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SHORT COMMUNICATION

# An update of the amazon prawn (*Macrobrachium amazonicum*) distribution in the low course of the São Francisco river (northeast Brazil)

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## Abstract

The prawn *Macrobrachium amazonicum* has been considered a successful colonizing species of freshwater environments beyond its native range; however, information on the distribution of the species in rivers in northeastern Brazil is doubtful or incomplete. This study updates the presence of the Amazon River prawn *Macrobrachium amazonicum* in the São Francisco River (northeast Brazil) where eight areas were sampled downstream from the Xingó Hydroelectric Plant (Alagoas/Sergipe) up to the mouth of the river, between April 2014 and February 2016. The specimens were sampled using manual trawls and artisanal traps. Hydrological data were obtained using a multi-parameter probe. Only 258 specimens were found in Piranhas, Pão de Açúcar, and Belo Monte, which are regions far from the mouth of the river. They were found in shallow (3.96 ± 1.01 m), warm (26.15 ± 1.18 °C), and oxygenated fresh waters (5.70 ± 1.14 mg $L^{-1}$) with low turbidity (71.33 ± 6.43 mg $L^{-1}$) and slight alkalinity (7.26 ± 0.53), always associated with the aquatic vegetation. The presence of *M. amazonicum* has not yet been evaluated in relation to possible impacts on local native diversity. Therefore, studies addressing the interaction of this species with native species are necessary to understand whether or not it poses a risk to endemic species.

## Keywords

Bioinvasion, crustacea, freshwater prawn, monitoring, non-native species

## Introduction

The Amazon River prawn *Macrobrachium amazonicum* (Heller, 1862) is abundant and caught in the Amazon region; it is consumed by all social classes (Collart and Moreira 1993). This prawn has a wide distribution in the tropical and subtropical regions of South America (Melo 2003), and is commonly found in lakes, dams, floodplains, and rivers in the main tropical and subtropical hydrographic basins (Coelho and Ramos-Porto 1985; Ramos-Porto and Coelho 1990; López and Pereira 1996; Pettovello 1996; Bialetzki et al. 1997; Magalhães 2000, 2001, 2002; Melo 2003; Montoya 2003; Valência and Campos 2007).

The wide distribution of *M. amazonicum* is a probable adaptive response to environmental differences in its natural distribution due to the high intra-population tolerance to environmental variables (Moraes-Riodades et al. 2006) and considerable morphological plasticity (Vergamini et al. 2011). *M. amazonicum* can complete its life cycle entirely in freshwaters (Maciel and Valenti 2009). These facts have made this species a successful colonizer of freshwater environments; however, it is not entirely clear whether this dispersal is natural or was also facilitated by human action in some regions through cultivation activities (Gurgel and Matos 1984; Magalhães et al. 2005; Vergamini et al. 2011;); or lack of monitoring of non-native species (Gajardo and Laikre 2003; Carr and Whoriskey 2006), which may have allowed animals to escape into the natural environment, as was the case with *Macrobrachium rosenbergii* (Oliveira and Santos 2021).

In northeastern Brazil, *M. amazonicum* is an exotic species introduced (Magalhães et al. 2005; Vergamini et al. 2011), probably by the National Department of Works Against Drought (DNOCS) in 1939 to serve as food for some species of carnivorous fish previously introduced in reservoirs in the region (Gurgel and Matos 1984; Collart and Moreira 1993; Silva 2006). Approximately thirty-four years after its introduction in the Northeast, i.e., in 1973, this prawn was the species with the highest total production in the Northeast water reservoir. In the following decade, this species also stood out as one of the most productive for the Brazilian Northeast region (Gurgel and Matos 1984; Silva 2006).

However, the information on *M. amazonicum* in northeastern rivers is doubtful or incomplete. For the São Francisco river, it is likely that the construction of the Palmeira dos Índios Public Reservoir (in Alagoas), also in 1939, may have been the starting point for the introduction and dispersion of *M. amazonicum* in the lower São Francisco river. Coelho and Ramos-Porto (1985) only cited in the São Francisco Basin upstream from the Paulo Afonso waterfall, without any other information. Thus, this study comments on the occurrence of *M. amazonicum* in the region of the lower São Francisco river, providing an updated view of its distribution.

The hydrographic basin of the São Francisco river is located between the coordinates 7° and 21°S and 35° to 47°W. It covers a drainage area of 639,219 km$^2$ (Araújo et al. 2016). This study was carried out in the lower São Francisco river, downstream from the Xingó Hydroelectric Plant (states of Alagoas and Sergipe) up


**Figure 1.** Sampling points performed in this study in the São Francisco River, northeast Brazil.

to the mouth of the river (Medeiros et al. 2014), in northeast Brazil, between April 2014 and February 2016.

The samples were collected near the cities of Piranhas, Pão de Açúcar, Belo Monte, Traipu, Porto Real do Colégio, Penedo, Penedinho and Piaçabuçu (state of Alagoas) (Figure 1), as part of the São Francisco River Environmental Monitoring Project (São Francisco Hydroelectric Company - CHESF). Temperature, depth, dissolved oxygen, electrical conductivity, pH, and total dissolved solids were measured in the morning, using a multi-parameter YSI PROplus probe. The substrate characteristics were recorded.

The animals were collected, under license no. 345/2013 (ICMBIO) for the capture and transport of biological material. A trawl net with 5 mm mesh was used, with ten minutes of duration, near the submerged aquatic vegetation at each collection point. In addition, a bottom trap (made of 200 mm PVC tube and 15 mm internode screen), which is locally known as "covo", was also used. The traps contained roasted rice cake as bait and were placed in the river at dusk and collected the next day after 12 hours of immersion.

The specimens were identified according to the bibliography of Holthuis (1952) and Melo (2003) which describes the species as having, among other characters,

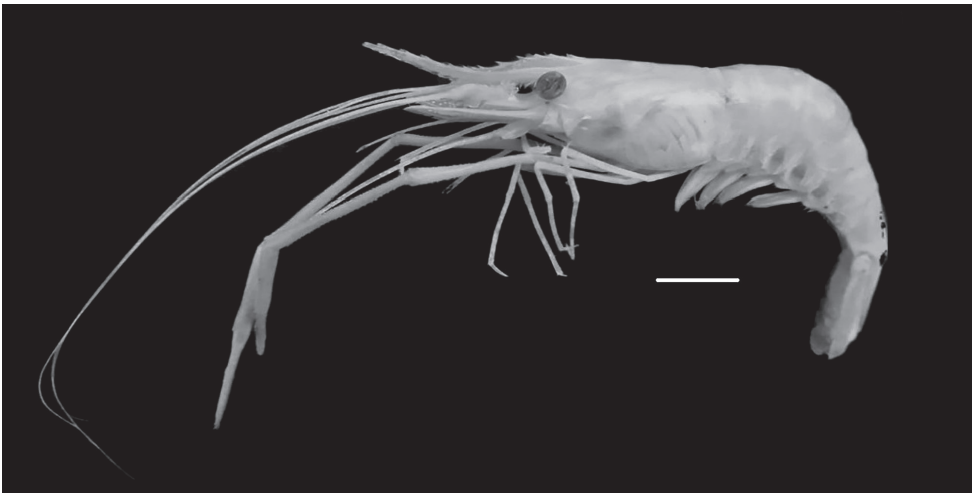

**Figure 2.** Male of the Amazon River Prawn, *Macrobrachium amazonicum*, collected in São Francisco river, northeast Brazil. Scale bar: 1 cm.

a long rostrum surpassing the scaphoid, rostrum with dorsal margin with 9 to 12 teeth, the first seven teeth forming a basal crest in the proximal half of the rostrum, and the last tooth more spaced and closer to the extremity, ventral margin of the rostrum has 8 to ten 10, telson ending in an acute median point with two pairs of spines on the posterior margin, and the inner pair do not reach the end of the telson.

Sex was determined according to the presence or absence of the male appendix in the second pair of pleopods, and was classified as males, females or ovigerous females. The animals were preserved in 70% alcohol and deposited at the Carcinological Collection of the Federal University of Alagoas, in Penedo, Brazil.

A Pearson correlation matrix (r) was constructed, using the BIOESTAT 3.0 program (Ayres et al. 2003), to establish the relationships between the occurrence of the species by locality and abiotic variables. The level of significance considered was 0.05.

A total of 258 *Macrobrachium amazonicum* specimens (Figure 2) were collected, 122 of which were male (47%) and 136 females (53%) (Table 1). At the time of capture, the prawns had a clear, almost transparent light color typical of this species.

The Amazon River prawn was collected only in Piranhas, Pão de Açúcar, and Belo Monte (140 km from the mouth of the river) (see Figure 1), which are far from the mouth of the River. Pearson's correlation matrix between abundance and variables did not indicate a correlation between any of the abiotic parameters and the collection sites that influence the distribution of animals ($p>0.05$)(Table 2).

In this study, *M. amazonicum* was detected in sites with occurrence of the Brazilian waterweed (*Egeria densa*), which is common in the lower São Francisco river region, in shallow (3.9 ± 1.01 m), warm (26.15 ± 1.18 °C), and oxygenated fresh waters (5.70 ± 1.14 mg L-1) with a low turbidity (71.33 ± 6.43 mg L-1) and slight alkalinity (7.26 ± 0.53) (Figure 3). Such conditions are slightly different from those

**Table 1.** Specimens of the Amazon River prawn, *Macrobrachium amazonicum*, collected in São Francisco River, northeast Brazil, between April 2014 and February 2016.

| Local | Date | Examined material | | |
|---|---|---|---|---|
| | | Male | Female | Ovigerous female |
| Piranhas 09°37.485'S, 37°44.438'W | April -2014 | 3 | 9 | 6 |
| | June - 2014 | 3 | 3 | - |
| | December - 2014 | 7 | 17 | 12 |
| | February - 2015 | 2 | 1 | - |
| | June - 2015 | 16 | 3 | 1 |
| | August - 2015 | 3 | 1 | 1 |
| | October - 2015 | 1 | 1 | - |
| Pão de Açúcar 09°45.271'S, 37°25.735'W | June - 2014 | 2 | 4 | - |
| | August - 2014 | 8 | 14 | 6 |
| | October - 2014 | - | 5 | 5 |
| | December -2014 | 2 | - | - |
| | April - 2015 | 9 | 18 | 16 |
| | June - 2015 | 4 | 11 | 10 |
| | August - 2015 | - | 4 | 4 |
| | October - 2015 | 1 | - | - |
| | February - 2016 | 13 | 5 | 5 |
| Belo Monte 09°49.635'S, 37°17.092'W | October - 2014 | 1 | 16 | 15 |
| | December -2014 | 1 | 6 | 5 |
| | February - 2015 | - | 1 | - |
| | April - 2015 | 3 | - | |
| | August - 2015 | 5 | 3 | 2 |
| | October - 2015 | 11 | 3 | 3 |
| | February - 2016 | 15 | 5 | 5 |

**Table 2.** Pearson's correlation matrix between abundance of *Macrobrachium amazonicum* and abiotic variables in São Francisco River, northeast Brazil, between April 2014 and February 2016.

| | Pearson's correlation matrix | |
|---|---|---|
| | R | p |
| Temperature | -0.752 | 0.06 |
| Dissolved oxygen | -0.359 | 0.381 |
| Total dissolved solids | -0.418 | 0.302 |
| Conductivity | -0.293 | 0.479 |
| pH | 0.023 | 0.795 |
| Salinity | -0.19 | 0.651 |

found in the typical region of the species in the Amazon, where populations occur at temperatures between 26-30 °C and slightly acidic pH (6.2-6.8) (Silva et al. 2002; Silva et al. 2007; Flexa et al. 2005).

We noticed that all places of occurrence of *M. amazonicum* in our study had low salinity, probably because even though species of the genus *Macrobrachium* need high salinity for their larval development (Alekhnovich and Kulesh 2001), some populations of *M. amazonicum* occur in inland regions without influences of marine or estuarine areas; larvae complete their development entirely in fresh-waters (Charmantier and Anger 2011). Araújo and Valenti (2010) reported that *M. amazonicum* larvae can osmoregulate, an advantage for the species, because, even if the females spawn in fresh water, the larvae survive until they reach brackish water. In

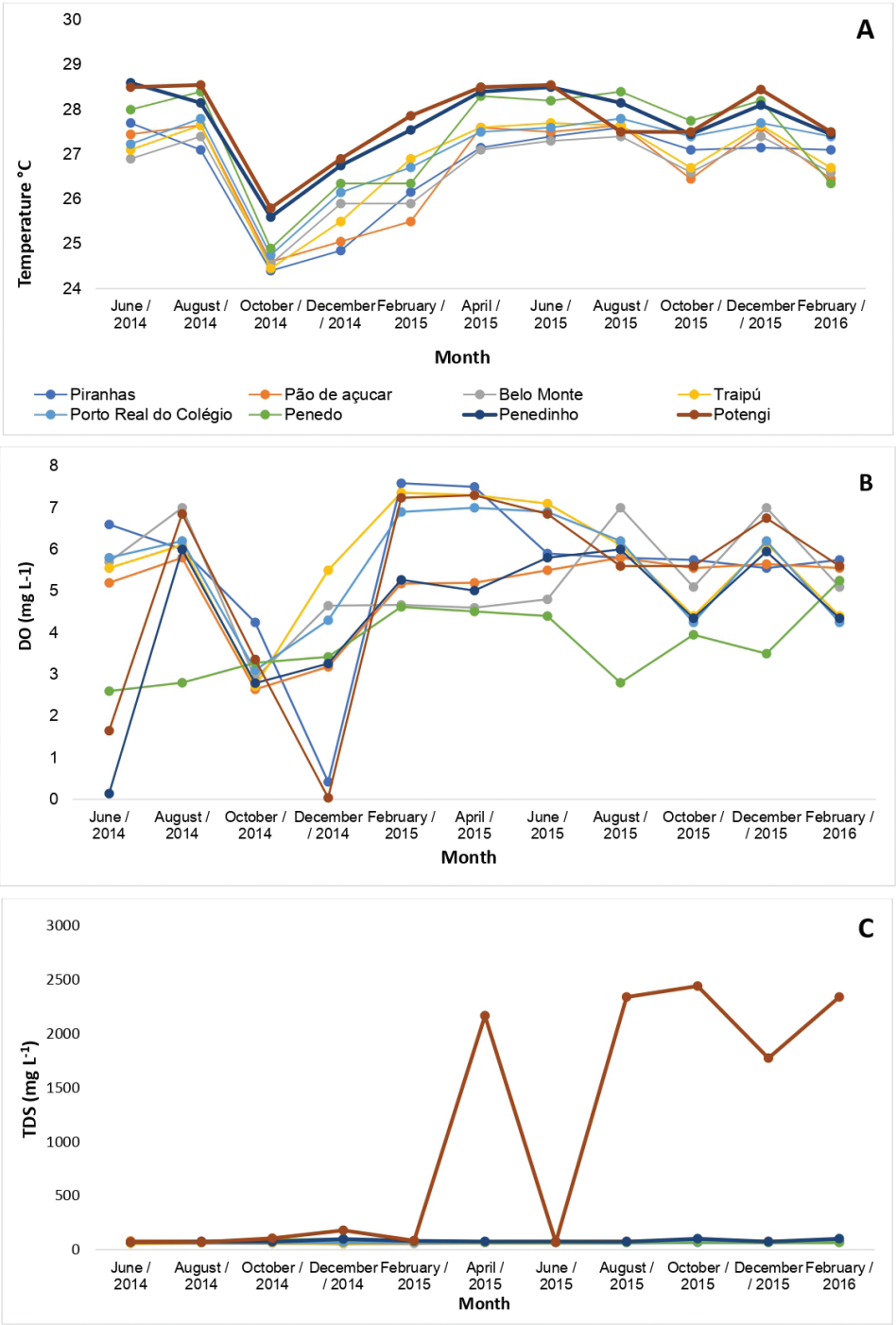


**Figure 3.** Hydrological data of study areas in São Francisco River, northeast Brazil, between April 2014 and February 2016. **A.** Temperature; **B.** Dissolved oxygen; **C.** Total dissolved solids.

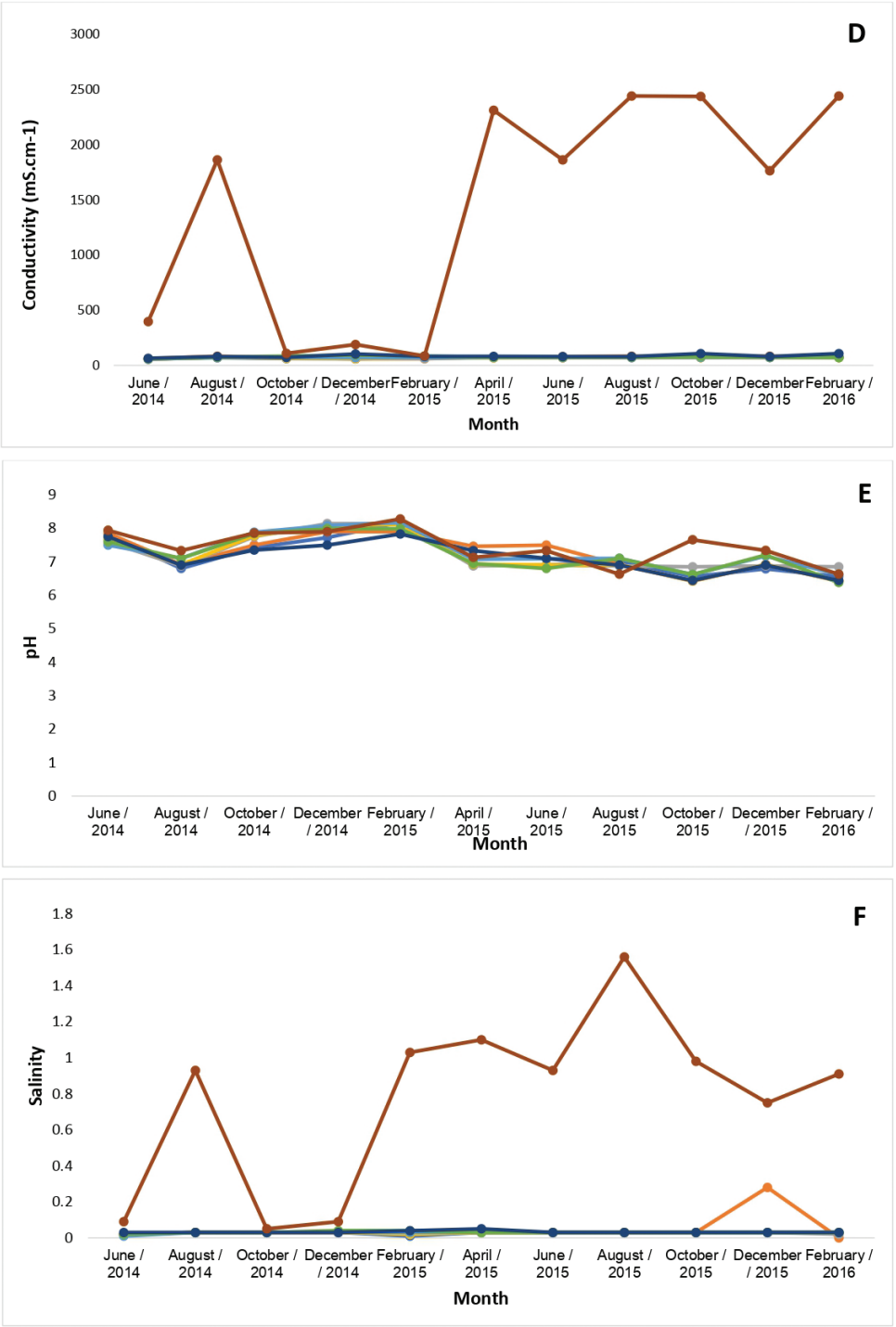


**Figure 3.** Continued. **D.** Conductivity; **E.** pH; **F.** Salinity.

addition, these authors corroborate in their studies, that there was metamorphosis of the larvae in low salinity, indicating a greater degree of adaptation to fresh water in relation to other species of *Macrobrachium*. These results may explain why there are no catches during sampling in the region near the mouth of the São Francisco River, leading us to infer that females of *M. amazonicum* had their entire reproductive process at points upstream of Foz do São Francisco (Piranhas, Pão de Açúcar and Belo Monte).

There were records of ovigerous females during all studied periods. The data presented here are interesting because, although the São Francisco river connects with the ocean and has an expressive fluviomarine plain, no specimens were found in sample sites with the influence of marine or estuarine areas. The specimens were found only in the typical habitat of continental populations of *M. amazonicum* that occur away from the coast (Maciel and Valenti 2009).

As previously noticed (Moraes-Riodades et al. 2006; Araújo and Valenti 2010), it is likely that *M. amazonicum* has adapted to environmental differences in the low course of the São Francisco River and managed to establish itself in low salinity. It is possible that there is a physical barrier that is preventing the animals from colonizing the other locations justifying the restriction of animals in the upper portion, since the environmental conditions are practically the same along the course of the river, but during the sampling, it was not identified. The vegetation (*Egeria densa*) where the animal was found in the upper locations was observed throughout the course of the river.

## Conclusion

The Amazon River prawn *Macrobrachium amazonicum* was found in the São Francisco River associated with aquatic vegetation more than 140 km away from the mouth of the river. Its occurrence only in water without a saline influence and the presence of ovigerous females throughout the studied period confirm that this exotic species managed to establish its ecological niche by reproducing entirely in freshwaters. The presence of *M. amazonicum* has not yet been evaluated in relation to possible impacts on local native diversity. Therefore, studies addressing the interaction of this species with native species are necessary to understand whether it poses a risk to endemic species or not.

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