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A Review of the Occurrence and Distribution of Whales of the Genus *Balaenoptera* along the Brazilian Coast

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ABSTRACT

Although whales of the genus *Balaenoptera* were caught during whaling operations off Brazil, their distribution along the coast has remained poorly known. A complete review of the available literature and unpublished information was therefore conducted in order to better understand the occurrence and distribution of these species along the Brazilian coast. Blue and fin whales were the most rarely reported species, since very few of them were killed during whaling operations and few have been sighted or found stranded along the coast. These two species may not regularly move north to equatorial waters, but remain in medium latitudes (20°S). Sei whales were heavily exploited in low and medium latitude whaling grounds off Brazil but were nearly absent from the stranding records. They were observed in autumn, winter and spring. Blue, fin and sei whales have not been recorded in northern Brazil. Bryde's whales have been observed throughout the year and along the entire Brazilian coast. The offshore form has been infrequently recorded but the coastal form is common mainly in southern and southeastern Brazil, where its distribution and seasonal movements appear to be influenced by the behaviour, distribution and abundance of its prey. Ordinary and dwarf minke whales were also observed on northeastern, southeastern and southern coasts. Dwarf minke whales (77% of the minke whale records) are far more commonly recorded than ordinary minkes (23%), possibly as a consequence of the more coastal distribution of the dwarf form. Individuals of both forms may remain through the summer in medium and low latitudes off Brazil.

KEYWORDS: BALEEN WHALE; BLUE WHALE; FIN WHALE; SEI WHALE; BRYDE'S WHALE; MINKE WHALE; SOUTH ATLANTIC; BIOLOGY; DISTRIBUTION; WHALING-MODERN; STRANDINGS; MIGRATION; MOVEMENTS

INTRODUCTION

There are formally five living species in the genus *Balaenoptera* distributed worldwide. The blue whale, *B. musculus* (Linnaeus, 1758); the fin whale, *B. physalus* (Linnaeus, 1758); the sei whale, *B. borealis* (Lesson, 1828) and the minke whale, *B. acutorostrata* (Lacépède, 1804) are known to be highly migratory. Bryde's whales, *B. edeni* (Anderson, 1878) are found only in tropical and warm temperate waters in both Hemispheres.

All the balaenopterid species occur in Brazilian waters, where they suffered varying degrees of exploitation (e.g. Paiva and Grangeiro, 1970; Williamson, 1975). In the past, information on occurrence and distribution was based essentially on whaling data and on some rare strandings and sightings. Two coastal whaling stations operated during the austral winter and spring in Brazil. The most important and the one that provided most of the available information operated in Costinha (6°57'S, 34°51'W), Paraíba state (PB), from 1910 to 1914 and from 1924 to 1985. Whaling statistics were collected from 1911-14; 1924-28; and 1947-85 (Williamson, 1975; whaling data from the International Whaling Statistics). Another station operated from 1960 to 1963 in Cabo Frio (22°53'S, 42°01'W), Rio de Janeiro state (RJ) but little information is available from this locality. Brazilian whaling data regarding the *Balaenoptera* species have been discussed previously (e.g. Grangeiro, 1962; Paiva and Grangeiro, 1965; 1970; Williamson, 1975; da Rocha, 1980; 1983; da Rocha and Braga, 1982; Zahl, 1988; Horwood, 1990).

Since whaling ceased, some information on balaenopterids off Brazil has been obtained from animals found ashore (e.g. Bittencourt, 1983; Geise and Borobia, 1988; Barros, 1991; Irion *et al.*, 1992; Reis *et al.*, 1993). Due to an increase in observing and reporting efforts in recent years, considerable new data have been obtained. The purpose of this paper is to review and update this information and to report on the occurrence and distribution of the genus *Balaenoptera* in Brazil.

MATERIAL AND METHODS

Data were compiled from personal observation, scientific literature, unpublished information acquired from colleagues and printed media files (e.g. newspapers and magazines). Museums and research laboratories were surveyed for summaries of specimens and information in their collections.

Data from sighted animals were obtained from opportunistic cruises on commercial, military, research and tourist vessels or from land-based points along the coast. Non-systematic beach surveys have been carried out by several groups working along the Brazilian coast in order to obtain data on stranded and accidentally caught whales (e.g. Secchi *et al.*, 1991; Möller *et al.*, 1992; Simões-Lopes and Ximenez, 1993; Almeida, 1995; Danilewicz *et al.*, 1996). Photographs of stranded and sighted whales were also acquired from the public.

In this study, the specific identity of the whales recorded was determined from the external morphology described in the literature (e.g. Leatherwood *et al.*, 1982b; Leatherwood and Reeves, 1983; Cummings, 1985; Gambell, 1985a; b; Stewart and Leatherwood, 1985; Yochem and Leatherwood, 1985) and/or osteological features (Omura *et al.*, 1970; 1981). Only animals that could be reliably identified have been included in the analysis.

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Whaling data were obtained from the International Whaling Commission and from Paiva and Grangeiro (1965; 1970), Williamson (1975), da Rocha (1983) and Horwood (1990).

For the purpose of describing distribution, the Brazilian coastline was divided into four main regions: the northern (from Amapá [AP] to Rio Grande do Norte [RN]), northeastern (from Paraíba [PB] to Bahia [BA]), southeastern (from Espírito Santo [ES] to São Paulo [SP]) and southern (from Paraná [PR] to Rio Grande do Sul [RS]) coasts. The codes of the Brazilian states abbreviated in the text and figures are listed in the Appendix.

RESULTS

Blue whales

Whaling data

Three blue whales were taken during whaling off Brazil. At Costinha, one whale was landed in 1948 (Williamson, 1975) and another 27.3m female in September 1965 (Ferreira and Tártari, 1965; Paiva and Grangeiro, 1970). Another specimen was captured off Cabo Frio, in 1962 (Williamson, 1975).

Sightings

Two blue whales were sighted during whaling operations off Costinha (da Rocha and Braga, 1982; Antonelli *et al.*, 1987). One possible sighting recorded by Hinton (1925) off RJ was mentioned by Yochem and Leatherwood (1985).

Strandings

The only confirmed blue whale stranding along the Brazilian coast is a 23.12m female stranded alive on Chui beach (33°45′S, 53°22′W) (RS) in 29 April 1992 (Irion *et al.*, 1992). The almost complete skeleton of this specimen was collected (MORG 0088) and details are given in Dalla-Rosa and Secchi (1997). A mandible (MORG 0003) collected in Albardão, 130km south of Rio Grande (32°07′S, 52°05′W), RS was also attributed to the species (Pinedo *et al.*, 1992).

Recent Holocene fossil and semi-fossil bones of blue whales have been collected in southern (Souza-Cunha, 1982, 1985; Souza-Cunha and Nunan, 1980) and southeastern (Mezzalira, 1982; 1985) Brazil.

Fin whales

Whaling data

Only three fin whales were killed off Costinha, one each in 1956, 1958 and 1971 (Williamson, 1975), during the 48 years of whaling. In contrast, during just four years of whaling at Cabo Frio, 84 fin whales were captured (Williamson, 1975).

Sightings

Nine fin whales were observed off Costinha during whaling operations from 1980 to 1986 (Antonelli *et al.*, 1987).

Strandings

Only two stranding records of fin whales have been recorded in Brazil: a 20m whale was found ashore in September 1941 at Peruíbe, 29°19′S, 47°01′W, SP (the almost complete skeleton is on exhibition at the Museu do Instituto de Pesca de Santos, SP); and a 11.10m male washed ashore on Guarajuba beach (BA) on 12 August 1991 (Reis *et al.*, 1993).

Sei whales

Whaling data

Sei whales were abundant off northeastern Brazil and predominated in the catches off Costinha between 1947 and 1965 (Williamson, 1975). Prior to 1967, the species was not distinguished from Bryde's whales in the catch statistics in this area. Williamson (1975) observed that from 1967 to 1974 a total of 251 sei and 25 Bryde's whales was killed off Costinha, so that *B. borealis* represented about 90% of the catch of these species combined. A total of about 3,600 sei whales was killed off Costinha up to 1974 (Williamson, 1975). After 1978, IWC regulations meant that sei whales were no longer taken in the region.

Sei whales were probably also the main species exploited off Cabo Frio, but for the whole period, this species and the Bryde's whale were not distinguished in the catches and thus the true proportion of sei and Bryde's whales in the catches is unknown. However, Omura (1962) reported that 12 Bryde's whales were landed there in 1961 when the reported combined catch was 453 (Williamson, 1975). From these data, sei whales may have represented some 97% of the total catch at Cabo Frio in 1961. If this is true, extrapolation to the whole period would suggest that about 1,100 sei whales may have been taken during the four year whaling period off Cabo Frio.

Sightings

Sei whale sightings were recorded during the whaling operations off Costinha from 1980 to 1985 (Antonelli *et al.*, 1987). During this period, only 74 sei whales were reported.

Strandings

Although sei whales were once abundant off Brazil, reported strandings have been rare. Barros (1991) reported the stranding of a live *Balaenoptera* cf. *borealis* photographed at Vila Velha (20°21′S, 40°17′W) (ES) on 7 March 1980. Since diagnostic characters such as the head's dorsal surface and the ventral grooves were underwater and only the flukes and dorsal fin could be seen in the photograph, this whale was identified based on 'the tall, pointed, upright dorsal fin positioned well behind the mid point of the back' (Barros, 1991). The author noted the difficulties in the identification of sei and Bryde's whale (e.g. see Mead, 1977). However, Omura *et al.* (1981) reported diagnostic differences in skull characters noting that the ventral surface of the maxillaries is more concave and the outer surface of the maxillaries is more straight in sei than in Bryde's whales. Photographs of the skull (fig. 2, p. 298 in Barros, 1991) show that the characters mentioned above were present in the Vila Velha specimen, confirming that it was a sei whale.

A nearly complete sei whale skull (CBL = 3600mm, UFSC 1090) was collected on Santinho beach, Florianópolis (27°35′S, 48°33′W) (SC) in November 1989 (Simões-Lopes and Ximenez, 1993). A *ca.* 12m long male was washed ashore on Boracéia Beach, Bertioga (23°50′S, 46°08′W) (SP) on 18 August 1988 (Santos and Siciliano, 1996). An incomplete skull (MORG 0123) collected in 1994 by a trawling boat off RS is also attributed to this species.

Bryde's whales

Whaling data

As noted earlier, Bryde's whales were declared as 'sei whales' at Costinha until 1967 and at Cabo Frio for the whole whaling period. Bryde's whales represented possibly 10% of the catch of the two species off Costinha

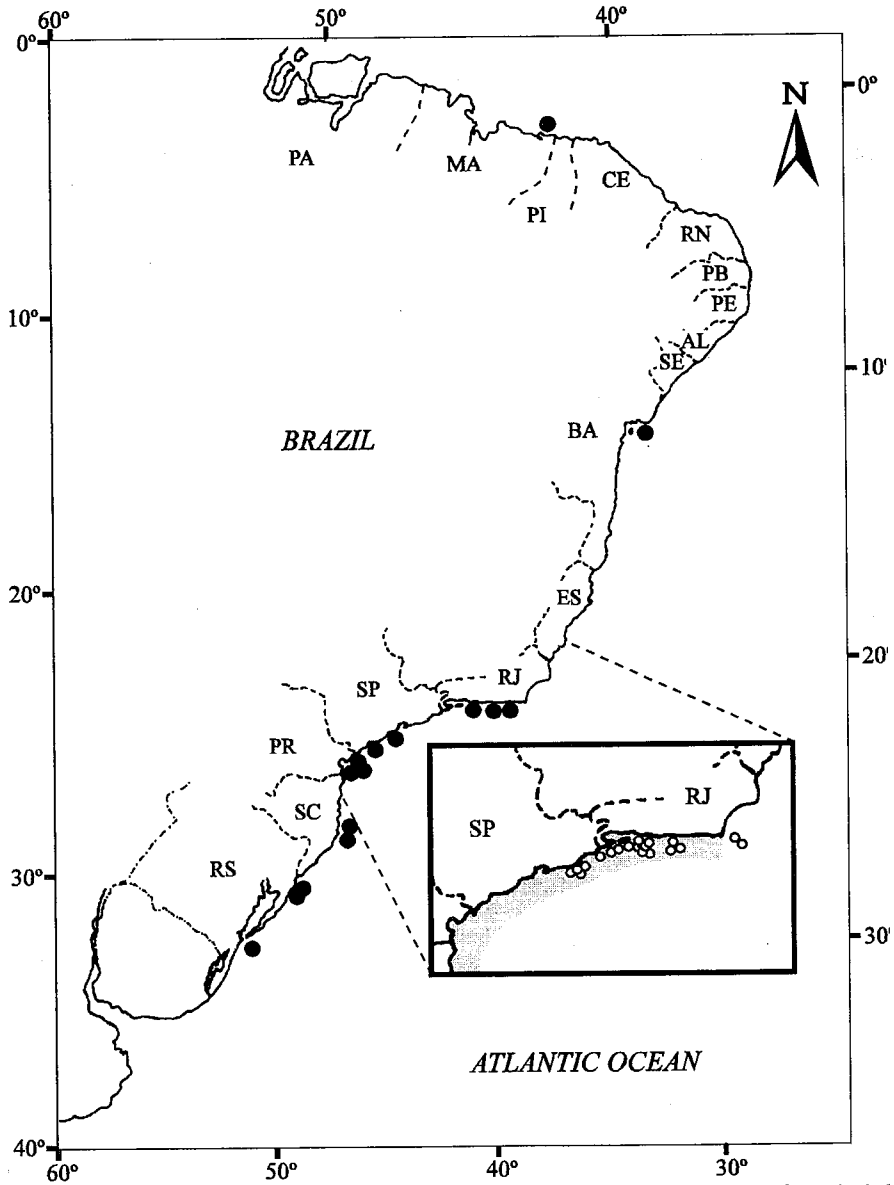

Fig. 1 - Strandings (●) and sightings (○) of Bryde's whales along the Brazilian coast. Grey shaded area indicates the region where the Brazilian sardine, *Sardinella brasiliensis*, is more abundant.

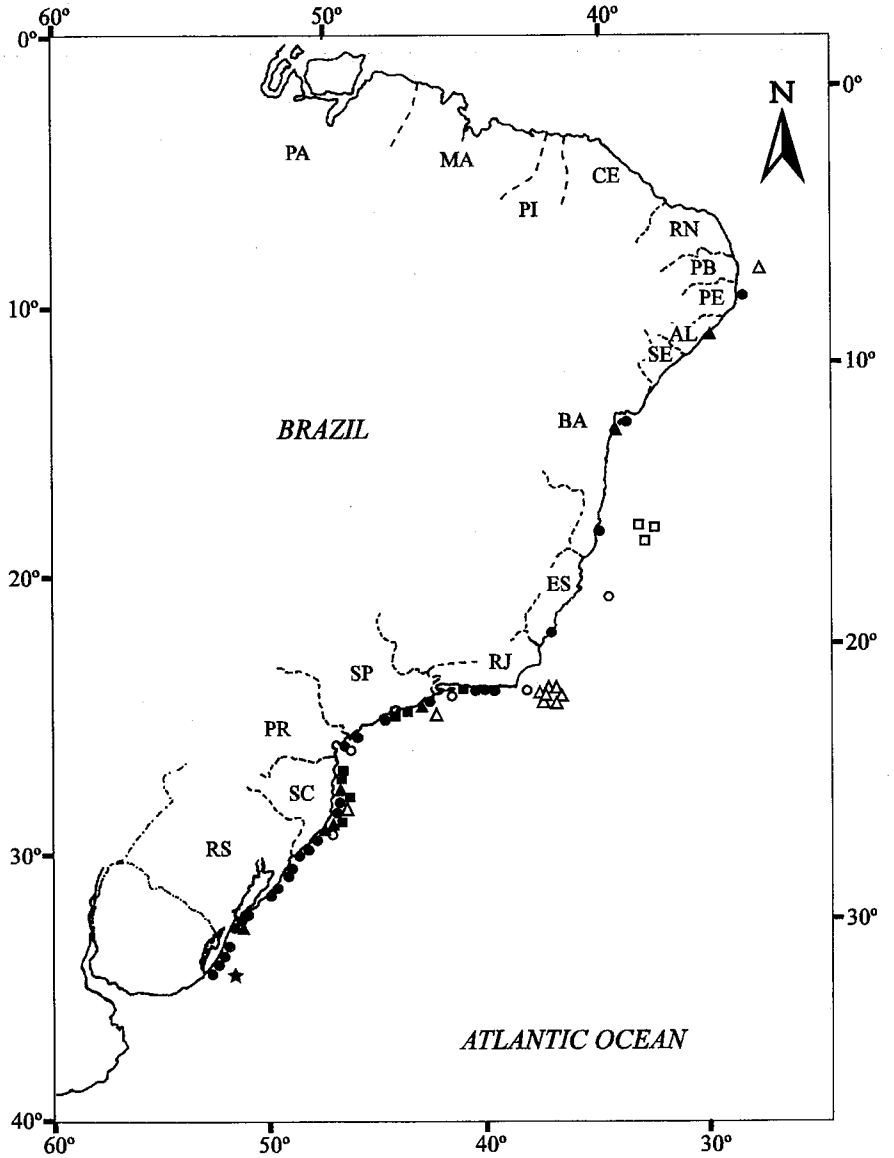

Fig. 2 - Sighting (open figures) and strandings (filled figures) of ordinary (□), dwarf (○) and unidentified (△) minke whales along the Brazilian coast.

(Williamson, 1975) and about 3% off RJ (see Omura, 1962). The estimated total catches were probably about 360 and 30 whales off Costinha and Cabo Frio, respectively (Williamson, 1975).

Sightings

The Bryde's whale is regularly observed in coastal areas wherever effort occurs. The 24 sightings reported in this study (Table 1, Fig. 1) have all been recorded in southeastern Brazil during the austral summer and autumn. Group sizes ranged from 1-3 with single animals and pairs representing 62.5% and 29.2% respectively.

The species has been observed feeding in coastal waters, often in multispecific associations. Siciliano and Santos (1994) observed Bryde's whales preying on Brazilian sardines (*Sardinella brasiliensis*), in association with brown boobies (*Sula leucogaster*), tuna fish (Scombridae), dolphin-fish (*Coryphaena hippurus*) and unidentified sharks. Bryde's whales feeding on clupeid fish associated with marine birds (brown booby, magnificent frigatebird, *Fregata magnificens* and terns, *Sterna* sp) have also been reported by de Oliveira *et al.* (1996).

Strandings

Bryde's whales are found stranded along the Brazilian coast more often than all balaenopterids except the minke whale. Strandings (Table 2, Fig. 1) have been recorded throughout the year and along the whole coast, although most of the records were recorded mainly in the southern and southeastern regions.

Minke whales

Two forms of minke whales occur in Brazilian waters: the Southern Hemisphere ordinary form and the dwarf form. Whenever possible, the two forms are treated separately following the recommendation of the IWC Scientific Committee (IWC, 1991; 1994). Methods used to distinguish the dwarf from the ordinary form are described in Zerbini *et al.* (1996b).

Whaling data

The minke whale was the most recently exploited species off Brazil and therefore has the most extensive information on catch procedures and statistics. Minke whales were taken only from 1965 to 1985 at Costinha, where about 14,600 animals were killed (e.g. Horwood, 1990). Apart from three possible dwarf minke whales killed in 1980 (da Rocha and Braga, 1982; Singarajah, 1984), the remaining animals are believed to have belonged to the ordinary form. Biological information and statistics on minke whales captured off Costinha were presented by Paiva and Grangeiro (1970), Williamson (1975), da Rocha (1980; 1983), da Rocha and Braga (1982), Singarajah (1984) and Horwood (1990).

Sightings

An IWC/IDCR minke whale marking and assessment cruise took place in November/December 1981 in oceanic waters between 4° and 15°S off Brazil. During the survey, 265 whales were observed in 179 sightings (Best *et al.*, 1986).

With the end of commercial whaling, no effort was made to specifically search for minke whales. At present, neither dwarf nor ordinary minke whales have been frequently sighted off Brazil, almost certainly because of a lack of searching and reporting effort. In addition, the small body size and the absence of a blow in tropical waters certainly contribute to the difficulty of spotting this species (see Leatherwood *et al.*, 1982a). This was particularly noted in two sightings of dwarf minke whales at close range, when no blow was observed (I.B. Moreno, pers. comm.).

Sightings of the two forms of minke whale are presented in Table 3 and plotted in Fig. 2. Reliable identification of dwarf or ordinary minke whales at sea has been questioned (Best, P.B., 1985; P. Arnold, pers. comm.). Best (1985) stated that ordinary minke whales with Type 2 flippers (his terminology) seen at sea have clear flippers contrasting to the darker dorsal pigmentation. Thus, they might be mistakenly identified as dwarf minke whales, which have a white patch on the flippers. For this reason, in Table 3, only animals that

Table 1

Confirmed sightings of Bryde's whales along the Brazilian coast.

No.	Date	Locality	Coordinates	No. of whales	Source
1	15 Nov. 1990	Ilhabela Island, SP	*ca* 23°45'S, 45°15'W	1	Hetzel and Lodi, unpublished data
2	3 Dec. 1990	Ilha de Búzios, SP	23°48'S, 45°08'W	1	Present study
3	2 Jan. 1993	Palmas Island, SP		1	Lodi and Hetzel, unpublished data
4	8 Jan. 1993	Cajaíba, RJ		1	Present study
5	9 Jan. 1993	Paraty, RJ	*ca* 23°05'S, 44°13'W	3+	Present study
6	13 Nov. 1993	Ponta da Juatinga, RJ	*ca* 23°17'S, 44°30'W	2	Hetzel and Lodi, 1993
7	25 Feb. 1994	Alcatrazes Island, SP	24°06'S, 45°21'W	1	Santos and Siciliano, 1996
8	27 Feb. 1994	Alcatrazes Island, SP	24°06'S, 45°21'W	2+	Santos and Siciliano, 1996
9	6 Nov. 1994	Marambaia, RJ	*ca* 23°05'S, 43°40'W	1	Present study
10	21 Nov. 1994	Marambaia, RJ	*ca* 23°05'S, 43°40'W	1	Present study
11	30 Nov. 1994	Marambaia, RJ	*ca* 23°05'S, 43°40'W	1	de Oliveira *et al.* in press
12	3 Jan. 1995	Marambaia, RJ	*ca* 23°05'S, 43°40'W	1	de Oliveira *et al.* in press
13	8 Jan. 1995	S. Sebastião, SP	23°51'S, 45°46'W	1	Present study
14	6 Mar. 1995	Marambaia, RJ	*ca* 23°05'S, 43°40'W	2	de Oliveira *et al.* in press
15	22 Mar. 1995	Marambaia, RJ	*ca* 23°05'S, 43°40'W	1	de Oliveira *et al.* in press
16	29 Mar. 1995	Marambaia, RJ	*ca* 23°05'S, 43°40'W	1	de Oliveira *et al.* in press
17	31 Mar. 1995	Marambaia, RJ	*ca* 23°05'S, 43°40'W	1	de Oliveira *et al.* in press
18	3 Apr. 1995	Barra da Tijuca, RJ	*ca* 22°56'S, 43°15'W	2	Present study
19	10 Apr. 1995	Marambaia, RJ	*ca* 23°05'S, 43°40'W	2	de Oliveira *et al.* in press
20	11 Apr. 1995	Marambaia, RJ	*ca* 23°05'S, 43°40'W	1	de Oliveira *et al.* in press
21	29 Apr. 1995	Arraial do Cabo, RJ	*ca* 23°05'S, 41°50'W	3	Present study
22	3 May 1995	Rio de Janeiro, RJ	*ca* 22°56'S, 43°15'W	2	Present study
23[1]	6 Jun. 1995	Bacia de Campos, RJ	2°36'S, 40°10'W	2	A.M. Scofano, pers. comm
24	30 Jan. 1996	Barra da Tijuca, RJ	*ca* 22 °56'S, 43°15'W	1	Present study

[1] The only sighting of a Bryde's whale in oceanic waters observed in this study.

Table 2

Confirmed strandings of inshore (I) and offshore (O) form Bryde's whales along the Brazilian Coast. TL = total length.

No.	Locality	Coordinates	Date	TL(m)	Sex	Form	Source
1	Cananéia, SP	25∞00'S, 47°55'W	1972				Santos and Siciliano, 1996
2	Maragogipe, BA	12°48'S, 38°55'W	30 Sep. 1981	14.0[1]	F[3]	I	Present study, Lima *et al.*1996
3	Rio de Janeiro, RJ	22°56'S, 43°15'W	29 Jan. 1983	7.1	M	I	Borobia and Geise, 1986
4	Superagui Island, PR	*ca.* 25°25'S, 48°00'W	29 Jun. 1983	13.0	F	I	Bittencourt, 1983
5	Itanhaém, SP	24°11'S, 46°47'W	1986				Santos and Siciliano, 1996
6	Rio Grande, RS	32°07'S, 52°05'W	Aug. 1989	15.0[1]		I	Present study
7	Angra dos Reis, RJ	23°00'S, 44°18'W	3 Apr. 1989	10.6	M		Present study
8	Caju Island, MA	*ca.* 2°45'S, 42°00W	21 Oct. 1991	10.0[1]		I	Almeida, 1995
9	Guaratuba, PR	25°53'S, 48°34'W	28 Apr. 1993	3.9	F		R.C. Zanelatto, pers. comm.
10	Laguna, SC	28°28'S, 48°46'W	17 Sep. 1993	8.8	F	O	M. Menezes, pers. comm.
11	Superagui Island, PR	*ca.* 25°25'S, 48°00'W	30 Sep. 1993	14.0[1]	M	I	R.C. Zanelatto, pers. comm.
12	Florianópolis, SC	27°35'S, 48°33'W	Jan. 1994				Present study
13	Tramandaí, RS	29°59'S, 50°07'W	22 Dec. 1994	10.8	M		L. Oliveira, pers. comm.
14	Saquarema, RJ	22°56'S, 42°30'W	7 Apr. 1995	12.4			MAQUA, unpublished data
15	Tramandaí, RS	29°59'S, 50°07'W	29 Feb. 1996	4.0[2]	M		L. Oliveira, pers. comm.

[1] Estimates. [2] Measured without head and fluke. [3] Pregnant.

Table 3

Confirmed sightings of minke whales along the Brazilian coast after the whaling period.

TL = total length; D = dwarf minke whale; O = ordinary minke whale.

No.	Date	Locality	Depth (m)	No. of whales	TL (m)	Form	Source
1	Jan. 1987	Ilha do Arvoredo, SC	20-30	2			Simões-Lopes and Ximenez, 1993
2	31 Aug. 1987	22°11'S, 39°55'W		2			R. von Seckendorff, pers. comm.
3	31 Oct. 1987	22°11'S, 39°55'W		2			R. von Seckendorff, pers. comm.
4	1 Nov. 1987	22°11'S, 39°55'W		1			R. von Seckendorff, pers. comm.
5	6 Nov. 1987	22°11'S, 39°55'W		1			R. von Seckendorff, pers. comm.
6	26 Aug. 1988	22°11'S, 39°55'W		2			R. von Seckendorff, pers. comm.
7	25 Sep. 1988	22°11'S, 39°55'W		1			R. von Seckendorff, pers. comm.
8	Aug. 1989	19°28'S, 35°36'W	3600	2		D	Zerbini *et al.*, 1996b
9	3 Dec. 1990	23°39'S, 44°55'W		1	7-8		Present study
10	May 1994	1° to 5°S, 30° to 35°W		3			Vaske Jr. *et al.*, 1994
11	26 Aug. 1994	Baía da Ilha Grande		1		D	Hetzel and Lodi, unpublished data
12	23 Nov. 1994	25°25'S, 46°07'W	129	1	6-7	D	I.B. Moreno, unpublished data
13	17 Apr. 1995	Bacia de Campos, RJ	200	2	6-7	D	A.M. Scofano, pers. comm.
14	28 Jun. 1995	23°37'S, 40°11'W		1			A.M. Scofano, pers. comm.
15	21 Aug. 1995	Praia de Palhoça, SC	4	1	3-4	D	Present study
16	27 Oct. 1995	17°01'S, 37°33'W	~600	3		O	MAQUA, unpublished data
17	27 Oct. 1995	17°01'S, 37°39'W	~600	1		O	MAQUA, unpublished data
18	30 Oct. 1995	16°56'S, 37°30'W	1174	1		O	MAQUA, unpublished data

could be accurately identified were classed as ordinary or dwarf minke whales. Otherwise, the specimens listed were not classified to form.

Strandings

Minke whale strandings have been observed along the whole coast except for the northern region (Table 4, Fig. 2) and represent about 67% (n = 42) of the confirmed balaenopterid stranding records. Dwarf minke whales represented 77% of the whales that could be distinguished to form (see also Zerbini *et al.* 1996b).

DISCUSSION

The highly migratory balaenopterids (blue, fin, sei and minke whales) reach medium and low latitudes off Brazil during their breeding season (e.g. Paiva and Grangeiro, 1970; Williamson, 1975). While the seasons when these species were recorded varied, with some individuals being recorded throughout the year (see below for minke whales), most whales were observed during the austral winter and spring. Blue, fin, sei and minke whales were recorded as far north as 5°S in the whaling grounds off the northeastern coast of Brazil, but none were observed along the northern coast. Williamson (1975) reported that minke whales migrate as far north as the northeastern tip of the South American continent but do not continue westwards towards northern Brazil and the Caribbean Sea. Although the observing and reporting effort for stranded marine mammals has increased in recent years for some portions of the northern coast, highly migratory balaenopterids have not yet been recorded there (M. Furtado and T. Alves Jr., pers. comm.). Therefore, it may be that, like the minke whale, blue, fin and sei whales migrating to northeastern Brazil do not move towards the northern coast.

In addition to whaling data, additional information on the distribution of these species has been obtained from strandings and sightings. Searching and reporting effort has increased substantially along the southern and southeastern coasts of Brazil in recent years, making these areas well surveyed for stranded cetaceans. However, for a great portion of the northern and northeastern coasts (including the old whaling ground area), searching effort remains minimal or non-existent.

Table 4

Strandings of dwarf (D) and ordinary (O) minke whales along the Brazilian coast.

No.	Locality	Coordinates	Date	TL(cm)	Sex	Form	Source
1	Recife, PB	08°03'S, 34°53'W				O	Hetzel and Lodi, 1993
2	Bertioga, SP	23°50'S, 46°08'W		8.5		O	Present study
3	S. Francisco do Sul, SC	26°14'S, 48°38'W	1 Sep. 1914	6.0		O	Brandao, 1914
4	Rio de Janeiro, RJ	22°56'S, 43°15'W	15 Oct. 1958			O	Present study
5	Rio de Janeiro, RJ	22°56'S, 43°15'W	13 Aug. 1968	5.0[1]	F	D	Geise and Borobia, 1988; Zerbini *et al.*, 1996b
6	Salvador, BA	12°55'S, 38°31'W	22 Aug. 1972				Present study
7	Rio Grande, RS	32°07'S, 52°05'W	26 Jun. 1976	2.9	M	D	Best, 1985; Baldas and Castello, 1986
8	Rio de Janeiro, RJ	22°56'S, 43°15'W	28 Jun. 1977	6.0[1]		D	Geise and Borobia, 1988; Zerbini *et al.*, 1996b
9	Rio de Janeiro, RJ	22°56'S, 43°15'W	05 Aug. 1977	5.0[1]		D	Geise and Borobia, 1988; Zerbini *et al.*, 1996b
10	Criciúma, SC	28°40'S, 49°22'W	Sep. 1980	4.5		D	Baldas and Castello, 1986
11	Rio Grande, RS	32°07'S, 52°05'W	1 Oct. 1984	2.7	M	D	Pinedo, unpublished data
12	Balneário Camboriú, SC	26°59'S, 48°39'W	1986	5.0[1]		D	Present study
13	Barra Velha, SC	26°37'S, 48°41'W	Jan. 1986				Ximenez *et al.*, 1987
14	Ilha Comprida, SP	25°01'S, 45°57'W	5 Sep. 1986	5.0[1]		D	Santos and Siciliano, 1996
15	Balneário Camboriu, SC	26°59'S, 48°39'W	14 Sep. 1986			O	Simões-Lopes and Ximenez, 1993
16	Rio Grande, RS	32°07'S, 52°05'W	28 Jul. 1987	2.85			Pinedo, unpublished data
17	Florianópolis, SC	27°35'S, 48°33'W	6 Nov. 1987	3.2			Simões-Lopes and Ximenez, 1993
18	Palhoca, SC	27°38'S, 48°39'W	24 Dec. 1987				Simões-Lopes and Ximenez, 1993
19	Florianópolis, SC	27°35'S, 48°33'W	25 May 1988	8.21	F	O	Simões-Lopes and Ximenez, 1993
20	Sombrio, SC	29°07'S, 49°33'W	Jun. 1989			D	Simões-Lopes and Ximenez, 1993
21	Prado, BA	17°20'S, 39°13'W	Aug. 1989	4.0[1]		D	Zerbini *et al.*, 1996b
22	Marataízes, ES	21°02'S, 40°50'W	4 Aug. 1989	3.66	F	D	Zerbini *et al.*, 1996b
23	Ubatuba, SP	23°23'S, 45°04'W	12 Oct. 1989	6.0[1]	F	D	Santos and Siciliano, 1996
24	Ilha do Mel, PR	25°30'S, 48°23'W	26 Jun. 1990	3.0	F	D	Bittencourt and Zanellato, 1992; Zerbini *et al.*, 1996b
25	Guarujá, SP	23°59'S, 46°15'W	10 Oct. 1990	8.0		O	Santos and Siciliano, 1996
26	Japaratinga, AL	09°05'S, 35°15'W	9 Mar. 1991				Present study
27	Camaçari, BA	12°43'S, 38°20'W	17 Jul. 1992	4.5		D	Zerbini *et al.*, 1996a
28	Pr. Concheiros, R. Grande, RS	33°27'S, 52°58'W	15 Aug. 1992	2.6		D	M.C. Pinedo, unpublished data
29	incidental catch off RS	33°35'S, 51°29'W	29 Nov. 1992	3.43	M	D	Secchi *et al.* 1993, Zerbini *et al.* 1996b
30	Itanhaém, SP	24°11'S, 46°47'W	05 Nov. 1992	5.0[1]	M	D	Santos and Siciliano, 1996
31	Pr. Sarita, R. Grande, RS	32°38'S, 52°26'W	11 Jan. 1993	<4.0[1]		D	Zerbini *et al.*, 1996b
32	Pr. Albardão, R. Grande, RS	33°13'S, 52°42'W	11 Jan. 1993	3.0[1]		D	Zerbini *et al.*, 1996b
33	Pr. Albardão, R. Grande, RS	33°13'S, 52°42'W	10 Feb. 1993	7.0		D	Zerbini *et al.*, 1996b
34	Laguna, SC	28°28'S, 48°46'W	Dec. 1993			D	Present study
35	São Sebastião, SP	23°49'S, 45°24'W	22 May 1994	5.0[1]			Santos and Siciliano, 1996
36	Atlântida Sul, RS	29°52'S, 50°03'W	14 Dec. 1993	7.0		D	Ott and Danilewicz, unpublished
37	S. Francisco do Sul, SC	26°14'S, 48°38'W	22 Feb.1995	4.0	F	O	Present study
38	Porto Belo, SC	27°09'S, 48°33'W	16 Jun. 1995		M	D	Present study
39	96km north of Lagoa do Peixe, RS	*ca* 30°55'S, 50°45'W	19 Aug. 1995	4.2		D	M. Martins, pers. comm.
40	Rio Grande, RS	32°07'S, 52°05'W	8 Sep. 1995	3.1	F	D	Dalla Rosa, pers. comm.
41	Tramandaí, RS	29°59'S, 50°07'W	28 Oct.1995	2.63		D	D. Danilewicz, pers. comm.
42	92km north of Lagoa do Peixe, RS	*ca* 30°55'S, 50°45'W	17 Dec. 1995	3.2		D	I.B. Moreno, pers. comm.

[1] Estimates.

Species identification is often difficult for non-cetologists because it depends on a number of factors (e.g. experience of examiners, location of carcasses, etc). During sighting surveys, the experience of the observer, the distance of the whale from the boat and weather and sea conditions are fundamental factors that affect the reliability of identifications. In stranded animals, the freshness of the carcass is particularly important, especially in the tropics where the temperature accelerates decomposition. In addition, the large size of most balaenopterids makes handling difficult and discourages the collection of the biological and osteological material that is needed for species identification. Hence, many whales sighted or stranded have had to be reported as 'unidentified whales' or simply *Balaenoptera* sp. (e.g. Best, R.C. *et al.*, 1986; Geise and Borobia, 1988).

Blue whales

Blue whales have seldom been observed and are certainly the rarest of the balaenopterids in Brazilian waters. Even during early whaling periods when the species was the main target of the industry, blue whales were not reported off Costinha. Cabo Frio, however, only started operations after blue whale stocks had already been greatly depleted (Gambell, 1976). Mackintosh (1965) observed that the blue whale and the fin whale may have similar distribution patterns, so the discussion in the section 'Fin whales' may apply to blue whales (assuming that only the Southern Hemisphere blue whale reaches the Brazilian coast).

Two sub-species of *B. musculus* have been described in the Southern Hemisphere: the larger 'true' blue whale (*B. m. musculus*) and the smaller pygmy blue whale (*B. m. brevicauda*). Although there is insufficient information to determine if both forms occur off the Brazilian coast, further morphological and genetic analysis of material collected in Brazil will help to solve this question (e.g. see Dalla Rosa and Secchi, 1997).

Fin whales

Although fin whales have been recorded more often than blue whales, they should still be considered rare along the Brazilian coast. As for blue whales, the stocks of fin whales had been considerably depleted by the time whaling began in 1960 at Cabo Frio (Gambell, 1976). Nevertheless, at least a few fin whales were taken there every year (Williamson, 1975).

Although there was considerable searching effort from Costinha during the early years of commercial whaling in Brazil, the number of fin whales is even smaller than that recorded in Cabo Frio, possibly because the species does not reach the area in great numbers. Mackintosh (1965) suggested that both blue and fin whales might not reach low latitudes. The same author (Mackintosh, 1966) noticed that these species were taken together with humpback whales, *Megaptera novaeangliae*, in temperate latitudes off South Africa and Chile, but they have not been regularly observed farther north on other whaling grounds for humpack whales such as the Brazilian Northeast coast.

The presence of fin whales at Cabo Frio (~23°S) supports the hypothesis that they primarily remain south of 20°S, as observed for other regions such as the Pacific coast of South America (e.g. Chile) and southern Africa (e.g. Clarke, 1962; Best, P.B., 1994).

Sei whales

Sei whales were the main whaling target at Cabo Frio and at Costinha from at least 1947 to 1965, when catches started to decline. The present status of this species off Brazil is unknown. The relatively low number of whales sighted off Costinha (74 whales from 1980 to 1986) by Antonelli *et al.* (1987) could indicate that the stock had not yet recovered from its reduction by whaling. These authors do not refer to the difficulties in separating sei and Bryde's whales at sea and so it may be that the number of sei whales sighted could have been even lower than reported by Antonelli *et al.* (1987).

In the past, sei whales must have been common along the Brazilian coast, moving north as far as the whaling grounds off Costinha where they were taken from June to November and apparently were more abundant from July to September (Paiva and Grangeiro, 1970). The sei whale found stranded in March 1980 in Vila Velha, ES, (Barros, 1991) suggests that this species may reach Brazilian waters earlier than previously thought.

Bryde's whales

The Bryde's whale is the only balaenopterid that regularly remains year-round in tropical and warm temperate waters between 40°N and 40°S (Omura, 1959). It has been recorded along the entire Brazilian coast and is the only balaenopterid observed on the northern coast. It is not known, however, if its distribution along the coast is continuous, or alternatively if the whale recorded in the northern coast represents a different population from those recorded on the northeastern, southeastern and southern coasts. The Bryde's whale is common in the nearby Caribbean region (e.g. Nortabartolo-di-Sciara, 1983; Díaz *et al.*, 1995).

Best (1977) described two allopatric forms of the Bryde's whale off South Africa, an offshore and an inshore form that differ in external characters, morphometrics, feeding habits and shape of baleen plates, as well as the seasonality of their breeding season. The offshore form have the posterior part of the body heavily scarred, probably as a consequence of wounds made by the cookie-cutter shark, *Isistius* spp. This form feeds mainly on euphausiids and the baleen plates are proportionally shorter and wider (the plate length/width ratio does not exceed 2.24). The inshore form, on the other hand, is relatively scar-free, feeds mainly on epipelagic clupeid, carangid and engraulid fishes and has longer and narrower baleen plates (baleen length/width ratio, in general, more than 2.25). Best (1977) suggested that both forms occurred off Brazil, based primarily on baleen measurements from two whales captured during whaling activities (Omura, 1962; Omura pers. comm. to Best, 1977). If true, most of the information presented here refers to the inshore form but our results also include records of possible offshore whales, supporting the suggestion that both forms occur off Brazil. However, additional studies are required to unequivocally determine whether both forms do occur off Brazil.

There is little precise information on the exploitation of the two forms separately. Best's (1977) suggestion was based on whaling data from Cabo Frio (Omura, 1962) and thus it is likely that both forms were killed in this region. There are no comparable data for the whales landed at Costinha.

Offshore whales

Only one stranded whale could be classified as offshore Bryde's whale following Best's (1977) description. The mean baleen length/width ratio for the three largest plates of the young whale stranded in Laguna (SC) (Table 2 no.10) was 1.54 ($n=3$, range 1.49-1.62).

Inshore whales

From the strandings data reported in Table 2, 6 whales (2, 3, 4, 6, 8 and 11) were considered inshore whales due to their lack of scarring. All sightings presented here, with the exception of the two whales sighted in deep oceanic waters off RJ (Table 1, number 23), refer to whales observed close to shore.

The high number of Bryde's whales recorded in the southeastern and southern regions is certainly related to the comparatively higher effort in these areas. The distribution and abundance of Bryde's whales within these regions may be closely related to prey concentration and movements. Off South Africa, inshore Bryde's whales feed on engraulid, carangid and clupeid schooling fish (Best, P.B., 1977). Whales with inshore form characteristics are also known to be piscivorous in other areas such as Venezuela (Nortabartolo-di-Sciara, 1983) and the Gulf of California, Mexico (Tershy *et al.*, 1993). Of the few stomach contents examined from the Brazilian coast, the whale stranded at Maragogipe, Baía de Todos os Santos (BA) (no 2, Table 2) had a large amount of relatively undigested *pititingas* (a coastal clupeid fish) in its stomach (Lima *et al.*, 1996). Evidence of feeding on clupeid fishes (de Oliveira *et al.*, 1996) and, Brazilian sardines (Siciliano and Santos, 1994) has been reported. This latter fish species is found from Central Brazil to Argentina (Figueiredo and Menezes, 1978) but is far more abundant along the Brazilian coast (Fig.1) between Cabo de São Tomé (~22°S) and Cabo de Santa Marta Grande (~28°S) (Saccardo and Rossi-Wongtschowski, 1991). This highly productive upwelling region is characterised by a complex oceanographic system that provides an excellent habitat for sardines and other schooling fish (e.g. Bakun and Parrish, 1990; Cergole, 1995). Bryde's whale movements in this area also appear to be related to prey behaviour. Sightings were recorded close inshore during summer and early autumn, a time which Matsuura (1979) and Saccardo (1983) reported as the sardine spawning season, with peaks being observed particularly in December and January. At this time, sardines approach the coast to spawn in shallower waters ranging from 15 to 50m in depth (Saccardo and Rossi-Wongtschowski, 1991). It seems likely that Bryde's whales also move inshore while following sardine schools. Prey abundance and availability also seem to affect distribution and movements of inshore Bryde's whales off Venezuela (Nortabartolo-di-Sciara, 1983).

Although feeding on other prey species has not yet been reported, several species of schooling fishes are common in the same area (e.g. see Matsuura *et al.*, 1985). It seems probable that the dynamics of these potential prey species may also affect the behaviour, seasonality and abundance of Bryde's whales in coastal waters off southeastern and southern Brazil.

Minke whales

The minke whale is the most abundant baleen whale species in the world. Recent estimates of the Southern minke whale population are around 750,000 individuals (e.g. IWC, 1991). Although these estimates do not treat dwarf and ordinary minke whales separately, they are for the area south of 60°S in the austral summer and probably refer almost exclusively to the ordinary form. Both forms have been observed off Brazil.

The northeastern coast of Brazil has been considered a breeding ground for ordinary minke whales (IWC, 1991). Males killed off Brazil had sperm in the tubules and active spermatogenesis was in progress (Williamson, 1975). A high proportion of sexually mature females (i.e. with at least one corpus in the ovaries) was found in the catches of 1977 and 1980 (da Rocha, 1980; da Rocha and Braga, 1982) and some whales appeared to have ovulated earlier in the season (Horwood, 1990). Although mating has not been observed, physiological evidence shows that minke whales are in breeding condition (e.g. Williamson, 1975). This author and, more recently, Singarajah (1984) reported that females caught off Brazil with visible embryos in the uterus were rare, as were sightings of mother-calf pairs (Williamson, 1975). Given this, Horwood (1990) suggested that pregnant females might be segregated from the rest of the population and give birth and nurse their calves outside the Brazilian whaling grounds. In southern Brazil, newborn ordinary minke whales have been killed incidentally in nets (Simões-Lopes and Ximenez, 1993), sighted (Zerbini *et al.*, 1996a) and found stranded (no. 37, Table 4). They have also been recorded in Uruguay (M. Lazaro, pers. comm.). It appears, therefore, that ordinary minke whales migrating to the east coast of South America may give birth in middle latitudes (between at least 25° - 35°S) of the western South Atlantic Ocean.

Less is known about reproduction of dwarf minke whales. Sexually mature whales were caught in whaling grounds off South Africa (Best, P.B., 1985) and off Brazil (da Rocha and Braga, 1982), while calves have been frequently recorded not only off southern Brazil (Zerbini *et al.*, 1996b; several records in Table 4) and Uruguay (M. Lázaro, pers. comm.) but also off northern Argentina (Baldas and Castello, 1986). Dwarf minke whale, therefore, may also give birth in the middle latitudes of the western South Atlantic as speculated by Baldas and Castello (1986).

Although both forms have been recorded from the northeastern coast of Brazil, most records are from the southern and southeastern coasts, where the observing and reporting effort has been greater. No minke whales have been reported, however, along the northern coast (Williamson, 1975; present study). These observations support the hypothesis that minke whales from the Southern and Northern Hemispheres do not intermingle, a hypothesis further supported by the large genetic difference between Southern and Northern forms of minke whales (e.g. Wada *et al.*, 1991; Hori *et al.*, 1994).

There has been great disparity in the frequency of strandings of the two forms of minke whale (see Table 4), with dwarf minkes representing 77% of the records (also see Zerbini *et al.*, 1996b) As previously suggested by Best (1985), this disparity may be a consequence of the more coastal distribution of dwarf minke whales. Sightings of both forms reported here (Table 3) support this idea. Except for the two whales recorded at a water depth of 3,600m (Zerbini *et al.*, 1996b), the other dwarf minke whales were all sighted in relatively shallow waters (between 4 - 200m deep) over the continental shelf. In addition, a dwarf minke was incidentally captured off RS in waters 143m deep (no. 29, Table 4; Secchi *et al.*, 1993). By contrast, confirmed ordinary minke whale sightings were recorded only in deep oceanic waters (>600m).

Ordinary minke whale migrations between breeding grounds off Brazil and the Antarctic Ocean (IWC management areas II and III - see Donovan, 1991) have been confirmed by marking experiments (Horwood, 1990). Williamson (1975) reported on the seasonality of ordinary minke whales in the whaling ground off Brazil between June and December. However, his observations were based on whaling activities and therefore did not cover months when the catcher-boat was not operating. Three minke whales (not distinguished to form) were recorded in May 1994 during a study conducted in the former whaling ground area (Vaske Jr. *et al.*, 1994). Information provided in Tables 3 and 4 indicates that both forms of minke whales are present off Brazil during summer and autumn months. Although this may reflect a difference in the timing of migration in different years or by particular individuals, it is possible that some minke whales stay in low and middle latitudes of the western South Atlantic Ocean throughout the summer. Summer observations of minke whales in middle latitudes of the Indian Ocean have been reported by Gambell *et al.* (1975). Dwarf minke whales were observed in Brazil, Uruguay and Argentina between April and February (Baldas and Castello, 1986; Zerbini *et al.*, 1996b, present study).

The hypothesis of oversummering in low-mid latitudes presupposes that minke whales feed in tropical and subtropical waters. Williamson (1975) reported that nearly all ordinary minke whales caught off northeastern Brazil (*ca.* 7°S) had empty stomachs but that small amounts of euphausids were found in about 3% of the whales. Although several of the stomachs examined from whales killed off South Africa (*ca.* 30°S) were also empty, the proportion of stomachs with food (15.2%) was higher than in Brazil (Best, P.B., 1982). No information on ordinary minke whales feeding in Brazil is available. The dwarf minke whale incidentally caught off RS in November 1992 had fed intensively on *Euphausia similis* (Secchi *et al.*, 1993). Most summer records of ordinary and dwarf minke whales were observed from sub-tropical (middle latitude) waters, where productivity is higher than in more northerly regions. This suggests that 'non-migrating' minke whales may concentrate in such areas where the food availability is likely to occur.

RECOMMENDATIONS

While a large amount of high quality biological information was obtained from balaenopterids caught during some whaling operations in other oceans, this was not the case in Brazil. Since the cessation of commercial whaling, stranded animals are now almost the only source of biological material. However, large whales are difficult to handle and, consequently, this discourages collection of relevant biological material. Even given the limitations of data from stranded animals we therefore suggest that as much information and samples (e.g. tissues, morphometrics, baleen plates, osteological material, stomach contents) as

possible be collected from stranded whales (IWC, 1986). This could be useful in improving our knowledge of the biology and behaviour of these species along the Brazilian coast.

Bryde's whales have regularly been observed in southeastern Brazil, where the species' distribution and movements may be affected by prey species dynamics. Therefore further studies should be conducted in this area in order to investigate the relation between this species and its prey and to define seasonal movements and abundance of this whale in the area.

Few morphological and genetic studies have been developed for large whales off Brazil. Such studies, using a variety of techniques, would help to:

(1) verify the phylogenetic relationship between whales found off Brazil and those from other oceans;
(2) investigate the stock identity of blue, fin, sei and minke whales and their link between Brazil, Antarctic feeding grounds and other areas;
(3) verify the relationship between inshore and offshore forms of Bryde's whales in Brazil;
(4) investigate the relationship between dwarf and ordinary minke whales and between dwarf minke whales from the west South Atlantic with those from other areas.

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APPENDIX

Codes (and shoreline coordinates) for the Brazilian States used in the text and figures.

Northern coast: AP - Amapá (4°20′N - 0°), PA - Pará (0° - 1°20′S), MA - Maranhão (1°20′S - 2°50′S), PI - Piauí (2°50′S - 2°55′S), CE - Ceará (2°55′S - 4°50′S), RN - Rio Grande do Norte (4°50′S - 6°29′S); Northeastern coast: PB - Paraíba (6°29′S - 7°33′S), PE - Pernambuco (7°33′S - 8°55′S), AL - Alagoas (8°55′S - 10°30′S), SE - Sergipe (10°30′S - 11°30′S), BA - Bahia (11°30′S - 18°20′S); Southeastern coast: ES - Espírito Santo (18°20′S - 21°18′S), RJ - Rio de Janeiro (21°18′S - 23°21′S), SP - São Paulo (23°21′S - 25°14′S) and Southern coast: PR - Paraná (25°14′S - 25°57′S), SC - Santa Catarina (25°57′S - 29°20′S), RS - Rio Grande do Sul (29°20′S - 33°45′S).

Abbreviations for the institutions mentioned in the text and figures

GEMARS - Grupo de Estudo de Mamíferos Aquáticos do Rio Grande do Sul. Porto Alegre - RS.

MAQUA - Projeto Mamíferos Aquáticos, Dept. de Oceanografia, Universidade Estadual do Rio de Janeiro. Rio de Janeiro - RJ.

MORG - Museu Oceanográfico 'Prof. Eliézer de Carvalho Rios', Universidade do Rio Grande. Rio Grande - RS.

UFSC - Laboratório de Mamíferos Aquáticos, Departamento de Zoologia e Ecologia, Universidade Federal de Santa Catarina. Florianópolis - SC.