EXTERNAL CHARACTERS OF SOUTHERN MINKE WHALES AND THE EXISTENCE OF A DIMINUTIVE FORM

PETER B. BEST*

ABSTRACT

Two colour phases were found amongst minke whales examined at the Durban whaling station. The majority of the animals had asymmetrically-coloured baleen, with the right series having a larger number of white plates anteriorly than the left, and with the remaining plates having a black outer border whose width amongst the longest plates averaged about 31–34% of the width of the plate. These animals also had plain or two-tone flippers (Type 1 or 2) on which white patches were never found, and dark pigment on the neck did not descend below the level of the eye. Whales of the second colour phase were much rarer (~3 to 4% of the minke whales taken). They had all-white baleen or baleen with an unusually large proportion of white plates (with little or no asymmetry), in which the largest plates were either completely white or with a narrow black outer border less than 10% of the width of the plate. The flippers carried a striking white patch connected to a roughly circular white blaze on the shoulder (Type 3), and dark pigment in the neck region extended onto the ventral grooves.

Type 3 whales appear to be born smaller and attain a smaller size at sexual maturity than Type 1 or 2 whales. Off Durban they were found closer inshore and earlier in the year than Type 1 or 2 whales, and were not killed from the same groups. Whales with similar coloration to Type 3 animals have also been recorded from Brazil, New Zealand and Australia, but probably do not occur in higher latitudes of the Antarctic.

INTRODUCTION

Minke whales in the Southern Hemisphere are reported to have either no white flipper bands (Ohsumi, Masaki and Kawamura, 1970; Van Utrecht and Van der Spoel, 1962; Williamson, 1959, 1961; Zemsky and Tormosov, 1964) or flippers with "light" (Taylor, 1957) or white bands (Aguayo, 1974). The existence of two Southern Hemisphere forms, one with and one without white flipper bands is suggested by data provided by Baker (1983), Gaskin (1972) and Kasuya and Ichihara (1965). The baleen coloration of southern

* *Mammal Research Institute, University of Pretoria, South Africa.*
Postal Address: c/o Oceanography Dept. University of Cape Town, Private Bag, Rondebosch 7700

Sci. Rep. Whales Res. Inst.,
No. 36, 1985, 1–33

minke whales has been usually reported as consisting of some anterior all-white plates and the rest white with dark borders externally, with considerable individual variation in the proportion of all-white plates, and with asymmetry in their distribution between left and right sides of the head (Kasuya and Ichihara, 1965; Ohsumi *et al.*, 1970; Williamson, 1959, 1961). Some individuals have been reported with no all-white plates (Ohsumi *et al.*, 1970), even on both sides of the head (Van Utrecht and Van der Spoel, 1962). Gaskin (1972), Guiler (1978) and Baker (1983) are the only authors so far who have described southern minke whales as simply having "yellow or pale ochre", "yellowish" or "yellow-grey" baleen with no mention of dark edges.

It is clearly of some interest to establish whether different colour phases of minke whales do occur in the Southern Hemisphere, and particularly to investigate whether these might vary geographically as potential indicators of stock identity. Systematic observations were therefore made of the coloration of the baleen and flippers (and certain other parts of the body) of minke whales landed at Durban (ca 30°S, 31°E) and on the factory ship *Nisshin Maru no.3* in the Antarctic. This paper presents analyses of these observations together with some morphometric data, and includes information from animals stranded on the South African coast and elsewhere.

MATERIAL AND METHODS

As part of their routine examination of minke whales on the flensing platform, the whaling inspectors at Durban were instructed to record variations in coloration.

The most convenient way of recording flipper patterns was by photography. Photographs of one or both flippers of each minke whale landed were taken with an Instamatic camera (using flash for night shots). In order to distinguish between individual whales, a slate bearing the platform number of the whale was included in each frame.

Photographs were taken in three seasons (1970, 1971 and 1973) for a total of 299 whales.

Baleen coloration was recorded in several ways. Initially (1969) separate counts were made of the number of all-white plates and the number with black edges for at least one series of each whale. The plates counted included all those defined as hairs by Williamson (1973). Because this was so laborious, a more rapid method of assessing the relative proportions of the two types of baleen was used subsequently (1970, 1971 and 1973). One entire side of baleen was carefully removed and laid straight and flat (fringe downwards) on the deck. Its total length and the length of the series of all-white plates were then measured with a steel or fibreglass tape in a straight line between the anterior and posterior extremities of the series. The relative length of the all-white section could then be used as a measure of the proportion of white

plates in the series. The coloration of baleen was recorded in these two ways for a total of 488 animals.

In addition, one of the longest baleen plates from one side of each whale was collected in 1970, 1971, 1973, 1974 and 1975, and fixed in formalin. These could be recognised as being from the left or right series depending on their shape, and were used to confirm on which side the measurements or counts of different-coloured baleen had been made. They were also used to provide measurements of the relative width of the black border to the outer edge of the plate.

The length and width of the plate were measured as described by Omura and Fujino (1954), while the width of the black border was measured with vernier calipers at the same level as the width of the plate. Baleen plates from 504 whales were so measured, to the nearest mm.

From 20 January to 17 February 1979, 161 minke whales were examined aboard the Japanese factory ship *Nisshin Maru no.3* while it operated along the ice edge between the longitudes of 62° and 107°E. The procedures followed were almost identical to those described above; the proportions of black and white baleen plates were obtained by measurement rather than counting, while a ruler rather than vernier calipers was used to measure the thickness of the black border.

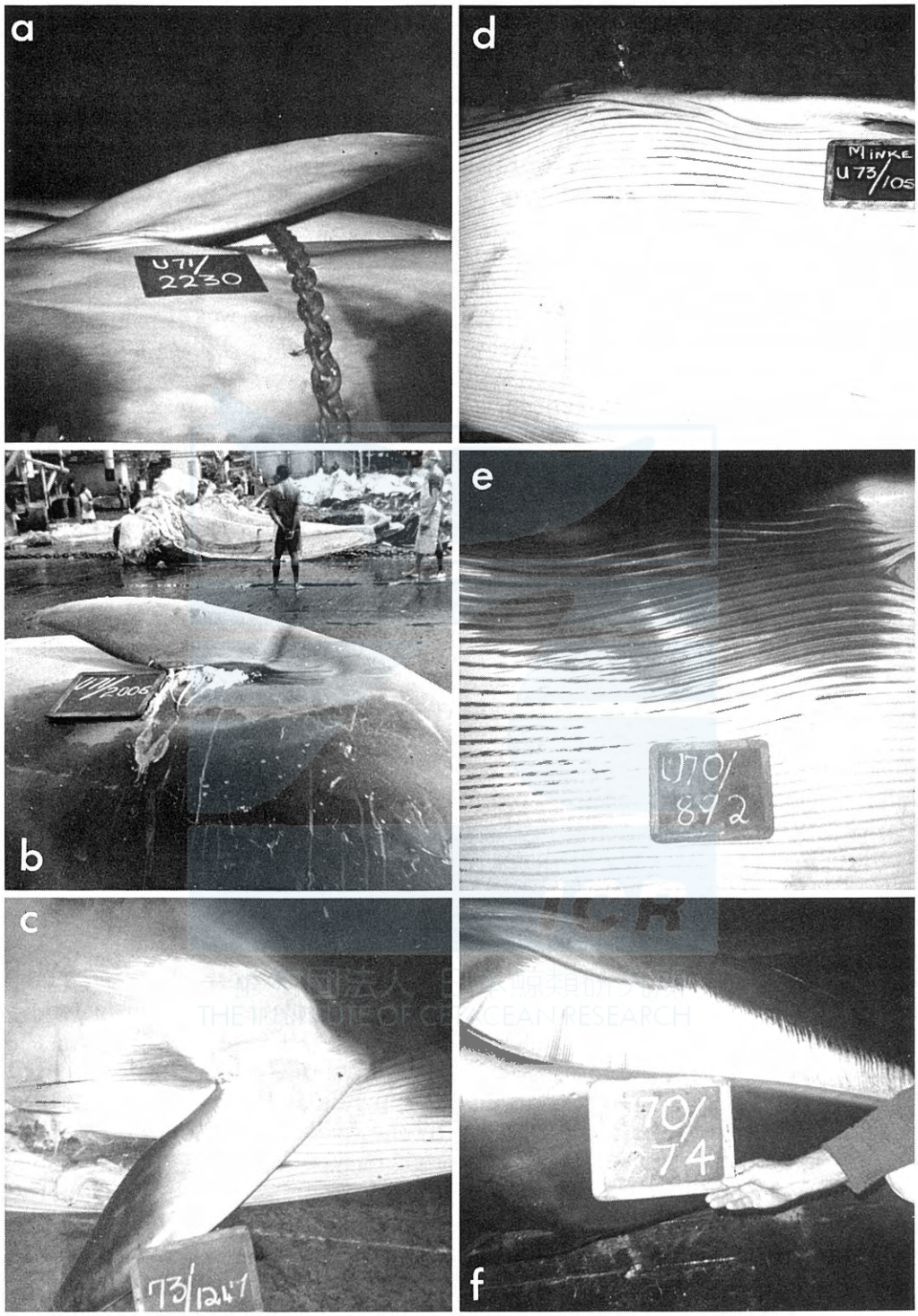
Throughout this paper a '±' figure following an estimate refers to one standard error.

COLORATION

Flipper and associated body coloration

From an examination of the photographs, the flipper coloration of minke whales landed at Durban and in the Antarctic could be classified into three types.

1. *Plain* – The outer surface of the flipper was a steely-grey (or slightly darker) colour, darkening on the trailing edge of the flipper but lightening to almost white on the leading edge. Such changes in coloration were not sharply differentiated but were diffuse in nature (Fig. 1a). This seemed to be equivalent to the Type 1 flipper coloration as illustrated by Doroshenko (1979) and Wada and Numachi (1979).
2. *Two-tone* – The outer surface of the flipper was of two tones of grey separated by a distinct line running perpendicularly across the width of the flipper approximately level with the axilla. This line varied from being roughly straight to being strongly backet-shaped in conformation, and separated the lighter colour of the distal part of the flipper from the darker proximal part (Fig. 1b). The clarity of this distinction into two tones varied considerably, depending on the degree of contrast between the colours of the proximal and distal parts of the flipper: the lighter in


a
U71/
2230
d
MINKE
U73/105
b
e
U70/
842
c
73/1247
f
70/
74

tone the distal part, the greater the distinction. Although animals could be classified as having weakly, moderately or strongly two-toned flippers, there actually appeared to be a continuous range in variation, with some flippers having such a faint line dividing the two tones that it was difficult to distinguish them from plain flippers, while at the other extreme the distal portion of the flipper was a bright grey colour (but never white). In all flippers there was a gradual darkening at the extreme trailing edge and a lightening at the leading edge, as described for plain flippers.

This seemed to be equivalent to the Type 2 flipper coloration as illustrated by Doroshenko (1979), and possibly to Types II and III coloration as illustrated by Wada and Numachi (1979).

3. *White* – The outer surface of the flipper was glossy white anteriorly and light grey rapidly deepening to glossy black posteriorly. The dividing line between the two was irregular in outline but clearly differentiated, and ran from the axilla to the leading edge of the flipper at about one-third of its length from the tip (Fig. 1c). The white proximal area of the flipper was connected (via the entire width of the flipper from anterior insertion to axilla) with a roughly circular white blaze on the shoulder immediately above the flipper. This blaze was highly irregular in outline but well-differentiated from the surrounding pigmented area. While there was some individual variation in these flipper patterns, and particularly the size and shape of the shoulder blaze, the basic coloration of the flipper remained proximally white and distally black. This has been termed "Type 3" flipper coloration in this paper.

Although Wada and Numachi (1979) illustrate a flipper with a white transverse band as Type IV, it is not clear whether this is similar to the Type 3 coloration described here, or is simply a representation of the band commonly see in minke whales from the Northern Hemisphere.

Classification of flipper patterns into these three types (particularly the first two) could be affected by prolonged post-mortem times, which tended to darken lightly-pigmented areas, and by skin damage (particularly to the flipper that lay beneath the whale's body as it was transported from the water to the flensing platform), which tended to obliterate pigmentation patterns. Some photographs at Durban were also taken from an inappropriate angle so that the outer surface of the flipper could not be seen. Some of these photo-

Fig. 1. Minke whale coloration patterns
a. Plain (Type 1) flipper
b. Two-tone (Type 2) flipper
c. White (Type 3) flipper
d. Throat region of a Type 1 or 2 whale
e. Throat region of a Type 3 whale
f. Baleen coloration of a Type 3 whale

graphs could be used, however, to make gross classifications of coloration type because of a difference between the pigmentation pattern in the neck region of minke whales with flipper Types 1 and 2 and those with Type 3. In the former, the dark pigment of the back did not extend ventrally farther than a line roughly between the eye and flipper insertion, so that the ventral grooves appeared almost entirely white in the throat region (Fig. 1d). In whales with Type 3 flippers, however, this dark pigment extended much farther ventrally (as much as 15 ventral grooves down from the level of the eye to flipper insertion), so that there was a distinct tongue of black extending onto the throat (Fig. 1e). This feature could be seen clearly in photographs of the flippers taken from the ventral side of the whale, when details of the actual outer surface of the flipper were obscured. Consequently it was possible to deduce from such photographs whether the whale had a flipper belonging to Type 1 or 2 or to Type 3, though it was impossible to discriminate between Types 1 and 2 from this angle. Similarly the slate was sometimes placed over the area where the dividing line of Type 2 flippers occurred, so that it was impossible to be certain whether the flipper was Type 1 or 2. Under both these circumstances if it was clear that the animal was not a Type 3 whale it was recorded as "Type 1 or 2".

TABLE 1. FLIPPER COLORATION OF MINKE WHALES AT DURBAN FOR WHICH BOTH FLIPPERS WERE EXAMINED

Colour type	Frequency (number of whales)
Both Type 1	26
One Type 1, one Type 2	17
Both Type 2	18
Both Type 3	3
Total	64

Photographs were taken of both flippers of 64 whales at Durban (Table 1). In 17 of these animals one flipper was judged to be Type 1 and the other Type 2. This indicates that there is no phenotypic distinction between the two flipper patterns, and that Type 1 is actually one extreme of a range of variation including Type 2. Of these 17 animals, 14 had a Type 2 left flipper and three a Type 1 left flipper. These proportions are significantly different from parity (chi-square test, Yates' correction, $P < 0.02$, $df = 1$), indicating that there may be asymmetry of pigmentation in the flippers of the southern minke whale, as in its baleen. This is confirmed by differences in the intensity of pigmentation between right and left flippers of whales in which both flippers were classified as Type 2. Out of the 18 whales so classified, 11 had both flippers of the same intensity while seven had the left flipper with a brighter band of pigmentation (*i.e.* a more striking two-tone coloration) than the right. None had the reverse condition.

TABLE 2. COLORATION OF LEFT AND RIGHT FLIPPERS OF MINKE WHALES

Colour type	Durban				Antarctic			
	Left		Right		Left		Right	
	No.	%	No.	%	No.	%	No.	%
Type 1	51	27.6	81	43.8	12	17.4	36	45.0
Type 2a	31	16.8	36	19.5	28	40.6	28	35.0
Type 2b	44	23.8	16	8.6	23	33.3	16	20.0
Type 2c	8	4.3	1	0.5	6	8.7	0	0
Type 1 or 2	46	24.9	44	23.8	–	–	–	–
Type 3	5	2.7	7	3.8	0	0	0	0
Total	185		185		69		80	

Because of this asymmetry in pigmentation, any analysis of the variation in flipper coloration for southern minke whales must separate data for left and right sides of the animal. In Table 2 data have been presented separately for whales whose left or right flippers only were examined, and including relevant data from those whales for which both flippers were examined. Flippers of the two-tone type have been further classified into weak(2a), moderate (2b) or strong (2c), based on the intensity of the contrast in pigmentation. As might be expected from the asymmetry of coloration, whales whose left flippers were examined had a greater ratio of Type 2 to Type 1 coloration than whales whose right flippers were examined, both at Durban (chi-square = 13.44, $p < 0.001$) and in the Antarctic (chi-square = 12.93, $p < 0.001$).

Furthermore, in both areas there was a higher proportion of Types 2b and 2c relative to Type 2a coloration in the left flippers than the right, though this was only statistically significant in the Durban data (chi-square = 12.10, $p < 0.001$, Durban; chi-square = 2.12, $p > 0.10$, Antarctic). The two areas studied, however, seemed to differ in the intensity of flipper coloration. The proportion of Type 2 relative to Type 1 flippers was higher in the Antarctic than Durban, both for left (chi-square = 9.09, $p < 0.005$) and right flippers (chi-square = 4.82, $p < 0.05$). This may reflect the shorter post-mortem times in the Antarctic (producing less darkening of pigmentation after death), or it may represent a real difference between the two populations. There was no significant difference, however, between the proportion of Type 2a relative to Types 2b and c coloration in the Antarctic and Durban (chi-square = 1.92, $p > 0.10$, left flippers; chi-square = 0.20, $p > 0.50$, right flippers).

No asymmetry of pigmentation could be detected in whales whose flippers were classified as Type 3, and no whale was found with a Type 3 flipper on one side and a different type on the other. This group seemed to form a relatively uncommon but distinct phenotype (see below), and was not encountered in the Antarctic sample.

Data presented by Doroshenko (1979) indicate significant differences in

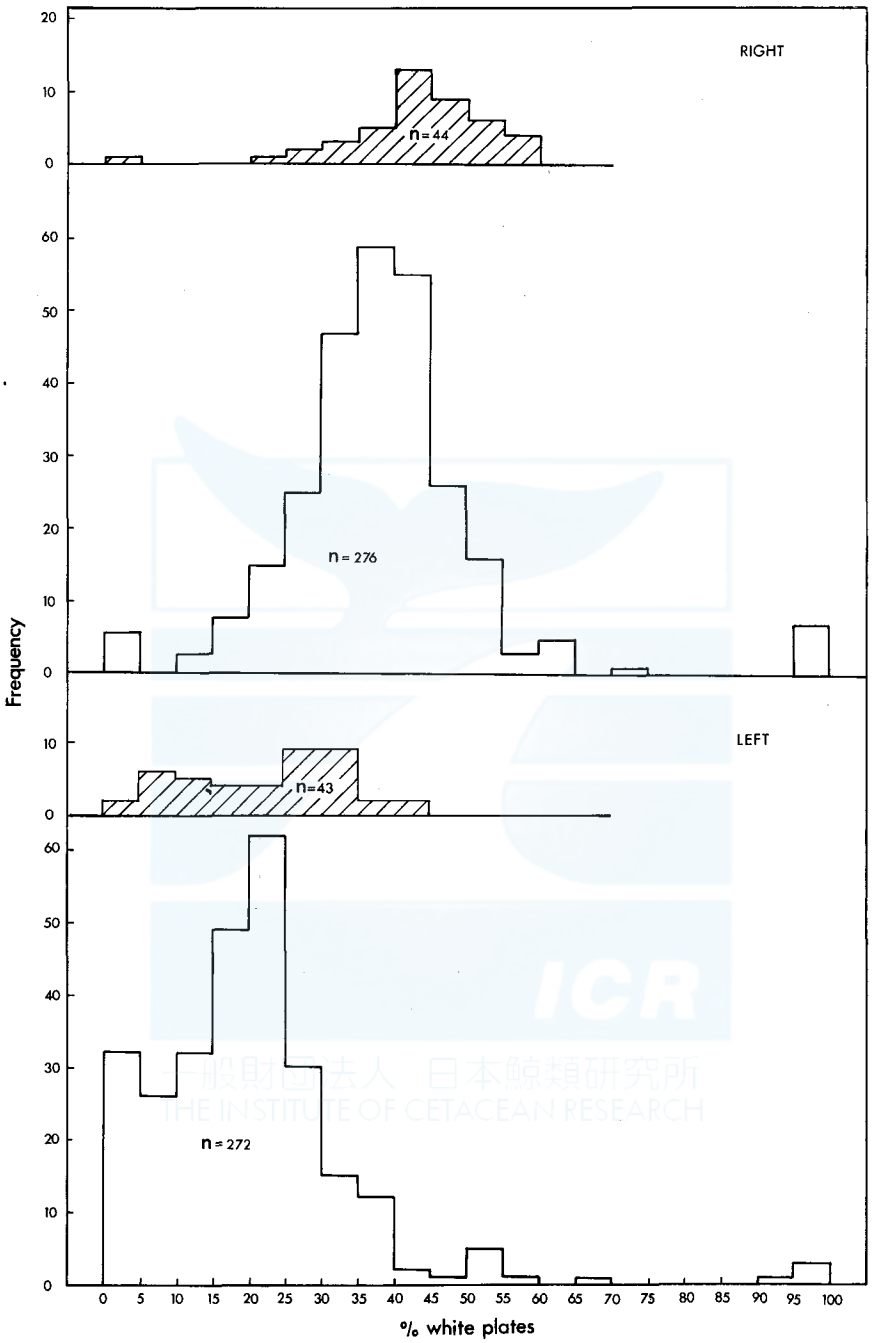


Fig. 2. Proportion of all-white baleen plates in each series, from plate counts (hatched) and proportional measurements (open).

the proportions of whales with Type 1 and Type 2 flippers between different areas of the Antarctic (Van Beek and Van Biezen, 1982), supporting the possibility that there may be population differences in this character. In presenting similar data (but for four flipper types), however, Wada and Numachi (1979) conclude that the data ".... include some bias arising from variation in the classification criterion among the observers, and that they are inadequate for stock identification or that the external characters of minke whales do not reflect stock units. Before this can be determined it is essential to unify the criterion classification technique of each observer." The apparent presence of whales with white bands on the flippers (their Type IV) in a small proportion of their data (0.9%) must therefore be viewed with caution.

Baleen coloration

The two methods of assessing the proportion of all-white plates in the baleen series did not give consistent results. Counts of individual baleen plates

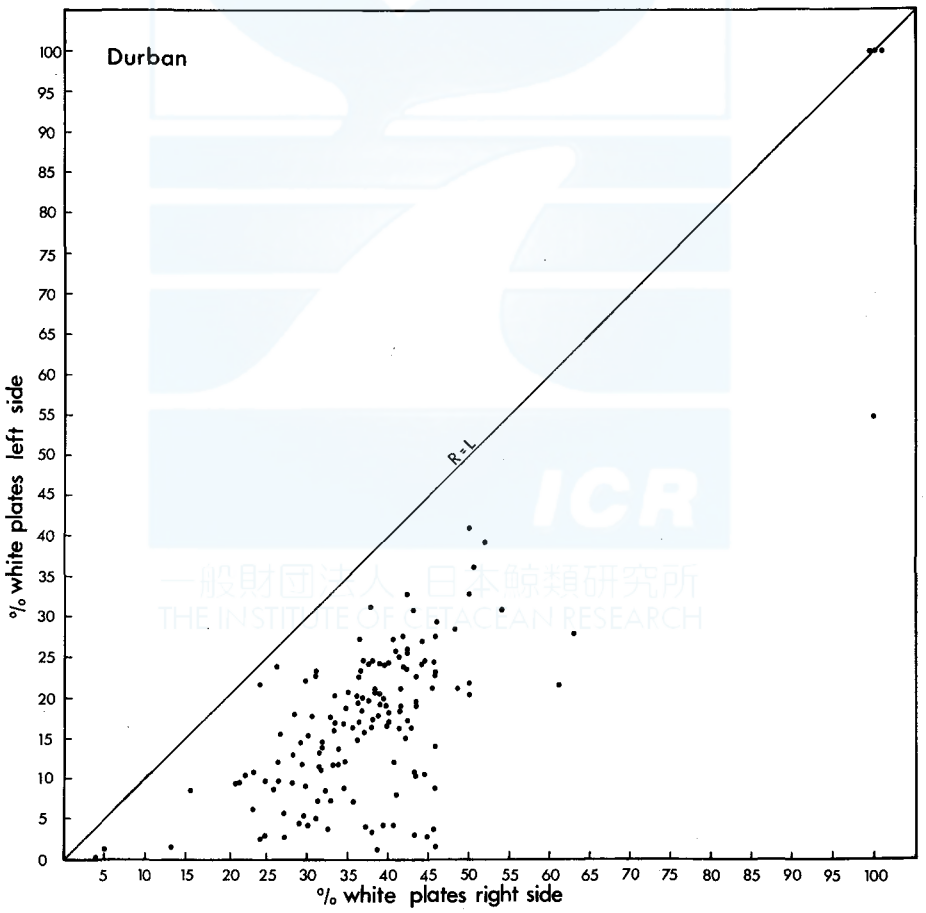


Fig. 3a. Comparison between proportions of all-white baleen plates on right and left sides of same whale at Durban.

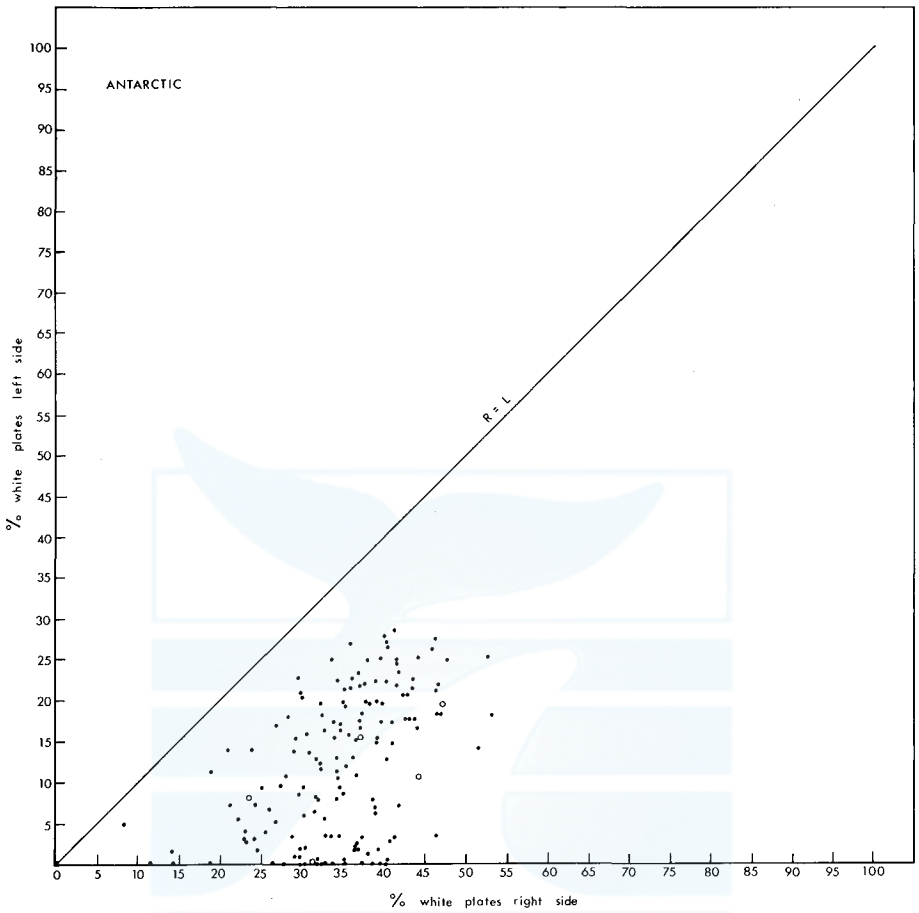


Fig. 3b. Comparison between proportions of all-white baleen plates on right and left sides of same whale in the Antarctic.

produced on average a higher proportion of all-white plates in the series than did relative measurements (Fig. 2). This is almost certainly due to the fact that a high proportion of the anterior, all-white section of the series consists of the small, closely-spaced structures termed "hairs" by Williamson (1973), and their relative contribution will therefore appear greater in counts than in measurements. However, the difference between the two methods is relatively small (the modes in the frequency data differing by 5 to 10%), and for further analysis the greater quantity of data (from measurements) has been used.

The proportion of all-white plates was measured for both right and left baleen series of the same animal in 148 whales from Durban (Fig. 3a) and 157 whales from the Antarctic (Fig. 3b). The asymmetry of the coloration in the majority of animals is clear. Four animals at Durban, however, seemed exceptional in the pattern of their coloration. Three of these were recorded as

having (on both sides of the head) all-white baleen or white baleen interspersed with a few black plates having a very thin black outer border, estimated at 0.3 cm wide (see Fig. 1f). The latter animals were considered in effect to have all-white baleen. The fourth whale was recorded as having all-white baleen on the right-hand side and an unusually high proportion of white plates on the left-hand side. It is possible that this animal also had white baleen interspersed with a few plates very thinly edged with black, but that the measurement of the white baleen on the left side was taken to the first black-edged plate (as was done with subsequent whales but with an explanatory note in the records).

The remaining 144 whales at Durban with asymmetrically-coloured baleen ranged from individuals with almost no white plates on either side (as recorded by Van Utrecht and Van der Spoel, 1962), to individuals where as much as 41% of the left side and 50% of the right side were white, and included animals with only 2 or 3% white plates on the left side but up to 46% white plates on the right. Despite this variation, there was no obvious separation of these animals into different groups, and there is clearly a positive correlation between the proportion of white plates on either side of the head of these animals ($r = 0.5612$, $p < 0.001$). The average proportion of white plates was $16.6 \pm 1.6\%$ for the left series and $36.7 \pm 3.2\%$ for the right series.

All but one of the animals in the Antarctic sample had asymmetrically-coloured baleen. The exception was an animal in which all plates on both sides of the head had black or "dusky" outer edges, though those towards the anterior end of the righthand series were lighter in colour. There was a positive correlation between the proportion of white plates on either side of the head in the whole sample ($r = 0.4966$, $p < 0.001$), and the mean proportion of white plates was $12.0 \pm 1.2\%$ for the left series and $34.4 \pm 2.8\%$ for the right series. There were no animals in the sample with all-white baleen or white baleen interspersed with a few black-edged plates.

The mean proportions of white plates on both the left and right sides of the head differed significantly between Durban and the Antarctic ($t = 4.57$, $p < 0.001$, left; $t = 2.33$, $p < 0.025$, right), suggesting either a difference between populations or a difference in interpretation of what constitutes a black-edged or a white plate between the two areas (the data being collected by a technician at Durban but by the author in the Antarctic).

The existence of two groups of whales differing in their baleen coloration is also suggested by the larger body of data from Durban given in Fig. 2. One large group has a modal proportion of all-white plates on the right side of the head of 35 to 40% and on the left side of the head of 20 to 25%, while a second, much smaller group has from 90 or 95 to 100% white plates on either side of the head.

On the left side there also appears to be an intermediate group of animals with a higher-than-normal proportion (mode 50 – 55%) of white plates. Some of these may be animals with white baleen irregularly streaked with some

black plates with narrow borders as described above, and in which the contribution of black-edged plates has been exaggerated because of the method of recording used (see above). It is impossible, however, to be sure on this point, consequently it is considered safest to ignore the data shown in Fig. 2 when calculating the relative proportions of the two groups of whales in the catch.

Correlation between flipper and baleen coloration

There was no significant correlation between increasing flipper pigmentation and the proportion of all-white baleen plates for animals with Types 1 and 2 flippers at Durban. Because of the asymmetry of pigmentation, data were analysed separately for left and right sides of each animal (Fig. 4). The correlation coefficients so calculated were -0.01212 ($n = 92$, $p > 0.9$) for the left and 0.07337 ($n = 90$, $p > 0.4$) for the right. This lack of correlation

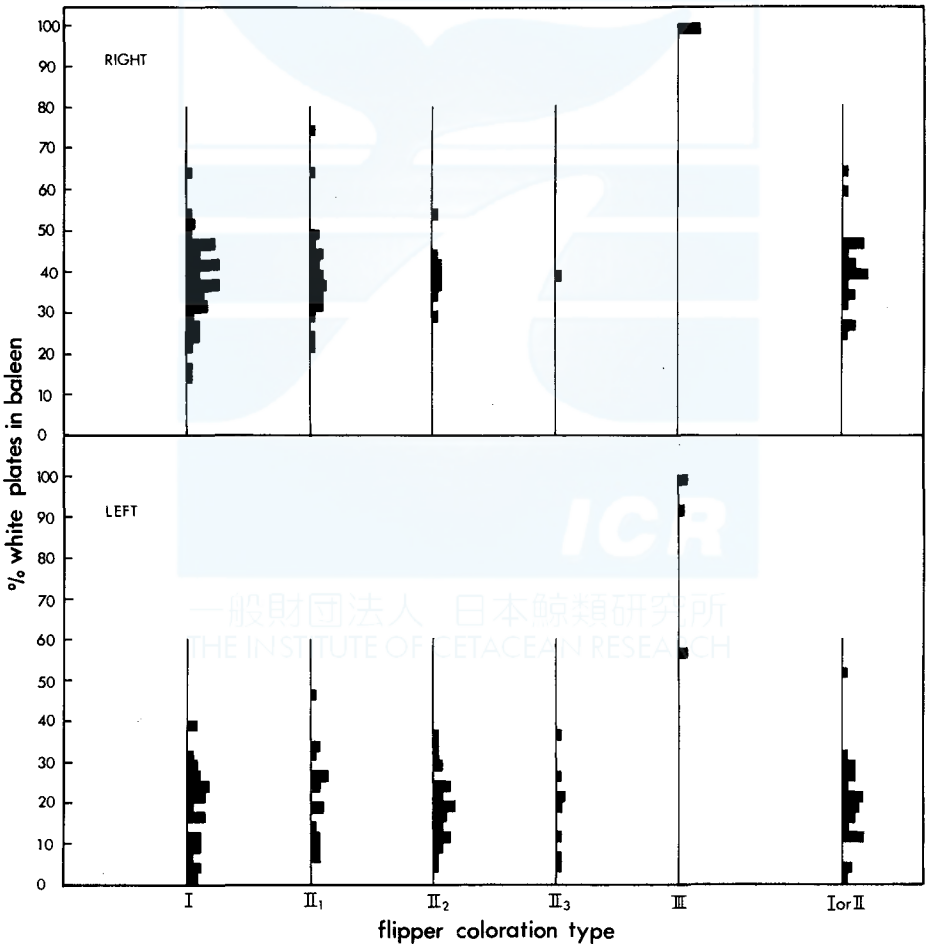


Fig. 4. Relationship between baleen and flipper coloration of same whale.

further suggests that whales with Types 1 and 2 flippers and asymmetrically coloured baleen are one homogeneous group. Whales with Type 3 flippers, however, differed from Types 1 or 2 in having all-white baleen or baleen with an unusually high proportion of white plates. These whales may therefore form an uncommon but distinct phenotype from the "normal" southern minke whale.

Width of black outer border of baleen

The width of the black outer edge (or border) of one of the longest plates of the baleen series was measured as a percentage of the total width of the plate. Some plates had a secondary black stripe on the lingual side of the black border: such plates were omitted from subsequent analysis. At Durban the frequency distribution of the relative width of the black border on the

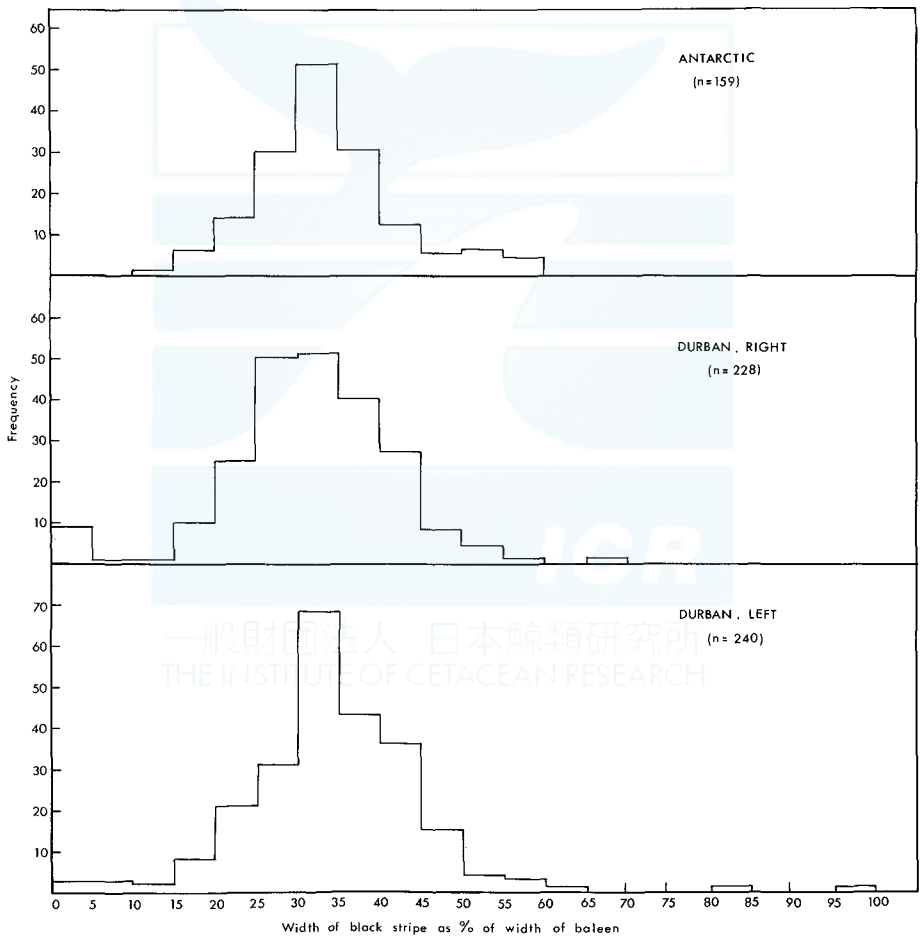


Fig. 5. Width of black border on one of longest baleen plates as a proportion of the total width of the plate at Durban, and in the Antarctic.

right side of the head shows a bimodality, with one group of animals having a mode around 25 – 35% and a second, much smaller, group having a mode of less than 5%; on the left side there is not such a pronounced bimodality but animals were still encountered with a black border less than 10% of the width of the plate (Fig. 5). Amongst such animals eight (or 50%) in fact had no black border at all. All whales with Type 3 flippers fell into this group, i.e. they either had all-white baleen or baleen with some plates having a very thin black outer border (less than 10% of the width of the plate). If only animals with a stripe 10% or more of the plate width (i.e. presumably Type 1 and 2 animals) are considered, the relative width of the border was greater on the left (34.9 $\pm$ 0.7%) than on the right (32.7 $\pm$ 0.6%) side of the whale ($t = 2.47$, $p < 0.02$, 450 df, the samples being independent as the left and right plates examined were from different animals). This difference in the coloration of the largest plates of the baleen series probably reflects the asymmetry of baleen pigmentation as a whole. Williamson (1961) has pointed out that the width of the border increases towards the back of the mouth, so that presumably the more anterior white plates in a series there are, the thinner the border will be on the largest plates. As there are (in asymmetrically-coloured animals) invariably more white plates on the right side of the head, it is to be expected that the width of the black border will be somewhat less in the largest plates of the right side.

In 159 animals examined in the Antarctic, the black border ranged from 14.7% to 58.5% of the width of the plate (right and left sides combined), with a mean of 33.4 $\pm$ 0.7% (Fig. 5).

Wada and Numachi (1979) classified baleen plates into six Types, depending on the width of the black border, with Type 0 representing plates with no black stripe and Type 5 representing all-black plates. The majority of animals (78%) were Types 2 and 3 (stripe one-third to one-half width of plate), which would be similar to the results obtained above for the Antarctic, but all six Types were recorded, although Types 0 and 5 only infrequently (0.1% and 0.2% respectively). However, Wada and Numachi (1979) express reservations about the reliability of this data (as described for flipper coloration – see above), and the inferred presence of minke whales in the Antarctic with no black border to the largest baleen plate must be viewed with caution.

Body coloration

Certain other features of body coloration were noted systematically in a limited number of animals examined at Durban, and in a larger sample of animals from the Antarctic in 1978/79.

(i) *Tongue of dark pigment extending onto the ventral grooves between the eye and the flipper insertion*

In 58 whales examined at Durban or in the Antarctic for which photo-

TABLE 3. DETAILS OF STRANDED (OR ENTRAPPED) MINKE WHALES WITH TYPE 3 PIGMENTATION

Field no.	Length (m)	Sex	Date stranded	Locality	Flipper colour	Pigment on grooves?	% white baleen	Source
72/8	1.92	M	15.5.72	Kommetjie, S.A. (34°07'S 18°21'E)	(L) Type 3 (R) Type 3	Yes Yes	100 100	SFRI files
N438	3.49	F	5.8.74	Nahoon Beach, S.A. (32°59'S 27°57'E)	(R) Type 3	Yes	–	G.J.B. Ross (pers. commn)
80/14	2.54	M	21.7.80	Gordons Bay, S.A. (34°09'S 18°51'E)	(L) Type 3 (R) Type 3	Yes Yes	100 100	SFRI files
–	–	–	26.6.76	N. of Rio Grande, Brazil (~32°S 52°W)	(L) –	Yes	–	G.R. Williamson (pers. commn)
–	–	–	–.6.54	Plimmerton, NZ (~41°05'S 174°52'E)	(R) Type 3	Yes	100	Gaskin (1968) Baker (1983)
–	3.85	M	17.8.80	Dargaville, NZ (~36°S 173°47'E)	(R) Type 3	Yes	100	M.W. Cawthorn (pers. commn)
–	4.04	F	27.8.82	Wonga Beach, Aus. (16°28'S 145°23'E)	(L) Type 3	Yes	100?	H. Marsh (pers. commn)
–	–	F	18.9.82*	Hook Reef, Aus. (19°50'S 149°13'E)	(L) Type 3 (R) Type 3	Yes Yes	– –	H. Marsh (pers. commn)

* Entrapped in coral reef.

graphs exist showing simultaneously both the pigmentation of the flipper and the region between the eye and the flipper insertion, all 53 with no such tongue had Type 1 or 2 flippers, while the remaining five animals with a tongue of dark pigmentation all had Type 3 flippers. Some of the animals with Type 1 or 2 flippers had dark pigment in the folds between the ventral grooves in this region, but this was only conspicuous when the throat region was relaxed, and none had the continuous dark pigmentation characteristic of Type 3 animals. This tongue of dark pigmentation was also present in eight stranded minke whales with Type 3 pigmentation (Table 3). When present this feature seemed to be symmetrical in extent between left and right sides of the same animal.

(ii) *Blowhole streaks*

A typical feature of the minke whales examined was a pair of grey streaks extending posteriorly for about 0.6 m from the blowholes, one from each opening (Fig. 6a). These streaks were irregular in course but both tended to veer towards the left side of the body posteriorly. They were present in all animals examined for this feature (12 at Durban and 149 in the Antarctic), all of which had Type 1 or 2 flippers. A similar marking was seen in a juvenile stranded minke whale from the South African coast that had Type 3 flippers (80/14), so it is possibly a universal feature of all southern minke whales. It can be seen in some of the photographs of ice-trapped animals published by Kellogg (1940) and Taylor (1957), and in a photograph of a calf stranded in New Zealand (Lillie, 1915). Photographs sent to me by M.W. Cawthorn of another animal stranded in New Zealand also show this charac-

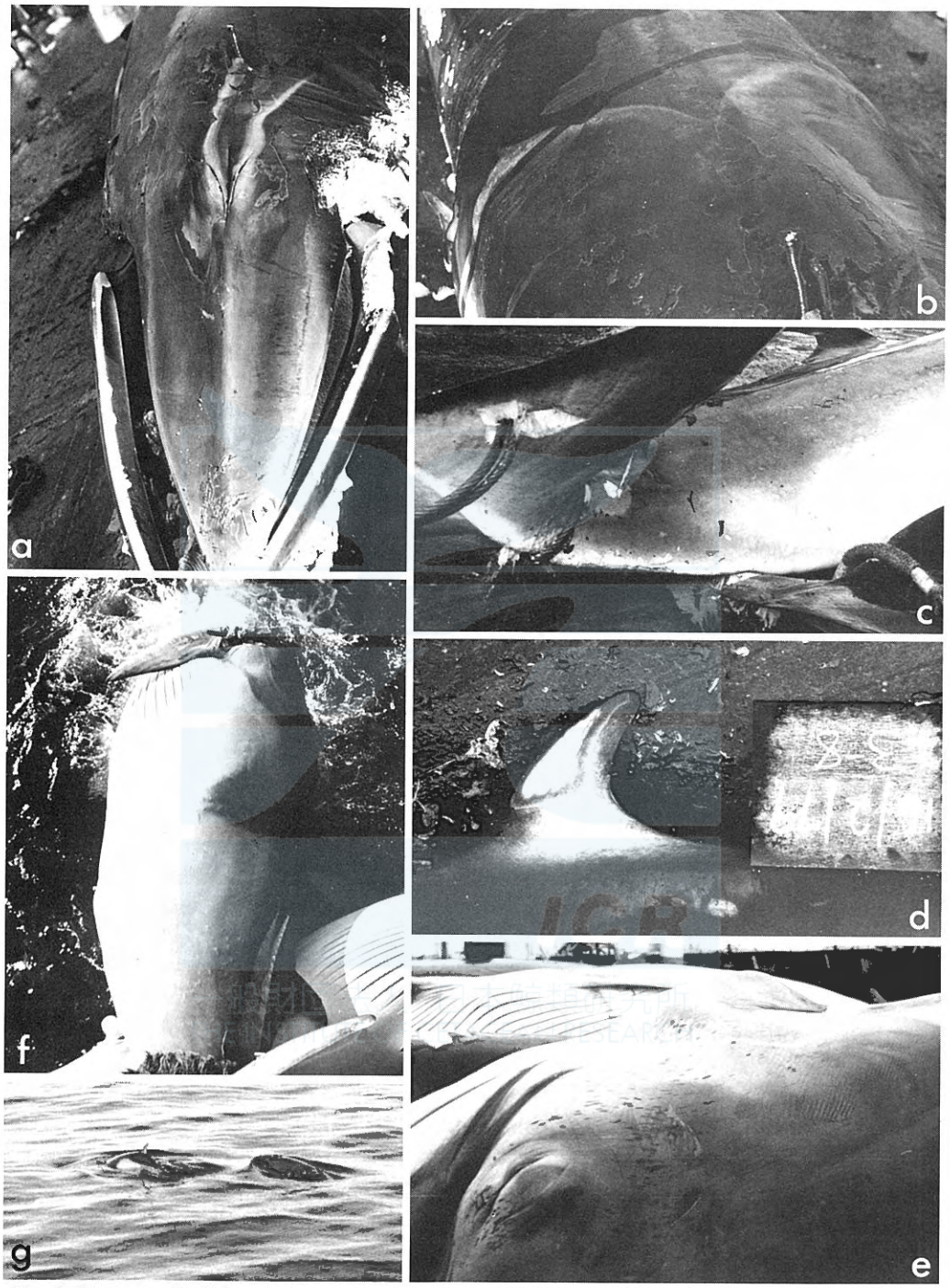


Fig. 6. Features of minke whale body coloration
a. streaks from blowhole
b. crescent-shaped streaks meeting mid-dorsally
c. chevron marks
d. dorsal fin flare
e. speckling
f. thorax blaze and flank patch
g. flank patch visible at sea

ter. However, it was not mentioned by Williamson (1959, 1961), Van Utrecht and Van der Spoel (1962), or Kasuya and Ichihara (1965).

(iii) *Grey streak up side*

In nearly all the animals examined, a crescent-shaped grey streak extended up each side of the whale above the flipper insertion towards the dorsal midline, where the streaks from either side met (Fig. 6b). This streak appears to be homologous to the pale streak originating near the anterior insertion of the flipper and extending towards the shoulder which was described and figured by Kasuya and Ichihara (1965), although the continuation of the streak as far as the mid-dorsum was not figured by those authors. This feature was seen in all 11 whales inspected at Durban, and in 96.3% of 134 whales examined in the Antarctic. It should be pointed out that this marking (as (ii) above) is most conspicuous in the living or freshly-dead animal, and rapidly fades after death, particularly when the animal is exposed to direct sunlight. Thus although it was not mentioned by Williamson (1959, 1961) or Van Utrecht and Van der Spoel (1962), the lack of previous descriptions of such features may in part represent an unfamiliarity with fresh material. Alternatively the markings may have been overlooked or considered unimportant: photographs of Williamson's (1959) whale no. 2 taken by the present author at the time the whale was flensed clearly show both the blowhole streaks and the crescent-shaped streaks meeting mid-dorsally. No minke whale with Type 3 flippers was examined for this feature at Durban. However a juvenile whale with Type 3 coloration stranded on the South African coast (80/14) shows a similar (but somewhat broader) crescent-shaped mark running from above the flipper towards the mid-dorsum, and there are indications of a similar marking in a whale with Type 3 body coloration stranded in New Zealand (Baker 1983). Consequently it is possible that this feature is common to all or nearly all southern minke whales.

(iv) *Caudal chevrons*

On most minke whales examined, the dark dorsal pigmentation extended ventrally as a pair of curved "chevrons" (pointing anteriorly), situated either side of the base of the tail on the caudal peduncle (Fig. 6c). Such markings were present in 80.3% of the 142 whales examined in the Antarctic for this character, all of which had Type 1 or 2 flipper coloration. No whales were inspected for this character at Durban. There were indications of possible chevron markings in a stranded minke whale from the South African coast that had Type 3 flippers (80/14), but the skin in the peduncle region was badly damaged.

(v) *Dorsal fin flare*

Some southern minke whales had a grey flare on the posterior half of the dorsal fin (Fig. 6d), as seen in some *Lagenorhynchus* species (see Fraser,

1966). This was very variable in intensity, and could be detected in only 55.4% of 74 minke whales examined in the Antarctic for this feature. It could not be detected in the only three whales with Type 3 flipper coloration that were examined, all of which were juveniles stranded on the South African coast, but because of the variability in this feature it is impossible to say whether such flares are only found in whales with Types 1 and 2 coloration.

(vi) *Speckling*

In some minke whales examined, small dark, irregularly-shaped speckles were present mid-laterally, usually at the border between the dark grey dorsal and the white ventral coloration (Fig. 6e). They were very variable in number, most often occurring in the region between the eye and the flipper insertion, but sometimes extending past the tip of the flipper and as far back as the level of the anus. Such speckling was seen in 63.6% of 11 whales landed at Durban but in only 30.7% of 114 whales examined in the Antarctic: all the whales examined in both localities had Type 1 or 2 flipper coloration. Such a character was not seen in two Type 3 coloration minke whales examined that stranded on the South African coast (72/8, 80/14), but because of its great variability in Type 1 and 2 animals it is impossible from this small sample size to determine whether Type 3 animals do or do not exhibit this feature.

Although it was not the subject of systematic recording, a conspicuous feature of the body pigmentation of most southern minke whales with Type 1 and 2 coloration at Durban and in the Antarctic was a light grey flank patch. Starting at the angle of the gape and progressing posteriorly, the border between the dark pigmentation of the back and the white of the belly initially ran between the angle of the gape and the anterior insertion of the flipper. Between the axillary region of the flipper and the caudal peduncle, however, this border extended dorsally twice (Fig. 6f). The first extension (or "thorax blaze") ran diagonally up from the axilla and then diagonally back again to about the same level, forming a roughly triangular invasion of light grey pigment dorsally. The second dorsal extension commenced only a short distance posterior to the completion of the first. The anterior border of this extension was nearly vertical and continued much farther dorsally than the "thorax blaze". Its posterior border sloped down gradually towards the midline, where it merged with the white of the ventral surface of the caudal peduncle.

Both Williamson (1959; 1975) and Kasuya and Ichihara (1965) have sketched these two dorsal extensions of light pigment on the side of southern minke whales (and Ohsumi *et al.* 1970 referred to "slight waves" in the transitional zone between dorsal and ventral pigmentation along the side of the body), but only in the illustration provided by Williamson (1975) was the prominence of the more posterior (flank) patch sufficiently stressed. This patch can be clearly seen at sea if the whale rounds its back before submerging (Fig. 6g): a photograph in Kellogg (1940) shows the flank patch and

thorax blaze in the living animals particularly well. Presumably it was also the flank patch that was referred to in Lillie (1915) as "a characteristic triangular patch of lighter colour... on either side of the back, in the region of the dorsal fin." A sketch accompanying this description shows the patches in dorsal view. The flank patches can in fact be most conspicuous from the air (pers. obs.), when in dorsal view they are seen extending up either side in front of the dorsal fin, which is therefore situated in a comparatively narrow strip of dark pigment extending along the middle of the back of the posterior half of the whale.

The thorax and flank patches seemed to be present in the majority of minke whales landed at Durban and in all minke whales examined in the Antarctic. In the three stranded animals with Type 3 flipper coloration examined on the South African coast, both thorax and flank patches could be discerned, although the latter was faint. Their position also appeared further anterior than in minke whales with Type 1 or 2 coloration, the thorax blaze terminating just posterior to the tip of the flipper and the flank patch about the level of the dorsal fin. A third, tongue-like dorsal extension of lighter pigment could be detected in all three animals between the dorsal fin and the fluke insertion, here termed the peduncle patch. This was not noted in animals with Type 1 or 2 flipper coloration, and may be typical of Type 3 animals. Baker (1983) refers to two or three deep scallops of pale pigment along the flanks in minke whales with Type 3 body coloration, whereas a photograph of a minke whale stranded at Dargaville, New Zealand, with Type 3 body coloration and all−white baleen clearly shows a third, peduncle patch (photograph supplied by M.W. Cawthorn).

MORPHOMETRICS

Total Length

Southern minke whales in general are estimated to reach sexual maturity at 7.19 m (23.6 ft) or 7.59 m (24.9 ft) in males (Ohsumi and Masaki, 1975; Best, 1982), and 8.0 to 8.1 m (26.2 to 26.6 ft) in females (Best, 1982; da Rocha, 1980; Doroshenko, Kuzmin, Nikolsky and Patsenko, 1974; Ohsumi and Masaki, 1975). Asymptotic lengths are 8.5 to 8.6 m (27.9 to 28.2 ft) in males and 8.93 to 8.99 m (29.3 to 29.5 ft) in females (Best, 1982; Ohsumi and Masaki, 1975).

In Table 4 details of length, sex and maturity are provided for 13 minke whales landed at Durban between 1970 and 1973 which are considered (on the basis of exhibiting at least two of the pigmentation characteristics) to be Type 3 animals. Four males, ranging from 6.71 to 6.83 m in total length, were classified as sexually mature based on a histological examination of their testes, and the weight of their larger testis was from 0.64 to 1.10 kg (mean 0.875 ± 0.114 kg), about four times heavier than the average for their size (Best, 1982). The largest male examined was 7.62 m long, but this animal was

TABLE 4. PIGMENTATION, AGE AND REPRODUCTIVE DETAILS OF MINKE WHALES LANDED AT DURBAN WITH TYPE 3 CHARACTERS

Platform no.	Length (m)	Sex	Date killed	Flipper colour	Pigment on grooves?	% white baleen	Width of black stripe % plate width	Age (=GLGs)	Testes Wt (g)	Testes Maturity	Ovaries Wt (g)	Ovaries Diameter c. luteum (cm)	Ovaries Diameter c. albicans (cm)	Uterus diameter (cm)	Remarks
837	6.96	F	25 May 1970	(L) Type 3 (R) Type 3	–	(L) 54.9 (R) 100	–	14 ?	–		–	–	–	7,8	
874	6.68	M	26 May 1970	(L) Type 3 (R) Type 3	Yes	(L) 100 (R) 100	–	17 ?	450, 435	–					
891	7.77	F	28 May 1970	(L) Type 3 (R) Type 3	Yes	(L) 100 (R) 100	–	30 ?			–	–	–	7,8	
1634	6.40	F	10 Aug. 1970	(R) Type 3	–	(L) 100 (R) 100	0	–			55, 40	4.0 0	0 2.2	3,4	
1214	6.15	F	26 May 1971	–	–	(R) 100	0	–			–	–	–	–	
981	7.62*	M	19 May 1973	(L) Type 3	Yes	(L) 55.7	0	10 ?	–	–					
1037	6.81	M	23 May 1973	(R) Type 3	–	(?) 68.2	–	21	1040, 880	Mature					
1245	7.37	F	19 June 1973	–	–	(R) 100	0	27 ? +			105, 95	0 0	2.5,1.45,1.05 0	6.25,5	Lactating
1246	6.71	M	19 June 1973	–	–	(L) 54.2	6	13 ?	720, 540	Mature					
1247	6.40	F	19 June 1973	(R) Type 3	Yes	(R) 70.5	4.3	–			45	0	0	5,3.75	One ovary lost
1248	6.83	M	19 June 1973	(R) Type 3	Yes	(R) 100	2.6	13	1100, 880	Mature					
1295	7.32	F	26 June 1973	–	–	(L) 68.2	7	–			70, 55	2.03 0	2.6 0.95	2,2.25	
1319	6.76	M	28 June 1973	(L) Type 3	–	(L) 91.7	2.4	19	640, 580	Mature					

* Measured to nearest foot (0.3 m)

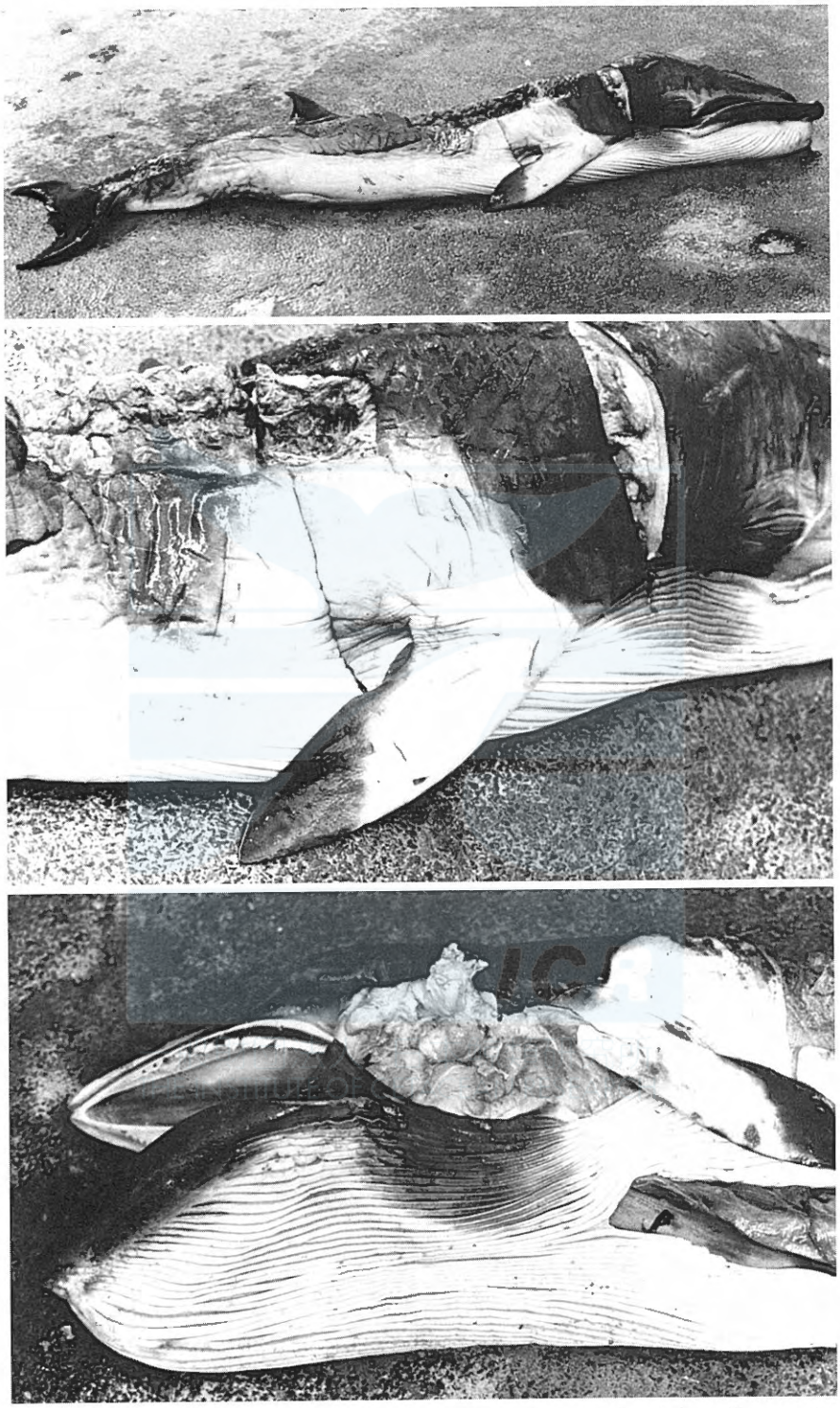


Fig. 7. Stranded newborn minke whale at Kommetjie, Cape Peninsula (PBB 72/8)

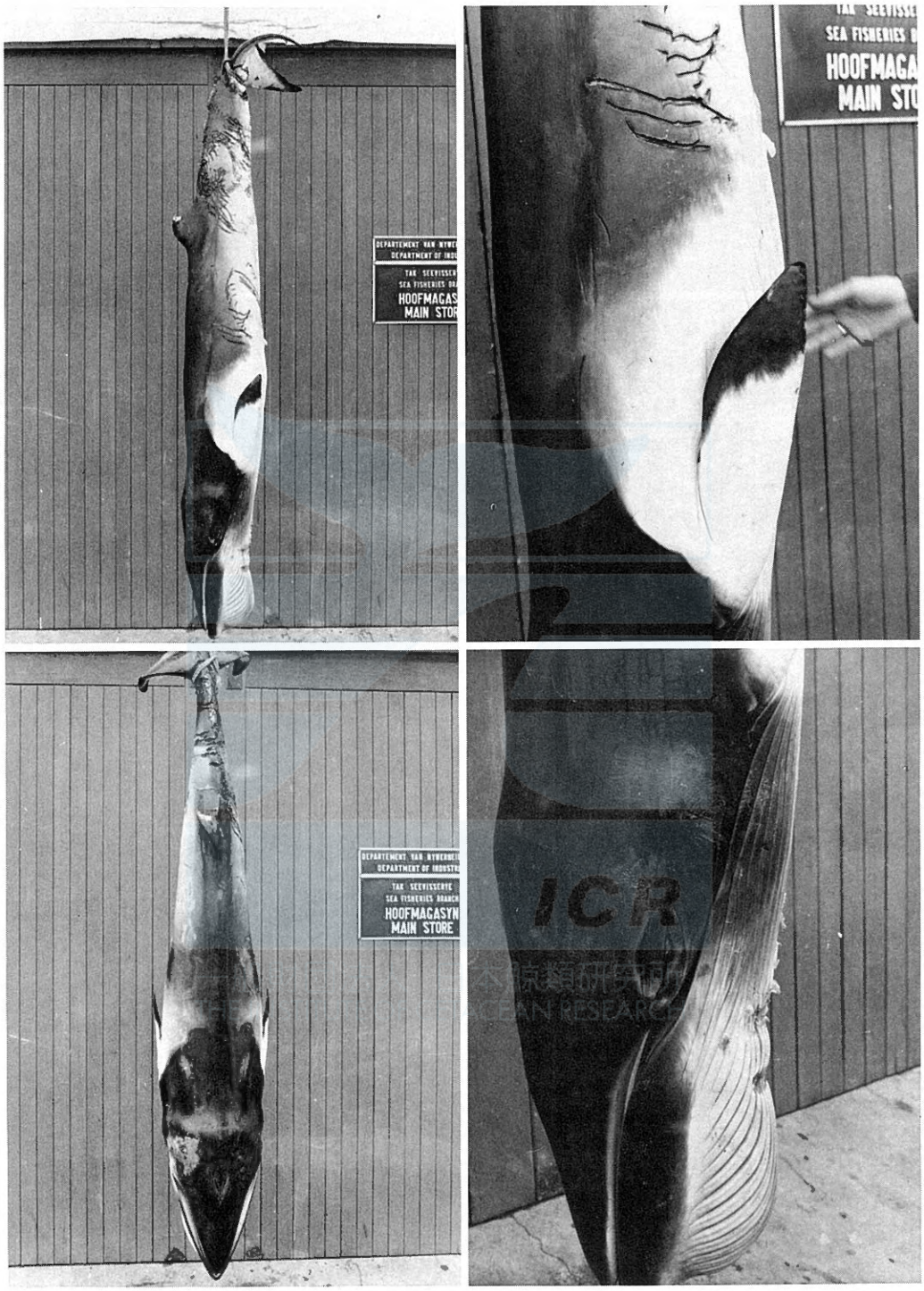


Fig. 8. Stranded juvenile minke whale at Gordons Bay, South Africa (PBB 80/14).

not measured as accurately as the others; the largest reliably-measured male was 6.83 m. Three females, ranging from 6.40 to 7.37 m in length, were classified as mature based on the presence of one or more corpora lutea or albicantia in the ovaries. The largest of these had three ovarian corpora, but was 0.5 m smaller than the smallest mature female with Type 1 or 2 coloration examined at Durban. The largest female examined was 7.77 m long.

The three whales with a 'white spot' on the flipper from Brazil mentioned by da Rocha and Braga (1982) also matured at an unusually small size. Two males 6.92 and 7.13 m in length were mature, each with a larger (?) testis weighing 1000 g, while a female 7.62 m long had eight ovarian corpora.

It seems clear that whales of this colour phase are significantly smaller than normally-pigmented southern minke whales, but with the small sample size available it is impossible to say how much smaller.

Further evidence of their diminutive nature comes from two juveniles stranded on the South African coast. A male minke whale 1.92 m long found dead on the beach at Kommetjie (Table 3) had a raw and completely unhealed umbilicus, while the lungs were air-filled, indicating a very recent live birth. The typical Type 3 flipper and associated body coloration was visible (Fig. 7). A male minke whale 2.54 m long seen swimming very slowly in Gordons Bay harbour, where it died later the same day (Table 3), had some severe lacerations to the posterior half of the body that were attributed to sharks. Its umbilicus was completely healed, both baleen series were fully erupted and there was heavy lungworm infestation in all bronchi, indicating an animal that had been alive for some time. The typical Type 3 flipper and associated body coloration was also visible on this animal (Fig. 8), and the baleen plates were all white.

The normal length at birth for southern minke whales is not well established, but most estimates lie in the range 2.7 to 2.9 m (Best, 1982; Ivashin and Mikhalev, 1978; Ohsumi and Masaki, 1975). While there may be considerable variation in this parameter, and strandlings may not be typical of normal newborn calves, the Kommetjie animal was only 68.5% of the estimated mean birth length, while the Gordons Bay animal was 74.1% of the length of the next smallest calf recorded with a healed umbilicus (Best, 1982). These examples suggest that whales of the Type 3 colour phase are born at a significantly smaller size than normally pigmented southern minke whales.

Body Proportions

Body measurements other than total length are available for only two whales with Type 3 coloration, the stranded juveniles 72/8 and 80/14. These, expressed as proportions of total length, are compared in Table 5 with similar measurements for six other juvenile minke whales (< 4 m long) stranded on the South African coast, and with measurements of 12 adult Antarctic minke whales (from Ohsumi *et al.*, 1970). In only two measurements did the values for both Type 3 animals fail to fall within the range for the six other juveniles,

TABLE 5. BODY PROPORTIONS (AS % TOTAL LENGTH) FOR SOUTHERN MINKE WHALES

Measurement	Type 3		Field no. & sex Type 1 or 2						Ohsumi et al. (1970) Range	Mean
	72/8 (M)	80/14 (M)	73/12 (F)	80/28 (M)	76/26 (F)	81/15 (F)	78/23 (M)	75/11 (F)		
Total length (cm)	192	254	301	341	343	345	353	377	710 – 930	
Tip of snout to centre of anus (%)	72.5	72.8	70.4	72.7	73.8	71.3	72.2	70.7	68.7 – 76.4	73.0
Tip of snout to centre of genital aperture	64.9	65.6	68.1	64.5	70.6	68.4	62.9	67.6	64.4 – 70.9	66.5
Tip of snout to tip of dorsal fin	71.5	71.3	76.1	73.6	72.9	74.8	74.8	73.1	(70.0 – 74.0	71.5)[2]
Tip of snout to ant. insertion dorsal fin	63.6	64.6	68.1	66.9	66.5	67.8	67.4	67.1	–	
Tip of snout to centre of umbilicus	54.3	52.4	52.8	51.9	52.5	53.0	49.9	51.5	47.5 – 62.4	53.7
Tip of snout to post. extremity ventral grooves	51.5	48.6	49.5	49.3	51.3	48.4	46.7	48.0	43.5 – 54.8	48.0
Tip of snout to ant. insertion flipper	31.5	28.9	30.2	30.5	30.0	28.7	28.9	27.7	24.0 – 32.0	29.3[4]
Tip of snout to external auditory meatus	25.2	24.2	27.2	24.9	25.1	24.6	–	23.6	23.4 – 27.0	25.1[3]
Tip of snout to angle of gape	18.2	17.9	20.6	18.0	21.6	18.3	20.1	17.2	17.1 – 20.5	18.7
Tip of snout to centre of eye	19.2	18.3	20.6	18.6	17.8	18.8	19.3	18.2	18.3 – 22.0	20.0
Tip of snout to centre of blowhole	13.2	14.0	15.0	14.5	13.4	13.9	13.0	13.3	12.2 – 16.0	14.3
Girth, at axilla	–	46.5	53.2[1]	47.5[1]	44.9[1]	52.2[1]	44.8	46.7[1]	–	
Girth, maximum	–	47.4	53.2[1]	47.5[1]	–	52.2[1]	44.8	49.3[1]	–	
Girth, at anus	28.5	27.0	–	29.9[1]	28.6[1]	29.3	28.6	31.0[1]	–	
Girth, midway anus to notch in flukes	–	17.7	–	20.5[1]	–	19.6	19.8	–	–	
Height of body at same locality	–	7.3	–	8.7	–	8.4	9.6	–	–	
Projection of lower jaw beyond upper	1.0	1.0	~0.8	0.9	0.4	0.4	1.3	0.7	–	
Centre of eye to external auditory meatus	–	6.1	6.6	6.5	5.8	5.8	–	5.8	4.7 – 5.7	5.1
Centre of eye to blowhole	–	10.8	12.0	11.1	11.4	10.4	9.9	10.5	–	
Blowhole length	4.0	3.9	3.5	4.0	3.1,3.4	4.5	3.1	3.1	–	
Blowhole width	2.3	2.2	2.2	2.8	–	1.9	1.4	1.6	–	
Eye length	1.5	1.4	1.5	1.3	1.2	1.7	2.0	1.3	–	
Eye height	–	0.3	0.4	–	–	0.5	0.6	0.2	–	
Length of genital slit	4.6	4.8	5.3	4.7	–	9.3	3.4	6.1	–	
Length of anal opening	1.3	1.4	0.2	1.8	–	0.7	0.7	0.5	–	
Flipper, length, ant. insertion to tip	19.2	16.5	19.9	17.6	16.9	18.0	15.6	16.2	12.5 – 17.5	15.8
Flipper, length, axilla to tip	12.6	11.7	12.1	12.3	11.1	12.8	12.0	10.6	–	
Flipper, maximum width	5.3	4.0	4.2	4.1	4.1	3.5	3.7	3.4	2.8 – 4.1	3.7
Dorsal fin, height	5.6	4.8	5.1	5.0	3.4	3.6	3.3	3.6	3.0 – 4.2	3.7
Dorsal fin, length of fin base	8.3	8.9	11.3	8.8	6.1	6.5	8.5	6.1	3.7 – 7.7	5.5
Flukes, width tip to tip	24.2	23.0	23.3[1]	24.3	19.5	24.6	20.1	24.1	25.1 – 35.8	29.0
Flukes, nearest point on ant. margin to notch	8.3	7.5	8.0	6.7	7.3	7.5	4.5	8.0	–	
Flukes, depth of notch	1.7	1.2	0.8	1.5	1.3	0.9	1.1	0.9	–	

[1] Measured half-way and then doubled
[2] To posterior emargination of dorsal fin, not tip
[3] Obtained by adding two measurements
[4] Obtained by subtracting two measurements

these being measurements concerning the position of the dorsal fin, which was apparently situated further forward in the Type 3 animals. Unfortunately the relevant measurements for the Antarctic minke whales are not comparable, being recorded to the posterior emargination of the dorsal fin rather than its tip or anterior insertion. Furthermore, Doroshenko (1979) reported small differences in the relative position of the dorsal fin between populations of southern minke whales, so the significance of the present finding remains uncertain until larger samples of Type 3 animals from different localities have been compared.

Both Type 3 animals measured differed from the sample of Antarctic adults in measurements concerning the size of the dorsal fin and the width of the tail flukes. The height of the dorsal fin was greater and the width of the tail flukes less in the Type 3 animals, but as the other juveniles examined appeared to be closer to the Type 3 animals in these measurements the differences may simply represent ontogenetic change. The length of the dorsal fin base is a particularly subjective measurement, and the differences shown here may arise mainly from differences in interpretation between Japanese and South African researchers.

Number of Ventral Grooves

These were normally counted (as recommended by Williamson, 1973) in the region between the eye and the flipper insertion, starting with the most dorsal (and smallest) groove and continuing to the mid-ventral groove (identified by tracing its path from the tip of the lower jaw). The counts are therefore essentially half-counts of the maximum number of grooves.

In the two stranded Type 3 animals these numbered 38 (72/8) and 27 (80/14) respectively, while in another five juveniles examined with Type 1 or 2 coloration the counts ranged from 22 to 38 with a mean of 32.8. Ohsumi *et al.* (1970) gave a range of 26 to 30 grooves in three animals with a mean of 28, and Williamson (1961) a single count of 30. These are all in reasonable agreement, indicating no significant difference in this character between Type 3 and other southern minke whales. In much larger samples, however, Doroshenko (1979) gave mean values (presumably for total counts) of 46 for two different populations ("Indian" and "New Zealand"), while for the Brazilian population da Rocha (1980) found a range of 15-35 with a mean of 22 in half-counts of grooves and Singarajah (1984) a mean of 47 in whole counts for both sexes. These results seem rather low compared to the present data, and may either represent population differences or (more likely) differences in interpretation. Da Rocha and Braga (1982) also give ventral groove counts of 19 to 29 (mean 23.7) for three minke whales landed in Brazil with (apparently) Type 3 flipper coloration, and state that the number and position of ventral grooves were "normal".

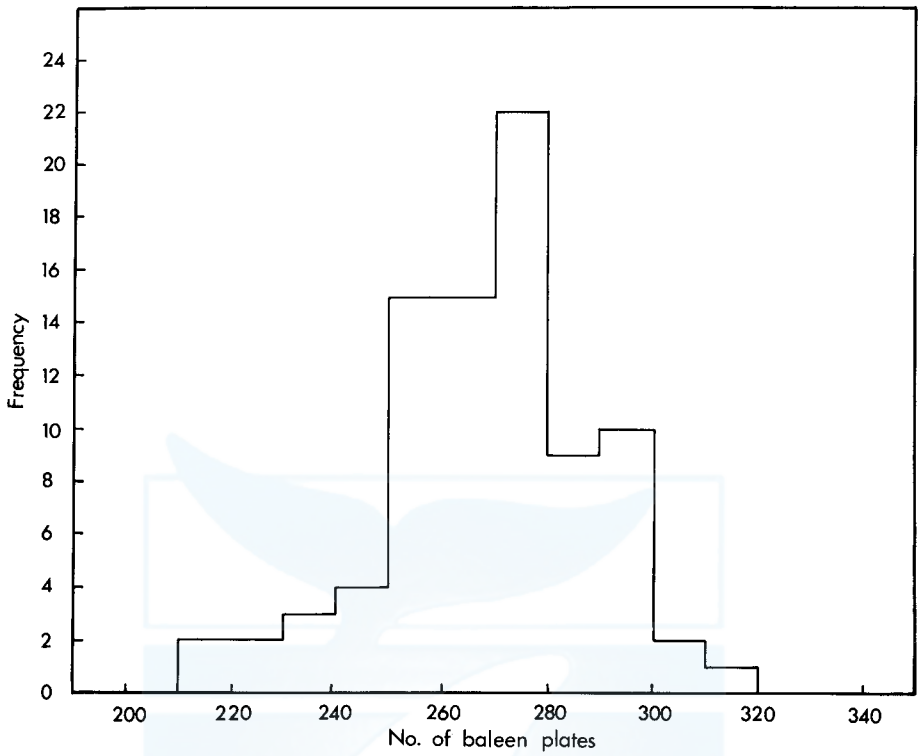


Fig. 9. Counts of baleen plates in minke whales at Durban.

Number of Baleen Plates

During the 1969 season at Durban, the whaling inspectors counted the number of baleen plates on one side of the mouth in 88 whales landed. These counts ranged from 215 to 310, but with three outlying counts of 135, 151 and 154. The latter are considered to be probable errors in recording, and have been omitted from the subsequent analysis.

The means of counts of left and right series were not significantly different (t-test, $p > 0.2$, $df = 83$), the samples being independent as they were from right and left sides of different animals, and so the data have been combined (Fig. 9). The distribution of counts approximates to a normal distribution, for which the mean was calculated as 268.3 ± 2.1.

Previous counts of baleen plates in southern minke whales are in general agreement with these values (270 either side-Van Utrecht and Van der Spoel, 1962; 247 on left side and 264 on right – Williamson, 1961), though Ohsumi *et al.* (1970) listed one animal in the four they examined with 359 plates on one side, more than in any animal examined at Durban. The remaining four series of baleen they counted ranged from 261 to 302. Doroshenko (1979) gives the mean number of baleen plates in the "Indian" population of minke whales as 242 and in the "New Zealand" population 274. Da Rocha (1980)

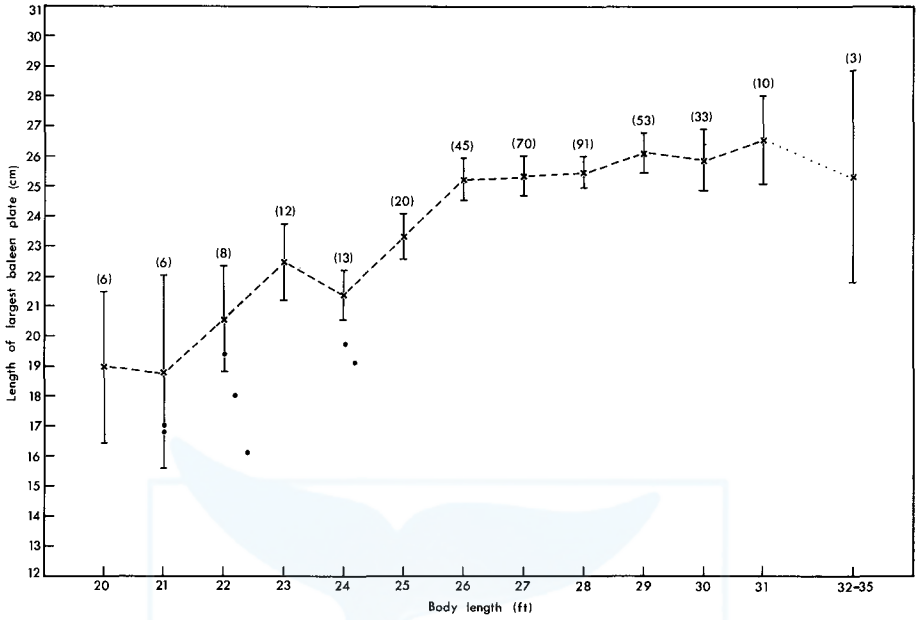


Fig. 10. Length of largest baleen plate against body length in minke whales at Durban (cross and vertical line = mean ± two standard errors for Type 1 and 2 whales, sample size in brackets; solid dot = individual data for Type 3 whales).

found a median value of 273 (range 155 to 415) in 246 minke whales from Brazil, while Singarajah (1984) gives an average count of 237 excluding hairs. There is no indication from these data of polymorphic variation.

The juvenile stranded at Kommetjie had 200 baleen plates on the left and 205 on the right, outside the range for Durban animals, but both series were incompletely erupted. The Gordons Bay juvenile had 251 plates on the left and 244 on the right, well within the range recorded at Durban. From this small sample, therefore, there does not seem to be any evidence of a significantly different number of baleen plates in minke whales with Type 3 coloration.

Dimensions of Baleen Plates

The largest baleen plates in minke whales with Type 1 and 2 coloration reached an average length of 25 to 27 cm in adult animals from Durban (Fig. 10). Other minke whales with this coloration have had baleen plates measured at 28 and 29 cm (Williamson, 1961), 30 cm (Van Utrecht and Van der Spoel 1962) or 22 – 26.1 cm (Ohsumi et al., 1970) in length. The largest baleen plates in the seven whales with Type 3 coloration examined did not exceed 20 cm and averaged 18 cm in length (Fig. 10). Even when whales in the same size range are compared, the values for the Type 3 animals all fall below the averages for Types 1 and 2, indicating that in relative terms also Type 3 whales seem to have shorter baleen plates for their size.

The shape of the longest baleen plates (as portrayed by the proportion breadth/length) did not differ significantly between Type 3 whales (average 0.43 ± 0.02, n = 5) and Types 1 and 2 whales (average 0.48 ± 0.01, n = 34), when the comparison was restricted to animals of the size range 21 to 24 ft ($t = 1.64$, $p > 0.10$). Overall, the proportion for minke whales with Type 1 and 2 coloration at Durban ranged from 0.37 to 0.78, with a mean of 0.51 ± 0.04 (n = 331): this compares with published values elsewhere of 0.42 to 0.64, with a mean of 0.52 (Ohsumi *et al.*, 1970).

DISCUSSION

In summary, two colour phases were found amongst the minke whales landed at the Durban whaling station. The majority of animals had asymmetrically-coloured baleen, in which the right side bore a larger number of anterior white plates than the left, and in which the remaining plates had a black outer border whose width amongst the largest plates averaged about 31 or 34% of the width of the plate, depending on which series was examined. These animals also had flippers whose pigmentation could be described as either plain or two-tone (Type 1 or 2) but on which white patches were never found. There also appeared to be asymmetry in the pigmentation of their flippers, the left flipper generally being brighter in contrast than the right, but there was no correlation between flipper and baleen coloration. The transitional zone between the dark dorsal and light ventral pigments on the neck was on a level with the eye and the flipper insertion. These animals seemed closest to the southern minke whales described by Williamson (1959, 1961), Van Utrecht and Van der Spoel (1962) and Ohsumi *et al.* (1970), although the occurrence of two-tone flippers was not mentioned by these authors. However, the apparent continual range in variation of flipper coloration within this colour phase suggests that the animals with two-tone flippers may have been overlooked. Following Williamson (1959), and taking into account the baleen coloration of the type specimens of *B. bonaerensis* (Burmeister, 1867) and *B. huttoni* (Gray, 1874; Williamson, 1959), Type 1 or 2 whales could be referred to as "*bonaerensis*"-type.

Whales of the second colour phase had all-white baleen or baleen with an unusually large proportion of white plates. The largest baleen plates of these animals were either completely white or carried a narrow black outer border less than 10% of the width of the plate. The flippers carried a striking white patch connected to a roughly circular white blaze on the shoulder (Type 3). There was no asymmetry of coloration in the flippers and little (if any) in baleen coloration. The transitional zone between the dark dorsal and light ventral pigmentation on the neck extended down onto the ventral grooves as a tongue of black pigmentation between the eye and flipper insertion on both sides of the head, to a roughly equal extent. These animals appeared to be born and to reach sexual maturity at a significantly smaller size

than normal southern minke whales, with a dorsal fin possibly situated somewhat farther forward. The largest baleen plates in adults of this colour phase were less than 20 cm in length, compared to an average of 25 to 27 cm in adults of the normal colour phase.

Whales of the latter phase have been described previously only by Baker (1983) and possibly da Rocha and Braga (1982), though neither account makes clear the distinction in baleen coloration between these and normal southern minke whales nor the difference in size. Although there have been other references to southern minke whales with "light" flippers or flippers with white patches (see Introduction), the majority of these have been sightings; it is possible that some of these records may have been of minke whales with Type 2 flippers, which, when seen in the living animal through the water, stand out clearly in contrast to the darker dorsal pigmentation (personal experience of the author).

The incidence of this second colour phase off Durban is low. There is no significant difference between the incidence of Type 3 flippers on right and left sides of the whales (chi-square test, $p > 0.8$, $df = 1$), and their incidence if the data are combined is 3.24% ($n = 370$). The incidence of whales with a black border to the baleen plate less than 10% of the baleen in width also did not differ significantly between left and right sides of the whales (chi-square test, $p > 0.25$, df 1), and their incidence if the data are combined is 3.41% ($n = 469$). The incidence in the catch is therefore estimated to be 3 to 4% of all minke whales landed.

Singarajah (1984) states initially that no minke whales with white stripes on their flippers were found amongst 1745 animals examined in Brazil between 1979 and 1981, but later that on rare occasions (e.g. in 1980 and 1981 about 0.2% of the catch) a second type with a white stripe was recorded. It is not clear whether the latter include the three animals in a sample of 902 minke whales examined in Brazil in 1980, which were described as having a 'white spot' on the flippers, distinct from the 'all-black' flippers normally found (da Rocha and Braga, 1982). If the latter are true Type 3 animals, their incidence off Brazil is apparently even lower than off Durban. However it should be pointed out that in both areas the data originates from whaling operations, where commercial incentives may have resulted in selection for the larger form.

No whales resembling this second colour phase were seen amongst the 161 animals examined in the Antarctic in 1978/79. Photographs and/or sketches of this colour phase were shown to flensing plant foremen and other personnel aboard the *Nisshin Maru no. 3*, and subsequently to Japanese scientists with first-hand experience of Antarctic minke whales. None claimed to have ever seen a whale resembling it, and it must be concluded that this colour phase does not normally migrate to higher latitudes of the Antarctic.

Against this must be balanced the data presented by Wada and Numachi (1979), which seems to show that minke whales with white-banded flippers,

and some with no black outer margin to their largest baleen plate, are found in the Antarctic. Given the authors' own reservations about their data, however, this conclusion must be treated with caution.

Besides Durban (ca 30°S, 31°E) and Costinha, Brazil (ca 7°S, 34°W), whales corresponding to this colour phase have been recorded from several other localities in the Southern Hemisphere (Table 3). These records indicate

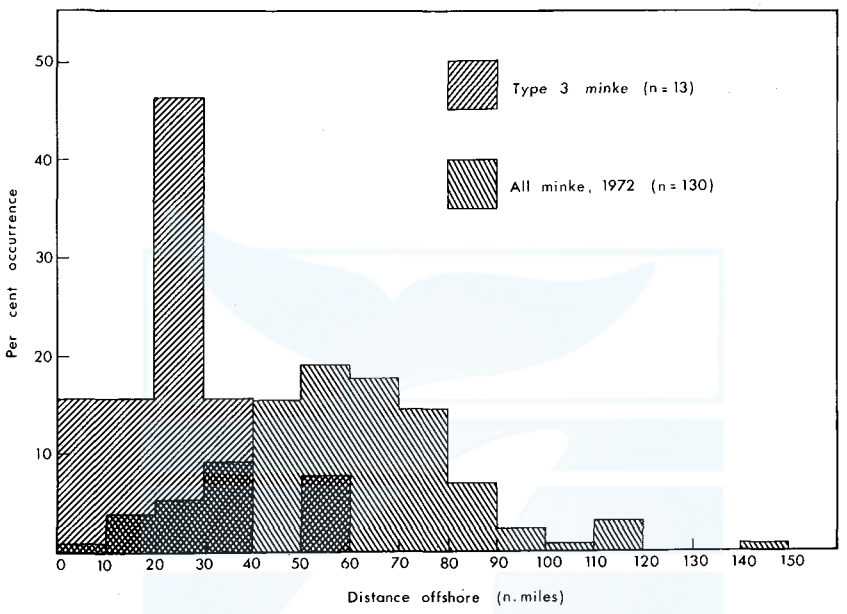


Fig. 11. Distribution of minke whale catches from coast, Durban whaling ground.

a latitudinal distribution from 7° to 41°S, and a presence in all three major oceans. Nowhere apart from the whaling grounds off Durban and Brazil is there a measure of its relative abundance, although Baker (1983) refers to it as "rare" compared to the "common" colour form. Apart from its probable exclusion from the higher latitudes of the Antarctic, the form appears to have the same overall distribution as the Type 1 or 2 animals. Patterns of schooling behaviour, onshore-offshore distribution and seasonality, however, may serve to segregate the animals to some extent.

Inspection of catch positions and times for the 13 Type 3 animals examined at Durban (Table 4) reveals that they were all captured singly, so that there is no evidence of schooling together with Type 1 or 2 animals. The onshore-offshore distribution of catch positions for the same 13 animals has been compared with that for 130 minke whales (coloration type unknown) landed at Durban in 1972 (as extracted from Best and Surmon, 1974, Fig. 1), the data being grouped in 10 n. mile intervals (Fig. 11). The animals with Type 3 coloration were distributed closer inshore than minke whales as a

whole, 77% of them being killed within 30 n. miles of the coast compared to only 10% of all minke whales. The mean distances offshore (27.0 ± 7.5 and 60.0 ± 5.6 n. miles respectively) were significantly different ($t = 5.62$, $p < 0.001$). (The dissimilarity in distribution might have been greater if it had been possible to identify and thus exclude any Type 3 animals killed in 1972). Of the 13 Type 3 animals examined at Durban, 12 (or 92%) were killed in the first half of the season (April to June) whereas in the same years (1970, 1971 and 1973) only 33% of the 530 other minke whales were killed in the same period. These proportions are significantly different (chi-square = 17.4, $p < 0.001$), suggesting a difference in seasonality of occurrence of Type 3 relative to Type 1 and 2 minke whales off Durban. (The alternative hypothesis, that more searching effort was spent inshore in the first half of the season, is considered very unlikely, as it was the last half of the season in which weather usually deteriorated).

Thus, at least for the Durban whaling area, there are indications of some spatial and temporal segregation of minke whales with Type 3 coloration from other minke whales. This segregation was not complete, however, and more information is needed on the seasonal movements and reproductive behaviour of Type 3 minke whales before any conclusions can be reached on the degree of reproductive isolation of this colour form from other minke whales. A decision on the taxonomic status of these animals is therefore premature.

It can be pointed out, however, that the differences in size, body and baleen coloration found between Type 3 and Type 1 and 2 (or "*bonaerensis*"-type) animals are at least as great as those between *B. acutorostrata* from the Northern Hemisphere and "*bonaerensis*"-type animals from the Southern Hemisphere (and the same seems to be true for skull characters – paper in preparation).

ACKNOWLEDGEMENTS

I would like to express my thanks to M.A. Meyer and P.G. Reyburn for their technical assistance in the field and laboratory, to the whaling inspectors K. Botes, R.A.W. Greeff, J.F. Groenewald, H.S. Huysamen, P.C.B. Jurgens, I. Muir, A.C. Paterson, P. van Rooyen, W.E. van Zyl and A. von Litsenborg for their help in collecting data and material, and to B. Mbonambi and P. Mthembu for practical assistance to the whaling inspectors on the flensing platform. M.W. Cawthorn (Fisheries Research Division, Wellington), H. Marsh (James Cook University, Townsville) and G.J.B. Ross (Port Elizabeth Museum) kindly provided information on stranded minke whales from New Zealand, Australia and the Eastern Cape Province respectively.

REFERENCES

AGUAYO, L. A., 1974. Baleen whales off continental Chile. pp. 209–17. *In*: W.E. SCHEVILL (ed.) *The whale problem. A status report*. Harvard University Press, Cambridge, Mass. i–x + 419 pp.

BAKER, A.N., 1983. *Whales and dolphins of New Zealand and Australia. An identification guide*. Wellington, Victoria University Press, 133 pp.

BEST, P.B., 1982. Seasonal abundance, feeding, reproduction, age and growth in minke whales off Durban (with incidental observations from the Antarctic). *Rep. int. Whal. Commn*, 32: 759–86.

BEST, P.B. and L.C. SURMON., 1974. Conservation and utilisation of whales off the Natal coast. *J.S. Afr. Wildl. Mgmt Ass.*, 4 (3): 149–56.

BURMEISTER, H., 1867. Preliminary description of a new species of finner whale (*Balaenoptera bonaerensis*). *Proc. zool. Soc. Lond.*, 1867: 707–713.

DA ROCHA, J.M., 1980. Progress report on Brazilian minke whaling. *Rep. int. Whal. Commn*, 30: 379–84.

DA ROCHA, J.M. and N.M.A. BRAGA., 1982. Progress report on cetacean research June 1980 to May 1981. *Rep. int. Whal. Commn*, 32: 155–9.

DOROSHENKO, N.V., 1979. Populations of minke whales in the Southern Hemisphere. *Rep. int. Whal. Commn*, 29: 361–4.

DOROSHENKO, N.V., A.A. KUZMIN, O.P. NIKOLSKY and N.M. PATSENKO., 1974. A study of the reproduction of the minke whale. *In*: S.M. KONOVALOV (ed.) *Issledovanya po biologii ryb i promyslovojokeanografii* 5: 145–52. TINRO, Vladivostok.

FRASER, F.C., 1966. Comments on the Delphinoidea. pp. 7– 31. *In*: K.S. NORRIS (ed.) *Whales, dolphins and porpoises*. University of California Press, Berkeley and Los Angeles. i–xv + 789 pp.

GASKIN, D.E., 1968. The New Zealand Cetacea. *Fish. Res. Bull.*, 1(n.s.): 1–92.

GASKIN, D.E., 1972. *Whales, dolphins and seals, with special reference to the New Zealand region*. London, Heinemann Educational Books, 200 pp.

GRAY, J.E., 1874. On the skeleton of the New-Zealand pike whale, *Balaenoptera Huttoni* (*Physalus antarcticus*, Hutton). *Ann. Mag. nat. Hist.* 4 (13): 448–452.

GUILER, E.R., 1978. Whale strandings in Tasmania since 1945 with notes on some seal reports. *Pap. Proc. Roy. Soc. Tasmania*, 112: 189–213.

IVASHIN, M.V. and YU. A. MIKHALEV., 1978. To the problem of the prenatal growth of minke whales *Balaenoptera acutorostrata* of the Southern Hemisphere and of the biology of their reproduction. *Rep. int. Whal. Commn*, 28: 201–5.

KASUYA, T. and T. ICHIHARA., 1965. Some informations on minke whales from the Antarctic. *Sci. Rep. Whales Res. Inst.*, 19: 37–43.

KELLOGG, R., 1940. Whales, giants of the sea. *National Geographic Magazine*, 77 (1): 35–90.

LILLIE, D.G., 1915. Cetacea. In: *Brit. Ant. ("Terra Nova") Exp., 1910. Nat. His. Rep. Zoology*, 1 (3): 85–124.

OHSUMI, S. and Y. MASAKI., 1975. Biological parameters of the Antarctic minke whale at the virginal population level. *J. Fish. Res. Bd Can.*, 32: 995–1004.

OHSUMI, S., Y. MASAKI and A. KAWAMURA., 1970. Stock of the Antarctic minke whale. *Sci. Rep. Whales Res. Inst.*, 22: 75–125.

OMURA, H. and K. FUJINO., 1954. Sei whales in the adjacent waters of Japan. II. Further studies on the external characters. *Sci. Rep. Whales Res. Inst.*, 9: 89–103.

SINGARAJAH, K.V., 1984. Observations on the occurrence and behaviour of minke whales off the coast of Brazil. *Sci. Rep. Whales Res. Inst., Tokyo* 35:17–38.

TAYLOR, R.J.F., 1957. An unusual record of three species of whale being restricted to pools in Antarctic sea-ice. *Proc. zool. Soc. Lond.* 129: 325–31.

VAN BEEK, J.G. and J.B. VAN BIESEN., 1982. A review of the morphological and biochemical research on population identification of southern minke whales. *Rep. int. Whal. Commn* 32: 753–8.

VAN UTRECHT, W.L. and S. VAN DER SPOEL., 1962. Observations on a minke whale (Mammalia, Cetacea) from the Antarctic. *Zeits. fur Säugertierk.* 27 (4): 217–21.

WADA, S. and K. NUMACHI., 1979. External and biochemical characters as an approach to stock identification for the Antarctic minke whale. *Rep. int. Whal. Commn* 29: 421–32.

WILLIAMSON, G.R., 1959. Three unusual rorqual whales from the Antarctic. *Proc. zool. Soc. Lond.* 133: 135–44.

WILLIAMSON, G.R., 1961. Two kinds of minke whale in the Antarctic. *Norsk Hvalfangsttid.* 50: 133–41.

WILLIAMSON, G.R., 1973. Counting and measuring baleen and ventral grooves of whales. *Sci. Rep. Whales Res. Inst., Tokyo* 25: 279–92.

WILLIAMSON, G.R., 1975. Minke whales off Brazil. *Sci. Rep. Whales Res. Inst., Tokyo* 27: 37–59.

ZEMSKY, V.A. and D.D. TORMOSOV., 1964. Small rorqual (*Balaenoptera acutorostrata*) from the Antarctic. *Norsk Hvalfangsttid.* 53: 302–5.