

FRASER'S DOLPHIN (*LAGENODELPHIS HOSEI* FRASER, 1956) IN SOUTHERN BRAZIL

Ignacio B. Moreno^{1,2*}, Daniel Danilewicz^{1,2}, Márcio Borges-Martins^{1,2,3}, Paulo H. Ott^{1,2}, Glauco Caon^{1,2} and Larissa R. Oliveira^{1,2}

Abstract – The Fraser's dolphin, *Lagenodelphis hosei* Fraser, 1956, is distributed in tropical oceanic waters worldwide. There is little information on the biology and distribution of this species in the Southwestern Atlantic Ocean. From September to November 1997, 10 stranded Fraser's dolphins were collected along the northern Rio Grande do Sul coast, southern Brazil. The reproductive status was determined for seven animals; the sample was comprised mainly of sexually mature dolphins. Total length varied from 241.0 to 245.0cm for females and 216.0 to 258.0cm for males. Several fetal bones were found in the vaginal channel of one female. Analyses of stomach contents from six animals revealed remains of coastal species of cephalopods, fishes and crustaceans, suggesting that these dolphins were feeding near-shore prior to stranding. Five dolphins had large quantity of the parasite *Phyllobotrium delphini* (larval stage) in the blubber layer, particularly in the genital region. Although this species is considered to be tropical in distribution, the records from the Southwestern Atlantic are concentrated in temperate areas (30°-35°S). Fraser's dolphin strandings in Rio Grande do Sul were not isolated events, and several other were recorded for the Brazilian, Uruguayan and Argentinean coast in the same and subsequent years. This may represent a complex phenomenon involving several causes, such as transient oceanographic events, diseases and other variables.

Resumo – O golfinho-de-fraser, *Lagenodelphis hosei* Fraser, 1956, é um cetáceo de hábitos caracteristicamente oceânicos, distribuído em águas tropicais em todos os oceanos do mundo. No oceano Atlântico Sul Ocidental, informações sobre a biologia e a distribuição dessa espécie são escassas. Entre setembro e novembro de 1997, 10 golfinhos-de-fraser foram coletados durante a realização de monitoramentos sistemáticos de praia, no litoral norte do Rio Grande do Sul, sul do Brasil. O estado reprodutivo foi determinado para sete animais, sendo que a maioria tratava-se de exemplares sexualmente maduros. O comprimento total variou entre 241,0 e 245,0cm para fêmeas e entre 216,0 e 258,0cm para machos. Uma das fêmeas apresentava restos ósseos de um feto no canal vaginal. A análise do conteúdo estomacal revelou a presença de restos de cefalópodes, peixes e crustáceos. Todas as espécies de presas encontradas nos estômagos ocorrem em águas de pouca profundidade e indicam que os golfinhos alimentaram-se em águas costeiras pouco antes do encalhe. Cinco exemplares apresentaram grande quantidade de parasitos (*Phyllobotrium delphini*, em estágio plerocercóide) na camada de gordura, principalmente em torno da região genital. Embora esta espécie seja considerada de hábitos tropicais em outros oceanos, os registros no Atlântico Sul Ocidental estão concentrados em áreas temperadas (30°-35°S). Os encalhes de *L. hosei* no Rio Grande do Sul não foram eventos isolados, e vários outros foram registrados para o Brasil, Uruguai e Argentina no mesmo ano e em anos subsequentes. Neste sentido, os encalhes podem representar um fenômeno mais complexo envolvendo várias causas, incluindo eventos oceanográficos temporários, doenças e outras variáveis.

Keywords: *Lagenodelphis hosei*, southern Brazil, Southwestern Atlantic Ocean, strandings, El Niño.

Introduction

The Fraser's dolphin, *Lagenodelphis hosei* Fraser, 1956, is distributed in tropical oceanic waters worldwide, between 30°N and 30°S (Perrin *et al.*, 1994). Records outside this distribution are considered to be atypical and might be influenced by transient oceanographic events (Perrin *et al.*, 1994; Dolar, 2002). Little is known about the biology of this species (Perrin *et al.*, 1994). Leatherwood *et al.* (1992) reviewed Fraser's dolphin records for the Atlantic Ocean; almost all of these were from the North Atlantic.

The first reported occurrence of Fraser's dolphin in the Southwest Atlantic was the strandings of four individuals in March 1991, in Uruguay (Praderi *et al.*, 1992). Moreno *et al.* (1998a;b) provided the first report of this species in Brazilian waters, which was a stranding during 1997. Additional Fraser's dolphin strandings had been occurred simultaneously in Brazil (Lailson-Brito *et al.*, 2000; Pinedo *et al.*, 2001) and Uruguay (Laporta *et al.*, 2002). In the last five years, new individuals and mass strandings are known for Brazil (Alvarenga *et al.*, 2000; Barros *et al.*, 2001; Di Benedetto *et al.*, 2001; Pinedo *et al.*, 2001; Van Bressen *et al.*, 2001), Uruguay (Laporta *et al.*, 2002) and Argentina (Van Bressen *et al.*, 2001; Hugo Castello, MACN, Buenos Aires, Argentina, pers. comm.).

The purpose of this paper is to present information on the distribution, parasites, diet, reproduction and osteology of this poorly-known species based on 10 individuals stranded in southern Brazil in 1997.

Material and Methods

Fraser's dolphins were collected during systematic beach surveys of northern Rio Grande do Sul State coast, southern Brazil, along 270km of sandy beaches from Torres (29°19'S; 049°42'W) to National Park of Lagoa do Peixe (31°21'S; 051°02'W) (Figure 1). These surveys were initiated in 1991 as part of a project to evaluate marine mammal and sea turtle fauna in the area. The surveyed area encompasses the whole northern coast of Rio Grande do Sul and the northern portion of the Mostardas' Peninsula. This region is located in the Subtropical Convergence and presents an influence of two currents: the Brazilian Current, transporting tropical water (temperature > 20°C, salinity > 36.00‰), and the Malvinas Current transporting subantarctic waters (temperature 4 to 15°C, salinity 33.70 to 34.15‰) (Garcia, 1997).

In the field, each specimen had the sex determined, the standard length recorded and, whenever possible, the external measurements were taken according to the

¹ Grupo de Estudos de Mamíferos Aquáticos do Rio Grande do Sul (GEMARS). Rua Felipe Neri, 382/203, Porto Alegre, RS, 90440-150, Brazil.

² Centro de Estudos Costeiros, Limnológicos e Marinhos (CECLIMAR) & Universidade Federal do Rio Grande do Sul (UFRGS). Av. Tramandaí, 976, Imbé, RS, 95625-000, Brazil.

³ Museu de Ciências Naturais - Fundação Zoobotânica do Rio Grande do Sul. Rua Dr. Salvador França, 1427, Porto Alegre, RS, 90690-000, Brazil.

*Corresponding author: igmoreno@terra.com.br.

American Society of Mammalogists (Norris, 1961). Whole stomachs were removed and frozen. In the laboratory, stomach contents were washed through a 1mm mesh sieve and preserved in 70% ethanol.

The gonads were collected and fixed in 10% formalin to determine the reproductive status. Females were considered to be sexually mature if at least one corpus albicans or luteum was present in the ovaries (Perrin and Donovan, 1984). Due to the stage of decomposition, males could not be classified about their maturity by the standard histological analysis of the testis. In this sense, sexual maturity was determined indirectly by comparing the testis weight of our specimens with those presented by Amano *et al.* (1996). Following their results, all dolphins with single testis weight heavier than 400g were considered sexually mature and all dolphins with single testis weight lighter than 100g were considered immature.

During the necropsies, the dolphins were examined for external and internal parasites. Examination was conducted mainly in the blubber layer and stomach. The parasites were preserved in 70% ethanol.

The ribs were counted in the field for both left and right sides. The first caudal vertebra was defined as the first vertebrae with a chevron immediately posterior to its caudal epiphysis (Romel, 1990) and labeled in the field. In all but one specimen the block of approximately 10 last caudal vertebrae was removed from the carcass and stored in tap water to avoid missing. Vertebral counts and cranial measurements and meristics followed Perrin (1975) and Romel (1990). Specimens were considered physically mature

if all vertebral epiphyses were fused to the centra (Perrin 1975). All material collected was deposited in the scientific collection of the Grupo de Estudos de Mamíferos Aquáticos do Rio Grande do Sul (GEMARS), Porto Alegre - Brazil.

Results

In the period between 20 September and 11 November 1997, ten Fraser's dolphins were found stranded in the northern Rio Grande do Sul, southern Brazil, along approximately 156km of sandy beaches (Figure 1). All animals were dead when collected, although local people informed us that three dolphins (GEMARS 0486, 0487 and 0488) live stranded together. Information on sex, length, weight, osteological data, physical and reproductive status are presented in Table 1.

External coloration was partly affected by the decomposition and sun exposure. However, the typical pattern of grayish dorsum, white ventral area and a well demarked eye-to-anus dark stripe (*e.g.* Jefferson *et al.*, 1997) was observed in the adult specimens. In the immature male (GEMARS 0435), the stripe was less defined and did not reach the anal region.

The reproductive status was analyzed for six animals through gonad inspection. It was determined that there were two mature females, three mature males and one immature male. The specimen GEMARS 0467 was a fetus/neonate 85.0cm long with its ventral area damaged, which precluded its sex identification. This animal still presented fetal folds, its dorsal fin was still folded and remain of the umbilical cord was

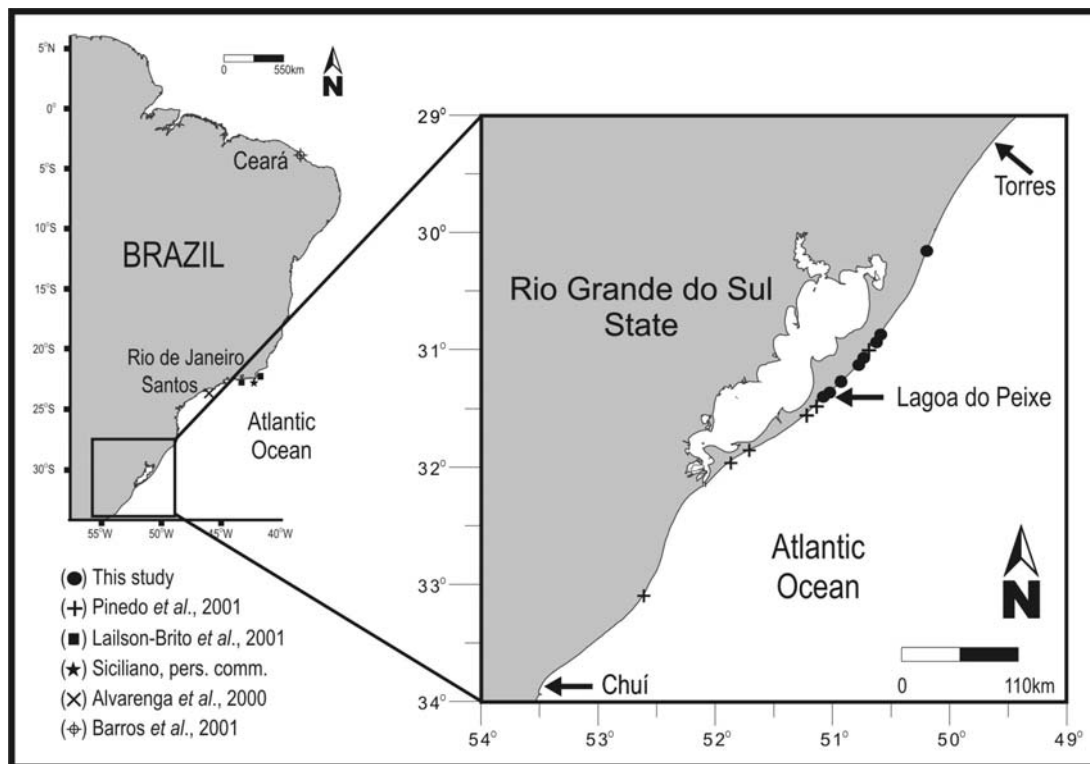


Figure 1. Location of stranded Fraser's dolphins along the Brazilian coast. Inset map provides greater detail of the Rio Grande do Sul State, southern Brazil. A symbol may represent more than one stranded individual.

present. The gonads of the female GEMARS 0487 could not be analyzed, but due to its large standard length (245.0cm), it was probably mature. The reproductive status of the male GEMARS 0486 could not be determined, since its gonads were not analyzed and its size is in the range of values for both mature and immature males. The smallest sexually mature female and male were 241.0cm and 248.0cm, respectively.

In the female GEMARS 0464 were found several fetal bones in the vaginal channel. The set of bones was composed of an almost complete skull, two scapulas, some ribs and other bones. There was no flesh attached to them, indicating that the abortion was not recent. The estimated condylobasal length (CBL) of the fetus was 56.89mm and the greatest length of left ramus 49.16mm.

Table 1. Characteristics of the *Lagenodelphis hosei* specimens stranded in the Rio Grande do Sul State, Brazil.

| Collection number | Date of collection | Coordinate | Sex | SL (cm) | Weight (kg) | Vertebral formula | Distal fusion maxilla/premaxilla | Physical status | Reproductive status ³ |
|-------------------|------------------------|----------------------------|-----|---------|-------------|-----------------------------------|----------------------------------|-----------------|----------------------------------|
| GEMARS 0435 | 20/Sep/97 | 30°10'00"S; 050°12'00"W | ♂ | 216.0 | 83.0 | C7+T16+L19+Ca38=80 | yes | I | I (g) |
| GEMARS 0461 | 10/Nov/97 | 31°10'14"S; 050°49'22"W | ♂ | 256.0 | - | C7+T16+L21+Ca27+8=79 ¹ | yes | M | M (g) |
| GEMARS 0463 | 10/Nov/97 | 31°16'57"S; 050°56'37"W | ♀ | 241.0 | - | - | yes | U | M (g) |
| GEMARS 0464 | 11/Nov/97 | 31°21'33"S; 051°02'31"W | ♀ | 245.5 | - | C7+T16+L20+Ca36=79 | yes | M | M (g) |
| GEMARS 0465 | 11/Nov/97 | 31°22'15"S; 051°03'07"W | ♂ | 258.0 | - | - | yes | U | M (g) |
| GEMARS 0467 | 11/Nov/97 | 31°04'15"S; 050°44'26"W | U | 85.0 | 5.0 | - | no | I | I (sl) |
| GEMARS 0470 | 11/Nov/97 | 30°57'25"S; 050°39'51"W | ♂ | 248.0 | - | - | yes | U | M (g) |
| GEMARS 0486 | 07/Dec/97 ² | 30°57'44"S; 050°40'03"W | ♂ | 226.5 | - | C7+T15+L21+Ca36=79 | yes | I | U |
| GEMARS 0487 | 07/Dec/97 ² | 30°57'44"S; 050°40'03"W | ♀ | 245.0 | - | C7+T16+L21+Ca35=79 | yes | M | M (sl) |
| GEMARS 0488 | 07/Dec/97 ² | 30°57'44"S; 050°40'03"W | ♂ | 253.0 | - | C7+T16+LCa55=78 | yes | I | M (g) |

⁽¹⁾ Number of the last caudal vertebrae estimated by comparison with an intact specimen; ⁽²⁾ Animals that live stranded together in 7 November 1997; ⁽³⁾ Reproductive status determined by gonads (g) or standard length (sl); (I) immature, (M) mature, (U) undetermined, (SL) standard length.

Table 2. Prey species identified in the stomach contents of the *Lagenodelphis hosei* (GEMARS 0435, 0461, 0463, 0464, 0465 and 0488) stranded in Rio Grande do Sul State, Brazil.

| | Taxon | N | FO | %N | %FO | Prey habit ¹ | Depth range of prey (m) ¹ |
|--------|--------------------------------|-----|----|-------|--------|-------------------------|--------------------------------------|
| Fish | <i>Urophycis brasiliensis</i> | 26 | 6 | 11.87 | 100.00 | demersal | 0-180 |
| | <i>Cynoscion guatucupa</i> | 183 | 1 | 83.56 | 16.67 | demersal | 0-120 |
| | <i>Porichthys porosissimus</i> | 9 | 1 | 4.11 | 16.67 | demersal | 40-120 |
| | <i>Trichiurus lepturus</i> | 1 | 1 | 0.46 | 16.67 | demersal/pelagic | 0-250 |
| | Total | 219 | 6 | 100 | | | |
| Squid | <i>Loligo sanpaulensis</i> | 3 | 1 | 75 | 50.00 | epipelagic | 0-120 |
| | <i>Argonauta nodosa</i> | 1 | 1 | 25 | 50.00 | demersal/pelagic | 80-180 |
| | Total | 4 | 2 | 100 | | | |
| Shrimp | Penneidae | 1 | 1 | 100 | 100.00 | | |
| | Total | 1 | 1 | 100 | | | |

(1) Haimovici (1997a,b); (N) number of prey; (FO) frequency of occurrence.

Remains of cephalopods, teleost fishes and crustaceans (Peneidae) were found in the stomach of six animals (Table 2). In the other four animals, including the neonate, the stomachs were empty. Five dolphins (GEMARS 0435, 0461, 0463, 0464, 0465) presented a large quantity of the parasites *Phyllobotrium delphini* in larval stages (plerocercoids) in the blubber layer, especially around the genital region. Selected skull measurements and meristics are presented in Table 3.

Discussion

The tooth counts from the collected dolphins (38-42 in upper and 39-43 in lower jaw) are in agreement with the range

presented for the species by Perrin *et al.* (1994). However, Pinedo *et al.* (2001) examined seven animals from Southern Brazil and found a wider range of values for this meristics, with 39-45 teeth in the upper jaw and 36-44 in the lower jaw. We verified no noteworthy differences in the vertebral counts between the studied animals and the literature (Perrin *et al.*, 1994).

Skull measurements of 31 Fraser's dolphins from different localities were compiled by Perrin *et al.* (1994). The authors commented that the range of published values for the parietal width (159 to 200mm) are wide and that the upper end of the range is too high, probably due to some error. However, two dolphins of this study (GEMARS 0461 and 0487) also presented such high values of parietal width,

Table 3. Skull measurements and meristics of the *Lagenodelphis hosei* specimens stranded in Rio Grande do Sul State, Brazil.

| Measurements and meristics | GEMARS 0435 | GEMARS 0461 | GEMARS 0463 | GEMARS 0464 | GEMARS 0465 | GEMARS 0467 | GEMARS 0470 | GEMARS 0486 | GEMARS 0487 | GEMARS 0488 |
|---------------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Condylbasal length (CBL) | 428.34 | 424.96 | 429.32 | 423.82 | +423.80 | 217.58 | 419.60 | 435.70 | +428.08 | 412.78 |
| Length of rostrum | 236.16 | 229.60 | 235.48 | 237.00 | - | 104.35 | 222.48 | 242.90 | - | 222.38 |
| Width of rostrum at base | 122.00 | 128.85 | 121.10 | 126.50 | 126.68 | 52.40 | 120.55 | 120.70 | 120.80 | 131.00 |
| Width of rostrum at 60mm | 83.75 | 93.95 | 85.80 | 90.60 | 91.57 | 31.00 | 84.40 | 84.40 | 90.00 | 86.65 |
| Width of rostrum at 1/2 length | 66.95 | 77.90 | 68.70 | 71.45 | - | - | 68.65 | 72.70 | - | 68.00 |
| Width of rostrum at 3/4 length | 50.20 | 63.65 | 50.75 | 50.85 | - | 24.10 | 53.45 | 58.60 | - | 52.70 |
| Width of premaxillaries at 1/2 length | 31.85 | 37.10 | 31.40 | 32.70 | - | 12.95 | 31.30 | 33.75 | - | 33.35 |
| Tip of rostrum to external nares | 291.66 | 290.74 | 298.46 | 297.08 | - | 129.65 | 281.70 | 306.06 | - | 279.32 |
| Tip of rostrum to internal nares | 294.60 | 281.28 | 295.40 | 295.80 | - | 138.70 | 284.90 | 298.72 | - | 282.60 |
| Greatest preorbital width | 206.10 | 220.62 | 208.94 | 217.00 | 214.55 | 92.70 | 208.40 | 211.86 | 214.60 | 213.50 |
| Greatest postorbital with | 227.70 | 236.00 | 229.56 | 236.18 | 233.09 | 98.95 | 232.84 | 234.96 | 235.38 | 235.90 |
| Greatest zygomatic width | 220.60 | 231.88 | 227.26 | 232.54 | 229.76 | - | 230.00 | 231.10 | 231.30 | 230.92 |
| Greatest width of external nares | 48.45 | 48.00 | 47.00 | 46.95 | 45.69 | 24.30 | 48.40 | 48.75 | 46.45 | 48.95 |
| Greatest width of internal nares | 66.45 | 77.15 | 68.65 | 69.80 | 66.50 | ~25.00 | 73.40 | 70.35 | 69.40 | 73.70 |
| Greatest premaxillary width | 77.60 | 81.55 | 76.30 | 81.50 | 80.56 | 41.75 | 77.90 | 78.55 | 80.80 | 80.90 |
| Greatest parietal width | 184.34 | 199.80 | 193.96 | 188.54 | 185.93 | 101.85 | 176.00 | 189.24 | 198.50 | 193.94 |
| Length of left posttemporal fossa | 74.25 | 67.00 | 60.25 | 68.25 | 70.52 | 41.00 | 72.65 | 72.00 | 71.00 | 67.00 |
| Height of left posttemporal fossa | 45.70 | 36.20 | 36.70 | 42.90 | 38.60 | ~22.70 | 37.60 | 41.65 | 42.65 | 42.60 |
| Projection of left premaxillaries | 9.10 | 8.85 | 12.95 | 21.60 | - | 10.00 | 7.25 | 11.70 | - | 18.35 |
| Length of left orbit | 50.90 | 55.10 | 50.30 | 53.90 | 53.48 | 30.75 | 55.40 | 50.70 | 53.00 | 50.00 |
| Length of lacrimal | 56.60 | 61.40 | 60.50 | 59.25 | 63.80 | 27.95 | 59.65 | 61.55 | 60.25 | 57.90 |
| Length of upper left tooth row | 201.70 | 194.85 | 201.58 | 200.60 | - | 92.35 | 196.85 | 201.50 | - | 187.25 |
| Length of lower left tooth row | 223.84 | 199.95 | 205.68 | - | 206.43 | 99.45 | 203.80 | 204.90 | - | 193.95 |
| Length of mandibular symphysis | 40.10 | 37.20 | 41.00 | 41.35 | 44.45 | - | 44.20 | 40.00 | - | 34.85 |
| Greatest length of left ramus | 361.56 | 356.40 | 362.36 | 360.80 | 367.26 | - | 353.20 | 366.60 | - | 344.58 |
| Greatest height of left ramus | 67.50 | 64.40 | 64.85 | 68.05 | 69.51 | - | 67.35 | 70.40 | 74.95 | 67.25 |
| Length of left mandibular fossa | 125.10 | 121.00 | 114.20 | - | 130.92 | - | 119.80 | 117.80 | 117.00 | 119.75 |
| Number of teeth (upper left) | 41 | 39 | 42 | - | - | - | 41 | 41 | - | 39 |
| Number of teeth (upper right) | 41 | 39 | 42 | - | - | - | 40 | 42 | - | 38 |
| Number of teeth (lower left) | 41 | 39 | 42 | - | 43 | - | 41 | 42 | - | 41 |
| Number of teeth (lower right) | 41 | 39 | 41 | - | 43 | - | 42 | 42 | - | 41 |

Obs.: Measurements in mm.

indicating that the range presented by Perrin *et al.* (1994) could be accurate (Table 1).

Fraser's dolphins are known to feed mainly on mesopelagic fishes and squids, feeding selectively by depth (deeper than 250m) and prey size (Robison and Craddock, 1983; Dolar, 2002). The prey species found in the stomach of *L. hosei* collected in this study occur over the continental shelf in shallow waters, demonstrating that the dolphins were foraging in coastal waters before stranding. This behavior is common for oceanic cetacean species when they are sick or/and injured and in the process of stranding (Gannon *et al.*, 1997). In the same way, the stomach contents of the *L. hosei* stranded in southern Rio Grande do Sul State (Pinedo *et al.*, 2001; Santos and Haimovici, 2001) and in Rio de Janeiro State, southeastern Brazil (Di Benedetto *et al.*, 2001) also presented prey species with similar habits to those reported in this study. At least eight internal parasite species were described to infect *L. hosei* (Jefferson and Leatherwood, 1994). The presence of *Phyllobotrium delphini* in the blubber was also found in specimens from Australia, Western North Pacific and North Atlantic (Tobayama *et al.*, 1973; McColl and Obendorf, 1982; Van Bree *et al.*, 1986). This parasite may have zooplanktonic and benthic crustaceans, cephalopods and fish as initial intermediate hosts (Raga, 1997). Probably dolphins are also intermediate or transport hosts, and sharks are the final hosts (Raga *et al.*, 2002).

The length at birth of *L. hosei* is considered to be about 100cm. Calves from 95-110cm and fetuses up to 110cm have been reported (Perrin *et al.*, 1994). The smallest dolphin collected in this study measured 85.0cm, being 10cm smaller than the smallest neonate ever reported for this species. It is not possible to affirm whether this animal was a newborn or an aborted fetus, but considering the information presented by Perrin *et al.* (1994), the aborted fetus hypothesis is more plausible. Another possibility is that size at birth is considerably smaller in the Atlantic Ocean and, in this case, the specimen was a calf indeed. However, this possibility is in disagreement with statements of Van Bree *et al.* (1996), which have suggested that *L. hosei* may be larger in the Atlantic than in the Pacific Ocean. Our data on size of the animals did not show any striking difference from those reported by Perrin *et al.* (1994) for the Pacific Ocean, and further analysis on age and growth are needed to test Van Bree's statements.

The presence of *L. hosei* in temperate areas of the world has been associated with the influence of warm water currents. In southern Africa, the records are restricted to the summer months (January and February) and are related to the warm waters of the Agulhas Current, which runs south in this period (Perrin *et al.*, 1994). The records for Uruguay (Praderi *et al.*, 1992) were also reported in an austral summer month (March 1991) and the authors correlated them with the influence of the tropical waters of the Brazil Current, which moves south during the summer. Nevertheless, it seems not to be the case presented here, since the animals were collected in the austral spring, when the cold waters of the Malvinas Current are still influencing the study area. It is important to mention that in the same period when the

studied dolphins were collected, hundreds of Magellanic penguins (*Spheniscus magellanicus*), some South American fur seals (*Arctocephalus australis*) and Southern sea lions (*Otaria flavescens*) were also found dead on beaches along the coast of Rio Grande do Sul State. These species inhabit cold and temperate waters of the South America and their occurrence during winter (June to September) and spring (September to December) is very common in Rio Grande do Sul State associated with the Malvinas Current.

The stranding of the ten Fraser's dolphins in 1997 reported in this study was not an isolated event. A few days before, between August 31 and October 3, more than sixty specimens of *L. hosei* were found dead along 250 km of beaches in Uruguay (Laporta *et al.*, 2002). In the southern coast of Rio Grande do Sul State, five Fraser's dolphins were also collected from September to November (Pinedo *et al.*, 2001). In 13 November 1997, a single stranding occurred in Arraial do Cabo, Rio de Janeiro State (22°57'S; 042°01'W). One month later, about 20 Fraser's dolphins were sighted swimming inside the Guanabara Bay, Rio de Janeiro State (ca 22°51'S; 043°10'W), and some of them were incidentally caught or stranded in that region (José Lailson-Brito, MAQUA, Rio de Janeiro, Brazil, pers. comm.). In summary, the stranding events of *L. hosei* in the Southwestern Atlantic in 1997 started in Uruguay, in the end of August, and finished in Southeastern Brazil, in December, involving about 100 animals in total. After 1997, additional records of *L. hosei* with similar stranding patterns (live, single and mass strandings) continue to be reported for the Southwestern Atlantic coast (Table 4).

Records on the occurrence of *L. hosei* in temperate regions of the world have been related to temporary oceanographic anomalies, such as "El Niño" (Van Bree *et al.*, 1986; Perrin *et al.*, 1994). In this sense, the "El Niño" event of 1997 was considered one of the most intense of the 20th Century (Webster and Palmer, 1997; Pontecorvo, 2001) and may be associated somehow with the first occurrence of *L. hosei* along the Brazilian coast.

Moreover, in a recent analysis of epidemiology of dolphin morbillivirus (DMV), Van Bresse *et al.* (2001) found antibodies against dolphin morbilliviruses in three out of four specimens of *L. hosei* stranded in Brazil and Argentina. In this same review, some coastal species from Southwestern Atlantic, such as franciscana, *Pontoporia blainvillei* (n=14), Atlantic spotted dolphin, *Stenella frontalis* (n=6) and tucuxi, *Sotalia fluviatilis* (n=5), were not reactive to DMV-iELISA tests. It is important to note that DMV can cause serious lethal diseases in cetaceans and it was responsible for the deaths of over 1,000 striped dolphins (*Stenella coeruleoalba*) in the Mediterranean Sea in 1990-1991 (Forcada *et al.*, 1994) and caused the die-off of several hundred of coastal bottlenose dolphins (*Tursiops truncatus*) in the US mid-Atlantic in 1987-1988 (Duignan *et al.*, 1996).

It is still premature to define the habitat preference of the Fraser's dolphin in the Southwestern Atlantic Ocean with the available data, since these events could represent an anomalous pattern. In this area, the records of this species are concentrated in the Subtropical Convergence region in temperate waters (35°-30°S), differing from the distribution

Table 4. Stranding events of *Lagenodelphis hosei* in the Southwestern Atlantic Ocean.

| | Date | Locality | Coordinate | Country | Number of animals | Reference and/or Collection |
|---------------------|--------------------------|---------------------------------------|---|-----------|-------------------|--|
| | March 1991 | Arroyo Pando to Punta José Ignacio | 34°48'S; 055°51'W to 34°49'S; 054°37'W about 120km | Uruguay | 4 | Praderi, <i>et al.</i> , 1992 MNHN-M 3267, 3268, 3273 |
| Probably same event | August-November 1997 | Piriápolis to El Calabrés | 34°52'S; 055°16'W to 34°26'S; 057°15'W about 250km | Uruguay | 65 | Laporta <i>et al.</i> , 2002 |
| | September-November 1997 | Mostardas to Chuí | 31°02'S; 050°43'W to 33°07'S; 052°38'W about 350km | Brazil | 5 | Pinedo <i>et al.</i> , 2001 LMM 2059, 2067, 2097, 2100, 2101 |
| | September-November 1997 | Cidreira to Lagoa do Peixe | 30°10'S; 050°12'W to 31°22'S; 051°03'W about 156km | Brazil | 10 | This study |
| | November-December 1997 | Arraial do Cabo and Baía de Guanabara | 22°57'S; 042°01'W and 22°51'S; 043°10'W about 120km | Brazil | ~21 | Lailson-Brito <i>et al.</i> , 2000 |
| | 2 August 1998 | Praia Seca | 22°56'S; 042°19'W | Brazil | 1 | S.Siciliano, pers. comm. MNRJ 51648 |
| | August and November 1998 | São José do Norte | 31°50'S; 051°42'W and 31°56'S; 051°52'W | Brazil | 2 | Pinedo <i>et al.</i> 2001 LMM 2141, 2181 |
| | 17 May 1999 | Praia de Taíba | 03°41'S; 038°37'W | Brazil | 1 | Barros <i>et al.</i> , 2001 AQUASIS 130111 |
| | March and April 1999 | Puerto Madryn | 42°54'S; 065°00'W | Argentina | 2 | Van Bressem <i>et al.</i> , 2001 and Laporta <i>et al.</i> , 2002 |
| | 12 September 1999 | Santos | 24°00'S; 046°16'W | Brazil | 1 | Alvarenga <i>et al.</i> , 2000 CEEMAM 072 |
| | September 1999 | Arraial do Cabo | 22°57'S; 042°01'W | Brazil | 2 | Van Bressem <i>et al.</i> , 2001 and Di Benedetto <i>et al.</i> , 2001 |
| Same event | November-December 2000 | Juan Lacaze | 34°26'S; 057°26'W | Uruguay | 15 | Laporta <i>et al.</i> , 2002 |
| | November-December 2000 | Punta Lara to Magdalena | 34°49'S; 057°58'W to 35°04'S; 057°31'W | Argentina | 13 | H.P.Castello, pers. comm. |
| | November 2001 | Mouth of Santa Lucía River | 34°47'S; 056°21'W | Uruguay | 50 | Laporta <i>et al.</i> , 2002 |

(AQUASIS) Associação de Pesquisa e Preservação de Ecossistemas Aquáticos; (CEEMAM) Centro de Estudos de Encalhes de Mamíferos Marinhos; (LMM) Laboratório de Mamíferos Marinhos e Tartarugas Marinhas (Dpto. de Oceanografia - FURG); (MNRJ) Museu Nacional do Rio de Janeiro, and (MNHN-M) Museo Nacional de Historia Natural.

observed in other areas (Perrin *et al.*, 1994; Jefferson and Leatherwood, 1994; Dolar, 2002). A commonplace, but problematic procedure, is extrapolating to a worldwide basis the habits and distribution of dolphin species based on data from a few areas. A typical example is the rough-toothed dolphin (*Steno bredanensis*). Based on records from the Pacific and Indian Ocean, this species is cited as a pelagic dolphin from tropical waters (Miyazaki and Perrin, 1994), while along the Brazilian coast this species is only known from coastal waters and may even endure cold temperatures (Ott and Danilewicz, 1996; Lodi and Hetzel, 1998).

The relatively high number of animals stranded in 1997, together with the absence of sightings during many dedicated surveys for cetaceans in Brazilian waters (Alexandre Zerbini, SAFS, Seattle, United States, pers. comm), suggest that *L. hosei* occurs in relatively low densities, large groups and may presents a patchy distribution in the Southwestern Atlantic Ocean.

The almost simultaneous records of this species in different areas of the Brazilian and Uruguayan coasts suggest that strandings recorded in the Rio Grande do Sul State in 1997, as well as other records for Southwestern Atlantic, may

probably represent a much more complex phenomenon involving several causes. The threats to the conservation of pelagic cetacean species are difficult to study and sometimes may just be noticed when the process is in advanced stage of development. In this sense, it is important to carry out extensive investigations (e.g. epidemiologic, contaminants, genetics, beach and vessel surveys) to find out the causes of these events and whether they are related to temporary oceanographic events ("El Niño"), climate change, diseases or other variables.

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References

- Alvarenga, F.S., Vicente, A.F.C., Zampiroli, E and Santos, M.C. de O. (2000) Nota sobre o primeiro registro do golfinho-de-Fraser, *Lagenodelphis hosei* Fraser 1956 (Cetacea - Delphinidae) no Estado de São Paulo, Brasil. Page 4 in Abstracts, IX Reunión de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur y III Congreso de la Sociedad Latinoamericana de Especialistas en Mamíferos Acuáticos de América del Sur, 30 October - 3 November, Buenos Aires, Argentina.
- Amano, M., Miyazaki, N. and Yanagisawa, F. (1996) Life history of Fraser's dolphin, *Lagenodelphis hosei*, based on a school captured off the Pacific coast of Japan. *Marine Mammal Science* 12(2): 199-214.
- Barros, H.M.D.R., Silva, C.P.N., Costa, A.F., Campos, A.A., Oliveira, J.A. and Meirelles, A.C.O. (2001) Primeiro registro de um golfinho de Fraser (*Lagenodelphis hosei*) para o litoral do Ceará. Page 41 in Abstracts, I Congresso Brasileiro de Mastozoologia, 6-9 September, Porto Alegre, Brasil.
- Di Benedetto, A.P.M., Ramos, R.M.A., Siciliano, S., Santos, R.A., Bastos, G. and Fagundes-Netto, E. (2001) Stomach contents of delphinids from Rio de Janeiro, southeastern Brazil. *Aquatic Mammals* 27(1): 24-28.
- Duignan, P.J., House, C., Odell, D.K., Wells, R.S., Hansen, L.J., Walsh, M.T., St. Aubin, D.J., Rima, B.K. and Geraci, J.R. (1996) Morbillivirus infection in bottlenose dolphins: evidence for recurrent epizootics in the western Atlantic and Gulf of Mexico. *Marine Mammal Science* 12(4): 499-515.
- Dolar, M.L.L. (2002) Fraser's dolphin, *Lagenodelphis hosei*. Pages 485-487 in Perrin, W.F., Wursig, B. and Thewissen, H.G.M. (Eds) *Encyclopedia of Marine Mammals*, Academic Press, San Diego, California.
- Forcada, J., Aguilar, A., Hammond, P.S., Pastor, X. and Ricardo, A. (1994) Distribution and numbers of striped dolphins in the western Mediterranean Sea after the 1990 epizootic outbreak. *Marine Mammal Science* 10(2): 137-150.
- Garcia, C.A.E. (1997) Physical Oceanography. Pages 94-96 in Seeliger, U., Oderbrecht, C. and Castello, J.P. (Eds) *Subtropical Convergence Environments - The coast and sea in the Southwestern Atlantic*. Springer-Verlag, Berlin, Germany.
- Gannon, P.D., Read, A.J. and Craddock, J.E. (1997). Stomach contents of long-finned pilot whales (*Globicephala melas*) stranded on the U.S. Mid-Atlantic coast. *Marine Mammal Science* 13(3): 405-418.
- Haimovici, M. (1997a) Demersal and benthic teleosts. Pages 129-136 in Seeliger, U., Oderbrecht, C. and Castello, J.P. (Eds) *Subtropical Convergence Environments - The coast and sea in the Southwestern Atlantic*. Springer-Verlag, Berlin, Germany.
- Haimovici, M. (1997b) Cephalopods. Pages 146-150 in Seeliger, U., Oderbrecht, C. and Castello, J.P. (Eds) *Subtropical Convergence Environments - The coast and sea in the Southwestern Atlantic*. Springer-Verlag, Berlin, Germany.
- Jefferson, T.A. and Leatherwood, S. (1994) *Lagenodelphis hosei*. *Mammalian Species* 470: 1-5.
- Jefferson, T.A., Pitman, R.L., Leatherwood, S. and Dolar, M.L.L. (1997) Developmental and sexual variation in the external appearance of Fraser's dolphins (*Lagenodelphis hosei*). *Aquatic Mammals* 23(3): 145-153.
- Lailson-Brito, J.Jr., Azeredo, M.A.A., Saldanha, M.F.C., Fernandez, M.A. and Herms, F. (2000) Estudo ecotoxicológico das concentrações de cádmio em tecidos de golfinhos (Cetacea, Delphinidae) de hábitos costeiros e oceânicos, de águas do Estado do Rio de Janeiro. Pages 183-197 in Espíndola, E.L.G., Paschoal, C.M.R.B., Rocha, O., Bohrer, M.B.C. and Oliveira Neto, A.L. (Eds) *Ecotoxicologia: perspectivas para o século XXI*. São Carlos, RiMa Editora.
- Laporta, P., Praderi, R., Le Bas, A. and Crespo, E.A. (2002) Presencia del delfin de Fraser *Lagenodelphis hosei* en costas del Atlántico Sudoccidental. Page 97 in Abstracts, X Reunión de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur e IV Congreso de la Sociedad Latinoamericana de Especialistas en Mamíferos Acuáticos de América del Sur, 14-19 October. Valdivia, Chile.
- Leatherwood, S., Jefferson, T.A., Norris, J.C., Stevens, W.E., Hansen, L.J. and Mullin, K.D. (1992) Occurrence and sounds of Fraser's dolphins (*Lagenodelphis hosei*) in the Gulf of Mexico. *Texas Journal of Science* 45(4): 349-354.
- Lodi, L. and Hetzel, B. (1998) O golfinho-de-dentes-rugosos (*Steno bredanensis*) no Brasil. *Bioikos* 12(1): 29-48.
- McColl, K.A. and Obendorf, D.I. (1982) Helminth parasites and associated pathology in stranded Fraser's dolphins, *Lagenodelphis hosei* (Fraser, 1956). *Aquatic Mammals* 9 (2): 30-34.
- Miyazaki, N. and Perrin, W.F. (1994) Rough-toothed Dolphin *Steno bredanensis* (Lesson, 1828). Page 1-21 in Ridgway, S.H. and Harrison, R. (Eds) *Handbook of marine mammals*, Volume 5: The first book of dolphins. Academic Press, New York.
- Moreno, I.B.; Ott, P.H.; ; Danilewicz, D.; Oliveira L.R.; Caon, G.; Martins, M.B. (1998a) Ocorrência do golfinho-de-Fraser (*Lagenodelphis hosei*, Fraser, 1956) na costa brasileira. Page 338 in Abstracts, XIII Congresso Brasileiro de Zoologia, 08-13 February. Recife, Brazil.
- Moreno, I.B.; Danilewicz, D.; Ott, P.H.; Caon, G.; Martins, M.B.

- Oliveira, L.R. and Messias, L. (1998b) Presença do golfinho-de-Fraser (*Lagenodelphis hosei*) na costa sul do Brasil. Page 134 in Abstracts, VIII Reunión de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur e II Congreso de la Sociedad Latinoamericana de Especialistas en Mamíferos Acuáticos de América del Sur, 25-29 October. Olinda, Brasil.
- Norris, K.S. (1961) Standardized methods for measuring and recording data on the smaller cetaceans. *Journal of Mammalogy* 42: 471-476.
- Ott, P.H. and Danilewicz, D. (1996) Southward range extension of *Steno bredanensis* in the southwest Atlantic and new records of *Stenella coeruleoalba* for Brazilian waters. *Aquatic Mammals* 22(3): 185-189.
- Perrin, W.F. (1975) Variation of spotted and spinner porpoise (Genus *Stenella*) in the eastern tropical Pacific and Hawaii. *Bulletin of the Scripps Institution of Oceanography* 21: 1-206.
- Perrin, W.F. and Donovan, G.P. (1984) Report of the workshop. *Reports of the International Whaling Commission* (special issue 6): 1-24.
- Perrin, W.F., Leatherwood, S. and Collet, A. (1994) Fraser's dolphin *Lagenodelphis hosei* Fraser, 1956. Pages 225-240 in Ridgway, S.H. and Harrison, R. (Eds) Handbook of marine mammals, Volume 5: The first -book of dolphins. Academic Press, New York.
- Pinedo, M.C., Lammardo, M and Barreto, A.S. (2001) Review of *Ziphius cavirostris*, *Mesoplodon grayi* and *Lagenodelphis hosei* (Cetacea: Ziphiidae and Delphinidae) in Brazilian waters, with new records from southern Brazil. *Atlântica* 23: 67-76.
- Pontecorvo, G. (2001) Supply side uncertainty and the management of commercial fisheries: *Peruvian Anchovetta*, an illustration. *Marine Policy* 25: 169-172.
- Praderi, R., Praderi, G. and Garcia, R. (1992) First record of Fraser's dolphin, *Lagenodelphis hosei*, in the South Atlantic Ocean (Mammalia: Cetacea: Delphinidae). *Comunicaciones Zoológicas del Museo de Historia Natural de Montevideo* 12(178): 1-6.
- Raga, J.A. (1997) Parasitology of marine mammals. Pages 67-90 in Jauniaux, T., Bouqueneau, J.M. and Coignoul, F. (Eds) *Marine Mammals, Seabirds and Pollution of Marine Systems*. Presses de la Faculte de Médecine Vétérinaire de L'Université de Liège. Liège. Belgium.
- Raga, J.A., Fernandez, M., Balbuena, J.A. and Aznar, F.J. (2002) Parasites. Pages 867-876 in Perrin, W.F., Wursig, B. and Thewissen, H.G.M. (Eds) *Encyclopedia of Marine Mammals*, Academic Press, San Diego.
- Robison, B.H. and Craddock, J.E. (1983) Mesopelagic fishes eaten by Fraser's dolphin, *Lagenodelphis hosei*. *Fishery Bulletin* 81(2): 283-289.
- Rommel, S. (1990) Osteology of the bottlenose dolphin. Pages 29-49 in Leatherwood, S. and Reeves. R.R (Eds) *The Bottlenose Dolphin*. Academic Press. San Diego.
- Santos, R.A. and Haimovici, M. (2001) Cephalopods in the diet of marine mammals stranded or incidentally caught along southeastern and southern Brazil (21-34°S). *Fisheries Research* 52: 99-112.
- Tobayama, T., Nishiwaki, M. and Yang, H.C. (1973) Records of the Fraser's Sarawak Dolphin (*Lagenodelphis hosei*) in the Western North Pacific. *Scientific Report of the Whales Research Institute* 25: 251-263.
- Van Bree, P.J.H., Collet, A., Desportes, G., Hussenot, E. and Raga, J.A. (1986) Le dauphin de Fraser, *Lagenodelphis hosei* (Cetacea, Odontoceti), espèce nouvelle pour la faune d'Europe. *Mammalia* 50 (1): 57-86.
- Van Bresseem, M-F., Van Waerebeek, K., Jepson, P.D., Raga, J.A., Duigman, P.J., Nielsen, O., Di Benedetto, A.P., Siciliano, S., Ramos, R., Kant, W., Peddemors, V., Kinoshita, R., Ross, P.S., López-Fernandez, A., Evans, K., Crespo, E., Barrett, T. (2001) An insight into the epidemiology of dolphin morbillivirus worldwide. *Veterinary Microbiology* 81: 287-304.
- Webster, P.J. and Palmer, T.N. (1997) The past and the future of El Niño. *Nature* 390: 582-584.

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