International Journal of Mosquito Research

ISSN: **2348-5906**
CODEN: **IJMRK2**
IJMR 2019; 6(2): 19-23

Received: 09-01-2019
Accepted: 13-02-2019

Rock Aïkpon
1. Centre de Recherche Entomologique de Cotonou (CREC), 06 BP 2604 Cotonou, Bénin
2. Ecole normale Supérieure de Natitingou ; Université Nationale des Sciences, Technologies, Ingénierie et de Mathématiques (UNSTIM), Bénin
3. GLOBE Zika Project, Benin

Gado Dramane
Ecole normale Supérieure de Natitingou ; Université Nationale des Sciences, Technologies, Ingénierie et de Mathématiques (UNSTIM), Bénin

Jean Robert Klotoé
Ecole normale Supérieure de Natitingou ; Université Nationale des Sciences, Technologies, Ingénierie et de Mathématiques (UNSTIM), Bénin

Mark Brettenny
GLOBE Zika Project, Benin

Yllias Lawani
GLOBE Zika Project, Benin

Gorgias Aïkpon
Faculté des Sciences Agronomiques ; Université d'Abomey-Calavi, Bénin

Anges Yadouléton
(1). Centre de Recherche Entomologique de Cotonou (CREC), 06 BP 2604 Cotonou, Bénin
(2). Ecole normale Supérieure de Natitingou ; Université Nationale des Sciences, Technologies, Ingénierie et de Mathématiques (UNSTIM), Bénin

Correspondence
Rock Aïkpon
1. Centre de Recherche Entomologique de Cotonou (CREC), 06 BP 2604 Cotonou, Bénin
2. Ecole normale Supérieure de Natitingou ; Université Nationale des Sciences, Technologies, Ingénierie et de Mathématiques (UNSTIM), Bénin
3. GLOBE Zika Project, Benin

Assessment of population dynamics and biting trends of *Aedes aegypti* in northern Benin: Public health implications

Rock Aïkpon, Gado Dramane, Jean Robert Klotoé, Mark Brettenny, Yllias Lawani, Gorgias Aïkpon and Anges Yadouléton

Abstract
Aedes aegypti represents a major vector of arboviruses, which include Zika viruses, dengue, chikungunya, yellow fever among others. Presence and abundance of this vector is associated with the risk of arboviral diseases transmission. Little is known about biting behaviour of *Aedes* mosquitoes in Benin. This study aimed to assess population dynamics and biting trends of *Aedes aegypti* mosquito in northern Benin. Abundance and biting cycle of *Aedes aegypti* were determined indoors *Vs* outdoors through monthly human landing catches.
A total of 485 adult *Aedes aegypti* mosquitoes were collected. The probability of exposure to *Aedes aegypti* bites was highest outdoors and in afternoon hours. This is enormous risk factors for potentiel outbreaks of arboviral diseases.
Findings of our study serve valuable informations about potentiel threat of the emergence of arboviral diseases in northen Benin. Therefore, it will be important to implement urgently vector control strategies to fight against *Aedes* mosquitoes in order to prevent any occurrence of arbovirus.

Keywords: *Aedes aegypti*, population dynamics, biting, Benin

Introduction
Aedes aegypti represents a major vector of arboviruses, which include Zika viruses, dengue, chikungunya and yellow fever [1-4]. These mosquito-borne viral diseases have emerged or re-emerged in several countries in the world during the past decades [5-8].
This vector was formerly found in sub-Saharan African where it originated [9], but has now spread to over continents through trade spread to other continents through trade and currently is distributed world wide through man-made activities [10, 11]. Known as a tree-hole mosquito, its larvae breed in human made containers [10]. Therefore, habit of people of adding water to containers, which can be for drinking, bathing (Storage) and other purposes could play a role in the production and maintenance of vector population and its abondance. Moreover, several environmental factors such as weather variables may play a important role in the transmission of arboviruses [12, 13]. For instance, rainfall, relative humidity and temperature can influence the incidence of dengue fever by affecting mosquito abundance and behaviour [14].
Presence of *Aedes aegypti* is associated with the potentiel risk for the occurrence or unexpected arrival of the arboviruses diseases. Transmission of arboviruses by *Ae. Aegypti* occurs in many African countries. In fact, the re-emergence of dengue fever has been observed in Cameroon [15], in Senegal [16], in Mauritius [17] and even, now and then in neighboring Benin countries. Nevertheless, few cases of arbovirus transmission have been reported in Benin. For instance, the last outbreak of yellow fever has historically been reported in the department of Atacora in the north east region of Benin since 1996. The area affected is Kerou district where 48 cases and 37 deaths have been recorded. This out break has been followed by immediate vaccination of the exposed population. However, the presence of the vector remains a potential threat to the occurrence of arboviruses in Benin.
In order to implement sustainable *Ae aegypti* control measures to prevent any occurrence of arbovirus in northen Benin, this study aimed to document the daytime activity, especially biting habits, of *Aedes aegypti* mosquitoes and provide recommendations on future

management of associated public health risks. Therefore we present here the current distribution and the prevalence as well as the biting behaviors of *Ae aegypti* in the study.

Matériels and Methods

Study area

The study was carried out in Atacora region located in the Northwest of Benin and includes three districts: Kouandé, Natitingou and Toukountouna (Figure 1). Those districts covered about 6,384 km2 and had an estimated population of 326,868 in 2015. Atacora region has a sub-equatorial type climate with one dry season (December-May) and only one rainy season (June to November). The annual mean rainfall is 1,300 mm and the mean monthly temperature ranges between 22° and 34 °C. The main economic activity is agriculture and it is characterized by the production of cotton and millet where various classes of pesticides are used for pest control. This area is caracterized the weak level of urbanization.

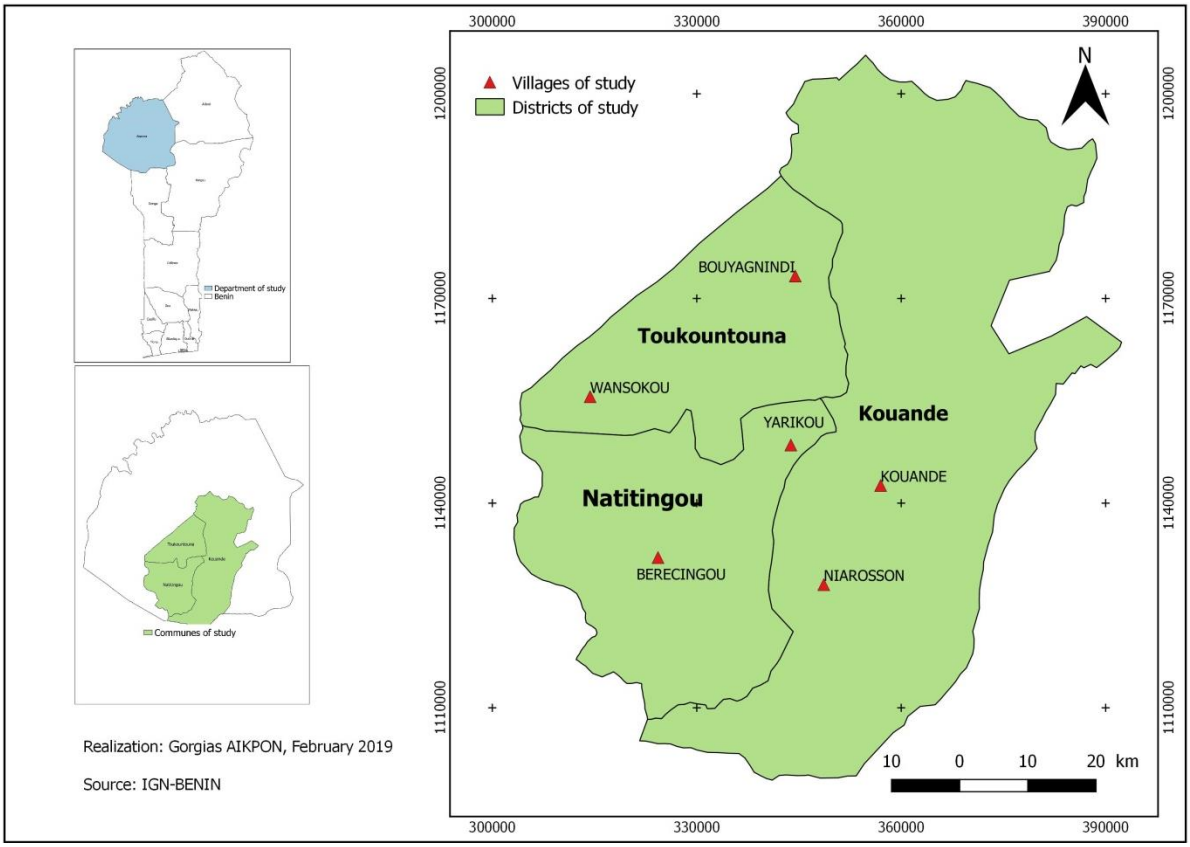

Fig 1: Map of study areas

Human landing catches (HLC)

Adult *Ae. Aegypti* mosquitoes were collected using human baits between 3pm-8pm, and 6am-12am during the study periods. In each district, two villages were selected, and two houses were chosen per village for mosquito collection. Monthly, mosquito collections were carried inside and outside houses using a mouth aspirator, by human volunteers (adults ≥ 18 years old) who resid within the sampling area and who had previously given consent. They were all trained before they started the catching of moquitoes. Two nights of mosquito collections a month were carried. In each village, mosquitoes were sampled indoors and outdoors (3-5 meters from the house). « Outdoors » describes any place outside the doors of the house selected for sampling, round and about it but within the homestead. « Indoors » describes the space within the door (s) of the selected house. To collect mosquitoes, the lower legs of the collectors were exposed such that when the perched to take blood meal the mosquitoes were collected using test tubes. The opening of the tube was plugged with cotton wool to prevent escape of the mosquito. Collections were recorded at intervals of 1 hour to gather more information on vector biting activities. Sampling was conducted in 2018 from January to December, from 3 pm to 8 pm in the afternoon and then from 6 am to 12 am in the morning.

All mosquitoes were transported to the laboratory, and identified on chill tables according to species using morphological characteristics [18, 19].

Data analysis

The human biting rate (HBR) which is the number of mosquitoes biting a person during a given time period (bites/p/t) (time being night, month or year), was calculated monthly. Comparisons of HBR was made by the Chi-square test between indoor and outdoor.

Results

Species composition of genus *Aedes* mosquito

As shown in figure 2, in total 485 mosquitoes were caught in the landing catches during the study period. These mosquitoes belonged to six species that are *Aedes aegypti, Aedes Vitatus, Aedes luteocephalus, Aedes longipalpis, Aedes gr. palpalis and Aedes gr. tarsalis.* The two most abundant species collected were *Aedes aegypti and Aedes vitatus* with respectively 55,46% and 20,82% of the total collected.

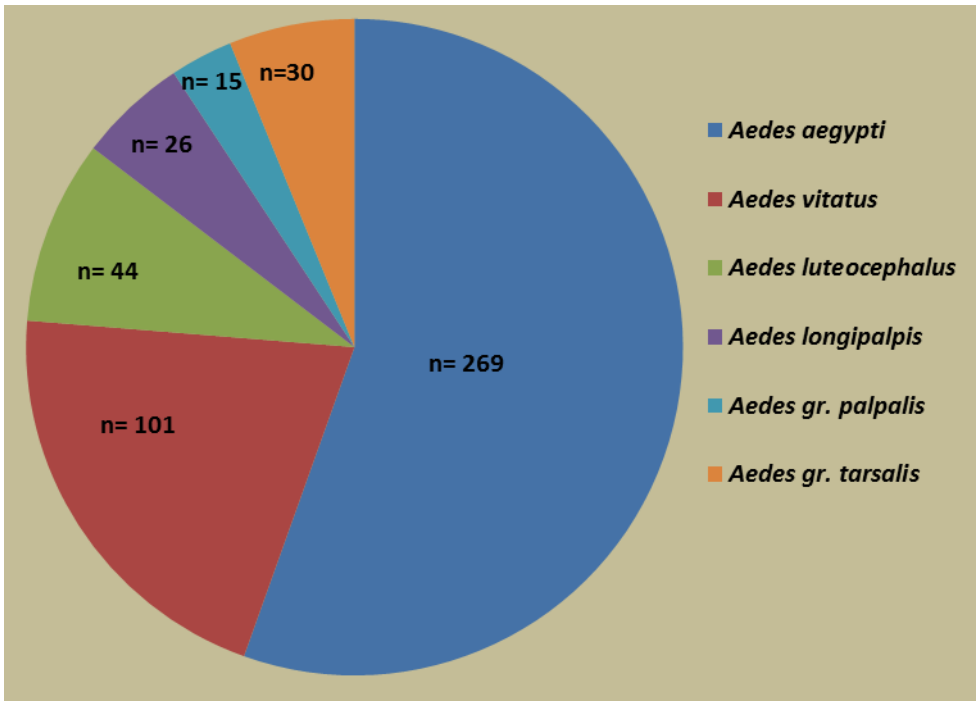

Fig 2: The numbers of adult *Aedes* species collected on human bait in study area from January to December 2018.

Hourly activity of *Aedes aegypti* mosquito in the study area

Aedes aegypti is known to bite diurnally. The number of *Aedes aegypti* mosquitoes collected varied among the hours. The chances of finding *Aedes aegypti* mosquitoes by HLC is higher in the afternoon hours with a major peak between 5pm and 6pm and in the morning hours with a second peak between 8am and 9am.

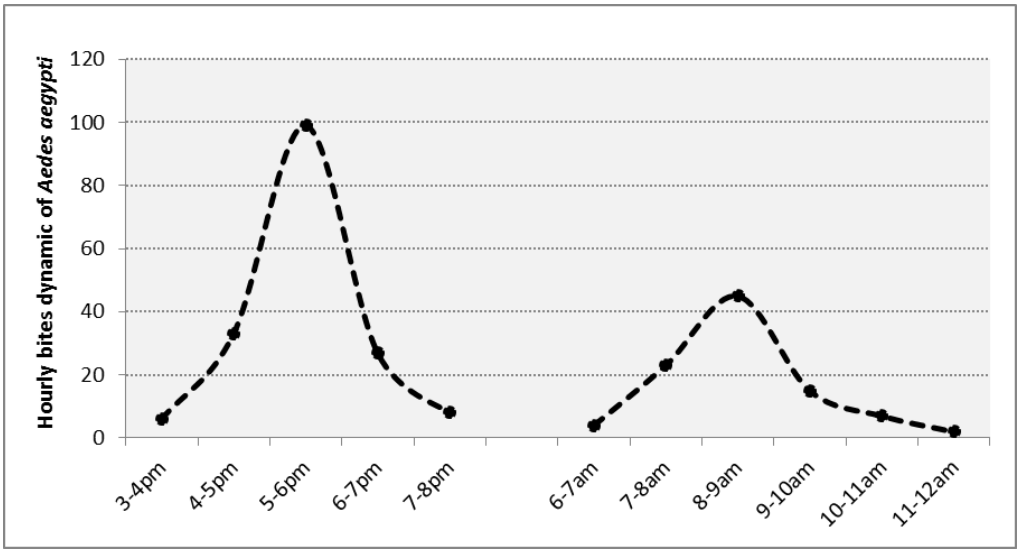

Fig 3: Day biting cycle of *Aedes aegypti* Mosquito in the study area

***Aedes aegypti* abondance and indoor/outdoor density**

The figure 4 shows a dynamics of Human Biting Rate (expressed in number of bite /person/ day) indoor *Vs* outdoor in the sudy areas. We noticed the presence of *Aedes aegypti* throughout the year. However, the monthly HBR was high during the rainy season (May to October) with a peak on July where each person received about 1.44 bites/day indoor against 1.75bites/day outdoor. In addition, the biting rate remains significantly higher outdoor during all the months of the year.

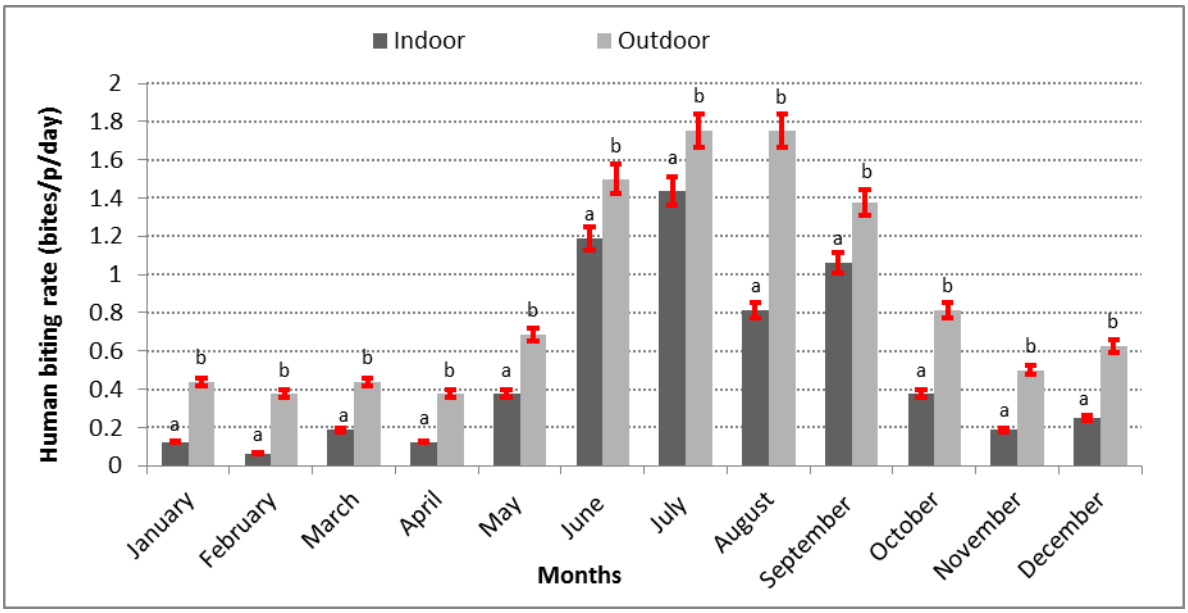

Fig 4: Dynamic Oh Hmana biting rate indoor *Vs* outdoor.

4. Discussion

This study assessed the population dynamics and biting trends of *Aedes aegypti* in northern Benin and is to our knowledge, the first documenting the day biting mosquito activity in Benin. This information on biting habits of mosquitoes active during the day in Benin, especially vector species, is primary step forward in assessing the local risks of mosquito-borne diseases.

The findings showed that *Aedes aegypti* was present all year round in the study area that may pose a potentiel risk of transmitting pathogens. *Aedes aegypti* is the most abundant species collected and is the species of greatest concern given its role in the transmission of dengue, chikungunya, and Zika viruses.The funding that more *Aedes aegypti* adult mosquitoes were abondant in this areas is consistent with the adaptation of this species to the domestic environment as its abundance is positively correlated with increasing urbanization [10, 20-23]. The fact that Africa's urbanization is occuring with far less infrastructural development, notably unreliable water and disposal of solid container wastes, suggest that the spread of *Aedes aegypti* may be greatly enhanced in future years [24].

The collection of more *Aedes aegypti* adult mosquitoes outdoors than indoors during the whole year is consistent with other studies in Kenya [25, 26], in Trinidad [27], in Malaysia [28, 29] and in Brazil [30]. Moreover, significantly more *Aedes aegypti* mosquitoes were collected in the afternoon than morning hours indicating the possibility that most of the human-vector contact is occurring in the afternoon hours. This finding is consistent with the experimental results by Gouck and Smith [31] but in contrast to the findings by Strauss and others [32] who found no significant difference in the number of *Aedes aegypti* mosquitoes that fed at different times of the day.

Findings of our study give credence to the potential public health threats posed by *Aedes aegypti* mosquitoes in Benin and provide baseline informations as far as its distribution and biting behaviour are concerned in the north of the country.

This study had some limitations. For instance, this study did not collect additional data about surrounding vegetation, presence of open containers, and site-specific temperatures which would have allowed for a more robust analysis of the determinants of variation in mosquito abundance across the study areas. In addition, it would be desirable to include in this study the assessment of the characteristics and distribution of larval breeding sites of *Aedes* mosquitoes in the study area.

5. Conclusion

This study documented for the first time the distribution and the biting trends of *Aedes aegypti* in the north of Benin. Most of the *Aedes aegyti* adult mosquitoes were colleted outdoors and in the afternoon hours. This is enormous risk factors and had major implications for potentiel outbreaks of arboviral diseases. Thus, it will be important to implement urgently vector control strategies to fight against *Aedes* mosquitoes in order to prevent emergence of arboviral diseases such as Zika, dengue, yellow ferver among others.

6. Acknowledgment

The authors of this manuscript thank the Director of the Ecole Normale Supérieure de Natitingou for funding this research work. We are grateful to Zika GLOBE Project for the technical assistance.

Competing interests

The authors declare that they have no competing interests.

Ethical consideration and consent to participate

Ethical approval for this study was granted by the Ethical Committee of Centre de Recherche Entomologique de Cotonou. The mosquito collectors gave prior verbal consent and they were vaccinated against yellow fever.

Authors' contributions

RA, GD, JRK, MB, YL, GA and AY designed the study. RA, GA and JKR carried out the field activities. RA drafted the manuscript and analyzed the data. AY and RA critically revised the manuscript. RA and MB conceived and designed the study and GD revised the manuscript for intellectual content. All authors read and approved the final manuscript.

7. References

1. Thonnon J, Fontenille D, Tall A, Diallo M, Renaudineau Y, Baudez B *et al.* Re-emergence of Yellow Fever in Senegal in 1995. Am J Trop Med Hyg. 1998; 59(1):108-114.
2. Farraudière L, Sonor F, Crico S, Etienne M, Mousson L, Hamel R *et al.* First detection of dengue and chikungunya viruses in natural populations of *Aedes aegypti* in Martinique during the 2013-2015 concomitant outbreak. Rev Panam Salud Publica. 2017; 41(e63).
3. Cigarroa-Toledo N, Blitvich B, Cetina-Trejo R, Talavera-Aguilar L, Baak-Baak C, Torres-Chablé O *et al.* Chikungunya virus in febrile humans and *Aedes aegypti* mosquitoes, Yucatan, Mexico. Emerg Infect Dis. 2016; 22(10).
4. Ferreira-de-Brito A, Ribeiro I, de Miranda R, Fernandes R, Campos S, da Silva K *et al*. First detection of natural infection of Aedes aegypti with Zika virus in Brazil and throughout South America. Mem Inst Oswaldo Cruz, Rio de Janeiro. 2016; 111(10):655-658.
5. Hennessey M, Fischer M, Staples JE. Zika Virus Spreads to New Areas-Region of the Americas, May 2015-January 2016. MMWR Morb Mortal Wkly Rep. 2016; 65(3):55-58.
6. Leroy EM, Nkoghe D, Ollomo B, Nze-Nkogue C, Becquart P, Grard G *et al*. Concurrent chikungunya and dengue virus infections during simultaneous outbreaks, Gabon, 2007. Emerg Infect Dis. 2009; 15(4):591-593.
7. Bhatt S, Gething PW, Brady OJ, Messina JP, Farlow AW, Moyes CL *et al.* The global distribution and burden of dengue. Nature. 2013; 496(7446):504-507.
8. Nsoesie EO, Kraemer MU, Golding N, Pigott DM, Brady OJ, Moyes CL *et al*. Global distribution and environmental suitability for chikungunya virus, 1952 to 2015. Euro Surveill. 2016; 21(20).
9. Moore M, Sylla M, Goss L, Burugu M, Sang R, Kamau L *et al*. Dual African origins of global *Aedes aegypti s.l.* populations revealed by mitochondrial DNA. PLoS Negl Trop Dis. 2013; 7(4).
10. Powell J, Tabachnick W. History of domestication and spread of Aedes aegypti- A Review. Mem Inst Oswaldo Cruz, Rio de Janeiro. 2013; 108(Suppl. I):11-17.
11. Kraemer M, Sinka M, Duda K, Mylne A, Shearer F, Barker C *et al*. The global distribution of the arbovirus vectors Aedes aegypti and Ae. albopictus. Ecol Epid Glob Health, 2015.
12. Bi P, Zhang Y, Parton KA. Weather variables and Japanese encephalitis in the metropolitan area of Jinan city, China. Journal of Infection. 2007; 55:551-556.
13. Wongkoon S, Jaroensutasinee M, Jaroensutasinee K. Distribution, seasonal variation & dengue transmission prediction in Sisaket, Thailand. Indian Journal of Medical Research. 2013; 138:347-353.
14. Thammapalo S, Chongsuwiwatwong V, McNeil D, Geater A. The climatic factors influencing the occurrence of dengue hemorrhagic fever in Thailand. Asian Journal of Tropical Medecine and Public Health. 2005; 36:191-196.
15. Peyrefitte CN, Rousset D, Pastorino BA, Pouillot R, Bessaud M, Tock F *et al*. Chikungunya virus, Cameroon, 2006. Emergence of Infectious Diseases. 2007; 13:768-771.
16. Sylla M, Bosio C, Urdaneta-Marquez L, Ndiaye M, Black WCt. Gene flow, subspecies composition, and dengue virus-2 susceptibility among Aedes aegypti collections in Senegal. PLoS Neglected Tropical Disease. 2009; 3:e408.
17. Issack MI, Pursem VN, Barkham TM, Ng LC, Inoue M, Manraj SS. Reemergence of dengue in Mauritius. Emergence Infectious Diseases. 2010; 16:716-718.
18. Edwards FW. Mosquitoes of the Ethiopian Region. III. Culicine Adults and Pupae. London, UK. British Museum (Natural History), 1941.
19. Rueda LM. Pictorial Keys for the Identification of Mosquitoes (Diptera:Culicidae) Associated with Dengue Virus Transmission. USA: Magnolia Press, 2004
20. Higa Y. Dengue vectors and their spatial distribution. Trop Med Health 2011; 39(4):17-27.
21. Saifur R, Dieng H, Hassan A, Salmah M, Satho T, Miake F *et al*. Changing domesticity of Aedes aegypti in northern peninsular Malaysia: Reproductive consequences and potential epidemiological implications. PLoS ONE. 2012; 7(2).
22. Leisnham P, LaDeau S, Juliano S. Spatial and temporal habitat segregation of mosquitoes in urban Florida. PLoS ONE. 2014; 9(3).
23. Hertz J, Lyaruu L, Ooi E, Mosha F, Crump J. Distribution of Aedes mosquitoes in the Kilimanjaro Region of northern Tanzania. Pathog Glob Health 2016; 110(3):108-112.
24. Freire M, Lall S, Leipziger D. Africa's urbanization: Challenges and opportunities, Working Paper No. 7. Washington DC: The Growth Dialogue, 2014,7
25. Yalwala S, Clark J, Oullo D, Ngonga D, Abuom D, Wanja E *et al*. Comparative efficacy of existing surveillance tools for *Aedes aegypti* in Western Kenya. J Vect Ecol. 2015; 40(2):301-307.
26. Lutomiah J, Barrera R, Makio A, Mutisya J, Koka H, Owaka S *et al*. Dengue outbreak in Mombasa City, Kenya, 2013-2014: Entomologic Investigations. PLoS Negl Trop Dis. 2016; 10(10).
27. Chadee D, Martinez R. Landing periodicity of Aedes aegypti with implications for dengue transmission in Trinidad, West Indies. J Vect Ecol. 2000; 25(2):158-163.
28. Hertz J, Lyaruu L, Ooi E, Mosha F, Crump J. Distribution of Aedes mosquitoes in the Kilimanjaro Region of northern Tanzania. Pathog Glob Health. 2016; 110(3):108-112.
29. Wan-Norafikah O, Nazni W, Noramiza S, Shafa'ar-Ko'ohar S, Heah S, Nor-Azlina A *et al*. Distribution of Aedes mosquitoes in three selected localities in Malaysia. Sains Malaysiana. 2012; 41(10):1309-1313.
30. Fàvaro E, Dibo M, Mondini A, Ferreira A, Barbosa A, Eiras A *et al*. Physiological state of Aedes (Stegomyia) aegypti mosquitoes captured with MosquiTRAPstm in Mirassol, São Paulo, Brazil. J Vect Ecol. 2006; 31(2):285-291.
31. Gouck H, Smith C. The effect of age and time of day on the avidity of *Aedes aegypti*. Florida Entomol. 1962; 45(2):93-94.
32. Strauss W, Maibach H, Khan A, Pearson T. Observations on biting behavior of Aedes aegypti (L.). Mosquito News. 1965; 25(3):272-276.