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Natural history of dolphins of the genus *Sotalia*

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Abstract: General biology, including food habits, reproduction, age and health of the dolphins of the genus *Sotalia*, are reviewed according to current scientific knowledge. At least 25 teleost fish families, 5 cephalopod families and 1 crustacean family are included in the diet of the Guiana dolphin (*S. guianensis*), while up to 13 fish families were identified in the stomachs of the tucuxi (*S. fluviatilis*). Among the fish consumed by *Sotalia* spp., the schooling fish are the most common ones and both dolphin species use similar foraging strategies. However, due to the completely different ecosystems used by them, prey species consumed by these dolphins are also different. The maximum age of incidentally caught Guiana dolphin was 30yr and the maximum age estimated in the tucuxi was 43yr. The maximum total body length and weight reached by *S. guianensis* was 222cm and 121kg, respectively, and for *S. fluviatilis* 152cm and 53kg, respectively. Sexual maturity in the Guiana dolphin was estimated to occur at 170-180 cm in males, and 160-169 cm in females, while onset maturity in the tucuxi occurs at around 140cm in males and 132-137 cm in females. Ovulation apparently occurs only in the left ovary of the tucuxi, while both ovaries of the Guiana dolphins are functional. The proportion of testes mass in relation to total body mass in adult males can reach up to 5% in the tucuxi, and 3.3% in the Guiana dolphin, suggesting a promiscuous mating system with sperm competition in both species. Although seasonal birth peaks can occur in Guiana dolphins, they seem to reproduce throughout the year. However, the tucuxi presents defined birth seasonality, with most females giving birth during the low-water season in the Amazon. We suggest maintaining *S. fluviatilis* in the 'Data Deficient' category of the IUCN Red Data Book. Nevertheless, due to the recent recognition of *S. guianensis* as a species, its conservation status has not been assessed yet. This species, however, deserves special attention as it is strongly subjected to anthropogenic pressures throughout its distribution.

Resumo: Aspectos da biologia geral, incluindo hábitos alimentares, reprodução, idade e saúde dos golfinhos do gênero *Sotalia* foram revisados de acordo com o conhecimento científico atual. Pelo menos 25 famílias de peixes teleósteos, 5 famílias de cefalópodes e 1 família de crustáceos foram identificadas na dieta do boto-cinza (*S. guianensis*), enquanto 13 famílias de peixes foram identificadas nos estômagos do tucuxi (*S. fluviatilis*). Ambas as espécies predam principalmente (mas não exclusivamente) sobre peixes formadores de cardume e utilizam estratégias de forrageio similares. No entanto, em função das diferenças nos ecossistemas em que ocorrem, as espécies de presas consumidas por estes golfinhos são totalmente diferentes. A idade máxima de botos-cinza incidentalmente capturados foi 30 anos e a idade máxima estimada no tucuxi foi de 43 anos. O comprimento e peso máximos registrados para *S. guianensis* foram de 222 cm e 121kg, e para *S. fluviatilis* de 152cm e 53kg, respectivamente. O comprimento de maturidade sexual no boto-cinza foi estimado em 170-180cm nos machos e 160-169cm nas fêmeas, enquanto que no tucuxi a maturidade ocorre em torno dos 140 cm nos machos e entre 132-137 cm nas fêmeas. A ovulação aparentemente ocorre apenas no ovário esquerdo no tucuxi, ao passo que ambos os ovários no boto-cinza são funcionais. A relação peso dos testículos/peso corporal de machos adultos pode alcançar 5% no tucuxi e 3,3% no boto-cinza, sugerindo um sistema reprodutivo promíscuo com competição de espermatozóides em ambas espécies. Embora picos de nascimento sazonais possam ocorrer em *S. guianensis*, a espécie parece se reproduzir o ano todo. No entanto, o tucuxi apresenta uma sazonalidade de nascimentos bem definida, com a maioria dos partos ocorrendo durante o período de nível baixo das águas dos rios da Amazônia. Em função das lacunas existentes em alguns aspectos da biologia do tucuxi, sugere-se a manutenção de *S. fluviatilis* como 'insuficientemente conhecida' (DD). Por outro lado, em virtude do recente reconhecimento de *S. guianensis* como espécie, seu status de conservação ainda não foi avaliado. Esta espécie, no entanto, requer especial atenção em função da forte pressão antrópica a que está sujeita ao longo de toda a sua distribuição.

Keywords: age, biology, feeding habits, health, reproduction, *Sotalia fluviatilis*, *Sotalia guianensis*.

Introduction

A three-dimensional morphometric analysis carried out on *Sotalia* skulls from the coastal and Amazonian regions revealed significant differences, separating the so-called marine and riverine ecotypes of *Sotalia fluviatilis* into two different species (Monteiro Filho *et al*., 2002). This was also supported by Cunha *et al*. (2005) and Caballero *et al*. (2007), who used the mitochondrial DNA control region and cytochrome-*b* sequence, as well as nuclear intron DNA sequences, showing that marine and riverine ecotypes form very divergent monophyletic groups. Therefore, the freshwater species, commonly known as tucuxi and distributed throughout the Amazon region (Gómez-Salazar *et al*., 2010 this volume), remained with the specific epithet *Sotalia fluviatilis* (Gervais and Deville *in* Gervais, 1853). However, the coastal species, which is distributed from Honduras (15º58'N) in Central America (da Silva and Best, 1996) to Santa Catarina State (27º35'S) (southern Brazil) in South America (Simões-Lopes, 1987)[6],

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[6] Simões-Lopes, P.C. (1987) *Sobre a ampliação da distribuição do gênero Sotalia Gray 1886 (Cetacea: Delphinidae) para águas do Estado de Santa Catarina – Brasil*. Pages 87-88 *in* Proceedings II Reunião de Trabalho de Especialistas em Mamíferos Aquáticos da América do Sul. Rio de Janeiro, Brazil.

is called *Sotalia guianensis* (Van Bénéden, 1864). In an attempt to associate the common name of the latter species with the geographic location where it was first described, Flores *et al*. (2010 this volume) recommended using Guiana dolphin as the vernacular name in English for *S. guianensis*, which was, therefore, adopted in this article.

Both species of the genus *Sotalia* were described in the 19th century and despite having been regularly observed, very little was known about their biology until 25-30yr ago. Continuous and long-term studies of the freshwater species started in 1979 at the National Institute of Amazonian Research (INPA, Manaus, Brazil) (Magnusson *et al*., 1980; da Silva, 1983; Best and da Silva, 1984). Long-term studies of the Guiana dolphin (*S. guianensis*) are also very recent. Apart from sporadic records and very few studies on parasites and morphology (Lins de Almeida, 1933; Carvalho, 1961; 1963), the first studies on the biology and ecology of the species only started in the 1980s (Borobia, 1984; Geise, 1984).

The main purpose of this document is to describe the general aspects of the biology of both species of the genus *Sotalia* with emphasis on age, food habits, reproduction, and health, comparing these parameters considering both species.

General Characteristics

Dolphins of the genus *Sotalia* are dark gray on their dorsal region. There are two lateral blazes of lighter gray that run dorso-ventrally, one behind the flippers and one about mid-way down the body. Ventral coloration can vary from pink to very light gray (da Silva and Best, 1994; 1996; Caballero *et al*., 2007; Randi *et al*., 2008). The Guiana dolphin can reach up to 222 cm in total length (Barbosa and Barros, 2006)[7] and 121kg (Rosas and Monteiro Filho, 2002), while the maximum total length and weight recorded for the tucuxi are 152cm and 53kg, respectively (da Silva and Best, 1994).

Age

Among the different techniques used to estimate age in *Sotalia* spp., the thin-section method originally described by Hohn *et al*. (1989) for bottlenose dolphins presents better reading acuity in Guiana dolphins (Rosas *et al*., 2003; Santos *et al*., 2003; Ramos and Di Beneditto, 2005; Ramos *et al*., 2008). According to Rosas *et al*. (2003), there is one accessory layer (sometimes two) between the neonatal line and the Growth Layer Group (GLG) of the first year. There is some evidence that the always-present accessory layer is attributed to weaning in this species. This hypothesis, however, still needs to be proved (Rosas *et al*., 2003). The maximum age estimated in Guiana dolphins incidentally caught in fishing nets was 30yr (Rosas *et al*., 2003; Di Beneditto and Ramos, 2004). On the other hand, the maximum number of GLGs counted in female and male tucuxi teeth was 43 and 26, respectively (da Silva, 1994). According to the latter author, the large variability in body lengths for different age groups makes the age prediction of tucuxis based on their body lengths unreliable. A similar observation was also made by Santos *et al*. (2003) concerning *S. guianensis*. According to Ramos *et al*. (2000) and Santos *et al*. (2003), the age of physical maturity in Guiana dolphins from southeastern Brazil is reached at 7yr. However, Fettuccia (2001), after analyzing the fusion of vertebral epiphyses of Guiana dolphins from southern Brazil, estimated that the physical maturity of this species occurs after 12yr of age. To our knowledge, there are no physical maturity estimations for the tucuxi.

Feeding Habits

At least 70 fish species consisting of 25 families are consumed by *S. guianensis* from the Brazilian coast (Borobia and Barros, 1989; Schmiegelow, 1990; Emerim, 1994; Reis *et al*., 1998[8]; Di Beneditto, 2000; Zanelatto, 2001; Santos *et al*., 2002; Gurjão *et al*., 2003; Oliveira, 2003; Marcucci *et al*., 2004[9]; Barbosa and Barros, 2006[7]; Di Beneditto and Siciliano, 2007; Oliveira *et al*., 2008) (Table 1). Cephalopod and crustacean species recorded in *S. guianensis* stomachs are presented in Table 2. Among the studies that analyzed more than 25 Guiana dolphin stomach contents, teleosts appeared with frequencies of occurrence between 91 to 100% of the stomachs analyzed, while cephalopods were recorded in frequencies varying from 40 to 74% (Di Beneditto, 2000; Zanelatto, 2001; Gurjão *et al*., 2003; Oliveira, 2003).

Despite being considered by most authors as a species with opportunistic feeding habits (Di Beneditto, 2000; Zanelatto, 2001; Santos *et al*., 2002; Oliveira, 2003; Gurjão *et al*., 2003), the trophic niche width of *S. guianensis* on the Paraná coast (southern Brazil), estimated using Levins' index (Krebs, 1989), was closer to the minimum

[7] Barbosa, L.A. and Barros, N.B. (2006) *Aspectos da distribuição, biologia e captura acidental do boto-cinza (*Sotalia guianensis*) no litoral do Espírito Santo, Brasil*. Page 47 *in* Siciliano, S., Borobia, M., Barros, N.B., Marques, F., Trujillo, F. and Flores, P.A.C. (Eds), Book of Abstracts, *Workshop on Research and Conservation of the genus* Sotalia, 19-23 June 2006, Armação dos Búzios, Rio de Janeiro, Brazil. *Latin American Journal of Aquatic Mammals* 8(1-2) (supplement). http://dx.doi.org/10.5597/lajam00147.a037.

[8] Reis, M.S.S., Reis, LW.D., Lima, F., Baracho, C. and Jorge, A. (1998) *Nota sobre a dieta alimentar do boto* Sotalia fluviatilis *Gervais, 1853 (Cetacea, Delphinidae) no litoral do estado da Bahia.* Page 173 *in* Abstracts, VIII Reunião de Trabalho de Especialistas em Mamíferos Aquáticos da América do Sul, 25-29 October, Olinda, PE, Brazil.

[9] Marcucci, A., Cremer, M.J. and Corrêa, M.F.M. (2004) *Hábito alimentar de* Sotalia guianensis *(Cetacea-Delphinidae) e* Pontoporia blainvillei *(Cetacea-Pontoporiidae) na costa norte de Santa Catarina, Brasil*. Page 128 *in* Abstracts, XI Reunión de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur, 11-17 September 2004, Quito, Ecuador.

value, suggesting that this dolphin could have a more specialized diet than an opportunistic one in that area (Oliveira, 2003). However, it is recommended that further studies analyzing a larger number of stomach contents throughout its distribution be carried out focusing on this subject.

Table 1. Fish species consumed by *Sotalia guianensis* on the Brazilian coast.

FISH SPECIES	FAMILY	LOCALITY	REFERENCES*
Cynoscion striatus	Sciaenidae	SE and S Brazil	2, 4
Cynoscion jamaicensis	Sciaenidae	SE and S Brazil	2, 3, 4, 11, 13
Cynoscion acoupa	Sciaenidae	SE and S Brazil	3, 7, 8, 13
Cynoscion leiarchus	Sciaenidae	SE and S Brazil	7, 8, 11
Cynoscion virescens	Sciaenidae	SE Brazil	3, 11
Cynoscion sp.	Sciaenidae	SE Brazil	2, 6
Micropogonias furnieri	Sciaenidae	SE and S Brazil	2, 3, 4, 6, 8, 11,12, 13
Stellifer rastrifer	Sciaenidae	SE and S Brazil	3, 8, 11, 13
Stellifer brasiliensis	Sciaenidae	SE and S Brazil	3, 7, 8, 11
Stellifer sp.	Sciaenidae	SE and S Brazil	2, 3, 6, 7,8, 11, 12, 13
Larimus breviceps	Sciaenidae	SE and S Brazil	7, 8, 11, 12
Isopisthus parvipinnis	Sciaenidae	SE and S Brazil	3, 6, 8, 11, 12, 13
Paralonchurus brasiliensis	Sciaenidae	SE and S Brazil	3, 4, 8, 11, 13
Umbrina canosai	Sciaenidae	SE Brazil	3
Umbrina coroides	Sciaenidae	SE Brazil	2
Umbrina sp.	Sciaenidae	SE and S Brazil	6, 8
Menticirrhus americanus	Sciaenidae	SE and S Brazil	3, 4, 8, 13
Menticirrhus sp.	Sciaenidae	SE Brazil	6
Bairdiella rhochus	Sciaenidae	NE Brazil	10, 13
Pogonias chromis	Sciaenidae	SE and S Brazil	3, 8
Nebris microps	Sciaenidae	SE Brazil	3
Ctenosciaena gracilicirrhus	Sciaenidae	SE and S Brazil	2, 3, 6, 13
Macrodon ancylodon	Sciaenidae	SE and S Brazil	3, 7,11
Diapterus rhombeus	Gerreidae	S Brazil	8, 13
Diapterus olisthostomus	Gerreidae	NE Brazil	5
Eucinostomus gula	Gerreidae	SE and S Brazil	8, 12
Eucinostomus argentus	Gerreidae	SE and S Brazil	8, 11
Eucinostomus melanopterus	Gerreidae	S Brazil	8
Eucinostomus sp.	Gerreidae	S Brazil	13
Gerres sp.	Gerreidae	NE Brazil	10
Mugil curema	Mugilidae	SE and S Brazil	4, 12
Mugil liza	Mugilidae	SE Brazil	6
Mugil brasiliensis	Mugilidae	SE Brazil	2
Mugil sp.	Mugilidae	SE and S Brazil	3, 7, 8, 9, 11, 12
Lycengraulis grossidens	Engraulidae	S Brazil	4, 8, 13
Anchoa tricolor	Engraulidae	S Brazil	8
Anchoviella lepidentostole	Engraulidae	S Brazil	8
Anchoa filifera	Engraulidae	SE and S Brazil	3, 7
Anchoa sp.	Engraulidae	SE and S Brazil	6, 8, 11, 13
Cetengraulis edentulus	Engraulidae	S Brazil	7, 13

continued

conclusion

FISH SPECIES	FAMILY	LOCALITY	REFERENCES*
Harengula clupeola	Clupeidae	SE and S Brazil	12
Odontognathus mucronatus	Clupeidae	SE Brazil	3
Sardinella brasiliensis	Clupeidae	SE and S Brazil	3, 8, 9, 13
Pellona harroweri	Clupeidae	SE and S Brazil	2, 3, 6, 8, 13
Bagre bagre	Ariidae	SE and S Brazil	3, 12
Sciadeichthys luniscutis	Ariidae	SE Brazil	3
Arius spixii	Ariidae	SE Brazil	3
Urophicys brasiliensis	Gadidae	SE and S Brazil	3, 13
Pomatomus saltator	Pomatomidae	SE Brazil	3, 6
Lutjanus griseus	Lujtanidae	S Brazil	13
Lujtanus sp.	Lujtanidae	SE Brazil	3
Ariosoma opisthophthalma	Congridae	SE Brazil	3
Haemulon steidachneri	Haemulidae	SE and S Brazil	12, 13
Genyatremus luteus	Haemulidae	S Brazil	8, 13
Orthopristis sp.	Haemulidae	SE Brazil	6
Orthopristis ruber	Haemulidae	SE and S Brazil	3, 11, 13
Conodon nobilis	Haemulidae	SE and S Brazil	3, 6, 7
Pomadasys corvinaeformis	Haemulidae	NE, SE and S Brazil	5, 11, 13
Centropomus undecimalis	Centropomidae	SE and S Brazil	2, 8
Trichiurus lepturus	Trichiuridae	NE, SE and S Brazil	2, 3, 4, 6, 8, 9, 10, 11, 12, 13
Porichthys porosissimus	Batrachoididae	SE and S Brazil	2, 3, 6, 8, 9, 11, 12, 13
Ophichthus gomesii	Ophichthiidae	S Brazil	8, 9
Myrophis punctatus	Ophichthiidae	SE and S Brazil	2, 13
Myrichthys ocellacus	Ophichthiidae	NE Brazil	5
Dules auriga	Serranidae	SE and S Brazil	12
Citharichthys sp.	Paralichthyidae	S Brazil	8, 13
Paralichthys orbignyanus	Paralichthyidae	SE Brazil	11
Paralichthys sp.	Paralichthyidae	S Brazil	13
Achiurus sp.	Achiridae	S Brazil	8
Peprilus paru	Stromateidae	SE Brazil	2, 3
Dactylopterus volitans	Dactylopteridae	NE Brazil	5
Pseudupeneus maculatus	Mullidae	NE Brazil	5
Oligoplites saliens	Carangidae	SE and S Brazil	12, 13
Caranx crysus	Carangidae	SE Brazil	6
Trachurus lathami	Carangidae	SE Brazil	6
Romboplites auroirubens	Carangidae	SE Brazil	6
Selene selapinnis	Carangidae	S Brazil	13
Chloroscombrus chrysurus	Carangidae	S Brazil	13
Synodus foetens	Synodontidae	S Brazil	13
Atherinella brasiliensis	Atherinopsidae	S Brazil	13
Unidentified	Scaridae	NE Brazil	5

NE=Northeast Brazil, SE= Southeast Brazil, S= South Brazil. *References: 1) Barbosa and Barros (2006)[7]; 2) Borobia and Barros (1989); 3) Di Beneditto (2000) and Di Beneditto and Siciliano (2007); 4) Emerim (1994); 5) Gurjão *et al*. (2003); 6) L. Barbosa and N. Barros (pers. comm.); 7) Marcucci *et al*. (2004)[9]; 8) Oliveira (2003); 9) Oliveira *et al*. (2008); 10) Reis *et al*. (1998)[8]; 11) Santos *et al*. (2002); 12) Schmiegelow (1990); 13) Zanelatto (2001).

Table 2. Cephalopod and crustacean species consumed by *Sotalia guianensis* on the Brazilian coast.

INVERTEBRATE SPECIES	Family	Locality	References*
CEPHALOPODS			
Loligo plei	Loliginidae	NE, SE and S Brazil	1, 3, 4, 6, 7, 8, 11
Loligo sanpaulensis	Loliginidae	SE and S Brazil	3, 6, 7, 11
Loligo sp.	Loliginidae	SE Brazil	1, 2, 10
Lolliguncula brevis	Loliginidae	NE, SE and S Brazil	1, 4, 6, 7, 8, 9, 11
Octopus sp.	Octopodidae	NE Brazil	8
Illex argentinus	Ommastrephidae	SE Brazil	5
Argonauta nodosa	Argonautidae	S Brazil	11
Unidentified	Sepiolidae	SE Brazil	2
CRUSTACEANS			
Farfantepenaeus brasiliensis	Penaeidae	SE and S Brazil	3, 4, 6
Farfantepenaeus paulensis	Penaeidae	SE Brazil	9
Litopenaeus schmitti	Penaeidae	SE Brazil	9
Xyphopenaeus kroyeri	Penaeidae	SE Brazil	7, 10

NE=Northeast Brazil, SE= Southeast Brazil, S= South Brazil. *References: 1) Borobia and Barros (1989); 2) Borobia *et al*. (1990)[10]; 3) Schmiegelow (1990); 4) Oliveira *et al*. (2008); 5) Geise and Gomes (1992)[11]; 6) Oliveira (2003); 7) Di Beneditto (2000); 8) Gurjão *et al*. (2003); 9) Santos *et al*. (2002); 10) L. Barbosa and N. Barros (pers. comm.); 11) Zanelatto (2001).

The fish length eaten by Guiana dolphins varied from 1.2 to 114.6cm (Di Beneditto, 2000; Santos *et al*., 2002; Gurjão *et al*., 2003; Oliveira, 2003; Oliveira *et al*., 2008), but the most frequent lengths consumed were between 3.2 to 16.2cm, suggesting that the species does not compete directly with the fisheries (Di Beneditto, 2000; Santos *et al*., 2002; Oliveira, 2003). This statement, however, is not shared by Gurjão *et al*. (2003), who suggested that the Guiana dolphin might compete with the artisanal fisheries on the Ceará coast (northern Brazil), based on the fish families consumed by this dolphin and those which are most commonly captured by the fisheries. The latter authors, however, did not take into consideration the fish length and a more detailed analysis must be carried out before reaching any conclusion on this topic.

In the Amazon, da Silva (1983) identified 27 fish species from 13 families in the stomachs of *S. fluviatilis* (Table 3). Comparing the food habits of *S. fluviatilis* with the sympatric Amazon River dolphin (*Inia geoffrensis*) in the Brazilian Amazon, da Silva (1986)[12] suggested that the tucuxi is more specialized in its diet than *I. geoffrensis*. The minimum and maximum body lengths of fish eaten by the tucuxi were 4.7cm and 37cm, respectively. The feeding behavior described by da Silva (1986)[12] for the tucuxi in the central Amazon is similar to that observed by Monteiro Filho (1995) for the Guiana dolphin on the southern Brazilian coast. According to these authors, both species usually prey on fish schools (although not exclusively) and use similar fishing strategies. However, due to the completely different ecosystems used by *S. guianensis* and *S. fluviatilis*, prey species consumed by these dolphins are also different.

The nutritional composition of milk from an 11yr old *S. guianensis* female, which was incidentally caught in a fishing net together with its 5mo old calf, was, for protein, 9.5g/100g; for fat, 17.1g/100g; for Na, 148.3mg/100g; for K, 129.1mg/100g; for Ca, 48.8mg/100g; for Mg, 8.1mg/100g; for Zn, 1.03mg/100g; and for P, 98.0mg/100g. The Fe concentration was lower than the resolution of the method (< 0.5mg/100g) (Rosas and Monteiro Filho, 2002).

[10] BOROBIA, M., BARROS, N.B., LODI, L., CAPISTRANO, L., DI BENEDITTO, A.P., ARRUDA RAMOS, R. AND SICILIANO, S. (1990) *Ecologia alimentar da forma marinha de* Sotalia fluviatilis*: Uma análise preliminar*. Page 10 *in* Abstracts, IV Reunión de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur, 12-15 November, Valdivia, Chile.

[11] GEISE, L. AND GOMES N. (1992) Ocorrência de plástico no estômago de um golfinho, *Sotalia guianensis* (Cetacea, Delphinidae). Pages 26-28 *in* Proceedings, *III Reunión de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur*, 25-30 July 1988, Montevideo, Uruguay.

[12] DA SILVA,V.M.F. (1986) Separação ecológica dos golfinhos de água doce da Amazônia. Pages 215-227 *in Proceedings I Reunião de Trabalho de Especialistas em Mamíferos Aquáticos da América do Sul*. Buenos Aires, Argentina.

Table 3. Fish species consumed by *Sotalia fluviatilis* in the Amazon basin, according to da Silva (1983).

Fish species	Family	Locality
Plagioscion sp.	Sciaenidae	Central Amazonia
Pachypops sp.	Sciaenidae	Central Amazonia
Hypopfthalmus perporosus	Pimelodidae	Central Amazonia
Calophysus macropterus	Pimelodidae	Central Amazonia
Pimelodus blochii	Pimelodidae	Central Amazonia
Pinirampus pinirampu	Pimelodidae	Central Amazonia
Ilisha sp.	Pristigasteridae	Central Amazonia
Pellona flavipinnis	Pristigasteridae	Central Amazonia
Triportheus sp.	Characidae	Central Amazonia
Brycon sp.	Characidae	Central Amazonia
Curimata ciliata	Curimatidae	Central Amazonia
Curimata kneri	Curimatidae	Central Amazonia
Curimata laticeps	Curimatidae	Central Amazonia
Curimata vittata	Curimatidae	Central Amazonia
Curimata latior	Curimatidae	Central Amazonia
Curimata sp.	Curimatidae	Central Amazonia
Curimatella meyere	Curimatidae	Central Amazonia
Eigenmannia melanopogon	Sternopygidae	Central Amazonia
Schizodon fasciatus	Anostomidae	Central Amazonia
Leporinus fasciatus	Anostomidae	Central Amazonia
Mylossoma aureum	Serrasalmidae	Central Amazonia
Mylossoma duriventre	Serrasalmidae	Central Amazonia
Acarichthys heckelii	Cichlidae	Central Amazonia
Hoplias malabaricus	Erythrinidae	Central Amazonia
Auchenipterus sp.	Auchenipteridae	Central Amazonia
Rhaphiodon vulpinus	Cynodontidae	Central Amazonia
Hydrolycus spp.	Cynodontidae	Central Amazonia
Prochilodus nigricans	Prochilodontidae	Central Amazonia

Reproduction

Body length at sexual maturity in *S. guianensis* was estimated to be between 170-180cm in males, and 160-169cm in females, and the age of sexual maturity in this dolphin species occurs between 6-7yr in males and 5-7yr in females (Table 4) (Ramos *et al*., 2000; Rosas and Monteiro Filho, 2002). Sexual maturity in *S. fluviatilis* is reached at around 140cm in males and between 132 and 137cm in females (Best and da Silva, 1984). Seasonality in testicular activity was not detected in the Guiana dolphin (Rosas and Monteiro Filho, 2002), while Best and da Silva (1984) mention that adult male tucuxis have seasonally active testes. Adult males of the genus *Sotalia* have large testes, which can reach up to 3.3% of the total body weight in *S. guianensis* (Rosas and Monteiro Filho, 2002) and 5% in active adult males of *S. fluviatilis* (Best and da Silva, 1984). According to Best and da Silva (1984), the tucuxi has a polyandrous mating system with sperm competition, while Rosas and Monteiro Filho (2002) mention a promiscuous mating system in the Guiana dolphin, also with sperm competition. However, considering that polyandry is a very rare mating system among mammals, Rosas and Monteiro Filho (2002) suggested that a promiscuous system with sperm competition may be more likely for both species of the genus *Sotalia*.

Length at birth of the Guiana dolphin was estimated to be between 92 and 106cm and the gestation period can last about one year (Ramos *et al*., 2000; Rosas and Monteiro Filho, 2002; Santos *et al*., 2003). On the other hand, Best and da Silva (1984) reported length at birth in *S. fluviatilis* to be around 71-83cm and a gestation period of about 10mo. Lactation period was estimated to be between 8.7 to 9.4mo in the Guiana dolphin (Ramos, 1997; Rosas and Monteiro Filho, 2002) and around 7mo in the tucuxi (Best and da Silva, 1984). As indicated by ovarian scars, Harrison and Brownell (1971)

and Best and da Silva (1984), after analyzing the ovaries of 15 females, suggested that ovulation in *S. fluviatilis* occurs exclusively in the left ovary, while Rosas and Monteiro Filho (2002), after analyzing the ovaries of 23 females, observed that both ovaries are functional in *S. guianensis*. The latter authors, however, mentioned that the left ovary matures earlier than the right one, and the Guiana dolphin can be classified as type II according to the categories described by Ohsumi (1964). Reproductive senescence was observed by Rosas and Monteiro Filho (2002) in ovaries of female *S. guianensis* older than 25yr. No information is available concerning reproductive senescence in the tucuxi. The main reproductive parameters of the dolphins of the genus *Sotalia* are presented in Table 4.

The peak of births of Guiana dolphins from the Rio de Janeiro coast occurs in the austral fall (Di Beneditto, 2000), while Rosas and Monteiro Filho (2002) did not record any defined seasonality in the births of this species on the Paraná coast, which is supported by the lack of seasonal testes activities observed in the Guiana dolphin from that region (Rosas and Monteiro Filho, 2002). On the other hand, according to Best and da Silva (1984), births of *S. fluviatilis* are very seasonal and occur during the low-water period in the Amazon basin, which is well supported by the seasonal testes activity recorded in this species.

HEALTH

Hematological values described by van Foreest (1980) for the Guiana dolphin and by Mello *et al*. (2009) for the tucuxi are presented in Table 5. Rosas *et al.* (2007) presented organ weight data for healthy *S. guianensis*, which can determine standards for postmortem evaluation and provide physiological information, and can also be used for systematic comparisons. The authors pointed out that they were able to compare only the adrenals, liver, heart, lungs and kidneys with *S. fluviatilis* as those were the only organ weights presented by da Silva and Best (1994) for the tucuxi. Most of the relative organ weights of *S. guianensis* had greater values than those of *S. fluviatilis*, which is probably due to ecological differences in the habitat used by these two dolphin species.

Lobomycosis was reported in Guiana dolphins by de Vries and Laarman (1974). Lobomycosis-like disease and nodular skin disease were reported in *S. guianensis* inhabiting the biologically and chemically contaminated Paranaguá estuary waters (southern Brazil), but were not recorded in Guiana dolphins living in the cleaner estuary of Cananéia (southeast Brazil), located only 60km from the Paranaguá estuary (Van Bressem *et al*., 2009). These diseases can be caused by organochlorine contaminants, which were not detected in high concentrations in Guiana dolphins from the Cananéia estuary (Yogui *et al*., 2003). Nevertheless, Guiana dolphins from the Paranaguá estuary presented similar organochlorine values to those reported in dolphins living in very industrialized areas of the northern hemisphere (Kajiwara *et al*., 2004), which can explain the skin diseases observed by Van Bressem *et al*. (2009) in dolphins from the estuary of Paranaguá. 'Tattoo lesions' or 'tattoo skin disease' were observed in Guiana dolphins from Baia Norte, Santa Catarina State (southern Brazil) (P. A. Flores, pers. comm.) and Sepetiba Bay, Rio de Janeiro (southeastern Brazil) (Van Bressem *et al*., 2007). Whitish lesions with a velvety appearance and associated with unrelated wounds, scars and tooth rakes were observed on the back, dorsal fin and flukes of two adult *S. guianensis* from Sepetiba Bay and may be related to poor water quality (Van Bressem *et al*., 2007). Greenwood and Taylor (1979) reported septicemia in *S. guianensis* caused by *Proteus morgani*, *Clostridium perfringers*, *Yersinia enterocolitica*, *Staphylococcus aureus* and

Table 4. Reproductive parameters of *Sotalia guianensis* and *Sotalia fluviatilis*, based on Ramos *et al*. (2000), Rosas and Monteiro Filho (2002), and Best and da Silva (1984).

PARAMETERS	*S. guianensis*		*S. fluviatilis*	
	♀	♂	♀	♂
Body size at maturation (cm)	160-169	170-180	132-137	140
Age at maturation (years)	5-7	6-7	UN	UN
Gestation period (months)	11-12	---	~10	---
Length of lactation (months)	8.7-9.4	---	~7	---
Size at birth (cm)	90-106		71-83	
Ovulation	both ovaries	---	left ovary only	---
Fetal growth rate (cm/month)	8.7-9.0		8.5	
Reproductive senescence	yes	---	UN	---
% Testes weight/body weight	up to 3.3		up to 5.0	

UN = unknown

Streptococcus fecalis and a possible case of botulism. Toxoplasmosis was also reported from one animal found dead in Niteroi, Rio de Janeiro State (Bandoli and Oliveira, 1977). Bossenecker (1978) mentioned hepatic degeneration, lung problems and severe vascular thrombosis in Guiana dolphins caught on the Caribbean coast of Colombia. Ruoppolo (2003) mentioned parasitic pneumonia caused by the presence of *Halocercus brasiliensis* as one of the main causes of mortality of *S. guianensis* from the coasts of São Paulo and Paraná States (southeast and southern Brazil, respectively) and no pathological lesions caused by gastrointestinal parasites. Marigo *et al*. (2010) presented a preliminary description of the parasite community and related lesions of specimens of *S. guianensis* from Paraná and São Paulo States.

The dorsal fin, flippers and flukes of *S. guianensis* can be severely injured, due to trauma related to net entanglements resulting in partial or complete amputations and deformations. Sometimes remains of nylon gillnets can be found around the body of Guiana dolphins (Azevedo *et al*., 2009). This constitutes a high percentage of non-lethal entanglements in gillnets that may, however, result in severe injuries and traumas, high stress levels and secondary mortality, which goes unaccounted for *S. guianensis* (Van Bressem *et al*., 2007).

Osteomyelitis was reported by Furtado and Simões-Lopes (1999) in *S. guianensis* from Santa Catarina coast, in southern Brazil. Osteomyelitis related to periodontal disease was also seen in the right mandible of a *S. guianensis* from Venezuela and possible *Crassicauda* lesions were also seen in the pterygoids of a mature *S. guianensis* from Rio de Janeiro coast (Van Bressem *et al*., 2007). Chronic bone lesions, degenerative infections, traumatic bone lesions and developmental bone anomalies in *S. guianensis* from Rio de Janeiro State were reported by Ramos *et al*. (2001) and Mendonça de Souza *et al*. (2006)[13]. On a broader scale, Fragoso *et al*. (2006)[14] analyzed the bone pathology of *S. guianensis* deposited in zoological collections in several Brazilian states.

As far as is known, apart from osteomyelitis (Fettuccia *et al*., 2005)[15], no other specific disease has been reported for the tucuxi. Spotte (1967) mentioned that a S. *fluviatilis* caught near Manaus (central Amazonia) by members of the Aquarium of Niagara Falls (USA) died, presumably from shock, and added that this species is very sensitive to handling and subject to fatality from shock. Trujillo *et al*. (1987) reported a tucuxi with a tripartite tail in the Colombian Amazon, but did not identify the cause of the deformity.

Table 5. Hematological values of *Sotalia guianensis* and *Sotalia fluviatilis*. Brazil.

	Sotalia guianensis (Van Foreest, 1980)		*Sotalia fluviatilis* (Mello *et al*., 2009)	
	Mean	Range	Mean	Range
Ht (%)	40.5	38 - 43	42.5	42 - 43
Hb (g/dL)	13.4	12.9 – 14.5	15.1	14.4 - 15.8
RBC (x10^{6}cells/µL)	4.27	3.7 – 5.0	5.6	5.2 – 5.9
MCV (fl)	94	86 - 101	76.5	70 - 83
MCH (pg)	31	29 - 34	---	---
MCHC (g/dL)	33	33.7 – 33.9	35	33 - 37
WBC (cell/µL)	9163	5700 - 14100	13200	10800 - 15600

[13] Mendonça de Souza, S.M.F., Laeta, M., and Siciliano, S. (2006) *Lesões ósseas em colunas vertebrais de golfinhos do gênero* Sotalia *provenientes do litoral norte do Rio de Janeiro, Brasil*. Page 32 *in* Siciliano, S., Borobia, M., Barros, N.B., Marques, F., Trujillo, F. and Flores, P.A.C. (Eds), Book of Abstracts, *Workshop on Research and Conservation of the genus* Sotalia, 19-23 June 2006, Armação dos Búzios, Rio de Janeiro, Brazil. *Latin American Journal of Aquatic Mammals* 8(1-2) (supplement). http://dx.doi.org/10.5597/lajam00147.a022

[14] Fragoso, A. B. L. *et al*. (2006) *Lesões ósseas degenerativas e distribuição etária de exemplares de boto-cinza,* Sotalia guianensis*, capturados acidentalmente e encalhados na costa brasileira*. Page 31 *in* Siciliano, S., Borobia, M., Barros, N.B., Marques, F., Trujillo, F. and Flores, P.A.C. (Eds), Book of Abstracts, *Workshop on Research and Conservation of the genus* Sotalia, 19-23 June 2006, Armação dos Búzios, Rio de Janeiro, Brazil. *Latin American Journal of Aquatic Mammals* 8(1-2) (supplement). http://dx.doi.org/10.5597/lajam00147.a021

[15] Fettuccia, D.C., da Silva, V.M.F. and Simões-Lopes, P.C. (2005) *Presença de costelas cervicais em golfinhos do gênero* Sotalia *e outras variações morfológicas.* Page 86 *in* Abstracts, III Congresso Brasileiro de Mastozoologia, Aracruz, 12-16 October, Espírito Santo, Brazil.

General Recommendations

Considering that the amount of natural history information available for the Guiana dolphin is mainly concentrated in the southeastern and southern Brazilian regions, it is recommended to sample the biological parameters from other areas. Therefore, we suggest that studies such as feeding habits, reproduction, age and health, should be carried out, taking into account the different population units identified by genetic analyses (see Cunha *et al*., 2005; Caballero *et al*., 2007; Caballero *et al*., 2010 this volume). Considering these population units, it is recommended that basic biometric data from incidentally caught or stranded dolphins be collected in a standardized way in order to allow comparisons between distinct geographical populations. Special attention should be given to information on *S. fluviatilis* from the main tributaries of the entire Amazon basin and on *S. guianensis* from Central America. This procedure would allow reliable comparative studies and identify potential threats to these dolphins throughout their distribution. Fresh carcasses should be weighed whenever possible since the weight/length relationship of specimens can be an indicator of their health (with a good sample size) and can be used as additional information in other analyses, such as contaminant studies. See suggestions of dolphin weighing techniques in Rosas (2000) and Rosas *et al*. (2007).

Attention should be given to the interpretation of the growth layer groups in teeth when estimating age, especially because *S. guianensis* can present 1 or 2 accessory layers, which can cause significant interference in the reliable age estimation if they are not properly identified as accessory layers. The elaboration of a 'guide' on how to read age in *S. fluviatilis* should be considered as most of the information concerning age estimation available today is for *S. guianensis* (see Rosas *et al*., 2003 and Ramos *et al*., 2008).

The photo identification catalogues, which already exist for some areas of the Guiana dolphin distribution, should be continuously updated and can be used to estimate vital parameters such as reproductive rate, calving interval, movement patterns and social organization (*e.g*. Santos and Rosso, 2008). These same catalogues can also be useful to assess some dermal pathologies (such as 'tattoo skin disease') and physical conditions of the dolphins (Van Bressem *et al*., 2009). Therefore, it is recommended that researchers compare catalogues to look for possible matches among different survey areas.

The recent separation of the two species of the genus *Sotalia* demands a revision on the conservation status of both species. It seems reasonable to maintain the tucuxi (*S. fluviatilis*) in the 'Data Deficient' category (IUCN, 2008)[16] due to the uncertainty of some biological parameters of this species and the lack of data quantifying incidental catches and pollution levels affecting this dolphin throughout the whole Amazon region. However, the organochlorine concentrations found in the Guiana dolphins` tissues from the coast of Paraná, Ubatuba and Baixada Paulista (southern Brazil) (Kajiwara *et al*., 2004; Alonso *et al*., 2010, this volume) and the hepatic trace elements observed in the livers of dolphins of the same area (Kunito *et al*., 2004), revealed similar values to those observed in dolphin species of very industrialized areas from the Northern Hemisphere. These, combined with habitat loss and the high incidental catches of Guiana dolphins in fishing nets throughout its distribution (Siciliano, 1994; Di Beneditto *et al*., 1998; Rosas 2000; Di Beneditto and Rosas, 2008), indicate that *S. guianensis* is strongly subjected to anthropogenic pressures and its conservation status deserves special attention.

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