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RESEARCH ARTICLE

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LIFE CYCLE AND STRUCTURE OF A POPULATION OF COLOMESUS PSITTACUS (BLOCH & SCHNEIDER, 1801) (OSTEICHTHYES, TETRAODONTIFORMES), IN THE MANGROVE AREA OF SÃO LUIS ISLAND, MARANHÃO, BRAZIL

Maria do Socorro Saraiva Pinheiro, João Filipe Soares da Silva and Wesley Lima Barbosa

Universidade Federal do Maranhão – UFMA, Departamento de Oceanografia e Limnologia, Av. dos Portugueses s/n, Bacanga, CEP 65.085-580, São Luís, Maranhão, Brasil

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*Corresponding author:

Maria do Socorro Saraiva Pinheiro

ABSTRACT

The striped puffer fish, *Colomesus psittacus*, belongs to the Tetraodontidae family, being one of the most frequent species in Maranhão estuaries. The main objective of this study was to present results about the structure of a population and the life cycle of *C. psittacus* present in an estuary under the influence of a mangrove swamp in the municipality of Raposa, São Luís island, Maranhão, Brazil. Sampling was monthly during the period of August 1999 and November 2000. A total of 374 fish specimens were collected, 114 males, 119 females and 141 with undetermined sex. The length range varied between 74-276 mm with a mean of 141.51 mm and standard deviation of 38.01. The sex ratio was tested by the Chi-square method, with a degree of freedom and a 0.05 degree of significance ($\chi^2 < 3,840$), and the Chi-square obtained was 0.10, so there was no significant difference at the level of significance 5%, therefore, the hypothesis of equality between the sexes (1:1) was accepted. The average length at first maturation (L_{50}) obtained for *C. psittacus* was 160.79 mm and the L_{100} was 197.71 mm for grouped sexes. *C. psittacus* completes its life cycle in the mangrove, as individuals in all stages of gonadal maturity were observed.

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INTRODUCTION

The mangrove is a complex tropical coastal ecosystem (Schaeffter-Novelli & Citron, 1986) dominated by typical plant species, where fauna and flora components adapted to an environment periodically flooded by the tides, with great variation in salinity, are associated (Watanabe, 1987). For Vannucci (2001) mangroves are marginal ecosystems well defined in space, with boundaries marked by tidal levels, and unlike other marginal systems, it is highly dynamic, very productive and with the ability to immobilize salts and heavy metals. Mangroves also provide goods and services to tropical populations around the world, and their occurrence favors high fish productivity (Vannucci, 1998). They have also been used to identify and monitor changes in sea level (Schaeffter-Novelli *et al.*, 2002). Puffer fish are bony fish of the order Tetraodontiformes belonging to the Tetraodontidae family, capable of inflating the body by swallowing water or air, and their bodies also lack typical scales, but with spiniform projections (Figueiredo; Menezes, 2000).

Although the meat of these fish is of good quality, consumption is limited, as many species are potentially toxic as they present the neurotoxin tetrodotoxin in large concentrations in the viscera and skin, which can lead to poisoning (Kodama *et al.*, 1984). However, the production of tetrodotoxin and its analogues are carried out by symbiotic bacteria (Oliveira *et al.*, 2003). *C. psittacus* is generally discarded in commercial catches as it has no economic importance, and its toxicity is known to fishermen. However, its important ecological function in the mangrove food chain has been highlighted, as it is considered a second order carnivore (Krumme *et al.*, 2007).

The present study aims to present results about the life cycle based on the identification of the gonad maturity stages of a population of *C. psittacus* present in an estuary under the influence of a mangrove swamp, because it is based on the hypothesis that the life cycle of a teleost is related to environmental conditions.

MATERIALS AND METHODS

The study area was chosen in a mangrove swamp in the municipality of Raposa located on the island of São Luís, State of Maranhão, northeastern Brazil (Figure 1). The sampling of fish for this study was carried out monthly between the period of August 1999 and November 2000. The fishing gear used was a stream net. These gears are fixed devices, placed at the entrance to the stream, supported by mangrove poles, where they are fixed during low tide, and harvesting takes place during the following low tide, totaling a capture effort of about 12 hours. The fish captured for this study were packed in plastic bags labeled in the field, placed in styrofoam boxes with ice and transported to the laboratory, where identification was carried out based on Fischer (1978), Figueiredo & Menezes (2000) and Nelson (1994). For each specimen, the following data were obtained: total length in millimeters (Ct), total weight in grams (Pt), sex and stage of gonadal maturity. The total length of the fish was obtained from the measurement taken from the tip of the snout to the longest end of the tail fin. Then, each specimen was weighed on a balance with a precision of 0.01 g. For the observation of sex and stage of gonadal maturity, the abdominal cavity of each fish was exposed, through an incision in the region of the genital pore towards the head. The identification of sex and gonad maturity stages of the collected specimens was made through macroscopic inspection of the gonads, comparing their aspects with the scales proposed by Vazzoler (1981; 1996) and Dias *et al.* (1998), adapted to the classification presented by Pinheiro (2010): immature (A), maturing (B), mature (C) and spawned (D).

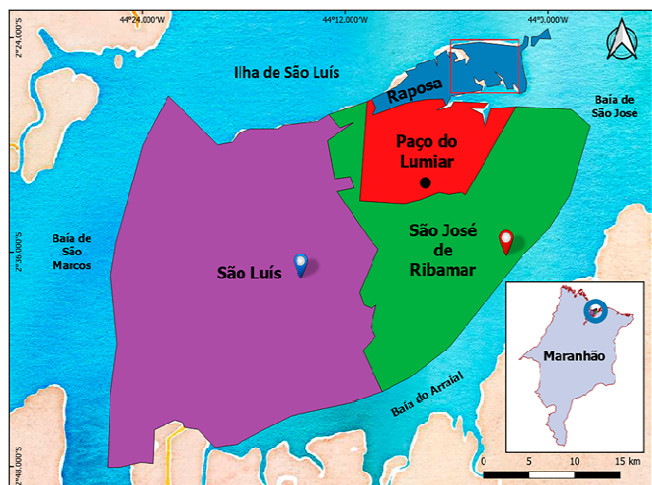


Figure 1. Location map of the municipality of Raposa, located on the island of São Luís

The sex ratio used for population composition was calculated for the total period and by length class. The sexual proportions found were tested using the Chi-square test (χ^2) using the null hypothesis as a 1:1 ratio between males and females with a significance level of 5% (Zar, 2010).

The estimate of the average length of the first gonadal maturation was obtained from the relative frequency data of young and adult individuals, and the total length of the analyzed specimens. Then, young individuals were identified in stage A, and adults in stages B, C and D. Table 1 shows the absolute and relative frequencies of youth and adults by length classes. The relative frequencies of youth and adults and length class were plotted, and the adjustment of points was made using the logistic model, according to Puzzi *et al.* (1985a; b).

$$fr = 1 - e^{-aLtb}$$

fr = relative frequency of adult individuals in each length class;

e = base of the natural logarithm;

Lt = average total length of the class;

a and b = estimated parameters.

The a and b coefficients of the expression were estimated using the least squares method, obtained from the regression between the frequency of adults in each length class. The logarithmic transformation of the empirical data was carried out in order to assess whether there was an allometric relationship between the variables involved, according to the expression:

$$\ln[-\ln(1 - fr)] = \ln a + b \ln Lt$$

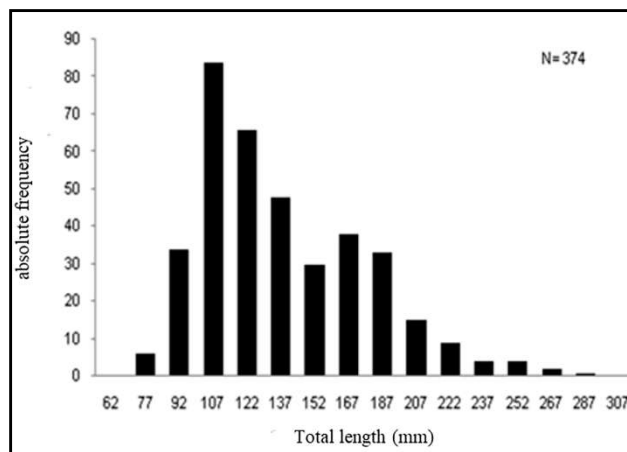


Figure 2. Frequency distribution by length class of *C. psittacus*

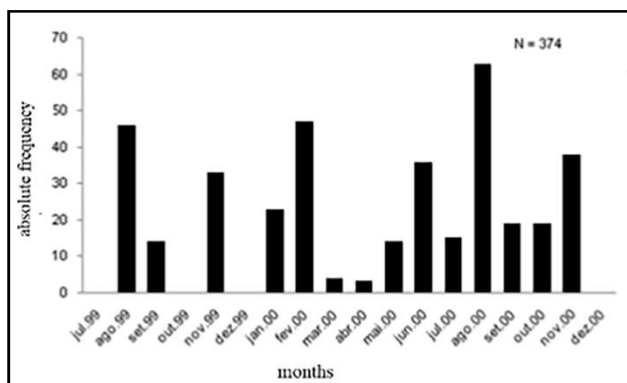


Figure 3. Frequency distribution during the sampling months of *C. psittacus*

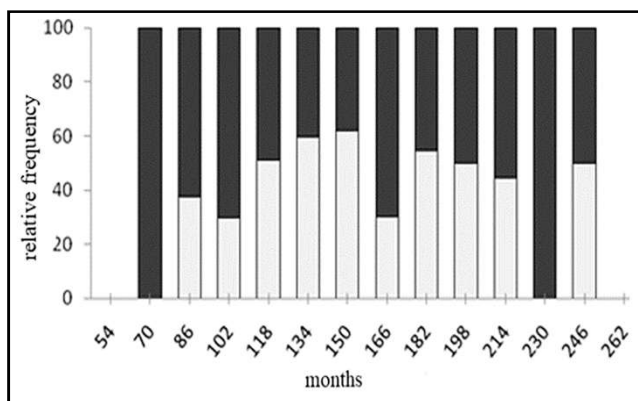


Figure 4. Relative frequency of males and females by length class of *C. Psittacus* (■ females, N=119; □ males, N=114)

RESULTS

A total of 374 specimens of *C. psittacus*, 114 males, 119 females and 141 with undetermined sex were collected. The length range ranged from 74 to 276 mm, with a mean of 141.51 mm and standard deviation of 38.01.

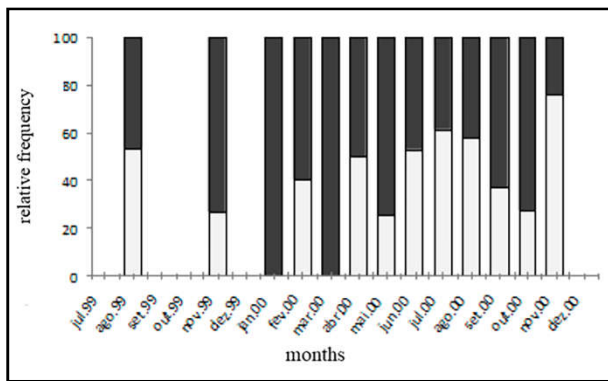


Figure 5. Relative frequency of males and females per month of *C. psittacus* (■ females, N=119; □ males, N=114)

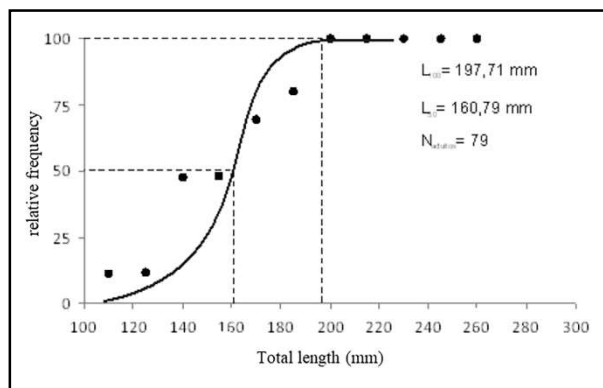


Figure 6. Relative frequency distribution of adults by length class for grouped sexes of *C. psittacus* collected in the Raposa mangrove between August 1999 and November 2000

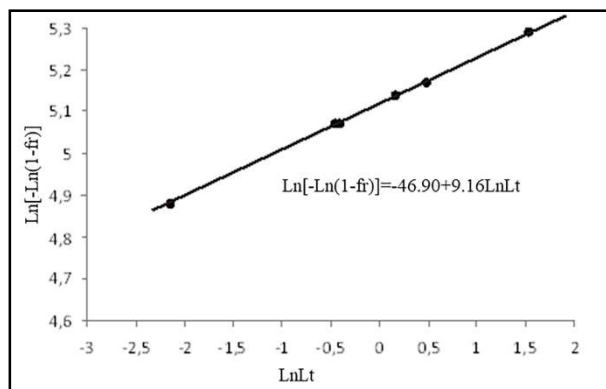


Figure 7. Relative frequency distribution of adults by length class for sexes grouped in logarithmic form of *C. psittacus* collected in the Raposa mangrove between August 1999 and November 2000

Figure 2 shows the absolute frequency distribution of individuals by length class, where a distinct mode is observed in the 107 mm length class. And Figure 3 shows the distribution of absolute frequencies of individuals throughout the collection period where it is observed that the frequency of individuals was homogeneous, being a little higher in August of the second year of collection. The sex ratio was analyzed by the chi-square test with one degree of freedom and 5% degree of significance ($\chi^2 < 3.840$). The chi-square obtained was 0.10, so there is no significant difference at the 5% significance level, therefore, the hypothesis of equality between the sexes (1:1) was accepted. Figure 4 shows the relative frequency of males and females by length class. This figure shows a greater number of individuals captured between the length classes from 86 to 214 mm, in this interval there was a trend towards equality in the relative frequency of males and females, with the exception of the 150 mm length class where there was a predominance in frequency relative of males, while in the 166 mm length class it was higher than females.

Table 1. Absolute (N) and relative (%) frequency of males and females by length class of *C. psittacus*

Length class (mm)	Males		Females		Total
	N	%	N	%	
54 - 70	0	0	0	0	0
70 - 86	0	0	1	100,00	1
86 - 102	3	37,5	5	62,50	8
102 - 118	8	29,63	19	70,37	27
118 - 134	24	51,06	23	48,94	47
134 - 150	31	59,62	21	40,38	52
150 - 166	18	62,07	11	37,93	29
166 - 182	6	30,00	14	70,00	20
182 - 198	12	54,55	10	45,45	22
198 - 214	6	50,00	6	50,00	12
214 - 230	4	44,44	5	55,56	9
230 - 246	0	0	2	100,00	2
246 - 262	2	50,00	2	50,00	4
262 - 278	0	0	0	0	0

In Figure 5 presents. the relative frequency of males and females per month of *C. psittacus*. This figure shows that the relative frequency of males was higher in July and November of the second year of collection. In August of the first year, and in April, June and August of the second year of collection, the frequency of males and females there was a tendency to equalize, in the other months in which the species was captured, the relative frequency of females was higher. For safety reasons, the classification of the gonad maturity stages was only assumed when they were visualized, so 93 immature individuals (A), 59 in maturation (B), 12 mature (C) and 8 spawned (D) were observed). The results of the analyzes of the length of first gonadal maturation were based on the relative frequency distribution of juveniles and adults by length class for grouped sexes. Thus, the value of L_{50} for grouped sexes was 160.79 mm, and L_{100} was 197.71 mm. The expressions that represent the relative frequencies of adult individuals by total length class for grouped sexes and the corresponding one in logarithmic form are respectively:

$$fr = 1 - e^{-9.16Lt^{4.28} \times 10^{-21}}$$

$$\ln[-\ln(1 - fr)] = -46.90 + 9.16 \ln Lt$$

Figure 6 shows the plotted values of relative frequency of adult individuals by total length class and Figure 7 shows the values plotted in logarithmic form for these variables.

DISCUSSION

The quantitative characteristics of fish samples are influenced by sampling techniques. In this study, due to the specific conditions of the sampling area, the most suitable fishing device was the stream net. The length frequency distribution of the captured specimens ranged between 74 and 276 mm, so it can be inferred that the sampling was not casual, that is, there was sample selection in relation to size. Because in other studies carried out in a mangrove system in northern Brazil, smaller specimens were collected, in this case between 20 and 270 mm (Barletta *et al.*, 2003). In a subequatorial system, bordered by mangrove trees, salinity should not be considered as it occurs in other systems, and according to Lowe-McConnell (1999) only very euryaline species can live in mangrove swamps, including cyprinodontiformes, poecilids, *Oryzias*, and some tilapias. True residents would include intertidal fish typically, primarily detritivores or aerial prey predators, as well as open lagoon fish that complete their life cycle in the lagoons close to them. Thus, puffer fish, *C. psittacus*, could be included as true residents in this mangrove system in the municipality of Raposa. The reproductive aspects addressed in this study were based on the macroscopic analysis of the gonads, so a scale of four maturity stages was adopted, as recommended by Matsuura (1977) when fish had never been studied for maturation, due to the impossibility of classifying into more detailed stages. The species *C. psittacus* was considered in this study in reproductive activity in the mangrove in the municipality of Raposa, because there were specimens in stages C (mature) and D (spawned). So, this species can be considered resident in this ecosystem, as well as

Barletta et al. (2003) observed in the estuary of the river Caeté and Giarrizzo and Krumme (2009) in the estuary of the river Curuçá, both in the State of Pará, northern Brazil.

CONCLUSION

The life cycle of the species *C. psittacus* is complete in the mangrove in the municipality of Raposa, as individuals were observed at all stages of gonadal maturity (A – immature, B – maturing, C – mature and D – spawned) when throughout the study period. Therefore, it can be inferred that this species uses the system for both growth and reproduction.

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