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Cephalopods in the diet of marine mammals stranded or incidentally caught along southeastern and southern Brazil (21–34°S)

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Abstract

Cephalopod remains found in 286 stomach contents of 13 species of odontocetes (*Pontoporia blainvillei*, *Lagenodelphis hosei*, *Sotalia fluviatilis*, *Stenella frontalis*, *Steno bredanensis*, *Tursiops truncatus*, *Delphinus* sp., *Globicephala melas*, *Orcinus orca*, *Pseudorca crassidens*, *Kogia breviceps*, *K. sima* and *Physeter macrocephalus*) four species of pinnipeds (*Arctocephalus australis*, *A. gazella*, *A. tropicalis* and *Mirounga leonina*) were identified and measured. The stomachs were collected from stranded or incidentally caught marine mammals from Rio de Janeiro to Paraná states (21–26°S) and Rio Grande do Sul (29–34°S), between 1985 and 1998. Twenty-five species of 16 families of cephalopods were identified. Cephalopod prey were small to medium sized. The diversity of cephalopods as prey was lower for coastal marine mammals and increased in offshore species that fed on diverse oegopsin squids including both the fast moving muscular squids and the less mobile neutrally buoyant cephalopods. In common dolphins, ommastrephid and loliginid squids and the sepiolid *Semirossia tenera*, were all important in the diet. Loliginid squids were the most frequent cephalopod in the diet of six other species of dolphins and three species of fur seals. *Loligo sanpaulensis* was recorded in specimens from throughout the study area, whilst *Loligo plei* and *Lolliguncula brevis* were frequent in the *northern* area. Benthic octopuses were found only in the diet of bottlenose dolphin and franciscana. Pelagic octopuses, particularly *Argonauta nodosa*, were only relatively frequent in the stomach contents of franciscana. In the stomach contents of larger odontocetes, as well as in Southern elephant seals and SubAntarctic fur seals, squids of the families Ancistrocheiridae, Chiroteuthidae, Cranchiidae, Enoploteuthidae, Histioteuthidae, Lycoteuthidae, Octopoteuthidae, Onychoteuthidae and especially Ommastrephidae were found.

Keywords: Feeding habits; Marine mammals; Southwestern Atlantic Ocean; Brazil; Food webs; Cephalopods

1. Introduction

The species composition and distribution of the coastal cephalopod fauna along southern and southeastern Brazil are relatively well known from commercial landings and bottom trawl survey data (Palacio, 1977; Haimovici and Perez, 1991a; Haimovici et al., 1994). Far less is known about the cephalopods from the upper slope and open ocean where only longline fishing for large pelagic fishes occurs and no surveys targeting cephalopods have been performed. Many marine mammals are cephalopod predators and can be excellent collectors of cephalopods, although generally only the chitinous beaks can be

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recovered (Clarke, 1980, 1986a, 1996). The study of marine mammal's diet can contribute substantial information on cephalopod distribution and biology, since many species, particularly the oceanic ones, are rarely caught by nets and other sampling methods. In addition, knowledge of the distribution, life style and habitat of cephalopod species found in the diet of marine mammals can aid the understanding of the predator's distribution and feeding habits. Nevertheless, it should be considered that the cephalopods found in stomach contents would not necessarily come from the area where the predator was caught or stranded.

At least 23 species of odontocetes and seven of pinnipeds have been recorded for southern (26–34°S) and southeastern Brazil (21–26°S) (Pinedo et al., 1992). The diet of several species has been studied and some of them are recorded as feeding to some degree on cehalopods: *Pontoporia blainvillei* (Pinedo, 1982; Ott, 1994; Bassoi, 1997), *Kogia sima* (Pinedo, 1987), *Physeter macrocephalus* (Clarke et al., 1980), *Kogia breviceps* (Secchi et al., 1994), *Globicephala melas* (Santos and Pinedo, 1994), *Orcinus orca* (Dalla Rosa, 1995) and *Feresa attenuata* (Zerbini and Santos, 1997).

There are several problems in the interpretation of the diet and the geographic distribution of the prey from the stomach contents of stranded animals. Beaks of cephalopods are known to remain undigested for longer periods than fish bones and otoliths (Clarke, 1996) and as most marine mammals perform migrations, the region from which the cephalopods originate cannot be precisely determined. Another point to be considered is that stranded animals, especially the oceanic species, may have been unhealthy and may have fed on prey or prey sizes that do not represent the normal diet of the healthy specimens. However in a comparative study in South Africa, no significant difference was observed in the percentage of cephalopods in the diets of stranded and non-stranded *Delphinus delphis*, *Lagenorhynchus obscurus* and *Cephalorhynchus heavisidii* (Sekiguchi et al., 1992), although differences were found in the percentages of other items in the diet. Where incidental catch in fisheries is the main cause of mortality as in the case of *P. blainvillei* and *Sotalia fluviatilis* in southern Brazil (Pinedo, 1994), stomach contents are expected to be more representative of the normal diet than those of stranded animals; although biases due to sex or age

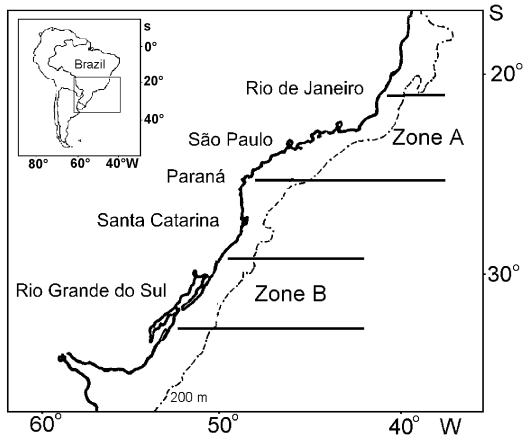

Fig. 1. Study area. Zone A: Rio de Janeiro to Paraná (21–26°S) and Zone B: Rio Grande do Sul (29–34°S).

related to behaviour in relation to the gear of the target species of the fishery also exist (Secchi et al., 1997). Despite the known limitations, the use of beaks from stranded animals is well established (Clarke, 1986a,b) and is sometimes the only available source of information and always a valuable alternative source of data.

The material for this study was cephalopod remains found in the stomach contents of 16 marine mammal species incidentally caught or stranded from Rio de Janeiro to Paraná (Zone A: 21–26°S) and along Rio Grande do Sul (Zone B: 29–34°S) (Fig. 1) and sent to us by colleagues for identification (Appendix A). The aim was to assess the relative importance of the different cephalopods in the diets of the marine mammals and to contribute to the understanding of the distribution and trophic relations of cephalopods in these regions. Data on non-cephalopod prey of the marine mammals from the study area are mentioned when available from published references, but no attempt was made to compare the relative importance of cephalopods and other prey.

2. Materials and methods

The cephalopods in 286 stomach contents of 13 species of odontocetes and four of pinnipeds collected between 1985 and 1998 were examined. Cephalopod remains, consisting mainly of beaks, were identified

with the aid of a reference collection at the *Departamento de Oceanografia* of the *Fundação Universidade do Rio Grande*. The cephalopod classification followed Sweeney and Roper (1998).

The size of cephalopods was estimated from measurements (0.1 mm) of the beaks: upper rostral length (URL) and lower rostral length (LRL) in squids and sepiolids and upper hood length (UHL) and lower hood length (LHL) in octopuses. Rostral and hood length definitions follow Clarke (1986b). Most prey mantle length and total mass were calculated from regressions relating squid or sepiolid rostral length and octopus hood length with dorsal mantle length (ML, mm) and with total mass (TM, g) obtained from the specimens in the reference collections. When local data were not available, size was estimated from regressions presented in Clarke (1986b).

3. Results

A total of 3233 upper beaks, 3521 lower beaks and cephalopod remains of 55 whole animals were recovered and 25 species of 16 families of cephalopods were identified (Fig. 2).

3.1. *P. blainvillei (franciscana) and S. fluviatilis (tucuxi)*

Most of the franciscana dolphins examined were incidentally caught and, of the cephalopods recorded, only coastal species were found. In the *northern* area (Zone A) *Loligo sanpaulensis* was the most frequent prey followed by *Loligo plei* and *Lolliguncula brevis*. In the *southern* area (Zone B), of the estimated 2775 cephalopods eaten, 2686 were *L. sanpaulensis,* 55 were pelagic octopus *Argonauta nodosa* and 27 were *L. plei.* Benthic sepiolid and octopuses were also found, but in low numbers (Table 1).

In both zones, fishes, mainly of the family Sciaenidae, occurred in ca. 90% of the stomach contents of the franciscana dolphin and cephalopods occurred in ca. 80% (Pinedo, 1982; Ott, 1994; Bassoi, 1997; Bassoi et al., 1998; Di Beneditto et al., 1998).

Most *S. fluviatilis* were also incidentally caught and occurred only in Zone A. The frequency of occurrence of fish, mainly sciaenids, and squids in stomach contents were 90 and 60%, respectively (Bassoi et al., 1998; Di Beneditto et al., 1998). The cephalopods eaten by the tucuxi were *L. sanpaulensis*, *L. brevis* and

Table 1
Numbers, mantle length (ML) and individual total mass (TM) of cephalopods eaten by *P. blainvillei* and *S. fluviatilis* sampled from Zone A: 21–26°S, and Zone B: 29–34°S

	Cephalopod species	S[a]	N[b]	ML (mm)			TM (g)		
				Mean	Range		Mean	Range	
P. blainvillei (Zone A), $n = 57$[c]	*L. plei*	26	155	166	66	266	69	8	183
	L. sanpaulensis	41	593	51	20	219	8	1	154
	L. brevis	21	134	49	24	84	11	1	77
P. blainvillei (Zone B), $n = 111$	*S. tenera*	2	2	38	32	45	4	2	5
	L. plei	17	27	154	68	211	58	9	109
	L. sanpaulensis	105	2686	103	22	220	45	1	197
	Loliginidae unidentified	1	1						
	Octopus tehuelchus	2	3	27	24	29	5	3	6
	Eledone gaucha	1	1	21	21	21	1	1	1
	A. nodosa	14	55	24	5	44	6	0.02	57
S. fluviatilis (Zone A), $n = 56$	*L. plei*	28	137	152	41	266	61	3	183
	L. sanpaulensis	24	260	45	14	195	6	0.3	150
	L. brevis	28	199	41	25	60	5	1	17
	Loliginidae unidentified	11	14						

[a] Number of stomachs with the cephalopod species.
[b] Total number of individuals of each cephalopod species found.
[c] n: number of stomachs examined.

Marine mammal	*Pontoporia blainvillei*	*Pontoporia blainvillei*	*Sotalia fluviatilis*	*Stenella frontalis*	*Steno bredanensis*	*Tursiops truncatus*	*Tursiops truncatus*	*Delphinus sp*	*Delphinus sp*	*Arctocephalus australis*	*Arctocephalus gazella*	*Arctocephalus tropicalis*	*Mirounga leonina*	*Lagenodelphis hosei*	*Feresa attenuata*	*Orcinus orca*	*Pseudorca crassidens*	*Globicephala melas*	*Kogia breviceps*	*Kogia breviceps*	*Kogia sima*
Habitat	Shelf								Shelf - Slope							Slope - Oceanic					
Zone	A	B	A	A	A	A	B	A	B	B	B	B	B	B	A	B	B	B	A	B	A
Number of stomachs examined	57	111	56	6	1	2	1	2	3	15	1	8	1	4	1	3	3	5	1	2	2
Loliginidae																					
Loligo sanpaulensis	●	●	●						●	●	○	●		○		○					
Loligo plei	●	○	●	●	●	○	○	○							○	○					
Lolliguncula brevis	●		●																		
Octopodidae																					
Octopus tehuelchus		○																			
Octopus vulgaris						○															
Eledone gaucha		○																			
Argonautidae																					
Argonauta nodosa		○								○		○									
Sepiolidae																					
Semirossia tenera		○							●												○
Heteroteuthis dispar																			○		○
Lycoteuthidae																					
Lycoteuthis lorigera													○			○		●		●	○
Enoploteuthidae																					
Abralia sp																			○		
Abralia redfieldi																					●
Ancistrocheiridae																					
Ancistrocheirus lesueurii																		○			
Octopoteuthidae																					
Octopoteuthis sp																○		○	○	○	○
Onychoteuthidae																					
Moroteuthis ingens																					○
Moroteuthis robsoni												○				○				○	○
Gonatidae																					
Gonatus antarcticus																○					
Histioteuthidae																					
Histioteuthis spp													○			○		●		●	●
Ommastrephidae																					
Hyaloteuthis pelagica									○												
Illex argentinus									●			○	○		○			○		●	○
Ornithoteuthis antillarum															○	○				○	●
Ommastrephes bartramii												●				○	○				
Chiroteuthidae																					
Chiroteuthis veranii																		○	○	○	○
Neoteuthidae																					
Alluroteuthis antarctica											○										
Cranchiidae									○							○		●			●
Bolitaenidae																					
Japetella diaphana																					○
Ocythoidae																					
Ocythoe tuberculata												○				○					

Fig. 2. Cephalopods in the diet of marine mammals from Rio de Janeiro to Paraná (21–26°S) and Rio Grande do Sul (29–34°S) states. Circles indicate the presence of cephalopods in the diet, black circles indicating the main cephalopod prey.

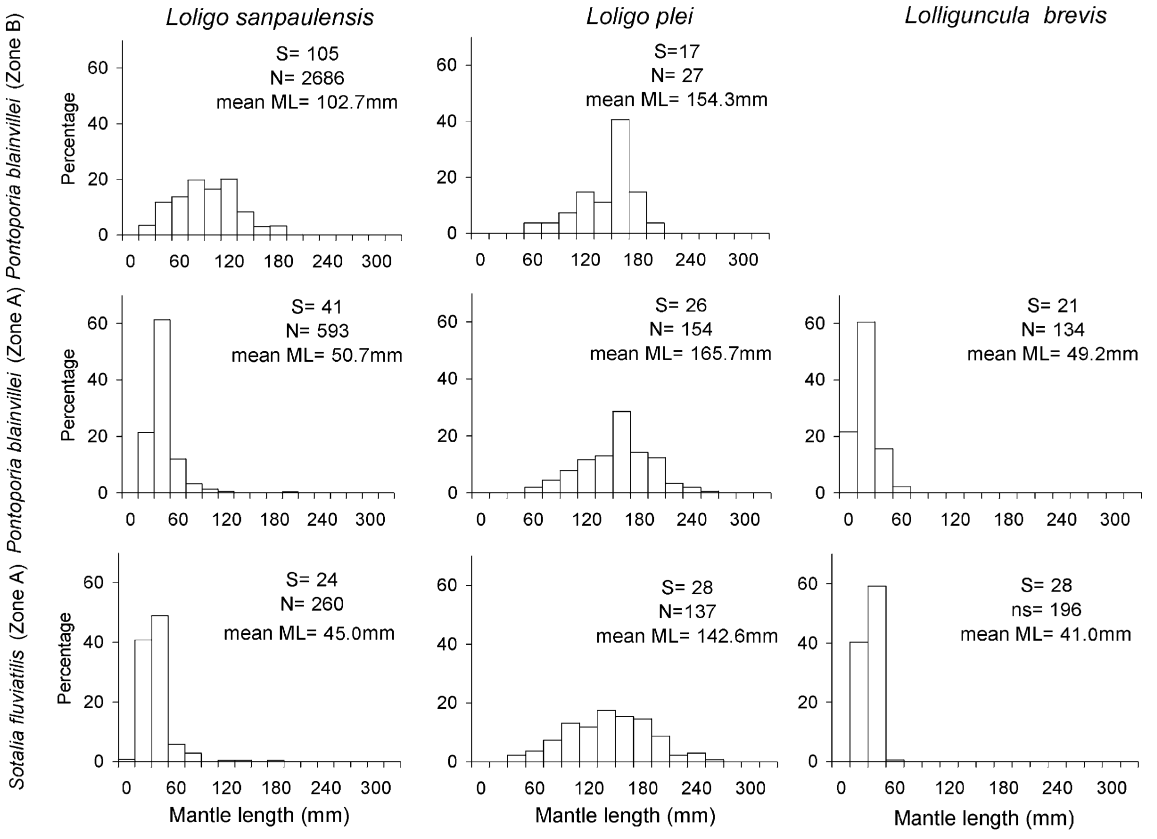

Fig. 3. ML distribution of *L. sanpaulensis*, *L. plei* and *L. brevis* from the diet of *P. blainvillei* and *S. fluviatilis* from Zone A: 21–26°S, and Zone B: 29–34°S (*S*: number of stomachs with the cephalopod species; *N*: total number of individuals measured).

L. plei (Table 5), of similar sizes to those eaten by *P. blainvillei* in the same zone (Fig. 3).

The sizes of *L. sanpaulensis* preyed on by franciscana and tucuxi dolphins in Zone A (mean ML 45.0 and 50.7 mm, respectively) were smaller than those eaten by franciscana in Zone B (mean ML 102.7 mm), while *L. plei* from both zones were small to medium sized, with mean ML around 150 mm (Fig. 3).

3.2. Delphinus sp. (common dolphin) and Lagenodelphis hosei (Fraser's dolphin)

In the two stomach contents of common dolphin from Zone A, only a few beaks of *L. plei* and unidentified loliginids were found. In three incidentally caught specimens from Zone B, *L. sanpaulensis*, the sepiolid *Semirossia tenera* and the ommastrephid *Illex argentinus* were frequent. *Hyaloteuthis pelagica* and unidentified Cranchiidae also occurred (Table 2).

Four stomach contents of *L. hosei* stranded in Zone B contained mostly medium sized *L. sanpaulensis* and one of them contained also a small *A. nodosa*. Fishes of the families Sciaenidae, Trichiuridae, Batrachoididae and Phycidae and unidentified crustaceans were also found in some of the stomach contents (Moreno et al., 1998).

3.3. Stenella frontalis (Atlantic spotted dolphin), Steno bredanensis (rough-toothed dolphin) and Tursiops truncatus (bottlenose dolphin)

In Zone A, all three species preyed mostly on small and medium sized *L. plei* (Table 2). *T. truncatus* also fed on a wide range of sizes of *Octopus vulgaris.* The

Table 2
Numbers, mantle length (ML) and individual total mass (TM) of cephalopods eaten by *Delphinus* sp., *L. hosei*, *S. frontalis*, *S. bredanensis* and *T. truncatus* sampled from Zone A: 21–26°S, and Zone B: 29–34°S

	Cephalopod species	S^a	N^b	ML (mm)			TM (g)		
				Mean	Range		Mean	Range	
Delphinus sp. (Zone A), $n = 2^c$	*L. plei*	2	2	180	177	183	77	74	80
	Loliginidae unidentified	2	2						
	Oegopsina unidentified	1	2						
Delphinus sp. (Zone B), $n = 3$	*S. tenera*	2	69	17	10	22	2	0.4	5
	L. sanpaulensis	3	58	50	28	83	8	2	22
	H. pelagica	1	1						
	I. argentinus	2	20	59	21	276	25	1	392
	Cranchiidae unidentified	1	5						
L. hosei (Zone B), $n = 4$	*L. sanpaulensis*	3	19	129	51	219	75	6	242
	A. nodosa	1	1	6	6	6	0.1	0.1	0.1
S. frontalis (Zone A), $n = 6$	*L. plei*	6	121	89	21	220	19	1	119
S. bredanensis (Zone A), $n = 1$	*L. plei*	1	38	215	153	278	119	54	202
T. truncatus (Zone A), $n = 2$	*L. plei*	2	10	203	135	234	104	40	138
	O. vulgaris	1	5	110	77	147	576	155	1210
T. truncatus (Zone B), $n = 1$	*L. plei*	1	2	171	166	175	68	65	72

[a] Number of stomachs with the cephalopod species.
[b] Total number of individuals of each cephalopod species found.
[c] *n*: number of stomachs examined.

single stomach of a bottlenose dolphin examined from Zone B contained two *L. plei* (Table 2). These dolphins feed mainly on fishes and the families found were Batrachoididae, Gerreidae Ophidiidae, Sciaenidae, Sparidae and Trichiuridae (Pinedo, 1982; Siciliano et al., 1998).

3.4. F. attenuata (pygmy killer whale), G. melas (long-finned pilot whale), O. orca (killer whale) and Pseudorca crassidens (false killer whale)

A single *F. attenuata,* stranded in Zone A was found to have eaten two *L. plei*, two *I. argentinus* and one *Ornithoteuthis antillarum* (Table 3) and the presence of fishes lens was also recorded (Zerbini and Santos, 1997).

Stomachs of the long-finned pilot whale, *G. melas*, stranded in Zone B were found to contain remains of offshore cephalopods (Table 3). Seventy percent of the identified specimens are considered neutrally buoyant in sea water, such as *Histioteuthis* spp., *Chiroteuthis veranii*, *Octopoteuthis* sp., *Ancistrocheirus lesueurii* and squids of the family Cranchiidae. Other squids found were small to medium sized *Lycoteuthis lorigera* and families belonged to the family Ommastrephidae, mainly medium sized to large *I. argentinus.*

The cephalopods in the stomachs of three killer whales *O. orca* stranded in Zone B were small to medium sized and included the same families found in the diet of *G. melas*, but also, the pelagic octopus *Ocythoe tuberculata*, the squid *Gonatus antarcticus* and coastal loliginids. Neutral buoyant species amounted to 53% of the identified specimens and other squids 46% (Table 3). In southern Brazil *O. orca* was found to feed on a variety of prey such as dolphins, elasmobranchs and bony fishes, besides cephalopods (Dalla Rosa, 1995).

Table 3
Numbers, mantle length (ML) and individual total mass (TM) of cephalopods eaten by *F. attenuata*, *G. melas*, *O. orca* and *P. crassidens* sampled from Zone A: 21–26°S, and Zone B: 29–34°S

	Cephalopod species	S[a]	N[b]	ML (mm)			TM (g)		
				Mean	Range		Mean	Range	
F. attenuata (Zone A), $n = 1$[c]	*L. plei*	1	2	149	136	162	51	41	61
	I. argentinus	1	2	227	187	267	245	130	360
	O. antillarum	1	1	131	131	131	32	32	32
	Ommastrephidae unidentified	1	1						
G. melas (Zone B), $n = 5$	*L. lorigera*	2	45	110	93	141	106	50	284
	A. lesueurii	2	3	172	61	244	469	21	840
	Octopoteuthis sp.	1	6	144	130	173	161	124	241
	Histioteuthis spp.	3	98	56	48	115	71	53	287
	I. argentinus	3	6	221	150	332	246	67	693
	Ommastrephidae unidentified	1	1						
	C. veranii	2	7						
	Cranchiidae unidentified	1	10						
	Oegopsina unidentified	3	11						
O. orca (Zone B), $n = 3$	*L. plei*	1	2	143	124	162	47	34	61
	L. sanpaulensis	1	10	126	58	185	72	10	158
	L. lorigera	1	1	110	110	110	76	76	76
	A. lesueurii	1	1	293	293	293	1476	1476	1476
	Octopoteuthis sp.	1	4	165	156	190	218	189	300
	Moroteuthis robsoni	1	3						
	Histioteuthis spp.	2	7	96	69	137	210	101	412
	G. antarcticus	1	6	201	188	214	173	143	203
	O. bartramii	1	1	287	287	287	687	687	687
	O. antillarum	1	1	44	44	44	3	3	3
	Cranchiidae unidentified	1	1						
	Oegopsina unidentified	1	44						
	O. tuberculata	2	3						
P. crassidens (Zone B), $n = 3$	*O. bartramii*	3	5	282	191	329	709	206	1038
	Oegopsina unidentified	1	1						
	Cephalopoda unidentified	1	1						

[a] Number of stomachs with the cephalopod species.
[b] Total number of individuals of each cephalopod species found.
[c] n: number of stomachs examined.

In the stomach contents of the three *P. crassidens* stranded in Zone B, the identified squids were medium sized *Ommastrephes bartramii* (Table 3).

3.5. *K. breviceps (pygmy sperm whale) and K. sima (dwarf sperm whale)*

The pygmy sperm whale stranded in both zones and the dwarf sperm whale in Zone A had eaten offshore cephalopods. No particular differences were observed in the families of cephalopods eaten by the two *Kogia* species or in the two zones. The cephalopods eaten were small to medium sized, among which neutrally buoyant squids such as *Histioteuthis* spp., *C. veranii*, *Octopoteuthis* sp. and Cranchiidae amounted to 65% of the specimens and muscular families like Ommastrephidae, Lycoteuthidae and Onychoteuthidae represented 31% (Table 4).

Only a few remains of fishes and crustaceans were found in the *Kogia* species collected in southern and southeastern Brazil (Secchi et al., 1994; Vicente et al., 1998; Zanelatto et al., 1996).

Table 4
Numbers, mantle length (ML) and individual total mass (TM) of cephalopods eaten by *K. sima* and *K. breviceps* sampled from Zone A: 21–26°S, and Zone B: 29–34°S

	Cephalopod species	S[a]	N[b]	ML (mm)			TM (g)		
				Mean	Range		Mean	Range	
K. sima (Zone A), $n = 2$[c]	*S. tenera*	1	2	20	18	23	4	3	6
	Heteroteuthis dispar	1	3						
	L. lorigera	1	7	94	81	109	57	28	96
	Abralia redfieldi	1	23	29	22	36	2	1	4
	Enoploteuthidae unidentified	1	8						
	Octopoteuthis sp.	1	1	147	147	147	166	166	166
	Moroteuthis ingens	1	1						
	Moroteuthis robsoni	1	3						
	Histioteuthis spp.	2	94	60	26	134	94	19	390
	I. argentinus	1	1	224	224	224	215	215	215
	O. antillarum	1	24	57	30	96	6	1	16
	C. veranii	1	1	119	119	119	43	43	43
	Cranchiidae unidentified	2	24						
	Oegopsina unidentified	2	11						
	Japetella diaphana	1	1						
	Octopoda unidentified	1	1						
K. breviceps (Zone A), $n = 1$	*Octopoteuthis* sp.	1	1						
	C. veranii	1	1						
	Oegopsina unidentified	1	1						
K. breviceps (Zone B), $n = 2$	*Heteroteuthis dispar*	1	5						
	L. lorigera	2	17	89	75	122	40	21	109
	Abralia sp.	1	5	36	30	43	3	2	4
	Octopoteuthis sp.	1	4	162	145	197	213	161	326
	Moroteuthis robsoni	1	2						
	Histioteuthis spp.	2	16	71	57	93	113	72	184
	I. argentinus	2	25	217	146	281	212	64	413
	O. antillarum	1	2	81	69	93	11	7	14
	C. veranii	1	1	104	104	104	29	29	29
	Oegopsina unidentified	2	2						

[a] Number of stomachs with the cephalopod species.
[b] Total number of individuals of each cephalopod species found.
[c] n: number of stomachs examined.

3.6. Arctocephalus australis (South American fur seal), A. gazella (Antarctic fur seal), A. tropicalis (SubAntarctic fur seal) and Mirounga leonina (Southern elephant seal)

All stomach contents of the three species of fur seals and the elephant seal were from Zone B (Table 5). *A. australis* was found to eat *L. sanpaulensis* and very small *A. nodosa*. The only *A. gazella* sampled, besides *L. sanpaulensis*, fed on *Alluroteuthis antarctica,* probably eaten before its arrival to southern Brazil as this squid is an Antarctic circumpolar species (Nesis, 1987). *Arctocephalus tropicalis* preyed on *L. sanpaulensis*, small to large *O. bartramii*, large *I. argentinus*, large *A. nodosa* and *O. tuberculata*.

The stomach contents of a single vagrant specimen of *M. leonina* stranded far north from its usual distribution range (Pinedo et al., 1992) contained two large *I. argentinus*, one *L. lorigera* and one *Histioteuthis* sp. (Table 5).

4. Size of cephalopod prey

Cephalopod sizes varied from small to medium sized: the smallest was an *A. nodosa* (0.02 g) eaten

Table 5
Numbers, mantle length (ML) and individual total mass (TM) of cephalopods eaten by *A. australis*, *A. gazella*, *A. tropicalis* and *M. leonina* sampled from Zone A: 21–26°S, and Zone B: 29–34°S

	Cephalopod species	S[a]	N[b]	ML (mm)			TM (g)		
				Mean	Range		Mean	Range	
A. australis (Zone B), $n = 15$[c]	*L. sanpaulensis*	15	37	98	45	185	39	5	157
	A. nodosa	1	3	15	10	18	1	0.2	1
A. gazella (Zone B), $n = 1$	*L. sanpaulensis*	1	1	111	111	111	46	46	46
	A. antarctica	1	5						
A. tropicalis (Zone B), $n = 8$	*L. sanpaulensis*	3	14	93	58	135	31	9	65
	Moroteuthis robsoni	1	1						
	I. argentinus	1	6	332	297	359	677	483	836
	O. bartramii	2	23	221	93	343	425	21	1135
	Ommastrephidae unidentified	3	10						
	Oegopsina unidentified	1	2						
	A. nodosa	2	2	103	76	131	255	71	439
	O. tuberculata	1	1						
M. leonina (Zone B), $n = 1$	*L. lorigera*	1	1	78	78	78	25	25	25
	Histioteuthis sp.	1	1	53	53	53	63	63	63
	I. argentinus	1	2	263	260	265	341	331	351

[a] Number of stomachs with the cephalopod species.
[b] Total number of individuals of each cephalopod species found.
[c] n: number of stomachs examined.

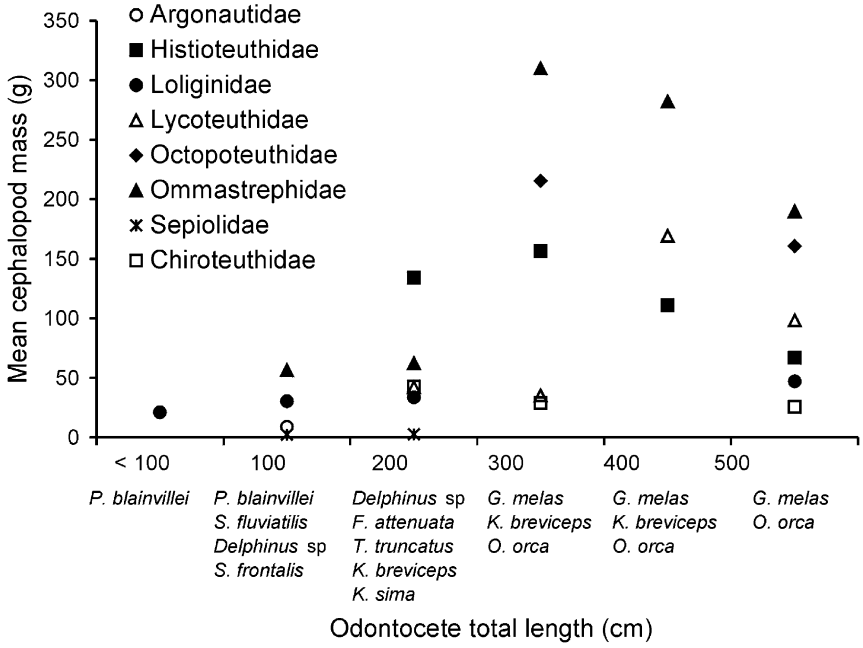

Fig. 4. Mean individual TM of different families of cephalopods preyed on by odontocete species of different total length.

by a *P. blainvillei* and the largest was an *A. lesueurii* (1476 g) eaten by an *O. orca*. The mean TM of the different families of cephalopods represented in the stomach contents was plotted against the total length of their odontocete predators (Fig. 4). Odontocetes of less than 3 m long ingested cephalopods varying from 2 to 134 g, while odontocetes between 3 and 6 m long fed on cephalopods with mean TM of 309 g. Differences were more evident for ommastrephids, which had mean TM of 56–62 g for odontocetes smaller than 3 m and 190–309 g in the larger specimens.

5. Discussion

Squids of the family Loliginidae are the most abundant coastal cephalopods in southern and southeastern Brazil (Juanicó, 1979) and, as expected, the most frequent family in the stomach contents of coastal marine mammals examined.

The most common loliginid squid in southern Brazil is *L. sanpaulensis* (Haimovici and Andriguetto, 1986) that occurs in the shelf from 20 to 42°S, associated with the Subtropical Convergence Zone (Roper et al., 1984; Haimovici and Perez, 1991a). Larger specimens occur only on the inner shelf, but the small specimens can be found, in the cold season, both on the inner shelf and on the upper slope (Andriguetto and Haimovici, 1991; Haimovici and Perez, 1991b). Most of the coastal marine mammals examined fed on this squid. The maximum sizes of squid in the stomach contents from Zone A were smaller than those from Zone B (Fig. 3). This difference is consistent with observations from bottom trawl surveys in both zones (Juanicó, 1979; Haimovici and Andriguetto, 1986; Costa and Fernandez, 1993). As in southern and southeastern Brazil, *L. sanpaulensis* was an important prey for *P. blainvillei* in Uruguay (Brownell, 1975, 1989) and northern Argentina (Perez et al., 1996).

L. sanpaulensis was also the main prey found in the stomach contents of Fraser's dolphin in southern Brazil. In South Africa this cetacean fed mainly on oceanic cephalopods (Sekiguchi et al., 1992) and according to Klinowska (1991) this is an offshore species, so the presence of only coastal cephalopods in our samples suggest that it fed on the shelf before stranding.

Young fur seals *A. australis*, from breeding grounds off Uruguay, and vagrant adult males of *A. gazella* and *A. tropicalis* from the Antarctic Convergence reach southern Brazil in winter (Pinedo et al., 1992). All these species preyed to some degree on *L. sanpaulensis*, particularly large ones that occur only on the inner shelf (Andriguetto and Haimovici, 1991). It is probable that these coastal squids were eaten shortly before stranding.

The other frequently recorded loliginid was *L. brevis*. This is a tropical estuarine and coastal species that has not been found south of Santa Marta Grande Cape (29°S) (Haimovici et al., 1989; Haimovici and Andriguetto, 1986; Haimovici and Perez, 1991a). It was preyed on only by *P. blainvillei* and *S. fluviatilis* in coastal or estuarine waters in Zone A. Its absence from the stomach contents of franciscana dolphins from Rio Grande do Sul supports the assumption that the distribution limit of *L. brevis* to the south is around 29°S (Haimovici and Perez, 1991a).

L. plei is a warm water species that is more abundant north of Rio Grande do Sul (Costa and Haimovici, 1990; Perez et al., 1997). Along the coast of Rio Grande do Sul it is only occasionally caught in the inner shelf but is frequent in the warm season in the outer shelf and upper slope (Haimovici and Andriguetto, 1986; Haimovici and Perez, 1991b). Its presence in the stomach contents of offshore species such as *F. attenuata* and *O. orca* can be considered to be part of their normal diet in the region.

Benthic shelf octopuses and sepiolids were eaten in small numbers and this probably reflects their relative scarcity in coastal waters of the region (Haimovici and Perez, 1991a). Few pelagic octopuses were recorded and they seem to be unimportant in the diet of both coastal and offshore marine mammals. They were found only in the diet of *P. blainvillei*, *O. orca* and *A. tropicalis*. It is noteworthy that pelagic octopuses are more abundant on the outer shelf and oceanic waters and the number of stomachs from oceanic marine mammals was low compared with those from near shore species.

The ommastrephids *I. argentinus*, *O. antillarum* and *O. bartramii* were the most frequent slope and oceanic cephalopods eaten by marine mammals along southern and southeastern Brazil. *I. argentinus* was more frequent in the stomach contents collected in southern Brazil in the cold season, when reproductive concen-

trations of this squid are found along the slope of that region (Santos and Haimovici, 1997).

The long-finned pilot whale, which is considered to feed heavily on squid (Evans, 1990; Clarke, 1996), in southern Brazil was found to feed on oceanic families such as Ommastrephidae, Cranchiidae, Chiroteuthidae and Histioteuthidae, also found in its diet in the northern Atlantic (Sergeant, 1962; Desportes and Mouritsen, 1993). Nevertheless loliginids and other coastal cephalopods, were also important in southern Argentina (Clarke and Goodall, 1994), Tasmania (Gales et al., 1992), South Africa (Sekiguchi et al., 1992) and the northwest Atlantic (Gannon et al., 1997).

Kogia species are mainly teuthophagous (Caldwell and Caldwell, 1989). As in our study, oceanic cephalopod families were found in the diet of *K. breviceps* and *K. sima* from South Africa (Ross, 1979; Sekiguchi et al., 1992) and Histioteuthidae and Chiroteuthidae were frequent in the stomach of a *K. sima* collected in southern Brazil (Pinedo, 1987).

The diet of *O. orca* includes mainly marine mammals, fishes and seabirds, while cephalopods are usually far less important (Evans, 1990). Nevertheless we found a fair number of beaks of oceanic squids in their stomachs.

Although the precise location where the sampled marine mammals fed and their ability to feed prior to their death was not known, some patterns on the distribution of cephalopods and the food habits of marine mammals in the study area were observed that can be summarised as follows. Most preyed cephalopods were small to medium sized under 200 g and only a few were over 1000 g. As reported by Clarke (1996) for other regions, in southern Brazil loliginids were the most important cephalopods in the diet of coastal marine mammals and ommastrephids were the most important in diet of offshore odontocetes. The diversity of cephalopod prey was low for coastal marine mammals and increased in offshore species that fed on a wide range of oegopsin squids including both the fast moving muscular squids and the less mobile mesopelagic and epipelagic neutrally buoyant families. Most of these offshore cephalopods were absent from former cephalopod surveys and the marine mammal stomach contents contributed also to knowledge of the oceanic cephalopod fauna of the southern and southeastern Brazil.

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Appendix A.

Source of stomach contents of marine mammal predators examined by the authors for predation on cephalopod species (*n*: number of stomachs examined)

Marine mammal	*n*	Year	Source	City
Delphinus sp.	3	1994–1996	E. Secchi, Museu Oceanográfico Prof. Eliézer C. Rios	Rio Grande, RS
	1	1996	M.O.S. Santos, Universidade de São Paulo	São Paulo, SP
	1	1997	F. Rosas, Universidade Federal do Paraná	Curitiba, PR
F. attenuata	1	1994	A. Zerbini, Universidade de São Paulo	São Paulo, SP
G. melas	2	1990–1997	E. Secchi, Museu Oceanográfico Prof. Eliézer C. Rios	Rio Grande, RS
	3	1985–1993	M. C. Pinedo, Fundação Universidade do Rio Grande	Rio Grande, RS
L. hosei	2	1997	A. Barreto, Fundação Universidade do Rio Grande	Rio Grande, RS
	2	1997	I. Moreno, Grupo de Estudos de Mamíferos Marinhos	Porto Alegre, RS
O. orca	3	1994–1998	L. Dalla Rosa, Museu Oceanográfico Prof. Eliézer C. Rios	Rio Grande, RS
	1	1994	M.C. Pinedo, Fundação Universidade do Rio Grande	Rio Grande, RS
P. crassidens	3	1996	M.C. Pinedo, Fundação Universidade do Rio Grande	Rio Grande, RS
S. fluviatilis	43	1987–1997	A.P. Di Beneditto, Universidade Federal Norte-Fluminense	Campos, RJ
	4	1996–1997	M. Oliveira S. Santos, Universidade de São Paulo	São Paulo, SP
	9	1997–1998	F. Rosas, Universidade Federal do Paraná	Curitiba, PR
S. frontalis	5	1992–1997	S. Siciliano, Museu Nacional do Rio de Janeiro	Rio de Janeiro, RJ
	1	1997	F. Rosas, Universidade Federal do Paraná	Curitiba, PR
S. bredanensis	1	1997	F. Rosas, Universidade Federal do Paraná	Curitiba, PR
T. truncatus	1	1992	S. Siciliano, Museu Nacional do Rio de Janeiro	Rio de Janeiro, RJ
	1	1996	M. O. S. Santos, Universidade de São Paulo	São Paulo, SP
	1	1991	P. Ott, Grupo de Estudos de Mamíferos Marinhos	Porto Alegre, RS
P. blainvillei	86	1994	M. Bassoi, Museu Oceanográfico Prof. Eliézer C. Rios	Rio Grande, RS
	25	1992–1994	P. Ott, Grupo de Estudos de Mamíferos Marinhos	Porto Alegre, RS
	47	1989–1997	A. P. Di Beneditto, Universidade Federal Norte-Fluminense	Campos, RJ
	10	1997–1998	F. Rosas, Universidade Federal do Paraná	Curitiba, PR
K. breviceps	2	1989	E. Secchi, Museu Oceanográfico Prof. Eliézer C. Rios	Rio Grande, RS
	1	1995	R. da Silva	Santos, SP
K. sima	1	1994	R. Zanelatto, Universidade Federal do Paraná	Curitiba, PR
	1	1998	E. Zampiroli, Centro de Estudos de Mamíferos Marinhos	Santos, SP
A. australis	12	1993–1994	L. de Oliveira, Grupo de Estudos de Mamíferos Marinhos	Porto Alegre, RS
	3	1992	M.C. Pinedo, Fundação Universidade do Rio Grande	Rio Grande, RS
A. gazella	1	1994	L. de Oliveira, Grupo de Estudos de Mamíferos Marinhos	Porto Alegre, RS
A. tropicalis	3	1994	L. de Oliveira, Grupo de Estudos de Mamíferos Marinhos	Porto Alegre, RS
	5	1992	M. C. Pinedo, Fundação Universidade do Rio Grande	Rio Grande, RS
M. leonina	1	1994	P. Ott, Grupo de Estudos de Mamíferos Marinhos	Porto Alegre, RS

References

Andriguetto, J.M., Haimovici, M., 1991. Abundance and distribution of *Loligo sanpaulensis* Brakoniecki, 1984 (Cephalopoda: Loliginidae) in southern Brazil. Sci. Mar. 55 (4), 611–618.

Bassoi, M., 1997. Avaliação da dieta alimentar de toninhas, *Pontoporia blainvillei* (Gervais e D'Orbigny, 1844), capturadas acidentalmente na pesca costeira de emalhe, no sul do Rio Grande do Sul. Monograph Fundação Universidade do Rio Grande, Rio Grande, RS, 68 pp.

Bassoi, M., Lucato, S.B., Santos, R.A., Santos, M.C.O., 1998. Novas informações sobre hábitos alimentares de cetáceos nas regiões norte do Paraná e sul de São Paulo, Brasil. (Abstract) 8ª Reunião de trabalho de especialistas em mamíferos aquáticos da América do Sul, Olinda, Brazil, 20 pp.

Brownell Jr., R.L., 1975. Feeding ecology of the franciscana dolphin, *Pontoporia blainvillei*, in Uruguayan waters. J. Fish. Res. Board Can. 32, 1073–1078.

Brownell Jr., R.L. 1989. Franciscana, *Pontoporia blainvillei* (Gervais and D'Orbigny, 1844). In: Ridgway, S.H., Harrison, R. (Eds.), Handbook of Marine Mammals: River Dolphins and the Larger Toothed Whales, Vol. 4. Academic Press, London, pp. 45–67.

Caldwell, D.K., Caldwell, M.C., 1989. Pygmy sperm whale *Kogia breviceps* (de Blainville, 1838). Dwarf sperm whale *Kogia simus* (Owen, 1866). In: Ridgway, S.H., Harrison, R. (Eds.), Handbook of Marine Mammals: River Dolphins and the Larger Toothed Whales, Vol. 4. Academic Press, London, pp. 235–260.

Clarke, M.R., 1980. Squids and whales. NERC News J. 2 (9), 4 –6.

Clarke, M.R., 1986a. Cephalopods in the diet of odontocetes. In: Bryden, M.M., Harrison, R. (Eds.), Research in Dolphins. Clarendon Press, Oxford, pp. 281–321.

Clarke, M.R., 1986b. A Handbook for the Identification of Cephalopod Beaks. Clarendon Press, Oxford, 273 pp.

Clarke, M.R., 1996. Cephalopods as prey. III. Cetaceans. In: Clarke, M.R. (Ed.), The Role of Cephalopods in the World's Oceans, Vol. 351. Philosophical Transactions of the Royal Society of London Series B, pp. 1053–1065.

Clarke, M.R., Goodall, N., 1994. Cephalopods in the diets of three odontocete cetacean species stranded at Tierra del Fuego, *Globicephala melaena* (Traill, 1809), *Hyperodon planifrons* (Flower, 1882) and *Cephalorhynchus commersonii* (Lacepede, 1804). Antarct. Sci. 6 (2), 149–154.

Clarke, M.R., MacLeod, N., Castello, H.P., Pinedo, M.C., 1980. Cephalopod remains from the stomach of a sperm whale stranded at Rio Grande do Sul in Brazil. Mar. Biol. 59, 235–239.

Costa, P.A.S., Haimovici, M., 1990. A pesca de polvos e lulas no litoral do Rio de Janeiro. Cien. Cult. 42 (12), 1124–1130.

Costa, P.A.S., Fernandez, F.C., 1993. Reproductive cycle of *Loligo sanpaulensis* (Cephalopoda: Loliginidae) in the Cabo Frio region. Brazil. Mar. Ecol. Progr. Ser. 101, 91–97.

Dalla Rosa, L., 1995. Interações com a pesca de espinhel e informações sobre a dieta alimentar de orca, *Orcinus orca* (Linnaeus, 1758) (Cetacea, Delphinidae), no sul e sudeste do Brasil. Monograph Fundação Universidade do Rio Grande, Rio Grande, RS, 39 pp.

Desportes, G., Mouritsen, R., 1993. Preliminary results on the diet of long-finned pilot whales off Faroe Islands. In: Donovan, G.P., Lockyer, C.H., Martin, A.R. (Eds.), Biology of Northern Hemisphere Pilot Whales, Vol. 14. Report of the International Whaling Community Special Issue, pp. 305–324.

Di Beneditto, A.P., Ramos, R., Lima, N.R., Santos, R.A., 1998. Feeding ecology of *Pontoporia blainvillei* and *Sotalia fluviatilis* in northern Rio de Janeiro, Brazil: a preliminary analysis. (Abstract) 8ª Reunião de trabalho de especialistas em mamíferos aquáticos da América do Sul, Olinda, Brazil, 66 pp.

Evans, P.G., 1990. The Natural History of Whales and Dolphins. Facts on File, Inc. Publications, New York, 343 pp.

Gales, R., Pemberton, D., Clarke, M.R., 1992. Stomach contents of long-finned pilot whale (*Globicephala melas*) and bottlenose dolphins (*Tursiops truncatus*) in Tasmania. Mar. Mamm. Sci. 8, 405–413.

Gannon, D.P., Read, A.J., Craddock, J.E., Fristrup, K.M., Nicolas, J.R., 1997. Feeding ecology ecology of long-finned pilot whales *Globicephala melas* in the western North Atlantic. Mar. Ecol. Prog. Ser. 148, 1–10.

Haimovici, M., Andriguetto, J.M., 1986. Cefalópodes costeiros capturados na pesca de arrasto do litoral sul do Brasil. Arq. Biol. Tecnol. 29 (3), 473–495.

Haimovici, M., Perez, J.A.A., 1991a. Coastal cephalopod fauna of southern Brazil. Bull. Mar. Sci. 49 (1-2), 221–230.

Haimovici, M., Perez, J.A.A., 1991b. Abundância e distribuição de cefalópodes em cruzeiros de prospecção pesqueira demersal na plataforma externa e talude continental do sul do Brasil. Atlântica 13 (1), 189–200.

Haimovici, M., Perez, J.A.A., Costa, P.A.S., 1989. A review of cephalopods occurring in the waters of Rio de Janeiro state, Brazil with first record of four species. Revta. Brasil. Biol. 49 (2), 503–510.

Haimovici, M., Perez, J.A.A., Santos, R.A., 1994. Class Cephalopoda Cuvier, 1797. In: Rios, E.C. (Ed.), Seashells of Brazil, 2nd Edition. Editora da FURG, Rio Grande, pp. 311–320 + Plates.

Juanicó, M., 1979. Contribuição ao estudo da biologia dos cefalópodes Loliginidae do Atlântico Sul Ocidental entre Rio de Janeiro e Mar del Plata. Ph.D. Thesis. Instituto Oceanográfico, Universidade de São Paulo, São Paulo, SP, 102 pp.

Klinowska, M., 1991. Dolphins, Porpoises and Whales of the World: The IUCN Red Data Book. IUCN, Cambridge, 429 pp.

Nesis, K.N., 1987. Cephalopods of the Word, Squids, Cuttlefishes, Octopuses and Allies. TFH Publications, Neptune City, NJ, 351 pp.

Moreno, I.B., Danilewicz, D.S., Ott, P.H., Caon, G., Martins, M.B., Oliveira, L.R., Messias, L., 1998. Presença do golfinho de Fraser (*Lagenodelphis hosei*) na costa sul do Brasil. (Abstract) 8ª Reunião de trabalho de especialistas em mamíferos aquáticos da América do Sul, Olinda, Brazil, 134 pp.

Ott, P.H., 1994. Estudo da ecologia alimentar de *Pontoporia blainvil*lei (Gervais e D'Orbigny, 1844) (Cetacea, Pontoporiidae) no litoral norte do Rio Grande do Sul, sul do Brasil. Monograph Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, 69 pp.

Palacio, F.J., 1977. A study of coastal cephalopods from Brazil with reference to Brazilian zoogeography. Ph.D. Thesis. University of Miami, Miami, 311 pp.

Perez, J.E., Gingarelli, M., Beilis, A., Corcuera, J., 1996. Alimentación del delfín franciscana en el sur de la provincia de Buenos Aires, Argentina. (Abstract) 7ª Reunión de trabajo de especialistas en mamíferos acuáticos de América del Sur, Viña del Mar, Chile, 91 pp.

Perez, J.A.A., Schettini, C.A.F., Buratto, J.R., Machado, M.J., 1997. A pesca de lulas (Mollusca: Cephalopoda) na Ilha do Arvoredo (SC): características e relações ecológicas, Verão de 1996. Notas Técnicas da FACIMAR 1, 9–21.

Pinedo, M.C., 1982. Análise dos conteúdos estomacais de *Pontoporia blainvillei* (Gervais e D'Orbigny, 1844) e *Tursiops gephyreus* (Lahille, 1908) (Cetacea, Platanistidae e Delphinidae) na zona estuarial e costeira de Rio Grande, RS, Brasil. M.Sc. Thesis. Fundação Universidade do Rio Grande, Rio Grande, RS, 95 pp.

Pinedo, M.C., 1987. First record of a dwarf sperm whale from southwest Atlantic, with reference to osteology, food habits and reproduction. Sci. Rep. Whales Res. Inst. 38, 171–186.

Pinedo, M.C., 1994. Review of small cetacean fishery interactions in southern Brazil with special reference to the franciscana. Rep. Int. Whaling Comm. Spec. Iss. 15, 251–264.

Pinedo, M.C., Rosas, F., Marmontel, M., 1992. Cetáceos e pinípedes do Brasil. Uma revisão dos registros e guia para identificação das espécies. UNEP/FUA Imprensa Universitária, Manaus, 213 pp.

Roper, C.F.E., Sweeney, M.J., Nauen, C.E., 1984. FAO Species Catalogue. 3. Cephalopods of the World. An Annotated and Illustrated Catalogue of Species of Interest to Fisheries. FAO Fisheries Synopsis No. 125, Vol. 3, 1984, 273 pp.

Ross, G.J.B., 1979. Records of pygmy and dwarf sperm whales, genus *Kogia*, from southern Africa, with biological notes and some comparisons. Ann. Cape Province Mus. (Nat. Hist.) 2, 259–327.

Santos, R.A., Pinedo, M.C., 1994. Cefalópodes na dieta de golfinhos piloto de nadadeira longa, *Globicephala melas*, no litoral do Rio Grande do Sul. (Abstract) 6ª Reunión de trabalhos de especialistas em mamíferos aquáticos da América del Sur, Florianópolis, Brazil, 94 pp.

Santos, R.A., Haimovici, M., 1997. Reproductive biology of winter–spring spawners of *Illex argentinus* (Cephalopoda: Ommastrephidae) off southern Brazil. Sci. Mar. 61 (1), 53–64.

Secchi, E.R., Campolin, N.B., Moller, L., 1994. Notas sobre o encalhe de dois cachalotes pigmeus *Kogia breviceps* na costa sul do Rio Grande do Sul — Brasil. In: Oporto, J.A. (Ed.), Anales de la 4ª Reunión de trabajo de especialistas en mamíferos acuáticos de América del Sur 12–15 November 1990, Chile, pp. 244–262.

Secchi, E.R., Dalla Rosa, L., Bassoi, M., Barcelos, L., 1997. Uma alternativa para minimizar o impacto da pesca costeira de emalhe sobre a população de toninhas, *Pontoporia blainvillei*, (Cetacea, Pontoporiidae), no sul do Brasil. Anales del VII COLACMAR Congresso Latino-Americano sobre Ciências do Mar, Santos, Brazil, pp. 428–429.

Sekiguchi, K., Klages, N.T.W., Best, P.B., 1992. Comparative analysis of the diets of smaller odontocete cetaceans along the coast of the Southern Africa. S. Afr. J. Mar. Sci. 12, 843–861.

Sergeant, D.E., 1962. The biology of the pilot or pothead whale *Globicephala melaena* (Traill) in Newfoundland waters. Bull. Fish. Res. Board Can. 132, 1–84.

Siciliano, S., Di Beneditto, A.P., Ramos, R., Santos, R.A., Costa, P.A.S., Fagundes-Neto, E.B., Bastos, G.C.C., 1998. Ítens alimentares de alguns delfinídeos do litoral do Rio de Janeiro. (Abstract) 8ª Reunião de trabalho de especialistas em mamíferos aquáticos da América do Sul, Olinda, Brazil, 197 pp.

Sweeney, M.J., Roper, C.F.E., 1998. Classification, type localities, and type repositories of recent Cephalopoda. In: Voss, N.A., Vecchione, M., Toll, R.B., Sweeney, M.J. (Eds.), Systematics and Biogeography of Cephalopods, Part II. Smithsonian Contribution to Zoology, Vol. 586, pp. 561–599.

Vicente, A.F.C., Zampirolli, E., Alvarenga, F.S., Pereira, T.M.A., Maranho, A., Santos, R.A., 1998. Registro de cachalote-anão *Kogia simus* (Owen, 1866) (Cetacea-Physeteridae) no estado de São Paulo, Brasil. (Abstract) 8ª Reunião de trabalho de especialistas em mamíferos aquáticos da América do Sul, Olinda, Brazil, 222 pp.

Zanelatto, R.C., Rosas, F.C.W., Santos, R.A., 1996. Análise do conteúdo estomacal de um cachalote anão *Kogia simus* (Cetacea: Kogiidae), registrado para o litoral do Paraná, Brasil. (Abstracts) 7ª Reunión de trabajo de especialistas em mamíferos acuáticos de América del Sur, Viña del Mar, Chile, 82 pp.

Zerbini, A.N., Santos, M.C.O., 1997. First record of the pygmy killer whale *Feresa attenuata* (Gray, 1874) for the Brazilian coast. Aquat. Mamm. 23 (2), 105–109.