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No. 21

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一般財団法人 日本鯨類研究所
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BLACK RIGHT WHALES IN THE NORTH PACIFIC

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INTRODUCTION

In 1956 two black right whales were taken on the coast of Japan by a special permit for scientific researches under Article 8 of the International Convention for the Regulation of Whaling. The result of researches on these whales have already been published by Omura (1957, 1958). The study contributed to the knowledge greatly, especially in the field of morphology and osteology of this species, but the material was confined only to sexually immature male and female.

Similar permits for taking of the black right whales in the North Pacific were granted to the Whales Research Institute in three consecutive years 1961–63 and also in 1968. Thus in total 13 black right whales were taken to date in the North Pacific, including those caught by the first permit. They include 8 males and 5 females in which two were pregnant, and their sizes range from 11.65 m, a sexually immature female, to 17.10 m, a physically mature male.

The results of studies on these whales have not been published yet in scientific journal, though brief reports were submited to the Scientific Committee of the International Whaling Commission and interim reports written in Japanese have been published in a journal named GEIKEN-TSUSHIN, a kind of newsletter of the Whales Research Institute.

All data obtained from these whales are now incorporated in this paper, except some material gathered in 1968 which are still in the course of study.

MATERIAL

In Table 1 is shown a list of black right whales taken by special permits to date, and in Fig. 1 the position of each whale taken.

As seen from this table and the figure the specimens were taken in rather a vast area of the North Pacific. Two whales were taken on the coast of Japan (56A, 56B), three in the waters south of Kodiak Island (61A, 61B, 61C), six in the Bering Sea (62A, 62B, 62C, 63A, 63B, 63C), and two in the Okhotsk Sea (68A, 68B). The first two and the last two whales were treated at landstations on the coast of Japan, but others were taken by pelagic expeditions which operated in the North Pacific. The materials contained in this paper were collected on board factory ships by S. Ohsumi in the season 1961, by T. Kasuya in 1962, and by T. Nemoto in 1963. They had been there as biologists during the whole season of the respective years. Two whales taken in the Okhotsk Sea (68A, 68B) were treated

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at Mombetsu landstation in Hokkaido and the field observations were carried out by H. Omura, S. Ohsumi, T. Kasuya, A. Kawamura, and S. Machida.

In 1961 two complete sets of skeleton were secured (61A, 61B). The raw bones were transported to Tokyo on board factory ship and later were investigated by the staffs of the Whales Research Institute, after extracting oils contained in them.

TABLE 1. LIST OF BLACK RIGHT WHALES TAKEN IN THE NORTH PACIFIC BY SPECIAL PERMITS

No	Sex	Body length (m)	Date taken	Position taken		Remark
56A*	F	11.65	23 V '56	38°32′ N	143°40′ E	Coast, Japan
56B*	M	12.40	30 VI '56	41°46.8′ N	148°59.5′ E	" "
61A	"	17.10	22 VIII '61	55°54′ N	153°07′ W	Pelagic
61B	"	17.00	" " "	55°54′ N	153°08′ W	"
61C	"	15.10	" " "	55°53′ N	153°06′ W	"
62A	F	14.10	30 VII '62	53°42′ N	171°17′ W	"
62B	M	14.70	10 VIII "	54°30′ N	170°22′ W	"
62C	"	16.10	" " "	54°18′ N	170°21′ W	"
63A	F**	16.10	5 VIII '63	53°52′ N	172°46′ W	"
63B	"***	15.40	" " "	54°04′ N	172°35′ W	"
63C	M	16.40	" " "	54°03′ N	172°50′ W	"
68A	"	15.20	20 VII '68	48°35′ N	145°20′ E	Okhotsk Sea
68B	F	12.60	25 " "	48°14′ N	146°39′ E	" "

* Already reported.
** Pregnant. 218 cm male fetus.
*** " . 270 cm female fetus.

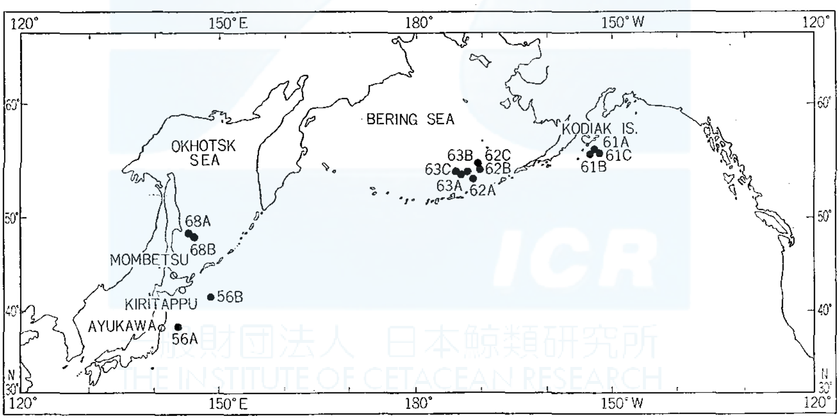

Fig. 1. Chart showing the position of each black right whale taken by special permits.

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Osteology of these skeletons are included in this paper. In 1968 two skeletons were also preserved for osteological study, but these are still in the course of preparation.

In addition to the material mentioned above are included in this paper the sighting data by Japanese whalers to date. These data cover not only those in the North Pacific but also those in the Antarctic, and were generously supplied by the whaling companies.

MORPHOLOGY

Body colour

General colour of the black right whales examined was black or slate-black. However, most whales had a pure white patch of various size on the umbilicus. Furthermore, two whales had also a white patch on the throat. The states of the white patches on the ventral side of each whale are as follows:

Whale No. 61A: Two patches. One was on umbilicus, arrow-shaped, and 18 cm long. Another one was found 40 cm posterior from the former on the anterior right margin of genital groove, and 10 cm in diameter.

Whale No. 61B: Two white patches. Long oval patch (79 × 28 cm) on umbilicus, and another one (31 × 7 cm) on the middle of throat.

Whale No. 61C: Large and pseudomorphic white colour covered over umbilicus and its posterior sides. Some small patches lied scattering.

Whale No. 62A: An oval patch (73 × 18 cm) was on umbilicus.

Whale No. 62B: Long oval patch over umbilicus (90 × 20 cm). The anterior half of palate was white, but baleen plates attached to the palate were black.

Whale No. 62C: Two large patches. One (193 × 200 cm) over umbilicus. This developed to the insertion part of penis, and its left margin developed to the left side of the body posteriorly (230 × 150 cm). Another one was on posterior right side, separated from the former (150 × 200 cm).

Whale No. 63A: Pseudomorphic patch (42 × 15 cm) over the umbilicus. Its margin zigzaged.

Whale No. 63B: Assymmetric zigzag patch (145 × 24 cm) over the umbilicus. On the tip of palmer side of the right flipper, four small white patches were found, Numerus very small patches (1 cm in diameter) lied scattering on the body, especially on the back side of neck and tail.

Whale No. 63C: A very large patch from throat to breast. An oval patch (55 × 30 cm) on the umbilicus. A splashed patch was found on the left axilla. The patches were on the posterior margin of the ventral side of left fluke. Over the tip of palate, a gray colour was found as the same as Whale No. 62B.

Whale No. 68A: Whale body was entirely black, and there was no white patch.

Whale No. 68B: There were three major patches on the abdomen. The anterior one was situated between both flippers, and the smallest among the three patches. It was long oval (72 × 22 cm). The middle one was E-shaped. The size was 97 cm along the body axis, and the width was 127 cm. Posterior one was the largest, and it was also E-shaped. There was umbilicus in the center of the patch. The anterior line of the patch developed to the anterior end of the reproductive groove. The length of the patch was 255 cm along body axis, and the width of one side was 168 cm, which extended beyond the lateral line of the body. There were other two small patches between middle and posterior patches.

The colour patterns of the whales examined are shown in Fig. 2.

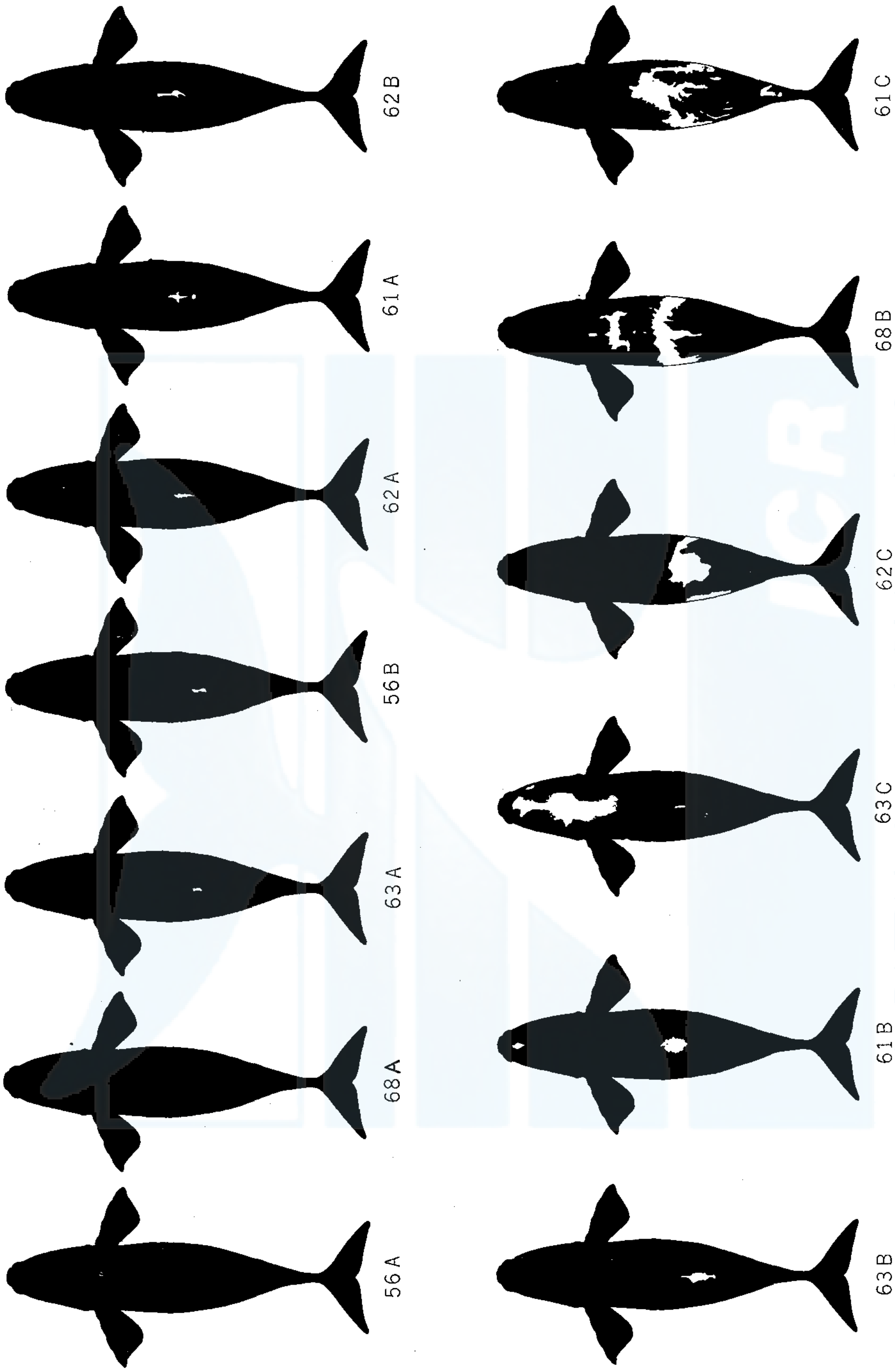

Fig. 2. Schematic drawing showing variation of white patches on the belly of black right whales in the North Pacific.

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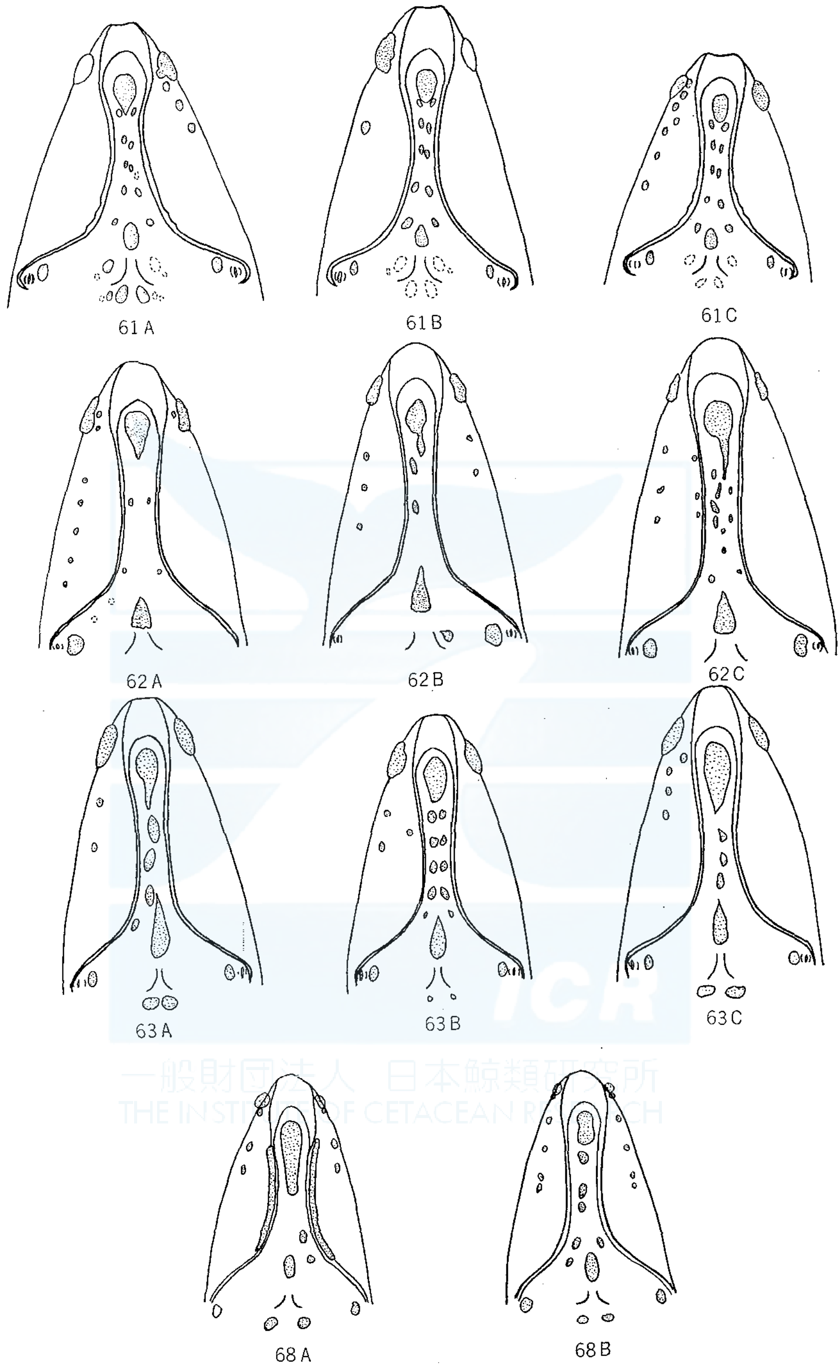

Fig. 3. Schematic drawing of shape and distribution of bonnet and other callosities on the head of black right whales examined, dorsal view.

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The classification of body colouration is as follows:

1. Entirely black: 56B, 68A.
2. Small patch on the umbilicus: 56A, 61A, 61B, 62A, 62B, 63A, 63B.
3. Large patch around umbilicus: 61C, 62C, 68B.
4. Large patch on the throat: 63C (in addition there was small patch on the umbilicus). Whale No. 61B had also small patch on the throat.

We did not found so developed white patch as the whale which was reported by Klumov (1962). The most specimens had patch on the umbilicus, so it may be concluded that the standard black right whale in the North Pacific has white patch on the umbilicus.

Two foetuses were found as shown in Table 1. They were already pigmented completely. There was a star-like white patch around the umbilical cord in the fetus of Whale No. 63A (Plate IX, Fig. 2). A white patch which was developed in lesser extent was also found on the umbilicus of Whale No. 63B fetus. In the latter fetus, there was additional splashed patch on the axilla. From the forgoing facts, it is considered that the white patch develops as early as in the fetal stage, and it is not due to the alternation of the skin by parasites, wound or other secondary causes.

Bonnet and callosities

The bonnet and other callosities which are conspicuous characteristic of the black right whale were found in all whales examined. The distribution and shapes of these callosities are drawn schematically in Fig. 3. The callosities were not observed for most whales on the hidden side of lower jaw at the time of flensing.

There is much individual variation in the number and shape of callosities. The distribution of callosities on the rostrum and mandible is not always in symmetrical arrangement. A pair of large callosities, similar to the bonnet in appearance, was found in the most anterior portion of mandible on all whales examined. The large callosity on the median line of chin was never found for any whales examined.

Whale No. 68A had peculiar callosities along the upper margine of both sides of lower lip as shown in Fig. 4. These callosities lined posteriorly at the position of 160 cm from tip of lower jaw, and the length was 220 cm (curved). Its breadth was 12 cm in anterior portion and 6 cm in posterior portion.

The structure of bonnet and callosity will be classified into three types. The first type is hard and sharp-pointed. Whale No. 56A had callosities of this type. This type was common in the whales examined. The second is hard but flat-headed type. Whale Nos. 68A and 68B had clearly this type of callosities. The third type is not so hard and rather even. Whale No. 61B had this type of callosities. In this individual, only one small callosity was in the left side of lower jaw. Most individuals were heavily infected with whale lice on the bonnet and other callosities, but this whale was poorly infected with them.

It is interesting that there were already bonnet and callosities on the fetues examined, although they were not horny as those on adult whales (Plate IX, Figs. 3 and 4). And the bonnet was a rising on which grew a group of hairs, and each of the other callosities was a rising on which a hair grew in the fetuses. These observations agree with the notes by the Discovery staffs (Matthews, 1938, p 176).

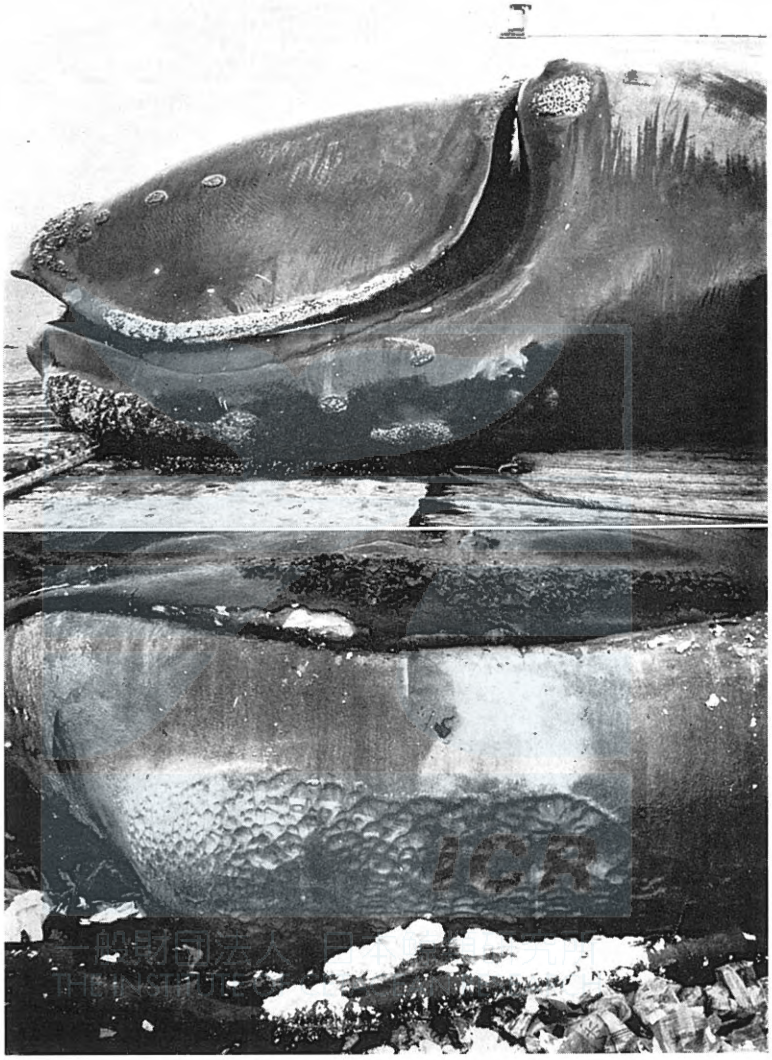

Fig. 4. Bonnet of the Whale No. 68A. For explanation see text.

In 1968 we could make an unexpected observation on the bonnet of the Whale No. 68A. A whale museum was under construction at Taiji, a town in Wakayama prefecture and where the old whaling with nets once flourlished. Before flensing specialists concerned had covered the head, including the bonnet, with gypsum and water for the purpose of making a plaster cast and finally a full-sized big model of this whale for the museum. After the plaster was removed from the head we observed that whole of the epithelium had been loosened from the body. Thus it was very easy to peel off the stratum corneum from the bonnet (Fig. 4, lower photograph). As seen in this photograph the bonnet is still visible as ridges of the corium. Hairs were still remained also. This fact and the observation on two

TABLE 2. NUMBER OF HAIRS ON THE HEAD OF BLACK RIGHT WHALES

Position	Whale No.									
	61A	61B	61C	62B	62C	63A	63B	63C	63A′	68A
Tip of snout	50	15	52	68	74	67	48	96	—	72
Bonnet	30	20	30	—	—	32	36	20	—	14
Front of blowhole	10	12	10	—	—	12	12	12	—	—
Back of blowhole	30	8	12	22	24	25	—	26	—	11
Tip of mandible	200	125	224	160	212	141	63+	192	Ca. 250	176
Bonnet-like callosity	12	8	10	—	—	8	—	—	—	9 (Right)
Callosities on chin, Left	10	20	15	—	—	12	—	—	2	—
Callosities on chin, Right	10	20	14	—	—	—	—	—	4	—

TABLE 3. MEASUREMENTS OF BODY PROPORTION

Items	62B	61C	68A
Sex	Male	Male	Male
Total length of body	1,470	1,510	1,520
Lower jow, projection beyond tip of snout	40	38	41
Tip of snout to blowhole (center)	380	340	337
Tip of snout to angle of gape	390	354	381
Tip of snout to center of eye	389	348	366
Tip of snout to anterior insertion of flipper	359	420	368
Tip of snout to axilla	465	520	450
Center of eye to center of ear	56	53	55
Notch of flukes to center of anus	407	420	447
Notch of flukes to center of umbilicus	728	770	759
Center of anus to center of reproductive apperture	214	190	202
Width of flukes at insertion	136	150	143
Notch of flukes to nearest part of anterior margin of flukes	127	130	126
Tail flukes, total spread	516	550	498
Tail flukes, tip to notch	261	300	259
Flipper, tip to axilla	248	235	264
Flipper, tip to anterior end of lower border	289	281	298
Flipper, tip to head of humerus	320	290	334
Flipper, greatest width	154	155	153
Head length, condyle to tip of snout	484	460	—
Skull length, condyle to tip of premaxilla	474	430	—
Greatest breadth of skull at orbits	267	280	—
Length of mandible (straight)	470	430	—
Circumference in front of flipper	974	650	968
Circumference at umbilicus	970	720	970
Circumference at anus	626	760	634
Circumference at caudal terminus or " small "	—	240	186
Depth of body at umbilicus	312	280	330
Depth of body at middle insertion of flipper	230	295	200
Depth of body at anterior insertion of flipper	280	275	—

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fetuses above mentioned will provide evidences that the bonnet is congenital.

Hair

Hairs were observed on the head of all whales examined, including two fetuses. It is often difficult to count number of hairs on the callosity, because many cyamids infect on it. Our result of counting hairs is shown in Table 2. Many hairs (120–230) scattered on the tip of chin. Hairs were also many on the tip of snout. They were 10–17 mm long in Whale No. 61A, on the contrary, the hairs of Whale No. 68B are obviously longer than the former as shown in Plate VI. In front and back of blowhole, 20–40 hairs were counted. Some hairs were also found on the bonnet, callosities and bonnet-like callosities, but it is difficult to count those hairs, because many whale lice also infected on these callosities.

Hairs were not only found in the callosities, but also found near them. One of hairs which grew on the bonnet of Whale No. 61B was 25 mm long. The total number of hairs of Whale No. 61B was about half of those of Whale Nos. 61A and

IN THE RIGHT BLACK WHALES (Unit: cm)

62C	63C	61B	61A	68B	62A	63B	63A	73A′	63B′
Male	Male	Male	Male	Female	Female	Female	Female	Male	Female
1,610	1,640	1,700	1,710	1,260	1,410	1,540	1,610	218	270
50	75	75	58	41	70	51	66	1	0
400	332	400	390	221	344	368	364	32	43
397	385	425	407	234	269	369	365	40	58
407	370	420	400	225	276	360	370	39	53
381	435	460	440	271	327	430	411	52	73
525	562	565	540	346	418	537	521	64	91
56	56	58	42	48	50	50	41	10	12
475	515	452	475	367	383	410	437	74	91
810	875	852	853	642	748	700	790	115	141
222	225	239	239	49	47	50	68	24	11
149	160	144	146	125	130	140	150	21	29
133	162	128	138	117	125	134	142	20	25
551	628	526	562	485	563	575	525	70	84
283	280	271	290	249	294	230	265	38	53
263	250	265	277	210	246	230	240	38	53.5
277	342	309	323	230	267	274	265	37	53
328	367	340	357	255	302	316	330	—	—
163	188	152	170	117	152	149	155	—	—
490	540	560	560	—	435	480	490	—	—
486	510	535	528	—	415	475	486	—	—
295	290	305	331	—	268	270	280	—	—
472	566	520	524	—	400	460	480	—	—
1,096	1,180	1,440	1,420	746	962	1,100	1,050	—	—
1,074	1,280	1,480	1,520	766	1,002	1,120	1,190	—	—
770	830	804	790	528	720	718	880	—	—
—	320	248	242	176	—	224	240	—	—
347	412	295	286	280	319	367	290	—	—
286	420	335	324	—	274	310	331	—	—
263	—	315	305	220	316	—	—	—	—

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61C. Variation in number of hairs seems to be correlated with the structure of bonnet or callosities.

Usually one hair grew on each small callosities, and it was agreed from the observation of fetuses that a rising of skin at the budding point of hair in the fetal stage grew into callosity afterwards. Furthermore, in the fetus, many hairs grew on the position which correspond with bonnet of the adult whale.

Body proportion

External body proportions were measured on many parts along the almost same series which was used by Omura (1958) for 13 right whales including two fetuses. They are shown in Table 3 as actual figures.

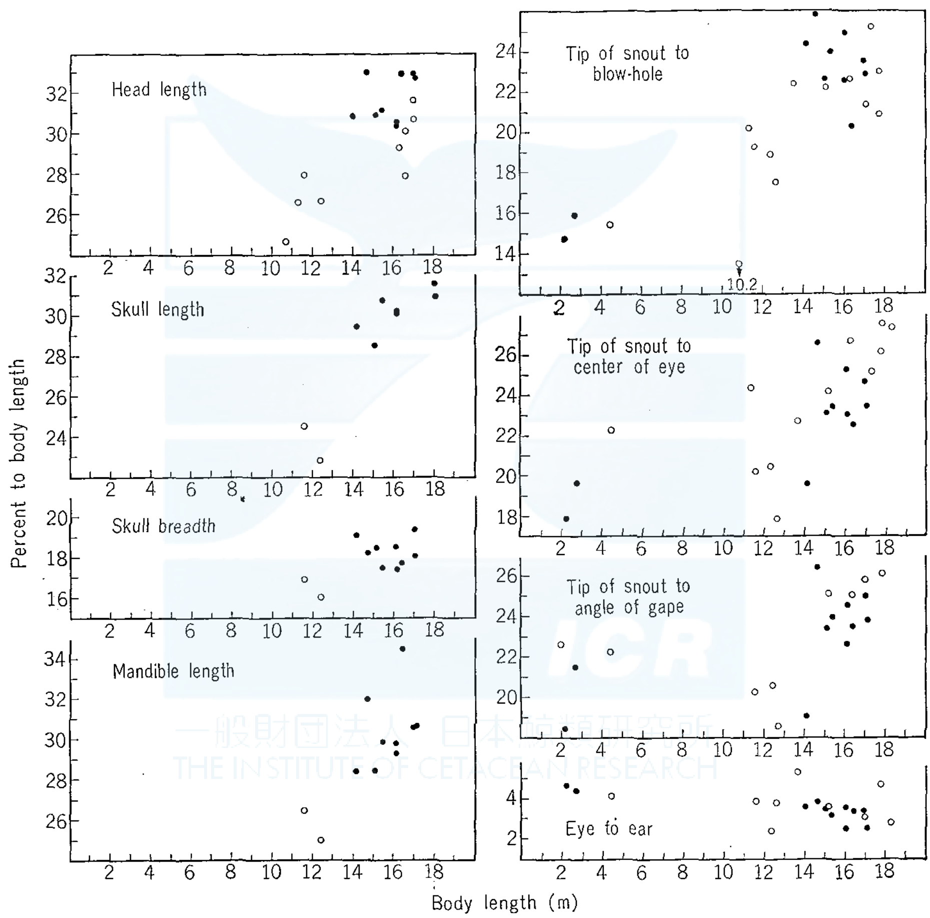

Fig. 5. 1. Relation between body length and proportional length of various parts of the body in black right whales in the North Pacific. Closed circle indicates that in American side and open circle in Asian side.

On the body proportion of the black right whale, Omura listed up 21 whales measured, by various authors, and Klumov (1962) added USSR data on 12 North

Pacific right whales including two fetuses. They compared body proportions on the right whales from three localities, and they got the same conclusion that the body proportions of the North Pacific right whales were not different from those in the North Atlantic and in the Southern Hemisphere.

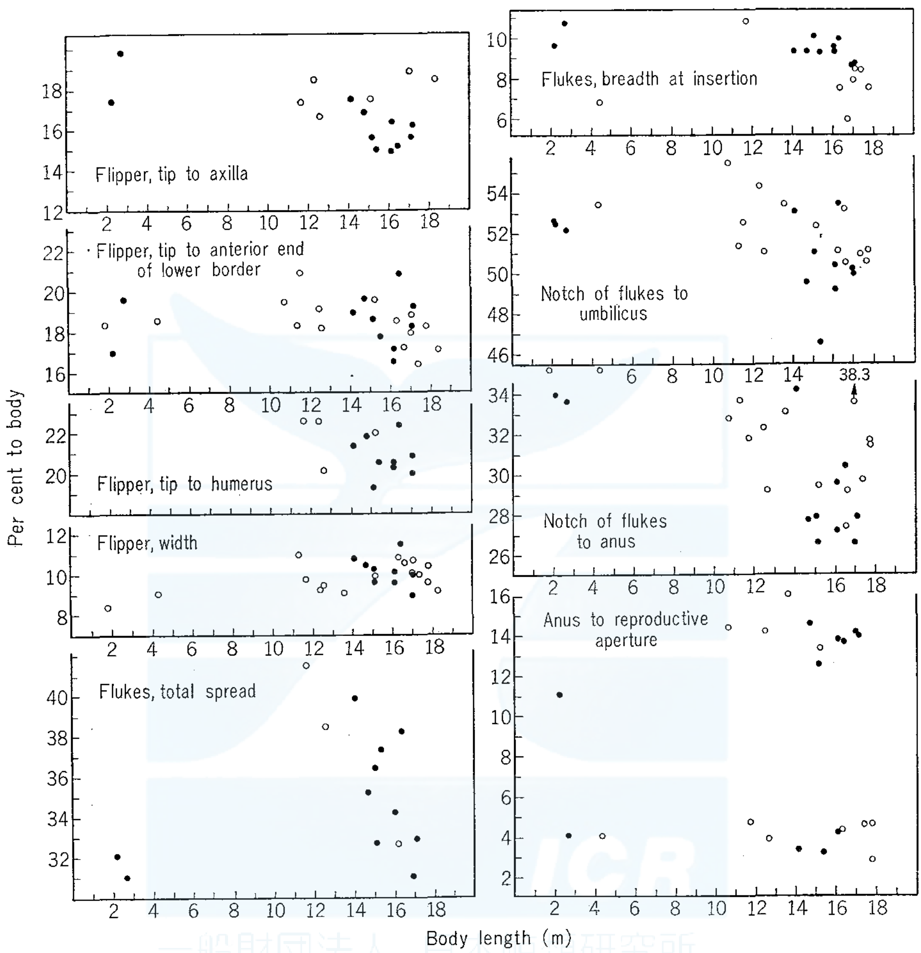

Fig. 5. 2. Relation between body length and proportional length of various parts of the body in black right whales in the North Pacific. Same symbols in figs. 5. 1. are used.

Present materials include the first data of the body proportions on the black right whales from the American side of the North Pacific. Klumov reports that the North Pacific right whales can be divided into two populations of American and Asian sides. Then, it will be worth to compare the body proportions of the right whales from Asian side (data by Matsuura and Maeda, 1942; Omura, 1958; Klumov, 1962, and present data of Whale Nos. 68A and 68B) with the present data of Whale Nos. 61A–63C.

Fig. 5 shows the relation between body length and body proportion of various parts. We have not enough materials to get a conclusion, but it seems that it is difficult to separate the black right whales of American side from those of Asian side by means of body proportions. It is suggested that there are some differences in the proportional length of flipper, tip to axilla, between present data and the data by Klumov. However, there may be a difference of method, in defining the point of axilla.

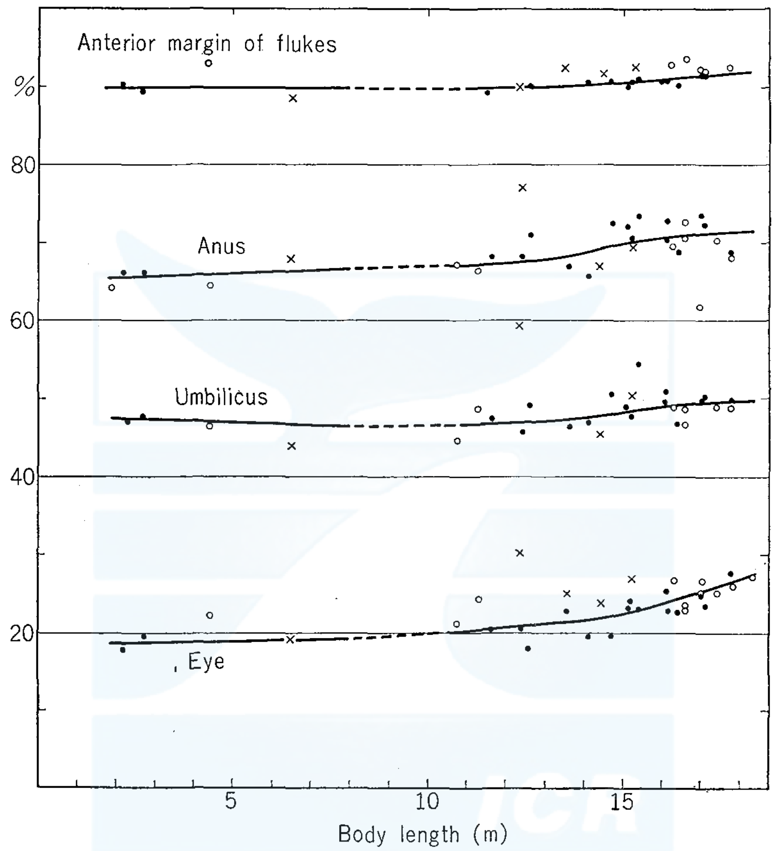

Fig. 6. Proportional change of various points of the body according to the growth in black right whales. Cross indicates figures cited from Matthews (1938), open circle cited from Omura (1958) and Klumov (1962), and closed circle present material.

Concerning to the change of body proportion according to the growth of body, Fig. 6 shows the proportional development of some points along the body axis. These points chosen are eye, umbilicus, anus, and anterior margin of flukes. This figure can not be said as complete, in length lacking the data of whales under 190 cm in length and those of between 7 and 10 m. The proportional position of eye moves posteriorly according to the growth of body, and its movement becomes rapid after the body length of 13 m is attained. Proportional position of umbilicus, anus and anterior margin of flukes shows almost the same tendency as that of eye. This means

TABLE 4. THICKNESS OF BLUBBER

Whole no.	62A		62B		61C		63B*		62C		63A*		63C		61B		61A	
Body length	14.1 m		14.7 m		15.1 m		15.4 m		16.1 m		16.1 m		16.4 m		17.0 m		17.1 m	
Sex	♀		♂		♂		♀		♂		♀		♀		♂		♂	
Position of the measurement	cm	% of body length	cm	% of body length	cm	% of body length	cm	% of body length	cm	% of body length	cm	% of body length	cm	% of body length	cm	% of body length	cm	% of body length
1	15.0	1.06	28.5	1.94	26.5	1.75	26.0	1.69	26.0	1.61	25.0	1.61	34.0	2.07	30.5	1.79	27.0	1.58
2	13.0	0.92	16.0	1.09	22.5	1.49	21.0	1.36	15.0	0.93	19.0	1.18	22.0	1.34	22.5	1.32	22.0	1.29
3	23.0	1.63	18.0	1.22	20.5	1.36	22.0	1.43	23.5	1.46	24.5	1.52	22.0	1.34	26.5	1.56	27.5	1.61
4	27.0	1.91	15.5	1.05	23.5	1.56	23.5	1.53	25.0	1.55	27.5	1.71	25.0	1.52	28.5	1.68	28.5	1.67
5	23.0	1.63	17.5	1.19	22.5	1.49	—	—	23.0	1.43	—	—	24.0	1.46	22.5	1.32	20.0	1.17
6	—	—	—	—	—	—	16.5	1.07	—	—	19.5	1.21	20.0	1.22	—	—	—	—
7	26.0	1.84	20.0	1.36	25.5	1.69	28.0	1.82	22.5	1.40	22.0	1.37	21.0	1.28	32.5	1.91	29.5	1.73
8	23.0	1.63	23.0	1.54	27.5	1.82	22.0	1.43	22.0	1.37	25.0	1.55	29.0	1.77	25.5	1.50	35.0	2.05
9	27.0	1.91	25.0	1.70	42.5	2.81	24.0	1.56	45.0	1.74	28.0	1.74	35.0	2.13	35.5	2.09	38.5	2.25
10	—	—	—	—	—	—	—	—	—	—	—	—	34.0	2.07	—	—	—	—
11	—	—	—	—	—	—	—	—	—	—	20.0	1.24	25.0	1.52	—	—	—	—
12	—	—	—	—	—	—	—	—	—	—	25.0	1.55	25.0	1.52	—	—	—	—

*: pregnant.

Position of the measurement ;

1	On the lateral line of the body, at the level of ear hole		
2	,,	,,	tip of flipper
3	,,	,,	umbilicus
4	,,	,,	reproductive aperture
5	,,	,,	anus
6	,,	on	tail
7	On the ventro-median line of the body,	,,	angle of gape
8	,,	,,	umbilicus
9	,,	,,	30 cm after anus
10	On the dorsal-median line of the body,	,,	insertion of flipper
11	,,	,,	umbilicus
12	,,	,,	reproductive aperture

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that the head becomes porportionally larger and the tail becomes proportionally shorter according to the growth of body. This tendency is similar to that observed in the fin whale (Ohsumi, 1960).

Thickness of blubber

Thickness of blubber was measured at various points as shown in Table 4. Thickness of blubber falls between 0.92 % and 2.81 % of body length in any points where measurement was made. And the value measured on the lateral line at the level of anus ranges between 1.17 % and 1.63 % of body length with the mean value of 1.38 %. On the other hand in blue and fin whales the thickness of blubber in the feeding ground accounts about 0.45 % of the body length, and in humpback whales about 1.1 % of the body length at the lateral side midway between dorsal fin and anus. The thickness of blubber changes with the season, but it is obvious that the black right whale exceeds balaenopterid and megapterid whales in the thickness.

Body weight

Weight of various parts of the body of 11 black right whales are shown in Appendix Table 1. These weights were measured after cutting into small pieces in

TABLE 5. BODY WEIGHT OF THE BLACK RIGHT WHALE

Body length (m)	Weight (ton)	Sex	Remarks
2.18	0.136	Male	Fetus of 63A
2.70	0.257	Female	Fetus of 63B
11.65	22.866	,,	Omura, 1958
12.40	22.473	Male	,,
12.60	28.917	Female	68B
14.10	47.555	,,	62A
14.70	52.894	Male	62B
15.10	55.254	,,	61C
15.20	48.562	,,	68A
15.40	62.341	Female	63B, Pregnant
16.10	74.229	,,	63A, ,,
16.10	67.769	Male	62C
16.30	58.590	Female	Klumov, 1962
16.40	78.499	Male	63C
16.60	63.130	Female	Klumov, 1962
17.00	66.134	Male	,,
17.00	65.756	,,	61B
17.06	63.485	,,	Klumov, 1962
17.10	67.239	,,	61A
17.40	106.50	Female	Klumov, 1962

fresh condition on the whaling factory ships or whaling station, with 500 kg platform scale or scale for truck cargo except Whale Nos. 61A and 61B. In these cases, the skulls were not cut in order to preserve the whole skeleton for osteological study, and they were measured with handmade balance and whaling harpoons as the weights. All of these weight data do not include the weight of blood and other body fluid lost during the processing of the carcass.

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Fig. 7 and Table 5 show the relation between body length and body weight of black right whale plotted on a logarithmic scale. This figure includes the weight of 5 whales from Klumov (1962) and 2 from Omura (1958). The smallest 2 weights are those of 2 fetuses from 63 A and 63B. The maximum weight is that of 17.4 m female which weighed 106.5 tons (Klumov, 1962). For these weight-length data the formula $W=bL^a$ can be applied, where W is weight in ton, L is body length in m. The constants " a " and " b " calculated by the method of least squares are shown below.

From all 20 data:
  $a=3.065$
  $b=0.01238$
From 18 data except 2 fetuses:
  $a=3.055$
  $b=0.001273$

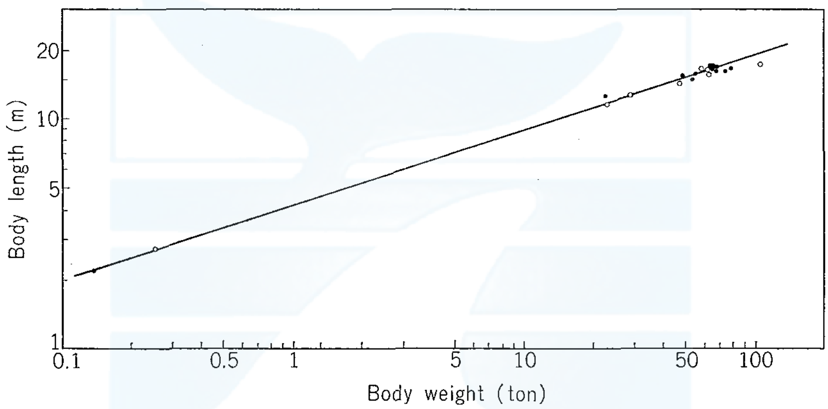

Fig. 7. Relation between body length and body weight of black right whales in the North Pacific. Open circle indicates female, and closed circle male.

TABLE 6. BODY WEIGHT OF BLUE, FIN, HUMPBACK WHALES AND WEIGHT OF BLACK RIGHT WHALE CALCULATED TO THE SAME LENGTH

Species	Body length (feet)	Body weight (ton)	Weight of right whale (ton)
Blue whale	83	110	185
Fin whale	68	50	135
Humpback whale	41	25	36
Sperm whale	51	41	66

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These two sets of constants are very similar and there is no reason to conclude that the difference is significant. So it will be concluded that the best formula to show the weight length relation of the North Pacific right whale is that shown at the top or $W=0.01238L^{3.065}$.

The comparison with other cetaceans reveals that the body weight of black right whale is far heavier than that of sperm and sei whales of the same size

(Omura, 1958). And it is also true in the case of blue and fin whales. Table 6 shows the weight of blue, fin and humpback whales cited from Ohno & Fujino (1952) and calculated weight of black right whale of the same body length. It shows that the weight of the humpback whale comes closest to that of North Pacific black right whale.

Fig. 8 shows the weight of blubber, meat, bone and vissera as the percentage of total body weight. The two data were cited from Omura (1958). Though all the 13 specimens were processed by Japanese whalers with same procedure, the weight of bone are largely affected by the amount of meat remaining on it and shows fairly wide variation. The weight of blubber also shows wide variation. Probably this is caused by the difference of physical condition.

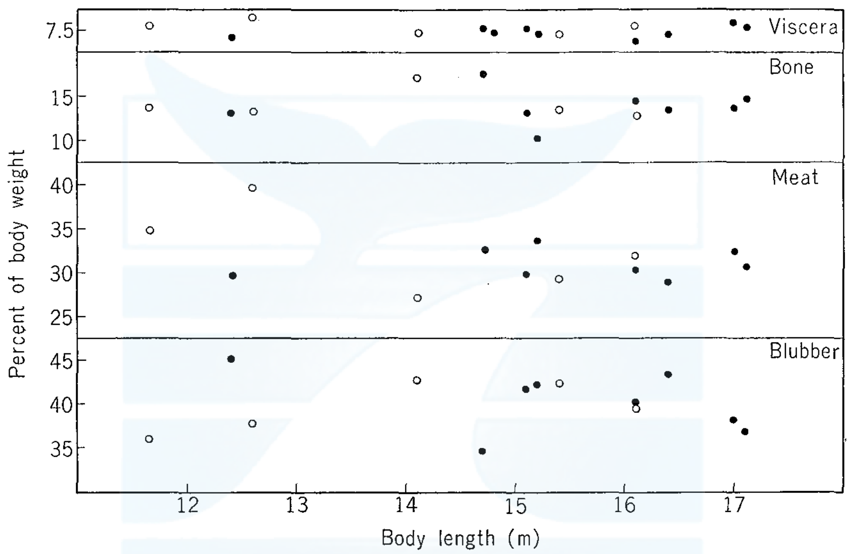

Fig. 8. Weight of various parts of the body expressed as percentages against the total weight of the body in black right whales in the North Pacific. Open circle indicates female, and closed circle male.

The relation between the percentage of blubber, meat, bone or viscera (excluding tongue) to body weight and body length is not clear. If we consider the growth rates of these parts are similar, then the mean values of those parts calculated from present 13 specimens are 39.8, 32.0, 13.8 and 7.6 % of body weight respectively.

Baleen

The colouration of the baleen plate of the black right whale was already discussed by Omura (1958). All the baleen plate of present 11 whales are, at dried condition, pure black or dark blueish gray. This difference of colour seems to be related with age of whale. Among present whales, only the smallest whale 68B had uniformly dark blueish gray baleen plates, and all the other 10 whales had pure black plates. 2 young black right whales reported by Omura also have grayish black colour at dried condition. But, at fresh and wet condition, the colour of all the baleen plates is paler than that of dried plates. At this condition, they were dark gray, and very slightly tinged with blue in 68A and slightly paler in the juvenile whale 68B. The colour of bristles is nearly pure black in both fresh and dried condition, but the bristles on baleen plate of suckling period is slightly brownish.

As already mentioned by Omura (1958) the baleen plates of anterior portion are bending inward and those of posterior portion are bending outward. The degree of the curve bending outward or inward differs from a whale to whale and seems to be merely an individual variation.

TABLE 7. MEASUREMENTS OF THE LONGEST BALEEN PLATES OF THE BLACK RIGHT WHALE

Specimen No.	Body length (m)	Sex	Number of Plates		Length[1)]		Width[2)]		Length/Width		Number of growth marks (n)	Length /n
			Right	Left	Right	Left	Right	Left	Right	Left		
6**	10.75	Male	240	—	40		—	—	—	—	—	—
9**	11.35	Female	222	—	—	—	—	—	—	—	—	—
56A*	11.65	Female	228	236	89		11.8			7.54	2	—
56B*	12.4	Male	257	259	90		14.0			7.43	2	—
68B	12.6	Female	234	236	97.0	99.0	17.0	15.0	5.71	6.60	2	—
62A	14.1	Female	234	237	201.0	203.0	21.0	21.5	9.57	9.44	6+	34
62B	14.7	Male	267	268	207.5	205.5	24.0	24.0	8.65	8.56	6+	35
61C	15.1	Male	230	221	185.0	186.5	21.5	22.0	8.60	8.48	9+	21
68A	15.2	Male	220	222	—	211.0	—	30.5	—	6.92	8+	26
63B	15.4	Female	239	231	218.0	217.0	25.0	25.0	8.72	8.68	8+	27
62C	16.1	Male	240	232	238.0	237.5	26.5	26.5	8.98	8.96	9+	26
63A	16.1	Female	206	210	240.0	238.0	26.0	26.5	9.23	8.98	9+	27
3**	16.3	Female	214	—	205		18			11.4	—	—
63C	16.4	Male	251	247	277.0	273.0	26.5	27.5	10.45	9.93	10+	28
7**	16.6	Male	250	—	220		—	—	—	—	—	—
8**	16.6	Male	246	—	260		26			10.0	—	—
61B	17.0	Male	242	245	254.5	250.0	26.5	27.5	9.60	9.09	12+	21
2**	17.0	Male	225	226	—	—	24		—	—	—	—
4**	17.06	Male	230	—	260		25			10.4	—	—
61A	17.1	Male	213	219	265.0	—	27.0	—	9.81	—	12+	22
5**	17.4	Female	217	—	260		—	—	—	—	—	—
10**	17.8	Female	159	160	237		18			13.2	—	—
1**	18.3	Female	205	220	200		—	—	—	—	—	—

* Omura (1958), ** Klumov (1962)
1) Measurement No. 2, 2) Measurement No. 3.

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Several transverse periodical growth marks are observed on the baleen plate of black right whale, probably this will correspond with so-called age mark observed on the baleen plate of balaenopterid whales. The number of this mark was counted with naked eyes and listed in Table 7.

The number of baleen plates of present 11 specimens comes within the range of 206 and 268. Omura (1958) and Klumov (1962) report 2 and 12 North Pacific right whales respectively, whose number of baleen plates were counted. Matthews (1938) counted also the number of baleen plates of 2 southern right whales. All the count reported by these authors coincides with the range of present specimen and no difference has been found between the whales from the North Pacific and southern hemisphere, nor according to left and right sides. The number of baleen plates shows no correlation with body length. The mean number of plates is 229 on both sides in the North Pacific black right whales.

Every 10th baleen plates were collected from the series of both right and left sides. In addition to these specimens the estimated longest baleen plates of each series were collected from 61A, 61B and 61C, but they were not always the longest. This result will show that the length of baleen plates is very similar around the largest one and it is very difficult to select the longest on the spot. After the gum line was marked with knife on the collected baleen plates, gum was removed with knife carefully, in order to preserve the base of the plate in the gum completely.

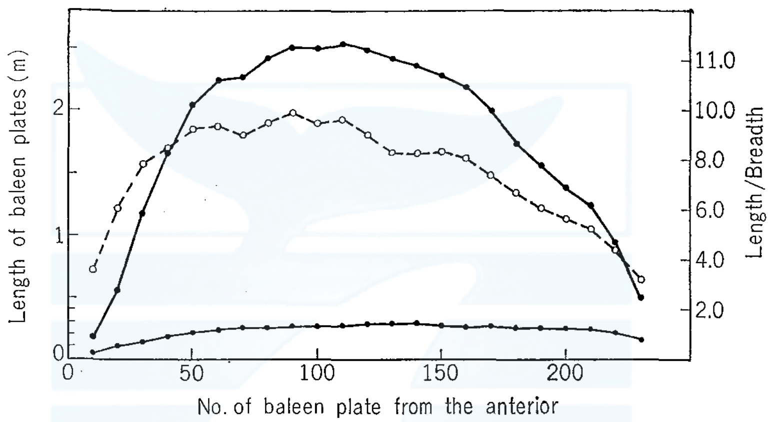

Fig. 9. Actual length, breadth and proportional length against breadth of the baleen plates of the Whale No. 61B. Closed circle shows actual length and beadth, and open circle pro portional length.

The measurements of these baleen plates were made of the following 4 series, 1) total length of the plate, exclusive bristles, along lateral (outer) edge, 2) length from gum line at lateral edge to tip along lateral edge, exclusive bristles, 3) width of plate at gum line along anterior surfase, 4) length of bristles beyond the tip of plate. In the case of 9 specimens, 61s, 62s and 63s, the width of baleen plate was measured at the straight angle to the outer edge. But in 68A and 68B, the measurements were made between the gum line on both external and internal edges after the method used by Omura (1958). The width of baleen plate obtained by the latter method is bigger than that obtained by the former. Full details of these measurement were tabulated in Appendix Table II, and selected measurements are given in Table 7.

As shown in Fig. 9 the length of baleen plate, measurement no. 2, increases rapidly at the anterior part of the series and reaches the plateau at 60th to 150th, then it decreases rather gradually in the posterior than in the anterior part. The maximum lengthes of baleen plate of all present 11 specimens are found between 100th and 120th plates. The width of baleen plate also shows the same tendency with the length, and the baleen plate with maximum width are found at around the baleen plate of the maximum length. But the change of the width by the position is more gradual than that of the length, so the ratio of the length and width shows fairly stable value in the baleen plates of around maximum length. The length / width ratios of the longest baleen plate are tabulated in Table 7. The difference in this ratio between right and left side is not significant. Though this length / width ratio seems to increase with the growth of the animal, the two female specimens reported by Klumov (1962), Nos. 3 and 10, have larger ratio than that expected from their body length. This is the result of the very small width of the baleen plate at the base, or width of 18 cm for both specimen. In our present data, such small width is only observed in the baleen plate anterior to 30th or 60th, which is less than 100 or 160 cm long.

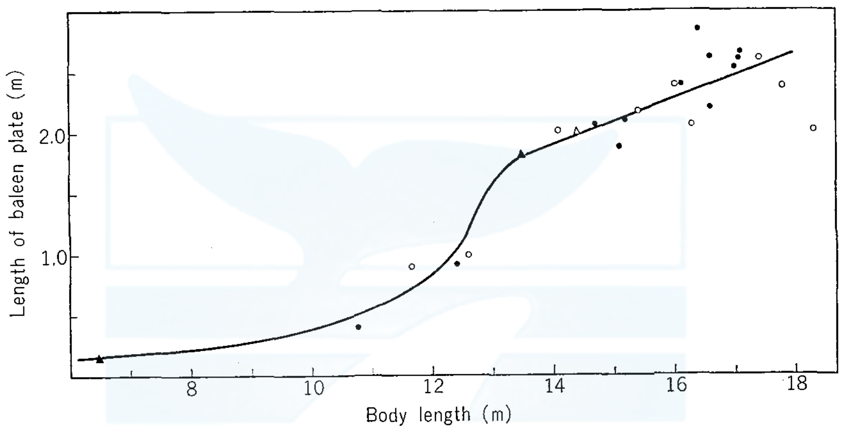

Fig. 10. Relation between body length and length of maximum baleen plate of black right whales. Regression line was drawn by hand. Circle indicates those from North Pacific, and triangle from Antarctic. In both symbols open means female and closed male.

Fig. 10 shows the relation between body length and the length of baleen plates, measurements No. 2, of the North Pacific and southern black right whale. In addition to present 11 specimens, data of 10 North Pacific right whales reported by Omura (1958) and Klumov (1962), and 4 southern right whales reported by Matthews (1938) were plotted. In this figure 6.5 m male is a suckling calf reported by Matthews, and 10,75 m male is a calf, reported as having been suckling and feeding concurrently by Klumov. Next three seems to have already weaned, but they still had neo-natal mark on the baleen plates. In all the other whales larger than 13.5 m in body length are lacking this mark already.

On the regression line in Fig. 10, which was drawn by hand, the part corresponding to the body length of 13.5 m or more indicate a straight line. The growth of baleen plate during suckling stage seems to be very slow and the length of baleen plate at the beginning of weaning stage will be about 50 cm. As the result there must be a rapid increase of the length of baleen plate between the time of the beginning of weaning, or about 11 m in body length, and the time at which 13.5 m in body length is attained. This is also infered from the spacing of growth marks on baleen plate. If the number of the growth marks is not small, the mean distance between each growth marks is shown approximately by dividing the length of baleen plate by the number of growth marks. This value calculated for the baleen plates with more than 6 growth marks falls between 21 cm and 35 cm with the mean value of 27 cm. On the other hand, the distance between the first age mark and the second is 47 cm and 51 cm on the baleen plate of 68B and 56A (or 56B) respectively.

Internal organs

Among the internal organs observed, the genital organs of both sexes are dealt with somewhere in this report. In this chapter, mentions are made on other internal organs.

Brain. The weight of brains of 4 specimens was measured with 10 or 15 kg spring balance on the factory ship. These measurement are shown in Table 8. The weight of cerebrum and cerebellum are 0.0034 and 0.0009 % of the body weight respectively in one specimen (62C). And the total weight of the both brains ranges from 2.4 to 3.1 kg, or from 0.0038 to 0.0050 % of the body weight. These figures indicate that the black right whale has considerably small brain than other cetaceans. The weight of brain seems to stop to increase at the stage between 14 and 16 m in body length, and then the ratio against body weight decreases with the growth of body.

TABLE 8. WEIGHT OF BRAIN OF THE BLACK RIGHT WHALES (Kg)

Specimen	62A	62C	63A	63C	Mean
Body length (m)	14.10	16.10	16.10	16.40	15.68
Cerebrum (Kg) Cerebellum (Kg)	} 2.4	2.3 0.6	} 3.1	} 3.0	} 2.85
% of body weight	0.0050	0.0043	0.0042	0.0038	0.0043

Intestine. The length of intestine of North Pacific right whale is shown in Table 9 and in Fig. 11. It is fairly difficult to get the accurate length of the intestine, because it is subject to the freshness of the carcass and the method of measurement, but the data in the table, will give some information about its length. The length of intestine was measured from just after the fourth segment of the stomach to

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TABLE 9. LENGTH OF INTESTINE OF THE BLACK RIGHT WHALE (m)

Specimen	Body length (m)	Small int.	Large int.	Sum	Intestine/Body length
56A	11.65	—	—	97.65	8.4
68B	12.60	80.8	5.1	85.9	6.8
62A	14.10	—	—	104.0	7.4
62B	14.70	86.2	2.7+	88.9+	6.1+
61C	15.10	99.8	3.8	103.6	6.9
62C	16.10	93.8	4.6	98.4	6.1
61B	17.00	91.5	4.6	99.1	5.7
61A	17.10	87.0	7.3	94.3	5.5

anus. As shown in the table, the intestine does not show the increase of its length with age. The specimen 56A (11.65 m) is a very young animal with the baleen plates which still have the baleen of suckling stage at their tip, and 61A and 61B are full grown animal, but the length of intestine does not show significant difference. So probably it can be said that the length of intestine of black right whale does not increase greatly after very young stage. The ratio of the length of intestine to body length decreases with age, and the ratio for full grown animal is less than 6.1 %.

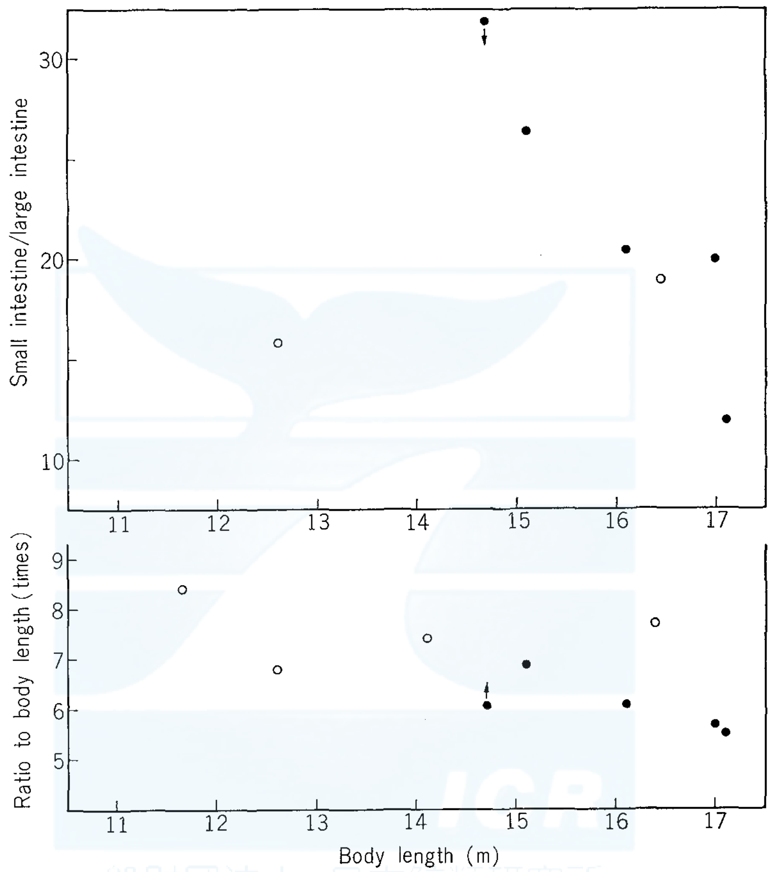

Fig. 11. Relation between body length and length of intestines in black right whales in the North Pacific. Open circle indicates female, and closed circle male.

Caecum. Though the intestines of 9 specimens were observed, the presence of caecum could not ascertained in any specimen by visual observation. A piece of intestine, about 60 cm in length, including the junction of small and large intestine was collected from the specimen 62C for further investigation. This specimen was studied by T. Kamiya of Faculty of Medical Science, University of Tokyo. Also obstructed by a small area of bad fixation detailed study of structure has not been possible on all part of that specimen, he could not find any trace of caecum on the intestine of black right whale (Fig. 12). In this point the black right whale is quite different from balaenopterid whales. Further anatomical investigation on this problem is being continued by him with the intestine of the fetuses of 63A and 63B.

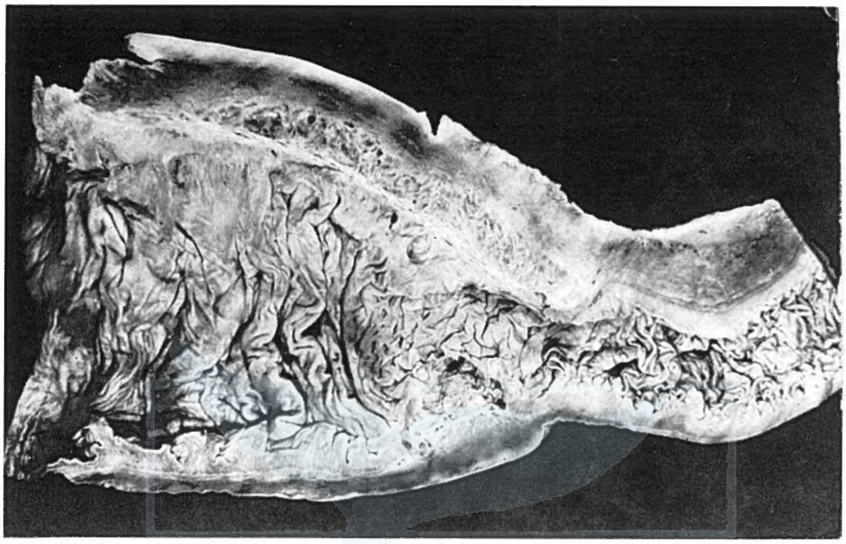

Fig. 12. Section of joint between small and large intestines in black right whale. Whale No. 61C. (Photo by T. Kamiya).

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Distribution and migration

Distribution. Figs. 13.1–13.7 were drawn by the data based on Omura (1958), Klumov (1962) and the sighting records by Japanese catchers in the years 1958–1968, separately by month.

In April a number of black right whales were sighted in the northeast coast of Honshu to the east of Hokkaido. According to these data, it seems that the black right whales are concentrated in the waters of 3–4°C at surface which coincides the Oyashio front in this month. In addition, it is probable that the North Pacific black right whale does not migrate to the waters north of 43°N latitude in this month (Omura, 1958), but a number of black right whales were observed in the waters from the Etorofu Kaikyo to the north of Etorofu Island by Klumov's figure (1962). Accordingly, from the sea ice conditions (Nasu and Machida 1968) it may be that the black right whales move from the Pacific area to the Okhotsk Sea following the melting of sea ice.

In May in the northeast coast of Honsyu the majority are sighted in almost same area as in April, but at north of Hokkaido, they are expanding along the coast of Kuril Islands. For the waters around Kamchatka peninsula, Tomilin (1957) describes that the North Pacific right whales stay in summer from the beginning of June, however, in this month two right whales were sighted in the east of south Kamchtka by Japanese whale catchers, and Townsend (1935) also reports that a number

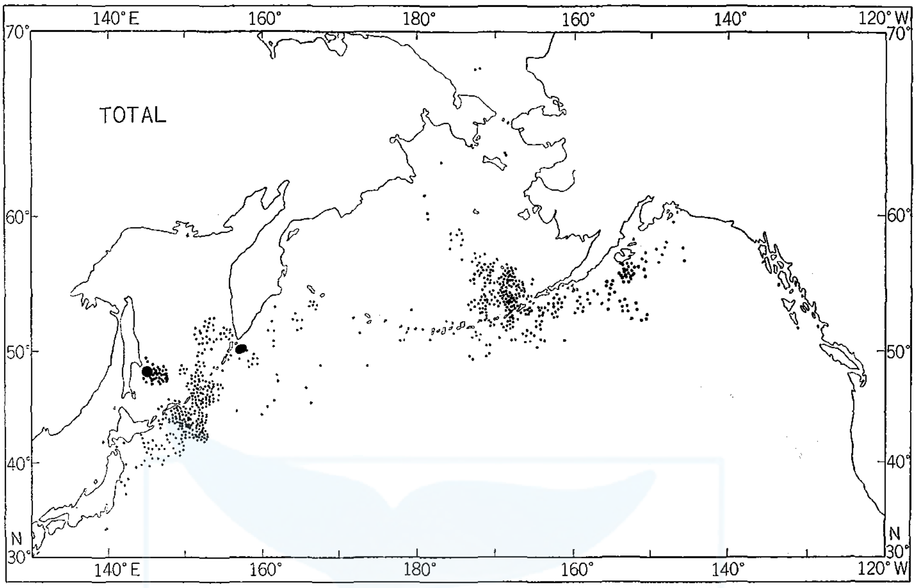

Fig. 13. 1. Sighting of black right whales in the North Pacific by Japanese whale catchers (1941–68) and those by USSR (1951–57), cited from Klumov (1962). Total sightings.

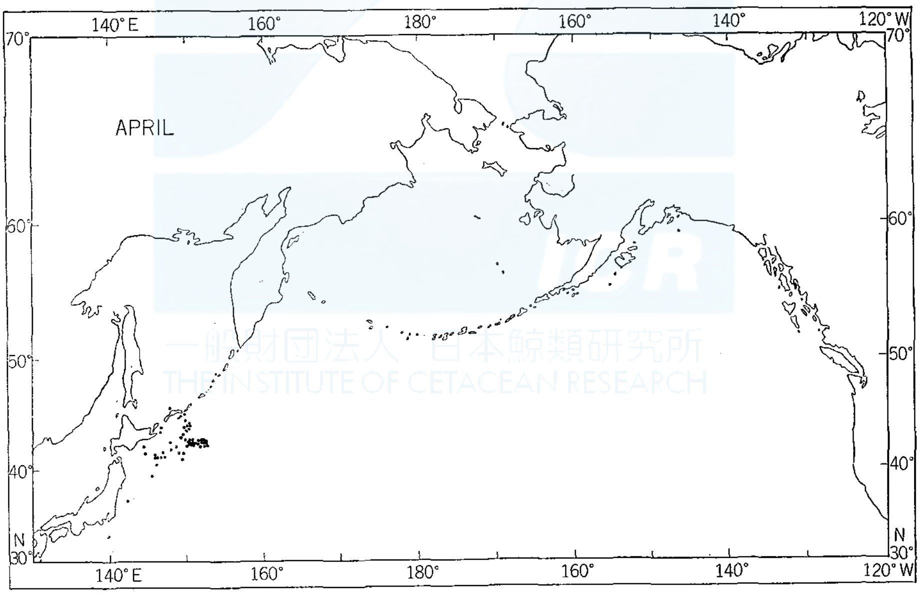

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Fig. 13. 2. Sighting of black right whales in the North Pacific by Japanese whale catchers (1941–68) and those by USSR (1951–57), cited from Klumov (1962). April.

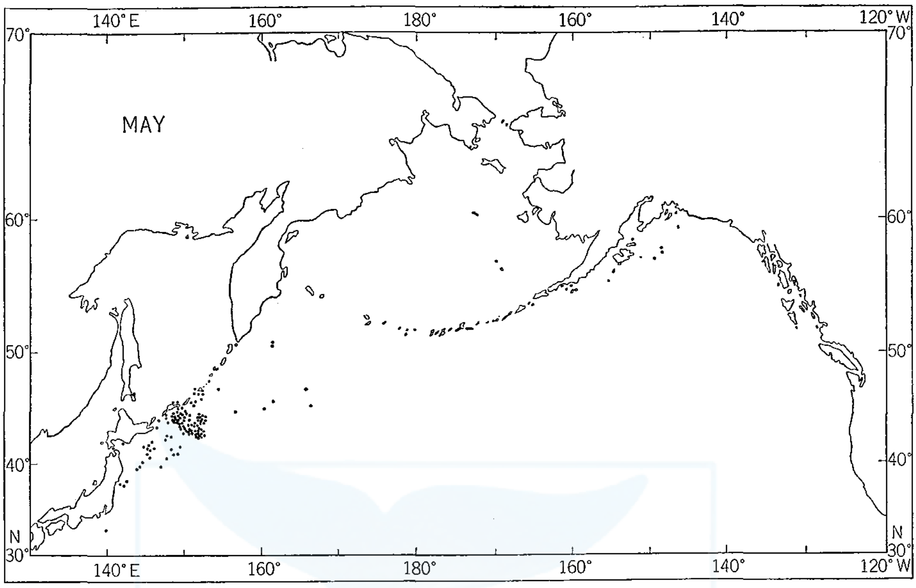

Fig. 13. 3. Sighting of black right whales in the North Pacific by Japanese whale catchers (1941–68) and those by USSR (1951–57), cited from Klumov (1962). May.

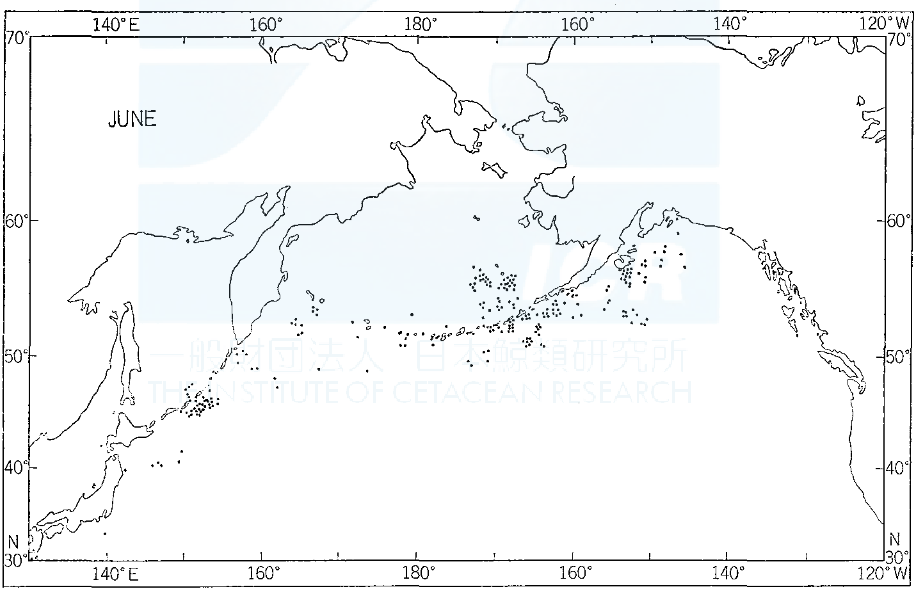

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Fig. 13. 4. Sighting of black right whales in the North Pacific by Japanese whale catchers (1941–68) and those by USSR (1951–57), cited from Klumov (1962). June.

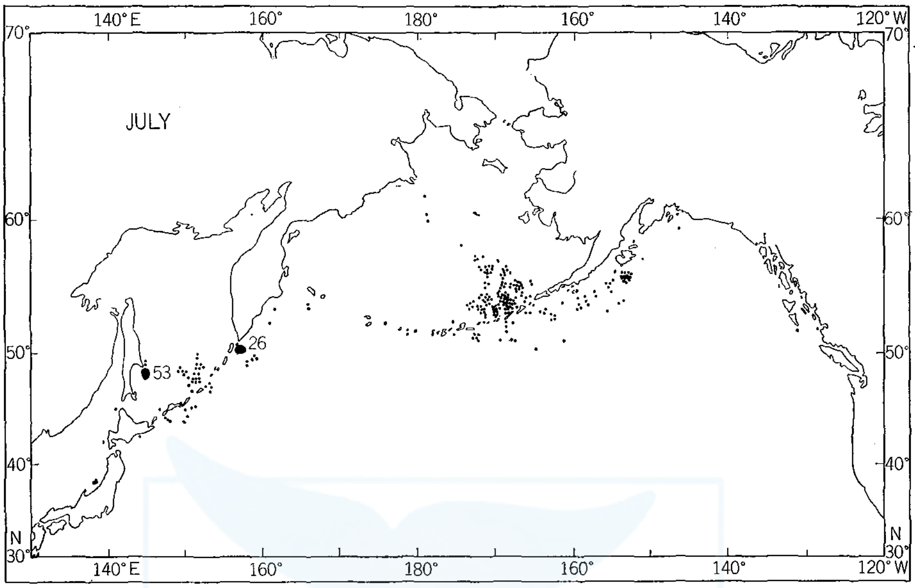

Fig. 13. 5. Sighting of black right whales in the North Pacific by Japanese whale catchers (1941–68) and those by USSR (1951–57), cited from Klumov (1962). July.

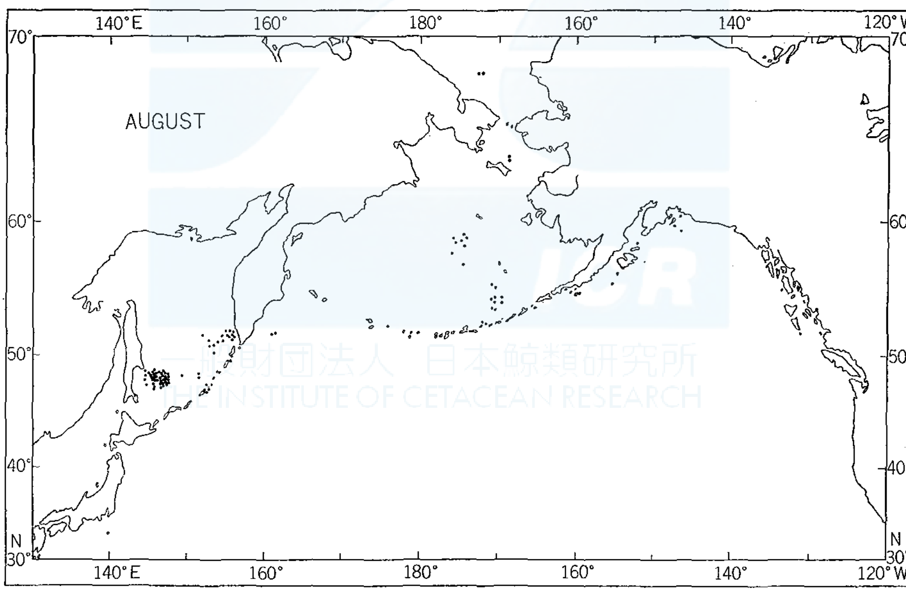

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Fig. 13. 6. Sighting of black right whales in the North Pacific by Japanese whale catchers (1941–68) and those by USSR (1951–57), cited from Klumov (1962). August.

of black right whales were killed in May on the south-east coast of Kamchatka and some in the Bering Sea.

In addition to these sightings three whales were observed in the waters of comparatively high latitudes, 57°N to 58°N and 148°W to 150°W, of eastern North Pacific, where the sea temperature at surface showed about 5°C. Therefore, it is supposed that in May black right whales in the eastern North Pacific migrate to higher latitudes than those in western North Pacific, in close agreement between the northward migration of the whale and the flowing of the warm water mass to the north (Matsuura 1936).

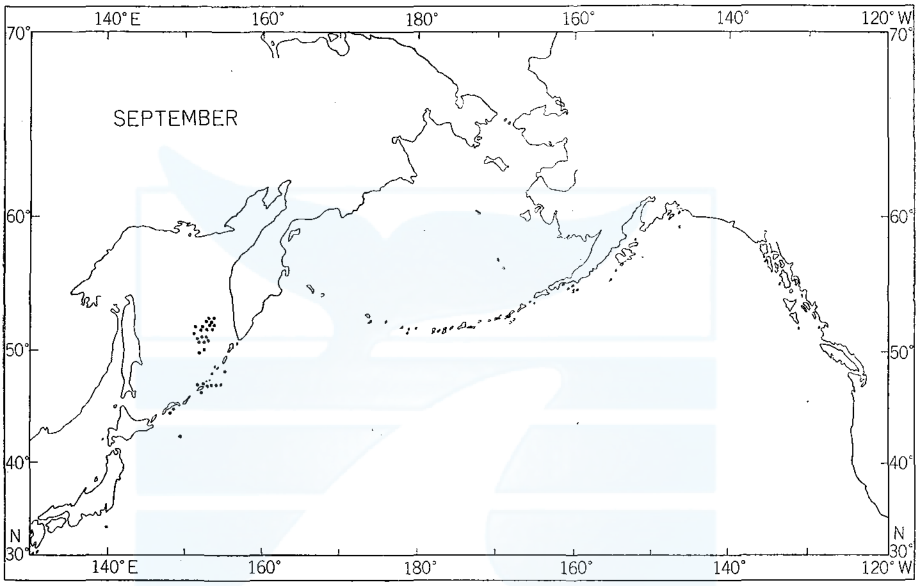

Fig. 13. 7. Sighting of black right whales in the North Pacific by Japanese whale catchers (1961–68) and those by USSR (1951–57), cited from Klumov (1962). September.

The sighted number of right whale in the sea region of the northeast coast of Honsyu and Hokkaido in June is fewer than in May. However, the heavey concentration area of right whales along the Kuril Islands in June is located in higher latitudes than in May, and the northern records of sightings reached as north as 50°N, to the east of Paramusiru Island (Klumov 1962). It is considered, therefore, that this is due to shifting north of the main concentrations as a whole.

In the subarctic pelagic whaling area, we have no records of sighting of black right whales prior to this month by Japanese whale catcher boats, and they entered in the Bering Sea at least in June. The most concentrated area of sighting is seen in the north sea region of Unalaska Island which coincides with the ground of fin whales.

In July most of the sightings were concentrated in the Bering Sea and there are practically no record to the west sea region of 180° longitude, in the adjacent waters of the Kamchatka Peninsula.

Such a phenomena, as Omura (1958) states, may be explained by the concentration of whale catcher boats in the Bering Sea in this month. In addition, the distribution of this species located from the north of Unalaska Island to the water mass boundery between the Bering central water and the Alaskan shelf water, and northern limit of the migration of the North Pacific black right whale in July is about 62°N in the Bering Sea.

It is supposed, therefore, that they enter in the Bering Sea in June and then they proceed to further north in July, and its moving route exists along the oceanic front.

According to Matsuura (1936), the sea region of heavy catch in Okhotsk Sea was found at the north side of Etorofu Island, but the recent records show many whales were sighted in the southeast coast of Cape Kitashiretoko in Saharin, where the East Saharin Current flows to the south.

In the waters along the Kuril Islands many whales were sighted at the east sea region of Paramushiru Island, at about 50°N, (Klumov, 1936), and the sighting has increased in the vicinity of 48°N and 151°E in the Okhotsk Sea, whereas, it is supposed that the black right whales in the Okhotsk Sea increase rapidly their number in July.

TABLE 10. THE MONTHLY CATCHES OF BLACK RIGHT WHALES IN THE ADJACENT WATERS TO JAPAN ESTIMATED FROM TOWNSEND'S CHART (1935)

	Sea of Japan	Okhotsk Sea	East China Sea
Feb.	2	—	2
Mar.	4	—	3
Apr.	18	3	—
May	77	4	—
June	52	37	—
July	42	64	—
Aug.	16	87	—
Sep.	6	110	—
Oct.	—	—	—
Nov.	—	1	—

Off the northeast of Honsyu, we have no record of sighting in August though the whaling is carrying on in this month too. It is supposed that there are only a few black right whales present in this sea region in August. Details of distribution along the Kuril Islands are not known, because the data is lacking. Off the Kitashiretoko in Okhotsk, a number of whales are sighted as in July. In the Bering Sea, the northern limit of distribution of North Pacific right whales was thought as lying at west side of St. Lawrence Island (Townsend, 1935), but, two whales were sighted in the Chukchi Sea by Japanese whale catcher boat in August 1959 (Nasu, 1960).

Omura (1958) states that there is no recent record of sighting of the North Pacific black right whales in the Sea of Japan, though it was hunted intensively by American whalers in the past. There is no further information on the sighting of black right whales since Omura's report (1958).

The monthly catches by American whalers estimated by Townsend's charts (1935) are shown in Table 10, from which it is supposed, at least, that they appear in the Sea of Japan in February, and the favourable whaling were conducted from May to June.

In the Okhotsk Sea similar to Klumov's sighting report (1962), a number of whales are killed in April and the peak of the catch is found in September.

From above statement the North Pacific black right whales in the ajacent waters to Japan, as supposed by Omura (1958), appear in the waters of Sanriku and south of Hokkaido in April, where many whales were sighted in the waters along the Oyashio front. In May they arrive in the southern part of Kuril Islands and appear about or a little north of 50°N in the western Pacific. In the Gulf of Alaska, they proceed to further north beyond 57°N.

In June many whales were sighted to the central part of Kuril Islands, and they also appear in the north side of Unalaska Island in the Bering Sea and staying there, and moved to further north from about July. According to Townsend (1935) the northern limit of the North Pacific black right whales is about 63°N, but two whales were sighted in the Chukchi Sea by Japanese whale catcher boat (Nasu, 1960).

In Okhotsk Sea, a number of whales were sighted in the north side of Etorofu Island (Klumov, 1962), it is supposed, therefore, that the black right whales moved from Pacific Ocean to Okhotsk Sea at the same time as melting sea ice, and the number of whale increased abruptly in June from Townsend and other informations.

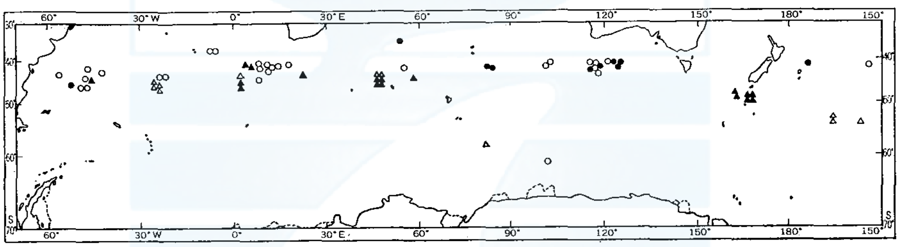

Fig. 14. Sighting of southern right whales in the seasons 1965/66—1967/68 by Japanese whale catchers. Closed circle indicates sightings in November, open circle in December, black triangle in January, and white triangle in February.

Morever many black right whales distributed in the southeast of Cape Kitashiretoko, where the fin whaling ground also located and the oceanic frontal zone by the East Saharine Current (cold) and the extension of Soya Current (warm) which was originated from Tsugaru Warm Current.

Distribution in the Antarctic Sightings of the southern right whales by Japanese whale catchers in the years 1965/66–1967/68 are shown in Fig. 14. Almost all of them were sighted between 40° and 50°S. Townsend (1935) also states that the southern right whales were taken in the days of old whaling nearly everywhere between 30° and 50°S in the southern hemisphere.

In addition, our recent records show a number of whales were sighted farther south of 50°S in December and February, but rarely south of 60°S, Mackintosh (1947) states that it is doubtful whether the right whale was so plentiful in the Antarctic as in temperate regions, even in the old whaling time.

It is supposed, therefore, that only limited number of the southern right whale may travel beyond the Antarctic Convergence.

Table 11 shows the result of sightings by research boats attached to Japanese expeditions. This table shows a trend of an increase of this species in recent years. In Table 12 are shown the sighting results in each area of the Antarctic whaling ground, and the maximum number of sighting is found in areas III-IV. While the heaviest taxation by the old whalers was made in an area from 25°W to 15°E, namely in the present Antarctic whaling areas I-II, the most favourable whaling grounds at that time was located in the waters north of 40°S, and the southernmost ground was in area V at about 53°S, excluding the adjacent waters to South American Continent. It is possible, therefore, that the maximum of sighting is found in the vicinity of area V affected by the fact that the present pelagic whaling operation is limited in the waters south of 40°S.

TABLE 11. THE NUMBER OF WHALES SIGHTED PER 100 NAUTICAL MILES IN THE ANTARCTIC BY JAPANESE WHALE CATCHERS (SURVEY BOATS ATTACHED TO EXPEDITIONS)

Year	Whale species					
	Blue	Fin	Hump	Sei	Right	Sperm
1965/66	0.05	0.38	0.01	3.94	0.01	0.26
1966/67	0.14	1.10	0.01	5.95	0.02	0.88
1967/68	0.11	2.19	0.02	3.76	0.02	0.73

TABLE 12. THE NUMBER OF THE SOUTHERN RIGHT WHALE SIGHTED PER 100 NAUTICAL MILES ACCORDING TO ANTARCTIC WHALEING AREAS BY JAPANESE WHALE CATCHERS

Year	Whaling area						
	I	IIE	IIW	III	IV	V	VI
1965/66	0.00	0.00	0.00	0.01	—	—	—
1966/67	0.00	0.17	0.18	0.01	0.02	0.00	0.00
1967/68	—	—	—	0.02	0.02	0.02	0.01

Consideration on abundance Table 13 shows the sighted number per 100 nautical miles for larger whale in the northern part of North Pacific in the years 1966–1968.

TABLE 13. THE NUMBER OF WHALES SIGHTED PER 100 NAUTICAL MILES IN THE NORTH PACIFIC BY JAPANESE CATCHERS (SURVEY BOATS ATTACHED TO EXPEDITIONS)

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Year	Whale species					
	Blue	Fin	Hump	Sei	Right	Sperm
1966	0.04	0.61	0.21	0.88	0.01	1.81
1967	0.03	0.61	0.12	1.57	0.01	4.03
1968	0.04	0.46	0.04	1.37	0.01	4.74

The values for the black right whale shows the minimum among larger whales, but they do not fluctuate in recent years. Since the North Pacific pelagic whaling grounds in recent years have a tendency to shift southwards compared with previous seasons, as already stated, it is probable that the black right whales migrate further north in mid-summer than that shown by our data. Therefore the distribution density of whales in the southern part in summer does not show true features of the population.

Table 14 shows the record of sighting of North Pacific black right whale by Japanese whale catchers, separately by coastal and pelagic whaling and by years. The numbers of sighting by pelagic whaling since 1966 have decreased compared with those prior to 1962, and this may probably due to the fact that the whaling itself has shifted towards the south. As a whole there is an indication that the number of the black right whales in the North Pacific has increased, taking into consideration the above fact. In the coastal whaling area we have no avairable data in the years 1958–1964, but it is shown in Table 14 that it has increased in recent years. The recent population of North Pacific black right whale in the north western Pacific, therefore, may be slightly higher than before.

On the other hand in the eastern North Pacific the records of sightings of this species are rather scanty (Gilmore, 1956; Slijper *et al.*, 1964; Rice and Fiscus, 1968), and Rice and Fiscus (1968) state that black right whales remain on the brink of extinction in the eastern North Pacific.

TABLE 14. RECORDS OF SIGHTING OF THE BLACK RIGHT WHALE IN THE NORTH PACIFIC BY JAPANESE WHALE CATCHERS

Region	Years													
	1954	'55	'56	'57	'58	'59	'60	'61	'62	'63	'64	'65	'66	'67
Pelagic	37	10	78	70	17	50	106	31	106	—1)	—1)	—1)	13	9
Coastal	13	2	3	45	—1)	—1)	—1)	—1)	—1)	—1)	—1)	102	34	83

1) No record available.

For the southern right whales Table 11 shows the sighting results of the larger whales by Japanese expeditions in the recent three years. In this table it is seen that the number of the southern right whales sighted per 100 nautical miles is quite similar to that of the humpback whales, but both shows the lowest figure than any other baleen and sperm whales. In Table 12 are shown the corresponding figures of the southern right whales according to each whaling area.

Recent sightings of the black right whales in the oceans other than the North Pacific by different authors are: in Florida waters (Moore, 1953, Layne, 1965), in the Gulf of Mexico (Moore and Clark, 1963), off Cape Cod (Schevill, 1962, Schevill and Watkins, 1966), off Nova Scotia and Newfoundland (Sergeant, 1966), in the Bay of Fundy (Neave and Wright, 1968)*, at Tristan da Cunha (Brown, 1958), on the coast of South Africa (Donnelly, 1967), on the coast of Chile (Clarke, 1965), in New Zealand waters (Gaskin, 1964, 1968), in Australian waters (Chittleborough, 1956), in the Antarctic (in the waters south of Indian Ocean and south of South Pacific Ocean, Zenkovich, 1962), and in the Atlantic, Indian and Pacific Oceans (Slijper *et al.*, 1964). These will suggest a sign of recovery of this species in various regions, though each stock is thought still at very low level.

SCHOOLING

The schooling of the black right whales is discussed by Omura (1958) and Nemoto (1964) in previous reports. From the observation through these series of

* Sighting of this species in this bay is commented by Schevill, W. E. (1968). *J. Mamm.*, 49 (4): 794–6.

catch, schools shown in Table 15 have been found in the northern part of the North Pacific. Differing from other baleen whales, the number of whales in a school is rather small in black right whales. The largest school observed is consisting of four black right whales (Omura, 1958).

TABLE 15. NUMBER OF BLACK RIGHT WHALES IN A SCHOOL IN THE NORTH PACIFIC

Year	Number of whales in a school		
	1	2	3
1961	10	10	1
1962	45	15	4
1963	21	8*	4
1968	2	—	—

* Including a cow and a calf.

Behavior

There have been fragmental observations on behavior of black right whales in the North Pacific. The whale caught in 1955 at Ayukawa in the coastal waters to Japan, suddenly jumped from the water and came up to the surface, and after then it spouted gentry several times. Matthews (1937) also reports that the right whale breached in jumping nearly clear of water and falling back to the water and he writes some illustrations in his paper.

TABLE 16. TIME INTERVALS OF BREACHING AND SPOUTING AND NUMBER OF SPOUTS AT ONE BREACHING

No. of whales	Frequency of spouting in one breaching	Interval of spouting	Interval of breaching
61A	3–4	20–30 Second	3–4 Minutes
B	8–9	18–20 „	4 „
C	7	10 „	3 „
62A	?	?	40 Second
B	3	12 Second	5 Minutes
C	4–5	25 „	5–6 „
63A	3–7	?	5 „
B	?	10–15 Second	2–5 „
C	1–2	10–25 „	4–7 „
68A	?	?	?
B	5	20–30 Second	?

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From the observation by Mr. Takamata the captain of the catcher boat of Toshi-Maru No. 17, it is said that right whale (61A) may feel the super sonic, as it breached and tried to escape from the catcher boat in the surface when the "Ultra-sound gun" was in operation. The wave of the "Ultra-sound gun" is ranging 25 kc within 500 meter, and 14 kc within 1000 meter far. But no change in behavior was observed on the Whale No. 68B caught in Okhotsk sea in 1968.

The black right whale caught in 1962 (62A) is the larger whale in the school of two whales, and Mr. Sato, the captain of the catcher boat Toshi-Maru No. 16 reported that the smaller whale escaped slowly after the capture of the larger whale, but after a while it came back again and swam around the captured whale.

Another observation is reported that many dolphins were swimming around the whale (63A) when it was chased and they traveled with the whale in company for a little while.

The time intervals of breaching and spouting and number of spouts at one breaching is observed in the investigation series in the North Pacific.

From these observations in Table 16, black right whales seem to breach after the dive of three to five minutes. Then they spout at the time intervals ranging 12 to 30 seconds. But when they are chased they make only one spout at one breaching.

There are always two spouting brows observed as the illustrations by Matthews (1938) and Nishiwaki (1965).

FOOD AND FEEDING

It has been described that black right whales take favourably copepods in the North Pacific. Two right whales caught in 1956 at the waters of Japanese coast had copepods, in their stomach mainly *Calanus plumchrus*, *C. finmarchicus*, and *Calanus cristatus* with small quantity of *Euphausia pacifica* larvae (Omura, 1958).

TABLE 17. STOMACH CONTENTS OF BLACK RIGHT WHALES IN THE NORTH PACIFIC

Whale No.	Contents	Quantity	Locality
61A	*Calanus plumchrus*	r	South of Kodiak Is.
B	,,	r	,,
C	,,	rr	,,
62A	*C. cristatus*	rrr	North of the Eastern Aleutian Is.
B	,,	r	,,
C	,,	rr	,,
63A	,,	rr	,,
B	,,	rr	,,
C	,,	rrr	,,
68A	*C. plumchrus, Metridia* sp	r	Okhotsk Sea
B	,,	r	,,

All nine right whales have eaten also copepods as shown in Table 17, and two right whales caught in 1968 fed on also copepods. Three whales caught in the Gulf of Alaska in 1961 fed on *Calanus plumchrus*, which consist main food of sei whales in that area. Other six whales caught in the waters north of the east Aleutian Islands took *Calanus cristatus*. Two whales caught in the Okhotsk Sea have taken copepods, considering from their trace of food in stomachs and fecal contents in their intestine.

The intestine of three whales taken in 1963 and two whales in 1968 were filled with faeces of red copepods, suggesting that they fed actively in the waters. As *Calanus cristatus* is one of the most important food for fin whales in the waters north of the east Aleutian Islands, black right whales compete with fin whales for *Calanus cristatus* in that area and with sei whales for *Calanus plumchrus* in the Gulf of Alaska.

It has been reported that black right whales feed on their food by skimming with their long baleen plates especially with fine fringes along their inner edge. They skim small copepod patches which scattered in the sea. One of the authors (Nemoto) saw in 1962 a film which shows feeding of black right whales, at Harvard University by courtesy of Mr. W. Schevill of the Woods Hole Oceanographic Institution. This film was taken from an airplane and the manner of feeding was as follows:

"Apart from current rip streak which was clearly observed in that film, two right whales were swimming with their mouth open to feed on the food. This is typical skimming feeding, and they moved forward and back again after a while, but always they fed with their mouth open at the surface along the clear current rip streak."

External parasites

Whale lice. Whale lice were common on all eleven black right whales. All whales had been covered by those lice thickly, especially on the bonnet and head callosities on the lower jaw. Other colony of whale lice were also observed around genital apertures and anus, and even on tail flukes of some specimens.

There have been ascertained the presence of two species of whale lice by the field observations. Yellow-white whale lice were found on bonnet and callosites, and yellow-brown lice on the other body surface of whales caught in 1961. Some specimens collected in 1963 have been sent to Mr. Rice of the United States, and they are identified as *Cyamus erraticus* and *Cyamus ovalis* by Dr. L. Margolis of the Biological Station at Nanaimo, Fisheries Research Board of Canada. It is said *Cyamus ovalis* were rather small and yellow-white and having shorter gill and the other is *C. ovalis.* Possibly those two species may also present on the black right whales caught in 1961 and 1962. *C. ovalis* was also described from right whales caught in 1956 in the waters adjacent to Japan (Omura, 1958). The parasitic whale lice were also common on the skin of the black right whales caught in 1968 (Table 18). They were mostly common on bonnets and callosites in the head of the two whales. Both *Cyamus ovalis* and *C. erraticus* were found on those whales too.

TABLE 18. PARASITIC CONDITION OF WHALE LICE ON BLACK RIGHT WHALES CAUGHT IN OKHOTSK SEA IN 1968

Position	Whale No. 68A					Whale No. 68B				
	C. ovalis		*C. erraticus*		Larvae	*C. ovalis*		*C. erraticus*		Larvae
Sex	M	F	M	F		M	F	M	F	
Bonnet	R	R	r	r	R	R	R	r	R	R
Callosites upon eye	R	R	R	r	R			unknown		
Callosites on the top of jaws	R	R	R	R	r	R	R	r	r	r
Genital groove	—	—	R	r	—	—	—	r	r	—
Eye part	—	—	r	R	r	—	—	—	—	—
Left flipper base	R	R	r	r	r			unknown		
Blow hole	—	—	R	r	—	r	r	R	R	R
Left jaw	r	R	—	—	R			unknown		
Middle lower jaw	—	—	—	—	—	R	R	—	r	R

R: numerous, r: not so numerous

Almost all *C. erraticus* found around genital grooves, eyes, mouth parts and blow hole were adult form and males were predominant, although small number of larvae and *C. ovalis* were also found on the blow hole of Whale No. 68B. But compratively many larvae of *C. erraticus* were found on callosites on the heads of the two whales taken in 1968.

Diatom film. The parasitic diatoms were found on the tail fluke of one black right whale caught in 1963 (63A) and they are identified as *Cocconeis ceticola* which is very common among baleen whales as parasites on epidermis both in southern and northern hemispheres (Hart, 1935; Nemoto, 1956). Scraps of epidermis had been collected from other whales, but no diatom had been found from other scraps of the epidermis of other whales caught in 1961 and 1962.

Slight films of diatom were observed on two whales caught in 1968 over the hole body surface. Especially, remarkable diatom patches were found on the white patch of the belly of Whale No. 68B.

TABLE 19. THE BODY PART WHERE HEAVY INFECTION OF THE WHALE LICE IS OBSERVED

Whale No.	Bonnet	Collosities	Genital aperture	Head	Body	Tail flukes
61A	rrr	rrr	r	r	rrr	r
B	rrr	rrr	r	r	r	r
C	rrr	rrr	r	r	r	r
62A	rrr	rrr	rrr	rrr	r	rrr
B	rrr	rrr	r	r	r	r
C	rrr	rrr	r	r	r	r
63A	rrr	rrr	r	r	r	r
B	rrr	rrr	r	r	r	r
C	rrr	rrr	r	r	r	r

rrr=heavy, rr=moderate, r=few.

Internal parasites. As for the internal organs, no parasitic worm was found on black right whales caught in Okhotsk sea in 1968 by visual observation.

Scar The oval white scar which is very common on balaenopterid whales has not been found on black right whales, except one on Whale No. 56B, in the former study (Omura, 1958). It may be possibly due to the thick surface epidermis of the black right whales. It is ranging 15 mm in this species, but black epidermis in the blubber of the balaenopterids is only 5 mm thick generally. In the black right whales caught in Okhotsk Sea in 1968, the oval scars were observed mainly in the posterior parts of the body. Whale lice infected in the scars which were not yet healed. Other scars were found on the epidermis of tail flukes and lower jaws of the two whales.

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Round black scars, however, are found on many specimens caught in years from 1961 to 1963. Several lines of white scars were observed on the left back of one right whale, 61B caught in 1961. The space of those stripes were ranging 7 to 9 cm, and this type of scar had been observed also on the specimens caught in 1956 (Omura, 1958). It was considered to be the biting scars of killer whales.

REPRODUCTION AND GROWTH

Sexual maturity

Male reproductive organs. The penis of black right whale is long and slender. It is pigmented with blue-black. As shown in Table 20, penis of adults is 215–270 cm in length, and 90–110 cm in girth at base. The cross section of glans penis is not round as those of Balaenopteridae, and it is nearly rectangle. Plate VIII Fig. 1 is a photograph of penis of Whale No. 61A.

TABLE 20. MEASUREMENTS OF REPRODUCTIVE ORGANS IN THE MALE RIGHT WHALES

Whale No.	Body length (m)	Size of testis (cm)		Weight of testis (kg)		Size of penis (cm)	
		Left	Right	Left	Right	Length	Girth at insertion
61A	17.1	187×78	191×78	452	520	225	110
61B	17.0	192×82	201×78	430	525	215	108
61C	15.1	170×70	170×65	322	305	220	90
62B	14.7	—	—	12.5	11.1	200	—
62C	16.1	190×70	185×70	445	415	270	—
63C	16.4	48×16	—	4.9	4.1	110+	—
68A	15.2	—	—	95	100	—	—

Fig. 15. Sperms of black right whale. (Photo by T. Kamiya).

The testis of the black right whale is very large. Table 20 also shows the size and weight of the testes. The largest one was 201 cm in length, 78 cm in diameter and 525 kg in weight. Combined weight of testes was 972 kg in the case of the heaviest (Whale No. 61A).

From the histological examinations, the testes of Whale No. 62B were still immature. Seminiferous tubule diameter is 183μ in average of 20 counts (130–250μ) in the testis of Whale No. 68A. There is no spermatogonia, but it is observed that spermatogenesis occurs actually. Spermatocytes in the testis tubule are mainly primary spermatocytes, and some spermatogonia and secondary spermatocytes are found. Then, it is determined that this whale is sexually immature, but it becomes mature soon. The testis tissue of Whale No. 62C was obviously mature.

White seminal fluid had flowed from the tip of penis of Whale No. 61C on the flensing deck. Fig. 15 is a microscopical photograph of the white fluid. Many mature sperms are seen in the fluid. The shape of the sperms is somewhat different from the figure (Fig. 35) which was drawn by Klumov (1962).

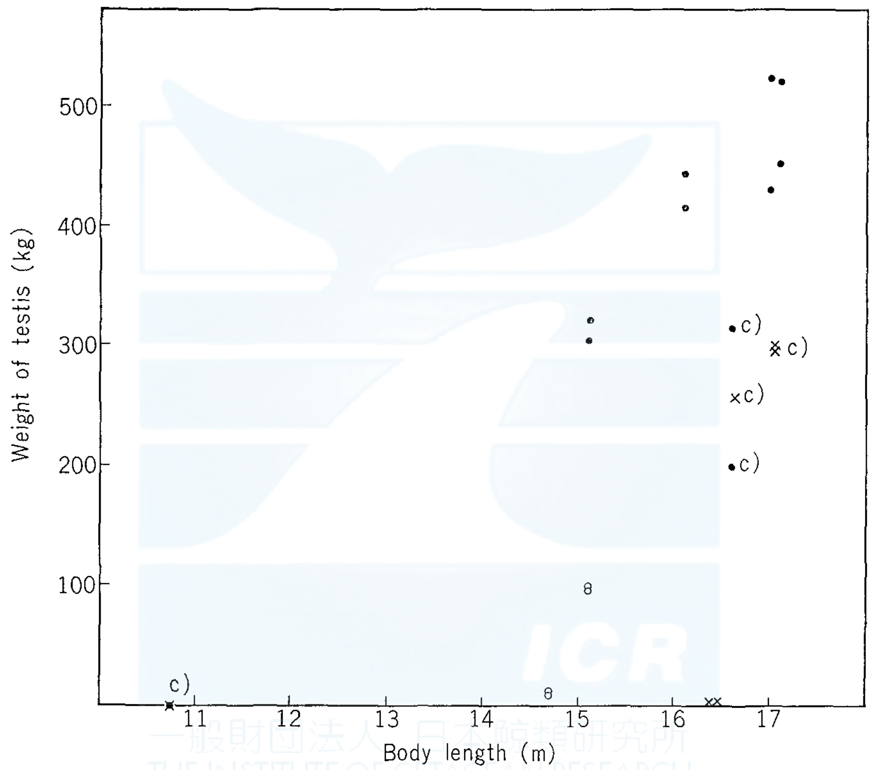

Fig. 16. Relation between body length and weight of testis in black right whales in the North Pacific. Open circle indicates immature, closed circle mature, cross without microscopic examination, and those with c) cited from Klumov (1962).

We have not yet so many materials to determine the weight of testis at the stage of maturity. Fig. 16 shows the relation between body length and weight of testis. There is a large gap in weights between immature and mature groups. Klumov (1962) describes that the testis attains at maturity in 150–200 kg in weight. However, deducting from body-length and testis-weight relationship on other whale species and from histological examinations, we estimate that it should be 80–140 kg.

Female reproductive organs There is a pair of nipple slits in the female. It is characteristic that the nipple slits do not run parallel to the genital slit, and the distance between each anterior ends is always wider than that between each posterior ends (Plate VIII, Fig. 2).

Vaginal band was not observed for the Whale Nos. 62A and 68B, so the existence of it was not confirmed for these individuals. Whale Nos. 63A and 63B had no vaginal band, but these were sexually mature. There was no vaginal band in the fetus of Whale No. 63B.

The size of mammary gland of a primiparous whale (No. 63B) was measured. It was spindle-shaped, and was 100 cm in length, 35 cm in width and 6 cm in thickness at middle. Its weight was 10 kg. Its section was pink, and was estimated to be not functional.

TABLE 21. MEASUREMENTS OF REPRODUCTIVE ORGANS IN THE FEMALE BLACK RIGHT WHALES

Whale No.	Body length (m)	Vaginal band	Weight of ovary (kg)		No. of corpora		Diameter of corp. lut. (cm)	Width of uterine horn (cm)		Remarks
			Left	Right	Left	Right		Left	Right	
62A	14.1	Not observed	—	—	0–0	0–0	—	7.0*	7.0*	Prepuberty
63B	15.4	No.	2.1	6.3	0–0	1–0	18	—	140	Primiparous
63A	16.1	No.	5.5	3.0	1–0	0–2	18	110	100	Multiparous
68B	12.6	No.	—	—	0–0	0–0	—	—	—	Immature

Remarks: *: Not opened

The interior wall of vagina of Whale No. 62A was provided with three prominent annular folds. A length of an uterine horn of Whale No. 63B was 340 cm. The width of uterine horn in which a fetus was found was 140 cm (after cutting open). Widths of a pair of uterine horns in another pregnant whale (No. 63A) were 110 and 100 cm.

Ovaries of the black right whales are relatively large and long oval-shaped. The ovaries of Whale No. 68B were immature, and those of Whale No. 62A were also immature. But there was a follicle of 3.8 cm in diameter in the left ovary of the latter whale. Therefore, this individual would attain at sexual maturity soon. Whale No. 63B had one corpus luteum in the right ovary, and a fetus was found in the right uterine horn. Its mammary gland was not mature. There were one corpus lateum and two corpora albicantia in the ovaries of Whale No. 63A. Its mammary gland was mature and resting.

Fetus We found two fetuses during years of our researches (Plate IX). One was obtained from Whale No. 63A. It was a male of 218 cm long and 136 kg in weight. Another one was found from Whale No. 63B. It was a female of 270 cm long and 257 kg in weight.

Body length at sexual maturity We have still scarce data to determine the body length at sexual maturity of the black right whale. Table 22 shows a size distribution of the North Pacific right whales by the stage of sexual maturity, gathering data by Matsuura and Maeda (1942), Omura (1958) and Klumov (1962), in addition to the present materials.

The largest immature male is 16.4 m (No. 63C), and the smallest mature male is 41 feet (Matsuura and Maeda, 1942). But in the latter case, there was no record on weight of testes. Klumov (1962) represents that it is possible that puberty comes when male's body length is 14–15 m. Assuming from Fig. 16, the average body length of the male black right whale at sexual maturity will be 14.5–15.5 m.

TABLE 22. SIZE DISTRIBUTION OF THE NORTH PACIFIC RIGHT WHALES BY SEX AND BY SEXUAL MATURITY

Body length (m)	Males		Females	
	Immature	Mature	Immature	Mature
10.5–10.9	1[c]	—	—	—
11.0–11.4	—	—	1[c]	—
11.5–11.9	—	—	1[b]	—
12.0–12.4	1[b]	—	—	—
12.5–12.9	—	1[a]	1	—
13.0–13.4	—	—	—	—
13.5–13.9	1[a]	—	—	—
14.0–14.4	—	—	1	—
14.5–14.9	1	—	—	—
15.0–15.4	1	1	—	1
15.5–15.9	—	—	—	—
16.0–16.4	1	1	—	2[d]
16.5–15.9	—	2[c]	—	—
17.0–17.4	—	3[d]	—	1[c]
17.5–17.9	—	—	—	2[a,c]
18.0–18.4	—	—	—	1[c]
Total	6	8	4	7

Remarks: a): Matsuura and Maeda (1942), b): Omura (1958), c): Klumov (1962), d): In which one from Klumov (1962).

The largest immature female was 14.1 m (No. 62A), and the smallest mature female was 15.4 m (No. 63B). Fig. 17 shows the relation between body length and number of corpora in the ovaries of the North Pacific right whales. Size distribution

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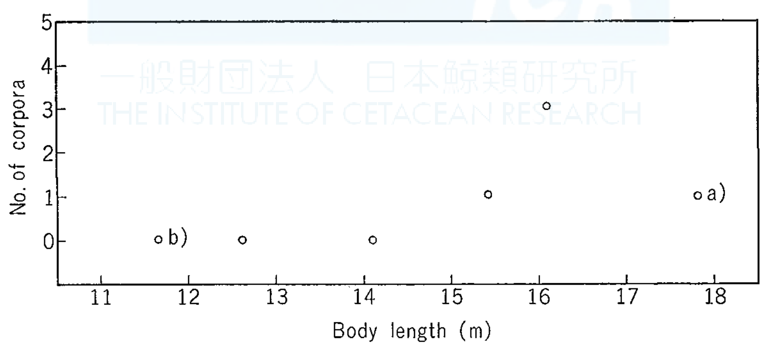

Fig. 17. Relation between body length and number of corpora in ovaries in black right whales in the North Pacific. In the figure circle attached with a) means cited from Matsuura and Maeda (1942), and b) from Omura (1958).

in Fig. 3 of Omura's paper and the present figures lead us to assume that the adult female is little larger than the male, and the estimated average body length of the female at sexual maturity will be 15.0–16.0 m.

Physical maturity

As an index of physical maturity, the condition of cartilage layer between epiphyses and centrum of the vertebral body has been employed. Table 23 shows the identification of ossification of dorsal and lumbar vertebrae for the present materials.

In the males, four whales (Nos. 63C, 62B, 61C and 68A) were considered as physically immature. However, the 5th lumbar of Whale No. 61C was ankylosed. Other three males (Nos. 62C, 61B and 61A) were decided to be physically mature.

TABLE 23. OSSIFICATION OF VERTEBRAE IN THE BLACK RIGHT WHALES

Whale No.	Sex	Body length (m)	Ossification of vertebrae		Weight of testes (kg)	No. of corpora
			Dorsal*	Lumbar*		
63C	Male	16.4	N	N	9.0	
62B	Male	14.7	N	N	23.6	
61C	Male	15.1	N	A	627	
68A	Male	15.2	—	N	195	
62C	Male	16.1	A	—	860	
61B	Male	17.0	A	A	955	
61A	Male	17.1	A	A	972	
68B	Female	12.6	—	N		0
62A	Female	14.1	N	N		0
63B	Female	15.4	N	N		1
63A	Female	16.1	N	N		3

Remarks: N: Not ankylosed, A: Ankylosed, *: Middle part

Although we have not enough data for determining the average body length at which male right whale attains at physical maturity, but it is estimated to be 16–17 m, based on the present materials.

All females (Nos. 68B, 62B, 63B and 63A) have not been attained physical maturity. Estimating from the number of corpora in the ovaries, they are relatively young. According to the size distribution of the North Pacific right whales by Matsuura (1936) and Omura (1958), as already estimated, adult female is larger than the adult male in average. Then, the average size of physical maturity of female is thought to somewhat larger than that of male, and it is estimated as 16.6–18 m.

Age characters

Among age characters of the black right whale, only ear plug and baleen plate are discussed here.

The external auditory meatus of the black right whale is filled with thick ear plug. The colour of this ear plug is pure black, and the texture is very soft, like as wet mud both before and after fixation in 10% solution of formalin. The internal structure of this ear plug is almost uniform, except one whale, without core in which growth layers are accumulated in the case of balaenopterids and eschrichtiids whales.

From the ear plug of Whale No. 62B, a small and soft core was collected with the outer covering. The length and width at base of this core is about 3.5 cm and 1.6 cm respectively. And this is very flat due to the small size of glove finger. The core is pale brown in colour and contained 12 dark laminae in it.

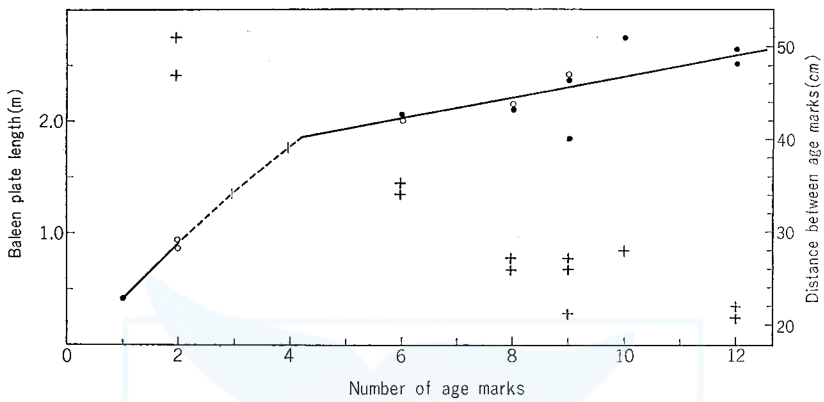

Fig. 18. Relation between length of baleen plate and number of age marks on baleen plate of the black right whales in the North Pacific. Distance between age marks is also plotted. Open circle indicates length of baleen plate of female, closed circle that of male, and cross mark distance between age marks.

As mentioned in the chapter of baleen plate, various number of growth marks are observed on the baleen plate of present specimens. Though there is no sufficient evidence, it will not be unreasonable to assume that this growth marks are related to age and are formed annually as in the case of blue and fin whales.

The numbers of this growth mark are shown in Table 7. The relation between the length of baleen plate and the number of age marks observed on the baleen is shown in Fig. 18. In this figure the spacing between age marks are also plotted (see the chapter of " *Baleen* "). The solid line at the left was drawn by hand to fit the 10 examples which have lost the neo-natal mark on the baleen plate.

TABLE. 24. MEASUREMENTS OF BALEEN PLATE WITH NEO-NATAL MARK (cm)

Speciment	Tip to neo-natal mark	Neo-natal mark to 1st age mark	1st age mark to 2nd age mark	2nd age mark to gum line
56A or B	9.0	17.0	51.0	8.5
68B	6.5	37.5	47.0	6.0
Mean	7.8	27.3	49.0	7.3

Among these whales the superfical increasing rate of the length of baleen plate are read, on the regression line, to be about 10 cm per an age mark. This value is smaller than the mean distance between age marks of each baleen plate. This superfical discrepancy is due to the decrease of the distance between age marks, or decrease of growth rate of baleen plate, in older animals.

The solid line at the left was drawn based on the distance between the first and second age mark on the baleen plate which still have the neo-natal mark (Table 24).

Dotted line was calculated from the spacing between age marks which can be read on Fig. 18. This dotted line joines with the regression line drawn for the baleen plates without neo-natal mark, approximately at the stage of 4 age marks. So we suppose that the period when the neo-natal mark is observed on the baleen plate does not exceed 4 years.

Judging from the measurement in Table 24, the season when a new age mark erupt out of the gum will be before summer, probably in winter or in spring.

Growth

As mentioned in the former chapters, we obtained 4 right whales which ages were determined by the age marks on baleen plate or laminae in ear plug. The 10.75 m male reported by Klumov (1962) have 40 cm long baleen plate, probably this whale have only one age mark. Matthews (1938) reports a 6.5 cm suckling calf captured at Durban in August. This whale may have been born in that winter. All of these informations are tabulated in Table 25.

TABLE 25. INFORMATIONS ON AGE AND GROWTH OF BLACK RIGHT WHALES

Specimen No.	Body length	Assumed age	Sex	Remarks
1020	6.50	0	Male	Matthews
6	10.75	≒0.5	Male	Klumov
65A	11.65	≒1.5	Female	Omura
65B	12.40	≒1.5	Male	”
68B	12.60	≒1.5	Female	
62B	14.70	12	Female	Puberty

These data suggest that the calf will be born in winter at less than 6 m long. And after about a half year, by the first summer, it will attain the body length of 10 to 11 m and starts to feed, then it will be weaned. By the second summer, or after one and a half year, it attains the length of about 12 m. The sexual maturity will be attained at the age of about 10 years as in the case of balaenopterid whales, considering a pubertal female with 12 laminae in the ear plug.

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Reproduction

The measurment of female reproductive organs are shown in Table 21. Two pregnant whales 63A and 63B were captured on 5 Aug. 1963. Their fetuses were 2.18 m male and 2.70 m female respectively. The female 62A was immature and had the largest follicle in the left ovary, which diameter was 3.8 cm.

No lactating female nor suckling calf was collected. And our present data is not sufficient to check the preliminary data on the reproduction of black right whale reported by Klumov (1962).

OSTEOLOGY

Omura (1958) reports two skeletons of the North Pacific black right whale taken on the coast of Japan (56A and 56B). Since then two more specimens have been obtained for osteological study. These are specimens 61A and 61B, taken in August 1961 during pelagic operation in the North Pacific. Body lengths of these whales were 17.10 and 17.00 m respectively, and both were males, as shown somewhere in this report.

The bones were brought back to home port aboard the factory ship and were transported by trucks to Tokyo, where they were burried in the earth about two and a half years until April 1964, for removal of soft parts attached thereon and extraction of oil contained in them. Various measurements and photographs contained in this report were taken during a period from December 1964 through following January.

The specimen 61A is now being kept at the Tokyo University of Fisheries, Tokyo, and 61B at the Smithsonian Institution, Washington, D.C.

Skull (Pls. X-XII) In general these two skulls resemble to the two skulls already reported, but most peculiar points are the bipartite malars in the 61A and presence of a shield on the supraoccipital bone of the 61B. The malar is described somewhere in this report. The shield is present on the mid-line of the skull. It is in fact a small and flat bony projection of about 3 cm thick on the skull. It begins a little below the apex, at first perpendicularly to the surface of the bone, and soon pointing downwards and parallel to the surface. The width of this projection is 129 mm at its base and 125 mm at the tip, and the length is 189 mm. The distance from the tip to the foramen magnum is 997 mm. To our knowledge such bony shield seems the first occurrence on the skull of whales.

The skulls of these two specimens are larger than any specimen reported before. The largest was the Edinburgh specimen reported by Turner (1913) which measures 4,190 mm in length (see Table 10, Omura 1958), but the lengths of skulls of 61A and 61B are far greater than this and measure 5,100 and 5,240 mm respectively, the former is a little shorter though body length of this whale is a bit larger than the latter whale.

In the former report by Omura (1958) it is noted that in the Provincetown specimen (Allen, 1908) the mastoid processes of the temporals direst obliquely inward when the skull is viewed posteriorly whereas in the Japanese specimens (56A and 56B) direct downward, and he thought this might be a difference according to age. The specimen 61A (Pl.XII, Fig. 1) resembles in this respect to the North Atlantic specimen, but 61B (Pl. XII, Fig. 2) to the Japanese specimens. Specimens 61A and 61B are both physically mature, though in the latter all vertebral epiphyses are fused to their centra, but linea epiphysialis is still visible in vertebrae from the first dorsal to the first caudal. On the other hand the Provincetown specimen is thought as physically immature, judged from figures in Plate XXIII of the report, the sixth dorsal, the sixth lumbar, and the sixth caudal are all lacking their epiphyses.

TABLE 26. SKULL MEASUREMENTS OF SPECIMENS 61A AND 61B

Measurements		61A			61B	
	in mm	% of length	% of breadth	in mm	% of length	% of breadth
Length of skull, straight	5,100	100.0	158.7	5,240	100.0	168.2
Length of max. at superior border, straight	4,115	80.7	128.0	4,270	81.5	137.1
Length of max., following curve of sup. external border	4,245	83.2	132.1	4,490	85.7	144.1
Length of premax., straight	4,260	83.5	132.5	4,440	84,7	142.5
Length of premax., along dorsal convexity	4,457	87.4	138.7	4,810	91.8	154.4
Length of rostrum, straight	4,027	79.0	125.3	4,155	79.3	133.4
Anterior end of nasals to end of rostrum, on curve	4,498	88.2	140.0	4,795	91.5	153.9
Length from tip of rostrum to anterior orbital margin, straight	4,568	89.6	142.1	4,660	88.9	149.6
Length from tip of premax, to posterior end of pterygoid	4,983	97.7	155.0	5,063	96.6	162.5
Length from tip of premax. to post. end of palatines, median.	4,843	95.0	150.7	4,980	95.0	159.9
Length from tip of premax. to ant. end of palatines, median.	4,307	84.5	134.0	4,490	85.7	144.1
Length of nasals, median.	303	5.9	9.4	396	7.6	12.7
Breadth of 2 nasals distally	345	6.8	10.7	299	5.7	9.6
Breadth of 2 nasals proximally	320	6.3	10.0	443	8.5	14.2
Greatest breadth of skull, orbits	3,214	63.0	100.0	3,115	59.4	100.0
Breadth of skull at middle of orbits	2,992	58.7	93.1	2,997	57.2	96.2
Breadth of skull at ant. and dist. ends of orbital process of frontal	3,010	59.0	93.7	2,960	56.5	95.0
Breadth of skull at orbital processes of maxillaries	2,874	56.4	89.4	2,785	53.1	89.4
Breadth of skull at squamosals	2,997	58.8	93.2	2,965	56.6	95.2
Breadth of rostrum at middle, straight	480	9.4	14.9	542	10.3	17.4
Breadth of orbital process of frontal at distal end R	258	5.1	8.0	235	4.5	7.5
Breadth of orbital process of frontal at distal end L	240	4.7	7.5	239	4.6	7.7
Greatest breadth of occipital bone	1,507	29.5	46.9	1,410	26.9	45.3
Height of supraoccipital bone, from foramen magnum	1,225	24.0	38.1	1,242	23.7	39.9
Transverse breadth of occipital condyles	427	8.4	13.3	464	8.9	14.9
Height of occipital condyle R	313	6.1	9.7	340	6.5	10.9
Height of occipital condyle L	310	6.1	9.6	343	6.5	11.0
Greatest breadth of foramen magnum	138	2.7	4.3	142	2.7	4.6
Greatest height of foramen magnum	138	2.7	4.3	141	2.7	4.5
Length of mandible, straight R	5,096	99.9	158.6	5,047	96.3	162.0
Length of mandible, straight L	5,063	99.3	157.5	5,015	95.7	161.0
Length of mandible, on curve R	5,395	105.8	167.9	5,354	102.2	171.9
Length of mandible, on curve L	5,402	105.9	168.1	5,365	102.4	172.2
Depth of mandible at middle R	348	6.8	10.8	336	6.4	10.8
Depth of mandible at middle L	358	7.0	11.1	345	6.6	11.1
Depth of mandible at coronoid R	552	10.8	17.2	507	9.7	16.3
Depth of mandible at coronoid L	555	10.9	17.3	509	9.7	16.3
Depth of mandible at condyle R	617	12.1	19.2	534	10.2	17.1
Depth of mandible at condyle L	615	12.1	19.1	532	10.2	17.1
Breadth of mandible at condyle R	493	9.7	15.3	393	7.5	12.6
Breadth of mandible at condyle L	496	9.7	15.4	404	7.7	13.0

There is less possibility, therefore, that this is a difference according to age.

In profile the rostrum of the specimen 61A is less curved and resembles to those reported previously (56A and 56B), whereas the specimen 61B resembles rather to these reported by True (1904). Slight difference in visual comparison in this respect, however, is thought to be of less taxonomic value.

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Skull measurements of the both specimens are shown in Table 26, in actual measurements of various parts in mm and percentages against total length as well as percentages to greatest breadth of the skull. In the previous paper the corresponding values of the specimens 56A and 56B are compared with 21 skulls of the North Atlantic specimens as reported by various authors (Allen 1908, Andrews 1908, Capellini 1877, Gasco 1879, Graells 1889, Guldberg, 1893, True 1904, Turner 1913). In comparison of these proportions of various parts of the skull we noticed that in the specimens 61A and 61B the proportional length of the " anterior end of nasals to the end of rostrum, on curve " is larger than any specimens reported before. The proportion of this length against the skull length is 70–80 percent in most specimens and the largest value is 83.8 (Amagansett specimen reported by True, 1904), whereas

TABLE 27. WEIGHT OF BONES, MEASURED AFTER DRYING

	61A		61B	
Skull (excluding specified bones)	1,030 kg		820 kg	
Malar	3.3		2.5	
Lachrymal	0.5		0.2	
Tympanic bulla	1.7		1.5	
Mandible (total of right and left)	480		440	
Hyoid bone	5.0		5.1	
Vertebra, cervicals (united)	39.2	904.1	42.4	777.8
Vertebra, dorsals (14 each)	259.4		213.2	
Vertebra, lumbars (10 each)	273.6		229.0	
Vertebra, caudals (25 and 26)	331.9		293.2	
Chevron bone	14.4		12.5	
Pelvic bone and femur (total)	2.3		2.0	
Sternum	7.9		3.3	
Rib (14 pairs each)	574.2		515.9	
Scapula (total of right and left)	123.6		94.9	
Humerus (")	69.9		70.0	
Radius (")	48.0		40.0	
Ulna (")	26.8		23.5	
Carpal (")	12.9		8.2	
Phalanges (")	15.6		11.7	
Total	3,320.2		2,829.1	

the corresponding figures of 61A and 61B are 88.2 and 91.5 respectively. However, in the proportional " length of rostrum, straight " the figures for the both specimens are within the range of those of the other specimens. In the previous report Omura (1958) noted that in the North Pacific specimens (56A and 56B) the curved lengths of maxillary and premaxillary are shorter than the North Atlantic specimens, but the proportional lengths of these bones of the specimens 61A and 61B are quite similar to those of the North Atlantic specimens. Breadth of occipital bone and height of supraoccipital bone of the specimens 56A and 56B are greater than in the specimens from the North Atlantic, but in the specimens 61A and 61B they are also quite similar to the North Atlantic specimens. In other proportions of skull no distinction between the specimens from the North Pacific and North Atlantic is noted.

The skull of 61A is a little shorter than that of 61B, but more broader than the latter, and mandibles are larger in 61A than 61B, as shown in Table 26. The bones of 61A are massive than those of 61B. The weight of each bone was measured just after the dismembering, on the flensing deck of the factory ship in 1961, result of which are shown in Appendix Table 1. We measured again the weights of bones of the both specimens in dried condition in January 1965. Bone weight may differ according to the method and stages of drying, but these two specimens were always treated together and we think the measured weight of the both specimens are quite comparable (Table 27). As shown in Table 27 the skull weight of 61A is 1,030 kg whereas 820 kg in 61B, and the weights of mandibles are 480 and 440 kg respectively. In the other bones too the specimen 61A is much heavier than 61B in general and in the total the former is heavier than the latter by about 500 kg. The both specimens are physically mature, but 61A is older than the other as stated before.

Lachrymals (Fig. 19) of the specimens 61A and 61B are larger, but resemble in general shape to those of 56A and 56B, being flat and rectangle in shape of which measurements are shown in Table 28.

Malars (Fig. 19) of 61B are similar in general shape to those of 56A and 56B, though their flattened portion which articulate between lachrymal and maxillary are somewhat shorter and the tips are rather pointing, whereas in the latter specimens

Fig. 19. Lachrymals (upper) and malars (lower) of the specimens 61A (left) and 61B (right).

TABLE 28. MEASUREMENTS OF LACHRYMALS OF SPECIMENS 61A AND 61B

	Length (mm)		Breadth (mm)	
	Right	Left	Right	Left
61A	425	474	96	85
61B	453	309*	94	79

* Tip broken

these portions are long and the margins of the tips flat. Measurements of malars are shown in Table 29. Malars of 61A are peculiar in appearance and are composed of two ossicles, namely, a longer, anterior piece and a shorter, more cuboidal, posteior piece. In addition in the right malar the anterior portion is in two pieces and the flattened part which articulate between lachrymal and maxillary is detached from the main body as a flat ossicle. In doubt that these elements are diaphysis and epiphyses we contacted with Professor A. J. Cave of the St. Bartholomew's Hospital Medical College in London and sent the photographs of malars of 61A and 61B as well as the specimens of 61A to him. He was kindly investigated them very closely, comparing them to other specimens in the British Museum (Natural History). The following statement is extracted from his personal communication and this explains fully the situation.

" This photograph shows (what the actual bones themselves confirm) that the specimen A malars are curiously distorted and are, in appearance and proportion, wholly distinct from malars of specimen B. Their lateral margins are remarkably tuberculated and their articular areas are abnormally pitted and ridged in a manner not exibited by the corresponding surfaces of cetacean malars in specimens in the British Museum (Natural History), with which the A malars have been compared.

TABLE 29. MEASUREMENTS OF MALARS OF THE SPECIMENS 61A AND 61B (mm)

	61A		61B	
	Right	Left	Right	Left
Length	426	451	449	455
Breadth	101	120	80	81

They are also broader and of more irregular outline. The conclusion is almost inescapable that the malars of specimen A are pathological, though I hesitate to put a name to their particular dystrophy.

The second point is that, having carefully examined the right and left malars of A, I conclude that your ' ossicle C ' (flattened portion) of the right malar is not a naturally independent ossicle but simply a malar fragment detached by a fracture.

Now as to the composition of the malar bone in your two specimens, A and B, malar is a single entity and doubtless represents the usual state of affairs in *Eubalaena*, as in cetacean generally. The specimen A malar, however, is in two pieces. These two elements are not diaphysis and epiphysis but merely the two components of a naturally bipartite malar. The bilateral symmetry of the condition is indicative of its congenital nature. Thus it would seem that, usually, the *Eubalaena glacialis* malar is a single bony entity, but that, as an individual variation—a congenital anomaly, if you like—the cetacean malar may be bipartite."

He also pointed out that such a condition was described and illustrated for *Balaena australis* by Beneden and Gervais (1868–79) and that the authors remark that the malar (jugal) was formed bilaterally ' de deux os parfaitement d'istincts ' and they regarded this condition as probably ' une disposition individuelle '.

Tympanic bulla (Fig. 20) Tympanic bullae were collected from both specimens, except the right bulla of the specimen 61A which was missed. In addition some were collected also from other specimens. Their longitudinal lengths are 120–140 mm. The shape of the bulla is different from that of balaenopterid whales, being pointed at one end, and it can easily be distinguished. The size is larger and heavier than that of fin and sei whales. The samples collected are not perfect. They were broken in some extent at their lips and the ossicles i.e. malleus, incus, and stapes were missed.

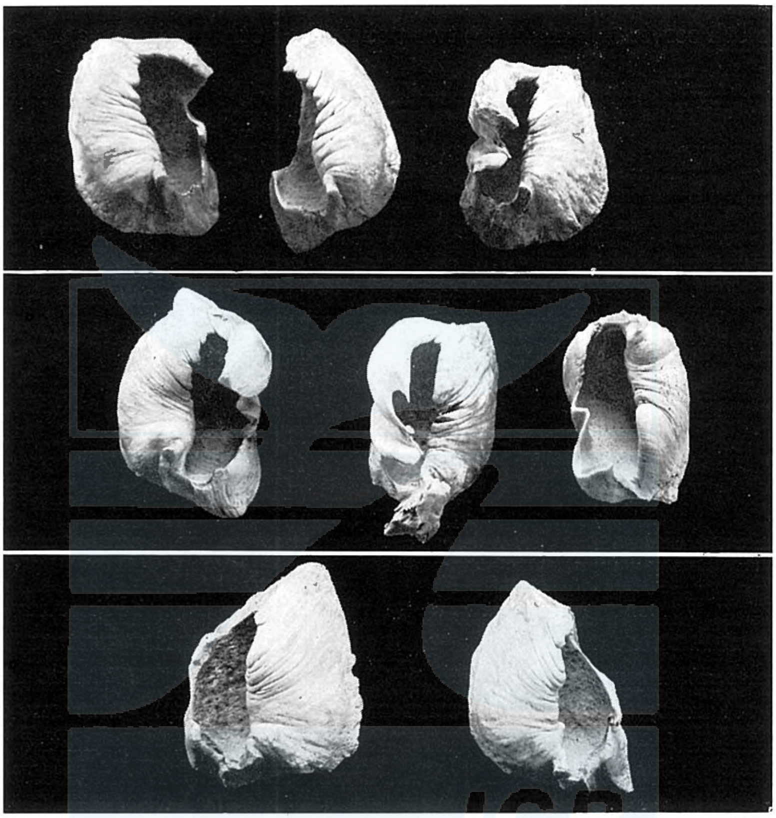

Fig. 20. Tympanic bullae of black right whales in the North Pacific. 1st line from left to right 61B (right), 61B (left), 61A (left). 2nd line from left to right 62C. 62B, 62A. Bottom left 63A, right 63B.

Vertebrae (Pls. XIII-XV) The total number of vertebrae of 61A and 61B are 56 and 57 respectively. In Table 30 the numbers are shown in detail, comparing with those of 56A, 56B, and with the other specimens which were counted at the time of treating. The total number of vertebrae in most specimens are 56–57 and one has 55. In this respect we find no difference from the black right whales in the North Atlantic.

The cervical vertebrae (Pl. XIII) of the both specimens are united into one solid mass as usual. They resemble in general shape, but differ from each other in some parts. The neural arches of 61A are separated into four parts, i.e. atlas, 2–4th, and 7th, whereas in 61B they are united into one process except that of the atlas.

The superior transverse processes of each vertebra are also united at their extremities in groups, but in this case again they are subject to individual variation. The cervical vertebrae of the 62C specimen have also been preserved, but in those three specimens the manner is different.

The inferior transverse processes are lacking in 4–7th vertebrae in both specimens. In the lateral view each vertebra is separated by sutures on the central body, but in the inferior side the combined bone of atlas and axis extends backwards and covers up to 5th cervicals. In these two points the both specimens agree with that of 56B.

TABLE 30. NUMBER OF VERTEBRAE

Specimens	C	D	L	Ca	Total
56A	7	14	10	25	56
56B	7	15	9	25	56
61A	7	14	10	25	56
61B	7	14	10	26	57
61C*	7	15	11	24	57
62A*	7	14	11	25	57
62B*	7	15	10	25	57
62C*	7	15	10	25	57
63A*	7	14	11	24	56
63B*	7	14	11	24	56
63C*	7	14	11	25	57
68A*	7	14	11	25	57
68B*	7	15	10	23	55

* Examined at the time of dismembering.

The dorsal vertebrae (Pl. XIV, Figs. 1 and 2) are present 14 in number in both specimens of 61A and 61B. Each of them had 14 pairs of ribs as stated later. All specimens hitherto reported from the North Pacific and North Atlantic Oceans have 14 dorsal vertebrae, except two specimens (Omura, 1958). The one is the San Sebastian whale reported by Gasco (1879) which has 13 dorsals, and the other is the 56B specimen which has 15 dorsals. In this respect both 61A and 61B agree with usual specimens. But as shown in Table 30, there are 5 specimens in total which have 15 dorsals. All of them had 15 pairs of ribs, excepting the specimens 68B which had a short rib in addition to 14 pairs. Thus, out of 13 individuals we investigated 8 had 14 dorsals and 5 had 15 dorsals. We may safely conclude, therefore, that the number of dorsal vertebrae is 14–15 in the black right whale in the North Pacific, whereas in those in the North Atlantic it is uniformly 14 with one exception. The last ribs are, however, very small compared with the preceding ones and easily be missed at the time of treating.

The epiphyses of the dorsal vertebrae are all fused completely to their centra in 61A, but in 61B linea epiphysialis is still visible though they are also ankylosed, as stated before. Each vertebra is very massive and the transverse processes as well as spinous processes and prezygapophyses are tuberculated at their extremities, very heavily pitted and ridged in 61A and in lesser degree in 61B. Such deformity is observed on almost all vertebrae except cervicals. Articulating facet of transverse process for rib is very faint in 14th dorsal of 61A and 13th and 14th of 61B. In these vertebrae the transverse processes are abruptly narrowed at their distal ends compared with those of preceding vertebrae (Fig. 21).

The spinous process is not evenly developed to the vertical and longitudinal plane which pass the center, namely it is not symmetric to this plane and giving an impression that it is twisted towards right or left irregularly. Such irregularity in the shape of spinous process is observed in vertebrae from 2nd dorsal to first caudal of 61A and in those from the 3rd dorsal to 4th caudal of 61B.

The lumbar vertebrae (P1.XIV, Figs. 3 and 4) are present 10 in number in both specimens. In 56A and 56B the number are 11 and 9 respectively. Out of ten specimens reported from the North Atlantic in this century only one has 10 lumbars and all others have 11 (See Table 11 of Omura, 1958). It seems that the black right whale in the North Pacific has a fewer number of lumbar vertebrae, but 6 specimens examined in fresh condition had 11 lumbars.

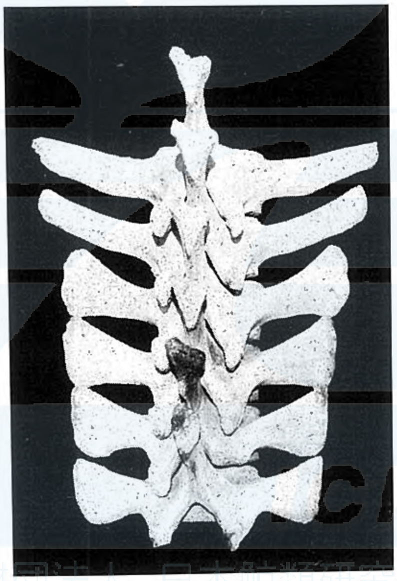

Fig. 21. Dorsal vertebrae of the specimen 61B, dorsal veiw. From bottom upwards 9th–14th.

The caudal vertebrae (P1. XV) were all secured in both specimens. Their number in 61A and 61B specimens are 25 and 26 respectively. The first caudal was determined by the bifurcated inferior median carina at posterior end of the centrum. This was 32nd vertebra in both specimens. The spinal process disappears from 15th caudal and the transverse processes completely disappear from 13th in both specimens. The first caudal with transverse process perforated by vertical foramen is 7th in both specimens, but 6th caudal of 61A bears incomplete, not perfectly perforated hole on both processes and 7th of 61B has a foramen only on the left side and on the inferior margin of the right transverse process a concavity is present instead of a hole (Fig. 22). Such concavity is also present on both sides of 6th caudal of 61B.

In Appendix Table III the actual measurements of each vertebra of 61A and 61B are shown, and in Table 31 selected measurements of skeletons in percentage of skull length for comparison to 56B.

Fig. 22. Sixth caudal vertebra of the specimen 61A (upper) and 7th caudal of 61B (lower).

Table 31 shows clearly that values for 61A and 61B are quite similar and the corresponding values for each specimen are mostly within the range of one percent. But when they are compared with 56B the values for the both specimens are all smaller than the corresponding values for the latter with only one exception which is the greatest breadth of the 1st dorsal of 61A. This is a reflection of the fact that the proportional length of the skull against total length of body is greater in 61A and 61B than in 56B. These figures are 30, 31, and 26 percent respectively. The pro-

TABLE 31. COMPARISON OF SKELETONS OF 3 SPECIMENS FROM THE NORTH PACIFIC

	61A	61B	56B*
Total length of whale in cm	1,710	1,700	1,240
Length of skull in mm, straight	5,100	5,240	3,230
	% of skull length	% of skull length	% of skull length
Atlas. Greatest breadth	16.6	16.2	18.0
,, ,, height	9.8	9.8	12.8
,, Transverse breadth, articulating face	8.9	9.4	13.1
,, Height, ,, ,,	6.6	6.6	10.1
,, Length, 7 centra together	5.4	5.5	7.4
1st dorsal. Greatest breadth	16.9	14.9	16.5
,, ,, ,, height	11.9	11.7	14.2
,, ,, Breadth, centrum	5.9	5.6	7.8
,, ,, Height, ,,	5.4	5.0	6.6
,, ,, Length, ,,	2.0	2.0	2.4
1st lumbar. Greatest breadth	24.2	24.0	26.2
,, ,, ,, height	16.2	15.2	17.5
,, ,, Breadth, centrum	7.1	6.8	8.7
,, ,, Height, ,,	5.9	5.8	8.0
,, ,, Length, ,,	4.5	4.4	5.7
1st caudal. Greatest breadth	20.1	20.9	22.3
,, ,, ,, height	16.3	15.6	18.7
,, ,, Breadth, centrum	7.7	7.1	9.4
,, ,, Height, ,,	7.9	7.3	9.4
,, ,, Length, ,,	5.4	5.1	6.6
Humerus. Mean length	13.2	13.2	17.0
Radius. ,, ,,	14.2	13.3	15.7
Ulna. ,, ,,	12.3	11.0	13.1
Neural spine ends on vertebra	No. 45 (Ca 14)	No. 45 (Ca 14)	No. 45 (Ca 14)
First vertebra with transverse process perforated by vertical foramen	No. 38 (Ca 7)	No. 38 (Ca 7)	No. 39 (Ca 8)
Transverse processes end on vertebra	No. 43 (Ca 12)	No. 43 (Ca 12)	No. 42 (Ca 11)
Prezygapophysis first definitely separated on vertebra	No. 15 (D 8)	No. 15 (D 8)	No. 16 (D 9)

* Cited from Omura (1958).

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portion of head becomes greater with growth of the body as stated elsewhere in this report.

In Fig. 23 are compared sizes of vertebrae of the specimens 61A and 56B, the latter cited from Omura, 1958. The former specimen is 17.1 m in body length and physically matured and the latter 12.4 m and sexually immature. Both were males and this figure shows, therefore, the growth of vertebral bones according to the growth of the whale body. As shown in the figure the growth is mostly attained in the regions of dorsal, lumbar, and anterior portion of caudal vertebrae.

Chevron bones (Fig. 24) Number of chevron bones of 61A and 61B is 18 and 17 respectively, but in the former specimen the left lamina of the last is cartilage. In small bones in the anterior and posterior portions the right and left laminae are not united into a mass but separated. These are observed in nos. 1, 2, and from no. 12 onwards in both specimens.

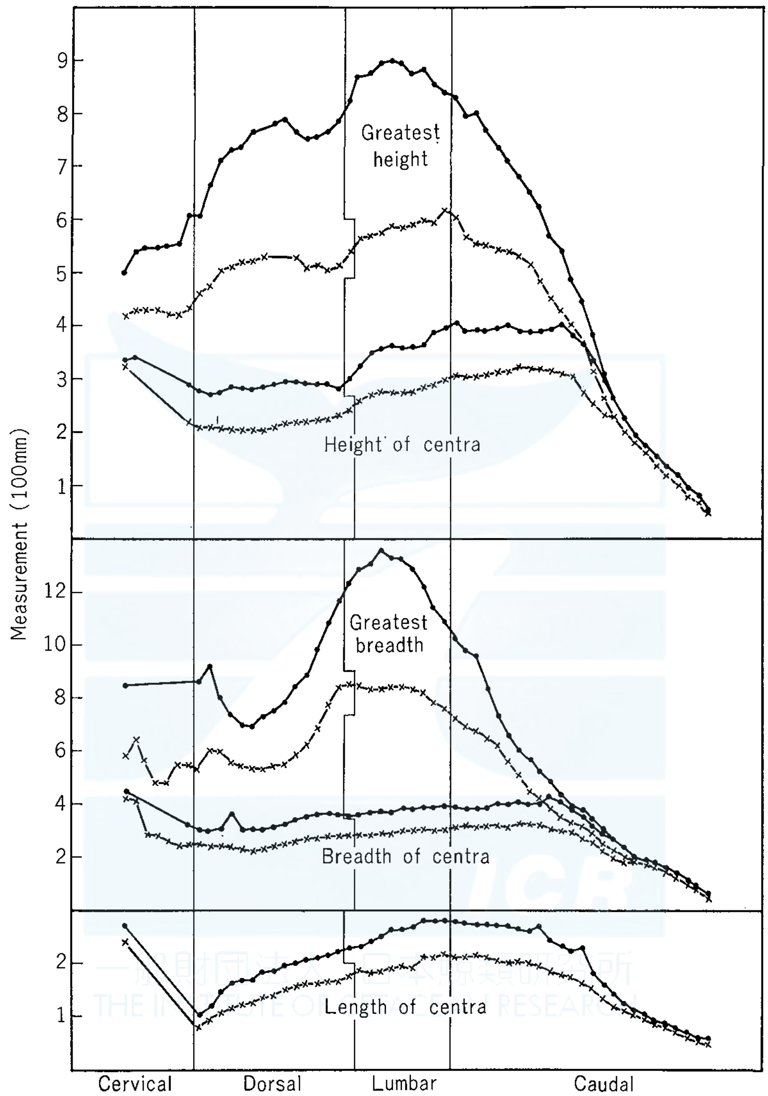

Fig. 23. Measurements of vertebrae of black right whales in the North Pacific. 12.4 m male, sexually immature, and 17.1 m male, physically mature, are compared. Crossed line indicates the former and dotted the latter.

The numbers of chevron bones are subject to an individual variation. All right whales hitherto taken by special permits were counted of their numbers at the time of treating and the numbers (or pairs) varied from 12 to 18. In addition to

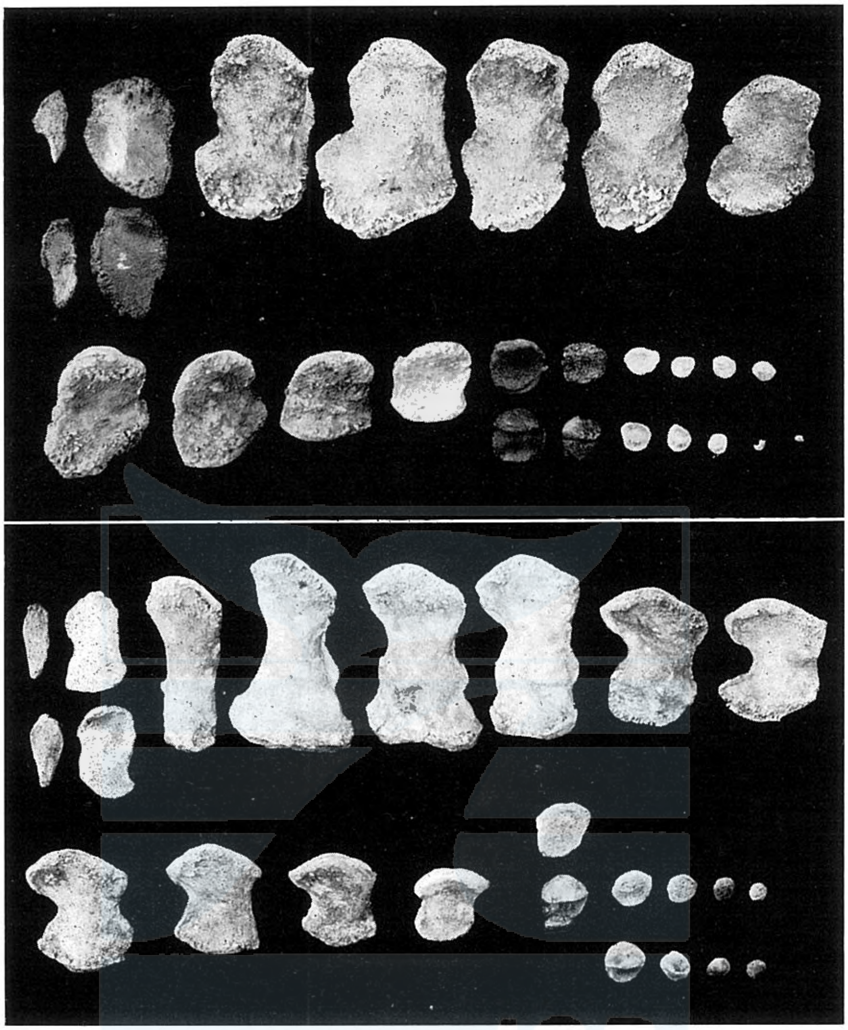

Fig. 24. Chevron bones of the specimens 61A (upper) and 61B (lower).

these there were also present 2–6 pairs of cartilages in the posterior portion.

In Table 32 are shown the measurements of each chevron bone of the both specimens.

Ribs (Pl.XVI) Both specimens have 14 pairs of ribs. Bones of 61B are nearly complete and only the 13th of the right side is somewhat broken at its distal end. In the 61A specimen, however, 5 ribs in all are broken of their heads. In both specimens the first rib is single headed as well as from 9th onwards of 61B. The last pair is much smaller in 61B than in 61A.

In Table 33 are shown the measurements of each rib of the both specimens.

Sternum (Fig. 25) There is a striking difference between sterna of the both specimens. The general shape does not differ greatly, but in size and in feature they are quite different. The greatest length of 61A is 711 mm whereas 524 mm in 61B, greatest breadth are 465 and 372 mm, and the thickness at middle measure 107 and 67 mm respectively. The weight of bone of 61A in dried condition is 7.9 kg against only 3.3 kg of 61B (Table 27). Thus the sternum of 61A is much larger and heavier than that of 61B, though there is only a slight difference in body length between both specimens.

TABLE 32. MEASUREMENTS OF CHEVRON BONES

No.	61A			61B		
	Height	Breadth	Distance*	Height	Breadth	Distance*
1	R 170	75	—	R 139	61	—
	L 138	65	—	L 145	46	—
2	R 211	142	—	R 173	110	—
	L 237	186	—	L 192	116	—
3	329	207	219	323	98	215
4	347	262	226	350	231	231
5	347	196	222	334	222	227
6	345	191	231	318	162	213
7	256	183	212	249	161	195
8	230	181	219	224	182	202
9	196	173	227	216	161	216
10	161	165	211	189	153	221
11	135	138	202	166	136	209
12	R 110	105	—	137	109	194
	L 111	99	—	—	—	—
13	R 80	78	—	R 105	91+	—
	L 92	85	—	L 114	101	—
14	R 52	56	—	R 79	78	—
	L 59	66	—	L 81	79	—
15	R 52	48	—	R 62	57	—
	L 44	42	—	L 58	61	—
16	R 39	46	—	R 49	52	—
	L 35	43	—	L 41	45	—
17	R 20	39	—	R 41	40	—
	L 31	43	—	L 35	40	—
18	R 14	18	—	—	—	—
	L Car.	Car.	—	—	—	—

* Distance of right and left laminae at their superior margin (outside).
R: Right lamina, L: Left lamina. In these chevrons two laminae are not united into single bone, but separated.
Car: Cartilage.

Further the surface of bone of 61B is nearly smooth and only lower half of the outer surface is somewhat rough towards its margin. But in the case of 61A the bone has an appearance that a cupful small and rounded bony grains are scattered on the surface of both sides. This seems quite abnormal and is thought as pathological as in the case of malars and parts of vertebrae.

Hyoid (Fig. 26) The combined bone of basihyal and thyrohyals, which are fused completely in the both specimens, is very massive in 61A and slender in 61B, though they resemble in general shape. The wings of 61A are rather short and their distal

TABLE 33. MEASUREMENTS OF RIBS

Rib No.	61A						61B					
	Right			Left			Right			Left		
	Length, straight	Length, on curve	Breadth distal end	Length straight	Length on curve	Breadth distal end	Length straight	Length on curve	Breadth distal end	Length straight	Length on curve	Breadth distal end
1	1,586	1,755	338	1,558	1,734	333	1,597	1,904	218	1,638	1,904	260
2	2,080	2,467	202	2,099	2,465	212	1,939	2,536	123	1,936	2,610	150
3	2,173	2,971	170	2,126	2,961	171	2,081	3,014	143	2,134	3,047	138
4	2,233	3,169	135	2,216	3,221	145	2,175	3,294	121	2,220	3,326	116
5	2,272	3,245	137	2,272	3,297	136	2,258	3,377	120	2,329	3,442	120
6	2,319	3,296	142	2,301	3,284	153	2,314	3,403	109	2,372	3,431	120
7	2,320	3,271	122	2,283+[1)]	3,234+[1)]	139	2,258	3,237	90	2,292	3,304	88
8	2,254+[1)]	2,705+[1)]	107	2,287	3,172	126	2,178	3,111	82	2,178	3,103	68
9	1,951+[1)]	2,178+[1)]	95	2,168+[1)]	3,019+[1)]	97	2,113	2,928	62	2,102	2,896	58
10	2,038	2,806	63	2,061+[1)]	2,804+[1)]	68	2,024	2,664	60	1,994	2,601	55
11	2,048	2,594	71	2,061	2,662	69	1,925	2,370	59	1,854	2,332	57
12	1,903	2,178	66	1,986	2,321	54	1,740	2,024	60	1,689	1,968	52
13	1,710	1,833	53	1,745	1,914	60	1,126+[2)]	1,164+[2)]	—	1,192	1,241	58
14	1,176	1,235	38	1,175	1,214	45	563	570	35	742	749	35

1) Head broken.
2) Distal end broken.

ends are pitted and ridged abnormally and suggest that here are attached some cartilages. The surface of bone is smooth in 61B, but that of 61A is quite contrary and has an appearance similar to that of sternum. Omura (1964) places much

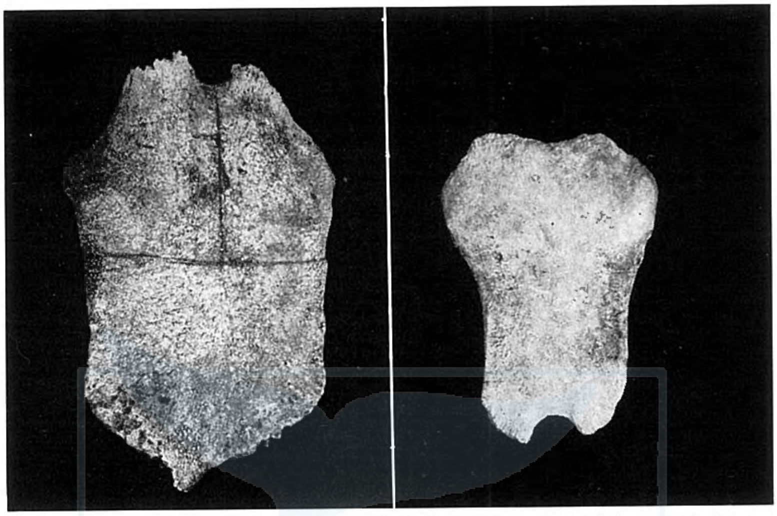

Fig. 25. Sternum of the specimens 61A (left) and 61B (right) ventral view.

TABLE 34. MEASUREMENTS OF HYOID BONES

Measurements	61A	61B	Other 5 specimens[1]
A. Ankylosed bone of basihyal and thyrohyals			
Overall length, on curve (mm)	824	978	770–930
Straight length (mm)	805	907	740–900
Greatest height[2]	26.6	19.9	20.5–24.9
Height at center[2]	19.9	14.9	16.3–18.4
Forward notch, depth[2]	5.0	3.4	2.1– 5.3
Height at middle of wing, right[2]	14.9	9.7	11.8–13.8
,, ,, ,, ,, ,, left[2]	14.3	9.2	12.2–13.7
Thickness ,, ,, ,, ,, right[2]	11.2	6.6	8.6– 9.8
,, ,, ,, ,, ,, left[2]	11.7	7.0	8.5– 9.7
Height at distal end, right[2]	16.7	12.7	12.4–19.1
,, ,, ,, ,, left[2]	15.7	13.2	12.2–17.6
B. Stylohyal			
Total length, right[2]	52.4	45.1	42.0–50.9
,, ,, left[2]	52.9	46.5	43.0–49.1
Height at middle, right[3]	16.0	17.2	13.9–20.9
,, ,, ,, left[3]	15.8	16.5	15.7–19.0

1) Cited from Omura (1964)
2) Expressed as percentages against overall length of combined bone.
3) ,, ,, ,, ,, length of stylohyal.

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importance on the smoothness of bones while separating the genus *Eubalaena* from the genus *Eschrichtius* by means of hyoid bones. In this respect 61B agrees and 61A disagrees, but there is a ground to think that the latter is pathological.

In Table 34 are shown measurements of hyoid bones of the both specimens, comparing with those of 5 specimens reported by Omura (1964). From this table it is clear that 61A is more massive than others and 61B is somewhat slender compared with other specimens.

Another important characteristics of *Eubalaena glacialis* in the hyoid bones are the broader distal ends of wings and roughly cylindrical stylohyals (Omura, 1964).

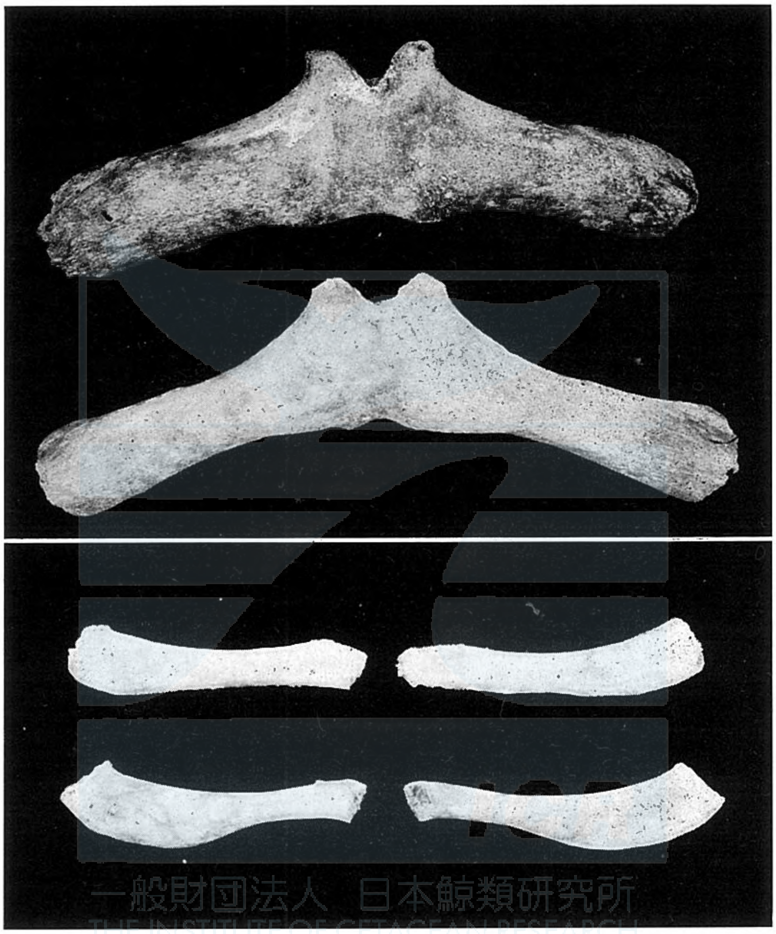

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Fig. 26. Hyoid bone of the specimens 61A and 61B. Upper figure shows the combined bone of basihyal and throhyals, and lower stylohyals. In both figures upper bone is the specimen 61A and lower 61B.

In these points the both specimens agree with other specimens.

Pelvic bone (Fig. 27) In both specimens the pelvic bones were secured with femurs and tibiae. The pelvic bone is an elongated bone and has a very short lateral process which ends to a tubercle, tuberculum laterale. The general form of the both specimens are similar, but those of 61A are more massive than those of 61B. The upper process, processus cranialis, is shorter in 61A than in 61B and the lower process, processus caudalis, is somewhat curved outwards in the former specimen whereas nearly straight in the latter specimen.

The femur is a very light bone and sponge-like in structure in both specimens. The general shape is triangle in lateral view and the pointed side attaches to the pelvis at near the lateral tubercle. The another side is flat and roughly round in

Fig. 27. Pelvic bone (inner) and femur (outer) of the specimens 61A and 61B. Left side 61A and right side 61B.

TABLE 35. MEASUREMENTS OF PELVIC BONE AND FEMUR (in mm)

	61A		61B	
	Right	Left	Right	Left
Pelvic bone				
Overall length (straight)	527	543	518	523
Tip of T. l. to tip of P. cr.	120	113	153	145
,, ,, ,, ,, ,, P. ca.	450	442	421	439
Breadth of P. ca. at middle	94	88	67	72
Femur (cartilage removed)				
Length	176	167	192	189
Breadth at distal end, long	117	115	123	130
,, ,, ,, ,, , short	93	82	77	71

T. l. Tuberculum laterale.
P. cr. Processus cranialis
P. ca. ,, caudalis

ventral view and here is attached a thick layer of cartilages. There present also tibia, an elongated cylindrical bone of cartilage of about 15 cm long and covered with thick capsule of connective tissue.

In Table 35 are shown the measurements of pelvic bones and femurs.

Scapula (Pl. XVII, Fig. 1) The scapula of the both specimens is similar in general shape to that of other specimens reported before. It is roughly symmetrically fan-shaped and the height is proportionally greater than that of balaenopterid whales.

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The coracoid is almost lacking and the acromion is also rudimental, but the latter process is somewhat greater in 61A than in 61B. The upper border is rounded and the glenoid border presents an oval outline with the antero-posterior diameter is greater than the transverse.

In Table 36 are shown the measurements of scapula of the both specimens.

Humerus, Radius and Ulna (Pl. XVII, Fig. 2) The humerus is short and constricted around the middle and the both epiphyses are united to the body, though linea epiphysialis is still visible in the both specimens. Radius and ulna are also short

TABLE 36. MEASUREMENTS OF SCAPULA

Measurement	61A		61B	
	Right	Left	Right	Left
Greatest breadth, straight	1,631	1,590	1,414	1,447
„ height	1,221	1,213	1,206	1,212
Outer edge, curved length	2,167	2,125	1,789	1,841
Thickness of outer edge :				
at anterior end	71	73	70	73
„ middle	61	58	48	56
„ posterior end	87	106	75	98
Length of acromion	60	60	28	26
Breadth of „	130	132	66	68
Breadth of glenoid fossa	382	383	408	409
Depth of „ „	356	351	370	368

TABLE 37. MEASUREMENTS OF HUMERUS, RADIUS AND ULNA

Measurement	61A		61B	
	Right	Left	Right	Left
Humerus				
Greatest length	673	669	691	697
Breadth at proximal end	526	534	481	491
„ „ distal „	364	373	375	384
Radius				
Length at middle	718	726	693	696
Breadth at proximal end	263	286	250	248
„ „ distal „	512	511	489	488
Ulna				
Length at middle	631	623	578	580
Breadth at proximal end	249	261	275	264
„ „ distal „	434	440	402	403

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and constricted towards the middle, much heavier in the latter. Their proximal epiphyses are ankylosed to the bodies, but the distal epiphyses are united only partly and some parts are remained unossified. The measurements of these bones are shown in Table 37.

Carpals and Phalanges (Pl. XVIII) The carpals are of no special feature. The formulae of phalanges for the 61A and 61B are $I_2\ II_5\ III_6\ IV_5\ V_3$ and $I_3\ II_5\ III_6\ IV_4\ V_4$ respectively. There is a slight difference in digits number between the both specimens, but this is thought of no special importance, being merely an individual difference.

The measurements of phalanges are given in Table 38.

TABLE 38. MEASUREMENTS OF PHALANGES

SPECIMEN 61A

Measurement	Right					Left				
	I	II	III	IV	V	I	II	III	IV	V
Length										
1st phalanx	162	269	253	225	187	178	290	273	224	191
2nd „	163	272	342	214	157	167	286	292	211	164
3rd „	—	189	275	180	135	—	230	277	179	150
4th „	—	147	192	152	—	—	152	193	136	116
5th „	—	70	151	117	—	—	82	151	68	—
6th „	—	—	108	—	—	—	—	109	—	—
Proximal breadth										
1st phalanx	142	196	190	172	162	140	212	187	174	161
2nd „	84	162	184	131	117	95	167	176	127	117
3rd „	—	126	166	90	67	—	135	158	91	75
4th „	—	92	122	79	—	—	95	118	66	51
5th „	—	52	95	52	—	—	57	95	40	—
6th „	—	—	64	—	—	—	—	59	—	—
Distal breadth										
1st phalanx	100	178	182	140	131	103	178	182	140	128
2nd „	55	141	175	102	90	58	150	166	101	83
3rd „	—	103	129	73	41	—	107	122	71	59
4th „	—	70	102	59	—	—	73	98	44	34
5th „	—	31	73	34	—	—	34	70	27	—
6th „	—	—	38	—	—	—	—	36	—	—

SPECIMEN 61B

Measurement	Right					Left				
	I	II	III	IV	V	I	II	III	IV	V
Length										
1st phalanx	173	250	253	128	176	171	245	244	213	183
2nd „	168	245	272	203	167	168	247	279	205	177
3rd „	123	194	227	171	152	118	193	233	177	158
4th „	—	153	183	134	119	—	155	188	139	124
5th „	—	120	145	—	—	—	106	155	—	—
6th „	—	—	57	—	—	—	—	29	—	—
Proximal breadth										
1st phalanx	145	195	164	156	167	135	193	171	165	169
2nd „	100	148	153	108	98	98	147	153	108	105
3rd „	63	121	144	75	62	63	123	143	75	64
4th „	—	79	105	53	43	—	85	105	55	44
5th „	—	47	73	—	—	—	54	74	—	—
6th „	—	—	39	—	—	—	—	39	—	—
Distal breadth										
1st phalanx	116	157	158	123	113	107	158	157	125	115
2nd „	70	134	153	88	77	68	136	152	89	81
3rd „	28	97	110	60	52	22	100	113	60	56
4th „	—	81	83	32	29	—	67	79	32	28
5th „	—	25	48	—	—	—	27	50	—	—
6th „	—	—	25	—	—	—	—	point	—	—

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TAXONOMIC CONSIDERATION

The body colour of the black right whales examined was black or slate-black with pure white patches of varying size on the ventral surface of the body in most specimens. Only two out of 13 specimens examined were entirely black. The colouration of the black right whales from the North Pacific, North Atlantic and southern hemisphere was already discussed by Omura (1958), refering reports by True (1904), Collett (1909), Andrews (1908), Matthews (1938) and Lonneberg (1906). He thought that there may be a similarity of colouration among whales from these oceans, and additional specimens we examined have supported this assumption. Collett (1909) describes that 20 per cent. of the 50 specimens captured in the course of the last three years (1906–1908 in the Hebrides) have been white-bellied (in the summary he says about 10 per cent, but this seems to be a missprint). But he classifies the colouration only into two categories, black and white-bellied, and their definition is not given. We can not, therefore, go farther to discuss about the frequency of occurrences of white-bellied whales from the both oceans. In the southern black right whale the presence of white patch on the ventral surface is also noted (Lonneberg, 1906, Matthews, 1938, Clarke, 1965).

No difference is present in the number of baleen plates between whales from the North Pacific and those from the southern hemisphere. But there is a slight difference in colouration of the baleen plates between North Pacific and North Atlantic. Andrews (1908) describes that in his Amagansett specimen the baleen, including both plates and bristles, was deep blue-black in colour, with the exception of the anterior portion, where for a distance backward of 18 inches, the bristles and extreme bases of the plates were pure white. Collett (1909) also reports that the baleen is black, both in the white-bellied specimens and in the black, though in some specimens a few of the foremost plates were white. On the contrary all of the baleen plates of our specimens are pure black or very dark bluish black in colour and the bristles nearly pure black. This has already been discussed by Omura (1958), based upon the specimens 56A and 56B, and since then no exception has been observed. Occurrence of such white baleen plate is rather doubtful in the southern right whale, judged from a few material available.

The bonnet and other callosities are the conspicuous characteristic of the black right whale, but their size and arrangement are subject to individual variation. The callosity which was present on the upper margin of the lip of the both sides in the specimen 68A is the most peculiar. Clarke (1965) reports an observation of a cow and calf of the southern right whale on the coast of Chile and describes that a large callosity was also present on the median line of the chin of the cow, in addition to the bonnet and other usual callosities. In our specimens none of them had any callosity on the mid-ventral line of the chin. He further describes that this median callosity is also seen in the figure by Gray in Dieffenbach's *Travels in New Zealand* (1843, Vol. II, Plate 1) as well as in Fig. 50 of Klumov (1962), and concludes that the presence or absence of the large median callosity on the chin is not likely to be of much significance among any differences which may eventually be shown to exist between the black right whales from the north and south. His conclusion may also be applied to the callosity on the margin of the lip in our specimen 68A, though we are not in favour of his observation of callosities shown in Fig. 50 of Klumov. They are on the lateral side of the chin, instead of median.

In the body proportions no significant difference has been observed among whales from the North Pacific, North Atlantic and the southern hemisphere, nor between those from east and west North Pacific as stated already.

As to the size of the body of the black right whale from different oceans Omura (1958) had assumed that the North Pacific whale may probably attains more larger body length than the North Atlantic whale. As stated before the average body length at which sexual maturity is attained is thought as 14.5–15.5 m in male and 15–16 m in female in the North Pacific whale. On the other hand Collett (1909) describes that the twelve females killed in 1907, in June and July, in the Hebrides, were all gravid. According to his table the sizes of these females are: 49 ft (14.9 m) 1, 48.5 ft (14.7 m) 1, 48 ft (14.6 m) 2, 47.5 ft (14.4 m) 2, 47 ft (14.3 m) 3, 46 ft (14 m) 1, 44.5 ft (13.5 m) 1, and 44 ft (13.4 m) 1. Thus all of them are below 15 m and the smallest is only 13.4 m. It is likely, therefore, that the average body length of the black right whales at sexual maturity is much larger in the North Pacific than in the North Atlantic. This conclusion, however, depends largely upon the reliability of the Collett's figure, because these were supplied from the manager, Capt. Carl Herlofsen, and were not measured by Prof. Collett himself. But Ruud (1937) states that fully grown northcaper (black right whale in the North Atlantic) is commonly between 45 and 50 feet (13.72–15.24 m), seldom more. It is clear, however, that a slight difference in the size of whale body, if any, is of little value in the taxonomic consideration.

For the southern right whale Matthews (1938) presents two occasions of female investigated at South Georgia. One was 15.23 m in length (Whale No. 1019) and the other 14.4 m (Whale No. 3560). According to him the former was lactating and in its ovaries there were in total 13 corpora lutea *b* and 9 very old. The latter was anoestrus and the ovaries were resting. They contained four old corpora lutea. This whale had been pregnant at least once before, judged from the mammary gland, which was involuted after functional activity. This will also suggest a slight differnece in body length at sexual maturity among whales from north and south, but no difinite conclusion will be drawn due to rather limited number of material available. Chittleborough (1956) reports a sighting of a pair of southern right whales in Frenchman's Bay, close to Albany, Western Australia. This pair consisted of a female approximately 55 ft (16.76 m) in length and a calf. The cow, accompanied by a calf, observed by Clarke (1965) was estimated 45–50 ft (13.72–15.24 m) long. Gaskin (1968) gives 50 ft (15.24 m) as an average adult male at sexual maturity and 60 ft (18.29 m) at physical maturity for the southern right whale. These figures suggest that they may not differ greatly in length from those of the North Pacific.

In the shape of the skull as well as in its proportional length of various parts no distinction was noted between whales from the North Pacific and the North Atlantic.

Omura (1958) raised a few points of difference, but these were erased by new specimens obtained, as stated before. But the number of the dorsal vertebrae is of some significance. Among the North Atlantic specimens 15 individuals have 14 dorsals and one has 13 (See Omura's Table 11). There are no specimen which has 15 dorsals. But in the North Pacific whales, out of 13 specimens 8 have 14 dorsals and the rest 5 have 15, as shown in Table 30. The total number of vertebrae is 55–57 for specimens from the both oceans and no distinction between them is noted.

For the southern right whale no sufficient data is available for comparison. Only one thing we can describe here is the bipartite malar, which was found in the skull of the specimen 61A, was also described and illustrated for *Balaena australis* by Beneden and Gervais (1868–79).

As to the tropical discontinuity in the world distribution of black right whales, which separates the northern and southern whales, Clarke (1965) describes that it is not so complete as that shown in the chart by Townsend (1935), but we have no material yet to contribute to this problem.

SUMMARY

1. Studies of the black right whales in the North Pacific were carried out under special permits to take for scientific researches.

2. The body colour was black or slate-black in general, but 11 specimens out of 13 had white patches of different sizes on the ventral side of the body.

3. Bonnet and other callosities were present on all whales examined, including two fetuses. They were also noted on the corium as ridges, after the stratum coruneum was peeled off from the skin. It is possible, therefore, that they are congenital.

4. Body proportions showed no remarkable differences between whales from the North Pacific and North Atlantic, nor between those from east and west North Pacific.

5. Head becomes proportionally larger and tail shorter with the growth of the body.

6. A formula expressing relation between body length and body weight, based upon actual measurements, was developed. The black right whale is much heavier than the balaenopterid whales of the same length.

7. The brain is much smaller than in other cetaceans in proportion to the body weight.

8. No coecum was present, differing from the balaenopterid whales.

9. Seasonal distribution and movement were discussed, based on the sighting data by Japanese whale catchers, in relation to the oceanographic condition of the sea. Data for the southern right whales are also presented.

10. *Calanus plumchrus* and *C. cristatus* are the main diet of this species in the North Pacific.

11. Among whale lice *Cyamus ovalis* and *C. erraticus* are common, heavily infected on the bonnet and other callosities.

12. From a study of the reproductive organs it is probable that this species

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in the North Pacific attains their sexual maturity at a body length of 14.5–15.5 m in male and 15–16 m in female. These lengths are thought a little higher than those in the North Atlantic.

13. Growth and age of this species were also studied in some extent.

14. An osteological study was made on two specimens. One had bipartite malars and others a shield on the supraoccipital bone. No specific distinction between whales from the North Pacific and North Atlantic is noted.

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APPENDIX TABLE I WEIGHT OF BLACK RIGHT WHALES IN THE NORTH PACIFIC

Whale no.	68 B		62 A		62 B		61 C		68 A		63 B	
Body length and Sex	12.6 m ♀		14.1 m ♀		14.7 m ♂		15.1 m ♂		15.2 m ♂		15.4 m ♀	
	weight in kg	% of total weight	weight in kg	% of total weight	weight in kg	% of total weight	weight in kg	% of total weight	weight in kg	% of total weight	weight in kg	% of total weight
Meat	11,390	39.39	12,008	25.25	17,367	32.83	16,538	29.93	16,375	33.70	18,197	29.19
Blubber	10,875	37.61	19,958	41.97	18,290	34.58	23,021	41.66	20,467	42.15	26,352	42.28
Bone, Total weight[4]	3,517	12.16	6,928	14.57	9,229	17.45	7,465	13.51	4,769	9.82	8,499	13.63
Skull	900	3.11	2,400	5.05	2,814	5.32	1,920	3.47	1,126	2.32	2,756	4.42
Mandibles	289	1.00	929	1.95	1,083	2.05	1,084	1.96	470	0.97	993	1.60
Ribs[1]	529	1.83	610	1.28	1,124	2.13	840	1.52	870	1.79	1,223	1.97
Vertebrae[2]	1,385	4.79	2,464	5.18	2,378	4.50	2,137	3.87	1,505	3.10	2,352	3.78
Flippers	260	0.90	168	0.35	1,559[5]	2.95	1,000	1.81	530	1.09	750	1.20
Scapulae	133	0.46	334	0.70	253	0.48	340	0.62	250	0.51	410	0.66
Viscera, Total weight	2,675	9.25	8,015	16.85	6,993	13.22	7,482	13.54	6,036	12.40	8,406	13.48
Heart	212	0.73	269	0.57	290	0.55	235	0.43	291	0.60	280	0.45
Lungs	196	0.68	365	0.77	235	0.44	308	0.56	288	0.59	440	0.71
Liver	262	0.91	495	1.04	580	1.10	540	0.98	396	0.81	600	0.96
Kidneys	124	0.43	190	0.40	222	0.42	385	0.70	197	0.40	253	0.41
Pancreas	23	0.08	40	0.09	72	0.14	7	0.01	33	0.06	20	0.03
Spleen	9	0.03	6	0.01	13	0.02	—	—	4	0.008	7	0.01
Stomach	185	0.64	228	0.48	244	0.46	165	0.30	202	0.41	250	0.40
Intestine	500	1.73	835	1.75	868	1.64	465	0.84	629	1.29	650	1.04
Tongue	—	—	4,628	9.73	2,970	5.62	3,200	5.79	2,520	5.19	3,970	6.37
Testes	—	—	—	—	24	0.05	627	1.14	195	0.40	—	—
Ovaries	—	—	20	0.04	—	—	—	—	—	—	8	0.01
Diaphragm	—	—	—	—	—	—	423	0.77	—	—	520	0.83
Others	1,164	4.02	939	2.00	1,499	1.71	1,197	2.16	1,282	2.65	1,408	2.26
Baleen plates	460	1.59	646	1.97	1,015	1.92	820	1.84	940	1.93	887	1.42
Total[8]	28,917	100.00	47,555	100.00	52,894	100.00	55,254	100.00	48,562	100.00	62,341[6]	100.00

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Whale no.	62C		63A		63C		61B		61A		Fetus of 63A	Fetus of 63B
Body length and Sex	16.1 m ♂		16.1 m ♀		16.4 m ♂		17.0 m ♂		17.1 m ♂		218 cm ♂	270 cm ♀
	weight in kg	% of total weight	weight in kg	% of total weight	weight in kg	% of total weight	weight in kg	% of total weight	weight in kg	% of total weight	weight in kg	weight in kg
Meat	20,900	30.84	23,635	31.85	22,527	28.70	21,102	32.09	20,540	30.55		
Blubber	27,117	40.00	29,464	39.70	33,940	43.24	24,926	37.90	24,755	36.82		
Bone, Total weight[4]	9,838	14.51	9,598	12.93	10,403	13.25	8,897	13.63	9,992	14.86		
Skull	2,929	4.32	3,041	4.10	2,986	3.80	2,160	3.28	2,340	3.48		
Mandibles	1,185	1.75	1,024	1.38	1,230	1.57	1,307	1.99	2,110	3.14		
Ribs[1]	1,364	2.01	1,314	1.77	1,330	1.69	1,232	1.87	1,306	1.94		
Vertebrae[2]	2,708	3.99	2,724	3.67	3,271	4.17	2,759	4.20	2,591	3.85		
Flippers	1,227	1.81	900	1.21	790	1.01	920	1.39	1,000	1.49		
Scapulae	405	0.60	580	0.78	780	0.99	440	0.66	600	0.89		
Viscera, Total weight	8,716	12.88	10,466	14.10	10,444	13.30	9,110	13.85	10,389	15.45		
Heart	343	0.51	310	0.42	350	0.45	broken	—	448	0.67		
Lungs	405	0.60	534	0.72	340	0.43	415	0.63	675	1.00		
Liver	665	0.98	640	0.86	680	0.87	580	0.88	615	0.91		
Kidneys	187	0.28	280	0.38	220	0.28	265	0.40	209	0.31		
Pancreas	34	0.05	25	0.03	26	0.03	34	0.05	26	0.04		
Spleen	5	0.01	5	0.01	7	0.01	8	0.01	7	0.01		
Stomach	149	0.22	280	0.38	350	0.45	295	0.45	280	0.42		
Intestine	722	1.07	878	1.18	830	1.06	605	0.92	642	0.95		
Tongue	4,371	6.45	4,650	6.27	4,950	6.31	3,550	5.40	4,450	6.62		
Testes	860	1.21	—	—	9	0.02	955	1.45	972	1.45		
Ovaries	—	—	8	0.01	—	—	—	—	—	—		
Diaphragm	—	—	600	0.76	505	0.77	617	0.99	550	0.74		
Others	975	1.50	2,306	3.10	2,082	2.65	1,898	2.89	1,448	2.15		
Baleen plates	1,198	1.77	1,066	1.44	1,185	1.51	1,725	2.62	1,563	2.32		
Total[3]	67,769	100.00	74,229[5]	100.00	78,499	100.00	65,760	100.00	67,239	100.00	136	257

1) Sternum is included.
2) Chevron and innominate bones are included.
3) Blood and other fluid are not included.
4) Hyoid is included.
5) Blubber of flipper is included.
6) Weight of fetus is not included.

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APPENDIX TABLE II MEASUREMENTS OF BALEEN PLATES OF BLACK RIGHT WHALES IN THE NORTH PACIFIC

Whale no.	68 B								62 A							
Body length and Sex	12.60 m ♀								14.10 m ♀							
Points measurd→	Right				Left				Right				Left			
No. from anterior ↓	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
10	32.5	20.5	3.5	9.5	—	—	—	—	31.5	21.0	3.5	7.5	26.0	17.5	3.5	7.0
20	52.5	38.5	6.5	9.5	56.0	41.0	6.5	7.5	61.0	45.5	7.0	8.0	54.0	40.0	6.5	8.5
30	72.5	56.5	9.5	6.5	74.0	58.0	11.0	5.5	95.5	79.0	12.0	8.5	87.5	71.0	10.0	17.0
40	85.5	70.5	12.0	8.0	88.0	72.0	—	8.0	125.5	109.0	16.0	26.0	119.5	103.0	14.5	21.0
50	96.0	80.5	13.0	8.0	96.5	79.0	13.0	7.5	158.0	141.0	17.5	18.0	155.5	138.0	16.5	16.0
60	102.0	86.5	14.0	6.5	104.0	88.5	13.5	8.0	181.5	161.5	18.5	18.5	179.5	160.0	18.0	19.0
70	108.0	93.0	13.5	5.5	107.0	92.0	14.5	8.0	196.0	171.0	19.0	22.0	196.0	174.0	18.5	21.0
80	111.0	96.0	14.5	6.5	110.0	96.0	13.5	6.5	207.5	183.5	19.5	21.5	206.0	181.5	19.5	22.0
90	115.0	97.0	15.5	5.0	112.0	96.0	14.0	6.0	212.5	191.5	20.0	22.5	217.5	193.5	19.5	18.5
100	115.0	96.0	16.0	5.5	116.0	99.0	15.0	6.0	223.0	200.0	22.0	22.0	222.5	196.5	21.0	20.0
110	114.5	96.5	15.5	7.0	114.0	97.0	14.5	8.5	224.0	201.0	21.0	20.0	223.0	196.0	21.5	20.5
120	112.0	95.5	17.0	6.5	113.0	97.0	16.0	6.5	222.0	197.5	23.5	20.5	221.5	196.0	22.0	21.0
130	112.5	95.0	16.5	6.5	113.0	98.0	16.0	7.0	213.5	187.0	21.0	21.0	225.5	203.0	21.5	21.5
140	109.5	92.5	—	6.5	—	—	—	—	204.5	180.0	22.0	19.5	207.5	182.0	22.5	14.5
150	106.0	88.0	16.5	6.5	106.0	89.0	16.0	7.0	196.0	167.5	20.5	14.0	199.0	173.0	22.0	12.0
160	102.0	82.0	17.5	7.0	99.0	82.0	15.0	7.5	178.5	153.0	19.5	13.5	186.0	160.5	20.0	10.0
170	95.0	77.0	17.0	8.0	96.0	79.0	14.5	8.0	161.0	138.0	20.0	12.0	164.5	148.0	20.0	13.5
180	87.5	70.0	15.0	8.5	86.5	69.5	13.5	8.5	145.5	122.0	16.5	7.0	146.5	124.5	17.5	8.0
190	79.5	63.0	13.5	6.5	71.5	54.5	12.5	7.0	128.0	106.5	16.0	6.5	131.5	110.5	15.5	5.0
200	66.0	51.0	12.0	9.0	64.5	47.5	11.0	10.0	101.5	83.5	15.0	6.5	106.5	88.5	15.0	5.0
210	48.5	31.5	9.0	7.5	36.0+	—	7.0	—	65.5	52.0	10.0	6.5	69.5	53.5	11.5	6.5
220	31.5	—	2.0	7.0	31.0	—	2.5	3.0	16.0+	16.0+	1.5	7.5	35.5	24.0	5.0	7.5
230	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
240	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
250	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
260	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Number of baleen plates	234				236				234				237			

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Whale no.	62B								61C							
Body length and Sex	14.70 m ♂								15.10 m ♂							
Points measured→	Right				Left				Right				Left			
No. from anterior ↓	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
10	34.5	23.5	3.5	7.0	32.0	21.5	4.0	8.5	14.5+	12.0	3.5	9.5	26.0	15.0	3.0	11.0
20	72.5	57.5	8.0	27.5	62.5	48.0	7.5	31.5	48.0	35.0	7.0	14.0	—	—	—	—
30	119.0	99.0	14.0	31.0	100.0	84.0	11.5	28.5	79.0	64.0	13.0	12.5	92.0	76.0	12.5+	34.0
40	145.5	129.0	18.5	27.5	136.0	119.0	16.5	27.0	112.5	97.5	18.0	26.0	122.0	107.5	18.0	36.5
50	168.5	151.0	20.0	30.5	159.5	141.0	20.0	29.5	136.0	121.5	19.5	34.0	151.0	134.0	19.5	37.5
60	186.0	168.0	21.0	29.0	176.5	157.5	20.5	31.5	161.5+	145.0	20.0	26.5	174.0	157.5	21.0	24.5
70	201.5	181.0	21.5	28.5	190.5	173.0	21.5	35.0	179.0+	163.5	20.0	24.0	186.0	169.5	21.0	25.5
80	211.0	191.0	22.5	29.0	210.5	188.0	22.0	30.5	191.0	173.5	20.0	24.0	191.5+	174.0+	20.0	23.5+
90	223.0	201.5	22.5	28.5	218.0	195.5	22.0	33.0	199.0	180.5	20.0	19.5+	201.5	181.5	21.0	23.0
100	227.5	206.5	23.0	28.5	225.0	202.0	23.0	29.5	204.0+	185.0	20.5	23.5	205.0	184.5	21.0	26.0
110	232.5	207.5	24.0	32.5	229.5	205.0	24.0	34.0	206.0	185.0	21.5	29.5	207.5	186.5	22.0	28.5
120	232.5	204.5	24.5	32.5	229.0	205.5	24.0	29.5	205.5	185.0	22.0	25.5	205.5	184.5	22.5	27.0
130	232.5	206.0	24.5	27.0	228.5	203.5	25.5	36.0	205.0	182.5	22.5	29.5	202.5	180.0	22.5	31.0
140	226.5	201.0	24.5	29.5	213.0	198.5	25.5	38.5	201.0	178.5	23.0	24.5	197.5	176.5	23.5	29.0
150	220.0	196.0	24.5	32.0	225.5	200.0	24.5	34.0	192.5	172.0	22.5	28.5	197.5	175.0	23.0	28.5
160	214.0	190.0	24.0	34.0	221.0	190.0	25.0	38.5	184.5+	165.0	21.0	27.5	178.0	157.0	22.0	25.5
170	202.0	179.0	23.5	36.0	204.0	181.0	25.0	34.0	171.0	149.0	23.0	31.0	159.5	140.5	21.0	26.5
180	192.5	169.0	22.0	28.0	192.5	170.5	23.5	29.5	150.0	130.0	19.5	38.0	141.0	120.5	19.5	32.0
190	181.5	157.5	23.0	20.0	182.0	160.5	22.5	28.5	132.0	115.5	18.5	38.0	125.0	107.5	20.0	30.5
200	167.5	145.0	21.0	22.5	169.0	146.0	21.5	28.5	115.5	99.5	17.5	24.5	108.5	90.0	15.5	23.5
210	152.5	130.5	23.5	21.0	153.0	132.0	24.5	23.0	94.5	80.5	17.0	12.5	75.5+	63.0	14.0	14.0
220	137.0	118.0	19.0	19.5	136.5	117.5	18.5	20.5	47.0+	33.5+	10.5	—	34.5	24.0	6.5	9.5
230	121.5	104.0	17.0	20.0	123.0	105.5	19.5	20.0	—	—	—	—	—	—	—	—
240	96.5	83.0	15.0	16.0	102.5	86.0	17.5	15.5	—	—	—	—	—	—	—	—
250	62.5	52.0	9.0	14.0	66.0	54.5	12.0	15.0	—	—	—	—	—	—	—	—
260	31.5	20.5	5.0	7.0	39.5	28.5	7.0	9.0	—	—	—	—	—	—	—	—
Number of baleen plates	267				268				230				221			

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Whale no.	68 A				63 B								62 C			
Body length and Sex	15.20 m ♂				15.40 m ♀								16.10 m ♂			
Points measured→	Left				Right				Left				Right			
No. from anterior ↓	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
10	34.5	21.0	4.9	9.0	30	22	4.7	10	30	26	5.5	15	37.5	26.0	5.0	13.5
20	70.0	56.5	10.4	13.0	63	55	9.0	19	72	56	8.5	18	71.5	58.5	10.5	22.5
30	106.5	92.0	15.5	16.5	103	92	13.5	18	104	93	12.0	16	117.5	102.0	17.0	30.0
40	145.5	129.5	19.0	8.0	147	123	16.5	19	146	129	17.0	18	156.5	141.5	21.0	29.5
50	169.0	151.5	22.0	8.0	173	152	19.5	19	175	160	20.0	19	187.0	169.0	23.0	26.5
60	183.5	165.5	23.0	4.5	196	176	21.0	17	198	179	20.5	16	217.0	197.5	24.5	27.0
70	209.5	191.0	24.5	6.5	212	191	21.5	20	214	192	24.0	18	232.0	211.0	25.0	34.0
80	220.0	201.0	25.0	6.5	223	202	22.0	21	222	206	21.5	18	252.0	230.0	25.5	28.5
90	224.5	206.0	25.0	7.0	232	208	24.5	20	231	210	24.5	19	256.0	236.0	26.0	32.0
100	227.5	207.0	27.0	9.5	237	214	24.0	17	237	213	24.5	17	256.0	238.0	26.5	33.0
110	233.5	211.0	30.5	5.0	237	218	24.5	18	238	213	24.5	17	259.5	236.0	27.5	28.0
120	229.5	207.0	29.5	5.0	237	218	25.0	15	239	217	25.0	17	255.0	232.5	27.5	36.0
130	226.5	205.0	32.0	8.0	234	211	25.0	11	229	209	26.5	18	248.5	223.0	28.5	34.0
140	219.5	198.5	31.5	7.5	223	200	17.0	10	221	201	27.0	16	240.5	218.0	27.5	31.0
150	202.5	181.0	28.5	15.0	218	200	26.5	14	212	194	26.0	17	226.5	202.0	28.5	27.0
160	186.5	166.5	27.5	5.5	206	184	26.5	14	193	175	23.5	15	210.5	189.0	26.0	31.5
170	169.0	149.0	28.0	10.0	179	161	23.0	7	191	170	23.5	14	196.0	175.5	25.0	28.5
180	149.5	131.0	25.0	4.5	162	145	20.5	17	175	155	22.0	17	183.0	161.0	24.5	28.0
190	129.5	113.0	24.5	10.5	145	130	21.5	13	157	136	21.0	12	162.5	144.0	21.5	28.5
200	105.0	90.5	21.0	5.0	121	110	20.5	12	139	124	21.5	13	143.0	125.0	20.0	24.0
210	56.5	45.5	13.5	12.5	—	—	—	—	117	100	20.0	14	106.5	91.0	16.0	6.5
220	16.0	7.5	1.0	3.0	92+	80	17.5	11	90	76	17.0	10	60.5	44.5	12.0	4.5
230	—	—	—	—	57+	47	9.0	11	—	—	—	—	—	—	—	—
240	—	—	—	—	20+	11	1.8	10	—	—	—	—	—	—	—	—
250	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
260	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Number of baleen plates	R: 220, L: 222				239				231				240			

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Whale no.	62C				63A								63C			
Body length and Sex	16.10 m ♂				16.10 m ♀								16.40 m ♂			
Points measured→	Left				Right				Left				Right			
No. from anterior ↓	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
10	38.5	26.5	6.0	13.5	31+	23	4.0	12	29+	28	4.3	6	29+	25	5.0	10
20	70.5	58.0	9.0	30.0	65+	55	10.0	5	67+	64	9.0	15	66+	56	10.0	19
30	118.0	103.5	15.0	31.5	103+	94	17.0	28	112+	107	16.0	22	117+	105	16.0	25
40	159.0	144.0	20.0	27.5	144+	136	19.5	16	166+	153	20.0	18	157+	147	19.5	29
50	197.0	179.0	22.0	26.0	184+	175	21.0	25	194+	184	22.0	31	196+	185	22.5	33
60	226.5	206.0	26.0	26.0	210+	197	23.5	32	214+	204	22.0	28	222+	212	24.0	34
70	241.0	219.5	24.5	26.5	225+	213	23.5	27	230+	222	23.0	23	241+	231	25.0	29
80	251.0	229.0	24.5	30.0	236+	223	24.0	24	234+	223	24.0	21	255+	251	25.5	31
90	258.5	237.0	26.5	32.5	250+	235	24.0	25	245+	234	25.0	21	272+	265	23.5+	23
100	259.0	237.5	26.5	29.0	240+	229	25.0	32	245+	233	25.0	27	278+	272	22.0+	28
110	258.0	235.5	28.0	31.0	247+	240	26.0	29	248+	238	26.5	29	281+	277	26.5	24
120	252.5	229.0	28.5	34.0	248+	237	27.0	21	233+	225	27.0	25	280+	276	25.0	27
130	249.5	226.5	28.5	33.5	235+	227	28.0	27	244+	237	27.0	21	272+	268	23.5+	25
140	245.0	222.0	29.0	26.5	225+	213	26.5	25	218+	213	25.0	23	272+	263	24.0	27
150	223.5	203.5	29.0	34.0	208+	198	25.5	21	191+	181	14.5	18	255+	245	27.5	28
160	216.0	193.5	27.5	28.5	183+	171	24.5	20	172+	163	24.0	12	246+	238	27.0	24
170	196.5	173.0	25.0	37.0	163+	154	25.0	14	146+	139	24.5	15	236+	230	27.0	19
180	181.0	158.5	23.5	30.5	134+	127	23.5	17	118+	111	21.5	15	214+	204	26.0	25
190	162.0	142.5	21.0	29.0	117+	111	17.0	22	86+	76	17.0	6	198+	187	26.0	28
200	143.0	125.5	19.5	22.0	70+	62	11.0	14	47+	37	9.0	7	170+	161	25.0	34
210	111.0	97.0	19.5	16.5	35+	25	4.0	11	28+	22	2.0	5	152+	145	22.5	30
220	60.0	46.0	10.5	6.5	—	—	—	—	—	—	—	—	137+	130	20.0	18
230	18.5	7.0	1.5	8.0	—	—	—	—	—	—	—	—	107+	102	18.5	16
240	—	—	—	—	—	—	—	—	—	—	—	—	64+	57	11.5	12
250	—	—	—	—	—	—	—	—	—	—	—	—	26+	23+	5.5	5.5
260	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Number of baleen plates	232				206				210				251			

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Whale no.	63C				61B								61A			
Body length and Sex	16.40 m ♂				17.00 m ♂								17.10 m ♂			
Points measured→	Left				Right				Left				Right			
No. from anterior ↓	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
10	—	—	—	—	32.0	17.5	4.8	17.0	29.9	17.0	5.3	19.8	45.0+	34.5	6.5	25.0
20	—	—	—	—	78.5	56.5	9.2	34.5	77.5	61.4	9.4	30.8	94.0	79.5	12.5	44.5
30	—	—	—	—	136.0	118.5	15.0	44.5	143.5	119.5	16.0	33.0	154.0	137.0	20.0	45.0
40	156+	143	8.0	31	186.5	165.5	19.5	36.5	185.0	165.5	19.5	29.5	204.0	186.0	23.0	51.5
50	186+	176	23.0	28	227.5	205.0	22.0	38.5	219.5	199.0	22.5	23.5	234.5	218.5	25.5	55.5
60	212+	204	25.0	37	246.0	224.5	24.0	22.0	233.0	209.5	24.0	25.0+	252.5	231.0	24.5	59.5
70	235+	226	26.0	37	253.0	227.0	25.0	38.0	257.5	232.0	24.5	37.5	270.5	242.5	25.5	43.0
80	260+	250	25.0	31	268.5	242.5	25.5	40.0	268.5	244.0	25.5	43.0	281.0	258.0	25.5	45.5
90	270+	265	26.0	33	280.0	251.5	25.5	52.5	271.0	245.5	26.0	40.5	287.5	264.0	27.0	53.5
100	277+	270	26.0	21	280.0	250.5	26.5	44.0	280.0	251.0	26.5	44.5	289.0	265.0	27.0	52.5
110	280+	272	26.0	20	283.5	254.5	26.5	54.0	280.5	250.0	27.0	51.5	283.0	260.0	27.0	55.5
120	275+	273	27.5	21	279.5	248.0	27.5	48.5	281.0	250.0	27.5	41.0	270.5	246.0	27.5	61.0
130	270+	265	27.0	21	274.5	242.0	29.0	42.0	280.0	250.5	27.0	50.5	252.0	231.5	28.0	44.5
140	266+	261	28.0	27	272.0	236.0	28.5	48.5	277.5	246.5	28.0	47.5	239.5	215.5	27.5	51.5
150	256+	249	28.0	24	258.5	228.0	27.0	50.0	267.0	236.5	28.5	52.0	193.0	169.5	24.5	38.5
160	245+	239	27.5	23	250.0	219.5	27.0	38.0	256.0	224.5	29.0	45.5	169.0	146.0	24.5	33.5
170	230+	225	27.5	14	232.0	199.5	27.0	32.5	241.0	213.5	29.0	39.5	152.0	130.5	23.0	28.0
180	206+	196	22.0	30	204.0	174.0	26.0	45.0	225.0	196.0	29.5	42.5	118.5	98.0	19.5	20.5
190	203+	199	26.0	30	183.5	156.5	25.5	37.0	196.5	169.5	27.0	22.0+	64.5+	48.5+	14.0	—
200	171+	165	24.5	21	164.5	139.5	24.5	32.5	178.0	148.5	27.0	35.5+	—	—	—	—
210	143+	137	22.0	28	145.0	124.5	23.5	27.5	156.5	133.5	25.0	32.0	—	—	—	—
220	133+	127	21.5	18	111.5	95.0	21.5	6.0	135.0	118.5	24.0	11.5	—	—	—	—
230	107+	93	18.0	11	66.0	50.0	15.5	15.5	97.0	79.0	18.0	11.0	—	—	—	—
240	64+	56	13.5	10	—	—	—	—	—	—	—	—	—	—	—	—
250	41+	35	8.0	9	—	—	—	—	—	—	—	—	—	—	—	—
260	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Number of baleen plates	247				240				245				R : 213, L : 219			

1) From base to tip of baleen plate along lateral edge.

2) From gum line to tip of baleen plate along lateral edge.

3) Width of baleen plate at gum line along anterior surface (In 68A and B, this measurement is made by deformed way, see text.).

4) Length of bristles beyond the tip of baleen plate.

APPENDIX TABLE III. MEASUREMENTS OF VERTEBRAE OF THE SPECIMENS 61A AND 61B

(1) Specimen 61A

Serial No.	Vertebral No.	Greatest breadth	Greatest height	Centrum			Neural canal	
				Breadth	Height	Length	Breadth	Height
1	C 1	845	498	454	R 336 L 339			
2	2		534					
3	3							
4	4		} 545			} 274		
5	5							
6	6		548+			(29)		
7	7		606	319	292	(56)	207	166
8	D 1	862	607	303	273	104	210	160
9	2	918	666	297	272	121	211	150
10	3	804	711	309	276	145	221	142
11	4	735	730	357	286	158	228	126
12	5	695	733	302	282	164	222	124
13	6	686	763	302	281	170	222	121
14	7	717	590+	304	286	180	209	123
15	8	754	779	312	292	186	201	119
16	9	780	788	324	296	194	206	125
17	10	838	763	338	296	202	205	130
18	11	886	748	350	290	206	198	127
19	12	983	756	358	288	211	203	124
20	13	1,076	763	359	287	216	203	126
21	14	1,164	784	363	282	222	201	127
22	L 1	1,234	826	363	300	228	193	128
23	2	1,293	871	362	323	231	196	128
24	3	1,310	877	365	348	242	192	120
25	4	1,360	897	372	358	248	201	114
26	5	1,333	902	372	366	259	197	114
27	6	1,325	894	377	358	263	195	97
28	7	1,286	874	383	361	268	180	95
29	8	1,215	885	389	366	278	161	96
30	9	1,144	854	389	384	281	151	104
31	10	1,085	838	393	393	278	138	95
32	Ca 1	1,023	830	393	404	275	127	90
33	2	983	795	383	389	276	108	90
34	3	955	801	391	393	276	121	86
35	4	828	771	389	388	268	96	89
36	5	731	736	397	396	273	95	79
37	6	663	707	396	398	269	85	59
38	7	600	679	410	391	265	76	50
39	8	567	651	404	390	260	62	44
40	9	520	619	405	390	272	57	43
41	10	479	572	415	393	246	33	33
42	11	430	538	402	402	234	28	28
43	12	389	486	380	379	225	13	14
44	13	377	443	354	376	228	6	6

Continued . . .

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Serial No.	Vertebral No.	Greatest breadth	Greatest height	Centrum			Neural canal	
				Breadth	Height	Length	Breadth	Height
45	14	348	384	322	333	182	10	8
46	15	308	309	282	300	162	—	—
47	16	265	263	—	—	143	—	—
48	17	235	226	—	—	127	—	—
49	18	198	195	—	—	114	—	—
50	19	196	173	—	—	107	—	—
51	20	176	155	—	—	97	—	—
52	21	158	135	—	—	88	—	—
53	22	143	117	—	—	78	—	—
54	23	122	96	—	—	68	—	—
55	24	95	78	—	—	62	—	—
56	25	63	55	—	—	63	—	—

(2) Specimen 61B

Serial No.	Vertebral No.	Greatest breadth	Greatest height	Centrum			Neural canal	
				Breadth	Height	Length	Breadth	Height
1	C 1	849	513	490	R 348 / L 347			
2	2		563					
3	3							
4	4					286		
5	5		619+					
6	6					(28)		
7	7			300	275	(60)	208	157
8	D 1	783	615	294	262	106	205	178
9	2	801	657	294	264	114	201	162
10	3	750	700	304	274	134	213	148
11	4	750	734	303	285	143	210	138
12	5	739	733	312	266	150	211	135
13	6	741	749	310	266	157	216	137
14	7	745	768	312	266	165	214	133
15	8	765	739	325	275	173	210	135
16	9	800	759	334	273	191	213	136
17	10	835	735	345	277	199	209	140
18	11	880	772	341	279	207	204	144
19	12	941	771	346	277	212	208	141
20	13	1,080	777	347	275	220	194	148
21	14	1,065	786	348	282	219	188	157
22	L 1	1,255	799	358	302	229	181	146
23	2	1,257	818	358	320	232	183	143
24	3	1,279	836	352	329	236	172	136
25	4	1,295	878	356	349	245	175	136
26	5	1,284	861	361	351	250	176	129
27	6	1,283	862	355	344	250	166	126
28	7	1,268	856	364	336	257	154	131
29	8	1,246	852	364	345	265	145	128
30	9	1,173	843	367	358	267	138	116
31	10	1,134	820	368	362	268	125	125

Continued . . .

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Serial No.	Vertebral No.	Greatest breadth	Greatest height	Centrum			Neural canal	
				Breadth	Height	Length	Breadth	Height
32	Ca 1	1,096	817	371	382	269	107	110
33	2	1,027	769	372	363	274	101	115
34	3	963	763	374	375	269	99	113
35	4	889	779	375	376	270	86	108
36	5	789	719	381	381	265	80	93
37	6	736	705	385	381	265	76	79
38	7	655	687	387	383	266	64	64
39	8	577	634	373	387	265	59	57
40	9	493	582	374	383	255	57	62
41	10	433	572	377	375	251	62	55
42	11	400	531	367	362	239	47	35
43	12	366	511	355	355	226	45	31
44	13	351	452	334	334	201	31	18
45	14	348	390	309	307	170	26	13
46	15	312	286	286	279	139	—	—
47	16	280	262	—	—	125	—	—
48	17	246	216	—	—	114	—	—
49	18	220	205	—	—	120	—	—
50	19	205	182	—	—	101	—	—
51	20	191	170	—	—	97	—	—
52	21	171	156	—	—	91	—	—
53	22	155	136	—	—	83	—	—
54	23	129	112	—	—	75	—	—
55	24	117	88	—	—	66	—	—
56	25	95	67	—	—	58	—	—
57	26	60	46	—	—	55	—	—

APPENDIX TABLE IV. PRODUCTS FROM BLACK RIGHT WHALES IN THE NORTH PACIFIC

Whale no.	62 A	62 B	61 C	63 B	62 C	63 A	63 C	61 A	61 B
Body length (m)	14.1	14.7	15.1	15.4	16.1	16.1	16.4	17.0	17.1
Sex	♀	♂	♂	♀	♂	♀	♂	♂	♂
Whale oil (ton)	10.3	10.3	16	19	14.9	21	23	32	
materials: blubber	20,123	18,425	21,600	21,500	27,206	24,630	27,700	46,840	
materials: bone	6,740	9,076	7,400	8,499	9,729	9,598	10,403	—	
materials: meat	1,188	3,417	—	—	2,224	—	—	—	
materials: viscera	7,500	6,381	5,090	7,836	8,051	9,054	9,274	13,695	
materials: total	35,551	37,299	34,090	41,677	46,350	47,182[1]	52,209[1]	60,535	
% of materials	28.9	27.6	47.0	45.6	32.1	44.5	44.1	52.9	
Liver oil, 100,000 IU/g, (kg)	15.7	9.7	—	22.4	21.2	5.7	3.6	28.7[3]	
weight of liver (kg)	495	580	—	600	665	640	680	1,735[3]	
Frozen meat (ton)	7,328	7,376	—	—	10,240	48,000[2]	—	46,854[3]	
Salted tail flukes (ton)	—	—	—	—	—	2,200[2]	—	1,100[3]	
Tolal products, except liver oil (ton)	17.6	17.7	—	—	25.1	113.2[2]	—	96.0[3]	

[1] Include "others". [2] Include 63 A, B and C. [3] Include 61 A, B and C.

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EXPLANATION OF PLATES

PLATE I

Fig. 1. Swimming of black right whale in the Bering Sea, 1962.
Fig. 2. Spouting of black right whale in the Gulf of Alaska, 1961.

PLATE II

Fig. 1. Black right whale on flensing deck of Mombetsu landstation, Hokkaido. Whale No. 68A.
Fig. 2. Black right whale on flensing deck of Mombetsu landstation, Hokkaido. Whale No. 68B.

PLATE III

Fig. 1. Bonnet of the Whale No. 61B.
Fig. 2. Callosities near the blowhole of the Whale No. 61A.

PLATE IV

Fig. 1. Bonnet of the Whale No. 63A.
Fig. 2. Callosities on chin of the Whale No. 68B.

PLATE V

Fig. 1. Hairs on the tip of upper jaw. Whale No. 68A.
Fig. 2. Hairs on the tip of upper jaw. Whale No. 68B.

PLATE VI

Fig. 1. Hairs on the tip of chin. Whale No. 61A.
Fig. 2. Hairs on the tip of chin. Whale No. 68B.

PLATE VII

Fig. 1. Baleen plates of black right whale. Whale No. 62B.
Fig. 2. Baleen plates of the Whale No. 62C. 10th, 20th, 30th . . . are sampled. Right side.
Fig. 3. Baleen plates of the Whale No. 62C. 10th, 20th, 30th . . . are sampled. Left side.

PLATE VIII

Fig. 1. Penis of black right whale. Whale No. 61A.
Fig. 2. Reproductive groove and mammary slits of black right whale. Whale No. 63A.

PLATE IX

Fig. 1. Fetus of black right whale. Whale No. 63A. Dorsal view.
Fig. 2. The same. Ventral view.
Fig. 3. Fetus of Whale No. 63B. Anterior view.
Fig. 4. Fetus of Whale No. 63A. Anterior view.

PLATE X

Fig. 1. Skull of the specimen 61A. Lateral view.
Fig. 2. The same. Dorsal view.
Fig. 3. The same. Ventral view.

PLATE XI

Fig. 1. Skull of the specimen 61B. Lateral view. Arrow indicates the bony shield on the supraoccipital bone.
Fig. 2. The same. Dorsal view.
Fig. 3. The same. Ventral view.

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PLATE XII

Fig. 1. Skull of the specimen 61A. Posterior view.
Fig. 2. Skull of the specimen 61B. Posterior view.
Fig. 3. Mandibles of the specimens 61A and 61B. Inner side 61A, outer side 61B.

PLATE XIII

Fig. 1. Cervical vertebrae of the specimens 61A (right) and 61B (left). Lateral view.
Fig. 2. The same. Anterior view.
Fig. 3. The same. Posterior view.

PLATE XIV

Fig. 1. Dorsal vertebrae of the specimen 61A.
Fig. 2. Dorsal vertebrae of the specimen 61B.
Fig. 3. Lumbar vertebrae of the specimen 61A.
Fig. 4. Lumbar vertebrae of the specimen 61B.

PLATE XV

Fig. 1. Caudal vertebrae of the specimen 61A.
Fig. 2. Caudal vertebrae of the specimen 61B.

PLATE XVI

Fig. 1. Ribs of the specimen 61A.
Fig. 2. Ribs of the specimen 61B.

PLATE XVII

Fig. 1. Scapula of the black right whale. Upper 61A and lower 61B.
Fig. 2. Humerus, Radius, and Ulna of the black right whale. Upper 61A and lower 61B.
(In both figures left is left side bones and right is right side bones)

PLATE XVIII

Fig. 1. Phalanges of the specimen 61A.
Fig. 2. Phalanges of the specimen 61B.
(In both figures lower is left side bones and upper is right side bones)

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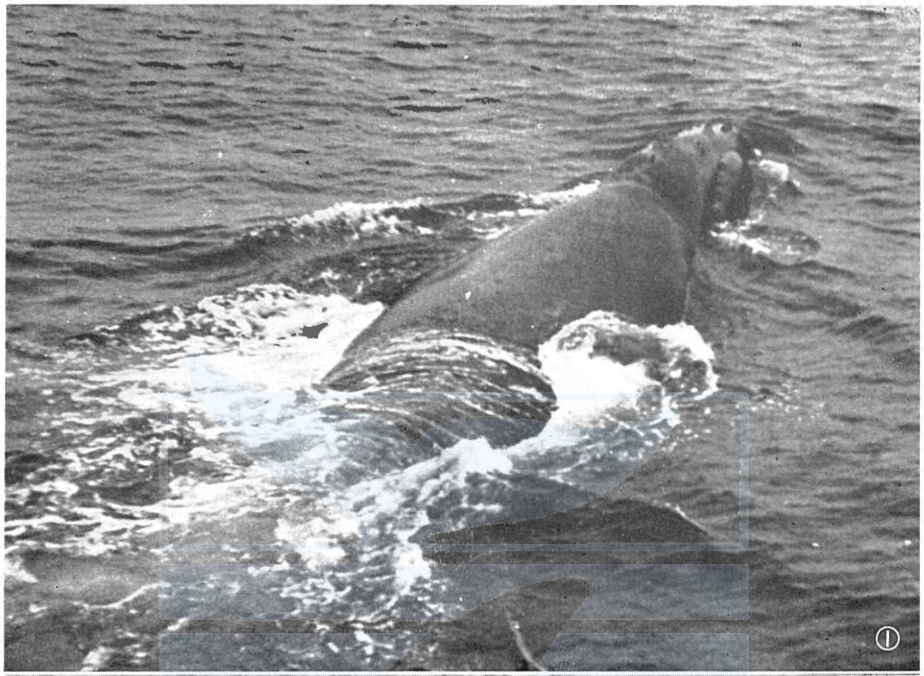
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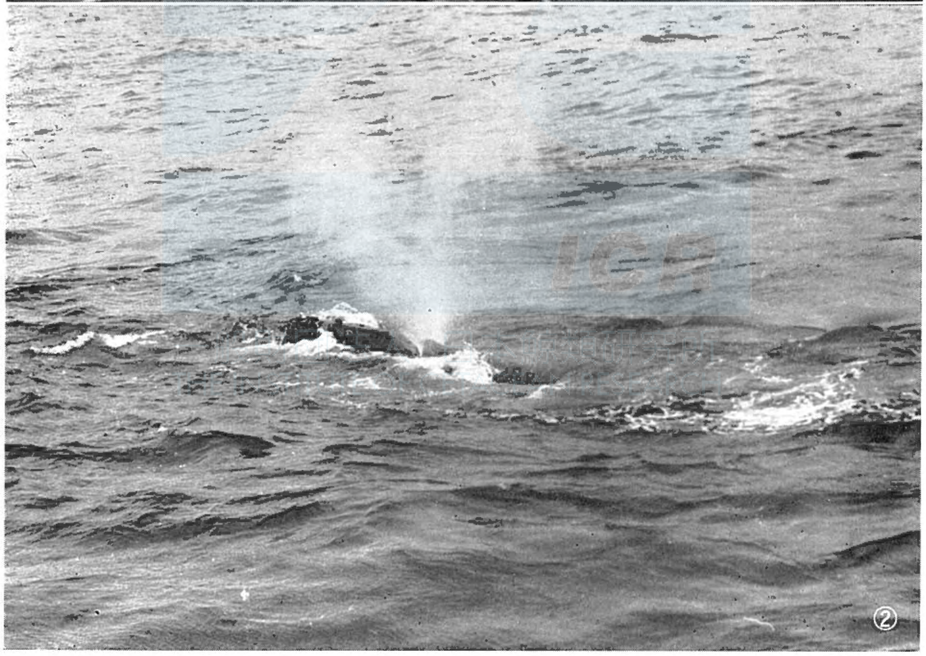
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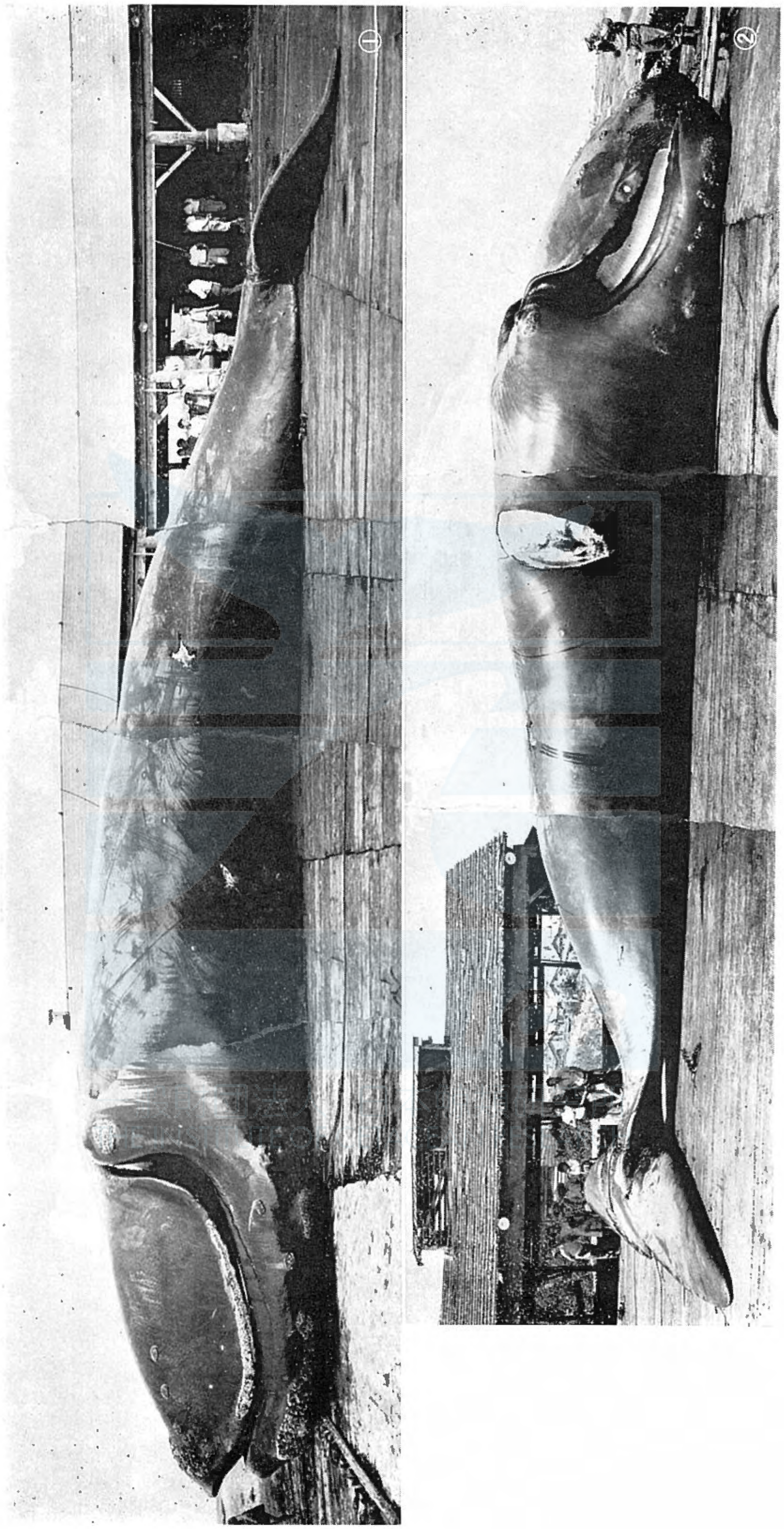

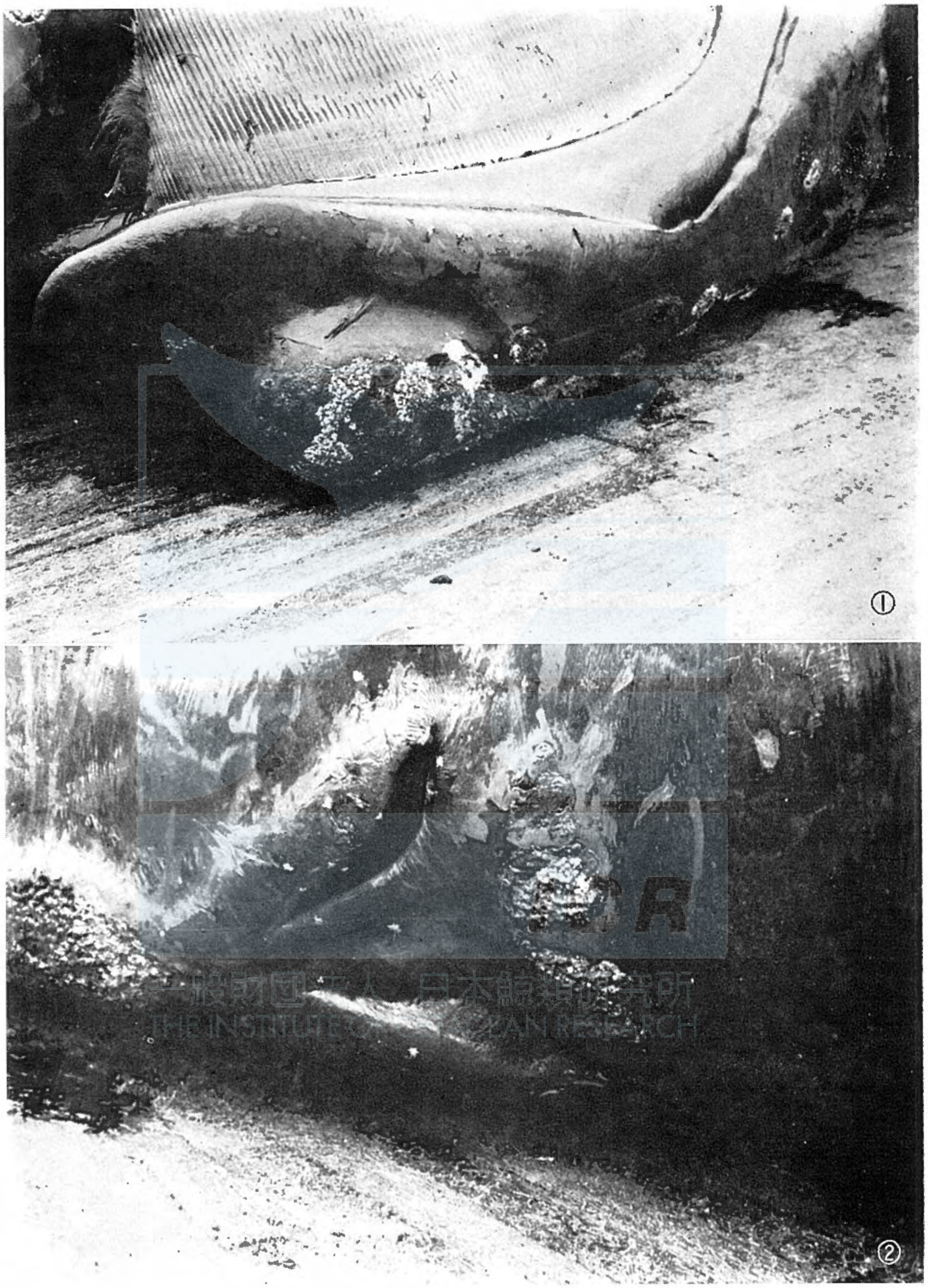

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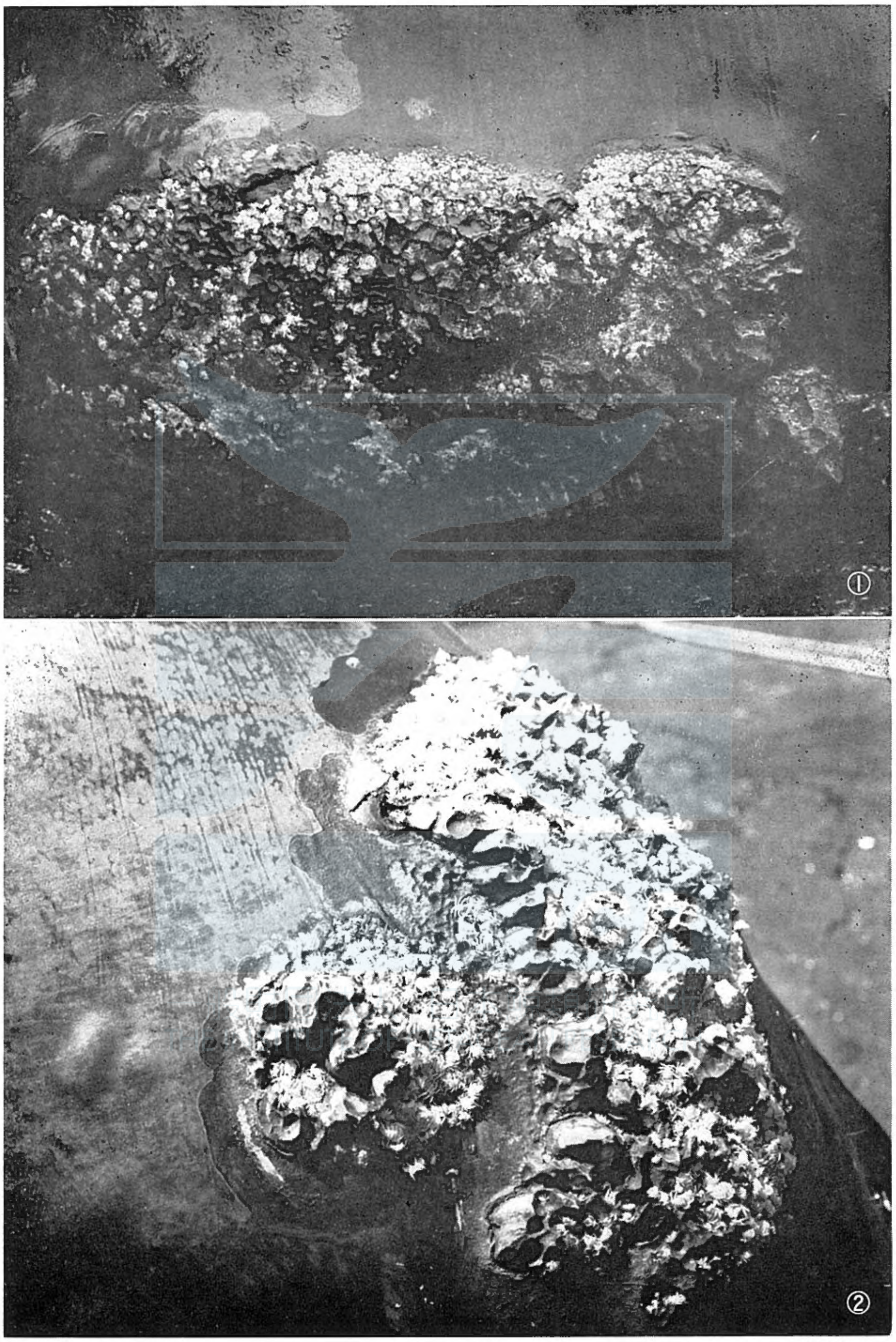
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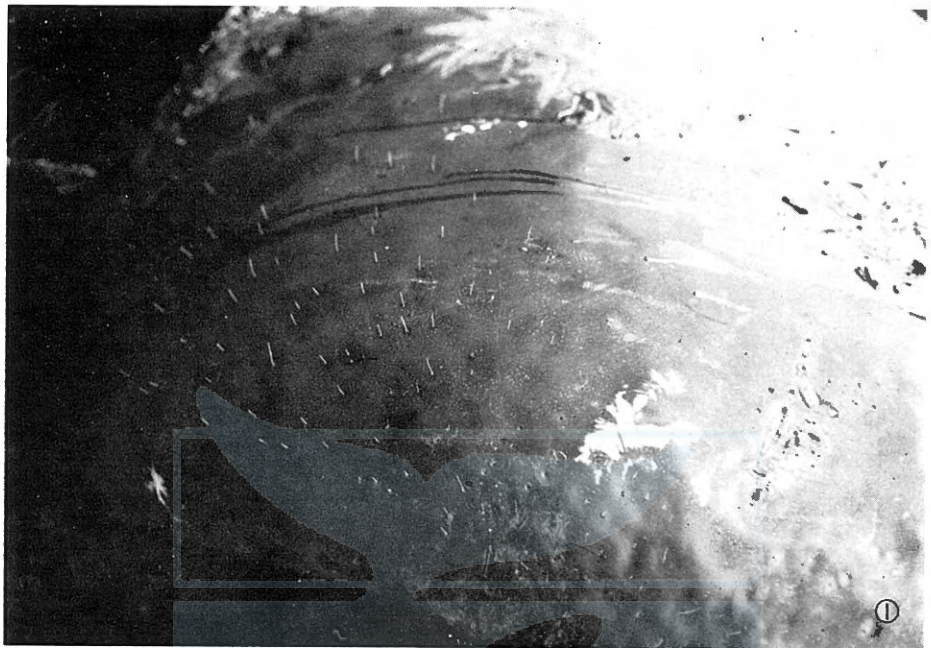
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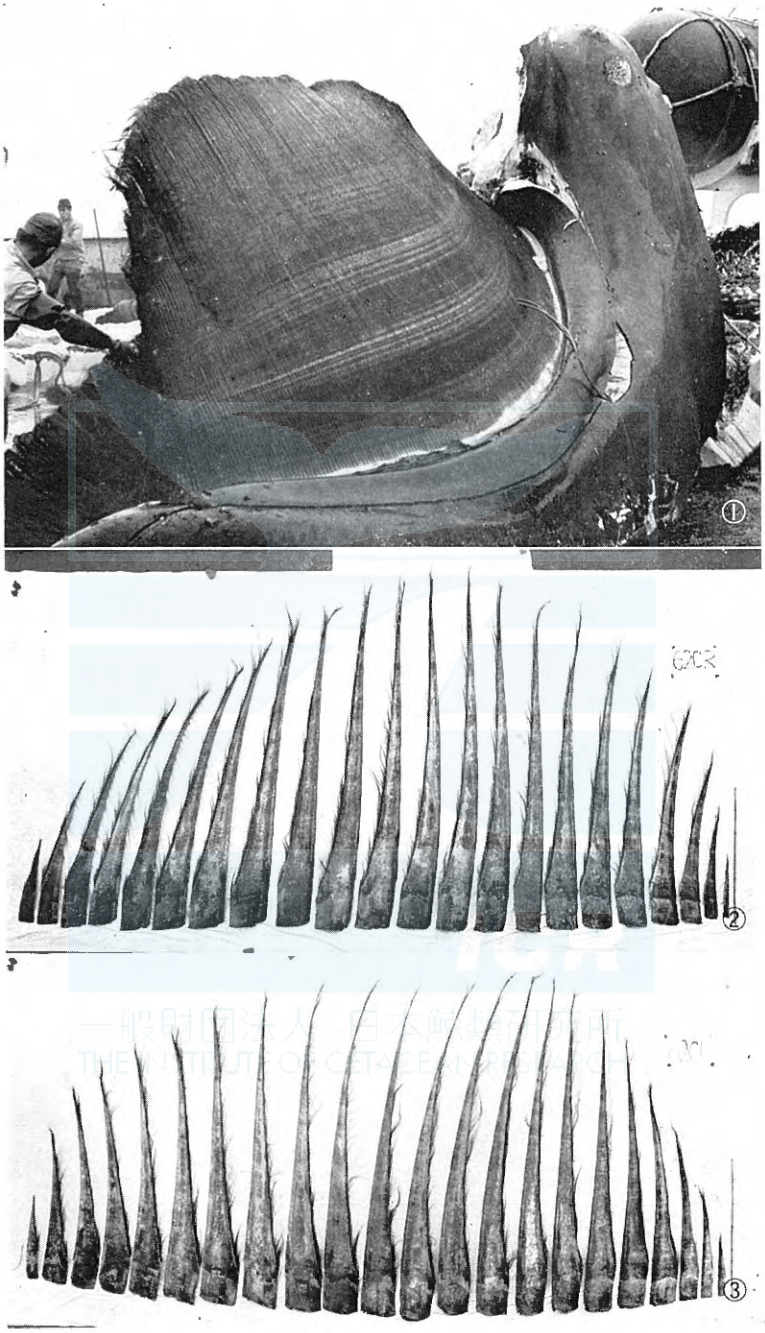

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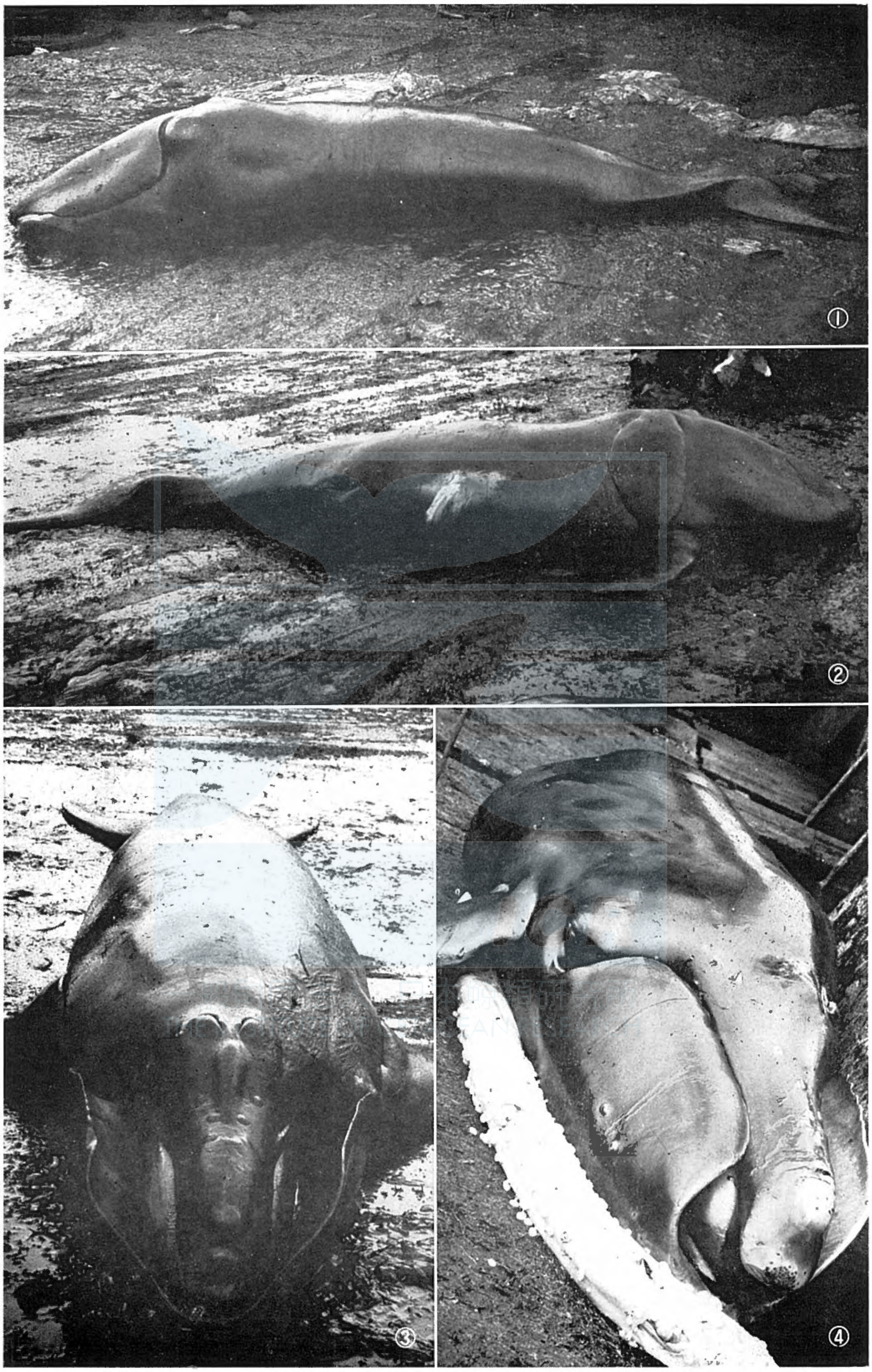
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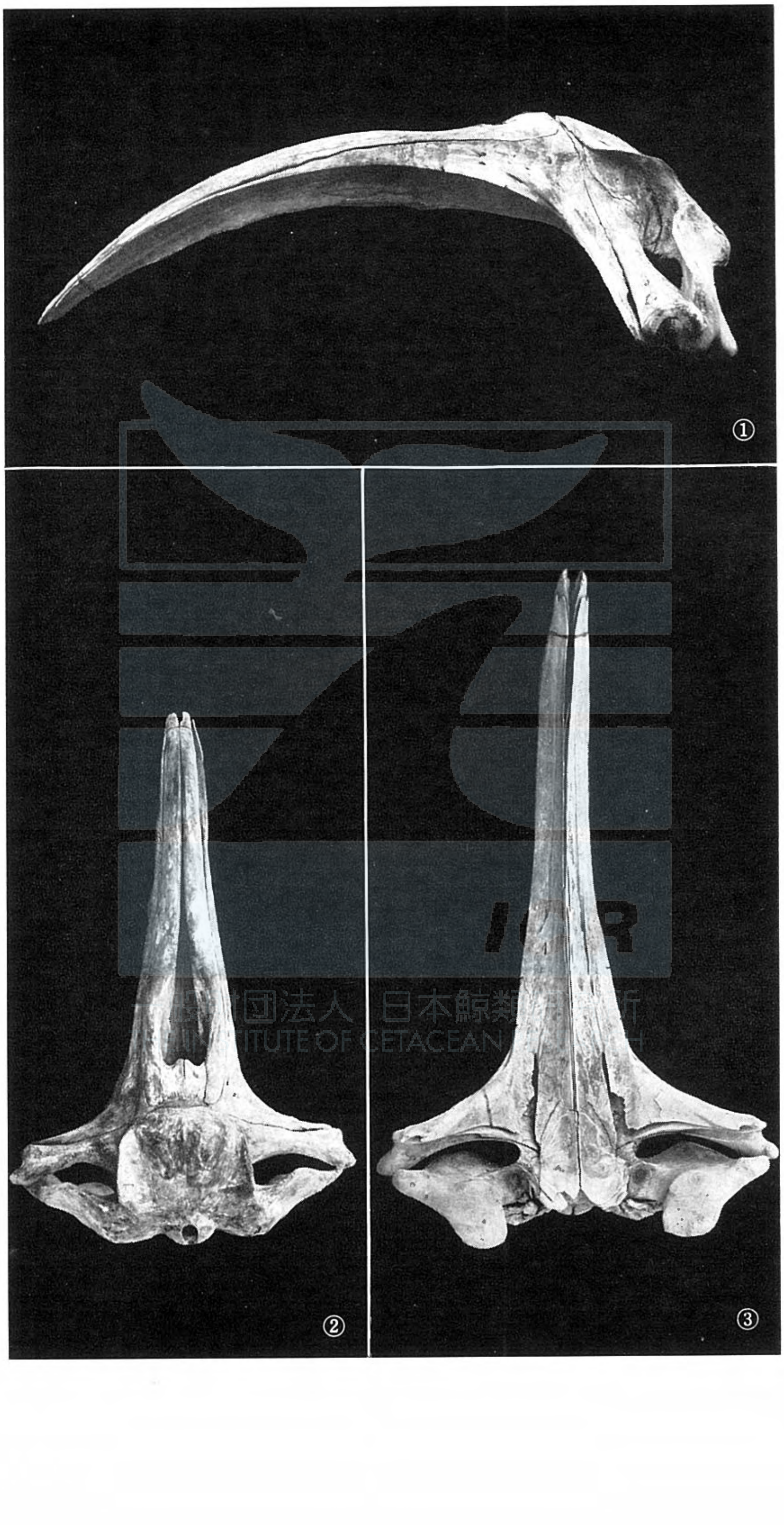

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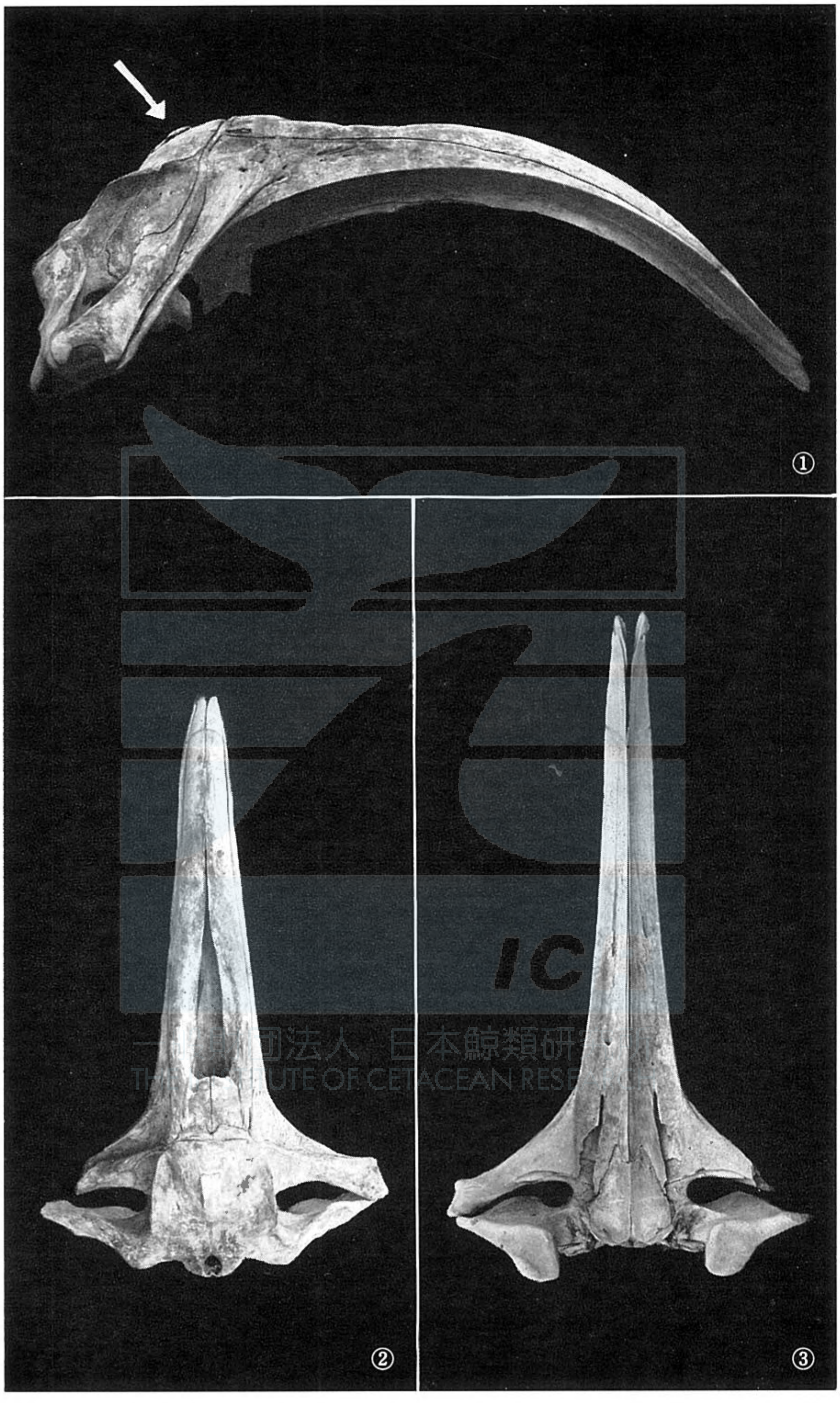
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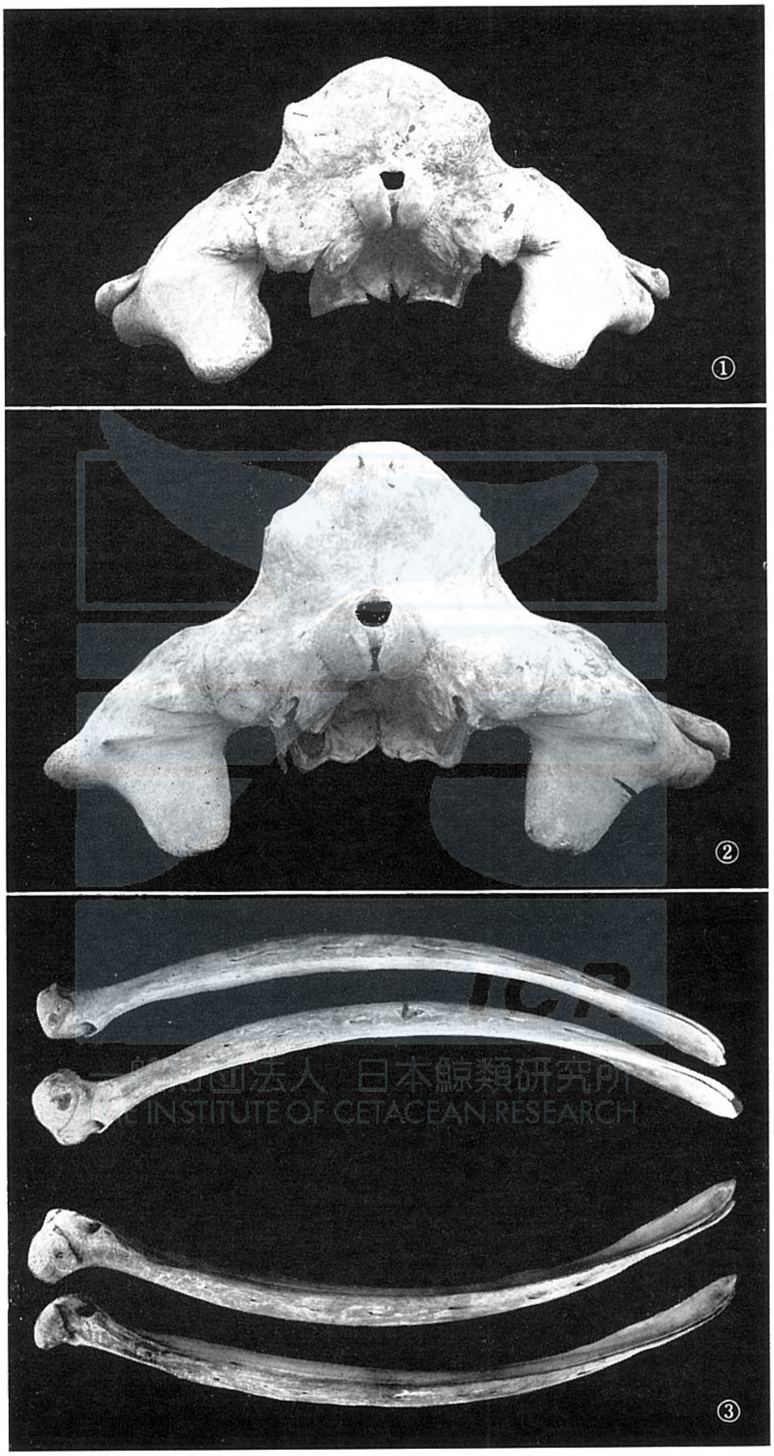

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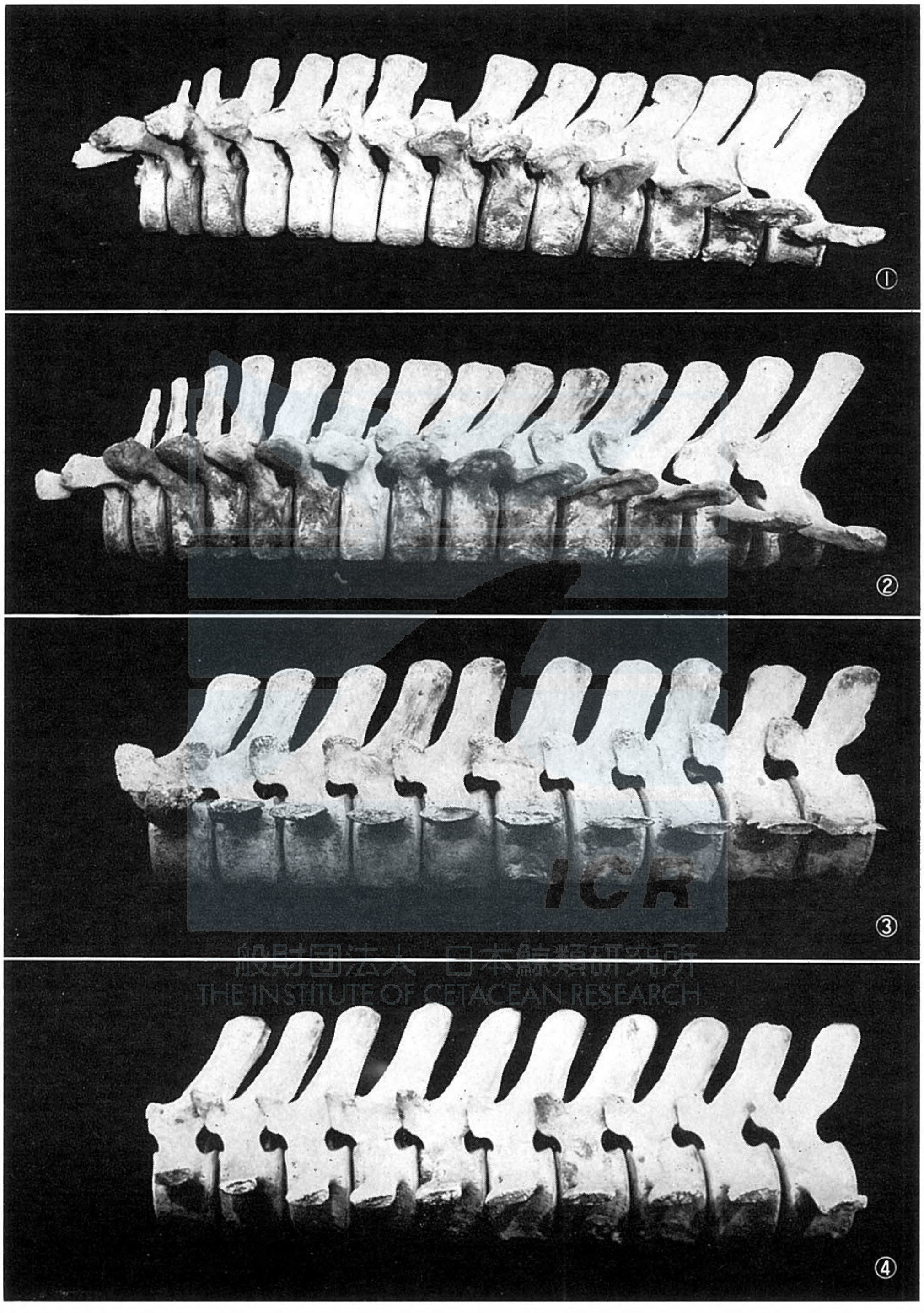

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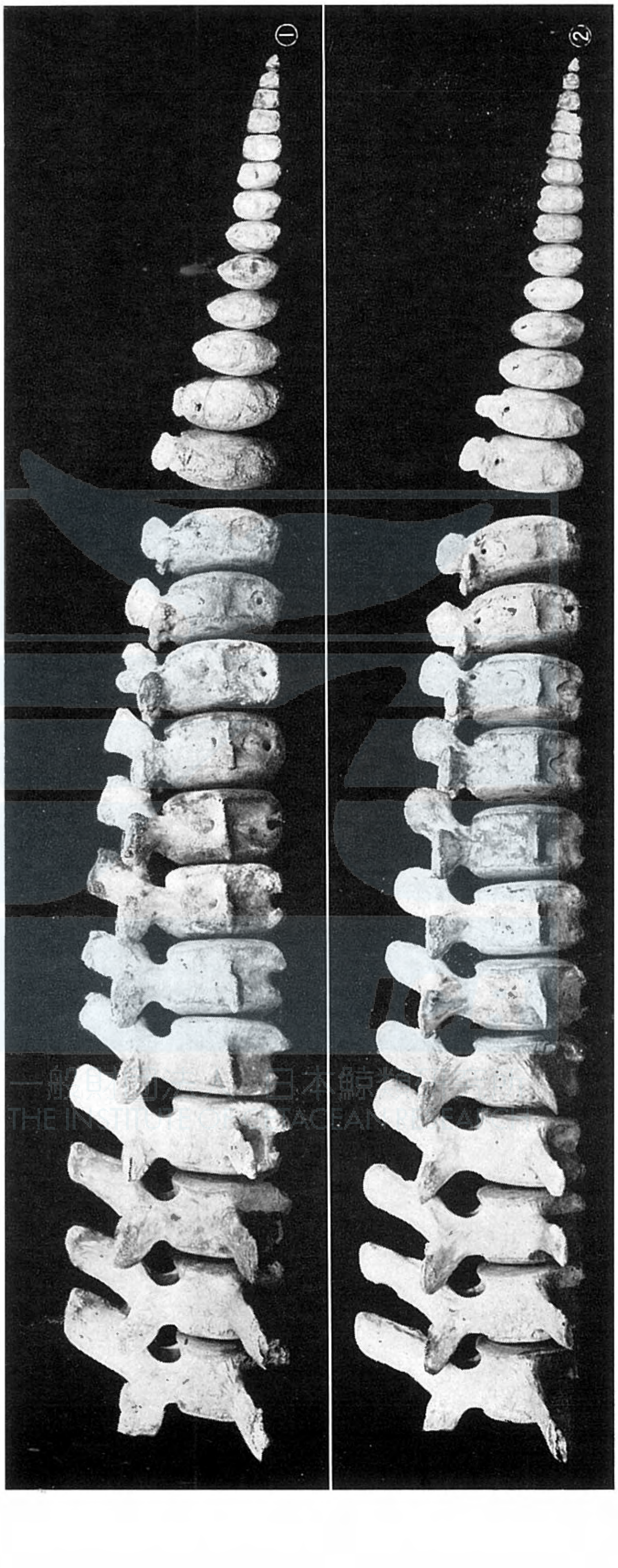
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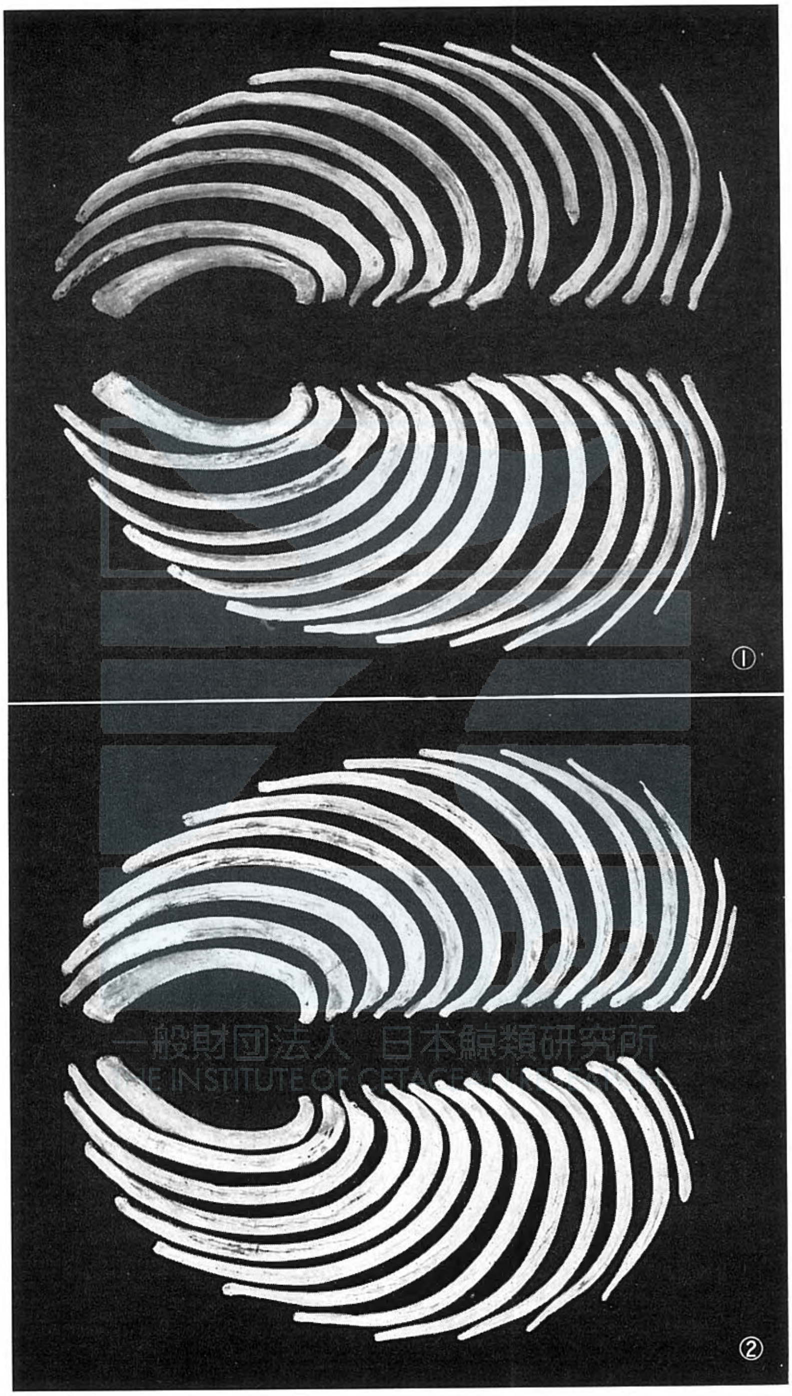

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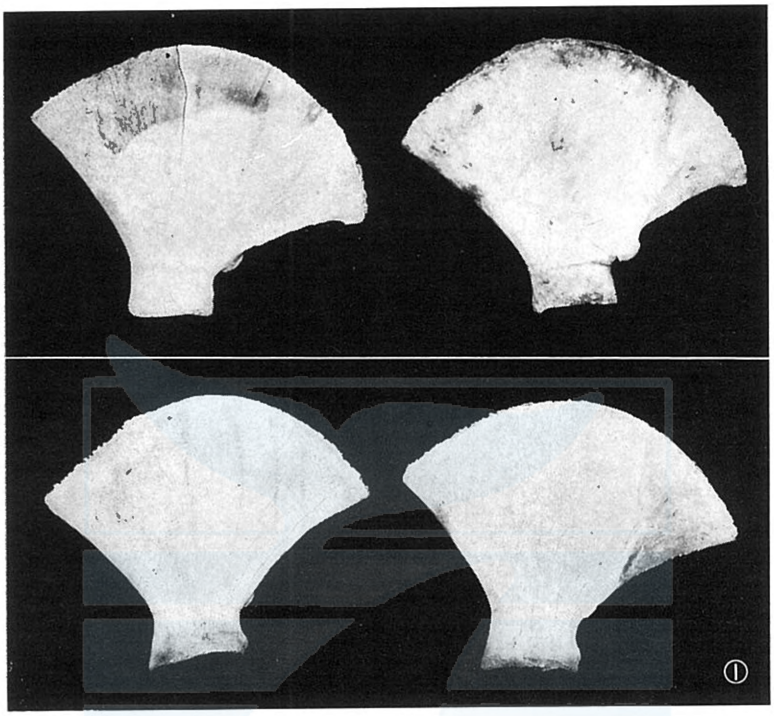

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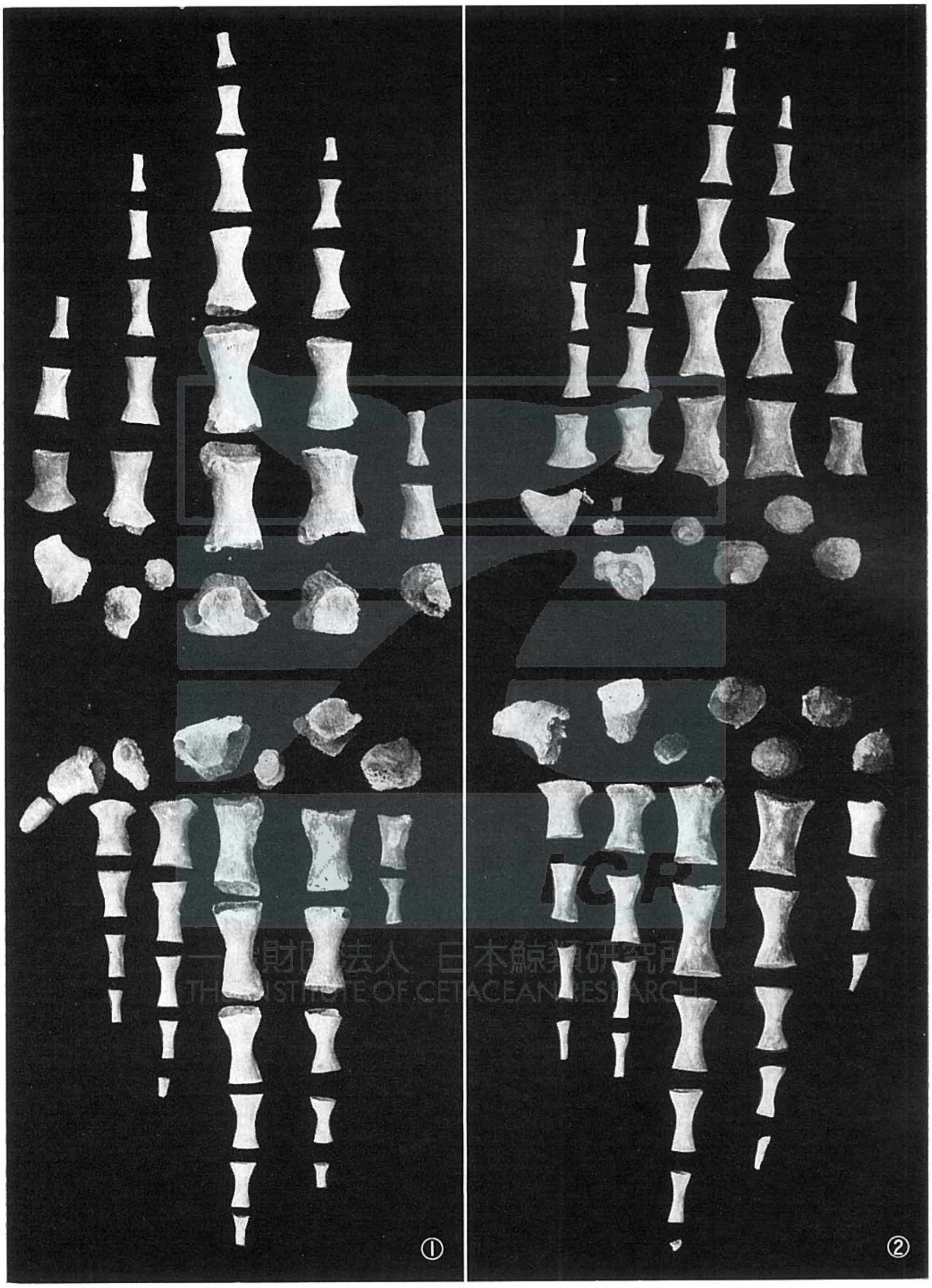
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THE DISCOVERY OF THE RIGHT WHALE SKULL IN THE KISAGATA SHELL BED

MASAHARU NISHIWAKI* AND YOSHIKAZU HASEGAWA**

INTRODUCTION

A skull of a big whale was discovered during the excavation work of constructing embankments at Kisagata Harbor, Akita Prefecture, on November 24, 1965. The skull was subsequently treated to be kept at the Kisagata-cho Aquarium. The news was delivered with photographs and a few materials to Nishiwaki through Prof. Mitsumasa Hashimoto and Prof. Yaichiro Okada.

Nishiwaki and Hasegawa visited Kisagata to identify of what skull it was and to witness the place of excavation in the summer of 1966. The exact point of excavation, however, could not be witnessed because the construction of embankments had been so advanced since the time of the discovery that the very point was not preserved as it had been. Consequently, informations of the situation and the environment of the discovery were collected and based on the observation on the exposed strata of the other point near by, the level of the layer where the skull had been buried in was presumed.

GEOLOGY

The skull had been buried in the lower part of the upper sand and gravel beds containning assemblages of molluscan shells. The result of the examination indicates that the beds were accumlated near the ancient coast line. Development of coastal dunes is remarkable in the area around the Kisagata Harbor. The thickness of dune sands near by the harbor is 1 to 2m. Under the dune sand, lies sand and gravel beds, 4 to 5m thick, are divided into two parts of layers by the border of milky white precipitate derived from mineral springs. Although there is no special difference between the two parts, the lower layers contained comparatively larger gravels. In the case of recognizing above mentioned border, the two parts can be separated.

Kisagata Shell Bed: The upper part of the upper sand and gravel beds is named here as the Kisagata Shell Bed. This layer is seen partly lenticular. The following 15 species were found in it, but *Serpulorbis imbricatus* and *Ostrea gigas* were most dominant in number.

1. *Tegula (Omphalius) rustica* (GMELIN)
2. *Serpulorbis imbricatus* (DUNKER)
3. *Batillaria multiformis* (LISCHKE)
4. *Neverita (Glossaulax) didyma* (RÖDING)
5. *Purpura (Mancinella) davigera* KUSTER

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** Section of Vertebrate Paleontology, National Science Museum.

6. *Babylonia japonica* (REEVE)
7. *Oliva mustelina* LAMARCK
8. *Narona* (*Solatia*) *nodulifera* (SOWERBY)
9. *Pseudogrammatodon dalli* (SMITH)
10. *Anadara* (*Scapharca*) *subcrenata* (LISCHKE)
11. *A.* (*S.*) *broughtonii* (SCHRENCK)
12. *Ostrea* (*Crassostrea*) *gigas* THUNBERG
13. *Protothaca jedoensis* (LISCHKE)
14. *Macoma incongrua* (V. MARTENS)
15. *Heteromacoma yantaiensis* (CROSSE et DEBEAOX)

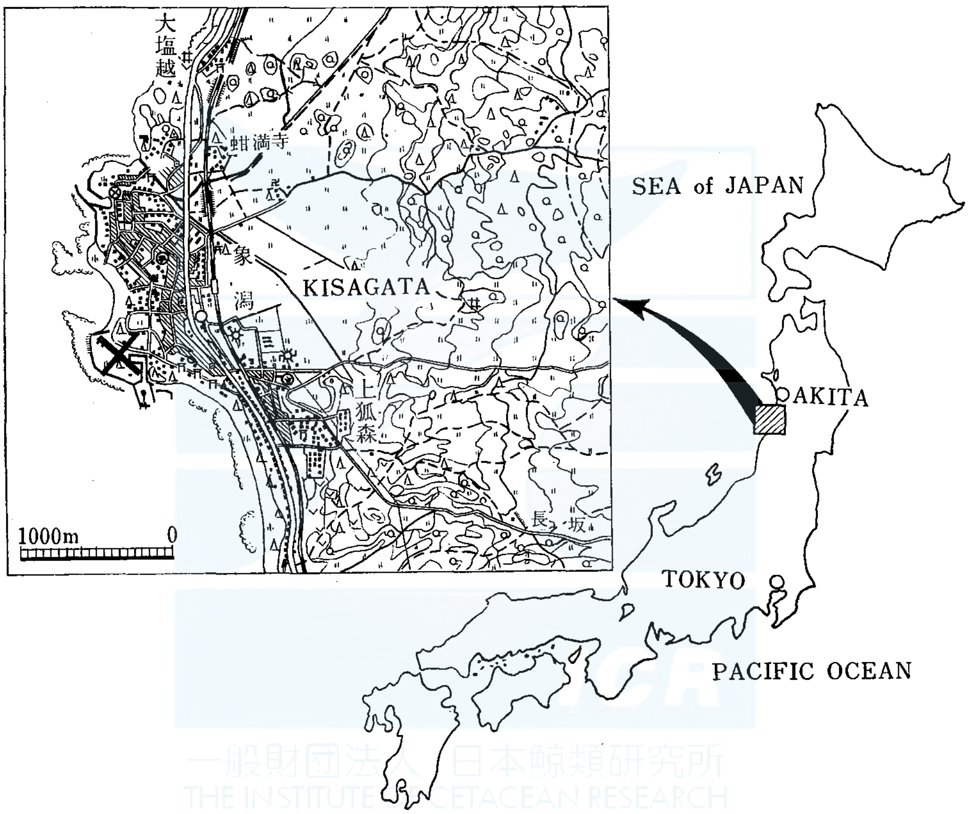

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Fig. 1. The place (×) where the skull was found: Kisagata-cho, Akita Prefecture.

All the species are living ones, they inhabit along the coasts near the low tide level in Honshu and other southern islands of Japan. *Ostrea* and *Serpulorbis* are often found adhered collectively to the surface of boulders, this indicates that these species are indigenous to the locality. Discovery of this bed, especially densely contained gravel and shell, verify the ancinet coastline.

According to Gakuro Inamura (1942), the Kisagata area had once been the picturesque sea dotted with literally numberless islets (Fig. 2), however, in 1804 a great earthquake happened, which caused the upheaval of ground and the beautiful sea was destroyed. The greater part of the area has turned to be paddy fields.

The layer in which the skull was found, was also a bed of sand and gravel mixture, lied just under the Kisagata Shell Bed and about 4m deep from the ground surface. Buried under the layer of coastal deposits, it is evident, the skull had been there since some time before 1804. However, nothing more can be presumed.

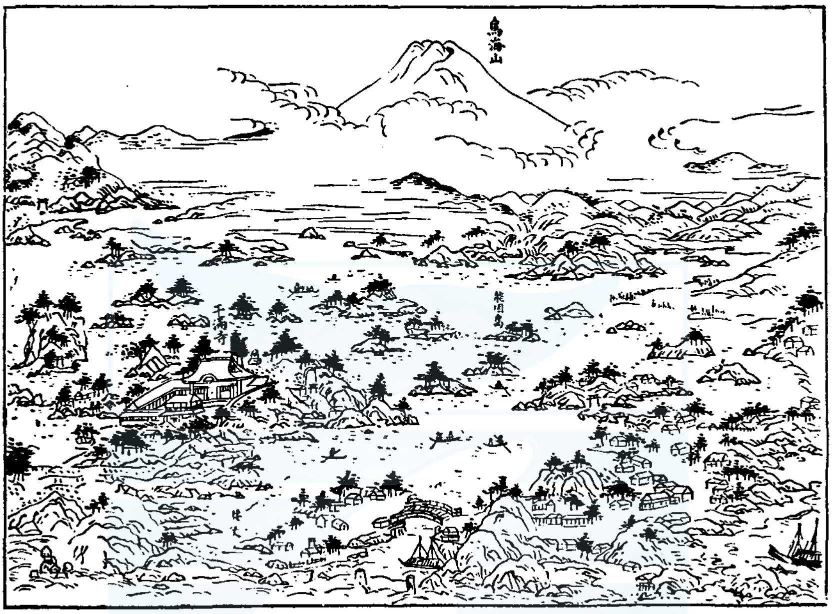

Fig. 2. The picture of the Kisagata area drawn by a local painter before the great earthquake in 1804. The scenery is the beautiful sea dotted with a great number of islets, known by the name of " ninetynine islets ". The point of the discovery is at the lower right corner.

EXAMINATION ON THE SPECIMEN

The squamosal was protruded horizontally, the mastoid process was largely swelling down, and compared the shape and the measured values of the occipital condyles with that of the living right whale, close similarity between them was found. Then discovered specimen can be identified as a right posterior part of skull of a right whale, *Eubalaena glacialis*. The skull had not been much fossilized. The whole skull, especially the part of occipital condyles were seen worn out and a stone of a human fist size had cracked into it. If readers reffer the formally published report by Omura (1958, and the report contained in this volume) in which the skeletons of this species are described, above comparison can be understood well.

This is the first record of discovery of part of remain of a right whale in the sediment on the coast of the Sea of Japan.

According to Tawnsend (1935), a considerable number of right whale population was found in the Sea of Japan about 100 years ago. Although in the North Pacific, several hundreds of right whale are presumed to be inhabited today and the number of whales seems to be increasing, very few have been found in the Sea of Japan. (Tago, 1900; Matsuura, 1936; Kuroda, 1938, 1940; Tomilin, 1957; Nishiwaki, 1965, 1967)

TABLE 1. DIMENSIONS OF THE SPECIMEN

	cm
Distance between center of ventral part of occipital condyles and outer end of squamosal	150
Distance between basal part of mastoid process and outer end of squamosal	90
Minimum height of squamosal at posterior end	43
Minimum antero-posterior length of squamosal	43
Antero-posterior length of mastoid process	45
Maximum width of mastoid process	40
Length of alar canal	21
Mimimum breadth of vomer	17
Distance between posterior end of occipital condyles and posterior edge of alar canal	74
Maximum thickness of occipital condyles (horizontal)	42+
Height of occipital condyle (vertical)	35+
Maximum breadth of occipital condyle	21+
Maximum breadth of foramen magnum	14
Length of a part of premaxilla	160
Maximum width of a part of premaxilla	16
Anterior width of a part of premaxilla	40
Thickness of premaxilla at sutual end	14

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EXPLANATION OF PLATES

PLATE I.

A. Environment of the spot of discovery.
 1. Dune sand at surface.
 2. Upper sand and gravel bed.
 X. approximate locality of the skull

B. Shells in the Kisagata Shell Bed.

C. Enlarged part of B.
 Surpulorbis and *Ostrea* are seen adhered to the surface of a boulder.

PLATE II.

A. Mineral spring's precipitate seen in the bed, and the constructing embankment at the south side of the bay is seen in the left.
 2. Upper bed.
 3. Lower bed.

B. Mineral spring predcipitate is seen between the upper and lower beds. The scene B is continued eastwared to scene A.

C. Shell bed (Sb), near by the scene B.
 1. Dune sand.
 2. Upper sand and gravel beds consist of coarse sand mixed with dispersed gravel.

PLATE III. Photographs of the specimen.

A. Caudal view of the specimen.

B. Ventral view of the specimen.

C. A part of left premaxilla of the specimen. (outer side)

D. A part of left premaxilla of the specimen. (ventral side)

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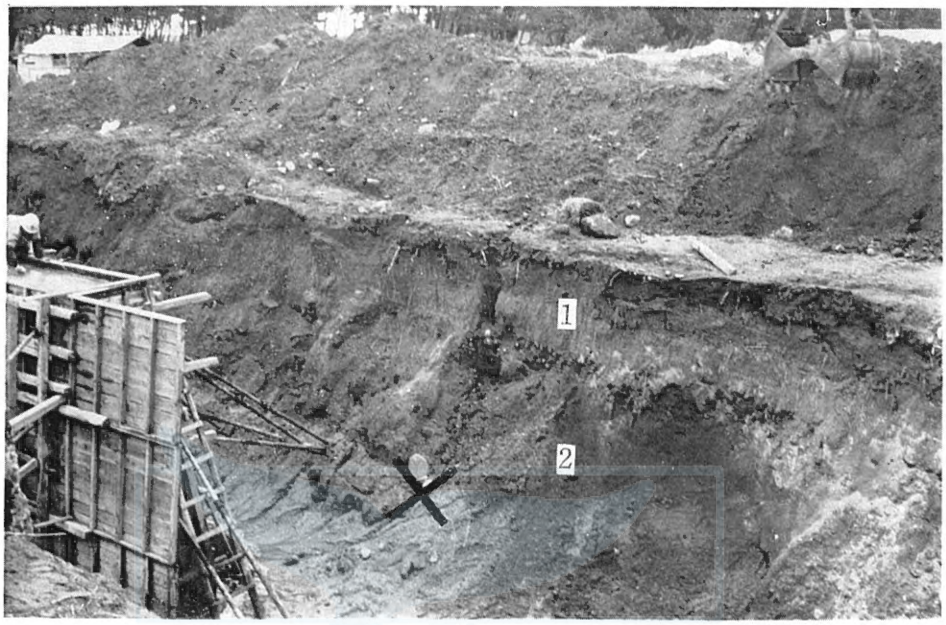

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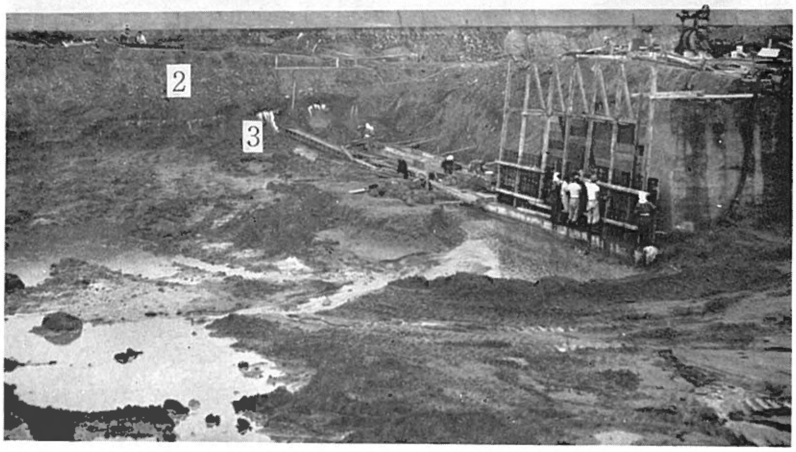

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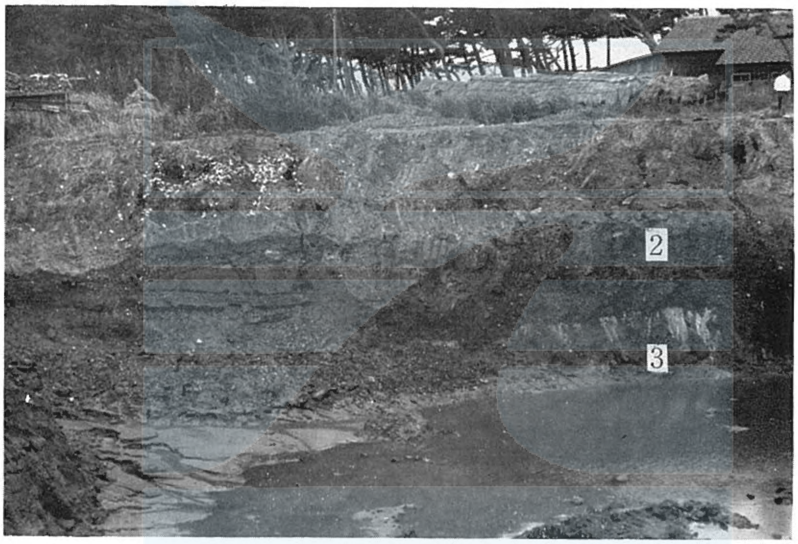

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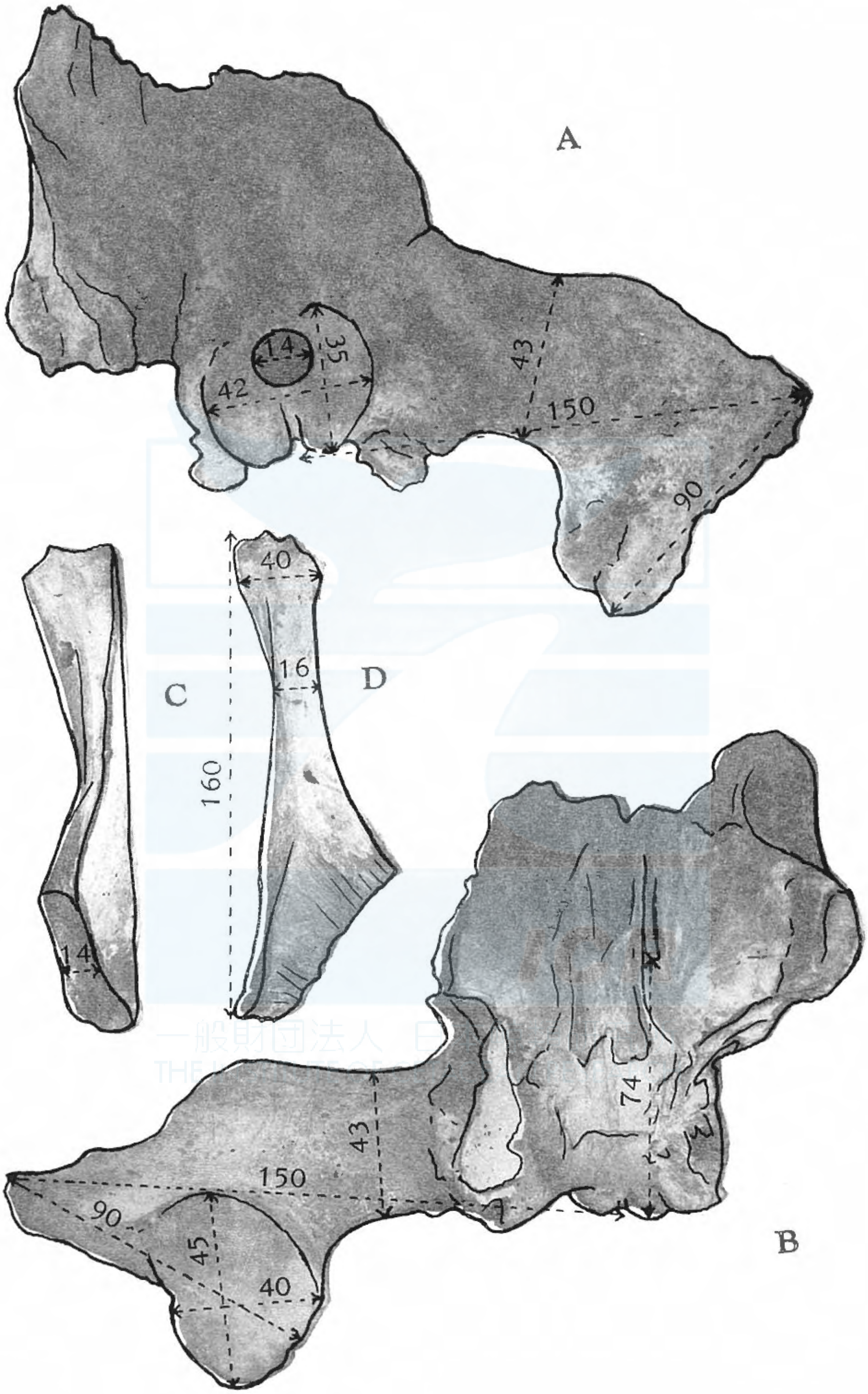
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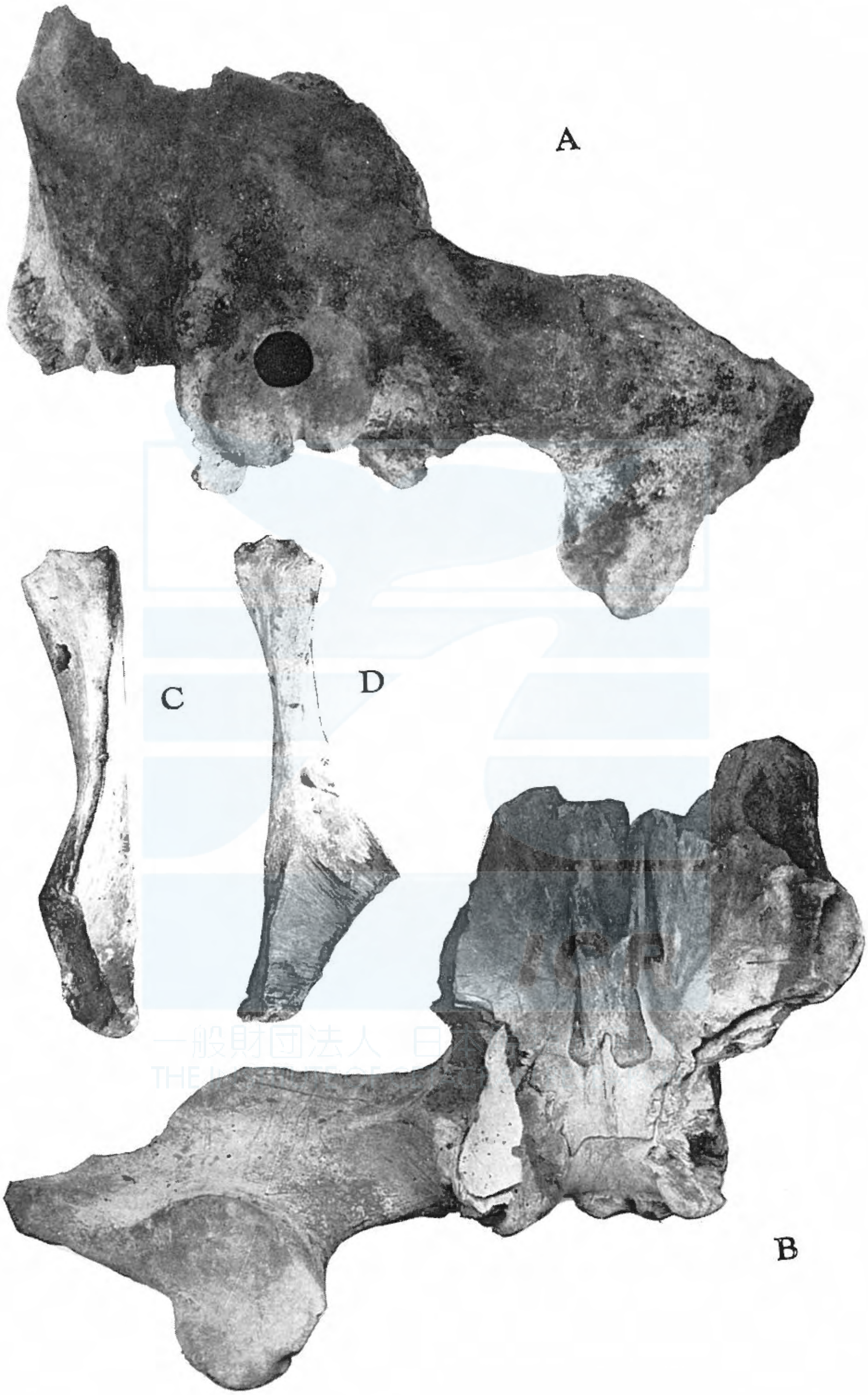
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OCCURRENCE AND RUPTURE OF VAGINAL BAND IN THE FIN, SEI AND BLUE WHALES

SEIJI OHSUMI*

The vaginal band is present crossing the entrance of vagina in some baleen whales. It was firstly reported by Mackintosh and Wheeler (1929) on the southern fin whales (*Balaenoptera physalus*) and the blue whales (*B. musculus*). After then, the presence of the band was reported for the southern fin whale (Wheeler, 1930; Laws, 1961), the southern humpback whale (*Megaptera novaeangliae*; Matthews, 1937), the northern fin whale (Ohsumi *et al.*, 1958) and the North Pacific right whale (*Eubalaena glacialis*; Omura, 1958).

As Mackintosh and Wheeler described, the vaginal band is not an abnormality, but is found in fairly large percentage. However, few one have noticed the occurrence of the band in the whales, and there are few data on the subject.

The vaginal band appears to be analogous to the hymen in the mankind. And I think that the occurrence and rupture of the band is useful for the examination of the reproductive behavior and physiology in the whales. In practice, we have rare chances to observe copulation or parturition of whales. But the occurrence and rupture of the vaginal band will represent the experience of copulation or parturition of the whales.

In this point of view, I examined the frequency occurrence of vaginal band and its tag in relation to the development of the whales.

MATERIAL AND METHOD

It is difficult to observe a vaginal band of a whale without insertion of observer's hand into the vulva. Because, in most immature female whales, the genital groove is closed, so that little can be seen of the genitalia. Vaginal band is present accrossing the vulva, and attach at the anterior and posterior borders of the entrance of vulva. Sometimes, mostly in mature females, tag of the vaginal band is found at entrance of vagina. Therefore, I inserted my hand into vagina of the whale before the time of flensing, and palpated the existence of vaginal band or its tag.

Mammary gland was observed and determined its maturity. Immature and pubertal mammary gland is thin and pale pinkish-white in colour, while mature gland is thicker and brown in colour (Ohsumi *et al.*, 1958). A pair of ovaries was observed on the follicle, corpus luteum and corpus albicans.

Then, the five stages of development and sexual maturity of examined whales were divided as follows:

Immature Mammary gland is immature, and the ovaries are rather small. Graafian follicles are too small to be found by naked eyes.

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Prepubertal Mammary gland is immature. Ovaries elongate, and the surface is rather smooth. The development of Graafian follicles leads to the formation of round protuberances. But there is no corpus luteum nor corpus albicans in the pair of ovaries.
Pubertal Mammary gland is still immature, but its colour becomes pinkish. In ovaries, there is at least one corpus luteum or corpus albicans. It is considered that one or more ovulation occurred already in the whale of this stage, but the pregnancy or at least parturition has not experienced. Because in the whale which have never been pregnant or are pregnant for the first time, mammary gland differs from the state of the gland in immature whale only in a slightly better development of the lobes (Mackintosh and Wheeler, 1929).
First pregnant Mammary gland remains in the immature appearance, but the colour becomes pinkish. There is embryo or foetus in the uterus, and of course, there is at least one corpus leteum in the ovaries. As van Lennep and van Utrecht (1953) and Laws (1961) remark that in the whales the lobules alveoli of mammary gland do not develop until the end of pregnancy. First pregnancy is easily distinguishable by observing the mammary gland. We must consider the case of abortion, but it is difficult to find the experience of abortion in the whale.
Multiparous Mammary gland is mature. And there is more than one corpus albicans in the ovaries. Chittleborough (1958) found that in the humpback whales which were very close to the time of parturition, the lobules and labeoli were well developed and colostrum was present in most cases. And after the first lactation, mammary gland becomes quite different from that of the gland which has not yet been functional.

In this stage are included the lactating and resting stages of primiparious animals, because they are not able to distinguish from the multiparous animals exept the individual with only one corpus albicans in the ovaries.

The occurrence of vaginal band or tag is summed up in the above five stages of sexual maturity respectively.

The investigations of vaginal band were made on the fin, sei and blue whales on board of factory ships in the Antarctic in 1958/59 season and in the northern part of the North Pacific in 1961 and 1964 seasons. The numbers of individuals examined are as follows:

	Antarctic	North Pacific	Total
Fin whale	70	317	387
Sei whale	—	206	206
Blue whale	2	12	14

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OCCURRENCE OF VAGINAL BAND OR ITS TAG

Tables 1, 2, 3 and 4 show the occurrence of vaginal band and its tag in the five stages of sexual maturity for the northern and southern fin whales, northern sei whales and blue whales respectively.

Immature stage

Of the total of 84 immature northern fin whales, the band was present in 35 (41.6%), and in the total of 42 immature southern fin whales, the band was present in 17 (40.5%). The frequency occurrences of vaginal band are similar each other in the northern and southern fin whales. These figures are higher than that which was reported on the southern fin whales by Mackintosh and Wheeler (1929). They reported that the vaginal band was present in 31 (21.4%) of the total of 145 immature females.

TABLE 1. OCCURRENCE OF VAGINAL BAND IN THE FIVE STAGES OF SEXUAL MATURITY FOR THE NORTHERN FIN WHALES

	Band present	Tag present	Band absent	Total
Actual figure				
Immature	35	—	49	84
Prepubertal	24	2	33	59
Pubertal	—	3	5	8
First pregnant	3	8	18	29
Multiparous	—	38	99	137
Total	62	51	204	317
Per cent				
Immature	41.6	0.0	58.4	
Prepubertal	40.7	3.4	55.9	
Pubertal	0.0	37.5	62.5	
First pregnant	10.3	27.6	62.1	
Multiparous	0.0	27.7	72.3	

TABLE 2. OCCURRENCE OF VAGINAL BAND IN THE FOUR STAGES OF SEXUAL MATURITY FOR THE SOUTHERN FIN WHALES

	Band present	Tag present	Band absent	Total
Actual figure				
Immature	17	—	25	42
Prepubertal	8	3	11	22
Pubertal	1	1	—	2
Multiparous	—	1	3	4
Total	26	5	39	70
Per cent				
Immature	40.5	0.0	59.5	
Prepubertal	36.4	13.6	50.0	
Pubertal	50.0	50.0	0.0	
Multiparous	0.0	25.0	75.0	

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However, they also described that not all these whales were examined on this structure, but it was definitely not present in 40 immature fin whales. The individuals which were not examined should be excluded in the calculation of the frequency. In their paper, if 71 immature whales were examined on this structure, the frequency occurrence is recalculated to be 43.7%. This figure is similar to my result. In this point of view, the frequency occurrence (14%) of vaginal band in the foetal stage by Mackintosh and Wheeler is also too low, because they reported five possessed band, while two definitely did not.

Of 22 immature northern sei whales, vaginal band was present in six (27.3 %). Matthews (1938) examined seven immature southern sei whales and one (14.3 %) possessed the vaginal band. This figure is lower than my result, but his materials are few to be compared the difference of frequencies between the two races.

I confirmed the presence of vaginal band in the immature female blue whale. That is to say, two immature females were examined on this structure and one undoubtly possessed an unbroken vaginal band. Mackintosh and Wheeler (1929) reported that a blue whale possessed only a tag of vaginal band.

There is no individual which possesses a tag in the immature stage for the examined 150 female whales.

TABLE 3. OCCURRENCE OF VAGINAL BAND IN THE FIVE STAGES OF SEXUAL MATURITY FOR THE NORTHERN SEI WHALES

	Band present	Tag present	Band absent	Total
Actual figure				
Immature	6	—	16	22
Prepubertal	2	4	11	17
Pubertal	—	—	1	1
First pregnant	—	6	12	18
Multiparous	—	40	108	148
Total	8	50	148	206
Per cent				
Immature	27.3	0.0	72.7	
Prepubertal	11.8	23.5	64.7	
Pubertal	0.0	0.0	100.0	
First pregnant	0.0	33.3	66.7	
Multiprous	0.0	27.0	73.0	

TABLE 4. OCCURRENCE OF VAGINAL BAND IN THE THREE STAGES OF SEXUAL MATURITY FOR THE BLUE WHALES

	Band present	Tag present	Band absent	Total
Actual figure				
Immature	1[a]	—	1[a]	2
Prepubertal	1[b]	—	4[c]	5
Multiparous	—	—	7[a]	7
Total	2	—	12	14

Remarks: a) Northern whale, b) Southern whale,
c) One southern whale and three northern whales.

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Prepubertal stage

There were the individuals of which tag was observed in the prepubertal stage. Of 59 prepubertal northern fin whales, two (3.6 %) possessed a tag. However, vaginal band was still present in 24 (40.7 %). Mackintosh and Wheeler (1929) also recorded an individual with vaginal band and with enlarged Graafian follicle in the ovary. On the present result, in 22 southern fin whales, three (13.6 %) possessed a tag, and eight (36.4 %) possessed a band in the prepubertal stage. In the

17 northern sei whales, tag was present in four (23.5 %), and two (11.8 %) had still vaginal band. Of five blue whales, there was no individual with tag, but one (20 %) had unbroken band in this stage.

Pubertal stage

I have small data on the examination of the vaginal band in this stage.

Of the total of eight northern fin whales, three (37.5 %) possessed a tag, and there was no individual with band. However, in two southern fin whales, one possessed an unbroken band. Two similar cases were recorded in the southern fin whales by Mackintosh and Wheeler (1929) and Wheeler (1930). One northern sei whale has no sign of vaginal band.

First pregnant stage

It is worth notice that there are individuals with unbroken vaginal band, although they are pregnant. In 29 northern fin whales of the first pregnant stage, three (10.3 %) still possessed unbroken vaginal band. Biological data of the three individuals are shown in Table 5. Laws (1961) introduced a similar record by D.F. S. Raitt on a pregnant southern fin whales which had an unbroken vaginal band. These results will show that it is probable that the vaginal band does not always rupture at the time of coition. This problem will be discussed in the following chapter.

TABLE 5. BIOLOGICAL DATA OF THE THREE NORTHERN FIN WHALES WHICH WERE FIRST PREGNANT AND WITH UNBROKEN VAGINAL BAND

Serial no.	Body length (feet)	Age (Years)	Corpora no.	Mammary gland		Foetus
				Maturity	Thickness (mm)	
10NKy 154	58	13	1–0, 0–0	Immature	23	♂ 106 cm
10NKy1413	63	14	0–0, 1–1	Immature	19	♀ 246
10NKy1424	64	—	1–0, 0–0	Pubertal	28	♀ 212

In the northern fin whales, eight (27.6 %) were with tag. In 12 northern sei whales, tag was present in six (33.3 %), and there was no individual which has unbroken vaginal band. I have no material on this structure for the southern fin whale and for the blue whale of the first prgnant stage.

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Multiparous stage

In this stage, the individual with unbroken vaginal band did not occur, but there were the whales with tag.

Of 137 northern fin whales, 38 (27.7 %) possessed a tag. According to Mackintosh and Wheeler, in the total of 206 mature southern fin whales, the tag was observed in 14 (6.8 %). This frequency occurrence seems to be low, because they described that not all these whales had been examined on this structure. Furthermore, in the present paper, the disappearance of tag according to age will be examined, and the result will show that the rate of disappearance is not so much.

In 148 northern sei whales, 40 (27.0%) possessed a tag. On the other hand, Matthews (1938) reported that a tag had been present in three (5.4%) out of 52 adult southern sei whales.

Seven northern blue whales in this stage were examined on this structure, and all individuals were absent in the vaginal band or tag.

RUPTURE OF VAGINAL BAND AND ITS BIOLOGICAL MEANING

In the previous chapter, the occurrence of vaginal band and tag was shown in each stage of sexual maturity of whales. The occurrence of unbroken band and tag changes according to the development of the stage. I want to discuss on the rupture of the band and its meaning in the sexual behavior and physiology of the whale in the present chapter.

TABLE 6. RATIO OCCURRENCE OF VAGINAL BAND AND TAG IN THE FIVE STAGES OF SEXUAL MATURITY, INCLUDING ALL WHALES EXAMINED

	Band	Tag	Total	Whales examined	Per cent of band and tag to whales examined
Actual no.					
Immature	59	—	59	150	
Prepubertal	35	9	44	103	
Pubertal	1	4	5	11	
First pregnant	3	14	17	47	
Multiparous	—	79	79	296	
Total	98	106	204	607	
Per cent					
Immature	100.0	0.0			39.3
Prepubertal	74.3	25.7			42.7
Pubertal	20.0	80.0			45.4
First pregnant	21.4	78.6			36.2
Multiparous	0.0	100.0			26.6

Table 6 shows the ratios of vaginal band and the tag in the five stages of sexual maturity summarizing the all materials of the three species. In the immature stage, there were 59 females with unbroken vaginal band, but there was no whales with tag. It is considerable from this result that the vaginal band is not broken in this stage, and then copulation will be not took place in this stage. Brown and Norris (1956) observed some sexual play of a infant bottlenose dolphin (*Tursiops truncatus*). However, it is doubtful that a young whale female really coputates or breaks its vaginal band by the sexual play.

Tag appears in the prepubertal stage (26%). This fact will mean that there is a possibility of experience of copulation or sexual play on at least one fourth of whales in this stage, for it can not be considered that the vaginal band cuts off without the result of copulation, considering with the behavior of Balaenopterids. If so, the ovulation will not be related with the stimulus by copulation in these whales, because the experience of ovulation must not be recognized in this stage.

The number of whales examined was small on the pubertal stage. But the percentage of tags increases in this stage (80%), and it is almost the same as that of the first pregnant stage. From this fact, it is estimated that the female whale becomes to copulate commonly in the pubertal stage. There was one fin whale with unbroken vaginal band. However, we cannot regard this whale as an unexperience of copulation, for some of the first pregnant whales have unbroken band, although they obviously have experiences of copulation.

TABLE 7. OCCURRENCE OF VAGINAL BAND AND TAG ACCORDING TO CORPORA NUMBER FOR THE NORTHERN FIN WHALES

No. of corpora	Band	Tag	Absent	Total
0	59	2	82	143
1– 2	3	18	38	59
3– 4	—	12	21	33
5– 6	—	6	18	24
7– 8	—	4	15	19
9–10	—	2	3	5
11–12	—	4	9	13
13–14	—	2	8	10
15–16	—	—	3	3
17–18	—	1	3	4
19–20	—	—	2	2
21–22	—	—	—	—
23–	—	—	2	2
Total	62	51	204	317

TABLE 8. OCCURRENCE OF VAGINAL BAND AND TAG ACCORDIND TO CORPORA NUMBER FOR THE NORTHERN SEI WHALES

No. of corpora	Band	Tag	Absent	Total
0	8	4	27	39
1– 2	—	10	20	30
3– 4	—	9	26	35
5– 6	—	8	21	29
7– 8	—	4	18	22
9–10	—	7	7	14
11–12	—	3	12	15
13–14	—	2	5	7
15–16	—	2	6	8
17–18	—	1	2	3
19–20	—	—	1	1
21–22	—	—	1	1
Total	8	50	146*	204

* : Excluded two whales which are multiparous but lost one ovary.

It is very interesting that three fin whales which were first pregnant and had unbroken vaginal band were found. Concerning on this fact, the duration of copulation in the whale is considered to be generally very short. According to the observation in aquariums, (Brown and Norris, 1966; Tavolga and Essapian, 1961), the bottlenose dolphin (*Tursiops truncatus*) lasted only at most ten seconds in copula-

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tion. Brown and Norris showed a figure of copulation of the dolphin, and Tavolga and Essapian took some photographs of the same behavior. These figures show that only tip or half of the penis inserted in the vulva. Considering from these observations, it will be convinced that the fertilization can succeed in without the break of vaginal band in the whales.

Primiparous and multiparous whales have no unbroken vaginal band. This means that at the time of parturition the all bands break off.

The percentage of existence of band or tag in the multiparous whales is clearly lower than the whales of other stages. This lets us consider that the tag of vaginal band gradually absorves accompanying with the time after rupture. Then, I calculated the ratios of band and tag in each age classes. As the age class, I used the number of corpora lutea and corpora albicantia in the ovaries of the examined whale.

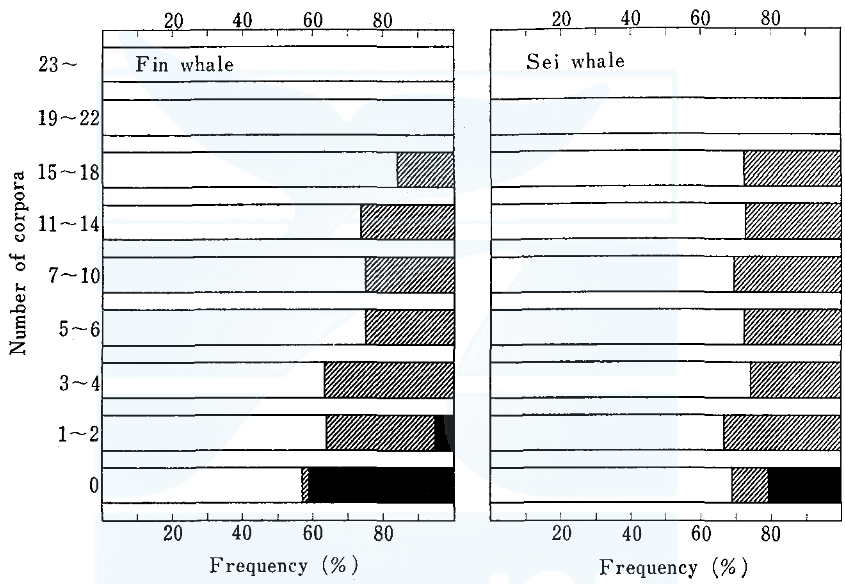

Fig. 1. Change in percentage of frequency occurrence of the female fin and sei whales with vaginal band, tag and band absent accompanying with the increment of corpora number.
Black: Band present, Stripe: Tag present, Blank: Band or tag absent.

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Tables 7 and 8 show the number of whales with band, tag and without band in several are classes. And Fig. 1 shows the change of ratio of band and tag to the total whales examined in each age classes accompanying with the increment of corpora number on the fin and sei whales. The frequency occurrence of band and tag tends to decrease with the increase of corpora number. This tendency is more clear in the fin whale than in the sei whale. Although there are relatively few materials on the whales which have many corpora in the ovaries, the tag was not observed for the whales with 19 corpora and over.

This result will confirm that the vaginal band gradually absorves after its rupture. However, it seems to take long time by the complete absorption of tag, considering the rate of increment of corpora in the ovaries. The annual rate of increment of corpora number is 1.43 according to Laws (1962) and 0.5 according to Ohsumi (1964).

FREQUENCY OCCURRENCE OF VAGINAL BAND AND DISCUSSION

We can recognize from above chapters that the tag represents the remain of the vaginal band, and the tag gradually disappears in the multiparous stage. Therefore, the multiparous whales should not be used to get the true frequency occurrence of vaginal band in the whales.

In this point of view, I calculated the frequency occurrence of vaginal band (unbroken band plus tag) for each whale populations summing up the immature, prepubertal, pubertal and the first pregnant stages as shown in Table 9. The confidence intervals of 90 per cent are also calculated based on the materials. The figures are also shown in the same Table.

TABLE 9. COMPARISON OF FREQUENCY OCCURRENCE OF VAGINAL BAND AMONG THE THREE SPECIES OF *BALAENOPTERA* IN SUM OF IMMATURE, PREPUBERTAL, PUBERTAL AND FIRST PREGNANCY STAGES

Species	Locality	Band or tag present		Band absent		Total
		No. of whales	Per cent	No. of whales	Per cent	
Fin whale	Northern Hem.	75	41.7	105	58.3	180
	Southern Hem.	30	45.5	36	54.5	66
Sei whale	Northern Hem.	18	31.0	40	69.0	58
Blue whale	Northern and Southern Hem.	2	27.6	5	72.4	7
90% confidence interval of per cent frequency						
Fin whale	Northern Hem.	35.7–47.7		52.3–64.3		
	Southern Hem.	35.9–55.6		44.4–64.1		
Sei whale	Northern Hem.	22.4–41.7		58.3–77.6		
Blue whale	Northern and Southern Hem.	11.1–45.0		55.0–88.9		

The highest frequency occurrence of the vaginal band is 45.5 % in the southern fin whale, and the lowest is 27.6 % in the blue whale. However, 90 per cent confidence intervals of the frequency occurrence overlap each other among the four populations. Using chi-square test, under 5 per cent of significant level, the equality of frequencies was not able to be denyed.

In conclusion, the vaginal band will occure in from a quater to a half of the female Balaenopterid whales. It is important to examine the vaginal band for the foetal stage, but I have yet few materials on this stage. It is relatively difficult to examine the vaginal band on the small foetus in the field, and I think it is better to examine the band after fixation with formallin in such cases.

It is obvious that there are vaginal band in other baleen whales, but the frequency occurrence have not yet obtained because of scarcity of the materials.

I have no report on the occurrence of vaginal band for the toothed whales. I have investigated the vaginal band on several toothed whales (Sperm whale, *Physeter catodon*; Bairde's beaked whale, *Barardius bairdi*; Bottlenosed dolphin, *Tursiops gilli*), but I have not yet found the vaginal band or its tag.

SUMMARY

1. Vaginal band occures in the fin, sei and blue whales. The frequency occurrence of it before the rupture is calculated as follows:

North Pacific fin whale:	41.7±6.0 %
Antarctic fin whale:	45.5±10.1 %
North Pacific sei whale:	31.0±10.7 %
North Pacific and Antarctic blue whale:	27.6±17.4 %

2. In the immature stage, vaginal band does not rupture, but after prepubertal stage its tag becomes to be present.

3. There is a posibility of experience of copulation or sexual play in the prepubertal and pubertal stages at least in the case of Balaenopterid whales.

4. Vaginal band does not always rupture in copulation, for there were three cases in which the first pregnant fin whales had unbroken vaginal band.

5. Vaginal band disappears gradually after the rupture, but it takes long time by the complete absorption.

6. There have been no record on the occurrence of vaginal band for the toothed whales.

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MORPHOLOGICAL CHARACTERISTICS AND MYELINIZATION OF ACOUSTIC SYSTEM IN THE DOLPHINS (*STENELLA CAERULEOALBA*)

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The acoustic system in the cetacean brain is more developed than the other common mammals. Since ancient times, it has been well known that the cetaceans possess a remarkably fine sense of hearing. Anatomically, Spitzka (1880, 1886) was the first investigator who had noticed this characteristic that the whales, dolphins and porpoises have the largest auditory nerves in the animal kingdom. Hatschek and Schlesinger (1902) described the same characteristic of the brain stem in a *Dolphines*. Hofmann (1908) and Valeton (1908) investigated the brain of adult dolphins, the former observed especially the superior olivary nucleus, while the latter did also the inferior colliculus. In view of developmental neuroanatomy, Langworthy (1932) dealt with the brain of *Tursiops truncatus* and appraised its acoustic system as high grade of development. Ogawa and Arifuku (1948) referred to aforecited works and pointed out that the comparative study of this system between *Odontoceti* and *Mystacoceti* had never been done. Therefore myelinization of the acoustic system in the cetacean brains was studied by Ogawa and Arifuku. This work is very important for the comparative and developmental anatomy of the acoustic system. Recently Morgane and McFarland (1965) represented the neuroanatomical correlates of functional specializations in the dolphin (*Tursiops truncatus*), however no study as for the developmental neuroanatomy was performed.

The authors were much interested in the striking development of the acoustic nerve and its tract of the brain stem in the dolphins. For the past years one of the authors, Kamiya, has collected embryos of the dolphins (*Stenella caeruleoalba* Meyen) which came from Kawana, Shizuoka Prefecture.

Myelinization during the course of embryonal development is observed on these materials in order to make clear the development of the acoustic system. The collection contains such a series of the embryos that their body lengths are 42, 51, 61, 74 and 88.8 cm. Besides the three brains of adult *Stenella caeruleoalba* were provided. All the brain stems were embedded in celloidin and sectioned 30 or 50μ in thickness in frontal series. The sections stained by Weigert-Pal carmin method have been studied microscopically, sketched and photographed. The authors do not intend to go into the details of each internal view here due to the limitation of space, however the representative sections of the adult and embryonal materials are shown in Figs. 3 to 23. Some adult brain stems were disected and observed macroscopically, e.g.

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one of them is shown in Fig. 2. In the following pages the acoustic tract in the adult material will be shown in the first part for reference and myelinization in the embryonal stage will be represented in the next part. Intracranial disposition of the brain stem was shown already in the preceding report (Hosokawa and Kamiya 1965).

Acoustic system of the brain stem in the adult *Stenella Caeruleoalba*

The radix of the cochlear nerve enters the ventro-lateral part of the medulla oblongata (Figs. 1, 2 and 12). The pars vestibularis of the n. octavus is found just lateral to the radix cochlearis.

1. *Nucleus cochlearis ventralis* (*ventral cochlear ganglion*): This is large ganglion and subdivided into two parts, one is called the pars ventralis and the other is the pars dorsalis. The former is about 6 mm in width and 9 mm long, the latter lies over the former and is just shifted to cranial. Size of the each part is approximatly the same, but the latter is a little larger than the former. Both of them send forth the nerve fibers towords midline of the medulla oblongata, then most fibers make up the trapezoid body (Figs. 8 to 11). While the some fibers originated from the pars dorsalis run up as far as the level of the rostral border of the facial nucleus, moreover these fibers can be traced up to the homolateral superior olivary nucleus (Fig. 12).

2. *Stria acustica dorsalis* (*Monakow's striae acusticae*): This stria exhibits conspicuous development as compaired with the other mammals; i.e. about 5 mm thick (Fig. 7). It seems that the vast majority of the nerve fibers in the *Monakow*'s striae acusticae are originated from the pars dorsalis of the ventral cochlear ganglion.

3. *Tractus cochlearis intermedialis* (*Held's tract*): The *Held*'s tract consists of several thin bundles, which penetrate into the trigeminal nucleus of spinal tract. They pass through the trigeminal nucleus and the facial nucleus too, after that they enter the dorsal part of the superior olivary nucleus and some fibers crossing the median plane on each side are observed (Figs. 9 and 10). This tract is not seen to hang over the dorsal side of the inferior cerebellar pedunculus in the *Stenella caeruleoalba.*

4. *Corpus trapezoideum* (*trapezoid body*): In ventral view of the brain stem, this comes into our notice through the extremely thin layer of the pyramidal tract in the area about 1 cm between the caudal edge of the pons and the rostral end of the olive (nucleus olivaris accessorius medio-rostralis to be exact). It consists of the fibers come from pars ventralis and dorsalis of ventral cochlear ganglion (Figs. 9 and 10). These fibers contain the dispersed nerve cells and certain nucleus, i.e. the nucleus corporis trapezoidei. The caudal part of the trapezoid body is constituted with the majority of fibers come from the pars ventralis of the ventral cochlear ganglion and some from the pars dorsalis, but the rostral division of the body accepts fibers from the both parts.

5. *Nucleus corporis trapezoidei*: The nucleus is placed near the midline within the trapezoid body. The nerve cells are widly dispersed among the nerve fibers of the trapezoid body (Figs. 9 to 13). However they tend to accumulate near the

trapezoid body, consequently they make up a large cellular mass so-called trapezoid nucleus. The nucleus is penetrated with transvers fibers which run crossing the median plane on each side. The nucleus extends up to the level of the rostral end of the superior olivary nucleus (Fig. 16).

6. *Nucleus preolivaris lateralis*: This is found ventro-lateral to the superior olivary nucleus in the cross sections. The preolivary nucleus is located at the level where the radix of the facial nerve emerges from the medulla oblongata (Fig. 11). The nucleus contains such the nerve cells as similar to the cells in the nucleus corpris trapezoidei in shape. At the higher level nucleus corporis trapezoidei is replaced by the other nerve cells, but these cells are dispersed widly among the myelinated nerve fibers in such a manner as the elements in the nucleus pontis, therefore the nucleus preolivaris medialis dose not represent itself as a clear-cut nucleus.

7. *Nucleus olivaris superior*: This nucleus is very large in proportion to the size of the trapezoid body and has place near the facial nucleus (Figs. 9, 10 and 11). Comparing with Primates the location of the superior olivary nucleus in the dolphins is shown more medial. The fibers arising from this nucleus are traced up to inside of the nucleus lemniscus lateralis.

8. *Lemniscus lateralis*: In the cross sections of the pons through the cranial level, the largest tract which attracts our attention is the lateral lemniscus. This tract involved a large cellular mass namely the nucleus lemniscus lateralis and some accessory nuclei on its way to the inferior colliculus. The lemniscus is divided into two main tracts by these nuclei. One in lateral side to the nuclei is made with fibers come from the trapezoid body, the other is medial and consists of the tracts which come from the superior olive and others. In the lateral lemniscus are seen cellular masses which seem to give rise to commissural fibers that pass medially and cross the midline.

9. *Nucleus lemniscus lateralis*: It appears as conspicuous cell clusters in the lemniscus lateralis (Figs. 13 to 17). Shape of this large nucleus is oval and its long axis runs in parallel with the lemniscus. Traced up, the fibers from this nucleus is seen to pass upwards as the lemniscus and to enter the inferior colliculus.

10. *Nucleus lemniscus lateralis accessorius dorsalis*: The nerve cells representing strong carminophilic cytoplasma are found rostro-dorsal to the nucleus of lateral lemniscus (Figs. 14 to 17). This accessory nucleus is embedded in the lemniscus, so then it differs from the nucleus dorsalis lemniscus lateralis in previous reports. Because the latter has characteristic of the central gray matter in the brain stem and it should be observed as segregated nucleus from the main nucleus of lateral lemniscus. This accessory nucleus is seen to connect with the nucleus of lateral lemniscus in some sections, even though stainability of the cells differs from the latter one (Fig. 17).

11. *Nucleus lemniscus lateralis accessorius medialis*: Strong carminophils and the size of the nerve cells in this nucleus are similar to those of the cells in the nucleus of the lemniscus lateralis accessorius dorsalis. Both of them are embedded in the lateral lemiscus (Figs. 13 to 16).

12. *Colliculus inferior*: It is found as a large spherical mass which is twice as large as the superior colliculus in diameter (Figs. 16 and 17). The lateral lemniscus is entering the ventral part of the colliculus and sends great quantities of fibers into it. The commissura colliculi inferior is well developed and many fibers from the cells of the colliculus appear upon its lateral surface as the brachium of the inferior colliculus (Fig. 17).

13. *Brachium colliculi inferior*: From the inferior colliculus fibers pass laterally to form a broad band on the outer surface. This very thick band is the brachium of the inferior colliculus and it runs forward to the medial geniculate body (Figs. 17 and 18).

14. *Some peculiar nuclei except the acoustic system*: In ventral view of the medulla oblongata in dolphins the prominent olivary eminence is seen apparently, this mass consists of the nucleus olivaris accessorius medialis and a few nerve fibers. The atrophied feature of the nucleus of inferior olive is showed in these materials as well as in *Lagenorhynchus obliquidens*. Strictly speaking, this accessory nucleus may be divided into two parts (Fig. 3). The authors will call them the nucleus olivaris inferior accessorius medio-ventralis and medio-dorsalis, which will be discussed later on. The medio-ventral one is very large nucleus about 1.5 cm in orocaudal length in adult and the other one is found dorsal and just caudal to the former at the level of the lower hypoglossal radix. The medio-dorsal one has a hilus directed towards the midline and its carminophils is stronger than the other. They are divided into each other by myelinated nerve fibers and both nuclei can be seen at once in some sections (Fig. 3). Development of the pons in the dolphins is commonly very poor, though the corpus pontobulbare (*Essick*) is very well developed in these materials. Other peculiar nuclei are the nucleus ellipticus and nucleus interstitialis which show high development compared with the other mammals (Fig. 18).

Myelinization of acoustic system in the embryonal stage

No myelinated nerve fibers are seen in the whole brain of the *Stenella caeruleo-alba* in an embryo of 42 cm body length. Stainability of the acoustic nerve is too faint to be demonstrated. The each fiber of *Monakow*'s striae acusticae, *Held*'s tract and the trapezoid body has not been stained by Weigert-Pal's method yet, neverth-eless these tracts have been well developed so that their courses are recongnizable easily in contrast with the other tracts.

Myelinated fibers of acoustic system appear in a 51 cm long embryo (Figs. 19 to 21). In this stage the sequence of myelination from peripheral tracts reaches the lateral lemniscus though myelination of the lateral lemniscus never comes to perfec-tion. *Monakow*'s striae acusticae and *Held*'s tract are stained most intensely and considerable fibers of the trapezoid body are myelinated too. The fibers between the inferior colliculus and the nucleus of lateral lemniscus are stained very slightly (Fig. 21). In the embryo length of 51 cm, the following tracts have been myelinated also; the fasciculus longitudinalis medialis, tractus tectospinalis, commissura vent-ralis alba and the tractus vestibulo-cerebellaris. The genu of facial nerve and the the other tracts, however, have never been stained at this stage yet (Fig. 20).

In a 61 cm long embryo, the lateral lemniscus is matured but the brachium colliculi inferior and the commissura colliculi inferior are not myelinated. The trigeminal nerve begins to myelinate in this stage, above all the pars minor is dominant over the pars major. The medial lemniscus and the superior cerebellar peduncle are not stained.

An embryo length of 74 cm is examined with great interest (Figs. 22 and 23). The brachium colliculi inferior becomes myelinized at last, accordingly the whole acoustic system up to the medial geniculate body is matured at this stage.

DISCUSSION

Recently the fact that the cetacean react to short radio wavelength was examined and observed (Kellogg and Kohler, 1952; Schevill and Lawrence, 1953; Fraser and Purves, 1954; Reysenbach de Hann, 1957, etc.). Anatomical observation of acoustic system in those animals have been done by many investigators as described in the opening paragraph. Moreover Riese (1936) and Romanes (1945) reported some observation about developmental anatomy of the whale's brains. However aspect of this system in *Stenella caeruleoalba* and its development have never been seen. The authors will make some comments on the previous reports and our observations.

State of telescoping (Miller, 1923) is observed at late embryonal stage in these materials. It seems that this phenomenon precedes the ossification of the skull itself. The dorsal cochlear ganglion is not found as has been in the other whales. The ventral cochlear ganglion is well developed and diveded into two parts in lieu of the absence of the dorsal one. The pars dorsalis of the ventral cochlear ganglion corresponds to the dorsal cochlear ganglion in the human brain, because the fibers of the *Monakow*'s striae acusticae mainly arise from the pars dorsalis. *Held*'s tract shows the peculiar course up to the upper nucleus in these materials. In the brains of human or some mammals, this tract is seen to hang over the dorsal side of the inferior cerebellar peduncle, however this tract of *Stenella caeruleoalba* pass through the trigeminal nucleus and does not hang over the peduncle. The trapezoid body is remarkably large in proportion to the size of the cochlear ganglion and it is seen as if naked bundles due to the extremely thin pyramidal tract. Natural atrophy of the pyramidal tract is understood anatomically, because of the absence of the extremities and their digits. The nerve cells in the trapezoid body are widly dispersed and they show similar size and stainability, therefore the preolivary and lateral preolivary nucleus are analogous to the nucleus of trapezoid body. The dorsal accessory nucleus of the lateral lemniscus is found in these materials. The nerve cells of this nucleus are intensely stained with carmin as well as the neurons of the medial accessory nucleus. Both of them belong to the acoustic system because they are embedded in the lateral lemniscus completely. Strikingly large inferior colliculus is dislocated just lateral and the vermis of cerebellum is hold between them in some parts (Figs. 15 and 23).

Pilleri reported that asymmetrization of the colliculi was found in *Eubalaena* *australis* (1964) and *Balaenoptera borealis* (1966). However the asymmetric construction of the inferior colliculus have never been seen in *Stenella caeruleoalba.*

Concerning the myelinization *Held*'s tract and *Monakow*'s striae acusticae are stained by Weigert-Pal method in a stage of the 51 cm length. The beginning of myelination in this system has been seen in a 45 cm long embryo of *Lissodelphis borealis* (Kamiya, 1962). In a little earliar stage of the 51 cm length of *Stenella caeruleoalba* it seems that the commencement of myelination takes place in the acoustic system. Ogawa and Arifuku (1948) described that *Monakow*'s striae acousticae was well developed in the dolphins, but less prominent in *Kogia breviceps* and the *Held*'s tract is highly developed both in dolphins and other toothed whales. The trapezoid body and the cochlear nerve take their myelin sheath at the same embryonal stage in the pigs, but this phenomenon is not so important. The problems awaiting solution are when myelination in this system takes place and mature itself. The ripe structure has been shown at an embryo length of 74 cm in this work. In a 70 cm long embryo of *Lagenorhynchus obliquidens* accomplishment of myelinization in acoustic system observed by Kamiya (1962). The systems of optic nerve and vestibular nerve are developed around the stage of myelination of acoustic nerve in these materials. The study on the development of the eye was reported in detail by Pillery (1964), however it is difficult to compare his observation with our data because of the difference in materials, e.g. sei whales and dolphins.

Peculiar development of the inferior olive have been noticed by a number of neuroanatomists; Williams, Kooy, Brunner, Kappers, Kuskens, Tsuru, etc. Hatschek and Schlesinger described the mediodorsal accessory olivary nucleus, as the chief nucleus of the olive. The authors insist that the medio-dorsal accessory olivary nucleus essentially differs from the medio-ventral one though both of them are found medial to the radix of the hypoglossal nerve. Because the nerve cells of the former are stained with carmin more stronger than those of the latter and myelination of the nerve fibers in the former is a little faster than the other in embryo. Making an additional remark, the authors are interested in the small size of the nucleus ambiguus in these materials, while it is shown that very large nucleus in *Balaenoptera borealis* (Hosokawa, 1950).

SUMMARY

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This work has been studied with the myelination method in embryo (*Flechsig*) in order to make clear the embryonal development of the acoustic system in *Stenella caeruleoalba*. The brain stem was prepared into serial sections and stained by the Weigert-Pal carmin method. Microscopic study of the sections revealed that there were many remarkable differences in the development of various internal structures, therefore the representative sections of adult materials are showed and explained.

In an embryo of 51 cm body length myelinated fibers of the acoustic system appear and its myelination reaches up to the lateral lemniscus. The whole acustic system as far as the medial geniculate body is myelinated completly in an embryo length of 74 cm. Development of this system is considerable fast in view of its

myelinization. However it seems that the rate of its development tends to retard a very little.

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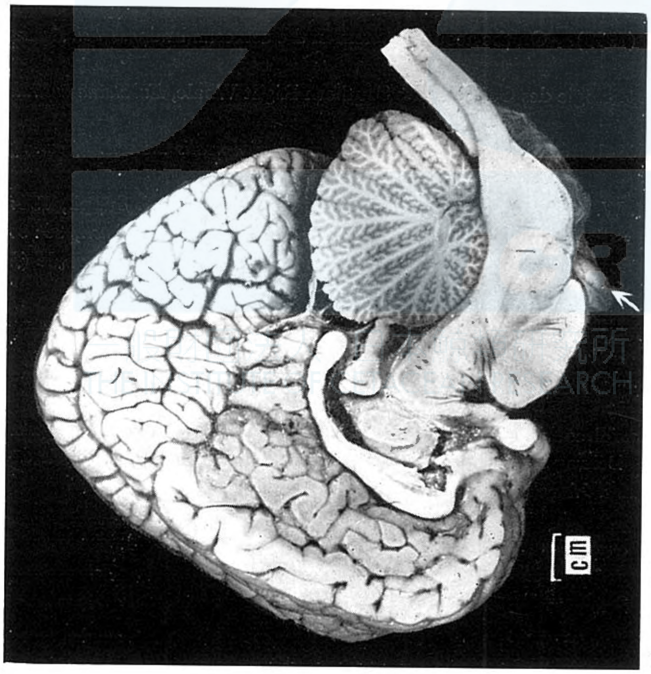

Fig. 1. Median section of the brain of the adult *Stenella caeruleoalba*. Arrow indicates the cochlear nerve.

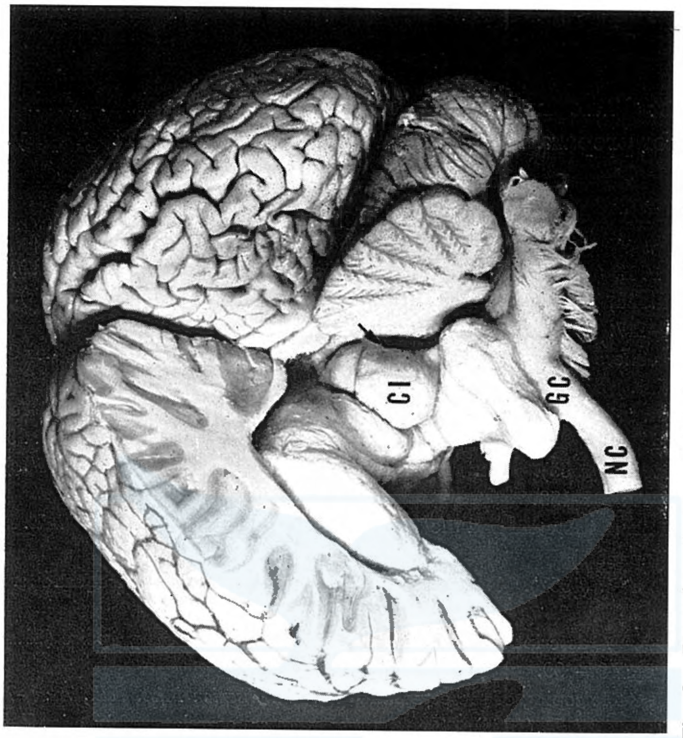

Fig. 2. Dorso-lateral view of the brain stem, the left hemisphere of the cerebellum was removed.
NC: Cochlear nerve, GC: Ventral cochlear ganglion,
CI: Inferior colliculus, Arrow: Commissure of the inferior colliculus.

Fig. 3. Section of medulla through the caudal end of the inferior olivary nucleus.

Fig. 4. Section of medulla through the middle of the inferior olivary nucleus.

Fig. 5. Section of medulla through at the rostal portion of the inferior olivary nucleus.

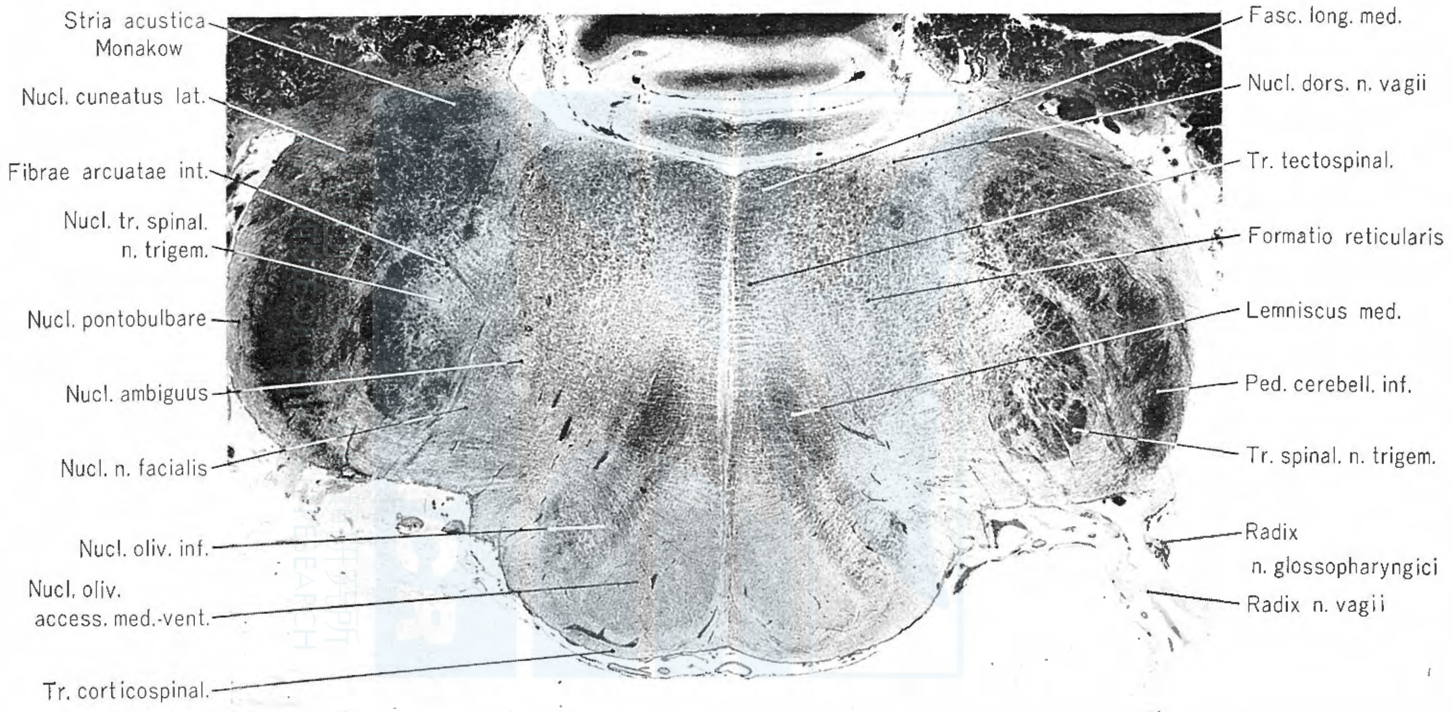

Fig. 6. Section through the rostral portion of medulla at the exit of glossopharyngeal nerves.

Fig. 7. Section through the medulla at the exit of the Monakow's striae acusticae.

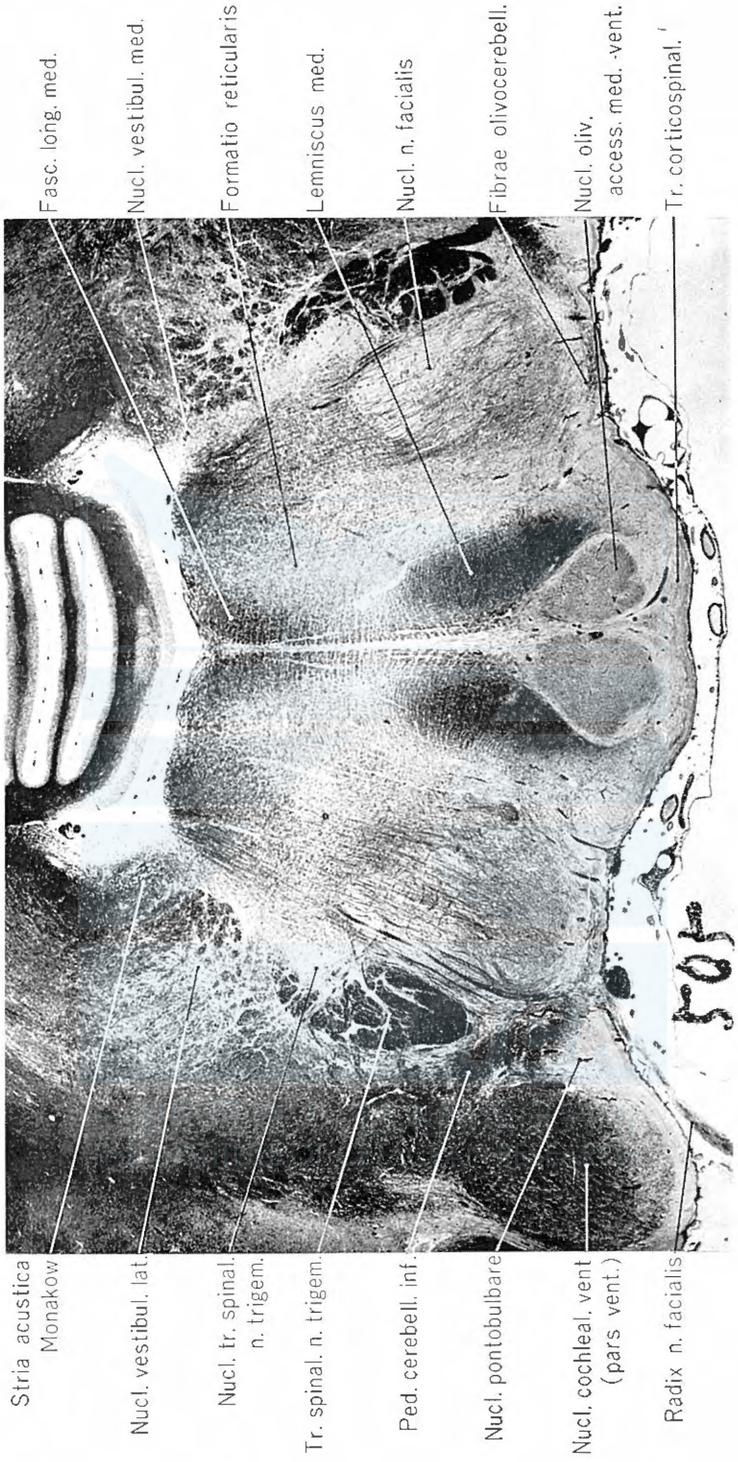

Fig. 8. Section of medulla at the ventral cochlear ganglion.

Fig. 9. Section through the caudal end of trapezoid body.

Fig. 10. Section through the caudal portion of trapezoid body at the level of the facial nucleus.

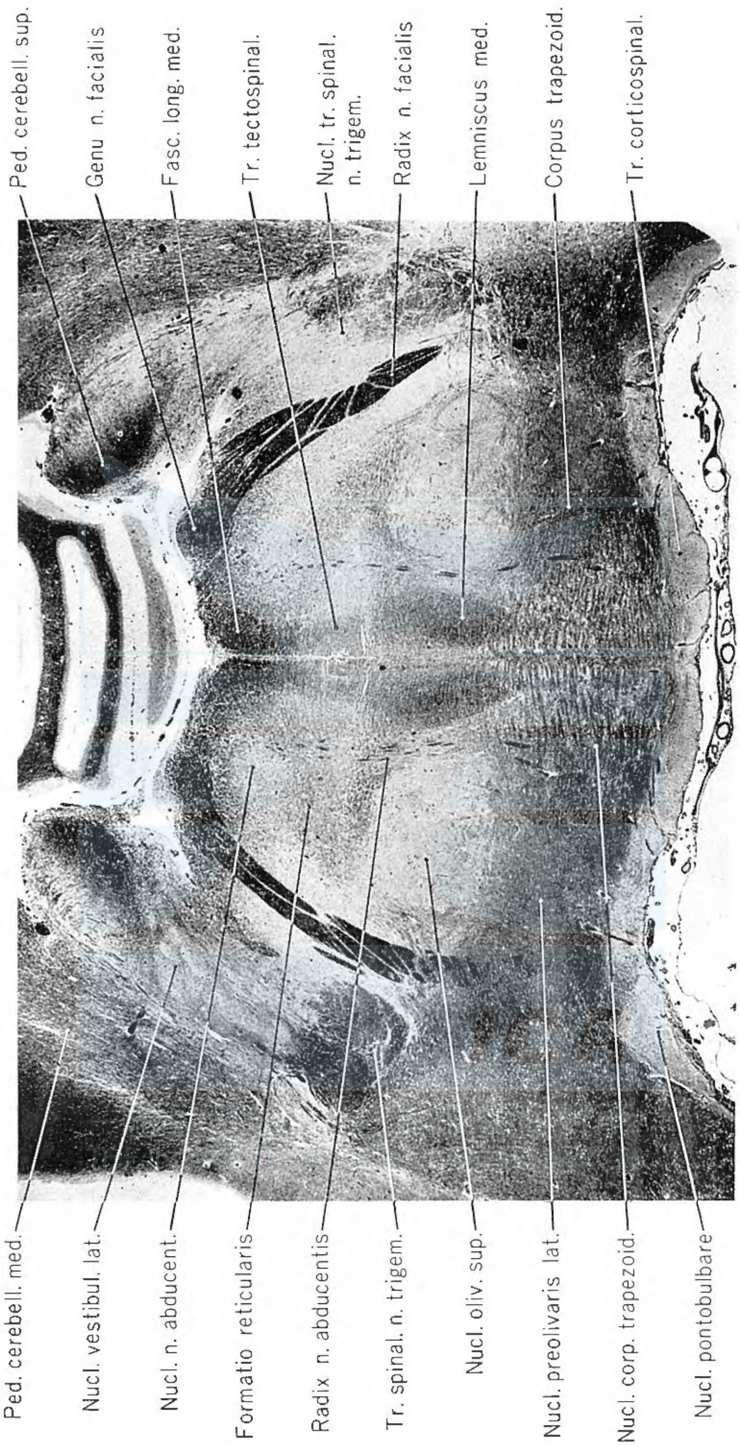

Fig. 11. Section through the middle of trapezoid body at the level of genu of the facial nerve.

Fig. 12. Section through the cranial end of trapezoid body at the exit of radix of the facial nerve.

Fig. 13. Section through the caudal end of pons.

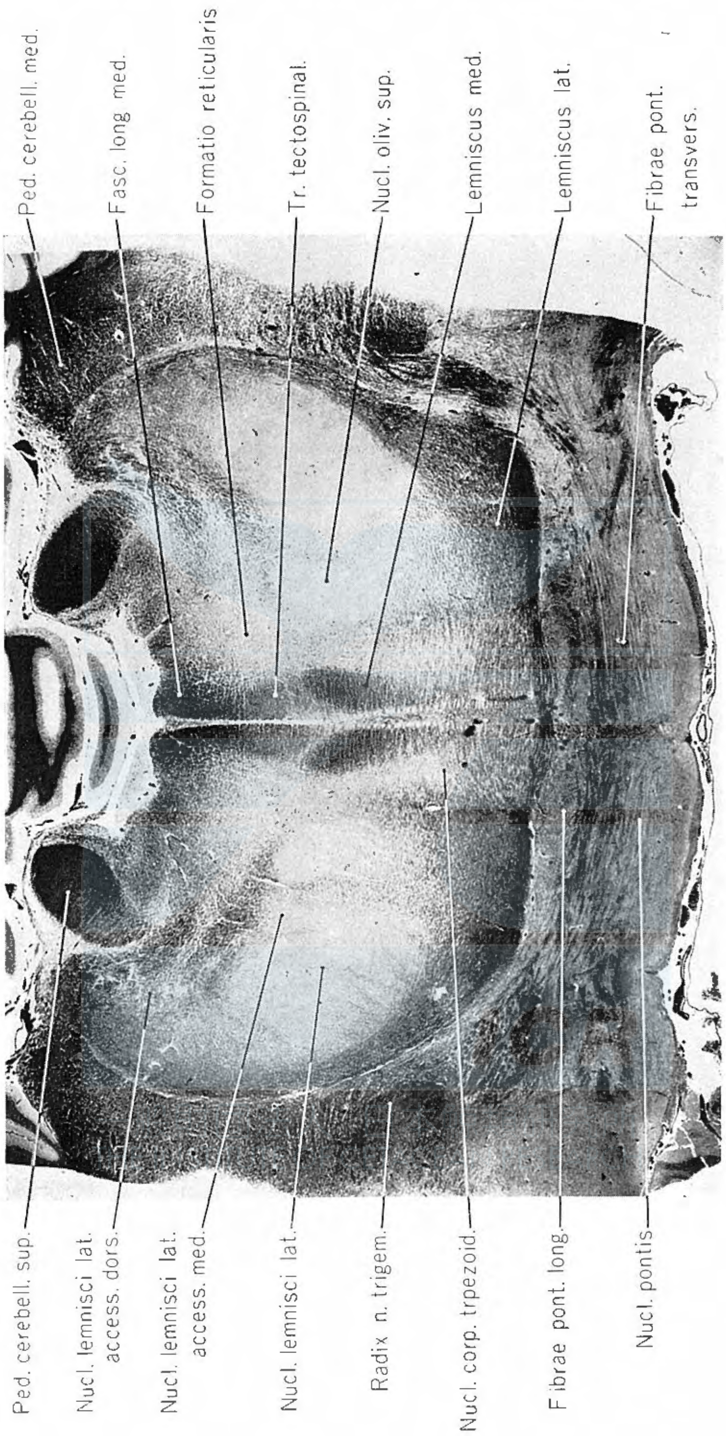

Fig. 14. Section through the middle of pons.

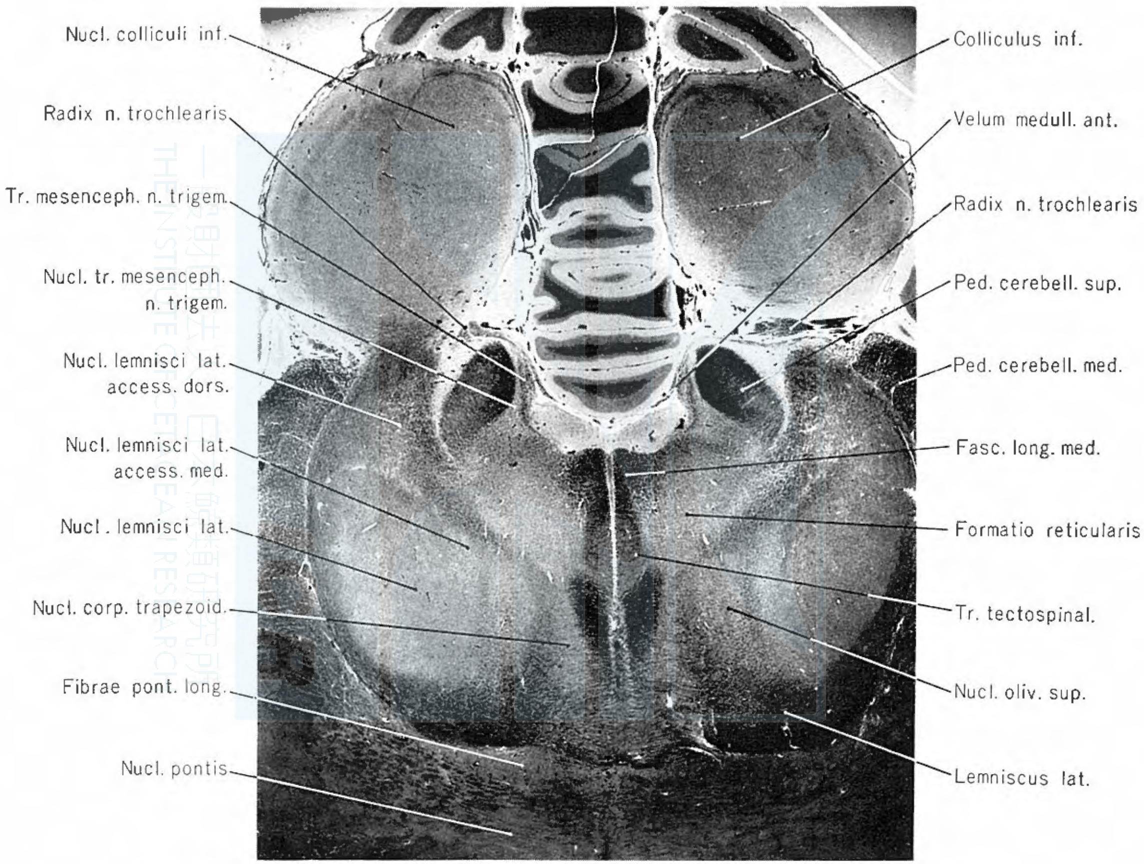

Fig. 15. Section through the inferior colliculus at the exit of radix of the trochlear nerve.

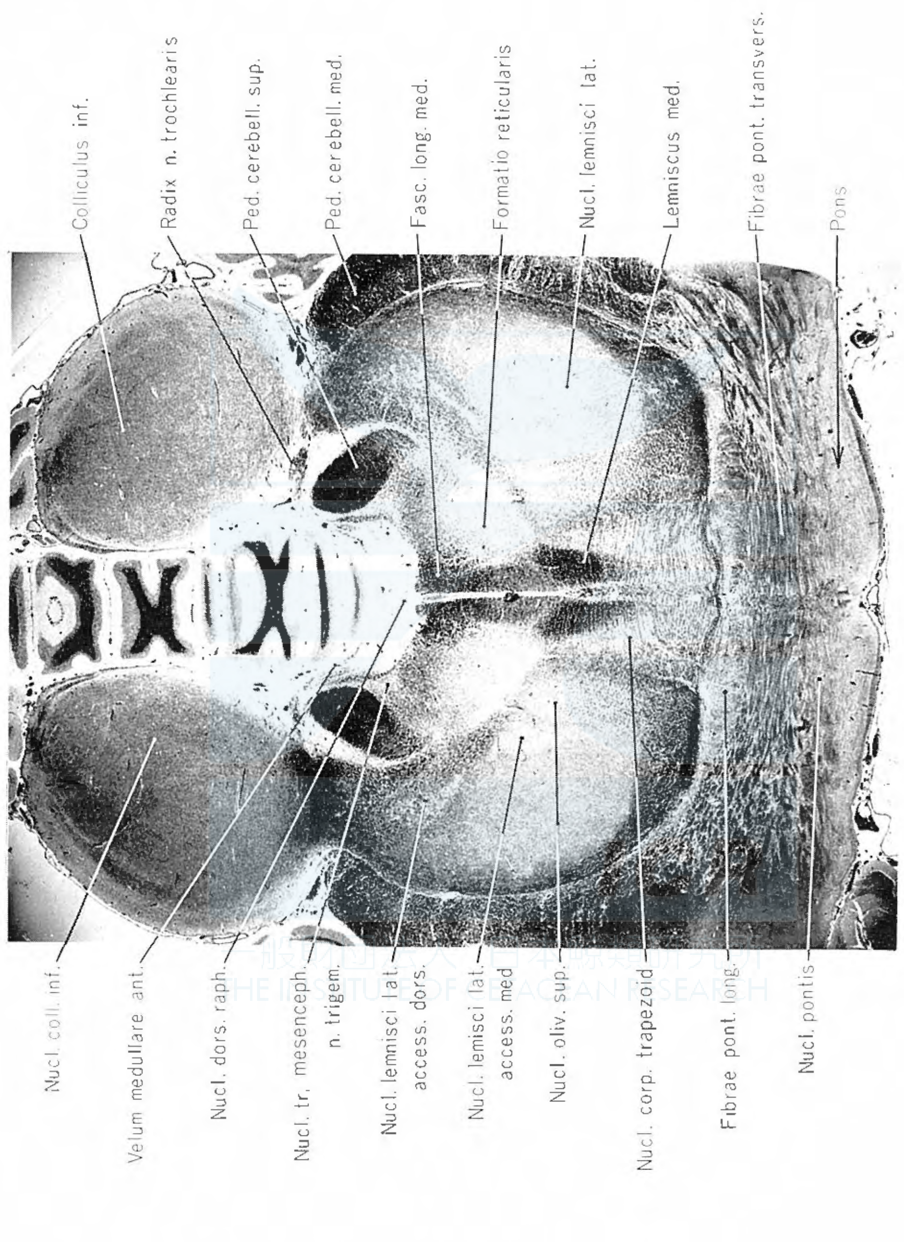

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Fig. 16. Section through the middle of inferior colliculus.

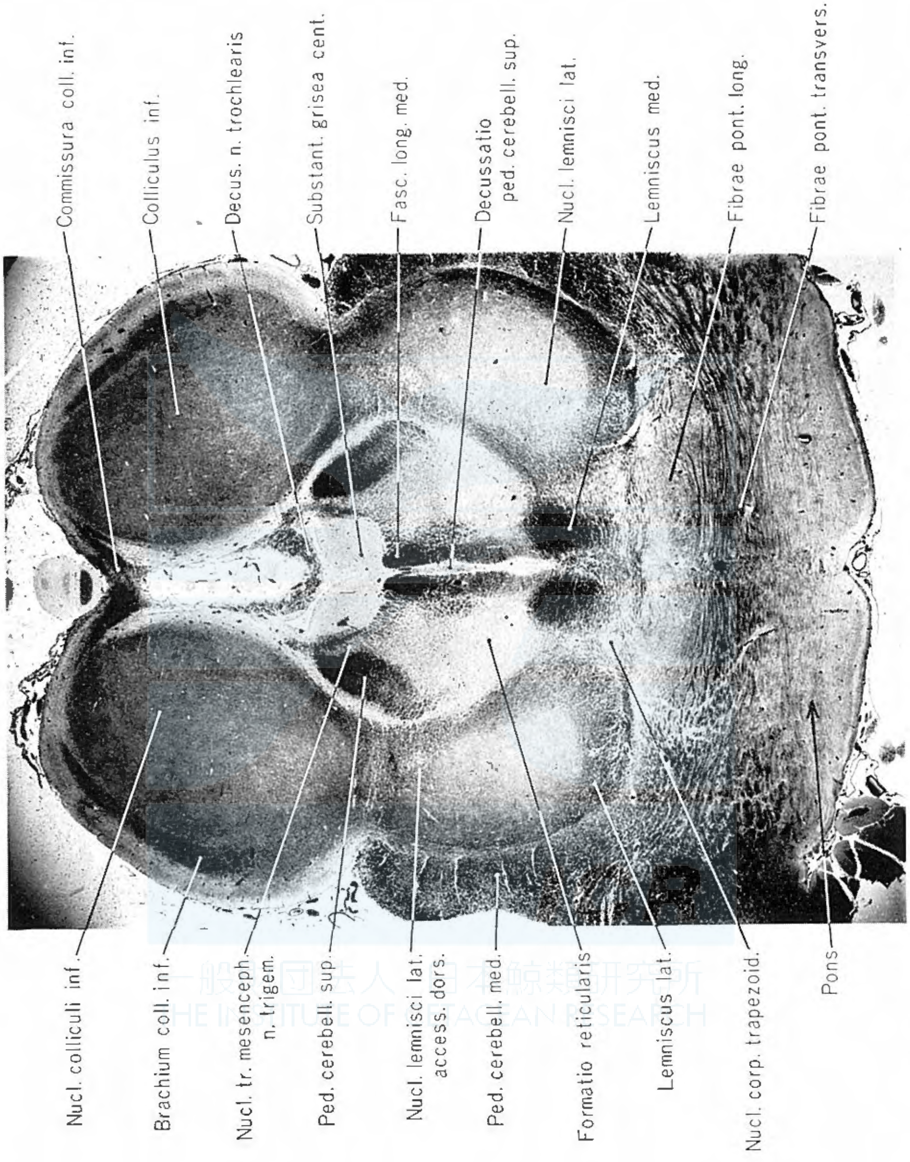

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Fig. 17. Section through the middle of inferior colliculus at the level of commissure of inferior colliculus.

Fig. 18. Section through the superior colliculus, brachium of the inferior colliculus, nucleus of ellipticus, interstitial nucleus and optic tract.
* Fasciculus retroflexus (Meynerti).

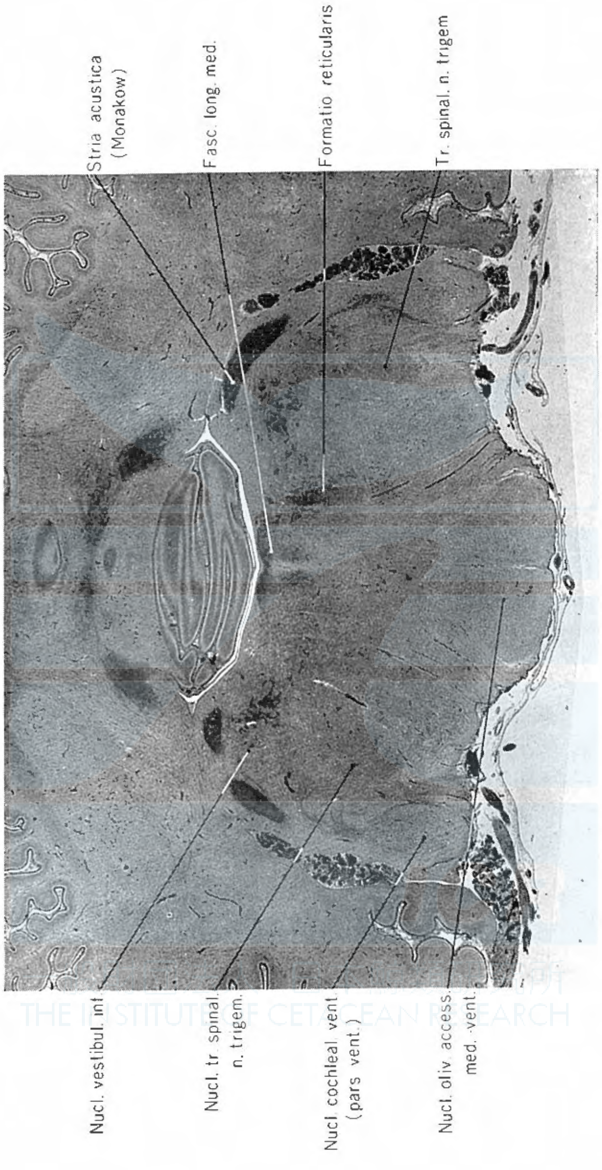

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Fig. 19. Section of medulla in embryo 51 cm long, at the exit of the Monakow's striae acusticae.

Fig. 20. Section of medulla in embryo 51 cm long, at the level of the trapezoid body and cochlear nerve.

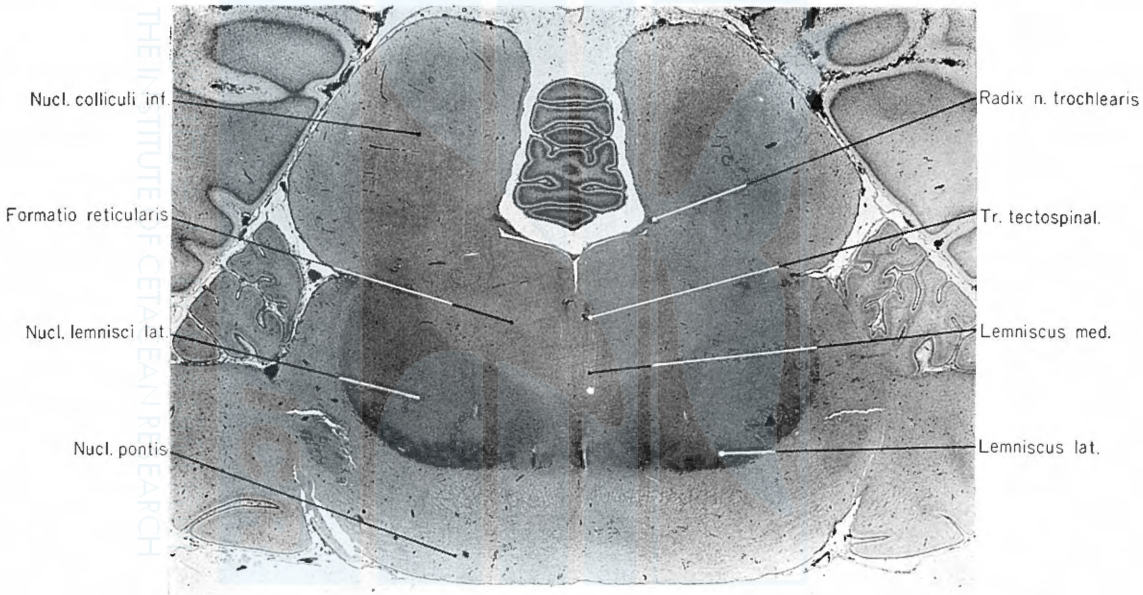

Fig. 21. Section of the midbrain in embryo 51 cm long, at the exit of the radix of trochlear nerve.

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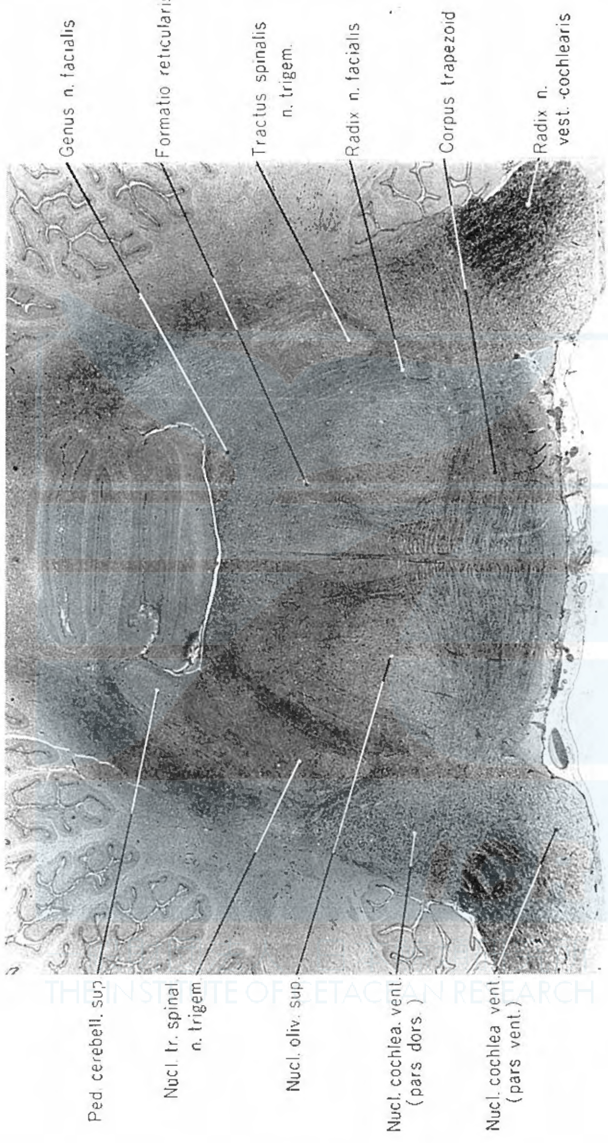

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Fig. 22. Section of medulla in embryo 74 cm long, at the level of the trapezoid body and radix of cochlear nerve.

Fig. 23. Section of medulla in embryo 74 cm long, at the level of the nucleus of lateral lemniscus.

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A SHORT CONTRIBUTION TO THE HISTORY OF WHALING IN JAPAN DURING THE 17TH CENTURY

BY
THIJS MOL & P.J.H. VAN BREE

By the publications of Möbius (1893), Andrews (1916), Omura *et al.* (1953), Budker (1957) and Slijper (1958) it has become known to the Western world that whaling and the whaling industry in Japan have an ancient history. In fact, this is not surprising as this is the case in so many other archipelagoes and coastal localities. There are world-wide discoveries of whale and dolphin remains in refuse heaps of prehistoric settlements indicating clearly that the animals were already at those times important as sources of food.

Nevertheless, it is interesting to note that long prior to the books and articles cited above, reports in Europe have been made of whale hunting by the inhabitants of Japan. In 1646 there was published a Dutch book about twelve voyages to the Far East. One part deals with the expedition of " upper-merchant " Hendrick Hagenaar, who started his trip in 1631 and returned safely in 1638. In several places short descriptions are given of whales and whaling in Japan. The book is rare, and reading the old Dutch text is rather difficult, so it is useful to quote here a more or less literal translation of the pertinent paragraphs.

Page 5: " On 26th March 1632, we passed the Tropic of Cancer; we saw a large number of Cachalots or whales, supposing they dreaded a tornado, (we therefore) took in the topsail."

Page 90: " On the 3rd of March 1636, we saw a whaling long-boat get hold of a rather (large) fish (whale) entering into the bay (situated) beyond the settlement. (This one was followed) by nine other vessels, (of) which (the crews) threw a large number of harpoons at the fish (every time) it surfaced until it at last (became) exhausted (and) bled to death; this provided great pleasure."

Page 156: " These revenues, as well as those from the fisheries at sea, were given to the particular Gentlemen of the Majesty (cf local nobility), the same (applies to) whaling; and yearly between 200 and 300 specimens are caught; (they) are not so large as ours, having blubber only 4, 5, 6, or 8 inches thick (but they have) very much meat, which is eaten here."

Much later—in 1786—again a book based on 17th century logbooks was published in the Netherlands. In this second publication (vol. 9, pages 38–39) we find:

" In the beginning of the summer month (cf June), our men saw the return of the Japanese boats, which had been on whale hunt. This hunt starts in the winter month (cf December) and lasts until the mentioned time. During this period they

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caught 274 small and large fishes (whales). The Japanese normally catch them not far away from the strand (coast). When they discover a fish (whale), they shoot it with harpoons and having hit it, they let the animal run (swim) so long that by fatigue or by loss of blood, it floats on the water. Afterwards they tow the fish (whale) to land, pull it up the shore and cut or hew the meat off it, as can be seen on the accompanying illustration."

The caption of the print, which we reproduce herewith, reads " Whaling at Firando, in Japan ". The artists is unknown and almost certainly never visited Japan (e.g., see the clothes of the men in the picture). He was very much inspired by a print made by H. (endrik) Goltzius (1558–1617) of a female Blackfish (*Globicephala melaena*), stranded near Zandvoort, the Netherlands, on 21st November 1594. This small whale is almost exactly reproduced (e.g., the laterally placed blowhole and the swollen mammae), so one is inclined to talk about a ' pirated ' picture. The other whales in the background are similar to the large one in front.*

Van Deinse, the well-known Dutch cetologist (1895–1965), who published extensively on the history of whaling, mentions this ' pirated ' print but does not seem to have consulted the original. In his thesis (1931, page 249) he calls it: " Whaling by the natives of the Dutch East Indies (now Indonesia)."

Although not pertaining specifically to Japanese whaling, there is an important

Fig. 1. Whaling at Firando, Japan. From a Netherlands' book (1786): see text.

* In the period this MS was sent to the editors and reading the proofs, we were informed that a preparatory study of this pirated print, a sepia drawing, is present in the collections of the Koninklijk Oudheidkundig Genootschap in Amsterdam.

17th century book containing a description of whaling in the Far East between 1655 and 1657. This is the Report of the Embassy of the Dutch East India Company to the Emperor of China by Joan Nieuhof published in 1665. On pages 158–160, the author describes both whales and whaling as follows:

" Near the island of Hainan, the Chinese capture whales in the same way as the Dutch in the North near Greenland, whereof they make oil which serves for several uses ".

Next come several paragraphs on the habits of the whales and also on their anatomy and biology. In this section, it is of great interest that the author mentions " sea spiders ", " sea moss " and " fish " as food for baleen-whales. One whale was seen which had 40 codfish in its stomach (? *Balaenoptera borealis*). Furthermore, quite interesting is the description of copulation. It is stated that the whales take up a vertical position in the water and clasp each other with their flippers (see Nishiwaki & Hayashi, 1950, figs. A3–A6); this position is maintained from half an hour to one hour.

On whaling we find: " The capture of whales happens in this way; as soon as they spot a whale at sea, they fall (go down) in a sloop, with a harpooner, that being the one who will strike the fish, in front. Having arrived near the fish, the harpooner shoots (this verb is used in the original text) his harpoon into the whale alongside the head, so that it gets struck. This harpoon is an iron of about three feet long, sharpened in front, provided with barbs and on the rear part a rope or line is fastened of about two hundred fathoms in length, which lays ready in the boat. The fish, having been struck with this iron and feeling itself hurt, darts with great force to the ground (bottom) as the rope is payed out. If it happens that the fish darts deeper than the rope is long, they must let it slip (let the end go); for if the line should be fastened to the boat or should the rope catch during the paying out, the whale would pull the sloop upside down.

Sometimes they fasten to the end of the rope an empty barrel which most of the time floats or returns (to the surface) and which they follow rowing. Sometimes it happens the whale makes off with it and they do not see it again. The fish, tossing about in the deep, becomes after a time powerless, and surfaces, dead or still living, on which the boat again draws near it, and not being dead, they spear it, that means, they stab it, with poles about half as long as lances, which are provided in front with iron points, into the sides, by which they are in danger to be overturned by the whale; for it strikes so fearfully with its tail and flippers, that the sea becomes as white as foam. The fish being dead, the blubber is cut off with long knives and afterwards they boil oil from it. When the blubber is cut off the whales, they let them (the carcasses) drift; whereupon many gulls light on them to scavenge. And so large are these dead bodies and trunks from which the blubber is cut, that from afar they look like living whales."

In the text of the book by Nieuhof only baleen-whales, dolphins, and killer-whales are mentioned; it is therefore rather strange that in the accompanying illustration a Cachalot or Sperm-Whale clearly shows. Our reproduction is taken from the 1665 edition. Later editions such as those of 1670 and 1693 have the added

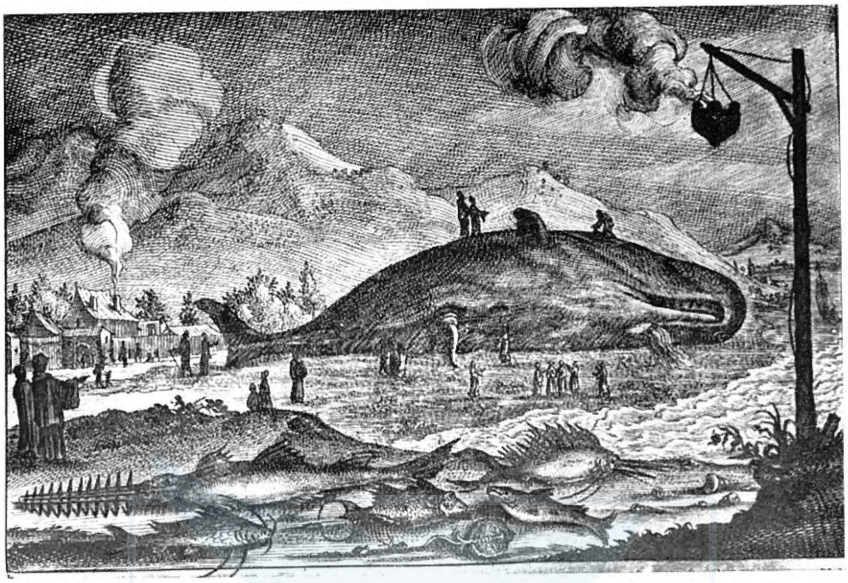

Fig. 2. Whaling at the island of Hainan. After Nieuhof (1665). For particulars see the text of the article.

title " Balene ". Although the men wear Chinese-type clothes, this print is also a ' pirated ' one. The unidentified artist copies almost exactly the etching made by Wenzel Hollar (1607–1677) (see Timm, 1961) and this artist, in turn, copies the copper engraving by Jan P. Saenredam (1565/66–1607; pupil of Goltzius) of a Cachalot stranded near Beverwijk, the Netherlands, on 13th January 1602 (see also Van Deinse, 1931, pages 179+184). On the print representing whaling at the island of Hainan, only the beacon in front is a new added element. We are able to reproduce the figure from the book by Nieuhof thanks to the courtesy of the management of the Netherlands Historical Maritime Museum in Amsterdam; we wish to express our appreciation to the Librarian of this Museum for her help.

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FATTY ACID COMPOSITION OF FINLES PORPOISE OIL*

HIDEO TSUYUKI** AND SHINGO ITOH**

INTRODUCTION

The Finlesp orpoise, *Neomeris phocaenoides*, belongs to the porpoise family and is the smallest of these family. They grow up body length 1.0–1.3 metres and inhabits in the Indian ocean; from the Cape of Good Hope to Japan, and in Japanese water; Setonaikai, Shikoku, Kyūshū. They live on crastacean, cephalopoda and small fishes, and independently are in no group.

The literature on the porpoise oils seems to have been a few, but it has been reported only simple properties of oil.

The writers report here the component fatty acid of Finles porpoise oil that is analyzed by gas-liquid chromatograph using a hydrogen ionization detector.

The writers wish to express here their thanks to President of The Whales Research Institute, Prof. Dr. Hideo Omura who is kind enough to present us Finles porpoise.

MATERIAL AND METHOD

Sample used

The Finles porpoise used in this experiment was caught in October 1963 at the Hashirimizu of Miura-peninsula, Kanagawa Prefecture, Japan. The sample was frozen as a part of the Finles porpoise, and it was male, but it was unknown about age, body length, body weight etc. The oil was extracted by boiling the material with water from the frozen part and the properties were examined by ordinary methods. These are shown in Table 1.

Preparation of fatty acid methyl ester

The sample oil was converted to fatty acid methyl ester by alkali-catalyzed methanolysis and the obtained methyl ester was refined by silicic acid column according to the procedure of Sano *et al.* (1965, 1966) with the following modification.

The sample oil was soluted in 50 ml of *n*-hexane, and also 10 ml of anhydrous methanol and 2 ml of 1/2 N-potassium hydroxide methanol solution as catalyzer were added. Then, the procedure were conducted on magnetic-stirrer in nitrogen atmosphere for 1.5 hours with periodic mixing. After the procedure, half-saturated sodium chloride solution was added, extracted by *n*-hexane and was washed with water and evaporated after adding anhydrous sodium sulfate. As result, crude

* An outline of this article was presented the Annual Meeting of Japanese Socity of Scientific Fisheries, Tokyo, April 3, 1967.

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TABLE 1. PROPERTIES OF FINLES PORPOISE OIL

Appearance (at 30°C)	Yellowish orange liquid
Oil content (%)	62.7
Refractive index (at 40°C)	1.4727
Specific gravity (at 26°C)	0.9435
Viscosity (at 50°C)	0.4970
Acid value	2.7
Iodine value (Wijs)	91.3
Saponification value	208.0
Unsaponifiables (%)	0.80

fatty acid methyl ester was obtained. Then, for the purpose of removal of colesterol, colouring material, impurities etc., the crude methyl ester was once again soluted in 5 ml of *n*-hexane, and passed through in glass column (in diameter 1.0 cm) packed with 2.0 grams of silicic acid activated at 120°C for half an hour. The glass column was washed with 60 ml of 2% ethyl ether-*n*-hexane. The solution extracted by 2% ethyl ether-*n*-hexane was added anhydrous sodium sulfate and then evaporated. The refined methyl ester was obtained in amount of 4.0 grams which was no smell and colourless, and was used in gas-liquid chromatograph analysis.

In addition, all procedures were conducted in nitrogen atmosphere, including release of a vacuum in the evaporating steps.

Gas-liquid chromatograph apparatus and conditions

Gas-liquid chromatograph apparatus used in this experiment was conducted on a dual-column Shimadzu Gas Chromatograph Apparatus, Model GC-IC, using a hydrogen flame ionization detector. A stainless steel, U sharped column, 225 cm long and 3 mm in diameter, was packed with 20% diethylene glycol succinate (DEGS) on Shimalite at 1.85kg/cm^2. The column oven was maintained at 215°C, and the flow rate of nitrogen gas was 72–76ml/min. The injector temperature was 260°C and detector temparature 240°C.

The individual fatty acid peaks were identified by comparing retention time with those in a known mixture of standard fatty acids, and semilogarithmic plots of carbon number *vs* relative retention time were used for identification by method of Nelson *et al.* (1960).

The identification of the unsaturated acids was checked further by hydrogenation over platinum black followed by gas-liquid chromatograph on the same condition.

All fatty acids are reported as weight percentages of the total known fatty acids presented by method of Magidman *et al.* (1962).

RESULTS AND DISCUSSION

The data obtained 26 of fatty acids as shown in Table 2. In these, saturated fatty acids are as follows; C_8, C_{10}, C_{12}, C_{13}, C_{14}, C_{15}, C_{16}, C_{18}, C_{19} and C_{20}, and unsaturated fatty acids are as follows; C_{12} monoenoic, C_{14} monoenoic, C_{14} dienoic, C_{16} monoenoic, C_{16} dienoic, C_{16} trienoic, C_{18} monoenoic, C_{18} dienoic, C_{18} trienoic, C_{20}

TABLE 2. FATTY ACID COMPOSITION OF FINLES PORPOISE OIL

Fatty acid No.	Weight per cent of total fatty acid
8	0.1
10	0.2
12-branched	0.3
12	0.9
12–1	0.7
13	0.2
14-branched	0.4
14	8.4
14–1	4.1
14–2	0.7
15	1.1
16	7.2
16–1	26.9
16–2	1.9
16–3	1.2
18	0.9
18–1	20.4
18–2	2.1
18–3	2.0
19	1.6
20	1.8
20–1	1.4
20–3	1.7
20–4	4.6
22–5	3.9
22–6	5.3

TABLE 3. A COMPARISON OF SATURATED AND UNSATURATED FATTY ACID OF FINLES PORPOISE OIL

Fatty acid No.	Weight per cent of total fatty acid	
	Saturated	Unsaturated
8	0.1	—
10	0.2	—
12	1.2	0.7
13	0.2	—
14	8.8	4.8
15	1.1	—
16	7.2	30.0
18	0.9	24.5
19	1.6	—
20	1.8	7.7
22	—	9.2
Total	23.1	76.9

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monoenoic, C_{20} trienoic, C_{20} tetraenoic, C_{22} pentaenoic and C_{22} hexaenoic. Moreover, there are branched-saturated fatty acids of C_{12} and C_{14}.

In the aspect of percentages of total fatty acids, the prominent fatty acid is C_{16} monoenoic (26.9%), the next prominent is C_{18} monoenoic (20.4%). Other percentages of component fatty acids were in order of high content as follows; saturated C_{14} (8.4%), saturated C_{16} (7.2%), C_{22} hexaenoic (5.3%), C_{20} tetraenoic (4.6%), C_{14} monoenoic (4.1%), C_{22} pentaenoic (3.9%), C_{18} dienoic (2.1%), C_{18} trienoic (2.0%), C_{16} dienoic (1.9%), saturated C_{20} (1.8%), C_{20} trienoic (1.7%), saturated C_{19} (1.6%), C_{20} monoenoic (1.4%), C_{16} trienoic (1.2%), saturated C_{15} (1.1%), saturated C_{12} (0.9%), saturated C_{18} (0.9%), C_{12} monoenoic (0.7%), C_{14} dienoic (0.7%), branched saturated C_{14} (0.4%), branched saturated C_{12} (0.3%), saturated C_{10} (0.2%), saturated C_{13} (0.2%), and saturated C_8 (0.1%).

Viewing in comparison of saturated and unsaturated fatty acids (shown in Table 3), the total of saturated fatty acids is 23.1%, on the other hand, the total of unsaturated fatty acids is 76.9%.

SUMMARY

1) The properties of Finles porpoise oil were studied.

2) Fatty acid composition of Finles porpoise oil was analyzed by gas-liquid chromatograph using a hydrogen ionization detector on a DEGS column.

3) The results obtained are as follows;

Total saturated fatty acids	23.1%:
octanoic	0.1%
decanoic	0.2%
dodecanoic	0.9%
dodecanoic (branched)	0.3%
tridecanoic	0.2%
tetradecanoic	8.4%
tetradecanoic (branched)	0.4%
pentadecanoic	1.1%
hexadecanoic	7.2%
octadecanoic	0.9%
eicosanoic	1.8%
Total unsaturated fatty acids	76.9%:
C_{12} monoenoic	0.7%
C_{14} monoenoic	4.1%
C_{14} dienoic	0.7%
C_{16} monoenoic	26.9%
C_{16} dienoic	1.9%
C_{16} trienoic	1.9%
C_{18} monoenoic	20.4%
C_{18} dienoic	2.1%
C_{18} trienoic	2.0%
C_{20} monoenoic	1.4%
C_{20} trienoic	1.7%

C_{20} tetraenoic	4.6 %
C_{22} pentaenoic	3.9 %
C_{22} hexaenoic	5.3 %

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FATTY ACID COMPOSITION OF MANY TOOTHED PILOT WHALE OIL*

HIDEO TSUYUKI** AND SHINGO ITOH**

The Many toothed pilot whale, *Peponocephala electra*, is a new genus species which was named by Nishiwaki and Norris (1966). It is not now known about the details of ecology and geographical distribution.

The purpose is minute examination of the component fatty acid of the Many toothed pilot whale oil by gas-liquid chromatography using a hydrogen ionization detector.

It is pleasure that the writers express here their sincere thanks to Prof. Dr. M. Nishiwaki who is kind enogh to present us the Many toothed pilot whale oil.

MATERIAL AND METHOD

Sample used

Material is the Many toothed pilot whale which was caught in the Suruga Bay, Shizuoka Prefecture, Japan, on March 23, 1965. The oil was extracted by boiling the material with water and the properties are shown in Table 1.

The methyl ester of the fatty acids was prepared by the procedure of Sano *et al* (1965, 1966) with the following modification.

In the first place, 5.0 grams of the sample oil was soluble in 5 times of *n*-hexane and adding to 10 ml of anhydrous methanol and 2 ml of N/2 potassium hydroxide-methanol solution as catalyzer. After conducting on magnetic stirrer in nitrogen atmosphere at room temperature for 1.5 hours, the reacted solution was also added 50 ml of half-saturated sodium chloride solution. Then, crude methyl ester of fatty acids was extracted by 20 ml *n*-hexane for several times, and evaporated the solution in nitrogen atmosphere, including release of a vacuum. The next, in order to refine the crude methyl ester, it was soluted in 2 times of *n*-hexane and passed through in glass column of 2 cm diameter packed with 2.0 grams of silicic acid activated at 120°C for 1 hour. Also, column was flowed with 60 ml of ethyl ether-*n*-hexane (1:50). The obtained solution was evaporated in nitrogen atmosphere releasing vacuum, after the dehydration by anhydrous sodium sulfate. After all, it was obtained that 3.8 grams of refined methyl ester was no smell and colourless.

Gas-liquid chromatograph conditions

The methyl ester of fatty acids obtained from the Many toothed pilot whale

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TABLE 1. PROPERTIES OF MANY TOOTHED PILOT WHALE OIL

Appearance (at 30°C)	Yellowish orange liquid
Oil content (%)	57.0
Refractive index (at 40°C)	1.4611
Specific gravity (at 26°C)	0.9226
Viscosity (at 50°C)	0.4780
Acid value	1.7
Iodine value (Wijs)	98.7
Saponification value	225.7
Unsaponifiables (%)	0.42

oil was analyzed with a Shimadzu Gas Chromatograph Model GC-IC. The instrument was equipped with a hydrogen ionization detector. The column used was composed of 3 mm I D by 225 cm U-sharped stainless steel containing diethylene glycol succinate polyester (DEGS) supported on 30–60 mesh Shimalite. Operating conditions were as follows; column temp. 215°C, injector temp. 260°C, detector temp. 240°C, a column inlet pressure of 1.2 kg/cm². N_2 was used, which measured 70 ml/min.

Chromatographic peaks were identified either by comparison of retention times with those of standards or from a graph relationship (A. Seher & R. Kühnast, 1965) between logarithm of retention time and the number of carbon atoms, and also hydrogenated methyl ester was used to verify the contained fatty acids of odd-carbon chain lengths. The hydrogenation method was as follows; the *n*-hexanoate solution of the methyl ester was added a pinch of platinum black as a catalyzer. The mixture was stirred with a magnetic stirrer for 24 hours in hydrogen atmosphere at room temperature. After the hydrogenated methyl ester was filtered, gas chromatograph was operated at the same conditions.

The fatty acids were evaluated quantitively by method of Magidman *et al* (1962). All fatty acids are reported as weight percentages of the total known fatty acids present.

RESULTS AND DISCUSSION

The results obtained are as follows; as saturated fatty acids, C_8, C_{10}, C_{12}, C_{14}, C_{16}, C_{18} and C_{20}, and as unsaturated fatty acids, C_{10} monoenoic, C_{12} monoenoic, C_{12} dienoic, C_{14} monoenoic, C_{14} dienoic, C_{16} monoenoic, C_{16} dienoic, C_{16} trienoic, C_{18} monoenoic, C_{18} dienoic, C_{18} trienoic, C_{20} monoenoic, C_{20} dienoic, C_{20} tetraenoic and also odd-carbon chain lengths of C_{13}, C_{15} and C_{19}.

The percentages of these fatty acids are shown in Table 2.

The oil of the Many toothed pilot whale was comparatively lower acid value and unsaponifiable matter content. Therefore it seems that the oil is glyceride and content of free acids is lower too.

According to Table 2, the fatty acid of the most prominent is C_{18} monoenoic 28.1 %, and the next prominent is C_{14} monoenoic 13.8 % and also saturated C_{16} is 11.4 %. The total of these fatty acids holds really 52.3 % of all total fatty acids. The

TABLE 2. FATTY ACID COMPOSITION OF MANY TOOTHED PILOT WHALE OIL

Fatty acid No.	Weight per cent of total fatty acid
8	0.1
10	0.3
10–1	0.3
12	1.3
12–1	2.0
12–2	3.8
13	0.3
14	7.3
14–1	13.8
14–2	4.9
15	0.5
16	11.4
16–1	5.3
16–2	6.9
16–3	0.9
18	0.8
18–1	28.1
18–2	3.7
18–3	0.8
19	1.4
20	1.7
20–1	0.6
20–2	1.5
20–4	2.3

TABLE 3. A COMPARISON OF SATURATED AND UNSATURATED FATTY ACID OF MANY TOOTHED PILOT WHALE OIL

Fatty acid No.	Weight per cent of total fatty acid	
	Saturated	Unsaturated
8	0.1	—
10	0.3	0.3
12	1.3	5.8
13	0.3	—
14	7.3	18.7
15	0.5	—
16	11.4	13.1
18	0.8	32.6
19	1.4	—
20	1.7	4.4
Total	25.1	74.9

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proportions of other component fatty acids are as follows; saturated C_{14} 7.3 %, C_{16} dienoic 6.9 %, C_{16} monoenoic 5.3 %, C_{14} dienoic 4.9 %, C_{12} dienoic 3.8 %, C_{18} dienoic 3.7 %, C_{20} tetraenoic 2.3 %, C_{12} monoenoic 2.0 %, saturated C_{20} 1.7 %, C_{20} dienoic 1.5 %, saturated C_{19} 1.4 %, saturated C_{12} 1.3 %, C_{16} trienoic 0.9 %, saturated C_{18} 0.8 %, C_{18} trienoic 0.8 %, C_{20} monoenoic 0.6 %, saturated C_{15} 0.5 %, saturated C_{10} 0.3 %, C_{10} monoenoic 0.3 %, saturated C_{13} 0.3 % and saturated C_8 0.1 %.

On the other hand, the proportions of total saturated fatty acids are 25.1 % in preparation for 74.9 % of total unsaturated fatty acids (shown in Table 3). In saturated fatty acids, C_{16} is 11.4 % of the largest quantity, the next C_{14} is 7.3 % and further C_{20} is 1.7 %. Against these proportions, in total unsaturated fatty acids holds nearly 3 times of percentages in comparison with that of saturated fatty acids.

SUMMARY

1) The properties of Many toothed pilot whale oil were studied.

2) Fatty acid composition of Many toothed pilot whale oil was analyzed by liquid chromatograph using a hydrogen ionization detector on a DEGS column.

3) The results obtained are as follows;

Total saturated fatty acids	25.1 %:
octanoic	0.1 %
decanoic	0.3 %
dodecanoic	0.3 %
tridecanoic	0.3 %
tetradecanoic	7.3 %
pentadecanoic	0.5 %
hexadecanoic	11.4 %
octadecanoic	0.8 %
nonadecanoic	1.4 %
eicosanoic	1.7 %
Total unsaturated fatty acids	74.9 %:
C_{10} monoenoic	0.3 %
C_{12} monoenoic	2.0 %
C_{12} dienoic	3.8 %
C_{14} monoenoic	13.8 %
C_{14} dienoic	4.9 %
C_{16} monoenoic	5.3 %
C_{16} dienoic	6.9 %
C_{16} trienoic	0.9 %
C_{18} monoenoic	28.1 %
C_{18} dienoic	3.7 %
C_{18} trienoic	0.8 %
C_{20} monoenoic	0.6 %
C_{20} dienoic	1.5 %
C_{20} tetraenoic	2.3 %

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