Original Article

Fauna and Larval Habitat Characteristics of Mosquitoes (Diptera: Culicidae) in Kashan County, Central Iran, 2019

Tahereh Sadat Asgarian[1]; *Seyed Hassan Moosa-Kazemi[1]; *Mohammad Mehdi Sedaghat[1]; Rouhullah Dehghani[2]; Mohammad Reza Yaghoobi-Ershadi[1]

[1]Department of Medical Entomology, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran
[2]Social Determinants of Health Research Center, Department of Environment Health, School of Public Health, Kashan University of Medical Sciences, Kashan, Iran

***Corresponding authors:** Dr Seyed Hassan Moosa-Kazemi, E-mail: moosakazemi@tums.ac.ir, Dr Mohammad Mehdi Sedaghat, E-mail: sedaghmm@tums.ac.ir

(Received 08 Feb 2020; accepted 24 Jan 2021)

Abstract

Background: Mosquitoes are responsible for spreading devastating parasites and pathogens causing some important infectious diseases. The present study was done to better understand and update the fauna of Culicidae and to find out the distribution and the type of their larval habitats in Kashan County.

Methods: This study was done in four districts of Kashan County (Central, Qamasr, Niasar and Barzok). Mosquito larvae were collected from 23 active larval habitats using a standard 350ml capacity mosquito dipper from April to late December 2019. The collected larvae were transferred to containers containing lactophenol, and after two weeks individually mounted in Berlese's fluid on a microscope slide and identified to species by morphological characters and valid keys.

Results: In this study, a total of 9789 larvae were collected from urban and rural areas in Kashan County. The identified genera were *Anopheles*, *Culiseta* and *Culex*. In this study larvae of *An. turkhudi*, *Cx. perexiguus*, *Cx. mimeticus*, *Cx. deserticola* and *Cs. subochrea* were collected for the first time from Kashan County.

Conclusion: The results of this study indicate the presence and activity of different mosquito species in Kashan County that some of them are vectors of arbovirus and other vector-borne diseases.

Keywords: Mosquito; Larvae; Surveillance

Introduction

Arthropod-borne diseases have always been a major health problem in different parts of Iran. Transmission of malaria, filariasis, enceph-alitis and other arboviral diseases by mosquitoes have made mosquitoes the most important arthropods in medicine and health (1-3). The mosquitoes are from the order Diptera, suborder Nematocera and the family Culicidae (4). Seven arboviral diseases, two bacterial diseases, four filarial and two protozoal diseases which are assumed to be transmitted by mosquitoes are found in Iran (1, 5). One genus and species (*Mansonia uniformis*) was added to Iranian mosquito checklist, thus there are 70 species and 8 (or 12) genera depending the classification of the tribe Aedini (6). This family has two subfamilies, Anophelinae and Culicinae in Iran. Azari-Hamidian et al. (1) reviewed mosquitoes of Iran and their medical and veterinary importance. There are diseases caused by mosquito-borne pathogens in Isfahan Province including Avian pox (chickens, pigeons and turkeys), West Nile fever (horses and humans), Anthrax (sheep, cattle and goats), mosquito-borne filariases (camels) and bird malaria (turkeys, hens/roosters, pigeons and migratory waterfowl).

Because of their high adaptation to different habitats, mosquitoes are successful organisms and are found all over the world except

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Published Online: March 31, 2021

Antarctica. Mosquito larvae are found in a range of habitats, including natural and artificial habitats, with temporary or permanent, stagnant or flowing waters, contaminated or clean waters, with or without vegetation, and even in the smallest places where water accumulates in it, such as pots, used tires and animal footprints (2, 3).

Based on literature, In Isfahan Province, ten species of *Anopheles*: *An. algeriensis*, *An. claviger*, *An. dthali*, *An. maculipennis*, *An. marteri*, *An. messeae*, *An. multicolor*, *An. sacharovi*, *An. superpictus*, and *An. turkhudi* have been reported (7-15). *An. messeae* was recorded based on egg chorion pattern (9). Zaim (10), Saebi (11) and Mousa-Kazemi et al. (12) reported the *Anopheles sacharovi* and *An. maculipennis* of the Maculipennis Group, based on morphological characters. The recent group species was also being verified later by PCR technique (13). Ladonni et al. (14) reported three species of *An. dthali*, *An. marteri*, and *An. turkhudi* to the fauna of the Isfahan province. Seven species of *Culex* have been reported in Isfahan Province including: *Cx. hortensis*, *Cx. mimeticus*, *Cx. modestus*, *Cx. perexiguus*, *Cx. pipiens*, *Cx. territans*, and *Cx. theileri* (10, 12, 16, 17). *Culiseta longiareolata*, *Cs. annulata* and *Cs. subochrea* are cited in the province (10, 12, 17). Three species of *Ochlerotatus caspius* s.l., *Oc. pulcritarsis*, and *Aedes vexans* have been reported in the province (10, 12, 18). Zaim (18) reported *Uranotaenia unguiculata*. Based on Ladonni et al. (14) there are at least 24 species and six genera in the province.

Little information is available about mosquitoes in Kashan County. Zaim (10) mentioned some aspects of mosquito larvae and adult ecology in Kashan County and relieved that the occurrences of 14 species in this area. Doroudgar et al. (15) studied the epidemiology of malaria in Kashan. This limited information are not sufficient as the basis to prevent possible epidemics of mosquito borne diseases. Because of the importance of mosquitoes in medicine and health and disturbances caused by bites, the special location of Kashan County, climate changes in the county, as well as the construction of garden of birds in Qamsar that have led to the entry of birds from 17 different countries into the area, therefore, fauna and ecological study and obtain data on larval habitats, species composition, active season, and activity peak of mosquito larvae in Kashan County are very important in integrated vector management. An entomology check program was felt after more than three decades in the county and a specialized study was done to better understand and update the fauna of Culicidae in Kashan County and to find out the distribution and the type of their larval habitats in the region, which can lead to preparation of basic information in the country and region and if necessary, be effective in adopting the right strategy of integrated vector management.

Materials and Methods

Kashan County is located in the north of Isfahan Province, between Karkas Mountains and the central desert of Iran. This county is bounded on the north by the central desert and the city of Qom, on the east by the desert plain, on the south by the towns of Borkhar and Meymeh and Natanz and on the west by the city of Mahallat. Kashan County has four districts (Central, Qamsar, Niasar and Barzok) and seven cities (Kashan, Meshkat, Qamsar, Niasar, Jowshaqan, Kamoo and Barzok). This is a faunistic and descriptive-sectional study that was done in four districts of Kashan County including Central District (Kashan and Meshkat cities), Qamasr District (Qamasr, Kamoo and Jowshaqan cities), Niasar District (Niasser City) and Barzok District (Barzok City).

The climate of the county varies depending on ups and downs. The uplands are cold, foots are temperate and plains, and especially on the margins of the desert are tropical. This county has a special position due to located on a large chain of roads in the country, located on the north-south transit route and located on the main communication route between eastern, western, northern and southern cities and provinces (19).

In this study, larval habitats were visited in 77 urban and rural areas of the county and 23

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active larval habitats were selected (Figs. 1, 2). Permanent or temporary, natural or artificial larvae habitats, with or without vegetation, slow flowing or still water and full or partial sunlight in urban or rural areas, visited and sampled monthly. Larvae and pupae of the mosquitoes were collected using a standard 350ml capacity mosquito dipper from April to late December 2019. Twenty dips were taken in each larval habitat. Sampling were always done by the same individual in the morning (08:00–12:00h) or afternoon (15:00–18:00h). Larvae from small water bodies collected by eye dropper. The collected larvae were transferred to petri dish containing lactophenol and the date, collection site and habitat type of the larvae were recorded with special code on the containers and in the relevant forms and transferred to medical entomology laboratory of Tehran University of Medical Sciences (TUMS). After that the larvae in lactophenol were transparent, each larva was individually mounted in Berlese's fluid on a microscope slide and identified to species by morphological characters and valid keys (20-22). Some mosquitoe specimens were deposited in the museum of medical entomology, TUMS.

Results

In this study, a total of 9789 larvae were collected from urban and rural areas of four districts of Central, Qamsar, Niasar and Barzok in Kashan County and were identified based on valid diagnostic keys at species level. The identified genera was *Anopheles* 772 (7.89%), *Culiseta* 1706 (17.42%) and *Culex* 7311 (74.69%) which included 13 species. *Culex pipiens* and *Cx. theileri* had the highest abundance with 3658 (37.36%) and 2555 (26.10%), respectively (Table 1).

Ten larval habitats were artificial and 13 were natural. 45.8% of larval habitats were in urban areas and 54.2% in rural areas. Among the larval habitats in urban areas, Kashan had the highest and Meshkat (Central District) the least abundance of larvae. In the rural areas, the larvae habitats of Khoncheh (from Central District) and Qazaan (from Qamsar District) had the highest and lowest abundance of mosquito larvae, respectively. In terms of mosquito fauna diversity, the Central District (Kashan and Meshkat cities) with 3 species (*Cx. pipiens*, *Cx. theileri* and *Cs. longiareolata*) had the least species diversity and districts of Barzok and Niasar with 11 species had the highest mosquito larvae fauna diversity. In terms of time distribution, the highest number of larvae was in August and the lowest number of larvae was in December. In this study, *Cx. pipiens*, *Cx. theileri*, *Cs. longiareolata* and *An. superpictus* s.l. showed the highest time dispersion. All *Anopheles* species in this study were collected from natural habitats. Among the Culicinae species, *Cx. pipiens*, *Cx. theileri* and *Cs. longiareolata* were collected from natural and artificial habitats and the rest of the species collected only from natural larval habitats. Larvae of *An. superpictus* s.l. and *An. maculipennis* s.l. were collected from permanent and temporary habitats and larvae *An. claviger* and *An. turkhudi* were found from a temporary habitat. The larval habitat characteristics of the species has been listed in Table 2.

In view of the simultaneous presence of different larval species in larval habitats, *Cx. theileri* was collected from 23 habitats with all others larvae. This species had the highest distribution in Kashan County. *Culiseta longiareolata* was collected from 20 larval habitats. *Anopheles superpictus* s.l. was collected from 10 larval sites in four districts of the county and had the highest dispersal among anopheline species. Species of *An. claviger*, *An. turkhudi*, *Cs. annulata* and *Cs. subochrea* each with a larval habitat had the least distribution in Kashan County (Table 3). Table 4 shows the species caught and coordinates of the collection sites of mosquito larvae in Kashan County.

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Table 1. Abundance of larvae of the mosquito species collected in Kashan County, central Iran, 2019

Species	Districts of Kashan County									
	Central		Qamsar		Niasar		Barzok		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
***An. superpictus* s.l.**	159	3.21	453	14.94	10	1.08	57	6.44	679	6.93
***An. maculipennis* s.l.**	0	0	54	1.78	15	1.63	22	2.49	91	0.93
An. claviger	0	0	0	0	1	0.10	0	0	1	0.01
An. turkhudi	0	0	0	0	0	0	1	0.11	1	0.01
Cx. pipiens	2651	53.56	733	24.17	37	4	237	26.78	3658	37.36
Cx. theileri	1028	20.8	1233	40.67	176	19.07	118	13.33	2555	26.10
Cx. deserticola	175	3.53	105	3.46	68	7.37	92	10.40	440	4.5
Cx. perexiguus	205	4.14	29	0.96	71	7.70	31	3.50	336	3.43
Cx. hortensis	150	3.03	31	1.02	40	4.33	33	3.73	254	2.60
Cx. mimeticus	15	0.30	39	1.29	0	0	14	1.58	68	0.70
Cs. longiareolata	566	11.43	355	11.7	460	49.84	280	31.64	1661	16.96
Cs. annulata	0	0	0	0	43	4.66	0	0	43	0.44
Cs. subochrea	0	0	0	0	2	0.22	0	0	2	0.02
Total	4949	100	3032	100	923	100	885	100	9789	100

Table 2. Characteristics of larval habitats and percentage of mosquito larvae in Kashan County, central Iran, 2019

Characteristic	Variables	Percentage of Culicidae larvae (%)												
		***An. superpictus* s. l.**	***An. maculipennis* s. l.**	***An. claviger***	***An. turkhud***	***Cx. pipiens***	***Cx.deserticola***	***Cx.hortensis***	***Cx. perexiguus***	***Cx. mimeticus***	***Cx. theileri***	***Cs. longiareolata***	***Cs. annulata***	***Cs. subochrea***
Permanence	Permanent	90	33.3	0	0	17.6	75	60	62.5	66.7	39.1	40	0	0
	Temporary	10	66.7	100	100	82.4	25	40	37.5	33.3	60.1	60	100	100
Water current	Slow flowing	70	33.3	0	0	0	75	60	62.5	66.7	34.8	35	0	0
	Still	30	66.7	100	100	100	25	40	37.5	33.3	65.2	65	100	100
Intensity of light	Full sunlight	80	33.3	0	0	23.5	75	40	75	66.7	73.9	85	0	0
	Partial sunlight	20	66.7	100	100	76.5	25	60	25	33.3	26.1	15	100	100
Turbidity	Clear	90	66.7	100	0	52.9	87.5	80	75	66.7	87	85	100	100
	Turbid	10	33.3	0	100	47.1	12.5	20	25	33.3	13	15	0	0
Vegetation	With vegetation	90	100	100	100	58.8	100	100	87.5	100	56.52	10	100	100
	Without vegetation	10	0	0	0	41.2	0	0	12.5	0	43.48	90	0	0
Substrate type	Mud	20	66.7	100	100	76.5	25	40	37.5	33.3	17.4	60	100	100
	Sand	80	33.3	0	0	23.5	75	60	62.5	66.7	82.6	40	0	0
Habitat type	Natural	100	100	100	100	11.8	100	100	100	100	56.6	50	100	100
	Artificial	0	0	0	0	88.2	0	0	0	0	43.4	50	0	0

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Table 3. Number of simultaneous presence of mosquito larvae in active larval habitats in Kashan County, central Iran, 2019

Species	No. of Larval habitat	*An. superpictus* s. l.	*An. maculipennis* s. l.	*An. claviger*	*An. turkhud*	*Cx. pipiens*	*Cx.deserticola*	*Cx.hortensis*	*Cx. perexiguus*	*Cx. mimeticus*	*Cx. theileri*	*Cs. longiareolata*	*Cs. annulata*	*Cs. subocrea*
***An. superpictus* s. l.**	10	*	2	-	1	7	6	4	5	3	10	10	-	-
***An. maculipennis* s. l.**	3	2	*	1	1	3	3	3	3	2	3	3	1	1
An. claviger	1	-	1	*	-	1	1	1	1	-	1	1	1	1
An. turkhudi	1	1	1	-	*	1	1	1	1	1	1	1	-	-
Cx. pipiens	17	7	3	1	1	*	7	5	7	3	17	17	1	1
Cx. deserticola	8	6	3	1	1	7	*	5	6	3	8	8	1	1
Cx. hortensis	5	4	3	1	1	5	5	*	4	3	5	5	1	1
Cx. perexiguus	8	5	3	1	1	7	6	4	*	3	8	8	1	1
Cx. mimeticus	3	3	2	-	1	3	3	3	3	*	3	3	-	-
Cx. theileri	23	10	3	1	1	17	8	5	8	3	*	20	1	1
Cs. longiareolata	20	10	3	1	1	17	8	5	8	3	20	*	1	1
Cs. annulata	1	-	1	1	-	1	1	1	1	-	1	1	*	1
Cs. subochrea	1	-	1	1	-	1	1	1	1	-	1	1	1	*

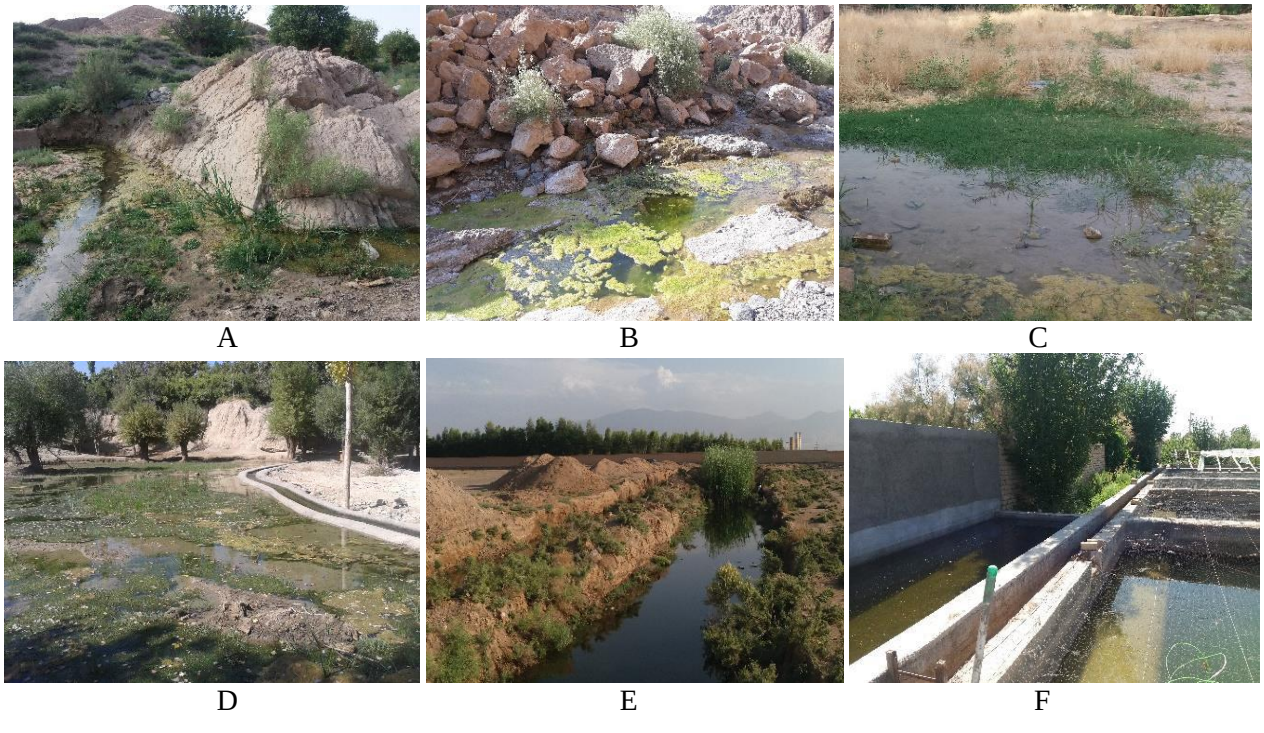

Fig. 1. Some of active larval habitats in the study areas of Kashan County, central Iran from April to late December 2019. A. Khoncheh (Permanent, Slow Flowing), B. Nabar (Natural and Permanent), C. Niasar (Temporary, Still), D. Barzok (Natural and Still), E. Kashan (Natural, Slow Flowing) and F. Kashan (Artificial and Still)

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Published Online: March 31, 2021

Table 4. Coordinates of the collection sites and mosquito larvae identified in Kashan County, central Iran, 2019

District	Site of Sampling	Longitude	Latitude	Mosquito larvae Identified
Central	Meshkat-Hamzer	51.25705	34.17636	*Cx. theileri*
Central	Meshkat	51.27324	34.18104	*Cs. longiareolata*, *Cx. pipiens*, *Cx. theileri*
Central	Taherabad	51.35628	34.0421	*Cs. longiareolata*, *Cx. pipiens*, *Cx. theileri*
Central	Ravand (Fish Farming)	51.37237	34.02696	*Cs. longiareolata*, *Cx. pipiens*, *Cx. theileri*
Central	Kashan University of Medical Science	51.41	34.01705	*Cs. longiareolata*, *Cx. pipiens*, *Cx. theileri*
Central	Wastewater treatment	51.39998	34.04713	*Cs. longiareolata*, *Cx. pipiens*, *Cx. theileri*
Central	Khoncheh	51.21894	33.98134	*An. superpictus* s. l., *Cs. longiareolata*, *Cx. theileri*, *Cx. deserticola*, *Cx. hortensis*, *Cx. mimeticus*, *Cx. perexiguus*, *Cx. pipiens*
Central	Jazeh	51.377 7	33.84543	*Cs. longiareolata*, *Cx. pipiens*, *Cx. theileri*
Qamsar	Moslemabad	51.50039	33.78592	*An. superpictus* s. l., *Cs. longiareolata*, *Cx. theileri*
Qamsar	Road of Javinan	51.48367	33.74182	*An. superpictus* s. l., *Cs. longiareolata*, *Cx. deserticola*, *Cx. hortensis*, *Cx. pipiens*, *Cx. theileri*
Qamsar	Farfahan-Wastewater	51.42875	33.77983	*Cs. longiareolata*, *Cx. pipiens*, *Cx. theileri*
Qamsar	Farfahan-River	51.43248	33.75867	*An. maculipennis* s. l., *An. superpictus* s. l., *Cs. longiareolata*, *Cx. pipiens*, *Cx. theileri*, *Cx. deserticola*, *Cx. hortensis*, *Cx. mimeticus*, *Cx. perexiguus*
Qamsar	Mazgan	51.40234	33.73779	*Cx. theileri*
Qamsar	Bonrood	51.42037	33.72226	*An. superpictus* s. l., *Cs. Longiareolata*, *Cx. deserticola*, *Cx. pipiens*, *Cx. theileri*
Qamsar	Qazaan	51.39733	33.7058	*Cs. longiareolata*, *Cx. deserticola*, *Cx. perexiguus*, *Cx. theileri*
Qamsar	Qohroud	51.42307	33.67773	*An. superpictus* s. l., *Cs. longiareolata*, *Cx. deserticola*, *Cx. pipiens*, *Cx. theileri*, *Cx. perexiguus*
Niasar	Kamal-al-Molk Spring	51.09115	34.0962	*An. superpictus* s. l., *Cs. longiareolata*, *Cx. pipiens*, *Cx. theileri*, *Cx. perexiguus*
Niasar	Kamal-al-Molk	51.11026	34.08385	*Cs. longiareolata*, *Cx. pipiens*, *Cx. theileri*
Niasar	Niasar	51.15015	33.97601	*An. maculipennis* s. l., *An. claviger*, *Cs. annulata*, *Cs. subochrea*, *Cs. longiareolata*, *Cx. deserticola*, *Cx. hortensis*, *Cx. pipiens*, *Cx. theileri*, *Cx. perexiguus*
Niasar	Nashalj	51.07791	33.97987	*Cs. longiareolata*, *Cx. perexiguus*, *Cx. pipiens*, *Cx. theileri*
Barzok	Nabar	51.20775	33.88567	*An. superpictus* s. l., *Cs. longiareolata*, *Cx. theileri*
Barzok	Barzok-Spring	51.22939	33.78756	*An. maculipennis* s. l., *An. superpictus* s. l., *An. turkhudi*, *Cs. longiareolata*, *Cx. deserticola*, *Cx. hortensis*, *Cx. pipiens*, *Cx. mimeticus*, *Cx. theileri*, *Cx. perexiguus*
Barzok	Barzok-Khavid	51.22525	33.79302	*An. superpictus* s. l., *Cs. longiareolata*, *Cx. theileri*

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Published Online: March 31, 2021

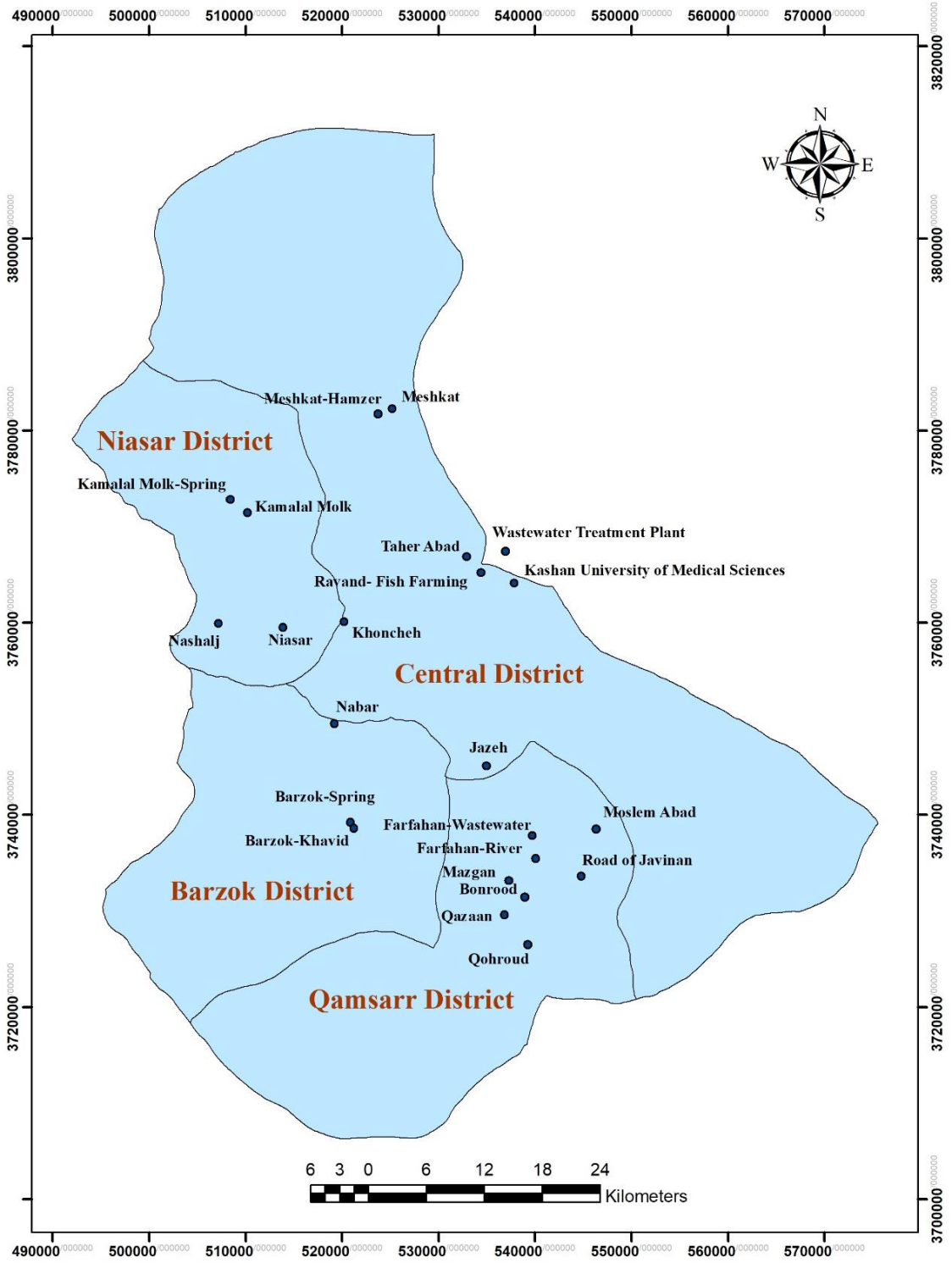

Fig. 2. The location of larva sampling places in Kashan County, central Iran, 2019

Discussion

In this study, 13 species of mosquito larvae were collected and identified from three genera of Culicidae. Larva of *An. turkhudi* was collected for the first time from Kashan County, the city of Barzok. Also among the species of *Culex*, larvae, *Cx. mimeticus* and *Cx. deserti-*

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Published Online: March 31, 2021

cola were found from Kashan County for the first time. Of the three species of *Culiseta* identified in this study, *Cs. subochrea* was identified for the first time in the county and found from a temporary natural habitat associated with *Cs. annulata* larvae in the city of Niasar. Zaim (10) reported *Cx. modestus* from Mahmoudabad of Kouhpayeh. We did not catch this species, because in recent years land leveling, destruction of lowlands and highlands, improvement of streams and cementation of streams have reduced larval habitats in different areas of Mahmoudabad (now is named Meshkat City). Zaim (10) also reported *An. multicolor* from Shurab area. In the new divisions of the country, this area has been separated from Kashan County and is an area in Aran and Bidgol County, therefore, it was not one of our study areas.

***Anopheles superpictus* s.l.**

This *Anopheles* is distributed throughout the Iranian Plateau and the slopes of the Alborz Mountains and southern Zagros, as well as the coastal plains of the Caspian Sea and the Persian Gulf (23) and is one of the seven species of malaria vectors in Iran (20). This species was the most abundant and distributed species among *Anopheles* in Kashan County with 87.95% of the *Anopheles* collected. Its larvae were collected from Qamasr, Khoncheh, Barzok, Qohroud, Javinan, Ka-malal-Molk, Moslem Abad and Nabar from June to November. Previous studies have also reported larvae of this species from different regions of Kashan County (10, 15). Barghamadi et al. (24) reported the best larval habitat for this species in Kohkiluyeh and Boyer-Ahmad Province, natural habitats with permanent and clear water, still, non-vege-tated with mud core. Moosa-Kazemi et al. (12) reported its larval habitat primarily on rocky at shallow depths and secondarily on sandy and sunny rivers also shallow creeks with muddy bed. In a study in Ardabil, larvae of this species were reported from permanent and temporary habitats with submerged vegetation and from riverbeds (25). In the study done in Pol Dokhtar County from Lorestan Province, the larvae of this species was mostly found in natural habitats of edge and bed of rivers with permanent, slow flowing and clear water with external or submerged vegetation (26). Soleimani-Ahmadi et al. (27) collected this species from larval breeding habitats including permanent habitats in riverbeds mostly without vegetation and algae also still and clear water with full sunlight and sandy substrates. In Kashan County, the best larval breeding habitats for this species was the natural habitat of river edge with permanent and Slow flowing water and external or submerged vegetation.

***Anopheles maculipennis* s.l.**

This species was included 11.79% of total Anophelinae species collected from Kashan County. It was found from temporary natural habitats in Niasar (July), in Barzok (September and October) and a permanent natural habitat in Qamasr (July and August), and 100% of its larval habitats in Kashan County had low to high vegetation. Zaim (10) reported this species only once in July 1984 from Qamsar. Larvae of this species have been reported in swamps, marshes, natural meadows, and water leaks in rivers and springs and in sandy beds of rivers and stagnant waters. This species is one of the malaria vectors in Iran and is the main vector in the Caspian coast in northern Iran (28).

Anopheles claviger

It occupies a variety of larval habitats but usually prefers non-polluted, permanent or semi-permanent waters and it has been reported in almost all provinces of the country and is widely distributed in the north and central parts of Iran (29). Waters that are warmed by sunlight, on the margins of rivers and canals in stagnant water or with slow flowing in areas with shades of plants and trees, are suitable for larval period (30). It is blood sucking outdoor and transfers Tularemia disease (29). In Kashan County, this species was found from Niasar in a temporary larval habitat with stagnant, semi-sunny, clear water and high vegetation in August. In 1984, Zaim (10) collected these mosquito larvae from a larval breeding place with running water next to a water stream in Mahmoudabad area in December.

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Anopheles turkhudi

This species has been reported from the south and some parts of central Iran (29, 31). In this study, the larvae of this mosquito were found from Kashan County for the first time from a temporary natural larval breeding place with vegetation also still and turbid water with partial sunlight and muddy substrates in Barzok in September. Ladonni et al. (14) reported this species from Fereydunshahr for the first time in Isfahan Province.

Culex pipiens

Its larval breeding place include both natural and artificial habitats. Among the larvae collected in Kashan County, this species was most abundant and was collected from April to late December. Among the different Districts of Kashan County, the most larvae of this species belonged to the Central District and the city of Kashan so that, out of 3,645 larvae *Cx. pipiens*, 2020 were collected from urban and rural Kashan, such as Kashan wastewater treatment plant, stabilization pond of Kashan University of Medical Sciences and waste water. In Iran, this species has been often reported from natural habitats (8). Zaim (10) found it from the natural habitats. Moosa-Kazemi et al. (30) and Azeri-Hamidian (32) collected it from man-made habitats, artificial habitats and rice fields. In Kashan County, the best larval habitat for this species was temporary larval breeding place with still and clear water, vegetation and partial sunlight. Many arbovirus diseases are transmitted to humans by *Cx. pipiens*, such as the Rift Valley fever, Japanese encephalitis, and the West Nile. This species is primarily an ornithophilic species that feeds on both man and animals (33).

Culex theileri

This mosquito is found in some parts of the world and has been reported from all provinces of Iran (34-38). In Kashan County, this species had the highest spatial distribution and was collected from all larval habitats in cities and villages all of the time study from April to December. Its larval habitats are diverse in Kashan County. The best habitat for its larvae was the natural, permanent and temporary habitat, with still and clear water, and fullest sunlight with or without vegetation. Zaim (18) reported it from natural habitats, Moosa-Kazemi et al. (37) and Yaghoobi-Ershadi et al. (38) reported it from natural and artificial habitats. *Cx. theileri* is a major vector of the Rift Valley fever virus in South Africa (39) and it is involved in the transmission of *Dirofilaria immitis* nematode to humans. In Iran, third instar larvae of *Cx. theileri* were naturally infected with *D. immitis* and may be the main vector of this parasite (35). *Culex theileri* also transmits West Nile and Sindbis viruses in vitro (40).

Culex hortensis

This species is widely distributed in the mountainous regions of Iran and has been reported from at least 23 provinces (10, 18, 32 and 41) and in Kashan County was collected from permanent natural larval breeding places in Central District, Khoncheh village (August), natural and permanent larval breeding places in Qamsar (August), natural and temporary larval habitat in Niasar (July and August) and natural and temporary larval habitat of Barzok (the months of September and October). The best habitat for larvae of this species in Kashan County was permanent habitats with slow flowing and clear water, full sunlight with vegetation. Zaim (10) reported this species from Dehnar, Qamsar, Qohroud, Barzok and Niasar in 1984. *Culex hortensis* has been introduced as a vector of avian malaria In vitro (42).

Culex deserticola

Larvae of this species were found in larval habitats with *Cx. hortensis* and is reported for the first time from Kashan County. Larvae were collected in Central District from the natural and permanent larval habitats of Khoncheh village in September and October, in Qamsar District from natural and permanent habitats of Qamsar City and villages of Qohroud and Qazaan in July and September, in Niasar District from a natural and temporary habitat in city of Niasar in June and July and in Barzok District from a temporary natural habitat from June to October. Its best larval habitats for this species in Kashan County was permanent hab-

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itats with slow flowing and clear water with vegetation and full or partial sunlight.

Culex perexiguus

It is distributed in most provinces in Iran (18). In Kashan County, this species was found from permanent or temporary natural larval habitats in Qamasr, Niasar, Barzok and the villages of Qohroud, Kamalal-Molk and Khoncheh from June to October. The best habitat for larvae of this species in Kashan was permanent habitats with slow flowing water, full sunlight and with vegetation. Zaim (10) found *Cx. perexiguus* (as *Cx. univittatus*) in Mahmoudabad of Kouhpayeh.

Culex mimeticus

It is widely distributed in Iran and its larvae are found along the rocks and on the riverside of mountainous areas with abundant vegetation (10). The best habitat for larvae of this species in Kashan County was permanent habitats with clear slow flowing water, full sunlight, and with vegetation, and was found from larval habitats in Khoncheh (July), Qamasr (September) and Barzok (August, September and October). In this study, *Cx. mimeticus* larvae were reported from Kashan County for the first time. Zaim (10) found only adult of this species from Qohroud.

Culiseta longiareolata

This species is widely distributed in Iran. This mosquito has a variety of larval habitats, and is found in clear to polluted waters and in fresh and saline waters (10, 43). In Kashan County, this species was an active mosquito species and its larvae were collected from different habitats throughout the study from April to late December. 93.2% of larval habitats of this species in Kashan County had no vegetation and 100% of them had still water. Zahirnia et al. (26) also collected 70% of the larvae of this species in Pol Dokhtar County from without vegetation habitats. It often is blood sucking from birds and rarely attacks humans. Although it feeds only on birds in North Africa, it feeds on large domestic animals in Europe, including France. This species has medical importance. Adults are vectors of brucellosis, avian influenza virus, West Nile (44) as well as avian malaria (42). Its larvae are known as mosquito larvae predators (45).

Culiseta annulata

In Iran, larvae have been found from mountainous areas and the Alborz and Zagros Mountains. It has also been reported from Bushehr (46). Azari-Hamidian (43) studied the larval habitat characteristics and associated species in Guilan Province. In Kashan County, this mosquito Larvae was found from a temporary natural habitat, partial sunlight with high vegetation, still and clear water in Niasar in June and July. This larval habitat was dried in mid-July. Larvae of this species were not found in the other studied areas. Zaim (10) reported larvae of this species in June from temporary larval habitats with still fresh water in Qohroud and from permanent larval habitats with saline flowing water from Mahmoudabad in October and November. Azari-Hamidian (43) reported it from both natural and artificial habitats.

Culiseta subochrea

Culiseta subochrea is found in a number of provinces in Iran (47-49). In Kashan County, this species was found in a temporary larval habitat with still and clear water, partial sunlight and tall vegetation with *Cs. annulata* in Niasar. Paksa et al. (48) collected this species from stagnant and turbid water habitats with muddy substrate and shallow depth.

Conclusion

The results of this study indicate the presence and activity of different mosquito species in Kashan County. Considering the dispersion of *An. superpictus* s.l. in different districts of Kashan County, its abundance and since it's one of the seven malaria vectors in the country, a study is needed to identify its complex species. This study could be a basis for more comprehensive research about the importance of mosquitoes in medicine and health. We declare that we have no conflict of interest.

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Published Online: March 31, 2021

Acknowledgements

Authors are grateful to Dr SM Asgarian for helping with field collections. The authors declare the ethical approval code as No.: IR.TUMS.VCR.REC.1397.1001.

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