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RECORDS OF ROSTRAL ANOMALIES IN Macrobrachium amazonicum (HELLER, 1862) (DECAPODA: PALAEMONIDAE) COLLECTED ALONG THE GREAT AMAZON RIVER BASIN

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Abstract

Morphological anomalies in decapod crustaceans are frequently reported in studies around the world, some of which are due to anthropogenic actions through environmental impacts. These deformities can affect different structures (e.g., carapace, scaphocerite, rostrum, chelipeds, abdomen and telson) and interfere with development, feeding, resource competition, and reproductive behavior of crustaceans. The palaemonid shrimps occur in various ecosystems, covering marine and freshwater areas; however, few studies report morphological anomalies in freshwater shrimps in Brazil. Therefore, this study aimed to report and catalog the morphological anomalies in the rostral forms of the shrimp *Macrobrachium amazonicum* (Heller, 1862), collected from the Great Amazon River Basin, Pará, Brazil. The specimens were captured during collections carried out along the Xingu River watershed, near the municipalities of Altamira and Vitória do Xingu, using bamboo traps, known as "matapis," baited with babassu. After the samples, the specimens were sorted out, and transported to the laboratory for subsequent biometric measurements, weighing, taxonomic identification, and registration of the abnormalities. A total of 2.199 specimens of the *M. amazonicum* were collected, being identified twenty shrimps with anomalies in the rostral region, corresponding to 0.9% of the total number of shrimps analyzed. Herein, the anomalies observed consisted of a reduction in the size of the rostrum, with varying shapes, and a decrease in the number of rostral teeth compared to the expected for the species. Further studies are needed to identify the potential causes of the anomalies in shrimps from the Amazon region.

Keywords: Amazon River shrimp. Morphological anomalies. Eastern Amazon. State of Pará.

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1 Introduction

Morphological anomalies in decapod crustaceans have been recorded since the nineteenth century (AGUIRRE; HENDRICKX, 2005) and are frequently reported in studies worldwide, involving shrimps, crayfish, lobsters, and crabs (MARIAPPAN; BALASUNDARAM; SCHMITZ, 2000; FOLLESA et al., 2008; ARAÚJO; CALADO, 2012). These anomalies can affect various body structures, including the carapace, scaphocerite, rostrum, chelipeds, uropods and telson, potentially interfering with species development, feeding, and ecological interactions, such as competition for resources or reproductive behaviour (ARAÚJO; CALADO, 2012; LEVESQUE et al., 2018).

With approximately 1.200 described species occupying diverse environments and ecosystems worldwide (FROLOVÁ; HORKÁ; ĎURIŠ, 2022), shrimps of the family Palaemonidae Rafinesque, 1815 are abundant organisms in marine and freshwater areas, with significant economic and ecological importance (GARCÍA-GUERRERO et al., 2013) serving as excellent bioindicators of environmental quality (WEBB, 2011). However, environments impacted by the release of organic or chemical pollutants, along with factors such as climate change, can severely affect the development of shrimp and other decapods, leading to various issues, including morphological anomalies (BÉGUER et al., 2010; ARAÚJO; CALADO, 2012; FEUILLASSIER et al., 2012; LEVESQUE et al., 2018).

Some genera of palaemonid shrimps, such as *Macrobrachium* Spence Bate, 1868 and *Palaemon* Weber, 1795, have already been documented with structural deformities (DE GRAVE, 1999; DE GRAVE; MENTLAK, 2008; MARTINS et al., 2022). Up to date, countless anthropogenic impacts have affected the morphology of the shrimps, for instance, Feuillassier et al. (2012) reported anomalies in the cephalothorax and rostrum of *Palaemon longirostris* Milne Edwards, 1837, and *Palaemon macrodactylus* Rathbun, 1902, and Levesque et al. (2018) observing abnormalities in the *Palaemon longirostris*, which both authors indicated environmental impacts as possible causes of these anomalies.

The Amazon River shrimp *Macrobrachium amazonicum* Heller, 1862, is a taxon widely distributed across Brazil and abundant in the Amazon Basin, with high ecological and social importance (BÉGUER et al., 2010; BENTES et al., 2011). Additionally, Martins et al. (2022) observed body abnormalities in the *M. amazonicum*.

For shrimps of the genus *Macrobrachium*, certain anomalies can potentially hinder taxonomic identification, as features like the number of rostral spines or telson shape are critical for species-rank classification (MELO, 2003).

Although these anomalies have been recorded in the literature, studies focusing on morphological anomalies in *Macrobrachium* shrimps remain scarce, particularly concerning shrimp from Amazonian rivers. Therefore, this study aims to characterize the morphological anomalies observed in the shrimp *M. amazonicum* collected from the Great Amazon River Basin (Xingu River), Pará, Brazil.

2 Material and Methods

Study Area

The samples were carried out in the Xingu River (see supplementary Table 1) (Fig. 1), which is a major clearwater tributary of the Amazon River (Schmid et al., 2024).

The monitoring points (MP) correspond to hydrographic locations of the Xingu River, covering the municipalities of Altamira, Anapu, Brasil Novo, Senador José Porfírio, and Vitória do Xingu (Fig. 1). According to the climatic zoning conducted by Alvares et al. (2013) based on Köppen's criteria (1936), the region has a tropical climate of the Am type (Tropical monsoon zone).

Field and laboratory procedure

Sampling was conducted along the banks of the Xingu River using artisanal traps ("matapis"), which consist of tubes made of splints with openings at both ends through which the crustaceans can enter but have difficulty exiting.

The traps were baited with hydrated babassu flour (*Attalea* spp.), a species of palm tree common in the Amazon region (see BENTES et al., 2011). Four traps ("matapis") were placed at each collection point, set at night and retrieved in the morning. Sampling occurred quarterly between January and October 2024.

After collection, the samples were frozen and transported in thermal boxes to the laboratory for identification, following the taxonomic key of Melo (2003).

Subsequently, the organisms were measured using a calliper (0.01 mm) to determine the Total Length (TL) and Carapace Length (CL); weighed using a precision scale (0.001 g) to obtain the Wet Weight (WW); and finally, photographed for the preparation of identification plates, through the camera Nikon D5300 and the Photoshop software®.

Once the procedures were completed, the organisms were registered in the Carcinological Collection of the Carcinology Laboratory (Labcrus) at the Federal Rural University of the Amazon (UFRA).

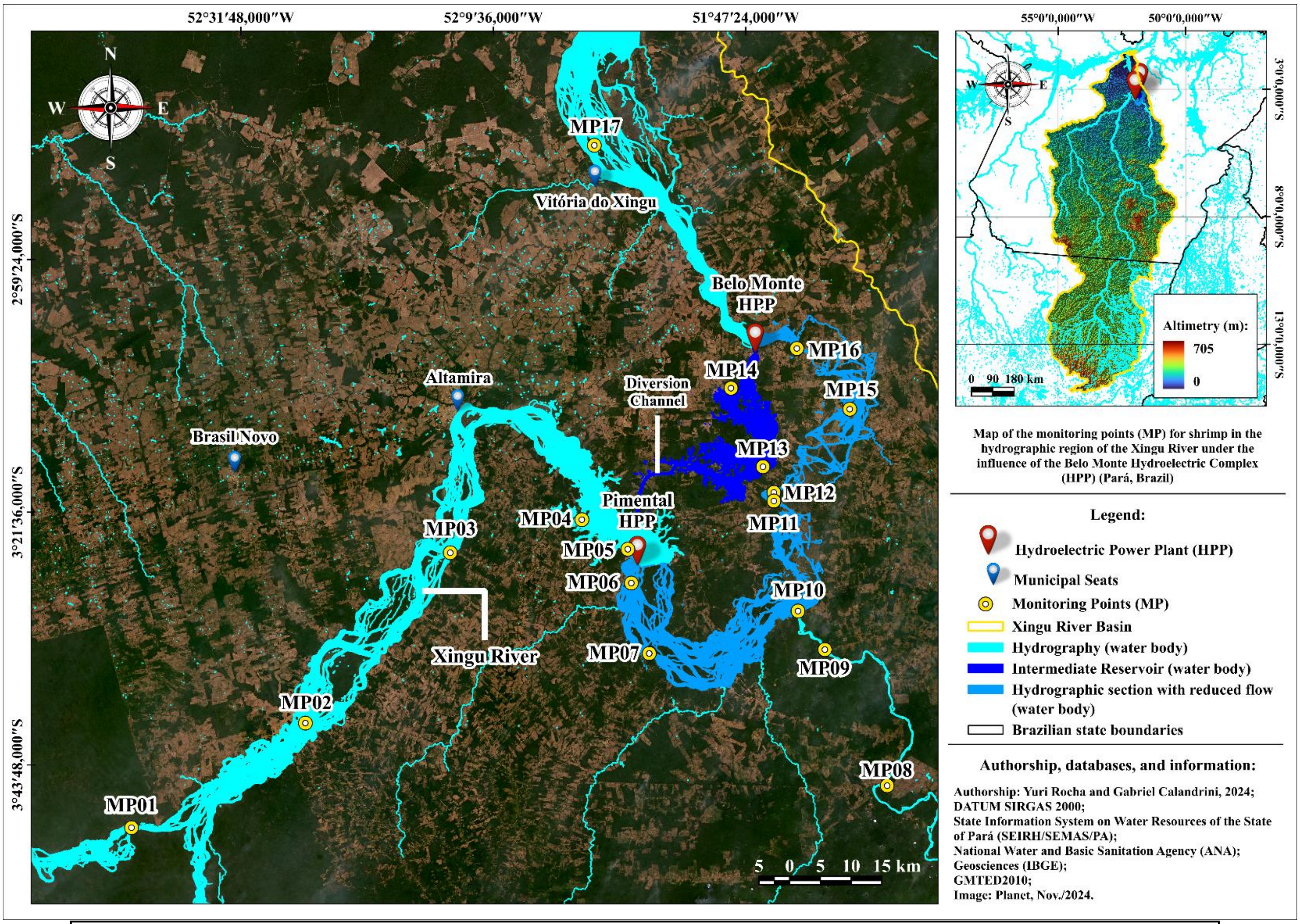

Figure 1. Map of the monitoring points (MP) for shrimp in the hydrographic region of the Xingu River (Pará, Brazil).

3 Results and Discussion

A total of 2.199 specimens of *Macrobrachium amazonicum* were collected along the Xingu River, of which 20 individuals exhibited morphological anomalies in the rostrum shape only two stations (MP4: 3°22'14.94" S; 52°1'48.71" W [7 exemplars] and MP7: 3°34'0.37" S; 51°55'53.29" W [13 exemplars]), accounting for 0.9% of the total shrimp collected along the total sampled area; with the range sizes and weights (TL: 4.58-8.12 cm; CL: 1.75-2.25 cm; WW: 1.8-3.2 g). The plate of shrimp images below was made based on the specimens with the best morphological preservation among those collected (Fig. 2). According to Melo (2003), the species *M. amazonicum* has a long rostrum with approximately nine to twelve teeth on the upper part and eight to ten teeth on the lower part. However, most of the anomalous shrimp had shorter, more irregular rostrums with fewer teeth, ranging from 1 to 7 on the upper side and 1 to 5 on the lower side, with most structures being smaller than the scaphocerite.

Studies on morphological anomalies are rare; however, specific records in *M. amazonicum* have been observed on the rostrum and telson structures by Martins et al. (2022) for the state of Pará, Tocantins River, Great Amazon River Basin, representing in this study the first record of *M. amazonicum* morphological anomalies reported in Brazilian freshwater environments.

Other shrimp species have also been recorded with different types of morphological anomalies, such as those in the abdomen, as reported for *Penaeus indicus* Milne Edwards, 1837, by Santander-Avaceña et al. (2019) in the Philippines.

Furthermore, De Grave; Mentlak (2008) and Feuillassier et al. (2012) documented anomalies in the rostrums of shrimp species *Palaemon longirostris* and *Palaemon macrodactylus* in the Gironde estuary in southwestern France.

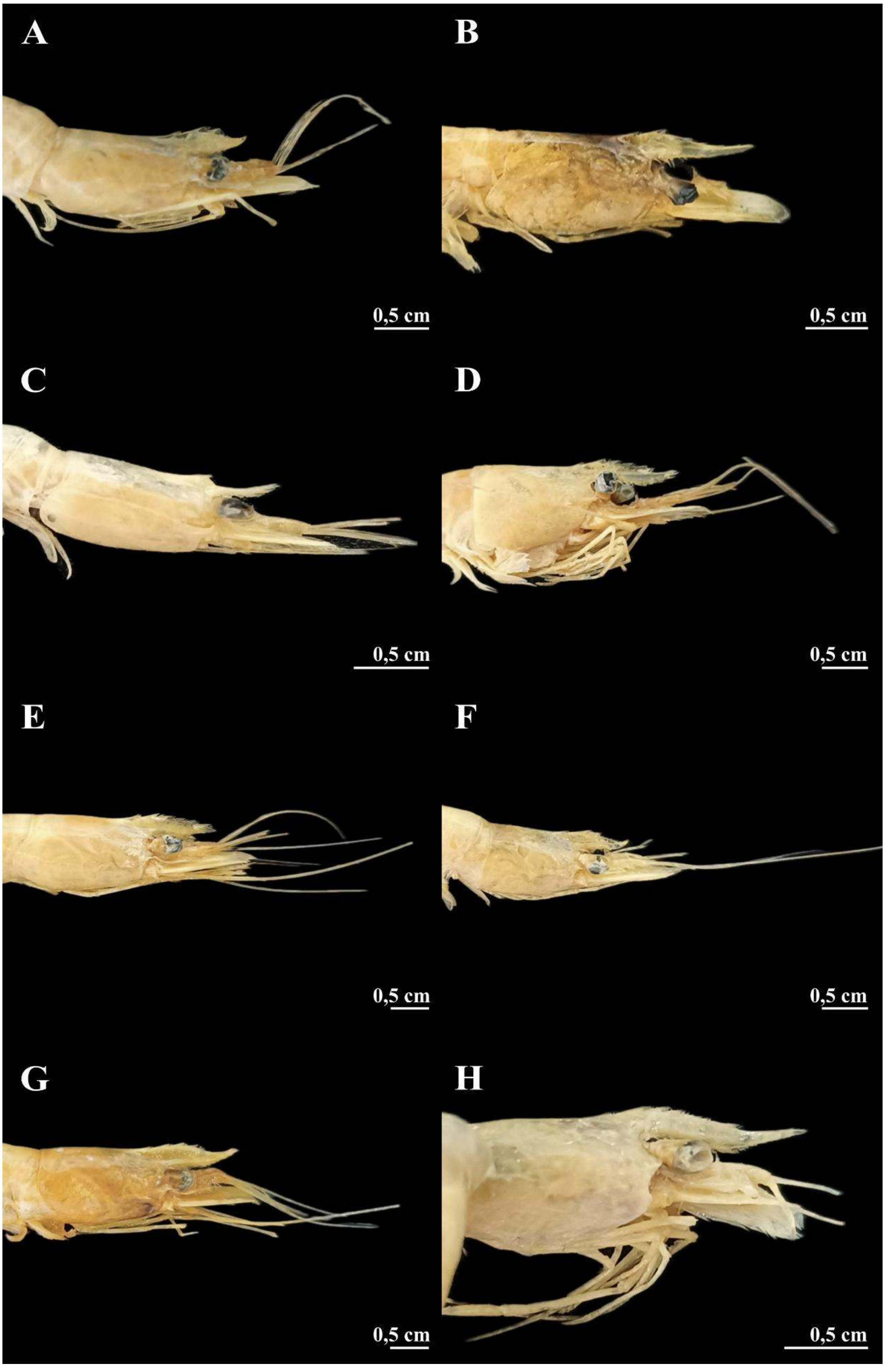

Figure 2. (A-H) Rostral morphological anomalies observed in specimens of *Macrobrachium amazonicum* (Heller, 1862) collected in the Xingu River, Pará State, Brazil.

The invasive shrimp species commonly known as the giant Malaysian prawn, *Macrobrachium rosenbergii* De Man, 1879, has also been recorded with morphological anomalies, as observed by Stalin et al. (2013), who reported deformities in the abdominal somites, telson, and other structures. This species was also documented by Pillai et al. (2005) with anomalies caused by pathogens, affecting the rostrum and other structures. Additionally, it is speculated that changes in physicochemical factors of water, such as dissolved oxygen levels - particularly in cases of eutrophication, or due to increases in temperature and pH - may affect shrimp malformations (RAJKUMAR et al., 2016). Exposure to extreme environments and physical damage caused by competition may also contribute to structural malformations (PANDOURSKI; EVTIMOVA, 2009; BÉGUER et al., 2010; FEUILLASSIER et al., 2012; MARTINS et al., 2022).

Aguirre and Hendrickx (2005) suggest that the observed malformations in the shrimp analyzed may result from the regeneration of these structures, triggered by various factors, including potential injuries caused by trawling. On the other hand, some studies performed by Rajkumar et al. (2016) and Ayub and Ahmed (1996) observed that environmental pollution, pesticide contamination, and other chemical compounds can contribute to the emergence of morphological anomalies in marine shrimps. Supporting this perspective, Levesque et al. (2018) identified high concentrations of herbicide compounds in areas where *Palaemon longirostris* shrimp exhibited multiple morphological anomalies.

Levesque et al. (2018) and Martins et al. (2022) associated these anomalies with environmental changes that might induce malformations in crustacean structures, potentially arising from the larval stage, or in adults by the presence of contaminants in water and sediments. In addition, Alves-Júnior et al. (2018) proposed that anomalies could also originate from natural processes such as ecdysis, associated with nutritional or congenital malformation. Finally, changes/anomalies in the defensive structures of crustaceans can impair competition for resources and compromise feeding, reproduction, and migration, potentially leading to higher mortality rates among individuals (BÉGUER et al., 2010; FEUILLASSIER et al., 2012).

4 Conclusions

Morphological anomalies can impact several aspects of the biology and behaviour of decapod shrimp, such as changes in the rostrum, which can primarily affect their defence strategies, making them more vulnerable to predation and thus influencing the population dynamics. Although morphological anomalies can affect shrimp, only 0.9% of the shrimp analyzed in this study exhibited any abnormalities. Therefore, more depth studies are needed to investigate the potential causes of morphological anomalies in shrimp from the Xingu River region, and other Amazon rivers. The causes of this phenomenon should also be studied in further research to possibly enable prevention of the potential environmental/anthropogenic impacts.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Conceptualization: F.A.A.J and G.S.M.C.; Research, development and writing: G.S.M.C.; Sample Analysis: G.S.M.C. and P.J.C.M.L; Map development: Y.A.S.R.; Review: F.S.M.; Review and correction: F.A.A.J., D.T.H.F. Translation to English: G.S.M.C.

DECLARATION OF INTEREST

The authors disclose that they have no known competing financial interests or personal relationships that could have appeared to influence the study reported in this manuscript.

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