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ORIGINAL ARTICLE

EPIDEMIOLOGICAL ASPECTS AND MALACOFAUNA OF THE SÃO FRANCISCO RIVER, NORTHEASTERN BRAZIL

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ABSTRACT

Limnic mollusks could negatively affect the ecosystem in which they are found, the economy, human and animals´ health. This study reports on a survey of freshwater sources mollusks and their spatial distribution, as well as investigating them for the presence of trematodes in the municipality of Nossa Senhora de Lourdes, Sergipe, Brazil. This study was performed through March 2016 and November 2017. The mollusks were collected in different water bodies in the georeferenced studied area, identified and analyzed for the presence of trematodes. Thirty-four water bodies were sampled, and mollusks were found in 18 (53%) of them. From the 5,196 found, 4,747 (91%) were gastropods and 449 (9%) bivalves - distributed in seven families and eleven species. Among the species found, two are of medical-veterinary importance (*Biomphalaria straminea* and *Melanoides tuberculata*) and four are exotic invasive species (*Corbicula fluminea, C. largillierti, Limnoperna fortunei* and *M. tuberculate*). Of the 1,473 mollusks analyzed for trematodes, five (0.33%) gastropods were infected, one specimen contained Vivax, two Pleurolophocercous, and two Virgulate. For the first time these six taxa have been described in the State of Sergipe: *Drepanotrema depressissimum, D. cimex, D. lucidum, Ancylidae, Physa acuta* and *C. largillierti*. This survey contributes to the knowledge of the biodiversity and spatial distribution of limnic mollusks and the presence of trematodes, in addition to serving to support the monitoring and prevention of exotic bio invasive species, and intermediate hosts, since the studied area presented potential for helminth transmission.

KEY WORDS: Snails; trematodes freshwater sources; spatial distribution; exotic and invasive mollusks; Sergipe State.

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INTRODUCTION

The Mollusca phylum is the second largest group of invertebrates, with gastropods and bivalves representing two of the major classes (Pombo, 2016; Marçal & Callil, 2017). They live in a wide variety of ecosystems, among them the freshwater sources ecosystem, and they are commonly found on a variety of substrates or associated with riparian vegetation (Thiengo et al., 2005; Marçal & Callil, 2017).

Limnic mollusks play a part in several complex interrelationships with other biotic and abiotic components in aquatic ecosystems and they have an important role at different trophic levels. They can be carnivores, predators, herbivores, scrapers, and filter feeders. Besides participating in the nutrients recycling and control of juvenile exotic populations, they are also excellent bioindicators of environmental pollution (Mansur et al., 2016; Miranda et al., 2016).

The limnic malacofauna is among the group of animals most threatened with extinction because of degradation of aquatic environments, the destruction of habitat through man activities, and the introduction of exotic and invasive species, and several other factors. This may cause significant changes in the trophic chains of the community and the population balance of these mollusks, contributing to the homogenization of their biodiversity.

In turn, exotic and invasive mollusks may bring serious economic losses to power generating plants and water treatment plants by causing reductions in the diameter or complete obstruction of pipes, and by clogging filters, pumps, gratings, and heat exchangers (Mansur et al., 2016; Santos et al., 2016a).

In addition to these potential environmental, bio invasive and economic impacts, it is essential to highlight the relationship between freshwater sources mollusks, especially gastropods, and health, as they are hosts for parasitic diseases that have a significant prevalence in man, as well as in animals, becoming a problem of medical and veterinary interest (Thiengo et al., 2005). Attention to limnic environments is not, therefore, just a concern in respect of the environment, but also in relation to public health (Pombo, 2016).

The knowledge about the groups of freshwater sources mollusks in the diverse bodies of water distributed throughout Brazil, particularly their interactions with trematodes, is still limited, especially in the Northeast region (Thiengo et al., 2005). In the State of Sergipe (SE), there have only been a significant number of studies of mollusks intermediate hosts of schistosomiasis (Katz, 2018). As revealed by Calasans (2019), in a rural and in a beach area in the metropolitan region of Aracaju, SE, who collected a sample of 6,423 *Biomphalaria glabrata*, of which 185 were infected with *Schistosoma mansoni*; Costa (2015), in the municipality of Nossa Senhora do Socorro, SE, found 10,270 *B. glabrata* mollusks, of which 912 were positive for the worm in question; and Santos (2013), when carrying out a malacological survey in a neighborhood of Aracaju, SE, found 10,270 *B. glabrata* mollusks, of which 912 were positive for the parasitic disease.

The municipality of Nossa Senhora de Lourdes, SE is bathed by the São Francisco River, and it is made up of a variety of water bodies, which have an unknown biodiversity of snails, which men come into close contact with, in order to carry out their daily activities. However, it is known that limnetic mollusks may harbor various types of cercarial larvae that are potential causes of parasitic diseases for man and for animals; in addition, the locality in question does not have up-to-date data on snail hosts of helminthiases of medical-veterinary and medical-sanitary importance, such as schistosomiasis, which is relevant information for epidemiological surveillance in the State of Sergipe.

In view of the above, this study is set out to make a survey of freshwater sources mollusks and their spatial distribution, and to investigate the presence of trematodes, relating to epidemiological aspects, in the municipality of Nossa Senhora de Lourdes, SE, Brazil.

MATERIAL AND METHODS

Study area

A descriptive cross-sectional epidemiological study of the limnic malacofauna was conducted from March 2016 to November 2017 in Nossa Senhora de Lourdes, Sergipe, Brazil (10°04'46" S and 37°03'25" W) (Figure 1). The region is part of the Caatinga biome, which has a semi-arid climate with minimum annual temperature of 25 ºC to 30 ºC, an irregular rainy season (March to July), with the possibility of excess water in winter; and a dry season (October to January) that may sometimes persist for eight months (Kotzian & Amaral, 2013).

Water bodies used by the local population were selected for malacological and parasitological investigation of mollusks.

Collection of limnic mollusks

The collections were carried out during three climatic periods, seeking to build a picture of local seasonal differences, the dry season: March, April, October, November 2016, and March 2017; the rainy season: from April to July 2017; and the period after the rainy season: from September to November 2017 (Buchmann, 2014).

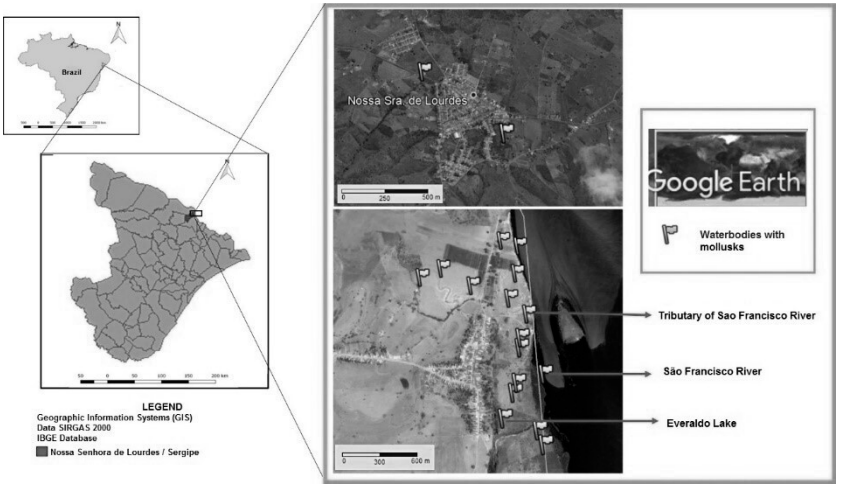

Figure 1. Area of study and distribution of water bodies with the presence of limnic mollusks in Nossa Senhora de Lourdes, State of Sergipe, Brazil.

The snails were collected by three people, from 10 am to 3 pm, on the banks of the water bodies, manually, with the help of tweezers and a dip scoop. The collection technique consisted of dragging the dip scoop across the breeding sites at the base of the submerged vegetation, and bringing the material collected to the surface, sweeping the bottom of the waterbody being searched to cover the largest possible area. The mollusks were then placed in plastic bags with water from the biotope itself, labelled with data referring to the collection area, and a location form was completed, stating the location with its reference point (Ministério da Saúde, 2008). Samples were then sent to the Entomology and Tropical Parasitology Laboratory (LEPaT) at the Federal University of Sergipe, São Cristóvão, SE, and then to the Malacology Laboratory of the Oswaldo Cruz Institute (LABMAL-IOC), Oswaldo Cruz Foundation, Rio de Janeiro in the State of Rio de Janeiro, where they were kept and investigated for helminth fauna, fixed, and identified.

Maintenance of limnic mollusks in the laboratory

In the laboratory, the mollusks were quantified, separated by size, and placed in containers containing chlorine-free water, using a mixture of sieved clay (10 parts), enriched with calcium carbonate (1.5 parts) and oyster shell flour (2 parts) as the substrate (MS, 2008). The snails were fed daily with fresh or dried lettuce leaves (*Lactuca sativa*), according to the genus. In addition, the water was changed weekly, and the presence of dead specimens was recorded (Ministério da Saúde, 2008).

Investigation of helminth fauna associated with limnic mollusks

To check for the presence of trematode larvae, the snails were kept in individual water containers and exposed to light using a 60W lamp for 4 hours (WHO, 2017; Ministério da Saúde, 2008). After this exposure, the water from these containers was examined using a microscope to check for the presence of trematodes (cercariae). The water in the containers was then replaced and the mollusks were observed following exposure to the dark. This step consisted in leaving the snails with no exposure to light. The water was then examined using a microscope on the following morning to check for the nocturnal elimination of the larvae, as some mollusks release larvae at night (Ministério da Saúde, 2008). These two procedures were undertaken weekly over a period of 45 days. The cercariae present were stained with Lugol iodine, prepared on slides, and examined under an optical microscope, with a magnification of between 40 and 100 × (Ministério da Saúde, 2008). The cercaria type was identified using the dichotomous keys proposed by Pinto and Melo (2013). Mollusks that died during packaging and transportation to the laboratory were discarded.

Fixation and identification of limnic mollusks

To fix the samples of the Planorbidae and Physidae families, the specimens were anesthetized with 1% sodium pentobarbital solution for six hours. They were then immersed in water at 70 ºC for between 30 and 60 seconds, depending on the species and size, to remove them from their shells. The anatomy of the mollusks was preserved in Railliet-Henry solution, with some specimens placed in 96% ethyl alcohol (Ministério da Saúde, 2008). The specimens of Thiaridae and Ampulariidae families were placed directly in the water, without anesthesia, at a temperature of 70 °C, depending on their size, whose period varied from 30 to 60 seconds. They were then euthanized by a modified version of the *niku-nuki* method (Fukuda et al., 2008). Those belonging to Thiaridae were removed from their shells and fixed in Railliet-Henry solution or 96% ethyl alcohol, and the Ampulariidae were placed directly in 96% ethyl alcohol. The bivalves of the families Corbiculidae and Mytilidae were fixed directly in 96% ethyl alcohol. All material was identified with the date and place of collection. The shells were kept in water, washed, and then dried at room temperature. The mollusks were identified by means of anatomical dissection using a stereoscopic microscope, a conchological method and by consulting specialized references from Paraense (1975, 2008), Simone (2006) and Pereira et al. (2012).

Spatial distribution

The absolute method was used, with instantaneous positioning of a point, which provides the coordinates of a place on Earth with the aid of a global position system receiver (GPS, Garmin), with the coordinates being assigned to the locations using the universal transverse mercator (UTM) system and the ellipsoidal reference. The unit of analysis was each collection point used in the survey.

The data was made available through a consultation system based on geographic information systems (GIS) as it could integrate different types of data and information related to geographic location. The GPS data was transferred to the computer using the GPS Track Maker Pro software (Version 13.9). The cartographic database of the municipality of Nossa Senhora de Lourdes, SE, made available by the Brazilian Institute of Geography and Statistics (IBGE), it was used in the construction of the maps, as well as the Google Earth client version, to obtain high spatial resolution images. The results were extracted in the form of thematic maps, using the *TerraView* 4.2.2 software (www.inpe.br).

RESULTS

A total of 34 water bodies were georeferenced, comprising rivers, ditches, lagoons, floodplains, streams, wells, ponds, and dams. From these, 18 (53%) presented limnic mollusks: (1) S 10° 01.436' W 036° 57.530', (2) S 10° 01.445' W 036° 57.536', (3) S 10° 04.861' W 037° 03.277', (4) S 10° 01.625' W 036° 57.480', (5) S 10° 01.674' W 036° 57.690', (6) S 10° 01.693' W 036° 57.695', (7) S 10° 01.716' W 036° 57.703', (8) S 10° 01.817' W 036° 57.654', (9) S 10° 01.466' W 036° 57.610', (10) S 10° 01.350'W 036° 57.743', (11) S 10° 01.780' W 036° 57.490', (12) S 10° 01.682' W 036° 58.185', (13) S 10° 01.650' W 036° 57.708', (14) S 10° 01.542' W 036° 57.637', (15) S 10° 01.482' W 036° 57.622', (16) S 10° 04.541' W 037° 03.657', (17) S 10° 01.263' W 036° 57.799', (18) S 10° 01.317' W 036° 57.709'(Table 1), with the São Francisco River being the waterbody with the most breeding sites.

From the 5,196 mollusks collected, with 3,723 (71.6%) dead, 4,747 (91%) were gastropods and 449 (9%) bivalves. The mollusks were distributed in seven families and 11 species (Table). From the gastropods, the most frequent species were *Melanoides tuberculata* 2,030 (43%) individuals in the São Francisco River, 32 (4%) in Salvador Pond; *B. straminea* (1,008 21%) in the São Francisco River, 168 (3%) in Everaldo Lake near São Francisco River; and *Pomacea lineata* 365 (7%) also collected in the São Francisco River and 2 (0.04%) in Everaldo Lake near River São Francisco. Regarding bivalves, they highlighted the frequency of *Corbicula flumínea* 82 (18%) in the São Francisco River and 16 (3%) in Well in Escurial floodplain; *C. largillierti* 26 (5%) in São Francisco River and 2 (0.04%) in São Francisco River tributary.

Table. List of freshwater sources bivalves and gastropods by waterbody, found between March 2016 and November 2017 in the municipality Nossa Senhora de Lourdes, Sergipe, Brazil.

	Bivalve						Gastropod					
	Corbiculidae		Mytilidae	Ampullariidae		Planorbidae				Physidae	Thiariidae	
Waterbody	*Corbicula fluminea*	*Corbicula largillierti*	*Limnoperna fortunei*	*Asolene meta*	*Pomacea lineata*	*Biomphalaria straminea*	*Drepanotrema cimex*	*Drepanotrema depressissimum*	*Drepanotrema lucidum*	*Physa acuta*	*Melanoides tuberculata*
1 Duó 1 dam						x		x			
2 Duó 2 dam								x			
3 Nossa Senhora de Lourdes dam								x			
4 São Francisco River tributary	x	x		x	x	x					x
5 Everaldo streams 1						x					
6 Everaldo streams 2						x					x
7 Everaldo streams 3						x					x
8 Everaldo Lake near River São Francisco					x	x	x		x		x
9 Nininho Lake	x							x			x
10 Well in Escurial floodplain	x										
11 São Francisco River	x	x	x	x	x	x	x	x	x	x	X	x
12 Alvaci Pond						x		x			
13 Everaldo Pond						x		x			x
14 Nininho Pond						x					

15 Viveiro de camarões Pond				x		
16 Salvador Pond			x			x
17 Ditch near Escurial floodplain			x			
18 Escurial floodplain	x		x			x

In respect of the climatic periods in which the mollusks were collected, the rainy season presented the largest number of specimens with 3,333 (64%), followed by the post-rainy periods, with 1,568 (30%), and the dry season with 295 (6%). Still in the rainy season, April/2017 was the month that stood out, with 1,333 taxa, and 315 specimens of the species *B. straminea* and *M. tuberculata* were highlighted during this period, in May/2017, with 837 specimens. In the post-rainy period, in September/2017, the density of the number of mollusks increased, totaling 937 individuals. From these, 399 were *M. tuberculata*, 171 *B. straminea* and 367 other mollusk species (Figure 2).

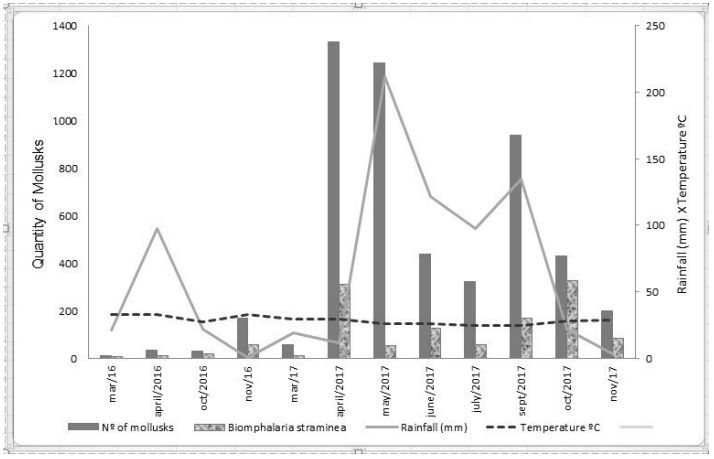

Figure 2. Quantitative analysis of mollusks and species *Biomphalaria straminea* and *Melanoides tuberculate* collected monthly from March/2016 to November/2017 in relation to rainfall and temperature in the municipality of Nossa Senhora de Lourdes, Sergipe, Brazil.

Among the species found, two are of veterinary importance (*B. straminea* and *M. tuberculata*) and four are exotic and invasive (*C. fluminea, C. largillierti, Limnoperna fortune* and *M. tuberculate*) (Figure 3).

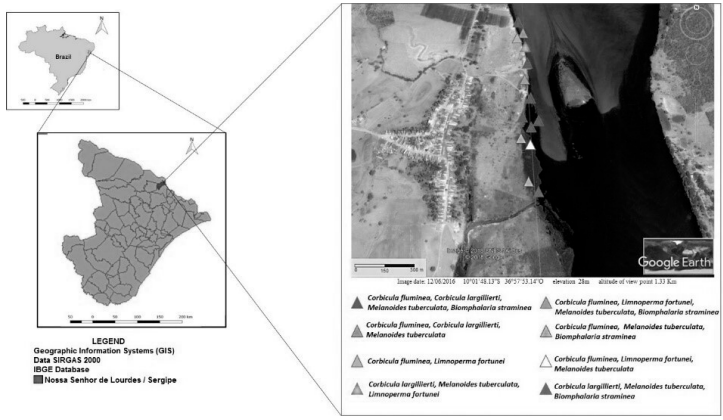

Figure 3. Location of exotic and invasive mollusk species of medical/ veterinary importance in the São Francisco River, in the municipality of Nossa Senhora de Lourdes, Sergipe, Brazil.

Of the 1,473 snails analyzed, five (0.33%) were positive for trematodes; 1/316 *B. straminea* examined presented Vivax cercaria, and 4/808 *M. tuberculata* presented other cercaria types - two pleurolophocercous cercaria, and two virgulate cercaria. All infected mollusks were collected in the São Francisco River, at different geographical points, as shown in Figure 4.

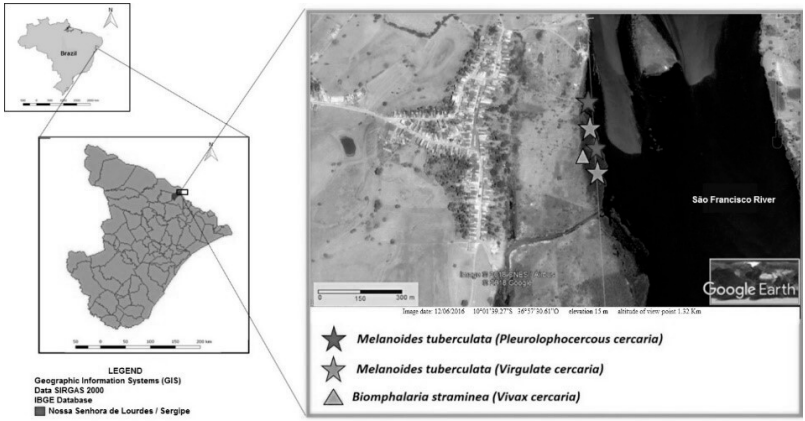

Figure 4. Distribution of trematodes associated with limnic gastropods in the São Francisco River, municipality of Nossa Senhora de Lourdes, Sergipe, Brazil.

Among the observed trematodes, Vivax cercaria and Virgulate cercaria emerged at night, Pleurolophocercous cercaria emerged both at night and under photo stimulation.

DISCUSSION

In this study, we identified the limnic malacofauna, and its distribution, in addition to highlighting the components that lead to the transmission of parasites that cause diseases, such as schistosomiasis, in the municipality of Nossa Senhora de Lourdes, Sergipe. The São Francisco River was the waterbody that showed the greatest biodiversity and number of mollusks. This is explained by the numerous anthropogenic impacts it has experienced in recent years, such as the release of organic waste into the river, and the desertification of the riparian forests on its banks, not to mention its exploitation for man water supply, animal husbandry, domestic life, fishing, and leisure. Miranda et al. (2016) have shown that places that are the most impacted by man action tend to have the greatest number and diversity of mollusks. In addition, there are characteristics, such as the type of substrate, water level, and the heterogeneous environment with rooted or floating vegetation close to the banks, which are associated with the prevalence of mollusks in a waterbody (Maltchik et al., 2010), characteristics that are present in the São Francisco River.

From the mollusks identified, the predominance of gastropods collected is explained by their ability to live in water bodies of a lentic or a lotic nature. In addition, they are tolerant to oxygen scarcity and extreme temperature variations, unlike bivalves, which are filter animals, dependent on oxygenated water to survive (Kotzian & Amaral, 2013; Mansur et al., 2016).

From the gastropods and bivalves found, it was the first time that six taxa have been described in the State of Sergipe: *D. depressissimum, D. cimex, D. lucidum, Ancylidae, Physa acuta* and *Corbicula largillierti*.

Drepanotrema depressissimum and *D. cimex* are native species, while *D. lucidum* is an exotic species (Paraense, 1975). Mollusks of the genus *Drepanotrema* are scraper feeders, and they were found in apparently polluted water in the São Francisco River, Nossa Senhora de Lourdes dam, Alvaci Pond and in other water bodies. They occur in lentic and lotic aquatic environments, usually on macrophytes, some species are able to tolerate anoxic environments and periods of drought (Paraense, 1975; Kotzian & Amaral, 2013).

Specimens of Ancylidae are small, and found in lentic environments in shallow water, covered by sands and algae, making them difficult to see (Fernandez et al., 2014). This may explain why only one specimen of the mollusk was collected in this study (Ovando et al., 2014).

Physa acuta is an herbivorous, exotic French species. Several specimens were found in the São Francisco River in slow-moving water that was visibly polluted, and, due to their resistance to this type of environment, are considered bioindicators (Ovando et al., 2014, Oliveira et al., 2021). There is experimental evidence that this limnic mollusk is an intermediate host of *Fasciola hepatica* (Barros et al., 2002).

Corbicula fluminea, C. largillierti and *M. tuberculata* are exotic invasive species; they cause changes to the ecosystem and the limnic biota, mainly to the population of natural native mollusks, in addition to causing economic problems, such as water pump obstruction, and problems in the operation of hydroelectric plants (Mansur et al., 2016; Santos et al., 2016a). Still considering bio invaders, four individuals of *L. fortune* were found in different locations in the São Francisco River, suggesting a possible progressive invasion of this bivalve.

Corbicula fluminea was recorded for the first time in the State of Sergipe, in the Xingó Hydroelectric Power Plant area, on the São Francisco River (Santana et al., 2013). In this study, 191 (3.67%) *C. fluminea* and 28 (0.53%) specimens of *C. largillierti* were found, a small amount compared to the previous species mentioned. Callil & Mansur (2002) reported that there is competition between *C. largillierti* and *C. fluminea* when they cohabit in the same environment, with a decrease in the former species. A malacological survey carried out by Miyahira et al. (2017) in the Guandu River, Rio de Janeiro, recorded three invasive species: *M. tuberculata, C. fluminea* and *C. largillierti*, the first two being characterized by dominance and wide distribution in the sampling sites in the studied region.

Regarding temperature, there was a variation between 24.5 ºC to 33 ºC, and rainfall from 0.25 to 211.37 mm, typical levels for the Caatinga. Mollusks became more evident in the months of April/2017 (29.5 °C; 11.5 mm) and May/2017 (26 °C; 211.37 mm), corresponding to the rainy season. Kotzian & Amaral (2013), when reporting the diversity of mollusks in the Contas River, located between the Caatinga and the Atlantic Forest areas, noted the predominance of snails in the latter biome, because precipitation is greater there than the former biome.

However, after the rainy season, it could have high densities of mollusks in the post-rain period, and, consequently, in the dry season. One of the main reasons for the return of its high density in September/2017, post-rainy period, is due to the abundance of macrophytic vegetation attached to the substrate, which favors protection from solar radiation, high temperatures and attachment to these animals (Ministério da Saúde, 2008). Regarding the dry period, Kretzschmar & Heckman (1995) reported that mollusk populations tend to reduce during the dry season, although there are species of mollusks, such as snails of the genus *Asolene* sp. and *Pomacea* sp., belonging to the Ampullariidea family, that have adaptations to survive in high temperatures, including the development of lungs, a protective operculum, and calcified eggs, which result in high reproductive rates. *Asolene meta* and *Pomacea lineata* were found attached to macrophyte vegetation in the São Francisco River and its tributaries, and the latter species was also present in the Everaldo lagoon, places that are visibly polluted. These ampullariids are among the largest limnic gastropods (Kotzian & Amaral, 2013; Miranda et al., 2016).

In relation to the seasonal period, *B. straminea* were evident in the post-rainy season period in October (2017), due to sufficient rain fall in the previous period allowing the snails to reproduce and proliferate in the environment (Barbosa et al., 2017). During the dry season, specimens of this species were found to be able to withstand temperatures up to 33 °C, as they have high resistance to desiccation, and undergo estivation and encystation processes (Santos et al., 2016a), which are the main factors responsible for their expansion in Northeast Brazil (Fernandez et al., 2014). Data such as these are a matter of concern, because in the summer, the São Francisco River receives many tourists.

Some individuals of *B. straminea* were collected in visibly polluted water, with the presence of organic matter and domestic sewage. When found in places of high toxicity, according to exorbitant changes in the chemical-physical parameters of the water, they have the potential to bioaccumulate chemical elements. Recent studies have shown that these species of mollusks are sensitive, making them a strong environmental bioindicator (Tallarico et al., 2014; Paredes et al., 2022).

In the present study, *M. tuberculata* was the most abundant species, with 3,104 (59.7%), distributed in eight of the 18 water bodies. Similar results were observed by Kotzian & Amaral (2013) in the Rio de Contas, located in the State of Bahia, between March/2011 and May/2012, where this gastropod comprised 68.5% of the collected samples, and it was present in 90% of areas surveyed. There are several characteristics that contribute to bio invasion: they are parthenogenic, viviparous, reproduce at a high population density, and they are able to survive in heterogeneous and adverse environments, such as eutrophic water bodies with brackish water (Santos et al., 2016a).

The abundance of *M. tuberculata* in the study area, in addition to being an environmental problem, is an epidemiological risk factor, as it is a species responsible for a high rate of infection and susceptible to the greatest diversity of trematodes, as demonstrated by two individuals releasing Virgulate cercaria and two Pleurolophocercous cercaria. The first belongs to the xiphidiocercaria group, a parasite of chiropterans, birds, and amphibians; and the second is part of the pleurolophocerca group, a parasite of the biliary system and liver of birds, reptiles, and mammals, including man (Pinto & Melo, 2013). Ximenes et al. (2017) found pleurolophocercous in *M. tuberculata* in Ilha Grande, Rio de Janeiro, identified as *Centrocestus formosanus* (Nishigori, 1924).

Our findings demonstrated that, after *M. tuberculata, B. straminea* was the mollusk with the highest spatial distribution, present in 14 of the 18 water bodies with a total of 1,264 (35.7%) individuals. Malacological research by Lima et al. (2018) in areas of schistosomiasis focus on the State of Sergipe, collected 43,546 snails, of these, 18,056 (43.3%) from the East and 24,706 (56.7%) in the State's Agreste region, the area that stood out the most in the study. Among the mollusks identified were *B. glabrata*, with 40,458 (97.8%) specimens, *B. straminea*, with 752 (1.8%), and *B. tenagophila*, with 153 (0.4%).

No *Schistosoma mansoni* cercariae emerged from *B. straminea*. Although this planorbidae has the lowest rates of natural infection with *S. mansoni* (Ministério da Saúde, 2008, Reis et al., 2021), its occurrence and the way it is spatially distributed across the region, especially in the peri domiciliary areas of water, should not be ignored as its significant distribution, associated with the lack of basic sanitation and the low socioeconomic level of the area under study, create conditions favorable to the transmission of schistosomiasis (Garcia et al., 2023). Deslandes (1951) highlighted the possible resistance of infected snails of the genus *Biomphalaria* sp. to the release of *S. mansoni* larvae, when analyzed using the photo-stimulation technique.

However, *B. straminea* released Vivax cercaria, an intestinal parasite of birds and mammals (Pinto & Melo, 2013). Miyahira et al. (2017) recorded the release of this cercarian type in a specimen of mollusk of the species *Gundlachia ticaga*, collected from the Guandu River, Rio de Janeiro.

In respect of the satellite image of the study area, its visualization provided a unique opportunity to analyze the spatial distribution of water bodies with the presence of mollusks, mainly in relation to the biodiversity of species found (Araújo et al., 2007; Leal-Neto et al., 2013; Santos et al., 2016b). The thematic maps obtained do not show the density of the mollusks identified in the different locations, but they do demonstrate the distribution of the species in the municipality of Nossa Senhora de Lourdes, Sergipe, especially along the São Francisco River.

As for the environmental conditions of the water collections now, some of them are dry compared to the studied period. However, it is noticeable that shells of *Biomphalaria* mollusks have been found buried in a possible process of aestivation, which reinforces the importance of the epidemiological data mentioned in this study (Teles & Carvalho, 2008). These findings can be explained mainly by seasonal droughts, a situation typical of the research area, which is in the semi-arid region of Sergipe, or by the increase in temperature that has occurred in recent years because of global warming, which has affected all natural systems around the world (Araújo, 2007; IPCC, 2023).

In this study, several taxa of mollusks were recorded, mostly exotics, in addition, to two species of medical importance, *B. straminea* and *M. tuberculata*, from which trematodes emerged. The survey made it possible to associate the spatial distribution of these limnic mollusks with the release of the larvae for the first time in the State of Sergipe, with their occurrence being restricted to the main waterbody, the São Francisco River. Studies of larval forms are of great relevance, as they can be considered a biological control of parasites of medical and veterinary importance (Silva et al., 2021).

Given the lack of knowledge about the problems that may be caused by exotic and bio invasive species, together with the possible diseases transmitted via mollusks that act as intermediate hosts, and the close contact of the population with water bodies, there is a clear need for investment in

malacological studies, monitoring and health education practices aimed at developing prevention tools for schistosomiasis and other waterborne helminths (Medeiros et al., 2002). In this regard, this survey contributes to the knowledge about the biodiversity and spatial distribution of limnic mollusks and trematodes, in addition to serving to support actions in respect of control and epidemiological surveillance in the State of Sergipe.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest to disclose.

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