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ENTOMOLOGICAL SURVEY OF MOSQUITO VECTORS OF LYMPHATIC FILARIASIS IN TALATAN-MAFARA AND TSAFE LOCAL GOVERNMENT AREAS OF ZAMFARA STATE, NIGERIA

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ABSTRACT

Entomological survey of mosquito vectors was carried out to determine species abundance and identify those responsible for the transmission of lymphatic filariasis in Talatan-mafara and Tsafe Local Government Areas of Zamfara State, Nigeria. Houses were randomly selected for mosquito collection. Aerosol (Baygon) was sprayed in the rooms to knockdown indoor resting mosquitoes. A total of 5,230 mosquitoes comprising of 3,104 females and 2,126 males were collected and 1,182 engorged females were dissected to isolate filarial worm, *Wuchereria bancrofti*. The species of mosquitoes encountered include *Culex quinquefasciatus* (84%), *Anopheles funestus* (10%) and *Anopheles gambiae* sl. (6%). The overall infection and infectivity rates of the mosquitoes with *Wuchereria bancrofti* were 1.86% and 1.44% respectively. The infection/infectivity rates of *Culex quinquefasciatus*, *Anopheles funestus* and *Anopheles gambiae* sl. were 1.01%/0.51%, 2.97%/2.97% and 4.54%/4.14% respectively.

Keywords: *Anopheles funestus*, *Anopheles gambiae*, sl., *Culex quinquefasciatus*, Lymphatic filariasis, Talatan-mafara, Tsafe

INTRODUCTION

Filariasis is caused by parasitic nematode commonly called "filariae". The thread-like (filarial) adult parasites live in the vessels, tissues or body cavities of the vertebrate hosts. The female worms are viviparous and produce microscopic embryos called 'microfilariae' (Anosike *et al.*, 2005). The microfilaria (mf) circulates in the blood or migrate through the skin from where they are ingested by vectors during blood meal. In Nigeria, the microfilariae of *Wuchereria bancrofti* exhibit nocturnal periodicity appearing between the hours of 10pm and 4:00am before they leave peripheral circulation almost completely during the day time (Anosike *et al*., 2005). Matured adult stages reside either in the lymphatic system or in connective tissues (Ottesen, 1984). When picked up by the vector, the microfilariae increase in size, moult and finally develop into infective filariform larvae (L3) (Nwoke *et al.*, 2010).

Wuchereria bancrofti is the most common cause of lymphatic filariasis (LF), accounting globally for approximately 90% of all infections (Lenhart *et al*., 2006). The disease is transmitted by species of mosquitoes of the genera *Aedes*, *Anopheles*, *Culex* and *Mansonia* (Nissen *et al*., 2002). In order to eliminate filariasis, some level of success has been achieved through mass drug administration; reducing the global prevalence from over 120 million (WHO, 1997) to 67.88 people (Ramaiha and Ottesen, 2014).

The World Health Organisation targeted lymphatic filariasis for elimination mainly through a strategy of mass drug administration (MDA) (Abel *et al*., 2002) which depends on the consumption of the recommended drug (Mariappan, 2007). However, non-compliance has led to low treatment coverage (Gyapong and Twum-Danso, 2006). Although, MDA alone has been shown to suppress transmission of lymphatic filariasis in many areas where it has been implemented, it is often accompanied by resurgence once there is residual infection in the population (Abel *et al.,* 2002). Therefore, sustained suppression of lymphatic filariasis could be achieved only through integration of different strategies of vector control along with MDA (Mariappan, 2007). This investigation is an attempt to determine the abundance of different species of mosquitoes as well as identify those responsible for the transmission of lymphatic filariasis in two Local Government Areas of Zamfara State, Nigeria.

MATERIALS AND METHODS

Study Area

Zamfara State is located in the North-western region of Nigeria. Tsafe and Talatan-mafara lie between 12°10' - 13° 10' N and 6° 15' - 7°15' E. Talatan-Mafara is about one hundred (100) kilometers west while Tsafe is about fifty (50) kilometers east from Gusau the State Capital.

The ethnic groups include: Hausa (dominant), Fulani and few of bare-bari (Kanuri). The major economic activities of the people are farming and rearing of animals, although some are engaged in trading. The people especially in the rural areas are living in thatched houses virtually unprotected from mosquito bites especially during the hot dry season.

Climate and Vegetation

The vegetation is Sudan savannah characterized by short and scattered trees (ZSG, 2011). Annual rainfall ranges from 36 - 80mm in the months of June to October. The hottest months (March to May) have approximately 40°C - 45°C and the coolest months (December to February) have range of 20°C - 25°C (ZSG, 2011).

Collection and Dissection of Mosquitoes

Three wards from each local government area were randomly selected, in each ward, two to four sites were randomly sampled Two to five houses were sampled from each site and one to three rooms in each house were sprayed using pyrethrin-based insecticide between the hours of 6:00am and 8:30am following the method of Dosson *et al*. (1995) and Veronica *et al.* (2014).

Fifteen to twenty-five (15 - 25) minutes later knocked down mosquitoes were collected from each room into separate containers, well labelled and taken to laboratory for further studies.

Identification of mosquitoes' species

Dissecting microscope and hand lens were used for detail observation and identification of the mosquitoes with particular reference to the head, thorax, wing and abdomen as described by standard taxonomic keys by Highto (1983) and WHO (1975). Morphological characteristics such as length of maxillary palp, wing spot, mouthpart and abdominal end were observed. The identified species were recorded and kept for further studies.

Dissection of mosquitoes

Engorged females were individually picked and placed on a slide and appendages (wings, legs antennae and palps) gently removed. Dissection was carried out as described by WHO (1975). The content of the dissected parts was carefully observed under a light microscope (using ×40 objective) for the presence of larval stages; first, second and third instar larvae (L1, L2 and L3). The infected mosquito and number of microfilariae present were noted and recorded. Infection and infectivity rates were calculated respectively using the formulae below:

$$\text{Infection Rate} = \frac{\text{Number of infected mosquitoes (L1, L2 and L3) Larvae)}}{\text{Number of mosquitoes examined}} \times 100$$

$$\text{Infectivity Rate} = \frac{\text{Number of infected mosquitoes with L3 Larvae Larvae)}}{\text{Number of mosquitoes examined}} \times 100$$

RESULTS

Mosquito Abundance

A total of 5,252 mosquitoes which comprises 3,104 females' and 2,148 males' mosquitoes were collected indoors from 123 houses in Tsafe and Talatan-mafara local government areas between the months of March and September, 2015. In Tsafe Local Government Area, a total of 520 and 1,830 mosquitoes were collected in dry and wet seasons respectively while in Talatan-mafara 689 and 3,010 mosquitoes were collected in dry and wet seasons respectively (Table 1). Mosquito abundance varied significantly between dry and wet seasons across the locations in Tsafe LG but did not vary significantly in Talatan-Mafara (Table 2). The comparison of mosquito abundance with respect to locations in Talatan-Mafara however, showed that there were significant variations between location one (Galadima) and two others locations (Ruwan-Bore and Kayayi) but there was no significant variation between Ruwan-Bore and Kayayi (Table 4).

Table 1: Mosquito abundance in Tsafe local government area during the dry and wet seasons

Locations (Wards)	Study Sites	No. of Mosquito (Dry season)	No. of Mosquito (Wet season)	Total
Tsafe Central	Bakin tumbi	I50 (30.0±3.4)	400 (80.0±11.4)	550
	Tashar hanne	180 (36.0±4.1)	370 (93.0±15.2)	
	Shiyar magazu	50 (13.0±1.0)	270 (68.0±4.1)	
	Magajin gari	30 (10.0±0.9)	140 (47.0±3.1)	550
Magazu	Tudun-Muntsira	45 (9.0±0.4)	230 (77.0±2.4)	
	Sabon-gari	20 (7.0±0.7)	100 (33.0±2.5)	
	Kucheri central	15 (4.0±0.5)	120 (30.0±3.16)	320
	Ruwa kusa	30 (8.0±0.7)	200 (40.0±3.73)	
	P. Value	0.83789	0.88478	170
Kucheri				
				275
				120
				135
				230

Mosquitoes' density was low in dry season compared to the wet season and also there was significant difference between dry and wet season (P = 0.00036). Numbers in parenthesis are means ± Standard error

Table 2: Mosquito abundance in respect to locations in Tsafe Local Government Area during the dry and wet seasons

Locations (Wards)	Dry season	Wet season	Total
Tsafe Central	330 (33.00±19.05)^{a}	770 (86.0±49.39)^{a}	1100
	125 (10.00±6.01)^{b}	640 (64.0±36.95)^{b}	765
Magazu	65 (6.00±3.41)^{c}	420 (36.0±20.73)^{c}	485
Kucheri			

Means along the same column with different superscript are significantly different at (P<0.05).
Numbers in parenthesis are means ± Standard error

Table 3: Mosquito abundance in Talatan-mafara local government area during the dry and wet seasons

Locations (Wards)	Study Sites	Dry season	Wet season	Total
Galadima	Kwanan-Damma	200 (40.0±3.3)	428 (86.0±12.3)	628
	Anguwan-Rogo	270 (54.0±5.6)	1437 (359.0±59.6)	
	Tsakuwa	60 (15.0±0.8)	852 (21.0±1.5)	1707
	Ruwan-Bore	60 (6.0±0.5)	95 (24.0±3.0)	
Ruwan-Bore	Milkidi	42 (8.0±1.2)	60 (15.0±2.2)	912
	Bakin-Zaje	27 (7.0±0.6)	68 (23.0±3.2)	
	Kayatawa	30 (10.0±0.5)	70 (18.0±2.4)	155
Kayayi	P. value	0.97973	0.99230	
				102
				95
				100

Mosquito density was low in the dry season compare to the months of August to October (raining season) however it does not differ significantly between dry and wet season as P. value = 0.32 (P>0.05). Numbers in parenthesis are means ± Standard error

Table 4: Mosquito abundance in respect to locations in Talatan-Mafara Local Government Area during the dry and wet seasons

Locations (Wards)	Dry season	Wet season	Total
Galadima	530 (38.00±21.86)[a]	2717 (150.0±86.6)[a]	3247
	102 (7.00±4.16)[b]	155 (19.0±11.0)[b]	257
	57 (8.00±4.70)[b]	138(20.0±11.4)[b]	195
Ruwan-Bore			
Kayayi			

Comparison of mosquitoes' density with respect to locations in Talatan-Mafara LG showed that Means along the same column with different superscript are significantly different at (P<0.05).
Numbers in parenthesis are means ± Standard error

Mosquito Species Composition

The species of mosquitoes collected during the period of study include; *Cx. quinquefasciatus* 4,373 (83%), *An. funestus* 515 (10%) and *An. gambiae sl.* 324 (7%). Out of the three species of mosquitoes recorded in the dry season in Tsafe LGA, *Cx. quinquefasciatus* 431 (85%) was found to be dominant while *An. funestus* 52 (10%) did not differ significantly from *An. gambiae* sl. 26 (5%). Similarly, in wet season, *Cx. quinquefasciatus* 1474 (80%) dominated but there was no significant variation between *An. funestus* 199 (11%) and *An. gambiae* sl. 157(9%) (Table 5).

In Talatan-Mafara LGA, *Cx. quinquefasciatus* 487 (74%) was found to be the dominant species followed by *An. funestus* 96 (15%) then *An. gambiae* sl. 74 (11%) in dry season. Statistically, there were no significant variation between *Cx. quinquefasciatus*, *An. funestus* and *An. gambiae* sl. (P>0.05). Likewise, in wet season, *Cx. quinquefasciatus* 1981 (89%) was found to be dominant followed by *An. funestus* 168 (7%) then *An. gambiae* sl. 85 (4%). There was no significant variation in abundance between *Cx. quinquefasciatus*, *An. funestus* and *An. gambiae* sl. (P>0.05) in Talatan-Mafara LG during wet season (Table 6).

Table 5: Mosquito species composition in Tsafe local government area during the months of March to May (dry season) and July to September (n=3)

Species	Dry season	Wet season	Total
Cx. quinquefasciatus	431 (54.0±37.2) [a]	1474 (184.0±68.7) [a]	1905
An. funestus	52 (7.0±2.7)[b]	199 (25.0±10.5) [b]	251
***An. gambiae* s.l.**	26 (3.0±1.7) [b]	157 (20.0±9.0)[b]	183
P. Value	0.032723	0.000267	

Means along the same column with different superscript are significantly different ($P<0.05$).
Numbers in parenthesis are means ± Standard error

Table 6: Mosquito species composition in Talatan-mafara local government area during the dry and wet seasons

Species	Dry season	Wet season	Total
Cx. quinquefasciatus	487 (70.0±37.2) [a]	1981 (283.0±485.3) [a]	2468
An. funestus	96 (14.0±5.1) [a]	168 (24.0±10.90) [a]	264
***An. gambiae* sl.**	74 (11.00±4.49) [a]	85 (12.00±7.75) [a]	159
P. Value	0.205387	0.195562	

Means along the same column with the same superscript are not significantly different ($P>0.05$)

Infection Rates of Mosquitoes

Of the 3,104 female mosquitoes collected from the study area, 1182 engorged (blood fed) females were dissected (Table 7 and 8). The species of mosquitoes dissected include: *Culex quinquefasciatus* 792 (67%), *Anopheles funestus* 236 (20%) and *Anopheles gambiae* sl. 154 (13%).

The infection rate of mosquitoes in dry and wet seasons in Tsafe Local Government were 1.76% and 2.50% respectively while Talatan-Mafara Local Government had 0.85% and 3.44% in dry and wet seasons respectively. The infection rate of mosquitoes in both seasons were significantly different in Tsafe (Table 7) and Talatan-Mafara (Table 8) Local government Area ($P<0.05$). Out of three species of mosquitoes examined during the dry season in Tsafe Local Government, *Wuchereria bancrofti* was recorded in 2 (5.6%) *An. funestus* out of 35 dissected and 2 (1.1%) *Cx. quinquefasciatus* out of 179 dissected but none was recorded in *An. gambiae* sl. However, during the wet season, *Wuchereria bancrofti* was recorded in all of the three species of mosquitoes examined, during the wet season, highest prevalence of *Wuchereria bancrofti* was found recorded in 3 (9.1) out of 33 dissected *An. gambiae sl*. followed by *An. funestus* 3 (6.4%) infected out of 47 dissected and the least was recorded in *Cx. quinquefasciatus* species 4 (1.3) infected out of 320 dissected (Table 7). On the other hand, during the dry season in Talatan-Mafara Local Government, *Wuchereria bancrofti* was recorded in *An. gambiae* sl. 1 (1.8%) infected out of 55 dissected, *An. funestus* 1 (1.4%) infected out of 73 dissected and none was recorded in *Cx. quinquefasciatus.* Whereas during the wet season, 6 (7.5%) *An. funestus* were recorded infected out of 80 dissected, *An*. *gambiae* sl. 3 (5.6%) out of 54 dissected and *Cx. quinquefasciatus* 2 (1.1) out of 186 dissected (Table 8).

Table 7: Prevalence of *Wuchereria bancrofti* in mosquitoes in Tsafe Local Government Area during the dry and wet seasons (n=3)

Seasons	Species	No. examined	No. infected	Prevalence (%)
Dry	*Cx. Quinquefasciatus*	179 (22.0±10.8)	2	1.1
	An. funestus	36 (5.0±2.1)	2	5.6
	An. gambiae sl.	12 (2.0±0.8)	0	0.0
Wet	*Cx. quinquefasciatus*	320 (40.0±7.1)	4	1.3
	An. funestus	47 (6.0±3.9)	3	6.4
	An. gambiae sl.	33 (4.00±3.3)	3	9.1

There was significant difference ($P<0.05$) in mosquitoes' infection rate between dry and wet season in Tsafe LG.

Table 8: Prevalence of *Wuchereria bancrofti* in mosquitoes in Talatan-mafara Local Government Area during the dry and wet seasons

Seasons	Species	No. examined	No. infected	Prevalence (%)
Dry	*Cx. quinquefasciatus*	107 (15.0±22.0)	0	0.0
	An. funestus	73 (10.0±7.0)	1	1.4
	An. gambiae sl.	55 (8.0±6.4)	1	1.8
Wet	*Cx. quinquefasciatus*	186 (3.0±11.5)	2	1.1
	An. funestus	80 (11.0±5.1)	6	7.5
	An. gambiae sl.	54 (8.0±4.0)	3	5.6

Mosquitoes' infection rate between dry and raining season in Talatan-Mafara showed no statistically significant difference at ($P<0.05$).

In comparison, the infection rate of mosquitoes with *Wuchereria bancrofti* between Tsafe and Talatan-Mafara LG, the three species of mosquitoes examined in Tsafe LG. Highest prevalence of *Wuchereria bancrofti* was recorded in *An. gambiae sl.* 3(6.7%) followed by *An. funestus* 5(6.0%), the least was recorded in *Cx. quinquefasciatus* 6(1.2%), while in Talatan-Mafara LG, highest prevalence was recorded in *An. funestus* 6 (3.9%) followed by *An. gambiae sl.* 4 (3.7%), least was in *Cx. quinquefasciatus* 2(0.7%). However, there was no statistically significant difference in infection rate between the two local governments at (P>0.05) (Table 9).

Table 9: Comparison in infection rate of mosquitoes by *Wuchereria bancrofti* in Tsafe and Talatan-Mafara Local Government Area

LGAs	Species	No. examined	No. infected	Prevalence (%)
Tsafe	*Cx. quinquefasciatus*	499	6	1.20
	An. funestus	83	5	
	An. gambiae sl.	45	3	6.02
Talatan-Mafara	*Cx. quinquefasciatus*	293	2	6.67
	An. funestus	153	6	
	An. gambiae sl.	109	4	
				0.68
				3.92
				3.67

The comparison in infection rate between two LGAs showed statistically, there was no significant variation (P>0.05).

Infectivity Rate of Mosquitoes

The infectivity rate of mosquitoes in Tsafe during dry and wet seasons were 0.88% and 1.50% respectively while Talatan-Mafara had 0.85% and 2.19% in dry and wet seasons respectively. The overall infectivity rate of mosquitoes with *Wuchereria bancrofti* was higher in Talatan-Mafara LG 10 (2.5%) than Tsafe LG 4 (1.8%). Some mosquitoes harbored more than one filarial worm, but not more than four

In Tsafe Local Government, infectivity rates with *Wuchereria bancrofti* were *An. gambiae* sl. 2 (4.4%), *An. funestus* 3 (3.6%) and *Cx. quinquefqsciatus* 3 (0.6%) whereas in Talatan-Mafara Local Government, infectivity rates were *An. gambiae* sl. 4 (3.8%), *An. funetus* 4(2.6%) and *Cx. quinquefqsciatus* 1 (0.3%) (Table 10).

Table 10: Infectivity rate of mosquitoes by *Wuchereria bancrofti* in Tsafe and Talatan-Mafara Local Government Area

LGAs	Species	No. examined	No. infected with L3 larvae	Prevalence (%)
Tsafe	*Cx. quinquefasciatus*	499	3	0.60
	An. funestus	83	3	3.61
	An. gambiae sl.	45	2	4.44
Talatan-Mafara	*Cx. quinquefasciatus*	293	1	0.34
	An. funestus	153	4	2.61
	An. gambiae sl.	109	4	3.67

The infectivity rate between two LGAs did not vary significantly (P>0.05).

DISCUSSION

Mosquito abundance

Mosquito population was found to be high in the main towns (headquarters) of both local governments during the wet season. This could be due to the fact that the sites (headquarter) consist of high human population compare to other sites (locations) within the L.G.A(s), weather prevalent at the time of collection and nature of the drainage systems. Large number of mosquitoes observed during the wet season is in contrast with the finding of Okorie *et al.* (2014) that mosquitoes were more abundant during the dry months of December, January and February compared to the wet months of March, April, May, June and July in Ibadan. Generally, places with high human population (urban areas) seem to harbour more mosquitoes than the places with low human population (rural areas); mosquitoes' egg can only get ripe (matured) with the availability of blood meal therefore, it could be as a result of what make those mosquitoes to search for where their host is available. For instance, Galadima ward (urban) had the highest abundance of mosquitoes which are generally *Culex quinquefasciatus* Moreover, the practice of husbandry is taking place in the area (cows, sheep and goats are reared at the backyard of many houses) which also attract mosquito for blood meal. Tsafe Central ward (headquarter of the LG) also had high population density of mosquito, a poor drainage systems was observed leading to stagnant water thus creating a favourable breeding site for *Cx. quinquefasciatus*.

The low population of *Anopheles funestus* (0.7%) and *An. gambiae sl.* (0.3%) in Galadima (urban) were probably due to unfavourable breeding habitat for the species as the water bodies were contaminated and the contaminated water bodies do not favour breeding activities for both *A. funestus* and *A. gambiae.* Hence, the predominant mosquitoes in the location were *Culex quinquefasciatus.* This agrees with the findings of (Nwoke *et al.*, 2014) that the increase of *Culex* species population is in line with the growth of towns, poor sanitation as well as industrialization.

Generally, *Culex quinquefasciatus* was dominant in urban and semi urban in the study area while *Anopheles gambiae* sl. and *Anopheles funestus* were dominant in rural the dominant of *Anopheles* species in the rural could be as due to the fact rural water bodies usually tend to be less polluted and those species of mosquito preferred unpolluted water for breeding activities hence found more in rural areas in order to favour its breeding. This is also in line with the findings that *Cx. quinquefasciatus* has increased in many towns due to increasing urbanization and resultant proliferation of unsanitary collections of water (Service, 1989) and Amechi *et al.* (2011). As a result of the urban overcrowding, the sanitation services in most of the urban areas, especially at the urban-periphery or squatter settlements are unable to cope adequately with the influx of people (WHO, 2010).

Infection/infectivity rate of mosquitoes

High infection/infectivity rates were recorded in *Anopheles gambiae* sl. and *Anopheles funestus* had in the rural areas and *Culex quinquefasciatus* in the urban and semi-urban areas. This is in line with the findings of Brengus (1975) that in Nigeria and other African countries, *Anopheles gambiae*, which breeds mainly in temporary habitats such as pools, puddles, hoof point, burrow pits etc. and *Anopheles funestus,* which breeds in numerous shallow, shaded, grassy streams and rivers are the natural vectors of *Wuchereria bancrofti* in the rural areas. There are also similar reports that *Anopheles gambiae* and *Anopheles funestus* are the main vectors in rural Nigeria while *Culex quinquefasciatus* remains the main vectors in urban and semi-urban areas (Oduola and Awe, 2006; Nwoke *et al*., 2010).

Similar observations were made where *Anopheles gambiae*, *Anopheles funestus* and *Culex quinquefasciatus* have been incriminated as vectors of *Wuchereria bancrofti* in an irrigation community in southern Ghana (Dzodzomenyo *et al.,* 1999; Onapa *et al.,* 2001). *Anopheles funestus* and *Anopheles gambiae* were found to be the vectors of *Wuchereria bancrofti* in three communities in Uganda (Anosike *et al.,* 2005). *Culex quinquefasciatus* and some *Anopheles* sp (*Anopheles gambiae* and *Anopheles funestus*) incriminated as vectors of filarial nematodes in Ebonyi State, Nigeria.

The infection/infectivity rate in Tsafe local government area was higher in wet season. This agrees with the findings of Badaki (2010) that transmission of bancroftian infection occurs mainly during rainy season when mosquitoes are most abundant.

Galadima and Tsafe Central wards (the headquarters of Talatan-Mafara and Tsafe local government areas respectively), recorded low infection rate. This could be as a result of the ongoing mass drug administration in the state. The project has been able to cover almost all the communities in the main towns and may have contributed to the reduction of *Wuchereria bancrofti* in both vectors and human. In some rural areas like Kucheri and Ruwan-bore wards, the project of mass drug administration is yet to reach them. Fortunately, the programme is ongoing and hopefully every point of the state (rural and urban) will be covered. The low infection/infectivity rate recorded in Kayayi ward, though a rural setting could be attributed to the few number of mosquitoes collected and dissected during the study period.

The overall microfilaria infection rate (8.55%) and infectivity rate (5.42%) in mosquitoes from the present study is comparable to reports from filariasis endemic countries (WHO, 1999; Pedersen and Mukolo, 2012). However, it is much higher than what was reported by Dogara *et al.* (2012) from Kano State Nigeria, where he recorded overall infection/infectivity rates of 0.07% and 0.0% respectively. This differences could be as a result of location (the work had been carried out in Kano State while this current study had been carried out in Zamfara State) and also could be as a result of the use of insecticide in Kano State has high impact to reduce the mosquito population.

CONCLUSIONS

There are three mosquito species in the study area namely; *Culex quinquefasciatus*, *Anopheles funestus* and *Anopheles gambiae*. *Culex quinquefasciatus* is the dominant species. All species of mosquitoes were infected with the filarial worm *Wuchereria bancrofti*

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