Fecundity of the shrimp *Macrobrachium jelskii* (Miers, 1877) in the southern portion of the state of Ceará, Brazil

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Biological knowledge on freshwater shrimps of the genus *Macrobrachium* is of the utmost importance due to the fundamental ecological role these organisms play in aquatic ecosystems. Few studies have been carried out on the biology and ecological relations of *Macrobrachium jelskii* in the semiarid regions of northeastern Brazil. The aim of the present study was to evaluate the fecundity of populations of the shrimp *M. jelskii* from rivers in different locations in the state of Ceará, Brazil. Sampling was carried out between June 2012 and February 2013 in the municipalities of Juazeiro do Norte, Lavras da Mangabeira, Milagres, Várzea Alegre and Farias Brito. Seventy-three ovigerous females were caught, with the cephalothorax length ranging from 6.62 mm to 10.98 mm. The largest mean fecundity rates were found in the municipalities of Milagres and Várzea Alegre. The increase in the number of eggs was associated with an increase in carapace length.
Keywords: Decapoda, Freshwater, Reproduction.

Fecundidade do camarão *Macrobrachium jelskii* (Miers, 1877) no Sul do estado do Ceará - Brasil
O conhecimento biológico das espécies de camarões de água doce, do gênero *Macrobrachium*, é de suma importância, tendo em vista que dentro dos ecossistemas aquáticos eles desempenham um papel fundamental nos processos ecológicos. Poucas são as pesquisas sobre a biologia e relações ecológicas do *Macrobrachium jelskii*, no semiárido nordestino. Desta forma esse trabalho teve o objetivo de avaliar a fecundidade de populações do camarão *M. jelskii* em rios de localidades distintas no interior do Ceará. O presente estudo foi realizado entre os meses de junho de 2012 a fevereiro de 2013 nas cidades de Juazeiro do Norte, Lavras da Mangabeira, Milagres, Várzea Alegre e Farias Brito. Foram capturadas 73 fêmeas ovígeras, com comprimento do cefalotórax médio de 8,35±0,96 mm, variando entre 6,62 mm a 10,98 mm. A fecundidade geral foi de 16 ±11,6, variando de 4 a 58 ovos entre as localidades. As cidades de Milagres e Várzea Alegre tiveram as maiores médias de fecundidade com 39,14±11,25 e 36,14 ± 6,96 ovos, respectivamente. O aumento do número de ovos deve estar relacionado ao aumento do comprimento da carapaça.
Palavras-chaves: Decapoda, Água-doce, Reprodução.

1. INTRODUCTION

Studies on the reproductive biology of species are important to the implementation of management and conservation measures [1]. The number of eggs produced by different crustaceans provides an indication of the reproductive potential of each species [2].

The potential fecundity of crustaceans is determined by the number of eggs in the initial development phase that are spawned and adhere to the pleopods of the female. The analysis of fecundity based on females bearing eggs in the initial development stage reduces errors stemming from egg loss throughout the development of the female as well as due to predation, miscarriage and parasitism [3].

The family Palaemonidae incubates the eggs in an incubation chamber formed by the dilation of the second sterna plate (pleura) [4]. The eggs are joined by a secretion produced by cement glands located at the base of the pleopods. This behavior of the female carrying the eggs may be one of the reasons for the success of the group, ensuring the protection of the offspring against predators [4].

The genus *Macrobrachium* includes more than 243 species throughout the world [5]. Thirty-three of these species are found in the Americas [6], 20 of which have records of occurrence in Brazil [7]. *Macrobrachium jelskii* is commonly known as the “sossego” shrimp in Brazil [8].

This species is restricted to freshwater environments, can be found in dark or clear waters with little marginal vegetation and a muddy substrate, fast-moving waters with grasses, rocks or sand [7].

The aims of the present study were to estimate the mean fecundity of *M. jelskii*, evaluate possible spatial differences in fecundity and body size and compare fecundity with other species of the genus.

2. MATERIALS AND METHODS

The state of Ceará (northeastern Brazil) is made up of 11 hydrological basins, including the sub-basin of the Salgado River located in the semiarid region of the southern portion of the state [9].

Sampling was performed between June 2012 and February 2013 in the municipalities of Juazeiro do Norte, Lavras da Mangabeira, Milagres, Várzea Alegre and Farias Brito (Figure 1) under license number 29615.

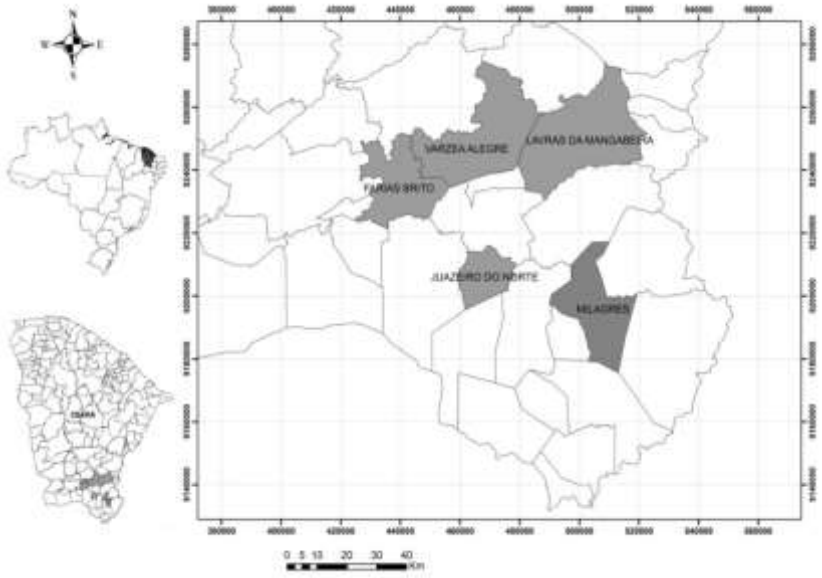

Figura 1: Location of municipalities in semiarid region of state of Ceará, Brazil

Were used for the capture of species, manuals networks, traps and screens, being subsequently analyzed using a stereomicroscope and keys dichotomous. In the field, water temperature was recorded with the aid of a digital thermometer with a precision of 0.1°C [7,10].

In the laboratory, ovigerous females were identified and cephalothorax length (CL, mm) was measured using a digital caliper with a precision of 0.01 mm. CL was considered the distance between the posterior edge of the orbital cavity and the posterior edge of the cephalothorax.

Pleopods bearing eggs were removed from the abdomen with a pincers. The eggs were laced in a Petri dish and counted under a stereomicroscope. The relationship between carapace length and number of eggs per females was determined for the obtainment of the logistic equation (y=ax+b).The relationship between carapace length and number of eggs per females was determined for the obtainment of the logistic. The Past program was used for analysis of covariance between the carapace length and number of eggs in the different locations by ANCOVA [11]. Mean CL of the females from different locations was compared in pairs by t test [11], with the level of significance set to $\alpha = 0.05$. We assumed data normality based at central limit theorem [11].

3. RESULTS AND DISCUSSION

Seventy-three ovigerous females were caught. CL ranged from 7.03 mm to 10.98 mm. A direct linear relationship was found between CL and number of eggs (y= 8.6169x-53.886) and (R^2= 0.5087) (Figure 2). The same pattern has been described for other shrimps of the genus *Macrobrachium*, such as *Macrobrachium carcinus* [12,13], *M. lamarrei* [14], *M. potiuna* and *M. borellii* [15] and *M. acanthurus* [16]. Still, the association between the size of the individual and the number of eggs is common among other decapod crustaceans that incubate their eggs, as in marine carideos *Exhippolysmata oplophoroides* [2], the lobsters *Panulirus argus* [17] and *P. laevicauda* [17].

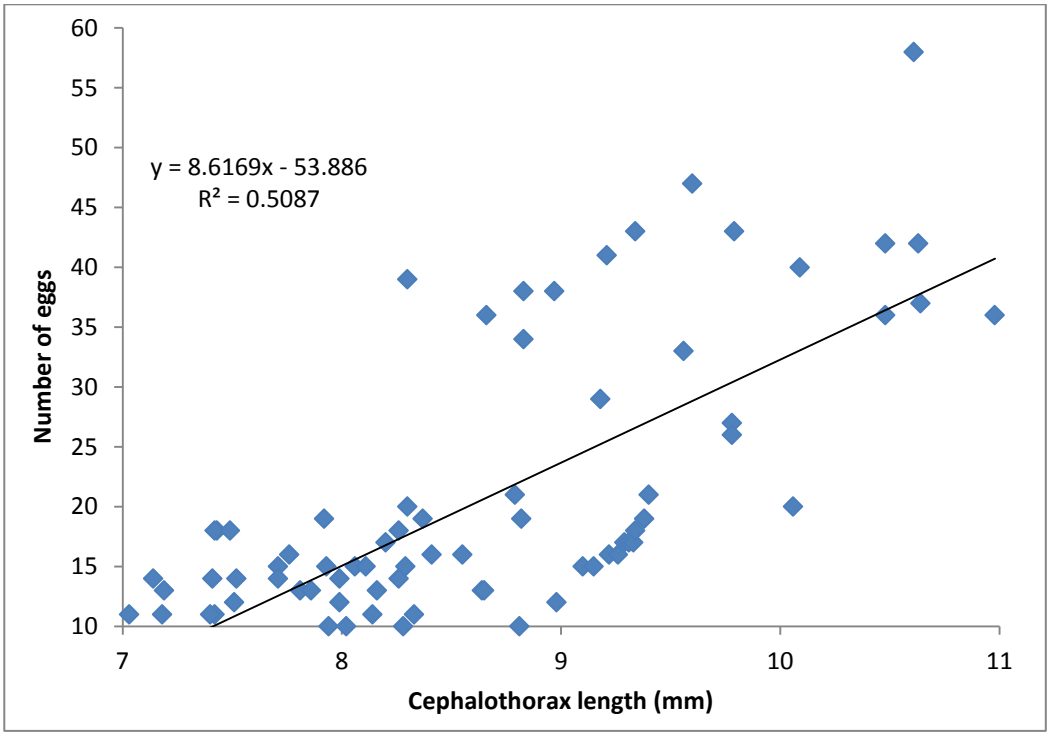

Figura 2: Relationship between cephalothorax length (mm) and number of eggs for all individuals of Macrobrachium jelskii *sampled in southern Ceará, Brazil*

Table 1: Macrobrachium jelskii – cephalothorax length (CL), mean fecundity, standard deviation (SD,) statistical significance between regressions (p) determined using ANCOVA; Different letters denote statistically significance difference (p < 0.05).

City	CL – SD	Average Fecundity	Max e Min Fecundity	P	Regression
Lavras da mangabeira	8.14 ± 0.41	15.86 ± 2.27	19 a13	a	y=3.203x-10.21
Milagres	10.47 ± 0.32	39.14 ± 11.25	58 a 20	b	y=14.59-113.7
Várzea Alegre	9.25 ± 0.59	36.14 ± 6.96	47 a 21	c	y=1.669x+20.7
Farias Brito	7.88 ± 0.47	13.3 ± 3.34	20 a 5	a	y=0.933x+5.944
Juazeiro do Norte	9.04 ± 0.58	15± 5.92	26 a 4	cd	y=9.669x-72.41

Among the sites analyzed, the largest mean fecundity rates were found in Milagres (39.14 eggs) and Várzea Alegre (36.14 eggs). These sites also had the largest mean CL (10.98 and 10.64 mm, respectively) (Table 1).

In the comparison of the relationship between number of eggs and CL, statistically significant differences were found among different sites ($p < 0.05$) (Table 1). According to [18],

crustacean fecundity is defined based on the number of eggs laid per spawning. However, water temperature is reported to exert a considerable influence on the reproduction of carid shrimps as the *Macrobrachium potiuna* [19] and according to [20] the temperature influences directly on the rate of metabolism of crustaceans.

The surface water temperature ranged from 28° to 37° C. In the municipalities of Várzea Alegre and Milagres, surface water temperature was within the limits established by [21] as ideal for the growth and reproduction of shrimps (28° to 30° C) (Figure 3). Thus, it is likely that water temperature affects fecundity in *M. jelskii* [22] report that differences and similarities in carapace length and fecundity among populations in different locations may occur due to the conditions of the environment. According to [23], the physiological conditions of females, season of the year and latitude also exert an influence on the number of eggs. Thus, the differences found among locations in the present study are likely the result of specific local conditions, such as water temperature.

The fecundity of *M. jelskii* ranged from 4 to 58 eggs (mean: 16 ± 11.62 eggs per female). This rate of fecundity maybe considered low in comparison to other members of the genus: 24 eggs per female in *M. pontiuna* [19] 270.79 eggs per female in *M. amazonicum* [24], 1,406.57 eggs per female in *M. olfersi* [25] (Table 2). According to [8,26,27], *M. jelskii* has a small number of eggs with large dimensions and volumes. The low fecundity rate is in agreement with data reported by [24, 28, 29, 30, 31]. The energy invested in the production of gametes can be distributed among many small eggs, as in less eggs larger and population patterns or own the species overall [32].The largest egg production is directly related to a longer time to develop, and this typically occurs when the female maximizes the energy expenditure per litter in order to increase the reproductive fitness when the mortality risk is low [33]. When this risk is high, the females usually invest in the production of more smaller eggs, which require less time of incubation, as in the case of invertebrates that incubate the eggs of adult survival contributes directly to the reproductive success, because the development of eggs depends on the adult [33].

Table 2: Fecundity values comparison to different species of Macrobrachium genus.

Species	Average Fecundity	Max e min CL	Max e Min Fecundity	Collection region	Authors
M. jelskii	16±11.62	10.98 a 7.03	4 a 58	Cariri – CE	Presente estudo
M. pontiuna	24±09	12.4 a 6.1	47 a 3	Mangaratiba-RJ	[19]
M. amazonicum	270.79±71.65	15.84 a 4.97	407 a 171	Cabaceiras do Paraguaçú - BA	[24]
M. olfersi	1,406.57±620.87	12 a 6.5	2,872 a 734	Ubatuba-SP	[25]

4. CONCLUSION

In conclusion, a direct, positive, linear relationship between cephalothorax length and number of eggs was found in *M. jeslkii*, which is a common characteristic of crustaceans of the suborder Pleocyemata. Water temperature may be a determinant factor influencing growth and fecundity. *Macrobrachium jelskii* has a reproductive strategy that consists of investing in eggs with larger dimensions and volumes and therefore exhibits a lower rate of fecundity in comparison to other species of the genus.

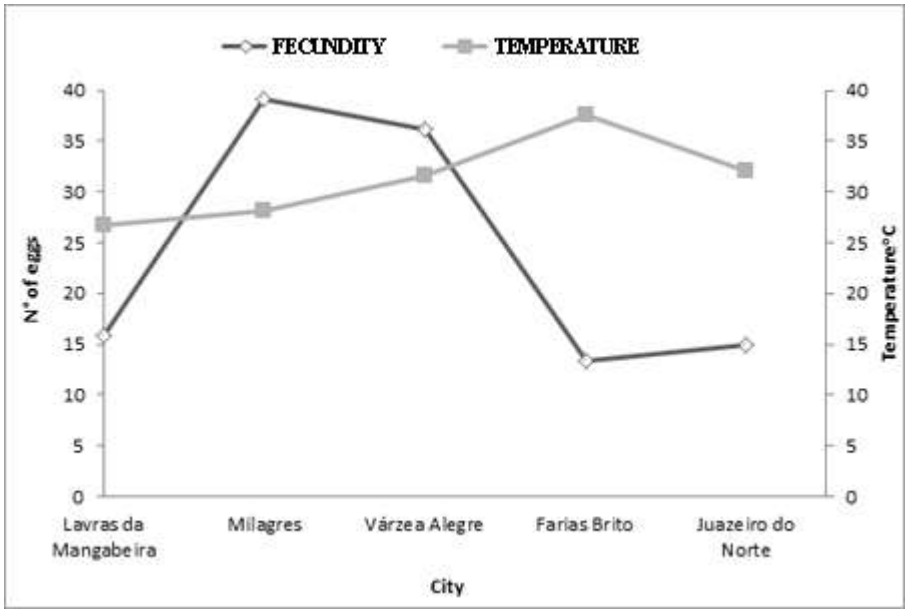

Figura 3: Association between Macrobrachium jelskii *fecundity and water temperature in municipalities in southern Ceará, Brazil*

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