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Zohreh Eslami, Mehregan Ebrahimi & Saber Sadeghi

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Late spring records of Odonata from the west margin of the Namak Lake, Northwest of Central Plateau of Iran

Zohreh Eslami[1], Mehregan Ebrahimi[1], Saber Sadeghi[1, 2]

[1] Department of Biology, Faculty of Sciences, Shiraz University, Shiraz, Iran
Emails: eslami.zohre86@gmail.com, mehregan.ebrahimi@gmail.com, hsabersadeghi@gmail.com
[2] responsible author

Abstract

A total of 20 Odonata species were recorded from 15 water bodies (3 natural water bodies and 12 man-made reservoirs) in a desert landscape west of the Namak Lake in the northwest of the Central Plateau of Iran, from 27 May to 20 June, 2017. The study area included Qom province and the northern part of Esfahan province (34.07 to 35.14 N, 51.33 to 50.89 E). For Qom province, 17 out of 18 species found are new provincial records. In addition *Selysiothemis nigra*, *Orthetrum chrysostigma* and *Orthetrum taeniolatum* are new findings for Esfahan province. The species around the man-made reservoirs are characterized by a broad ecological amplitude ("generalists") while species assemblages of natural water bodies consisted of more sensitive species. In the arid climate of central part of Iran, man-made reservoirs are major habitats for Odonata species. Although these reservoirs have increased the amount of habitat for generalist species, they do not foster sensitive and specialist species. Furthermore, considering the more intense droughts predicted for these areas in the future, and the current scenario of environmental degradation, some sensitive species may be in danger of local extinction.

Key words: Central Plateau of Iran, Odonata, dragonflies, damselflies, Namak Lake, salinity, bioindicatorial value.

Introduction

The dragonfly fauna of Iran has been studied less than most other countries of the Western Palaearctic (Schneider et al. 2018), although over recent years some studies have been made and – compared with Schmidt (1954) - new records from different parts of Iran have been published (i.e. Bakhshi & Sadeghi 2014; Eslami et al. 2014; Kiany & Sadeghi 2016; Sadeghi & Mohammadalizadeh 2009; Kosterin & Ahmadi 2018, Schneider et al. 2018). However to our knowledge there is no study on the dragonfly fauna of the central part of Iran (west of Namak Lake) where the climate is extremely arid with very few perennial water bodies. In fact, in this area groundwater resources are the only available source for drinking, agricultural and industrial purposes; however due to climatic changes and very low precipitation, these resources are under pressure. Additionally continuous decline of the groundwater level due to the limited

natural recharge of the aquifer has caused intrusion of saline water and consequently poor freshwater quality. Unfortunately during the last decade, with the replacement of the Qanat system with deep wells in many area and intensive groundwater use, this situation is deteriorating (Baghvand et al. 2010). In consequence, flora and fauna, including Odonata, depending on freshwater are in danger. However due to the lack of information on the Odonata fauna, past and ongoing changes cannot be detected. One of the main aims of this study was to identify the Odonata fauna of the desert habitats west of the Namak Lake, and to investigate the species composition of water bodies with some degree of salinity. Another aim was to compare the Odonata species composition among different type of water sources. From May 27 to Jun 20, 2017 several field trips to the Namak Lake were carried out. Fifteen water bodies were visited, only three of them were natural water bodies that have been formed by rivers, while 12 were man-made reservoirs and canals related to irrigation systems.

Material and Methods

The studied area is situated in the northwest of the Iranian Central Plateau (34.07 to 35.14 N, 51.33 to 50.89 E). This area encompasses Qom province and the northwestern part of Esfahan province (Fig. 1). It covers a total area of 7,857 km², with elevations from 600 to 3,300 m a.s.l. Average monthly temperatures in this area range from 15 to 40°C during summer and –1.7 to 18°C during winter. The average annual precipitation is 150 mm (range = 0.5 - 28.1 mm / month) (Ebrahimi et al. 2013).

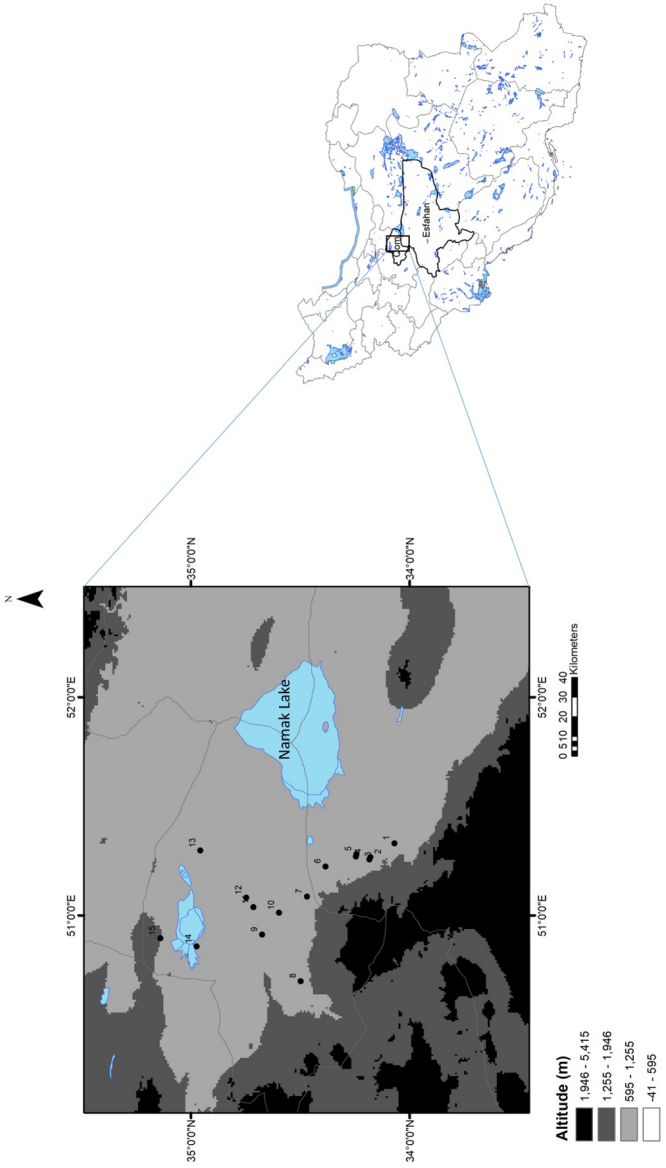
With the help of Google Earth and local people we identified the locations of water bodies west of Namak Lake. Most of them were man-made reservoirs related to the irrigation system and fed by wells. During our field trips we noticed that some of them had dried up; we were able to survey 15 waterbodies (Fig. 1).

Considering the fragile nature of the ecosystems at the water bodies visited, we tried to collect only one or two voucher specimens for each species at each location. The exception was *Ischnura elegans* (Vander Linden, 1820), multiple specimens of this species were collected for molecular analysis. Some easily recognizable common species were identified by sight only or released after identification. Collected specimens were preserved in 70% and 96% ethanol, then were transferred to the Entomology Research Lab of Shiraz University and identified with the help of the identification keys and other references (Dijkstra & Lewington 2006; Dumont 1991).The collected material is deposited in the Zoological Museum and Collection of Biology Department at Shiraz University (ZM-CBSU), Iran.

All photos were taken by Canon PowerShot SX230 and Canon EOS 1200D, with Tamron AF70-300mm, F/4-5.6 Macro lens, in natural condition. Photographs were taken by the first author.

Fig. 1a, b. Locations of 15 study water bodies to the west of the Namak Lake on the northwest of the Central Plateau of Iran. a- Altitudinal map, b-Google earth map. For explanation of the numbers see the text.

All surveys were conducted between 9:00 and 18:00 on calm and sunny days. Physical parameters of water including pH, salinity, conductivity and Total dissolved solids (TDS) were measured using a HACH HQ30d multi meter.



1a

Localities examined

Esfahan province (Loc. 1- 6)

Loc. 1. Khozaq village, 34.070056°N, 51.331944°E, 947 m a.s.l., a 30 x 30 m concrete water reservoir with maximum depth of about 2 m, surrounded by agricultural fields, fed by a well, enclosed with a fence about 1 meter distance from edges, with bushes of *Alhagi maurorum* Medik. along the edges, no aquatic macrophytes or riparian trees (Fig. 2), salinity = 2.45 (‰).

Loc. 2. Meshkat city, 34.18005°N, 51.26893°E, 858 m a.s.l., a 15 x 10 m concrete water reservoir with maximum depth of about 1.5 m, less than 100 m distant from the main road, surrounded by orchards on three sides, no aquatic macrophytes or riparian trees, with floating algal patches and some bushes of *A. maurorum* along the edges (Fig. 3), salinity = 0.38 (‰).

Loc. 3. Meshkat city, 34.184103°N, 51.257124°E, 892 m a.s.l., a circular concrete pond with a diameter of 25 meters and about 60 cm depth. This is the main reservoir of Meshkat Qanat, with concrete inlet and outlet channels used for conducting water to agricultural lands. The highway in less than 100 m distant to its west. There are orchards on the east side, no aquatic macrophytes or riparian trees, just a few *A. maurorum* bushes along the edges, algal mats cover significant portion of bottom (Fig. 4), salinity = 0.59 (‰).

Loc. 4. San San village, 34.245861°N, 51.271167°E, 853 m a.s.l., a 45 x 45 m concrete water reservoir with maximum depth of about 3 m, built above ground level, fed by a well, surrounded by agricultural fields with mainly cucumber crops; no aquatic macrophytes, algal mats, riparian trees or bushes (Fig. 5), salinity = 7.09 (‰).

Loc. 5. San San village, 34.243944°N, 51.282388°E, 838 m a.s.l., a 20 x 15 m concrete reservoir with maximum depth of about 1.5 m, surrounded by bare ground, some bushes along the edge, no aquatic macrophytes, algal mats or riparian trees, the water level was 20 cm (Fig. 6), Salinity = 5.67 (‰).

Fig. 2. A reservoir at Khozaq village, Esfahan province (Loc. 1).

Fig. 3. A reservoir at Meshkat city, Esfahan province (Loc. 2).

Fig. 4. Main reservoir of Meshkat Qanat, Esfahan province (Loc. 3).

Fig. 5. A reservoir at San San village, Esfahan province (Loc. 4).

Fig. 6a. Dried farmland around the reservoir, b. A reservoir at San San village, Esfahan province (Loc. 5).

Fig. 7. A reservoir at 12 kilometer north of Ab Shirin village, Esfahan province (Loc. 6).

Loc. 6. 12 kilometer north of Ab Shirin village, 34.384806°N, 51.225333°E, 912 m a.s.l., a 40 x 40 m concrete water reservoir with maximum depth of about 2 m, fed by a well, beside the main road and surrounded on three side by farmlands and gardens, with bushes and shrubs at one side; no aquatic macrophytes, algal mats cover the bottom. There were two temporary outlets, formed by grassy channels around the pond (Fig. 7), salinity = 1.71 (‰).

Qom province (Loc. 7-15):

Loc. 7. Zanburak village, 34.470167°N, 51.0875°E, 924 m a.s.l., a 25 x 35 m concrete water reservoir with a maximum depth of about 2 m, fed by a well, beside the road, surrounded by open agricultural land, with submerged aquatic macrophytes and floating algal mats and some bushes around the edge. A narrow concrete channel connects this pond to another pond 80 m away. This 25 x 25 m large concrete pond has the same characteristics. We surveyed both ponds and the channel (Fig. 8), salinity = 1.64 (‰).

Loc. 8. 16 km south west of Qom, part of Qomrood River near Tayeghan village, 34.498111°N, 50.699222°E, 1,069 m a.s.l., this part of the river is 3-4 m wide, running in a small valley, creating several pools of different sizes; bank bordered with tamarisk shrubs, pool with emergent macrophytes (*Phragmites* sp.) along the edge; algal mats on bottom; bottom consists of rocks and boulders in medium fast reaches and silt, gravel and sand in slow reaches and pools. Local people use this site as a picnic site and probably because of this, considerable amounts of solid waste like glass and plastic were observed in riparian area (Fig. 9), salinity = 5.12 (‰).

Loc. 9. North East of Qom city, 200 meters east of Persian Gulf freeway, 34.674528°N, 50.912694°E, 911 m a.s.l., backwater section in the downstream part of Qomrood River, right after passing through the city, surrounded by industrial and urban areas, with some tamarisk shrubs and emergent aquatic macrophytes (e.g. *Phragmites* sp) at the margin, muddy bed, smelly, disturbed extensively and loaded with solid waste (Fig. 10), salinity = 3.77 (‰).

Loc. 10. 1km south west of Ghanavat city, 34.597278°N, 51.013972°E, 896 m a.s.l., a 50 x 30 m concrete water reservoir with maximum depth of about 2 m, located almost in the middle of an agricultural patch, an area of about 300 km², fed by a well, built above ground level, with some bushes along the edge, without any aquatic macrophytes, algal mats or riparian trees, salinity = 4.15 (‰).

Loc. 11. 3 km south west of Qomroud city, 34.714639°N, 51.038639°E, 855 m a.s.l., a 2 meter wide canal, almost one kilometer long, surrounded with farmlands, with dense riparian vegetation, emergent aquatic macrophytes (e.g. *Phragmites* sp.) and algal mats, water smelly and almost black (Fig. 11), salinity = 1.38 (‰). No Odonata.

Loc. 12. 2 km north of Qomroud city, 34.745022°N, 51.068800°E, 845m a.s.l., 1 meter wide shallow canal, beside the road, with few trees and vegetation along the edge; algal mats on bottom; bottom consists of silt, gravel and sand (Fig. 12), salinity = 5.67 (‰). No Odonata.

Loc. 13. Marreh wetland, 50 km north east of Qom city, km. 50 of Qom-Garmsar Highway, 34.957694°N, 51.298667°E, 813 m a.s.l., a wetland surrounded by salty desert, located in Masileh watershed, fed by Shour and Karaj Rivers; in winter the wetland reaches 10,000 hectares in area, but in late spring and summer its area decreases, and most of it appears as a clay plain. At the time of our survey the wetland mainly consisted of water patches with marshy margins, riparian vegetation mostly of *Salicornia* sp. and *Tamarix* sp., submerged aquatic macrophytes, several species of birds and numerous mosquitoes (Fig. 13), salinity in surveyed water patches = 8.8 (‰).

Fig. 8 a. A reservoir at Zanburak village, Qom province (Loc. 7). b. Concrete channels that connect the reservoir of picture (a) to another one.

Fig. 9 (a-c). Qomrood River near Tayeghan village, Qom province (Loc. 8).

Fig. 10. Backwater section downstream of Qomrood River, beside Qom city, Qom province (Loc. 9).

Fig. 11. A concrete canal 3 km south west of Qomroud city, Qom province (Loc. 11).

Fig. 12. A shallow canal 2 km north of Qomroud city, Qom province (Loc. 12).

Fig. 13a, b. Marreh wetland, Qom province (Loc. 13).

Fig. 14. A reservoir at 30 km north of Qom city, at margin of Hoz-e-Soltan Lake, Qom province (Loc. 14).

Loc. 14. 30 km north of Qom city, at margin of Hoz-e-Soltan Lake, 34.97512°N, 50.858732°E, 818 m a.s.l., a 45 x 35 concrete water reservoir with maximum depth of about 2 m, fed by a well, beside the freeway, surrounded by bare ground (worked farmland), due to reduced water inflow only a small percentage of the reservoir had water, and on the dried bottom *Tamarix* sp. and *Alhagi* bushes had grown (Fig. 14), Salinity = 9.9 (‰). Only one specimen, an *Orthetrum* sp., was observed.

Loc. 15. Baghak village, 15 km north of Hoz-e-Soltan Lake, 35.140737°N, 50.896738°E, 1,257 m a.s.l., a concrete water reservoir with 770 m^2 area and maximum depth of 3 m, located in the middle of Baghak village, fed by Qanat, bank with gentle slope, with large patches of floating aquatic macrophytes and without riparian vegetation, There were also several smaller reservoirs in the village, all of them dried up (Fig. 15), salinity = .55 (‰).

Fig. 15 a. A reservoir at Baghak village, Qom province (Loc. 15). b. Reservoirs in the Baghak village that had dried up.

Recorded species

Coenagrionidae

Ischnura elegans (Vander Linden, 1820)

Loc. 1: Several ♂♂, ♀♀, copulae seen, 4 ♂♂ and 1 ♀ collected, Loc. 8: many ♂♂, ♀♀ and several copulae seen, 4 ♂♂ collected, Loc. 9: several ♂♂, ♀♀ seen, 1 ♂ collected (Fig. 16).

Ischnura evansi Morton, 1919

Loc. 8: many ♂♂, ♀♀ and several copulae seen, 2 ♂♂ and 2 ♀♀ collected.

Ischnura fountaineae Morton, 1905

Loc. 5: Several ♂♂, ♀♀ and 1 copulae seen, 1 ♂ and 1 ♀ collected; Loc. 7: Two ♂,

Fig. 16a. *Ischnura elegans*: male, b. female.

♀ seen, 1 ♀ collected; Loc. 8: Many ♂♂, ♀♀ and several copulae seen, 2 ♂ and 1 ♀ collected; Loc. 9: Several ♂♂, ♀♀ seen, 1 ♂ and 1 ♀ collected, Loc. 13. Many ♂♂, ♀♀ and several copulae seen, 3 ♂ and 1 ♀ Collected; Loc. 15: Several ♂♂, ♀♀, seen, 2 ♂♂ and 1 ♀ collected.

Ischnura pumilio (Charpentier, 1825)

Loc. 9: 1 ♂ collected

Erythromma viridulum (Charpentier, 1840)

Loc. 6: Several ♂♂, ♀♀ and 2 copulae seen, 1 ♂ and 1 ♀ collected; Loc. 10: Several ♂♂, ♀♀ and copulae seen, 2 ♂♂ and 1 ♀ collected.

Family Platycnemididae

Platycnemis dealbata Klug in Selys, 1863

Loc. 8: Many ♂♂, ♀♀ and many ovipositing tandems seen.

Gomphidae

Paragomphus lineatus (Selys, 1850)

Loc. 8: 4 ♂♂ seen, 1 ♂ collected

Onychogomphus lefebvrii (Rambur, 1842)

Loc. 8: 3 ♂♂ seen, 1 ♂ collected

Aeshnidae

Anax imperator Leach, 1815

Loc. 6: several ♂♂ seen, 1 ♂ collected; Loc. 3: 1 ♂ seen.

Anax parthenope (Selys, 1839)

Loc. 15: two ♂♂ seen, 1 ♂ collected; Loc. 3: several ♂♂ and 1 copula seen, 1 ♂ collected.

Libellulidae

Selysiothemis nigra (Vander Linden, 1825)

Loc. 6: Several ♂♂, ♀♀ and copulae seen, 1 ♂ collected.

Crocothemis erythraea (Brullé, 1832)

Loc. 1: Several ♂♂, ♀♀ seen; Loc. 2: Several ♂♂, ♀♀ seen; Loc. 3: 4 ♂♂ seen, 1 ♂ collected, Loc. 4: 2 ♂♂ seen; Loc. 6: Several ♂♂, ♀♀ seen, 1 ♂ collected; Loc. 7: Several ♂♂, ♀♀ seen; Loc. 8: Several ♂♂, ♀♀ seen; Loc. 9: 3 ♂♂ seen; Loc. 15: Several ♂♂, ♀♀ seen, 1 ♂ collected (Fig. 17).

Fig. 17a. male, b. female of *Crocothemis erythraea* perching on plastic debris.

Fig. 18. A male of *Orthetrum anceps*.

Trithemis kirbyi Selys, 1891

Loc. 1: Several ♂♂ seen; Loc. 3: Several ♂♂ seen; Loc. 6: Several ♂♂ seen; 1 ♂ collected, Loc. 7: 4 ♂♂ seen; Loc. 9: 2 ♂♂ seen; Loc. 10: Several ♂♂, ♀♀ seen,1 ♂ collected; Loc. 15: Several ♂♂, ♀♀ seen, 1 ♂ collected.

Orthetrum sabina (Drury, 1773)

Loc. 1: 3 ♂♂ seen, 1 ♂ collected; Loc. 3: 2 ♂♂ seen; Loc. 6: 3 ♂♂ seen; 1 ♂ collected.

Orthetrum cancellatum (Linnaeus, 1758)

Loc. 6: 3 ♂♂ seen, 1 ♂ collected; Loc. 9: 2 ♂♂ seen; 1 ♂ collected; Loc. 10: Several ♂♂ seen, 1 ♂ collected; Loc. 13: 2 ♂♂ seen.

Orthetrum anceps (Schneider, 1845)

Loc. 8: Several ♂♂ ♀♀ seen; 1 ♂ collected (Fig. 18).

Orthetrum brunneum (Fonscolombe, 1837)

Loc. 4: 4 ♂♂ seen, 1 ♂ collected; Loc. 7: 3 ♂♂ seen, 1 ♂ collected; Loc. 8: Several ♂♂, ♀♀ seen, 1 ♂ collected.

Orthetrum taeniolatum (Schneider, 1845)

Loc. 1: several ♂♂ ♀♀ and 2 copulae seen, 1 ♂ collected; Loc. 3: several ♂♂ ♀♀ seen; 1 ♂ collected; Loc. 10: Several ♂♂ seen, 1 ♂ collected; Loc. 13: 2 ♂♂ seen.

Orthetrum chrysostigma (Burmeister, 1839)

Loc. 3: several ♂♂ seen, 1 ♂ collected; Loc. 5: several ♂♂ ♀♀ and 1 copulae seen, 1 ♂ collected.

Sympetrum fonscolombii (Selys, 1840)

Loc. 1: several ♂♂ ♀♀, 1 ♂ collected.

Discussion

Of 100 autochthonous taxa of dragonflies that have been confirmed to be present in Iran (Schneider et al. 2018), 20 species were recorded during this study. The biogeographic affiliation of the species encountered following to the classification proposed by Heidari and Dumont (2002), comprises 5 Eurosiberian species (*I. pumilio*, *I. elegans*, *O. brunneum*, *O. cancellatum*, *O. taeniolatum*), 4 Irano-Turanian species (*I. evansii*, *I. fountaineae*, *S. nigra*, *O. lefebvrii*), 3 Mediterranean species (*E. viridulum*, *P. dealbata*, *O. anceps*), 3 species with a broad West Palaearctic/Afrotropical distribution (*A. imperator*, *C. erythraea*, *S. fonscolombii*), 2 Oriental species (*P. lineatus*, *O. sabina*) and 3 species with range that span both the Afrotropical and Oriental regions (*A. parthenope*, *O. chrysostigma*, *T. kirbyi*).

Ischnura elegans and *Calopteryx splendens intermedia* Selys, 1887 (syn. *Calopteryx intermedia persica* Bartenef, 1912) are the only Odonata species that have been reported from Qom province before (Schmidt 1954). Several Odonata species have been reported from different parts of Esfahan province, however there are only two species records from our studied area of this province (the arid part of the north), *Diplacodes lefebvrii* (Rambur, 1842) from Kashan city, and *Sympetrum meridionale* (Selys, 1841) from Kadich, north of Esfahan province (Schmidt 1954; Heidari & Dumont 2002; Schneider et al. 2018).

All of the 18 species recorded from Qom province, except *Ischnura elegans*, are new records for this province. In addition *Selysiothemis nigra*, *Orthetrum chrysostigma* and *Orthetrum taeniolatum* are new findings for Esfahan province.

Ischnura elegans was found during our study in Qom province, while *Diplacodes lefebvrii* (Rambur, 1842), recorded in Kashan city in September 1999 (Schneider et al. 2018), was not discovered during our visits around the Kashan city. The reason could be the time of our survey (May) that did not match the flight season of this species. The same reason could be attributed to the absence of *S. meridionale* from our species list. *Calopteryx splendens intermedia* prefers rivers and streams; we visited such a habitat at locality 8 but did not find this species, maybe because of the water salinity (Salinity = 5.12 (‰)), Bäthe and Coring (2011) also showed that increasing salinity could be the reason of the closely related taxon *C. splendens splendens*' absence from their studied rivers.

The most common species was *C. erythraea* (found in 9 water bodies); this finding is easily explained by the fact that this species is a good disperser, has exophytic oviposition, prefers higher temperatures and tolerates salinity (Khrokalo & Matushkina 2010; Suhling et al. 2003); this high plasticity to harsh ecological conditions enables it to colonise most of the waterbodies in the studied area.

Of 20 recorded Odonate species, 6 were Zygoptera and 14 were Anisoptera. One probable reason of low number of Zygoptera could be that they are species with endophytic oviposition requiring submerged vegetation for oviposition (Suhling et al. 2003). As aeshnids also exhibit endophytic oviposition, *Anax*-species were only observed in low numbers.

The most common member of the Zygoptera was *I. fountaineae* which was found at 7 localities. This is not a surprise since this species is the most thermophilic species in the nymphal phase and the most thermoxerophilic in the adult phase compared with *I. elegans*, *I. evansi* and *I. pumilio* (Borisov 2006b) and is considered a desert dweller with high abundance at artificial reservoirs of the desert zone (Borisov 2006a).

Species richness was almost equal between natural and man-made water bodies, as we recorded 14 species in 3 natural water bodies (localities 8, 9, 13) and 15 species in 12 man-made reservoirs, but species composition was different: There were 9 shared species that occur in both types of water bodies namely *I. elegans*, *I. fountaineae*, *C. erythraea*, *T. kirbyi*, *O. sabina*, *O. cancellatum*, *O. anceps*, *O. brunneum*, and *A. imperator*, while *P. lineatus*, *O. lefebvrii*, *P. dealbata*, *I. evansi*, and *I. pumilio* were restricted to natural water reservoirs (localities 8 and 9), and *E. viridulum*, *S. nigra*, *O. taeniolatum*, *O. chrysostigma*, *S. fonscolombii*, and *A. parthenope* were found only in man-made reservoirs.

Species that we recorded around the man-made reservoirs are stress-tolerant and generalist species, with the ability to colonise waterbodies in their initial stages of succession (Borisov 2006b; Chovanec & Raab 1997; Pinkert et al. 2017; Suhling et al. 2006; Suhling et al. 2015). Although we visited man-made water bodies with different habitat qualities, all of them were suffering from some degree of disturbance. Their Odonata assemblages also indicate that these habitats tend to be degraded (Renner et al. 2018; Samways & Steytler 1996; Suhling et al. 2006). On the other hand *O. lefebvrii* and *P. lineatus*, found only at locality 8, are sensitive to habitat and water quality degradation, so their existence indicates good habitat quality (Amr et al. 2013; Debata et al. 2013).

However since we could not find any taxon of *Calopteryx*, it seems that habitat quality even at locality 8 is not good enough for more sensitive species, e.g. with demands for higher oxygen content in the water.

According to their electrical conductivity (ECi) and based on Rhoades (1992) the water bodies studied can be classified as follows: slightly saline (EC= 0.7±2.0), moderately saline (EC= 2.0±10.0) and highly saline (EC= 10.0±20.5).

Species of slightly saline waters (localities 2, 3, 15): *I. fountaineae*, *O. taeniolatum*, *O. sabina*, *O. cancellatum*, *O. chrysostigma*, *T. kirbyi*, *C. erythraea*, *A. parthenope*.

Species of moderately saline waters (localities 1, 6, 7 8, 9, 10, 11): *I. fountaineae*, *I. elegans*, *I. evansi*, *I. pumilio*, *E. viridulum*, *P. dealbata*, *S. nigra*, *C. erythraea*, *T. kirbyi*, *O. sabina*, *O. cancellatum*, *O. taeniolatum*, *O. brunneum*, *O. anceps*, *S. fonscolombii*, *P. lineatus*, *O. lefebvrii*, *A. imperator*, *A. parthenope*.

Species of highly saline waters (localities 4, 5, 12, 13, 14) were *C. erythraea*, *O. cancellatum*, *I. fountaineae* and *O. chrysostigma*.

All species that we found in highly saline waters, have also been recorded in saline waters during several studies before (Beschovski & Marinov 2007; Carchini & Di Domenico 1992; Gauci & Sciberras 2010; Suhling et al. 2003; Zia et al. 2018), they are apparently adapted to water with a high salt content.

Ischnura fountaineae, *Crocothemis erythraea*, and *Orthetrum cancellatum* obviously don't have any bioindicatorial value for the degree of salinity as they occurred at all studied water bodies ranging from low to high electrical conductivity.

In central Iran where the climate is extremely arid and where very few perennial water sources are available, man-made reservoirs related to irrigation system are the main habitat for Odonata species. Our study shows that although these reservoirs are suitable habitats for opportunistic and generalist species, but they cannot sustain sensitive and specialist species, probably because of their poor habitat structures (i.e. lack of riparian vegetation). Although all of the species recorded here are listed as "Least Concern" in the IUCN red list of threatened species (IUCN 2018), to our knowledge there is no information about the status of these species in central of Iran. Considering that more intense droughts are predicted for these areas and the current scenario of environmental degradation and habitat disturbance, some sensitive species on this list may be in danger of local extinction. As a consequence, to improve knowledge of conservation status of these species in central of Iran and to making management decisions, further investigations with a wider coverage are necessary.

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