Case Study

POTENTIAL FOR TRANSMISSION OF SCHISTOSOMIASIS IN KAYONZA DISTRICT

A. Isabwe[1], E. Ruberanziza[2], D. Mupfasoni[2], J. Ruxin[2], J. Clerinx[3], PT. White[1].

[1]*Kigali Institute of Education (KIE), Faculty of Sciences, Dpt. of Biology-Chemistry Physical Education and Sports, Kigali, Rwanda.*
[2]*Neglected Tropical Disease (NTD)-Control Program, Access Project, Kigali, Rwanda.*
[3]*Institute of Tropical Medicine, Antwerp (ITM), Dpt. of Clinical Sciences, Antwerp, Belgium.*

ABSTRACT

Introduction: Schistosomiasis, also known as bilharzia or snail fever, is a tropical parasitic disease caused by a trematode platyhelminthes called Schistosoma sp. Schistosoma species are transmitted by cercariae penetrating the skin when a person is bathing, washing clothes, fishing or engaged in agricultural activities; involving contact with fresh water that has fecal or urinary contamination, and contains the parasites' snail host. The present study aimed to survey freshwater snails in Kayonza District (Rwanda) especially Lake Muhazi and surrounding water bodies, stream and swamps to assess the potential for transmission of two species of Schistosoma: S. mansoni and S. haematobium.
Methods: Six sites were selected to assess the potential for transmission of schistosomiasis. The intermediate hosts of schistosomes, namely the snails Biomphalaria sp., Bulinus sp. and Lymnaea sp., were collected and brought to the laboratory and investigated to see if trematode cercaria responsible for the disease were present.
Results: Snails dissected were not only infected with trematode cercaria but also with annelids and flatworms (Platyhelminths). Cercaria found therein were of two types: furcocercous, probably responsible for schistosomiasis; and gymnocephalous cercaria for fasciolasis: an infection of cattle, goats and sheep.
Conclusion: Biomphalaria sp were the major hosts for schistosome cercaria, and most snails collected of this species were infected. Moreover, they were found in large number from all sites. Lymnaea sp, hosts snails for Fasciola cercaria, were also found in a considerable number compared to the low number of Bulinus sp in the region. District and national authorities may wish to further investigate this infestation and identify potential interventions to disrupt the disease transmission.

Keywords: *Schistosomiasis - Biomphalaria sp - Bulinus sp - Fresh water snails - Kayonza district - Rwanda*

RESUME

Introduction: La schistosomiase également connue sous le nom de bilharziose est une maladie parasitaire tropicale causée par des plathelminthes trématodes appelés schistosomes. Les Schistosomes sont transmises par des cercaires pénétrant la peau quand une personne se baigne, lave des vêtements, pêche ou pendant des activités agricoles en contact avec l'eau douce contaminée par des matières fécales ou urinaires, et contenant les mollusques hôtes intermédiaires des parasites. La présente étude visait à examiner les mollusques d'eau douce dans le district de Kayonza (Rwanda) particulièrement le lac Muhazi et les eaux environnantes: les ruisseaux et les marais; pour évaluer le potentiel de la transmission de deux espèces de schistosome: Schistosoma mansoni et Schistosoma haematobium.
Méthodes: Six endroits ont été choisis pour évaluer le potentiel pour la transmission de la schistosomiase. Des mollusques hôtes intermédiaires des schistosomes, à savoir les espèces de Biomphalaria, Bulinus et Lymnaea ont été collectés, amenés au laboratoire et étudiés pour voir si les cercaires de trématodes responsables de la maladie étaient présentes.
Résultats: Des mollusques disséqués ont été atteints par les cercaires de trématodes mais également par des annélides et des vers plats (Plathelminthes). Les Cercaires trouvées là-dedans étaient de deux types: furcocercaires, probablement responsable de la schistosomiase et cercaires gymnocéphales probablement responsables du fasciolose: une infection du bétail, des chèvres et des moutons.
Conclusion: Les espèces Biomphalaria étaient les principaux hôtes des cercaires des schistosomes, les plus infectés parmi les espèces des mollusques collectés. Ces espèces de Biomphalaria ont été trouvées en grand nombre dans tous les sites. Les espèces de Lymnaea, mollusques hôtes intermédiaires pour les cercaires de Fasciola, ont été également trouvés en nombre considérable comparé à un nombre peu élevé des espèces Bulinus dans la région. Les autorités de district et ainsi que nationales devraient étudier davantage cette infestation et identifier les interventions potentielles pour interrompre sa transmission.

Mots-clés : *Schistosomiase - Biomphalaria sp - Bulinus sp - Mollusques d'eau douce - Kayonza district - Rwanda.*

INTRODUCTION

Schistosomiasis also known as bilharzia or snail fever is a tropical parasitic disease caused by several species of trematode worms of the genus Schistosoma sp. The transmission cycle requires the contamination of surface water by excreta, specific freshwater snails which act as intermediate hosts, and human water contact [1].
In 1996, schistosomiasis was reported to be endemic in 74 tropical countries, and over 200 million people living in rural and agricultural areas were estimated to be infected. Between 500 and 600 million people were considered at risk of becoming infected. Schistosomiasis is one of the most widespread of all human parasitic diseases, ranking second only to malaria in terms of its socioeconomic and public health importance in tropical and subtropical areas. It is also the most prevalent of the waterborne diseases and one of the greatest risks to health in rural areas of developing countries [2].
The disease is chronic, insidious and causes cumulative damage to the body of the patient. It chiefly attacks the intestine or bladder and causes lower resistance of

*Correspondence to: Dr. Eugene Ruberanziza, Access Project, Kigali, Rwanda
Email: eugenedio@yahoo.fr
Cell phone: +250 78 830 6388

individuals to other diseases. It saps energy, lowering the output of the worker and the receptivity of the schoolchild. In many countries, it may be classed not only as an important health problem, but also as a major social and economic issue [3].

Schistosoma species vary with geographical regions. S. mansoni and S. haematobium infections predominate in the Sub-Saharan Africa. S. mansoni is endemic in parts of South America and the Caribbean. S. japonicum is common in China, Indonesia and the Philippines [4].
Both S. haematobium and S. mansoni are widespread in East and Central Africa where transmission occurs in nearly all major lakes and in many smaller water bodies [4].

Habitat requirements of snails

The schistosomiasis intermediate host snails occur mostly in permanent and stagnant water bodies, e.g. rivers, streams, lakes, farms dams and irrigation or drainage channels. The snails are tolerant of water varying widely in its physical and chemical characteristics. They appear to prefer a shaded habitat associated with aquatic plants but light is essential for reproduction and development of embryos [5].
The optimal temperature is about 25^{o}C, the conductivity of about 300 Ms/cm and a pH of 6 to 8. Decaying animal or vegetable matter and human/animal excreta in moderation have a favorable effect on snails. They show distress to high salinity and when the oxygen tension falls below 75% of saturation, and suffocate when it falls below 10% [5].

Schistosomiasis in Rwanda

Since 1975, it was known that intestinal schistosomiasis was locally endemic and it was diagnosed in many areas. In 1980, a great number of infected children (5-10 years) was undoubtedly a sign of high potential of transmission in Rwanda. This was concluded after a survey of stool carried out in children by the Rwandan Ministry of Health. In addition, infected snails of the genus Biomphalaria have been found around lakes mostly in May and June [6].
According to the most recent survey reports of the Rwanda Ministry of Health's Neglected tropical Disease (NTD) Control Program, the main transmission areas were found around Lakes Ruhondo, Burera, Kivu, Muhazi, Rweru, Mugesera and some swampy areas in Nyagatare district [7, 8, 9].
Since 2008, the Rwanda Ministry of Health has conducted a de-worming campaign against schistosomiasis using praziquantel targeting school aged children and adults at high risk [10, 11].

METHODS

The Kayonza district is one of the 30 districts of the country, and is located in Eastern Province. The District has twelve sectors and bounds with Tanzania in East, Gatsibo district in North, Rwamagana district in West, Ngoma and Kirehe districts in South. Three sectors in the West border Lake Muhazi, one of the major lakes in the country. The hydrography of the district is rich in small water bodies, swamps and rivers. The major lakes in the district are Lake Nasho, Lake Hago and Lake Ihema in Akagera National Park. Numerous rivers namely Kanyonyombya and Kadiridimba enrich the district's hydrography. According to the recent data form the Rwandan NTD Control Program (Ministry of Health), schistosomiasis has a low prevalence in Kayonza district [7].

Selection of sites

To choose sites for snail collection, attention was paid to those areas that seemed to be suitable for snail habitats and in which human activities were frequent [12]. In all, six potential transmission sites were identified and chosen for investigation. In the field, characteristics of the sites were recorded. Figure 2 shows selected sites for snail collection.

Collection of snails

At the sites, snails were collected using a scoop net. The snails were transported to the laboratory at Kigali Institute of Education (KIE) in containers filled with wet grasses. At each site, human activities were recorded. The laboratory contains equipment designed for students' practice purpose. Even though it has no materials for specific schistosomiasis screening in humans such as Kato-Katz kits, the laboratory contains materials allowing the assessment of the potential for transmission of schistosomiasis by evaluating the presence of infection in freshwater snails. In the laboratory, the following steps were followed to investigate infection in the snails collected:

- Snails were placed in separate compartments according to the sites. Some drops of water were added in each compartment.
- The snails were identified to Genus, they were taken from each compartment and measured with mm graph paper and then crushed in water in a petri dish.
- The snail's body shell removed, were dissected under a binocular microscope.
- The parasites present in the snails were identified and drawings were made.
- Every time the parasites were found, preservation was carried out by putting a sample in formalin (10%). A sample was also smeared on a slide and dried in air.
- Preserved specimens have been used to take digital microscopic pictures of parasites found using a digital

camera DCM 35 attached to a laptop. Parasite length has been measured with an eyepiece micrometer calibrated with a Zeiss stage micrometer.

Description of site surveyed

The Eastern part of Kayonza District is characterized by the presence of the Akagera National Park which is unhabited. The Western region of Kayonza is much populated; therefore site selection took into consideration of human habitant concentration. Five of the six sites selected were characterized by human activities such as washing clothes, water collection, swimming, fishing and cattle drinking. These sites were Rukara, Mukarange, Gahini, Ryamanyoni and Mwiri sites. Munazi site were in addition of the above activities characterized by the presence of intense agricultural activities.

RESULTS

Human activities at the sites surveyed

People are contaminated with schistosomes when they get in contact with fresh water containing potential intermediate host snails. This is mainly done when they indulge in activities like water collection and washing clothes, or swimming in water bodies such as lakes and ponds.

Snails collected

In all, 258 snails, meaning an average of 43 snails per site, have been collected in six sites. This was a suitable sample to screen snails for schistosome infection according to the statement of Appleton who recommends at least 40 snails per site to assess the schistosomiasis transmission potentialities [13]. Table 2 shows snail species, the number and size range collected from each site.

Table 1: Number of snails collected, species and size

	Snail species, number and size								
	Biomphalaria sp			*Lymnea sp*			*Bulinus sp*		
Site No	Number	Mean size (mm)	Range (mm)	Number	Mean size (mm)	Range (mm)	Number	Mean size (mm)	Range (mm)
1	25	10.7	6-22	14	12.2	6-22	-	-	-
2	25	9.8	5-13	17	9.0	4-14	5	6.6	5-9
3	19	10.1	6-13	23	11.1	6-14	-	-	-
4	16	10.0	5-12	17	10.7	7-15	2	5	5-10
5	24	10.0	6-15	16	10.5	5-14	2	6	4-8
6	31	11.1	6-14	17	10.2	6-14	5	7.6	5-9
Total	**140**	**10.3**	**5-22**	**104**	**10.6**	**4-22**	**14**	**7.6**	**5.9**

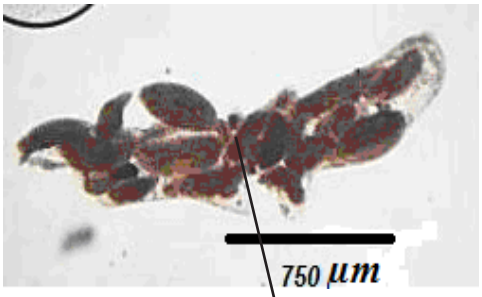
About 140 (54.3%) snails of Biomphalaria sp have been collected, and 104 (40.3%) snails of Lymnaea sp, against only 14 (5.4%) snails of Bulinus sp [table 2]. The mean ranges of snails are 10.3 mm, 10.6 mm and 6.3 mm for the three species Biomphalaria sp, Lymnaea sp and Bulinus sp, respectively. The snail species collected are illustrated in Figure 4.

[Photo: Isabwe A]

Figure 1: Snails species surveyed

Parasites of Biomphalaria sp

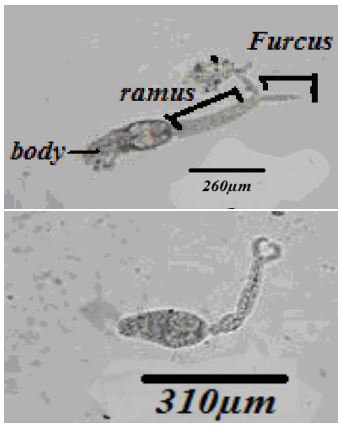
The figure 5 shows Sporocysts found from Biomphalaria sp; and 2 types of cercaria in dissected snails of Biomphalaria sp [figure 7]. The last are furcocercaria and gymnocercaria types of cercaria.



[Photo: Isabwe A]

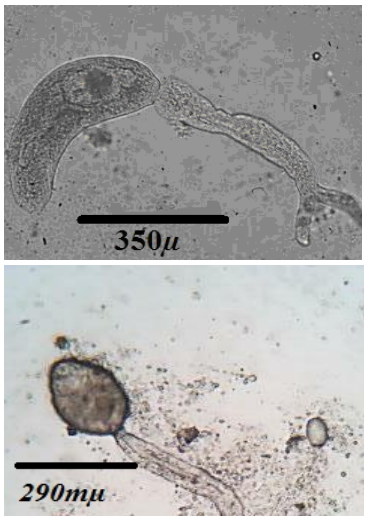
Gymnocephalous cercaria with tails

Figure 2: Sporocysts from Biomphalaria sp



[Photo: Isabwe A]

Figure 3: Furcocercous cercaria from Biomphalaria sp (magnification: 40X)



[Photo: Isabwe A]

Figure 4: Furcocercous and gymnocephalous cercaria from Biomphalaria sp (magnification: 100X)

Figure 5: Flatworms from Biomphalaria sp [Photo: Isabwe A]

Figure 6: Gymnocephalous cercaria from Lymnaea sp. [Photo: Isabwe A]

Figure 7: Flatworms from Lymnaea sp [Photo: Isabwe A]

Table 2: Infection rate in Biomphalaria sp

		Cercaria types				Other parasites			
	Number of snails	Furcocercous		Gymnocephalous		Annelids		Flatworms	
Site No	N	N	(%)	N	(%)	N	(%)	N	(%)
1	25	1	4	0	0	1	4	0	0
2	25	1	4	0	0	0	0	0	0
3	19	4	21.9	0	0	0	0	1	5.2
4	16	2	12.5	0	0	0	0	2	12.5
5	24	2	8.3	1	4	0	0	2	8.3
6	31	6	19.3	0	0	0	0	1	3.2
Total	**140**	**16**	**11.4**	**1**	**0.7**	**1**	**0.7**	**6**	**4.2**

Table 2 shows infection rates in Biomphalaria sp snails.

In 140 Biomphalaria sp snails collected, 16 (11.4%) were infected with furcocercercous cercaria [table 2]. These were from all sites. Only one snail from Ryamanyoni site was found infected with Gymnocephalous cercaria. Annelids have been found in one Biomphalaria sp snail at Rukara site.

Parasites of Lymnaea sp

Lymnea sp snails were infected with Gymnocephalous cercaria, flatworms as well as an annelid: Chaetogaster limnei. [Figures 6, 7, 8].

In all 104 Lymnaea sp snails collected, 4 (3.8%) snails was found infected with furcocercous cercaria while gymnocephalous cercaria were found in 10 (9.6%) snails. 3 (2.9%) snails were infected with flatworms [Figure 10], and 6 (5.8%) snails were infected with annelid: Chaetogaster lymnei [Figure 8].

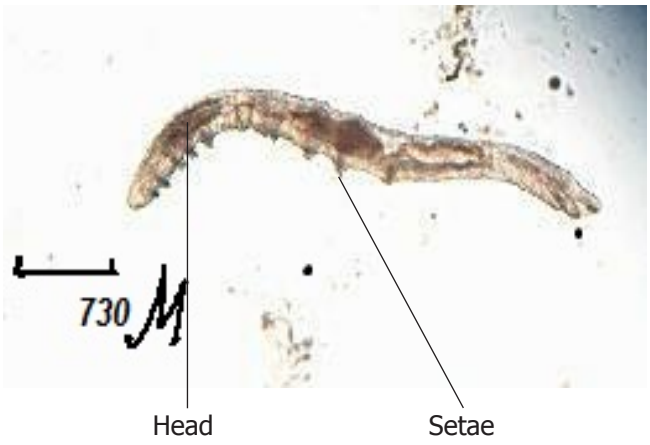


Figure 8: Chaetogaster limnaei from Lymnaea sp and Bulinus sp [Photo: Isabwe A]

Parasites of Bulinus sp

The only parasite found in Bulinus sp snails were Chaetogaster limnei [Figure 11]. In 14 Bulinus sp snails collected, 3 (21.4%) were infected with Chaetogaster lymnei. There was no Bulinus sp snail infected with cercaria. Snails infected with Chaetogaster lymnei were from Ryamanyoni and Munazi sites.

DISCUSSION

In 258 snails examined, 54.3%% were Biomphalaria sp, 40.3% Lymnaea sp and a very small number (5.4%) of Bulinus sp. In all sites, Biomphalaria sp and Lymnaea sp occurred together and in 4 of the 6 sites, a small number of Bulinus sp were also collected. After the investigation, parasites that were observed to infect snails were cercaria of two types according to their tails: furcocercous and gymnocephalous. In addition, two more parasites that have been found, were annelids (Chaetogaster limnaei) and flatworms whose identification to genus was not done.
Biomphalaria sp was infected at an average of 11.4% with cercaria of Furcocercous type and at only 0.7% with Gymnocephalous type of cercaria. These species were also infected with annelids at 0.7% and flatworms at 4.2%.

According to Cowper and Appleton' findings (table 4), the mean length of furcocercous cercaria found in snails in the present study was smaller than that normally observed in Schistosoma sp which are known to infect humans [5, 12]. Thus, it could be possible that some furcocercous found in our setting were not of the human type.
Lymnaea sp examined had no furcocercous cercaria but gymnocephalous were there at 9.6%; annelids and flatworms were 5.7% and 2.8%, respectively.
Bulinus sp samples collected were in a low number compared to the total number of snails and were not infected with any cercaria and flatworms.

Table 3: Comparison between mean sizes

Body parts measured	Cercaria mean size (µm)		Cercaria mean size (µm)	
	Cowper (1971) [5]	Appleton (1996) [13]	Present study (2010)	
			Furcocercous	Gymnocephalous
Body	168	179	126	134
Rumus	221	273	219	132
Furcus	78	96	65	-
Whole cercaria	467	548	410	226

This observation corroborates the findings by the Rwandan NTD Control Program of the Ministry of Health which concluded to the absence of urinary schistosomiasis caused by Schistosoma haematobium whose intermediate host snail is Bulinus sp. [7]. Infection of Bulinus sp with Annelids were observed at 21.4%. After identification, the annelid was found to be Chaetogaster limnaei. This is in accordance with Ibrahim's findings in the field populations of freshwater snails, which state that the prevalence of Cheatogaster limnaei is higher in Bulinus sp. than other snail species [13].

Referring to data presented in table 1, all six sites surveyed were used for water collection and washing clothes while the overall infection rate in schistosome cercaria was 11.4% in Biomphalaria sp. Hence these sites were considered to be potential for transmission of S. mansoni infection.
Of all sites, cattle drinking were observed in five sites. The overall prevalence in Gymnocephalous cercaria was 9.6% in Lymnaea sp. Since fascioliasis was associated with Lymnaea sp. as intermediate host, the disease was likely to outbreak in the area.

CONCLUSION

The present study showed that Biomphalaria sp was the major host for schistosome cercaria and the mostly infected in snails species. Moreover, the later was found in a large number from all sites. Lymnaea sp, host snails for Fasciola cercaria, was also found in a considerable number compared to a low number of Bulinus sp in the region.
The presence of intermediate host snails for schistosomiasis and fascioliasis, the fact that the region is rich in water bodies, lakes and swampy areas and a high number of people who use water bodies in their day-to-day activities, show that there is a potentiality to transmission of the diseases concerned in the region. Therefore, sensitize the population on schistosomiasis awareness, its consequences and prevention should be used as a remedial. Emphasizing on the use of improved pit latrine, advocate for water and sanitation in the region to limit people to get in contact with contaminated water.

Acknowledgements

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