

Phenological Groups of Dragonflies (Insecta: Odonata) in Khorezm Oasis

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Abstract This article presents the species composition and phenology of dragonflies distributed in the Khorezm oasis. When analyzing the results of the observations made in 2020-2021, four phenological groups were noted: spring-summer species, summer species, summer and autumn species, all-season-specific species (spring, summer, autumn). Accordingly, all-season-specific species (10 species) were numerically superior to others.

Keywords Imago, Phenology, Seasonal rhythm, Biotopes

1. Introduction

Abiotic factors, such as climate (temperature, air humidity, light) are important for the lifestyle of insects. Sudden changes in temperature throughout the year create unfavorable conditions for some species, while others develop adaptations and continue to survive. Representatives of the family of dragonflies (Insecta: Odonata) are amphibious insects. Their lifestyle is directly related to the water, and the appearance of the imago and their flight depends on the temperature of the water [10]. According to the results of observations, the periods of seasonal activity of all dragonfly species increase from north to south.

2. Literature Review

All species of dragonflies are active mainly in the first half of the day in spring and late autumn. At the end of the spring season and the beginning of the summer season, species are divided into two: species that are active in the evening and species that are active in the daytime [1]. According to the opinion of most odonatologists, besides the climate, the geographical condition of the area (plain, hilly or mountainous area) is also important to the main factors influencing the flight patterns of insects. Sometimes a sudden increase in air temperature in the last days of winter or in early spring can cause the emergence of early spring species [2].

During our research, the seasonal activity of dragonflies spread across the plains of the Khorezm oasis was studied,

and the emergence periods of dragonflies were studied by dividing them into phenological groups.

3. Research Methodology

Khorezm oasis, sometimes Khorezm oasis located in the lower reaches of the Amu Darya River. It occupies the entire territory of the Khorezm province of Uzbekistan, the southern part of Karakalpakstan (an autonomous republic within Uzbekistan), as well as the northern and northeastern parts of the Dashoguz province of Turkmenistan. The center of the ancient historical region of Khorezm [9].

The surface of the region mainly consists of plains, it has completely changed as a result of human economic activity and turned into an anthropogenic landscape. The area has an average height of 90-108 meters above sea level and is part of the plains of Uzbekistan. The climate is continental with moderately cold winters and dry hot summers. The lowest temperature is -32 °C, the highest temperature is +47 °C. In the oasis, Amudarya supplies water to all canals and cultivated fields [7]. Large salty lake and small lakes and artificial fisheries are well developed in the region. Biomaterials were collected from water bodies in the Khorezm oasis in 2020-2021. Dragonflies in the imago stage were collected from places near water bodies, lakes, irrigation networks. The coordinates of each monitored area were determined by mobile phone (Table 1).

Determinants were used to identify species [3], [5], [6], [8]. Phenological observations were carried out in all seasons of the year, from the time when the dragonflies leave the nest in the spring months until they leave for the winter, and special attention was paid to the following situations: the natural climatic conditions of the Khorezm oasis, the time of the first emergence of the imago stage, the laying of eggs by the dragonflies, which were observed at the end of the season,

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their last individuals. Based on the analysis of the literature and the results of the observations, we divided the phenological periods of dragonflies into 4 groups:

1. Spring and summer species
2. Summer species
3. Summer and autumn species
4. All-season-specific (spring, summer, autumn) species [2], [4], [5].

Table 1

Place of conducted experiments		Coordinates
Karakalpakstan	Amudarya Biosphere Reserve	41°58'42.26"C, 60°21'53.31"B
	Ellikqala district	41°53'26.73"C 60°48'27.64"B
	Beruni district	41°40'5.22"C 60°42'41.36"B
Khorezm region	Bogot district	41°18'38.30"C 60°48'44.67"B
	Gurlan district, Vazir village	41°53'24.08"C 60°25'55.46"B
	Khiva district	41°25'49.16"C 60°14'10.05"B
		41°25'49.16"C 60°14'10.05"B
		41°24'22.58"C 60°23'0.02"B
	Koshkopir district	41°28'13.17"C 60°13'41.74"B
		41°33'27.85"C 60°20'16.82"B
	Urganch district.,	41°30'6.75"C 60°33'48.75"B
		41°38'49.11"C 60°42'5.20"B

4. Analysis and Results

During 2020 and 2021, dragonflies belonging to 2 suborders, 6 families, 8 subfamilies, 11 genera, 23 species were found in three biotopes of the Khorezm oasis (Tables 2, 3).

Table 2

Family	Subfamily	Number of genera
Lestidae	Sympycmatinae	1
Coenagrionidae	Ischnurinae	1
Gomphidae	Gomphinae	2
Aechnidae	Aechninae	1
Libellulidae	Libellulinae	2
	Pantaliinae	1
	Sympetrinae	1
Macrodiplactidae	Macrodiplacinae	1
Total: 6	8	11

The activity of the flight periods of dragonflies was also studied in the months from March of the spring season to late autumn and winter. Based on the collected data, the development of dragonflies in the Khorezm oasis starts from the last ten days of March and continues until the end of October or, for some species, the first ten days of November. (Table 2) In general, the flying activity of dragonflies in the Khorezm oasis lasted for 9 months during the year.

Spring and summer species. These species were observed to be active, when the temperature of the spring season exceeds +10 degrees. Their period lasts from the third ten days of March to the last days of August. By the second ten days of April, *Anax imperator* (Leach, 1915), belonging to the genus *Anax*, can be found in orchards, around lakes and ditches. By the first 10 days of May, *Orthetrum sabina* species begins to fly. We have actively recorded this species in all biotopes. Also, in the last days of May (2021.V.22), in the observations made in the Amudarya Biosphere Reserve, it was observed that *Anax imperator*, *Anax parthenope* species came to artificial lighting at night. By the summer months, a sharp increase in air temperature and the influx of dry hot air causes the species to actively hunt at night (Borisov, 2007).

Summer species were found in June, July, August. Species such as *Gomphus flavipes*, *Lindenia tetrachrylla* were found from the second ten days of June, from the middle of June, to the second ten days of July, August. The *Gomphus flavipes* species was found in areas typical of the agro-landscape biotope. It is noted that the larvae of this species were found in running water. We met *Lindenia tetrachrylla* species mainly in groves near the Amudarya, and around water bodies with thick reeds, in the Amudarya Biosphere Reserve-in the process of spawning, breeding and hunting. The colors of the imagoes of these species are light yellow and gray.

Summer and autumn species. In this phenological group, we include species belonging to the Anisoptera suborder, which are active from the second ten days of June to the first ten days of October. In particular, *S. Arenicolor* was found around forests and lakes from the second half of June to the end of September. A species close to the desert biotope was observed in large numbers in all observed areas of the Khorezm oasis. *S. f. flaveolum* species is active from July to the beginning of September. This species was observed in small numbers in the studied territory. Being suitable for agrolandscape biopic, this species was found mainly near cultivated fields. *S. vulgatum decoloratum* was found in large numbers from June until almost mid-November (when the autumn season was warm). *S. meridionale* was found from the beginning of July to the end of September. It was observed mainly along the water. *S. striolatum pallidum* was found from the second ten days of July until late autumn. It was found in large numbers at the beginning of warm November, at +15, +20 degrees, on sunny days (12.xi.2020, Urganch district).

Table 3

Registered species		Flying time, months (March-November)									
		Phenological groups	3	4	5	6	7	8	9	10	11
Suborder: Zygoptera Family: Coenagrionidae											
1	<i>Sympecma fusca</i> (VanderLinden, 1820)	All-season-specific species	+	+	+	+	+	+	+	+	+
2	<i>Sympecma gobica</i> (Foerster, 1900)	All-season-specific species	+	+	+	+	+	+	+	+	+
3	<i>Sympecma paedisca</i> (Brauer, 1877)	All-season-specific species	+	+	+	+	+	+	+	+	+
Family: Lestidae (03)											
4	<i>Ischnura elegans</i> (VanderLinden, 1820)	All-season-specific species	+	+	+	+	+	+	+	+	-
5	<i>Ischnura fountainei</i> (Morton, 1905)	All-season-specific species	+	+	+	+	+	+	+	+	-
6	<i>Ischnura pumilio</i> (Charpentier, 1825)	All-season-specific species	+	+	+	+	+	+	+	+	-
Suborder: Anisoptera : Family Aeshnidae (02)											
7	<i>Anax imperator</i> (Leach, 1915)	Spring and summer species	-	+	+	+	+	+	-	-	-
8	<i>Anax p. Parthenope</i> (Selys, 1839)	All-season-specific species	+	+	+	+	+	+	+	+	-
Family: Gomphidae (02)											
9	<i>Gomphus flavipes liniatus</i> (Charpentier, 1825)	Summer species	-	-	-	+	+	+	-	-	-
10	<i>Lindenia tetraphylla</i> (Vander Linden, 1825)	Summer species	-	-	-	+	+	+	-	-	-
Family: Libellulidae (13 species)											
11	<i>Crocothemis erythraea</i> (Morton, 1920)	All-season-specific species	-	+	+	+	+	+	+	+	-
12	<i>Crocothemis servilia</i> (Drury, 1770)	All-season-specific species	-	+	+	+	+	+	+	+	-
13	<i>Sympetrum striolatum pallidum</i> (Selys, 1887)	Summer and autumn species	-	-	-	-	+	+	+	+	+
14	<i>Sympetrum f. Flaveolum</i> (Linnaeus, 1758)	Summer and autumn species	-	-	-	+	+	+	+	+	+
15	<i>Sympetrum vulgatum decoloratum</i> (Selys, 1884)	Summer and autumn species	-	-	-	+	+	+	+	+	+
16	<i>Sympetrum arenicolor</i> (Jodicke, 1994)	Summer and autumn species	-	-	-	-	+	+	+	+	+
17	<i>Sympetrum meridionale</i> (Selys, 1841)	Summer and autumn species	-	-	-	-	+	+	+	+	+
18	<i>Pantala flavescens</i> (Fabricius, 1798)	All-season-specific species	-	+	+	+	+	+	+	-	-
19	<i>Orthetrum brunneum</i> (Fonscolombe, 1837)	Summer and autumn species	-	-	+	+	+	+	+	-	-
20	<i>Orthetrum cancellatum</i> (Linnaeus, 1758)	Summer and autumn species	-	+	+	+	+	+	+	+	-
21	<i>Orthetrum a. albistylum</i> (Selys, 1848)	Summer and autumn species	-	+	+	+	+	+	+	+	-
22	<i>Orthetrum sabina</i> (Drury, 1770)	Spring and summer species	-	+	+	+	+	+	+	+	-
Family: Macrodiplactidae											
23	<i>Selysiothemis nigra</i> (VanderLinden, 1825)	Summer species	-	-	-	+	+	+	-	-	-

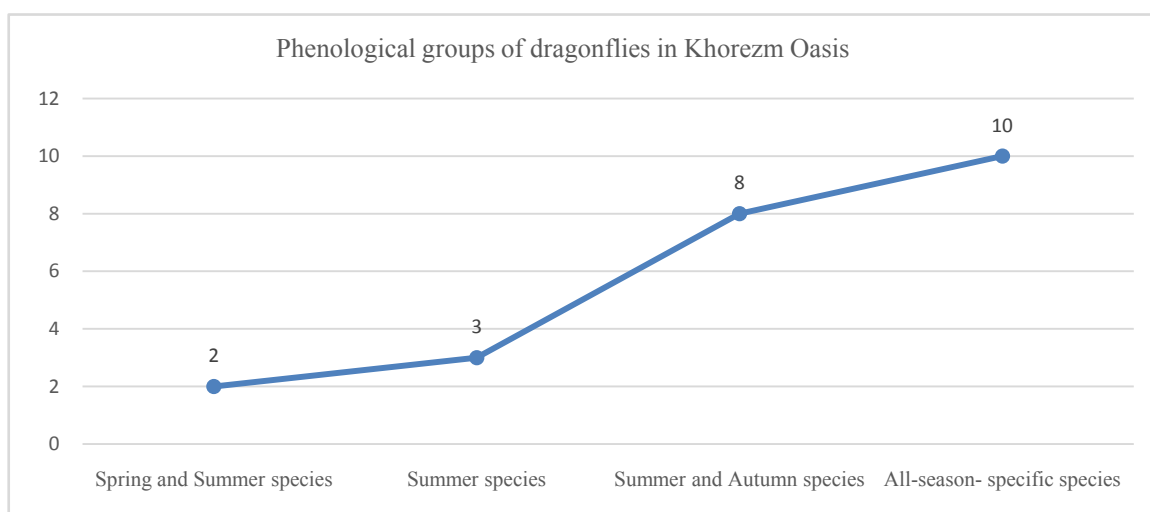


Figure 1. Phenological groups of dragonflies in Khorezm Oasis

All-season-specific species (spring, summer, autumn). In early spring, you can find *S. paedisca*, *S. fusca*, *S. gobica* species belonging to the genus *Sympetma*. Since members of this genus are imago-wintering species, it was observed that they flew actively during the anomalous temperature rise in late February or early March (03.III.2021). On hot summer days, it was observed in gardens, shade in cool cultivated areas and trees in dark places. Also, until the end of the season, we observed the imagoes of *Sympetma* species in the state of wintering in reeds around lakes and ditches. In addition, it was observed in orchards around Urganch district, Cholish post, Amudarya in November 2020, in the second 10 days, when the temperature was +12, +15 degrees. They were observed in large numbers on sunny days. In the last ten days of April, when the temperature is +12, +20 degrees, such species as *A. parthenope*, *C. erytheria*, *C. servilia*, *P. flavescens*, belonging to this phenological group begin to fly. Also, until the end of the season, we observed the imagoes of *Sympetma* species in the state of wintering in reeds around lakes and ditches. Moreover, it was observed in orchards around Urganch district, Cholish post, Amudarya on the second 10 days of November 2020. The fact that the Central Asian countries are mostly sunny for 9 months during the year ensures the activity of dragonflies until late autumn [1]. Therefore, it was a bit difficult to separate them into phenological groups. In some cases, at the end of February and at the beginning of March, when the temperature suddenly exceeded +12 degrees, we witnessed the emergence of *I. elegans*, *I. fountainei*, *I. pumilio*, *S. fusca*, *S. gobica* species belonging to the suborder Zygoptera. By late autumn, a sharp drop in temperature became a limiting factor for autumn species. In 2020, the activity of representatives of the genus *Sympetrum* was observed until November 20, and in 2021, we can see that the temperature drops below zero by October 15 as a limiting factor for the dragonfly fauna. In the course of the conducted research, the all-season-specific species formed the largest number.

5. Conclusions

According to the results of the conducted research, the seasonal activity and phenology of dragonflies were monitored at 12 points (Table 1) in Khorezm Oasis during 2020-2021. There are four phenological groups: Spring and Summer species – 2; Summer species – 3; Summer and Autumn species – 8; All-season-specific-species- 10 (Fig. 1). Seasonal activity of dragonflies started from the second ten days of April and continued until the last ten days of October,

when the temperature reached +20 degrees. According to some late autumn observations, it was observed that the species *Sympetrum vulgatum* belonging to the genus *Sympetrum*, the species *Sympetma fusca* belonging to the genus *Sympetma* were also active in November when the temperature was +10 C, +12 C (2020.xi.12). Seasonal activity of dragonflies in the oasis can last up to 8.5 or 9 months, depending on the temperature.

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