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Full Length Research Paper

Physiological age structures of female anopheline and culicine mosquito populations (Diptera: Culicidae) in Makurdi, North Central Nigeria

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Physiological ages of mosquitoes were determined from four localities in Makurdi between July, 2011 and June, 2012. A total of 4,320 adult female Anopheline and Culicine mosquitoes were dissected using standard procedures. Their order of abundance was: *Culex quinquefasciatus* 2,418 (56.0%) > *Anopheles gambiae* s.l. 1,040 (24.1%) >*Anopheles funestus* 641 (14.8%) > 'unidentified' *Anopheles* species 221 (5.1%) respectively. There was a significant difference (P < 0.05) between the mosquito species and their abundance. 92.3% of the mosquitoes were parous and varied significantly (P < 0.05) across the four localities. The ages were determined using the number of dilatations along the length of an ovariole of each female mosquito dissected. The age groups were: 1-parous, 2-parous and 3-parous respectively. There were significant differences (P < 0.05) between the 1-parous and 2-parous age groups, unlike the 3-parous group across the localities and seasons,. These findings indicated that Makurdi is potentially endemic for both malaria and lymphatic filariasis since the physiological ages showed that the mosquito vectors were old enough for the parasites to complete their extrinsic incubation periods within them. This work provides entomological baseline data on mosquito longevity required for implementation and evaluation of vector control interventions in the study area.

Key words: Physiological age, anopheline, culicine, mosquitoes, Makurdi, Nigeria.

INTRODUCTION

Of all the insects known to man, mosquitoes are unquestionably the ones which cause most illness, economic loss and discomfort to man (Dandalo, 2007). According to Dandalo (2007), several mosquitoes belonging to the genera *Anopheles, Culex and Aedes* are vectors for pathogens of various diseases such as malaria, filariasis, yellow fever, dengue, Japanese Encephalitis and haemorrhagic fever.

Vector age is therefore, one of the most sensitive parameters influencing the epidemiology of vector-borne diseases. It is a critical determinant of the ability of most arthropod vectors to transmit a range of human pathogens. According to Uttah (2013), the study of the age structure of vector population is of great importance in the epidemiology of vector-borne diseases and the assessment of all control measures. Mayagaya *et al.* (2009) has reported that determination of physiological age of mosquitoes avails scientists the opportunity to estimate several epidemiological indices that help for the better understanding of the vector-borne disease for informed decision-making process.

The physiological age of mosquitoes and its implications

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on the reproduction and disease transmission have also been documented by several authors; Gillies (1957); Beklemishev *et al.* (1959); Inyama *et al*. (2003); Cook *et al.* (2007); Roberts (2010); Service (2012); Ndoen *et al.* (2012) and recently by Uttah *et al*. (2013). However, scanty data exist on the physiological age of *Culex quinquefasiatus* and on the effect of this age on its behaviour.

It has been reported that total sperm capacity and mating success vary by male age in *Aedes aegypti* (Ponlawat and Harrington, 2007). This, according to the report, can be used to estimate reproductive potential. It is also demonstrated that male insemination rates were dependent on female age with virgin *Aedes aegypti* (Ponlawat and Harrington, 2007). Similarly, Mahmood and Reisen (1982 &1994) reported that the number of spermatocysts decreased and the length of the sperm reservoir increased with age in *Anopheles stephensi* and as well, reported the effect of age on the male reproductive system and mating ability of virgin adult mosquitoes respectively.

Vector age has also been described by Cook *et al.* (2007) as one of the most sensitive parameters that influence the epidemiology of vector-borne diseases. It is a critical determinant of the ability of most arthropod vectors to transmit a range of human pathogens. Uttah *et al*. (2013) pointed out that the usefulness of determining the physiological age of mosquitoes is an assessment of the effectiveness or otherwise of control measures. It has been reported by Uttah *et al*. (2013) that the number of previous blood meals taken by a mosquito can be deduced from the batches of eggs laid. Similarly, Githeko *et al.* (1993) reported that the number of times a female mosquito has laid eggs is determined by the number of follicular dilatations in the ovarioles. Similarly, Uttah *et al*. (2013) also reported that the older the female mosquito, the greater is her epidemiological significance, as each blood meal provides an additional chance of the vectors being infected by the host or the hosts acquiring infection from a vector.

There is paucity of information on mosquito physiological age in general and in the North-Central Nigeria in particular where Makurdi – the study area, is located. The present study therefore, is aimed at determining the age structures of female anopheline and culicine mosquitoes in the localities of Makurdi with a view to providing a pre-control data that would be useful in the future mosquito control programmes.

MATERIALS AND METHODS

Study Area

Makurdi is the capital of Benue State and is located in the middle belt, North of Central Nigeria. It is located between longitude $8^{o}35$'E and $8^{o}41$'E and latitude $7^{o}45$'N and $9^{o}52$'N, characterized by undulating rolling plain with irregular river valley and ridges with steep slopes. According to the Federal Republic of Nigeria official gazette of 2006 population census, published in 2010, Makurdi had the population of 297,398 people (comprising 157,295 males and 140,103 females); and the town is placed 106.4m above sea level (National Meteorological Agency, 2011).

Makurdi is an urban setting which lies within the Benue trough, intersected by the river Benue which is a major source of water with other net-works of streams, standing pools, over filled and blocked gutters and drainages. Over grown bushes and fields, even around residential homes and offices are easily noticeable in Makurdi. These provide suitable breeding sites for mosquitoes throughout the wet season (April-October) and dry season (November-March).There is also characteristic high temperature in Makurdi, (30^{o}C-39^{o}C), which aids in the speedy development and hatching of mosquito eggs. It is suspected that temperature may have an impact on transmission of vector diseases in the selected localities (High-level, Wurukum, North-bank and Wadata) throughout the year.

The above localities were selected for mosquito sample collection because they are the most populated parts of Makurdi town and they have more breeding sites for mosquitoes in the area; they also have a closer proximity to river Benue in the study area (Fig. 1).

Other detailed geographical and regional indices of the study area have been provided by Udo (1981) and Nyagba (1995).

Ethical Consideration and Collection of Mosquito Samples

Mosquito samples were collected from a total of forty (40) households, ten (10) from each locality in the study area using a randomised design.

Verbal informed consent was obtained from the head of each of the randomly selected households before their houses were accessed for mosquito collection in all the study localities. All mosquito samples were collected using standard procedures as provided by WHO (1975). Sampling units were randomly selected from the four localities and due to the present security challenges in Nigeria, the mosquito samples were collected with the help of “fly boys” who were recruited from the various study localities where they were well known by the residents of the localities sampled.

The mosquitoes were collected from 6 am to 9 am and 6 pm to 9 pm from living rooms in the study localities, either alive or dead. These periods for sample collection were chosen because previous studies have shown that most mosquitoes enter houses to feed at early hours of the night and struggle to go out in the early hours of the day

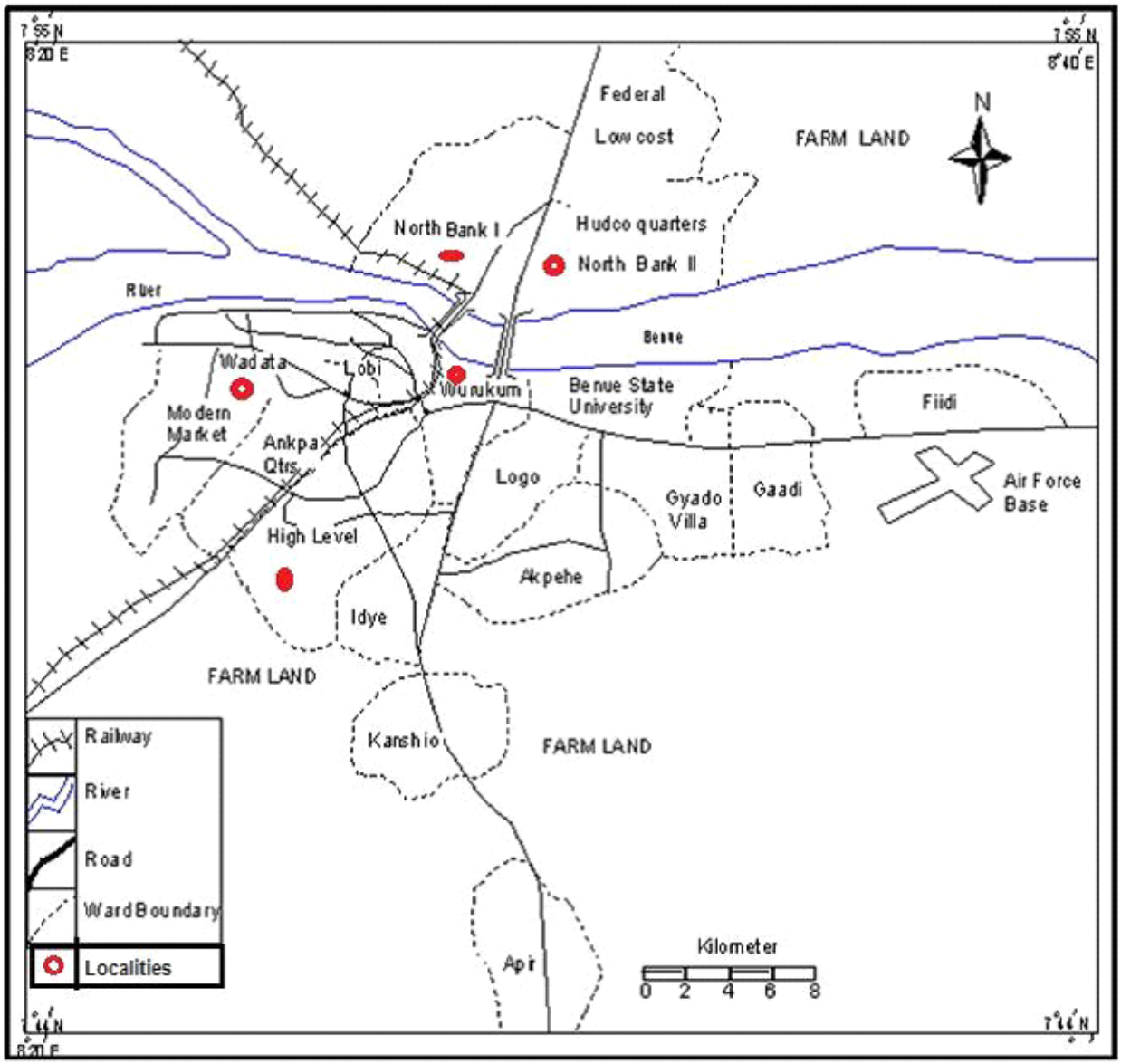

Figure 1. Map of Makurdi town showing the Study Localities. (Ministry of Lands and Survey, 2011).

to rest outdoors (Laumann, 2010; Service, 2012).

The mosquitoes were collected from dark corners, walls, ceilings, clothing and other objects inside living rooms using mouth-aspirators (sucking tubes) with the help of battery-operated torch-lights (Service, 1976; Dandalo, 2007); pyrethrum spray collection (PSC) was also used for mosquito collection, which involved the laying of white cloth on the floor and on surfaces of immovable furniture in the houses. The houses were then sprayed using BAYGON (1.0% propoxum, 0.1% imiprothrin and 98% propellant/solvent) as described by Dandalo (2007). After 10 minutes, the cloth was removed and inspected outdoors for knocked down mosquitoes. Window trap method was also used where applicable: The trap consisted of a cage made of 1 ft^3 framework of wire which was covered with mosquito netting. A narrow entrance funnel of ¼ in diameter was made at one end and a string was tied from its narrow end to the four corners of the trap to support the funnel (Service, 1976; Dandalo, 2007).The window traps were now installed in the houses and inspected on daily basis for mosquito collection. The suitability of the sampling methods was determined based on the nature of the houses to be sampled. The mosquito specimens collected from the different capture methods were sorted out separately using forceps and kept in holding tubes, inside cooling boxes, and carried to the laboratory on the same day or the following day for characterization, identification, dissection and examination

using methods as in Ungureanu (1972); WHO (1975); Goodman *et al.* (2003); Aigbodion and Nnoka (2008) and Abeyasingha *et al.* (2009). Those mosquito samples that could not be processed on the same day were refrigerated and dissected on the following day according to the methods of Ungureanu (1972).

Even though, the mosquito population for this study was only drawn from indoor-resting mosquitoes, which were expected to be only females, some male mosquitoes were also caught along with the females. Male mosquitoes were therefore, distinguished from the females using key morphological features as described by Service (2012).

Identification of Mosquito Samples

Dissecting microscope was used for detailed observation and identification of the mosquitoes with particular reference to the head, thorax, wings and hind-legs according to Gilles and Coetzee (1987) and Coetzee (1989). Morphological characteristics such as length of maxillary palps, wing spots, leg shape, mouthparts and abdominal end model as presented by Coetzee (2000), Oguoma *et al.* (2010) and Service (2012) were used to identify the *Anopheles* species that co-exist in Makurdi. Observations of the morphological features were made at $\times 40$ magnification of the microscope.

reparation of Mosquitoes for Dissection

Live blood fed mosquitoes were killed with chloroform, ether or carbon (IV) oxide while unfed mosquitoes were collected in a test tube and while at the bottom, the end of the tube was rubbed sharply against the palm of the hand to stun the mosquitoes according to the WHO standard of 1975.

After immobilization, each mosquito was placed on a slide and held by one wing while the legs were being removed one at a time and after wards, the other wing was pulled off.

The mosquito was then placed on a fresh dry slide and arranged in a more suitable position for dissection of the stomach/abdominal region and salivary glands as described by WHO (1975) and as adopted by Abeyasingha *et al*. (2009). A mosquito dissection CD titled: 'Mosquitoes and Malaria' (1988): courtesy of the Nigerian Institute of Medical Research (NIMR), was also used as a guide during the dissection session.

Abdominal Dissection for Determination of Parity Rates and age

After the extraction of the ovary, a gentle pressure was exerted on the abdomen to bring out the Malpighian tubules and the stomach following the methods of Abeyasingha *et al*. (2009). The abdomens of the female mosquitoes were dissected to confirm the parity or nulliparity of the mosquitoes by examining the tracheolar skeins on the surface of the stomach walls for the *Anopheles* species. When the stomach was partially extracted, the Malpighian tubules were severed from around the stomach as close as possible without tearing the gut wall, while the rectum was cut off from the stomach just below the pyloric ampulla. The stomach was then transferred to another clean slide containing a drop of saline and covered with a cover slip.

This was viewed under a compound microscope ($\times 40$) for the condition of tracheolar skeins on the surface of the stomach wall. Tracheae with terminal coiling signified nulliparity while stretched tracheae signified parity (WHO, 1975). The anaesthetized mosquito was placed on its back on a microscope slide and a drop of diluted Carnoy's fixative (2 parts absolute alcohol, 1 part glacial acetic acid) was added according to Abeyasingha *et al*. (2009). This was then placed under a dissecting microscope and dissected. After two (2) minutes, the dissected mosquito was examined under an Olympus stereoscopic binocular microscope ($\times 40$) where the tracheolar skeins, Christopher's stages and dilatations were looked for as described by Gillies (1957).

Dilatations were located by isolating the ovarioles so that the stalks were straightened, making possible the examination for the presence or absence of dilatations, follicular sacs and follicular relics. Females in which the ovaries had coiled tracheolar skeins were considered to be nulliparous while those whose tracheolar skeins were stretched out were recorded as being parous. In some female mosquitoes however, not all developed eggs were laid; some were still retained in the ovaries (but were not more than five in number), these were also considered to be parous according to Abeyasingha *et al*. (2009).The number of dilatations on the stalk of the ovarioles were seen clearly and counted.

The dilatations represent the number of times the mosquito had laid eggs and hence, the potential risk of disease transmission (Abeyasingha *et al*., 2009; Service, 2012).

Statistical Analyses of Data

The Predictive Analytical Software (PASW) Version 18 was used in running Chi-square statistic on the data collected. Significant levels were measured at 95% confidence level with significant differences considered at $p < 0.05$.

We tested for homogeneity across sample localities so as to determine whether or not the nature of the sample localities affected the distribution of data across them.

RESULTS

dilatations (knots or tangles) along the length of an ovariole of each female mosquito dissected from the four

study localities over the 12 month study period is presented in Table 1.

Of the 3,989 parous (those that had already laid at least one batch of eggs) mosquitoes dissected, thorough microscopic observations revealed that 3,517 (88.2%) of them had one (1) dilatation each (i.e they had deposited one batch of eggs before); 461 (11.6%) had two (2) dilatations each (two batches of eggs) while 11 (0.3%) had three dilatations on their ovarian stalks, indicating that they had laid up to three batches of eggs in their life time before the time of dissection.

Three age groups were therefore, established in this study as: 1-parous, 2-parous and 3-parous respectively (Table 1).The differences between the age groups were statistically significant ($p < 0.05$). Also, both 1-parous and 2-parous age groups varied significantly with the localities from where the mosquitoes were collected ($p < 0.05$). However, there was no significant difference between the 3-parous age group and the localities ($p > 0.05$).

The age structure of the mosquitoes in relation to the study months is presented in **Table 2.**

For 1- parous age group, the highest percentage of mosquitoes occurred in October (85.0%) while February had the lowest percentage of mosquitoes that were 1-parous (74.1%). There were no marked variations in the distribution of the 1- parous mosquitoes across the 12 month study period ($\chi^2 = 6.151, d.f = 11, p = 19.68$).

The mosquitoes in the 2- parous age group had their highest percentage occurrence (17.9%) in June and the lowest (4.5%) in April. Similarly, there were no significant differences in the distribution of the 2- parous mosquitoes and the months during which they were collected ($_z d.f = 11, p = 19.68$).

The oldest 3- parous mosquitoes were found only in 6 out of the 12 month study period and there was no significant difference in the distribution of the 3- parous mosquitoes across the study period ($\chi^2 = 1.545, d.f = 5, p = 11.07$).

The results of the physiological age structure of the dissected mosquitoes in the study area in relation to the species of mosquitoes and the study seasons are presented in Table 3. Both season and mosquito species were found to have a combined significant effect ($p < 0.05$) on the age structure of the mosquitoes dissected in Makurdi. The 1-parous mosquitoes were more in number [3517(81.4%)] than the 2-parous ones [461(10.7%)] which in turn were more than the 3-parous mosquitoes [11(0.2%)] for both wet and dry seasons. Mosquito densities in all the three age groups were significantly more ($p < 0.05$) in the wet seasons than in the dry season of the study period.

There was a significant variation in the distribution of both 1- parous and 2- parous mosquitoes during the wet and dry seasons ($\chi^2 = 254.7, d.f = 2, p = 5.991$) for 1-parous mosquitoes and ($\chi^2 = 40.403, d.f = 2, p = 5.991$) for 2- parous respectively. However, there was no significant difference ($\chi^2 = 1.273, d.f = 2, p = 5.991$) in the distribution of the 3- parous mosquitoes across the wet and dry seasons. The 1- parous mosquitoes had 81.9% parity rate in the wet season 1; 81.6% in the dry season and 80.5% in the wet season 2 respectively. The 2- parous mosquitoes had 10.9% parity rate during the wet season 1; 9.7% in the dry season and 10.7% during the wet season 2. The oldest 3- parous mosquitoes had similar percentage seasonal occurrences of 0.2% for both wet season 1 and dry season, and then 0.3% for wet season 2 respectively.

In terms of mosquito species, Chi-square (χ^2) analysis showed significant differences between both the 1-parous and 2- parous age groups, and the mosquito species: ($\chi^2 = 454.1, d.f = 3, p = 7.815$) and ($\chi^2 = 45.081, d.f = 3, p = 7.815$) respectively. However, the 3- parous age group did not differ significantly in relation to the species of mosquitoes ($\chi^2 = 1.000, d.f = 1, p = 3.841$). Irrespective of seasons, the oldest mosquitoes in this study were *Anopheles gambiae* and *Culex quinquefasciatus*, both species of which their members had undergone up to three gonotrophic cycles (3- parous).

DISCUSSION

The physiological age of mosquitoes and its implications on the reproduction and disease transmission have been documented by several authors; Gillies (1957); Beklemishev *et al.* (1959); Inyama *et al*. (2003); Cook *et al.* (2007); Roberts (2010); Service (2012); Ndoen *et al.* (2012) and recently by Uttah *et al*. (2013c). However, scanty data exist on the physiological age of *Culex quinquefasiatus* and on the effect of this age on its behaviour.

The present investigation has therefore, provided information on the physiological age of *Culex quinquefasciatus* which is in agreement with the report of Manyi and Imandeh (2008) in showing that apart from *Anopheles gambiae* s.l., *Culex quinquefasciatus* was the oldest species in the study area (3-parous). This is demonstrated by the fact that this mosquito was found throughout the year in the study seasons. This is in agreement with the report of Roberts (2010).

Vector age has been described by Cook *et al.* (2007) as one of the most sensitive parameters that influence the epidemiology of vector-borne diseases. It is a critical determinant of the ability of most arthropod vectors to

Table 1. Age Structure of Dissected Mosquitoes from four study Localities in Makurdi.

Study Locality	Number Dissected	Number Nulliparous (%)	Number Parous (%)	Age Groups (%) 1-parous	2-parous	3-parous
High-Level	1,128	7(0.6)	1,121(99.4)	966(85.6)	151(13.4)	4(0.3)
Wurukum	1,193	65(5.4)	1,128(94.5)	912(76.4)	211(17.7)	5(0.4)
North-Bank	834	208(24.9)	626(75.1)	541(64.9)	85(10.2)	0(0.0)
Wadata	1,165	51(4.4)	1,114(95.6)	1,098(94.2)	14(1.2)	2(0.2)
Total	**4,320**	**331(7.7)**	**3,989 (92.3)**	**3,517 (81.4)**	**461(10.7)**	**11(0.2)**

(a) 1-parous vs Locality: $\chi^2 = 194.3,\ d.f = 3,\ p = 7.815$

(b) 2-parous vs Locality: $\chi^2 = 187.5,\ d.f = 3,\ p = 7.815$

(c) 3-parous vs Locality: $\chi^2 = 1.273,\ d.f = 2,\ p = 5.991$

Table 2. Monthly age Structure of Mosquitoes Dissected from Makurdi During the Study Period.

Month of Study	Number of Mosquitoes dissected	Age groups (%) Nulliparous	1-parous	2-parous	3-parous
Ju1y, 20l1	503	33 (6.6)	425 (84.5)	45 (8.9)	0(0.0)
August, 2011	558	48 (8.6)	445 (79.7)	63 (11.3)	2(0.4)
September, 2011	569	36 (6.3)	456 (80.1)	74 (13.0)	3(0.5)
October, 2011	321	18 (5.6)	273 (85.0)	30 (9.3)	0(0.0)
November, 2011	202	16 (7.9)	162 (80.2)	23 (11.4)	1(0.5)
December, 2011	186	12 (6.4)	154 (83.9)	20 (10.7)	0(0.0)
January, 2012	174	11 (6.3)	147 (84.5)	16 (9.2)	0(0.0)
February, 2012	178	21 (11.8)	132 (74.1)	25 (14.0)	0(0.0)
March, 2012	297	28 (9.4)	251 (84.5)	17 (5.7)	1(0.3)
April, 2012	309	34 (11.0)	259 (83.8)	14 (4.5)	2 (0.6)
May, 2012	510	48 (9.4)	420 (82.3)	42 (8.2)	0(0.0)
June, 2012	513	26 (5.1)	393 (76.6)	92 (17.9)	2 (0.4)
TOTAL	**4,320**	**331(7.7)**	**3,517(81.4)**	**461(10.7)**	**11(0.2)**

transmit a range of human pathogens. Uttah *et al*. (2013) pointed out that the usefulness of determining the physiological age of mosquitoes is an assessment of the effectiveness or otherwise of control measures. In the present study area, no vector control measures have been put in place neither by government nor NGOs, and this is clearly reflected in the vector longevity (3-parous) and abundance recorded in this study.

The age of the mosquitoes as established in this study have indicated that there is great need to initiate strong and long lasting control measures against the mosquito vectors so as to reduce their life span and hence their transmission potential. This was why Mayagaya *et al*. (2009) stated that "determination of physiological age of mosquitoes enables scientists to estimate several epidemiological indices that help for our better understanding of the vector-borne diseases for informed decision-making process".

Results from the present study indicate that there was high rate of parous female mosquitoes during the two wet seasons surveyed in the study area. This translates to high longevity (life span) of female anopheline and culicine mosquitoes in the area during the period of study. This is epidemiologically significant as the infected mosquitoes could be involved in the transmission of malaria and filariasis. The age structure of the mosquitoes

Table 3. Age Structure of the Dissected Mosquitoes from Makurdi in Relation to species and Seasons.

Mosquito species and seasons	Number of mosquitoes Dissected	Number Nulliparous (%)	Number Parous (%)	Age groups (%)		
				1-parous	2-parous	3-parous
Wet Season 1:(July-Oct. 2011)						
Culex quinquefasciatus	985	78(7.9)	907(92.1)	799(81.1)	106(10.8)	2(0.2)
Anopheles gambiae	545	16(2.9)	529(97.1)	467(85.7)	59(10.8)	3(0.5)
Anopheles funestus	362	39(10.8)	323(89.2)	286(79.0)	37(10.2)	0(0.0)
Anopheles (unidentified)	59	2(3.4)	57(96.6)	47(79.7)	10(16.9)	0(0.0)
Wet season 1Total	**1,951**	**135(6.9)**	**1,816(93.1)**	**1,599(81.9)**	**212(10.9)**	**5(0.2)**
Dry Season: (Nov. 2011-March 2012)						
Culex quinquefasciatus	760	66(8.7)	694(91.3)	616(81.0)	77(10.1)	1(0.1)
Anopheles gambiae	148	8(5.4)	140(94.6)	124(83.8)	15(10.1)	1(0.7)
Anopheles funestus	69	11(15.9)	58(84.0)	55(79.7)	3(4.3)	0(0.0)
Anopheles (unidentified)	60	3(5.0)	57(95.0)	51(85.0)	6(10.0)	0(0.0)
Dry season Total	**1,037**	**88(8.5)**	**949(91.5)**	**846(81.6)**	**101(9.7)**	**2(0.2)**
Wet Season 2: (April-June 2012)						
Culex quinquefasciatus	673	64(9.5)	609(90.5)	546(81.1)	62(9.2)	1(0.1)
Anopheles gambiae	347	18(5.2)	329(94.8)	274(79.0)	52(15.0)	3(0.9)
Anopheles funestus	210	19(9.0)	191(90.9)	171(81.4)	20(9.5)	0(0.0)
Anopheles (unidentified)	102	7(6.9)	95(93.1)	81(79.4)	14(13.7)	0(0.0)
Wet season 2 Total	**1,332**	**108(8.1)**	**1,224(91.9)**	**1,072(80.5)**	**148(11.1)**	**4(0.3)**
Total	**4,320**	**331(7.7)**	**3,989(92.3)**	**3517(81.4)**	**461(10.7)**	**11(0.2)**

as reported in the months during which this investigation was carried out were comparable to that reported at Calabar (Uttah *et al*., 2013) where 1-parous females were also most abundant followed by 2-parous. However, unlike in the work of Uttah *et al.* (2013), no 4-parous females were found in this study, 3-parous was the highest age grade but the least in terms of mosquito abundance.

The distribution of the age groups in terms of the sampling months showed that the proportions of 1-parous, 2-parous and 3-parous mosquitoes increased in the wet season months, contrary to the findings of Uttah *et al*. (2013), where the 3-parous females were more abundant during the dry season months than the wet season months.

Previous observations have shown that infection rates are higher in older mosquitoes (6 – 20 gonotrophic cycles) as reported by Gillet (1971) and Service (1993), than among younger mosquitoes. This is because the more the number of gonotrophic cycles, the more the blood meals and development of the *Plasmodium* and *Wuchereria bancrofti* life cycles in the gut of the mosquito (Uttah, 2013). The fact that old females (2-parous and 3-parous) have been recorded in the present study implies that Makurdi would have high sporozoite and microfilarial rates in the mosquito populations.

The 1-3parous age groups as found in the present study had been corroborated to be sufficient for the completion of the extrinsic incubation period for *Plasmodium* species by Ndoen *et al*. (2012). Cook *et al.* (2007) estimated this period to be between 9 – 14 days for *Plasmodium,* depending on temperature; while Chandler and Read (1969) estimated that for microfilarial nematode, it is between 8 – 14 days, also depending on temperature and humidity.

Gillies (1957) earlier reported that the ages of *Anopheles gambiae* and *Anopheles funestus* are dependent upon the availability of the initial blood meal and seasonal variability in weather parameters. The fact that *Anopheles gambiae* was the oldest species in this study (3-parous) suggested suitable temperature, humidity and availability of blood meals for this vector in the study area.

The data obtained in the present study on the age structure of the mosquitoes would now make it possible to evaluate the effectiveness of insecticidal measures employed by the inhabitants and also to establish the time when the mosquito population is at the peak of the transmission period (wet season) as earlier reported by Beklemishev *et al*. (1959). According to O'Connor *et al.*(2009), apart from establishing the total mosquito density, the proportion of likely infective or epidemiologically dangerous mosquitoes at each period of the season (those whose age suggests that they may contain sporozoites or microfilarial in their salivary glands), can also be determined by the age structure of mosquitoes in a given population.

CONCLUSION

The study has revealed that the oldest mosquitoes were those that had completed up to three gonotrophic cycles (three ovipositions). This period has been reported to be enough for both *Plasmodium* species and *Wuchereria bancrofti* to complete their extrinsic incubation period in the mosquito vectors. This implies that the older the mosquitoes, the greater their likelihood of transmitting diseases. This calls for a serious mosquito control interventions in the area to reduce the mosquito longevity and hence their vector potential. It is therefore, recommended that further studies be carried out on the physiological age of mosquitoes as this plays significant roles in the infection rate of mosquitoes. Studies could also be extended to determine the chronological age of the mosquitoes as this would serve as a relative estimate of the vectorial capacity of the mosquitoes and their disease transmission potential in this area.

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