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Reproductive biology of *Macrobrachium surinamicum* (Decapoda: Palaemonidae) in the Amazon River mouth

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ABSTRACT

Macrobrachium surinamicum is an indigenous prawn distributed from the lower Amazon and Tocantins river basins to Venezuela in the Orinoco Delta region. It is common bycatch fauna of *Macrobrachium amazonicum* artisan fishing in the states of Pará and Amapá. The aim of this study was to investigate aspects on reproductive biology (reproductive period, size of sexual maturity population, fecundity, reproductive output and recruitment) of *M. surinamicum* from four important areas to artisanal prawn fishing located at the Amazon River mouth (Amapá and Pará). The specimens were captured using 20 handcrafted traps called "matapi". A number of 675 prawns were captured, 258 males, 409 females and eight juveniles, resulting in 1:1.6 (Male: Female) sex ratio. The reproductive peak period occurred from March to July, coinciding with the higher rainfall period. The juvenile prawn occurred only in May and July. Total length of egg-bearing females ranged from 12.12 to 38.30 mm, with mean female length at first maturity (L50) of 23.7 mm. Fecundity increased with prawn size and varied between 174 and 1780 eggs per female. Mean egg volume increased gradually from 0.031 (Stage I) to 0.060 mm^3 (Stage III) during embryogenesis. *Macrobrachium surinamicum* depends on brackish water to complete the larval development. Irrespective of female size, reproductive output of *M. surinamicum* varied between 4.3 % and 35.5 % of their body weight for egg production. The knowledge of the reproductive biology reported in the present study is an important tool to define strategies to preserve *M. surinamicum* in Amazon River mouth.

KEYWORDS: Palaemonid eggs, bycatch fauna, fecundity, morphometric relationships, reproductive output

Biologia reprodutiva do camarão *Macrobrachium surinamicum* (Decapoda: Palaemonidae) na foz do rio Amazonas

RESUMO

Macrobrachium surinamicum é uma espécie nativa de camarão de água doce distribuída do Brasil, nas bacias do rio Amazonas e Tocantins até a Venezuela na região do Delta do Orinoco. Este é fauna acompanhante comum da pesca artesanal de *Macrobrachium amazonicum* nos estados do Pará e Amapá. O objetivo deste trabalho foi abordar aspectos gerais da biologia reprodutiva (período reprodutivo, tamanho de primeira maturação, fecundidade, investimento reprodutivo e recrutamento) de *M. surinamicum* de quatro importantes áreas de pesca artesanal de camarão localizada na foz do rio Amazonas (Amapá e Pará). Os exemplares foram capturados usando 20 armadilhas artesanais, conhecidas localmente como matapi. Um total de 675 camarões foi capturado, 258 machos, 409 fêmeas e oito juvenis, resultando uma razão sexual geral de 1: 1,6 (macho:fêmea). Os picos reprodutivos ocorreram de março a julho, coincidindo com o período mais chuvoso. Os jovens foram observados em maio e julho. O comprimento total das fêmeas ovígeras variou de 12,12 a 38,30 mm, com o comprimento de primeira maturação (L50) estimado em 23,7 mm. A fecundidade aumentou com o tamanho das fêmeas, variando entre 174 e 1780 ovos por espécime. Volume médio dos ovos aumentou gradualmente durante a embriogênese saindo de 0,031 (Estágio I) para 0,060mm^3 (Estágio III). *Macrobrachium surinamicum* dependem de água salobra para completar seu desenvolvimento larval. Independentemente do tamanho da fêmea, o investimento reprodutivo de *M. surinamicum* variou entre 4,3 % e 35,5% do seu peso corporal para a produção de ovos. O conhecimento da biologia reprodutiva relatada no presente estudo é uma ferramenta importante para ajudar a definir estratégias para preservar *M. surinamicum* na foz do Rio Amazonas.

PALAVRAS-CHAVE: ovos de palaemonideos, fauna acompanhante, fecundidade, relações morfométricas, investimento reprodutivo.

INTRODUCTION

The genus *Macrobrachium* (Bate 1868) is especially important among palaemonid prawns including species of major scientific and economic interest. Therefore, understanding the reproductive periodicity of this group is imperative to develop management and culture programs (Fransozo *et al*. 2004). The poor knowledge of the fauna in the coastal zone of the state of Pará (Barros and Pimentel 2001) and Amapá is related to its large territory, biological richness and insufficient collecting efforts in the region.

In the estuarine zones of the Amazonian states, prawn exploitation is directed towards two freshwater species, *Macrobrachium amazonicum* (Heller 1862) and *M. carcinus* (Linnaeus 1758), which are exclusively caught through artisanal fishing in the states of Pará and Amapá (Silva *et al*. 2002; Vieira and Neto 2006; Lima and Santos 2014). This activity has great economic importance in the Amazonian rivers; however, few studies on fisheries has been conducted, especially those concerning to bycatch fauna, including freshwater crabs and small fish (Lima *et al*. 2013) and other prawns with low economic value as *Macrobrachium surinamicum* (Espírito-Santo *et al*. 2005; Bentes *et al*. 2011; Lima and Santos 2014).

Macrobrachium surinamicum is distributed from Brazil in the lower Amazon and Tocantins river basins (Amapá and Pará) to Venezuela in the Orinoco Delta region (Melo 2003; Montoya 2003). This prawn does not have economic importance in the region, but stands out for being often caught and marketed with *M. amazonicum* (Espírito Santo *et al*. 2005; Lima and Santos 2014). Size at which this prawn reaches the sexual maturity, reproductive period, fecundity and fertility are unknown data.

The knowledge of reproductive biology (fecundity and fertility) of palaemonid prawns is important tool to evaluate the potential candidates for aquaculture and to define strategies for biodiversity preservation (Mossolin and Bueno 2002). In this group, fecundity can be defined as the number of eggs laid per hatching that can be found adhered to the female pleopods (Lima *et al*. 2014). The knowledge of species fecundity is important to estimate the reproductive potential and stock size of natural populations. Therefore, the aim of this study was to investigate aspects on reproductive biology (reproductive period, size of sexual maturity population, individual and population fecundity, reproductive output and recruitment) of *M. surinamicum* from four important areas to artisanal prawn fishing located at the Amazon River mouth (Amapá and Pará).

MATERIALS AND METHODS

Study Area

The study area comprised the regions of Santana Island (00º03'40.9"S and 051º08'46.6"W), Rasa Island (00º16'08.1"S and 051º07'25.9"W), Pequena Island (00º15'20.0"S and 051º18'10.6"W) and Mazagão Velho (00º15'39.9"S and 051º20' 42.3'W) State of Amapá, located at the Amazon River mouth near the limit between Pará and Amapá states (Figure 1). The areas studied are relatively

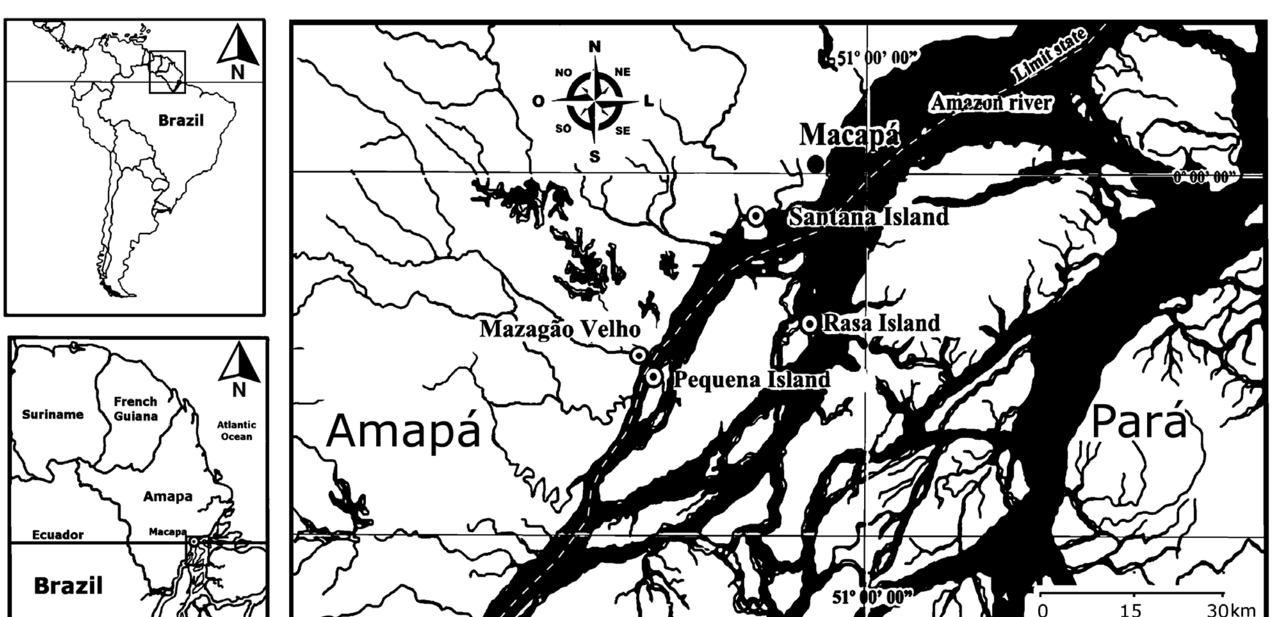

Figure 1. Study area location - 1) Pequena Island, 2) Santana Island, 3) Rasa Island and 4) Mazagão Velho.

similar in their physiography and important to artisanal prawn fishing. All the study area shows various drainage channels, with varying sizes and depths, allowing the daily flooding and the formation of a wide diversity of microhabitats. In the site of Santana Island, the "várzea" vegetation is open and sparse with the presence of a narrow border of macrophytes. In Pequena and Rasa islands, the "várzea" vegetation is moderately dense with some wide bands of macrophytes occupying its edge. In the Mazagão Velho, "várzea" vegetation is dense with large and wide bands of macrophytes along the river.

Prawn collection and Rainfall data

Prawns were monthly collected from January 2009 to January 2010, using a handcrafted trap called matapi (30 cm in diameter, 50 cm in length and 5mm in crack size), baited with flour of babaçu (*Orbignya speciosa*) fruit. Twenty matapis were used at each collection site. Traps were set at depths of 1 to 2 meters, for an immersion time of 12 hours, on average. This sampling time is equivalent to the capture performed by artisanal fishermen, which occurs every tidal cycle (twice daily). All prawn collection occurred at daybreak. The caught specimen were properly labeled and preserved in plastic bags containing solution of 4% formalin added of 70% ethanol (1:1).

At the laboratory, *Macrobrachium surinamicum* fauna was sorted from the bycatch of the target species and stored using 80% ethanol until screening. The specimen identification was performed according to Melo (2003) and the sexual differentiation was assessed by observing the secondary sexual characteristics, such as male appendix in the second pleopods, which is absent in females. Carapace length (distance from the inside of the eye socket to the center of the posterior margin of the carapace) and total length (linear distance from the rostrum extremity to the telson tip) were measured with digital calipers (Absolute 500-196-20, Mitutoyo, Tokyo, Japan) at 0.01 mm precision, and the body wet weight determined (balance with 0.01 g precision; BL 320H, Shimadzu, Harbour City, Hong Kong). Prawns were grouped into the following demographic categories: adult males, non-ovigerous adult females, ovigerous females and juveniles (smaller prawns than the smallest ovigerous female and undifferentiated sex). Rainfall data was obtained at the Nucleus of Hydrometeorology and Renewable Energy of Institute of Scientific and Technological Research of the State of Amapá - IEPA (NHMET/IEPA).

Reproductive parameters

The reproductive period was determined by the presence of ovigerous females during the sampling period. Size at first individual maturity was determined as that of the smallest ovigerous female. Length at first maturity was estimated by fitting the frequency of mature females to a logistic model (King 1995): y=1/ [1+exp (-r (TL-Lm))]. Where, r is the slope, TL is the total length and Lm the size at first maturity (Lm=a/b)).

The fecundity was obtained by direct counting the eggs of 49 ovigerous females that were randomly selected considering the integrity of eggs and collection months. The entire egg mass was removed under a dissecting binocular stereo microscope (K 400L, Motic, Causeway Bay, Hong Kong) and all eggs were counted. The development stages of eggs were classified as follows (Wehrtmann 1990): Stage I: eggs recently extruded; uniform yolk; no eye pigments visible; Stage II: eye pigments barely visible, and Stage III: eyes clearly visible and fully developed. The recruitment was assessed by the presence of juvenile individuals in the sampled population. To determine the egg volume, a total of 10 eggs were separated from each ovigerous female to measure the length (longest axis) and width (shortest axis) under a compound binocular microscope equipped with calibrated ocular micrometer. Egg volume was calculated as (Wehrtmann 1990): $v = \pi * l * h * (h)^2$; where "l" is length; "h" width in mm and π =3.14. The reproductive output (RO) was calculated by dividing the total egg wet mass by the female wet mass, which was determined with an analytic balance (0.0001 g precision).

Statistical analysis

The differences in monthly abundance between areas were analyzed using the Student test (Zar 1999). The differences in sex ratio were analyzed and tested using the Chi-square ($\chi 2$) test (Zar1999). Pearson's linear regression model was used to correlate total weight and total length, body size and number eggs, body size and mass of incubated eggs for each embryonic stage. For each of the three embryonic stages, the mean egg volume with standard deviation was calculated and submitted to an analysis of variance (ANOVA, α= 0.05) with a posteriori Tukey test (Zar 1999). Linear regressions were generated for each embryonic stage to depict the relation between fecundity and females' size (FS), and also to analyze the relationship between RO and female size (TL). All statistical analyses were conducted using the Biostat 5.0 software at α= 0.05.

RESULTS

Macrobrachium surinamicum showed abundance pattern with high density of individuals coinciding with high rainfall (Figure 2). In the present study, 675 specimens of *M. surinamicum* were captured, 258 males, 409 females and 8 juvenile, resulting in a sex ratio of 1:1.6 (male: female). The sex ratio was significantly different from that of 1:1 in March, April, July and October of 2009 (Table 1) and in Santana Island, Pequena Island and Rasa Island in favour of females. Whereas in Mazagão Velho it did not differ from the 1:1 ratio (Table 2). Ovigerous *M. surinamicum* females were found throughout the year; however, the reproductive peak period was found from March to July 2009, coinciding with high rainfall; while juvenile prawns were found only in May and July, but in small numbers (Figure 3).

Total length was 38.30 mm for female and 49.76 mm for male. Among females, 192 (46.9%) carried their eggs in the abdomen. Ovigerous females ranged in total length from 12.12 to 38.30 mm (Table 3). The length at first maturity (L50) estimated for females was 23.7 mm (TL). From the class interval of 48.0 mm onwards, all the females presented mature ovaries (Figure 4).

Fecundity of *M. surinamicum* varied between 174 and 1780 eggs for individuals, total length between 12.12 and 38.3 mm. The relationship between fecundity (egg number and mass volume) and female size (carapace length) was positive and highly significant ($P < 0.0001$) for the development Stage I to III (Figure 5).

Mean egg length and volume increased significantly during embryogenesis ($P < 0.001$) (Table 4). There was a negative statistically significant relationship ($P = 0.00038$) between RO and CL in *M. surinamicum*; however, we cannot say that RO is determined by CL in view of the R^2 is very low (Figure 6). Females converted on average 14.3 ± 6.0% of their body weight into eggs production and RO varied between 4.3 % and 35.5 %. This agrees with range reported for other species of *Macrobrachium* (Table 5).

Table 1. Monthly chi-square (χ^2) values and sex ratio of *Macrobrachium surinamicum* sampled in Santana Island, Pequena Island, Rasa Island and Mazagão Velho from Jan/2009 to Jan/2010.

Months	Sites Grouped			
	♂	♀	χ^2	Ratio (♂:♀)
January/09	6	5	0.09	1:0.8
February	9	3	3.00	1:0.3
March	41	73	8.98*	1:1.8
April	48	121	31.53*	1:2.5
May	63	70	0.37	1:1.1
June	27	39	2.18	1:1.4
July	34	59	6.72*	1:1.7
August	12	23	3.46	1:1.9
September	0	0	0	-
October	0	6	6.00*	0:6
November	0	0	0,00	-
December	0	1	1.00	0:1
January/2010	18	9	3.57	1:0.5
Total	258	409	34.18	1:1.6

*Significant data at P<0.05.

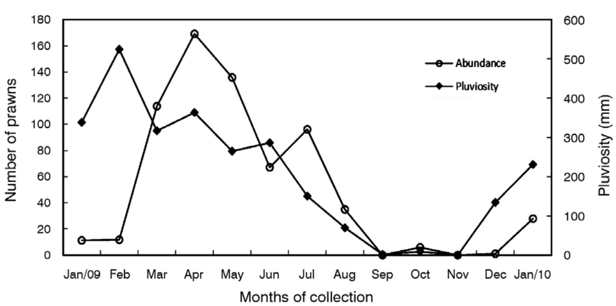

Figure 2. Absolute frequency distribution of *Macrobrachium surinamicum* sampled in Santana Island, Pequena Island, Rasa Island and Mazagão Velho from Jan/2009 to Jan/2010.

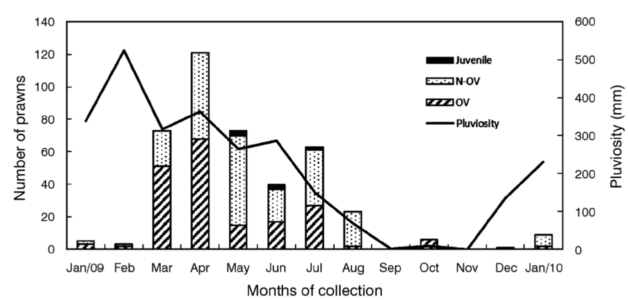

Figure 3. Absolute frequency distribution of ovigerous, non-ovigerous females and juveniles of *Macrobrachium surinamicum* sampled in Santana Island, Pequena Island, Rasa Island and Mazagão Velho from Jan/2009 to Jan/2010.

Table 2. General chi-square values and sex ratio of *Macrobrachium surinamicum* sampled in Santana Island, Pequena Island and Rasa Island and Mazagão Velho from Jan/2009 to Jan/2010.

Study site	Months Grouped			
	♂	♀	X^2	Ratio (♂:♀)
Pequena Island	72	136	19.69*	1:1.8
Rasa Island	58	91	7.31*	1:1.6
Santana Island	55	103	14.58*	1:1.9
Mazagão Velho	71	79	0.16	1:1.1
Total	258	409	34.18*	1:1.6

*Significant data at P<0.05.

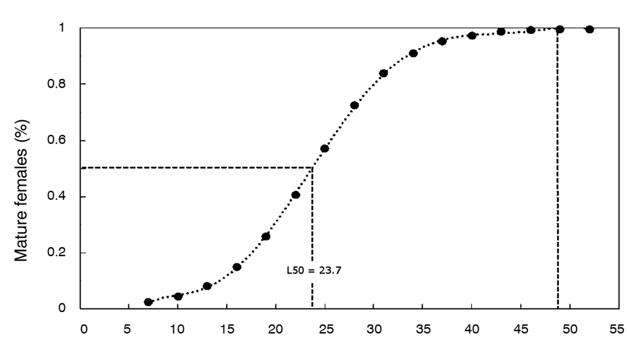

Figure 4. Logistic curve of sexual maturity estimated for *Macrobrachium surinamicum* in Santana Island, Pequena Island, Rasa Island and Mazagão Velho from Jan/2009 to Jan/2010. The dashed line represent the class interval where the probability of being mature is 50% and 100% (CL). Equation: $Y = -5E\text{-}09x^6 + 9E - 07x^5 - 6E\text{-}05x^4 + 0.0021x^3 + 0.2453x - 0.6695$; $R^2 = 0.9999$.

Table 3. Distribution frequency according to the size classes (Carapace Length) of *Macrobrachium surinamicum* sampled in Santana Island, Pequena Island, Rasa Island and Mazagão Velho from Jan/2009 to Jan/2010.

Size Classes (TL, mm)	Adult Males		Non-ovigerous females		Ovigerous females		Juveniles		Total	
	N	%	N	%	N	%	N	%	N	%
07-10	0	0.00	0	0.0	0	0.0	2	25.00	2	0.15
10-13	0	0.00	2	0.9	0	0.0	6	75.00	8	0.59
13-16	2	0.78	13	6.0	1	0.5	0	0.00	16	1.19
16-19	9	3.49	29	13.4	7	3.6	0	0.00	45	3.34
19-22	11	4.26	45	20.7	19	9.9	0	0.00	75	5.56
22-25	19	7.36	69	31.8	28	14.6	0	0.00	116	8.61
25-28	35	13.57	34	15.7	32	16.7	0	0.00	101	7.49
28-31	34	13.18	12	5.5	58	30.2	0	0.00	104	7.72
31-34	39	15.12	7	3.2	37	19.3	0	0.00	83	6.16
34-37	37	14.34	1	0.5	9	4.7	0	0.00	47	3.49
37-40	32	12.40	1	0.5	1	0.5	0	0.00	34	2.52
40-43	20	7.75	2	0.9	0	0.0	0	0.00	22	1.63
43-46	7	2.71	1	0.5	0	0.0	0	0.00	8	0.59
46-49	6	2.33	1	0.5	0	0.0	0	0.00	7	0.52
49-52	6	2.33	0	0.0	0	0.0	0	0.00	6	0.45
52-55	1	0.39	0	0.0	0	0.0	0	0.00	674	50.00
Total	258	100	217	100.0	192	100.0	8	100.00	1348	100.00

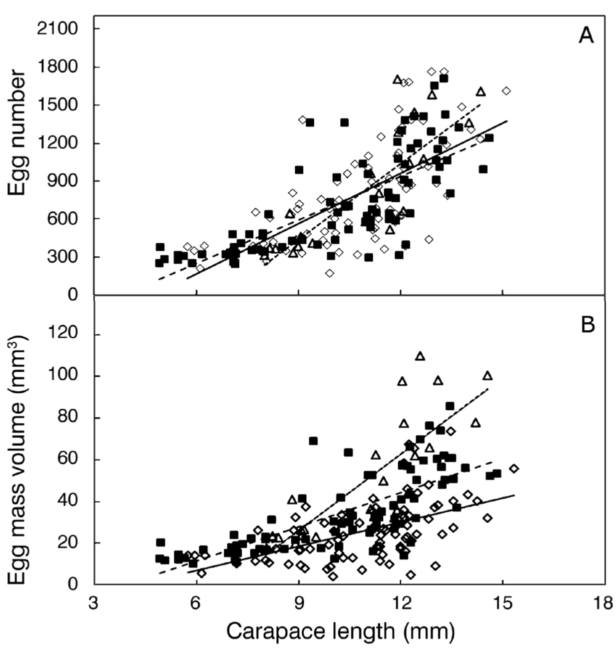

Figure 5. Ratio between fecundity and female size for each of the three embryonic stages of *Macrobrachium surinamicum* sampled in Santana Island. Pequena Island and Rasa Island and Mazagão Velho from Jan/2009 to Jan/2010. A - Carapace length (mm) and egg number: Stage I (◊, diamond) solid line, Y = 130.0x – 609.1, N = 82, R^2 = 0.429; Stage II (■, solid square) dashed line, Y = 112x – 416.1, N = 87, R^2 = 0.62; Stage III(Δ, triangle) dotted line, Y = 196.3x – 1333.1, N = 23, R^2 = 0.669; B - carapace length (mm) and egg mass volume (mm³): Stage I (◊, diamond) solid line, Y = 3.727x – 15.07, N = 82, R^2 = 0.290; Stage II (■, solid square) dashed line, Y = 5.260x – 19.73, N = 87, R^2 = 0.562; Stage III (Δ, triangle) dotted line, Y = 11.73x - 79.53, N = 23, R^2 = 0.638.

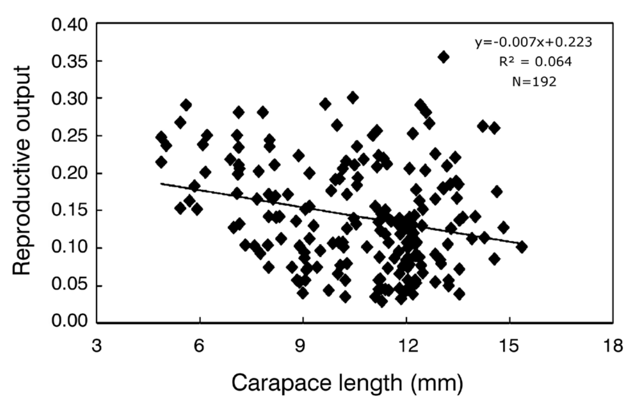

Figure 6. Ratio between female carapace length (mm) and reproductive output of *Macrobrachium surinamicum* considering all developmental egg stages.

Table 4. Average (± standard deviation) values of egg volume (mm³) and egg length (mm) for three embryonic developmental egg stages of *Macrobrachium surinamicum* sampled in Santana Island, Pequena Island, Rasa Island and Mazagão Velho from Jan/2009 to Jan/2010. N = number of observations. Means within a row followed by different letters are significantly different ($P < 0.001$) by ANOVA.

Egg stage	N	Mean egg volume (mm³)	Mean egg length (mm)
I	83	0.031 (± 0.006) a	0.272 (± 0.024) a
II	86	0.047 (± 0.004) b	0.295 (± 0.027) b
III	23	0.060 (± 0.004) c	0.323 (± 0.034) c

Table 5. Reproductive output (RO) of different *Macrobrachium* species.

Species	Mean (%); (min-Max)	Reference
M. surinamicum	14.3 (4.3-35.5)	Present study
M. amazonicum	17.7 (4.8-21.8)	Lima *et al.* (2014)
M. carcinus	12.0 (4.0-21.0)	Lara and Wehrtmann 2009
M. hainanense	10.5 (3.7-17.1)	Mantel and Dudgeon (2005)
M. acanthurus	19.0 (14.0-30.0)	Anger and Moreira (1998)
M. olfersi	22.0 (7.0-38.0)	Anger and Moreira (1998)

DISCUSSION

Our results showed abundance pattern antagonistic to that of *M. amazonicum* (Lima *et al*. 2014), with high density of *M. surinamicum* in the rainy season (Nóbrega *et al*. 2013; Lima *et al*. 2014). The prawns are caught in abundance along the banks of the Amazon River during low water, when they are migrating from the lowland (Lima *et al*. 2014). Similar data are presented by Nóbrega *et al*. (2013), suggesting that abundance of both prawns are strongly influenced by rainfall on the lower Amazon River estuary.

Macrobrachium surinamicum females predominated in the population in this study. This biased-female ratio seems to be common in caridean prawns, particularly in species of *Macrobrachium* genus (Antunes and Oshiro 2004; Fransozo *et al*. 2004; and Lima *et al*. 2014). However, the ratio in favor of males or identical proportion of males and females can also be observed in this genus (Mantel and Dudgeon 2005; Mattos and Oshiro 2009). Deviations in the sex ratio could be a consequence of differences in size, mortality and birth rates between males and females or other factors, such as molt rates, dispersal, reproduction and differential migration (Botelho *et al*. 2001). Among populations of a same species, the sex ratio also may be influenced by environmental conditions, geographical characteristics and anthropogenic interferences (Lima *et al*. 2014).

The recruitment occurs when an age group integrates for the first time into the exploitable stock. *Macrobrachium surinamicum* juveniles were present from May to July, in contrast with data observed by Nóbrega *et al*. (2013) for Pará. However, our data are insufficient to indicate a pattern of recruitment in the studied areas. The reduced number of juveniles sampled can be associated to adjustment in the spacing of cracks matapis (5 mm) used in the present study, and possibly do not affect the local population structure of *M. surinamicum*. However, *M. surinamicum* as bycatch fauna in fishing of *M. amazonicum* can be prevented using the measurements from 8 to 10 mm crack reported by Lima *et al*. (2014).

Numerous studies with different decapods have shown that fecundity is closely related to female size (Wehrtmann and Lardies 1999; Oh *et al*. 2002; Nazari *et al*. 2003). As a general rule, larger females of the same species have larger ovaries, capable of producing more offspring than smaller individuals. Moreover, larger females are able to carry more embryos than smaller ones due to a larger physical space available for egg attachment (Nazari *et al*. 2003; Lara and Wehrtmann 2009; Lima *et al*. 2014). The results of our study corroborate this tendency.

Fecundity of *M. surinamicum* increased linearly with the size of females, especially when considering embryos in early developmental stages. Such a positive linear relation has also been described for other *Macrobrachium* species (Valenti *et al.* 1989; Mossolin and Bueno 2002; Lara and Wehrtmann 2009), indicating a common characteristic in this genus.

As a general rule, estuarine *Macrobrachium* species that depend on estuarine environments to complete the larval development have large sizes and produce much more eggs than the majority of other caridean prawns (Lara and Wehrtmann 2009; Bentes *et al.* 2011; Lima *et al.* 2014). In contrast, *M. surinamicum* has small size and produce much more eggs than the other *Macrobrachium* prawns with similar sizes, whose absolute fecundity is lower than 200 eggs (Phone *et al.* 2005; Mantel and Dudgeon 2005; Garcia-Dávila *et al.* 2000).

The intra- and interespecific differences in fecundity of *Macrobrachium* species are influenced by differences in female size (Graziani *et al.* 1993; Da Silva *et al.* 2004) depending on temperature, food quality and quantity, which may vary along the latitudinal range of species distribution (Fransozo *et al.* 2004). In estuarine species, such as *M. carcinus* and *M. rosenbergii,* there is a visible increased size of animals, number of eggs and larval stages; contrary to the typical species of continental waters, whose numbers of eggs and larval stages are quite low. Nevertheless, *M. surinamicum* is an estuarine species with small size and a considerable number of eggs.

Differences in the maximum reproductive output among crustacean species seem to be primarily the result of differences in female body size; however egg size, latitudinal and seasonal variations, and habitat adaptation may also influence the reproductive output. The reproductive output of *M. surinamicum* was not related to the female size, and this finding is in accordance with the results reported for other *Macrobrachium* species (Mantel and Dudgeon 2005; Lara and Wehrtmann 2009; Lima *et al.* 2014). Apparently, the reproductive output in *Macrobrachium* is associated with the individual condition of females and not size, since specimens of different sizes may have similar reproductive output (Lima *et al.* 2014).

CONCLUSION

Like other estuarine *Macrobrachium* species, *M. surinamicum* abundance is strongly influenced by rainfall. The low number of juvenile prawns can be related to spacing of cracks matapis in use and possibly it does not affect the local population structure of *M. surinamicum*. *Macrobrachium surinamicum* showed abundance pattern antagonistic to that of *M. amazonicum*, with high density of juveniles in the rainy season and scarcity when rainy was lower. Prawns are caught in abundance along the banks during low water, when they are migrating from the lowland. Females are more abundant than males, similar to that observed in other *Macrobrachium* species. The reproductive peak of *M. surinamicum* has positive correlation with the rainy season, but the species reproduces continuously throughout the year. Fecundity of this prawn is variable and has positive correlation with female size. *Macrobrachium surinamicum* has small size and produce much more eggs than the other *Macrobrachium* species with similar sizes. The reproductive output in *M. surinamicum* was not related to the female size; there is a need for more studies to determine which factors actually affect the egg production of this species. The knowledge of the reproductive biology reported in the present study is an important tool for helping to define strategies to preserve *M. surinamicum* in Amazon River mouth.

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