

Growth parameters of *Pontoporia blainvillei* and *Sotalia fluviatilis* (Cetacea) in northern Rio de Janeiro, Brazil

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Abstract

Growth parameters of 93 *Pontoporia blainvillei* and 84 *Sotalia fluviatilis* accidentally captured in gillnets or stranded along the sea coast of northern Rio de Janeiro State, Brazil (21°37'–22°25'S) were analysed (1989–96). Data of length-at-age was fitted by non-linear Gompertz model. Growth parameters estimated for *P. blainvillei* were: sexual dimorphism in body length significant only to four years, so, length range of 0–3 years not showed growth differentiated; asymptotic length of 117.1 cm for males and 144.7 cm for females; length at birth of 71.0 cm; prenatal growth rate of 0.25 cm/day; birth occur in all seasons; males and females attain sexual maturity at two years, 115.0 cm and at three years, 130.0 cm, respectively. *S. fluviatilis* presented non sexual dimorphism in body length; asymptotic length of 191.7 cm for males and females; length at birth of 106.0 cm; prenatal growth rate of 0.31 cm/day; birth occur from spring to autumn, with a peak during autumn; males and females attain sexual maturity at six years, with 180.0 cm for male and 160.0 cm for females. The results of the present study suggest that there are alterations in the reproductive investment in *P. blainvillei*. Probably, this species varies its growth strategies along its distribution. *S. fluviatilis* showed patterns similar to those observed for other populations of this species.

Key words: *Pontoporia blainvillei*, *Sotalia fluviatilis*, growth, birth, sexual maturity, Cetacea.

Introduction

Populations of *Pontoporia blainvillei* and *Sotalia fluviatilis* have been affected by fisheries along their geographic range (Siciliano, 1994). The northern range of *P. blainvillei* extends to Itaúnas, Espírito Santo State (18°S), Brazil (Siciliano, 1994) and the southernmost is inside Golfo Nuevo (42°S),

Argentina (Crespo *et al.*, 1998). Analyses of morphological variations of *P. blainvillei* showed this species presents two ecotypes: a smaller form, that occurs from Rio de Janeiro to Santa Catarina, Brazil (22°–27°S) and a larger form that ranges from Rio Grande do Sul, Brazil to Argentina (32°–38°S) (Pinedo, 1991). Some authors suggest that the two geographical forms represent two population stocks (Pinedo, 1991; Secchi *et al.*, 1998). Growth and reproductive biology of *P. blainvillei* is well described for specimens obtained in Uruguayan waters (Harrison & Brownell, 1971; Kasuya & Brownell, 1979; Harrison *et al.*, 1981; Brownell, 1984).

S. fluviatilis occurs as far north as the Caribbean, from the Honduras coast (15°N) (da Silva & Best, 1996) to Santa Catarina State (27°S), Brazil (Simões-Lopes, 1987). There are two different ecotypes of *S. fluviatilis*: marine and fluvial forms (Borobia *et al.*, 1991; da Silva & Best, 1996). These two ecotypes can be recognized based on variation of the dimensions of the cranium and body size. The fluvial form is smaller than the marine form (Borobia & Sergeant, 1990). Although *S. fluviatilis* is frequent in the southeastern coast of Brazil, information on its reproductive cycles is scarce. Characteristics of the growth of this species were studied only in specimens from the coasts of São Paulo and Paraná (24°–25°S), Brazil (Schmiegelow, 1990).

In northern Rio de Janeiro, gillnets were responsible for the accidental capture of 353 dolphins between 1989 and 1996. During this period, 127 *P. blainvillei*, 78 *S. fluviatilis*, 5 *Tursiops truncatus*, 2 *Steno bredanensis*, 1 *Stenella frontalis*, 1 *Pseudorca crassidens*, and 139 unidentified specimens were reported. Most of the accidental captures occurred at less than 5 nm off the coast and at a depth of less than 20 m (Di Benedetto *et al.*, 1998). An analysis of age structure of *P. blainvillei* and *S. fluviatilis* showed that the most represented age-classes were between newborn to two years old for *P. blainvillei*

and between four to six years old in *S. fluviatilis* (Ramos, 1997).

Information on the growth in individuals of *P. blainvillei* and *S. fluviatilis* that inhabit the area north of Rio de Janeiro is necessary to establish comparisons with individuals of other geographic areas and to develop a comprehensive management plan aimed at the conservation of all populations under human impact. Therefore, the purpose of the present study was to obtain growth parameters from *P. blainvillei* and *S. fluviatilis* accidentally captured in fisheries or stranded in northern Rio de Janeiro, and to verify whether there are differences in the growth strategies of these two species in relation to other populations.

Material and Methods

A total of 93 *P. blainvillei* (43 males; 48 females; 2 sex unidentified) and 84 *S. fluviatilis* (48 males; 29 females; 7 sex unidentified) accidentally captured in fisheries or stranded along the sea coast of northern Rio de Janeiro (21°37'–22°25'S) from 1989 to 1996 were analysed. Six fetuses of *P. blainvillei* and three of *S. fluviatilis* were collected from pregnant females. We included in the sample analysed, more two fetuses of *P. blainvillei* and one of *S. fluviatilis* analysed by Lodi *et al.* (1987) and Lodi & Capistrano (1990).

Age was estimated through the number of growth layers group present in the dentine and cement. *Growth layer group* (GLG) is a generic term, and it is used to define groups of incremental growth layers, which may be recognized by virtue of a cyclic repetition. Such a cyclic repetition of incremental growth layers involve one constant or regularly change between more stained and less stained layer (Perrin & Myrick, 1980).

The method of decalcified thin and stained sections of the teeth for optical microscope were used following the recommendations of Hohn *et al.* (1989) and Perrin & Myrick (1980). Large straight teeth were selected, stored in glycerin and ethanol (1:1), fixed in 10% formalin and decalcified in RDO (a commercial bone decalcifier) between 2 and 6 h for *P. blainvillei* and between 2 and 32 h for *S. fluviatilis*. Transparency and flexibility of the tooth defined the end of the decalcification. The teeth were cut on the longitudinal plane on a freezing microtome. Anterior–posterior sections were cut to a thickness of 20–30 µm in the teeth of *P. blainvillei* and labial–lingual sections were cut to a thickness of 40 µm in the teeth of *S. fluviatilis*. The sections were stained with Mayer's haematoxylin for 30 min and mounted in 100% glycerin.

Mid-longitudinal sections with well-marked layers were selected and a standard of reading was established. The counts of the growth layers

were made using a compound microscope at magnifications of 25× and 50× and a dissecting microscope at 16× and 50×, both with transmitted light. Three series of readings were accomplished by one of the authors. A fourth reading was accomplished using a microphotograph print of the section where all the growth layers were marked. The sets of counts were then compared. When differences occurred between counts, a best age estimate for each specimen was determined re-examining the section and photography together. The age was estimated without reference to biological data.

The growth layers in the teeth of *P. blainvillei* specimens were counted in the dentine and cement. For *S. fluviatilis*, the layers were counted only in the dentine, because the cemental layers were thin and not well differentiated. Only the number of complete layers was considered for age determination in both species and the results were expressed in years old. We used fraction of layer only for calves with less than one complete layer: (i) tooth with only neonatal line (age considered to be zero or newborn) and (ii) tooth with postnatal dentinal layer, but not one complete cycle (age considered to be 0.5 GLG).

Body length in cm, was measured by a straight line in axial projections from the tip of the upper jaw to the notch of the flukes, including fetuses collected from pregnant females. Growth was determined by fitting non linear, Gompertz model to length-at-age data, through the Curve Expert 1.3 for Windows program:

$$Y = ae [-e (b - cx)], \quad (1)$$

where y is a measure size, a is the asymptotic value, b is the correction factor, c is the growth rate constant and x is age (Zullinger *et al.*, 1984).

A significant sexual dimorphism for body length of *P. blainvillei* was observed by Ramos (1997). Because of the sexual dimorphism, the growth curve in this specie was fitted separately for sex. We compared length distributions of males and females of *P. blainvillei* by age class to verified which age begins the growth differentiated. Nonparametric Kolmogorov–Smirnov (K–S) test through of Statistic 4.5 for Windows program was used (Sokal & Rohlf, 1995).

A commonly used method of estimating length at birth is to regress the percent postnatal at each length interval on length and to calculate the length at which 50% of specimens are predicted to be postnatal (50% interpolation). However, this method require a sample size adequate (Hohn & Hamond, 1985). Other method used is to examine a series of largest fetuses and newborn calves lengths and infer an intermediate value (qualitative

interpolation) (Perrin & Reilly, 1984). Because of the sample size of largest fetuses and newborn calves in the present study wasn't enough to apply these methods. We estimated length at birth from postnatal growth equation (Gompertz model).

To estimate prenatal growth rate, we used the method of Kasuya (1977) applied for *P. blainvillei* in Uruguayan waters (Kasuya & Brownell, 1979). This method was adjusted for eight odontocetes species through the follow linear regression:

$$Y = 0.001802x + 0.1234, \quad (2)$$

where, y is prenatal growth rate in cm/day in the linear phase of the growth and x is the length at birth in cm.

Fetal age was extrapolated through prenatal growth rate and gestation period. Gestation period considered was 10.5 mo for *P. blainvillei* (Kasuya & Brownell, 1979) and 11.6 mo for *S. fluviatilis* (Schmiegelow, 1990).

In the present study, histological examination of the gonads was not accomplished. This diminishes the accuracy of age at attainment of sexual maturity determination. We used a combination of several criterions of reproductive conditions to evaluate sexual maturity. Reproductive condition of females was determined from examination of ovaries, mammary glands and uteri. Females with at least one ovulation scars in the external surface of the ovary, pregnant (presence of a fetus), lactating (milk present in the mammary glands) were considered sexually mature. Reproductive condition of males was determined from examination of epididymis. Males with presence of sperm in the epididymis were considered sexually active.

Other criterion used in this study was average length at attainment of gonad activity. The commonly used method is the relationship between the weight of gonads and body length to examine the medium moment of gonads maturity or the reproductive activity in cetaceans (Sergeant *et al.*, 1973; Hui, 1979; Harrison *et al.*, 1981; Best & da Silva, 1984; Cockcroft & Ross, 1989; Lockyer & Walton, 1994). Nevertheless, in some cases, the weight of gonads is unavailable. Collet & Girons (1984) compared morphometric relationship between gonad length and body length with histology analysis of gonads in *Delphinus delphis*. These authors verified that the results were similar and suggested that morphometric relationship can be used to estimate sexual activity when it is not possible to conduct histological analysis. To estimate the average length at attainment of gonad activity, we used the relationship between combined length of the gonads (CLG) left and right and body length.

The state of physical maturity was evaluated by the fusion degree of the vertebral epiphyses (Perrin

& Reilly, 1984; Pinedo, 1995). Individuals, which the post-cranial skeleton showed all epiphyses fused to vertebra were considered physically mature.

Results

Growth

P. blainvillei—Length ranges of 39 males and 43 females are showed in Table 1. Although a different body length range might be observed among sexes, this sexual dimorphism was significant only for the specimens at four years (K-S test; $n=10$; $P \leq 0.05$).

Growth curves fitted to length-at-age data by Gompertz model (equation 1) are presented in the Figure 1. Growth parameters estimated through these curves are presented in the Table 2. Postnatal growth curve estimated a asymptotic length of 117.1 cm for males and 144.7 cm for females. Length at birth was estimated at 61.0 cm for males and 76.0 cm for females. As growth differentiated occur only after four years, the length-at-age data for male and female up to three years were fitted together by Gompertz model, exclude age interval which occur the sexual dimorphism. Through this curve, we obtained a length at birth of 71.0 cm for both sexes.

Prenatal growth rate during the linear phase of the growth (equation 2), using the length at birth of 71.0 cm, was 0.25 cm/day (or 7.6 cm/mo).

S. fluviatilis—Length ranges of 45 males and 25 females are showed in Table 1. Growth curves fitted to length-at-age data by Gompertz model (equation 1) are presented in the Figure 2. Growth parameters estimated through these curves are presented in the Table 2. Postnatal growth curve estimated an asymptotic length of 191.7 cm for both sexes. Length at birth was estimated at 106.0 cm.

Prenatal growth rate during the linear phase of the growth (equation 2), using the length at birth of 106.0 cm, was 0.31 cm/day (or 9.4 cm/mo).

Birth

P. blainvillei—Length range of eight fetuses was from 8.5 to 65.5 cm (Table 3). The sex was only identified for two females and one male. The other six fetuses had less than 21 cm and it was not possible to identify their sex. We combined the fetal growth rate (7.6 cm/mo), length at birth (71.0 cm), and gestation period (10.5 mo) to estimate the age of all fetuses. Age range was from 1.3 to 9.7 mos. Body length of one newborn (0 GLG) and nine calves (0.5 GLG) varied between 66.0 and 85.0 cm. All calves over 80.0 cm presented some alimentary remains (i.e., fish otoliths) in the stomach. Calves between 78.0 and 80.0 cm length had milk ($n=2$) or food solid ($n=2$). These length ranges coincided with the teeth full eruption (Fig. 3).

Table 1. Body length mean (minimum–maximum) for each age-class in males and females of *Pontoporia blainvillei* and *Sotalia fluviatilis* accidentally captured in gillnets or stranded in northern Rio de Janeiro, Brazil, from 1989 to 1996.

Age	Males		Females	
	<i>n</i>	Length range	<i>n</i>	Length range
<i>P. blainvillei</i>				
0	5	81.1 (78.0–88.0)	6	83.2 (74.0–95.0)
1	8	99.4 (94.0–105.0)	7	103.9 (95.0–114.0)
2	18	109.4 (98.0–120.0)	10	111.6 (90.0–120.0)
3	4	116.5 (113.0–121.0)	7	124.2 (117.5–140.0)
4	4	118.1 (115.0–120.0)	6	133.8 (129.5–138.5)
5	—	—	2	139.5 (138.0–141.0)
≥6	—	—	5	141.1 (137.0–147.5)
total	39	—	43	—
<i>S. fluviatilis</i>				
0	2	102.0 (97.0–107.0)	—	—
1	3	130.7 (129.0–132.0)	3	131.7 (121.0–138.0)
2	2	139.8 (135.0–144.5)	3	140.3 (130.0–151.0)
3	2	159.5 (155.0–164.0)	3	154.7 (146.0–160.0)
4	12	163.1 (133.0–175.0)	1	163.0
5	7	169.9 (164.0–177.0)	4	169.3 (164.0–177.0)
6	7	178.8 (165.0–189.0)	4	176.3 (161.0–185.0)
7	3	183.3 (174.0–191.0)	3	180.3 (174.5–186.0)
8	2	193.5 (187.0–200.0)	1	185.0
≥9	3	190.0 (187.0–193.0)	3	189.7 (178.0–198.0)
total	43	—	25	—

According to date of death, age of fetuses and calves (0 and 0.5 GLG, respectively) and gestation period (10.5 mos), we extrapolated the birth date. Birth dates of eight fetuses and nine calves were estimated for all the seasons: 33% winter (June to August), 28% spring (September to November), 11% summer (December to February), and 28% autumn (March to April).

S. fluviatilis—Length range of fetuses (two females and two males) was from 45.0 to 63.5 cm (Table 3). We combined the fetal growth rate (9.0 cm/mo), length at birth (106.0 cm), and gestation period (11.6 mo) to estimate the age of all fetuses. Age range was from 4.0 to 7.0 mos. Only one newborn of 97.0 cm (0 GLG) and one calve of 107.0 cm (0.5 GLG) were reported. These calves had erupted teeth and milk in the stomach, suggesting that they were in suckling.

According to date of death, age of fetuses and calves (0 and 0.5 GLG, respectively) and gestation period (11.6 mos), we extrapolated the birth date for four fetuses and two calves. The peak of birth was estimated to autumn (50%), possibly beginning in the end of spring (16.7%) and summer (33.3%).

Sexual and physical maturity

P. blainvillei—Smallest known sexually mature female had 131.0 cm and four years (pregnant). Other sexually mature females had three years or older and length between 138.0 to 147.5 cm long. These females were three pregnant, four lactating and two both. None male had sperm in the epididymis, suggesting that most of them were immature or seasonally inactive. Morphometric relationship between gonads and body length indicated an increase in the size of testicles at a body length of approximately 113.0 cm, and an increase in the size of ovaries at a body length of about 130.0 cm (Fig. 4). These results suggest that males attain sexual maturity at two years and 115.0 cm long. Females attain sexual maturity at three years and 130.0 cm long.

Fusion of all vertebral epiphyses to the centrum was observed in three males, six females and one sex unidentified (14%) of the 71 complete postcranial axial skeletons analysed. Length and age of males varied from 120.0 to 121.0 cm (average of 120.5 cm) and from three to five years, respectively. For females, the length and age varied from 138.0 to 147.4 cm (average of 140.6 cm) and from three to

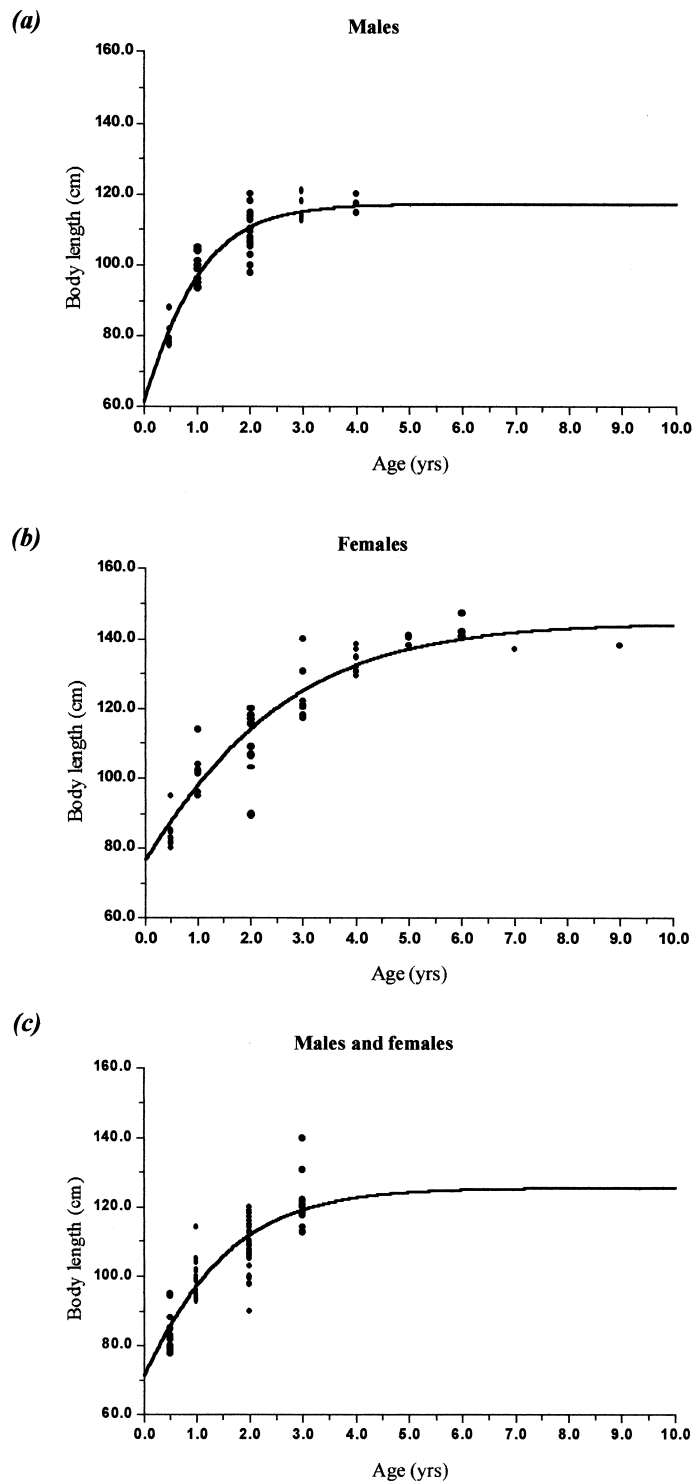


Figure 1. Scatterplots of length-at-age for 39 males (curve *a*) and 43 females (curve *b*) of *Pontoporia blainvillei* accidentally captured in gillnets or stranded in northern Rio de Janeiro, Brazil, from 1989 to 1996. The curve *c* represent the length-at-age data for males and females up to three years ($n=65$), without sexual dimorphism. The solid line represents the predicted growth trajectory from the Gompertz model.

Table 2. Growth parameters values from the Gompertz growth model fitted to length-at-age data of *Pontoporia blainvillei* and *Sotalia fluviatilis* accidentally captured in gillnets or stranded in northern Rio de Janeiro, Brazil, from 1989 to 1996.

Sex	<i>n</i>	Age range (yrs)	Body length range (cm)	Asymptotic length (cm)	Correction factor	Growth rate constant	Correlation coefficient (<i>r</i>)
<i>P. blainvillei</i>							
male	39	0–4	78.0–120.0	117.1	–0.4464	1.215	0.91
female	43	0–9	74.0–147.5	144.7	–0.4542	0.494	0.93
both	75	0–3*	74.0–138.5	125.4	–0.5752	0.804	0.86
<i>S. fluviatilis</i>							
both	66	0–30	97.0–200.0	191.7	–0.5216	0.345	0.94

*Age interval without sexual dimorphism.

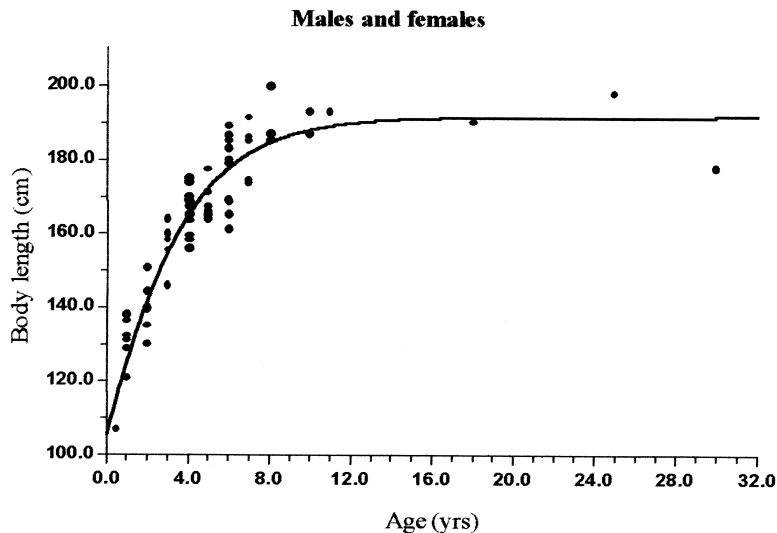


Figure 2. Scatterplots of length-at-age for males and females of 66 *Sotalia fluviatilis* accidentally captured in gillnets or stranded in northern Rio de Janeiro, Brazil, from 1989 to 1996. The solid line represents the predicted growth trajectory from the Gompertz model.

nine years. These results suggest that males reached physical maturity at three years old and 120.0 cm long. Females reached physical maturity at four years and 140.0 cm long.

S. fluviatilis—Smallest known sexually mature female had 161.0 cm and six years (pregnant). Other sexually mature females had six years or older and length between 178.0 to 193.0 cm long. These females were two pregnant and three lactating. Three males had sperm in the epididymis. These males had six (183.0 cm), ten (193.0 cm) and 18 (190.0 cm) years. The high testis long (>35 cm of CLG) was associated with 100% incidence of sperm in the epididymis. Morphometric relationship between gonads and body length indicated an increase

in the size of testicles at a body length of around 180.0 cm, and an increase in the size of ovaries at a body length of about 170.0 cm (Fig. 4). These results suggest that males and females attain sexual maturity at six years, when they reached 180.0 and 160.0 cm long, respectively.

Fusion of all vertebral epiphyses to the centrum was observed in one male and two females (13%) of the 23 complete postcranial axial skeletons analysed. Length and age were one male of 18 years and 190.0 cm, one female of 30 years and 178.0 cm, and other female of 182.0 cm without age estimated. These results suggest that males and females reached physical maturity at seven years and 185.0 cm long.

Table 3. Age and birth date estimated to fetuses and calves (newborn and 0.5 GLG) of *Pontoporia blainvillei* and *Sotalia fluviatilis* accidentally captured in gillnets or stranded in northern Rio de Janeiro, Brazil, from 1989 to 1996. The estimates were extrapolated through following parameters: *P. blainvillei*—length at birth of 71 cm, prenatal growth rate of 0.25 cm/day and gestation of 10.5 mo; and *S. fluviatilis*—length at birth of 106 cm, prenatal growth rate of 0.31 cm/day and gestation of 11.6 mo

	Body length (cm)	Sex	Estimated age (mo)	Date of death (da/mo/yr)	Estimated birth date (mo)	
<i>P. blainvillei</i>						
Fetuses	63.0*	female	9.3	13/06/86	July	
	16.7**	—	2.5	22/01/88	September	
	65.5	male	9.7	26/08/89	September	
	8.5	—	1.3	17/10/91	July	
	17.0	—	2.5	14/07/92	March	
	21.0	—	3.1	17/12/92	July	
	11.0	—	1.6	30/06/96	March	
	56.0	female	8.3	16/01/97	March	
				(GLG)		
	Calves	82.0	female	0.5	01/09/90	March
74.0		female	newborn	21/06/91	June	
79.3		male	0.5	27/02/92	August	
85.0		female	0.5	01/08/92	February	
78.2		male	0.5	29/10/93	April	
78.0		male	0.5	31/01/95	July	
83.0		female	0.5	03/03/95	September	
82.0		male	0.5	30/04/95	October	
88.0		male	0.5	--/03/96	September	
80.0		female	0.5	04/07/96	January	
<i>S. fluviatilis</i>						
Fetuses			(mo)			
	59.5**	male	6.5	27/11/87	April	
	63.5	female	7.0	22/10/88	March	
	45.0	female	5.0	28/07/90	February	
36.0	male	4.0	30/07/96	March		
Calves			(GLG)			
	107.0	male	0.5	06/05/91	November	
	97.0	male	newborn	23/01/93	January	

*Lodi *et al.*, 1987; **Lodi & Capistrano, 1990.

Discussion

Growth

P. blainvillei—The Gompertz model was fitted to growth rate of specimens from Uruguayan waters. This model presented a good adjustment for males, but females results could not adjusted to the model (Kasuya & Brownell, 1979). These authors estimated the mean asymptotic length of 133.3 cm for males and 153.0 cm for females through of mean body length of individuals four years or older. The asymptotic values smaller to our sample corroborate to hypothesis of differentiated growth between populations.

Ramos (1997) fitted postnatal growth curves in same sample of this study by dividing into distinct

phases: (i) an accelerated growth phase that occurs during the first year of age; (ii) a slow growth phase that occurs from the first year and to physical maturity; and (iii) an asymptotic growth phase when the body length remain invariable (116.5 cm for males and 135.7 for females). This result was near at our values obtained by non-linear Gompertz model, indicating that both curves can be fitted.

S. fluviatilis—The non linear von Bertalanffy model was fitted to growth data of 23 specimens from São Paulo and Paraná coast, Brazil (Schmiegelow, 1990). This author estimated an asymptotic length of 182.6 cm for both sexes. Higher asymptotic length estimated to our sample might be related to: (i) different growth model applied, (ii) absence of

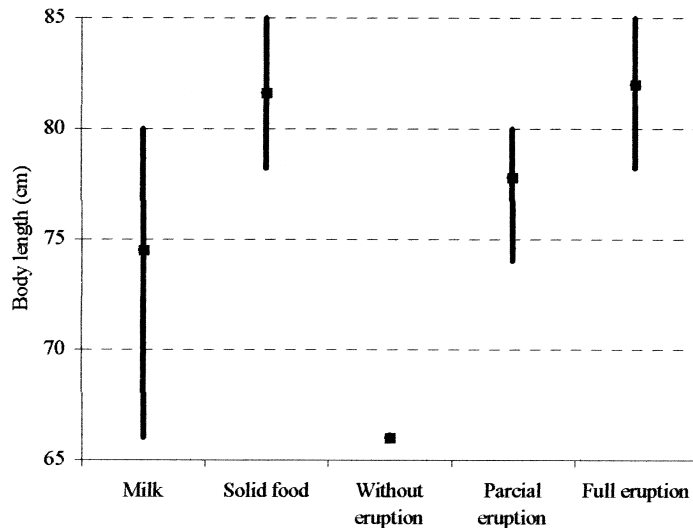


Figure 3. Analyses of stomach content (milk or solid food) and three tooth eruption stages (without, partial and full eruption) to body length of calves (newborn and 0.5 GLG) of *Pontoporia blainvillei* accidentally captured in gillnets or stranded in northern Rio de Janeiro, Brazil, from 1989 to 1996.

same age and length ranges (1–2 years and 100–150.0 cm) from São Paulo and Paraná sample, and (iii) growth rate differentiated among populations. The same growth model should be applied for two samples, and, other morphology characters should be tested to evaluate whether there is a growth rate differentiated.

The same method applied by Ramos (1997) to *P. blainvillei* sample also was used for *S. fluviatilis*. As already mentioned, the author fitted postnatal growth curves by dividing into three distinct phases. The asymptotic growth phase in *S. fluviatilis* was attained at 186.8 cm and seven years for both sexes. This result was near at our values obtained by non linear Gompertz model, indicating that both curves also can be fitted for the growth of *S. fluviatilis*.

Birth

P. blainvillei—Length at birth in the Uruguayan coast has been estimated between 70.0 and 85.0 cm, probably nearer 70.0 cm (Kasuya & Brownell, 1979; Harrison *et al.*, 1981; Brownell, 1984). In the southern Brazilian coast, newborns are between 59.0 to 78.0 cm in length. Although some of the smaller individuals might have been aborted fetuses (Pinedo *et al.*, 1989). Length at birth estimated in the present study was similar to sample from South Brazil and Uruguay. This result suggests that morphological variation between two ecotypes (a smaller form from 22°–27°S and a larger form from 32°–38°S), proposed by Pinedo (1991) to this species, should occur in old age.

In the present study, births were estimate in all season suggesting that there was not a typical reproductive period. This result was different from the reproductive seasonal pattern observed for population that in habit southern Brazil and Uruguayan coasts: from September to December (Harrison *et al.*, 1981; Brownell, 1984; Pinedo *et al.*, 1989). The variation of resource allocation between somatic and reproductive investment might cause alterations in the reproductive periodicity, as well as in morphological differentiation (Stearns, 1992).

S. fluviatilis—Schmiegelow (1990) estimated length at birth between 86.7 to 91.7 cm for specimens from São Paulo coast. This length range was smaller than our results. However, we reported in the study area, a newborn of 86.0 cm (unpublished data) captured accidentally by fisheries in February of 1998. Possibly, the reduced number of greater fetuses and newborns analysed might be causing this difference or an individual variation could be occurring.

Di Benedetto (1997) observed that in a series of sightings of *S. fluviatilis* along the study area that calves were present during the whole year, mostly during the months of autumn and winter. Calves sighting during winter might represent the born during autumn, as estimated in the present study. Calves from São Paulo and South of Paraná coast are born during the whole year, but a high frequency of birth was observed in the spring and summer (Schmiegelow, 1990).

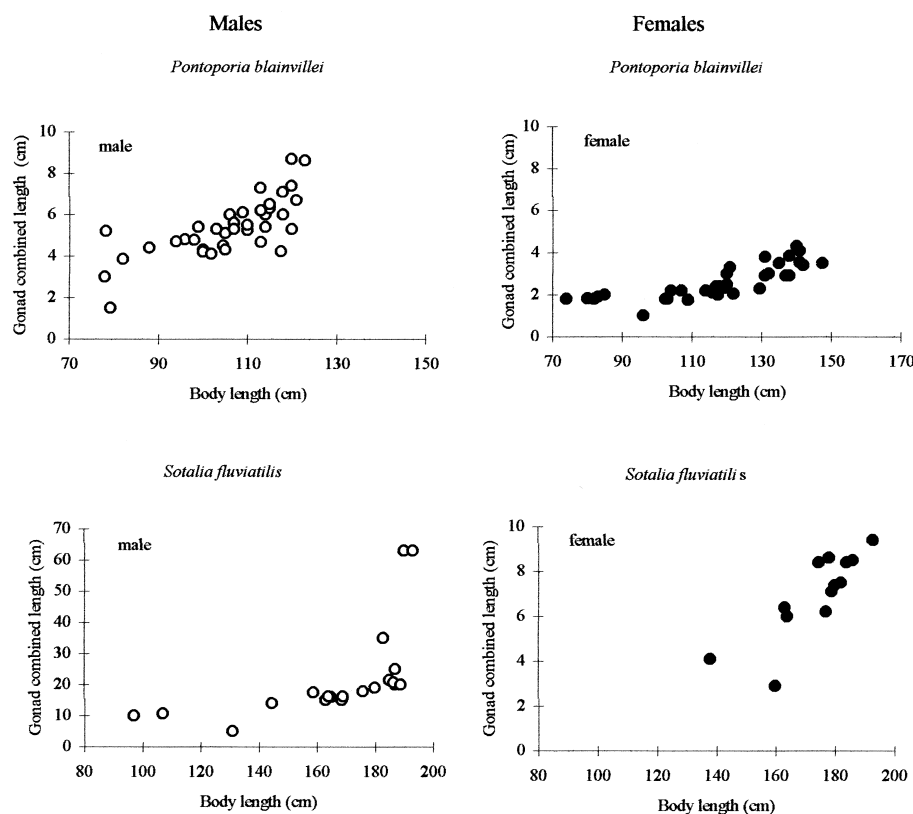


Figure 4. Relationship between body length and gonads combined length of the females and males of *Pontoporia blainvillei* and *Sotalia fluviatilis* accidentally captured in gillnets or stranded in northern Rio de Janeiro, Brazil, from 1989 to 1996.

Sexual and physical maturity

P. blainvillei—The age at sexual maturity in individuals from northern Rio de Janeiro was similar to estimates for specimens from Uruguayan coast (2.7–3.0 years). In contrast, length to our sample was smaller than Uruguay sample (130.0 cm for males and 140.0 cm for females) (Kasuya & Brownell, 1979; Harrison *et al.*, 1981; Brownell, 1984). These results suggested that *P. blainvillei* attains sexual maturity at a similar age to the South and North ecotypes and that the difference in the body length at maturity might be related to morphologic variation among them.

In northern Rio de Janeiro, the length at physical maturity was smaller when compared to specimens from Uruguay (133.3 cm for males and 150.0 cm for females) (Kasuya & Brownell, 1979). This difference might relate to morphologic variations between the two ecotypes, as mentioned before. Thus, we might suppose that the physical maturity was proportionally related to the body size.

The results of the present study suggest that there are alterations in the reproductive investment in the northern ecotype. Probably, *P. blainvillei* varies its growth strategies along its distribution. Intra-specific morphological variations might be result of several factors such as: the occurrence of geographical variations (ecocline or Bergmann's rule), the allocation of resources between growth and reproduction (Principle of Allocation) and reduction of gene flow of small isolated population (genetic drift) (Mayr, 1977; Lincoln *et al.*, 1982; Stearns, 1992).

S. fluviatilis—The age and length at maturity in north of Rio de Janeiro was similar to that estimated in previous studies (da Silva & Best, 1996). Borobia (1989) estimated that adult size is attained when there are five years or older. Schmiegelow (1990) estimated the length maximum from São Paulo sample to 180.1 cm. These values were near and it suggests that attainment of sexual and physical maturity not present significant variation along its distribution.

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