Assiut Vet. Med. J. Vol. 43 No. 86, July 2000

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MOSQUITOES AND FILARIASIS IN ELMINIA GOVERNORATE, EGYPT

(With 7 Tables and 11 Figures)

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(Received at 22/5/2000)

البعوض ومرض الفلاريا في محافظة المنيا – مصر

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في هذا البحث يسجل لأول مرة وجود مرض الفلاريا في مركز ملوي بمحافظة المنيا . وقد تـم في هذا المركز فحص سحبات دم ١٢٥٠ شخصا يمثلون فئات مختلفة وقد تبين وجود ٩ حـالات مصـابة بنسـبة ٠،٧٢% ونسـبة الإصابة في الإناث أكثر من الذكور . من عملية الأستقصاء للبعوض الموجود في منطقة الإصابة تبين أن بعوضة الكيولكس بيبينز موليستس هي أكثر إنتشارا خلال العام كما أنها النوع الوحيد المصاب بأطوار الفوشيريريا بانكروفتي. كمـا تـم في هذا البحث دراسة الكثافة العددية والتوزيع الموسمي لجنس الكيولكس وقد تبين وجـود سـتة أنواع هي: كيولكس بيبينز موليستس وكيولكس أنتينائس وكيولكس يونيفيتاتس وكيولوكس ثيلارى وكيولوكس كاسبيس وثيوبالديا لونجريولاتا.

SUMMARY

Filariasis was observed for the first time in Malawe (Elminia Governorate). Blood films examination of 1250 persons revealed the presence of microfilariae in 9 cases (3 males + 6 females). From the mosquitoes collected, *Culex pipiens molestus* was the most predominent and the only species that carry filarial infection. Six species of culicine mosquitoes were encountered and identified from the locality, *Culex pipiens molestus* Forskal (1775); *Culex antennatus* Becker (1903); *Culex univittatus* Theobald (1901); *Culex theileri* Theobald (1903); *Aedes caspius Pallas* (1771) and *Theobaldia longiareolata* Macquart (1902). The density of *Culex pipiens molestus* was high throughout the year, with a peak in the summer season.

Key words: *Mosquitoes and Filariasis*

INTRODUCTION

Filariasis is widespread extending throughout the tropical and sub-tropical countries. In eastern mediterranean region, the disease in prevalent in Sudan, Saudi Arabia, Somalia and isolated areas in Egypt.

Faust and Russel (1964), pointed out that Bancroftian filariasis is indigenous throughout practically all of the warm region of the world. Lymphatic filariasis caused by *Wuchereria bancrofti* is characterized by a broad range of clinical presentations among the infected individuals (Ottesen, 1992). Individuals with localized lymphatic damage or pahtology rarely have circulating microfilariae in the peripheral circulation. Other individuals can harbor active infections as well as large numbers of microfilariae in their peripheral circulation and yet be totally asymptomatic (Abdel-Aal, 1983; Connor et al., 1986; Hussein et al., 1987 and Abdel-Aal et al., 1990).

Abdel-Aal (1983) noticed that *Culex pipiens molestus* was a more efficient vector both biologically and behaviourally. El-Naffar et al. (1990) noticed that *Culex pipiens molestus* was the most predominent and the only species that carries filarial infection in Sohag Governorate. *Culex pipiens* complex is regarded as one of the cosmopoliation mosquito species that shows interfering variability of morphology and biology and has been recognized as the vector of urban periodic *Wuchereria bancrofti* in the world (Bates, 1949 and Horsfall, 1955). Rifaat et al. (1968) incriminated *Culex antennatus* as a secondary vector of filariasis in the Nile Delta in Egypt.

El-Scrougi et al. (2000) found the IgG4 response against antigen extracts from *Wuchereria bancrofti* and *Dirofilaria immitis* adult worm was determined by ELISA in 65 Egyptian adult male patients suffering from different clinical manifestations of *Wuhereria bancrofti.*

The present work was carried out to throw light on filariasis and to study the population density and seasonal distribution of the adult and larval stages of mosquitoes specially those which are responsible for filarial transmission at Malawe district (Elminia Governorate).

MATERIALS and METHODS

The present study was conducted in Elminia Governorate (Malawe and Baniharam), during the period from June 1998 – May 1999. The climatic conditions of localities were recorded regularly: monthly means minima and maxima for air temperature, water

temperature and relative humidity. Other factors such as water pH and salinity were also given.

Blood examination of human population was carried out to detect the circulating microfilariae in the peripheral blood and to estimate the prevalence of filariasis in the indicated areas.

The study was performed of 2250 indiciduals representing different sexes and ages and chosen randomly from the two localities.

Blood was collected from the inhabitants using the thick night blood films which gave good results especially in scantly infection. The thick blood films are stained for about one hour in 3% solution of Giemsa stain in buffered water at 7.2.

The adult stages of *Culex pipiens molestus* from indicated area were monthly collected from indoor at night while biting human baits or from the walls by means of suction funnel connected to bored bottle. Routine dissection of mosquitoes was done on a slide under binocular microscope, to determine the perecentage of their infected and infective forms.

Mosquito larvae were collected from cesspit and pool by a conical bag with nylon netting fixed around the iron triangle, about 30cm long, and with a long handle was used. Samples of three net dips were taken from the surface rapidly and gently, 3 dips represented one square foot, in which the summer of the larvae were estimated.

The adult mosquitoes resting indoors and outdoors were collected by aspirator tubes. Aspirator collections commonly referred to as hand capture and the number of mosquitoes caught in 30 minutes represented the density recorded. The collected adults and mosquito larvae were identified according to Abdel-Malek (1956); Stone (1959); Gad (1963) and Abdel-Aal (1983).

Scanning electron microscopy of the main mosquito vector of filariasis *Culex pipiens molestus*. Each adult and larva was fixed in 4% gluteraldehyde in sodium cacodylate buffer for 2hrs, washed in the same buffer (pH 7.4), dehydrate with ethanol. Specimens were mounted on stubs, coated with carbon and gold and examined with a Jeol JEM-1200 EXIIElelctron Microscope.

RESULTS

Two localities (Malawe district and Baniharam village) were examined, but the only filarious area was Malawe city. The maximum temperature was ranging from 22 to 41°C and the minimum was from 8 to 22°C. Water temperature varied from 19 to 38°C. The relative

humidity was 41 to 84%, water pH was from 7.1 to 8,72 and the water salinity was from 0.40 to 0.908.

Density of filarial disease in Man:

In Malawe city a total of 1250 inhabitants were examined for microfilariae (Fig. 8 & 9), nine cases were positive i.e 0.72% of the infected persons, 3(0.24%) were males and 6(0.48%) were females. According to the age groups, the peak of infection was observed in age groups ranging from 21-30 and 41-50 years old and are represented by 2.04 and 2.33% for both groups, the high infection was observed in the age group of 41-50 years old (Table 2).

In Baniharam village blood films from 1000 inhabitants were examined throughout the year. No positive cases were found.

Prevalence of natural filarial infection in mosquitoes:

Culex pipiens molestus was observed to be the only species that carries filarial larvae in Malawe city. 15 out of 1398 (1.07%) adult females dissected were found carrying filarial larvae.

The percentage of infective mosquitoes was 0.29% (4 out 1398). The percentage of infected mosquitoes was found to be higher during.

August and represented by 3.0% (3 of 100) (Table 3). In Baniharam village, adult females of *Culex pipiens molestus* dissected were found free from filarial infection.

Population density and seasonal distribution of culicid mosquitoes:

A- Larvae:

I) Pools: Table (4) indicates that population density of culicid larvae collected from pools was 3205. Of that number 2227 (69.48%) were *Culex pipiens molestus* larvae; 160(4.99%) were larvae of *Culex antennatus*; 75(2.34%) were the larvae of *Culex univittatus*; 373(11.64%) were *Culex theileri* larvae; 127(3.96%) were the larvae of *Aedes caspius* and 243(7.58%) were *Theobaldia longiareolata*. The monthly distribution of larvae collected is shown in (Table 4 and Fig. 1).

II) Cesspits: The culicid larvae collected from cesspits were 250 out of that number 200 (80.00%) were *Culex pipiens molestus* larvae; 28(11.20%) were the larvae of *Culex antennatus*; and 22(8.80%) were *Culex theileri*. The monthly distribution of the larvae is shown in (Table 5 and Fig. 2).

B) Adults:

Monthly and seasonal population density of female (culicid/Man/hour) indoor and out door per aspirator tube were carried out all the year round (Table 6).

Indoor: Tables (6 & 7) indicate that the density of mosquitoes was 160, and the highest density occurs in summer season, especially in June and August which is represented by 19 females. From *Culex pipiens molestus*; one hundred females was caught throughout the year. The distribution was 32; 31; 26 and 11 in summer, autumn, spring and winter respectively. Out of 26 females collected of *Culex theileri* throughout the year; 13, 7 and 6 were caught in summer, autumn and spring. No females were found during winter. The distribution of 34 females collected of *Theobaldia longiareolata*, was 15, 9, 7 and 3 during spring, summer, autumn and winter respectively.

Outdoor: The population density of culicid mosquitoes was found to be high in both August and June and is represented by 14 as shown in Tables (6 & 7). From *Culex pipiens molestus*; 49 females were caught throughout, its distribution was 20, 15, 8 & 6 in summer, autumn, spring and winter respectively. Twenty seven *Culex theileri* were caught throughout the year. The distribution was 12, 8 and 7 in summer, autumn and spring. No females were found in winter. From *Aedes caspius*, 10 females were caught throughout the year. Their distribution was 4 in summer, only 3 in autumn and spring. No females were observed in winter. *Theobaldia longiareolata* collected is represented by females, from this number, 9 were in spring; 3 in summer; 1 in autumn and winter seasons. Monthly distribution of the different species is shown in (Fig.3).

Intake of microfilariae by *Culex pipiens molestus:*

The period required for filarial larvae to invade the thoracic muscles of *Culex pipiens molestus:*

Laboratory strains of *Culex pipiens molestus* (Fig. 4-8) were experimently infected with microfilaria bancrofti by allowing them to feed on a blood of volunteer filariasis patient. Dissection of mosquitoes showed that the filarial larvae invaded the thoracic muscles of *Culex pipiens molestus* mosquitoes after 4 hours (Fig. 10).

Clinical features of filariasis:

An individuals investigated in this study were examined clinically for lymphadenitis, lymphangitis, scrotal swelling, elephantiasis and urine was examined for evidence of chyluria (Fig. 11).

DISCUSSION

In the present work, the clinical manifestation of the diseases appeared as elephantiasis of the lower limbs, enlarged inguinal lymph

nodes, lymphadenitis, lymph varices, cracked skin and chyluria, all these manifestations were shown in persons from any age, except lower limb elephantiasis, cracked skin and chyluria which were prominently in old age groups. This can be explained by long continuous exposure to infection. This observations agrees with those reported by WHO Expert Committee (1984), reporting that the chronic stage of filariasis develops 10-15 years from the onset of the first acute attack and added that the severity of chronic clinical manifestations lead to increase with age.

Also, observation in the present study showed that microfilaremia could be detected in some individuals with acute manifestations.

From the present results, it was concluded that *culex pipiens molestus* is the main filarial transmitter as compared to the other culicid species. This conclusion is attributed due to the fact that, *Culex pipiens molestus* was the most predominent species and was present in greater number indoor than outdoor, and also the filarial infection being effected by night bites when, persons are mostly indoor. Also the biting pattern of this species is considered with the aggregation of filarial larvae in the peripheral blood of infected persons at night. These opinions are in agreement with Khalil et al. (1932); Wassif (1969); Makhloof (1975); Rifaat et al. (1978); Soliman (1985) and Abdel-Aal (1983, 1990).

From the results of the present study, it is concluded that the increased temperature and humidity in summer may stimulate the increased breeding rate of *Culex pipiens molestus*. This finding agrees with Kirkpatrick (1925) and Abdel-Aal et al. (1990) in Egypt, but contradicts with the results of Oda (1980) in Japan who stated that, high temperature seems to be one of the factors inhibiting the *Culex pipiens molestus* to invade the southern parts of Japan.

The filarial larvae could be detected within the thoracic muscles of *Culex pipiens molestus* after 4 hours of fully infected blood meal. This finding agrees with that found by Abdel-Aal (1983) and Elnaffar et al. (1990), but differ with the result obtained by Iyenger (1936), and Bahr (1959). The factors responsible for these differences can be attributed to the different culicid mosquitoes or to the different environmental conditions.

REFERENCES

Abdel-Aal, A.A. (1983): Survey and ecology of mosquitoes with emphasis on the relationships between filariasis and culicids in Assiut governorate; Ph.D. Thesis, Zool. Dept., Faculty of Science, Assiut University.

Abdel-Aal, A.A.; Elnaffar, M.K.; Soliman, F.M. and Ibrahim, M.F. (1990): The population density and seasonal distribution of mosquitoes in Sohag governorate, A. R. Egypt. Bull. Fac. Sci. Assiut University, 19(2-E): 111-130.

Abdel-Malek, A. (1956): Mosquitoes of north-eastern Sinai: Bull. Soc. Entom. Egypt (LX), 60: 97-106.

Bahr, M.P.H. (1959): A story of *Filaria bancrofti* part I. Early history part II. Metamorphosis of *Wuchereria bancrofti* in the mosquitoes and filarial periodicity. J. Trop. Med. Hyg. 62 (3-4): 85.

Bates, M. (1949): The natural history of mosquitoes: The MacMillan Co. New York, PP. 379.

Conner, J.H.; Palmieri, J.R. and Gibson, D.W. (1986): Pathogenrsis lymphatic filariasis in Man. Z. Parasitenkd, 72: 13.

Elnaffar, M.K.; Abdel-Aal, A.A.; soliman, F.M. and Ibrahim, M.E. (1990): Studies on filariasis and the role played b mosquitoes in its transmission in Sohag Governorate, A.R. Egypt. Bull. Fac. Sc., Assiut Univ. 19(2-E): 131-148.

Elserougi, A.O.; Fekry, A.A.; Farrag, A.M.K. and Wafaa, A.A.S. (2000): Evaluation of the IgG4 in Egyptian Bancroftian filariasis. J. Egypt, Soc. Parasitol., 30(1): 59-67.

Faust, E.C. and Russel, P.F. (1964): Craig and Faust's "clinical parasitology: 7th Ed. Henery Kimpton, London.

Gad, A.M. (1963): Insects of medical importance. (Notes in Arabic) Institute of Med. Ent. Mn. Of Pub. Hlth., Dokky, Egypt.

Horsfall, W.R. (1955): Mosquitoes: The Ronald press company, U.S.A.

IHussein, R.; Grogi, M. and Ottesen, E.A. (1987): IgG antibody subclasses in human filariasis. Differential subclasses recognition of parasite antigens correlates with different clinical manifestations of infection. J. Immunol., 139: 2794-2798.

Lyengar, M.O.T. (1936): Entery of filariasis larvae into body cavity of mosquito. J. Parasit., 28: 190-194.

Khalil, M.; Halawani, A. and Hilmy, I.S. (19320: On the transmission of filariasis bancrofti in Egypt. J. Egy. Med. Ass., 15: 317-322.

Kirkpatrick, T.W. (1925): The mosquitoes of Egypt: Egypt Gov. Press, Cairo.

Makhlouf, L.M. (1975): Studies on the role played by some insects in transmitting some parasitic disease in Assiut Governorate: M.D. Thesis, Faculty of Medicine, Assiut University.

Oda, T.; Mori, A.; Ueda, M. and Kurokawa, K. (1980): Effects of temperature on the oviposition and hatching of eggs in *Culex pipiens molestus* and *Culex pipiens quinquefasciatus:* Tropical Medicine, 22(3): 167-172.

Ottesen, E.A. (1992): Infection and disease in lymphatic filariasis; an immunological prespective. Parasitology, 104: 571-579.

Rifaat, M.A.; Shwarby, A.A. and Wassif, S.F. (19680; Preliminary note on the role of Culex antennatus ias a secondary vector of filariasis in egypt: J. Egy. Helth. Ass., 43(4): 285-290.

Rifaat, M.A.; Salem, S.A.; Hassan, Z.A.; Mohamed, N.H.; Hegazy, MiM and Abdel-Maged, M.S. (1978): Diagnosis of filariasis by different means in Ezbet-Elborg in Damietta Governorate, Egypt, J. Egypt. Soc. Parasit., 8(2): 233-341.

Sliman, B.A. (1985): Field studies on the transmission of bancroftian filariasis by mosquitoes; M.Sc. Thesis, entom. Dep., faculty of Science, Ain Shams University.

Stone, A.; Knight, K.L. and Starche, h. (1959): A synoptic catalog of the mosquitoes of the wold: ent. Soc. Amer., Washinton, PP. 385.

Wassif, S.E. (1969): Survey of Egyptian culicines in the Nile Delta with special reference to filaria transmission M.D. Thesis, Ain Shams Univ., Cairo.

WHO Expert, Committee (1984): On lymphatic filariasis. Fourth report WHO, Tech, Rep. Ser. No. 702, 112 p.

EXPLANATION OF FIGURES

Fig. 1: Monthly distribution of mosquito-larvae collected from pools in Malawe district (June 1998-May 1999).

Fig. 2: Monthly distribution of mosquito-larvae collected from cesspits in Malawe district (June 1998-May 1999).

Fig. 3: Monthly distribution of adult mosquitoes collected by aspirator tube in Malawe district (June 1998-May 1999).

Fig. 4-7: Scanning electron micrographs of the ventral terminal segment of fourth stage larva and male terminalia of mosquito vector of filariasis *Culex pipiens molestus.*

4 & 5: Ventral terminal segment of fourth stage larva. Of Anp. Anal papillae; St. Siphonal tufts in two sub ventral rows and siphon not more than five time as long as broad; v.b. ventral brush.

6 & 7: Male terminalia. Cl, clasper; L, leaflets of mesosome; Mes, mesosome or phalosome; spine of clasper. Phalosome a paired structure, each half with three prominent process. Basal arm of paraproct a small process.

Fig. 8: Photomicrograph of the anterior end of microfilaria bancrofti showing sheath end, cephalic space, spicule and prepuce, Sp. (1250 x).

Fig. 9: Photomicrograph of tail end of microfilaria bancrofti showing the body sheath (SH) and the nuclei (N) do not extending to the tip of the tail (1250 x).

Fig. 10: Section in thoracic muscles (M) in mosquito vector of filariasis *Culex pipiens molestus*. Showing microfilaria (Micr.).

Fig. 11: A patient showing lymphadenitis in right leg.

Table (1) : The climatic conditions of Malawe district during different months (June 1998 - May 1999)

Months	Air temp. °C.		R.H. %	Water temp. °C	Water pH	Water salinity
	Max.	Mini.				
June	41	22.0	49	37	8.30	0.815
July	39	21.5	43	36	8.53	0.908
Aug.	40	19.8	41	38	8.72	0.900
Sep.	35	21.0	68	32	8.34	0.902
Oct.	31	13.0	60	27	8.01	0.870
Nov.	29	15.0	75	26	7.60	0.620
Dec.	23	16.5	81	21	7.20	0.560
Jan.	22	8.0	84	19	7.10	0.414
Feb.	23	8.0	55	20	7.20	0.400
Mar.	26	13.0	57	23	7.60	0.550
Apr.	28	16.0	49	24	7.85	0.645
May	34	16.0	47	30	8.10	0.750

Table (2) : Age and sex distribution of person with microfilaremia among inhabitants of Malawe district(from June, 1998- May 1999)

Age group (year)	Males			Females			Total		
	No. exa.	No. +Ve	%	No. exa.	No. +Ve	%	No. exa.	No. +ve	%
10 -20	120	-	-	100	-	-	220	-	-
21 -30	116	2	1.72	80	2	2.50	196	4	2.04
31 -40	100	-	-	90	-	-	190	-	-
41 -50	125	1	0.80	90	4	4.44	215	5	2.33
51 -60	130	-	-	103	-	-	233	-	-
61 -70	100	-	-	90	-	-	190	-	-
71 -	1	-	-	5	-	-	6	-	-
Total	692	3	0.24	558	6	0.48	1250	9	0.72

Table (3) : Prevalence of natural filarial infection among *Culex pipiens molestus* at Malawe district .

Months 1998-1999	No.dissected	Infected		Infective	
		No.	%	No.	%
June	100	-	-	-	-
July	190	-	-	-	-
August	100	3	3.00	-	-
Sep.	230	3	1.30	2	0.87
Oct.	100	-	-	-	-
Nov.	80	-	-	-	-
Dec.	70	-	-	-	-
Jan.	30	-	-	-	-
Feb.	20	-	-	-	-
Mar.	100	-	-	-	-
Apr.	188	4	2.13	-	-
May	190	5	2.63	2	0.05
Total	1398	15	1.05	4	0.29

Table(4) : The population density and seasonal distribution of culicid larvae collected from breeding places (pools) in Malawe district from June 1998 - May 1999 .

Months	Seasons	Culicines												Total No.
		Culex pipiens molestus		*Culex antennatus*		*Culex univittatus*		*Culex theileri*		*Aedes caspius*		*Theobaldia longiareolata*		
June	Summer	300		8		-	1.00	30		15		8		
July	No.	313	948	15	43.00	-		40	105	20	65	12	38	1200
Aug	%	315	42.57	20	26.88	1	1.33	35	28.15	30	51.18	18	15.64	37.44
Sep.	Autumn	220		20		2		50		20		20		800
Oct.	No.	154	535	7	36.00	15	27.00	40	120	10	32	15	50	24.96
Nov.	%	161	24.00	9	22.50	10	36.00	30	32.17	2	25.20	15	20.58	
Dec.	Winter	100		8		7		30		-		22		
Jan.	No.	90	302	15	43.00	6	17.00	15	65	-	-	21	68	505
Feb.	%	98	13.56	20	26.88	4	36.00	20	17.43	-	-	25	27.98	15.76
Mar.	Spring	106		13		7		27		3		28		
Apr.	N0.	117	442	11	36.00	9	20.00	24	83	8	30	35	87	700
May.	%	219	19.85	14	23.74	4	26.67	32	22.25	19	23,62	14	35.80	21.84
Total	No.	2227		160		75		373		127		243		3205
	%	69.48		4.99		2,34		11.64		3.96		7.58		

Table(5) : The population density and seasonal distribution of culicid larvae collected from breeding places (cesspits) in Malawe district from June 1998 - May 1999 .

Months	Seasons	Culicines												Total No.
		Culex pipiens molestus		*Culex antennatus*		*Culex univitatus*		*Culex theileri*		*Aedes caspius*		*Theobaldia longiareolata*		
June	Summer	24		1		-		2		-		-		
July	No.	20	79	2	7	-	-	3	8	-	-	-	-	
Aug	%	25	39.50	4	25.00	-	-	3	36.36	-	-	-	-	84
Sep.	Autumn	14		4		-		1		-		-		
Oct.	No.	15	39	2	12	-	-	2	5	-	-	-	-	
Nov.	%	10	19.50	6	42.86	-	-	1	22.73	-	-	-	-	56
Dec.	Winter	8		-		-		1		-		-		
Jan.	No.	6	21	2	2	-	-	3	8	-	-	-	-	
Feb.	%	7	10.50	-	7.14	-	-	4	36.36	-	-	-	-	31
Mar.	Spring	25		1		-		-		-		-		
Apr.	N0.	21	71	2	7	-	-	-	1	-	-	-	-	
May.	%	25	35.50.	4	25.00	-	-	1	4.55.	-	-	-	-	79
Total	No.	200		28		-		22		-		-		
	%	80.00		11.20		-		8.80						250

Table(6) : Seasonal density of adult culicid mosq[illegible] aspirator tube (indoor and outdoor) i[illegible] June 1998 --1999 .

Month	Season		Indoor			
			Total	D.	M.	S.E.
June	Summer	No.	54.00	19	4.75	2.70
July		%	33.75	16	4.00	1.90
Aug.				19	4.75	1.70
Sep.	Autumn	No.	45.00	13	3.25	1.70
Oct.		%	28.12	15	3.75	0.50
Nov.				17	4.25	1.[illegible]
Dec.	Winter	No.	14.00	7	1.75	0.[illegible]
Jan.		%	8.75	3	0.75	0.[illegible]
Feb.				4	1.00	[illegible]
Mar.	Spring	No.	47.00	13	3.25	0.[illegible]
Apr.		%	29.37	17	4.25	0.[illegible]
May				17	4.25	2.[illegible]

D. Density
M. Mean
S.E. Standard error

Table(7) : Population density and seasonal distribution of adult mosquitoes per aspirator tube (indoor and outdoor) in Malawe district from June 1998 - May 1999 .

Month	Season	Indoor												Outdoor											
		Culex pipiens molestus		*Culex antennatus*		*Culex univittatus*		*Culex theileri*		*Aedes caspius*		*Theobaldia longiareolata*		*Culex pipiens molestus*		*Culex antennatus*		*Culex univittatus*		*Culex theileri*		*Aedes caspius*		*Theobaldia longiareolata*	
June July Aug.	Summer No. %	32.0 32.0	11 10 11	- -	- - -	- -	- - -	13.00 50.00	5 4 4	- -	- - -	9.00 26.47	3 2 4	20.00 40.81	7 5 8	- -	- - -	- -	- - -	12.00 44.40	5 4 3	4.00 40.00	1 1 2	3.00 21.42	1 1 1
Sep. Oct. Nov.	Autumn No. %	31.00 31.00	9 11 11	- -	- - -	- -	- - -	7.00 26.92	2 3 2	- -	- - -	7.00 20.58	2 1 4	15.00 30.61	4 6 5	- -	- - -	- -	- - -	8.00 29.62	3 4 1	3.00 30.00	2 1 -	1.00 7.24	- - 1
Dec. Jan. Feb.	Winter No. %	11.00 11.00	5 3 3	- -	- - -	- -	- - -	- -	- - -	- -	- - -	3.00 8.82	2 - 1	6.00 12.24	2 2 2	- -	- - -	- -	- - -	- -	- - -	- -	- - -	1.00 7.14	- - 1
Mar. Apr. May.	Spring No. %	26.00 26.00	7 9 10	- -	- - -	- -	- - -	6.00 23.07	1 2 3	- -	- - -	15.00 44.11	5 6 4	8.00 16.32	1 1 6	- -	- - -	- -	- - -	7.00 25.92	2 3 2	3.00 30.00	- 1 2	9.00 64.28	3 4 2
Total	No. %	100 62.50		-		-		26 16.25		-		34 21.25		49 49.0		-		-		27 27.0		10 10.0		14 14.0	

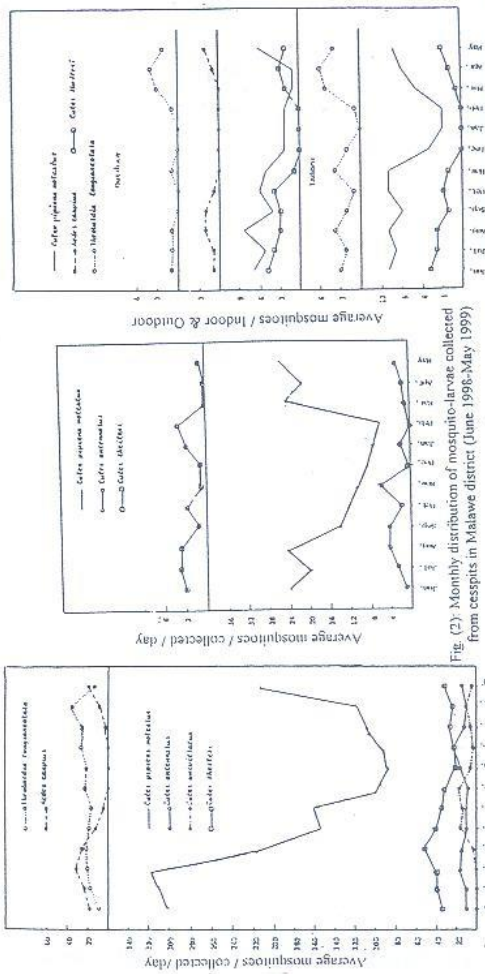


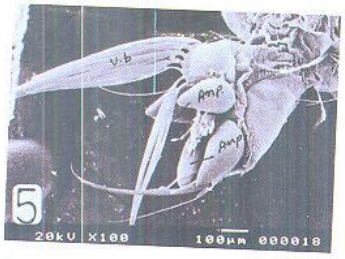
Fig. (1): Monthly distribution of mosquito- larvae collected from pools in Malawe district (June 1998-May 1999)

Fig. (2): Monthly distribution of mosquito-larvae collected from cesspits in Malawe district (June 1998-May 1999)

Fig. (3): Monthly distribution of adult mosquitoes collected by aspirator tube in Malawe district (June 1998-May 1999)


4
SK
20kV X50
500µm 000017


6
Fibres
20kV X200
100µm 000016


5
V.b
Amp
Amp
20kV X100
100µm 000018


7
SP.
SC.
CL
20kV X750
10µm 000015


8
SP.


9
SH
M.


10
Micr.
M.


11