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Asian Pacific Journal of Tropical Biomedicine

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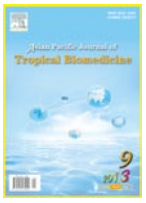

Document heading doi: 10.1016/S2221-1691(13)60137-9

Larval habitats of mosquito fauna in Osogbo metropolis, Southwestern Nigeria

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PEER REVIEW

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Comments

The manuscript is of good quality which would be of great interest to those involved in the epidemiology and control of mosquito-borne diseases. The manuscript is well articulated and provided reproducible methodology for future research in any parts of the world. The study would be a reference point for future surveillance and control of mosquito borne diseases in the metropolis. It has significant contribution to knowledge and disease control.

Details on Page 676

ABSTRACT

Objective: To determine the larval habitats of mosquito fauna and possible impact of land use/ land cover changes on the epidemiology of mosquito-borne diseases in Osogbo metropolis, Southwestern, Nigeria.

Methods: All accessible larval habitats were surveyed between May and September, 2011 in Osogbo metropolis while Land Use/ Land cover of the city was analyzed using 2 Lansat Multispectral Scanner satellite imagery of SPOT 1986 and LANDSAT TM 2009.

Results: A total of six species namely, *Aedes aegypti*, *Aedes albopictus*, *Aedes vittatus*, *Anopheles gambiae* complex, *Culex quinquefasciatus* and *Eretmapodite chrysogaster* were encountered during the study. The occurrence and contribution of disused tyres was significantly higher ($P<0.05$) than the other habitats encountered, while there were no significant differences in the contribution of gutters/run-offs, septic tanks/ drums, ground pools/open drains and discarded containers to the breeding of mosquitoes ($P>0.05$). The accessible land use/ land covered of the study area between 1986 and 2009 showed that the wet land coverage and settlement area increased from 0.19 to 9.09 hectare and 1.00 to 2.01 hectare respectively while the forest area decreased from 60.18 to 50.14 hectare.

Conclusion: The contribution of the habitats coupled with the increasing rate of flooded environment which could provide ample breeding sites for mosquitoes call for sustained environmental sanitation and management in Osogbo metropolis.

KEYWORDS

Larval habitats, Mosquitoes, Land use/ land cover, Nigeria

1. Introduction

Mosquitoes are of public health importance as they constitute serious biting nuisance and transmit most deadly and life-threatening diseases such as malaria, dengue fever, yellow fever and bancroftian filariasis[1-6]. The brunt of these diseases is mostly felt in Africa due to the poor socio-economic conditions and large expanse of the aquatic habitats which provide conducive breeding sites for the mosquitoes[7,8]. The insects have defied several

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Foundation Project: This work was supported by the Management of Osun State University, Osogbo, Nigeria (Grant No. UNIOSUN/SET 11/ 004)

Article history:
Received 20 Jun 2013
Received in revised form 28 Jun, 2nd revised form 5 Jul, 3rd revised form 12 Jul 2013
Accepted 16 Aug 2013
Available online 28 Sep 2013

control arsenals being deployed to combat them and the recent increase in insecticide-resistant mosquitoes possibly signify the need to search for more viable but environmental friendly strategies to control the mosquito vectors[9].

Larval control (source reduction) is a successful way of reducing mosquito densities by decimating the number of larvae that will emerge into adults[10]. Nigeria started the war against mosquitoes through environmental control by bush clearing and removal of waste and stagnant water long before the declaration of the World Health Organization's program of 1955[11]. These efforts were strengthened by the regular activities of environmental supervisors (Sanitary supervisors). The understanding was that these activities will keep the environment free of mosquito breeding sites and other life-threatening diseases[11]. However, the post independence era (after 1960) of Nigeria has witnessed paradigm shift in the control of mosquitoes with the stoppage of regular activities of sanitary supervisors and replaced them with environmental management and campaign against adult mosquitoes.

The present reality of demographic growth and urbanization being experienced in many parts of Nigeria has come without many public health problems[1]. These problems, including unplanned urban growth, inadequate waste disposal, irrigation and poor drainage, usually alter ecosystem and thus promote prolific breeding of mosquitoes. Therefore, the proper understanding of the environmental factors that promote the breeding of mosquitoes becomes imperative for successful planning of mosquito control measures.

Information from Osogbo, a town in Southwestern Nigeria reveals that it is endemic for malaria[12], but no information exists on the types of species and the breeding sites of mosquito fauna in the metropolis. It is against this background that the present study was carried out to provide information on larval habitats of mosquito fauna, and use Geographic Information System/ Remote Sensing to understand the possible effect of land use/land cover changes and the implications on the epidemiology of mosquito-borne diseases in Osogbo metropolis, Southwestern, Nigeria

2. Materials and methods

2.1. Study area

Osogbo is located on latitude $7^{o}30^{'}$ N and $4^{o}30^{'}$ E in the derived Savanna Zone of Southwestern Nigeria. The area experiences two seasons, the dry season (November to March) and the wet season (April to October). Osogbo as the State Capital of Osun, Nigeria enjoys basic social amenities such as electricity, pipe borne water and road networks.

2.2. Collection of mosquito larvae

The larval sampling of all accessible breeding sites was carried out in Osogbo metropolis weekly between 7:00 to 11:00 for six months (May to September, 2011). The breeding sites were grouped into five; gutters/ run-offs, septic tanks/ drums, ground pools/ open drains, discarded containers and used tires. The mosquito larvae were collected with plastic scoopers and sieves of about 0.55 mm mesh -size into labeled containers and transferred to laboratory for analysis.

2.3. Larval identification

All larvae collected were identified with the aid of dissecting microscope using the keys described by Hopkins[13]. Some larvae were allowed to emerge into adult inside mosquito cage and identified using the keys described by Gillet[14].

2.4. Environmental mapping using Geographical Information System (GIS) and Remote Sensing (RS).

The land cover change/ land use change and habitat classification were done using GIS/RS for classification of the land use pattern of the study area by analyzing and comparing the 2 Lansat Multispectral Scanner satellite imagery of SPOT 1986 and LANDSAT TM 2009. The changes in the analysis using remote sensing were used to forecast the possible effect on epidemiology of mosquito-borne diseases in Osogbo metropolis.

2.5. Data analysis

The data obtained were analyzed using SPSS version 17. Student *t*-test and chi-square were used to determine the significant differences in habitat and species distribution at the study area after the data were transformed by square root of x+0.5. Shannon-Weinner Index was used to determine the species diversity of the breeding sites.

3. Results

3.1. Distribution of mosquito larval habitats

A total of 336 larval habitats were encountered out of which 212 (63.09%) were positive for mosquito larvae. The occurrence and contribution of the five major larval habitats encountered are summarized in Figure 1. The number of discarded tyres was significantly higher ($P<0.05$) than the other habitats, while there were no significant differences in the contribution of gutters/ run-offs, septic tanks/ drums, ground pools/ open drains and discarded containers to the breeding of mosquitoes ($P>0.05$).

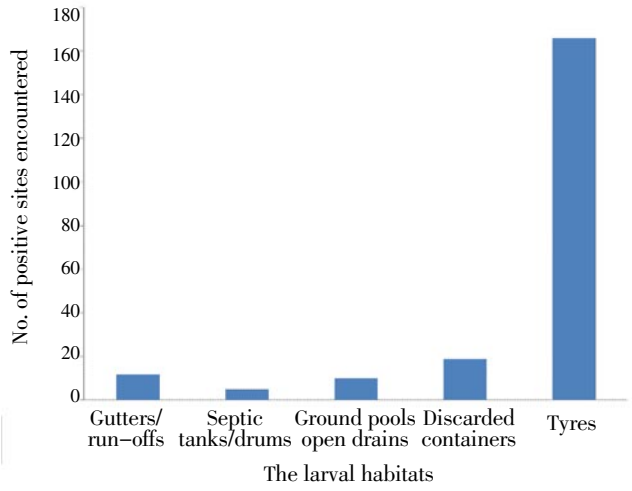

Figure 1. The occurrence of the mosquito larval habitats in Osogbo metropolis.

3.2. Species occurrence at the breeding sites

The species diversity of mosquito fauna encountered at the breeding sites is summarized in Table 1. A total of six species were encountered which belong to four genera; *Aedes*, *Culex*, *Anopheles* and *Eretmapodites*. The species encountered were *Ae. aegypti*, *Ae. albopictus*, *Ae. vittatus*, *An. gambiae* complex, *Cx. quinquefasciatus* and *Er. chrysogaster*. *Ae. aegypti* and *Cx. quinquefasciatus* were found in three out of the five habitats while *An. gambiae* complex was found only in two habitats (ground pools and gutters/ run-offs). *Ae. albopictus* was only encountered in disused tires. Disused tyres had the highest species diversity (Shannon-Weiner index=0.60) while ground pools/open drains had the least species diversity (Shannon-Weiner index=0.30). There was no significant difference in the occurrence of the mosquitoes in each habitat ($P>0.05$) except in tyres where significant variation was observed in the occurrence of the mosquitoes ($P<0.05$).

3.3. Land use/ land cover of Osogbo metropolis using GIS/RS

The accessible land use/ land covered of the study area showed that the farm land, forest coverage had decreased between 1986 and 2009 while the settlement area and flooded increased within the period. The wet land coverage and settlement area increased from 0.19 to 9.09 hectare and 1.00 to 2.01 hectare respectively while the forest area decreased from 60.18 to 50.14 hectare (Figure 2).

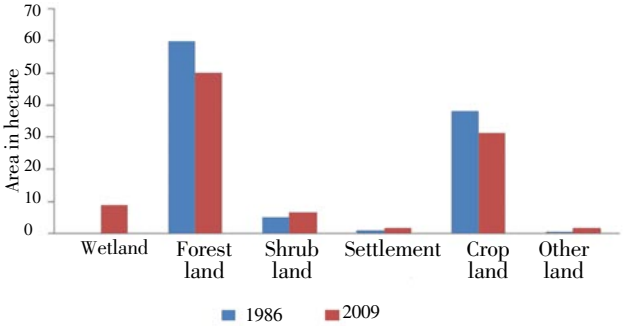

Figure 2. Changes in land use between 1986 and 2009 in Osogbo, Southwestern Nigeria

4. Discussion

Increasing population density due to rural-urban drift is one of the major characteristics of many cities in Nigeria. The accessible satellite imagery showed that Osogbo metropolis had experienced increase in settlements and flooded area but reduction in forest coverage area between 1986 and 2009. The increase in land use/ land cover signifies the high spate of urbanization with consequential increase in flooded area. The flooded environment could provide amble opportunities for water borne diseases and create conducive breeding sites for mosquitoes[15]. Though, no previous record exists on mosquito fauna in Osogbo metropolis to allow comparison with the

Table 1
The species diversity of mosquito fauna in different larval habitats in Osogbo metropolis, southwestern Nigeria.

Breeding habitats	Mosquito Species	No. of positive sampling	No.(%) of occurrence	Shanon-Wiener Index (HS)
Gutters/ runoffs	*Anopheles gambiae* complex	12	2(3.82)	0.48
	Cx. quinquefasciatus		11(91.66)	
	Er. chrystogaster		4(33.33)	
Septic tanks/drums	*Ae. aegypti*	5	5(100.00)	0.48
	Ae.vittatus		1(20.00)	
	Er. chrystogaster		2(40.00)	
Tyres	*Ae. aegypti*	166	164(98.79)	0.60
	Ae. albopictus		5(3.01)	
	Cx. quinquefasciatus		2(1.29)	
	Er. Chrysogaster		6(2.83)	
Ground pools/ open drains	*An. gambiae* complex	10	10(100.00)	0.30
	Cx. quinquefasciatus		5(50.00)	
Discarded containers	*Ae. aegypti*	19	18(94.73)	0.48
	Ae. vittatus		1(5.26)	
	Er. Chrysogaster		3(15.78)	

present results, the high prevalence of malaria previously recorded in the metropolis could be the resultant impacts of the flooding conditions which normally create conducive breeding sites for malaria vectors[16].

Paradoxically, a relatively low occurrence of the positive breeding sites was encountered during this study when compared with other urban areas in Nigeria such as Benin City, Lagos and Abeokuta[10,16,17]. The low occurrence of the breeding sites may be attributed to the pragmatic approach of the State Government on environmental sanitation and management which led to the declaration of state of emergency on environmental sanitation through daily cleaning of surroundings and channeling of the major streams and rivers in the metropolis. This is evident by the low occurrence of *An. gambiae* complex (malaria vector) and *Cx. quinquefasciatus* which prefer breeding in stagnant gutters and blocked drainages[8,10,15]. This action culminated in the reduction of potential breeding sites such as blocked gutters, swampy areas, discarded containers and bushy surroundings. Efforts to sustain this preventive sanitary activity will indubitably, remain a cost-effective measure to reduce mosquito-borne diseases through larval reduction rather than spending huge amount of resources on treatment.

However, the high occurrence of the disused tyres and its attendant contribution to the breeding sites virtually in all the areas of Osogbo metropolis is worrisome. The discarded tyres were found around the mechanic workshop and residential areas during the course of this study. Our interaction with the residents during the study revealed that most of the residents are ignorant of the potential contribution of disused tires to the epidemiology of mosquito-borne diseases and thus, not targeted for removal during weekly environmental sanitation. This habitat had the highest species diversity and bred the important vectors (*Aedes* species) which are known vectors of dengue fever, yellow fever and bancroftian filariasis[1,18]. It is pertinent to emphasize that the preponderance of *Aedes* species encountered in the present study suggest the high risk of residents to dengue fever. In Nigeria, the prevalence and distribution of dengue fever still remain unknown and the current global trend in the distribution of dengue could leave one to be worried due to the influx of foreign tourists to the town. Further studies on the prevalence of dengue and resistance in reported cases of malaria in the metropolis will therefore be of immense benefit in shedding light to the aforementioned speculation. This however, is part of our future plans.

In conclusion, the present study has reported the larval habitats and the species composition of mosquitoes in Osogbo metropolis. We have also utilized the GIS/RS to predict the possible environmental changes and its impact on the epidemiology of mosquito-borne diseases in the metropolis. As Osogbo continues to experience more demographic growth, there is need for sustained environmental sanitation and management by the State Government so as to reduce the incidence of mosquito borne diseases. Residents should also be educated on the potential breeding sites of mosquitoes and the need for their elimination.

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgements

The authors thank the Management of Osun State University, Osogbo, Nigeria for the logistic support in carrying this study through Project number UNIOSUN/SET 11/ 004.

Comments

Background

Osogbo metropolis is one town in Southwestern Nigeria and the capital of Osun State. Earlier before now, there is no information on the breeding sites of mosquito vectors and the extent of their distribution within Osogbo metropolis. The paper presents information on the different larval habitats of mosquito fauna and possible impact of land use/ land cover changes on the epidemiology of mosquito-borne diseases in Osogbo metropolis, Southwestern, Nigeria.

Research frontiers

This is the use of Geographical Information System and Remote Sensing in predicting the epidemiology of mosquito borne diseases. It also assessed the impact of environmental sanitation and human activities in relation to the breeding of mosquito vectors. This is with a view to providing baseline information on control and preventive measures to combat mosquito-borne diseases in the study area. The study, to the best knowledge of the authors, is the first report on mosquito vector habitats and the epidemiological effects of land use/ land changes in the metropolis.

Related reports

The authors cited related reports and proper references to the methods adopted were cited. There was clarity in methods except few errors pointed where the version of the statistical package used should be added. The paper reports a relative low number of breeding sites which contradicts earlier reports on mosquitoes in other cities in Nigeria. The reason

adducted to this was premised on the weekly environmental sanitation exercise being enforced by the State Government.

Innovations and breakthroughs

The manuscript is innovative in providing baseline data on mosquito vectors in the study area. It also utilizes geographic information system to predict the impact of land use and land cover on the epidemiology of mosquito-borne diseases in the study area. The study is original and gives impetus on the possible effect of influx of tourists at introducing new parasites that are hitherto alien to the area of study. The results demonstrated clearly that environmental sanitation could go a long way in preventing and decimating the population of mosquito vectors in urban areas.

Applications

The methods used can be applied in future research studies, as there are adequate explanatory notes to show the line of study. The results are useful for the control programmes, policy makers and the organization involved in mosquito borne diseases to design the effective strategies in reducing the menace of the infections at the study area. Most importantly, the study emphasizes the need for public health education of the contribution of discarded tyres to the breeding of mosquito vectors. This habitat is most often being neglected during environmental sanitation.

Peer review

The manuscript is of good quality which would be of great interest to those involved in the epidemiology and control of mosquito-borne diseases. The manuscript is well articulated and provided reproducible methodology for future research in any parts of the world. The study would be a reference point for future surveillance and control of mosquito borne diseases in the metropolis. It has significant contribution to knowledge and disease control.

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