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(RESEARCH ARTICLE)

Characterization of medical interest arthropods from hôspital du Mali in Bamako

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Abstract

Arthropods of medical interest are vectors that may transmit pathogens (bacteria, parasites and viruses) that cause disease in humans and animals across the world. These transmitted infectious agents are responsible for many cases of infection, some of which are fatal. The study aim was to assess the exposure of people staying or visiting hospital for treatment or assistance to arthropods born infection inside the hospital (*Hospital du Mali)*.

Longitudinal survey with monthly investigation was carried out from September 2022 to December 2023 in *Hospital du Mali* to collect endophilic and exophilic arthropods using diverse method of sampling. CDC light traps, mouth aspirator, spray catch, and soapy water were used as collection methods in randomly selected rooms at the hospital. The arthropods were identified morphologically using a binocular dissecting scoop; female *Anopheles* were tested by PCR and ELISA respectively for specific composition and *Plasmodium* infection index. In total, 9673 arthropods mostly insects were collected including 7388 *Culex*, 103 *Anopheles*, 81 *Aedes*, and 2101 other insects. The study showed that, among the arthropods of medical interest, the most frequent group during both rainy and dry season were Diptera with high proportion of mosquitoes.

Keywords: Arthropods; Vector; Infection Risk; Hospital; Mali

1. Introduction

Arthropods belong to the invertebrate phylum with a cuticle (or external skeleton) and articulated appendages; they include crustaceans, insects, myriapods, and arachnids. There are more than one and a half million current species of arthropods that have very varied lifestyles [1] . Unfortunately, a good number of arthropods are also bio aggressors, whether they are pests of crops or harvested products, destroyers of frameworks, harmful and/or potential vectors of pathogens for human or animal health [2] **.** Some arthropods, due to their bioecology, share the same living environment as humans and/or domestic animals. Among those that coexist with humans, there are some that are directly or indirectly associated with transmission of pathologies to human and/or animal [3] . Since a long time, arthropods are source of health problems to man, often synonymous with nuisances; they are also the cause of painful bites, itching, and even fearsome epidemics. Among these arthropods, mosquitoes are the most fearsome, both by their abundance and by the diseases they transmit [4–7] .In addition to malaria, other diseases of local importance transmitted by arthropods include leishmaniasis, trypanosomiasis, onchocerciasis, Chagas disease, plague, etc., caused by sandflies, tsetse flies, blackflies, triatomines and fleas, respectively. These vectors have in common the transmission of pathogens

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during a blood meal, which also depends on pathogen-vector-host interactions [8] . In Mali, arthropods are vectors of several diseases with significant public health concern[9] ,

among human or animal pathologies[10] . Some are venomous, others allergenic, urticating-vesicant, transmitters of myiasis, intermediate hosts, passive transporters, active vectors [11, 12] . Hospitals, places par excellence dedicated to health and well-being, are also environments conducive to the development of arthropod of medical interest. The *Hôpital du Mali* in Bamako is in an urban area where stable water is observed (pipes, crawl spaces, ponds, basins, septic tanks, water collection network, flowerpot bowls, poorly maintained gutters). The hospital staff as well as the patients and their companions constantly complain about the nuisance of Arthropods both day and night; which could constitute a risk of emergence or re-emergence of tropical diseases [13–17] . Here we were interested in the Arthropods present in the hospital space, whether they are venomous, allergenic, urticating or vesicant, agents of myiasis or intermediate hosts [18, 19] . So far, no data were published on the relationship between the presence of arthropods and the exposure risk in hospital in Mali. The current study aim was to assess the exposure of people staying or visiting hospital for treatment or assistance to arthropods borne diseases inside the hospital (*Hôpital du Mali*); by characterizing and determine the seasonal variation, the transmission and nuisance parameters of the endophilic and exophilic arthropods collected inside the hospital.

2. Methodology

2.1. Study site

The *Hôpital du Mali*, located on the right side of the Niger River in Missabougou in commune VI of the Bamako district, not far from the Baguinéda Canal, is a gift from China Government to Mali. This 3rd reference hospital was inaugurated in 2010 and equipped largely for the first time by the Chinese partner.

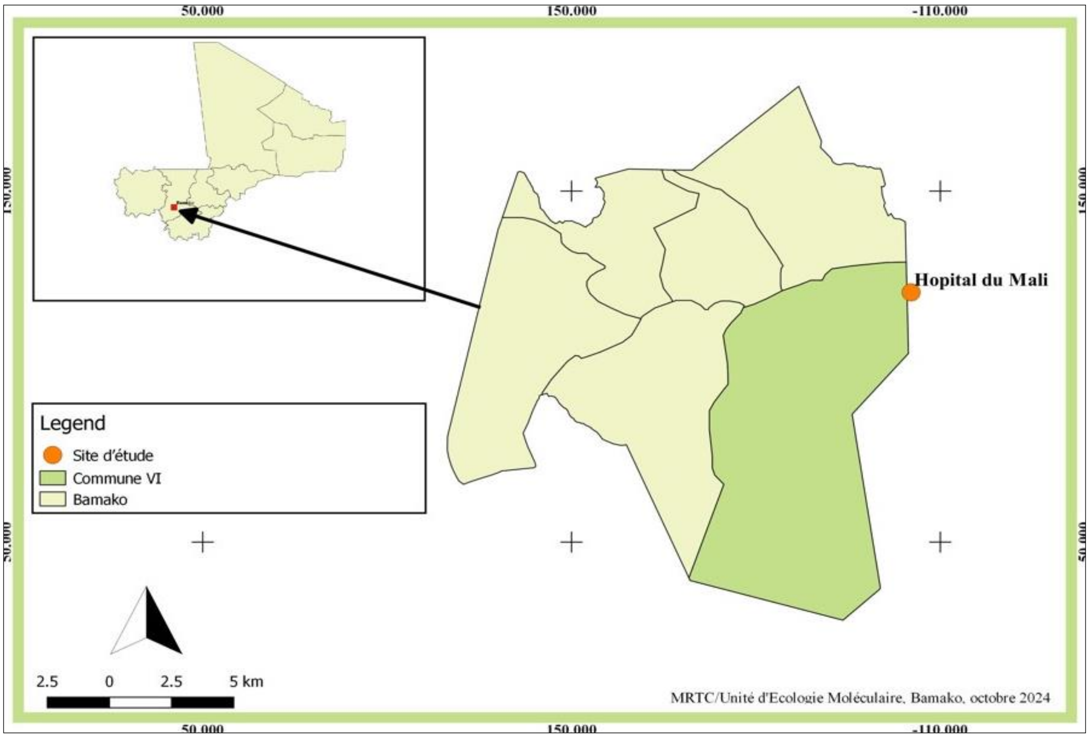

Figure 1 Localization of the Hôpital du Mali in the commune VI on the map of the district of Bamako, Mali (Source MRTC Molecular Ecology Unit, 2024)

2.2. Materials

The consumable material is composed of 15ml Falcon tubes, 2.5ml Eppendorf tubes, 80% Ethanol, soft and rigid forceps, binocular magnifying glass, petri dishes, scientific entomology documents, permanent marker, mouth aspirators, electric lamp, adhesive tape, rubber bands, paper cups with mosquito nets, hydrophile cotton, white sheets and insecticides.

2.3. Methods

Multiple tools and several sampling methods were used to collected arthropods, including:

- **CDC (Center of Disease Control) light traps**: Four (4) CDC traps were set in the evening at sunset (6:00 pm) and removed in the following morning at sunrise (6:00 am). They were used to collect insects in the night, inside and outside the rooms. The traps are equipped with a light source to attract flying arthropods that will be drawn inside the collection device by an incoming ventilation system sustained by rechargeable 6-volt batteries to run the system as described by Sudia [20] (Fig 2a).
- **Mouth aspirator**: A total of 15 rooms were randomly selected to collect mosquitoes and other arthropods indoors during the weekend. A mouth aspirator is a simple tool made with small plexiglass tube and a flexible tube connected to each other at a junction point with a mosquito net filter to prevent the arthropods passing into the mouth when aspirated by the collector. The technique consists of searching for indoor resting arthropods in the different rooms using a torch light and aspirate them with the mouth aspirator. The air flow will draw the arthropods inside the tube. Then, they are transferred into cups [21] (Fig 2b). All collected arthropods were recorded by date and by room with an individual identification number.
- **Spray-catch (PSC):** each month, a total of 15 rooms were randomly selected for sampling. The collection was done by covering with white sheets the floor of the room, closing doors and windows and all other openings and spraying with pyrethrum-based insecticide. It should be noted that before spraying, all objects and food that could be contaminated by the insecticide were removed from the room or covered. The insecticide was sprayed by a collector from the back of the room towards the door, moving backwards step by step until the room was filled with a fine mist of insecticide. The door was then quickly closed for 5 to 10 minutes. At the end of this time, all the sheets were taken back with care to collect all knockdown arthropods without crushing them (Fig 2c) and then separately preserved in 1.5 ml tubes with 80% Ethanol.
- **Collection using soapy water:** A total of six (6) soapy water traps were set. These are basin-shaped containers of varying dimensions, transparent or opaque, colored, or not, filled with soapy water 2/3 full and able to be foaming. The basins are placed in the different pavilions under light source. This technique attracts light-sensitive arthropods that will be trapped by falling in the soapy water [22] (Fig2d).

All samples collected by the different methods are labeled and packaged in tubes with 80% Ethanol and then identified later.

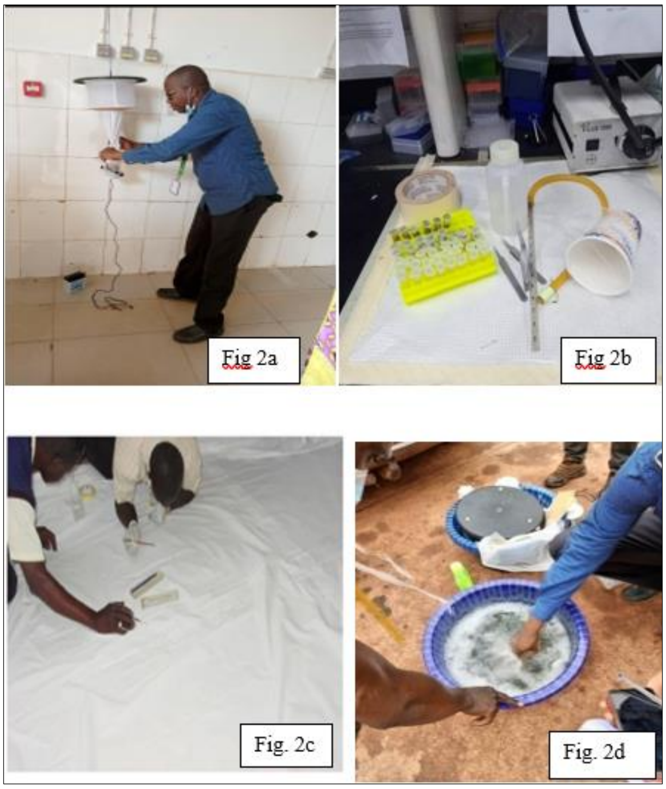

Figure 2 Illustrative images of different collection methods

2.4. Identification of arthropods

The identification procedure was done by steps. First, arthropods were subjected to morphological sorting, then they were observed under the binocular scoop and identified using the collection entomological keys documents, such as Insects of France and Western Europe established by Chinery [23] , insects from Africa and Tropical America [24–26] for Culicidae.

The identified arthropods were placed in 80% Ethanol in 2.5 ml Eppendorf tubes or 15 ml Falcon tubes depending on their size with assignment of a unique identification number.

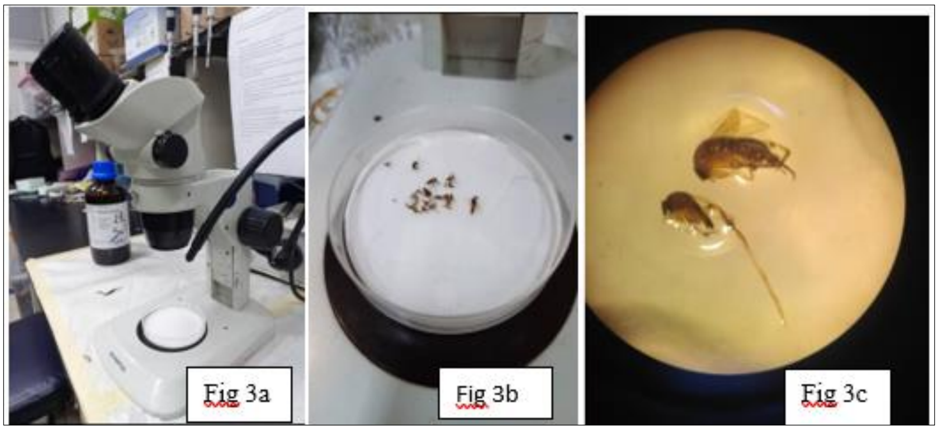

Figure 3 Illustrative images of sample identification under magnification

2.5. Data analysis

The data were initially recorded on field collection sheets. They were entered and saved on the Windows 2016 Excel software. A check to eliminate all inconsistencies was carried out before and after entry. For the analysis of the composition of the collected arthropods, the determination of the population density of endophilic and exophilic arthropods as well as the determination of the transmission and/or nuisance parameters of the mosquitoes, Windows 2016 Excel, SPSS25.0 and GraphPad Prism 9.1.0 software were used. The data were then subjected to the Kruskall-Wallis test at the significance threshold set at 5%.

2.6. Ethical clearance

Before the data collection, authorization was obtained from the hospital authorities. The workers and patients of the different services or departments of the hospital have approved and accepted the protocol and they also give their free and informed consent. The results are anonymous and could be used only for research purpose.

3. Results

Table 1 Frequency of different orders of arthropods collected with different collection tools (CDC, mouth aspirator, spray-catch, soapy water) at the *Hôpital du Mali*

Orders	CDC	%	Asp.-Spray	%	Water-Soap	%	Total
Beetles	19	0.9	3	0.06	23	0.91	45
Diptera	1924	90.84	4862	96.68	2222	87.96	9008
Ephemeroptera	10	0.47	5	0.10	3	0.12	18
Hemiptera	137	6.47	11	0.22	152	6.02	300
Hymenoptera	2	0.09	6	0.12	24	0.95	32
Lepidoptera	11	0.52	11	0.22	10	0.4	32
Orthoptera	15	0.71	0	0	42	1.66	57

Spiders	0	0	5	0.10	10	0.4	15
Blattoptera	0	0	126	2.5	40	1.58	166
Total	2118	100	5029	100	2526	100	9673

NB: n = number of arthropods; Asp-spray = combined results of the mouth aspirator and spray-catch methods.

Among different collected arthropods (Table 1), Diptera were the most represented, respectively (96.68% by spray-catch, 90.84% with CDC trap and 87.96% with Soap Water) followed by Hemiptera (6.47%, 6.02% and 0.2%), Blattoptera (2.5%, 1.58% and 0%), Orthoptera (1.66%, 0.71% and 0%), Coleoptera (0.91%, 0.06% and 0.9%), Lepidoptera (0.52%, 0.22% and 0.4%), Hymenoptera (0.09%, 0.12% and 0.95%), Ephemeroptera (0.47%, 0.10%, and 0.12%) and Araneae (0.10%, 0.4% and 0%).

Table 2 Frequency of *Culicidae* of arthropods collected in different department/service using three different collection methods including CDC trap, mouth aspirator+spray catches and Soapy water

Department Or Service	***Anopheles***			***Culex***			***Aedes***			**Total per service**	
	CDC	**Asp + SPC**	**SW**	**CDC**	**Asp + SPC**	**SW**	**CDC**	**Asp + SPC**	**SW**	**mean %**	**number**
Entrance office	3	2	3	163	322	89	3	1	2	7,8	588
Laundry	4	0	6	33	11	171	0	0	1	3,0	226
Surgery	2	0	1	26	96	17	0	0	2	1,9	144
Laboratory	3	4	5	322	547	23	4	0	8	12,1	916
Medicine	0	4	3	120	819	264	1	19	1	16,3	1231
Neurosurgery	0	2	0	19	221	153	0	0	2	5,2	397
Pediatrics	2	3	3	226	992	199	2	3	1	18,9	1431
PMA	0	4	8	136	314	47	5	3	1	6,8	518
Radiology	0	0	3	53	116	44	0	1	0	2,9	217
Radiotherapy	0	7	0	20	136	34	0	0	0	2,6	197
Resuscitation	12	1	5	286	261	196	6	4	4	10,2	775
Covid room	1	0	0	17	119	0	0	0	0	1,8	137
Emergency	4	3	5	167	456	153	2	1	4	10,5	795
Total	31	30	42	1588	4410	1390	23	32	26	100%	7572
	103 (1.4%)			7388 (97.5%)			81 (1.1%)				

NB: Asp-Spray: Spray-catch mouth aspirator; ES: Soapy water; CDC: Center of disease Control; Others: other arthropods other than mosquitoes

Results have shown that among a total of 7572 culicidae recorded from the data (table 2), most of them were *Culex* genus (97.5%, n=7388) followed by *Anopheles* (1.5%, n=103) and *Aedes* (1.1, n=83). Between the investigated services, the pediatric room (n=1431), medicine room (n=1231) and the laboratory (n=916) were more attractive to mosquito while the Covid room (n=137) and Surgery room (144) showed less attractiveness to mosquitoes. Except the absence of *Aedes* genus in the Covid room and the Radiotherapy, at least single culicidae was recorded in all the rooms for the study period. All collection method used in this study seem to be relevant for culicidae sampling, but the combination of mouth aspirator follows by spray-catch (ASP+SPC) recorded the best numbers of samples almost in all rooms.

There was no significant difference between *Anopheles* with the different techniques of collection (p=0.763). While there was a significant difference between traps (p=0.0032) with *Culex*. No significant difference was observed in *Aedes* with the different capture techniques (p=0.926).

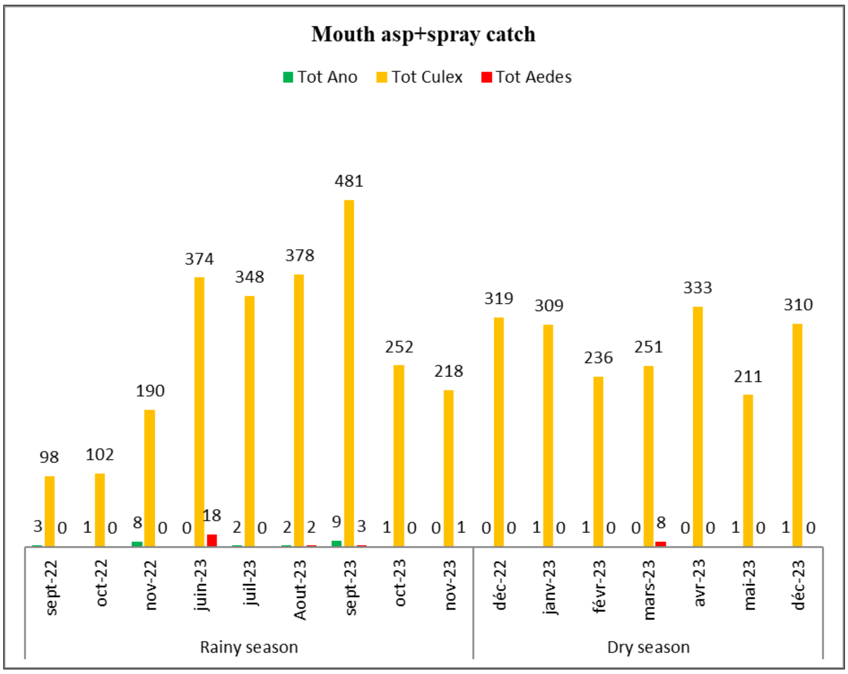

Figure 4 Seasonal variation of Culicidae sampled with the mouth aspirator and spray-catch in the selected rooms of the *Hopital du Mali* in Bamako

By looking into the seasonal variation of the Culicidae sampled in the *Hôpital* du Mali by mouth aspirator and spray catches (figure 4), the *Culex* genus showed a constant presence with dominant frequences for the untired study period including wet and dry season, with a peak in September. But *Anopheles* and *Aedes* genus are more likely to be active mostly in the wet season illustrated here by highest number of *Aedes* collected in August (18 individuals) and the highest number of *Anopheles* in September (9 individuals). There was significant difference between *Culex* and the two other genus (*Anopheles* and *Aedes*) in term of seasonal variation, but no significant difference between total three Culicidae seasonal frequencies variation, p = 0.429 (two-way ANOVA).

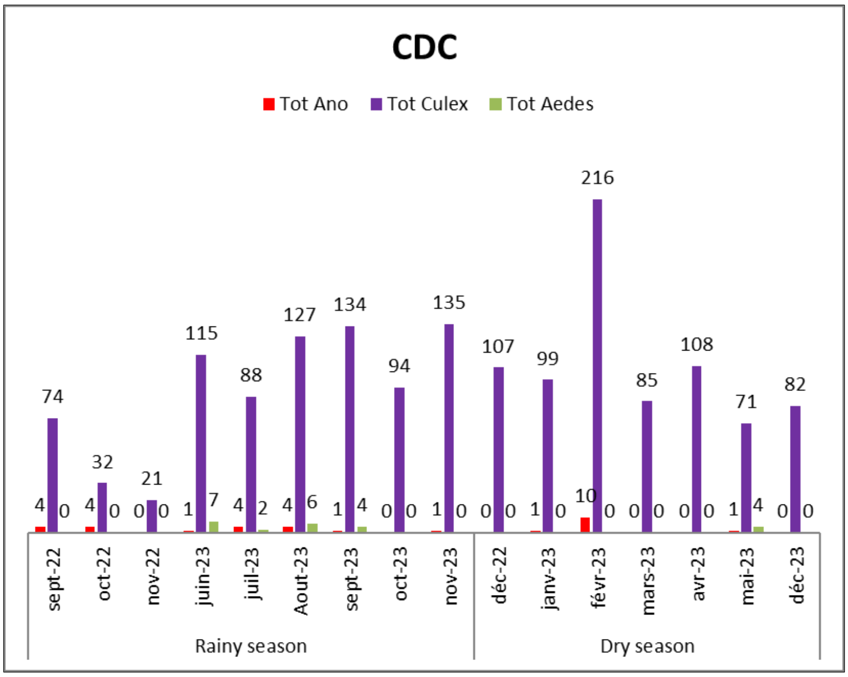

Figure 5 Seasonal variation of Culicidae collected by the CDC light trap in the Hopital du Mali, in Bamako

Less *Aedes* and *Anopheles* were sampled by the CDC traps in both dry season and wet season (Figure 5). The highest collected mosquito was *Culex* in wet season and dry season with a peak of 216 and 135 recorded respectively in February and November 2023. There was no significant difference between seasons regarding the *Culex* mean number between dry and wet season (p-value=0.3850, Figure 5).

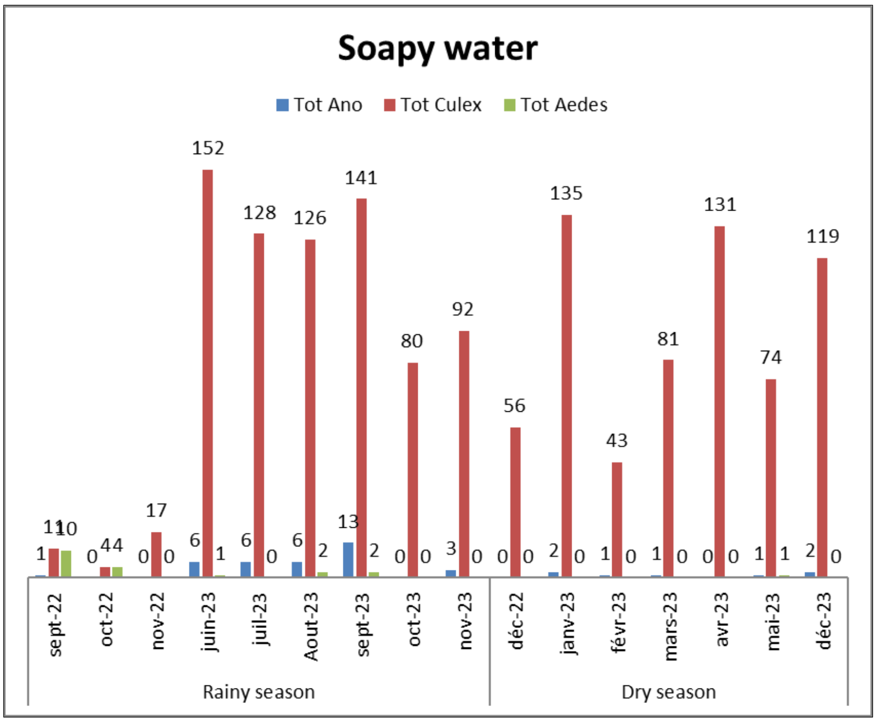

Figure 6 Seasonal variation of Culicidae collected with soapy water in the Hopital du Mali, in Bamako

The sampling method using soapy water recorded the high number of *Culex* in June and September 2023 respectively 152 and 141 in the rainy season, as for the dry season, the highest number was recorded in January and April 2023 (135 and 131). *Anopheles* and *Aedes* of this collection method were more represented in the rainy season than in the dry season (Figure 6), but the difference was not significant between seasons, p = 0.406 (two-way ANOVA).

Table 3 Frequency of other arthropods of medical interest collected in the different selected rooms of the *Hôpital du Mali* of Bamako, from the different sampling methods

Department Or Service	**Other arthropods of medical interest**							
	Blattodae	**Diptera**						
	Blattidae	**Calliphoridae**	**Muscidae**	**Psychodidae**	**Sarcophagidae**	**Drosophilidae**	**%**	**Effectif**
Entrance office	5	0	8	97	0	0	**7,2**	**110**
Laundry	1	4	17	114	1	0	**9,0**	**137**
Surgery	3	3	12	55	0	0	**4,8**	**73**
Gynecology	17	1	14	130	0	0	**10,7**	**162**
Laboratoiry	46	3	17	163	0	0	**15,1**	**229**
Médicine	3	2	16	55	0	0	**5,0**	**76**
Pédiatrics	33	0	22	154	1	1	**13,9**	**211**
PMA	13	0	11	87	0	0	**7,3**	**111**
Radiology	1	0	2	17	0	0	**1,3**	**20**
Radiotherapy	2	0	0	19	0	0	**1,4**	**21**
Resuscitation	18	3	25	170	0	0	**14,2**	**216**
Covid room	8	0	0	25	0	0	**2,2**	**33**
Emergency	16	1	18	86	0	1	**8,0**	**122**
Total	**166**	**17**	**162**	**1172**	**2**	**2**	**100,0**	**1521**

Psychodidae represent 77.1% of the total insects confirming their predominance in all locations, followed by cockroaches (10.9%) and Muscidae (10.7%) with slightly lower numbers. Calliphoridae, Sarcophagidae and Drosophilidae are almost insignificant in terms of total numbers. Locations such as the laboratory, intensive care unit and pediatrics represent the most significant infestations, which can pose a serious health problem.

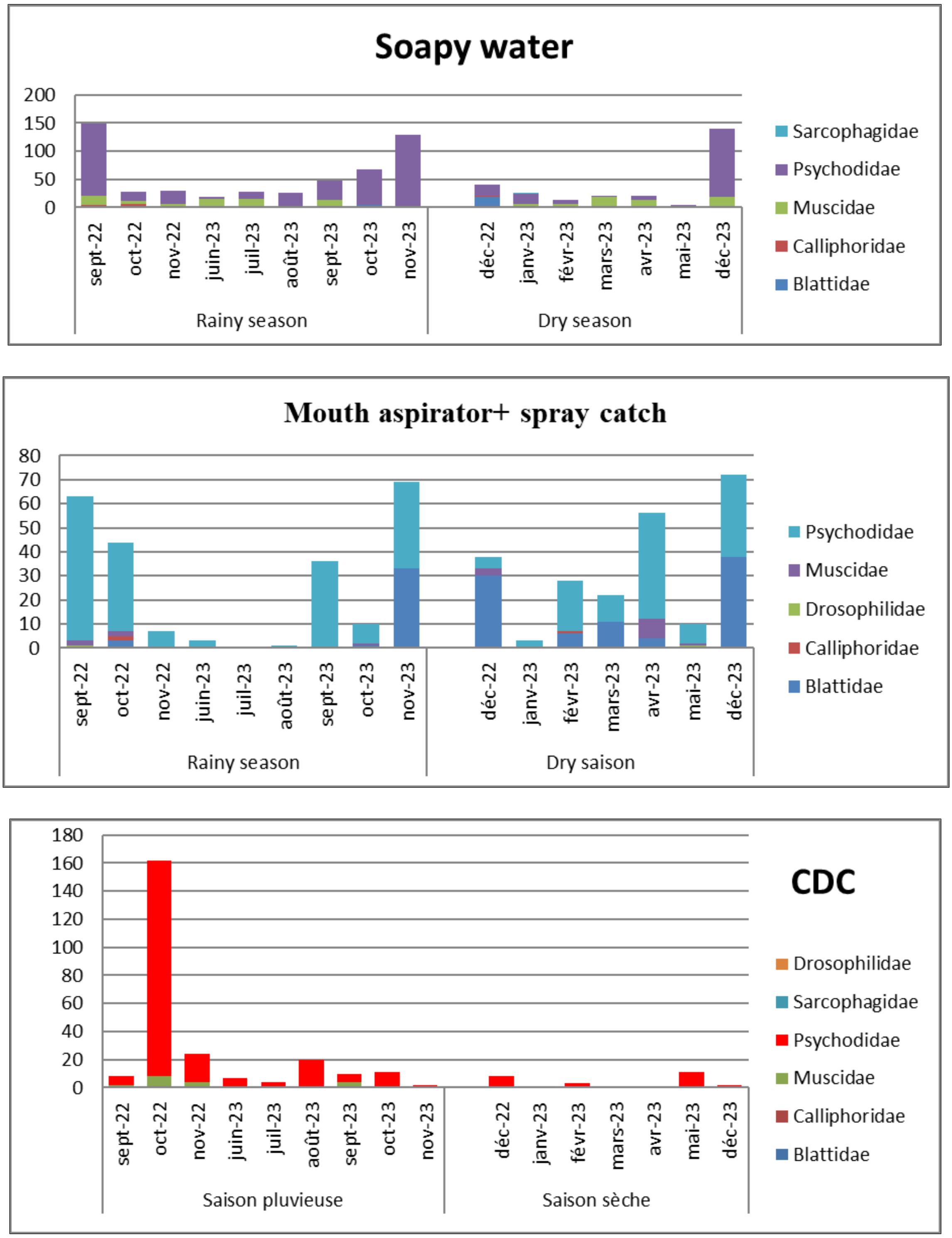

Figure 7 (a,b,c) Seasonal variation of other insects of medical interest with the different capture tools (mouth aspirator plus catch spray, CDC, soapy water)

The figure 7 is representing the variation of other (*non-Culicidae*) insects of medical interest collected from the different method of sampling including Soapy water (a), Mouth aspirator + spray-catch (b) and CDC Light trap (c) in both wet season and dry season. All method succeeds to collect the Psychodidae, Muscidae, calliphoridae and Blattidae, however the Sacrophagidae were missing in mouth aspirator and spray catch, while Drosophilidae were missing in the Saopy water.

The best number of Sacrophagidae was found in Sopy water, but the highest number of Psychodidae was found in CDC trap, also in the combination of mouth aspirator and spray catch.

The Figure (7a) shows an abundance of Psychodidae in the rainy and dry season particularly in September 2022 and December 2023, the other families (Sarcophagidae, Muscidae, Calliphoridae, Blattidae) show low and constant levels with both seasons. However, the p-value = 0.3536 indicates that there is no significant difference between the two seasons in terms of abundance of the species presented.

Figure (7b) indicates the dominance of Psychodidae and Blattidae in both seasons while Muscidae, Drosophilidae, and Calliphoridae show a slight increase, but remain overall not very abundant, p-value = 0.1577 means that these differences are not statistically significant.

The Psychodidae largely dominate with a very significant peak in September 2022. The other groups present very low levels, almost negligible. (rainy season), while there is a very low abundance for all families with almost zero values in some months. Pvalue= 0.004469 indicates a significant difference between the two seasons. (figure 7c)

4. Discussion

Diseases transmission is most of the time linked to the interaction of Human and arthropods, mainly Diptera. Tropical vector borne diseases are spread in Sub Saharan African countries because of the suitable natural conditions for vectors bioecology. This study contributed to show the risk factors of peoples visiting the hospital of *Hôpital du Mali* in Bamako, including patients, their parents and professional agents taking care to the others. The data have reported strong evidence of presence of insects associated with medical and veterinary interest.

In total, two classes, 9 orders, 24 families, 32 genera and 37 species of arthropods identified. These arthropods were collected by CDC traps, mouth aspirator + spray catch and soapy water, i.e. 2118, 5029 and 2539 species respectively. Among the 2 classes of Arthropods collected, insects represent the most dominant class followed by arachnids. Our results corroborate with those of other researchers who have investigated other research approaches of medical-veterinary interest on the diversity of arthropods in three different eco-climatic zones in Mali in 2023, who report that the arthropods captured in Bia, Thiérola and Keniéroba belong to 2 classes, 13 orders, 63 families, 155 genera and 170 species identified; and that the class of insects is the most dominant group, followed by arachnids [27] , Likewise a study carried out in Algeria by Boubrouta[28] , in the context of arthropods of medical and veterinary interest in the Zéralda hunting reserve in Algeria, which reports that insects occupy the first rank of their sampling with 73 species compared to Arachnids.

Diptera were found to be the most abundant arthropods collected in this study, regardless of the sampling method used (mouth aspirator, CDC or soapy water), followed by Hemiptera, Blattoptera, Orthoptera, Coleoptera, Lepidoptera, Hymenoptera, Ephemeroptera and Araneae (Table 1). However, our results are different from those of Ouattara[29] , on the biodiversity of arthropods associated with rice (*Oryza sativa*) in an integrated production system in Bama in Burkina Faso who found that Araneae were the most representative order followed by Hymenoptera, Heteroptera, Coleoptera, Orthoptera, Diptera and Lepidoptera.

The dominance of insects and especially Diptera could be linked among other things to the suitable conditions for rapid biological development of Diptera and to the great diversity of species [30] . The predominance of insects in the samples has been reported by many other authors throughout the world [31–37] .

Table 2 reveals the predominance of *Culex* in pediatrics, laboratory and medicine, mainly captured using asp-spray, CDC and soapy water. *Anopheles* were most common in intensive care (captured by CDC), followed by PMA (soapy water) and radiotherapy (Asp-spray). *Aedes* were predominantly present in medicine (Asp-spray) then in laboratory (soapy water) and in intensive care (CDC). Insects were mainly concentrated in medicine, laundry and pediatrics.

There was no significant difference in *Anopheles, Aedes* and other insects by the different sampling methods. However, there was a significant difference in *Culex.*

About the seasonal variation, this study showed that arthropod frequencies are higher during the rainy season than during the dry season. Similar results were found by Assitoun [38] on the seasonal variation of arthropods of medical, veterinary and agricultural interest in different eco-climatic zones of Mali. These authors found that arthropods are present in all seasons, but their frequencies were higher during the rainy season.

A strong dominance of culicidae was observed with the different collection tools, this dominance raises concerns about the transmission of vector-borne diseases. culicidae are notably known to transmit malaria, lymphatic filariasis, Japanese encephalitis, dengue fever, chikungunya, yellow fever, Cross fever, West Nile fever and Zika virus. Other researchers like Mohand [39] , who conducted a study on the contribution to the study of Diptera and vectors and intermediate hosts of parasites of medical and veterinary interest in Algeria, found 08 families of Diptera with a dominance of culicidae (2202 individuals), followed by Simuliidae with 937 individuals and Psychodidae with 183 individuals; the other families were weakly represented.

5. Conclusion

This study conducted at the *Hôpital du Mali* hospital, identified a rich diversity of arthropods, with a predominance of mosquitoes, particularly of the genus *Culex.* The data revealed important seasonal variation, with a significant increase in the populations of arthropods of medical interest during the rainy season. These results confirm the association of these insects to diseases spread even in the health centers as potential vectors of diseases such as malaria and dengue fever, thus representing a significant risk to the health of patients, particularly the most vulnerable. The highlighted also the need to implement adapted vector control strategies, specifically targeting the most problematic considering seasonal variations. Further studies are needed to better understand the ecological factors influencing arthropod population dynamics in this hospital environment and to evaluate the effectiveness of control interventions.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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