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Assessment of *Wuchereria Bancrofti* in Indoor Resting Mosquitoes in Port Harcourt Local Government Area. Rivers State, Nigeria.

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ABSTRACT

Background and Objective: Mosquitoes are known to transmit serious diseases including yellow fever, zika virus, malaria, filariasis, and dengue fever. This study was designed to assess the presence of *Wuchereria bancrofti* indoor resting mosquitoes present in Port Harcourt Local Government Area, Nigeria**.**

Material and Methods: A total of 240 structures (screed Mud, Zinc, Block, wood and thatch) were randomly sampled to obtain the indoor resting density across the four (4) study stations (Port Harcourt Township, Marine Base, Diobu and Eagle Island). Indoor resting mosquitoes were collected using pyrethrum spray catch method between 6am – 10am for 12 months Survey (March 2023 to February 2024). The knock down mosquitoes collected were taken to Rivers State University Entomology Laboratory for identification and dissection. Analysis of variance (Anova) and Student t-test was used to test significant difference.

Results: The number of structure (house) patterns varied across stations, the highest was recorded in block 105 (43.75%), followed by zinc 54 (22.5%), wood 45 (18.75%), Screed mud 30 (8.75%), and thatch 9(3.75%). Anova showed significant difference at a P-value of 0.003. Indoor resting density (IRD) of mosquitoes of 7.1 was recorded from six (6) species namely; *Culex quiquefasciatus* (2.6), *Anopheles gambiae s.l* (1.6), *Culex tigripes* 1.0, *Culex pipens* (0.9*), Anopheles funestus* (0.6), and *Aedes egypti* (0.5). Analysis of variance showed significant difference at a P-value of 0.0001. Marine Base had IRD of 7.8, Diobu 7.4, Port Harcourt Township 7.3 and the least IRD was recorded at Eagle Island 5.8. There was no significant difference at a P-value of 0.92. The seasonal variation of indoor resting mosquitoes had the highest collection of mosquitoes in wet season at an IRD of 4.87 and the least collection was recorded at dry season at an IRD of 2.12. Student t-test showed statistically not different at P=0.010547. The abdominal characteristics of the indoor resting mosquitoes were observed; freshly fed, unfed, Gravid and half gravid d (31.2%, 29.9%, 19.4%, 19.2%) respectively. Analysis of variance showed significant difference at a P-value of 0.52. The number of mosquitoes dissected was 1,179 (70.0%). *Cx. quinquefasciatus* 438 (37.2%), *An. gambiae s.l* 245 (20.8%), *Cx. tigripes* 179 (15.2%), *Cx. pipiens* 151(12.8%), *An. funestus* 95 (8.0%) and *Ae. egypti* 71(6.0%). Analysis of variance showed significant difference at a P-value of 0.0001. A total of 37 (3.1%) mosquitoes harbored *Wuchereria bancrofti*. *Culex quinquefasciatus* 32 (2.7%), and *Cx. pipiens* 5 (0.4%) respectively. Analysis of variance showed significant difference at a P-value of 0.0001. The highest infection rate was recorded in Diobu 17 (1.4%) and Marine Base 11 (0.9%), followed by Port Harcourt Township 7 (0.5%), and Eagle Island 2 (0.1) respectively. Analysis of variance showed significant difference at a P-value of 0.014.

Conclusion: The lack of good drainage, waste and sewage system contributed to the high rate of mosquitoes in Port Harcourt, so proper and modern drainage system should be erected by the government and environmental sanitation should be enforced on the residents by Rivers State Government in Port Harcourt Local Government Area.

Key words: *Wuchererеia bancrofti*, Mosquitoes, Indoor resting density, *Culex*, *Anopheles*, *Aedes*, Port Harcourt.

Introduction

Mosquitoes are known as annoying biting pests and vectors of disease-causing agents to humans and other animals. The slender, elongated body of the adult is covered with scales as are the veins of the wings. Mosquitoes are also characterized by long, fragile-looking legs and elongated, piercing mouthparts. The feathery antennae of the male are generally bushier

than those of the female [1]. The males and sometimes the females, feed on nectar and other plant juices. In most species, however, the females require the proteins obtained from a blood meal in order to mature their eggs. Different species of mosquitoes show preferences and in many cases, narrow restrictions as to host animals. Mosquitoes are apparently attracted to host animals by moisture, lactic acid, carbon dioxide, body heat, and movement [2].

Mosquitoes are important because of their immense significance as vectors and pests of both man and animal [3, 4]. The accurate identification of mosquito vector species and knowledge of their biology, ecology, and geographical distribution are considered important factors for surveillance and control of vectors and mosquito-borne diseases [5]. Morphological identification is the gold standard and the conventional method to identify mosquito species depending on their external characters [6]. Mosquitoes which breed and transmit disease in Nigeria, are guided by human activities, urbanization and overcrowding as well as industrialization which together create multiple breeding sites [7]. The availability and proximity of human settlements to these numerous breeding sites of the vectors play significant role in the disease transmission and intensity in both rural and urban areas [8].

Wuchereria bancrofti is a parasitic nematode transmitted to humans by various mosquito vectors such as; *Anopheline, Culex, Aedes and Mansonia play variable roles depending on the geographic context [*9, 10*]*. In Nigeria, Lymphatic filariasis continues to pose a significant public health burden within the South-south and the South-east regions and among those moderately affected [11]. The presence of mosquito densities contributes to persistent transmission [12]. National campaigns including mass drug administration (MDA) and distribution of insecticide treated nets have made strides in controlling Lymphatic filariasis. Entomological surveillance remains critically important in understanding the ongoing transmission dynamics [11]. Assessing indoor resting mosquitos is practically valuable in estimating local LF transmission potential, pyrethrum spray catch (PSC) methods enables researchers to sample mosquitoes resting in houses, providing direct insight into the population of vectors that have fed recently and may harbor infective larvae [13]. Studies employing PSC and dissection techniques in sentinel communities have revealed varying infection and infective rates, highlighting localized transmission intensity and guiding control efforts [14]. However, gaps remain in the literature regarding entomological assessments in Port Harcourt Local Government Area (LGA) of Rivers State, while community awareness studies have identified active transmission of LF and its misconceptions influencing control strategies in the region. [15].

Comprehensive investigations into the presence and infectivity of indoor resting mosquitoes in Port Harcourt LGA are lacking. This underscores the need for targeted entomological surveillance to inform localized intervention strategies. Therefore, this study aims to assess the presence of *Wuchereria bancrofti* in indoor resting mosquitoes collected with-in Port Harcourt LGA, by employing standardized sampling and dissection approaches, this work will elucidate the extent of vector borne LF transmission in the region and contribute to evidence based vector control and elimination efforts, while direct epidemiological or entomological data on *Wuchereria bancrofti* specifically with Port Harcourt Government Area remains scarce, broader research in port Harcourt valuable insights. Though, the presence of LF is acknowledged in Port Harcourt, specific surveillance data such as infection prevalence, vector distribution, or clinical morbidity with in Port Harcourt Local Government Area is currently unavailable in published literature, this gap highlights a critical need for localized entomological and epidemiological studies.

Materials and methods

Study Area: Port Harcourt Township is the central area and administrative hub of Port Harcourt, the capital of Rivers State, Nigeria. It serves as the cultural, commercial and social center of the city. Port Harcourt township coordinates are 4.45’35’’N and 7.1’47” E (Fig 3.1). Port Harcourt Township is characterized by a mix of residential, commercial and government buildings. The township also accommodates numerous banks, shopping centers, markets, restaurants, and entertainment venues. The area is well planned with wide roads, pedestrian walkways, and green spaces.

Marine Base is one of the slum settlements in central Port Harcourt. The settlement, which covers about 7,338 meters. The settlement is surrounded by creeks, is dotted with shanties and makeshift structures. The settlement provides accommodation to low income earners who cannot afford the high cost of apartments in the main city center of Port

Harcourt. Marine Base coordinates are latitude 4.76983 and longitude 7.0272 (Fig 3.1). The settlement in marine base is characterized by filthy and unkempt environment as many of the residents do not have good toilet facilities in their houses. It is also devoid of basic amenities, such as pipe-borne water and steady electricity supply.

Diobu is a densely populated neighborhood in Port Harcourt, Rivers State, it is located within the Port Harcourt metropolis. Although the neighborhood ranks among one of the oldest, and commercially vibrant places in the city, about a third of its residents live below the poverty level. The coordinates of Diobu are: 4°47'24"N, 6°59'36"E (Fig 3.1). Most of the commercial activities existing in Diobu are brought about by its numerous marketplaces. The neighborhood is a home to a mix of residential, commercial, and industrial areas. It has a rich history and is considered a meeting point of different ethnic groups and cultures. Overall, Diobu is a vibrant and dynamic part of Port Harcourt, contributing to the city's economic and cultural growth.

Eagle Island is a residential area that was developed to accommodate the growing population of Port Harcourt. It is surrounded by water bodies, including the New Calabar River and the Old Calabar River, which gives the neighborhood a unique geographical setting. The coordinates of Eagle Island are 4.7828515 and 6.9772897 (Fig 3.1). The neighborhood is known for its well-planned layout, with wide roads, green spaces, and modern infrastructure. It is divided into several sections, each with its own designated area for residential, commercial and recreational purpose. Eagle Island offers a serene environment with waterfront views and a relatively peaceful atmosphere compared to the bustling city of Port Harcourt. Overall, Eagle Island in Port Harcourt provides a residential community with its own distinct character and amenities, contributing to the urban and landscape of the city.

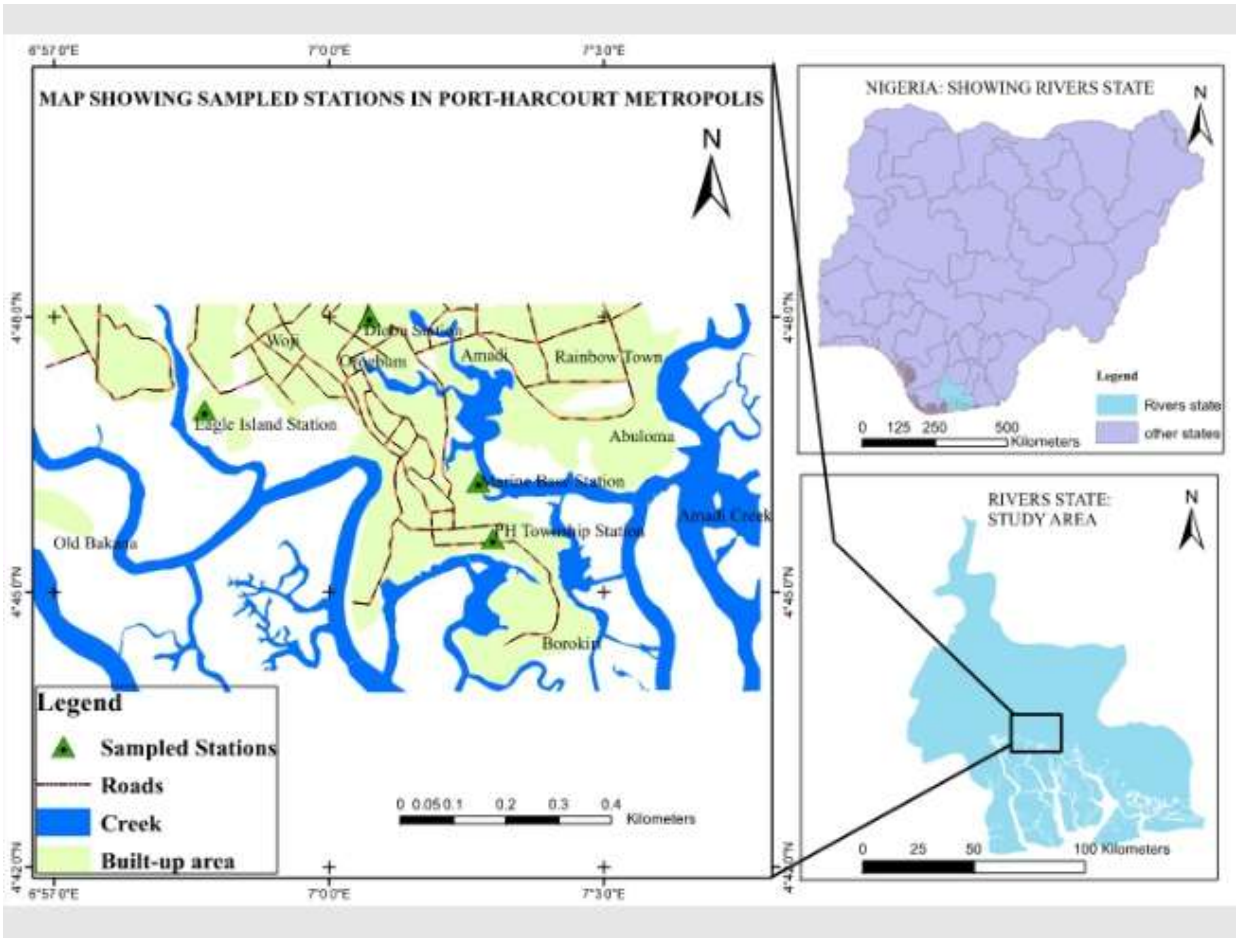


Figure 3.1: Map Showing Sampled Stations in Port Harcourt Local Government Area

Assessment of the Sampling Stations: The housing structures were made up of thatch, screed mud, wood, block and zinc houses. Some houses bear resemblances of traditional architectural pattern with mud walls and thatched roofs. The sources of water for the communities are borehole, rainfall and streams, few of the study sites are surrounded by chains of Islands. Thus, some are located within the coastal region of Port Harcourt city and they can all be reached by road and boats (local and speed boats). Much of the Area is water logged, settlement pattern is a random type and human inhabitants are confined to families and compounds. Business, civil servant work, oil and gas, transport and fishing are the main occupations engaged by the residents, these occupations run along gender lines. Business is done by both female and males, while fishing is predominantly a male occupation and is done more intensively at morning and night in the coastal stations. The stations were geo-referenced and recorded (Fig 3.1).

Ethical Consideration: Verbal informed consent was obtained from the head of each of the randomly selected households before their houses were accessed for mosquito collection in all the four (4) study localities. Adult mosquitoes were collected four (4) times in a month from 240 houses in two overlapping seasons; wet (April-November) and dry (December-March). The structure (houses) were consistently used throughout the twelve (12) months sampling period.

Assessment of Indoor Resting Density of mosquitoes: Structures (rooms) were randomly selected and sampled across the four study locations (Port Harcourt Township, Marine Base, Diobu and Eagle Island) in a duration of 12 months (March 2023 to January 2024). Five [5] houses (rooms) were sampled per station and month, summing it up to twenty [20] structures in a month for the four stations, sixty [60] structures per station in twelve [12] months, a grand total of 240 structures in a validity period of twelve [12] months. Structure patterns varied across station and they are: Thatch, Zinc, Block, Screed Mud, and Wood. The Indoor Resting Density (IRD) was calculated using the formula by [17] criteria; IRD = No of Mosquitoes collected/number of structures sampled.

Collection of Mosquito Samples: Sampling structures were randomly selected from four localities: Port Harcourt Township, Marine Base, Diobu, and Eagle Island. Adult mosquito indoor collection was carried out during the morning hours between 6am – 10am following the standard of WHO [16] procedure. Total indoor resting mosquito were collected using a pyrethrum spray method [17].

A Commercial grade pyrelthroid insecticide (Raid) was used due to availability and safety. The pyrelthroid spray catch (PSC) involve removing all large pieces of furniture, covering the floor with while sheets. Insecticide was sprayed from outside of the house onto the windows, and doors before entering inside the house and spraying the entire inside of the selected room. All doors and windows remained close for 10 – 15 minutes after spraying to allow for mosquitoes' knockdown. The doors were shut and reopened after 10-15 minutes for harvesting of the knockdown mosquitoes [18].

All dead and immobile mosquitoes were collected carefully with a forceps and placed in a petri dish lined with a what man paper and the Petri dishes were properly labeled following the different catching zones with specific house pattern. The collections were taken to the Rivers State University Entomology Laboratory for immediate analysis.

Mosquito Identification: A dissecting microscope was used for detailed observation and proper identification of mosquitoes based on their morphological features [1] with particular reference to the head, thorax, wings, and hind legs according to [19]. Morphological characteristics such as length of maxillary palps, wing patterns spots, leg banding, scales, mouthparts (proboscis) and abdominal end model were used to identify the *Anopheles, Culex, Aedes* mosquitoes that exist in Port Harcourt Local Government Area.

Statistical Analysis: Data were entered in Microsoft Excel and transferred to Minitab 18 for analysis. Analysis of variance (Anova) was examined to check significant difference at $P<0.5$. Mean separation was done using Tukey Multiple Comparison Tests. Indoor Resting Density was calculated using the formula by [20]: IRD = Total number of mosquito's collected/Total number of structures (rooms) sprayed. The IRD of mosquito's seasonal variation between wet and dry was analyzed using student t-test. ArcGIS version 10.2.1 software was used for mapping the study stations. Temperature and Relative humidity was recorded in the study locations using thermal-hydrometer.

RESULTS

The number of structures (house) patterns varied across stations the highest was recorded in block 105 (43.75%), followed by zinc 54 (22.5%), and wood 45 (18.75%). Screed mud 30 (8.75%) and thatch 9 (3.75%), recorded the least respectively (Fig. 4.1). Analysis of Variance showed significant difference at a P-value of 0.003.

The number of mosquitoes sampled in structure (house) patterns comprises of block 498 (29.6%), wood 435 (25.9%), zinc 421 (25%), screed mud 181 (10.8%) and thatch 108 (6.42%) respectively (Fig 4.2). Analysis of variance showed no significant difference at a P-value of 0.09.

In the indoor density of mosquitoes, a total of 7.1 mosquitoes was recorded from six (6) species. *Culex quinquefasciatus a*nd *Anopheles gambiae S.I.* recorded the highest indoor resting density values of 2.6 and 1.6, followed by IRD of *Culex tigripes* 1.0, *Culex pipens* 0.9. While *Anopheles funestus* and *Aedes egypti* recorded the least IRD values of 0.6 and 0.5 respectively (Fig. 4.3).

Analysis of variance showed significant difference at a P-value of 0.0001 (Appendix 2). Statically, only *Culex quinquefasciatus* showed significant difference in IRD values when compared to other species.

The indoor resting density (IRD) of mosquitoes across the stations showed Marine Base had the highest IRD of 7.8, followed by Diobu 7.4, Port Harcourt Township 7.3 and the least IRD was recorded at Eagle Island 5.8 respectively (Fig. 4.4). Analysis of variance showed no significant difference at a P-value of 0.92.

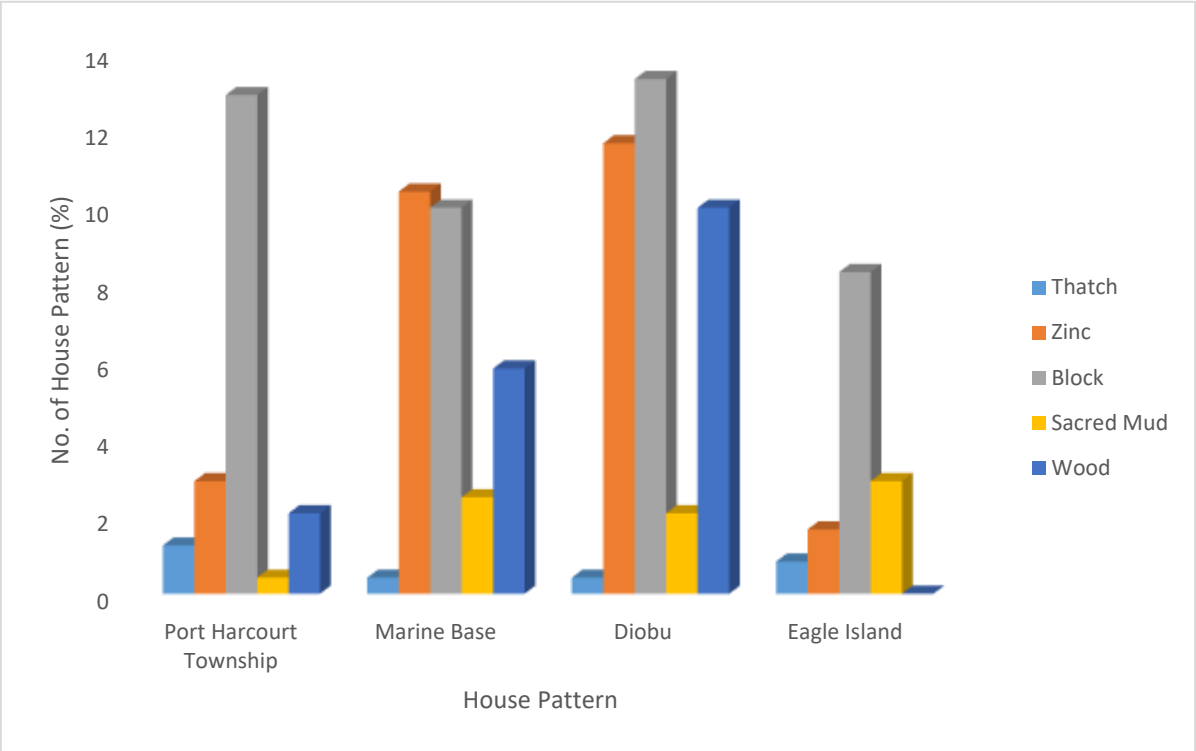


Fig 4.1 Number of Structure (House) Patterns Sampled

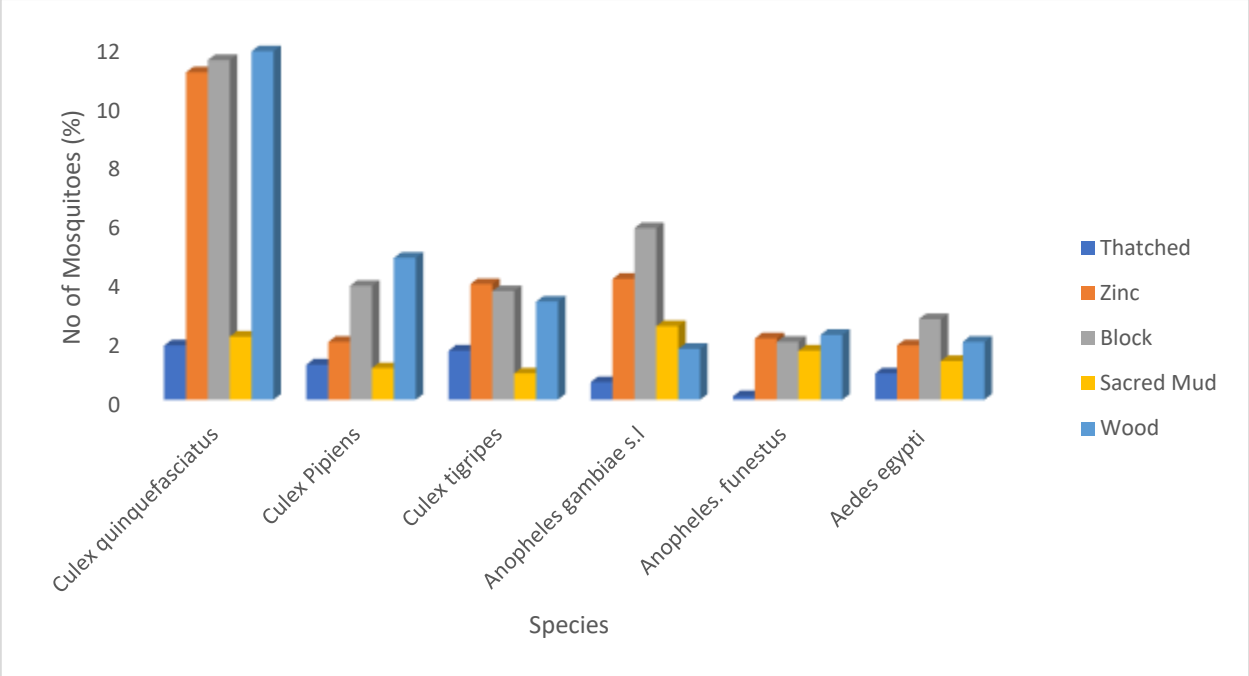


Fig 4.2 Number of Mosquitoes in Structure (House) Patterns

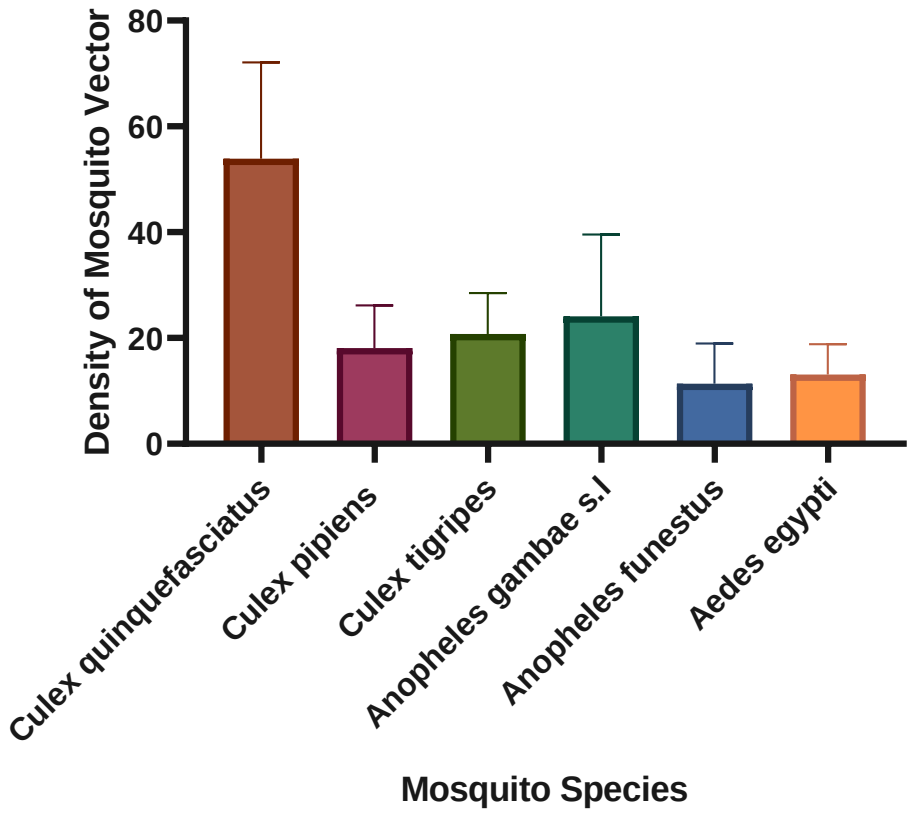


Fig. 4.3: Indoor Resting Density of Mosquitoes

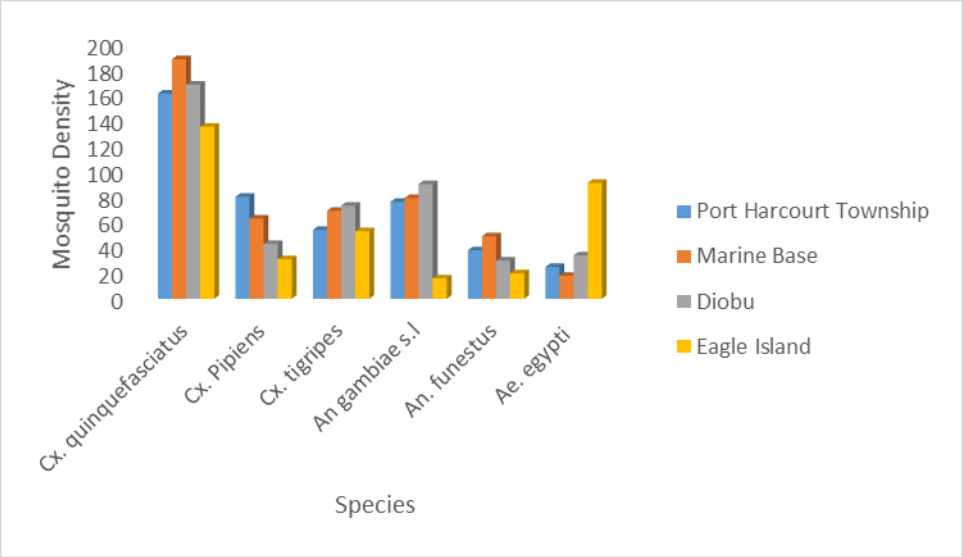


Fig. 4.4: Indoor Resting Density of Mosquitoes across Stations

The seasonal variation of indoor resting mosquitoes (species) had the highest collection of mosquitoes in wet season at an IRD of 4.87 *(Cx. quinquefasciatus* 1.82, *Cx. pipens* 0.61, *Cx. tigripes* 0.7, *An. gambiae S.I* 0.88, *An. funestus* 0.43 and *Ae. egypti* 0.41). The least collection was recorded at dry season at an IRD of 2.12 (*Cx. quinquefasciatus* 1.87, *Cx. pipens* 0.29, *Cx. tigripes* 0.33, *An. gambiae s.I* 0.31, *An. funestus* 0.12 and *Ae. egypti* 0.2) respectively (Fig. 4.5). There was significant difference at a P-value of 0.001. The difference occurred at *Cx. quinquefasciatus* and *An. funestus* at a P-value of 0.05 and 0.04 respectively.

The seasonal variation of indoor resting mosquitoes had the highest collection of mosquitoes in wet season at an IRD of 4.87 (APR-0.81, MAY-0.58, JUN-0.67, JUL-0.67, AUG-0.76, SEP-0.64 and OCT-0.74). The least collection was recorded at dry season at an IRD of 2.12 (NOV-0.60, DEC-0.37, JAN-0.28, FEB-0.37 and MAR-0.5) respectively (Fig. 4.6). Student t. test showed statistically not different at P=0.010547.

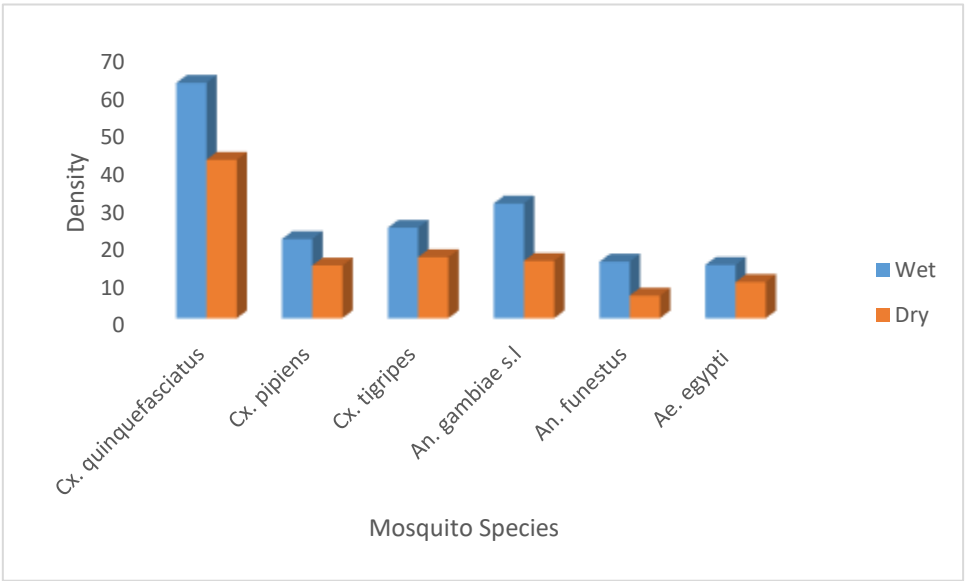


Fig 4.5 Indoor Resting Density of Mosquitoes in Wet and Dry Season

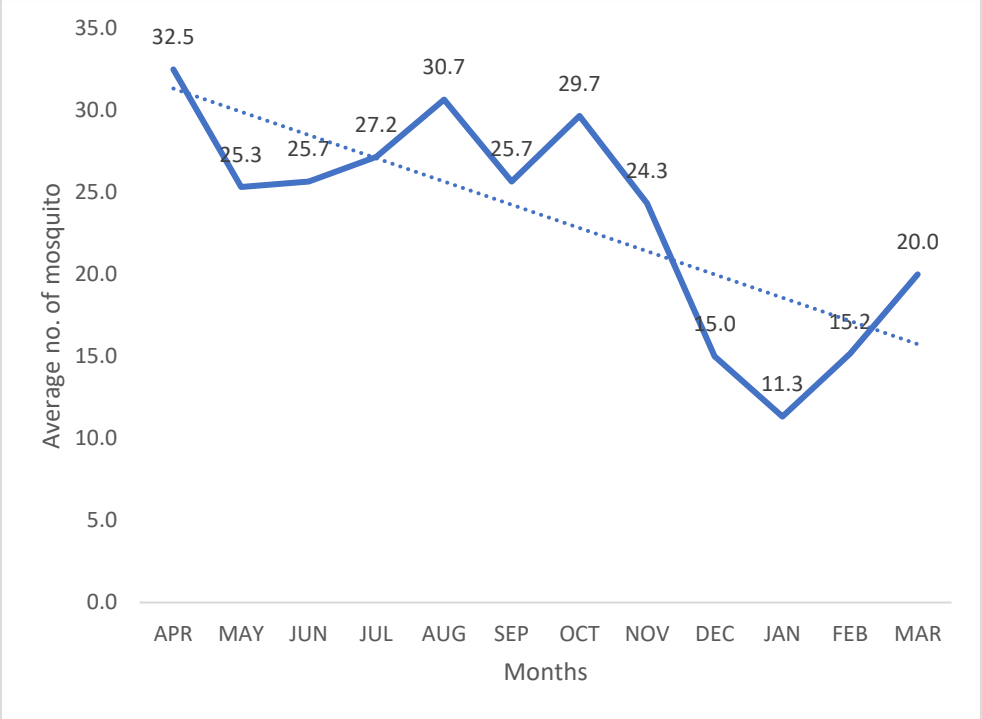
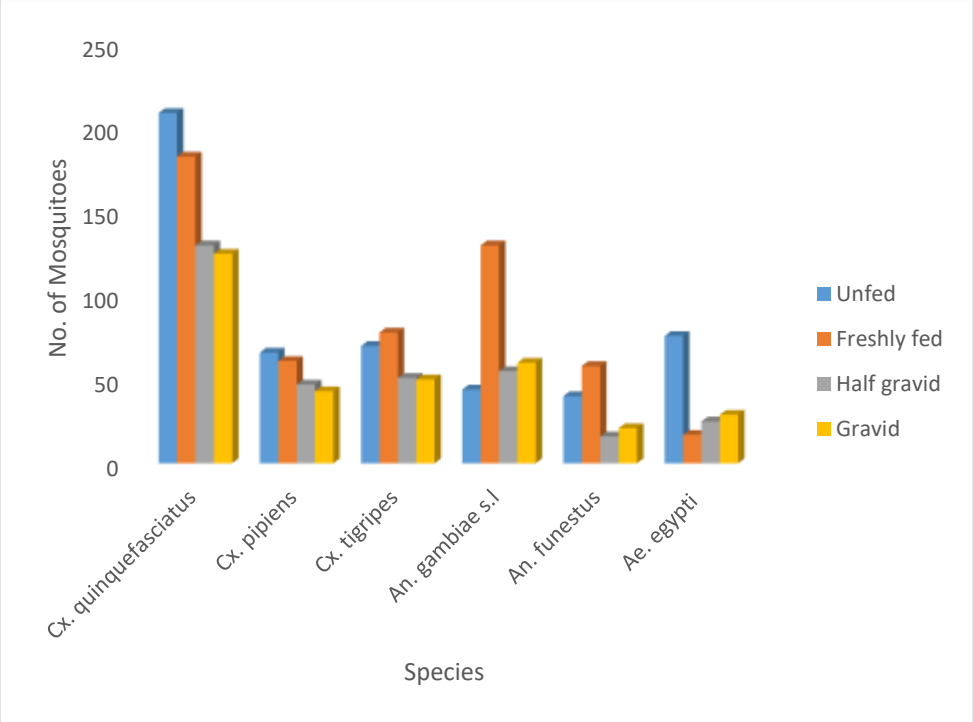
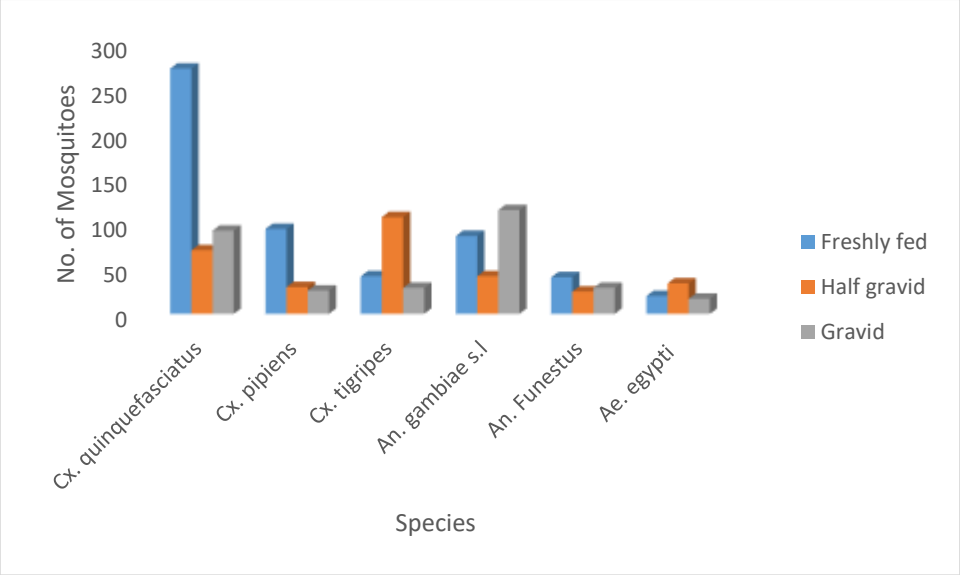


Fig. 4.6: Seasonal Variation of Indoor Resting Mosquitoes



4.7 Abdominal Characteristics of Mosquitoes



4.8 Number of Mosquitoes Dissected

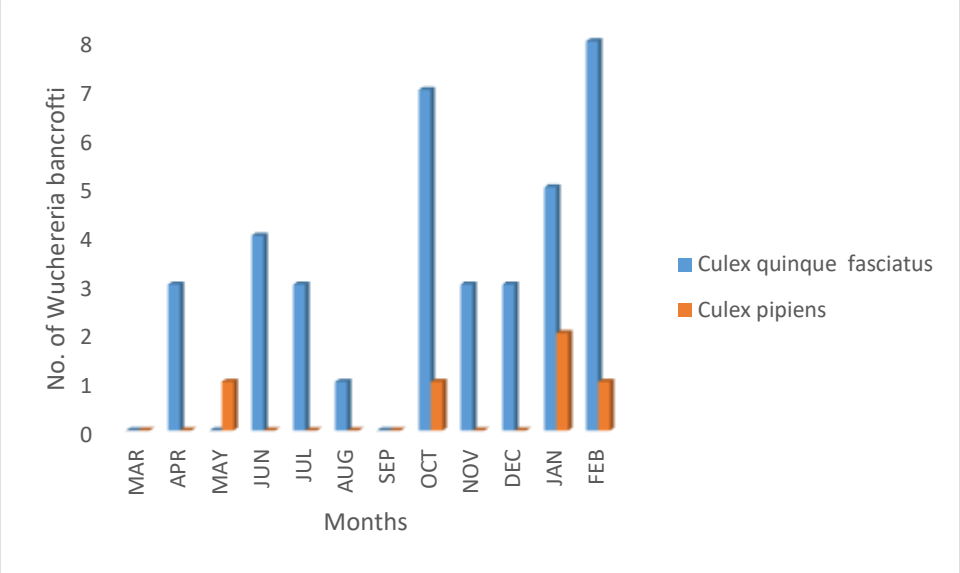


Fig 4.10 Detection of *Wuchereria bancrofti (microfilaria)* in Mosquitoes

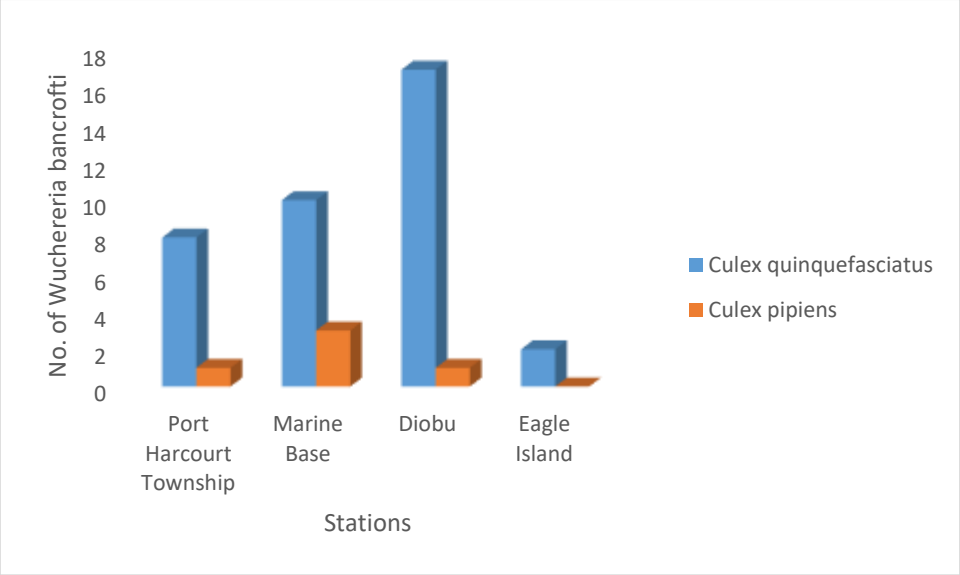


Fig 4.11 Detection of *Wuchereria bancrofti* (microfilaria) in Mosquitoes across Stations

The abdominal characteristics of the indoor resting mosquitoes were observed and the highest were recorded by freshly fed and unfed (31.2%, 29.9%) respectively. Gravid and half gravid had the least value (19.4%, 19.2%) respectively (Fig 4.7). Analysis of variance showed significant difference at a P-value of 0.52.

The number of mosquitoes dissected was 1,179 (70.0%). *Cx. quinquefasciatus* recorded the highest value of 438 (37.2%), followed by *An. gambiae s.l* 245 (20.8%), *Cx. tigripes* 179 (15.2%), *Cx. pipiens* 151(12.8%). The least value was recorded in *An. funestus* 95 (8.0%) and *Ae. egypti* 71(6.0%) respectively (Fig 4.8). Analysis of variance showed significant difference at a P-value of 0.0001.

A total of 37 (3.1%) mosquitoes were detected of harboring *Wuchereria bancrofti* (microfilarie) after dissection. *Culex quinquefasciatus* recorded the highest value of 32 (2.7%), while the least value of 5 (0.4%) was observed in *Cx. pipiens* (Fig 4.10). Analysis of variance showed significant difference at a P-value of 0.0001. The difference occurred at *Cx. quinquefasciatus*. The highest value was recorded in station Diobu 17 (1.4%) and Marine Base 11 (0.9%). The least value was recorded in Port Harcourt Township 7 (0.5%) and Eagle Island 2 (0.1) respectively. (Fig 4.11). Analysis of variance showed significant difference at a P-value of 0.014.

DISCUSSION

Pyrethrum spray catch (PSC) employed in this study has been described as a common means of collecting mosquitoes that are resting inside buildings and animal shelters, PSC is an efficient technique and its effectiveness depends on the type of house in which the sampling activities takes place. This collection method has been employed by [21] and it is also in line with the work of [22] who used PSC as a collection technique for indoor resting mosquitoes.

Mosquito indoor resting density is influenced by various house characteristics. Generally, houses with thatched roofs, mud walls and open eaves tend to have higher mosquito densities compared to those with metal roofs, brick walls and closed eaves. In this present study, block 498 (29.6%), wood 435 (25.9%), and zinc 421 (25%), had the highest number due to the abundant structural buildings present in Port Harcourt Local Government Area (Fig 4.6). This finding confirms with the urban building structure in Port Harcourt local government area. *Culex quinquefasciatus* had the highest indoor resting density compared to other species found in the study area. The differences of mosquito species across structures (house) types were significant. This finding is a demonstration on the need to improve housing and environmental conditions as a modern tool for disease control in Port Harcourt local government area.

The mosquitoes obtained in this study throughout the twelve [12] months period and across the four [4] stations were 1,684. This result was higher than the reports of [23] who reported mosquito collection of 1,296 for the studies on entomological survey of mosquitoes responsible for the transmission of lymphatic filariasis in Cross River State, Nigeria. The mosquito collection of this present study is slightly higher than reports of [24] who reported a total of 1,600 mosquitoes in Ibadan while the report from this study was lower than the report of Ebenezer *et al.* (2013) who recorded a total of 4,566 mosquitoes in the study of atial distribution and indoor-resting density of mosquitoes' species in the lowland rainforest of Bayelsa State, Nigeria. The study of [22] on composition of mosquito species and physiological states of indoor man-biting mosquitoes at Nteye, South-Eastern Nigeria recorded a total of 185 mosquitoes, thus; much lower than the present study. This does not fall in line with this present study, the difference could be linked to the number of months sampled and the sampling method used and the distribution of species encountered.

Indoor resting density of adult mosquitoes was 7.0, comprising of six [6] species were collected during the study period, namely: *Culex quinquefasciatus*, *Culex tigripes*, *Anopheles gambiae s.l*, *Anopheles funestus* and *Aedes egypti* (Fig.4.1).The availability of these species in these stations was due to the presence of suitable breeding sites which include ground water pools, domestic container, stagnant water bodies, gutter and improper drainage systems, damaged soak-away (septic) tanks, unclean environment and discarded used vehicle tyres around homes suitable for mosquito breeding, this finding are in line with [26].

All the adult mosquitoes collected in this study have also been reported in different places in Nigeria [27] reported *Cx. quinquefasciatus, An. gambie s.l, Ae. egypti* in Nibo Community in Anambra State, same species have also been reported in several studies (28; 29; 30) Admittedly, All the species of mosquitoes reported in this study have also been previously documented by several authors in Nigeria (31; 26) and in other African countries (32; 33). The research of [34] reported the IRD of the three [3] genera of mosquito in Andoni, Rivers State, Nigeria. This is in line with the present study.

The dominant IRD of mosquito species encountered in this study was *Cx. quinquefasiatus* with an overall IRD (2.6%) followed by *Anopheles gamebiae s.l* (1.2%) while *Cx. tigipes* (1.0%) *Culex pipiens* (0.9%), *Ae. egypti* (0.6%) and the least overall IRD of mosquito species was *Ae. funestus* (0.5%). this finding corroborated with that of [35] who reported that *Cx. quinquefasciatus* was the most abundant species recorded in Benin City. This present study is also in line with the finding of [28], who studied the parity rate of indoor resting adult mosquitoes within the female hostels of Nnamdi Azikwe University, Akwa, South Eastern Nigeria.

In this present study *Cx. quinquefasciatus* constituted the highest biting indoor species across the study stations, the observation is in tandem with [30] and Irikannu *et al.* (2020). The work of [34] also reported high number of *Cx. quinquefasiatus* of indoor resting mosquitoes in Andoni, Rivers State on the study of prevalence of mosquito's harboring micro-filarial in four communities in Adoni, Rivers State, Nigeria. This is also in line with the findings of [7]. The high number of *Cx. quinquefasciatus* in Port Harcourt Local Government Area adjudged to have very close proximity to urban area, supports previous reports by (37,38) who reported that *Cx. quinquefasciatus* was the dominant mosquito specie of the urban cities and towns.

The high number of *Cx. quinquefasciatus* in the study area is also linked to the fact that, Cx. quinquefasciatus breed in un-sanitized areas with smelling water collection and in areas with pit latrines, stagnant water, which are eminent in the study areas. *Cx. quinquefasciatus* has been observed to breed near dwelling homes and bite humans indoor even during the dry season due to availability of water and their continuous breeding in septic tanks throughout the year. *An. gambiae s.l* was the second highest overall abundant mosquito in this study and this collaborates with the report of [35]. This finding is also in accordance with that of [39]; [35]. Result by [2] reported that *Cx. quinquefasciatus* and *An. gambiae s.l* are the dominant and most common vectors in Africa.

The presence of established vectors such as *Cx. quinquefasciatus* and *An. gambie s.l* in the study location is an indication that such habitats could contribute to vector risk- filariasis and malaria disease transmission in Port Harcourt local government area. Other species of mosquitoes encountered in this study include; *Cx. pipiens*, *Cx. tigripes*, *An. funestus* and

Ae. egypti. They all occurred in lower numbers compared to *Cx. quinquefasciatus. Ae. egypti* was presently in low IRD. This is in accordance with the findings of [22] and also in line with the report of [34]. This observation shows that, this vector is a twilight (day) biter and has contact with humans during outdoor activities, which increases the chances of mosquito borne disease transmission. Characterizations of dominant mosquito vectors include well adaptation to a wide range of climatic conditions and habitats, high anthropophagic propensity and variable adult resting behavior [40].

Indoor resting density of mosquitoes across the four stations where Marine Base had the highest IRD of 7.7, followed by Diobu 7.3, Port Harcourt Township 7.2 and the least was in Eagle Island 5.7 respectively (Fig. 4.2). The high IRD in Marine Base could be attributed to favorable sites for the vector present at Marine Base, such as; clustered housing, pit latrines, unhygienic environment, littered containers, stagnant water, improper disposal system, and presence of creeks as a source of water for domestic purposes compared to other stations. A combination of the above factors may be the reason why mosquitoes were more abundant in Marine Base when compared to other stations. This report aligns with the report of [41] who reported increase in mosquitoes to be linked to the presence of uncontrolled domestic runoffs, poor maintenance of gutters and pit toilets.

In this present study, mosquito populations were relatively abundant during the wet season with an IRD of 4.85. The highest was observed in April with an IRD of 0.81. This is similar to the report by [42] where mosquitoes peaked at the month of April, as also observed in this present study and also in accordance with the study of [43]. This observation is linked to the high rainfall, characterized with abundant stagnant water reservoirs across the various stations. A combination of high rainfall and humidity may be responsible for the high IRD of mosquitoes of mosquitoes in wet season. This statement is in line with the report of [44]. Dry season had the least IRD 2.12. The highest IRD of mosquitoes in dry season was observed in the month of November (0.60). The fact that the mosquito abundance coincides to a great extent with period of rainfall is an indication that rainfall plays a significant role in mosquito population dynamics. High IRD of mosquitoes in the study location due to the availability of breeding sites which could either be permanent or temporally throughout the year, increase in human development and activities generate diverse habitats for mosquitoes in the study locations, this is similar to the report by [45]. This study shows the highest IRD of mosquitoes was observed in April 0.8 (wet season). December and January had the least seasonal IRD of 0.57 and 0.28, which represents the dry season (Fig. 4.3). The result of this study, strongly revealed that rainfall had a remarkable effect on the mosquito vector population in the study area. More mosquitoes were recorded in the wet season. This is in line with the study of (46) who similarly reported that mosquitoes' population were reduced by decreasing rainfall and both *Culex quinquefasciatus* and Anopheles species were found to dominate in the wet season.

The abdominal characteristics of female mosquitoes collected indoors was determined by observing their abdomen to differentiate those that had blood meal, this is in line with the work described by (47). The mosquitoes were grouped into four categories, unfed (UF), freshly fed (FF), half gravid (HG) and gravid (G). This is in conformity with the study of [22]. In this present study, the fact that, the mosquitoes were searched within the study premises during the morning period and collected using forceps favored the collection of numerous mosquito species except *Ae. egypti* which is notable for being a day and outdoor bitters. This favored numerous collection of freshly fed mosquitoes (33.1%), this occurred because the blood meal activity of *Culex* mosquitoes are more intense at night, it is followed by the search for shelter and rest for the subsequent morning [48]. This result of 31.3% freshly fed mosquitoes is likely due to the endophagy and zoophilic nature of female *Culex, Aedes* and *Anopheles* mosquitoes because they were observable numerous domestic animals present at the various sampling stations and this is in accordance with the result of [43]. The presence of domesticated animals in the same house with humans could play a role in blood feeding habits of mosquitoes from both humans and animals. A remarkable number of mosquitoes were unfed (29.9%); the large proportion of the unfed female mosquitoes could be due to the use of protective clothing during the night. It may also be influenced by some host seeking factors. Also the huge difference between the unfed and half gravid or gravid (19.2%, 19.4%) could be due to the fact that mosquitoes may have been trapped indoors while searching for blood meal after emergence from the breeding sites. This finding is in agreement with the result of [24].

Two (2) mosquito species out of six (6) were detected for the presence of *Wuchereria bancrofti* (microfilaria). *Culex quinquefasiatus* had the highest vector infection rate (parous) of 2.7% followed by *Cx. pipiens* 0.4% (Fig 4.10). This is lower than the result of [34] who recorded infection rate of *Cx. quinquefasiatus* 51.5%. This present finding may be linked to difference in sample location and number of mosquitoes harboring *Wuchereria bancrofti*. The result of this present study is higher than the report of [49], who recorded *Culex quinquefasciatus* 1.01% infection rate of *Wuchereia bancrofti* (microfilaria). The findings of this present study indicate that *Cx. quinquefasiatus* is probably the most adaptive vector due to its wide spread distribution and existence in a range of temperate regions [50]. This conforms to the findings of this study as *Cx. quinquefasciatus* was the most prevalent vector species, so it gave the highest vector infection (parous) rate. The report of [51] stated that *Cx. quinquefasiatus* is the major vector playing significant role in transmission of lymphatic filariasis in Nigeria. The incrimination of *Cx. quinquefasciatus* in this study is in line with the observation of [52], who reported a greater number of *Culex* specie. It proved to be the most significant vector responsible for the transmission of Lymphatic filariasis in Khana and Gokana, Ogoniland in Rivers State. The present study also agrees with the report by [53] who reported that *Cx quinquefasciatus* is the most predominant vector of Lymphatic filariasis in Nigeria.

The low occurrence of microfilariae in the mosquitoes in this present study could be linked to the use of different vector control measures by the residents in the study areas, thereby reducing the vector transmission rate. For instance, studies have shown that the use of insecticide treated bed nets (ITN), which was implemented by malaria control programs, helped in reducing filariasis transmission in endemic regions [54]. Importantly, use of long-lasting insecticide nets (LLIN) and deworming programs have significantly contributed to the reduction of microfilariae infection rate, despite the irregular implementation of Mass Drug Administration (MDA) [55].

The non-infection rate of mosquito in this study is in conformity with the findings of this study, as large number of mosquitoes were not carrier of the parasitic nematode worm (*Wuchereria bancrofti*). The high number of uninfected mosquitoes (non-parous) could also be an indication of high abundance of mosquitoes breeding sites which continuously provide the study areas with young mosquitoes. This statement is in conformity with [44]. No microfilaria was found in *Cx. tigripes, An. gambiae s.l, An. funestus* and *Ae. egypti* respectively.

The vector infection rate across study stations, showed Diobu to have the highest infection rate of 1.4%, followed by Marine Base 0.9%, Port Harcourt Township 0.5% and the least occurred in Eagle Island 0.1% (Fig. 4.11). The highest infection (parous) rate was recorded in Diobu. This is linked to the fact that Diobu had the highest number of physically observed patients suffering from filariasis (Fig 18), which in turn creates favorable environment for uninfected vectors to take a blood meal from infected humans and infect uninfected inhabitants in the study location making Diobu a vulnerable station compared to other stations. It may also be linked to the fact that in Diobu, mosquito breeding sites were frequently observed, such as; domestic runoffs, tyres, discarded household materials, water cans and plastic containers. This assertion conforms to the report of [44] who stated that the combination of one or more of these factors leads to increase in mosquito abundance and vector infection capacity.

CONCLUSION

This study revealed three genera of mosquitoes were present in the four [4] study areas in Port Harcourt Local Government Area. *Culicides, Anopholine* and *Aedes* recorded in this present study, serve as vectors of filariasis, malaria and yellow fever in the study areas.

This study presents insights into the indoor resting density (IRD) of female mosquitoes in Port Harcourt, providing critical data for targeted vector control interventions in the state. By employing the pyrethrum spray catch method across the four stations over twelve [12] months validity period. It uniquely identifies the optimal timing for insecticide spraying, particularly in the month of April, when the highest occurrence of mosquitoes were observed. This study underscores the necessity of community involvement in mosquito control measures, paving the way for more effective and localized vector management strategies.

Contribution to Knowledge

The data from this study will add to the knowledge of mosquito disease dynamics in the study area. Thus; providing information necessary for designing a sustainable mosquito control strategy to eliminate mosquito disease transmission and the possibility of outbreak of mosquito- borne diseases in Port Harcourt and beyond.

This study discovered the presence of enabling environment for *Cx. quniquefasciatus, Cx. pipiens, Cx. tigripes, An. gambiae s.l, An. funestus* and *Ae. egypti* in Port Harcourt Local Government Area. Thus; provide valuable insights into efficient control strategies for mosquito disease endemic areas, thereby facilitating vector surveillance and enhancing disease control efforts.

Recommendations

Mosquitoes are one of the deadliest insects in the world, mainly because as adults they serve as vectors of disease, thus; it is very vital to control mosquitoes (larvicides) at an early stage, when they are most vulnerable. The current speed in the war against mosquito-transmitted diseases is moving with an increasing energy. Health education is highly recommended for sensitizing the inhabitants on the importance of clean environment and personal hygiene practices, in turn there will be a decline in mosquito transmitted diseases in Port Harcourt.

REFERENCES

1. Gillies, M. T. & De Meillon, B. (1968). The *Anophelinae* of Africa South of the Sahara (Ethiopian Zoographical Region). *South African Institute of Medical Research Johannesburg*. 54, 343.

2. Oduola, A. O. & Awe, O. O. (2006). Behavioural bating preference of culex quinquefaciatus in human host on Lagos metropolis, Nigeria. *Journal of Vector Borne Diseases,* 43(1), 16 – 20.

3. Grobbelaar, A. A., J. Weyer, N. Moolla, P. Jansen, van Vuren, F. Moises, & Paweska. J. T. (2016). Resurgence of yellow fever in Angola, 2015–2016. *Emerging Infectious Disease*. 22: 1854–1855.

4. Paules, C. I., & A. S. Fauci. (2017). Yellow fever — Once again on the radar screen in the Americas. *New England Journal of Medicine* 376: 1397–1399.

5. Amini, M., Hanafi-Bojd, A. A. Aghapour, A. A. & Chavshin, A. R. (2020). "Larval habitats and species diversity of mosquitoes (Diptera: Culicidae) in West Azerbaijan Province, Northwestern Iran," *BMC Ecology*, 20 (1), 60.

6. Chan, A., Chiang, L. P. & Hapuarachchi, H. C. (2014). "DNA barcoding: complementing morphological identification of mosquito species in Singapore," *Parasites & Vectors*, vol. 7, no. 1.

7. Nwoke, B. E. B., Nwoke, E. A., Ukaga, C. N. & Nwachukwu, M. I. (2010). Epidemiological Characteristics of Bancroftian Filariasis and the Nigerian Environment. *Journal of Public Health and Epidemiology,* 113 – 117.

8. Anosike, J. C., Onwuliri, C. O. E. and Onwuliri, V. A. (2003). Human filariasis in Dass Local Government Area of Bauchi State, Nigeria, *Tropical Ecology*, 44(2), 217 – 227.

9. World Health Organizatoin, WHO (2023). Lymphatic filariasis .

10. CDC, Center for Disease and Control (2018). Parasite: Lymphatic filariasis.

11. Waje T, Iliyasu C, Yaki.L.M, & Aura I. k. (2024). A review of epidemiology of lymphatic filariasis in Nigeria. *Pan African Medical Journal*. 47.142.39746.

12. Eneanya O, Cano J, Dorigatti I, Anagbogu F, Okoronkwo C, GraskeT, & Donnelly C.A. (2018). Environmental suitability for lymphatic filaraisis in Nigeria. Parasites and Vectors. 10(1186)13071-3097-9.

13. Pam D D, De souza D K, D'Souza S, Opoku M, Sanda S, Nazardden I, Anagbogu F,N, Okoronkwo C, Davies E, Elhassan E, Molyneux D H, Bockarie M, J, & Koudou B.G (2017). Is mass drug administration against lymphatic filariasis required in urban settings? The experience in Kano, Nigeria. *PLOS. Neglected Tropical Diseases* 11(10)006004. 10.1371.

14. Richards F,O, Emukah E, Gravies P, M, Nkwocha O, Nwukwo L, Rakers L, Mosher A, Patterson A, Ozaki M, Nwoke B E B, Ukaga C, N, Njoku C, Nwodu K, Obasi A & Miri E. S. (2013). Community wide distribution of long lasting insecticidal nets can halt transmission of lymphatic filariasis in Southeastern Nigeria. *The American Journal of Tropical Medicine and Hygiene.* 89(3):578-587.

15. Nzeako S O, Okunnuga O H, Nduka F O & Ezenwaka C O, (2016). Lymphatic filariasis and malaria awareness amongst residents of Port Harcourt Metropolis. *International Journal of Applied Science- Research and Review.* 10(21767)2349-7238.

16. World Health Organization, WHO (1975). Manual on practical entomology in malaria. Part II: Methods and techniques. World Health Organization, Geneva.

17. World Health Organization, WHO, (2013). Manual for indoor residual spraying application of residual sprays for vector control. Geneva: World Health Organization.

18. Service, M. W. (1993). Mosquito Ecology: Field sampling methods. Chapman and Hall.99.

19. Gillies, M. T. Coetzee, M. A. (1987). A supplement to the *Anophelinae* of Africa South of the Sahara. *Publications of the South Africa Institute for Medical Research.* 55, 1 – 143.

20. William, J. & Pinto, J. (2012). Training manual on vector control management for mosquitoes. Control with special emphasis on malaria vectors. *Special Emphasis Publication,* 66(1), 1 – 283.

21. Mboera, L. E. G., Magesa, S. & Molteni, F. (2006). Indoors man-biting mosquitoes and their implication on malaria transmission in Mpwa and Iringa Districts, Tanzania. *Tanzania Health Research Bulletin,* 8(3), 141 – 144.

22. Irikannu, K., Nwalioba, E., Umeanaeto, P., Nzeukwu, C., Aniefuna, C., Obiefule, E., Elosiuba, N. & Uzochukwu, C. (2022). Composition of mosquito species and physiological states of indoor man-Bitting mosquitoes at Nteje-South-Eastern Nigeria. *The Bioscientist,* 10(1), 113 – 122.

23. Mbah, M., Akpan, S. S., Otubassey, I. B. & Daniel, H. B. (2015). Entomological survey of mosquitoes responsible for the transmission of lymphatic filariasis in Biase, Cross River State, Nigeria. *Journal of Medicine Sciences,* 1, 1 – 5.

24. Okorie, N. P., Popoola, K. O. K., Olayemi, M. A., Kolade, T. I., George. O. & Ademowo, C. (2014). Species composition and temporal distribution of mosquitos' populations in Ibadan, south West Nigeria. *Journal of Entomology and Zoology Studies,* 2(4), 164 – 169.

25. Ebenezer, A., Ben, H. I. B. & Enaregha, E. (2013). Atial distribution and indoor-resting density of mosquito species in the lowland rainforest of Bayelsa State, Nigeria. *International Journal of Tropical Medicine,* 8(4), 87 – 91.

26. Afolabi, O. J., Simon-Oke, I. A. & Osomo, B. O. (2013). Distribution, abundance and diversity of mosquitoes in Akure, Ondo State, Nigeria. *Journal of Parasitology and Vector Biology,* 5(10), 32 – 136.

27. Onyido, A. E., Ezeani, A. C., Irikannu, K. C., Umeanto, P. U., Egbuche, C. M., Chikezie, F. M. & Ugha, C. N. (2016). Anthropophilic mosquito species prevalence in Nibo Community, Awka, South, South Local Government, Anambra State. *Ewemen Journal of Epidemiology and Clinical Medicine,* 2(1), 14 – 20.

28. Umeanaeto, P., Asogwa, A. N., Onyido, A., Irikannu, K. & Ifeanyichukwu, M. O. (2017). The parity rate of indoor-resisting adult female anopheles and culex mosquitoes and their implication in diseases transmission in Nnamdi Azikiwe University Female Hostels, Awka, South-Eastern Nigeria. *International Journal of Environment Agriculture and Biotechnology,* 2(4), 1551 – 1556.

29. Egbuche, C. M., Onyido, A. E., Umeanaeto, P. U., Nwankwo, E. N., Omah, I. F., Ukonze, C. B., Okeke, J. J., Ezihe, C. K., Irikannu, K. C., Aniekwe, M. I., Ogbodo, J. C. & Enyinnaya, J. O. (2020). Anopheles species composition and some climatic factors that influence their survival and population abundance in Anambra East LGA, Anambra State, Nigeria. *Nigerian Journal of Parasitology,* 4(2), 240 – 250.

30. Onwuzurike, I. V., Onyebueke, A., Irikannu, K., Nzeukwu, C., Ogbonna, C. U., Nwangwu, R. L. & Ochtaka, C. S. (2021). Relative abundance and diversity of man-biting mosquito species before and after indoor residual spraying programme in Akka and Environms, Anambra State. Nigeria. *Trends in Entomology.*

31. Okiwelu, S. N. & Noutcha, M. A. E. (2012). Breeding sites of *Culex quinquefaciatus* during the rainy season in rural lowland rainforest, Rivers State, Nigeria. *Public Health Research,* 2(4), 64 – 68.

32. Muturi, E., Mwangangi, J., Shilidu, J., Jacob, B. G., Mbogo, C. M., Githuse, J., Novak, R. J. (2008). Environmental factors associated with the distribution of *Anopheles arabiensis and Culex quinquefasciatus i*n Rice agro-ecosystem in Mwea, Kenya. *Journal of Vector Ecology,* 33(1), 56 – 63.

33. Mutebi, J. P., Crabtree, M. B., Kading, R. C., Powers, A. M., Lutwama, J. J. & Miller, B. R. (2012). Mosquitoes of Western Uganda, *Journal of medical Entomology,* 49(6), 1289 – 1306.

34. Dimkpa, C. H., Ebere, N. & Ugbomeh, A. P. (2019). Prevalence of mosquitoes harbouring microfilaria in four communities in Andoni, Rivers State. *Asia Journal of Biological Science,* 12, 851 – 859.

35. Omoregie, A. O., Omoregie, M. E., Adetimehin, A. D. & Aigbodion, F. I., (2019). Species composition of mosquitoes from boarding school dormitories in Benin City, Edo State, Nigeria. *Nigeria Annals of pure and Applied Sciences,* 2, 25 – 34.

36. Irikannu, K. C., Onyido, A. E., Nwankwo, E. N., Umeameto, P. U., Onwube, O., Ogaraku, J. C., Ezeagwuna, D. A., Onyebueke, A. C. & Okoduwa, A. U. (2020). A survey of man-biting mosquito species in a tropical rainforest community in the Southeastern Nigeria. 38(3), 498 – 506.

37. Bockarie, M. J., Pedersen, E. M., White, G. B. & Michael, E. (2009). Role of vector control in the global program to eliminate lymphatic filariasis. *Annual Revolutionary Entomol*ogy.54, 469–487.

38. Mullen, G. R. & Durden, L. A. (2019). Medical and veterinary entomology third edition.

39. Mzilahowa, T., Gowelo, S., Chiphwanya, J., Bauleni, A, & Mukaka, M. (2023). *Anopheles funestus sensu stricto* Giles (*Diptera*: *Culcidae)* bites after sunrise at two rural villages in Northern Malawi and its implication for malaria control. *Malawi Mediciene Journal*. 35(2):80-88.

40. Sinka, M. E., Rubio-Palis, Y. & Manguin, S. (2010). "The dominant *Anopheles* vectors of human malaria in the Americas: occurrence data, distribution maps and bionomic précis," *Parasites and Vectors*, vol. 3, 2010.

41. Aigbodion, F. I. & Odiachi, F. C. (2003). Breeding in Benin City, Nigeria, *Nigeria Journal of Entomology*, 20, 1 – 7.

42. Oduola, A. O., Adelaya, O. J. & Awolola, S. (2016). Dynamics of Anopheline vector species composition and reported mosquito borne diseases case during rain and dry seasons in two selected communities of Kwara State. *Nigerian Journal of Parasitology*, 37(2), 157 – 213.

43. Abubakar, A. S., Adeniyi, K. A., Joshua, B. B., Musa, M. D., Abubakar, Z., Jibrin, Mu., Ibrahim, H., Muhammed, A. A. H., Nuradden, A. & Humumaira, A. L. (2023). Abdomenial status and blood meal preference of Anopheles gambiae complexes in some communities of Dutse Local Government Area, Northwestern Nigeria. *Dutse Journal of Pure and Applied Sciences*, 3, 1 – 18.

44. Adeleke, M. A., Mafiana & C. F., Idowu, A. B., Sam-Wobo, S. O., & Idowu, O. A. (2010). Population dynamics of indoor sampled mosquitoes and their implications in Abeokuta, south-western Nigeria. *Journal of Vector Borne Diseases*. 47(1), 33–38.

45. Ototo, E., Zhou, N., Githeko, A. K., & Yan, G. (2015). Surveillance of mosquito borne disease vector population density and biting behaviour in Western Kenya. *Mosquito Borne Disease Journal*, 14(1), 3 – 7.

46. Kasili, S., Oyieke, F., Wamae, E. & Mbago, C. (2009). Seasonal changes of infectivity, rates ofbancroftian filariasis vectors in coast province, Kenya. *Journal of Vector Borne Disease,* (46), 219 – 224.

47. Service, M. W. (1993). Mosquito ecology: Field sampling methods. 2nd edition, Elsevier publishers, Essex, United Kingdom.

48. World Health Organization, WHO, (2013b). Manual for indoor residual spraying application of residual sprays for vector control. Geneva: World Health Organization.

49. Aliyu, A. A., Sow, G. J. & Ndams, I. S. (2020). Entomological survey of mosquito vectors of lymphatic filariasis in Talatan-mafara and Tsafe Local Government Area of Zamfara State, Nigeria. *Journal of Sciences,* 4(2), 207 – 216.

50. Kelly Hope, L. A., Molyneux, D. H. & Bockarie, M. J. (2013). Can malaria vector control accelerate the interruption of lymphatic filariasis transmission in Africa. Capturing a window of opportunity? *Parasites & Vectors,* 3305 – 3639.

51. Amaechi, A. A., Nwoke, B. E. B. & Ukaga, C. N. (2011). A comparative study of human lymphatic filariasis vectors and filarial transmission indices control trial using insecticide treated bednets (ITBN) in Ebonyi State, Nigeria. *Global Research Journal of Science,* 1, 18 – 23.

52. Amadi, E. C. & Eze, N. C. (2017). An entomological survey and determination of vectoral infection rates for lymphatic filariasis in Ogoniland, Niger Delta, Nigeria. *Nigeria Journal of Parasitology,* 10, 4324.

53. Anosike, J. C., Nwoke, B. E., Ajayi, E. G., Onwuliro, C. O., Okoo, O. U., Oku, E. E., Asor, J. E., Amajuoyi, O. U., Ikpeama, C. A., Ogbusu, E. I. & Meribe C. O. (2005). By lymphatic filariasis among the Ezza people of Ebonyi state, Eastern Nigeria, *Annual Agricultural Environmental and Medicine*, 12(2), 181 – 186.

54. Martens, W. J., Niessen, L. W., Rotmans, J., Jetten, T. H. & McMichael, A. J. (1995) Potential impact of global climate change on malaria risk. *Environmental health perspectives* 103(5), 458–464.

55. Ngenga, S. M., Kanyi, K. M., Mutungi, F. M., Okoyo, C., Matendechero, H. S., Pollan, R. L., Halliday, K. E. Brooker, S. J., Wamae, C. N., Onsongo, J. K. & Won, K. Y. (2017). Assessment of lymphatic filariasis prior to re-starting mass drug administration campaigns in coastal Kenya. *Parasite and Vectors,* 10(1), 99.