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Schistosoma mansoni infection in residents of a riverside community in Eastern Amazon

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ABSTRACT

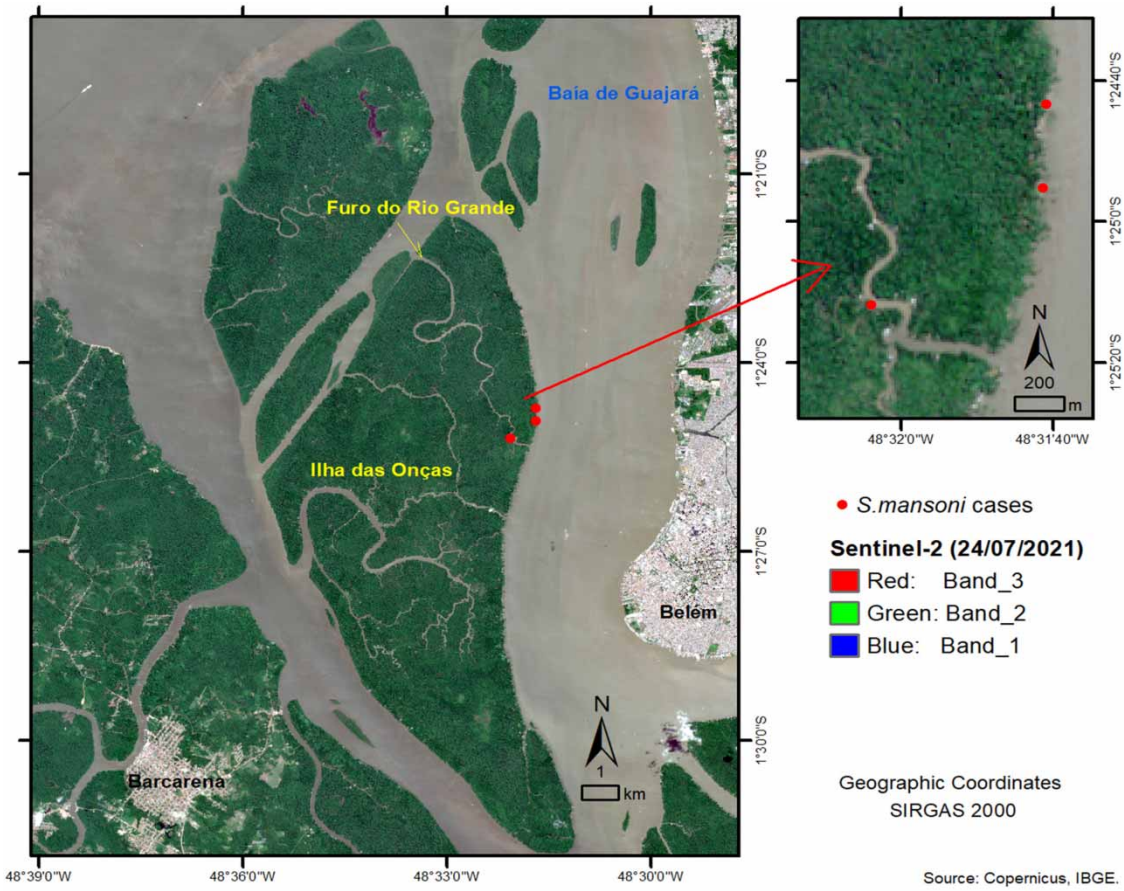
Schistosoma mansoni worms cause a waterborne parasitic disease called schistosomiasis. It commonly affects individuals in lack of sanitation structure. In Brazil, Pará state has Belém as one of the worst sanitation-ranking places in 2023, where schistosomiasis transmission was already documented. This study reports the occurrence of schistosomiasis in residents of Ilha das Onças, an island next to Belém. Stool samples were obtained from participants over 2 years old, all residents from Furo do Rio Grande, one of the rivers on the island. The Kato-Katz technique was performed for parasite investigation in the stool samples. Each participant responded to a sociodemographic and clinical questionnaire. The residences were georeferenced for map designing. Three out of 263 participants were *S. mansoni* positive, all men, ages ranging from 19 to 41 years old, with low parasitic load. Malacological surveys were carried out, but no *Biomphalaria* snails were found. Risk factors for schistosomiasis establishment are present on the island, and the lack of sanitation makes it a potential risk area. Malacological surveys are highly encouraged as preventive measures, as well as health surveillance for riverside populations, generating data that will help health authorities in the management and planning of preventive control actions.

Key words: basic sanitation, epidemiology, health surveillance, parasitic infections, riverside population, snails

HIGHLIGHTS

- The study revealed the presence of *Schistosoma mansoni* infection in residents of Ilha das Onças.
- The area had no previous reports of the disease.
- Only male individuals tested positive for the infection.
- No *Biomphalaria* snails were found in the peridomestic area of infected individuals.
- Environmental conditions might enable schistosomiasis establishment on the island.

GRAPHICAL ABSTRACT



INTRODUCTION

Schistosomiasis is a chronic waterborne parasitic disease that affects approximately 251 million people worldwide. Classified by the World Health Organization (WHO) as a neglected tropical disease, it has significant epidemiological importance in Brazil, where infection by *Schistosoma mansoni* (*S. mansoni*) primarily affects individuals living in environments lacking access to clean water and inadequate sanitation infrastructure (Brasil 2014; WHO 2023).

In Pará state, Belém ranks 95th out of the 100 worst sanitation-ranking places in 2023, considering indicators related to water supply, sewage collection and treatment, as well as investment losses (Instituto Trata Brasil 2023). The population uses the extensive number of rivers in the state for different purposes since it serves work activities, recreational and consumption purposes. However, the water analysis shows high levels of total coliforms, which makes it unsuitable for consumption (Neu *et al.* 2016; Costa *et al.* 2022).

This inadequate sanitation infrastructure and the numerous open-air canal networks that frequently overflow due to the region's rainfalls facilitates schistosomiasis transmission in Belém. Furthermore, the presence of *Biomphalaria* intermediate hosts enables the occurrence of new disease foci and the maintenance of transmission areas, increasing risk not only for the urban population but also primarily for those who depend extensively on water use, such as the riverside communities residing on the numerous islands around the city (Neu *et al.* 2016; Goveia *et al.* 2019). This study aims to report the occurrence of *S. mansoni* infection in residents of the Furo do Rio Grande community, at Ilha das Onças, Pará, Brazil.

METHODS

The study area, Ilha das Onças (S01°26′19.0″, W048°32′20.0″), is an island located in the Baía de Guajará (Guajará Bay), part of Barcarena Municipality (Figure 1), a 30-min boat ride from Belém. The Furo do Rio Grande area, one of the water channels

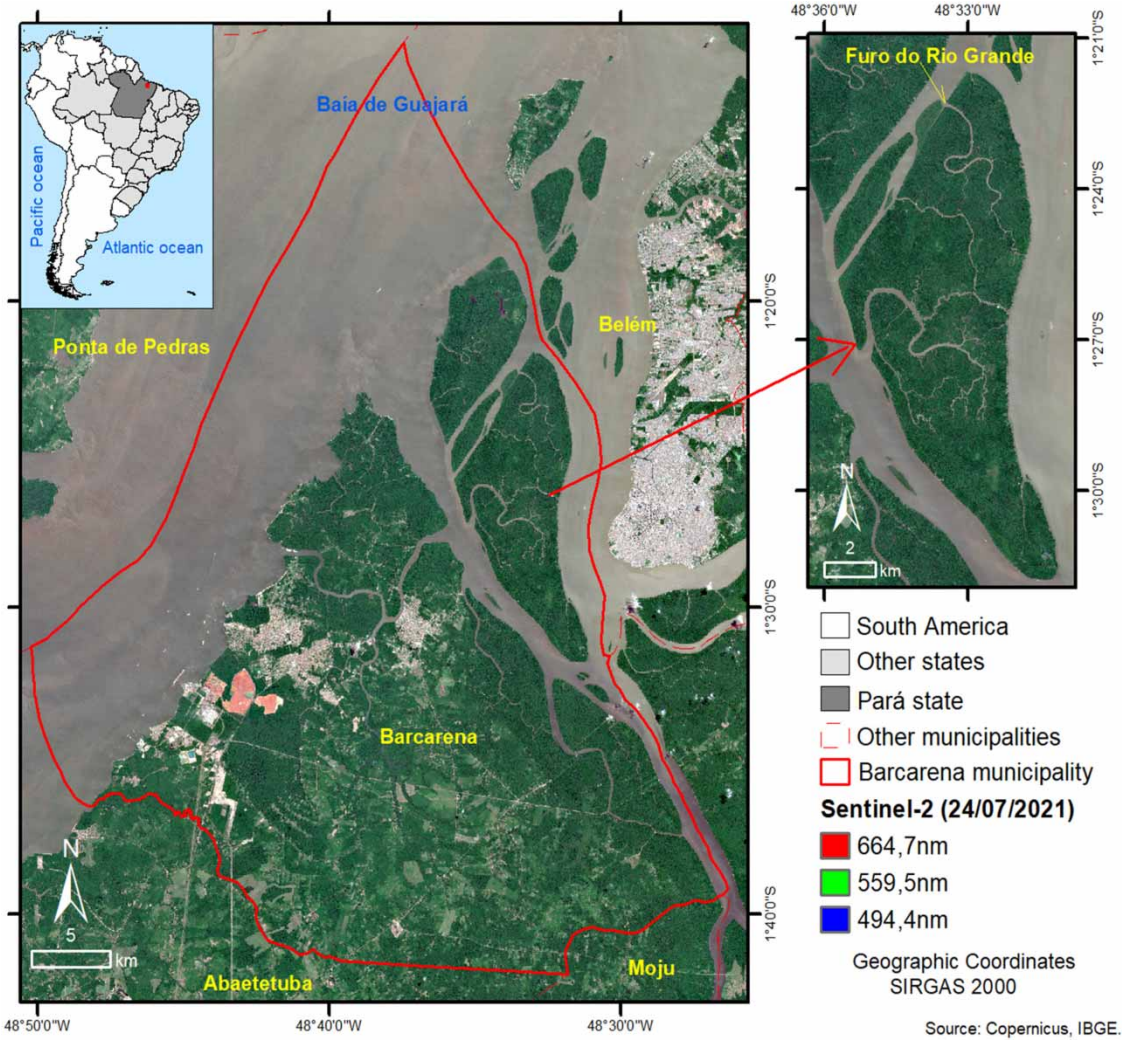


Figure 1 | Barcarena municipality, with Ilha das Onças highlighted on the right.

that crosses the island, was chosen due to the number of families along it, difficulties accessing clean drinking water, lack of a sewage system and no garbage collection (Tavares *et al.* 2021).

Stool samples were collected in 70 ml tubes, labeled with the participant information and received at the Basic Health Unit (UBS) of Ilha das Onças, to be later transported to the Laboratório de Parasitoses Intestinais e Esquistossomose (LPIE) at Instituto Evandro Chagas (IEC/SVSA/MS) for examinations by the Kato-Katz Helmtest® kit (Biomanguinhos, FIOCRUZ, Rio de Janeiro, RJ, Brazil) (Katz *et al.* 1972), which is the recommended procedure by the World Health Organization (WHO) and the Brazilian Ministry of Health (Brasil 2014; WHO 2023). This technique allows the quantification of individual worm burden by defining the number of eggs per gram (EPG) of feces, establishing the disease burden (Sousa *et al.* 2017; WHO 2023). A single exam was performed and, from each fecal sample, two slides were made for analysis.

Each participant responded to a structured questionnaire containing sociodemographic and clinically relevant information for the study. Children under 2 years of age, individuals who refused to participate in the research and with incomplete informed consent forms were excluded from the study.

The residences were georeferenced using a *Global Navigation Satellite System* (GNSS) device, specifically the Garmin GPSMap 62s model (GARMIN INTERNATIONAL INC, Olathe, Kansas, EUA), to obtain geographic coordinates. Cartographic databases (municipal, state, federal boundaries and hydrography) were obtained from the Instituto Brasileiro de Geografia e Estatística (IBGE – http://www.ibge.gov.br/). Sentinel-2 satellite images were obtained from the *European Space Agency* (ESA – https://sentinels.copernicus.eu/web/sentinel/home).

The spatial distribution map was created in ArcGIS 10.4 (http://www.arcgis.com/) using IBGE datasets, ESA images and *S. mansoni* cases (houses of individuals infected with *S. mansoni*).

Ethical considerations

This study was submitted to the Instituto Evandro Chagas (IEC) Research Ethics Committee (CEP) and approved under certification No. 5.244.276 and Certificate of Presentation for Ethical Appreciation (CAAE): 52200721.5.0000.0019.

RESULTS AND DISCUSSION

From a total of 263 samples, 3 (1.14%) tested positive for *S. mansoni* (Figure 2), of which all were male. The EPG of feces and the parasitic load classification are shown in Table 1. All patients claimed to have resided in the area for at least 9 years. Ages ranged from 19 to 41 years, and the highest reported level of education was high school.

The fact that only male individuals tested positive is consistent with studies that report a higher occurrence of schistosomiasis in this gender. This is because men are often more exposed to infection due to their occupational activities, such as farming, fishing, hunting and plant extraction, as well as recreational pursuits frequently taking place in environments with direct water contact. This exposure makes them more susceptible to not only schistosomiasis but also to other waterborne diseases (Silva da Paz *et al.* 2021).

All clinical features were investigated considering the known and well-established medical scenario of the disease (McManus *et al.* 2018). Also, the symptoms were considered for a 30-day-period (from 1 to 30 March 2022), with the exception of the stool test, which was considered for a 1-year-period (from 1 March 2021 to 1 March 2022). Only one patient reported having lost weight. No symptoms such as diarrhea, fever, vomiting or blood in the stools were listed and only one reported frequent abdominal pain. The patients were treated at their residences (Figure 3) with Praziquantel 50 mg/kg, following the guidelines of the Brazilian Ministry of Health (Brasil 2022). The cases found allow for an assessment of schistosomiasis circulation in Ilha das Onças, an area with no previous reports of this disease. Additionally, the low parasite burden does not exclude individuals with *S. mansoni* as possible carriers of schistosomiasis, since low prevalence areas are often underestimated and commonly the patients show few or no symptoms at all (Enk *et al.* 2008; Sousa *et al.* 2017).

Malacological surveys were also carried out in the peridomestic area of the infected individuals through active searching in the morning, however, no specimens of *Biomphalaria* were found. Risk factors for schistosomiasis establishment, such as lack of basic sanitation, direct contact of sewage with water and environmental conditions, are present in this area and enable it to become a potential disease locus. Furthermore, new malacological investigations on the island should be encouraged to enable its monitoring (Brasil 2014; Rodrigues *et al.* 2019).

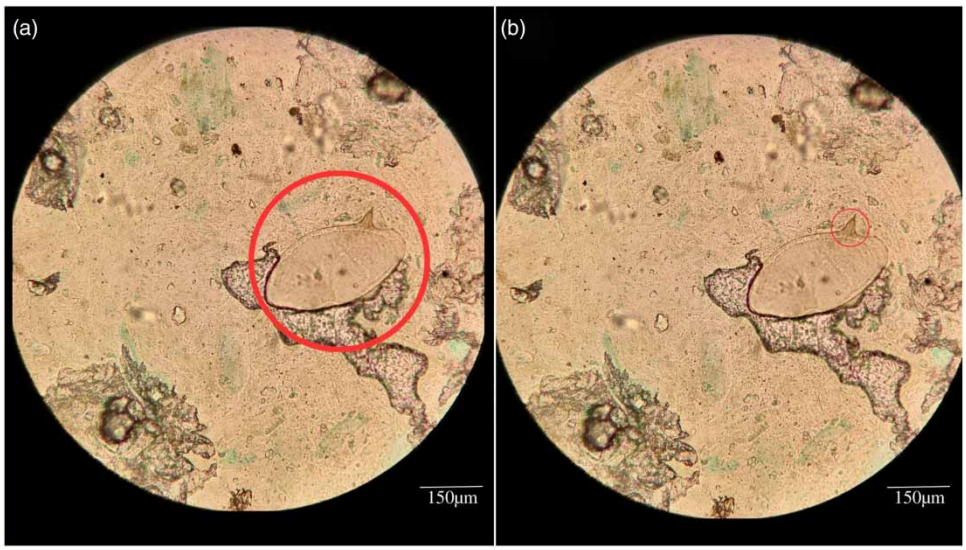


Figure 2 | Kato-Katz slide showing one *S. mansoni* egg, indicating: (a) Oval shape and (b) Lateral spike.

Table 1 | Profile and parasitic load of patients infected with *S. mansoni*

	Patient 1	Patient 2	Patient 3
Sex	Male	Male	Male
Age	19	41	24
Education	High school	Incomplete elementary education	Incomplete high school
History of working[a]	Yes	Yes	Yes
Eggs per gram of feces (EPG)	12	12	12
Parasitic load[b]	Low	Low	Low
Clinical features			
Abdominal pain[c]	No	No	Yes
Diarrhea[c]	No	No	No
Blood in the stool[c]	No	No	No
Fever[c]	No	No	No
Vomit[c]	No	No	No
Weight loss[c]	No	No	Yes
History of stool test[d]	No	No	No

[a]Work in agriculture and extractivism activities.
[b]1–99 eggs: low parasitic burden; 100–399 eggs: moderate parasitic burden; ≥400 eggs: high parasitic burden (WHO 2023).
[c]30-day-period.
[d]1-year-period.

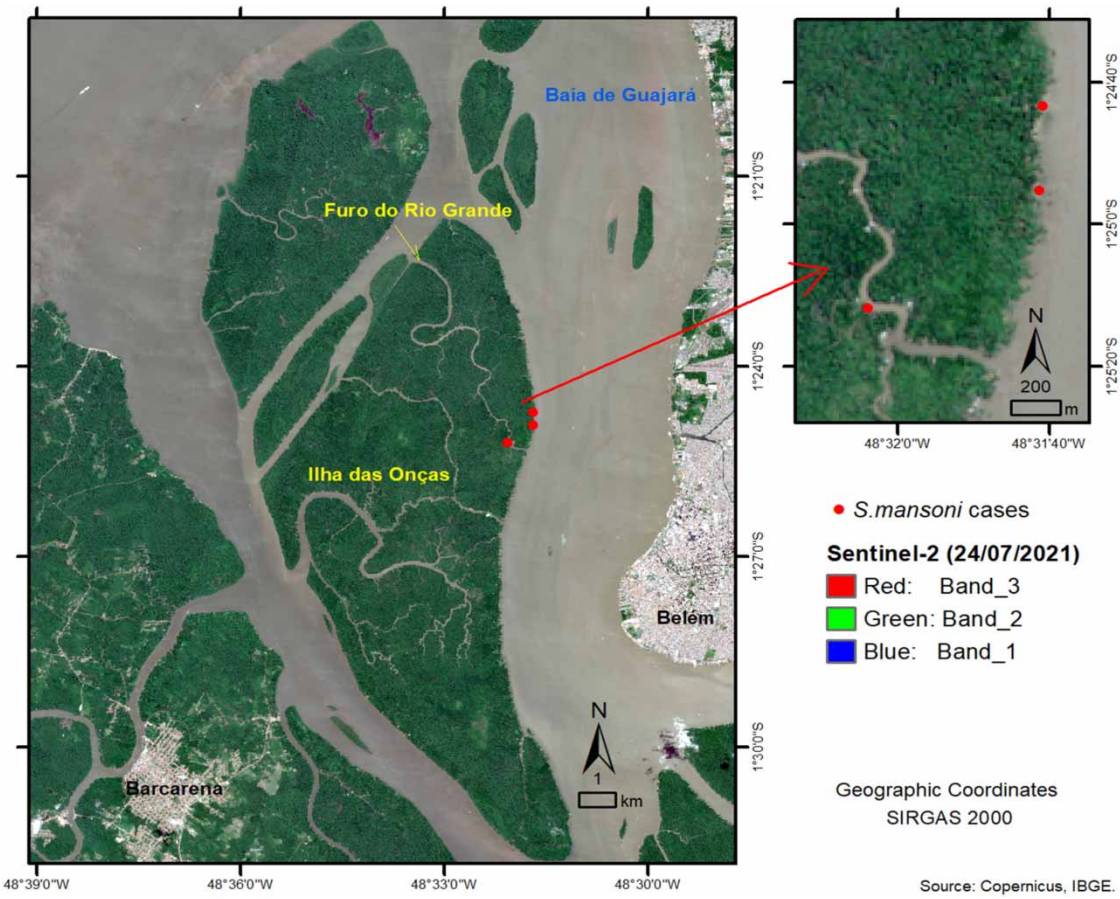


Figure 3 | Residences of *S. mansoni* infected patients on Ilha das Onças (red dots).

The follow-up investigations were performed for cure assessment 4 months after the patients' treatment and no *S. mansoni* eggs were found. The schistosomiasis cases were reported to the Barcarena Health Department for patient monitoring. All cases were considered allochthonous.

The use of geoprocessing in this study helps not only the assessment of risk areas for schistosomiasis but also combines information about the disease, and environmental and spatial data, favoring the local health agents and health agency's work as a whole. This mapping enables a wide view of the environment, supporting local epidemiological surveillance through the identification of possible risk areas for diseases occurring in a given space (Guimarães *et al.* 2010; Hino *et al.* 2011; Nardi *et al.* 2013).

The difficulty for public health surveillance to access all riverside residential areas is commonly the main factor that makes studies about those populations scarce. The diseases' evaluation occurring among people living in the endemic areas can generate data that will contribute to better management and planning of prevention and control actions such as health educational campaigns, safe access to drinking water, snail monitoring in the area and, in some cases, preventive chemotherapy (Inobaya *et al.* 2014), ensuring healthcare and health education for these communities (Silva *et al.* 2014; Rouquayrol *et al.* 2018).

At Ilha das Onças and the Amazon region as a whole, riverside populations lack basic sanitation and a proper sewage system, which allows the waste to be spread directly into the water flow, contaminating and contributing to vectors and disease proliferation. These conditions can facilitate the migration of *S. mansoni* and various other parasites, enabling their dispersion and the establishment of new potential contamination risk areas (Correa & Pinheiro 2017; Rodrigues *et al.* 2019). The absence of sanitation was attempted to be addressed on Ilha das Onças through the implementation of projects that aimed to reduce the impact of waste contamination in effluents. However, these projects are not yet capable of fulfilling the local needs (Neu *et al.* 2016).

CONCLUSION

The study revealed the presence of schistosomiasis caused by *S. mansoni* in residents of Ilha das Onças, an area where there have never been reports of this parasitic disease. Despite being considered a neglected and low-priority disease for public health, it remains a persistent health issue in the state. Therefore, it is necessary to emphasize the importance of epidemiological studies in riverside populations to contribute to health and environmental surveillance actions.

Although the presence of *Biomphalaria* snails was not identified, Ilha das Onças might be a potential area for schistosomiasis establishment, as it has conditions for the maintenance of its cycle. These findings also support the importance of malacological investigation as a preventive measure since without its intermediate host schistosomiasis cycle cannot be completed, preventing its continuity and, consequently, its establishment in new locations.

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DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

CONFLICT OF INTEREST

The authors declare there is no conflict.

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