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Freshwater mollusk species of Itupararanga Reservoir, São Paulo, Brazil

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Abstract

The Itupararanga Reservoir, located within an environmental protection area, is an important water source that supplies four cities in the state of São Paulo. Samples of mollusks were collected in the reservoir to create an inventory of species and identify possible bioindicators. Thirteen species were identified: *Diplodon caipira* (Ihering, 1893), *Anodontites trapesialis* (Lamarck, 1819), *Pisidium globulus* Clessin, 1888, *Pomacea figulina* (Spix in Wagner, 1827), *Omalonyx convexus* (Heynemann, 1868), *Drepanotrema cimex* (Moricand, 1839), *Biomphalaria tenagophila* (d'Orbigny, 1835), *Uncancylus concentricus* (d'Orbigny, 1835), *Stenophysa marmorata* (Guilding, 1828), and *Pseudosuccinea columella* (Say, 1817), which are native to Brazil, and *Corbicula fluminea* (O.F. Müller, 1774), *Melanoides tuberculata* (O.F. Müller, 1774), and *Physa acuta* Draparnaud, 1805, which are invasive species. This is the first inventory of mollusks in this area, and this initial study will allow complementary research into populational ecology. Additionally, this inventory contributes records that clarify the areas of occurrence of the reported species.

Keywords

Bivalvia, Gastropoda, invasive species, Paraná river basin, species inventory, Sorocaba River, Tietê river basin

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Introduction

Reservoirs are distinctive man-made ecosystems with attributes that differ from lakes or rivers, but with intermediate characteristics that are similar to both. Features such as low-water residence time and quick changes in total volume due to oscillations in supply needs turn reservoirs into unique environments, with consequences for aquatic life. The Itupararanga Reservoir is a tropical water source that integrates the middle portion of the Tietê river basin, one of the largest in São Paulo state, and the Upper Sorocaba sub-basin. The Itupararanga Environmental Protection Area is a sustainable-use protected area that was created to keep the reservoir's water clean and its surrounding vegetation protected from the advances of urbanization, especially considering the lack of sewage treatment in some cities surrounding the reservoir (Taniwaki and Smith 2011). Sustainable-use protected areas serve is as a mechanism to bring together the goals of sustainable development and conservation in large areas with forest remnants (Brasil 2000).

Water quality reports for the reservoir indicate that in recent years its ecotoxicity index has decreased, while eutrophication has increased (CETESB 2017; Beghelli et al. 2014; Bottino et al. 2013; Taniwaki and Smith 2011). In terms of trophic status, the reservoir is eutrophic in the portion that receives water from the Sorocaba River, while its middle portion is considered mesotrophic, and the portion closest to the dam is classified as oligotrophic (Pedrazzi et al. 2014).

Benthic organisms are historically established bioindicators due to the numerous attributes that enable them to respond to environmental changes (Monteiro et al. 2008; Predrazzi et al. 2014), and they are considered an effective tool for evaluating the water quality and health of freshwater ecosystems in protected areas (Callisto et al. 2001). Gastropods and bivalves, the largest classes of Mollusca, are also part of the freshwater benthic community, surpassed only by arthropods in species richness (Bogan 2008; Strong et al. 2008). Both groups have been able to successfully colonize freshwater environments through a number of survival strategies, such as parasitic larvae on some bivalves, while gastropods have the ability to undergo estivation under critical conditions (e.g., drought periods; Alyakrinskaya 2004). Considering that 99% of mollusk extinctions are non-marine species (Lydeard et al. 2004; Cowie et al. 2017) and the importance of inland waters as a natural source of water and for human society and economy activity, the preservation of freshwater environments is essential (Dudgeon et al. 2006). Moreover, the major drivers for extinction are habitat destruction, the impact of introduced species, over-exploitation, and overcollecting; while the effects of all such factors are possibly worsened by climate change (Urban 2015; Marques 2016). All those factors have intensified in recent years, revealing a biodiversity crisis (Cowie et al. 2017). In addition to the extinction of mollusk species owing to environmental degradation, the introduction of nonnative species can dramatically reduce native biodiversity (Crooks 2002; Strauss et al. 2006). Exotic mollusks compete with their native equivalents for the use of resources and initiate negative biotic interactions, with the potential to affect aquatic systems greatly and adversely as a whole (Frehse et al. 2016; Miyahira et al. 2020). Species inventories are the initial step in achieving results in biodiversity conservation. While still lacking for many groups and areas, these basic surveys can provide valuable information for the expansion of taxonomic and population studies.

Previous studies with macroinvertebrates in the Itupararanga Reservoir have employed efficient methods for sampling insect larvae (Beghelli et al. 2012; Beghelli et al. 2014; Taniwaki and Smith 2011) but were less effective at collecting mollusks. Therefore, our study of the malacofauna in this reservoir meets the need to obtain qualitative and quantitative information to improve environmental characterization. Thus, the goal of our study was to carry out a qualitative survey of mollusks in the Itupararanga Reservoir, aimed at identifying species that can be used as bioindicators of anthropic effects, clarifying species occurrences, and providing more accurate information on the local fauna, thus establishing a basis for conservation efforts in the region.

Study Area

The Itupararanga Reservoir is part of a hydrological management unit (UGRHI-10) that covers 35 municipalities across 11,827 km^2 of São Paulo state in southeastern Brazil (CBH-SMT 2016). The Itupararanga Environmental Protection Area (APA Itupararanga in Portuguese) where the reservoir is located occupies eight municipalities: Alumínio, Cotia, Ibiúna, Mairinque, Piedade, São Roque, Vargem Grande Paulista, and Votorantim (Fig. 1). The prevailing vegetation types are semideciduous forests and deciduous broadleaf forests of secondary forest and pioneer formations (Beu et al. 2011), with areas of Atlantic Forest and Cerrado as well. Two seasonal periods are evident: summer, which has well-distributed precipitation, and dry winter. The reservoir is dendritic and occupies 27,23 of the 934,03 km^2 of the protected area. It is located upstream of the Sorocaba River, which is formed by the junction of the Sorocabuçu, Sorocamirim, and Una rivers. All these rivers cross the municipality of Ibiúna, before meeting to form the Sorocaba River (Beu 2014). Water from the Itupararanga Reservoir is used for many purposes, such as agriculture and leisure, as the water supply for the surrounding population, and in power generation for an aluminum plant.

Methods

A total of 25 sampling stations were set, 23 of which were located in the reservoir (identified by numbers 1–23) and two in tributary rivers: one in the Una River (24) and one in the Sorocabuçu River (25). The sampling stations were established in the Itupararanga Reservoir, mostly on the left bank (Fig. 1), human populations are denser and macrophyte density is greater. Aquatic plant clusters offer stable shelter and/or food for mollusks (Medeiros et al. 2002; Martello et al. 2008), providing stability to the species capable of occupying this habitat. Sampling was carried out in 2013 (September to November) and 2014 (January, February, July, August, and September), and each sampling station was visited only once. The coordinates of each station were recorded by a GPS device (Garmin eTrex Vista, datum WGS84) (Table 1).

A boat was used to cross the reservoir, and the mollusks were sampled from macrophytes or the sandy sediment that forms extensive sandbanks. The most suitable methodology was applied for each niche observed. To collect floating macrophytes, a rectangular polyvinyl chloride (PVC) sieve (80 × 80 cm) with a mesh size of 0.3 mm was used to remove plants from the bottom while avoiding the detachment of mollusks from the roots. Macrophytes rooted in the sediment were slowly pulled from the water; following the removal of the root, the green foliage above the water was discarded, and only the

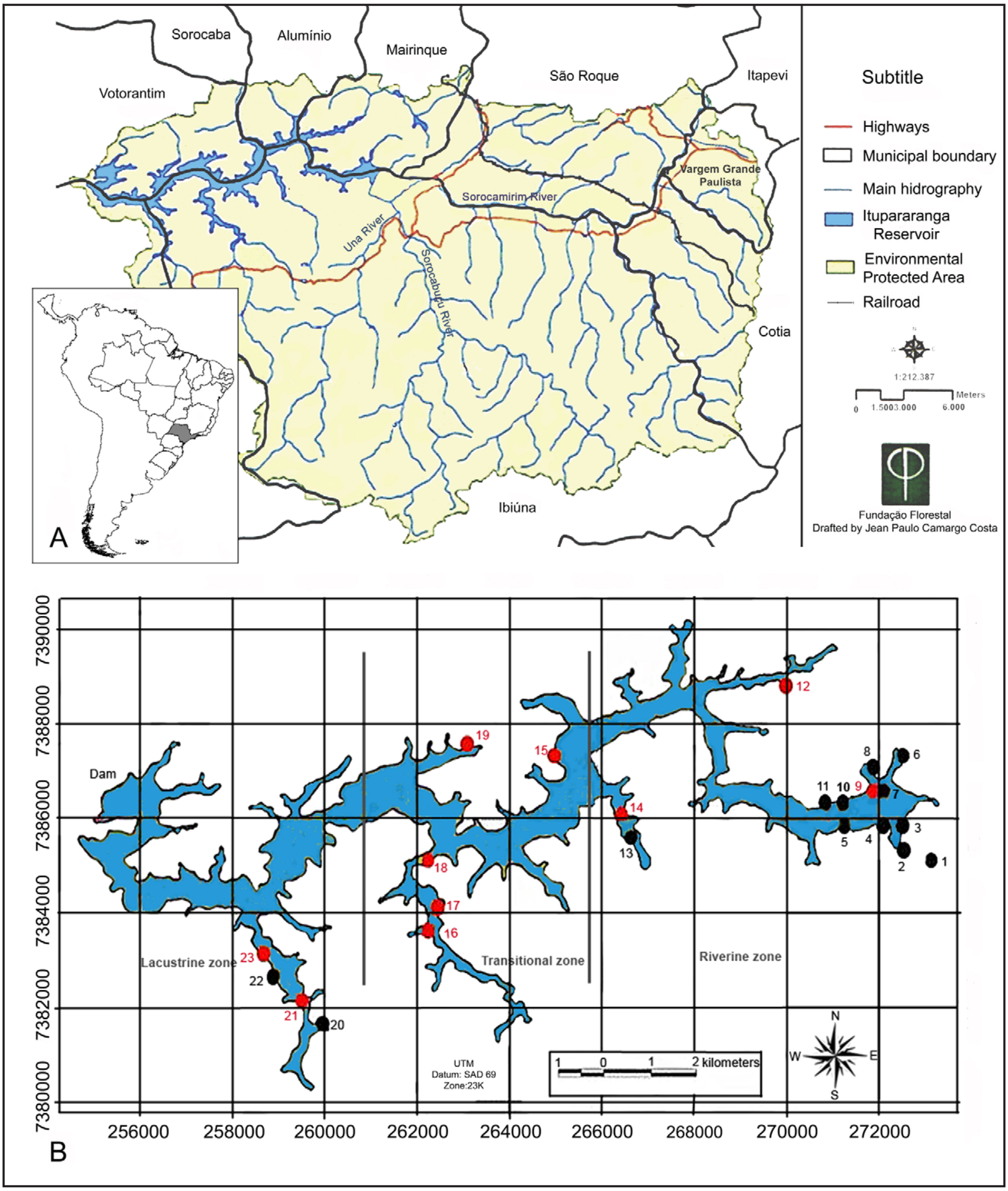

Figure 1. Studied area and sampling sites at Itupararanga reservoir. **A.** Location of Itupararanga Environmental Protection Area with the reservoir. Modified from Fundação Florestal (2010). **B.** Sampling stations at Itupararanga Reservoir with (black dots) or without (red dots) occurrence of mollusk species. Stations 24 and 25 were not plotted on the map because they are located in the Una and Sorocabuçu rivers, respectively. Map modified from Beghelli et al. (2014).

stems and submerged roots were kept. To collect the sediment, a modified Petersen dredge was launched repeatedly until the amount of sediment reached a volume of 10 L. The dredge was used in water 2–4 m deep to collect the sandy bottom in the middle of the left branches of the reservoir. Active searches by hand, without a pre-determined surveying time, were also carried out at stations in which the dredge could not penetrate the sediment and at collection sites on the banks of the reservoir.

Macrophytes and sediment were washed in running water with a 250 μm mesh screen sieve to remove excess sediment and then transferred to translucent plastic trays in a box with fluorescent lighting to facilitate the detection of mollusks. The mollusks were anesthetized with menthol crystals under refrigeration for 24–48 h until the musculature was relaxed, and then fixed in 70%

Table 1. Geographical coordinates of sampling stations and date of collections.

Station	Coordinates		Date
	Latitute (S)	Longitute (W)	
1	23°38′13″	047°13′07″	25 Oct. 2013
2	23°38′07″	047°13′56″	27 Nov. 2013
3	23°37′40″	047°13′49″	26 Feb. 2014
4	23°37′25″	047°13′56″	12/26 Feb. 2014
5	23°37′17″	047°14′08″	26 Feb. 2014
6	23°36′37″	047°13′44″	26 Feb. 2014
7	23°36′54″	047°14′02″	12 Feb. 2014
8	23°36′39″	047°16′16″	06/23 Jul. 2014
9	23°36′53″	047°14′04″	23 Jul. 2014
10	23°36′58″	047°14′22″	26 Feb. 2014
11	23°36′59″	047°14′46″	26 Feb. 2014
12	23°35′32″	047°15′14″	03 Sept. 2014
13	23°37′38″	047°17′02″	08 Nov. 2013
14	23°37′24″	047°17′09″	23 Jul. 2014
15	23°36′24″	047°18′15″	08 Nov. 2013
16	23°39′21″	047°18′37″	19 Feb. 2014
17	23°39′04″	047°18′52″	06 Aug. 2014
18	23°37″46″	047°20′03″	19. Feb. 2014
19	23°36′31″	047°20′53″	27 Aug. 2014
20	23°39′31″	047°21′06″	08 Jan. 2014
21	23°39′38″	047°21′25″	20 Aug. 2014
22	23°38′55″	047°21′49″	05 Feb. 2014
23	23°38′51″	047°21″48″	20 Aug. 2014
24	23°39′18″	047°13′31″	25 Sept. 2013
25	23°43′13″	047°11′17″	10 Sept. 2014

ethanol. Only live specimens were considered and identified. Identifications to species were based on general literature (e.g., Barbosa 1995; Simone 2006; Brasil 2007; Ohlweiler et al. 2010) and species-specific papers (Mansur and Pereira 2006; Thiengo et al. 2011) using shell features or soft body morphology. Experts were consulted to confirm the identification of species with unstable taxonomy. Images of shells were taken using a digital camera connected to a stereomicroscope (Stereo Discovery V8, Carl Zeiss Microscopy) for small animals (≤5 mm) and a Canon PowerShot SX400 IS camera for larger specimens (>5 mm).

The reservoir was divided into three main zones: riverine, near the tributaries; transitional, in the middle of the reservoir, and lacustrine, close to the dam (Beghelli et al. 2014) for our analysis. According to Thornton et al. (1982), these zones occur in a reservoir due to differences in the limnological characteristics of each region. The number of sampling stations in each zone differed from year to year (2013–2014), while the water level and the position of the floating macrophytes varied greatly. The riverine zone had a greater number of sandbanks and macrophytes than the other zones of the reservoir, which were investigated in detail.

Brief diagnoses of the species are presented, followed by comments on each species and geographic distribution. The systematic classification presented in this study follows the proposals made by Bouchet and Rocroi (2010) for Bivalvia and Bouchet et al. (2017) for Gastropoda. The samples were deposited in the Coleção de Invertebrados Bentônicos (CIB) of the Departamento de Biologia, Centro de Ciências Humanas e Biológicas, Universidade Federal de São Carlos (Sorocaba, SP, Brazil). A collecting permit was provided by the Chico Mendes Institute for Biodiversity Conservation (SISBIO 25043).

Results

Thirteen species of mollusks were identified: nine gastropods and four bivalves, totaling 302 specimens (Table 2). The gastropods were mainly associated with macrophytes and bivalves with the mainly sandy bottom sediments (Fig. 2).

We identified three native bivalve species, *Anodontites trapesialis* (Lamarck, 1819), *Diplodon caipira* (Ihering, 1893), and *Pisidium globulus* Clessin, 1888, and one invasive bivalve species, *Corbicula fluminea* (O.F. Müller, 1774). Among the gastropods, we found seven native species, *Pomacea figulina* (Spix in Wagner, 1827), *Omalonyx convexus* (Heynemann, 1868), *Drepanotrema cimex* (Moricand, 1839), *Uncancylus concentricus* (d'Orbigny, 1835), *Stenophysa marmorata* (Guilding, 1828), *Pseudosuccinea columella* (Say, 1817), and *Biomphalaria tenagophila* (d'Orbigny, 1835), and two invasive species, *Melanoides tuberculata* (O.F. Müller, 1774) and *Physa acuta* Draparnaud, 1805 (Table 2).

The most frequent species were *P. figulina*, *B. tenagophila*, and *C. fluminea* (Table 2, Fig. 3). *Pomacea figulina* was found associated with the floating macrophytes *Eichhornia crassipes* (Mart) Solms. (water hyacinth) and *Pistia stratiotis* L. (water lettuce), with the rooted macrophyte *Urochloa* sp., and in the sediment, while *Biomphalaria tenagophila* was found associated with floating (*E. crassipes* and *P. stratiotis*) and rooted macrophytes (*Urocloa* sp. and *Myriophyllum aquaticum* (Vell) Verdc.). *Corbicula fluminea* was found buried in the sediment, in the same habitat as *A. trapesialis* and *D. caipira*. The latter was always associated with extensive sandbanks. The species found in the Una River (Station 24) were *D. cimex* and *P. acuta*, while *P. globulus*, *U. concentricus*, and *P. acuta* were found in the Sorocabuçu River (Station 25). The species *S. marmorata*, *U. concentricus*, *D. cimex*, and *P. acuta* were always found associated with rooted macrophytes *Urochloa* sp. (Table 2).

From the 25 stations sampled in this study, 10 did not exhibit mollusks and were located mainly in the transitional zone, where no banks of macrophytes were found during the sampling (Fig. 1). The mollusks were found mainly in the riverine zone, where macrophyte banks, especially of floating species (*E. crassipes*, *P. stratiotis*) were present. Stations 2, 3, 4, 6, 10, 11, and 13 comprised banks of floating macrophytes, where *P. figulina*, *O. convexus*, *B. tenagophila*, and *P. columella* were found. Besides the floating macrophytes, station 13 also presented rooted macrophytes *Urochloa* sp. and *M. aquaticum*, where *P. figulina* and *B. tenagophila*, respectively, were found. At station 1, *D. cimex*, *P. acuta*, and *P.*

Table 2. List of mollusk species. Data includes species name, number of specimens in each site, type of micro-habitat, sampling method used, and vouchers numbers of the species collected in Itupararanga Reservoir, Una and Sorocabuçu rivers. Macrophyte 1: *Urochloa* sp.; Macrophyte 2: *Myriophyllum aquaticum* (Vell) Verdc.; Macrophyte 3: *Pistia stratiotes* L.; Macrophyte 4: *Eichhornia crassipes* (Mart) Solms. MC = manual collection; D = modified Petersen dredge; PVC = PVC sieve; RM = method for collection of rooted macrophyte.

Class, family, species	Station															Total	Micro-habitat	Collection method
	1	2	3	4	5	6	7	8	10	11	13	20	22	24	25			
BIVALVIA																		
HYRIIDAE																		
Diplodon caipira							3						4			7	Sediment	MC/ D
MYCETOPODIDAE																		
Anodontites trapesialis							11	22					1			34	Sediment	MC/ D
CYRENIDAE																		
Corbicula fluminea				1	1		20						4			26	Sediment	MC/ D
SPHAERIIDAE																		
Pisidium globulus		1													1	2	Macr. 1/4	RM/ PVC
GASTROPODA																		
AMPULLARIIDAE																		
Pomacea figulina			3	10					2	19	1	26				61	Sediment & Macr. 1/3/4	RM/ PVC/MC
THIARIDAE																		
Melanoides tuberculata												43				43	Sediment	MC/ D
SUCCINEIDAE																		
Omalonyx convexus				5		9										14	Macr. 4	PVC
PLANORBIDAE																		
Drepanotrema cimex	13													1		14	Macr. 1	RM
Biomphalaria tenagophila			51	1						1	1					54	Macr. 1/2/3/4	RM/ PVC
Uncancylus concentricus															5	5	Macr.1	RM
PHYSIDAE																		
Stenophysa marmorata												24				24	Macr. 1	RM
Physa acuta	4													1	10	15	Macr. 1	RM
LYMNAEIDAE																		
Pseudosuccinea columella	1	1										1				3	Macr. 1/3	RM/ PVC
Total species at each station	**3**	**2**	**2**	**4**	**1**	**1**	**3**	**1**	**1**	**2**	**2**	**4**	**3**	**2**	**3**			

columella were found associated with *Urochloa* sp. The other stations in the riverine zone (stations 5, 7, and 8) comprised muddy-sediment areas (station 5) and extensive sandbanks (stations 7 and 8), in which *A. trapesialis*, *C. fluminea*, and *D. caipira* were found. In the lacustrine zone, *D. caipira*, *A. trapesialis* and *C. fluminea* were found, also in the sandy sediment in station 22; at station 20, *S. marmorata, P. columella*, and *P. figulina* were found associated with *Urochloa* sp., and *M. tuberculata* and *P. figulina* in the sediment at the margins of a water retention construction (Table 2).

Taxonomy

Class Bivalvia Linnaeus, 1758
Family Hyriidae Swainson, 1840

***Diplodon caipira* (Ihering, 1893)**
Figures 4A–D

Material examined. BRAZIL – São Paulo state • Itupararanga Reservoir; 23°38′55″S, 047°21′49″W; 05.II.2014; B.M. Vendramini and E.P. Arruda leg.; buried in sediment/collected with modified Petersen dredge; CIB 317 (4 spec.) • Itupararanga Reservoir; 23°36′54″S, 047°14′02″W; 12.II.2014W; B.M. Vendramini and E.P. Arruda leg.; buried in sediment/collected with modified Petersen dredge; CIB 320 (3 spec.).

Identification. Valves oval, posterior dorsal margin slightly convex, anterior dorsal margin straight, anterior margin rounded and posterior one truncated with a concavity formed by a radial groove on posterior slope; shell slightly elongated in posterior portion, forming a lower region; sculpture with weak, fine, commarginal ribs on shell surface and marked grooves on posterior slope; weak radial darker bands present on central slope of valves. A smaller specimen examined showed a straighter posterior dorsal margin with weak radial ribs sculpture that vanish on the central slope. Periostracum from dark brown to black and white hypostracum. Umbo subcentral and orthogyrate. Hinge with cardinal and lateral teeth; right valve with two cardinal and one lateral teeth; cardinal teeth lamellar and parallel to each other, crenellated on internal face, lower cardinal more conspicuous than superior one, with tiny posterior irregular pointed tooth-like projections; lamellar lateral teeth slightly arched and elongated, ending near posterior adductor muscle scar. Left valve with one cardinal tooth and two lateral posterior teeth; cardinal tooth lamellar, with crenulated internal face and small posterior irregular tooth-like projections; lateral teeth lamellar and parallel to each other, elongated and ending near posterior adductor muscle scar. Pallial line conspicuous and complete; anterior muscle scars more evident than the

Figure 2. Habitat sampled at Itupararanga Reservoir. **A.** Station 2 with extensive macrophyte floating bank of *E. crassipes* and *P. stratiotes*. **B.** Station 20 with *Urochloa* sp. **C.** Station 7, a sandbank exposed during the dry period. **D.** *Anodontites trapesialis* (105 mm in length) visible on the sandbank (station 7) due to decrease in the water level. **E.** Station 4, near a cattle pasture. **F.** Station 3, a stretch of Sorocaba River near its confluence with the Itupararanga Reservoir with *E. crassipes* and *P. stratiotes*.

posterior ones. Analyzed shells ranged from 27 mm × 18 mm to 57 mm × 40 mm (length × height).

Comments. Simone (2006) considered *D. caipira* to be a synonym of *D. expansus* (Küster, 1856). However, Pereira et al (2013), Miyahira et al. (2019), and Cuezzo et al. (2020) considered it to be a valid species and stated that *Diplodon* species do not have well-established diagnostic characters for their identification.

Geographical distribution. Upper Paraná River (Sapucaí and Pardo rivers) (Machado et al. 2008); Piracicaba River, Tietê river basin (Ihering 1893). Our new records are the first from the Sorocaba river basin, São Paulo state.

Family Mycetopodidae Gray, 1840

***Anodontites trapesialis* (Lamarck, 1819)**
Figures 2D, 4E–H

Material examined. BRAZIL – São Paulo state • Itupararanga Reservoir; 23°38′55″S, 047°21′49″W; 05.II.2014;

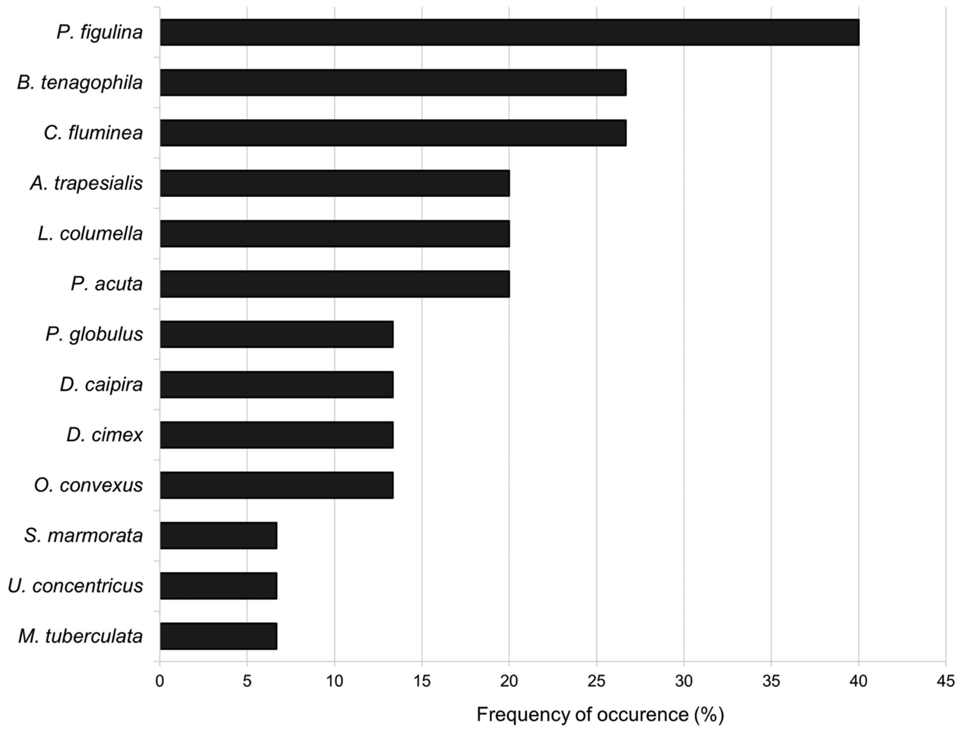

Figure 3. Frequency of occurrence (in percentage) of each mollusk species found during the study.

B.M. Vendramini and E.P. Arruda leg.; buried in sediment/collected with modified Petersen dredge; CIB 318 (1 spec.) • Itupararanga Reservoir; 23°36′54″S, 047°14′02″W; 12.II.2014; B.M. Vendramini and E.P. Arruda leg.; buried in sediment/collected manually; CIB 319 (11 spec.) • Itupararanga Reservoir; 23°36′39″S, 047°16′16″W; 6–23.VII.2014; B.M. Vendramini and E.P. Arruda leg.; buried in sediment/collected manually; CIB 348, 349 (22 spec.).

Identification. Valves subtrapezoidal with straight dorsal margin, parallel to anteroposterior axis, rounded anterior margin and posterior one truncated and deep ventrally. Shell with pedal gap and posterior portion low and elongated; shell smooth with commarginal periostracal folds that are closer and higher at the posterior slope, giving it a wrinkled appearance. Umbo anterior, subcentral and orthogyrate. Periostracum bends around the shell's margin to the interior. Color ranging from yellowish brown to dark brown. Hinge straight, toothless. Interior surface iridescent, with both adductor muscle scars very evident; pallial line conspicuous. Sampled organisms ranged from 112 mm × 70 mm to 130 mm × 90 mm (length × height).

Geographical distribution. Mexico to Argentina, except Guyana, Suriname, French Guiana, and Chile (Cuezzo et al. 2020).

Family Cyrenidae Gray, 1847

Corbicula fluminea **(O.F. Müller, 1774)**
Figures 4I–L

Material examined. BRAZIL – São Paulo state • Itupararanga Reservoir; 23°38′55″S, 047°21′49″W; 05.II.2014; B.M. Vendramini and E.P. Arruda leg.; buried in sediment/collected with modified Petersen dredge; CIB 316 (4 spec.) • Itupararanga Reservoir; 23°36′54″S, 047°14′02″W; 12.II.2014; B.M. Vendramini and E.P. Arruda leg.; buried in sediment/collected with modified Petersen dredge; CIB 321 (20 spec.) • Itupararanga Reservoir; 23°37′25″S, 047°13′56″W; 26.II.2014; B.M. Vendramini and E.P. Arruda leg.; buried in sediment/collected manually; CIB 339 (1 spec.) • Itupararanga Reservoir; 23°37′17″S, 047°14′08″W; 26.II.2014; B.M. Vendramini and E.P. Arruda leg.; buried in sediment/collected manually; CIB 347 (1 spec.).

Identification. Valves trigonal, with anterior and posterior straight dorsal margins, deep ventrally, and similar in size. Anterior and posterior margins low and rounded, continuous with ventral one. Posterior portion more projected than anterior, forming a rostrum. Shell heavy with regularly spaced commarginal ribs. Umbo subcentral and orthogyrate; umbonal region high and inflated. Exterior of shell blackish, with occasional brown stains; interior variously white to yellow or brown. Right valve with three cardinal teeth; anterior cardinal tooth lamellar and parallel to dorsal margin; median cardinal trigonal and robust; posterior cardinal lamellar, bifid and parallel to margin; two lateral teeth on each side, very elongated, parallel to each other with internal faces crenellated, ventral tooth more conspicuous than dorsal one. Left valve with three cardinal teeth; anterior one trigonal, robust, and almost parallel to dorsal margin; median tooth trigonal, slightly bifid, posteriorly deep; posterior tooth lamellar, small, and parallel to dorsal margin. One lateral tooth on each side, very elongated with crenellated internal and external faces. Muscle scars conspicuous; entire

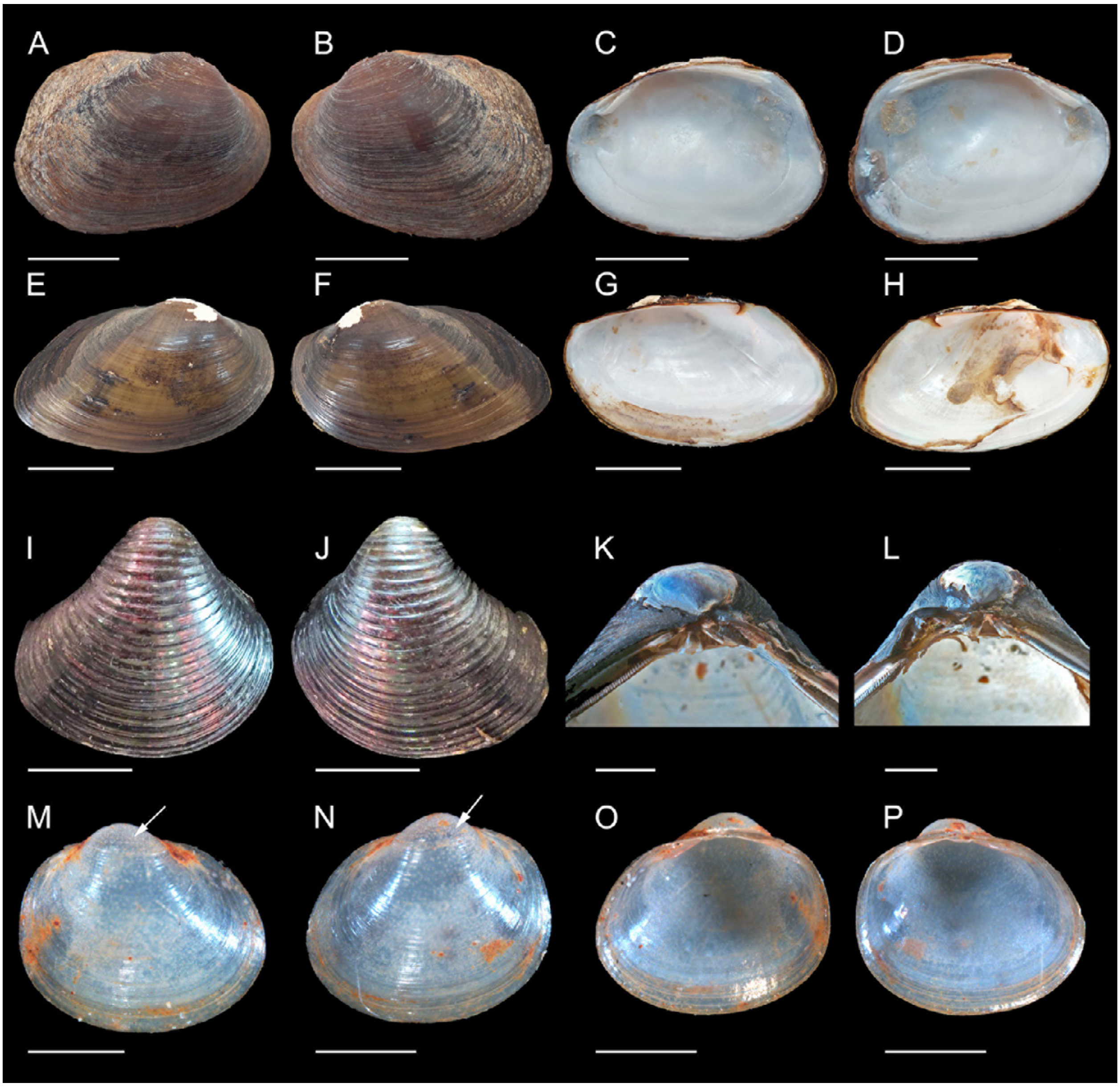

Figure 4. Bivalve species collected in Itupararanga Reservoir. **A–D.** *Diplodon caipira*: (**A**) external view of right valve; (**B**) external view of the left valve; (**C**) internal view of the right valve; (**D**) internal view of the left valve. **E–H.** *Anodontites trapesialis*: (**E**) external view of right valve; (**F**) external view of the left valve; (**G)** internal view of the right valve; (**H**) internal view of the left valve. **I–L.** *Corbicula fluminea*: (**I**) external view of right valve; (**J**) external view of the left valve; (**K**) internal view of the right hinge; (**L**) internal view of the left hinge. **M–P.** *Pisidium globulus*: (**M**) external view of right valve; (**N**) external view of the left valve; (**O**) internal view of the right valve; (**P**) internal view of the left valve. Scale bars A–D = 20 mm; E, G, H = 50mm; I, J = 10 mm; K, L = 4 mm. M–P = 1 mm. The arrows in figures M and N point to the pustules in *P. globulus*.

pallial line. Collected specimens ranged from 17 mm × 15 mm (length × height) to 38 mm × 35 mm.

Geographical distribution. Native to Southeast Asia, but introduced to North America, Africa, Europe, and South America (Simone 2006; Santos et al. 2012).

Family Sphaeriidae Deshayes, 1855

Pisidium globulus **Clessin, 1888**
Figures 4M–P

Material examined. BRAZIL – São Paulo state • Itupararanga Reservoir; 23°38′07″S, 047°13′56″W; 27.XI.2013; B.M. Vendramini and E.P. Arruda leg.; associated with roots of *Eichhornia crassipes*/collected with PVC sieve; CIB 304 (1 spec.) • Sorocabuçu River; 23°43′13″S, 047° 11′17″W; 10.IX.2014; B.M. Vendramini and E.P. Arruda leg.; associated with roots of *Urochloa* sp.; CIB. 352 (1 spec.).

Identification. Shell spherical, discoid, and translucent; thin, fragile, and small. Dorsal anterior and posterior margins straight, almost same length, and slightly deepened ventrally; anterior and ventral margins rounded; posterior one almost straight. Umbos slightly displaced posteriorly; umbonal region high. Sculpture consisting of fine, regular, commarginal grooves and small, rounded, randomly arranged protuberances over entire external surface of shell. Right valve hinge with small lamellar cardinal tooth and two lateral teeth on each side; lateral teeth lamellar and parallel to each other, ventral lateral tooth bigger than dorsal one. Left valve hinge with two cardinal teeth and one lateral on each side; cardinal teeth lamellar, almost parallel to each other, dorsal one inconspicuous and ventral one with a dorsally projected apex. The largest analyzed specimen was 2.5 mm long × 2 mm high.

Comments. Species of *Pisidium* are very similar and diagnostic differences are often subtle, making information about them conflicting and difficult to discerning based only on a combination of shell characters (Cuezzo et al. 2020). Our identification follows Mansur and Pereira (2006). However, our specimens have irregular, rounded, pustule-like protuberances on the shell, which is not a mentioned for any *Pisidium* species.

Geographical distribution. Sinos river basin, Rio Grande do Sul state (Atlântico-Sul Basin); Nova Teutônia, Santa Catarina state (Uruguai river basin) (Mansur and Pereira 2006) and Ilha Grande State Park, Rio de Janeiro State (Santos et al. 2010). Our records are the first from the Sorocaba river basin, São Paulo state.

Class Gastropoda
Family Ampullariidae Gray, 1824

***Pomacea figulina* (Spix in Wagner, 1827)**
Figure 5A

Material examined. BRAZIL – São Paulo state • Itupararanga Reservoir; 23°37′38″S, 047°17′02″W; 08.XI.2013; B.M. Vendramini and E.P. Arruda leg.; associated with roots of *Urochloa* sp; CIB 301 (1 spec.) • Itupararanga Reservoir; 23°39′31″S, 047°21′06″W; 08.I.2014; B.M. Vendramini and E.P. Arruda leg.; buried in sediment/collected manually; CIB 308, 309, 310, 312 (26 spec.) • Itupararanga Reservoir; 23°37′25″S, 047°13′56″W; 12.II.2014; B.M. Vendramini and E.P. Arruda leg.; associated with roots of *Eichhornia crassipes* and *Pistia stratiotis*/collected with PVC sieve; CIB 323, 335 (10 spec.) • Itupararanga Reservoir; 23°36′59″S, 047°14′46″W; 26.II.2014; B.M. Vendramini and E.P. Arruda leg.; associated with roots of *Eichhornia crassipes*/collected with PVC sieve; CIB 329, 330, 331, 333 (19 spec.) • Itupararanga Reservoir; 23°36′58″S, 047°14′22″W; 26.II.2014; B.M. Vendramini and E.P. Arruda leg.; associated with roots of *Eichhornia crassipes*/collected with PVC sieve; CIB 334 (2 spec.) • Itupararanga Reservoir; 23°37′40″S, 047°13′49″W; 26.II.2014; B.M. Vendramini and E.P. Arruda leg.; associated with roots of *Eichhornia crassipes*/collected with PVC sieve; CIB 346 (3 spec.).

Identification. Shell dark nut-browned with light brown bands all over. Spire small and conical, with marked suture between whorls; aperture large, oval, with thin lip. Operculum oval, corneous, dark brown. Mantle pale brown to gray, as is most of body. Male reproductive system with three penial sheath glands: basal outer, inner median, and apical. The shape and arrangement of these glands match *P. figulina* as described by Thiengo (1987) and Thiengo et al. (2011).

Comments. Shells of *Pomacea* species are very similar to each other, and their morphology may undergo environmental influence, serving only as a superficial guide for their identification. Differentiation between species should be based on the morphology of the male reproductive system, such as the size and shape of the penis sheath and the arrangement of its glands, shape, and size of the prostate and penis (Thiengo et al. 2011; Cuezzo et al. 2020). Our specimens were 7–65 mm high × 5–50 mm wide, with apertures 3–30 mm wide.

Geographical distribution. Rio Grande do Norte, Paraíba, Bahia, and Minas Gerais states (S.C. Thiengo pers. comm.); Sorocaba River, São Paulo state (Rodrigues et al. 2016).

Family Thiaridae Gill, 1871

***Melanoides tuberculata* (O.F. Müller, 1774)**
Figure 5B

Material examined. BRAZIL – São Paulo state • Itupararanga Reservoir; 23°39′31″S, 047°21′06″W; 08.I.2014; B.M. Vendramini and E.P. Arruda leg.; buried in sediment/collected with modified Petersen dredge and manually; CIB 313 (43 spec.).

Identification. Shell conical and elongated, with dextral coiling and well-defined whorls. Ornamentation with slightly spiral grooves and strong ribs, creating regularly distributed, small, elevated nodules. Color yellow to nut-brown, with brown bands very evident on later whorls. Aperture drop-shaped. Operculum corneous and drop-shaped. Our specimens were 17–33 mm high × 6–12 mm wide, with apertures 4–7 mm wide.

Geographical distribution. Native to Asia, and North and East Africa; now introduced to several countries in the Americas and Oceania. In Brazil, there are records from all states, except Rio Grande do Sul (Santos et al. 2012). Our record is the first from the Sorocaba river basin, São Paulo state.

Family Succineidae Beck, 1837

***Omalonyx convexus* (Heynemann 1868)**
Figure 5C, D

Material examined. BRAZIL – São Paulo state • Itupararanga Reservoir; 23°37′25″S, 047°13′56″W; 12–26.II.2014; B.M. Vendramini and E.P. Arruda leg.; associated with roots of *Eichhornia crassipes*/collected with PVC sieve; CIB 324, 338 (5 spec.) • Itupararanga Reservoir; 23°36′37″S, 047°13′44″W; 26.II.2014; B.M. Vendramini and E.P. Arruda leg.; associated with roots of *Eichhornia crassipes*/collected with PVC sieve; CIB 340 (9 spec.).

Identification. Animal slug-like; shell fingernail-shaped, orange, transparent, reduced, and slightly convex with a

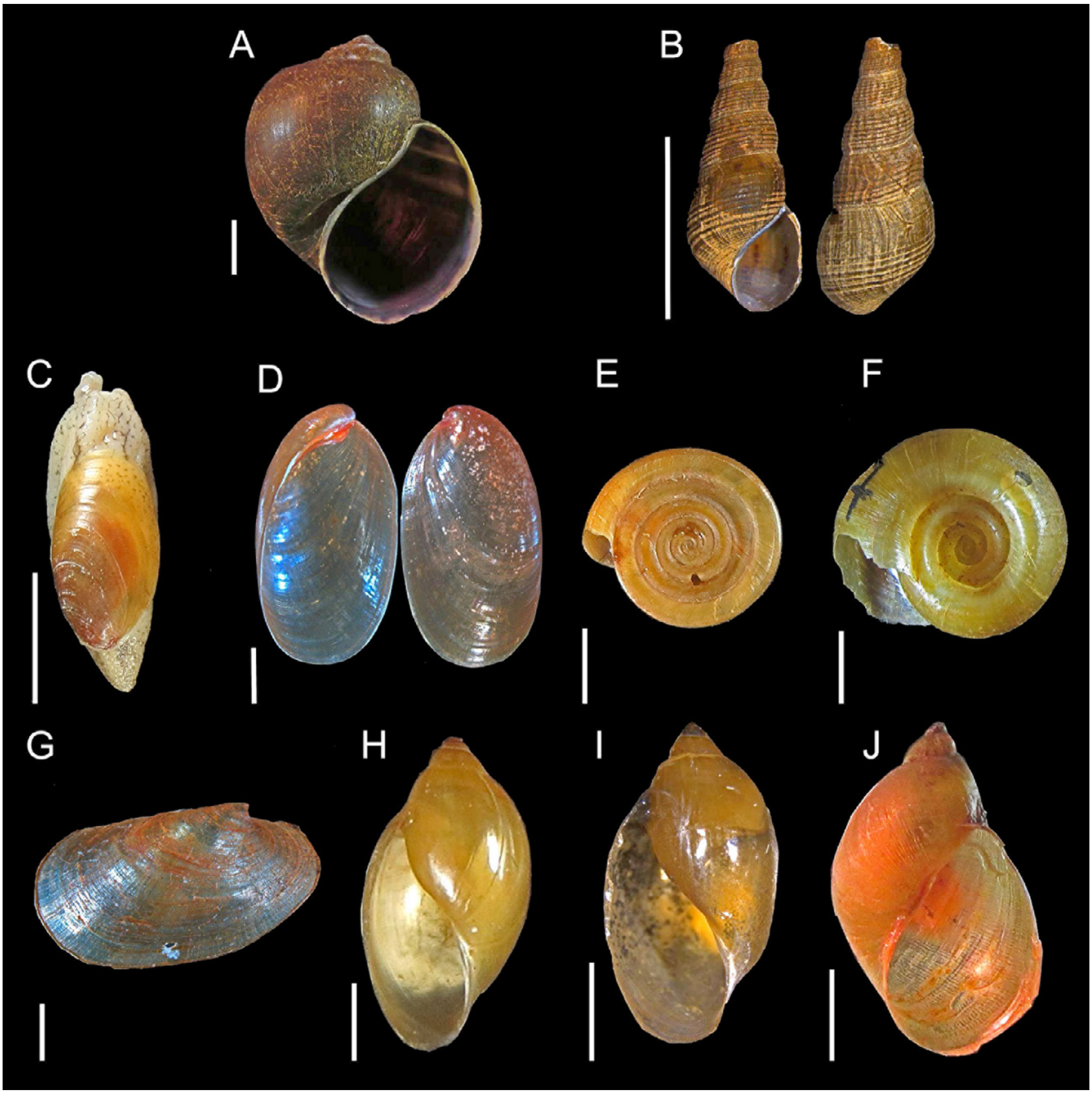

Figure 5. Gastropod species collected in Itupararanga Reservoir. **A.** *Pomacea figulina*. **B.** *Melanoides tuberculata*. **C, D.** *Omalonyx convexus*, complete animal and shell. **E.** *Drepanotrema cimex*. **F.** *Biomphalaria tenagophila*. **G.** *Uncancylus concentricus*. **H.** *Stenophysa marmorata*. **I.** *Physa acuta*. **J.** *Pseudosuccinea columella*. Scale bars: A, B = 10mm; C, F = 5 mm; D, G = 2 mm; E, H, I, J = 2.5 mm.

short spire; internally with a narrow projection similar to a tooth which fits the animal body. Mantle dorsally expanded, involving only the shell's edge. Body yellow to orange, with black pigmentation regularly distributed in two bands behind head. Evertophallus with proximal region wider than posterior region; internal surface of evertophallus with longitudinal folds in wider proximal region and papillae in distal region.

Comments. The taxonomy of *Omalonyx* is full of misunderstandings, and the reproductive system must be studied for a correct identification. The distribution of *O. convexus* overlaps that of *O. unguis* (d'Orbigny, 1835); these species can be distinguished following Arruda and Thomé (2008) and Coscarelli and Vigidal (2016). Our specimens were 6–9 mm high × 3–6 mm wide.

Geographical distribution. Argentina, Uruguay, Bolivia, and Rio Grande do Sul state, Brazil (Arruda and Thome 2008, 2011; Cuezzo et al. 2020). Our records are the first from the Sorocaba river basin, São Paulo state.

Family Planorbidae Rafinesque, 1815

Drepanotrema cimex **(Moricand, 1839)**
Figure 5E

Material examined. BRAZIL – São Paulo state • Una River; 23°39′18″S, 047°13′31″W; 25.IX.2013; B.M. Vendramini and E.P. Arruda leg.; associated with *Urochloa* sp.; CIB 296 (1 spec.) • Itupararanga Reservoir; 23°38′13″S, 047°13′07″W; 25.X.2013; B.M. Vendramini and E.P. Arruda leg.; associated with *Urochloa* sp.; CIB 299 (13 spec.).

Identification. Shell small, discoidal, fragile, with seven well-defined whorls which increase regularly in size. Aperture sickle-shaped. Shell pale brown to yellow. Cephalopodal mass with pigmented bands. Our specimens 1.5–7.0 mm high × 1.5–6.0 mm wide. Most specimens 8 mm high × 11 mm wide (Barbosa 1995).

Geographical distribution. Neotropical region (Rumi et al. 2004), including Mexico, the Antilles, Cuba, Haiti, Puerto Rico, Jamaica, Venezuela, Brazil, Peru, Argentina, and Uruguay (Cuezzo et al. 2020). According to Paraense (1975), this species is distributed throughout the whole of Brazil. Our records are the first from the Sorocaba river basin, São Paulo state.

Biomphalaria tenagophila **(d'Orbigny, 1835)**
Figure 5E

Material examined. BRAZIL – São Paulo state • Itupararanga Reservoir; 23°36′59″S, 047°14′46″W; 26.II.2014; B.M. Vendramini and E.P. Arruda leg.; associated with roots of *Eichhornia crassipes*/collected with PVC sieve; CIB 328 (1 spec.) • Itupararanga Reservoir; 23°37′25″S, 047°13′56″W; 26.II.2014; B.M. Vendramini and E.P. Arruda leg.; associated with roots of *Eichhornia crassipes*/collected with PVC sieve; CIB 337 (1 spec.); • Itupararanga Reservoir; 23°37′40″S, 047°13′49″W; 26.II.2014; B.M. Vendramini and E.P. Arruda leg.; associated with roots of *Eichhornia crassipes*, *Pistia stratiotis* and *Urochloa* sp./collected with PVC sieve; CIB 344 (51 spec.) • Itupararanga Reservoir; 23°37′38″S, 047°17′02″W; 08.XI.2013; B.M. Vendramini and E.P. Arruda leg.; associated with roots of *Myriophyllum aquaticum*; CIB 303 (1 spec.).

Identification. Shell pale brown to orange, with 7–8 whorls that increase regularly in size; keel present on both sides but more pronounced to left. Aperture rounded. Mantle smooth, without a crest above renal tube. Prepuce narrow near penial sheath; vas deferens narrow; prostate arborescent, with numerous diverticula. Vagina pot-shaped, dilated in posterior region near uterus. Our specimens 4–16 mm wide × 4.5–18 mm high.

Comments. The morphology of all *Biomphalaria* species in Brazil is similar. The most distinctive feature of *B. tenagophila* is the absence of the crest on the renal tube (Brasil 2007). Most of the animals collected in the Itupararanga reservoir were infected by *Chaetogaster* sp., an annelid ectoparasite (Oligochaeta, Naididae). Finding this parasite on snails while we were desiccating the individuals for identification was accidental.

Geographical distribution. Argentina, Uruguay, Paraguay, Peru, and Brazil (Cuezzo et al. 2020). In Brazil, in Bahia state (Central-Western region), South and Southeast regions. In all hydrographic basins of in São Paulo state (Ohweiler et al. 2010).

Uncancylus concentricus **(d'Orbigny, 1835)**
Figure 5G

Material examined. BRAZIL – São Paulo state • Sorocabuçu River; 23°43′13″S, 047°11′17″W; 10.IX.2014; B.M. Vendramini and E.P. Arruda leg.; associated with roots of *Urochloa* sp.; CIB 353 (5 spec.).

Identification. Shell cap-shaped, high, thin, translucent, pale brown; protoconch with pointed apex, flexed to the right, almost reaching edge of teleoconch. Radial lines distributed all over shell. Periostracum with fine projections. Anterior and posterior left muscle scars elliptical and transversal to anteroposterior axis; anterior right muscle scars elliptical and transversal to anteroposterior axis, extending posteriorly, acquiring a half-moon shape. Our specimens 5–10 mm high × 3–5 mm wide.

Geographical distribution. Neotropics: Costa Rica to Argentina. In Brazil, known from Bahia, Goiás, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Rio de Janeiro, São Paulo, and Rio Grande do Sul (Santos et al 2009; Cuezzo et al. 2020). Our record is the first from the Sorocaba river basin, São Paulo state.

Family Physidae Fitzinger, 1833

Stenophysa marmorata **(Guilding, 1828)**
Figure 5H

Material examined. BRAZIL – São Paulo state • Itupararanga Reservoir; 23°39′31″S, 047°21′06″W; 08.I.2014; B.M. Vendramini and E.P. Arruda leg.; associated with roots of *Urochloa* sp.; CIB 322 (24 spec.).

Identification. Shell thin, sinistral, fusiform, pale brown to yellow, and with 5 whorls. Body whorl larger than spire; suture shallow. Aperture elongate-oval, narrower posteriorly, similar to an elongated drop. Body and mantle with irregular melanin spots. Mantle with rounded projections, each projection presenting black, circular stains. Our specimens were 5.5–10.0 mm high × 2.5–4.5 mm wide.

Geographical distribution. Central and South America; widely distributed in Brazil, including São Paulo state (Ohlweiler et al. 2010).

Physa acuta **Draparnaud, 1805**
Figure 5I

Material examined. BRAZIL – São Paulo State • Una River; 23°39′18″S, 047°13′31″W; 25.IX.2013; B.M. Vendramini and E.P. Arruda leg.; associated with roots of *Urochloa* sp.; CIB 295 (1 spec.) • Itupararanga Reservoir; 23°38′13″S, 047°13′07″W; 25.X.2013; B.M. Vendramini and E.P. Arruda leg.; associated with roots of *Urochloa* sp.; CIB 300 (4 spec.) • Sorocabuçu River; 23°43′13″S, 047°11′17″W; 10.IX.2014; B.M. Vendramini and E.P. Arruda leg.; associated with roots of *Urochloa* sp.; CIB 351 (10 spec.).

Identification. Shell sinistral, rounded, with spire pointed; translucent, fragile, shining, pale brown to yellow. Aperture large, forming most of shell's width. Aperture elongate-oval, with weakly defined collumelar lip and demarcated by a typical columellar fold, which creates a discreet flap on right side of aperture. Whorls five, with shallow and poorly marked suture. Ornamentation inconspicuous with only narrow spiral lines. Foot long, tapered toward posterior end. Mantle grayish, with a few, irregularly distributed white spots; rounded and digitiform projections on both sides of mantle. Our specimens 1.5–6.0 mm high × 2.5–10 mm wide.

Comments. *Physa acuta* is similar to *S. marmorata*, and both species can be easily confused. The most distinguishable features are the body whorl and the mantle margin. *Physa acuta* shows a more rounded body whorl compared to *S. marmorata*, when shells of the same size are compared, and it has a mantle with digitiform projections. *Stenophysa marmorata* has a conical body whorl, and the mantle extends much beyond the shell margins and with rounded projections. In juveniles, these characters may not be easily distinguishable, demanding the dissection of the reproductive system (hermaphrodite); in *P. acuta* there is a preputial gland near the region of the prepuce, while *S. marmorata* lacks this gland (Ohlweiler et al. 2010).

Geographical distribution. Origin probably North America; now widely distributed around the world, as well as in Brazil (Santos et al. 2012). Reported from the Tietê river basin (Ohlweiler et al. 2010). Our records are the first from the Sorocaba river basin, São Paulo state.

Family Lymnaeidae Rafinesque, 1815

***Pseudosuccinea columella* (Say, 1817)**
Figure 5J

Material examined. BRAZIL – São Paulo State • Itupararanga Reservoir; 23°38′13″S, 047°13′07″W; 25.X.2013; B.M. Vendramini and E.P. Arruda leg.; associated with roots of *Eichhornia crassipes*/collected with PVC sieve; CIB 298 (1 spec.) • Itupararanga Reservoir; 23°38′13″S, 047°13′07″W; 25.X.2013; B.M. Vendramini and E.P. Arruda leg.; associated with roots of *Eichhornia crassipes*/ collected with PVC sieve; CIB 305 (1 spec.) • Itupararanga Reservoir; 23°39′31″S, 047°21′06″W; 08.I.2014; B.M. Vendramini and E.P. Arruda leg.; associated with roots of *Urochloa* sp.; CIB 315 (1 spec.).

Identification. Shell dextral, small, rounded, fragile, pale brown. Aperture large, oval, very wide in its anterior portion. Whorls 4; body whorl larger than spire. Periostracum translucent and shining. Sculpture consisting of fine incremental and spiral lines that cross to form a cancellate pattern mainly on the body whorl. Mantle grayish with irregularly distributed whitish spots (Ohlweiler et al. 2010). Our specimens were 2.5–3.0 mm high × 4.0–5.0 mm wide.

Geographical distribution. Central and South America, west of the Andes (Simone 2006). Cuezzo et al. (2020) stated that *P. columella* is distributed worldwide. In Brazil, *P. columella* was first recorded by Paraense (1983) in Amazonas state, but this species has since been found elsewhere in Brazil, including São Paulo state (Ohlweiler et al. 2010).

Discussion

The management plan for the Itupararanga Environmental Protection Area does not record the presence of mollusks in the reservoir. Beghelli and Arruda (2011) recorded the presence of empty shells of *Corbicula* sp. in the reservoir, and later, Rodrigues et al. (2016) reported the occurrence of *P. figulina* and *M. tuberculata*. Although studies have evaluated water quality and the macroinvertebrate community in the reservoir (Beghelli et al. 2012, 2014; Rodrigues et al. 2016; Taniwaki and Smith 2011), mollusks were poorly sampled, probably because these studies were conducted in the central, deep portions of the reservoir. By contrast, our study sampled various niches, targeting mollusks, mainly in the branches of the reservoir. The varied use of sampling techniques and the greater sampling effort in the riverine zone prevents us from making a quantitative comparison of richness and abundance between the stations, but we document a wide variety of mollusk habitats in the Itupararanga Reservoir, in which only a few species had previously been found. Of the 13 species collected, seven were recorded in the Sorocaba River subbasin for the first time (*D. capiria*, *P. globulus*, *O. convexus*, *D. cimex*, *U. concentricus*, *M. tuberculata*, and *P. acuta*).

We recorded presence of three invasive species, *C. fluminea*, *M. tuberculata*, and *P. acuta*, at our sampling sites. As in other locations in the Tietê river basin (França et al. 2007; Suriani et al. 2007), invasive mollusks are present in the Itupararanga Reservoir, as the plasticity of these species leads to their success as bioinvaders (Ponder and Lindberg 2008; Santos et al. 2012). However, our sampling does not allow us to assess whether these invasive species constitute a threat to the native species of mollusks in the Itupararanga Reservoir. These species are seen as a threat to native species in other Brazilian reservoirs, leading to a homogenization of the freshwater fauna (Mansur et al. 2004); they are capable of increasing toxic ammonia concentrations and can lead to hypoxia due to the decomposition of dead animals when these species occur in abundance (Miyahira et al. 2020). *Corbicula fluminea*, *M. tuberculata*, *P. acuta*, and *Limnoperna fortunei* (Dunker, 1857) are the most frequently found invasive species in Brazilian reservoirs, and the ecological impact of these non-native species is possibly synergistic (Miyahira et al. 2020).

The invasive golden mussel *L. fortunei* was not found in the Itupararanga Reservoir. This species has been documented in the Paraguay, Uruguay, Paraná (including the Tietê), and São Fransciso rivers basins and in Guaíba Lake (Mansur et al. 2012; Miyahira et al. 2020). Reasons for its absence can be natural or methodological. Although different sampling techniques were used in the present study, we did not use artificial substrates, nor did we search for the planktonic larvae, techniques commonly used for monitoring *L. fortunei* (Mansur et al. 2012). Further investigation is necessary in this reservoir. *Limnoperna fortunei* mainly attaches to hard substrates and occurs in well-oxygenated waters (Santos et al. 2012). The species has also been found in macrophyte roots, although much less commonly (Marçal and Callil 2012, Pereira et al. 2012). The scarcity of hard substrates in the Itupararanga Reservoir may have hampered the establishment of this species, while floating macrophytes are constantly dragged by the water current. The absence of large ship traffic on the Sorocaba River towards the Itupararanga Reservoir may be another barrier to the establishment of *L. fortunei*. According to Cataldo et al. (2005), dispersal of *L. fortunei* is achieved by long-distance ship traffic. The Ituparanga Dam does not have a ship lift.

The mollusks that we collected on macrophytes roots in the Itupararanga Reservoir and in the Una and Sorocabuçu rivers have been frequently found associated with aquatic plants. Pfeifer and Pitoni (2003) recorded the presence of *B. tenagophila*, *P. canaliculata* (Lamarck, 1819), and *Pisidium* sp. among the roots of *E. azurea* (Sw.) Kunth, and *P. canaliculata* and *Drepanotrema* sp. in roots of *E. crassipes*. Martello et al. (2008) found *P. canaliculata*, *L. columella*, and *S. marmorata* in the roots of *E. azurea* and *M. aquaticum*.

The mollusks were sampled in shallow portions of the Itupararanga Reservoir, mainly in the riverine zone, where the water flow suspends fine organic particles, facilitating feeding by species, particularly bivalves. The riverine zone of the Itupararanga Reservoir was considered the most eutrophicated zone by Beghelli et al. (2014) and Rodrigues et al. (2016), with human-induced low dissolved oxygen. More productive environments can support more individuals, but excess nutrient can lead to unfavorable conditions, such as a reduction of oxygen levels leading to the dominance by resistant organisms (Odume et al. 2012). The riverine zone of the Itupararanga Reservoir has many sandbanks and clusters of floating macrophytes, especially *E. crassipes* and *P. stratiotes*. According to Strixino and Trivinho-Strixino (1984), the morphological features of *E. crassipes* allow for the accumulation of material in the submerged roots, providing vegetal and periphyton debris to invertebrates and favoring colonization by many organisms. These macrophyte clusters are strongly influenced by the water flow, which increases in the rainy summer, increasing the probability of plant transport. In the Itupararanga Reservoir, the increased occurrence of *E. crassipes* corresponds to decreased water flow of the rivers during the dry winter season, which favors the establishment and development of floating species, mainly in the most eutrophic riverine zone (Pavão et al. 2017). Consequently, the presence and abundance of the gastropods *P. figulina*, *O. convexus*, *B. tenagophila*, and *P. columella* and the bivalve *P. globulus*, which we found mainly in floating macrophytes at stations 2–4, 6, 10, and 11, may be influenced by seasonal variations in water flow in the Itupararanga Reservoir.

Beghelli et al. (2014) noted that starting from the riverine zone of the Itupararanga Reservoir, dissolved oxygen values tend to increase in a horizontal gradient, while the excess of organic matter, brought by the tributaries dilutes along this same gradient. The transitional zone was classified as mesosaprobic by Rodrigues et al. (2016), presenting better water quality than the riverine zone. In our study, we collected no mollusks at stations in the transitional zone of the reservoir. The stations in which mollusks were collected in the lacustrine zone had sandbanks (station 22) and macrophytes (station 20). Station 20, in the lacustrine zone, is located next to a water retention construction of the Paruru, a stream receiving untreated domestic sewage and where many clumps of an invasive *Urochloa* sp. grow. In this station were found *Stenophysa marmorata* and *L. columella* associated with *Urochloa* sp., *P. figulina* and *Melanoides tuberculata* in the sediment. *Melanoides tuberculata* was only found at this station, next to a water retention construction. The absence of mollusks in the transitional zone and the low mollusk richness in the lacustrine zone is probably related to environmental homogeneity, lack of shelter, and possible niches for mollusks, since most species preferably attach to macrophytes or are in sandbanks. The stations with highest species occurrence (stations 3 and 20) are those with considerable habitat diversity, mainly at the reservoir margins.

Among the native bivalves, *A. trapesialis* is widely distributed in the Neotropical region and has been reported in the lower region of the Tietê River (França et al. 2007) and the Sorocaba River (Smith et al. 2014); *D. caipira* has been recorded in the tributaries of the Upper Paraná River (Sapucaí and Pardo rivers) (Machado et al. 2008). In the Tietê river basin, *D. caipira* was recorded in the Piracicaba River, its type locality, where it has not been found recently (Machado et al. 2008). Our study is the first to report *D. caipira* from the Sorocaba River. The taxonomy and distribution of this species are widely unknown (Miyahira et al. 2019), and our new data can be useful for its conservation. The presence of *A. trapesialis* and *D. caipira* emphasizes the importance of the reservoir as part of a protected area. The occurrence of these species in the reservoir may encourage deeper research into many aspects of their biology that remain unknown, such as their reproductive habits and population biology (Miyahira et al. 2017). The stability of the sandbanks in which *A. trapesialis* and *D. caipira* live, as well as the frequency of sediment deposition, influences their distribution (Hegeman et al. 2014). The distribution of *A. trapesialis* may be associated sediment rich in organic matter, as organic matter is the main food source for filter feeders such as bivalves (Colle and Callil 2012). *A. trapesialis* and *D. caipira* are noteworthy as their development from larvae into juveniles and dispersal depends on attachment to the gills of fish hosts. The larvae of unionid mussels, like *A. trapesialis* and *D. caipira*, are parasitic in the inner demibranch of fish. In *Anodontites trapesialis* (Lamarck, 1819), after about 27 days as parasitic, larvae release from their host and settle to the bottom (Callil et al. 2012). Hence, the conservation management of fish species is needed to avoid extinction of mussels. Our new data on *D. caipira* and *A. trapesialis* expand the known distribution of these species.

Our sampling attempts also focused on *Biomphalaria*, as three species of this genus can host trematodes of medical interest, and at reservoir *B. tenagophila* occurs. This species was found at sampling stations where sewage discharge was present and interfered with water conductivity (Taniwaki and Smith 2011), a possible reason for these organisms in our study. *Biomphalaria tenagophila* is one of the most frequent species of the genus has already been reported from the Tietê river basin (Vaz et al. 1987); further investigation is needed to verify the parasitological potential of *B. tenagophila* in the Itupararanga Reservoir. The specimens we collected were infected with an annelid ectoparasite, *Chaetogaster* sp., which is quite common in *Biomphalaria* (Martins and Alves 2010). This infection can be a protection against trematodes, as the annelid feeds on miracidia and cercariae (Eveland and Haseeb 2011), representing a facultative mutualism.

Another well-established species in the Itupararanga Reservoir, *P. figulina*, is mainly associated with macrophytes (stations 3, 4, 10, and 11), but specimens were also found living in sediment at station 20. Although our sampling was qualitative, we observed that the most frequent mollusk species was *P. figulina*. The macrophytes were mainly characterized by an emerged top, allowing floating on the surface, and dense roots to which the specimens were adhered. The collection of floating macrophytes with PVC sieves was especially important for collecting *P. figulina*, which often drop off the roots and down to the bottom when the macrophytes are disturbed.

Our study found several species recorded for the first time from the Sorocaba river basin. Most of these species, especially the gastropods, are resistant and able to live in habitats that range from oxygenated to severely polluted conditions (Ohlweiler et al. 2010). *Uncancylus concentricus* was the only species found exclusively at a river sampling site (the Sorocabuçu River), which is explained its occurrence on gravel, preferably in lentic environments with lower macrophyte density (Pereira et al. 2011). The presence of *U. concentricus* indicates high oxygenation levels in lotic environments (Sá et al. 2013). *Drepanotrema cimex* and *P. acuta* were found both in the Itupararanga Reservoir and the surveyed rivers. Both species live in varied environments, from pristine to polluted, and reach highest population densities in the rainy season (França et al. 2007; Pastorino and Darrigan 2011).

Of the mollusk species found in the Itupararanga Reservoir, *A. trapesialis* and *P. figulina* have potential for use as bioindicators due to their large populations and their benthic substrate, which qualifies them for toxicity tests in a freshwater environment. Additionally, *P. figulina* has a short life cycle and is fast growing and can be an alternative for cultivation and laboratory tests (OECD 2010). Filter feeding mussels, such *A. trapesialis*, have long been used as bioindicators for environmental monitoring and as effective biomarkers of pesticides and trace elements like mercury, lead, and cadmium (Lopes et al. 1992; Callil and Junk 1999; Tomazelli et al. 2003).

Our results represent the first step towards an inventory of mollusks from the Itupararanga Reservoir, providing new data which may be useful for conservation efforts. Our study also contributes to the biomonitoring of the freshwater fauna and helps in identifying sampling sites with a probability of higher diversity of mollusk species. Integrating our new data with data from other aquatic studies may be useful in developing guidelines meant to increase reservoir water quality. Further studies can provide a better perspective of the reservoir dynamics and to understand how effective the protected area is for native mollusk conservation. However, given the number of non-native species found and the visible decline in the water quality of the Itupararanga Reservoir (CETESB 2017; Beghelli et al. 2014; Bottino et al. 2013), the conservation of native mollusks depends on preserving the environment in the surrounding areas, whose multiple uses are harming the balance of the ecosystem (Frascareli et al. 2015).

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Authors' Contributions

Conceptualization: EPA. Data curation: BMV. Formal analysis: BMV. Funding acquisition: EPA. Methodology:

BMV, EPA. Supervision: EPA. Visualization: EPA. Writing – original draft: EPA, BMV. Writing – review and editing: BMV, EPA.

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