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Bacteriological Studies on Freshness of Whale Meat.

(Report No. II)

By

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It was already reported in our previous paper that the degree of freshness of whale meat is proportional to the number of bacteria detected in blood and muscles, that bacteria are the chief factor in the decrease of freshness and that intestinal tracts are the main origin of the invasing bacteria. Here are the results of our further studies based in the material collected in the summer of 1948, which may justify our observations given in the previous paper.

In the summer of 1948, we collected our samples from three sei whales and one sperm whale in the same way as in the previous experiments at Ayukawa, a whaling land station in the Ojika Peninsular, Miyagi Prefecture. We examined the number of bacteria in blood and muscles on the spot and made other experiments in our laboratory in Tokyo.

1. Freshness and the number of bacteria. (a) Slide glass preparations of heart and liver blood. Slide glasses thinnly smeared with blood which had flowed from the heart and the liver respectively during the dissection were prepared, and stained with Giemsa solution, subjected to microscopic examinations with the result many bacteria, both rod and spherical, were detected. The number of bacteria in one field would indicate the approximate degree of freshness. Yet it does not make a precise standard. (b) The number of bacteria in heart blood and muscles.

Table 1

		No. 1 (sei whale)	No. 2 (sei whale)	No. 3 (sei whale)	No. 4 (sperm whale)
date of the catch		July 25	July 25	July 25	July 27
locality of the catch		E 1/2 N 178	E 3/4 N 178	E 1/2 N 181	E 1/4 N 180
temperature of air & water, air pressure		24–25°, 28°, 767	25°, 28°, 767	25°, 28°, 767	25°, 27°, 768
hours post-catch		34	26	68	24
number of bacteria	Blood(ml)	70.000	12.000	9.360.000	23.400
	muscle(gm)	9.400	8.000		
so-called freshnes		80%	80%	50%	80%

It was reported in the previous paper that the number of bacteria in heart blood and muscles obtained by aerobic culture is approximately proportional to the degree of freshness. It is now assumed that the number of the bacteria per ml. will make a standard in the determination of the degree of freshness. (Refer to table No. 1)

2. Freshness and histological degeneration of muscles and the liver. The results of histological examinations of portions of the livers and muscles from sei whales No. 1 and 2 of Table 1 will be shown in Table 2.

Due to the limited portions of the samples, bacteria filling vessels in the muscle were not detected by this experiment.

Table 2

Histological Observations

	No. 2 sei whale (26 hrs. post-catch)	No. 1 sei whale (34 hrs. post-catch)
Muscle sample	1. Shrivelling of muscle fibres medium degree; curves & ruggedness discerned.	1. Shrivelling of muslce fibres high degree; curves & ruggedness conspicuous.
	2. Muscle fibres indistinct.	2. Muscle fibres obscure.
	3. Nuclei in muscular cells discerned.	3. Nuclei in muscular cells obscure.
	4. No bacteria detected.	4. A few individual bacteria detected in connective tissue.
Liver sample	1. Formation of vacuoles marked.	1. Degeneration of vacuoles high degree.
	2. Irregularity of arrangement of liver cells medium degree.	2. Grouping of liver cells very irregular.
	3. Liver lobules disorderly.	3. Liver lobules disorderly.
	4. Porta hepatis transverse fissure, hilum disorderly.	4. Porta hepatis (transverse fissure, hilum) disorderly.
	5. Haemosiderin discerned.	5. Haemosiderin granules conspicuous.
	6. A few bacteria detected between cells.	6. Bacteria fill vessels.

3. Determination of species of the isolated bacteria. Determination of species was attempted regarding the 128 strains of bacteria isolated from blood, muscles and intestinal contents. It proved that even the bacteria isolated by anaerobic culture can grow by aerobic culture after successive transfering on culture media. So we made all the succeeding investigations of biological characters by aerobic culture.

By microscopic examinations of shapes, sizes, grouping, Gram staining and motility as well as by characteristics of colonies on agar media and by gelatin liquefaction and indole reaction, typical 39 strains were selected from the above mentioned 128 strains of bacteria, and subjected to various biological examinations. As the result, six species of Gram positive spheres, three species of Gram negative spheres, five species of Gram positive rhods and ten species of Gram negative rhods, namely twenty-four species in all, were isolated. They were identified according to Bergey's Manual of Determinative Bacteriology (5th Ed.) and other literatures: and those determined were as follows: Nine species of Micrococcuss five species of Bacillus, six species of Achromobacter, three species of Escherichia and one species of Aerobacter aerogenes. (Refer to table 3)

Table 3

The species of Bacteria Detected (Isolated in the summer of 1948)

names	samples	habitats (according to literature)
Bacillus silvaticus	muscle	soil
B. laterosporus	blood	soil, water
B. brevis	blood, muscle large and small intestines	ubiquitous
B. adhaerens	large intestfne	soil
B. novus	blood, large and small intestines	ubiquitous
Achromobacter liquefaciens	blood	water
A. butyri	blood	milk
A. candicans	large intestine	soil
A. pestifer	blood	air
A. nitrificans	blood, large intestine	soil
A. ubiquitum	blood	water, soil
Escherichia coli communis	blood	intestinal tracts of man and Vertebrata
E. acidi lactici	blood	intestinal tracts of man and Vertebrata
E. freundii	blood	water, soil, intestinal tracts of man and animals
Aerobacter aerogenes	blood	vegetables, ceveals, intestinal tracts of man and animals
Micrococcus varians	blood, muscles large intestine	sea water, water, air, milk
M. flavus	blood, small intestine	air, milk
M. epidermidis	blood, large and small intestines	skin, milk, infection
M. *luteolus*	blood	cheese
M. saccatus	blood, large and small intestines	nasal mucous membrane
M. halophilus	blood	sea water
M. perflavus	blood, muscles	water, air
M. caseolyticus	blood	udders, food stuff
M. rhodochrous	blood	water

The biological characteristic of the above mentioned bacteria coincided with those found in references in all but a few minor points, and any new species was not detected by the present experiments. In comparison with our investigations in 1947, Micrococcus and Achromobacter were isolaled by both the previous and present experiments while Flavobacterium and Streptococcus faecalis were not detected this time. We succeeded, however, in obtaining Escherichia and Aerobacter for the first time. (Refer to Table 4)

Summary

(1) The degree of freshness is roughly proportional to the number of bacteria in blood and muscles. The number of bacteria in heart blood may be a standard in the determination of the degree of freshness. An approximate degree of freshness may be calculated by means of stained slide glass samples.

(2) In the case of a low degree of freshness, conspicuous deterioration was discerned histologically in the liver and muscles, and clumps of bacteria filling vessels were detected by microscopic examinations.

(3) Besides Micrococcus and Achromobacter which had already been isolated in 1947, Aerobacter and Escherichia were newly isolated by the present experiments. These are the species generally detected in intestinal tracts of man and animals.

It is especially worth noticing that Escherichia and Aerobacter which are generally found in intestinal tracts of man and animals were detected in blood, for it leads to the assumption that these bacteria penetrated into blood vkssels after death and distributed all over the carcass.

Table 5

Species \ Character	shape	side	arrangement	Gram stain	spore	motility	surface colonies on solid media	Boullion turbidity	Boullion deposit	Boullion surface grows	colonies on potato	gelatin liquefaction	B.T.B milk	Indol
F 8	rod	1.3∼1.5 x 2.0∼4.5	single, short chain	+	+ terminal	+	yellowish brown viscid,	+	+	−	brownish white, viscid	+ stratiform liquefaction	acid coagulation	−
B 22	rod	1.0∼1.2 x 2.0∼3.5	single, short chain	+	+ central	+	white, round	+	++	−	greyish white, poor growth	+ crateriform	no change	−
BCIF 60	rod	0.6∼1.0 x 2.0∼3.5	single, scattered, in short chain	+	+ terminal	+	greyish white, viscid	+	+	−	greyish white	+ infundibuliform	acid coagulation, later peptonisation	−
C 73	rod	0.8∼1.2 x 3.0∼4.5	single, short chain, groups	+	+ central	−	greyish white convex, small colony	++	+	−	yellowish brown	+ crateriform	acid coagulation	−
BIC 64	rod	0.8∼1.0 x 3.0∼5.0	singly, pairs	+	+ terminal	+	greyish purple convex, small colony	+	+	−	greyish white	+ infundbuliform	no change	−
B 16	rod	0.6∼0.8 x 1.0∼1.5	in groups	−	−	+	transparent, colorless round viscid, glistening	++	++	+	brownish white, glistening	+ infundibuliform	alkali	−
B 18	rod	0.5∼0.7 x 1.0∼1.3	singly, pair	−	−	−	transparent, glistening, viscid	++	+++	+	greyish white, poor growth	+ infundibuliform	no change	−
C 11	rod	0.5∼0.7 x 0.7∼1.2	singly, pair	−	−	−	white, raised, small colony	+++	++	+++	white raised, viscid, poor growth	−	alkali	−
B 35	rod	1.2∼1.5 x 1.5∼2.5	singly, in groups	−	−	+	greyish yellow, raised, large colony	++	++	−	brownish white	−	no change	−
BC 33	rod	0.6∼0.7 x 0.8∼1.2	singly,	−	−	+	greyish white, smooth	++	++	−	white, poor growth	+ crateriform	no change	+
B 39	rod	0.8∼1.0 x 1.5∼2.0	singly short chains	−	−	−	white, round, raised, viscid	++	++	+	greyish white	−	acid coagulation	±
B 21	rod	0.6∼0.7 x 1.0∼1.3	single,	−	−	+	greyish white, round	++	+	−	greyish white	−	acid coagulation	+
B 13	rod	0.6∼0.7 x 1.2∼1.5	in groups	−	−	−	greyish white, round	++	+	−	greyish white,	−	acid coagulation	+
B 17	rod	0.6∼0.7 x 1.0∼1.3	in groups	−	−	−	greyish white, convex	++	+	−	greyish white	−	acid coagulation	+
B 9	rod	0.6∼0.7 x 1.0∼1.2	single,	−	−	+	greyish white	++	+	+	greyish white	−	acid coagulation	−
BCF 17	spherical	1.2	pairs, in grape-like clusters	−	−	−	white, round vescid	+	+	−	greyish white	−	acid	−
BI 13	spherical	1.0∼1.2	in grape-like clusters	−	−	−	yellow, round, dry	+	+	−	whitish yellow, stunted growth	+ crateriform	acid	−
BIC 1	spherical	0.8∼1.0	in groups	−	−	−	greyish white smooth, glistening	++	++	−	greyish white	−	acid→alkali	−
B 33	spherical	1.2∼1.3	pair, in groups	+	−	−	orange yellow, raised, dry	+	+	−	orange yellow, dry raised	+ infundibuliform	no change	−
BIC 17	spherical	0.6∼0.8	pair, botryoid	+	−	−	transparent dewdrop-shaped	+	+	−	grey semitransparent growth	+ saccate	acid	−
B 19	spherical	0.8∼1.0	pair, short chain	+	−	−	transparent dewdrop-shaped	+	+	−	poor growth	−	no change	−
BF 21	spherical	1.2∼1.5	pair	+	−	−	yellow, round raised	+	+	+	vivid yellow, raised glistening	+ stratiform	acid	−
B 6	spherical	1.0	pair	+	−	−	dewdrop-shaped	+	+	−	glistening, poor growth	+ saccate	coagulation later, peptonisation, acid	−
B 42	spherical	0.9∼1.0	pair, in groups	+	−	−	orangered opaque, small colony	+	+	−	poor growth	−	no change	−

Note B: blood; C: colon; I: Intestine F: muscles

B milk	Indol	H_2S.	Methyl-red test	Voges-Prosk	Citrate media	Neutral red	Nitrate reduction	Katalase	Sugar decomposition: glucose	lactose	galactose	arabinose	sucrose	dextrin	mannitol	inositol	dulcitol	species	habitat (according to literature)
l coagulation	−	−	−	−	+	−	−	±	+	+	−	+	±	±	+	−	−	Bacillus silvaticus	soil
hange	−	−	−	−	±	−	++	+	+	−	−	−	−	±	+	−	−	B. laterosporus	soil, water
l coagulation, r peptonisation	−	−	+	−	−	−	−	+	+	+	+	+	+	+	+	−	−	B. brevis	ubiquitous
l coagulation	−	+	+++	−	±	−	−	+	+	−	+	+	+	+	+	±	−	B. adhaerens	soil
hange	−	−	+	−	−	−	−	+	+	+	+	+	+	+	+	±	−	B. novus	ubiquitous
li	−	+	−	−	−	−	−	+	−	−	±	−	+	−	−	+	±	Achromobacter liquefaciens	water
hange	−	+	−	−	−	⊕	−	+	⊕	−	−	−	−	−	−	−	−	A. butyri	milk
li	−	−	−	−	++	−	−	+	−	−	−	−	−	−	−	−	−	A. candicans	soil
hange	−	+	−	−	−	−	+	+	−	−	−	−	−	−	−	−	−	A. pestifer	air
hange	+	++	−	−	+	⊕	++	+	⊕	−	−	−	⊕	−	−	±	−	A. nitrificans	soil
l coagulation	±	++	−	−	+	⊕	++	+	⊕	⊕	⊕	⊕	⊕	−	⊕	−	−	A. ubiquitum	water, soil
l coagulation	+	+	±	−	−	⊕	++	+	⊕	⊕	⊕	⊕	−	−	⊕	−	−	Escherichia coli communis	intestinal tracts of man and vertebrate
l coagulation	+	+	+	−	−	⊕	+	+	⊕	⊕	⊕	⊕	−	−	⊕	−	−	E. acidi lactici	intestinal tracts of man and vertebrate
l coagulation	+	+	+	−	±	⊕	+	±	⊕	⊕	⊕	⊕	⊕	−	⊕	±	−	E. freundii	water soil, intestinal tracts of man and animal
l coagulation	−	±	−	+	++	⊕	++	+	⊕	⊕	⊕	⊕	⊕	−	⊕	−	−	Aerobacter aerogones	intestinal tracts of man and animals, vegetables, cereal
l	−	−	−	−	−	−	++	−	±	±	±	−	±	−	+	−	−	Micrococcus varians	sea water, water, air, milk
l	−	−	−	−	±	−	−	−	+	±	−	−	−	−	−	−	−	M. flavus	air, milk
d→alkali	−	++	++	−	++	−	++	+	+	+	+	−	±	−	+	±	±	M. epidermidis	skin, milk; infections
change	−	−	+	−	−	−	−	−	+	−	−	−	±	−	±	−	−	M. luteolus	cheese
d	−	+	+++	−	−	−	−	−	+	+	+	−	+	+	+	−	−	M. saccatus	nasal mucous membrane
change	−	−	+++	−	−	−	−	−	+	+	+	−	−	+	+	−	−	M. halophilus	sea water
d	−	−	−	−	−	−	−	++	−	−	−	−	−	−	−	−	−	M. perflavus	water, air
gulation later, peptonisation, acid	−	+	++	−	−	−	−	++	+	+	+	+	+	+	+	−	−	M. caseolyticus	udders, food stuff
change	−	+	−	−	−	−	−	++	−	−	−	−	−	−	−	−	−	M. rhodochrous	water

+ acidformation ○ gas formation

On the Pelvic Cartilages of the Balaenoptera-Foetuses, with Remarks on the Specifical and Sexual Difference

BY

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(*Anatomical studies on the whalebone-whale foetuses, No. 1*)

Introduction

It is well known that the whales have no hind-limb protruding on the surface of the body. But probably all of them have the rudimentary pelvis as a pair of slender bones.[1] Unlike in most mammals, whose pelvic girdle consists of three elements (ischium, pubis and ilium) coalescing into a single bone, the cetacean pelvis is made of only one element, a fact stated first by Eschricht and Reinhardt (1866), who found a single center of ossification in it. This bone is believed to represent the ischium, for it is connected with the crura penis or clitoridis, and also with the musculus ischiocavernosus.[2][3]

While in the Odontoceti the pelvis is the sole remnant of the hind-limb, most of the Mysticeti have one or two other pairs of very small bones or cartilages placed near the middle of pelvis. One pair of them is attached to the pelvis by ligaments and accompanies the third pair at its caudal end. They were found at first by Reinhardt (1848) in a newborn Greenland Right-whale and asserted then by Eschricht and Reinhardt (1866) in a half-grown and a full-grown whale of the same species (Fig. 1). Later, Struthers (1881) observed eleven pairs of the rudimentary bones, studying minutely the articulations and neighbouring muscles. The supernumerary pelvic bones are nowadays supposed to represent femur and tibia, as suggested by the discoverers of them.

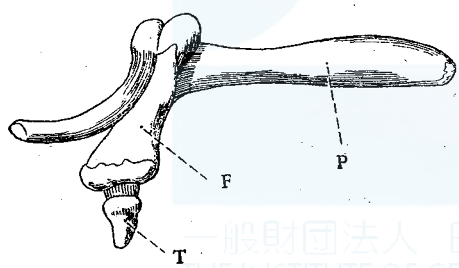

Fig. 1 Side view of bones of posterior extremity of Greenland Right-whale (from Eschricht and Reinhardt)
P……Pelvis F……Femur T……Tibia

1) In Cogia the presence of the pelvis is not yet ascertained. (van Oort: Zool. Medel. Rijksmuseum Nat. Hist. Leiden. 9, 1926.)

2) Schneider (1795) took the cetacean pelvis for pubis.

3) The Eschricht and Reinhardt's interpretation of the cetacean pelvis, that its cranial and caudal portions represent respectively pubis and ischium, while the lateral process corresponds to ilium, may be also true, if we take in mind the relations to neighbouring structures.

On the other hand, in the adult Humpback Eschricht found only the second pair, and afterwards Struthers (1888) confirmed also the absence of the third pair in this species. The same result was mentioned by Burmeister (1867) and Struthers (1872, 93) also for the Fin-whale, in which the only existing femur was extremely vestigial. Further, the lesser Fin-whale (Balaenoptera acuto-rostrata, Lac.) and the Sei-whale show, according to Struthers etc., no trace of femur and tibia, just like in the Odontoceti (Fig. 2).

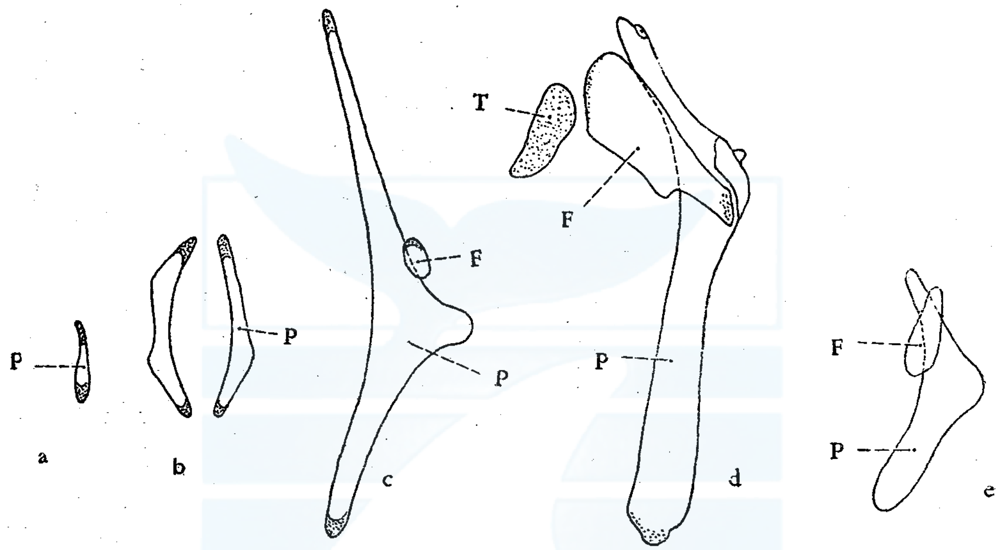

Fig. 2 Cetacean skeletons of hind-limbs (from Struthers)
a. Lesser Fin-whale (14.5 feet, male) b. Sei-whale (36 feet, male)
c. Fin-whale (64 feet, male) d. Greenland Right-whale (48 feet, male)
e. Humpback-whale (40 feet, male)

During my Antarctic whaling voyage on board the Nissin-Maru No. 1 (1947–48), I examined the cartilages in question in the Balaenoptera-foetuses and found some noteworthy facts.

The materials examined by me are as follows:

Foetuses of the Blue whale (Balaenoptera musculus, L.) 9.

(male, 6; female, 3; max. length, 22 feet 2 inches; min. length, 3 feet 11 inches)

Foetuses of the Fin-whale (B. physalus, L.) 9.

(male, 5; female, 4; max. length, 15 feet 1 inch; min. length, 2 feet 1 inch)

Additionally for comparison, each one pair of pelvic bones of adult Blue and Fin-whales.

Pelvic cartilages of the Blue and Fin foetuses

Both species have besides a pair of pelvis another pair of very small cartilages, the third pair being completely absent. The pelvis (Fig. 3, 4) is elongated, somewhat curved, hammerlike in form, and has a very short lateral process, corresponding to "promontry" of Struthers. The upper process, processus cranialis, is pointed at the end and deserves the name "apex cranialis", while the lower one, proc. caudalis, is shorter, with its somewhat rounded extremity. The lateral process, the shortest of all processes, ends also not sharpened, but has here a more or less eminent tubercle, tuberculum laterale.

Near the tubercle, a little more ventrad and craniad, there is a small, oval piece of cartilage, the upper end of which is pointed in some cases, especially

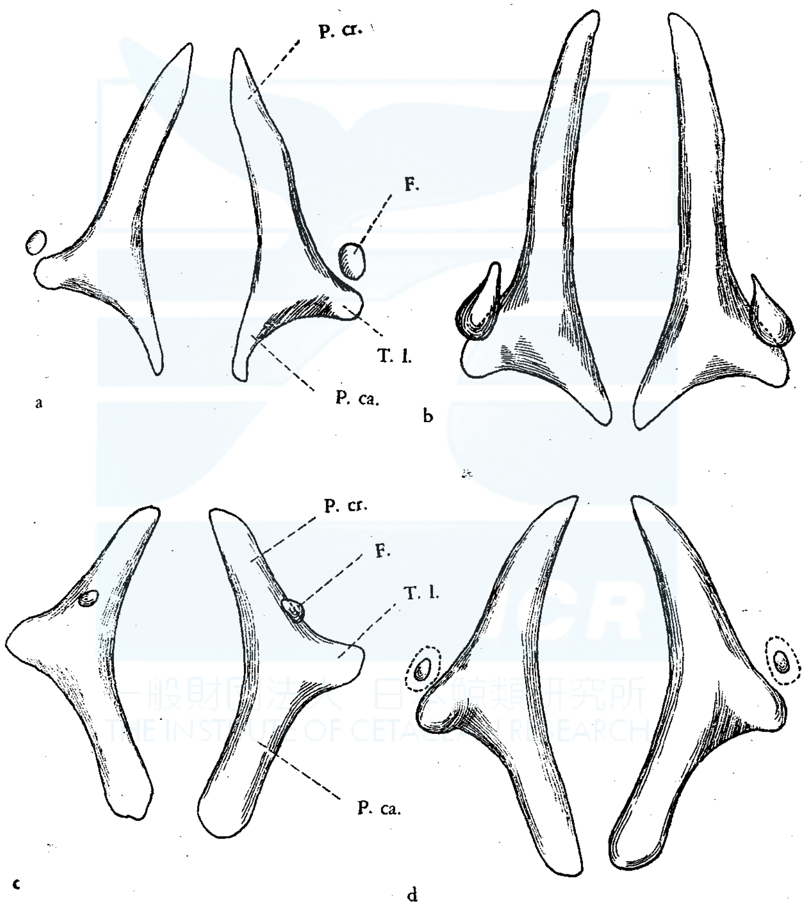

Fig. 3 Pelvic cartilages of the Fin and Blue foetuses
a. Fin, male (13 feet 6 inches long) b. Fin, female (15 feet 1 inch long)
c. Blue, male (12 feet 3 inches long) d. Blue, female (14 feet 11 inches long)

1) In the adult whales the cranial process is rather flattened mediolaterad, in opposite to the club-like caudal process (Fig. 4).

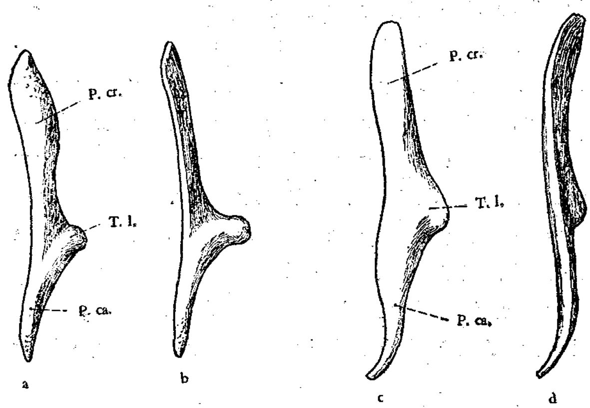

Fig. 4 Pelvic bone of adult whalebone-whales
a, b, Fin-whale, lateral and ventrel view
c, d, Blue whale, lateral and ventral view
P. cr., Proc. cranialis; P. ca., Proc. caudalis;
T. l., Tuberculum laterale

in the Fin-whale. This small cartilage, being nothing but the remnant of femur, is covered with a thick capsule of connective tissue. The remnant of femur does not increase in size proportionately with the growth of the foetus: in other words, much more remarkable individual variation is seen in the size of this cartilage than in that of the pelvis. This difference might be understood by the more vestigial nature of the former. It is moreover likely, that the femur is more rudimentary in the Blue whale than in the Fin-whale. For, according to my observation, the femur of considerably larger foetuses of Blue whale (12 feet 4 inches, male; 13 feet 4 inches, male; 15 feet 5 inches, female; 22 feet 2 inches, male) is sometimes made solely of connective tissue, containing no cartilage. The ligamentous band between femur and pelvis is very loose, and here I found no articular formation, though Eschricht, Reinhardt and Struthers mentioned an articulation respectively in an adult Greenland Right-whale and in an adult Fin-whale.

Ossification of the pelvic cartilages

Neither pelvis nor femur of all the foetuses, measuring from 2 feet 11 inches up to 22 feet 2 inches in length, showed any trace of ossification. It is therefore supposed that these skeletons are ossified only after the parturition. For, consulting the statistics published by Mackintosh, Wheeler (1927) and Matthews (1937), it seems certain that the foetus of 22 feet is only a little before the birth. Reinhardt found in a newborn Greenland Right-whale an ossified portion of the femur in its middle part, but no ossification in pelvis and tibia.

Position and locality of the pelvic cartilages

The cartilaginous pelvis exists on each side, rather laterad and caudad, to the external genital orifice, with its axis nearly parallel to that of the whale-body. We can palpate them after removal of the skin as somewhat hard objects. All of my specimens were not so small as to settle the problem upon the presence of an external protrusion representing the hind-limb reported by Guldberg (1894, 99) and Kükenthal (1895) in Phocaena communis (Fig. 5). I have known, however,

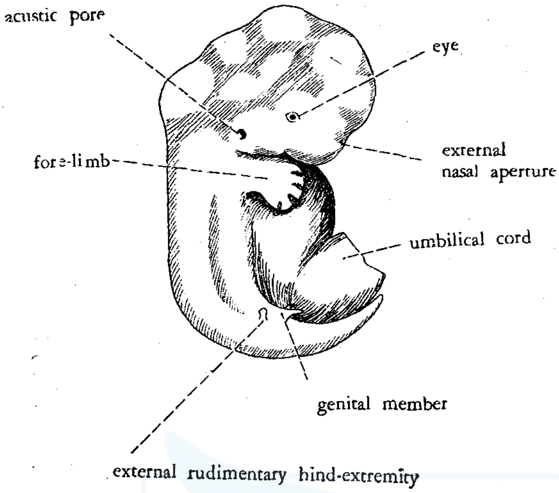

Fig. 5 The 17 mm. long Phocaena-embryo seen from the right side. (Guldberg)

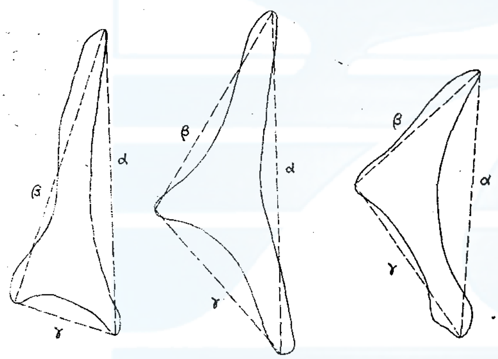

Fig. 6. Measurements of the pelvic cartilage

that the pelvis is located in small foetuses under the skin more superficially, while those in larger ones lie more deeply embedded in the muscular layer and so more hardly palpable.

Difference of the foetal pelvis in form between Fin- and Blue whale

In the Fin foetus the caudal process of the cartilaginous pelvis is relatively shorter than in the Blue, viz. the pelvis of the former has the lateral process placed more caudad than that of the latter (Fig. 3). My measurements of the distances 1) from the cranial apex to the caudal end (α), 2) from the cranial apex to the lateral tubercle (β), 3) from the caudal end to the lateral tubercle (γ), and the relative length of β and γ (β/γ) (Fig. 6) are shown in Table 1.

While the average of this index β/γ is in the foetal Fin-whale 2.01 (max., 2.67; min., 1.63), it is in the foetal Blue whale only 1.06 (max., 1.25; min., 0.71); there is accordingly a distinct difference between the both species. Fig. 7 indicates my data diagrammatically. From this figure we know that the index β/γ is in the Fin foetuses, without exception, more than 1.5, while in the Blue foetuses it lies always under 1.5. It is interesting that these intimately related two species of Balaenopterides show such a remarkable difference in the form of pelvis. I can't decide, however, whether the same difference is present also in the adult whales, but the postnatal existence of approximately the same relation is unplausible.[1]

1) Struthers (1893) stated that the characteristics in the form of pelvic bones of some adult whales (Megaptera, Right-whale) are to be seen also in the immature, younger whales.

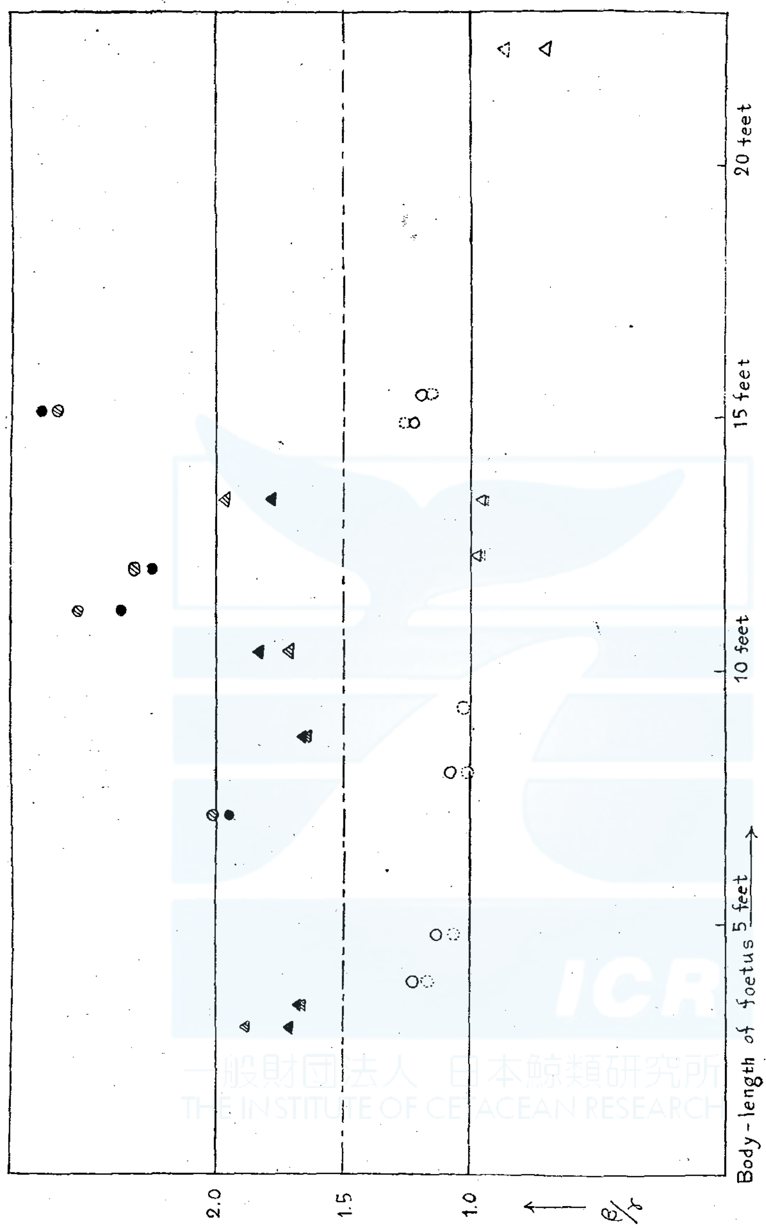

Fig. 7. β/γ index of the cartilaginous pelvis of Blue and Fin-whale foetus.
Fin-whale ; male (▲, right; ◭, left), female (●, right; ◍, left)
Blue whale; male (△, right; ◬, left), female (○, right; ◌, left)

According to Eschricht, Reinhardt and Struthers, the posterior part of the pelvic bone exceeds considerably in length the anterior part in the Greenland Right-whale. Hence the ratio in question seems to be in this whale by far less than 1.0. After Struthers' measurement of eleven specimens, this ratio seems to fall between 0.3 and 0.7 (average, 0.41) for the Greenland Right-whale. And I calculated, using Struthers' data, that this ratio is for a male Megaptera of 40 feet long 0.77, i.e. an intermediate value between the Greenland Right-whale and the Blue foetus. In this way we can probably determine the kind of whalebone-whales from the form and size of pelvis, especially by consulting the relative length of the upper and lower processes.

Sexual difference of the cartilaginous pelvis

In both the Fin and Blue foetuses the β/γ index of the pelvis is larger in the female than in the male (Fig. 7). As to the Fin-whale, this index is in the female almost always more than 2.0 (average, 2.34; max., 2.67; min., 1.95), while in the male it is, without exception, less than 2.0 (average, 1.75; max., 1.97; min., 1.63). In the Blue whale, the critical point of the ratio for the sexual difference is 1.0 (average for the male, 0.91; max., 0.98; min., 0.71: average for female, 1.14; max., 1.25; min., 1.00). Further investigation of the pelvic bones in the adult Fin- and Blue whales is from this viewpoint very desirable.[1)]

Angle between the cranial and caudal process of the pelvis

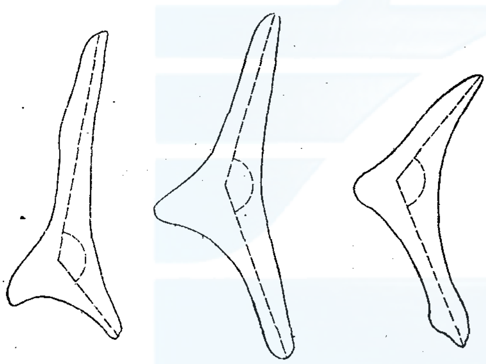

Fig. 8. Angle of the pelvic cartilage

These processes make each other at the level of the lateral process an obtuse angle opened mediad (Fig. 8). This angle, measured with goniometer, shows no remarkable specifical or sexual difference (Table 1), the average being in the Fin and Blue foetuses respectively 136°(male, 136°; female, 137°) and 133° (male, 124°; female, 137°); the individual variation is in the Fin-whale 127°–148°, and in the Blue whale 120°–149°. Neither exists any remarkable difference between the right and left pelvis (average for the Fin-male: right, 136°, left 136°; female: right, 138°, left, 136°; average for the Blue- male: right, 123°, left, 125°; female: right, 140°, left, 138°), though some instances showed the angle tolerably asymmetrical.

1) From Struthers' data no distinct sexual difference seems to exist in the relative length between anterior and posterior parts in the Greenland Right-whale, because this ratio becomes probably 0.30 (♀) and 0.45 (♂). In his opinion, however, it is easier to tell the sexual difference of the pelvic bone in Mysticetus than in human beings, for the hinder end of this bone is much thickened in the male, while it is flattened, usually with expansion, in the female.

N.B. According to Struthers, this angle appears to be in the female Greenland Right-whale somewhat larger than in the male, the average being respectively 139° and 124°.

Development of the pelvis in length

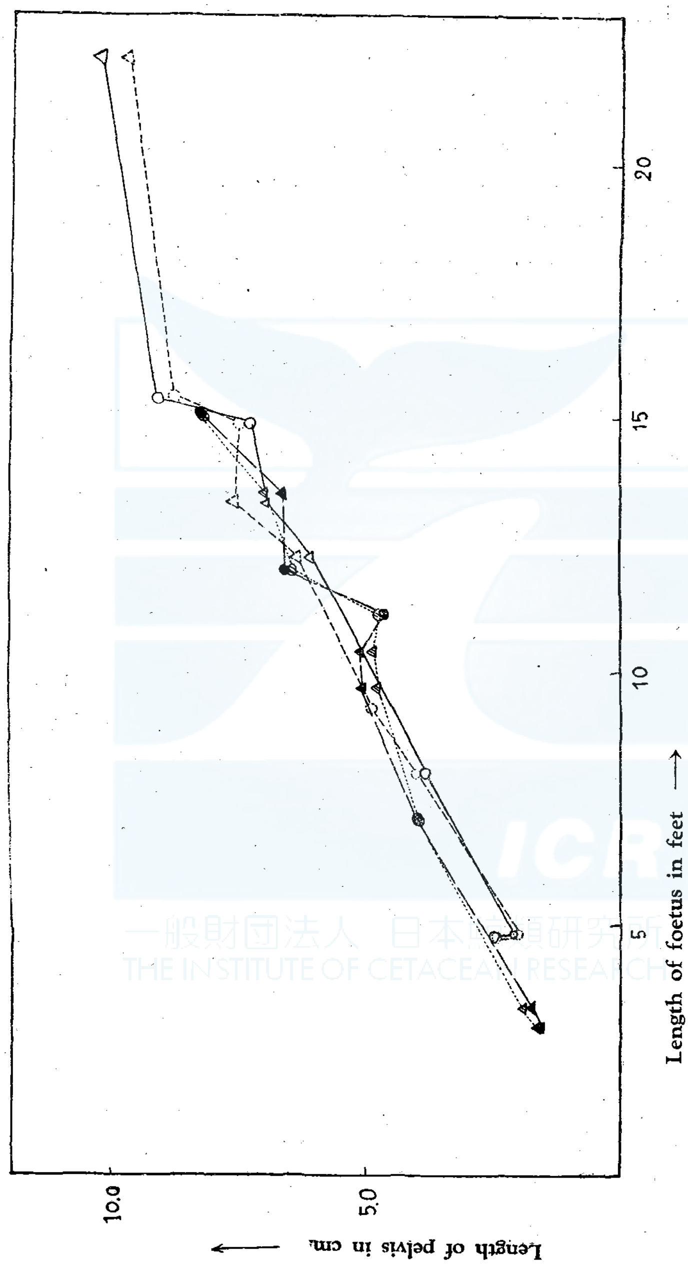

Fig. 9. Diagram showing the development in length of the pelvic cartilage of Blue and Fin-whale foetus.

Fin-whale ; male (▲, right; ◭, left), female (●, right; ◍, left)
Blue whale; male (▲, right; △, left), female (○, right; ○, left)

The length of the cartilaginous pelvis in various intrauterine stages is shown in Fig. 9. By the length of the pelvis I mean the distance from the cranial apex to the caudal end (α in Table 1), and by the body length the distance from the rostral extremity to the median notch of the caudal flipper. We see from this figure that the relative length of pelvis to the whole body remains, regardless of size, sex and species of the foetuses, almost constant.[1)2)] The cartilaginous pelvis occupies about 1.6-1.8% of the total length of the body (average, Fin-whale-male, 1.8, female, 1.7; Blue whale-male, 1.6, female, 1.7, max., 1.9. min., 1.4)(Table 1).

Nearly the same ratio seems to hold good in the adult stage, for from Struthers' data, this ratio becomes 1.7 in an adult male Fin-whale of 50 feet, 1.6 in an adult male Sei-whale of 36 feet, 1.9 both in an adult male lesser Fin-whale of 14.5 feet and in an adult male Megaptera of 40 feet. But in the Greenland Right-whale the pelvis seems to be relatively larger, occupying 2.3% (max., 3.0, min., 2.0) of the total length of the body.

Summary

1) From the viewpoint of the rudimentary skeletons pertaining to the hind-limb, the whalebone-whales can be classified into the following three groups: Group 1, to which the Greenland Right-whale belongs, has besides the pelvis two pairs of subsidiary bones or cartilages (femur and tibia). Group 2, in which other than the pelvis only the femur is present, comprises the Humpback, the Fin-whale and perhaps also the Blue whale. Group 3, which has neither femur nor tibia but has the pelvis only, seems to comprise the Sei-whale and the lesser Fin-whale.

2) Many foetuses of Fin- and Blue whales studied in this paper have two pairs of cartilages corresponding to pelvis and femur, which show no trace of the bony nucleus within them. Very likely, therefore, the ossification of them takes place only after the parturition.

3) The pelvis of whales, though generally it is hammerlike in form, shows remarkably different shapes according to the species. Especially the ratio of length between the anterior and posterior portions of the pelvis is characteristic to each species.

4) In the Fin and Blue foetuses the sexual difference is marked in the form of the pelvis. The ratio mentioned in the preceding paragraph is always greater in the female than in the male; namely, the female pelvis has relatively longer cranial process than the male.

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1) Flower (1876) stated that the pelvic bone of whales is usually more largely developed in the male than in the female.

2) I never found such an asymmetrical development of pelvis as observed by Struthers (1893) in an adult Sei-whale.

Table 1.

Measurements of hind-limb cartilages of Blue and Fin-whale foetuses

Foetus (species, length, sex)	right or left	α (length of pelvis in cm)	β (length of anterior portion)	γ (length of posterior portion)	δ (length of femur in cm)	α×100 / body-length	β/γ	weight of pelvis in gr.	weight of femur in gr.	ossification	angle between cranial and caudal processes
No.83, Fin 2f. 11i., ♂	r	1.63	1.45	0.85	0.2	1.8	1.71	0.05	<0.01	(−)	127
	l	1.65	1.5	0.8	0.2	1.9	1.88	0.05	<0.01	(−)	132
No.80, Fin 3f.4i., ♂	r	1.8	1.6	0.95	0.6	1.8	1.68	0.08	0.01	(−)	134
	l	1.9	1.5	0.9	0.6	1.9	1.67	0.07	0.01	(−)	148
No, 95, Blue 3f.10i., ♀	r	2.1	1.45	1.2	—	1.8	1.21	0.08	—	(−)	144
	l	2.0	1.3	1.1	—	1.7	1.18	0.08	—	(−)	149
No.101, Blue 4f.9i., ♀	r	2.6	1.8	1.7	—	1.8	1.13	0.17	—	(−)	138
	l	2.6	1.8	1.9	—	1.8	1.06	0.18	—	(−)	135
No.91, Fin 7f.1i., ♀	r	4.0	3.7	1.9	0.4	1.9	1.95	0.65	0.008	(−)	139
	l	4.0	3.7	1.85	0.3	1.9	2.00	0.73	0.008	(−)	134
No. 151, Blue 8f., ♀	r	3.95	2.9	2.7	0.65	1.6	1.08	0.98	0.10	(−)	139
	l	4.0	2.8	2.8	0.7	1.6	1.00	0.90	0.11	(−)	139
No.81, Fin 8f.8i., ♂	r	5.1	4.05	2.45	1.1	1.9	1.65	1.31	0.11	(−)	142
	l	4.8	3.9	2.4	1.0	1.8	1.63	1.26	0.09	(−)	137
No.137, Blue 9f.3i., ♀	r	—	—	—	—	—	—	—	—	—	—
	l	4.95	3.05	3.0	—	1.8	1.02	1.10	—	(−)	—
No. 143, Fin 10f.4i., ♂	r	5.1	4.2	2.3	0.3	1.6	1.83	1.03	0.01	(−)	139
	l	4.9	4.2	2.45	0.35	1.6	1.71	0.97	0.006	(−)	121
No. 132, Fin 11f.2i., ♀	r	4.7	4.5	1.9	0.35	1.4	2.37	1.29	0.007	(−)	139
	l	4.8	4.8	1.9	0.35	1.4	2.53	1.47	0.007	(−)	135
No. 146, Fin 12f., ♀	r	6.6	3.15	2.75	0.6	1.9	2.24	3.54	0.04	(−)	—
	l	6.5	6.15	2.65	0.6	1.8	2.32	3.17	0.04	(−)	—
No. 97, Blue 12f.3i., ♂	r	6.1	4.1	4.2	0	1.6	0.98	2.9	0.06	(−)	120
	l	6.4	4.3	4.4	0	1.7	0.98	3.3	0.04	(−)	127
No. 98, Blue 13f. 4i., ♂	r	7.0	4.8	5.0	0.6	1.7	0.96	4.3	0.01	(−)	121
	l	7.6	4.8	5.0	0	1.9	0.96	4.7	—	(−)	125
No. 142, Fin 13f. 6i., ♂	r	6.65	5.7	3.2	0.65	1.6	1.78	3.58	0.07	(−)	139
	l	7.0	5.9	3.0	0.85	1.7	1.97	3.89	0.15	(−)	143
No. 153, Blue 14f. 11i., ♀	r	7.4	5.4	4.4	0.5	1.6	1.23	4.81	0.06	(−)	132
	l	7.5	5.5	4.4	0.5	1.6	1.25	4.81	—	(−)	130
No. 149, Fin 15f. 1i., ♀	r	8.3	7.75	2.9	1.8	1.8	2.67	6.25	0.42	(−)	136
	l	8.3	7.7	2.95	1.7	1.8	2.61	6.8	0.37	(−)	139
No. 150, Blue 15f.5i., ♀	r	9.1	6.2	5.2	0	1.9	1.19	7.1	—	(−)	148
	l	8.8	6.1	5.2	0	1.9	1.17	6.02	—	(−)	136
No. 155, Blue 22f.2i., ♂	r	10.3	5.6	7.85	0	1.4	0.71	15.02	—	(−)	129
	l	9.75	6.2	7.1	0	1.5	0.87	14.61	—	(−)	123

5) The obtuse angle between the cranial and caudal portions of pelvis is in the average 136° and 133° respectively for the Fin and the Blue foetuses. It shows no remarkable variation as to species, sex, age and body-side of whales.

6) The length of pelvis is in the Fin and the Blue foetuses about 1.6-1.8% of the body length. This ratio seems to be nearly constant for almost all whalebone whales, regardless of species, sex and age, probably with the exception of Greenland Right-whale, which shows a ratio of far greater than 2.0%.

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Iconography on the abdominal cavity and viscera of the Balaenoptera, with special remarks upon the peritoneal coverings

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In the baleen whales the abdominal and pelvic viscera with the peritoneal coverings have been seldom studied; only a few authors mentioned them in papers concerning stomach, ovary and testis etc. Meanwhile H. von W. Schulte was probably the only one scientist who worked systematically upon this subject, when he dissected a female foetus of the Sei whale. Recently I had the opportunity to go into this problem by observing foetuses obtained on board of the factory ship, "Nissin Maru No. 1" in the Antarctic expedition in 1948–49. Following foetuses, fixed with formalin, were examined with naked eye.

Serial Number	Species	Sex	Body length
26	Fin	female	3 feet
28	Fin	female	3 feet 5 inches
43	Blue	male	7 feet 8 inches

In the description I will mention at first the general form of the abdomina cavity, dividing it for the sake of convenience into the preumbilical and thel postumbilical region; illustrations of the relatively more simple constructed postumbilical region in both sexes will follow, and then the pictures showing the more complicated preumbilical region will be added. Next each of the abdominal and pelvic viscera will be treated, laying stress especially on the peritoneal coverings as well as on the topographical relations between the viscera and the parietal peritoneum. Bibliography will be noted at the end.

OBSERVATIONS

I GENERAL OUTLINE

The lateral view of the abdominal cavity is schematically shown in Fig. 1, in which the capacious preumbilical region is more of a rounded form, while the postumbilical region is narrow in dorsoventral direction. The narrowness of the latter is due to the huge mass of longitudinal muscles, which lie ventrally to the vertebral column, protruding considerably from the dorsal wall in this part of the body. The postumbilical region is divided by a large peritoneal fold, plica urogenitalis, or better to be called plica genitalis, as it is not concerned with urinary organs, into two cavities, excavationes rectovesicales dorsalis et ventralis.[1]

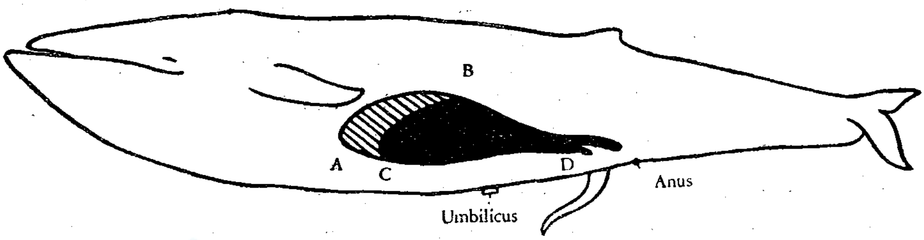


Fig. 1

The highest point of the abdominal cavity, that is, the locus, where the diaphragma reaches the most deeply into the thoracic cavity (Fig. 1, A), is at the level of 9. thor. vertebra, while the lowest point of the thoracic cavity, where the diaphragma takes origin from the posterior abdominal wall (Fig. 1, B), is at the upper end of 3. lumb. vertebra (median) or the lower end of 4. lumb. vertebra (laterally) and the point, where the diaphragma is attached to ribs median ventrally (Fig. 1, C), corresponds to the level of 12. thor. vertebra. The caudal end of the excavatio rectovesicalis ventralis (Fig. 1, D) is at the height of 14. lumb. vertebra.

Actual measurements in No. 26 resulted; A-D 20.5 cm, the greatest breadth of the abdominal cavity 8 cm, the greatest depth 7 cm, both at the level of the 2. lumb. vertebra.

The black area in Fig. 1 denotes the abdominal cavity, the obliquely lined area a portion of the diaphragma which is projecting into the thoracic cavity, with the heart on its ventral slope and with the lungs on its dorsal slope.

Fig. 2 shows the ventral view of the parietal peritoneum, muscles and fat tissues entirely picked off. At the middle the cut surface of the umbilical cord is found, having two arteries and two veins. Cranially to it and median, the umbilical vein is seen, two at first but soon they join into one. Caudally to the navel there is the bladder with the umbilical arteries on both sides; besides, the liver, the intestines, and the plica urogenitalis are visible through the thin parietal

1) Although they are called "excavatio rectouterina et vesicouterina" in the human anatomy, these names are not appropriate here, for the conditions in the whale are nearly the same between male and female.

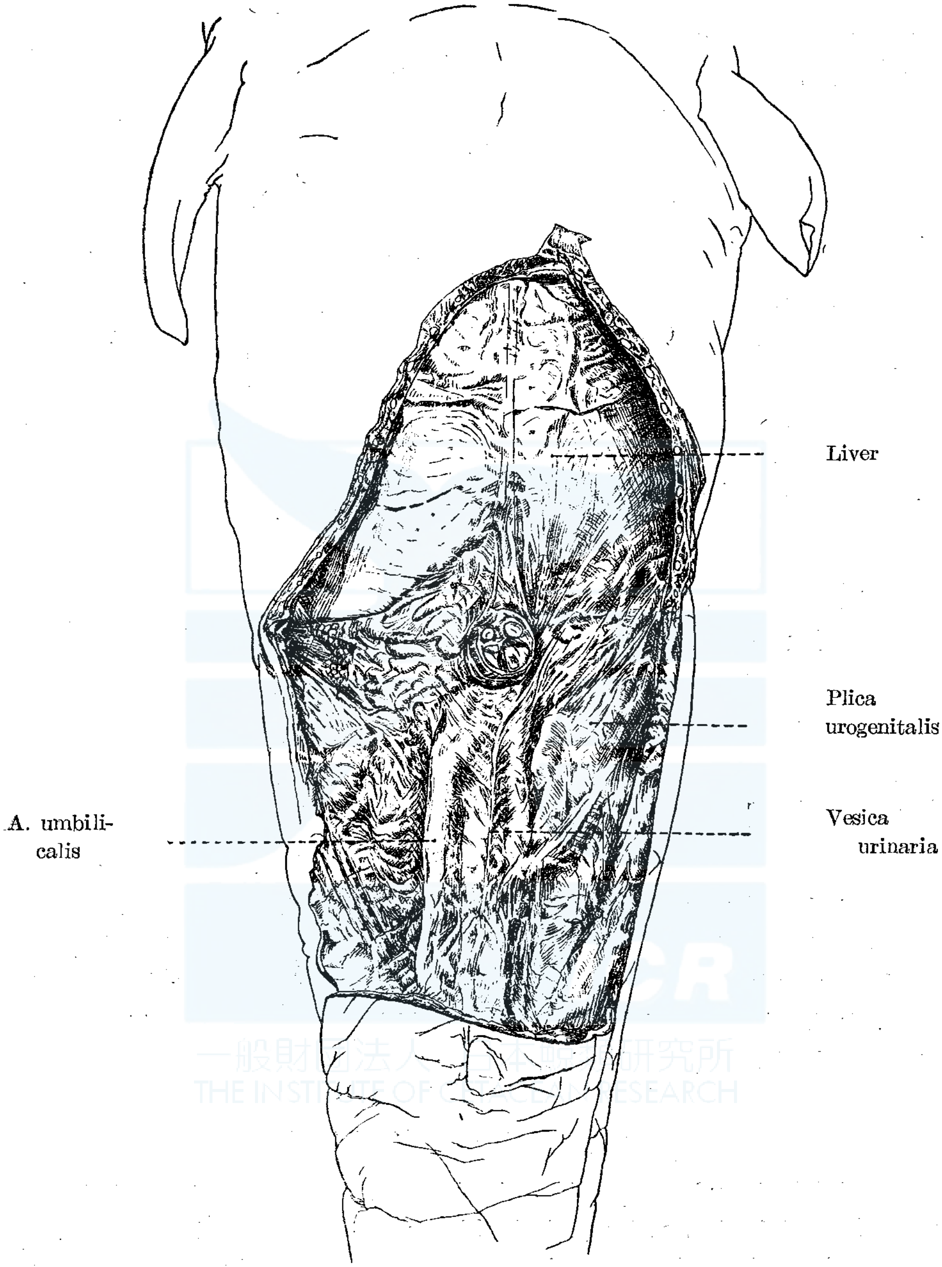
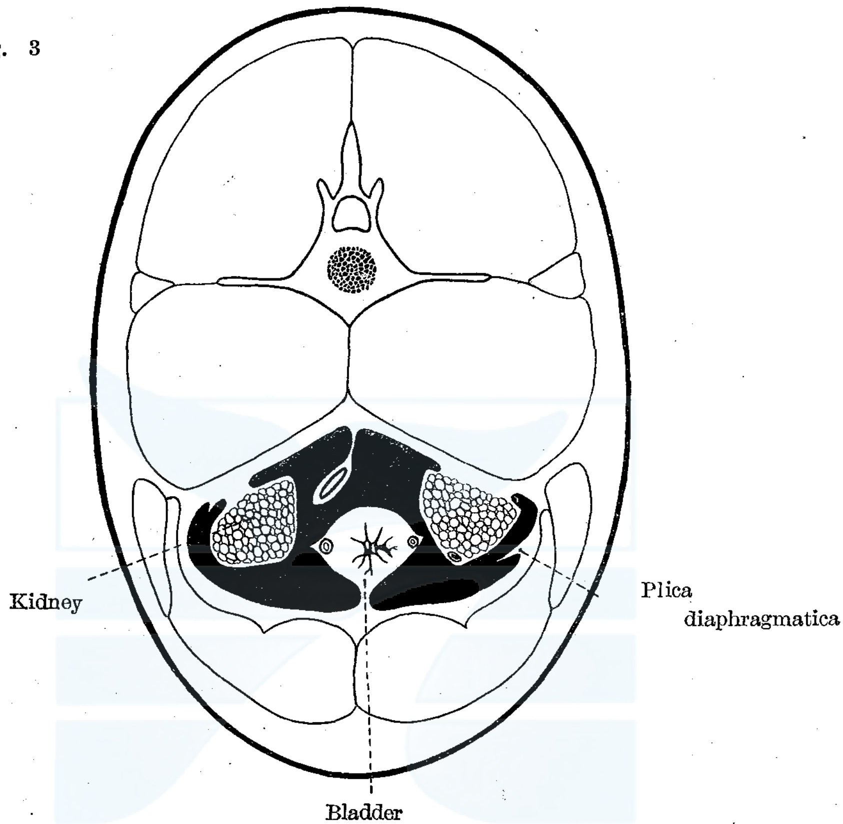


Fig. 2

peritoneum of the anterior body wall.

Fig. 3 is a diagram showing a transection of the whale's body at the lower part of the navel. Dorsally median, mesocolon is found, kidneys lateral to it, and

Fig. 3



more ventrolaterally a part of plica urogenitalis, which deserves here the name, plica diaphragmatica, and the bladder lies ventrally median with the umbilical arteries. The large muscles dorsal to the abdominal cavity and ventral to the vertebral column is the above mentioned musculature which makes the postumbilical region so narrow in dorsoventral direction.

II POSTUMBILICAL REGION

No definite boundary is to determine between the pelvic cavity and the other parts of the abdominal cavity, and the kidneys cause remarkable prominences on the posterior abdominal wall. In both sexes the large peritoneal duplicature, plica urogenitalis, rises from the lateral wall corresponding to the height of the upper end of the kidney and extends mediocaudally and ventrally to the kidney, forming the plica diaphragmatica; both halves, left and right, of the fold join together at the lowest level of the kidney, and form the so-called plica lata, which divides the cavity completely into two excavations already mentioned. Of them the excavatio rectovesicalis ventralis, which contains the bladder is small, while the excavatio rectovesicalis dorsalis is elongated with the colon passing in it. The plica urogenitalis shows remarkable sexual differences.

(1) In the female.

Fig. 4 represents the female pelvic viscera in situ, the parietal peritoneum deprived off. Cut surfaces of the bladder and of the umbilical artery are visible

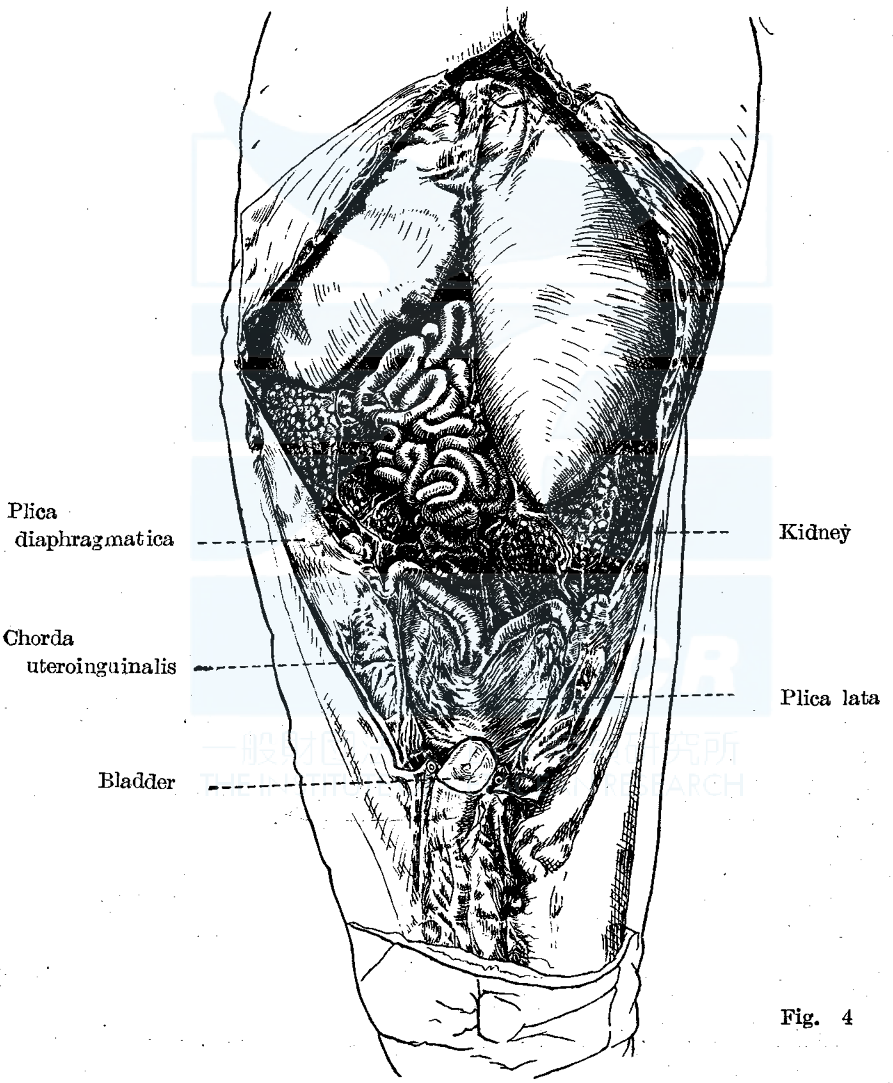
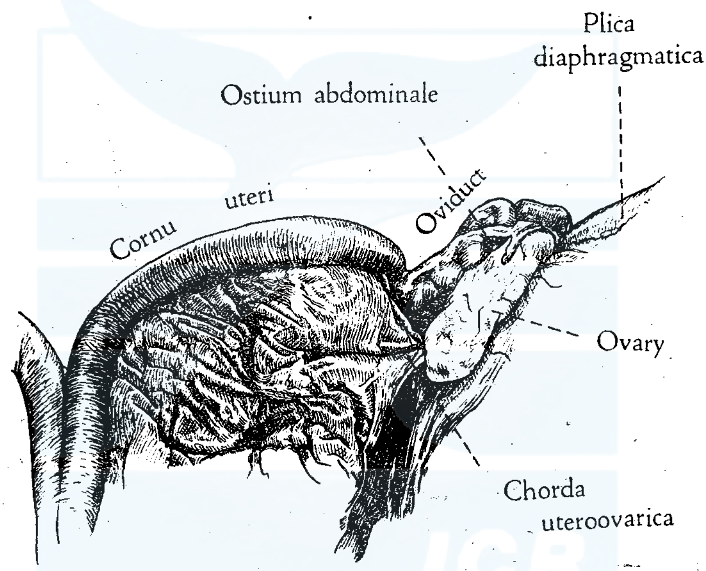


Fig. 4

in the caudal part. The ovary is attached dorsally to the plica diaphragmatica near the lower margin of the kidney. At the upper edge of the plica lata the uterine cornua and the oviducts are seen. The plica lata is thick and not so transparent, that the uterine corpus and ovary can not be seen through. On the plica lata we see a pair of thick bands (chorda uteroinguinalis = lig. teres uteri) running caudad from the distal end of the uterine cornua.

Fig. 5 shows a part of the plica urogenitalis seen from behind; only the right half is drawn. After making a ventral curvature, the uterus continues to the oviduct, which is short, thin but remarkably wound, lying a little lower than the border of the mesosalpinx and the part of the peritoneum more distal than the

Fig. 5



abdominal aperture of the oviduct is folded, forming a ligament.[2]. In Fig. 5 this ligament is partially cut to make the ostium abdominale visible, but no fimbriae are seen. The chorda uteroovarica (= lig. ovarii proprium) runs from the plica lata to the medial central part of the ovary. The right ovary is situated a little higher than the left.

To show this part more clearly, the transverse sections passing through the ovary and just above the union of uterine cornua are illustrated in Fig. 6 A et B. In A the ovary is found attached dorsally to the plica urogenitalis by means of

2) Ommanney noted this ligament and the wavy course of the oviduct is illustrated well in the paper of Beauregard et Boulart (1882).

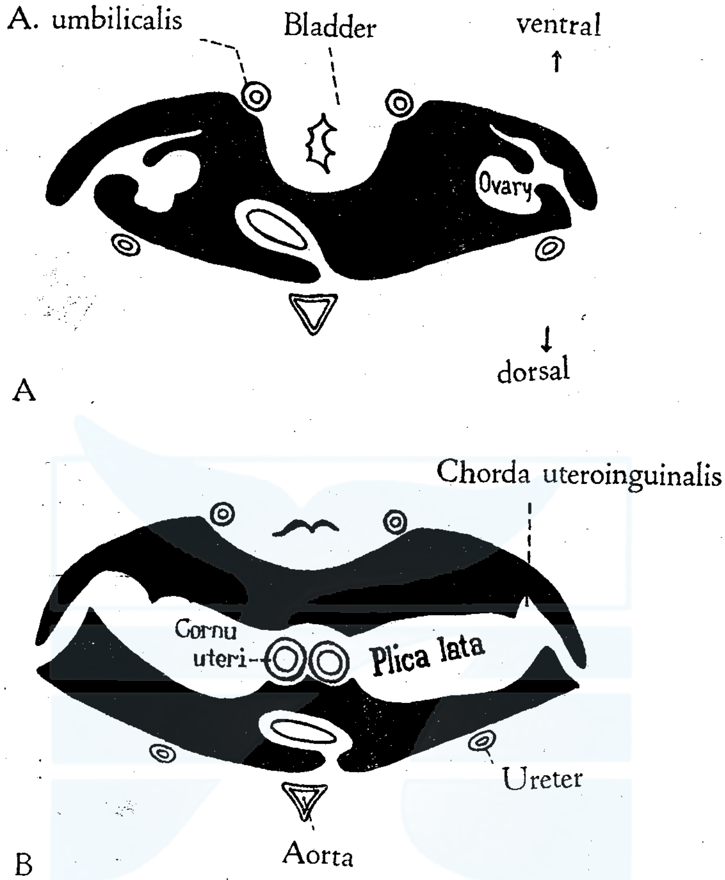


Fig. 6

mesoovarium and in B the thickness of the plica lata and of the chorda uteroinguinalis are indicated.

(2) In the male

Fig. 7 shows the postumbilical region in the male. The plica diaphragmatica suspends the testis at the height of the caudal end of the kidney. The epididymis is seen cranially to the testis and the vas deferens runs caudad, lateral to the testis and between them a deep furrow, sinus epididymidis, is formed, being bounded by a peritoneal fold on the side of vas deferens. The vas deferens is bent mediad, dorsally to the mesorchiagus of Eschricht (=gubernaculum testis?), a strong cord running from the testis on the ventral surface of the plica lata, and converges from both sides in this peritoneal fold to open into the urethra.

Fig. 8 shows schematically the relationships between plica urogenitalis, testis,

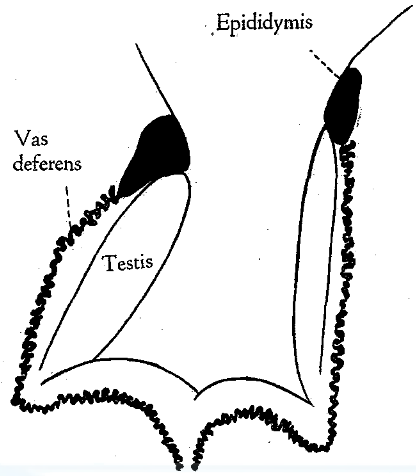

Epididymis
Vas deferens
Testis

Fig. 7

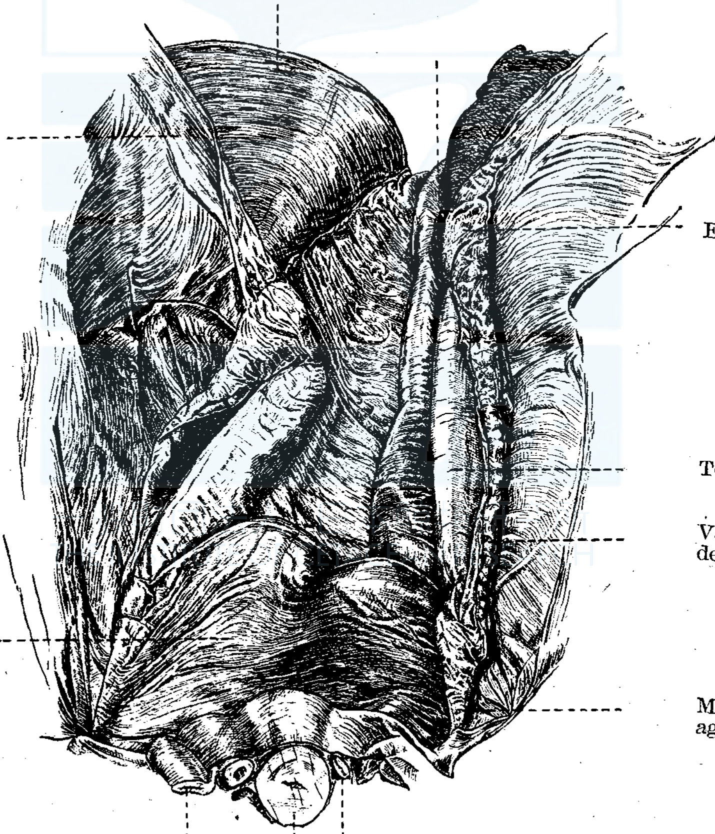

Kidney
Colon
Plica diaphragmatica
Epididymis
Testis
Vas deferens
Plica lata
Mesoorchiagus
Ureter
Bladder
A. umbilicalis

Fig. 8

epididymis and vas deferens.

The dorsal surface of the plica diaphragmatica is smooth; strong fibres are seen at the edge of this fold and at the caudal end of testis. Fig. 9 is a diagram of this part, cut near the middle of testis.

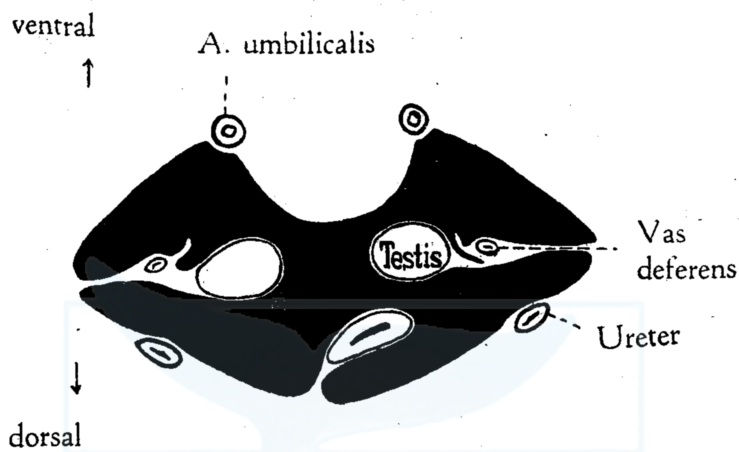


Fig. 9

(3) Excavatio rectovesicalis dorsalis

Fig. 10 shows a longitudinal section of the dorsal excavatio rectovesicalis. The rectum, except its small portion near the anus, is cut off but the mesocolon remains. From ventrally the bladder, the urethra, next the uterus and vagina are recognized

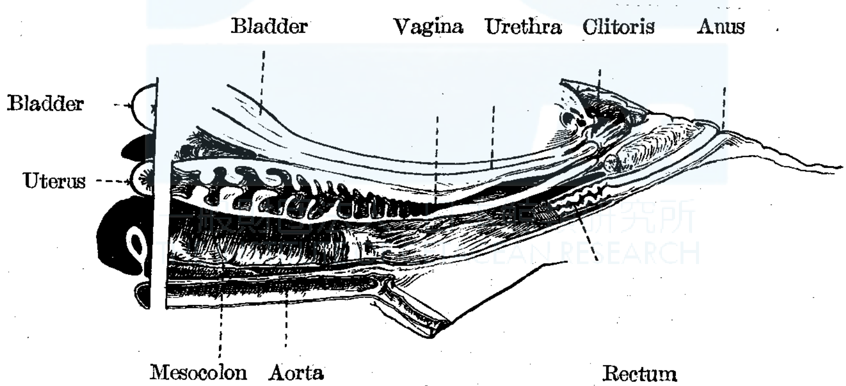


Fig. 10

and the abdominal cavity reaches very deeply near the anus. At the left side of this figure a diagram of the transectioned outline of this area is added.

III PREUMBILICAL REGION

As to this region, no remarkable sexual difference is ascertained.

In Fig. 4 the ventral mesohepaticum (=lig. falciforme hepatis) is cut off and two umbilical veins unite into one before they enter the liver. The large liver occupies the upper part of the abdominal cavity and the small intestine, forming a mass, lies under the left hepatic lobe and extends from here to the right and

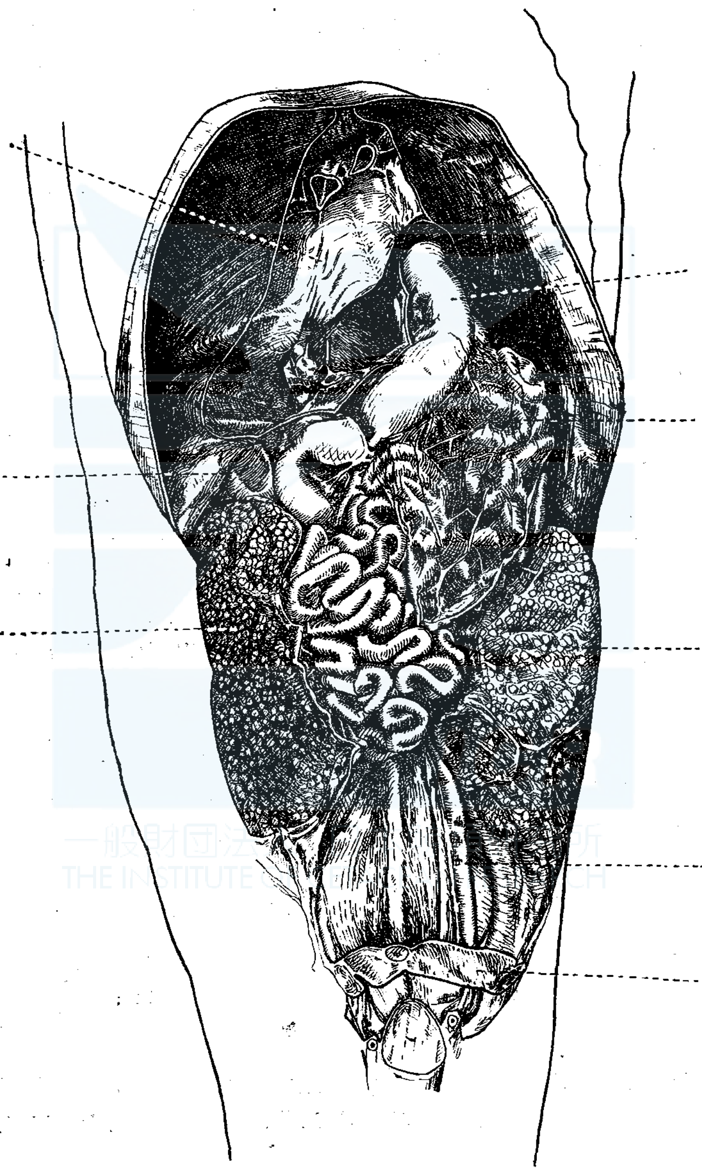


Fig. 11

caudal direction upto the umbilical region. The hepatic parenchyma is so fragile that we can easily pick it off with pincette, leaving only the capsule. The fragility seems to be due partly to insufficient fixation as I did not inject any fixing fluid intravascularly.

In Fig. 11 the plica urogenitalis and the hepatic parenchyma are taken off. The hepatic capsule is cut along the line, where it reflects upon the diaphragma and turns to the lesser omentum. The liver is adhered in a square form to the diaphragma and also to the 2. and 3. chamber of stomach, and to the pancreas. The lesser omentum is very small and no foramen epiploicum is present. The right lateral mesohepaticum (=lig. triangulare hepatis) does not exist distinctly, while the left lateral one is slender but well developed, courses at first laterad, next caudad. The 2., 3. and 4. chamber of stomach (the fourth chamber is nothing but the duodenal ampulle) come into sight and the small intestine hitherto concealed by the left hepatic lobe can be seen, its mass extending from left cranial to right caudad and nearly half of it being envelopped by the larger omentum. The larger omentum, originally situated between the stomach and the mass of the small intestine, is artificially stretched to show its whole extent. The kidney is proportionately very large; to the relatively higher located right kidney is attached the right adrenal body. In the caudal part the colon is seen running downwards between both kidneys and we see here the cut surfaces of uterus and plica lata.

By obliteration of the foramen epiploicum the omental bursa is all over closed and the larger omentum retains its cavity, bursa omenti majoris. Now the larger omentum is cut at its entrance, hiatus bursae omenti majoris, and the small intestine is for the greatest part taken off, cut at the duodenojejunal flexure and just before the ileocaecal transition, leaving the radix mesenterii. The kidneys are also cut off. Fig. 12 was drawn from a little left side. We see the attachment of the larger omentum to the stomach, but not its attachment to the pancreas, owing to the presence of colon. The caecum is located at the height of umbilicus. The colon ascends on the ventral surface of the mesentery, and without any definite transverse portion, descends then on the dorsal surface of the mesentery. The left adrenal body is located apart from the kidney, dorsally to colon descendens.

In Fig. 13 the colon is cut off, and the stomach is lifted a little. The ascending colon is adhered to the pancreas and the lines of origin of the larger omentum from stomach and pancreas are clearly seen. The duodenum, continuing from the ampulla duodeni, descends and turns to left around the caudal end of radix mesenterii, then runs further transversally and ascends dorsally to reach the duodenojejunal flexure.

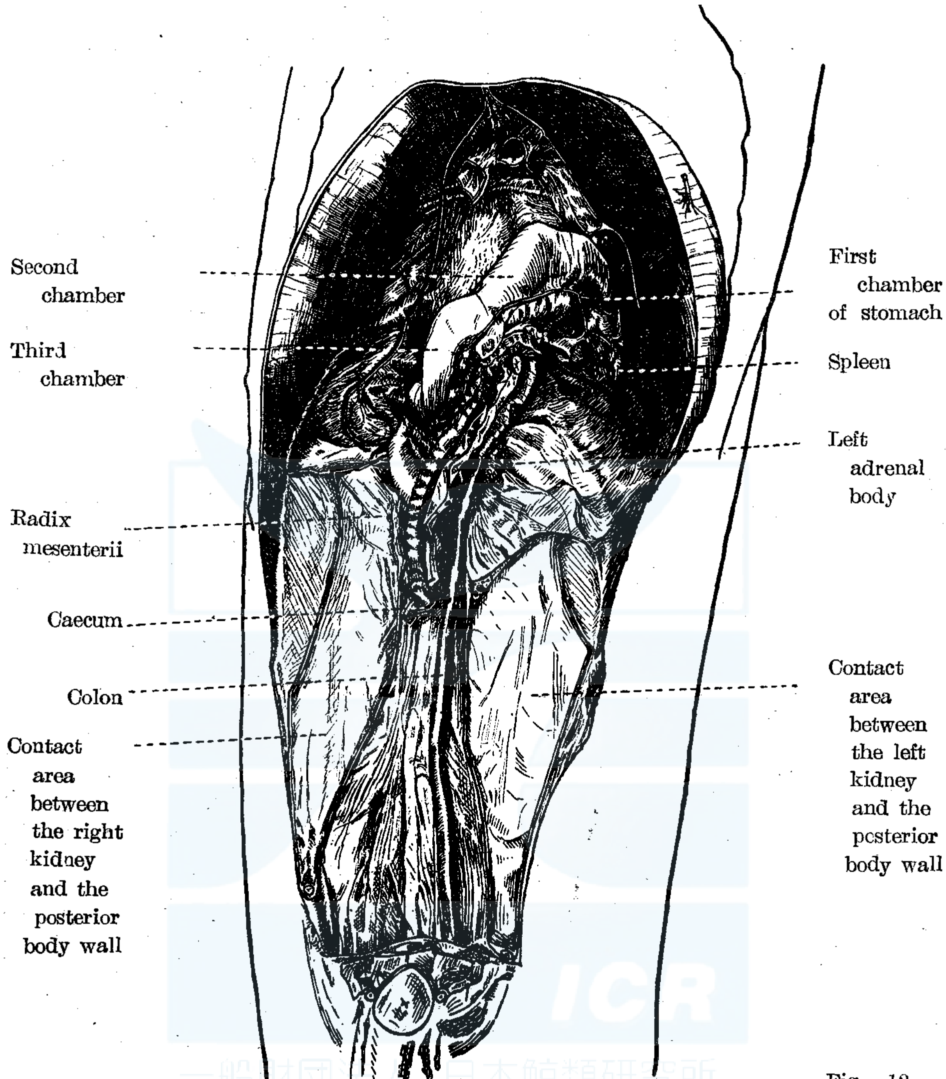
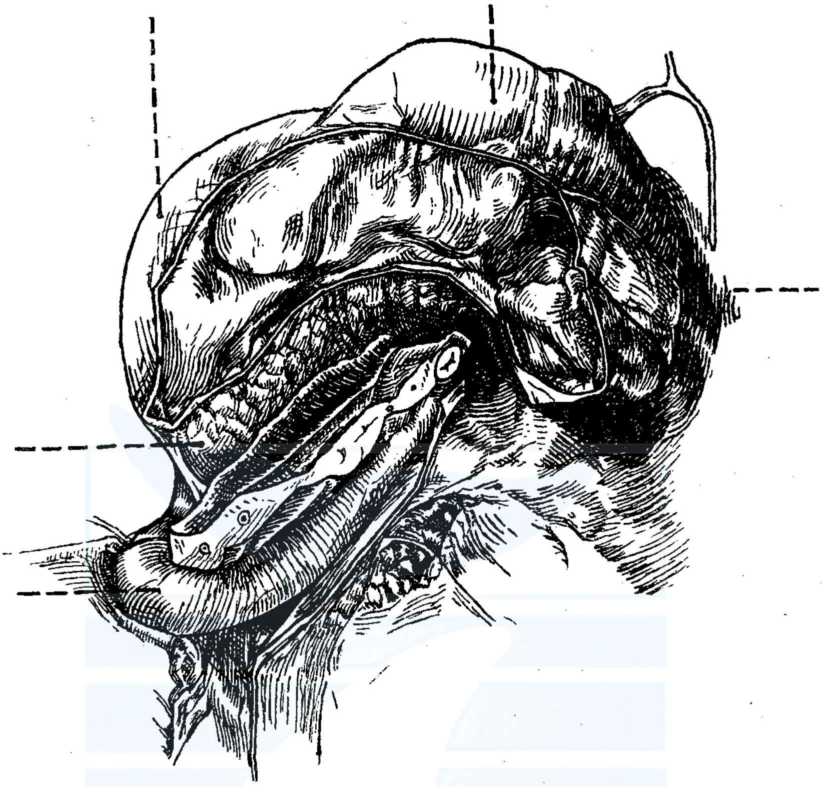


Fig. 12

In Fig. 14 all chambers of the stomach are taken off; we see now the total ventral aspect of the pancreas. The 4. chamber is cut at its junction with duodenum transversum and the colon is cut just proximally to its adhesion to the pancreas, so that a part of the colon remains attached to the pancreas. As the inferior vena cava penetrates deep through the liver, its sectioned surfaces, cranial and caudal, are seen and on the left side of its caudal cut is the area where the 1. chamber of stomach is attached to the diaphragma and at the middle of this area we see the end of the oesophagus. In the pancreas, tuber omentale is strongly formed and

Fig. 13



the cut surface of the portal vein is visible, appearing from behind the pancreas, to enter the liver. The part of the pancreas left to tuber omentale is its corpus, which makes a part of the dorsal wall of the omental bursa, and the cauda of the pancreas is directed dorsad. The part left to tuber omentale is of a small triangular form, faces also to the omental bursa from behind and the caput of pancreas slopes dorsad at the right side of tuber omentale; the 4. stomachal chamber is adhered to the caput.

Fig. 15 shows the posterior body wall itself, almost all of the viscera deprived of. The area of attachment of the liver and of the 1. stomachal chamber to the diaphragma is naturally the same as in the former figure but caudally to the area of the 1. stomachal chamber there is a place, where the cauda of the pancreas is attached to the diaphragma. And the inferior vena cava passes behind the middle of the pancreas area. The mesoduodenum is, after the caput of pancreas has disappeared, is directly broadly adhered to the posterior body wall, bending transversad caudally to it and disappearing at the pancreatic cauda area, where the duodenojejunal flexure lies. Scarcely any mobility of the duodenum can be assumed

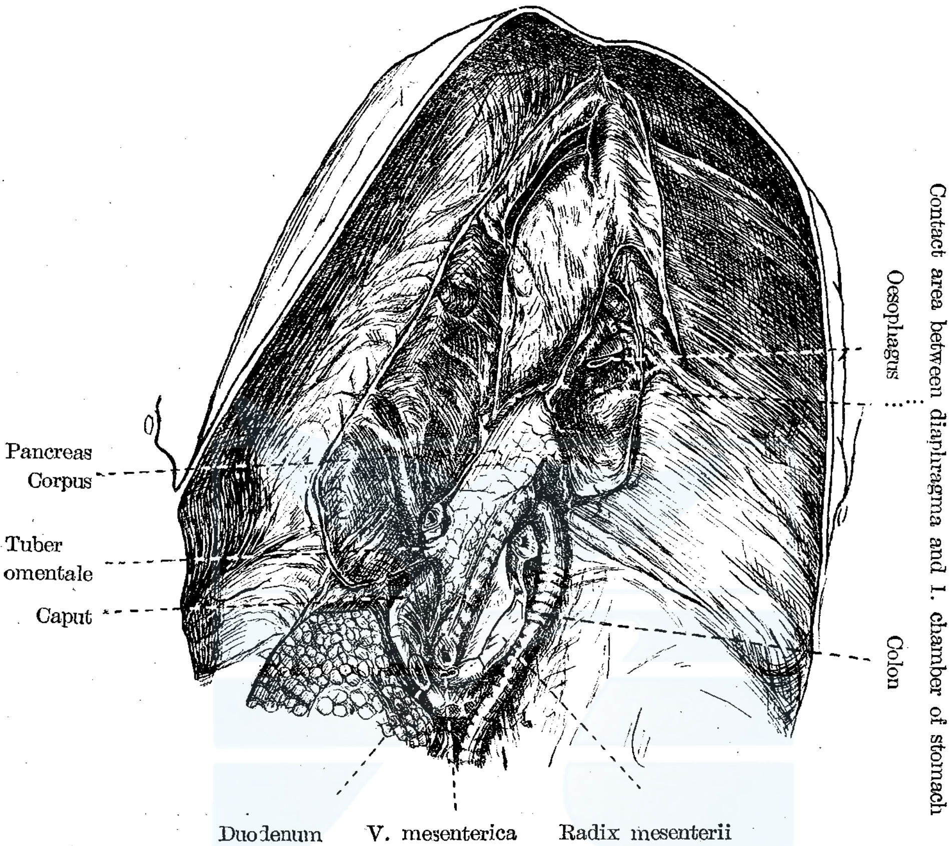


Fig. 14

from the broadness of mesoduodenum. The mesocolon is situated left to the mesoduodenum ascendens and ends at the pancreatic cauda area, for it is adhered to the ventral surface of radix mesenterii. The part between the pancreas-area and the mesoduodenum-area is radix mesenterii and there the cut end of the mesenterial artery is seen. The right adrenal body lies partially concealed by the pancreas.

Fig. 16 shows the stomach already illustrated in Fig. 11, but viewed from more right and ventral direction. The 2. and 3. chamber are adhered to the liver and the 4. chamber to the ventral surface of the pancreas. The part of the hepatic capsule which faces to the omental bursa, that is, the free surface of the papillar process is taken off, so the pancreatic corpus can be seen and the upper border of the pancreas in this figure is the entrance to the bursa of the larger omentum.

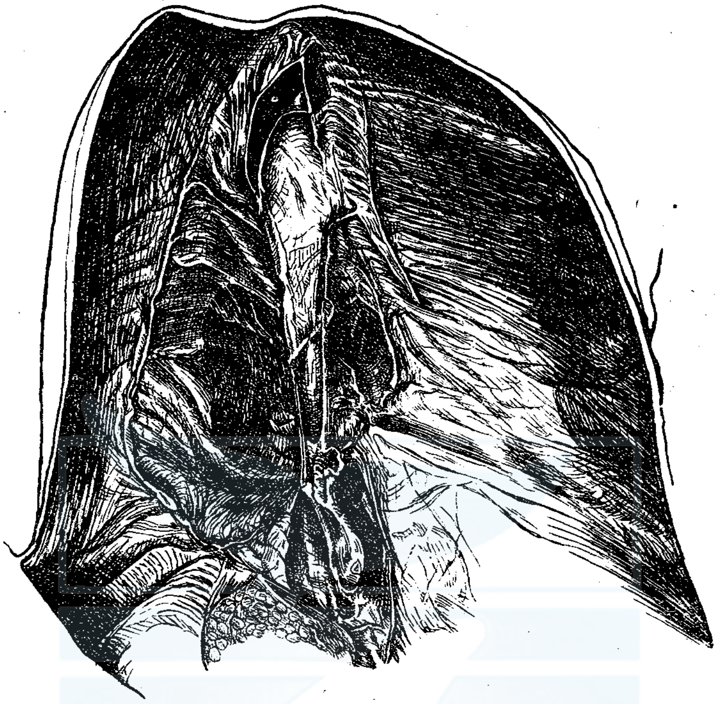


Fig. 15 (a)

IV REMARKS UPON EACH ORGAN

In this chapter, the abdominal and pelvic viscera will be described, especially in relation to the peritoneal covering. In the following figures the white area always means the part covered with peritoneum, the oblique-lined area the portion adhered to other organs or to the body wall, the dotted area the part facing to the omental bursa.

(1) Liver (Fig. 17)

It occupies nearly all of the upper abdominal cavity, its right lobe is very large, but the left lobe extends more caudally and covers from ventral the mass of small intestine, stomach and upper part of the left kindey (Fig. 4); so we can easily recognize on the dorsal surface of the liver, hollows caused by stomach, duodenum, intestine and kidney. As the inferior vena cava is entirely embedded into the liver, the caudate lobe can not be discriminated and the right and the left lobe of the liver are directly continuous in the dorsal part. Only the papillar process is well developed and adhered ventrally to the 2. and 3. stomachal chamber

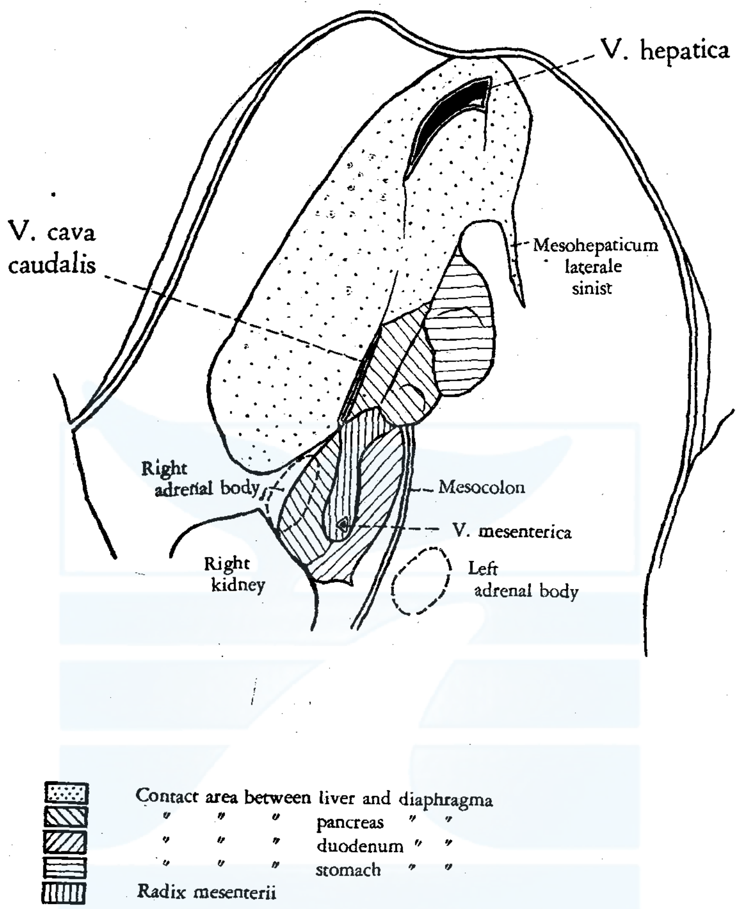


Fig. 15 (b)

and the dorsal durface of its base is attached to the pancreas so that it is nearly encircled with stomach and pancreas, projecting into the omental bursa between them. We see neither the quadrate lobe nor the gall bladder. The ventral meso-hepaticum broadens from the point where the inferior vena cava passes through the diaphragma, to which the liver is attached in a square form.

(2) Pancreas

Fig. 18 shows the relation of the pancreas to other organs. The area, where it is attached to posterior abdominal wall, is finely oblique-lined, while the area of its attachment to other organs is roughly oblique-lined. The pancreas is situ-ated dorsally to stomach and duodenum, cranially to colon and almost parallel to


Ampulla duodeni
Pancreas

Fig. 16

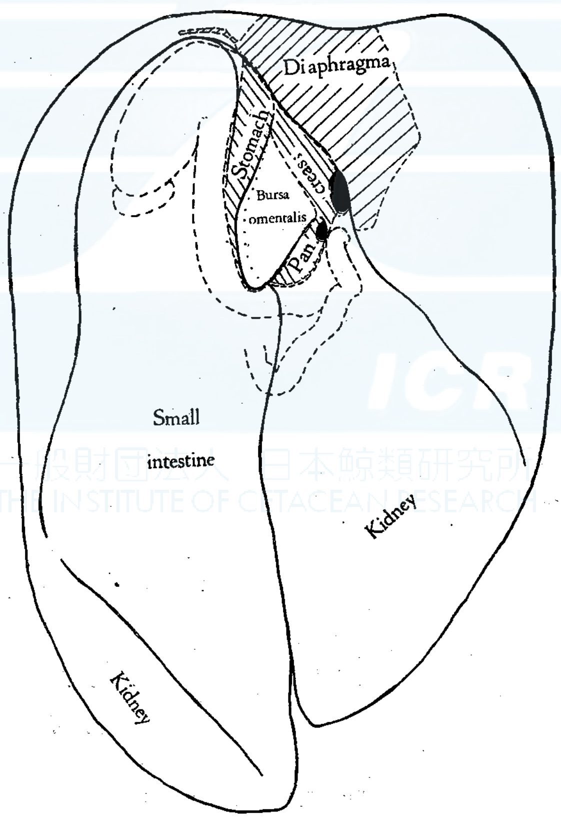
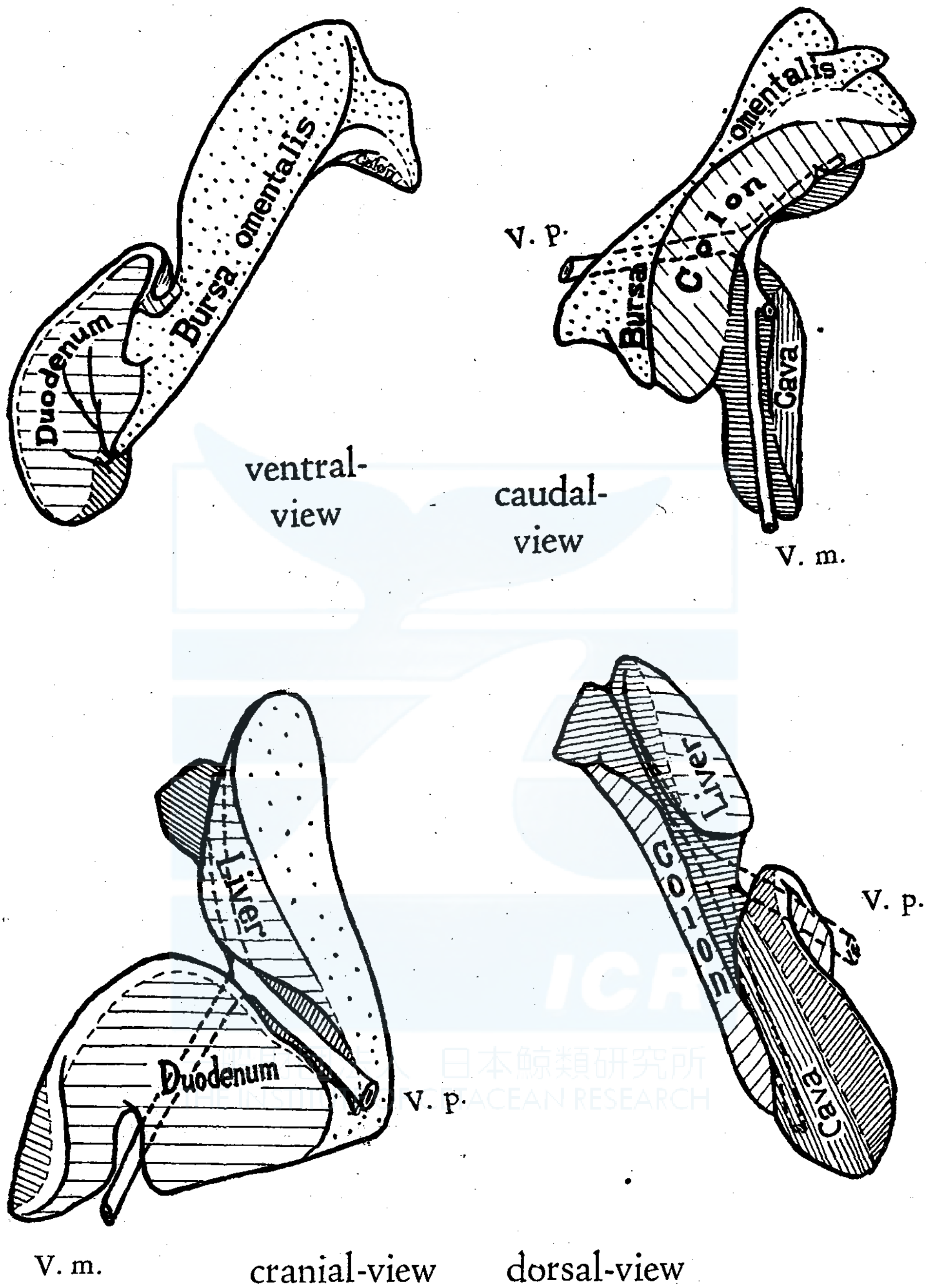

Diaphragma
Stomach
creas
Bursa
omentalis
Pan
Small
intestine
Kidney
Kidney

Fig. 17



V. p. V. portae
V. m. V. mesenterica

Fig. 18 Pancreas

these organs, it is elongated from left cranial and dorsal towards right, ventrad and caudad. Its form is ellipsoid in the ventrodorsal direction and nearly triangular, seen from a vertical plane to its long axis. The caput is more expanded than the ampulla duodeni, which is located more ventrally; so its peripheral border has the peritoneal covering. The processus uncinatus is small. The corpus, which is near the caput triangular in shape, and more left of a square form, makes a part of the dorsal wall of the omental bursa. The boundary between caput and corpus, is remarkably prominent ventrad, tuber omentale, and in some specimens goes into the liver along the portal vein. The caudal margin of the corpus is adhered to the colon. The cauda is bent dorsad, and mark together with the 1. chamber of stomach the leftmost portion of the omental bursa. Between this area and that, where colon and pancreas are attached, there remains a small area covered with peritoneum. The pancreas of Fig. 18, seen from ventrally, is the same as that of Fig. 15 and the figure seen from cranially shows the pancreas in Fig. 16, the stomach being omitted here. The figure seen from caudally corresponds to Fig. 13 viewed from almost horizontally. The veins coming from the intestines make deep furrows on the back of the pancreas and participate in the formation of the portal vein along tuber omentale.

(3) Stomach and duodenum (Fig. 19)

The abdominal part of oesophagus, between diaphragma and stomach, is rather long and the dorsal surface of 1. stomachal chamber is adhered to the diaphragma in a wide area. The 2. and 3. chamber are extended obliquely from cranial left to caudal right, and on the right side they are attached to the liver, pancreas and the basis of proc. papillaris. The 4. chamber, that is, ampulla duodeni, is adhered to the pancreatic caput dorsally and the duodenum changes its course abruptly at the radix mesenterii and ascends behind this and continues to jejunum.

(4) Bursa omentalis

By the lost of foramen epiploicum the omental bursa, the capacity of which is small, has no opening. It is surrounded by 1., 2. and 3. stomachal chambers, cauda and corpus of the pancreas and divided into three portions. The attachment of pancreas to the posterior body wall and to the liver causes the absence of vestibule and of superior recessus in the omental bursa. The papillar process is projecting into it, particularly into the area between the 2. stomachal chamber and the pancreatic corpus. The peritoneum covering the stomach turns over to the pancreas at the boundary between 3. and 4. chambers of stomach, just cranially to the border of the pancreas where it is attached to colon and it passes to 1. stomachal chamber from the pancreatic cauda and, bending near the spleen, returns to its original point. Caudally from this hiatus extends the bursa omenti majoris.

(5) Small intestine

The coiled mass of the small intestine is in the upper abdominal cavity, specially in the left side as if its more caudal development were prevented by the

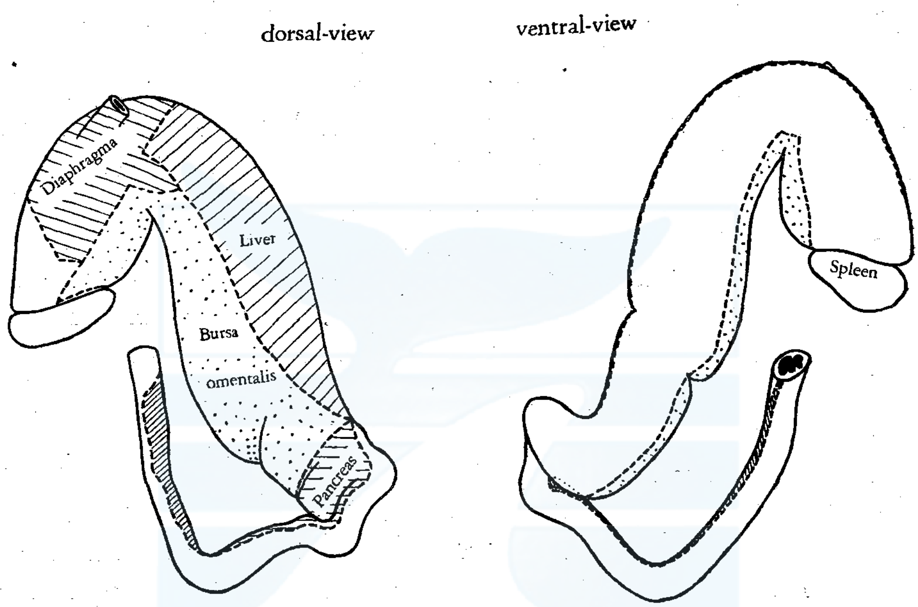


Fig. 19 Stomach

presence of kidneys. The long axis of the intestinal mass is directed from left cranial to right caudad and its upper 2/3 is covered by the left hepatic lobe. No rest of the ductus omphalomesenterica (Meckel's diverticle) is seen.

(6) Colon

The caecum is located in the right side nearly at the level of the umbilicus and the mesocolon ascendens is adhered to the ventral surface of radix mesenterii and the upper part of the colon is adhered to the pancreas. The colon bends at the cranial end of the radix mesenterii dorsad and descends dorsally along the radix mesenterii, and so the mesocolon descendens rises from the posterior body wall. Passing between both kidneys, it descends into the dorsal excavatio recto-vesicalis. No transverse portion of the colon is discernible and the whole colon is in a plane directed sagittally, that is, dorsoventrally rather than frontally.

(7) Spleen

The spleen, attached to the outer surface of 1. stomachal chamber, is relatively very small and except this area of attachment it is covered all over with peritoneum. Dorsally a strong lig. gastrolienalis is found.

(8) Adrenal body

The right adrenal body is attached to the right kidney and located between kidney, liver and duodenum, concealed partially by pancreas. The left adrenal body is tolerably distant from the left kidney and near the colon descendens about at the same level of the right one.

(9) Kidney (Fig. 20)

The voluminous kidney is seen directly by taking off the parietal peritoneum. And through its capsule numerous renculi are found. The right kidney is located

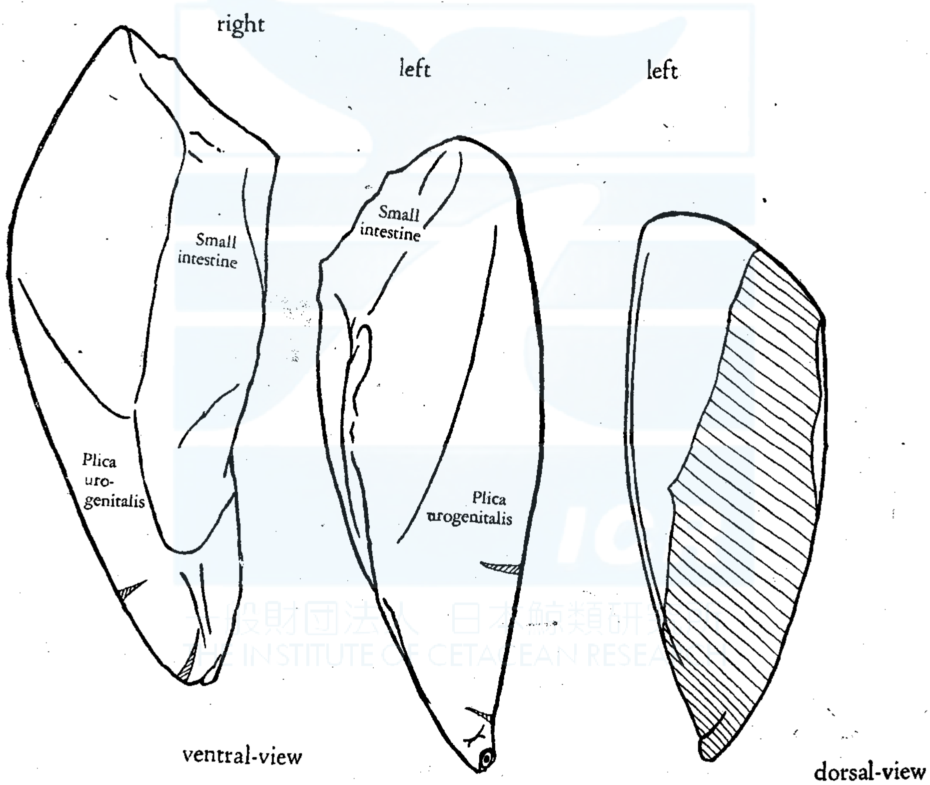


Fig. 20

a little more cranially. The area where the kidney is attached to the posterior body wall is broad, its cranial, lateral line is concave. The areas faced to the liver, small intestine and plica urogenitalis are easily recognizable. The hilus exists at the upper end, where the blood vessels enter the kidney and it is at the caudal end that the ureter leaves. Moreover, laterally between the lateral body wall and the kidney two peritoneal folds are formed, bringing forth some recesses[3], the caudal one of which is just above the origin of the ureter.

(10) Bladder

Its dorsal surface faces to the abdominal cavity and near its cranial portion it bulges with its peduncle, but the more caudally, the less it is prominent into the abdominal cavity.

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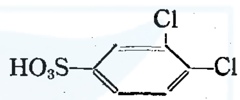
Isolation of Histidine from Whale Blood using 3,4-Dichlorobenzene Sulfonic Acid

SHICHIRO AKIYA and OTOMATSU HOSHINO

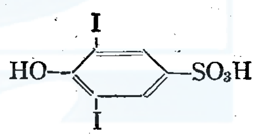
Isolation[1] of histidine from hydrolyzed product of proteins used silver or mercury salts method, and a sublimate method in industry. However, the latter necessitates the use of hydrogen sulfide gas, a large amount of mercuric chloride, and results in a variety of yield on histidine according to the condition of precipitation, as well as the process being very complicated.

Stein and Bergmann[2),3)], in 1938–1940, made a wide ressearch to find aromatic sulfonic acids which would form insoluble salts with amino acids and found three kinds which made insoluble salts with histidine. These acids were:

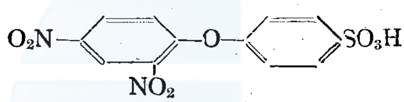
3,4-Dichlorobenzene sulfonic acid



2,6-Diiodophenol-4-sulfonic acid



0-(2,4-Dinitrophenyl)-p-phenol sulfonic acid



Vickery[4)], in 1941, employed one of the salts, 3,4-dichlorobenzene sulfonic acid (hereafter designated 3,4-D), and obtained good results in isolating histidine from the hydrolyzed solution of horse red blood cells. Further, in 1942, he applied 3,4-D method for the quantitative estimation of histidine.[5)]

The features of histidine isolation by 3,4-D are as follows:

1) Preparation of 3,4-D is very easy and 3,4-D is the specific precipitation agent for histidine.

2) Histidine precipitates gradually as a disulfonate from acid solution whereas precipitation as silver or mercury salts occurs from neutural to weak alkaline solutions.

3) Isolation of the disulfonate of histidine is complete and easy since it is crystalline and can easily be purified by discoloration and recrystallization. The crystals also have far higher decomposition point (275–280°C) than 3,4-D salts of other amino acides (generally m.p. around 200°C) which makes it easy to prove.

4) Although the process is not quantitative, it is much easier than the silver or mercury salt method.

Tawara[6] separated histidine from dried whale blood powder. The authors examined isolation of histidine from whale and cattle blood by the use of 3,4-D and the results were compared with that of Tawara's.

It should be noted that the dried and powdered whale blood contains far larger amounts of moisuture and salts than those of cattle and horse blood, so that a correction must be made of the values. If this crude whale blood powder is hydrolyzed and 3,4-D used, isolation does not proceed smoothly due to obstruction by salts, resulting in the decrease in the amount of histidine disulfonate, so that the yield cannot be made better by adjusting the content of moisture and salts.

In order to remove salts from whale blood powder prior to hydrolysis, a pretreatment is made by adding water to the crude blood powder, stirring well and filtering. The residue is washed well with water and air-dried. This blood powder (hereafter designated as the pretreated blood powder) contains almost no salts so that, when the hydrolyzed solution is concentrated, only the hydrochlorides of glutamic acid precipitates out. The yield of histidine also increases remarkably, being better than that obtained from cattle blood carried out as a control. On the other hand, isolation of glutamic acid hydrochloride is very difficult from untreated whale blood powder owing to occlusion of sodium hydrochloride.

Addition of water to cattle blood powder results in its swelling which makes it hard to wash with water. This elimination of washing with water allows some inclusion of salts. The blood cells used by Vickery was washed well with water so that the yield in final product is very high. It can be assumed, therefore, that the content of salt in blood powder controls the formation of histidine disulfonate when using 3,4-D method.

Monosulfonate of leucine is obtained in a considerable amount from the mother liquor after separating histidine disulfonate.

Recently, Takagi, Suzuki and Asahina[7], used acid clay in the hydrolyzed solution of cattle blood to adsorb basic amino acids, then eluted this by weak alkali. This alkaline solution was electrolytically dialyzed, then 3,4-D added, and histidine was isolated with a good yield as its disulfonate. As was explained in their report, majority of 3,4-D can be recovered as a barium salt.

Acids used for hydrolysis were hydrochloric and sulfuric acids but the yield of histidine disulfonate was not so good when 30-35% sulfuric acid was used.

The method of isolation and the results are given in Tables I and II.

Table I. Method of Isolation

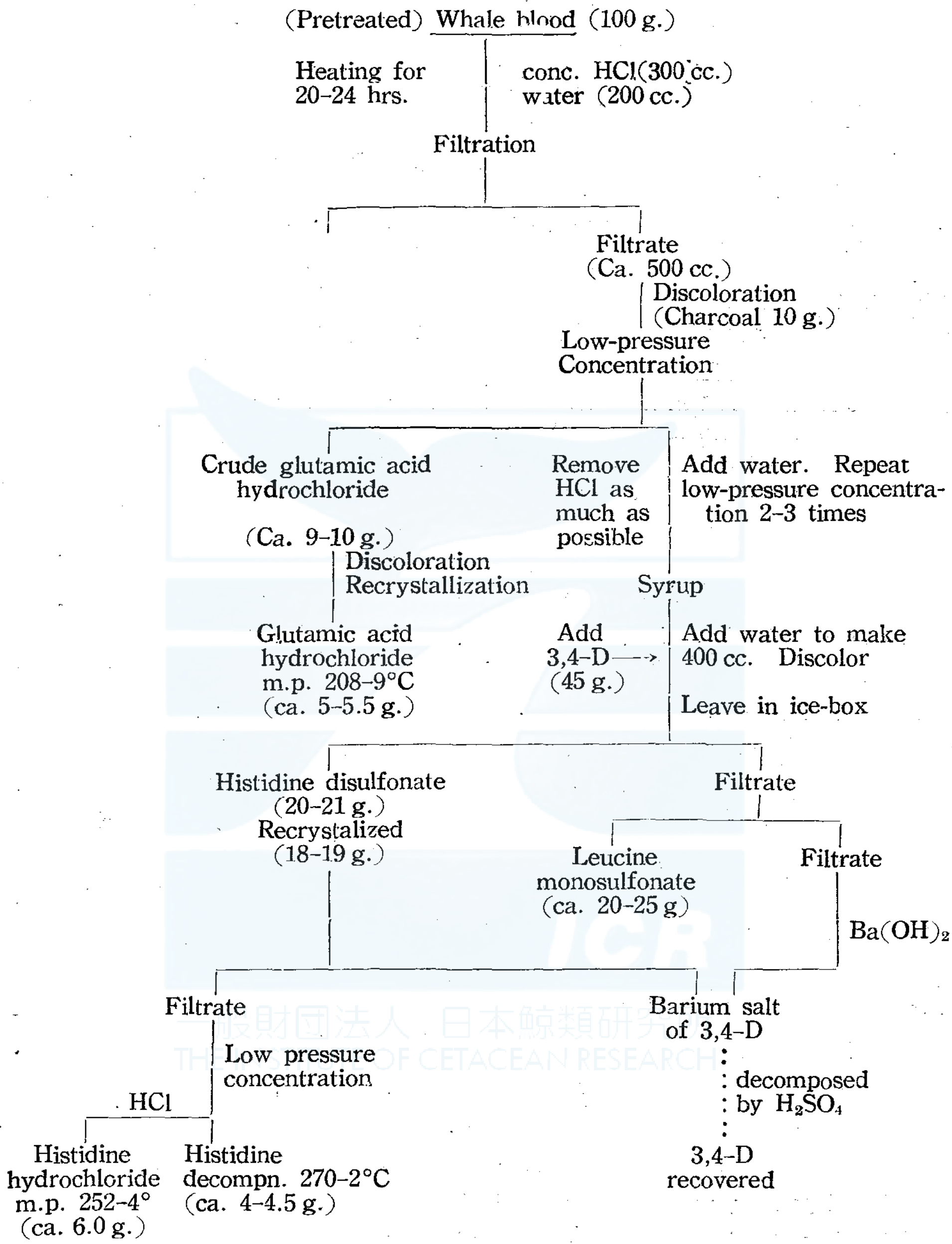


Table II. Amount of Histidine Disulfonate isolated from 100 g. (moisture corrected) of Various Blood Powder (salts uncorrected)

Kinds of Blood		Moisture (%)	Histidine disulfonate (g)	Remarks	
Untreated Whale blood	No. 1	28.6	12.3	Contained chorides (as NaCl) 9.4%	Glutamic acid hydrochloride not isolated due to salt precipitation
	No. 2	28.6	13.3		
	No. 3	28.6	13.6		
Cattle blood	No. 1	12.0	14.5		
	No. 2	12.0	17.3		
Pretreated whale blood	No. 1	Hydrolyzed after corection	18.6	Glutamic acid hydrochloride isol'd	
	No. 2		19.0	〃 not isolated	
			25.7		
Horse blood	Blood cells	5.5	25.7	Taken from the data of Vickery[4] for comparison	
	Technical hemo-globin	7.7	18.1		

(Note: The yield on histidine disulfonate does not differ much even when separation of glutamic acid hydrochloride is carried out as in No. 1 of pretreated whale blood. The amount of leucine monosulfonate decreases slightly).

EXPERIMENTAL

1) *Preparation of 3,4-Dichlorobenzen sulfonic acid*:

A mixture of 65 cc. of o-dichlorobenzen and 140 cc. of conc. H_2SO_4($d=1.84$) is heated in a flask in an oil bath at 185±5°C for 24 hours under air cooling. After cool, 700 cc. of water is added and discolored with activated charcoal. The discolored solution is concentrated to one-half of its volume on a water bath, cooled, and filtered through a glass filter. The residue on the filter is washed with conc. HCl, H_2SO_4 removed, suck and dried. In order to remove conc. HCl and water, this residue is placed in an evaporating dish, melted on a small flame and heated gradually to 130°C at which the heating is continued for a few minutes. After cooling and before solidification, the mass is stirred into small pieces and is kept in the dessicator since it is hygroscopic.

3,4-Dichlorobenzen sulfonic acid (3,4-D) herewith obtained contains a small amount of water and is a white, crystalline mass which melts at around 70°C. This can suitably be employed for the isolation of histidine.

2) *Hydrolysis of Whale Blood Powder*:

In order to examine the effect of salts, hydrolysis were carried out with crude whale blood powder, washed and unwashed with water.

(a) Untreated blood powder—Small pieces of crude whale blood powder is ground in a mortar, sieved to remove all occluded substances, and prepared into a fine powder.

Moisture—1 g. of untreated blood powder is dried at 100–110°C to constant weight and the residual powder was found to weigh 0.714 g. Therefore, moisture is 28.6 %.

Chloride—Sufficient water is added to 10 g. of untreated blood powder to make 100 cc., filtered, and 1 cc. of the filtrate is titrated with 0.1 N $AgNO_3$ to determine the amount of chloride which, as NaCl, came out as 9.4%.

It follows, therefore, that the protein portion amounts to 62 %.

(b) Pretreated blood powder—The untreated blood powder is stirred into 5 times its volume of warm water of around 50°, filtered, washed well with water and dried. By this process, majority of haemoglobin remains in the residue while albumin and globulin dissolve into the aqueous solution together with salts and water-soluble proteins.

Untreated blood powder possesses a saline taste while such is not the case in treated blood in which the odor peculiar to whales has also disappeared.

Method of isolation using pretreated blood powder is given as follows:

A mixture of 100 g. of pretreated whale blood powder, 300 cc. of conc. HCl and 200 cc. of water is heated for 2-3 hours in a water bath, and then hydrolyzed by heating over an open flame for 20 hours with reflux attachment. After separating by filtration, the solution is discolored by a small amount of activated charcoal* and is concentrated under reduced pressure on a water bath of 50-60°C. The solution turns syrupy when reduced to one-third its original volume. When the solution becomes cool, the hydrochloride of glutamic acid precipitates out. If the untreated blood has been used, a large amount of salts precipitate out here. The syrup is left overnight in an ice-chamber after which it is filtered, the residue washed with a small amount of conc. HCl and dried. A viscous, crystalline mass of crude glutamic acid hydrochloride is obtained to the amount of 9-10 g. This is discolored and recrystastallized from hydrochloric acide to white crystals of m. p. 208-9°C. Yield, ca. 5-5.5 g.

The filtrate obtained after separation of glutamic acid hydrochloride and the washings** from activated charcoal are brought together, sufficient water added to make the total amount about 300 cc, and is again concentrated under reduced pressure to a syrupy state. Addition of water and concentration under reduced

* The pretreated whale blood powder No. 1 in Table II was discolored before concentration and No. 2 was not treated. When not discolored, the solution, during concentration, is very hard to bring down the volume, and the concentrated liquid is very dark in color. Glutamic acid hydrochloride cannot be separated from such a liquid.

** Activated charcoal used for discoloration is extracted twice with boiling water.

pressure is repeated again to remove as much HCl as possible. Water is then added to the syrup to bring the whole volume to 400 cc., and discolored until the solution becomes clear and yellow. The hot washings from activated charcoal is concentrated, added to the main syrup and the whole is again concentrated to about 400 cc. The pH of the solution becomes 1.0 to 2.0.

3) *Isolation of Histidine*:

To the hydrolyzed solution, 45 g. of 3,4-D is dissolved, a minute amount of histidine disulfonate crystals is added as a seed, and the whole is left in an ice-chamber for a few days. The disulfonate precipitates out in the bottom of the flask as a crystalline mass.

The crystals of histidine disulfonate are prismatic while monosulfonate of leucine is fine needles. The latter easily precipitates out by slight swirling of the hydrolyzed solution so that it must be decanted its supernatent liquid, quietly and carefully.

If the sulfonates of histidine and leucine percipitates out at the same time, the solution is heated to dissolve both crystals and then left for a few days in an ice-chamber so as to allow histidine disulfonate to precipite out. In general, histidine salt crystals precipitate out first, and separation of leucine monosulfonate is not difficult. Yield of crude leucine monosulfonate, 20-25 g.

The crude crystals of histidine disulfonate, decompn. 260-270°, is dissolved in water and discolored, and then recrystallized to white needle crystals of decompn. 275-280°C. The yield decreases by about 5-8 % when recrystallized.

To obtain histidine from its disulfonate, the latter is dissolved in eight times its volume of boiling water, cold, saturated solution of $Ba(OH)_2$ added to pH 7.2, and the barium salt of 3,4-D that separates out on cooling is filtered off. The barium salt is washed with water, the washings added to the mother liquid and the whole volume condensed to less than one-half of its volume under reduced pressure. In order to remove 3,4-D still present in the solution, the solution of $Ba(OH)_2$ is added until the pH is 8.5, and the small amount of barium salt that separates out is filtered off. Barium hydroxide is quantitatively removed by H_2SO_4, the solution brought to pH 7.2, and concentrated under reduced pressure by which free histidine separates out.

After removal of histidine, the filtrate is further concentrated and a small amount of histidine precipitates out upon addition of alcohol. These are recrystallized by dissolving in a small amount of water and adding alcohol. Histidine has a decomposition point of 270-2°C. Yield is about one-quarter of the disulfonate.

Histidine hydrochloride is obtained by the addition of equimolecular amount of HCl to the solution of pH 7.2 obtained after removal of 3,4-D by $Ba(OH)_2$

which brings the pH of the solution to 2.8. By concentration under reduced pressure, and allowing the whole to stand overnight after addition of alcohol, white crystals of histidine hydrochloride, m.p. 252–4°, can be obtained. These crystals did not show any depression of melting point when fused with histidine hydrochloride of Takeda Pharmaceutical Industries. Some histidine disulfonate can be recovered from the mother liquor by concentration and addition of an excess of 3,4-D. The yield of hydrochloride is about one-third of histidine disulfonate.

CONCLUSION

Isolation of histidine from whale blood powder using 3,4-dichlorobenzene sulfonic acid was carried out. Whale blood cotains a large amount of moisture and salts and the latter is responsible for the obstruction of isolation process. Therefore, the blood was pretreated to warm and cold water washings by which the salts were removed and a result approximately equal to those from cattle and horse blood was obtained. The hydrochlorides of glutamic acid can also be obtained easily from the pretreated blood whereas its separation is very difficult from untreated blood owing to the precipitation of salts.

The authors wishes to acknowledge their indebtedness to Mr. Tawara of the Whales Research Institute for his kindnesses in supplying the material and for many valuable advices. The authors' thanks are also due Mr. Motohashi, co-operation, and to Mr. Nambara who undertook part of the experiments.

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Studies on Kitol IV
Purification of Kitol by Chromatographie

By
TADASHI TAWARA, RYUSUKE FUKAZAWA

Previously the authors separated whale liver oil into Vitamin A fraction and Kitol fraction through their different solubility to the solvent.(1) This Kitol fraction showed Extinction value of 500 at 290 mμ, which is about of 70% pure, being $E^{1\%}_{1\,cm}(290\,m\mu)=707$(2) in pure Kitol. The authors purified it through chromatographie and obtained light yellow glassy lump of $E^{1\%}_{1\,cm}(290\,m\mu)=680$. Its melting point was 72°C[1] and it showed pure scarlet colour in the Carr-Price reaction. This colour showed its maximum some seconds later, being rather stable. The same colour is also obtained by conc. sulphulic acid, acid clay and glycerol-dichlorhydorine. It had a slight odour like terpene and was easily soluble in petroleum ether acetone and chloroform; soluble in ethanol and methanol; but quite insoluble in water. It was unstable in the air and light. When it was left exposed in powdered form in the room for two days, $E^{1\%}_{1\,cm}(290\,m\mu)$ decreased to 500. When kept in a dark room filled with CO_2 gas, it showed little change even two days later. When it was preserved in petroleum ether solution, it was so unstable that even when kept in the dark room, it oxidized rapidly and precipitated white insoluble matter. This precipitate was insoluble in olive oil too,[2] while easily soluble in chloroform and acetone, and soluble in ethanol and methanol. Alkaline treatment produced a red substance, which could be removed from Kitol as saponifiable matter. Absorption curve of Kitol obtained by the authors is as shown in the following figure.

The authors wish to express their gratitude to the Taiyo Fishing Company Ltd. for providing the sample liver oil used in the present experiment.

Experimental Part

300 g. of a mixture of liver oil of blue and fin whales caught in the Antarctic (containing 100,000 I.U. of Vitamin A) was saponified with 300 cc. of 20% alcoholic potash; and 32.5 g. of unsaponifiable matter was obtained therefrom. This unsaponifiable matter was dissolved in 1 L of petroleum ether; and from this solution 90% methanol was extracted 35 times, 500 cc. at each extraction. Most of

1) Melting point of crystalized Kitol is 88—90°C. (3)
2) Even when Kitol was preserved in olive solution it gave this white precipitate.

sterin and Vitamin A collected in the methanol layer. After the petroleum ether layer was washed several times with water and then dried, petroleum ether was distilled. When the residue was saponified again with a small amount of 20% alcoholic potash, unsaponifiable matter was obtained which was reddish yellow and viscous. Very thin chloroform solution of this unsaponifiable matter showed blue colour with the first drop of chloroform solution of antimony trichloride; but further addition of the same solution caused the blue colour to change instantly to cherry red. This is $E^{1\%}_{1\,cm}$ (290 mμ) = 500. 500 cc. of petroleum ether solution of this substance was passed into an adsorption column of aluminium oxide. Aluminium oxide used in this experiment as adsorbent was a mixture of equal amounts of "BL6" manufactured by the Japan Aluminium Co. Ltd. and inactivated "BL6"[3]. When this adsorption column was developed by the use of petroleum ether, a yellow layer of Vitamin A was formed at the bottom a colourless layer of Kitol in the middle, and a light yellow layer of unknown matter at the top. When this chromatogramm column was further developed with petroleum ether, the yellow part of the Vitamin A layer finally separated from the alminium layer, moved into the vessel bellow as petroleum ether solution. The aluminium adsorbed was eluted with petoleum ether containing a few drops of methanol and washed with water to remove methanol. Then chromatogramm was again made and the slight amount of Vitamin A at the bottom was washed off. The top of this chromatogramm, light yellow in colour, adsorbed a matter which showed blue in the Carr-Price reaction. This matter was adsorbed a little easier by aluminium oxide than Kitol and was slower than Vitamin A in the appearance of blue in the Carr-Price reaction. Namely, when antimony trichloride was added to a mixture of Vitamin A and Kitol, blue colour appeared first; then the blue gradually changed to purple, then finally to red. But when antimony trichloride was added to a mixture of this unknown matter and Kitol, the first colour to appear was red, which gradually turned to purple. Moreover, when this mixture was dissolved in petroleum ether and extracted again and again with pure methanol, Kitol moved gradually to methanol, leaving this unknown matter in the petroleum ether layer. From the above facts, this unknown matter was thought to be of larger molecule than Kitol.

After removing the upper part of chromatogramm in which this unknown matter was adsorbed, the Kitol layer in the middle was eluted in the same way as in the above experiment. When this was passed into a very short adsorption column consisting of inactivated alminium oxide "BL6" to which 10% activated alminium had been added, most of the Kitol flowed down without being adsorbed and the

3) It was too adsorptive for "BL6" to separate Vitamin A from Kitol.

unknown matter which showed blue colour with antimony trichloride was adsorbed in the column. After shaking 300 cc of methanol with the above petroleum ether solution of Kitol (about 1.5 L)[4] and removing the methanol layer, the petroleum

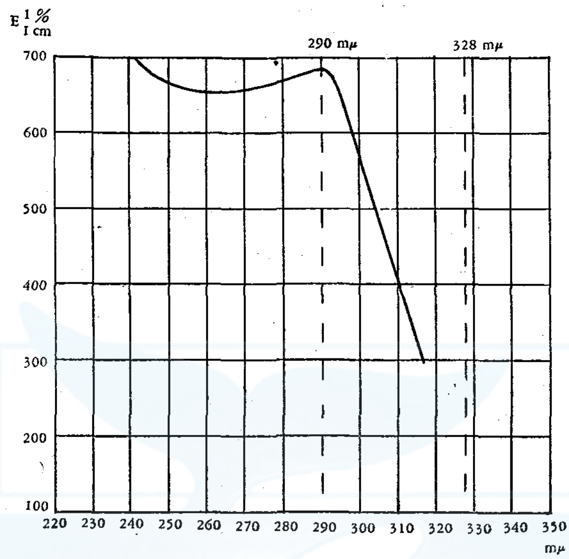

Fig. 1

layer was washed. After drying it, petroleum ether was distilled off to obtain about 5 g. of light yellow glassy lump which had a melting point of 72°C. This is E1% (290 mμ) = 680.[5] It showed pure scarlet in the Carr-Price reaction.

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(3) Ditto.

4) to remove a slight amount of oxide produced in adsorption treatment.

5) 97% in Kitol purity.

Substances Related to Vitamin A in the Whale Liver Oil

By

SEIICHI ISHIKAWA, YOSHIMORI OMOTE, HIROSHI OKUDA

The maximum of absorption spectrum of whale liver oil is near 310 mμ, considerably deviating from 328 mμ, that of vitamin A. This point was pursued to isolate kitol having the absorption maximum at 290 mμ.[1] Furthermore, substances related to vitamin A such as anhydro vitamin A and subvitamin A have been confirmed in ordinary fish liver oils. Also in the whale liver oil, these vitamins may be expected being present. It is very interesting that there are some substances with the structure closely related to vitamin A. This paper is concerned with the analytical method of substances related to vitamin A, with the thermal change of whale liver oil, and with the action of maleic anhydride upon the whale liver oil.

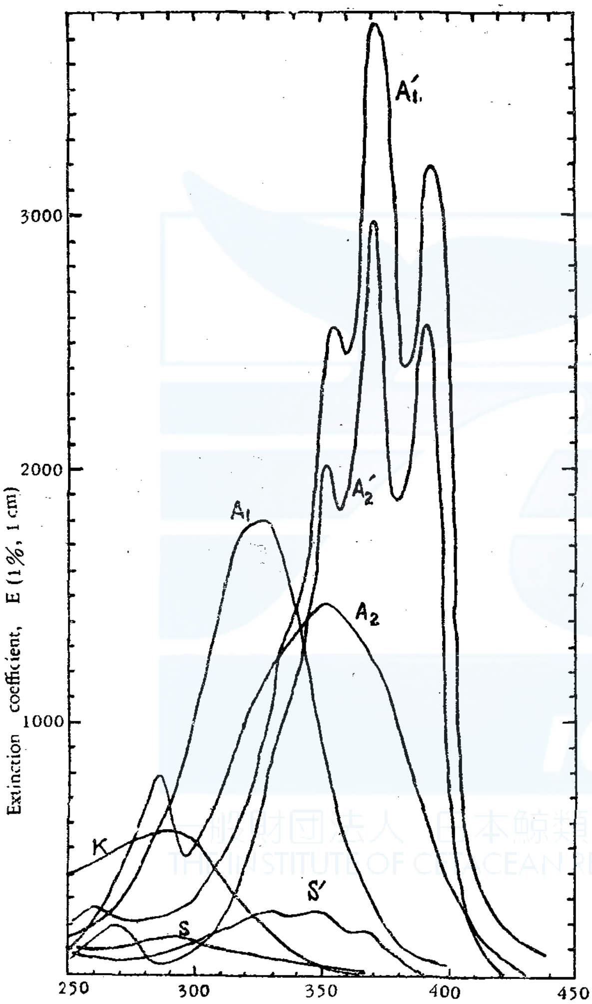

Fig. 1. Absorption spectra of vitamin A_1 (A_1), vitamin A_2 (A_2), subvitamin A (S), kitol (K), anhydrovitamin A_1 (A_1'), anhydrovitamin A_2 (A_2') and anhydrosubvitamin A (S′).

Analysis of Absorption Spectrum of Whale Liver Oil.

Every substance related to vitamin A shows strong absorption between 250–400 mμ. The absorption spectra of hitherto known substances related to vitamin A are summarized in Fig. 1.[1)2)3)]

An example of absorption spectrum of whale liver oil is shown in curve S in Fig. 2. As compared with Fig. 1 deviation of the maximum of the curve S from 328 mμ, the maximum of vitamin A, to shorter wave length was considered to be due to the presence of kitol. On the assumption that additional resultant of absorption spectra of vitamin A and kitol would make the curve S, each component was calculated as shown by the curves A and K in Fig. 2. A represents the absorption spectrum of vitamin A_1, and K shows that of kitol. S′ is the curve obtained by the additional composition of A and K on the figure. This method is temporarily called AK method.

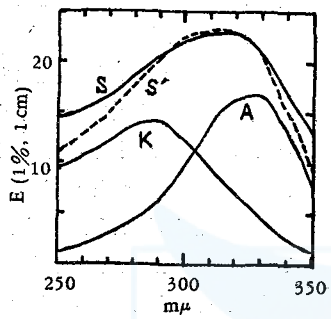

Fig. 2. Analysis of the absorption curve of whale liver oil, (S) sample, (S′) resultant, (A) vitamin A, (K) kitol.

For the purpose of discussion on reliability of this method, using the same liver oil, the extinction coefficient of vitamin A at 328 mμ calculated by AK method was compared with results determined by the following two methods.
1. AKA′ method.......To analyze the original curve assuming that it is composed of vitamin A_1, kitol, and anhydro vitamin A_1.
2. Morton-Stubbs's correction[4].

Non correction	AK method	MS correction	AKA′ method
21.4	17.5	15.9	11.7

Although these corrections are less strict due to calculation on the rough assumption, they may present us far nearer value to the true vitamin A than non corrected extinction coefficient at 328 mμ in the sample, taken for that of vitamin A.

Thermal Change of Whale Liver Oil.

It has been already known that kitol produces vitamin A by thermal decomposition and that 1 mole of vitamin A is yielded from 1 mole of kitol.[1)5)] Therefore, also in case whale liver oil is heated itself, its containing kitol is expected to decompose to vitamin A. However, when liver oil is heated open in the air, the decomposition of vitamin A by oxidation makes it impossible to find newly produced vitamin A. So, first of all, whale liver oil was heated in carbon dioxide at 220°, and cod liver oil unit was measured with the lapse of time. This result is shown in Fig. 3.

When heated for 2 minutes, cod liver oil unit of the oil reached about 130 %

of that of original, while after heating for longer time, vitamin A was found to decompose. When heated under high vacuum, its absorption curve was compared as shown in Fig. 4.

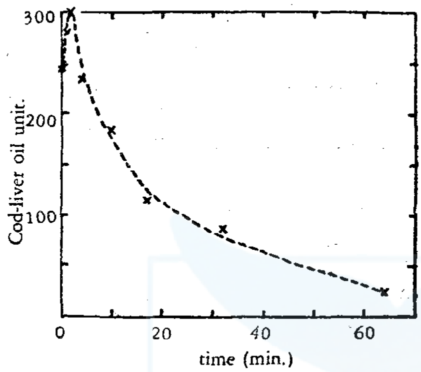

Fig. 3. Change of cod liver oil unit of the whale liver oil heated in the CO_2 tube.

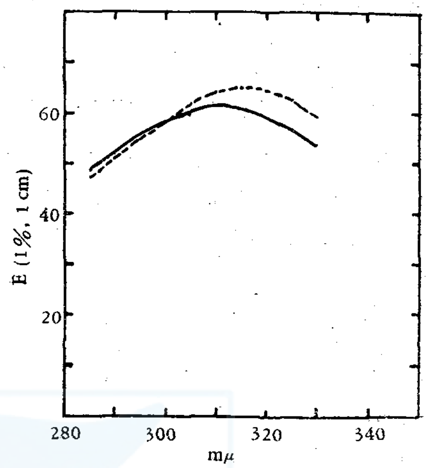

Fig. 4. Change of the absorption spectrum of whale liver oil heated in vacuum, at 220°, for 3 min.; — original sample,...... sample heated.

The extinction coefficients of vitamin A and kitol were calculated with application of AK method, on the basis of which vitamin A produced from 1 mole of

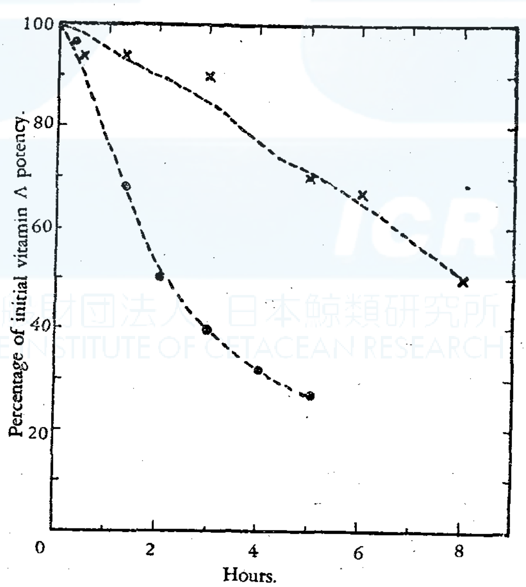

Fig. 5. Reaction of the whale liver oil vitamin A with maleic anhydride at (•) 50°C, (×) 25°C.

kitol was calculated to be 1.42 mole. Taking the decomposition of vitamin A into consideration, there is a possibility for more increase than the above figure. This contradicts with the figures previously reported that from 1 mole of kitol 1 mole of vitamin A was formed. This respect will be persued in future.

Reaction of Whale Liver Oil with Maleic Anhydride.

Baxter and others[6] stated a method to analyze vitamin A and neo-vitamin A by the action of maleic anhydride. The authors observed the reaction of whale liver oil with maleic anhydride by their method. From this result the relation between decrease of cod liver oil unit and reaction time was found as shown in Fig. 5.

On the assumption that antimony trichloride produced blue color with only vitamin A and neo-vitamin A, the amount of neo-vitamin A was calculated to be 46.5 % of the total vitamin. This figure is approximately same as that found with common fish liver oils.[9]

The absorption spectrum of whale liver oil reacted with maleic anhydride was shown in Fig. 6. Absorption of vitamin A nearly disappeared and rather similar curve to the spectrum of kitol was found.

Moreover, diene value was measured for the purpose of the reference to study the reaction of maleic anhydride upon whale liver oil and its molecular distillates. The results were shown in Table I, with comparison of cod liver oil unit.

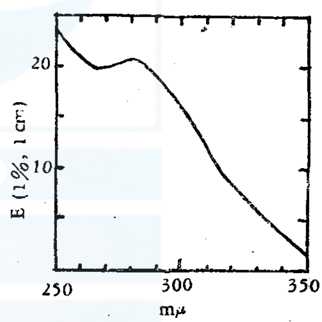

Fig. 6. Absorption spectrum of the whale liver oil reacted with maleic anhydride at room temperature.

Table I Diene Values of Whale Liver Oil and Its Molecular Distillates

	Temperature	%	Diene value		Cod liver oil unit	E (328)	A (328)
			Found	Theoretical			
Original sample			2.5	1.6	92	21.4	16.6
Distillate 1.	170°C	2.3	33.9	35.6	2105	367	360
Distillate 2.	200°C	6.2	15.1	10.9	631	120	110
Distillate 3.	210°C	7.4	3.1	5.7	345	63	58
Distillate 4.	220°C	23.5	1.4	1.8	88	19	18
Distillate 5.	230°C	17.1	1.8	0.9	41	10	9
Residue			3.0	0	—	2.9	0

Experimental Part

Experimental 1. Analysis of the Absorption Spectrum of Whale Liver Oil.

(1) AK method.........The observed curve is assumed to consist of absorption spectrum of pure vitamin A_1 and pure kitol only, additionally composed. Let absorption coefficients of sample at 290 mμ and 330 mμ, being near their absorption maxima, be represented by E (290) and E (330), and that of pure vitamin A_1 at 330 mμ in the sample, A (330), and that of pure kitol at 290 mμ, A (290). Then the following equations are obtained.

$$\left.\begin{array}{l} E(330) = A(330) + 0.293\,K(290) \\ E(290) = K(290) + 0.390\,A(330) \end{array}\right\}$$

Factor 0.293 means ratio of pure kitol, K (330)/K (290), and factor 0.390 means ratio of pure vitamin A_1, A (290) / A (330), all of which were quoted from the reference in Fig. 1. The values of A (330) and K (290) from the above equations are solved as follows:

$$\left.\begin{array}{l} A(330) = 1.13\ E(330) - 0.33\ E(290) \\ K(290) = 1.13\ E(290) - 0.44\ E(330) \end{array}\right\} \text{AK equation}$$

The way of finding A (328) from A (330) is only to multiply it by 1.018. If AK method is applied to the absorption spectrum of Antarctic whale liver oil (sample 1), we can get A (330) = 17.2, K (290) = 13.4 and A (328) = 17.5. On the basis of these figures A and K curves in Fig. 2 were plotted similarly to that of pure substance.

(2) AKA′ method.........Let absorption coefficients of sample at 290 mμ, 330 mμ and 350 mμ, be respectively represented by E (290), E (330) and E (350), that of vitamin A_1 in the sample at 330 mμ, A (330), that of kitol at 290 mμ, K (290), and that of anhydro vitamin A_1, A′ (350), and the following equations can be obtained similarly to (1).

$$\left.\begin{array}{l} A(330) = 1.462\ E(330) - 0.383\ E(290) - 0.595\ E(350) \\ K(290) = 1.139\ E(290) + 0.101\ E(350) - 0.498\ E(330) \\ A'(350) = 0.112\ E(290) + 1.304\ E(350) - 0.728\ E(330) \end{array}\right\} \text{AKA}' \text{ equation}$$

The sample 1 was analyzed with these equations as follows.

A (330) = 15.7, A (328) = 15.9, K (290) = 14.7, A′ (350) = 3.2

This fact proves the presence of anhydro vitamin A in the whale liver oil, although small amount. So, unsaponifiable matter in this liver oil was treated by chromatography. As expected, anhydro vitamin A fraction could be isolated and confirmed.

(3) MS method.........This method, which shows how to get corrected E (328) of vitamin A when absorption spectrum of vitamin A is affected by other irrelevant spectra, is on the basis of the assumption that other spectra can be regarded linear near the maximum of vitamin A. The wave length corresponding to 6/7

of the height of the peak in the curve of vitamin A_1 in Fig. 1 was found 311 mμ and 337 mμ. Now when the absorption coefficients of the sample at 311 mμ, 328 mμ and 337 mμ. are expressed in E (311), E (328) and E (337), corrected E (328) viz, A (328) is shown in the following equation.

A (328) = 7 E (328) − 2.42 E (311) − 4.58 E (337)..........MS equation.

A (328) of sample 1 was determined 11.7 in this method.

Experiment 2. Thermal Change of Whale Liver Oil.

(1) Whale liver oil (sample 2) was put in the small test tube, the atmosphere being substituted with carbon dioxide at 10^{-2} mm, and sealed in ampoule. 8 ampoules were heated in the oil bath for 1, 2, 4, 8, 16, 32 and 64 minutes and cod liver oil units of them were determined by antimony trichloride method. The resutls are shown in Fig. 3.

(2) Two ampoules of sample 2 were similarly made, sealed immediately after degassing at 50°, under the vacuum of 10^{-4} mm, one of which was heated for 3 minutes at 220°. The absorption spectra of both ampoules were compared each other as shwon in Fig. 4. The amount of vitamin A and kitol in the above two ampoules was calculated by AK method.

	E (330)	E (290)	A (328)	K (290)
Before heating	53.17	51.81	43.80	35.15
After heating	59.08	50.80	50.80	31.41

When calculated with molecular weight of vitamin A = 286, E (328) = 1800,[7] molecular weight of kitol = 572, E (290) = 707[5], 1 g. of oil with E = 1 will contain 1.94×10^{-6} mole of vitamin A at 328 mμ and 2.47×10^{-6} mole of kitol at 290 mμ. Then the number of molecules of vitamin A produced from 1 molecule of kitol is shown in the following equation.

$$\text{Vitamin A mole} = \frac{\text{A (328) increased}}{\text{K (290) decreased}} \times \frac{1.94 \times 10^{-6}}{2.47 \times 10^{-6}}$$

$$= \frac{\text{A (328) increased}}{\text{K (290) decreased}} \times 0.786$$

The result through application of the above experiment to this equation was that 1 mole of kitol produced 1.42 mole of vitamin A.

Experiment 3. Reaction of Maleic Anhydride upon Whale Liver Oil.

(1) Sample 2 was dissolved in dry benzene to make a solution having the cod liver oil unit of about 1.0. An aliquot of 5 cc. was added to the same volume of maleic anhydride solution (10 g. maleic anhydride per 100 cc. benzene). After a

certain hours' storage in the thermostat at 25° and 50°, an aliquot was then removed to determine the cod liver oil unit.

Under the same condition, a comparative experiment was carried on for sample and benzene only instead of maleic anhydride solution. From both values, the remaining amount of vitamin A not reacted with maleic anhydride was calculated. Assuming that the initial amount of vitamin A was 100, the relation between the recovery of vitamin A and the reaction time was shown in Fig. 5. Moreover, the recovery after 16 hours' reaction at 25° was 44.5 %. According to Baxter and others,[6] under the same condition, the recovery of vitamin A palmitate was 90%, and that of neovitamin A palmitate was 5 %. Then the percentage of neovitamin A in the sample was calculated as follows.

$$\% \text{ of neovitamin A} = \frac{44.5-5}{90-5} \times 100 = 46.5 \%$$

(2) 0.2 g. of maleic anhydride was let to react with 1 g. of sample 2 in benzene solution below 50°. When it began to show not blue but reddish purple, in antimony trichloride reaction, the absorption spectrum of the solution was searched (Fig. 6).

(3) After molecular distillation of sample 1, diene values of original sample, distillates and residual oil were measured. 5 cc. of xylene solution of maleic anhydride (about 5 %) was added to about 500 mg. of the sample and after sealing under carbon dioxide keeping at 100° for three hours, the residual maleic anhydride was titrated with alkali in the water solution. Diene value is shown in the following equation.

$$\text{Diene value} = \frac{1.269 \times \text{normal alkali in cc.}}{\text{sample in g.}}$$

As a reference, cod liver oil unit, E (328) and A (328) were also annexed in Table I.

The theoretical diene value in the table was calculated on the basis of the value of A (328), assuming that 2 moles of maleic anhydride react with 1 mole of vitamin A (viz, theroretical diene value of pure vitamin A is 178).

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Thermal Decomposition of Kitol

By

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MASAO KIJIMA, HIROSHI OKUDA

In 1943 Embree and Shantz[1] isolated a new substance related to vitamin A from whale liver oil and called it kitol. Their kitol was glassy yellow solid, having molecular formula of $C_{40}H_{58}(OH)_2$, two hydroxyl radicals and eight double bonds.

By color reaction, absorption spectrum, analytical distillation and biological assay, they confirmed that kitol produced vitamin A by pyrolysis in molecular distillation and moreover carried on the quantitative experiment to report that 1 mole of kitol produced 1 mole of vitamin A. It was also ascertained by them that kitol ester was decomposed thermally and produced corresponding vitamin A ester.[2]

After that, Baxter and others[3] isolated kitol in crystalline form, with use of which they carried on the pyrolysis experiment, with a yield of less 1 mole of vitamin A from 1 mole of kitol.

The chemical structure of kitol is still unknown. Formation of vitamin A by thermal decomposition is an important key to infer the kitol structure, so that the authors determined to carry out the further detailed study in this respect. It must be added that this respect is very significant for the practical method of changing kitol of whale liver oil to valuable vitamin A with a good yield.

Isolation of Kitol from Whale Lvier Oil.

With hydrated methanol vitamin A and cholesterol were extracted and removed from unsaponifiable matter dissolved in petroleum ether. Then petroleum ether solution was chromatographed to concentrate kitol. This kitol, still containing a small quantity of solvent was heated in vacuo at 150° for 5 minutes to eliminate the volatile fraction completely. The absorption spectrum of kitol thus obtained is shown in Fig. 1. As seen clearly in it, there is a maximum peculiar to kitol at

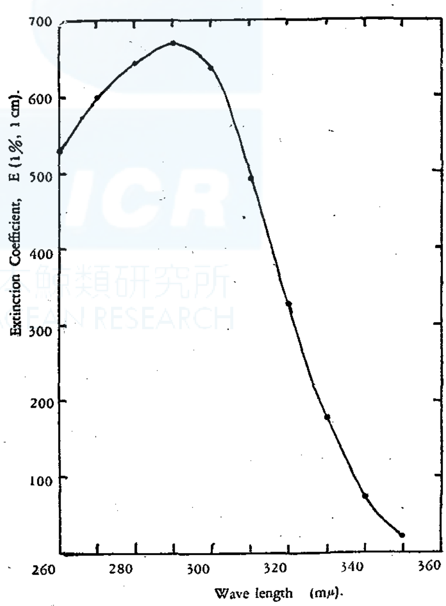

Fig. 1. Absorption spectrum of kitol.

290 mμ, the extinction coefficient E (1%, 1 cm) being 670, much higher than E (1%, 1 cm, 286 mμ)=580 obtained by Embree, being 95% of Baxter's E (1%, 1cm, 290 mμ)=707. As such an extent of purity was considered not to hinder the following experiments, this kitol was used.

Change of Kitol During Molecular Distillation.

Baxter and others[1] confirmed that 1 mole of kitol palmitate produced 0.65 mole or 0.75 mole of vitamin A palmitate by molecular distillation at 240° to 270° under the vacuum of 3μ. Previously the authors[2] observed that kitol was partly decomposed to produce vitamin A in the analytical distillation of unsaponifiable matter in whale liver oil. This time, however, the authors tried to distil kitol itself molecularly under high vacuum.

On the contrary to expectation the result was that most part of kitol was distilled by 5 minutes' heating at 220° without decomposition, but left not distilled by 1 minute's heating at 200° or 10 minutes' heating at 160°. (Figs. 2, 3 and 4)

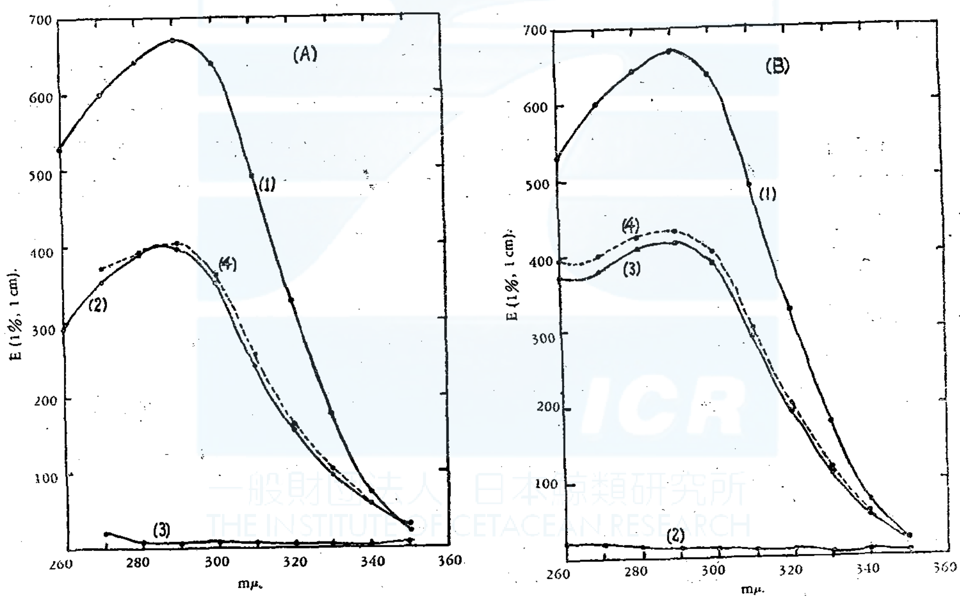

Fig. 2. Absorption spectra of molecular distillation products of kitol.
(A) 220°, 5 min. (B) 160°, 10 min. (1) kitol, (2) distillate, (3) residue, (4) total

As clearly shown in these figures, it is danger to calculate the decomposition ratio of kitol to vitamin A on the basis of the result of the experiments, because the absorption spectrum does not change so much as it shows the clear formation of vitamin A. It would be noteworthy to clarify that free kitol was

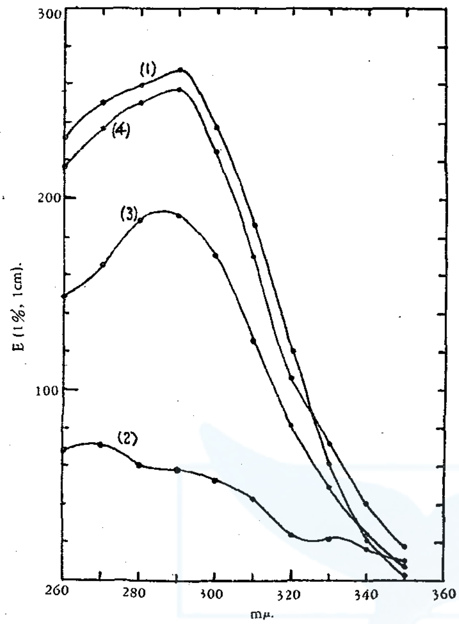

Fig. 3. Absorption spectra of molecular distillation products of kitol, 200°, 1 min, (1) kitol, (2) distillate, (3) residue, (4) total.

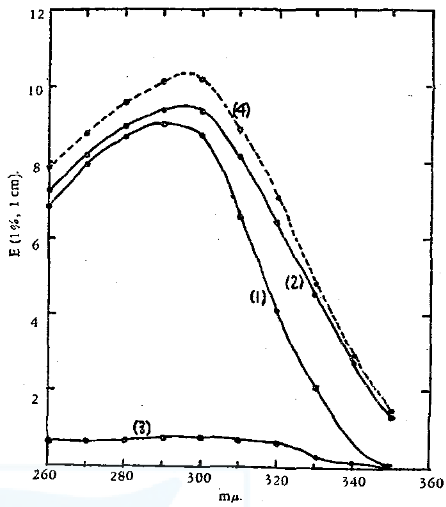

Fig. 4. Absorption spectra of molecular distillation products of kitol dissolved in the oil, 220°, 5 min., (1) kitol, (2) distillate, (3) residue, (4) total.

hardly decomposed and distilled out through molecular distillation under high vacuum and that this was true even if oil was added as solvent.

Change of Kitol Heated in Sealed Tube.

After kitol dissolved in the corn oil was heated at 220° in the slender glass tube for 1 to 16 minutes, Embree and others[1] determine the produced vitamin A by blue absorption value E (620 mμ) with antimony trichloride and remaining kitol by E (286 mμ) with vitamin A correction, on the basis of which decomposition ratio was calculated.

For the purpose of confirmation of vitamin A formation from kitol, kitol oil sealed in the glass tube with carbon dioxide was heated at 220°, with which absorption spectrum at 300 to 350 mμ was persued. The curves obtained showed clearly formation of vitamin A (Fig. 5).

The result calculated by the application of the principle of AK method which was explained in the reliminary report[1] was that in case of 8 minutes' heating 1 mole of kitol produced 1.67 mole of vitamin A.

Through the more careful experiment under the same condition change of absorption spectrum between 260 and 350 mμ was studied. The result was shown

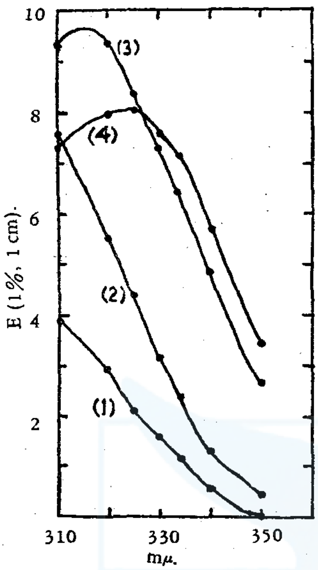

Fig. 5. Absorption spectra of decomposed kitol heated in the CO_2 sealed tube, at 220°, (1) 0 min., (2) 1 min., (3) 2min., (4) 8 min.

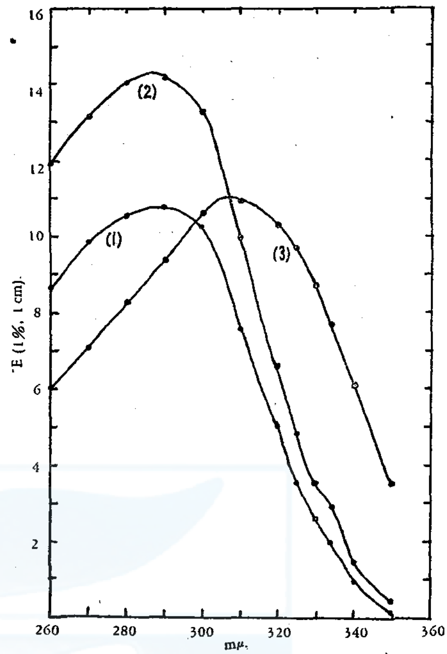

Fig. 6. Absorption spectra of decomposed kitol heated in the CO_2 sealed tube, at 220°, (1) 0 min., (2) 1 min., (2) 1 min., (3) 8 min.

in Fig. 6. The yield from 1 mole of kitol was 1.38 mole of vitamin A.

However, the experiment of heating for 1 minute showed that the potency of kitol rather increased. This problem will be discussed in the future report, for there is a necessity for further study.

Change of Kitol Heated in Vacuum Sealed Tube.

In order to improve the yield of vitamin A, the authors carried on a pyrolysis experiment about kitol under high vacuum (Fig. 7). After a thermal decomposition of kitol oil sealed under reduced pressure of 10^{-4} mm, the conclusion that 1 mole of kitol produced 1.97 mole of vitamin A was derived as expected. Also in this case the experiment of 1 minute's heating showed that vitamin A formation ratio was negative. This fact suggests us that kitol is likely to be decomposed thermally through the complicated process.

Properties of Vitamin A Formed from Kitol Decomposed by Heat.

It is still questionable whether or not vitamin A formed from kitol decomposed by heat is vitamin A in a strict sense. Perhaps it is possible that anhydro vitamin

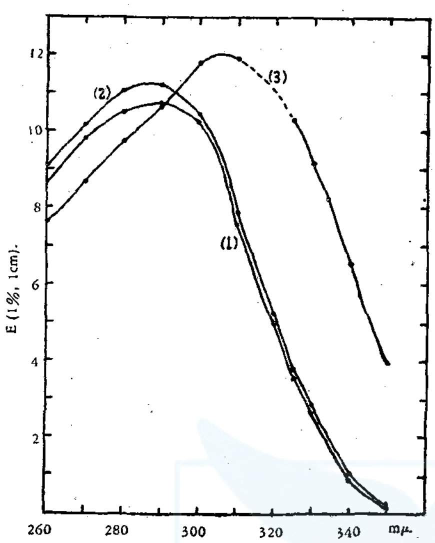

Fig. 7. Absorption spectra of decomposed kitol heated in the vacuum sealed tube, at 220°, in 10^{-4} mm, (1) 0 min, (2) 1 min., (3) 8 min.

A may be formed, too. In the present report, however, substances showing absorption spectrum similar to vitamin A which were formed from kitol decomposed, were all represented by vitamin A. The comparative color reaction between kitol oil and its thermally decomposed oil is shown in Table I.

This table shows clearly that the color reaction of thermally decomposed kitol oil quite agrees with that of vitamin A. Similarly to the preliminary report, the percentage of cis and trans vitamin A was determined, 21.2% for the former and the rest for the latter. It is interesting for the presumption of kitol structure that most of vitamin A produced from kitol is found to be trans type.

Table I

Color Reactions of Kitol before and after Thermal Decomposition

Reagent	Kitol oil	After thermal decomposition
Antimony trichloride	vivid red	blue (rather stable)
Trichloro-acetic acid	red with more kitol oil, colorless with less kitol.	azure blue
Acetic anhydride and conc. sulfuric acid	red→reddish brown	blue→purple→dark green

Experimental Part

Experiment 1. Isolation of Kitol from Whale Liver Oil.

1 kg. of Antarctic whale liver oil was saponified. After ether extraction about 200 g. of unsaponifiable matter was obtained, dissolved in 2 L of petrolem ether, extracted with about 90% methanol, until the petroleum ether layer hardly gave blue color like vitamin A with antimony trichloride reagent. The petroleum ether solution washed with methanolic potash, then with water, was dried on sodium sulfate. This petroleum solution was passed through the chromatographic column (40×4 cm) containing alumina. Then it was developed with petroleum ether saturated

with methanol, when narrow orange band appeared at the bottom. This seemed to be anhydro vitamin A. When this layer eluted, alumina was nearly colorless and showed vivid red color peculiar to kitol with antimony trichloride reagent. The adsorbent was taken out and eluted with 1L of petroleum ether and 50 cc. of methanol. This petroleum ether solution was washed with water and dried, chromatographed again. After extracting the adsorbent, the petroleum ether solution was evaporated to concentrate kitol as residue. It was heated in the micro molecular still shown in Fig. 8, at 150°, under 10^{-4} mm for 5 minutes. The residue was glassy solid of orange color, showing vivid red with chloroform solution of antimony trichloride (30%), same but lighter color with 20% chloroform solution of trichloro-acetic acid and similarly red and soon reddish brown with acetic anhydride and conc. sulfuric acid. The absorption spectrum of finally obtained kitol was shown in Fig. 1.

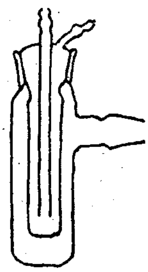

Fig. 8.
Micromolecular still.

Experiment 2. Molecular Distillation of Kitol (1).

(1) Kitol obtained in the experiment 1 was heated at 220°, for 5 minutes under vacuum of 10^{-4} mm in the apparatus shwon in Fig. 8 connected with Hickman's oil diffusion pump. After reaction, evaporating surface was separated from condenser both being washed with isopropanol, the washing accurately diluted to a certain volume and the extinction was measured by Beckman spectrophotometer. Extinction coefficient was obtained by extinction divided by gram of sample per 100 cc. Thus obtained extinction coefficient was figured in Fig. 2.

(2) The result of experiment with 10 minutes' heating at 160° was also shown in Fig. 2. The sum of extinction coefficient of the distillate and the residue is far smaller than that of the sample (control). This being likely to be effected by weighing and diluting errors, the same experiment was carried on with some solvent in order to reduce errors.

Experiment 3. Molecular Distillation of Kitol (2).

(1) Evaporating benzine from the petroleum solution of kitol in vacuo, the residue gave viscous oil. Similar experiment to Exp. 1 was made with this oil. (Fig. 3).

(2) Molecular distillation of kitol oil.

Kitol and cod liver oil were distilled in order to make an experiment under the same condition as molecular distillation of natural liver oil. The cod liver oil was the residue after 5 minutes' distillation at 150° under 10^{-4} mm in the apparatus shown in Fig. 7 with use of cod liver oil which had lost the vitamin A reaction through the preliminary heating at 200° and stirring mixed with Japanese acid clay. The kitol oil was prepared from 60 mg. of kitol obtained in the experiment 1 and 1.1 g. of the above refined cod liver oil fully mixed. This kitol oil was used in the following experiments. Moreover, since the absorption spectrum of oil itself was affected by heat, the same cod liver oil which did not contain kitol was distilled under the same condition as above. (blank test). The results are shown in Fig. 4. Heating condition was: at 220° for 5 minutes under 10^{-4} mm.

Experiment 4. Thermal Decomposition of Kitol in Carbon Dioxide Sealed Tube (1).

Kitol oil was weighed in a small test tube and the air in it was displaced by carbon dioxide. Instantly after, it was sealed and heated. When reaction was finished, sealed tube was cut off, the content dissolved in isopropanol to measure its extinction. The result was shown in Fig. 5. It was heated at 220° for 1, 2 and 8 minutes.

Now, in order to find the amount of vitamin A and kitol from this result with AK method, for convenience's sake, extinction coefficients at 330 mμ and 310 mμ were analyzed. As spectrum of pure vitamin A were used the same date as in the preliminary report, while that of kitol was based on the spectrum obtained in Exp. 1 in the present report. Hence, the following equations are obtained.

$$A(330)=1.439\ E(330)-0.5175\ E(310)$$
$$K(310)=1.439\ E(310)-1.218\ E(330)$$
$$A(328)=1.018\ A(330),\quad K(290)=1.362\ K(310)$$

The equation to calculate decomposition ratio of kitol based on A (328) and K(290), was mentioned in the preliminary report.[5] The result was as follows.

Heated for	0 min.	1 min.	2 min.	8 min.
A (328)	0.265	0.635	5.79	7.225
K (290)	5.05	9.40	6.18	1.77
Mole of vitamin A per 1 mole of kitol		−0.09	−4.21	1.67

Experiment 5. Thermal Decomposition of Kitol in Carbon Dioxide Sealed Tube (2).

Almost similarly to Exp. 4, carbon dioxide displacement was made with special care and the range of the absorption spectrum was 260 to 350 mμ (Fig. 7).

AK equation was as follows:

$$A(328) = 1.018 \times \{1.115\ E(330) - 0.2942\ E(290)\}$$
$$K(290) = 1.115\ E(290) - 0.4350\ E(330)$$

The result of calculation was:

Heated for	0 min.	1 min.	8 min.
A (328)	−0.248	−0.238	7.17
K (290)	10.87	14.25	6.64
mole of vitamin A per 1 mole of kitol		−0.02	1.38

Experiment 6. Thermal Decomposition of Kitol in Vacuum Sealed Tube.

Similar to Exp. 5, excepting that sample was sealed under vacuum of 10^{-4}mm. The result of calculation was as follows.

Heated for	0 min.	1 min.	8 min.
A (328)	−0.248	−0.0825	7.225
K (290)	10.87	11.24	7.89
mole of vitamin A per 1 mole of kitol		−0.361	1.97

Experiment 7. Reaction Velocity of Maleic Anhydride with Vitamin A Produced.

In the same method as the preliminary report[5] maleic anhydride reagent reacted with vitamin A obtained by 8 minutes' heating of kitol oil in carbon dioxide. After 16 hours at 25°, the recovery was 20%. Since it is known that recovery of vitamin A and neovitamin A under the same condition is respectively 3% and 83%, the percentage of neovitamin A in the sample is calculated as follows.

$$\%\ \text{of neovitamin A} = \frac{20-3}{83-3} \times 100 = 21.2\%$$

Namely, the vitamin A obtained by the decomposition of kitol was found to consist of 21.2% of cis type and 78.8% of trans type.

Summary

(1) Kitol was distilled nearly without decomposition, through molecular distillation under 10^{-4} mm.

(2) When kitol was heated at 220° for 8 minutes, sealed in carbon dioxide or vacuum, the absorption spectrum changed to show the formation of vitamin A. Analysis of the spectrum ascertained that 1 mole of kitol decomposed to produce 1.4 to 2.0 mole of vitamin A.

(3) Vitamin A obtained by thermal decomposition of kitol consisted of 80% of trans type and 20% of cis type.

In conclusion, the authors express their cordial thanks to Mr. T. Yamakawa and Mr. Hirao for accordance of facilities for measurement of absorption spectrum and Mr. T. Tawara for his assistance of obtaining the material and kitol extraction.

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Grey Whales in the East Sea Area of Korea

BY
KAZUHIRO MIZUE

Introduction

Rhachianebtes goaucus is classified into a Suborder Mystacoceti but it is quite a different species from Balaenidae or Balaenopterynae. Apart from them, it forms a family Rhachianectes by itself. Due to its resemblance to the fossil whales of the Pleisiocetus group in the shape of the skull it is often called a "living fossil".

Whales of this species were captured so abundantly off the coast of California once that they are still called Californian grey whales. But the catch there began to decrease rapidly towards the middle of the 19th century. It is reported, however, they are on the increase in the recent years. Besides California, a considerable catch of grey whales was made in the East sea area of Korea, but their stock has completely been exhausted at present. Roy C. Andrews made a detailed study of grey whales at Urusan, the landstation in the East sea area of Korea during the season 1909-1910, which will be found in the Memoirs of the American Museum of Natural History-V. We shall here make some study of the same subject statistically based on the data after 1910.

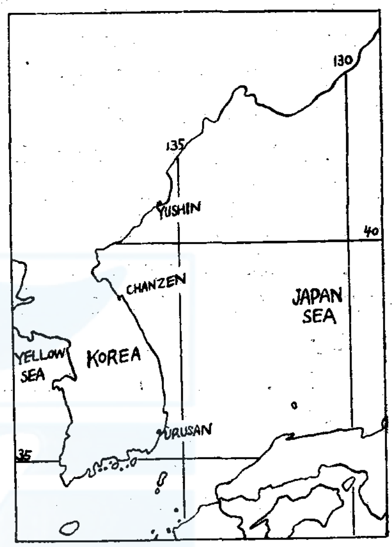

Fig. 1.

Number of the Catch

Fig. 2 shows a number curve of the catches of grey whales in our adjacent waters according to the years. It is based on the data from 1910 up to the present. In spite of the lack of the data of some years, the curve gives a clear idea of the rapid decrease of

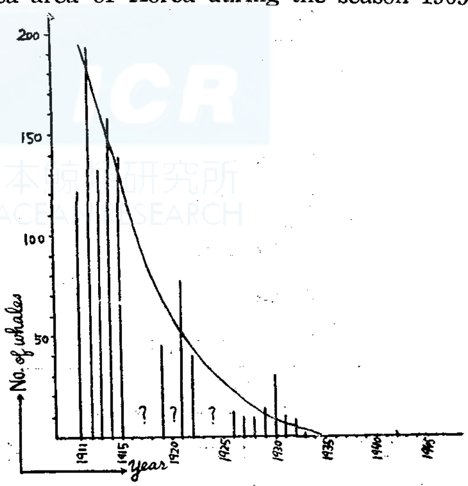

Fig. 2.

the catch. It is not before 1903 that Norwegian Whaling was adopted in the East sea area of Korea for the first time, and in thirty years, almost the last grey whale was hunted up there. The fact will indicate that the stock of grey whales in our adjacent waters was but a small one existing, as it were, independently, having no intercourse with the stocks of other waters.

At the middle of the 19th century when grey whales along the coast of California were feared to have gone to exhaustion, in the East sea area of Korea the stock was still kept intact, which began to decrease after 1903; during the fifteen years from 1934 up to the present not a single grey whale was captured there. Meanwhile, along the Californian coast, it is reported, grey whales are on the increase. It apparently proves the fact that there is no intercourse between the two stocks of grey whales on the east and the west sides of the Pacific.

No catch of Grey Whales has been made off the eastern coast of Korea since 1933. Of the thirty years' whaling history there, the records of the seven years, —1911, 1914, 1919, 1921, 1922, 1926, and 1932— are completely preserved in the monthly reports of the various whaling companies forwarded to the Japanese Whaling Society. Based on the data we shall here make some reports of the grey whales in this place.

Table 1.

Sea-area.	%	Whaling season
Kunile-Islands	0.2	August
Hokkaido-Okhotsk	0.2	May
Hokkaido-Pacific	0.2	July
Sanriku	0.7	October
Kinan	0.0	
Bonin-Islands	0.0	
Goto-Tsushima	4.2	December
West of Korea	0.4	May
East of Korea	94.2	November-May
Japan-Sea	0.0	
Formosa-Ryukyu	0.0	

Sea-Area is divided by location of the land-station

In Table 1 are shown percentages of the yearly catches in the seven years according to the sea areas; the division of the sea areas is based on the sites of the landstations. The whaling ground of gray whales in the Goto-Tsushima sea area actually belong to the east sea area of Korea. So 98% of the catch of grey whales are made off the eastern coast of Korea. Grey whales in our adjacent waters are different from other baleen whales in point of the distribution; they have seldom been captured in the ground belonging to the Pacific. Besiees the East sea area of Korea, three were caught at Ayukawa of the Sanriku sea area and one off Nemuro, Hokkaido in 1914, two in the northern part of the Yellow Sea in 1922, one off Sakhalin in 1826 and one off Otomae, the North Kurile Islands in 1942. The number is so small compared with that of the catch made in the East sea area of Korea that they may be regarded as exceptional. However, these eight grey whales were all caught in the waters north of 38°N.

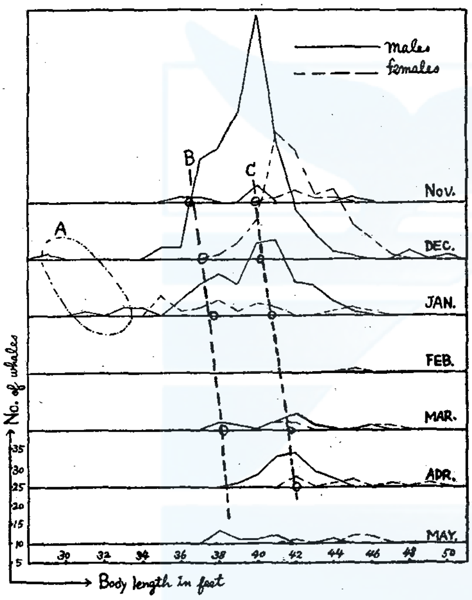

Fig. 3

In spite of the yearly decrease of the number, body-length frequency curves of the grey whales according to the years follow the same pattern every year rising into peaks in almost the similar months. Fig. 3 shows body-length frequency curves of the whale catch according to the months. Here monthly variations in number are noticable, and in the case of male grey whales, the peaks in the curves apparently move from the left to the right according to the months, showing the process of their growth. (As for the females, due to the scantiness of the number, the phenomenon is hardly discernible) A-group in Fig. 3 is composed of one-year-old male animals, B-and C-groups of two-years-old and three-years-old ones respectively. According to R. C. Andrews the period of delivery of grey whales lasts from the end of December to the beginning of January next year, and their body-length at birth is 14 feet, which gains no less than 18 feet during the first year after the birth. Seeing the growth speed of grey whales, like any other species, is extremely high in the first year, it is quite assumable that the young whale born during the previous winter, is some 30 feet long when it appears in the Korean waters the next season. The body-length of grey whales at birth, as it is calculated from my data is 15 to 16 feet.

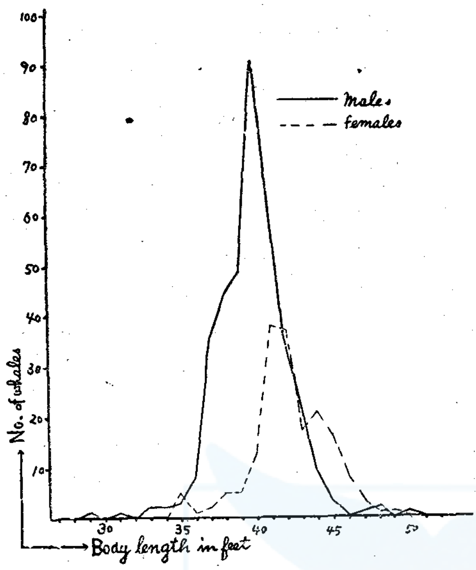

Fig. 4

Fig. 4 presents body length frequency curves of the whale catch according to the sexes. In the case of male grey whales the curve rises into a peak at 40 feet while in females a peak forms at 41 to 42 feet and again at 44 feet. According to Figs. 3 and 4 female grey whales, like any other species of baleen whales, are larger in size than males.

Table 2

	November			December			January		
	♂	♀	to.	♂	♀	to.	♂	♀	to.
Number of Whales	7	6	13	220	125	345	97	22	119
Average length in feet	39.7	42.3	40.9	39.6	42.3	40.5	39.8	39.0	39.6
Sex-ratio	53.8	46.2		63.8	36.2		81.5	18.5	

February			March			April			May			Total		
♂	♀	to.	♂	♀	to.	♂	♀	to.	♂	♀	to.	♂	♀	to.
	1	1	11	6	17	29	8	37	8	8	13	37.2	173	545
	45	45	41.4	43.5	42.1	41.8	44.8	42.6	39.8	44.8	41.7	39.9	42.1	40.6
0.0	100.0		64.7	35.3		78.4	21.6		61.5	38.5		68.3	31.7	

In Table 2 are shown average body lengths and sex ratios of the whole catch according to the months. There is two feet's variation between the body lengths of the two sexes, and the maximun body length of the males is 50 feet and that of the females 49 feet, while the minimum body length is 29 feet for the males and 35 feet for the females. *In Table 3 you will find these particulars of the* body length of grey whales compared with the measuring values calculated by other writers in the past.

Table 3

	Average for all Specimens of both sex		Average for all females		Average for all males		Max. of female	Max. of males	Min. of females	Min. of males
	No. of whale	length	No. of whale	length	No. of Whale	length	length	length	length	length
Korea, by Andrew	23	38′ 9½″	3	41′ 4″	20	38′ 6″	43′ 3″	41′ 1″	38′ 1″	32′ 2″
Korea, by Whalers	123	39′ 10″	50	41′ 2″	73	39′ 0″	45′ 0″	43′ 0″	32′ 0″	35′ 5″
California, by Scammon	4	40′ 8″			3	40′ 8″		48′ 0″		32′ 0″
Korea.	545	40′ 7″	174	42′ 1″	372	39′11″	49′ 0″	50′ 0″	35′ 0″	29′ 0″

Table 4

Month	%
November	2.4
December	63.1
January	21.8
February	0.8
March	3.1
April	6.8
May	2.4

Table 4 presents the percentages of the monthly catches shown in Table 2. According to it the catch of December forms the highest percentage of 63.1 and then comes the 21.8% of January. The catches of the other months cannot be compared with those of the above two months. When we divide the catches of both December and November into decades, it will be found that there is a small variation between the whaling seasons of the two sexes and that the best season for both males and females is from the middle of December towards the end, and the next best is either the beginning of January or that of December.

Table 5

Month	November		December			January			Feb.
	Middle	last	first	middle	last	first	middle	last	first
No. of male	0	6	28	81	111	74	23	1	0
No. of females	0	6	29	49	47	14	7	1	0
Total	0	12	57	130	158	88	30	2	0

Localities of the Catch

As has already been made clear by tables and figures, grey whales are quite regular in their appearance in the east sea area of Korea. According to Table 5, males begin to arrive there at the end of November, increase in number till they reach the greatest number at the end of December, which declines towards the middle of January. After that, male grey whales are no longer seen in this sea area. As for females, they begin to appear at the end of November, reach the greatest number at the middle of December towards the end and decrease in number till they leave the place for the north at the middle of January. Thus grey whales stay for only two months in this sea area; the place is also a good whaling ground for Fin Whales and many catcher-boats work during the season,—from September to March next year. They would have certainly caught grey whales if they had seen them in the months of October, November, February and March. The localities of the catch of grey whales, compared with those of fin whales, are quite near the coast. Their chief grounds are found within 10 sea-knots from the shore.

Grey whales come to the east sea area of Korea for the purpose of delivery as was already pointed out by R. C. Andrews. Female animals captured before the middle of December, are, with almost no exception, with big foetuses immediately before birth. It is quite assumable that delivery is made among the islands at the southern extremity of the Korean Peninsula. Pregnant whales hasten to the place of delivery by themselves, and a little later, herds of grey whales appear in this sea area. In the case of sperm ahales, many females led by one strong male, from so-called "Harem". The contrary is true of grey whales; in their case, the leader is a female and many males follow her. The fact will be made clear by a survey of the sex ratio of the catch. Mr. Andrews writes in his book, "One or two females lead ten to fifteen males." By this he must have meant the pairing migration, for the waters at the southern extremity of the Korean Peninsula present a place of pairing for grey whale as well.

After delivery, female animals accompanied by cubs and apart from the herd, go up north on their nursing migration.

According to Cap. H. G. Melson, the two female Grey Whales captured off Chanzen (39° N.) at the middle of March, 1912 are found with foetuses of seven and ten inches respectively,—both are two months and half after fecundation.

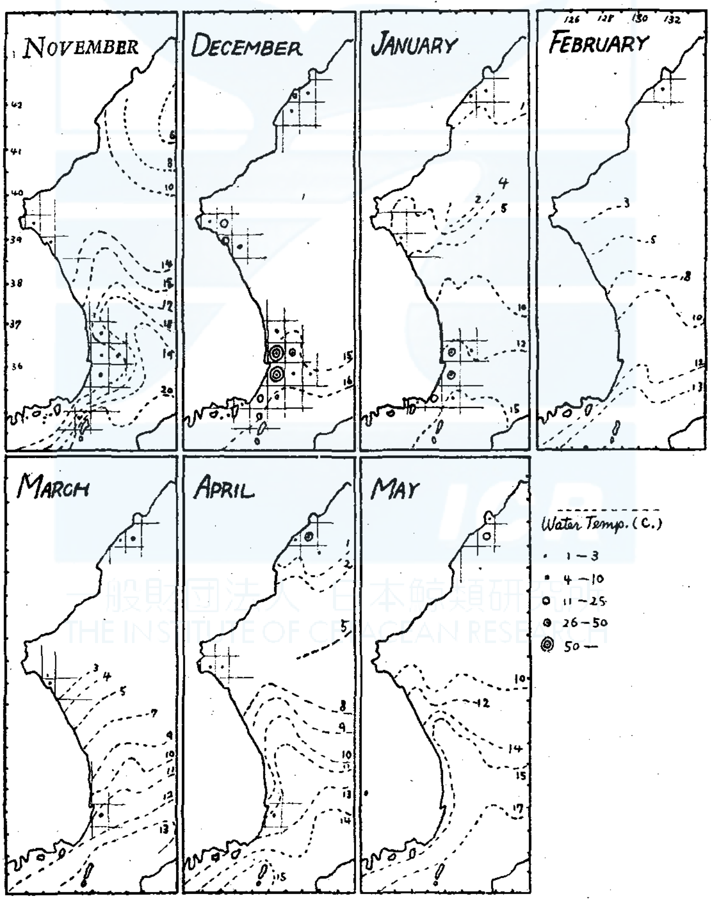

Fig. 5

From this and other data the pairing season of grey whales is assumed to be at the beginning of January. According to Mr. Scammon, the five female whales with small foetuses captured along the coast of California (31°–37° N) in up-season, had thick blubber contrary to the animals nursing cubs. It is not supposable that female grey whales copulate while nursing. So their delivery may happen, in the most favorable condition, every other year.

Grey whales in down-season do not seem to hunt for food, for the animals captured then have no food in their stomach but green colored gastic juice. In up-season, after delivery or pairing, they begin to search for food. Grey whales caught off Yushin, North Korea in up-season-from March to May, are sure to be found with Crustacea in their stomach. According to Mr. Tago, Nephrops thomsonii, small sized Crustacea, was found in the stomach contents of the two grey whales caught in the nothern waters of the Yellow-Sea in May, 1922.

Fig. 5 shows the localities of catch according to the months based on the data of the seven years. At the end of November a small number of grey whales appear both off Urusan and Chanzen. In December, catches are made in three places, the best ground being off Urusan. The animals start on their northwards migration in January and the catch off Urusan decreases. It is interesting to notice that no grey whale is caught in the month of February, except one at Yushin in the north. The fact may indicate that grey whales go up north through the distant offing during that month. In March catches begin to be made in the northern part of this sea area. Either in April or May the catch there forms a comparatively large percentage of the whole catch. These grey whales captured in the northern part, are assumably stray or belated animals from the main herd. Generally spreaking, grey whales on their southwards migration get up speed, but slacken it when they go up north.

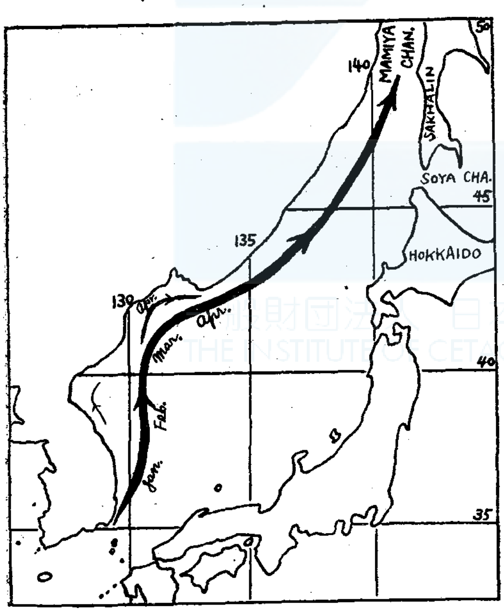

Fig. 6

The general routes of the migration of grey whales off the eastern coast of Korea, based on the various data at our disposal, is shown in Figs. 6 and 7.

From the above two figures, we

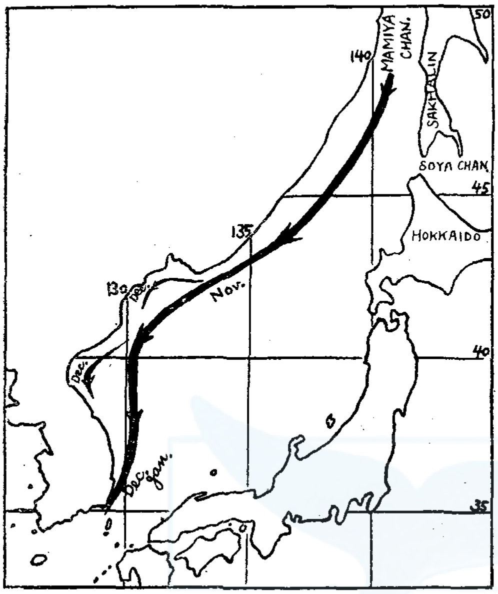

Fig. 7

can assume the movement of grey whales in the east sea area of Korea. As for there where about after then, it is reported by Mr. Tago that they reach Hokkaido or the western coast of Sakhalin in May or June and then through the Mamiya Channal go to the northern part of the sea of Okhotsk, where they seem to spend their summer. On their southwards migration they seem to take the same course as they come up north. It is not probable that grey whales pass through the Soya Channal to the farther north, for fin and hump-back whales are captured there from the landstation in Hokkaido but not grey whales. Nor is it assumable that they go between the Kurile Islands to the North Pacific and further to the Bering Sea, for the North Kurile Islands have many landstations from where both male sperm whales and fin whales were caught abundantly but no grey whale has ever been captured since 1919. (Though one was captured off Otomae, a landstation of the North Kurile Islands, in August, 1942, it ought to be regarded as exceptional.)

According to Mr. Scammon (1874), grey whales in the American side of the Pacific go down as far as 20° N. but in the Asian side they go no farther than 34° N. Nor will they go to the water whose temperature rises higher than 20°C. The right temperature of water for both delivery and pairing of grey whales is assumed to be 15°–20°C. In Fig. 5 the dotted lines show the distribution of the annual mean temperature of the surface water in the East sea area of Korea.

October 30, 1949

ICR

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Food of Whales

(In the Adjacent Waters of Japan)

BY

Kazuhiro Mizue

Introduction

Biological investigations of whales have been made in the last three years since the end of the War,—1946, 1947 and 1948 — in each landstation of the coastal whaling in Japan. Based on the records of such investigations, we are here going to make a report of the stomach contents of whales. The records consist of four items; — food contained or empty, quantity, species and degree of digestion. Of these, we will not refer to the degree of digestion in the present piece. Suffice it to say that our material is confined to the contents of the first room only, though the stomach of whales is divided into four rooms.

Table 1 shows the numbers of the catches of these three years according to the species. (The results of the factory whaling in the Bonin Islands sea area are excluded from the number.) In Table 2 are shown the total numbers of the catches of the three years of the various sea area and the whaling seasons according to the sea areas. These two tables will give readers a brief idea of the catches of our coastal whaling. The biological investigations before mentioned were made of all the whales posted in these tables.

Table 1

Year \ Whale species	Right	Blue	Fin	Sei	Humpback	Sperm	Total
1946	0	8	232	545	8	957	1750
1947	0	30	257	383	8	964	1642
1948	1	49	176	533	8	823	1590
Total	1	87	665	1461	24	2744	4982

Table 2

Sea-area \ Whale species	Right		Blue		Fin		Sei		Humpback		Sperm		
	No.	Whalling	No.	W.S.	No.	W.S.	No.	W.S.	No.	W.S.	No.	W.S.	Total
Hokkaido-Okhotsk	0		0		411	Jul.-Aug.	18	Jul.-Aug.	4	Jun.-Aug.	75	Aug.	508
Hokkaido-Pacific	0		58	Oct.	128	Oct.	442	Sep.-Oct.	7	Oct.	649	Sep.-Oct.	1284

Sanriku	1	Jan.	28	May -Jun.	86	May -Aug.	946	May -Aug.	6	May	1944	May -Dec.	3011
Kinan	0		0		0		2	Apr. -Jun.	1	May	54	Apr. -May	57
Goto-Tsushima	0		1	May	40	Mar. & Aug.	53	Jul. Aug.	6	Jan.	22	May	122
Total	1		87		665		1461		24		2744		4982

Food Contained on Empty, and Quantity

Whether food is contained in the first room of the stomach or it is empty, and the quantity of food, if any, are shown according to the species in Tables 3 — 9.

Table 3

Blue whales – Stomach contents

Food (quantity) / Sea area	Contained					Empty	No. of stomachs examined
	R	rrr	rr	r	Total		
Hokkaido -Okhotsk							
Hokkaido -Pacific	1	8	6	20	35	23	58
Sanriku		3	3	11	17	11	28
Kinan							
Goto-Tsushima						1	1
Total	1	11	9	31	52	35	87

Table 4

Fin whales – Stomach contents

Food (quantity) / Sea area	Contained					Empty	No. of stomachs examined
	R	rrr	rr	r	Total		
Hokkaido-Okhotsk	1	61	24	181	267	144	411
Hokkaido-Pacific		16	18	60	94	34	128
Sanriku		8	16	21	45	41	86
Kinan							
Goto-Tsushima		6	3	3	12	28	40
Total	1	91	61	265	418	247	665

Table 5

Sei whales – Stomach contents

Food (quantity) / Sea area	Contained					Empty	No. of stomachs examined
		rrr	rr	r	Total		
Hokkaido-Okhotsk	R	4	2	3	9	9	18
Hokkaido -Pacific		42	66	180	297	145	442
Sanriku	9	27	58	310	399	547	946
Kinan	4	1			1	1	2
Goto-Tsusima	4	6	10	11	31	22	53
Total	17	80	36	504	737	724	1461

Table 6

Hump-back whales – Stomach contents

Food (quantity) / Sea area	Contained					Empty	No. of stomachs examined
	R	rrr	rr	r	Total		
Hokkaido -Okhotsk			1	2	3	1	4
Hokkaido -Pacific				1	1	6	7
Sanriku		1	1	1	2	4	6
Kinan				1	1		1
Goto-Tsushima						6	6
Total		1	2	4	7	17	24

Table 7

Sperm (males) – Stomach contents

Food (quality) / Sea area	Contained					Empty	No. of stomachs examined
	R	rrr	rr	r	Total		
Hokkaido -Okhotsk		10		20	30	45	75
Hokkaido -Pacific	1	13	25	198	237	123	360
Sanriku		17	54	425	496	379	875
Kinan		1	8	32	41	6	47
Goto-Tsushima				5	5	3	8
Total	1	41	87	680	809	556	1365

Table 8

Sperm (females) – Stomach contents

Food (quantity) / Sea area	Contained					Empty	No. of stomachs examined
	R	rrr	rr	r	Total		
Hokkaido -Okhotsk							
Hokkaido -Pacific		14	18	150	182	107	289
Sanriku		13	51	557	621	448	1069
Kinan				7	7		7
Goto-Tsushima	1		1	6	8	6	14
Total	1	27	70	720	818	561	1379

Table 9

Sperm (Males and Females) – Stomach contents

Food (quantity) / Sea area	Contained					Empty	No. of Stomachs examined
	R	rrr	rr	r	Total		
Hokkaido-Okhotsk		10		20	30	45	75
Hokkaido-Pacific	1	27	43	348	419	230	649
Sanriku		30	105	982	1.117	827	1.944
Kinan		1	8	39	48	6	54
Goto-Tsushima	1		1	11	13	9	22
Total	2	68	157	1.400	1.627	1.117	2.744

Remarks –– Shown by the Quantity

R = The Number with very much food
rrr = The Number with much food
rr = The Number with moderate food
r = The Number with little food

From these seven tables we know that the best grounds of our coastal whaling are the Sanriku and the Hokkaido-Pacific sea areas. Next to these ranks the Hokkaido-Okhotsk sea area, grounds for fin whales. In point of the quantity of the food for whales, the Hakkaido-Pacific sea area is by far the best. The comparison between the two best whaling grounds, the Hokkaido-Pacific and the Sanriku sea areas shows that the former surpasses the latter in the quantity of food for every species of whales. This fact as well as the differences of the whaling seasons between the two sea areas and some other points justifies the assumption that whales make migrations from off the coast of Sanriku to the Hokkaido-Pacific sea area in search of food. The Antarctic Ocean is a vast breeding place for the food of whales and in point of quantity it is unsurpassed by any place on earth. Yet according to Mr. Ohmura who made reports on board a Japanese factory ship in the Antarctic Ocean in the season 1940–1941, 30% of the blue whales and 40% of the fin whales captured then were found hungry, that is, their stomachs were quite empty of food when dissected. Our adjacent waters with abundant food for whales are qualified for excellent whaling grounds. Especially, the Hokkaido-Pacific sea area where female sperm whales have the destinations of their northern migrations,—the former species go as far as the neighbouring waters of Etorohu Island, 45° N and the latter the Nemuro Peninsula, 43° 30′ N.—is, in point of the quantity of food, comparable with the Antarctic Ocean, though on a smaller scale. Also, the Hokkaido-Okhotsk sea area where catch is confined to fin whales and male sperm whales, is plentiful in the material for the food of whales. As far the Kinan and the Goto-Tsushima sea area the catch is too small to draw a difinite conclution; yet comparatively few animals go hungry there. Especially the percentage of the hungry sperm whales in the Kinan sea area is low. In short, our adjacent waters make good whaling grounds with abundant food.

There is hardly any variation found between the stomach contents of the two sexes of all the species except sperm whales. The size and the number of the catch of sperm whales differ greatly according to the sexes. Females are generally found in Harem while some males, so-called "Old Bulls" live unaccompanied and go far into the cold water area of the north. Due to these differences we consider it necessary to treat the whales of this species separately according to the sexes. As far the quantity of food, however, no difference is discernible between the sexes.

Species of Food

The following tables will show the species of food according to the sea areas.

Table 10

Blue Whales – Stomach contents

Food (Species) / Sea area	Contained				Empty	No. of stomachs examined
	Kri.	Sar.	Sq.	Total		
Hokkaido-Okhotsk						

Hokkaido-Pacific	34		1	35	23	58
Sanriku	16	1		17	11	28
Kinan						
Goto-Tsushima					1	1
Total	50	1	1	35	35	87

Table 11

Fin Whales – Stomach contents

Food (Species) / Sea area	Contained						Empty	No. of Stomachs exa-mined
	Kri.	Mac.	Sq.	Sar.	San.	Total		
Hokkaido-Okhotsk	267					267	144	411
Hokkaido-Pacific	90		2	1	1	94	34	128
Sanriku	43	1		1		45	41	86
Kinan								
Goto-Tsushima	10	1		1		12	28	40
Total	410	2	2	3	1	418	245	665

Table 12

Sei Whales – Stomach contents

Food (Species) / Sea area	Contained								Emp-ty	No. of stomachs examined
	Kri.	Sq.	Sar.	San.	Mac.	Men.	Oct.	Total.		
Hokkaido-Okhotsk	9							9	9	18
Hokkaido-Pacific	103	135	32	16	10		1	297	145	422
Sanriku	253	10	107	25	1	2	1	399	547	946
Kinan	1							1	1	2
Goto-Tsushima	1		29		1			31	22	53
Total	367	145	168	41	12	2	2	737	724	1.461

Table 13

Hump-back Whales – Stomach contents

Food (Species) / Sea area	Contained			Empty	No. of stomachs examined
	Kri.	Sar.	Total		
Hokkaido-Okhotsk	3		3	1	4
Hokkaido-Pacific		1	1	6	7
Sanriku	2		2	4	6
Kinan			1		1
Goto-Tsushima	1			6	6
Total	6	1	7	17	24

Remarks — Shown by the food species

Kri. = The number, eater Krill
Sar. = 〃 Sardine
Mar. = 〃 Mackerel
San. = 〃 Sanma
Men. = 〃 Menuke
Oct. = 〃 Octopus
Sha. = 〃 Shark
Sq. = 〃 Squid
Cod. = 〃 Codfish

The data contained in Tables 10—13 are concerned exclusively with baleen whales and they make it clear that the larger the sizes of the whales are, the fewer the varieties of food they eat. In other words, the whales having large sized baleen eat more homogenious food consisting only of small food. All the blue whales in Table 10 eat "Krill" except two which have sardines and squids respectively in their stomachs. Most fin whales eat "Krill" but some sardines, mackerels and sanmas, showing they take greater varieties of food than blue whales. As for sei whales, they are arrant gross feeders. Besides "Krill", they eat sardines, squids and other kinds of food shown in Table 12. Most sei whales caught in the Goto-Tsushima sea area have sardines in their stomachs.—sei whales are called "Iwashi-whale" in Japanese, "Iwashi" meaning sardine. The name is derived from their staple food in this sea area—Also in the Sanriku sea area sardines are eaten by a considerable number of sei whales. In the Hokkaido-Pacific sea area, however, it is often the case that squids make their stomach contents rather than "Krill". All the species of whales eat, besides "Krill", squids, the proper food for sperm whales, in this sea area. We cannot arrive at any definite conclusion regarding the catch of any species of the Kinan sea area as the number of the catch there is so small with only one land station at Oshima. So is the case with humpback whales whose catch are so scanty in our adjacent waters.

Now we are going to deal with the food of sperm whales, the only large sized species of Odontoceti.

Table 14

Sperm Whales (Males) – Stomach contents

Food (Species) / Sea area	Contained									Empty	No. of stomachs examined
	Sq.	Kri.	Oct.	Cod.	Sha.	Men.	Sar.	San.	Total		
Hokkaido-Okhotsk	28					2			30	45	75
Hokkaido-Pacific	210		5	4	1	10	1	6	237	123	360
Sanriku	441		11	18	2	23	1		496	379	875
Kinan	41								41	6	47
Goto-Tsushima	5								5	3	8
Total	725		16	22	3	35	2	6	809	556	1.365

Table 15

Sperm Whales (Females) – Stomach contents

Food (Species) / Sea area	Contained									Empty	No. of stomachs examined
	Sq.	Kri.	Oct.	Cod.	Sha.	Men.	Sar.	San.	Total		
Hokkaido-Okhotsk											
Hokkaido-Pacific	174	1		6		1			182	107	289
Sanriku	600	1	3			16	1		621	448	1.069
Kinan	7								7		7
Goto-Tsushima	7						1		8	6	14
Total	788	2	3	6		17	2		818	561	1.379

Table 16

Sperm Whales (Males and Females) – Stomach contents

Food (Species) / Sea area	Contained									Empty	No. of stomachs examined
	Sq.	Kri.	Oct.	Cod.	Sha.	Men.	Sar.	San.	Total		
Hokkaido-Okhotsk	28					2			30	45	75
Hokkaido-Pacific	384	1	5	10	1	11	1	6	419	230	649
Sanriku	1.041	1	14	18	2	39	2		1.117	827	1.944
Kinan	48								48	6	54
Goto-Tsusima	12						1		13	9	22
Total	1.513	2	19	28	3	52	4	6	1.627	1.117	2.744

As is shown in these tables, most sperm whales live on squids but eat some other kinds of food too. For instance some considerable number caught in the Hokkaido-Pacific and the Sanriku sea areas contain "Menuke" in their stomachs and other noticable number codfish. Although squids are the staple food for both the sexes of the sperm whales in these sea areas males take more miscellaneous food than females; of almost the same number of males and females with food in their stomachs, other food than squids are found in 84 males and 30 females.— Tables 14 and 15. Thus male sperm whales show a strong tendency to take various kinds of food. This may be due to the fact that males, mostly "Old Bulls", swim alone in search of food and go far into the north while the activities of females are restricted as composing numbers of Harem. These differences of environments will result in the differences of the stomach contents of the two sexes.

Octopuses are also found in the stomach contents of sperm whales. They are often found mixed with squids and as often overlooked. So the actual number of sperm whales which eat octopuses may be greater than what are shown in these tables. However, it is not certain to what species these octopuses belong. Nor are known the species of the squids and of the sharks sperm whales eat in our adjacent waters. A comparatively large number of sperm whales, mostly males, contain codfish, submarine fish, in their stomachs. In this case, they consist of both Gadus marcrocephalus and Theragra chalcogramma. "Menuke" belong to the Family of Scorpaenidae and taste good, the species which make food for sperm whales are either Sebastodes flammeus or Se. iracundus. "Sanma" is the Japanese name for Cololabis saira and lives in cold waters. Sardines here include Sardinia melahosticta, Etrumeus micropus and Engraulis japonica, and mackerels both Scomber japonicus and Sc. tapeinocephalus.

Herrings are not found in the stomach contents of Sei whales in our adjacent waters. It is due to the fact that though the Hokkaido-Pacific sea area is the main fishing ground for herrings in Japan, whales in their migration do not arrive there during the fishing season for herrings.

Schizopoda is the most important food for all the whales of Mystacoceti and make the staple food for blue and fin whales. It is called "Krill" by European whalers. In the Antarctic Ocean ,'Krill" means Euphausia superba, but in our adjacent waters the plankton belonging to Copepoda, for instance, Calamus sp., as well as Euphausia sp. are included in "Krill". Calamus sp. and Euphausia sp. are quite different species, so it is but proper to treat them separately in the future researches. In the adjacent waters of Japan, the Euphausia sp. mostly consists of Eu. pellucida and Eu. sprendeus but sometimes of Eu. gibba and Mysis sp. in the warm water area, and the Calamus sp. consits of Ca. fimmarchicus of the cold current and Ca. vulgaris and Ca. minor of the warm current.

Appendix

The migration and the distribution of whales are much influenced by the material of their food, and the food, in its turn, is affected by the oceanological nature of the sea water. So the value of the whaling grounds depends upon the two factors, the material of the food for whales and the oceanological nature of the sea water. Therefore we consider it necessary to make more study of these two factors in their inseparable relations; for this purpose we are going to give out further study of the food of whales, and this statistic study of the same subject based on the data of the three years after the War should be the first of the series which will follow hereafter.

July 22, 1949.

Biological Investigation on Blue Whales (*Blalaenoptera musculus*) and Fin Whales (*Balaenoptera physalus*) caught by the Japanese Antarctic Whaling Fleets.

July 1948

BY

MASAHARU NISHIWAKI, TADAHIRO OYE

Table of Contents

Appendix.

I.

1. Geographical study on krill and whale composition
2. Reason for this study.
3. Sectional region.
4. Amount of krill by region.
5. Synthetic study on krill.
6. Whale composition by region.
7. Blue whale composition.
8. Fin whale composition.

II. The relation between anterior hypophysis and age.

1. Weight distribution by body length.
2. Relation with sexual maturity.
3. Relation with physical maturity.

End.

Chapter I Introduction

I. Authorized Antarcitc whaling expedition in the season 1948-49.

The third whaling expedition since the cessation of the war was authorized by GHQ, SCAP with a far better condition than the previous years.

The Japanese Whaling fleets, with a composition as shown below, were able to carry out their operation, bringing valuable foodstuff and scientific results of various investigations. We owed all of them to the kindness of the SCAP authorities with deep gratitude from the bottom of our heart.

The Japanese Antarcitc Whaling Expedition in the season 1948-49 was composed of the following two fleets.

The first fleet (Nihon Suisan K.K.)

Name of vessel	Category of vessel	Gross tonnage	Type of engine	HP
Hashidate-maru	Factory ship	10,841 tons	turbine	8,600
Tadotsu-maru	Refrigerator	10,175	〃	8,600
Settsu-maru	Refrigerator	9,670	diesel	3,600
Sagami-maru	Frozen meat carrier	988	〃	800
Chikuzen-maru	〃	1,161	〃	800
Gyokuei-maru	Tanker	10,245	〃	4,000
Koyo-maru No. 1	Catcher	364	〃	1,800
Koyo-maru No. 2	〃	366	〃	〃
Koyo-maru No. 3	〃	〃	〃	〃
Koyo-maru No. 5	〃	〃	〃	〃
Shonan-maru No. 8	〃	355	recipro	1,000
Shonan-maru No. 11	〃	354	〃	1,000
Kyo-maru No. 6	〃	374	diesel	1,800

Note. Kyo-maru No. 6 was chartered by Kyokuyo Hogei K.K.

The second fleet (Taiyo Gyogyo K.K)

Name of vessel	Category of vessel	Gross tonnage	Type of engine	HP
Nisshin-maru	Factory ship	11,781 tons	turbine	5,000
Tenyo-maru	Refrigerator	10,269	〃	5,000
Tenyo-maru No. 2	〃	10,595	diesel	5,400
Bansyu-maru	〃	983	semi-diesel	800
Tenyo-maru No. 3	〃	3,500	diesel	2,400
Bansyu-maru No. 35	Frozen meat carrier	999	〃	950
Bansyu-maru No. 36	〃	998	〃	950
Bansyu-maru No. 38	〃	998	〃	950
San Diego maru	tanker	7,268	〃	2,400
Fumi-maru No. 3	catcher	312	〃	1,600
Fumi-maru No. 5	〃	384	〃	1,600
Fumi-maru No. 6	〃	304	〃	1,600
Seki-maru	〃	365	〃	1,600
Seki-maru No. 3	〃	300	recipro	1,400
Seki-maru No. 7	〃	306	diesel	1,600
Seki-maru No. 8	〃	300	〃	1,600

II. Purpose of the whaling investigation.

This investigation was carried out on board of the Hashidate-maru, factory ship, Nihon-suisan K.K., and the Nisshin-maru, factory ship, Taiyo Gyogyo K.K., which operated from 15 Dec. 1948 to 26 March 1949 with the above authorization. Their action is shown in Fig. 1. The whaling ground was divided into four large sections, indicated by different colours for the convenience, understanding the characteristics of each whaling ground. In some cases, these divisions, could be taken as seasonal. (Cf. Appendix I: Geographical study on krill and whale composition)

Number of whales caught by the Japanese fleets during this season were 631 blue whales (*Balaenoptera musculus*) 1,013 and fin whales (*Balaenoptera physalus*), of which 2 blue whales were lost by the Nisshin-maru (1 whale torn off at tail and 1 flowing whale lost).

The purpose of this investigation was to find out the composition of the whales caught as a part of the investigation on Cetaceae in the Antarctic, the natural resources of the world. At the same time, this would show the world, the sincerity of the Japanese Fleets for the International Regulations in figures. As has been pointed out in many places in this report physiological and histological study on individual whales, or anatomical study on whale foetus were omitted.

In short, this is a statistical study for the above mantioned purpose. Even if they were statistical data, some under studying such as relations between colour of the eye lens and age, or between baleen and age, will be made published. In separate reports though only a part of them was included in the appendix.

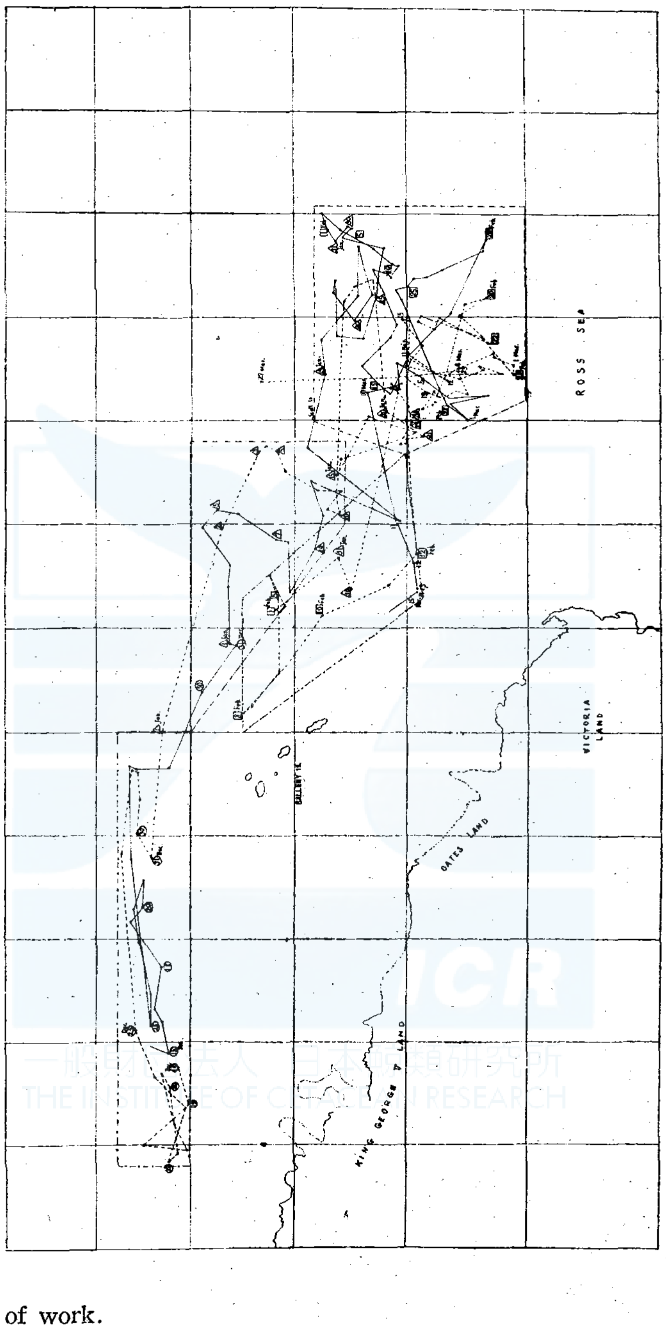


Fig. 1.

III. Methods of work.

1) Species, sex, serial number, date when whales were killed and date when treatment was commenced were described in a usual way. Time was taken in a

unit of 5 minutes.

2) Body length was measured with a 100 feet steel tape according to the International Regulations.

3) In order to obtain statistical data, the number and clarity of pale spots on blue whales were observed with the naked eye.

On fin whales, investigation was carried on the following items:

Depth of body colour, extent of the pigmentation on the ventral grooves, i.e. how the pigmentation on the lower part of the flipper expends to the ventral groves with the normal extention up to the 11th or 13th groove from the navel line presence of pigmentation behind the anus, and unification of right and left pigmentation in front of tail flukes.

4) White scar: Total number of white scars was compared with number of last year's and of older one.

5) External parasites: The number and kinds of parasites attached to the body surface (except the undersurface in contact with the flensing deck) with emphasis on frequency of species of parasites.

6) Thickness of blubber: As the flensing method by the Japanese fleet was different from that by foreign fleets, it was measured in cm. at the following two points: (1) The point on a vertical line from the dorsal fin where it intersects the horizontal line of the body and (2) the point on the vertical cut near the ear hole, where it intersects the mid-dorsal fin.

7) Mammary glands: Cutting off in several places at right angles to the body axis, the colour and thickness of the thickest portion was observed.

8) Foetus: Sex and body length were observed on every foetus the latter with a steel tape. Body weight was also measured on some foetuses.

9) Stomach contents: The size and amount of *Euphausia* were mainly measured with the degree of digestion by the method used in the Dicsovery Reports.

10) Testes: The weight of testes was measured in Kg with a platform scale after connective tissue and epidymis had been removed: the center width and height and length of diameter was measured with a caliper.

11) Ovary: The weight of ovaries was measured after removal of connective tissue: the presence of corpora lutea was investigated by cutting the ovary with a knife, and also the diamerer of the largest Graafian follicle was measured.

12) Ossification of vertebrae at thoracic and lumbar series:

In thoracic series between 7th and 8th one from the head, and in lumbar series, between 8th and 9th one from the first chevron bone of the caudal series, it was observed. In case of harpooning scar at the above points, the nearest one was chosen.

Ankylosis was graded according to the Discovery Reports.

13) Various parts of whale body were measured with a steel tape according to Mackintosh and Wheeler's method in the Discovery Reports.

(1) Total length.
(2) Lower jaw: proportion beyond tip of snout (omitted).
(3) Tip of snout to blow hole.
(4) Tip of snout to angle of gape (omitted).
(5) Tip of snout to center of eye.
(6) Tip of snout to tip of flipper.
(7) Eye to ear, certres.
(8) Notch of flukes to posterior emargination of dorsal fin.
(9) Flukes, width at insertion.
(10) Notch of flukes to anus.
(11) Notch of flukes to umbilicus.
(12) Notch of flukes to end of ventral grooves.
(13) Anus to reproductive aperture (centers).
(14) Dorsal fin, vertical height.
(15) Dorsal fin, length of base.
(16) Flipper, tip to axilla.
(17) Flipper, tip to anterior end of lower border.
(18) Flipper, length along curve of lower border.
(19) Flipper, greatest width.
(20) Severed head, condyle to tip.
(21) Skull, greatest width.
(22) Skull length, condyle to tip of premaxilla (omitted).
(23) Flipper, tip to head of humerus.
(24) Tail, depth at dorsal fin.
(25) Flukes, notch to tip.
(26) Flukes, total spread (omitted).

14) After dissection, the weight of various parts of whale body was obtained by adding the weights of blocks cut into suitable size (about 50 cm^3) for weighing on a 200 kg platform scale. Then, loss of blood and other body fluids was unavoidable, though collected saw-dusts was weighed and added. Stomach and intestinal contents were removed as much as possible.

The difference on dissecting method between the Nisshin-maru and the Hashidate-maru brought inevitably the different size of each block. However, it can be safely said the whole body weight is correct. For the purpose of comparing with blue whales caught in the adjacent waters of Japan, emphasis of this investigation was put on blue whales. As mentioned above, the loss of blood and other body fluids makes the figures inexact as the body weight but if the errors are assumed to be same for all the bodies studied, the figures must present an approximate body weight.

This investigation was carried out carefully so as to diminish individual errors, by some biologists and their assistants under the supervision of whaling inspectors appointed by the Japanese Government. The following men were in charge.

Title	On Hashidate-maru	On Nisshin-maru
Senior Government Inspector	Yoshiro Terada	Keijiro Maeda
Junior Government Inspector	Katsunari Ozaki	Shigeo Miyamoto
Government Biologist	Masaharu Nishiwaki	Tadahiro Oye

IV. There was no special limit on the action of the Japanese whaling fleets in the season 1948-49 except to observe the International whaling Regulations. With the later opening of the whaling season by a week than last year, the Nisshin-maru set sail from Yokosuka on 12th Nov. 1948 and the Hashidate-maru left Yokohama on 13th Nov. 1948. Both fleets reached 65° South Latitude, on 14 Dec. 1948 through the east seas of Australia. The further action of their enormous efforts and expenses, both fleets tried in vain to enter the Ross Sea by any means. If an airplane had been allowed to use it would have contributed much to find out the entrance to the Ross Sea and to scout whales.

Though they could not enter the Ross Sea, they obtained satisfactory results operating in West Longitude. The Nisshin-maru leaving the whaling ground on 15 March 1949, and the Hashidate-maru, on 26th March 1949, they returned home through the same course.

V. Catch amount by the Japanese whaling fleets in the season 1948-49.

As shown on Fig. 2, we caught smaller number of whales than expected in the early stage of whaling season. Later, however, we caught not only numerous whales but also large sized ones, as shown on whale composition by region. At the end of December, we commenced the entrance investigation to the Ross Sea, to two reasons, season opening on 15th Dec. and both fleets's eager hope for operating in the Ross Sea. As time went by, we could find better and better whaling grounds.

Though about the middle of Jan. rather an animated appearance presented, most whales, especially blue whale, were small. After the full effort for search-

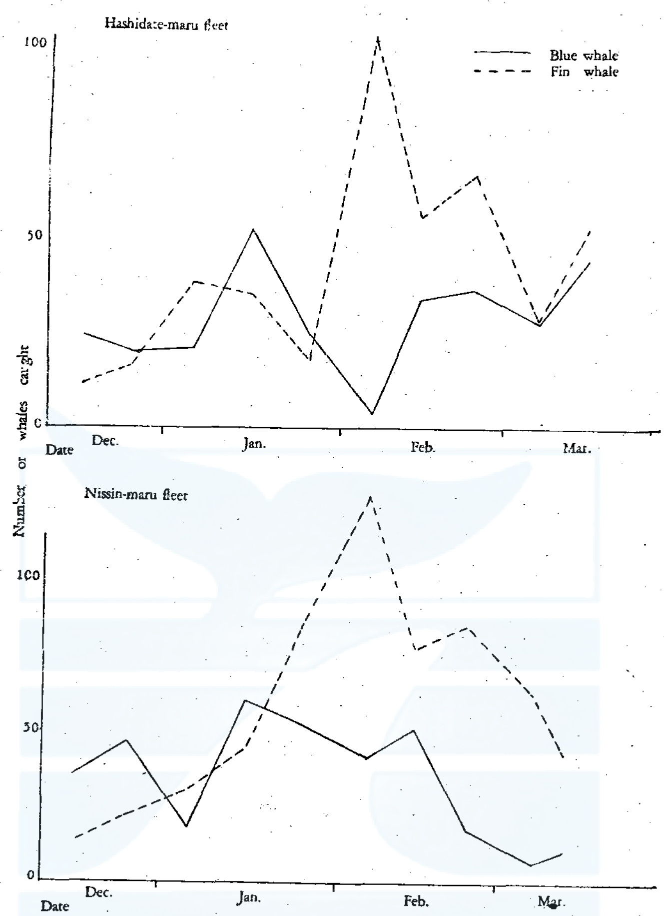


Fig. 2.

ing the good whaling ground, fortunately, moving from East Longitude through Scott Island to West Longitude in the middle of Jan., the Nisshin-maru fleets discovered the good fin whale ground and the Hashidate-maru fleets too. The success of this season became definite in this ground. Great was the exploit of the Nisshin-maru fleet which brought the success of the other fleet as well as of herself. The principal object was fin whale for weather (mainly fog) and pursuit hours made it profitable. The rare catch of blue whale was due to the operation more than 50 miles off from pack ice line. So we can not tell there were few blue whales in this waters and in this season.

This whaling ground was the so-called virgin ground for us, where the Japanese fleets had never operated in the past including the pre-war time. Good as this year's catch was, it is a question whether there is such a good whaling ground in such Longitude and Latitude every year, taking into consideration the fact of no finding the entrance to the Ross Sea. Rather speaking, it should be considered the whaling ground relating to the Ross Sea.

As usual, the suddenly increasing coldness at the beginning of March brings the freezing of the sea. About that time whale begins to move north. The precious experience during this time was gained by the Hashidate-maru fleet which operated as long as 26th March. Quite formidable was the velocity of the monsoon and freezing.

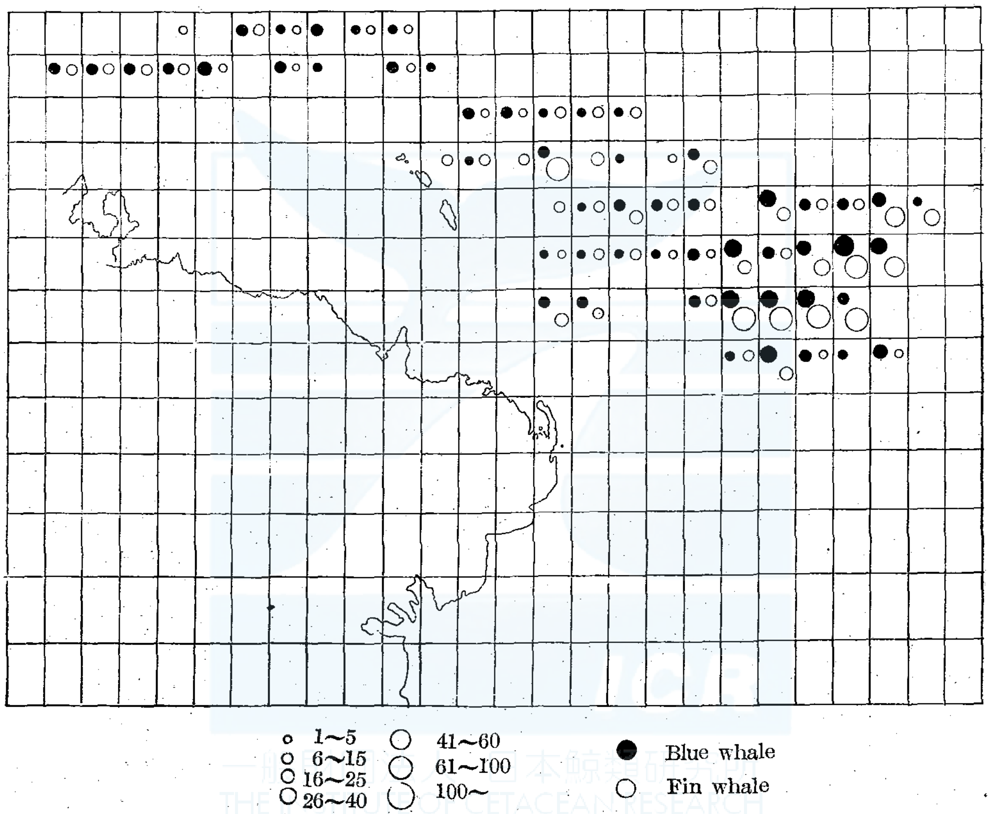


Fig. 3. The Map of catch by Japanese fleets. (1948~49 Expedition)

Fig. 3 shows the number of whales caught by region with the usual standard. (the Whaling ground in the Antarctic Whaling data 6-1 by the Japanese Whaling Association)

MATERIALS AND DATA.

The whales examined in the course of the work by the Hashidate-maru and the Nisshin-maru are classified as follows.

species		By the Hashidate-maru	By the Nisshin-maru	total
	Male	183	208	391
Blue whale	Female	108	132	240
	total	291	340	631
	Male	203	285	488
Fin whale	Female	222	302	524
	total	425	587	1012

Grand total 1643 whales (1137 B.W.U.)

The data on the individuals will be separately published by Fisheries Agency.

The average interval between death and the Commencement treating was as follows.

Name of fleet	the Hashidate-maru	the Nisshin-maru
blue whale	5 h. 41 m.	5 h. 01 m.
fin whale	6 h. 00 m.	4 h. 57 m.
average	5 h. 52 m.	4 h. 59 m.

Expression of terms

*Species Blue whale......B, Fin whale......F.

*Sex Male ....M, Female ....F.

*Colour of Blue whale

Pale spot............distribution............ none............0
scarce 1
few 2
normal 3
numerous ...4
very numerous.....................5

degree of distinctness none.................................0
indistinct...........................I
distinct...............................II
very distinct III

White flecks.........distribution.........equal to pale spot's description

Striation.........degree of distinctness.........eaual to the above

*Colour of Fin whale

Colour.........normal.........N, Blackish.........B.

Extention of pigmentation on ventral grooves

......upper than normal..U

normal (11-13 stripes of ventral grooves upward from navel line)..N lower than nommal L

Tongue-like pigmentation behind anus

present........+, absent........−

Meeting of pigmentation in frot of tail flukes

meet........+ not meet........−

white scars Number none.....0 State...more numerous last year than

scarce ....1 previous years ....a

few ....2 last year equal to previous years ...b

numerous ....3 more scarce last year than

very numerous ...4 previous years c

*External parasites

infected a little ....−

infected numerous..++

infected very numerous ....+++

*Thickness of blubber

The point on verticl line from the dorsal fin, where it intersects the horizontal cut side of the body ....point No. 1

The point on the vertical cut near the ear-hole, where it intersects the mid-dorsal line ....point No. 2

*Mammary glands

Colour.....white.............W.

reddish yellow......Ry pink...P

dark yellow ....Dy brownish yellow (normal colour)...Y

red ....R brown ....B

*Stomach contents (Auphausis s.)

Size........length (from rostrum to telson) over 5 cm...............L.

5 cm to 4 cm ....M.

under 4 cm ....S.

mixture ....X.

Quantity.....empty.............0

few.................r

moderate ....rr

much ....rrr

full ....R

Degree of digestion........................fully digested...........f

half digested ....ff

fresh.......................fff

very fresh ....F.

Ossification of vertebrae

Nos ....descript the numbers of each series

State ....ankylosed, no sign of join ....A

ankylosed, but a sign of join visible ......a

not ankylosed, thin cartilage ....n

not ankylosed, thick cartilage ....N

Constitution of whales caught

Fig. 4 shows it for this season. Its mode is at 79 feet for male blue whale

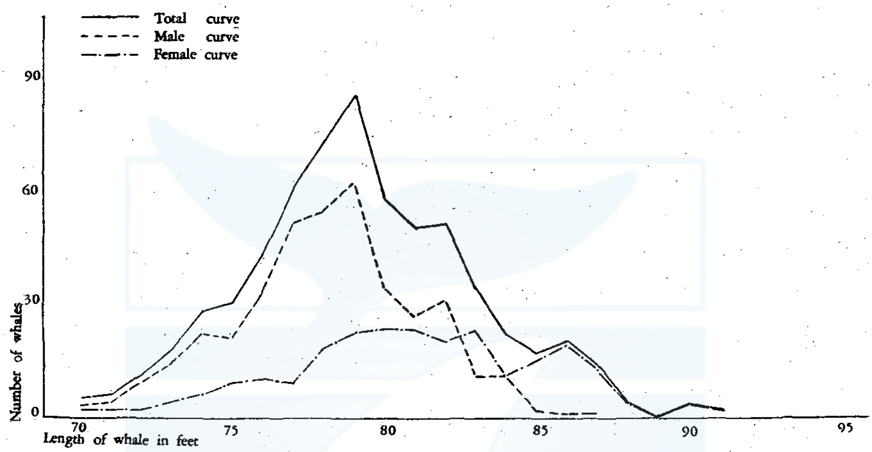


Fig. 4a. Size of whales caught (From all examples of Japanese fleet in 1948~49 expedition) Blue whale.

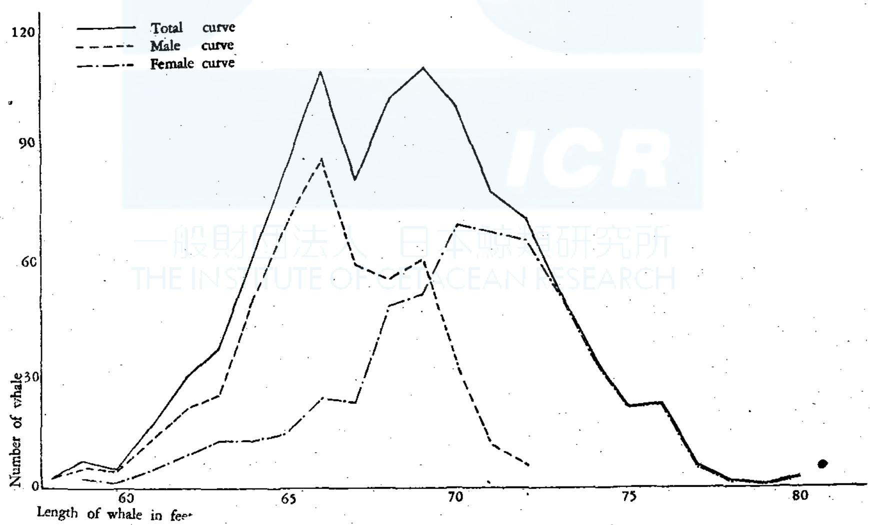


Fig. 4b. Size of whales caught (From all examples of Japanese fleet in 1948~49 expedition) Fin whale.

and at 83 feet for female blue whale, but the latter shows the nearly uniform catch from 78 feet to 86 feet. This fact made the one peak as whole. On fin whale, it shows 66 feet for male and 70 feet for female. Both male and female show the usual catch constitution with the respective peak on the whole curve. In this season, there was no violence of the International Regulations concerning the body length. It can be endorsed by this graph too.

2. Sex ratio

Sex ratio, as the whole, is as follows.

	male	female	total
Blue whale	391	240	631
	62.0%	38.0%	
foetus	50	33	83
	60.2%	39.8%	
Fin whale	488	524	1012
	48.2%	51.8%	
foetus	82	88	120
	48.8%	51.8%	

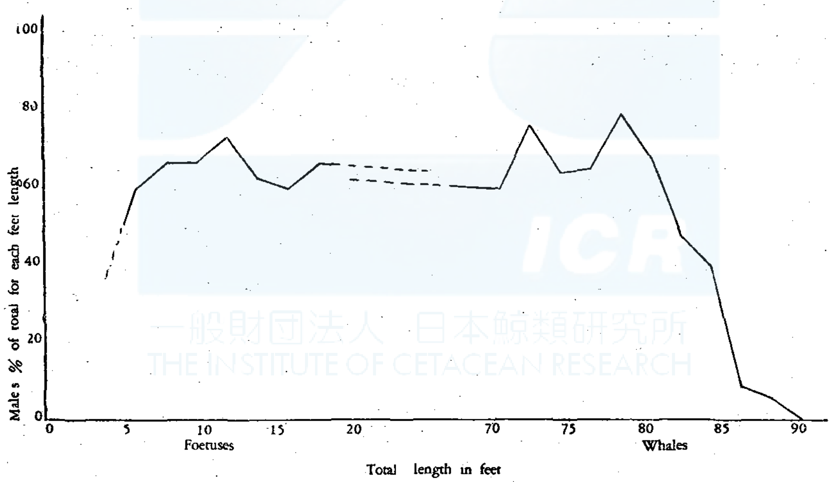


Fig. 5a. Sex ratio and total length. (Blue whale)

Sex ratio by body length is shown on Fig. 5a and 5b. On blue whale, more that 60% of total male are under 78 feet, long extremely few over 79 feet and none more than 88 feet. On fin whale too, the same is true with the boder line of 64

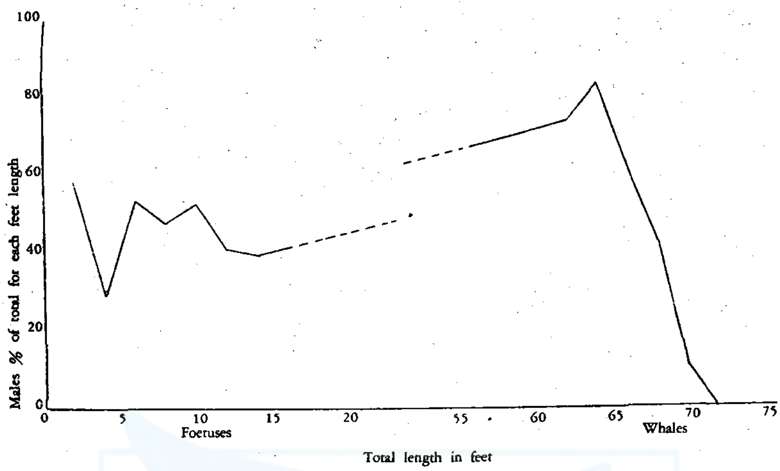


Fig. 5b. Sex ratio and total length. (Blue whale)

feet. These reason is quite same as last year. (Cf. the Report for 1947-48)

The composition of whales classified by group of size.

The size of sexual maturity was according to Mackintosh and Wheeler. Generally blue and fin whale also reach maturity at the following length.

male blue whale...........74 feet 2 inches (74 feet)
female blue whale.........77 feet 9 inches (77 feet)
male fin whale...............63 feet 8 inches (63 feet)
female fin whale...........65 feet 7 inches (65 feet)

species classification	blue whale	number	%	fin whale	number	%
group I	70 ft. and under	5	0.8	under 55 ft.	0	0
group II	71-85 ft.	583	92.4	55-65 ft.	237	23.5
group III	86 ft.	43	6.8	over 66 ft.	775	76.5
total		631			1012	
immature male		30	7.9		43	8.8
mature male		361	92.1		445	91.2
immature female		35	14.6		39	7.4
mature female		205	85.4		485	92.6
total immature		65	10.3		82	8.1
total mature		566	89.7		920	91.9

Male Whale composition

On all blue and fin male whales which were caught by the Japanese fleets, their testis's weight and size were measured. By the result of last year's investigation, the weight and size were nearly parallel. So in this report the size was neglected. For the weight can show clearer quantity, while the size needs multiplication, not always meaning the quantity.

(1) Total weight of right and left testis by body length is plotted in Figs. 6a

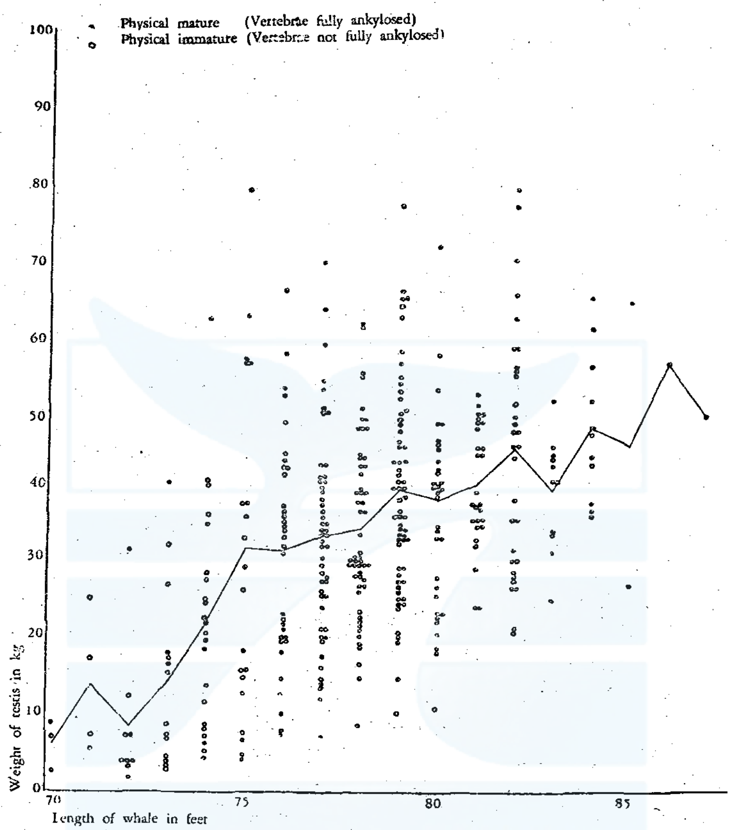


Fig. 6 a. Weight of testis in different length. (Blue whale)

and 6b with the average value in graph. These show that there is more steep slope of the curve on blue whale under 75 feet (more increasing ratio of weight of the testis) and gentle slope over 75 feet though increases. Supposing that blue whale comes to sexual maturity in 75 feet nearly same curve is gained on fin whales. The weight of genitals increases remarkably under 62 feet. That is, the fin whale reaches maturity at 62 feet long.

(2) The average body length by the weight of testis is shown in Figs. 7a and 7b. After the remarkable increase of body length till 10 kgs in testis's weight on blue whales the more the weight of testis increases, the less notable the increase of body length is. And the same is true with fin whales with the border of 5 kgs. This is another point of view for the above mentioned and means that as long as

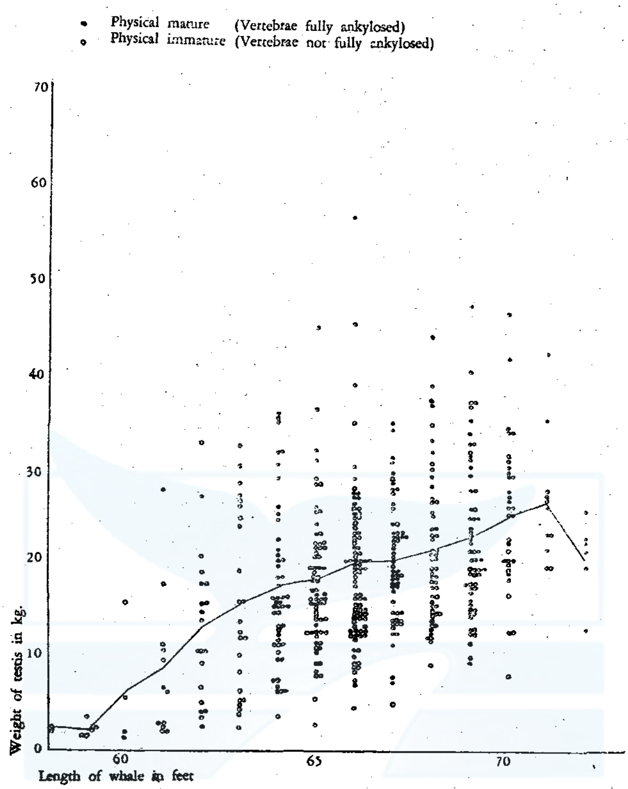


Fig. 6b. Weight of testis in different length. (Blue whale).

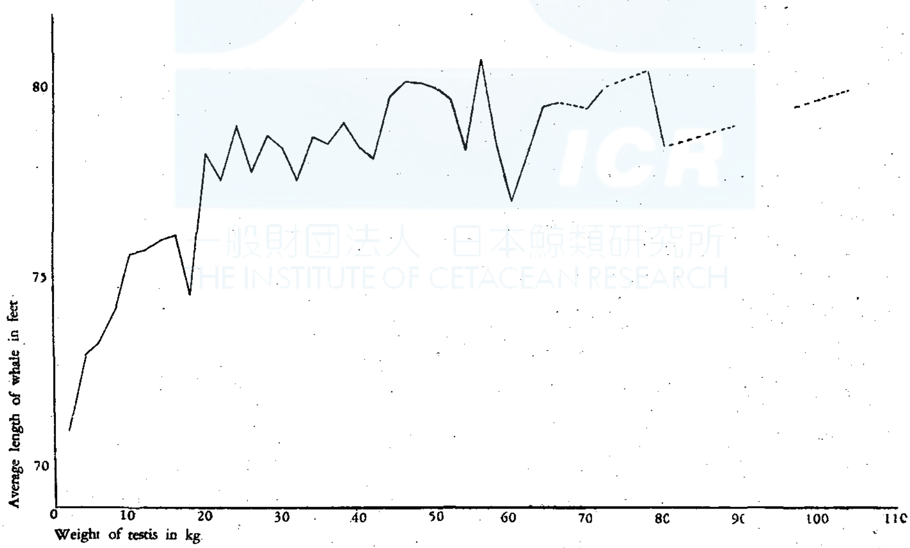


Fig. 7a. Average length of whales in each class of weight of testis. (Blue whale)

the whale grows into the constant weight of testis and body length, it shows the rapid development and after that gentle.

Hitherto, the Japanese investigators have classified sexual mature and immature with the weight of testis, 10 kg for blue whale and 5 kg for fin whale. In Fig. 6 too, you can find it appropriate.

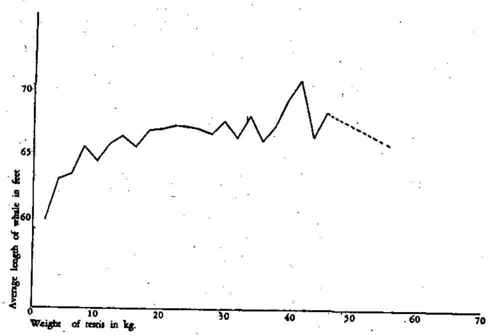


Fig. 7b. Average of whales in each class of weight of testis. (Fin whale)

(3) Next, from another point of maturity by body length. 10 kg total weight of right and left for blue whale and view, let's study the sexual and physical 5 kg for fin whale were regarded as sexual mature and percentage of sexual matur for total number by body length was made into chart (Cf. Figs. 8a and 8b). These curves show the sexual maturity. And on every whale caught, the ankylosis was observed at thoracic region and lumbar.

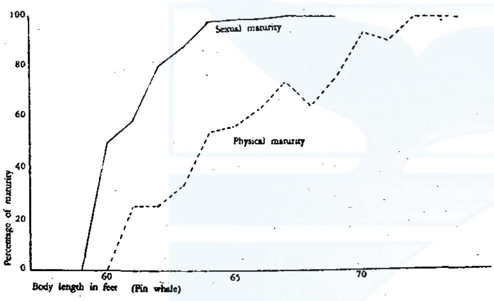


Fig. 8a. Maturity curve on different length. (Male)

When either of them were ankylosed, the whales were considered physical mature and their percentage for total number by body length was made into chart in Figs. 8a and 8b.

These charts show that the body length of sexual and physical mature is 75 ft and 79 ft respectively for blue whales and 62 feet and 69 feet for fin whales, if we can regard the body length of more than 75% of mature as that of physical and sexual mature.

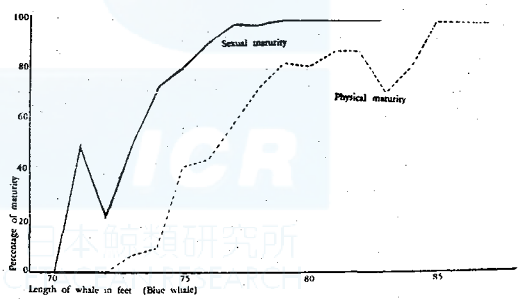


Fig. 8b. Maturity curve on different length. (Male)

FEMALE WHALE COMPOSITION

Similar to the report of the 1947–48 season, we studied female whale composition—principally on the presence of corpora lutea in the ovaries and complementally presence of foetus, weight of the ovaries, condition of the ovarian follicles and state of the mammary glands.

The number of corpora lutea distributed by body length is shown in Figs. 9a

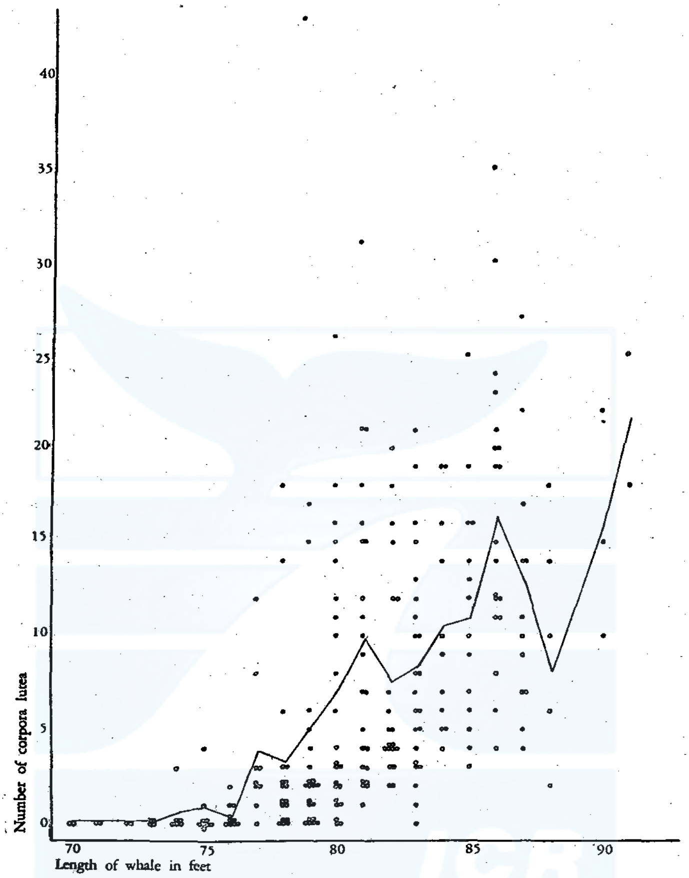


Fig. 9a. Length of whale and number of corpora lutea. (Blue whale)

and 9b. On blue whales (Fig. 9a) the average curve of the number of corpora lutea by body length rises extremely high from 78 feet to 81 feet and around them shows a rather gentle curve. Compared with the last year's data, it can be said that the gentle curve in more than 80 feet means more numerous younger whales (small number of corpora lutea). Shaded dots mean the physically mature whale. (This year, even though the thoracic series of vertebrae were not ankylosed, whales with ankylosed lumbar series of vertebrae were regarded as physically mature.) With some exceptions, generally, physically mature whales have more than 12 corpora luteas. The fact that there are some immature whales with many corpora luteas is due to taking for not ankylosed owing to the unsufficient bone shaving in observation on board of the Nisshin-maru. But the data were not revied.

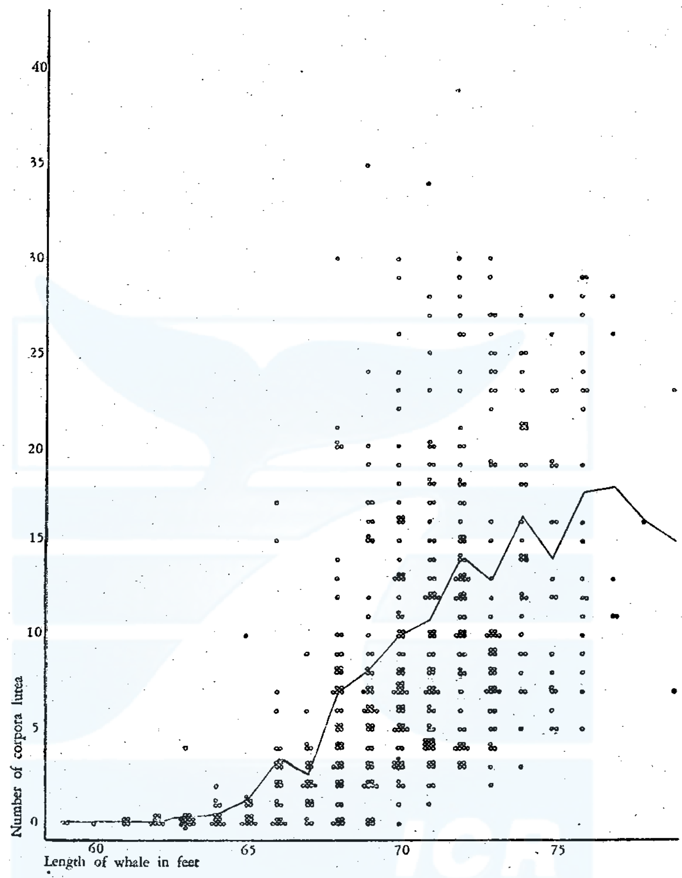


Fig. 9b. Length of whale and number of corpora lutea. (Fin whale)

Nearly the same thing can be said with fin whales (Fig. 9b) There is a lower turning point of average of number of corpora lutea for the body length around 67 feet. This corresponds with the last year's data but means comparatively small number of corpora lutea, this is due to larger number of whales of younger age.

The relation of physical maturity of fin whales too agrees almost with that of blue whales. It is quite unusual that a whale with 53 corpora luteas (72 feet in length) was caught. Further information about it will be mentioned elsewhere.

As for the average length of whales in each class of corpora lutea numbers (Figs. 10a and 10b), sudden increase of average body length (from 81 feet to 84 feet) can be seen between 6 and 7 corpora luteas in blue whales (Fig. 10a). After that, it fluctuates around 83,5 feet in general with some unevenness. And

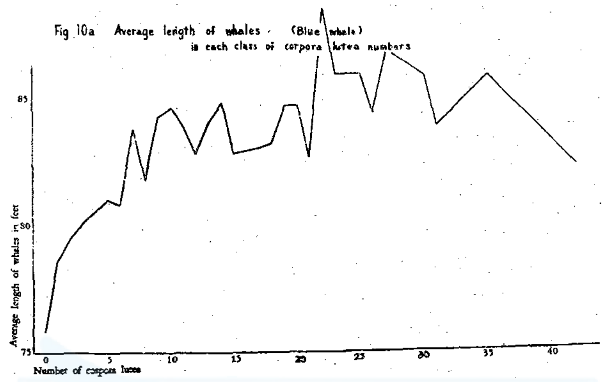


Fig. 10a. Average length of whales. (Blue whale) in each class of corpora lutea numbers.

between 21 and 22 in number of corpora lutea, a sudden change can be seen again and after 22, there is a group of 84 feet. According to the last year's data, though 86 feet group was found in large number of corpora lutea, normal size of female blue whale was generally 84 feet. And the same was true for this year too.

These facts lead that lately the average body length of whales has been becoming smaller and that the standard length of whales is about 84 feet and after that it keeps growing (increases the body length) though it is slack.

These curves of the last two years show the decrease of average body length around the largest number of corpora lutea. As seen in human being and other mammals, isn't it a proof that a phenomenon of shrinking in old age is found in whales also?

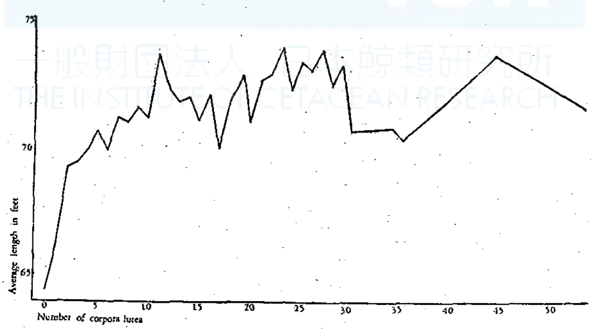


Fig. 10b. Average length of Whales. (Fin whale) in each class of corpora lutea numbers

The same thing can be said with fin whales (Fig. 10b). Its standard body length is 72 feet and the group of whales with larger number of corpora lutea is 73 feet type, it is thought.

From another point of view, the ratio of the number of sexual mature (whale, with more 1 in number of corpora lutea) to the number of sexual immature (whales with no corpora lutea) in each body length in percentage was made into chart in Fig. 11. If sexual mature is supposed of the body length (age) in which sexual mature is over 75% of the total, the length of sexual mature is 78 feet in blue whale and 67 feet in fin whale. (The broken line show physical matures which can bring the same result. It will be stated later.) The percentage of physical maturity in this body length, (78 feet, for blue whales and 67 feet for fin whale) is 11% for the former and 15% for the latter.

The average number of corpora lutea is 3 for both blue and fin whales

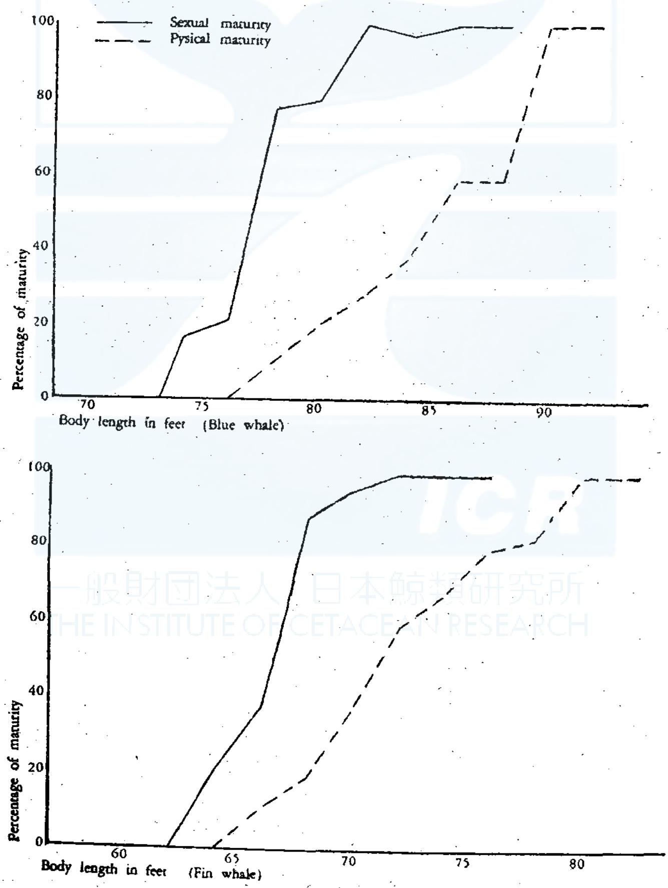


Fig. 11. Maturity curve on different length. (Female)

(omitting the figure below decimal point).

The average number of corpora lutea for each body length is shown in Fig. 12

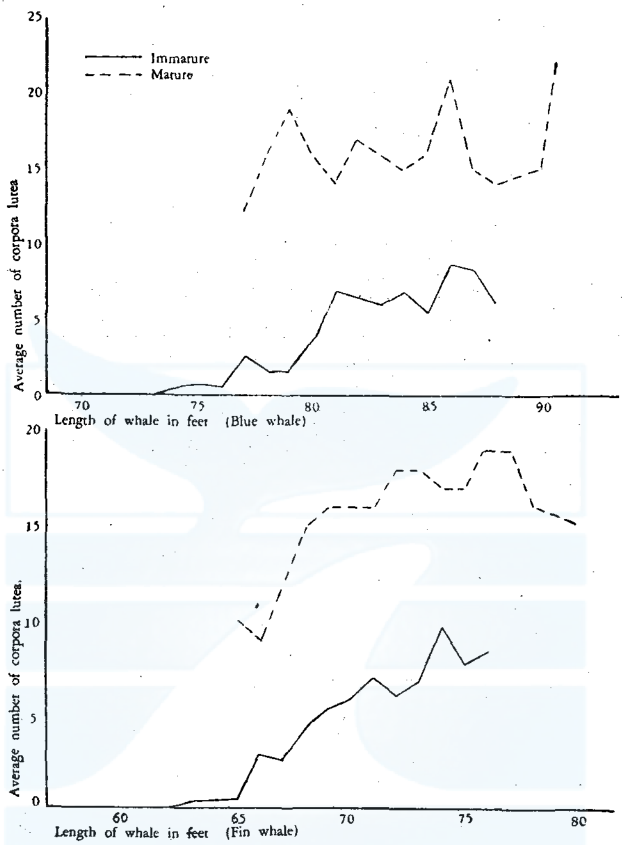


Fig. 12. Average number of corpora lutea in different length on physical maturity.

respectively on physical mature and immature. There the increase of number of corpora lutea with the increase of body length is found. It is an interesting fact that mature and immature are divided distinctly with an border line of 10 in number of corpora lutea (both in blue and fin whales). The last year's data did not divide them so distinctly as this.

The relation between mature and immature, namely percentage of mature whale for total whales in each body length is shown with physical maturity curve in Fig. 11. The curve for this year is extremely typical by chance. The body length 75% of which is mature is 89 feet for blue and 75 feet for fin whale.

Let's compare the sexual maturity with the physical maturity. In sexual maturity, some blue whales suddenly begin to get mature about 73 feet in length and almost all female whales have grown up in 82 feet long. In physical maturity, however, early matured whale begins to reach maturity around 76 feet in length and late matured one does not show the perfect maturity till 90 feet long. This is probably the reason why the body length of whales is laid stress on as data of age.

On fin whales the former begins from 62 to 72 feet long and the latter 64 feet in length, probably with an increase of body length to 80 feet.

The average number of corpora lutea in the body length, 75% of which reach physi al maturity, namely 89 feet for blue whales and 75 feet for fin whales, is 12 for the former and 14 for the latter. The average number of corpora lutea in physical mature only is 17 both on blue and fin whales. It is very interesting to read the charts again, considering the above items.

The composition of female whales by sexual immature (with no corpora lutea) pregnant and resting one, is shown as Fig. 13. Immature has a special peak but

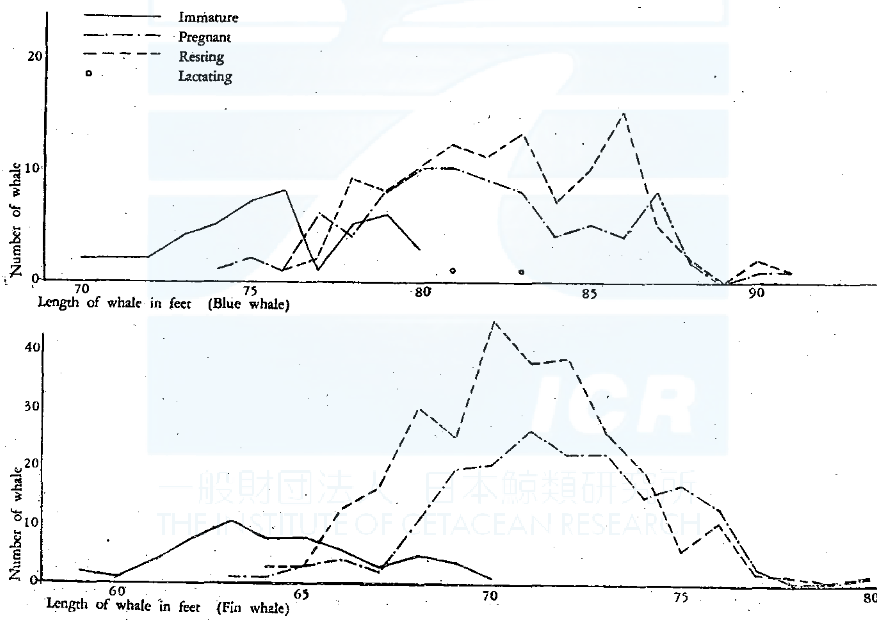


Fig. 13. Maturity of female in all Japanese fleet.

this, as Figs. 4a and 4b show, forms a part of the gentle curve as whole. It is natural that the number of immature increases towards small in body length but the peak in 76 feet on blue whales proves that large sized whales were caught as whole. The more this peak of immature moves to small in length, the younger whales are chased, it proves. The modes of pregnant and resting one agree well. Even from this fact, probably the pregnant ratio is nearly 45% of total mature whales.

The same observation can be done with fin whales and their pregnant ratio is less than blue whales. The percentage of the pregnant whales by month for this year is shown as Fig. 14. After a slight decrease from December to January, blue

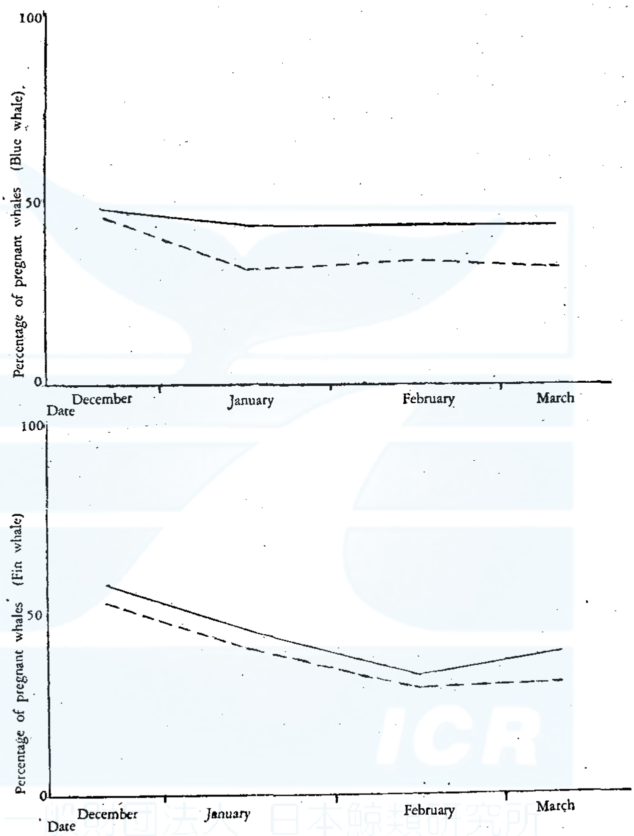


Fig. 14. Percentage of pregnant whales in catch by month. (contain the whale, which has functional corpora lutea & no foetus)

whales show nearly same percentage, around 45% (in a real line for mature female whales and in a broken line for total female whales). This is thought a a very good condition for whales.

Fin whales show slight increase in March but in general, show the decreasing line in and after December. Even in February when both the Nisshin-maru and the Hashidate-maru fleets caught more fin whales, it is thought a good efficiency to keep the percentage more than 30%.

Anyhow, it is fortunate for whales that this year there was no large fluctuation or no descendance to around 10% as seen last year.

The figures of the pregnant ratio through the whole whaling season is as the following table.

Whale species	Sexual immature	Resting	Pregnant	Total
No of blue whales	45	112	83	240
%	18.7%	46.7%	34.6%	100%
% for total mature		57.4%	42.6%	100%
No of fin whales	61	295	168	524
%	11.6%	56.3%	32.1%	100%
% for total mature		63.7%	36.3%	100%

Note: Resting stage contains lactating stage.

The frequency curve of the number of corpora lutea is shown in Figs. 15a and 15b.

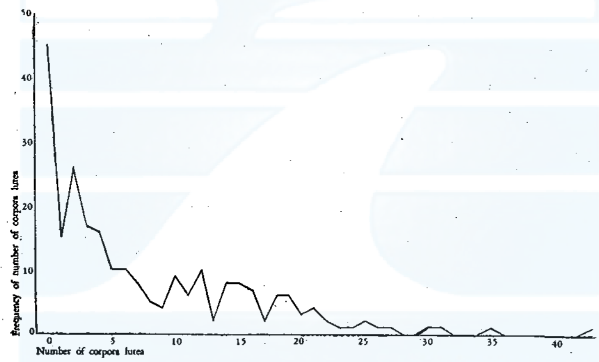


Fig. 15a. Frequency of number of corpora lutea. (Blue whale)

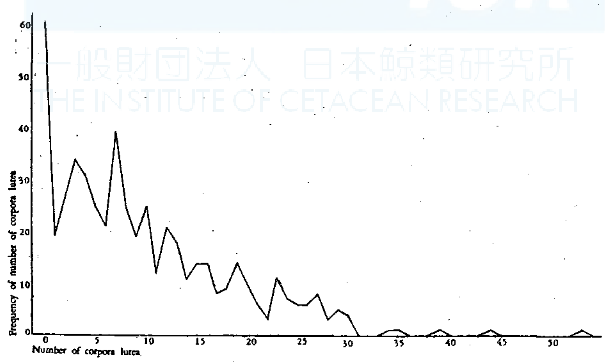


Fig. 15b. Frequency of numbers of corpora lutea. (Fin whale)

The blue whale's peaks for this year are 2, 6, 10, 12, 14, 19, 23, 25 and 29 for last year.

The fin whale's peaks for this year are 3, 7, 10, 12, 15, 19, 23, 27 and 29, agreeing with 2, 5, 7, 10, 12, 14, 18, 23, 27, and 30 for last year.

Both are the extremely gentle curves and especially more whales with more than 10 in number of corpora lutea are very conspicuous.

Under the classification of female whales into sexual immature, resting and pregnant group, (Lactating whales are included in the resting or pregnant group specially, marked with O.), the average weight of ovaries in each body length is shown in Fig. 16a and Fig. 16b.

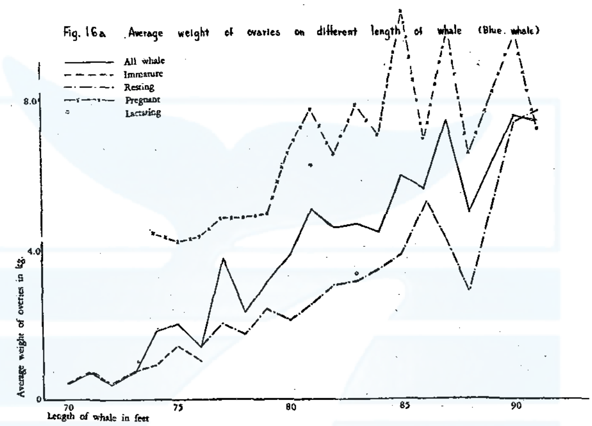


Fig. 16a. Average weight of ovaries on different length of whale. (Blue whale)

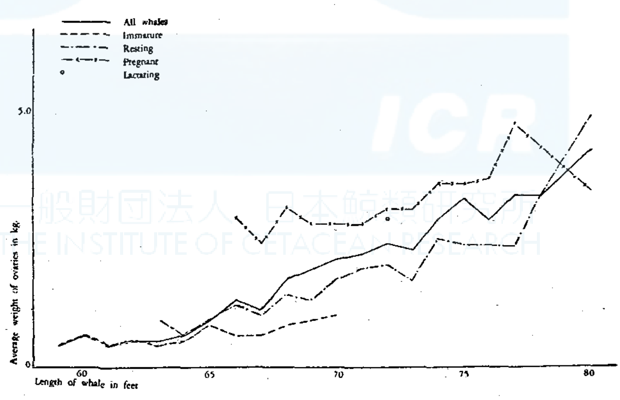


Fig. 16b. Average weight of ovaris on different length of whale. (Fin whale)

The real line means the average weight of all female whales and it is due to the existence of functional corpora lutea that there is the curve of pregnant whales in the far heavier part than this.

It is natural that ovaries of resting whales are heavier than those of immature and that the ovaries of the pregnant whales are the heaviest.

And it is also natural and interesting that each curve shows an increasing weight with age (body length).

Figs. 17a and 17b show the comparative curve of the average number of

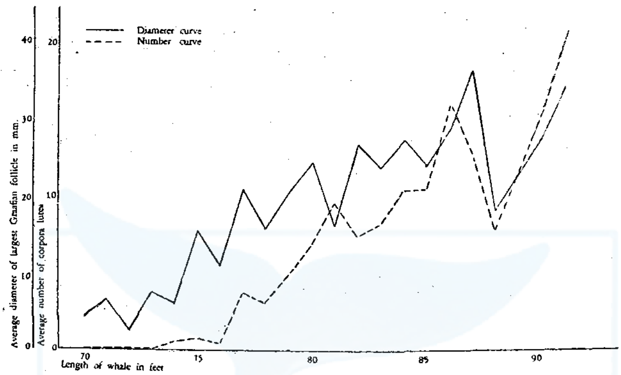


Fig. 17a. Average diameter of largest Graafian follicle and average number of corpora lutea. (Blue whale)

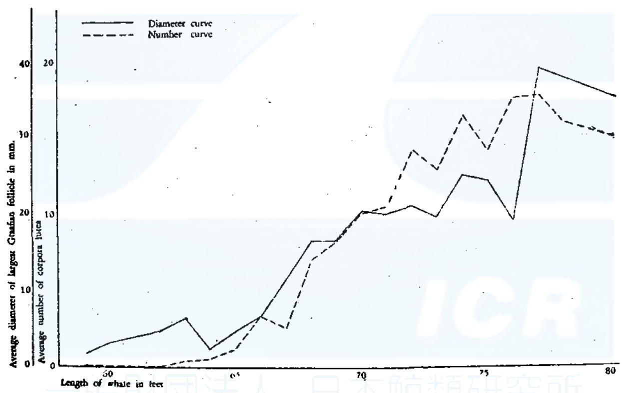


Fig. 17b. Average diameter of largest Graafian follicle and average number of corpora lutea. (Fin whale)

corpora lutea in each body length (same with Figs. 9a and 9b) and average diameter of the largest Graafian follicle.

They show that the less the number of corpora lutea is and the shorter the body length is, the smaller is the Graafian follicle, with quite the same trend in both average curves.

Some maintain the theory that the Graafian follicle in ovaries with the functional corpora lutea is small but we asserts the above theory, namely the largest

Graafian follicle becomes large in proportion to age (body length and the number

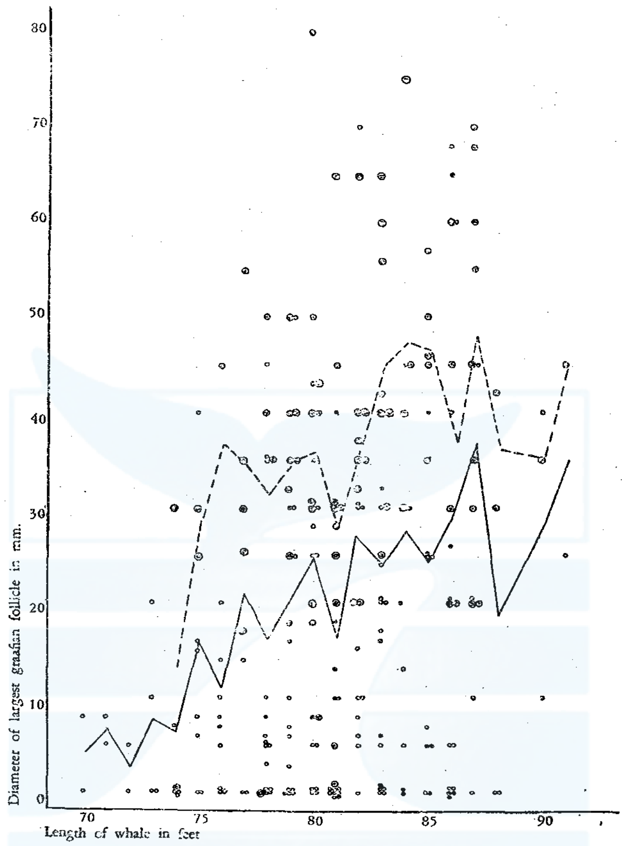


Fig. 18a. Diameter of largest Graafian follicle. (Blue whale)

of corpora lutea) Figs. 18a and 18b explain it.

○ means whales physically immature and not pregnant
◎ means whales physically immature and pregnant.
● means whales physically mature and not pregnant.
⦿ means whales physically mature and pregnant.

And the real line curve is the average diameter of Graafian follicle of all whales for each body length and the broken line curve is that of pregnant whales only. Both in blue and fin whales, their trends agree entirely and Graafian follicle of pregnant whales (with functional corpora lutea) is never smaller than that of other whales. Rather speaking, its average is larger than the average of all whales. But in some cases, whales with functional corpora lutea and yet non-

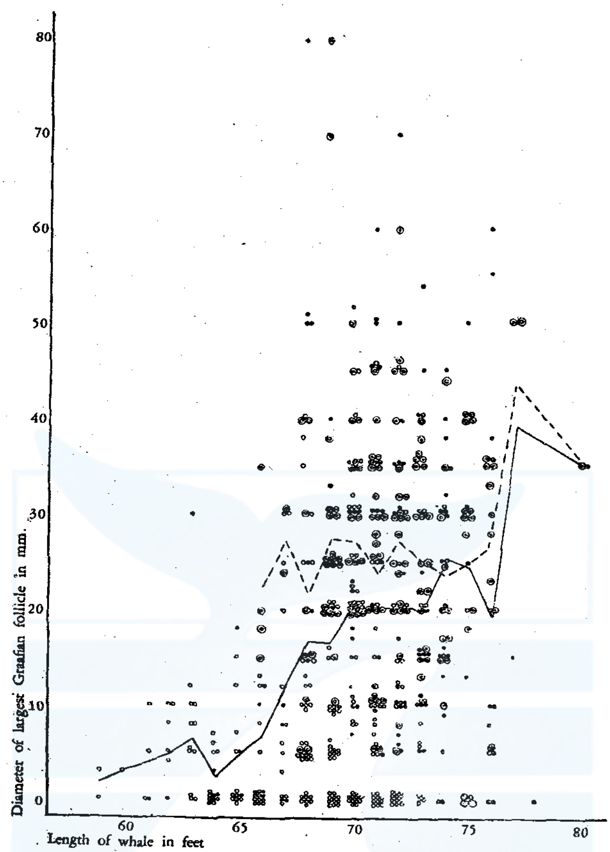


Fig. 18b. Diameter of largest Graafian follicle. (Fin whale)

developed Graafian follicle were found. And the same is true with whales in other (resting or lactating) stages. What we can infer from these facts is the usual fact that when one developed ovum has been discharged from ovary, the next ovum does not develop but after the development of the whole ovary, the ovum is probably discharged one by one.

MAMMARY GLANDS

This time too the investigation on the colour and thickness of mammary glands was carried out . The number of whales observed is 240 blue female and 524 fin female whales. The whales, on mammary glands of which the secretion of milk had been found in treating them, as well as with the jetting milk from their pappilae were counted as lactating one. In other cases than this, all were in not lactating stage and classified into resting, (This time all lactating whales were resting one.)

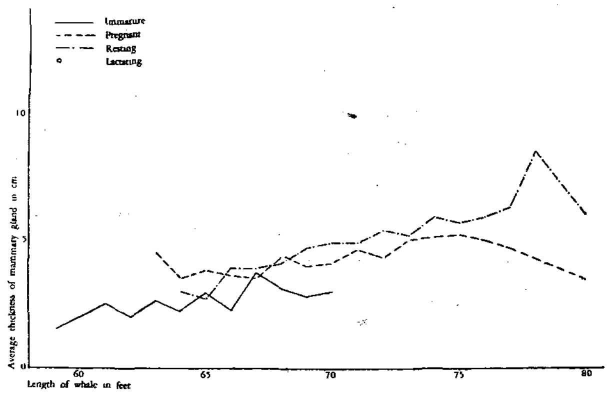


Fig. 19a. Average thickness of mammary gland in different length. (Fin whale)

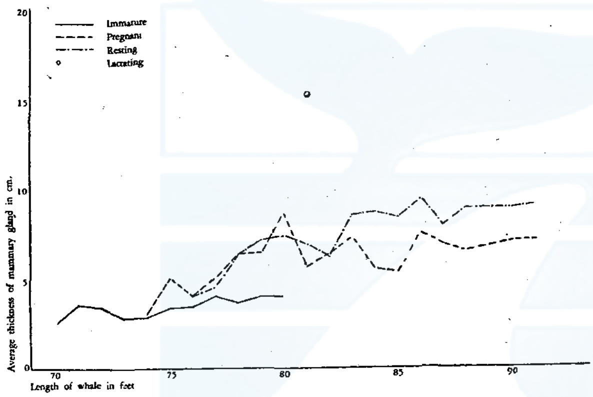


Fig. 19b. Average thickness of mammary gland in different length. (Blue whale)

pregnant and immature.

On each of them, the average thickness in each body length is shown in Fig. 9 a and Fig. 19 b. There, we can find that though the thickness inceases with age (body length) the lactating whales only have far thicker mammary glands, irrespective of this fact. It is same as last year that the younger whales are the lighter colour they show and the yellowish brown becomes deep with its age. The mammary glands of lactating whales is red brownish yellow, irrespective of their age. It is same as the thickness of mammary glands and thickness of blubber of lactating whale increase and decrease regardless of their age.

Next, classifimed into each condition, % of colour is as follows.

Table 3 Percentage of colours of mammary glands

a. Blue whale

1. Nisshin-maru

State of colour		un-known	Y	B	R	W	P	Dy	Ry				Total
Immature	No. of whales					6	15		22				43
	%					14	35		51				100
Resting		2	1	1	2	14	19	17	22				65
	%	3.1	1.5	1.5	3.1	1	29.2	26.2	33.9				100
Pregnant				1			10	13					24
	%			4			42	54					100
Total		2	1	2	2	7	44	30	44				132

2. Hashidate-maru

State of Colour		un-known	Y	B	R	W	P	Dy	Ry				Total
Immature	No. of colour		2	1		10	10	1					24
	%		8	4		42	42	4					100
Resting		1	13	3		4	4	13	9				47
	%	2	28	6		8	8	28	20				100
Pregnant			18			2	6	11	5				37
	%		35			5	16	30	14				100
(Lactating)									(2)				(2)
	%								100				100
Total			28			16	20	25	14				108

b. Fin Whale

1. Nisshin-maru

State of coloure		un-known	Y	B	R	W	P	Dy	Ry			Total
Immature	No. of Whales	1				6	20		1			28
	%	4				21	71		4			100
Resting					2	1	43	52	73			172
	%				1.1	0.6	25	30.8	42.5			100
Pregnant			1		2		34	24	42			103
	%				1.9		33	23.3	40.8			100
(Lactating)									(1)			(1)
	%								100			100
Total		1	1		4	7	97	77	116			302

2. Hashidate-maru

State of colour		un-known	Y	B	R	W	P	Dy	Ry	By			Total
Immature	No. of Whale		3			15	12	2	1				33
	%		9			46	36	6	3				100
Resting			47	1		4	14	45	11	2			124
	%		38	1		3	11	36	9	2			100
Pregnant			29	1			3	22	9	1			65
	%		45	1			5	34	14	1			100
Total		–	79	2		19	29	69	21	3			222

On both blue and fin whales, in these tables there are more numerous Y (yellow) whales for the Hashidate-maru and larger number of P (pink) and Ry (reddish yellow) whales and less number of Y whales for the Nisshin-maru. These are probably due to the difference of observer's estimate and to disloyality to notabilia in observation. Though the expression may be not good, the notabilia defines "Y" the most usually observed colour. Really the colour of the mammary glands is not yellow always but has a tinge of red and cream. Nevertheless, the fact that only one whale for each species has Y leads and interpretation that the observers confused it with P, Dy or Ry.

Therefore, neglecting the Nisshin-maru's data, the classification of body colours by body length, basing on the Hashidate-maru's data only, is shown in the following table.

Table 4

Colour of mammary glands in different length

a. Blue whale (Hashidate-maru)

colour / body length	unknown	W	P	Y	Dy	Ry	B	By	R	Total
70		1								1
71			2							2
72			1							1
73		3								3
74		1								1
75		2		1	2					5
76		3	2	1						6
77		1	1	3						5
78		3	4	4	1					12
79		1	5	3	1		1			11
80		1	3	2	3	1	1			11
81				3	2	3				8
82				1	7	2				10
83	1			3	2	3				9
84					2	1	1			4
85			1	2	3					6
86				2	1	2	1			6
87				3	1	2				6
88			1							1
89										
90										
Total	1	16	20	28	25	14	4	0	0	108

In observing the mammary gland, some whales were found secreting the brown sticky fluid. After coming back home, only those which were stated on the data,

b. Fin whale (Hashidate-maru)

colour / body length	un-known	W	P	Y	Dy	Ry	B	By	R	Total
56										
57										
58										
59		1								1
60		1								1
61		2	1							3
62		3	2							5
63		4	2							6
64		1	2	1	1					5
65		2	2		2					6
66		2	4	1	1					8
67		1	4	5	2					12
68			6	12	6	3				27
69		2	3	11	7	3	1			27
70			2	13	9	3		2		29
71				9	11	1				21
72				8	8	4	1	1		22
73				7	8	3				18
74				6	7	1				14
75				2	3					6
76				4	3	2				9
77					1	1				2
78										
79										
Total	0	19	29	79	69	21	2	3	0	222

were chosen and studied into the following table. As there were some whales which were not mentioned for the short of the previous notice even if they were discovered, the further investigation should be carried out in another chance.

What I can study on the table is:—

1. Generally speaking they were so-called "whales which had experiencecd paturition" with large number of corpora lutea.

2. Their mammary glands were thicker than the normal whales.

3. No blue whale with foetus was found. Many fin whales were pregnant, even if they were secreting fluid.

4. They were discovered whenever the period might be, not depending on the catching date, and time.

5. Many whales were physically mature and large in body length.

Table 5

species	No.	Date killed	body length	mammary grand		ovary						physical maturity
				thickness in cm	colour	no. of functional corpora lutea	no. of old corpora lutea	diameter of the largest Graafian follicle	weight	focus sex	focus body length	
Blue whale	H-1	0450. 15th Dec.	85	12	Y	0 0	9 16	5	2.1 2.4			AA
	H-2	0445. 15th Dec.	86	10	Y	0 0	15 9	68	1.6 1.6			AA
	H-27	1905. 19th Dec.	80	14	B	0 0	7 4	35	1.1 1.5			aa
	H-565	0605. 1st Mar.	80	14	RY	0 0	11 7	8	1.1 1.0			AA
	H-574	1150. 2nd Mar.	87	10	RY	0 0	17 10	200	2.4 2.4			AA
	H-712	1415. 20th Mar.	78	10	Y	0 0	1 1	10	1.0 1.2			NN
	N-46	1050. 20th Dec.	83	11	DY	0 0	30	20	1.9 1.5			NN
Fin whale	H-58	1355. 24th Dec.	74	9	Dr	1 0	12 4	30	3.0 2.0	F	7′4″	AA
	H-82	0100. 3rd Jan.	73	9	RY	1 0	8 7	36	2.9 1.7	M	2′10″	aA
	H-268	1900. 1st Feb.	72	7	DY	0 0	8 9	40	6.5 0.6			AA
	H-321	0805. 4th Feb.	76	7	Y	1 0	11 3	30	1.7 0.9	M	10′2″	AA
	H-370	1310. 11th Feb.	69	4	DY	1 0	10 9	25	1.3 0.7	F	10′1″	aA
	H-372	1710. 11th. Feb.	71	6	DY	0 0	5 4	8	0.6 0.4			aa
	H-384	1900. 12th. Feb.	74	10	DY	1 0	6 7	32	2.2 1.3			AA
	H-394	1045. 3rd Mar.	76	4	Y	1 0	4 2	35	1.3 0.7	F	10′1″	aa
	N-120	0625. 2nd Jan.	74	7	RY	1 0	7 4	15	2.1 1.7	F	43″	aA
	N-129	0735. 3rd Jan.	68	4	P	0 1	2 5	30	1.3 2.4	F	4′9″	NN

6. Some fin whales with the functional corpora lutea and no foetus were found. (They probably miscarried.)

In short, there is necessity for the observation on the largest corpora lutea and histological study on ovaries and mammary glands. The brown fluid secreting whales in the data are enumerated as follows.

FOETUS

On 83 foetuses of blue whales and 170 foetuses of fin whales, mean growth curve by month is shown in following figures and tables. There is nothing to be

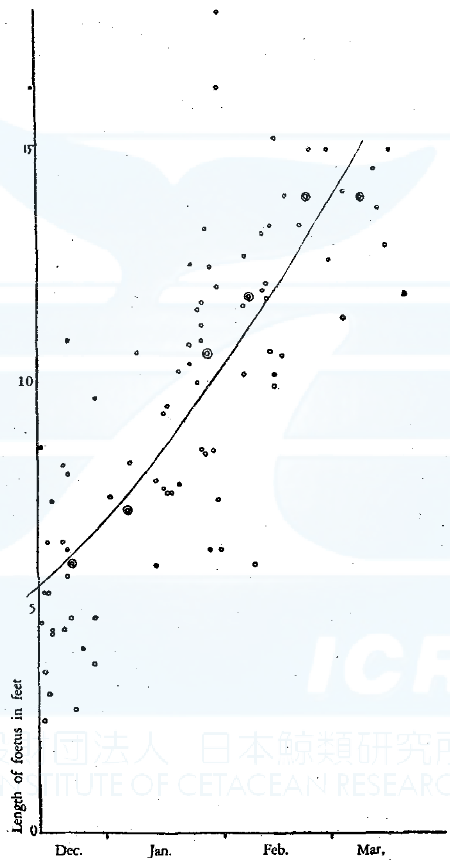


Fig. 20a. Mean growth curve of foetus. (Blue whale)

mentioned specially. As the whole, male occupied 60.2% in sex ratio for blue whales and 48.2% for fin whales. The smallest of them was a female 2 feet 6 inches long for the former and a male just 1 foot long for fin whale. The largest of them was female 21 feet 6 inches for blue whale and a female 13 feet 4 inches ong for fin whale.

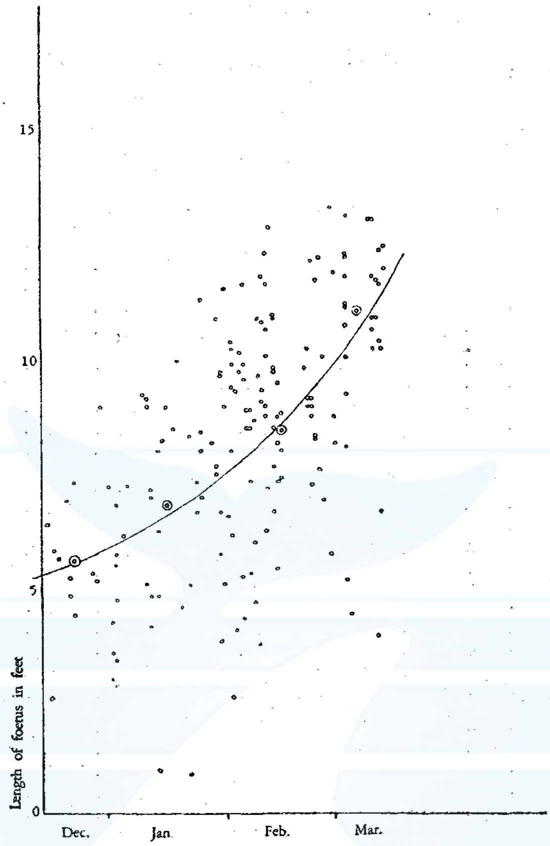


Fig. 20b. Mean growth curve of foetus. (Fin whale)

A fin whale, 71 feet in length which was caught by the "Hashidate-maru" fleet on March 14, was with a twin, male 12′6″ (380.0 kg) and femalle 12′0″ (375.0 kg) A fin whales, 75 feet long, which was caught by the Nisshin-maru fleet on March 11, was with a twin, female 11′10″ (302,0 kg) and female 10′11″ (244.0 kg). The former had two functional corpora luteas and the latter, one The development of these foetuses was normal and there is nothing to be stated specially.

A blue whale, 80 feet long, caught by the Hashidate-maru fleet on January 14. had a malformed foetus 5′11″ (85.0 kg). It was very fat in dumpy shape for its body length and the part below its waistwas bent sharp towards the ventral side. (The body length was measured in stretching its waist.) Its upper lip was a harelip and the forelegs were abnormal as shown in the figure. And the development of

Table 6

Whale foetuses measured and weighted in the Antarctic in the season 1948/49 on the Japanese fleets

Blue whale foetuses

Date when measured	Mother Length	Foetus Length	Foetus Sex	Weight in Kg.	Date when measured	Mother Length	Foetus Length	Foetus Sex	Weignt in Kg.
15th Cec.	83′	8′ 6″	M		26th Jan.	80′	11′ 2″	M	
16th 〃	87′	4′ 8″	F		27th 〃	83′	8′ 5″	F	
〃 〃	82′	5′ 4″	M		〃 〃	75′	8′ 4″	F	
〃 〃	83′	2′ 6″	F	5.0	28th 〃	85′	13′ 3″	F	
17th 〃	79′	5′ 4″	F	34.5	〃 〃	90′	11′ 8″	M	
〃 〃	83′	3′ 7″	M	14.0	29th 〃	81′	6′ 3″	M	
〃 〃	86′	6′ 5″	M		〃 〃	83′	12′ 5 ′	F	
〃 〃	82′	3′ 1″	F		〃 〃	78′	8′ 5″	M	
18th 〃	87′	4′ 6″	F		30th 〃	83′	16′ 4″	F	
19th 〃	83′	7′ 4″	M		〃 〃	86′	18′ 0″	M	
21st 〃	81′	6′ 5″	M		〃 〃	75′	7′ 4″	M	
〃 〃	79′	4′ 6″	F		6th 〃	81′	11′ 7″	M	
〃 〃	81′	8′ 1″	F		〃 〃	79′	12′ 8″	M	
22nd 〃	77′	7′ 11″	M		〃 〃	80′	10′ 1″	M	
23rd 〃	82′	10′ 10″	M	279.7	9th 〃	80′	5′ 11″	F	
〃 〃	88′	5′ 8″	F	49.0	11th 〃	81′	13′ 2″	M	
〃 〃	77′	6′ 3″	M		〃 〃	11′	11′ 11′	M	
24th 〃	78′	4′ 9″	M	35.0	12th 〃	87′	11′ 9″	M	
〃 〃	85′	2′ 9″	F		〃 〃	82′	12′ 1″	M	
27th 〃	79′	4′ 1″	F	19.5	13th 〃	84′	10′ 7″	M	
29th 〃	86′	3′ 9″	F	13.3	14th 〃	81′	13′ 4″	M	
〃 〃	87′	4′ 9″	M		〃 〃	82′	9′ 10″	M	
30th 〃	81′	9′ 7″	M		〃 〃	88′	15′ 3″	F	
2nd Jan.	85′	7′ 5″	M		15th 〃	79′	10′ 1″	F	245.0
7th 〃	79′	8′ 2″	F		16th 〃	74′	10′ 6″	M	
9th 〃	84′	10′ 7″	M		17th 〃	84′	14′ 0″	M	
14th 〃	80′	5′ 11″	M	85.0	22nd 〃	87′	13′ 4″	M	
〃 〃	81′	7′ 9″	F		23rd 〃	80′	15′ 0″	M	
16th 〃	85′	9′ 3″	F		28th 〃	82′	15′ 0″	F	
17th 〃	85′	7′ 6″	M		〃 〃	77′	12′ 7″	F	508.0
〃 〃	80′	7′ 7″	M	113.7	3rd Mar.	87′	18′ 10″	F	
〃 〃	91′	9′ 5″	M		4th 〃	82′	14′ 1″	F	630.0
18th 〃	77′	7′ 6″	M	140.4	〃 〃	77′	11′ 4″	F	346.0
20th 〃	80′	10′ 2″	F	242.0	12th 〃	87′	14′ 7″	F	
〃 〃	81′	7′ 8″	M		13th 〃	77′	13′ 9″	M	
23rd 〃	83′	12′ 6″	M	415.0	15th 〃	79′	12′ 11″	M	515.0
〃 〃	80′	10′ 9″	F		17th 〃	81′	15′ 0″	M	
〃 〃	82′	10′ 4″	M		〃 〃	78′	4′ 2″	F	20.0
25th 〃	87′	9′ 11″	F	242.0	20th 〃	78′	11′ 10″	M	427.0
〃 〃	82′	11′ 6″	F	365.0	〃 〃	80′	21′ 6″	F	2645.1
26th 〃	85′	9′ 3″	F						

tail fin and penis was quite good.

It weighed heavier for its body length. The lengths of each part of its body will be mentioned later. (No. H—160)

There was another malformed foetus, male, 18′00″ long,

Table 7

Whale foetuses measured and weighted in the Antarctic in the season 1948/49 on the Japanese fleets

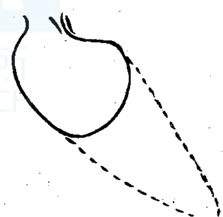
Fin whale foetuses

Date when measured	Mother Length	Foetus Length	Foetus Sex	Weight in Kg.	Date when measured	Mother Length	Foetus Length	Foetus Sex	Weight in Kg.
16th Dec.	70′	6′ 5″	F		30th 〃	69′	7′ 8″	M	
17th 〃	68′	2′ 7″	F	5.4	30th 〃	73′	7′ 6″	F	
18th 〃	74′	5′ 10″	M		30th 〃	77′	10′ 11″	M	
20th 〃	72′	5′ 8″	F		30th 〃	67′	9′ 8″	M	
23rd 〃	72′	6′ 11″	F	71.8	30th 〃	71′	9′ 9″	F	204.0
23rd 〃	72′	4′ 10″	M	33.0	30th 〃	71′	3′ 10″	F	
23rd 〃	70′	5′ 3″	F		31st 〃	69′	6′ 8″	F	66.5
24th 〃	72′	5′ 7″	F		31st 〃	75′	5′ 9″	M	42.7
24th 〃	72′	4′ 5″	M		31st 〃	70′	11′ 7″	F	
28th 〃	71′	5′ 4″	F		31st 〃	72′	5′ 1″	M	
29th 〃	75′	5′ 2″	M		31st 〃	68′	9′ 0″	M	
31th 〃	72′	9′ 0″	M		1st Feb.	70′	6′ 7″	M	70.1
1st Jan.	75′	7′ 3″	M		2nd 〃	73′	10′ 5″	M	
2nd 〃	74′	4′ 3″	F		2nd 〃	74′	10′ 3″	M	
2nd 〃	71′	3′ 0″	F		2nd 〃	72′	6′ 2″	F	57.4
2nd 〃	72′	3′ 7″	F		2nd 〃	70′	9′ 11″	F	
3rd 〃	76′	5′ 9″	F	42.6	2nd 〃	75′	9′ 5″	M	
3rd 〃	66′	3′ 5″	F		3rd 〃	71′	2′ 7″	F	5.4
3rd 〃	73′	2′ 10″	M	7.1	3rd 〃	71′	8′ 0″	F	115.0
3rd 〃	70′	6′ 10″	F	69.5	3rd 〃	70′	9′ 4″	M	158.4
3rd 〃	68′	4′ 9″	F		3rd 〃	68′	4′ 1″	M	
3rd 〃	68′	5′ 6″	M		4th 〃	69′	9′ 9″	M	217.0
5th 〃	71′	6′ 2″	M	69.0	4th 〃	76′	10′ 2″	M	242.0
6th 〃	74′	7′ 3″	M	90.0	5th 〃	74′	11′ 8″	M	
10th 〃	74′	9′ 3″	F		5th 〃	69′	9′ 11″	M	231.0
11th 〃	68′	5′ 1″	M		5th 〃	70′	4′ 4″	F	
12th 〃	73′	9′ 2″	M		5th 〃	72′	9′ 7″	M	
12th 〃	76′	9′ 0″	M		6th 〃	73′	5′ 3″	M	
12th 〃	73′	4′ 10″	M		7th Feb.	75′	8′ 1″	F	
12th 〃	74′	4′ 2″	M		〃 〃	76′	8′ 6″	F	
12th 〃	69′	7′ 2″	F		〃 〃	70′	5′ 4″	M	
12th 〃	72′	7′ 0″	M		〃 〃	69′	7′ 4″	M	
14th 〃	71′	8′ 0″	M		〃 〃	69′	8′ 11″	M	
14th 〃	68′	6′ 3″	M		〃 〃	71′	8′ 6″	M	
14th 〃	76′	4′ 10″	F		8th 〃	66′	6′ 0″	M	68.0
15th 〃	69′	1′ 0″	M		9th 〃	70′	4′ 8″	F	25.0
15th 〃	71′	8′ 3″	F		〃 〃	73′	8′ 8″	F	165.0
16th 〃	76′	9′ 0″	F	183.3	〃 〃	70′	10′ 11″	M	
18th 〃	73′	8′ 6″	M	117.5	〃 〃	71′	9′ 8″	F	202.0
19th Jan.	72′	10′ 0″	F		10th 〃	71′	3′ 9″	F	19.0
21st 〃	71′	4′ 7″	F		〃 〃	70′	9, 4″	M	177.0
22nd 〃	73′	8′ 4″	M		〃 〃	72′	9′ 1″	F	
22nd 〃	75′	1′ 11″	M		〃 〃	71′	10′ 10″	M	
22nd 〃	69′	5′ 1″	M		〃 〃	76′	11′ 10″	F	
24th 〃	73′	6′ 8″	M		11th 〃	74′	10′ 8″	F	
24th 〃	71′	7′ 4″	M	96.0	〃 〃	75′	12′ 4″	M	
25th 〃	68′	8′ 0″	F		〃 〃	70,	9′ 0″	F	
25th 〃	73′	7′ 0″	F		〃 〃	76′	6′ 3″	F	
26th 〃	71′	8′ 5″	M		〃 〃	69′	10′ 1″	F	
28th 〃	71′	8′ 5″	M		〃 〃	73′	7′ 2″	F	

Fin whale foetuses (continued)

Date when measured		Mother Length	Foetus Length	Foetus Sex	Weight in Kg.	Date when measured		Mother Length	Foetus Length	Foetus Sex	Weight in Kg.
″	″	69′	8′ 9″	M	160.0	″	″	73′	6′ 11″	M	
″	″	74′	11′ 8″	F		28th	″	69′	13′ 4″	F	
12th	″	71′	12′ 11″	F		″	″	73′	5′ 9″	F	
13th	″	69′	8′ 6″	F		1st	Mar.	72′	8′ 9″	F	
″	″	77′	11′ 0″	M		″	″	72′	11′ 11″	F	
″	″	70′	6′ 8″	F		″	″	72′	8′ 2″	F	
″	″	68′	10′ 11″	F		4th	″	74′	13′ 2″	F	
″	″	72′	7′ 8″	F		″	″	77′	8′ 1″	M	
″	″	73′	9′ 9″	M		″	″	76′	10′ 1″	F	271.0
14th	″	69′	9′ 10″	F		″	″	71′	5′ 2″	M	35.0
″	″	75′	8′ 9″	M		″	″	73′	10′ 9″	F	
″	″	70′	7′ 4″	F	105.0	″	″	72′	12′ 4″	F	419.0
″	″	71′	9′ 6″	M		″	″	71′	11′ 2″	F	
15th	″	67′	5′ 5″	F		″	″	72′	12′ 3″	F	
″	″	73′	8′ 10″	M	165.0	5th	″	73′	11′ 3″	F	
″	″	71′	7′ 5″	F	110.5	″	″	73′	9′ 3″	M	
″	″	69′	8′ 0″	M	128.0	″	″	74′	11′ 10″	M	
″	″	75′	18′ 0″	M		″	″	76′	4′ 5″	F	
″	″	72′	8′ 2″	F	135.0	11th	″	69′	10′ 8″	M	
21st	″	71′	9′ 10″	M	198.0	″	″	75′	10′ 11″	F	
22nd	″	69′	10′ 3″	F					11′ 10″	F	
″	″	70′	9′ 2″	F		″	″	80′	13′ 1″	F	
23rd	″	71′	9′ 0″	F		″	″	71′	10′ 3″	M	
23rd	Feb.	75′	12′ 2″	M		12th	″	68′	13′ 1″	M	
″	″	71′	8′ 9″	M		″	″	70′	10′ 11″	F	
″	″	66′	7′ 3″	F		″	″	70′	3′ 11″	F	
″	″	72′	9′ 0″	M	202.0	13th	″	69′	11′ 9″	M	
24th	″	70′	9′ 2″	F		″	″	68′	12′ 5″	F	
″	″	71′	8′ 4″	M		″	″	66′	10′ 5″	F	
″	″	71′	11′ 9″	M		″	″	75′	10′ 3″	F	
25th	″	73′	8′ 3″	M		″	″	69′	6′ 8″	M	
″	″	73′	12′ 3′	F		″	″	70′	11′ 8″	M	
″	″	69′	7′ 7″	F		15th	″	71′	12′ 6″	M	
26th	″	75,	10′ 1″	M					12′ 0″	F	

in a fin whale 75 feet in lengh caught by the Hashidate-maru fleet on Feb. 14.



With the amnion adhered closely to its body and indistinguishable eyes, sexuaorgans and anus, the flippers and tail flukes were scarcely developed and only its mouth could be distinguished. And its whole body had changed to the callcareous matter like the cyst of nematoda. As this foetus was at a glance, very weird, to our pity, the deck workers threw it into the sea while our of us was just in a room for another business.

Though we think the functional corpora lutea was dead and developed no longer as mentioned above, (probably it is the preceeding year's foetus), it was 150×120×65mm without a vacuoles inside it, and to the naked eye, there was no difference between it and other corpora luteas with a normal foetus.

The Nisshin-maru caught a fiin whale 72 feet long, bearing a male foetus 5′ 11″ long, with the malformed head and tail.

Last, date when all foetuses were caught, the body length of mother whales, the body length, sex and weight of foetus were ennumerated.

The study in relation to mature whales will be stated elsewhere.

Table 8

	H—160 M. 5′—10″ Malformed foetus weight 85.0 kg.	H—678 Twin M. 12′—6″ weight 380.0 kg.	 F. 12′—0″ 375.0 kg.
	m.	m.	m.
1	1.76	3.80	3.67
2			
3	.30	.55	.57
4	.44		
5	.30	.68	.70
6	.87	1.64	1.62
7	.15.5	.22	.22
8	.50	1.03	1.15
9	.16.5	.25	.25
10	.17	1.22	1.15
11	.77	1.85	1.80
12	.71	1.75	1.70
13	.12	.37	.09
14	.04	.12	.13
15	.08.5	.24	.19
16	.20.5	.41	.40
17	.25.5	.55	.53
18	.27	.57	.54
19	.11.5	.14	.12
20	.40	.80	.89
21			
22			
23			
24	.29	.35	.35
25	.41 and 40	.45 and 45	.52 and 50
26			

EXTERNAL CHARACTERISTICS

I. Body colour.

As in other years, pale spot distribution and degree of its distinctness, white flecks distribution and degree of distinctness of striation on the ventral surface of tail flukes were examined on blue whales. On fin whales, (1) the colour of dorsal surface, (2) its degree of spreading to the ventral groove, (3) whether the body colour spread to the anus, like the tongue, behind it or not, and (4) just at the front of the tail fluke, whether right and left body colour band joined or not, were observed.

The above percentage by sex is shown as follows:

Table 9

	Male Total	Male %	Female Tolal	Female %
a. BLUE WHALE				
Pale spot: distribution				
0	2	0.5	0	0
1	9	2.3	6	2.5
2	76	19.4	48	20.0
3	161	41.2	107	44.2
4	131	33.9	76	31.6
5	12	3.1	4	1.7
Pale spot: degree of distinctness				
0	2	0.6	0	0
I	58	14.8	31	12.9
II	284	72.6	173	72.1
III	47	12.0	36	15.0
White flecks				
0	1	0.3	2	0.8
1	42	10.7	15	6.3
2	98	25.1	67	27.9
3	167	42.7	95	39.6
4	82	20.9	61	25.4
anomaly	1	0.3	—	—
Striation				
0	14	3.6	6	2.5
I	147	37.6	66	27.5
II	171	43.7	121	50.4
III	59	15.1	47	19.6
b. FIN WHALE				
(1) Colour				
N	374	76.6	419	20.0
B	114	23.4	105	80.0
(2) Extention of pigmentation on ventral grooves				
U	127	26.0	159	30.4
N	201	41.2	223	42.6
L	160	32.8	141	27.0
(3) Tongue of pigmentation behind anus				
+	400	82.0	405	77.4
−	88	18.0	118	22.6
(4) Meeting of pigmentation infront of tailflukes				
+	320	65.6	308	58.9
−	168	34.3	216	41.4

On abnormal colour

(1) The special white flecks on blue whales is that of the blue whale No. 148, 78 feet long, caught by the Hashidate-maru on Jan. 13. With no pale spot and no normal white flecks, its neighbourhood was pure white (Cf. Fig. 26).

(2) The abnormal fin whale on item No. 3 was caught by the Nisshin-maru. It was female, No. 796 with two processes towards anus. The rostral process was large and long and the right and left processes met on the median line, where

the lengthwise slender black part could be found at the nearer part to the caudal than the anus.

II. External propotions (length)

In both fleets, 1 male and 1 female blue whales, 7 male and 9 female fin whales were measured on length of each part of body. And foetus were measured as many as possible (scores of foetuses).

We would like to study on this question only, separately from this report. It is conceptionally as an established theory that the anterior of the body occupies larger perecentage and the posterior part smaller percentage with an increase of body length (age). But here is only shown the data.

Table 10

MEASUREMENT OF EXTERNAL PROPORTIONS

Whale serial number	Measurement of external proportions in meter 1	3	5	6	7	8	9	10	11	12	13
Fin whale male											
H—39	18.06	omitted	3.85	7.50	0.90	4.10	omitted	5.00	8.05	7.07	1.44
H—25	19.20	3.50	3.70	7.75	0.80	4.50	0.93	5.55	8.75	8.65	1.39
H-158	19.50	3.30	3.78	7.90	0.85	4.60	0.90	5.35	9.25	8.60	1.55
N-927	19.68	3.66	4.04	8.31	0.97	4.22	omicted	5.41	8.76	7.80	1.24
H-219	20.42	3.80	4.05	8.40	0.85	4.86	1.00	5.95	9.25	8.90	1.40
H-127	20.53	4.05	4.25	8.65	0.85	4.70	0.98	5.70	8.75	8.70	1.45
Fin whale female											
N—85	18.54		3.68	7.52	0.94	4.39	omitted	5.26	8.13	0.58	1.02
H—15	20.62	3.95	4.25	8.60	0.74	4.52	1.03	5.55	8.96	9.00	0.65
N-795	21.41	4.34	4.47	8.94	0.99	4.65	omitted	5.74	9.14	omitted	0.66
H 264	21.45	3.80	4.48	8.60	0.92	5.25	0.99	5.90	10.00	9.25	0.60
H-540	21.50	3.95	4.40	8.90	0.95	5.10	omitted	6.1.	9.70	9.40	0.70
N—86	21.51	4.27	4.72	9.24	1.07	5.84	omitted	6.02	9.96	9.01	0.63
H—68	22.25	4.45	4.80	9.45	0.95	5.15	1.12	6.15	9.85	9.65	0.65
H—21	22.30	4.20	4.80	9.20	0.98	5.28	1.08	6.10	9.85	9.40	0.63
H-105	22.65	4.90	5.10	9.90	0.98	5.15	1.10	5.90	9.25	9.60	0.60
N-783	23.04	4.70	4.95	9.91	1.09	5.18	omitted	6.40	10.16	omitted	0.71
Blue whale male											
N—79	24.71	4.72	5.33	omitted	1.30	5.38	omitted	6.73	10.46	9.78	1.50
Blue whale female											
N-831	24.87	4.67	5.13	10.01	1.27	5.61	omitted	6.98	10.90	omitted	0.61

Whale serial u mber	Measurement of external proportions in meter 14	15	16	17	18	19	20	21	23	24	25
Fin whale male											
H—39	0.35	0.58	1.60	2.10	2.20	0.50	omitted	omitted	omitted	1.75	omitted
H—25	0.45	0.85	1.80	2.25	2.40	0.53	omitted	2.10	2.42	omitted	omitted
H-158	0.43	1.16	1.75	2.52	2.55	0.48	4.80	omitted	omitted	1.58	2.14
N-927	0.38	1.32	1.96	omitted	2.46	0.56	2.21	2.21	omitted	omitted	omitted
H-219	0.50	1.10	1.82	2.51	2.64	0.54	omitted	2.34	2.63	1.80	2.00
H-127	0.40	1.55	1.75	2.55	2.60	0.58	omitted	2.05	2.63	1.75	omitted

Fin whale female											
N—85	0.46	1.02	2.26	omitted	2.31	0.51	omitted	1.83	omitted	omitted	2.16
H—15	0.44	1.20	2.13	2.75	2.85	0.59	5.25	2.35	2.55	1.95	omitted
N-795	0.48	0.79	2.46	omitted	2.06	0.63	omitted	2.84	omitted	omitted	omitted
H-264	0.75	0.92	1.90	2.70	2.80	0.54	5.55	omitted	omitted	omitted	2.06
H-540	0.40	1.35	1.90	2.40	2.55	0.58	5.20	2.08	2.69	1.90	omitted
N—86	0.41	1.24	2.36	omitted	2.51	0.53	omitted	2.54	omitted	omitted	omitted
H—68	0.40	1.15	2.20	2.75	2.85	0.65	5.60	2.70	2.90	1.75	omitted
H—21	0.45	1.15	2.20	2.52	2.60	0.59	omitted	2.20	2.70	2.06	2.35
H-105	0.55	0.85	2.86	2.78	2.96	0.68	omitted	2.54	1.96	2.13	omitted
N-783	0.48	1.19	2.89	omitted	2.34	1.07	omitted	2.21	omitted	omitted	omitted
Blue whale male											
N—79	0.23	1.12	3.35	omitted	3.55	0.76	omitted	2.84	omitted	0.71	omitted
Blue whale female											
N-831	0.20	0.63	2.97	omitted	3.07	0.89	omitted	2.87	omitted	omitted	omitted

III. External proportion (weight)

The gross weight of foetus (for each whale) has been stated in the paragraph

Table 11

WEIGHT OF DIFFERENT PARTS

Whale serial number	Body length in feet and fathesbys naked by	Weight of different parts						Actual weight of parts
		Blubber	Ventral grooves	Meat	Bones	Internal organs	Others	
Fin whale male								
H—25	62-lean	5.843	3.830	19.600	7.002	3.532	0.579	40.386
N-927	65-normal	8.895	1.505	17.355	8.027	3.817	8.756	48.355
H-127	67-lean	6.510	3.950	21.559	8.401	4.540	0.649	45.609
H-219	67-normal	7.400	4.975	22.840	7.686	5.899	0.564	49.361
Fin whale female								
N—85	61-normal	6.790	2.200	16.529	5.910	2.285	3.657	37.371
H—15	68-normal	8.713	4.624	22.064	8.012	5.120	0.853	49.386
N-795	70-normal	9.754	3.698	23.266	9.800	5.169	8.644	60.331
H-540	71-lean	7.898	5.215	25.180	8.669	5.350	0.776	53.088
N—86	71-normal	8.173	4.484	20.792	9.514	4.036	6.460	53.459
H—21	73-lean	9.152	6.710	24.237	10.012	6.173	0.850	57.134
H—68	73-normal	7.790	5.545	28.305	10.675	5.364	0.850	58.529
H-105	74 normal	11.639	6.610	25.814	8.911	5.320	0.928	59.222
N-783	79-normal	10.292	4.069	21.446	9.132	4.268	8.281	57.488
Blue whale male								
N—79	81-lean	15.197	4.188	21.414	16.691	6.321	10.309	76.912
Blue whale female								
N-831	82-normal	20.276	6.210	29.240	16.188	9.404	15.433	99.666

of foetus. On the weight of mature, 1 male and 1 female blue whales and 4 male and 8 female fin whales were weighed.

As this intends to be published in the separate paper like the length of body proportions, here is only shown the following principal data.

PARASITES

I. External parasites.

Table 12

PARASITES

External parasites

	Male		Female	
	No. of infected whales	% for total	No. of infected whales	% for total
BLUE WHALE				
Cyamus	14	3.5	4	1.7
Coronula sp.	1	0.2	2	0.8
Conchoderma sp.	0	0	0	0
Pennella sp.	1	0.2	1	0.4
Diatom film	51	13.0	26	10.8
FIN WHALE				
Cyamus	37	7.6	9	1.7
Coronula sp.	10	0.2	4	0.8
Conchoderma sp.	1	0.0	0	0
Pennella sp.	1	0.0	2	0.4
Diatom film	147	30.1	134	25.5

As each whale was investigated on the infection rate of whale lice, diatom film, Coronula, Conchoderma and Pennella, it was shown above.

II. White scars.

On each individual, the number of white scars and ratio between new and old scar were observed. It is thought that the number increases with the age of whales so the increased number by body length is shown. P is it. And it is thought that the older it is, the more increases the percentage of C, namely, those with more white scars for years prior to last year than for this year. So the percentage of C is put in the following table with the number of A,B and C.

Table 13

	MALE						FEMALE					
	a	b	c	Total	P	% of c	a	b	c	Total	P	% of c
Blue whale												
70	2	0	1	3	1.3	33	0	0	2	2	2.5	—
71	0	3	1	4	2.0	—	0	1	1	2	2.5	—
72	1	5	3	9	2.0	33	0	1	1	2	2.0	—
73	2	4	8	14	2.1	57	0	1	3	4	2.0	—
74	3	4	15	22	2.3	68	3	1	2	6	1.5	33
75	2	3	16	21	2.9	76	1	4	4	9	2.2	44
76	1	3	29	33	2.7	88	2	4	4	10	2.3	40
77	2	7	42	51	2.9	82	1	3	5	9	2.0	56
78	4	8	42	54	3.1	78	3	5	10	18	2.6	56
79	5	6	50	61	3.2	82	1	5	16	22	2.5	73

80	3	1	30	34	3.1	88	2	4	16	22	3.0	73
81	31	1	23	27	4.1	85	3	3	17	23	3.1	74
82	5	4	22	31	3.3	71	1	3	15	19	2.9	79
83	0	0	11	11	3.4	100	0	2	21	23	3.2	91
84	2	1	8	11	3.2	77	0	1	10	11	3.4	91
85	0	0	2	2	3.5	100	2	0	13	15	3.0	87
86	0	1	0	1	4.0	—	0	3	16	19	3.5	84
87	0	0	1	1	4.0	—	1	1	11	13	3.1	85
88								0	3	4	3.0	—
89												
90							0	0	3	3	3.7	—
91							0	0	2	2	4.0	—
Fin whale												
58	0	2	0	2	1.0	—						
59	1	2	2	5	1.8	40	0	0	2	2	2.0	—
60	2	1	1	4	2.0	—	0	1	0	1	2.0	—
61	2	5	5	12	1.8	42	0	3	1	4	1.5	—
62	2	3	15	20	2.3	75	1	5	2	8	1.3	25
63	1	8	15	24	2.3	63	3	7	3	13	2.0	23
64	3	17	28	48	2.5	58	1	7	4	12	1.6	33
65	8	14	47	69	2.6	68	3	5	6	14	1.9	43
66	4	19	62	85	2.7	73	2	8	13	23	2.4	57
67	5	11	42	58	2.9	72	4	9	9	22	2.1	41
68	2	9	43	54	2.9	80	1	20	25	46	2.2	54
69	1	11	47	59	2.8	80	4	9	37	50	2.4	74
70	1	3	27	31	3.5	87	2	14	50	66	2.8	76
71	0	0	10	11	3.2	91	2	7	58	67	2.8	87
72	0	0	6	6	3.3	100	3	7	54	64	3.1	84
73							4	5	40	49	3.1	82
74							2	1	29	32	3.4	91
75							0	3	17	20	3.2	85
76							2	0	19	21	3.3	91
77							0	1	4	5	3.0	80
78							1	0	0	1	5.0	—
79							0	0	2	2	3.5	—

THICKNESS OF BLUBBER

This year, thickness of blubber was measured at two points. Namely, the point No. 1 was on a vertical line from the dorsal fin where it intersected the horizontal cut side of the body and the point No. 2 was on the vertical cut near the earhole, where it intersected the middorsal line.

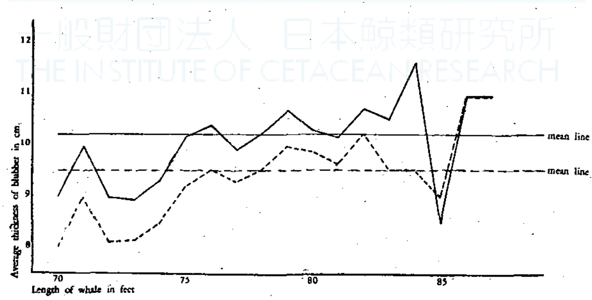


Fig. 21a. Variations of thickness of blubber in different length of whales. (Male Blue whale)

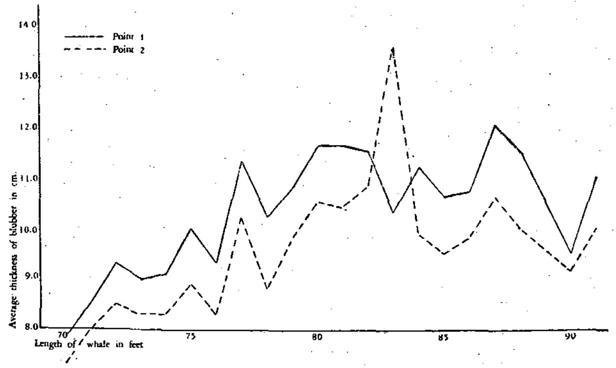


Fig. 21b. Variations of thickness of blubber in length of whales.
(Female Blue whale)

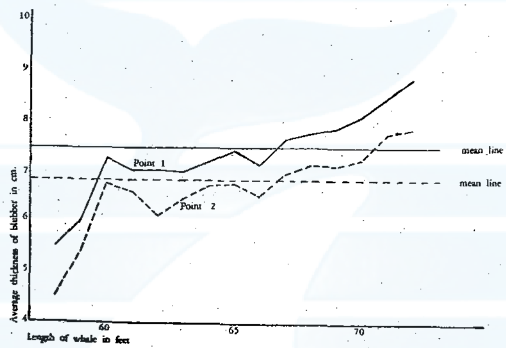


Fig. 21c. Variations of thickness of blubber in length of whales.
(Male Fin whale)

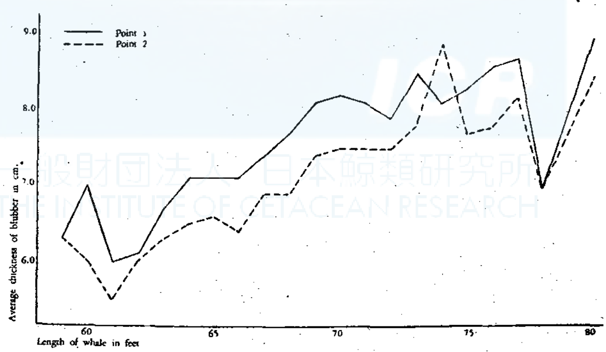


Fig. 21d. Variations of thickness of blubber in length of whales.
(Female Fin whale)

Fig. 21a to Fig. 21d show the mean thickness of blubber by body length and sex. With an increase of body length the blubber becomes thicker.

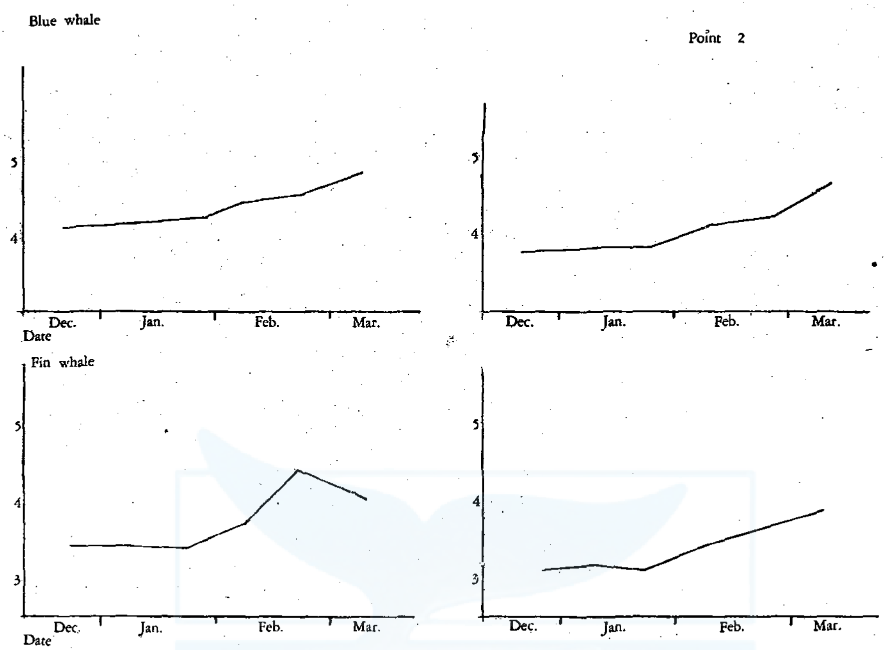


Fig. 22a. Thickness of Blubber. (Male whale)

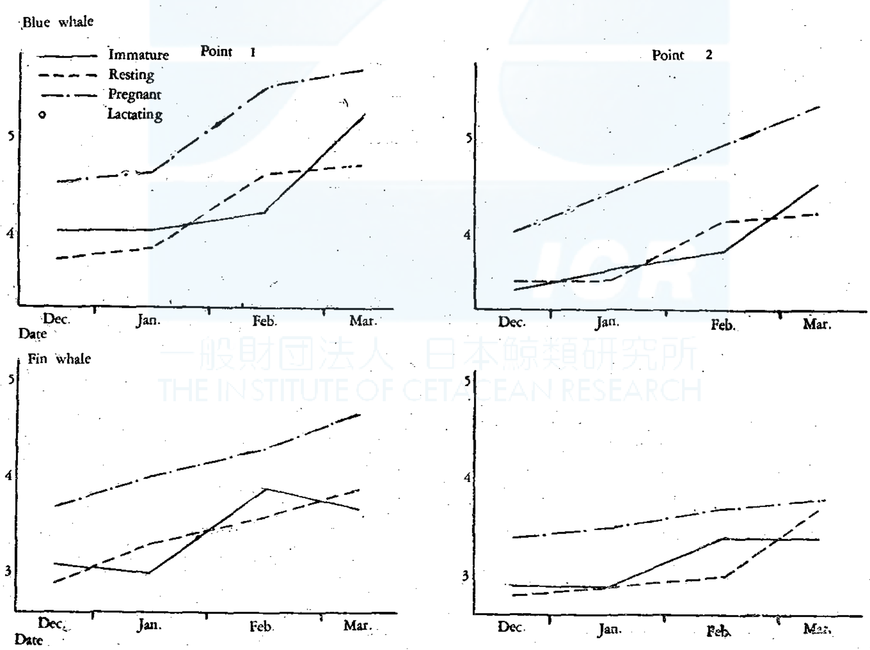


Fig. 22b. Thicknsss of Blubber. (Female whale)

Table 14

week	Blue whale male: No. of whales	Blue whale male: Point 1.	Blue whale male: Point 2.	Blue whale female: No. of whales	Blue whale female: Point 1.	Blue whale female: Point 2.	Fin whale male: No. of whales	Fin whale male: Point 1.	Fin whale male: Point 2.	Fin whale female: No. of whales	Fin whale female: Point 1.	Fin whale female: Point 2.
		cm.	cm.		cm.	cm.		cm.	cm.		cm.	cm.
1st	33	10.5	9.6	36	10.3	9.2	17	7.0	6.5	12	7.4	6.8
2nd	16	9.2	8.8	14	10.1	9.0	11	6.6	5.5	10	7.4	6.8
3rd	22	9.0	8.0	8	10.2	8.1	21	6.6	6.0	32	6.9	6.3
4th	22	9.4	8.8	20	9.2	9.1	26	6.4	6.2	13	7.0	6.5
5th	69	9.6	8.8	28	10.3	9.5	30	6.8	6.2	28	7.6	7.0
6th	27	9.2	8.3	25	10.4	10.0	17	6.5	5.9	32	7.8	6.8
7th	37	9.4	8.8	19	10.8	9.5	49	7.0	6.3	35	8.0	7.0
8th	4	9.8	8.5	12	11.0	10.5	85	7.2	6.7	92	7.5	7.1
9th	49	10.4	9.6	23	12.4	10.5	58	7.5	6.8	87	7.9	7.0
10th	47	10.4	9.6	13	11.4	10.6	29	8.0	6.9	27	8.6	7.7
11th	24	11.1	10.6	13	11.1	10.6	62	8.3	7.3	63	8.4	7.8
12th	17	11.0	10.4	6	12.5	11.6	42	8.1	7.6	40	8.6	8.1
13th	22	12.2	11.8	13	12.0	10.8	41	7.9	7.5	53	8.8	8.1
14th	11	11.4	10.8	10	12.5	11.5						
15th	1	11.0	11.0									

No of whales: Number of whales examined.

1st week...........15th Dec.~21sth Dec.
2nd week ....22nd Dec.~28th Dec. etc.

There are large variations in one or two examples, so called "minor example", where lean of fat examples make the curve disturb. But it was without modification, as it was.

Then, the monthly variation was studied. The figures for each month were the average percentage of the blubber thickness for the body length of the whales caught in each month.

It is whatever species or sex may be that from December to March, the blubber gradually increases its thickness, There are some fin whales which show decrease in March but it is due to more numerous, immature whales than in other months. As you can understand in other tables, immature whale shows low percentage.

Though same with it, instead of percentage for body length, averaged thickness of blubber in each week, regardless of body length is in the following table. They were classified into each species and sex.

These, too, proves the thickness of blubber increases week by week.

1st week 15th Dec. to 21st Dec.

2nd week 22nd Dec. to 28th Dec. etc.

FOOD

This time, too, krill was a staple food. The usual investigation on it was as shown in Table 15 (blue whales) and Table 16 (fin whales).

Owing to the new whaling ground east of 180°, the relation between the present catch and krill seems to be so interesting that it will be stated on the paragraph of whales by whaling region. So it is omitted here. Generally speaking more belong to the small sized one or so called "S" and we have had specialists examine on the sample whether all of them were *Euphausis superba* or another species.

The principal creatures mixed in the present krill are as follows.

2 whales (fin whales only) had fed squids.

9 whales had fed the skipper-like fish (two for blue whales and 7 for fin (whales)

1 whale had fed the luminous fish (1 blue whale)

None which had fed large sized Teleosteis or jelly fish as seen last year, could, be found.

Feeding time of whales

One of the feedings when we were looking at flensing was that the stomachs

Table 15 Stomach contents (Blue whale)

Name of fleet	Half-months	No. of stomach examined	No. of stomach with krill	No. of stomach empty	% of stomach with krill	No. with much krill (R.)	No. with moderate krill (rrr)	No. with little krill (rr)	No. with very little krill (r)	Type of krill				
										L	M	S	X	?
Hashidate-maru fleet	December	44	31	13	70	8	5	11	7	15	15	1	0	0
	January	50	17	33	34	3	0	4	10	3	9	4	1	0
		48	11	37	23	0	4	3	4	3	1	6	1	0
	February	30	17	13	57	3	8	4	2	3	11	5	0	0
		45	16	29	36	3	4	6	3	1	4	11	0	0
	March	52	30	22	58	4	11	7	8	0	9	21	0	0
		22	13	9	59	0	3	6	4	0	10	3	0	0
	Total	291	135	156	46	21	35	41	38	23	59	51	2	0
Nisshin-maru fleet	December	81	59	22	73	10	14	20	15	6	26	27	0	0
	January	39	24	15	62	2	9	7	6	0	7	17	0	0 damage stom ach × 1
		98	43	55	44	3	9	12	19	0	1	42	0	0
	February	63	39	24	62	4	18	11	6	0	4	35	0	0
		40	25	15	63	5	4	3	13	0	15	10	0	0
	March	18	8	10	44	2	1	3	2	0	7	1	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	339	198	141	58	26	55	56	61	6	60	132	0	0

Table 16 Stomach contents (Fin whale)

Name of fleet	Half-mouths	No. of stomach examined	No. of stomach with krill	No. of stomach empty	% of stomach with krill	No. with much krill (R)	No. with morderate kill (rrr)	No. with little krill (rr)	No. with very little krill (r)	Type of krill L	M	S	X	?
Hashidate-mare fleet	December	27	19	8	70	0	3	5	11	2	16	1	0	0
	January	51	22	29	43	2	2	5	13	5	1	15	1	0
		40	12	28	30	0	0	6	6	0	4	8	0	0
	February	153	84	69	55	14	28	19	23	25	47	12	0	0
		72	43	29	60	10	12	14	7	1	3	39	0	0
	March	82	44	38	55	4	13	15	13	0	23	21	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	425	224	201	53	30	58	63	73	33	94	96	1	0
Nisshin-maru fleet	December	33	23	10	70	3	4	5	11	3	9	11	0	0
	January	67	41	26	63	3	8	16	14	0	15	26	0	0
		94	48	46	51	2	8	18	20	0	0	48	0	0
	Eebruary	190	104	86	55	21	20	39	24	0	3	101	0	0
		100	50	50	50	7	10	17	16	0	4	46	0	0
	March	101	61	40	60	19	17	16	9	0	38	23	0	0
	Total	585	327	258	56	55	67	111	93	3	69	254	0	0

damage stomach × 2.

of the whales flensesed in the night were often vacant.

As most of the whales which were flensed in the night were those which were caught in the afternoon the day before. So we considered if the whales often took their food in the morning and showed the existence of the content in their stomach by time when they were caught (every one hour)——namely the percentage of the number of examples with krill in their first stomach for all examples at that time (Fig. 23).

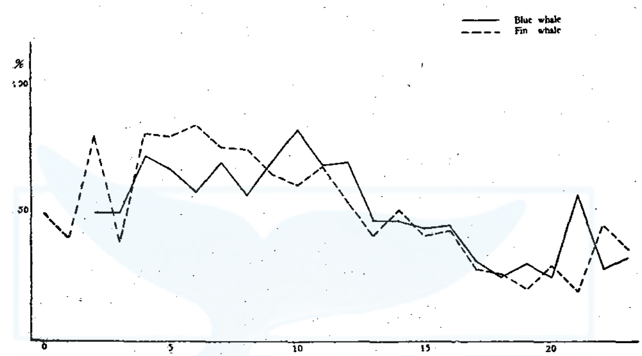


Fig. 23.

As result, with a clear peak it is thought more whales take their food in the morning. If they took their food two or three times a day, the curve should have two or three peaks. It is consequently, thought that they take their food once a day.

Kinds of things should be, however, taken into consideration for it.

(1) Though it is safely considered that F and fff mean scarce difference between feeding time and time when the whales were caught, ff and f may show the earlier time than latter time.

As time-relation is unknown from F to ff and that it can apply to all times, ff and f also were treated as feeding at that time. And as to f and r, the possibility of refluence from the second stomach is thought in case of whale's death.

(2) Essentially, this study should be made on the time when the whales have been discovered. For there is a short or long hour of chasing before the time when the whales have been caught and they have probably no spare time to feed in chasing. This, too, can apply to every time and the chasing hours had to be inquired catcher boats separately. So it was not taken into consideration.

(3) Even though the time and month is same, it differs meteorologically between December and February and between Long. 60°S and Long. 70°S. Therefore, is

it good to treat in the same way? We think it too should be corrected but we left it neglected.

(4) It may show the different condition of krill floating in the water rather than the whale's habit to feed in the morning.

BALEEN

Among all the whales which both fleets caught and processed, we brought the right and left one of the longest baleen (nearly at the middle part of the series).

Kinds of studies concerning it are under preparation at present to publish in the separate reports.

Here is shown the length of the external edge of the longest right and left baleen, measured on board of the Hashidate-maru in processing. The number of

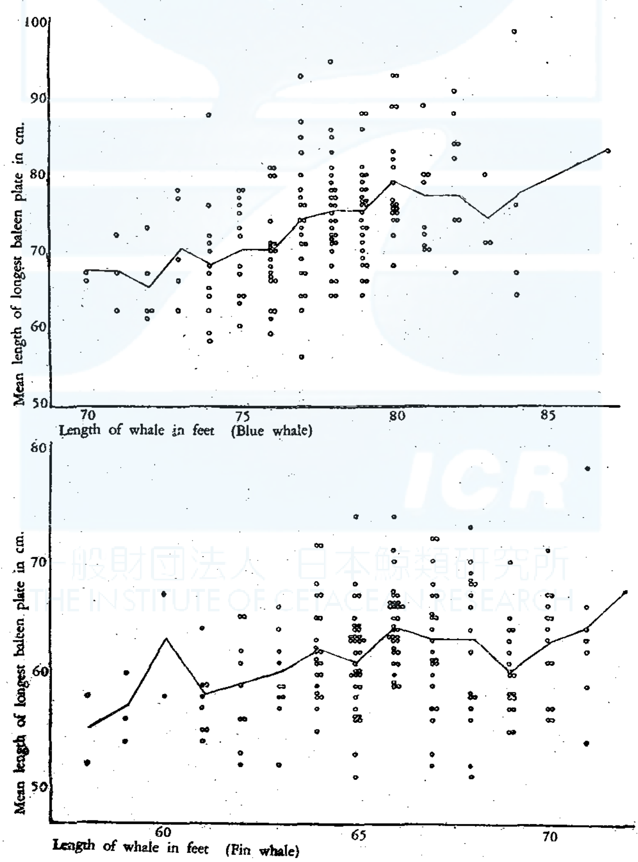


Fig. 24a. Body length and longest baleen plate. (Male whale)

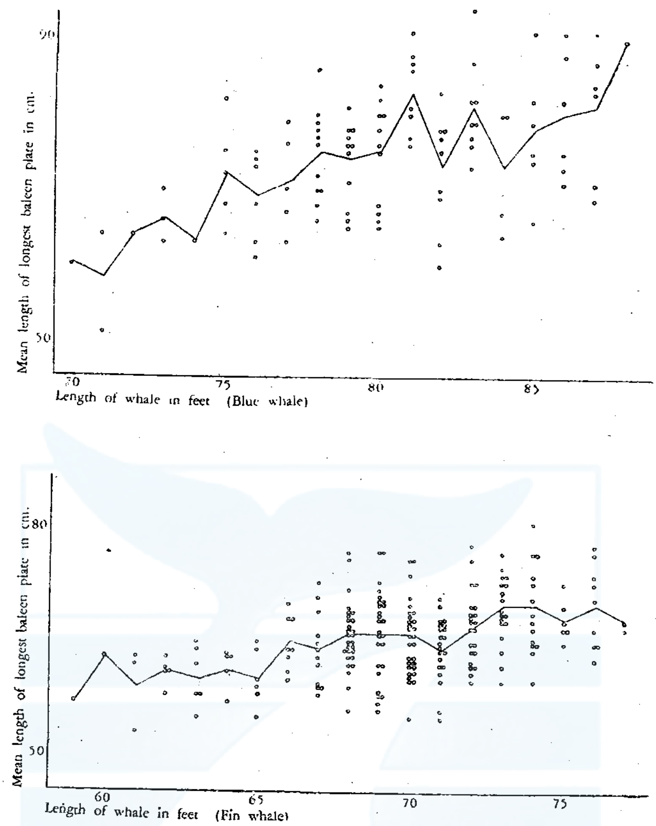


Fig. 24b. Body length and longest baleen plate. (Female)

baleen plate depends not only on species but also on individuals. We could find even in difference of a few plates by right and left baleens. However we could draw the conclusion that the increase of number of plates can hardly be thought in proportion to age.

And yet, it is probably truth that the length increases with age though the length shows a large variation.

The following graphs show the relation between the length of baleen and the body length on the whales processed on board of the above "Hashidate-maru" (Figs 24 and 25)

They show well the above fact but as data concerning age they are inferior to other data (number of corpora lutea and weight of testis), we think.

SUMMARY

The summary of various factors from catch by the Japanese whaling fleets for the

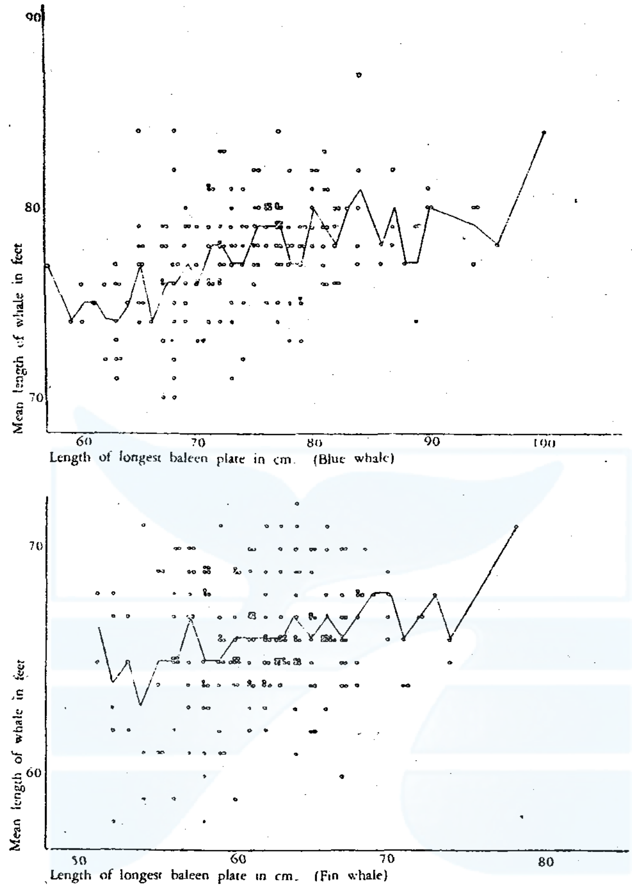


Fig. 25a. Mean length of whales in length of baleen plate.

1948/49 season is as follows.

Average Body Length

	male	female	total
Blue whale	78.12 ft.	81.04 ft.	79.21 ft.
Fin whale	66.24	70.22	68.25

The average body length of the whales caught in this whaling expedition is as seen above and the Japanese whaling fleets operated with more care than last year, so that there was no violation concerning the body length.

The body length showed generally a decrease, as compared with that of last year (only blue male whales increased 0.24 feet). This may give us a general trend that it is decreasing year after year.

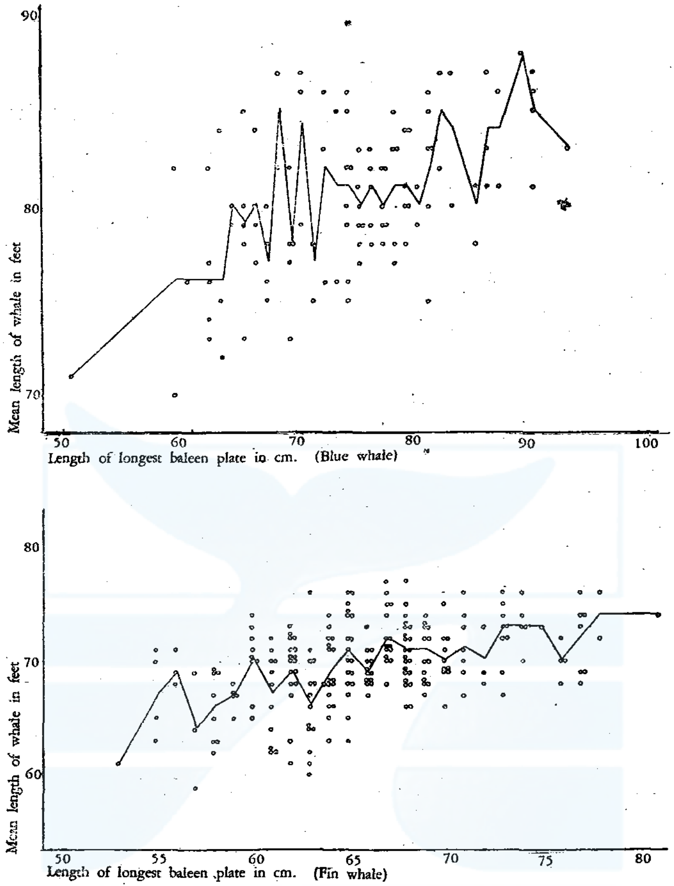


Fig. 25b. Mean length of whales in length of baleen plate.

The mature body length by species and sex is as follows.

Sexually mature body length:

	male	female
blue whale	75 feet	78 feet
fin whale	62 feet	67 feet

Physically mature body length:

	male	female
blue whale	79 feet	89 feet
fin whale	69 feet	75 feet

These almost agree with data last year and in Discovery Reports.

Percentage of pregnanct whales is as follows.

blue whale	42.6 %	for total mature famales
fin whale	36.3 %	

On blue whales, it is hopeful for their resources that there is little monthly variation in spite of lower percentage than last year.

It is very difficult to judge the sex with body colour and it is inaccurate also to judge age with body colour, we think. But it is thought that the distinctness of white flecks on blue whales means something concerning age. (Of course its accuracy is questionable)

We drew the data concerning age from white scars, but we wonder whether it is right or not. It is finally same as last year. To our great pity, baleen, external proportion, and relation between crystalline lens in the eyeballs and age will appear elsewhere..

THE END

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Vol. 9 No. 2

M. Nishiwaki and T. Hayashi:
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APPENDIX I

A study on krill and whale composition by whaling region

In the present expedition, the schedule was that: both fleets were to make the first operation from Long. 150°E. to Long. 160°E. where the good catch had been shown in the earlier stage last year and after the opening of the entrance to the Ross Sea, they were two go southward and to chase whales with a good oil yield in the Ross Sea. Cut they arrived at the whaling ground and began their operation to find that though the whales from Long. 150°E. to 160°E. were big, their group was thin and not good. So they operated moving eastward, at the same time for the purpose of scouting the entrance to the Ross Sea.

Though operation began on Dec. 15, a week later than last year, catch during December ended in medium and that the future of scouting whales was not so much hopeful. In January, both fleets could not find the entrance to the Ross Sea at all, notwithstanding their extraordinary efforts for scouting it. The whales caught were young, small and few in number. During January, both factory ships were chasing fairly large groups of fin whales eastward beyond Long. 180°E.

Contrary to the expection, though it would not last long, in this area they were blessed with so rich catch of fin whales in reality that they could complete the scheduled amount of production, leaving the entrance to the Ross Sea unknown at last. (It is wondered, if it did not open up this year.)

The whaling season being over, (of course during the season too) we considered to find that there had been no operation in the area of west longitude beyond Long. 180°E. for the past including the pre-war years. We found that there were far smaller sized krills and more difference on the whale groups than the operation regions for the past. This is the reason why we tried this study.

First of all, we divided the operating grounds by both fleets into the following four regions.

The 1st region: the area surrounded by the four points:

144° 0′ E	63°30′ S
165° 0′ E	65° 0′ S
144° 0′ E	65° 0′ S
165° 0′ E	65° 0′ S

The 2nd region: the area surrounded by the four points

165° 0′ E	65° 0′ S
179° 0′ E	68° 0′ S
179° 0′ E	68° 0′ S

The 3rd region:	the area surrounded by five points.	
	Scott Island	
	169°30′ W	Latitude of Scott Island
	178°30′ E	69° 0′ S
	169° 0′ W	71° 0′ S
	169°30′ W	71° 0′ S
The 4th region;	the area surrounded by the four points.	
	165° 0′ E	61° 0′ S
	171°30′ E	69°20′ S
	178°30′ E	69° 0′ S

Their seasonal information is as follows.

	the Hashidate-maru	the Nisshin-maru
1st region	15 Dec. — 1 Jan.	15 Dec. — 29 Dec.
2nd region	2 Jan. — 12 Jan. and 15 Jan.	30 Dec. — 14 Jan.
3rd region	29 Jan. — 12 Feb.	11 Mar. — 15 Mar.
4th region	13 Jan. — 27 Jan. (except 15 Jan.) and 13 Feb. — 26 Mar.	15 Jan. — 10 Mar.

We thought to unite the 2nd and 3rd regions but separated them partly because of the about mentioned whaling condition and partly because of seasonally some separation between them. We think the 2nd and 3rd regions depended on the different pack ice lines in the adjacent waters of Balleny Island.

Mainly we compared the 1st region with the 4th one, and with the 2nd and 3rd one for conference.

Tables AI and AII show the size and amount of krill by the whaling region and whale species.

The data were calculated by the fleet but they were collected and studied on the whales caught by the Japanese fleets. But we explained the interesting data separately.

1. The size of krill is put in the lower column of percentage. (It shows the percentage of L. M. S. and X for L+M+S+X, by region, excepting the empty stomach)

In the first region, blue whales showed 48.2% for M, 28.9% for S and 22.9% for L. Naturally dominant type of krill was M. However, if we separate it by fleets, the Hashidate-maru in the more western of the 1st region shows 48.4% for L, 48.4% for M and 3.2% for S, in the equal dominancy for L and M. On the contrary, the Nisshin-maru in the farther eastern region shows 10.5% for L, 84.2%

Table A I

Blue whale unknown = damage stomatch × 1.......2nd. region

		R	rrr	rr	r	Total	% in total	% in L+M+S +X
L	1	7	2	7	3	19	17.0	22.9
	2	1		3	1	5	6.6	13.2
	3		1			1	3.8	7.1
	4	2	2			4	1.0	2.0
M	1	7	11	13	9	40	35.7	48.2
	2	2	2	6	6	16	21.1	42.1
	3	2		4	3	9	34.1	64.3
	4	10	24	9	11	54	0.31	27.3
S	1	4	6	6	8	24	21.4	28.9
	2	1	4	6	6	14	22.4	44.7
	3		3	1		4	15.4	28.6
	4	11	35	43	49	138	33.0	69.5
X	1							
	2							
	3							
	4			1	1	2	0.5	1.0
O	1					29	25.9	
	2					38	50.0	
	3					10	46.2	
	4					220	52.6	
Total	1	18	19	26	20	83	74.1	
	2	4	6	15	13	83	50.0	
	3	2	4	5	3	14	53.8	
	4	23	61	53	61	198	47.4	

for M and 5.3% for S.

Fin whales showed 65.8% for M, 23.7% for S and 10.5% for L. M was the dominant type.

In the 2nd region, blue whales showed 44.7% for S 42.1% for M and 13.2% for L and fin whales showed 61.7% for S, 26.7 % for M and 10.0% for L. The dominant type changed to S, though M was fairly large.

In the 3rd region, M was 64.3% for blue whales and 48.7% for fin whales, S: 28.6% and 21.9% and L: 7.1% and 29.5% respectively. However, separated them by fleet, though the Nisshin-maru moved from the sourth region westward to the 3rd region and it was the last stage of the whaling season, blue whales

Table A II

Fin whale unknown = damage stomach × 2......4th region

		R	rrr	rr	r	Total	% in total	% in L+M+S +X
L	1		2	1	1	4	7.3	10.5
	2	2		2	2	6	5.5	10.0
	3	5	7	4	7	23	14.1	29.5
	4	4	2		2	8	1.2	2.1
M	1	2	3	8	12	25	45.2	15.8
	2	2	5	6	3	16	14.5	26.7
	3	6	16	5	11	38	23.3	48.7
	4	20	29	24	10	83	12.1	22.1
S	1	1	1	1	6	9	16.4	23.7
	2	1	6	11	19	37	33.5	11.1
	3	1	2	9	5	17	10.4	21.9
	4	41	52	102	89	284	41.5	75.7
X	1							
	2			1		1	0.9	1.7
	3							
	4							
O	1					17	30.7	
	2					50	45.5	
	3					85	52.2	
	4					307	45.0	
Total	1	3	6	10	19	38	69.3	
	2	5	11	20	24	60	54.5	
	3	12	25	18	23	78	47.8	
	4	65	83	126	101	375	55.0	

showed 100.0% for M, namely all M and fin whales showed 82.6% for M and 17.4% for S. However, owing to the moving westward for 2 weeks out of the whaling season in the 4th region, its season was earlier and did not agree with that of the Nisshin-maru.

Blue whales showed 50.0% for S, 37.5% for M and 12.5% for L and fin whales showed 41.8% for L, 34.5% for M and 23.6% for S. Its dominant type was L.

In the 4th region, blue whales showed 69.7% for S, 27.3% for M, 2.0% for L and 1.0% for X and fin whales showed 75.7% for S, 22.1% for M and 2.1% for L. Even if they were separated by fleet, this tendendy was equal and in natural the dominant type was S.

2. As to quality, the percentage of whales with stomach full of food for the total is as follows.

	blue whales	fin whales
1st region	74.1%	69.3%
2nd region	50.0%	54.5%
3rd region	53.8%	47.8%
4th region	47.4%	55.0%

The amount of food in stomach is as follows, supposing 4/4 for R, 3/4 for rrr, 2/4 for rr and 1/4 for r and the average for them multiplied by number of each whale and added and divided by total whales by region.

	blue whales	fin whales
1st region	2.4/4 (rr)	1.8/4 (rr)
2nd region	2.0/4 (rr)	2.0/4 (rr)
3rd region	2.4/4 (rr)	2.3/4 (rr)
4th region	2.2/4 (rr)	2.3/4 (rr)

On an average, they fed much to the extent of nearly a half cf their stomach and if we compare this with the above mentioned percentage of whales with stomach full of food, it can be safely thought they are, the quantitative data by region. Thus, we can see there was more krill in the 1st region than in others and only as to the percentage of whales with food in their stomach, the 3rd region showed the larger percentage, though the 2nd too, fairly large. It was nearly as much in the 4th region as in the 3rd one, far less than in the 1st one, we think.

After the above synthetic studies, it can be safely said that the more westward it goes, the bigger the size of krill becomes and the larger its quantity is.

The absolute majority of krill in the 4th region was S mixed with so small sized one as we wondered if it was another species (under investigation now) and it lasted for a long time but its quantity was not so large.

In Balleny region, (the 2nd and 3rd regions) M was the dominant type and though the larger sized one than it was often found, its quantity was small.

In connection with the above, as the body length and maturity seemed to be different by region, examined roughly their constitutions. They are shown in Table AIII (blue whales) and A IV (fin whales)

On blue whales

Both male and female, the 1st region showed the longest and the 4th, 3rd and 2nd one came after. The order of their sexual maturity was 1, 4, 3 and 2 similarly. But the order of the weight of their testis was 3, 4, 1 and 2. And that

Table A III

Blue whale Male

	1	2	3	4
Body length (average)	78.9 feet (58)	77.5 feet (48)	77.9 feet (11)	78.1 feet (274)
Sexual immature	1	11	1	20
Sexual mature	57	37	10	254
% of mature	98.3	78.7	90.9	92.7
Weight of testicles (average)	32.4 kg	26.8 kg	39.1 kg	36.5 kg
Physical mature	25	27	4	88
Physical mature	33	21	7	186
% of mature	56.9	43.8	63.5	67.9
Physical maturity	na (4.0)	na (3.6)	aa (4.9)	aa (4.6)

Blue whale female

Body length (average)	feet 82.4 (54)	feet 78.8 (29)	feet 80.8 (13)	feet 81.0 (144)
Sexual mature	2	5	5	25
Sexual mature {Resting	52 {28	16 {13	8 {4	119 {67
Sexual mature {Pregnant	24	3	4	52
% of mature	96.3	55.2	61.5	82.6
% of pregnant in total mature	46.5	18.8	50.0	43.7
Number of Corpora lutea	10.0	3.7	4.5	8.0
Physical immature	35	27	9	100
Physical mature	19	2	4	44
% of mature	35.2	6.9	30.8	30.6
Physical maturity	nn (3.0)	nn (1.9)	nn (2.5)	nn (2.8)

Sex ratio

Male	58	48	11	274
Female	54	29	13	144
% of male (ratis)	51.8	62.3	45.8	65.6

of % of physical mature was 4, 3, 1 and 2 for male and 1, 3, 4 and 2 for female. That of average number of corpora lutea, too, was 1, 4, 3, and 2.

In the physical maturity, by vertebral column the number of NN, Nn, na, aa, aA and AA, multiplied by NN=1, Nn=2, nn=3, na=4, aa=5, aA=6, and AA=7 and added and then divided by total number of whales were put in the parenthisis and were translated into the above marks. (The marks such as N, n, a, A and their combinations are the same as explained in the paragraph of "ossification of vertebrae" in this report.) They seems to be approximate to the average in the region,

Table A IV

Fin whale male.

	1	2	3	4
Body length (average)	66.4 feet(31)	66.3 feet(57)	65.7 feet(77)	66.2 feet(323)
Sexual immature	4	3	5	12
Sexual mature	27	54	72	311
% of mature	87.1	94.7	93.5	96.3
Weight of testicles (average)	14.7 kg	16.6 kg	18.3 kg	19.8 kg
Physical immature	14	24	31	116
Physical mature	17	33	46	207
% of mature	54.8	57.9	59.7	64.1
Physical maturity	na (4.0)	na (41)	na (4.3)	na (44)

Fin whale female

Body length (average)	70.2 feet(24)	71.1 feet(53)	69.9 feet(56)	70.1 feet(361)
Sexual immature	2	5	10	14
Sexual mature	22	48	76	316
Resting	10	26	47	212
Pregnant	12	22	29	105
% of mature	91.7	90.6	88.4	87.8
% of pregnant in total mature	54.5	45.8	38.2	33.1
Number of Corpora lutea	10.7	13.0	9.2	8.5
Physical immature	12	17	48	216
Physical mature	12	36	38	145
% of mature	50	67.9	44.1	40.2
Physical maturity	na (3.8)	aa (4.6)	na (3.5)	nn (3.3)

Sex ratio

Male	31	57	77	323
Female	24	53	86	361
% of male (ratis)	56.4	51.8	47.2	47.2

though they may be not so appropriate.

The pregnant ratio was in its real figure lower in the 4th region than 1st one but can't it safely be said that the former should better, if we take the season into consideration? It is notable that it is 18.8% in the 2nd region in connection with the fact that there were more younger whales on the whole.

Sex ratio is 51.8% in the 1st region and 65.6% in the 4th region, showing the considerable difference.

And pale spots seemed to have some features but it was not noted because of the individual's subjective data included. At that time, only the whales in the

1st region seemed very big and large. It was probably all the more distinctive dues to more numerous whales of small size in the 2nd region. Somebody says the whales in the 4th region are of South American species but can it be true? We expect the further study on it.

On fin whales

On male, gradually, from the 1st to the 4th region the body length becomes smaller and the weight of testis is reverse. Accordingly, we can say that there were more numerous mature males in the 4th region though they were small in length.

On the percentage of physical matures also, the same result was obtained as on the sexual maturity.

Sex ratio was 56.4% in the 1st region, dropping to 47.2% in the 4th region.

On female, the 2nd region showed the longest body length and the 1st, 4th and 3rd region follow it. And the order of number of corpora lutea was 2, 1, 3 and 4 and that of % of sexual mature was 1, 2, 3 and 4. That of % of physical mature was 2, 1, 3 and 4 and the pregnant ratio dropped gradually from the 1st to the 4th region. This is probably natural from the seasonal point of view. Gradually as compared the 1st region with the 4th one, it can be said that male showed the quite same trend as blue whale and the whales in the 4th region are smaller in body length but more numerous matures that those in the 1st region.

We can safely say that with similarity in the body length, there are more females of mature both sexually and physically in the 1st region than in the 4th one.

In short, it seems to us that between the group in the 1st region and the group in the 4th region, there is a local difference. We can see the above mentioned difference on figures.

APPENDIX II

On the Relation between the Weight of Anterior Hypophysis and the age of whales.

On anterior hypophysis, an organ closely related to sexual glands, physical maturity and metabolism of fat, an investigation was planned in this expedition. The Nisshin-maru fleet, Taiyo Gyogyo K. K. happened to undertake its commercializing and took it up on individuals, so its weight and size were measured.

Here is a statistical study on the weight of anterior hypophysis and the body length in sexual and physical mature inferring from it.

(1) Weight of anterior hypophysis in each body length.

It was plotted by blue and fin whales, in each body length in Fig. A-1 and Fig. A-2 with for female and for male. Fig. A-3 shows these average.

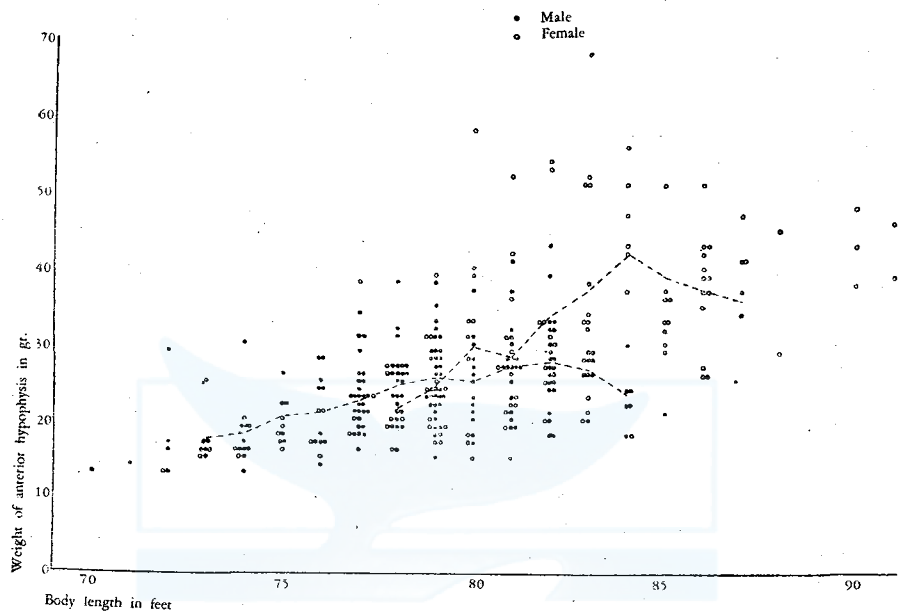

Fig. A-1. Blue whale.

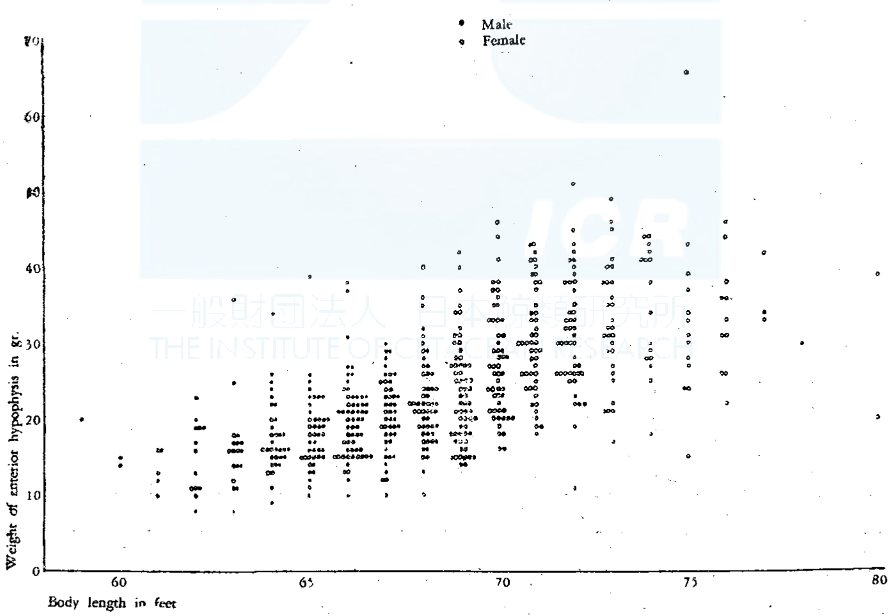

Fig. A-2. Fin whale.

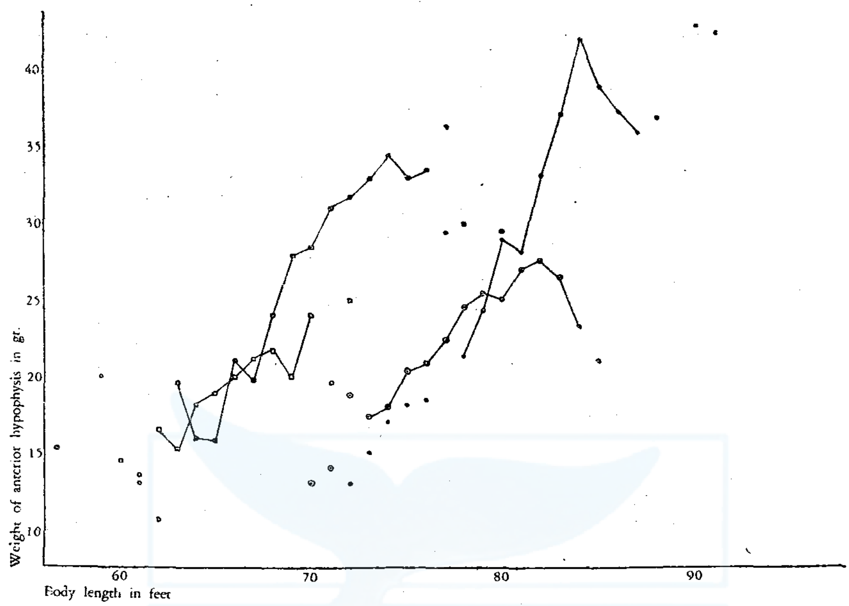

Fig. A-3

Blue whale male shows remarkable increase of weight between 74 and 75 feet in body length and fin whale male between 63 and 64 feet. But, as compared to the average weight curve of testicles in each body length, even whales longer than 75 and 64 feet show more increase of weight. On female, there is a remarkable increase of weight between 81 and 84 feet for blue whales and between 67 and 69 feet for fin whales.

These large increases of anterior hypophysis may be considered to show the sexual maturity. These shall be studied afterwards.

What is common to both blue and fin whales is: On longer whales than a certain body length, anterior hypophysis of female is heavier than that of male and on shorter ones, reversely, that of male is heavier. The longer the body length becomes, the more remarkable becomes the difference of anterior hypophysis weight between female and male. Its boundary line in body length is 80 feet for blue whales and 68 feet for fin whales.

(2) Its relation to the sexual maturity.

In addition to the relation between the sexual glands and the body length in the above report, we studied on the relation between the weight of anterior hypophysis and the sexual glands here. We can get (1) the anterior hypophysis weight in sexually maturity and indirectly (2) the then body length from it.

Male:

a. As we call whales more than 10kgs for blue whales and 5kgs for fin whales in total weight of the right and left testis, the sexual mature, we can make the percentage of sexual maturity into graph by anterior hypophysis weight. It is Fig. A 4. But 1 gr unit lessened so many instances that 3 gr unit was used. A grs in the figure includes (A−1) and (A+1) grs. For instance, 16, 17 and 18 grs were together calculated as 17 grs.

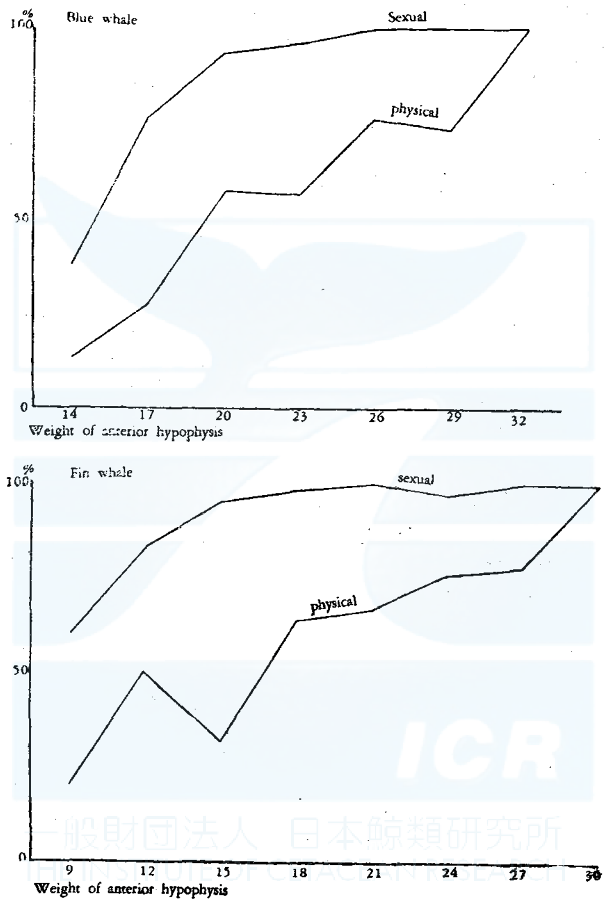

Fig. A-4

If the anterior hypophysis weight, with which more than 75% of whales are mature, is the boundary line of sexual mature, it can be safely thought that it is 17 grs for blue whales and 12 grs for fin whales.

b. In Fig. A-3 rarity of instances can not show how long whales are with anterior hypophysis 17 grs for blue whale and 12 grs for fin in weight. Approximately it is 73 feet for blue and 62 feet for fin whales.

Exactly the average body length of all blue whales with anterior hypophysis 17 grs in weight was found 74.8 feet, rearly 75 feet. The average body length of 3 fin whales with 12 grs anterior hypophysis in weight was found 64 feet and, when including whales with 11 grs and 13 grs, the average was 64.2 feet, namely about 64 feet.

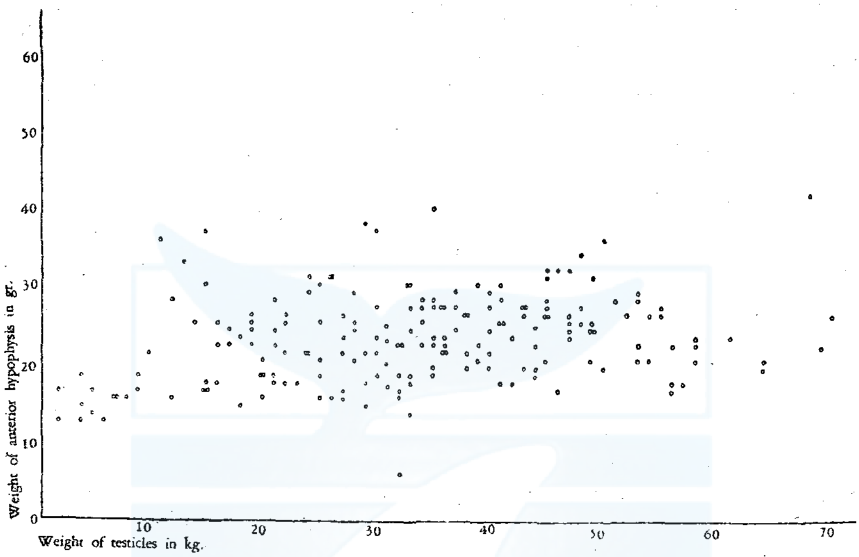

Fig. A-5 Blue whale.

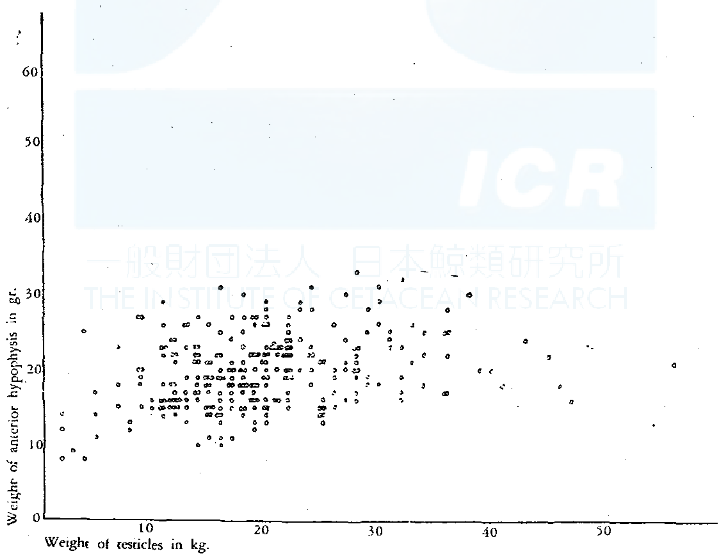

Fig. A-6 Fin whale.

c. Next, the weight of anterior hypophysis was plotted in each weight of testis. Fig. A-5 is of blue whales and Fig. A-6 is of Fin whales. fig A-7 is the average weight of anterior hypophysis in every 10 kg of testis weights were (fin whales less than 10 kg in testis weight were divided into two classes, 1—4 kgs and 5—9kgs).

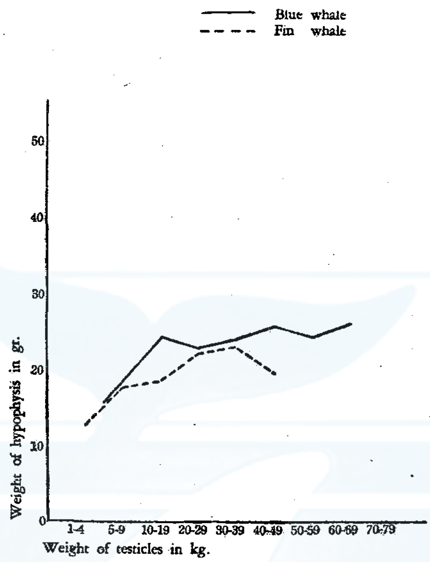

Fig. A-7

About when the sexual glands reach maturity, the increase of anterior hypophysis weight is remarkable.

Female:

a. Fig. A-8 shows the sexual maturity curve by weight of anterior hypophysis' as sexual immature for 0 in number of a corpora lutea and mature for more than 1. In this figure too, 3 grs was 1 unit: 6, 7 and 8 grs were treated as 7 grs. Namely it shows the percentage of sexual mature for all individuals with anterior hypophysis (a−1), a and (a+1) grs in weight. It is 23 grs in weight of anterior hypophysis for blue whales and 20 grs for fin whales of which more than 75% are mature.

b. This body length is 78 feet for blue whales and 66 feet for fin whales, from Fig. 3.

As done in male, the average body length of female blue and fin whales with anterior hypophysis 23 grs and 20 grs in weight respectively was calculated 80.1 feet—90 feet for the former and 66.4 feet=66 feet for the latter.

c. In Fig. A-9 and Fig. A-10, the weight of anterior hypophysis by number of

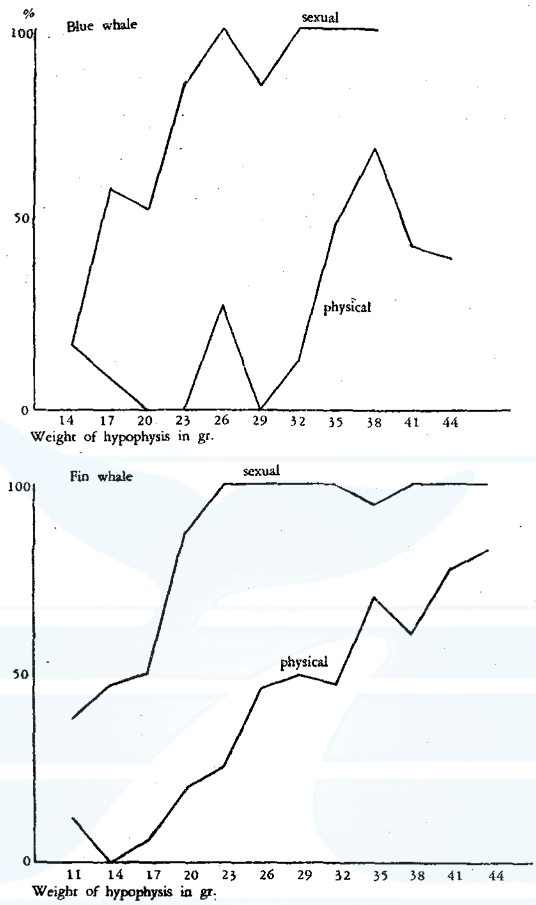

Fig. A-8

corpora lutea was plotted in blue and fin whales. Their average was collected in Fig. A-11 by every 5 or 10 in number of corpora lutea. This shows the remarkable increase of the weight of anterior hypophysis in the stage from 0 to 1—5 in number of corpora lutea. And its weight does not seem to increase in both blue and fin whales with more than 11 in number of corpora lutea and this stage seems to us of physical maturity.

(3) The relation to physical maturity

Ankylosis is observed at thoracic and lumbar regions of vertebrae. Whales with anylosis in either of them are considered physically mature. The percentage of physical mature for number of examples, a grams in weight of anterior hypohpysis is shown in Figs. 4 and 8, together with the percentage of sexual mature.

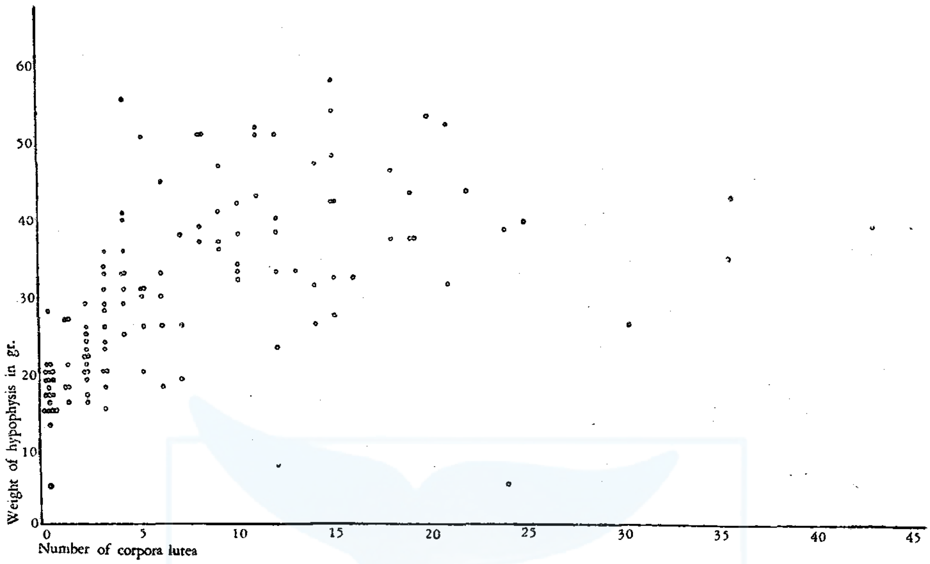

Fig. A-9 whales

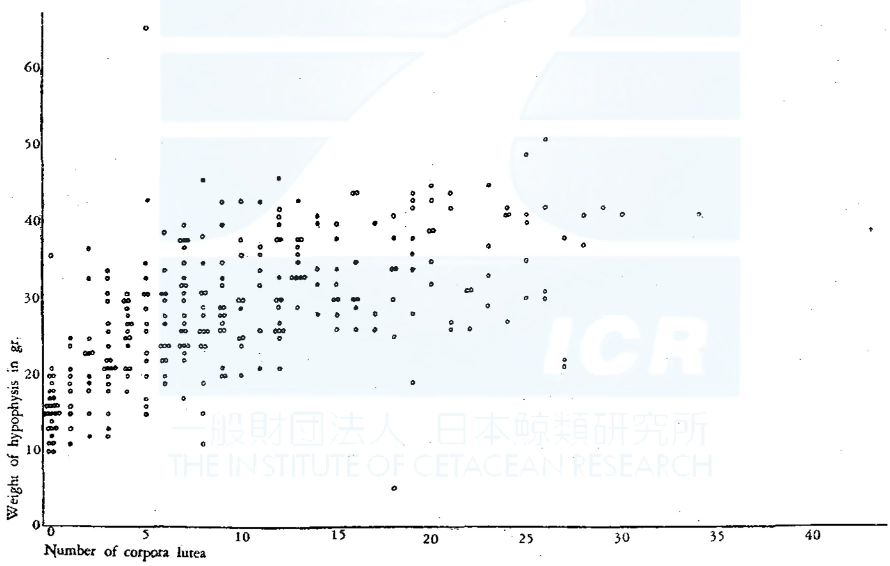

Fig. A-10 whales

3 gr unit was taken and a grs includes (a−1) and (a+1) grams.

Male

Judging from Fig. A-4, the weight of anterior hypophysis in physical mature is 26 grs for blue whales and 24 grs for fin whales. The body length is 80 feet for blue whales and 68 feet for fin whales from Fig. A-3. The average body

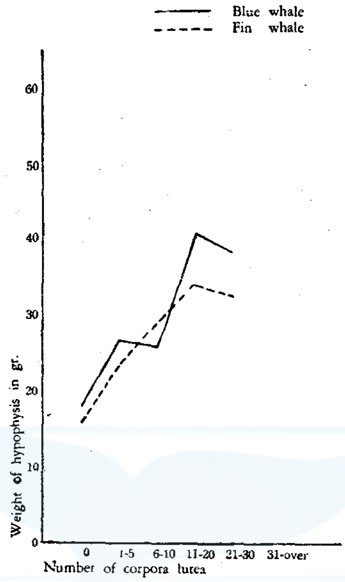

Fig. A-11

length calculated on the individuals with 26 grs in weight of anterior hypophysis for blue whales and 24 grs for fin whales is respectively 79.3 feet and 77.9 feet.

Female

Fig. A-8 does not show an increase of % of number of physical mature in proportion to the increase of weight of anterior hypophysis. According to some literature, whales of 11 in number of corpora lutea may be concidered physically mature. In this report, too, proves it and from Fig. A-9 and Fig. A-10 the average weight of anterior hypophysis with 11 in number of corpora lutea is 39 grs for blue whales and 33 grs for fin whales. (When instances, are few, then include those of more and fewer by 1 in number of corpora lutea than them) In Fig. A-11, it is 40 grs for blue whales but only for reference for this graph contains those of number of corpora lutea near 20. The body length in the stage of 39 grs in weight of anterior hypophysis for blue whales and 33 grs for fin whales is respectively 84 feet and 71 feet, judging from Fig. A-3. Directly averaged length is 84.4 feet and 72.4 feet each. Let's sum up the results of (2) and (3). The first figures mean the weight of anterior hypophysis, the second, mature body length inferred from the weight of anterior hypophysis, and the third in parenthises, the mature body length calculated directly from the sexual glands and the body length.

		sexual maturity			physical maturity		
blue	male	17 gr	75 ft	(75 ft)	26 gr	80 ft	(79 ft)
	female	23	78	(77)	36 ?	84 ?	(88)
fin	male	12	64	(62)	24	68	(69)
	female	20	66	(66)	33 ?	72 ?	(75)

(4) It is said that anterior hypopsis has a close relation to fat metabolism. Therefore, among male and female, blue and fin whales, in body length with the most numerous examples in it the relation between thickness of blubber at point No. 1 and the weight of anterior hypophsis was plotted in Fig. A-12. There, dots

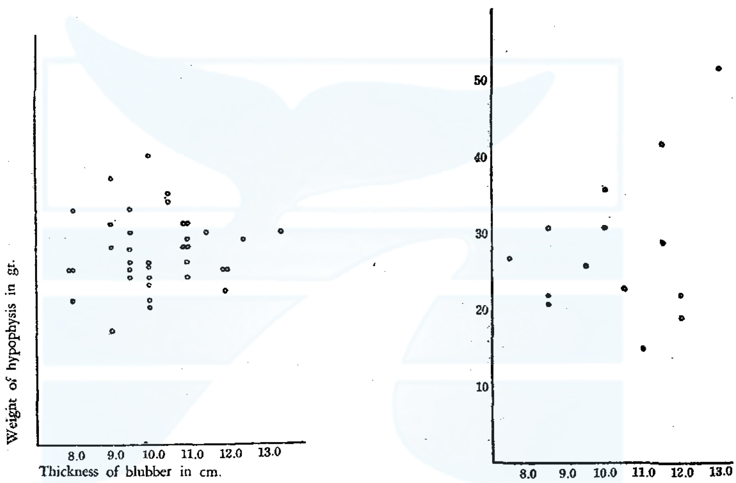

Fig. A-12. Blue whale male, 79 feet. Blue whale female, 81 feet.

mean the average of more than 5 examples. A definite parallel relation between them seems not to be drawn from it.

(5) Conclusion

We think we may draw the rough conclusion as follows.

1. In the early age, anterior hypophysis of males is heavier than that of female but over 80 feet for blue whales and 68 feet for fin whales, female show heavier anterior hypophysis and difference between male and female becomes remarkable with an increase of body length.

2. In the stage of sexual maturing, the increase of weight of anterior hypophysis is notable and then the weight is:

	Male	Frale
Blue whales	17 gr	23 gr

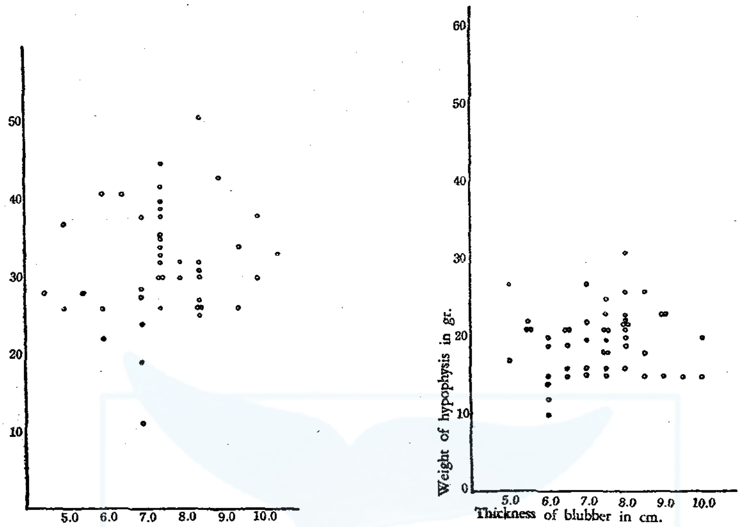

Fig. A-13. Fin whale male, 66 feef. Fin whale femall, 72 feet.

Fin whales	12 gr	20 gr

The body length inferred from the weight of anterior hypophysis is:

	Male	Female
Blue whales	75 feet	78 feet
Fin whales	64 feet	66 feet

This agrees nearly with the following body length in sexual mature directly rom the sexual glands:

	Male	Female
Blue whales	75 feet	77 feet
Fin whales	62 feet	66 feet

3. The weight of anterior hypophysis in the stage of physically maturity is as below, and after that does not increase so much.

	Male	Female
Blue whales	26 gr	39 gr?
Fin whales	24 gr	33 gr?

The body length calculated from the weight of anterior hypophysis is:

	Male	Female
Blue whales	80 feet	84 feet?
Fin whales	68 feet	72 feet?

The body length calculated directly from the ankylosis of vertebrae and body length is:

	Male	Femal
Blue whales	79 feet	88 feet
Fin whales	69 feet	72 feet

On female, there is a rough similarity.

6. The relation between the weight of anterior hypophysis and the thickness of blubber at point No. 1 is not definite.