Crepuscular Man-Biting Mosquitoes Of A Tropical Zoological Garden In Enugu, South-Eastern Nigeria

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Citation

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Abstract

Ovitraps and human baits methods were used in sampling crepuscular man-biting mosquitoes of the Zoological Garden Enugu which were studied between February and July 2005. Aedes aegypti, A. albopictus, A. luteocephalus, A. vittatus and A. africanus were among the mosquitoes identified in the Zoo. However, six of the 7 Aedes mosquitoes were members of the Stegomyia subgenus while A. comminsii belonged to the Aedimorphus subgenus. Approximately 6 and 3 out of every nine mosquitoes biting man per hour during the study period were A. albopictus and A. luteocephalus respectively. The other species had less than one mosquito bite per man per hour. Excepting Anopheles gambiae, these are mainly diurnal and outdoor biters, feeding mainly during dusk hours between 4.00 and 8.00pm local time which corresponds to the time many tourists visit the Zoo. Members of the Stegomyia subgenus identified have been implicated in various yellow fever (YF) epidemics in Nigeria. Their preponderance, as well as the presence of the monkey reservoir hosts of YF virus and other Arboviruses, may make this zoological garden uncomfortable for the tourists. Proper care must be taken to ensure that the Zoo environment is not a potential source of epidemics. All water containers should be covered to prevent mosquitoes breeding in them. Discarded vehicle tyre, broken utensils, tin cans, snail and coconut shells must be properly disposed. Intermittent fogging of the Zoo environment with Pyrethrin insecticide may reduce adult mosquito population and thereby fly-man contact.

INTRODUCTION

Mosquitoes are small slender-bodied insects which viciously hunt their hosts, especially man, for blood meals. They have worldwide distribution and are found in both tropics and temperate regions of the world. The mosquitoes breed in a variety of habitats where there is stagnant water including swamps, edges of river, slow flowing streams, tree holes, plant axils, crab holes, broken bamboo stems, tin cans, plastic containers of all sorts, water holding cisterns and tanks, coconut shells, foot prints of animals and man, sand excavation ditches, stone quarry sites, motor vehicle tyre prints, sunlit or shaded quiescent water, scoops in concrete slabs used in feeding animals and cassava fermentation pots (Onyido et al 2006a, b; Service, 1980; Iwuala 1979; Hopkins 1952).

Mosquitoes are regarded as public enemies because of their biting annoyance, noise nuisance, sleeplessness, allergic reactions and disease transmission due to their bites. They transmit human diseases such as malaria, yellow fever, dengue haemorrhagic fever and encephalitis (Onyido et al 2008; Monath, 1985; Gillet, 1972). Mosquitoes also transmit animal diseases like the fowl pox of poultry, myxomatosis of rabbits, Rift-valley fever of sheep, encephalitis of horses and birds, and heart worm diseases of dogs (Soulsby, 1982). All these diseases cause great suffering to man and livestock. They do not only cause high morbidity and mortality in human and animal populations but lead to huge economic loss (Soulsby, 1982; Service, 1980; Gordon and Lavoipierre, 1972).

Zoological gardens are simulated natural ecological habitats for keeping animals in captivity. They form important tourist attraction centers that bring large populations of adults and children together for sight-seeing and recreation. It is pertinent that mosquito populations should be controlled to protect the public and the animals from mosquito-borne diseases and prevent the zoological gardens from being centers for the dissemination of vector-borne infections. Surveillance of mosquito population and their biting activities is therefore a bold step towards providing the baseline information for the control of the mosquitoes and mosquito-borne diseases. This work is aimed at studying the man-biting mosquitoes of Enugu zoological garden with a

view to providing data for their control. Specifically the man-biting species will be identified and their biting activities elucidated.

MATERIALS AND METHODS

Study Area: Enugu is a cosmopolitan city with many tourist attraction centers including the zoological garden harboring many animal species. At Nigerian independence in 1960, it became the capital city of Eastern Nigeria but with the creation of seven states (Enugu, Abia, Imo, Anambra, Cross-River, Bayelsa, Rivers and Akwa-Ibom) from Eastern Nigeria, it presently serves as the capital city of Enugu State. It has a teeming population of about 3 million people comprising youths of various stages and people from various walks of life and professions.

Enugu has many tertiary institutions of higher learning including the Institute of Management and Technology, Enugu State University of Science and Technology, University of Nigeria Enugu Campus, Biggard Memorial Seminary, School of Dental Therapy and Technology, Federal School of statistics, Federal Training School, Our Savior's Institute of Technology, the Nigerian Law School Campus, and Caritas University. It also has many secondary and primary schools. Also found in Enugu are many tertiary and specialist hospitals like University of Nigeria Teaching Hospital, National Orthopaedic Hospital, National Neuropsy–psychiatric hospital and Parklane General Hospital. In Addition there are many health centers, polyclinics and private hospitals, maternities and clinics.

Enugu metropolis also serves as the commercial nerve centre of Enugu State and the administrative headquarters of many National and State institution. It has a branch of the Central Bank of Nigeria, many commercial banks and departmental stores, the famous Ogbette and Aria markets with many lock-up and open stalls. It is the Zonal headquarters of Nigerian Telecommunications, Nigerian Postal Services, Power Holding of Nigeria (formerly, National Electric Power Authority), Project Development Agency, Industrial Training Fund and Federal Secretariat.

Geographically Enugu is located between latitudes 6o and 7o North of Equator and Longitude 7o and 8o East of Greenwich. It has an undulating topography and is situate in the valley of Udi Hills. It has 8 months of (April - October) rainy season and 4 months (November - March) of dry season. It has derived savannah vegetation with tall grasses and few trees. It is located within the transitional zone between the guinea savannah in the north and rain forest belt in the south.

The Zoological Garden is a small strip of Land between Government Reserved Area – a low density area and Abakpa Nike – a high density area (Ikpeze, 2005). It is bounded in the North by Army barracks of the 82 Division, Nigerian Army and in the south by the Air Force Quarters. It is separated from Abakpa Nike by Enugu – Onitsha Express way and bounded by the Government reserved Area in the East. The animals are kept under the simulated natural conditions provided by the forest and giant trees. Common animals in the Zoo include lions, elephants, chimps, snake, crocodiles, antelopes and birds such as peacocks. People from all walks of life come in with their families to watch the animals.

Collection of mosquito eggs using ovitraps: Locally modified American Centre for Diseases Control (CDC) ovitraps were used for the collection of Aedes mosquito eggs in the zoological garden. Each ovitrap consisted of a black plastic cup of about a litre volume, half-filled with water and lined internally with a strip of white calico cloth measuring 2cm in width and a length equal to the internal perimeter of the cup. The traps were then placed strategically at various points in the zoological garden. The traps were left for 48 hours before collection. Twenty traps were placed in each occasion once a month for 6 months. After collection the white Calico strips were examined for mosquito eggs and the positive strips separated from non-positive ones and sent to the laboratory for hatching and rearing to adult for easy identification.

Collection of Adult Mosquitoes: Man-biting adult mosquitoes were collected using human bait method. The collections were done at monthly intervals. Each collection was between 1700 and 2000 hrs (5.00 to 8.00 pm local time). On each occasion four volunteers were used for the collection. Each volunteer wore out the shoes, sat on a low stool with the shirt sleeves and pairs of trousers rolled to the elbows and knees respectively to expose their extremities for mosquito bites. With the aid of torchlight and vials (test tubes), mosquitoes alighting to bite man were collected and stoppered with a ball of cotton wool. The time of collection was recorded and placed in the vial. All the mosquitoes collected were grouped into quarter-hourly collections, properly labeled, packed in a separate polythene bags and taken to the laboratory of the National Arbovirus and Vectors Research Centre at 33 Park Avenue, GRA, Enugu, for identification and processing.

Identification of mosquitoes: The mosquitoes were separated into Anopheles and Culicine groups using the length of the palps, antennae, spotted wings and speckled legs. The Culicine group was separated into Aedes and Culex mosquitoes, using presence of dark and white silvery patterns on the thorax and abdomen for Aedes, and pale brown coloration without any visible ornamentation for Culex. Individual species were then identified using the Keys of Service (1980), Gillet (1972) and Hopkins (1952).

Calculation of biting rates: At the end of the study, the biting rates of individual mosquitoes were calculated as follows:

Biting rate = Total number of individual mosquitoes collected divided by the number of man hours used in collection

Man hours = The product of the number of volunteer workers employed and the number of hours used in catching the mosquitoes.

Ethical Considerations: All volunteer workers were first educated on the nature of the work to be done. They were then given yellow fever vaccines at least 10 days before commencement of the work. They were also given adequate training on how best to collect the mosquitoes to prevent infection. Also during the studies all health matters of the volunteers were taken care of properly.

RESULTS

The result of Aedes mosquito eggs collected with ovitraps from February to July 2005 is summarized in Table 1. A total of 118traps were set between February and July; 56 out of the 118 traps were positive and these yielded 2120 Aedes mosquito eggs. No trap was positive in February while only 5 (20%) of the total traps set in March were positive and yielded only 57 mosquito eggs. From April to July, between 50% and 80% of the traps set were positive and these yielded an average of 40 to 50 eggs per positive paddle.

Table 2 shows the mosquitoes identified from the eggs collected. Five Aedes species were identified; A. aegypti constituting the bulk with 758 mosquitoes (65%). This was followed by A. albopictus 235 (20.3%). Others were A. luteocephalus 83 (7.1%), A. vittatus 45 (3.9%), and A. africanus 43 (3.7%). Out of 2120 mosquito eggs, 1160 hatched out and were identified into species.

Table 3 shows the number of different species of mosquitoes collected in each month with human bait method. A total of 1112 mosquitoes consisting of 14 species were collected of which seven species were Aedes. Two species of Culex, Eretmapodites and Anopheles respectively, were collected. Other mosquitoes collected were only one species each. From the species totals, A. albopictus formed the bulk of the collection with 681 mosquitoes (61.4% of the total collection). A .luteocephalus followed with 312 mosquitoes (26.06% of the total collection). Other species were between one and thirty mosquitoes each.

From the monthly totals, the highest number of mosquitoes was collected between April and June. The collections in June topped the list with 328 mosquitoes (29.49%). Except in April when only three mosquitoes species were collected, between six and eight species were collected each month from May to September. From the biting rates, a total of 9.5 mosquitoes bit each worker every hour (i.e. 9.5 mosquitoes per man per hour). Approximately 6 out of every nine mosquitoes that bit man per hour were A. albopictus, while approximately 3 out of 9 mosquitoes biting man per hour were A. luteocephalus. Other species had less than one mosquito bite per man per hour.

Biting Habits of the Mosquitoes: Mosquitoes started landing on the human volunteers within five minutes of sitting down to work. However intense and localized mosquito bites were experienced behind a private clinic bordering with the Zoo garden. Most of the mosquitoes were identified to be Aedes albopictus. This area yielded more mosquitoes than any other place selected for mosquito collection in the Zoo.

Figure 1 shows a graph of quarter-hourly collections of different man-biting mosquito species from the Zoo. The plots of three most abundant species, A. albopictus, A. luteocephalus and A. aegypti, were matched against the plot of all the mosquitoes collected. A. albopictus started landing on the volunteer workers almost immediately they settled to work between 4.45pm and 5.00pm. It continued to bite until about 6.00 to 6.15pm when the numbers dropped gradually till the end of the study period. The graph trailed closely to the overall mosquito graph until between 6.00 - 6.15pm, suggesting that it constituted a high percentage of the mosquitoes biting in the first hour of the study. A. luteocephalus which was initially collected in small numbers sharply rose to an all high peak of about 140 mosquitoes between 7.00 and 7.15pm and dropped sharply to virtually zero by 7.30pm, indicating that most mosquito bites between 6.30 and 7.30pm were from A. luteocephalus. Aedes aegypti collections were steady but consistently low throughout the collection period.

Figure 1

Table 1: mosquito eggs collected with ovitraps from February to July 2005

Month	No of ovitraps set	No. of ovitraps +ve	No. of ovitraps -ve	No. of eggs collected	No of larvae hatched out
February	20	0	20	0	0
March	20	5	15	57	37
April	20	10	8	667	394
May	20	16	4	431	232
June	18	10	8	360	191
July	20	15	5	605	306
Total	**118**	**56**	**60**	**2120**	**1160 (84.72%)**

Figure 2

Table 2: mosquitoes identified from the eggs collected with ovitraps

Mosquito species	No. identified	%
Aedes aegypti	754	65.0
Aedes albopictus	235	20.3
Aedes luteocephalus	83	7.1
Aedes vittatus	45	3.9
Aedes africanus	43	3.7
Total	**1160**	**100**

Figure 3

Table 3: Different Man-biting mosquito species collected from Enugu Zoological Garden from February to October 2005

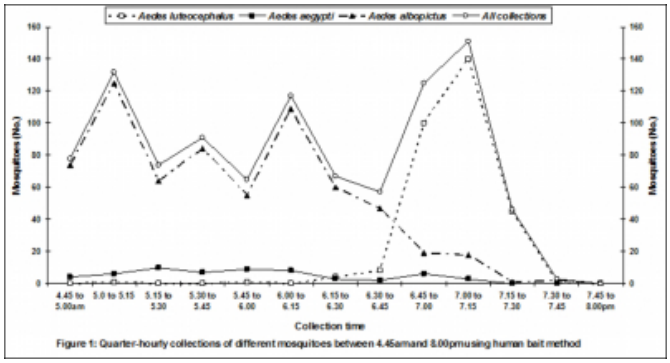
Mosquito species	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total	%	Mean biting rates
A. aegypti	0	5	11	6	8	2	2	3	8	45	4.05	0.38
A. albopictus	1	88	139	144	203	48	21	15	22	681	61.24	5.68
A. luteocephalus	0	49	32	102	88	12	5	21	3	312	28.06	2.6
A. africanus	0	0	0	1	1	3	0	5	0	10	0.90	0.33
A. cumminsii	0	0	0	0	0	0	1	1	0	2	0.18	0.02
A. vittatus	0	0	0	0	4	0	2	0	0	6	0.54	0.05
A. circumluteolus	0	0	0	0	1	0	0	0	0	1	0.09	0.008
A. gambiae	0	0	0	2	0	0	0	0	0	2	0.18	0.02
A. coustani	1	0	0	0	0	0	0	0	0	1	0.09	0.008
C. quinquefasciatus	3	1	0	5	9	2	2	0	0	22	1.98	0.18
C. annulioris	0	0	0	0	14	2	0	0	0	16	1.43	0.13
E. chrysogaster	0	0	0	0	0	0	7	0	1	8	0.72	0.07
E. quinquevittatus	0	0	0	2	0	0	0	2	0	4	0.36	0.03
M. africana	1	0	0	0	0	0	1	0	0	2	0.18	0.02
Total	**6**	**143**	**182**	**262**	**328**	**69**	**41**	**47**	**34**	**1112**	**100**	**9.526**
Percentage	**0.54**	**12.86**	**16.37**	**23.56**	**29.49**	**6.20**	**3.69**	**4.23**	**3.06**	**100**		

Field Observation: Enugu Zoo has a natural setting for animals. Tall forest trees with large canopies provided shelter for animals. In addition, some parts of the Zoo were not properly kept and as a result have become bushy thereby providing hiding places for rodents and other small animals including reptiles. Zoo-attendants were housed about half-a kilometer from the Zoo under the same simulated zoo condition.

DISCUSSION

Most of the collections from the ovitraps were between April and July; no eggs were collected in the month of February. This could be due to harsh dry season weather prevalent at the time (Iloeje, 2001) and because most mosquitoes especially the Aedes group survive adverse weather conditions as eggs (Service, 1980), there may not be adults to lay their eggs in the ovitraps. The relatively small number of eggs collected in March could be as a result of the hatching out of few eggs from those surviving the harsh hot weather conditions after the first rains. Eggs of Aedes mosquitoes are known to hatch out in small batches as an adaptive strategy for surviving unfavourable environmental conditions (Chandler and Read, 1961). The collection of a large number of eggs, 2063 (97.3%) between April and July signifies the arrival of favourable weather conditions for the breeding of these mosquitoes. Also the large number of eggs collected within this period indicated intensive breeding of mosquitoes especially the Aedes mosquitoes within the zoological garden during the rainy season.

Figure 4



Out of the 14 species of mosquito collected with human bait method, 7 were Aedes mosquitoes, of which six species were members of the Stegomyia subgenus while one, specifically A. cumminsii belonged to the Aedimorphus subgenus. All the six members of the Stegomyia subgenus have been implicated in various yellow fever epidemics in Nigeria (Onyido et al 2006 a and b; Bang et al 1981 and 1980; Fagbani et al 1975; Lee et al 1974; Service, 1974; Lee and Moore, 1972; Savage et al 1972). In addition to yellow fever transmission other mosquito species collected are proven vectors of other insect-borne infections responsible for high morbidity and mortality in human and livestock populations (Onyido et al 2008). Anopheles gambiae is regarded as the most efficient malaria vector throughout the world (Gordon and Lavoipierre, 1972), while A. coustani is of local importance in malaria transmission (Gillet, 1972). Culex quinquefasciatus transmits the filarial worm, Wuchereria bancrofti to man of which heavy infection leads to elephantiasis (Service, 1980). Eretmapodites chrysogaster transmits both Rift Valley virus and Yellow Fever Virus in East Africa (Gillet, 1972). Several species of Mansonia especially M. africana and M. uniformis are proven arbovirus vectors in Africa (Service, 1980) and filarial worms (Gillet, 1972). A. cumminsii transmits Spondweni virus in East Africa (Gillet, 1972).

With the exception of the Anopheles group which are mainly

indoor nocturnal feeders others are mainly diurnal and outdoor biters feeding mainly during dusk hours usually between 4.00 to 8.00pm local time. They also bite under tree shades. This corresponds to the time when many tourists visit the Zoo for sight-seeing and recreation. The preponderance of these man-biting mosquitoes especially A. aegypti, A. luteocephalus and A. albopictus and the monkey reservoir hosts of Yellow Fever virus and other Arboviruses may make the zoological garden uncomfortable for the tourists. The implication of these results is that tourists visiting the zoological garden should do so before dusk hours and also should not rest long under the tree canopies to avoid being bitten by these mosquitoes. This may sound reasonable but fairly impracticable. It therefore calls for proper care of the Zoo environment so as not to become potential source of epidemics. This can be done by ensuring that all water containers are covered to prevent mosquitoes breeding in them. Also discarded motor vehicle tyres, broken utensils, tin cans, snail and coconut shells are properly disposed. Where possible, fogging the Zoo environment with Pyrethrin insecticide should be done at intervals to reduce the population of adult mosquitoes and thereby fly-man contact.

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