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Mosquitoes (Diptera: Culicidae) in El Gharbia Governorate, Egypt: their spatial distribution, abundance and factors affecting their breeding related to the situation of lymphatic filariasis

Yousrya M. Abdel-Hamid[1], Azza A. Mostafa[1], Kamilia M. Allam[1] and Mohamed A. Kenawy[2]

Research Institute of Medical Entomology[1], The General Organization for Institutes and Teaching Hospitals, Ministry of Health, Dokki, Giza, Department of Entomology[2], Faculty of Science, Ain Shams University, Cairo 11566, Egypt.

ABSTRACT

Mosquitoes were surveyed (March - May, and November 2007) in all centers of the El Gharbia Governorate. Seven mosquito species (6 culicine and 1 anopheline) were collected. These are *Culex pipiens, Cx. perexiguus, Cx. antennatus,* Cx. *theileri, Ochlerotatus detritus*, *Culiseta longiareolata* and *Anopheles tenebrosus. Cx. pipiens,* the main filariasis vector was the most common or predominating species (ca. 45%, 15 adult/room and 86%, 63 larva/SU, $P<0.01$). *Cx. antennatus* (ca. 38%, 13 adult/room) was also common species ($P<0.01$). For the three common species, *Cx, pipiens, Cx. perexiguus* and *Cx. antennatus* the relation of their larval and adult indoor densities with the environmental factors (water temperature and pH; indoor- and outdoor- temperature and RH) were examined. No infection with *Wuchereria bancrofti* were found in 1493 blood sample examined. Only one Elephantiasis case was reported from El Santa center (1/ 196 examined sample).

Key Words: Mosquitoes- Distribution-Abundance- Breeding habitats- Filariasis- *Wuchereria bancrofti*- *El* Gharbia Governorate-Egypt

INTRODUCTION

El Gharbia Governorate locates in the center of the Nile Delta bordering with Kafr El Sheikh Governorate to its north, El Menoufia Governorate to the south, and Damietta and Rosetta branches of the Nile to the east. The capital of El Gharbia is Tanta City that locates about 90 km² from Cairo. The governorate encompasses eight administrative centers in addition to a large number of cities, towns, and villages. El Gharbia with a population of around 4,000,000 and covers about 25,400 km², the majority of which are agricultural lands.The major economic resources for the governorate are agriculture and food and textile industries. The most important crops in it are wheat, rice and cotton in addition to some fruits and flowers. Extended irrigation water network and various water collections are found in the governorate which has its impact on the occurrence and abundance of the mosquitoes (Kenawy *et al.,* 1996).

In only one occasion, the mosquitoes were surveyed in the governorate by El-Said and Kenawy (1983) in 4 localities in two centers (Tanta and El Mahla El Kobra) and seven mosquito species were reported, of which *Cx. pipiens* was the most common species (in all surveyed localities). Culicine mosquitoes in Egypt are vectors of filariasis (Southgate, 1979), Rift valley fever (RVF) virus (Meegan *et al.,* 1980), West Nile virus (Taylor *et al.* 1956) and several other viruses (Darwish and Hoogstraal, 1981). *Anopheles pharoensis* is the proven malaria vector, *An. multicolor* is suspected as a vector while *An. tenebrosus* has no role in malaria

transmission in Egypt (El Said *et al.*, 1986 and kenawy, 1988)

The present study was planned to update and provide further observations on the mosquito fauna of the governorate. This is important for planning a vector control program based on solid biological and ecological information of mosquito fauna mainly the disease vectors.

MATERIALS AND METHODS

The Study Areas:

The survey was carried out (March - May and November 2007) in three localities representing each of the eight centers of the governorate (Table 1). Locations (longitude and latitude) of these centers were recorded using a global positioning system (GPS) navigator.

Table 1: Coordinates of the surveyed centers in El Gharbia Governorate.

District		Longitude E	Latitude N
East	**El Santa**	31° 06' 34.60''	30° 44'55.30''
	Zefta	31° 15' 00.80''	30° 37'13.10''
	El Mahalla El Kobra	31° 05' 38.70''	30° 59'16.60''
	Samanoud	31° 15' 39.20''	31° 00'14.40''
West	**Tanta**	31° 01' 97.20''	30° 44'49.40''
	Kafr El Zayat	30° 47'16.50''	30° 53'27.30''
	Kotour	30° 58' 42.95''	31° 58'42.90''
	Basyoun	30° 50' 48.40''	30° 57 32.50''

Mosquito Survey

Mosquito Larvae were collected by netting and adults were collected from inside houses by hand collection and space spraying (0.2% pyrethroid in kerosene) as described by Abdel-Hamid *et al.* (2009). Keys (Harbach, 1988 and Glick, 1992) were used for mosquito identification.

Filariasis Survey

The AMRAD-ICT Filariasis card Test (ICT-Fil, Immunochromatographic Diagnostic Tests Company, Balgowlah, New South Wales, Australia) was used to detect the *Wuchereria bancrofti* antigen in the whole blood (Ramzy *et al.,* 1999). Finger prick blood samples were drawn onto the card (El-Setouhy *et al.,* 2007) and the results were read visually (negative/positive) after 15 minutes.

Statistical Analysis

Means and Standard Errors were calculated for larval and adult densities of the reported mosquito species. Means were compared by the one-way ANOVA and if significantly different, they were exposed to pairwise comparison by Tukey test. Multiple Regression analysis was used to examine the relation of larval density to the temperature and pH of the breeding water and of the indoor adult density to the indoor- and outdoor-temperature and relative humidity (RH). The slopes of the regression equations were tested for deviation from 0 by t-test. The PAST (PAleontological Statistics Version 2.08, Hammer *et al.* 2001) computerized program was used for statistical analysis

RESULTS

Species Composition

Seven mosquito species (6 culicine and 1 anopheline) were collected (Fig. 1). These are *Culex (Culex) pipiens* Linnaeus, *Cx. (Cx.) perexiguus* Theobald, *Cx. (Cx.) antennatus* (Becker), Cx. *(Cx.) theileri* Theobald, *Ochlerotatus (Oc.) detritus* (Haliday), *Culiseta* (*Allotheobaldia*) *longiareolata* (Macquart) and *Anopheles (An.) tenebrosus Dönitz. Cx. pipiens, Cx. perexiguus* and *Cx. antennatus* were collected as larvae and adults from all centers. *Cx. theileri* and *An. tenebrosus* were collected as adults from Basyoun

and El Mahalla El Kobra, respectively. *Oc. detritus* was collected as adults from Al Santa and Tanta. *Cs. longiareolata* was collected as larvae from Tanta.

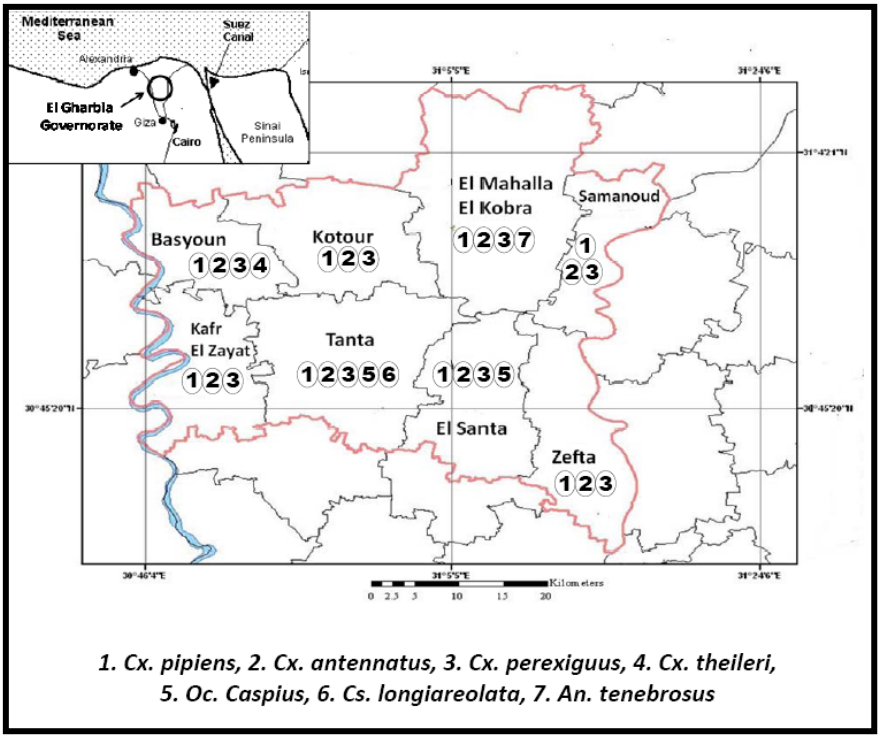

Fig. 1: Distribution of the reported mosquito species in El Gharbia Governorate

Relative Abundance

From 290 collections (Survey unit; SU each of 10 net dips) a total of 20981 larvae of four species were collected (Table 2) of which *Cx. pipiens* was the predominant species (85.61%, 63.30 larva/SU, $P<0.01$). From 256 examined rooms, a total of 8753 adults of six species were collected (Table 2) of which 3317 (37.90%) were collected by space spraying and 5436 (62.10%) were collected by hand collection. Most of the collections were females (7185, 82.09%) in comparison to males (1568, 17.91%). *Cx. pipiens* (44.67%, 15.29 adult/room) and *Cx. antennatus* (38.42%, 13.32 adult/room) were the most common species ($P<0.01$).

Results based on the percentage of each mosquito species from total collected in each center revealed that: (1) in larval collection, *Cx. pipiens* was the most common species in all districts (47.3-100%) except in El Santa where *Cx antennatus* was the most common (74.0%), (2) In adult collections: *Cx. pipiens* was also the most common species in all centers (40.1-52.5%) except in El Santa and El Mahalla El Kobra where *Cx. antennatus* was the most common (63.2 and 51.2%, respectively). In general, for all species (Fig. 2) larvae were most common in El Mahlla El Kobra (29.6%) while adults were most common in Zefta (29.6%) than in the other centers. Larvae and adults were most common in the eastern part (65.7 and 63.8%, respectively) than the western part (34.3 and 36.2%, respectively) of the governorate. However, For all species, mean densities of both adults (3.28±1.76-20.42±8.69 adult/room) and larvae (1.14±0.62-55.40±53.10 larva/SU) were insignificantly different among the study centers (F = 1.80 and 0.49, respectively. $d.f.$ = 7, 24. $P>0.05$).

Table 2: Relative abundance of the reported mosquito species in El Gharbia Governorate

Species	Larvae (Tot: 20981)			Adults (Tot: 8753)		
	No	%	Mean density±SE	No	%	Means density±SE
Cx. pipiens	17962	85.61	63.30±17.68A	3910	44.67	15.29±3.56A
Cx. antennatus	912	4.35	4.04±1.47B	3363	38.42	13.32±2.55A
Cx. perexiguus	2086	9.94	8.88±6.12B	1465	16.74	5.84±1.13B
Cx. theileri				6	0.07	0.02±0.01C
Oc. detritus				8	0.09	0.05±0.03C
Cs. longiareolata	21	0.10	0.09±0.09C			
An. tenebrosus				1	0.01	0.01±0.003C
F (d.f.)			10.1 (3,44), *P* <0.01			9.7 (5,42), *P*<0.01

Density: larva/10 net and adult/room; in each column, means with different letters are significantly different (pair wise comparison by Tukey test, *P* <0.01).

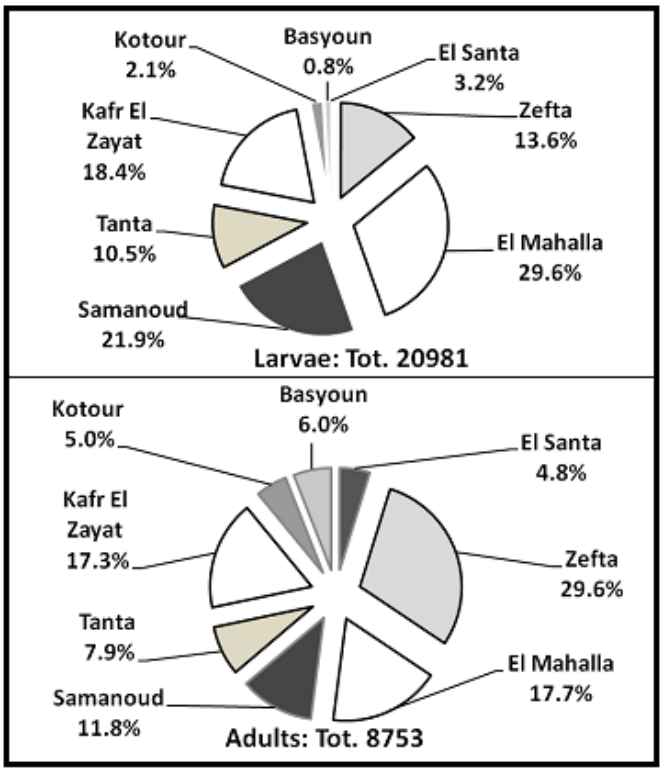

Fig. 2: Percentages of the collected mosquito larvae and adults (all species) in the eight centers of Gharbia Governorate

Breeding Habitats

Five types of breeding habitats (Fig. 3) were detected of which the irrigation drains were the most productive (57.1% of collected larvae) followed by swamps (20.6%), Irrigation canals (11.6%), Cesspits (8.9%) and the least productive one was the streams (1.8%).

Factors Affecting Breeding and Abundance

1. Effect of Water Temperature and pH On the Larval Density

Breeding water was mostly alkaline (pH= 6.8-8.2) and have a temperature range of 21-34^{o}C. Multiple regression analysis (Table 3) for the three common species, revealed that larval density of *Cx. pipiens* increases (P>0.05) as temperature increased and decreases as pH (P>0.05) increased. Densities of *Cx. antennatus* and *Cx. perexiguus*

increase as both temperature and pH increased (P>0.05). In general for all reported larvae, density increases as temperature increased and decreases as pH increased (P>0.05).

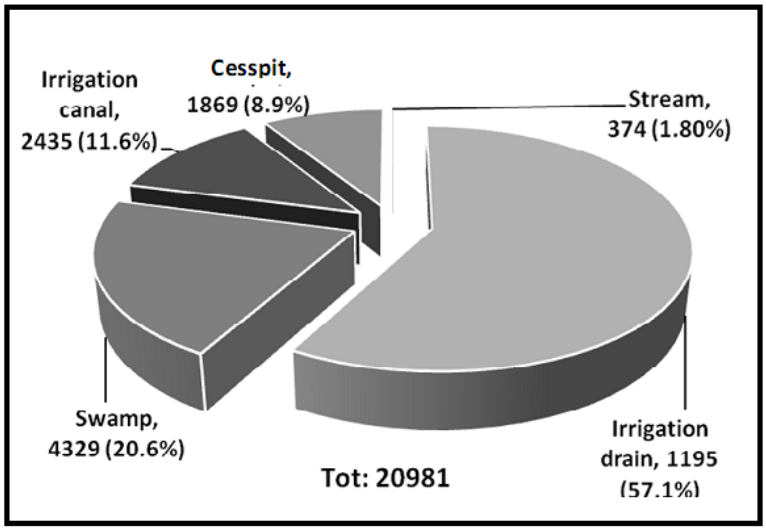

Fig. 3: Relative productivity (Number and % of collected larvae) of the different breeding habitats

2. Effect of Temperature and Relative Humidity on the indoor adult Density

Multiple regression analysis for the relation of temperature and RH with the indoor density of mosquito adults (Table 3) revealed that: (1) *Cx. pipiens* and *Cx. perexiguus* densities increase as indoor temperature (range=21.9- 29.3^{o}C), outdoor RH (range=43.9-80.0%) while they decrease as outdoor temperature (range= 20.7 -29.5^{o}) and indoor RH (range=46.1-76.8%-) increased, (2) *Cx. antennatus* density increases as indoor-temperature and RH increased, while it decreases as outdoor- temperature and RH increased (P>0.05) and (3) Generally for all adults, density increases as indoor temperature and outdoor RH increased, while it decreases as outdoor temperature and indoor RH increased (P>0.05).

Table 3: Multiple regression analysis for the effect of temperature (T: Indoor= IT, Outdoor=OT), relative humidity (RH: Indoor=IRH, Outdoor= ORH) and pH on the density of mosquito larvae (No/ 10 net dip) and adults (No/room)

Species	Larvae				Adults					
	a	*b*		R^2	*a*	*b*				R^2
		T	pH			IT	OT	I H	ORH	
Cx. pipiens	323.2	3.0	-46.3	0.2	-122.8	12.3	-8.1	-1.5	2.0	0.5
Cx. antennatus	-22.7	0.4	2.3	0.1	-33.0	1.5	-0.1	0. 5	-0.2	0.3
Cx. perexiguus	-94.2	1.7	8.1	0.1	-32.3	4.4	-2.9	-1.0	1.0	0.4
All species	280.0	5.2	-45.7	0.2	-186.8	18.2	-11.2	-2.0	2. 7	0.3

Abbreviations: a = constant (intercept), b = the slope (regression coefficient) not deviated from 0 by t-test, P>0.05, R^2=Coefficient of Determination.

Filariasis Infection

In a total of 1493 blood sample examined from the eight centers, no infection with *Wuchereria bancrofti* was found. Only one Elephantiasis case was reported from El Santa center (1/ 196 examined sample).

DISCUSSION

Seven mosquito species were collected of which *Cx. pipiens*, *Cx.*

perexiguus, and Cx. antennatus were collected as larvae and adults from all surveyed centers. Except for Cx. *theileri,* the other species were previously reported in the only occasion (El-Said and Kenawy, 1983) where mosquitoes were surveyed in this governorate. *An. pharoensis* was missed in this study. This may be due to missing of the rice growing period, the main breeding habitat for such malaria vector. Based on this and the previous study, the mosquito fauna can be represented by *Cx. pipiens*, *Cx. antennatus, Cx. perexiguus*, *Cx. theileri, Oc. caspius, Cs. longiareolata*, *An. tenebrosus* and *An. (Cellia) pharoensis Theobald.* Among the study centers, mean densities of both larvae and adults were similar ($P>0.05$).

Culex pipiens, the main filariasis vector (Harb *et al.,* 1993) was the most common or the predominating species (ca. 45%, 15 adult/room and 86%, 63 larva/SU, $P<0.01$) in agreement with the previous observations by El-Said and Kenawy (1983). *Cx. antennatus* (ca. 38%, 13 adult/room) was also common species ($P<0.01$). Due to the facts that our collected samples were limited (1493 blood sample) and that the governorate is covered by the Mass Drug Administration (MDA) national programme of Ministry of Health to eliminate lymphatic filariasis (Ramzy *et al.,* 2005 and El-Setouhy *et al.,* 2007), no *Wuchereria bancrofti* infections were detected. However, the detection of one elephantiasis case indicates old history of disease transmission in this governorate. This is different from the situation in the adjacent El Menoufia Governorate where lymphatic filariasis is circulating (ca. 5% infection, range= 2-14%) associated mainly with the abundance of *Cx. pipiens* adults (Abdel-Hamid *et al*., 2011) and El Sharqiya Governorate (Abdel Hamid *et al.*, 2009). *Culex pipiens* was also the chief vector of RVF virus during the 1977-78 epizootics in Egypt (Hoogstraal *et al.*, 1979 and Megan *et al.*, 1980). In addition, *Cx. pipiens, Cx. antennatus*, and *Cx. perexiguus* were also potential vectors during 1993 outbreak (Turell, 1996). The governorate has a history of RVF transmission as during 1993, the disease was documented among persons residing in such governorate and other 9 governorates (Arthur *et al*., 1993).

Five types of breeding habitats for mosquito larvae were detected during the study of which the irrigation drains were the most productive and the least productive one was the streams in agreement with the finding of Kenawy *et al.* (1996) in El Sharqiya Governorate. Breeding water was mostly alkaline (pH= 6.8-8.2) as previously reported in El Ismailia (kenawy and El Said, 1990 and Abdel Hamid *et al.*, 2011) and in El Sharqiya (Abdel Hamid *et al.*, 2009). The temperature range (ca. 21-34^{o}C) of the breeding water as observed in this study is comparable to 21-37^{o}C (kenawy and El Said, 1990) for culicine mosquitoes in the Canal Zone in a year period. Analysis revealed that larval density of *Cx. pipiens*. and in general for all reported larvae, density increases as temperature increased and decreases as pH increased ($P>0.05$) in agreement with Abdel Hamid *et al.* (2011) in El Ismailia. Densities of *Cx. antennatus* and *Cx. perexiguus* were directly proportional with temperature and pH of the breeding water. Similar results were obtained by Kenawy and El-Said (1990) in El Ismailia and Kenawy *et al.* (1996) in El Sharqiya. Other authors had different relations in the other governorates such as Abdel Hamid et *al.* (2009) In Sharqiya and Abdel-Hamid *et al.* (2011) in El Menufia. Several other physico-chemical factors, e.g. salinity and free ammonia are known to affect the survival and abundance of mosquito larvae (Sinha, 1976; Saxena *et al.* 1992 and Wanji *et al.* 2009*)*.

Multiple regression analysis for the relation of temperature and RH with the density of mosquito adults revealed

that generally for all adults of the three common species, density increases as indoor temperature and outdoor RH increased, while it decreases as outdoor temperature and indoor RH increased (P>0.05). Different relations were observed for the same mosquito species in El Sharqiya (Abdel Hamid et *al.*, 2009) and El Menufia (Abdel-Hamid *et al.*, 2011) governorates.

It can be concluded that the prevalence and abundance of culicine mosquito species mainly the *Cx. pipiens* the main filariasis vector in El Gharbia with its history of filariasis as indicated by detecting one elephantiasis case may pause a risk of such disease transmission in this area.

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ARABIC SUMMARY

البعوض (ذات الجناحين : كيوليسيدى) فى محافظة الغربيه بمصر:
توزيعه الجغرافى، غزارته والعوامل المؤثره على توالده وعلاقتها بوضع مرض الفيلاريا اللمفاويه

يسريه محمد عبد الحميد[١]- عزه عبد الفتاح مصطفى[١]- كاميليا محمود علام[١]- محمد أمين قناوى[٢]
[١]معهد بحوث الحشرات الطبيه- الهيئه العامه للمعاهد والمستشفيات التعليميه- وزارة الصحه- الدقى- الجيزه،
[٢]قسم علم الحشرات- كلية العلوم- جامعة عين شمس- العباسيه- القاهره- جمهورية مصر العربيه

أجريت المسوحات الحشريه (مارس- مايو ونوفمبر ٢٠٠٧) فى جميع مراكز محافظة الغربيه تم خلالها جمع سبعة انواع من البعوض وهى كيولكس بيانز، كيولكس بيريكسيجس، كيولكس أنتناتس، كيولكس ثيلارى، أوكليروتاتس ديتريتس، كوليسيتا لاتجيرولاتا وانوقيليس تينيبروسس. كيولكس بيانز الناقل الرئيسى لمرض الفيلاريا كان النوع الأكثر شيوعآ او السائد (حوالى ٤٥% من الطور اليافع و ٨٦% من اليرقات) كما وان كيولكس أنتناتس (حوالى ٣٨% من الطور اليافع) كان ايضا من الأنواع الشائعه. بالنسبه للثلاث انواع الشائعه: كيولكس بيانز، كيولكس بيريكسيجس وكيولكس أنتناتس تم دراسة علاقه كثافة يرقاتها و طورها اليافع بالعوامل البيئيه. طفيلياً لم توجد اى اصابه بطفيلى الغيلاريا بين ١٩٤٣ عينة دم كما استدل على وجود حالة واحده لداء الفيل بين ١٩٦ حالة تم فحصها بمركز السنطه.