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MOSQUITO FAUNA (DIPTERA, CULICIDAE) IN TARHUNA REGION, LIBYA

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Mosquito Fauna (Diptera, Culicidae) in Tarhuna Region, Libya. Khalefa, A. S., Ghana, S., Rashid, N. M., Shaibi, T. — This study was conducted on mosquito larvae (Diptera, Culicidae) in Tarhuna, Libya during the period from January 2018 to December 2018. It aimed to determine the species diversity of mosquitos' larvae in Tarhuna. Mosquito larvae were collected by dipper 400 ml from eight water locations (four permanent and four temporary water locations). 4,877 larvae were collected, 3,162 from the permanent aquatic locations and 1,715 larvae from the temporary locations. Seven species of mosquito larvae were recorded: *Culiseta longiareolata, Culex perexiguus, Culex theileri, Culex laticinctus, Culex pipiens, Culex quinquefasciatus* and *Anopheles sergentii*. *Cs. longiareolata* was the most abundant species of mosquito larva in both permanent and temporary locations. There were temporal differences in the number of larvae of collected species among months. The results of this study showed that these species were recorded for the first time in Tarhuna and some of them are vectors for some diseases.
Key words: mosquitoes; larvae; diversity; water habitat; Tarhuna; Libya.

Introduction

The faunistic and epidemiological research on vectors of diseases is very important (Aliota et al., 2016; Wagner et al., 2018). Mosquitoes (Diptera, Culicidae) are free-living ectoparasites that have great medical importance. Some mosquito species are responsible for transmitting a variety of diseases causative agents such as malaria; filariasis, Chikungunya, West Nile virus, Dengue, yellow fever, Japanese and encephalitis; and Rift valley fever (Failloux et al., 2017).

Mosquitoes are distributed worldwide with more than 3500 described species (Harbach, 2018). Although the geographic spread of mosquito-borne diseases has grown in recent decades, the epidemiology of mosquito-borne diseases in North Africa and the Middle East is still poorly understood (Robert et al., 2019). Mosquito occurrence data are essential not just for improving our understanding of mosquito systematics, but also for assessing the danger of vector-borne diseases (Hutchings et al., 2016). In Libya, the knowledge of mosquitos' fauna is disorganized and the available published and unpublished reports (1933 to 1990) on mosquito species are listing 5 genera and 38 species (Gebreel, 1982; Gebreel et al., 1985; Goodwin & Paltrinier, 1959; Macdonald, 1982; Ramsdale, 1990; Shalaby, 1972; Vermeil, 1953; Zahar, 1974; Zavattari, 1934).

The information regarding mosquitoes-borne diseases in Libya is poor with few reports on malaria cases (Hamid et al., 2018; Martelli et al., 2015) and WNV (Shaibi et al., 2017). Libya has been suffered from difficult security and health conditions, due to the civil war and the waves of illegal immigrants who had entered the country and settled in the cities and villages for a period of time before crossing into Europe. This exposes the country to the introduction of several pathogens, especially those transmitted by mosquitoes. Although, Libya was declared by WHO as a country free of malaria in 1973, in recent years there have been cases of local transmission of malaria (Ba et al., 2018). The return of malaria to the country has become a looming threat, and it threatens neighboring countries in North Africa and Europe.

Monitoring pathogen vectors becomes a necessary step in making up disease surveillance and control programs. Therefore, the list of mosquitos' species in Libya needs to be updated. The aim of this study was to provide new insights into the diversity and temporal distribution of mosquito species in Tarhuna region, which is one of the main immigrant hubs from the south to the north of Libya. Therefore, the aim of the present study was to determine the species diversity of mosquitos' larvae in Tarhuna.

Material and methods

Study area and sampling sites

The study area is represented by the district of Tarhuna (fig. 1), which is located about 88 km southeast of Tripoli (32°00'–32°40' N and 13°20'–14°20' E) and occupies approximately 3820 km^2, and it rises approximately 398 m above sea level. The study area is characterized by a semi-arid climate. In winter, the average annual rainfall is 100–300 mm^3, whereas summer is hot and dry, and the average annual temperature is about 18 °C (Mahkloufet al., 2018). Eight sites were selected for the larval collection. Four of them are permanent habitat (water spring) (Ain Weef: 32°25' N 13°22' E, 409 m elevation; Ain Mesaahdia: 32°31' N 13°45' E, 425 m; Ain Mellin: 32°25' N 13°44' E, 409 m; Ain Sharsharh: 32°25' N 13°22' E, 398 m), and the rest are Semi-permanent habitats(water tanks, pools, etc.) (Sakia: 32°37' N 13°21' E, 367 m; Tarhuna Center: 32°31' N 13°45' E, 397 m; Tarhuna Agricultural Project: 32°31' N 13°16' E, 340 m and Ouechtata: 32°14' N 13°38' E, 350 m).

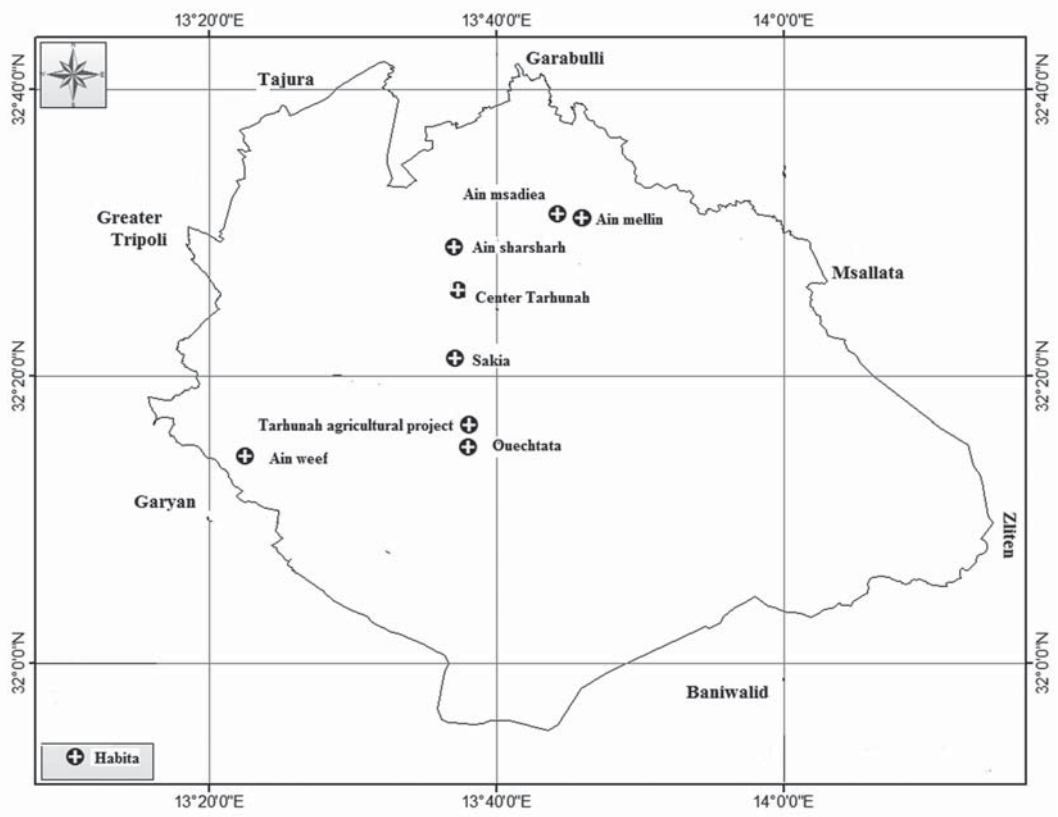

Fig. 1. Study area map of Tarhuna.

Larval sampling

Mosquito larvae were collected monthly from January 2018 to December 2018. Samples were taken by dipper (400 ml) with 3–5 water scoops from the edges and middle of the habitat. The third and fourth instars of mosquito larvae were preserved in 70 % ethanol and identified using MosKeyTool (Gunay et al., 2017). Larvae were placed in Nesbitt's solution for three hours for clearing, then a little Puris medium solution was dropped on a slide to load the larva. In the case of the specimen with a siphon, the larva was cut at the end of the sixth abdominal segment to make the siphon horizontal and help to lay the slide cover. The first and second larval instars were reared until reach the third or fourth instar, and then the same previous steps were followed.

Data Analysis

The relative abundance (RA %) was estimated by the ratio between number of specimens of the larvae species and the total number of larvae specimens of all mosquito species collected in the site ×100. The distribution of mosquito species was estimated using the pattern of occurrence (C %) as described by Rydzanicz & Lonc (2003), using the following formula: $C = n/N \times 100$. Where n = number of sites positive for the occurrence of mosquitoes species and N = total number of study sites. According to occurrence value mosquito species were classified into 5 categories: If C = 0–20 % the distribution pattern of the species is sporadic (C1), C = 20.1–40 % the distribution pattern of the species is infrequent (C2), C = 40.1–60 % the distribution pattern of the species is moderate (C3), C = 60.1–80 % the distribution pattern of the species is frequent (C4) and C = 80.1–100 % the distribution pattern of the species is constant (C5).

Results

During the study period, 4,877 larvae of mosquitoes were collected from Tarhuna; 3,162 larvae from the permanent aquatic habitat and 1,715 larvae from the semi-permanent habitat.

Seven species were identified: *Culiseta longiareolata* Macquart, 1838, *Culex theileri* Theobald, 1903, *Culex laticinctus* Edwards, 1913, *Culex perexiguus* Theobald, 1903, *Culex pipiens* Linnaeus, 1758, *Culex quinquefasciatus* Say, 1823 and *Anopheles sergentii* Theobald, 1907. The highest prevalence of mosquito larva species was for *Cs. longiareolata* with 2,646 larvae (54.3 %) (table 1), while the lowest was for *Cx. quinquefasciatus* with 21 larvae (0.4 %) whereas the rest ranged from 2.7 % to 16.2 %.

Table 1. Prevalence of mosquito larvae collected from Tarhuna

Species	Permanent habitat N (RA, %)	Semi-permanent habitat N (RA, %)
Cs. longiareolata	1693 (53.5)	953 (55.6)
Cx. theileri	180 (5.7)	153 (8.9)
Cx. laticinctus	672 (21.3)	9 (0.5)
Cx. perexiguus	375 (11.9)	416 (24.3)
Cx. quinquefasciatus	0 (0)	21 (1.2)
Cx. pipiens	0 (0)	132 (7.7)
An. sergentii	242 (7.6)	31 (1.8)
Total	3162 (100)	1715 (100)

Note. N— total larvae; RA (%) — relative abundance.

To know the distribution of mosquitoes, the pattern of occurrence was estimated for all locations (table 2). *Cs. longiareolata* was the most dominant species with pattern C3 in

Table 2. The pattern of occurrence of mosquito species collected in Tarhuna

Species	Semi-permanent habitat		Permanent habitat	
	(%) RA	Occurrence	(%) RA	Occurrence
Cs. longiareolata	C3	53.5	C3	55.6
Cx. laticinctus	C1	21.3	C2	0.5
Cx. perexiguus	C2	11.8	C1	24.3
Cx. theileri	C1	5.7	C1	8.9
Cx. quinquefasciatus	C1	0	C1	1.2
Cx. pipiens	C1	0	C1	7.7
An. sergentii	C1	7.7	C1	1.8

Note. Occurrence: C1 — sporadic; C2 — infrequent; C3 — moderate; RA (%) — relative abundance.

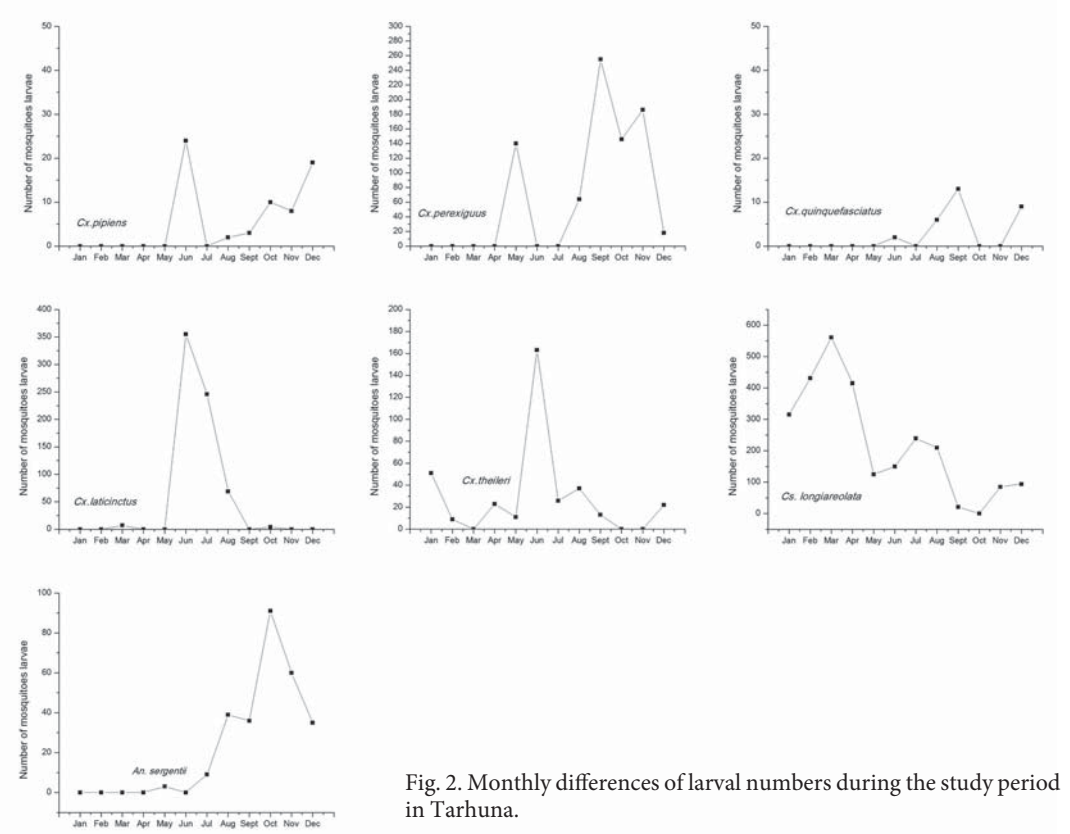

Fig. 2. Monthly differences of larval numbers during the study period in Tarhuna.

both permanent and semi-permanent habitats. *Cx. perexiguus* larvae showed pattern C2 in the permanent habitat and C1 in the semi-permanent habitat. *Cx. laticinctus* larvae showed pattern C1 in the permanent habitat and C2 in the semi-permanent habit. The rest four species showed pattern C1.

The monthly abundance of the larvae mosquito species varied among months of the year (fig. 2). As for the larvae of *Cs. longiareolata*, the highest abundance was in March and July by 561 and 239 larvae, respectively, while *Cx. laticinctus*, *Cx. theileri*, and *Cx. pipiens* showed their peaks in June, 535, 163 and 24 larvae, respectively. *Cx. perexiguus* showed three peaks, in May (186 larvae), September (255 larvae), and November (140 larvae). Regarding *Cx. quinquefasciatus*, the highest rise in September was the 13 larvae, while the height was *An. sergentii* gradually from May to its highest level in October 91 larva.

Discussion and conclusions

Few studies have been conducted regarding mosquitoes and their breeding sites in Libya, and this study is considered the first study on Tarhuna. The present study was conducted in order to identify mosquitos' larvae collected from Tarhuna, to determine temporal and spatial variation. This study showed the presence of seven species (*Cs. longiareolata, Cx. theileri, Cx. laticinctus, Cx. perexiguus*, *Cx. pipiens*, *Cx. quinquefasciatus* and *An. sergentii*) that have been previously recorded in Libya and represent around 18 % of the total Libyan mosquito fauna (38 species) (Aqeehal et al., 2019 a; Goodwin, 1961; Shalaby, 1972).

Although around 65 % of mosquitos' larvae specimens were collected from the permanent habitat, five species were found in the permanent and semi-permanent, whereas *Cx. pipiens* and *Cx. quinquefasciatus*, were found only in the semi-permanent habitat; water quality as well as the presence of vegetation and shade, and water turbidity and velocity impact the suitability of habitat for mosquito breeding (Alahmed, 2012).

Cs. longiareolata larvae were the predominant species in this study. It has been reported that they are most commonly found in rock pools or any type of man-made container, including wooden and metal barrels, concrete tanks, and wells (Becker & Hoffmann, 2011). The larvae can withstand a high level of pollutants. They are filter feeders, but they are also predatory feeders capable of cannibalism (Maslov et al., 1990). Larvae of *Cx. perexiguus* constituted the second place among collected larvae in this study; it was found more frequently in semi-permanent habitats. The larvae of *Cx. perexiguus* have been found in water bodies away from human habitat; they can withstand moderate salt (Harbach, 1988). *Cx. pipiens* constituted a small percentage of the larvae collected in our study. In previous studies, *Cx. pipiens* was found to be the predominant mosquito species in many studies, in Libya (Aqeehal et al., 2019 b) and other areas (Gad et al., 1995; Knio et al., 2005; Nikookar et al., 2015). *Cx. theileri*, *Cx. quinquefasciatus*, and *An. sergentii* were collected in few numbers in this study.

It was observed that the species which were recorded in this study showed a remarkable increase in abundance from May to November; this is due to the appropriate weather conditions. The activity of *Cx. laticinctus*, *Cx. theileri* and *Cx. pipiens* peaked in June. These results are consistent with the published results (Mohammed, 2012). On the other hand, in the cold months, some species larvae were recorded. In addition, we found the larvae of *Cx. laticinctus* in permanent habitats in June. However, it is mainly a summer mosquito, found in a wide range of habitats from temporary to permanent habitats (Harbach, 1988; Kitron & Pener, 1986).

The results of our study show that the mosquito species recorded have potential importance; they are considered vectors of several pathogens. The significance of these findings lies in the fact that Tarhuna is one of the main migration routes to northwestern of Libya (UNHCR, 2019). Many diseases causative agents can be transmitted by mosquito species recorded in this study. *An. sergentii* is a dominant vector for *Plasmodium* spp., the causative agent of malaria (Tabbabi et al., 2020). In the few past years, several cases of malaria have been documented in Libya (Gebreel et al., 1985; Martelli et al., 2015); between 2015 and 2019, unpublished reports mentioned four indigenous cases of malaria in Libya. *Cx. theileri*, *Cx. pipiens*, *Cx. quinquefasciatus*, and *An. sergentii*. *Cx. theileri* females feed mainly on the blood of mammals and birds (Muñoz et al., 2012); they are considered as a vector of pathogens that infect humans and animals, especially the West Nile virus (Demirci et al., 2014).

This study is a contribution to draw a comprehensive picture regarding mosquitos' fauna in Tarhuna and in Libya. More studies using other methods are required to give a clearer picture of mosquitoes in Tarhuna.

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