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Distribution and abundance of mosquito larvae in Ohafia, Abia State, Nigeria

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ABSTRACT: Quite a number of diseases are transmitted by mosquitoes. The abundance and distribution of mosquito vectors are related to the characteristics of larval habitats. A survey of the distribution and abundance of mosquito larvae was carried out at Nkporo and Abiriba Communities of Ohafia, Abia State, Nigeria. It was carried out during the dry and wet seasons from November 2014 to June 2015. The mosquito larvae were collected using dipper and pipette method from five mosquito habitats namely ground pools (58), household containers (213), domestic run-offs (49), gutters (55) and tree holes/leaf axils (43). A total of 2 641 mosquito larvae belonging to three genera and five species were collected. These were; *Culex quinquesfaciatus* (40%),*Aedes aegypti* (22%), *Aedes albopictus* (17%), *Anopheles gambiae* (14%), and *Anopheles funestus* (2%), Household containers had the highest number of larvae (60 %), while tree holes/leaf axils had the least (6%). From Nkporo, 53% of the larvae were collected while 47% was from Abiriba community. *Anopheles funestus* was recorded only in Nkporo community. However, the abundance of mosquito larvae sampled from the different habitats in the two communities were significantly different (X^2 = 166,692, df = 16, P<0,05) from each other. There were also significant differences in the seasonal distribution of mosquito larvae in both dry (X^2 = 56,865, df = 12, P<0,05) and wet (X^2 = 22,241, df = 12, P<0,05) seasons in Nkporo community and dry (X^2=31,776, df = 12, P<0,05) season in Abiriba community. These findings are useful in knowledge expansion on the vector ecology with particular interest on the type of habitat preference, this will be helpful in larval control programs.

Keywords: Mosquito, Larval habitats, Seasonal distribution, Abundance, Ohafia, Nigeria.

RESUMEN: Distribución y abundancia de larvas de mosquitos en Ohafia, estado de Abia, Nigeria. Una gran cantidad de enfermedades son transmitidas por mosquitos. La abundancia y distribución de mosquitos vectores están relacionadas con las características de los hábitats larvarios. Se realizó un estudio de la distribución y abundancia de larvas de mosquitos en las comunidades de Nkporo y Abiriba, Ohafia, estado de Abia, Nigeria. Se llevó a cabo durante las estaciones seca y húmeda de noviembre de 2014 a junio de 2015. Las larvas de mosquitos se recolectaron utilizando el método de cucharón y pipeta de cinco hábitats de mosquitos, a saber: piscinas molidas (58), contenedores domésticos (213), escorrentías domésticas (49), canales (55) y agujeros de árboles / axilas de hojas (43). Se recolectó un total de 2 641 larvas de mosquito pertenecientes a tres géneros y cinco especies. Éstas eran; *Culex quinquesfaciatus* (40%), *Aedes aegypti* (22%), *Aedes albopictus* (17%), *Anopheles gambiae* (14%) y *Anopheles funestus* (2%). Los contenedores domésticos presentaron el mayor número de larvas (60%), mientras que los agujeros de los árboles / axilas de las hojas fueron los que menos (6%). De Nkporo, el 53% de las larvas fueron recolectadas, mientras que el 47% fue de la comunidad de Abiriba. *Anopheles funestus* solo se registró en la comunidad de Nkporo. Sin embargo, la abundancia de larvas de mosquitos muestreados de los diferentes hábitats en las dos comunidades fue significativamente diferente (X^2 = 166,692, df = 16, P<0,05) entre sí. También hubo diferencias significativas en la distribución estacional de las larvas de mosquitos en las estaciones tanto secas (X^2 = 56,865, df = 12, P<0,05) como húmedas (X^2 = 22,241, df = 12, P<0,05) en la comunidad de Nkporo y secas (X^2=31,776, df = 12, P<0,05) en la comunidad de Abiriba. Estos hallazgos son útiles en la expansión del conocimiento sobre la ecología vectorial con especial interés en el tipo de preferencia de hábitat, esto será útil en los programas de control de larvas.

Palabras clave: Mosquito, hábitats larvales, distribución estacional, abundancia, Ohafia, Nigeria.

Mosquito-borne diseases pose a major threat to both human populations and diversity of indigenous fauna throughout the world where they transmit diseases to more than 700 million people annually (Adeleke, Mafiana, Idowu, Sam-Wobo & Idowu, 2010). Species tend to breed in both natural habitats and artificial containers such as ground pools, gutters, domestic run-offs, tree holes, septic tanks (Mafiana et al., 1989; Okogun,

Nwoke, Okere, Anosike & Esekhegbe, 2003; Aigbodion & Anyiwe, 2005). Environmental and climatic factors directly influence the distribution of mosquito larvae (Mafiana, Anaeme & Olatunde, 1998).

Studies to determine the distribution and abundance of mosquito larvae in various habitats have been carried out in various parts of Nigeria (Adeleke, Mafiana, Idowu, Adekunle & Sam-Wobo, 2008; Olayemi, Ukubuiwe & Oyibo-Usman, 2014; Akpan & Nwabueze, 2015). Species encountered in the various studies include *Anopheles gambiae, Aedes aegypti, Culex quinquefasciatus, Mansonia africana,* etc. These studies will help to ascertain the present state of the different mosquito species in each locality as this is necessary in mosquito control. For any vector control measures to be successful, knowledge of the breeding ecology of mosquitoes including, the types and preferences for larval habitats, spatial and temporal distribution of breeding sites, as well as, the physical, biological and chemical characteristics of the habitats are required (Olayemi, Omalu, Famotele, Shegna & Idris, 2010; Egbuche, Ezihe, Aribodor & Ukonze, 2016; Goselle et al., 2017). The continued transmission of mosquito borne diseases is associated with climatic factors and the vast larval habitats that exist in a particular environment that necessitates breeding of the vectors (Oluwasogo et al., 2016). Studies to identify mosquito larval habitats have been carried out in several parts of Nigeria including Abeokuta (Mafiana et al., 1998; Adeleke et al., 2008), Ekpoma (Okogun et al., 2003), Uyo (Usip & Edem, 2003) and Awka (Mbanugo & Okpalononuju, 2003). Therefore, this study was to determine seasonal distribution and abundance of mosquito larvae at Nkporo and Abiriba communities of Ohafia, Abia State, south eastern Nigeria.

MATERIALS AND METHODS

Study Area: This study was carried out in two communities namely Nkporo and Abiriba at Ohafia Local Government Area (Latitude 05°37″N - 5°617 ″N and longitude 7° 50 ″E and 7°833″E) of Abia State, southeastern Nigeria. The study area is within the tropical rainforest zone of Nigeria with two clearly distinguishable annual seasons – wet and dry seasons. The annual rainfall ranges from 1 750 to 2 000mm and a mean annual temperature range of 26°C to 28°C.The entire Local Government Area has a population estimation of 350 000 inhabitants (National population commission, 2006). Two communities were selected purposely selected to represent rural (Nkporo) and Peri-urban (Abiriba) settlements in the local Government Area. The communities were selected due to their different population size which affects human activities.

Methodology: Investigations were carried arbitrarily in selected streets, roads, private and public residences and open places to determine seasonal distribution and abundance of mosquito larvae. Larval sampling was done monthly between 07.00 and 11.00 hours for eight months (from November 2014 to June 2015) representing (four months each of wet and four dry seasons). The larvae in the ground pools, containers, gutters and domestic run-offs were collected with the aid of plastic dippers while pipette was used for the collection of larvae from tree holes. Dippers could not be used in containers. Therefore, the water in them were emptied into the bowls and larvae collected according to (Service, 1993). The larvae collected were poured through a fine sieve into a white bowl to concentrate them. All collected larvae were transferred into labelled specimen bottles and transported to laboratory for rearing and identification.

Habitat characteristics recorded included the presence of vegetation, the intensity or duration of sunlight and the depth of aquatic microhabitat, submerged, emergent and terrestrial vegetation. Algal cover and debris were estimated as percentage of the habitats using a square grid.

In the laboratory, larvae were kept in bowls covered with a fine nylon mesh, to prevent emerging adults from flying away. They were subsequently transferred into rearing cage.

The cages were stood in tomatoes tins containing water to deny ants and other predators access to the larvae. The larvae were fed with a mixture of yeast and biscuits. The set up was monitored daily until the emergence of adults.

Data were analysed using Chi-Square SPSS version 20.0

RESULTS

Mosquito breeding habitats and mosquito abundance at Ohafia L.G.A: The mosquito larvae habitats identified from the study area were ground pools 14%, containers 51%, domestic run-offs 12%, gutters 13% and tree holes 10 %. Containers had the highest breeding habitats followed by ground pools while the least was tree hole. Similarly containers housed the highest number of mosquito larvae, followed by ground pools then domestic runoff, while tree holes contained the least number (Table 1). (X^2=1,036; df=4, p>0,05).

TABLE 1
Percentage of mosquito breeding habitat type's abundance of larvae in Nkporo and Abiriba communities in Ohafia, Abia State.

Location	Ground Pools	Containers	Domestic Run-offs	Gutter	Tree holes	Total
Nkporo	13,7	49,3	11,5	15,42	10,1	54,3
Abiriba	14,1	52,9	12,0	10,47	10,5	45,7
	13,9	51,0	11,7	13,2	10,3	

Distribution of mosquito larval species collected in the study area: The abundance and distribution of species of mosquitoes in the study area is shown in Table 2. *Culex quinquefasciatus* recorded the highest population (40%), followed by *Ae. aegypti* (27%), then *Ae. albopictus* (17%), while the number of *An. gambiae* collected was (14%). The least larval species collected was *An. funestus* (2%) and it was found to breed only at Nkporo community.

The percentage of *An. gambiae* collected from Nkporo (60%) were significantly higher compare with those collected from Abiriba (40%) respectively, whereas 100% of the *An. funestus* were caught in Nkporo community. In contrary, a higher population of *Ae aegypti* were collected in Abiriba community than in Nkporo community i.e. 52% and 48% respectively. Similarly, a higher population of *Ae. albopictus* were collected in Abiriba (53%) community, while 48% were in Nkporo community. Higher population of *Culex* (55%) were caught in Nkporo community while 45% were caught in Abiriba community. Statistical analysis shows that there was significant different (X^2= 81,335, df = 4, p<0,05) in the distribution of mosquito larval species caught in the study area.

TABLE 2
Distribution of mosquito larval species collected in the study area.

Mosquito Larval Species	Nkporo (%)	Abiriba (%)
Culex quinquefasciatus	55	45
Aedes aegypti	48	52
Aedes albopictus	48	53
Anopheles gambiae	60	40
Anopheles funestus	100	0
Total	54	47

Seasonal/monthly distribution of mosquito larval species in the study area: In Nkporo community, the highest collection (56%) was made in November during the dry season, followed by (30%) in December. Then the month of January (10%) and the least collections were made in the month of February (4%). In the month of November, *C. quinquefasciatus* were the highest larvae caught, (40%). While *An. funestus* were the least larvae collected. Same trend was seen in all the other months of dry season in Nkporo community. However, statistical analysis shows that there was statistical difference (X^2= 56,865, df = 12, p<0,05) in the monthly distribution of mosquito larval species during dry season in Nkporo community.

During the rainy season in Nkporo community, highest collection were made in the month of June (53%), followed by the month of May (26%), then the month of April (17%). The least collections were made in the month of March (5%). *Ae. Aegypti* had the highest collection in the month of March (26%), while *An. funestus* were the least (0,00%). In the month of April, the larvae collected in highest number were *C. quinquefasciatus* (42%), while *An. funestus* were the least (4%). This trend also was observed in other months of the rainy season in Nkporo community. The month of May recorded (40%) for *C. quinquefasciatus*. While *An. funestus* (4%). However in the month of June, *C. quinquefasciatus* also recorded the highest collection of (40%) while *An. funestus* was the least (4%). Statistical analysis shows that there was significant difference (X^2= 22,241, df = 12, p<0,05) in the monthly distribution of mosquito larval species during rainy season in Nkporo community.

During dry season in Abiriba community, the month of November contained highest number of collections (51%) followed by December (30%), then January (17%) and the month of February had the least number (3%). *An. funestus* were not caught in any of the months of the dry season. While *C. quinquefasciatus* were the highest mosquito larval species caught in all the month of the dry season in Abiriba community. Statistical analysis shows that there was significant difference (X^2= 31,776, df = 12, p<0,05) in the monthly distribution of mosquito larval species during dry season in Abiriba community.

During rainy season in Abiriba community the month of November was when the highest collections were made (54%) and the least collections were made in the month of March (4%). *Ae. aegypti* had the collections of

TABLE 3
Seasonal/monthly distribution of mosquito larval species in the study area (%)

Location	Season	Month	*Anopheles gambiae*	*Anopheles funestus*	*Aedes aegypti*	*Aedes albopictus*	*Culex quinquefasciatus*	Species Total
NKPORO	DRY	Nov	15,4	7,0	26,3	11,0	40,4	55,5
		Dec	13,7	6,5	13,7	19,4	46,8	30,2
		Jan	19,1	0,0	4,8	14,3	61,9	10,2
		Feb	23,5	0,0	5,9	29,4	41,2	4,1
	WET	Mar	32,0	0,0	26,0	18,0	24,0	5,0
		April	18,1	3,6	27,1	9,6	41,6	16,6
		May	17,0	3,5	23,6	16,2	39,8	25,9
		June	13,5	4,0	27,0	15,4	40,1	52,5
ABIRIBA	DRY	Nov	10,7	0,00	28,4	18,1	42,8	50,7
		Dec	12,8	0,00	30,4	16,0	40,8	29,5
		Jan	8,6	0,00	27,1	11,4	52,9	16,5
		Feb	7,14	0,00	57,1	7,1	28,6	3,3
	WET	Mar	12,9	0,0	38,7	12,9	35,5	100,0
		April	7,7	0,0	31,9	17,6	42,9	3,9
		May	11,55	0,0	31,9	16,3	40,2	11,30
		June	14,81	0,0	29,9	23,4	31,9	31,2

the collection made in the month of March (39%), while *An. funestus* was the least (0.00). Infact, *An. funestus* was not found during rainy season in Abiriba community. Apart from the month of March, all other months, April (43%), May (40%) and June (32%), *C. quinquefasciatus* recorded the highest number of collections. Statistical analysis shows that there was no significant difference (X^2= 8,830, df = 12, p>0,05) in the monthly distribution of mosquito larval species during rainy season in Abiriba community. (Table 3)

DISCUSSION

This study revealed that five species from three genera of mosquito larvae were present in the study area. Two *Anopheles* species larvae were collected (*An. gambiae* and *An. funestus*), two *Aedes* species (*Ae. aegypti* and *Ae. albopictus*) and one *Culex* species (*Cx. quinquefasciatus*). This is probably due to the presence of suitable breeding habitats such as domestic water containers, run-offs, gutters and other breeding places created by man. This results are similar to reports by different researchers from different parts of Nigeria (Oguoma & Ikpeze, 2008; Umaru, Akogun & Owuama, 2006; Onyido, Ezike, Ozumba, Nwankwo & Nwankwo, 2009). Of the five breeding habitats sampled during the study in the two communities, it was observed that containers had the highest number of mosquito larvae (60,02%) while the tree holes recorded the least number of mosquito larvae (6,40%). This agrees with the work done by Awolola, Oyewole, Koekemoer and Coetzee (2005), Okogun (2005), Anosike et al. (2007) and Adeleke et al. (2010), who noticed that domestic containers were the preferred breeding habitats of mosquitoes. Okogun et al. (2005) also noted that the greater number of larvae observed in containers was due to the absence of or reduced larvae predation by mosquito natural enemies in such habitat. These were also seen in the result of this study. According to Mafiana et al. (1998), tree holes can only retain water for short period of time and dry up at the time of no rain. This may be the reason to explain the low contribution of tree holes to the breeding of mosquito in the study.

Different mosquito species use different habitats for breeding as well as water quality (Onyido et al., 2009). This observation agreed with this study. Some species are restricted to a single type of breeding habitat and water quality. Others possess a larger adaptability, but their presence in a given type of breeding site was due to oviposition habits of the female mosquito which is the main determining factor of the presence of larvae in different types of larval habitats. Worthy to note in this study, was the high prevalence of *Cx. quinquefasciatus* in all the habitats. This is not a surprise because of its preference for polluted water (Mafiana et al., 1998). It was also observed in the current study that *Cx. quinquefasciatus* was not only caught in large quantities from dirty domestic

runoffs and gutters. *Anopheles gambiae* was another species of mosquito that was found in all the habitats in high quantities. The high prevalence of *An. gambiae* can be explained by the fact that the female species of *An. gambiae* preferentially select these habitats for oviposition and this is also in agreement with the works of Bentley and Day (1989). Furthermore, it was observed that *An. gambiae* had high occurrence in containers, domestic run offs and gutters shows that *An. gambiae* can utilize other habitats apart from ground pools which was originally known (Igbinosa, 1989). Although it was observed that the *Anopheles* species lacked the ability to breed in containers but, evidence from this work showed that *Anopheles* species can utilize containers as well as other habitats as breeding sites. This result corroborates the work of Opoku, Ansa-Asare and Amoako (2005) which reported that anopheles species also occur in a wide range of habitats, but with relatively low nutrient status and high oxygen level, and which also in agreement with the findings of Aigbodion and Odiachi (2003), who documented large numbers of *An. gambiae* in containers, domestic run-offs and gutters. *Ae. aegypti* was also found to be high in this study, mostly their remarkably high prevalence in tree holes. The indiscriminate breeding habit displayed by *Ae. aegypti* has been reported by Adeleke et al. (2008). Also, according to Sattler et al. (2005) the species preference of breeding site was not only for the site in question but also for the water quality: depth, light and vegetation which served as sources of food and shelter appropriate for their survival and development. According to findings from this study, it was observed that all the mosquito genera preferred shallow water to deep type. It was observed that light does not have much effect on the abundance of *Culex* and *Aedes* while anopheles preferred mostly sunlight and semi-shaded water. In addition, all the mosquito genera found in the study area existed in the habitat without vegetation and in the presence of algae. While it was observed that they lack preference for water with floating plants.

Seasonal variations were also observed in the abundance and distribution of mosquito larvae in the study area. Collections made during the rainy season were about two-third of all the mosquito larvae collected in both rainy and dry season. These findings agreed with that of Bunza, Suleiman, Yusuf and Bala (2010). From this study, the month of June which had the highest amount of rainfall recorded the highest number of larvae encountered during the study. High rate in abundance of mosquito larvae in the month of June and other months of wet seasons showed that rainfall is a key factor in determining mosquito breeding rate. The study in Kenya also showed that the rainy season presents favourable environmental conditions that enhance mosquito breeding and survival through the proliferation of larval habitats and improved humidity respectively (Minakawa, Pamela & Yan, 2002). Also, similar findings by Jaensen, Niklasson and Henriksson (1986) on influence of weather and hydrological conditions on mosquito abundance have been demonstrated. *C. quinquefasciatus* was the most encountered species in all of the eight months of this study. This might be attributed to the presence of open drains, cracked and open septic tanks,flooded drains and natural containers that were mostly polluted with organic matter. while *Ae. aegypti* was another species that was encountered in a high number during both dry and rainy seasons.

This is an indication that the climatic and environmental conditions of Abiriba and Nkporo communities are conducive to support the survival and development of the mosquito vector. Surprisingly, *An. funestus* was only caught in some months of dry season (November and December) and some months of rainy season (April, May and June) in Nkporo community, but was not found at all in all the months of both dry and rainy seasons in Abiriba community. *Anopheles funestus* breeds normally in fairly clean, sunlit, small collections of standing water. This was in existence in some areas of Nkporo community and was probably the reason behind the presence of *A. funestus* in that area.

The outcome of this study indicates that there was a high vector breeding sites and therefore, vector control measures should be properly applied in the area. This requires proper environmental planning and surveillance. This is important to avoid the risk of outbreak of mosquito-borne diseases in the area.

This study has provided vital information to the distribution and abundance of mosquito larvae within Ohafia Local Government Area. A combination of factors of abundant rainfall, tropical temperatures and high relative humidity, breakdown of public pipe borne water systems that cause people to store up water in containers, increase in human development efforts, indiscriminate disposal of tins and cans used for food, all these and many more accounted for mosquito breeding both in dry and wet period of the study. Eliminating such mosquito breeding areas can be an extremely effective and permanent way to reduce mosquito population without resorting to insecticides.

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