A note on observations on cetaceans in the western Indian sector of the Southern Ocean (20-56°S and 45-57°30'E), January to March 2004

P. JAYASANKAR[+], ANOOP A. KRISHNAN[*], M. RAJAGOPALAN[**] AND P.K. KRISHNAKUMAR[†]

Contact e-mail: jayasankarp@vsnl.com

ABSTRACT

A multi-disciplinary and multi-institutional pilot expedition was organised by the National Centre for Antarctic and Ocean Research (NCAOR) to the ice-free areas of the Western Indian Ocean sector of the Southern Ocean onboard *ORV Sagar Kanya* during the austral summer of 2004 (January-March). This survey, conducted by the Central Marine Fisheries Research Institute (CMFRI), is the first Indian attempt to survey for cetacean diversity in the Southern Ocean. The ultimate objective is to determine distribution, relative abundance, migration patterns and critical habitat parameters. 68% of a total of 13 sightings (22 individuals) were positively identified and species observed included Antarctic minke whales (*Balaenoptera bonaerensis*), fin whales (*B. physalus*), sei whales (*B. borealis*) and blue whales (*B. musculus*). The blue whales were not identified to the sub-species level. The highest concentration of cetaceans was between 35° and 37°S (along 45°E) and between 48° and 53°S (along 45°E). Relatively small numbers of cetaceans were observed during the present cruise, possibly because most of the cetacean sighting effort was made during inclement sea conditions. Results on the sighting characteristics and occurrence patterns of the cetaceans in relation to the region and hydrographical parameters are discussed briefly *vis a vis* published information from the Southern Ocean.

KEYWORDS: SOUTHERN OCEAN; CETACEAN SIGHTINGS; ANTARCTIC MINKE WHALE; FIN WHALE; HUMPBACK WHALE; SEI WHALE; BLUE WHALE; SOUTHERN HEMISPHERE; SURVEY-VESSEL; DISTRIBUTION

INTRODUCTION

The Southern Ocean is one of the most dynamic oceans in the world, with a very strong current system and it plays a prominent role in controlling the global ocean-atmospheric climate system (Luis and Pandey, 2004). However, many aspects of its oceanography and the response of the Southern Ocean to climate change remain unknown, primarily due to the lack of high-resolution oceanographic observations, which in the Indian Ocean sector have been limited to the Arabian Sea, Bay of Bengal and Indian Ocean basin (Pandey *et al*., 2006).

In addition, many aspects of the biology of the Southern Ocean, especially in the western Indian Ocean sector remain unknown. Among the living resources of this region are the marine mammals, several species of which (especially the 'Great Whales') have been severely depleted as a result of human activities, including whaling. Species known to have been reduced in number include blue whales (*Balaenoptera musculus*), fin whales (*B. physalus*), sei whales (*B. borealis*) and humpback whales (*Megaptera novaeangliae*). The severe depletion of almost all stocks of 'great whales' in the Southern Hemisphere is well documented (Cherfas, 1989; Clarke and Lamberson, 1982; Laws, 1985). Amongst the efforts of the International Whaling Commission (IWC) to facilitate the recovery of the great whales was the establishment of an Indian Ocean sanctuary in 1979 (Leatherwood and Donovan, 1991). The sanctuary consists of those waters of the Northern Hemisphere from the coast of Africa to 100°E and those waters of the Southern Hemisphere between 20°E and 130°E from the Equator to 55°S. In 1994, the IWC declared the majority of the Southern Ocean a sanctuary from commercial whaling (IWC, 1995). The northern boundary of the Southern Ocean Sanctuary follows the 40°S parallel of latitude, except in the Indian Ocean sector where it joins the southern boundary of the Indian Ocean Sanctuary at 55°S and around South America and into the South Pacific where the boundary is at 60°S.

Despite the fact that the Southern Ocean is one of the most important feeding grounds for cetaceans, including the great whales, relatively little is known about their distribution and relative abundance outside the area south of 60°S during the austral summer and even less is known about their behaviour and ecology (De Boer, 2000a; Leatherwood and Donovan, 1991). Visual surveys of cetaceans can provide valuable baseline information for long-term research and monitoring of their populations and thus identify areas of concern for management of their populations. The present note presents the results of the cetacean sighting survey component of a multidisciplinary cruise (not a dedicated cetacean cruise). It forms the first large scale Indian attempt to investigate the distribution and relative abundance of cetaceans in the Southern Ocean.

The opportunity for this work was attained by the Central Marine Fisheries Research Institute (CMFRI) during a Pilot Expedition (PESO) organised by the National Centre for Antarctic and Ocean Research (NCAOR), Goa, to the ice-free areas of the region onboard *ORV Sagar Kanya* during the austral summer of 2004 (January-March). This expedition, as a prelude to long-term observational programmes in the Southern Ocean, was multi-disciplinary and multi-institutional in nature, involving a dedicated team of 30 scientists drawn from various research and

[+] *Central Marine Fisheries Research Institute (CMFRI), PB No.1603, Ernakulam North PO, Cochin 682 018, India*. Present address: *Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar-751 002, India*.
[*] *Export Inspection Agency, Marol, Andheri (East), Mumbai 400 093, India*.
[**] *Madras Research Centre of CMFRI, 75, Santhome High Road, Raja Annamalaipuram, Chennai 600 028, India*.
[†] *Veraval Regional Centre of CMFRI, Bhidia, Veraval 362 269*.

development institutions/universities. Information on the major objectives, programmes and brief account of preliminary results of various studies/experiments/ observations of the PESO cruise can be found elsewhere (Pandey *et al*., 2006).

METHODS

Cruise track and sighting schedule

The *ORV Sagar Kanya* left Port Louis (Mauritius; 20°09'S, 57°30'E) on 23 January 2004. The cruise proceeded to 31°S, 45°E and further along the meridian 45°E to 56°S latitude. The return leg was along 57°E, back to Port Louis, where the ship arrived on 4 March 2004 (Fig. 1). Tracklines and procedures followed were not developed to optimise cetacean studies but for other components of the multidisciplinary cruise. As dedicated ship time was not available for the cetacean component, fine-scale work (e.g. prey sampling where cetaceans are known to congregate for feeding) could not be undertaken. Sightings data were thus collected only in 'passing mode' (i.e. the vessel did not deviate from the trackline).

Field identification

Identification in the field was based mainly on Jefferson *et al*. (1993). Cetaceans were identified to the lowest taxonomic level possible. Species identification was not always possible for all sightings due to sea state, time spent at the surface by the cetaceans or distance of sighting from vessel. Species identity (and length estimates) were determined only for animals close to the vessel and in good sea conditions. Sightings were initially identified as 'possible' or 'confirmed' or, usually for animals far from the vessel, 'unidentified'. Photographs and videos were taken of the sightings and later confirmed and identified with the help of appropriate experts. Thus, in this note, 68% of individual cetaceans sighted during the cruise were identified to species level.

Data collection

During each sighting, data on date and time (GMT and local time), place (nearest landmark), latitude and longitude, number of animals, distance from vessel (km), depth of the area (m), movement of the animals and their visible characteristics, as well as weather condition and sea state were recorded. Observation conditions were characterised using sea state (according to the Beaufort scale), swell height, wind direction, wind speed cloud cover and precipitation (e.g. rain, snow, fog, haze, etc).

Beaufort 0-2 was associated with good conditions (although 0 and 1 were never encountered), Beaufort 3-4 with average conditions and Beaufort 5+ with poor conditions. Precipitation at times reduced visibility to less than 100m. At Beaufort 5 and above, cetaceans were difficult to sight and could only be identified with certainty if they were close to the ship (within 200m). The wind force was never below 2 throughout the entire cruise. This information was collected at two hourly intervals and when sightings were made.

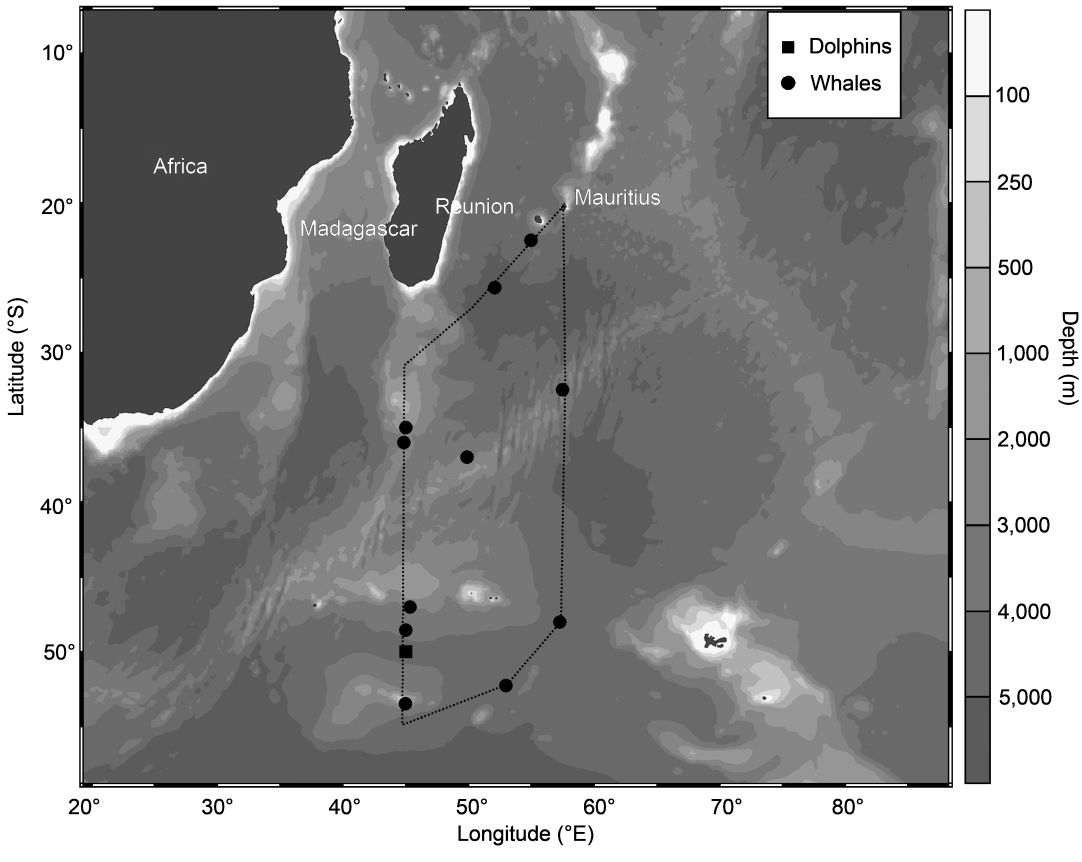

Fig. 1. Track of *ORV Sagar Kanya* pilot cruise to the Western Indian Sector of Southern Ocean and locations of cetacean sightings during the Austral Summer of 2004.

In addition, Sea Surface Temperature (SST) was measured using a Conductivity Temperature and Depth (CTD) system (SBE 9/11, Sea-Bird Electronics, USA; temperature accuracy: +0.001°C and depth +0.005% of the full scale) and salinity was measured using a salinometer (Autosal 8400A, Guildline, Canada), at places where cetaceans were sighted as well as throughout the cruise.

RESULTS

Sea state and sighting frequency

Information on cetacean sightings and hydrographical data is presented in Table 1. Survey effort totalled 415hr (mean= 9.8hr day^{-1}, SE=0.5) and covered approximately 9,260 linear km on effort; 12.9% (53.5hr) at Beaufort 2), 51.6% (214.2hr) at Beaufort 3-4 and 35.5% (146.9hr) at Beaufort ≥5.

Cetaceans were sighted on 12 of the 42 days at sea. Thirteen sightings (22 individuals) were made during the present cruise in the area between 22°S and 53°S latitudes (Fig. 1). The mean number of sightings per day was 0.31 (SE=0.08, range 0-2), number of individuals sighted per day was 0.52 (SE=0.15, range 0-3) and the mean encounter rate for the entire survey was 0.13 sightings per 100 linear km. The highest concentration of cetaceans was between 35° and 37°S (along 45°E), where the mean number of individuals sighted was 0.24 hr^{-1} and between 48° and 53°S (along 45°E), where the mean number of individuals sighted was 0.27hr^{-1}. This indicates their possible abundance around Bob Fischer Ridge, Deacon Seamount and Madagascar basin during the austral summer (Table 2). Cetaceans were also sighted over Mascarene plain, near Prince Edward Islands, the Fracture zone around Crozet Island, Lena Seamount and Marion Dufresne Seamount. The highest number of cetaceans encountered on a single day was three (mean sighting rate of individuals 0.3 hr^{-1}) which occurred on four different days during the voyage between 35°01'S, 44°00'E and 49°59'S, 45°00'E, where depth ranged from 2,245 to 4,000m.

Cetacean species and sighting characteristics

The present survey was aimed at detecting all cetacean species and thus sightings were conducted over the full range of weather conditions at which cues might be visible (most Southern Ocean are medium to large whales with cues that can be detected in relatively high Beaufort sea states). Sixty eight percent of the whales sighted in Beaufort 3-6 were positively identified (Table 3). The relatively large number of unidentified sightings in Beaufort 3-4 reflected the fact that sightings could be made several nautical miles away under those conditions; the confirmed sightings seen in Beaufort 5-6 were close to the ship.

A total of seven baleen whale and dolphin sightings were made that could not be identified to species, mainly due to their great distance from the ship. A total of 68% of sightings were identified to species (Table 4); sightings of the rorquals are summarised below.

Fin whale (Balaenoptera physalus)

Two sightings of fin whales were made, both at station depths of 2,727m: a single animal seen in the Bob Fischer Ridge and Fracture zone (36°07'S, 44°51'E) moving in a south westerly direction; and a group of three at Bob Fischer Ridge (37°01'S, 49°53'E) moving in a southerly direction. SST varied from 5.0-7.0°C and salinity ranged from 34.30-

Table 2

Sighting frequencies (all cetaceans combined) in seven regions of the Southern Ocean.

Region	Mean[1]	SD	SE	Range
Madagascar basin	0.16	0.39	0.11	0-1
Bob Fischer Ridge	0.25	0.45	0.13	0-1
Prince Edward Island region	0.08	0.29	0.08	0-1
Deacon seamount	0.25	0.62	0.18	0-2
Lena seamount	0.08	0.29	0.08	0-1
Marion Dufresne seamount	0.08	0.29	0.08	0-1
Southwest Indian Ridge	0.08	0.29	0.08	0-1

[1]Number of sightings/total number of cetacean sightings in the whole cruise

Table 3

Cetacean sightings in relation to wind strength made on board *ORV Sagar Kanya* in the Southern Ocean.

Beaufort scale	Number of sightings	Number of individuals	Percentage of species identified
3	2	2	50.00
4	6	13	53.85
5	2	4	100.00
6	1	2	100.00
7	0	0	0
8	1	1	0
Total	12	22	45.45

Table 1

Information on cetacean sightings made on board *ORV Sagar Kanya* in the western Indian sector of Southern Ocean during the austral summer 2004.

Date	Species	Number of sightings	Number of individuals	°S	°E	Depth (m)	SST (°C)	Salinity (‰)
24/01/04	Unidentified baleen whale	1	1	22° 30'	54° 58'	4,234	27.1	34.91
26/01/04	Unidentified baleen whale	1	1	25° 39'	52° 04'	5,109	27.3	34.72
02/02/04	Antarctic minke whale	1	3	35° 01'	44°00'	2,245	21.8	35.70
03/02/04	Fin whale	1	1	36° 07'	44° 51'	2,727	21.8	35.62
04/02/04	Fin whale	1	3	37° 01'	49° 53'	2,727	21.0	35.60
11/02/04	Sei whale	1	2	47° 07'	45° 21'	3,301	7.0	34.30
12/02/04	Sei whale	2	3	48° 35'	45° 03'	3,505	5.0	34.38
13/02/04	Unidentified dolphins	1	3	49° 59'	45° 00'	4,000	4.0	34.34
15/02/04	1 blue whale and 1 unidentified baleen whale	1	2	53° 28'	44° 59'	326	2.2	34.52
20/02/04	Blue whale	1	1	52° 14'	52° 58'	4,240	4.8	33.64
22/02/04	Blue whale	1	1	48° 08'	57° 14'	4,500	4.8	33.77
29/02/04	Unidentified baleen whale	1	1	32° 29'	57° 28'	690	23.0	35.67

Table 4

Sighting frequencies of cetaceans encountered in the Southern Ocean cruise.

Species	Mean[1]	SD	SE	Range
Antarctic minke whale	0.08	0.29	0.08	0-1
Fin whale	0.17	0.39	0.11	0-1
Sei whale	0.25	0.62	0.18	0-2
Blue whale	0.25	0.45	0.13	0-1
Unidentified baleen whale	0.33	0.49	0.14	0-1
Unidentified dolphin	0.08	0.29	0.08	0-1

[1]Number of sightings/total number of cetacean sightings in the whole cruise.

34.38%. The estimated lengths of the animals, which were seen about 200m from the vessel, were between 21-23m in length. After the first sighted blow, whales undertook a long slow, fairly shallow roll ending at the surface with the dorsal fin, repeated 4-5 times at intervals of 10-20s; after this, the back was arched more steeply, before a deep dive.

Blue whale (Balaenoptera musculus)

Three blue whale sightings were made: one near Lena seamount (53°28'S, 44°59'E, 326m depth) moving south; one to the southeast of Crozet Island (48°08'S, 57°14'E, 4,500m depth) moving southwest; and one near Marion Dufresne Seamount (52°14'S, 52°58'E, 4,240m depth). SST ranged from 2.20-4.80°C and salinity from 33.64-34.52‰. The animals were estimated at 25-28m in length. After the first blow, the whales undertook several short (*ca* 20s) shallow dives.

Antarctic minke whale (Balaenoptera bonaerensis)

There was one sighting of Antarctic minke whales comprising three individuals (estimated at 8-9m in length) moving northeasterly. This was made at Bob Fisher Ridge (35°01'S, 44°00'E), at a depth of around 2,245m. The SST was 21.80°C and salinity was 35.70%. No flipper patches were seen (a characteristic feature of *B. acutorostrata*).

Sei whale (Balaenoptera borealis)

Three sei whale sightings were made: one comprising two animals between Prince Edward Island and Crozet Island (47°07'S, 45°21'E) moving in a south-easterly direction; and two, both comprising three animals, off Deacon Seamount (48°35'S, 45°03'E). The depths ranged from 3,301-3,510m, SST ranged from 5°-7°C and salinity ranged from 34.30-34.38%.

Unidentified whales

Four sightings (consisting of four individuals) of unidentified whales were made near Madagascar basin, Lena Mount and southwest Indian Ridge. One group of unidentified dolphins (three individuals) was seen moving rapidly 160 n.miles south off Deacon Seamount. The SST, salinity and depth information is given in Table 1.

DISCUSSION

De Boer *et al*. (2003) have made a comprehensive review of the published information relating to the over 40 cetacean species found in the Indian Ocean Sanctuary. Donovan (2007) summarised information on those whale species found in the Antarctic during the austral summer, where they feed.

It is difficult to separate true or normal blue whales (*B. musculus intermedia*) from pygmy blue whales (*B. musculus brevicauda*) at sea (e.g. Williams and Donovan, 2007). Although true/normal blue whales are generally found in more southerly latitudes than pygmy blue whales in the austral summer (e.g. Branch *et al*., 2007), there was insufficient information to identify the three animals seen during the present study.

Two species of minke whale are found in the Southern Hemisphere; the Antarctic minke whale and the diminutive form of minke whale (Arnold *et al*., 1987; Best, 1985) which is actually genetically related to the common minke whale found in the Northern Hemisphere. The sighting made at 35°S in February was identified as an Antarctic minke given the absence of the characteristic white flipper band. Kasuya and Wada (1991) found that although the latitudes of highest minke whale densities were south of 60°S during November to March, considerable sightings of minke whales were reported to the north of 55°S in the austral summer, suggesting that in summer not all individuals migrate to waters south of the Antarctic convergence. This is in agreement with the present observation.

Fin whales have been encountered mainly between 40-60°S and 30-90°E in the Indian Ocean sector in recent years (Donovan, 2007). The present sightings of fin whales were between 44° and 49°E but somewhat further north (36°-37°S) than the main concentrations which are between 50 and 65°S.

Sei whales generally have the most northerly austral distribution of the 'Antarctic' whales (Donovan, 2007), with their distribution mainly on or near the Antarctic Convergence (around 40°-50°S). The observation of Kasuya and Wada (1991) that high sei whale densities are encountered between 40° and 55°S in January and between 40° and 50°S in February is in accord with our sightings (Table 1).

Although the sample sizes are small, during the present cruise blue whales were encountered in the lowest SST range, sei whales preferring slightly warmer waters, while fin and minke whales were sighted in much higher SSTs. The results for blue and sei whales are not unexpected and is related to their feeding behaviour (e.g. Donovan, 2007; Kasamatsu *et al*., 1990; Kawamura, 1994). Fin and minke whales usually feed in colder waters than observed here but have been found in warmer waters. It is not clear whether these were animals that had returned from the Antarctic or animals that not migrated.

Relatively small numbers of cetaceans were observed during the present cruise and this to a great part reflects the fact that almost 90% of the cetacean sighting effort time was made in 'average' to 'poor' conditions. In addition, the survey was generally further north than the expected peak densities in January-February (e.g. De Boer, 2000b; Donovan, 2007) Despite this, the present results show that marine mammal research programnes can be conducted aboard vessels that are not primarily designed for cetacean research. The practicality and possibility of conducting certain kinds of cetacean research aboard such vessels has been reported elsewhere (De Boer *et al*., 1999; Reid *et al*., 1999; Thiele and Chester, 2000; Tynan, 1997) although the objectives must be clearly specified.

Considerably more focussed research is required to allow more accurate determination of spatial and temporal changes in distribution. Examining cetacean species diversity and their prey abundance in the Southern Ocean environment in their current state will provide some

understanding of the dynamics of recovering populations. The interactions between the greatly depleted species and those that have increased dramatically since commercial whaling ceased should be an important focus for research within this ecosystem (Thiele and Chester, 2000). The present survey can be seen as the first Indian attempt to contribute to the ongoing global effort to collect data on Southern Ocean cetacean species distribution and abundance from platforms of opportunity, ultimately to help determine distribution, migration patterns and critical habitat parameters.

ACKNOWLEDGEMENTS

We acknowledge the Director of CMFRI, for encouragement and the facilities provided. We are thankful to the Chief Scientist at PESO, M. Sudhakar from NCAOR and V. Ravindranathan and V.N. Sanjeevan from the Ministry of Earth Sciences, Government of India, as well as all the Scientists and Research Scholars who helped us during the cruise. Critical comments were offered by Ken Findlay, Thomas A. Jefferson, Dipani Sutaria and E. Vivekanandan, which improved the manuscript. We also acknowledge the hospitality and assistance offered by the Captain and the crew members of *ORV Sagar Kanya* during the cruise. Funding for this work was provided by the Ministry of Earth Sciences.

REFERENCES

Arnold, P., Marsh, H. and Heinsohn, G. 1987. The occurrence of two forms of minke whales in east Australian waters with a description of external characters and skeleton of the diminutive or dwarf form. *Sci. Rep. Whales Res. Inst., Tokyo* 38: 1-46.

Best, P.B. 1985. External characters of southern minke whales and the existence of a diminutive form. *Sci. Rep. Whales Res. Inst., Tokyo* 36: 1-33.

Branch, T.A., Stafford, K.M., Palacios, D.M., Allison, C., Bannister, J.L., Burton, C.L.K., Cabrera, E., Carlson, C.A., Galletti Vernazzani, B., Gill, P.C., Hucke-Gaete, R., Jenner, K.C.S., Jenner, M., Matsuoka, K., Mikhalev, Y., Miyashita, T., Morrice, M., Nishiwaki, S., Sturrock, V.J., Tormosov, D., Anderson, R.C., Baker, A.N., Best, P.B., Borsa, P., Brownell, R.L., Childerhouse, S., Findlay, K., Gerrodette, T., Ilangakoon, A.D., Joergensen, M., Kahn, D.K., Ljungblad, B., Maughan, B., McCauley, R.D., McKay, S., Norris, T.F., Oman Whale and Dolphin Research Group, Rankin, S., Samaran, F., Thiele, D., Van Waerebeek, K. and Warneke, R.M. 2007. Past and present distribution, densities and movements of blue whales in the Southern Hemisphere and northern Indian Ocean. *Mammal Rev*. 37(2): 116-75.

Cherfas, J. 1989. *The Hunting of the Whale. A Tragedy That Must End*. Penguin Books, London, England. 248pp.

Clarke, C.W. and Lamberson, R. 1982. An economic history and analysis of pelagic whaling. *Mar. Policy* 103: 120.

De Boer, M.N. 2000a. A note on cetacean observations in the Indian Ocean Sanctuary and the South China Sea, Mauritius to the Philippines, April 1999. *J. Cetacean Res. Manage*. 2(3): 197-200.

De Boer, M.N. 2000b. Observations on occurence and distribution of cetaceans in the Southern Ocean Sanctuary and southern part of the Indian Ocean Sanctuary. Paper SC/52/O9 presented to the IWC Scientific Committee, June 2000, in Adelaide, Australia (unpublished). 10pp. [Paper available from the Office of this Journal].

De Boer, M.N., Baldwin, R., Burton, C.L.K., Eyre, L., Jenner, K.C.S., Jenner, M.N.M., Keith, S.G., McCabe, K.A., Parsons, E.C.M., Peddemors, V.M., Rosenbaum, H.C., Rudolph, P., Thiele, D. and Simmonds, M. 2003. Cetaceans in the Indian Ocean Sanctuary: a review. *Whale and Dolphin Conservation Society*: 52pp. [Available from *www.wdcs.org]*.

De Boer, M.N., Frizell, J. and Sonntag, R.P. 1999. Cetacean observations in the Southern Ocean and Indian Ocean sanctuaries. Paper SC/51/O12 presented to the IWC Scientific Committee, May 1999, Grenada, WI (unpublished). 14pp. [Paper available from the Office of this Journal].

Donovan, G.P. 2007. Whales —overview. pp.1067-72. *In*: Riffenburgh, B. (eds). *Encyclopedia of the Antarctic*. Routledge, Taylor and Francis, New York and London.

International Whaling Commission. 1995. Chairman's Report of the Forty-Sixth Annual Meeting, Appendix 21. Amendments to the Schedule. *Rep. int. Whal. Commn* 45:52.

Jefferson, T.A., Leatherwood, S. and Webber, M.A. 1993. *FAO Species Identification Guide. Marine Mammals of the World*. FAO, Rome. 320pp.

Kasamatsu, F., Joyce, G.G., Ensor, P. and Mermoz, J. 1990. Current occurrence of cetacea in the Southern Hemisphere; results from the IWC/IDCR Southern Hemisphere minke whale assessment cruises, 1978/79-1987/88. Paper SC/42/O15 presented to the IWC Scientific Committee, June 1990 (unpublished). 77pp. [Paper available from the Office of this Journal].

Kasuya, T. and Wada, S. 1991. Distribution of large cetaceans in the Indian Ocean: data from Japanese sightings records, November-March. *In* Leatherwood, S. and Donovan, G.P. Cetaceans and cetacean research in the Indian Ocean Sanctuary. *UNEP Mar. Mamm. Tech. Rep*. 3: 139-70. Nairobi, Kenya.

Kawamura, A. 1994. A review of baleen whale feeding in the Southern Ocean. *Rep. int. Whal. Commn* 44: 261-72.

Laws, R.M. 1985. The ecology of the Southern Ocean. *Am. Sci*. 73: 26-40.

Leatherwood, S. and Donovan, G.P. 1991. Cetaceans and Cetacean Research in the Indian Ocean Sanctuary. *UNEP Mar. Mamm. Tech. Rep*. 3: vii-287. Nairobi, Kenya.

Luis, A.J. and Pandey, P.C. 2004. Seasonal variability of QSCAT-derived wind stress over the Southern Ocean. *Geophysical Res. Letters* 31.

Pandey, P.C., Khare, N. and Sudhaker, M. 2006. Oceanographic research: Indian efforts and preliminary results from the Southern Ocean. *Curr. Sci*. 90(7): 978-84.

Reid, K., Secchi, E. and Thiele, D. 1999. Existing national cetacean monitoring programs in the Southern Ocean standardizing cetacean monitoring across platforms and opportunities for complementary and collaborative work with existing cetacean research. Paper SC/M99/WP4 presented to the IWC SOWER 2000 workshop, Edinburgh, 1999 (unpublished). 7pp. [Paper available from the Office of this Journal].

Thiele, D. and Chester, E.T. 2000. Cetacean distribution off Eastern Antarctica (80-150°E) during the austral summer of 1995/96. *Deep-Sea Res. II* 47: 2543-72.

Tynan, C. 1997. Cetacean distributions and oceanographic features near the Kerguelan Plateau. *Geophys. Res. Lett*. 24(22): 2793-96.

Williams, R. and Donovan, G.P. 2007. Blue whale. pp.170-71. *In*: Riffenburgh, B. (eds). *Encyclopedia of the Antarctic*. Routledge, Taylor and Francis, New York and London.

Paper received: February 2007
Paper accepted: October 2007