

Comparison between the diet of two dolphins from south-eastern Brazil: proximate-composition and caloric value of prey species

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*A comparison between the diet of the franciscana and the boto-cinza is presented through the proximate-composition and caloric value of their main prey. The fish *Stellifer cf. rastrifer*, *Pellona harroweri*, *Anchoa filifera*, *Isopisthus parvippinnis* and *Trichiurus lepturus* and the squids *Loligo sanpaulensis* and *L. plei* were analysed for water, protein, lipid and mineral contents and gross energy (GE). The fish are more important in the diet of the boto-cinza and squids are consumed mostly by the franciscana. *Loligo sanpaulensis* had the higher water content and protein was the largest fraction of the organic matter in all prey species. Squids presented greater GE values than fish. The data on prey composition and energy from this study are the first for these South American dolphins.*

Keywords: diet, dolphins, south-eastern Brazil, proximate-composition, caloric value

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The franciscana, *Pontoporia blainvillei* (Gervais & D'Orbigny, 1844), and the boto-cinza, *Sotalia guianensis* (Van Bénédén, 1864) are vulnerable cetaceans along the western South Atlantic waters (IBAMA, 2001). They are sympatric along the south-eastern Brazilian coast (19°S–25°S) (Siciliano *et al.*, 2006) and the study conducted by Di Benedetto *et al.* (2001) compared their feeding habits in northern Rio de Janeiro State (21°18'S–22°25'S). The present note compares the diet of these dolphins considering the proximate-composition and caloric value of their preferred prey.

The feeding habits of the franciscana and the boto-cinza described in Di Benedetto & Ramos (2001) and Di Benedetto & Ramos (2004), respectively, were used to select the prey species for the proximate-composition and calorimetric analysis. The fish *Stellifer cf. rastrifer*, *Pellona harroweri*, *Anchoa filifera* and *Isopisthus parvippinnis* are representative for the franciscana, while *Trichiurus lepturus* is the main fish species for the boto-cinza. The squids *Loligo sanpaulensis* and *L. plei* are important for both dolphin species.

During April and May 2007, the known prey specimens were collected along the northern Rio de Janeiro State coast. The whole fresh specimens were homogenized, forming a composed sample of each prey species, which was frozen and lyophilized. The water content and the dry mass, as well as the mineral matter were determined gravimetrically by

desiccation at 105°C and by incineration in an oven at 600°C, respectively. The crude protein was obtained by the Kjeldahl method (Cunniff, 1998) and the protein content by calculation of the Kjeldahl nitrogen \times 6.25. The lipids were extracted using Folch *et al.*'s (1957) method and its content was determined gravimetrically. The protein, lipid and mineral content values were expressed as dry mass percentage (%DM). The gross energy (GE) was determined using a bomb calorimeter and was expressed as kcal per kg DM⁻¹. All samples were analysed in triplicate, except for GE. The statistical analyses were processed in the R-system 2.2.1 software (P value \leq 0.05). The prey groups were compared by t -test and the GE values for each prey species by Chi-square test (Zar, 1999).

The total amount of ingested fish and squids by the two dolphins was previously described in Di Benedetto *et al.* (2001). In the present study, these data were statistically analysed and revealed that the biomass recorded per stomach was significantly different, as well as the fish specimen number and size and squid specimen number (Table 1). The results indicated that fish are more important for the boto-cinza, while squids for franciscana.

The water, protein, lipid, mineral and GE values are summarized in Table 2. All the fish species and the squid *L. plei* had similar mean water content values. However, the value for *L. sanpaulensis* was around 7% higher than that of other prey. The proximate-composition results indicated that protein was the largest fraction of the organic matter in all prey species, which contained a minor amount of lipids. The mineral matter values were 2.5 times greater in fish than in

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Table 1. Diet comparison between the franciscana and the boto-cinza by the *t*-test (modified from Di Benedetto *et al.*, 2001).

Prey groups	Franciscana		Boto-cinza		P
	Min–Max	Mean(SD)	Min–Max	Mean(SD)	
Fish ¹					
Individuals per stomach (n)	1–201	48.0(47.0)	2–112	27.8(28.2)	0.0034
Biomass per stomach (g)	0.1–338.7	83.5(85.5)	26.1–4466.4	1393.7(1,251.0)	1.1e-07
Size (cm)	2.9–24.8	6.0(4.7)	3.2–66.1	13.3(12.8)	1.4e-07
Squids ²					
Individuals per stomach (n)	1–75	15.9(17.2)	1–57	8.0(11.3)	0.0098
Biomass per stomach (g)	1.1–2543.1	299.3(464.4)	3.6–1350.5	120.3(228.3)	0.0199
Size (cm)	2.3–23.0	8.0(5.1)	3.4–22.2	8.0(5.1)	0.9806

¹, all fish species consumed by the franciscana (N = 19) and the boto-cinza (N = 31); ², all squid species consumed by the franciscana and the boto-cinza (N = 3); SD, standard deviation; Min, minimum; Max, maximum.

squids. In relation to the GE values, there was a significant difference considering all the species ($\chi^2 = 220.5$, $P < 2.2e-16$). *Anchoa filifera*, *P. harroweri*, *I. parvipinnis* and *T. lepturus* had equivalent values ($\chi^2 = 4.9$, $P = 0.1814$), while *S. cf. rastrifer* and the squids showed the lower and the higher values, respectively.

The diet of these dolphins has been already described for other areas, where similar feeding habits were noted for the boto-cinza (e.g. Santos *et al.*, 2002) and the franciscana (e.g. Danilewicz *et al.*, 2002). According to these authors, the franciscana ingests small-size prey (up to 10 cm) and squids are very representative of its diet, while the boto-cinza is primarily piscivorous and presents greater plasticity regarding the prey size.

The main prey species of both dolphins are abundant all year round in northern Rio de Janeiro State (Di Benedetto *et al.*, 2001). Regarding the franciscana, prey selectivity is mainly related to its oral apparatus and digestive tract (Brownell & Ness, 1970; Jefferson *et al.*, 1993), which limit the size of the ingested preys. In turn, fish and squid species with higher water content are easier to be digested by the franciscana. These characteristics and the high water content in *L. sanpaulensis* can explain, at least in part, the great importance of this prey in the franciscana diet, which was previously reported by Di Benedetto & Ramos (2001).

A basic protein diet is expected in a carnivorous species, such as dolphins (Schmidt-Nielsen, 1996). Differences in the prey species regarding proximate-composition and caloric content can be reflecting environmental conditions, preys body structure, ontogenetic and reproductive state, and also depend on region or season (Perez, 1994; Kastelein *et al.*,

2002). In general, the caloric intake from squids is lower than from fish (Cox *et al.*, 1996; Walker, 1996). However, in Hawaiian waters the caloric content of fish, shrimps and squids consumed by *Stenella frontalis* did not show significant differences (Benoit-Bird, 2004). Perez (1994) did calorimetric measurements of Alaskan organisms ingested by marine mammals and detected that energy values can vary between the squid and fish species, without a specific trend.

The franciscana and the boto-cinza have marked differences in growth and reproductive parameters (Ramos *et al.*, 2000). These authors verified that the former has higher growth rates, lower body dimensions, earlier sexual maturity attainment and shorter birth intervals than the latter. These features can conduct the franciscana to greater energetic needs, which could be related to its squid preference, once in the study area these organisms are providing higher energy content than the fish species.

This study presented the first comparative information about the proximate-composition and caloric value of the prey species consumed by these South American dolphins, providing baseline data for future bioenergetics and nutritional needs studies and improving the knowledge about their feeding ecology.

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Table 2. Water content, dry mass, proximate-composition (protein, lipid and mineral) and gross energy (GE) values for the main prey species of the franciscana and the boto-cinza. Mean (standard deviation).

Prey species	Water content (%WM)	Dry mass (%WM)	Protein (%DM)	Lipid (%DM)	Mineral (%DM)	GE (kcal kg DM ⁻¹)
Fish						
<i>Stellifer cf. rastrifer</i>	76.0 (0.2)	24.0 (0.2)	69.8 (0.6)	5.3 (0.6)	23.3 (0.7)	4253.7
<i>Anchoa filifera</i>	77.0 (0.2)	23.0 (0.2)	77.8 (0.8)	5.4 (1.1)	17.2 (1.0)	4782.9
<i>Pellona harroweri</i>	78.3 (0.2)	21.7 (0.2)	77.4 (1.3)	5.9 (0.9)	19.3 (0.4)	4572.5
<i>Isopisthus parvipinnis</i>	79.0 (0.1)	21.0 (0.1)	78.5 (1.6)	5.5 (0.1)	16.7 (1.9)	4695.2
<i>Trichiurus lepturus</i>	78.5 (0.6)	21.5 (0.6)	83.9 (2.6)	4.6 (1.3)	15.5 (1.7)	4717.9
Squids						
<i>Loligo sanpaulensis</i>	85.1 (0.6)	14.8 (0.5)	84.5 (2.8)	7.5 (0.2)	6.1 (0.3)	5568.0
<i>Loligo plei</i>	78.4 (0.7)	21.6 (0.7)	86.3 (0.9)	2.3 (0.3)	8.8 (0.5)	5125.2

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