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

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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. dhalii, Culex sitiaticus, Cx. theileri, Cx. pipiens, Cx. tritaeniorhynchus and Culiseta longiareolata. Cx. 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.

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, A. dhalii, A. Patton, 1905, A. fluvatilis James, 1902, A. maculipennis Meigen, 1818, A. saharoi 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 Combouliu, 1902, but sporozoites have not been found in this species and it is not considered a vector in Iran. Recently, Dinparast- Djadid et al. (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...
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 (setariosis) (Setaria labiatopapillosa, S. digitata, and S. equina), and Dipetalonema 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), Guysevitch 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 (Anophelineae and Culicineae), 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. tritaeniiorhynchus Giles, Cx. arbeienei Salem, Cx. latricinctus Edwards, Cx. siniticus 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.

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’ E) (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., 2006). 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. ppiens 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. ppiens (19%), Cx. theileri (14.2%), An. dthali (5.2%), An. superpictus (4.6%) and Cs. sinaiticus (0.3%). In the larval collection, of 1505 Culicidae larvae collected, Cs. longiareolata (34.1%) predominated, followed by Cx. theileri (29.3%), Cx. ppiens (18.7%), Cx. tritaeniorhynchus (7.3%), An. dthali (7.3%), An. superpictus (6.1%) and Cs. 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.

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

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

<table>
<thead>
<tr>
<th>Species</th>
<th>No. (%)</th>
<th>Larvae No. (%)</th>
<th>Adult No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cx. theileri</td>
<td>442 (293)</td>
<td>164 (14.2)</td>
<td></td>
</tr>
<tr>
<td>Cx. sinaiticus</td>
<td>19 (1.3)</td>
<td>3 (0.3)</td>
<td></td>
</tr>
<tr>
<td>Cx. pipiens</td>
<td>281 (18.7)</td>
<td>219 (19)</td>
<td></td>
</tr>
<tr>
<td>Cx. tritaeniorhynchus</td>
<td>110 (7.3)</td>
<td>404 (35.1)</td>
<td></td>
</tr>
<tr>
<td>An. superpictus</td>
<td>48 (3.2)</td>
<td>53 (4.6)</td>
<td></td>
</tr>
<tr>
<td>An. dthali</td>
<td>92 (6.1)</td>
<td>60 (5.2)</td>
<td></td>
</tr>
<tr>
<td>Cx. longiareolata</td>
<td>513 (34.1)</td>
<td>249 (21.6)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1505 (100)</td>
<td>1152 (100)</td>
<td>514 (100)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Species</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cx. theileri</td>
<td>21 (3.5)</td>
<td>87 (14.4)</td>
<td>256 (42.2)</td>
<td>113 (18.6)</td>
<td>51 (15)</td>
<td>38 (6.3)</td>
<td>606 (100)</td>
</tr>
<tr>
<td>Cx. sinaiticus</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>7 (31.9)</td>
<td>12 (54.5)</td>
<td>0 (0)</td>
<td>3 (13.6)</td>
<td>22 (100)</td>
</tr>
<tr>
<td>Cx. pipiens</td>
<td>8 (16)</td>
<td>0 (0)</td>
<td>69 (13.8)</td>
<td>304 (60.8)</td>
<td>108 (21.6)</td>
<td>11 (2.2)</td>
<td>500 (100)</td>
</tr>
<tr>
<td>Cx. tritaeniorhynchus</td>
<td>0 (0)</td>
<td>144 (28.1)</td>
<td>73 (14.2)</td>
<td>232 (45.1)</td>
<td>14 (2.7)</td>
<td>51 (9.9)</td>
<td>514 (100)</td>
</tr>
<tr>
<td>An. superpictus</td>
<td>9 (8.9)</td>
<td>3 (3)</td>
<td>17 (16.8)</td>
<td>27 (26.7)</td>
<td>20 (19.8)</td>
<td>25 (24.8)</td>
<td>101 (100)</td>
</tr>
<tr>
<td>An. dthali</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>66 (43.4)</td>
<td>41 (27)</td>
<td>45 (29.6)</td>
<td>0 (0)</td>
<td>152 (100)</td>
</tr>
<tr>
<td>Cx. longiareolata</td>
<td>63 (8.3)</td>
<td>46 (6)</td>
<td>218 (28.6)</td>
<td>199 (28.1)</td>
<td>38 (5)</td>
<td>198 (26)</td>
<td>762 (100)</td>
</tr>
<tr>
<td>Total</td>
<td>101 (3.8)</td>
<td>280 (10.5)</td>
<td>706 (26.6)</td>
<td>928 (34.9)</td>
<td>316 (11.9)</td>
<td>326 (12.3)</td>
<td>2657 (100)</td>
</tr>
</tbody>
</table>

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 boiling 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 (Banafi 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 southwestern 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 Chabahar, 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%).
Culex sinaiticus reported from Bushehr, Khuzestan, Sistan and Bluchestan, Fars, Kerman and Hormozgan provinces (Zaim et al., 1985). In present study this species has the lowest population with total of 22 specimens. This is in agreement with a study at Mahshahr district, Khuzestan province that Cx. sinaiticus has 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, Cx. longiareolata, and Cs. subochrea, which were discovered earlier in Fars (Zaim, 1987). This species reported from Gilan, Mazandaran, West & East Azerbaijan, Kurdistan, Zanjan, Bakhtaran, Hamadan, Luristan, Markazi, Teheran, Semnan, Khorasan, Isfahan, Chahar-Mahall, Yazd, Kerman, Sistan & Baluchistan, Hormozgan, Kohkiluye & Boyer-Ahmad, Bushehr, Khorasan, 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 Sistan & Baluchistan 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 (Salti 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 Cs. 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.

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