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Distribution of Mosquitoes Along Wadi El-Rayan Protected Area

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ABSTRACT

The knowledge of mosquito distribution in any environment is very important to control and avoid their effect on humans and animals. For this purpose, the present study was designed to monitor the mosquito distribution and abundance along Wadi El-Rayan Protected Area Fayoum Governorate. Throughout the four seasons from winter 2017 to autumn 2018, 10 mosquito species were recorded during this study belong to two genera. *Culex* was the most abundant genus and comprised 4 species representing 88.01% of the total mosquito count and *Anopheles* represented by 6 species (11.99% of the total mosquito count). *Culex pipiens* was the major dominant and common species followed by *Culex antennatus* and *Culex bivittatus* while *Anopheles multicolor* and *Anopheles tenebrosus* were the rarest mosquito species. Mosquito abundance was varied seasonally and flourished in summer, while it declines during winter. On the other hand, the mosquitoes were well distributed among study sites, but it was highly abundant at site 2 and low at site 4. The diversity indices and species richness are narrow ranged among the surveyed site, which indicates the stability of the mosquito community in the protectorate.

KEYWORDS

Mosquitoes, Abundance, Diversity, Wadi El-Rayan Protected Area.

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INTRODUCTION

Mosquitoes stand out most among the numerous species of blood- sucking arthropods that annoy humans But what is more important, is their role in transmission of many serious diseases **(Morsy *et al*, 1990)**. At least 3500 species of mosquitoes are known all over the world and being found in almost every country **(Stone, 1975).** Most of these species act as vectors of different pathogens that cause dengue fever, yellow fever, malaria, lymphatic filariasis, Japanese encephalitis and other serious diseases of humans **(Service 1996).** In Egypt, *Culex* spp. have a wide distribution and are the main vector of the Rift valley fever virus **(Darwish and Hoogastraal, 1981)**, *Wuchereria bancrofti* **(Gad *et al*., 1996)** and Western Nile virus **(Pelah *et al*., 2002).** *Bancroftian filariasis* is focally endemic in the Nile Delta of Egypt **(Harb *et al*.,1993).** The main vector responsible for transmission of filariasis in Egypt is *C. pipiens* L **(Southgate 1979).**

A basic attribute of mosquito populations is abundance; consequently, its estimation is one of the most important activities of mosquito ecologists. Abundance is a key factor in various types of studies, including life table analyses, assessment of control strategies, and estimation of vectorial capacity. Furthermore, mosquito vectors often shift their feeding preference seasonally or spatially, depending on the availability of the blood meal source. For example, *Cx. quinquefasciatus* showed an opportunistic preference for a blood meal. In peninsular Florida, it is responsible for an epizootic cycle and sustaining the virus circulation within reservoir host bird(s) **(Day, 2001, Shaman *et al* 2002)**. However, it has been incriminated with the enzootic/epidemic transmission cycle of WNV in urban and sub-urban areas in Louisiana due to feeding preference to humans and other mammals **(Balsamo *et al* 2003, Palmisano *et al* 2005, Nasci *et al* 2001, Brown *et al* 2008, DeGroote *et al* 2008).**

Studies across Africa have demonstrated the link between irrigated agriculture and health. Although irrigation may not necessarily increase the prevalence of malaria **(Ijumba and Lindsay 2001, Mutero *et al*., 2004),** it has been shown to aggravate the problem of other mosquito-borne disease. A proper understanding of the relationship between agricultural activity and the occurrence, abundance and distribution of mosquito densities may provide information relevant to the development and implementation of an Integrated Vector Management (IVM) program based on adult productivity and variability.

Wadi El-Rayan has a special historical significance as a major crossroad that was used for many centuries by travelers between the Nile Valley and the oases of the Western Desert. Remains of human settlements from Egyptian and Roman-Greek eras are found in the area **(Fakhry, 1957).** In the seventies two lakes were created in the lower portion of Wadi El-Rayan sub-depression to channel out excess agricultural drainage water in order to low-down the increase of the water table in the Fayoum main depression and in the Qaroun lake. The creation of a large body of water in this hyper-arid area had a striking ecological impact: new species of plants, mammals, birds and invertebrates moved to Wadi El Rayan area. The Wadi El Rayan depression is an important site for the deposition of Eolian sand in the Western Desert. Extensive dune fields run the length of WRPA oriented NNW to SSE and, probably, they are formed within the Holocene period as a result of disintegration and transportation of friable stones. The dunes vary in length from a few hundred meters to thirty km and may reach a height of 30 m **(IUCN, 2000a).** The climate Wadi El-Rayan is typically Saharan, hot and dry with scanty winter rain and bright sunshine throughout the year. According to the bioclimatic provinces of Egypt defined by, the area is hyper-arid with mild winters and hot summers. The vegetation is confined to inter-dune areas around springs and at the base of large dunes. The vegetation cover is made of perennial plants and a few individuals of *Calligonum comosum* and *Zygophyllum album* **Ayyad and Ghabbour, (1986).**

Insects biodiversity and activity is very much affected by the environmental factors in which they live **(Gullan & Cranston, 2000).** It is believed that diversity evolves through niche specialization and resource partitioning. There are few studies surveying the distribution and prevalence of the mosquitoes in Egypt. Therefore, the present study aimed to investigate the distribution and diversity of the mosquito's fauna of medical importance in four selected sites of Wadi El-Rayan Protected Area Fayoum Governorate.

.MATERIALS AND METHODS

The study area

Wadi El-Rayan Protected Area (WRPA) is one of Egypt's 27 protected areas. Natural features and landscapes, biodiversity and the World Heritage site in Wadi-Hitan have drawn national and international attention to its value. It is located in El- Fayoum Governorate on the Western Desert of Egypt about 120 Km from Cairo. The WRPA is a popular recreation area due to its close proximity to Cairo. It is visited by over 150,000 visitors per year. Wadi El-Rayan Protected Area (WRPA) is a large natural area of desert, lakes and oasis located in the Western Desert of Egypt in the Fayoum Governorate.

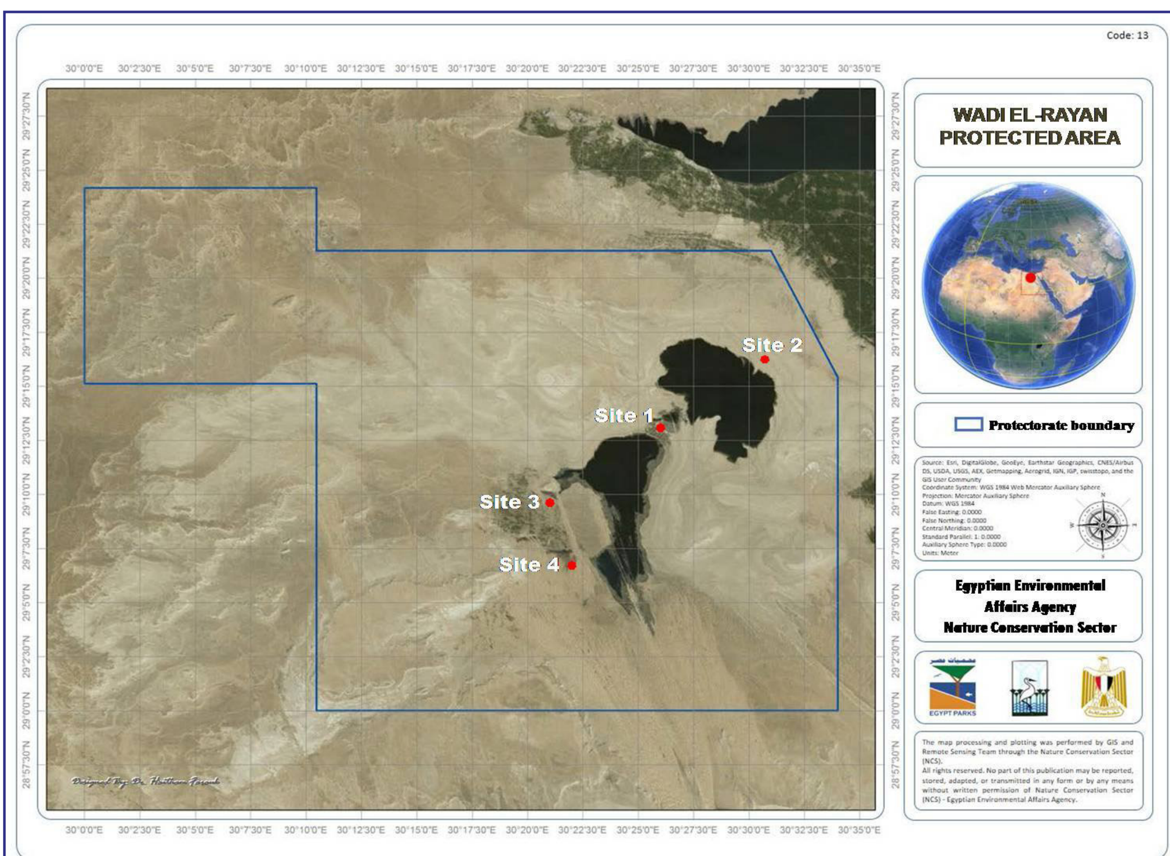

Fig. (1): Landsat image showing the study area and the investigated sectors and sites at (WRPA).

Four stations were chosen and covering a limit of 2 Km within the protected area. The name of stations is depending on the local native inhabitant inside the protected area. Accurate reading of the exact position of each sampling station is taken by the GPS (Satellite- based (Global positioning system) set. (figure1).

Field trips and Sample collection

Mosquitoes were surveyed in several field trips for one year from winter 2017 to autumn 2018 in different selected sites along (WAPRA). The study site consists of four different ecological habitats in site1 (Waterfalls and cafeterias area), site2 (the village of Moses), site3 (the village of Al-Khidr) and site4 (Vanguard village area). Two types of traps were used: a CDC light and BG-sentinel (BGS) traps. Baits used in these traps were carbon dioxide. One pair of traps was placed at each study site for 24 hours collection of mosquitoes. Each pair consisted of CDC light and BG-sentinel (BGS) traps. For the day collection traps were set around 8.00 am – 8.05 am and collected on the second day at the same time. Four replicates were conducted at each study site.

Identification of mosquito species

Collected traps were then sealed into a plastic bag and caught mosquitoes were killed using chloroform. Most of the mosquitoes collected were identified morphologically to species using the keys given by **kirkpatrick (1925), Gad (1963)** and **Morsy *et al*, (1990).**

Data analysis

Four diversity indices were calculated to estimate the stability of groups structuralize, species richness **(Margalef, 1968),** Shannon–Wiener diversity index **(Shannon and Wiener, 1963),** Evenness or equitability **(Pielou, 1975),** and Simpson index **(Simpson, 1949).**

RESULTS

Medical mosquito composition

The survey conducted along Wadi Al-Rian Protected Area showed that there are 10 mosquito species recorded during this study. The annual average abundance of recorded mosquito was 137.625 ind./trap. Two genera were representing the mosquito community in this survey. Genus *Culex* was the most abundant and diversify one with an annual average of 121.125 ind./trap (88.01% of the total mosquito count) and represented by 4 species comprised 40.00% of the total recorded species. The second genus was *Anopheles* with an annual average of 16.5 ind./trap (11.99% of the total mosquito count) and represented by 6 species comprised 60% of the total recorded species (Figure, 2).

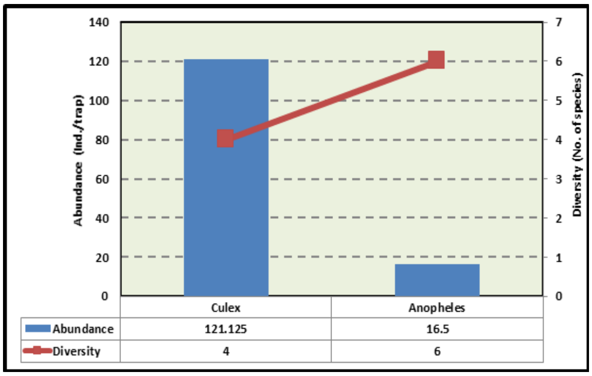

Fig. (2): Abundance and number of species for each of mosquito genera recorded in Wadi Al-Rian Protected Area.

The dominance of mosquito species recorded in Wadi Al-Rian Protectorate

Figure (3) cleared that there are three species recorded the major bulk of mosquito abundance and collectively comprised 86.51% of the total mosquito count. The first one was *Culex pipiens* that was the major dominant and common species during the study period; it recorded a relative bundance of 45.82% of the total mosquito count. *Culex antennatus* was the second dominant species with a relative abundance of 22.8% of the total mosquito count. *Culex univittatus* was the third dominant species, it represented by 17.9% of the total mosquito count. In this context, the remained recorded species (7 species) were rare and collectively represented with 13.49% of the total mosquito count. The first one was *Anopheles coustani* with an annual average of 3.54% of the total mosquito count, followed by *Anopheles pharoensis* 3.27% of the total mosquito count, *Anopheles anopheles* 1.86% of the total mosquito count, *Culex perexiguus* 1.5% of the total mosquito count, *Anopheles sergenti* and *Anopheles tenebrosus* with the same annual average of 1.36% of the total mosquito count and the rarest species was *Anopheles multicolor* with an annual average of 0.59% of the total mosquito count.

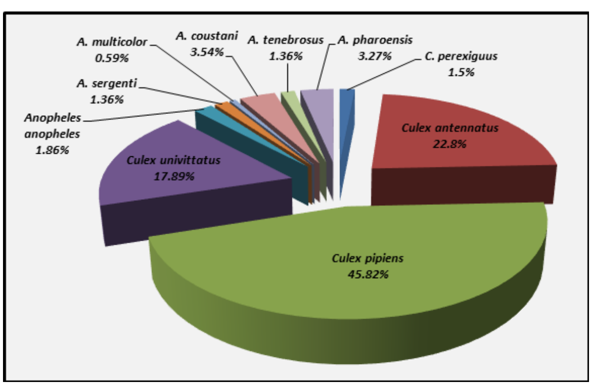

Fig. (3): The dominance of mosquito species recorded in Wadi Al-Rian Protected Area.

Temporal distributions of the mosquito species recorded in Wadi Al-Rian Protectorate.

As shown in figure (4), the temporal abundance of mosquito was varied greatly from season to another. They were flourished in summer with an average abundance of 250.25 ind./trap (45.46% of the total recorded mosquito count), followed by spring (130.75 ind./trap, 23.75%), autumn (129.75 ind/trap, 23.6%) and winter cam at the last (39.75 ind./trap, 7.22% of the total recorded counts).

In this context, the species abundance was varied during investigated seasons as follow; during summer, *Culex pipiens* was the major dominant and common species with an abundance of 88.5 ind./trap, followed by *Culex antennatus* with an average of 71.5 ind./trap, *Culex univittatus* (45.25 ind./trap), *Anopheles coustani* (11.75 ind./trap), *Anopheles pharoensis* (10.5 ind./trap), *Anopheles tenebrosus* (6 ind./trap), *Anopheles anopheles* (5.75 ind./trap), *Culex perexiguus* (4.5 ind./trap), *Anopheles sergenti* (4.25 ind./trap) and *Anopheles multicolor* (2.25 ind./trap).

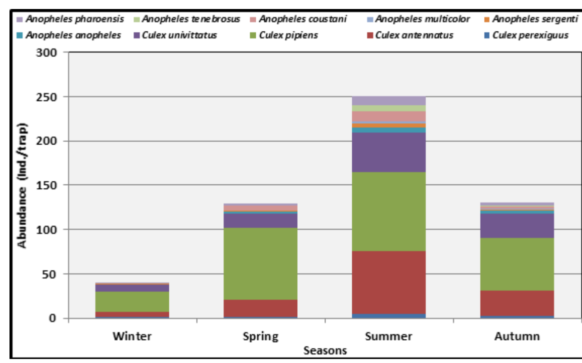

Fig. (4): The temporal abundance of the mosquito recorded in Wadi Al-Rian Protected.

During autumn, *Culex pipiens* was the main dominant species with an abundance of 60 ind./trap, followed by *Culex antennatus* with an average of 28.5 ind./trap, *Culex univittatus* (27.75 ind./trap), *Anopheles pharoensis* (4.25 ind./trap), *Anopheles anopheles* (2.75 ind./trap), *Anopheles coustani* (2.25 ind./trap), *Culex perexiguus* (2 ind./trap), *Anopheles sergenti* (1.75 ind./trap), *Anopheles tenebrosus* (1 ind./trap) and *Anopheles multicolor* (0.5 ind./trap). During spring, *Culex pipiens* was the main dominant species with an abundance of 81.25 ind./trap, followed by *Culex antennatus* with an average of 19.25 ind./trap, *Culex univittatus* (16.75 ind./trap), *Anopheles coustani* (5.5 ind./trap), *Anopheles pharoensis* (2.25 ind./trap), *Anopheles anopheles* (1.75 ind./trap),*Culex perexiguus* (1 ind./trap), *Anopheles sergenti* (1 ind./trap), *Anopheles tenebrosus* and *Anopheles multicolor* have the same abundance of 0.5 ind./trap. During winter, *Culex pipiens* was the dominant species with an abundance of 22. 5 ind./trap, followed by *Culex univittatus* with an average of 8.75 ind./trap, *Culex antennatus* (6.25 ind./trap), *Anopheles pharoensis* (1 ind./trap), *Culex perexiguus* (0.75 ind./trap) and *Anopheles sergenti* (0.5 ind./trap) (Figure, 4).

Spatial distributions of the mosquito species recorded in Wadi Al-Rian Protectorate.

The spatial distribution of recorded mosquito at study area showed that the abundance was high at site 2 with an annual average of 149 ind./trap which represented about (27.07 % of the total abundance), followed by site 1 (143.5 ind./trap, 26.07%) and site 3 (137.25 ind./trap, 24.2%). While, site 4 had the lowest abundance of 120.75 (21.93 % of the total abundance) (Figure, 5).

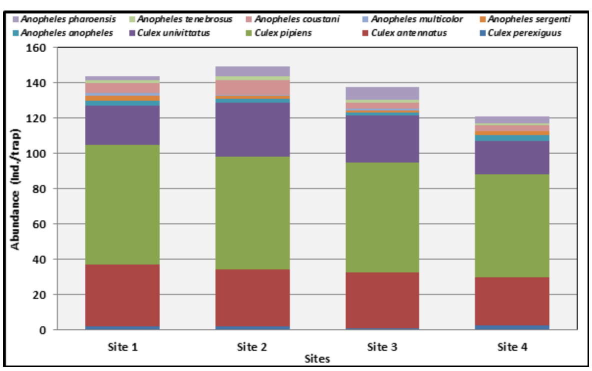

Fig. (5): The spatial abundance of the mosquito recorded in Wadi Al-Rian Protected.

With regards to the spatial variations of mosquito abundance, the species abundance was varied on narrow range between surveyed sites. At site 1, *Culex pipiens* was the main dominant species with an abundance of 67.75 ind./trap, followed by *Culex antennatus* with an average of 34.75 ind./trap, *Culex univittatus* (22.5 ind./trap), *Anopheles coustani* (5.25 ind./trap), *Anopheles anopheles* (2.75 ind./trap), *Anopheles sergenti* (2.75 ind./trap), *Culex perexiguus* (2.25 ind./trap), *Anopheles pharoensis* (2.25 ind./trap), *Anopheles tenebrosus* (1.75 ind./trap) and *Anopheles multicolor* (1.5 ind./trap). At site 2, *Culex pipiens* was the dominant species with an abundance of 64 ind./trap, followed by *Culex antennatus* with an average of 32.25 ind./trap, *Culex univittatus* (30.25 ind./trap), *Anopheles coustani* (8 ind./trap), *Anopheles pharoensis* (5.25 ind./trap), *Anopheles anopheles* (2.5 ind./trap), *Anopheles tenebrosus* (2.5 ind./trap), *Culex perexiguus* (2 ind./trap), *Anopheles sergenti* (1.55 ind./trap) and *Anopheles multicolor* (0.75 ind./trap). At site 3, *Culex pipiens* was the main dominant with an abundance of 62.25 ind./trap, followed by *Culex antennatus* with an average of 31. 5 ind./trap, *Culex univittatus* (26.75 ind./trap), *Anopheles pharoensis* (7 ind./trap), *Anopheles coustani* (3.25 ind./trap), *Anopheles anopheles* (1.75 ind./trap), *Anopheles tenebrosus* (1.75 ind./trap) and each of *Culex perexiguus*, *Anopheles sergenti* and *Anopheles multicolor* has the same abundance of 1 ind./trap. At site 4, *Culex pipiens* was dominant species with an abundance of 58.25 ind./trap, followed by *Culex antennatus* with an average of 27 ind./trap, *Culex univittatus* (19 ind./trap), *Anopheles pharoensis* (3.5 ind./trap), *Anopheles anopheles* (3.25 ind./trap), *Culex perexiguus* and *Anopheles coustani* with the same abundance (3 ind./trap), *Anopheles sergenti* (2.25 ind./trap) and *Anopheles tenebrosus* (1. 5 ind./trap) (Figure, 5).

Spatiotemporal distribution of mosquito recorded in Wadi Al-Rian Protectorate

At all surveyed sites during the whole study period, mosquito abundance shows high two peaks (Fig.,6). The first peak occurred in Site 2 during summer with an abundance of 288 ind./trap and the second peak was recorded in site 1 during summer with an abundance of 181 ind./trap. While, the smallest values of mosquito abundance were recorded at site 2 during winter (33 ind./trap), site 3 during winter (36 ind./trap) and site 1 during winter with an abundance of 41 ind./trap.

According to the present data, *Culex pipiens* abundance was fluctuated between the high value (98 ind./trap) at site 1 during summer and low value (17 ind./trap) at site 2 during winter. While, the high abundance value of *Culex antennatus* (88 ind./trap) was recorded at site 1 during summer, while the low value (5 ind./trap) were recorded at site 2 during winter. *Culex univittatus* abundance was ranged between highest abundance (65 ind./trap) at site 2 during summer, and lowest abundance (5 ind./trap) at site 4 during winter. *Anopheles coustani* recorded its highest abundance (18 ind./trap) at site 2 during summer, while its lowest one (2 ind./trap) happened at each of site 1 during spring and site 1 during autumn. *Anopheles pharoensis* had a high abundance (18 ind./trap) at site 3 during summer, but the low value (1 ind./trap) was noticed at site 4 during spring. *Anopheles anopheles* abundance was ranged between highest abundance (8 ind./trap) at site 4 during summer, and lowest abundance (2 ind./trap) at many sites during deferent season. *Culex perexiguus* recorded its highest abundance (7 ind./trap) at site 1 during summer, while its lowest one (1 ind./trap) happened at site 1 during winter. *Anopheles sergenti* abundance was ranged between highest abundance (7 ind./trap) at site 1 during summer, and lowest abundance (2 ind./trap) at many sites during deferent season. *Anopheles tenebrosus* had a high abundance (8 ind./trap) at site 2 during summer, but the low value (2 ind./trap) was noticed at many sites during deferent season. Finally, *Anopheles multicolor* site 4 during spring. *Anopheles anopheles* had a high abundance (5 ind./trap) at site 1 during summer, but the low value (1 ind./trap) was noticed at each of site 1 and site 2 during spring.

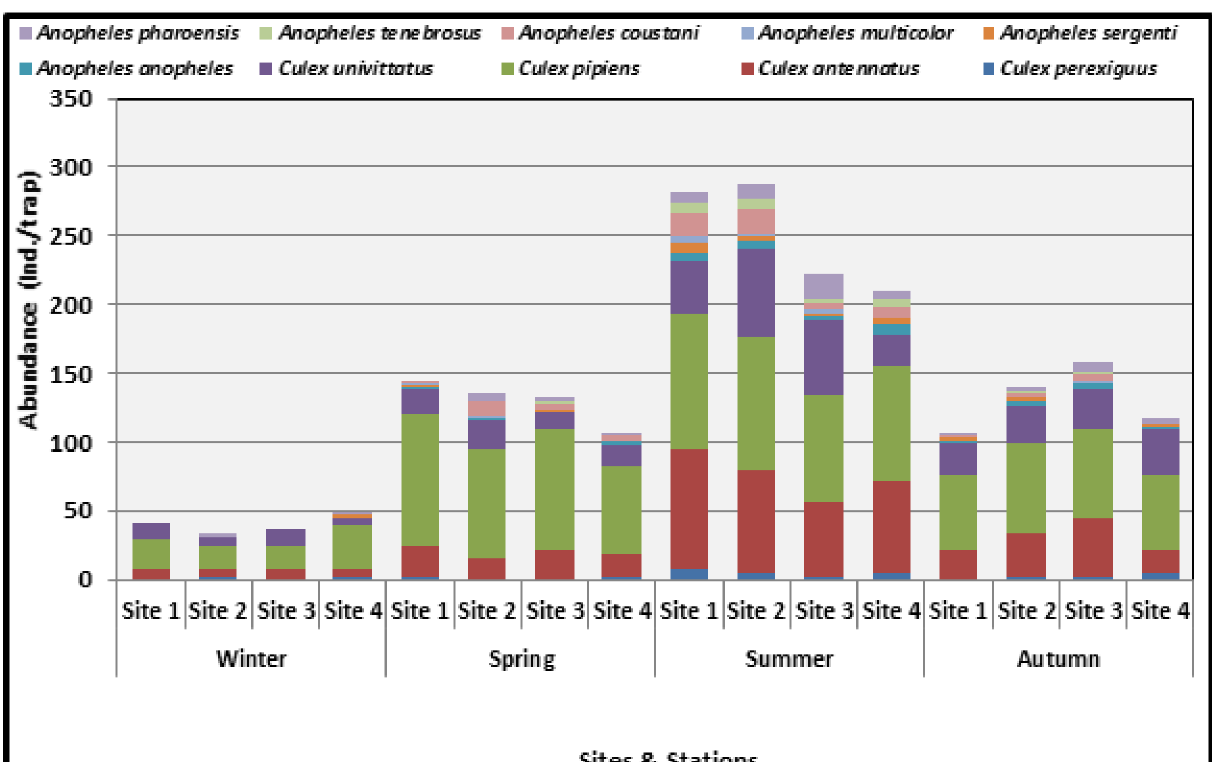

Fig. (6): The Abundance (ind./trap) of the mosquito species recorded at different sites of Wadi Al-Rian Protected.

Diversity indices of mosquito distribution in Wadi Al-Rian Protectorate

As a result of the table (1), the ecological diversity indices fluctuated within a wide range between stations during four seasons. Where, the highest value of species richness (1.666) was recorded in site 3 during summer, followed by 1.619 in site 2 during autumn, while the lowest value (0.5386) occurred in site 1 during winter, followed by 0.5581 in site 3 during winter. Also, the highest value of Shannon index (1.703) was recorded in site 1 during summer, followed by 1.663 in site 2 during summer, but the lowest value (0.9954) was recorded in site 1 during winter, followed by 1.027 in site 3 during winter. In this context, the highest Evenness values were 0.9351 and 0.9061 during winter at site 3 and site 1, respectively, but, the lowest Evenness values were 0.5236 at site 1 during spring and 0.5679 at site 3 during spring. Concerning the Simpson index, its highest value was 0.7642 and 0.7576 during summer at site 2 and site 2, respectively. While, the lowest value of Simpson index was 0.5261 at site 1 during spring, followed by 0.5281 at site 4 during winter.

Table (1) : *The Diversity indices for mosquito species inhabiting Wadi Al-Rian Protected Area.*

Seasons	Sites	Species richness	Eveness index	Shannon index	Simpson index
Winter	site 1	0.5386	0.9061	0.9954	0.6122
	site 2	1.144	0.8055	1.296	0.6799
	site 3	0.5581	0.9351	1.027	0.6365
	site 4	1.285	0.6121	1.097	0.5281
Spring	site 1	1.407	0.5236	1.089	0.5261
	site 2	1.223	0.6632	1.29	0.6219
	site 3	1.227	0.5679	1.105	0.5288
	site 4	1.287	0.6389	1.243	0.6032
Summer	site 1	1.596	0.7395	1.703	0.7576
	site 2	1.589	0.7223	1.663	0.7642
	site 3	1.666	0.6911	1.591	0.7526
	site 4	1.496	0.7248	1.593	0.7281
Autumn	site 1	1.284	0.663	1.29	0.656
	site 2	1.619	0.6653	1.462	0.6977
	site 3	1.58	0.6909	1.518	0.722
	site 4	1.258	0.7132	1.388	0.6914

DISCUSSION

Insects are powerful and rapid adaptive organisms with high fecundity rate and short life cycle. Due to human interruption in agro-ecosystem and global climatic variations are disturbing the insect ecosystem. Today, Wadi Al-Rayan Protected Area is 1,759 km2 in size. WRPA's natural landscapes are a popular attraction for national and international visitors. A growing number of people are attracted to the only waterfalls in Egypt, sand beaches, natural beauty, camping, bird watching, and the internationally important World Heritage Site. The protected area also hosts a variety of economic activities that support local communities, such as fish farming, traditional fishing in the Rayan lakes, agriculture at the land reclamation area, oil extraction, and cafeterias that serve tourists. The variety of resources and services in the protected area require sustainable sources of funding accompanied by wise and effective management. With these ingredients, WRPA staff can protect the natural values, thereby ensuring the provision of sustained benefits to local communities. According to the present study, conducted along Wadi Al-Rayan Protected Area 10 mosquito species namely; *Culex pipiens*, *Culex antennatus, Culex univittatus, Culex perexiguus, Anopheles coustani*, *Anopheles pharoensis*, *Anopheles tenebrosus*, *Anopheles anopheles*, *Anopheles sergenti* and *Anopheles multicolor* belonging two genera were recorded in four stations. The results are similar to **(Farid *et al*., 2000;El-Bashier *et al*., 2006, Muturi *et al*., 2006 and EL-Sheikh *et al,* 2010).** The current study revealed that the annual average abundance of recorded mosquito was 137.625 ind./trap. Two genera were representing the mosquito community in this survey. Genus of *Culex* was the most abundant and diversify one with an annual average of 121.125 ind./trap (88.01% of the total mosquito count) and represented by 4 species comprised 40.00% of the total recorded species. The second genus was *Anopheles* with an annual average of 16.5 ind./trap (11.99% of the total mosquito count) and represented by 6 species comprised 60% of the total recorded species. Also, **EL-Sheikh *et al,* (2010**) resulted that the most abundant types were: *Cx. pipiens*, *Cx. antennatus*, *Cx. univittatus*, *An. pharoensis* and *An. coustani*. *C. pipiens* and *Cx. antennatus* were found in all types of breeding places. **Rifaat *et al*., (1970)** in Sharkia reported that *Cx. pipiens* represented 83.4% of all larvae collected thought the year and the larvae prefer wells and cesspits, while rice fields were abundant. Mohamed *et al*., (1981) in Giza found that *Cx. pipiens* was the most common mosquito species forming 97.95 of all species and the larvae found in all breeding places especially in cesspits, canals, drains, seepage and lastly wells. **Kenawy and El Said (1990)** reported that the rice is of significant preference for breeding of culicine larvae the most common species in Nile valley, Oases and Suez canal zone. **El Shazly *et al*., (1998)** in Mansoura found that the most abundant types were *Cx. univittatus, Cx. antennatus* and *Ae. caspius*, while the least common types were *Cx. deserticola* and neither detected *Cx. pipiens* in drains, sewage wells nor rice fields. Only a small percent was in a canal of Mansoura center, also, *Cx. antennatus* found only in rice field . **Mostafa *et al*., (2002)** over three years of study found that *Cx. pipiens* and *Cx. antennatus* were the main species in four Egyptian governorates. In the current study the spatial distribution of recorded mosquito at study area showed that the abundance was high at site 2 with an annual average of 149 ind./trap which represented about (27.07 % of the total abundance), followed by site 1 (143.5 ind./trap, 26.07%) and site 3 (137.25 ind./trap, 24.2%). While, site 4 had the lowest abundance of 120.75 (21.93 % of the total abundance). **Kirkpartick (1925)** found that these species were abundant only in the Nile Delta, and **Salem (1933)** who found them around Cairo and Oases. **Wassif (1969)** found these species in great numbers along the costal area. **Hurlbut and Weitz (1956)** found them among the commonest five mosquitoes of Nile Delta perhaps the discrepancy in the density comes from the fact that the species prefers to have shelters outside human habitations. **El Shazly *et al*., (1998)** gave the same observation. Also, *Culiseta sp*. was recorded in canals, drains and sewage wells and not detected in rice field in the different areas, this differs from that of **Kikpatrick (1925)** who found it throughout the Nile Valley and **Salem (1933)** who found it in the Oases, but it agreed with **Gad (1956) and Morsy *et al*., (1990)** who found it in the Suez canal zone, around Cairo, in Faiyum, in Northern Delta and in some Oases. Moreover, *Cx. deserticola* was found only in few numbers in canals and sewage wells, the results agreed with those published by **El Shazly *et al*., (1998).**

Also at the present study, the highest value of species richness (1.666) was recorded in site 3 during summer, followed by 1.619 in site 2 during autumn, while the lowest value (0.5386) occurred in site 1 during winter, followed by 0.5581 in site 3 during winter. Also, the highest value of Shannon index (1.703) was recorded in site 1 during summer, followed by 1.663 in site 2 during summer, but the lowest value (0.9954) was recorded in site 1 during winter, followed by 1.027 in site 3 during winter. In this context, the highest Evenness values were 0.9351 and 0.9061 during winter at site 3 and site 1, respectively, but, the lowest Evenness values were 0.5236 at site 1 during spring and 0.5679 at site 3 during spring. Concerning the Simpson index, its highest value was 0.7642 and 0.7576 during summer at site 2 and site 2, respectively. While, the lowest value of Simpson index was 0.5261 at site 1 during spring, followed by 0.5281 at site 4 during winter. This similar to **EL-Sheikh *et al,* (2010)** revealed that there is a significant variation in mosquito density and species richness was observed in the three agro-ecosystems and Fowa city. These variations may be due to the observed differences in the diversity of aquatic habitats among the three villages and Fowa city. The irrigated agroecosystem had more diverse habitat types, thereby supporting diverse mosquito species. The *Culex* mosquitoes breed in a wide range of habitats although they have been able to exploit the same habitats as *Anopheles* mosquitoes **(Mwangangi *et al.,* 2009).** Previous studies have reported a positive relationship between habitat type diversity and mosquito species richness **(Kenawy and El-Said 1989; Ijumba *et al*., 2002; Shililu *et al*., 2003).**

CONCLUSIONS

The number of collected mosquito species is considered not higher compared to relevant studies. Both two types of CDC light and BG-sentinel (BGS) traps showed to be suitable traps in collecting mosquitoes. Furthermore, they show to have no negative effects on the environment and/or human being. This study provides the necessary information required for future management and control programs of mosquitoes in the region.

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