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DISTRIBUTION OF SNAILS, INTERMEDIATE HOSTS OF SCHISTOSOMES IN AND AROUND KISANGANI, DEMOCRATIC REPUBLIC OF THE CONGO

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ABSTRACT

Introduction: This study investigated the distribution and abundance of snails that can transmit schistosomiasis, a parasitic disease, in Kisangani, Democratic Republic of Congo. **Materials and Methods:** Five swampy sites were selected based on reported schistosomiasis cases and local knowledge of contact with water and snail presence. Non-probabilistic (convenience) sampling was employed. **Results:** Eight snail species were found, all of which can transmit various types of schistosomiasis or other diseases. The identified snail species can transmit schistosomiasis caused by Schistosoma mansoni, S. haematobium, and potentially S. intercalatum, as well as fascioliasis, another parasitic disease. Snail densities were high in the Onane, Kakole, and Gouvernorat sites, which are rivers and water points potentially contaminated with human waste. Cases of schistosomiasis have been reported in all Health Zones where snail samples were collected. **Conclusion:** This study provides valuable data on the distribution of snails that can transmit schistosomiasis in Kisangani. Further research is needed to better understand the schistosomiasis situation and develop control strategies.

KEYWORDS: distribution of snails, schistosome, Kisangani

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INTRODUCTION

A better understanding of the abundance and distribution of intermediate snail hosts is essential for understanding schistosomiasis transmission and informing effective public health interventions in endemic areas. [1]

Schistosomiasis is a neglected tropical disease (NTD) caused by trematodes of the genus Schistosoma (S.) [2-4]. It is endemic in 78 countries worldwide. It affects more than 229 million people in tropical and subtropical regions, with over 90% of cases in sub-Saharan Africa. It is responsible for 800,000 deaths a year [2]. According to WHO estimates, at least 251.4 million people will need preventive treatment in 2021. [3,4].

The distribution of schistosomes is directly linked to the geographical range of their snail intermediate hosts [5,6].

Nigeria, Ethiopia, Kenya, Mozambique and the Democratic Republic of Congo (DRC) are the five most affected countries in Africa [7].

The work of Gillet and Wolfs in 1954 [8] revealed several foci of schistosomiasis in the various provinces of the DRC (formerly Belgian Congo). The outbreak in and around Kisangani (formerly Stanleyville) was endemic for S. intercalatum. S. mansoni and S. haematobium were not found there. Explorations at the time did not reveal the intermediate snail hosts of S. mansoni. But as the vectors of S. intercalatum are the same as those of S. haematobium, this suggested that the outbreak would be affected by the latter in the near future.

Among recent works, Esol'e et al [9] found in 2019 in Bavaido, 24 km north of Kisangani on national road no. 4, urine samples contaminated with Schistosoma haematobium and stool samples contaminated with Schistosoma mansoni.

It is clear that the outbreak in and around Kisangani is affected by three species of Schistosoma, suggesting an evolution in the aquatic malacological fauna since the work of Gillet and Wolfs [8].

The aim of this study is to determine the abundance and distribution of snail intermediate hosts of schistosomes in and around the city of Kisangani.

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MATERIALS AND METHODS

Study site

This study was carried out in five swampy sites in Tshopo province, namely the Onane River in the Wanierukula Health Zone (00°28'40.84"N25°41'11.01°E), the Tomboli-mboli stream in the Yakusu Health Zone (00°34'39.59"N25°01'32, 84"E), the Kakole river in the Tshopo HZ (00°43'05,42"N25°18'37,18"E), the water conduits behind the Gouvernorat (00°31'14,49"N25°11'51,74°E) and at the ANR station (00°30'47,18"N25°10'48,41"E) in the Makiso-Kisangani HZ. The choice of these sites was based on agglomerations associated with human schistosomiasis and on local knowledge of contact with water and the presence of snails. The study was carried out from May 10 to 17, 2024. The geographical coordinates of the study sites were captured using the Global Positioning System (GPS).

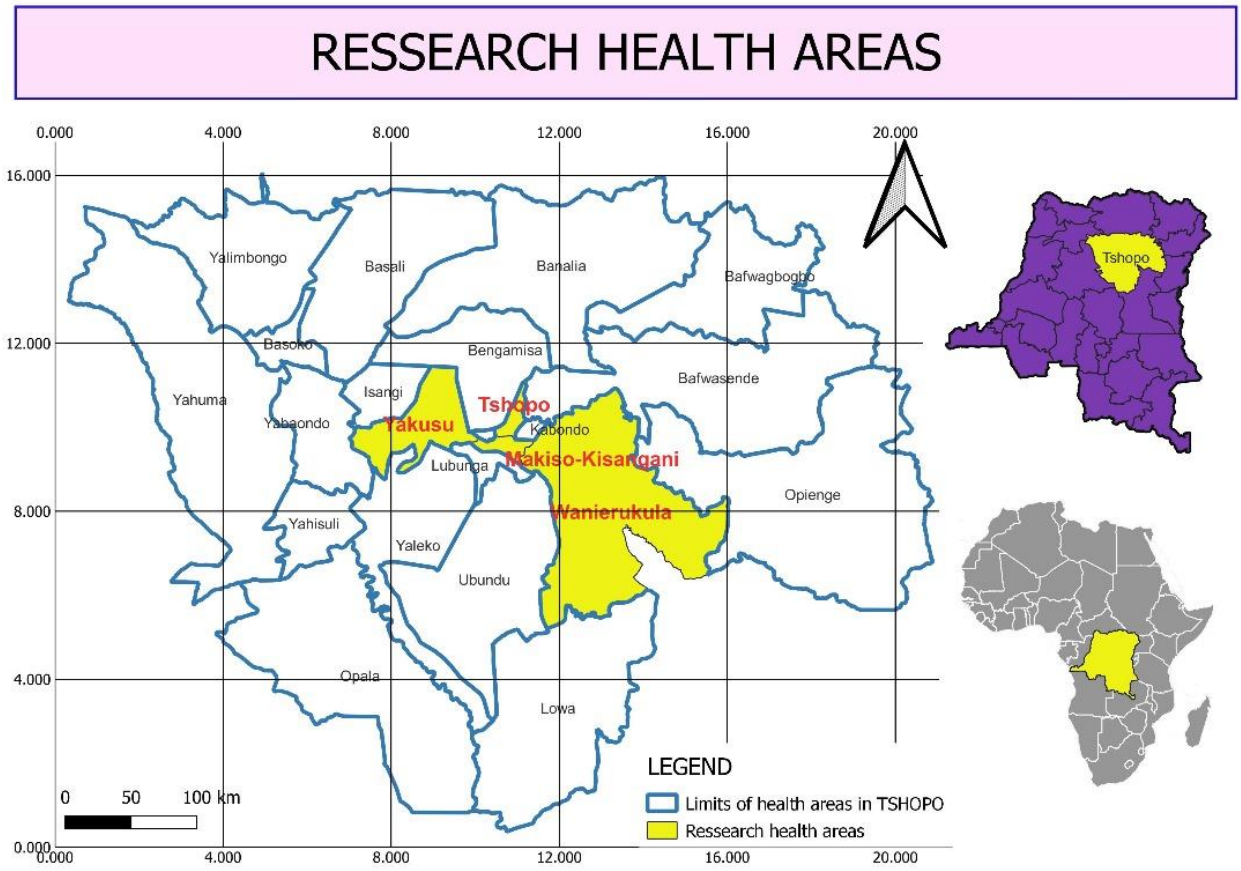

Figure1. Research health zones

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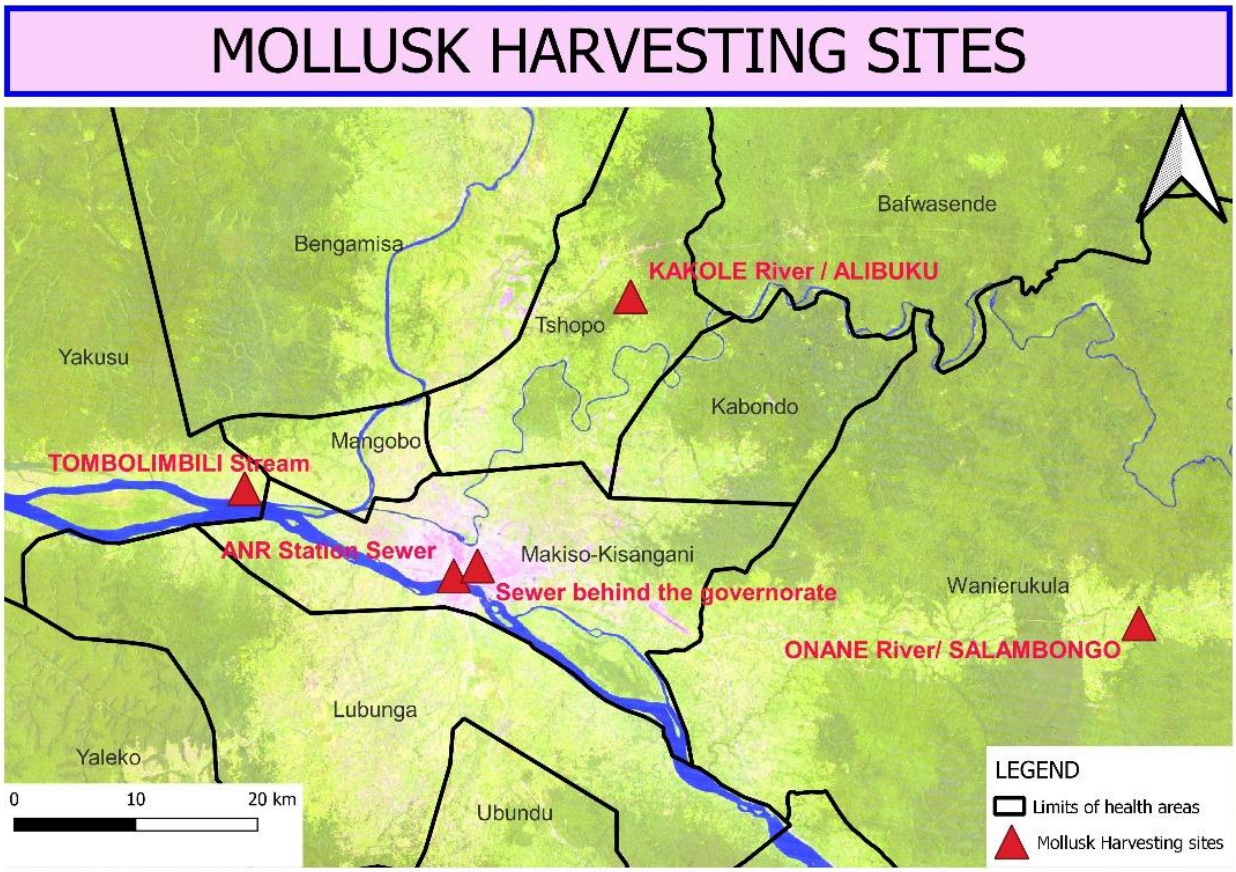

Figure 2. Location of snail harvesting sites

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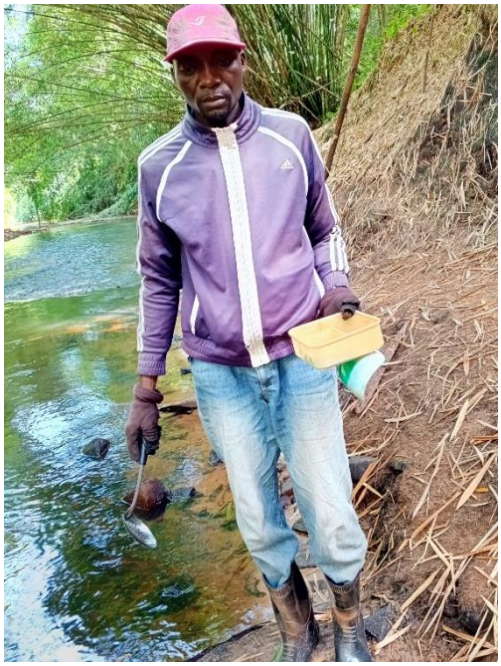

Fig 3. Onane river: Snail harvests

Fig 4. Onane river: Abundant harvests

Fig 5. Tomboli-mboli stream: continent activities

Fig 6. Snail harvests

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Type of study

The study is cross-sectional and descriptive, and covered all snails collected from the various marsh sites selected.

Data collection process

Sampling was non-probabilistic for convenience. Harvesting was carried out from 9am to 11am at each site.

Two prospectors were deployed per site to search for snails by systematic dredging of submerged vegetation and aquatic supports.

Specimens of snail populations were collected using gloves, dip nets, ladles, entomological forceps and coolers containing Ice-boxes for preservation. The snails were placed between two layers of moistened hydrophilic absorbent cotton (wetted and wrung out thoroughly) in a plastic petri dish or similar container. The collected snails were sent to the entomological laboratory of the University of Kinshasa for analysis and specification.

Identification process

Snail species identification criteria were based on the Mandahl-Barth identification key [10]. The density of snails collected was assessed using the technique employed by Sellin and Simonkovich [11], which consists of counting the number of snails collected by the same prospector after 30 minutes. Thus, a site with 1 to 10 snails was considered to have a low density; from 11 to 50 snails as having a medium density and more than 50 snails as having a high density.

Data management and statistical analysis

The data collected were entered into Excel 2019 and then imported into R 4.4.0 for analysis.
Descriptive statistics were produced to determine the abundance and distribution of snails at the different sites. In addition, the biplot of the principal component analysis and the cluster dendrogram of the hierarchical ascending classification of sites according to their density, Health Zones and the type of environment in which they are found were produced.

Mapping of the geographical distribution of the various sites where snails were harvested was produced with QGIS 3.36 software, using geographical coordinates collected in the field.

RESULTS

3.1 Distribution and density of snails at various sites during the period May 10-17, 2024.

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Table 1: Distribution and density of snails at various sites

Health Zone	Site	Species	Percentage	Snails collected within 30 minutes	Density
Makiso - Kisangani	ANR water pipeline	*Bulinus umbilicatus*	38	34	Moderate
		Bulinus truncatus	62		
		Total	100		
Makiso - Kisangani	Gouvernorat water pipeline	*Biomphalaria pfeifferi*	44	90	High
		Biomphalaria camerunensis	56		
		Total	100		
Tshopo	Kakole River	*Lymnae natalensis*	73	90	High
		Pirenella conica	27		
		Total	100		
Wanierukula	Onane River	*Lymnae truncatala*	100	82	High
		Total	100		
Yakusu	Tombolimboli stream	*Bulinus globosus*	57	32	Moderate
		Physa acuta	12		
		Bulinus trucantus	31		
		Total	100		

Bulinus trucantus accounts for 62% of the snails harvested from the ANR water pipeline. Biomphalaria camerunensis accounts for 56% of snails harvested from the Gouvernorat water pipeline. Seventy-three percent of the snails harvested from the Kakole river belong to the Lymnae natalensis family. Lymnae trucantela is the only species found at the Onane River in Wanierukula and Bulinus globosus is the most prevalent at the Tombolimboli Stream in Yakusu, accounting for 57% of the snails harvested. Density is high at the Onane River, Kakole River and Gouvernorat water pipeline sites, with 82 snails, 90 snails and

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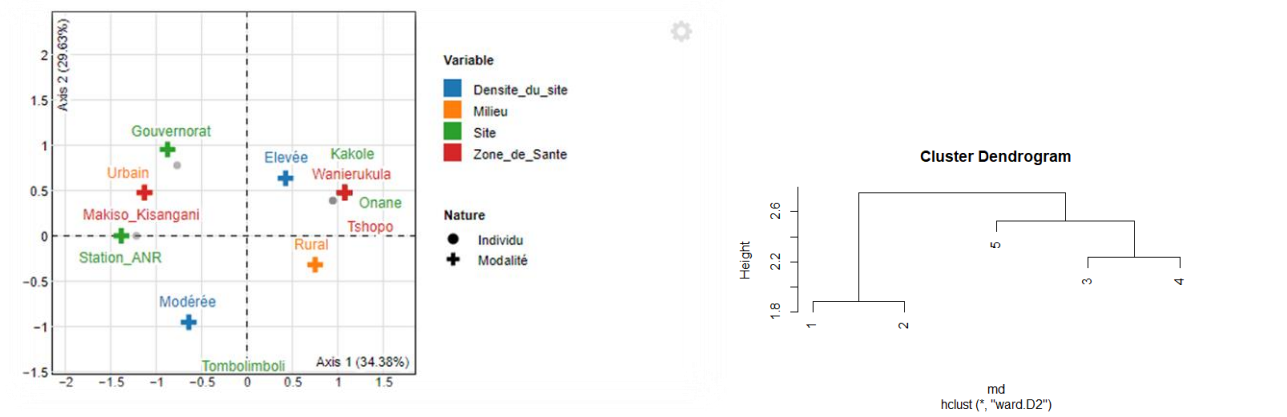
90 snails harvested within 30 minutes respectively. The Tombolimboli Stream and ANR water pipeline sites had moderate densities, with 32 and 34 snails harvested within 30 minutes respectively.

3.2. Spatial distribution of sites by density, Health Zone and type of environment



1 = Tombolimboli, 2 = Onane, 3 = Kakole,
4 = ANR Station, 5 = Gouvernorat

Figure 7: Biplot diagram of the Multiple Component Analysis (a) and Dendrogram of the Hierarchical Ascending Classification (b) of the distribution of snail harvesting sites according to their density, Health Zones and the types of environments in which they are found.

These graphs show that the Onane and Kakole sites form the same cluster and are very close to each other, because they have a high snail density and are all located in rural areas.

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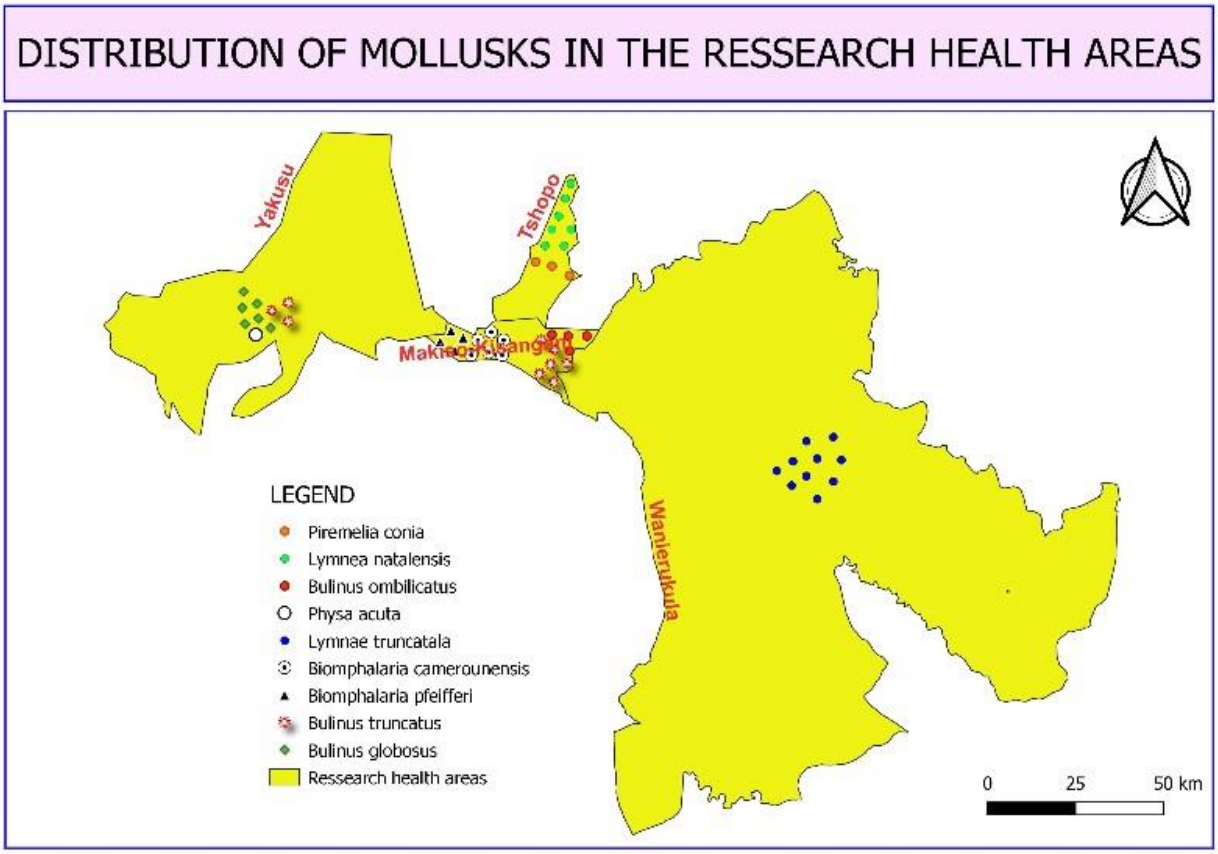

Figure 8. Distribution of snail species harvested

DISCUSSION

All eight snail species collected are of medical importance. [12-22]

The two snail species found in the ANR water pipe in the Makiso-Kisangani SLA (Bulinus umbilicatus and Bulinus truncatus) are intermediate hosts of Schistosoma haematobium [12,13]. The two snail species collected from the Gouvernorat water pipe in the Makiso-Kisangani HZ (Biomphalaria pfeifferi and Biomphalaria camerunensis) are intermediate hosts of Schistosoma mansoni [14,15]. Of the two snail species found in the Kakole River in the Tshopo SZ, Lymnae natalensis is the intermediate host of Fasciola gigantica [16,17], while Pirenella conica is the intermediate host of several trematodes, including the heterophyid digenetic flukes that give rise to heterophyiasis [18]. The species Lymnae truncatala, found in the Onane River in the Wanierukula HZ, is the intermediate host of Faciola hepatica [19]. Among the species found in the Tombolimboli stream in the Yakusu HZ, Bulinus globosus and Bulinus truncatus are intermediate hosts of Schistosoma haematobium [20,22] and are also cited as intermediate hosts of

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Schistosoma intercalatum [23,24], while Physa acuta is the intermediate host of larval digenetic trematodes [21].

Since the beginning of 2024, cases of schistosomiasis have been reported in certain Health Zones (HZ) in Tshopo Province. These HZ are Bafwagbogbo, Banalia, Basoko, Bengamisa, Kabondo, Lowa, Lubunga, Makiso-Kisangani, Mangobo, Opala, Opienge, Tshopo, Wanierukula, Yahuma, Yakusu and Yaleko. The HZ with the most reported cases was Lubunga HZ with 73 cases, followed by Tshopo HZ with 65 cases and Makiso-Kisangani HZ with 39 cases. We were unable to visit the Lubunga commune due to insecurity caused by ethnic conflict between the Mbole and Lengola peoples.

All the HZ where study sites were selected reported cases of schistosomiasis. These data may be under-reported, because in some sites, such as the Kakole River, there is a microscope but no laboratory technician, and in the Onane River, there is no microscope for examining stools and urine. Microscopes can be found in most health zones in the Reference General Hospitals and in the Reference Health Centers. Health Centers very rarely have microscopes.

We did not have access to HZ notification data by Schistosoma species for comparison with the various intermediate snail hosts collected there, which is one of the limitations of this study.

We have collected snail intermediate hosts of hepatic flukes from the Kakole and Onane rivers. These diseases can be confused with schistosomiasis due to the abdominal pain and hepatomegaly they can cause [25].

Unlike Gillet and Wolfs [8], who identified Bulinus africanus in Yakusu and Kisangani (formerly Stanleyville) in 1954, our work found other species of the Bulinus genus, as well as Physa acuta in Yakusu and Biomphalaria pfeifferi and Biomphalaria camerunensis in Kisangani. This difference may be due, on the one hand, to the evolution of snail classification, which is one of the most difficult fields and is constantly being modified over the years, and, on the other hand, to a possible evolution of the malacological fauna.

The Onane, Kakole and Gouvernorat sites had high snail densities, whereas the Tombolimboli and ANR Station sites had moderate densities. This may be due to a number of factors. The abundance of snail species is linked to the importance of human activities, notably defecation, urination and swimming. Rivers are the preferred place for bathing in rural areas, and most people defecate and pee in them when swimming. The fact that the Onane and Kakole river sites form the same cluster in the hierarchical ascending classification of snail-harvesting sites demonstrates this reality. The drains in some unhealthy

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areas are an overflow for septic tank overflows, in addition to household wastewater. This encourages the growth of algae, one of the snails' main sources of food [26,27]. As no species is found at more than one site, with the exception of Bulinus truncatus which is found at Yakusu and in the ANR water pipes in Kisangani, the ecosystem at all sites should be studied to assess its influence on species distribution.

CONCLUSION

The results of this study provide new information on the distribution and abundance of snail intermediate hosts of human schistosomiasis in and around the Kisangani outbreak. The species found can transmit schistosomiasis to Schistosoma mansoni, Schistosoma haematobium and Schistosoma intercalatum. There are also species that play a role in the transmission of fascioliasis. According to the province's surveillance data in our possession, several HZ, beyond those whose sites were selected for the study, report cases of human schistosomiasis. An in-depth study of all these HZ, examining the various potential sites and the prevalence of the different Schistosoma species in the populations around these sites, would be necessary. This would make it possible to adjust the various strategies used to control and eliminate this disease.

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