

Data on biology and exploitation of West Atlantic sperm whales, *Physeter macrocephalus* (Cetacea: Physeteridae) off the coast of Paraíba, Brazil

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ABSTRACT. This study analyzes data on the biology of sperm whales, *Physeter macrocephalus* Linnaeus, 1758, obtained between 1965 and 1980 by the COPESBRA at the Costinha Whaling Station, Paraíba, Brazil. The data come from the log books of the whaling ships and from the spreadsheets containing biological information filled out by employees of the SUDEPE at the flensing plan of the whaling station. The catches occurred from June to December, in an area delimited by 06°22'-07°52'S and 33°26'-34°58'W. A total of 641 sperm whales were killed in this period. The average sex ratio was 2.05 females to each male. The mean largest frequency of females was recorded in the first and the last months of the season, and that of males in July/August. The mean total length (TL) of males was 11.4 m (minimum 7.2 m, maximum 17.6 m). The females had a mean TL of 10.1 m (minimum 8.6 m, maximum 12.9 m). A decrease was observed in the TL of females along the years. Fetuses were observed in 8.3% of the catches. They had TL between 0.24 and 4.3 m. All sperm whales had food in their stomachs, showing that they feed in the area. As in other places north to the 40°S, there was a higher frequency of females than males. The difference between the time of maximum catch of males and females may reflect a temporal segregation in the arrival of sperm whales in the area. The reproductive activity of sperm whales in these tropical waters occurs year-round.

KEY WORDS. Biological data; Costinha Whaling Station; sperm whale.

The sperm whale *Physeter macrocephalus* Linnaeus, 1758 the largest of Odontocetes, is one of the animals with widest distribution on the planet, just compared among mammals to the killer whale, *Orcinus orca* (Linnaeus, 1758), Delphinidae, the rat, *Rattus norvegicus* (Berkenhout, 1769), Muridae, and modern humans (WHITEHEAD 2003). Though wide, the distribution of the sperm whale is not continuous, but rather concentrates on what the old whalers call "whaling grounds" (TOWNSEND 1935). The latter can be associated with oceanographic conditions, the topography of the sea ground and the primary and secondary productivity of waters (GASKIN 1982, JAQUET & WHITEHEAD 1996, JAQUET *et al.* 1996).

Commercial exploitation of sperm whales began around 1712, when large scale operations took place (WHITEHEAD 2002), first in open boats with manual harpoon, and latter (the modern phase) with ships armed with the cannon-harpoon (STARBUCK 1878, TØNNESSEN & JOHNSEN 1982). Hunting took place in several parts of the globe. In the 1960s, sperm whale hunting intensified after a population decline of most large whales, and reached a peak in 1964 when 29.255 sperm whales were killed worldwide (RICE 1989). Finally, in 1980 a partial moratoria and in 1986 a general moratoria of the commercial sperm whaling was recommended by the International Whaling Commission (IWC).

During the modern phase, sperm whales were captured in Brazil from 1952 to 1980, when, following the IWC recommendation, the Brazilian government banned the commercial hunting of sperm whales in Brazilian waters (ROCHA 1980a). Two main terrestrial whaling stations captured sperm whales in Brazil. The most important was located in Costinha, state of Paraíba, and was operated by the Companhia de Pesca Norte do Brasil (COPESBRA), responsible for almost 2/3 of Brazilian captures of sperm whales. COPESBRA operated between 1911 and 1985. During this time 19,922 whales of seven different species were captured (KISHIWADA 2007), however, the diversification of the species captured and the use of modern technology started only after the Japanese company Nippon Reizo Kabushiki Kaisha (today Nichirei Corporation) acquired part of the COPESBRA in 1958.

The data on processed whales collected by COPESBRA after 1958 are the main source of biological information on the sperm whales in the eastern coast of South America. Up to now, such data were used mainly to produce annual reports of captures to the IWC, as for instance the reports of the Brazilian Delegation for 1975, 1976, 1980 and the papers on catch statistics by GRANGEIRO (1962), FERREIRA & TÁRTARI (1965), PAIVA & GRANGEIRO (1965, 1970) and SUDEPE (1977). None of these contributions focused on the biology of sperm whales. Consider-

ing the scarce existing knowledge on sperm whales from the West Atlantic of the Southern Hemisphere, this work will study some characteristics of the stock of sperm whales exploited off the coast of Paraíba, Brazil.

MATERIAL AND METHODS

The present study is based on data gathered during the commercial catches of sperm whales made by COPESBRA between 1965 and 1980. Comparative data was taken from the International Whaling Statistic (IWS), the papers by SINGARAJAH (1985), KISHIWADA (2007), PAIVA & GRANGEIRO (1965, 1970), ROCHA (1980a, b) WILLIAMSON (1975) and internal reports to SUDEPE by the Brazilian delegation to the 27th, 28th, and 30th annual meetings of the IWC.

The whaling station of Costinha (6°57'45"S, 34°51'28"W), municipal district of Lucena, was located on the left margin of Rio Paraíba's estuary, on the opposite side of Cabedelo's harbor.

The whaling season lasted from June to December. Back then, whaling ships set off to sea daily, leaving Cabedelo between 03:30-04:00 AM and returning to the factory no later than 11:00 PM (GRANGEIRO 1962, KISHIWADA 2007). The information on whales was recorded in the whaler's log books and in spreadsheets of biological data filled out by employees of the former Superintendência do Desenvolvimento da Pesca (SUDEPE) at the flensing plan of the whaling station. In the log books the following data was registered: date and hour of departure from harbor and arrival at the whaling station; numbers of shots fired and of successful shots; name of the ship; port of registration (RGP) of the ship; the gunner's name; sequential number of the animal killed; whale species; date, hour, geographic position and number of whales sighted in the group; conditions of the sea, sky, rain, wind, temperature and barometric pressure.

In the spreadsheets of biological data the whales were identified with the same number attributed to them at the time of capture in the log book. The former contained the date, sex and total length (in meters and feet) of the whale, thickness of the blubber, presence of food in the stomach, size of the testes (males), sex and total length of the fetus (when present) and a field for other observations.

In this study, we defined a group as two or more animals moving together and in a coordinate way. To determine the state of sexual maturation, the classification of WHITEHEAD *et al.* (1997) was adopted, as follows: mature males > 13 m; females and immature individuals between 7 and 12 m (mature females > 9 m); first year of life between 5 and 6 m; and calves < 4.5 m. We based our estimates of the age of the fetuses, on the criteria used by RICE (1989), where the pregnancy period from 14 to 15 months is divided into two phases: the phase of embryonic growth (60 days) and in the phase of linear growth (1 to 1.1 cm/day⁻¹).

The information on date, catch position, sex, total length, stomach content, sex and size of the fetus and number of individuals sighted in the group was tabulated in electronic spreadsheets and the basic statistics were calculated.

RESULTS

The whaling area extended over the 200 n.miles of exclusive economical zone of Brazil (UNITED NATIONS 1980), constituting a small part of the sperm whale IWC Division I of the Southern Hemisphere. This division was defined by the IWC as the area between longitudes 60° and 30°W (DONOVAN 1980). The catches of sperm whales occurred in a zone delimited by the latitudes 06°22' and 07°52'S and longitudes 33°26' and 34°58'W (Fig. 1). In that area, the continental shelf extends about 20 miles off the coast and at its border the depth increases abruptly from 60 to 4000 m. The substratum in the shelf area is irregular and rocky.

The most important oceanographic feature of the area is the proximity to the equatorial current system. The trade winds from southeast drive the waters to the west, forming the South-equatorial Current. A large part of this current goes to the south and follows a longitudinal N-S direction, until about 40° S, where the direction changes to the east. It is called Current of Brazil, and because it comes from the equatorial and tropical areas (PEREIRA & SOARES-GOMES 2002), it is characterized by warm and more saline waters.

The average superficial water temperature in the whaling area was 27°C, remaining practically constant during the year. The speed of the current fell from 1.04 knots in June to 0.60 in December (SINGARAJAH 1984).

Between 1952 and 1980, 686 sperm whales were killed off the coast of Paraíba (KISHIWADA 2007); of these, 641 catches took place between 1965 and 1980. Table I shows the number of annual catches by COPESBRA compared with catches by the Sociedade de Pesca Taiyo Limitada (SPTL), in Cabo Frio, Rio de Janeiro.

The mean total length (TL) of the males caught was 11.4 m, with a minimum of 7.2 m and a maximum of 17.6 m. Of these, 18% were considered sexually mature because they were more than 13 m long. The females had a mean TL of 10.1 m with minimum and maximum lengths of 8.6 and 12.9 m, respectively. Five females (1%) measured between 8.6 and 8.9 m, a size considered immature by WHITEHEAD *et al.* (1997).

There were no records of captured calves of less than one year of age accompanied by their mothers.

A decrease of mean TL was observed among females with the passing years (Fig. 2). Among males there were strong oscillations of TL in the studied period. Monthly analyses showed a higher frequency of smaller individuals of both sexes at the beginning and the end of the season (Fig. 3).

Out of the 641 individuals caught in the studied period, 431 were females and 210 were males. Figure 4 shows the annual number of sperm whales hunted between 1965 and 1980. Notice that the number of animals killed varied from year to year. However, with a few exceptions, females were in larger numbers, especially in 1969 (59 females), 1973 (53 females) and 1970 (45 females). Males were more frequently caught in the seasons of 1970, 1972 and 1973, with 31, 24 and 22 animals, respectively.

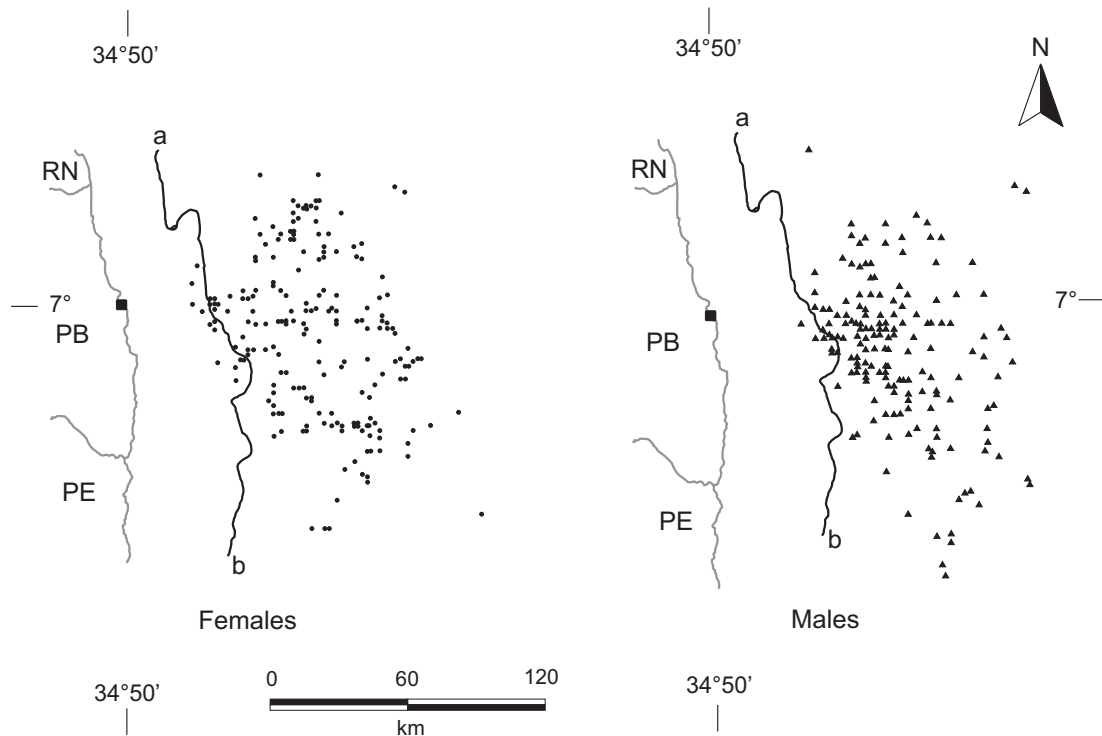
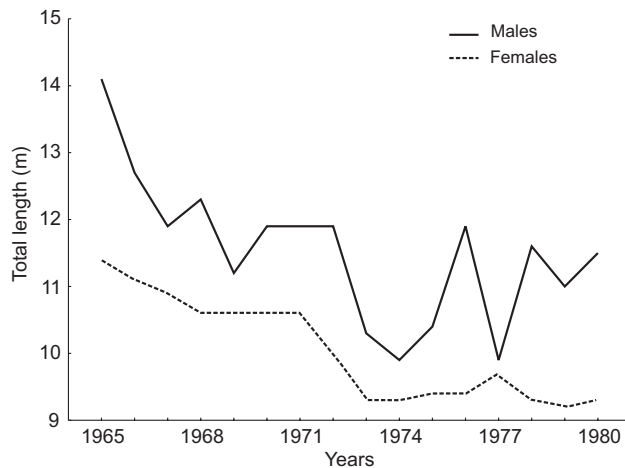
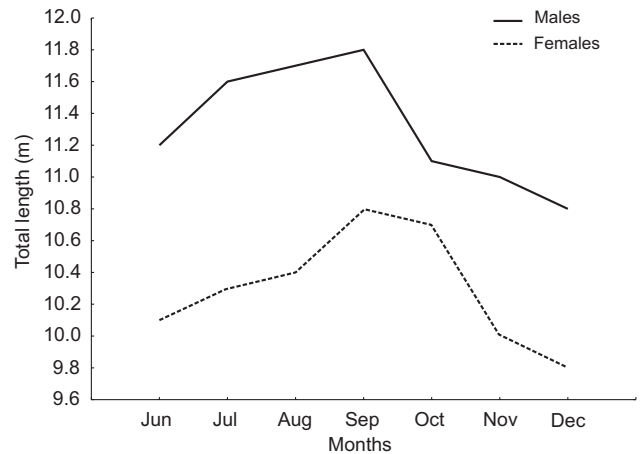


Figure 1. Geographic positions where male and female sperm whales were caught by COPESBRA during the period 1965 to 1980. Line a to b = limit of the continental shelf. (RN) State of Rio Grande do Norte, (PB) state of Paraíba, (PE) state of Pernambuco.



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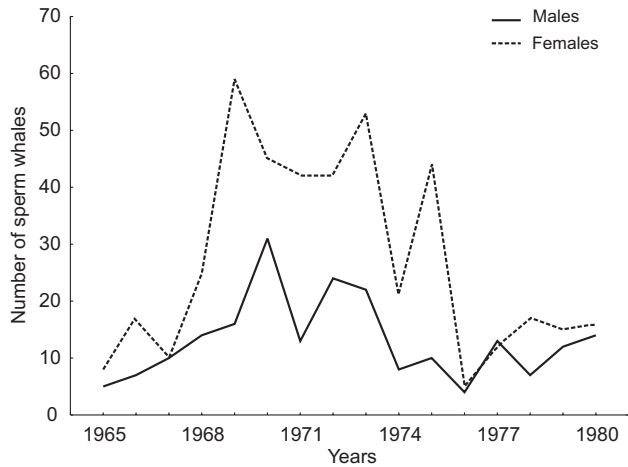
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Figures 2-3. Mean total length of sperm whales caught off Paraíba between 1965 and 1980: by year, (2) and by month (3).

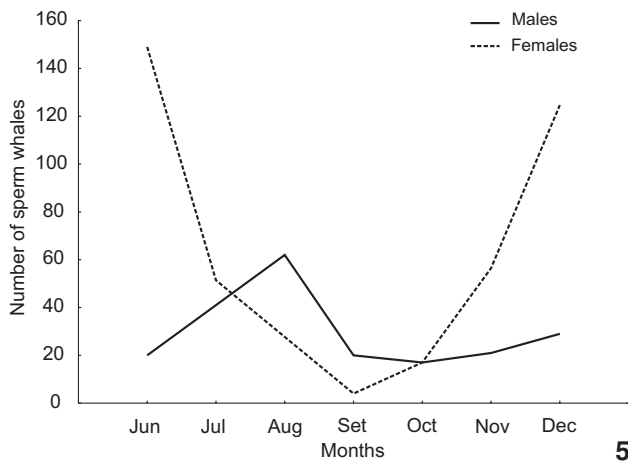
The average sex ratio for the studied period was 2.05 females for each male, with largest values in 1975 (4.4), in 1969 (3.68) and in 1971 (3.23). Only in 1967, 1976 and 1977 the number of males was almost the same as that of females, with rates of respectively 1:1, 0.8:1 and 0.9:1. Apart from these years

males did not outnumber females (Tab. II).

The monthly records of catches (Fig. 5) revealed a higher frequency of females at the beginning and the end of the season, while the higher frequency of males was in July and August. The curve of females is "U" shaped, indicating a higher



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Figures 4-5. Number of sperm whales caught by COPESBRA between 1965 and 1980: by year (4) and by month (5).

rate of captures in June (149 individuals) and December (125 individuals) with an abrupt decrease in September (4 individuals). Catches of males showed a progressive increase, with a maximum in August (62 specimens), followed by a decline in October (17 animals), and a small increase at the end of the season.

Thirty six cases of pregnant females were recorded, totaling 8.3% of the total females caught between 1965 and 1980. The fetuses were in different stages of development, with TL varying between 0.2 and 4.6 m. Of these, 14 were males, 20 were females and one had unrecorded sex. One male fetus (UFPB-5965) (Fig. 6) has been kept in the Marine Mammal Collection of the Departamento de Sistemática e Ecologia of Universidade Federal da Paraíba. Measuring 24 cm it is approximately 85 days old according to RICE (1989). The pregnant females showed a mean length of 10.1 m, with a minimum of

Table I. Captures of sperm whales in oceanic waters off the coast of Paraíba between 1952 and 1980 made by COPESBRA and in Cabo Frio by SPTL. Modified from WILLIAMSON (1975) and SINGARAJAH (1985).

Year	Costinha	Cabo Frio
1952	1	–
1953	1	–
1954	1	–
1955	1	–
1956	3	–
1957	2	–
1958	4	–
1959	11	–
1960	1	28
1961	5	97
1962	4	81
1963	7	35
1964	4	–
1965	13	–
1966	24	–
1967	20	–
1968	39	–
1969	75	–
1970	76	–
1971	55	–
1972	66	–
1973	75	–
1974	29	–
1975	54	–
1976	9	–
1977	25	–
1978	24	–
1979	27	–
1980	30	–
Total	686	241

8.6 m and a maximum of 11.2 m. They were caught between 06°33'-07°50'S and 33°38'-34°32'W (Fig. 1). Catches of 26 lactating females were also recorded, approximately 6% of all captured females. The monthly variation of pregnant females is shown in figure 7.



Figure 6. Sperm whale fetus in the collection of the UFPB.

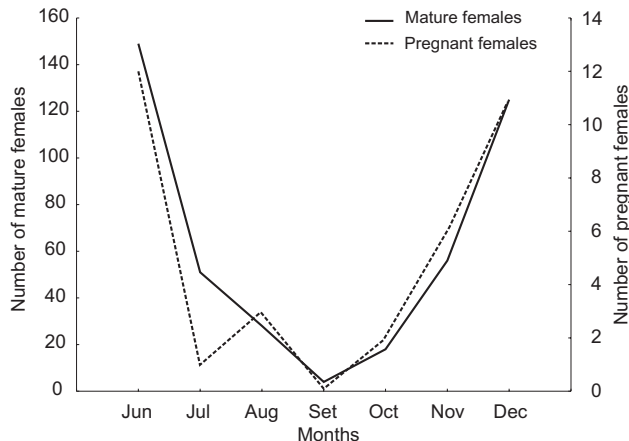


Figure 7. Monthly variation of pregnant sperm whales caught by COPESBRA between 1965 and 1980.

Table III shows fetus size, date of capture of the mother and projected estimates of the possible date of birth of sperm whale fetuses caught by COPESBRA.

According to the spreadsheets of biological data, all sperm whales caught by COPESBRA showed rests of food in the stomach. However, no identification of the stomach content was made at the time.

DISCUSSION

The number of sperm whales exploited by COPESBRA since its beginning up to 1980 (686 animals) is not very significant when compared with catches in Antarctica. Between the seasons of 1949-1950 and 1967-1968, a total of 89,544 animals were caught in Antarctic whaling grounds with a mean

Table II. Number, sex and sex ratio of sperm whales caught annually by COPESBRA between 1965 and 1980.

Year	Males	Females	Total	Sex ratio
1965	5	8	13	1: 1.60
1966	7	17	24	1: 2.42
1967	10	10	20	1: 1.00
1968	14	25	39	1: 1.70
1969	16	59	75	1: 3.68
1970	31	45	76	1: 1.45
1971	13	42	55	1: 3.23
1972	24	42	66	1: 1.75
1973	22	53	75	1: 2.40
1974	8	21	29	1: 2.60
1975	10	44	54	1: 4.40
1976	4	5	9	1: 0.80
1977	13	12	25	1: 0.90
1978	7	17	24	1: 2.42
1979	12	15	27	1: 1.25
1980	14	16	30	1: 1.14
Total	210	431	641	1: 2.05

number of 4,712.8 individuals per season. This represents, just in one season, 6.8 times more than the total number of sperm whales exploited off the coast of Paraíba since 1911. This number is also much smaller than the number of catches reported from other tropical areas (Tab. IV).

Table III. Date of capture, sex, total length (m), and total length of the mothers (m) of fetuses obtained by COPESBRA between 1966 and 1980. Expected month of birth is given in the last column, estimated pairing occurred 14 month earlier.

Date of capture	Sex of fetus	Total length of fetus	Total length of mother	Expected month of birth
Jun.29.1968	F	1.5	10.8	Jan
Jun.19.1970	F	1.5	10.5	Jan
Oct.25.1970	M	2.9	10.7	Jan
Jun.29.1968	F	1.1	10.8	Feb
Jun.30.1980	F	1.5	9.3	Feb
Dec.08.1970	F	2.5	10.6	Mar
Dec.04.1978	M	2.0	8.6	May
Jun.14.1971	M	4.3	10.8	Jun
Jun.14.1971	M	4.6	10.7	Jun
Nov.19.1972	F	1.5	9.4	Jun
Jun.30.1970	I	3.7	10.5	Jul
Dec.03.1975	M	1.5	10.3	Jul
Jul.23.1973	F	3.5	9.2	Aug
Aug.25.1978	M	3.4	9.4	Sept
Aug.25.1978	M	3.5	9.4	Sept
Oct.14.1970	M	0.3	10.5	Sept
Nov.08.1968	M	0.5	10.6	Sept
Dec.14.1969	M	1.1	10.9	Sept
Dec.04.1978	F	0.8	9.1	Sept
Dec.15.1980	M	1.0	8.6	Sept
Jun.19.1970	M	2.5	10.6	Oct
Jun.19.1970	F	2.6	10.6	Oct
Nov.25.1966	F	0.5	11.2	Oct
Dec.05.1969	F	0.5	10.5	Oct
Jun.23.1970	F	1.6	10.5	Nov
Aug.25.1978	F	3.0	9.4	Nov
Nov.03.1973	F	4.1	9.2	Nov
Nov.11.1979	F	1.0	9.2	Nov
Dec.05.1969	M	0.4	10.7	Nov
Jun.23.1970	F	1.8	10.5	Dec
Jun.23.1980	M	1.8	10.2	Dec
Nov.08.1968	F	3.3	10.5	Dec
Dec.10.1969	F	4.1	11.0	Dec
Dec.08.1970	F	3.6	10.8	Dec
Dec.07.1972	M	4.1	9.2	Dec
-	I	0.2	-	-

(M) Male, (F) female, (I) sex unknown.

Table IV. Number of sperm whales caught/Number of catcher ships used in different tropical areas between 1974 and 1980. Source: IWS.

Year	1974	1975	1976	1977	1978	1979	1980
Brazil*	29/1	54/1	9/1	25/1	24/1	27/1	30/1
Azores	146/-	149/-	69/-	70/-	93/-	114/-	132/-
Madeira	88/-	237/-	126/-	152/-	173/-	184/-	198/-
Spain	371/5	376/5	270/5	90/2	118/5	82/4	13/3
South Africa	1,783/6	1,682/5	-	-	-	-	-
Peru	1,286/3	793/3	1,500/3	799/3	770/3	742/3	450/-
Chile	125/3	48/3	85/3	40/3	100/3	34/3	94/-
Australia	1,080/3	1,172/3	995/3	624/3	679/3	-	-
Indian Ocean	723/-	793/-	771/-	795/-	814/-	584/-	-
Total	5,631/21	5,304/20	3,825/15	2,595/12	2,771/15	1,767/11	917/4

In the four seasons of activity of the whaling station of Cabo Frio, the number of sperm whale catches was considerably larger than that of the COPESBRA in the same period (see Tab. I). However, at Costinha, the captures increased from 1965 on, when a significant change occurred in the number of catches and target species. The sperm whale and minke whale captures increased, the sei whale catches declined and the humpback whale disappeared from the records (Fig. 8 and Tab. V). The COPESBRA always prioritized the catch of baleen whales over the sperm whales. Initially, humpback whales were preferred; soon thereafter, the preference shifted to sei whales; finally, the focus was on the catch of minke whales.

The positions recorded by the whaling ship between 1965 and 1980 reveal that the area of sperm whale hunting off the coast of Paraíba remained the same. According to SINGARAJAH (1985) the whaling ground of the COPESBRA covered an area of about 15.000 n. miles², while the area of SPTL in Cabo Frio was 42.000 n.miles². This made the coastal whaling operations from Cabo Frio more difficult and more expensive, probably contributing to the closing of the activities of that company. The spatial distribution of sperm whale catches off the coast of Paraíba (Fig. 1) is almost the same for males and females. However, while the distribution of males tended to concentrate in one area, females had a more homogeneous distribution.

JAQUET (1996) indicates that the Brazilian coast from states of Rio Grande do Norte to Rio Grande do Sul, with the exception of a small strip in the mouth of the San Francisco river, is one of the areas of larger concentration of sperm whales in the globe.

The mean total length of the animals caught was within the general pattern described for the species (RICE 1989). However, in the catches made by COPESBRA, we noticed a decrease of size in the course of time, especially in females (Fig. 2). WHITEHEAD (2003) indicated the large mature males as the main target of whalers in the world, therefore KASUYA (1991) showed

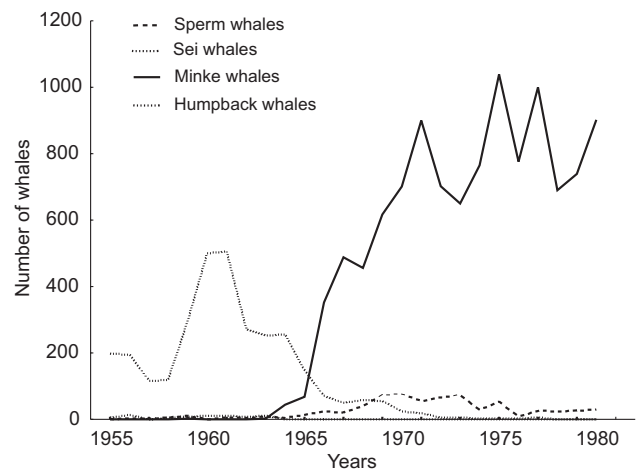


Figure 8. Baleen whales and sperm whales captured by COPESBRA between 1955 and 1980.

that, as exploitation progressed in the North Pacific, the average length of males diminished but not that of females. However, in our study, we verified a higher number of females in the catches, probably because larger whales were not consistently selected by the gunner. These numbers may be responsible for the decrease in mean TL from 11.4 m in 1965 to 9.3 m in 1980 (Fig. 2).

Only 18% of the males caught were larger than 13 m; in other words, 82% were not sexually mature. In agreement with WHITEHEAD (2003), in low latitudes the large males wander among groups of females for a period of a few months, tending to live a solitary life for the remaining of the year. The monthly analysis showed that smaller individuals were caught more frequently in the beginning and in the end of the season. This temporal segregation pattern was also observed by ROCHA

Table V. Number of baleen whales and sperm whales captured yearly by COPESBRA between 1955 and 1980.

Year	Sperm whales	Sei whales	Minke whales	Humpback whales	Total
1955	1	198		6	205
1956	3	196		14	213
1957	2	115			117
1958	4	118		5	127
1959	11	294	2	8	315
1960	1	500		10	511
1961	5	504		11	520
1962	4	272		8	284
1963	7	253	2	10	272
1964	4	256	44		304
1965	13	149	68		230
1966	24	72	352		448
1967	20	49	488		557
1968	39	58	456		553
1969	75	56	617		748
1970	76	23	701		800
1971	55	18	900		973
1972	66	5	702		773
1973	75	6	650		731
1974	29	2	765		796
1975	54	3	1,039		1,096
1976	9	3	776		788
1977	25	5	1,000		1,030
1978	24		690		714
1979	27		739		766
1980	30		902		932
1981			749		749
1982			854		854
1983			625		625
1984			600		600
1985			598		598
Total	683	3,155	1,4319	72	18,229

(1980b) and LUCENA (2006) for the minke whales, *Balaenoptera bonaerensis* Burmeister, 1867, Balaenopteridae, hunted in the same area by COPESBRA. ROCHA (1980b) considers this pattern as a reproductive strategy of the species.

Table VI. Average TL (in meters) of sperm whales caught in different whaling grounds, for the years 1977-1980. Source: IWS.

Whaling ground	1977	1978	1979	1980
Brazil	9.7	9.2	9.2	9.3
Antarctica	13.7	14.2	14.5	–
Iceland	14.3	14.6	14.7	14.3
Spain	–	11.3	–	–
Japan, pelagic (North Pacific)	12.1	11.5	11.5	–
Japan, coastal (North Pacific)	10.9	11.3	11.5	11.7
Ex-USSR, pelagic (North Pacific)	11.7	13.7	13.0	–
South Atlantic, pelagic	12.6	12.4	12.7	–
South Pacific Ocean, pelagic	10.5	11.0	10.7	–
Indian Ocean, pelagi	12.1	11.8	11.4	–
Australia	12.5	12.2	–	–

The mean size of the sperm whales caught off the coast of Paraíba was lower than that of animals from other waters (Tab. VI). This may be related to a higher percentage of females captured off Paraíba coupled with a more intensive selection of large males at other whaling grounds.

From 1976 on, the IWC recommended a minimum size of 9.2 m and maximum size of 13.7 m for the capture of sperm whales in the Southern Hemisphere (RICE 1989). This measure was intended to avoid the capture of sexually immature animals and also of large, sexually mature males. Our data shows that 25 females and six males smaller than 9.2 m and seven males above 13.7 m were killed after 1976. These numbers represent 33% of the sperm whales caught after 1976. It may be considered, however, that the estimate of size of a live sperm whale at sea may have such a margin of error.

Five of the 25 females captured (between 1978 and 1980) measured between 8.6 and 8.9 m. Even though this size range was considered by WHITEHEAD *et al.* (1997) to correspond to immature individuals, one of the females, measuring 8.6 m, was pregnant.

The high frequency of females in the catch statistics is in agreement with the results of whaling in other areas of the Southern Hemisphere located north of 40°S like the terrestrial bases in Donkergat, Cape Province (33°S), Durban, Natal (30°S), Albany, Western Australia (35°S) and in the south of Chile (37°S) (RICE 1989). Several mass stranding of females have been recorded in Tasmania (42°S) and in New Zealand (39°S) (ROBSON 1984). On the other side, south of 65°S, adult males were regularly captured during the Antarctic summer (HOLM & JOANSGÅRD 1959).

Temperature is apparently a limiting factor in the distribution of females, but less so in males: while females seem to be restricted to areas with superficial sea temperatures above 15°C, males, especially large mature males, can be found even when temperatures are close to 0°C.

The high frequency of female sperm whales in the whaling statistics of the COPESBRA may be explained by two factors: 1) the lack of selection for size by the gunner; according to ROCHA (1980b), the gunner had instructions to shoot the nearest animal; 2) the composition of the groups of sperm whales found in waters off the coast of Paraíba.

According to BEST (1979), in addition to the solitary habits of a few mature males, sperm whales in tropical waters either gather in large groups of mature females and immatures, or in small groups of young mature males, known as bachelors' groups. The data from log books of the COPESBRA's whaler show that the majority of sperm whales caught were part of family units formed by mature females and immature individuals (Tab. VII). This may explain the higher frequency

of females in catches. Among single sighted animals, the frequency of large males was higher.

The sex ratio of two females for each male had been already observed by GRANGEIRO (1962) in the first years of sperm whaling off the coast of Paraíba. KAHN *et al.* (1993) mention that during the last 40 years of sperm whaling the preference for catching mature males ended up changing the adult sex ratio in some areas (CLARKE *et al.* 1980). It has been suggested that this change resulted in a disruption of the sperm whale's mating system, leading to a reduction in pregnancy rates, thus lessening the potential of the population for recovery (CLARKE *et al.* 1980, MAY & BEDDINGTON 1980, WHITEHEAD 1987). However, during whaling off the coast of Paraíba there was no selection for size, and the sex ratio found in our study may reflect the real situation of

Table VII. Number of sperm whales sighted yearly, number of individuals, sex and size of individuals captured off Paraíba waters.

Year	Number of animals sighted in each group	Number of individuals captured		Mean total length of individuals captured (m)	
		M	F	M	F
1975	20	2	8	10.5	9.4
1975	4	1	3	16.1	9.5
1975	4	0	4	–	9.3
1975	1	1	0	10.8	–
1975	15	0	5	–	9.5
1975	4	1	1	10.5	9.1
1975	4	1	3	10.8	9.3
1975	12	0	6	–	9.4
1976	5	0	2	–	9.6
1976	10	0	4	–	9.4
1976	1	1	0	16.4	–
1976	1	1	0	10.7	–
1977	5	1	2	9.1	9.9
1977	6	0	3	–	9.4
1977	9	0	4	–	9.7
1977	10	0	2	–	9.4
1977	1	1	0	10.4	–
1977	8	4	0	9.5	–
1977	1	1	0	15.5	–
1980	15	0	9	–	9.8
1980	5	0	2	–	9.3
1980	10	7	0	10.5	–
1980	1	1	0	11.6	–
1980	1	1	0	16.6	–

the sperm whales' population in the area.

According to some authors (BEST *et al.* 1984, RICE 1989, WHITEHEAD 2003), the sex ratio is near one at birth for sperm whales. In our sample, 14 fetuses were males and 20 were females and the difference was not found to be significant according to the results of the Mann-Whitney test.

The catch of males as well as females by COPESBRA showed annual fluctuations (Fig. 4), which is consistent with the statement of WHITEHEAD (2003) that the distribution of sperm whales in some areas, particularly in low latitudes, has also large mensal and annual variations.

In the monthly analysis we verified different peaks of capture for females and males. Females were more frequent in the beginning and in the end of the season, whereas males were more frequent in the middle of the season (Fig. 5). These differences suggest a temporal segregation in the arrival of the sperm whales in the hunting area. Even though the species is present in the area throughout the year, the whaling season in Paraíba lasted only seven months per year. Consequently, it is possible that the pattern herein observed would be different if the hunting season, and consequently the records thereof, were for the whole year.

The presence of large fetuses of (4 m or longer) that would be born shortly after capture, together with a record of 6% of lactating females suggest that some sperm whales are born in this whaling area.

The fetuses recovered at Costinha show different degrees of development, varying from 0.24 to 4.6 meters and were obtained from June to December, except in September when de number of mature females was lowest. (See Figs 7 and Tab. III).

As seen in table III, estimates of birth time based on fetus length showed higher frequencies between September-December. Consequently, pairing is expected to have taken place 14 months earlier. This agrees with data of several authors, reported by BEST *et al.* (1984), for the Southern Hemisphere sperm whales.

It is interesting to notice the similarity between the monthly curves of capture of mature females and pregnant females (Fig. 7). This suggests that, each month, the presence of pregnant females was proportional to the total number of females killed. The simultaneous capture of non pregnant with lactating and pregnant females with fetuses of different sizes had been already reported for other areas, as for example South Africa (BEST *et al.* 1984) and Japan (KASUYA 1986). This suggests that births may occur along the whole year, if we consider a gestation of 14 months, but higher frequencies are observed between September and December (Tab. III and BEST *et al.* 1984). RICE (1989) suggests that births in the Southern Hemisphere occur between November and March; however, the author believes that data from equatorial areas are still incomplete.

Our findings agree with more recent data on Brazilian sperm whale stranding (RAMOS *et al.* 2001) showing that most calf stranding occur in beaches of Brazilian Northeast between 5°S and 11°S in summer and autumn. Further, on January 11,

1998 we recorded a stranded male calf measuring 3.3 m in Praia de Oitero (6°50'S), Paraíba. The specimen is preserved in the collection of the UFPB, number 3556. On May 7, 2006 another 4 m calf stranded alive near the city of Cabedelo, Paraíba, being thereafter returned to sea. Thus, sperm whales dwelling in waters off Paraíba may be at any stage of their reproductive cycles, from conception to birth. This data confirm the hypothesis that sperm whales reproduce in tropical waters (REEVES *et al.* 2002).

Since all animals killed showed food remains in the stomach we believe that sperm whales feed normally in the area. There is no data from COPESBRA on what kind of food was eaten, but a male stranded at Praia de Campina, Mamanguape, Paraíba state had beaks of squids of different sizes in the stomach. GURJÃO *et al.* (2003) examined the stomach contents of three sperm whales stranded in the coast of Ceará, (~5°S) Brazil and found 20 species of squid, most of them (76%) belonging in the family Histioteuthidae. Preference for species of this family was also observed in sperm whales of the North Pacific Ocean, but variations may occur in different areas (CLARKE 1987).

ACKNOWLEDGEMENTS

We thank to IBAMA, COPESBRA and several colleagues for making available the information on sperm whales captured and processed in the Whaling Station of Costinha. We also thank the reviewers of an earlier version of this manuscript for valuable suggestions. This paper is part of a master dissertation presented to Programa de Pós-graduação em Desenvolvimento e Meio Ambiente (PRODEMA/UFPB). CAPES and CNPq provided a fellowship to the first and second authors, respectively.

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Submitted: 20.I.2009; Accepted: 14.XII.2009.

Editorial responsibility: Maria Lúcia Negreiros-Fransozo