GSC Biological and Pharmaceutical Sciences
eISSN: 2581-3250 CODEN (USA): GBPSC2
Cross Ref DOI: 10.30574/gscbps
Journal homepage: https://gsconlinepress.com/journals/gscbps/

(RESEARCH ARTICLE)

Check for updates

Malaria vector transmission assessment in Banambani village of Kati, Mali

COULIBALY Yaya Zié [2], COULIBALY Boubacar [2], DIARRA Rabiatou A [1, 2], DIALLO Moussa [2], KEITA Moussa [2], SAMAKE Djibril [2], KONE Massiriba [1, 2], CAMARA Makan [1, 2], TRAORE Astan [1], DAO Adama [2] and YARO Alpha Seydou [1, 2]

[1] *Faculty of Science and Technology (FST), University of Science, Technology and Technology of Bamako (USTT-B); Badalabougou Hill, Rue L.S Senghor, PO Box E: 3206 Bamako/Mali.*
[2] *Malaria Research and Training Center, International Center for Excellence in Research (ICER-Mali), Faculty of Medicine and Odontostomatology, Faculty of Pharmacy; PO Box: 1805, Point G Bamako/Mali.*

GSC Biological and Pharmaceutical Sciences, 2025, 31(01), 231-238

Publication history: Received on 06 March 2025; revised on 14 April 2025; accepted on 16 April 2025

Article DOI: https://doi.org/10.30574/gscbps.2025.31.1.0149

Abstract

Prior assessment of the culicidea fauna is necessary for the implementation of effective vector control strategies. The aim of this study was to assess malaria transmission parameters while providing basic entomological data for the Kati health district. A longitudinal cross-sectional study with biweekly collections was conducted from September to December 2022 in Banambani, a rural village of Kati district. Residual wild fauna was collected inside huts (40 huts) between 08 and 12 in the morning. A mouth aspirator was used to collect the mosquitoes. A total of 547 collected female mosquitoes were morphologically identified and molecularly to determined sub species of A*nopheles gambiae* s.l. by PCR. Sporozoite infections were determined by ELISA-CSP and blood meal ELISA. The results showed that the highest infections were observed in November, with an average infection rate of 1.8%. The highest entomological inoculation rate (0.48 pi/h/month) was observed in October, with an average of 0.30 infectious bites per man per month from September to December 2022. *An. gambiae* s.l. was the main vector in the study area. *An. coluzzii* was the main vector, and *An. arabiensis* was a minor vector.

Keywords: Malaria; Vector transmission; Banambani; Mali

1. Introduction

Malaria is a major public health problem worldwide (Anges et al., 2022). According to a World Health Organization report, 247 million cases of malaria have been recorded, including 593,000 deaths (WHO, 2023). In Africa, the number of malaria cases is 234,000,000 and the number of deaths due to this disease is 602,000 (WHO, 2023). In Mali, malaria is transmitted by two main vectors: *Anopheles gambiae* s.l., which has a highly complex genetic structure linked to ecological conditions (Touré et al., 1998), and *Anopheles funestus* sp (Touré, 1979). Malaria is present almost everywhere in Mali, with a gradient of endemicity decreasing from south to north (Dadé Ben Sidi Haïdara et al., 2021).

According to the 2020 report of the local health information system, health facilities reported 2,884,537 cases of malaria, including 1,454 deaths recorded in hospitals (DGSHP, 2021). This makes malaria the leading cause of mortality and morbidity in endemic countries, particularly affecting children under five, pregnant women, and immunocompromised individuals (Anges et al., 2022). Due to the rarity of the dominant vector species, *An. funestus* (TOURE, 1979), and the many efforts made to control it, malaria is still the leading pathology encountered in this village. However, eco-climatic changes associated with human activities could favor the emergence of other vector species. The present study was initiated to assess the level of malaria vector transmission in Banambani.

* Corresponding author: Yaya Zié COULIBALY

2. Study Methodology

2.1. Study site

The village of Banambani (12°48' north latitude, 8°2' west longitude) is located in the Cercle de Kati, Koulikoro region, 7 km northeast of Kati (Figure 1).

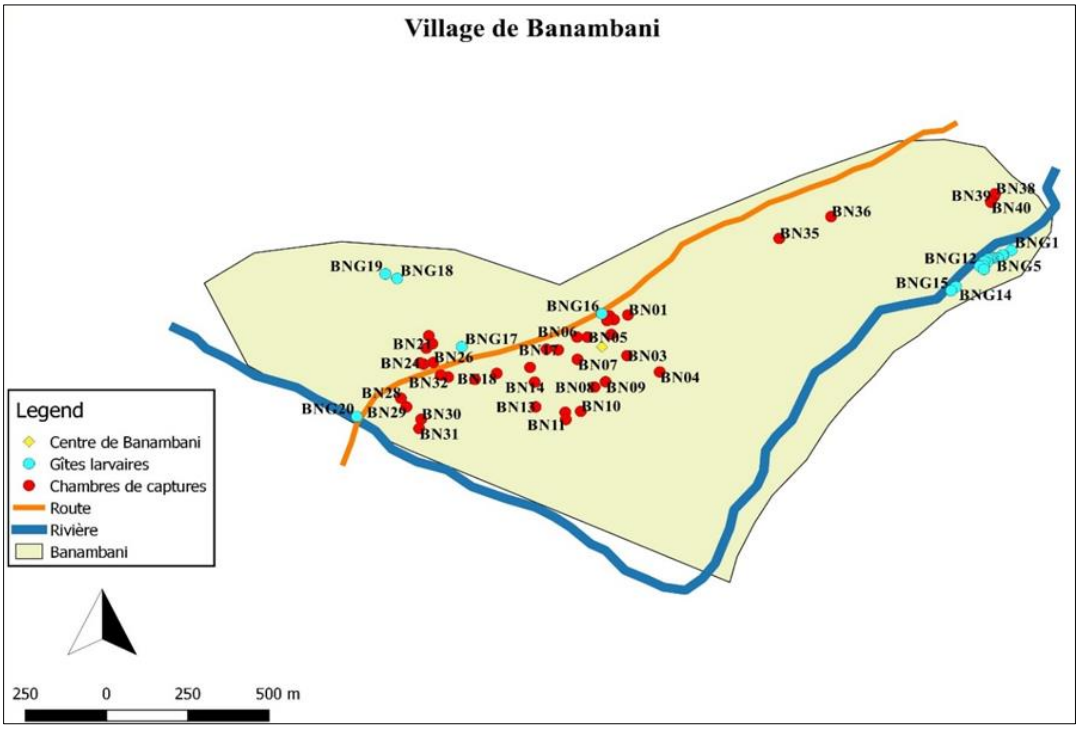

Figure 1 Study site (MRTC Entomology/ M. SANGARE /M. SAMAKE)

2.2. Material used

The animal material consisted of the residual culicid fauna of the village of Banambani. Consumables included mosquito nets, a plastic wristband, a cardboard pot, hygrophilic cotton, a mouth aspirator, ethanol diluted to 80%, a flashlight, freezer boxes, and 1.5 ml Eppendorf tubes.

2.3. Methods

The study was a longitudinal bi-monthly survey. It was conducted from September to December 2022. Residual culicid fauna was collected in 40 geo-referenced huts, obtained after systematic random sampling of 775 identified in the village. The method used was a mouth aspirator. The captors, equipped with a flashlight and a mouth aspirator, meticulously searched the nooks and crannies of each hut for mosquitoes between 08 and 12 o'clock in the morning.

The captured mosquitoes were kept in small cardboard pots covered with mosquito netting. They were then anaesthetized and placed in 1.5 ml Eppendorf tubes containing 80% ethanol. The village initial was marked on each tube. They were placed in freezer boxes and sent to the MRTC Molecular Ecology Laboratory for identification.

The composition of the anopheline fauna was determined using morphological identification keys established by (M. Gillies. & Meillon., 1968; M. Gillies. & Coetzee, 1987). The PCR technique was used for the molecular identification of *Anopheles* species, the ELISA-CSP for the detection of *Plasmodium* infection and the "blood meal" ELISA to test the origin of the blood meal.

3. Results

3.1. Composition of the anopheline malaria vector fauna in Banambani

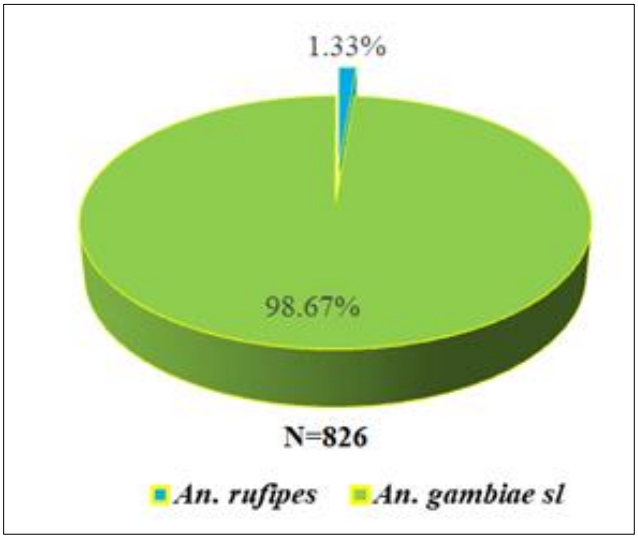

Figure 2 Composition of the anopheline fauna in Banambani

A total of 826 *Anopheles* were captured during the study period. It was observed that the anopheline fauna consisted of 98.67% *An. gambiae* s.l. versus 1.33% *An. rufipes* among our collected samples (Figure 2).

3.2. Frequency of anopheline fauna by sex at Banambani

Table 1 Monthly variation of *An. gambiae* s.l. and *An. rufipes* by sex at Banambani

Month /Year	gam_F	gam_M	Ruf_F	Ruf_M	Total
September-22	161	15	0	0	176
October-22	277	270	3	5	555
November-22	32	9	2	1	44
December-22	30	4	0	0	34
Overall	500	315	5	6	826

gam_F: *gambiae* female; gam_M*: gambiae* male; Ruf_F: *rufipes* female; Ruf_M: *rufipes* male

Table 1 shows that the anopheline fauna was composed of *An. gambiae* s.l. and *An. rufipes*. *An. gambiae* s.l. was in the majority among the samples during the study period. Females were much more numerous than males. This seems to be related to the more endophilic nature of females. *An. rufipes* was not found in September and December. The number of collected females and males of both species was high in October.

3.3. Molecular Composition of *An. gambiae* Species

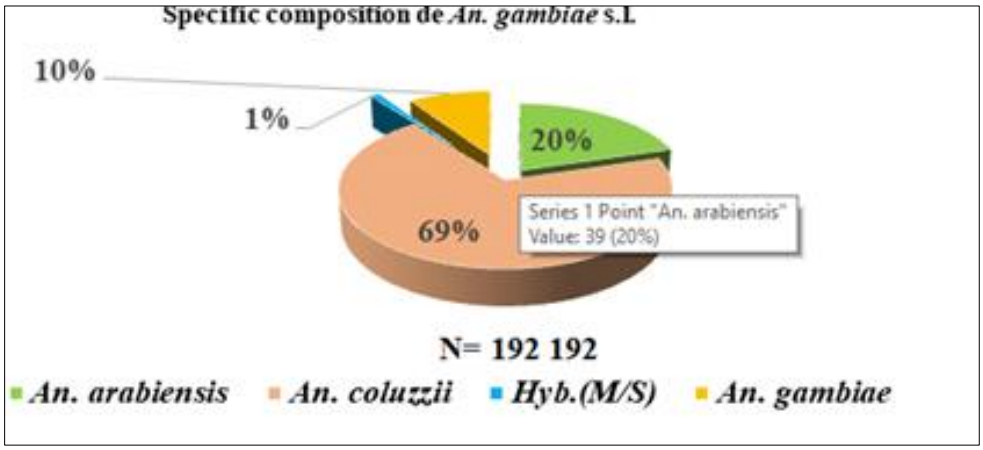

Figure 3 Molecular composition of species in the *An. gambiae* complex

Figure 3 shows that the *An. gambiae* complex consisted of *An. coluzzii, An. arabiensis*, *An. gambiae* and low frequency hybrid species (M/S).

3.4. Determination of entomological parameters

Mean monthly density of *An. gambiae* s.l.

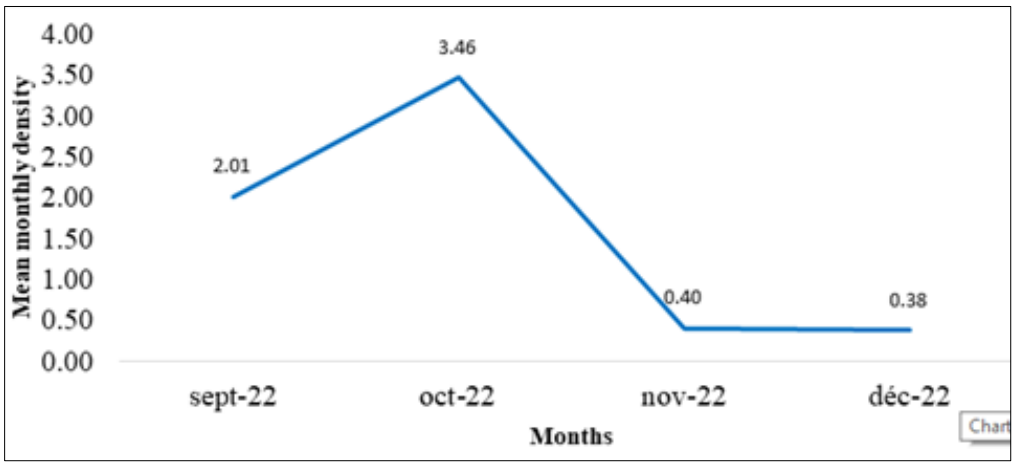

Figure 4 Mean monthly density of *An. gambiae* s.l.

The monthly density of *An. gambiae* s.l. peaked in October. It decreased in November and December.

3.5. Monthly mean human bating rate

The average monthly aggressiveness peaked in October with 1.08 bites/man/night. The lowest values were observed in November and December (Figure 5).

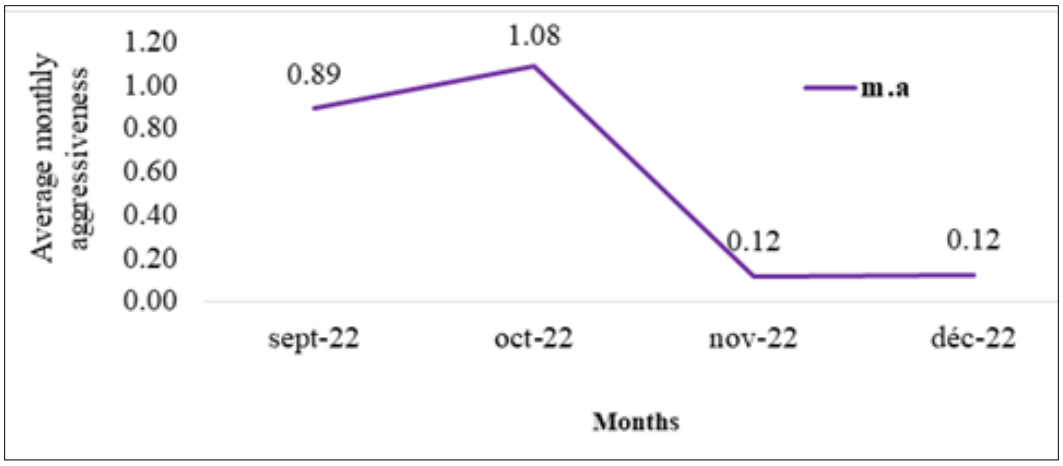

Figure 5 Monthly mean human bating rate of *An. gambiae* s.l.

3.6. Monthly anthropophilic rate

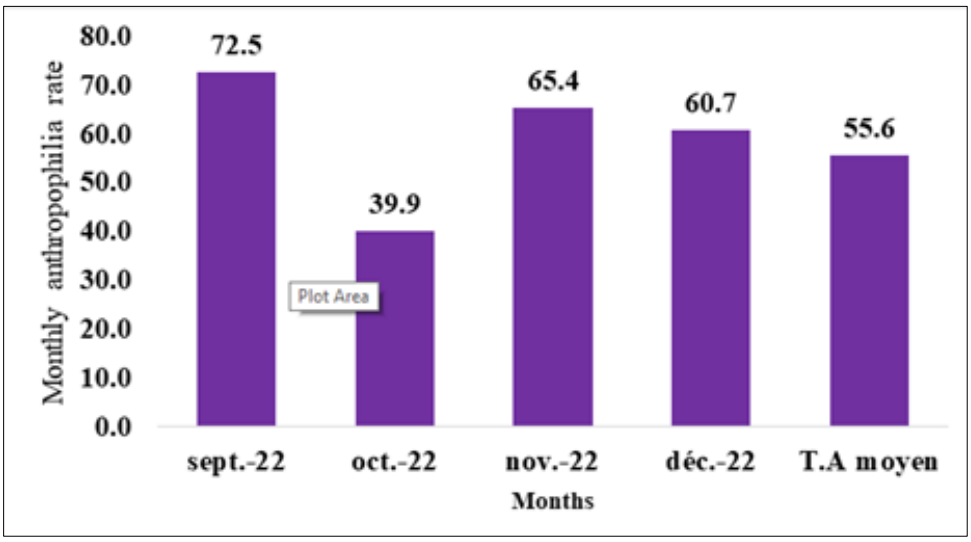

Figure 6 Monthly anthropophilic rate of *An. gambiae* s.l.

The highest monthly anthropophilic rate was observed in September with 72.5%. The lowest rate was recorded in October.

3.7. Monthly infection rate

Table 2 Monthly infection rate of *An. gambiae* s.l. in Banambani

Months /Year	Number of Anopheles treated	Number of Anopheles positive	Infection rate	P-value
Sept.-22	216	3	1.4	0.161
Oct.-22	270	4	1.5	
Nov.-22	29	2	6.9	
Déc.-22	32	1	3.1	
T.I mean	547	10	3.2	

During the four months of the study, 10 mosquitoes with sporozoite antigen were detected out of 547 samples processed. The highest monthly infection rate was observed in November. The monthly infection rate was not significantly different (P value = 0.16).

3.8. Entomological inoculation rate (EIR)

Table 3 Entomological inoculation rate of *An. gambiae* s.l. in Banambani from September to December 2022

Month /Year	IS	m.a	T.I.E/months
Sept. 22	0.014	0.89	0.37
Oct. 22	0.015	1.08	0.48
Nov. 22	0.069	0.12	0.24
Dec. 22	0.031	0.12	0.11
Mean	**0.032**	**0.56**	**0.30**

The highest entomological vaccination rate was observed in October, with 0.48 infectious bites per man per month. The lowest rate was observed in December.

3.9. Frequency of *An. gambiae* species involved in malaria transmission during the study period

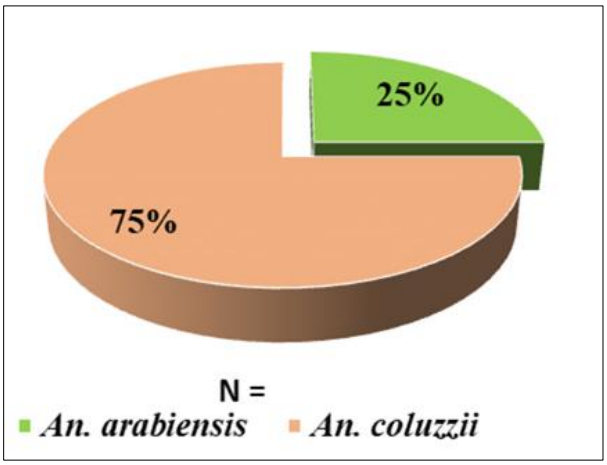

Figure 7 Malaria transmission rate by *An. gambiae* s.l. during the study period

Vector transmission of malaria was 75% by *An. coluzzii* and 25% by *An. arabiensis* during the study period.

4. Discussions

4.1. Composition of the anopheline fauna at Banambani

The anopheline fauna at Banambani was mainly composed of *An. gambiae* s.l. and *An. rufipes* during the study period (Figure 2). These results confirm those of (Dao, 2020), who recorded 99% *An. gambiae* s.l. and 0.5% *An. rufipes* in Bandiagara. They differ from those of (TOURE, 1979) at Banambani, who reported that *An. gambiae* s.l. accounted for 9.47% of the anopheline fauna, compared to 88.4% of *An. funestus* at Banambani. The absence of *An. funestus* in our study site could be explained by the facts of eco-climatic change linked to anthropic actions, which could favor the emergence of other vector species.

4.2. Composition of the *Anopheles complex* involved in malaria transmission

The *Anopheles complex* included *An. coluzzii, An. arabiensis, An. gambiae* and the hybrid form (M/S). However, *An. coluzzii* was predominant during the study period (Figure 3). These results are not similar to those of (Balam, 2010) who reported that the specific composition of *An. gambiae* in Banambani was composed of *An. coluzzii* (90%), *An. gambiae* (6%) and hybrids (4%). Plasmodium falciparum infection was dominated by *An. coluzzii*.

4.3. Entomological parameters

The highest density was recorded in October (Figure 4). Our results confirm those of (Balam, 2010), who recorded a density of 6 mosquitoes per hut per day in October in Banambani. These results can be explained by the fact that the huts are productive during periods of low rainfall frequency. The decrease in density in November and December could be explained by the early cessation of rainfall. *Anopheles* were more aggressive in September and October (Figure 5). Our results are comparable to those of Balam (2010) who found higher monthly human bating rate in September and October in Banambani.

The ELISA (blood meal) test on mosquitoes showed an average anthropophilic rate of 55.6% (Figure 6). This anthropophilic rate is similar to that reported by Keïta et al, 2014, McBride, 2016, who reported that humans are the preferred hosts for *An. gambiae* s.l.

ELISA (csp) testing of 547 treated female *Anopheles* revealed 10 *Anopheles* positive for *Plasmodium falciparum*. The peak infection rate was observed in November in Banambani (Table 2). These results are comparable to those of Balam, (2010) who found a TI of 7.02% in the same month. In addition to September and October, November may also be a transmission period where the observed infection rate may be high in some locations in Mali. Maiga, (2018) had found a malaria infection prevalence of 53.3% in Ouélessebougou in November.

The average entomological inoculation rate is lower than in the study by Balam, (2010) who had found an average EIR of 0.89 pi/h/month in Banambani. This reduction in the average EIR could be explained by several interventions, especially the use of the integrated control method recommended by national malaria control programs. These have helped to reduce malaria morbidity by 50-60% and all-cause mortality by 20% in Africa (Alonso et al., 1991; 1995).

5. Conclusion

The present study showed that *An. gambiae* s.l. is the main malaria vector in Banambani, with a higher density in October. Peak infection was observed in November. This suggests the importance of intensifying malaria vector control activities. Most infections were caused by *An. coluzzii* and a small proportion by *An. arabiensis*.

Acknowledgements: The authors thank the MRTC/ICER MALI (Malaria Research and Training Center/ International Center for Excellence in Research) in Bamako Mali, the Faculty of Medicine and Odontostomatology, the community of Banambani for their financial, technical and material support, and the staff of the Entomology and Parasitology Laboratory of the Faculty of Science and Technic of Bamako.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declared no conflict of interest.

Statement of informed consent.

Permission was obtained from all individual participants included in the study.

References

[1] Alonso, P. L., Lindsay, S. W., Armstrong, J. R., Conteh, M., Hill, A. G., David, P. H., Fegan, G., de Francisco, A., Hall, A. J., & Shenton, F. C. (1991). The effect of insecticide-treated bed nets on mortality of Gambian children. Lancet (London, England), 337(8756), 1499-1502. https://doi.org/10.1016/0140-6736(91)93194-e

[2] Anges, Y., Gado, D., Yvette, B., Carine, T., Gildas, H., Falilath, S., & Lamine, B.-M. (2022).

[3] Malaria transmission in the district of Karimama in North-East of Benin. 37(3).

[4] Balam, M. (2010). Utilisation du *Bacillus thuringiensis israelensis* (Bti) dans le cadre du contrôle des vecteurs du paludisme en milieu rural de Banambani et de N'Gabakoro droit au MALI. [Thesis, Université de Bamako]. https://www.bibliosante.ml/handle/123456789/7148

[5] Dadé Ben Sidi Haïdara, Souleymane Sekou Diarra, Sékou, Sékou Fantamady Traoré, & Seydou Doumbia. (2021). Spatio-temporal analysis of the incidence of morbidity and mortality from severe malaria in the health district of Selingue, Mali. 11.

[6] Dao, A. S. (2020). Monitoring of malaria vector resistance to insecticides in five sentinel sites in Mali [Thesis, USTTB]. https://www.bibliosante.ml/handle/123456789/3800

[7] Gillies., M., & Coetzee, M. (1987). A supplement to the Anophelinae of Africa south of the Sahara (Afrotropical Region). 55, 143.

[8] Gillies., M., & Meillon., B. De. (1968). The Anophelinae of Africa south of the Sahara. Publication of the South African Institute for Medical Research, 54 : 343p.

[9] Keïta, M., Baber, I., Sogoba, N., Maïga, H. M., Diallo, M., Doumbia, S., & Traoré, S. F. (2014). Vector-borne transmission of malaria in a village on the banks of the Niger River and its fishing hamlet (Kéniéroba and Fourda, Mali). Bulletin of the Society of Exotic Pathology, 107(5), 356-368. https://doi.org/10.1007/s13149-014-0398-x

[10] Maiga, M. A. (2018). Malaria indicators of malaria infection in male adults and children aged 5 to 50 years in Ouelessebougou, Mali. https://www.bibliosante.ml/handle/123456789/1930

[11] McBride, C. S. (2016). Genes and Odors Underlying the Recent Evolution of Mosquito Preference for Humans. Current Biology: CB, 26(1), R41-46. https://doi.org/10.1016/j.cub.2015.11.032

[12] OMS. (2023). Background to World Malaria Day 2023. https://www.who.int/en/campaigns/world-malaria-day/2023/background

[13] TOURE. (1979). Bioecology of Anopheles (Diptera-culicidae) in a rural area of Sudanese savannah in Mali, Banambani village - Kati district: impact on the transmission of malaria and Bancroft filariasis. [Thesis]. National School of Medicine and Pharmacy of Mali.

[14] Touré, Y. T., Petrarca, V., Traoré, S. F., Coulibaly, A., Maiga, H. M., Sankaré, O., Sow, M., Di Deco, M. A., & Coluzzi, M. (1998). The distribution and inversion polymorphism of chromosomally recognized taxa of the Anopheles gambiae complex in Mali, West Africa. Parassitologia, 40(4), 477-511.