

Human population exposure to residual malaria transmission by the main vector, *Anopheles s.l.* in the city of Bobo-Dioulasso, Burkina Faso

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Abstract

Background

Urban malaria poses a significant public health challenge in many African countries, driven by rapid urbanization and accelerating population growth. Malaria transmission among non-immune urban populations has the potential to emerge as a critical public health concern. To address this threat, a more comprehensive understanding of the biological and ecological factors of urban malaria transmission is essential for set up an updated vector control strategies.

Methods

This study aimed to investigate key biological aspects of the *Anopheles* vector and their implications for residual malaria transmission in order to guide vector control strategies tailored to vulnerable populations in Bobo-Dioulasso, Burkina Faso. For this purpose, mosquito sampling was conducted in 2023 and 2024, using both fauna residual capture and human landing catch techniques in areas located close and distant from riverbanks. Collected specimens were morphologically identified, and molecular analyses (PCR) were performed to i) determine species composition within the *Anopheles gambiae* complex, ii) detect *Plasmodium* infections, and iii) assess host feeding preferences.

Results

These data were used to evaluate levels of malaria exposure in urban settings. As results, three mosquito genera were identified: *Culex* spp. (72.63%), *Anopheles* spp. (22.68%), and *Aedes* spp. (4.68%). All *Anopheles* specimens belonged to the *An. gambiae* complex, comprising 90.82% *An. arabiensis*, 6.00% *An. gambiae* s.s., and 3.22% *An. coluzzii*. Among these, both endophilic and exophilic populations were observed, with 58.84% of females being gravid. Molecular diagnostics revealed that 27.03% of the *Anopheles* specimens were infected with *Plasmodium falciparum*, while 0.16% carried a dual infection (*P. falciparum* and *P. malariae*). Blood meal analysis indicated a predominance of mixed blood meals (56.65%), followed by zoophilic (22.44%) and anthropophilic (20.91%) feedings.

Conclusions

These findings confirm the presence of active, indigenous malaria transmission hotspots within the urban environment of Bobo-Dioulasso. The observed vector behaviors and infection rates underscore the importance of context-specific interventions aimed at mitigating malaria transmission in urban African settings.

Background

Malaria is a parasitic disease of global concern, transmitted through the bites of infected female mosquitoes of the genus *Anopheles*. Despite progress in vector control, it remains a major public health threat, particularly in intertropical endemic regions, but also may threaten non-endemic areas (1). The disease is primarily caused by five species of *Plasmodium*: *P. falciparum*, *P. vivax*, *P. ovale*, *P. malariae*, and *P. knowlesi*, which together are responsible for significant morbidity and mortality worldwide (2). According to the latest World Health Organization (WHO) malaria report, an estimated of 263 million malaria cases and 597,000 related deaths occurred globally in 2023, with an increase of closely 11 million cases and a rise in mortality compared to 2022. Approximately 95% of malaria-related deaths occurred in Africa, where access to essential preventive, diagnostic, and therapeutic services remains limited for many at-risk populations (3). Burkina Faso remains heavily burdened by malaria. In 2022, it ranked among the ten countries with the highest malaria case counts and fatalities, contributing to 3.2% of global cases and 2.7% of global malaria-related deaths. In 2023, over ten million malaria cases were reported by national health services, accounting for approximately 3.1% of global cases and 2.7% of global deaths (4). The country experiences endemic transmission year-round, with prevalence rates ranging from 21–24%. A marked seasonal increase in cases occurs during the rainy season (from May to October), with the transmission peak lasting up to three months in the north, six months in the center, and as long as nine months in the southern regions (5).

The predominantly endophagic and endophilic behavior of primary malaria vectors has led to widespread implementation of indoor-targeted control measures, such as Long-Lasting Insecticidal Nets (LLINs) and Indoor Residual Spraying (IRS) (6, 7). While these interventions have contributed to a reduction in transmission in many areas, they have also induced notable shifts in mosquito species composition and behavior (8–10). In some settings, such interventions have facilitated the emergence or predominance of more exophilic species such as *An. arabiensis*, and behavioral adaptations in species such as *An. gambiae* and *An. funestus*, resulting in increased outdoor biting activity (11–13). Notably, changes in biting behavior have been observed in *An. gambiae* s.s., including shifts to earlier feeding times and increased zoophilic and mixed blood meal patterns (6, 8, 14).

Despite the widespread deployment of LLINs and IRS, malaria transmission persists in many regions of Burkina Faso, particularly in urban settings (15). This persistence is attributed partly to a range of sociodemographic and environmental factors. Rapid and often unplanned urbanization, coupled with poor drainage, stagnant water, and inadequate waste management, creates favorable breeding conditions for malaria vectors (16). Mosquito larvae develop in a variety of aquatic habitats, both permanent and temporary, including marshes, rivers, puddles, and artificial containers. While *Anopheles* s.s mosquitoes generally prefer clean and unpolluted water, *An. arabiensis* favors sunlit, open habitats (17, 18). Urban density further exacerbates transmission risk and is often accompanied by presumptive treatment practices, which can lead to misdiagnoses, inappropriate antimalarial use, and the emergence of drug resistance (19, 20).

Moreover, in urban areas traditionally classified as low-endemic zones (21), both children and adults tend to acquire partial immunity more slowly, rendering them more vulnerable to severe malaria than their

rural counterparts (22). These epidemiological dynamics underscore the need for revised and context-specific approaches to malaria diagnosis, treatment, and vector control in urban environments. A critical step toward this goal is the identification of local environmental factors driving malaria transmission.

This study aimed to evaluate ecological determinants influencing human exposure to malaria vector bites in selected urban areas of Bobo-Dioulasso, Burkina Faso. By examining *Anopheles* infection rates, blood meal sources, and clinical malaria incidence, the research seeks to improve the understanding of urban malaria transmission dynamics and contribute to the development of more effective and context-adapted control strategies.

Methods

Study Area

This study was conducted in the city of Bobo-Dioulasso, the capital of the Haut-Bassin region. Bobo-Dioulasso is the economic capital of Burkina Faso and is in the southwest of the country; its coordinates are latitude 11°10'37" North, longitude 4°17'52" West, and an altitude of 423 meters above sea level. The study was carried out transversally in several neighborhoods, including Sarfalao, Kua, Sabaribougou, Koden, Farakan, and Dogona (Fig. 1). These neighborhoods were selected based on the presence of a watercourse, permanent breeding sites, and temporary breeding sites created by human activities. Agriculture and artisanal activities being the main activities in these neighborhoods have resulted in the development of numerous sites in favor for mosquito reproduction. This is due, on one hand, to stagnant irrigation water on cultivated plots, and on the other, to the improper management of waste and materials related to these activities. These neighborhoods are densely populated, thus classified as popular or high-density areas. Therefore, it is important to focus on these areas to determine the impact of the environment on the persistence and transmission of malaria.

Human-Bait Capture

Human-bait capture was carried out following the standard WHO protocol (2016). It required eight individuals (collectors) per neighborhood, with two collectors per house. They were divided into two groups: the first group captured mosquitoes from 6 p.m to 1 a.m, and the second group from 1 a.m to 9 a.m. The individuals themselves served as bait to attract mosquitoes. Seated on a chair and equipped with a flashlight, they captured mosquitoes that landed on their bare legs using hemolysis tubes, without waiting for the mosquitoes to become engorged. To reduce biases related to differences in attractiveness to mosquitoes among individuals, the collectors rotated between indoor and outdoor locations every hour. The supervision was conducted by a technician from IRSS/MURAZ and a local agent. The captured mosquitoes were identified based on their genus and species (for *Anopheles*) using taxonomic identification keys and were preserved on silica gel.

Residual Fauna Capture

Residual fauna capture was conducted according to the WHO protocol (2014) and involved collecting mosquitoes randomly in houses for this study. The collection was performed in bedrooms between 6 a.m and 8 a.m using a pyrethroid-type insecticide (Kaltax), which kills or immobilizes mosquitoes. Before spraying, houses were cleared of all food and pets. White sheets were then spread across the entire floor of each room. Finally, all openings (windows, doors, and holes) were carefully sealed to prevent mosquitoes inside from escaping and those outside from entering, during or after spraying. Once these preparations were made, the insecticide was sprayed toward the roof in a clockwise direction, continuing until the entire house was covered with the product. The opening hours remained closed for 10 to 15 minutes. After the allocated time, the sheets were carefully removed and taken outside. Dead or stunned mosquitoes were sorted from other insects and placed into labeled petri dishes (with date, house number, and neighborhood) to be transported to the laboratory of IRSS/Centre MURAZ and preserved at -20°C.

Molecular Identification

The captured mosquitoes were first identified at the genus level using a binocular magnifying glass (AmScope; United Scope LLC) and based on the morphological identification key described by Gillies et De Meillon (23) for anophelines. Subsequently, these species were differentiated through allele-specific PCR amplification following the protocol of Santolamazza et al., (24). This protocol utilizes the insertion polymorphisms of SINE200 retrotransposable elements to examine the genetic differentiation between *An. gambiae* and *An. coluzzii* species, the primary malaria vector in Africa. The primers used were as follows: S200X 6.1F: TCG-CCT-TAG-ACC-TTG-CGT-TA and S200X 6.1R: CGC-TTC-AAG-AAT-TCG-AGA-TAC. For amplification, 18 µL of PCR reaction mix (5x FIREPol® Master Mix Ready to Load with 7.5 mM MgCl₂) were added to 2 µL of extracted genomic DNA. The PCR began with an initial Taq polymerase activation at 94°C for 10 minutes, followed by 35 cycles consisting of Denaturation at 94°C for 30 seconds, Primer annealing at 54°C for 30 seconds and Extension at 72°C for 1 minute. A final extension step was carried out at 72°C for 10 minutes to ensure complete synthesis of DNA strands.

The amplified products were separated on a 2% agarose gel stained with ethidium bromide. The PCR product sizes were estimated using a molecular weight marker of 100 base pairs (bp). After migration for 30 to 45 minutes, the DNA bands were visualized under ultraviolet light. The expected band sizes were as follows: 479 bp for *An. coluzzii*, 249 bp for *An. gambiae* s.s and 223 bp for *An. Arabiensis*.

Molecular analysis

The *Anopheles* samples were subjected to DNA extraction following the 2% CTAB protocol established by Myriam and Cécile (2003). Each specimen was ground in 200 µL of 2% CTAB solution using a tissue homogenizer, promoting the lysis of cell membranes. The homogenates were then incubated in a water bath at 65°C for 10 minutes to inactivate thermolabile enzymes, followed by a step to separate the DNA from cellular debris using 200 µL of chloroform. The isolated DNA was precipitated with 200 µL of isopropanol, purified with 200 µL of 70% ethanol, and suspended in pure water for 24 hours. The purified DNA was subsequently used for various PCR analyses.

Table 1
Primers used for identification of plasmodium species

Species	Primers	Sequence 5'–3'	References
Universal primer	Fal F	GTATCTGATCGTCTTCACTCCC	(25)
<i>P. falciparum</i>	Fal R	AACAGACGGGTAGTCATGATTGAG	
<i>P. ovale</i>	Fal R	CTGTTCTTTGCATTCTTATGC	
<i>P. malariae</i>	Fal R	CGTTAAGATAAACGCCAAGC	

The amplification begun with an incubation at 95°C for 5 minutes, followed by cycles that include denaturation at 95°C for 30 seconds, primer annealing at 58°C for 45 seconds, and DNA strand elongation at 72°C for 1 minute. This cycle was repeated 35 times. Finally, a final elongation step was performed at 72°C for 5 minutes to complete the process. The PCR products obtained were separated on a 2% agarose gel stained with ethidium bromide. The size of the PCR products was estimated using a 100 bp molecular weight marker. The expected band sizes are as follows: 276 bp for *P. falciparum*, 376 bp for *P. ovale*, 411 bp for *P. malariae*.

Origin of the Blood Meal

The origin of the blood meal in engorged and semi-gravid *Anopheles* mosquitoes was determined using the protocol described by Kent and Norris (2005). This protocol was modified and divided into two multiplex PCRs (PCR1 and PCR2) based on the use of specific primers to identify the blood meals of *An. gambiae* s.l., such as (Table 2 and Table 3):

Table 2
Primers used for identification trophic preference in *An. gambiae* s.l., (PCR 1)

Species	Primers	Sequence 5'–3'	References
Universal primer	Fal F	GGTTGTCCTCCAATTCATGTTA	(26)
sheep	Fal R	CTATCCTACTAATCCTCATCCTCATG	
donkey	Fal R	CTGGTAATCGTCCATCTAC	
Chicken	Fal R	ACACACCCTAGTAGAGTGAGG	
Goat	Fal R	CCTAATCTTAGTACTTGTACCCTTCCTC	

Table 3
Primers used for identification trophic preference in *An. gambiae* s.l., (PCR 2)

Species	Primers	Sequence 5'–3'	References
Universal primer	Fal F	GGTTGTCCTCCAATTCATGTTA	(26)
pig	Fal R	CCTCGCAGCCGTACATCTC	
Human	Fal R	GGCTTACTTCTCTTCATTCTCTCCT	
Dog	Fal R	GGAATTGTACTATTATTCGCAACCAT	
Beef	Fal R	CATCGGCACAAATTTAGTCG	

The amplification started with an incubation at 95°C for 3 minutes and 30 seconds, followed by 40 successive cycles comprising: denaturation at 95°C for 30 seconds, primer annealing at 60°C for 50 seconds, and DNA strand elongation at 72°C for 40 seconds. Finally, a final incubation step at 72°C for 5 minutes completes the amplification. The resulting PCR products were separated on a 2% agarose gel stained with ethidium bromide. A 100 bp molecular weight marker was used to estimate the sizes. The expected PCR product sizes are as follows: 340 bp (sheep), 150 bp (goat), 290 bp (chicken), 460 bp (donkey), 500 bp (pig), 350 bp (human), 750 bp (dog), 600 bp (beef).

Collection of Clinical Data

The clinical data based on malaria infected cases were collected from the monthly records of the various Health Centers “Centre de Santé et de Promotion Sociale (CSPS)” in the six neighborhoods through the head nurses of these health centers. This was made possible by authorization granted by the Direction Régionale de la Santé (DRS) and the head nurses of the Dafra and Do health districts.

Data Analysis

The data were analyzed using RSTUDIO software version 4.4.2. The relationships between the mean abundance and the number of positive cases were assessed using Pearson's correlation coefficient. Subsequently, ANOVA or Kruskal-Wallis tests were performed, depending on whether the distribution followed the normal distribution or not, with a significance level set at 0.05. P-values below 0.05 were considered significant in the analysis.

Results

Density of Residual Fauna Capture

Overall, the analysis of the resting mosquito fauna revealed a predominance of *Culex* spp. with a total number of 10,203 corresponding to 72.63%. Also, an effectif of 3,186 of *Anopheles* spp. individuals was collected prevailing to a rate of 22.68% followed by *Aedes*. with a total number of 658 individuals corresponding to 4.68%.

Density of *Anopheles* species

The analysis of species distribution collected by human-bait and residual fauna capture reveals that *An. arabiensis* is the predominant species across most sampling sites, regardless of proximity to water bodies both proximal (close) and distal (far). However, notable spatial variations were observed in certain localities. For instance, in Farakan, *An. arabiensis* accounted for 97% of specimens in distal areas, compared to 88% in proximal areas. A similar pattern was observed in Kua, where its prevalence was higher in distal sites (96%) than in proximal ones (84%). Conversely, greater species diversity was recorded in certain proximal areas. In Koden-close, for example, *An. coluzzii* and *An. gambiae* s.s. were more frequently encountered, representing 4% and 10% of the *Anopheles* population, respectively, whereas in Koden-far, only *An. gambiae* s.s. was present, at 10%. These differences may reflect microhabitat variations or ecological preferences influencing species distribution between proximal and distal zones.

In other localities, such as Sabaribougou and Sarfalao, the differences between proximal and distal areas were less pronounced for *An. arabiensis*, suggesting a relatively homogeneous distribution of this species across spatial gradients. Notably, in Sarfalao-far, *An. gambiae* s.s. reached a higher proportion (13%) compared to only 3% in Sarfalao-close, indicating potential site-specific environmental factors favoring this species in distal zones. Additionally, *An. coluzzii* showed a relatively elevated presence in Kua-close (7%), potentially suggesting a preference for habitats closer to human settlements (Table 4).

Table 4
Density of *Anopheles* species

Sites	<i>An. arabiensis</i> n (%)	<i>An. coluzzii</i> n (%)	<i>An. gambiae</i> n (%)	Total n (%)
Dogona-far	68 (11.93)	02 (10)	03 (08.57)	73 (11.64)
Dogona-close	63 (11.05)	03 (15)	03 (08.57)	69 (11)
Farakan-far	29 (05.09)	ND	01 (02.86)	30 (04.80)
Farakan-close	23 (04.03)	01 (05)	02 (05.71)	26 (04.14)
Kodeni-far	56 (09.82)	ND	05 (14.28)	61 (09.73)
Kodeni-close	43 (07.54)	02 (10)	06 (17.14)	51 (08.13)
Sabaribougou-far	51 (08.95)	ND	02 (05.71)	53 (08.45)
Sabaribougou-close	37 (06.50)	03 (15)	01 (02.86)	41 (06.54)
Kua-far	51 (08.95)	02 (10)	ND	53 (08.45)
Kua-close	49 (08.60)	04 (20)	06 (17.14)	59 (09.41)
Sarfallao-far	40 (07.02)	01 (05)	06 (17.14)	47 (07.50)
Sarfallao-close	60 (10.53)	02 (10)	02 (05.71)	64 (10.21)
Total	570 (90.91)	20 (03.19)	37 (05.90)	627 (100)
ND: No determined				

Seasonal Density of anopheline Species

Overall, the analysis shows that *An. arabiensis* is the most widely distributed species during both the rainy season and the dry season. On the other hand, *An. gambiae* s.s. is less predominant during the dry season, while *An. coluzzii* stands out as the least abundant species during the rainy season (Fig. 2). This density does not show a significant difference ($P = 0.38$).

Resting Behavior of Vectors

The curve below illustrates the evolution of *Anopheles* abundance inside and outside houses over time. Globally, a gradual increase in the number of *Anopheles* was observed from 6 p.m to 5 a.m, with a peak from 10 p.m to 11 p.m indoors and from midnight to 1 a.m outdoors, followed by a decrease until their complete disappearance between 5 a.m and 9 a.m, both indoors and outdoors (Fig. 3).

Infection Rate

The analysis of Fig. 4 below shows the distribution of infection rates based on the position of the species relative to the houses. Outside, a widespread distribution of infections by *P. falciparum* was observed, along with the presence of dual infection by *P. falciparum* and *P. malariae*. This dual infection was absent indoors. These observations are consistent regardless of whether the houses are close to or far from the riverbanks.

Clinical Data

The clinical data revealed that, across all neighborhoods, the month of September records the highest number of positive malaria cases (Fig. 5). The number of tests conducted, and positive cases increases month by month in all neighborhoods. The proportion of positive cases relative to the number of tests remains significant in every neighborhood. Kua and Sabaribougou stand out with a higher number of tests conducted and positive cases, especially in August and September. For instance, in August, Kua conducted 2,869 tests resulting in 2,177 positive cases, and in September, approximately 4,000 tests with 2,500 positive cases. Similarly, in Sabaribougou, August recorded 1,551 positive cases out of 3,410 tests, and September showed 2,700 positive cases out of 5,000 tests. In contrast, Dogona and Kodené experienced more moderate growth in positive cases.

The analysis of the results shows a positive relationship between the two events: in other words, the more abundant the *Anopheles* mosquitoes, the higher the number of positive malaria cases (Fig. 6). This observation is supported by the correlation test, which shows a positive sign ($\rho = 0.12$). In other words, a greater abundance of these vectors was correlated with an increase in the transmission of the parasite responsible for the disease.

Trophic Preferences of Vectors

The results below highlighted the trophic preferences of species according to the months and the location of houses (Fig. 7). Mosquitoes with mixed blood meals dominate over several periods, particularly in April, July, and September, in houses close to the shores. During this same period, the proportion of zoophilic mosquitoes reached its peak. Anthropophilic mosquitoes were present but in smaller quantities compared to other groups, although their presence remains relatively stable throughout the months.

Discussion

This study aimed to assess the environmental and ecological factors influencing human exposure to malaria vectors in selected urban areas of Bobo-Dioulasso. Among these factors, variations in mosquito density, species composition, infection rates, and blood-feeding preferences remain very important. Here, the analysis of the resting mosquito fauna revealed a predominance of *Culex* spp. (72.63%), followed by *Anopheles* spp. (22.68%) and *Aedes* spp. (4.68%). The dominance of *Culex* is likely attributable to its high ecological plasticity and its capacity to breed in a wide range of habitats, particularly polluted and stagnant water bodies frequently encountered in urban environments.

Urbanization, climate variability, agricultural runoff, and inefficient waste management create optimal conditions for their proliferation (27). These observations are consistent with those reported by Chahed et al in Algeria and by Fillinger et al (28, 29) in Dar es Salaam, though they contrast with findings from Hamaidia and Berchi in Souk-Ahras, Algeria, and Namountougou et al (30, 31) in Burkina Faso, where *Anopheles* spp. were more prevalent.

Molecular analyses of the *An. gambiae* sensu lato (s.l.) complex revealed the presence of three sibling species: *An. arabiensis* (90.91%), *An. gambiae* s.s. (5.90%), and *An. coluzzii* (3.19%). The predominance of *An. arabiensis* is likely due to its exceptional adaptability, including its tolerance to arid conditions and its ability to reproduce in urban and even polluted environments (32). These findings align with recent works done by (33), who also reported high frequencies of *An. arabiensis* in urban areas of Bamako, Mali.

Temporal variations in female *Anopheles* abundance revealed that exophilic behavior was more pronounced between 12 a.m. and 5 a.m., whereas endophilic activity peaked between 7 p.m. and 1 a.m. This suggests a behavioral adaptation to ambient temperature and host availability, with mosquitoes preferring cooler outdoor environments during the early morning hours. Similar trends were observed in Uganda (34) and Sudan, where *An. arabiensis* exhibited flexible resting behavior depending on seasonal conditions (35). From 6 a.m. to 9 a.m., mosquito abundance declined significantly, likely due to the cessation of host-seeking activity and a shift toward resting behavior, a pattern corroborated by studies from Nigeria (36).

Notably, exophilic *An. gambiae* s.l. populations exhibited higher *Plasmodium* infection rates compared to their endophilic counterparts, regardless of proximity to riverbanks. This elevated infection rate may result from increased host diversity and accessibility outdoors, where vector control tools such as LLINs and IRS are ineffective. Indoors, the presence of insecticides limits mosquito feeding success, whereas exophilic mosquitoes benefit from unrestricted access to blood meals, increasing their likelihood of acquiring and transmitting *Plasmodium* spp. This observation is consistent with findings from Burkina Faso, where IRS with DDT significantly reduced indoor biting rates but led to a fivefold increase in exophagic behavior due to the excito-repellent properties of the insecticide (37).

Clinical surveillance data revealed malaria cases across all sampled neighborhoods, aligning with the confirmed presence of *Plasmodium falciparum* and *P. malariae* in mosquito vectors. A positive correlation ($\rho = 0.11595$) was observed between infection rates and vector density, supporting WHO's findings on vector–pathogen–host interactions (3).

Blood meal analysis indicated a dominant mixed feeding preference in *Anopheles* mosquitoes, particularly in April, July, and September, in areas adjacent to riverbanks. This mixed trophic behavior may reflect host availability, including the presence of humans, livestock, and domestic animals, as well as mosquito adaptability. The proximity of animal reservoirs to human dwellings increases the likelihood of opportunistic feeding (38). Species such as *An. arabiensis* and *An. gambiae* are known to modulate their host preferences according to environmental and seasonal cues (39), and insecticide resistance may further influence host-seeking behavior (40).

Interestingly, the peak in zoophilic behavior overlapped with the period of heightened mixed feeding, notably in August, likely due to the increased availability of animal hosts. The pronounced seasonal variation in trophic behavior and the concurrent increase in zoophilic and endophilic mosquito densities during April, August, and September suggest these months represent critical periods for malaria transmission risk. As such, targeted vector control efforts and more granular ecological assessments during these months may enhance the effectiveness of malaria prevention strategies.

Conclusion

This study identified three genera of culicid mosquitoes within the study area: *Anopheles*, *Culex*, and *Aedes*. Within the *Anopheles* genus, three sibling species were detected *An. gambiae* s.l., *An. coluzzii*, and *An. Arabiensis* considered as the predominant species. These mosquitoes exhibited both endophilic and exophilic behaviors and demonstrated a broad host range, feeding on humans as well as domestic animals including cattle, goats, and poultry. Blood meal analysis confirmed a mixed trophic preference, though a high degree of anthropophily was consistently observed. This strong human-biting behavior significantly elevates the risk of vector-borne disease transmission, particularly malaria, among the inhabitants of Bobo-Dioulasso. The entomological findings reported here are consistent with the elevated number of malaria cases recorded across the various primary healthcare centers (CSPS) in the region. These results underscore the urgent need for targeted and context-specific vector control strategies to reduce human–vector contact and mitigate the burden of malaria in urban and peri-urban settings.

Abbreviations

s.l.

sensu lato

s.s.

sensu stricto

PCR

Polymerase Chain Reaction

WHO

World Health Organization

LLINs

Long-Lasting Insecticidal Nets

IRS

Indoor Residual Spraying

IRSS

Institut de Recherche en Sciences de la Santé

DNA

Desoxyribonucleic acid

CTAB

Declarations

Ethics approval and consent to participate

This study was approved by the Ethical Research Committee of the Institut de Recherche en Sciences de la Santé (IRSS) under reference number 008-2022/CEIRES, dated 20 January 2022. In accordance with national and institutional guidelines, informed consent was not required, as the study did not involve human participants or the collection of any personal or identifiable information. Only mosquito populations were collected for entomological analysis.

Consent for publication

Not applicable

Availability of data and materials

Not applicable

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

MN, OG and MFA designed the study, MFA, KWUK and KA contributed to the implementation of the study. MFA, RKY, and KLN performed laboratory and fieldwork. MFA and RKY analysed the data. AMF, NM, and OG interpreted the results and drafted the manuscript, which was critically revised by coauthors. All authors read and approved the final manuscript.

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Figures

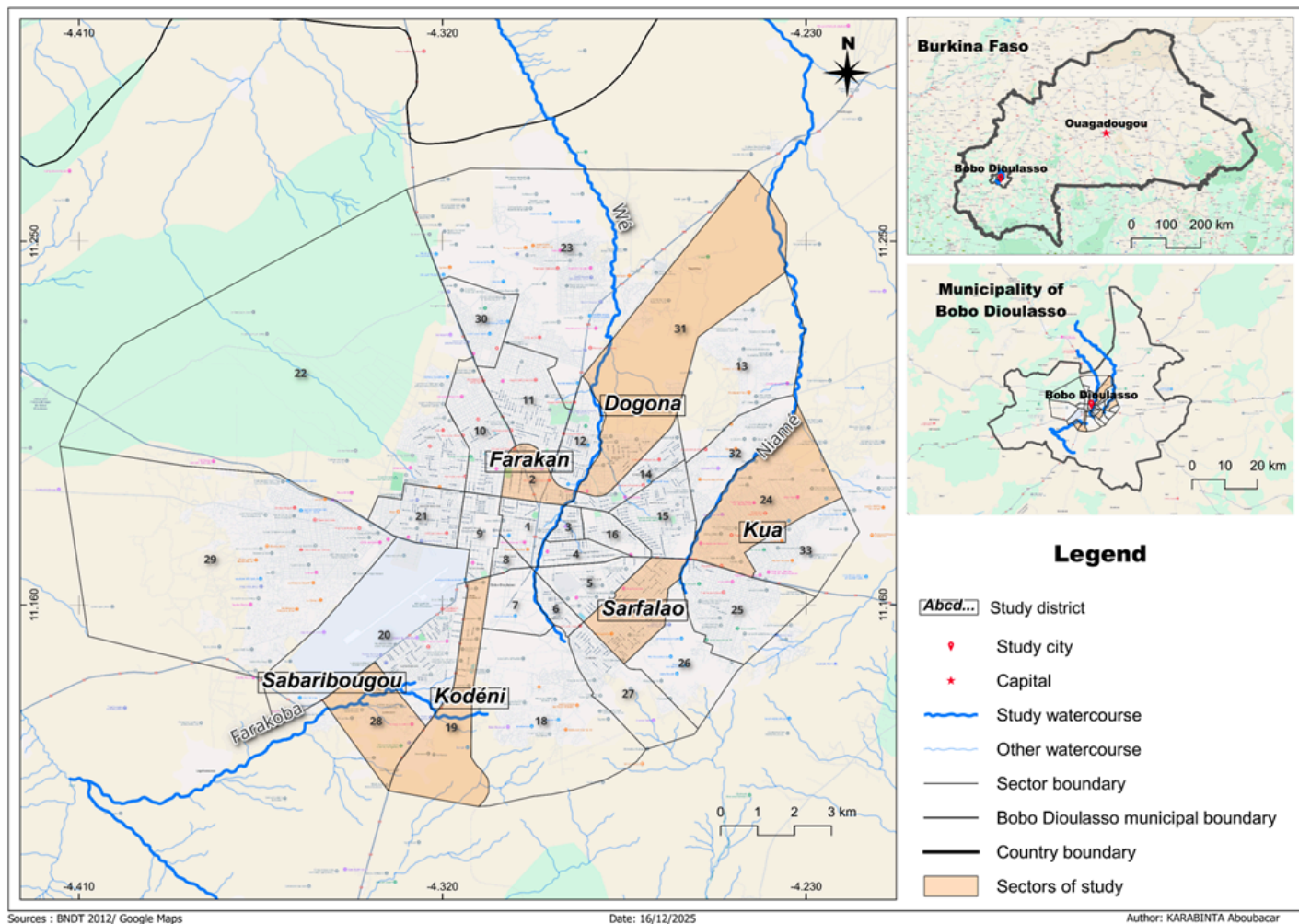


Figure 1

Study Areas located in Bobo-Dioulasso, western Burkina Faso

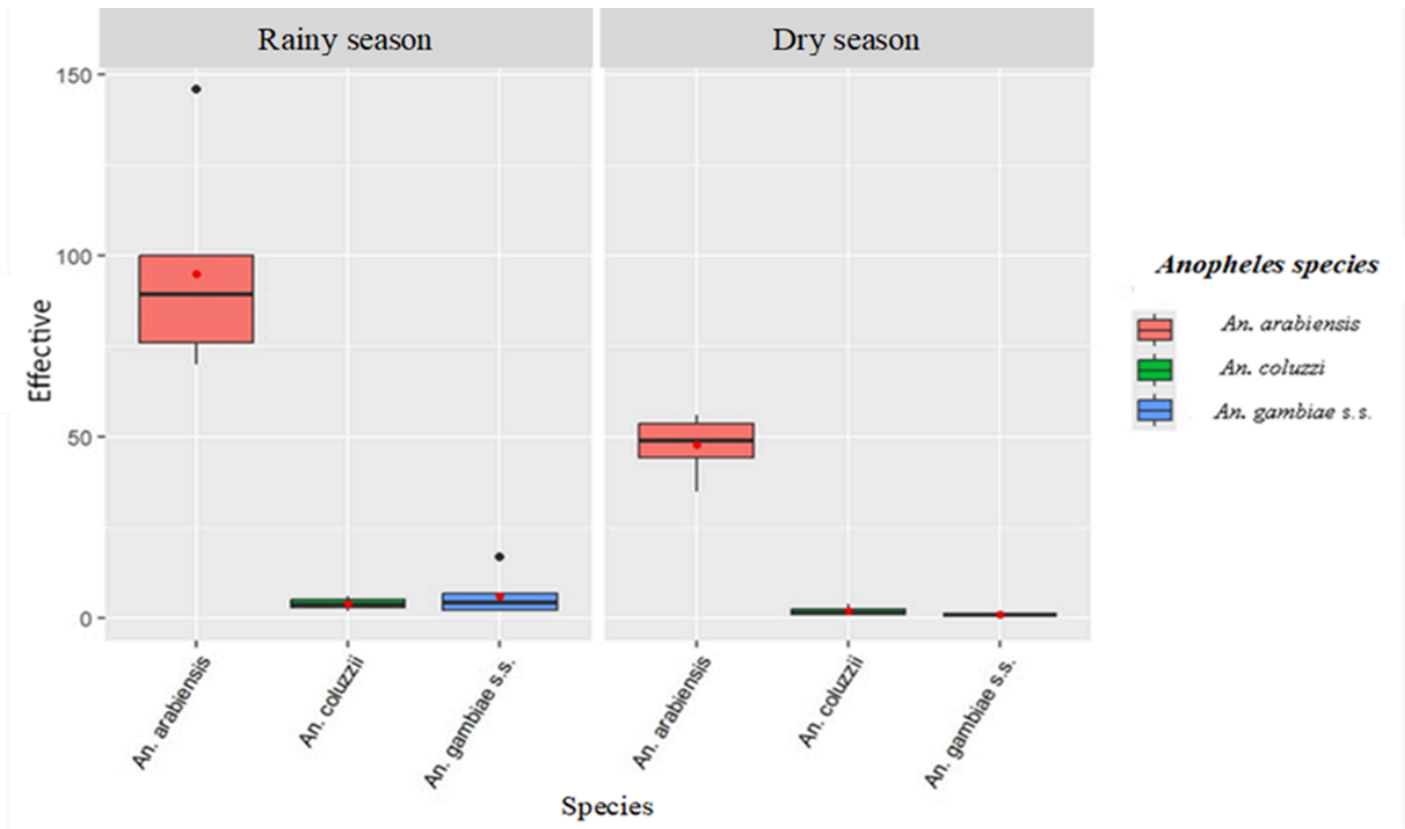


Figure 2

Distribution of *Anopheline* Species According to Seasons

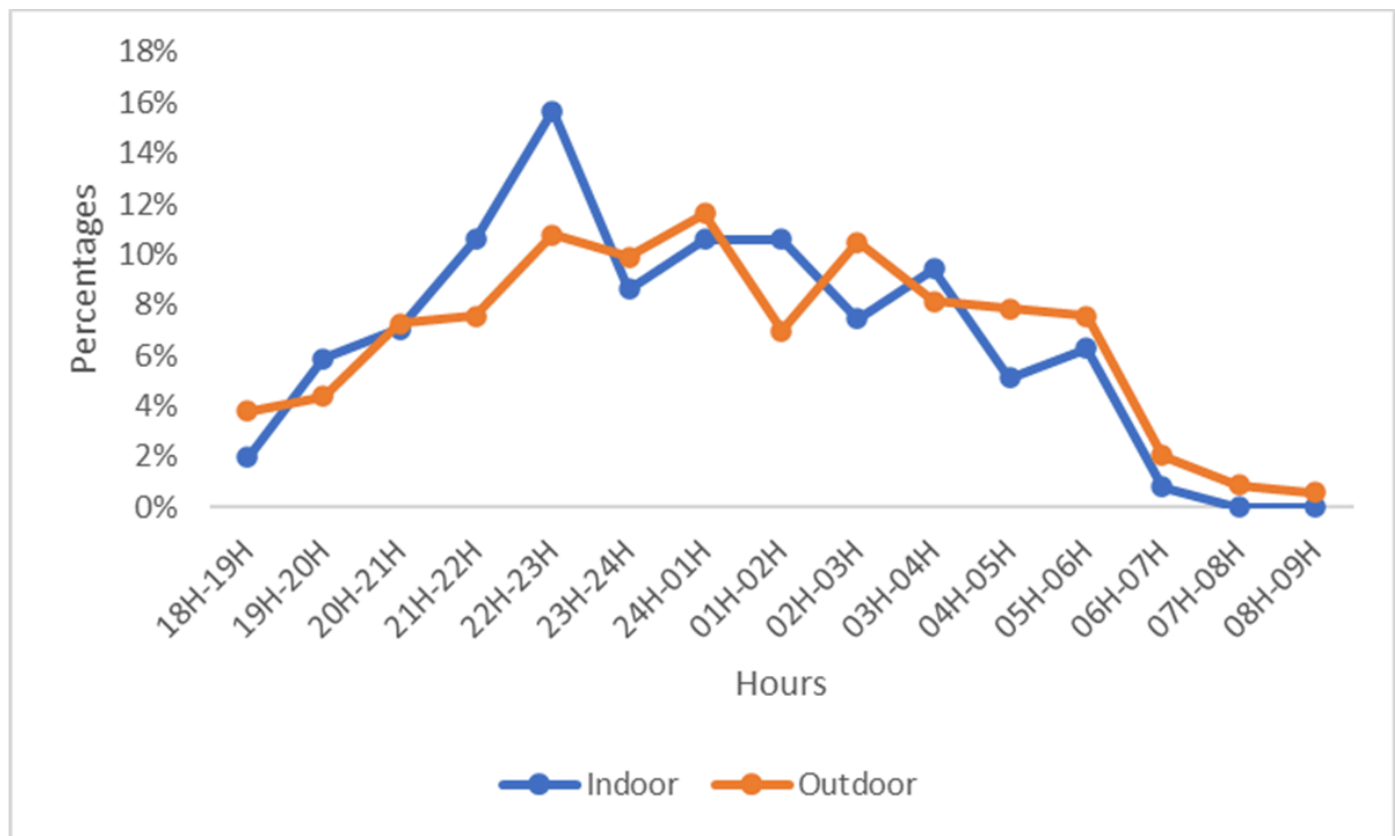


Figure 3

Curve Showing the Evolution of anopheles Abundance Inside and Outside Houses Over Time

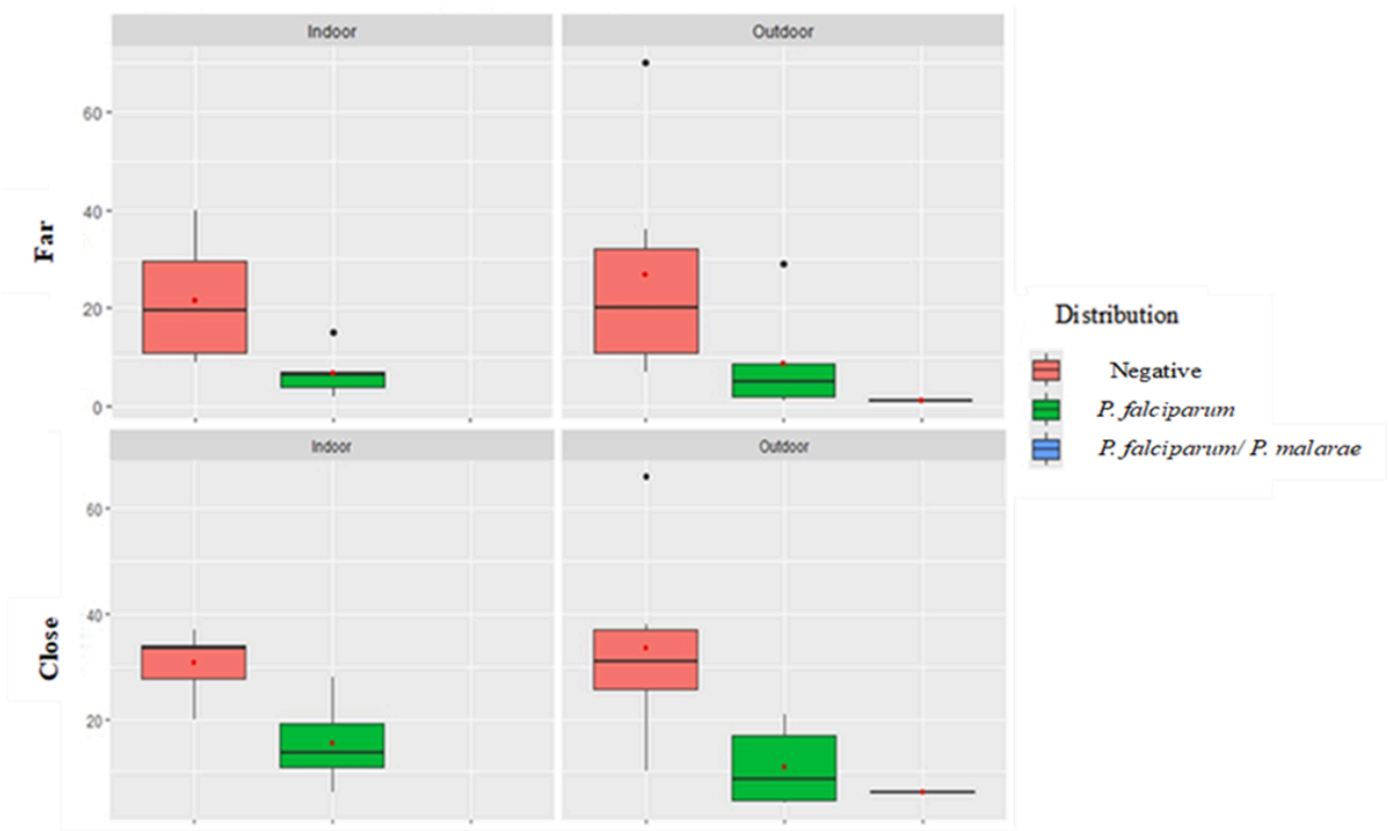


Figure 4

Distribution of Different *Plasmodium* Species Based on the Environment

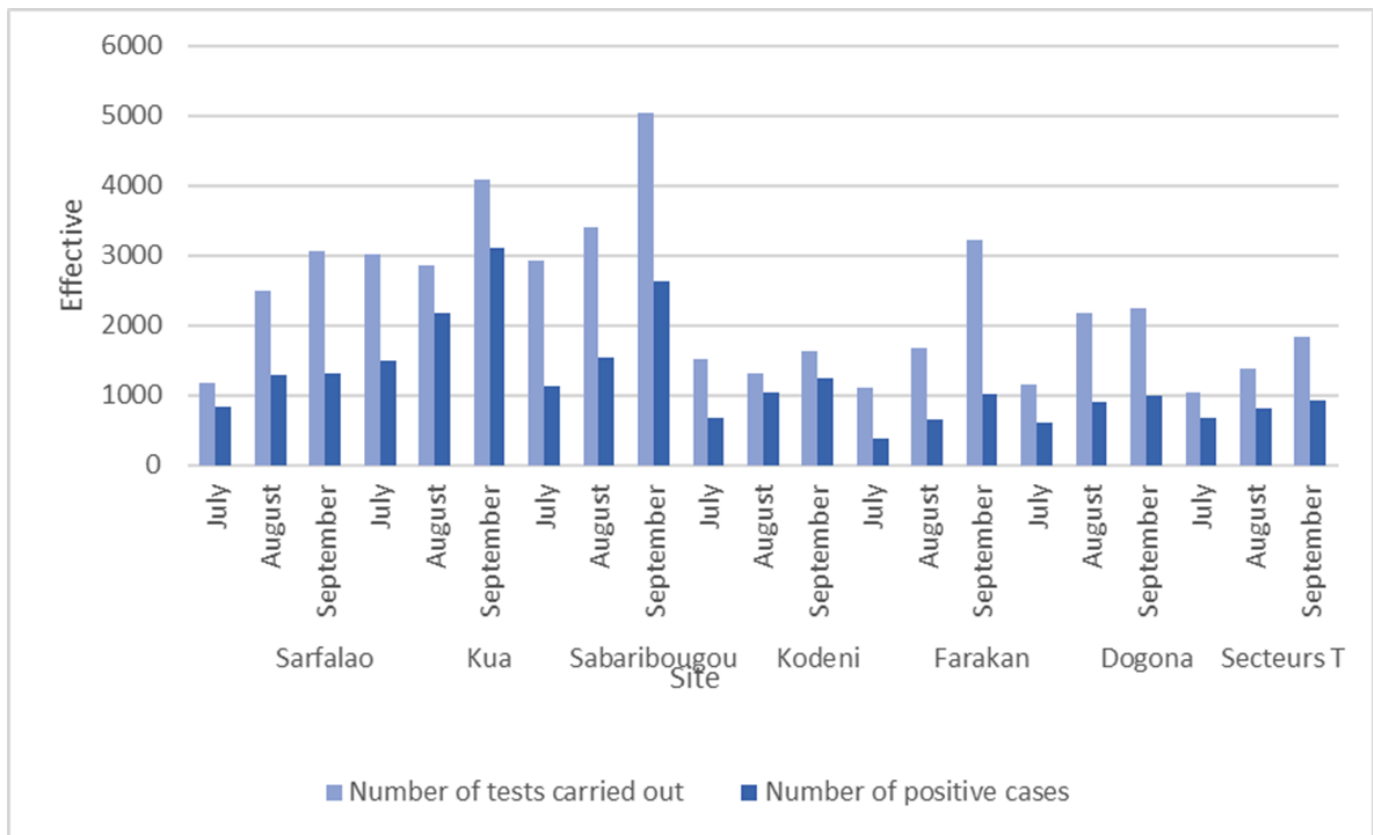


Figure 5

Clinical data of the different neighborhoods based on the months

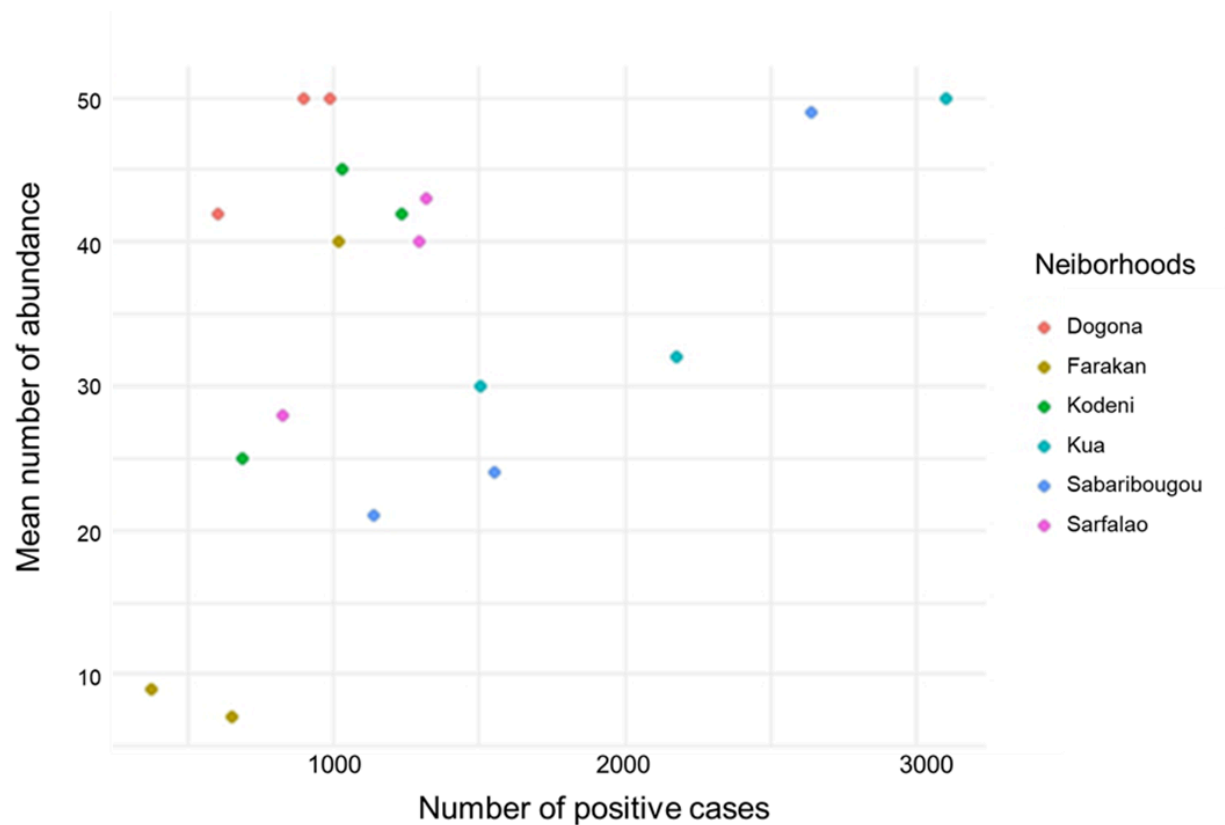


Figure 6

Correlation between *Anopheles* mosquito abundance and malaria incidence

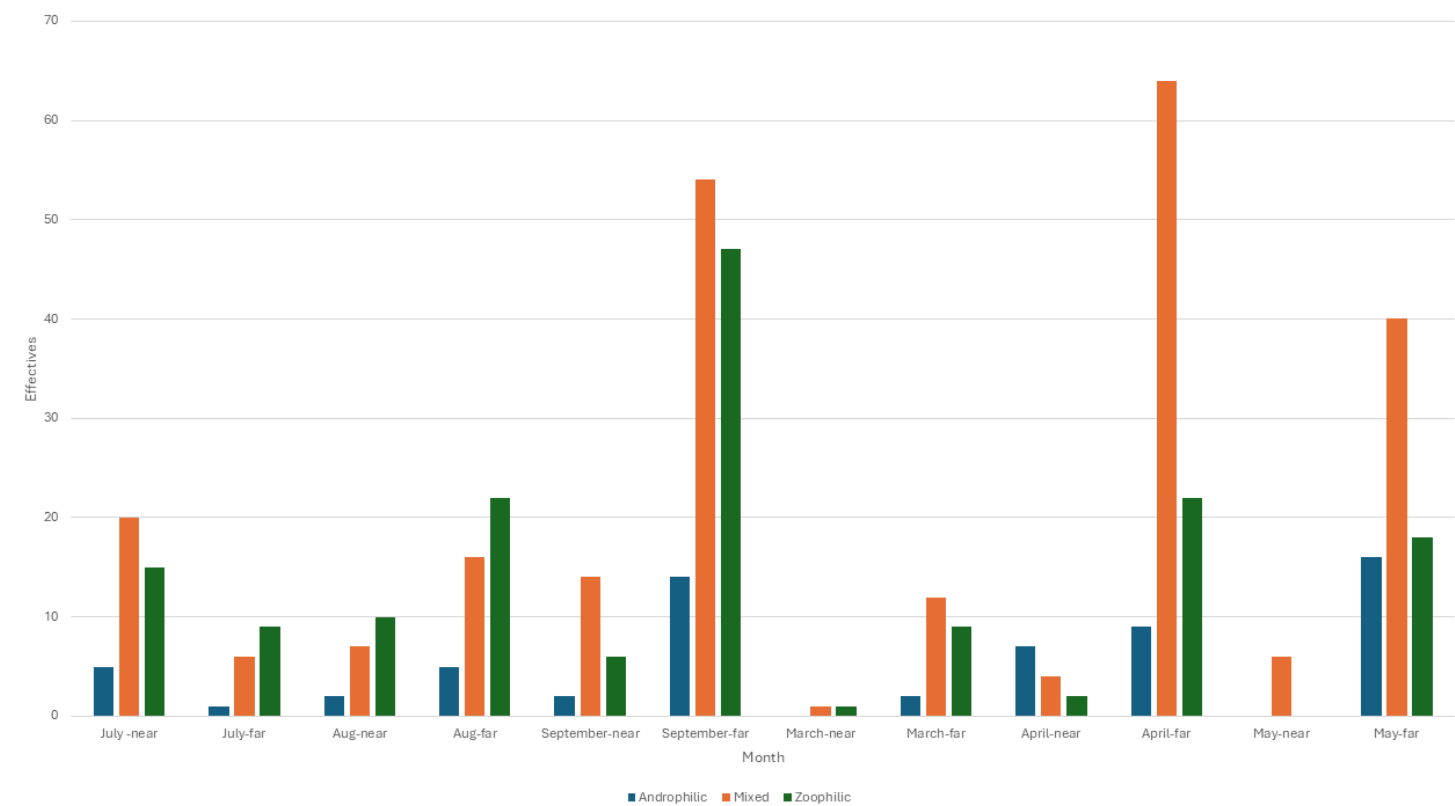


Figure 7

Distribution of trophic preferences according to the month and the positioning of the house (far or close)