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KEY FOR FIRST RECORDED DRAGONFLY (ODONATA: ANISOPTERA) FAUNA OF DISTRICT LOWER DIR, KHYBER PAKHTUNKHWA, PAKISTAN

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ABSTRACT

Dragonflies (Odonata: Anisoptera) are beautiful insects with high species diversity worldwide. These insects are indicators of environmental pollution and are predators of important insect vectors of human pathogens and parasites, especially mosquitoes. The present research was the first record of 318 specimens of dragonflies from district Lower Dir (LD), Khyber Pakhtunkhwa, Pakistan collected during May-July 2011. Among the specimens collected there were 11 species, 7 genera and 3 families. The number of specimens collected in each family were 17 Cordulegasteridae (5.3%), 18 Gomphidae (5.7%), and 283 Libellulidae (89.0%). All cordulegastrids were the golden ringed, Cordulegaster brevistigmata brevistigmata Selys. All gomphids were Clubtails, Onychogomphus bistrigatus Selys. Libellulids species were: blue or black percher, Diplacodes lefebvrei (Rambur); ground skimmer, D. trivialis Rambur; black tailed skimmer, Orthetrum cancellatum (L); common red skimmer, O. pruinosum neglectum (Rambur); slender skimmer, O. sabina (Drury); triangle skimmer, O. triangulare triangulare (Selys); wandering glider or global skimmer, Pantala flavescens (Fabricius); spine legged redbolt, Rhodthemis rufa (Rambur) and common skimmer, Sympetrum decoloratum Selys. A dichotomous key based on external morphology, coloration and wing venation was prepared to facilitate the identification of the dragonfly fauna of the LD and aid conservation efforts of dragonflies in Pakistan.

Keywords: Cordulegasteridae, Dragonflies, Dichotomous key, Gomphidae, Identification, Libellulidae.

1. INTRODUCTION

The Lower Dir (LD) is one of the 24 districts of Khyber Pukhtunkhwa (KP) Province, Pakistan. It lies in the valley of the Panjkora, which arises in the Hindu Kush at 35° 45' 21" North. It joins the Swat river near Chakdara, where the district is usually entered at 34° 40' 32" North. A part from the tehsils of Adenzai around Chakdara and Munda in the south-west, LD is rugged and mountainous (Figure 1). Summer is the pleasant weather for tourists [1]. The

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literacy ratio of LD is among the population aged 10 years and above is 29.90%. The male literacy ratio is 48.76% compared with 12.25% for female. It is considered one of the most sensitive areas in Pakistan in term of religious extremism. It was ruled by a princely dynasty until 1969. There were limited facilities for education, health, road, transportation and communication for the inhabitants [2]. The dragonfly fauna of LD has not been explored in the past.

Odonata are found in running and standing bodies of freshwater and some species are tolerant of brackish and salty waters. They are easily recognized by a long, slender abdomen, large eyes, short antennae and long membranous wings that are held as perpendicular to the body. Many dragonfly species have limited ranges and are specific to certain habitats such as alpine mountain bogs or desert wadi. Their sensitivity to habitat quality makes them well-suited agents for monitoring changes in the environment [3]. They also possess medicinal properties and are used in medicine preparation in some countries [4]. However, they are fried in coconut oil and served with vegetables as delicious cuisines [5]. Thompson and Watts [6] have used them for genetic studies.

The larvae of dragonflies prey on amphibian larvae, crustaceans, mollusks, flatworms and leeches. During outbreaks of two destructive inchworms of geometrid moths, the spring cankerworm, *Paleacrita vernata* (Peck, 1795) and fall cankerworm, *Alsophila pometaria* (Harris, 1841), dragonfly feeds on inchworms that are dispersing by ballooning [7]. A single adult of dragonfly may eat 300-400 gnats/day. Their nymphs feed on mosquito larvae and other aquatic fauna [8]. Dragonflies can be used to control the insect vectors of dengue fever (*Aedes* sp Meigen, 1818, that breed in water containers), malaria (*Anopheles* sp Meigen, 1818) and filarial diseases [roundworms, *Wuchereria bancrofti* Seurat, 1921; filarial worm, *Loa loa* (Cobbold, 1864) and *Onchocerca volvulus* (Cobbold, 1877) (Nematodes)] [9]. They have great variations in their sensitivity to different sorts of pollution and are thus used as indicator of water pollution.

Some species of dragonflies are becoming extinct at a rapid rate. They should be conserved, as they are part of the world's biodiversity. Their characteristics make them suitable subjects for biological research, especially for studies on their behavior and ecology [10]. The objective of the present study is to develop a dichotomous key for the identification of dragonflies to facilitate the work of students and researchers and to increase awareness and education in the LD area.

2. MATERIALS AND METHODS

The LD is bounded by Swat district to the east, Bajour Agency to the west, Upper Dir (UD) to the north and Malakand district to the south. Timergara, the district headquarters, lies at only 2,700 ft (820 m). The climate of Dir is cold and damp with mountains usually covered with white snow that receives snowfall during December-February.

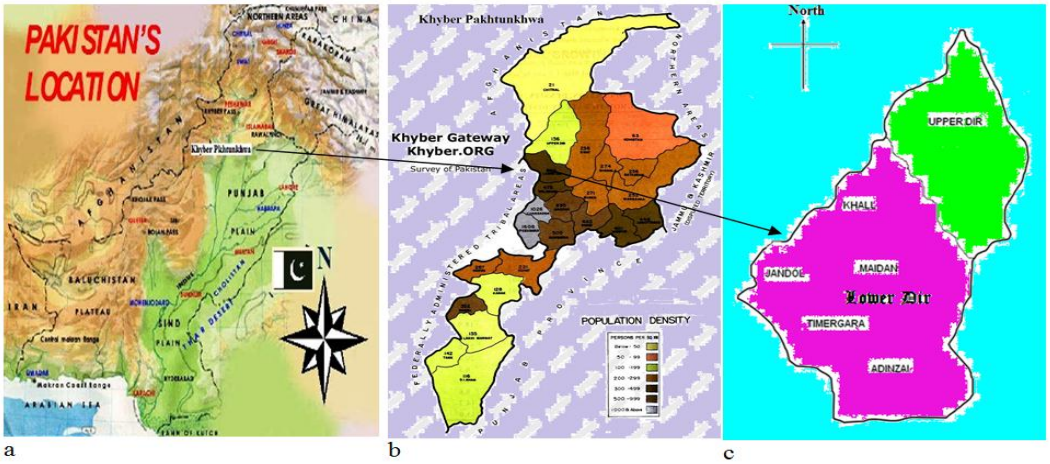

Figure-1. Map of district Lower Dir, Pakistan, the survey area where from dragonflies (Odonata: Anisoptera) were collecting: a) map of Pakistan showing Khyber Pakhtunkhwa [11, 12]; b) map of Khyber Pakhtunkhwa showing Lower Dir [13, 14]; c) map of Lower Dir [2].

The average rain is 700 mm and the temperature varies from –6-38 °C (Figure 1) [1]. The present study was conducted during May-July 2011 in LD, KP, Pakistan.

2.1. Collection and Preservation

Dragonflies were collected by random sampling from different area of LD by using aerial nets, collected specimens were placed them in triangular envelope after killing them in cyanide bottle, they were pinned and their body parts were set on appropriate setting boards in the laboratory, Department of Zoology, Hazara University, Mansehra, Pakistan. On drying, they were properly labeled and mounted in the insect boxes. Naphthalene balls were placed in boxes to keep them safe from pests [15-17].

2.2. Identification and Description

Specimens were identified to species with the aid of established keys [18, 19] and by comparison with preserved and identified specimens at the National Insect Museum, National Agriculture Research Centre, Islamabad, Pakistan; pictorials and literature available [20]. A comprehensive dichotomous key was prepared for classification of all species collected, specifically for families, genera and species. All the identified specimens were deposited in the Zoological Museum, Department of Zoology, Hazara University, Mansehra, Pakistan [12, 21, 22].

3. RESULTS

Dragonflies 318 (Odonata: Anisoptera) were collected by random sampling belonging to 11 species, 7 genera and 3 families including Corduligestridae, Gomphidae and Libellulidae. The characteristics of families are given below:

3.1. Family: Cordulegastridae

The name Cordulegastridae comes from the Greek kordylinus means club-shaped and gaster means belly. Their common name spiketails refers to the females prominent ovipositors. Some vernacular names for the species of this family are biddies and flying adder. The family is distributed worldwide. They have large, brown or black bodies with yellow markings. They are found along small, clear, woodland streams and flying slowly 30-70 cm above water. When disturbed, they can fly very rapidly. They also are found on metallic roads at evening. The 10-10 ante-nodal and 9-9 post-nodal nerves are present in spiketails. The fore, hind wing spans and abdomen length were 47.9±1.66, 46.5±1.78 and 46±1.6 mm (n=10 for each), respectively. Dragonflies belonging to the family Cordulegastridae [23, 24] have been accepted with some minor differences. The female hovers just above water with her body in a vertical position and makes repeated dips into the water with her abdomen. Usually, the female lays the eggs in the sand and shallow water. All 8 species in North America belong to the genus *Cordulegaster*. Only one species of this family has been reported from Pakistan which has been also reported from the present study area, LD, i.e., the goldenringed dragonfly, *Cordulegaster brevistigma brevistigma* Selys, 1854 (Table 1).

3.2. Family: Gomphidae

The dragonflies of Gomphidae family are known as clubtails, may be derived from Latin word gomphus or gond means hinge and refers to the club-like widening of the end of abdomen (abdominal segments 7-9). However, this club is usually less pronounced in females and is entirely absent in some species. Clubtails have been identified by their small and broadly isolated eyes, a trait they share with the Petaluridae and damselflies. Their body size is medium to large. The fore, hind wing spans and abdomen length of adults were 26.9±2.99, 25.8±2.57 and 40-70 mm (n=10 for each), respectively. They breed in streams particularly in open forests. They are yellow or green in shade with black markings. The nymph burrows into the sediments of streams. Naiad crawls out onto the shore for emergence instead climbing up the vegetation. It contains about 90 genera and 900 species. Their 9 genera and 12 species of this family have been reported from Pakistan. During the present study, only one species has been collected from the study area, LD, i.e., the clubtail dragonfly, *Onychogomphus bistrigatus* Selys, 1854 (Table 1).

3.3. Family: Libellulidae

The family name has been derived from the Latin word libella, which means booklet. They also commonly known as skimmers or perchers. They and their relatives from the Libellulidae, are the largest family of dragonflies in the world. Sometimes, it is considered to contain the family: Corduliidae as the subfamily Corduliinae and the family: Macromiidae as the subfamily Macromiinae. Even if these are excluded (as Silsbee), there remains a family of over 1000 species with nearly worldwide distribution. They are almost certainly the most often seen of all dragonflies. The libellulids have stout-bodied larvae with the lower lip or labium developed into a

mask over the lower part of the face. Dragonflies of this family have broadened abdomen, size varies from small to large and their body is shorter than their wings span, however, they are erratic in colors, moreover, several species have colored wings patterns. The males are often brightly colored. They are frequently found in the wide swampy areas. During rest, some species hold their abdomen upward and some with wings forward and depressed. During the present study, the following species have been collected from the study area, LD, i.e., the blue or black-percher, *Diplacodes lefebvrei* (Rambur, 1842); ground-skimmer, *Diplacodes trivialis* Rambur, 1842; black tailed skimmer, *Orthetrum cancellatum* (Linnaeus, 1758); common red skimmer, *Orthetrum pruinosum neglectum* (Rambur, 1909); slender skimmer, *Orthetrum sabina* (Drury, 1773); triangle skimmer, *Orthetrum triangulare triangulare* (Selys, 1878); wandering glider or global skimmer, *Pantala flavescens* (Fabricius, 1798); spine legged redbolt, *Rhodothemis rufa* (Rambur, 1842) and common skimmer, *Sympetrum decoloratum* Selys, 1884 are belonging to this family (Table 1).

Table-1. The identification dichotomous key to the families, genera and species of the first recorded collection of 318 dragonflies from district Lower Dir (LD), Khyber Pakhtunkhwa, Pakistan during May-July 2011.

1) Key to Families of Anisoptera of Upper Dir, Pakistan	
1a	Chitineous exoskeleton, jointed legs, wings present or absent……..…….. ……Phylum: Arthropoda
1a(i)	A consolidated thorax with 3 pairs of legs……..……..Subphylum: Hexapoda
1a(ii)	Antenna may hidden or 1 or 2 pairs segmented and various shapes present between eyes, 3 pairs jointed leg……Class: Insecta
1a(iii)	Wings transparent or hard with 1 or 2 pairs……Subclass: Pterygota
1a(iv)	Lacked the ability to fold the wings back over the abdomen……Division: Palaeoptera
1a(v)	Beautiful insects that ever roamed earth, carnivorous, predators, toothed mandibles, harmless bite……Order: Odonata
1a(vi)	Included dragonflies, two pairs of strong transparent wings, hindwing is broader than the forewing, large multifaceted eyes, larvae, known as nymphs…… ……Suborder: Anisoptera
1b(i)	Eyes separated…….. ……..……2
1b(ii)	Eyes confluent on vertex…..……..……3
2a	Eyes oval shape, slightly separated, meeting at a point……Family: Cordulegasteridae
2b	Eyes widely separated……..……..……Family: Gomphidae
2c	Thorax non-metallic, base of hindwings rounded in both sex, anal loop socks shape……Family: Libellulidae
1a) Key to genera of Family Gomphidae of Upper Dir, Pakistan	
1a(i)	Forewings have entire trigone, subtrigone and hyper trigone……1b
1a(ii)	Forewings have traversed trigone, subtrigone and hyper trigone ……..……..1ai
1b	Tornus angulated in male, 4 anal loop present, anal triangle with 3 cells, 5 superior and inferior anal appendages of equal length, anal triangle with 4 cells……*Onychogomphus* Selys, 1854
1bi	Tornus not angulated in male, 4 anal loop not present, anal triangle not with 3 cells, 5 superior and inferior anal appendages of equal length not present, anal triangle not with 4 cells……

	……..*
1ai) Key to *Onychogomphus* species of Family Gomphidae of Upper Dir, Pakistan	
1a(i)	Medium size, body yellow with appendages long and curled……2
1a(ii)	Large size, body blue with appendages medium size and straight……..3
2	Branches of inferior anal appendages slightly shorter than superior…… ……*bistrigatus* (Selys, 1854)
1b) Key to genera of Family Cordulegasteridae of Upper Dir, Pakistan	
1a(i)	A massive brown or black body with yellow markings……2
1a(ii)	A medium yellow or brown body with black markings……3
2	Very large sized dragonflies with black and yellow body markings…… ……*Cordulegaster* Leach, 1815
1bi) Key to *Cordulegaster* species of Family Cordulegasteridae of Upper Dir, Pakistan	
1a(i)	Discoidal cells traversed in all wings, hardly ever complete in hind wing, anal triangle is present……2
1a(ii)	Discoidal cells not traversed in all wings, hardly ever complete in hind wing, anal not triangle is present……3
2	Frons below from point of occiput, it is black along with yellow hairs, on the second abdominal segment black spots meeting broadly on the sides……..*brevistigma* Selys 1854
1c) Key to genera of Family Labellulidae of Upper Dir, Pakistan	
1a	Anal loop closed from tip……2
1b	Anal loop open from tip……3
2a(1a)	Forewings with complete distal antenodal nerve……4
2b(1a)	Forewings with incomplete distal antenodal nerve……5
3a(1b)	Small dragonflies, body slim and cylindrical from 7-10 abdominal segments……6
3b(1b)	Medium sized dragonflies, forewings have more than 12 antenodal nerves…….. ……*Orthetrum* Newman, 1833
4a(2a)	Discoidal field consist of 2 cells, body red……*Rhodothemis* Ris, 1909
4b(2a)	Discoidal field variable, Cu ii starting from the posterior angle of discoidal cell in hindwings……*Diplacodes* Kirby, 1889
5a(2b)	Discoidal field converging at wings border……..*Sympetrum* Newman, 1833
5b(2b)	Discoidal field diverging or parallel at wings border……*Pantala* Hagen, 1861
1ci) Key to *Orthetrum* species of Upper Dir, Pakistan	
1a	Male body colour red……2
1b	Male body colour blue or black and yellow……3
2a(1a)	Face black……*purinosum neglectum* (Rambur, 1842)
2b(1a)	Face red……4
3a(1b)	Abdomen slim and compressed……*sabina* (Drury, 1770)
3b(1b)	Abdomen not slim, pruinosed……5
4a(2b)	Base of hindwings with black markings……*triangulare triangulare* (Selys, 1878)
4b(2b)	Base of hindwings without black markings……6
5: 3b(1b)	Antenodal nerves bright yellow……*cancellatum cancellatum* (Linnaeus, 1758)
1cii) Key to *Rhodothemis* species of Upper Dir, Pakistan	
1a	The extremely prominent and robust spines present on the femora and tibiae of *R. rufa* is the most obvious distinguishing feature……2
1b	Not prominent and week spines present on the femora and tibiae……3
2(a)	Middorsal ridge of 1-5 abdominal segments……*rufa* (Rambur, 1842)
1ciii) Key to *Sympetrum* species of Upper Dir, Pakistan	
1a	Pterostigma is black ……2
1b	Pterostigma is not black……3
2(1a)	Wings are hyaline……*decoloratum* Selys, 1884
1civ) Key to *Diplacodes* species of Upper Dir, Pakistan	

1a	Small, body entirely silvery black……..……...2
1b	Small, body greenish yellow or blue……3
2(1a)	Thorax is covered with fine blue pruinescence……*lefebvrei* (Rambur, 1842)
3(1b)	Abdomen somewhat dilated at origin and then triquetral….*trivialis* (Rambur, 1842)
1cv) Key to *Pantala* species of Upper Dir, Pakistan	
1a	Anal appendages turning to black to apex……...……..2
1b	Anal appendages not turning to black to apex……..3
2(1a)	Anal loop long and slim ……..*flavescens* (Fabricius, 1798)

*other genera or species in the family not collected at the LD site.

4. DISCUSSION

During the present research, 318 individual dragonflies were collected from different areas of district LD during May-July 2011. The 2 species, i.e., *C. brevistagma brevistagma* and *O. bistrigatus* are belonging to families Cordulegasteridae and Gomphidae, respectively. The 9 species, i.e., *R. rufa*, *O. cancellatum*, *D. lefebvrei*, *D. trivialis*, *O. pruinosum neglectum*, *O. triangulare*, *S. decoloratum*, *O. sabina* and *P. flavescens* are belonging to family Libellulidae. Yousaf [24] collected and identified 64 species and subspecies belonging to 24 genera of 6 subfamilies of dragonflies form various localities of West Pakistan. Kumar and Parsad [25] reported 162 odonate species from western Himalaya. Kanth [26] describe 39 species of dragonflies belonging to 22 genera from Azad Jammu and Kashmir. Both researches showed similarities because they have same geographical area and climate.

In an extensive recent survey [19], 10 agro-ecological regions of Pakistan were explored from 2005-2009. A total of 1349 specimens belonging to 5 families, 39 genera and 68 species were collected and identified. The different areas of Pakistan are occupied by different dragonfly families. Aeshnidae and Labellulidae are distributed throughout the country, Corduliidae dragonflies are restricted in mountainous and sub mountainous areas, whereas Cordulagesteridae species are found in only mountainous areas. The species of Gomphidae are found in all parts of Pakistan. Therefore, the present survey was conducted in short period but identified some species that were the same as reported by Chaudhry [19].

Riservato, et al. [27] reported that habitat loss and degradation caused by humans was the main threat for both threatened and non-threatened species, and have affected 110 dragonfly species, including 30 of the 31 threatened species. Water pollution was also a major concern as it was having an impact on 97 species, of which 30 of them were threatened. Natural disasters such as the disappearance of breeding habitats due to drought, had the next biggest impact, affecting 75 species, of which 26 are threatened. Global warming was likely to exacerbate the impact and extent of several of these threats. It is one of the biggest present and future threats to dragonflies. The alpine and Mediterranean species confined to man-made sub-desert areas are the most sensitive to global change. Therefore, dragonflies in the LD are currently not threatened but conservation is still needed to sustain diversity in the future. The dragonfly species are secure in the long term, this need to be combined with the political will to truly integrate biodiversity

conservation into all policy sectors. Sustained investment in species, site and landscape level conservation and monitoring is needed for LD, KP, Pakistan.

Khaliq [28] identified 19 Odonata species from Poonch district of Azad Jammu and Kashmir, Pakistan. Khaliq, et al. [29] recorded 6 anisopterous species from district Mansehra (KP). Khaliq, et al. [30] identified 22 dragonfly species from Murree hills. Ahmad and Yousuf [31] added 3 new genera and 4 species to the anisopterous fauna of KP. Ahmad [7] identified 21 dragonfly species belonging to 14 genera and 4 families from KP. Arshad [32] recorded 14 dragonfly species belonging to 9 genera from Balochistan. Khaliq, et al. [33] recorded 13 dragonfly species from Gilgit, Baltistan and Kashmir. Rehman [34] described 35 species of dragonflies belonging to 22 genera of 12 subfamilies in 3 families from Punjab. Ullah [35] recorded 12 dragonfly species belonging to 10 genera and 2 families from Sindh. Diversity of dragonflies in the LD was similar to these areas as the current study found anisopterans in 11 species in 3 families, i.e., Cordulegasteridae, Gomphidae and Libellulidae. Therefore, the dragonflies are an important topic for research and study as they have the great biodiversity all over the world. The species need to improve monitoring, surveys and studies in some important areas of Pakistan.

5. CONCLUSION

At the present, a detailed dichotomous key for identification of dragonflies of LD was established, that can be expanded to prepare key of the dragonflies in other areas of Pakistan. It is helpful for taxonomical studies of the same. Monitoring, surveys and taxonomic studies of dragonflies in some important areas of Pakistan may indicate the effects of the environment and the need for dragonfly conservation methods. These methods are a future need for conservation of dragonflies and preserve their current diversity in a changing environment.

6. RECOMMENDATION

Dragonflies are important predators of crops pests, dengue and malarial vector (mosquitoes) and other harmful insects, and awareness about dragonflies should be generated in local public through electronic and print media to save them from injudicious use of pesticides in fields. Steps should be taken to minimize the chances of disturbances and loss of natural habitats of Odonata, as it adversely affects species composition and abundance.

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