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When alien fauna overtakes the native one: the molluscs of Piranhas-Açu River

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Abstract. This work documents the malacofauna of Piranhas-Açu River, Northeastern Brazil. Before the diversion of São Francisco River, that may bring several alien species. We collected 1535 molluscs of which 82.1% were invasive exotic.

Key words: Bivalve, Gastropod, benthic fauna, bioinvasion, limnic environment.

Resumo: **Quando a fauna exótica supera a nativa: os moluscos do Rio Piranhas-Açu.** Este trabalho documenta a malacofauna do rio Piranhas-Açu, no Nordeste brasileiro, antes de receber águas transpostas do Rio São Francisco e com elas várias espécies exóticas. Foram coletados 1535 espécimes das quais 82,1% eram exóticas invasoras.

Palavras-chave: Bivalve, gastrópode, fauna bentônica, bioinvasão, ambiente límnico.

Limnic environments are amongst the most impacted habitats in the world, mainly regarding biodiversity. Studies demonstrate a growing number of extinctions in freshwater ecosystems, warning that the decline in biodiversity in these environments is much greater than that of the most affected terrestrial environments (Taylor *et al.* 1996, Neves *et al.* 1997, Ricciardi & Rasmussen 1999). This loss of biodiversity is linked to habitat deterioration due to: pollution, sediment movement, toxic contaminants, fragmentation and regulation of water flow by dams and the presence of exotic species (Benke 1990, Neves *et al.* 1997, Richter *et al.* 1997, Mack *et al.* 2000).

In the Brazilian semi-arid region, in addition to the typical dry period that lasts, on average, nine months in the state of Rio Grande do Norte, the aquatic ecosystems have been rapidly modified by anthropic action, mainly through the building and drying of ponds, barraging rivers, establishment of industries, and the flow of people caused by tourism (Gurgel *et al.* 2002). Due to the vulnerability of this ecosystem in the face of human activities and climate change, we can observe that this habitat suffers with the loss of mollusc biodiversity – accentuated still by the presence of exotic species. Identifying the species most susceptible to extinction is of utmost importance in planning the conservation of terrestrial natural ecosystems (Zhang *et al.* 2017). The Piranhas River is set to receive waters from the São Francisco River (Northern axis) once the transposition is finished. This may bring several species that will be able to competitively exclude the native species found in the Piranhas River, potentially reducing the biodiversity of an environment that is already fragile. Although the benthic invertebrate fauna of this river was studied in 2002, the molluscs were identified at the order level, which prevents conclusions about their origin (Andrade *et al.* 2008).

According to the definitions adopted by the International Convention on Biological Diversity

(CDB 2010), to be considered exotic, a species must be in a place other than that of its natural distribution. To be considered established, it must reproduce and generate fertile descendants, as well as having high likelihood of surviving in the new habitat. If the species expands its distribution in the new habitat, threatening native biodiversity, it will be considered an invasive exotic species.

The objective of this work is to identify and quantify the species of limnic molluscs that inhabit the final stretch of the Piranhas-Açu River (Fig. 1). The collections were done in January (rainy season) and June (dry season) 2018. Surveys were carried out near the municipality of Alto do Rodrigues/RN.

For the collection of the molluscs, three transects were drawn perpendicularly to the banks of the river. Each one was 15 meters long and placed 30 meters apart from each other. Every five meters, a sample of sediment was collected, totalling 3 points per transect. At each point, a square with an area of 0.25m² was positioned onto the riverbed and the sediment inside the square was removed; sieved through a 0.2µm mesh and fixed in 70% alcohol with Bengal Rose dye, to highlight the organisms. Only organisms with soft tissue were accepted, that is, empty shells were discarded. Next, the molluscs were removed from the sediment, identified with the help of malacological guides (Simone 2006, Pereira *et al*. 2012) and counted. In several samples, in addition to the sediment, submerged macrophytes were also collected. An Analysis of Variance (ANOVA) was used to test for significant differences in mollusc densities between dry and rainy season.

In total, 1535 organisms, belonging to five species, were collected (Table I). Three belonged to the Gastropoda class: *Pomacea lineata* (Spix, 1827), *Biomphalaria* sp. and *Melanoides tuberculatus* (Müller, 1774) and two to the Bivalvia class: *Eupera* cf. *modioliforme* (Anton, 1837) and *Corbicula* sp. Of these, two species were exotic: *Melanoides tuberculatus* and *Corbicula* sp. (Fig. 2). It was not possible to identify the latter one at its lowest taxonomic level, however, there are 4 species of the genus *Corbicula* introduced in Brazil: *C. fluminalis*, *C. fluminea*, *C. largillierti* and *Corbicula* sp. (Pereira *et al.* 2014).

In total, 723 specimens of *M. tuberculatus* were sampled, with highest density of 242 ± 160 ind./m² during rainy season (Table I). In the present study, we found the predominant presence of this mollusc in all sampling points. This species can easily adapt to different environmental conditions

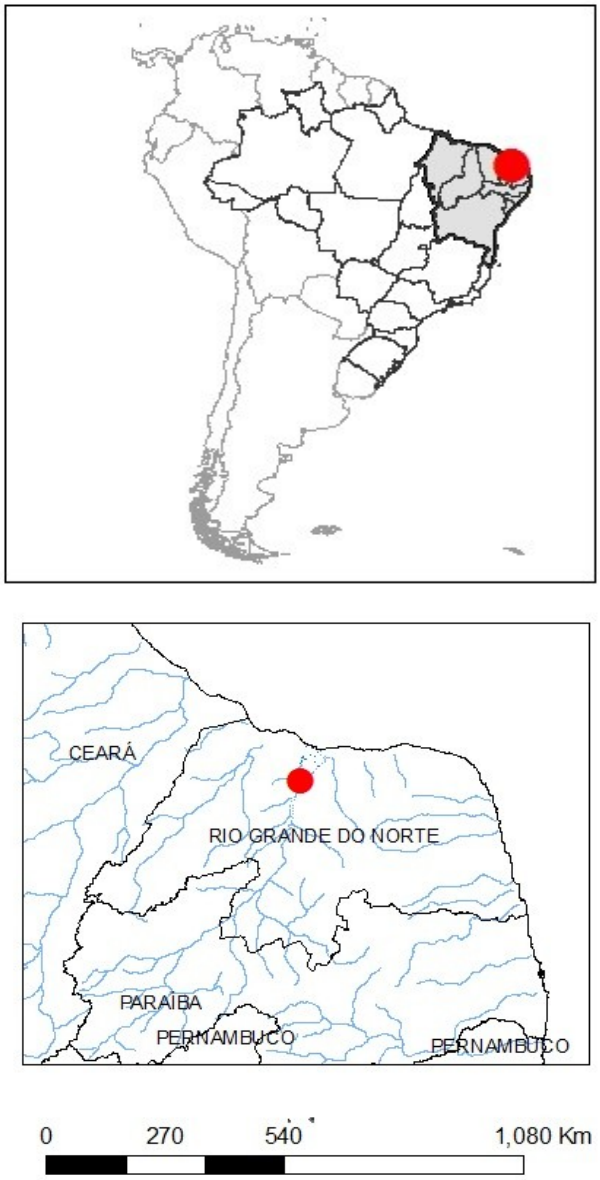

Figure 1. Location map of the sampling area: position of the state of Rio Grande do Norte (RN) in South America (left) and Piranhas-Açu River in the state of RN, with details of the intermittent rivers in the region (right).

(Vidigal *et al.* 2005), surpassing the populations of the native gastropods *Biomphalaria* sp. and *P. lineata.*

There was no statistical difference between dry and rainy season for relative abundance (p= 0.949) or mean density of species (p= 0.360). However, the gastropods population density was higher during dry season. fact that commonly happens in semi-arid aquatic systems (Abílio *et al.* 2006) and may be related to a higher speed of water flow during the rainy period (Andrade *et al*. 2008), which carries these molluscs away. Bivalves,

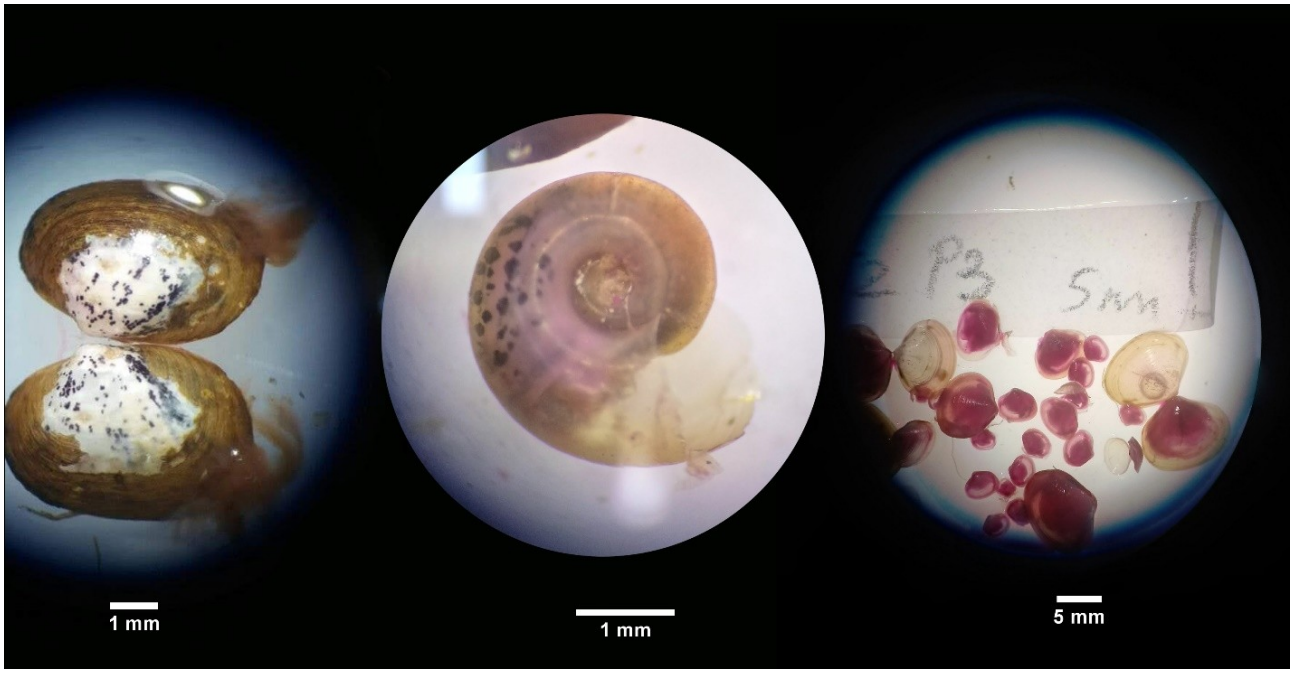

Figure 1. Some of the molluscs from Piranhas-Açu River. From left to right: *Eupera* cf. *modioliforme*, *Biomphalaria* sp. and *Corbicula* sp.

Table I. Relative abundance expressed in percentage and mean density of mollusc expressed in individuals per meter squared (ind./m²), collected in a stretch of the Piranhas-Açu River, Rio Grande do Norte Estate, Brazil, In both seasons (rainy and dry) of 2018.

Taxon			Relative abundance (%)		Mean density (ind/m²) ± SD	
Class	**Family**	**Species**	**Rainy**	**Dry**	**Rainy**	**Dry**
Gastropoda	Ampullariidae	*Pomacea lineata*	0.4	0.7	0.9 ±1.01	2±0.9
	Planorbidae	*Biomphalaria* sp.	4	5.9	9.3±4.3	12±13.2
	Thiaridae	*Melanoides tuberculatus*	68.5	58.7	160±81.4	242.7±160.3
Bivalvia	Cyrenidae	*Corbicula* sp.	27.1	34.6	64±15.2	62.7±86.7
	Sphaeriidae	*Eupera* cf. *modioliforme*	0.1	0	0.7±1.2	0

however, presented lower density during dry season. *Corbicula* sp. presented slight reduction in density, while *E*. cf. *modioliforme* was not found in this period. According to Moreno and Callisto (2006), this higher number found in rainy season is due to the increase in the volume of the river, which increases the number of submerged substrates, increasing the number of available habitats. In the dry season, the opposite takes place.

Mollusc fauna surveys in rivers of the Brazilian northeast usually present richness inferior to 10 species (see Silva *et al*. 2020). While in south of Brazil, it can reach values of 30 to 40 species (Veitenheimer-Mendes *et al*. 1992, Mansur & Pereira 2006, Maltchik *et al*. 2010), using the same sampling methodology. The factor most attributed to this variation is the quantity of drainage areas and levels of rainfall (Pereira *et al*. 2014), which are higher in the south of the country. Kotzian & Amaral (2013) ascertained that the malacofauna of a river can present different biodiversity according to the pluviometric measurements and the local vegetation, as is the case of the Contas river in the state of Bahia. In its 360km of length, this river travels from

the Atlantic Forest biome with a semi-humid climate to the Caatinga biome, which is semi-arid. In the latter one the malacofauna richness decreases from 13 to 9 species.

In addition to the competitive relationship between native and invasive species, low richness of molluscs in the semi-arid region is associated with the climate of this region, which creates bordering conditions to the native limnetic malacofauna (Wolfe 2002, Kotzian & Amaral 2013, Do Nascimento Filho *et al*. 2014).

In this survey, exotic species constituted 82.1% of the total number of specimens sampled, it is likely that this affects negatively the native malacofauna due to competition for food and space in the benthic habitat. However, it is possible that after invading a new habitat, the population of some exotic species will stabilise and eventually decline over time, as with the species *Corbicula fluminea* and *Corbicula largillierti*. About 25 years after the beginning of their invasion in Río de la Plata, Argentina, these populations have decreased by 90% (Reshaid *et al.* 2017).

The present work is the first to focus on the malacofauna in this river and constitutes an important step to further preservation efforts to protect these molluscs in an environment that has been undergoing constant human changes and will soon receive the contribution of waters from the transposition of the São Francisco River.

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