BJAST
BRAZILIAN JOURNAL OF AQUATIC SCIENCE AND TECHNOLOGY
V 28
N 01
2024

POPULATION STRUCTURE OF *DIAPTERUS RHOMBEUS* (CUVIER, 1829) (PERCIFORMES, GERREIDAE) IN AN ESTUARINE ENVIRONMENT OF THE STATE OF ESPÍRITO SANTO (BRAZIL)

Andrade, F. F.[a], Sciarretta, T. R.[a], Chiquieri, J.[b], Cardoso, R. O.[c*], Cattani, A. P.[c], Spach, H. L.[c] & Hostim-Silva, M.[a,b]

[a]Laboratório de Ecologia de Peixes Marinhos (DCAB/CEUNES), Universidade Federal do Espírito Santo, São Mateus, Brazil.
[b]Laboratório de Pesca e Aquicultura (DCAB/CEUNES), Universidade Federal do Espírito Santo, São Mateus, Brazil.
[c]Laboratório de Ecologia de Peixes, Centro de Estudos do Mar, Universidade Federal do Paraná, Pontal do Paraná, Brazil.

*rafael.bioufrgs@gmail.com (Corresponding author).

Cite as: Andrade, F. F., Sciarretta, T. R., Chiquieri, J., Cardoso, R. O., Cattani, A. P., Spach, H. L. & Hostim-Silva, M. (2024). Title. Braz. J. Aquatic. Sci. Technol. 28(1):06-09. ISSN 1983-9057. DOI: 10.14210/bjast.v28n1.19756

Received: 20/07/23. **Revised:** 20/06/24. **Accepted:** 24/06/24. **Published:** 07/29/24.

Document type: Research article.

Funding: The authors received no specific funding for this work.

Competing interest: The authors declare no competing interest.

ABSTRACT

The Family Gerreidae is composed of demersal fish, widely distributed in coastal regions, and is considered one of the most representative families in tropical estuaries. Belonging to this family, *Diapterus rhombeus* is found along the Brazilian coast and is characterized by small individuals found on sandy bottoms, gravel, or muddy bottoms, up to about 70 meters deep. This study aimed to characterize the population structure of *Diapterus rhombeus* in the estuary of Barra Nova / São Mateus, northern region of the state of Espírito Santo, in order to provide data to support future research, management, and conservation of this species. Monthly samplings collected 414 individuals from August 2011 to July 2012, using a bottom trawl. The total length ranged from 4.7 to 19.3 cm. The overall sex ratio indicated a predominance of males, with 1.6 males for each female. The L_{50} for males and females was 14.4 cm and 14.6 cm, respectively. The present study pointed out the great ecological importance of Barra Nova for *D. rhombeus* concerning its life cycle, including from the time of recruitment of juveniles to the reproduction in the estuarine environment.

Keywords: *Diapterus rhombeus*. Estuary. Population Structure. Life Cycle.

1 Introduction

The Family Gerreidae is represented by fish known as *mojarras*. They are marine and commonly found in brackish waters (Gonzáles-Acosta, 2005, Soares et al., 2016), with a wide distribution in tropical and subtropical areas, inhabiting coastal areas on unconsolidated bottoms, such as sand, gravel, or mud (Garcia Junior et al., 2010; Costa, Albieri, Neves, Santos & Araujo, 2012).

Among the fish fauna, species of this family are important in estuarine-lagoon and limnetic systems of the tropical and subtropical regions of the world (Deckert & Greenfield, 1987; Dias et al., 2011; Pineda-Peralta et al., 2016), and represent an important resource in artisanal fishing for human consumption (Silva et al., 2011; Costa et al., 2012; Chi-Espínola et al., 2018). There are known 44 species distributed in eight genus including *Diapterus*, composed of four species that inhabit the coast of the American continent: *D. auratus*, *D. rhombeus*, distributed in the Atlantic Ocean, and D. brevirostris and *D. aureoles* in the Pacific Ocean (Vergara-Solana et al., 2013).

Research on the reproductive biology, population structure, and dietary habits of *D. rhombeus* was carried out in the Gulf of Mexico (Aguirre-León & Díaz-Ruiz, 2006; Pineda-Peralta et al., 2016; Chi-Espínola et al., 2018). In Brazil, studies were conducted on breeding (Bezerra, et al., 2001; Souza & Chaves, 2007; Reis-Filho & Leduc, 2018), feeding (Pessanha & Araújo 2012; Ramos, Barletta, Dantas, Lima & Costa, 2014; Araújo, Dantas & Pessanha, 2016), population structure (Dias et al., 2011; Costa et al., 2012; Elliff et al., 2013) and otoliths (Rossi-Wongtschowski, 2016) of *D. rhombeus*.

This study aimed to characterize for the first time the population structure of *Diapterus rhombeus*, in the estuary of Barra Nova/São Mateus, northern region of the state of Espírito Santo (Brazil), to support future research, management, and conservation efforts for this species.

2 Material and Methods

2.1 Study area

The study was conducted in the estuarine region of the Mariricu River, a tributary of the São Mateus River, in the District of Barra Nova, northern region of the state of Espírito Santo (18º57'05" S and 39º44'47" W) (Figure 1).

Along the estuary of Barra Nova, mangrove forests are well developed, with *Avicennia schaueriana*, *Avicennia germinans*, *Laguncularia racemosa* and *Rhizophora* mangle trees that ranged from 10 to 19 meters in height (Petrobras, 2007). Besides the mangroves, the region of Barra Nova shows sandbanks and rocky shores, with a great biological diversity (Brasil, 2002). The region has a humid tropical climate, typical of intertropical regions, with two well-defined seasons, a warm period

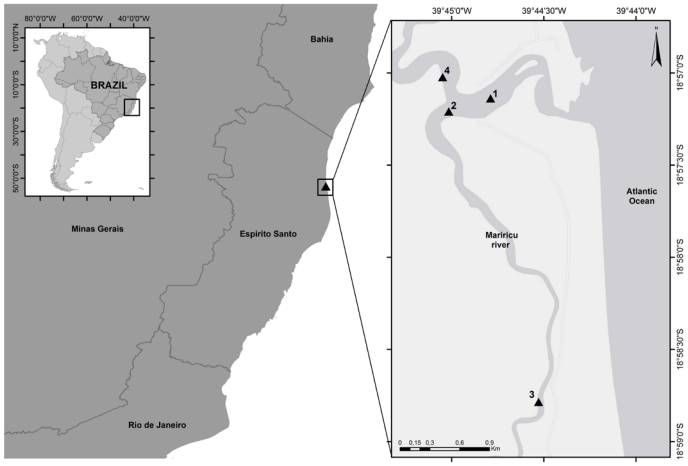

Figure 1. Location of the 4 sampling sites in the District of Barra Nova, in the estuarine region of the Mariricu River, in the northern region of the state of Espírito Santo.

between November and April, and a period with milder weather between May and October. The average annual temperature is 24.1 °C. The average annual rainfall is 1,313 mm. Rainfall occurs most intensely in the warm period, from 1,000 to 1,100 mm, approximately 75% of the annual total (Incaper, 2011). This area has great tourism potential, an important source of employment and income for the local population (São Mateus, 2003). The implementation of a conservation unit in Barra Nova is under discussion, where there once was an ecological station created through the Organic Law of the Municipality of São Mateus, where the North Capixaba Terminal, managed by Petrobrás Transporte S.A., was installed. According to the Planning of the district of Barra Nova (São Mateus, 2003), one of the main agents of degradation of the region's ecosystems is related to land use and occupation, because there are lands with varied dimensions located near the Mariricu River bank.

2.2 Data collection

In each of the four sampling sites (Figure 1), in the spread tide period, three 5-min monthly trawls at an average speed of 2.9 km/h, using a bottom trawl net with doors (2.80 m mouth opening by 3.90 m in length and distance between opposites knots of 3.9 cm in the body and 2.2 cm in the bag of the net) were carried out. After sampling, all the material was placed in properly labeled plastic bags, and stored in a polystyrene box with ice, transported to the laboratory where the fish were identified, measured using an ichthyometer accurate to 1.0 mm, determining the total length (from the tip of the snout to the posterior part of the caudal fin) and standard length (from the tip of the snout to the end of the vertebral column) and weighed on a digital scale (0.01 g).

Before each trawl, water temperature and salinity were measured with a mercury thermometer and refractometer, respectively. The information on the monthly averages of rainfall during the study period was taken from the database of the Capixaba Institute for Research, Technical Assistance and Rural Extension (INCAPER).

2.3 Data analysis

In the analysis of abundance and frequency of occurrence, the specimens with a length range from 4.7 cm to 19.7 cm were grouped into 10 length classes according to Sturges' Rule (Vieira, 1980). The structure was also analyzed for the abundance of individuals and frequency distribution of males and females in total length classes (cm) for the whole period. The influence of environmental variables on abundance was assessed using Spearman's correlation coefficient (Zar, 1998).

Significant differences in the monthly sex ratios over the whole sampling period were tested using the chi-square test, with a degree of freedom equal to 1 and a significance level of 0.05 (Zar, 1996). The relationship between weight and total length for each sex was established by Equation 01 (Ricker, 1975).

$$TW = a.TL^{b} \quad \text{[Equation 01]}$$

Where TW means the total weight in g; a is the linear coefficient; TL means the total length in cm; and b is the slope (both coefficients determined using the least-squares method).

For analysis of the reproductive period, all the specimens caught during the twelve sampling months were used. After the biometric procedures, fish were dissected through an abdominal incision of the genital pore towards the head for gonadal exposure. The macroscopic identification of the sex and stage of gonadal development was performed through observation of the turgidity, size, shape, area occupied in the coelomic cavity, color, vascularization, and visualization of ova, following the scale of Vazzoler (1996), being classified into four categories: immature (A), maturing (B), mature (C), depleted (D) or in recovery.

The size at which 50% of the female and male populations reached the first sexual maturity (L_{50}) (Ihaka & Gentleman, 1996), was estimated using the software R 2.13.0 (R Core Team, 2024) according to the sigmoidal model (Equation 02), adapted from Fonteles-Filho (1989) and Vazzoler (1996), considering the mature and depleted stages.

$$y = \frac{1}{1 + e^{-r(x - L_{50})}} \quad \text{[Equation 02]}$$

For practical characterization of the gonadal maturation stages, macroscopically it was defined: stage A (immature), the ovaries and testicles are small, filiform, located close to the dorsal wall, occupying 1/3 of the coelomic cavity; stage B (maturing), the ovaries occupy about 1/3 to 2/3 of the coelomic cavity, with intense vascularization; and the testicles are developed, lobulated, and their membrane ruptures under pressure, eliminating viscous sperm; stage C (mature), ovaries occupying almost the entire the coelomic cavity, turgid and with rosy-orange coloration; the testicles are turgid, whitish, occupying a large part of the coelomic cavity; stage D (depleted or in recovery), the ovaries are at different degrees of flaccidity, hemorrhagic aspect, occupying less than 1/3 of the abdominal cavity; the testicles are flaccid with hemorrhagic appearance (Figure 2).

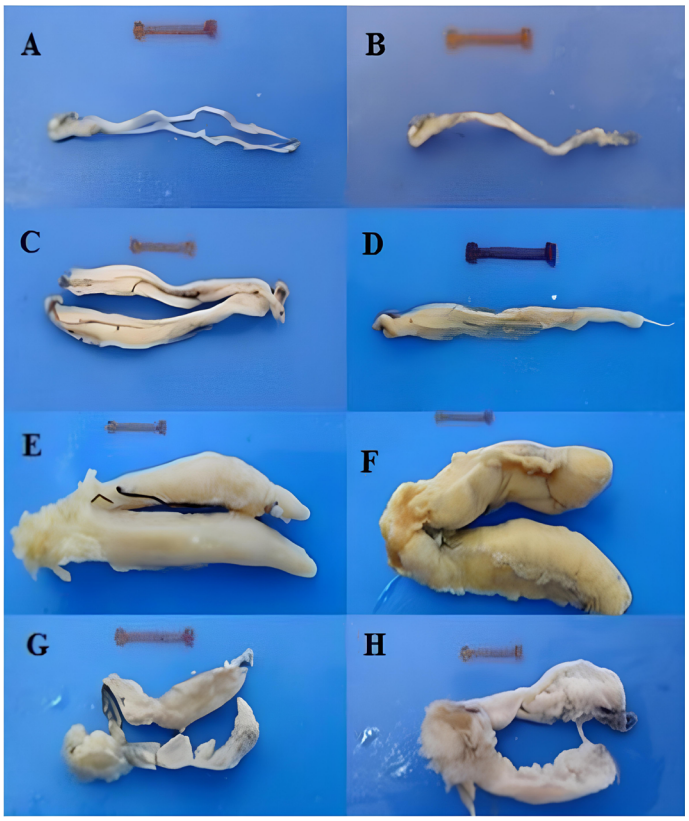

Figure 2. Macroscopic analysis of different maturity stages of gonads without the characteristic stain due to the effect of formaldehyde: immature male (A) and female (B), maturing male (C) and female (D), mature male (E) and female (F), and depleted male (G) and female (H), respectively. Scale of 1 cm.

3 Results

3.1 Abiotic parameters

The water temperature ranged from 22.8 °C in June 2012 to 34.5 °C in January 2012, while the mean value for the entire study period was 25.3 °C. The lowest temperatures occurred in May, June, and July, while the highest temperatures were recorded between January and March (Figure 3A). The Spearman test (Zar, 1998) indicated no significant correlation between the abundance of individuals and water temperature (n = 144, rs = 0.0293; p = 0.7268).

Water salinity varied between 2‰ in January to 42‰ in August. From November onwards, there was a decline in salinity, with very low values in December and January, while the other months of the year presented values predominantly higher than 24 (Figure 3B). However, the Spearman correlation test (Zar, 1998) showed that salinity (n = 144, rs = 0.0875, p = 0.2967) had no significant influence on catch frequency.

Figure 3C illustrates the monthly rainfall variation between 2011 and 2012. Rainier months were October, November, December, and January with rainfall values between 130 and 225 mm monthly, and the months with the lowest rainfall were August, September, and June, ranging from 20 to 30 mm monthly.

3.2 Population structure

From August 2011 to July 2012, 414 specimens of *Diapterus rhombeus* were

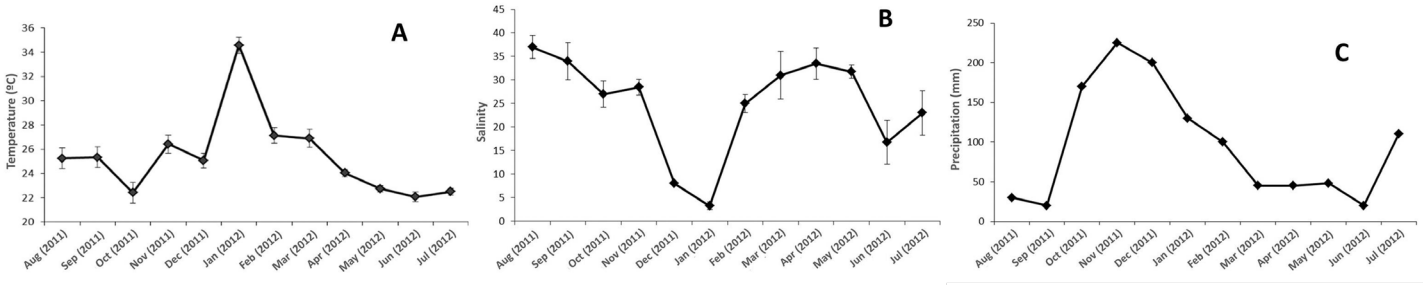

Figure 3. Variation in water temperature (°C), salinity (‰) and standard deviation, and monthly rainfall (mm), in the estuary of Barra Nova, state of Espírito Santo, from August 2011 to July 2012.

collected in the estuary of Barra Nova. The highest catches were observed between August and February (321 specimens), while the lowest catches occurred from March to July (93 specimens) (Figure 4A). The analysis of the frequency distribution of total length classes for the whole study period (Figure 4B) showed a common pattern found for the size of the individuals in this population, with a higher concentration of individuals in the median classes.

Figure 4C shows the frequency distribution of *Diapterus rhombeus* males and females, by total length class, considering the whole period sampled. Males and females showed lengths ranging from 4.9 to 19.3 cm and 7.0 to 18.6 cm, respectively.

In August, September, and October, the first four length classes (4.7 to 10.7 cm) presented the highest number of individuals (Figures 5A, 5B, and 5C). From November onwards (Figure 5D), there was an increase in the number of individuals in longer-length classes (> 10.7 cm).

In January, February, and March (Figures 5F, 5G, and 5H), there was an increase in the frequency of individuals of longer length classes, with no occurrence of specimens smaller than 10.7 cm. The pattern of distribution of the number of individuals per length class from April to July (Figures 5I, 5J, and 5L) remained the same. The recruitment of individuals with lengths between 4.7 cm and 9.2 cm occurred again in the samplings. Size classes between 9.2 and 13.7 were not well represented in this period, gradually increasing the frequency of longer-length classes.

3.3 Sex ratio

The results of the sex ratio for the study period showed a predominance of males (M), with 213 individuals (61.21%), compared to females (F), which totaled 135 individuals (38.79%), indicating a total ratio of 1.6 M: 1 F. The chi-square test, considering degree of freedom of 1 (df 2-1) and significance level of 5%, resulted in χ^2 = 5.02, higher than the expected value of χ^2 = 3.84, proving that the difference is statistically significant (Table 1). Only in August and November of 2011 and February and May of 2012, there was no significant difference in the sex ratio, maintaining the expected proportion (1:1) for fish in natural environments.

3.4 Spatio-temporal variation

The analysis of the catch by sampling area revealed a greater abundance in the area close to the river mouth (site 1), where 194 individuals (46.86%) were caught, and in the area located in the south arm of the Mariricu River (site 2), with 108 individuals (26.09%). In the innermost part of the estuary (site 3), 89 individuals were caught (21.50%), while in site 4, located in the north arm of the river, 23 individuals (5.56%) were collected.

Figure 6 illustrates the distribution of individuals in total length (TL) classes for each site; *D. rhombeus* specimens were caught in all sampling sites, and a high number of individuals in site 1. There was no pattern in the spatial-temporal distribution of length classes.

The distribution of monthly abundance during the study months shows that, from November, the captured individuals presented the highest values of total length (cm) and total biomass (g) (Table 2).

3.5 Length-weight relationship

From the scatter plot of total weight (TW) versus total length (TL) of males and females (Figure 7), the total weight-length relationship for the study period was $0.0102.TL^{3.1492}$ (R^2 = 0.9514) for males, and $0.0076.TL^{3.2641}$ (R^2 = 0.9681) for females. The value of the allometry coefficient (b = 3.2641) indicates positive allometric growth, having as a reference value for isometry b = 3.

Table 1. Sex ratio of *Diapterus rhombeus* collected in the estuary of Barra Nova (Espírito Santo) between August 2011 and July 2012. % = relative frequency. χ^2 = Chi-square test for the ratio 1: 1, (d.f. = 1). * Significant at the level of 5%

Months	Number of individuals			%		Proportion M:F	χ^2
	Male	Female	Total	Male	Female		
August (2011)	11	13	24	45.83	54.17	0.84:1	0.69
September (2011)	41	19	60	68.33	31.67	2.15:1	13.44*
October (2011)	13	7	20	65.00	35.00	1.86:1	9.00*
November (2011)	31	27	58	53.45	46.55	1.15:1	0.48
December (2011)	27	11	38	71.05	28.95	2.46:1	17.73*
January (2012)	36	10	46	78.26	21.74	3.60:1	31.95*
February(2012)	13	19	32	40.63	59.38	0.69:1	3.52
March (2012)	10	6	16	62.50	37.50	1.67:1	6.25*
April (2012)	12	3	15	80.00	20.00	4:1	36.00*
May (2012)	7	9	16	43.75	56.25	0.78:1	1.56
June (2012)	10	4	14	71.43	28.57	2.5:1	18.37*
July (2012)	2	7	9	22.22	77.78	0.29:1	30.86*
Total	213	135	348	38.79	61.21	1.57:1	5.02

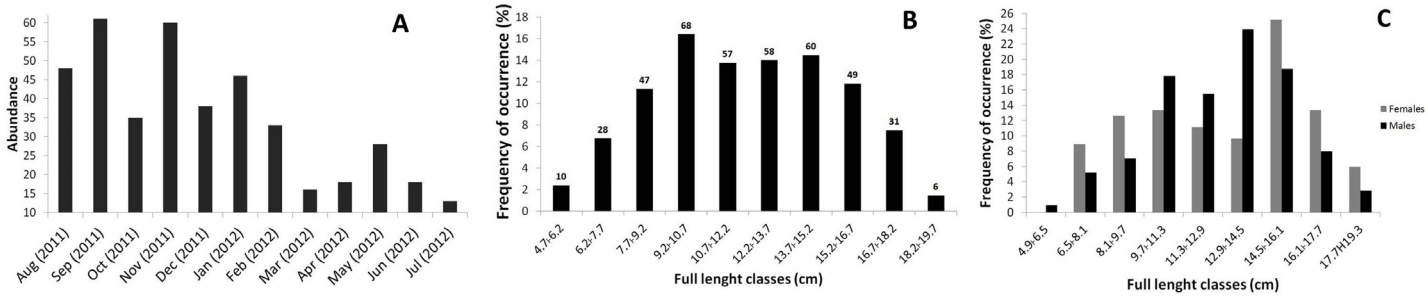

Figure 4. A - Monthly abundance of Diapterus rhombeus from August 2011 to July 2012. B - Distribution of frequency of occurrence (%) of total length classes (cm) from August 2011 to July 2012. Values above the bars represent the number of individuals per class. C - Distribution of frequency of occurrence (%) of males and females by total length classes (TL), from August 2011 to July 2012.

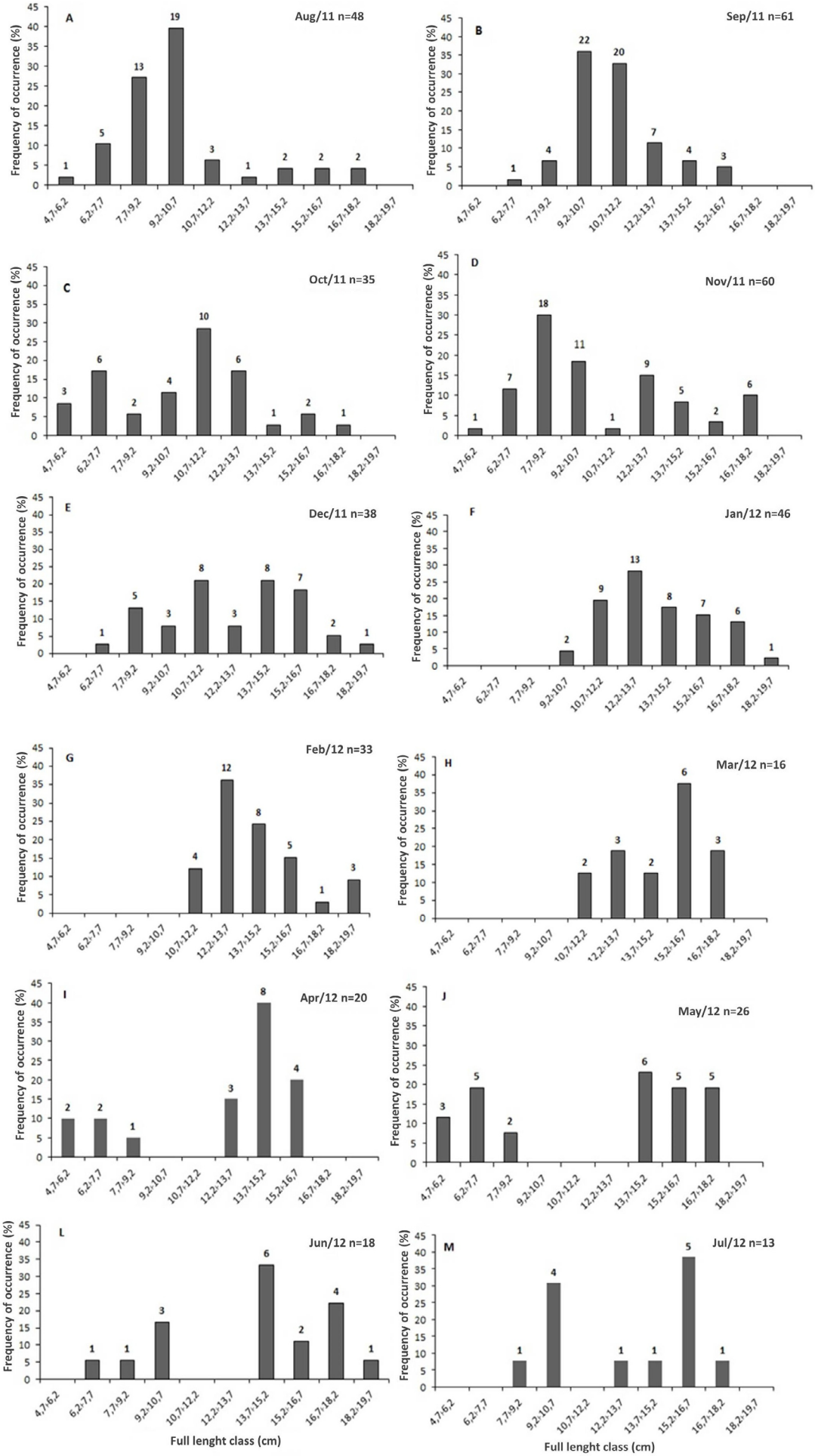

Figure 5. Monthly distribution of frequency of occurrence (%) of total length class intervals. Values above the bars represent the number of individuals per class.

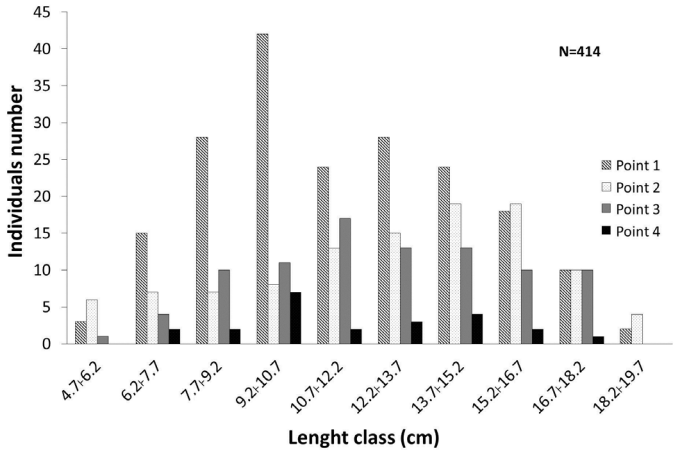

Figure 6. Variation in the number of individuals (N) of *Diapterus rhombeus* per total length class (TL) collected in the estuary of Barra Nova, state of Espírito Santo, from August 2011 to July 2012.

Table 2. Monthly distribution of abundance (N), length (TL cm), confidence interval (CI), total weight (g), and total biomass (g) of *Diapterus rhombeus* collected in the estuary of Barra Nova, state of Espírito Santo, from August 2011 to July

Months	N	TL			CI	TW			CI	Biomass (g)
		Max.	Min.	Mean		Max.	Min.	Mean		
August (2011)	48	17.0	4.7	9.9	0.74	88.6	1.2	17.1	5.27	820.0
September (2011)	61	15.7	7.2	11.2	0.46	5.8	63.6	22.0	3.24	1343.6
October (2011)	35	16.7	4.9	10.5	1.05	81.8	2.4	24.5	6.84	856.5
November (2011)	60	17.7	6.1	10.8	0.86	98.1	4.5	25.6	6.67	1535.4
December (2011)	38	19.3	7.5	12.9	0.96	125.6	6.0	38.2	9.03	1451.6
January (2012)	46	18.5	10.0	13.9	0.64	106.0	12.3	44.1	7.45	2026.4
February(2012)	33	18.6	10.7	14.3	1.07	111.4	18.4	48.4	8.59	1596.2
March (2012)	16	17.6	11.4	14.9	0.95	86.5	22.5	54.4	9.45	869.7
April (2012)	20	16.2	5.8	12.7	1.59	75.2	2.3	40.7	10.83	814.7
May (2012)	26	17.9	4.7	12.4	1.77	92.4	1.2	41.3	12.28	1073.2
June (2012)	18	18.6	7.0	14.0	1.64	120.9	4.0	52.5	15.76	944.1
July (2012)	13	16.7	8.5	13.2	1.68	83.5	7.0	42.6	14.93	553.7

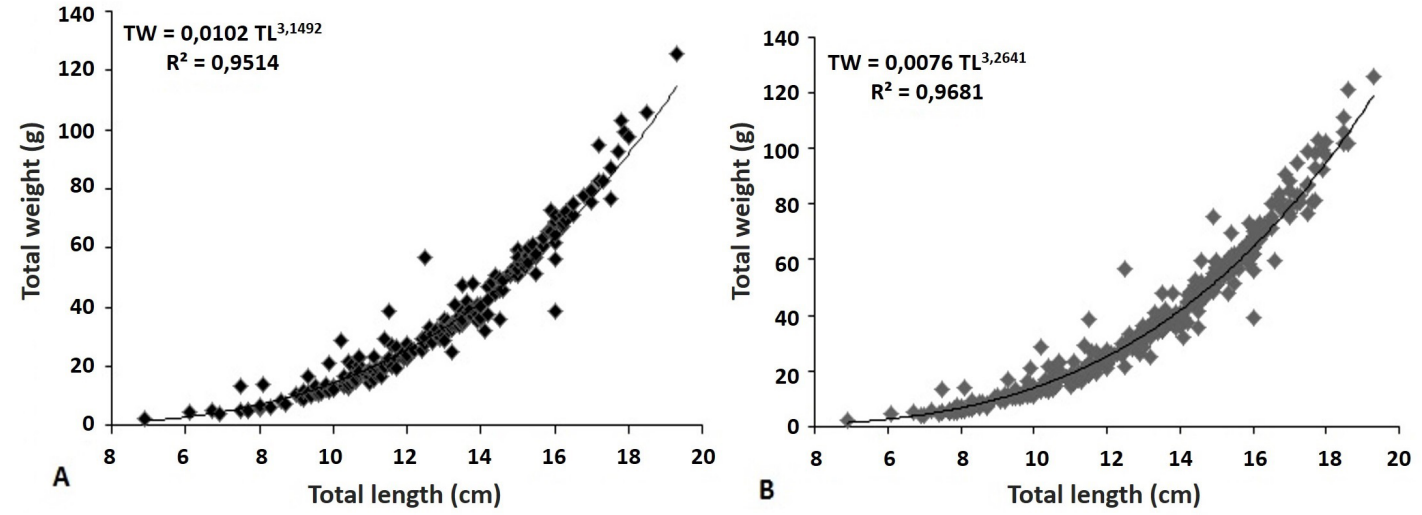

Figure 7. Relationship between total weight (TW) and total length (TL) for males (A) (N=123) and females (B) (N=135) of *Diapterus rhombeus* caught in the estuary of Barra Nova, state of Espírito Santo, from August 2011 to July 2012.

3.6 Size at first maturity

The estimated mean length at first maturity (L_{50}) for males was 14.4 cm (Figure 8A), and for females, 14.6 cm (Figure 8B). The expressions of the curves were represented by Equation 3 (males) and Equation 4 (females).

$$y = \frac{1}{1 + e^{-0.6418(x-14.4)}} \quad \text{[Equation 03]}$$

$$y = \frac{1}{1 + e^{-0.9618(x-14.66)}} \quad \text{[Equation 04]}$$

3.7 Reproductive period

After macroscopic analysis of the gonads, we identified 213 males, 135 females, and 66 individuals were considered as indeterminate sex, once it was not possible to distinguish the sex.

Although all stages were present in most sampled months, the highest occurrence of immature individuals (A) was observed in August, October, and November. The specimens with maturing gonads (B) were more abundant in September, February, and June; while mature individuals (C) were frequent throughout the year, peaking in June. Specimens with depleted gonads (D) occurred in greater numbers in April, May, and June.

The analysis of the monthly distribution of the frequency of maturity stages for males indicated a higher occurrence of specimens with immature gonads (A) between August and December. Individuals with gonads at maturity stage (B) were observed throughout the period, but more frequently in September, January, and February. Males with mature gonads (C) presented higher frequency from November to January (Figure 9). Females with mature gonads (34.81%) were found in most of the studied months, absent only in September, April, and June. Depleted individuals (D) occurred from March through June (Figure 9).

4 Discussion

The data analyzed in this study, evaluated by the nonparametric Spearman correlation test, indicated that water temperature and salinity have no significant influence on the abundance of catches. Therefore, the abundance of *Diapterus rhombeus* in the estuary of Barra Nova during the study period was not related to these analyzed abiotic parameters. Chaves & Otto (1998) reported similar results in the Guaratuba Bay (state of Paraná) where they did not detect a correlation between temperature and abundance, registering high and low frequencies of *D. rhombeus* catches throughout the year.

The abundance of individuals may be more related to rainfall, which reached the highest values between October and February when the highest catches were recorded. In March, rainfall decreased, with the number of catches also decreasing, except for August and September, which, despite the low rainfall, had a high abundance of individuals. In studies carried out in Mexico, Aguirre-León & Díaz-Ruiz (2006) related the abundance of *D. rhombeus* specimens to rainfall, where the frequency of catches was higher in the rainy season. This is probably because rainfall contributes considerably to the transportation of substances from the mainland to the coastal zone, primary productivity, and availability of allochthonous nutrients (Pereira & Soares-Gomes, 2002).

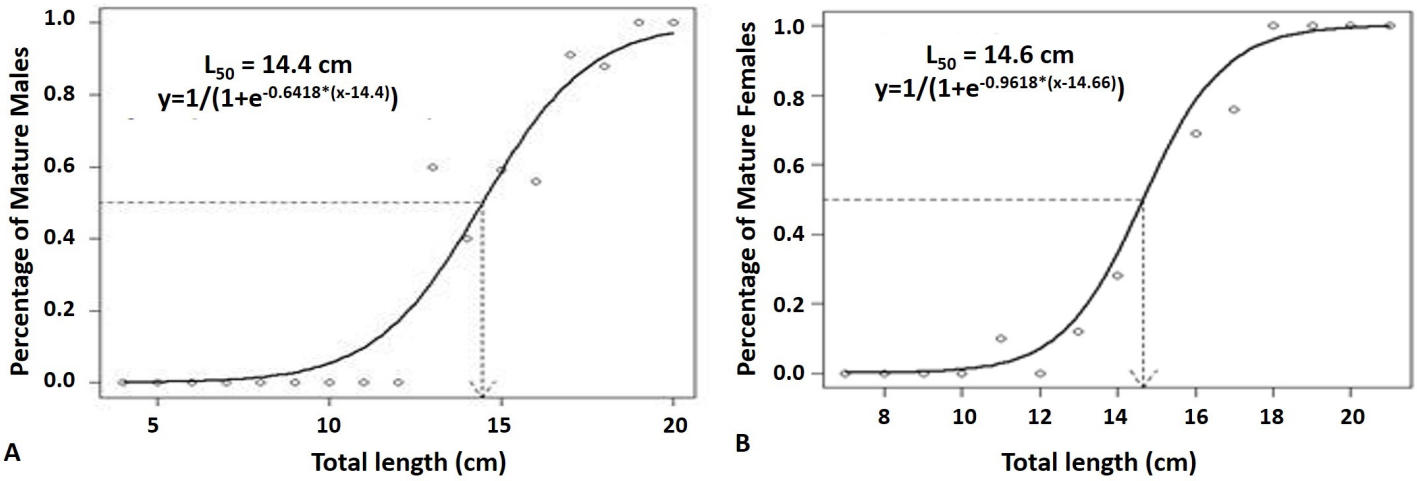

Figure 8. Curve of size at first gonadal maturity for males (A) and females (B) of *Diapterus rhombeus*, in the estuary of Barra Nova, state of Espírito Santo, from August 2011 to July 2012.

The frequency of occurrence of total length classes showed that 64.74% of the individuals are between the 4.7 and 13.7 cm classes, smaller than the size at first maturity determined for both sexes in this study (approximately 14.5 cm). Therefore, the population of *Diapterus rhombeus* in the estuary of Barra Nova was mainly represented by juveniles, which reinforces the importance of the estuary of Barra Nova, as a suitable environment for fish recruitment. Similar results were also reported by Ayala-Pérez et al. (2001) and Aguirre-Léon & Díaz-Ruiz (2006) in Mexico, as well as by Elliff et al. (2013) in studies conducted in the estuary of Santos, in which 74.3% of the *D. rhombeus* population was composed of individuals smaller than 15 cm.

The size structure in the estuary of Barra Nova (TL, from 4.7 cm to 19.3 cm) was similar to those reported by Chaves & Otto (1998), with a size range between 5.8 cm and 20.5 cm for the Guaratuba Bay (Paraná); Costa et al. (2012), found specimens varying from 5.0 cm to 23.0 cm in the Sepetiba Bay (Rio de Janeiro); Elliff et al. (2013) recorded total length ranging from 4.6 cm to 25.0 cm for the estuary of Santos (São Paulo); Bezerra et al. (2001) reported individuals varying between 10.2 cm and 35.4 cm, on beaches of Pernambuco. This fact induces us to believe that individuals with smaller sizes are found in semi-enclosed areas, such as bays and estuaries, and adult individuals are distributed in adjacent coastal zones (Ayala-Perez et al., 2001; Costa et al., 2012).

The results obtained through the monthly distribution of individuals by length class showed a higher frequency of individuals in the smaller size classes, from August to November. Ayala-Perez et al. (2001), Costa et al. (2012) and Elliff et al. (2013) reported recruitment of juveniles for the same period. Chaves and Otto (1998) using a bottom trawl net, found a different result, in which the recruitment period in the Guaratuba Bay (state of Paraná) occurs between December and February. The differences may be related to the physical, geomorphological, and climatic characteristics of the environments, which directly influence the life cycle of the organisms inhabiting these sites, as well as methodological differences and variations in sample size and strata of the population analyzed in each case (Elliff et al., 2013).

In this study, the sex ratio for the entire study period was 1.6 males for 1 female; the χ^2 test evidenced that the difference is significant concerning the expected 1:1 ratio for fish in natural environments. Through the monthly analysis, males were predominant in September, October, December, March, and June. According to Vazzoler (1996) and Wu et al. (2001), the predominance of one of the sexes in a population may be related to differences in growth rate, longevity, and migration to spawning grounds. In August, November, February, and May, the frequencies showed an expected trend of 1:1 in the sex ratio. Similar results were found by Aguirre-Léon & Díaz-Ruiz (2006) and Elliff et al. (2013), in which the ratio of males to females remained 1:1.

The sex ratio in fish changes throughout the life cycle due to continuous events that act differently on individuals of each sex. Information to characterize the population structure is of utmost importance, in addition to providing support for the study of other aspects such as assessment of reproductive potential and estimates of stock size (Vazzoler, 1996; Oliveira et al., 2012).

The analysis of the spatial distribution showed the presence of specimens in all sampling sites, with a greater abundance of individuals in site 1, located in the outermost part of the estuary. The highest number of individuals in this site was attributed to the high frequencies of juveniles, which, after spawning, move to estuaries either actively or passively by tidal currents, aggregating in these environments, as already observed by Whitfield (1989) in southern Africa.

The length-to-weight ratio for males and females of *D. rhombeus* in the studied area showed a positive allometric growth pattern (b> 3.0). The coefficient of allometry (b) is an indicator of the growth rate, that is, it shows when the growth presents an irrelevant increase in weight (Le Cren, 1951). When b = 3.0, the species exhibits isometric growth, i.e., the weight increases proportionally to the length. However, when b < 3.0, the growth is negative allometric, that is, the increase in weight is greater than the development in length, and when b > 3.0, the growth is positive allometric, with the increase in length exceeding the development in weight. This relationship is the same as that reported by Costa et al. (2012) and Chaves & Otto (1998). The allometric coefficient values for females and males indicate positive allometric growth for both sexes, which may be related to the great number of juveniles in the population.

The mean length at first gonadal maturity (L_{50}) is defined as the length at which 50% of individuals in a population start the reproductive cycle (Vazzoler, 1996). It is a very sensitive parameter in the life cycle of animals since the energy that was once destined to invest in the individual's growth and survival starts to be used for reproduction (Schaffer, 1974; Barbieri et al., 2004).

In the present study, the size at first maturity estimated for males and females was 14.4 cm and 14.6 cm, respectively. The first maturity size found here was very close to that observed by Chaves & Otto (1998) and Elliff et al. (2013), which estimated L_{50} at 15 cm for males and females. Bezerra et al. (2001) in studies to know the reproductive cycle of *D. rhombeus* on the coast of the state of Pernambuco recorded an L_{50} of 15.2 cm for males and females. A different result was reported by Costa et al. (2012) for *D. rhombeus* on the coast of Rio de Janeiro, with values between 8.0 and 9.0 cm. According to Barbieri et al. (2004), this reproductive precocity is an adaptive characteristic considered a strategy adopted by species in general, to recover population balance.

The present study evidenced the great ecological importance of Barra Nova for *D. rhombeus* concerning its life cycle, from the recruitment of juveniles to the reproduction in the estuarine environment. Nevertheless, it also opened a new work front, suggesting further research in areas adjacent to the coast, because new questions emerged, which can be solved through the continuity of this line of research.

References

Ayala-Pérez, L.A.; Gómez-Montes, B.A. & Ramos M.J. 2001. Distribución, abundancia y parâmetros poblacionales de la mojarra Diapterus rhombeus (Pisces: Gerreidae) en la Laguna de Términos, Campeche, México. Rev. biol. Trop. 49(2): 635-642.

Aguirre-León, A. & Díaz-Ruiz, S. 2006. Estructura de tallas, madurez gonádica y alimentación del pez Diapterus rhombeus (Gerreidae) en el sistema fluvio-deltaico Pom-Atasta, Campeche, México. Rev. biol. Trop. 54(2): 599-611.

Araújo, A.L.F.; Dantas, R.P. & Pessanha, A.L.M. 2016. Feeding ecology of three juvenile mojarras (Gerreidae) in a tropical estuary of northeastern Brazil. Neotrop. Ichthyol. 14(01): e150039.

Barbieri, G.; Salles, F.A.; Cestarolli, M.A. & Teixeira-Filho, A.R. 2004. Estratégias reprodutivas do dourado, Salminus maxilosus e do curimbatá, Prochilodus lineatus, no rio Mogi Guaçu, São Paulo, com ênfase nos parâmetros matemáticos da dinâmica populacional. Acta Sci. 26(2): 169-174.

Bezerra, R.S.; Vieira, V.L.A. & Santos, A.J.G. 2001. Ciclo reprodutivo da carapeba prateada Diapterus rhombeus (Cuvier, 1829), no litoral de Pernambuco, Brasil. Trop. Oceanogr. 29(1): 67-78.

Brasil. 2002. Ministério do Meio Ambiente. Secretaria de Biodiversidade e Florestas. Biodiversidade brasileira: Avaliação e identificação de áreas e ações prioritárias para conservação, utilização sustentável e repartição dos benefícios da biodiversidade nos biomas brasileiros, Brasília. Ministério do Meio Ambiente (MMA).

Chaves, P.T.C. & Otto, G. 1998. Aspectos biológicos de Diapterus rhombeus (Cuvier) (Teleostei, Gerreidae) na Baía de Guaratuba, Paraná, Brasil. Rev. Bras. Zool. 15(2): 289-295.

Chi-Espínola, A.A.; Vega-Cendejas, M.E. & Canto-Maza, W.G. 2018. Feeding habits of the mojarras (Gerreidae) population in the hyperhaline lagoon system of Ría Lagartos, Yucatan, Mexico. Lat. Am. J. Aquat. Res. 46(4): 810-819.

Costa, M.R.; Albieri, R.J.; Neves, L.M.; Santos, A.B.L.; & Araújo, F.G. 2012. Distribution and size of the Mojarra Diapterus rhombeus (Cuvier) (Actinopterygii, Gerreidae) in a Southeastern Brazilian Bay. Braz. J. Oceanogr. 60 (2): 201-209.

Deckert, G.D. & Greenfield, D.W. 1987. A review of the western Atlantic species of the genera Diapterus and Eugerres (Pisces: Gerreidae). Copeia, 1987(1): 182-194

Dias, J.F.; Gonçalves, A.M.; Fernandez, W.S.; Silbiger, H.L.N.; Fiadi, C.B., & Schmidt, T.C.S. 2011. Ichthyofauna in an estuary of the Mataripe area, Todos os Santos Bay, Bahia, Brazil. Braz. J. Oceanogr. 59(1): 75-95.

Elliff, C.I.; Tutui, S.L.S.; Souza, M.R. & Tomás, A.R.G. 2013. Population structure of caitipa mojarra (Diapterus rhombeus) in an estuarine system of Southeastern Brazil. B. Inst. Pesca 39(4): 411-421.

Fonteles-Filho, A.A. 1989. Recursos pesqueiros: Biologia e dinâmica populacional, Fortaleza, Imprensa Oficial do Ceará. 296 p.

Garcia Júnior, J.; Mendes, L.F.; Sampaio, C.L.S. & Lins, J.E. 2010. Biodiversidade marinha da Bacia Potiguar: Ictiofauna, Rio de Janeiro, Museu Nacional. 195 p.

Ihaka, R. & Gentleman. R. 1996. A language for data analysis and graphics. J. Comput. Graph. Stat. 5(3): 299-314.

Incaper. Instituto Capixaba de pesquisa, assistência técnica e extensão rural. 2011. Programa de assistência técnica e extensão rural PROATER 2011/2013-Planejamento e programação de ações, Espírito Santo, Governo do Estado do Espírito Santo. 519 p.

Le Cren, E.D. 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (Perca fluviatilis). J. Anim. Ecol. 20: 201-219.

Oliveira, M.R.; Costa, E.; Araújo, A.; Pessoa, E.K.R.; Carvalho, M.; Cavalcante, L.M. F. & Chellappa, S. 2012. Sex ratio and length-weight relationship for five marine fish species from Brazil. J. Mar. Biol. Ocea. 1(2): 1000103.

Pereira, R.C. & Soares-Gomes, A. 2002. Biologia marinha, Rio de Janeiro, Interciência. 656 p.

Pessanha, A.L.M & Araújo, F.G. 2012. Spatial and size feeding niche partitioning of the rhomboid mojarras Diapterus rhombeus (Cuvier, 1829) in a tropical Brazilian Bay. Mar. Biol. Res. London, 8(3): 273-283.

Petrobras. 2007. Diagnóstico ambiental: atividade de produção e escoamento de gás natural e petróleo do Campo de Camarupim, Bacia do Espírito Santo, Vitória, Petrobrás. 200 p.

Pineda-Peralta, A.; Ramos-Miranda, J.; Castillo-Rivera, M. & Arreguín-Sánchez, F. 2016. Cambios en la dieta de dos especies de mojarras (Gerreidae) en la Laguna de Términos, Campeche, México. Rev. Biol. Mar. Oceanogr. 51(2): 385-394.

Ramos, J.A.A.; Barletta, M.; Dantas, D.V.; Lima, A.R.A. & Costa, M.F. 2014. Trophic niche and habitat shifts of sympatric Gerreidae. J. Fish Biol. 85(5): 1446-1469.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations: Bulletin Fisheries Research Board Canada, Canada, Department of the Environment Fisheries and Marine Service, 401 p.

Rossi-Wongtschowski, C.L.D.B.; Chalom, A.; Siliprandi, C.C.; Brenha-Nunes, M.R.; Conversani, V.R.M.; Santificetur, C. & Giaretta, M.B. 2016. COSS-Brasil: Coleção de Otólitos de Peixes Marinhos da Região Sudeste-Sul do Brasil. São Paulo, Instituto Oceanográfico da Universidade de São Paulo.

São Mateus (Município). 2003. Lei nº 027 de 14 de agosto de 2003. Lei Complementar -Plano de Ordenamento do Distrito de Barra Nova Norte. Espírito Santo. Governo do estado do Espírito Santo.

Schaffer, W.M. 1974. Selection for optimal life histories: the effects of age structure. Ecology, 55(2): 291-303.

Silva, J.F.; Espósito, T.S.; Marcuschi, M.; Ribeiro, K.; Cavalli, R.O.; Oliveira, V. & Bezerra, R.S. 2011. Purification and partial characterisation of a trypsin from the processing waste of the silver mojarra (Diapterus rhombeus). Food Chem. 129(3): 777-782.

Soares, E.C.; Guimarães-Paiva, A.; Lima-Santos, E.; Moreira-Pereira, S.; Santana-Santos, E.; Almeida, E.O. & Silva, T.J. 2016. Potential of carapeba (Eugerres brasilianus) for aquaculture production. Lat. Am. J. Aquat. Res. 44(4): 718-725.

Souza, L.M. & Chaves, P.T. 2007. Atividade reprodutiva de peixes (Teleostei) e o defeso da pesca de arrasto no litoral norte de Santa Catarina, Brasil. Rev. Bras. Zool. 24(4): 1113-1121.

Vazzoler, A.E.A.M. 1996. Biologia da Reprodução de Peixes Teleósteos: Teoria e Prática. Maringá. EDUEM/CNPq/NUPELIA, 191 p.

Vergara-Solana, F.J.; García-Rodriguez, F.J.; Tavera, J.J., Luna, E.D. & Cruz Agüero, J. D.L. 2013. Molecular and morphometric systematics of Diapterus (Perciformes, Gerreidae). Zool. Scr. 43(4): 338-350.

Vieira, S. 1980. Introdução à Bioestatística, Rio de Janeiro. Campus, 296 p.

Whitfield, A.K.; Beckley, L.E.; Bennett, B.A.; Branch, G.M.; Kok, H.M.; Potter, I.C. & Van Der Elst, R.P. 1989. Composition, species richness and similarity of ichthyofaunas in eelgrass Zostera capensis beds of southern Africa. Afr. J. Mar. Sci. 8(1): 251–259.

Wu, C.C.; Su, W.C. & Kawasaki, T. 2001. Reproductive biology of the dolphin fish Corphaena hippurus on the east cost of Taiwan. Fish. Sci. 67: 784-793.

Zar, J.H. 1996. Biostatistical analysis, New Jersey. Pearson New International, 944 p.