NORTH PACIFIC RIGHT WHALE

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INTRODUCTION

It is generally accepted that the right whales or black right whales live in three isolated communities, i. e. in the North Atlantic, North Pacific and southern hemisphere, being separated by continental area and wide vacant tropical belt of water, mainly based on the chart showing distribution of whales as shown by logbook records of American whaleships, presented by Townsend (1935).

The Atlantic right whale has been studied, both from east and west sides, by various authors since the capture of a young example in the port of San Sebastian, Spain, in 1854. Outline of these studies are well summarized by True (1904), and in more historically by J. A. Allen (1908). True's account, however, contains an exhaustive summary of all the published accounts of the external and osteological characters of all the then known specimens, both European and American, and much original matter relating to several American examples not previously described. Since then Andrews (1908, 1909), Collett (1909), Turner (1913), and G. M. Allen (1916) contributed greatly to our knowledge of the North Atlantic right whale. And it is established that *Balaena nordcaper* Lacépède, *B. biscayensis* Eschricht, *B. cisarctica* Cope, *B. britanica* Gray, *B. tarentina* Capellini, etc. are all synoniums and they belong to a single species *Eubalaena glacialis* Bonnaterre, a distinct species from the Greenland or bowhead whale, *Balaena mysticetus* Linnaeus.

Very little is known about the southern right whale, *B. australis* of the South Atlantic and *B. antipodarum* and *B. novae-zelandiae* of the South Pacific. J. A. Allen (1908) describes, without comment, that two (possibly three) species of *Eubalaena* occur in the southern hemisphere, though he summarizes well the North Atlantic right whale. Harmer (1928) states that it seems probable that several species of southern right whale that have been described should all be referred to as a single species, which is closely allied to, but possibly distinct from, the Biscay whale [*Eubalaena glacialis*]. Matthews (1938) notes body proportions and other characters of five southern right whales observed by the Discovery staff at South Georgia and Cape Province, South Africa. Further he reports that a specimen was taken by special permission and brought into Leith Harbour, South Georgia, where its skeleton was prepared for the British Museum (Natural History). But this skeleton was unfortunately lost;

while awaiting shipment an avalanche from the nearby mountain overhelmed the old part of the whaling station at Leith Harbour where it lay. Since then no systematic study of this species has been appeared, as far as I am aware.

More less is known about the North Pacific right whale. Only scanty and fragmental reports have been appeared, because of lack of specimen, though hunting of this species was carried on vastly in the North Pacific by American whalers and a number was taken locally by the Russian and Japanese.

In the early days of nineteenth century the North Pacific right whale was called as "cullamach" or "kuliomoch" whale. Gray (1846) named this species *Balaena japonica* and later it was renamed *B. sieboldii* by him (1864). And the name *B. aleoutiensis* was given by Van Beneden (1865). But these were named without sufficient type specimen. True (1904) treats briefly in his account the North Pacific right whale under the name "*Balaena sieboldii* Gray (?), based mainly on an account by Scammon (1874) and the whalebone kept in the National Museum, Washington. He closes the chapter by quoting Van Beneden's opinion (1875) that the right whale of the coasts of Japan is a distinct species from that of the North Atlantic. His statement was commented by J. A. Allen (1908) as having not noticed to the attitude of Flower (1891) who describes that "This form [*Balaena australis*] inhabits the temperate seas of both northern and southern hemisphere, and is divided into several so-called species according to their geographical distribution:—*B. biscayensis* of the North Atlantic, *B. japonica* of the North Pacific, *B. australis* of the South Atlantic, and *B. antipodarum* and *B. novae-zelandiae* of the South Pacific".

The distinction among the right whales from the North Atlantic, North Pacific, and southern hemisphere has not been established yet owing to the lack of the specimen and necessary measurements of the latter two, but Fraser (1937) uses the name "Black Right Whale" to include all of these, regarding, not as so many distinct species, but rather as local races of one species which is widely distributed. Recently Tomilin (1957) describes single species of *Eubalaena glacialis* and under this name three different sub-species. These are *E. glacialis glacialis* Bonnaterre from the North Atlantic, *E. glacialis sieboldii* Gray from the North Pacific, and *E. glacialis australis* Desmoulin from the southern hemisphere.

The hitherto-noted difference between the North Atlantic and North Pacific right whales is the color of baleen plates (Tomilin 1957). Matsuura (1936) made some statistical study of whales taken in the coasts of Japan. He (1942) also measured body proportions of two right whales taken by the "Tonan Maru" expedition in the waters south of Kam-

tchatka in 1941. This may be the first record of the North Pacific right whale whose body proportions were measured, but this report is not popular to cetologists of other countries, because it is written in Japanese and was not made public.

In 1956 two right whales were killed in the coastal waters of Japan by a special permission for scientific research under Article 8 of the International Convention for the Regulation of Whaling. These two whales were observed and measured of their external as well as internal characters by the staff of the Whales Research Institute. A brief report on the observation of these whales was made public by Omura (1957). In the present account these whales are treated in detail with other data hitherto obtained by ourselves including those by Matsuura, and comparing with those from different localities by various authors.

Followings are the catch particulars of the two right whales taken in 1956.

Date of catch	*Position of catch*	*Body length in feet*	*Sex*	*Where processed*
May 23, 1956	38°—33′N, 143°—40′E	38	F	Ayukawa
June 30, 1956	41°—46.8 N, 148°—59.5′E	41	M	Kirittapu

RECENT OCCURRENCE AND MIGRATION

Historical. In old days prior to the present century some North Pacific right whales were killed yearly in the coastal waters of Japan by nets fishing. These grounds were located on the south and west coasts of Japan and these hunting was carried out mainly in winter. At Senzaki, a small town located western side of Honshu and facing to the Japan Sea, a total of various kinds of about 15 whales in average were taken yearly in a period from 1802 to 1850. The right whale occupied about 20 per cent of the catch, and the rest were fins, humpbacks, and grey whales, etc. The catch lasted from December to March following, having its peak in January. At Taiji, a small town located southern-most part of Honshu, also such whaling had been conducted in winter until 1878, when it came to an end with a disaster. On December 24th 1878 almost all the fishing vessels engaged in whaling were sunk and about one hundred people were drown because of a sudden storm, while pursueing a big right whale.

The Norwegian whaling has been introduced to Japan at the beginning of this century and gradually the whaling had moved to northern grounds where whaling is operated mostly in summer. Matsuura (1936) summarizes the catches of the North Pacific right whale in ten years from 1925 to 1934. Table 1 is reproduced here from his account, slightly changed for clarification.

This table shows well the monthly distribution, hence migration, of the North Pacific right whale. In February it approaches to the Bonin Island, in March and April to the south-west coast of Honshu, during April and July to the north-east coast of Honshu, and from May until September it stays in the waters near Hokkaido. But in the line of Hokkaido in this table is included the catch in the Okhotsk Sea and in the waters around Kuril Islands. The best ground in these days was the coasts around Iturup and Urup Islands in the Kuril Islands.

TABLE 1. MONTHLY CATCH OF THE NORTH PACIFIC RIGHT WHALE IN JAPAN DURING 1925—34. (after Matsuura)

Locality	Feb.	Mar.	Apr.	May	Jul.	Aug.	Sept.	Total
Hokkaido[1)]	—	—	—	13	16	24	4	57
NE coasts of Honshu	—	—	1	2	1	—	—	4
SW coasts of Honshu	—	1	1	—	—	—	—	2
Bonin Island	3	—	—	—	—	—	—	3
Total	3	1	2	15	17	24	4	66

1) Including Kuril islands.

TABLE 2. RECORDS OF RECENT SIGHTINGS OF NORTH PACIFIC RIGHT WHALE BY JAPANESE WHALE CATCHERS.

Year	Coastal whaling					Pelagic whaling in the North Pacific						Total
	Apr.	May	Jun.	Jul.	Total	May	Jun.	Jul.	Aug.	Sept.	Total	
1941	—	—	—	—	—[1)]	—	2	4	—	—	6	6
1948	—	—	—	1	1	—	—	—	—	—	—[2)]	1
1949	—	—	—	—	—	—	—	—	—	—	—[2)]	—
1950	2	2	—	—	4	—	—	—	—	—	—[2)]	4
1951	4	7	—	—	11	—	—	—	—	—	—[2)]	11
1952	4	—	—	—	4	—	—	—	—	—	—[1)]	4
1953	—	5	1	—	6	—	—	—	—	—	—[1)]	6
1954	4	9	—	—	13	2	10	10	2	—	24	37
1955	2	—	—	—	2	—	3	5	—	—	8	10
1956	—	1	2	—	3	1	8	63	—	3	75	78
1957	21	22	1	1	45	—	10	15	—	—	25	70
Grand total	37	46	4	2	89	3	33	97	2	3	138	227

1) No record available.
2) Not operated.

Recent occurrence. As regards the recent occurrences of the North Pacific right whales I have collected records of sightings by Japanese whale catchers which are tabulated in table 2, separately by coastal and pelagic whaling and by months. In the column of the coastal whaling the data from 1948 to 1955 were collected from log-books of catchers and those for 1956 and 1957 were supplied from the whaling companies concerned, but not the all were informed. In the column of the pelagic whaling in the North Pacific the data for 1941 were taken from Matsuura (1942),

and the rest were supplied from Mr. T. Kawakami of the Fisheries Agency of Japanese Government.

As shown in table 2 a total of 227 right whales were sighted by Japanese whale catchers during 11 years from 1941 to 1957. Number of sightings in each year differs considerably, from nil in 1949 to 78 in 1956. It seems that the sighting has increased in recent years, but we should put the fact in mind that in 1956, when a special permission for taking of right whales for scientific purposes was issued, catchers were requested to make full records of sightings of that species. Further it occurs without doubt that the same whale or the same school of whales be sighted by different catchers, thus increasing the numbers of sighting records considerably. It is obvious, therefore, that these data have little value for the study of relative abundance in different years. But these data are very useful for the study of distribution and migration of whales, when the positions of these sightings are plotted in chart according to the time observed (figs. 1).

Distribution and migration. Figure 1 shows the positions of the North Pacific right whales sighted in each month in these 11 years. In April right whales were only sighted in the waters east of Hokkaido and north-east coast of Honshu. In addition to these sightings two whales were observed in the coast of Taiji, southern-most part of Honshu, though these whales were not plotted in figure 1. We have no record of sighting in April in the waters north of 43° North Latitude. This may partly be due to the fact that the Japanese pelagic whaling begin in May and no catcher boat operating in these waters in April, but it is probable that the North Pacific right whale does not migrate so north in this month, judged from the chart showing the positions of monthly catch by American whalers by Townsend (1935), which coincides well with figure 1.

In May also the majority are sighted in the same area as in the previous month, but slightly they shifted to north and three were sighted between 45° and 47° North Latitude. None was sighted in and nearby the Bering Sea, though Japanese pelagic whaling had in operation generally from the middle of May there. Tomilin (1957) describes that the North Pacific right whale stays in the waters around Kamtchatka and in the Okhotsk Sea from the beginning of June to the end of October. His statement agrees with our observations, but according to Townsend (1935) a number of right whales were killed in old days in May in the south-east coast of Kamtchatka and some in the Bering Sea, and a few in the south-east coast of Hokkaido. This discrepancy may not be explained until further data are obtained in future.

In June the majority shifted further to north and approach very close to the Aleutian chain, Komandor Islands, and south-east coast of Kam-

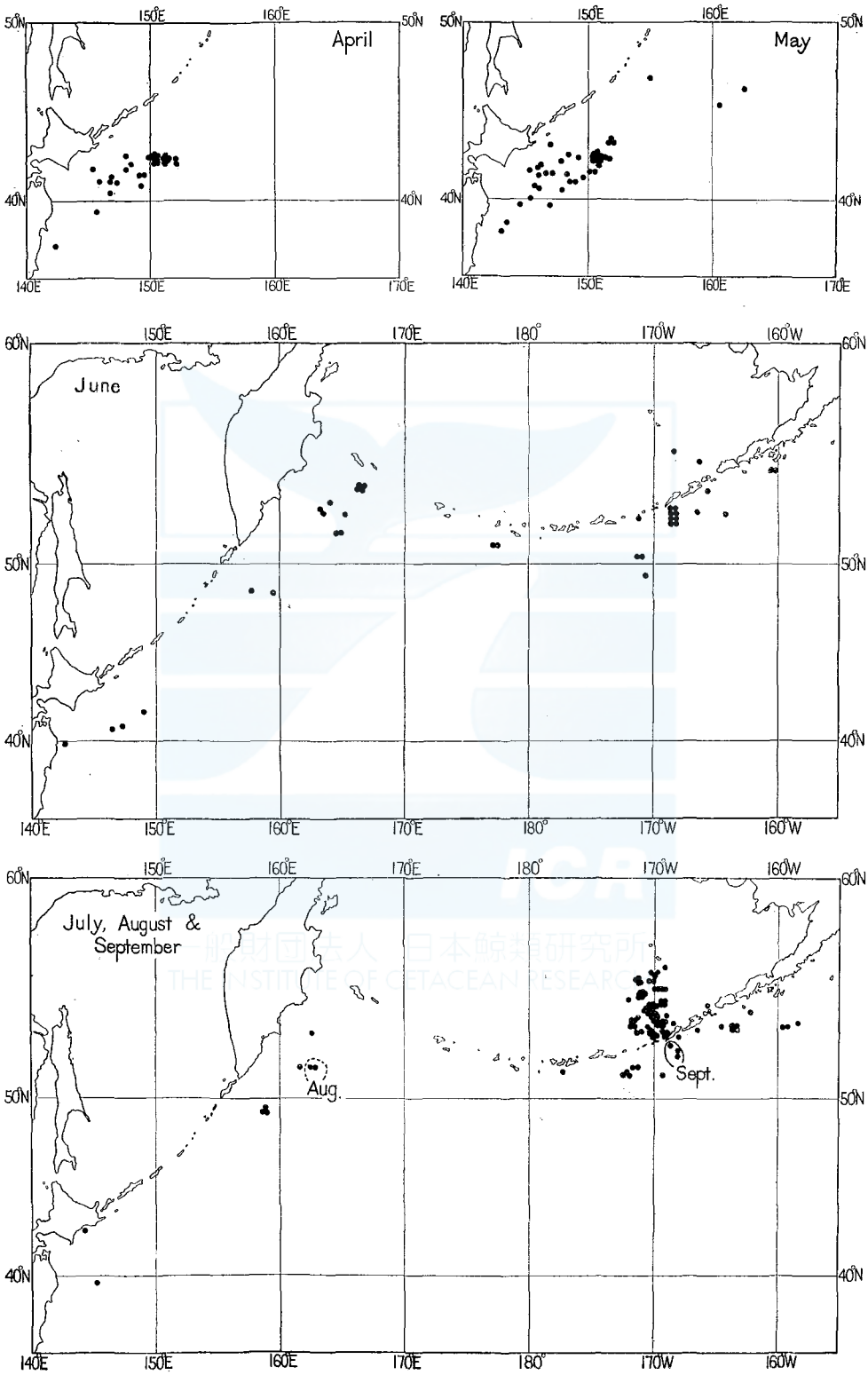


Fig. 1. Sighting of the North Pacific right whales in the years 1941–1957 by Japanese whale catchers.

tchatka, but only two were sighted in the Bering Sea, north of the Aleutian chain. We have no recent record of right whale sighted prior to this month in the west coasts of the North America by our catchers. It is well known, however, that another stock of right whales than the western stock occurs in the eastern coast of the North Pacific. Whales around the Aleutian chain in figure 1 are without doubt belong to the stock in the so-called "Kodiak ground" in the gulf of Alaska. Gilmore (1956) reports an observation of the North Pacific right whale from the coast of La Jolla, southern California, and presents a chart showing supposed distribution and migration of this stock.

In July most of the sightings were recorded in the Bering Sea around 170° West Longitude. Only a few records of sightings are observed in the waters west of 180° Longitude, but this may probably be explained by concentration of catchers in the former area in this month.

In August and September only a few numbers were sighted, two from the south-east coast of Kamtchatka in August and three in the waters south of Unimak Island of the Aleutian chain in September. None was sighted in the coastal waters around Japan after July.

From above it is concluded about the migration of the North Pacific right whales that they appear in the waters east of north-east localities of Honshu and south of Hokkaido in April, staying there in May and then they proceed to further north. In June they arrive in the Bering Sea and its nearby waters and staying there during the whole summer. According to the chart by Townsend (1935) the northern limit of migration of this species is lying west side of St. Lawrence Island.

As to the southern limit of migration we have no recent record of sighting, but three right whales were taken in February during 1925–34 as shown in table 1. Townsend (1935) reports that some whales were killed in the west coast of Formosa in February and March in the days of American whaling. It is supposed, therefore, that the southern limit of the migration of the North Pacific right whale, at least that of stragglers, is about or a little north of 20° North Latitude in the western side of the North Pacific.

We have no record of recent sighting of the North Pacific right whale in the Sea of Japan and Okhotsk Sea, though it was hunted intensively by American whalers in these waters too in the past.

In table 3 are shown the frequencies of the numbers of the North Pacific right whales in the schools, sighted by the Japanese whale catchers during the years 1941–1957. Of the 164 instances 111 or about 68 per cent of the total were met solitary, and 45 or about 27 per cent in double, including 6 cases recorded as female which accompanied by a calf. The highest numbers in a school is 4, but such occasions account

TABLE 3. FREQUENCIES OF THE NUMBERS OF NORTH PACIFIC RIGHT WHALES IN THE SCHOOLS ENCOUNTERED

Year	Coastal whaling			Pelagic whaling in the North Pacific				Total			
	Numbers in school			Numbers in school				Numbers in school			
	1	2	3	1	2	3	4	1	2	3	4
1941	—	—	—	3	—	1	—	3	—	1	—
1948	1	—	—	—	—	—	—	1	—	—	—
1949	—	—	—	—	—	—	—	—	—	—	—
1950	2	1	—	—	—	—	—	2	1	—	—
1951	9	1	—	—	—	—	—	9	1	—	—
1952	4	—	—	—	—	—	—	4	—	—	—
1953	4	1	—	—	—	—	—	4	1	—	—
1954	6	2	1	6	9	—	—	12	11	1	—
1955	—	1	—	8	—	—	—	8	1	—	—
1956	3	—	—	33	14	2	2	36	14	2	2
1957	24	9	1	8	7	1	—	32	16	2	—
Total	53	15	2	58	30	4	2	111	45	6	2
%	75.7	21.4	2.9	61.7	31.9	4.3	2.1	67.7	27.4	3.7	1.2

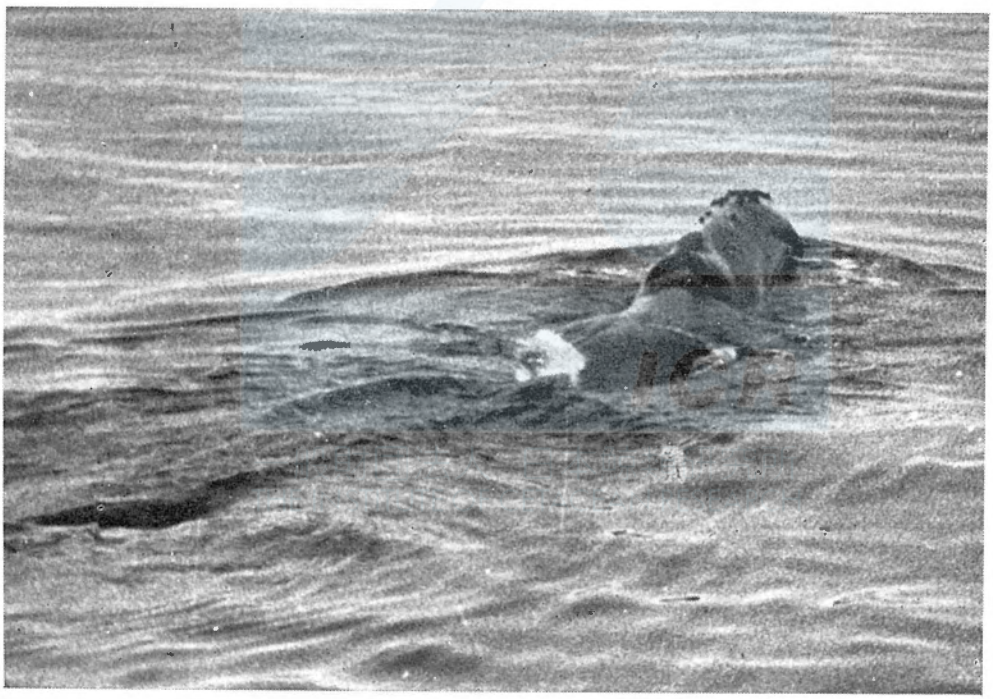


Fig. 2. North Pacific right whale.
Position. 51°12′N, 170°14′W
Date. 27th June 1956.
(Photo by Mr. S. Watase)

only 1.2 per cent of the total.

The North Pacific right whale shown in figure 2 was sighted solitary by a catcher boat on June 27th 1956 at 51°12′ North Latitude and 170°14′ West Longitude. This picture was taken by Mr. S. Watase of the Taiyo Gyogyo K. K., Tokyo, and referred to with the permission of the Japan Whaling Association, who has the copyright of this picture.

SIZE AND WEIGHT

Size. Scammon (1874) describes about the body length of the North Pacific right whale that " Its average adult length may be calculated at 60 feet—it rarely attains to 70 feet,—and the two sexes vary but little in size ". This statement was criticized by Tomilin (1957) as having been confused with Greenland whale (*Balaena mysticetus*), but I am not in favor of the Tomilin's opinion.

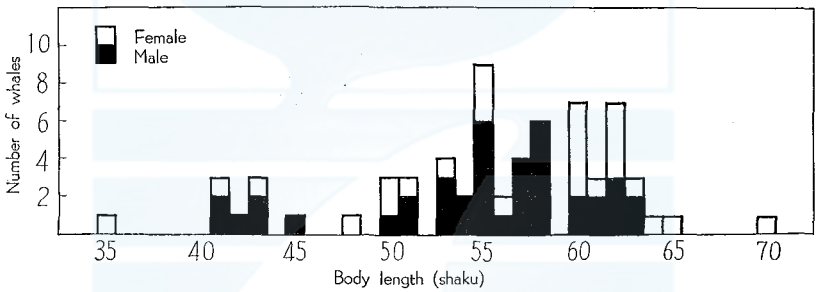


Fig. 3. Size distribution of North Pacific right whales taken in the years 1925-34. (1 Shaku ≒ 1 Foot)

(Based on the data of Matsuura (1936))

Matsuura (1936) presents size distribution of the right whales taken in the adjacent waters of Japan in ten years 1925–34, which is reproduced here in figure 3, in the form of histograms. This figure supports in some extent the above statement by Scammon. Since the Matsuura's account is based upon the catch reports from various whaling companies and he himself did not measured the body length of the whales taken, the body lengths in his account are not deemed as always correct. Nevertheless I don't think that there are great difference, say over 5 feet, from the correct length. Another evidence supporting Scammon's statement is the whale measured by Matsuura himself in 1941. In this year he went to the northern Pacific as an inspector on board the " Tonan Maru ". This expedition took three right whales in which two were measured of their body proportion by Matsuura. He also made some biological observations of the whales taken. These are included in his

report briefly (1942). One of these whales was a immature male of 13.6 meter (44 feet 7 inches) long. But another one was a mature female of 17.8 meter (58 feet 5 inches) long. This is the biggest black right whale (*Eubalaena*) ever appeared in scientific papers. The body proportion of these whales are shown in table 7, in addition to two North Pacific right whales measured by ourselves and show a good coincidence to the latter. Hence I believe his measurement is correct. This whale is reported as having attained its sexual maturity, but it contained in its ovaries only one corpus albicans.

The biggest North Atlantic right whale ever recorded is the female captured off the southern coast of Long Island, New York, near the village of Amagansett and reported by Andrews (1908). The body length of this whale was measured by the whalers at the time of capture as 56 feet and 7 inches taken with a tape laterally, from the tip of the snout to end of the" flukes ". But later it was measured by Andrews as 54 feet (16.5 meter) from the tip of the snout to the notch of the flukes, along the mid-dorsal line. This whale was assigned as adult.

According to Collett (1909) the largest of all the North Atlantic right whales taken by Norwegians in the sea to the east of Iceland and around the Faroe Islands, the Shetlands and the Hebrides during the years 1889-1908 was a female taken in 1903 and measured 54 feet (16.4 meters). The average lengths of males and females were 45.8 feet (13.9 meters) and 47 feet (14.3 meters) respectively in 1907 and the corresponding figures in 1908 were 43.8 feet (13.3 meters) and 44 feet (13.4 meters) respectively. Hence larger body length of the North Pacific right whale than that in the North Atlantic is highly probable.

The largest one out of the four southern right whales reported by Matthews (1938) is a female which measured 15.23 meters (50 feet), and shows no remarkable difference in size from the North Atlantic right whale.

I have no sufficient data in relation to the average body length at which sexual maturity is attained in the North Pacific right whales. The body length of the two right whales takes in 1956 for scientific purposes were 11.65 meters (38 feet 3 inches) female and 12.4 meters (40 feet 8 inches) male. Both were sexually immature and no follicle was observed on the surface of the ovaries of the female. Matsuura (1942) reports that his third whale, which was also taken by the " Tonan Maru " expedition in 1941 but body proportion was not measured, as sexually mature. This was a male of 41 feet long. But I don't think his statement as to the sexual condition is correct. He conducted no microscopic examination of the testis of the said whale, nor recorded the weight or volume of the testes.

His 58-foot female had apparently reached its sexual maturity, because this whale contained one corpus albicans in its ovaries. One might imagine that more corpora albicantia be accumulated for this huge size, but we have no other evidence at present to judge whether or not this is an unusual case.

Weight. Weight of various parts of the body of the two North Pacific right whales are already shown in a brief report by Omura (1957). It is reproduced here in table 4.

TABLE 4. WEIGHT OF NORTH PACIFIC RIGHT WHALE

	Ayukawa 1,165cm ♀		Kirittapu 1,240cm ♂	
	Weight in kg	% of total weight	weight in kg	% of total weight
Meat	7,990	34.94	6,622	29.77
Blubber	8,259	36.11	10,030	45.08
Bone, total weight	3,166	13,84	2,921[4]	13.13
Skull	993	4.34	645	2.93
Mandibles	253	1.11	338	1.51
Ribs	368[1]	1.61	487[1]	2.19
Vertebrae	1,109[2]	4.85	935[2]	4.19
Flippers	337	1.47	383	1.73
Scapulae	106	0.46	128	0.58
Viscera, total weight	3,188	13·96	2,435	10.95
Heart	180	0.80	154	0.69
Lung	204	0.90	163	0.73
Liver	216	0.94	109	0.49
Kidney	68	0.29	24[5]	0.11
Stomach	105	0.46	77	0.35
Intestine	381	1.66	279[5]	1.25
Tongue	1,369	6.00	888	4.00
Others	665	2.91	741	3.33
Baleen plates	263	1.15	239	1.07
Total	22,866[3]	100.00	22,247[3]	100.00

1) Include weight of sternum.
2) Include weight of chevrons and innominate bones.
3) Blood is not included in the total weight.
4) Include weight of hyoid.
5) Decomposed heavily.

The Ayukawa whale was killed on May 23rd 1956 and was processed on the following day, in a good fresh condition. The Kirittapu whale was taken on June 30th 1956, but was not treated until June 2nd. Thus about 42 hours has elapsed from the time of killing to the commencement of the treating. Further two grenades exploded in the abdomen at the time of killing. Internal organs went to decay accordingly and meat was not suitable for food. Such difference in freshness should be borne in mind when comparing the weights of these whales.

Meat and blubber were weighed divided in many times after they were cut into pieces, and then these weights were added together according to these items. Bones were weighed separately but they were never sawed into pieces, because skeletons were to be prepared as specimen for later study of osteology. Also were weighed the internal organs separately. Blood was not weighed at all.

TABLE 5. WEIGHT OF NORTH PACIFIC RIGHT WHALE COMPARED WITH SPERM AND SEI WHALES OF SIMILAR SIZE

	Ayukawa specimen (1,165cm)	Sperm whale (1,220cm)	Sei whale (1,220cm)
Total weight in kg	22,866	17,030	10,550
Meat	34.9%	33.4%	57.7%
Blubber	36.1 〃	33.0 〃	17.8 〃
Bones	13.8 〃	9.9 〃	13.4 〃
Internal organs	14.0 〃	9.5 〃	9.1 〃
Others	1.2 〃	14.2 〃	2.0 〃

TABLE 6. THICKNESS OF BLUBBER OF NORTH PACIFIC RIGHT WHALE

Positions of the body measured	Ayukawa whale 1,165cm ♀		Kirittapu whale 1,240cm ♂	
	in cm	‰ of body length	in cm	‰ of body length
On the lateral line of the body				
at the level of earhole	13.5	11.6	—	—
〃 tip of flipper	—	—	13.0	10.5
〃 umbilicus	15.0	12.9	15.0	12.1
〃 reproductive aperture	—	—	15 0	12.1
〃 anus	13.0	11.2	14.5	11.7
On the ventro-median line of the body				
at the level of angle of gape	21.0	18.0	—	—
〃 umbilicus	17.0	14.6	—	—
〃 30 cm after anus	23.0	19.7	—	—

Total weights of the Ayukawa and Kirittapu whales are about 23 and 22 metric tons respectively, instead of the body length of the latter is longer than the former by 75 cm. Only blubber is heavier in the Kirittapu whale. This is possively due to the fact that blubber is affected very slowly by decomposition of the body. Lighter weight of bones in the Kirittapu whale is due one part to the fact that all meat had removed from the bones cleanly, and another to the lesser amount of oil contained in bones because of decomposition of the body. It is also possible that the weights of meat and internal organs of the Kirittapu whale are much lighter than the actual weight in fresh condition.

In table 5 the weight of the Ayukawa whale is compared with sperm and sei whales of similar size, calculated by Omura (1950). It is clear that the North Pacific right whale is much heavier than these species.

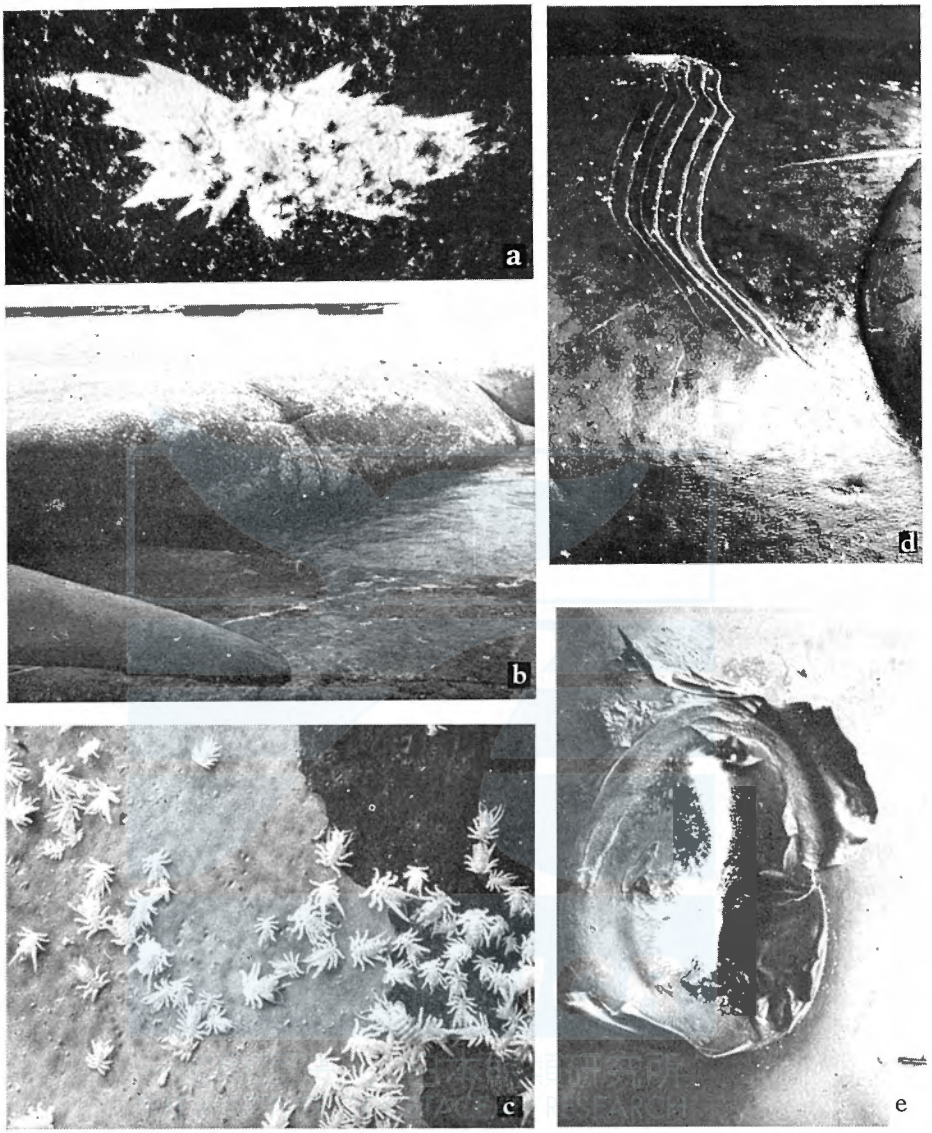


Fig. 4. a. White patch over the umbilicus of Ayukawa whale. Whale lice are also seen all over the skin. b. Ayukawa whale. Note the whale lice infecting all over the body. The transverse gloove across the genital aperture was caused by chain while towing by catcher. c. Amphipod crustaceans on the skin of the Ayukawa whale. d. White linear scars on the skin of the Ayukawa whale. Tip of the right flipper is seen on the right. e. Oval white scar on the left lip of the Kirittapu whale (long axis horizontal).

Thickness of blubber. Thickness of bubber was measured at various points, as shown in table 6. The thickness exceeds 1.0 per cent of the body length in any point where measurement was taken place. In blue and fin whales thickness of blubber accounts about 0.5 per cent of the body length, measured at the lateral side midway between the dorsal fin and the anus. It is obvious that the balaenid whales have much thicker blubber than the balaenopterid whales.

EXTERNAL CHARACTERS

Color. The Ayukawa and Kirittapu whales were both completely pigmented a dark blue-black except that the former had a white patch over the umbilicus (fig. 4a). The latter had uniform color throughout the body. True (1904) summs up the body color of the then known specimens of the North Atlantic right whale as follows: "Three specimens of the European Nordcaper are recorded as being entirely black, and the Iceland specimens were also black, with the exception of one young one, which was reported to the lighter colored on the belly. Of three American specimens, two are recorded as entirely black, and one (adult female) as having 'a great deal of pure white on its under side'". Collett (1909) describes that a uniform black must be considered to be the typical color, covering the entire body without any great differences of shade, but in some specimens more or less of the ventral surface is white. And according to him 20 per cent of 50 specimens captured in the course of the last three years (1906–1908) in the North Atlantic by Norwegians were white-bellied. He also presents a good photograph of white-bellied female. Andrews (1908) reports that his Amagansett whale was everywhere dense ivory-black with the exception of the flukes and flippers and the region immediately surrounding the genitalia, where there were numerous milk-white patches varying in diameter from two to fourteen inches. According to Matthews (1938) all three southern right whales whose color was noted at South Africa and South Georgia had conspicuous white marking on the belly, varying in shape and size. But he mentions that Lonneberg (1906) records white patches on two out of seven southern right whales examined at South Georgia.

The foregoing facts may lead to a conclusion that the typical color is uniform black, but some specimens more or less white-bellied, in the North Atlantic and probably also in the southern right whales.

The white patch on the umbilicus of the Ayukawa whale is an irregular ellipse in shape and rather small, its long and short axes being 45 and 21 cm respectively. This white patch is not possibly due to the alteration of the skin produced by parasitic cirripeds. We have no other recent

record on the body color of the North Pacific right whale. Scammon (1874) describes however that the color is generally black, yet there are many individuals with more or less white about the throat and pectorals, and sometimes they are pied all over. Ohtsuki (1951) notes that the "Semi" or "Semi-kujira", North Pacific right whale, is black all over the body, except belly where white. He also published a figure of white bellied one. His book entitled "Geishiko" (On whales) was published in an early days of the nineteenth century and the exact date is unknown. It was reproduced, however, in 1951 by the Japan Whaling Association for the reference to the people concerned. These suggest that there may be a similarity of body color among right whales from the North Pacific, North Atlantic and southern hemisphere.

Scar. The Ayukawa and Kirittapu whales had white linear scars on their bodies. These scars were noted in the Ayukawa whale in groups of several lines at four different parts of the body. The most remarkable scars (fig. 4d) were on the skin just behind the right flipper. As shown in this figure these scars were consisted of six lines, running down parallel from the level of the axilla and obliquely forward at the belly. Other three groups were on the left side of the tail, also in groups of similar but shorter lines. In the Kirittapu whale these lines were observed almost all over the body. Collett (1909) also noted such white stripes on the skin in most, though not all, of the specimens of the North Atlantic right whale he observed, running in all directions, and measuring up to one meter in length and about 50 mm wide. He thought these stripes may have been produced by the rubbing of the animal against the bottom when following the plankton-crustaceans upon which it feeds. But it is thought more probable that these may be the scars caused by biting of killer whales, judged from figure 4 d. In addition to these linear scars the Kirittapu whale had a wound, incompletely healed, 150 cm in length and about 10 cm in depth, similar to that caused by a harpon, near the flank on the right side of the body.

The oval white scar which generally seen on the skin of the balaenopterid whales was not detected from these right whales, except one on the left lip of the Kirittapu whale (fig. 4 e).

External parasite. The Ayukawa and Kirittapu whales were thickly infected by whale lice, amphipod crustaceans (figs. 4 b, 4 c), but in lesser extent in the latter specimen. The body color of the former was looked as if having yellowish-brown pigment over the whole body at the first sight when it was hauled up through slip-way to the flensing platform of the landstation. Thus the whale was covered by lice almost whole body, but most thickly on the so-called "bonnet" and similar callosities on the lower jaw, and around the genital aperture. The Kirittapu whale

was also infected thickly, but in lesser extent on the flank. The whale lice on the "bonnet" or other callosities of the Ayukawa whale were yellowish-white in color; elsewhere they were yellowish-brown. All of these lice on this whale were identified as *Cyamus ceti* by Mr. T. Nemoto of the Whales Research Institute. In addition to this species *C. ovalis* was also detected on the Kirittapu whale by him, but the gill of these specimens is said as somewhat different from published descriptions. Studies on these problems will be reported by somebody else.

No other external parasite, such as *Coronula*, *Conchoderma* or *Pennella* was detected from these whales, nor was diatom infection visible to the naked eye. No diatoms have so far been detected on samples of skin which were collected.

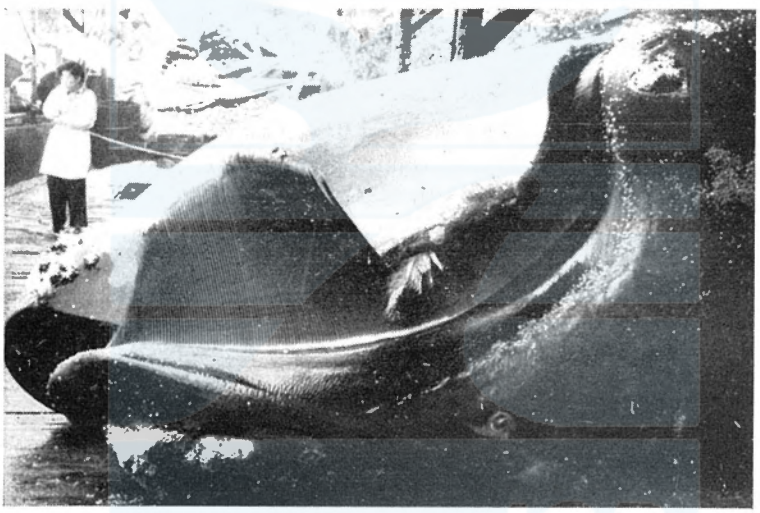


Fig. 5. Ayukawa whale. Bonnet and other callosities on the upper jaw.

Head. In the Ayukawa whale the "bonnet", the largest and most anterior callosity on the upper jaw, begins from a point 20 cm behind the tip of the upper jaw (fig. 5). It is oval in outline and its length is about 75 cm. A group of much smaller callosities occupies the mid-line of the rostrum between the bonnet and the blow-holes, behind which lies a pair (fig. 6). The region of the blow-holes is slightly elevated above the general level of the head. The blow-holes are 27 cm long along the curve, and diverging anteriorly 10 cm and posteriorly 37 cm (fig. 6).

The lower lip of this whale had a maximum depth of 117 cm. There was a further group of callosities in line on each side of the lower jaw, starting just behind the tip and running towards the gape. The most anterior one was the largest and irregularly outlined, long axis being

36 cm. A line of another three small callosities runs back towards the gape, their outlines being circle in the 2nd and 3rd and the 4th oval. Their lengths were 7, 6.5, and 7.5 cm respectively. Breadth of the 4th was 6 cm. The length from the tip of the lower jaw to the centers

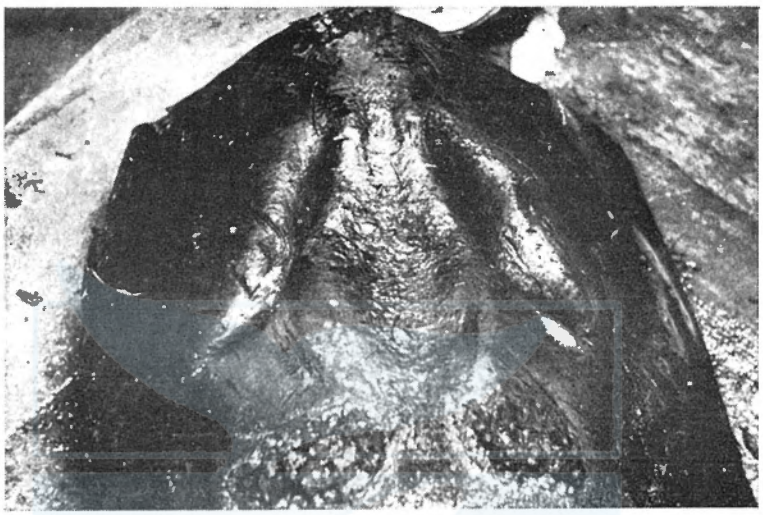


Fig. 6. Blow-holes of the Ayukawa whale. Obliquely posterior view. Note two callosities behind the nostrils.

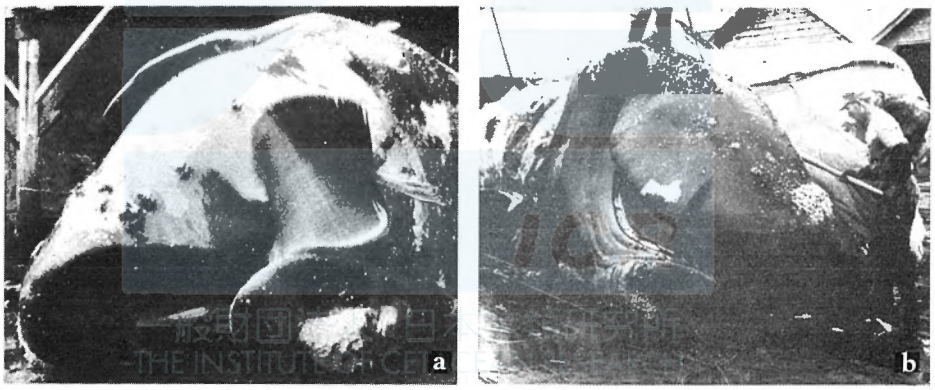


Fig. 7. a. Ayukawa whale. Note four callosities on the lower jaw. b. Kirittapu whale. Note five callosities on the lower jaw.

of the 1st, 2nd, 3rd, and 4th callosities, measured in straight line along the axis of the whale body, were 20, 32, 59, and 112 cm respectively. The 2nd situated just behind the 1st (figs. 7 a, b). In addition to these callosities there was another one callosity, nearly circular in shape, on each side of the head just above the eye (fig. 5). Its size is larger than those on the mandible, except the first, but smaller than the "bonnet". All these callosities were thickly infected with cyamids of different sizes.

The anterior portion of the Kirittapu whale presented the same general appearance, except that the number of callosities on the mandible. There was one more callosity behind the 4th, on the same level, as shown in figure 7 b. This was similar in shape and size with others, except the first. These callosities were situated with more fairly constant distance from each other than the Ayukawa whale.

In the Ayukawa whale the distance from the 3rd to 4th is nearly the double of that from the 2nd to 3rd, measured in straight line along the body axis. It is possible, therefore, that the arrangement of these callosities with a fairly constant spacing, as seen in the Kirittapu whale, is typical and in the Ayukawa whale the 4th was lacking, being renumbered the present 4th as 5th.

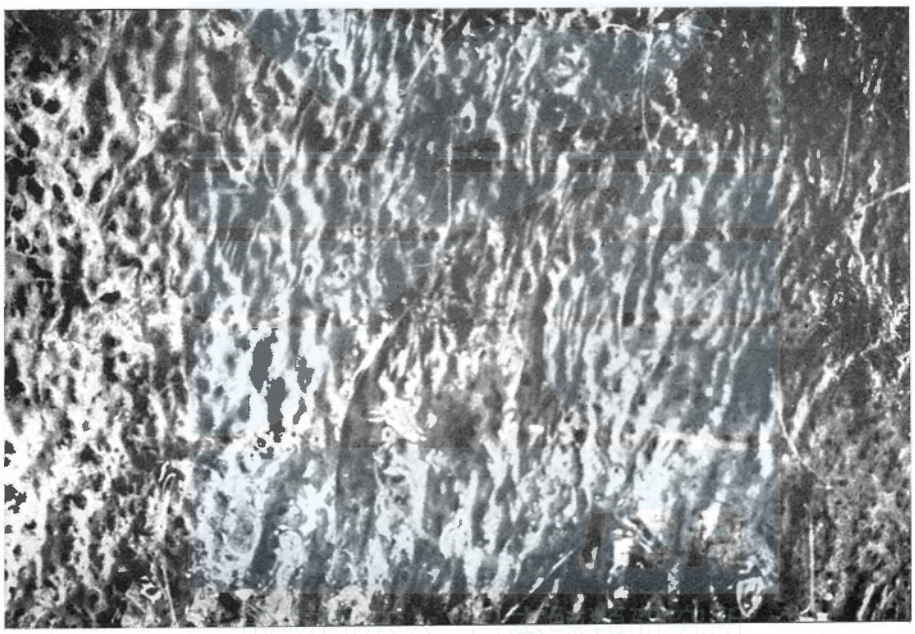


Fig. 8. Ayukawa whale. Hairs on the chin.

Hair occurred on the head of both whales, on the rostrum as well as on the mandible. In the Ayukawa specimen a group of about 160 hairs was observed on the chin (fig. 8), and each one in the center of the 2nd, 3rd, and 4th callosities on the mandible. In the Kirittapu whale hairs were observed as follows: 27 in front of the "bonnet", 11 just before the blow-hole, 20 after the blow-hole, 118 on the chin, 3 in the 1st callosity, and each one in the center of the other callosities on the mandible.

The "bonnet" and other callosities on the right whales from the North Atlantic and southern hemisphere had long been an object of

speculations. The cause of the formation was thought as: an excreascence formed by the adhesion of *Coronula*, irritation of the whale louse, due to disease of the outer layers of integument, and produced by the animal rubbing itself against rocks in order to get rid of the barnacles. Ridewood (1901) concludes that the bonnet would appear to be a circumscribed area of skin, where, for some reason not apparent, the cornified layers fail to rub off at their normal rate, but remain and accumulate to produce a hard mass, projecting above the general surface of the epidermis as a kind of corn. This opinion, however, was proved not to be the case by Matthews (1938), after examining microscopic sections prepared from well-preserved material. He states further that on two occasions different members of the Discovery Staff, when examining right whales, noted that the callosities on the mandible "may have marked the position of hairs", and "their appearance suggested that they may have been occupying the position of hair follicles". Further he describes that the occurrence of fully developed callosities in whale No. 1020, a sucking calf, shows that they are congenital and not developed after adult life is reached.

The presence of hair in the mandibular callosities in our two specimens, sexually immature male and female, well supports the observations of the Discovery Staff. Further the arrangement of the "bonnet" and other callosities in our specimens is exactly similar in general to those in whales from the North Atlantic reported by Andrews (1909), and from the southern hemisphere reported by Matthews (1938).

Body proportion. The body proportions of the Ayukawa and Kirittapu whales were shown in table 7, in actual length in cm as well as percentages against the total body length. In this table also shown the body proportions of two North Pacific right whales taken by the "Tonan Maru" expedition in 1941 and reported by Matsuura (1942) for reference. Catch particulars of these whales are as follows:

Date of catch	*Position of catch*	*Body length in feet*	*Sex*
June 10 1941	48°27′ N, 157°51′E	58	F
June 11 1941	48°23′ N, 159°29′E	45	M

Only four North Pacific right whales shown in table 7 were measured of their body proportion until at present, though there are twelve specimens from the North Atlantic and five from the southern hemisphere to my knowledge. These are listed in table 8, arranged in the order of their body length and according to the geographical areas.

In figures 9, 10 and 11 are shown the body proportions of right whales from the North Pacific, North Atlantic, and southern hemisphere, by different symbols, which show percentages of each measurements

against the body length of the respective whales. I calculated the percentages of the specimen reported by various authors, in case no proportion was given by the author.

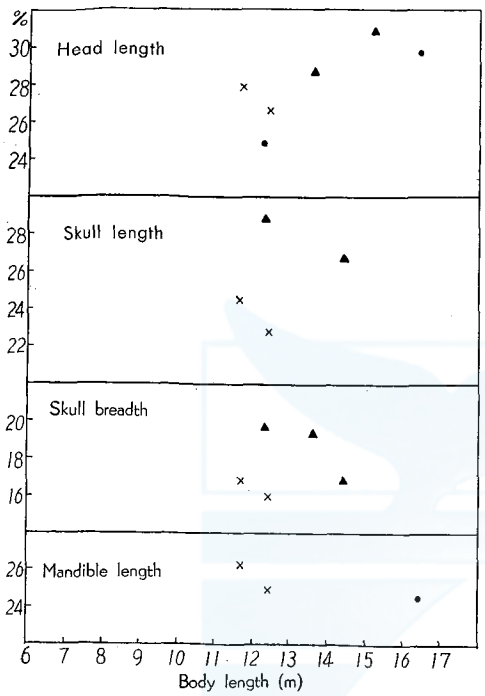


Fig. 9 a. Body proportion of right whale (1)
× North Pacific right whale.
● North Atlantic 〃 〃
▲ Southern 〃 〃

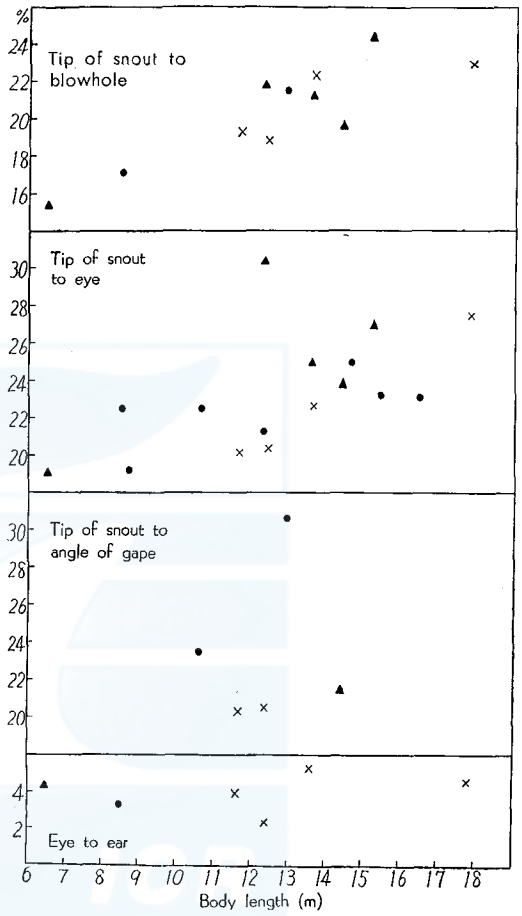
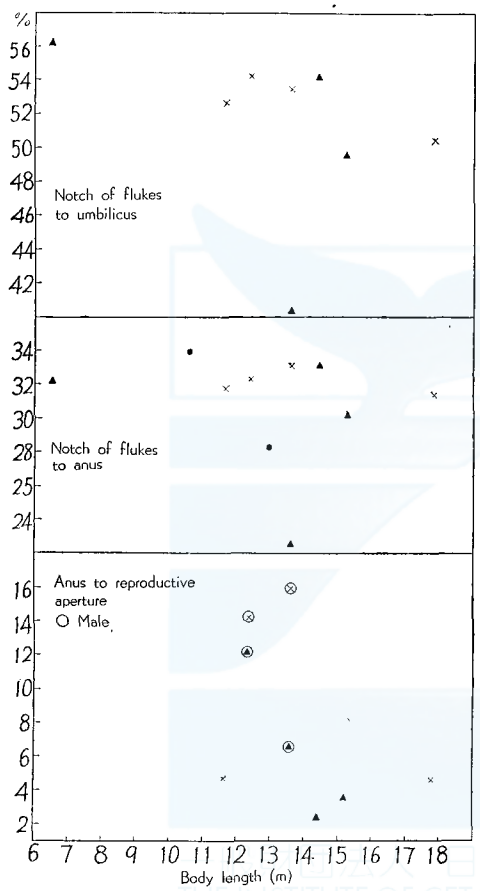


Fig. 9 b. Body proportion of right whale (2).

Proportions of various parts in the anterior portion of the body are given in figures 9. a and 9 b. Some abnormal value are seen in these figures, i. e. each one in the 2nd figure (tip of snout to eye) and the 3rd (tip of snout to angle of gape) from the top in figure 9. b. These are one from the southern hemisphere and one from the North Atlantic. Otherwise no significant difference is noted among whales from the three different oceans. Further it seems that the head length, lengths from tip of snout to blowhole and from tip of snout to eye increase their proportion according to the growth of body, as generally seen in the other species of whales.

Body proportions in the posterior portion of body are shown in figure 10 a, i. e. lengths from notch of flukes to umbilicus, from the same to anus, and anus to reproductive aperture, in three figures. Also some exceptional value are seen in these figures. But these are presented by single whale from the Southern Ocean, reported by Matthews (1938).



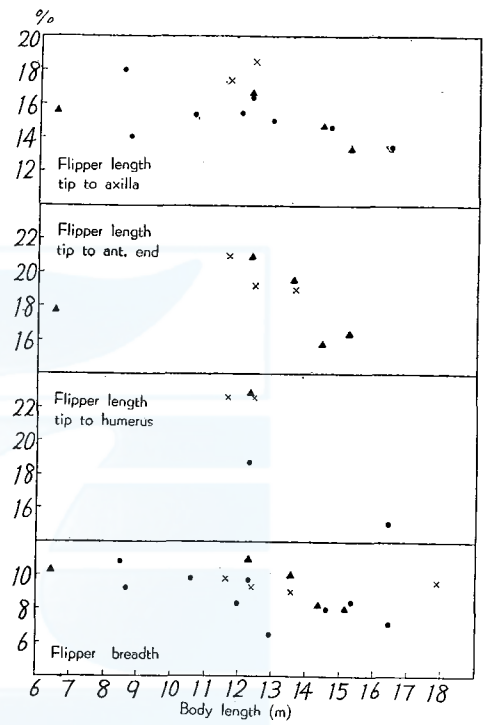


Fig. 10a. Body proportion of right whale (3).

Fig. 10b. Body proportion of right whale (4).
× North Pacific right whale
● North Atlantic 〃 〃
▲ Southern 〃 〃

This is No. 503 whale, a male of 13.54 meters long, and was measured at South Georgia. This whale shows much lower value than other whales in these three parts, though in other parts no abnormality is noted. Excepting this whale, we may conclude that there is no difference of proportion in the posterior part of the body among right whales from three different oceans. Further it is probable that the proportion of the length from notch of flukes to umbilicus against total body length decreases according to the growth of the body, as seen in the other species

TABLE 7. BODY PROPORTION OF NORTH PACIFIC RIGHT WHALE.

Measurements	Ayukawa ♀ immature		Kirittapu ♂ immature		Tonan Maru[1] ♂ immature		Tonan Maru[1] ♀ mature	
	in cm	%	in cm	%	in cm	%	in cm	%
Total length of body	1,165	100.0	1,240	100.0	1,360	100.0	1,780	100.0
Lower jaw, projection beyond tip of snout	30	2.6	40	3.2	—	—	—	—
Tip of snout to blowhole (centre)	225	19.3	233	18.8	305	22.4	409	23.0
Tip of snout to angle of gape	237	20.3	256	20.6	—	—	—	—
Tip of snout to centre of eye	235	20.2	253	20.4	309	22.7	490	27.5
Tip of snout to anterior insertion of flipper	270	23.2	290	23.4	—	—	—	—
Tip of snout to axilla	347	29.8	340	27.4	—	—	—	—
Centre of eye to centre of ear	46	3.9	30	2.4	72	5.3	82	4.6
Notch of flukes to posterior emargination of dorsal hump	416	35.7	—	—	—	—	—	—
Notch of flukes to centre of anus	370	31.8	400	32.3	450	33.1	559	31.4
Notch of flukes to umbilicus	613	52.6	672	54.2	728	53.5	899	50.5
Centre of anus to centre of reproductive aperture	55	4.7	176	14.2	218	16.0	82	4.6
Width of flukes at insertion	125	10.7	—	—	—	—	—	—
Notch of flukes to the nearest part of the anterior margin of the flukes	112	9.6	115	9.3	—	—	—	—
Tail flukes, total spread	483	41.5	—	—	—	—	—	—
Tail flukes, tip to notch	237	20.3	245	19.8	—	—	—	—
Flipper, tip to axilla	203	17.4	229	18.5	—	—	—	—
Flipper, tip to anterior end of lower border	245	21.0	238	19.2	245[2]	18.0[2]	—	—
Flipper, tip to head of humerus	263	22.6	280	22.6	—	—	—	—
Flipper, greatest width	114	9.8	115	9.3	124	9.1	171	9.6
Head length, condyle to tip of snout	325	27.9	330	26.6	—	—	—	—
Skull length, condyle to tip of premaxilla	285	24.5	283	22.8	—	—	—	—
Greatest breadth of skull at orbits	197	16.9	198	16.0	—	—	—	—
Length of mandible (straight)	307	26.4	310	25.0	—	—	—	—
Circumference in front of flippers	676	58.0	746	60.2	—	—	—	—
〃 at umbilicus	686	58.9	780	62.9	—	—	—	—
〃 〃 anus	484	41.5	510	41.1	—	—	—	—
〃 〃 caudal terminus or "small"	170	14.6	184	14.8	—	—	—	—
Depth of body at umbilicus	175	15.0	258	20.8	—	—	—	—
〃 middle of insertion of flipper	209	17.9	—	—	—	—	—	—
〃 anterior insertion of flipper	—	—	245	19.8	—	—	—	—

1) Cited from Matsuura (1942). Lengths in cm were calculated from percentages.
2) Along the lower border.

of whales. The length from anus to reproductive aperture is much greater in male than female in the black right whales too.

TABLE 8. LIST OF RIGHT WHALES MEASURED BY VARIOUS AUTHORS

Body length (cm)	Locality and year		Sex	Authority
	Pacific Ocean			
1,165	Ayukawa, Japan.	1956	♀	Present author
1,240	Kirittapu, Japan.	〃	♂	〃
1,360	South of Kamtchatka.	1941	♂	Matsuura, 1942
1,780	〃	〃	♀	〃
	Atlantic Ocean			
848	Long Island, U.S.A.	1908	♀	Andrews, 1909
869	San Sebastian, Spain.	1853		Fisher, 1871[1)]
1,059	Provincetown, U.S.A.	1909	♀	Allen, 1916
1,199	Taranto, Italy.	1877	♀	Capellini, 1877[1)]
1,227	Wainscott, U.S.A.	1907	♀	Andrews, 1908
1,229	Charleston, U.S.A.	1880	♂	Manigault, 1885[1)]
1,293	Cape cod, U.S.A.	1895	♂	Allen, 1916
1,318	East of Iceland.	1889	♀	Guldberg, 1891[1)]
1,463	Egg Harbor, U.S.A.	1882	♀	Holder, 1883[1)]
1,543	Ré Island, France.	1680	♀	Sequette, 1682[1)]
1,615	Cape Lookout, U.S.A.	1894	♀	Brimley, 1894[1)]
1,646	Amagansett, U.S.A.	1907	♀	Andrews, 1908
	Southern Ocean			
650	South Africa.	1926	♂	Matthews, 1938
1,232	South Georgia.	〃	♂	〃
1,354	〃	〃	♂	〃
1,440	〃	1931	♀	〃
1,523	South Africa.	1926	♀	〃

1) Cited from True (1904)

Figure 10 b. concerns solely to proportions of flippers. The breadth shows fair coincidence each other. As regards to the length of flipper however it seems that the North Pacific specimens have greater value than those from the North Atlantic, if not to those from the Southern Ocean. Andrews (1908) published a photograph of inferior surface of left pectoral fin of the Amagansett whale, which is outlined in figure 12, compared with that of the Kirittapu whale.

It is obvious that the Kirittapu whale has a more pointed flipper at its distal end. The

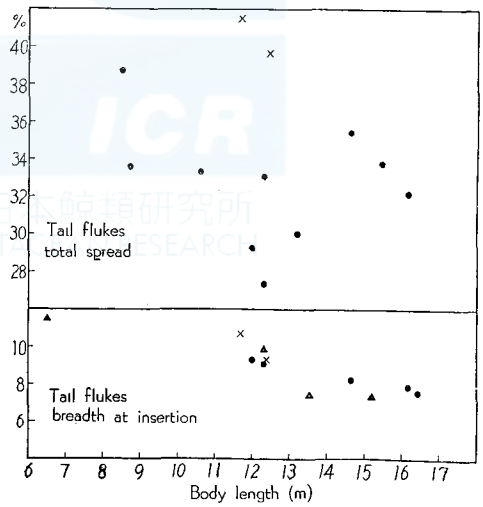
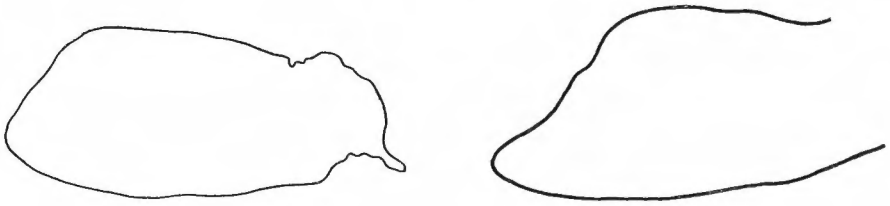
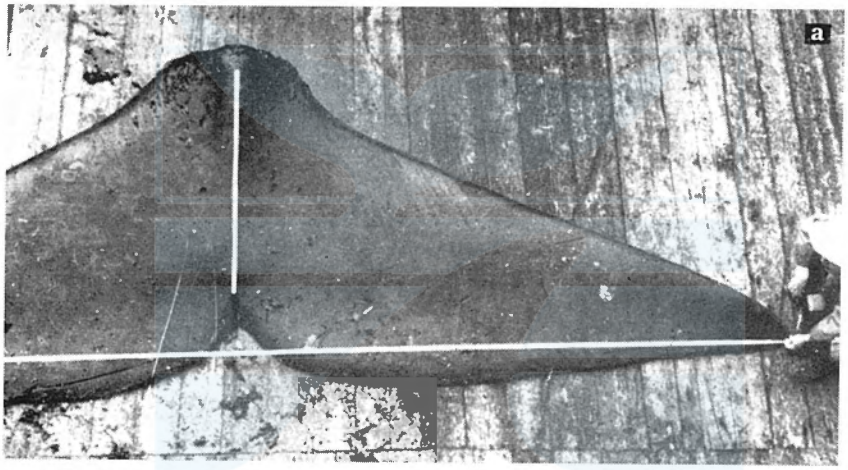


Fig. 11. Body proportion of right whale (5)
× North Pacific right whale
● North Atlantic ,, ,,
▲ Southern ,, ,,



A B

Fig. 12. Flipper of right whale. (Inferior view).
A. North Atlantic right whale. Outlined from photograph (Andrews, 1908)
B. North Pacific right whale. Kirittapu whale.



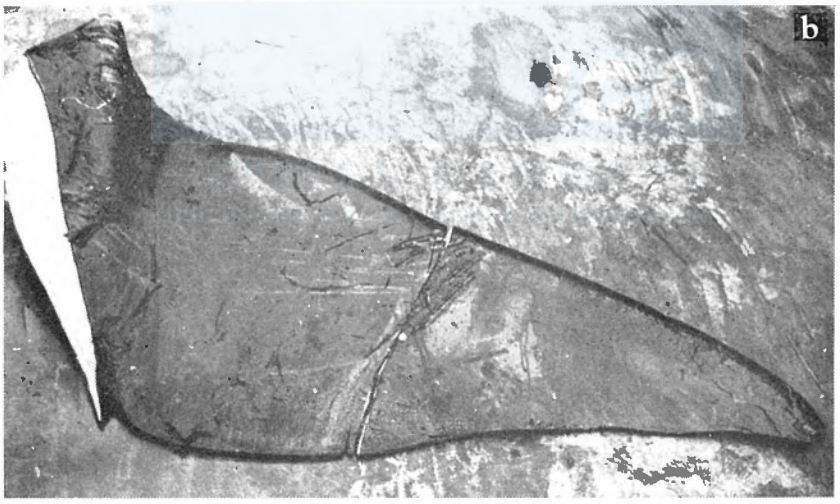


Fig. 13a. Tail fluke of the Ayukawa whale.
Fig. 13b. Right tail fluke of the Kirittapu whale.

Ayukawa whale presented the same general appearance in flipper as the Kirittapu whale. But according to photographs published by Collett (1909), a black-bellied male (plate XXV of his account) is suggested to have obtuse flipper as that of the Amagansett whale and a white-bellied female (plate XXVII of his account) pointed one as that of the Kirittapu whale. Matthews (1938) also presents a number of photographs of the southern right whale and his No. 3560 whale (plate XIII, fig. 2 of his report) is also suggested to have a pointed flipper. It is possible, therefore, that these shapes of flipper should not be deemed as a specific character, nor a difference according to the local race. It is thought that this is only an individual difference (or injured?) and further no correlation is observed according to sex.

Relative size of tail flukes against the total body length is shown in figure 11. The North Pacific specimens seem to have larger tail flukes than those from other oceans, judged from the upper figure in figure 11, which shows the total spread of tail flukes. But there is a wide individual variation and nothing particular may be drawn as to the difference among whales from three different oceans. The breadths at insertion of the tail flukes agree fairly well in the specimens plotted here and it is suggested that the proportion of this breadth decrease with growth of body. In figures 13 a and b are shown the photographs of the tail flukes of the Ayukawa and Kirittapu specimens.

BALEEN AND FOOD

Baleen. Baleen plates numbered 228 on the right side and 236 on the left in the Ayukawa whale and 257 on the right and 259 on the left in the Kirittapu whale. Matthews (1938) records two instances of the southern right whales whose number of plates were examined. These are 235 and 227 on one side. Hence there is no difference between the North Pacific and southern right whales in this respect.

In the Ayukawa whale the longest plate was 89 cm long, from the gum to tip along the outer edge, exclusive of the bristles, and 11.8 cm wide at the gum, and in the Kirittapu specimen the longest was 90 cm long and 14 cm wide. These lengths and widths were measured at the time of the treating of the whale body at the respective landstations. Then each one from each ten group in the row of baleen plates, i.e. 10th, 20th, 30th, etc., were preserved for further study, both from right and left sides for the both specimens. Later these baleen plates were measured at our laboratory, in the following three parts: a. length from the tip, exclusive of the bristles, to the insertion of gum on the inner edge; b. length from the same to a point on the outer edge cut by a

line, drawn parallel with ridges of the plate from the insertion of gum on the inner side ; c. width of plate between two points on the inner and outer edges mentioned above.

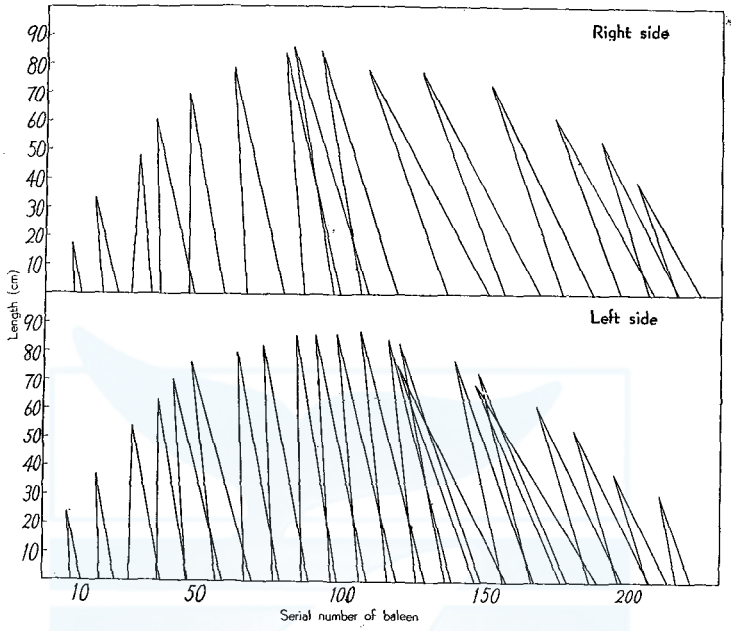


Fig. 14. Sizes of baleen plates selected one from each ten series. Ayukawa whale.

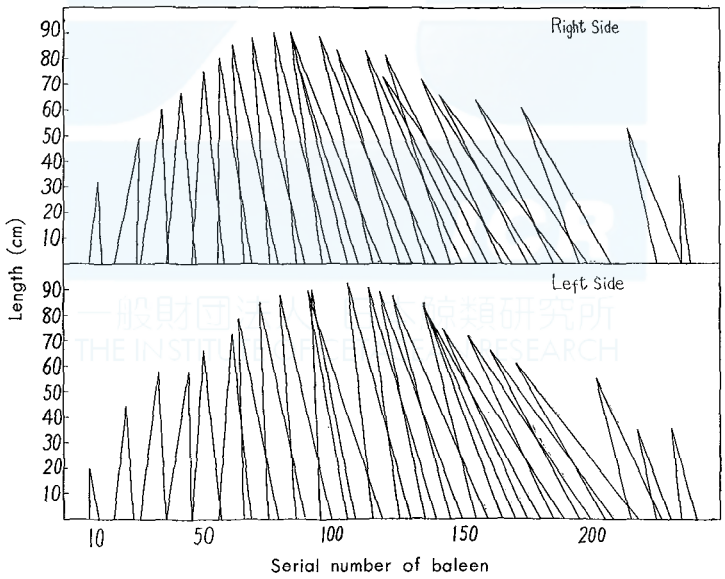


Fig. 15. Sizes of baleen plates selected one from each ten series. Kirittapu whale.

Figures 14 and 15 show the sizes of baleen plates of two specimens, based on these measurements, as well as the variation of sizes according to serial numbers.

Figure 16 a shows a photograph of the selected baleen plates of the Ayukawa specimen, and figure 16 b the Kirittapu specimen. As seen in these photographs some differences are noted between two specimens. In the Kirittapu specimen baleen plates in the anterior portion are bending inward and those in the posterior portion outward more strongly than the Ayukawa whale (compare the 20th and 170th plates in figures 16 a and b). It can not be concluded however, whether or not this is a difference according to sex for lack of more material.

Fig. 16 a. Left baleen plates of the Ayukawa whale. ♀
From left to right: formost one, 20th, 70th, 120th, 170th and two from after portion.

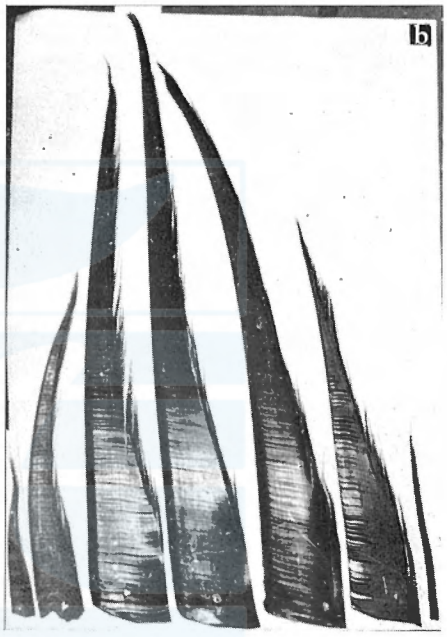


Fig. 16 b. Left baleen plates of the Kirittapu whale. ♂
Left to right: foremost one, 20th, 70th, 120th, 170th, 220th and aftermost one.

In the Ayukawa whale the largest plate among the baleen specimens preserved is the 100th of the right side which measures 101.5 cm long from the base to tip, exclusive of bristles, and its width at base 12.7 cm. In the Kirittapu whale the longest is the 120th of the left side which measures 106.6 cm long and 14.2 cm breadth. The thickness at base is 0.5 cm in both samples. The longest bristle measured 22.5 cm. True (1904) reports that four baleen plates which may be assigned to the North Pacific right whales are kept in the National Museum, Washington, and the longest among them measures 8 feet 6 inches (259 cm). This is much longer than our specimens and longer than any of the

baleen plates reported from the North Atlantic right whales. This will support my opinion that the North Pacific right whale may bigger than that from the North Atlantic, mentioned in the item of size.

The color of the baleen plates are uniform grayish-black in both whales. True (1904) describes that the aforecited whalebone in the National Museum is entirely black. Tomilin (1957) also reports that his specimen from the North Pacific is blackish in color. According to Andrews (1908) the baleen of the Amagansett specimen, including both plates and bristles, was deep blue-black in color, 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 in some specimens from the North Atlantic a few of the foremost plates were white. Such white coloration is not observed in our specimens, nor in literatures cited above. It may naturally be premature to conclude here that such white coloration never occur in the North Pacific right whale.

Food. The Ayukawa whale had an almost empty stomach, and what food remained was half-digested. Examined microscopically by Mr. T. Nemoto of our institute, the contents were considered to the largely *Calanus plumchrus* mixed with some *C. finmarchicus* and *Euphausia pacifica*. The stomach of the Kirittapu whale was almost empty also, and all that could be scraped out could just go into the palm of a man's hand. The scrapings were identified by him as a mixture of *C. plumchrus*, *C. cristatus* and *C. finmarchicus*, and most was *C. plumchrus*. Matsuura (1942) describes that among three right whales taken in 1941 by the "Tonan Maru" expedition in the northern Pacific two were empty and the third contained a small amount of *C. plumchrus* in its stomach. Collett (1909) states that the food of the North Atlantic right whale, both in the Hebrides and off Iceland, was found to be exclusively pelagic crustaceans (the "krill" of Norwegian whalers), a Euphausiid about half an inch long, probably *Boreophausia inermis*. According to Matthews (1938) one southern right whale was recorded as containing some fairly fresh food (krill, *Euphausia superba*) and a lot of darkish fluid. He (1932) also recorded how the southern right whale feeds on shoals of the pelagic *Grimothea* postlarva of *Munida gregaria* off the coast of Patagonia. It may be concluded, therefore, that the right whales from three different oceans are all live on planktonic crustaceans.

REPRODUCTIVE ORGANS

Only a little information was obtained on the reproductive organs from the Ayukawa and Kirittapu whales. The former specimen, a female of

38 feet in body length, was still sexually immature. The genital groove was closed and nothing could seen of the genitalia, but the presence of the virginal band was ascertained, running antero-posteriorly across the entrance to the vagina. In course of dismembering of the whale body a mass consisted of ovaries, uterine cornua, vagina, and ligamentum was put aside for preservation as sample for further study. But unfortunately this mass was thrown into cooker by somebody. It was observed however by myself that these ovaries are still immature and no follicle was seen on their surface.

Fig. 17. Penis of the Kirittapu whale.

In the Kirittapu whale, a male of 41 feet long, the penis was completely withdrawn into the cavity within the genital groove. After flensing it was secured as sample (fig. 17). It was long and slender, being different in shape from those of balaenopterid or sperm whales.

Collett (1904) published a photograph of a male from the Hebrides (plate XXV of his account). Body length of this whale is not given in his account, but, it is possible that this whale is bigger than the Kirittapu specimen, judged from a man standing nearly to the whale in the picture. In this whale the penis is extruded of its major parts from the cavity and its shape is also long and slender, having a strong resemblance to that of the Kirittapu whale.

The penis of the Kirittapu whale was frozen and later was shipped from the landstation to Tokyo, but unfortunately it was decomposed because it was transported as a usual cargo by mistake.

The testes had already putrefied at the time of dismembering, so that

histological examination was impossible, but they were judged as sexually immature by the staff of the Whales Research Institute examined.

OSTEOLOGY

Both skeletons of the Ayukawa and Kirittapu whales were preserved as specimen. All vertebrae, including chevron bones, of the former whale were however damaged greatly by mistake at the time of processing, being thrown into a cooker. Skull, ribs, scapullae and bones of flippers of this whale are now in the "Ayukawa Whale Museum". A perfect set of skeleton was obtained from the latter whale, which has been kept at the "National Science Museum, Tokyo". The skull of the Ayukawa whale is somewhat broken because of grenades which hit inferior part of the head at the time of killing. In this account, therefore, is dealt mainly the skeleton of the Kirittapu whale.

Fig. 18. Skull of right whale (Posterior view)
A. North Atlantic specimen. Outlined from drawing (Allen, 1908). Length 3,650 mm
B. North Pacific specimen. Kirittapu whale. Length 3,230 mm

Skull. The skulls of the two black right whales from the coast of Japan (pls. II–IV) resemble in general appearance to those from the North Atlantic. But there are some difference in visual comparison. The one is the direction of the mastoid processes of the temporals. J. A. Allen (1908) published a picture of occipital view of skull of the North Atlantic right whale (48 feet long) taken at Provincetown, Mass., in April, 1864. In this picture mostoid processes of right and left temporals are directed obliquely inward and two lines along each inner surface of the processes meet with an angle of about 50° (fig. 18 A). In the Ayukawa and Kirittapu specimens, however, the processes directing downward and two lines along each inner surface of the processes run nearly parallel from each other (pl. III and fig. 18 B). This is the most remarkable difference in visual comparison between specimens from two different oceans. But there is a possibility that this is only a difference according to age. Skull length of these three specimens are 3,650, 3,022 and 3,230 mm respectively.

In profile the Japanese specimen (pl. IV fig. 1) has less curved rostrum than two skulls presented by True (1904). But the Provincetwon specimen, cited above, has also less curved rostrum than the True's specimens. The shape of the rostrum of the Japanese specimen agrees with that of the Provincetown specimen in this point, but it seems that the latter is much slender, comparing the figure given by Allen and plate 4.

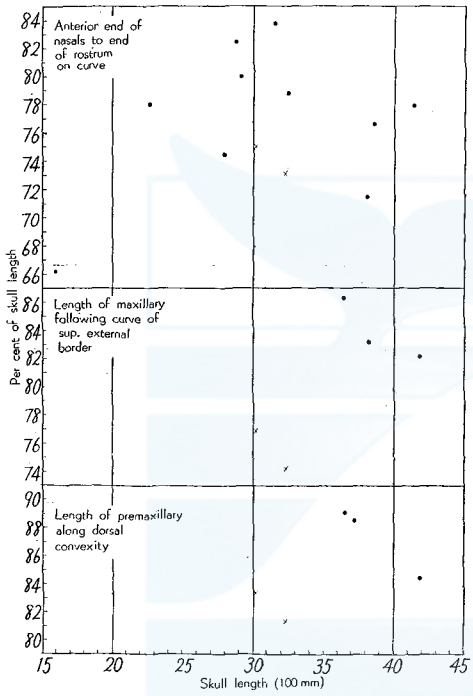


Fig. 19a. Measurements of skull of right whale (1).

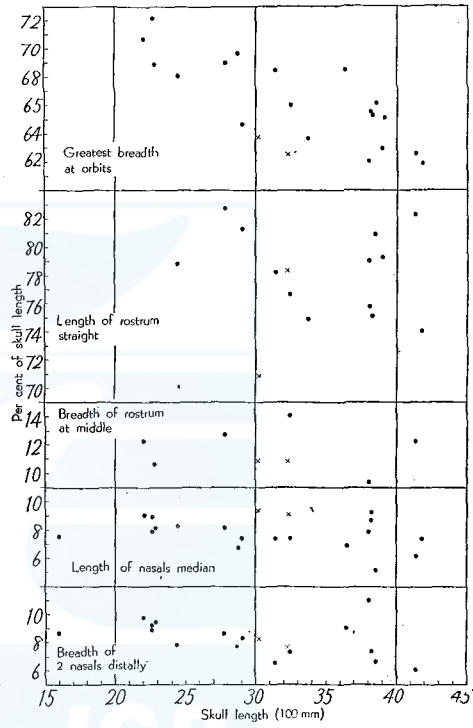


Fig. 19b. Measurements of skull of right whale (2).

× North Pacific right whale ● North Atlantic right whale

True (1904) states that the measurements of the American and the European skulls vary considerably among themselves. He further says it seems probable that the discrepancies are in part due to the shrinking and warping of the various bones of the skull, and the long, slender maxillae and premaxillae, the long orbital processes of the frontals and maxillae, seem quite easily subject to such distortion. It is quite natural, therefore, that there might occur some modification in the shape of the rostrum during the course of preservation. But it seems probable that the shrinking and warping of bones will affect in much lesser extent to the mastoid processes of the temporal. Hence the difference in the direction of the mastoid processes, noted above, should be deemed

as important, if it is not a difference according to age and exist in all Atlantic specimens. The Kirittapu skeleton was shipped from the land-station to the "National Science Museum" in Tokyo as raw bones, and there it had been burried in the earth for about six months, during summer. The photographs and the measurements of this specimen were taken just after the excavation was took place. It is possible, therefore, that this skull was modified very little by the shrinking and warping of the various bones of the skull, if any, at least at the time of measurement and taking photographs.

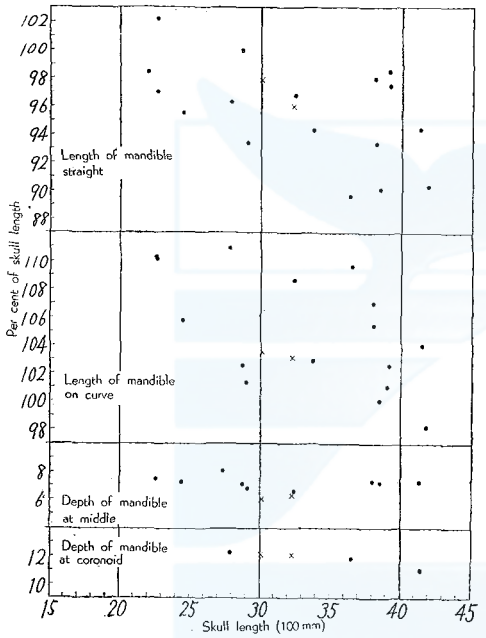


Fig. 20a. Measurements of skull of right whale (3).

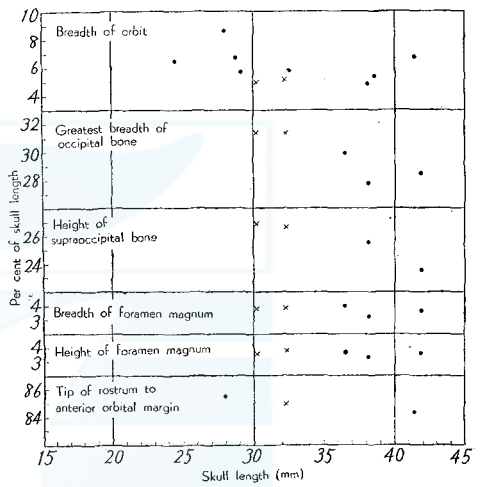


Fig. 20b. Measurements of skull of right whale (4).

× North Pacific right whale
● North Atlantic right whale

In table 9 are shown the measurements of the various parts of the skulls of both specimens from the coast of Japan, in actual measurements in millimeter and percentages against total length as well as percentages against greatest breadth of the skull. In order to compare these proportions to those of specimens from other localities I have cited measurements of the North Atlantic right whales by other authors as far as I can. List of these specimens are tabulated in table 10, arranged in the order of skull length.

All of these measurements are plotted in figures 19 and 20, their skull length being expressed on the horizontal axes and the proportion of various parts against the skull length on the vertical axes. Different symbols are used in these figures in order to make clear the Japanese specimens from those from the North Atlantic.

TABLE 9. SKULL MEASUREMENTS OF NORTH PACIFIC RIGHT WHALE

Measurements	Ayukawa specimen ♀, 1,165cm, imm.			Kirittapu specimen ♂, 1,240cm, imm.		
	in mm	% of length	% of breadth	in mm	% of length	% of breadth
Length of skull, straight	3,022	100.0	156.9	3,230	100.0	159.9
Length of maxillary at superior border, straight	2,190	72.5	113.7	R. 2,350	72.8	116.3
				L. 2,325	72.0	115.1
〃 , following curve of sup. external border	2,320	76.8	120.5	R. 2,420	74.9	119.8
				L. 2,370	73.4	117.3
Length of premaxillary, straight	2,415	79.9	125.4	R. 2,520	78.0	124.8
				L. 2,500	77.4	123.8
〃 , along dorsal convexity	2,518	83.3	130.7	R. 2,630	81.4	130.2
				L. 2,620	81.1	129.7
Length of rostrum, straight	2,143	70.9	111.3	2,530[3]	78.3	125.2
Anterior end of nasals to end of rostrum, on curve	2,265	75.0	117.6	2,360	73.1	116.8
Length from tip of rostrum to anterior orbital margin, straight	—	—	—	R. 2,670	82.7	132.2
				L. 2,820	87.3	139.6
Length from tip of premaxillary to posterior end of pterygoid	2,801	92.7	145.4	R. 2,985	92.4	147.8
				L. 2,975	92.1	147.3
Length from tip of premaxillary to post. end of palatines, median	2,740	90.7	142.3	2,900	89.8	143.6
Length from tip of premaxillary to ant. end of palatines, median	2,347	77.7	121.9	2,590	80.2	128.2
Length of nasals, median	281	9.3	14.6	R. 294	9.1	14.6
				L. 288	8.9	14.3
Breadth of 2 nasals distally	247	8.2	12.8	247	7.6	12.2
〃 proximally	248	8.2	12.9	328	10.2	16.2
Greatest breadth of skull, orbits	1,926[1]	63.7	100.0	2,020	62.5	100.0
Breadth of skull at middle of orbits	—	—	—	1,960	60.7	97.0
〃 ant. and dist. ends of orbital processes of frontal	—	—	—	1,985	61.5	98.3
Breadth of skull at orbital processes of maxillaries	1,722	57.0	89.4	1,900	58.8	94.1
Breadth of skull at squamosals	1,798	59.4	93.4	1,950	60.4	96.5
Breadth of rostrum at middle, straight	326	10.8	16.9	350	10.8	17.3
Breadth of orbital process of frontal at distal end	R. 152	5.0	7.9	R. 167	5.2	8.3
	L. 151	5.0	7.8	L. 166	5.1	8.2
Greatest breadth of occipital bone	950	31.4	49.3	1,010	31.3	50.0
Height of supraoccipital bone, from foramen magnum	813	26.9	42.2	861	26.7	42.6
Transverse breadth of occipital condyles	399	13.2	20.7	396	12.3	19.6
Height of occipital condyle	R. 283	9.4	14.7	R. 275	8.5	13.6
	L. 272	9.0	14.1	L. 275	8.5	13.6
Greatest breadth of foramen magnum	116	3.8	6.0	122	3.8	6.0
Greatest height of foramen magnum	113	3.7	5.9	122	3.8	6.0
Length of mandible, straight	R. 2,958	97.9	153.6	R. 3,100	96.0	153.5
	L. —[2]	—	—	L. 3,100	96.0	153.5
〃 , on curve	R. 3,125	103.4	162.3	R. 3,280	101.5	162.4
	—	—	—	L. 3,380	104.6	167.3
Depth of mandible at middle	R. 182	6.0	9.4	R. 200	6.2	9.9
	—	—	—	L. 210	6.5	10.4
〃 coronoid	R. 363	12.0	18.8	R. 385	11.9	19.1
	—	—	—	L. 390	12.1	19.3
〃 condyle	R. 366	12.1	19.0	R. 382	11.8	18.9
	—	—	—	L. 382	11.8	18.9
Breadth of mandible at condyle	—	—	—	R. 390	12.1	19.3
				L. 392	12.1	19.4

1) Left side broken. Twice right 1/2. 2) Broken.
3) From fronto-maxillary sutures.

As shown in these figures no remarkable difference is noted between the specimens from the North Pacific and North Atlantic. The curved lengths of maxillary and premaxillary seem shorter in the North Pacific specimen, but few samples of the North Atlantic specimens were measured of these lengths (fig. 19 a, centre and bottom). Further there is a wide range of variation in the length from anterior end of nasals to end of rostrum, on curve (fig. 19 a, top). I can not conclude, therefore, that the North Pacific specimen has a shorter maxillary and premaxillary.

TABLE 10. LIST OF SKULLS OF RIGHT WHALES MEASURED BY VARIOUS AUTHORS

Skull length(mm)	Locality	Sex	and age	Body length of whale	Authority
1,600	San Sebastian, Spain. 1854		jr.	24/ 10″	Gasco, 1879[1]
2,212	Taranto, Italy. 1877 (from Gasco's figure)	♀	—		True, 1904
2,268	〃	♀	imm.	39′ 4″	Gasco, 1878[1]
2,270	〃	♀	—		Capellini, 1877[1]
2,286	〃 (from Gasco's figure)	♀	—		True, 1904
2,451	New Jersey, U.S.A. (type *B. cisarctica*)	—	jr.		True, 1904
2,794	Wainscott, Long Island, U.S.A. 1907	♀	jr.	40′ 3″	Andrews, 1908
2,880	Guetaria, Spain. 1878			34′ 3″	Graells, 1889[1]
2,908	Charleston, U.S.A. 1880	♂	—	40′ 4″	True, 1904
3,020	Ayukawa, Japan. 1956	♀	imm.	1,165cm	Present author
3,150	Amagansett, Long Island, U.S.A.				True, 1904
3,230	Kirittapu, Japan. 1956	♂	imm.	1,240cm	Present author
3,251	Long Island, U.S.A.				True, 1904
3,378	Iceland, 1891 (Capt. Berg, II)			42′±	Guldberg, 1894[1]
3,650	Provincetown, U.S.A. 1864			48′	Allen, 1908
3,810	Long Island, U.S.A.				True, 1904
3,820	Scotland.				Turner, 1913
3,828	Iceland. 1890			46′ 4″±	Guldberg, 1893[1]
3 861	Cape Lookout, U.S.A. 1874	♂	ad.	50′ 0″±	True, 1904
3,909	Iceland, 1891 (Capt. Berg, I)	♂	—	47′ 7″	Guldberg, 1893[1]
3,919	Iceland, 1891 (Capt. Berg, III)	♂	—	47′ 7″±	Guldberg, 1893[1]
4,140	Amagansett, Long Island, U.S.A. 1907	♀	ad.	54′	Andrews, 1908
4,190	Edinburg.				Turner, 1913

1) Cited from True, 1904.

The Ayukawa specimen seems to have a shorter rostrum than others (fig. 19 b 2nd figure from the top), but this is due to the different way of measurement. In the Kirittapu whale the length of rostrum was measured from the fronto-maxillary sutures on the dorsal surface of the skull, but in the Ayukawa whale this length was measured from the base, a point on the lateral edge of maxillary at middle of curve, hence smaller. Breadth of occipital bone and height of supraoccipital bone of

the North Pacific specimens are greater than others (fig. 20 b), but again the measurements on these points are still scanty in order to get to any definite conclusion.

From these figures wide variations of proportion are observed mainly in : the length from anterior end of nasals to end of rostrum, the length of maxillary following curve of superior external border, the length of premaxillary along dorsal convexity, the greatest breadth at orbits, the length of rostrum in straight, the length of mandible in straight, and the same on curve. These are the portions of skull which are thought easily be affected by shrinking and warping. Further these measure-

Fig. 21. Lachrymals (right and left) and malars (center) of the Kirittapu whale.

ments are probably subject to different methods of measurements. The proportions of skull, in these figures, other than listed above show much smaller ranges of variation according to individuals. These portion of the skull are hardly be thought to be affected greatly by modification of bones with elapse of time, if it is preserved properly. Also the method of measurement on these portion may not differ greatly by different authors. In these measurements the Japanese specimens agree quite well to that from the North Atlantic.

Lachrymals are long and flat, their lengths of right and left being 335 and 302 mm respectively. Malars are also long and thin and curved at their distal ends. The lengths of right and left malars are 382 and 381 mm respectively, measured in straight, and their straight portion articulate between lacrymal and maxillary (fig. 21)

In conclusion above there is no property which separates definitely the North Pacific right whale from the North Atlantic specimen as distinct, as far as the skull measurements are compared.

Vertebrae. The number of vertebrae of the Ayukawa and Kirittapu whales are different, the formulae of the both specimens being C7, D14, L11, Ca25=57 and C7, D15, L9, Ca25=56 respectively. The vertebral formula for the Kirittapu specimen is erroneously reported as having 10 lumbars and 24 caudals in the Omura's preliminary report (1957). It should be corrected as above.

The number of lumbars is fixed by the position of the first chevron. True (1904) states that the transition from the quite sharp inferior carina of the lumbar vertebrae to the paired inferior ridges of the caudals is not always abrupt, hence it is extremely difficult in many cases to determine correctly the number of lumbars. Andrews (1908) describes that although in both specimens (Amagansett and Wainscott whales) the posterior end of the inferior median carina was distinctly widened upon the 32nd vertebra, yet the 33rd vertebra was the first to bear a chevron and is thus denoted as the first caudal. The Ayukawa and Kirittapu whales were examined *in situ* at the landstations, the former specimen by myself and the latter by the staff of the Whales Research Institute. And it was ascertained that the first chevron was attached to the 33rd vertebra of the Ayukawa whale and 32nd in the Kirittapu whale.

In the Kirittapu specimen the posterior end of the inferior median carina of the 31st vertebra is abruptly thickened (pl. VI fig. 2), but no clear bifurcation is observed. The clear bifurcation is only observable upon the 32nd vertebra (fig. 22). Thus the 32nd vertebra was denoted as the first caudal.

The number of vertebrae of the North Atlantic right whales hitherto examined by various authors are shown in table 11. It will be observed from this table that in the North Atlantic specimens the number of dorsals is uniformly 14, the only one exception is in the San Sebastian (Spain) skeleton which has 13 pairs. According to True (1904), however, in this case Gasco thinks there may have been 14 pairs of ribs. The Ayukawa specimen agrees well in this respect, having 14 pairs of ribs, but the Kirittapu specimen has 15 pairs of ribs as stated later. This is only one exception in table 11.

The number of lumbars is uniformly 11 in the American specimens with one exception of the Long Island specimen (I), which numbers 10. In the European specimens 12 and 13 lumbars are reported by Guldberg and Gasco. True (1904) describes that it is obvious that the question of the real number of lumbars in the species cannot be authoritatively settled until the chevron bones are examined *in situ* in a number of

adults and foetal specimens. His opinion is based on the question whether or not the first caudal are regarded as that in which a thickning of the posterior end of the inferior median carina first occurs. But it was ascertained by Andrews (1908), who observed both Amagansett and Wainscott specimens in the fresh, that the thickning of the inferior median carina first occurs upon the last lumbar. Thus the True's opinion that 11 lumbars may be regarded as the normal number, varying from 10 to 12, was confirmed by evidence observed *in situ*.

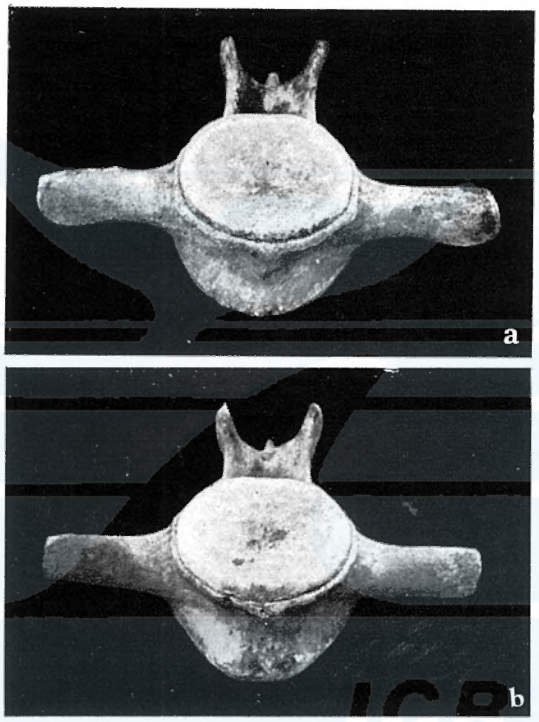


Fig. 22. Vertebrae of the Kirittapu whale.
a 31st. b 32nd.

In the Japanese specimens, the Ayukawa whale agrees well in this respect too, but the Kirittapu whale is exceptional, having only 9 lumbars. In the latter specimen the last lumbar bears a distinctly thickning of the inferior median carina at its posterior end, and further it was ascertained that the 32nd vertebra was the first to bear a chevron, as stated above.

The numbers of caudals are varying from 23 to 26 in the specimens listed in table 11. The Japanese specimens present no difference in this respect. Also in the total number of vertebrae nothing particular is observed between the specimens from the two different oceans.

The measurements of each vertebra of the Kirittapu whale are shown

TABLE 11. VERTEBRAL FORMULAE OF THE NORTH PACIFIC AND NORTH ATLANTIC RIGHT WHALES

Locality	Sex	Age	Author	C	D	L	Ca	Total
Taranto, Italy	♀	adol.	Gasco, 1878	7	14	12	23	56
〃 〃	♀	—	Capellini, 1877	7	14	—	36 —	57
San Sebastian, Spain	—	jr.	Gasco, 1879	7	13	13	23	56
Iceland (I)	—	—	Guldberg, 1893	7	14	12	21(+3)	54(+3)
〃 (II)	—	—	〃 〃	7	14	—	35 —	56
〃 (III)	—	—	〃 〃	7	14	—	35 —	56
Long Island (I), USA	—	—	True, 1904	7	14	10	26	57
〃 〃 (II), 〃	—	—	〃 〃	7	14	11	20+	52+
New Jersey, 〃	—	jr.	〃 〃	7	14	11	24	56
Charleston, 〃	♂	jr.	〃 〃	7	14	11	23	55
Cape Lookout, 〃	♂	ad.	〃 〃	7	14	11	22+	54+
Provincetown, 〃	—	—	〃 〃	7	14	11	24	56
Long Island (III), 〃	—	—	〃 〃	7	14	11	25	57
Amagansett, 〃	♀	ad.	Andrews, 1908	7	14	11	24	56
Wainscott, 〃	♀	juv.	〃 〃	7	14	11	23	55
Provincetown, 〃	—	—	Allen, 1908	7	14	11	24	56
Ayukawa, Japan	♀	jr.	Present author	7	14	11	25	57
Kirittapu, 〃	♂	jr.	〃 〃	7	15	9	25	56

TABLE 12. MEASUREMENTS OF VERTEBRAE OF NORTH PACIFIC RIGHT WHALE. KIRITTAPU WHALE (cont.)

(in mm)

Serial No.	Vertebral No.	Greatest breadth	Greatest height	Centrum: Breadth in front	Centrum: Height in front	Centrum: Length	Neural canal: Breadth	Neural canal: Height	Remarks
1	*C* 1	580	415	422	[4] 325		116	119	[4] articulating face
2	2	641	432	410					
3	3	572	428	284			240		
4	4	475	428	280					
5	5	473	[2] 416+	263		22			[2] breakage
6	6	554	[2] 421+	242		28			
7	7		435	249	[5] 220	53	165	131	[5] aft.
8	*D* 1	534	459	251	212	79	172	128	
9	2	603	476	236	210	93	168	127	
10	3	588	506	237	207	107	174	128	
11	4	552	510	237	206	117	168	125	
12	5	540	520	231	205	121	167	123	
13	6	525	522	223	204	127	163	116	
14	7	[1] 518	528	230	206	133	162	119	[1] twice left half
15	8	538	[3] —	239	212	140	160	119	[3] S.P. broken
16	9	551	[3] —	248	216	148	166	115	
17	10	585	526	255	220	155	167	109	

TABLE 12. MEASUREMENTS OF VERTEBRAE OF NORTH PACIFIC RIGHT WHALE. KIRITTAPU WHALE (cont.)
(in mm)

Serial No.	Vertebral No.	Greatest breadth	Greatest height	Centrum			Neural canal		Remarks
				Breadth in front	Height in front	Length	Breadth	Height	
18	11	616	512	265	222	158	172	105	
19	12	678	514	268	225	161	175	98	
20	13	765	505	275	227	167	177	97	
21	14	837	517	281	234	167	178	98	
22	15	845	541	284	243	176	176	96	
23	*L* 1	847	564	282	258	183	177	90	
24	2	825	572	283	271	180	174	86	
25	3	834	583	286	279	185	174	79	
26	4	840	592	293	275	190	172	78	
27	5	843	584	300	273	195	165	79	
28	6	830	588	296	276	190	154	85	
29	7	819	598	304	283	208	132	83	
30	8	782	597	297	291	209	126	81	
31	9	756	619	302	301	216	118	87	
32	*Ca* 1	721	605	305	305	212	115	84	
33	2	690	569	317	307	210	104	71	
34	3	678	553	312	306	214	90	72	
35	4	643	554	315	310	208	81	60	
36	5	615	545	318	315	206	74	54	
37	6	561	542	312	317	202	67	46	
38	7	507	533	326	325	205	64	46	
39	8	446	517	316	319	202	51	37	
40	9	415	487	316	320	196	35	36	
41	10	378	452	300	317	184	30	29	
42	11	350	428	297	309	181	28	26	
43	12	332	399	288	304	174	24	21	
44	13	313	370	272	276	164	—	—	
45	14	294	316	250	257	153	—	—	
46	15	250	263	223	228	134	—	—	
47	16	219	229	197	192	121	—	—	
48	17	200	198	160	156	112	—	—	
49	18	189	179	145	146	107	—	—	
50	19	179	159	132	128	102	—	—	
51	20	155	137	128	125	92	—	—	
52	21	140	119	114	108	82	—	—	
53	22	121	102	102	91	72	—	—	
54	23	98	82	84	74	66	—	—	
55	24	78	68	66	56	55	—	—	
56	25	55	54	—	—	47	—	—	

in table 12, in actual length of mm. The cervicals (pl. V) are all united into a solid mass, but viewed in profile the neural arches of the 5th, 6th and 7th are entirely free from the preceding ankylosed cervicals and among themselves. The diapophyses of the atlas and axis and those of the 6th and 7th are united and thickned at their extremities. In other cervicals the diapophyses are all free and very thin and much shorter than those united. The parapophyses are only developed on 2nd and 3rd. Each of the centra is separated from the others by well-

TABLE 13. MEASUREMENTS OF SKELETON. NORTH PACIFIC AND NORTH ATLANTIC RIGHT WHALES COMPARED

	Kirittapu	Amagansett[1]	Wainscott[1]
Total length of whale in cm	1,240	1,646	1,227
Length of skull in mm, straight	3,230	4,140	2,794
	% of skull length	% of skull length	% of skull length
Greatest breadth of atlas	18.0	18.4	21.3
〃 depth 〃 〃	12.8	10.4	15.4
Length of diapophysis of atlas	4.5	4.9	5.2
Height of neural spine of atlas	3.0	2.4	4.1
Greatest breadth of 1st dorsal	16.5[4]	16.8[5]	19.3[5]
〃 depth 〃 〃 〃	14.2[4]	13.8[5]	15.9[5]
Depth of centrum 〃 〃 〃	6.6[4]	5.5[5]	7.0[5]
Breadth 〃 〃 〃 〃 〃	7.8[4]	6.7[5]	9.1[5]
Length of diapophysis of 1st dorsal	6.2	6.7	5.9
Height of neural spine of 1st dorsal	3.6	3.3	2.9
Greatest breadth of 1st lumbar	26.2[4]	27.3[5]	30.0[5]
〃 depth 〃 〃 〃	17.5[4]	16.5[5]	17.5[5]
Depth of centrum 〃 〃 〃	8.0[4]	6.1[5]	7.5[5]
Breadth 〃 〃 〃 〃 〃	8.7[4]	7.6[5]	10.0[5]
Length of diapophysis of 1st lumbar	9.0	9.8	10.0
Height of neural spine 〃 〃 〃	6.7	7.6	5.9
Greatest breadth of 1st caudal	22.3[4]	22.0[5]	22.2[5]
〃 depth 〃 〃 〃	18.7[4]	18.4[5]	20.4[5]
Depth of centrum 〃 〃 〃	9.4[4]	7.9[5]	10.9[5]
Breadth 〃 〃 〃 〃 〃	9.4[4]	8.1[5]	11.1[5]
Length of diapophysis of 1st caudal	7.8	7.9	5.9
Height of neural spine 〃 〃 〃	6.6	7.3	7.2
Length of humerus[2]	17.0	13.4	17.2
Length of radius[3]	15.7	12.8	17.2
Length of ulna[3]	13.1	11.0	14.7
Neural spine ends on vertebra	No. 45 (Ca. 14)	No. 45 (Ca. 13)	No. 44 (Ca. 12)
First vertebra with transverse process perforated by vertical foramen	No. 39 (Ca. 8)	No. 39 (Ca. 7)	No. 38 (Ca. 6)
Transverse processes end on vertebra	No. 42 (Ca. 11)	No. 42 (Ca. 10)	No. 41 (Ca. 9)
Anterior zygapophysis first definitely separated on vertebra	No. 16 (D. 9)	No. 15 (D. 8)	No. 17 (D. 10)

1) Andrews, 1908
2) Including epiphyses
3) Excluding epiphyses
4) Anterior
5) Posterior

marked sutures in the lateral view, but in the inferior side the combined bone of atlas and axis extends backwards and covers up to 5th cervicals, thus making only the sutures 5–6 and 6–7 visible.

The posterior epiphysis of the 7th cervical is not fused to its centrum. The epiphyses of all vertebrae, other than cervicals, are not ankylosed to their centra, hence the whale is physically immature.

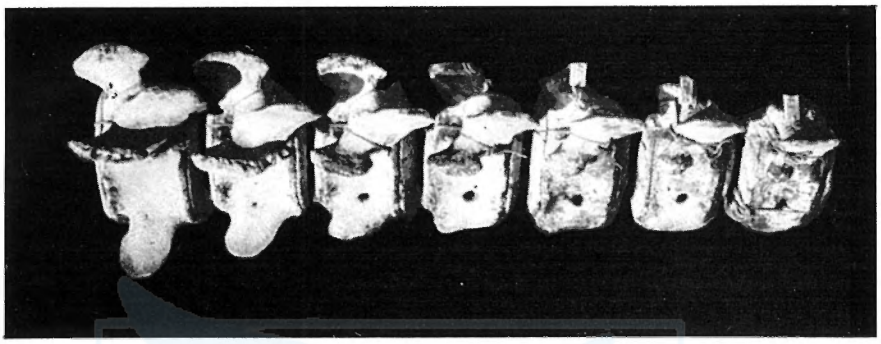


Fig. 23. Caudal vertebrae of the Kirittapu whale. Dorsal view. Note the vertical foramina on the transverse processes.
Left to right: 37th–43rd.

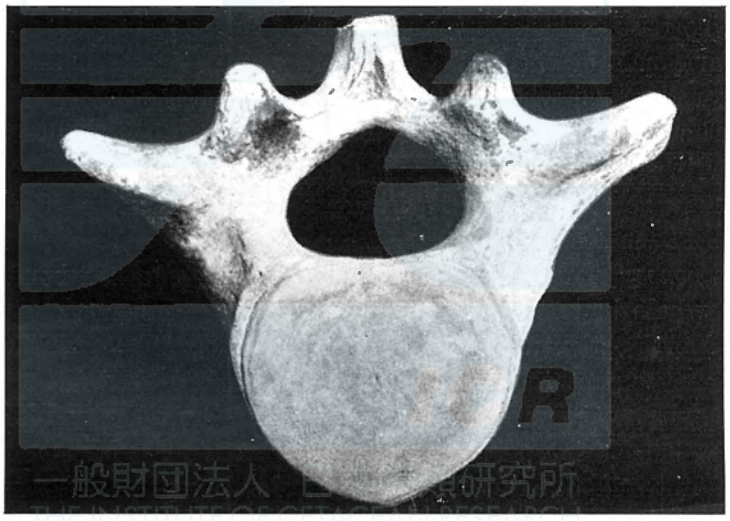


Fig. 24. 16th vertebra of the Kirittapu whale. Anterior view.

In table 13 are shown the measurements of the skeleton of the Kirittapu whale, reduced to percentages of the skull length, in order to compare with two specimens from the North Atlantic, reported by Andrews (1908). It will be observed from this table that there is no remarkable difference of the vertebrae between the specimens from two different oceans. Most of the measurements of the Kirittapu specimen fall in the range of variation of those of two specimens from the North Atlantic. The neural spine ends on the 45th vertebra in the Kirittapu and Amagansett specimens, and on 44th in the Wainscott specimen. The first ver-

tebra with transverse process perforated by vertical foramen is the 39th in the former two specimens, and 38th in the latter. A quite similar case is the vertebral number on which transverse processes end. In the Kirittapu specimen appear the vertical foramina definitely on both transverse processes of the 39th vertebra, but there are sign of such foramen on the 38th and also on the 37th in lesser degree (fig. 23).

The first vertebra on which anterior zygapophysis definitely separated is different according to these three specimens, in the Kirittapu whale on the 16th (fig. 24) and in the two American specimens on the 15th and 17th respectively.

In figure 25 the vertebrae of the Kirittapu whale are compared with those of sei whale, a female of 43 feet long. The body length of this sei whale is longer only by 2 feet than the Kirittapu specimen of right whale. Its vertebral formula is C7, D14, L13, Ca22=56. This skeleton was sent to the Staatliches Museum für Naturkunde, Stuttgart, Germany, but I was able to measure the bones before shipment. Measurements of this specimen are also shown in figure 25.

It will be observed clearly from this figure that the vertebral bodies and neural canals of the right whale are much greater in diameter, but less thicker than sei whale. The spinous processes are longer in sei whale. The transverse processes too, especially in the dorsal region, are longer in sei whale.

These may be the differences in vertebrae between the balaenid and balaenopterid whales.

Chevron bones. The Ayukawa whale had 12 chevron bones and the Kirittapu whale had 15. The numbers of chevron bones ever recorded from the North Atlantic specimens vary from 9 to 12. This number, however, may suject to individual variation and has a little value for taxonomic purpose. In the Kirittapu specimen the right and left laminae of the 1st, 2nd and the last five chevrons are not united together (fig. 26). The first and the last five are considerably smaller than the rest. The fourth is the biggest.

It table 14 are shown the measurements of each chevron bone of the Kirittapu specimen.

Ribs. The number of pairs of ribs is uniformly 14 in specimens from the North Atlantic. The Ayukawa specimen has also 14 pairs of ribs, but the Kirittapu specimen has 15, being only one exceptional case ever recorded (pl. VII). The first rib is single headed in both specimens. The measurements of each rib are shown in table 15 for both specimens. The difference between the Ayukawa and Kirittapu specimens, other than the number, is the greater breadth of the first rib at its distal end in the former. This is clearly shown in plate VIII (fig. 1). The last rib is

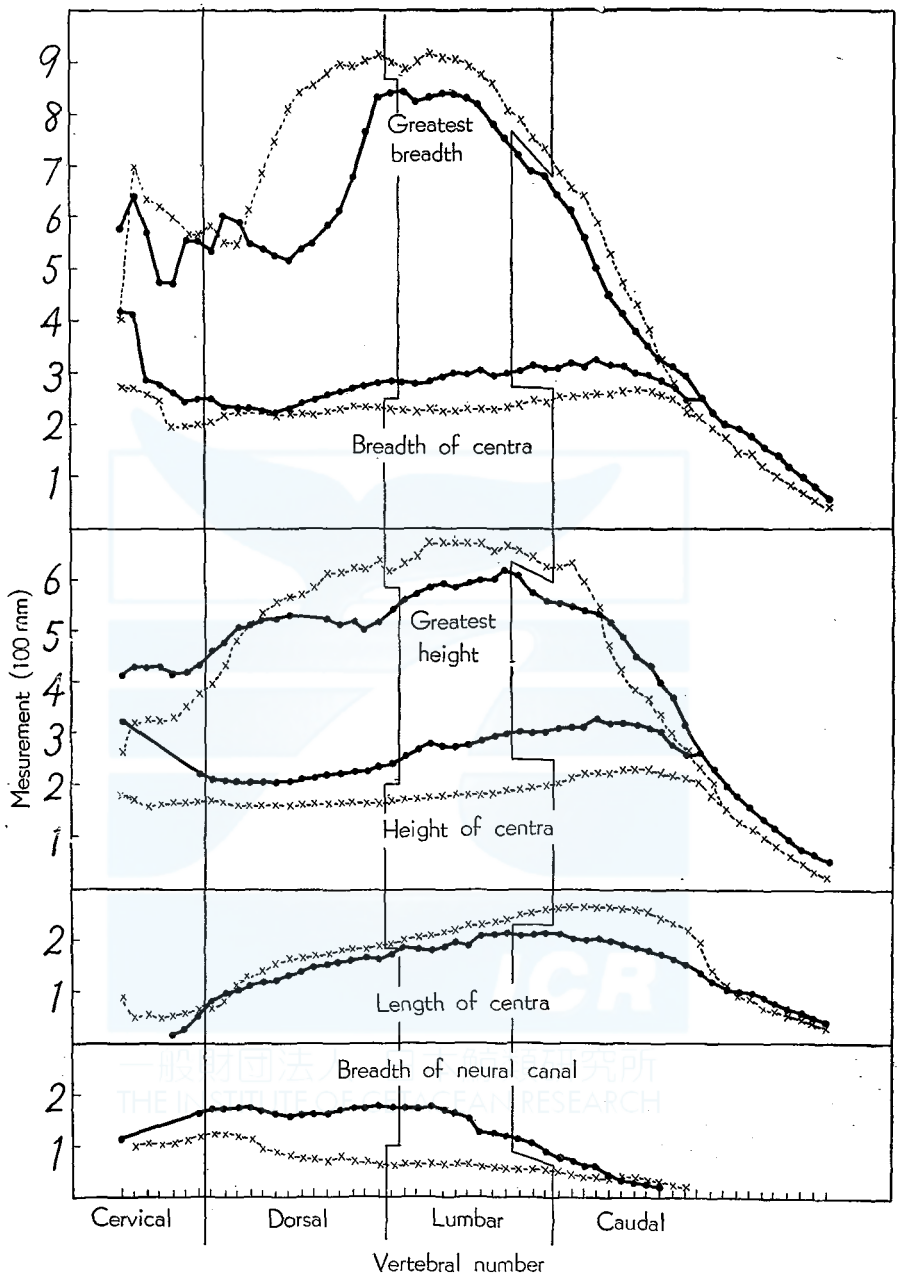


Fig. 25. Measurements of vertebrae of right whale compared with sei whale,
●—● Right whale ×—× Sei whale

TABLE 14. MEASUREMENTS OF CHEVRON BONES
KIRITTAPU WHALE (in mm)

No.	Height	Breadth	Distance[1]	Remark
1	126 110	67 66	—	not united
2	184 197	120 105	—	〃 〃
3	217	150	187	
4	222	163	187	
5	222	147	183	
6	214	138	188	
7	183	140	190	
8	158	124	189	
9	142	116	183	
10	129	114	170	
11	112 —	98 —	—	not united right lamina missed
12	99 93	83 87	—	not united
13	60 57	64 61	—	〃 〃
14	—	—	—	broken
15	—	—	—	〃

1) Distance of 2 laminae at their superior margin (outside).

TABLE 15. MEASUREMENTS OF RIBS OF NORTH PACIFIC
RIGHT WHALE (in mm)

Rib No.	Ayukawa				Kirittapu			
	Right		Left		Right		Left	
	Length[1]	Breadth[2]	Length[1]	Breadth[2]	Length[1]	Breadth[2]	Length[1]	Breadth[2]
1	1,025	228	1,036	234	1,107	144	1,067	124
2	1,419	136	1,385	129	1,422	152	1,386	128
3	1,561	120	1,545	121	1,674	116	1,637	104
4	1,610	106	1,609	113	1,737	102	1,732	105
5	1,640	104	1.647	105	1,776	98	1.761	94
6	1,650	101	1,644	97	1,799	97	1,784	94
7	1,581	79	1,587	76	1,769	91	1,754	88
8	1,532	68	1,541	68	1,654	69	1,674	65
9	1,471	68	1,482	67	1,599	69	1,597	62
10	1,409	63	1,422	64	1,514	65	1,535	67
11	1,346	58	1,363	55	1,474	64	1,487	67
12	1,239	57	1,238	57	1,421	66	1,430	67
13	1,148	54	1,111	55	1,310	52	1,343	59
14	541	40	590	35	983	37	971	42
15	—	—	—	—	653	31	604	43

1. Straight
2. At distal end

much shorter than that immediately succeeding in both specimens.

Sternum The Kirittapu whale has a sternum of rudely elongated heart-shaped, its height being 399 mm and its breadth 256 mm (fig. 27 a). Thickness of the sternum is 74 mm.

Only a few sterna have been recorded from the North Atlantic specimens, but they are all rudely heart-shaped. True (1904) reports that only the skeleton in the American Museum, New York, has the sternum of cruciform and says that one might almost believe that it did not belong to the skeleton to which it is attached. According to Allen (1908) however, this sternum is a restoration in wood, doubtless modeled after that of a fin whale, supplied by the preparator. Other sterna ever recorded are all more or less heart-shaped form, though there are great individual variation in the form. The sternum of the Kirittapu whale agrees in this point.

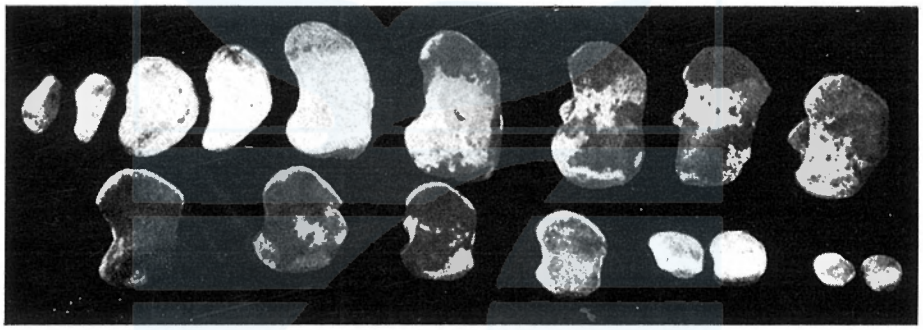


Fig. 26. Chevron bones of the Kirittapu whale. The last two are excluded because of breakage.
From left to right:
Upper; 1st (right and left), 2nd (right and left), 3rd, 4th, 5th, 6th and 7th.
Lower; 8th, 9th, 10th, 11th, 12th (right and left) and 13th (right and left).

Hyoid. The hyoid bones of the Kirittapu whale are shown in figure 27 b. The combined basihyal and thyrohyals is 573 mm in transverse diameter and 120 mm depth at median. Basihyal and thyrohyals are united completely, but the sutures are still visible. The median notch is rather shallow and wide. Length of the right and left stylohyals are 256 and 244 mm respectively.

The hyoid bones of the Ayukawa whale are similar in shape, but the basihyal and thyrohyals are not ankylosed into a mass.

Scapula. The scapula of the Ayukawa and Kirittapu specimens agrees well in general form with that of specimen from the North Atlantic (pl. VIII fig. 2). It is nearly symmetrically fan-shaped, the suprascapula border is regularly rounded. The glenoid border presents an oval outline, with the antero-posterior diameter greater than the transverse. The coracoid is undeveloped. The difference in the scapulae of both Japanese speci-

mens are confined chiefly to the acromion. The length of the acromion of the Ayukawa specimen is about twice of that of the Kirittapu specimen. In the latter specimen the length of acromion is smaller than the breadth. Allen (1908) states that the average width of the acromion process is rather more than one-half of the length, hence the Kirittapu specimen may be exceptional.

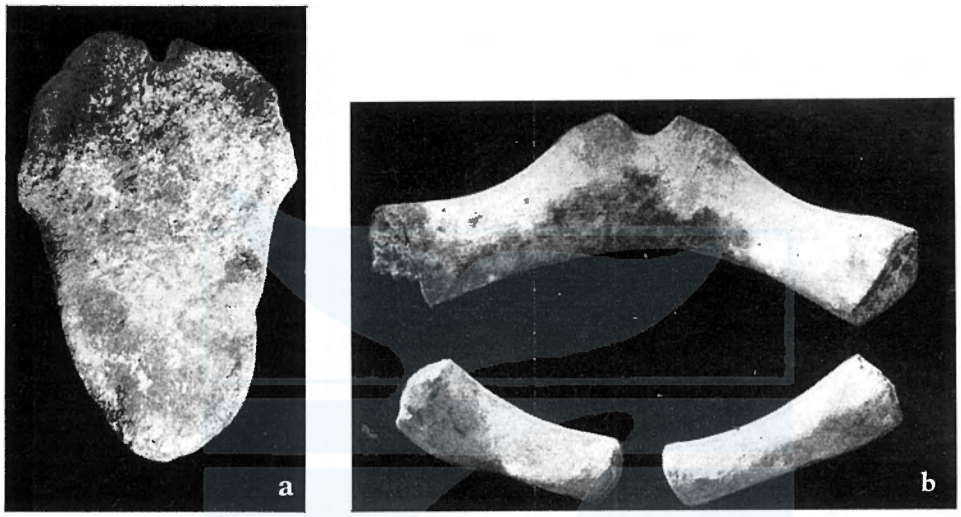


Fig. 27. Sternum and hyoid bones of the Kirittapu whale.
a. Sternum b. Upper: Combined bone of basihyal and thyrohyals.
Lower: Stylohyals.

TABLE 16. MEASUREMENTS OF SCAPULAE OF NORTH PACIFIC RIGHT WHALE (in mm)

Measurement	Ayukawa		Kirittapu	
	Right	Left	Right	Left
Greatest breadth	868	873	1,060	980
〃 height	689	697	779	775
Length of acromion	155	117+	65	65
Breadth of acromion	—	—	77	77
Breadth of glenoid fossa	330	328	343	344
Depth of glenoid fossa	245	251	278	276

The measurements of the scapulae of both Japanese specimens are shown in table 16.

Humerus, Radius and Ulna. The humerus, radius and ulna of the Kirittapu whale are shown in plate VIII. The humerus is a short and thick bone, constricted around the middle. The proximal and distal epiphyses of the humerus are all free and not united to their body. In the Ayukawa specimen also both epiphyses are not ankylosed. The radius is broad

and flat distally, proximal end being much less expanded and much thicker. The ulna is fan-shaped in its distal portion and much constricted than the radius at middle. The proximal and distal epiphyses of the radius and ulna are all free in both specimens. The measurements of the humerus, radius and ulna of the Ayukawa and Kirittapu whales are given in table 17.

Carpals. In the right and left flippers of the Ayukawa specimen there are five carpal bones of different size. They are irregularly rounded in shape and the long and short diameters of the largest are 74 and 64mm, and the smallest 33 and 22 mm. In the Kirittapu specimen the carpal bones were still wholly concealed in the hardened cartilage, when the flippers were excavated from earth after six months of burying during the summer (pl. VIII).

TABLE 17. MEASUREMENTS OF HUMERUS, RADIUS AND ULNA OF NORTH PACIFIC RIGHT WHALE (in mm)

Measurement	Ayukawa		Kirittapu	
	Right	Left	Right	Left
Humerus[1]				
Greatest length	500	492	556	549
Breadth at proximal end	349	343	375	404
〃 〃 distal end	303	302	316	307
Radius[2]				
Length at middle	498	496	505	506
Breadth at proximal end	242	241	263	259
〃 〃 distal end	363	359	394	398
Ulna[2]				
Length at middle	441	443	422	423
Breadth at proximal end	175	162+	185	185
〃 distal end	234	237	288	291

1) Including epiphyses 2) Excluding epiphyses

Phalanges. The formula for the phalanges of the Kirittapu specimen is I_3 II_5 III_6 IV_4 V_4. This is carefully confirmed by arranging the digits and cartilages, which were still remained at the time of examination. This formula correspond with the Ayukawa series, with one slight difference. The right flipper of the Ayukawa specimen agrees with this formula, but the left digit V has 3 phalanges, while others correspond. Andrews (1908) gives the formula I_1 II_4 III_5 IV_4 V_3 for the specimen from the North Atlantic, although this formula agrees with that of none of the skeletons in American Museums as shown by True (1904), which True himself has stated that the series of phalanges in all the mounted American skeletons is imcomplete.

According to Allen (1908), however, his Provincetown specimen has

the phalangeal formula I_2 II_5 III_6 IV_4 V_3. It may be that, therefore, there is an individual difference in the number of phalanges. As already stated the shape of the flipper is deemed to subject to individual difference, and it is probable that this is a reflection of difference in number of phalanges. I should like to point out here again that the flippers of the Japanese specimen are more pointed at its distal end than that of the specimen presented by Andrews (1908) (fig. 12).

TABLE 18. MEASUREMENTS OF PHALANGES OF NORTH PACIFIC RIGHT WHALE. KIRITTAPU SPECIMEN (in mm)

Measurement	Right					Left				
	I	II	III	IV	V	I	II	III	IV	V
Length										
1st qhalanx	121	149	175	167	137	113	154	176	160	138
2nd 〃	127	171	189	162	133	134	173	189	156	128
3rd 〃	83+	156	176	128	112	95	154	177	133	110
4th 〃	—	130	148	63	69	—	135	150	62	70
5th 〃	—	91+	107	—	—	—	99	111	—	—
6th 〃	—	—	86	—	—	—	—	75	—	—
Proximal breadth										
1st phalanx	101	138	136	135	138	97	135	137	132	139
2nd 〃	75	122	136	97	88	75	125	136	93	88
3rd 〃	39+	109	130	70	58	45	111	130	68	58
4th 〃	—	83	100	49	34	—	86	102	52	37
5th 〃	—	59	77	—	—	—	59	74	—	—
6th 〃	—	—	48	—	—	—	—	45	—	—
Distal breadth										
1st phalanx	90	129	135	111	105	88	130	135	110	108
2nd 〃	56	128	144	85	73	57	132	143	81	73
3rd 〃	broken	96	113	57	44	16	93	111	56	43
4th 〃	—	70	83	26	20	—	69	82	30	20
5th 〃	—	31+	59	—	—	—	37	53	—	—
6th 〃	—	—	30	—	—	—	—	27	—	—

The measurements of phalanges of the Kirittapu specimen are shown in table 18.

Pelvic bones. The pelvic bones of the Ayukawa and Kirittapu whale have been preserved and now being under examination by other researchers.

CONCLUSIONS

Two black right whales, 38 feet female and 41 feet male, were killed in 1956 in the coasts of Japan by a special permission for scientific researches. The external and internal characters of the whales were studied. Records of recent sightings of the North Pacific right whales were also studied in relation to their migration. The results of these studies may be summarized as follows:

1. The North Pacific right whales appear in the waters east of North-East Honshu and south of Hokkaido in April, staying there in May and then they proceed to further north. In June they arrive in the Bering Sea and its nearby waters and staying there during the whole summer. In these months a number of black right whales were also sighted in the eastern part of the Bering Sea.

Of the 164 instances of sightings of the black right whales about 68 per cent were met solitary. The highest numbers in a school was 4.

2. The North Pacific right whale may probably attains more longer body length than the North Atlantic right whale.

3. The total body weight of two black right whales were about 23 and 22 metric tons respectively, which are much heavier than sperm whale of similar size.

4. The body color of two whales was uniform dark blue-black, except a small white patch on the umbilicus of the female.

5. Both whales had white linear scars on their bodies. They were thickly infected by whale lice, amphipod crustaceans, and most remarkably on the "bonnet" and other callosities.

6. The size and location of these callosities showed no difference from those from the North Atlantic and southern hemisphere.

7. The body proportion of the North Pacific right whale has also showed no difference, compared with black right whales from different oceans.

8. Number of baleen plates were 228-259 on each side of the upper jaw. Color of baleen plates are uniform grayish-black and no white plate was observed.

9. *Calanus plumchrus, C. finmarchicus, C. cristatus and Euphausia pacifica* were found from the stomach of the two whales.

10. Both whales were sexually immature.

11. The skull measurements of the two whales provided no evidence as to the distinction of the North Pacific right whale from the North Atlantic right whale.

12. In the posterior view of the skull, however, the direction of the mastoid processes of the temporals differed from a skull of the North Atlantic right whale. But it is probable that this is a difference according to age.

13. The vertebral formulae for the two specimens are C7, D14, L11, Ca 25=57 and C7, D15, L9, Ca25=56. The former agrees to that reported for the North Atlantic specimens, while the latter exceptional.

14. The number of chevrons of both whales were 12 and 15 respectively.

15. The number of pairs of ribs of one specimen was 14, which is the uniform number in the North Atlantic specimens. But the other

specimen had 15 pairs of ribs. This is the single exception ever recorded.

16. The sternum, scapula, humerus, radius and ulna showed no special feature.

17. The phalangeal formula for two specimens was I_3 II_5 III_6 IV_4 V_4, and differed from the formulae reported for the North Atlantic specimens. The shape of the flipper, however, differs individually. Hence the numbers of phalanges may subject to individual variation.

18. From the foregoing statements it may be concluded that there is no specific distinction which separates definitely the North Pacific right whale from the North Atlantic right whale. The name *Eubalaena glacialis*, therefore, should be applied to the North Pacific right whale.

ACKNOWLEDGEMENTS

This work was enabled by a special permission for taking of two black right whales for scientific purposes granted by the Fisheries Agency of Japanese Government. Arrangements of the application were made by the Japan Whaling Association.

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I would like to thank the Ayukawa Whale Museum and the National Science Museum in Tokyo for the help of their staff in examination of skeletons.

Sincere thanks are due to the whaling companies concerned, to the Nihon Kinkai Hogei K. K. and Nitto Hogei K. K. The right whales were taken by catchers of these companies and were disected at their landstations. Further they supported the researches financially. I should like also to thank these companies for facilities presented to me and other members of the research group at their landstations during our stay.

The data of recent sightings of the right whales were generously supplied by the Nihon Suisan K. K., Taiyo Gyogyo K. K., Kyokuyo Hogei K. K. and by two companies listed above. Mr. T. Kawakami of the Fisheries Agency has also kindly supplied the data which he himself collected during several years on board factory ships operated in the northern Pacific. Without their co-operation the present report may be obliged to change its contents.

The drawings were made by myself, but photographs were taken by the staff of the Whales Research Institute, including myself, except one shown in figure 2, which was taken by Mr. S. Watase of the Taiyo Gyogyo K. K.

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Fig. 1. North Pacific right whale. Ayukawa specimen. Female. 1,165 cm long.

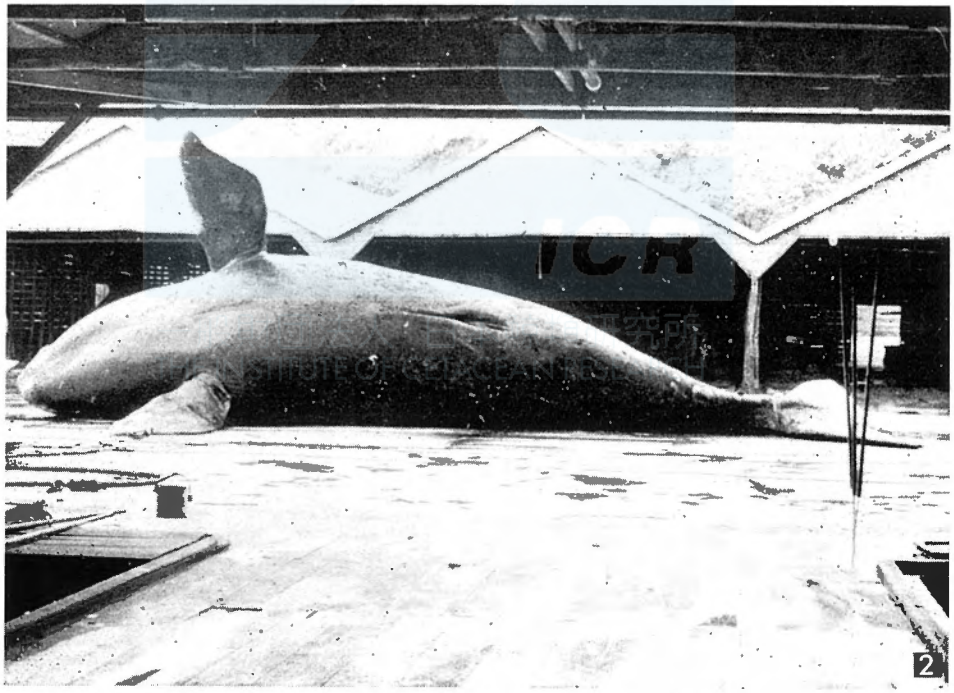

Fig. 2. North Pacific right whale. Kiritttapu specimen. Male. 1,240 cm long.

Fig. 1. Skull of North Pacific right whale. Kirittapu specimen. Dorsal view.

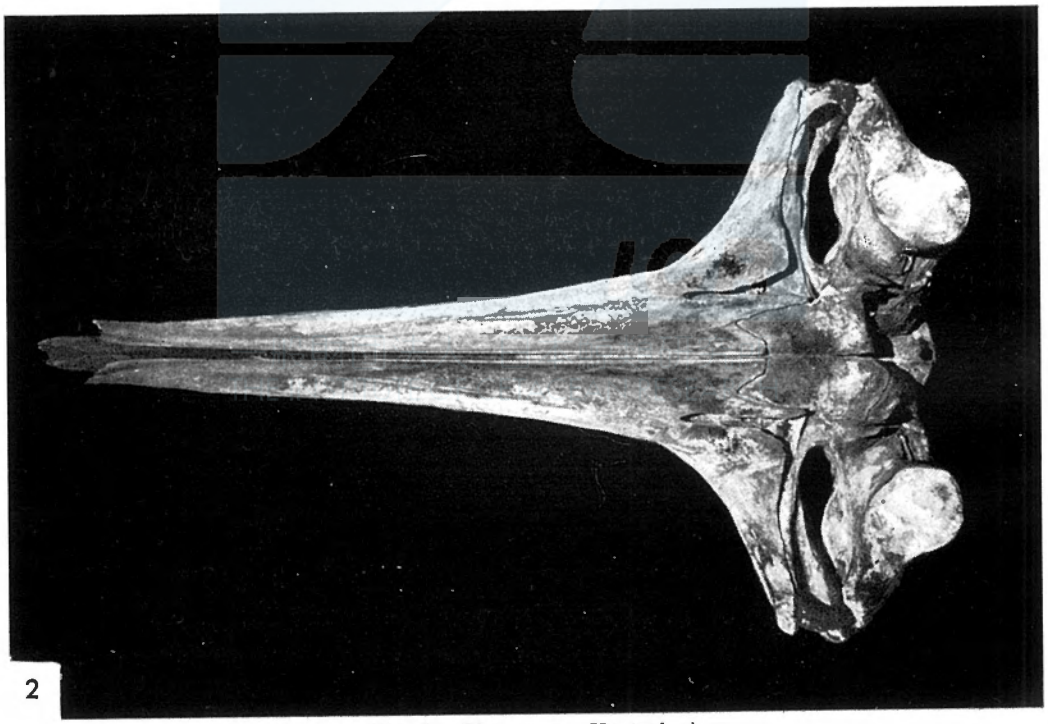

Fig. 2. The same. Ventral view.

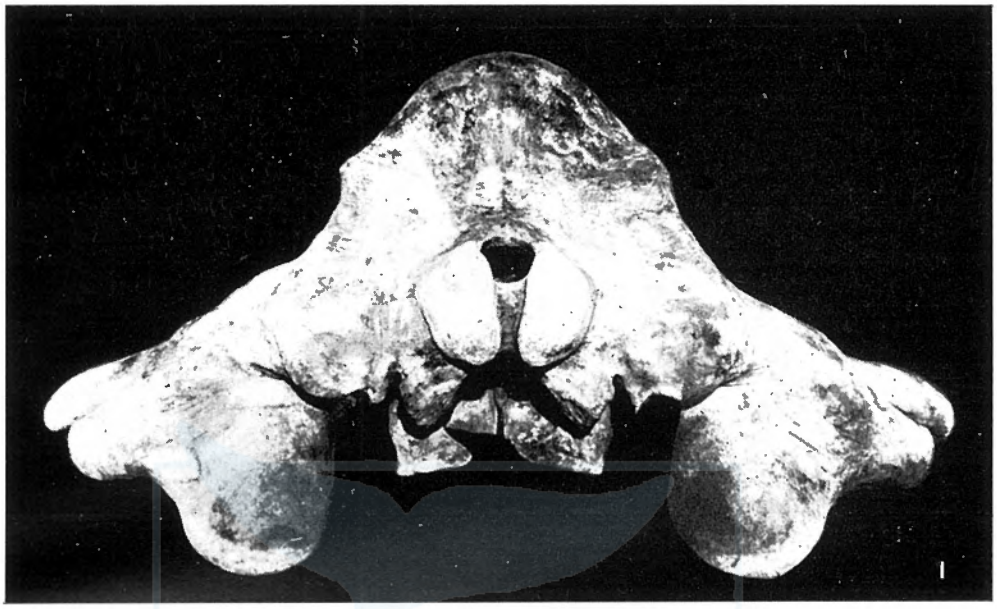

Fig. 1. Skull of North Pacific right whale. Kirittapu specimen. Posterior view.

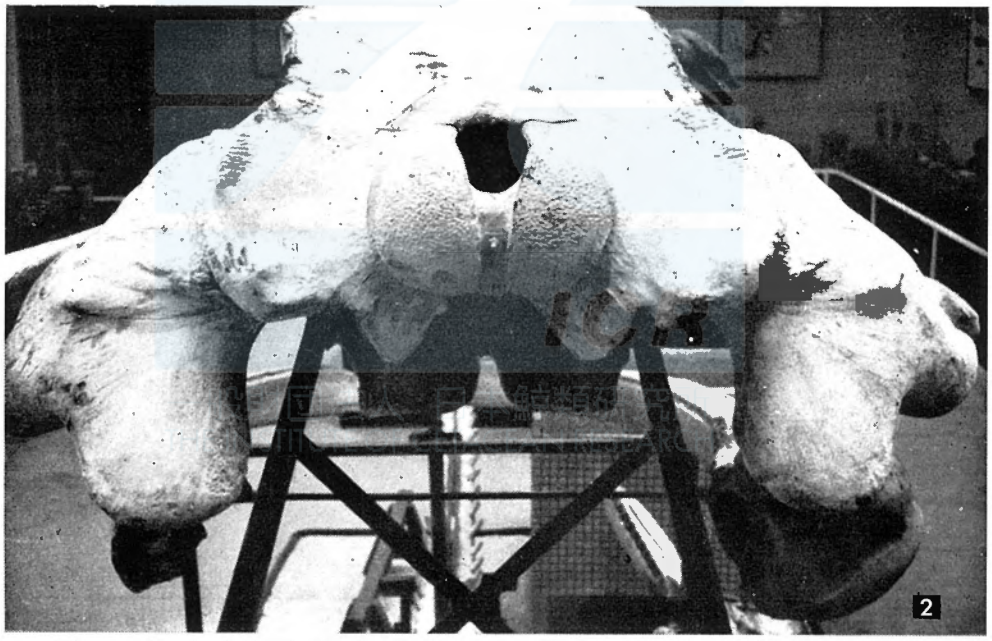

Fig. 2. Skull of North Pacific right whale. Ayukawa specimen. Posterior view.

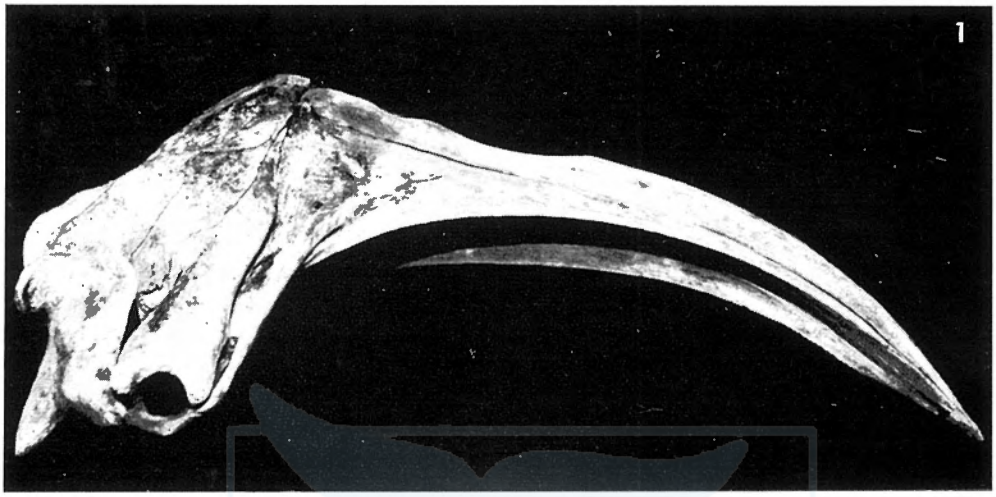

Fig. 1. Skull of North Pacific right whale. Kirittapu specimen. Lateral view.

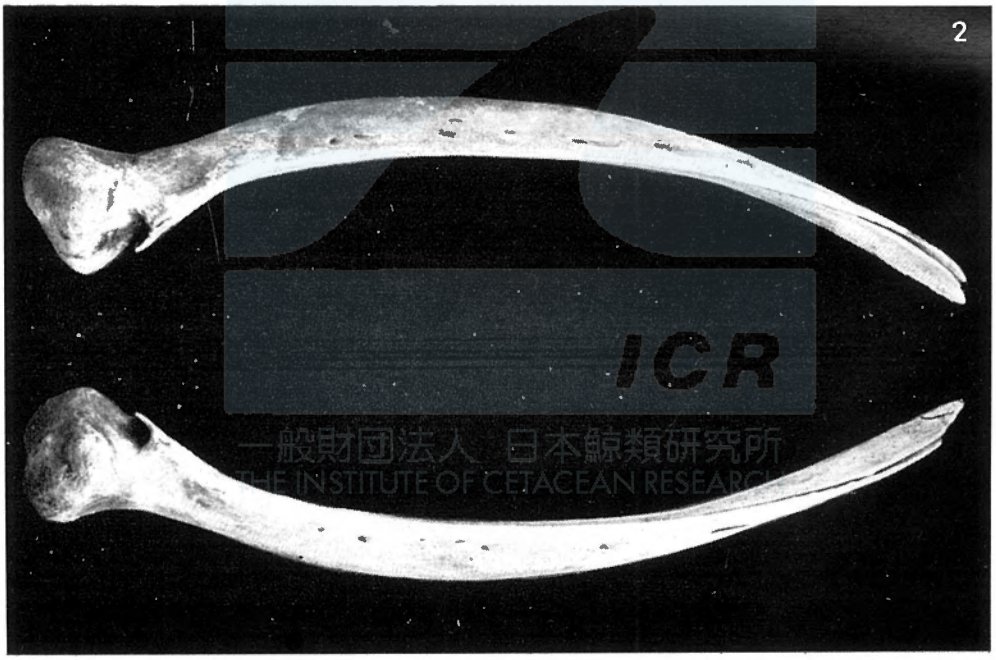

Fig. 2. Mandibles of North Pacific right whale. Kirittapu specimen. Dorsal view.

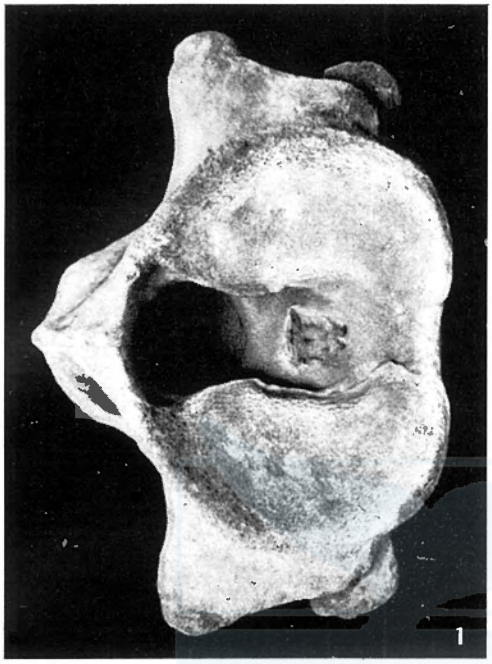

Fig. 1. Cervical vertebrae of the Kirittapu whale. Anterior view.

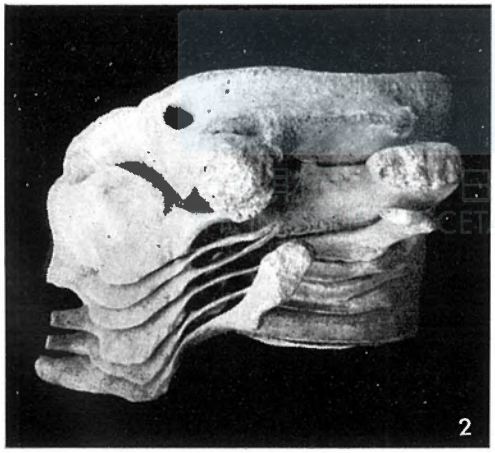

Fig. 2. The same. Lateral view.

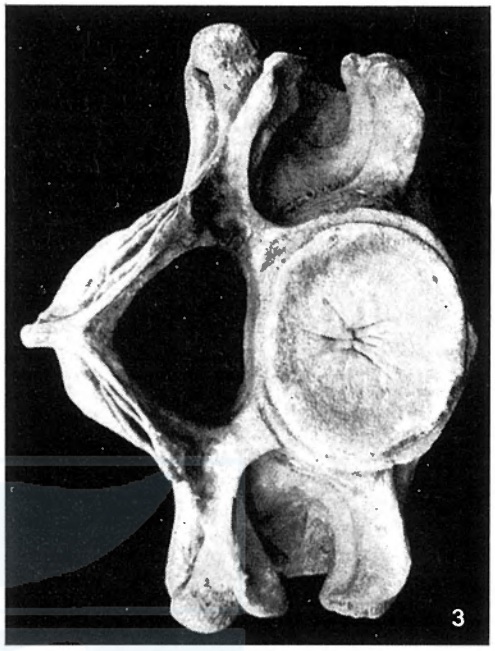

Fig. 3. The same. Posterior view.

Fig. 4. The same. Ventral view.

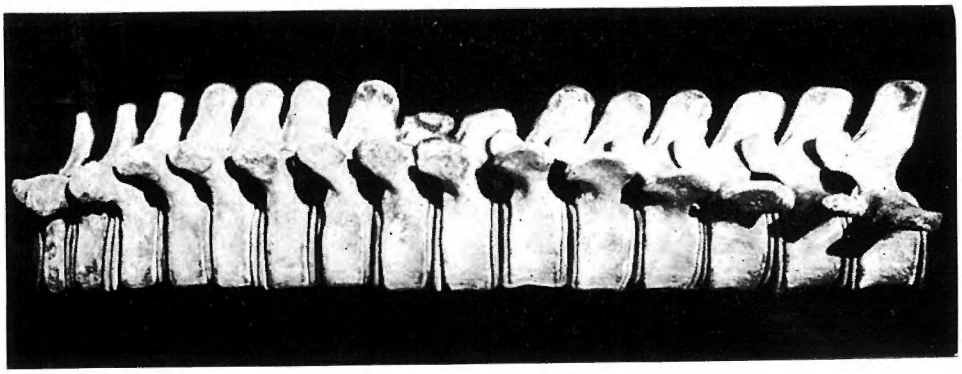

Fig. 1. Dorsal vertebrae of the Kirittapu whale.

Fig. 2. Lumbar vertebrae of the Kirittapu whale.

Fig. 3. Caudal vertebrae of the Kirittapu whale. 1st—11th.

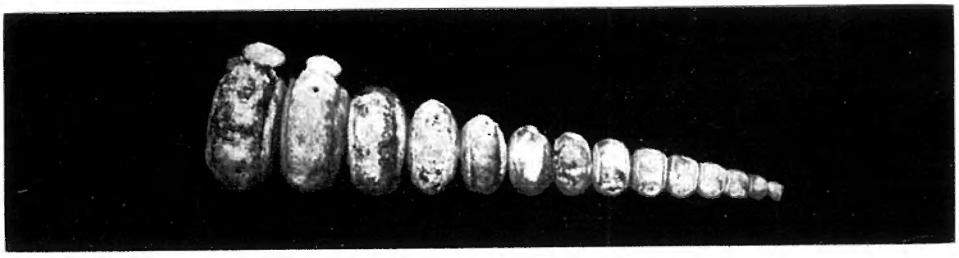

Fig. 4. Caudal vertebrae of the Kirittapu whale. 12th—25th.

Fig. 1. Right ribs of the Kirittapu whale.

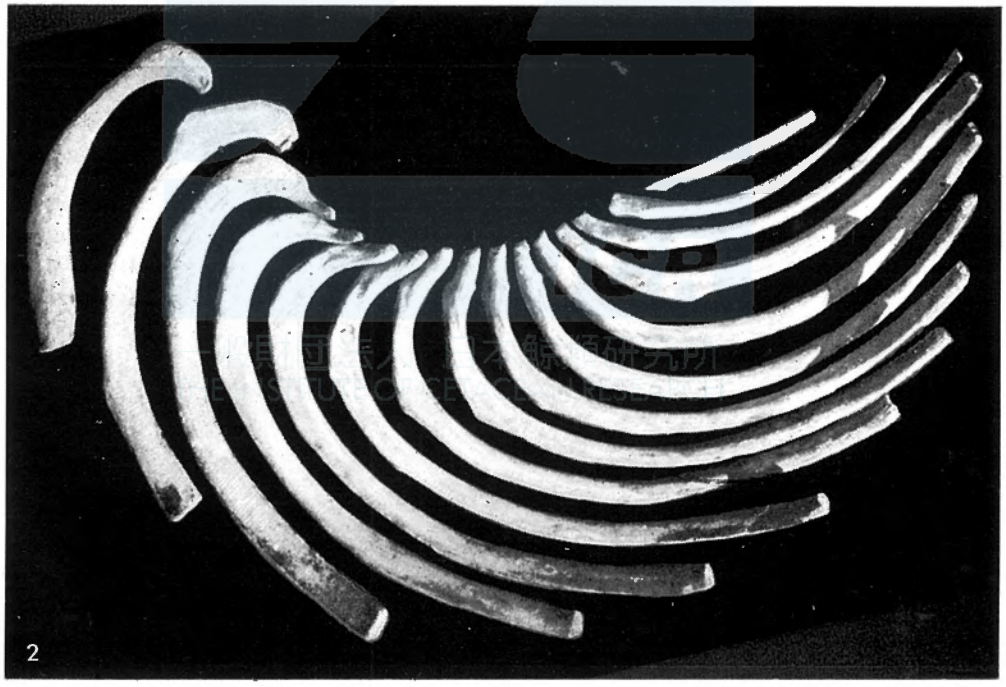

Fig. 2. Left ribs of the Kirittapu whale.

Fig. 1. 1st, 2nd and 3rd right ribs of the Ayukawa whale.

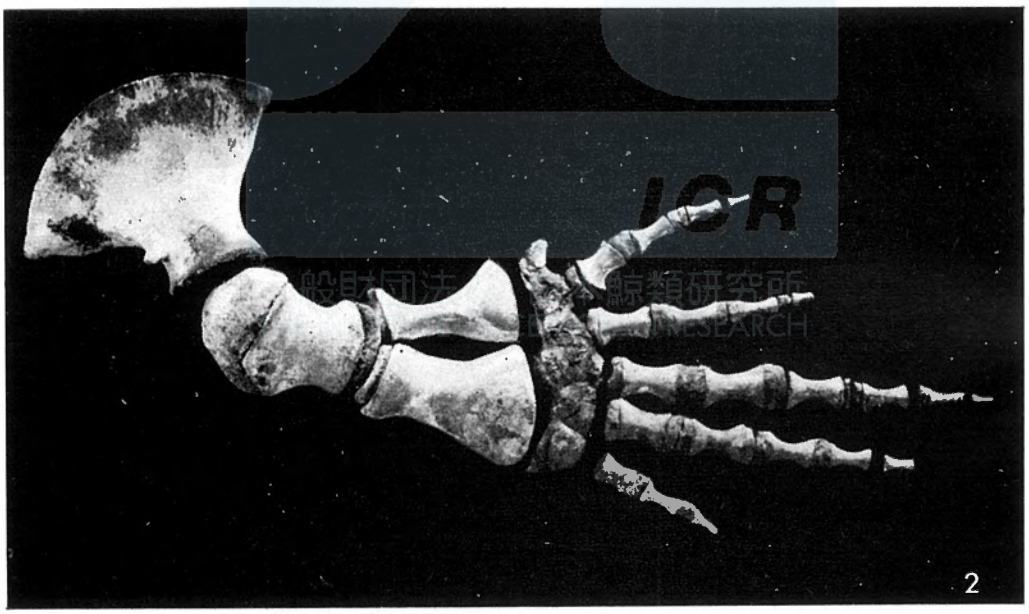

Fig. 2. Scapula, humerus, radius, ulna and phalanges of the Kirittapu whale. Left side.