Population structure and relative growth of freshwater prawn Macrobrachium brasiliense (Decapoda, Palaemonidae) from São Paulo State, Brazil.

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ABSTRACT: Population structure and relative growth of freshwater prawn Macrobrachium brasiliense (Decapoda, Palaemonidae) from São Paulo State, Brazil. We conducted a study of M. brasiliense to examine the population biology with emphasis on sex ratio and size frequency distribution and to describe the mathematical equations referring to relative growth used to detect sexual dimorphism. The specimens were analyzed in terms of population structure, male:female ratio, size frequency distribution, recruitment and relative growth. A total of 280 animals were monthly collected during one year. Proportion of females (72.14%) was significantly higher than that of males (27.86%) and ovigerous females were absent. There was no correlation between the variation of temperature or rainfall and number of males and females captured. Sex dimorphism was observed with respect to size, with males being significantly heavier and larger than females. Seasonal variation in female size associated with the peak of juvenile recruitment from March to June support the hypothesis of a greater reproductive activity in summer, despite no collected ovigerous females during this season. According to the sexual proportion of individuals in size classes, the reversal pattern was observed for the population studied. The relative growth allow us to infer that sexual maturity is reached between 9 and 10 mm of carapace length for both sexes, a size when the difference in growth is observed for males and females. Macrobrachium brasiliense is a species without economic importance but shows atypical biological patterns that encourage further studies on reproduction and population dynamics.

Key-words: Crustacea, Palaemonidae, freshwater prawn, growth.

RESUMO: Estrutura populacional e crescimento relativo do camarão de água doce Macrobrachium brasiliense (Decapoda, Palaemonidae) no estado de São Paulo, Brasil. O presente estudo sobre M. brasiliense foi conduzido para examinar a biologia populacional com ênfase na razão sexual e na distribuição de freqüência de tamanho, além de descrever as equações matemáticas referentes ao crescimento relativo utilizadas para detectar o dimorfismo sexual. Os exemplares foram avaliados quanto aos aspectos biológicos (estrutura populacional, proporção macho:fêmea, distribuição de freqüência de tamanho, recrutamento e crescimento relativo) comparados por sexo e estações climáticas. Foram coletados mensalmente, durante um ano, um total de 280 animais. A proporção de fêmeas (72.14%) foi significativamente maior que a de machos (27.86%), enquanto fêmeas ovígeras estiveram ausentes. Não houve correlação entre as variações da temperatura e da pluviosidade com o número de machos e fêmeas capturados. O dimorfismo sexual foi observado com relação ao tamanho, sendo que os machos foram significativamente maiores e mais pesados que as fêmeas. Apesar da ausência de fêmeas ovígeras, a hipótese da maior atividade reprodutiva no verão foi corroborada em função da variação sazonal no tamanho das fêmeas associada ao pico de recrutamento de juvenis de Março a Junho. Foi constatado um padrão reverso na proporção sexual dos indivíduos nas classes de tamanho. Evidências a partir do crescimento relativo indicaram que a maturidade sexual é

atingida entre 9 e 10 mm de comprimento de carapaça para ambos sexos, tamanho na qual se observou diferença no crescimento entre machos e fêmeas. Macrobrachium brasiliense é uma espécie sem importância econômica mas com um padrão biológico atípico que encoraja a realização de estudos futuros sobre reprodução e dinâmica populacional.
Palavras-chave: Crustacea, Palaemonidae, camarão água doce, crescimento.

Introduction

Studies of crustacean populations provide important information on species dynamics, as well as for preservation of natural biodiversity. Population studies of freshwater caridean prawn are less numerous than those on the remaining decapods, especially with respect to the marine and considering the species described thus far. A decrease in natural populations of caridean prawn has been observed during the last twenty years, principally as a function of the limited knowledge on the biology of this fauna (Carvalho et al., 1979; Valenti, 1984; Bauer, 2004) as a support during the adverse climatic conditions affecting particular areas, overfishing of crustacean stocks aiming tourist and economic activities and for the regulation of natural exploitation.

Most caridean prawn are marine, although a few live in fresh water and estuaries areas, spending part of their life-time in this habitat but returning to the sea-water region to breed (Smaldon et al., 1993). The biology and ecology of this group is diverse and complex, probably as a consequence of its adaptation to various environments during evolution (Pereira, 1997; Bauer, 2004).

The species of the genus Macrobrachium Bate, 1868 are included in this group, which comprises species economically interesting to human activity and others are a conspicuous and important component of freshwater and estuarine ecosystems throughout tropical and warm temperate areas of the world. The genus has approximately 210 species presently described and recognised throughout the world (Holthuis, 1952; Coelho & Ramos-Porto, 1985; Melo et al., 1988; Pinheiro & Hebling, 1998; Pereira et al., 2002; Melo, 2003; Short, 2004), with nearly half of these described in the 50 or so years since the last major revisionary works on the group by Holthuis (1952). A total of 18 species of Macrobrachium occur in the Brazilian territory: Macrobrachium acanthurus (Wiegmann, 1836); Macrobrachium amazonicum (Heller, 1862); Macrobrachium birai Lobão, Melo & Fernandes 1986; Macrobrachium borelli (Nobili, 1896); Macrobrachium brasiliense (Heller, 1862); Macrobrachium carcinus (Linnaeus, 1758); Macrobrachium denticulatum Ostrowski, Fonseca & Ferreira, 1996; Macrobrachium ferreirai Kensley & Walker, 1982; Macrobrachium heterochirus (Wiegmann, 1836); Macrobrachium holthuisi Genofre & Lobão, 1978; Macrobrachium iheringi (Ortmann, 1897); Macrobrachium inpa Kensley & Walker, 1982; Macrobrachium jelskii (Miers, 1877); Macrobrachium nattereri (Heller, 1862); Macrobrachium olfersi (Wiegmann, 1836); Macrobrachium petronioi Melo, Lobão & Fernandes, 1986; Macrobrachium potiuna (Müller, 1880), and Macrobrachium surinamicum (Holthuis, 1948).

Despite of this promissing scenaria and potential group of study in the Brazilian waters, detailed information concerning the general biology of these species is scanty in the scientific literature (see Mossolin & Bueno, 2002 for review). In this way, we conducted a study of M. brasiliense to examine the population biology with emphasis on sex ratio and size frequency distribution and to describe the mathematical equations referring to relative growth used to detect sexual dimorphism.

Material and methods

Samples of M. brasiliense were collected monthly from May 1994 to April 1995 from the Ribeirão Claro stream in the municipality of Serra Azul (21º 19' S and 47º 37' W), located in the physiographic zone of Ribeirão Preto (São Paulo, Brazil). Prawns were collected by three people during a period of 1 h on the same area of about 100 m^2 during daytime. At each sampling occasion the specimens were captured manually by sweeping sieves (50 cm in diameter and 3 mm mesh size) were introduced through the marginal vegetation (mainly consisting of species of the Families Hydrocharitaceae, Juncaceae and Pontederiaceae) and removed with ascending movements in order to find the prawns.

The water depth rarely exceeds 100 cm and the river bottom is mainly composed of sand. The water samples were collected from the bottom on all sampling occasions, which allowed recording simultaneously water temperature and salinity. The temperature (°C) was measured with a mercury thermometer and salinity (p.s.u) using an optical refractometer Atago S/1000. The mean water outflow (m^3/s) was calculated during each season from the formula Q = A x V, where Q is water outflow, A = mean area of transversal section of water flow (m^2), V = mean current speed (m/s). The total monthly mean water rainfalls were obtained from DAEE (Departamento de Águas e Energia Elétrica).

Captured specimens were immediately transferred to plastic buckets containing water and vegetation from the collecting site and were transported to the laboratory and maintained frozen until analysis. Sex was checked by the presence of a appendix masculinae on the second pleopod. The male/female ratio was analyzed on the basis of the frequency of individuals captured during the study period. Total length (CT), carapace length (CC), abdomen length (CA), second pleura length (CPL), highest propodus height (APR) and highest propodus length (CPR) were determined for each animal (Fig. 1). Measurements were made with a caliper rule (0.1 mm) and under a stereoscope with a camera lucida for smaller specimens. Total wet weight (WW) of fresh animals was checked. Damaged individuals with regenerating or otherwise anomalous limbs were discarded.

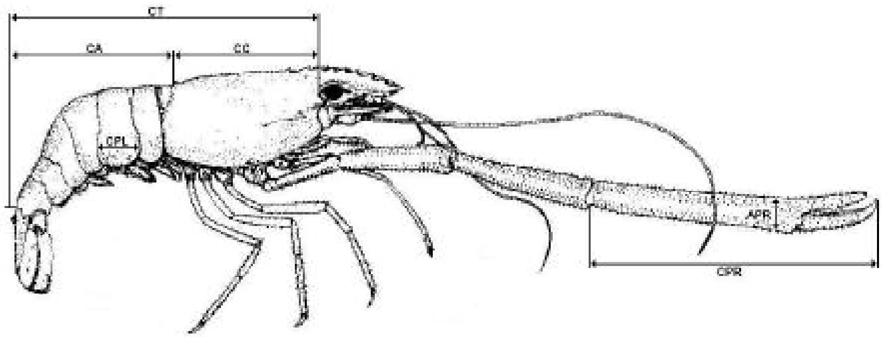

Figure 1: Schematic presentation of the measurements made for each speciemen of M. brasiliense (CT = Total length, CC = carapace length, CA = abdomen length, CPL = second pleura length, APR = highest propodus height, and CPR = highest propodus length) (Modified from Melo, 2003).

Morphometric relations were used to apply the power function ($Y = aX^b$), which was fitted to the data. The CC dimension was used as independent variable because it is used to indicate size in caridean prawn studies. The pattern of allometry was established for each parameter by the b-value slop (b = 1, isometry; b ‹ 1, negative allometry, b › 1: positive allometry). To detect the b-difference from unit, the b value was tested by Student t-test (Zar, 1996). The logarithmic transformation ($\ln Y = \ln a + b.\ln X$) of the power function was used. The parameters of the equations and the coefficient of determination (r^2) obtained were compared to each other. Analysis of variance was performed for all regressions. To classify juveniles and adults, we used the point at which the slope becomes discontinuous or changes direction, and marks the transition from the juvenile to the adult phase. We also combine this analysis with the morphological observations on the first two pars of pleopods.

Data concerning to the mean individual weight and size were compared by the Mann-Whitney Rank Sum test (Sokal & Rohlf, 1979). The male/female ratio along the studied months and within size classes was compared by the c^2 test and classified according to Wenner (1972). The population normality was tested by the Kolmogorov-Smirnov Normality test (KS) (Sokal & Rohlf, 1979). Pearson coefficient was calculated to check relationships between the absolute values of each environmental factor and the abundance of studied population. The level of significance was set at P ‹ 0.05.

Results

During the one-year study, a total of 280 specimens of M. brasiliense were collected. The total number of females captured (n = 202 or 72.14%) greatly outnumbered that of males (n = 78 or 27.86%). No ovigerous females were captured during the study. On average, males were significantly larger and heavier than females. The mean, maximum and minimum carapace length was 10.56 ± 4.05, 19.8 and 4.3 mm for males and 7.32 ± 2.82, 16.1 and 3.1 mm for females. The mean, highest and lowest weights obtained for males were 0.10 ± 1.15, 5.17 and 0.03 g, and those obtained for females were 0.33 ± 0.43, 2.13 and 0.01 g.

The salinity at these sampling sites was zero p.s.u. The total annual mean water temperature (22.2 ± 2.71 °C) and rainfall (122.36 ± 126.55 mm) varied as a function of season from 17.5 (June) to 25°C (from November to January) and from zero (August) to 430.67 mm (February), respectively. The mean water outflow was 0.0137 ± 0.001 m^3/s. No significant correlation was detected between number of individuals and rainfall index, temperature or water outflow during the period of study.

The size frequency distribution was not normal (KS = 0.139) for either sex, with a peak of occurrence in the 2nd size class (4.0 ¾| 6.0 mm). Males and females presented unimodal distribution with the absence of recruits for males (2 ¾| 4 mm) and peaks of occurrence in the size classes 3 and 4 (6 ¾| 10 mm) for males and 2 and 3 (4 ¾| 8 mm) classes for females (Tab. I). Monthly CC values were, in general, unimodal and slightly asymmetrical in both sexes. Recruitment into the studied area (by specimens belonging to the previously defined size class 2.0 ¾| 8.5 mm) occurs from March to June and September, and minimum recruitment from November to January.

The number of females was significantly higher than the number of males (c^2 = 7.56), with a total sex-ratio of 1/2.6. It was only in January that no significant difference was observed between sexes (Fig. 2). The proportion of males in the size classes in relation to females resulted in a sigmoid curve characterizing a reverse pattern (Fig. 3).

Table I: Size frequency distribution (CC = carapace length) of M. brasiliense individuals collected in the Ribeirão Preto region in 1994/1995.

Size classes CC (mm)	Females		Males		Total	
	N	**%**	**N**	**%**	**N**	**%**
2.0 ¾| 4.0	2	0.71	0	0	2	0.71
4.0 ¾| 6.0	83	29.64	7	2.50	90	32.14
6.0 ¾| 8.0	53	18.93	16	5.71	69	24.64
8.0 ¾| 10.0	27	9.64	16	5.71	43	15.36
10.0 ¾| 12.0	16	5.71	15	5.36	31	11.07
12.0 ¾| 14.0	15	5.36	7	2.50	22	7.86
14.0 ¾| 16.0	5	1.79	6	2.14	11	3.93
16.0 ¾| 18.0	1	0.36	6	2.14	7	2.50
18.0 ¾| 20.0	0	0	5	1.79	5	1.79
Total	202	72.14	78	27.86	280	

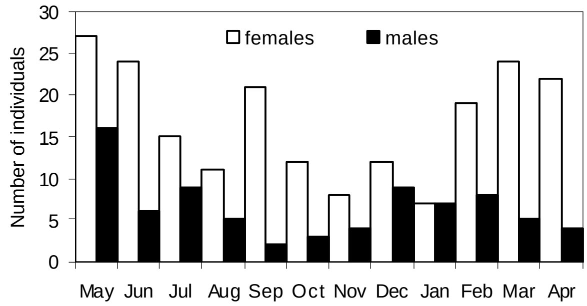

Figure 2: Number of M. brasiliense individuals captured during the sampling period (May/1994 to April/1995).

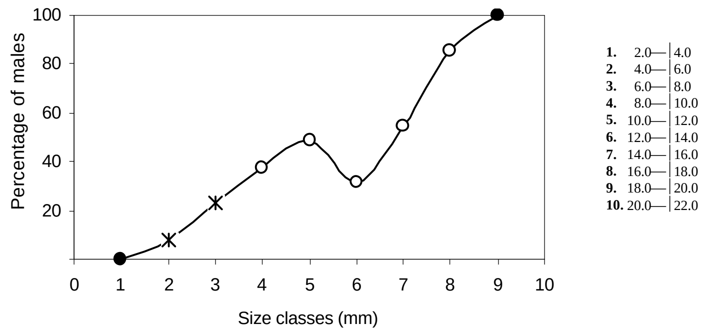

Figure 3: Sex-ratio as a percentage of M. brasiliense males in relation to size, with indication of those values showing significant (*), non-significant (0), or 100% (•) deviation from the expected 1:1 sex-ratio.

The regression equations applied to the data, coefficient of determination and level of allometry are presented in Tab. II. The Fig. 4 shows that there was a slight difference in the trend line in the point dispersal for males and females.

Table II: M. brasiliense regression equations for the relations: CT = Total length, CC = carapace length, CA = abdomen length, CPL = second pleura length, APR = highest propodus height, CPR = highest propodus length and wet weight (WW). (N = number of individuals; r^2 = coefficient of determination; ln = neperian logarithm; A = allometry: (=) isometry, (+) positive allometry, (-) negative allometry; t = Student t-test value; ns = not significant).

Relations	Groups	N	$Y=ax^b$	lnY=lna+blnX	r^2	A	t
CC/CT	Males	78	$CC=0.2276CT^{1.12}$	lnCC=-1.48+1.12lnCT	0.98	+	6.09*
	Females	202	$CC=0.2647CT^{1.07}$	lnCC=-1.33+1.07lnCT	0.97	+	5.26*
	Total	280	$CC=0.2547CT^{1.08}$	lnCC=-1.37+1.08lnCT	0.98	+	8.22*
CA/CC	Males	78	$CA=3.0043CC^{0.81}$	lnCA=1.10+0.81lnCC	0.95	_	8.45*
	Females	202	$CA=2.6729CC^{0.86}$	lnCA=0.98+0.86lnCC	0.97	_	8.09*
	Total	280	$CA=2.714CC^{0.85}$	lnCA=1.00+0.85lnCC	0.94	_	11.50*
CPL/CC	Males	78	$CPL=0.7388CC^{0.73}$	lnCPL=-0.30+0.73lnCC	0.94	_	12.34*
	Females	201	$CPL=0.6184CC^{0.82}$	lnCPL=-0.48+0.82lnCC	0.88	_	8.30*
	Total	279	$CPL=0.6568CC^{0.79}$	lnCPL=-0.42+0.79lnCC	0.91	_	13.99*
CPR/CC	Males	69	$CPR=0.5488CC^{1.21}$	lnCPR=-0.60+1.21lnCC	0.94	+	5.57*
	Females	164	$CPR=0.6250CC^{1.14}$	lnCPR=-0.47+1.14lnCC	0.82	+	3.29*
	Total	233	$CPR=0.5827CC^{1.18}$	lnCPR=-0.54+1.18lnCC	0.88	+	6.19*
APR/CC	Males	69	$APR=0.0671CC^{1.21}$	lnAPR=-2.79+1.26lnCC	0.92	+	5.21*
	Females	164	$APR=0.0983CC^{1.03}$	lnAPR=-2.32+1.03lnCC	0.79	=	0.74^{ns}
	Total	233	$APR=0.0841CC^{1.11}$	lnAPR=-2.48+1.11lnCC	0.85	+	3.69*
WW/CC	Males	78	$WW=0.0004CC^{3.14}$	lnWW=-7.84+3.14lnCC	0.95	=	1.59^{ns}
	Females	202	$WW=0.0004CC^{3.15}$	lnWW=-7.87+3.15lnCC	0.89	=	1.92^{ns}
	Total	280	$WW=0.0004CC^{3.15}$	lnWW=-7.86+3.15lnCC	0.92	+	2.64*

* = p<0,005; ns = p>0,05

Males and females presented a positive allometric growth for the chelar dimensions studied, whereas both manifested an isometric growth in almost all the relations determined.

Among the equations used to describe the relative growth of M. brasiliense, the CPL/CPR versus CC relationships presented a similar pattern with good and positive coefficients of determination, and were considered to be the equations that best described the relative growth of this species.

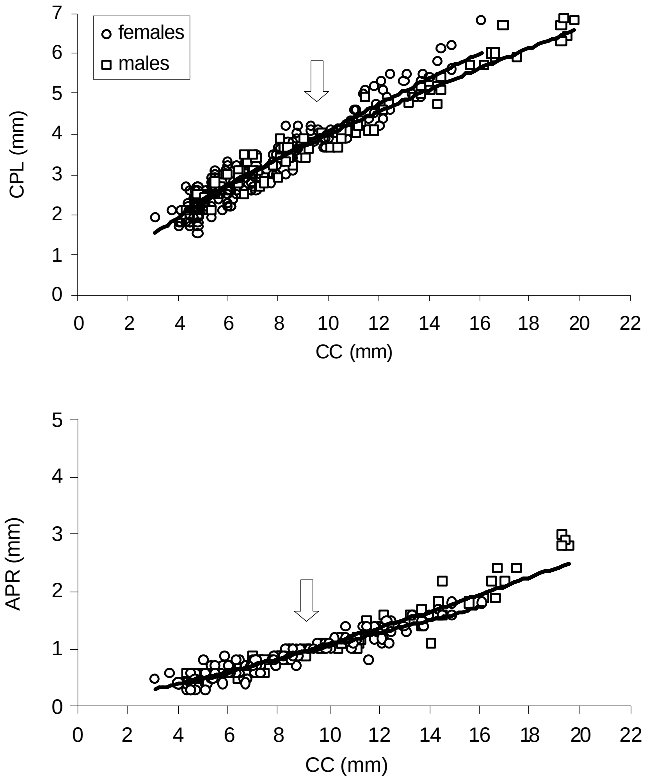

Figure 4: Relative growth of second pleura length (CPL) and highest propodus height (APR) of M. brasiliense in relation to carapace length (CC). The arrows indicate the size at which occur the discontinuities of the points that correspond to the change of maturity phase. The regression equations are described in Table II.

Discussion

The differences in mean weight and carapace length among sexes indicate the existence of sex dimorphism with respect to size in M. brasiliense. This differencial body growth rates between males and females have been reported for many Macrobrachium species. Mossolin & Bueno (2003) and Fransozo et al. (2004) studying M. olfersi and M. iheringi respectively, observed that males reached a greater total length than females as a function of the differences in growth rates and patterns of population structure between sexes. In M. brasiliense, dimorphism seems to be due to the same causes, with the additional fact that the larger size reached by males may be related to domination over females, as well pre-adult males, during the copulation process. Another hypothesis is the relation with the hierarchy in favor of male size that can interfere with the growth of submissive individuals in the population, as demonstrated to M. rosembergii by Sampaio & Valenti (1996).

Although the abundance of the animals was not correlated with temperature, rainfall or water flow, slight oscillations in the number of individuals were observed, with a tendency to an increase in the winter and a decrease in the summer. This pattern differs from that observed for other species such as M. iheringi studied by Fransozo et al. (2004) in Botucatu - São Paulo; M. amazonicum by Collart & Moreira (1993) in Manaus – Central Amazon Region; M. ohione by Truesdale & Mermilliod (1979) in Morgan City - Louisiana – United States; M. tenellum by Román-Contreras (1979) in Tres Palos - Mexico, and M. olfersi by Mossolin & Bueno (2002) in São Sebastião – São Paulo. However, the M. acanthurus population evaluated by Carvalho et al. (1979) in Bahia presented a seasonal variation similar to that of the population studied in present work. According to this authors, the high abundance in winter is related to the rainy season, which affects migration. This explanation does not seem to be applied to M. brasiliense, since for the Ribeirão Preto region the lowest annual rainfall rate is recorded in winter. Thus, factors other than those considered and analyzed here may lead to this adverse pattern. For example, the abundance of local vegetation, food availability, water quality impaired by the sugar cane culture (planting, maintenance and harvesting) near the stream under study may have contributed to this differentiated picture. Also the high abundance it was probably caused by the molt stage, due to some species of freshwater prawn hidden during the molt specially in summer.

Size frequency distribution revealed a greater abundance of females in the first size classes and a larger number of males in the final classes. The high increase in number of individuals starting from the 2^{nd} class characterizes a marked recruitment of females measuring 4 to 6 mmCC, indicating an early preparation for reproduction compared to males. Furthermore, females seem to have a shorter life span or to grow less than males, as confirmed by the larger number of males in the final size classes. A similar result was obtained by Fransozo et al. (2004), who studied the species M. iheringi in the Botucatu region in São Paulo State.

The large amount of juveniles in March/June supports the hypothesis of a greater reproductive activity in summer despite the non-captured ovigerous females. According to Pérez (1984), under laboratory conditions, M. brasiliense reached the juvenile phase within about 50 days (embryo development and larval development). This time is compatible with the appearance of young individuals in the population (March/June) approximately 50 days after the reproductive peak (December/February). There was also a higher incidence of adults (mature individuals) of both sexes from December to May, followed by a low recruitment of young individuals in summer (November to January), probably due to low reproductive activity in winter. Although this population showed evidence of a greater reproductive rate in summer, this activity occurred throughout the year, as proved by the constant presence of juveniles in the population. The reproductive activity of this population could be better characterized if ovigerous females were captured and gonadal analysis were performed during the studied period.

According to Williams et al. (1990), the frequency of juveniles in a population may be altered as a function of factors such as predation, mortality and shelters. In the case of the studied population, there seemed to be signs of predation in view of the high presence of adult (Family Belostomatidae) and larval forms (Order Odonata) of insects. Furthermore, there were seasonal fluctuations (not quantified during the study) in the presence of marginal vegetation at the collection site, which represents the refuge for the early phases of the life cycle of this prawn. According to Magalhães (1999), M. brasiliense has cryptic habitats and is more active at night, and this is the probable cause of the presence of juvenile and subadult specimens in diurnal samples.

In combination with this factor, the absence of ovigerous females was also an important point in the present study, indicating the need for further studies on this population since this is a rare pattern for these crustaceans. The data obtained by daylight collection in the present study provide little information about the reason for this absence. Also, Rodriguez (1982) reported only two ovigerous females out of a total of 121 individuals captured in Venezuela. However, some hypotheses can be raised, such as: 1) ovigerous females may be taking shelter at other points along this stream, showing a cryptic habit during daylight, a common occurrence observed among ovigerous females of the genus Macrobrachium inhabiting streams along the littoral; 2) localization in a region with a high mean annual temperature may act on the embryonic development of eggs which may be extremely rapid, with the females reducing as much as possible the time of egg incubation, in contrast to the results reported by Perez (1984), who observed a prolonged embryonic development; 3) if this species has cryptic habit and is more active at night, the use of traps (as cages) could help to explain the absence of ovigerous females.

In the population studied the proportion of males per size class resulted in a sigmoid curve characterizing a reverse pattern which, according to Wenner (1972), may suggest the occurrence of sex reversal among these animals, mainly when a scarcity of females occurs in the population. Although this is quite an initial assumption for M. brasiliense, it can not be ruled out. Laboratory experiments and gonadal histology may help to elucidate this theory.

Fransozo et al. (2004) also obtained a larger number of females in the population of M. iheringi. According to these authors, this fact may characterize a restructuring of the group in terms of total abundance in order to increase the number of recruits via reproduction. Similar results were also obtained by Roman-Contreras (1991) in a study on M. tenellum (Smith, 1871) in the state of Guerrero, Mexico, and by Carvalho et al. (1979) in a study on M. acanthurus on the Island of Itaparica, Bahia, Brazil.

According to Anger & Moreira (1998), not enough data are available to allow generalizations about the morphometric patterns of prawn, particularly with regard to sexual dimorphism in the proportions of body dimensions. Also, the available data do not show a relationship of these traits with geographic origin or ecology of the species. In view of these considerations, we performed a close comparison with a similar species inhabiting Brazilian waters, i.e., M. iheringi, in terms of size, ecological habitat and sampling region.

Sexual dimorphism (between 9 and 10 mm CC) was demonstrated for M. brasiliense by the APR/CC relationship, showing a positive allometry in male growth and isometry in female growth. Rodrigues (1996) found a similar pattern of dimorphism in M. Iheringi. This relationship is consistently described in the literature (Vannini & Guerardi, 1988) as an important mechanism characterizing the dimorphism and maturity phase in crustaceans. According to Hartnoll (1974), the higher allometry in males occurs as a function of dominant position over females, of community hierarchy during intra- and interspecific fights, and also of copulation mechanism.

Sexual dimorphism was not demonstrated in M. brasiliense by the CPL/CT ratio. However, Rodrigues (1996) recorded this dimorphism on the basis of this ratio, a fact justified by the difference between sexes in the function of the second abdominal pleura, which in females increases the growth of the egg incubating chamber. The negative allometry observed in the CPL/CT and CPL/CC ratios in M. brasiliense may be related to an extremely rapid egg incubation process which, according to this hypothesis, may cause the pleura not to develop at the same proportion as observed in M. iheringi.

An isometric growth was observed for the WW/CC and WW/CT ratios in all M. brasiliense groups of interest, with no difference between sexes, although, on average, males were heavier than females. Lobão et al. (1986) and Rodrigues (1996) observed positive allometric growth for males and females of M. Iheringi. This same pattern was observed by Bond & Buckup (1983) and Souza & Fontoura (1995) for M. potiuna, with a greater weight gain by females compared to males of the same length. Valenti (1984) observed dimorphism for this ratio in M. carcinus, with males reaching a greater weight than females of the same size class. However, the absence of sexual dimorphism for the WW/CT ratio was observed by Bond & Buckup (1983) in M. borelli, by Lobão & Lona (1979) in M. holthuisi, and by Valenti (1984) and Valenti et al. (1987) in M. acanthurus.

Thus, we may infer that species of the genus Macrobrachium do not follow a typical weight growth pattern as observed for crustaceans a fact possibly related to the differences in ecological, physiological and evolutive aspects of the life cycle of these species. The study of the WW/CT ratio in relation to the molt and gonadal cycles may provide information for a better understanding of this pattern, as suggested by Mantelatto & Martinelli (1999) for crustaceans.

A comparison between sexes, populations or different species in terms of the variation in degree of fattening (f) can only be made when the corresponding "q" values are equal or very close, because of the negative correlation existing between these two parameters (Valenti, 1984). Thus, the degree of fattening of M. brasiliense can only be compared by showing equal "f" values for males and females, indicating that the degree of fattening did not vary between sexes.

Despite the high number of described species and the potential interest among Macrobrachium genus, available data on biology of M. brasiliense are scanty and incomplete. This studied species, without economic importance, shows an atypical life cycle patterns, a condition that makes it a species with great potential for study. Macrobrachium brasiliense belongs to a group of Macrobrachium species that no depends on estuarine water to successfully complete larval cycle. Regarding the phylogenetic relationships within this genus, the pattern of life cycle presented by M. brasiliense appear to be very important start point to improve out understanding of evolution among this group, as well as an adaptative strategy to stablishment in freshwater biotopes. More accurate and comparative investigations of populations from different areas, as well as reproductive aspects of gonadal histology, individual growth in the laboratory, copulation, embryo development, molecular phylogenetic analysis and the existence of a possible nocturnal and cryptic behavior of ovigerous females may help elucidate the life cycle of M. brasiliense.

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