Biodiversity of mosquito larval habitats and its public health implication in communities of Tai Solarin University of Education, Ijagun, Ijebu-Ode, Ogun State

TOS Adewoga[1], AA Adenusi[2], EO Okedere[1], OA Adediran[3], AAR Adebambo[1], FM Banjo[1], TOO Uthman[1], AL Adefuye[4] and FB Egunjobi[1]

Department of Biological Sciences[1], Tai Solarin University of Education, Ijagun, Ijebu-Ode, Ogun State, Department of Medical Parasitology and Entomology[2], University of Lagos, Department of Veterinary Parasitology and Entomology[3], University of Ibadan and Department of Educational Technology[4], Tai Solarin University of Education, Ijebu-Ode, Nigeria.

Abstract

Background: The larval habitats of mosquitoes were investigated in Tai Solarin University of Education communities of Ijebu-ode area in Ogun state, Nigeria. The study determined the breeding sites of the existing mosquito fauna and its possible public health implications on the residents of the area.

Methods: The mosquito larval breeding habitats were sampled October 2018 to February 2019 using plastic dippers. The habitats were grouped as ground pools/ponds, gutters/open drains, tyres and domestic containers and the insect encounter were identified using standard identification keys.

Results: Eleven species of mosquitoes were encountered in the four habitats namely *Culex pipiens, Culex quinquefasciatus, Culex nigripalpus, Anopheles bancroftii, Eretmapodite chrysogaster, Aedes taeniorhynchus, Aedes mediovittatus, Anopheles subpictus, Aedes togoi* and *Aedes aegypti*. *Culex pipiens* bred in all the habitats sampled while *Culex quinquefasciatus* bred in three habitats at both dry and wet season except tyres. *Culex nigripalpus*, *Anopheles gambiae* and *Anopheles bancroftii* occurred in three habitats while other species bred only in one or two habitats. Gutters/open drains and domestic containers recorded the highest number of species occurrence in the four habitats. The availability of the habitats to support the breeding of *Aedes*, *Culex and Anopheles* which are known vectors of yellow fever, lymphatic filariasis, zika virus, chikungunya fever, west nile fever and malaria suggest that the residents of Tai Solarin University of Education Communities of Ijebu-Ode area, are at risk of mosquito-borne diseases and the health hazards they cause to the environment.

Conclusion: It is important that residents of the area know some control strategies of all these mosquito borne diseases and are enlightened on the environmental factors that contribute to mosquito breeding. Also, government should institute weekly proper sanitation measures to reduce mosquito breeding sites.

Keywords: *Anopheles bancroftii, Anopheles gambiae, Culex quinquefasciatus, Eretmapodite Chrysogaster, Aedes mediovittatus*

Résumé

Contexte : Les habitats larvaires des moustiques ont été étudiés dans les communautés de l'Université d'éducation Tai Solarin de la région d'Ijebu-ode dans l'État d'Ogun, au Nigéria. L'étude a déterminé les sites de reproduction de la faune de moustiques existante et ses éventuelles implications de santé publique sur les résidents de la région.

Méthodes : Les habitats de reproduction des larves de moustiques ont été échantillonnés d'octobre 2018 à février 2019 à l'aide de louches en plastique. Les habitats ont été regroupés en bassins/étangs creusés, gouttières/drains à ciel ouvert, pneus et conteneurs domestiques et les insectes rencontrés ont été identifiés à l'aide de clés d'identification standard.

Résultats : Onze espèces de moustiques ont été rencontrées dans les quatre habitats à savoir Culex pipiens, Culex quinquefasciatus, Culex nigripalpus, Anopheles bancroftii, Eretmapodite chrysogaster, Aedes taeniorhynchus, Aedes mediovittatus, Anopheles subpictus, Aedes agoi et Aedes. Culex pipiens se reproduisait dans tous les habitats échantillonnés tandis que Culex quinquefasciatus se reproduisait dans trois habitats à la fois en saison sèche et en saison humide, à l'exception des pneus. Culex nigripalpus, Anopheles gambiae et Anopheles bancroftii étaient présents dans trois habitats tandis que d'autres espèces ne se reproduisaient que dans

Correspondence: Dr. T.O.S. Adewoga, Department of Biological Sciences, Tai Solarin Universityof Education,Ijagun, Ijebu Ode, Ogun State, Nigeria. E-mail: waltolad@yahoo.com amd elizabetholuwaseyiben@gmail.com.

un ou deux habitats. Les gouttières/drains à ciel ouvert et les conteneurs domestiques ont enregistré le plus grand nombre d'espèces présentes dans les quatre habitats. La disponibilité des habitats pour soutenir la reproduction d'Aedes, Culex et Anopheles qui sont des vecteurs connus de la fièvre jaune, de la filariose lymphatique, du virus zika, de la fièvre chikungunya, de la fièvre du Nil occidental et du paludisme suggèrent que les résidents de l'Université Tai Solarin des communautés éducatives d'Ijebu - Zone d'Ode, sont à risque de maladies transmises par les moustiques et les dangers pour la santé qu'ils causent à l'environnement.

Conclusion : Il est important que les résidents de la région connaissent certaines stratégies de contrôle de toutes ces maladies transmises par les moustiques et soient éclairés sur les facteurs environnementaux qui contribuent à la reproduction des moustiques. En outre, le gouvernement devrait instituer des mesures d'assainissement hebdomadaires appropriées pour réduire les sites de reproduction des moustiques.

Mots clés : *Anopheles bancroftii, Anopheles gambiae, Culex quinquefasciatus, Eretmapodite Chrysogaster, Aedes mediovittatus*

Introduction

According to WHO, as cited by [1], mosquitoes are widely distributed throughout the world and they utilize different water bodies for their breeding. Mosquitoes are the single most important taxon of arthropods affecting human health globally and are amongst the most prolific species contributing to the spread of endemic or exotic diseases. [14]. They belong to the family culicidae. They are mostly important to public health because they transmit various diseases such as malaria, yellow fever, filariasis, dengue fever, encephalitis and equine encephalitis. These are mainly caused by various mosquito species such as A*nopheles* species, A*edes* species and C*ulex* species [15]. All types of mosquitoes adopt aquatic habitat for their breeding which may be artificial or natural [15].

The possible and confirmed mosquito larval habitats are the potential indoor and outdoor breeding containers which compose of both natural such as coconut shells, leaf axils e.t.c. and artificial containers which include polystyrene containers, glass containers, gutters e.t.c. [16]. Also, the conversion of natural habitats such as the woodland pools, salt marshes, and swamp e.t.c. to residential and agricultural land increases mosquito larval habitats [11]. According to a sampling carried out in a village in western Kenya, it revealed 104 aquatic habitats of 6 types for *Anopheles gambiae* larval alone. These include: burrow pits, drainage channels, livestock hoof prints, rain pools, tyre tracks and pools in stream beds. All these were created by human activity and were highly clustered in dispersion pattern with the village landscape [5].

Even, the distribution and abundance of mosquitoes varies based on the environmental changes such as temperature, humidity, rainfall, urbanization, deforestation, vegetation clearance for crop plantations and large scale population movement which also contribute to the breeding of various mosquito species. Therefore, changes in environmental conditions may have direct or indirect effect on disappearance of some species [15]. As Nigeria is undergoing rapid urbanization of settlements, areas that were formerly referred to as rural are rapidly attaining urbanization, thus resulted in some areas being densely populated. In order to attain urbanization, constructions of the surface run-off (gutters/culverts), the provision of open or partially covered soakage pits for houses, the excavation pits made and abandoned by the construction companies at construction sites, disposed sachet water and cement water reservoirs are all creating good and active breeding sites for mosquitoes in urban settlements, this has major public health implication [4].

Studies to identify local mosquito species have been carried out in several parts of Nigeria including Ibadan, Lagos, Zaria and Benin [12]. Though this study has been carried out in Abeokuta Southwest Nigeria [1] but any attempt has not been made to carry out this study in TASUED communities of Ijebu-Ode Area. The recent tremendous change in environmental conditions of the area as a result of high population of people moving in to the local area every year due to the presence of higher institution. Hence, in order to prevent the outbreak of mosquito borne diseases in the area, there is need for current documentation of the mosquito species and their habitats as well as the public health implications on the populace.

This study therefore investigated the breeding sites of mosquito, the species diversity and distribution, larval habitats and its public health implications in communities of Tai Solarin University of Education, Ijagun, Ogun State.

Materials and methods

Study area

The study was conducted in Tai Solarin University of Education communities. TASUED was founded in the year 2005, and was located in Ijagun around

Ijebu-Ode area of Ogun State. The area has a population of 209,175 (2006 national population census).

This study was conducted in five select communities of TASUED which include Ijagun, Abapawa, Ogbo, Imaweje, and Ijele. All these areas are highly populated with the students of TASUED alongside the community members in that areas. The study was carried out between October 2018 and February 2019. The breeding sites sampled were categorized into four groups according to the similarity of the habitat;

1. Gutter/drains which include gutters, open drains, peri-domestic run-offs from bathroom, and soak away.
2. Ground pools which include rain water collection on the road, pool water around public taps, wells and abandoned ponds.
3. Used tyres that hold water in the environment.
4. Domestic containers which include discarded pots, tanks, plastic rubbers, buckets, pure water nylon and aluminium containers.

Mosquito larva collection

Mosquito larvae were collected in the ground pools which include rain water collection on the road, pool water around public taps, wells and abandoned pond, domestic containers and gutters/drains which include gutters, open drains, peri-domestic run-offs from bathroom and soak away with the aid of plastic dipper and the sieve of about 0.55mm mesh size was used for the collection of larvae. Mosquito larvae were collected from five different areas within TASUED communities. The collected samples for each area were placed in bottles. The bottles were labeled indicating the type of breeding site, date of collections and the season from which they were collected. The samples for each habitat at each area were transferred into a larval/ mosquito cage. The mosquito larvae was allowed to emerge into adult inside the mosquito cage (plastic covered with net). The adult mosquitoes were then collected into a transparent nylon and examined with the aid of a hand lens and identified.

Identification of different species mosquitoes

According to [8] and the knowledge of [6], mosquitoes possess only one pair of functional wings, the fore-wings. The hind-wings are represented by a pair of small, knob-like halteres. Mosquitoes are distinguished from other flies of a somewhat similar shape and size by: [1] the possession of a conspicuous (visible) forward-projecting proboscis; [2] the presence of numerous appressed scales on the thorax, legs, abdomen and wing veins; and [3] a fringe of scales along the posterior margin of the wings.

Among the mosquito species, (i) Anopheles larvae do not have a siphon and stay parallel to the water surface. (ii) Aedes and Culex mosquitoes are similar, but Culex larvae have long siphon and lighter color. (iii) The body of Culex mosquitoes is also hairy compared to Aedes mosquitoes.

Whereas in adults, (i) Aedes mosquitoes are black and have white patches. (ii) Culex and Anopheles mosquitoes are yellowish, but can be identified by observing their resting positions. (iii) Anopheles mosquitoes have a 45-degree angle when resting while Culex mosquitoes stay parallel to the surface [7]. Adult mosquitoes were identified morphologically under a microscope to species level using identification keys.

Statistical analysis

The distribution of mosquitoes in the study area was analysed by recording the number of mosquito species found in each habitat. Percentage occurrence of the mosquito larvae were calculated based on the larvae population per site to the total number of larvae collected using simple percentages.

Results

During the wet seasons (October - November) in gutters/drains, a total of 75 observations were made and six species of mosquitoes were encountered. The larvae of *Cx. quinquefasciatus* was the most abundant species occurring 23(30.67%) times out of total occurrences; followed by *Cx pipien s*and *An bancrofti i*each with 14(18.67%) respectively and *An. Gambiae sensulato* 13(17.33%) times, *Eretmapodite chysogaster* did not occur until during the dry season.

In domestic containers, nine species of mosquitoes were encountered. *Cx. quinquefasciatus* was the most abundant species with 27(41.54%) times out of 65 occurrences. Others include *Cxpipiens* 21(32.31%); *Ae. aegypti* and *Aemediovittatus* each with 4(6.15%) times; *Cx. nigripapus* and *Ae. Gambiaesensulato* each with 3(4.62) times and *Ae. taeniorhynchus*, *An. bancroftii* and *An. subpictus* each with 1(1.54%) times, out of 65 occurrences.

Ground pools harbored five species of mosquito, among which *Cx. quinquefasciatus* that occurred 25(47.17%) times; *An. bancroftii* 12(22.64%) times; *Angambiae*sensulato 11(20.75%) times; *Cx. pipiens* 4(7.55%) times and *An. subpictus* 1(1.89%) times out of 53 occurrences.

Table 1: Types of Sampling Habitats and Number of Records for Each Species in Both Wet And Dry Seasons

Habitats	Species	No/Population in Wet Season	No/Population in Dry Season	Total Number of Wet and Dry Seasons
	Cx. Pipiens	14	09	23
Gutters/drains	*Cx. quinquefasciatus*	23	114	137
	Cx. nigripapus	11	14	25
	An. gambiaes.l.	13	01	14
	An. bancroftii	14	02	16
	Er. Chrysogaster	00	04	04
	Total	75	144	219
	Cx. Pipiens	21	04	25
	Cx. quinquefasciatus	27	20	47
	Ae. taeniorhynchus	01	00	01
	Ae.aegyptiAe.	04	06	10
Domestic containers	*Mediovittatus*	04	02	06
	An. bancroftii	01	00	01
	Cx. nigripapus	03	00	03
	An. gambiaes.l	03	03	06
	An. subpictus	01	00	01
	Total	65	35	100
	An. bancroftii	12	00	12
	An. gambiaes.l.	11	02	13
Ground pools	*Cx. quinquefasciatus*	25	00	25
	Cx. pipiens	04	00	04
	An. subpictus	01	00	01
	Total	53	02	55
	Ae.Aegypti	36	00	36
	Ae. Taeniorhynchus	12	00	12
Tyres	*Cx. pipiens*	01	00	01
	Cx. nigripapus	01	00	01
	Ae. Togoi	02	00	02
	Total	52	00	52

Table 2: Percentage occurrence of mosquito species in the wet and dry season in TASUED communities of Ijebu-Ode area Ogun State Nigeria.

S/No	Species	Wet Season Number	Percentage occurrence	Dry Season Number	Percentage occurrence	Total
1.	*Cx. Pipiens*	40	16.33	13	7.18	53
2.	*Cx. quinquefasciatus*	75	30.61	134	74.03	209
3.	*Cx. nigripapus*	15	6.12	14	7.73	29
4.	*An. gambiae*	27	11.02	6	3.31	33
5.	*An.bancroftii*	27	11.02	2	1.10	29
6.	*Er. chrysogaster*	-	0.00	4	2.21	4
7.	*Ae. taeniorhynchus*	13	5.31	-	0.00	13
8.	*Ae. aegypti*	40	16.33	6	3.31	46
9.	*Ae. mediovittatus*	4	1.63	2	1.10	6
10.	*An. subpictus*	2	0.82	-	0.00	2
11.	*Ae. togoi*	2	0.82	-	0.00	2
	Total	245	100%	181	100%	426

Tyres as one of the mosquito habitats also harbored five species of mosquito, among which *Ae. eagypti* occurred 36(69.23%) times, *Aetaeniorhynchus* occurred 12(23.08%) times, *Aetogoi*2(3.85%) times, while *Cx. Pipiens* and *Cx. nigripapus* each occurred 1(1.92%) time out of 52 occurrences.

In the dry season, six mosquito species were encountered in the gutters and drains. Among the six, *Cx. quinquefasciatus* was the most encountered species which occurred 114(79.17%)times, followed by Cx. *nigripapus* 14(9.72%) times, *Cx. pipiens* 9(6.25%) times, *Er. chrysogaster* 4(2.78%) times, *An. bancroftii* 2(1.39%) times and *An. gambiae*sensulato 1(0.69%) times out of 144 occurrences.

In the domestic containers, five mosquito species were encountered, prominent among them was the *Cx. quinquefasciatus* 20(57.14%) times, this was followed by *Ae. aegypti* 6(17.14%) times, then *Cx. pipiens* 4(11.43%) times, followed by *An. gambiaesensulato* which occurred 3(8.57%) times and *Ae. mediovittatus* which occurred 2(5.71%) times out of 35 occurrences. Only the *An. gambiae*sensulato was encountered in the ground pools which occurred 2(100%) times. None was encountered in tyres during the dry season because of the absence of water. When the data of both wet and dry seasons for all the breeding habitats were pooled, domestic containers harbored the highest number of species followed by gutters/drains, ground pools and tyres.

Discussion

The study investigated the biodiversity of mosquito larval habitat and its public health implication in communities of TASUED. The knowledge of larval habitat diversity in TASUED communities and the influence of mosquito species diversity and abundance is important in knowing the vector control strategies on public health.

The presence of four genera of mosquitoes, *Anopheles, Culex, Aedes,* and *Eretmapodites* were observed in the present study unlike five species that were encountered by [1] when they studied mosquito larval habitats and public health implication in Abeokuta Ogun State, Nigeria.

The breeding of mosquitoes was observed virtually in all habitats sampled. Gutter, domestic containers, ground pools and tyres constituted the most important breeding sites for mosquitoes in the study area. Tyres were found to be important habitat habouring *A. aegypti* larval population during the wet season in all the habitat sampled. This agrees with the study conducted by [9] in Mombasa and Malindi that found tyres and containers to be important habitats for immature *A. aegypti* productivity in urban setting. Also, earlier report on mosquito breeding sites in Abeokuta showed that tyres and domestic containers provide the highest number of breeding sites in both wet and dry seasons [10]. *Culex quinquefasciatus* which are the vectors of filariasis and encephalitis had its highest occurrence in gutters/ drains during the dry season followed by domestic containers. These habitats include open drains, peri-domestic run offs from bathrooms and soak away,

Table 3: Mosquito species occurrence in different habitats

S/No	Species	Habitats							
		Gutters/Drains		Domestic Containers		Ground Pools		Tyres	
		No	%	No	%	No	%	No	%
1.	*Cx. Pipiens*	23	10.50	25	25	04	7.27	01	1.92
2.	*Cx. quinquefasciatus*	137	62.56	47	47	25	45.45	-	0.00
3.	*Cx. nigripapus*	25	11.42	03	3	-	0.00	01	1.92
4.	*An. gambiae*	14	6.39	06	6	13	23.64	-	0.00
5.	*An.bancroftii*	16	7.31	01	1	12	21.82	-	0.00
6.	*Er. chrysogaster*	04	1.83	-		-	0.00	-	0.00
7.	*Ae. taeniorhynchus*	-	0	01	1	-	0.00	12	23.08
8.	*Ae. aegypti*	-	0	10	10	-	0.00	36	69.23
9.	*Ae. mediovittatus*	-	0	06	6	-	0.00	-	0.00
10.	*An. subpictus*	-	0	01	1	01	1.82	-	0.00
11.	*Ae. togoi*	-	0	-		-		02	3.85
	Total	219	100%	100	100%	55	100%	52	100%

discarded pots, tanks, pure water nylon and aluminium containers and so on. The presence of these larvae pose a great risk of mosquito- borne infection outbreaks. This finding concur with the work of [13] which stated that *C. quinquefasciatus* uses dirty and polluted aquatic sources as larval habitat. It was also reported by [1] that the intense breeding of mosquitoes was observed in tyres and domestic containers in both seasons. By contrast, gutters were described as short period breeding sites, and this was not the situation in the study of [1] as they asserted that gutters were seen in both seasons with high number of mosquito species. The same situation occurred in the present study, as the gutters and drains provide the largest number of mosquitoes in both wet and dry seasons. In TASUED communities of Ijebu-Ode area Ogun State, the poor sanitation of these communities appears to be as a result of most of the gutters have been blocked with refuse and sewage, therefore rendering the water stagnant.

Secondly, during the wet season, run offs brought about by rainfall washes away mosquito larvae but such does not occur during the dry season and with the continual using of the bathrooms, water remains stagnant in the gutters and drains thus, providing avenue for continuous breeding of the mosquitoes, as observed and could be clearly seen in Table 1 and 2.

Thirdly, some gutters and drains are confined, water inside them have no avenue to flow, thus becoming permanent breeding sites for the mosquitoes which therefore exposing the resident of these areas to dangers of mosquitoes bite and associated illness such as malaria, yellow fever, filariasis, dengue fever, West Nile fever, zika fever, Japanese encephalitis, chikungunya virus infection, e.t.c. which have some major symptoms like head ache, restlessness, irritability, drowsiness, convulsion, anorexia, fever. e.t.c.

Culex mosquitoes are found in all the four habitats sampled, i.e. gutters and drains, domestic containers, ground pools and tyres. *Anopheles* mosquitoes are found in three of the four habitats namely gutters and drains, domestic containers and ground pools, *Aedes* are found in just two habitats which are the tyres and domestic containers while *Eretmapodite s*is found in only the gutters and drains.

Conclusion

The identification of breeding sites of mosquito larvae can help in the mapping and prediction of oviposition site selection and also in the distribution of these vectors. Hence, this will pave way for the development of entomological monitoring and also targeted control strategies for the vectors, therefore reducing the great risk of mosquito-borne infection outbreak in TASUED communities.

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Received = 26/08/2020
Accepted = 28/05/2021