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ECOLOGICAL FACTORS FAVOURING MOSQUITOES BREDING IN AKOKO NORTHWEST LOCAL GOVERNMENT AREA, ONDO STATE, NIGERIA

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ABSTRACT

The presence and abundance of mosquito larvae in various aquatic habitats are influenced by specific environmental conditions. This research focuses on analyzing key physicochemical factors, including pH, temperature, dissolved oxygen, total dissolved solids and electrical conductivity and the physical descriptions including Length, breath, nearness to building and the depth, of breeding sites to determine their roles in creating conducive environments for mosquitoes in Akoko North West Local Government Area of Ondo State, Nigeria. Water samples were collected from multiple breeding sites across the Local Government Area, including stagnant ponds, gutters, and marshes. These samples were analyzed for the aforementioned physicochemical parameters using standard laboratory methods. The results indicated that water bodies were acidic (0.36-7.00), moderate temperatures (20.75-29.00^{0}C), moderate dissolved oxygen levels (9.53-19.95), high electrical conductivity (909.50-1985.00µS/cm) and high total dissolved solids (454-945ppm) were most favorable for mosquito larval development. Additionally, Physical description of each of the sites showed that larvae were found in shallow and muddy habitats. The distance between the breeding sites and residential abodes ranged between 3 to 12m, a distance that can easily be covered by vectors, and can allow effective transmission of mosquito borne diseases. The depth in all breeding sites ranged from 0.02 and 0.23, mosquito larvae were seen in breeding sites with depth as low as 0.02 at Ikakumo. Length of the study area had a significant effect on the breeding of *Culex* species, as longer the length values reduced their presence, mean length from all the sampled sites showed no significant difference across settlements. The range of nearness to building was between 0.36m to 12.98m. Nearness to building had a significant effect on the breeding *of Culex sp*ecies. The study concluded that neglected breeding sites should be monitored and controlled through proper drainage systems and education of locals to avoid breeding of mosquitoes in this Local Government Area which can serve as hot spots for mosquito borne diseases in the local environment.

Keywords: Ecological factors, Mosquitoes, Akoko North East, Ondo State

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Introduction

Mosquitoes breed in various types of water bodies, with stagnant water being the most common and suitable for egg-laying (Service, 2010). The breeding habitats can range from natural sources like ponds, marshes, and wetlands to artificial containers such as tires, buckets, and flower pots (Becker *et al*., 2010). Some species, like *Anopheles* Meigen, 1818, prefer clean, unpolluted water, while others, like *Aedes aegypti* Linnaeus, 1762 can breed in urban environments with small water accumulations (Gubler, 2002). Breeding site availability and water quality are crucial factors influencing mosquito population dynamics and distribution (WHO, 2021). Mosquito breeding sites are crucial in the transmission of mosquito-borne diseases, as these locations provide the environment necessary for mosquitoes to reproduce and thrive (Becker, *et al*., 2010). The presence of breeding sites, such as stagnant water bodies, directly correlates with increased mosquito populations, which enhances the risk of disease outbreaks like malaria, dengue fever, and Zika virus (WHO, 2021). *Anopheles* mosquitoes, which are vectors for malaria, often breed in clean, sunlit water, making areas with such conditions more prone to malaria transmission (Becker, *et al*., 2010). Similarly, *A aegypti,* the primary vector for dengue and Zika viruses, breeds in small containers of water commonly found in urban settings, linking urbanization and improper waste management to these diseases (WHO, 2021; Adeyekun *et al.,* 2025). The concentration and distribution of mosquito breeding sites can significantly influence the geographical spread of diseases, impacting public health measures and resource allocation (Foster and Walker, 2019). The objectives are to know the breeding sites of mosquitoes in Akoko North East as there is lack of data on mosquito breeding sites from this Local Government Area, establish the species of mosquito common to each breeding sites which included Anophelines and Culicines and to find out the relationship between different types of breeding sites and mosquito species.

Materials and Methods

Study Area

Akoko North East is a Local Government Area (LGA) (Fig. 1) located in the northern part of Ondo State, Nigeria. The area is part of the larger Akoko region. The administrative headquarters of Akoko North East is Ikare-Akoko, the largest town in the LGA and a major commercial and cultural hub. The economy of Akoko North East is predominantly agrarian, with agriculture being the mainstay for most residents. Ugbe-Akoko is closely linked to Ikare-Akoko and shares many of its cultural and economic characteristics. Major crops grown in the area include yam, cassava, maize, and cocoa (National Bureau of Statistics, 2021).

Study Method

This research was conducted for three months, from January-May 2024. Advocacy visits were paid to the heads of the Communities before samplings. Samplings were done randomly by searching for breeding sites at the four cardinal areas, starting from the epicentre of the communities. Apparatus used on the field included Surveying tape used to measure the length and breadth of the breeding sites as well as the nearest to building, Garmin GPS device used to determine the coordinates of each village and the breeding sites, meter rule for measuring the depth of the breeding sites, hand-held Multimeter by Yieryi, China, for measuring of physicochemical parameters (pH, temperature, electrical conductivity, and total dissolved solid), these parameters were chosen based on the direct effects they have on Dipterous breeding, the multimeter was calibrated before usage based on manufacturers instruction and reagents, calibration was done at intervals of once per week. 100 ml plastic dippers for larvae collection,

transportation containers, experimental gloves and safety boots were worn to prevent contact with the polluted water; other equipments were Pasteur pipettes, white handkerchiefs and sieves. Collected water samples from each site were taken to the laboratory and placed in rearing cages, adult mosquitoes thereafter were preserved in 1.5ml Eppendorf tubes containing prepared silica gel and were identified.

Statistical Analyses

Larvae density and larvae abundance were calculated immediately at the study site to know the number of larvae collected per site and village.

$$\text{Larvae density} = \frac{\text{Total number of larvae per site}}{\text{Total volume of water, in ml}}$$

$$\text{Larvae Abundance} = \frac{\text{Total number of larvae in a village}}{\text{Total number of positive sites}}$$

The mean of physicochemical parameters and physical descriptions, correlation coefficients between physicochemical parameters, physical description of sites and larvae density were determined by correlation analysis and comparison of the mean using SPSS (Statistical Package for Social Science) version 24.0.

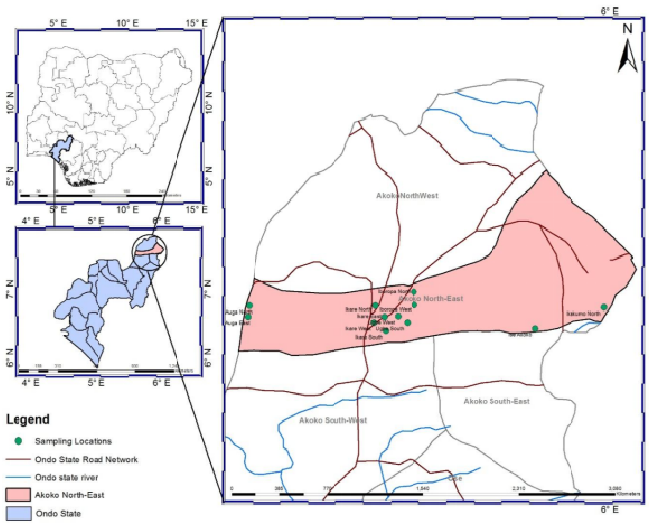

Fig. 1: Map of Study Area.

Results

Table 1 showed the mean of physical parameters (Length, Breadth, Depth and Nearness to Building) and Larva Density of mosquito breeding sites in Ikare, Ugbe and Ikakumo of Akoko North East local government area in Ondo state. The mean of nearness to building in Ikare (0.36+0.28) and Ikakumo (3.72+0.00) revealed that the breeding sites for the mosquitoes were very close to residence, which could allow effective transmission of mosquito borne disease in the local government areas. Mean depth from all the sites showed that sites at Ikare, Ugbe, and Ikakumo were significantly different as presented in Table 1. Negative correlation existed between the larval abundance and the physical characteristics as seen in Table 2, implying the higher the larval abundance the lesser the human interaction with the sites.

Table 3 showed the mean of physicochemical parameters and larvae density of water samples at different towns within and around the study area, which revealed a significant difference across the villages. Table 4 showed the correlation coefficients between water physicochemical parameters and larvae density. It was seen that the larvae density had a positive correlation with the following; electrical conductivity (0.24), pH (0.23), total dissolved solid (0.25) and dissolved oxygen (0.72), implying increase in these physicochemical parameters in the environment encouraged breeding of mosquitoes and also the acidic nature of the water bodies favoured mosquito breeding.

Fig. 2 revealed the larva density of the mosquitoes found in the study area. It was seen that Ugbe south, Ugbe west and Ikare south has a high larva density while Ikare north and Ikare west has mid larva density.

Table 1: Mean of Physical Parameters and Larvae Density of Water Samples at Different Study area

Location	Length (m)	Breadth (m)	Depth (m)	NTB (m)	LD
Ikare	2.19 ± 2.54^{b}	1.28 ± 1.48^{b}	0.23 ± 0.20^{a}	0.36 ± 0.28^{a}	0.13 ± 0.14^{a}
Ugbe	11.7 ± 6.77^{ab}	6.64 ± 10.35^{ab}	0.12 ± 0.02^{a}	12.61 ± 12.98^{ab}	0.10 ± 0.11^{a}
Ikakumo	0.63 ± 0.00^{a}	0.51 ± 0.00^{a}	0.02 ± 0.00^{a}	3.72 ± 0.00^{b}	0.06 ± 0.00^{a}

Means having the same alphabet down the column are not significantly different from one another at p>0.05
Keys: NTB: Nearest to Building, LD: Larvae Density

Table 2: Mean Values of Physicochemical Parameters, Physical Parameters and Larvae Density

Location	EC (µS/cm)	Temp (^{0}C)	pH	TDS (ppm)	DO_2	LD
Ikare	909.5 ± 554.58^{a}	20.75 ± 0.73^{a}	7.08 ± 0.75^{a}	454.00 ± 277.04^{b}	19.95 ± 22.96^{ab}	0.13 ± 0.14^{a}
Ugbe	1409.67 ± 740.06^{ab}	21.17 ± 2.30^{a}	7.06 ± 0.70^{a}	712.33 ± 354.22^{ab}	$9.53 \pm .38^{b}$	0.10 ± 0.11^{a}
Ikakumo	1985.00 ± 0.00^{a}	29.00 ± 0.00^{b}	0.36 ± 0.00^{b}	945.00 ± 0.00^{ab}	11.00 ± 0.00^{a}	0.06 ± 0.00^{a}

Table 3: Correlation of Physical Parameters and Larvae Density of Water Samples at Different in Study Area

Variables	Length	Breadth	Depth	Nearest to Building	Larvae Density
Length	1				
Breadth	-0.025	1			
Depth	0.109	-0.231	1		
Nearest to Building	0.375	-0.195	0.321	1	
Larvae Density	-0.409	-0.357	-0.038	-0.433	1

Means having the same alphabet down the column are not significantly different from one another at p>0.05
Keys: EC- Electrical Conductivity, TDS-Total Dissolved Solid, LD- Larvae Density

Table 4: Correlation between Water Physicochemical Parameters and Larvae Density

Variables	EC	Temp	pH	PPM	DO2	LD
EC	1					
Temp	0.69	1				
Ph	-0.34	-0.87	1			
PPM	0.99	0.65	-0.30	1		
DO2	0.45	0.03	0.28	0.46	1	
LD	0.24	-0.13	0.23	0.25	0.72	1

EC- Electrical Conductivity, Temp- Temperature, TDS- Total Dissolved Solid, LD- Larvae Density

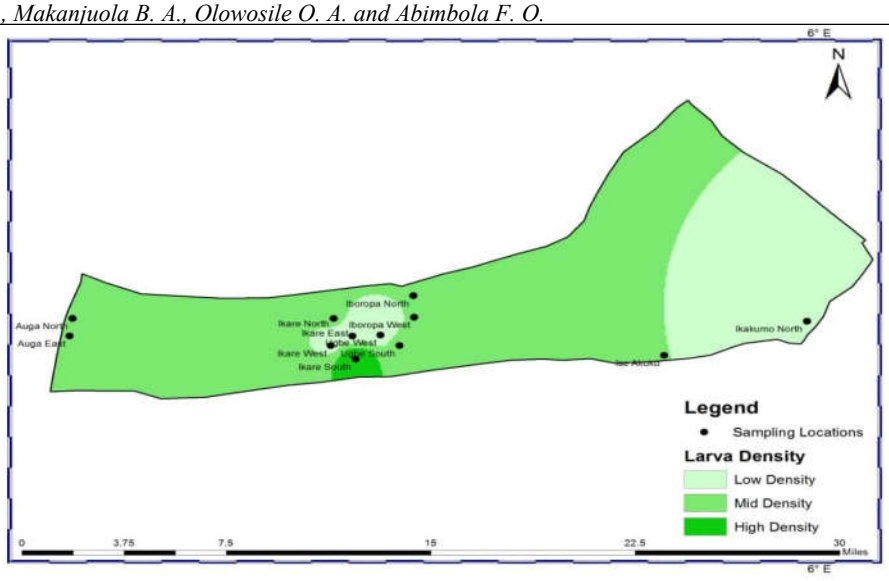

Figure 2: Larva Density of the breeding sites

Discussion

Most of the mosquito breeding sites visited were exposed to direct sunlight and turbid which aided the abundance and breeding of mosquitoes. Gravid females use open and turbid habitats for oviposition because such sites are warm and reduce larva and pupal development time (Adeyekun, 2021). Majority of the sites encountered were permanent breeding sites and supported mosquito larvae breeding. Physical description of each of the sites showed that larvae were found in shallow and muddy habitats. The distance between the breeding sites and residential abodes ranged between 3 to 12 m, a distance that can easily be covered by the vectors, and can allow effective transmission of mosquito borne diseases in the local government area. Length, breadth, depth and nearness to building were found to be the main variable influencing the abundance and distribution of mosquito larvae and predators in habitats investigated. Depth had significant effect on all the mosquito species larvae as higher depth values increases the number of these species. The depth in all breeding sites ranged from 0.02 and 0.23, mosquito larvae were seen in breeding sites with depth as low as 0.02 at Ikakumo. Mean depth from all the sites showed that sites at Ikare, Ugbe and Ikakumo were significantly different as presented in Table 1. Aedes adapt to a wide range of depth as they nominated most of the habitats revealing that depth is a major factor in the distribution of mosquitoes (Adeyekun *et al.,* 2022). Length of the study area had a significant effect on the breeding of *Culex species*, as higher the length values reduced their presence. Length had no significant effect on the other species, mean length from all the sampled sites showed no significant difference across settlements. The range of nearness to building was between 0.36m to 12.98m as shown in Table 1. Nearness to building had a significant effect on the breeding of *Culex sp* as higher nearness to building reduced its presence, but had no effect on the other species.

The findings reveal significant variability among villages and provide insight into how these factors may influence mosquito habitat suitability (Oniya *et al.,* 2019; Mbanzulu *et al*., 2022. High electrical conductivity values in Ikakumo suggest higher concentrations of dissolved ions in the water, potentially indicating more nutrient-rich environments. This nutrient enrichment could create favorable conditions for mosquito larvae development, as these environments often support

more abundant microbial growth and organic matter, which serve as food for larvae (Faiman *et al*., 2019). Temperature measurements showed the highest value in Ikakumo (29.00 ± 0.00°C) and the lowest in Ikare (20.75 ± 0.73°C). Temperature is a critical factor influencing mosquito breeding as it affects the metabolic rate and developmental stages of mosquito larvae. Higher temperatures, such as those in Ikakumo, typically accelerate larval development and can increase the frequency of mosquito breeding cycles. Conversely, the lower temperatures in Ikare might result in slower development and fewer breeding events, potentially leading to a lower mosquito population in this village (Faiman *et al*., 2019).

The pH levels in the studied villages ranged from highly acidic in Ikakumo (0.36 ± 0.00) to more neutral in Ikare (7.08 ± 0.75). Acidic conditions are generally less favorable for mosquito larvae compared to neutral or slightly alkaline conditions. However, given the high conductivity and temperature in Ikakumo, other factors might mitigate the adverse effects of low pH, allowing mosquito larvae to persist despite the acidic environment (Dickson *et al*., 2017). The TDS was highest in Ikakumo (945.00 ± 0.00 mg/L) and lowest in Ikare (454.00 ± 277.04 mg/L). Higher TDS levels suggest a greater concentration of dissolved substances, which, similar to electrical conductivity, can indicate a more nutrient-rich environment. High TDS levels in Ikakumo may contribute to a more conducive habitat for mosquito larvae by providing ample nutrients and supporting a diverse microbial community. This may explain the higher larvae density observed in Ikakumo compared to other villages.

The highest mean DO was recorded in Ikakumo (11.00 ± 0.00 mg/L), and the lowest in Ugbe (9.53 ± 0.38 mg/L). Dissolved oxygen is crucial for the survival of aquatic organisms, including mosquito larvae. Higher DO levels in Ikakumo could support a more robust aquatic ecosystem, potentially including a larger population of mosquito larvae. Adequate oxygen levels are essential for healthy larvae development, making Ikakumo's high DO levels a factor that could enhance breeding conditions despite other potentially less favorable conditions (Dickson *et al*., 2017).

Larvae density was highest in Ikare (0.13 ± 0.14 larvae per liter) and lowest in Ikakumo (0.06 ± 0.00 larvae per liter). Although the larvae density values showed no significant difference among villages, the trend observed is noteworthy. Despite the high conductivity, temperature, and TDS in Ikakumo, which are generally favorable for mosquito breeding, the larvae density is lower than expected. This could be due to other environmental or ecological factors not measured in this study, such as predation, habitat structure, or the presence of larvicides.

The study indicates that several physicochemical parameters have varying degrees of influence on mosquito breeding sites within Akoko North East LGA. High electrical conductivity, temperature, and TDS in Ikakumo create an environment that is generally conducive to mosquito larvae development. However, the anomalously low pH and the lower larvae density in Ikakumo suggest that other factors may play a role in shaping the mosquito populations. Conversely, Ikare, with its lower temperature and higher pH, shows a higher larvae density, indicating that pH and temperature might also interact in complex ways to influence breeding site suitability.

The major limitation of the study is the dryness of the environment being a derived savanna, insecurity in some of the local areas was also a limiting factor.

Conclusion

Physicochemical parameters of water play a crucial role in determining the suitability of breeding sites for mosquitoes. This study, conducted across different villages in the Akoko

North East Local Government Area, has highlighted significant variations in key water quality indicators, including electrical conductivity, temperature, pH, total dissolved solids (TDS), and dissolved oxygen (DO). These variations impact mosquito larvae density and, consequently, the potential risk of mosquito-borne diseases. There is need for improving drainage systems, reducing stagnant water and proper education of the locals to prevent outbreak and spread of mosquito borne diseases.

Conflict of Interest

The authors have declared that no competing interests exist.

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