

# OCEANOGRÁFIA:

Desvelando la Belleza, los Misterios y los Desafíos del Mar



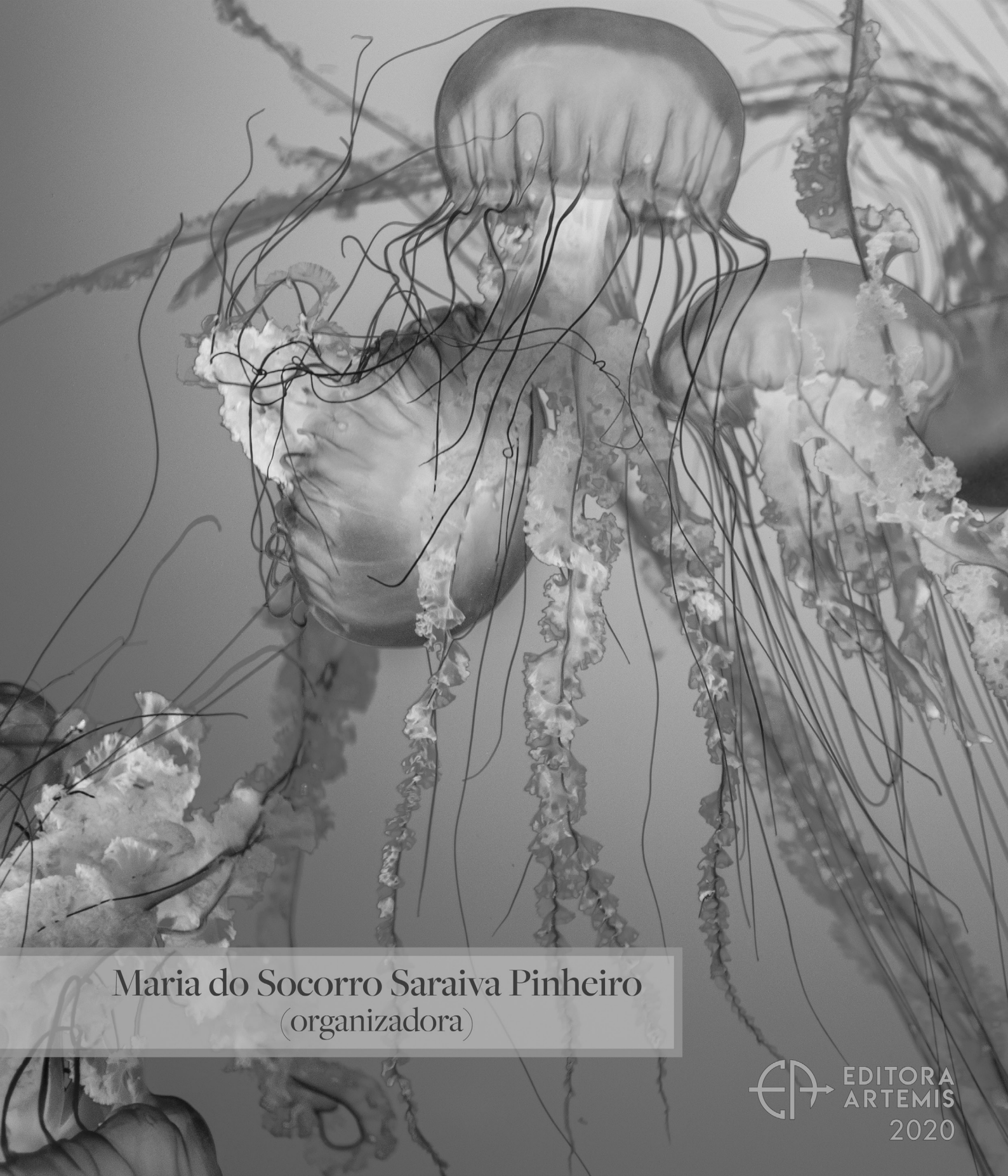
Maria do Socorro Saraiva Pinheiro  
(organizadora)

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## APRESENTAÇÃO

Em 2016, as Nações Unidas concluíram a primeira Avaliação Mundial dos Oceanos que apontou a urgência de gerenciar com sustentabilidade as atividades no oceano. Por esta razão, em 2017, foi proclamada a Década da Ciência Oceânica para o Desenvolvimento Sustentável, a ser implementada de 2021 a 2030, buscando cumprir os compromissos da Agenda 2030, com foco no Objetivo de Desenvolvimento Sustentável (ODS) 14 e correlatos. Neste sentido a obra **“Oceanografía: desvelando la belleza, los misterios y los desafíos del mar”** traz uma coletânea de trabalhos científicos que busca contribuir com uma base científica de apoio às ações de gerenciamento sustentável do Oceano executadas por diversos países. Entre os temas apresentados nesta obra estão: impactos ambientais em zonas costeiras, aquicultura, ecologia de ictiofauna, conservação de ecossistemas marinhos e zoonoses de organismos aquáticos.

Maria do Socorro Saraiva Pinheiro

## SUMÁRIO

<b>CAPÍTULO 1</b> .....	<b>1</b>
AVALIAÇÃO DE ALTERAÇÕES DE LINHA DE COSTA A PARTIR DA FERRAMENTA DE IMAGENS HISTÓRICAS DO GOOGLE EARTH: O CASO DA PRAIA DE ITACURUÇÁ (MANGARATIBA (RJ) – BRASIL)	
Rayane Romão Saad Abude Kátia Regina Góes Souza	
<b>DOI 10.37572/EdArt_1633110201</b>	
<b>CAPÍTULO 2</b> .....	<b>14</b>
DELIMITACIÓN DE LA PLATAFORMA CONTINENTAL ARGENTINA: IMPORTANCIA GEOESTRATÉGICA EN LA DETERMINACIÓN DEL LÍMITE EXTERIOR DEL MARGEN CONTINENTAL	
Marcelo Francisco Veneziano	
<b>DOI 10.37572/EdArt_1633110202</b>	
<b>CAPÍTULO 3</b> .....	<b>29</b>
LAS COMUNIDADES MARINAS BENTÓNICAS DE LA RESERVA NACIONAL KATALALIXAR (CHILE)	
Matthias Gorny Américo Montiel Germán Zapata-Hernández Raúl Pereda	
<b>DOI 10.37572/EdArt_1633110203</b>	
<b>CAPÍTULO 4</b> .....	<b>45</b>
DESEQUILIBRIO ECOLÓGICO EN LOS ECOSISTEMAS ROCOSOS INTERMAREALES Y SUBMAREALES DEL SUR DEL PERÚ	
Dr. Graciano Alberto Del Carpio Tejada Blgo. Marco Samuel Ríos Morales	
<b>DOI 10.37572/EdArt_1633110204</b>	
<b>CAPÍTULO 5</b> .....	<b>61</b>
STRUCTURE OF A FISH ASSEMBLAGE IN A MANGROVE IN RAPOSA, SÃO LUIS ISLAND, MARANHÃO, BRAZIL	
Maria do Socorro Saraiva Pinheiro Roberto Goitein	
<b>DOI 10.37572/EdArt_1633110205</b>	
<b>CAPÍTULO 6</b> .....	<b>74</b>
MEXILHÕES (MYTILIDAE) NO BRASIL: CONSIDERAÇÕES PARA GESTÃO	
Augusto Luiz Ferreira Júnior Roberto Ferreira Artoni Susete Wambier Christo	
<b>DOI 10.37572/EdArt_1633110206</b>	

<b>CAPÍTULO 7 .....</b>	<b>86</b>
PARÁSITOS ZONÓTICOS DE INTERÉS EN SALUD PÚBLICA EN MYTILUS EDULIS PLATENSIS DE LA COSTA DEL GOLFO SAN JORGE, PATAGONIA ARGENTINA	
Claudia Beatriz Torrencillas	
María Angélica Fajardo	
Betiana Romina Garrido	
Marco Julio Sánchez	
Ivana Leticia Mellado	
María Alejandra Córdoba	
Aleixandre Isabel Gorriz	
Thevenet Paula Sánchez	
<b>DOI 10.37572/EdArt_1633110207</b>	
<b>CAPÍTULO 8 .....</b>	<b>99</b>
OBTENCIÓN DE HIDROLIZADOS PROTEICOS A PARTIR DE DESECHOS DE LA INDUSTRIA PESQUERA	
Nair de Los Ángeles Pereira	
María Florencia Fangio	
Yamila Eliana Rodríguez	
María Delfina Garbari	
Analía Verónica Fernández-Gimenez	
<b>DOI 10.37572/EdArt_1633110208</b>	
<b>SOBRE A ORGANIZADORA .....</b>	<b>111</b>
<b>INDICE REMISSIVO .....</b>	<b>112</b>

## STRUCTURE OF A FISH ASSEMBLAGE IN A MANGROVE IN RAPOSA, SÃO LUIS ISLAND, MARANHÃO, BRAZIL

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**ABSTRACT:** This study analyzes aspects of the fish community present in a mangrove on the island of São Luís, Maranhão, Brazil; encompassing species composition, frequency of occurrence and sexual proportion. Sampling was monthly for 16 months. 10824 specimens of fish were collected, representing 63 species belonging to 27 families. The Sciaenidae family was the most important with ten species; followed by Carangidae, with six species; Ariidae, Haemulidae and Gerreidae with four species.

*Genyatremus luteus* was the most frequent species, corresponding to 95% of the samples. Second were *Micropogonias furnieri*, *Stellifer naso*, *Mugil curema* and *Colomesus psittacus*, each present in 88% of the samples. Sex was observed in 38 species, and in 18 species the hypothesis of equality (1:1) was accepted and rejected for 9 species.

**KEYWORDS:** Ichthyofauna; Sex ratio; Frequency of occurrence; Sciaenidae.

### ESTRUCTURA DE UN CONJUNTO DE PECES EN UN MANGLAR EN RAPOSA, ISLA SÃO LUIS, MARANHÃO, BRASIL.

**RESUMEN:** En este estudio se abordaron aspectos de la comunidad de peces presentes en un manglar en la isla de São Luís, Maranhão, Brasil; que cubre la composición de especies, la frecuencia de ocurrencia y la población sexual. El muestreo fue mensual durante 16 meses. Se recolectaron 10824 ejemplares de peces, que representan 63 especies pertenecientes a 27 familias. La familia Sciaenidae fue la más importante con diez especies; seguido de Carangidae, con seis especies; Ariidae, Haemulidae y Gerreidae con cuatro especies. *Genyatremus luteus* fue la especie más frecuente, correspondiente al 95% de las muestras. En



segundo lugar se ubicaron las especies *Micropogonias furnieri*, *Stellifer naso*, *Mugil curema* y *Colomesus psittacus*, cada una presente en el 88% de las muestras. Se pudo observar el sexo en 38 especies, y en 18 especies se aceptó y rechazó la hipótesis de igualdad (1:1) para 9 especies.

**PALABRAS CLAVE:** Ictiofauna; Proporción sexual; Frecuencia de ocurrencia; Sciaenidae.

## 1 . INTRODUCTION

The mangrove system is characterized by the presence mainly of halophyte plant species, which occur in the transition zone between the marine and terrestrial environments, and tolerate high salinities (Hossain, 2001), including in salinity stress as observed by Santos (1989) in two areas located on São Luís Island, on the Anajatuba River and on Tubarão Bay in the State of Maranhão. Characterizing a type of estuary based on data from the available literature proves to be a complex task. The existing classifications are based on the variation in salinity, tidal amplitudes, or geomorphological characteristics. So it was considered for this study that the type of estuary present in the Raposa mangrove of the Baía de Maré type, proposed by Kjerfve and Magill (1989). In this classification, the authors address both salinity and geomorphological characteristics; these types of estuaries would have salinities ranging from oceanic to brackish and would have coastal features formed by some large-scale geological event.

The main objective of this study was to address structural characteristics of the associations of teleost fish in a mangrove, emphasizing the composition, frequency of occurrence and sexual proportion.

## 2 . MATERIAL AND METHODS

### 2.1 Study área

The study area is located in the northeastern part of the island of São Luís, municipality of Raposa (02° 25' 22"S and 44° 05' 21"W) (Meneghetti and Kux, 2014), comprising a set of tidal channels, flooded during high tide. It is characterized by low relief and a dominant mangrove flora. The main supply of river waters comes from the Paciência River basin, on the east side of the island of São Luís.

### 2.2 Sample design

The collection of fish for the accomplishment of this study was monthly between

August 1999 and November 2000. The fish were captured with igarapé net, also called “taping net”. They are fixed devices, arranged at the entrance to the stream, supported by mangrove poles, fixed during low tide; the harvest is carried out at the next low tide, totaling an effort of 12 hours.

The fish caught for this study were packaged in the field in polystyrene boxes with ice and transported to the laboratory, where identification was carried out based on Cervigón (1993), Fischer (1978), Cervigón et al. (1992), FIGUEIREDO and MENEZES (1980), MENEZES and FIGUEIREDO (1980), MENEZES and FIGUEIREDO (1985), FIGUEIREDO and MENEZES (2000).

For the study of the proportions of males and females and identification of the gonadal maturity stages of the species collected, some care was taken. The abdominal cavity of each fish, with the exception of pleuronectiforms, was exposed through an incision in the region of the genital pore towards the head, to observe sex and the identification of both sex was done through visual inspection of the gonads, comparing their aspects with the scales proposed by VAZZOLER (1996).

### **2.3 2.3 Data analysis**

To verify the frequency of occurrence, samples of all species were grouped by month of collection and the study was based on the ratio between the total number of samples where a given species occurred and the total number of samples.

Therefore, to determine the frequency of occurrence of species caught in the Raposa mangrove, the following nomenclature was adopted: Constants - species (or families) present between 50 to 100% of the samples; Moderate - species (or families) present between 20 to 49% of the samples; Little constant - species (or families) present between 10 to 19% of the samples; Rare - species (or families) present in less than 10% of the samples.

For the study of the sexual proportion of the populations, the Chi-square test was applied in order to test whether there was a significant predominance of males or females for each species, taking as a null hypothesis the ratio 1:1 (ZAR, 1999).

## **3 . RESULTS**

### **3.1 General characteristics of the composition of the fish association.**

10,824 individuals were collected, comprising 63 species distributed in 27 families. Table 1 shows the list of fish collected in the mangrove of Raposa, accompanied by the names of orders and families follow the ordering proposed by NELSON (1994).

Table 1. List of teleost fish species that occur in the mangrove of Raposa, São Luís island.

Order Clupeiformes
Family Clupeidae
<i>Odontognathus</i> sp.
Family Engraulidae
<i>Anchoa</i> sp.
<i>Cetengraulis edentulus</i> (Cuvier, 1928)
<i>Pterengraulis atherinoides</i> (Linnaeus, 1766)
Order Elopiformes
Family Elopidae
<i>Elops saurus</i> Linnaeus, 1766
Order Anguilliformes
Family Muraenidae
<i>Gymnothorax funebris</i> Ranzani, 1839
Family Ophichthidae
<i>Ophichthus parilis</i> (Richardson, 1844)
Order Siluriformes
Family Ariidae
<i>Sciades herzbergii</i> (Bloch, 1794)
<i>Arius</i> sp.
<i>Cathorops spixii</i> (Agassiz, 1829)
<i>Cathorops</i> sp.
Family Auchenipteridae
<i>Pseudauchenipterus nodosus</i> (Bloch, 1794)
Family Batrachoidiformes
Family Batrachoididae
<i>Batrachoides surinamensis</i> (Bloch & Schneider, 1801)
<i>Thalassophryne nattereri</i> Steindachner, 1876.
Order Beloniformes
Family Belonidae
<i>Strongylura marina</i> (Walbaum, 1792)
Order Atheriniformes
Family Atherinopsidae
<i>Atherinella brasiliense</i> (Quoy & Gaimard, 1825)
Order Cyprinodontiformes
Family Anablepidae
<i>Anableps anableps</i> (Linnaeus, 1758)
Order Perciformes
Family Centropomidae
<i>Centropomus parallelus</i> Poey, 1860
<i>Centropomus undecimalis</i> (Block, 1792)
Family Serranidae
<i>Epinephelus itajara</i> (Lichtenstein, 1822).
<i>Rypticus randalli</i> Courtenay, 1967
Family Carangidae
<i>Caranx latus</i> Agassiz, 1831
<i>Caranx</i> sp.
<i>Oligoplites palometa</i> (Cuvier, 1832)
<i>Oligoplites saurus</i> (Bloch & Schneider, 1801)
<i>Selene vomer</i> (Linnaeus, 1758)
<i>Trachinotus carolinus</i> (Linnaeus, 1766)
Family Lutjanidae
<i>Lutjanus buccanella</i> (Cuvier, 1828)
<i>Lutjanus jocu</i> (Bloch & Schneider, 1801)
<i>Lutjanus synagris</i> (Linnaeus, 1758)
Family Lobotidae
<i>Lobotes surinamensis</i> (Bloch, 1790)



**Family Gerreidae**

*Diapterus auratus* Ranzani, 1842  
*Diapterus rhombeus* (Cuvier, 1829)  
*Eucinostomus argenteus* Baird & Girard, 1855  
*Eugerres* sp.

**Family Haemulidae**

*Conodon nobilis* (Linnaeus, 1758)  
*Genyatremus luteus* (Bloch, 1790)  
*Orthopristis ruber* (Cuvier, 1830)  
*Pomadasys corvinaeformis* (Steindachner, 1868).

**Family Sciaenidae**

*Cynoscion acoupa* (Lacepède, 1801)  
*Cynoscion leiarchus* (Cuvier, 1830)  
*Cynoscion* sp.  
*Isopisthus parvipinnis* (Cuvier, 1830)  
*Macrodon ancylodon* (Bloch & Schneider, 1801)  
*Micropogonias furnieri* (Desmarest, 1823)  
*Bairdiella ronchus* (Cuvier, 1830)  
*Stellifer naso* (Jordan, 1889)  
*Stellifer* sp.  
*Nebris microps* Cuvier 1830

**Family Ehippidae**

*Chaetodipterus faber* (Broussonet, 1782)

**Family Mugilidae**

*Mugil curema* Valenciennes, 1836  
*Mugil gaimardianus* Desmarest, 1831  
*Mugil incilis* Hancock, 1830

**Family Polynemidae**

*Polydactylus oligodon* (Günther, 1860)

**Family Trichiuridae**

*Trichiurus lepturus* Linnaeus, 1758

**Order Pleuronectiformes**

**Family Paralichthyidae**

*Paralichthys* sp.  
*Citharichthys* sp.

**Family Achiridae**

*Achirus* sp.  
*Trinectes* sp.

**Family Cynoglossidae**

*Symphurus diomedeanus* (Goode & Bean, 1885)

**Order Tetraodontiformes**

**Family Tetraodontidae**

*Colomesus psittacus* (Bloch & Schneider, 1801).  
*Lagocephalus* sp.  
*Sphoeroides testudineus* (Linnaeus, 1758).

---

Considering the number of species, the family Sciaenidae was the most important with ten species; followed by Carangidae, with six species; Ariidae, Haemulidae and Gerreidae with four species; Engraulidae, Lutjanidae, Mugilidae and Tetraodontidae, with three species; Batrachoididae, Centropomidae, Serranidae, Paralichthyidae and Achiridae with two species; the remaining thirteen families contributed one species each.

### 3.2 Frequency of occurrence.

*Genyatremus luteus* was the most frequent species, corresponding to 95% of the samples. In second place were the species *Micropogonias furnieri*, *Stellifer naso*, *Mugil curema* and *Colomesus psittacus*, each one present in 88% of the samples.

Of the sixty-three species collected in the mangrove of Raposa, nineteen were considered “constant”, including those mentioned above; fourteen, “moderate”; nineteen, “little constant” and eleven, “rare” (Table 2).

Table 2. Frequency of occurrence of species caught in Mangue da Raposa.

Species	Constants	Moderatr	Little Constant	Rare
<i>Odontognathus</i> sp.				*
<i>Anchoa</i> sp.		*		
<i>C. edentulus</i>		*		
<i>P. atherinoides</i>			*	
<i>E. saurus</i>		*		
<i>G. funebris</i>		*		
<i>O. parilis</i>				*
<i>S. herzbergii</i>	*			
<i>Arius</i> sp.	*			
<i>C. spixii</i>		*		
<i>Cathorops</i> sp	*			
<i>P. nodosus</i>		*		
<i>B. surinamensis</i>	*			
<i>T. nattereri</i>				*
<i>S. marina</i>		*		
<i>A. brasiliense</i>				*
<i>A. anableps</i>		*		
<i>C. parallelus</i>	*			
<i>C. undecimalis</i>		*		
<i>E. itajara</i>		*		
<i>R. randalli</i>	*			
<i>C. latus</i>			*	
<i>Caranx</i> sp				*
<i>O. palometa</i>			*	
<i>O. saurus</i>	*			
<i>S. vomer</i>		*		
<i>T. carolinus</i>			*	
<i>L. buccanella</i>				*
<i>L. jocu</i>			*	
<i>L. synagris</i>		*		
<i>L. surinamensis</i>			*	
<i>D. auratus</i>			*	
<i>D. rhombeus</i>			*	
<i>E. argenteus</i>	*			
<i>Eugerres</i> sp.				*
<i>C. nobilis</i>			*	

<i>G. luteus</i>	*			
<i>O. ruber</i>				*
<i>P. corvinaeformis</i>		*		
<i>C. acoupa</i>	*			
<i>C. leiarchus</i>	*			
<i>Cynoscion</i> sp.			*	
<i>I. parvipinnis</i>				*
<i>M. ancylodon</i>			*	
<i>M. furnieri</i>	*			
<i>B. ronchus</i>			*	
<i>S. naso</i>	*			
<i>Stellifer</i> sp.			*	
<i>N. microps</i>				*
<i>C. faber</i>		*		
<i>M. curema</i>	*			
<i>M. gaimardianus</i>	*			
<i>M. incilis</i>		*		
<i>P. oligodon</i>			*	
<i>T. lepturus</i>	*			
<i>Paralichthys</i> sp.			*	
<i>Citharichthys</i> sp.			*	
<i>Achirus</i> sp.			*	
<i>Trinectes</i> sp.	*			
<i>S. diomedeanus</i>			*	
<i>C. psittacus</i>	*			
<i>Lagocephalus</i> sp.			*	
<i>S. testudineus</i>	*			

The families Ariidae, Haemulidae and Sciaenidae were the most frequent families, each with representatives in 100% of the samples obtained.

Of the twenty-seven families collected in the mangrove of Raposa, fourteen were considered “constant”, including those mentioned above; five, “moderate”; five, “little constant” and three “rare”, as shown in Table 3.

Table 3. Frequency of occurrence of families captured in Mangue da Raposa.

Family	Constants	Moderate	Little Constant	Rare
Clupeidae				*
Engraulidae	*			
Elopidae			*	
Muraenidae		*		
Ophichthidae				*
Ariidae	*			
Auchenipteridae		*		
Batrachoididae	*			
Belonidae		*		
Atherinopsidae				*
Anablepidae		*		
Centropomidae	*			



Serranidae	*		
Carangidae	*		
Lutjanidae	*		
Lobotidae			*
Gerreidae	*		
Haemulidae	*		
Sciaenidae	*		
Ephippidae		*	
Mugilidae	*		
Polynemidae			*
Trichiuridae	*		
Paralichthyidae			*
Achiridae	*		
Cynoglossidae			*
Tetraodontidae	*		

### 3.3 Sexual proportion.

A total of 1914 specimens of 38 species could be classified according to sex, for safety reasons this classification was only adopted when the gonads were effectively visualized.

The hypothesis of equality in the proportions of males and females tested by the Chi-square test at the significance level of 0.05 was accepted for 18 species and rejected for 9 species, as shown in Table 4.

Table 4. Number of males and females per species and the  $\chi^2$  result

Species	Males	Females	$\chi^2$
<i>Anchoa</i> sp.		12	
<i>E. saurus</i>		3	
<i>G. funebris</i>	5	2	1,28
<i>S. herzbergii</i>	6	7	0,08
<i>Arius</i> sp.	29	23	0,70
<i>C. spixii</i>		1	
<i>Cathorops</i> sp.	49	69	3,4
<i>P. nodosus</i>	17	12	0,86
<i>B. surinamensis</i>	6	22	9,14*
<i>T. nattereri</i>	1		
<i>S. marina</i>	2	7	2,78
<i>A. anableps</i>	17	34	5,66*
<i>C. parallelus</i>		2	
<i>R. randalli</i>	14	51	21,06*
<i>L. jocu</i>		1	
<i>L. synagris</i>	13	15	0,14
<i>E. argenteus</i>	3	10	1,66
<i>C. nobilis</i>	1	5	2,66
<i>G. luteus</i>	8	23	7,26*
<i>P. corvinaeformis</i>	6	7	0,08

<i>C. acoupa</i>	3	12	5,4*
<i>C. leiarchus</i>	7	12	1,32
<i>I. parvipinnis</i>		1	
<i>M. furnieri</i>	54	44	1,02
<i>B. ronchus</i>	1	2	0,34
<i>S. naso</i>	31	50	4,46*
<i>Stellifer</i> sp.	26	29	0,16
<i>M. curema</i>	240	246	0,08
<i>M. gaimardianus</i>	58	72	1,50
<i>M. incilis</i>	7	12	1,32
<i>P. oligodon</i>		2	
<i>T. lepturus</i>	20	47	10,88*
<i>Paralichthys</i> sp.	1		
<i>Achirus</i> sp.		7	
<i>Trinectes</i> sp.	2	29	23,53*
<i>S. diomedeanus</i>		1	
<i>C. psittacus</i>	114	119	0,10
<i>S. testudineus</i>	69	112	10,22*

The species *Anchoa* sp, *Elops saurus*, *Cathorops spixii*, *Centropomus parallelus*, *Lutjanus jocu*, *Isopisthus parvipinnis*, *Polydactylus oligodon*, *Achirus* sp., *Symphurus diomedeanus*, only female individuals were observed, while the species *Thalassophryne nattereri* and *Paralichthys* sp. only males were observed; for this reason the hypothesis has not been tested.

#### 4 . DISCUSSION

The Sciaenidae family had the largest number of species in the mangrove system, followed by the Carangidae family. These results corroborate those found by MARTINS-JURAS (1989) in estuarine areas on the island of São Luís.

ROJAS et al. (1994) observed that the Ariidae family in mangrove areas in Costa Rica was the most abundant in number of individuals, and the largest number of species; STONER (1986) the Gerreidae family, in Laguna de Joyuda, Puerto Rico; SEDBERRY and CARTER (1993) family Haemulidae, Belize, Central America.

CHAVES and CORRÊA (1998) in the bay of Guaratuba, Paraná, observed three families with greater representation: Ariidae, Gerreidae and Sciaenidae; VENDEL et al. (2002) in the Baguaçu gamboa found that the families with the highest representation of species were: Engraulidae, Gerreidae, Gobiidae and Tetraodontidae, in addition to Clupeidae, Mugilidae and Sciaenidae; VENDEL et al. (2003) in a tidal plain of Paranaguá bay, concluded that the families with the greatest specific wealth were: Engraulidae, Gerreidae, Mugilidae and Tetraodontidae; SPACH et al. (2003) in the tidal channels, the greatest specific richness observed was from the families Carangidae and Gerreidae; SPACH et al. (2004) on sea plains in Pontal do Sul, observed that the

families with the greatest specific wealth were Carangidae and Sciaenidae; VENDEL and CHAVES (2006) observed two families with greater representation Gerreidae and Gobiidae on the coast of Santa Catarina.

The species that were most constant in the mangrove of Raposa were: *Genyatremus luteus*, in 93.8% of the samples; *Colomesus psittacus*, *Stellifer naso* and *Micropogonias furnieri* in 87.5% of the samples, each one, and *Trinectes* sp., in 75% of the samples.

*Genyatremus luteus* was also one of the most frequent species in other studies carried out in the Maranhão estuaries (MARTINS-JURAS et al. 1987; MARTINS-JURAS, 1989; BATISTA and REGO, 1996; CASTRO, 1997; 2001; PINHEIRO Jr. et al. 2005).

The presence of typically freshwater species was not observed, even occasionally during the capture period in the Raposa mangrove. But the fact that freshwater fish did not occur in this study is also not necessarily due to the presence of mangroves. According to LACERDA (1984), mangrove trees are not necessarily restricted to the high salinity environment; on the contrary, its development appears better in areas of low salinity, and its occurrence in the coastal environment seems to be linked to competition with other terrestrial plants.

CHAVES and CORRÊA (1998) did not observe the presence of freshwater fish in mangrove areas of Guaratuba bay, they considered that the high salinity perhaps explained the absence of fish associated with freshwater. However, CHAVES and VENDEL (2001) exploring a larger area and different habitats from CHAVES and CORRÊA (1998), plus the addition of other types of devices, on occasion captured a dulcícola species, *Rhamdia quelen*.

According to VAZZOLER (1996) the sex ratio in fish varies over the life cycle depending on the successive events that act differently on individuals of each sex, and mortality and growth are the main factors that can determine differences in the proportion sexual.

In this study *B. surinamensis*, *A. anableps*, *R. randalli*, *G. luteus*, *C. acoupa*, *S. naso*, *T. lepturus*, *Trinectes* sp. and *S. testudineus*, the sex ratio differed significantly from the sex ratio 1:1. But as the mangrove/estuary environment is usually more occupied by juvenile or pre-adult phases, the sex ratio should not manifest significant differences between males and females (LOWE-MCCONNELL, 1999).

The sex ratio for *Sphoeroides testudineus* in Gamboa do Baguaçu varied significantly during the year and the ratio of two males to one female coincided with the spawning period (ROCHA et al., 2002). While for *Sphoeroides greeleyi* in this same system, the number of females was higher than the number of males for most of the year, however during the months of January to March it was the same, and this corresponded to the end of the reproductive period after spawning.



## 5 . FINAL CONSIDERATIONS

Among the species present in the mangrove of Raposa, none can be considered endemic, as in the Golfão Maranhense.

The Sciaenidae family has a wide geographical distribution and many species on the five continents, so the fact that it was the most representative family, ten species, corroborates its interspecific heterogeneity.

Although the mangrove is a conspicuous environment, but provides places for protection against predation and feeding, the frequency of occurrence of certain species in the mangrove in this study is likely to be correlated with the tolerance of these species to the variation of some limiting environmental variables, such as salinity.

Several factors interfere differently in the sex ratio, among them mortality and growth that determines difference in the sex ratio, because in most cases there is a differential growth between males and females, then there should be further study at the level of length classes.

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## **SOBRE A ORGANIZADORA**

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## ÍNDICE REMISSIVO

### A

*Acanthogorgia* 39, 40  
*Acesta* 40  
*Acipenser persicus* 102, 109  
Alcalase 99, 101, 102, 103, 104, 106  
*Apomatus* 40  
Ariidae 61, 64, 65, 67, 69  
Atlántico sur occidental 19

### B

Balanço sedimentar 1, 3, 6, 9, 11  
Bentos del sublitoral 30  
Biodiversidad 30, 32, 42, 44, 45, 54, 56  
Bioseguridad 91  
Bivalves 74, 75, 76, 80, 81, 96, 98

### C

Carangidae 61, 64, 65, 68, 69, 70  
*Chaetopterus* 37  
CONVEMAR 14, 15, 16, 17, 25, 27  
COPLA 16, 22, 24, 25, 26, 27, 28  
*Cosmasteria* 37, 40  
*Crepipatella* 37  
Criptogénico 80  
*Crypstosporodinium spp* 91

### D

*Desmophyllum* 37, 40  
Diversidade 71, 74, 75, 76, 77, 79

### E

*E. anchoita* 99, 101, 102, 103, 104, 106, 107  
*Engraulis ringens* 47  
EPTAs 88, 93, 95  
Erosão 1, 2, 4, 6, 9, 11, 12  
Erosão costeira 2, 11, 12  
*Errina* 37, 40, 42

## F

Fauna bentónica 30, 43, 49  
Fiordos 29, 30, 31, 33, 42, 43, 44  
*Fisurella* 50  
Formula de Gardiner 24  
Formula de Hedberg 24  
Frequency of occurrence 61, 62, 63, 66, 67, 71

## G

*Gastrointestinales* 92  
*G. duodenalis* 90, 92  
Geoprocessamento 1, 2, 3, 4, 11, 12  
Gerenciamento costeiro 2, 3, 4, 11, 12, 13  
*Giardia* spp 87, 88, 90, 91, 92, 93, 95  
GIS 2  
GOM-Player Plus 35  
Gonads 63, 68  
Google Earth PRO 1, 3, 5, 11

## H

Haemulidae 61, 65, 67, 68, 69  
*Heliaster* 50, 51, 53, 55, 57, 59

## I

Ichthyofauna 61

## J

Jurisdição 15

## L

*Latrunculia* 40  
Lepetellidos 50  
*Lessonia* 45, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 59  
Linha de costa 1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13  
*Lithopyllum* sp. 45  
*Loxechinus* 37, 50, 56  
*Luidia* 51

## M

*Macrocystis* 37, 48, 52  
Mangrove 61, 62, 63, 64, 66, 67, 69, 70, 71, 72

Maricultura 89  
*Merluccius hubbsi* 99  
Mexilhões 74, 76, 77, 78, 79, 80, 82  
*Meyenaster* 51, 52  
Mitilídeos 74, 75, 76, 80  
Moluscos 52, 75, 77, 79, 80, 81, 87, 88, 89, 90, 91, 92, 93, 94  
*Mundia* 39  
*Mytella* 74, 75, 76, 77, 78, 79, 81, 83, 84, 85  
*Mytilus edulis platensis* 77, 86, 87, 89, 90, 91, 92, 93, 95

## N

Neutraxe 99, 101, 103, 106

## O

*Ovalipes* 40

## P

Paramolgula 40  
Patagonia chilena 30, 31, 32, 42, 43  
Patógeno-hospedador 94  
*Pleoticus muelleri* 99, 108, 109  
Proteasas 100, 102, 106  
*Pyura* 51, 52

## Q

QGis 5, 6, 11

## R

Recurso renovável 74, 75  
RNK 30, 31, 32, 33, 37, 40, 42, 43

## S

Sciaenidae 61, 62, 65, 67, 68, 69, 70, 71  
*Scopalina* 39, 40  
*Selaroides leptolepis* 104, 109  
Sensoriamento remoto 1, 2, 4, 11, 12, 13  
Sex ratio 61, 70, 71

## T

Técnica de IFD 91  
*Tegula* 50, 54, 56, 57



Teleost 62, 64  
Território 1, 2, 15  
*Tetrapigus niger* 45, 50, 54, 57  
*Thouarella* 37

## V

Vectores 94

## Z

ZEE 20, 21, 25  
Zoonosis 87, 93, 94



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