

MORPHOLOGICAL STUDY OF PELVIC BONES OF THE MINKE WHALE FROM THE ANTARCTIC

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ABSTRACT

In the 1978-79 Antarctic whaling season a total of 72 pairs of pelvic bone of the minke whale, 36 from males and 36 from females, were collected for morphological study. The basic forms for males and females are thought to be "drum stick" and "knife" respectively, as in the case in the North Atlantic animals. There are, however, very wide range of variation both in males and females and the individual sex can not be determined by the pelvic bone alone.

Existence of ossified remnant of femur was noted in whales exceeding one third of total whales examined, both in males and females.

INTRODUCTION

In the 1976-77 Antarctic whaling season a total of 51 pairs of pelvic bones of the minke whale, 50 from males and one from females, was collected by Japanese expeditions for morphological study. These results have suggested some doubts on sexual dimorphism of the bone, which was confirmed in whales from the North Atlantic, and the size of bones was thought to be a little smaller than those from the North Atlantic, and the presence of the ossified remnant of the femur was noted in some specimens (Omura, 1978).

In the 1978-79 season a total of 72 pairs of pelvic bones, 36 from males and 36 from females, were collected by courtesy of Mr H. Kato on board the whaling factory ship *Nisshin Maru No. 3*. He joined the southern hemisphere minke whale assessment cruise 1978-79, a program of the International Decade of Cetacean Research of the International Whaling Commission, led by Dr Peter B. Best of the South Africa, and after conclusion of the cruise he remained in the factory and carried out biological investigation of whales treated in the factory. Dr P. B. Best had also remained in the factory ship for some time and according to Kato he also helped in collection of the sample. Material thus collected are the basis of this study.

MATERIAL

The pelvic bones were collected from minke whales taken in the Antarctic during a period from 18 January to 3 March 1979, in which period the expedition moved from eastern part of the Area III eastwards to western part of the Area V. As

shown in Table 1 bones were mostly or 75 percent of the total were collected in Area IV. In this table are also shown distribution of body length classes, separately by sexes.

When sampling the bone care was taken in order to secure the remnant of the femur, and thus much meat and other tissues were attached to the bones. These samples were kept frozen in the factory ship and then transported to WRI.

At the laboratory these bones were boiled for some hours in order to remove meat and other soft parts from the bone, each pair is being packed in a small bag made of cotton cloth. Thus all solid bones were secured, even if a very small remnant of femur was present. The bones were boiled again, after removal of all soft parts, for extraction of oil and finally they were dried by direct sun. All of these bones are shown in Plates I-VII. Date and position and other catch particulars of whales from which bones were collected are shown in Appendix Table together with measurements of each bone.

TABLE 1. NUMBER OF MINKE WHALES FROM WHICH SAMPLES OF PELVIC BONES WERE COLLECTED IN THE 1978-79 SEASON

Body length in m	Area III			Area IV			Area V			Total		
	M	F	T	M	F	T	M	F	T	M	F	T
5.5-5.9	—	—	—	—	1	1	—	—	—	—	1	1
6.0-6.4	—	—	—	—	—	—	—	—	—	—	—	—
6.5-6.9	—	—	—	1	2	3	—	—	—	1	2	3
7.0-7.4	—	—	—	—	2	2	1	—	1	1	2	3
7.5-7.9	3	1	4	6	3	9	3	1	4	12	5	17
8.0-8.4	2	2	4	15	6	21	—	1	1	17	9	26
8.5-8.9	—	1	1	5	7	12	—	1	1	5	9	14
9.0-9.4	—	2	2	—	3	3	—	—	—	—	5	5
9.5-9.9	—	—	—	—	2	2	—	—	—	—	2	2
Over 10.0	—	—	—	—	1*	1	—	—	—	—	1	1
Total	5	6	11	27	27	54	4	3	7	36	36	72

M...male, F...Female, T...Total

* 10.1 meter.

RESULTS AND DISCUSSION

According to Burmeister (1867) his whale of *Balaenoptera bonaerensis* was found dead, floating on the river Plata, near Belgrano, about ten miles from Buenos Ayres, by a fisherman, who brought the body on shore. This was a male of 32 feet (9.6 m) long and had the small bone of the pelvis, which is $7\frac{1}{2}$ inches (19.1 cm) long and $1\frac{1}{2}$ inch (3.8 cm) broad in the middle, and of a lanceolate form, being narrowed at both ends. Heyerdahl jr. (1973) found sexual dimorphism in pelvic bones of the minke whale from the North Atlantic, those of the female having the shape of a knife while those of the male look like drum stick. Burmeister's "lanceolate form" may possibly similar to Heyerdahl's "drum stick". In my previous work (Omura, 1978), however, there were wide range of variation in the shape of pelvic

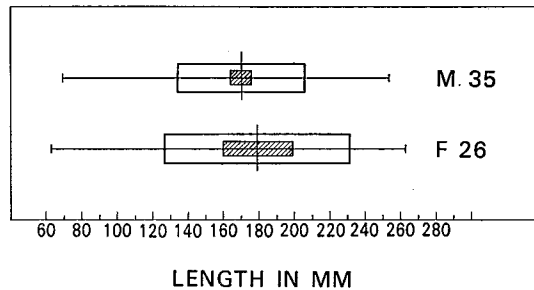


Fig. 1. Comparison of length of pelvic bones of minke whales from the Antarctic between males and females. The horizontal line represents the range; the vertical midline, the arithmetic mean; the outer and inner boxes, the standard deviation and standard error on either side of the mean respectively. The numerals in the figure are sample number of males and females.

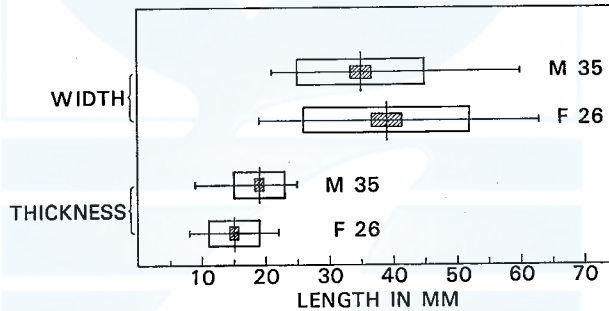


Fig. 2. Comparison of width and thickness of pelvic bones of minke whales from the Antarctic between males and females. See Fig. 1 for explanation.

bone of males, though only one sample from female showed the shape of a knife in general.

In the 1978-79 season pelvic bones were collected from 36 males and 36 females, as shown in Table 1. Photographs of these bones of males are shown in Plates I-III and Figs 1-3 of Plate VII and those of females in Plates IV-VI and Figs 4-7 of Plate VII.

In these figures typical drum stick type may be observed in pelvic bones of males, for example Figs 1, 6 and 8 of Plate I, Figs 2, 8 and 10 of Plate II, Figs 5, 6 and 11 of Plate III. Typical knife shape are observed in pelvic bones of females, for example Figs 1, 2, 6 and 7 of Plate IV, Figs 2, 4 and 7 of Plate V, and Fig. 4 of Plate VI. These two forms are thought to be the basic forms of the pelvic bones of the minke whale from the Antarctic too. There are, however, a good range of variations both in males and females, and it is very difficult or nearly impossible to identify males and females only by the shape of these bones.

In Figs 1 and 2 pelvic bones of males and females are compared of their length, width and thickness. In these cases samples are taken from whales at or above

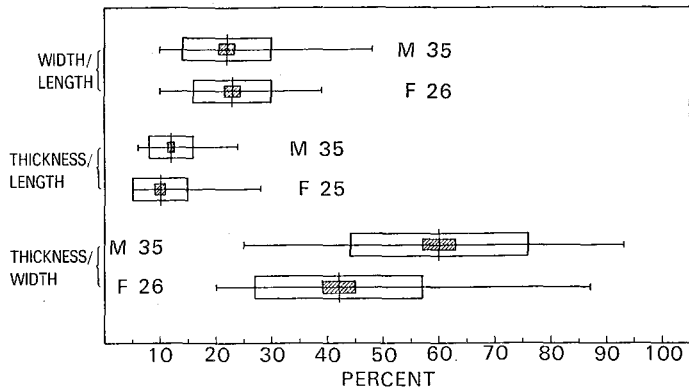


Fig. 3. Comparison of proportion Width/Length, Thickness/Length, and Thickness/Width of pelvic bone of minke whales from the Antarctic between males and females. See Fig. 1 for explanation.

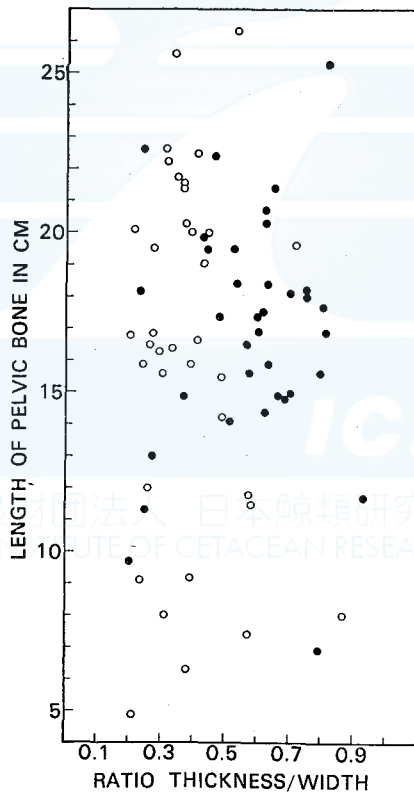


Fig. 4. Relation between length of pelvic bones and ratio Thickness/Width across the promontory in minke whales from the Antarctic. Closed circle indicates male and open circle female.

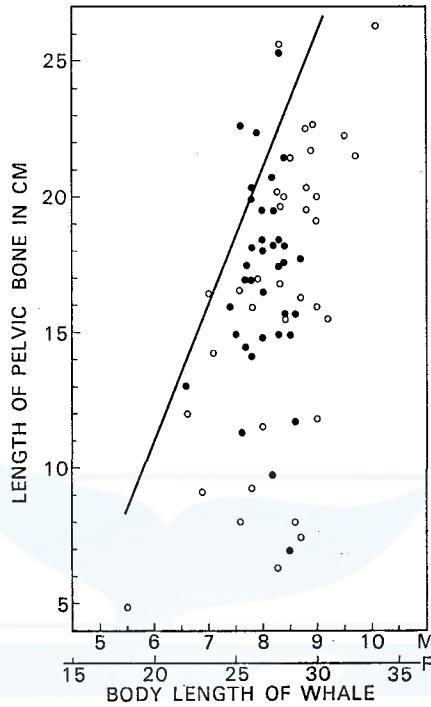


Fig. 5. Relation between length of pelvic bone and body length of minke whales from the Antarctic. The straight line in the figure is the regression line obtained by Hyerdahl jr. (1973) for minke whales from the North Atlantic. Closed circle indicates male and open circle female.

average body length of sexual maturity or 7.2 m or over in males and 8.0 m or over in females (Ohsumi and Masaki, 1975). As seen in Figs 1 and 2 there are no distinction between males and females in the length and width of pelvic bones, but some difference is present in the thickness, in males the bones are somewhat thicker than those in females in general. Width and thickness of bones are measured at their promontories.

In Fig. 3 the proportion width/length, thickness/length, and thickness/width of pelvic bones of minke whales from the Antarctic between males and females are compared. In these cases the distinction between males and females is only noted in ratio thickness/width, but in this case too ranges are overlapping in most parts, suggesting difficulty of identification of sexes individually by means of pelvic bones only.

In Fig. 4 the ratios thickness/width of the pelvic bones across the promontory are plotted against respective length of the bones. Heyerdahl jr. (1973) found that the female bones tend to maintain their proportions while the male bones diverge towards a rounder shape, with the increase of length of the bone. As seen in this figure no such tendency is observed in pelvic bones of minke whales from the Antarctic. There are wide range of variations.

In Fig. 5 the relation between length of pelvic bone and body length of minke whales from which respective bones were obtained. The straightline in this figure is the regression line obtained by Heyerdahl jr. (1973) for minke whales from the North Atlantic. No such regression line can be drawn for minke whales from the Antarctic. It is possible, however, in minke whales from the Antarctic the pelvic bones are smaller than those of minkes in the North Atlantic, as already noted in the preliminary report (Omura, 1978).

Presence of ossified remnant of femur in the minke whales from the Antarctic was already reported in the preliminary report (Omura, 1978), but in that report the occurrence was 25 percent against the total of 51 pairs investigated. This percent of occurrence was very higher than those from the North Atlantic. Heyerdahl jr. (1973) reports none disclosed any trace of a femur, with the exception of one of the 32 X-ray photographs. This was from a 25-ft (7.5 m) female minke whale, with remnants of femur anterior and lateral to the promontory.

TABLE 2. OCCURRENCE OF FEMUR IN PELVIC BONES OF MINKE WHALES FROM THE ANTARCTIC

Area	Male		Female		Total	
	No. examined	Femur present	No. examined	Femur present	No. examined	Femur present
III	5	1	6	4	11	5
IV	27	11	27	9	54	20
V	4	2	3	0	7	2
Total	36	14	36	13	72	27
% Occurrence		38.9		36.1		37.5

As seen in Table 2 in the pelvic bones collected in the 1978-79 season from the Antarctic the presence of ossified remnant of femur was amounted 37.5 percent of the total of 72 animals, showing much higher percent than in the 1976-77 season (Omura, 1978). This is clearly due to the fact that a special caution was paid when sampling the bone, not to miss the bone even it is very small.

The size of the ossified remnant femur bones is different individually and in most cases they present on both sides, but in some specimens it exist only on one side. Measurements of three dimentions of these bones are given in the Appendix Table. Usually these bones are present anterior and lateral to the promontory and apart from the main bone. There present, however, clear articulating tubercles both in the main bone and femur in some specimens and in the extreme cases these bones are completely fused together, as shown in Figs 2 and 6 of Plate IV and Fig. 8 of Plate V.

Burmeister (1867) found no trace of femur in his specimen of *Balaenoptera bonaerensis* and describes "No vestige of an attachment of another bone to any part of its surface is visible; and it is the same with the European species, according to the observation of Eschricht and Reinhart". Since then most authors followed this opinion and Hosokawa (1951) classified baleen whales into the following three

groups from the viewpoint of the rudimentary skeletons pertaining to the hindlimb. Group 1, to which the Greenland right whale belongs, has besides the pelvis two pairs of subsidiary bones of cartilages (femur and tibia). Group 2, in which other than the pelvis only the femur is present, comprises the humpback, the fin whale and perhaps also the blue whale. Group 3, which has neither femur nor tibia but has the pelvis only, seems to comprise the sei whale and the lesser fin whale (minke).

In his group 1 also the black right whale can be added (Omura *et al.*, 1969), and in this case femurs were all ossified. Existence of the femur in the minke whale was first noticed by Heyerdahl jr. (1973), though in his specimen the bone was a nodule of cartilage. In this study it was proved that the existence of the femur in minke whales from the Antarctic is not rare, being exceeded one third of the total minke whales examined, both in male and female. In my previous works on the skeleton of the minke whales (Omura, 1957, 1975; Omura and Kasuya, 1976) also the pelvic bones were reported, but no special statement was made on the presence of the femur. It was first noted in the collection of pelvic bones of minke whales from the Antarctic in the 1976-77 season (Omura, 1978). I have used some of them for covering photograph of the Christmas card 1978 (Fig. 6).

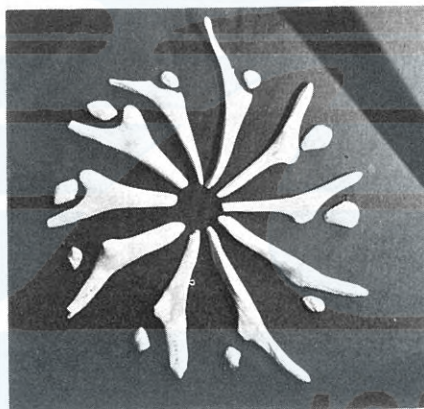


Fig. 6. Some of the pelvic bones of the minke whales from the Antarctic collected in the 1976-77 season. See text for explanation.

Hosokawa (1951) includes the sei whale also in his group 3 i.e. neither femur nor tibia present. However, this may be doubtful. A complete set of skeleton of the Bryde's whale, a very close relatives of the sei whale, was obtained in 1977 for the taxonomic study from the southern hemisphere. The study has not been completed yet, but the whale had a pair of pelvic bones with ossified femurs.

ACKNOWLEDGEMENTS

I am much indebted to Mr H. Kato of the Whales Research Institute and Dr P. B. Best of South Africa for collection of samples of the pelvic bones on board the factory ship *Nisshin Maru No. 3*. Without their help this study could not be carried out.

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PELVIC BONE OF MINKE

APPENDIX TABLE. CATCH PARTICULARS OF THE MINKE WHALE FROM WHICH PELVIC BONES WERE SAMPLED AND MEASUREMENTS OF BONES (1978-79 SEASON)

Whale No.	Date, catch	Sex	Body length m	Position, catch		Area	Measurements in mm							
				Another side			One side		Another side		Femur*	Thick- ness	Femur*	
				Length	Width		Length	Width	Length	Width				Length
				Lat.	Long.		Length	Width	Thick- ness	Femur*	Length	Width	Thick- ness	Femur*
78N1493	20 Jan. '79	♂	8.4	67°-20' S	68°-39' E	III	162	26	22	none	150	29	21	none
78N1562	24 " "	"	7.8	67°-04' S	62°-02' E	"	144	28	14	"	138	27	14	"
78N1574	25 " "	"	8.4	67°-10' S	65°-02' E	"	189	37	18	"	174	40	18	"
78N1603	26 " "	"	7.6	67°-05' S	65°-15' E	"	222	58	14	"	230	62	14	"
78N1637	" "	"	7.6	"	"	"	114	49	11	"	112	47	13	31, 25, 16
78N1414	18 " "	♀	8.3	67°-21' S	68°-10' E	"	201	63	13	"	122+	Broken		none
78N1450	19 " "	"	8.4	67°-24' S	67°-58' E	"	201	44	22	60, 32, 25	199	54	20	43, 21, 22
78N1529	21 " "	"	7.6	67°-32' S	68°-14' E	"	80	32	10	none	80	36	11	none
78N1551	22 " "	"	9.0	67°-34' S	68°-04' E	"	197	30	13	26, 24, 18	184	30	13	26, 22, 18
78N1576	25 " "	"	9.2	67°-10' S	65°-02' E	"	169	34	13	22, 18, 16	141	28	16	none
78N1643	26 " "	"	8.5	67°-05' S	65°-15' E	"	213	50	18	42, 25, 21	215	47	17	40, 22, 22
78N1669	27 " "	♂	8.7	67°-09' S	71°-48' E	IV	172	22	18	none	181	23	18	none
78N1710	28 " "	"	8.5	69°-58' S	72°-11' E	"	69	21	16	"	69	21	17	"
78N1746	29 " "	"	8.3	67°-46' S	73°-09' E	"	253	28	22	28, 24, 24	252	23	19	"
78N1801	2 Feb. '79	"	8.5	67°-46' S	74°-34' E	"	153	29	19	26, 22, 21	145	30	22	25, 24, 20
78N1865	3 " "	"	8.4	67°-38' S	72°-46' E	"	170	41	24	18, 15, 11	179	39	24	26, 19, 16
78N1885	4 " "	"	8.2	67°-47' S	73°-26' E	"	177	35	25	21, 17, 13	187	32	25	none
78N1928	5 " "	"	8.3	67°-52' S	73°-53' E	"	173	32	19	none	175	31	19	"
78N1966	6 " "	"	7.8	67°-56' S	74°-00' E	"	202	24	19	11, 8, 7	203	28	18	"
78N1985	8 " "	"	8.3	67°-11' S	73°-18' E	"	185	37	23	none	182	48	21	"
78N2016	9 " "	"	8.6	67°-19' S	74°-01' E	"	89	27	24	21, 21, 11	144	24	23	24, 19, 17
78N2070	10 " "	"	8.6	66°-14' S	78°-25' E	"	158	40	22	none	153	48	18	none
78N2138	12 " "	"	8.2	65°-42' S	89°-55' E	"	211	40	26	34, 24, 20	203	39	23	29, 21, 17
78N2176	13 " "	"	7.9	64°-51' S	92°-44' E	"	205	36	16	23, 19, 12	243	36	17	23, 17, 14
78N2201	14 " "	"	8.2	63°-50' S	94°-52' E	"	191	48	24	none	199	48	26	none
78N2210	15 " "	"	7.5	64°-02' S	98°-53' E	"	147	31	11	"	151	31	12	"
78N2213	16 " "	"	8.0	64°-40' S	104°-08' E	"	169	20	10	"	161	21	13	"

Continued . . .

APPENDIX TABLE. Continued.

Whale No.	Date, catch	Sex	Body length in	Position, catch		Area	Measurements in mm							
				Lat.	Long.		One side			Another side				
							Length	Width	Thick- ness	Femur*	Length	Width	Thick- ness	Femur*
78N2215	16 Jan. '79	♂	8.0	64°-40' S	104°-08' E	IV	194	46	23	none	196	47	18	none
78N2252	17 "	"	8.2	65°-04' S	106°-15' E	"	95	49	9	"	98	43	9	"
78N2258	"	"	7.8	"	"	"	194	40	17	"	203	41	17	"
78N2300	18 "	"	8.0	65°-17' S	109°-33' E	"	177	28	20	"	183	24	19	"
78N2328	19 "	"	8.3	64°-51' S	111°-18' E	"	175	34	21	"	123	32	22	"
78N2379	20 "	"	8.0	64°-34' S	114°-12' E	"	187	34	19	"	180	37	18	"
78N2406	21 "	"	8.0	64°-29' S	117°-09' E	"	167	22	15	"	129	21	14	"
78N2422	22 "	"	8.4	64°-39' S	117°-45' E	"	217	36	23	26, 17, 14	210	31	20	26, 17, 15
78N2450	23 "	"	6.6	65°-18' S	123°-45' E	"	130	44	12	36, 23, 12	129	43	11	35, 27, 12
78N2488	24 "	"	7.7	65°-14' S	125°-15' E	"	138	21	14	none	149	23	13	none
78N2582	26 "	"	7.7	65°-04' S	128°-47' E	"	171	53	22	36, 27, 25	167	54	21	40, 28, 26
78N1648	27 Jan. '79	♀	8.8	67°-09' S	71°-48' E	"	203	48	17	33, 21, 17	202	48	18	40, 24, 19
78N1782	30 "	"	8.8	67°-46' S	74°-01' E	"	219	28	12	none	231	33	13	none
78N1799	31 "	"	8.3	67°-43' S	73°-42' E	"	252	50	17	25, 15, 12	260	52	16	"
78N1901	4 Feb. '79	"	8.0	67°-47' S	73°-20' E	"	168	31	13	none	164	35	14	"
78N1915	5 "	"	8.0	67°-52' S	73°-53' E	"	112	26	16	"	118	24	13	"
78N1961	6 "	"	8.4	67°-56' S	74°-00' E	"	155	49	14	"	157	48	15	"
78N1983	8 "	"	8.3	67°-11' S	73°-18' E	"	203	19	13	"	189	19	14	"
78N2017	9 "	"	9.7	67°-19' S	74°-01' E	"	227	60	22	29, 21, 15	202	60	21	22, 15, 14
78N2019	"	"	9.0	"	"	"	200	39	16	none	199	44	16	none
78N2109	11 "	"	8.7	66°-07' S	85°-51' E	"	75	26	17	"	73	31	15	"
78N2132	12 "	"	8.9	65°-42' S	89°-55' E	"	217	51	18	"	missed			"
78N2169	13 "	"	8.6	64°-51' S	92°-44' E	"	88	24	21	42, 30, 23	71	26	22	36, 30, 24
78N2200	"	"	9.0	"	"	"	118	21	12	none	missed			none
78N2208	15 "	"	7.9	64°-02' S	98°-53' E	"	170	44	12	30, 14, 13	168	44	12	"
78N2222	16 "	"	8.8	64°-40' S	104°-08' E	"	196	60	16	42, 28, 25	193	61	16	42, 30, 25
78N2224	"	"	10.1	"	"	"	263	34	17	none	263	32	18	none
78N2294	18 "	"	7.1	65°-17' S	109°-33' E	"	141	22	12	"	143	26	11	"
78N2325	19 "	"	9.5	64°-51' S	111°-18' E	"	225	41	13	"	219	40	12	"

78N2370	20	"	"	7.6	64°-34' S	114°-12' E	"	168	51	13	31, 25, 22	161	49	13	29, 24, 20
78N2371	"	"	"	7.0	"	"	"	161	29	10	none	166	28	9	none
78N2403	21	"	"	8.3	64°-29' S	117°-09' E	"	165	41	9	20, 18, 16	170	47	8	27, 22, 19
78N2432	22	"	"	6.9	64°-39' S	117°-45' E	"	91	44	10	15, 14, 12	broken	broken	18	18, 15, 14
78N2466	23	"	"	8.9	65°-18' S	123°-45' E	"	228	56	16	none	223	54	18	none
78N2493	24	"	"	5.5	65°-14' S	125°-15' E	"	49	28	6	"	missed	missed	"	"
78N2523	25	"	"	7.8	65°-18' S	127°-52' E	"	90	26	9	"	93	23	10	"
78N2544	25	"	"	6.6	"	"	"	119	34	8	"	120	30	8	"
78N2574	26	"	"	9.0	65°-04' S	128°-47' E	"	156	25	10	"	161	27	10	"
78N2614	27	"	"	7.8	65°-07' S	131°-22' E	V	180	33	23	"	181	33	23	"
78N2684	2 Mar. '79	"	"	7.4	64°-53' S	133°-45' E	"	161	33	18	24, 15, 14	157	33	23	30, 19, 14
78N2699	"	"	"	7.7	"	"	"	174	46	21	none	174	45	22	none
78N2763	3	"	"	7.8	64°-56' S	134°-38' E	"	168	32	19	24, 21, 17	170	25	15	"
78N2618	27 Feb. '79	♀	"	8.7	65°-07' S	131°-22' E	"	162	38	11	none	164	40	11	"
78N2649	28	"	"	8.3	65°-24' S	131°-55' E	"	63	21	8	"	missed	missed	"	"
78N2725	3 Mar. '79	"	"	7.8	64°-56' S	134°-38' E	"	160	49	11	"	157	44	11	"

* Three dimensions.



EXPLANATION OF PLATES

Pelvic bones of minke whales from the Antarctic collected in the 1978/79 season.

PLATE I

Fig. 1.	78N1493	Male	Fig. 6.	78N1669	Male
Fig. 2.	78N1562	„	Fig. 7.	78N1710	„
Fig. 3.	78N1574	„	Fig. 8.	78N1746	„
Fig. 4.	78N1603	„	Fig. 9.	78N1801	„
Fig. 5.	78N1637	„	Fig. 10.	78N1865	„

PLATE II

Fig. 1.	78N1885	Male	Fig. 7.	78N2138	Male
Fig. 2.	78N1928	„	Fig. 8.	78N2176	„
Fig. 3.	78N1966	„	Fig. 9.	78N2201	„
Fig. 4.	78N1985	„	Fig. 10.	78N2210	„
Fig. 5.	78N2016	„	Fig. 11.	78N2213	„
Fig. 6.	78N2070	„	Fig. 12.	78N2215	„

PLATE III

Fig. 1.	78N2252	Male	Fig. 7.	78N2422	Male
Fig. 2.	78N2258	„	Fig. 8.	78N2450	„
Fig. 3.	78N2300	„	Fig. 9.	78N2488	„
Fig. 4.	78N2328	„	Fig. 10.	78N2582	„
Fig. 5.	78N2379	„	Fig. 11.	78N2614	„
Fig. 6.	78N2406	„			

PLATE IV

Fig. 1.	78N1414	Female	Fig. 6.	78N1643	Female
Fig. 2.	78N1450	„	Fig. 7.	78N1648	„
Fig. 3.	78N1529	„	Fig. 8.	78N1782	„
Fig. 4.	78N1551	„	Fig. 9.	78N1799	„
Fig. 5.	78N1576	„	Fig. 10.	78N1901	„

PLATE V

Fig. 1.	78N1915	Female	Fig. 7.	78N2132	Female
Fig. 2.	78N1961	„	Fig. 8.	78N2169	„
Fig. 3.	78N1983	„	Fig. 9.	78N2200	„
Fig. 4.	78N2017	„	Fig. 10.	78N2208	„
Fig. 5.	78N2019	„	Fig. 11.	78N2222	„
Fig. 6.	78N2109	„			

PLATE VI

Fig. 1.	78N2224	Female	Fig. 7.	78N2432	Female
Fig. 2.	78N2294	„	Fig. 8.	78N2466	„
Fig. 3.	78N2325	„	Fig. 9.	78N2493	„
Fig. 4.	78N2370	„	Fig. 10.	78N2523	„
Fig. 5.	78N2371	„	Fig. 11.	78N2544	„
Fig. 6.	78N2403	„			

PLATE VII

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|---------|---------|------|---------|---------|--------|
| Fig. 1. | 78N2684 | Male | Fig. 5. | 78N2618 | Female |
| Fig. 2. | 78N2699 | „ | Fig. 6. | 78N2649 | „ |
| Fig. 3. | 78N2763 | „ | Fig. 7. | 78N2725 | „ |
| Fig. 4. | 78N2574 | „ | | | |



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