FRESHWATER MOLLUSKS FROM LAGOA DA CABRINHA OF LAGOAS DO NORTE PARK, TERESINA, PIAUÍ, BRAZIL

MOLUSCOS DE ÁGUA DOCE DA LAGOA DA CABRINHA DO PARQUE LAGOAS DO NORTE, TERESINA, PIAUÍ, BRASIL

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Abstract
Freshwater molluscs can live in different types of environments acting in different ways in ecosystems. The exotic species and intermediate hosts of parasitic helminths are quite common in water collections, thus being of medical and veterinary importance. And this study provides a list of mollusks from a water collection located in the municipality of Teresina, Piauí. The collections were carried out during the months of September 2020 to May 2021, through active search, using capture shells in five points, previously defined. A total of 4228 molluscs were collected in the following species: *Melanoides tuberculata* (Müller, 1848) (Thiaridae) (n = 4069), *Biomphalaria straminea* (Dunker, 1848) (Planorbidae) (n = 144), *Pomacea canaliculata* (Spix, 1827) (Ampullariidae) (n = 8) and *Physa* sp. (Physidae) (n = 7). The data found in this study revealed that *M. tuberculata* is the most abundant species in the locality. In addition, specimens of *B. straminea*, transmitters of schistosomiasis mansoni, were also found. It appears that, because it is a water collection present in urban areas, the

presence of these species makes this environment conducive to environmental imbalances and facilitates the transmission of waterborne diseases.
Keywords: *Diversity, Gastropods, Planorbidae, Schistosomiasis, Thiaridae.*

Resumo
Moluscos dulciaquícolas podem viver em diversos tipos de ambientes atuando de diferentes formas nos ecossistemas. As espécies exóticas e hospedeiros intermediários de helmintos parasitas são bastante comuns em coleções hídricas, sendo assim de importância médica e veterinária. Este estudo fornece uma lista de moluscos de uma coleção hídrica localizada no município de Teresina, Piauí. As coletas foram realizadas durante os meses de setembro de 2020 a maio de 2021, através de busca ativa, utilizando-se de conchas de captura em cinco pontos, previamente definidos. Foram coletados ao total 4228 moluscos distribuídos nas seguintes espécies: *Melanoides tuberculata* (Müller, 1848) (Thiaridae) (n = 4069), *Biomphalaria straminea* (Dunker, 1848) (Planorbidae) (n = 144), *Pomacea canaliculata* (Spix, 1827) (Ampullariidae) (n = 8) e *Physa* sp. (Physidae) (n = 7). Os dados encontrados neste estudo revelaram que *M. tuberculata* é a espécie mais abundante na localidade. Além disso, espécimes de *B. straminea*, transmissoras de esquistossomose mansoni, também foram encontradas. Depreende-se, que, por se tratar de uma coleção hídrica presente em área urbana, a presença de dessas espécies tornam esse ambiente propício para desequilíbrios ambientais e facilitam a transmissão de doenças de veiculação hídrica.
Palavras-chave: Diversidade, Esquistossomose, Gastrópodes, Planorbidae, Thiaridae.

INTRODUCTION

The phylum Mollusca represents an important taxonomic group, being the second largest in number of species among the representatives of the kingdom Animalia (STRONG *et al*. 2008). These animals are present in diverse ecosystems and have developed specific abilities, acting as filter-feeding agents, herbivores, predators, ectoparasites, commensals, intermediate hosts of trematodes of medical and veterinary interest (COLLEY *et al*. 2012, SILVA *et al*. 2020).

The regions that have the Cerrado and/or Caatinga biome constantly suffer from temporal irregularity, with the Brazilian Northeast being the region that suffers the most from intense periodic droughts, stimulating the snails to develop specific biological characteristics to adapt to these habitats subject to hydrological disturbances with the cycles of drought and floods. Due to the high adaptability that most molluscs have, we observed a wide geographical distribution of them. Genus such as *Biomphalaria (Preston, 1910); Drepanotrema (Crosse & P. Fischer, 1880); Melanoides (Olivier, 1804); Physa (Draparnaud, 1801) and Pomacea (Perry, 1810)*, have already been identified in the Northeast region, as well as other regions of the country. (SILVA *et al*, 2020; OKUMURA *et al*, 2020; BEZERRA *et al*, 2018). Easily dulciaquic mollusks are introduced to new environments through the flow of water, plants, and waterfowl, making the dispersal of these individuals more feasible (AZEVÊDO et al. 2014).

Freshwater collections are environments subject to invasion by exotic species due to their dispersal by the water flow itself (FRANÇA *et al*. 2007). Exotic mollusk species enter the environment naturally or through human intervention and can be responsible for causing drastic changes that can permanently affect native species (GREGORIC *et al*. 2007, FARANI *et al*. 2015) and bioinvasion is considered the second most important factor in the decline of global biodiversity (CAIN *et al*. 2011).

Gastropod mollusks and bivalves can also act as intermediate hosts for several species of trematodes, including some species that are parasitic to humans and animals (PINTO; MELO 2013, RODRIGUES *et al*. 2017). Among these organisms, representatives of the Planorbidae family, particularly the genus Biomphalaria, are responsible for transmitting schistosomiasis mansoni in Brazil (BARBOSA *et al*. 2018, MELO *et al*. 2018).
The Brazilian Northeast presents more than half of its area with a predominant semi-arid zone (ABÍLIO *et al*. 2007), and the State of Piauí is located in an area of ecological tension, with influence of biomes such as caatinga and cerrado (SOUZA *et al*. 2017). The preservation of freshwater environments is one of the main alternatives to ensure the sustainability of natural resources, and the study of biodiversity in these environments becomes an important tool in the development of preservation actions and consequently the ecological integrity of these water bodies (ABILIO *et al*. 2006).

Therefore, the identification of the mollusk species that inhabit a water body present in an urban area will provide important information to increase the knowledge of the malacofauna present in the State of Piauí, as well as will contribute to the understanding of the different biological and ecological interactions that these organisms maintain with the environment. Thus, this study aimed to identify the diversity of mollusks present in the Cabrinha Lagoon of Lagoas do Norte Park, in Teresina, Piauí, in order to understand the relationship between the abundance of these animals and the environmental factors present in the environment.

MATERIAL AND METHODS

1. Study Area

The city of Teresina, capital of the State of Piauí, is in the north central Piauí mesoregion, with geographical coordinates 5º05'12" south latitude and 42º48'42" west longitude. Teresina is inserted in the mesothermal character, with an average monthly temperature oscillating between 26.9 ºC and 30.1ºC and an annual value of 28.1ºC. The relative humidity in the urban area ranges from 75 to 83% (MENEZES *et al*. 2016).

Within its urban area is located the Lagoas do Norte Environmental Park, in the Matadouro district, the northern part of the city, with a total area of 25,867 m^2. Due to its physical geographic characteristics, between the confluence of the Parnaíba and Poti rivers) this park has a low topography and an expressive number of lagoons, including the Cabrinha Lagoon, where the malacological collections of this study were performed. The vegetation is diverse, presenting aquatic and underwater species such as *Eichornia crassipes* (water hyacinth) and *montrichardia linifera* (Arruda); On the margins we find endemic species such as *Terminalia cattapa* (Almond tree) and *Bambusa* spp. (Bamboo). The fauna also has a diversity among Amphibians, Reptiles, Fish and Mamiferos (TERESINA, 2014).

This Park emerged from a project of the Teresina City Hall for the recovery and conservation of areas considered vulnerable in the city because they were occupied by housing totally subjected to high environmental and social risks (SANTOS; LIMA 2015). Later the construction of the park some ponds underwent revitalization, however the Cabrinha Lagoon until the time of collection had not suffered with a revitalization, so in the same was found essential conditions for the occurrence of mollusks.

2. Data Analysis

A total of five mollusk collections were performed during the period from September 2020 to May 2021 at five previously defined points in the Cabrinha Lagoon, approximately 1.5 m from the shore. The mollusks were collected with the help of a metal capture shell with 2 mm holes and a bottom of about 15 cm attached to a 1.5 m long wooden rod. The estimated collection time at each point was approximately 30 minutes, with 3 collectors in total. The specimens were taken to the Laboratory of Zoology and Parasite Biology of the State University of Piauí, Poeta Torquato Neto campus, for further analysis.

Mollusks of each morphotype were used for the taxonomic identification process (DESLANDES 1951, PARAENSE 1975, SOUZA 2006). In addition to mollusk collection, environmental data such as temperature, pH, and bank depth were collected at the selected points, as well as rainfall data from the region.

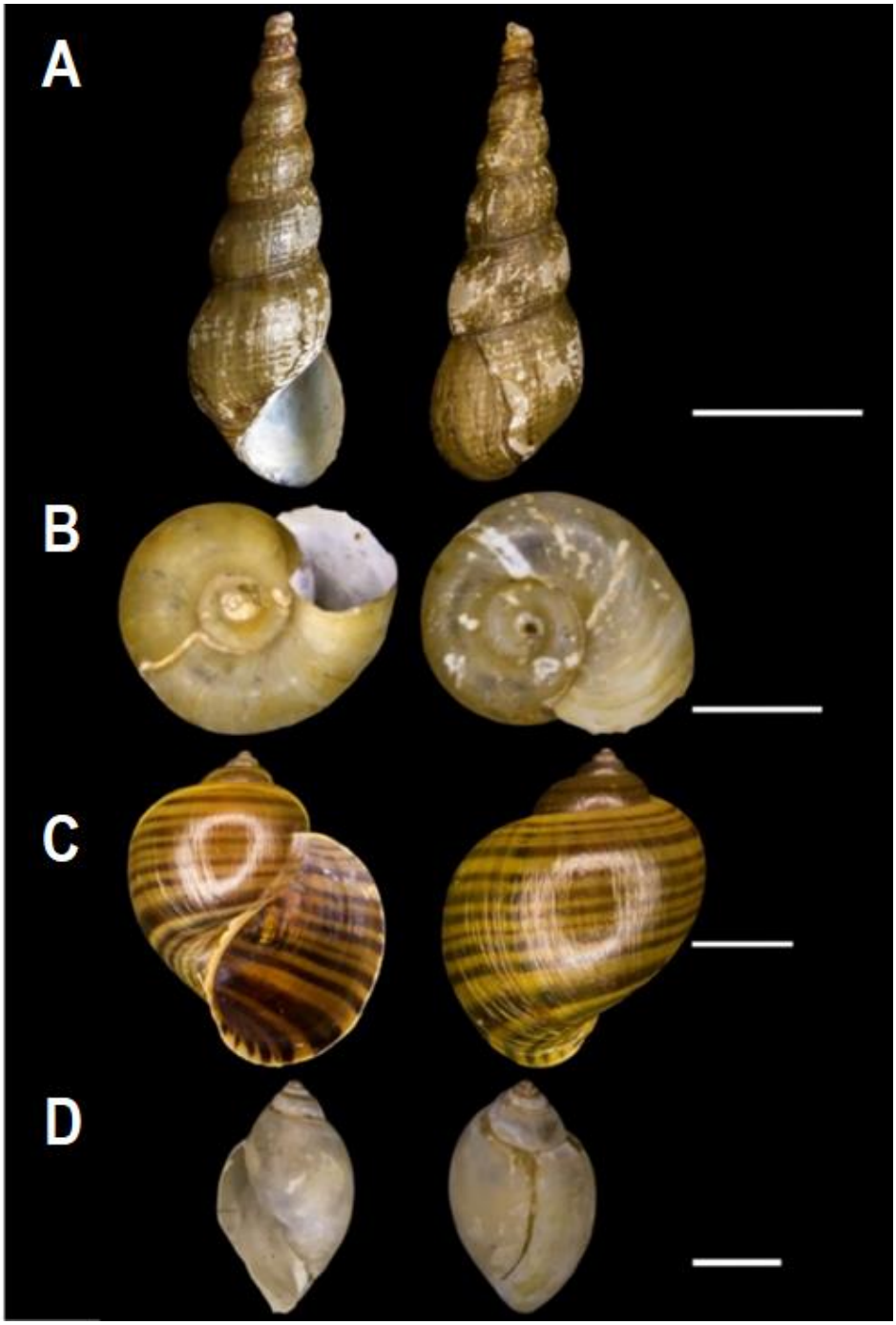
The data were entered into a Microsoft Excel spreadsheet and the statistical tests were performed in IBM® SPSS® software, from the company Statistical Product and Service Solutions, version 25.0. At the end of the sample processing, the relative abundance was calculated to determine the size of the mollusk population in a given habitat. For the comparison between two groups, the T-test was used. The Shapiro-Wilk test was performed to verify the normality of the data. For the analysis of seasonality, Spearman's nonparametric correlation coefficient was used. Differences were considered significant when $p < 0.05$.

To measure the specific biodiversity of the collected mollusks the Shannon-Wiener index was calculated, to show the distribution of individuals among the existing species the Pielou equitability was done, and to express the proportional importance of the most abundant species in a given sample the Berger-Parker abundance calculation was performed.

RESULTS

During the sampling period, 4,228 mollusks were collected from the five collection points of Cabrinha Lagoon. Five species of mollusks were found, *Melanoides tuberculata* (Müller, 1848) (Thiaridae), *Biomphalaria straminea* (Dunker, 1848) (Planorbidae), *Pomacea canaliculata* (Spix, 1827) (Ampullariidae) and *Physa* sp. (Physidae). Among the specimens collected, the species *M. tuberculate* had the highest number of specimens (n = 4,069, min = 0, max = 465, mean = 162.76 ± 131.80), followed by *B. straminea* (n = 144, min = 0, max = 90, mean = 5.76 ± 19.09). The species that had less occurrence were Specimens of *P. canaliculata* (n = 8, min = 0, max = 5, mean = 0.32 ± 1.06) followed by *Physa* sp. (n = 7, min = 0, max = 7, mean = 0.28 ± 1.4) (Figure 1).

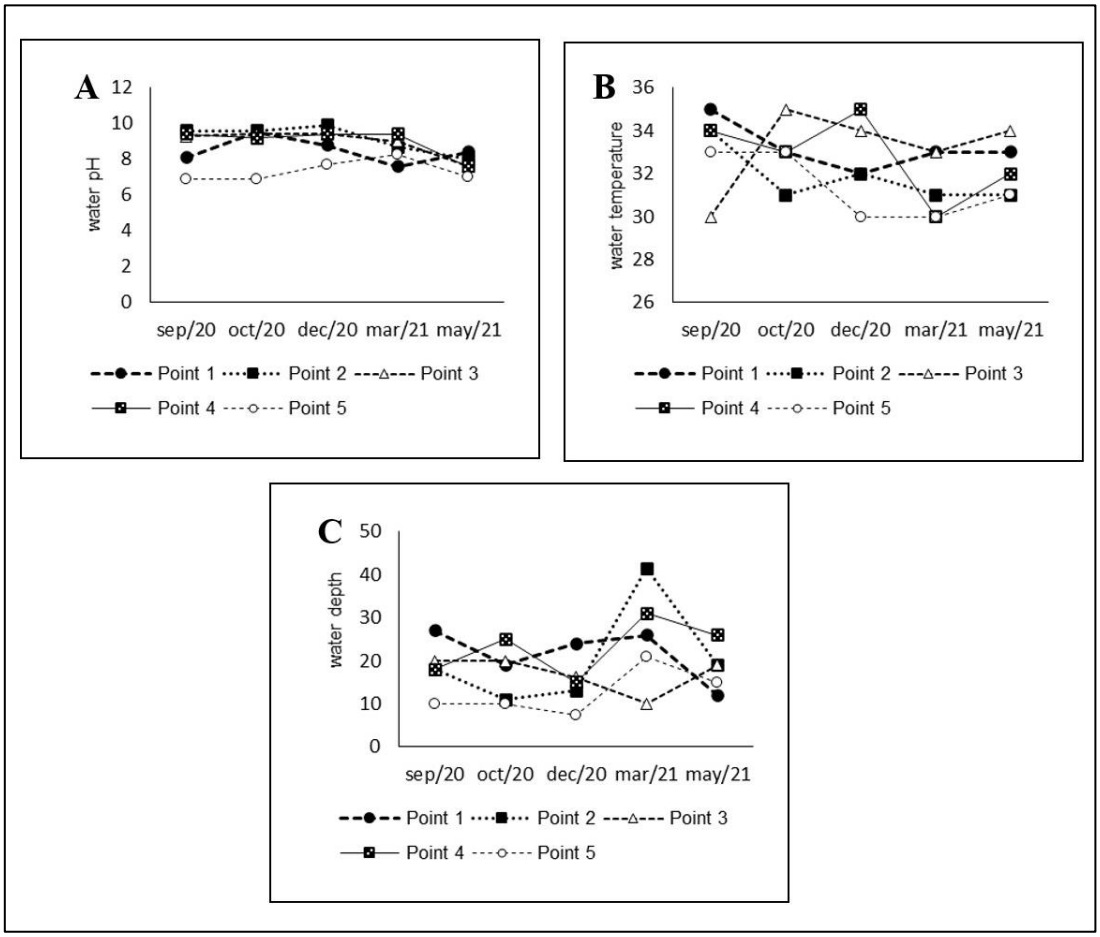
Figure 1. Mollusks collected from the Cabrinha Lagoon of the Lagoas do Norte Environmental Park, Teresina, Piauí, Brazil. a: *Melanoides tuberculate*; b: *Biomphalaria straminea*; c: *Pomacea canaliculate*; d: *Physa* sp. Scale bars = a: 23.2 mm, b: 5.9 mm, c: 29.5 mm, d: 5.1.



Regarding the monthly abundance of mollusks among the collection months, the month of October 2020 stood out the most important with 991 individuals (23.43%), followed March 2021, (n = 984, 23.27%), December 2020 (n = 960, 22.70%), May 2021 (n = 902, 21.33%), and September 2020 (n = 286, 6.76%).

In relation to environmental factors such as temperature (ºC), pH and depth (cm), variation was observed among the months analyzed. As for temperature, the months with the highest average values were: September 2020 (mean = 33.4, min = 30, max = 35) and October 2020 (mean = 33, min = 31, max = 35). As for pH, the months in which the highest mean values were recorded were: September 2020 (mean = 9.1, min = 8.1, max = 9.6) and December 2020 (mean = 9.0, min = 7.7, max = 9.9). Regarding depth, it was possible to observe the highest averages in the months of March 2021 (mean = 25.9, min = 10, max = 41.5) and September 2020 (mean = 20.2, min = 18, max = 27) (Figure 2).

Figure 2. Monthly variation of the pH (A), temperature (B) and depth water (C) collected at the sampled collection points of the Cabrinha Lagoon in Lagoas do Norte Environmental Park in Teresina-PI, in the period from September 2020 to May 2021.



The correlation between environmental factors and the abundance of each sampled species showed positivity to pH and the species *M. tuberculata* and *B. straminea*, indicating that for these organisms there is a relation between pH and abundance. As for depth, it was possible to observe a positive correlation with the species *B. straminea*, indicating that for this species, the greater the depth, the lower the abundance (Table 1).

Table 1: Spearman correlation coefficients were obtained from the correlation between the abundance of mollusks and environmental variables (pH, temperature, and depth) in the Cabrinha Lagoon, Teresina, PI. (p<0.05).

Mollusks		Water pH (pH)	Water Temperature (°C)	Water Depth (cm)
M. tuberculata	Correlation Coefficient	0,404*	0,155	0,106
	P-Value	0,04	0,45	0,61
B. straminea	Correlativo Coefficient	-0,463*	-0,205	0,433*
	P-Value	0,02	0,326	0,030
P. canaliculata	Correlation Coefficient	-0,242	-0,153	0,003
	P-Value	0,245	0,465	0,98
Physa sp.	Correlation Coefficient	-0,284	-0,158	-0,128
	P-Value	0,168	,0451	0,543

Regarding the ecological descriptors, at collection point 03, the diversity (Shannon index, H') of species was 0.03 (S = 2) and the (Pielou's equitability, J') was 0.04, while at collection point 05, diversity was higher at 0.82 (S = 4) and Pielou's equitability, (J' = 0.59), showing a different pattern of species frequencies (Table 2).

Table 2: Ecological descriptors of mollusks collected in September, October, and December 2020 and March and May 2021 in the Cabrinha Lagoon in the municipality of Teresina, PI**.**

Ecological Descriptors	Lagoon Cabrinha				
	Point 1	Point 2	Point 3	Point 4	Point 5
Species Richness (S')	1	1	2	1	4
Index Shannon-Wiener (H')	0	0	0.03[a]	0	0.82[a]
Equitability of Pielou (J')	0	0	0.04	0	0.59
Index of Berger-Parker (D')	1	1	0.99	1	0.55
Dominant Species	M.t	M.t	M.t	M.t	B.s

Caption: a = comparison for the diversity index (H ') between collection points 3 and 5. Kruskal-Wallis test. H = 3.0, degrees of freedom (df) = 3, p-value = 0.39. Legend: M.t = *Melanoides tuberculata*: B.s = *Biomphalaria straminea*.

Despite the apparent high diversity of species at collection point 5 (H= 3.0, df = 3, p = 0.39) this value was not significant. In the other areas that make up the researched environment, collection points 1, 2 and 4 presented diversity and equitability indexes equal to 0. These results show that there is no diversity at these points, with the majority dominance of a single species to the other stations. The dominance of the species, according to the Berger-Parker index, ranged from 0.55 to 0.99 for both environments surveyed and *M. tuberculata* was the species most found.

DISCUSSION

The data observed on the malacofauna inhabiting the Cabrinha Lagoon of the Northern Lagoons Park reveal that *M. tuberculata* is the most abundant species in the locality, and this result was possible to observe in other malacological surveys conducted in various parts of the country (BOAVENTURA *et al*. 2002, SANTANA *et al*. 2009, KOTZIAN; AMARAL 2013, SILVA *et al*. 2020). *Melanoides tuberculata* is a native species of the African and Asia continent, being considered an invasive species due to its migratory capacity and easy adaptation, adapting to all types of substrate and water bodies with different degrees of trophy and pollution. (SURIANI *et al*., 2007; PAULA *et al*., 2017). As stated by Paula and collaborators in 2017, invasive mollusks pose a significant threat to indigenous species due to their aggressive competition for habitat and resources. In addition, records of competition with schistosomiasis-transmitting planorbid mollusks have already been described in Brazil

(GIOVANELLI *et al*. 2003, PINTO; MELO 2011), revealing an important biological control role that can be developed by this species (THIENGO *et al*. 2005).

The specie *B. straminea* was the second most abundant, and it was possible to observe the occurrence of these individuals during the months of October and December 2020, and May 2021. Among the species of the genus *Biomphalaria* transmitting schistosomiasis mansoni, this is the most adaptable to all climates and ecological conditions, being the most comprehensive among the vector species (TERRA *et al*. 2018). The high distribution of these organisms in diverse types of environments compensates for their lower susceptibility to *Schistosoma mansoni* Sambon, 1907, the causative species of schistosomiasis mansoni in Brazil (CARVALHO *et al*. 1980), however, it is still an excellent transmitter, capable of maintaining high rates of human infection as occurs in several foci in northeastern Brazil (FAVRE *et al*. 2001, BARBOSA *et al*. 2006, GOMES *et al*. 2016).

It was possible to observe individuals of the specie *P. canaliculata* during the months of September 2020 and May 2021, and *Physa* sp. only during the month of May 2021. According to Miranda *et al*. (2016), the low occurrence of individuals of the genus *Physa* in malacological surveys is frequent because this species does not adapt well to the seasonal changes that occur between the rainy period and the dry period. Júnior e Santos (1986) and Souza *et al*. (2006) point out that representatives of the Physidae family are common in areas with sewage deposition, which was confirmed through this study, because specimens of this family were found only in the period when there was a higher concentration of human and animal waste and with no water flow.

Regarding the lower abundance of *P. canaliculata*, Thiengo *et al*. (2005) justify that the individuals of this species are considered amphibians because they bury themselves in the muddy substrate, resisting desiccation, and appear after the beginning of the rainy season, which makes it difficult to find these specimens during collections.

The decrease of *B. straminea* individuals with increase in water depth reflects the negative influence of this variable on the abundance of specimens. A study conducted in Jaboatão dos Guararapes by Souza *et al*. (2008), justifies the lower abundance of mollusks in the rainy season because the water in the river and lake increases and, consequently, there is the greater velocity in the currents, preventing the animals from settling in the vegetation, causing their transport to other points. During this transportation process, many mollusks die due to the friction of the water with stones, sand, and other materials that are in the water collection (ANDRADE *et al*. 2010).

Based on the data obtained in this study, it was demonstrated that there is a diversity of mollusks inhabiting the Cabrinha Lagoon in Lagoas do Norte Park, including the presence of *M. tuberculata*, which is considered an important invasive species of water collections in Brazil, and *B. straminea*, one of the vector species for schistosomiasis mansoni in the country, however, because this work has a small sample number, the results may not reflect the biodiversity of molluscs in the Cabrinha Lagoon. Given this panorama, it is expected that the results of this study will contribute to the understanding of biological and ecological factors of the mollusk species that live in northeastern Brazil, as well as contribute with information about the relationship of these individuals with seasonal factors, to expand the knowledge about the malacofauna of Brazil.

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