Online ISSN: 2588-3526

Journal of Wildlife and Biodiversity

Volume 9(4): 104-122 (2025) (http://www.wildlife-biodiversity.com/)

Research Article

Diversity, distribution, and habitat preference of dragonfly (Odonata) in District Mardan, Khyber Pakhtunkhwa, Pakistan

Seemab[1], Sobia Attaullah[1], Sanaullah Khan[2], Mujeeb Ullah[1*]

[1]Department of Zoology, Islamia College University, Peshawar
[2]Institute of Zoological Science, University of Peshawar
*Email: mujibkhanicp@gmail.com

How to cite: Seemab, Attaullah, S, Khan, S., Ullah, M. (2025). Diversity, distribution, and habitat preference of dragonfly (Odonata) in District Mardan, Khyber Pakhtunkhwa, Pakistan, Journal of Wildlife and Biodiversity, 9(4), 104-122. DOI: https://doi.org/10.5281/zenodo.18208780

Abstract

Dragonflies are recognized as flagship species in freshwater conservation and act as a bio-control agent of important pests. To update existing information on the species composition, diversity and abundance in district Mardan, this study was carried out from March 2022 to October 2024. The total of 2240 collected specimens was identified into 23 species belonging to 14 genera and 4 families. Libullidae was the predominant family with 13 genera and 19 species; *Orthetrum purinosum neglectum, Orthetrum coerulescens anceps, Orthetrum triangulare, Orthetrum cancellatum cancellatum, Orthetrum Chrysostigma luzonicum, Orthetrum chrysis, Orthetrum Sabina, Trithemis festiva, Trithmis aurora, Trithemis kirbyi, Neurothemis tulia tulia, Neurothemis fluctuans, Brachythemis contaminate, Pantala flavescens, Acisoma panorpoides, Crocothemis serivilia, Sympetrum hypomelas, Diplocodes lefebrvei* and *Palpopluera sexmaculata,* followed by Gomphidae with two genera and two species: *Onychogomphus bristigatus and Ictinogomphus angulosus*. The rest of the two families, Aeshnidae and Cordulliidae, each comprised of a single species and a single genus: *Anax immaculifrons* and *Macromia moorei. Orthetrum purinosum neglectum* was reported as the most dominant (RA=25%) and constantly distributed species, whereas *Sympetrum hypomelas* was ranked satellite (RA=0.08%) and sporadically distributed species. Among the four tehsils, Rustam was found to be the most diverse in terms of the highest number of species (23), Simpson diversity index I-D (0.8818), Shannon diversity index H (2.51302), Evenness index E (0.801475), and Margelaf Richness index D (3.350969). Preferred

habitats of various dragonfly species were also analyzed. Keeping in mind the declining diversity of dragonflies due to habitat destruction, an extensive study needs to be carried in the study area to focus on the habitat preferences and conservation of different dragonfly species.
Keywords: Dragonfly, distribution, habitat preference, district Mardan, Khyber Pakhtunkhwa, Pakistan

Introduction

Dragonflies belong to sub sub-suborder Anisoptera of the order Odonata and class Insecta with approximately 3092 species. Dragonflies are large to medium-sized, often colorful, diurnal insects whose adults are efficient fliers (May, 2019). Their bodies are recognized by a slender abdomen, large globular eyes, short antennae, and long wings, either hyaline or provided with colored patterns (Bibi et al., 2020). Their separated eyes and dissimilar wing pairs distinguish them from damselflies (the word aniso means unequal) (Masih & Pathak, 2022). The order Odonata comprises 6313 species and 600 genera globally distributed among the three sub-orders: Anisoptera (the more robust dragonflies with approximately 3092 species), Zygoptera (the delicate damselflies with almost 3217 species), and Anisozygoptera (primitive dragonflies with 4 species). The 3092 species of dragonflies fall under 344 genera and 11 families (May, 2019). Important families are: Aeshnidae, Austropetaliidae, Chlorogomphidae, Cordulegastridae, Corduliidae, Gomphidae, Libellulidae, Macromiidae, Neopetaliidae, Petaluridae, and Synthemistidae (Ballare & Ware, 2011). Just three families, the Aeshnidae, Gomphidae, and Libellulidae, together constitute about three-fourths of the total number of anisopterous species (Misof, 2002) With Libellulidae being the largest, having more than 1000 species (Nur-ul-Islam et al., 2021).

Odonates can be found on every continent except Antarctica. Tropics have a high number of species and families compared to temperate regions (Bomphrey et al., 2016). They exhibit incomplete metamorphosis, and the life history can be covered in three stages, i.e., egg, nymph, and adult. Most of their lifetime is spent in the larval stage, inhabiting water bodies (both running and standing) and becoming visible only when they emerge from the water as winged adults upon the arrival of spring or summer (Tennessen, 2009). Adults can be seen wandering around lakes, rivers, ponds, streams, rice fields, or even abandoned agricultural land (Ware et al., 2007).

Both the larvae and adults are general predators (May, 2019). Their larvae act as bio-control agents feeding on several insect larval stages, such as tsetse fly, white flies, and mosquito larvae, and thus help to control many vector-borne diseases like malaria, dengue, filarial, etc (Nur-ul-Islam et

al., 2021). *Crocothemis serivilia* larvae have been reported to feed upon larvae and adults of *Aedes aejepti* mosquito (Sebastian et al., 1990) and larvae of *Hemianax ephipiger* control the snail population, an intermediate host for the human parasite, schistosomes (Younes et al., 2016). Larvae of dragonflies serve as food for freshwater fishes, and adults are consumed by songbirds. Anisopterans are utilized in the treatment of sore throat and the preparation of eye ointments (Usman et al., 2017)

Dragonflies are recognized as flagship species in freshwater conservation (Hart et al., 2014). They are employed as an environmental quality assessment tool, as they are vulnerable to even small-scale climate changes in their habitat (Noor-Ul-Islam et al., 2021). Their abundance in aquatic ecosystems is significantly affected by water quality, urbanization, industrialization, and the use of chemical fertilizers. These habitat-destroying activities have caused a serious decline in dragonfly diversity has been observed worldwide in the past few decades (Khan et al., 2022)
In a survey conducted all across Pakistan, a total of 68 species belonging to 05 families, 39 genera were reported by Chaudhry et al., (2016). *Sympetrum hypomelas* (Selys, 1884) was added to the Anisopteran fauna of Pakistan for the first time from the district of Swabi of Khyber Pakhtunkhwa by Nur-ul-Islam et al., (2021). Similarly, Zia et al., (2024) described the Anisoptera fauna of Pakistan to now reach a total of 74 species with the addition of *Aeshna mixta* from the Neelum valley of Kashmir. The current study aimed to study the biodiversity, distribution, and habitat preference of dragonfly fauna in District Mardan, Khyber Pakhtunkhwa, Pakistan.

Material and methods

Study Area

This present research study was conducted in District Mardan (34.20 0N and 72.05 0E, 1632 km^2 area) of Khyber Pakhtunkhwa, Pakistan. This is an important district of the province in terms of its widespread plains extensively utilized for agriculture and horticulture, and a variety of water bodies, which have provided unlimited habitats for aquatic animals. In its North, Mardan shares its border with Malakand district, in the south with the District Swabi, in the east with Buner, and in the west with Nowshera. The district is administratively divided into five Tehsils: Takht Bhai, Mardan, Katlang, Rustam, and Ghari Kapora. This area experiences an annual precipitation of

approximately 599 millimeters with a 22 °C average annual temperature, and is characterized by extreme summers and winters (Younas et al., 2024).

Study Period

The survey was carried out from March 2022 to October 2024, and adult dragonflies were caught from 9:00 AM to 5:00 PM in the hot months of the year.

Collection Sites

Dragonfly specimens were randomly collected from 36 locations in four Tehsils of District Mardan (Tehsil Takht Bhai, Tehsil Mardan, Tehsil Katlang, and Tehsil Rustam). During the study period, different habitats were surveyed, including ditches or agricultural canals, riparian land associated with slow-flowing streams, ponds, rice fields, open abandoned fields, and around small waterfalls in the foothills.

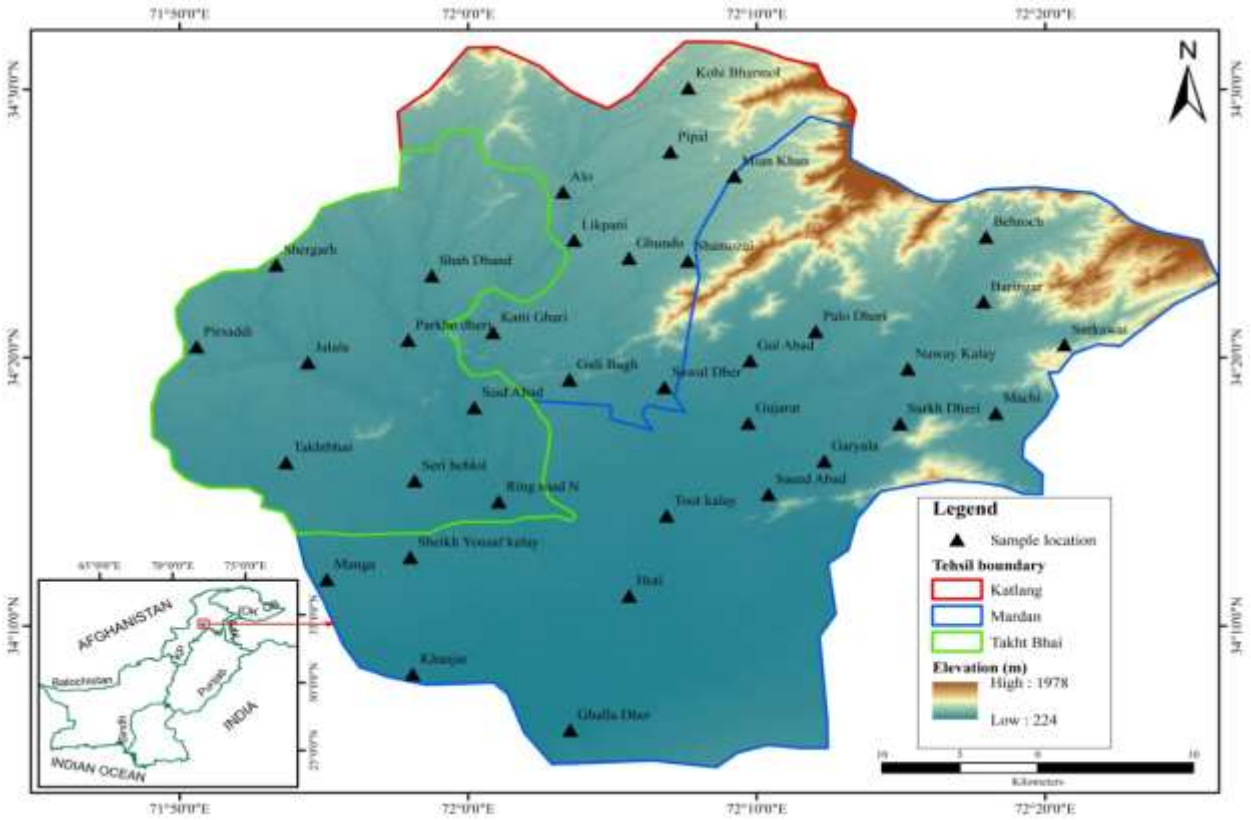

Figure 1. Map of the study area

Collection, Labelling, and Morphometric Measurements

Adult flies were captured from 36 different localities, mostly through hand picking and aerial net, and killed in a cyanide bottle for up to 30 minutes. Once dried out, proper labelling was done (time and date, locality name, and habitat details). Full body measurement from head to the last abdominal segment, length of fore-wings and hind-wings from the base to the tip were calculated manually using a scale in the units of millimeters.

Identification and Preservation

After that, mounting in insect boxes was carried out with wings open, straightened abdomens, and forwardly directed legs, and secured for morphological examination. The specimens were preserved in dry form in insect boxes, which were secured from pest attack by placing naphthalene balls and ant-killing powder was sprinkled inside the boxes as per (Chaudhry et al., 2016). Proper examination of dragonflies was done under an OLYMPUS (SZ2-ILST) stereoscope. Identification based on morphology was performed up to the species level using the work of Fraser, (1934-36) and Chaudhry et al., (2016).

2.4 Data Analysis

The distribution and Relative abundance of different species in the surveyed area were calculated using the equations as per. Dolai et al., (2023):

Relative abundance R = I/L x 100. Here, I symbolize the number of specimens of species collected, whereas L implies the total specimen of all species. Species are classified as; **Satellite** (with R < 1%), **subdominant** (R < 5%), and **dominant** (R > 5%).

Distribution (C) =n/N×100. Here N stands for total collection sites covered, whereas n represents the number of sites of that particular species. Species were ranked as **Sporadic** C1 with a percentage ranging from 0-20, **infrequent** C2 for a distribution of 20.1-40%, **moderate** C3 for 40.1-60%, **frequent** species C4 for ones having a percent distribution of 60.1-80% and finally species with 80.1-100% frequency are marked as **constant** C5.

The following biodiversity indices were calculated across sampling sites (Younas et al., 2024):

Simpson diversity index, **SDI=1-n-**$\sum$n (n-1)/N (N-1) where n=number of specimens of that particular species and N=total number of specimens of all species collected in the study area.

Shannon diversity index H = -∑ (pi Ln pi. Here specimen of that particular species/total specimen of all species, and Ln=natural log

Evenness index E = H/Ln S. Here S is the number of all species present in the study area.

Margelaf species Richness index, D = S-1/Ln N, where S is the number of all Species and N is the total number of specimens of all species recorded in the area.

Results

In the current survey, 2,240 specimens of dragonflies were identified into 23 species falling under 14 genera and 4 families. The most predominant family was Libullidae with 19 species and 13 genera, followed by the family Gomphidae represented by two genera and two species. The rest of the two families, Aeshnidae and Cordulliidae, each comprised of single species and a single genus. The detailed checklist of the recorded species is given in Table 1.

Table 1. Checklist of dragonfly species recorded in the study area

S.no	Family	Genus	Species
1	Libullidae	Orthetrum	*Orthetrum purinosum neglectum*
2			*Orthetrum coerulescens anceps*
3			*Orthetrum triangulare*
4			*Orthetrum cancellatum cancellatum*
5			*Orthetrum Chrysostigma luzonicum*
6			*Orthetrum chrysis*
7			*Orthetrum Sabina*
8		Trithemis	*Trithemis festiva*
9			*Trithemis aurora*
10			*Trithemis kirbyi*
11		Neurothemis	*Neurothemis tulia tulia*
12			*Neurothemis fluctuans*
13		Brachythemis	*Brachythemis contaminata*
14		Pantala	*Pantala flavescens*
15		Acisoma	*Acisoma panorpoides*

16		Crocothemis	*Crocothemis servilia*
17		Sympetrum	*Sympetrum hypomelas*
18		Diplocodes	*Diplocodes lefebrvei*
19		Palpopluera	*Palpopluera sexmaculata*
20	Gomphidae	Onychogomphus	*Onychogomphus bristigatus*
21	-	Ictinogomphus	*Ictinogomphus angulosus*
22	Aeshnidae	Anax	*Anax immaculifrons*
23	Cordulliidae	Macromia	*Macromia moorei*

Family Libullidae and Gomphidae were recorded from all four tehsils of the district, with the highest specimen frequency from Tehsil Rustam. Family Aeshnidae was recorded from Tehsil Katlang and Rustam. Whereas the family Cordulliidae was reported only from Rustam. The highest occurrence frequency of 31.25% (710 specimens) was recorded for tehsil Rustam, followed by Katlang with 28.6% frequency (641), then Takhtbhai with 26.6% (586 specimens), and tehsil Mardan with the least number, 13.5% (303) of dragonfly specimens collected. The detail was depicted in Figure 1.

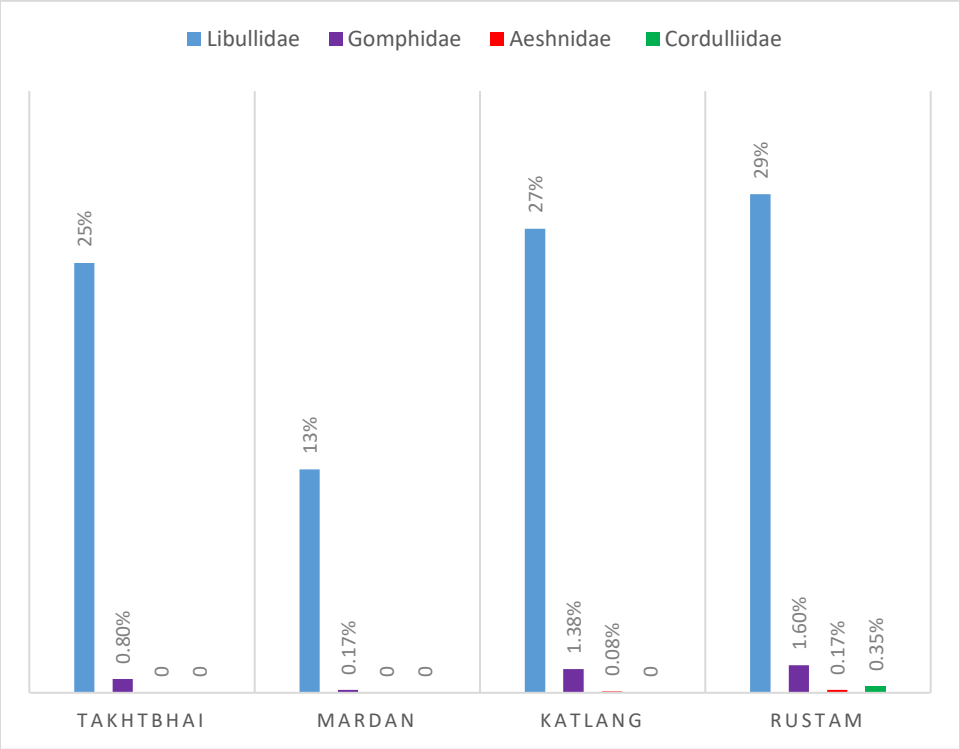

Figure 1. Specimen count of dragonflies by families and Tehsils of District Mardan

Of these, 6 species; *Orthetrum purinosum neglectum, Trithmis aurora, Neurothemis fluctuans, Pantala flavescens, Crocothemis serivilia,* and *Diplocodes lefebrvei* exhibited constant distribution C values (80.1-100%) while 4 species; *Neurothemis tulia tulia, Sympetrum hypomelas, Anax immaculifrons,* and *Macromia moorei* showed sporadic distribution (C=0-20%). Distribution values of 3 species: *Orthetrum triangulare triangulare, Trithemis kirbyi kirbyi,* and *Palpopluera sexmaculata* came under the range of "infrequent" (C=20.1-40%). The remaining ten species showed frequent and moderate distribution status as illustrated in Table 2. Similarly, *Orthetrum triangulare triangulare, Trithemis kirbyi kirbyi, Neurothemis tulia tulia, Sympetrum hypomelas, Palpopluera sexmaculata, Anax immaculifrons,* and *Macromia moorei* were ranked as satellite species (R<1%) in terms of Relative abundance, whereas *Orthetrum purinosum neglectum, Trithemis aurora, Neurothemis fluctuans, Brachythemis contaminata, Crocothemis serivilia,* and *Diplocodes lefebrvei* showed dominant status (R>5%). The remaining 10 species showed sub-dominant status (R <5%) respectively. *Orthetrum pruniosum neglectum* was recorded to be the most predominant species with an abundance of 25 %, followed by *Diplocodes lefebrvei* with an abundance of 18.5% (Figure 2)

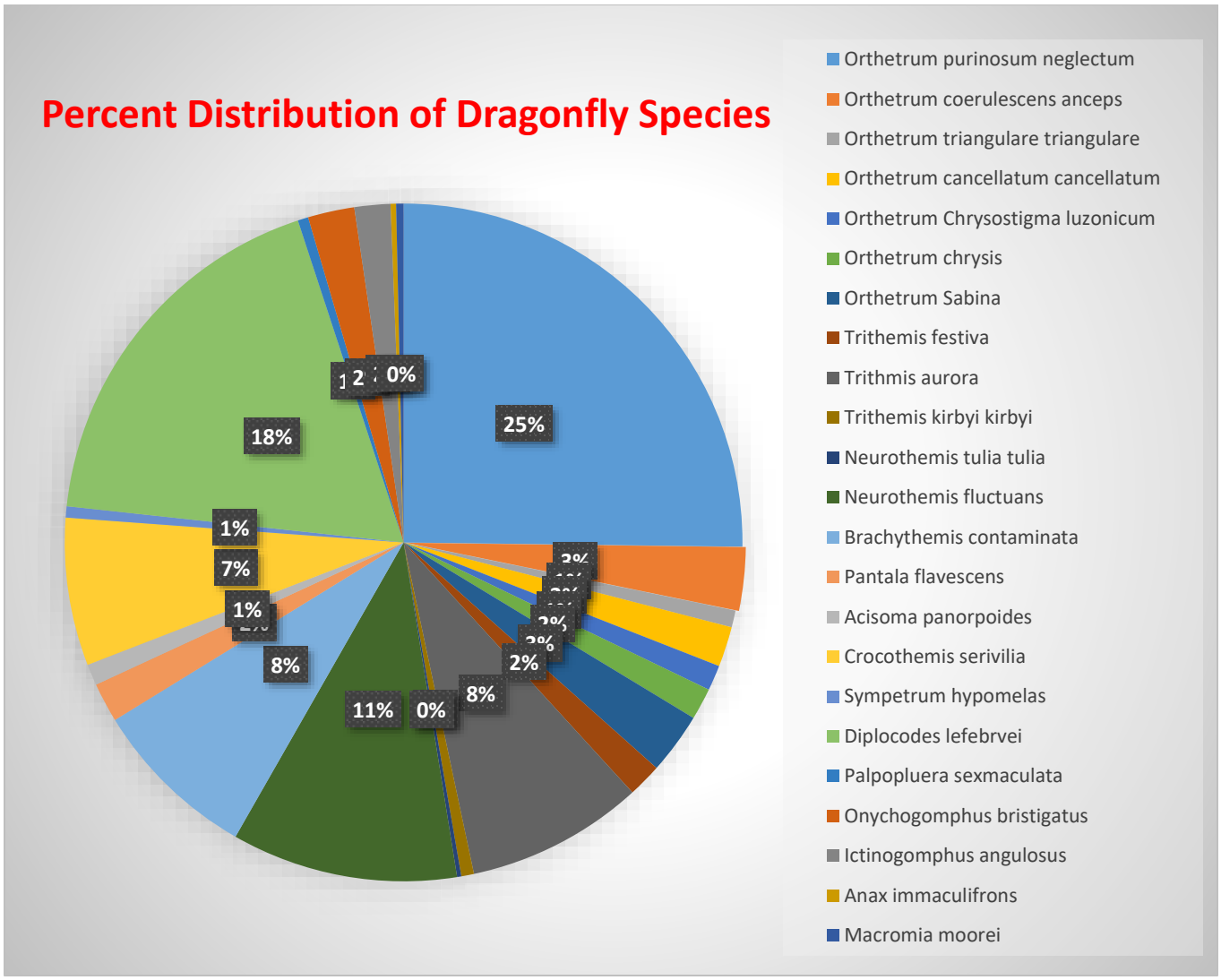

Figure 2. Percent distribution of dragonfly species in the study area

Table 2. Distribution and Relative abundance of dragonfly fauna in District Mardan

Species	**(n)**	**(C)**	**Status of C**	**(I)**	**R**	Status of **R %**
Orthetrum purinosum neglectum	37	100	Constant	562	25.08	Dominant
Orthetrum coerulescens anceps	20	54.05	Moderate	69	3.08	Sub-dominant
Orthetrum triangulare triangulare	9	24.32	Infrequent	18	0.80	Satellite
Orthetrum cancellatum cancellatum	20	54.05	Moderate	43	1.91	Sub-dominant

Orthetrum Chrysostigma luzonicum	16	43.24	Moderate	27	1.20	Sub-dominant
Orthetrum chrysis	16	43.24	Moderate	34	1.51	Sub-dominant
Orthetrum Sabina	27	72.97	Frequent	65	2.90	Sub-dominant
Trithemis festiva	21	56.75	Moderate	36	1.60	Sub-dominant
Trithmis aurora	34	91.8	Constant	190	8.48	Dominant
Trithemis kirbyi kirbyi	9	24.32	Infrequent	14	0.62	Satellite
Neurothemis tulia tulia	5	13.51	Sporadic	6	0.26	Satellite
Neurothemis fluctuans	37	100	Constant	241	10.75	Dominant
Brachythemis contaminata	29	78.37	Frequent	178	7.94	Dominant
Pantala flavescens	35	94.59	Constant	42	1.87	Sub- dominant
Acisoma panorpoides	18	48.64	Moderate	23	1.02	Sub- dominant
Crocothemis serivilia	37	100	Constant	157	7.00	Dominant
Sympetrum hypomelas	1	2.70	Sporadic	2	0.08	Satellite
Diplocodes lefebrvei	37	100	Constant	416	18.57	Dominant
Palpopluera sexmaculata	9	24.32	Infrequent	13	0.58	Satellite
Onychogomphus bristigatus	26	70.27	Frequent	50	2.23	Sub- dominant
Ictinogomphus angulosus	17	45.94	Moderate	40	1.78	Sub- dominant
Anax immaculifrons	4	10.81	Sporadic	6	0.26	Satellite
Macromia moorei	3	8.10	Sporadic	8	0.35	Satellite

Table description: Collection sites (n), distribution C=n/N×100 %, Status on the basis of C %, number of specimen (I), relative abundance R=I/L×100 %, relative abundance Status

Tehsil Rustam of the study area was found to be the most diverse in terms of highest number of species (23), Simpson diversity index (0.8818), Shannon diversity index (2.51302) Evenness index (0.801475) and Margelaf Richness index (3.350969) followed by Katlang with 20 species, Simpson index of 0.86927, Shannon index of 2.3633, Evenness index of 0.788889 and Margelaf Richness index of 2.939798, followed by Takhtbhai with a total of 19 species, Simpson diversity index value of 0.86055, Shannon index 2.31251, and Evenness 0.78538, and Margelaf Richness index of 2.824274. Mardan was found to be the least diverse with 17 recorded species and the least calculated values of Simpson diversity index (0.83431), Shannon diversity index (2.13603), Evenness index (0.753925) and Margelaf richness index (2.800271) (table 3).

Table 3. Diversity indices of different parts of the study area

Study Area	(S)	(N)	(I-D)	(H)	(E)	D=S-1/LnN
Takht bhai	19	586	0.86055	2.31251	0.78538	2.824274
Mardan	17	303	0.83431	2.13603	0.753925	2.800271
Katlang	20	641	0.86927	2.3633	0.788889	2.939798
Rustam	23	710	0.8818	2.51302	0.801475	3.350969

No of species (S), No of specimens (N), Simpson Diversity Index (I-D), Shannon Diversity Index (H), Evenness Index (E), Margalef Richness index D=S-1/LnN.

Six different habitats were periodically surveyed for the collection of dragonflies. Table 4 illustrates the habitat preference of different species in 6 different habitats, including ditches/ agricultural canals, slow-flowing streams, ponds, rice fields/marshes, abandoned or destroyed lands, and waterfalls in the vicinity of hills. Some species were found to have generalized habitat, whereas others, such as *Sympetrum hypomelas*, *Anax immaculifrons,* and *Macromia moorei,* were found associated with water bodies in the vicinity of hills

Table 4. Habitat preference of different dragonfly species

Family	Species	Agricultural canals/ditches	Slow-flowing Stream	Pond	Rice fields	Abandoned fields	Waterfall/vicinity of hills	Total
Libullidae	*Orthetrum purinosum neglectum*	103	98	110	109	102	40	562
	Orthetrum coerulescens anceps	13	21	14	06	09	06	69

	Orthetrum triangulare	-	09	02	-	03	04	18
	Orthetrum cancellatum cancellatum	03	08	13	16	03	-	43
	Orthetrum Chrysostigma luzonicum	-	09	08	04	06	-	27
	Orthetrum chrysis	06	10	11	03	04		34
	Orthetrum Sabina	05	16	16	19	09		65
	Trithemis festiva	06	13	08	07	02		36
	Trithemis aurora	26	56	41	38	29	-	190
	Trithemis kirbyi	-	03	04	02	05		14
	Neurothemis tulia tulia	-	-	-	06	-	-	06
	Neurothemis fluctuans	87	66	42	21	23	02	241
	Brachythemis contaminata	53	15	45	41	24		178
	Pantala flavescens		14	11	10	04	03	42
	Acisoma panorpoides	-	11	06	06	-	-	23
	Crocothemis serivilia	23	36	42	33	17	06	157
	Sympetrum hypomelas	-	-	-	-	-	02	02
	Diplocodes lefebrvei	62	98	91	101	64	-	416
	Palpopluera sexmaculata	05	03	03	02	-	-	13
Gomphidae	*Onychogomphus bristigatus*	01	13	09	06	21		50
	Ictinogomphus angulosus	11	03	05	05	16		40
Aeshnidae	*Anax immaculifrons*		02 hills				04 hills	06
Cordulidae	*Macromia moorei*	-	05 forests	03	-	-	-	08
Total		404	509	484	435	341	67	2,240

Discussion

District Mardan has wide-ranging landscapes from plain agricultural fields to hilly areas and a variety of fresh water sources. These water bodies and the associated terrestrial zones provide favorable habitats for dragonfly fauna. Despite being rich in suitable habitats, the odonatological record of Pakistan in general and KP in particular is very poor. The present study was designed to assess the diversity of dragonfly fauna in District Mardan, KP, for a period of two and a half years (from 2022 to October 2024).

The 23 identified species belonged to 14 genera and 4 families. The most predominant family was Libullidae with 19 species and 13 genera, followed by the family Gomphidae with two genera and two species. The rest of the two families, Aeshnidae and Cordulliidae, each comprised of single species and a single genus. All the species in our results, except *Sympetrum hypomelas,* have been reported by Chaudhry et al., (2016) from several localities of Pakistan. *Sympetrum hypomelas* was added to the Anisopteran fauna of Pakistan in by Nur-ul-Islam et al., (2021).

In the same way, a research survey carried out (Khan & Zia, 2016) in Buner, one of the adjacent districts to Mardan in 2016 described 11 species: *Orthetrum purinosum neglectum, Orthetrum coerulescens anceps, Orthetrum triangulare, Orthetrum Sabina, Trithemis aurora, Trithemis festiva, Sympetrum commixta, Pantala flavescens, Palpoleura sexmaculata, Onychogomphus bistrigatus,* and *Anax immaculifrons.* Rehman et al. (2020) covered the Anisopteran diversity of Swabi, another adjacent district to Mardan, and found twenty-three species falling under fifteen genera and three families. These included; *Burmagomphus sivalikensis, Onychogomphus bristigatus and Ictinogomphus angulosus* from family *Gomphidae, Anax parthenope* from family Aeshnidae*, Acisoma panorpoides panorpoides, Zygonyx torrida isis, Zyxomma petiolatum, Orthetrum pruinosum neglectum, Orthetrum triangulare triangulare, Orthetrum sabina, Orthetrum coerulescens anceps, Sympetrum commixtum, Sympetrum decoloratum, Diplacodes lefebvrei, Diplacodes trivialis, Palpopleura sexmaculata sexmaculata, Pantala flavescens, Trithemis festiva, Trithemis aurora, Trithemis kirbyi kirbyi, Brachythemis contaminata, Crocothemis erythraea* and *Crocothemis servilla* from family Libullidae. Khan et al., (2022) identified 12 species of dragonfly from district Mardan: *Orthetrum coerulescens anceps, Orthetrum pruinosum neglectum, Orthetrum sabina, Orthetrum Chrysostigma luzonicum, Orthetrum chrysis, Trithemis festiva, Trithemis aurora, Thrithemis kirbyi kirbyi, Brachythemis*

contaiminata, and *Tramea Virginia,* from family Libullidae; two species: *Ictinogomphus angulosus and Onychogomphus bistrigata* from family Gomphidae.

The findings of the current study revealed Libullidae to be the predominant family both in terms of species richness/number of species and abundance of 95% (19 identified species under 10 genera and a total of 2,136 specimens). In the same way, Libullidae was reported to be the predominant dragonfly family by several researchers from Pakistan and KP (Chaudhry et al., 2016, Zia et al., 2019, Rehman et al., 2020, Khan et al., 2022 Rafique et al., 2022). Family Gomphidae was found to stand second in terms of richness and abundance of 4% (2 species under two genera and a total of 90 captured adults). These species have previously been documented from Mardan (Khan et al., 2022), Buner (Khan & Zia, 2016), Neelum Valley, Azad Jammu and Kashmir (AJK) (Jahangeer et al., 2025) along with *Burmagomphus sivalikensis* from the district of Swabi (Rehman et al., 2020) And *Ictinogomphus ferox* collected from the district of Charsadda (Seyab et al., 2015) Haripur district of Khyber Pakhtunkhwa (Bibi et al., 2020).

The recent survey collected 08 specimens of Corduliidae from the foothills in Tehsil Rustam, which were identified as a single species, *Macromia moorei*. This species was also collected from Azad Jammu and Kashmir (Rashied et al., 2024) and Mardan (Chaudhry et al., 2016). Six individuals of the family Aeshnidae were collected in the present study from the hilly areas of the district. This species has also been reported from the Neelum Valley, AJK, and the Karak district of KP (Usman et al., 2017, Rashied et al., 2024).

The distribution and relative abundance of dragonflies have not been satisfactorily studied in Pakistan. In the current survey, *Orthetrum purinosum neglectum, Neurothemis fluctuans, Crocothemis serivilia, and Diplocodes lefebrvei* were recorded from all sites of the study area and showed 100% distribution, showing their vast adaptability to urban and rural setups. The common red skimmer, *O.purinosum neglectum* was found with constant distribution in Mardan previously as well (Khan et al., 2022). *Trithemis aurora* and *Orthetrum purinosum neglectum* was declared "constant sepcies" in district Buner as well (Jehangir Khan et al., 2016).

Three species in our survey; *Onychogomphus bristigatus, Brachythemis contaminata, Orthetrum Sabina* observed to be "frequent" in distribution and occurrence with a frequency of 60.1-80%. Whereas *Orthetrum coerulescens anceps, Orthetrum cancellatum cancellatum, Orthetrum Chrysostigma luzonicum, Orthetrum chrysis, Trithemis festiva, Acisoma panorpoides and Ictinogomphus angulosus* were declared as "Moderate" with distribution frequency ranging from

40.1 to 60%. These findings were not in agreement with (Jehangir Khan et al., 2016) as *Trithemis festiva* was declared as constant, *Pantala flavescens* as sporadic, and *Onychogomphus bristigatus* as an infrequent species, while describing their distribution in district Buner. *Palpopluera sexmaculata,* proclaimed to the status of "infrequent" with distribution values of 20.1-40%, was in accordance with Khan et al., (2016). Whereas *Orthetrum triangulare triangulare, Trithemis kirbyi kirbyi,* established in this study as infrequent, was not in line with the findings of Khan et al., (2016). Similarly, *Palpopluera sexmaculata* and *Trithemis festiva* were considered infrequent, whereas *Orthetrum triangulare triangulare* was found to be frequently distributed in the Kashmir valley of Pakistan (Rafi et al., 2009). Four species, *Neurothemis tulia tulia, Sympetrum hypomelas, Anax immaculifrons, and Macromia moorei*, exhibited the least distribution frequency (less than 20%) and were classified as "sporadic". *A. immaculifrons* was recorded as sporadic by Khan et al., (2016) as well. Also, *S. hypomelas was* claimed as a rare species and was added as a new record to the dragonfly fauna of Pakistan by Nur-ul-Islam et al., (2021).

In the current study, six species: *Orthetrum purinosum neglectum* (I=562), *Diplocodes lefebrvei* (416), *Neurothemis fluctuans* (I=241), *Trithmis aurora* (I=190), *Brachythemis contaminata* (I=178), and *Crocothemis serivilia (I=157),* were given the status of Dominant with relative abundance more than 5%. *O. purinosum neglectum* was the most predominant one, RA=25%. Similar to the current results, *Orthetrum purinosum neglectum* and *Trithmis aurora were* documented as dominant species from the Buner district (Khan & Zia, 2016). On the contrary, in district Swat KP, *Pantala flavescens* was reported as the most abundant species, followed by *Orthetrum purinosum neglectum*. The same study documented *Trithemis aurora* as a rare species (Attaullah et al., 2021), which was in contradiction to the current findings. Likewise, *O.purinosum neglectum* was reported to be rare in Southern Punjab (Sidra et al., 2022). In contrast to the current results, *Crocothemis serivilia* (RA=1.4) and *Brachythemis contaminata* (RA=0.7) was reported as rare species in Neelum valley of Pakistan (Jahangeer et al., 2025).

As per the results of this study, *Palpopluera sexmaculata* and *Anax immaculifrons* were also revealed as satellite species in Buner (Khan & Zia, 2016). Whereas *Orthetrum triangulare triangulare* was reported as the most abundant and widespread Anisopteran species from Kashmir (Rafi et al., 2009) and sub-dominant from Buner (Khan & Zia, 2016) not in line with our findings. Similar to the findings of this study, *Trithemis festiva* and *Orthetrum Chrysostigma luzonicum* were reported as a subdominant species from Neelum valley, Kashmir, also (Jahangeer et al.,

2025). Conversely, a study previously conducted in similar areas in Mardan district found *Orthetrum coerulescens anceps* as the most abundant and *Orthetrum purinosum neglectum* as the second most abundant (Khan et al., 2022). In contrast to the current results, (Khan & Zia, 2016) from Buner found *Trithemis festiva* to be the most abundant and dominant species.

Generally, the family Libellulidae is one of the largest families dominating standing water and bearing anthropogenic disturbances (Banaybanay et al., 2024). But *Brachythemis contaminata,* commonly known as "ditch jewel," inhabiting ditches, has the capability of tolerating polluted water and inhabiting new habitats (Kaushik et al., 1990, Afnitha, 2021). Similarly, *Trithemis aurora,* commonly found around open standing water bodies, can colonize man-made waters or even disturbed habitats (Adu et al., 2016). Correspondingly, a study in 2018 established that the Crocothemis genus can withstand high levels of salinity, followed by the species of the Orthetrum genus (Zia et al., 2018).

The study area in the present survey was divided into four communities: tehsil Takht Bhai, tehsil Mardan, tehsil Katlang, and tehsil Rustam, and different diversity indices were compared among them. The maximum number of species (S=23), specimens (N=710), and the highest values of Simpson diversity index, Shannon index, Evenness, and Margalef species richness was calculated for the tehsil Rustam. Tehsil Katlang stands second, followed by tehsil Takhtbhai and tehsil Mardan. An increase values of diversity indexes means higher diversity in that area.

All four regions exhibited a moderate level of diversity (Shannon index value ≥2), though the landscape of this area and unlimited freshwater bodies, accompanied by rich vegetation, can support a rich diversity of odonates. Generally, dragonfly diversity was high in pollution-free water with abundant vegetation. Hence tehsil Mardan, being an over-populated urban city has lower diversity as compared to Rustam and Katlang, where the habitats appeared less affected by anthropogenic activities. Similarly, tehsil Takhtbhai also exhibits lower diversity of dragonflies comparatively. The possible reasons most likely are the extensive agricultural practices (sugarcane and tobacco), which resulted in habitat disturbance as chemical fertilizers and pesticides discharge increases water pollution. It has been an established fact that Anisopteran fauna composition can significantly alter as a result of human activities (Banaybanay et al., 2024). Although the results of different diversity indexes calculated in this study is a bit inconsistent with a similar study previously conducted in Mardan (Khan et al., 2022).

Orthetrum purinosum neglectum, the most abundant species, was found to colonize nearly every kind of habitat from filthy ditches to slow-flowing streams, marshy rice fields, and even in the foothills near waterfalls. Whereas *Sympetrum hypomelas,* the rare one, was only found associated with water bodies near the foothills. Similarly, *Anax immaculifrons* and *Macromia moorei* were only found in clear water ponds associated with waterfalls and forested regions in hilly areas. However, the habitat preferences of dragonflies are not studied by many researchers in Pakistan or Khyber Pakhtunkhwa, (Chaudhry et al., 2016) carried out an extensive study and documented dragonfly fauna and its habitat association all over the country. (Jahangeer et al., 2025) gave an account of the diversity and habitat choices of dragonfly species in the Azad Jammu and Kashmir region of Pakistan.

Conclusion

A serious decline in dragonfly diversity has been observed worldwide and in the study area in the past few decades. The major threat to dragonflies' species extinction is habitat destruction, such as urbanization, industrial discharge, accumulation of toxic metals in water bodies, and the use of pesticides in farming (Khan et al., 2022) as well as cutting down of vegetation from nearby water bodies, changing water routes, construction of dams, and many more (Masih & Pathak, 2022). So, it is recommended that an extensive study be conducted in District Mardan to cover the habitat preferences of different dragonfly species and habitat conservation measures to be adopted to conserve the diverse fauna of this order.

References

Adu, B., Kehinde, K. K., & Ogbogu, S. (2016). Monitoring of environmental disturbance using abundance and distribution of red-vein and dark-vein species of genus Trithemis (Odonata: Libellulidae). *Zoologist (The)*, *14*, 31-36.

Afnitha, K. (2021). Odonate Diversity and Their Role as Bio-Indicators.

Attaullah, M., Ullah, I., Ali, M., Maula, F., Ilahi, I., Ahmad, B., Khwaja, S., Ullah, Z., Siraj, M., & Raheel, S. (2021). Diversity of the anisoptera & zygoptera (Odonata: Insecta) of Swat, Pakistan. *Brazilian Journal of Biology*, *83*, e251958.

Ballare, E. F., & Ware, J. L. (2011). Dragons fly, biologists classify: an overview of molecular odonate studies, and our evolutionary understanding of dragonfly and damselfly (Insecta: Odonata) behavior. *International Journal of Odonatology*, *14*(2), 137-147.

Banaybanay, D. P., AMPARADO, O. A., MORILLA, L. J. G., & ESTAÑO, L. A. (2024). Species diversity of Odonata in the urban ecosystem of Iligan City, Philippines. *Biodiversitas Journal of Biological Diversity*, *25*(2).

Bibi, S., Khan, M. F., & Rehman, A. (2020). Dragonfly fauna of district Haripur, Khyber Pakhtunkhwa, Pakistan. *Arthropods*.

Bomphrey, R. J., Nakata, T., Henningsson, P., & Lin, H.-T. (2016). Flight of the dragonflies and damselflies. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *371*(1704), 20150389.

Chaudhry, M. T., Mohsin, A., Shaheen, F. A., Arshad, M., & Zia, A. (2016). Dragonflies (Odonata: Anisoptera) of Pakistan. *Pakistan Journal of Zoology*, *48*(6).

Dolai, S., Mallick, M. A. I., & Ghorai, N. (2023). Diversity and abundance of odonates (dragonflies and damselflies) and lepidopteran (butterflies) fauna of Kalyani Lake park, Nadia district, West Bengal, India.

Fraser, F. C. (1934-36). *The Fauna of British India Including Ceylon and Burma. Vols. 1-3*. Taylor and Francis.

Hart, L. A., Bowker, M. B., Tarboton, W., & Downs, C. T. (2014). Species composition, distribution and habitat types of Odonata in the iSimangaliso Wetland Park, KwaZulu-Natal, South Africa and the associated conservation implications. *Plos one*, *9*(3), e92588.

Jahangeer, M., Awan, M. S., Saleem, M. M., Mughal, T., Arshad, M., Bashir, M., Hussain, A., Ali, U., & Minhas, R. A. (2025). Biodiversity and Spatial Distribution of Dragonflies in the State Biosphere Reserve: Ghamot National Park, Neelum Valley, Pakistan. *Journal of Wildlife and Ecology*, *9*(1), 22-30.

Jehangir Khan, J. K., Saifullah, S., & Ahmed Zia, A. Z. (2016). Biodiversity of dragonflies and their life threatening factors in Tehsil Chamla and Daggar of district Buner, Khyber Pakhtunkhwa, Pakistan.

Kaushik, S., Sharma, S., Saxena, M., & Saksena, D. (1990). Habitat ecology of anisopteran nymphs in certain water bodies of Madhya Pradesh. *Acta hydrochimica et hydrobiologica*, *18*(4), 443-447.

Khan, J., & Zia, A. (2016). Biodiversity of Dragonflies and their Life Threatening Factors in Tehsil Chamla and Daggar of District Buner, Khyber Pakhtunkhwa, Pakistan. *Pakistan Journal of Zoology*, *48*(4).

Khan, K., Shams, N., Rahman, G., Shah, S. U., Ullah, M., Jamal, M., Badshah, N., & Zia, S. A. (2022). Heavy Metals Accumulation in Dragonflies (Insecta: Odonata) and Their Microhabitats in District Mardan, Khyber Pakhtunkhwa, Pakistan.

Masih, S. C., & Pathak, R. K. (2022). Odonate ecology and diversity-A review.

May, M. L. (2019). Odonata: who they are and what they have done for us lately: classification and ecosystem services of dragonflies. *Insects*, *10*(3), 62.

Misof, B. (2002). Diversity of Anisoptera (Odonata): infering speciation processes from patterns of morphological diversity. *Zoology*, *105*(4), 355-365.

Noor-Ul-Islam, H., Khan, K., Zia, S. A., Naeem, M., & Shams, W. A. (2021). Heavy metals accumulation in dragonflies (Odonata) and their habitats in district Swabi, Khyber Pakhtunkhwa, Pakistan: Assessing dragonfly bionomics in the region. *Bulletin of environmental contamination and toxicology*, *107*, 838-847.

Nur-ul-Islam, H., Zia, A., Khan, K., Ali, H., & Aziz, A. (2021). Sympetrum hypomelas (Selys, 1884), an addition to anisoptera fauna of Pakistan. *Pakistan Journal of Agricultural Research*, *34*(3), 538-544.

Rafi, M. A., Khan, M. R., Zia, A., & Shehzad, A. (2009). Diversity of Odonata in district Poonch and Sudhnoti of Kashmir Valley-Pakistan, with a new record for the country. *Halteres*, *1*(1), 28-35.

Rafique, A., Sarwar, Z. M., Ahmad, N., Shami, A., Ali, R., El Hadi Mohamed, F. M. A., Galil, A., & Alam, P. (2022). BIODIVERSITY AND TAXONOMIC STUDY OF ORDER ODONATA FROM DISTRICT MULTAN, PUNJAB, PAKISTAN. *Ann. For. Res*, *65*(1), 1046-1058.

Rashied, S., Zia, A., Minhas, R. A., Aslam, S., Bhatti, A. R., & Ali, G. (2024). Diversity of the Anisoptera and Zygoptera (Odonata: Insecta) of State Biosphere Reserve Neelum of Azad Jammu and Kashmir, Pakistan. *Pakistan J Zool*, 1-7.

Rehman, A., Ahmad, S., Zia, A., Ali, A., Shahjeer, K., Latif, A., & Khan, T. (2020). Dragonflies (Anisoptera: Odonata) fauna of District Swabi Khyber Pakhtunkhwa, Pakistan.

Sebastian, A., Sein, M. M., Thu, M. M., & Corbet, P. S. (1990). Suppression of Aedes aegypti (Diptera: Culicidae) using augmentative release of dragonfly larvae (Odonata: Libellulidae) with community participation in Yangon, Myanmar1. *Bulletin of entomological Research*, *80*(2), 223-232.

Seyab, M., Mehmood, A., Khan, S., & Jan, A. (2015). Exploring the dragonfly Fauna of Tehsil Tangi District Charsadda, Khyber Pakhtunkhwa, Pakistan. *Journal of Entomology and Zoology Studies*, *3*(4), 186-188.

Sidra, S., Mahmood, A., Moavia, M., & Saadaat, H. B. (2022). Anisopteran Diversity in Two Riverine Habitats of Southern Punjab, Pakistan. *Inland Water Biology*, *15*(4), 361-367. https://doi.org/10.1134/S1995082922040411

Tennessen, K. (2009). Odonata: Dragonflies, Damselflies. In *Encyclopedia of insects* (pp. 721-729). Elsevier.

Usman, K., Pervaiz, K., Rehman, H. U., & Mohammad, W. (2017). Exploring of dragonfly fauna in lower region of district Karak KP, Pakistan.

Ware, J., May, M., & Kjer, K. (2007). Phylogeny of the higher Libelluloidea (Anisoptera: Odonata): an exploration of the most speciose superfamily of dragonflies. *Molecular Phylogenetics and Evolution*, *45*(1), 289-310.

Younas, S., Zahid, M., Ullah, M., Sajid, M., Khan, M., Attaullah, S., & Khan, K. (2024). Spider diversity in different habitats at District Mardan, Khyber Pakhtunkhwa Pakistan. *Brazilian Journal of Biology*, *84*, e283767.

Younes, A., El-Sherief, H., Gawish, F., & Mahmoud, M. (2016). Experimental evaluation of Odonata nymph in the biocontrol of schistosomiasis intermediate hosts. *Asian Pacific Journal of Tropical Biomedicine*, *6*(12), 995-1000.

Zia, A., Din, A., Azam, I., Munir, A., & Afsheen, S. (2018). Effect of salinity gradients on species composition of Odonata naiads. *Arthropods*, *7*(1), 11-25.

Zia, A., Hussain, I., Mehmood, S. A., Ahmad, S., Shah, M., & Bhatti, A. R. (2019). Richness and distribution of Odonata in Kurram district, Khyber Pakhtunkhwa. *Pakistan Journal of Agricultural Research*, *32*(4), 589.

Zia, A., Shabnem, B., Mehmood, S. A., Mastoi, M. I., Shehzad, A., & Ahmed, S. (2024). Aeshna mixta (Latreille, 1805), a new record for the Odonata (Anisoptera: Aeshnidae) fauna of Pakistan. *Arthropods*, *13*(2), 87-93.