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Original Article

Reproductive parameters of *Oreochromis mossambicus* in Laguna de Los Patos, Cumaná, Venezuela

Parâmetros reprodutivos de *Oreochromis mossambicus* em Laguna de Los Patos, Cumaná, Venezuela

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Abstract

A total of 381 specimens of the tilapia *Oreochromis mossambicus* collected monthly from May 2017 to May 2018 in the Laguna de Los Patos, Cumaná, Venezuela, to evaluate reproductive parameters of this non-native species. Significant differences were found in relation to average height and weight between males and females, with the highest values in males. The sex ratio was 1:1.5 (males:females), which deviates significantly from the expected 1:1 ratio. The mean length of sexual maturity (Lm50) was 18.0 cm in females and 20.1 cm in males, reflecting that females mature at smaller sizes than males. The monthly variations of the gonadosomatic index (GSI) and the stages of sexual maturity show two reproductive peaks during the study, in October 2017 and April 2018, coinciding with the rainy and dry seasons in the region respectively. The condition factor (CF) showed significant differences between months, but not between sexes, with an average of 1.87 in females and 1.84 in males. The average absolute fecundity was 921 ± 604.6 eggs per fish, with a relative fecundity of 8.36 ± 3.09 eggs per gram of fish. Differences in oocyte size in mature females confirm that the species can spawn repeatedly over a period, which is considered an important factor for the establishment of tilapia in non-native environments.

Keywords: tilapia, reproduction, fecundity, oocytes, gonadosomatic index.

Resumo

Um total de 381 espécimes da tilápia *Oreochromis mossambicus* foram coletados mensalmente de maio de 2017 a maio de 2018, na Laguna de Los Patos, Cumaná, Venezuela, para avaliar parâmetros reprodutivos desta espécie não nativa. Foram encontradas diferenças significativas em relação às médias de altura e peso entre machos e fêmeas, sendo os maiores valores no sexo masculino. A razão sexual foi de 1:1,5 (machos:fêmeas), o que se desvia significativamente da proporção esperada de 1:1. O comprimento médio de maturação sexual (Lm50) foi de 18,0 cm nas fêmeas e 20,1 cm nos machos, refletindo que as fêmeas amadurecem em tamanhos menores que os machos. As variações mensais do índice gonadossomático (IGS) e dos estágios de maturidade sexual mostram dois picos reprodutivos durante o estudo, em outubro de 2017 e abril de 2018, coincidindo com as estações chuvosa e seca na região, respectivamente. O fator de condição (FC) apresentou diferenças significativas entre os meses, mas não entre os sexos, com média de 1,87 no sexo feminino e 1,84 no masculino. A fecundidade absoluta média foi de 921 ± 604,6 ovos por peixe, com fecundidade relativa de 8,36 ± 3,09 ovos por grama de peixe. Diferenças no tamanho dos ovócitos em fêmeas maduras confirmam que a espécie pode desovar repetidamente ao longo de um período, o que é considerado um fator importante para o estabelecimento de tilápias em ambientes não nativos.

Palavras-chave: tilápia, reprodução, fecundidade, ovócitos, índice gonadossomático.

1. Introduction

The Mozambican tilapia *Oreochromis mossambicus* (Peters, 1852), is a mouth-hatched cichlid of African origin, introduced to many regions of the world for aquaculture purposes, as well as for recreational fishing, aquatic weed control and research (El-Sayed, 2006). However, its introduction has had a negative impact on

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native species, which is why it has come to be considered a highly invasive species, being directly related to the disappearance of native species in several regions of the American continent, mainly due to their displacement in competition for space and food, and to the predation of fish eggs and larvae (McKaye et al., 1995; Pérez et al., 2004; Monroe et al., 2023).

In the Laguna de Los Patos, in northeastern Venezuela, the tilapia *O. mossambicus* was introduced in 1964, and several years later the negative effect on the fish diversity of the lagoon was reported, corroborated by a marked decrease in the number of local species, presumably due to the aggressive attack on larvae and juveniles by tilapia (Aguilera and Carvajal, 1976). Currently, more than five decades later, this species is a natural part of the lagoon's ichthyofauna, being a commercialized resource, given its relative abundance throughout the year (Salazar et al., 2019). There are no published data on the tilapia fishery, but this accounts for 60% of the total fish catch in the Laguna de Los Patos, where 80 families live and benefit from the resource (Quintero et al. 2002).

Reproduction is one of the essential biological aspects that allows a higher population density of a given species and its survival. The reproductive behavior of tilapia, characterized by parental care of eggs and fry, and semi-permanent and early reproduction (Pérez et al., 2004), have ensured a high recruitment of the species in adjacent lakes and rivers, constituting a serious threat to the survival of other native fishes and a greater expansion into non-native environments (Roshni and Renjithkumar, 2020). Studies on reproductive parameters, as well as the variation of certain biological indices related to reproduction, such as gonadosomatic index (GSI), condition factor (CF) and fecundity, can reveal how fish use environmental and energy resources. These are of great importance in predicting the status of the population, the establishment of the species and the design of strategies for appropriate management (Chander 2016; Adite et al., 2017).

The aim of this study was to estimate some morphophysiological and reproductive parameters of *O. mossambicus,* to evaluate how these characteristics may have influenced the successful establishment of this fish in non-native bodies of water, such as the Laguna de los Patos. This research could serve as an example to predict the establishment of a tilapia species in a new body of water, after an accidental or sought-after introduction.

2. Materials and Methods

2.1. Study area

The Laguna de Los Patos is a body of water made up of four small coastal lagoons connected to each other, located on the southern coast of the Gulf of Cariaco, Sucre state, Venezuela, between 10°25'42'' N latitude and 64°25'42'' W longitude (Figure 1). This lagoon covers a total area of 1.5 km^2, with an average depth of between 0.4 and 1.9 m. It communicates with the sea through the beach of San Luis in the Caribbean Sea, however, due to the accumulation of sand at the outlet of the lagoon, there is no direct contact of the waters of the lagoon with the sea throughout the year (Cumana, 2010). The salinity in this lagoon experiences large fluctuations ranging from 0.4 to 40 due to the entry of fresh water from drains, irrigation systems and some streams that flow into the area and wastewater from some sectors (Márquez et al., 2007; Salazar et al., 2019). This body of water is considered one of the most intervened aquatic ecosystems in the region, due to the growth of population settlements in its surroundings, which has contributed over time, to the disappearance of fish species that were common in that area and today it can be said that only species with high resistance to extreme environmental conditions are achieved (Pérez et al., 2003). During the study period, precipitation data in the area (NASA POWER website) identified a rainy season (July-December) and a dry season (January-June) in the coastal area that includes the Laguna de Los Patos.

2.2 Collection of specimens

Monthly samples of *O. mossambicus* were collected between May 2017 and May 2018, in two areas (A and B) of the Los Patos lagoon (Figure 1), at average depths of 0.5 m and 1.0 m respectively. A 10.0 x 1.2 m monofilament fixed net with a variable mesh diameter (1 cm in the center and 3 cm at the ends) was used for capture. The fish were transported alive in 60 L plastic containers with water to the laboratory, where they were placed in ice water (± 4 °C) for 30 min, to cause death by hypothermia. The identification of the species was carried out using the descriptions of Froese and Pauly (2024).

2.3. Morphometric characteristics

Each individual had the total length determined with a graduated ichthyometer (± 1 mm), and the total weight with an Ohaus electronic balance (± 1.0 g accuracy). The size composition of the sample was analyzed through frequency histograms, and the total length-to-total weight relationship was estimated, following the linear regression analysis method according to the equation: $W = a L^b$, (Le Cren, 1951); where W is the total weight of the fish (g), L is the total length (cm), *a* and *b* are constant. The value of *b* was compared with a student's t-test (Sokal and Rohlf, 1981) vs. the value of $b = 3$, considering the physiological law of allometry that considers that weight varies as a function of length to cubic power ($L^{3)}$ (Ricker, 1973).

2.4. Reproductive condition of fish

The gonads were removed and macroscopically examined for sex identification. The number of males and females was counted, only in those specimens where it was possible to identify their gametes, and a Chi-square test (χ^2) was applied, with a reliability of 95% to verify how far the values deviate from the theoretical 1:1 ratio. The number of juveniles (stage I) per month was also quantified. The determination of the stage of sexual maturity was made based on the size, shape and coloration of the gonads, according to the criteria established by Dadzie (1974), who classifies fish into five stages: juvenile (stage I), immature (stage II), maturing (stage III), mature (stage IV) and spawning (stage V). The frequency of each stage of

Figure 1. Relative location of Laguna de los Patos, Sucre state, Venezuela, showing the two collection zones (A and B) of Oreochromis mossambicus. Adapted from Google Earth (2023).

gonadal development per month was calculated in both males and females. The gonadosomatic index (GSI) was calculated according to the expression: GSI = GW / W * 100 (Vazzoler, 1996), where GW= total gonad weight (g) and W = total weight of the fish (g). The Condition Factor (CF) was determined for both males and females, according to the equation CF = 100 W / L^3, where W is the total weight (g) and L is the total length (cm).

The mean length of sexual maturity (Lm50) was estimated on the basis of the length frequency of males and females in stages III and IV, made with a scatter plot and using the Excel program, to obtain the constants *a* and *b*. Then, the difference-of-squares method was applied, which uses the Excel Solver routine to recalculate parameters *a* and *b* that best fit the experimental data (Haddon, 2001). Finally, the theoretical maturity ratio (M) was determined using the formula $M = 1/ [1 + e^{-a\,(L-b)}]$, where L is the total length· *a* is the slope of the curve obtained by plotting the proportion of mature specimens in each size class and *b* = Lm50, the mean length of sexual maturity of 50% of individuals.

The ovaries of 38 stage IV females were kept in Gilson's solution for 15 days and dissected to count the number of eggs and estimate absolute fecundity (AF), expressed as the number of oocytes per female. Weight-related fecundity (F) was calculated according to the formula F = AF/W where AF is the absolute fecundity and W the total weight of the fish, expressed as number of oocytes per gram of body weight (Araya et al., 2003). The oocytes were measured from micrographs and with the help of the Sigma Scan Pro image analysis program. Diameters were grouped into class intervals and plotted on frequency histograms to estimate the type of ovarian development.

2.5. Statistics

The values of all the parameters evaluated were expressed as mean ± standard error. The means of the different parameters were analyzed by means of one-way ANOVA (Sokal and Rohlf, 1981), after a normality test, with a subsequent analysis of means (Tukey's test with $P<0.05$). Statistical analyses were performed with the statistical package Statgrafics Plus version 5.1 in Windows environment.

3. Results

3.1. Morphometric characteristics

A total of 381 specimens were collected, 180 females (45.4%), 126 males (34.2%) and 75 juveniles (20.5%). The mean L in females was 17.5 cm, while in males it was 18.5 cm and 16.8 cm in juveniles (Table 1). The average W was 97.4 g

Table 1. Minimum, maximum and average total length and weight by sex of *Oreochromis mossambicus* in Laguna de Los Patos in the period 2017-2018. ($\overline{X}$ ± Standard error).

	Length (cm)			Weight (g)			*n*
	Min	**Max**	**$\overline{X}$ ± SE**	**Min**	**Max**	**$\overline{X}$ ± SE**	
Females	13.2	30.0	17.5 ± 0.2	30.0	655.5	97.4 ± 4.3	180
Males	13.2	33.5	18.5 ± 0.4	36.2	583.5	133.2 ± 10.0	126
Juveniles	12.5	21.5	16.8 ± 0.2	34.6	221.7	91.7± 3.6	75

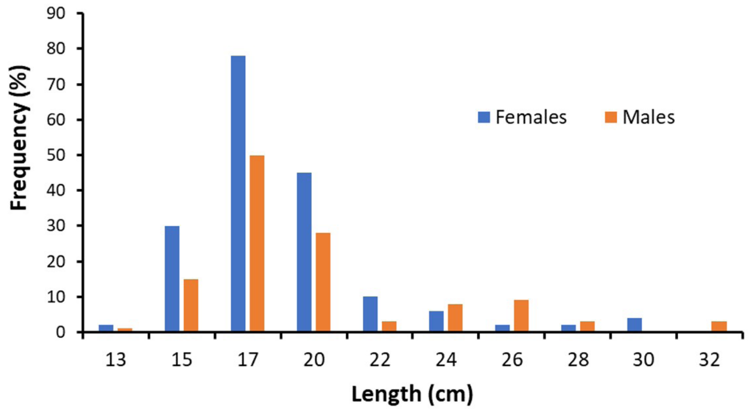

Figure 2. Frequency distribution in length of females and males of Oreochromis mossambicus in Laguna de Los Patos, Venezuela, in the period 2017-2018.

for females, 133.2 g for males and 91.7 g for juveniles. The student's t-test showed that there are significant differences ($P<0.05$) in relation to average L and W between males and females, with the highest values being found in males, with maximum sizes of 33.5 cm. The frequency distribution in length of *O. mossambicus* (Figure 2) shows that the highest proportion of females (70%) was found in the size range of 14.2 cm to 18.7 cm, while in males the highest proportion (56%) was found in sizes between 15.0 and 18.0 cm, with a scarce presence of specimens in larger sizes. The total length-to-total weight ratio of all specimens (Figure 3) showed a potential type model, expressed as $W = 0.0159 L^{3.0497}$ with a correlation of 0.9602 ($P<0.05$), indicating a strong relationship between the two variables. The type of growth, determined by Student's t-test, showed an isometric growth for *O. mossambicus* (b = 3.0497) where the organisms present a proportional growth between size and weight.

3.2. Reproductive condition of fish

The average M:F ratio (Table 2) was 1:1.5, which is significantly different from the expected ratio of 1:1 (χ^2 = 46.01, d.f. = 1, $P<0.05$), indicating that there is a predominance in the number of females collected, mainly in the rainy season. Macroscopic observation of the gonads in females during the study (Figure 4a) showed three periods of sexual maturity (stage III and IV): from May to July 2017 (dry season), October to December 2017 (rainy season) and from February to June 2018 (dry season), indicating that the species reproduces almost all year round. However, the time when the highest proportion of mature females was recorded was during the dry season. In males (Figure 4b) the highest proportion of mature males was found in the rainy season (November 2017).

The monthly mean values of the gonadosomatic index (GSI) (Figure 5) showed significant differences between females and males ($P<0.05$), being higher in females, with values ranging from 1.17 to 23.34, while in males it ranged from 1.0 to 2.6.

The condition factor (CF) in *O. mossambicus* showed monthly variations between 1.5×10^3 and 2.2×10^3 (Figure 6) without showing significant differences between the sexes ($P>0.05$). The highest values of FC were recorded in October and December in females, during the rainy season.

In Figure 7 it is shown the percentage of mature females and males in stages III and IV of *O. mossambicus,* together with the equations of the theoretical maturity ratio (M). From these equations the mean size of sexual maturity (Lm50) was at 18.0 cm total length in females and 20.1 cm in males.

The average absolute fecundity of *O. mossambicus* was found to be 921 ± 604 eggs per female, while the relative fecundity yielded an average of 8.36 ± 3.09 eggs/g. Absolute fecundity showed a high correlation (R^2 = 0.8349) with total length (Figure 8), which indicates that larger females produced more eggs per unit of body weight.

Oocytes in mature females showed a highly variable size range, from 1.0 mm to 2.8 mm (Figure 9), with a higher frequency of oocytes in the size 2.6 mm.

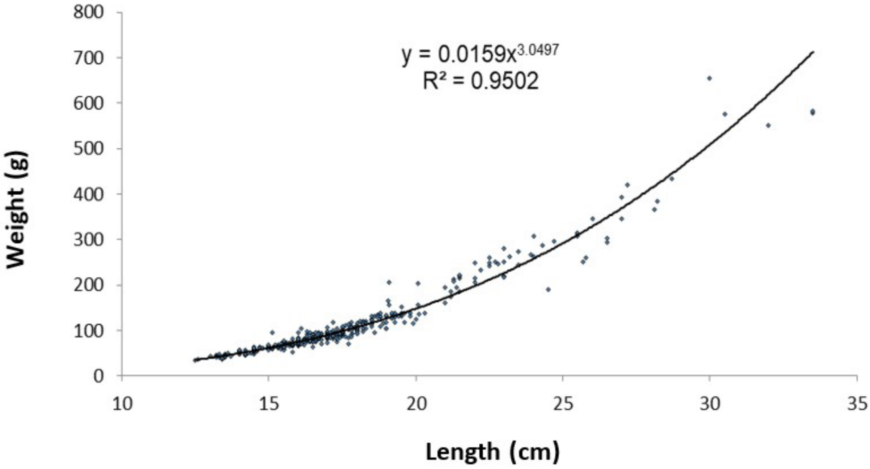

Figure 3. Length-weight relationship of Oreochromis mossambicus captured in Los Patos lagoon, Venezuela, in the period 2017-2018. Number of measurements = 381.

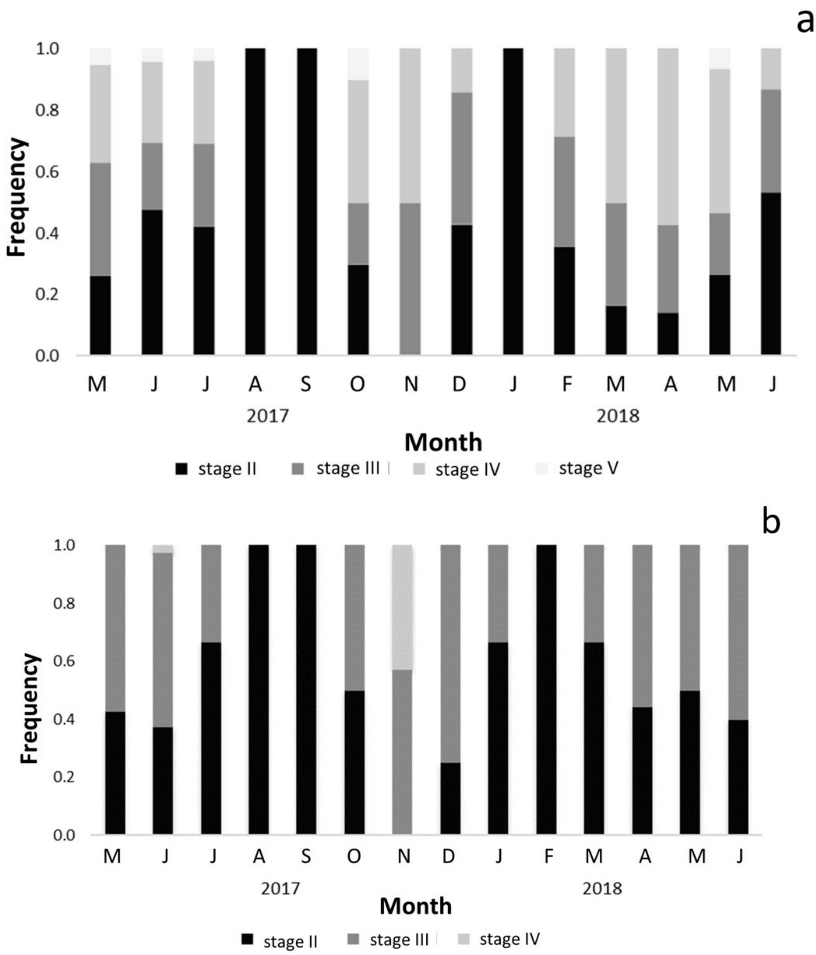

Figure 4. Frequency of sexual maturity stages in females (a) and males (b) of Oreochromis mossambicus in Laguna de Los Patos, Venezuela, in the period 2017-2018.

Table 2. Monthly variation of the male-female ratio (M:F) of *Oreochromis mossambicus* collected in Laguna de Los Patos, Cumaná, Venezuela in the period 2017-2018.

Month	Males	Females	Total	χ^2	M:F ratio
Jun-17	40	23	63	4.60	1:0.6
Jul-17	12	28	40	6.43	1:2.3
Aug-17	1	5	6	2.83	1:5.0
Sep-17	6	30	36	16.03	1:4.0
Oct-17	11	16	27	0.96	1:1.5
Nov-17	7	6	13	0.15	1:0.9
Dec-17	8	7	15	0.13	1:0.9
Jan-18	6	2	8	2.13	1:0.3
Feb-18	8	15	23	2.17	1:1.9
Mar-18	3	7	10	1.70	1:2.3
Apr-18	10	8	18	0.28	1:0.8
May-18	9	16	25	2.00	1:1.8
Jun-18	5	17	22	6.59	1:3.4
Total	126	180	306	46.01	1:1.5

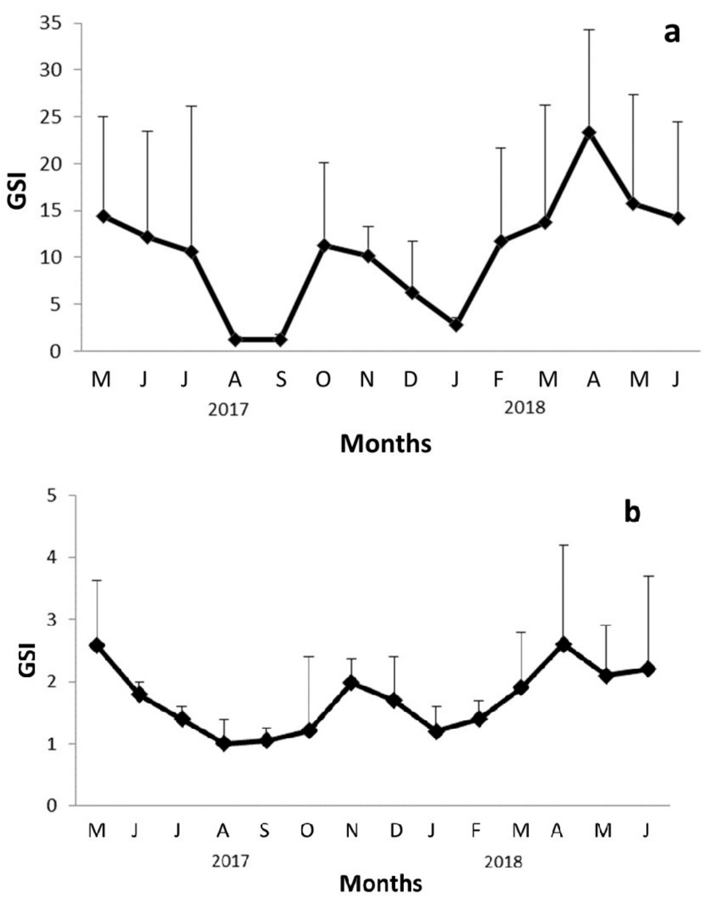

Figure 5. Monthly variations of gonadosomatic index (GSI) in females (a) and males (b) of Oreochromis mossambicus in Laguna de Los Patos, Venezuela, in the period 2017-2018. Values are the mean ± standard error.

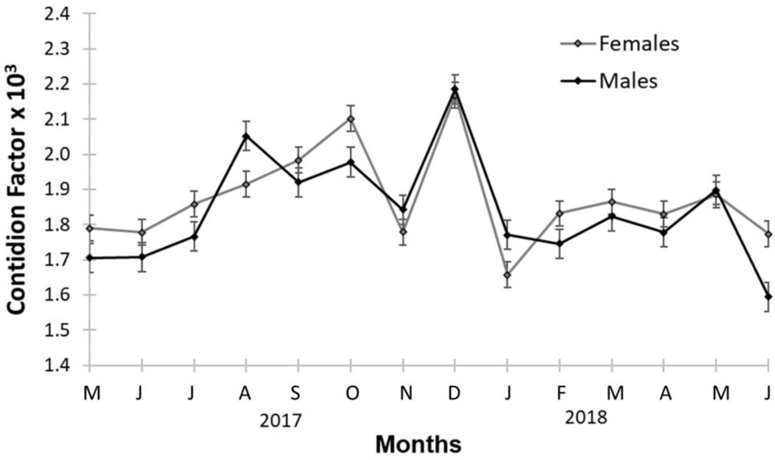

Figure 6. Monthly variations of the condition factor (CF) (mean ± standard error) in females and males of Oreochromis mossambicus in Laguna de Los Patos, Venezuela, in the period 2017-2018.

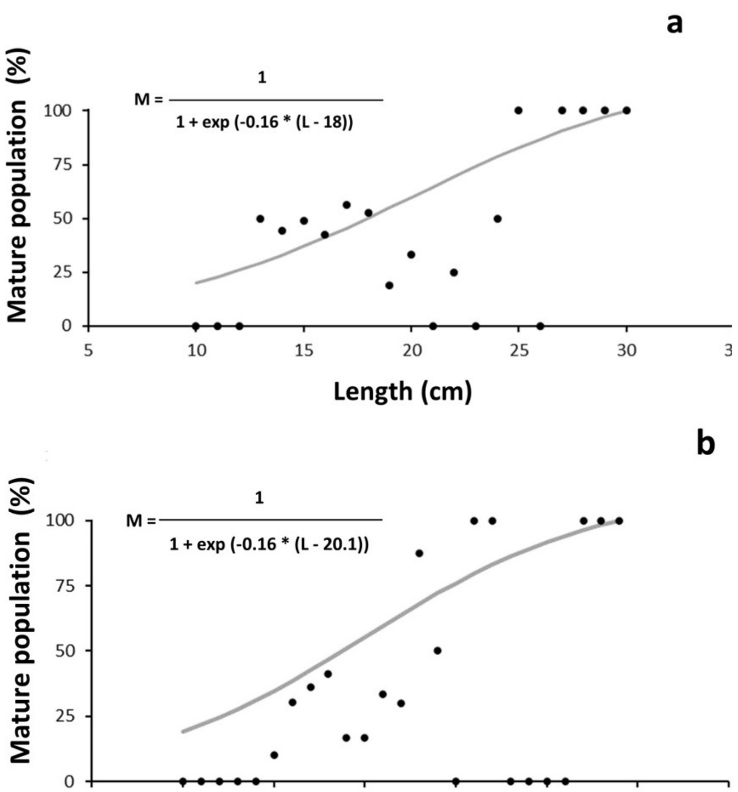

Figure 7. Percentage of mature females (a) and males (b) in stages III and IV of Oreochromis mossambicus, collected in Laguna de Los Patos, Venezuela, in the period 2017-2018. The equations of the theoretical maturity ratio (M) are shown.

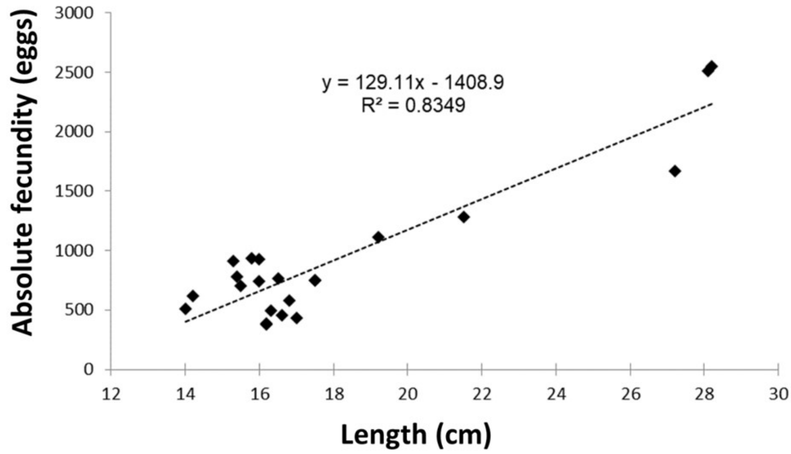

Figure 8. Relationship between fecundity and total length in females of Oreochromis mossambicus in the Los Patos lagoon, Venezuela, in the period 2017-2018.

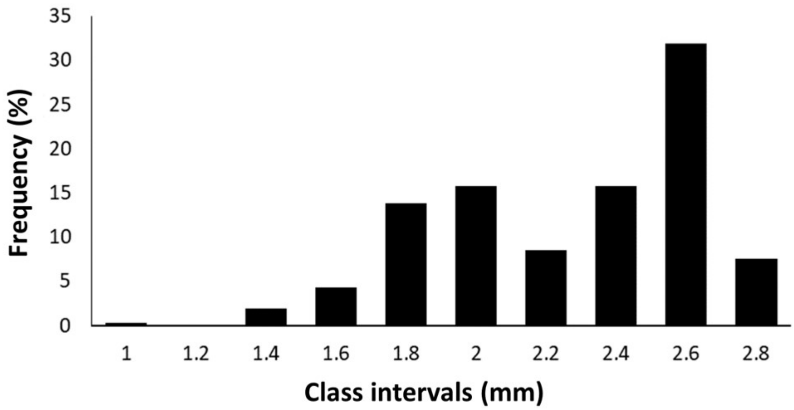

Figure 9. Oocyte diameter frequency in mature females of Oreochromis mossambicus collected in Laguna de Los Patos, Venezuela, in the period 2017-2018.

4. Discussion

The size difference between males and females found in *O. mossambicus* has been reported in previous studies by Russell et al. (2012) who mention that, in tilapia, in general, the male grows more than the females, which has been related to reproductive behavior. During the onset of spermiogenesis, males have a higher growth rate, which decreases at the end of the sexual maturation period, while in females, somatic growth is reduced during the initial stages of vitellogenesis, since energy resources are allocated more to oocyte development during the reproductive season. Oocyte development can occur several times a year, affecting the size of females (Bhatta et al., 2012). It has also been associated with reduced feed intake by female *O. mossambicus* during hatchling, so growth in females will be markedly reduced during this period (Hodgkiss and Man, 1978).

The size of *O. mossambicus* found in this work are within the range reported by several researchers for the species (Bluhdorn and Arthington, 1990; Shubha and Reddy, 2018). However, Russell et al. (2012) found a higher proportion of sizes around 30 cm in *O. mossambicus* in some reservoirs in Australia. Size differences can be attributed to the conditions of the body of water where the fish live, such as food availability, population density, and ecological factors (Marcano et al., 2002), which produces a variable size distribution from one region to another and even within the same region (Vazzoler, 1996). On the other hand, fishing regimes adopted for the exploitation of a resource can led to changes in the size of individuals, in their growth rate and in their reproductive capacity, one of the most notable changes being the reduction in the average size of fish in the stock (Csirke and Gumy, 1996). Fishing activity in Laguna de Los Patos is mainly aimed at tilapia, due to its easy catch, relative abundance, and permanence throughout the year (Salazar et al., 2019), which could lead to a reduction in the size of the population, because of a decrease in the proportion of larger fish, due to increased commercial interest.

Regarding the type of growth of *O. mossambicus,* in this work it was found that growth was isometric (b = 3.0497), indicating that the organisms present a proportional growth between size and weight being like that reported by Mortuza and Misned (2013) in other tilapia species.

The average M:F ratio found in this work of 1:1.5, is probably due to a differential use of the habitat by the sexes during spawning activity. At the beginning of the breeding season, males tend to move away to deeper places to continue the process of making nests for courtship and egg laying, while females use the submerged vegetation on the shores of the lagoon as shelter and food supply, making them more vulnerable to capture (Dwivedi et al., 2016).

In the present work it was found three periods of sexual maturity (stages III and IV) in females indicating that the species reproduces almost all year round. Seasonal variation in the reproduction of tilapia of the genus *Oreochromis* has been widely documented. In tropical environments, these fish reproduce several times during the year, with peaks of reproductive activity associated with the dry and rainy seasons (Zimmermann, 2005). Roshni and Renjithkumar (2020), confirmed that *O. mossambicus* in Lake Vembanad India, presented two spawning peaks, with the highest occurrence of mature ovaries from May to August and from November to December. In *O. niloticus*, Dwivedi et al. (2016), mention two breeding periods, one from March to June, during the dry season and another from September to November during the rainy season. Similarly, Peña-Mendoza et al. (2005), recorded two breeding periods for the same species at the Emiliano Zapata dam Mexico, one in August and the other in February. During the rainy season, the circulation of water leads to an increase in nutrients, which results in an increase in the availability and quality of food for the young, so the species develops its gonads for reproduction, to ensure the survival of its progeny (Espínola et al., 2016). On the other hand, during the dry season, the increase in temperature or light intensity are the factors that activate the endocrine function of the brain, particularly in the hypothalamus, initiating the reproductive process (Russell et al., 2012). As is the case in Laguna de los Patos, where the development of gonads seems to be more associated with an increase in temperature typical of the dry season, than with the rainy season. Perea-Ganchou et al. (2017) found that in tilapia of the genus *Oreochromis*, the highest number of eggs and larvae are recorded during the first months of the year, when the level of accumulated precipitation was lower than in other months and times of the year. Similarly, Weyl and Hecht (1998) *in O. mossambicus* and *Tilapia rendalli*, in Lake Chicamba Mozambique, found that the reproductive activity of both cichlids was limited to the summer season, when the average water temperature exceeded 24 °C.

The results of gonadosomatic index (GSI), showed significant differences between females and males being higher in females than in males. The difference in the values obtained in the GSI between males and females is also reported by Peterson et al. (2004) in *O. niloticus* and by Mahomoud et al. (2011) in *Tilapia zillii.* In Lake Vembanad India, the monthly variation of the GSI in both males and females showed maximum values in the dry season, and minimum values in the rainy season, the latter being an indication of the species' spawning season in the region (Roshni and Renjithkumar, 2020). The GSI values confirm the reproductive seasonality found in females and males of *O. mossambicus* previously carried out through macroscopic observation of the gonads.

The monthly variations on the condition factor (CF) of *O. mossambicus* may be related to the reproductive activity of the fish. The highest values found in females during the rainy season, could be associated with an increase in primary productivity and food resources in the lagoon, improving the physical condition of the organisms, which also have more space due to the increase in the volume of water in the system (Shalloof, 2009). On the other hand, the lowest values were found in January, coinciding with the spawning period of the fish, which causes an energy expenditure of the organism to produce eggs and sperm, compromising its physical condition (Maddock and Burton, 1999). Fluctuations in the condition factor of many fish have been observed with respect to their reproductive cycle, feeding conditions, and other environmental and physiological factors (Wootton, 2011; Datta et al., 2013; De Giosa et al., 2014).

The results of the mean size of sexual maturity (Lm50) of *O. mossambicus* indicated the females matured at smaller size (18.0 cm) than the males (20.1 cm). This has been pointed out by other authors for the genus *Oreochromis* (Russell et al., 2012; Abera, 2013). Our Lm50 values are above those reported by Roshni and Renjithkumar (2020) for *O. mossambicus* in a lake in India, who reported values of 14.2 cm for females and 15.5 cm for males. However, these are below those reported by Russell et al. (2012) for the same species (24.4 cm in females and 27.8 cm in males) in some reservoirs in Australia. The fishing pressure probably exerted on the largest individuals in an area where the species is caught as part of the diet of the inhabitants of the region may be leading to directional selection, which produces a marked reduction in the size of the species' sexual maturation. In this sense, it is known that the selective removal of large adult fish results in exploited populations maturing at younger ages and smaller sizes, investing more energy in reproduction (Sharpe and Hendry, 2009; Audzijonyte et al., 2015) thus ensuring a greater chance of surviving and perpetuating itself as a species (Thuesen et al., 2011).

The result of average absolute fecundity of *O. mossambicus* was 921 ± 604 eggs per female and the relative fecundity 8.36 ± 3.09 eggs/g. These values were lower than those reported by Roshni and Renjithkumar (2020) in the same species, who reported an average of 1,469 eggs per female and 15.54 eggs/g in smaller females (11.2-23.8 cm L). Fecundity in the genus *Oreochromis* may vary between populations and between years, due to fishing pressure on each stock, competition for food, overexploitation and environmental abiotic factors (Duponchelle et al., 2000; Little and Hulata, 2000), but in general, it is considered low compared to other fish, due to parental care (as the number of eggs is limited by the size of the oral cavity) and the extended spawning season (Shubha and Reddy, 2018; Sakhare and Chalak, 2019). This could explain the low fecundity of *O. mossambicus* in Laguna de Los Patos, due to the sexual activity it exhibits during much of the year.

A high correlation was found between absolute fecundity with female size in *O. mossambicus*, which agrees with Peña-Mendoza et al. (2005), who suggest that the larger the fish, the greater the space in the abdominal cavity for the embryonic development of oocytes. However, there is evidence that total fecundity in tilapia is closely related more to maternal age than to size (Coward and Bromage, 2000). Further studies must be made to corroborate this.

Results of oocyte size showed a wide range of sizes from 1.0 to 2.8 mm with a higher frequency in the size 2.6 mm. Ganie et al. (2013) reported smaller egg sizes in mature females of *O. mossambicus* (1.0 to 1.4 mm), while other researchers have reported egg diameters of up to 3.7 mm in other tilapia species (Coward and Bromage, 2000; Gómez-Márquez et al., 2003). Oocyte size in tilapia is species-specific and has been related to the size of the breeding female, suggesting that larger females produce larger eggs (Duponchelle et al., 2000). The frequency distribution of oocyte diameters indicates that the ovary of mature females contains oocytes at different stages of maturity at the same time. This means that the same female can spawn several times in a short period of time, as the batch of oocytes matures, which is typical of a synchronous ovary by groups (Hutchison et al., 2012; Russell et al., 2012), allowing tilapia to shed a greater number of eggs and larvae than other fish. This reproductive characteristic shows that, despite the high anthropogenic intervention of the Laguna de los Patos system, with the consequent loss of species (Pérez et al., 2003), the tilapia *O. mossambicus* is adapted to withstand the conditions of Laguna de Los Patos, probably more so than many local species, which could explain its expansion and dominance in the ecosystem.

5. Conclusions

The reproductive characteristics of *O. mossambicus* in Laguna de Los Patos indicate that the species reproduces almost year-round, with two main spawning peaks related to the drought and rainy seasons in the region, which is considered an important factor for the successful establishment of tilapia in this place. This study represents the first report on reproductive aspects of the species introduced to the Laguna de los Patos more than seven decades ago and provides basic information on the state of the resource in this body of water.

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