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Population and reproductive biology of *Callichirus major* (Say, 1818) (Decapoda: Axiidae: Callianassidae) in an urban beach, Northeastern Brazil

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Abstract: The objective of this study was to describe the population and reproductive biology of *Callichirus major* (Say, 1818) in Pau Amarelo beach, State of Pernambuco, Northeastern Brazil, based on: relative growth, sex ratio, reproductive period and recruitment of juveniles. Samplings were carried out monthly from May 2011 to April 2012. The individuals of *C. major* were collected with suction pump, fixed and identified in the laboratory. The abiotic variables were analyzed to identify the factors that influence the development of the population. A total of 274 specimens of *C. major* were collected, in which the sexual dimorphism was evident, especially with the males reaching larger sizes in: Total Length, Carapace Length, Length and Major Cheliped, while the females were significantly heavier than malesin Wet Weight. Females were more abundant than males (1.0♀: 0.65♂), and the recruitment of juvenile was higher in the dry periods. The population of *C. major* of Pau Amarelo beach presented biometric measurements typical of other species of the same family. This study contributes to the development of new research in the area, even in the Northeast, where there is little documentation on the species in this region.

Key words: Body size, sex ratio, mud beach, ghost shrimps, burrowing crustaceans.

Resumo: Biologia populacional e reprodutiva do *Callichirus major* (Say, 1818) (Decapoda: Axiidae: Callianassidae) em uma praia urbana, Nordeste do Brasil. O objetivo deste estudo foi avaliar a biologia populacional e reprodutiva do *Callichirus major* na praia de Pau Amarelo, Estado de Pernambuco, Brasil, através dos parâmetros como: crescimento relativo, proporção sexual, período reprodutivo, e recrutamento de juvenis. As amostras foram realizadas mensalmente de Maio de 2011 a Abril 2012. Os indivíduos de *C. major* foram coletados com auxilio de bomba de sucção e posteriormente fixados e identificados em laboratório. Os parâmetros abióticos foram analisados para identificar quais fatores influenciam o desenvolvimento da população. Um total de 274 espécimes de *C. major* foram coletados, no qual o dimorfismo sexual foi evidente, especialmente com machos alcançando maiores tamanhos em: Comprimento Total, Comprimento da Carapaça e Comprimento do Quelípodo Maior, enquanto as fêmeas foram significantes apenas no Peso Úmido. Foram observadas as fêmeas mais abundantes que os machos na população (1.0♀: 0.65♂). O recrutamento de juvenis foi maior nos períodos secos. A população de *C. major* da praia de Pau Amarelo apresentou medidas biométricas típicas de outras comunidades da mesma família. Assim, este estudo

contribui para o desenvolvimento de novas pesquisas na área, baseado que na região Nordeste do Brasil há poucas pesquisas sobre a espécie na região.

Palavras-chave: Tamanhos corpóreos, proporção sexual, praia lamosa, camarão fantasma, crustáceos escavadores

Introduction

Burrowing crustaceans of the Infraorder Axiidea have as their main ecological feature the construction of deep galleries in sandy or muddy substrate of shallow waters (Griffis & Chavez 1988), occurring in intertidal zones in beaches with low hydrodynamics (Rodrigues & Shimizu 1997, Alves-Júnior *et al*. 2014a,b). Their presence is detected by small apertures frequently surrounded by fecal pellets (Weimer & Hoyt 1964, Frankenberg *et al*. 1967, Rodrigues & Shimizu 1997, Alves-Júnior *et al*. 2014a).

In Brazilian coast, the population aspects of ghost shrimps are poorly documented, in especial about the aspects of *Callichirus major* (Say, 1818), with studies concentrated in three regions: Southern and Southeastern regions, with studies performed by Borzone & Souza (1996), Shimizu (1997), Rodrigues & Shimizu (1997), Souza *et al.* (1998), Souza & Borzone (2003) and Peiró *et al*. (2014); and Northeastern region by Araújo *et al*. (2000), Botter-Carvalho *et al*. (2002, 2007) and Alves-Júnior *et al*. (2014a,b). *Callichirus major* has great importance in benthic communities, due the burrowing activity in substrates, revolveing the structure of the sediment, causing the resuspension of organic matter and heavy metals, which may cause the death of individuals of meiofauna (Rodrigues & Shimizu 1997; Alves-Júnior *et al*. 2014a).

In the Brazilian beaches, *C. major* is collected with suction pumps for utilization as bait in coastal areas, but as observed by Borzone & Souza (1996), this method causes changes in all benthic community, causing imbalance in the populations, especially in symbiotic species of *C. major* (as mollusks, nematodes, crabs, copepods and polychaetes) (Rodrigues & Shimizu 1997; Souza & Borzone 2003). The overexploitation of *C. major* species may cause alterations in the density of the animal or even its disappearance (Borzone & Souza 1996, Rodrigues & Shimizu 1997). Due to these factors, the aim of this paper was to analyze the population and reproductive biology of *C. major*, including the abundance, allometric growth, sex ratio, reproductive period and recruitment at Pau Amarelo beach, localized in State of Pernambuco, Northeastern Brazil.

Material and Methods

Sampling data: Callichirus major was sampled monthly from May/2011 to March/ 2012 in the intertidal zone, from two sites in the muddy beach of Pau Amarelo (7° 55' S, 34° 49' W; 7° 52' S, 34° 49" W), located at Municipality of Paulista, State of Pernambuco (Figure 1). The first site was located in initial portion of Pau Amarelo beach, which have intersection with the Janga beach (7° 55' 27" S, 34° 49' 9" W), and the second site was in final portion of Pau Amarelo beach, intersection with Conceição beach (7° 54' 22" S, 34° 49' 21" W). The animals were collected using a suction pump during low tide (Hailstone & Stephenson 1961, Rodrigues 1976) and after samples, all individuals were stored in plastic bags, transported to the laboratory and preserved in alcohol 70% until the time of the analysis. In the laboratory, each individual was identified and sexed according to Melo (1999), and posteriorly classified as juvenile males, juvenile females, adult males, non-ovigerous adults females and ovigerous females according to Alves-Júnior *et al*. (2014b).

Data Analysis: Each specimen had the following body dimension measured: Total length (TL), Carapace length (CL), Major cheliped length (MCL), Telson width (TW) and Wet weight (WW) with the aid of a digital caliper (0.01 mm scale). The frequency distribution by size class was obtained (using 2 mm size classes), to determine the mode of each sex. The Student *t* test and the *U* de Mann-Whitney-Wilcoxon test were applied to assess whether there is sexual dimorfism in the biometric measures, with homocedastic (TL; CL; TW and WW) and heterocedastic data (MCL) respectively ($\alpha = 0.05$).

The relative growth of *C. major* was analyzed based on the allometric equation ($y = ax^b$) (Huxley 1950), in which the carapace length (CL) was considered the independent variable (x) (Rodrigues 1985), while the other body dimensions were dependent variables (y). The level of allometric relation of each body dimension was determined for each sex which: if "b" = 1 isometric growth; "b" > 1 allometric positive; "b" < 1 allometric negative, for the wet weight the reference value of "b" will be

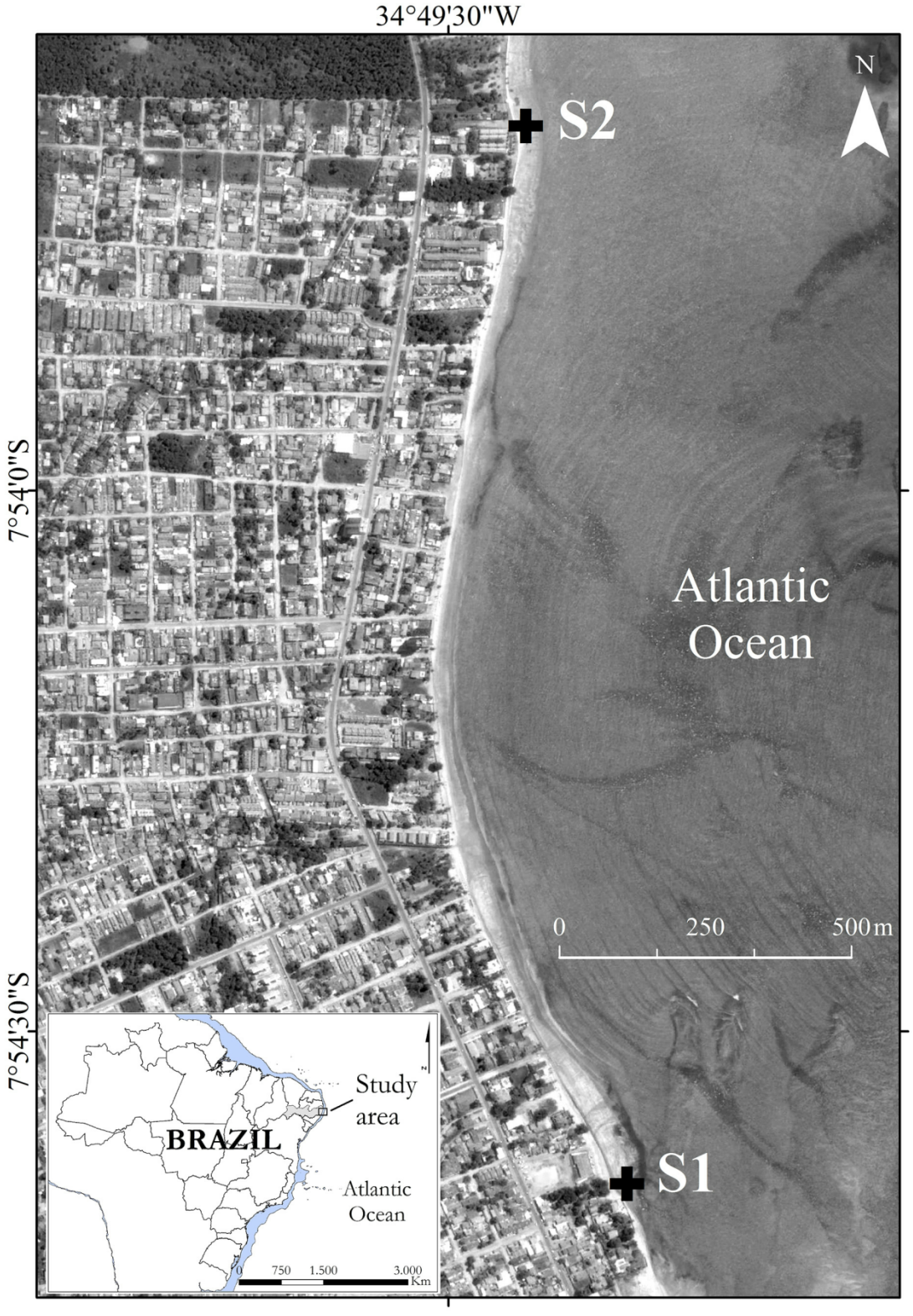

Figure 1. Location of the study site at Pau Amarelo beach, State of Pernambuco, Northeastern Brazil. Symbols in S = Station.

based in 3 (Huxley 1950). The statistical significance of the constant 'b' in relation to the unity was calculated with a *t* test (α = 0.05) (Zar 1996). Through a non-hierarchical classification (K-means cluster), the inflection point between the significative changes for each biometric relation (especially between juveniles and adults) were estimated using the software Past ® (Paleontological Statistics Software, version 3.0) (Corgos & Freire 2006).

The sex ratio was analyzed by months and by the total study period, and a Chi-square test was applied to verify if the sex ratio deviated significantly from the expected proportion (1:1), with critical value of χ^2 = 3.84. The reproductive period of *C. major* was based on the proportions of ovigerous females, calculated in relation to adult females in each month and classified, according to Pinheiro & Fransozo (2002), as: seasonal (occurrence of ovigerous females restricted to some months or seasons), continuous (ovigerous females in all months with similar proportions) or seasonal-continuous (ovigerous females in all months, with distinguishable peaks of high reproductive activity in some of them). The identification of the recruitment period was based where the juveniles were significantly more abundant than adults by months. The proportion of juveniles on the total crabs sampled by month determined the recruitment period, tested by the chi-square goodness of fit test (χ^2) (α = 0.05).

Abiotic factors: Burrow and sea water temperatures were measured *in situ* with a digital thermometer, and the sea water salinity, with a refractometer. The climate in the locality is characterized as megathermal with rainfall concentrated from March to August and a well-defined dry period (September to February), characterizing the As' climate (Hot Humid Tropical) (Köeppen 1948, Cavalcanti & Kempf 1967/69). The Student *t* test was applied to compare the abiotic factors between the dry and rainy periods (α = 0.05) with the minimum, mean (± standard deviation) and maximum values of each variable were estimated. A correlation matrix, with Pearson's coefficient of linear correlation (*r*), was applied to verify the influence of the abiotic factors in the total abundance of *C. major,* as well as in the abundance of ovigerous females was assessed with Pearson's coefficient of linear correlation.

Results

The burrow temperature ranged from 27.6 to 34.6 °C (31.1 ± 3.5 °C). The water temperature varied from 28.4 to 34.5 °C (31.5 ± 3.05 °C). The salinity varied from 32.0 to 37.0 (34.5 ± 2.5) (Table I). The following abiotic factors did not vary significantly between dry and rainy periods: burrow temperature (t = 0.54; p = 0.59; r = 0.17), water temperature (t = 0.62; p = 0.54; r = 0.19) and salinity (t = 0.86; p = 0.40; r = 0.26).

Table I. Abiotic factors in the samples of *C. major* at Pau Amarelo beach, State of Pernambuco, Northeastern Brazil.

Months	burrow temperature (°C)	water temperature (°C)	Salinity
May/11	27.6	28.4	33.0
Jun/11	29.2	30.2	32.0
Jul/11	29.7	29.5	34.0
Aug/11	31.5	30.3	33.0
Set/11	30.7	29.4	35.0
Oct/11	31.1	32.3	36.0
Nov/11	30.6	33.2	35.0
Dec/11	31.8	34.5	34.0
Jan/12	32.3	31.1	36.0
Feb/12	34.6	32.6	37.0
Mar/12	30.4	30.5	35.0

A total of 274 individuals of *C. major* were sampled, being 139 females (129 non-ovigerous and 10 ovigerous), 90 males and 45 non-sexed juveniles (Fig. 2). The sex ratio was 1: 0.65 (♀:♂),with females being significantly more abundant than males (χ^2 = 5.78; p < 0.05), which the females reached 85.5 % of total of population, especially in the months of July/2011 (χ^2 = 4.15; p < 0.05) with 61.8 %, August/ 2011 (χ^2 = 8.07; p < 0.05), November/ 2011 (χ^2 = 4.1; p < 0.05) with 63.33 % and March/ 2012 (χ^2 = 21.16; p < 0.05) 96 %. However, the ovigerous females were not abundant composing only 0.03 % in the collected population in Pau Amarelo beach.

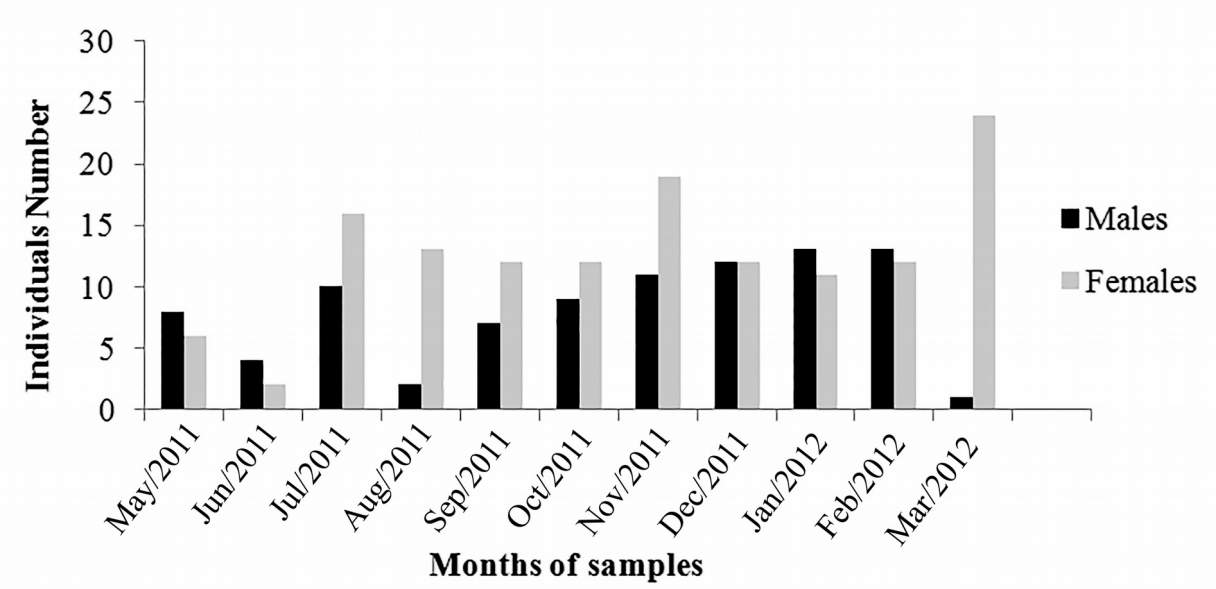

Figure 2. Number of males and females of *C. major* collected at Pau Amarelo beach, State of Pernambuco, Northeastern Brazil.

Table II. The values minimum (Min.), maximum (Max.), mean and standard deviation (Stand. dev.) of the biometric variables for both the sex of *Callichirus major* collected at Pau Amarelo beach, State of Pernambuco, Brazil.

Measure	TL ♂	TL ♀	CL ♂	CL ♀	MCL ♂	MCL ♀	TW ♂	TW ♀	WW ♂	WW ♀
Min.	30.13	36.35	5.74	8.58	7.20	3.30	4.05	3.00	0.11	0.80
Max.	89.90	94.67	19.54	9.95	25.23	17.30	23.08	25.34	1.85	4.25
Mean	51.80	36.35	10.50	9.95	9.10	3.30	10.20	3.93	1.85	2.53
Stand. dev.	12.20	12.63	2.50	1.80	4.80	2.64	4.30	3.32	5.59	2.44

Note: TL = Total length; CL= Carapace length; MCL = Major cheliped length; TW = Telson width; WW = Wet weight. The values TL, CL, MCL, TL in millimeters; WW in grams.

The minimum, maximum, mean and standard deviation values are expressed in Table II. Significant differences were found between the sizes of males and females of *C. major*, being the males showing larger sizes when compared to females in TL (t = -23.37; p = 0.0001), CL (t = 2.09; p = 0.04), MCL (u = 123355; p = 0.045), TW (t = -0.94; p = 0.034), while the females showed significant values in and WW (t = 9.41; p = 0.05).

In relationships between CL *vs*. TL, was observed a negative allometric growth (Fig. 3) for females (b = 0.98 for males and b = 0.74 for females), while the males grows in isomerism, delimiting that *C. major* grows more in CL when compared to TL only in females. A positive allometric growth was observed in MCL (Fig. 4) for both sexes (b = 2.14 for males and b = 1.36 for females), indicating that *C. major* chelipeds grow at a higher rate than the carapace, especially for males.

The telson width showed positive allometric growth (Fig. 5) for both sexes (b = 1.83 for males and b = 1.17 for females), indicating an expressive growth of telson. In relationships CL *vs.* WW, *C. major* showed positive allometric growth (Fig. 6) for both sexes (b = 4.2315 for males and b = 3.3392 for females), indicating an expressive growth of weight. Analyzing the distribution by size class (CL) of *C. major*, it could be observed that males were more frequent between 4.0 ⊢ 6.0 mm, 8.0 ⊢ 10.0, 10.0 ⊢ 12.0 and dominating the size classes between 18 ⊢ 20 mm, while females were frequent at 6.0 ⊢ 8.0,

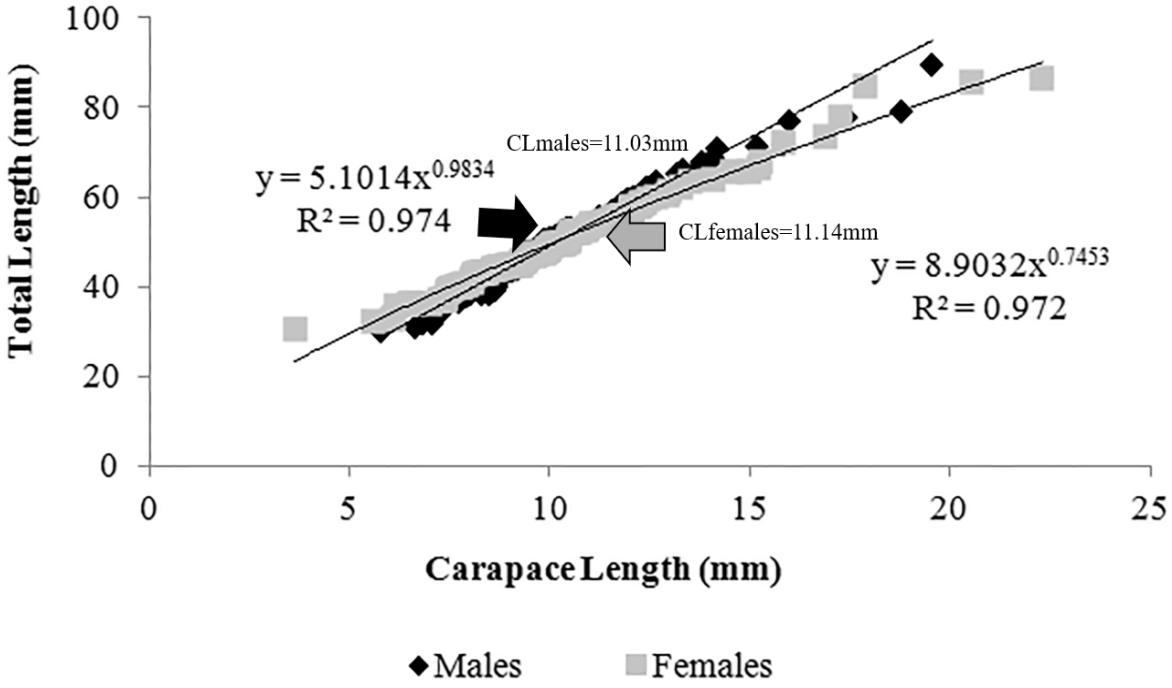

Figure 3. Relationship between the Carapace Length (CL) and the Total Length (TL) for males and females of *C. major* at Pau Amarelo beach, State of Pernambuco, Northeastern Brazil.

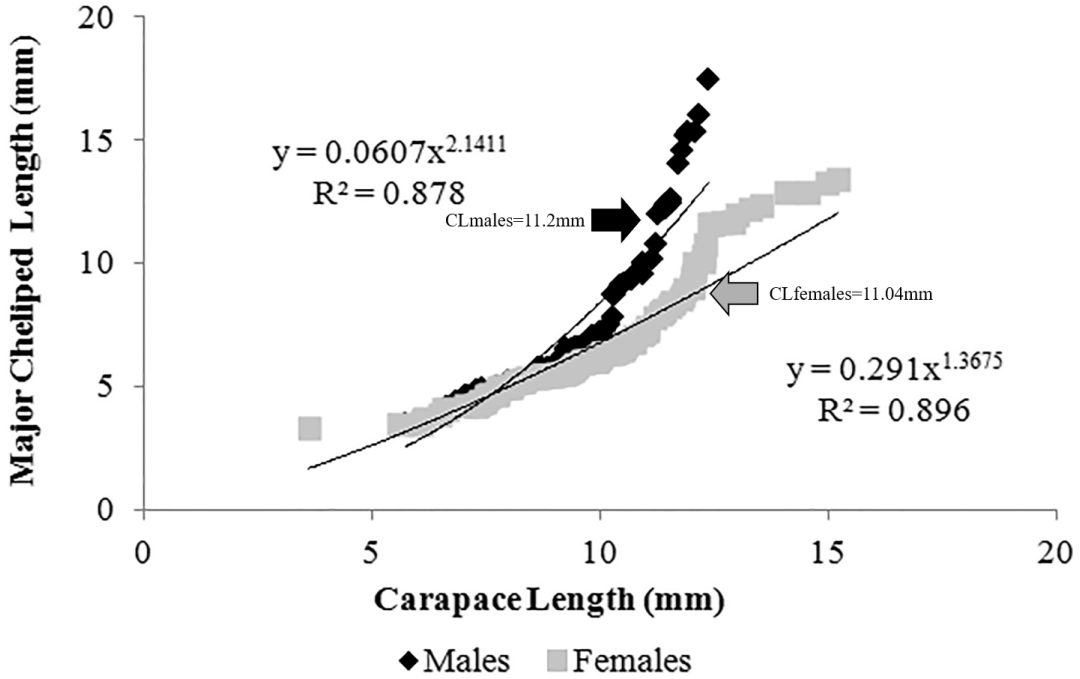

Figure 4. Relationship between the Carapace Length (CL) and the Major Cheliped Length (MCL) for males and females of *C. major* at Pau Amarelo beach, State of Pernambuco, Northeastern Brazil.

12.0 ⊢ 14.0 and 16.0 ⊢ 18.0 mm and dominating the size class above 20 mm (Fig. 7).

The recruitment of juveniles into the population (Fig. 8) occurred in all months of the year, especially in November/2011 and February/2012, when juveniles were significantly more frequent than adults (χ^2 = 5.44 and 6.13, respectively; $p < 0.05$), in the period of summer (high temperature period). In other months collected, the *C. major* no showed difference in the frequency of juveniles and adults. The adults were significantly

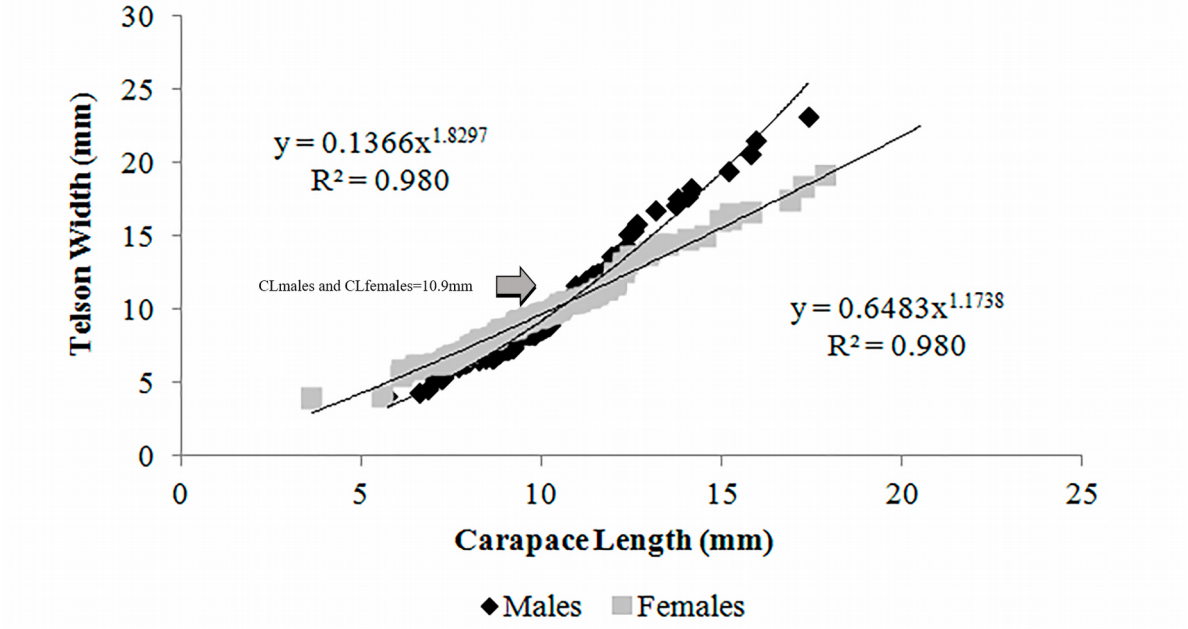

Figure 5. Relationship between the Carapace Length (CL) and the Telson Width (TW) for males and females of *C. major* at Pau Amarelo beach, State of Pernambuco, Northeastern Brazil.

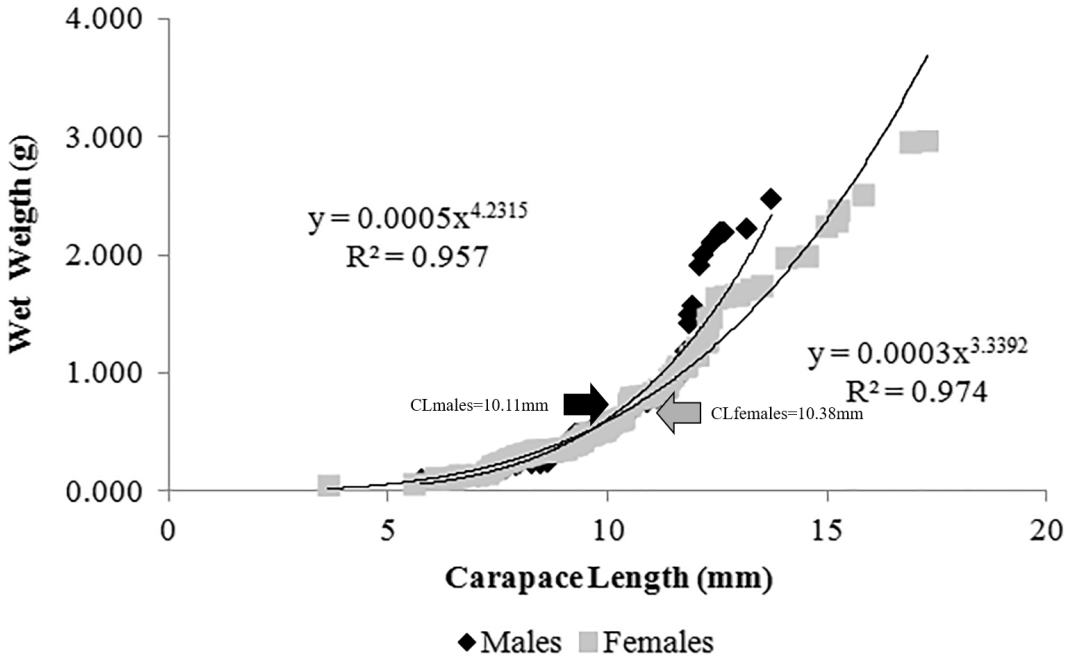

Figure 6. Relationship between the Carapace Length (CL) and the Wet Weight (WW) for males and females of *C. major* at Pau Amarelo beach, State of Pernambuco, Northeastern Brazil.

dominant in July, August and October (χ^2 = 4.18, 5.13 and 7.25, respectively; $p < 0.05$).

The frequency of ovigerous females was higher in the months of September/ 2011, January/ 2012 and February/ 2012, characteristic by months of the dry period. The reproductive period presented seasonal characteristic, with ovigerous females occurring in only a period (dry season). Among the analyzed abiotic variables, only salinity was significantly correlated to total abundance of *C. major* was salinity (Table III). The water temperature was also positively correlated, despite not significant, to the abundance of total individuals and ovigerous females, but this relationship between these variables could exist and be potentially detected if a larger sampling was carried out. The burrow temperature was negatively correlated to the abundance of ovigerous females, based on positive

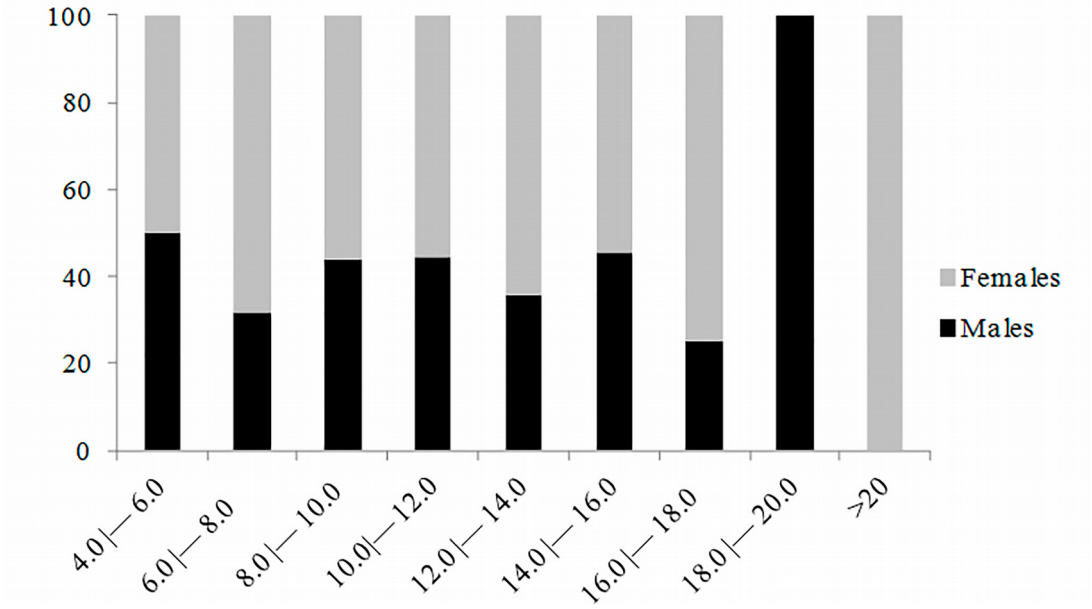

Figure 7. Relative frequency of size classes for males and females of *Callichirus major* at Pau Amarelo beach, State of Pernambuco, Northeastern Brazil.

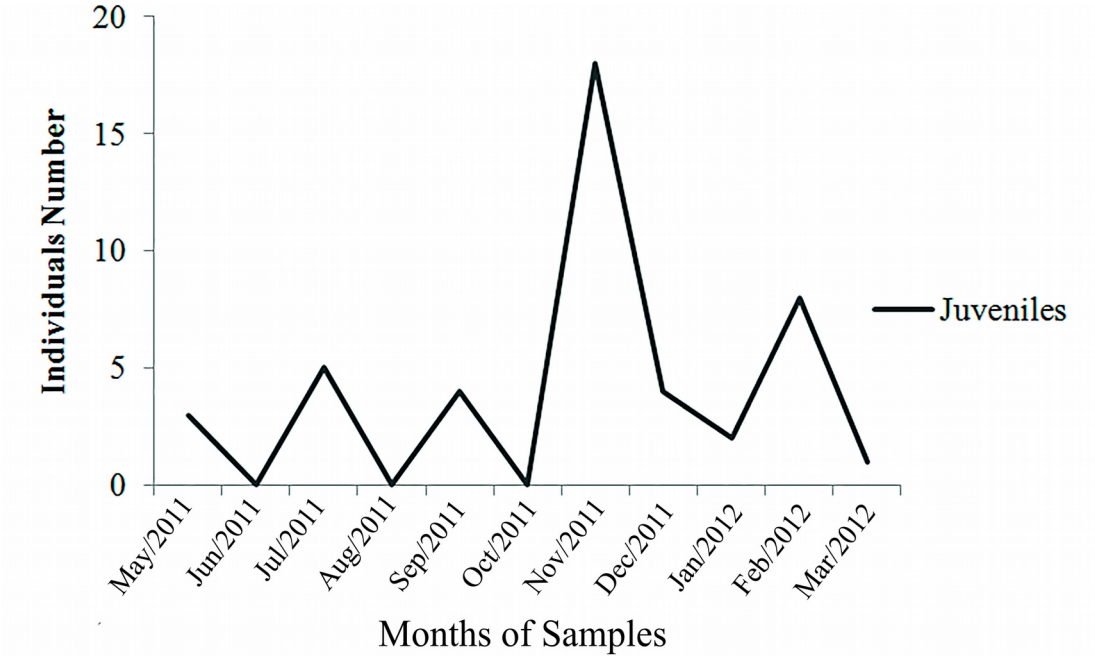

Figure 8. Frequency of juveniles of *C. major* collected at Pau Amarelo beach, State of Pernambuco, Northeastern Brazil.

Table III. Correlation of the abiotic factors with the abundance of total individuals and ovigerous females of *Callichirus major* at Pau Amarelo beach, Pernambuco, Northeastern Brazil.

	Correlation with the abundance of total individuals			Correlation with the abundance of ovigerous females		
	WT	**BT**	**Sal**	**WT**	**BT**	**Sal**
r	0.4136	0.4091	0.7394	0.5680	-0.0183	0.5818
t	1.3629	1.3449	3.2950	2.0702	-0.0548	2.1462
p	0.2060	0.2115	0.0093	0.0683	0.9575	0.0603

correlations mean that the parameters are related to an increase in the animal abundance, while negative correlations, cause the decrease in the animal abundance.

Discussion

The abiotic variables did not vary significantly between the dry and rainy periods, but as recorded in Northeastern regions, the dry period is well defined between (September to February) which is observed by high temperatures (Köeppen 1948, Cavalcanti & Kempf 1967/69), thus indicating in Pau Amarelo beach an elevated water and burrow temperatures in these periods. Other studies indicate that the temperature present seasonal patterns in States of Alagoas and Pernambuco, acting mainly in the water and burrows of burrowing crustaceans as analyzed by Aragão (1998), Botter-Carvalho *et al*. (2002, 2007) and Alves-Júnior *et al*. (2014a). The salinity is directly correlated with the dry and rainy periods (Cavalcanti & Kempf 1967/69). However, the seasonal variation was not significant in the Pau Amarelo beach, possibly due to the high input of freshwater from rivers existing in the area during all year.

In this study, the females were more abundant than males with proportion of 1: 0.65 (♀:♂), similar results were recorded in others groups, for example in gebiideans shrimps as *Upogebia deltaura* (Leach, 1816) by Tunberg (1986) in western Sweden, from *Upogebia pusilla* (Petagna, 1792) by Dworschak (1988) in Northern Adriatic Sea and *Axianassa australis* Rodrigues & Shimizu, 1992 analyzed by Botter-Carvalho *et al*. (2015) from State of Pernambuco, Brazil. For axiideans shrimps as observed by Dumbauld *et al*. (1996) with *Neotrypaea californiensis* (Dana, 1854) from Willapa Bay, Washington USA and with *Callichirus major* by Rodrigues & Shimizu (1997) from State of São Paulo and Alves-Júnior *et al*. (2014a) from Piedade beach, State of Pernambuco, both the States located in Brazil.

In the population of *C. major* sampled at Pau Amarelo beach, temporal fluctuations of sex ratio were observed, with females more abundant in the months of July/ 2011, August/ 2011, November/2011 and March/2012, and ovigerous females occurring in the months of September/ 2011, January/ 2012 and February/ 2012, those results corroborates with Hernáez & Wehrtmann (2007) with *Callichirus seilacheri* (Bott, 1955) in Chile and Alves-Júnior *et al*. (2014a) from Piedade beach in Brazil, indicating the presence of females and ovigerous females in the population being associated with dry periods, which the environment is with higher temperatures, contributing to egg production, reproductive periods and intra and interspecific factors as combat and predation (Rodrigues 1985).

The differentiation in sex ratio may be related to the sampling method, with females, especially the ovigerous females captured more easily, due occur in the highest part of the galleries to promote eggs ventilation, while the males can build deeper burrows than females (Tunberg 1986, Felder & Lovett 1989, Tamaki *et al*. 1997, Dworschak 2015), this same characteristic was observed by Rowden & Jones (1994), for *Callianassa subterranea* (Montagu, 1808) and by Botter-Carvalho *et al*. (2007) and Alves-Júnior *et al*. (2014a) for *C. major*.

Some studies with species of axiideans showed females attaining larger sizes than males, as analyzed by Pezzuto (1993), for *Neocallichirus mirim* (Rodrigues, 1971) and Souza *et al*. (1998) for *C. major* both in region Southern of Brazil. On the other hand, several studies with axiideans found males larger than females such as those observed by Hailstone and Stephenson (1961) for *Trypaea australiensis* Dana, 1852, Forbes (1973) for *Callichirus kraussi* (Stebbing, 1900), Shimizu (1997) and Alves-Júnior *et al*. (2014b) for *C. major*. Thus, those relationships may be associated with the development somatic observed in males, which the energy is directed for growth used for the territorial combat, attributing higher energy to growth in special as observed in this paper on carapace and cheliped, while the females reached larger sizes, possibly a larger body may contain more eggs corroborating with Hartnoll (1985).

In relationships CL *vs* TL, the species of *C. major* sampled in Pau Amarelo beach, showed negative growth for females and isometric for males, indicated by most energy investment in independent variable (CL) only females, similar results were found by Nates & Felder (1999) for *Lepidophthalmus louisianensis* (Schmitt, 1935). The population of *C. major* studied by Alves-Júnior *et al*. (2014b) in Piedade beach, Pernambuco indicated for both the sex growth in the same proportion (isometric growth), however, the negative growth analyzed in Pau Amarelo beach can be related the larger protection against predators or combat.

The relationships CL *vs*. MCL, for specimens of *C. major* sampled in Pau Amarelo beach, showed positive allometric growth. A similar result was obtained by Alves-Júnior *et al*. (2014b) for *C. major*, which justifies the cheliped grows at high rates

compared to carapace, thus, this appendix assists in combat and excavation of gallery (Felder & Lovett, 1989). According to Rodrigues (1985) for the same species and Hailstone & Stephenson (1961) studying *T. australiensis*, whereas the grows rates when compared cheliped and carapace have changes during the ontogenic development of animal, but these rates are similar between the sexes. These changes are adaptations for life in plankton and posteriorly in benthic habitats as observed in several decapod species after the larval development and indicates onset of maturity (Posey 1986).

In relationships CL *vs*. TW, specimens of *C. major* showed positive growth, this relationship corroborates with studies in others axiideans shrimps as for example *Neotrypaea gigas* Dana, 1852 and *N. californiensis* Dana, 1854 by Witbaard & Duneveld (1989) and *C. major* observed by Alves-Júnior *et al*. (2014b). The telson has different functions throughout the life of the animal, being used in larval phase in swimming and in adult phases for locomotion and in building the galleries (Posey 1986, Witbaard & Duneveld 1989).

In relationships CL *vs.* WW, *C. major* showed positive allometric growth, the high weight acquisition in the Pau Amarelo beach, may be associated the large quantity of organic matters along the tidal flat, due the great entrance of polluted waters through of great urban pressure occurring in Pau Amarelo. However, this high food supply in the area can be intensify the animal growth as increase in body proportions, as also for females analyzed by Pianka (1972) the increment of in egg production and rise of weight.

The distribution of ghost shrimps *C. major* by size class demonstrated the males occurring in the smaller classes, and the females dominating the larger classes (unimodal), similar results found by Alves-Júnior *et al*. (2014a) for *C. major* from Piedade beach. Studies with gebiideans shrimps as Botter-*Carvalho et al*. (2015) observed for *Axianassa australis* with females reaching larger sizes classes compared to males follow the Gaussian distribution. Anthropic impacts on the population of ghost shrimps can be alter the size class of the animal, i.e., overexploitation by fishery as observed by Hernáez & Wehrtmann (2007) for *C. seilacheri* and Alves-Júnior *et al*. (2014a) for *C. major* and environmental factors as coastal erosion (Botter-Carvalho *et al*. 2002), deposition of organic matter or heavy metals on tidal flat (Shimizu 1997), those environmental factors are observed in Pau Amarelo beach, due the strong urbanization in the area.

For the recruitment of *C. major,* it was observed a continuous input of juveniles along of year, with peaks in November/2011 and February/2012. The frequent capture of juveniles through the suction pump corroborates with Witbaard & Duineveld (1989) for *Callianassa subterranea* (Montagu, 1808) in the North Sea, which observed the galleries of juveniles shallower compared to adults, being caught frequently. Those peaks of juveniles in population are common as analyzed by Rodrigues (1976) in particular in dry periods, results as also observed in Pau Amarelo beach, which the recruitment was intensified in the periods of summer, similar results found by Alves-Júnior *et al*. (2014a) from Piedade beach (between summer and autumn). The Pau Amarelo beach presents characteristics of an urbanized beach, with great offer of organic matters and low hydrodynamics (muddy beach), may be an attractive for juveniles can indicate the constant recruitment.

For the population of *C. major* sampled in Pau Amarelo beach, it was possible to observe the presence of ovigerous females in dry periods (September/ 2011, January/ 2012 and February/ 2012), characteristic by summer in Northeastern regions (Cavalcanti & Kempf 1967/69). Studies in Brazilian coast observed the similar results for *C. major* as Souza *et al*. (1998), Araújo *et al*. (2000), Botter-Carvalho *et al*. (2007) and Alves-Júnior *et al*. (2014a). On the other hand, Peiró *et al*. (2014) observed the species of *C. major* with continuous reproduction along the year in Ubatuba, State of São Paulo, Brazil, however, others studies with axiideans shrimps, was observed the presence of ovigerous females in dry periods as Felder & Griffis (1994) for *Lepidophthalmus louisianensis* (Schmitt, 1935) at Mississippi and Bilodeau *et al*. (2005), for *Callichirus islagrande* (Schmitt, 1935) at Louisiana, both in USA.

Salinity was significantly correlated to total abundance of *C. major* in Pau Amarelo beach, but for the abundance of ovigerous females the salinity showed correlated but no significant. Some studies indicated the salinity acting on seasonal fluctuations in the population of axiideans and gebiideans shrimps as analyzed by Hill (1977), Posey (1986) and Alves-Júnior *et al*. (2014a). The water temperature and burrow temperature no showing significance. In this paper as observed by Posey (1986) and Tamaki *et al*. (1996), although there was no significance the temperature favors the sexual

activity, metabolism, egg production, burrowing activity and embryonic development.

Thus, in this paper is possible conclude that the abiotic factors in Pau Amarelo beach were not significant when compared with the abundance of this species; the females are more abundant in the population, which observed in others axiideans shrimps in the Brazilian coast. Significant differences in morphology were found between the sizes of males and females of *C. major*. The variables CL *vs*. CT showed allometric negative only females and isometric for males, while the relationships CL *vs*. MCL, CL *vs*. TW and CL *vs*. WW showed allometric positive. The reproductive period showed occur only the summer (dry period). The recruitment of the species occurs in peaks in summer. For the correlation matrix only the salinity showed significant for the total abundance and only related for ovigerous females in population. So, this paper increases the aspects about the biology reproductive of *C. major* in an urban muddy beach in Northeastern Brazil.

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