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## Whale observations in the pack ice off the Fimbul Ice Shelf, Antarctica

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During January and February of 1976 and 1977 seal censuses were carried out in the pack ice off the Fimbul Ice Shelf, in the King Haakon VII Sea, Antarctica. These two censuses formed part of a series started in 1974 (Hall-Martin, 1974a; Wilson, 1975a; Condy, 1976a and 1977). Whales were observed during all four censuses, but only during the latter two was an attempt made to determine their density and investigate their distribution according to pack ice concentration. The results are presented here and, where possible, data from the 1974 and 1975 census voyages have been included. The areas censused are shown in Fig. 1.

### Methods

During the seal censuses in 1976 and 1977, all whales within 400 m on either side of the ship were recorded. The whales were identified and their number, the date, time (local), and local pack ice concentration within 100 m of the whales were recorded. Observations were made from the ship's bridge 10 m above the waterline, and the limits of the 400 m census strips were estimated using a sighting board similar to that described by Siniff, Cline & Erickson (1970), but modified to

enable delimitation of the 400 m limit. The ship's position was recorded every 20-40 minutes using an Omega navigational aid in 1976, and a Redifon RSN I satellite navigating unit in 1977. Cross-checks with positional plots from conventional navigation techniques were made as often as possible. The ship's erratic course and speed through the pack ice made dead reckoning of ship's position, projected from a

Table 1

Estimated density of minke whales and killer whales observed in the pack ice off the Fimbul Ice Shelf, Antarctica.

Date	Distance travelled (km)	Area censused (km <sup>2</sup> )	Whales observed		Density (whales/km <sup>2</sup> )	
			minke	killer	minke	killer
Jan/Feb 1976	481,40	385,12	48	0	0,12	0
Jan/Feb 1977	720,43	576,34	76	14	0,13	0,02

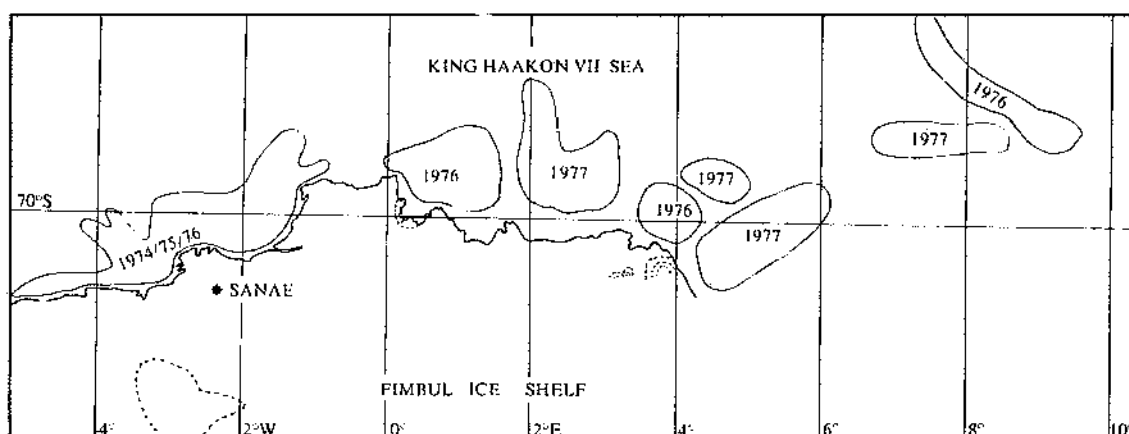


Fig. 1. Areas off the Fimbul Ice Shelf surveyed in January/February 1974-1977.

Table 2

Occurrence of minke whales and killer whales in different pack ice concentrations off the Fimbul Ice Shelf, Antarctica.

Date	Species	Ice concentration (in tenths)										
		0,0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1,0
Jan/Feb 1976 (Condy (1976b))	Minke whale	22	—	9	5	—	3	—	7	1	1	—
	Killer whale	—	—	—	—	—	—	—	—	—	—	—
Jan/Feb 1977 (Condy (1977))	Minke whale	35	9	8	10	6	—	—	4	4	—	—
	Killer whale	8	—	5	1	—	—	—	—	—	—	—
Jan/Feb 1976 & 1977 combined	Minke whale	57	9	17	15	6	3	—	11	5	1	—
	Killer whale	8	—	5	1	—	—	—	—	—	—	—

known position, unreliable. At the end of the voyages the straight-line distance travelled between positional plots was summed to give total distance travelled, and this distance was multiplied by strip width (0,8 km) to determine area censused. Standard deviations are given with mean values in the text and tables.

## Results

### Species density

The only species encountered in the pack ice during the 1976 and 1977 censuses were minke whales (*Balaenoptera acutorostrata*) and killer whales (*Orcinus orca*). Data on the number counted and their estimated density are given in Table 1. During the 1974 seal census only a few solitary minke whales and one group of four to six killer whales were observed (Hall-Martin, 1974b), in an area of 371 km<sup>2</sup>. In 1975 Wilson (1975b) recorded 31 minke whales and 12 killer whales, most of which were observed within 400 m either side of the ship (Wilson, *in litt.*), although the limits of the census strip were estimated by eye only (Wilson, 1975a). An area of 312 km<sup>2</sup> was surveyed, giving minke and killer whale densities of 0,10 and 0,04 per km<sup>2</sup> respectively.

### Distribution according to pack ice concentration

Pack ice concentration was estimated in tenths, 0,0 being open sea, 0,5 being approximately 50 per cent ice coverage, and 1,0 being total ice coverage. Throughout the voyages pack ice concentration within a 100 m radius of the ship was recorded every 30 minutes, and for every whale observation it was recorded within a 100 m radius of the site of surfacing when first seen. During the 1976 voyage mean pack ice concentration was 0,56 ± 0,20 (*n* = 206), and 0,48 ± 0,25 (*n* = 336) during the 1977 voyage. When estimating ice concentration, all forms of ice were considered to contribute to ice coverage, whether it was brash ice, large or small ice floes, or bay ice, and stratification according to the different types was not made. The occurrence of minke and killer whales in relation to ice concentration within 100 m of their first seen surfacing site, within the census strip, is given in Table 2. In 1976 14 minke whales (29,2 per cent of the total) were seen right up against the ice shelf, and 23 (30,3 per cent) in the 1977 survey. In all these cases ice shelf and pack ice were separated by a lead approximately 50 m wide. All minke and killer whales seen in open water (Table 2) were in wide leads within the pack ice.

Most minke whales (86,3 per cent) and all killer whales were observed in open to medium (0,0–0,5) concentrated pack ice with more whales seen in open leads within the pack ice than in any other types of pack ice. In 1976 the ship was beset in very close pack ice (0,9–1,0) for 26 hours (Condy, 1976b), and during this time one minke whale was sighted in a small patch of open water (about 3 m<sup>2</sup>) at the stern of the ship. It was thought that this whale had found the open area to be a convenient breathing place while passing beneath the

pack ice, and that minke whales would not normally have been seen in such close pack ice.

### School size

At each sighting an attempt was made to record school size; all individuals seen within 100 m of each other were considered to be part of the same school. However, in most cases members of one school were within a few metres of each other. Data on school size frequency are given in Table 3, and for the periods Jan/Feb 1975, 1976 and 1977 mean school size for minke whales was 2,8 ± 2,4 (*n* = 55), and for killer whales 5,0 ± 2,6 (*n* = 5).

Data concerning school composition were limited. Five of the 14 observed killer whales were adult males, no calves of either species were seen, and according to descriptions given by Condy, Van Aarde & Bester (1978), the majority of killer whales observed were subadults.

### Other species observed

During the voyages between Cape Town and the South African Antarctic base SANAE, various other species of whales were observed, and are recorded in Table 4. Identification of these whales was based on Brown *et al.* (1974).

## Discussion

Nishiwaki and Sasao (*in press*) indicated that minke whales were disturbed by shipping to the extent that they changed their habits and migration routes. During the present surveys while the ship was moving, usually at a speed of < 4 knots,

Table 3

School size of minke whales and killer whales observed in the pack ice off the Fimbul Ice Shelf, Antarctica, in Jan/Feb 1975, 1976 and 1977.

Number of individuals per school	*Minke whales		*Killer whales	
	Observed frequency	% frequency	Observed frequency	% frequency
1	24	43,6	1	20,0
2	8	14,5	—	—
3	9	16,4	—	—
4	4	7,3	—	—
5	5	9,1	2	40,0
6	—	—	1	20,0
7	—	—	—	—
8	3	5,5	1	20,0
9	—	—	—	—
10	2	3,6	—	—
> 10	—	—	—	—
Total number of schools	55	100,0	5	100,0

\*Data from Wilson (1975b), Condy (1976b) and Condy (1977).

most sighted minke whales were travelling faster and were seldom seen closer than 100 m from the ship. However, when the ship was drifting in the pack ice with engines stopped, minke whales often came to within 20 m of the ship. It thus seems that they were disturbed by the noise and motion of the ship, but whether this caused local emigration to the extent that it biased the census data is not known. Since the ship's course through pack ice was highly erratic and only occasionally followed open leads, the calculated total distance travelled and hence area surveyed are likely to be underestimates. Therefore the calculated densities of both minke whales and killer whales are probably greater than the real values. The minke whale density observed during the three surveys from 1975 to 1977 (mean  $0,12 \pm 0,02$  per  $\text{km}^2$ ) was greater than that of leopard seals (mean  $0,02 \pm 0,01$  per  $\text{km}^2$ ) and Weddell seals ( $0,07 - 0,01$  per  $\text{km}^2$ ) observed over the four seal surveys since 1974, but less than the density of Ross seals (mean  $0,29 \pm 0,18$  per  $\text{km}^2$ ) and crabeater seals (mean  $1,23 - 0,37$  per  $\text{km}^2$ ) also observed over the four seal surveys. Ohsumi, Masaki & Kawamura (1970) noted that school size of minke whales increased with increasing latitude. Between  $50^\circ\text{S}$  and  $60^\circ\text{S}$  they noted a mean school size of  $2,30 \pm 1,09$  ( $n = 401$ ). All minke whale observations made during the present studies were made south of  $69^\circ\text{S}$ , in or very close to the pack ice, and mean group size ( $2,8 \pm 2,4$ ;  $n = 55$ ) was significantly higher ( $P < 0,01$ ) than that noted by Ohsumi *et al.* (1970) between  $50^\circ\text{S}$  and  $60^\circ\text{S}$ . As suggested by Ohsumi *et al.* (1970), it appears that minke whales have a greater schooling tendency in their feeding grounds. The presence of pack ice appears to further intensify this behaviour.

It appears that their relatively small size enables minke whales to make use of very small areas of open water, and gives them a considerable advantage in pack ice over the larger whales found in Antarctic waters. Killer whales were not often seen, and were never seen in as close pack ice as the minke whales. As seals and penguins were less abundant in close pack ice (Hall-Martin, 1974a; Wilson, 1975a; Condy, 1976a), the paucity of killer whales under these conditions was not unexpected. Mean school size of killer whales ( $5,0 \pm 2,6$ ;  $n = 5$ ) in the pack ice was slightly larger ( $P < 0,5$  NS) than that recorded at Marion Island (mean  $4,20 \pm 3,17$ ;  $n = 281$ ) by Condy *et al.* (1978). Voisin (1972) noted that killer whales were usually seen in schools of up to 12 animals at Possession Island in the Crozet Archipelago, and at Île aux Cochons, also in the Crozet group. Voisin (1976) noted that they occurred most often singly or in small schools, the largest of which consisted of 6 individuals.

During the 1976 seal survey 62,5 per cent of the crabeater seals were fairly heavily scarred (Condy, 1976b). Hall-Martin (1974b) found that 63,0 per cent were scarred during the 1974 survey, and Wilson (1975b) found that 25,2 per cent were scarred during the 1975 survey. Some authors (Lindsey, 1938;

Bertram, 1940; and Laws, 1958, 1964) have suggested that these scars resulted from attacks by killer whales. The paucity of killer whales in the areas studied seems to be inconsistent with the large number of scarred crabeater seals seen, if killer whales are to be considered responsible for the scarring. It seems therefore that killer whales are not the major cause of scarring on crabeater seals but rather leopard seals, as suggested by Siniff and Bengtson (1977), appear to be largely responsible.

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Table 4

Whales observed between Cape Town and the South African Antarctic base SANAE.

Date	Species	Number sighted	Position
*14/1/75	Fin whale	10-12	$50^\circ 00' \text{S}$ , $17^\circ 32' \text{E}$
*19/1/75	Fin whale	7-9	$65^\circ 39' \text{S}$ , $02^\circ 16' \text{E}$
31/1/76	Blue whale	1	$69^\circ 00' \text{S}$ , $11^\circ 15' \text{E}$
8/2/76	Sperm whale	1	$64^\circ 10' \text{S}$ , $24^\circ 18' \text{E}$
9/1/77	Sperm whale	2	$43^\circ 57' \text{S}$ , $11^\circ 15' \text{E}$
12/1/77	Fin whale	3	$54^\circ 10' \text{S}$ , $03^\circ 17' \text{E}$
"	Fin whale (?)	2-3	$54^\circ 28' \text{S}$ , $03^\circ 20' \text{E}$
13/1/77	Fin whale	2	$57^\circ 41' \text{S}$ , $02^\circ 43' \text{E}$
30/1/77	Sperm whale	3	$68^\circ 06' \text{S}$ , $16^\circ 46' \text{E}$

\*From Wilson (1975b).