Arquivos de Ciências do Mar

SIZE AND AGE AT FIRST MATURITY OF THE CRUCIFIX SEA CATFISH, Sciades proops (VALENCIENNES, 1840) (SILURIFORMES: ARIIDAE), CAUGHT OFF WESTERN MARANHÃO STATE, BRAZIL

Comprimento e idade na primeira maturidade sexual do uritinga, *Sciades proops* (Valenciennes, 1840) (Siluriformes: Ariidae), capturado no litoral ocidental do Maranhão, Brasil

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ABSTRACT

The aim of the present study was to determine size and age at first maturity of the crucifix sea catfish, Sciades proops, *on the western coast of the state of Maranhão (Brazil) between the cities of São Luís (2° 32'S-44° 18'W) and Turiaçu (1°20'S-45°20'W) from November, 2005 to August, 2006. One hundred sixty-one specimens were caught with gillnets operating at the surface, middle of the water column and bottom over a complete tide cycle. Mean size at first maturity for males and females was estimated as 35.2 cm and 36.6 cm, corresponding to 1.7 and 1.8 years, respectively. All males and females are able to reproduce at 41.7 cm and 44.7 cm, respectively. The results indicate larger variations in reproductive size for the species investigated when compared to data available in the literature.*

***Key words*:** *crucifix sea catfish,* Sciades proops, *gonad maturation, size, age.*

RESUMO

O tamanho e idade de primeira maturação do uritinga, Sciades proops, *capturado no litoral Ocidental do Maranhão foi determinado através da distribuição de freqüência relativa dos indivíduos adultos em classes de comprimento total. O tamanho de primeira maturação (L_{50}) foi considerado como aquele no qual 50% dos indivíduos da população estão aptos a iniciarem o ciclo reprodutivo, enquanto que a idade foi obtida a partir do L_{50} e dos parâmetros de crescimento conhecidos para a espécie. O comprimento total médio nos quais todos os indivíduos estão em condições de participar do processo reprodutivo, correspondente à freqüência de 100%, foi estimado gráfica e analiticamente. O tamanho de primeira maturação gonadal foi estimado em 36,6 cm para fêmeas e 35,2 cm para machos, o que corresponde a 1,2 ano para fêmeas e 1,5 ano para machos. A partir de 44,7 cm e 41,7 cm de comprimento, para fêmeas e machos respectivamente, 100% dos indivíduos estão aptos a se reproduzir.*

Palavras-chaves: *uritinga,* Sciades proops, *maturação gonadal, tamanho, idade.*

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INTRODUCTION

Size at first sexual maturity is a biological variable that allows establishing when an individual reaches adulthood in mean terms. The determination of this parameter assists in the sustainable management of fishery resources and the definition of regulatory policies regarding species by offering knowledge on the length and age limits between juvenile and adult stocks (Fonteles-Filho, 1989; Castro, 1999).

The species *Sciades proops* (Valenciennes, 1840), commonly known as the crucifix sea catfish, is a resource of considerable importance to fishery activities, especially artisanal fisheries. A large number of studies report the importance of catfish as fishery resources throughout Brazil in terms of economic value and as subsistence to the human population (Mishima & Tanji, 1982; Araújo, 1984; Reis, 1986; Barbieri *et al.*, 1992).

Ariidae catfish in Brazil have been widely studied in investigations addressing aspects such as feeding (Araújo, 1984; Reis, 1986; Melo & Teixeira, 1992; Pedra *et al.*, 2006; Giarrizzo & Saint Paul, 2007), distribution (Craig, 1980; Mishima & Tanji, 1981; Araujo 1988; Azevedo *et al.*, 1999), age, growth (Oliveira & Novelli, 2005) and reproduction (Barbieri *et al.*, 1992; Chaves, 1994; Gomes & Araújo, 2004; Fávaro *et al.*, 2005; Silva *et al.*, 2007). *S. proops*, however, has been studied very little, despite its recognized commercial importance. The few studies published on this species were carried out in French Guyana and were studies on growth (Lecomte *et al.*, 1986, 1989; Rojas-Beltran, 1989; Meunier *et al.*, 1994). In Brazil, there have been only two studies on this species – one addressing feeding habits off Itamaracá Island in the state of Pernambuco (Guedes & Vasconcelos Filho, 1980) and another carried out on the western coast of the state of Maranhão addressing reproductive biology (Silva *et al.*, 2007).

The importance of this resource is easily proven by the daily catch volume. However, there are virtually no scientific records on the species, especially with regard to its biological characteristics, growth and size at first sexual maturity, which are essential aspects to the management of species subject to fishery exploitation. Thus, there is a need to estimate size and age at first maturity of the crucifix sea catfish. The results of the present study could be used in stock assessment models and as reference for the management of fisheries targeting this species.

MATERIAL AND METHODS

Study area

The study area comprises the coastal and estuarine zones of the western coast of the state of Maranhão (Brazil), located between latitudes 1°20'S and 2°32'S and longitudes 44°18'W and 45°20'W, covering a region spanning from São Marcos Bay to Turiaçu Bay (Figure 1).

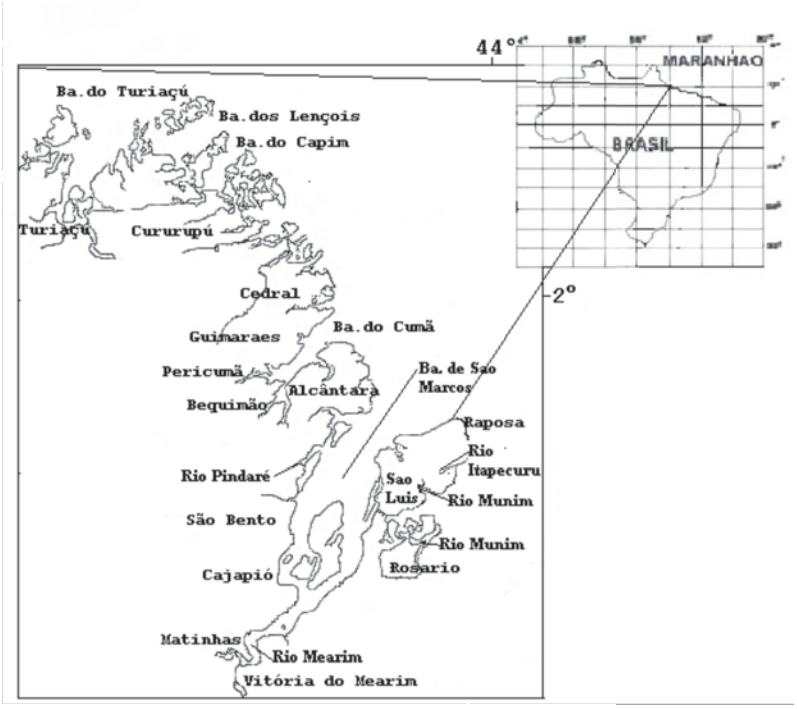

Figure 1 - Sampling area, comprising coastal and estuarine zones of the western coast of Maranhão State.

Species characteristics

The crucifix sea catfish, *S. proops*, has a broad geographic distribution, occurring from the Guyanas to the Atlantic coast of South America, with records of occurrence as far as the Parnaíba Delta in Piauí State (Fischer, 1978). The species has considerable commercial value in the northern and northeastern regions of Brazil, where it is generally found over sandy/muddy bottoms in shallow coastal waters and is also abundant in estuaries and stagnant brackish water.

The species has the following description: somewhat flat head; broadly curved snout; mouth located in the lower portion; three pairs of whiskers (1 pair in the maxillary region and 2 pairs on the head), the maxillary whiskers are near the mouth and extend toward the pectoral fins; the upper part of the head is hard and quite wrinkled, extending to approximately the eye region; villiform teeth in a broad, U-shaped palate; the total number of gill rakers in the first arch is 15 to 18; dorsal and pectoral fins with strong, erect spines; well-developed adipose fin; pectoral fins normally with 11 soft rays (Fischer, *op cit*).

Data collection

Sampling took place from November 2005 to August 2006, in six fishery áreas in the western coast of the state of Maranhão: Apeuzinho, Atim, Urumaru, Muricitil, Pericaua and Porto Rico (Figure 1). Fishes were collected using drifting gillnets operating at the surface, middle of the water column and bottom over two tide cycles. This fishing gear is made from monofilament nylon, 1.0 to 1.2 mm in diameter and mesh size between 95 mm and 100 mm. Fishing with this type of gear is carried out in deeper, wider bays and on the ocean at distances of five to 10 miles from shore.

Specimens were placed in plastic bags and conserved on ice until arriving at the laboratory. Voucher material was deposited in the Ichthyology Collection of the Federal University of Maranhão. The following attributes were determined for each specimen: total length (cm), total weight (g), sex, gonad weight (g) and maturity stage. In the determination of maturity stage, the following macroscopic aspects of the gonads were considered: size, coloration, transparency, surface vascularization, flaccidity, size in relation to abdominal cavity and, in the case of ovaries, the visualization of oocytes (Vazzoler, 1996).

In the estimation of minimum size at first maturity, the specimens were grouped into juvenile and adult categories according to gender. Juveniles were considered individuals with immature gonads. Relative frequencies per 3-cm length classes were plotted on graphs, thereby constructing a dispersion diagram of total length and percentage of adult males and females. This relationship exhibited a logistic form, with an inflection point corresponding to half of the frequencies and an asymptotic point corresponding to the total of frequencies, the adjustment of which was performed with the following equation: $f_r = 1 - e^{a l_t^b}$, in which:

f_r = relative frequency of adult individuals
e = basis of natural logarithms
a = condition factor related to the degree of weight gain of the individuals
b = constant related to the growth type of the individuals.

The logarithmic transformation of the empirical data was then performed, demonstrating a linear correlation between the variables involved based on the following expression:

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

where, fr = relative frequency of adult individuals; a = intersect; b = slope; L_t = total length.

Mean size at first maturity was considered that at which the median of the accumulated frequency (f_r = 0.5) provides an estimate of the length (Lt) at which the individuals reach maturity. Mean age at first maturity (t_{50}) was determined with the data on size at first maturity and the growth curve established by Azevedo (2007).

RESULTS

Total length of the specimens captured for the present study ranged from 30.1 to 56.7 cm for males and 29 to 67.1 cm for females. Mean length was 41.6 cm and 46.1 cm for males and females, respectively. Results from the analysis of size at first maturity based on the relative frequency distribution of adult males and females per length class are displayed in Table 1 and Figure 2-3. The graphically plotted values produced sigmoid curves, described by the following equations:

females: $fr = 1 - e^{1,57.10^{-7} L_t^{4,18}}$

males: $fr = 1 - e^{3.10^{-4} L_t^{2,19}}$

which were confirmed by the linearity of the logarithmic shape of these variables, generating the equations:

females: $\ln [- \ln (1 - f_r)] = -15.668 + 4.18 L_t$ ($R^2 = 0.90$)
males : $\ln [- \ln (1 - f_r)] = - 8.20 + 2.19 L_t$ ($R^2 = 0.95$)

The growth parameters for the species were obtained from Azevedo (2007), using the mean length of the formation of age bands on sagittal otoliths, which led to the following estimates:

Table I - Absolute (n) and relative (%) length frequency distribution of juvenile and adult specimens of *Sciades proops*.

Length (cm)	Females					Males				
	Immature		Mature		Total	Immature		Mature		Total
	n (F)	%	n (F)	%		n (M)	%	N (M)	%	
29 - 32	2	100.0	-	-	2	2	100.0	-	-	2
32 - 35	3	100.0	-	-	3	2	40.0	3	60.0	5
35 - 38	2	50.0	2	50.0	4	2	22.2	7	77.8	9
38 - 41	2	15.4	11	84.6	13	2	14.3	12	85.7	14
41 - 44	1	5.9	16	94.1	17	-	-	11	100.0	11
44 - 47	1	4.3	22	95.7	23	-	-	13	100.0	13
47 - 50	1	11.1	8	96.8	9	-	-	6	100.0	6
50 - 53	-	-	8	100.0	8	-	-	1	100.0	1
53 - 56	-	-	12	100.0	12	-	-	1	100.0	1
56 - 59	-	-	2	100.0	2	-	-	1	100.0	1
59 - 62	-	-	2	100.0	2	-	-	-		-
62 - 65	-	-	1	100.0	1	-	-	-		-
65 - 68	-	-	2	100.0	2	-	-	-		-
Total	12	-	86	-	98	8	-	55	-	63

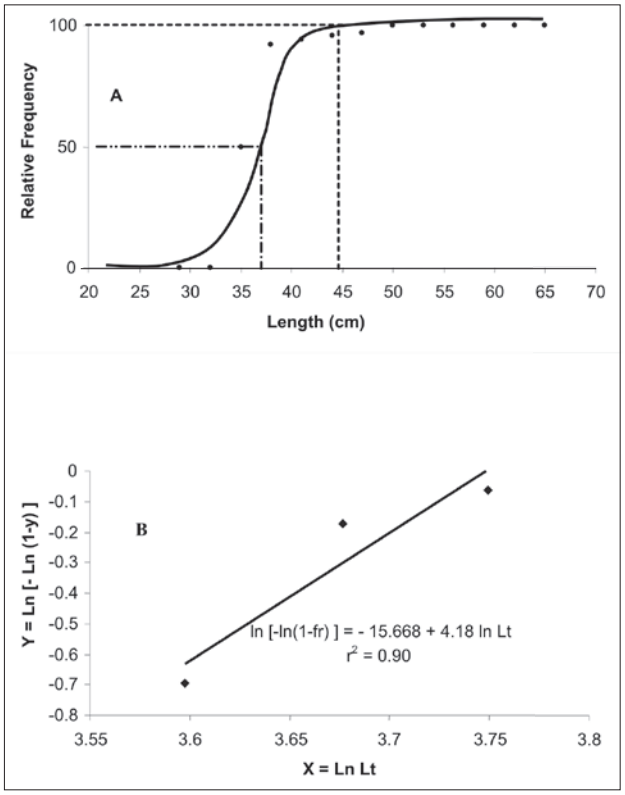

Figure 2 - Relative frequency of adults females by total length class (A) and logarithmic transformation (B) (L50 = first sexual maturation size).

Males: $L\infty$ = 59.68 cm, K = 0.28. yr^{-1}, t_0 = -1.52 year.
Females: $L\infty$ = 70.63 cm, K = 0.26.yr^{-1}, t_0 = -1.01 year.

Size at first maturity (length at which 50% of the specimens had maturing gonads) was estimated as 36.6 and 35.2 for females and males, respectively. L_{100} (length at which all individuals are ready to participate in the reproductive process) was estimated as 44.7 and 41.7 cm for females and males, respectively. The mean age at which the individuals reached first maturity was 1.7 years for females and 1.8 year for males.

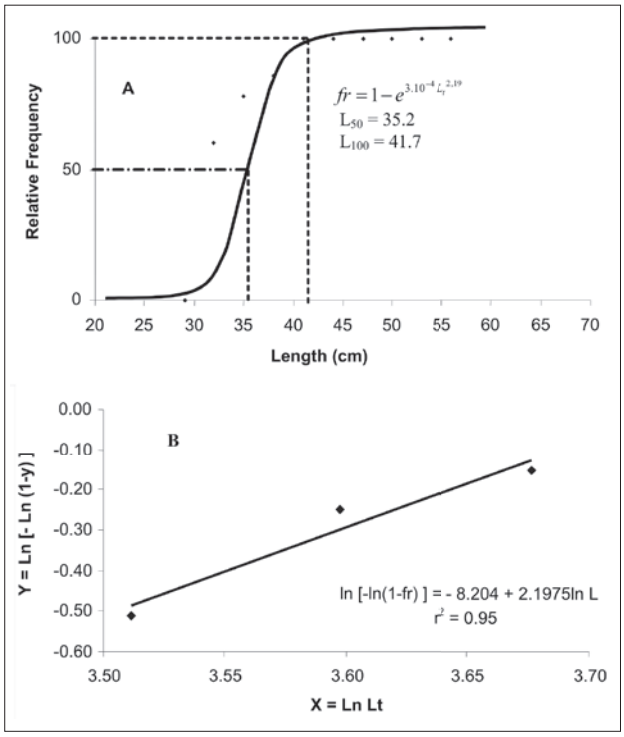

Figure 3 – Relative frequency of adults males by total length class (A) and logarithmic transformation (B) (L50 = first sexual maturation size).

DISCUSSION

Sexual maturity occurs throughout growth in size and the advance in age. It depends upon demographic conditions and is determined by both genetic as well as environmental aspects (Stearns & Crandall 1984). The beginning of sexual maturity represents a critical transition in the life of an individual. Prior to this phase, the allocation of time and energy is related to growth and survival. After the occurrence of this event, there is a potential conflict between the allocation of time and resources for reproduction and/or survival (Wootton, 1984). Sato & Godinho (1999) propose that size at first maturity is indicated by that of the smallest specimen caught in advanced stages of gonad maturity.

Data on size at first maturity of *S. proops* caught on the western coast of the state of Maranhão

(Brazil) indicate that males reproduce beginning at a mean length of 35.2 cm and females reach maturity beginning at a mean length of 36.6 cm. The mean length at which 100% of the individuals are ready to participate in the reproductive process was estimated at 41.7 and 44.7 for males and females, respectively. For the same species, Lecomte *et al.* (1989) found 51 cm to be the size at first maturity considering both genders in estuaries in French Guyana.

Vazzoler (1996) states that size at first maturity is a rather unstable reproductive tactic; it is closely related to growth and has intraspecific spatial and temporal variations related to both the biotic and abiotic environmental conditions prevalent in the region occupied or the period in which the population is submitted to such conditions. According to Vazzoler (1991), a number of tropical species reach maturity at 40 to 50% of asymptotic length (L_∞). However, first maturity for *S. proops* corresponded to 58.9% and 51.8% of asymptotic length for males and females, respectively, in the present study.

According to Nikolsky (1963), variations in food supply may also alter growth rate and first maturity, with increased growth and early sexual maturity when feeding conditions are advantageous. According to Pannela (1974), after reaching first maturity, tropical fish exhibit a reduction in growth rate, as a large portion of energy is channeled to the metabolic processes of reproduction, which is extended for a more or less long period of time. In the case of *S. proops*, this would explain the fact that females reach first maturity at a larger size than males, as they have a slower growth rate, which retards energy expenditure on reproduction activity.

The proposals that emerge in different studies on the subject suggest that the reflection of environmental changes in size and age of first maturity depends upon the effects over growth and mortality rates. Environmental changes that increase the growth rate generally lead to a drop in age at first maturity (Castro, 1999).

The results of the present study reveal a greater variation in the size of individuals as they initiate their participation in the reproductive cycle when compared to the findings described by Lecome *et al*. (1989). These differences may be associated to adaptation processes stemming from physiochemical and climatic variables, such as salinity, temperature and precipitation, as well as a response to the increase in fishing effort to which this species has been submitted.

Acknowledgements - The authors are grateful to Moaci Coimbra and Raimundo Nonato Junior for their help in laboratory and to fisherman José Patrício (Penheca) for catching the samples. We are also thankful to Richard Boike for his English assistance in the drafting of the manuscript and CNPq for a grant (PIBIC scholarship) to the first author.

REFERENCES

Andreata, J. V.; Barbieri, L. R. R.; Sebilia, A. S. B.; Sil va, M. H. C. & Santos, R. P. A list of Marapendi Lagoon fishes, Rio de Janeiro, Brazil. *Atlântica*, v.11, p.5-17, 1989.

Almeida, Z. S.; Castro, A. C. L.; Paz, A. C.; Ribeiro, D.; Barbosa, N. & Ramos, T. Diagnóstico da pesca artesanal no litoral do Estado do Maranhão, *in* Isaac, V. J.; Haimovici, M.; Martins, A. S. & Andrigueto, J. M. (org), *A pesca marinha e estuarina do Brasil no início do século XXI: Recursos, tecnologias, aspectos socioeconômicos e institucionais*. Universidade Federal do Pará. 188p., Belém, 2006

Araújo, F. G. Hábitos alimentares de três bagres marinhos (Ariidae) no estuário da Lagoa dos Patos (RS), Brasil. *Atlântica*, v.7, p.47-63, 1984

Araujo, F. G. Abundância relativa, distribuição e movimentos sazonais de bagres marinhos (Siluriformes, Ariidae) no estuário da Lagoa dos Patos, RS. *Rev. Bras. Zool.*, v.5, n.4, p.509-543, 1988.

Azevedo, J. W. J. *Estrutura populacional, crescimento e reprodução do uritinga, Sciades proops, (Valenciennes 1840) (Siluriformes, Ariidae), capturado no litoral Ocidental do Maranhão e desembarcado na Raposa, Ilha de São Luís-MA*. Monografia de graduação não publicada, Universidade Federal do Maranhão, 77p., São Luis, 2007.

Azevedo, M. C. C.; Araújo, F. G.; Cruz-Filho, A. G.; Gomes, I. D. & Pessanha, A. L. G. Variação espacial e temporal de bagres marinhos (Siluriformes, Ariidae) na Baía de Sepetiba, Rio de Janeiro. *Rev. Bras. Biol.* v.59, n.3, p.443-454, 1999.

Barbieri, G.; Santos, R. P. & Andreata, J. V. Reproductive biology of the marine catfish, *Genidens genidens* (Siluriformes, Ariidae), in the Jacarepaguá Lagoon system, Rio de Janeiro, Brazil. *Environ. Biol. Fish.*, v.35, p.23-35, 1992.

Castro, A. C. L. Características ecológicas da Ictiofauna estuarina da Ilha de São Luís-MA. *Bol.Lab. Hidrobiol.*, v.10, p.1-18, 1997.

Castro, A. C. L. Tamanho e idade de primeira maturação da corvina, *Plagioscion squamosisimus* (Heckel, 1840) (Acanthopterygii, Sciaenidae), do

reservatório de Barra Bonita – SP. *Bol. Mus. Para. Emílio Goeldi*, v.15, n.1, p.119-133, Belém, 1999.

Chaves, P. T. C. A incubação de ovos e larvas em *Genidens genidens* (Valenciennes) (Siluriformes, Ariidae) da Baía de Guaratuba, Paraná, Brasil. *Rev. Bras. Zool*., v.11, n.4. p.641-648, 1994.

Craig, I. D. H. Contribuição ao conhecimento da fauna íctica costeira da região de Peruíbe, SP. I: Família Ariidae. *Rev. Bras. Biol.*, v.40, n.4, p.755-758, 1980.

Fávaro, L. F.; Frehse, F. A.; Oliveira, R. N. & Junior, R. S. Reprodução do bagre amarelo, *Cathorops spixii* (Siluriformes, Ariidae), da Baía de Pinheiros, região estuarina do litoral do Paraná, Brasil. *Rev. Bras. Zool*., v.22, n.4, p.1022-1029, 2005.

Fischer, W. Species identifcation sheets for fishery purposes. *Western Central Atlantic* (Fishing Area 31), Rome. *FAO*, 1. sem paginação, 1978.

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

Giarrizzo, T. & Saint-Paul, U. Ontogenetic and seasonal shifts in the diet of the pemecou sea catfish *Sciades herzbergii* (Siluriformes: Ariidae), from a macrotidal mangrove creek in the Curuçá estuary, Northern Brazil. *Rev. Biol. Trop*., v.56, n.2, p.861-873, 2008.

Gomes, I. D. & Araújo, F. G. Reproductive biology of two marine catfishes (Siluriformes, Ariidae) in the Sepetiba Bay, Brazil. *Rev. Biol. Trop*., v.52, n.1, p.143-156, 2004.

Guedes, D. S. & Vasconcelos Filho, A. L. *Estudo ecológico da região de Itamaracá, Pernambuco, Brasil.* IX. Informações sobre alimentação dos bagres branco e amarelo (Pisces, Ariidae). Trabalhos Oceanográficos da Universidade Federal de Pernambuco, v.15, p.323-330, 1980.

Lecomte, F.; Meunier, F. J. & Rojas-Beltran, R. Donnes preliminiares sur la croissance de deux téléostéens de Guyane, *Arius proops* (Ariidae, Siluriforme) et *Leporinus friderici* (Anostomidae, Characoidei). *Cybium***.** v.10, n.2, p.121-134, 1986.

Lecomte, F.; Meunier, F. J. & Rojas-Beltran, R. Some data on the growth of *Arius proops* (Ariidae, Siluriforme) in the estuaries of French Guyana. *Aquatic Living Resource*, v.2, p.63–68, 1989.

Melo, S. C. & Teixeira, R. L. Distribuição, reprodução e alimentação de *Cathorops spixii* e *Arius rugispinis* (Pisces: Ariidae) do Complexo Mundaú/Manguaba, Maceió-AL. *Rev. Bras. Biol*. v.52, n.1, p.169-180, 1992.

Meunier, F. J. ; Rojas-Beltran, R.; Boujard, T. & Lecomte, F. Rythmes saisonniers de la croissance chez quelques Téléostéens de Guyane française. *Revue D'Hydrobiologie Tropicale,* v.27, n.4, p.423-440, 1994.

Mishima, M. & Tanji, S. Distribuição geográfica dos bagres marinhos (Osteichthyes, Ariidae) no complexo estuarino lagunar de Cananéia (25°S, 48°W). *Bol. Inst. Pesca***.,** v.8, p.157-172, 1981.

Mishima, M. & Tanji, S. Nicho alimentar de bagres marinhos (Teleostei, Ariidae) no complexo estuarino lagunar de Cananéia (25°S, 48°W). *Bol. Inst. Pesca*., v.9, p.131-140, 1982.

Nikolsky, G. V. The ecology of fishes. London, *Academic Press*, 352p., 1963

Oliveira, M. A. & Novelli, R. Idade e crescimento do bagre *Genidens genidens* na Baía da Lagoa do Açu, norte do Estado do Rio de Janeiro. *Tropical Oceanography*., v.33, n.1, p.57-66, 2005.

Pannela, G. Otolith growth patterns: an aid in age determination in temperate and tropical fishes. *in* Bagenal, T. B. (ed). Ageing of fishes. *Unwin Brothers*, Surrey. p.28–39, 1974.

Pedra, M. L. R.; Oliveira, M. A. & Novelli, R. Biologia alimentar do bagre *Genidens genidens* (Valenciennes, 1839) na Barra da Lagoa do Açu, norte do Estado do Rio de Janeiro. *Acta Biol. Leop.* v.28, n.1, p.38-41, 2006.

Reis, E. G. Reproduction and feeding habits of the marine catfish *Netuma barba* (Siluriformes, Ariidae) in the estuary of Lagoa dos Patos, Brazil. *Atlântica*, v.8, p.35-55, 1986.

Reis, R. E.; Kullander, S. O. & Ferraris, JR. C. J. Check list of the freshwater fishes of South and Central America. Porto Alegre, *EDIPUCRS*, 729p., 2003.

Rojas-Beltran, R. Quelques aspects de l'écologie alimentaire de trois mâchoirans (Teleostei, Siluriformes, Ariidae) de la Guyane. *Cybium*. v.13, n.2, p.181-187, 1989.

Santos, E. P. *Dinâmica de populações aplicada a pesca e piscicultura.* Hucitec e Ed. Universidade de São Paulo, São Paulo, Brasil, 129p., 1978.

Silva, G. C.; Castro, A. C. L. & Gubiani, E. A. Biologia reprodutiva do *Hexanematichthys proops* (Valenciennes, 1840) (Siluriformes: Ariidae) no litoral ocidental maranhense. *Iheringia*. Série Zoologia, Porto Alegre. v.27, p.383-389, 2007.

Stearns, S. C. & Crandall, R. E. Plasticity for age at sexual maturity: a life-history reponses to inavoidable stress; *in* Potts, G. W. & R. J. Wootton.

(eds), *Fish reproduction: strategies and tactics*. New York Academic Press. p.13–33, 1984.

Stride, R.K. *Diagnóstico da pesca artesanal marinha do Estado do Maranhão*. Projeto Pesca Artesanal, O.D.A./ FINEP/UFMA. 205p., 1992

Sato, Y. & Godinho, H. P. Peixes da bacia do rio São Francisco. p. 401-413; *in* LOWE MCCONNELL, R. H. (eds.), *Estudos Ecológicos de Comunidades de Peixes Tropicais*. São Paulo, EDUSP, 534p., 1999.

Wootton, R. J. Introduction: strategies and tactics in fish reproduction, *in* Potts, G. W. & R. J. Wootton (eds.), *Fish Reproduction: strategies and tactics*. New York Academic Press, p.1–12, 1984.

Vazzoler, A. E. A. M. Síntese de conhecimentos sobre a biologia da corvina, *Micropogonias furnieri* (Desmarest, 1928), da costa do Brasil. *Atlântica*, v.13, p.55-74, 1991.

Vazzoler, A. E. A. M. *Biologia da reprodução de peixes teleósteos: Teoria e prática*. Maringá: Eduem/SBI/ CNPq/Nupelia, 169p., 1996.