

# The Advance of *Culex quinquefasciatus* (Say) into Rural Eco-vegetational Zones in Bayelsa State, Nigeria

Amawulu Ebenezer<sup>1,2</sup>, M. Aline E. Noutcha<sup>1</sup>, Samuel N. Okiwelu<sup>1,\*</sup>

<sup>1</sup>Entomology & Pest Management Unit, Department of Animal and Environmental Biology, University of Port Harcourt, Port Harcourt, Rivers State, Nigeria

<sup>2</sup>Current Address: Isaac Jasper Adaka Boro College of Education, Bayelsa State, Nigeria

**Abstract** **Background:** *Culex quinquefasciatus* had always been characterized as an urban vector of Bancroftian filariasis in West Africa. However, there have been records of limited entry into rural pockets in East and West Africa. Studies were therefore undertaken to investigate the extent of its advance and behaviour in rural areas of diverse vegetation, Bayelsa State, Nigeria. **Methods:** *Culex quinquefasciatus* were collected by the pyrethrum spray catch technique from houses where occupants had slept the previous night in rural towns/villages across ecovegetational zones (Fresh water swamp forest, brackish water swamp forest, Mangrove water forest) in Bayelsa State, Nigeria, April, 2009- March, 2010. **Results:** A total of 2084 *Culex quinquefasciatus*, approximately 4-fold the number of *Anopheles gambiae s.l.* was collected. More were collected in the wet than dry season and the difference was significant ( $\chi^2_{cal.} = 403.9$ ,  $df=1$ ,  $p<0.05$ ). It occurred across the three eco-vegetational zones; differences were not significant. The dominant gonotrophic stage was unfed (57.1%); the other three stages were: fed (20.9%), gravid (11.1%) and half-gravid (10.9%). Indoor resting densities across the eco-vegetational zones were 24.2-47.0 mosquitoes/room/night. Spatial variation in densities was not significant. Man-biting rates were 7.6-13.2 bites/person/night. Differences in man-biting rates were significant ( $t=12.083$ ,  $df=6$ ,  $p=0.00$ ); higher densities and biting rates were recorded in the wet season. **Conclusion:** The rural advance of *Culex quinquefasciatus* into different eco-vegetational zones is more extensive than envisaged. Based on the high densities, behavioural attributes of endophagy and endophily, it may become an important vector of rural lymphatic filariasis in West Africa.

**Keywords** *Culex quinquefasciatus*, Rural, Advance, Behaviour, Nigeria

## 1. Introduction

*Wuchereria bancrofti* and *Brugia malayi* are unique among the various mosquito-transmitted parasites; larval development can take place in several genera of mosquitoes [1]. Globally, three transmission zones are recognized where each of the three genera (*Aedes*, *Anopheles*, *Culex*) predominates. In West Africa, *Anopheles* mosquitoes are the principal vectors whereas in East Africa, transmission is mainly by *Culex quinquefasciatus* and other members of the *Culex pipiens* complex [2]. However, *Cx. quinquefasciatus* is considered an urban vector of the disease in West Africa, breeding in urban polluted waters [3, 4]. There have been recent reports of *Cx. quinquefasciatus* distribution increasing with urbanization and human activity, and many rural pockets that were relatively free of this species are now increasingly colonized [5, 6]. The available record of this rural advance in Nigeria was in the lowland rain forest [5]. Malaria and lymphatic filariasis are endemic in Bayelsa State

[7]. The distribution and behaviour of *Cx. quinquefasciatus* were investigated during studies on *Anopheles gambiae* complex and malaria transmission in semi-urban/rural settings across the eco-vegetational zones in Bayelsa State.

## 2. Materials and Methods

### 2.1. Study Area

Bayelsa state occupies an area of 21,110km<sup>2</sup>, comprising three eco vegetational zones (Mangrove Water forest, Fresh water swamp forest and Brackish water swamp forest) there are two seasons: rainy (March-October) and dry (November-February).

### 2.2. Methods

The sampling locations were in semi-urban and rural villages located in 7 Local Government Areas (LGAs)- Nembe, Yenagoa, Sagbama, Kolokuma/Opokuma, Ogbia, Ekeremor, Southern Ijaw. The spread across eco-vegetational zones is: Mangrove coastal water forest (Nembe); Fresh water swamp forest (Yenagoa, Sagbama, Kolokuma/Opokuma); Brackish water swamp forest (Ogbia, Ekeremor, Southern Ijaw). Six towns and villages were

\* Corresponding author:

okiwelu2003@yahoo.com (Samuel N. Okiwelu)

Published online at <http://journal.sapub.org/als>

Copyright © 2014 Scientific & Academic Publishing. All Rights Reserved

randomly selected from each LGA for a total of 42 towns /villages (Fig 1). Permission to sample was obtained from the State Ministry of Health, through the Directors, Primary Health Care (PHC) centres in the LGAs. Pyrethroid spray catches were used in the randomly selected houses in each town/village. Verbal consent was obtained from the household heads.

In each house at least one person must have slept in the selected room, the night prior to the morning of collection. Prior to spraying, the floors of the selected rooms were covered with clean white sheets. Spraying of commercial pyrethroid (Raid) was undertaken, 06.00-07.30hr. The rooms were kept airtight for 15 minutes. The white sheets were inspected for adults, which were picked up with fine forceps into labelled Petri dishes and preserved in the refrigerator for identification. Mosquitoes were identified by the keys [3, 8, 9]. Collected *Cx. quinquefasciatus* were placed in gonotrophic stages (fed, unfed, gravid, half-gravid). Indoor resting density (ird) was obtained by dividing the number of collected female *Cx. quinquefasciatus* by the number of houses. Man biting rate (mbr) was obtained by dividing the number of fed *Cx. quinquefasciatus* by the number of occupants.

### 2.3. Statistical Analyses

Chi square test was used to determine the significance of differences in seasonal adult abundance while the t-test was applied to differences in man-biting rates across towns and villages. ANOVA was applied to differences in adults' abundance across eco-vegetational zones, gonotrophic stages and spatial variation in indoor resting density (ird)

## 3. Results

### 3.1. Distribution and Abundance

A total of 2084 *Cx. quinquefasciatus* were caught, April, 2009- March, 2010; 519 (24.9%) and 1565 (75.1%) were collected in the dry and rainy seasons respectively. The monthly numbers were 129.75 and 195.63 in the dry and rainy seasons respectively. Seasonal differences were significant ( $\chi^2_{cal.} = 403.9, df=1, p<0.05$ ). *Cx. quinquefasciatus* occurred across the 3 eco-vegetational zones (Table 1). Differences in numbers across eco vegetational zones were not significant ( $F_{cal.} = 0.628; p\text{-value } 0.652, p>0.05$ ).

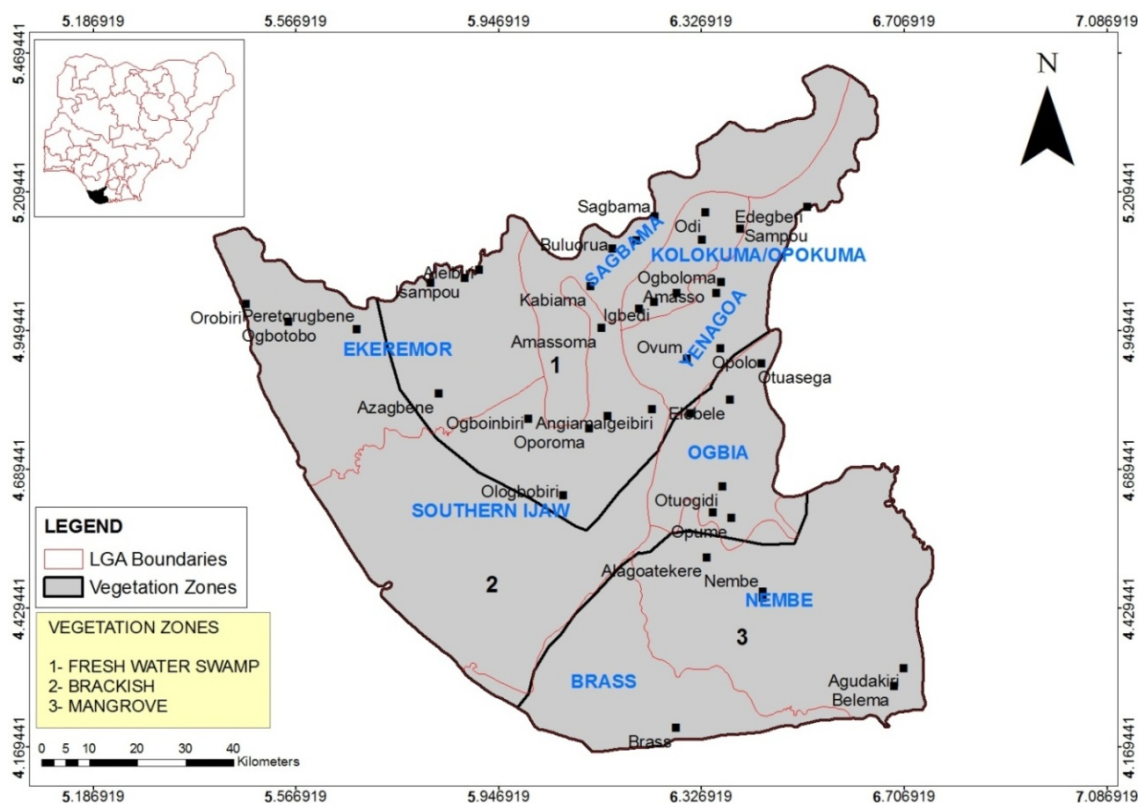


Figure 1. Study sites in respective Local Government Area

Table 1. Numbers of PSC-Collected *Culex quinquefasciatus* across Eco-vegetational zones in Bayelsa State 2009-2010

Eco-vegetational zones	Number caught	Number/LGA	Number/Village
Fresh Water Swamp Forest	897	299	49.8
Brackish Water Swamp Forest	919	306	51.1
Mangrove Coastal Water Forest	268	268	44.7
<b>Total</b>	<b>2084</b>		

$F_{cal.} = 0.628, p\text{-value} = 0.652, p>0.05$  (Not Significant)

### 3.2. Gonotrophic Status

When the numbers of *Cx. quinquefasciatus* in the different gonotrophic stages were pooled, 57.1% were unfed, 20.9% fed, 11.1% gravid and 10.9% half gravid (Table 2). Differences in the gonotrophic stages were significant ( $F_{\text{cal}}=18.174$ ,  $df=3$ ,  $p=0.000$ ).

**Table 2.** Seasonal Gonotrophic Status of PSC-Collected *Culex quinquefasciatus*

Abdominal Conditions	Number (%) caught each Season		Total
	Dry	Wet	
Fed	127 (29.1)*	309 (70.9)*	436 (20.9)**
Unfed	212 (17.8)*	977 (82.2)*	1189 (57.1)**
Gravid	88 (38.1)*	143 (61.9)*	231 (11.1)§
Half Gravid	92 (40.4)*	136 (59.6)*	228 (10.9)§
Total	519 (24.9)	1565 (75.1)	2084

\*Numbers in parentheses are percentages of *Culex quinquefasciatus* in each gonotrophic stage.

\*\*Significant differences between fed and unfed *Cx. quinquefasciatus*

§Differences between gravid and half gravid were not significant

### 3.3. Indoor Resting Density (ird) and Man Biting Rate (mbr)

**Table 3.** Indoor resting density (ird) and man-biting rate (mbr) of PSC-*Culex quinquefasciatus* in towns/villages September, 2009- August, 2010

Variables	Locations							Total
	Yenagoa	Sagbama	Kaiama	Ogbia	Oporoma	Ekeremor	Nembe	
No houses visited	8	7	8	8	7	7	9	54
No occupants	14	11	17	12	12	14	19	99
Mean occupant/room	1.8	1.6	2.1	1.5	1.7	2.0	2.1	1.8*
No (%) <i>Cx. quinquefasciatus</i>	199 (9.5)	329 (15.8)	369 (17.7)	337 (16.2)	292 (14.0)	290 (13.9)	268 (12.9)	2084
Indoor resting density (ird)	24.7	47.0	46.1	42.1	41.7	41.1	29.8	38.6*
No (%) Fed <i>Cx. quinquefasciatus</i>	107 (24.5)	153 (35.1)	180 (41.3)	158 (36.2)	143 (32.8)	146 (33.5)	178 (40.8)	436 (20.9)
Man-biting rates (mbr)	7.6	9.0	10.6	13.2	11.9	10.4	9.4	4.4*

\*Mean number of occupants/room, ird and mbr

Indoor resting densities were 24.2, 29.8, 41.1, 41.7, 46.1 and 47.0 mosquitoes/ room /night at Yenagoa, Nembe, Ekeremor, Oporoma, Ogbia, Kaiama and Sagbama respectively (Table 3). These densities were significantly higher than those of *An. gambiae s.l.* collected simultaneously [11]. Spatial variation in ird was not significant ( $F_{\text{cal}} = 1.365$ ,  $df = 6$ ,  $p>0.05$ ). Man biting rates varied, 7.6-13.2 bites/person/night. Highest mbr was at Ogbia while the least at Yenagoa (Table 3). Differences in man-biting rates across towns/villages were significant ( $t=12.083$ ,  $df=6$ ,  $p=0.00$ ). Highest percent of fed mosquitoes was at Kaiama (Table 3). There were 2-fold or higher increases in irds and mbrs from the dry to the rainy season (Table 4).

**Table 4.** Seasonal variation in ird and mbr of *Cx. quinquefasciatus*

Variables	Seasons		Total
	Dry	Wet	
No <i>Cx. quinquefasciatus</i> caught	519	1565	2084
No <i>Cx. quinquefasciatus</i> fed	127	309	436
No of occupants	99	99	198
Ird	9.6	18.1	
Mbr	1.28	3.12	

## 4. Discussion

Surprisingly, the numbers of *Cx. quinquefasciatus* were about 4-fold the numbers of *Anopheles gambiae s.l.* collected during the same period [10]. The invasion of rural areas by *Cx. quinquefasciatus*, recorded at rural pockets in Tanzania [5], in the lowland rainforest, Rivers State, Nigeria has extended further to diverse vegetation zones [6]. The invasion of rural areas by *Cx. quinquefasciatus* is more extensive than originally thought. Reproduction occurred throughout the year in both dry and wet seasons, although numbers were higher during the rainy season. It was therefore not surprising that indoor resting densities and man-biting rates were higher in the wet season. In semi-urban Yenagoa and rural Sagbama, Kaiama, Ogbia, Oporoma, Ekeremor, and Nembe, *Cx. quinquefasciatus* was both endophilic and endophagic, similar observations had been reported [3]. The feeding and resting behaviours indicate that it may be a significant vector in rural Bancroftian filariasis in West Africa. Since *Cx. quinquefasciatus* is dominant in some of these rural areas, it may displace *An. gambiae* complex from parts of its range.

## REFERENCES

- [1] Bockarie M.J., Pedersen E.M., White G.B. and Michael E. 2009, Role of vector control in the Global Program to eliminate Lymphatic filariasis. *Ann. Rev. Entomol.* 54:469-487.
- [2] White G.B. "Lymphatic filariasis" in *Geographic Distribution of Arthropod-borne Diseases and their Principal Vectors*. pp. 23-34. Geneva. World Health Organization. Vector Biol. Control Div. WHO/VBC/89.967. 1989.
- [3] Service M. *Medical Entomology for Students*. 4<sup>th</sup> Edition. Cambridge University Press. 289pp. 2008.
- [4] Foster W.A. and E.D. Walker 2009. Mosquitoes (*Culicidae*) pp. 207-260 *In Medical and Veterinary Entomology*. 2<sup>nd</sup> Edition. Gary R. Mullen and lance A. Durden (Eds). Elsevier/Academic Press. Amsterdam. 637pp.
- [5] Chavasse D.C., Lines D.J., Ichimori K., Marijani J. 1995, Mosquito control in Dar es Salaam -I- Assessment of *Cx. quinquefasciatus* breeding sites prior to intervention. *Med. Vet. Entomol.* 9:141-146.
- [6] Okiwelu, S.N. & Noutcha, M.A. E. 2012, Breeding Site Preferences of *Culex quinquefasciatus* (SAY) in Rural Lowland Rainforest, Rivers State, Nigeria. *Public Health Research* 2(4):64-68.
- [7] Ebenezer A. & E.G. Amadi 2008, Prevalence of Haemoparasitic infection in humans and insect vectors in Yenagoa, Bayelsa State. *Nig. J. Parasitol.* 29(2):131-135.
- [8] Gillet J.D. 1972. *Common African Mosquitoes and their Medical Importance*. William Heineman. Medical Books Ltd. London. 106pp.
- [9] Gillies M.T. and M. Coetzee. 1987. *A supplement to the Anophelinae of Africa, south of the Sahara. (AfroTropical region)*. Publication of the South African Institute for Medical Research, Johannesburg. 55pp.
- [10] Ebenezer A., S.N. Okiwelu, P.I. Agi, M.A.E Noutcha, T.S. Awolola & A.O. Oduola, 2012, Species composition of the *Anopheles gambiae* complex across ecovegetational zones in Bayelsa state, Niger Delta region, Nigeria. *J. Vector Borne Dis* 49: 1– 164-167.
- [11] Ebenezer, A. "Spatial and Temporal Patterns of malaria infections and *Anopheles gambiae s.l.* Distribution in Bayelsa State, Nigeria," PhD thesis, University of Port Harcourt, Nigeria, July 2011.