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Natural Sciences

Original article

Reproductive biology of *Macrobrachium amazonicum* (Heller, 1862) (Crustacea: Decapoda, Palaemonidae) from the mouth and lower Amazon River regions, Brazil

Biología reproductiva de *Macrobrachium amazonicum* (Heller, 1862) (Crustacea, Decapoda, Palaemonidae) en la desembocadura y las regiones bajas del río Amazonas, Brasil

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Abstract

Reproductive biology studies are crucial for understanding ecological and behavioral processes and establishing pillars for the sustainable exploitation of species of economic interest. Our study encompasses the general aspects of *Macrobachium amazonicum* reproductive biology in two important artisanal fishing areas: the mouth and lower sections of the Amazon River, located in the Brazilian states of Amapá and Pará, respectively. We captured 6,796 prawns, 4,163 females and 2,633 males, using 20 artisanal traps known locally as *matapi*. Our results showed that the reproductive peaks in both areas coincide with the rainy season in the Amazon (November 2017 to April 2018). Recruitment peaks were observed in July, both in the mouth and the lower Amazon regions. The average standard length of the females captured in the Amazon mouth was 56.85 ± 11.34 mm and 43.57 ± 10.48 mm in the lower Amazon section. There was a positive correlation between fecundity and female size in the regions. The average egg production was 3.026 ± 1.169 at the mouth and 1.346 ± 434 in the lower section. The reproductive investment average of the species was 11.05% (± 1.66) at the mouth and 12.67% (± 2.55) in the lower region. The mouth and lower Amazon River regions are favorable areas for the reproduction of *M. amazonicum*, as they attract females of all sizes.

Keywords: Reproduction of palemonids; Fertility of the Amazonian prawn; Sexual maturity.

Resumen

Los estudios de biología reproductiva son cruciales para comprender los procesos ecológicos y comportamentales de las especies y para el establecimiento de las bases de la explotación sostenible de especies de interés económico. En este estudio cubrimos los aspectos generales de la biología reproductiva de *Macrobachium amazonicum* en dos importantes áreas de pesca artesanal de este camarón en la desembocadura y el bajo río Amazonas en los estados de Amapá y Pará, respectivamente. Se capturaron 6.796 camarones, 4.163 hembras y 2.633 machos, utilizando 20 trampas artesanales conocidas localmente como *matapi*. Los resultados demostraron que los picos reproductivos en ambas áreas coincidieron con la temporada de lluvias en la Amazonía (noviembre de 2017 a abril de 2018). Se observaron picos de reclutamiento en julio tanto en la desembocadura como en la región del bajo Amazonas. En la desembocadura la longitud estándar promedio de las hembras fue de 56,85 ± 11,34 mm y en el bajo Amazonas, de 43,57 ± 10,48 mm. Hubo una correlación positiva entre la fecundidad y el tamaño de la hembra en ambas regiones. La producción promedio de huevos fue de 3.026 ± 1.169 en la desembocadura y de 1.346 ± 434 en el bajo Amazonas. El promedio de

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la inversión reproductiva de la especie fue del 11,05% (± 1,66) en la desembocadura y del 12,67% (± 2,55) en el bajo Amazonas. Las regiones de la desembocadura y el bajo Amazonas son áreas favorables para la reproducción de *M. amazonicum*, ya que atraen hembras de todos los tamaños.

Palabras clave: Reproducción de palemónidos; Fertilidad del camarón amazónico; Madurez sexual.

Introduction

The environment is determining for species population characteristics, as it results in behavioral and biological differences associated with the availability of resources (**Bentes *et al.***, 2016), which determine population sizes by acting directly on the fertility and fecundity rates of the species (**Silva**, 2011).

Studying the reproductive biology of the prawn provides information on reproductive strategies, sexual maturity, reproductive investment, and the number of eggs produced by the females, which is crucial to evaluate the reproductive potential, as it provides data useful in the establishment of appropriate management strategies, the conservation and rational exploitation of natural stocks, and avoiding the depletion risks (**Flexa *et al.***, 2005). *Macrobrachium amazonicum* (**Heller**, 1862) is a prawn of great scientific and commercial interest (**Silva *et al.***, 2007), which is widely consumed in the Amazon region. There are two types of populations related to the environment of occurrence: a) populations that inhabit rivers, freshwater lakes, and streams with no contact with the coast, and b) populations living in estuarine regions that depend on brackish water to complete their life cycle (**Moraes-Valenti & Valenti**, 2010).

In general, the populations of *M. amazonicum* are characterized by having a continuous reproductive activity, with ovigerous females all year round (**Sampaio *et al.***, 2007). However, generalizations can lead to unsustainable exploitation of the species on a local or regional scale. For example, signs of *M. amazonicum* overfishing have been registered in several Amazon regions, such as the Guarujá Bay, in Pará (**Lucena-Fredou *et al.***, 2010), the Bragança Peninsula, in northeast Pará (**Freire *et al.***, 2012), and in the mouth of the Amazon River in Amapá (**Lima *et al.***, 2014). In this context, our study addresses the reproductive biology (reproductive period, sexual maturity, fecundity, and reproductive investment) of *M. amazonicum* in two important areas of artisanal shrimp fishing in the mouth and lower sections of the Amazon River in the Brazilian states of Amapá and Pará.

Materials and methods

Study area

The study area comprises the regions of Mazagão (00º15’39.9’’S and 51º20 ‘42.3’W) located on the mouth of the Amazon River in the state of Amapá, and the Ilha das Marrecas in the lower Amazon River, state of Pará (02º12’19.3’’S and 54º46 ‘17.9’W) (**Figure 1**). These regions have two distinct climatic periods: the rainy period, between January and June, and the dry period, from July to December, which coincide with floods and high waters, and ebb and low waters in the Amazon River, respectively, and change the environment depending on the flood pulse. In addition to the effect of the flood pulse resulting from the rains, Mazagão also has a daily influence of the tide, given its proximity to the sea.

Specimen collection and rainfall data

M. amazonicum specimens were collected monthly from May 2017 to April 2018, using twenty artisanal traps called *matapi* (cylindrical creel made by hand using vines and palm trees from the Amazon floodplain, 50 cm long, 25 cm in diameter and a 5 mm-distance between splints) baited with *Orbignya speciosa* flour (babassu) and tied with a rope at a depth of one meter (**De Araújo *et al.***, 2014) in the Amazon River at dusk (5:30 pm) for a period of 12 h (**Lima *et al.***, 2016). The captured specimens were properly labeled and preserved in plastic bags containing hydrated ethyl alcohol (70%).

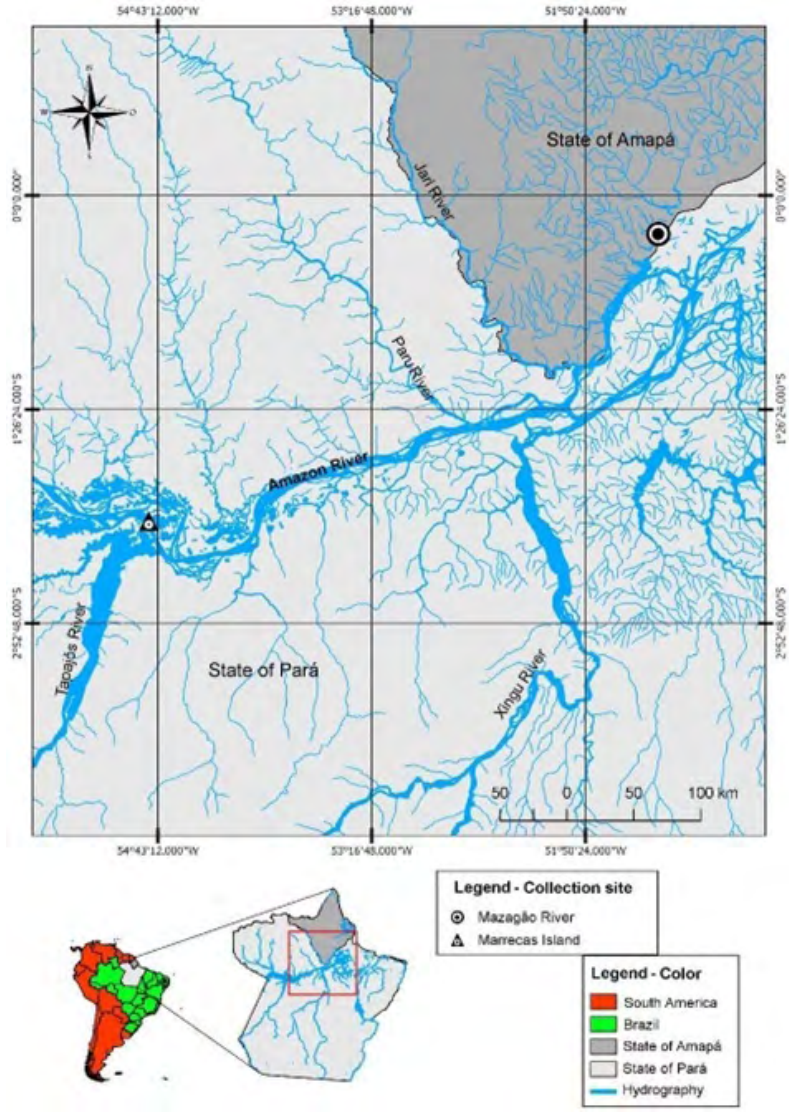

Figure 1. Location of *Macrobrachium amazonicum* capture areas in the mouth and lower Amazon between May 2017 and April 2018. (●) Mazagão, (▲) Ilha das Marrecas

Laboratory analysis

In the laboratory, we made the taxonomic identification, sexing, and biometrics of the prawns. For the taxonomic identification, we followed **Melo** (2003). Sexing was determined based on the presence or absence of the male appendix observed in the endopod of the second pair of pleopods of each prawn. Biometrics included standard length - SL (distance measured between the base of the eyeball and the tip of the telson given in mm) (**Lima *et al.***, 2014) measured using an analog caliper (125MEB-6/200, Starfer Itu -Sp, 0.05 mm accuracy) and the total wet mass (g) (TM) a semi-analytical digital scale (AD 330, Mars, 0.001 g accuracy, Santa Rita do Sapucaí-MG, Brazil). The prawns were classified in the following categories: adult males, adult ovigerous and non-ovigerous females, and juveniles. Males and females smaller than the smallest ovigerous female found were considered young (**De Almeida Melo *et al.***, 2022), and those with a size equal to or greater than the smallest ovigerous female were considered adult (**Duarte *et al.***, 2025; **Lima *et al.***, 2014).

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Reproductive aspects

The reproductive period was determined by the occurrence of ovigerous females and recruitment by the presence of young specimens. To determine the length of the first individual maturation, we considered the length of classes between the ovigerous females. We determined the standard length of sexual maturity by analyzing 50% of the ovigerous females. Fecundity was recorded by direct egg counting of 30 ovigerous females randomly selected, considering the integrity of the eggs. Females' egg masses were carefully removed under a dissecting binocular stereo microscope (K 400L, Motic, Causeway Bay, Hong Kong), and the eggs in each mass were counted. Egg development stages were classified according to **Wehrtmann** (1990): Stage I: freshly extruded eggs, uniform yolk, no visible eye pigment; Stage II: barely visible eye pigments, and Stage III: eyes clearly visible and fully developed.

To determine the egg volume, we separated 10 eggs from each ovigerous female to measure the length (longest axis) and width (shortest axis) under a compound binocular microscope equipped with a calibrated eye micrometer. The volume of the eggs was calculated using the **Wehrtmann** (1990) formula:

$$V = \pi * l * h * (h)^2,$$

where "l" is length; ''H'' width in mm, and $\pi = 3.14$.

Reproductive investment (RI) was estimated by dividing the egg mass dry weight by the female's dry weight and multiplying by 100 to obtain percentage values (**Hines**, 1982). For this calculation, we used only the dry weight of females with IN-stage eggs and their egg mass, as suggested by **Zimmermann *et al*.** (2015). Then, we conducted a linear regression analysis between RI and SL, also relating TM to SL (**Lima *et al*.**, 2014; **Rodrigues *et al*.**, 2025).

Statistical analysis

To check the differences in the monthly abundance of ovigerous and non-ovigerous females between the study areas, we applied a t test (**Zar**, 1999), and to verify if there were differences in the average volume of eggs in each of the three embryonic stages, we used the Mann-Whitney test (U) after checking data normality and homoscedasticity with the Kolmogorov-Smirnov and Bartlett tests (**Ayres *et al*.**, 2007).

We used linear regressions at each embryonic stage to describe the relationship between fecundity and female length (LF), and to analyze the relationship between RI and female total length (TL), and the relationship between total wet mass (TM) and standard length (SL). All statistical analyses were performed using the Biostat 5.0 software with $\alpha = 0.05$ (**Ayres *et al*.**, 2007).

Results

For the study, we captured 6,796 *M. amazonicum* specimens from two regions: Ilha das Marrecas and Mazagão. The number of individuals collected in Mazagão exceeded that of Ilha das Marrecas, with females outnumbering males in both locations. The proportion of ovigerous females was significantly higher in Mazagão compared to Ilha das Marrecas ($P < 0.05$). While a considerable number of ovigerous females were found in both regions, Mazagão presented a greater prevalence.

The size of females (standard length, SL) captured in Mazagão ranged from 10.07 to 98.99 mm, with an average of 56.85 ± 11.34 mm. In Ilha das Marrecas, the females had a SL of 9.40 to 92.98 mm, with an average of 43.57 ± 10.48 mm, i.e., the size of females in Mazagão was larger than that of females in Ilha das Marrecas. The biometric relationships between the total wet mass (TM) and the standard length (SL) of both sexes in both areas were statistically significant (**Figure 2**).

Among the females captured in both areas, 37.73% carried eggs in their abdomen and 62.86% did not (**Table 1**). In Mazagão, we found more standard-length class ovigerous females. In both study regions, the highest number of juvenile prawns was observed in the

standard-length class (30.4 to 38.4 mm) (**Table 1**). Only 0.31% of ovigerous females in Mazagão and Ilha das Marrecas showed distribution in the standard length class 38.4 to 46.4 mm (**Table 1**), suggesting that the first gonadal maturation of females in *M. amazonicum* populations in both areas occurs with this length.

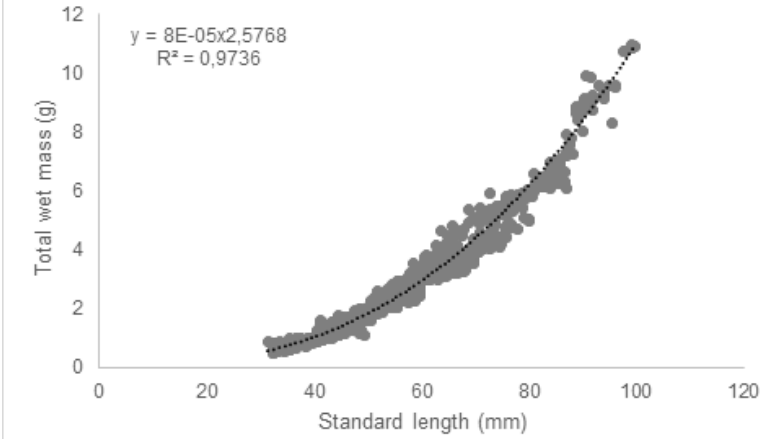

Figure 2. Biometric proportions (standard length and total wet mass) between *M. amazonicum* males and females sampled in Mazagão and Ilha das Marrecas between May 2017 to April 2018

Table 1. Frequency of *M. amazonicum* distribution according to the standard-length classes captured in Mazagão and Ilha das Marrecas between May 2017 and April 2018. M - Mazagão, I.M - Ilha das Marrecas

Standard length classes (SL, mm)	Site	Adults						Juveniles					
		Males		Non-ovigerous females		Females ovigerous		Males		Females		Total	
		N	%	N	%	N	%	N	%	N	%	N	%
30.4--|38.4	M	0	0.00	2	0.05	0	0.00	70	0.49	123	1.63	109	0.54
	I.M	0	0.00	1	0.04	0	0.00	134	3.01	235	6.04	370	0.04
38.4--|46.4	M	537	13.26	220	5.43	9	0.22	7	0.17	14	0.35	773	19.09
	I.M	9	0.39	2	0.09	2	0.09	83	3.56	132	5.66	96	4.12
46.4--|54.4	M	768	18.97	652	16.10	168	4.15	34	0.84	0	0.00	1622	40.06
	I.M	173	7.42	578	24.79	174	7.46	0	0.00	86	3.69	925	39.67
54.4--|62.4	M	253	6.25	332	8.20	366	9.04	0	0.00	0	0.00	951	23.49
	I.M	270	11.58	382	16.38	204	8.75	0	0.00	0	0.00	856	36.71
62.4--|70.4	M	80	1.98	89	2.20	131	3.24	0	0.00	0	0.00	300	7.41
	I.M	122	5.23	67	2.87	34	1.46	0	0.00	0	0.00	223	9.56
70.4--|78.4	M	30	0.74	8	0.20	10	0.25	0	0.00	0	0.00	48	1.19
	I.M	30	1.29	17	0.73	25	1.07	0	0.00	0	0.00	72	3.09
78.4--|86.4	M	9	0.22	35	0.86	67	1.65	0	0.00	0	0.00	111	2.74
	I.M	1	0.04	67	2.87	90	3.86	0	0.00	0	0.00	158	6.78
94.4--|102.4	M	57	1.41	45	1.11	120	2.96	0	0.00	0	0.00	222	5.48
	I.M	1	0.04	20	0.86	89	3.82	0	0.00	0	0.00	1	0.04
Total	M	1734	42.82	1383	34.15	871	21.52	70	1.50	123	1.97	4132	100
	I.M	606	25,98	1134	48,62	708	26,50	123	3,55	235	9,39	2664	100

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In Mazagão, non-ovigerous females and juvenile shrimps capture rates were higher in the summer (July to October, 2017) than in the winter period (December 2017, January, February, and April 2018) in places where ovigerous females were more abundant. In Ilha das Marrecas, non-ovigerous females and juvenile shrimps were more abundant in June, July, and October 2017. On the other hand, ovigerous females were abundant in the rainy season (November 2017 to April 2018). Juvenile shrimps were found almost all year round, but the capture peak in absolute and percentage terms was observed in June and July in Mazagão and in June, August, September, October, and March in Ilha das Marrecas, with 35 to 60.45% capture of juveniles (**Figure 3 A-B**).

The average number of eggs observed in ovigerous females in Ilha das Marrecas was 1.346 ± 434, lower than the average number of 3.026 ± 1.169 eggs recorded for ovigerous females in Mazagão, showing statistical differences for the quantity of eggs ($t = 5.38$; $P<0.001$). The linear regression for the number of eggs was positive for standard-length females in every stage of embryonic development ($p<0.001$), which indicated an increase in fecundity with growth of ovigerous females (**Figure 4 A-B**). The linear correlations between egg volumes in stages I, II, and III were not positive for standard-length females (**Figure 4 C-D**), indicating that female size directly influenced egg dimensions.

The average volume of *M. amazonicum* eggs varied statistically among embryonic development stages in both study areas ($U = 44.04$, $p = <0.001$). However, comparing the volume of each embryonic stage (I, II, and III) between the areas, Ilha das Marrecas showed a higher average for Stage I (304 ± 156) than Mazagão (35.65 ± 11.07) ($t = 55.00$; $P = <0.001$). For Stage II, Ilha das Marrecas also had a higher average egg volume (478 ±

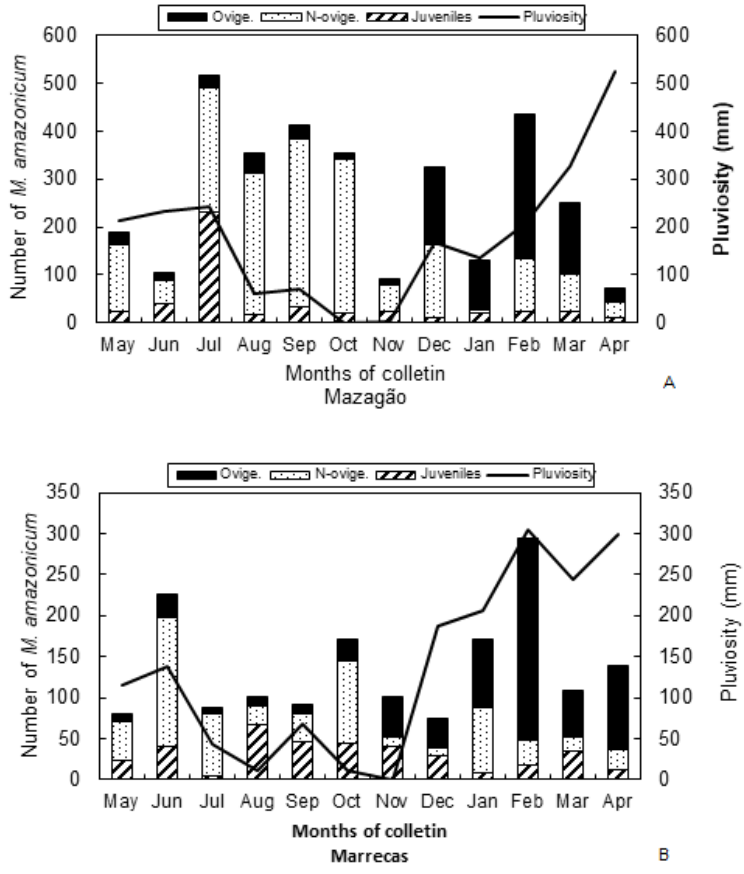

Figure 3. Distribution of the absolute frequency of ovigerous, non-ovigerous, and juvenile *M. amazonicum* females sampled in Mazagão and Ilha das Marrecas between May 2017 to April 2018

183) than Mazagão (45.29±22,93) (t = 175.00; P = <0.001). In Stage III, the average egg volume in Mazagão (39.03 ± 4.83) was significantly lower than that observed in Ilha das Marrecas (643 ± 197) (t = 28.00; P < 0.001), which indicated that ovigerous females from Ilha das Marrecas produced a considerably larger volume of eggs compared to those from Mazagão (**Table 2**).

As for *M. amazonicum* reproductive investment (R.I.) and SL, there was no significant relationship (P = 0.89), which indicated that the RI was not determined by the female length (**Figure 5**). Females captured in Mazagão converted an average of 11.05% (± 1.66 g) of their body weight for egg production, while those captured in Ilha das Marrecas converted an average of 12.67% (± 2.55 g).

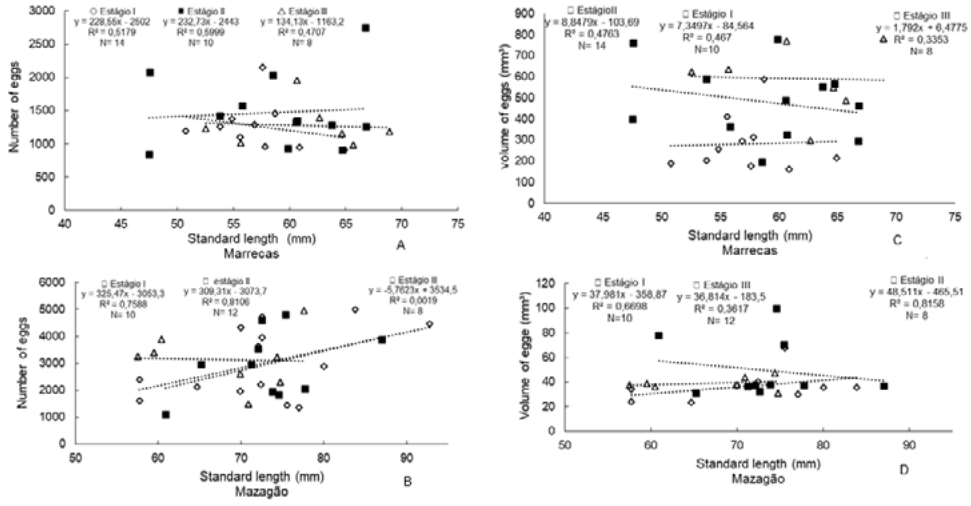

Figure 4. Relationship between fecundity and standard-length females for each of the three *M. amazonicum* embryonic stages captured in Mazagão and Ilha das Marrecas between May 2017 to April 2018. **A-B.** Standard length (mm) and number of eggs; **C-D.** Standard length (mm) and volume of eggs

Table 2. Average, minimum, and maximum values of egg volume (mm³) in the three embryonic development stages of *Macrobrachium amazonicum* captured in Mazagão and Ilha das Marrecas between May 2017 and April 2018

Internship eggs	Site	N	Egg average volume (mm³)	± SD	Minimum	Maximum
I	M	10	35.65	11.07	23.69	67.86
II	M	12	45.29	22.93	20.08	99.62
III	M	8	39.03	4.83	31.31	47.44
Internship eggs	**Site**	**N**	**Egg average volume (mm³)**	**± SD**	**Minimum (mm³)**	**Maximum (mm³)**
I	I.M	14	304	156	163	620
II	I.M	10	478	183	194	778
III	I.M	8	643	197	297	995

M: Mazagão, IM: Ilha das Marrecas, N: number of shrimps; SD: standard deviation

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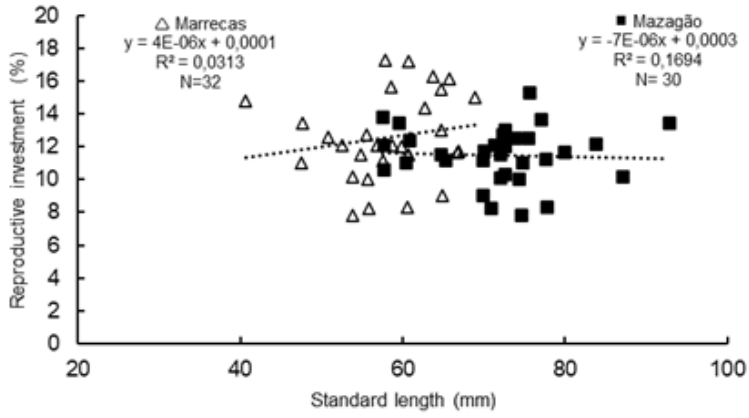

Figure 5. Relationship between *M. amazonicum* standard length (mm) and reproductive investment, considering all stages of embryonic development of eggs captured in Mazagão and Ilha das Marrecas between May 2017 and April 2018

Discussion

Macrobrachium amazonicum ovigerous females were captured throughout the study period in Mazagão and Ilha das Marrecas, indicating a continuous reproductive cycle within the population. This reproductive characteristic is common for the species' healthy populations in several Brazilian regions (**Silva *et al.***, 2002; **Sampaio *et al.***, 2007; **Bentes *et al.***, 2011; **Lima *et al.***, 2013). It is highly probable that *M. amazonicum* individual females undergo multiple cycles of maturation, spawning, and recovery throughout the year (**Silva *et al.***, 2002). Such a pattern was observed in the present study, with ovigerous and juvenile females found in every month of the sampling period.

Regarding female standard length, the largest specimen was captured in Mazagão. This difference in length may be associated with the proximity of the Mazagão region to the mouth of the Amazon River in an area of intense tidal activity and daily transport of organic matter, which may be contributing to an 'enrichment' of this region and the subsequent improvement of nutritional conditions for female growth. Thus, the standard length of females collected in Mazagão was similar to that reported in studies involving other estuarine areas in the Amazon region (**Freire *et al.***, 2012; **Hayd & Anger**, 2013; **Duarte *et al.***, 2025). Likewise, the females collected in Ilha das Marrecas had similar lengths to those collected in sweet water systems (**Silva & Sampaio**, 2004; **Silva**, 2011).

The peak of *M. amazonicum* reproductive activity occurred during the winter season in Mazagão and Ilha das Marrecas (**Figure 4 A–B**), indicating a reproductive pattern influenced by the regional rainfall regime. In the Amazon region, ovigerous females are also most abundant during the rainy period, similar to our study (**Silva *et al.***, 2005; **Silva *et al.***, 2007; **Bentes *et al.***, 2011). In contrast, no relationship with rainfall was seen among the populations from the Jaguaribe River in northeastern Brazil collected by **Sampaio *et al.*** (2007), indicating an atypical behavior of this species in the region, probably due to the locally arid climate. These variations suggest that while *M. amazonicum* exhibits rainfall-linked reproductive seasonality in Amazonian ecosystems, this pattern may be modulated by local environmental conditions, reinforcing the species' ecological plasticity across different hydrographic basins.

In our study, we found that only 1,579 females carried eggs in their abdomen. However, ovigerous females were recorded throughout the entire year, indicating a continuous reproductive cycle for *M. amazonicum* populations in both Mazagão and Ilha das Marrecas. The size of the gonads' first maturation was established for 30.4 to 38.4 mm standard-length class females in both areas. These values are notably lower than those

reported for other locations such as Combú Island, Icoaraci District, Arapiranga Island, and Mosqueiro Island, where the size at first maturation was estimated in 55.7 mm (**Azeved**o, 2004; **Bentes *et al.***, 2016; **Freire *et al.,*** 2012; **Lima *et al.***, 2014; **Sampaio *et al.***, 2007). The gonadal maturation in young individuals is common in *M. amazonicum* prawns (**Bentes *et al.***, 2016; **Lima *et al.***, 2014), and reflects an adaptation of the species to environmental conditions to optimize the maintenance of the population.

Early gonadal maturation in young individuals is a common trait in *M. amazonicum* (**Bentes *et al.***, 2016; **Lima *et al.***, 2014) and is generally considered an adaptive strategy that enhances reproductive success under variable or unstable environmental conditions. The lower maturation sizes observed in this study may reflect specific ecological pressures or differences in habitat productivity in Mazagão and Ilha das Marrecas. This plasticity in reproductive parameters reinforces the ecological adaptability of M. amazonicum, enabling it to maintain viable populations across diverse environments with varying degrees of environmental stress and resource availability.

The highest fecundity among prawn species of the *Macrobrachium* genus has been reported in *M. rosenbergii* (**De Man**, 1879) and *M. carcinus* (**Linnaeus**, 1758), with females capable of producing between 14,000 and 242,000 eggs per spawning event (**Lara & Wehrtmann**, 2009). In the present study, fecundity in *M. amazonicum* increased with female size, demonstrating a significant positive linear relationship between standard length and egg number. This pattern has also been described for *M. amazonicum* (**Medina *et al.***, 2008; **Silva**, 2011), *M. acanthurus* (**Valenti *et al.***, 1989; **Tamburus *et al.***, 2012), *M. olfersi* (**Mossolin & Bueno**, 2002), and *M. carcinus* (**Lara & Wehrtmann**, 2009), indicating that this correlation is a general reproductive trait of the *Macrobrachium* genus.

Regarding the number of eggs, the minimum and maximum fecundity recorded for *M. amazonicum* were 1,099 to 5,011 eggs in Mazagão and 833 to 2,748 eggs in Ilha das Marrecas, showing that females in these regions can keep high population densities throughout the year. Females' fecundity in estuarine (Mazagão-AP) and continental (Ilha das Marrecas-PA) regions was higher than the fecundity recorded for females of the same species in the Tucuruí Hydroelectric Reservoir, Pará (**Silva *et al.,*** 2005), and Vigia city in Pará (**Silva *et al.***, 2002), and similar to the monthly average of females captured in the Jaguaribe River, Ceará (**Silva *et al.***, 2004).

As for the volume of eggs, Ilha das Marrecas (continental) had a larger volume than that observed in Mazagão (estuary), demonstrating the standard characteristics of the reproduction of *M. amazonicum,* since continental water specimens generally present an abbreviated larval development and a reduced number of eggs but of great volume in response to an environment poor in nutrients. Coastal species have a greater quantity of eggs, smaller in volume, and their complete metamorphosis of planktonic zoea larvae occurs in the brackish waters of the estuaries (**Williamson**, 1972; **Magalhães**, 1985; **Walker**, 1992). This combination of traits exemplifies the genus' evolutionary adaptation to diverse environmental conditions.

Differences in maximum reproductive yield in crustacean species are related to the disparity in female length, biotic or abiotic factors, such as egg size, latitudinal and seasonal variations, and habitat adaptation (**Mantelatto** & **Fransozo**, 1997) that may influence the reproductive investment. In our study, medium-length *M. amazonicum* females converted 5.7 - 24.58% of body weight for egg production in Mazagão and 3.5 - 21.35% in Ilha das Marrecas. These values are close to the 15-31% observed for *M. carcinus* (**Lara & Wehrtmann**, 2009), the 14-30% for *M. acanthurus* (**Anger & Moreira**, 1998), the 4-17% for *M. hainanense* (**Mantel & Dudgeon**, 2005), and the 7 to 38% for *M. olfersi* (**Anger & Moreira**, 1998), indicating that reproductive performance is variable in species of the genus *Macrobrachium.* In addition, the present study showed that the reproductive investment of *M. amazonicum* in Mazagão and Ilha das Marrecas was not related to female length, since different-length females were able to reproduce (**Mantel & Dudgeon**, 2005; **Lara & Wehrtmann**, 2009).

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Mazagão (estuary) and Ilha das Marrecas (continental) are favorable areas for the reproduction of *M. amazonicum*, since they attract females of all sizes. However, due to the existence of variations between estuarine and continental *M. amazonicum* populations in terms of structure, size, fecundity, and fertility, there is a need to establish different management measures, including adjustments in fishing equipment and the definition of minimum catch size for *M. amazonicum* in Mazagão and Ilha das Marrecas, according to the peculiarities of each region. Additionally, the values in the present study evidenced that the females captured in Mazagão and Ilha das Marrecas can be potential breeding stock for aquaculture.

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Author contributions

SRMC, SSD: Conceptualization; **SRMC, SSD, JdFL:** Methodology; **SSD:** Software; **JdFL, SRMC:** Validation; ***SSD, JdFL, SRMC***: Investigation; **SSD, JdFL, SRMC:** Resources; **SSD, JdFL:** original draft preparation; **SRMC, SSD, JdFL:** Manuscript review and editing. All authors read and agreed on the final version of the manuscript.

Conflicts of interest

The authors declare no conflicts of interest.

References

Anger, K. & Moreira, G. (1998). Morphometric and reproductive traits of tropical caridean shrimps. *Journal of Crustacean Biology*, *18*, 823-838.

Ayres, M., Ayres Jr., M., Ayres, D. L., Santos, A. de A. S. (2007). BioEstat-aplicações estatísticas nas áreas das ciências bio-médicas (5th ed.). Embrapa Amazônia Oriental (CPATU).

Azevedo, E. F. (2004). Biologia reprodutiva do camarão regional *Macrobrachium amazonicum (Heller, 1862) (Decapoda; Palaemonidae),* na ilha do Combu (Belém, PA). Trabalho de conclusão de curso. Universidade Federal do Pará, 89p.

Bentes, B.S., Martinelli, J.M., Souza, L.S., Cavalcante, D.V., Almeida, M.C., Isaac, V.J. (2011). Spatial distribution of the Amazon river prawn *Macrobrachium amazonicum* (Heller 1862) (Decapoda, Caridea, Palaemonidae) in two perennial creeks of an estuary on the northern coast of Brazil (Guajará Bay, Belém, Pará). *Brazilian Journal of Biology*, *71*, 925-935.

Bentes, B. S., Silva, J. C. S., Martinelli-Lemos, J. M., Nahum, V. J. I. (2016). Abundância e relações morfométricas do camarão-da-amazônia *Macrobrachium amazonicum* (Heller, 1862) (Decapoda, Palaemonidae) em um estuário amazônico-costa norte do brasil. *Biota Amazônia*, *6*(4), 1-9.

De Araújo, M. V. L. F., de Araújo Silva, K. C., Silva, B. B., da Silva Ferreira, I. L., Cintra, I. H. A. (2014). Pesca e procedimentos de captura do camarão-da-Amazônia à jusante de uma usina hidrelétrica na Amazônia brasileira. *Biota Amazonia, 4*(*2*), 102-112.

De Almeida Melo, O., da Silva, L. M. A., de Farias Lima, J., Silva, S. L. F., Sousa, P. H. C., Duarte, S. S., Cintra, I. H. A. (2022). Estrutura populacional do camarão-da-Amazônia *Macrobrachium amazonicum* (Heller 1862) na foz do Rio Amazonas. *Brazilian Journal of Animal and Environmental Research, 5*(1), 490-511.

Duarte, S. S; Lima, F. L., Couceiro, R. G. (2025). Population structure of freshwater prawn *Macrobrachium amazonicum* (Crustacea, Palaemonidae) in two regions of the Amazon River, Brazil. *Revista de Biología Tropical*, *73*(1), e4ahgnf87-e4ahgnf87.

Flexa, C. E., Silva, K. C. A., Cintra, I. H. A. (2005). Morfometria do camarão-canela, *Macrobrachium amazonicum* (Heller, 1862), no município de Cametá–Pará. *Boletim Técnico-Científico do Cepnor, 5*(1), 41-54.

Freire, J.L., Marques, C.B., Silva, B.B. (2012). Estrutura populacional e biologia reprodutiva do camarão-da-Amazônia *Macrobrachium amazonicum* (Heller,1862) (Decapoda: Palaemonidae) em um estuário da região Nordeste do Pará, Brasil. *Brazilian Journal of Aquatic Science and Technology*, *16*(*2*), 65-76.

Hayd, L. & Anger, K. (2013). Reproductive and morphometric traits of *Macrobrachium amazonicum* (Decapoda Palaemonidae) from the Pantanal, Brazil, suggests initial speciation. *Revista Bioligia Tropical, 61*, 39-57

Lara, L.R. & Wehrtmann I.S. (2009). Reproductive biology of the freshwater shrimp *Macrobrachium carcinus* (L.) (Decapoda: Palaemonidae) from Costa Rica, Central America. *Journal of Crustacean Biology*, *29*, 343-349.

Lima, J.F., Silva, T.C., Silva, L.M.A., García, J.S. (2013). Brachyuran crustaceans from the bycatch of prawn fisheries at the mouth of the Amazon River. *Acta Amazonica*, *43*, 93-100.

Lima, J. F. (2014). Viabilidade de matapis adaptados com diferentes espaçamentos entre talas sobre a captura do camarão-da-amazônia (*Macrobrachium amazonicum* Heller, 1862) no estuário do Rio Amazonas. Macapá: Embrapa Amapá, 2014. http://www.infoteca.cnptia.embrapa.br/infoteca/handle/doc/984373

Lima J. F., García J. S., Silva T. C. (2014). Natural diet and feeding habits of a freshwater prawn (*Macrobrachium carcinus*: Crustacea, Decapoda) in the estuary of the Amazon River. *Acta Amazonica*, *44*, 235-244.

Lima, J.F., Cintra, I. H.A., Bastos, A. M., Damasceno, L. F., Montagner, D., Varela E. S. (2016). Caracterização do sistema pesqueiro de produção do camarão-da-Amazônia no Estuário Amazônico. *Embrapa Amapá Documentos*, *95*.

Lucena-Frédou, F., Rosa Filho, J. S., Silva, M. C. M., Azevedo, E. F. (2010). Population dynamics of the river prawn *Macrobrachium amazonicum* (Heller, 1862) (Decapoda, Palaemonidae) on Combú island (Amazon estuary). *Crustaceana*, *83*(*3*), 277-290.

Magalhães, C. (1985). Desenvolvimento larval obtido em laboratório de palaemonídeos da Região Amazônica. I. *Macrobrachium amazonicum* (Heller, 1862) (Crustacea, Decapoda). *Amazoniana, 9*(*2*), 247-274.

Mantelatto, F.L.M. & Fransozo, L. (1997). Fecundity of the crab *Callinectes ornatus* Ordway, 1863 (Decapoda, Brachyura, Potunidae) from the Ubatuba region, São Paulo, Brazil. *Crustaceana*, *70*, 214-226.

Mantel, S.K. & Dudgeon, D. (2005). Reproduction and sexual dimorphism of the palaemonid shrimp *Macrobrachium hainanensein* Hong Kong streams. *Journal of Crustacean Biology*, *25*, 450-459.

Melo, A.G. (2003). *Manual de identificação dos Crustacea Decapoda de água doce do Brasil. São Paulo.* Loyola/Museu de Zoologia, USP.

Medina, J.C.P., Severeyn Y.G., Severeyn, A.F.H. (2008). Aspectos reproductivos del camarón *Macrobrachium amazonicum* (Heller) en la zona de Nazaret, San Rafael de El Moján, Lago de Maracaibo, Venezuela. *Ciencia*, *16*, 402-408.

Mossolin, E.C. & Bueno, S.L.S. (2002). Reproductive biology of *Macrobrachium olfersi* (Decapoda, Palaemonidae) in São Sebastião, Brazil. *Journal of Crustacean Biology*, *22*, 367-376.

Moraes-Valenti, P. & Valenti, W.C. (2010). Culture of the Amazon River prawn *Macrobrachium amazonicum*. In: New, M.B.; Valenti, W.C.; Tidwell, J.H.; D'abramo, L.R.; Kutty, M.N. *Freshwater prawns: biology and farming*. Oxford Wiley-Blackwell.

Rodrigues, L. R., da Costa, J. R. P., de Andrade, L. S. (2025). Fecundidade e Sucesso Competitivo de *Macrobrachium* spp. que Cohabitam em Ambientes de Represamento. Ensaios e Ciência: *Ciências Biológicas, Agrárias e da Saúde*, *29*(1), 247-261

Sampaio, C.M.S., Silva, R.R., Santos, J.A., Sales, S.P. (2007). Reproductive cycle of *Macrobrachium amazonicum* females (Crustacean, Palaemonidae). *Brazilian Journal of Biology*, *67*, 551-559.

Silva, K.C.A., Souza, R.A.L., Cintra, I.H.A. (2002). Camarão-cascudo *Macrobrachium amazonicum* (Heller, 1862) (Crustacea, Decapoda, Palaemonidae) no município de Vigia, Pará, Brasil. *Boletim Técnico-Científico do CEPNOR*, *2*, 41-73.

Silva, R.R. & Sampaio, C.M.S. (2004). Ciclo reprodutivo de fêmeas de *Macrobrachium amazonicum* (Crustacea, Palaemonidae). In: Abstracts of AquaCiência 2004, Vitória, p. 382. Jaboticabal, Sociedade Brasileira de Aqüicultura e Biologia Aquática.

Silva, K.C.A., Cintra, I.H.A., Muniz, A.P.M. (2005). Aspectos bioecológicos de *Macrobrachium amazonicum* (Heller, 1862) a jusante do reservatório da hidrelétrica de Tucuruí, Pará. *Boletim Técnico-Científico do CEPNOR*, *5*, 55-71.

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doi: https://doi.org/10.18257/raccefyn.3230

Silva, M.C.N., Frédou, F.L., Souto-Filho, J. (2007). Estudo do crescimento do camarão *Macrobrachium amazonicum* (Heller, 1862) da Ilha de Combú, Belém, Estado do Pará. Amazonia. *Ciência e Desenvolvimento*, *2*, 85-104.

Silva, B.B. (2011). *Ecologia, pesca e dinâmica populacional do camarão-da-Amazônia – Macrobrachium amazonicum (Heller, 1862) (Decapoda: Palaemonidae) capturado na região das ilhas de Belém-Pará, Brasil.* Tese de Doutorado, Universidade Federal do Pará.

Tamburus, A.F., Mossolin, E.C., Mantelatto, F.L. (2012). Populational and reproductive aspects of *Macrobrachium acanthurus* (Wiegmann, 1836) (Crustacea: Palaemonidae) from North Coast of São Paulo State, Brazil. *Brazilian Journal of Aquatic Science and Technology*, *16*, 9-18.

Valenti, W.C., Cardoso, J., V. Lobão. (1989). Fecundidade em *Macrobrachium acanthurus* (Wiegmann, 1836) do Rio Ribeira de Iguape (Crustacea, Decapoda, Palaemonidae). *Revista Brasileira de Zoologia*, *6*, 9-15.

Walker, I. (1992). Life history traits of shrimps (Decapoda, Palaemonidae) of Amazonian Inland waters and their phylogenetic interpretation. *Studies on Neotropical Fauna and Environment, 2-3*(*27*), 131-143.

Wehrtmann, I.S. (1990). Distribution and reproduction of *Ambidexter panamense* and *Palaemonetes schmittii in* Pacific Costa Rica (Crustacea, Decapoda). *Revista de Biología Tropical*, *38*, 327-329.

Williamson, D. L. (1972). Larval development in a marine and freshwater species of *Macrobrachium* (Decapoda, Palaemonidae). *Crustaceana, 3*(*23*), 282-298.

Zar, J.H. (1999). *Biostatistical analysis*. Prentice-Hall.

Zimmermann, U., Carvalho, F.L., Mantelatto, F.L. (2015). The reproductive performance of the Red-Algae shrimp *Leander paulensis* (Ortmann, 1897) (Decapoda, Palaemonidae) and the effect of post-spawning female weight gain on weight-dependent parameters. *Brazilian Journal of Oceanography, 63*(3), 207-216.