.

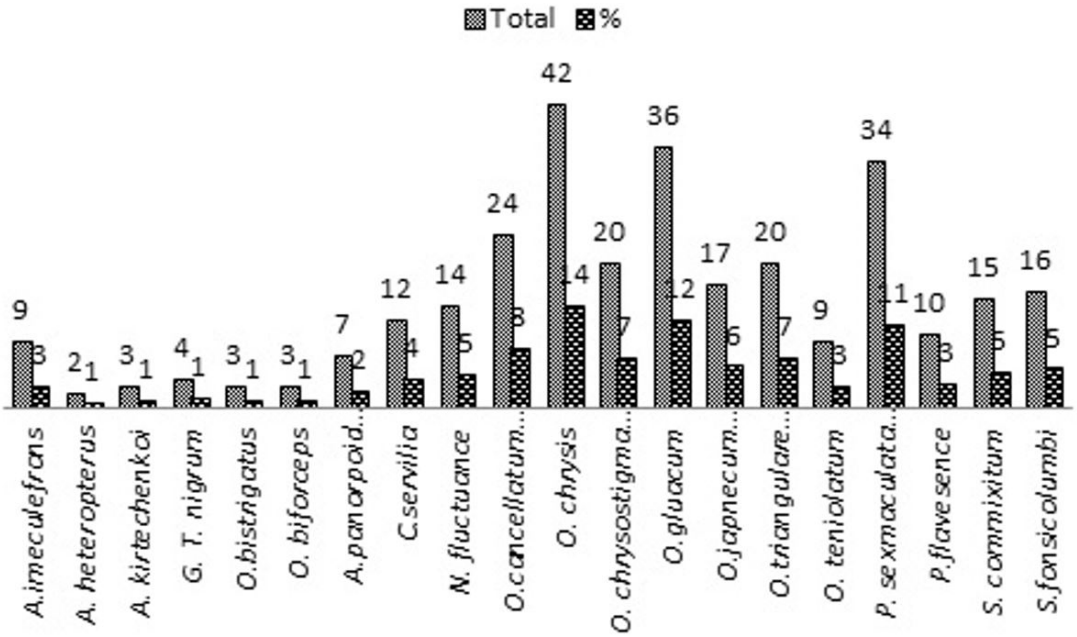

Figure 2. Abundance of dragonflies recorded in upper Siran valley district Mansehra.

Table 1. Richness of dragonflies species at different localities of upper Siran valley District Mansehra during 2016 -2018.

Species	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	Total
A.immaculifrons	-	1	-	1	2	1	1	1	1	1	-	09
I. rapax	1	-	-	-	-	-	-		1	-	-	02
A. kiritschenkoi	-	1	-	-	-		-	-	-	1	1	03
G. t. nigam	1	-	-	-	-	1	1	-	-	-	1	04
O. bistrigatus	-	-	-	1	1	-	-	-	1	-	-	03
O. biforceps	1	1	-	-	-	-	-	1	-	-	-	03
A. panorpoides panorpoides	1	-	2	1	1	-	1	-	-	-	1	07
C. servilia	1	1	-	2	2	1	-	2	1	1	1	12
N. fluctuans	-	2	3	1	1	-	-	3	-	4	-	14
O. cancellatum cancellatum	1	-	4	1	3	3	4	-	-	5	3	24
O. chrysis	-	2	4	6	1	5	1	6	2	8	7	42
O. chrysostigma luzonicum	1	3	-	-	4	2	1	3	-	5	1	20
O. glaucum	3	4	1	2	1	4	2	7	9	1	2	36
O. japonicum internum	-	-	1	1	2	3	3	-	4	1	2	17
O. triangulare triangulare	1	2	4	1	2	1	2	2	1	2	2	20
O. taeniolatum	-	-	1	1	-	3	-	1	1	-	2	09
P. sexmaculata sexmaculata	2	3	6	1	6	3	5	4	1	2	3	34
P. flavescens	1	-	-	-	2	3	1	1	-	2	-	10
S. commixtum	2	2	1	2	-	-	4	1	2	-	1	15
S. fonscolombei	2	1	-	2	1	3	-	1	4	1	1	16
Total number of species	18	23	27	23	29	33	26	33	28	34	28	300

L1=Suham, L2= Dadar, L3= Bella, L4= Jabori, L5= Sachan, L6= Kodhar, L7= Nawaz abad, L8= Jabbar, L9= Deuvili, L10= Munda Gucha and L11=Chajja.

richness is observed at Munda gucha (11.33%) followed by Jabbar (11.00%) and Sachan (9.67%) respectively. However lowest richness was recorded at locality Suham (6.00%). Possible reason for high richness at Mund gucha is presence of variable aquatic spots as here is found three catchment areas of river Siren this locality is found in an undisturbed ecology that is far away from human disturbances. However at Suham there are less aquatic spots and more human population is present that obviously affects lives of Odonata (Zia et al., 2009b). Being aquatic in larval stage the biology of dragonflies has a strong relationship with aquatic bodies and water bodies thus impact their populations as well as distribution.

Two way cluster analysis showed that Dragonflies clusters based on localities and species occurrence relationships. The self-organizing map (SOM) assigned 11 localities containing 20 species into the SOM output units, according to the recorded resemblances in odonate groupings. SOM output units were split into four clusters (A–D) based on the dendrogram generated by hierarchical cluster analysis. These clusters were further grouped into two sub clusters i.e. sub cluster A–B and sub cluster C–D. Sub clusters A–B was included on 6 species, whereas sub clusters C-D was consisted on 14 species. The relationship and distribution with locality showed that, L1, L2, L3,L4,L5,L6.L7,L8,L9,L10 and L11 were included 13,12,10,14,14,13,12,13,12,13 and 14 respectively (Figure 3).

The canonical correspondence analysis (CCA) represent the differences in environmental variables among different group Patterns based on non-metric multidimensional scaling (NMDS) ordination illustrated changes in the environmental variables during March to October. These variables were divided into six categories i.e. altitude was the most correlated with the NMDS axes ($r2 = 0.501$, $p < 0.01$). Minimum temperature in March and April was the most contributing variable ($r2 = 0.522$, $p < 0.01$) among all meteorological variables, annual average temperature ($r2 = 0.4201$, $p < 0.01$). In the land use category, the proportion of forest was the most determinant ($r2 = 0.631$,

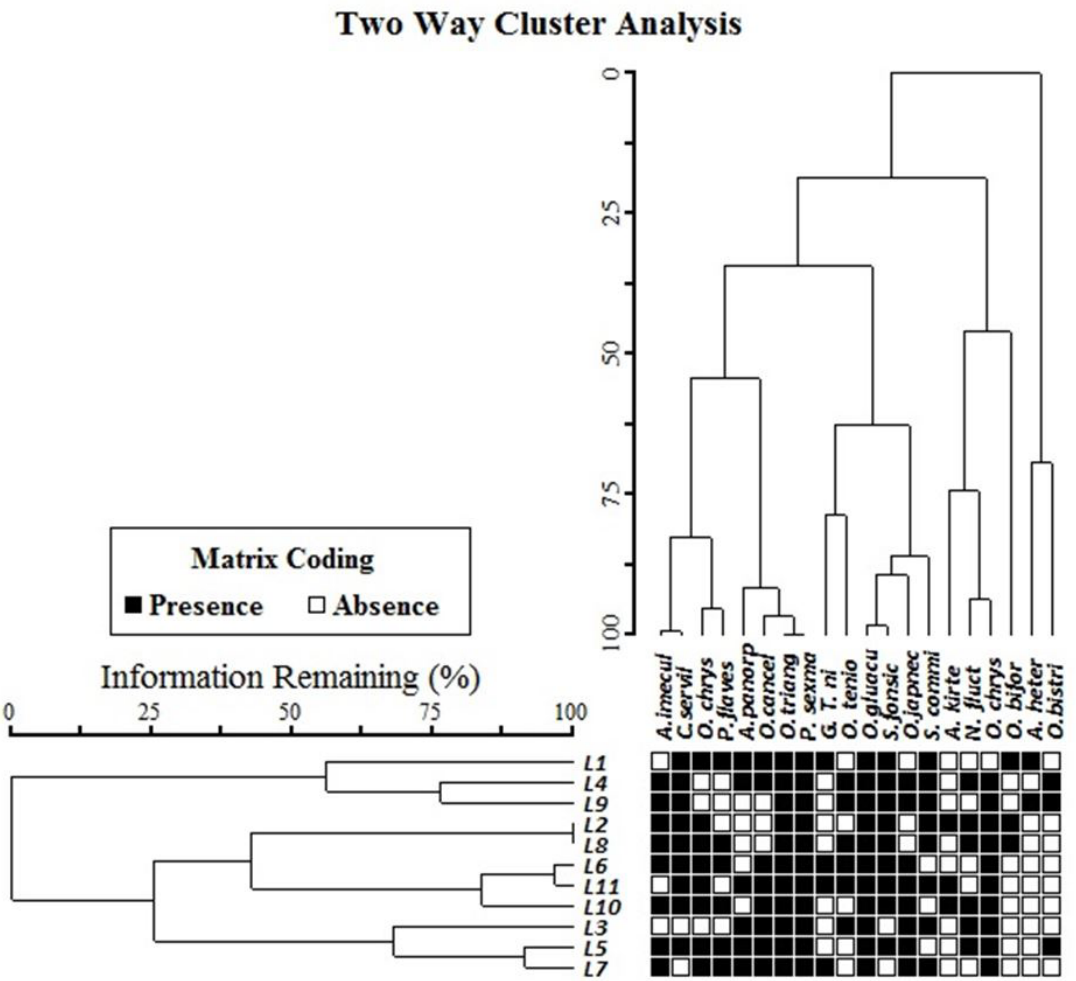

Figure 3. Two ways cluster analysis of Dragonflies constructed on the basis of localities and species occurrence relationships based on the dendrogram of hierarchical analysis. L1=Suham, L2= Dadar, L3= Bella, L4= Jabori, L5= Sachan, L6= Kodhar, L7= Nawaz abad, L8= Jabbar, L9= Deuvili, L10= Munda Gucha and L11=Chajja.

$p < 0.01$), followed by the proportion of agricultural land area ($r2 = 0.4279$, $p < 0.01$). Among the hydrological variables, the proportion of stream was the most correlated ($r2 = 0.410$, $p < 0.01$), Environmental factors that were estimated significant factors of odonate clustering patterns by the NMDS analysis (Figure 4). Among geographical variables, altitude and stream order were selected and were highest in clusters C and D. While lowest in clusters A and B. Among the meteorological variables, minimum temperature in March and April and average temperature were found significantly higher in June to August in all clusters. Among the land use variables, forest (%) was the highest in cluster A and C. Among the hydrological variables streams (%) was the highest in cluster C-D.

4. Discussion

The first faunal work on Anisoptera of Pakistan was conducted by Yousuf (1972) reporting 46 species under 24 genera and 6 subfamilies. From Pakistan a record of 120 species of Odonata is currently known (Chaudhry, 2010; Zia, 2010; Zia et al., 2009a; Zia, 2015; Din, 2012). However the areas under administrative boundaries of Hazara division especially of district Mansehra remain neglected and over looked. Till date only studies available on record that includes some information for the Odonata fauna of district Mansehra includes work of Khaliq et al. (1992) who reported six dragonflies species form Mansehra while Chaudhry (2010) reported only single species i.e., *Anax immaculifrons* without mentioning details for the specific locality visited. It is also worth mentioning that both of these studies were based on random sampling and thus couldn't bring forth any information for the inhabiting Odonate fauna and/or its seasonal distribution and abundance. However in present study repeated surveys were conducted every month and every season during three consecutive years i.e., 2016-2018 to collect a clear picture for the dragonflies' distribution and abundance.

The Odonata fauna of Hazara division is important to study as it has got an important geographical position due to its administrative boundaries. At its eastern side lies the territory of Azad Jammu and Kashmir (AJ&K) that connects with the Indian held Kashmir. From Azad Jammu and Kashmir a record of 89 species has been reported so far (Kanth, 1985; Khaliq, 1990; Luqman, 1995; Zia et al. 2009b; Rafi et al., 2009). At northern end of Hazara division is Gilgit and Baltistan (Northern areas of Pakistan) behind which comes the boundaries of China. From Gilgit Baltistan a record of 35 species is known (Khaliq et al., 1994; Jehangir, 1997; Zia et al., 2011a). Western border of Hazara division touches the areas of Malakand division that coincides with the Afghanistan

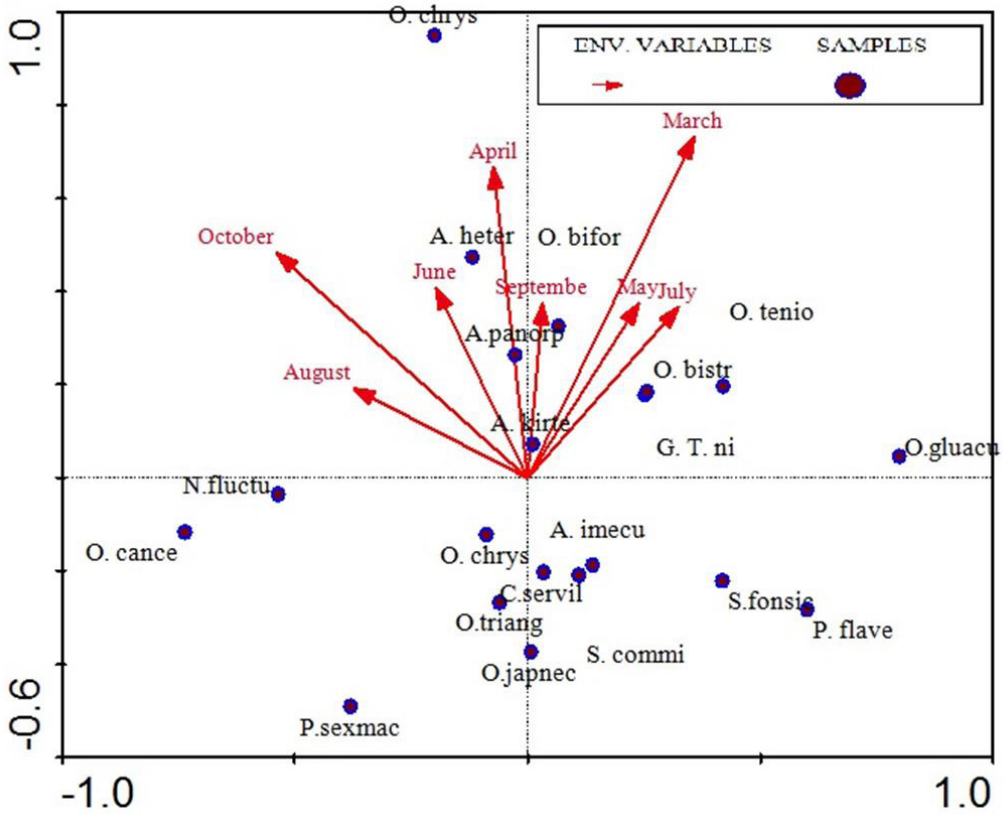

Figure 4. Biplots of environmental variables in different categories of non-metric multidimensional scaling (NMDS) ordination.

province “Kunar”. From Malakand division, a record of 32 species of Odonata is known (Ahmad, 1994; Ahmad and Yousuf, 1994; Khaliq and Maula, 1999; Rauf et al., 2011; Akhtar et al. 2014; Seyab et al., 2015). At its Southern end comes the Potohar region of Punjab province that is itself a representation of nine geographic regions (Shah, 2017) and from here a record of 53 species is documented by various workers like (Khaliq et al., 1993; Rehman, 1994; Niazi, 1984; Zia, 2010 and Din, 2012).

The geographic location of Hazara division as discussed above highlights its importance from insect faunal perspectives. Mansehra district is located at a central position in Hazara division and thus is important to explore for Odonata species. Dragonflies being a group of flying insects have very wide distribution (Zia et al., 2011b). They continue to move and migrate in search of food and with seasonal shifts. Many of the Indian and Chinese species are expected to be seen here when season (especially cold) there gets harsher for their survival. The earlier studies (Khaliq et al., 1992; Chaudhry, 2010) together come up with a record of only six Anisopterous species from Mansehra district. However present work documents 20 species. It thus becomes evident that if this area be explored extensively, it can surely bring forward more important records for the country as its geographic location is very important and it is least explored as compared to other areas of the country.

The seasonal abundance diversity was maximum during summer (80.66%) in three sequent years at all localities, while the lowest population occurred during autumn (6.00%) at each locality. Among species highest population was recorded for *O. chrysis* (14.00%), followed by *O. gluacum* (12.00%), *Palpapoleura sexmaculata sexmaculata* (11.33%) and *O. cancellatum cancellatum (*8.00%), respectively.While lowest papulation was recorded for *Anormogomphus heteropterus (*0.67%). In term of localities abundance of dragonflies, highest species richness was observed at L10 (11.33%) followed by L8 (11.00%) and L5 (9.67%) respectively. However lowest species richness was recorded at locality L1 (6.00%). Therefore the localities, like L1, L2 and L4, which are near to the rural populated areas having lowest abundance diversity, the reasons are human activities and disturbance of habitat. While the localities having highest abundance diversity, which for away from rural populated area, human activities and habitat is secure from disturbance. Regarding the seasonal abundance, generally, the results indicate to importance of the two seasons, spring and summer. The highest and lowest seasonal abundance occurred during these two seasons in all localities. The variations in the seasonal abundance of dragonflies are due to environmental effects with the meteorological variations. Therefore, the dragonflies are an important topic for research and study as they have the great biodiversity all over the world. Priorities for identifying species of dragonflies need to improve monitoring, surveys and should focus research on environmental effects of dragonfly population in Pakistan.

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