

Short Communication

The fauna and active season of mosquitoes in West of Fars Province, Southwest of Iran

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ABSTRACT

Culicidae are highly important for public health as they can be vectors of diseases and are responsible for a wide spectrum of infections. Five collection sites were selected randomly with regards to existing facilities in Firouzabad County. For collecting larvae and total catch for adult mosquitoes, sampling was carried out by dipping technique for collecting larvae and total catch for adult mosquitoes. A total of 689 adults and 1313 larvae of Culicidae were collected, of which 3 genera and 6 species of Culicidae were recognized, namely, *Anopheles superpictus*, *Anopheles d'thali*, *Culex sinaiticus*, *Culex theileri*, *Culex mimeticus*, and *Culiseta longiareolata*. *Cx. theileri* was the most frequent Culicidae collected at Firouzabad, with a total of 613 and 247 larval and adult specimens, respectively. The highest number of mosquitoes was collected in June (31.1%) and the lowest in May (3.4%). The mean temperatures in June and May were 31.3°C and 28.2°C, respectively. We found some vectors that are of medical and veterinary importance; our results could be applied in vector control programs that aim at eradication or control of mosquitoes in this area.

Keywords: Culicidae, Monthly frequency, Fars, Southwestern Iran

La faune et la saison active des moustiques (Diptères: Culicidés) dans l'ouest de la province de Fars, sud-ouest de l'Iran

Résumé: Les moustiques (Culicidés) sont les plus importants vecteurs de maladie parmi les arthropodes, ils sont responsables de nombreuses infections. cette étude a été réalisée entre les mois d'avril et septembre 2012. Cinq sites de collections ont été sélectionnés au hasard parmi les installations existantes dans la ville de Firouzabad. L'échantillonnage a été effectué à l'aide d'une technique de trempage pour la collecte des larves et « total catch » (total des captures) pour les moustiques adultes. Au total, 689 moustiques adultes et 1313 larves de Culicidés ont été recueillis, comprenant 3 genres et 6 espèces de Culicidés identifiés; à savoir: *Anopheles superpictus*, *Anopheles d'thali*, *Culex sinaiticus*, *Culex theileri*, *Culex mimeticus* et *Culiseta longiareolata*. *Cx. theileri* était le moustique culicidé le plus fréquent à Firouzabad, avec un total de 613 et 247 spécimens de larves et de moustiques adultes respectivement collectés. Le nombre le plus élevé de moustiques a été recueilli en juin (31,1%) et le plus bas en mai (3,4%). Les températures moyennes durant les mois de juin et de mai

étaient respectivement de 31,3°C et de 28,2 °C. Cette étude a démontré qu'il existaient parmi les moustiques collectés à Firouzabad, des vecteurs potentiels de maladies transmissibles à l'homme et à l'animal. Ces vecteurs sont plus actifs au cours des mois de juin et juillet.

Mots-clés: Culicidés, Fréquence mensuelle, Fars, l'ouest de la province de Iran

INTRODUCTION

According to a recent study, the list of mosquitoes in Iran includes two subfamilies, Anophelinae and Culicinae, 64 species, and 3 subspecies belonging to seven genera, *Anopheles*, *Uranotaenia*, *Culiseta*, *Coquillettidia*, *Culex*, *Aedes*, and *Ochlerotatus* (Azari-Hamidian, 2007). (Mosquito-borne diseases such as Malaria, West Nile, Sindbis viruses, dengue fever, and *Dirofilaria* were reported from Iran (Naficy and Saidi, 1970; Saidi et al., 1976; Azari-Hamidian and Harbach, 2009; Chinikar et al., 2010). Malaria was native to most parts of Iran, but after six decades of effort, the disease has become limited to the southeastern part of the country (Raeisi et al., 2013). Seven species of the genus *Anopheles* Meigen (i.e., *An. maculipennis* Meigens. l., *An. sacharovi* Favre, *An. culicifacies* Giles s.l., *An. d'thali* Patton, *An. fluviatilis* James s.l., *An. stephensi* Liston, *An. superpictus* Grassi) are the known malaria vectors in Iran and *An. pulcherrimus* Theobald is considered a potential vector of malaria in the southeastern area of the country (Edrissian, 2006; Azari-Hamidian et al., 2009; Moosa-Kazemi et al., 2009). Dengue fever is transmitted by *Aedes aegypti* and *Ae. albopictus* (WHO, 2014). Previously, a case of dengue fever in Iran was reported in 2010 (Chinikar et al., 2010). The vector of dengue fever, *Aedes aegypti*, was previously reported from Iran (Zaim et al., 1985). Updating knowledge of the Culicidae fauna of Fars Province has been a priority for many years; up to now, 16 species of Culicinae have been recorded in Fars Province (Zaim, 1987), which include *Cs. subochrea* Edwards, *Cs. longiareolata* Macquart, *Ur. unguiculata* Edwards, *Ae. caspius* Pallas, *Cx. antennatus* (Becker), *Cx. bitaeniorhynchus* Giles, *Cx. tritaeniorhynchus* Giles, *Cx. arbieeni* Salem, *Cx.*

laticinctus Edwards, *Cx. Sinaiticus* Kirkpatrick, *Cx. torrentium* Martini, *Cx. Mimeticus* Noe, *Cx. pipiens* Linnaeus, *Cx. quinquefasciatus* Say, *Cx. hortensis* Ficalbiand, and *Cx. theileri* Theobald. Ecological data, such as larval habitats, species composition, and active season, play a key role in vector management and effective control strategies against mosquito-borne diseases. Therefore, the main objective of our study was to determine the fauna and active season of mosquito in western regions of Fars Province, southern Iran.

MATERIALS AND METHODS

Study setting. The study was carried out from April to September, 2012. Five sites (rural districts) (Mahkoya, Zanjiran, Dehrod, Dadenjan, and Banab) were selected randomly with regard to existing facilities in Firouzabad County, west of Fars Province, Iran. Firouzabad County with geographical coordinates 53°32'E; 29°37'N at an altitude of 1600 m above sea level in Fars Province south of Iran. This district has 116,622 inhabitants living in an area of 3.8 km² and constitutes 2.8% of the total area of Fars Province. The climate is moderate with the mean annual rainfall, relative humidity, and annual temperature of 147.8 mm, 31%, and 23.1°C, respectively. Due to this situation, some diseases such as Leishmania are highly common in this area and other vector-borne diseases can emerge (Khosravani et al., 2016). Herein, maximum and minimum mean temperatures were 40.8°C and 11.1°C in July and April, respectively. The mean relative humidity was 32%. During this study, rainfall was reported in April (4 mm) only.

Sample collection. To study the mosquito fauna and seasonal abundance, sampling was carried out by

Table 1. Number and locality of the culicid mosquitoes in Firouzabad County ,Fars Province, April-September 2012

Species	Site1: Mahkoya	Site2: Zanjiran	Site 3: Dehrod	Site 4: Dadenjan	Site 5: Banab	Total(%) Larvae Adult
<i>Cx. theileri</i>	198	8	438	83	133	613(46.7%)247(35.8%)
<i>Cx. sinaiticus</i>	24	1	-	6	-	18(1.4%) 13(1.9%)
<i>Cx. mimeticus</i>	91	28	140	-	11	178(13.5%) 92(13.4%)
<i>An. superpictus</i>	-	41	10	19	-	21(1.6%) 49(7.1%)
<i>An. d'thali</i>	29	88	71	6	118	219 (16.7%)93(13.5%)
<i>Cs. longiareolata</i>	85	132	217	3	22	264 (20.1%)195(28.3%)
Total	427(21.3%)	298(14.9%)	876(43.7%)	117(5.9%)	284(14.2%)	1313(100%)689(100%)

Table 2. Monthly activity in species composition and abundance of mosquitoes in Firouzabad County, Fars Province, April-September 2012

Species	Apr	May	Jun	Jul	Aug	Sep	Total
<i>Cx. theileri</i>	-	12	311	146	255	136	860
<i>Cx. sinaiticus</i>	-	3	-	26	2	-	31
<i>Cx. mimeticus</i>	17	2	104	147	-	-	270
<i>An. superpictus</i>	1	-	-	23	29	17	70
<i>An. d'thali</i>	9	-	-	193	32	78	312
<i>Cs. longiareolata</i>	60	52	207	18	21	101	459
Total	87(4.3%)	69(3.4%)	622(31.1%)	553(27.7%)	339(17%)	332(16.5%)	2002(100%)

performed dipping technique for collecting larvae and total catch or pyrethrum space spray collection (PSSC) for adult mosquitoes (Ladonni et al., 2015). The mosquito larvae were collected from different oviposition sites such as rock holes, discarded tires, irrigation channels, ponds, and animal footprints (Zaim, 1987). Survey was within a radius of 1 km around the sampling sites. In indoor sites, mosquito samples were collected from human dwellings and cattle sheds. All the samples, including adults and larvae, were brought to the laboratory of the entomology department, Shiraz University of Medical Sciences, Shiraz, Iran. The mosquito larvae were preserved in lactophenol and the microscopic slides were prepared using chloral gum mounting after one week. This medium has high

refractive index and is efficient for mounting small arthropods. Adult mosquito samples were killed by chloroform and mounted by special pines. Binocular microscope was used for the taxonomic study, and identification (at adult stages) was performed up to the species level with the aid of taxonomic keys provided in the literature (Shahgudian, 1960; Azari-Hamidian et al., 2009). The mosquito name abbreviations were cited based on Reinert (Reinert, 2009).

RESULTS AND DISCUSSION

A total of 689 adult and 1313 larvae of Culicidae were collected, of which three genera and six species of Culicidae were recognized (Table 1). *Cx. theileri* was the most frequent Culicidae collected at Firouzabad, with a total of 613 and 247 specimens by larval and

adult collection, respectively. Monthly distributions of the most and least abundant species, namely, *Cx. theileri*, *Cs. longiareolata*, and *Cx. sinaiticus*, are shown in Figure 1. The highest number of mosquitoes was collected in Dehrod (876 specimens) and the lowest in Dadenjan (117 specimens). Monthly variation in species composition and abundance of mosquitoes is exhibited in Table 2. The highest number of mosquitoes was collected in June (622 specimens) and the lowest in May (69 specimens). The mean temperatures in June and May were 31.3°C and 28.2°C, respectively. The effect of temperature on monthly abundance of mosquitoes in Firouzabad County is illustrated in Figure 2. In the present investigation, three genera and six species were found. Two *Anophel* species were collected in this investigation, including *An. superpictus* and *An. d'thali*. In this study *An. d'thali* (15.6%) was the most abundant anopheline species.

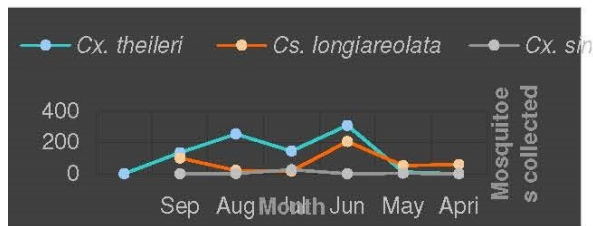


Figure 1. Monthly activity of the most and least abundant species, *Cx. theileri*, *Cs. longiareolata*, and *Cx. sinaiticus* in Firouzabad County, Fars Province, April-September 2012.

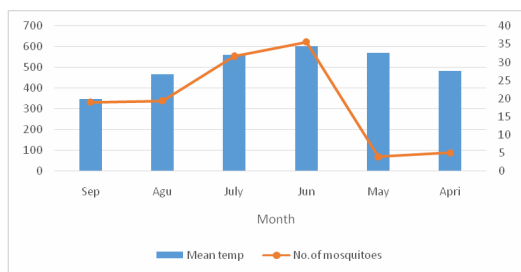


Figure 2. The effect of temperature on monthly abundance of mosquitoes in the five collection sites, Firouzabad County, Fars Province, April-September 2012

This species is widespread in semi-arid regions from Atlantic coast of North Africa to Baluchestan,

northwest Pakistan, and southern Iran. It is common in many areas, boarding the Red sea and the Gulf of Aden and extends from the Sudan coast through Ethiopia, southwestern Arabia, and Somalia almost to Mogadishu (Shililu et al., 2003). *An. d'thali* was identified as the secondary malaria vector in Iran (Manouchehri and Rohani, 1975). A study conducted in Hormozgan Province showed that *An. d'thali* (29.3%) is the most common anopheline species in this area (Majnoonpour et al., 2015). In contrast, in Isfahan Province *An. d'thali* (0.1%) was reported as the least abundant anopheline species. The monthly activity of this species in Isfahan Province was reported in September and in our study it was recorded from April and July to September (Ladonni et al., 2015). *An. superpictus* is considered a major malaria vector in central plateau and the secondary vector in the southern areas of Iran (Edrissian, 2006). This species has a widespread distribution in Iran, and two distinct morphological forms (A and B) of this species were reported from Iran (Oshaghi et al., 2006). The monthly activity of this species in Isfahan Province was reported from July to August and in our study was reported from April and July to September (Ladonni et al., 2015). In contrast with our study, a study in Kurdistan, western Iran, showed that *An. superpictus* (57.7%) was the most common anopheline species in this area and is active in July to October (Banafshi et al., 2013). *An. d'thali* and *An. superpictus* are the proven vectors of malaria in Iran. *Cx. theileri* is found in Palaearctic, Afrotropical, and Oriental regions. This species has been recorded in all provinces of Iran (Zaim, 1987). This species is a known vector of the canine heart worm nematode (*D. immitis*), in northwestern Iran (Azari-Hamidian and Harbach, 2009). In this study, *Cx. theileri* (43%) was the most abundant species. *Cx. theileri* in our study was collected from May to September, which is in line with a study carried out in Isfahan Province (Ladonni et al., 2015). Eight species of mosquitoes were collected in Lenjan and Mobarakeh areas (Isfahan Province), where *Cx. theileri* was one of the most abundant species (Moosa-Kazemi et al., 2000). *Cx. theileri* was reported

the most abundant culicine species in Ardebil and Zanjan provinces, Iran (Ghavami and Ladonni, 2005; Abai et al., 2007). This species was one of the culicine species collected at Chabahar, with a total of 291 and 418 specimens by means of PSSC and larval collection, respectively (Moosa-Kazemi et al., 2009). The monthly activity of this species in western Iran was reported from August to October 2005 and June to August 2006 (Banafshi et al., 2013), and in our study it was reported from May to September. In agreement with our investigation, the monthly activity of *Cx. theileri* in Isfahan Province was reported from May to September (Ladonni et al., 2015). *Cx. sinaiticus* was reported from Bushehr, Khuzestan, Sistan and Baluchistan, Fars, Kerman, and Hormozgan provinces (Zaim et al., 1985). In the present study, this species had the lowest population with a total of 31 specimens. This is in agreement with a study performed in Mahshahr district, Khuzestan Province, where *Cx. sinaiticus* had the lowest population with a total of four specimens. *Cx. sinaiticus* and *Cx. theileri* were previously reported from Fars Province (Zaim, 1987). *An. maculipennis* Meigen and *Cx. Theileri* Theobald are the known vectors of *Setaria labiato-papillosa* and *Dirofilaria immitis*, respectively, in northwestern Iran (Azari-Hamidian et al., 2009). *Cx. mimeticus* is distributed in Mazandaran, West and East Azerbaijan, Kurdistan, Zanjan, Bakhtaran, Luristan, Semnan, Khorasan, Isfahan, Chahar-Mahall, Yazd, Kerman, Hormozgan, Fars, Kohkiluyeh, Bushehr, and Khuzistan provinces. Larvae are mostly found in small permanent pools in crevices in rocks and backwaters of rapidly flowing mountain streams with vegetation and in full sunlight (Zaim, 1987). *Cx. mimeticus* larvae were collected in July and August in western Iran (Banafshi et al., 2013). In this study, the monthly activity of this species started from April to July. One species of *Culiseta*, i.e., *Cs. longiareolata*, was found in this investigation. Two species of the genus, *Cs. longiareolata* and *Cs. subochrea*, were discovered earlier in Fars. These species were reported from Guilan, Mazandaran, West and East Azerbaijan, Kurdistan, Zanjan, Bakhtaran,

Hamadan, Luristan, Markazi, Teheran, Semnan, Khorasan, Isfahan, Chahar-Mahall, Yazd, Kerman, Sistan and Baluchistan, Hormozgan, Kohkiluyeh, Bushehr, Khuzistan, and Ilam provinces. Larvae occur in a wide variety of man-made and natural waterbodies (Zaim, 1987). *Cs. longiareolata* was reported as the most abundant culicine species in Kurdistan, Kermanshah, and Sistan and Baluchistan provinces (Moosa-Kazemi et al., 2009; Moosa-Kazemi et al., 2015). In the current study, this species was the second most abundant species with a total of 195 and 264 specimens by means of adult and larval collection, respectively. The species *Cs. longiareolata* was one of the culicine mosquitoes collected at Mahshahr, with a total of 15 and 182 specimens by means of adult and larval collection, respectively. Adults of this species never enter houses and rarely bite humans; accordingly, this species appear to be of no medical significance. The monthly activity of this species in western Iran was reported from July to October and in our study was reported from April to September (Banafshi et al., 2013). In our study, some potential vectors of medical and veterinary importance were identified such as *An. superpictus*, *An. d'thali*, and *Cx. theileri*. The present study was carried out only in one county of Fars Province; thus, we recommend further studies to be carried out to explore the remaining areas of the province for mosquito composition and to find the mosquito biodiversity for implementing control strategies.

Ethics

I hereby declare all ethical standards have been respected in preparation of the submitted article.

Conflict of Interest

The authors declare that they have no conflict of interest.

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References

- Abai, M.R., Azari-Hamidian, S., Ladonni, H., Hakimi, M., Mashhadi-Esmail, K., Kousha, A., *et al.*, 2007. Fauna and checklist of mosquitoes (Diptera: Culicidae) of East Azerbaijan Province, northwestern Iran. *J Arth Bor Dis* 1, 27-33.
- Azari-Hamidian, S., 2007. Checklist of Iranian mosquitoes (Diptera: Culicidae). *J Vec Ecol* 32, 235-242.
- Azari-Hamidian, S., Harbach, R.E., 2009. Keys to the adult females and fourth-instar larvae of the mosquitoes of Iran (Diptera: Culicidae). *Zootaxa* 2078.
- Azari-Hamidian, S., Yaghoobi-Ershadi, M.R., Javadian, E., Abai, M.R., Mobedi, I., Linton, Y.M., *et al.*, 2009. Distribution and ecology of mosquitoes in a focus of dirofilariasis in northwestern Iran, with the first finding of filarial larvae in naturally infected local mosquitoes. *Med Vet Entomol* 23, 111-121.
- Banafshi, O., Abai, M., Ladonni, H., Bakhshi, H., 2013. The fauna and ecology of mosquito larvae (Diptera: Culicidae) in western Iran. *Turkish J Zool* 37, 298-307.
- Chinikar, S., Ghiasi, S.M., Moradi, M., Madihi, S.R., 2010. Laboratory detection facility of dengue fever (DF) in Iran: the first imported case. *Int J Infect Dis* 8, 13-15.
- Edrissian, G.H., 2006. Malaria in Iran: Past and present situation. *Iranian J Parasitol* 1, 1-14.
- Ghavami, M.B., Ladonni, H., 2005. The fauna and frequency of different mosquito species (Diptera: Culicidae) in Zanjan Province. *J Zanjan Uni Med Sci* 13, 46-54.
- Khosravani, M., Nasiri, Z., Keshavarz, D., Rafat-Panah, A., 2016. Epidemiological trend of cutaneous leishmaniasis in two endemic focus of disease, south of Iran. *J Parasit Dis* 40, 1609-1613.
- Ladonni, H., Azari-Hamidian, S., Alizadeh, M., Abai, M.R., Bakhshi, H., 2015. The fauna, habitats, and affinity indices of mosquito larvae (Diptera: Culicidae) in Central Iran. *N West J Zool* 11, 76-85.
- Majnoonpour, M.R., Soleimani-Ahmadi, M., Poorahmad-Garbandi, F., 2015. Fauna and distribution of Anopheleline mosquitoes in Sirik county, Hormozgan province, 2014. *hums-jpm* 2, 29-35.
- Manouchehri, A.V., Rohani, F., 1975. Notes on the ecology of *Anopheles dthali* Patton in Southern Iran. *Ann Trop Med Parasitol* 69, 393-397.
- Moosa-Kazemi, S., Vatandoost, H., Nikookar, H., Fathian, M., 2009. Culicinae (Diptera: culicidae) mosquitoes in chabahar county, sisthan and baluchistan province, southeastern iran. *Iran J Arthropod Borne Dis* 3, 29-35.
- Moosa-Kazemi, S., Zaim, M., Zahraii, A., 2000. Fauna and ecology of Culicidae of the Zarrin-Shahr and Mobarakeh area in Isfahan province. *J Yasuj Uni Med Sci* 5, 46-54.
- Moosa-Kazemi, S.H., Zahirnia, A.H., Sharifi, F., Davari, B., 2015. The Fauna and Ecology of Mosquitoes (Diptera: Culicidae) in Western Iran. *J Arthropod Borne Dis* 9, 49-59.
- Naficy, K., Saidi, S., 1970. Serological survey on viral antibodies in Iran. *Trop Geogr Med* 22, 183-188.
- Oshaghi, M.A., Yaghoobi, F., Vatandoost, H., Abai, M.R., Akbarzadeh, K., 2006. Anopheles stephensi biological forms, geographical distribution and malaria transmission in malarious regions of Iran. *Pakistan J Biol Sci* 9, 294-298.
- Raeisi, A., Gouya, M.M., Nadim, A., Ranjbar, M., Hasanzehi, A., Fallahnezhad, M., *et al.*, 2013. Determination of Malaria Epidemiological Status in Iran's Malarious Areas as Baseline Information for Implementation of Malaria Elimination Program in Iran. *Iran J Public Health* 42, 326-333.
- Reinert, J.F., 2009. List of abbreviations for currently valid generic-level taxa in family Culicidae (Diptera). *Eu Mosquito Bull* 27, 68-76.
- Saidi, S., Tesh, R., Javadian, E., Nadim, A., 1976. The prevalence of human infection of West Nile in Iran. *Iranian J Pub Health* 5, 8-14.
- Shahgudian, E.R., 1960. A key to the anophelines of Iran. *Acta Med Iran* 3, 38-48.
- Shililu, J., Ghebremeskel, T., Mengistu, S., Fekadu, H., Zerom, M., Mbogo, C., *et al.*, 2003. Distribution of anopheline mosquitoes in Eritrea. *Am J Trop Med Hyg* 69, 295-302.
- WHO, 2014. World Malaria and Dengue Report.
- Zaim, M., 1987. The distribution and larval habitat characteristics of Iranian Culicinae. *J Am Mosq Control Assoc* 3, 568-573.
- Zaim, M., Manouchehri, A.V., Yaghoobi-Ershadi, M.R., 1985. Mosquito fauna of Iran. *Iranian J Pub Health* 13, 3-10.