Age and growth of the Brazilian sharpnose shark, *Rhizoprionodon lalandii* and Caribbean sharpnose shark, *R. porosus* (Elasmobranchii, Carcharhinidae) on the northern coast of Brazil (Maranhão)

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Abstract. Age and growth of *R. lalandii* and *R. porosus* were estimated from vertebrae age bands off northern Brazil. Marginal increment values were estimated in order to identify a tendency toward annual band formation, with this pattern assumed for both species. There was no significant difference in growth between sexes and the estimated parameters were: L_∞ = 78.10 cm; k = 0.301; t_0 = -1.463 years for *R. lalandii* and L_∞ = 112.99 cm; k = 0.171; t_0 = -1.751 years for *R. porosus*. Age ranged from one to six years for *R. lalandii*, with an age at first maturity (t_{mat}) of 2.6 years; the majority of the sample was formed by adult individuals (61.9%). For *R. porosus*, age ranged from less than one year (0^+) to five years, with t_{mat} = 3.3 years; the majority of the sample was made up of juveniles (72.4%). Contrary to what was found for *R. lalandii*, the estimated L_∞ for *R. porosus* was much greater than the maximum length in this sample (85.5 cm). This is attributed to the selectivity of the gillnet, which is gear that catches *R. lalandii* individuals in all age classes and *R. porosus* individuals up to five years of age.

Keywords: Vertebrae, Age structure, Age at first maturity, Maximum age

Resumo. Idade e crescimento do tubarão figuinho, *Rhizoprionodon lalandii* e do tubarão rabo seco, *R. porosus* (Elasmobranchii, Carcharhinidae) na costa norte do Brasil (Maranhão). A idade e o crescimento de *R. lalandii* e *R. porosus* foram estimados à partir da contagem de anéis etários presentes nas vértebras. Valores de incremento marginal estimados mostraram uma tendência de formação anual do anel, para ambas as espécies. Não houve diferença significativa no crescimento entre os sexos, e os parâmetros estimados foram: L_∞ = 78,10 cm; k = 0,301; t_0 = -1,463 anos para *R. lalandii* e L_∞ = 112,99 cm; k = 0,171; t_0 = -1,751 anos para *R. porosus*. As idades variaram entre 1 e 6 anos para *R. lalandii*, com uma idade de primeira maturação (t_{mat}) de 2,6 anos, e a maioria da amostra formada por indivíduos adultos (61,9%). Já para *R. porosus*, foram amostrados indivíduos com menos de um ano (0^+) até 5 anos de idade, e t_{mat} = 3,3 anos, e a maior parte da amostra formada por indivíduos jovens (72,4%). O L_∞ estimado para *R. porosus* foi muito superior ao comprimento máximo da espécie na amostra (85,5 cm). Tal fato parece estar vinculado à seletividade da rede de emalhar, onde esta rede captura indivíduos em todas as classes de idade para *R. lalandii* e até os 5 anos de idade para *R. porosus*.

Palavras-chave: Vértebra, Estrutura etária, Idade de primeira maturação, Idade máxima

Introduction

Several elasmobranch populations throughout the world have been depleted due to overexploitation (Baum *et al.* 2003). Despite the low number of fisheries that effectively target sharks and rays, they have been heavily exploited in the world as bycatch (Stride *et al.* 1992, Yokota & Lessa 2006). The high fishing effort exerted over elasmobranch populations, along with their biological and ecological characteristics (high longevity, low fecundity and late age at first maturity), makes them vulnerable to excessive

mortality due to fisheries (Holden 1974). For this reason, population assessments on elasmobranches are need for determining both the risks brought about by exploitation and how to circumvent these risks through management measures (Walker 2007). Information on age is the basis for growth rate, mortality and productivity estimates, composing input data for age-based stock assessment methods (Campana 2001), which are especially needed for exploited populations.

Among the seven shark species of the genus *Rhizoprionodon* spread throughout the world, two are recorded for Brazil: The Brazilian sharpnose shark (*R. lalandii*) and the Caribbean sharpnose shark (*R. porosus*). Both species are only found in the western Atlantic from Central America to Uruguay, including the entire Brazilian coast (Compagno 1984). Despite sharing the same habitats, the abundance of each species varies according to region. Along the southeastern and southern coast of Brazil, *R. lalandii* is more abundant than *R. porosus* (Ferreira 1988, Motta *et al.* 2005), whereas the opposite pattern is recorded throughout the northern and northeastern regions (Lessa 1986, Lessa 1988a, Menni & Lessa 1998; Yokota & Lessa 2006).

Along the coast of the state of Maranhão (northeastern Brazil) (1º35'S/46º W to 3º S/42W), these two species are incidentally caught using gillnets that target the Brazilian Spanish mackerel (*Scomberomorus brasiliensis*) and acoupa weakfish (*Cynoscion acoupa*) (Stride *et al.* 1992, Menni & Lessa 1998), operating in coastal waters to depths of 40 m. In landings between 1990 and 2000, *R. porosus* ranked the second most frequent elasmobranch species, making up 20.5% of total catches, whereas *R. lalandii* ranked the fifth, corresponding to 5% of the total number of elasmobranches caught (Lessa 1986, Lessa & Menni 1994).

Studies on *R. lalandii* and *R. porosus* have focused on diet (Silva & Almeida 2001), genetics (Mendonça *et al.* 2009, Pinhal *et al.* 2009), occurrence, length frequency (Motta *et al.* 2005) and reproductive biology (Menni & Lessa 1998, Ferreira 1988, Lessa 1988b, Machado *et al.* 2000, Mattos *et al.* 2001, Motta *et al.* 2007, Andrade *et al.* 2008). Although extensively studied due to the wide range of distribution, age and growth aspects have not yet been investigated for either species.

The Brazilian sharpnose shark is included on the IUCN red list as "data deficient" (Rosa *et al.* 2004), whereas the Caribbean sharpnose shark is listed in the "least concern" category (Lessa *et al.* 2006). In Brazil, neither species has yet been included on the National List of Endangered or Overexploited Species (Brasil 2004). Nonetheless, as subsidizing policies that foster exploitation have brought about an overall decrease in CPUE for sharks in coastal areas of Brazil, age and growth information is required in order to appropriately assess the status of these species using age-based methods. Thus, the specific aims of the present study were to provide growth parameters derived from vertebral analyses for both species, with the aim of contributing toward the management of these species in northern/northeastern Brazil.

Materials and methods

From 1984 to 1989, specimens of both species were collected on fishing operations targeting the Brazilian Spanish mackerel (*Scomberomorus brasiliensis*) using sailing boats equipped with gillnets measuring up to 900 m in length, 7.5 m in height and mesh size of 8.0 cm mesh size. In 1998, motorized boats used a 1200 m net with similar a mesh size. Fishing operations were carried out in areas with depths ranging from 6 to 40 m on four to seven-day trips along the coast of the state of Maranhão (1º35'S/46º W to 3º S/42' W) between Tubarão and Turiaçú bays (Fig. 1).

The natural total length (TL) and sex were recorded for each individual and a block of approximately 5 vertebrae was removed from the region just below the first dorsal fin. The vertebrae were cleaned of excess conjunctive tissue, fixed in 4% formaldehyde for 24 h and preserved in 70% alcohol. The vertebrae were embedded in polyester resin, labeled and cut with the aid of a low-speed metallographic saw and diamond cutting disk. Two to three longitudinal cuts were performed on each vertebra in order to reach section that passed precisely through the nucleus of the vertebra. Each vertebral body was sectioned on the frontal plane, as suggested by Cailliet *et al.* (1983), at a thickness of approximately 0.3 mm. The growth rings, made up of translucent (narrow) and opaque (wide) bands (Casselman 1983), were observed and measured on each cut using a stereomicroscope at a magnification of 10 x and the aid of a micrometric ocular, which enabled measuring the distances necessary for the estimation of the marginal increment (MI) and back-calculated lengths.

The linear relation between the radius of the hard structure (distance form the nucleus to the edge of the structure) and the length of the individuals from each species were estimated. The difference between sexes was compared using analysis of covariance (ANCOVA). To estimate the accuracy of the ring counts, two readings were

performed on different occasions, with no knowledge regarding the length of the individuals. The index of average percentage error (IAPE) was estimated for each age class, following the method described by Campana (2001).

$$IAPE = 100\% \times \frac{1}{R} \times \sum_{i=1}^{R} \frac{\left| X_{ij} - \overline{X_j} \right|}{\overline{X_j}}$$

in which N = number of vertebrae; R = number of readings performed on individual j; X_{ij} = age i determined for individual j; X_j = mean age

calculated for individual j.

MI values were calculated for each individual and mean monthly values were estimated using the following formula:

$$MI = \frac{VR - R_n}{R_n - R_{n-1}}$$

in which VR = distance between the nucleus and edge of the hard structure; R_n = distance between the nucleus and last ring; R_{n-1} = distance between the nucleus and penultimate ring.
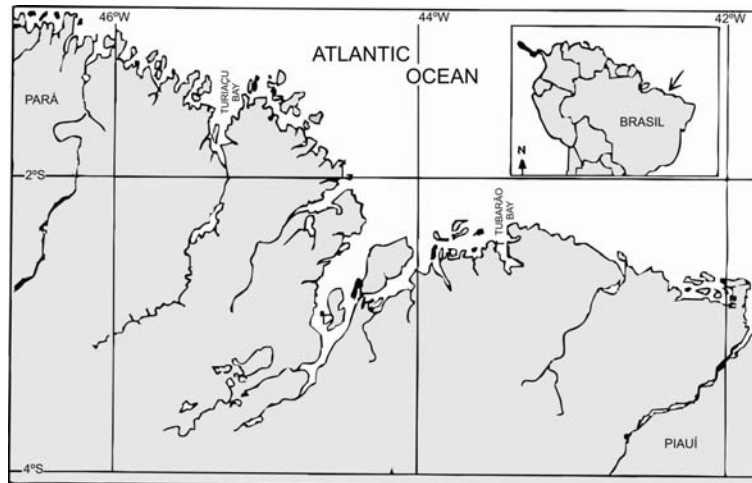

Figure 1. Location of the sampling area for the Brazilian sharpnose shark (*Rhizoprionodon lalandii*) and Caribbean sharpnose shark (*R. porosus*) collected off Maranhão state.

The lengths of the individuals at previous ages were back-calculated from measurements between the nucleus and each ring in the structure, following the method described by Fraser-Lee, which assumes a linear relation in the proportionality between the two variables (Francis 1990):

$$L_t = \left(\frac{R_t}{VR} \right) \times (L_c - a) + a$$

in which L_t = is the back-calculated length corresponding to age t; R_t = distance between the nucleus and each ring at age t; VR = radius of the structure; L_c = length at the time of capture; a = interception of the regression between VR and L_c.

Five models were adjusted to the age and length data (observed and back-calculated): The von Bertalanffy growth function (VBGF) (von Bertalanffy 1938) (g1); the generalized VBGF (g2) and the logistic model (g3) described by Katsanevakis (2006); and the Gompertz (g4) and Richards (g5) models described by Schnute (1981):

$$g1: L_t = L_\infty \times \left[1 - e^{-k \times (t - t_0)} \right]$$

$$g2: L_t = L_\infty \times \left[1 - e^{-k \times (t - t_0)} \right]^p$$

$$g3: L_t = L_\infty \times \left[1 + e^{-k \times (t - t_0)} \right]^{-1}$$

$$g4: L_t = L_\infty \times e^{\left[-a \times e^{(-k \times t)} \right]}$$

$$g5: L_t = \frac{L_\infty}{\left[1 + e^{(-k \times t + b)} \right]^m}$$

in which L_t is predicted length at age t; L_∞ is the mean asymptotic total length; k is the growth coefficient; t_0 is the age when length is theoretically zero, and p, a, b and m are constants of the models.

The parameters of these models were estimated using the Solver function on the Excel program. The likelihood tools and bootstrap iteration functions of the PopTools program (Hood 2006) were used to generate confidence intervals for each parameter based on minimum likelihood. The modified von Bertalanffy model was also used, which allows estimating the size at birth of the species studied (L_0) (Semba *et al.* 2009):

$$L_t = L_0 + (L_\infty - L_0) \times \left[1 - e^{-k \times t} \right]$$

Model selection was carried out using the

Akaike information criterion (AIC), which reveals a better adjusted curve for the model with the lowest AIC (Katsanevakis, 2006):

$$AIC = -2 \times \log(\ell(\theta/data)) + 2K$$

in which $\log(\ell(\theta/data))$ is the numerical value of the log-likelihood at the minimal point; θ is the vector of the estimated parameters of the model; and K is the number of estimated parameters. Comparisons of growth curves by sex were based on the likelihood test for the curve with the best AIC (Cerrato, 1990).

Results

Eighty-four specimens of *R. lalandii* were collected, with lengths ranging from 48 to 76.5 cm and a modal length of 56 cm (Figure 2a). There was no significant difference in length between genders (Kolmogorov-Smirnov two-sample test, P > 0.05) (Figure 2a). The *R. porosus* sample (134 specimens) was composed of 101 males (75.4%), ranging in length from 37.6 to 85.5 cm (mean = 59.2 cm), with a bimodal frequency distribution (modal classes = 50 and 66 m); and 33 females, with lengths ranging from 37.9 to 80.5 cm (mean = 52.5 cm). There was a significant difference in length between sexes (Kolmogorov-Smirnov two-sample test, P < 0.05) (Fig. 2b).
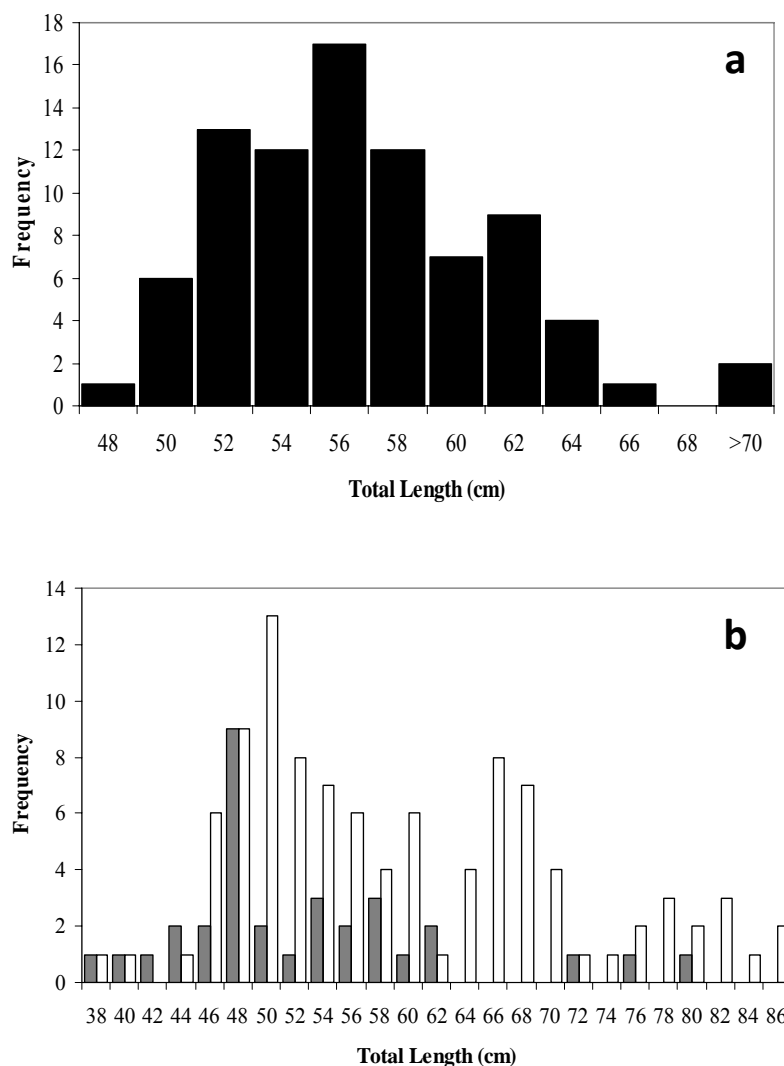

Figure 2. Length-frequency distributions for the Brazilian sharpnose shark, *Rhizoprionodon lalandii* (a) and Caribbean sharpnose shark, *R. porosus* (b) caught off Maranhão state (black bars=sex together, white bars = males; grey bars = females).

There were no significant differences between sexes regarding the relation of the vertebral radius and total length (ANCOVA, P > 0.05) for either species. The regression for both sexes combined resulted in the equation $TL = 8.463 \times VR + 25.735$ (r^2 = 0.912) for *R. lalandii* and the equation $TL = 10.952 \times VR + 18.670$ (r^2 = 0.899) for *R. porosus*. The IAPE value for *R. lalandii* ranged from 4.4% for the four-ring class (n = 18) to 6.3% for the two-ring class (n = 17), with a mean error of 4.6% for the overall sample between the two readings. For *R. porosus*, the two-ring class had the highest IAPE value (7.2%, n = 51) and the six-ring class had the lowest (2.7%, n = 3); the IAPE for the overall sample was 3.4%.

The *R. lalandii* individuals were not caught between March and May, but there was a tendency toward an increase in MI at February and June, with a drop between July and November (Fig. 3a). The *R. porosus* specimens were only caught between April and September, which does not allow accuracy in the determination of an annual growth ring. The lowest monthly MI was estimated in April and the highest in September, which allows reflecting on the hypothesis of the formation of an annual ring in the months prior to and close to April (Fig. 3b). For both species, the data do not allow an accurate identification of the period of new ring formation and it was therefore assumed that each ring is formed annually.

Back-calculated length for the time of birth corresponded to 26.95 cm for *R. lalandii* and 29.02 for *R. porosus*. Both species exhibited a similar pattern of annual growth (observed from the back-calculated lengths) of around 12 cm in the first year and, in the last year, 4.5 cm for *R. lalandii* and 6.6 cm and *R. porosus* (Table I).
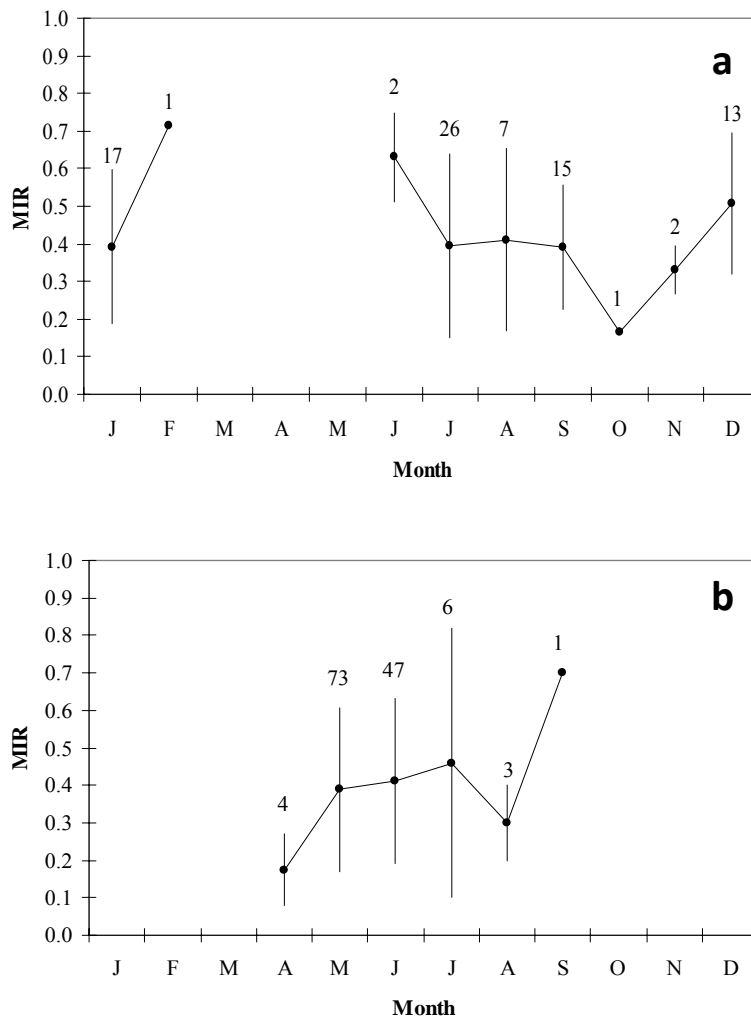

Figure 3. Mean vertebral marginal increment (MI) by month for the Brazilian sharpnose shark, *Rhizoprionodon lalandii* (a) and Caribbean sharpnose shark, *R. porosus* (b). Vertical bars are standard deviation of means.

Table I. Mean back-calculated (BC) and observed length-at-age (OL) data for Brazilian sharpnose shark (*Rhizoprionodon lalandii*) and Caribbean sharpnose shark (*R. porosus*) collected off Maranhão state (SD=standard deviation).

Age (yr)	*R. lalandii*				*R. porosus*			
	BC (cm)	SD	OL (cm)	SD	BC (cm)	SD	OL (cm)	SD
0	26.95	1.49	-	-	29.02	1.08	42.26	2.37
1	39.68	2.93	51.12	1.60	41.53	1.34	49.10	2.95
2	48.81	2.21	55.65	2.46	52.36	1.48	57.88	4.94
3	56.16	1.22	60.13	2.32	62.07	1.87	67.78	4.08
4	62.31	0.21	64.22	1.07	70.46	1.53	76.10	5.97
5	68.14	0.00	-	-	77.08	0.00	79.83	4.65
6	72.68	0.00	76.09	0.60	-	-	-	-

All back-calculated lengths for each age were used to estimate the growth curves. For *R. lalandii*, the model that best fit the data was the generalized VBGF (g2), but due to the high values of the parameters and their respective confidence intervals, this model was discarded and the VBGF (g1), which had the second best fit, was used (Table II). For *R. porosus*, the model with the best fit was the VBGF (g1) (Table II). L_0 values calculated by the modified VBGF for both species (*R. lalandii* – 27.86 cm; *R. porosus* – 29.22 cm) were similar to those described using the mean back-calculated lengths for age 0. The likelihood test revealed no significant difference in growth between sexes for either species, which resulted in growth curves for combined sexes.

R. lalandii has very fast growth. The L_∞ value was close to its maximal length (L_{max}=76.5 cm) (Table II, Fig. 4) and age ranged from 1 to 6 years (Fig. 5a), with the majority of individuals in the two-year-old class. According to Lessa (1988b), size at first maturity for the species in the state of Maranhão is 49 cm, but other authors report figures ranging from 50 to 66 cm (Ferreira, 1988, Motta *et al.* 2007, Andrade *et al.* 2008). Thus, we assumed a mean size at first maturity of 55 cm, corresponding to an age of 2.6 years. The majority of individuals in the sample (61.9%) were adults.
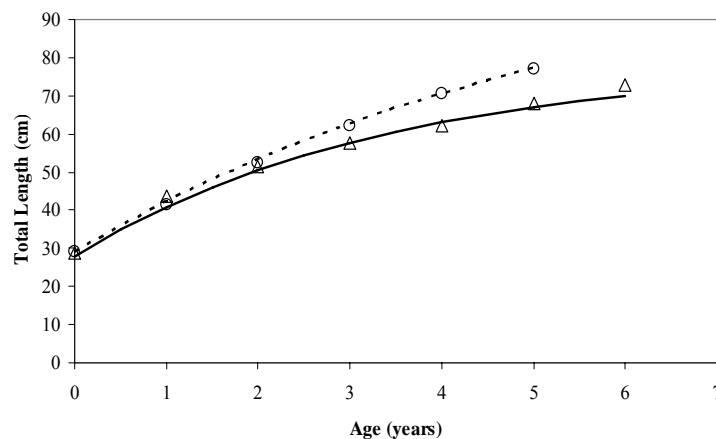

Figure 4. von Bertalanffy growth curves generated for Brazilian sharpnose shark, *Rhizoprionodon lalandii* (full line) with the mean back-calculated length-at-age (Δ) and for Caribbean sharpnose shark, *R. porosus* (dotted line) and the mean back-calculated length-at-age (O) off Maranhão state.

For *R. porosus*, estimated L_∞ was much higher than the maximal length found in the sample (85.5 cm) and the *k* value reveals that the species also has fast growth, but nearly

half that estimated for *R. lalandii* (Table II, Fig. 4). Ages varied from 0^+ to 5 years, with the majority of individuals at 1 year of age (Fig. 5b). Machado *et al.* (2000) and Mattos *et al.* (2001) describe a size at first maturity of around 65 cm, which results in an age at first maturity of 3.3 years. The majority of the sample was made up of juveniles (72.4%).
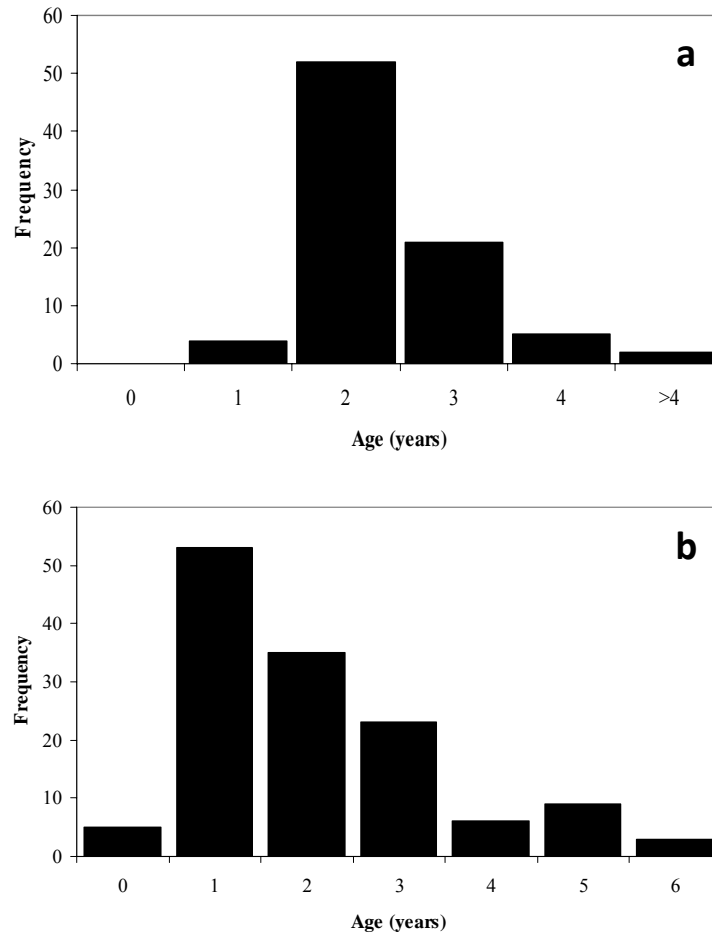

Figure 5. Age composition of the sample of Brazilian sharpnose shark, *Rhizoprionodon lalandii* (a) and Caribbean sharpnose shark, *R. porosus* (b) collected off Maranhão state.

Discussion

Marginal increment analysis for *R. lalandii* and *R. porosus* did not allow accuracy in the identification of the formation of an annual growth ring due to the small number or absence of individuals in some months. However, using the example of the pattern for other species of the genus, annual formation is most likely, as demonstrated for *R. taylori* (Simpfendorfer 1993) and *R. terraenovae* (Parsons 1985, Branstetter 1987, Carlson & Baremore 2003, Loefer & Sedberry, 2003).

Little is known regarding the growth of species of *Rhizoprionodon* along the coast of Brazil. According to Branstetter (1990), Camhi *et al.* (1998) and Smith *et al.* (1998), species of small coastal sharks in the northern hemisphere have very fast growth, as is the case of the two species studied here. However, the growth of these two species, while fast, is slower than that of other species from the same genus (Table III). Analyzing the growth curves for the first year of life, the growth rate for the two species is of the same magnitude (approximately 13 cm/year), diminishing in the second year of life. The growth rate in the juvenile phase is similar between the two species (11.4 and 11.2 cm/year), with an abrupt reduction in the adult phase (> 2 years) for *R. lalandii* (4.8 cm/years), whereas *R. porosus* has a growth rate of 7.3 cm/year beginning at three years of age.

Table II. Comparison of the principals parameters (L_∞ and k) estimated with the different models for *Rhizoprionodon lalandii* and *R. porosus*, with respectives values of standard error (SE), Confidence intervals for 95% (Lower and Upper CI) and Akaike's information criterion (AIC) for each

Model	Maximum asymptotic size ($L\infty$)				Growth coefficient (k)				AIC
	Estimated	SE	Lower CI	Upper CI	Estimated	SE	Lower CI	Upper CI	
R. lalandii									
g1: VBGF[a]	78.103	0.061	74.681	82.18	0.301	0.001	0.268	0.336	1140.837
g2: Generalized[b]	99.103	7.221	78.489	1002.4	0.11	0.003	<0.001	0.278	1136.611
g3: Logistic[c]	67.388	0.03	65.641	69.299	0.73	0.001	0.686	0.776	1181.014
g4: Gompertz[d]	71.012	0.038	68.893	73.572	0.51	0.001	0.473	0.548	1157.573
g5: Richards[e]	70.747	0.049	67.087	73.161	0.524	0.002	0.479	0.731	1161.041
R. porosus									
g1: VBGF[f]	112.99	0.228	101.605	129.717	0.171	0.001	0.136	0.206	1596.891
g2: Generalized[g]	112.486	15.763	88.659	2034.42	0.173	0.003	<0.001	0.387	1598.895
g3: Logistic[h]	80.039	0.05	77.089	83.183	0.629	0.001	0.589	0.67	1610.766
g4: Gompertz[i]	88.279	0.085	83.687	94.582	1.101	0.001	0.356	0.435	1600.743
g5: Richards[j]	86.642	0.124	77.635	92.702	0.429	0.003	0.369	0.707	1603.765

Other parameters: *R. lalandii* - [a]t_0 = -1.463 and L_0 = 27.857; [b]t_0 = -0.763 and p = 0.506; [c]t_0 = 0.451; [d]a = 0.930; [e]b = -2.731 and m = 14.647; *R. porosus* - [f]t_0 = -1.751 and L_0 = 29.220; [g]t_0 = -1.760 and p = 1.007; [h]t_0 = 0.855; [i]a = 1.101; [j]b = -1.857 and m = 7.455.

Table III. Comparison of VBGF parameters of small coastal species of sharks reported by different authors (M – male; F – female).

Species	L∞ (cm TL)	k	t0 (years)	n	Author
Rhizoprionodon lalandii	78.1	0.3	-1.46	84	Presente study
Rhizoprionodon porosus	112.9	0.17	-1.75	134	Presente study
Rhizoprionodon terraenovae	92.5	0.45	-2.01	215	Parsons (1985)
Rhizoprionodon terraenovae	108	0.36	0.98	20	Branstetter (1987)
Rhizoprionodon terraenovae	94	0.73	-0.88	304	Carlson and Baremore (2003)
Rhizoprionodon terraenovae	98.3(M)/98.8(F)	0.50(M)/0.49(F)	-0.94(M)/-0.91(F)	116(M)/123(F)	Loefer and Sedberry (2003)
Rhizoprionodon taylori	65.2(M)/73.2(F)	1.34(M)/1.01(F)	0.41(M)/0.45(F)	52(M)/85(F)	Simpfendorfer (1993)
Carcharhinus acronotus	130.3(M)/139.3(F)	0.21(M)/0.18(F)	-3.90(M)/-4.07(F)	104(M)/117(F)	Driggers *et al.* (2004)
Carcharhinus porosus	136.4	0.08	-3.27	504	Lessa e Santana (1998)
Isogomphodon oxyrhynchus	171.4	0.12	-2.61	105	Lessa *et al.* (2000)
Sphyrna tiburo	89.7(M)/122.6(F)	0.69(M)/0.28(F)	-0.04(M)/-0.79(F)	50(M)/65(F)	Carlson and Parsons (1997)

Specimens of *R. lalandii* were caught in all phases of life, with a maximal length in the sample of 76.5 cm, which is near to the maximal length of 77 to 78 cm reported in the literature (Compagno 1984, Motta *et al.* 2005, Andrade *et al.* 2008), and a L_∞ close to the L_{max} (only 2% greater). The sample was made up of individuals of all ages – from one to six years. In a study carried out by Simpfendorfer (1993) on *R. taylori*, which has a similar maximal length to that of *R. lalandii*, maximal age was seven years, but with a much greater growth constant ($k = 1.337$ for males and 1.013 for females).

Maximal age for *R. lalandii* reveals one of the shortest lifecycles among species of small coastal sharks. Loefer & Sedberry (2003) and Carlson & Parsons (1997) found a maximal age of 11 years for *R. terraenovae* and *Sphyrna tiburo* respectively. Maximal age for *Carcharhinus porosus* (Lessa & Santana, 1998) and *Isogomphodon oxyrhynchus* (Lessa *et al.* 2000) has been found to be 12 years and *C. acronotus* (Driggers *et al.* 2004) can reach 19 years. The rapid growth, early maturation and short lifecycle of the Brazilian sharpnose shark reveal that the species must be exposed to high levels of predation by larger sharks. According to Branstetter (1990), predation on sharks under 100 cm is high due to the lesser swimming ability and more edible size. In agreement with this author, the biological characteristics of *R. lalandii* suggest that the species must undergo high natural mortality and, when added to the considerable fishery efforts, this situation may place the equilibrium of the population at risk.

For *R. porosus* on the coast of the state of Pernambuco (northeastern Brazil), the maximal age of 10 years would correspond to an individual 100.5 cm in length, with an estimated L_∞ of 111.2 cm (Montealegre-Quijano 2002). However, the maximal age for the individuals on the coast of the state of Maranhão (present sample) was five years, corresponding to a $L_{max} = 85.5$ cm and $L_\infty = 113$. Montealegre-Quijano (2002) suggests the formation of two rings per year, whereas other studies on species from the genus *Rhizoprionodon* have demonstrated the formation of one annual ring (Parsons 1985, Branstetter 1987, Simpfendorfer 1993, Carlson & Baremore 2003, Loefer & Sedberry 2003). Similarly to the finding described by Montealegre-Quijano (2002), estimated L_∞ in the present study was similar to that maximal length (110 cm) mentioned by Compagno (1984) for the species. Although the growth coefficient for *R. porosus* is lower than that for *R. lalandii*, Branstetter (1990) reports that shark species with

higher k values than 0.1 can be considered as having fast growth, which is a pattern linked to habitat as well as the biological and ecological characteristics of the species. Furthermore, gillnets directed at species of boney fish incidentally catch *R. lalandii* individuals of all age classes beginning at one year of age as well as *R. porosus* juveniles (72.4%) and adults up to five years of age. The strong influence on this selectivity pattern from the fishing gear is demonstrated by the mean lengths and ages of the two species, which were quite similar (*R. lalandii* – 56.5 cm, 3 years; *R. porosus* – 57.6 cm, 2.6 years).

The considerable fishery efforts directed at *R. lalandii* and juvenile *R. porosus* specimens in the state of Maranhão by the artisanal fleet, along with the biological and population characteristics of the two species (such as high natural mortality), may affect the equilibrium of the population. Thus, management measures are needed that prioritize changes in the selectivity of the fishing gear and a reduction in fishery efforts through the establishment of protected areas in order to ensure the sustainability of these important elements of the biodiversity of northern Brazil.

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