

Morphometry and Reproductive Seasonality of the Exotic Species of Prawn *Macrobrachium Rosenbergii* on the Mosqueiro Island Belém-PA

Morfometria e Sazonalidade Reprodutiva da Espécie Exótica de Camarão *Macrobrachium rosenbergii* na Ilha do Mosqueiro Belém-PA

Tainára Cunha Gemaque^{*a}; Sérgio Rodrigues da Silva^a; Giovanni Resende de Oliveira^b; Walther Yoshiharu Ishikawa^c; Anderson Correia^d; Daniel Pereira da Costa^e

^aUniversidade Federal de Minas Gerais, Stricto Sensu Graduate Program in Zootechnics. MG, Brasil.

^bEmpresa Pesquisa Agropecuária de Minas Gerais, Campo Experimental de Leopoldina. MG, Brazil.

^cUniversidade de São Paulo, Hospital das Clínicas. SP, Brazil.

^dUniversidade de Araraquara. SP, Brasil.

^eUniversidade do Estado do Amapá, Campus Território dos Lagos. AP, Brasil.

*E-mail: tainarapesca@gmail.com

Abstract

The Brazilian Amazon is one of the richest environments of the planet regarding biological diversity, home to a diverse fauna consisting of not only native species, but also exotic ones, such as the giant river prawn (*Macrobrachium rosenbergii*). The aim of this study was to investigate aspects on development, reproductive period, fecundity and the best fishing season of *M. rosenbergii* in the region of Mosqueiro Island, Belém district, Pará state, Brazil. For this study, the specimens were monthly captured from March 2013 to February 2014, using a casting net. A number of 189 animals were captured, three crustacean species and two species of fish. The *M. rosenbergii* account for a percentage of 64% of total capture (n = 121), 64 males and 57 females. Egg-bearing females were more commonly found from March 2013 to January 2014. During the study, it was found that fishing of the prawn *M. rosenbergii* is usually made with casting net, unlike other species in the region. It was also observed that the species is well adapted to the Amazon region, with an established reproductive population.

Keywords: *Macrobrachium rosenbergii*. Amazon. Ovigerous Females

Resumo

A Amazônia Brasileira é considerada um dos ambientes mais ricos em diversidade biológica do planeta, abriga uma fauna diversificada que consiste não somente de espécies nativas, mas também algumas exóticas, como o camarão gigante da Malásia (*Macrobrachium rosenbergii*). O objetivo deste estudo foi a obtenção de informações sobre o seu desenvolvimento, período reprodutivo, fecundidade, e qual a melhor época de captura na região da Ilha do Mosqueiro, distrito de Belém-PA, Brasil. Para isto, foram realizadas coletas mensalmente a partir de março de 2013 a fevereiro de 2014, utilizando-se o apetrecho de pesca conhecida como tarrafa. 189 indivíduos foram capturados, sendo identificadas três espécies de crustáceos e duas espécies de peixes. O camarão *M. rosenbergii* obteve um percentual de 64% de captura (n = 121), dos quais 64 eram do sexo masculino e 57 do sexo feminino. As fêmeas ovígeras foram mais abundantes em março de 2013 e janeiro de 2014. Durante o estudo, foi visto que a pesca do camarão *M. rosenbergii* geralmente é feita com auxílio de tarrafa, ao contrário do que ocorre com outras espécies na região. Foi verificado que a espécie se adaptou bem à região Amazônica, com uma população bem estabelecida.

Palavras-chave: *Macrobrachium rosenbergii*. Amazônia. Fêmeas Ovígeras.

1 Introduction

The worldwide culture of prawns has grown to become one of the most productive aquaculture sectors (FAO, 2018). *M. rosenbergii* is an exotic Asiatic specie introduced in Brazil for economic purposes in the 1970s (PINHEIRO; HEBLING, 1998). However, the introduction of exotic species is a worrying factor, and may cause an environmental impact on native fauna, since *M. rosenbergii* competes for the same space, food and it can bring health risk with regional species (LATINI et al., 2016; HO et al., 2018; GANGNONNGIW et al. 2020).

Prawns farming worldwide is based on a similar technological package, characterized by three phases: Controlled Reproduction, Larvae Culture, and Grow-out Culture (XU et al., 2018). The reproductive process of *M. rosenbergii* begins between six and eight months of age and is conditioned to the female's intermittent cycle, which

periodically (about four times a year) provides the eggs production and conditions her body for copulation and the period of embryonic development after the pre-nuptial change occurred (COHEN, 1985).

In the reproductive season, mature females migrate to estuarine regions for eggs incubation and after larval phase, the post-larvae and the first juvenile stages have low tolerance to salinity, migrating to fresh water. The *M. rosenbergii* fertility is related to the females' size and age, ranging from 80,000 to 100,000 eggs. The males' reproductive capacity of this species is distinguished by three morphological types of adults: individuals called "small", "orange quela" and "blue chela" (RA'ANAN; COHEN, 1985).

According to Baghel, Lakra and Hao (2004) in captivity the population of *M. rosenbergii* has a higher proportion of females than males, about 0.41: 1.0 male: female. Due to the difference in size between the sexes, this affects the final

product, reducing the average population weight.

The aim of this study was to obtain information on the reproductive period, the best capture time and to quantify the eggs to evaluate the reproductive capacity of the giant river prawn (*Macrobrachium rosenbergii*) in the region of Mosqueiro Island, District of Belém, Pará, Brazil.

2 Material and Methods

The study area is comprised in the Mosqueiro island region, Belém-Pará District (01° 27 '21 "S / 48° 30' 16" W) located in Guajará Bay where it forms part of the Amazon estuary. This region is located in a highly dynamic environment, with strong tidal currents sufficient to provide water mixing, and in the period of low rainfall due to the marine water influence, it becomes brackish (RIBEIRO, 2004). The climate in the region is hot and humid, with average temperatures between 23 and 32 ° C, the relative air humidity is 85% with peaks of up to 100% in the periods from December to May, corresponding to the rainy period in the region (RIBEIRO, 2004).

The catches of *M. rosenbergii* were made monthly (from March 2013 to February 2014), in two places on Mosqueiro Island (Porto do Cajueiro and Bahia do Sol), using 4-m diameter pans and 5-cmmesh between the opposites. This tool was chosen because it has low selectivity, as it captures from young specimens to adults. The collections were carried out in the morning (between 4:00 and 6:00 am), observing the species nocturnal habits. According to Peebles (1979), *M. rosenbergii* presents greater locomotor activity during the night.

The captured crustaceans were separated from the accompanying fauna, placed in plastic bags and placed on ice. They were then taken to the Fish technology laboratory at Amapá State University in Macapá – AP. In the laboratory, the captured specimens were identified according to the specialized FAO literature (CERVIGÓN *et al.*, 1992).

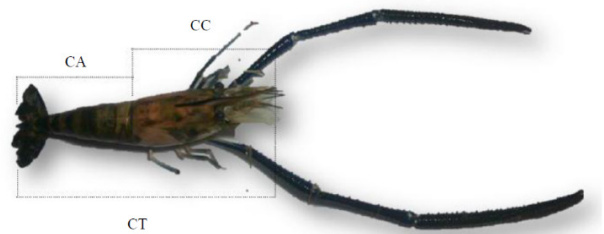
During the study period from March 2013 to February 2014, 189 individuals were captured, of which 121 were captured from the species *M. rosenbergii*, 49 were from *Macrobrachium amazonicum*, 11 were *Callinectes Danae* and 8 were two other fish species.

For the determination of the females' gonadal stage external characteristics (eggs adhered to the pleopods or the pleura enlargement to form the incubator chamber) and internal characteristics according to the gonads colors and sizes in relation to the cephalothorax were observed. The gonadal maturation stages were determined in a macroscopic way, where five stages were defined for the females (I: immature; II: in maturity; III: mature; IV: with eggs adhered to the pleopods and V: spawned), based on the ovary color, size, location and appearance. For the males, two maturation stages were observed (I: immature and II: mature) (CARVALHO; PEREIRA, 1981; CHAVES; MAGALHÃES, 1993; SILVA *et al.*, 2009).

For both sexes, total length measurements - CT (measurement taken from the end of the rostral spine to the telson), the length of the abdomen - CA (measurement taken from the anterior end of the 1st abdominal somite to the telson) and the length of the cephalothorax - CC (distance between end of the rostral spine to the posterior margin of the cephalothorax) were recorded in millimeters with the aid of a precision caliper (Figure 1). The individuals' total weight (PT), cephalothorax weight (CP), and abdomen weight (PA) were obtained using a precision scale. The total males' and females' participation, and the sex ratio were accounted.

To obtain the number of eggs, the ovigerous masses were cleaned, removing bristles, pleopods and other materials that could influence the weighing, and a total of a sub-sample equivalent to 10% for the egg count was removed from the total.

Figure 1 - Measurements of abdomen length (WC), cephalothorax length (WC) and total length (CT) in *M. rosenbergii*



Source: Research data.

To verify monthly differences in the sexes proportion, the frequencies observed by sex were compared with the expected frequencies, in a distribution of 1: 1 (male / female) using Test X², where the hypotheses were tested: Ho = null hypothesis where the number of males is equal to the number of females and H1 = alternative hypothesis where the number of males is different from the number of females, using the following expression:

$$X^2 = 2 \frac{(Nobs - Nesp)^2}{Nesp}$$

Nesp

Where:

X² = chi-square

Nobs = number of females observed in the sample

Nesp = expected number of females

The calculated X² was compared as X² (n - 1) α = 0.05 tabulated

Absolute fertility was obtained, a parameter that measures the effective species reproductive capacity and corresponds to the total number of eggs produced per female (FONTELES FILHO, 2011).

3 Results and Discussion

Of the 121 individuals captured, 64 were male and 57 female. The maximum, average and minimum lengths and weight for males, females and ovigerous females are shown in Table 1.

Table 1 - Maximum, average and minimum weight and lengths of the *M. rosenbergii* specimens

Sexo	Length (cm)			Weight (g)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
Male	7.8	16.1	24.4	3.93	110.52	217.1
Female	12	16.95	21.9	26.3	67.92	109.53
Ovigerous	12.9	16.65	20.4	28.5	67.26	106.01

Source: Research data

It is observed that the individuals with greater and lesser lengths and total weights found were male. According to Holthuis (1980), the maximum total length for the male is 320 mm and 250 mm for the female. In the municipality of Salva Terra (Ilha do Marajó) Cintra *et al.* (2003) found a male with 259 mm and a female with a total length of 232 mm.

Of the 121 individuals of the species of *M. rosenbergii*, 53% (n = 64) were males and the other 47% (n = 57) were females with an average sex ratio of males / females of 1.4: 1. Among females, ovigerous represented 16% (n = 11) of the total. In the studies developed by Brody *et al.* (1980) and Cohen *et al.* (1981), the authors stated that there is an interaction between social castes and the dominance hierarchy. The male ratio is relatively constant, being about 5: 1 (males for each female). However, according to Valenti (1996), this ratio is dynamic and may vary according to the environment.

Females were identified at all maturation stages throughout the year and a higher frequency of ovigerous females at the beginning of the rainy season (first trimester) (Table 2). Corroborating the study carried out by Pinheiro and Hebling (1998) where the authors observed that in nature, reproduction can occur throughout the year, being more intense in the period when environmental factors favor gonadal development and the offspring survival.

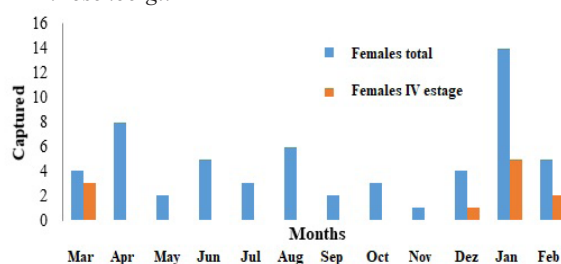
Table 2 - Monthly frequency of gonadal stages in females of *M. rosenbergii*.

Month	Nº Female	Gonadal stage				
		I	II	III	IV	V
Mar/13	4				3	1
Apr/13	8	1	1	4		
May/13	2	1	1	1		
Jun/13	5	2	2			
Jul/13	3	3				
Aug/13	6	2	3	1		
Sep/13	2	2				
Oct/13	3			2		
Nov/13	1	1				
Dez/13	4	1	1	1	1	1
Jan/14	14		2	1	5	6
Feb/14	5	1			2	4
Total	57	14	10	10	11	12

Source: Research data

A significant number of females were registered with a percentage of 47% (n = 57) of the total sample, of these 16%

(n = 11) were in stage IV maturation (with eggs adhered to the pleopods) presenting a higher incidence in the months of March 2013 and January 2014 (Figure 2). According to Pinheiro and Hebling (1998), the reproductive season is associated with the rainfall regime, thermal variations and the geographical region photoperiod in which they occur.

Figure 2 - Number of females and ovigerous females captured from *M. rosenbergii*

Source: Research data.

The number of eggs per female ranged from 5,254 to 52,358. The smallest (12.9 cm) and the largest (20.4 cm) ovigerous female had 7,190 and 52,358 eggs in February and March 2014, respectively. According to Pinheiro and Hebling (1998), most carcinologists have defined fertility as the number of eggs hatched per female in each spawning. According to Sastry (1983), the crustaceans fertility shows great variation among the species, reflecting peculiar reproductive and ecological strategies.

Prawns has a positive correlation for the fertility / length ratio, being able to externalize up to about 170 thousand eggs (LING; MERICAN, 1961; RAO, 1991). Intraspecific variations can occur due to the influence of exogenous factors on development and reproduction, such as water temperature, rainfall and photoperiod. According to Mohamad *et al.* (2017), temperatures above 30 degrees celsius can compromise the genetic expression of Hsp70 mRNA with a negative effect on the females' fertility of *M. rosenbergii*. Anita and Sirisha (2017) state that *M. rosenbergii* grows more in rainy periods (monsoons) and with reduced photoperiod. Thus, the environment may influence the time of sexual maturity arrival.

4 Conclusion

M. rosenbergii can be captured in all months of the year, showing a greater abundance of males, with the exception of April and August 2013 and January and February 2014 (rainy period in the Amazon region) where females were more abundant. The reproductive period is concentrated from

December to March and the females' fertility in the region is between 5,254 to 52,358 eggs per prawn.

References

- ANITHA, N., SIRISHA, G. Influence of photoperiod and rainfall on body length of male and female freshwater prawn "*Macrobrachium rosenbergii*". *Int. J. Fish. Aquat. Stud.*, v.5, n.1, p.35-37, 2017.
- BAGHEL, D.S., LAKRA, W.L., RAO, G.P.S. Altered sex ratio in giant fresh water prawn, *Macrobrachium rosenbergii* (de Man) using hormone bioencapsulated live *Artemia* feed. *Aquac. Res.* v.35, n.10, p.943-947, 2004. doi: 10.1111/j.1365-2109.2004.01104.x
- BRODY, T. *et al.* Yield characters of *Macrobrachium rosenbergii* in monoculture. *Aquaculture*, v.21, p.375-385, 1980. doi: 10.1111/j.1365-2109.1987.tb00324.x
- CARVALHO, H.A.; PEREIRA, M.C.G. Descrição dos estádios ovarianos de *Macrobrachium acanthurus* (Wiegmann, 1836) (Crustacea, Palaemonidae) durante o ciclo reprodutivo. *Ciênc. Cult.*, v.33, n.10, p.1353-1358, 1981.
- CERVIGÓN, F.R. *et al.* Fichas FAO de identificación de especies para los fines de la pesca. Guía de campo de las especies comerciales marinas y de aguas salobres de la costa septentrional de Sur América. Rome: FAO, p.513, 1992.
- CHAVES, P.T.; MAGALHÃES, C. O desenvolvimento ovocitário em *Macrobrachium amazonicum* (Heller, 1862) (Crustacea: Decapoda: Palaemonidae), camarão dulcícola da região Amazônica. *Acta amaz.* v.23, n.1, p.17-23, 1993. doi: 10.1590/1809-43921993231023
- CINTRA, I.A.; SILVA, K.C.A.; MUNIZ A.P.M. Ocorrência de *Macrobrachium rosenbergii* (de Man, 1879) em áreas estuarinas do estado do Pará (Crustacea, Decapoda, Palaemonidae). *Bol. Téc. Cient. CEPNOR*, v.3, n.1, p.219-227, 2003.
- COHEN, D.; RA'ANAN, Z.; BRODY, T. Population profile development and morphotypic differentiation in the giant freshwater prawn *Macrobrachium rosenbergii* (de Man). *J. World Mar. Soc.*, v.12, n.2, p.231-243, 1981. doi: 10.1111/j.1749-7345.1981.tb00298.x
- FAO. The State of World Fisheries and Aquaculture 2018 - Meeting the Sustainable Development Goals., Rome. p.210, 2018.
- FONTELES-FILHO, A. A. Oceanografia, biologia e dinâmica populacional de recursos pesqueiros. Fortaleza, Expressão Gráfica, 2011.
- GANGNONNGIWAB, W. *et al.* In experimental challenge with infectious clones of *Macrobrachium rosenbergii* nodavirus (MrNV) and extra small virus (XSV), MrNV alone can cause mortality in freshwater prawn (*Macrobrachium rosenbergii*). *Virology*, v.540, p.30-37, 2020. doi: 10.1016/j.virol.2019.11.004
- HO, *et al.* Structure of the *Macrobrachium rosenbergii* nodavirus: a new genus within the Nodaviridae? *PLoS Biol.*, v.16, n.10, e3000038, 2018. doi: 10.1371/journal.pbio.3000038
- HOLTHUIS, L.B. FAO species catalogue. Prawns and prawns of the world. An annotated catalogue of species of interest to fisheries. *FAO Fisheries Synopses*, v.125, n.1, p.261, 1980.
- LATINI *et al.* Espécies exóticas invasoras de águas Continentais no Brasil. Brasília: MMA, 2016.
- LING, S.W.; MERICAN, AB. A. Notes on the life and habits of the adults and larval stages of *Macrobrachium rosenbergii* (De Man). *Indo-Pacific Fish. Counc. Proceed.*, v.9, n.2, p.55-60, 1961.
- MOHAMAD, A. *et al.* Effect of thermal stress on Hsp70 gene expression and female reproductive performance of giant freshwater prawn, *Macrobrachium rosenbergii*. *Aquac. Res.*, p.1-17, 2017. doi: 10.1111/are.13442
- PEEBLES, J.B. Molting, movement, and dispersion in the freshwater prawn *Macrobrachium rosenbergii*. *J. Fish Biol.*, v.36, p.1080-1088, 1979. doi: 10.1139/f79-151
- PINHEIRO, M.A.A.; HEBLING, N.J. Biologia de *Macrobrachium amazonicum* (De Man, 1879). In: VALENTI, W.C. Carcinicultura de água doce: tecnologia para produção de Camarões. São Paulo: FAPESP, p.21-46, 1998.
- RA'ANAN, Z.; COHEN, D. Ontogeny of social structure and population dynamics in the giant freshwater prawn, *Macrobrachium rosenbergii* (De Man). In: WENNEER, A.M. Factors in adult growth. Boston: A. A. Balkema, 1985. p.277-311.
- RAO, K.J. Reproductive biology of the giant freshwater prawn *Macrobrachium rosenbergii* (De Man) from Lake Kolleru (Andhra Pradesh). *Indi. J. Anim. Sci.*, v.61, n.7, p.780-787, 1991.
- RIBEIRO, K.T.S. Água e saúde em Belém. In: RIBEIRO, K.T.S. Água e saúde humana em Belém. Belém: Cejup. 2004.
- SASTRY, A.N. Ecological aspects of reproduction. Pages 179-270. In: VERNBERG F J.; VERNBERG W.B. The Biology of crustacea. environmental adaptations. New York: Academic Press, 1983. p.383.
- SILVA, G.M.F. *et al.* Gonadal structure analysis of *Macrobrachium amazonicum* (Heller, 1862) from a wild population: a new insight on the morphotype characterization. *Aquac. Res.*, v.40, p.798-803, 2009. doi: 10.1111/j.1365-2109.2009.02165.x
- VALENTI, W.C. *Criação de camarões em águas interiores*. Jaboticabal: Funep, 1996.
- XU, W.-J., MORRIS, T.C., SAMOCHA, T.M., Effects of two commercial feeds for semiintensive and hyper-intensive culture and four C/N ratios on water quality and performance of *Litopenaeus vannamei* juveniles at high density in biofloc-based, zero exchange outdoor tanks. *Aquaculture*, v.490, p.194-202, 2018. doi: 10.1016/j.aquaculture.2018.02.028.