

Species composition of mosquitoes (Diptera: Culicidae) in Farashband district, southwest of Iran

Z. Soltani,¹ D. Keshavarzi²

¹Communicable Disease Unit, Faculty of Health, Shiraz University of Medical Sciences, Shiraz, Iran;

²Department of Medical Entomology and Vector Control, School of Public Health, Tehran University of Medical Sciences, Tehran

Abstract

Mosquitoes are potential vectors of some important diseases for humans and animals. Apart from mosquito borne diseases, mosquitoes cause nuisances for both humans and animals when they are abundant. The objective of this study was to determine the fauna of mosquitoes (Diptera: Culicidae) in Farashband County, southwest of Iran. The study was carried out from April to September 2012. Four collection sites, were selected randomly with regard to existing facilities in Farashband County. Sampling was carried out by dipping technique for

collecting larvae and pyrethrum space spray collection (PSSC) for adult mosquitoes. Mean temperature was recorded for every month. A total of 1152 adults and 1505 larvae of Culicidae mosquitoes were collected, of which 3 genera and 7 species of Culicidae were recognized, namely, *Anopheles superpictus*, *An. dthali*, *Culex sitaiticus*, *Cx. theileri*, *Cx. pipiens*, *Cx. tritaeniorhynchus* and *Culiseta longiareolata*. *Cs. longiareolata* was the most frequent Culicidae mosquito collected at Farashband, with a total of 513, and 249 specimens, by larval and PSSC collection, respectively. The highest numbers of mosquitoes were collected in July (34.9%) and the lowest in April (3.8%), respectively. Regarding this research, there are some potential vectors in medical and veterinary importance in Farashband County and they are more active in July and June.

Correspondence: Davood Keshavarzi, Department of Medical Entomology and Vector Control, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran.

Tel.: +98.713.2355254 - Fax: +98.713.2355254.

E-mail: Keshavarzd25@Gmail.com ; farscdc@sums.ac.ir

Key words: Culicidae; mosquito; fauna; Fars; Iran.

Acknowledgements: the authors gratefully acknowledge the cooperation of Health-Medical Systems of Farashband County in executing this study. We also would like to thank the following colleagues for their help in identifying and collecting insects and for their moral support: M. Ebrahimi and F. Soltani (Communicable Disease Unit, Faculty of Health, Shiraz University of Medical Sciences, Shiraz, Iran), K. Amraee (Department of Medical Entomology and Vector Control, School of Public Health, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran), H. Faramarzi (Department of Community Medicine, Shiraz University of Medical Sciences, Shiraz, Iran), R. Mahammed (Young Researchers and Elite Club, Marvdasht Branch, Islamic Azad University, Marvdash, Iran).

Funding: this study was financially supported by Shiraz University of Medical Sciences (Project No.: 916246).

Received for publication: 3 September 2016.

Revision received: 10 October 2016.

Accepted for publication: 10 October 2016.

©Copyright Z. Soltani and D. Keshavarzi, 2016

Licensee PAGEPress, Italy

Journal of Entomological and Acarological Research 2016; 48:6268

doi:10.4081/jeur.2016.6268

This article is distributed under the terms of the Creative Commons Attribution Noncommercial License (by-nc 4.0) which permits any noncommercial use, distribution, and reproduction in any medium, provided the original author(s) and source are credited.

Introduction

Mosquitoes are potential vectors of some important diseases for humans and animals (Balenghien *et al.*, 2006). Apart from mosquito borne diseases, mosquitoes cause nuisances for both humans and animals when they are abundant. Nuisances caused by mosquitoes decrease milk production and reduce weight of domestic animals (Alptekin and Kasap, 1996). Some arboviral and parasitic diseases are transmitted by Culicidae mosquitoes in Iran, including West Nile and Sindbis viruses, Malaria, *Dirofilaria immitis* (dog heart worm), and *Dirofilaria repens* (Sadigian, 1969; Naficy and Saidi, 1970; Siavashi and Massoud, 1995; Maraghi *et al.*, 2006). Currently, malaria in many countries especially in South Africa is one of the most important problems of the health. Unfortunately, many people die due to this disease around the world every year (WHO, 2009). This disease is very geographically specific and remains an important cause of mortality and morbidity in many parts of the world. In 2012, there were 99 countries and territories highly struggling malaria transmission and 5 countries in the prevention of reintroduction phase (WHO, 2013). Malaria is the most important mosquito-borne disease in Iran and seven species of the genus *Anopheles*: *A. culicifacies* Giles, 1901, *A. dthali* Patton, 1905, *A. fluviatilis* James, 1902, *A. maculipennis* Meigen, 1818, *A. sacharovi* Favre, 1903, *A. stephensi* Liston, 1901 and *A. superpictus* Grassi, 1899 are known its proven vectors in Iran (Edrissian, 2006). Zaim (1993) mentioned *A. pulcherrimus* Theobald, 1902 as a potential vector of malaria in southeastern Iran. Eshghy (1977) observed *Plasmodium* oocysts in *A. multicolor* Comboulou, 1902, but sporozoites have not been found in this species and it is not considered a vector in Iran. Recently, Dinparast-Djadid (2009) reported *An. hyrcanus* Pallas, 1771, as a potential vector of *P. falciparum* based on Nested PCR in Guilan Province. *An. maculipennis* and *Culex theileri* Theobald, 1903, are known vectors of *Setaria*

labiatopapillosa and *Dirofilaria immitis* respectively, in northwestern Iran (Azari-Hamidian *et al.*, 2009a). The mosquito borne filariae, *Dirofilaria* (dirofilariasis) (*Dirofilaria immitis* and *D. repens*), *Setaria* (setariasis) (*Setaria labiatopapillosa*, *S. digitata*, and *S. equina*), and *Diptaltonema evansi* (Camel filariasis, Spirurida: Onchocercidae) are found in Iran (Eslami, 1997; Azari-Hamidian *et al.*, 2007; Maraghi *et al.*, 2006; Oryan *et al.*, 2008). According to a new research on classification of mosquitoes, the family Culicidae includes 2 subfamilies, 11 tribes, 95 genera and 3520 species in the world fauna (Harbach, 2007). The faunistic studies of medically important mosquito species in Iran have been conducted by many researchers. For example, Mattingly and Knight (1956), Senevet and Andarelli (1959), Gutsevitch *et al.* (1974), and Harbach (1988) worked on the mosquitoes of certain countries and specific areas of the region. In 1986, Zaim and Cranston (1986) published a checklist and keys to the Culicinae of Iran. According to the recent study, the checklist of the mosquitoes of Iran includes 2 subfamilies (Anophelinae and Culicinae), 64 species and 3 subspecies belonging to seven genera (*Anopheles*, *Uranotaenia*, *Culiseta*, *Coquillettidia*, *Culex*, *Aedes* and *Ochlerotatus*) (Azari-Hamidian *et al.*, 2009b). Until present, 16 species of Culicinae mosquitoes have been recorded in Fars Province (Zaim, 1987). Including *Ochlerotatus caspius* (Pallas), *Culista subochrea* (Edwards), *Cs. longiareolata* (Macquart), *Culex 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* Ficalbi, *Cx. theileri* Theobald and *Ur. unguiculata unguiculata* Edwards. There are few data about the ecology of mosquitoes in Fars Province. There is no data available about the mosquito fauna of Farashband district. Ecological data, such as larval habitats, species composition and active season, play an important role in vector management and effective control strategies against mosquito-borne diseases (Ali *et al.*, 2013). Therefore, the main objective of our study was to determine the species composition and active season of mosquito in western Fars province, southern Iran. There is dire need to gather baseline data on population composition of mosquito species so that their role as vector for various human and animal diseases may be better understood. With a view to this urgent need, present research is proposed, so that data can be made available for future researchers.

Materials and methods

Study area

The study was carried out in Farashband district, west Fars Province, southwest of Iran (52° 14 -23 55 N, 28° 08 -11 28) (Figure 1). The capital of the county is Farashband. At the 2006 census, the county's population was 38,679, in 8474 families. Annual mean precipitation is 190 mm, annual mean potential evaporation is 1927.35 mm, and annual mean temperature is 25.45°C. The mean relative humidity was 32% (Khosravani *et al.*, 2015). Fars is one of the 31 provinces of Iran, located in the southern part of the country (29.62° N, 52.53° E). Due to topographic characters, there are three distinct climatic parts of this province. The first part is a hilly area in the north and northwest of the province. This part has a moderate temperature with 400-600 mm of precipitation annually. The central part of the province is marked by a relatively moderate temperature and hot and dry weather in summer. The average annual precipitation measures here 200-400 mm, the Farashband district is located in this part. The third part is the lowland of south and southeast regions of the province with moderate temperature in winter and very hot wet weather in summer. The average rainfall of this part is below 200 mm annually. Maximum and minimum temperatures of collection sites have shown in Figure 2.

Collection methods

Sampling was carried out by pyrethrum space spray collection (PSSC) or total catch for adult mosquitoes and suction pipette or dipping technique depending on the size of the exposed surface for collecting larvae during April to September 2012 (Moosa-Kazem *et al.*, 2009). The specimens were collected from four stations (Nowjein, Khoshab, Emamzadeh and Mansurabad) in the different areas of the district.

The mosquito larvae were collected from different breeding sites such as irrigation channels, sluice, drains, etc. Four scoops were taken from each breeding site (350 mL each). Larval and adult collections were conducted three times per month in 2012. The adult mosquitoes were collected from human dwelling and animal sheds in the morning and during sunrise. Before spray, white cloth sheets were spread on the floor and then all the windows and other exit points in each indoor place were closed. Pyrethrum was sprayed for 30-45 s in the entire



Figure 1. Map of Iran, highlighting the positions of Fars Province and Farashband County.

space of the room and the room was closed for 10 min. After 15 min, all knocked-down or dead mosquitoes lying on the cloth sheet were collected carefully with the forceps and placed in sample dishes. In each station, six rooms were randomly chosen within a 15 m distance.

Night catches or human landing catches were performed indoor between 7 p.m. and 7 a.m. by two trained collectors. The collected larvae were preserved in 70% alcohol containing 5% glycerin, and cleared in lactophenol for identification. The adult specimens and the third and fourth stage larvae were identified using the keys of Shahgudian (1960), Zaim and Cranston (1986), Harbach (1988), Azari-Hamidian and Harbach (2009b). Mosquito name abbreviations were cited based on Reinert (2009).

Results

During the study period, 1152 adults and 1505 larvae of mosquitoes were collected from the Farashband County, and three genera were represented: *Anopheles* (2 species), *Culex* (4 species) and *Culiseta* (1 species). The following 7 species were identified from the study area: *An. superpictus*, *An. dthali*, *Cx. theileri*, *Cx. sitaiticus* Kirkpatrick, 1924,

Cx. tritaeniorhynchus Giles, *Cx. pipiens* Linnaeus, and *Cs. longiareolata* Macquart. Composition and localities of the mosquitoes collected in this survey are shown in Table 1.

In PSSC collection overall, *Cx. tritaeniorhynchus* (35.1%) predominated, followed by *Cs. longiareolata* (21.6%), *Cx. pipiens* (19%), *Cx. theileri* (14.2%), *An. dthali* (5.2%), *An. superpictus* (4.6%) and *Cx. sinaiticus* (0.3%). In the larval collection, of 1505 Culicidae larvae collected, *Cs. longiareolata* (34.1%) predominated, followed by *Cx. theileri* (29.3%), *Cx. pipiens* (18.7%), *Cx. tritaeniorhynchus* (7.3%), *An. dthali* (7.3%), *An. superpictus* (6.1%) and *Cx. sinaiticus* (1.3%), respectively (Table 2). *Cs. longiareolata* was the most frequent Culicidae mosquito collected at Farashband, with total of 513, and 249 specimens, by larval and adult collection, respectively. The highest numbers of mosquitoes were collected in the Nowjein (898 specimens) and the lowest in the Mansurabad (442 specimens). Monthly variation in species composition and abundance of mosquitoes shown in Table 3. The highest numbers of mosquitoes (adults and larvae) were collected in July (928 specimens) and the lowest in April (101 specimens). Mean temperature in July and May were 36.5°C and 31.6°C, respectively. Overall, in this study there was no significant relationships between mean temperatures and abundance of mosquitoes ($P > 0.05$).

Table 1. Composition and localities of the Culicidae mosquitoes collected in Farashband County, Fars Province, April - September 2012.

Species	Nowjein	Khoshab	Villages Emamzadeh	Mansurabad	No (%)
<i>Cx. theileri</i>	114	288	172	32	606 (22.8)
<i>Cx. sinaiticus</i>	-	22	-	-	22 (0.8)
<i>Cx. pipiens</i>	202	77	183	38	500 (18.8)
<i>Cx. tritaeniorhynchus</i>	257	108	-	149	514 (19.4)
<i>An. superpictus</i>	38	15	-	48	101 (3.8)
<i>An. dthali</i>	64	-	33	55	152 (5.7)
<i>Cs. longiareolata</i>	223	115	304	120	762 (28.7)
Total	898	625	602	442	2657 (100)

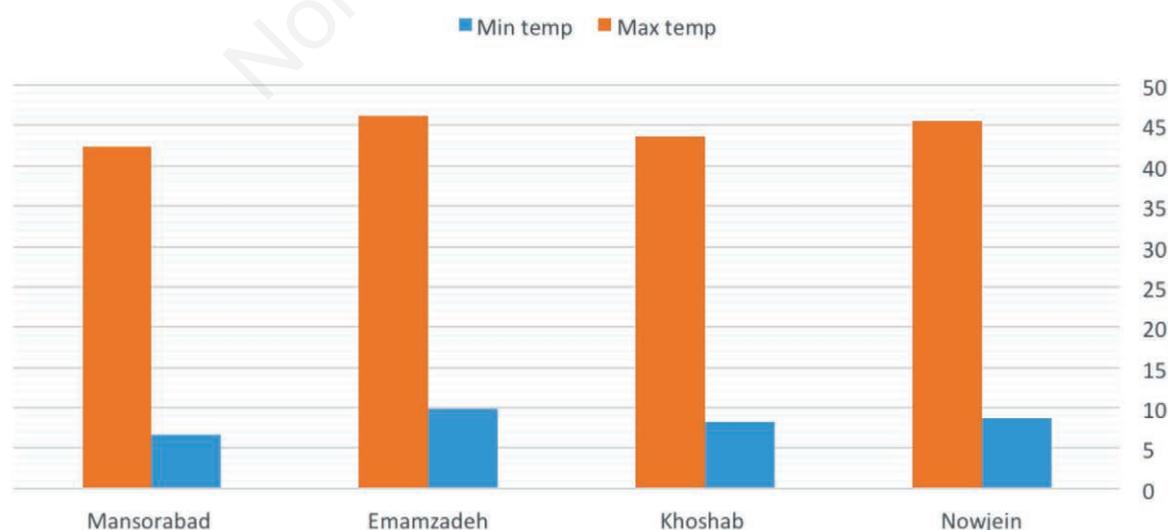


Figure 2. Ambient temperature of collection sites in Farashband County, Fars Province, April - September 2012. Min, minimum; Max, maximum.

Discussion

For an effective control of mosquito species, knowledge of the fauna of mosquito is very important (Moosa-Kazemi *et al.*, 2005). In the present investigation three genera and seven species were found. Two *Anopheles* species were collected in this investigation, including *Anopheles superpictus* and *An. dthali* (5.7%) was the most abundant anopheline species. This species is widespread in semi-arid regions from the 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 (De Millone, 1947; Stone *et al.*, 1959). *An. dthali* was identified as secondary malaria vector in Iran (Manouchehri *et al.*, 1976). The study at Hormozgan province showed that *An. dthali* (29.3%) is more common anopheline species in this area (Majnoonpour *et al.*, 2015). In contrast, in Isfahan Province *An. dthali* (0.1%) was reported as the least abundant anopheline species. The monthly activity of this species in Isfahan Province was reported from September and in our study recorded from Jun to September (Ladonni *et al.*, 2015).

An. superpictus is considered as a major malaria vector in central plateau, and the secondary vector in the southern areas of the country (Edrissian, 2006). This species has a widespread distribution in Iran and two distinct morphological forms (A and B) of this species 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 to September (Ladonni *et al.*, 2015). Different with our study, the study at Kurdistan, western Iran, showed that *An. superpictus* (57.7%) is more common anopheline species in this area and is active in July to October (Banafshi *et al.*, 2013). *An. dthali* and *An. superpictus* are the proven vectors of malaria in Iran (Hanafi-Bojd *et al.*, 2011).

Culex theileri is found in Palaearctic, Afrotropical and Oriental regions. This species has been recorded in all provinces of Iran (Zaim, 1987). This species is known vector of the canine heartworm nematode (*D. immitis*), in northwestern Iran (Azari-Hamidian *et al.*, 2009a). In this study *Cx. theileri* (22.8%) was one of the most abundant species. Eight species of mosquitoes was collected in Lenjan and Mobarakeh areas (Isfahan Province) where *Cx. theileri* was one of the most abundant species (Mousakazemi *et al.*, 2000). *Cx. Theileri* reported as 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 mosquito collected at Chababar, with 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, (Hanafi-Bojd *et al.*, 2011). 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. theileri* Theobald is known vector of *Dirofilaria immitis*, in northwestern Iran (Azari-Hamidian *et al.*, 2009a).

Cx. pipiens distributed in Europe, Africa, some regions of Asia, the middle part of North America, Southern America, and Australia (Vinogradova, 2000). This species is distributed in the most part of Iran (Zaim *et al.*, 1985). In our study, *Cx. pipiens* was one of the most frequent Culicine mosquitoes and collected at all villages. *Cx. pipiens* is autogenous (the first egg laying performed without a blood feeding) and has at least three complex populations (Vinogradova, 2000). The monthly activity of this species in Neka county of Mazandaran Province, Iran, was started in the end of May, and was increased in the beginning of July and decreased slowly in the mid of summer (Nikookar *et al.*, 2010). The monthly activity of this species in this study was reported from April and Jun to September.

Cx. tritaeniorhynchus is restricted to the Palaearctic (southern Asia), Afrotropical, and Oriental regions (Zaim and Cranston, 1987). This species was the second most abundant species of *Culex* for this area with total of 514 specimens (19.4%). This species is known to occur in other areas of Iran (Zaim and Cranston, 1987; Azari-Hamidian *et al.*, 2007). The study at Shadegan region, southwestern Iran, showed that *Cx. tritaeniorhynchus* is the one of the more common species in this area (Navidpour *et al.*, 2012). This is different with Azari-Hamidian (2005), who reported a different relative abundance of culicine mosquitoes in the Kerman area: *Cx. tritaeniorhynchus* (10.8%), *Cx. sinaiticus* (6.3%) and *Cx. theileri* (3.8%).

Table 2. Number and prevalence of adult and larvae mosquitoes collected by pyrethrum space spray and larval collections in Farashband County, Fars Province, April - September 2012.

Species No. (%)	Larvae No. (%)	Adult
<i>Cx. theileri</i>	442 (293)	164 (14.2)
<i>Cx. sinaiticus</i>	19 (1.3)	3 (0.3)
<i>Cx. pipiens</i>	281 (18.7)	219 (19)
<i>Cx. tritaeniorhynchus</i>	110 (7.3)	404 (35.1)
<i>An. superpictus</i>	48 (3.2)	53 (4.6)
<i>An. dthali</i>	92 (6.1)	60 (5.2)
<i>Cs. longiareolata</i>	513 (34.1)	249 (21.6)
Total	1505 (100)	1152 (100)

Table 3. Monthly variation in species composition and abundance of mosquitoes in Farashband County, Fars Province, April - September 2012.

Species	Apr	May	Jun	Jul No. (%)	Aug	Sep	Total
<i>Cx. theileri</i>	21 (3.5)	87 (14.4)	256 (42.2)	113 (18.6)	51 (15)	38 (6.3)	606 (100)
<i>Cx. sinaiticus</i>	0 (0)	0 (0)	7 (31.9)	12 (54.5)	0 (0)	3 (13.6)	22 (100)
<i>Cx. pipiens</i>	8 (16)	0 (0)	69 (13.8)	304 (60.8)	108 (21.6)	11 (2.2)	500 (100)
<i>Cx. tritaeniorhynchus</i>	0 (0)	144 (28.1)	73 (14.2)	232 (45.1)	14 (2.7)	51 (9.9)	514 (100)
<i>An. superpictus</i>	9 (8.9)	3 (3)	17 (16.8)	27 (26.7)	20 (19.8)	25 (24.8)	101 (100)
<i>An. dthali</i>	0 (0)	0 (0)	66 (43.4)	41 (27)	45 (29.6)	0 (0)	152 (100)
<i>Cs. longiareolata</i>	63 (8.3)	46 (6)	218 (28.6)	199 (26.1)	38 (5)	198 (26)	762 (100)
Total	101 (3.8)	280 (10.5)	706 (26.6)	928 (34.9)	316 (11.9)	326 (12.3)	2657 (100)

Cx. sinaiticus reported from Bushehr, Khuzestan, Sistan and Bluchestan, Fars, Kerman and Hormozgan provinces (Zaim *et al.*, 1985). In present study this species have the lowest population with total of 22 specimens. This is in agreement with a study at Mahshahr district, Khuzestan province that *Cx. sinaiticus* have the lowest population with total of 4 specimen (Farhadinejad *et al.*, 2015).

One species of *Culiseta*, i.e. *Culiseta longiareolata*, was found in this investigation. Two species of the genus, *Cs. longiareolata*, and *Cs. subochrea*, which were discovered earlier in Fars (Zaim, 1987). This species reported from Guilan, Mazandaran, West & East Azerbaijan, Kurdistan, Zanjan, Bakhtaran, Hamadan, Luristan, Markazi, Teheran, Semnan, Khorasan, Isfahan, Chahar-Mahall, Yazd, Kerman, Sistan & Baluchistan, Hormozgan, Kohkiluyeh, Bushehr, Khuzistan and Ilam provinces. Larvae occur in a wide variety of man-made and natural bodies of permanent or transient (Zaim, 1987). *Cs. longiareolata* reported as the most abundant culicine species, in Kurdistan, Kermanshah and Sistanbaluchistan provinces (Moosa-Kazemi *et al.*, 2009; Moosa-Kazemi *et al.*, 2015). In our study this species was the most abundant species with total of 249 and 513 specimens by means of adult and larval collection, respectively. The species *Cs. longiareolata* was one of the culicine mosquitoes collected at Mahshahr, with total of 15 and 182 specimens by means of adult and larval collection, respectively (Farhadinejad *et al.*, 2015). Adults of this species never enter houses and rarely bite Man, so this species appears to be of no medical importance (Salit *et al.*, 1994). 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).

Conclusions

In our research, some potential vectors of medical and veterinary importance such as *An. superpictus*, *An. dthali* and *Cx. theileri* were identified. The current study was carried out only in one county of Fars Province and further studies on mosquito composition are needed in the remaining unexplored areas for shaping control strategies in the future.

References

- ABAI M.R., AZARI-HAMIDIAN S., LADONNI H., HAKIMI M., MASHHAD-ESMAIL K., KOUSSHA A., VATANDOOST H., 2007 - Fauna and checklist of mosquitoes (Diptera: Culicidae) of East Azerbaijan Province, northwestern Iran. - Iran. J. Arthropod-Borne Dis. 1: 27-33.
- ALPTEKIN D., KASAP H., 1996 - Tarsus yoresinde Anopheles sacharovi erginlerinin mevsimsel kan emme ve parite oranları ile ergin ve ergin öncesi populasyon yo unlu u. - Turk J Zool. 20: 21-26.
- ALI N., MARJANKHAN K., KAUSAR A., 2013 - Study on Mosquitoes of Swat Ranizai Sub Division of Malakand. - Pak. J. Zool. 45: 503-510.
- AZARI-HAMIDIAN S., YAGHOUBI-ERSHADI M.R., JAVADIAN E., ABAI M.R., MOBEDI I., LINTON Y.M., HARBACH R.E., 2009a - 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.
- AZARI-HAMIDIAN S., HARBACH R.E., 2009b - Keys to the adult females and forth-instar larvae of the mosquitoes of Iran. - Zootaxa. 2078: 1-33.
- AZARI-HAMIDIAN S., YAGHOUBI-ERSHADI M.R., JAVADIAN E., ABAI M.R., MOBEDI I., 2007 - Review of dirofilariasis in Iran. - J. Guilan Univ. Med. Sci. 15: 102-113.
- AZARI-HAMIDIAN S., ABAI M.R., MASHAYEKHI M., LADONNI A., VATANDOOST H., HANAFI-BOJD A.A., FAGHIH-NAINI F., JEDARI M., 2005 - The subfamily Culicinae (Diptera: Culicidae) in Kerman Province, southern Iran. - Iran. J. Public Health. 34: 67-69.
- BALENGHEIN T., FOUQUE F., SABATIER P., BICOUT D.J., 2006 - Horse, bird and human-seeking behavior and seasonal abundance of mosquitoes in a West Nile virus focus of southern France. - J. Med Entomol. 43: 936-946.
- BANAFSHI O., ABAI M., LADONNI H., BAKHSHI H., 2013 - The fauna and ecology of mosquito larvae (Diptera: Culicidae) in western Iran. - Turk. J. Zool. 37: 298-307.
- DEMILLONE B., 1947 - Publications of the South. - African Institute for Medical Research, No. 49.
- DINPARAST-DJADID N., JAZAYERI H., GHOLIZADEH S., RAD S.H., ZAKERI S., 2009 - First record of a new member of *Anopheles Hyrcanus* Group from Iran: molecular identification, diagnosis, phylogeny, status of kdr resistance and *Plasmodium* infection. - J. Med. Entomol. 46: 1084-1093.
- ESLAMI A., 1997 - Veterinary Helminthology (Vol. III). Nematoda and Acanthocephala (2th edn). - Tehran University Publications, Tehran.
- EDRISSIAN G.H., 2006 - Malaria in Iran: Past and present situation. - Iran. J. Parasitol. 1: 1-14.
- ESHGHI N., 1977 - *Anopheles multicolor* Cambouliu and its role in the transmission of malaria in Iran. - J. Entom. Soc. Iran. 4: 87-88.
- FARHADINEJAD R., MOUSAVI M., AMRAEE K., 2015 - The species composition of mosquitoes (Diptera: Culicidae) in the Mahshahr district, Khuzestan province, southwest of Iran. - Arch Razi Inst. 70: 89-95.
- GHAVAMI M.B., LADONNI H., 2005 - Fauna and frequency of different mosquito species (Diptera: Culicidae) in Zanjan Province. - J. Zanjan Univ. Med. Sci. 13: 46-54 [In Persian].
- GUTSEVICH A.V., 1943 - On the mosquitoes of north Iran. - Doklady Akademii nauk SSSR. 40: 123-125.
- HARBACH R.E., 1988 - The mosquitoes of the subgenus *Culex* in southwestern Asia and Egypt (Diptera: Culicidae). - American Entomological Institute. 24: 240-241.
- HARBACH R.E., HOWARD T.M., 2007 - Correction in the status and rank of names used to denote varietal forms of mosquitoes (Diptera: Culicidae). - Zootaxa 1542:35-48.
- HANAFI-BOJD A.A., AZARI-HAMIDIAN S., VATANDOOST H., CHARRAHY Z., 2011 - Spatio-temporal distribution of malaria vectors (Diptera: Culicidae) across different climatic zones of Iran. - Asian Pac. J. Trop. Dis. 4: 498-504.
- KHOSRAVANI M., NASIRI Z., KESHAVARZI D., RAFAT-PANAH A., 2015 - Epidemiological trend of cutaneous leishmaniasis in two endemic focus of disease, south of Iran. - J. Parasit. Dis. 7: 41-47.
- 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.
- MARAGHI S., RAHDAR M., AKBARI H., RADMANESH M., SABERI A.A., 2006 - Human dirofilariasis due to *Dirofilaria repens* in Ahvaz, Iran: a report of three cases. - Pak. J. Med Sci. 22: 211-213.
- MATTINGLY P.E., KNIGHT K.L., 1956 - The mosquitoes of Arabia, I. Bulletin of the British Museum (Natural History). - Entomol. Ser. 4: 91-141.
- MANOUCHEHRI A.V., DJANBAKHSH B., ESHGHI N., 1976 - The biting cycle of *Anopheles dthali*, *A. fluviatilis* and *A. stephensi* in southern Iran. - Trop Geogr Med. 28: 224-227.
- MAJNOONPOUR M.R., SOLEIMANI-AHMADI M., POORAHMAD-GARBANDI F., 2014 - Fauna and distribution of Anopheleline Mosquitoes in Sirik County, Hormozgan Province. - Int. J. Prev. Med. 2: 29-35.
- MOOSA-KAZEMI S.H., ZAIM M., ZAHRAII RAMAZANI A.R., 2005 - Fauna and Ecology of Culicidae Mosquitoes of Zarrin-Shahr and Mobarakeh, Isfahan province, center of Iran. - Medicine and Health in the tropics congress, 11-15 September Marseille, France.
- MOOSA-KAZEMI S.H., VATANDOOST H., NIKOOKAR H., FATHIAAN M.,

- 2009 - Culicinae (Diptera Culicidae) mosquitoes in Chababar County, Sistan and Baluchistan Province, southeastern Iran. - Iran J. Arthropod-Borne Dis. 3: 29-35.
- MOOSA-KAZEMI S.H., HOSEIN ZAHIRNIA A., SHARIFI F., DAVARI B., 2015 - the Fauna and Ecology of Mosquitoes (Diptera: Culicidae) in Western Iran. - Iran. J. Arthropod-Borne Dis. 9: 49-59.
- NIKOOKAR S.H. *et al.*, 2010 - Species Composition and Diversity of Mosquitoes in Neka County, Mazandaran Province, Northern Iran. - Iran J. Arthropod-Borne Dis. 4: 26-34.
- NAVIDPOUR S., VAZIRIANZADEH B., HARBACH R., JAHANIFARD E., MORAVVEI S.A., 2012 - the identification of culicinae mosquitoes in the Shadegan wetland in southwestern Iran. - J. Insect Sci. 12: 105-109.
- NAFICY K., SAIDI S., 1970 - Serological survey on viral antibodies in Iran. - Trop. Geogr. Med. 2: 183-188.
- ORYAN A., VALINEZHAD A and BAHRAMI S., 2008 - Prevalence and pathology of camel filariasis in Iran. - Parasitol. Res. 103: 1125-1131.
- OSHAGHI M.A., VATANDOOST H., SEDAGHAT M.M., NADAF S.R., YAAGHOBI F., SHEMSHAD K., ABAI M.R., and AKBARZADEH K., 2006 - Review of the cryptic taxa within the genus *Anopheles* in Iran, with particular reference to the main malaria vectors. - 6th International Congress of Dipterology, Fukuoka, Japan: 188 p.
- REINERT J.F., 2009 - List of abbreviations for currently valid generic-level taxa in family Culicidae (Diptera). - Eur. Mosquito Bull. 27: 68-76
- SALLIT A.M., ZAKARIA M., BALBA M., ZAGHLOUL T., 1994 - the mosquito fauna of Kuwait. - J Kuwait Univ. 21: 77-85.
- SADIGIAN A., 1969 - Helminth parasites of stray dog and jackals in Shabsavar area, Caspian Sea region. - J. Parasitol. 55: 372-374.
- SENEVET G., ANDARELLI L., 1959 - Les moustiques de l'Afrique du Nord et du Bassin Méditerranéen. Les genres *Culex*, *Uranotaenia*, *Theobaldia*, *Orthopodomyia* et *Mansonia*. - Encycl. Entomol. 37: 1-383.
- SIAVASHI M.R., MASSOUD J., 1995 - Human cutaneous dirofilariasis in Iran: a report of two cases. - Iran. J. Med Sci. 20: 85-86.
- SHAHGUDIAN E.R., 1960 - A key to Anopheline of Iran. - Acta Med. Iran. 3: 38-48.
- STONI A., KNIGHT K.L., STARCKE H.A., 1959 - synoptic catalogue of the mosquitoes of the world (Diptera: Culicidae). - Thomas Say Foundation, Entomological Society of America, Washington, DC.
- VINOGRADOVA E.B., 2000 - *Culex p. pipiens* mosquitoes: taxonomy, distribution, ecology, physiology, genetics and control. - Pensoft Publishers, Sofia.
- WHO, 2009 - World malaria report 2009. WHO Press, Geneva: 66.
- WHO, 2013 - Malaria. Available from: www.who.int/mediacentre/factsheets/fs094/en/
- ZAIM M., SUBBARAO S.K., MANOUCHEHRI A.V., COCHRANE A.H., 1993 - Role of *Anopheles culicifacies* s.l. and *An. pulcherrimus* in malaria transmission in Ghassreghand (Baluchistan), Iran. - J. Am. Mosq. Control Assoc. 9: 23-26.
- ZAIM M., CRANESTON P.S., 1986 - Checklist and keys to the Culicinae of Iran (Diptera: Culicidae). - Mosq. Syst. 18: 233-245.
- ZAIM M., 1987 - The distribution and larval habitat of Iranian Culicinae (Diptera: Culicidae). - J. Am- Mosq. Cont. Assoc. 4: 568-573.
- ZAIM M., MANOUCHEHRI A.V. YAGHOOBI-ERSHADI M.R., 1985 - Mosquito fauna of Iran, 3. *Culex*. - Iran. J. Public Health. 14: 1-12.