Age estimation of marine tucuxi dolphins (*Sotalia fluviatilis*) in south-eastern Brazil

M.C. de O. Santos*[‡], S. Rosso* and R.M.A. Ramos[†]

*Projeto Atlantis/LabMar, Departamento de Ecologia Geral, Instituto de Biociências, Universidade de São Paulo, Rua do Matão, Travessa 14, Cidade Universitária, São Paulo, SP, Brazil, 05508-900.
[†]Universidade Estadual do Norte Fluminense, Centro de Biociências e Biotecnologia, Laboratório de Ciências Ambientais, Av. Alberto Lamego, 2000, Campos, RJ, Brazil, 28015-620. [‡]Corresponding author, e-mail: marcosos@usp.br

This study reports the age estimation of marine tucuxi dolphins (*Sotalia fluviatilis*) found dead along the south-east coast of Brazil (24°40′S–25°30′S). The investigated specimens were collected from August 1995 to December 1998. Ages were estimated through the number of Growth Layer Groups (GLGs) from decalcified and stained thin sections of teeth. A total of 36 individuals was investigated. Estimated ages of marine tucuxis varied from zero to 29 years. The growth curve was attained from a modification of the von Bertalanffy equation applied to body length and age data. It was possible to estimate the total length of 97.8 cm in newborns, physical maturity was attained at seven years of age, and an asymptotic length of 179.8 cm.

INTRODUCTION

In Brazil age estimation of small cetacean was first reported at the end of the 1980s. Since then, a few studies on cetacean age estimation have been carried out. Borobia (1989) was the first to estimate the age of the marine tucuxi dolphin, *Sotalia fluviatilis* (Cetacea: Delphinidae).

The first investigations on the relationship between the disposal of cyclical dentinal layers in marine mammals teeth and their age were presented in the 1930s (Scheffer & Myrick, 1980). Since then, the techniques employed to estimate small cetacean ages were improved (see examples in Perrin & Myrick, 1980), and became a worldwide standardized procedure. The ability to estimate small cetacean age is extremely important in their natural history study (Hohn et al., 1989).

This poorly known cetacean species is distributed in coastal waters from Santa Catarina (27°S), southern Brazil, to Honduras (14°N), central America (Flores, 2001). In her study, Borobia (1989) analysed teeth collected from dead tucuxi specimens found along this species range. Marine tucuxi age estimations were also presented by Schmiegelow (1990). That author analysed stranded specimens collected in São Paulo and in Paraná state coasts (24°40′S–25°30′S), south-eastern Brazil. Ramos et al. (2000) analysed growth parameters of marine tucuxis incidentally captured in gill-nets set for sharks and sciaenids in the northern coast of Rio de Janeiro (21°37′S–22°25′S). The main objective of the present study was to estimate the age of marine tucuxis found dead in coastal and estuarine waters of south-eastern Brazil, presenting new information on growth parameters.

MATERIALS AND METHODS

Tucuxi dolphins (N=31) were found dead along approximately 115 km of beaches located at Ilha Comprida

(SP), Ilha do Cardoso (SP) and Ilha do Superagui (PR) (24°40′S–25°30′S), south-eastern Brazil (Figure 1), as well as at local estuarine waters (N=5). The studied individuals were collected from August 1995 to December 1998. To estimate the sampled cetaceans age, the method based on thin and decalcified teeth sections for optical microscope analyses was used following Kasuya (1976), Perrin & Myrick (1980) and Hohn et al. (1989). All the collected teeth were preserved in a solution composed of glycerin and ethanol (1:1). Large and straight teeth were selected, fixed in 10% formalin and decalcified in a commercial bone decalcifier, at intervals between two and 32 hours. These intervals ended when each tooth presented adequate flexibility and transparency. Teeth were sectioned in a freezing microtome. Labial-lingual sections of 40 μm were
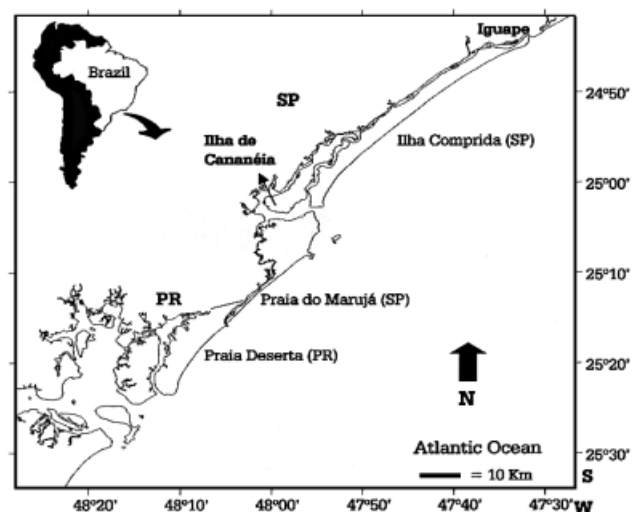

Figure 1. Detailed map showing the region in south-eastern Brazil where the stranded specimens were collected.

Table 1. *Reported ages of marine tucuxi dolphins (*Sotalia fluviatilis*) found dead in the southern coast of São Paulo and the northern coast of Paraná (24°40'S–25°30'S), from August 1995 to December 1998.*

Code and notification date (D/M/Y)	Notification Site	TBL (cm)	Gender	Age (GLGs)
PA-000 (08/08/95)	Ilha Comprida	190	F	7
PA-008 (26/06/96)	Estuary	90		1
PA-010 (17/07/96)	Ilha do Cardoso	175		3
PA-013 (19/07/96)	Ilha Comprida	165		3
PA-015 (30/07/96)	Ilha Comprida	183	F	28
PA-019 (31/07/96)	Ilha do Cardoso	181	M	6
PA-026 (23/08/96)	Ilha Comprida			6
PA-027 (23/08/96)	Ilha Comprida			24
PA-029 (23/08/96)	Ilha Comprida	180		26
PA-039 (29/09/96)	Ilha Comprida			29
PA-044 (09/10/96)	Ilha do Superagui	177		22
PA-049 (10/10/96)	Ilha Comprida			10
PA-051 (10/10/96)	Ilha Comprida	133		1
PA-053 (30/10/96)	Ilha do Superagui	130	F	5
PA-059 (28/11/96)	Ilha Comprida	179		24
PA-067 (20/01/97)	Ilha do Cardoso	74		0
PA-073 (11/03/97)	Ilha do Superagui	145		1
PA-075 (25/03/97)	Ilha Comprida	200	M	28
PA-079 (29/04/97)	Ilha do Superagui	180	M	13
PA-080 (11/06/97)	Ilha do Cardoso	187	F	14
PA-082 (11/06/97)	Ilha do Superagui	180	F	6
PA-083 (15/07/97)	Estuary	173	F	21
PA-086 (10/08/97)	Ilha Comprida			3
PA-089 (11/08/97)	Ilha do Superagui	162	F	3
PA-090 (11/08/97)	Ilha do Superagui	196	M	5
PA-092 (22/08/97)	Ilha do Superagui	140	F	1
PA-095 (11/10/97)	Estuary	163	M	7
PA-098 (30/09/97)	Ilha do Superagui	181	F	6
PA-099 (22/11/97)	Ilha Comprida	191		6
PA-100 (13/12/97)	Ilha Comprida			7
PA-101 (18/12/97)	Ilha Comprida	156	F	29
PA-102 (10/02/98)	Estuary	178	M	21
PA-104 (09/12/97)	Ilha do Superagui	160	F	22
PA-106 (12/02/98)	Ilha do Superagui	180	F	22
PA-110 (01/05/98)	Ilha do Superagui	200	F	21
PA-131 (31/12/98)	Estuary	196	M	21

TBL, total body length; F, female; M, male; GLGs, Growth Layer Groups.

stained with Mayer's haematoxylin for 30 min and mounted in 100% glycerin. Only the mid-longitudinal sections with well-marked layers were selected for age estimation. Age was estimated by the number of Growth Layer Groups (GLG) (see Perrin & Myrick, 1980). In this study, we considered only complete GLG counts, expressed as years old. Teeth sections were analysed with a stereoscopic microscope at magnifications of 16× and 50×, as well as with an optical microscope at 25× and 75×, both with transmitted light. Three readers made three distinct counts with a minimum interval of 20 days between readings. Data set was then compared between readers. When necessary, photographs were taken with a Nikon SMZ-U stereoscopic microscope to investigate different counts between readers. Tucuxis' growth parameters were investigated using the length-at-age data. A post-natal growth curve for both sexes pooled together was fitted by the exponential equation:
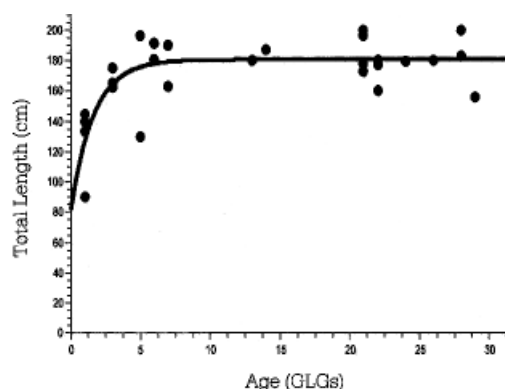
$$y = a(b - e^{-cx}) \quad (1)$$

Figure 2. Growth curve fitted to marine tucuxis total body length (TBL) and age (GLG) based on a modification of the von Bertalanffy linear equation. Specimens (N=27) were found dead along the beaches of Ilha Comprida, Praia do Marujá and Praia Deserta, as well as in inner waters close to Ilha de Cananéia, Brazil.

modified from the non-linear von Bertalanffy model, where *y* is a measure of total body length, *a* is the asymptotic value, *b* is the correction factor, *c* is the growth rate constant and *x* is the age (Zullinger et al., 1994). The asymptotic total body length was estimated from the quoted equation and the growth curve.

RESULTS

Total body length of tucuxi dolphins varied from 74 to 200 cm (N=30) (Table 1). Only seven males and 13 females could be sexed. The age of the 36 investigated individuals varied between zero and 29 years old, which is known as the maximum age observed in the local population. The growth curve plotted with the gathered data is represented in Figure 2. The asymptotic length of 179.8 cm was estimated at seven years old. Length at birth of 97.8 cm was also estimated.

DISCUSSION

Most of the observed specimens were found in an advanced state of decomposition, preventing the authors from obtaining important biological information such as total body length and gender, as well as to collect their gonads to evaluate sexual maturity and cause of death.

Through the marine tucuxi growth curve presented in Figure 2, it is possible to observe a variation in total length values of individuals with the same age. The range of these variations was homogeneous for each age throughout the curve. The same variations were also observed in pilot whales (*Globicephala melas*) collected in Newfoundland (Sergeant, 1962), harbour porpoises (*Phocoena phocoena*) collected in the Bay of Fundy (Gaskin & Blair, 1977) and in bottlenose dolphins (*Tursiops truncatus*) collected in the region between North Carolina and New Jersey (Hohn, 1980). Although cetaceans present high growth rates in their first years (Bryden, 1972), the variation in total length can be considered common at any age (Hohn, 1990). However, growth curves are not adequate to estimate an individual age in a surveyed cetacean population, mainly when the gathered data come exclusively from strandings. Coastal and oceanic bottlenose dolphins which occur in the same latitude can attain different body sizes at the same age (Hohn, 1990). Thus the presented growth curve on marine tucuxis has its own limitations, as the sample size is relatively small, age-classes are not uniformly distributed, mainly stranded specimens were used and males and females were pooled together.

Three other studies presented marine tucuxi growth curves (Borobia, 1989; Schmiegelow, 1990; Ramos et al., 2000). Borobia (1989) analysed stranded individuals along most of the species distribution and applied her data to the von Bertalanffy non-linear equation. The length at birth was estimated as 105 cm and the asymptotic length as 187.2 cm. Physical maturation would be reached between five and ten years old. Schmiegelow (1990), with stranded specimens reported in the same region of the present study, estimated the length at birth to be 91.2 cm and the asymptotic length as 180.1 cm. Physical maturity would be attained at the age of six years old. That author employed the von Bertalanffy equation in his study. Ramos et al. (2000) employed the Gompertz equation to achieve their

tucuxi growth curve. Those authors used mainly incidentally captured individuals. The length at birth was estimated to be 106 cm and the asymptotic length as 191.7 cm. Through the analyses of 23 complete postcranial axial skeletons, Ramos et al. (2000) suggested that physical maturity would be reached at seven years old and 185 cm long for both males and females. The different results observed in each quoted study can be attributed to differences in sample sizes, age-classes, sources of sampled individuals (strandings and/or incidental captures), possible geographical variation of the species, and to the use of different equations to describe the species growth parameters. Data gathered from growth curves are not always the best to describe biological aspects on a cetacean species biology, mainly when the sampled individuals came exclusively from strandings or incidental captures. To better understand marine tucuxis biology, multidisciplinary studies must be conducted on a greater number of samples.

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