Journal of Animal & Plant Sciences, 31(6): 2021, Page: 1848-1854
ISSN (print): 1018-7081; ISSN (online): 2309-8694
https://doi.org/10.36899/JAPS.2021.6.0389

DISTRIBUTION AND ABUNDANCE OF ODONATES FUANA OF TANAWAL REGION DISTRICT MANSEHRA, PAKISTAN

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ABSTRACT

Throughout the present study a total of 425 specimens were collected to assess the distribution and abundance of Odonata fauna. Odonata is order of Dragonflies and Damselflies, their nymphs and adults are predators. They are environmental indicators and play important role in biological control of insect pests. Result revealed 19 species belonging to 02 suborders viz., Anisoptera and Zygoptera under 06 families. Most abundant family recorded was Libellulidae (74%) followed by family Chlorocyphidae and Calopterigidae (11%) and (7%) respectively. Whereas family Aeshnidae were found least abundant (2%). Genus *Orthetrum* (Newman, 1833) dominated with percentage (51%) followed by genera *Rhinocypha* (Rambur, 1842)*, Neurobasis* (Selys, 1853) and *Pantala* (Hagen, 1861) 11%, (7%) and (7%) respectively. While least abundant genus was *sympetrum* (Newman, 1833) having percentage (2%). Highest richness is observed at locality Galli badral (12.47%) followed by Shungli (12.00%) and Phulra (11.29%) respectively. However lowest richness was recorded at locality Lassan (4.47%). Regarding species abundance *Orthetrum triangulare triangulare* (Selys, 1878) was dominated (18.11%) followed by *O. purinosum neglectum* (Rambur, 1842), (16.47%), *Neurobasis chinensis chinensis* (Linnaeus, 1758), (7.05%) and *Rhinocypha quadrimaculata* (Selys, 1853), (5.88%)*,* respectively. While lowest abundance was observed for *Ictinogomphus rapax* (Rambur, 1842) *(*1.41%).The canonical correspondence analysis showed thatall Odonata species were associated with submerged vegetation. Anisoptera and Zygoptera species were associated with sunny and shady biotypes. Two species; *O. triangulare triangulare* and O. *pruinosum neglectum* showed positive association with temperature. A Zygoptera species *Megalestes major* was found in moist habitat. Relative humidity was found as an influencing factor for the population growth of Anisopteran and Zygopteran species. Cluster analysis showed that all species were clustered into two groups; genera *Anax Ictingomphus Crocothemis*, *Neurothemis, Orthetrum Palpopleura*, *Pantala* and *Sympetrum* were clustered into group I. Wheras Group II comes up with all Zygoptera species. The current information/data base will be helpful in preservation of ecosystem management approaches of Odonata.

Key words: Odonata, abundance, distribution, Cluster analysis, Canonical correspondence analysis, Tanawal.
Published first online March 31, 2021 Published final Nov. 20, 2021.

INTRODUCTION

Odonata is the order of dragon and damselflies, their body size is medium to large and known to be most ancient flying insects (Rafi *et al.,* 2009; Mehmood *et al.,* 2020). Larvae of Odanata are aquatic and inhabiting in running and standing freshwater bodies. The geographic location of Hazara division is important 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. They continue to move and migrate in search of food and with seasonal shifts (Zia *et al.,* 2011b). Many of the Indian and Chinese species are expected to be here when season (especially cold) there gets harsher for their survival. The earlier studies Khaliq *et al.,* (1992) and Chaudhry (2010) together come up with a record of only seven Anisopterous species from Mansehra district. However present work documents 19 species (Khaliq and Siddique, 1995), Odonates are environmental indicators and their naiads (Nymphs) are aquatic, therefore they have amphibious life cycle. Odonates adult and naiads are suitable for evaluating the environmental changes and water pollution (Dijkstra and Lewington, 2006). According to Zia *et al.* (2008) these insects are very important for biological control of crop pests. Their larvae are also prey on mosquito larvae and other small invertebrates (Din *et al.,* 2013; Bhatti *et al.,* 2013). The members of this order are also important prey of birds, fishes and few invertebrates thus being a significant constituent in ecosystem (Chaudhry, 2010). Globally, it is reported that about six thousand and five hundred species

of Odonata were reported (Zia *et al.,* 2011a). Whereas Dragon and Damselflies from Pakistan are less discovered and only 121 species are reported (Zia *et. al.,* 2009; Chaudhry, 2010; Zia, 2010; Din, 2012). Therefore, current study was planned to determine the distribution and abundance of odonata from Tanawal region of District Mansehra. Environmental factors/variables were also recorded and analyzed their effects of distribution and abundance on Odonate fauna.

MATERIALS AND METHODS

Study sites: Surveys were conducted during summer season of three consecutive years (2016 - 2018) in upper Tanawal district Mansehra. Geographically Tanawal is situated at 34°.15` degree to 34°.23` degree latitude on the North and 72°.52` to 73°.10` degree longitude in the East. The Siran river flows through it from North to South, and it divides Tanawal in two parts which may be termed as eastern Tanawal and western Tanawal. In the South of Tanawal situated Haripur district, the river Indus in its West, Black Mountains in North, Abbottabad and Mansehra located in the East, and Agror valley in the north-east (Fig. 1).

Collection and preservation of samples: For sampling, methods Wahizatul-Afzan *et al.* (2006) with minor additions were followed. Collected specimens were brought to Department of Zoology, Hazara University Mansehra for pinning and mounting.

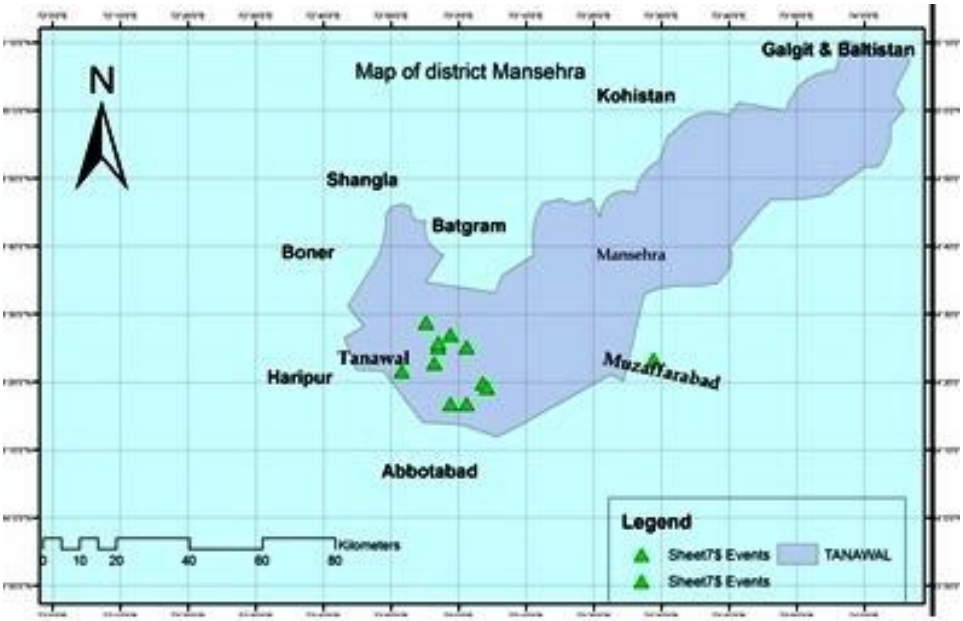

Figure 1. Map of District Mansehra showing the distribution of Odonata in Tanawal region during 2016-2018

Environmental variables: Eleven environmental variables were measured in the all localities. Water temperature (°C) was taken using thermometer, data of relative humidity (%), rain fall (mmh-1), wind speed (mph) and moisture (g/m^3) were taken from metrological and forest Department of Government Khyber Pakhtunkhwa. Whereas altitude (m), latitude (degree), longitude (degree) were get through GPS. Submerged vegetation (0 for absent of aquatic plants at the visited locality, 1 for present of aquatic plants at visited locality) was noted, shade (shady place) and sunny biotopes (types of space where sunlight persist most of the day), Vilenica (2017).

Identification: 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.

Data analysis and presentation: The abundance of the various families genera and species were estimated, localities and species richness were presented by pie chart using computer program "Excel" version 2010. CCA was applied by "MVSP" (Multivariate statistical packages) software (Duigan and Kovach, 1991; Kovach, 1995; Rana *et al.,* 2010) to check the effect of different environmental variables on distribution and abundance of Odonata. Cluster analysis was done based on habitat preference using "PAST" statistical software (Ryan *et al.,* 1995) to investigate the relationship among Odonata species.

RESULTS

A total of 425 specimens were collected and their identification revealed 19 species belonging to 02 suborders viz., Anisoptera and Zygoptera under 06 families. Anisoptera yields with 03 families, Aeshnidae represented single genus and species i.e. *Anax parthenope (*Selys, 1853*)* while Gomphidae comes up with single genus under 02 species *Ictingomphus biforceps* (Selys, 1854) and *I. rapax* (Rambur, 1842). Family Libellulidae was revealed under 07 genera with 12 species i.e. *Acisoma panorpoides panorpoides* (Rambur,1842), *Crocothemis servilia servilia* (Drury,1770), *Neurothemis tullia tullia* (Drury,1773), *Orthetrum cancellatum cancellatum* (Linnaeus,1758)*, O. chrysis* (Selys,1891), *O.glaucum* (Brauer, 1865), *O. pruinosum neglectum* (Rambur,1842), *O. triangulare triangulare* (Selys,1878), *Palpopleura sexmaculata sexmaculata* (Fabricius,1787), *Pantala flavescens* (Fabricius,1798), *Sympetrum decoloratum* **(**Selys, 1884) and *S. haematoneura* (Fraser, 1924). Whereas, sub order Zygoptera was resulted into 03 families viz., Calopterigidae with single genus and species i.e., *Neurobasis chinensis chinensis* (Linnaeus, 1758). While family Chlorocyphidae was included into single genus under two species *i.e. Rhinocypha quadrimaculata* (Selys, 1853) and *R. unimaculata* (Selys, 1853). Whereas Chlorolestidae was recorded under single genus and species i.e., *Megalestes major* (Selys, 1962). Family Libellulidae was found most dominated with a percentage of (74%) followed by family Chlorocyphidae and Calopterigidae along with percentage (11%) and (7%) respectively. Whereas family Aeshnidae were found least abundant having (2%) presented in (Fig. 2).

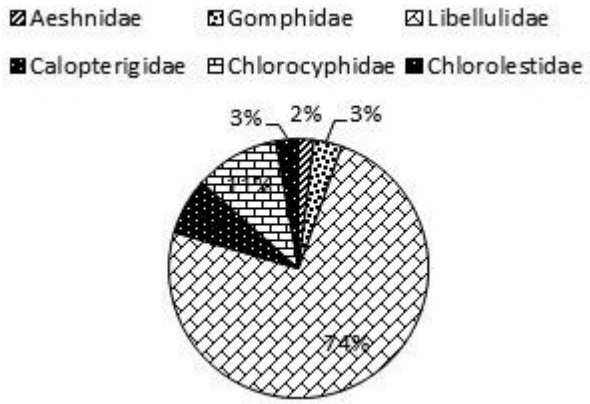

Figure 2. Abundance of Odonata families of Tanawal region of district Mansehra during 2016 -2018.

Genus *Orthetrum* dominated with percentage 51% followed by genera were *Rhinocypha, Neurobasis* and *Pantala* with percentage 11%, 7% and 7% respectively. While least abundant genus was *Sympetrum* having percentage 2% shown (Fig. 3).

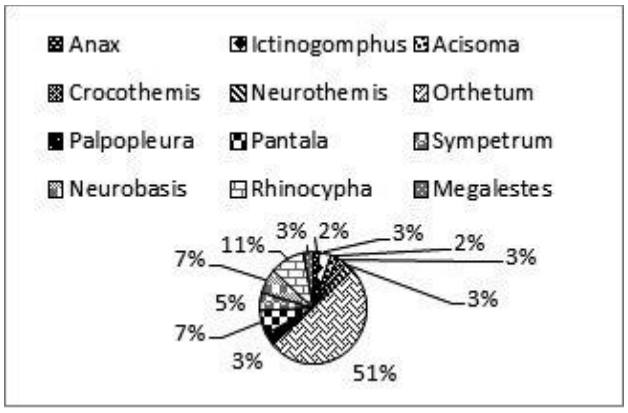

Figure 3. Abundance of Odonata genera of Tanawal region of district Mansehra during 2016-2018

Richness at different localities for all recorded species was also calculated and shown in (Table1). It is evident that highest richness is observed at Galli badaral (12.47%) followed by Shungli (12.00%) and Phulra (11.29%) respectively. However lowest richness was recorded at locality Lassan (4.47%). Species abundance was calculated for all recorded species. Among these *O. triangulare triangulare* dominated with a percentage of (18.11%) followed by *O. pruinosum neglectum* (16.47%), *Neurobasis chinensis chinensis* (7.05%) and *Rhinocypha quadrimaculata* (5.88%)*,* respectively. While lowest abundance was observed for *Ictinogomphus rapax (*1.41%).

Canonical correspondence analysis (CCA) was done on Odonates species to confirm the effect of environmental factors. For this purpose eleven (11) variables were studied i.e., temperature (C°), relative humidity (%), rain fall (mmh^{-1}), wind speed (mph), submerged vegetation (0 for absent of aquatic plants at the visited locality, 1 for present of aquatic plants at visited locality), sunny biotopes (types of space where sunlight persist most of the day), altitude (m), latitude (degree), longitude (degree), shade and moisture (g/m^3). All Odonata species were found strongly associated with submerged vegetations which found around river and water bodies. Anisoptera species were seen usually associated with sunny biotopes while Zygoptera species mainly associated with shade. Two species i.e. *O. triangulare triangulare* and O. *pruinosum neglectum* showed positive association with temperature. A Zygoptera species *Megalestes major* was found to inhabit with moisture. Relative humidity was observed as a strong influenced factor on population growth of both Anisoptera and Zygoptera. Latitude and longitude were not found to influence the population of Odonata while increase in altitude, reduced the population of Odonata. However, wind speed and rain fall negatively associated with Odonates population (Fig. 4).

Table 1. Abundance of Odonata in different localities of Tanawal District Mansehra during 2016 -2018.

Localities and material examined		Geographic information		
Localities	No.of specimens	Lat.'	Long.'	Elev. m
Karori	38 (8.94%)	34.45	72.98	1248
Shergarrh	28 (6.59%)	34.42	73.02	1160
Darband	12 (2.82%)	34.48	72.92	522
Parhinna	32 (7.53%)	34.39	73.48	1536
Shungli	51 (12.0%)	34.42	72.95	1525
Lassan	19 (4.47%)	34.38	72.94	796
Chansair maira	39 (9.18%)	34.36	72.86	1309
Phulra	48 (11.29%)	34.28	72.98	911
Gujjra	28 (6.59%)	34.28	73.02	829
Galli badral	53 (12.47%)	34.33	73.06	1328
Seri	37 (8.70%)	34.32	73.07	1593
Sawnmaira	40 (9.41%)	34.43	72.95	788

Lat.=Latitude, Long.=Longitude, Elev.=Elevation, m=meter and in parenthesis indicated the relative richness

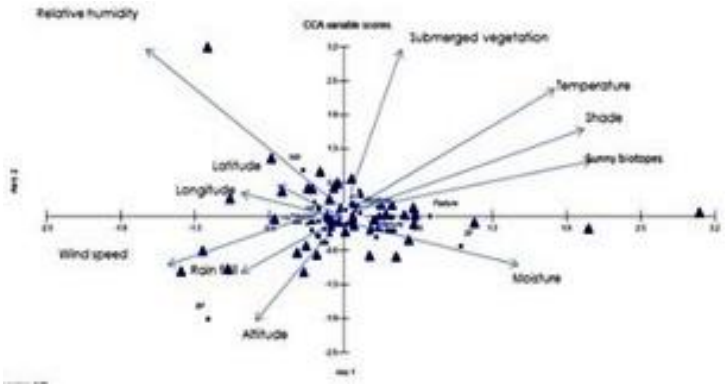

Figure 4. Canonical Correspondence Analysis (CCA) showing the effect of environmental factors on distribution of Odonata in Tanawal region of district Mansehra during 2016-2018.

Cluster analysis presented the relationship among Odonata species on the basis of habitat preference of different species on selected sites. Odonata were co-related on the basis of morphological and ecological characters. All species were clustered into 2 groups I and II, group -I further sub divided into four sub groups, sub group IA consists Aeshnids and Gomphids dragonfly species while sub group IB comes up with genera *Crocothemis, Neurothemis* and one species of *Orthetrum*. Sub group IC clustered in to all *Orthetrum* species whereas sub group ID clustered in to genera *Palpopleura, Pantala* and *Sympetrum*.Group II comes up with all Zygoptera species (Fig.5).

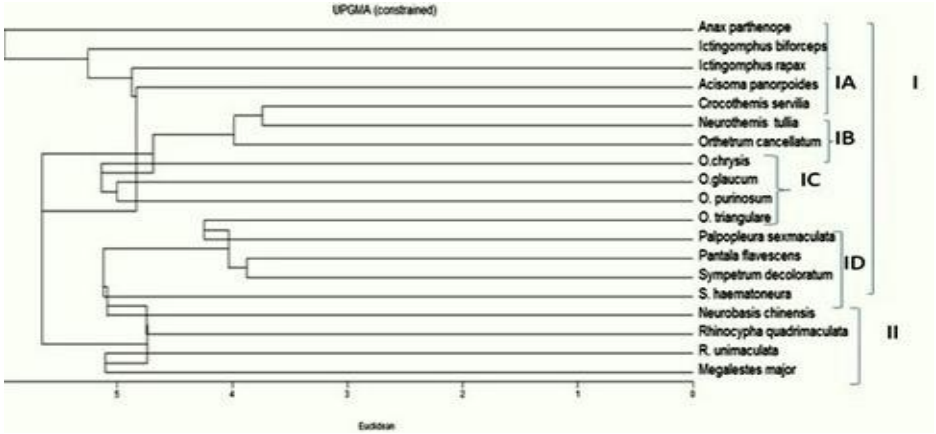

Figure 5. Cluster Analysis (CA) based on Euclidean distance showing relationship and Preference of Odonata species with selected localities of Tanawal region of district Mansehra during 2016-2018.

DISCUSSION

Current research work is the first attempt on Odonata fauna in Tanawal region of district Mansehra. From Pakistan a record of 121 species of Odonata is currently known (Chaudhry, 2010; Zia, 2010; Zia *et al.,* 2009; Din, 2012; Ahmad, 1994; Adnan, 2010; Raza, 2016; Akhtar, 2014 and Seyab *et al.,* 215). However, the areas under administrative boundaries of Hazara division especially of district Mansehra remain neglected and over looked. Till date studies are only available on records that includes some information for the Odonata fauna of District Mansehra includes work of Khaliq *et al.* (1992) who reported six dragonfly species from Mansehra while Chaudhry (2010) reported only single species without mentioning details for 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 distribution and abundance in studied areas. However, in present study repeated surveys were conducted every month and every season during three consecutive years i.e., 2016-2018 to bring forth a clear picture for dragonflies' distribution and abundance.

During present work, Libellulidae dominated with a percentage of 74% whereas Family Aeshnidae was found least abundant having 2%. In term of Genus *Orthetrum* dominated with percentage 51% while least abundant genus was *sympetrum* having percentage 2%. Highest richness is observed at Galli badaral (12.47%) followed by Shungli (12.00%) and Phulra (11.29%) respectively. However lowest richness was recorded at locality Lassan (4.47%). It is important to mention that the locality Lassan being nearer to urbanized areas showed lowest abundance diversity as Odonata life get affected by human activities and habitat disturbances. While the localities showing highest abundance, diversity were far away from populated areas, human activities and habitat there was thus least disturbed. Therefore, dragonflies are taken as popular indicators of climate change and environmental variations (Mehmood, 2016; Zia 2011b). Priorities for identifying species of Odonata are needed to improve by monitoring, surveys and focused research on environmental factors affecting their population in Pakistan.

Odonata were strongly associated with submerged vegetation which found around river and water bodies, which prevent soil from erosion (Heywood, 1993; Franco and Afonso, 2003). Odonata used submerged vegetation as sites for oviposition and their inflexible stems provide a substrate for Odonata nymphs in last instars leaves the water, climbing and dry their wings and abdomen (Thompson *et al.,* 2003; Rouquette and Thompson, 2007). Adult Zygoptera as Caloptrigids were strongly associated with submerged vegetation (Rouquette and Thompson, 2007). Outcomes of the current research work that submerged vegetation is providing protection to dragonflies from predators and other climate conditions. Findings of the present research work were similar to the results of Sato and Riddiford (2007) and (Khaliq and Maula, 1999). A strong association was recorded between submerged vegetations and Zygoptera species. The CCA indicated correlation between shade and Zygoptera species. Dragonflies regulated body temperature exothermically through solar imputed and their thermoregulation is accomplished by behavior and physiological reactions (Corbet, 1999). Therefore, outcomes of the present studies were similar as recorded by Remsburg *et al.* (2008). It is observed that shade reduced Anisoptera habitat preference which is in accordance with the records of Hofmann and Mason, (2005). According to the findings of Samways and Steytler (1996) that Water temperature and shade are the most important environmental variables for Anisoptera and Zygoptera. However, the current study revealed that two suborders responded differently, Zygoptera species reflected greater ecological diversity and they were collected at localities with mostly shaded, whereas Anisoptera species were recorded in sunny biotopes. However, present study showed that submerged vegetation and shade were the most important environmental variables.

Acknowledgement: Author thank to Dr. Inamullah, Associate Professor, Department of Genetics Hazara University for their contribution towards statistical analysis of data.

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