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Scientific Article

Reproductive biology of the largehead hairtail *Trichiurus lepturus* (Teleostei: Trichiuridae): implications to the fisheries management on shallow coastal waters in northeastern Brazil

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ABSTRACT

The largehead hairtail *Trichiurus lepturus* is an important fishery resource and a source of income for artisanal fishers in northeastern Brazil. In the region, this species has recently attracted the attention of investors considering its export to Asian countries. The aim of this research was to obtain data regarding reproductive biology to manage populations, as certain fishing gears usually caught juveniles. Specimens were obtained monthly from August 2017 to July 2018 from fixed traps in the municipality of Bitupitá, Ceará state, Brazil. A total of 437 specimens were sampled, ranging from 30.2 to 98.5 cm, including 255 females and 182 males. The sex ratio was 1:1.4 (M:F), with females predominating in larger length classes. The reproductive period occurs between August and December, coinciding with the dry season in the region. The species exhibits asynchronous oocyte development and batch spawning, with an average fecundity of 51,209 oocytes per batch. The results of this study are fundamental for characterizing and understanding the reproductive biology of *T. lepturus*, given its commercial importance in the region and the potential for increased catches targeting export markets. It was also observed that 37% of the specimens captured were below L50. This study represents an initial step in filling the knowledge gap in northeastern Brazil with reproductive data, enabling the establishment of management priorities for this important species.

Keywords: Reproductive period; Size at first maturity; Fecundity; Fisheries; Fixed traps.

Biologia reprodutiva do *Trichiurus lepturus* (Teleostei: Trichiuridae): implicações para o manejo pesqueiro em águas costeiras rasas no nordeste do Brasil

RESUMO

O peixe-espada *Trichiurus lepturus* é um importante recurso pesqueiro e fonte de renda para pescadores artesanais no nordeste do Brasil. Na região essa espécie atraiu recentemente a atenção de investidores que avaliam a exportação para países asiáticos. O objetivo desta pesquisa foi obter dados da biologia reprodutiva para manejo populacional, já que determinados equipamentos de pesca geralmente capturam juvenis. Os espécimes foram obtidos mensalmente de agosto de 2017 a julho de 2018 em currais de pesca no município de Bitupitá, estado do Ceará, Brasil. Foram amostrados 437 exemplares variando entre 30,2 e 98,5 cm, sendo 255 fêmeas e 182 machos. A proporção sexual foi de 1:1,4 (M:F), com predomínio de fêmeas nas classes de maior comprimento. O período reprodutivo ocorre entre agosto e dezembro, correspondendo ao período seco na região. A espécie tem desenvolvimento assíncrono dos ovócitos e desova parcelada, com fecundidade média de 51.209 oócitos por lote. Os resultados deste estudo são fundamentais para caracterizar e compreender a biologia reprodutiva de *T. lepturus*, visto que este é importante comercialmente na região, com possibilidade de aumento das capturas e foco na exportação. Observou-se também que 37% dos exemplares capturados estavam abaixo do L50. Este estudo representa um começo para preencher a lacuna de conhecimento no nordeste do Brasil com dados reprodutivos, sendo possível determinar prioridades de manejo para essa importante espécie.

Palavras-chave: Período reprodutivo; Comprimento de primeira maturidade; Fecundidade; Pesca; Armadilhas fixas.

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INTRODUCTION

The largehead hairtail *Trichiurus lepturus* (Linnaeus, 1758) is an amphidromous and cosmopolitan species that is distributed worldwide throughout tropical and temperate waters, between 60°N and 45°S (Bittar et al., 2008; Magro, 2006; Martins & Haimovici, 2000). Its annual catch fishery production is around 1.1 million tons, being the 12 largest in the world production, corresponding to 2% (FAO, 2022). In Brazil, according to the latest data on fishing production, its catch was 2,673.2, 2,523.2, and 2,530.1 tons in 2009, 2010 and 2011, respectively. In Brazil, the fishery production of the species surpassed 2,500 tons in 2011 (MPA, 2011). The *T. lepturus* is in the least concern category on the International Union for Conservation of Nature (IUCN) Red List of threatened species (IUCN, 2015) and is not included in the red book of Brazilian fauna threatened with extinction (ICMBio, 2018).

Studies regarding the reproductive biology of *T. lepturus* have been carried out in China (Kwok & Ni, 1999), Japan (Munekiyo & Kuwahara, 1984a; Shiokawa, 1988), Taiwan (Jean & Lee, 1984), Philippines (Guillena, 2018), Indonesia (Kusnandi, 2016; Muchlis & Prihatiningsih, 2014; Nurulludin, 2014), India (Narasimham, 1994; Prabhu, 1955; Rajesh et al., 2015; Reuben et al., 1997) and Australia (Clain et al., 2023). In Brazil, some studies on reproductive biology of the *T. lepturus* have been carried out in south and southeast regions (Bellini, 1980; Del Puente & Chaves, 2009; Magro, 2005; Magro, 2006; Martins & Haimovici, 2000; Souza & Chaves, 2007) and few in the northeast (Nunes et al., 2020; Santos et al., 2024; Silva et al., 2021a).

In southern Brazil, the *T. lepturus* spawns intermittently during the late spring and summer on the continental shelf and probably throughout the year on the continental slope (Magro, 2006; Martins & Haimovici, 2000). Del Puente and Chaves (2009) analyzed the use of bottom gillnet, drift gillnet, and bottom trawl fishing on the northern coast of Santa Catarina (south of Brazil) and described the occurrence of actively females and males capable of reproduction, with high values of gonadosomatic index (GSI) for both sexes. These authors indicated that bottom gill net and drift gill net fishing is selective towards individuals during their reproductive period throughout the year, with peaks in spring and summer.

In northeastern Brazil, specifically in Maranhão state, the *T. lepturus* caught by fixed traps had relatively low fecundity, prolonged reproduction and early sexual maturity (Nunes et al., 2020). Magro (2006) confirmed that the genetic-population structure of the *T. lepturus* in north Brazil (Belém, Pará) differs from populations in the southern regions. This indicates an isolated population due the Amazon River plume, which is a strong barrier for several taxa (Tosetto et al., 2022).

The largehead hairtail is an important fishery resource in Bitupitá, Ceará, Brazil, being caught by arrowhead fixed traps. This species is a popular food and serves as a source of income for artisanal fishers and is sold at about R$ 4/kg (US$ 0.85/kg). The *T. lepturus* has recently attracted the attention of investors, and the processing and marketing of this fish have been discussed to be exported to Asian countries (Almeida, personal communication). Therefore, knowledge of the reproductive biology of the *T. lepturus* is necessary for future stock assessment, as well as for managing its capture, mainly the catch of juveniles by given fishing gears. Thus, the present study obtained quantitative and qualitative data on the reproductive biology of the *T. lepturus* as caught from artisanal arrowhead fixed trap fishing near the municipality of Bitupitá, Ceará, Brazil.

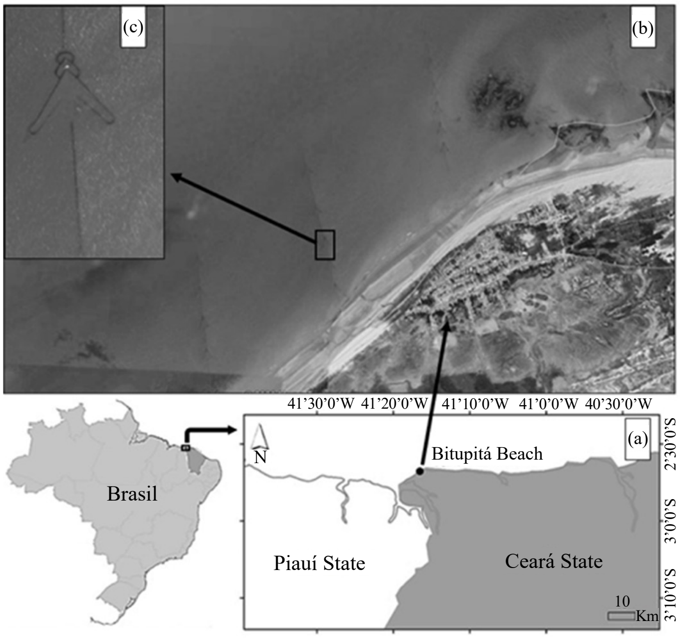
MATERIALS AND METHODS

Study site

The present study was carried out in the Bitupitá district of the municipality of Barroquinha, Ceará state, Brazil (Fig. 1a). The region features a rainy season from January to May with an average rainfall of 850 mm, and a dry season from June to December with an average rainfall of below 200 mm (Funceme, 2009). The sea water has a temperature range of 27 to 28.5°C and an average of 43 and 37 practical salinity unity in the dry and rainy season, respectively (Barletta et al., 2017; Silva et al., 2015). There are currently 33 arrowhead fixed traps in the region of the present study (Figs. 1b and 1c). They are arranged in rows perpendicular to the beach line, in which the last one can be up to 2 km from the beach. This fishing gear has low selectivity in relation to the size of the captured species. The fixed trap is built by hand with different compartments, allowing the fish to enter and not be able to leave. The removal of the captured animals occurs at low tide with the aid of a net. The traps vary between 400 to 700 m in length and 6 to 12 m in height, and each trap is managed by one fisher with a canoe (Silva et al., 2021b).

Sample collection and laboratory processing

Specimens were obtained monthly from August 2017 to July 2018 by the local fishers. The samples were stored on ice in a styrofoam container and transported to the Laboratory of Fisheries Bioecology at the Universidade Federal de Piauí for biometrics analyses. The following measurements were recorded: total length (cm), with the aid of an ichthyometer; the total weight; and the eviscerated weight (g), on an electronic scale



Source: Google Earth.

Figure 1. (a) Map of Bitupitá district, in Ceará state, northeastern Brazil. (b) Lines of traps distributed in a perpendicular manner throughout the coastal zone. (c) Image of an arrowhead fixed trap.

with accuracy of 2 g. Then, the liver and gonads were removed for weighing (g) with an analytical scale.

The gonads were assessed macroscopically to identify sex and the developmental phase and were classified as follows: immature, developing, spawning capable, actively spawning, regressing, and regenerating (Brown-Peterson et al., 2011). Histological slides were made to confirm the macroscopic evaluation, following methods described in Vazzoler (1996). The gonads were fixed in 10% formaldehyde and preserved in 70% alcohol. Subsequently, the gonads underwent series of dehydration in alcohol, diaphanization in xylol, immersion in paraffin, cut to 5 µm in thickness in a microtome and stained with hematoxylin and eosin.

The slides containing the section of the gonads were analyzed with the aid of a binocular microscope with magnifications of 40, 100 and 400x. The histological sections were classified following criteria for the phases of sexual maturity and stages of oocyte development as described in Brown-Peterson et al. (2011).

Data analysis

The number and amplitude of the length classes for males and females were established (Sturges, 1926). The sexual proportions were estimated by month and by length classes and tested using a χ^2 test. The length-weight relationship was estimated for sexes grouped and separated according to the potential equation (Eq. 1) (Le Cren, 1951):

$$W_t = a\ L_t^{\ b} \tag{1}$$

Where: W_t: total weight (g); L_t: total length (cm); a: intercept of the curve; b: allometry coefficient.

The species growth was considered isometric when the value of b = 3, and allometric when this value was lower or higher than 3 (b < 3 or b > 3) (Santos, 1978). The value of b was tested using the Student’s *t*-test. All statistical analyses were considered significant at the 5% level ($p < 0.05$).

The GSI was calculated using the Eq. 2 (Flores et al., 2015):

$$GSI = GW / FW * 100 \tag{2}$$

Where: GW: weight of the gonad (g); FW: weight of the gutted fish (g).

The hepatosomatic index (HSI) was estimated using the Eq. 3 (Pardoe et al., 2008):

$$HSI = LW / FW * 100 \tag{3}$$

Where: LW: liver weight (g); FW: weight of the gutted fish (g).

For the length at first maturity (L_{50}), the values of the relative frequency of adults in each length class were adjusted to a logistic curve according to the Eq. 4:

$$MF = 1/1{+}\exp - (A + B*TL) \tag{4}$$

Where: MF: fraction of mature fish specimens; TL: total length (cm).

This analysis was performed using the package SizeMat in R (Torrejon-Magallanes, 2020).

The fecundity was obtained using the gravimetric method proposed by Hunter and Macewicz (1985) and Murua and Saborido-Rey (2003). For this, a small portion of the actively spawning gonad was weighed on an analytical balance (0.001 g). Then, the oocytes in maturation were counted with the aid of a binocular stereomicroscope. Fecundity (F) was calculated using the Eq. 5:

$$F = N / PP * PG \tag{5}$$

Where: N: number of oocytes counted; PP: weight of the fish tissue portion (g); PG: weight of the gonad (g).

The actively spawning ovarian sections were analyzed and photographed in a 5-megapixel trinocular microscope coupled to obtain the diameter of the oocytes. The diameter of 100 oocytes of each developmental stage was counted and measured using the imaging software ZEN 2 Core.

Data were evaluated for normality (Shapiro-Wilk's test) and homoscedasticity (Levene's test). Then, Mann-Whitney's non-parametric tests were applied to assess sexual differences and differences in GSI, HIS, and fish total length between dry and rainy seasons. The average monthly rainfall was obtained from the website of the Cearense Foundation of Meteorology and Water Resources (FUNCEME) (Funceme, 2018), and the rainy and dry seasons were defined according to FUNCEME (2009).

The Kruskal-Wallis' test was used to evaluate differences between oocyte diameters and monthly variations in the GSI and HSI. After confirming the statistical difference, the Mann-Whitney's test was applied as *post-hoc*. The statistical software PAST (Hammer et al., 2001) was used, and the level of significance considered was $\alpha = 0.05$.

RESULTS

The total of 437 *T. lepturus* specimens was sampled from arrowhead fixed traps fishing. Among them, 255 were females and 182 males. A significant difference in the class 52.9–60.5 cm and in the classes above 68.2 cm were recorded when the sex ratio/length class was considered. Females were more frequent. The class 90.9–98.6 cm was composed only by females (Fig. 2).

The average sexual proportion was 1:1.4 (M:F). Considering months with significant differences, September was the only one with male predominance. Considering all specimens, the mean total length was 61.4 ± 18.2 cm and varied between 30.2 and 98.5 cm. The females ranged between 30.2 and 98.5 cm (64.7 ± 18.1), while males between 31.8 and 88.2 cm (56.9 ± 17.3). Weights ranged from 14 to 774 g (196.9 ± 145.3), with females varying from 14 to 774 g (224.2 ± 153.2) and males from 18 to 404 g (158.6 ± 124.1). Females were larger (Mann-Whitney's U test = 17,229; p = 4.4061E-06) and heavier than males (Mann-Whitney's U Test = 7,454; p = 9.9082E-06). The length-weight relationships were isometric: females ($Wt = 0.00054\ Lt^{3.05}$), males ($Wt = 0.000575\ Lt^{3.04}$) and for grouped sex ($Wt = 0.000575\ Lt^{3.04}$) (Table 1).

The average length of first sexual maturity (L_{50}) was 54.7 cm for females, 53.2 cm for males, and 53.5 cm for grouped sexes (Fig. 3). The average fecundity was 51,209, ranging from 10,832 oocytes for a specimen of 52.4 cm in length and 102 g

Table 1. Values of a, b, *p* and confidence intervals for the values of a and b in the length-weight relationship of the *Trichiurus lepturus* caught in fixed traps in northeastern Brazil.

Length-weight relationships	Both sexes	Males	Females
p-value	0.379	0.495	0.571
Value of a	0.00054	0.00058	0.000575
Value of b	3.054	3.035	3.039
Upper limit of a	0.120	0.102	0.134
Lower limit of a	-0.119	-0.101	-0.133
Upper limit of b	10.695	12.433	14.788
Lower limit of b	-4.587	-6.363	-8.711
Allometry coefficient	Isometry	Isometry	Isometry

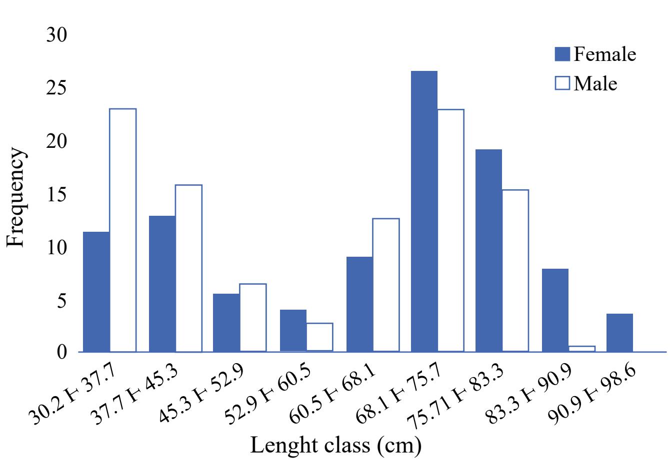


Figure 2. Histogram of length class frequency of the *Trichiurus lepturus* caught in fishing corrals in northeastern Brazil.

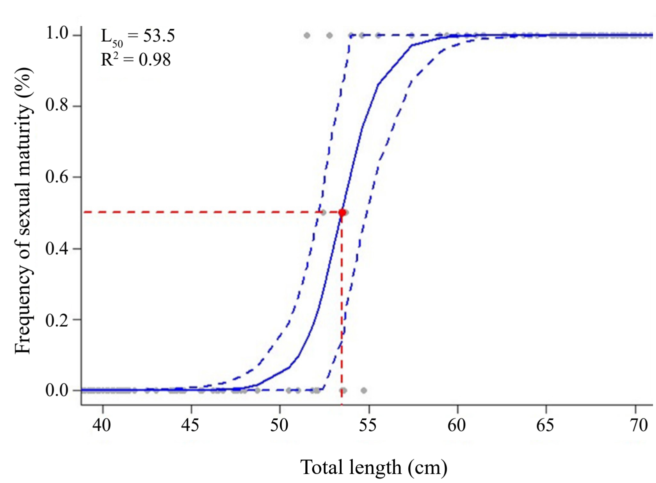


Figure 3. First size of sexual maturity (L_{50}) for grouped sexes of *Trichiurus lepturus* caught in fixed traps in northeastern Brazil.

in weight to 173,340 oocytes for a specimen of 92.6 cm in length and 528 g in weight. The average relative fecundity was 180.42 eggs/g fish weight.

The GSI showed a significant difference between months (Kruskal-Wallis, $p_{Females} < 0.01$; $p_{Males} < 0.01$). In January, there is an increase in rainfall, representing the beginning of the rainy season, and this period coincides with low GSI values for both sexes. This indicates the end of the reproductive period, as the highest GSI values are shown during the dry period (Fig. 4).

Regarding seasons, a significant difference was observed between the GSI of females (Mann-Whitney's U = 4,451.5; $p < 0.01$) and males (Mann-Whitney's U = 2,553.5; $p < 0.01$), in which the highest values were recorded in the dry season. Females and males had the highest GSI values from August to December and August to September, respectively.

For the average monthly HSI, a significant difference was shown between months (Kruskal-Wallis, $p_{Females} < 0.01$; $p_{Males} < 0.01$).

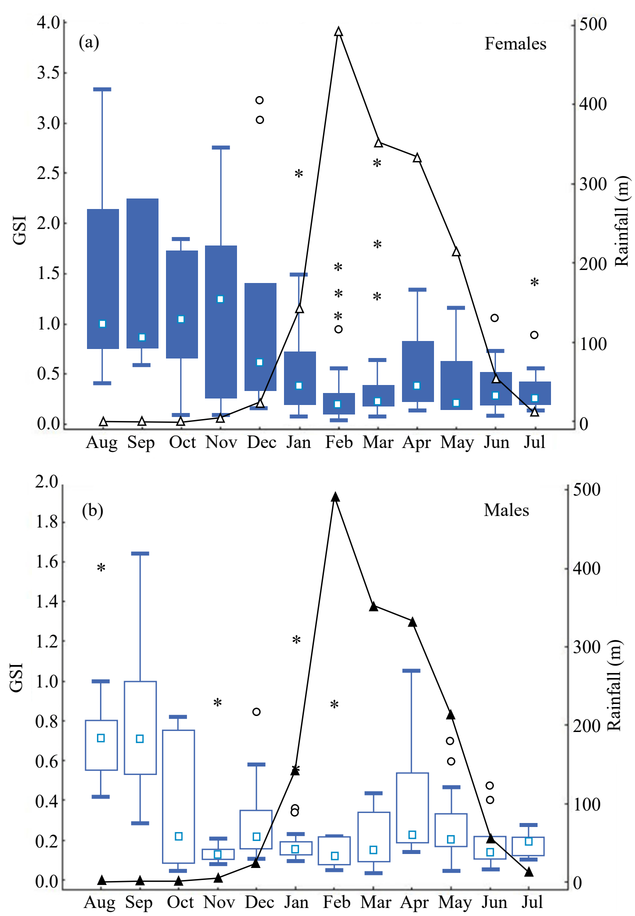


Figure 4. Boxplot of monthly variation of rainfall and gonadosomatic index (GSI) between (a) females and (b) males of the *Trichiurus lepturus* caught in fixed traps in northeastern Brazil.

It was observed that the months with higher HSI values for females (August to December) and for males (August and October) differed from the other months. The HSI values for both sexes were inversely proportional to rainfall, in which higher HIS were recorded when rainfall was low or 0. Regarding the seasons, only females showed a significant difference between the HSI and the seasons (Mann-Whitney, $U_{Females} = 4960$; $p_{Females} = < 0.01$; $U_{Males} = 3102$; $p_{Males} = 0.095$).

Regarding the gonadal development, females capable of spawning were observed, and regressed individuals appeared in almost all months of the year. Active spawning occurred between the months of August and December, corroborating the GSI values, but it extended until April with few remaining individuals (Figs. 5 and 6).

Actively reproductive males appeared only in the months of August and September (dry season), while those capable of spawning and regressed individuals were observed almost every month of the year, with an increase in the number of individuals during the rainy season and coinciding with that of females (Figs. 5 and 7).

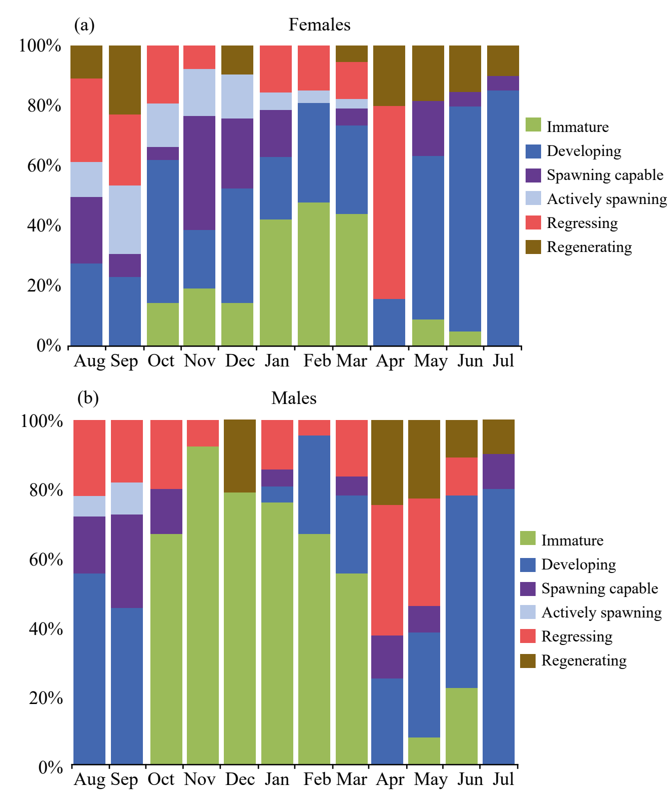
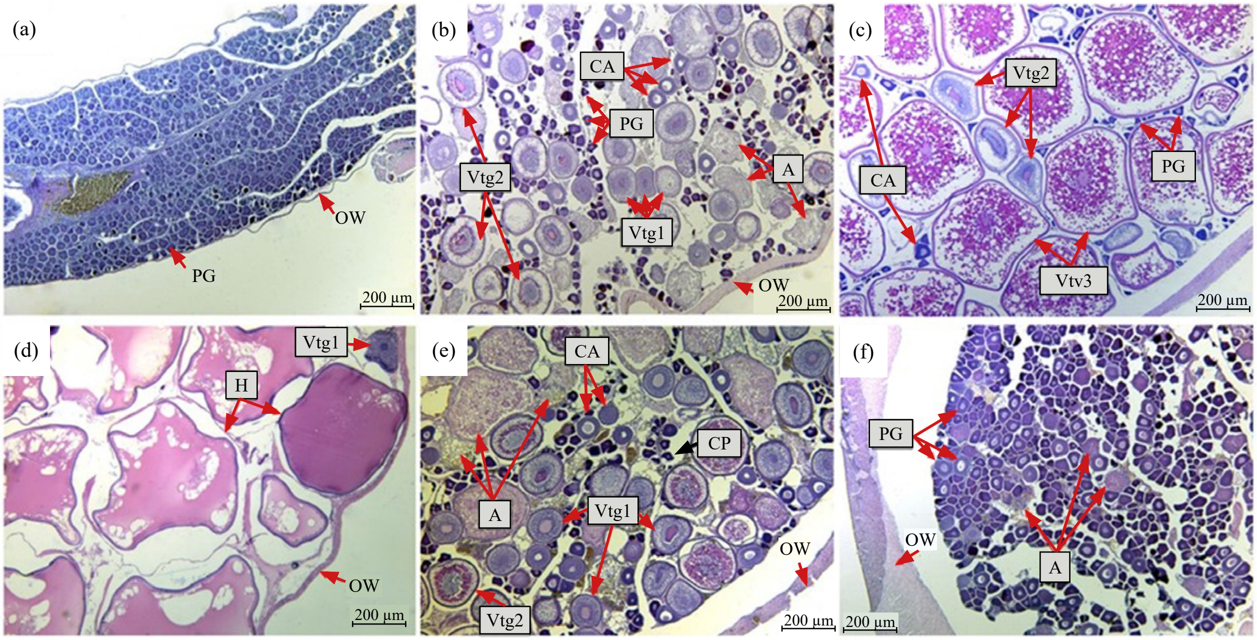
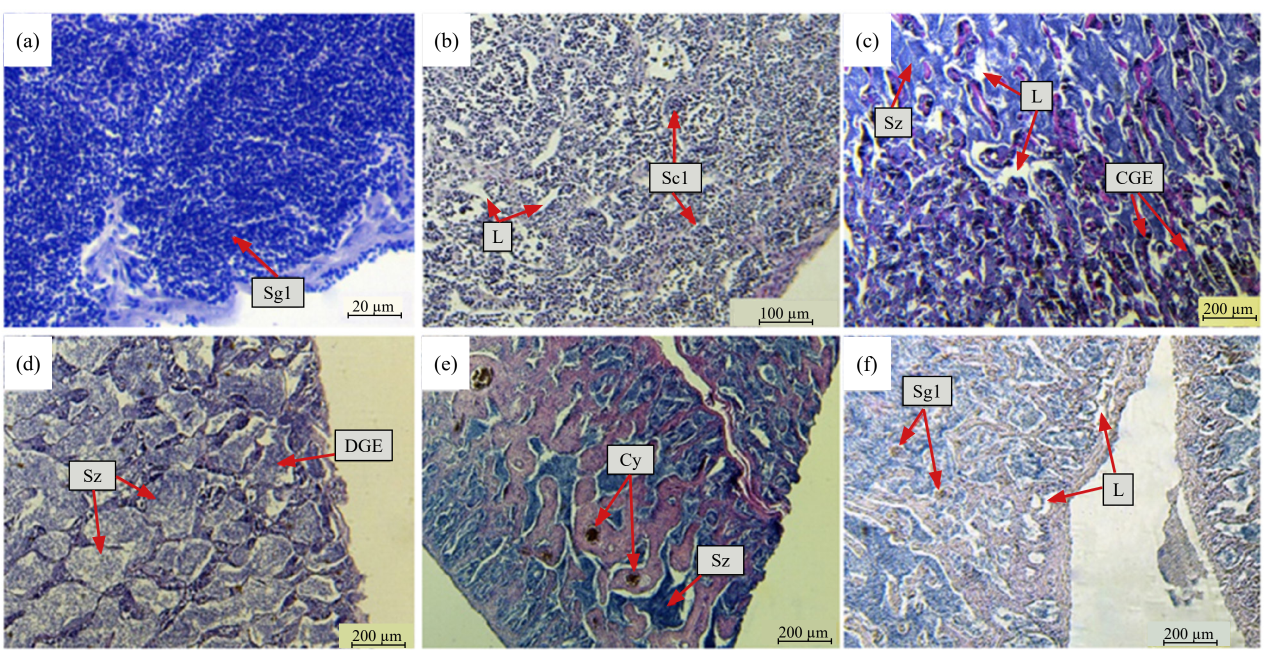


Figure 5. Monthly variation for maturity stages (immature, developing, spawning capable, actively spawning, regressing, and regenerating) for females and males of *Trichiurus lepturus* caught in fixed traps in northeastern Brazil.



PG: primary growth oocyte; OW: ovarian wall; CA: cortical alveolar oocyte; Vtg1: primary vitellogenic oocyte; Vtg2: secondary vitellogenic oocyte; Vtg3: tertiary vitellogenic oocyte; H: hydrated oocytes; A: atresia.

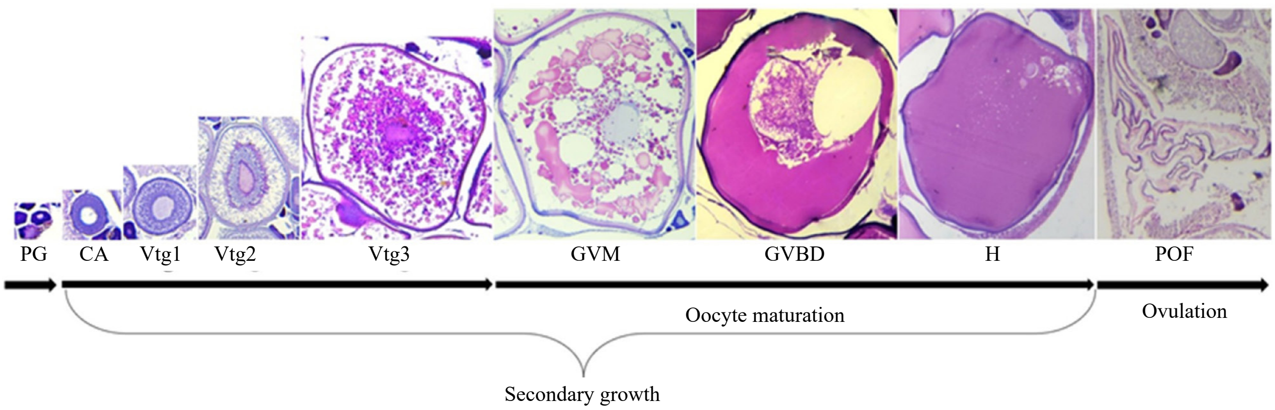
Figure 6. Photomicrographs of ovarian histology of a female *Trichiurus lepturus* showing the reproductive phases (a) immature (scale bar = 200 µm); (b) developing (scale bar = 200 µm); (c) spawning capable (scale bar = 200 µm); (d) actively spawning subphase (scale bar = 200 µm); (e) regressing (scale bar = 200 µm); (f) regenerating (scale bar = 100 µm).



Sg1: primary spermatogonia; L: lumen of lobule; Sc1: primary spermatocyte; CGE: continuous germinal epithelium; Sz: spermatozoa; DGE: discontinuous germinal epithelium; Cy: spermatocyst.

Figure 7. Photomicrographs of testicular histology of a male of *Trichiurus lepturus* showing the reproductive phases: (a) immature (scale bar = 20 µm); (b) developing: (scale bar = 100 µm); (c) spawning capable (scale bar = 200 µm); (d) actively spawning subphase (scale bar = 200 µm); (e) regressing (scale bar = 200 µm); (f) regenerating (scale bar = 200 µm).

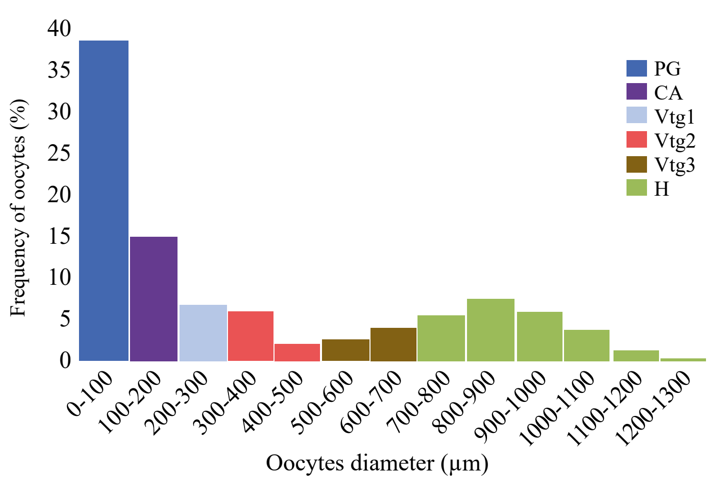
The oocyte diameter varied from 52.8 to 1,291 µm. Primary growth was considered by the presence of oogonia and oocytes in primary growth and ranged from 52.8 to 108.9 µm (85 ± 12). The secondary growth can be divided into the sub-stages of cortical alveolar and vitellogenesis. Cortical alveolar was 125.5 to 232.6 µm (167.1 ± 25), which is characterized by the presence of oil vesicles in the oocyte. Vitellogenesis was divided into primary vitellogenesis, at 214.4 to 369.8 µm (277 ± 35); secondary vitellogenesis, at 334.7 to 569.8 µm (445.2 ± 54.6); and tertiary vitellogenesis (Vtg3), at 477.3 to 886.4 µm (729.5 ± 97.6). Oocyte maturation can be divided into three nuclear events: germinal vesicle migration, breakdown of the germinal vesicle, and hydration 805 to 1,291.3 µm (1,028.8 ± 103.8). Ovulation is characterized by the appearance of post-ovulatory follicles, which will be reabsorbed later by the body (Fig. 8).



PG: primary growth; CA: cortical alveolar; Vtg1: primary vitellogenesis; Vtg2: secondary vitellogenesis; GVM: germinal vesicle migration; GVBD: breakdown of the germinal vesicle; H: hydration; POF: post-ovulatory follicles.

Figure 8. Progression of oocyte development for females of *Trichiurus lepturus* caught in fixed traps in northeastern Brazil.

The diameters for each stage showed statistical difference according to the Mann-Whitney's *a-posteriori* test. *T. lepturus* has an asynchronous oocyte development and spawned intermittently due to the simultaneous occurrence of oocytes in different vitellogenic stages. This difference is evident when observing the frequency distributions of cell diameters of females in the vitellogenic stage, indicating continuous recruitment of oocytes (Fig. 9).



PG: primary growth; CA: cortical alveolar; Vtg1: primary vitellogenesis; Vtg2: secondary vitellogenesis; H: hydration.

Figure 9. Frequency of oocytes diameter from actively spawning females of *Trichiurus lepturus* caught in fixed traps in northeastern Brazil.

DISCUSSION

The largehead hairtail is a cosmopolitan species, being abundant on the shelf and slope. It has a flexible reproductive strategy, as the reproductive period is prolonged with decreasing latitude (Martins & Haimovici, 1997, 2000). It was observed that the species has asynchronous oocyte development and intermittent spawning, a result similar to that obtained by several authors, such as in Brazil (Magro, 2006) and Indonesia (Kusnandi, 2016; Muchlis & Prihatiningsih, 2014). Associated with the reproductive flexibility mentioned, batch spawning increases the probability of offspring survival (Lambert & Ware, 1984).

However, fishing pressure and environmental variables (e.g., climate) affect its life cycle and consequently its population size. Climate is directly related to sexual maturity and reproductive cycle, as these characteristics are influenced by abiotic and biotic environmental conditions and food availability. Therefore, distinct growth rates are observed in studies conducted throughout their distribution (Santos et al., 2018; Vazzoler, 1996). Biomass is another parameter that varies between periods of the year and may be related to seasonal migrations dictated by environmental variations, as observed in Asia in 1991 and 2000 (Jung et al., 2017).

Throughout the distribution of *T. lepturus*, a variation in the period of reproduction and the length at first maturity (L50) is observed. Therefore, these parameters diverge when comparing different studies. Abiotic factors (e.g., temperature, salinity, and dissolved oxygen), season and depth influence L50. Latitude also influences L50, since the higher the latitude, the higher the value of L50. Martins and Haimovici (2000) state that *T. lepturus* reaches maturity at a smaller size in warmer and less productive waters. Therefore, it has longer spawning periods. In fact, this pattern was observed, since the L50 obtained was similar to studies conducted in warmer climate, such as Nunes et al. (2020) in northeast Brazil; Del Puente and Chaves (2009), Magro (2005), and Martins and Haimovici (2000) in southeast and southern Brazil; Narasimham (1994), Prabhu (1955), Rajesh et al. (2015), and Reuben et al. (1997) in India; and Kusnandi (2016) in Indonesia. It was different from the values obtained in regions of temperate climate. This pattern is typical of species from tropical and subtropical regions, characterized by a longer reproductive period when compared to those from temperate regions (Nikolsky, 1963).

A spatial segregation between the sexes was observed, and, as pointed out by Munekiyo and Kuwahara (1984a, 1984b), males are more frequent in deeper waters. This segregation occurs during the reproductive process, in which females concentrate in shallow waters because this region has more food (Magro, 2006). Thus, it is believed that females prefer coastal and shallow areas due to the increased food availability. Females were more abundant in this research, a result justified by the position of the traps in the coastal area.

The latitude also influences the reproductive period of the species. As previously mentioned, Martins and Haimovici (2000) state that *T. lepturus* has a flexible reproductive strategy, since spawning has irregular periodicity at low latitudes (Bellini, 1980; Sheridan et al., 1984; Tampi et al., 1968). At high latitudes, spawning occurs from late spring to summer (Munekiyo & Kuwahara, 1984a). In India and Indonesia, spawning is prolonged and occurs several times a year (Narasimham, 1994; Nurulludin, 2014). However, in this study area, *T. lepturus* spawns throughout the dry season (from June to December). A similar pattern was recorded by Nunes et al. (2020) in the municipality of Raposa, Maranhão, northeast Brazil, reinforcing the influence of the latitudinal gradient on reproduction.

Regarding fishing activity, *T. lepturus* can be both target and bycatch (Magro, 2005, 2006). Each type of fishery can interfere in the life cycle of the species, depending on the dynamics, fishing gear used and its selectivity, as well as the depth of the fishing action. It is worth noting that each fishing gear is constructed distinctly and reflects the possibility of capturing a particular target species, in addition to consider the environmental variables of the fishing area (Sienna et al., 2019). In fact, the fishing gear that caught the specimens in this research does not select the animals by size. The capture takes place at low tide, i.e., when there is a decrease in the water volume.

In Brazil, multiple fisheries affect populations of *T. lepturus*. The industrial fishing is more present in the southeast and southern regions, whereas the artisanal scale is more common in the northeast and northern regions. However, the lack of landings monitoring and consequently of fishing statistics hinders the feasibility of managing this fishery (Gonçalves Neto et al., 2021). It is known that frequent and large catches, when not managed, lead to population decline (Jeong et al., 2021).

However, how can we manage fisheries in Brazil if we do not know what is being extracted from our seas? This is of concern, considering that recently the catches of *T. lepturus* in the northeast of Brazil have attracted the attention of investors, and the expansion of its processing and marketing have been discussed to be exported to Asian countries. Several current studies cite that its stocks in Asia are declining (Jeong et al., 2021; Panhwar et al., 2018; Yang et al., 2022). Considering this, the Asian market aims to import the species from new countries and found in Brazil a product with an attractive value.

In the northeast, fishing for *T. lepturus* is basically done by arrowhead fixed traps, a passive fishing gear, traditional in the region and with low selectivity that retains juvenile and adults at low tide. The fish mistake these structures as areas of protection and shelter, but when they are retained, regardless of length, they get lost in the mazes and can no longer get out (Fonteles-Filho & Espínola, 2001). However, it is incumbent on the fisherman to use nets with larger mesh sizes at the time of harvest. In some regions of the northeast (e.g., Alagoas), there is a specific legislation for the mesh size used at harvest. According to the Federal Act nº 1, January 12, 2005, of the Ministry of Environment, mesh size cannot be smaller than 90 mm.

About 35% of specimens caught were below L50, suggesting pressure on the juvenile population. It is known that length at first maturity when achieved at an early age is effective in enhancing the population genetic representativity in the next generations, but individuals exhibit low fertility and exposure to a greater number of predators (Vazzoler, 1996). However, it is widely discussed that overfishing directly affects recruitment, once the specimens respond by growing less and maturing earlier (Fonteles-Filho, 2011; Ghosh et al., 2014; Kwok & Ni, 1999; Lowe-McConnell, 1999; Ordines et al., 2019; Sparre & Venema, 1998).

In warmer and less productive environments, the specie matures at a smaller size, being compensated by longer spawning periods. The opposite is observed in colder waters (Martins & Haimovici, 2000). Nevertheless, it can be suggested that this species is resilient, as it is succeeding in dealing with human pressures and climate changes. This study represents a start to fill the knowledge gap in northeastern Brazil with reproductive data. In this way, it will be possible to determine management priorities for this economically and ecologically important species, especially for traditional communities.

CONFLICT OF INTEREST

Nothing to declare.

DATA AVAILABILITY STATEMENT

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

AUTHORS' CONTRIBUTIONS

Conceptualization: Silva, C.E.L.S.; **Data curation:** Silva, C.E.L.S.; **Formal Analysis:** Silva, C.E.L.S.; **Methodology:** Silva, C.E.L.S.; **Writing – original draft:** Silva, C.E.L.S.; **Supervision:** Fernandes, C.A.F., Feitosa, C.V.; **Writing – review & editing:** Fernandes, C.A.F., Feitosa, C.V.; **Validation:** Fernandes, C.A.F.; **Project administration:** Feitosa, C.V.; **Final approval:** Silva, C.E.L.S.

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