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Mosquito Population Dynamics in the Vicinity of Kindia, Maritime Guinea, Republic of Guinea

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Abstract

Mosquitoes (*Diptera*, *Culicidae*) are a family of insects of considerable importance to public health. A total of 4,558 mosquitoes were collected between January 3, 2021, and December 8, 2024, using MP-100 traps. Sixteen mosquito species were identified and classified into a single family, the *Culicidae*. During the study period, traps were placed inside homes and near patios, yards, and surrounding vegetation from 7:00 p.m. to 7:00 a.m., following strict guidelines. Very early in the morning, the catches were retrieved with the utmost safety precautions (gloves, alcohol, lab coat, plastic bag). Species identification was carried out at the Entomology Laboratory of the Guinean Institute for Applied Biological Research (GIABR) and the Laboratory for Applied Research in Natural Sciences. Over the course of 3,698 hours and classified into 16 species: *Culex quinquefasciatus* 1238 (27.16%), *Aedes vittatus* 751 (16.47%), *Anopheles* (*Anophelinae*) *coustani* 386 (8.46%), *Anopheles gambiae* 366 (8.02%), *Aedes ochraceus* 360 (7.49%), *Culex univittatus* 311 (6.82%), *Anopheles* (*Cellia*) *funestus* 277 (6.07%), *Culex antennatus* 209 (4.58%), *Culex neavei* 192 (4.21%), *Aedes vexans* 185 (4.05%), *Aedes dendrophilus* 83 (1.82%), *Aedes aegypti* 74 (1.62%), *Anopheles* (*Cellia*) *pretoriensis* and *Eretmapodites chrysogaster* had the same number of mosquitoes collected and the same frequency of 40 (0.87%), *Mansonia uniformis* 33 (0.72%) and *Mansonia africana* 13(0.28%). In conclusion, a statistically significant difference was observed between the dry season (83.9%) and the rainy season (16.1%).

Keywords

Mosquito, Population Dynamics, Vicinity of Kindia, Lower Guinea, Republic of Guinea

1. Introduction

Man has suffered from the activities of mosquito since time immemorial and it is ranked as man's most important insect pest. Mosquitoes belonging to the genera *Anopheles*, *Culex* and *Aedes* are the vectors for the pathogens of different diseases such as malaria, filariasis, Japanese encephalitis, dengue and dengue haemorrhagic fever, epidemic polyarthritis, yellow fever and *chikungunya* [1]-[3]. These diseases devastate Indian economy every year [4]. Tropical areas are more vulnerable to parasitic diseases and the risk of contracting arthropod-borne illnesses is increased due to climate change and intensifying globalization [5]. Worldwide, mosquitoes transmit diseases to more than 700 million people annually and are responsible for 1 death for every 17 people currently alive [6]. Malaria results from an infection by a protozoan carried by *Anopheles stephensi*.

About 2.5 billion people are at risk, more than 500 million people become seriously ill with malaria every year, and more than one million people die due to malaria [7].

Culex quinquefasciatus is responsible for the transmission of Lymphatic filariasis caused by *Wuchereria bancrofti*. Lymphatic filariasis, disease affecting the arms, legs and genitals, is much prevalent in India. Lymphatic filariasis infects 80 million people annually of which 30 million cases exist in chronic infection. There are 45 million cases of Lymphatic filariasis in India alone [8].

In humans, malaria is a parasitic disease caused by five species of the genus Plasmodium, namely: *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium ovale*, *Plasmodium malariae*, and *Plasmodium knowlesi* [9]. It is transmitted through the bite of the female *Anopheles* mosquito (*Anopheles* sp.) [10].

This study aimed to assess mosquito population dynamics and to identify the dominant blood-feeding species that serve as primary malaria vectors in the vicinity of Kindia, Maritime Guinea, Republic of Guinea.

2. Materials and Methods

2.1. Study Environment

The Kindia Prefecture lies at an elevation of 458.13 m and is located in the western part of Guinea; agriculture and, above all, small-scale livestock farming are the main economic activities.

The hydrography and topography make Kindia a true transition zone between Lower Guinea and

Middle Guinea. It lies between 10˚03' north latitude and 12˚52' west longitude. The population is estimated at 438,315 inhabitants [11]. With a population growth rate of 34% per year. Its population density is 48 inhabitants per km^2 and it covers an area of 9,115 km^2 [12]. It is bordered to the west by the prefecture of Coyah, to the northwest by the prefecture of Dubréka, to the north by the prefecture of Fria, to the northeast by the prefecture of Télimélé, to the east by the prefecture of Mamou, to the south by Sierra Leone, and to the southwest by the prefecture of Forécariah [12]. Today, it presents itself as a veritable mosaic of ethnic groups, with a large Soussou majority. The other ethnic groups are the Peul, the Malinké, the Djalonké, and the Djakanké, who are farmers, herders, merchants, and civil servants [12]. Peri-urban commerce is generally unsanitary [12] (see **Figure 1** and **Figure 2**).

Figure 1. Maps of natural regions and the administrative regions of the Republic of Guinea. Nations online project: https://www.nationsonline.org/Chatgpt.com [13].

Figure 2. Map showing the various locations (red dots) where mosquitoes were collected in the vicinity of Kindia (2021-2024), Sergey, Y./GLONASS GPS satellite. [14].

2.2. Materials

The biological material consists of mosquitoes collected in the vicinity of Kindia, and the sampling was both descriptive and quantitative.

2.3. Study Setting

The Guinean Institute for Applied Biological Research and the Laboratory for Applied Research in Natural Sciences served as the setting for the study.

2.4. Methods

This study was conducted from 2021 to 2024; each habitat was surveyed using a descriptive and quantitative methodology. The collection effort depended on environmental conditions. MP-100 traps were set up between 7:00 p.m. and 7:00 a.m. Over the course of 3,698 hours, 4,558 mosquitoes were collected and classified into 16 species. The number of night traps was 1, and the number of traps used was also 1.

2.5. Collection and Identification

The trap used was the MP-100.

During the study period, traps were placed inside homes and near patios, yards, and surrounding vegetation from 7:00 p.m. to 7:00 a.m., following strict guidelines. Very early in the morning, the catches were retrieved with the utmost safety precautions (gloves, alcohol, lab coat, plastic bag). Species identification was carried out at the Entomology Laboratory of the Guinean Institute for Applied Biological Research (GIABR) and the Laboratory for Applied Research in Natural Sciences, using the identification key from [15].

2.6. Quantitative Analyses

The analyses are mainly descriptive and qualitative. The processed data were entered into spreadsheets (Excel 2010 and word).

3. Results

The sampling focused on mosquitoes collected in the various habitats studied. A total of 4,558 mosquitoes were collected between january 3, 2021, and december 8, 2024, using MP-100 traps. Sixteen mosquito species were identified and classified into a single family, the *Culicidae*.

Table 1 shows the number of mosquito species collected, as well as their frequency: *Culex quinquefasciatus* 1238 (27.16%), *Aedes vittatus* 751 (16.47%), *Anopheles* (*Anophelinae*) *coustani* 386 (8.46%), *Anopheles gambiae* 366 (8.02%), *Aedes ochraceus* 360 (7.49%), *Culex univittatus* 311 (6.82%), *Anopheles* (*Cellia*) *funestus* 277 (6.07%), *Culex antennatus* 209 (4.58%), *Culex neavei* 192 (4.21%), *Aedes vexans* 185 (4.05%), *Aedes dendrophilus* 83 (1.82%), *Aedes aegypti* 74 (1.62%), *Anopheles* (*Cellia*) *pretoriensis* and *Eretmapodites chrysogaster* had the same number of mosquitoes collected and the same frequency of 40 (0.87%), *Mansonia* *uniformis* 33 (0.72%) and *Mansonia africana* 13 (0.28%).

Table 1. Summary of species and their frequency.

Species	Number of captures	Frequency (%)
Anopheles (*Cellia*) *funestus* (Giles, 1900)	277	6.07
Anopheles (*Anophelinae*) *coustani* (Lavaran,1900)	386	8.46
Anopheles gambiae (*species complex*) (Giles, 1902)	366	8.02
Anopheles (*Cellia*) *pretoriensis* (Theobald, 1903)	40	0.87
Aedes aegypti (Linnaeus in Hasselquist, 1762)	74	1.62
Aedes dendrophilus (Edwards, 1921)	83	1.82
Aedes ochraceus (Theobald, 1901)	360	7.89
Aedes vittatus (Bigot, 1861)	751	16.47
Aedes vexans (Meigen, 1830)	185	4.05
Mansonia uniformis (Theobald, 1901)	33	0.72
Mansonia africana (Blanchard, 1901)	13	0.28
Culex quinquefasciatus (Say, 1823)	1238	27.16
Culex univittatus (Theobald, 1901)	311	6.82
Culex antennatus (Becker, 1903)	209	4.58
Culex neavei (Theobald, 1906)	192	4.21
Eretmapodites chrysogaster (Theobald, 1901)	40	0.87
Total	4558	99.91

Figure 3 shows that the most commonly collected mosquito genera were *Culex* (42.78%), *Aedes* (31.87%), and *Anopheles* (23.45%), while the least commonly collected genera were *Mansonia* (1%) and *Eretmapodites chrysogaster* (0.87%).

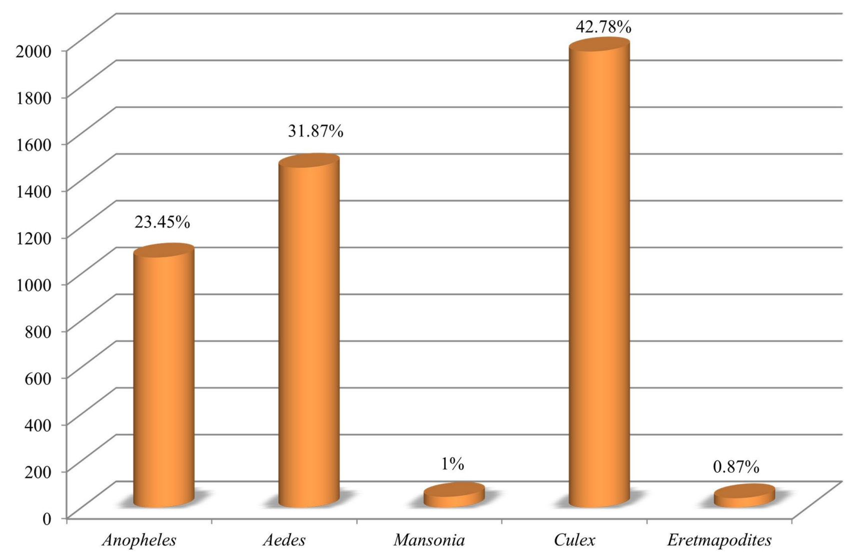

Figure 3. Allocation of comprehensive income.

In **Table 2**, we observe that the number of mosquitoes collected in the various habitats varies. Inside dwellings, we collected: *Mansonia africana* 259 (5.68%), *Anopheles* (*Cellia*) *funestus* 74 (1.64%), *Anopheles gambiae* 35 (0.76%), *Culex univittatus* 5 (0.10%), *Aedes dendrophilus* (0.04%), and the results obtained in areas adjacent to residential zones (terraces, gardens, and surrounding vegetation) are as follows: *Culex quinquefasciatus* 979 (21.47%), *Aedes vittatus* 751 (16.47%), *Anopheles* (*Anophelinae*) *coustani* 386 (8.46%), *Aedes ochraceus* 358 (7.85%), *Anopheles gambiae* 331 (7.26%), *Culex univittatus* 311 (6.82%), *Culex antennatus* 204 (4.47%), *Anopheles* (*Cellia*) *funestus* 203 (4.45%), *Culex neavei* 192 (4.21%), *Aedes vexans* 185 (4.05%), *Aedes dendrophilus* 83 (1.82%), *Aedes aegypti* 74 (1.62%), *Anopheles* (*Cellia*) *pretoriensis* and *Eretmapodites chrysogaster* had the same number of mosquitoes collected and the same frequency of 40 (0.87%), *Mansonia uniformis* 33 (0.72%) and *Mansonia africana* 13 (0.28%). In conclusion, this study shows that the results obtained in these habitats indicate that many more mosquitoes were collected near dwellings than inside them, and that depended not only on access conditions but also on abundance and collection conditions.

Table 2. Distribution of captured species by habitat and their frequency.

Habitats	Species	Number of captures	Frequency (%)
Interior of the home	*Anopheles* (*Cellia*) *funestus* (Giles, 1900)	74	1.64
	Anopheles (*Anophelinae*) *coustani* (Lavaran,1900)	-	-
	Anopheles gambiae (*species complex*) (Giles, 1902)	35	0.76
	Anopheles (*Cellia*) *pretoriensis* (Theobald, 1903)	-	-
	Aedes aegypti (Linnaeus in Hasselquist, 1762)	-	-
	Aedes dendrophilus (Edwards, 1921)	2	0.04
	Aedes ochraceus (Theobald, 1901)	-	-
	Aedes vittatus (Bigot, 1861)	-	-
	Aedes vexans (Meigen, 1830)	-	-
	Mansonia uniformis (Theobald, 1901)	-	-
	Mansonia africana (Blanchard, 1901)	259	5.68
	Culex quinquefasciatus (Say, 1823)	-	-
	Culex univittatus (Theobald, 1901)	5	0.10
	Culex antennatus (Becker, 1903)	-	-
	Culex neavei (Theobald, 1906)	-	-
	Eretmapodites chrysogaster (Theobald, 1901)	-	-
Proximity to residential areas: patios, yards,	*Anopheles* (*Cellia*) *funestus* (Giles, 1900)	203	4.45
	Anopheles (*Anophelinae*) *coustani* (Lavaran,1900)	386	8.46
	Anopheles gambiae (*species complex*) (Giles, 1902)	331	7.26

Continued

surrounding	*Anopheles* (*Cellia*) *pretoriensis* (*Theobald, 1903*)	40	0.87
Vegetation.	*Aedes aegypti* (Linnaeus in Hasselquist, 1762)	74	1.62
	Aedes dendrophilus (Edwards, 1921)	83	1.82
	Aedes ochraceus (Theobald, 1901)	358	7.85
	Aedes vittatus (Bigot, 1861)	751	16.47
	Aedes vexans (Meigen, 1830)	185	4.05
	Mansonia uniformis (Theobald, 1901)	33	0.72
	Mansonia africana (Blanchard, 1901)	13	0.28
	Culex quinquefasciatus (Say, 1823)	979	21.47
	Culex univittatus (Theobald, 1901)	311	6.82
	Culex antennatus (Becker, 1903)	204	4.47
	Culex neavei (Theobald, 1906)	192	4.21
	Eretmapodites chrysogaster (Theobald, 1901)	40	0.87
	Total	4558	99.91

An Analysis of **Table 3** allowed us to identify a single family of mosquitoes (*Culicidae*), 5 genera of mosquitoes (*Culex*, *Aedes, Anopheles*, *Mansonia* and *Eretmapodites*), and 16 species: *Culex quinquefasciatus*, *Aedes vittatus*, *Anopheles* (*Anophelinae*) *coustani*, *Anopheles gambiae*, *Aedes ochraceus*, *Culex univittatus*, *Anopheles* (*Cellia*) *funestus*, *Culex antennatus*, *Culex neavei*, *Aedes vexans*, *Aedes dendrophilus*, *Aedes aegypti*, *Anopheles* (*Cellia*) *pretoriensis* and *Eretmapodites chrysogaster* had the same number of mosquitoes collected and the same frequency, *Mansonia uniformis* and *Mansonia africana*.

Table 3. Breakdown of captured species by order, family, and species.

Order	Families	Species
		Anopheles (*Cellia*) *funestus* (Giles, 1900)
		Anopheles (*Anophelinae*) coustani (Lavaran, 1900)
		Anopheles gambiae (*species complex*) (Giles, 1902)
		Anopheles (*Cellia*) *pretoriensis* (Theobald, 1903)
		Aedes aegypti (Linnaeus in Hasselquist, 1762)
		Aedes dendrophilus (Edwards, 1921)
		Aedes ochraceus (Theobald, 1901)
		Aedes vittatus (Bigot, 1861)
Diptera	*Culicidae*	*Aedes vexans* (Meigen, 1830)
		Mansonia uniformis (Theobald, 1901)
		Mansonia africana (Blanchard, 1901)
		Culex quinquefasciatus (Say, 1823)

Continued

Culex univittatus (Theobald, 1901)
Culex antennatus (Becker, 1903)
Culex neavei (Theobald, 1906)
Eretmapodites chrysogaster (Theobald, 1901)

Figure 4 shows a statistically significant difference between the dry season and the rainy season. In conclusion, a statistically significant difference was observed between the dry season (83.9%) and the rainy season (16.1%). ($P < 0.0001$).

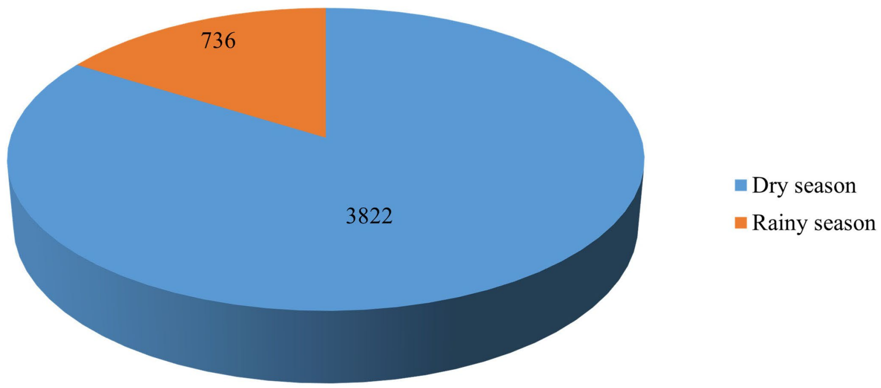

Figure 4. Mosquito population dynamics during the two seasons.

4. Discussion

A total of 4,558 mosquitoes were collected between January 3, 2021, and December 8, 2024, using MP-100 traps. Sixteen mosquito species were identified and classified into a single family, the *Culicidae*, 5 genera of mosquitoes (*Culex*, *Aedes*, *Anopheles*, *Mansonia* and *Eretmapodites*), and 16 species: *Culex quinquefasciatus* 1238 (27.16%), *Aedes vittatus* 751 (16.47%), *Anopheles* (*Anophelinae*) *coustani* 386 (8.46%), *Anopheles gambiae* 366 (8.02%), *Aedes ochraceus* 360 (7.49%), *Culex univittatus* 311 (6.82%), *Anopheles* (*Cellia*) *funestus* 277 (6.07%), *Culex antennatus* 209 (4.58%), *Culex neavei* 192 (4.21%), *Aedes vexans* 185 (4.05%), *Aedes dendrophilus* 83 (1.82%), *Aedes aegypti* 74 (1.62%), *Anopheles* (Cellia) pretoriensis and *Eretmapodites chrysogaster* had the same number of mosquitoes collected and the same frequency of 40 (0.87%), *Mansonia uniformis* 33 (0.72%) and *Mansonia africana* 13 (0.28%).

When comparing the results of our study with those from the island nation (Cape Verde) and the countries furthest into the Sahara (Mauritania, Niger); a greater number of species in countries with a sub-humid zone (Burkina Faso, Senegal, Mali); a large number of species (56 species).

distributed in a single country versus a small number of species (4 species) present in all 8 countries. Regarding the 4 species, *An. arabiensis*, *Ae. aegypti*, *Cx. quinquefasciatus*, and *Lt. tigripes*, present in each of the 8 countries, it is noteworthy that the first three are extremely closely associated with humans, that likely facilitated the pantropical spread of *Ae. aegypti* and *Cx. quinquefasciatus*. *Aedes aegypti* is a special case in that a wild population with very little association with humans persists in forested areas, fairly isolated from the domestic population, laying eggs in tree holes and fruit husks, feeding preferentially on wild animals, and not entering houses [16]. The current absence of *An. stephensi* is significant because this invasive species is already present in the western Persian Gulf. It first became established in Saudi Arabia, then in Djibouti in 2012, then in Ethiopia, and then in Sudan [17] [18], so that the introduction of this major vector of human Plasmodium is feared in eight countries in particular (Cape Verde, Burkina Faso, Gambia, Mali, Mauritania, Niger, Senegal, and Chad) [18].

There are 9 species that are potentially the most commonly found in irrigated rice-growing areas, including 7 *Anopheles* (*An. arabiensis*, *An. coluzzii, An. funestus, An. pharoensis, An. rufipes, An. squamosus, and An. ziemanni*)*, 1 Culex* (*Cx. antennatus*)*, and 1 Uranotaenia* (*Ur. balfouri*). Tree-hole species are mainly *Aedes* of the subgenus *Stegomyia*/*Ae. aegypti*, *Ae.* (*Stg.*) *luteocephalus* [19], *Ae.* (*Stg.*) *metallicus* [20] and 1 *Culex* of the subgenus *Culiciomyia* (*Cx. nebulosus*); these 4 species can also be captured in anthropogenic domestic breeding sites, sometimes cohabiting with *Cx. Quinquefasciatus* and *Lt. tigripes*. Finally, *Cx. Quinquefasciatus* and *Cx.* (*Cux.*) *duttoni* [21] are associated with human-made aquatic habitats rich in organic matter, such as latrines for the former and muddy water from earthen ditches for the latter. To conclude on mosquito ecology, some species have a larval ecology linked to permanent or sub-permanent natural habitats, such as the edges of ponds or backwaters, and pools, while others have an ecology directly linked to human activity.

5. Conclusion

This study summarizes the current knowledge regarding the distribution of 4,558 mosquito species found in various habitats. The most commonly found species are *Culex quinquefasciatus*, Anopheles, vector mosquitoes, and mosquitoes that bite humans; it also appears that the level of research varies by country and raises the issue of a lack of entomologists and standardized surveys. This synthesis, largely focused on species richness as a marker of biodiversity, should serve as a basis for future research on the destruction, fragmentation, and preservation of natural habitats, climate change, and the emergence of new vector-borne pathogens. It can already be useful in the fields of vector control and public health. However, the presence of potentially dangerous zoonotic diseases should not be overlooked; these diseases are transmitted from one host to another when conditions are favorable, underscoring their vulnerability to ecosystem disturbances. It is therefore likely that these diseases and their vectors will spread across borders, thereby increasing the risk of human infection. Mosquitoes are a major reservoir of zoonotic pathogens. It is therefore essential to identify and understand the transmission routes between wildlife and humans.

Authors' Contributions

Namory Keita, Sergey Yakovlev, Aboubacar Hady Touré, Ibrahima Baïlo Diallo, Abdoulaye Baldé, Raphael Dore, and Amara Cissé designed and supervised the study and conducted the fieldwork and laboratory experiments. Mariama Bah, Souleymane Diallo, Bonaventure Kolié, Ibrahima Gouressy, and Alphonse Keller Konkon reviewed and approved the final version of the manuscript.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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