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RESEARCH ARTICLE

INTERMEDIATE HOST MOLLUSKS DISTRIBUTION ASSOCIATED TO THE RISK OF SCHISTOSOMIASIS TRANSMISSION IN BAMAKO DISTRICT

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ABSTRACT

Introduction: Schistosomiasis is an endemic parasitic disease in Mali. Despite control efforts carried out by the Ministry of Health and Social Development, transmission still occur in Bamako district. This situation is most likely due to irregular mass treatment and, above all, to the lack of running water replaced by water body from rain or rivers, that favor the development of mollusks. Object: The current study aimed to investigate the distribution of intermediate host mollusks and the risk of schistosomiasis transmission in Bamako. **Methode:** This was a cross-sectional, one-time study conducted from April to June 2025. It covered all six communes. Gastropod collection was carried out between 8:00 a.m. and 11:00 a.m. Sample Specimens were collected using forceps on aquatic vegetation and on submerged or partially submerged supports. **Results:** Species identification and cercaria emission tests were performed in the Laboratory. From the total of 307 samples 66.4% (n = 204) belonged to *Bulinus truncatus*, 32.6% (n = 100) to *Bulinus globosus*, and 0.97% (n = 3) to *Biomphalaria pfeifferi*. Communes I (CI) and V (CV) provided the largest number of samples, with 35.8% (110/307) of the mollusks captured, whereas no samples were observed in communes II and III. Relative densities varied from 27.5 gastropods/person/15 minutes at Dialakorodji 1 to 0 at Bankoni, Bougouba (CII) and Farako (CIII). Natural infestation rates were higher in CI (7.95%), low in CIV (2.77%), and zero in CII, CIII, and V. **Conclusion:** Only one species, *Bulinus truncatus*, was found to be infested. The observation of mollusks infected with cercariae shows the existence of active transmission foci of schistosomiasis in the Bamako district. Control of mollusks through watercourse sanitation seem to be a useful complementary strategy to strengthen chemotherapy outcomes.

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INTRODUCTION

Schistosomiasis is the second most widespread tropical waterborne parasitic disease after malaria It is caused by trematode worms and is one of the parasitic diseases with high morbidity in many regions of the world (Dabo A., 2002). It affects nearly 240 million people worldwide, most of whom live in sub-Saharan Africa (WHO, 2023). Despite efforts, schistosomiasis persists due to various factors such as poverty and lack of access to adequate sanitation facilities (Jaquet, 2023). Studies conducted in endemic settings show that the risk of expansion of parasitosis is high in areas with water management schemes and in rural settings (Bagayan et al., 2014). The most affected individuals are school-aged children (SAC), who constitute the high-risk group (Abdellahi, 2017). The parasites responsible for this disease are Schistosomes, whose life cycle is complex and involves both mammalian hosts (humans) and freshwater mollusks. The parasite must develop in freshwater gastropods (intermediate hosts). These gastropods are key elements in the schistosome life cycle (Aubry, 2024). Transmission, expansion, and maintenance of the disease are linked to the interaction of two major factors: (1) the presence and use of surface waters favorable to the development of intermediate host mollusks and (2) poor hygiene conditions that promote contamination of the gastropods. These two conditions are present in the Bamako district.

Its population is estimated at 4,211,468 inhabitants in 2022, with an annual growth rate of 3.3 according to INSTAT (2023). This rapid and uncontrolled growth of the capital creates major hygiene, health, drinking-water supply, and domestic/industrial waste-disposal problems. Lacking adequate drainage and sewer systems, rainwater and wastewater are channeled through tributaries of the Niger River (Farako, Woyowayanako, Bankoni, Sogoniko, etc.), which are also excellent habitats for mollusks. During the rainy season and until these tributaries dry up, these waterways are used by local populations for various activities (washing, dishwashing, fishing, irrigation/gardening, etc.). The persistence of schistosomiasis in the Bamako district despite regular mass drug administration campaigns for children by the National Control Program for Schistosomiasis and Geohelminthiasis (PNLSH) suggests that there is active transmission foci linked to the presence of infected intermediate host mollusks in watercourses. In Mali, three species of mollusks (family Planorbidae) are involved in the transmission of human schistosomes: *Bulinus truncatus* and *Bulinus globosus* (subfamily Bulininae), intermediate hosts of *Schistosoma haematobium*, and *Biomphalaria pfeifferi* (subfamily Planorbinae), which transmits *Schistosoma mansoni* (Madsen et al., 1987; Coulibaly & Madsen, 1990; Dabo et al., 1994; Dabo et al., 1995). To sustain control results against this parasitosis, WHO has redefined its priorities by recommending snail control as a complementary strategy to preventive chemotherapy (WHO, 2023). It is within this framework that this study was initiated on the distribution of intermediate host mollusks and schistosomiasis transmission in the Bamako district, where conditions favorable to both maintenance and expansion of bilharziasis are present.

METHODOLOGY

Study site

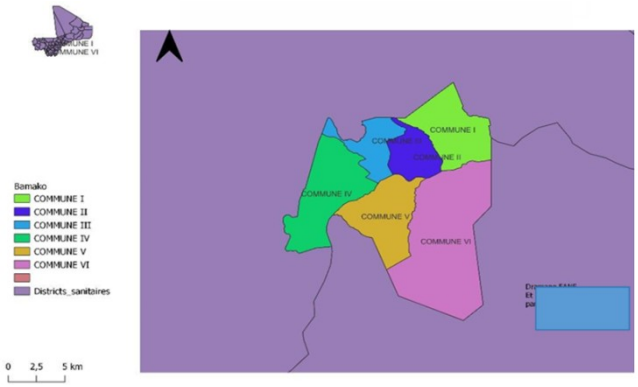


Figure 1. Carte du district de Bamako (Source : LEP 2026)

The study was conducted in the Bamako District, a basin surrounded by hills and crossed by the Niger River between 12°39′ North latitude and 7°59 West longitude (Figure 1). It covers an area of 1,420 km² (INSTAT, 2023). It belongs to the north-Sudanian climatic zone, with two main seasons: the rainy season from June to November, and the dry season from December to May. Average annual rainfall is about 1,400 mm. Temperatures are generally high, with an annual mean of 33°C (INSTAT, 2023).

Sampling: This was a cross-sectional one-time study conducted from April to June 2025. The study focused on mollusks, intermediate hosts of human schistosomes.

Mollusk collection was carried out at human–water contact points (H-WCPs) associated with the population's various daily activities (laundry, washing utensils, fishing, market gardening, etc.), recreational activities (bathing, games), crossings/wading, and others. The number of H-WCPs varied depending on the size of the habitat.

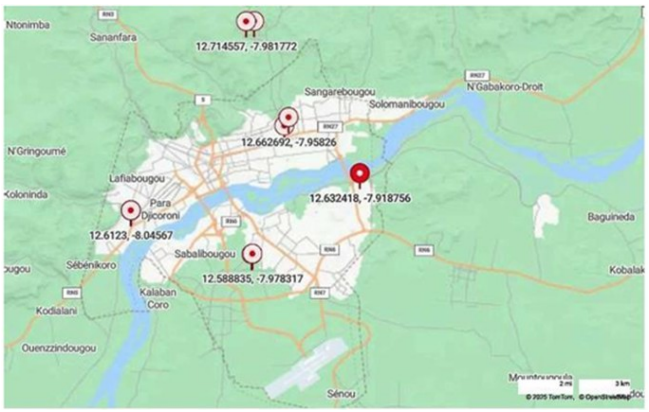


Figure 2. Map showing collection sites in Bamako (Fane D., 2026).

Collection was performed by 2 people for 15 minutes sampling per person and per habitat, using forceps. Each investigator collect all mollusk samples observed in the water in vegetation and on different submerged or partially submerged supports. At the end of the 15-minute collection , all samples from the same habitat are combined, ensuring that the total number of mollusks collected is divided by the number of collectors to determine the relative density (RD) of mollusks with respect to the surveyed habitat. All collected samples were then kept and transported to the laboratory in labeled tubes filled halfway with water and containing sprigs of aquatic plants. To maintain moisture around the mollusks during transport, the tubes were wrapped in towels moistened with water. Only intermediate host mollusk species of human schistosomes were targeted. Collected mollusks were transferred into labeled plastic trays according to the conservation tubes. The samples were washed and morphologically identified using the freshwater gastropod identification guide for West Africa from the Danis Bilharzia Laboratory (Danish, 1987). Specimens of *Biomphalaria pfeifferi* are recognizable by their discoid shell with a diameter greater than 3 mm; *Bulinus truncatus* and *Bulinus globosus* are recognizable by their conical shell; the columellar margin is truncated in *Bulinus globosus*, while truncation is absent in *Bulinus truncatus*.

The natural infestation rate (NIR/TIN) was determined by placing groups of 2–5 mollusks in Petri dishes and exposing them to sunlight or the light of an electric lamp for 15–30 minutes to stimulate the emergence of furcocercariae (Chrystelle, 2022). After exposure, all mollusks from a positive group were placed individually in small containers to identify those that actually emitted cercariae. Once identified, the natural infestation rate can be calculated as the ratio of the number of positive samples to the total number of exposed individuals. Negative samples were kept in rearing conditions for at least two weeks, during which they were tested daily, 2–3 times per day, to diagnose any possible infestation.

Data entry and analysis: The data base was generated in Microsoft Excel (Windows 10 Professional) and the data were then analyzed using IBM SPSS Statistics 20. The Chi-square test and, when necessary, Fisher's exact test was used to

compare qualitative variables, with a significance threshold set at 5%. Results were presented narratively as tables and figures. Relative density was calculated by relating the number of collected mollusks to collection time and per person. Infestation rate was calculated based on the number of mollusks that released cercariae relative to the total number of exposed mollusks.

Ethical Considerations: The study protocol was approved by the Ethics Committee of the University of Science, Technics and and Technologies of Bamako (USTTB). The nearby local communities were informed about study methodology prior to implementation. The study had no negative impact on the local communities.

RESULTS

Spatial distribution and species of gastropods collected by commune in the Bamako District: A total of three hundred seven (307) gastropod samples were collected in four of the six communes of the Bamako district (Table I). Three species belonging to the family Planorbidae were identified: *Bulinus globosus* and *Bulinus truncatus* (subfamily Bulininae) and *Biomphalaria pfeifferi* (subfamily Planorbinae). *Bulinus truncatus*, with a total frequency of 66.5% (n = 204/307), predominated in all communes that provided samples, except in Commune V where *Bulinus globosus* was more frequent. *Biomphalaria pfeifferi* was the least frequent species with 0.9% (n = 03/307). It was recorded only in CIV. The distribution of species by commune shows that Commune I was the most productive with 43.1% (88/307), whereas Communes II and III produced no samples. It appears from Table II that the frequencies of the two species (*Bulinus truncatus* and *Bulinus globosus*) collected at the Dialakorodji 1 and 2 sites in Commune I are comparable (p = 0.056). In Commune V, however, the frequency of *Bulinus truncatus* was significantly higher than that of *Bulinus globosus* at Daoudabougou 1, whereas the frequency of *Bulinus globosus* was significantly higher at Daoudabougou 2 than at Daoudabougou 1 (p = 0.0076).

Relative density by commune: Figures 12 and 13 show the variation in relative densities of *Bulinus truncatus* in the Bamako district. The mean relative densities by species were 66%, 32%, and 2% for *Bulinus truncatus*, *Bulinus globosus*, and *Biomphalaria pfeifferi*, respectively. The highest density (44 g/p/15 min) was observed in Commune I, whereas no samples were found in Communes II and III (Figure 12). In the other communes that provided *Bulinus truncatus* samples, the lowest density was obtained in Commune VI with 13 g/p/15 min.

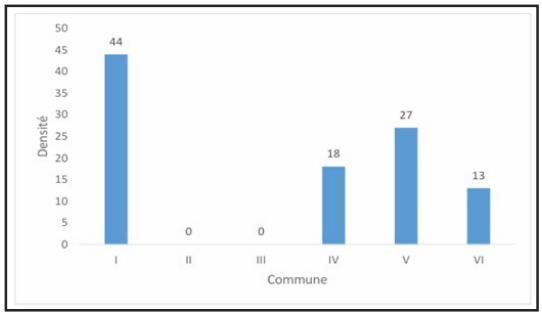


Figure 3. Variation of the relative density of *Bulinus truncatus* by commune

Regarding densities observed by habitat for *B. truncatus*, Figure 13 shows that the highest densities were recorded at Dialakorodji 1 and the lowest at Daoudabougou 2.

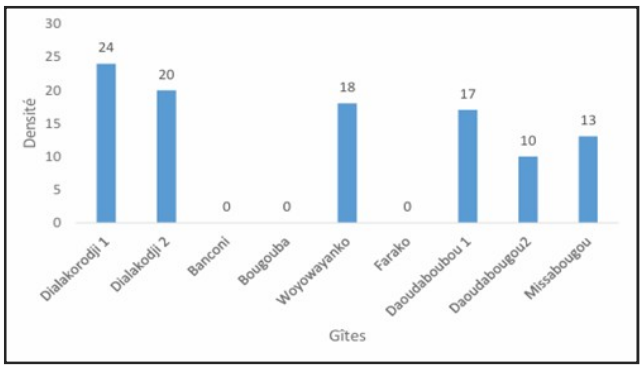


Figure 4 .Variation of relative densities of *Bulinus truncatus* collected by habitats)

Natural infestation rates of intermediate host mollusks of human schistosomes by commune and by habitat in the Bamako district: The table III, is related to the distribution of natural infestation rates of *Bulinus truncatus*. It shows that the overall natural infestation rate (NIR/TIN) of this species was 4.90% (10/204). In total, among the six communes surveyed, three (CI, IV, and VI) (50%) provided positive mollusks. Rates ranged from 7.95% in CI to 2.77% in CIV. In CV, where 56 *B. truncatus* samples were observed, none was positive ($p < 0.0001$). Elsewhere, no *B. globosus* or *Biomphalaria pfeifferi* exposed emitted schistosome cercariae. Table IV shows that 4 out of 9 (44.4%) *B. truncatus* samples emitted schistosome cercariae. Dialakorodji 1 was the most productive habitat with a NIR of 10.41, whereas Dialakorodji 2 had only 0.05 parasitized mollusks.

DISCUSSION

Spatial distribution and identification of gastropods collected by commune: Schistosomiasis is a disease caused by the presence of intermediate hosts, namely mollusks. Six communes were included in our study (Communes I, II, III, IV, V, and VI). Overall, 307 gastropods were collected across the different communes. Three intermediate host mollusk species of human schistosomes were collected in four out of six communes in the Bamako district during this study: *Bulinus truncatus*, *Bulinus globosus*, and *Biomphalaria pfeifferi*. All three species involved in schistosome transmission in Mali were previously described in many locations in the country, particularly in the Niger Office irrigated perimeter, around the Sélingué dam, in the Dogon Plateau region, and in Bamako (Madsen et al., 1987; Dabo et al., 1994). The absence of mollusks in certain communes of the district could be explained by the survey period from April to June, which is particularly hot, during which most habitats (Niger tributaries) were either dry or polluted by wastewater. This is the case in Communes II and III, where the rivers originally designed to drain rainwater also serve as channels for wastewater and debris of all kinds. The shells observed at some human–water contact points reflect the drying up of these points.

Relative density by commune: The average relative densities observed were sometimes low compared with those observed in the Bamako district in December by Dabo et al. (2025): for

Table I. Distribution and identification of intermediate host mollusks of human schistosomes (% in parentheses) captured according to communes, April–June 2025

Catégorie	*Bulinus truncatus*	*Bulinus globosus*	*Biomphalaria pfeifferi*	Total
Commune I	88 (43,1)	22 (22)	0	110 (35,8)
Commune II	0	0	0	0
Commune III	0	0	0	0
Commune IV	36 (17,7)	16 (16)	3 (100)	55 (18,0)
Commune V	54 (26,5)	56 (56)	0	110 (35,8)
Commune VI	26 (12,7)	6 (6)	0	32 (10,4)
Total	**204 (100)**	**100 (100)**	**3 (100)**	**307 (100)**

C* : Commune

Table II. Distribution and species of intermediate host mollusks of human schistosomes (% in parentheses) collected according to sites

Sous-zone	*Bulinus truncatus*	*Bulinus globosus*	*Biomphalaria pfeifferi*	Total	p
CI* Dialakorodji I	48 (87,3)	7 (12,7)	0	55 (100)	0,056
CI* Dialakorodji 2	40 (72,7)	15 (27,3)	0	55 (100)	
CII Banconi	0	0	0	0	
CII Bougouba	0	0	0	0	
CIII Farako	0	0	0	0	
CIV Woyowayanako	36 (65,4)	16 (29,1)	3 (5,5)	55 (100)	
CV Daoudabougou 1	34 (61,8)	21 (38,2)	0	55 (100)	0,0076
CV Daoudabougou 2	20 (36,4)	35 (63,6)	0	55 (100)	
CVI Missabougou	26 (81,2)	6 (18,8)	0	32 (100)	
Total	**204**	**100**	**3**	**307 (100)**	

C* : Commune

Table III. Variation in the natural infestation rate of intermediate host mollusk species of human schistosomes collected by commune

Sites d'étude	Bulinus truncatus Nb	Inf	TIN	Bulinus globosus Nb	Inf	TIN	Biomphalaria pfeifferi Nb.	Inf	TIN
CI	88	7	7,95	22	0	0	0	0	0
CII	0	0	0	0	0	0	0	0	0
CIII	0	0	0	0	0	0	0	0	0
CIV	36	1	2,77	16	0	0	3	0	0
CV	56	0	0	54	0	0	0	0	0
CVI	26	2	7,69	6	0	0	0	0	0
Total	**204**	**10**	**4,90**	**100**	**0**	**0**	**3**	**0**	**0**

B: *Bulinus* ;Biom :*Biomphalaria* ; Nb: number ; Inf.: infected ; TIN: Natural infestation rate.

Table IV. Variation in the natural infestation rate of intermediate host mollusks of human schistosomes captured according to habitats

Sites d'étude	Bulinus truncatus Nb	Inf	TIN	Bulinus globosus Nb	Inf.	TIN	Biomphalaria pfeifferi Nb.	Inf.	TIN
Dialakorodji I	48	5	10,41	7	0	0	0	0	0
Dialakorodji 2	40	2	0,05	15	0	0	0	0	0
Bougouba	0	0	0	0	0	0	0	0	0
Bankoni	0	0	0	0	0	0	0	0	0
Woyowayanako	36	1	2,77	16	0	0	3	0	0
Farako	0	0	0	0	0	0	0	0	0
Daoudabougou 1	34	0	0	21	0	0	0	0	0
Daoudabougou 2	20	0	0	35	0	0	0	0	0
Missabougou	26	2	7,69	6	0	0	0	0	0
Total	**204**	**10**	**4,90**	**100**	**0**	**0**	**3**	**0**	**0**

B: *Bulinus*; Biom: *Biomphalaria*; Nb: number; Inf.: infected; TIN: Natural infestation rate

Bulinus truncatus (108 g/p/15 min vs 66 g/p/15 min) and for *Biomphalaria pfeifferi* (78 g/p/15 min vs 2 g/p/15 min). They were sometimes high during this study for *Bulinus globosus*, with 32 g/p/15 min vs 13 g/p/15 min. In Martinique, Pointier et al. (1984) reported high densities of *Biomphalaria* ranging from 40.5 to 256. In Burkina Faso, high densities of *Biomphalaria pfeifferi* and *Bulinus truncatus*, and low densities of *Bulinus globosus* were also recorded by Zongo (2010).

Natural infestation rates of intermediate host mollusks: The overall mean natural infestation rate (TIN/NIR) was 4.90% for *Bulinus truncatus*, the only species that released schistosome cercariae. The rate observed in this study was similar to that reported by Tounkara (2007), who observed a total infestation rate ranging from 3.6 to 9.4% depending on sites in the Bamako district. In 2015, the TIN of *Bulinus truncatus* was 8.4% in December and that of *Biomphalaria pfeifferi* was 2.6% in January (Dabo et al., 2015). By contrast, Diaw et al. reported a rate of 44.36%, which was much higher (Diaw et al., 1991). TIN was zero in Communes II, III, and V. This may be explained by the absence of mollusks in the habitats of CII and CIII. For CV, the absence of parasitized mollusks could be linked to the abandonment of habitats by the population due to pollution by wastewater. CI and VI, with relatively polluted habitats, recorded the highest rates: 7.95% and 7.69%, respectively. The lowest rate was observed in CIV (2.77%). There is also a significant variation in TIN according to habitats ($p = 0.041$), ranging from 10.41% at Dialakorodji 1 to 0.05% at Dialakorodji 2. Five sites out of nine sampled (Banconi, Bougouba, Daoudabougou 1–2, and Farako) provided no infested mollusks, either due to the absence of mollusks or habitat pollution. The study period (hot dry season) likely played a major role under these conditions in mollusk infestation.

Bulinus truncatus was the most infested species with 4.90%. As reflected by its distribution, this species was the one most exposed to miracidia in the habitats. The absence of infested *Biomphalaria pfeifferi* could be linked, on the one hand, to the low colonization of habitats by this species and, on the other hand, to the hypo-endemicity of *Schistosoma haematobium*. As for *Bulinus globosus*, it was associated with polluted habitats at Daoudabougou. The results regarding the presence of intermediate host mollusks (especially *Bulinus truncatus*) support active transmission of schistosomes (*Schistosoma haematobium*) in the Bamako district.

CONCLUSION

Data from the current study show that, in the Bamako district, there are active transmission sites for the schistosomiasis disease due to the presence of intermediate host mollusks and environmental conditions favorable to their infestation. Three mollusk species (*Bulinus truncatus*, *Bulinus globosus*, and *Biomphalaria pfeifferi*) were recorded during the malacological survey, but *Bulinus truncatus* was the only species that released schistosome cercariae.

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