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THE INSTITUTE OF CETACEAN RESEARCH

THE SCIENTIFIC REPORTS OF THE WHALES RESEARCH INSTITUTE

CONTENTS OF NUMBER 12

OSTEOLOGICAL STUDY OF THE LITTLE PIKED WHALE FROM THE COAST OF JAPAN

HIDEO OMURA

INTRODUCTION

Omura and Sakiura (1956) studied the external characters of the little piked whale from the coast of Japan and have concluded that the grounds for recognizing *Balaenoptera davidsoni* as a subspecies of *B. acuto-rostrata* have not been justified from these characters.

In June 1956 two skeletons of this whale were preserved at Ayukawa for osteological study, taken in the Area V in the Omura and Sakiura's report. These two whales had been buried in sand of the beach at Ayukawa for about five months after having been removed of their blubber, meat, and viscera etc. In the following October these skeletons were digged out from the sand and one skeleton, 25 feet male, was sent to the National Science Museum in Tokyo. Another one, 18 feet male, has been preserved at the Ayukawa Whale Museum. These two skeletons are nearly complete, except some breakage on several processes of the vertebrae, caused by the harpoon at the time of killing. The sternum and left innominate bone of the 18 feet male whale were missed when digging them out from the sand.

I have investigated these skeletons before long from the time of digging out, in a condition of not completely dried up. In several parts of the skull and some vertebrae, especially in the caudal region, there still remained some quantity of oil.

In addition to the above mentioned two skeletons a complete dried skull of unknown sex and 18 feet long minke whale, killed in April 1954, was also investigated.

The osteological characters of the little piked whale from the Atlantic ocean were fuller studied by various authors (Gray, 1846; Lilljeborg, 1862; Bambeke, 1868; Carte & Macalister, 1868; Capellini, 1877; Beneden & Gervais, 1880; Turner, 1891–92; True, 1904). But only a few accounts have been appeard on the skeleton of the little piked whale from the Pacific (Scammon, 1873, 1874 p. 49–51; True, 1904; Cowan, 1939), and virtually none for the individuals from the coast of Japan, as far as I am aware. Further there remain still some doubts for the identification of the Pacific individuals.

The material collected by the examination of the skeleton of the little piked whale from the coast of Japan are studied in this report, comparing to those by different authors on the eastern Pacific and Atlantic specimens.

I am much indebted to Messrs. K. Fujino and T. Ichihara of my Institute, who assisted me greatly in measuring the skeleton and took the photographs shown in this paper. My sincere thanks are due to Dr. Y. Taki of the National Science Museum in Tokyo and Mr. S. Aizawa of the Ayukawa Whale Museum, who gave me all the help I needed while working at their museums.

SKULL

The little piked whale from the Pacific has been named as *Balaenoptera davidsoni*, a different species from the Atlantic specimen *B. acuto-rostrata*, by Scammon (1872, 1874). True (1904) and Cowan (1939) have noted few differences in visual comparison of skulls from the two oceans, while concluding most of the skull measurements are virtually identical. The principal of these differences are (1) that the nasal processes of the maxillae are bent toward the median line much more strongly in the Pacific than in the Atlantic skulls, and (2) that the orbital process of the maxillae is shorter and thicker or directed more medially and less directly posteriorly in the former than in the latter. True has also noted that in the Pacific skulls the vomer appeared to descent more opposite the anterior end of the palatines, giving a stronger curve to the inferior profile of the cranium, and that the palatines were broader posteriorly.

It may not be necessary to give here a general description of the three skulls before me (pls. 1–3), which agree well in general in visual comparison to the skulls from other localities.

What needed is to examine the differences, which is deemed to separate the Pacific skull from the Atlantic individuals. Three skulls from the coast of Japan present very interesting feature about the shape of the nasal processes of the maxillae. They bent strongly toward the median line in the 25 feet male specimen, but slightly in the 18 feet male (Ayukawa Whale Museum (B)). The latter resembles more closely in this character to the specimen from the Atlantic shown by True (1904) than the specimens from the Pacific. Another 18 feet male (Ayukawa W. M. (A)) seems to bear an intermediate feature in this character.

As regards the orbital process of maxillae the skulls before me show individual variations and it is highly probable that there is no ground recognizing this character as distinct. In the 18 feet male (A) the vomer shows no special feature, giving a smoothed curve to the inferior

TABLE 1. SKULL MEASUREMENTS OF THE LITTLE PIKED WHALE FROM JAPAN

Measurement	Tokyo S. M. male 25 ft. jr.			Ayukawa W. M. male 18 ft. jr. (A)			Ayukawa W. M. 18 ft. (B)[1]		
	mm	percent of length	percent of breadth	mm	percent of length	percent of breadth	mm	percent of length	percent of breadth
Length of skull (condylo-premaxillary)	1,520	**100.0**	185.4	1,152	**100.0**	186.7	1,115	**100.0**	196.3
〃 〃 beak	919	60.5	112.1	661	57.4	107.1	644	57.8	113.4
〃 〃 maxilla	1,070	70.4	130.5	772	67.0	125.1	768	68.9	135.2
〃 〃 premaxilla	1,110	73.0	135.4	798	69.3	129.3	793	71.1	139.6
Tip of beak to foramen magnum dorsally	1,545	101.6	188.4	1,159	100.6	187.8	1,125	100.9	198.1
〃 〃 〃 〃 posterior end of pterygoids	1,362	89.6	166.1	—	—	—	968	86.8	170.4
Length of supraoccipital bone from foramen magnum	382	25.1	46.6	301	26.1	48.8	284	25.5	50.0
Greatest breadth of skull (squamosal)	820	53.9	**100.0**	617	53.6	**100.0**	568	50.9	**100.0**
Breadth at base of beak	495	32.6	60.4	372	32.3	60.3	345	30.9	60.7
〃 〃 middle of beak	291	19.1	35.5	218	18.9	35.3	201	18.0	35.4
〃 〃 〃 〃 orbital borders of frontal	743	48.9	90.6	548	47.6	88.8	502	45.0	88.4
〃 of occiput between squamosal suturs	593	39.0	72.3	478	41.5	77.5	454	40.7	79.9
Greatest breadth of maxilla posterior to beak	739	48.6	90.1	527	45.7	85.4	488	43.8	85.9
〃 〃 between outer borders of both premaxillae	205	13.5	25.0	149	12.9	24.1	137	12.3	24.1
〃 〃 〃 inner borders of both premaxillae	143	9.4	17.4	105	9.1	17.0	93	8.3	16.4
Length of nasals mesially	142	9.3	17.3	110	9.5	17.8	101	9.1	17.8
Breadth of nasals in front	90	5.9	11.0	75	6.5	12.2	62	5.6	10.9
Height of occipital condyle (right)	92	6.1	11.2	94	8.2	15.2	87	7.8	15.3
〃 〃 〃 〃 (left)	94	6.2	11.5	93	8.1	15.1	91	8.2	16.0
Breadth of occipital condyle (right)	82	5.4	10.0	78	6.8	12.6	66	6.9	11.6
〃 〃 〃 〃 (left)	84	5.5	10.2	78	6.8	12.6	71	6.4	12.5
Length of mandible (right, straight)	1,474	97.0	179.8	1,084	94.1	175.7	—	—	—
〃 〃 〃 (left, straight)	1,483	97.6	180.9	1,086	94.3	176.0	—	—	—
〃 〃 〃 along outer surface (right)	1,543	101.5	188.2	1,138	98.8	184.4	—	—	—
〃 〃 〃 〃 〃 〃 (left)	1,552	102.1	189.3	1,148	99.7	186.1	—	—	—
Height of right mandible at condyle	143	9.4	17.4	117	10.2	19.0	—	—	—
〃 〃 〃 〃 〃 coronoid	200	13.2	24.4	152	13.2	24.6	—	—	—
〃 〃 〃 〃 〃 symphysis	88	5.8	10.7	66	5.7	10.7	—	—	—
〃 〃 left mandible at condyle	143	9.4	17.4	114	9.9	18.5	—	—	—
〃 〃 〃 〃 〃 coronoid	196	12.9	23.9	152	13.2	24.6	—	—	—

1) Sex and age unknown.

profile of the cranium, which is shown clearly in plate 3.

In conclusion no specific difference was noted in the visual comparison between our skulls and those from the Atlantic, reported by True (1904).

The measurements of the skulls from the coast of Japan are shown in table 1 in mm together with the percentages of length and greatest width across the squamosals of the skull. As shown in this table there is a noticeable difference in skull length between the two 18 feet males. It should be remembered, however, that the specimen (A) is measured at a state of not completely dried, as mentioned already.

As far as I am aware, thanks to the other authors, we have now the measurements of skull for 18 whales from different localities, including 3 from the coast of Japan. These measurements are tabulated in table 2, arranged in the order of the skull length, neglecting of their localities. Of the 18 whales 13 were cited from True (1904), and 2 from Cowan (1939). The skull length of the whales reported by them were measured in inches. I have converted these inches into mm for the convenience of comparison and calculated the percentages for the 2 whales reported by Cowan (1939).

As seen in table 2 most of the skull measurements, reduced to percentages of the skull length, of the little piked whales from different localities are virtually identical. There is no remarkable difference between the skulls from Atlantic and Pacific oceans. Table 2 shows also the growth or age variation of various parts of the skull. These are shown more clearly in figure 1. The proportions of the lengths of premaxillae and beak increase steadily with the growth of the skull. But the proportion of the depth of the supraoccipital bone decreases with the growth. These facts lead to a conclusion that the antero-posterior growth of the skull is taken place mostly in the facial region.

The lateral expansion of the skull, on the other hand shows a different feature from the antero-posterior growth. The growth curve of the greatest width of skull and that of the greatest width of maxilla posterior to beak have maxima at some points between 1500 and 1800 mm of skull length. It is probable, therefore, that the lateral expansion of the skull would cease or grow very little compared with the growth in length after an attainment of some age. From table 2 it is suggested that the physical maturity is attained at about 1550 mm of the skull length. The skull length of our 25 feet male specimen is 1520 mm. In this whale most of the epiphyses of the vertebrae do not ankylosed to their centra, but this whale was measured at a state of not completely dried. Therefore, some shrinkage of the skull is expected. All whales of their skull length 1537 mm or over are recorded as adult, in case the

TABLE 2. SKULL MEASUREMENTS OF THE LITTLE PIKED WHALES FROM ATLANTIC AND PACIFIC OCEANS REDUCED TO PERCENTAGES OF THE SKULL LENGTH

Mesasurement	Queensferry, Scotland. (Knox; Turner, 1892)	Sooke, B.C. (Cowan, 1939)	Alloa, Scotland. (Turner, 1892)	Harwichport, Mass. (True, 1904)	Japan. Ayukawa W. M. (B)	Elie, Scotland. (Turner, 1892)	Japan. Ayukawa W. M. (A)	Burntisland, Scotland. (Turner, 1870)	Loc. unknown, Pacific. (Dall, 1874)[4]	Greenland. (Gray, 1846)	Japan. Tokyo S. M.	Coast of Norway. (True, 1904)	Pultney Pt. B. C. (Cowan, 1939)	St. Paul Id., Alaska. (True, 1904)	Puget Sound, Wash. Type of *B. davidsoni* (True, 1904)	Bergen, Norway. Lilljeborg, (1862)	Granton, Scotland. (Turner, 1892)	Dunbar, Scotland. (Turner, 1892)
Sex and age	♀ jr.		jr.	jr.		♂ jr.	♂ jr.	♀			♂ jr.	ad.		ad.	♀ ad.		♀ ad.	♀ ?
Total length of whale	9′ 11″	15′			18′	18′	18′	18′			25′					23′	28′4″	30′±
Length of skull in mm (Condylo-premaxillary, straight)	813	965	1,016	1,105	1,115	1,130[1]	1,152	1,168[1]	1,219	1,245[2]	1,520	1,537	1,549	1,556[1]	1,562	1,588	1,778	1,816[1]
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Length of beak	62.5	60.5	62.5	61.5	57.8	60.7	57.4	60.0	62.5	62.0[2]	60.5	60.8	63.9	62.0[1]	61.8	65.2	67.8	67.3
〃 〃 maxilla	67.2	—	69.4	70.1	68.9	68.0	67.0	70.1	68.7	—	70.4	—	—	—	—	—	73.2	72.7
〃 〃 premaxilla	64.6	68.4	69.4	71.9	71.1	71.3[1]	69.3	72.8[1]	—	—	73.0	75.2	73.8	75.9[1]	73.6	—	75.7	74.8[1]
Foramen magnum to tip of beak dorsally	—	100.0	102.5	104.6	100.9	103.2[1]	100.6	103.2[1]	—	—	101.6	104.1	103.3	102.1[1]	104.1	—	106.4	105.0[1]
〃 〃 〃 occipital crest	—	27.0	28.1	29.3	25.5	28.1	26.1	28.3	—	—	25.1	28.1	27.0	25.3	27.6	—	27.1	26.2
Greatest breadth of skull (squamosal)	50.0	52.6	—	51.1	50.9	51.7	53.6	50.0	—	—	53.9	57.2	55.7	54.7	57.3	56.6	55.4	54.6
Breadth at base of beak	31.3	33.6	31.9	32.2	30.9	32.6	32.3	30.5	34.4[3]	31.8	32.6	33.9	32.8	32.7	35.0	33.6	32.9	33.9
〃 〃 middle of beak	21.0	—	25.6	19.8	18.0	22.5	18.9	21.8	18.8[3]	20.4	19.1	20.7	—	17.9	20.7	21.2	24.3	23.1
〃 〃 〃 orbital borders of frontals	46.9	—	45.0	44.3	45.0	44.0	47.6	45.6	—	44.9	48.9	52.1	—	50.0	53.3	—	51.0	50.7
Greatest breadth of maxilla posterior to beak	45.3	47.4	—	45.0	43.8	41.6	45.7	—	—	—	48.6	50.4	49.2	48.2	—	—	49.3	49.7
〃 〃 outer borders of premaxillae	9.4	11.8	11.9	11.3	12.3	11.8	12.9	10.9	—	—	13.5	13.6	13.5	13.4	15.4	—	13.6	13.3
〃 〃 between inner borders of premaxillae	7.8	9.2	10.0	9.9	8.3	10.1	9.1	8.7	—	—	9.4	9.1	9.8	9.8	10.6	—	10.0	10.5
Length of mandible (straight)	93.8	—	99.4	97.7	—	96.6	94.2	98.9	97.9	—	97.3	100.0	—	—	—	—	101.4	100.7
〃 〃 〃 along outer surface	98.4	98.7	103.7	103.4	—	103.4	99.3	106.5	—	—	101.8	109.0	109.8	—	—	105.0	109.3	108.0
Height of mandible at condyle	10.2	—	8.7	9.9	—	10.7	10.1	9.8	—	—	9.4	—	—	—	—	—	9.3	10.5
〃 〃 〃 〃 coronoid	13.3	13.2	12.5	12.6	—	12.3	13.2	12.5	12.5	—	13.1	13.1	12.7	—	—	—	12.8	12.9
〃 〃 〃 〃 symphysis	5.5	—	5.6	5.7	—	5.1	5.7	4.3	—	—	5.8	—	—	—	—	—	5.4	5.6

1) 2″ added for breakage   2) 2.4″ added for premaxillae   3) Curved   4) In appendix to Scammon, 1874

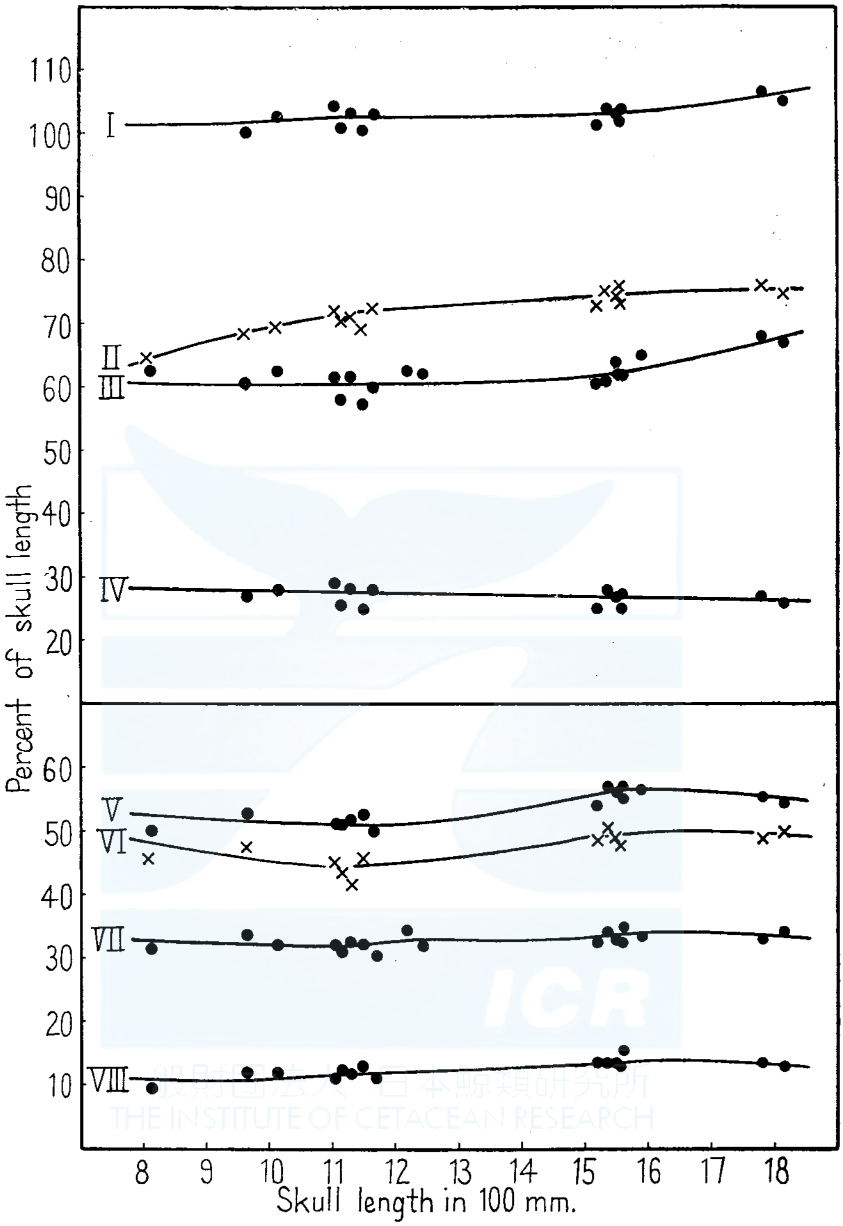

Fig. 1. Growth of various parts of skull in the little piked whale. (Based on material by various authors).

I Foramen magnum to tip of beak dorsally.
II Length of premaxilla.
III Length of beak.
IV Foramen magnum to occipital crest.
V Greatest breadth of skull.
VI Greatest breadth of maxilla posterior to beak.
VII Breadth at base of beak.
VIII Greatest breadth outer borders of premaxillae.

maturity is recorded. If we assume that the physical maturity is attained in the little piked whale at about 1550 mm of its skull length, then we get to a conclusion from figure 1 that post-physical maturity increments would continue antero-posteriorly in the facial region, but the lateral expansion of the skull may cease after attainment of the physical maturity. Of course, such conclusion may premature, because the data contained in this table are obtained by various authors from quite different localities of the world. Further I feel lack of material, especially in the larger groups of whales, in order to get to a rigid conclusion.

TABLE 3. MEASUREMENT OF TYMPANIC BULLA OF THE LITTLE PIKED WHALE FROM JAPAN (in mm)

Specimen	Length		Greatest breadth		Mesial distance between 2 bullae
	Right	Left	Right	Left	
17 feet male	92	91	69	61+[2]	93
18 feet male[1]	90	90	69	70	118
25 feet male	91	90	73	72	143

1) Ayukawa W. M. (A). 2) Breakage

Measurements of the tympanic bullae are shown in table 3. A skull of 17 feet male, kept in our Institute, is also available for this study. Measurements of bullae of this whale are included in the table. As shown in table 3 practically no difference is noted in the size of bulla, but there is a considerable difference in the distance of right and left bullae according to body length. Purves (1955) states that 'measurement of the mesial distance between the two tympanic bullae in skulls of various ages shows that here too the increase in dimension is very slight [in the Mysticeti]', but this is not proved by our specimens of the little piked whale.

The lachrymal and malar (figs. 2 and 3) are of no special importance. These two bones are not fused at each ends. The lachrymal is fitted in between the maxillary and frontal and the anterior flat and broader end of the malar articulates with the orbital process of the maxillary beneath the lachrymal. The posterior smaller end of the malar articulates with the temporal.

The mandible (pl. 4) exhibits no important feature. Its measurement is included in tables 1 and 2.

VERTEBRAL COLUMN

The vertebral formulae of our specimens, known to be complete skeletons, are as follows:

25 feet male C7+D11+L12+Ca18=48

18 feet male (A) C7+D11+L12+Ca17=47

The 1st caudal is easily detected by the presence of the bifurcated inferior median carina forming a facet for the attachment of the 1st chevron bone.

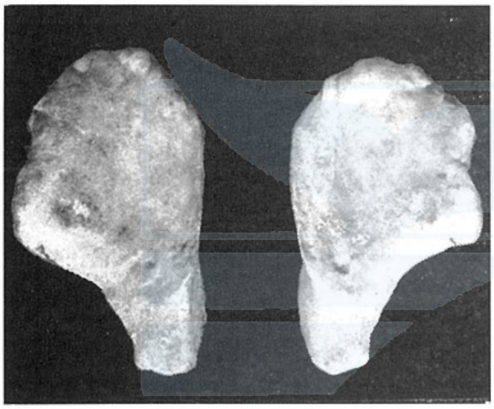

Fig. 2. Lachrymal of the little piked whale from Japan. 25 feet male. Ventral view.

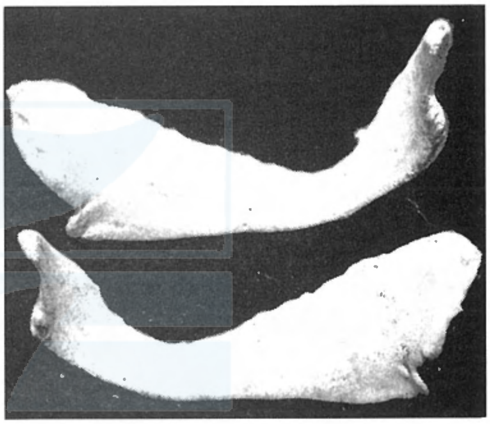

Fig. 3. Malar of the little piked whale from Japan. 25 feet male.

Cowan (1939) reports of his juvenile specimen as cervicals 7, dorsals 11, lumbars 12, caudals 18, total 48. Our 25 feet male has the same number of vertebrae. According to True (1904) all of the specimens reported by various authors from Atlantic and Pacific oceans have 7 cervicals and 11 dorsals. No single exception has been reported in this respect. As to the lumbars the majority have 12 and some 13. The caudals are mostly 18, though they range 16–20. It is concluded, therefore, that the little piked whale from the coast of Japan is identical to those from other localities in this character.

In the two skeletons before me there are some individual variations in the shape of the cervicals (pls. 6 and 7). In both specimens the spine of the atlas is strong and that of the axis is reduced to a ridge in the 18 feet male, but in a lesser degree in the 25 feet male. Neural spines are rudimentary on 3rd, 4th, and 5th, better developed on 6th and 7th in both specimens. In the 25 feet male diapophyses are much longer than parapophyses in 2nd to 7th, whereas in the 18 feet male the both processes are nearly the same length in 3rd. Parapophysis in 7th is reduced to a tubercle in both specimens. Such tubercle is also present on the 1st dorsal, in less developed form. The left diapophysis and parapophysis of the axis in the 18 feet male united, forming a ring, whereas the ring is not completed yet on the right side. In none of the cervicals is this ring present in the 25 feet male. Such ring formation is seemed to have a good individual variation. A series of cervicals of unknown body length and sex, but completely matured, have been kept in our Institute. In this specimen complete rings are formed on both sides of the axis and 5th cervical and one on the right side of the 4th.

In both specimens diapophyses of the axis and 3rd directed posteriorly, 4th and 5th transversely, 6th and 7th anteriorly.

In other regions of the vertebrae of the 25 feet male, the transverse processes up to 6th dorsal directed anteriorly, 7th and 8th dorsal transversely, 9th and 10th dorsal posteriorly, 11th dorsal transversely, 1st to 10th lumbar anteriorly, 11th lumbar transversely, 12th lumbar and 1st caudal posteriorly, 2nd caudal transversely, 3rd to 7th caudal anteriorly. In the 18 feet male such directions of the transverse processes are; 1st to 8th dorsal anteriorly, 9th dorsal to 1st lumbar transversely, 2nd to 10th lumbar posteriorly, 11th and 12th lumbar transversely, 1st to 4th caudal anteriorly, 5th caudal transversely. These are subject to individual variations and have no specific value for identification.

The actual measurements of the vertebrae of the both 25 and 18 feet males are given in table 4. In both specimens the transverse processes are greatest in lateral extent in 10th or 11th dorsal and the greatest height of the vertebra, measured from the base of the centrum, is greatest in 8th or 9th lumbar, but 5th and 6th lumbar of the 18 feet male are exceptionally high. Breadth and height of the centrum is greater in 4th to 6th caudal in the 25 feet male, while in the 18 feet male in 12th lumbar to 6th caudal. Length of the centrum is greatest in 2nd caudal in the both specimens.

In figure 4 measurements of the vertebrae are plotted in the order of vertebral number for the two specimens. It is clearly shown in figure 4 that in what part of the vertebral column the growth takes place mostly according to the growth of the body or age, in particular in the course of the time of body growth from 18 to 25 feet. Of course there might exist some individual variations between the two specimens, neverthless it is highly probable that the age differences might be far greater than the individual differences. In figure 4 it is shown that the lateral expansion of the transeverse processes is most remarkable in

TABLE 4. DIMENSIONS OF VERTEBRAE OF THE LITTLE PIKED WHALE FROM JAPAN (in mm)

Vertebral no.	Tokyo S. M. 25 feet male					Ayukawa W. M. 18 feet male (A)				
	Greatest breadth[1]	Greatest height[2]	Centrum			Greatest breadth[1]	Greatest height[2]	Centrum		
			Breadth in front	Height in front	Length			Breadth in front	Height in front	Length
C 1	335	190	165[4]	R. 103[4] L. 99[4]	39	257	166	160[4]	R. 112[4] L. 108[4]	32
2	412	201	167[4]	R. 109[4] L. 107[4]	34	318	163	156[4]	R. 103[4] L. 106[4]	27
3	332	155	141	86	28	276	120+	122	80	19
4	338	150	134	87	30	267	131	115	80	20+
5	338	159	129	88	33	271	138	110	82	21
6	358	178	127	92	37	278	148	110	82	21
7	365	178+	127	92	40	283	150	108	81	25
D 1	386	205	128	90	49	285	172	109	80	30
2	396	228	128	89	62	304	190+	106	76	44
3	388	272	129	91	73+	315	222+	104	77	60
4	452	315	129	92	92	356	249	101	80	68
5	512	336	127	93	100	400	258	101	82	61+
6	550[3]	357	127	93	100+	434	266	Broken	78	83
7	592	367	127	93	114	461	274	〃	78	78+
8	603	379	129	95	121	472	282	100	80	90
9	610	387	131	96	130	480	293	104	82	91
10	626	403	132	98	127	486	303	108	83	92
11	634[3]	419	130	99	132	482	314	109	84	97
L 1	590	400	132	102	139	480	316	111	89	99
2	587	445	134	108	141	482	324	112	90	103
3	594[3]	449	138	110	148	480	327	113	92	106
4	594	458	138	113	150	476	330	114	95	107
5	596	472	140	113	156	476[3]	356	115	98	112
6	589	483	140	119	157	468[3]	359	114	102	111
7	569	481	142	119	162	454[3]	345	116	100	112
8	549	491	143	120	165	436[3]	344	115	100	114
9	521	490	146	122	173	404	353	118	102	120
10	488	484	153	128	180	386	348	121	104	126
11	487	482	156	132	187	368	334	123	106	131
12	458[3]	464	162	140	193	338	322	125	110	133
Ca 1	412	452	163	147	193	310	305	125	110	132
2	385	413	161	145	195	283	288	127	113	135
3	341	383	170	150	193	241	261	124	115	133
4	285	325	176	153	180	210	218	124	117	130
5	244	293+	177	157	176	178	200	124	116	125
6	201	248	176	154	174	148	181	123	113	122
7	166	231	164	150	164	122	161	120	111	119
8	143	200	145	150	155	104	137	107	111	111
9	124	165	134	148	133	93	115	100	104	90
10	111	135	119	125	92	85	91	85	86	63
11	102	102	98	99	65	72	71	72	68	52
12	93	98	85	80	58	65	62	64	60	50
13	86	75	69	75	55	58	56	59	55	46
14	80	68	57	63	51	50	46	51	46	40
15	69	54	48	49	43	41	37	42	37	34
16	53	39	43	39	36	32	27	32	27	28
17	41	33	29	28	29	21	21	21	21	22
18	29	20	22	20	27	—	—	—	—	—

1) Across the transverse processes.
2) From base of centrum to tip of spinous process.
3) Measurement of a half breadth from median was doubled because of breakage of right or left transverse process.
4) Measured at articulating surface.

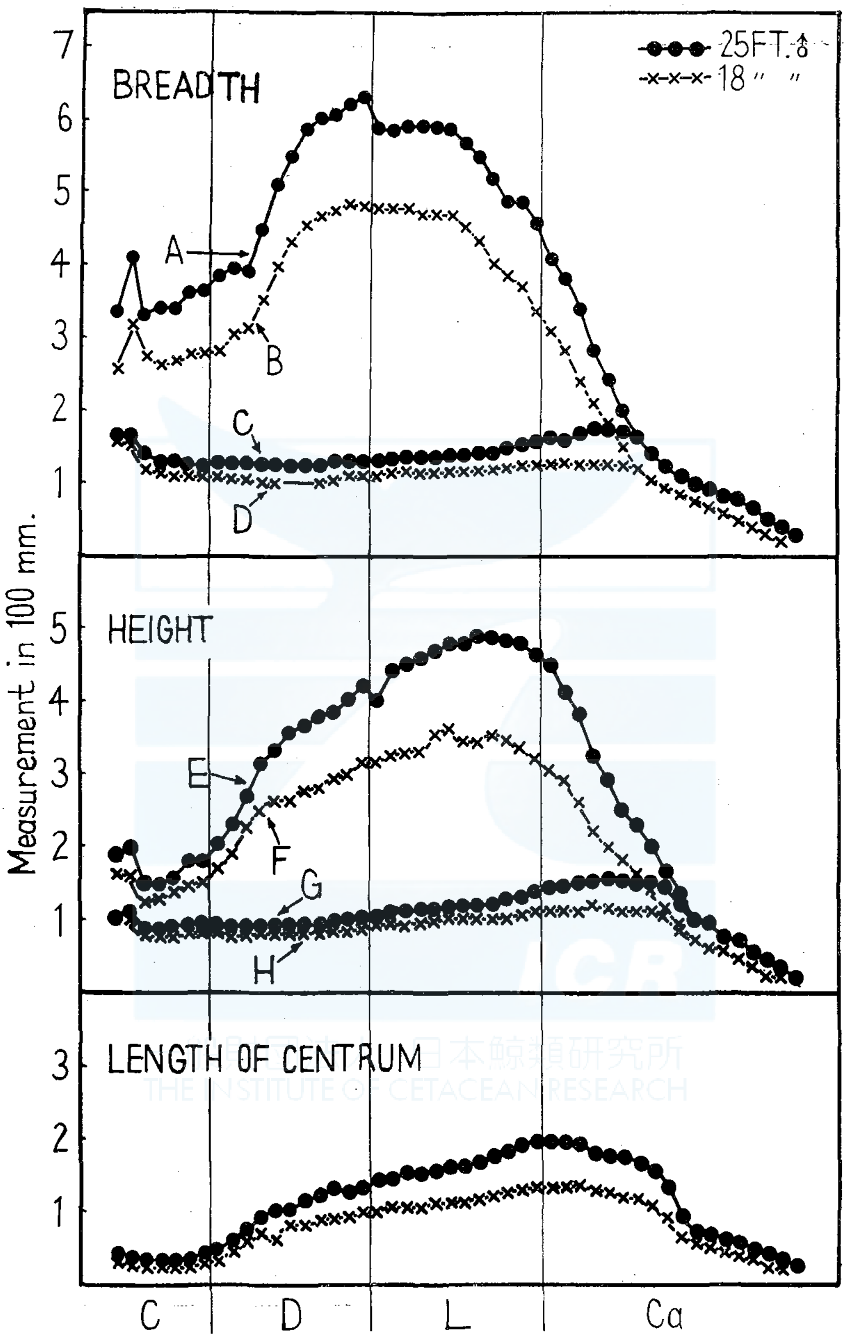

Fig. 4. Dimensions of vertebrae of the little piked whale from Japan. 25 and 18 feet males compared.

A.B; Greatest breadth across transverse processes.
C.D; Breadth of centrum in front.
E.F; greatest height from base of centrum to tip of spinous process.
G.H; Height of centrum in front.

a region of the vertebrae latter half of the dorsals and the first half of the lumbars. This would mean that the whale body itself expand laterally mostly in these parts with the growth of the body. On the other hand, greater growth of the spinous processes are observed in the latter half region of the lumbars. The growth of the centra is taken place most remarkably in the first several vertebrae of the

TABLE 5. COMPARISON OF SKELETON OF LITTLE PIKED WHALE FROM DIFFERENT WATERS

Measurement	Granton, Scotland. (Turner, 1892)	Cromer, England. (Flower, 1864)	Bergen, Norway. (Lilljeborg, 1862)	Norway. (True, 1904)	Norway. (Malm, 1869)	Drogheda, Ireland. (Carte & Macalister, 1867)	Harwichport, Mass. (True, 1904)	Japan. Tokyo S. M.	Japan. Ayukawa W. M. (A)
Sex and age	♀ ad.	♂ ad.	—	ad.	jr.	♀ jr.	jr.	♂ jr.	♂ jr.
Total length of whale	28′4″					13′11″		25′	18′
Length of skull, straight (mm)	1,778	1,651	1,588	1,537	1,240	940	1,105	1,520	1,152
	%	%	%	%	%	%	%	%	%
Greatest breadth, atlas	19.2	19.2	19.2	18.7	—	20.9	—	22.0	22.3
Depth centrum, 〃	—	—	—	—	—	—	—	6.6[4]	9.5[4]
Greatest breadth, axis	28.9	26.2	26.8	26.8	—	—	24.7	27.1	27.6
Depth centrum, 〃	—	—	—	5.3[1]	—	—	6.3	7.1[4]	9.1[4]
Greatest breadth, 1st dorsal	—	—	—	26.4	—	—	22.4	25.4	24.7
Depth centrum, 〃 〃	5.4	—	—	5.8[2]	—	—	6.3	5.9	6.9
Greatest breadth, 1st lumbar	—	—	—	41.4	—	39.2	37.0	38.8	41.7
Depth centrum, 〃 〃	—	—	—	7.5	—	—	7.5	6.7	7.7
Greatest breadth, 1st caudal	24.3	—	—	28.2	—	—	25.3	27·1	26.9
Depth centrum, 〃 〃	10.0	—	—	9.5	—	—	8.7	9.7	9.5
Greatest length, sternum	27.9	22.3	22.8	24.0	—	—	14.4	22.3	—
〃 breadth, 〃	12.9	15.4	15.2	12.8	—	—	10.3	14.9	—
〃 〃 , scapula	42.9	40.8	37.6	39.8	—	31.8	33.9	38.1	33.7
〃 depth, 〃	22.9	23.1	22.4	22.8	—	20.3	20.7	24.0	21.6
Length of radius	26.4	24.6	27.2	24.9[3]	22.9	23.0	25.3	26.8	24.8
〃 〃 ulna	25.7±	—	24.4	21.9	—	19.6	23.6	25.6[5]	23.5[5]

1) Posterior median.
2) Anterior.
3) With proximal epiphysis.
4) Articulating surface.
5) Between articulating surfaces and include both epiphyses.

caudals. This would connected with more violent movements of the flukes in larger whales. Only a slight growth is attained in the cervicals, except some expansion of the transverse processes.

In table 5 selected measurements are shown, reduced to percentages of the skull length, comparing to those from other localities, which were cited from True (1904) but converted of their skull length into mm by me for the convenience of comparison. Nothing particular is noted in this table.

TABLE 6. DISAPPEARANCE OF SEVERAL PROCESSES AND APPEARANCE OF FORAMINA IN THE LITTLE PIKED WHALE

	British Columbia (Cowan 1939)	Japan 25 feet ♂	Japan 18 feet ♂
Last vertebra to bear a neural spine	8th	10th	9th
Last vertebra to bear transverse processes	5th	6th	6th
First vertebra to have the transverse process perforated by a vertical foramen	3rd	4th	3rd

Fig. 5. Chevron bones of the little piked whale from Japan. 25 feet male.
Upper: Right to left 1st–5th.
Lower: 〃 〃 〃 6th–10th.

The disappearance of the neural or transverse processes and the appearance of the foramina on the transverse processes in the caudal vertebrae of the Japanese specimens are shown in table 6, together with those from British Columbia as reported by Cowan (1939). There are some individual differences in these characters as noted in the table.

CHEVRON BONE

The number of chevron bones (fig. 5) are 10 in the 25 feet male, 8 in the 18 feet male. The right and left laminae of each chevron are all united in both specimens. The number of chevrons from the Atlantic is usually 9, but sometimes 8, as reported by True (1904). The whale from British Columbia reported by Cowan (1939) has 10 chevrons, 1st small and slender, 2nd longest, 3rd broadest. The 25 feet male from Japan is virtually identical with this whale in this respect.

TABLE 7. DIMENSION OF CHEVRON BONES OF THE LITTLE PIKED WHALE FROM JAPAN (in mm)

Specimens and measurements		Chevron bones									
		1	2	3	4	5	6	7	8	9	10
25 feet ♂	greatest height[1]	151	212	198	179	148	132	110	81	61	32
	greatest breadth[2]	55	113	124	125	112	111	110	109	64	45
18 feet ♂	greatest height[1]	99	128	128	113	96	84	61	27	—	—
	greatest breadth[2]	42	81	87	78	72	73	68	35	—	—

1) Dorso-ventrally.
2) Antero-posteriorly.

TABLE 8. LENGTH OF RIBS OF THE LITTLE PIKED WHALE FROM JAPAN, STRAIGHT (in mm)

Rib no.	25 feet male		18 feet male	
	Right	Left	Right	Left
1	574	578	413	410
2	868	878	620	621
3	1,042	1,054	714+	716
4	1,079	1,100	737	725
5	1,073	1,092	710	710
6	1,033	1,037+	688	676
7	970	935+	660	651
8	931	935	642	632
9	899	893	611	598
10	888	875	590	586
11	846	810+	592	588

The measurements of the chervon bones are given in table 7. In the 25 feet male, height is greater than breadth in 1st to 6th, same length in 7th, and shorter in 8th to 10th. In the 18 feet male specimen, all chevrons except last two are longer than broader.

RIB

The both specimens from Japan have 11 pairs of ribs (pl. 5). The 1st rib is shortest, but with broadly expanded distal end, the 4th longest. The 11th rib on the left side of the 18 feet male is strongly twisted. A rudiment of capitulum and collum is present on 2nd to 8th. Cowan (1939) states on the ribs of his specimen from British Columbia: 'Ribs 22 in number, 4th rib longest, 3rd heaviest. Combined neck and head not present on 1 and 2, large on 3 and forming a prominent angle on 4 to 8'. There is a rudiment of capitulum and collum also in the 2nd rib of the specimens from Japan, as stated above. Otherwise his statement could be applied to our specimens.

In table 8 are shown the measurements of the ribs on either side of our specimens.

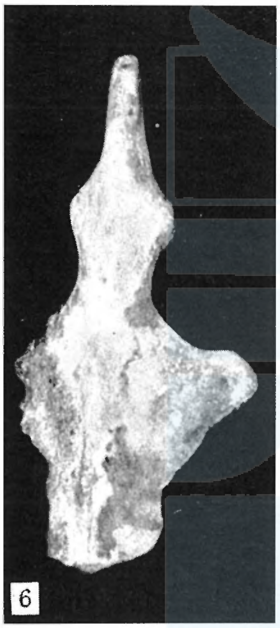

Fig. 6. Sternum of the little piked whale from the coast of Japan. 25 feet male. Ventral view.

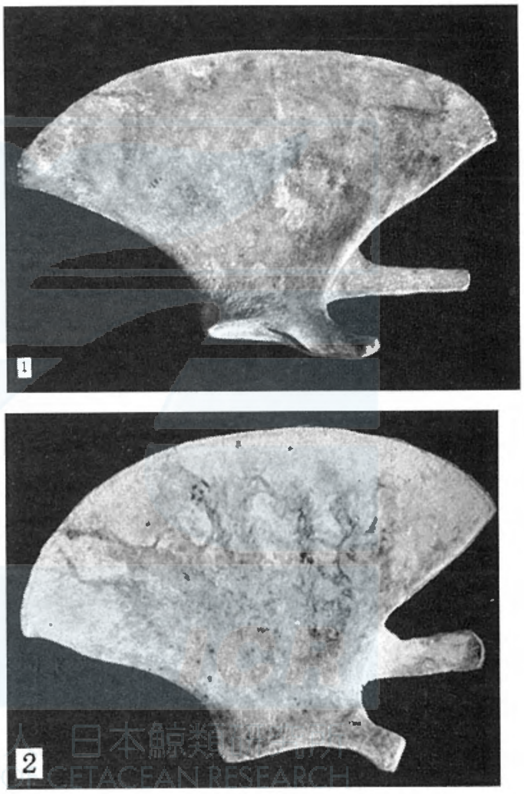

Fig. 7. Scapula of the little piked whale from Japan.
1: 25 feet male. Left side.
2: 18 feet male. 〃 〃

STERNUM

The sternum of the 18 feet male was unfortunately missed. The sternum of the 25 feet male is shown in figure 6. Its antero-posterior length is 339 mm, and the breadth across the transverse arms is estimated as about 225 mm, because of the breakage on the right arm.

The sternum is quite similar in its form to the adult specimen from British Columbia reported by Cowan (1939), and differs from any of the ten specimens from the Atlantic figured by True (1904). Cowan attaches much weight to this character, but since the sternum is to be regarded as a rudimentary organ and subject to individual variation largely, it is thought to have less taxonomic value.

SCAPULA

The scapulae of the 25 and 18 feet males are shown in figure 7 and their measurements in table 9.

TABLE 9. MEASUREMENTS OF SCAPULA OF THE LITTLE PIKED WHALE FROM JAPAN (in mm)

Specimen		Breadth	Depth	Length of acromion[1)]	Length of coracoid[1)]	Percentage of depth against breadth
25 feet male	right	579	365	145	88	63%
	left	572	360	154	91	63 〃
18 feet male	right	388	249	97	44	64 〃
	left	391	246	97	42	63 〃

1) Median

In both specimens their depths are 63 or 64 per cent of their breadth, not differing considerably from those from Atlantic. Cowan (1939) reports that his specimens from British Columbia have relatively broader and shallower scapulae than those from the Atlantic. In his adult individual the height of scapula is only 54 per cent of its breadth and he thought that this character is significant, combined with other characters, for recognizing *Balaenoptera davidsoni* as a subspecies of *B. acuto-rostrata*, should these differences be substantiated. Our specimens have not proved that this is a specific character for the individual from the Pacific.

In table 10 the scapulae of the specimens from Japan are compared with those from other localities, cited from True (1904) and Cowan (1939), expressed as percentages of length of skull. Nothing particular is noted in this table between those from Atlantic and Pacific oceans, excluding that from Pultney Point, B. C., which shows a exceptional value for breadth. It is clear also from this table that the proportional breadth of the scapula increases with age.

The acromions of both individuals are long, slender and recurved, pointing upward, but not broadening at their tips unlikely to those reported by Cowan. The length of the coracoid processes of the 25 and

18 feet males, measured at their median are about 60 and 43 per cent of the length of the acromion respectively.

TABLE 10. COMPARISON OF SCAPULA OF THE LITTLE PIKED WHALE FROM DIFFERENT WATERS

Locality	Length of skull in mm	Percentage of breadth of scapula	Percentage of depth of scapula
Drogheda, Ireland	940	31.8	20.3
Sooke, B.C.	965	32.9	19.7
Mass (U.S.N.M.)	1,105	33.9	20.7
Japan*	1,152	33.7	21.6
Japan*	1,520	38.1	24.0
Norway (U.S.N.M.)	1,537	39.8	22.8
Pultney Point, B.C.	1,549	45.1	24.5
Norway	1,588	37.6	22.4
Cromer, England	1,651	40.8	23.1
Granton, Scotland	1,778	42.9	22.9

* Right side.

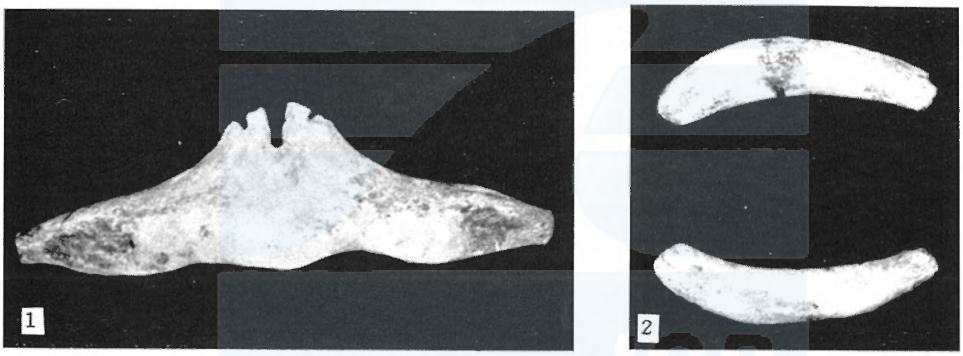

Fig. 8. Hyoid bone of the little piked whale from Japan. 25 feet male.
1: Combined basihyal and thyrohyals.
2: Stylohyals.

HYOID

Hyoid bones of the 25 feet male are shown in figure 8.

Combined basihyal and thyrohyals strongly concave from the dorsal aspect. There is a deep median notch in the anterior margin in both individuals. In addition to this median notch there are two shallower notches in the anterior margin in that of the 25 feet male, on the borders of basihyal and thyrohyals. Otherwise these bones are united completely. None of such notch is present in the hyoid of the 18 feet male. The stylohyals, shorter and slightly curved, exhibit no important features.

Measurements of the hyoid bones of the Japanese specimens are given in table 11 for reference.

TABLE 11. DIMENSIONS OF HYOID BONES OF THE LITTLE PIKED WHALE FROM JAPAN (in mm)

Measurement	25 feet ♂	18 feet ♂
Ankylosed basihyal and thyrohyals		
Breadth in straight	390	288
Antero-posterior length, greatest	112	—1)
〃 〃 〃 , median	85	76
Stylohyal		
Greatest length	R. 243 L. 251	R. 158 L. 161
〃 breadth	R. 50 L. 48	R. 33 L. 35

1) Damaged.

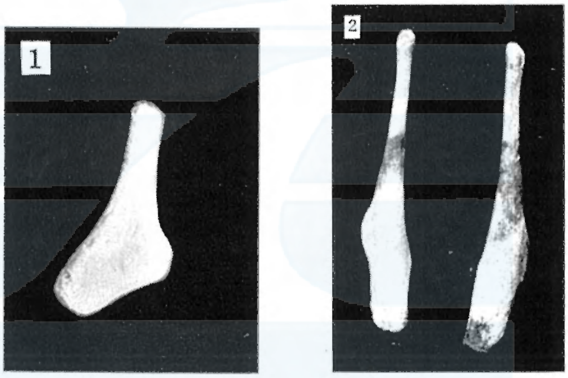

Fig. 9. Pelvic bone of the little piked whale from Japan.
1: 18 feet male.
2: 25 feet male.

PELVIC BONE

The pelvic bones of the two specimens from Japan are quite different in their form from each other, as shown in figure 9.

In the pelvic bone of the 25 feet male the ilium is long and slender, ishium short and broader, and less curved at the pubes, giving a straight outline as a whole. In the specimen of 18 feet male, the ilium is short, more curved at the pubes, making a well-marked promontory. These two forms are different from that of British Columbia as reported by Cowan (1939). But it is probable that the pelvic bone has a little value for taxonomic purpose.

TABLE 12. DIMENSIONS OF PELVIC BONE OF THE LITTLE PIKED WHALE FROM JAPAN (in mm)

Measurement		25 feet male	18 feet male[1)]
Length in straight	R.	174	—
	L.	181	89
Greatest breadth at pubes	R.	27	—
	L.	26	34

1) Right missing.

TABLE 13. MEASUREMENTS OF HUMERUS, RADIUS, AND ULNA OF THE LITTLE PIKED WHALE FROM JAPAN (in mm)

Measurement	25 feet male		18 feet male	
	Right	Left	Right	Left
Humerus, length	251	243	187	189
〃 , diameter at middle	123	118	99	99
Radius, length	407	414	286	284
〃 , diameter at middle	78	76	—	—
Ulna, length between articulating surfaces	385	382	271	269
〃 , 〃 from olecranon	427	420	305	303
〃 , diameter at middle	53	55	—	—

Note. All length were measured with epiphyses.

TABLE 14. PHALANGEAL FORMULA OF THE LITTLE PIKED WHALE FROM JAPAN (INCLUDING METACARPALS)

Specimen		II	III	IV	V
25 feet male	right	4	6 (+1)	7	2 (+2)
	left	4	7	6 (+1)	4
18 feet male	right	5	5	5	4
	left	4	6	5	4

Fig. 10. Humerus, radius, and ulna of the little piked whale from Japan. 25 feet male.

The measurements of the pelvic bone of the individuals from the coast of Japan are shown in table 12.

HUMERUS, RADIUS, AND ULNA

There is nothing particular to remark about the form of these bones in our specimens. The humerus is short and relatively broad, radius and ulna long and slender (fig. 10). Measurements of these bones are given in table 13.

In the 25 feet male each three carpals have been preserved from both sides. In the 18 feet male all carpals have been missed.

Phalangeal formulae of the both specimens are given in table 14.

CONCLUSION

As shown above there is no significant difference in the skeleton, which separates the little piked whale from the coast of Japan from those from the Northeast Pacific or the Atlantic oceans. The cranial properties, vertebral formula, and other osteological characters are virtually identical with the individuals from other localities. The form of the sternum of our specimen is quite similar to that from British Columbia and differs from any of the Atlantic specimens. But I do not think that this difference is of essential value. The conclusion therefore is that we can consider *acuto-rostrata* and *davidsoni* conspecific, which makes the name *Balaenoptera davidsoni* Scammon a synonym of *Balaenoptera acuto-rostrata* Lacépède.

It is suggested that the post-physical maturity increments in the skull would continue antero-posteriorly in the facial region, but the lateral expansion of the skull may cease after attainment of the physical maturity.

Proportional increase of the vertebrae according to the body growth is also studied briefly.

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EXPLANATION OF THE PLATES

PLATE 1

Skull of the little piked whale from the coast of Japan. Dorsal view.

Fig. 1. 25 feet male.
Fig. 2. 18 feet male (A).
Fig. 3. 18 feet male (B).

PLATE 2

Skull of the little piked whale from the coast of Japan. Ventral view.

Fig. 1. 25 feet male.
Fig. 2. 18 feet male (A).
Fig. 3. 18 feet male (B).

PLATE 3

Skull of the little piked whale from the coast of Japan. Lateral and posterior view.

Fig. 1. 25 feet male.
Fig. 2. 18 feet male. (A).
Fig. 3. 25 feet male.
Fig. 4. 18 feet male (A).

PLATE 4

Mandible of the little piked whale from the coast of Japan.

Fig. 1. 25 feet male. Dorsal view.
Fig. 2. 18 feet male (A). Dorsal view.
Fig. 3. 25 feet male. Lateral and inner view of left mandible.
Fig. 4. 18 feet male (A). Lateral and outer view of right mandible.

PLATE 5

Ribs of the little piked whale from the coast of Japan.
Fig. 1. 18 feet male (A). Right side.
Fig. 2. 25 feet male. Left side.

PLATE 6

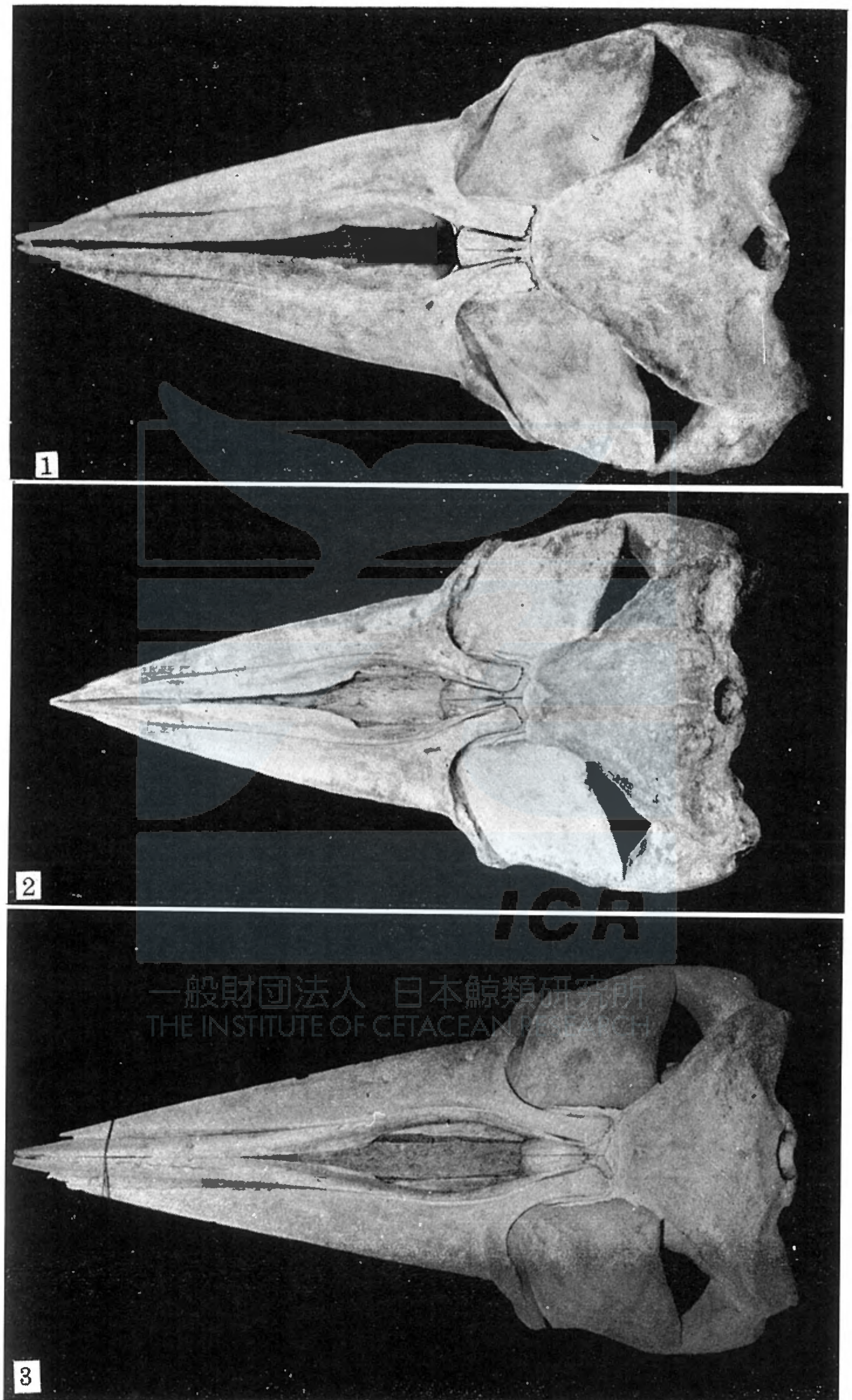
Cervical vertebrae of the little piked whale from the coast of Japan. 25 feet male.
Figs. 1–7. 1st–7th cervicals.

PLATE 7

Cervical vertebrae of the little piked whale from the coast of Japan. 18 feet male (A). Anterior view.
Figs. 1–7. 1st–7th cervicals.

PLATE 8

Vertebrae of the little piked whale from the coast of Japan. 25 feet male.
Fig. 1. 1st dorsal to 6th lumbar.
Fig. 2. 7th lumbar to 7th caudal.
Fig. 3. 8th caudal to 18th caudal.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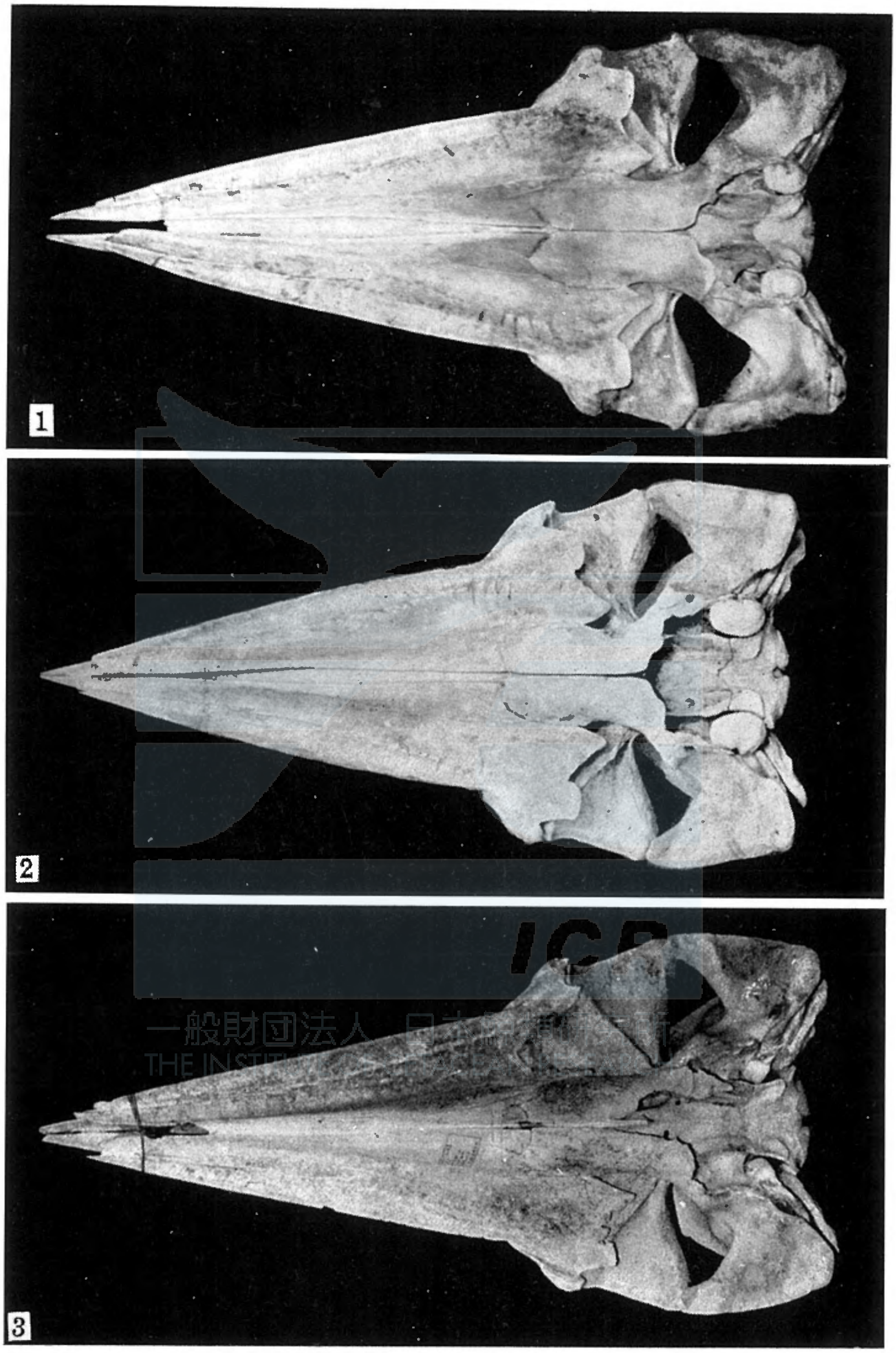
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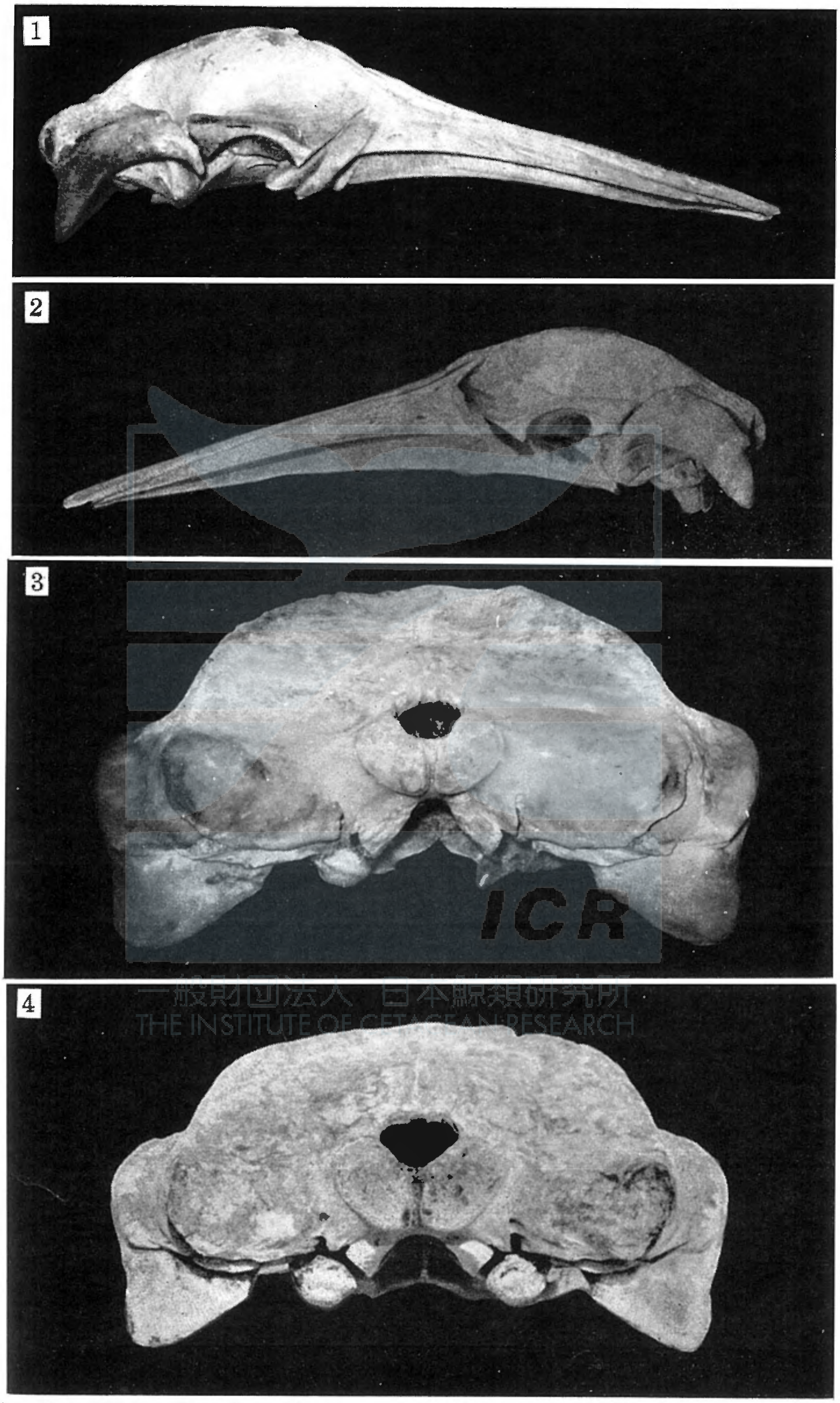
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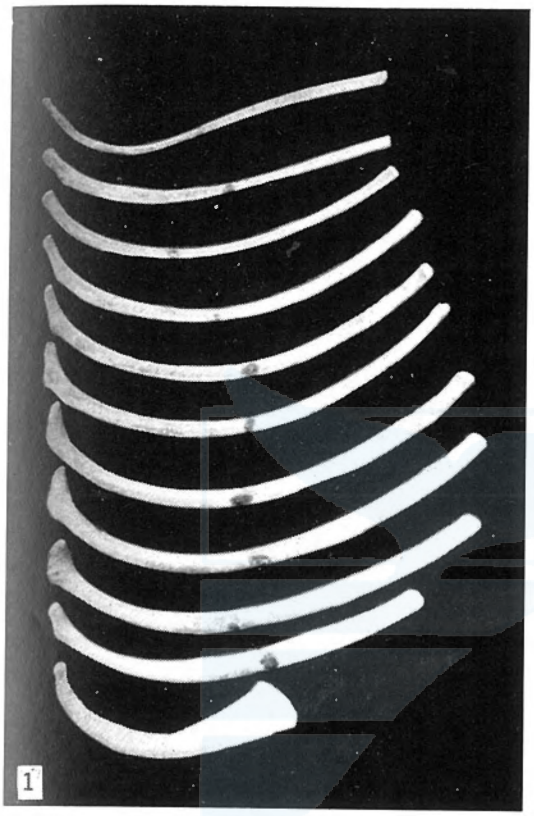
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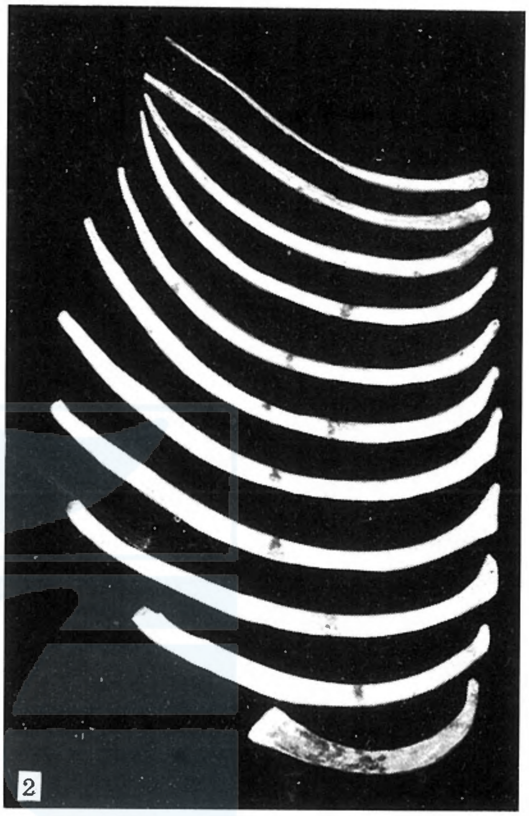
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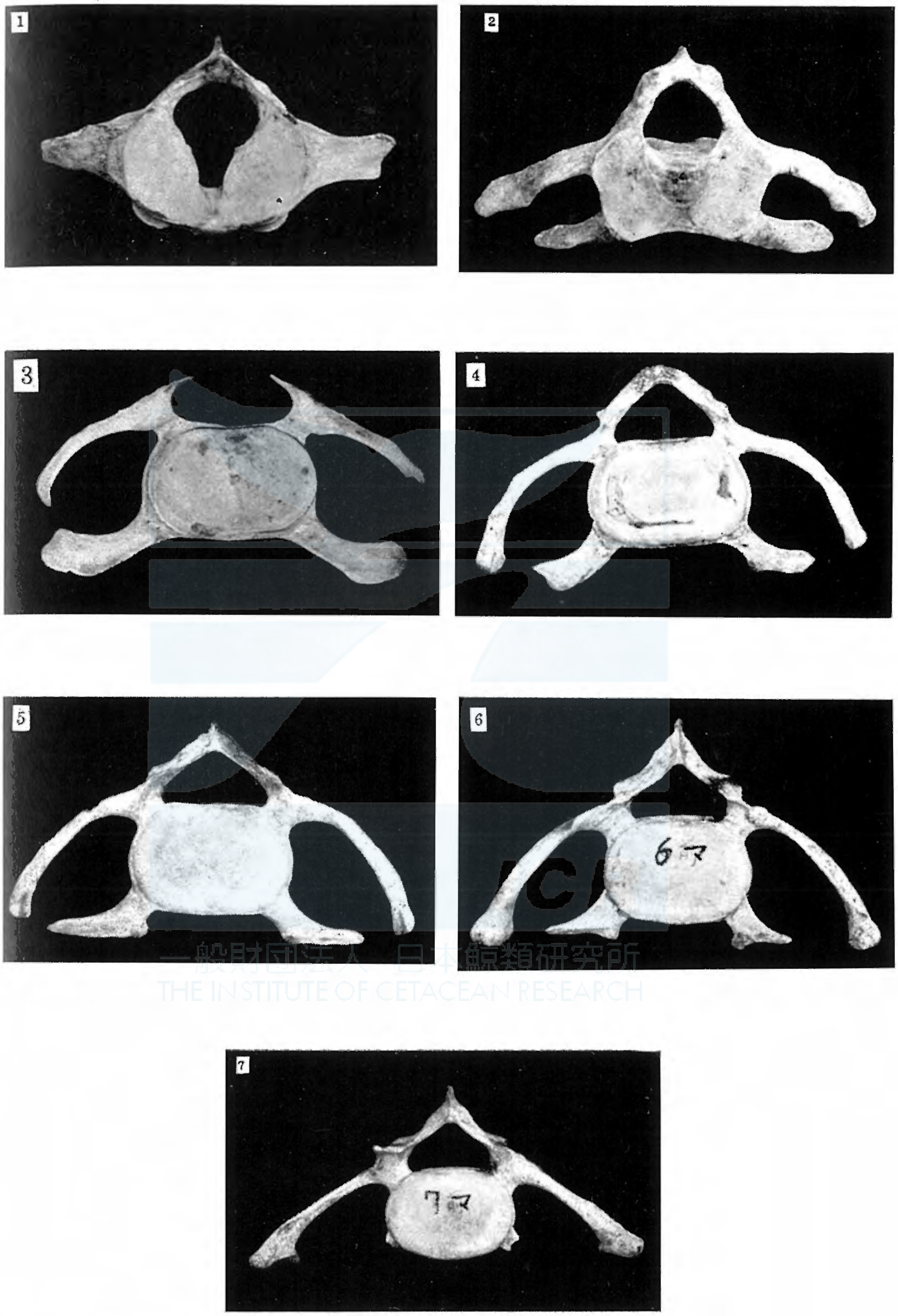
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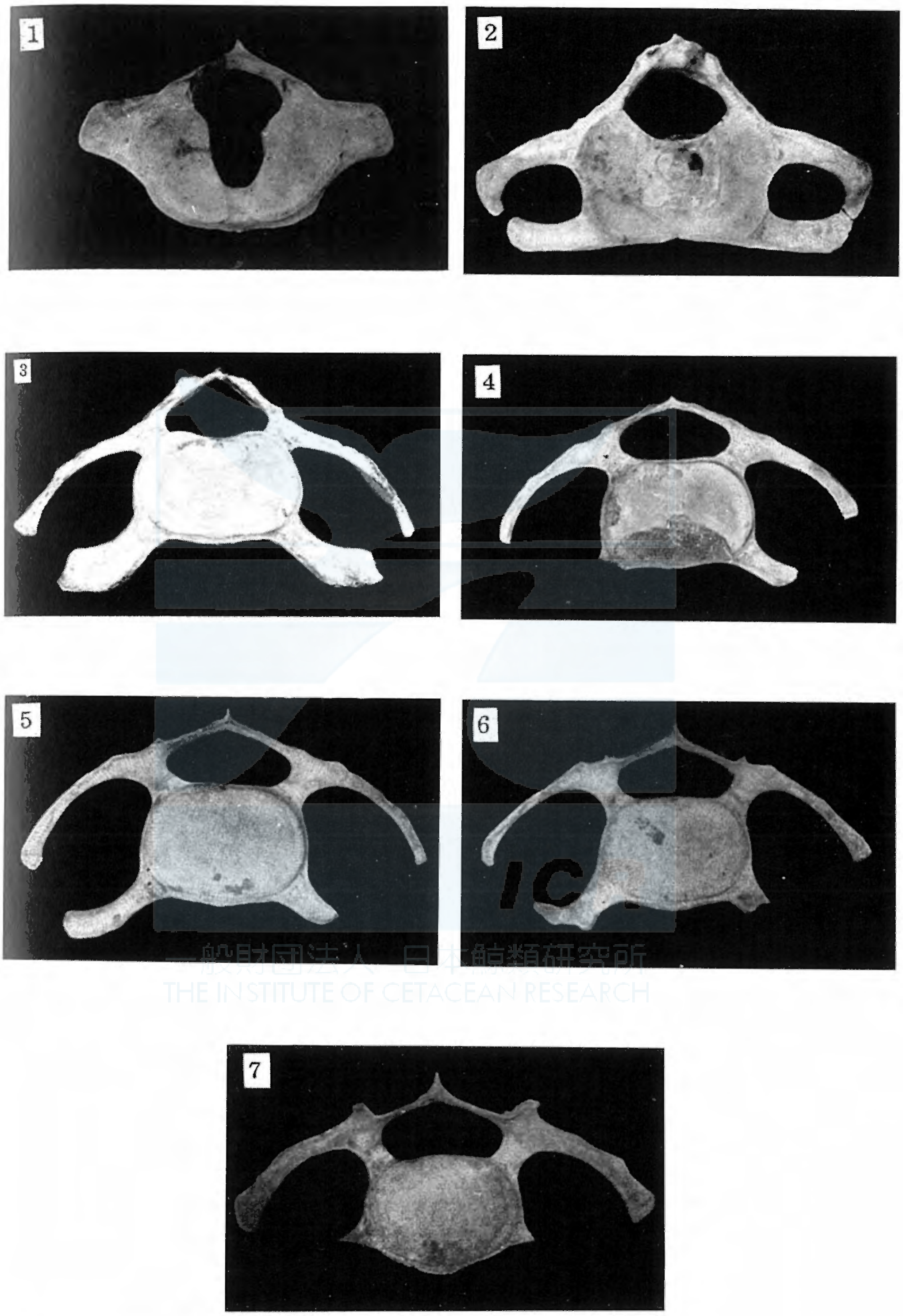
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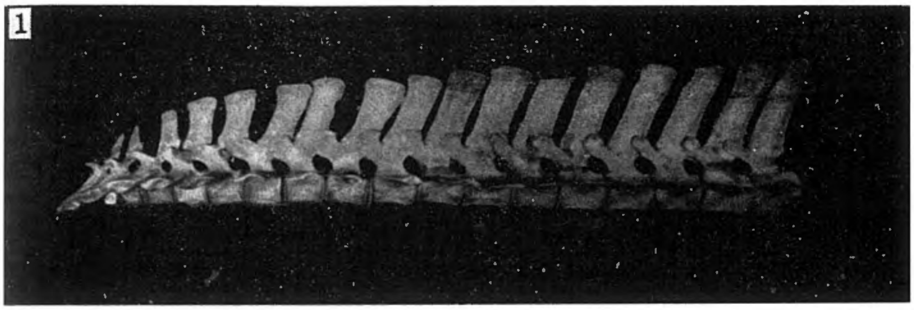

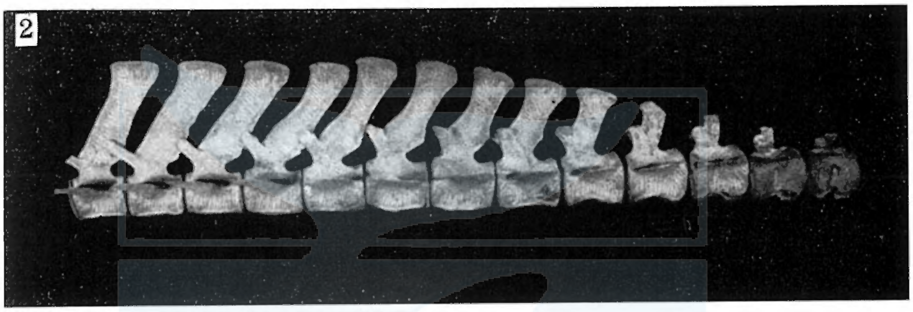

AGE CHARACTERISTICS OF EAR PLUGS OF WHALES

MASAHARU NISHIWAKI

INTRODUCTION

In the course of investigation of the sound conductivity in the Cetacea, especially in the fin whale, P. E. Purves found the lamination of the wax plug fitted in the external auditory meatus. This fact was described in the *Discovery Reports* Vol. XXVII published in March, 1955. To Purves's study many respects are paid by this author, and he supported that the lamination of the wax plug has periodicity very closely connected with age.

Purves further reported on the relation between age and body length at the sexual maturity. But his explanation did not seem quite satisfactory. Afterward Purves with R. M. Laws stated about the ear plug of the North Atlantic fin whale and supplemented the forementioned report. It is not very appropriated that the samples cited in their reports contain more males than females.

On board F/F "Tonan-maru" in the 1955/56 Antarctic whaling season, the author collected several ear plugs from the fin whales mainly females. The lamination of ear plug of these samples was compared with other age-determination data in this report.

Greatful thanks are due to the Nippon-Suisan Co. for help in the collection of the materials on board of the F/F "Tonan-maru". Acknowledgement is especially due to Mr. Kohtaro Ono who assisted the author in collecting ear plug, and it is also due to Mrs. Kazuko Morita who prepared the materials for observation.

MATERIALS AND METHOD OF OBSERVATION

The data of the materials of this report are shown in Table 1. In the collection of samples it so devised that samples as many as available be collected excepting unusual data. On the factory ship, however, every possible care must be taken not to curtail the efficiency of flensing work of collection. To this end the materials were collected only by the author himself and a specified person. This man had no experience of ear plug collection and he carried out this collection as a side work. Next season more samples should be collected to make the data available for age determination of whales taken.

The materials were divided into halves; one part was dried in the air, and the other part was preserved in 10% formalin.

TABLE 1. OBSERVATIONS ON WHALES CAUGHT IN THE ANTERCTIC SEASON 1955/56

Serial No.	Species	Sex	Body length (feet)	Number of lamination	Length of core (mm)	Number of corpora albicantia		Foetus	Weight of testis (kg)	Age-group from baleen	Absorption of crystalline lens	Ossification of vertebra
10T 285	F	F	60	4	13	0 0	0 0	−		III	94	
〃 286	〃	〃	74	44	42	0 0	15 12	+		V	79	T6:A
〃 363	〃	〃	68	20	31	1 0	1 2	+		IV	86	
〃 364	〃	〃	73	53	71	1 0	17 15	+		VI	83	
〃 376	〃	〃	73	45	57	1 0	8 9	+		V	82	
〃 397	〃	〃	59	7	20	0 0	0 0	−		II	93	
〃 485	〃	〃	73	49	48	1 0	5 5	+		VI	77	
〃 498	〃	〃	73	31	54	1 0	7 5	+		V	84	T6:N
〃 499	〃	〃	76	23	54	1 0	6 3	+		VI	85	T10:N
〃 534	〃	〃	62	12	29	1 0	0 0	+		IV	92	
〃 535	〃	〃	70	41	68	1 0	6 5	+		V	87	T3:a, T6:a T10:A, L1:A
〃 567	〃	〃	74	65	44	1 1	20 18	+		V	74	
〃 585	〃	〃	69	41	55	1 0	6 8	+		V	84	T7:a
〃 776	〃	〃	53	6	17	0 0	0 0	−		II	93	
〃 837	〃	〃	74	64	87	1 0	15 16	+		VI	78	
〃 924	〃	〃	74	61	85	1 0	11 15	+		VI	80	T7:a
〃 958	〃	〃	70	18	64	1 0	3 2	+		VI	85	
〃 1022	〃	〃	72	55	61	0 0	7 15	−		VI	78	
〃 1028	〃	〃	72	32	37	1 0	3 10	+		VIII	83	
〃 1058	〃	〃	72	70	70	1 0	17 22	+		VI	75	
〃 1069	〃	〃	65	9	16	0 0	0 0	−		IV	91	
〃 1320	〃	〃	73	37	52	1 0	8 13	+		VI	86	
〃 1400	〃	〃	70	29	71	1 0	3 3	+		VI	82	T7:n
〃 1431	〃	〃	72	50	63	1 0	8 15	+		VI	78	
〃 1440	〃	〃	70	13	38	1 0	2 1	+		VI	90	

TABLE 1. (*Continued*)

Serial No.	Species	Sex	Body length (feet)	Number of Lamination	Length of core (mm)	Number of corpora albicantia	Foetus	Weight of testis (kg)	Age-group from baleen	Absorption of crystaline lens	Ossification of vertebra
10T1471	F	F	62	10	27	0 0 0 0	–		IV	91	
〃 1522	〃	〃	72	23	53	1 2 0 4	+		VI	88	T7:N L1:n
〃 1551	〃	〃	72	17	34	1 1 0 2	+		V	89	
〃 1585	〃	〃	71	56	90	0 9 0 10	–		VI	82	
〃 1613	〃	〃	70	28	33	1 5 0 2	+		V	86	
〃 1705	〃	〃	62	13	34	0 0 0 0	–		IV	86	
〃 1755	〃	〃	72	86	85	1 21 0 31	–		VII	72	
〃 1780	〃	〃	75	37	63	1 12 0 6	+		VI	80	
〃 1820	〃	〃	62	9	29	0 0 0 0	–		IV	90	
〃 131	〃	M	58	17	31			1.7 1.6	III	90	
〃 319	〃	〃	62	33	49			over 10.0 〃 10.0	III	81	
〃 1023	〃	〃	62	29	46			10.0 10.0	IV	88	
〃 1025	〃	〃	64	34	26			4.7 4.5	IV	82	
〃 1352	〃	〃	66	25	37			over 10.0 〃 10.0	V	87	
〃 603	B	F	81	10	25	1 0 0 0	+		V	88	
〃 605	〃	〃	85	12	26	0 1 0 2	–		VI	85	
〃 1162	〃	〃	80	8	26	0 1 0 0	–		VI	90	
〃 628	H	〃	47	20	34	1 2 0 5	+		IV	84	
〃 727	〃	〃	41	25	84	1 5 0 3	+		V	79	T6:N L1:N

Species: F=fin whale; B=blue whale: H=humpback whale.
Sex: F=female; M=male.
Ossification: T=thoracic; L=lumbar; A=ankylosed, no sign of join;
a =ankslosed, but a sign of join visible; n=not ankylosed, thin cartilag;
N =not ankylosed, thick cartilage.

The lamination of ear plug was observed by two method. As the first step the lamination was read by X-ray photographs. In this case the lamination of the dried materials could be observed clearly than the formalin preserved materials. In the young viz. thick lamination materials were read easily, but in the aged viz. very thin lamination materials were hard to read according to the two preservation methods. The other method was to grind down the ear plug to the level of the longitudinal axis. The lamination was observed with a magnifying-glass or a dissecting-microscope. In this case the dried materials with thin lamination were defective, because they were broken into drops. The formalin preserved materials were suitable for grinding down, because they had moderate stickness and hardness. But the young viz. soft materials were not suitable for grinding down by the two methods. It was thought that they would be better to be observed by X-ray.

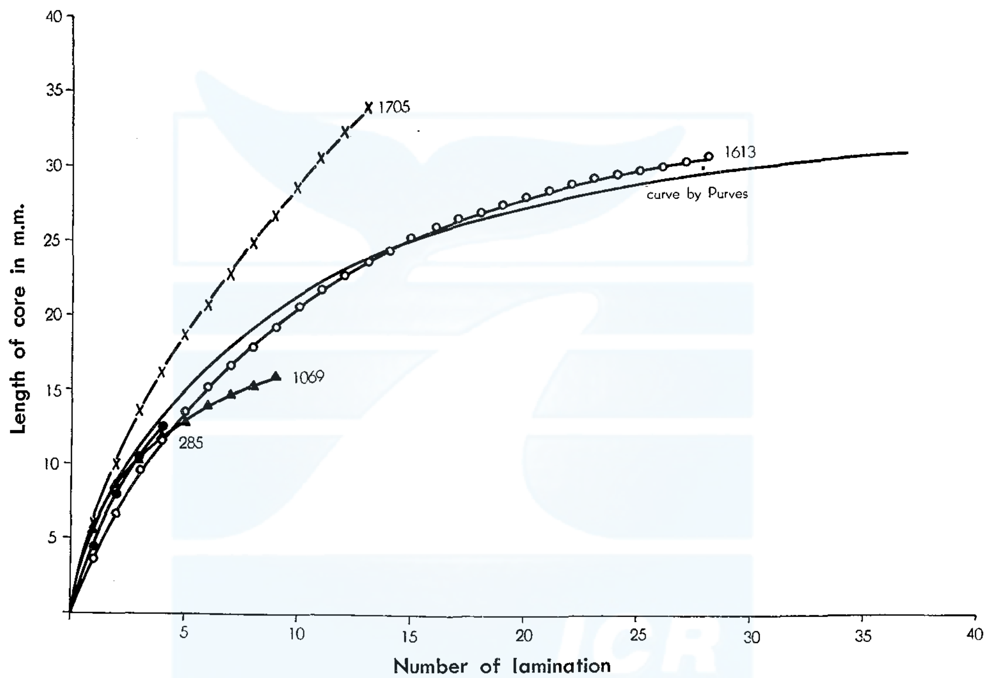

Fig. 1. Growth curve of the core of the ear plug in several fin whales.

DISCUSSION

Purves illustrates the growth curve of the core of wax plug in respect to a male specimen from the southern hemisphere with the same number of laminations as Lillie's specimen. On the right side of his illustration, he writes down the body length corresponding to the age shown by the number of laminations. In the impression from this figure is that the growth curve is very systematicaly and that the number of laminations may be presumed from some length of core. And further more, it seems that some rule may exist between the length of core and the body length.

As shown in Fig. 1, a sample (10T1613=No. 1613 whale of 10th "Tonan-maru" expedition), which has almost the same growth curve illustrated by Purves, was collected. Some samples (10T285, 10T1069) in young stage viz. few number of laminations showed nearly the same growth with Purves's curve. These samples were measured regarding the thickness of each lamination according to the method of Purves. On the other hand, it was quite different in the case of the length of core which is the sum of the thickness of each lamination. These data are shown in Fig. 2. Each sign is plotted against the length of core

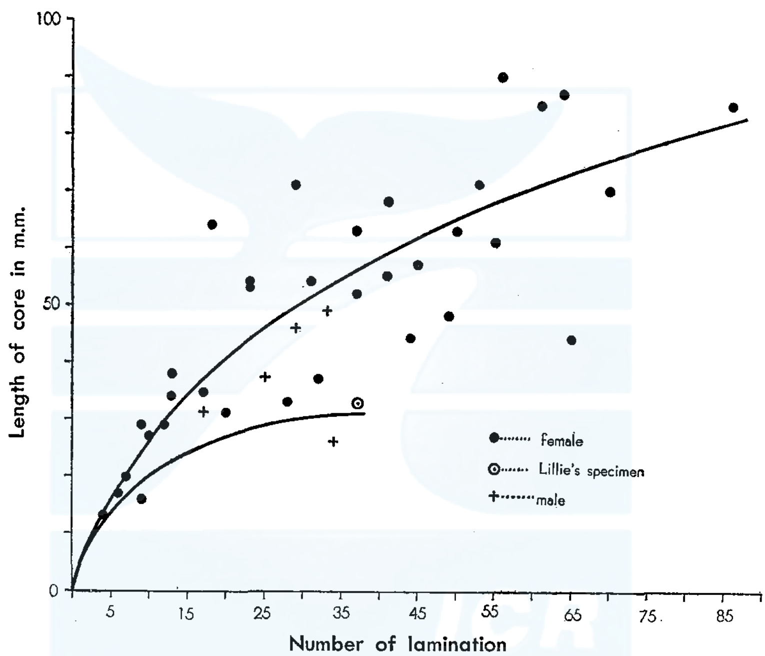

Fig. 2. Variation of core length in different ear plug.

of ear plug in individual whales according to the number of laminations. There are many variances in these plotted points, and big individual variations are found in the increase of the thickness of lamination. Then, the example of the same number of laminations as in Lillie's specimen shown by Purves seems to be an example of the least growth. This fact is clarified in *The Norwegian Whaling Gazette* No. 1 of 1956 by examples of H. W. Symons (Symons exampled only length of plug, except length of core or number of lamination).

The relation between the number of lamination and the number of corpora albicantia is shown in Fig. 3, The straight line in the figure shows an average. The variances are relatively small and the relation is settled well. Marks (+) in the figure are the data from Laws and Purves. These data are limited and on young stages only, so they do not seem to explain the aspect, but they are in the approval limit of the average line. From Fig. 3 it is considered that 10 laminations are evenly matched to 1 corpus albicans. If the explanation of Purves refers to 10 laminations, that will take 4-5 years just to reach the sexual maturity. This age does not coincide with the principle of Mackintosh which was cited in the report of Purves, but coincides which the age of sexual maturity in the report of the author formerly published.

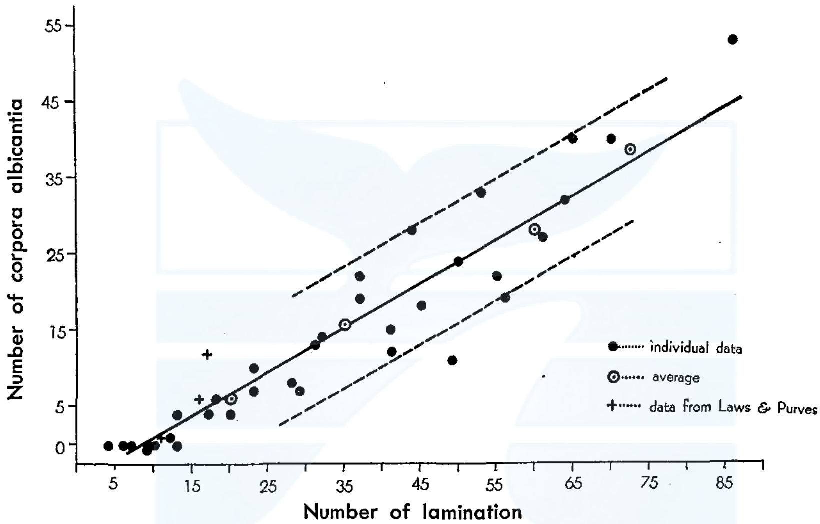

Fig. 3. Relation between number of corpora albicantia and number of lamination in the ear plug.

If the two laminations grow up in a year, on the average line of this figure the ovulation is formed at the average rate of 2.4 per one breeding season. This fact almost coincides with the present studies in this field. Next regarding the body length according to the number of corpora albicantia (in Fig. 4) and the number of laminations (in Fig. 5), it was expected that the co-ordinates of the number of corpora albicantia and the number of laminations would be placed by the average rate in Fig. 3. But they are not the same in these figures. Owing to the shortage of data, it might exaggerate the fact, but, the average line is much the same in Figs. 4 and 5. In Fig. 4, nothing of corpora albicantia is minimum, so it is impossible to prepare the immature females. On the other hand, Fig. 5 shows that the immature females may be possible to be classified according to the number of laminations (or in some age groups). It is very useful that male's data can be compared in the female's figure with the same values. In the other study, it was observed

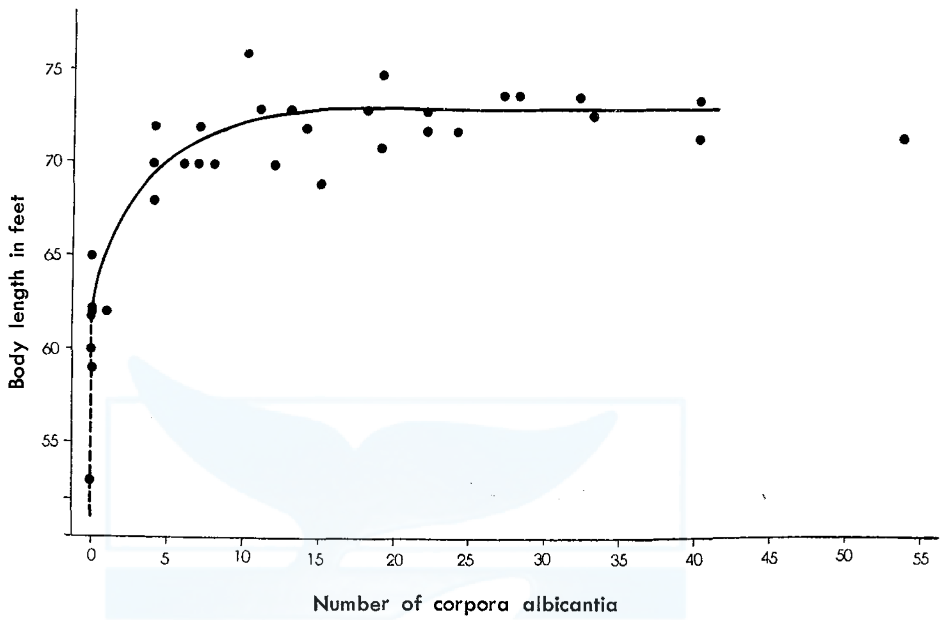

Fig. 4. Increase of body length according to number of corpora albicantia.

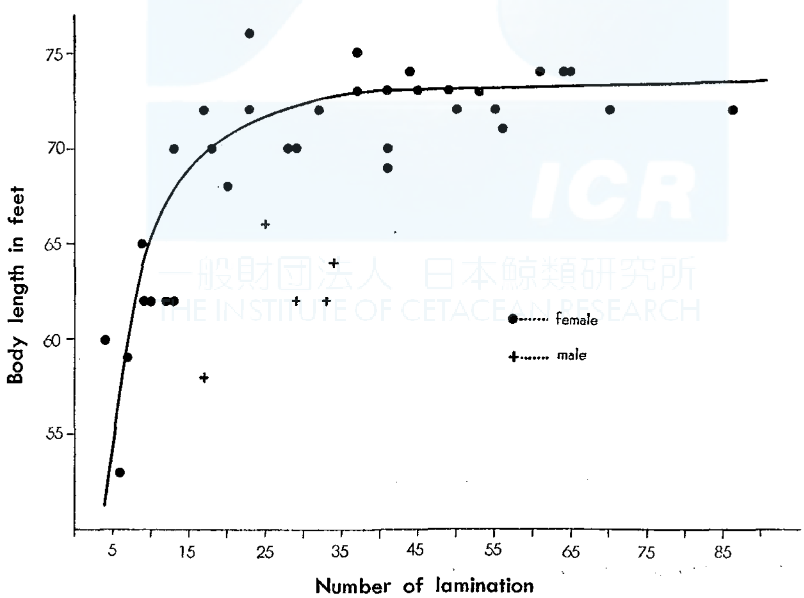

Fig. 5. Increase of body length according to number of lamination in the ear plug.

that the female fin whale of the southern hemisphere attained to the sexual maturity in 64 feet of body length and reached the physical maturity at 14–15 of corpora albicantia numbers. On the average line

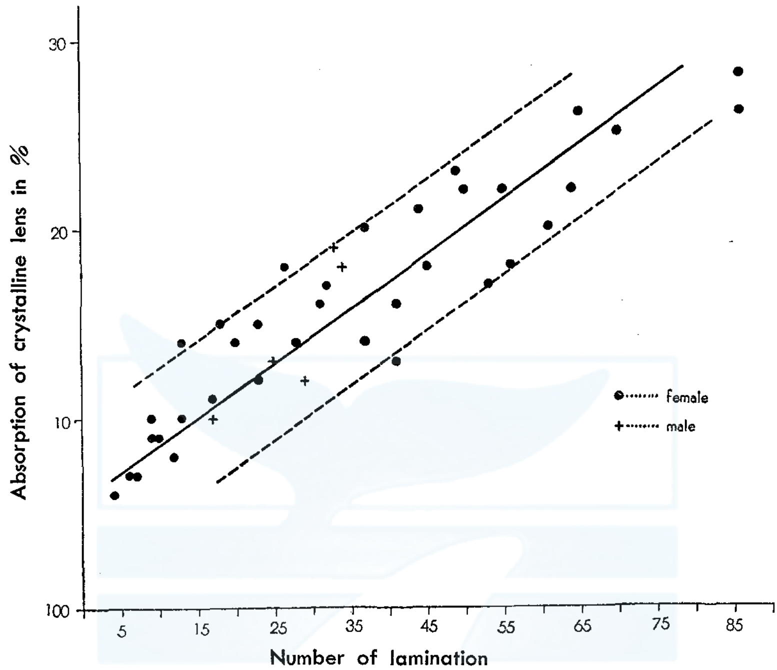

Fig. 6. Relation between light absorption of crystalline lens and number of lamination in the ear plug.

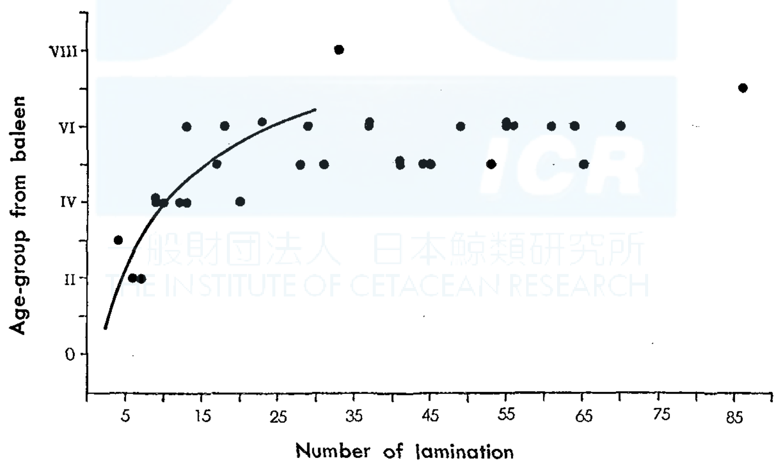

Fig. 7. Relation between estimated age from baleen and number of lamination in the ear plug.

of body length in these figures, the body length at sexual maturity is just the same as that study. It is considered that the number of lamination at the sexual maturity is 10, and that the age is 4–5 years.

The points sidling along the average lines of these figures are considered to show their attaining to the physical maturity, and they at 14–15 of corpora albicantia and 30–35 of laminations viz., 15–17 years. The data shown by Laws and Purves are not quoted here because the growth rate of the fin whale body length is considered to have some differences between northern and southern hemisphere.

In the previous study of the author, he stated that the absorption of crystalline lens was also increased with age. Now the relation between the number of lamination and the absorption of crystalline lens is shown as a straight line as in Fig. 6. But the variance is larger than the relation by number of corpora albicantia. The author suggested in his previous reports that the absorption of crystalline lens would be possible to compare the data of males and females with same values. But now since the ear plug has proved to furnish more accurate data. If these fact are correct, the observation of the absorption of crystalline lens would not be needed in future.

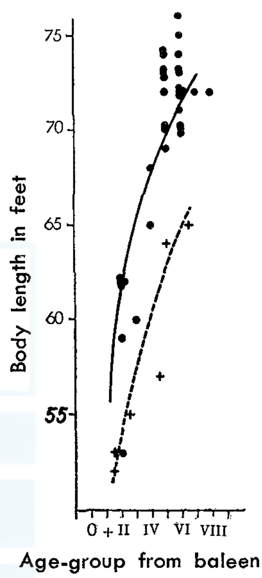

Fig. 8. Increase of body length according to age estimated from baleen.

The data of the age group from baleen plates are shown in Fig. 7 with the number of lamination. The regular relation is expected make a rectilineal change. But with advance in age from baleen the growth curve shows a sidling rightward curve. This is by because the tip of baleen plate is chipped, and does not show the regular age. As stated in the previous report, there are large individual variations in the age when the tip of baleen begins to chip away. The growth curve of body length according to age-group from baleen is shown in Fig. 8. But its accuracy is not so high as others. The data of Laws and Purves as shown in dotted line do not coincide which may show the difference of the fin whale body length between the northern and southern hemi-spheres. The important characters of the age data from baleen plates are concerned with the period where the plates does not chip away (under III or IV). The data of this period and the number of laminations are considered to constitute important subjects of future study.

CONCLUSION

This report is an introduction of the joint study on the ear plug observations which will begin in the near future.

1. The materials can be collected easily on a factory ship.
2. Keeping in 10% formalin solution is the best method for preservation of the ear plug.
3. It is easy to grind down the aged or hardened materials, but the best observation method of the young or soft materials is to take X-ray photograph.
4. The age characteristics of the ear plug are found clearily in the number of laminations, but there are considerable variations in the length of ear plug, the length of core and the weight of ear plug.
5. The female fin whales of the southern hemisphere reach their sexual maturity in 4–5 years, then their ovulation is formed at the average rate of 2.4 per one breeding season.
6. They attain to their physical maturity in 15–17 years.
7. The absorption of crystalline lens is comparatively difficult to survey, and does not offer the better data than the lamination of the ear plug.
8. It is considered necessary to make studies on the ear plug of the whales whose baleen plate have not yet chipped away.

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FOODS OF BALEEN WHALES IN THE NORTHERN PACIFIC

TAKAHISA NEMOTO

It is well known that the food item of whales is one of the most important problems on the biology of whales. Many studies on foods of whales have been carried out up to the present in the Atlantic and Antarctic waters by many excellent biologists. After Mackintosh & Wheeler (1929) investigated the foods of southern blue and fin whales, Ruud (1932) and Hardy & Gunther (1935) made also comprehensive studies of biology of food planktons. Recently, Peters (1955) discussed some biology of *Euphausia superba*, the main food of whales in the Antarctic baleen whales, and Marr (1956) also discussed the relation between *Euphausia superba* and surface currents of the sea in his preliminary paper. In the northern Atlantic, Hjort & Ruud (1929) and Einarsson (1945, p. 159–160) described the importance of copepods and euphausiids as foods of whales refering to many previous papers. On the other hand, though considerable attentions have been paid to the foods of whales, comparatively little is known of the problem in the northern Pacific before the year 1942. The previous nots on the problems are found in papers by Zenkovitch (1937), Hollis (1939), Ponomareva (1949) and some others. Recently, useful works have been carried out one after another by many biologists to which I refer in the suitable columns of this paper as occasion demands.

In the summer of 1952, the staffs of the Whales Research Institute in Tokyo entered into the studies on foods of whales in order to study the biology of whales and planktons. Thus during the last six years, a large amount of data on foods of whales have been collected through Japanese whaling expeditions. In addition, plankton samples collected in vertical hauls with plankton nets also amount to a considerable number. The present studies is designed to describe the outline on the relation between whales and their foods mainly based above samples. Some biology of euphausiids which consist important parts of foods of whales is also investigated to some extent in this paper.

I would like to express my sincere thanks to Dr. Hideo Omura, the director of the Institute for suggesting this investigation as well as for constant guidance. Thanks are also due to Dr. Yoshiyuki Matsue, Professor of the University of Tokyo and Mr. Yuzo Komaki for valuable suggestions in the course of this work. I am also indebted to Dr.

Albert, H. Banner and Dr. Brian, P. Boden for sending me kindly valuable reprints on euphausiids and kind personal communications.

MATERIAL AND METHOD

The present paper is mainly based on stomach samples of whales captured in the northern part of North Pacific for three years since the year 1954 to 1956, and data on quantity and freshness of stomach contents collected by inspectors and biologists through Japanese whaling expeditions since the year 1952 to 1956. The main part of above materials have been collected by following inspectors and biologists on board.

1952 Haruyuki Sakiura, Katsunari Ozaki, Kazuo Fujino.
1953 Yasutake Nozawa, Iwao Takayama, Takahisa Nemoto.
1954 Setsuo Nishimote, Tamenaga Nakazato, Takehiko Kawakami, Ikuyo Hasegawa, Kazuo Fujino, Seiji Kimura.
1955 Yasutake Nozawa, Saburo Ikeda, Kenichi Iguchi, Kazuo Fujino.
1956 Heihachiro Kawamura, Sumio Matono, Sadao Ishii, Seiji Kimura.

The method of observation on stomach contents has followed the one adopted by previous works (Mizue, 1952 and others). Stomach contents in the first stomach are classified into following species.

Euphausiids
Copepods (mostly Calanoids including *Metridia* species in rare cases)
Fish
Squids

Then, the quantity of stomachs is divided into following classes.

Classes	0	r	rr	rrr	R
Condition of stomachs	Empty	Few	Moderate	Rich	Full

The freshness of the stomach contents is also determined by following grades.

Grades	f	ff	fff	F
Condition of contents	Nearly digested	A little digested	Fresh	Very fresh

Above classifications are made by naked eyes, and not so exact in strict sense. The stomach samples have been collected from a part of contents on board, washed for some times and preserved in 10 percent formalin sea water. The sampling of zooplanktons by plankton nets in the whaling grounds has started in the spring of 1953. Present study is mainly based on the materials collected during the year 1955, through the whale marking cruise by 'Konan Maru No. 5'. All the samples have been taken in vertical hauls with the special net for zooplanktons: Mouth diameter—45 cm; length 80 cm, shape conical, materical synthetic-resin-processed silk grit gauze 54 (aperture 0.33 mm). All plankton samples have been preserved also in 5-10 percent formalin sea water. The sample divider has been used for the fractioning of above samples. The plankton number in a sample is obtained from the multiple inverse proportional to the fractioning. On some of zooplanktons body length is measured for further investigations. Euphausiids are measured from the tip of the rostrum to the end of the telson with an accuracy of 1 mm or 0.5 mm for the smaller specimens, being straightened out on a measuring glass. Copepods are mesured the cephalothorax length with a built in micrometer with bioculer microscope. The papers and books used for the identification of plankton species are listed in the last part of this paper.

WHALING GROUNDS

HYDROGRAPHY

The whaling grounds where now Japanese pelagic whaling operates are all *feeding area type* whaling grounds. Almost all whales swarm on their foods, and the concentration of whales for their reproducting never be considered. Mating grounds, such as whaling grounds off Lower California for grey whales, is considered to be in far south regions. And all Japanese pelagic whaling grounds are situated at the northern part of North Pacific.

Oceanographical studies on these parts of the North Pacific have been carried out by Uda (1935), Barnes & Thompson (1938), Mishima & Nishizawa (1955) and some other workers. Fleming (1955) has advanced, in recent years, a general summery of the oceanographycal conditions of the North Pacific. This conception will surely prove to be of the greatest use for the comprehension of the biological conditions in the whaling grounds. Brief quotations of the review may, therefore, be of interest. I will chiefly use quotations from the paper by Fleming on the point.

Fleming has divided the northern pacific to 3 zone, Boreal zone, Subarctic zone and Central zone. Japanese whaling grounds lies in Boreal and Subarctic zones after his divisions. Fleming, further, points out characteristics of above divisions of zones. Boreal zone is divided into five regions as shown in figure 1. These five regions are as follows:

1. *Kamchata-Kurile coastal region*—Southerly flow of cold, dilute, nutrient-rich. Mostly ice-covered in winter.
2. *Western gyral region*—Irregular currents but average counterclockwise circulation. Very high nutrient content. Strong mixing between Aleutian Islands. Includes part of Alaskan shelf.
3. *Alaskan coastal region*—Northerly flow of warm, dilute, medium nutrient-content water. Mostly Ice-covered in water. Shallow area having an irregular coast with many rivers.

4. *American coastal region*—Northerly flow north of about 50°N and southerly in lower latitudes. Salinities low because of local precipitation and runoff. Temperatures relatively warm in northern part. Nutrients variable but usually moderate to high. Generally irregular coast.

5. *Alaskan gyral*—Subarctic water that turns northward and forms a counterclockwise gyral. Salinity moderate. Temperature relatively high. Divergence supplies nutrients so that content is generally high. Precipitation high. Deep area.

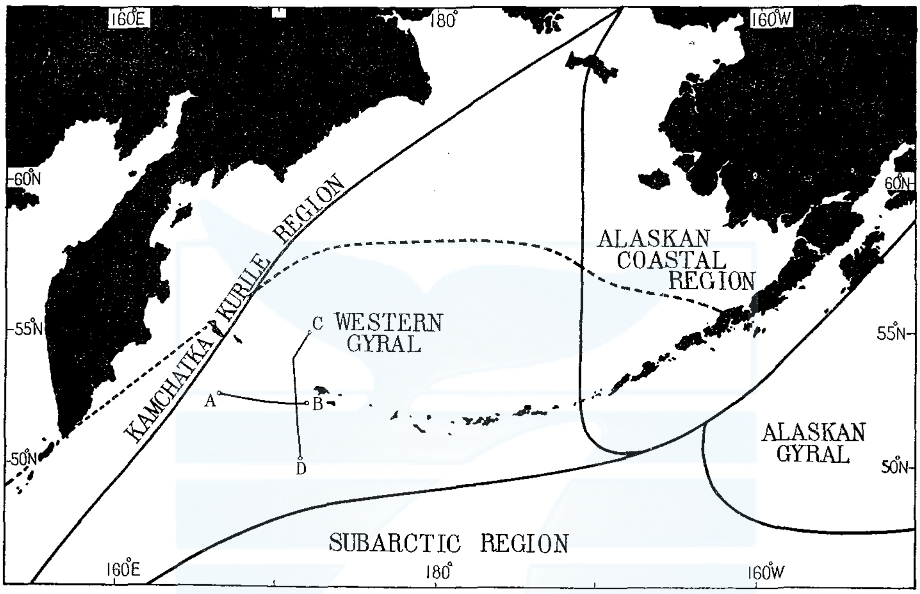

Fig. 1. Natural regions of the northern Pacific Ocean; Broken line—February ice limit. (Divisions follow the figure by Fleming, 1955).

Main Japanese whaling grounds locate along the boundary regions between *Kamchata-Kurile coastal region* and *western gyral region*, between *Alaskan coastal region* and *Alaskan gyral*. Other main whaling grounds locate in the adjacent waters to Aleutian Islands and along the slope of the continental shelf of Alaska. The boundary between subarctic region and boreal zone may have also some value for our pelagic whaling though there has been no observation for whales. The central zone called by Fleming is considered to has no weight for Japanese whaling. From the year 1952 to 1953, Japanese expeditions operated chiefly in the waters of the south-western side of the Aleutian Islands. On the sea condition of the area in early summer, Mishima & Nishizawa (1955) describe that, 'A warm water mass of low salinity is found to flow east to west. It reaches as far west as longitude 165° east, on its way spreading several branches into the Bering', and 'A large clockwise eddy of this water is thus formed to the south or south west of Attu Island'. Whaling grounds lie along above eddy, the boundary between the cold current of low salinity along the eastern side of Kamchatka Peninsula. And a whaling grounds is formed on the branch of above stated cold current bent east from the southern end of that peninsula and flows along the Aleutian Ridge. Japanese whaling factory ship 'Kinjo Maru' operated in early summer in 1954 on the branch

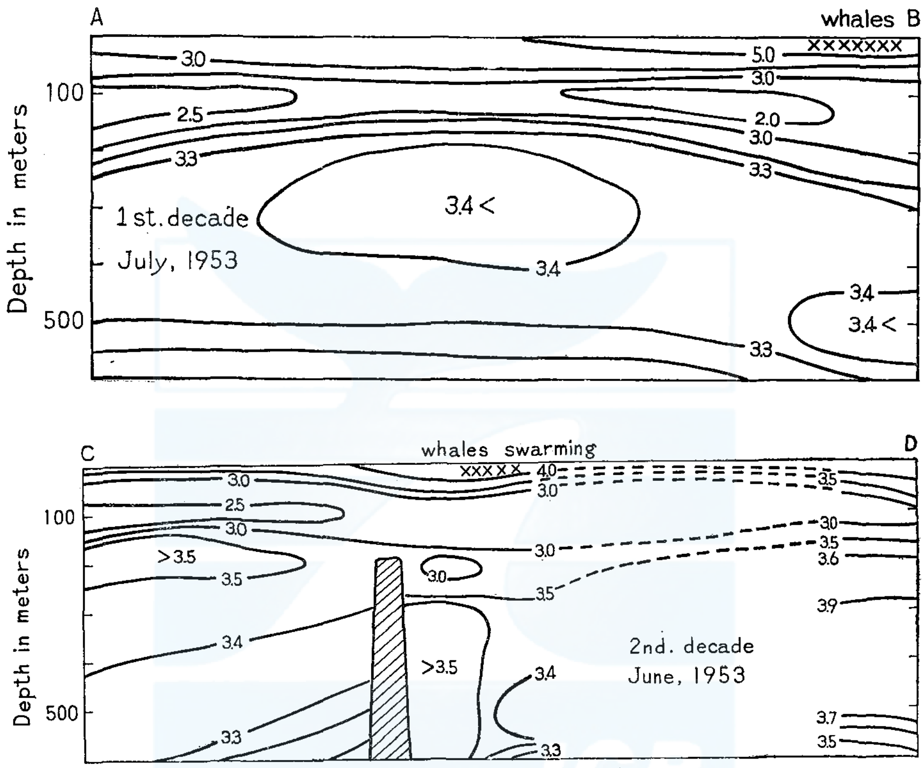

Fig. 2. Vertical distribution of temperature in sections A–B and C–D illustrated in figure 1. (Drawn by K. Nasu).
Crosses—Whales are swarming

and caught considerable number of fin whales. From the data of temperature obtained by the 'Tenyo Maru' cruise in summer of 1953 (Watanabe, 1954), two vertical sections of isotherms are drawn by Keiji Nasu of the Whales Research Institute. In section A–B, the surface water temperatures are higher than 4°C in first decade of July, and the subsurface layer (sensu Mishima & Nishizawa, 1955) is found at 100 m level. The boundary of such cold layer, that is, the sea region under where the cold layer is found, is considered to be good whaling grounds (Uda, 1953; 1954; Uda & Nasu, 1956). In fact, the tendency that whales swarm in such regions has been observed as shown in figure 2. I have observed above tendencies also in the data of the 'Takunan

Maru No. 6' in the adjacent sea waters to Japan in 1955. Some biological result of the latter cruise is also discussed in this volume. In addition to this type of whaling grounds Ruud (1932) fully discussed the general summery to the whaling grounds. Ruud describes, 'if, therefore, an area of production is to possess any importance as a rendezvous of whales there must be a concentration of Krill there. Such concentrations are found in the area of convergence, in backwaters, in the vortices of mixed layers, and at the centre of areas where there is a cyclonic movement'. Such centre area of cyclonic movement is the most favourable whaling ground also in northern hemisphere as discussed by Uda (1954).

Barnes & Thompson (1938) made compehensive study on the north part of the eastern Aleutian Islands and Bering Sea. By their studies the surface currents of north of the Aleutian Ridge, parallele the ridge towards the east near Bogoslof Island, then swing north in the vicinity of Unalaska Islands as the water met the continental shelf and then double back along the shelf as it heads to the north-west just south of the Plibilof Islands. Thus, the upwelling current along the continental shelf by the currents, and backwaters between above currents and the water from Bristol Bay and Yukon Delta, are valid causes for the formation of whales' swarming.

The ice covers the northern half of Bering Sea in winter (Fleming, 1955; Pilot chart of the North Pacific Ocean, 1955), where considerable number of fin, humpback and gray whales are swarming. This migrations of fin, humpback and gray whales to the arctic sea through Bering Strait is proved by the catch data of Japanese whaling expedition in 1940. Whales in these area in summer must retreat to south waters from there before ice prevailing the area exept few whales which inhabit among the broken ice or narrow uncovered sea areas.

WHALING GROUNDS AND CATCH

Japanese northern Pacific pelagic whaling expeditions have been operating since the year 1952. Outlines of the whaling in the North Pacific is discussed by Omura (1955). He also disscusses on the brief history of pelagic whaling in the northern part of the North Pacific. So, I only state short review of the problem here.

Whaling grounds. Japanese main whaling grounds lie along Aleutian Islands, Komandor Islands and off Kamchatka Peninsula as shown in figures 1 and 3. These whaling grounds may be divided for convenience into four grounds. Namely, A ground: the south part of Komandor, off Kamchatka Peninsula and west south of Attu Islands; B ground;

the north part of Komandor Islands; C ground: the north part of the eastern Aleutian Islands; D ground: the south part of the eastern Aleutian Islands. The first whaling grounds divided, by further observations, into two subdivisions. The longitude line 168° east may be the appropriate line by which the first whaling grounds is divided. Japanese whaling expeditions operated only in A ground in years 1952 and 1953. Successive expeditions in 1954, and 1955 operated also in C and D whaling grounds. In 1956, Japanese whaling have operated in B ground besides above A, C and D grounds.

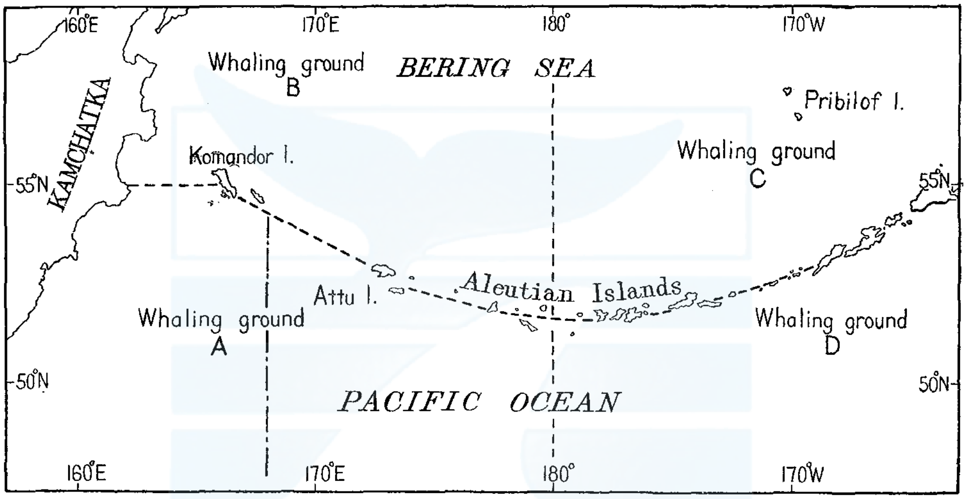

Fig. 3. Whaling grounds in the northern part of the North Pacific.

Catch. Japanese pelagic whaling has captured such number of baleen whales as shown in table 1 since the year 1952. In these five years, Japanese whaling expeditions have caught 429 blue, 4771 fin, 309 sei and 368 humpback whales. When these catch data are divided by above classifications of whaling grounds, some peculial features in them are observed. The species of baleen whales differ considerably in each localities. The considerable difference in the catch is also observed between the catch of two subdivisions of whaling ground A as stated above. In west area of 168°E in whaling ground A, fin whales are dominant in number with considerable catch of blue and sei whales as described in table 1. But fin whales are dominant with some humpback whales in the east of 168°E, and blue and sei whales are captured in far smaller number. In the whaling ground B, the north part of Komandor Islands, fin whales are only dominant whales though very few sei whales are caught in this water. Blue and humpback whales have never been caught by the operation. Especially the fact that no blue whales has been caught by previous Japanese expeditions in waters north of Komandor Islands suggests that blue whales seldom migrate to these waters (Omura, 1955). On the south area of the middle Aleutian Islands, I find no peculiar feature in the composition of whales caught if this area is separated from other parts. So I did not deal with this area as a division. The catch composition of whales in whaling grounds along the east Aleutian Inslands shows remarkable difference from western regions. Only fin whales are caught in the north

TABLE 1. NUMBER OF CATCH BY JAPANESE EXPEDITIONS IN THE NORTHERN PACIFIC SINCE THE YEAR 1952 TO 1956

Whaling ground A (West of 168°E)

Whale species	Year				
	1952	1953	1954	1955	1956
Blue	29	83	28	23	1
Fin	130	273	442	87	186
Humpback	11	17	15	—	1
Sei	9	96	67	20	29

Whaling ground A (East of 168°E)

Whale species	Year				
	1952	1953	1954	1955	1956
Blue	26	6	—	—	—
Fin	83	197	122	61	154*
Humpback	25	17	1	18	34
Sei	5	2	21	—	13

* Including 1 whale lost.

	Whaling ground B	Whaling ground C			Whaling ground D		
	Year	Year			Year		
Whale species	1956	1954	1955	1956	1954	1955	1956
Blue	—	—	—	—	117	47	69
Fin	255*	587	1177	774*	165	35	46
Humpback	—	6	10	—	114	89	2
Sei	5	1	—	—	40	1	1

* Including 1 whale lost.

waters of the eastern Aleutian Islands, though 16 humpback and 1 sei whales have been caught in a ambiguous position between Unimak and Atka Pass. As in the northern part of the western Aleutian waters, no blue whale has been caught also in waters north of the eastern Aleutian Islands and in one north of Pribilof Island. On the other hand, comparatively many blue and humpback whales have been caught, and fin whales are not so dominant in the south area of the eastern Aleutian Islands. Blue and humpback whales are important catch in this water. Besides above whaling grounds, the 'Tonan Maru' operated in the arctic sea through the Bering Strait in 1940, and caught fin, humpback and gray whales on which, to my regret, no biological collection is remained. So the discussion on whales in these waters is eluded in this paper.

FOOD OF WHALES

STOMACH CONTENTS OF WHALES

Generally speaking, baleen whales in these waters take mainly zooplanktons as in other parts of the world. And some other foods, such as squids and fish are also occasionaly found in stomachs of them. On this subject, it is proper to treat it by respective whale species as discussed by previous workers.

TABLE 2. STOMACH CONTENTS OF BALEEN WHALES CAUGHT BY JAPANESE WHALING FLEETS FROM 1952 TO 1956 IN THE NORTHERN PART OF NORTH PACIFIC

	Whale species			
Kinds of stomach contents	Blue	Fin	Sei	Humpback
Euphausiids	196	1674	4	201
Eu. & Copepods	2	102	—	2
Eu. & Squids	—	2	—	1
Eu. & Fish	—	3	—	11
Eu., Fish & Squids	—	1	—	—
Copepods	—	667	107	—
Co. & Squids	—	1	4	—
Fish	—	3	4	45
Fish & Squids	—	—	1	—
Squids	—	10	12	1
Empty	228	2292	173	107
No. of stomachs examined	426	4755	305	368
Not examined	3	16	4	—

Blue whales. Blue whales are famous for the plankton feeder, only take euphausiids in the Antarctic waters though some rare appearances of fish, amphipods have been observed (Mackintosh & Wheeler, 1929; Mizue & Murata, 1951). Blue whales feed mostly on *Euphausia superba* in the Antractic, also on *E. crystallorophias* (Marr, 1956) and *Thysanoëssa macrura* (unpublished data by Japanese whaling expeditions in 1956). *Thysanoëssa inermis* and *Meganyctiphanes norvegica* are their favourite foods in the Atlantic (Hjort & Ruud, 1929). Rough classifications of stomach contents of whales examined on board are described in table 2. The table shows blue whales feed only on euphausiids with exceptional whales feeding on the mixture of euphausiids and copepods. This apparently indicates that blue whales are real *euphausiids feeder* in the

North Pacific as considered until now. Matsuura & Maeda (1942) also state blue whales feed on euphausiids and blue whales are not polyphagous. While there are also some different data and conclusions by Mizue (1951) and Sleptzov (1955). Blue whales have sardines and squids respectively in their stomachs (Mizue, 1951), and Sleptsov (1955) describes on blue whales in Kurile waters that they feed sometimes not only on zooplanktons but also on small gregarious fish, whenever blue whales meet those fish. Indeed, 6 blue whales out of 15 whales fed on fish after his data. Perhaps, the Kurile waters are less productive as compared with the northern waters for zooplanktons, so blue whales in the Kurile waters feed on fish for want of their favourite foods of euphausiids. Foods of blue whales investigated by Sars (1874) in the Atlantic are all krill (*Thysanoëssa inermis*), and lodde or capelin has never been found in stomachs of them.

Fin whales. It is thought that fin whales are not so regulate in seasonal migrations as blue whales because fin whales are polyphagous, being able to take their foods anywhere that planktons, fish or squids are abundant. Their staple foods have been considered to be not so restricted as blue whales, though many fin whales are also planktonophager. Fin whales take *Euphausia superba*, *E. cristallorophias*, and *Thysanoëssa macrura* in the Antarctic waters like blue whales. In the Atlantic, fin whales feed not only on euphausiids, *Thysanoëssa inermis*, *Meganyctiphanes norvegica*, but also on swarming fish, such as Sild and Lodde. Copepod, *Calanus finmarchicus*, is also considered one of the staple diet in some seasons in the Atlantic (Hjort & Ruud, 1929).

In the northern Pacific waters, Zenkovitch (1934) describes that herrings are found in stomachs of fin whales and fin whales persue those swarms of herrings in Bering Sea. Matsuura & Maeda (1941) examined stomach contents of fin whales and observed that the most of fin whales in the waters off Kamchatka feed on euphausiids, *E. pellucida* (*E. pellucida* is canceled by Hansen in 1905). Besides, 2 whales feed on *Calanus cristatus* and 5 whales feed on cods. Kasahara (1950) consideres from above facts and data by Mizue (1952) on the whales in the Japanese waters, that euphausiids in the northern Pacific are rather poor as the foods of fin whales. And the polyphagous habit of fin whales may be due to above scantiness of eupnausiids. In recent years, Banner (1949) reports, that 27 fin whales from Akutan Island, feed only on a euphausiid, *Thysanoëssa inermis*, but Sleptsov (1955), Kleinenberg & Makarov (1955) also describe that the considerable parts of food of fin whales are occupied by fish and cephalopods. Sleptsov (1955) states further that cephalopods is confirmed as one of the staple food of fin whales in Aleutian waters. Fish are also considered to be the staple food for fin whales by the latter warkers. Indeed, far many fin whales take fish and squids after them as compared the Japanese data illustrated in table 2. The Japanese data show, the most fin whales take euphausiids and copepods as staple foods though squids and fish are also found in some occasions. However, they never be considered to be the favourite food for fin whales. In the adjacent waters to Aleutian Islands, fish and squids are considered to be only the makeshift foods for fin whales when they meet no swarm of zooplanktons. Collett (1911–12) describes some observation in the Atlantic that, when fin whales has to choose between fish and euphausiid diet, they choose the euphausiids.

It is often observed that fin whales or sei whales taking fish are suffered by the parasitic nematods in their stomachs. As the some larvae of those nematods are considered to originate in fish (Margoris & Pike 1956), the ichthyophager of fin whales may be an acquired taste of some unusual fin whales from the weaning. The fact that some fin whales take fish along Aleutian Islands, is apparently due to that swarming fish are very aboundant as compared with euphausiids or copepods, favourite foods of fin whales.

Humpback whales. Euphausiids are the main food of humpback whales. But humpback whales feed on swarming fish as well as euphausiids in some cases. They take herrings commonly (Zenkovitch, 1934) and considerable number of them feed on fish, cods, sardins, herrings also in recent studies (Sleptsov, 1955; Kleinenberg & Makarov, 1955). In the adjacent waters to Attu Islands, they mainly feed on atka mackerels which constitutes large swarms of themselves by Japanese observations. Copepods and squids are scaresly observed as shown in table 2. Thus, the value of copepods and squids as foods for humpbacks are considered to be very few. Only 2 whales feeds on the mixture of copepods with euphausiids and 2 whales feeds on squids and the mixture of squids and euphausiids. To my regret, the data by Mizue (1951) and the discussion by Kasahara (1950) can not be refered on this point because their division of food 'Krill' contains two different groups, copepods and euphausiids, and their observations are not so accurate. Howell & Huey (1930) describe some foods of whales from California waters, and suggest that 16 humpbacks feed on shrimps (perhaps *Euphausia pacifica*) and 5 whales on sardines. From above many observations, only two different groups, euphausiids and fish are considered to be the favourite foods for humpback whales.

Sei whales. Very famous works have been carried out on foods of sei whales in the north Atlantic until now. The migration of sei whales was also studied in connection with the conditions of zooplanktons (Hjord & Ruud, 1929). Sei whales are noted to favour copepods, *Calanus* *finmarchicus* in the Atlantic, so that abundance of *Calanus finmarchicus* in whaling grounds directly influence the number of whales which swarm in the area. In the northern Pacific the data by previous workers show sei whales take fish and squids as well as 'Krill' (Mizue, 1951) or copepods (Sleptsov, 1955). Sei whales mostly feed on copepods as shown in table 2 in Japanese whaling grounds as in the Atlantic. Only 4 whales take other zooplankton euphausiids only. This number is far smaller when I compare with those in adjacent waters to Japan where many sei whales feed on a euphausiid, *Euphausia pacifica*. From the data of the Whales Research Institute, the favourite foods of sei whales in the Japanese waters are euphausiids, mainly *Euphausia pacifica* sometimes *Thysanoëssa inermis* or *T. longipes* in the cold waters. A copepod, *Calanus finmarchicus* is also found from early spring to summer in these waters (unpublished data of the Whales Research Institute). The indistinct species 'Krill' described by Kasahara (1950) and Mizue (1951) must be corrected by above described species. Besides copepods, 12 whales take squids and 4 whales on fish only. But these foods are considered also incidental appearances in the northern part of the North Pacific where copepods are abundant.

SPECIES OF FOODS

Planktons

The species of food planktons for baleen whales in the sea adjacent to Japan is fully discussed by Nakai (1954), and this paper shows some differences between foods of whales in the northern Pacific and Japanese waters. From summerized review of this survey (Nakai, 1954) and my data, following plankton species are considered as staple foods for baleen whales in the northern part of the North Pacific. As stated in above chapter, main foods of baleen whales in these waters are euphausiids and copepods, and dominant species of them are restricted to some species mostly common in the sea. Some other less significant species are discussed last part of this chapter.

Euphausiids	*Euphausia pacifica* Hansen	Copepods	*Calanus cristatus* Krϕyer
	Thysanoëssa inermis (Krϕyer)		*Calanus plumchrus* Marukawa
	Thysanoëssa longipes Brandt		*Calanus finmarchicus* (Gunner)
	Thysanoëssa spinifera Holmes		*Metridia lucens* (Boeck)

Euphausia pacifica Hansen. In spite of the fact that *E. pacifica* is one of the most important euphausiid in the adjacent waters to Japan and Korean waters (Nakai, 1942, 1954), very few observations has been made by Japanese workers as disscussed by Nakai (1942). He insists on the importance of it as foods of whales and fish. Indeed, *E. pacifica* is the most dominant food in the adjacent waters to Japan, off Sanriku (the north east part of Japan) and Hokkaido. *E. pacifica* is also noted by Howell & Huey (1930) to play some part of foods of gray, fin and humphack whales in the Californian waters.

The northern distribution of *E. pacifica* is considered from Japanese data as north as Aleutian Islands where considerable number of it found in stomachs of whales. In the north parts of Aleutian Islands, though many specimens are collected by tow nets, it vanishes as dominant species in stomachs of whales. So it is considered the importance of *E. pacifica* as food of whales in Aleutian waters is not so heavy as in Japanese waters. Only 9 specimens out of 126 collected euphausiids samples are filled with dominant patches of *E. pacifica* as shown in

TABLE 3. DOMINANT APPEARANCES OF EUPHAUSIIDS IN COLLECTED SAMPLES

Species of euphausiids	Whale species: Blue	Fin	Humpback	Sei	Total
E. pacifica	2	6	1	—	9
T. inermis	8	65	8	1	92
T. longipes	2	21	1	—	24
T. spinifera	—	1	—	—	1

TABLE 4. APPEARANCES OF EUPHAUSIIDS IN COLLECTED SAMPLES

Species of euphausiids	Whale species: Blue	Fin	Humpback	Sei	Total
E. pacifica	2	14	1	—	17
T. inermis	9	76	10	1	95
T. longipes	5	57	2	2	66
T. spinifera	1	15	3	—	19

table 3. Especially, in the north part of the eastern Aleutian Islands where many whales feed on *T. inermis*, *E. pacifica* has scarecely been observed from Japanese collections. The larval form of *E. pacifica* described by Boden (1950) also seem to be common in southern waters of Aleutian Islands in summer. However, furcilia stages of it do not occur in stomachs of whales as following euphausiids, although some incidental appearances of noupli and furcilia larva of them are observed. Ruud (1932) also describes such conclusion on *E. superba*. The cancelled species *Euphausia pellucida* quoted by Mizue (1952) and Kasahara (1950) perhaps mean this *E. pacifica*, the most dominant species in the waters to which they refered.

Thysanoëssa inermis (Krφyer) Hansen. It is one of the most famous food euphausiid as 'small krill' in the Atlantic. It is so important in some seasons as the migrations of blue and fin whales are affected by the conditions of swarming of it (Hjort & Ruud, 1929). In the northern Pacific, perhaps Banner (1949) is the first to describe this species from the fin whales of adjacent waters to Akutan Islands. He again describes *T. inermis* as dominant foods of whales referring to the distribution of *T. inermis* of those waters (1954). Many collections of the Whales Research Institute show that *T. inermis* is the most important species of euphausiids, as swarms of *T. inermis* have been found as stomach contents of whales in Bering Sea, adjacent waters of Aleutian Islands, Kurile waters and also in Okhotsk Sea. *T. inermis*

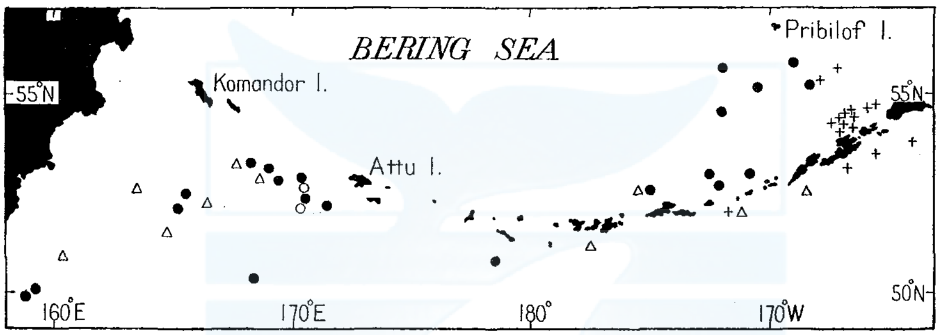

Fig. 4. Main occurrences of some euphausiids: Open circls—*Thysanoëssa longipes* spineless form; Solid circles—*Thysanoëssa longipes*; Crosses—*Thysanoëssa spinifera*; Open triangles—*Euphausia pacifica*.

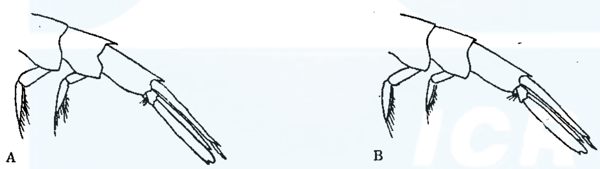

Fig. 5. Abdominal spines of *Thysanoëssa inermis* (Krφyer) Hansen.
A. Two spine form. B. One spine form with rudimentary spine on 5th segment.

distributes widly in the whaling grounds and the utmost concentration of it is found in C whaling ground. Fin whales in C whaling ground take almost only these swarms of *T. inermis*.

Ten furcilia stages of *T. inermis* (Einarsson 1945), have not been found as foods like *E. pacifica* by my studies. Above fact may be due to the want of storage of fat in larval stages of euphausiids and different biological conditions from adults in depth of distributions or degree of their congregations. The density of swarms of euphausiids is considered to has great significance for feeding habits of whales. I suppose if the patch of euphausiids is not so dense, as in larval stages whales perhaps take no notice of them. And sparse patches of euphausiids may be saved from whales' swallowing.

In some taxonomical points of *T. inermis* differences have been discussed on the Atlantic specimens. Hansen (1915) reports the presence of a spine in the fifth abdominal segments on the Pacific specimens. On the contrary, Einarsson (1945) states 'None of the numerous specimens examined by me have shown eaven the slightest sign of a spine on the fifth segment' on the Atlantic specimens. In vast collections at my hand, the fifth abdominal segments also have usually abdominal spine as described by Hansen (1915). The case wanting the spine is rarely observed. I count these two formes on some collections and the two spined form is dominant in each 100 specimens of collections. As compared with Atlantic specimens discussed by Einersson (1945), one characteristic features of Pacific specimens of *T. inermis* is considered to

TABLE 5. NUMBER OF ABDOMINAL SPINES OF *T. INERMIS*

Year	Samples' no.	One spined form*	Two spined form
1953	475	6	94
1954	K728	10	90
1955	118	13	87
〃	393	7	93
〃	1655	8	92
〃	1811	19	81
〃	1848	30	70
〃	1849	11	89
〃	1871	—	100
〃	1879	2	98
〃	1885	13	87

* Including those with rudimentary spines in the 5th segment.

bear two abdominal spines. The distribution of these two form show some differences even in northern Pacific. However, further discussion on this point needs more examinations.

Thosanoëssa longipes Brandt. *T. longipes* is also the most common euphausiid alike *T. inermis* in northern part of the North Pacific. So it is considered to bear considerable significance as the food of whales (Ponomareva, 1954), though *T. longipes* has occured less in number as dominant foods of whales as shown in table 3. The cases that swarmes of *T. longipes* appeares in dominant number are about one-third of *T. inermis* in the collections. On the contraly, *T. longipes* is the most abundant and frequent in samples collected by surface plankton nets from 200 m. Above data suggests that adults and adolescents of *T. longipes* distribute scatteredly in the surface waters of the sea, not so concentrated as *T. inermis* in every times. *T. longipes* is also found in the Okhotsk Sea and the adjacent waters to Japan as whales' foods.

On the taxonomical points of *T. longipes*, Banner (1949), and Boden, Johnson & Brinton (1955) describe the smaller form of *T. longipes* which lacks the conspicuous abdominal spines. Those spineless form inhabits the whaling grounds in considerable number in the same surface waters. The spineless form has appeared in 2 stomachs of whales dominantly in my collections, and swarms of spine form have been mingled with it.

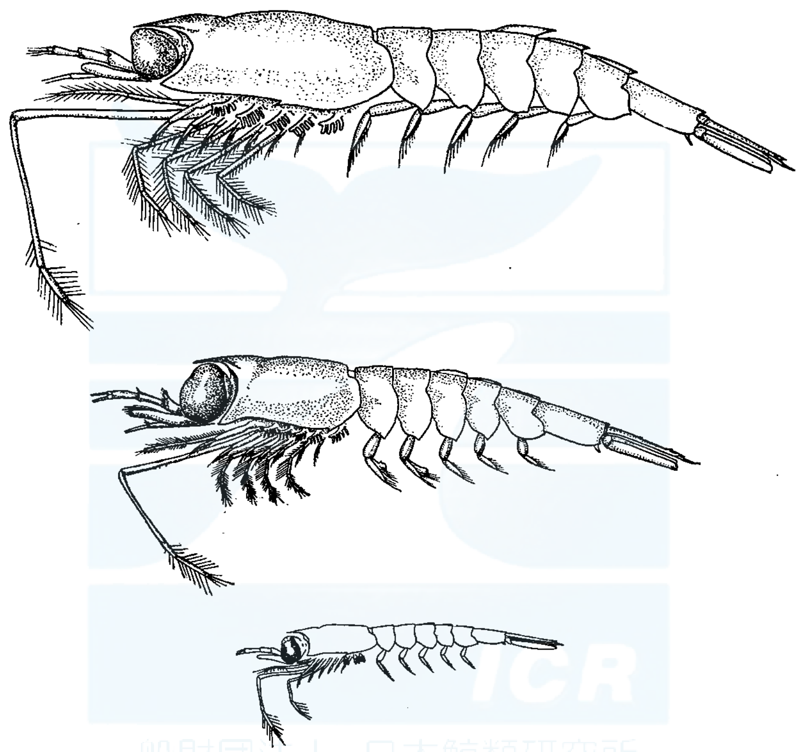

Fig. 6. *Thysanoëssa longipes* Brandt. Upper; Adult female of spine form from the left side. Middle; Adult male of spineless form from the left side. (×4) Lower; Juvenile form of spine form about 7 mm.

The eyes of spineless form is larger than the original form in some specimens as compared the spine form as shown in figure 6. Some of them possess a greatly enlarged eye (Boden, Johnson & Brinton, 1955), which has occurred more frequently in eastern side of the North Pacific in rough speaking. This variation in the size of eyes is formarly noted by Banner. Banner (1949) states 'Both forms of *T. longipes* are fragile. Especially so is the spineless form*. This special feature is well observed in first stomachs of whales. The eyes of *T. longipes* are almost broken by the digestion of whales though eyes of other euphausiids such as *T. inermis* or *Euphausia pacifica* are never broken in the same conditions. The spineless form is more fragile in such cases as stated in Banner's paper.

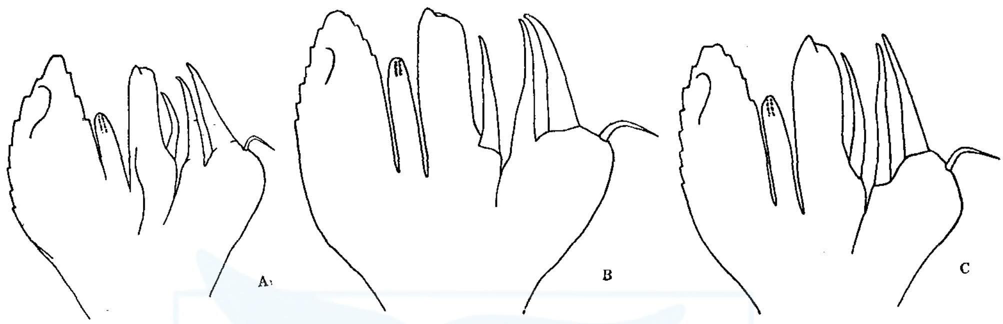

Fig. 7. Male copulatory oagans of *Thysanoëssa longipes* Brandt. A.B. Spineless form. C. Spine form. (×50)

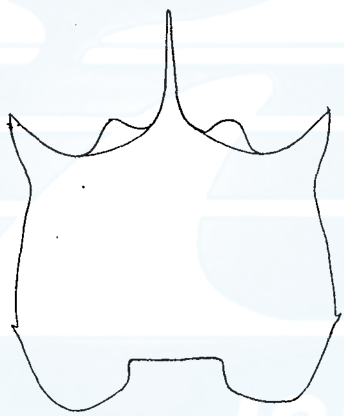

Fig. 8. Carapace of spineless form of *Thysanoëssa longipes* Brandt. (×10)

The position of the lateral denticle of carapace in spineless form differs from that of the original form. The lateral denticle of spine form is located in about middle of the lateral margin of carapace, a little to the back. On the other hand, the lateral denticle of spineless form is

* On the spineless form of *Thysanoëssa longipes*, Drs. Boden and Brinton kindly sent me a letter that 'At present it is best to consider the spineless and spined specimens as "forms" of the same species', and 'It is possible that further information on distribution etc., may cause us to revise our present opinion'. I also consider this spineless form as a form of *Thysanoëssa longipes* in the process of my examinations. But, spineless form differs from spine form of *T. longipes* in some points, such as rostrum, carapace denticles, eyes, some body proportions, body length at the sexual maturity and distributions. So further examination may be able to devide above two forms of *T. longipes*. Here I describe this spineless form as a 'form' of *T. longipes* after the descriptions by Dr. Banner and Drs. Boden and Brinton.

located in the far back position. The length ratio, from the anterior spine to the lateral denticle: lateral margin of carapace, is ranging 50–60% in the spine form, while ranging 70–80% in the spineless form. On the whole, lateral denticles of euphausiids are in fixed positions for each species. *Thysanoëssa raschii* has a pair of well developed denticles always anterior to the middle of the margin, and *E. pacifica* bears strong denticles a little anterior to the middle of lateral margin of the carapace. So the difference between above two forms is the very interesting feature in variations of euphausiids. On this point, though such variation of position of lateral denticles of *Thysanoëssa* species has not been noticed, Hansen (1911) describes the denticle on the lower margin of the carpace of *Nematoscelis* species shows some geographical variations.

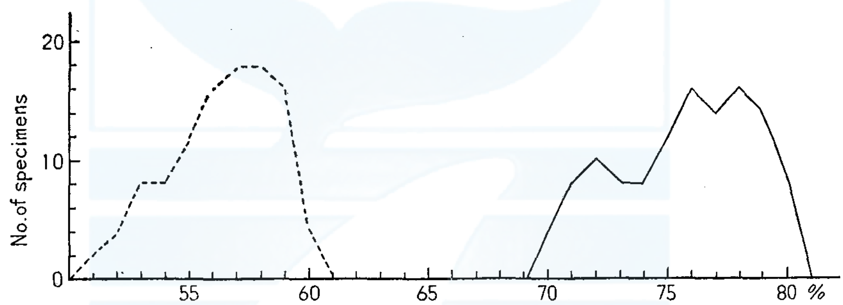

Fig. 9. Length ratio, from the anterior spine to the lateral denticle: lateral margin of carapace, of the *Thysanoëssa longipes* Brandt. Solid line—Spineless form. Broken line—Spine form.

In some larval form (over 7 mm) of *T. longipes* the denticle is located in the middle of the lateral margin of carapace suggesting that it may become the spine form when it will be mature, though the juvenile stages of *T. longipes* bear only dorsal keels on the third, fourth and fifth abdominal segments, and never have acute abdominal spines, and this distinction is the same as the adult spineless form. Moreover the size of such juvenile stages is also in the same range of the latter. In this developmental stages, the position of lateral denticles may be sufficient evidence to divide two forms of *T. longipes*.

On the distributional range of two forms of *T. longipes*. Boden, Johnson & Brinton (1955) state, 'The large specimens of *T. longipes*, which bear abdominal spines, are rarely taken south of 50°N, whereas the southern limit of the range of the smaller form is about 40°N'. Main occurrances of *T. longipes* in my data generally coincide with above statement, exept some of those found in adjacent waters to Japan. Considerable number of fin and sei whales take sometimes swarms of spine form of *T. longipes* at about 40°N, 150°E. The spineless form has not been occurred in adjacent waters to Japan and Okhotsk Sea owing to the scanty collection of stomach samples.

The adolescents of *T. longipes* bear no sings of conspicuous abdominal spines in length about 10 to 12 mm. They bear only dorsal keel and the spine of last abdominal segments like adult spineless forms. But spineless forms have often short spines on fifth abdominal segments. The eyes of them are also easy to be broken by any causes.

Thysanoëssa raschii (M. Sars) Hansen. *T. raschii* has not appeared as foods of whales in samples gathered from 1952 to 1956 in the whaling grounds though recent study by Sleptsov (1955) shows that *T. raschii* is fed by whales in the Kurile Islands waters. According to Banner's description (1949, 1954), *T. inermis* is dominant food for Akutan whales against to *T. raschii* is the only euphausiid found in the cod and pollack stomachs. Banner suggests (1954) that, 'such difference may be due to the fact that *T. raschii* is an inshore species, whereas *T. inermis* is more commonly found the margin of the continental shelf in the Akutan waters'. By Japanese operations, whales mostly have been caught along the margin of continental shelf or in boundaries of different water masses far in the offing, and the catch within the margin of continental shelf are very scarece. Thus, *T. raschii* may be rare as foods of whales in Akutan waters. In the unpublished data from the Okhotsk Sea, considerable specimens of *T. raschii* are found among other euphausiids, *Euphausia pacifica*, *Thysanoëssa longipes*, and *T. inermis*. This occurances of *T. raschii* may be due to the sea depth of whaling grounds. The sea depth of Okhotsk whaling ground is far shallower than the depth of Akutan whaling grounds exept some areas where fin whales caught within the Alaskan continental shelf.

Thysanoëssa spinifera Holmes. This species has been found in less number as foods of whales. Only 1 fin whale took it dominantly, and it is thought *T. spinifera* is not so important as *T. inermis* or *T. longipes*. Hollis (1939) describes that *T. spinifera* occurred as foods of fin and humpback whales dominantly in Bering Sea. He states further, 'The egg masses were particularly numerous in the stomach of a humpback shot on August 26, and would lead one to believe that over a short period of time they may be of some importance as foods'. His suggestion that egg masses may be the food of whales is very interesting. I would like to treat this problem in following chapter. The distribution of *T. spinifera* holds something to be examined. By Hansen (1915), the most western records is taken at 179°07′30″E–54°12′N and Boden, Johnson, & Brinton (1955) describe, 'It occurs along the western coast of North America from northern Baja California to the south-eastern Bering Sea, usually within 200 miles of shore'. In the collected samples, *T. spinifera* has occured mostly along the margin of continental shelf. The most western occurrence is about 170°W–54°N and *T. spinifera* mostly converges on the north waters of Unalaska Islands as shown in figure 4. So, it may be concluded that *T. spinifera* inhabits only eastern side of the North Pacific from these observation. In other words, *T. spinifera* inhabits mainly in natural regions *Alaskan Coastal Region, Alaskan Gyral,* and *American Coastal Region* called by Fleming (1955). Some larval form of *T. spinifera* may be transported by the sea current from the Pacific to Bering seas, because the Pacific waters set north into the Bering Sea at velocities up to 0.4 knot between Unimak and Unalaska Islands (Barnes & Thompson 1938).

Calanus cristatus (Krφyer). Usually, *C. cristatus* is the most famous copepod whaling grounds in the North Pacific. 'Calanus' or 'Red rice' called by whalers means usually this species in the whaling grounds. Fin whales take *Calanus cristatus* most favourably. This is clearly illustrated in table 2. Copepods fed by fin whales in table 2 are almost all *Calanus cristatus* and occurrences of other copepods are only in some occasions as disscussed in the description of *C. plumchrus*. The developmental stage of *Calanus cristatus* is almost all the copepodite 5, and very few exeptional copepodite 4 is found among the former. But no adults has been found in Japanese collections. The patch of *Calanus cristatus* copepodid 5 is considered to be extremely dense in the surface waters. But towards the biological autumn of these areas, *Calanus cristatus* disappeared from the surface waters. Such phenomenon is also fully described by Nakai & Honjo (1954) and Bogorov & Vinogradov (1955). For example, fin whales caught at the south-west area of Attu Islands in June and July in 1953 took no other foods than *Calanus cristatus*. Whereas, when the time of their swarming passed, euphausiids take the place of copepods in late August to September. Bogorov & Vinogradov (1955-a) also examined the distribution of *Calanus cristatus* in Kurile waters in 1953, and lead to the same results. *Calanus cristatus* is important as foods of whale also in the Olyutorskiy Bay. Brodsky (1950) describes that, 280 fin whales out of 304 whales caught in Olyutorskiy Bay took unmixed patches of *C. cristatus*.

All specimens of *Calanus cristatus* belong to the copepodite 5 stage, and *Calanus cristatus* means this copepodite 5 stage in following discussions. The harvest of *C. cristatus* is abundant or poor according to the oceanographical conditions year to year. For example, *C. cristatus* is extremly abundant in 1953, while it is scarce in other years. I would call the year when *Calanus cristatus* is abundant as 'Calanus year', and 'Krill year' when euphausiids are abundant.

Calanus plumchrus Marukawa. *Calanus plumchrus* has been discussed by many biologists from the taxonomical point of view. It has been considered as the synonym with *Calanus tonsus* Brady (Campbell, 1930; Tanaka, 1954) or *Calanus tonsus* f. *plumchrus* (Brodsky 1950; Marshall & Orr, 1955). Brodsky suggests (1950) further that *C. plumchrus* may be a seasonal form of *C. tonsus* f. *typica*. Recently, Nakai (personal communications) and Tanaka (1956) have studied these two species and come to the conclusion that *Calanus plumchrus* is a characteristic copepod of the North Pacific, and is distinct from *Calanus tonsus* Brady of the Antarctic. Detailed description on this point will be found in the discussion by Tanaka (1956), and I use the specific name *Calanus plumchrus* in this report.

TABLE 6. OCCURRENCES OF *CALANUS PLUMCHRUS* IN D WHALING GROUND IN 1954

	Fin whales		Sei whales	
Decades	*C. plumchrus*	*C. cristatus*	*C. plumchrus*	*C. cristatus*
1st. decade June	1	2	—	4
3rd. 〃	6	12	13	2
1st. decade July	1	—	—	—

Calanus plumchrus is considered to be very abundant in those northern part of the North Pacific. The number of *C. plumchrus* is far numerous than any other macro copepods in samples collected by plankton nets. While, *C. plumchrus* is not observed so often as *C. cristatus* dominantly in stomachs of whales. I have noticed no dominant specimens of *C. plumchrus* in data of fin whales of 1952 and 1953, exept sei whales caught in August in A whaling ground fed on *C. plumchrus*. In D whaling ground in 1954 only 1 fin whale take *C. plumchrus* in first decade of June when 33 fin whales caught in the decade. Similarly, 6 whales out of 64 fin whales fed on *C. plumchrus* and 12 whales fed on *C. cristatus* in third decade of June, and 1 whale in July. In this season, sei whales also swarm on the patch of *C. plumchrus* in this sea area. *C. plumchrus* is fed by 13 sei whales out of 15 whales which took copepods in third decade of June.

It may be suggested by above facts that *Calanus plumchrus* never swarm so markedly as *Calanus cristatus* in these waters. Only those whales that skim their foods, such as sei whales or right whales (Ingebrigtsen, 1929), may easily take the sparse patch of *Calanus plumchrus*.

Calanus finmarchicus (Gunner). The most famous copepod *C. finmarchicus* as foods of whales in the Atlantic has been layed aside because it occures not so frequent is Japanese waters. As stated in the part of sei whale, occasionaly it has been taken by sei whales in the adjacent waters to Japan. However, *C. finmarchicus* is considered not so important in the northern part of the North Pacific as in the Atlantic. It has only occurred with other copepods, *C. cristatus* or *C. plumchrus* though considerable number of them has appeared in samples by plankton nets. Besides, the copepods in the samples are not always the typical form of *C. finmarchicus*. Some of them rather resembles to *Calanus helgolandicus*. The relation between above two forms may be the most interesting subject on which many studies have been carried out by many biologists. Extensive discussions of this problem will be found in the papers by Rees (1949), Brodsky (1950) and Marshall & Orr (1955). Including *C. heligolandicus* only the specific name *C. finmarchicus* is used in this paper.

Metridia lucens Boeck. This fine species is not so important as the former 3 species. Matsuura & Maeda (1942) describe this from stomchs of sei whales in the waters off Kamchatka Peninsula, and I observed the stomach of 1 fin whale caught at 55°38′N, 169°00′W with *Metridia lucens*. Other *Metridia* species such as *M. okhotensis* or *M. pacifica* described by Sleptsov (1955) as foods of whales have not been observed in my collections as dominant foods of whales though they are found in few number.

Fish

Some baleen whales in the northern part of the North Pacific take swarming fish too. As shown in table 2, humpback whales in sometimes undoubtedly ichthyophager. A few fin and sei whales also take fish as discussed by many research workers. These fish species are listed following.

Cod	*Gadus macrocephalus*
Whiting	*Theragra chalcogramma*
	Eleginus navaga gracilis
Atka mackerel	*Pleurogrammus monopterigius*
Sand lance	*Amodites hexapterus hexapterus*
Capelin	*Mallotus catervarius*
Rockfish	*Sebastodes polyspinis*
Saury	*Cololabis saira*
See lamprey	*Entosphenus tridentatus*

Pleurogrammus monopterigius and *Cololabis saira* are most commonly found in stomachs of humpback and sei whales respectively. Especially one of favourite foods of humpback whales is Atka mackerels. Humpback whales take mainly it in two regions, the west waters of Attu Islands and the south waters of Amchitka Islands. They have taken no other foods than Atka mackerels in these waters. Atka mackerels may be swarming in large number along the offshore of these Islands, and humpback whales flock togather to take them. To the interest, other fin and sei whales seldom take Atka mackerels although they are swarming in the same waters. The data shows that only 2 fin whales take Atka mackerels at the same time in the sea area. Since the year 1952, 3 fin whales have taken fish dominantly, and 4 whales fish with euphausiids or squids. The latter whales may take those fish which were in taking their foods with swarms of euphausiids. The fact that stomach of fish are satiated by euphausiids suggests those fish are involved in swallowing of whales.

It is often observed that sei whales have taken sauries in the adjacent waters to Japan (Mizue, 1951) and 5 sei whales has been found to take them through this survey. The locations of such whales caught are considered to be limited to the western side of the North Pacific. Those swarmings of saury looking for light of the ship have often been observed from the factory ship in night in the western whaling grounds.

TABLE 7. OCCURRENCES OF SWARMING FISH FOUND IN STOMACHS OF HUMPBACK WHALES

	Year			
Kinds of fish	1953	1954	1955	1956
Atka mackerel	11	—	13	21
Cod	2	—	—	—
Capelin	—	3	—	—
Sand lance	—	2	—	—
Unknown	—	1	2	—

Sand lance is one of the favourite foods of little piked whales of adjacent waters to Japan (Omura, 1956). Few of them are sometimes found in stomachs of humpback whales in whaling ground D.

Cod and rockfish are considered not to swarm so closely like Atka mackerels as to stimulate whales' appetites. Few baleen whales take cod or rockfish as compared with other fish above described, while many sperm whales take them in these waters (Betesheva & Akimushkin, 1955).

From above observations, I consider that fish are only makeshift foods for blue, fin and sei whales and rather important for humpback whales in the northern part of the North Pacific where zooplanktons are more abundant than any other southern waters.

Squid

Large squids, *Ommastrephes sloani pacificus* is the most important, and some small squid (*Watasenia scintillans*) and opalescent squid (*Loligo opalescens*) are also considered to be appeared in some cases.

Others

Other organisms, such as *Themisto* sp. *Sagitta* sp. are occasionally observed among euphausiids and copepods. These trespassers are so abundant as planktons that whales can hardly help swallowing a certain number as discussed by Mackintosh & Wheeler (1929). Some live specimens of *Pandalus* shrimps are collected in a stomach of a fin whale through Japanese investigations. To the interest, they have survived other euphausiids in the same stomach by about six hours.

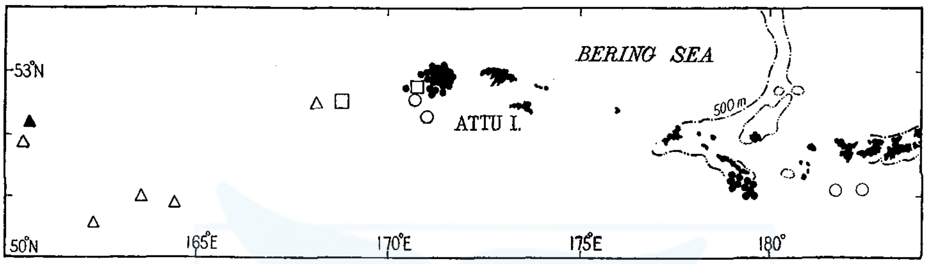

Fig. 10. Occurrences of fish eaten by baleen whales: Solid circles—*Pleurogrammus monopterigius* eaten by humpback whales; Open circles—*Pleurogrammus monopterigius* eaten by fin whales; Solid triangle—*Cololabis saira* eaten by fin whales; Open triangles—*Cololabis saira* eaten by sei whales; Open squares—*Gadus macrocephalus* eaten by fin and humpback whales.

FEEDING HABITS OF WHALES

Preferences for foods by whale species. From the observations on stomach contents of whales, considerable differences are noticed among favourite foods of each whale species as stated in foods of whales. The data at my hand accordingly somewhat differ from those of U.S.S.R. collected in Kurile waters. Sleptsov (1955) states that baleen whales are polyphagous, they take any foods whenever they meet zooplanktons, cephalopods, and swarming fish. But it is considered baleen whales possess remarkable preferences for foods after my observation. The main causes for this phenomenon are considered as follows.

First, the differences of baleen plates may be attributable to their selection for foods. As baleen plates differ in length, breadth, and thickness. The degree of luxuriance, size and length of baleen fringes, these characteristic dispositions of baleen fringes have direct effect to foods of whales. Whales with fine baleen fringes, such as sei whales or right whales (*Balaena glacialis*) are fitted to skim micro-zooplanktons mainly copepods. Blue whales which have fairly rough baleen fringes prefer euphausiids. Marshall & Orr (1955) suggest that *Calanus finmarchicus* possibly may escape capture by some species of whales with rough baleen finges, as *Calanus* is much smaller than euphausiids. It is an interesting illustration on this point that Mizue (1951) states, 'The whales having large sized baleen eat more homogenious food consisting only of small food', that is, 'larger the sized of the whales are the fewer the varieties of food they eat'. However, the degree of luxuriancy of baleen fringes is considered to be not so important as decides food species of whales.

The preference of whales for foods are considered to be affected partly by the ecological condition of food planktons, fish or squids in the sea waters. The condition of density in the sea differs markedly by each species, for example euphausiids bears different form of swarmings from copepods. This must effect the whales in selection of their favourite foods. Heretofore, two types of feeding habits of whales have been considered, *Skimming* and *Swallowing*. Sei whales are observed to 'skim' the food (Ingebrigtsen, 1929), while blue, fin and humpback whales turn over, aften with part of the head above water swallowing foods (Ingebrigtsen, 1929). If some swarmings of zoo-planktons are not so crowded, whales such as blue, fin and humpback whales may pay little attention to such swarming of foods. While some observations in the North Pacific show that sei whales often take copepods, *Calanus plumchrus* or *C. finmarchicus* of comparatively small quantity. The cases, *Calanus plumchrus* found in the west-south of Attu Islands in 1953, or *C. plumchrus* in the eastern-south waters of Aleutian Islands in 1954 are the facts illustrative of above observations. On the whole, the fed copepods are fresh in the first stomachs suggesting that sei whales took them a little while prior to that time of capture. From above observations, it may be concluded that sei whales have skimed the waters to take copepods. They can take the swarm of *C. plumchrus* which is less crowded swarming sparsely as not to stimulate fin whales' appetite. Ingebrigtsen (1929) describes the feeding habit of sei whales as follows: 'It swims at great speed through the swarms of copepods, with half open mouth, its head above water to just behind the nostrils. The copepods rush in with the water and are filtered from the waters by the whalebone plates. When a suitable mouthful of copepods has been taken the whale dives, shuts its mouth and swallows the food'. I observed this *skimming* of sei whales in morning in the adjacent waters to Japan in 1955. If sei whales take their foods in this method, they can take rather rough swarms of copepods as above described.

Kitou (1956) observes many patches of *C. heligolandicus* at the surface of the sea. Many orange coloured patches of *C. heligolandicus*, each of them covering an area of 1 to 4m^2 and 1 to 2m deep, distribute so far as 15 miles. These swarms may be favourable condition for sei whales. *Calanus cristatus*, one of the favourite food of fin whales, are always found in a large quantity in stomachs of whales, suggesting that swarms of *Calanus cristatus* are more crowded than *C. finmarchicus* or *C. plumchrus* in these waters. The catch of fin whales in August 1953 in the whaling ground A decreased markedly as compared with the catch in June and July. The phenomenon is considered to be due to the poor of favourite foods, *Calanus cristatus* or euphausiids in this mouth. Fin whales must have gone from these waters to another where their favourite foods were more abundant. In the case that sei whales have taken *C. plumchrus* in the eastern-south of Aleutian Islands in 1954, sei whales have shoaled in large number. These also comparatively many fin whales were found, which scarcely take *C. plumchrus* dominatly. They take mainly euphausiids, thus sei whales and fin whales must have different preferences for food planktons. Hollis (1939) describe very phenomenal occurrences of eggs masses of euphausiids from stomachs of Alaskan whales. If the egg masses of euphausiids is enermous, it is probable that whales are attracted to them.

In next, the depth of distribution of zooplanktons and other organisms must be discussed in relation to the whales' feeding habits. Sei whales, sometimes, have taken squids with copepods. The same freshness of above two species suggests that they have been fed at the same time. This means that the depth of distribution is perhaps same for two species. The sei whales may take squids which come up from the depth to take copepods, because one of favourite foods of squids are copepods in these waters (Sleptsov, 1955).

Feeding activity in a day. When Japanese biologists examine stomachs of whales they describe usually only quantities of stomach contents by the classifications of four grades (R, rrr, rr, r). There are some works carried out to weight the contents (Nishimoto, Tozawa & Kawakami, 1952; Betesheva 1955), however, I have no accurate data if above four classifications mean real volume of contents. Such classifications may be affected by sizes of whales, species of whales, and the decision by naked eyes is of course not so accurate. In addition, the fact, that whales often disgorge their stomach contents when they are attacked by harpoons, has been sometimes observed. For these reasons, the discussion on the data is not so stable. While some interesting tendencies are derived from them.

When I classify the fullness of stomach contents by the time of whales caught, it is indicated that baleen whales caught in the morning take more foods in quantities than those caught in daytime or the afternoon. There is also interesting tendency, whales with stomach contents again increase in number from the evening to night. Figures drawn after the data are shown in figures 11 and 12. The most remarkables of fin whales are found in August and September in 1952, 2nd decade of

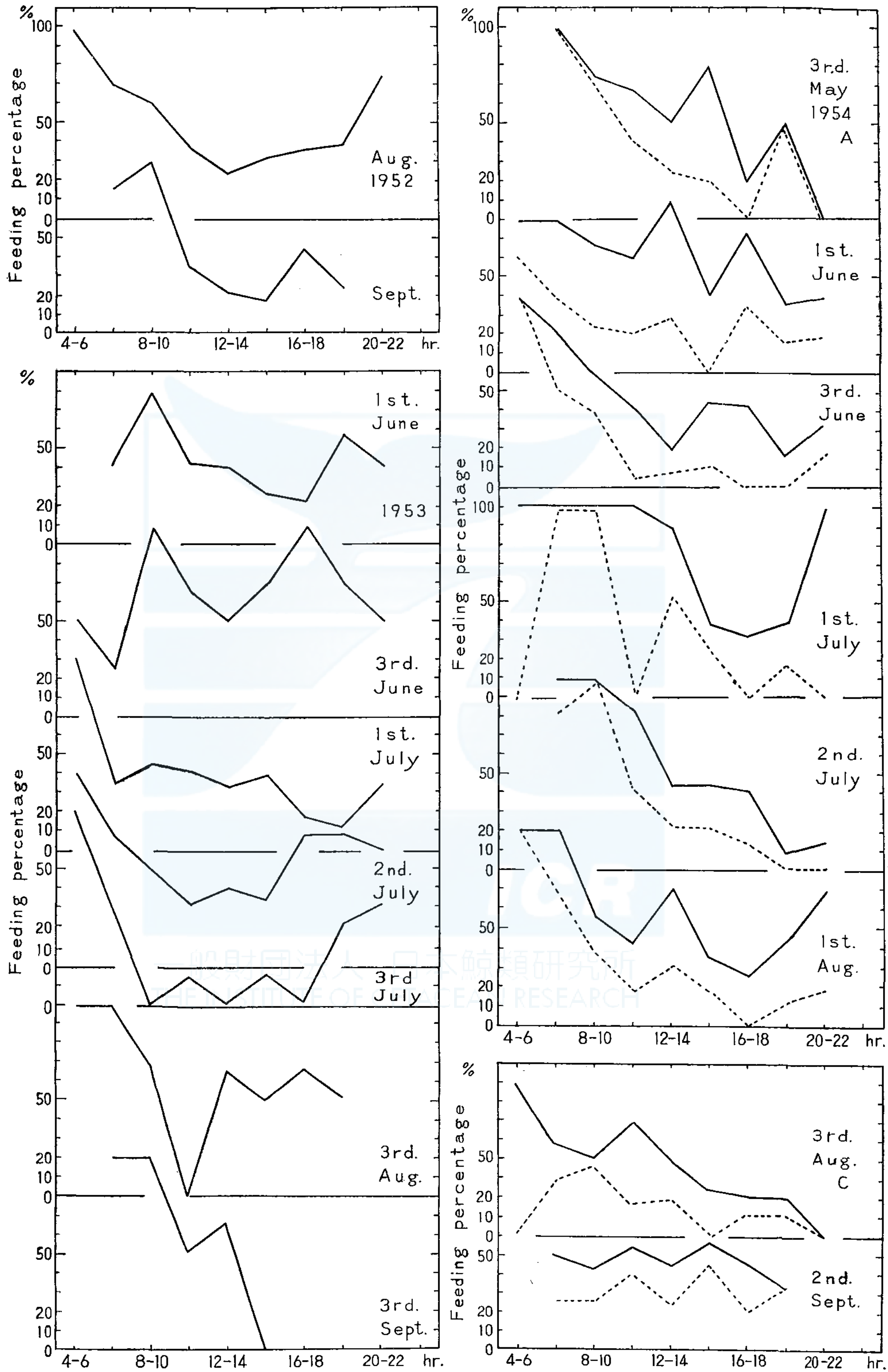

Fig. 11. Feeding percentages of fin whales in A and D whaling grounds. Solid line—The percentage of the number of fin whales with foods in their first stomachs more than r for all whales caught at that time. Broken line—Those more than rr.

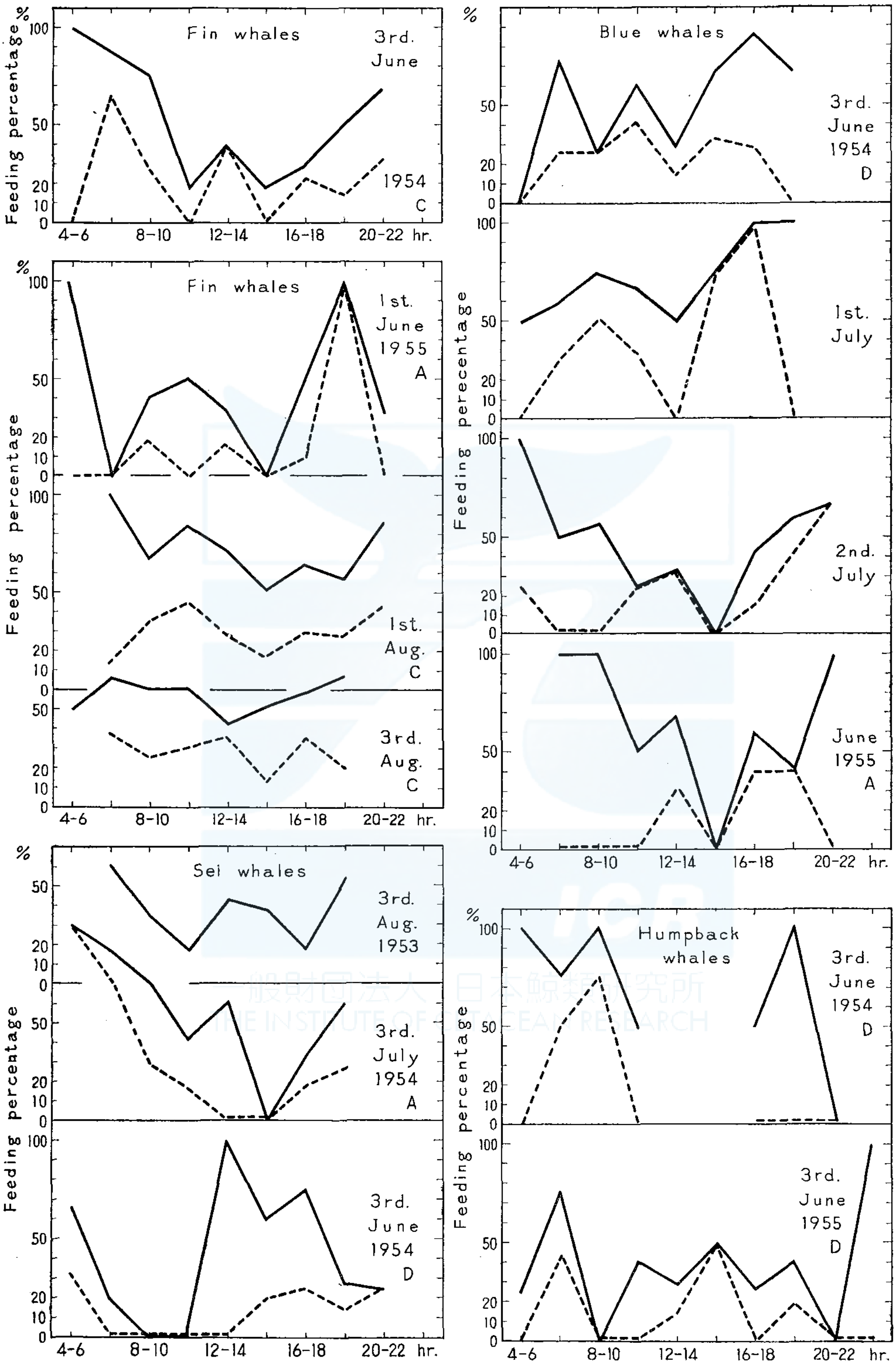

Fig. 12. Feeding percentages of fin, sei, blue and humpback whales in A, B, C and D whaling grounds. Solid line—The percentage of the number of whales with foods in their first stomachs more than r for all whales caught at that time. Broken line —Those more than rr.

July in 1953, and 3rd decade of July in 1953. The figures in some other decades show somewhat indistinct decrease in daytimes. Genellary speaking, feeding activities are comparatively heigh though in the daytime especially in whaling grounds C, where a euphausiid *T. inermis* is abundant along the margin of continental shelf. *T. inermis* in this waters may have more chance to stay at the surface waters owing to the upwelling currents along the margin of the continental shelf. Thus whales may take more foods in the daytime than other whaling grounds. On blue and fin whales in the Antarctic waters, Nishiwaki & Oye (1952) also have noticed the stomachs of whales caught mainly in the afternoon were often vacant. They conclude that more whales take their foods in the morning, and a clear peak in the morning in feeding percentages show that they take their foods once a day. Although they do not allude the slight ascent of feeding percentage is also observed in their figures.

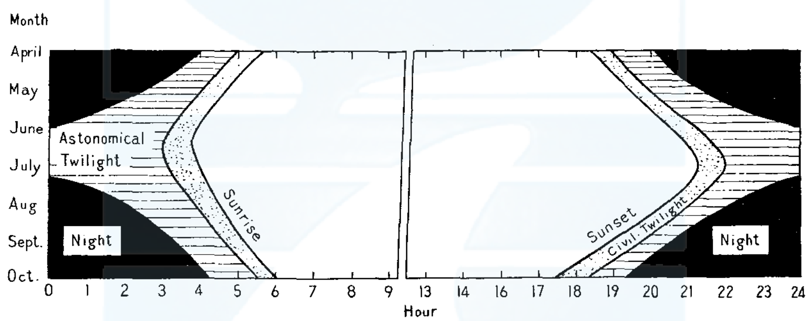

Fig. 13. The duration of twilight of the latitude 50 North after the abridged nautical almanac 1956.

The brief review of the research work undertaken by Slava whaling fleet of the U.S.S.R. (a pamphlet for the International Whaling Commission 7th meeting in Moscow, July, 1955) also alludes to such tendency.

If whales take more foods in the morning or evening than in the daytime, it is considered intuitively that the tendency is partly due to the clear diurnal migrations of zooplanktons. Ingebrigtsen (1929) states '*skimming* of sei whales takes place especially in the evening or early in the morning when the copepods are most at the surface of the sea'.

The diurnal migrations of zooplanktons are well known by many excellent biologists. The research for copepods, mainly *Calanus finmarchicus*, are fully discussed and summerized by Marshall & Orr (1955). From the results of many those works, Marshall & Orr states 'It is now generally agreed that the immediate stimulus to diurnal migration is light, perhaps modified in extreme cases by temperature'. In the whaling ground A, fin whales take *Calanus cristatus* dominantly in June and July as stated before. The feeding percentages in these seasons vary very remarkedly as shown in figure 11. All fin whales caught between four to six o'clock take their foods, and the feeding percentage of whales caught in the next time section between six to eight o'clock suddenly has decreased. As the sun rises at about four o'clock in July in these waters and whaling catchers have commenced their chasing with sunrise, whales which captured at four to six o'clocks must have taken easily swarms of *Calanus cristatus* concentrated at the surface waters in the morning. And feeding percentages have fallen according with the sunrises and *Calanus cristatus* swim down to avoid the light.

Marr (1955, 1956) describes that the adolescents and adults of *Euphausia superba* are mostly limited to the surface waters mainly above 10 meter depth. And typical diurnal migration of *Euphausia superba* is not observed by Hardy & Gunther (1935). By their discussions the behaviour of *E. superba* appeared to be very erratic, but far more specimens are

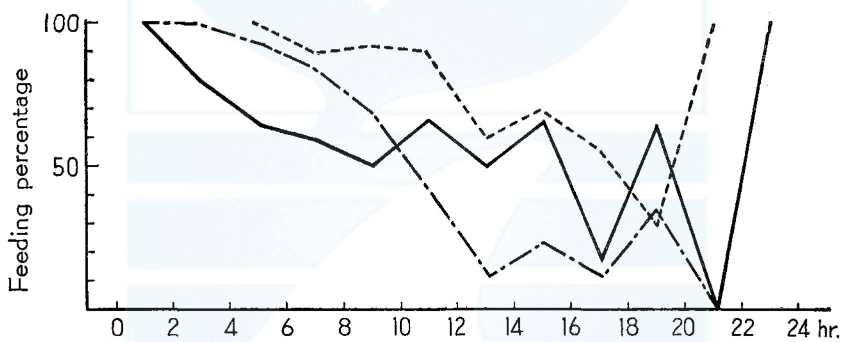

Fig. 14. Feeding percentages of fin whales in the Antarctic in 1955. Solid line—1st decade of January. Chain line—2nd decade of January. Dotted line—3rd decade of February.

taken at the surface during the hour of darkness than during daylight. They suggest that the migration may be less marked when the light become weaker as in the late of March and April in the Antarctic waters. The Japanese investigations on board show that the typical decrease in the feeding percentage through daytimes also occurres in the Antarctic. As shown in figure 14, whales caught in the first decade of January show sudden decrease in feeding percentage from four o'clock. While, feeding percentage of morning shows a low pitched decrease in 2nd decade of January. In 3rd decade of February, the feeding percentage is still heigh between ten and twelve o'clock. As discussed by Hardy & Gunther (1935), the light become weaker towards the end of the summer in the Antarctic. The low pitched decrease corresponds with the intensity of the light in the sea.

The diurnal migrations of zooplanktons are considered to be also affected by the depth of the sea, stages of their biological development

(Marshall & Orr, 1955) and hydrographical condition of the sea. Some biology of *Calanus cristatus* is made by Bogorov & Vinogradov (1955a). They suggest the vertical distribution of *C. cristatus* show pecurial feature in some part of the North Pacific where the intermediate cold waters are found. *C. cristatus* is scarce in the intermediate cold layer, but very abundant above the layer. In waters where the intermediate cold layer vanished, *C. cristatus* is not so restricted at the surface waters. Accordingly *C. cristatus* above the intermediate cold layer swim down not so deep to the cold layer though in the daytimes.

Sei whales often take *Calanus plumchrus* also in daytimes in June in 1954. In other words *Calanus plumchrus* is considered to show not so distinct diurnal migrations because *C. plumchrus* is collected by vertical plankton nets more than other *Calanus* in daytimes' towing. Although sei whales are considered to dive not so deep as other fin and blue whales (Ingebrigtsen, 1929) they must be easy to skim *C. plumchrus* in daytimes if only *C. plumchrus* is limited to the surface waters in some seasons in the North Pacific.

The vertical migrations of zooplanktons are fairly speedy in some cases. Big krill *Meganyctiphanes norvegica* swims vertically about 128 meters for an hour and is capable of bursts of 271 meters in an hour (Bainbridge, 1953). It is thought by some observation *Calanus acutus*, a big Antarctic copepod, migrates vertically 50 m or more in an hour. Recent investigations also show that the deep scattering layer, considered to be of zooplanktons also migrates fairly speedy. The diurnal migration of euphausiids' layer has not been examined in these whaling grounds. But, in the adjacent waters to Japan, Saito & Mishima (1953) observed the deep scattering layer consists of *Euphausia pacifica* in the water off Hokkaido by the echo-sounder. They state the deep scattering layer is observed 50 to 60 m deep from the surface waters at 35 mintes past 4 p.m. Then, it come up gradually and it come up to the surface after the sun-set.

A pending question, how deep whales dive usually below the water surface, has not been dissolved successfully to this time. Ommanney (1932) states, 'It may be said, then that a whale probably does not descent to depth much greater than 130 feet, but can remain below for periods of up to half an hour', from the view of the danger of caisson disease. As adult specimens of *C. cristatus* have been found usually in deep waters below 500 meters in northern part of the North Pacific (Nakai & Honjo, 1954; Anraku, 1954; Nakai & Honjo, 1954) suggest, the fact no adult specimens of *C. cristatus* is found in stomachs of whales means baleen whales dive not so deep as 500 meters. Of course, adult specimens of *C. plumchrus* have been found at the surface waters in northern parts of Bering Sea above 150 meters the presence of them never means such conclusion as *C. cristatus*.

Recently, Owatari, Matsumoto & Kimura (1954) investigated feeding habits of some dolphins, and presume that 'the dolphins do not likely to swim deeper than 40 meters at any time nevertheless there are many sardins escaped from above waters in the deeper waters of 40 meters. The dolphins swim streight rising and falling at the surface waters above 40 meter depth, and when they meet their foods they take foods swimming hither and thither'. Of course, it is true that other sperm whales and baired beaked whales take foods in far deeper waters as described in the paper by Laurie (1933). Sperm whales caught along the Aleutian Islands have often taken deep-sea fish and deep-sea crabs.

In contradiction to this, Matsushita (1955) has examined stomach contens of sperm whales in the Antarctic during the years 1953–54, and states that sperm whales caught at night are less in number but fed better than those caught in daytimes. By his observation, sperm whales caught at early in the morning took abundant foods, but those caught in daytime fed less, and whales fed regained in number in the night. He suggests from above findings, the most favourite food of sperm whales, gigantic deep-sea cephalopods and fish may come up to the sea water surface through night and be caught by sperm whales. If it is true, sperm whales need not dive so deep to take deep-sea cephalopods as considered to this time by Iwai (1956) and others. Sleptsov (1955) also consideres, many deep-sea cephalopods come to the surface through night with other oceanic deep-sea fish, forming good feeding grounds for whales. One of causes for such phenomenon must be the intensity of the illumination by daylight, and the next their main foods, smaller zooplanktons also come up to the surface waters through the night.

On some other marine mammals feeding habits also have been examined. Taylor, Fujinaga & Wilke (1955) describe that feeding activity of seals is probably a response to the upward migration of lantern fish and squids at night. They state that though seals take their foods in night than in daytimes. Main foods of seals are those lantern fish belonging to *Myctophidae* (Taylor, Fujinaga & Wilke, 1955). Thus they conclude seals feed more actively before and during sunrise than during daylight. Alike above seals, sei whales in Bonin waters (Nishimoto, Tozawa & Kawakami, 1952) or in waters off Japan (unpublished data of the Whales Research Institute) take many lantern fish also in twilight time of a day. From above many observations, it may be concluded, feeding activity of whales must be partly affected by vertical diurnal migration of crowding patches of zooplanktons, fish and squids.

THE INFLUENCE OF CHASING TIMES TO STOMACH CONTENTS

The review of U.S.S.R. (1955) shows that the stomach quantity of captured whales are also affected by the time of chasing. Whales caught with short chasing have a few foods at least. On the contraly, the long time chasing causes vacant stomachs of whales. That is, the longer the time of chasing, the fewer whales which have foods in their stomachs.

TABLE 8. FRESHNESS OF THE STOMACH CONTENTS OF FIN WHALES IN 1954

Time of chasing (minutes)	Freshness of stomach contents: Euphausiids				Copepods			
	f	ff	fff	F	f	ff	fff	F
0- 30	13	9	14	1	5	—	4	—
31- 60	19	40	22	5	9	8	—	—
61- 90	31	26	12	2	6	7	3	2
91-120	27	26	10	5	2	7	2	—
121-150	20	14	5	1	7	2	—	1
151-180	6	11	4	—	2	4	—	—
181-210	7	7	3	—	—	—	—	—
211-240	—	6	—	—	—	—	—	—
241-270	1	3	—	—	—	—	—	—
271-300	—	—	—	—	—	—	—	—
301-330	2	1	—	—	—	—	—	—
331-360	—	1	—	—	—	—	—	—

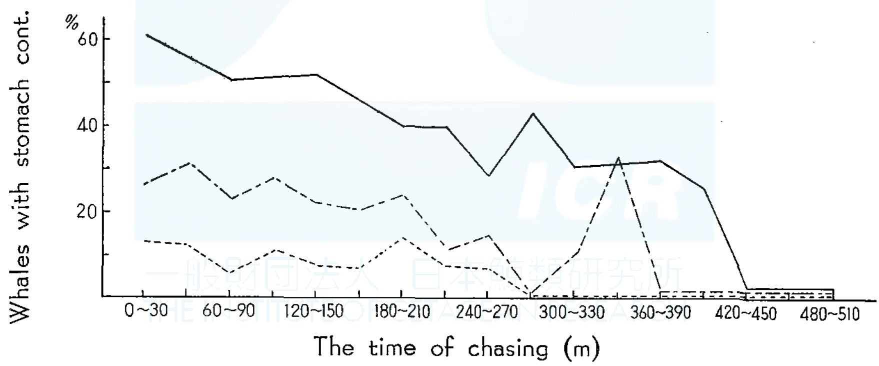

Fig. 15. The variation in stomach quantity of fin whales in 1954 by chasing intervals in minutes. Solid line—More than r. Chain line—More than rr. Broken line—More than rrr.

The quantity of stomachs of whales decreases in accordance with prolongation of chasing as shown in figure 15. This phenomenon at the same time, suggests the whales with full stomachs are more easily caught than with vacant stomachs. The result is essencially similar to that described by Ingebrigtsen (1929), 'When these whales have no copepods they are often so shy and difficult to approach within shooting range, that they may be chased all day without being shot'. The freshness of the stomach contents also declines, as shown in table 8 with prolongations of chasing. As the freshness of foods suffer no peculial change while waiting to be flensed by my observations, the foods is considered to be digested during chasing.

BIOLOGICAL DATA ON FOOD PLANKTONS

AGE AND GROWTH OF EUPHAUSIIDS

The growth of various species of euphausiids has been studied by Ruud (1932) and Einarsson (1945). *Euphausia superba* is biennial in the Antarctic water (Ruud, 1932), and *Thysanoëssa inermis*, the most famous food for baleen whales in the Atlantic, is annual in southern localities, biennial in north and Icelandic waters, and some specimens in West Greenland waters are considered to be triennial (Einarsson, 1945). To the northern Pacific, above conclusions are applied in various points. In the materials composed of stomach samples, I have measured about 30 specimens of each sample as possible at the same time examining the maturity of the external and internal sexual organs. The maturity of the external sexual maturity is determined by the formation of the endopodite of first and second pairs of pleopods in male, and of the thelycum and the presence of spermatophores in females.

The internal sexual maturity is determined by the examination of ovary and the presence of loose spermatophores in the spermatophore sac. As for the grades of maturity of euphausiids, I use the classification described by Einarsson. Those are the following groups: '1. The larval and early post-larval stages, showing no sign of external characters. 2. Juveniles and adolescents showing various degrees of development of the external sexual characters, but not showing mature characteristics. 3. Adults with the external sexual characters fully formed, the males with loose spermatophores in the spermatophore sac, and the great majority of the females fertilized, i.e. with spermatophores inserted into the thelycum. 4. Specimens which are larger than the usual mature size of the species in a certain area, but showing immature external sexual characteristics'. The results of my observation and measurements are shown in following figures. Specimens belong to 1 group and show slight development of external characters, such as only swelling has appeared in the first endopods, are put into 1 group.

Euphausia pacifica. As *E. pacifica* appears in less number among the materials, the exact life cycle is not able to be illustrated. The fertilized specimens of females with spermatophores in their thelycum are also rarely found. However, distinct two size groups are observed as illustrated in figure 16. From June to September, the larger group, perhaps belong to 1 or 2 year group is usually found throughout the summer in the whaling ground A. The smaller groups, ranging from 6 to 12 mm, is found in September in the whaling ground D. They are considered to be 0 year group as sizes of them are suggesting that they have hatched in this spring or early summer. Boden (1950) also describes the latter larval stages of *E. pacifica* are abundant from spring to summer in southern California waters. It is probable that these larval stages may develop to length about 10 mm in autumn, though the growth of euphausiids is completely differs in the locality of them. These juveniles and adolescents may attain to about 20 mm in next year, and

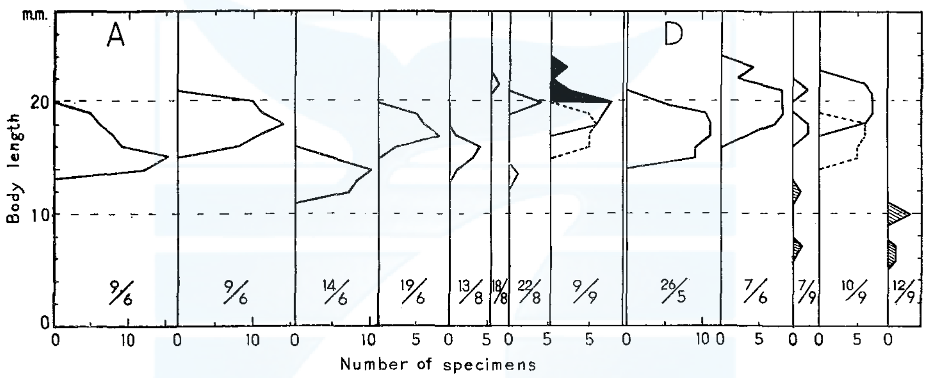

Fig. 16. Size distribution in *Euphausia pacifica* in the whaling grounds A and D. Oblique shading—The larval and early post larval stages, showing no sign of external characters. No shading—Juveniles and adlescents showing various degrees of development of the external sexual characters, but not showing mature characteristics. Blacked—Adults with the external sexual characters fully formed, the great majority of the females fertilized, i.e. with spermatophores inserted into the thelycum. Solid line—Females, broken line—Males.

E. pacifica is considered to reach the sexual maturity in full one year or more. Females collected on 9th in September in the whaling ground A bear spermatophores inserted, eggs of which have also fairly fertilized. But, this is perhaps the rare example, as the spawning of *E. pacifica* may occur in the more early season of a year from above results.

E. pacifica of about 15 mm in length collected in the wamer waters bears full sexual characters. *E. pacifica* may reach to the sexual maturity within a year in the far southern waters of Japanese coast like other euphausiids described following.

Thysanoëssa inermis. *T. inermis* in the North Pacific whaling grounds is divided to three type by developmental conditions. In the west whaling ground A, the specimens with spermatophores are only found in first decade of June. And adolescents with almost grown external sexual characters are found during June to September. Males and females are perfectly classified by the external characters, and the difference in size between males and females is observed from 18 mm in length. These adolescents are considered 1 or 2 year groups. One male specimens of 15 mm in length is collected in the far south waters at 42°28′ N, 149°48′ E in August through 'Takunan maru' cruise, which shows full grown external sexual characters and has loose spermatophore in the spermatophore sac. From the body length, it may belong to 1 year group, judging by comparison with the Atlantic specimens described by Einarsson (1945).

TABLE 9. OCCURRENCES OF FEMALE SPECIMENS OF *T. INERMIS* WITH SPERMATOPHORES

Whaling area	Year	Date	Total no.	With spermatophores
D	1954	5 July	1000	200
〃	〃	19 〃	500	100
〃	〃	30 〃	400	250
A	1955	2 June	280	80
〃	〃	6 〃	170	130
D	〃	1 July	290	200

The collections from the whaling ground C and D show some differences from those from the whaling ground A. Many fertilized specimens are collected in July in the whaling ground D, while all other materials collected after July show no fertilized character. Thus it is considered the mating season of *T. inermis* in the south waters of eastern Aleutian Islands comes to an end in July. Perhaps the mating season of *T. inermis* in this waters begins in early spring, larvae grow about 10 mm or more in next year, those are 1 year group, then it grows in second year about the length 20 mm to 26 mm and spawns. Specimens which are larger than those fertilized mature in sizes, but showing immature external sexual characters are found on 9th September sizes of which are 24 mm to 28 mm. It is not certain if the larger specimens will be mature in the third year. Einarsson (1945) consideres, *T. inermis* in West Greenland waters may be adult in the third year at about 28 mm in length. Thus some specimens of *T. inermis* in this waters may be considered triennial.

In the north parts of the eastern Aleutian Islands the whaling ground C, *T. inermis* shows interesting features. None of specimen in the samples shows any external and internal characters fully developed. While the body length of some of them are exceedingly larger than those collected in the west or southern waters. The figure gives the measurement of these specimens caught in the north part of the eastern

Aleutian Islands. The larger materials collected on 13th September are about 27 mm in length showing no sexual character fully formed. These specimens may develope a little more and spawn in next year. The

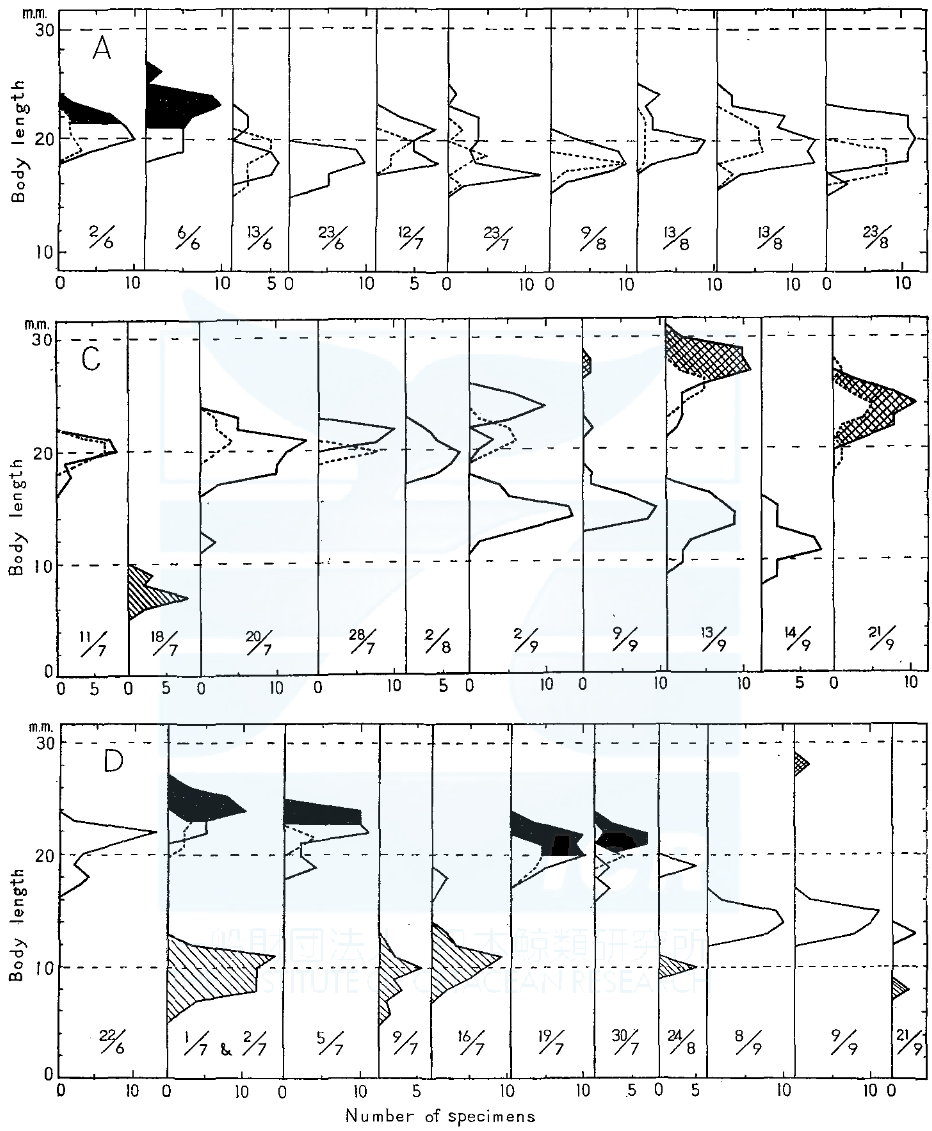

Fig. 17. Size distribution in *Thysanoëssa inermis* in the whaling grounds A, C and D. Double shading—Specimens which are larger than the usual mature size of the species in a certain area, but showing immature external sexual characteristics.

smaller group, about 10 mm to 18 mm also occurres in the late of summer. As compared these size distributions with those reported by Einarsson in West Greenland waters, the *T. inermis* in the whaling ground C, may be generally triennial as the specimens in West Greenland waters. But some of them are considered to be biennal as the speciemens in southern waters. In either case, the complete sexual maturity in two cases is attained in two years at least.

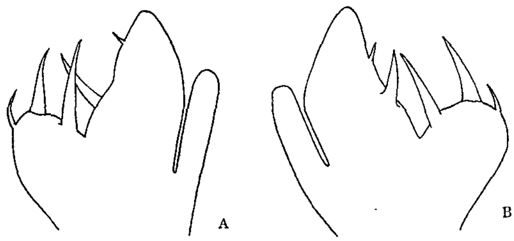

Fig. 18. Immature male copulatory organs of *Thysanoëssa inermis* (Krφyer) Hansen of comparatively large specimens. A, 26 mm. B, 24 mm ×50.

Thysanoëssa longipes. The materials of *T. longipes* in my samples are comparatively abundant as compared with other euphausiids, and the more detailed disscussion can be obtained. In whaling ground A, the firtilized female specimens, such as with spermaphores inserted into the thelycum or eggs are fully developed are found only in June, owing to the scanty data before then. These full developed specimens have sizes from about 20 to 28 mm in female and 18 mm to 24 mm in males. The juvenils and adolescents are suceessively found from June to September. Specimens about 13 mm in length are found 19th July most of which show no sign of external development of sexual characters of males. These specimens may be considered to be 1 year group. In the collections following these, there are many specimens considered to be 1 year group about 20 mm in length. They have well developed external characters, but the thelycum of females is not full grown and therefore it is empty. The differences of size distributions between males and females is observed from this developmental stage as illustrated in figure 19. In the late August, the smaller size group appears in collections by plankton nets. Some furcilia larvae have mingled with them. These specimens are apparently 0 year group, which have hatched in spring of this year. With allowance for the scanty collection of 1 year group in spring, above 0 year group developes to about 15 mm in next spring, and grow about 20 mm in summer successively. Thus it may be concluded *T. longipes* in this waters does not reach sexual maturity before it is two years of age.

The samples from C and D whaling ground show somewhat defferent manner of growth. The fertilized specimens of *T. longipes* have been found only 2 cases in C and D whaling grounds. Specimens collected on 7th July in C whaling ground and 7th July in D whaling ground are all full mature. It is interesting that some full grown specimens are found in summer, which have no signes of mating or spawning though

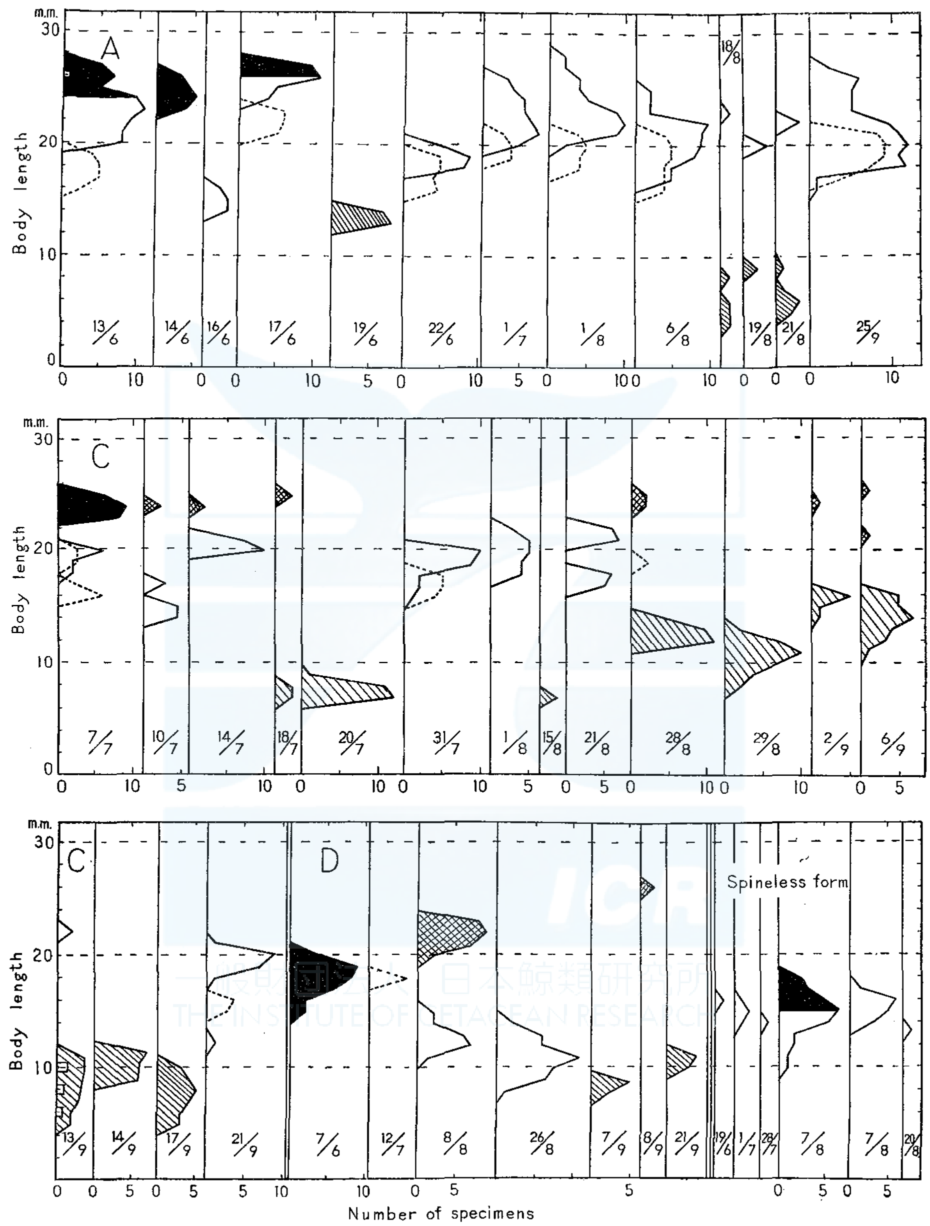

Fig. 19. Size distribution in *Thysanoëssa longipes* in the whaling grounds A, C and D.

they have full developed thelycum and the male copuratory organs. They may survive the winter and spawn in the next spring as the 3 year group.

The smaller specimens are also found in the summer season, so two size groups of immature are observed through the latter whaling season from July to September as shown in figure 19. As to the development of the spineless form of *T. longipes*, I would condider it is usually annual in these waters. Because it have full grown sexual characters at about 15 mm to 18 mm in length, and the larger specimen than 18 mm has never been collected. Female spineless forms collected on 7th in August have

TABLE 10. OCCURRENCES OF FEMALES SPECIMENS OF *T. LONGIPES* WITH SPERMATOPHORES

Whaling area	Year	Date	Total no.	With spermatophores
B	1954	7 June	30	25
C	1955	6 〃	30	20
A	1956	13 〃	100	30
〃	〃	13 〃	440	60
〃	〃	14 〃	20	18
〃	〃	16 〃	20	18
〃	〃	17 〃	45	5
〃	〃	19 〃	200	6

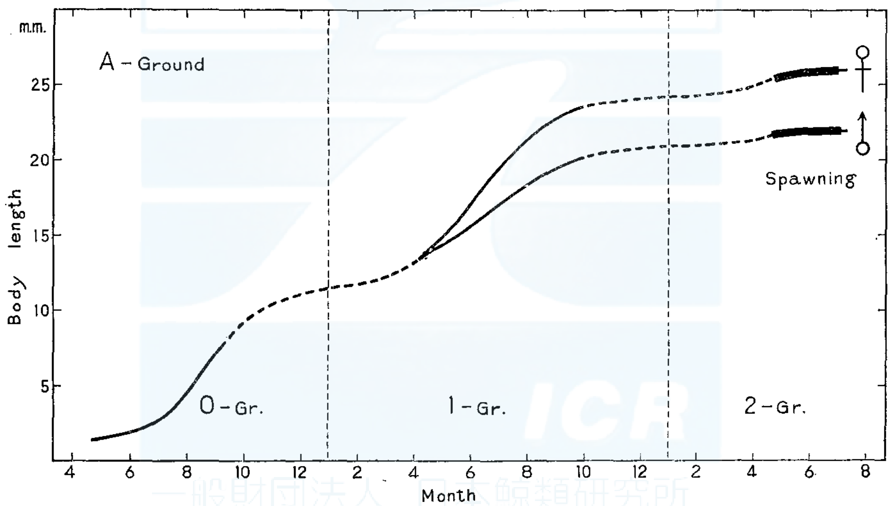

Fig. 20. The life cycle of *Thysanoëssa longipes* in A whaling ground.

spermatophores inserted into the thelycum, while the original form among above spineless form is not full mature. As the furcilia stage of *T. longipes* has the lateral denticles of carapace in somewhat behind position from adult specimens, spineless forms may make rapid progress in genital glands with some features such as the lateral denticle remained as larval form by some stimulant. Above suggestion, however, is uncertain because there is no valid prove for it now.

Thysanoëssa spinifera. *T. spinifera* only distributes in the eastern side of the North Pacific as considered from the stomach contents of whales and samples by plankton nets, and some interesting biology on *T. spinifera* was described by Hollis (1939). Hollis (1939) describes that the egg masses of *T. spinifera* were particularly numerous in the humpback whales shot on August 26 in Alaskan waters. This result suggests that the spawning of *T. spinifera* may occurres in summer. Some specimens in my materials also bear such fertilized features. In nine cases from stomach contents females of *T. spinifera* with spermatophores inserted

TABLE 11. OCCURRENCES OF FERTILIZED FEMALES OF *T. SPINIFERA* WITH SPERMATOPHORES INSERTED INTO THERYCUM IN C GROUND

Year	Date	Total no.	With spermatophores
1954	7 June	1	1
〃	5 July	14	12
〃	5 〃	5	1*
〃	30 〃	6	6
1956	10 〃	14	10
〃	11 〃	6	6
〃	14 〃	70	48
〃	31 〃	30	25
〃	1 Aug.	60	50

* Only one spermatophore.

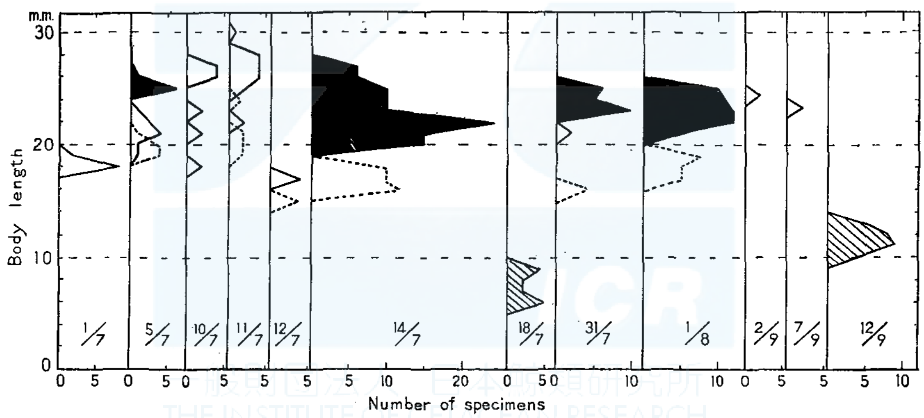

Fig. 21. Size distribution in *Thysanoëssa spinifera* in the north-eastern part of North Pacific.

into the thelycum as shown in table 11. The egg is considerably developing especially in specimens found on 7th June, 5th, 30th July, and also 2nd September besides the formar nine cases.

The first specimen is considered to be full mature, with full grown egg masses in the ovary, though the size of body is 20 mm, rather smaller as compared the latter grown specimens. The latter cases comprise specimens of length between 20 and 28 mm. Males found with above fertilized females also bear the external sexual characters fully formed and with loose spermatophores in their spermatophore sacks. As stated on *T. longipes* males are far smaller than adult females, sizes of males is usually ranging between 15 and 24 mm. Above stated result completely coincides with the one reported by Hollis (1939) that *T. spinifera* may spawn in summer from June to September in Alaskan waters, the whaling grounds C and D.

Juveniles and adolescents bearing no full grown external sexual characters are also found in summer in these waters. Specimens found from whales' stomachs caught on 18th July and 12th September have little signes of such characters. From these samples figures of the size distribution and life cycles of *T. spinifera* may be illustrated. It is, thus considered that *T. spinifera* is biennial, reaching about 10 mm in length in the first year and 20 to 24 mm in the second year when it becomes mature. The difference between males and females in the growth is observed from the first year, and external sexual characters, in endopods of first and second pleopods also begin to grow in the same year. There are some large specimens, about 26 to 30 mm, with mature external sexual characters with no spermatophors. But, I am not sure if the larger specimens of *T. spinifera* in the samples obtained on 10th and 11th July in these waters grow further in the third summer and spawn like *T. inermis* in the Atlantic (Einarsson, 1945, p. 150).

SEX RATIO OF EUPHAUSIIDS

Einarsson (1945) examined the sex ratio of euphausiids and states, 'as the sexes were on the hole found in similer numbers and of similer size, I have not considered it necessary to divide the catches as to sex'. But some different results are obtained through this study. As described in the paper by Ruud (1932), Sars found no males of *Euphausia antarctica*, (synonym *E. superba* juv.) owing to only use the male external character of the endopodite of first and second pairs of pleopods as the marks to divide both sexes. The classification on the sex, therefore, should be ascertained by the presence of spermatheca of females bisides male characters (Ruud, 1932).

The sex of the euphaussiids in my samples, are determined by careful consideration to the points, and males and females are found not in similer numbers. Sizes of specimens by each sex differ also considerably in some species as stated before. Generally speaking, more females are found than males. I count 100 specimens of each adult euphausiids, then females are observed dominantly in almost all samples as shown in table 12. The total occurrences of females are also prevalent in the recent study of euphausiids by Boden (1955).

ZOOPLANKTONS COLLECTED IN WHALING GROUNDS

Besides the stomach samples of whales, many euphausiids and copepods are collected by plankton nets. I would state short review on those samples here. Further discussions on the materials will be given in another article in future. The plankton samples are only restricted to the surface waters' samples collected by vertical hauls from 50, 100, 150 and 200 meters to the surface.

TABLE 12. OCCURRENCES OF MALE EUPHAUSIIDS IN EACH 100 SPECIMENS

No. of males	Species			
	E. pacifica	*T. inermis*	*T. longipes*	*T. spinifera*
10~14	—	5	1	—
15~19	1	3	—	—
20~24	—	3	—	—
25~29	—	8	4	—
30~34	—	3	2	1
35~39	1	—	—	—
40~44	—	1	—	—
45~50	2	—	—	1

TABLE 13. TOTAL OCCURRENCES OF EUPHAUSIACEA PREPARED BY THE FIRST SURVEY OF 'W. SCORESLY', 1950, IN THE BENGUELA CURRENT*

Species of euphausiids	Adult male	Adult female
Thysanopoda microphthalma	—	1
Nyctiphanes capensis	23	75
Euphausia hanseni	—	4
E. lucens	40	304
E. recurva	41	46
E. similis var. *armata*	1	1
E. tenera	—	2
Nematoscelis megalops	3	7
Thysanoëssa gregaria	2	—
Nematobrachion boöpis	—	2

* Figured up from the data by Boden, 1955.

Main species collected by plankton nets are nearly the same as previous reports in this water (Brodsky, 1950; Banner, 1949; Anraku, 1954; Boden, Jhonson & Brinton, 1955). Euphausiids in our samples are as followings:

Euphausia pacifica; *Thysanoëssa longipes*; *T. inermis*; *T. raschii*; *T. spinifera*; *Thessarabrachion oculatus*.

T. longipes is the most dominant euphausiid collected by plankton nets in the samples and *T. inermis* is less in number on the contrary to the result that *T. inermis* is the most dominant foods for baleen whales.

T. raschii and *T. spinifera* are chiefly found in hauls within the margin of Alaskan continental shelf.

The adult *Thessarabrachion oculatus* is usually found below 100 meters (Boden, Jhonson & Brinton, 1955). Only one female of *T. oculatus* is collected by the haul from 50 meter to the surface at the position 51°17′N, 162°56′E.

The main copepods are as follows:

Calanus cristatus Krφyer
Calanus plumchrus Marukawa
Calanus finmarchicus (Gunner)
Calanus helgolandicus (Claus)
Eucalanus bungi bungi Jhonson
Pseudocalanus elongatus (Boeck)
Pseudocalanus gracilis Sars
Centropages abdominalis Sato
Aetideus armatus (Boeck)
Euchaeta japonica Marukawa
Gaidius brevispinus (Sars)
Gaidius tenuispinus (Sars)
Scolecithricella minor (Brady)
Heterorhabdus papilliger (Claus)
Candacia columbiae Campbell
Metridia lucens Boeck
Pleuromamma robusta (Dahl)
Acartia clausi Giesbrecht
Oithona similis Claus

Calanus plumchrus is the most dominant *Calanus* in for '*Calanus*' species. *Calanus finmarchicus* has not been reported by Japanese workers from the whaling ground A (Anraku, 1954). But '*Calanus*' with typical 5th foot of *C. finmarchicus* has been occasionaly found in my samples. Many other '*Calanus*' are rather related to *C. helgolandicus* as described by previous studies (Mori, 1937; Anraku, 1954). The smaller '*Calanus*' *Calanus pacificus* is reported by Brodsky (1950) from Pacific waters. By his descriptions, *Calanus pacificus* is smaller than *C. helgolandicus*, and the endopod of the left leg reaches only to the distal edge of the second segment of the exopod in the male fith foot. '*Calanus*' with such fith pair of foot has also observed in the samples. Tanaka (1956) states on this point, the fith pair of foot of *C. helgolandicus* is very variable, so it is not proper to attach importance to only the fith foot of *Calanus* related to *C. finmarchicus*.

C. plumchrus is the most dominant copepod in the samples collected by plankton nets, the adults of which are considered to distribute in deep waters blow 150 m (Anraku, 1954). By my studies it is observed that the adults occurred in the vertical haul from 150 meter to the surface on 23 August at the position, 53°03′N, 166°58′E. Many adults are collected by the vertical haul from 100 meter to the surface at the position 57°09′N, 173°44′W. Other many specimens are found in vertical hauls from 200 meter to the surface. In the northern area, above facts suggest that the adult *Calanus plumchrus* appears commonly in the surface waters in the northern waters of Bering Sea. In the southern waters along the Aleutian Islands, *Calanus plumchrus* may be commonly found below 150 meter as described by Anraku (1954).

Calanus finmarchicus, *Calanus plnmchrus* and *Metridia lucens* are the most important foods for oceanic fish in these waters. Though they are not so important as whales' foods, Pacific salmons in these waters take many *C. plumchrus* as well as *C. cristatus*. The sparse swarms of *C. plumchrus* are considered to be sufficent to stimulate appetites of such fish. *Calanus pacificus* Brodsky is considered as one of the main foods of baleen whales in the Pacific (Sleptsov, 1955). But, the swarms of *Calanus pacificus* is also considered to be not so congregated as *C. cristatus* in northern part of the North Pacific. Consequently, the swarms of *C. pacificus* in stomachs of whales never have been found by Japanese investigations.

Many specimens of *Encalanus bungi bungi* are observed in plankton samples, though I have few specimens in stomach samples. Sleptsov (1955) describes, *Eucalanus bungi bungi* constitues some part of foods of whales, but it has not been appeared as foods of whales by my observation. This fact suggests, *E. bungi bungi* swarms not so closely as other food copepods, *C. cristatus* and *C. plumchrus*, and not forms huge biological masses. Accordingly, *E. bungi bungi* is considered to be of little importance as foods of whales. Stored fatty nutrients in body of *Eucalanus* are also not so abundant as other calanoid copepods.

Metridia lucens is also very abundant in plankton samples. It is observed from the stomach of a fin whale caught at the position 55°38′N, 169°00′W with euphausiids. This is a only example for the dominant *Metridia* appeared in my observation. The sizes of the *Metridia lucens* are comparative smaller than other locations in the whaling grounds. As they are found in the warm backwaters off the Alaskan continental shelf. These *Metridia* may have developed in such warmer backwaters, and are remained in smaller sizes.

DISCUSSION

The whaling ground of northern Pacific is far smaller as compared with Antarctic one, but it has some peculial features from the view of distribution of foods and oceanographic conditions. The stomach contents of whales show some variations from year to year especially among fin whales. In the whaling ground A, *E. pacifica*, *T. longipes* and *C. cristatus* are main foods of baleen whales from early summer, *T. inermis* is rather less in this water. Generally speaking, euphausiids are more important than *C. cristatus*. While in *Calanus year* as 1953, *C. cristatus* is more dominant from early May to July. Fin whales swarmed in this season to take *C. cristatus*, and many fin whales were caught in from May to July in *Calanus year*. On the other hand, blue whales never migrate to the grounds if euphausiids are not abundant. When euphausiids are abundant as *Krill year* 1954, blue whales arrive at the

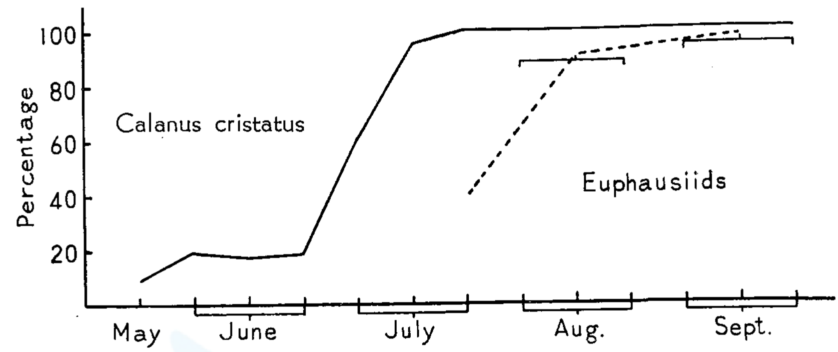

Fig. 22. The transition of foods of fin whales from *C. cristatus* to euphausiids in the whaling ground A.
Broken line—1952. Solid line—1953.

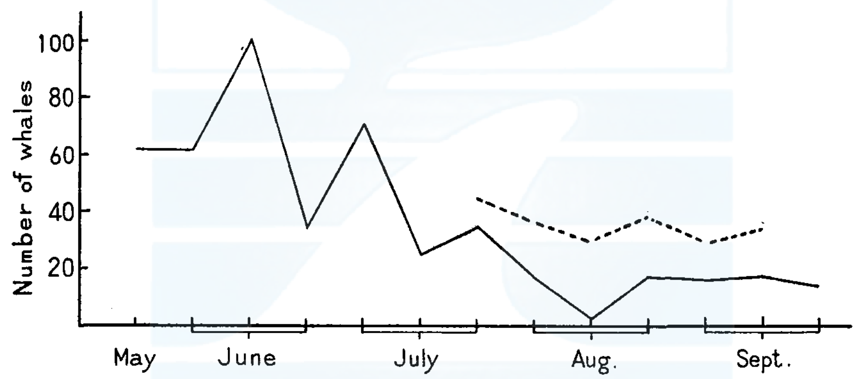

Fig. 23. Number of fin whales caught in the whaling ground A.
Broken line—1952. Solid line—1953.

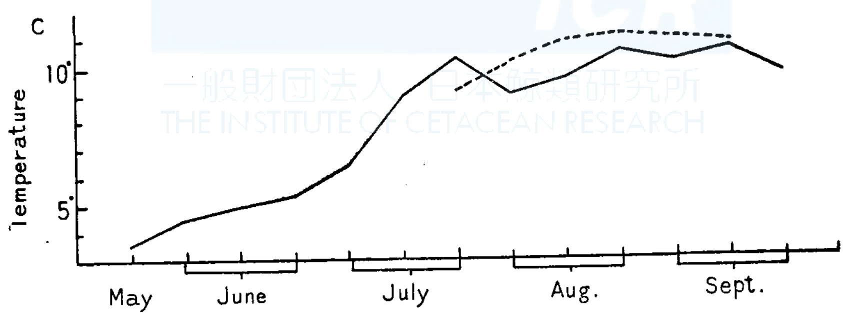

Fig. 24. Mean surface temperature at mid noon position of the factory ship in the whaling ground A. Broken line—1952. Solid line—1953.

whaling ground A already in June from southern waters. In 1953, some blue whales were caught in first decade of July, and many blue whales were captured in September. The height of 2 year group euphausiids was observed in late July, and of 1 year group in September in 1953. Blue whales should swarmed on each euphausiids' swarms. Generally, blue whales approach the cape Kamtchatke Peninsula or waters off Kurile Islands from the south eastern warmer waters. Then blue whales migrate along the Islands towards north-east. As to the migratory routes to north waters, it is considered blue whales follow the routes much further off the coast, while they come back to the south waters along the shore (Omura, 1952). Perhaps it is due to the distribution of eupahusiids.

TABLE 14. STOMACH CONTENTS OF FIN WHALES IN WHALING GROUND A

	Year				
Kinds of stomach contents	1952	1953	1954	1955	1956
Euphausiids	79	83	182	32	149
Eu. & Copepods	4	15	18	1	17
Eu. & Squids	—	—	—	—	1
Eu. & Fish	—	1	—	—	—
Copepods	19	105	92	48	47
Co. & Squids	—	—	—	—	1
Fish	—	1	—	—	1
Squids	1	—	—	—	7
Empty	110	252	272	67	114
No of stomachs examined	213	457	564	148	336
Not examined	—	13	—	—	—

In June and July, the water south-west of Attu Islands at about 52°N, 170°E, attracts many fin whales every year as stated above. It is the most static whaling ground for fin whales in the North Pacific. Those fin whales mostly take *C. cristatus*. When the biological autumn comes in this sea region, *C. cristatus* subsides to deep waters to be mature. Thus *C. cristatus* becames scarce at surface waters in the late of July and euphausiid gradually take copepods' place though euphausiids are still not so abundant in July. The catch of fin whales decrease in number consequently in August in this waters as in 1952 and 1953 as shown in figure 22. Especially only those fin whales with empty stomachs are caught in August of 1953. Bogorov & Vinogradov (1955a) describe that *C. cristatus* was very abundant during May to July in the surface waters off Kamtchatka and Kurile Islands in 1953. Whereas it showed phenomenal decrease in August and vanished from the surface waters in September. This fact endorses above observation obtained through Japanese whaling expeditions. Accordingly whaling grounds consist of *C. cristatus* may be said to be passing prosperity.

One of the causes may be the transition of the water temperature.

The surface water temperature at mid noon position of the factory ship alteres markedly and rise rapidly during the first and second 10 days period of July as shown in figure 24. This marked change in water temperature is regarded as one of the contributing causes of the change in principal whale foods. As *C. cristatus* distributes mainly in the lower temperature waters, Nakai & Honjo (1954) state the sudden rise of water temperature hastenes the subsiding of *C. cristatus*. Bogorov & Vinogradov (1955 b) also observe, the rise of surface temperature causes the subsiding of *C. cristatus* and *C. tonsus* in the north-west part of Pacific. In August, considerable swarms of fin whales are caught in the whaling ground B, the north waters of Komandor Islands in 1956.

TABLE 15. SIZE OF EUPHAUSIIDS MEASURED ON BOARD IN 1954

C whaling ground

	Length (mm)			
Decade	5–15	15–20	20–30	Unknown
1st June	—	—	—	—
3rd 〃	—	—	—	—
1st July	—	1	16	—
2nd 〃	—	1	29	2
1st Aug.	—	—	64	—

D whaling ground

	Length (mm)			
Decade	5–15	15–20	20–30	Unknown
1st June	—	6	7	—
3rd 〃	2	11	38	—
1st July	7	13	51	20
2nd 〃	20	4	44	9

Those fin whales may come from southern waters to take foods, because the southern waters, the whaling ground A are unproductive in August and there are few *C. cristatus* in surface waters in 1956. On the other hand, *C. cristatus* is considered to be at the height in this northern waters, the whaling ground B, just in August about a month late.

In the north waters of east Aleutian Islands, fin whales take *C. cristatus* in off waters from continental shelf slope, while they take *T. inermis* mainly distributing along the continental shelf slope. This fact also suggests that the deep waters is necessary for *C. cristatus* to be adults as considered to these days. On the other hand *T. inermis* spawns on the bank of continental shelf (Hjort & Ruud, 1929; Einarsson 1945) and drift to the surface strata where the larva develops (Einarsson, 1945). So, *T. inermis* circulates in the sea waters from bank of the shelf to off waters and vice versa. The distributions of *T. inermis* as illustrated in figure 25, show apparently this circulation. *T. raschii* and *T. spinifera* are more coastal form as considered to this time, and they never spawn in so off waters. Because no fertilized specimens of above two species have been collected in off waters. The size measurement of euphausiids also has been carried out on board. In 1954, the comparatively much

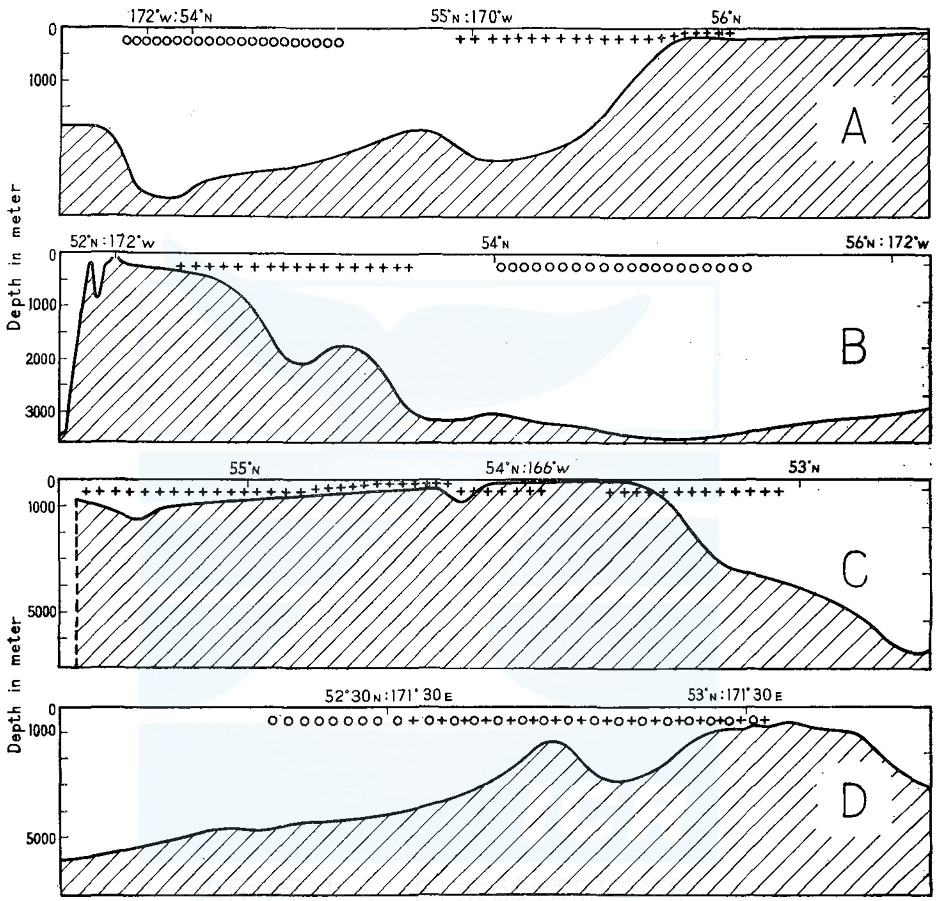

Fig. 25. The distributions of *Calanus cristatus* and *Thyanoëssa inermis* in relation to the sea depth of whaling grounds. Open symbols—*Calanns cristatus*. Crosses—*Thysanoëssa inermis*. C figure,—Cut the center position at an angle of 45° from north-west.

data are obtained as shown in table 15. The larger euphausiids are more dominant in C and D whaling grounds than the smaller one. This smaller group, ranging 5 to 15 mm is directly considered to be 1 year or 0 year groups. I observe the rare occurrences of such 0 year groups in C and D whaling ground chiefly consist of *T. inermis* and *T. longipes*. The furcilia larva of *T. inermis* is observed on 29th July in the stomach of 1 fin whale caught at 54°33′N, 171°43′W.

Rund (1932) and Marr (1956) also consider the occurrences of furcilia stages of *E. superba* in the Antarctic. But the dominant foods for *Balaenopteridae* whales are those over 20 mm or more in length. And as a rule *Furcilia* stages of euphausiids may not be able to be favourite foods of whales as discussed in the special part on euphausiids.

The whaling ground C has large continental shelf in the north-east part. As winds blow usually to north-east in summer, some physical processes of enrichment of surface waters are considered (Cooper, 1952). Cooper states in his summary that, ' Winds blowing intermittently towards a continental slope may produce vertical oscillations which bring about spillage of deeper nutrient-richer water from the ocean to the continental shelf '. With the upwelling current caused by sea currents met the continental shelf from south-west along the Aleutian ridge, the border line of Alaskan continental shelf should be very powerful productive region. Swarms of euphausiids on the border line is also due above causes. Hardy & Gunther (1935), also describe the distribution of blue and fin whales is deduced from the phosphate values of waters by the examination on the waters of South Georgia.

It is often observed by the whalers that, the state of whaling grounds has changed during the stormy weather. They say whales swam in an area migrate to another waters after the storm in some occations. If above observations is true, it may be attributable to the change of aspects in their food planktons by storm. However, Hardy & Gunther (1935) state that their results do not confirm the supposition that plankton organisms tend to sink from the surface layers during stormy weather. And stormy weather does not influence the state of swarms of zooplanktons. Uda & Nasu (1956) describe the relation between the whaling condition and the cyclone. They conclude that ' Shoaling condition of whales on the days after the passage of cyclone was better than that on the days before the passage of cyclone '. But by my observation, whales never shoal or disperse as a rule according with any weather conditions. Whales are considered to only swarm or disperse on their foods or for the reproducting.

The rendezvous of whales is found along the boundary between two currents in the whaling ground A. The center of rendezvous of whales lies in south-east waters in June, whereas the center ascends to north in July. It descends again to south from August to September according with the variation of boundary region. The intensity of the cold current along the Kamchatka Peninsula and the current along the south of Aleutian Islands decide above boundary. The migrating routes of baleen whales appear in the zone of abundant food such as above boundaries, and it seems that the migration of whale schools are subjected by the north and south movement of the front of abundant food zone

(Uda, 1954). The whale schools in the north waters of the eastern Aleutian Islands may attain there along those routes of boundaries.

When the examination on zooplanktons of stomach contents is carried out, the simplicity of dominant species is more often observed than those mingled with two or three species at the same rates. Nakai & Honjo (1954) state those simplicity of foods' species suggest that they apt to form the swarm of single species in the sea. In other words, each zooplanktons tend to form the swarm of themselves. This characteristic feature of planktons may partly due to the different ecological or the different spawning seasons of each species. As stated before, *Thysanoëssa spinifera* may spawn in summer, and *Euphausia pacifica, Thysanoëssa longipes* and *Thysanoëssa inermis* spawn during spring to

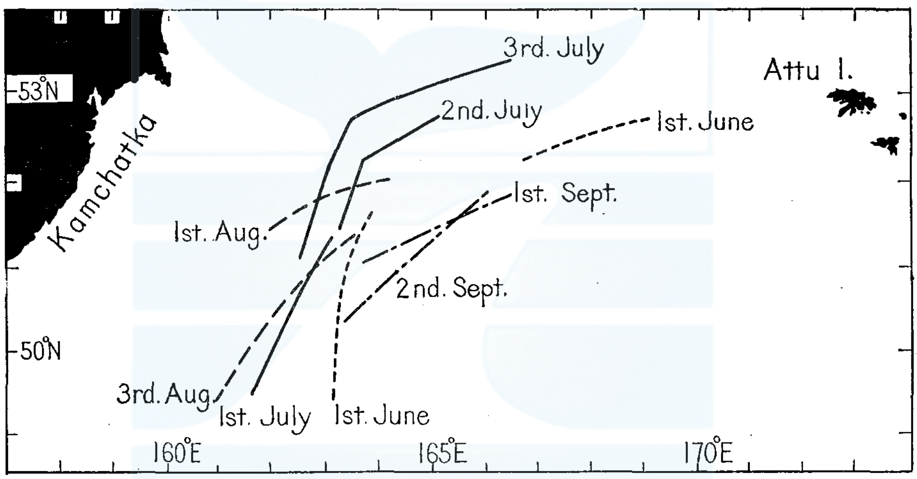

Fig. 26. The centre lines of the whaling ground in 1953 in the whaling ground A.

early summer in these waters. If euphausiids swarms for spawning as considered by Hjort & Ruud (1929), respective eupeausiids swarm separetely for their reproducting. Generally speaking *T. raschii* and *T. spinifera* are coastal forms, usually found within the continental shelf. *T. inermis* is more commonly found beyond the margin of the continental shelf (Banner, 1954). And above respective euphausiids may be carried by water currents of different conditions to the same waters. However, they may never dismiss their swarms.

Each swarms of zooplanktons must have peculial characters as biological masses, and preferences of whales for foods are due to such differences of biological masses. Very rare example, that blue whales took copepods in considerable quantity, are observed in two cases. In both cases, copepods are mingled with euphausiids at about the same rate.

Humpback whales, that never take copepods, also take the mixture of euphausiids and copepods. Above facts suggest that, the swarming mixtures of copepods and euphausiids bear the characteristic features of euphausiids' swarms, and blue and humpback whales take the swarms of copepods and euphausiids for the swarms of euphausiids. It is a very interesting fact that the mingled swarms of euphausiids and copepods stimulate blue and humpback whales' appetite, which have poor appetites for swarms of copepods.

In the first stomachs of whales, it is occasionaly found that foods are digested different grades in the first stomachs of whales. Further observations reveal that the foods of different digested grades are also considered different swarms of euphausiids. Because the species of each swarms are different from each other. I use every attention in dealing with such samples of different groups, as the simplicity of swarms is very important for the biology of euphausiids, and it is considered, whales should have taken successively such swarms of different species in the neighbourhood in the sea waters.

SUMMARY

The first summarized study on foods of baleen whales in the northern Pacific is stated. The essential points are concluded as follows.

1. The hydrographic conditions of the whaling grounds are discussed referring mainly to the papers by Barnes & Thompson (1938), Mishima & Nishizawa (1955), and Fleming (1955).

2. Generally speaking, baleen whales are planktonophager in the northern part of the North Pacific. Blue whales feed only on euphausiids, and fin whales feed mainly on euphausiids. When those zooplanktons are poor fin whales take fish or squids instead of zooplanktons. Only humpback whales take fish as well as euphausiids, but they never take copepods and squids favourably. The most favourite foods of sei whales is copepods though some of them take euphausiids, fish and squids. Baleen whales are not polyphagous animals in the northern part of the North Pacific.

The swarms of zooplanktons have peculial features according with the species of zooplanktons. Their characteristic features must have influence on the preferences of whales for their favourite foods.

3. Then, the important foods of baleen whales is as follows :

Euphausiids	*Euphausia pacifica*
	Thysanoëssa inermis
	Thysanoëssa longipes

Copepods	*Calanus cristatus*
	Calanus plumchrus
Fish, Atka mackerel	*Pleurogrammus monopterigius*

Thysanoëssa inermis and *Calanus cristatus* are the most important foods among them. The harvests of above two species in each whaling grounds control the migrations of whales, and whales never migrate to such area as their favourite foods are scanty. The spineless forms of *T. longipes* have also appeared as a large swarms of euphausiids in two occasions.

For baleen whales two forms of taking foods are considered. 'Skimming' by sei and right whales, and 'Gulping' or 'Swallowing' by blue, fin and humpback whales. The former method is able to take any sparse patches of zoöplanktons in the sea. The preferences of baleen whales for foods are affected by the degree of the congregation of zooplanktons. If swarms of zooplanktons are sparse, the *Swallowing* type of whales can not take them so successfully as *Skimming* type of whales.

4. Feeding activity of whales may partly be a response to the upward migration of zooplanktons, fish and squids. More whales take their foods in the morning or in the evening than in daytimes. The quantity of stomach contents decrease in accordance with prolongation of chasing. The freshness of stomach contents also declines with prolongations of chasing by catcher boats.

5. The age and growth of euphausiids in the northern part of the North Pacific may be summarized as follows:

Euphausia pacifica becomes mature at the age of two year about 20 mm in length in adjacent waters to Aleutian Islands. Spawnings take place in early spring to summer. *Thysanoëssa inermis* is also biennial in the adjacent waters to Aleutian Islands. In far southern localities it becomes mature in one year and spawns at a length 15 to 18 mm. Some specimens of *T. inermis* may be triennial in the north waters eastern Aleutian Islands. *T. longipes* becomes mature at the age of two years and spawns at a length of 20 to 28 mm. Spineless sorms of *T. longipes* matures in on year and spawns at a length of 15 to 18 mm. Some of the original forms of *T. longipes* may survive in the third year and spawn. Mating and spawning take place in late spring to early summer. The spawning of *T. spinifera* takes place in summer in Alaskan coast waters. As to the sex ratio of euphausiids, males are dominant usually in the swarms of euphausiids.

6. In the northern part of the North Pacific, and the Bering Sea, following species of zooplanktons are commonly found in the surface waters.

Adolescents and juveniles of *Thysanoëssa longipes* are the most abundant in the surface water in summar. *T. inermis* and *Euphausia pacifica* come next. *Thysanoëssa spinifera* and *T. raschii* are only found in the coastal waters. Among copepods, *Calanus plumchrus*, *C. finmarchicus*, *C. helgolandicus*, *C. cristatus*, *Eucalanus bungi bungi*, *Metridia lucens* and *Oithona similis* are the main constituents of the samples collected palnkton nets. The typical form of *C. finmarchicus* is also found in the samples. Other organisms *Sagitta elegans*, *Tomopteris pacifica*, *Limacina helicina*, and *Themisto* sp., are also very abundant in the surface samples collected by plankton nets.

7. It is considered that there are *Calanus year* when copepods are abundant, and *Euphausiid year* when euphausiids are abundant. Fin whales stay in the whaling ground consists of *Calanus* for a long date in *Calanus year*, and if there is the transition time from *Calanus cristatus* to euphausiids as in 1953 in the whaling ground A, fin whales leave the waters to seek their foods. Thus, the catch of fin whales in the whaling ground A is inconstant in the each period of seasons. The whaling ground consists of *C. cristatus* may be passing prosperity, on the other hand, the whaling ground consists of euphausiids along the margin of continental shelf is far stable through out the season.

8. The migrating route of baleen whales appears in the zone of abundant foods, and the whaling grounds are mainly situated along the boundary of different water masses, along the slope of Alaskan continental shelf. The concentration of euphausiids and copepods by currents are found in the areas of convergence, in backwaters and at the center of areas where there is a cyclonic movement.

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OCEANOGRAPHIC CONDITIONS OF THE WHALING GROUNDS IN THE WATERS ADJACENT TO ALEUTIAN ISLANDS AND THE BERING SEA IN SUMMER OF 1955

KEIJI NASU

INTRODUCTION

The present paper gives the outline of the results investigated by Japanese research members in the waters adjacent to Aleutian Islands and the Bering Sea during the Whaling Survey including whale-marking experiment in the summer of 1955 on boad of the " Konan-maru No. 5 ", belonging to the Nippon Suisan Co. Ltd. During the season, 73 Stations were occupied by the boat as shown in figure 1, the observed data at these stations are compiled with respect to the oceanographic elements such as water temperature, salinity (chlorinity), transparency of the sea water, colour of the sea water, dissolved oxygen, planktons, and other sea-living organisms sampled from various depths, and also with the weather elements such as air temperature, sea-fog etc. Above materials are collected on board by the author and Takehiko Kawakami of the Japanese Fisheries Agency.

The author wishes to express his hearty thanks to Dr. Michitaka Uda, Professor of the Tokyo University of Fisheries and also to Mr. Makoto Ishino for their instructions and aids given during the preparation of this report.

WATER TEMPERATURE AND SALINITY AT THE SEA SURFACE

The surface temperature in the period during the survey from early July to late September in the Bering Sea and the southern Aleutian Waters in the North Pacific vary from 11.8°C at its maximum to the lowest value 6.5°C. In general the isothermal lines run parallel to the Aleutian Islands from west to east. On the other hand a warm water mass flows in the sea-region on the northern side of the eastern Aleutian Islands from the continental shelf-water on the Alaskan side in the period from middle to late decade of August at its most prosperious extention, and converges to the easterly-going stream along the northern side of Aleutian Islands at about 170°W longitude. Apparently the boundary line of convergence shifts month by month in accordance with the fluctuation of the two water masses, i.e. in July lying near at

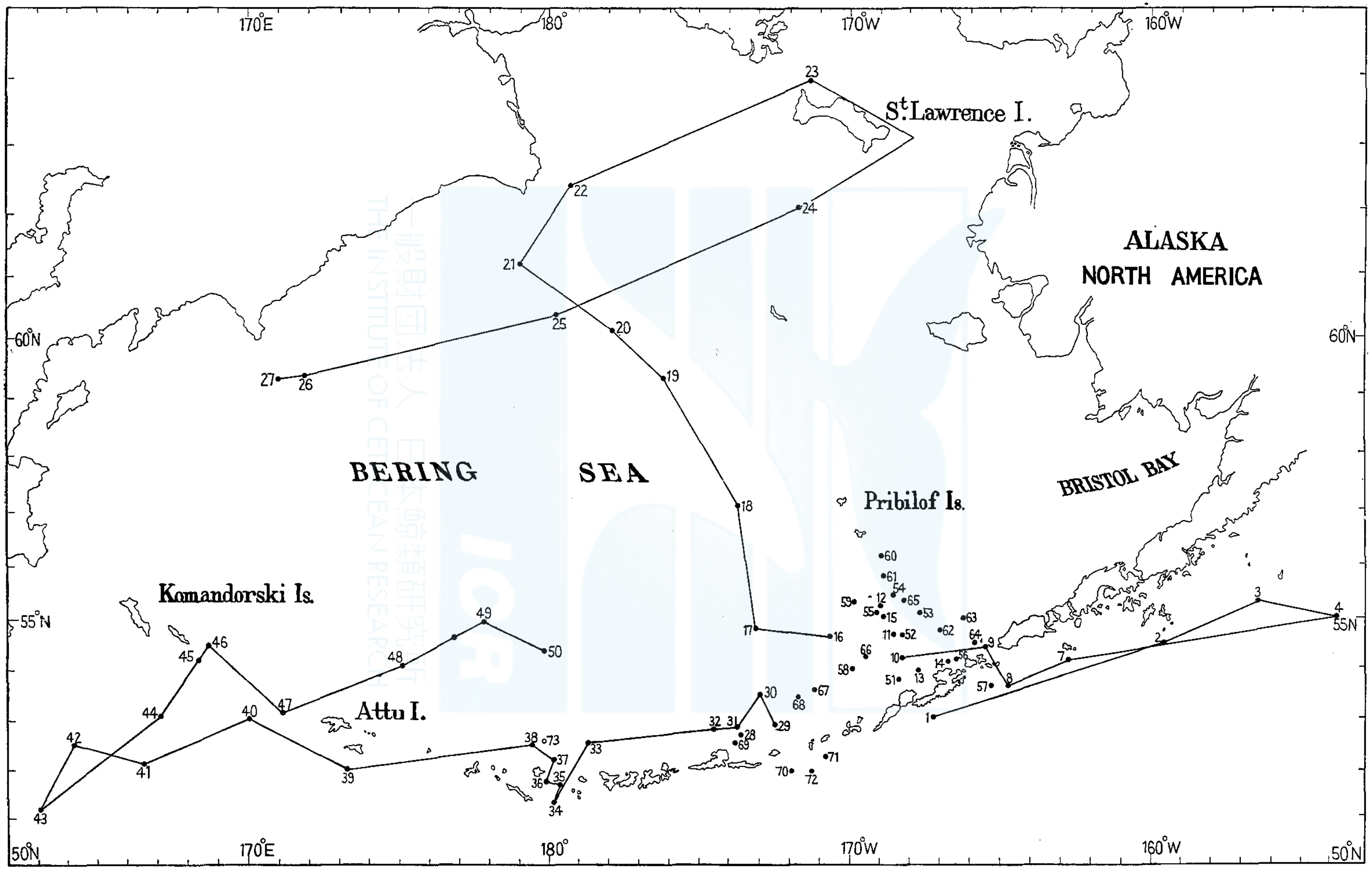

Fig. 1. Hydrographic Stations Carried out by Konan-maru No. 5 in the Summer Season of 1955.

about 170°W and in August lying near at 171°W due to its shift to southernmost and westerly location by the stronger inflow of water mass from the continental shelf region, and in September it lies at about 168°W after its easterly shift. Also, the water along the Islands shows lower temperature than that of the open sea, especially it shows a comparatively extensive cold water area in August near the Amchitka I. lying about at Lat. 52°00′N, 180°Lg. It seems that those cold water areas are formed by the upwelling due to the effect of the submarine topographical conditions. Moreover it is observed the increased rate of sea-fog occurrence over those Aleutian cold water areas on the inflowing occasion of warm and moist air current through southerly wind. It was already proved that such dense sea-fog regions are the favourable whaling grounds, especially of sperm whales (Uda & Nasu, 1956).

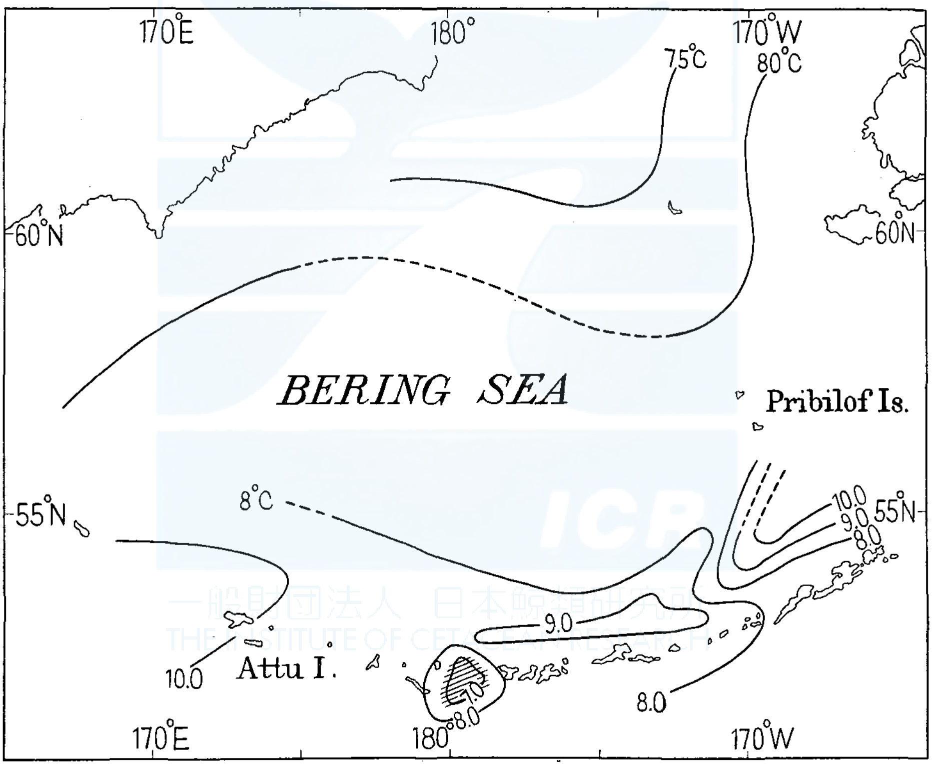

Fig. 2. Horizontal Distribution of Surface Temperature (Aug., 1955) ///: dense sea-fog.

In next, glancing over the isotherms in August in the whole area of Bering Sea, the 8°C-isothermal line running from St. Lawrence I. is found in the central Bering Sea toward south to the western part of the sea along 58°N-line. In general the water temperature in the deeper central sea-region is lower than that in the shallower sea-region on the continental shelf (see Fig. 2). Such a thermal difference in those regions may be due to the different conditions of bottom depths in the rising stage of water temperature in summer. Also a very cold water in the layer of 25-50 m depths is observed along the Siberian Coast. On the other hand, the hydrographical conditions of the monthly whaling grounds lying along the northern side of Aleutian Islands in the west-longitudes, (those found on the north to the Unalaska I. in the Aleutian chain) are following: A separated warm water area (centred at 8°C area) covers the western whaling grounds nearly along 55°N-line north to Unalaska I. in July (in Aug. of 1954 the corresponding warm water area around 9.0°C was also recognized).

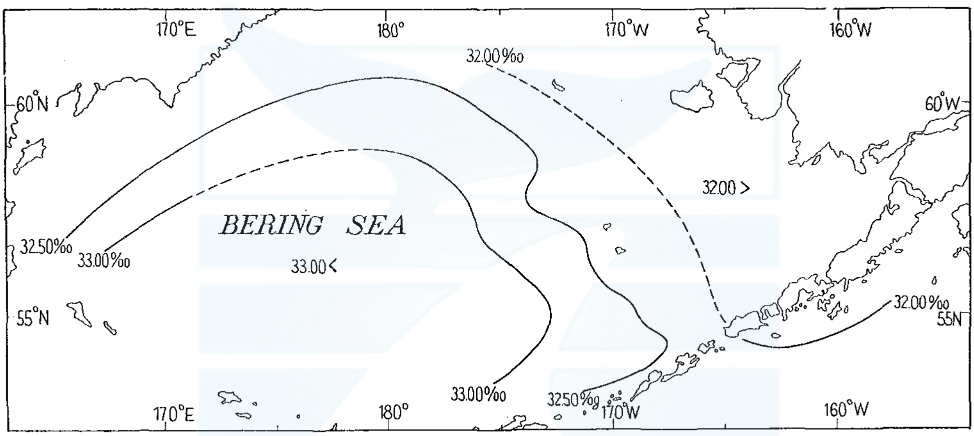

Fig. 3. Salinity (S ‰) at the Surface (July to August, 1955).

Since after about middle August the isolated water mass, combined together with the tongue-like inflow in warm water of about 10°C from the continental shelf on the side of Alaska extends to about 171°W toward south along the Aleutian Islands. In September the isolated warm water area of about 8°C which disappeared once in August appears again, and moreover in smaller scale than those in July to August. At present the origin and its process of formation of the warm water mass is not clear and is left for future study.

The hydrography of the Bering Sea basing on the distribution of salinity is as follows; the isohaline of 32.50 ‰ runs nearly along the 200 m isobathymetric line, showing an arc from nearly Lat. 60°N, 180°Lg. to the middle part of the Kamchatka Peninsula with the parallel distribution of 32.00 ‰ lines on both sides of it. The sea-region of waters having lower salinity less than 32.50 ‰ in the Bering-Sea covers an extensive area on the western side of Alaska compared than that on the eastern side of Siberia-Kamchatka (except the vicinity of Anadir Bay). The above phenomena are explained by the discharge of Yukon River, Kushokwin River on the side of Alaska and of the Anadir River on the side of Siberia (Barnes & Thompson, 1938). Referring to the pilot chart published by the H.O. of U.S. Navy the limit of sea-ice distribution in its melting period resembles very well to the location of 32.50 ‰ isohaline, suggesting the dominant influence of ice-melted water on the surface distribution of salinity (see Fig. 3).

DICHOTHERMAL WATER AND THERMOCLINE

It is wellknown fact that in Bering Sea and North Pacific Ocean the dichothermal water (intermediate cold water) in summer has been formed by the sinking of surface water cooled in winter. Also the results of our survey ascertained it and added some new data to it. The outline is as follows; on the whole in Bering Sea, excepting the shallower sea-region on the continental shelf and the waters around the Aleutian Is., the dichothermal water lying in the depths from 25 m to 150 m and having its core water temperature (−1.5°∼+4.0°C, and only one station 4.83°C recorded) are found evidently almost everywhere in the area and also in the northern part of North Pacific Ocean along the southern side of Aleutian Islands.

TABLE 1. POSITION AND DEPTH OF DICHOTHERMAL WATER

Position	62–28N 179–18W	61–12N 178–57W	58–45N 179–40W	57–00N 178–55W	53–31N 172–59W
Depth (m)	25	75	100	146	150

Generally the dichothermal depth as shown in table 1 is shallower in the northern region, moderately deeper in the central region and deeper in the southern region. In the western Bering Sea the dichothermal depth near the water of 57°N (56°54′N, 173°17′E. St. observed by Oshoro-maru) shows deeper than the north waters, and shallower again as it goes to south (e.g. St. 48).

On the other hand the distribution of water temperature varies gradually from the eastern region passing through the central region around 180°Lg. to the western region, i.e. the temperature in the dichothermal layer of the central region (east to C. Navarin-60°N) rises from −1.5 to 3.32°C, moreover coming on the oceanic plateau near 57°N it falls and it rises again near the Aleutian Is.

In the western Bering Sea the minimum dichothermal temperature rises from −0.58°C (St. 27) at the south to C. Olyutorskii towards the vicinity of Aleutian Is. Next in the Northwestern Part of North Pacific south to Komandorskii Is. the depth of the intermediate minimum water temperature lies uniformly about at the 100 m depth and it is relatively low except some station in Bering Sea, especially low near the coast of Kamchatka Peninsula. Moreover in the waters south to Aleutian Islands in the west Longitude the depth of 100 m, showing comparatively warmer values of about 3°–5°C. At this place, comparing the general feature of dichothermal layers in the Bering Sea and that in the Pacific Ocean north to 50°N (except those east to 160°W), the layer lies uniformly at about 100 m depth in the east and west longitudes contrary to the 25–150 m depths in the Bering Sea. This fact may be due to the somewhat conspicuous effect of topographical conditions. The water temperature shows its highest value in the area of west longitude on the Pacific side and lowest value in the area of east longitude (partly lowest in the Bering Sea) and rising gradually from west to east in general. In the Bering Sea from spring to autumn season the rise of surface water temperature by solar radiation causes the remarkable development of thermocline (spring layer), in almost all sea-regions except some few areas. Thermocline has not been found in the waters of west longitudes whaling grounds north to Unalaska I. in this research and its most remarkable development was found near the east coast of Kamchatka south to Komandorskii Is. Also in the central region of Bering Sea (e.g. St. 19) and the northernmost oceanographical station (St. 23) locating north to St. Lawrence I. thermocline developes very remarkably showing its depth at about the 10–15 m on the shallower portion of the continental shelf and about 50 m in the central part of Bering Sea together with the region south to Komandorskii Is.

DISSOLVED OXYGEN

The quantity of dissolved oxygen at the sea surface in the Bering Sea and its adjacent Pacific areas amounts from 4.43 to 11.05 cc/L. In general its distribution shows higher quantity near to the side of Kamchatka Peninsula and Siberian Coast compared to the Alaskan side, in the region from Attu I. to Boweres Bank on the east the richly dissolved exygen area more than 10 cc/L. On the other hand in the region around Boweres Bank and from near Amchtka Pass to Umnak I. On the both sides of Aleutian Islands the poorest area of dissolved oxygen is found in the surveyed region of Bering Sea. Its pattern resembles well to the prescribed distribution of cold water area denoted by surface isotherms, representating the effect of upwelling by the Aleutian ridge (see Fig. 4).

Regarding to the vertical distribution of dissolved oxygen in the East Longitudes Whaling Grounds, the distribution of dissolved oxygen differs

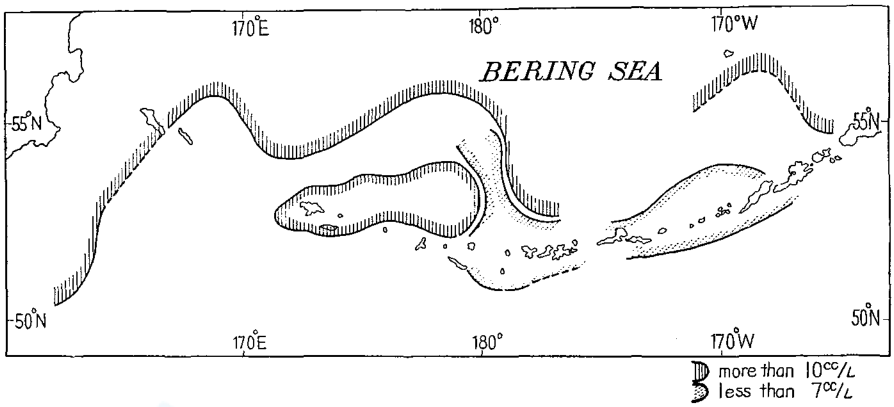

Fig. 4. Horizontal Distribution of Surface Dissolved Oxygen.
(Aug. to Sep. 1955)

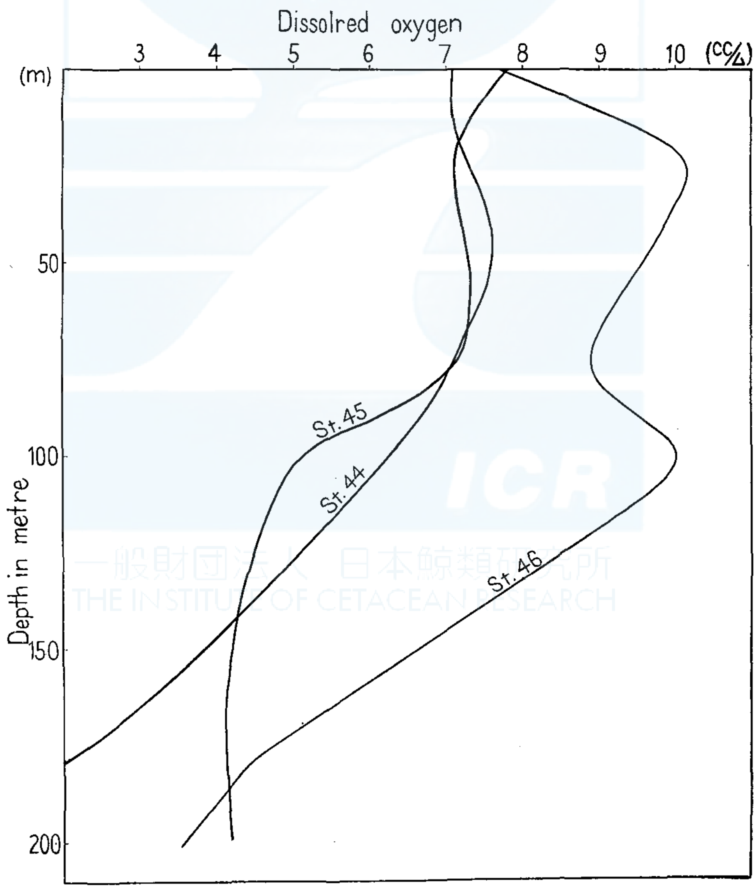

Fig. 5. Vertical Distribution of Dissolved Oxygen.
(Aug. to Sept. 1955).

considerably between the upper and lower layers separated by the boundary layer at about 100 m depth. In short, in the upper layer less than 100 m depth a maximum dissolved oxygen layer is found at about 25 m depth (St. 46) which may be produced by the blooming of phyto-plankton in the euphotic layer due to photosynthesis, and on the other hand the dissolved oxygen decreases with the depth at 80 m and again increased at 110 m depth. Roughly speaking, in the above mentioned area the value of oxygen keeps nearly constant at the depths less than 100 m and shows spring layer in the depths from 100 to 200 m (there is no datum of below 200 m depth due to the lack of observation) (see Fig. 5).

Next, in the West Longitudes Whaling Grounds the distribution of dissolved oxygen somewhat varies to the depth of 100 m, however below 100 m depth it decreases with the increase of depth gradually. The saturation percentage of dissolved oxygen shows supersaturation over the almost whole area (except the poor dissoloved oxygen areas in the region near Boweres Bank and the region along the Aleutian Islands from 180°Lg. to 168°W), especially the higher supersaturation % in the region south to C. Olyutorskii. Though there is no datum of dissolved oxygen in the region north to 56°N in the summer of 1955 owing to the lack of water sampling for oxygen analysis, referring to the survey of U.S. Navy in 1933 and that in 1934 by U.S. Coast and Geodetic Survey, it may be concluded that in the waters along the 170°W line extending to St. Lawrence I. except the vicinity of Pribilof Is. the rich dissolved oxygen amounts to supersaturation. Generally the oxygen at the sea surface of Bering Sea shows almost supersaturation over the whole area of the sea except the regions near Boweres Bank and on the both sides of Aleutian Islands from 180° to 168°W together with Pribilof Is.

WHALING GROUNDS IN RELATION TO HYDROGRAPHIC CONDITIONS

It is well-known that in the waters around the line of convergence as the boundary of two currents a favourable fishing grounds is formed by the accumulation of concentrated planktons (phyto- and zoo-plankton) and other sea-livings attracted to them. The good example is seen also in northern waters i.e. as already mentioned above the concentrated abundance of whales are shown around the line of convergence in the fishing grounds north to Unalaska I. and the movement of whales following the shift of the line of convergence is seen.

These features may be explained as follows : the dense populations of phyto- and zoo-plankton due to blooming in the richly fertilized region along the Aleutian Islands due to the upwelling of deep water having rich nutrient salts are transported by the east-going Aleutian current and then collides with the fresh water mass inflowing from Alaskan coastal area, where the densely concentrated food-planktons of whales may be resulted near the boundary of two water masses. In order to estimate the rate of whales sighted (S_w) in relation to water temperature, we may put the following quantity,

$$S_w = \frac{We}{Ne} \times 100(‰)$$

where *We* : the observed frequency of whales for each 1°C of water temperature.

Ne : the observed frequency of water temperature for each 1°C.

Calling S_w-curve as the Appearance Curve of whales and then plot

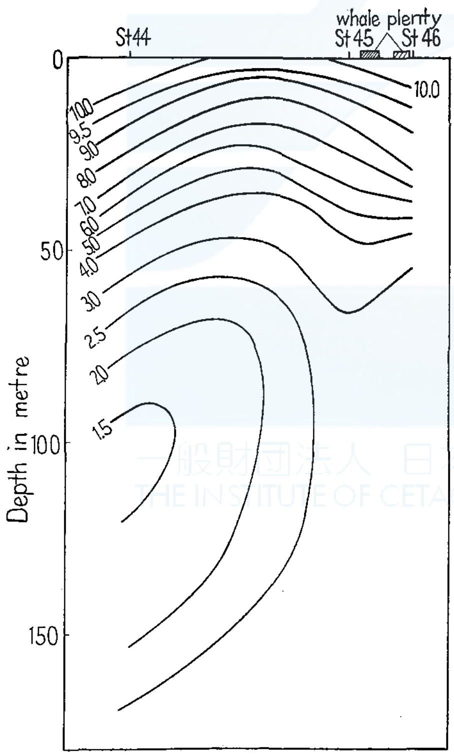

Fig. 6. Relation to the Dichothermal Core Water and the Whales. (Aug. 1955).

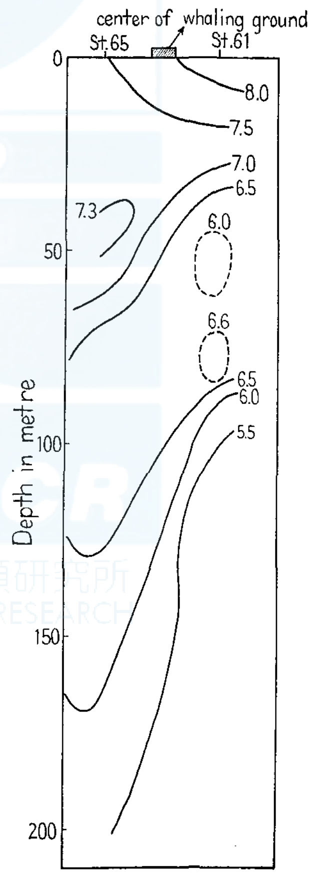

Fig. 7. Vertical Distribution of Dissolved Oxygen (cc/L) and the Whaling Ground. (Aug. 1955).

them for each species of whales during the whole fishing period, the mode of the S_w-curve can find at (8.0 ± 1.0°C) with respect to the surface water temperature statistically i.e. the highest rate of whale appearance at the temperature. The distribution of whales in relation to dichothermal water was noticed already by Uda (1956), and in this investigation also the same is proved. In other words, except the relatively cold water area at the surface influenced by the intermediate cold water. Comparatively many whales are found on both sides of it in somewhat warmer water area (see Fig. 6). In the Northeast searegion of Japan off Sanriku a similar feature of whaling grounds, especially of sperm whales, is conspicuously noted by the result of whale-marking survey in 1955.

Next, regarding to the relation of dissolved oxygen, the concentration of whales is observed in the narrow zone denoting the steep horizontal gradient from very rich oxygen water mass to poor oxygen water mass in the layer of depths from 10 m to 150 m (see Fig. 7). With respect to the relation between the abrupt change of dissolved oxygen in the layer about at 10 m depth and the distribution of whales, Marr (1956) has pointed out the densely concentrated krills as the favourite food of whales in the very surface layer within 10 m depth in the Antarctic. And author also observed many swarms of euphausiids in the surface areas south by east off Komandorskii Islands. The distribution of whales are considered to show its denser concentration in the such region slightly shifted from the maximum portion of the phytoplankton quantity.

DEEP SCATTERING LAYER AND WHALING GROUNDS

The author has observed the deep scattering layer on echogram with its evening ascent and morning descent in the fishing grounds such as of Sergestes shrimps etc. (Uda, 1956). In this investigation we recorded it off the cape of Olyutorskii and euphausia (*T. inermis*) was sampled by planktonnet hawl at the same time, of which creature was not sampled at the St. 27 (59°18′N, 170°52′E). The author hopes in the indirect searching method of whales during the night by utilizing the echo-trace of deep scattering layer due to the food plankton of whales may be put to practical use.

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THE TWINNING IN SOUTHERN FIN WHALES

SEIJI KIMURA

The study on twinning gives many interesting problems to embryology, morphology, genetics and many other branches of zoology. But the reports on twinning in whales have been often fragmentary (Haldane, 1910; Risting, 1925; Wheeler, 1930; Matsuura, 1936, 1940; Paulsen, 1939; Omura, 1942; Brinkmann, 1948; Slijper, 1949). Most of them discuss the frequency of twins, though Matsuura (1940) attempted to analysis the monozygotic twins (EZ) and dizygotic twins (TZ) in blue and fin whales by means of Weinberg's differencial method, and Slijper presumed the relation between frequency of twins and the age of their mother.

The reason, why twinning studies in whales remain in primitive stage, is attributed to rare chances to get materials, and besides it is also one of the reasons that we have no necessity to consider their application to the whales research problem.

I consider, however, that the study of twinning is one of the ways in whales-population investigations. For example, the frequency of twins differs in races of man. This fact will be applied to distinguish the populations of whales. And the morphological study of EZ, TZ and multiple foetuses is the most effective means to catch hereditary characters of whales, of which brothers or sisters cannot be caught. We must consider the application of it to determine populations of whales. The study on number of ovulations in whales is a subject to be solved as a base of the age determination with corpora lutea in ovaries, and the study of twins will give suggestion to it. Furthermore, it has been known in humankind and some domestic animals that the occurrence of twins relates to ages of their mothers, so twin studies will confirm age characters of whales.

I studied multiple foetuses of southern fin whales (*Balaenoptera physalus*, L.) statistically, using the data of biological investigation on Japanese whaling fleets in the Antarctic waters (Area V) from 1946/47 to 1954/55 seasons. And I also used International Whaling Statistics (1933/34–1952/53) for this study.

My sincere thanks are due to Mr. Setsuo Nishimoto of the Fisheries Agency, to whom I am indebted for the precious photographs shown in figures 2, 12 and 13. And I am much indebted to Dr. Hideo Omura, the President of the Whales Research Institute, who kindly read my draft and critisized it. Thanks are also due to Dr. Masaharu Nishiwaki of the Whales Research Institute, and Assistant Professor Takashi Hibiya

of the University of Tokyo for many valuable suggestions.

FREQUENCY OF TWINS

In connection with the great bulk of their babies, the whales are uniparous, and the frequency of multiplets is very low.

Now, table 1 shows the frequency of twins in some baleen whales which were got by three biologists. These values were got before the 2nd World War, and number of whales examined are not enough. Since the reopening of the Antarctic whaling, a number of whales have been caught there, and consequently number of examined whales increased suddenly, especially in fin and sei whales.

TABLE 1. FREQUENCY OF TWINS BY THREE REPORTERS IN BALEEN WHALES

Species	Risting ('27)	Paulsen ('37)	Matsuura ('40)
Blue	0.7%	0.68%	0.4%
Fin	0.7	0·93	0.9
Sei	—	1.09	0.7
Humpback	—	0.39	0.4

TABLE 2. FREQUENCY OF MULTIPLETS IN SEVERAL BALEEN WHALES FROM THE ANTARCTIC REGION

Species	Pregnant whales	Twins	Triplets	Quadriplets	Quintuplets	Sextuplets	Multiplets total
Blue	19,057	148	9	0	0	0	157
		0.777%	**0.047**	**0.000**	**0.000**	**0.000**	**0.824**
Fin	39,947	328	13	4	1	2	348
		0.821%	**0.033**	**0.010**	**0.003**	**0.005**	**0.872**
Sei	1,098	25	0	0	0	0	25
		2.277%	**0.000**	**0.000**	**0.000**	**0.000**	**2.277**
Humpback	2,979	17	0	0	0	0	17
		0.571%	**0.000**	**0.000**	**0.000**	**0.000**	**0.571**

I calculated the frequency of multiple foetuses (the number of multiplet pregnancy in % of the total number of pregnant females) as shown in table 2, using the International Whaling Statistics (I.W.S.) from 1933/34 to 1952/53.

The frequency of twins varies with the species of whales, that is to say, it is the highest in sei whales, and it is next in fin whales, but the latter is a half of the former. It is slightly lower in blue whales than in fin whales. The frequency in humpback whales is the lowest and it is a quarter of that in sei whales. This ranking is the same of that by Paulsen (1939), though the values are different. On the other hand, these values are slightly higher in sei and blue whales than the values calculated by Matsuura (1940). On the fin whales, Paulsen, Matsuura and I get nearly the same value.

When I calculate the frequency of multiple foetuses on the year when number of pregnant fin whales is more than 500, 0.19 % is the lowest, and 1.28 % is the highest, and the most are near the mean, so we cannot see notable fluctuations in the years. The frequency of twins is almost constant in the same species of mammals, and the value which I got above seems to show this phenomenon. However, it has been well known that there are tolerable variation in various races or in locality of one species. In the 4006 pregnant fin whales caught by Japanese whaling fleets from 1946/47 to 1954/55 in the Antarctic Area V, 40 whales have multiple foetuses, therefore frequency of multiple foetuses is 0.999 %. This is slightly higher than the mean. According

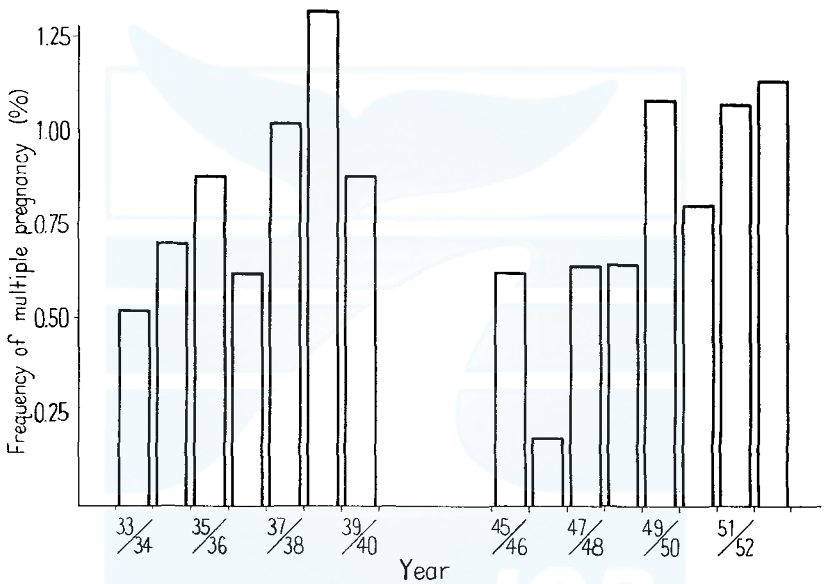

Fig. 1. Frequency of multiple pregnancy in the whaling seasons from 1933/34 to 1952/53.

to Brinkmann (1948), the frequency of twins is 1.93 % in the Antarctic Area II, III, and IV. This is considerably high, although it is calculated by the result in only one year, and so it is not final value. In order to solve the problem, we must get the frequency of twins in each areas.

In connection with the lowness of frequency of multiple foetuses in whales, it is noticed that they have only one pair of nipples. The relation between number of foetuses and number of nipples is already generally known.

Besides, it is known in sheep that those who intend to breed twins have more nipples than the normal. Therefore, whales have very suitable mammary organs for uniparous.

Pinnipedia, a sort of aquatic mammals, is uniparous, and has a pair of nipples, situated inguinally like Cetacea. In Sirenia there is a pair of axillary ones, but they occur practically upon the posterior border of the flippers (Howell, 1930). Probably it is an effect of adaptation for the aquatic life that typical aquatic mammals are uniparous and have only a pair of nipples.

DIFFERENTIATION OF MONOZYGOTIC (EZ) AND DIZYGOTIC TWINS (TZ)

It is well known in humankind that there are EZ and TZ. But they had believed until recent years that there was no EZ in domestic animals. But Kronacher (1932) corrected the mistakes by his study on cows.

About whales, Matsuura (1940) discussed the differentiation of EZ and TZ. He studied twins statistically by means of Weinberg's differencial method, and assumed that EZ were one ninth of total twins in fin whales, although he could not prove the evidence of EZ. It is regrettable that most of the report on multiple foetuses in the past are about only foetus length and sex, and the records to determine the differentiation of multiple foetuses such as condition of placenta and ovaries are seldom remained. Wheeler (1930), Matsuura (1940), Omura (1942) and Brinkmann (1948) noted the number of corpora lutea in ovaries. I think that the determination of the differentiation of EZ and TZ is easier and more exact in whales than in man and domestic mammals. Because, when we catch a whale, it is dissected directly, its uterus is opened, and we can observe placenta. Further more, by the removed ovaries we can confirm the result of ovulation. The differentiation of multiplets are naturally determined by the number of ovulated eggs. After ovulation, functional corpora lutea are formed, and they are clearly found in whales. Therefore, by the calculation of functional corpora lutea, we can determine the kind of multiplets. Mackintosh & Wheeler (1929) and Matsuura (1940) mentioned that it was considered that more than one egg might be formed in the same follicle. But I suppose that it will be almost ignored. My supposition is allowed by the fact that the twins of which mothers have one functional corpus luteum are all like-sexed. When two eggs are ovulated from two ovarian folliculs at the same time, and one of the two eggs is not fertilized and the other is fertilized into twins, there will be two functional corpora lutea in spite of EZ. Therefore, it must be strictly needful to examine the placenta. But I think that the differentiation of multiplets is practically determined by number of functional corpora lutea. When we determine the kind of multiplets by the functional corpora lutea, we can find EZ in the reports by Machintosh & Wheeler (1929), Matsuura (1940), Omura (1942), Brinkmann (1948) and Slijper (1949). And as stated below, EZ are also found in our materials.

TABLE 3. NUMBER OF LIKE- AND UNLIKE-SEXED TWINS

	♂♂	♂♀	♀♀	?
Number of pairs	94	102	86	4
Percent	33.3	36.2	30.5	—
Ratio to ♂♀	0.92	1.00	0.84	—

According to I.W.S. (1933/34–1950/51, 1952/53), the combination of sexes of twins in fin whales is shown in table 3.

If all the twins are TZ, ♂♂ : ♂♀ : ♀♀ must be equal to 0.5 : 1.0 : 0.5. Nevertheless, the value of like-sexed twins (♀♀, ♂♂) is higher than the theoretical value. This means that there are really EZ.

Weiberg's differential method is,

$$TZ=\frac{\text{unlike-sexed twins}}{2pq}$$

p: sex ratio of ♂
q: sex ratio of ♀

Now, in 23184 fin foetuses which are discovered and determined their sex in the Antarctic seasons from 1946/47 to 1952/53 (by I.W.S.), $p=50.59\,\%$ and $q=49.41\,\%$.

$$TZ=\frac{102}{2\times 0.5059\times 0.4941}$$

$$=204$$

Therefore, the percentage of TZ to total twins is

$$204/282\times 100=72.4\,\%$$

That is to say, a quarter of total twins is EZ. This value is higher than that calculated by Matsuura (1940).

According to Stern (1949), the ratio of EZ is 34.2 % in American white race, and is 28.9 % in American black race. The other hand, it is 72 % in Japanese.

Thus, the ratio of EZ and TZ in the twins in different in human races. So, such phenomena are supposed to be true in whales, too.

Table 4 shows the item of 40 multiplets discovered by Japanese whaling investigation in the Antarctic Area V from 1946/47 to 1954/55 (v. appendix). By the number of functional corpora lutea, the difference of twins was judged. One example of EZ is shown in figure 2.

The ratio of EZ to total twins is 42.9 %, and this is higher than that which was calculated statistically. And when we calculate the ratio of

TABLE 4. EXAMPLE OF MULTIPLE FOETUSES IN THE ANTARCTIC AREA V

Twins							Triplets	Quadriplet
EZ		TZ				?		
♂♂	♀♀	♂♂	♂♀	♀♀	?	♂♂		
6	8	2	12	5	1	3	2	1
43.6%	56.4	10.0	60.0	25.0	5.0	—	—	—

Fig. 2. Monozygotic twin foetuses of a southern fin whale (*Balaenoptera physalus*, L.) and the ovaries of their mother. Individuals of No. 25 in appendix.

Male 3′10″ Male 3′10″

Number of corpora lutea

5 { Left 1+2
Right 0+2 }

(Photo. by Mr. Setsuo Nishimoto)

EZ in the Antarctic Area II, III, and IV by the report of Brinkmann (1948), it is 1/11 (9.0 %). This is very low value.

Regarding the sex ratio of twins (Table 4), ♂♂:♂♀:♀♀=33.3 %: 36.2 %:30.5 %, that is to say, ♂♂ is more than ♀♀. And ♂:♀=51.4 %: 48.6 %. But in the twins of the Area V, ♂♂:♂♀:♀♀=30.5 %:33.4 %: 36.1 %, and ♂:♀=47.2%:52.8 %. Therefore, ♀ is more than ♂.

About the sex ratio of EZ, ♂♂:♀♀=43.6 %:56.4 %. This differs a little from the theoretical value (♂:♀=50 %:50 %).

About the combination of sex in TZ, ♂♂:♂♀:♀♀=2:12:15=10.5 %: 63.2%:26.3%. However, theoretically, ♂♂:♂♀:♀♀=25 % :50 % :25 %. So, in our investigation the ratio of ♂♂ is especially low. But as the three examples which are not able to be determined their kinds are all ♂♂, the ratio of ♂♂ will really increase in EZ or TZ.

GROWTH OF TWINS

In the uniparous mammals, multiplet pregnancy will be abnormal in many points. Therefore multiplet pregnancy shows a little morbid tendency, and progress of its pregnancy is more restricted than that of usual pregnancy. The frequency of early birth and abortion is more in multiplet pregnancy than in the normal pregnancy. In man, this fact is well known.

According to Hervitt (1934), in cattle, twins are little lighter than normal baby when they are born. Apart from abortion, the rate of still-birth is the same as that of normal birth. And the pregnant period of twins is 8–10 days shorter than the normal.

In whales, it is difficult to know the rate of abortion, rate of still-birth, pregnant period and growth of foetuses.

In order to search for the rate of abortion, I calculated the frequency of multiple foetuses (number of multiplets/number of total foetuses) with the body length classes of discovered foetuses which had been reported in I.W.S. from 1933/34 to 1952/53 (excluded 1951/52). The values are about twice of the true frequency of multiple pregnancy, because I summed up all number of multiple foetuses, for example twin is constituted on two foetuses and triplet on three foetuses.

As shown in figure 3, the frequency of multiplets increases till 13 feet of body length, and after that it decreases to the value of the early stages. It is difficult to explain these phenomena especially about the increasing period. I suppose that in the early stage of pregnancy the rate of abortion of single foetuses is higher than that of multiplets. Thus, the frequency of multiplets increase then. However, after 13 feet of body length, which is in the later stage of pregnancy, the rate of abortion of multiplets is higher than that of single foetuses.

Next, in order to estimate the growth of multiplets, I calculated the mean body length from September to April as shown in figure 4. The

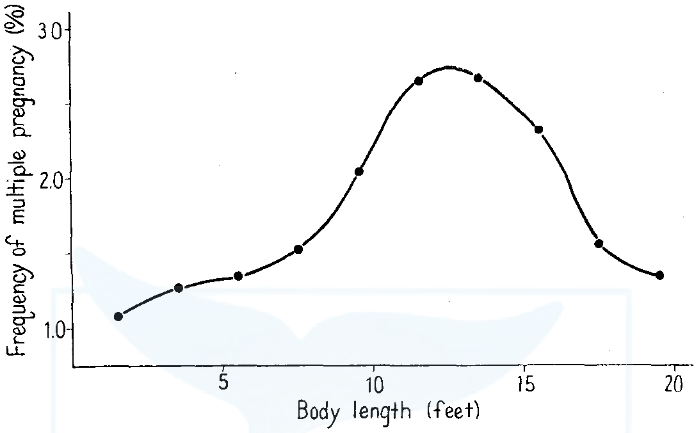

Fig. 3. Variation of the frequency of multiple pregnancy according to the body length of foetuses.

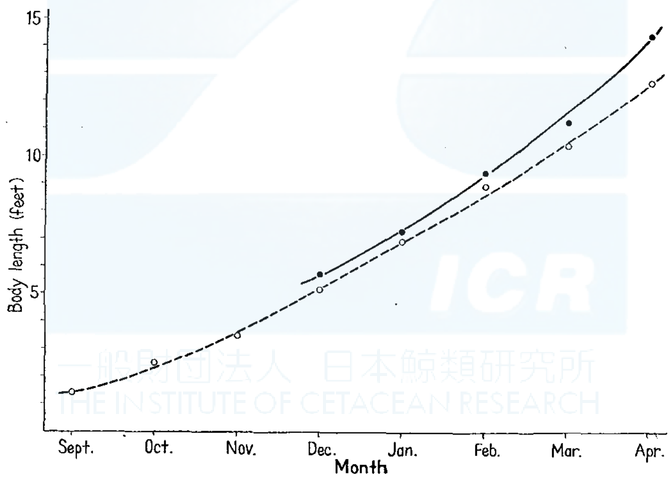

Fig. 4. Growth curve of foetuses.
Solid line····Multiplets, Broken line····Common foetuses

mean body length of multiplets is bigger than that of common foetuses in each month. Besides, the multiplets do not decline growth compared with common foetuses. Furthermore, if we move the growth curve of the multiplets to the right about 10 days, the two curves agree with one another.

By the facts stated above, two explanations are born. If the breeding season of multiplets is the same as that of common foetuses, the growth of multiplets is bigger than that of common foetuses. The other hand, if the growth rate of multiplets agree with that of common, the mean breeding season of multiplets is 10 days earlier than that of common. In this connection, Sanders (1935) states that the occurrence of twin is effected by the season in cattle. I can not deside which is true, but at any rate I can state that the growth of multiplets is not worse than that of the common. However, it is not clear which is longer, multiplet foetus or single foetus, when they are born. The longest twin which is reported is 20 feet.

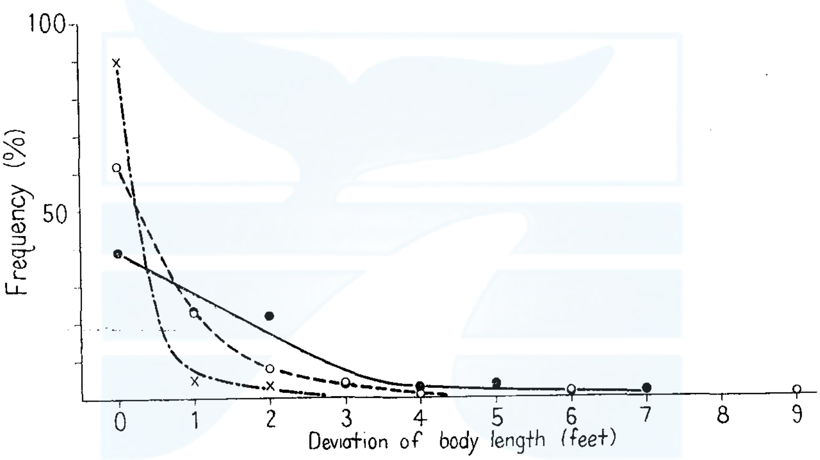

Fig. 5. Distribution of the deviation of the body length between two individuals of a couple of twins.
Chain line····1∼5 ft. class, Broken line····6∼10 ft. class
Solid line····11∼15 ft. class.

As a matter of course about the growth or mortality rate of twins after they are born, we can not investigate. To know the individual variation of body length during growth is important to criticize the size composition, and especially, the individual variation of growth during foetal stage is a problem to consider for the calculation of pregnant period and body length in birth by means of the seasonal growth of foetuses. Now, the two foetuses of a couple of twins are fertilized in the same time, and we can know the individual variation of foetuses during their growth, by comparing the two foetues of a couple of twins.

Difference of body length of the two foetuses of a couple of twins is calculated from I.W.S. The most different twins are 13′0″ and 4′0″ (♀♀). In such a case, one of them will be dead, but the record on it has not been reported. Twinning of ♀♀ tends to be more different each other than that of ♂♂, but this tendency is not so remarkable. Difference of twinning of ♂♀ is bigger than that of ♂♂, but shorter than ♀♀.

Figure 5 shows the frequency of size distribution of the difference of foetal length in three classes of body length. In small foetuses (1–5 feet), the deviation of body length is very short, excluding an exceptional case in which the deviation is 6 feet. As the body length advances, the difference tends to be gradually bigger. In the size class of 11–15 feet, same length in the two individuals of a couple of twins compose only 40 % of the total.

When I get the mean deviation of body length with size class (Fig. 6), the tendency stated above becomes clearly. The longer the body length grow, the bigger the deviation becomes. It is supposed that the mean

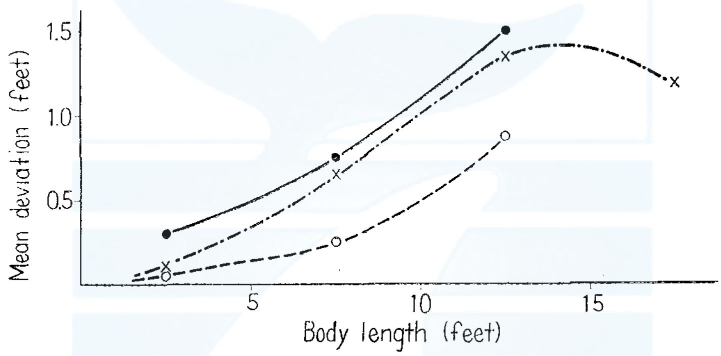

Fig. 6. Variation of mean deviation of the body length between two individuals of a couple of twins.
Solid line····EZ, Broken line····TZ,
Chain line····Twins (from I.W.S.)

deviation of foetal length will become 2 feet by the period when they are born. Therefore, it is clear that the deviation of body length during foetal growth is considerably big. And it is dangerous to regard the two foetuses which are the same length as the individuals which is fertilized in the same time.

The EZ is supposed to be less in variation of length than the TZ. But according to our material (Japanese whaling fleets, Area V, 1946/47–1954/55), the variation of EZ is higher than that of TZ. On this point, the cases in which the development of the two individuals of EZ is considerably different are known to exist. Komai (1934) states that the rate of body weight in the two twin babies is 1:0.85 in EZ as same as TZ in Japanese race. This shows that the former is more disturbed its development than the latter. Then, these facts are in agreement with my result.

TABLE 5. DEVIATION OF BODY LENGTH IN UNLIKE-SEXED TWINS

♂ > ♀ ·········	20
♂ = ♀ ·········	58
♂ > ♀ ·········	24

In order to know which is larger, males or females in foetal stage, table 5 is got by means of unlike-sexed twins. From this table, it is supposed that there is no variation of length by sex in foetal stage.

TWINS AND THEIR MOTHER'S AGE

The frequency of twins varies remarkably with their mother's age. And it increases in proportion with the mother's age. These phenomena are well known in man and domestic mammals.

On the whales, Slijper (1949) shows that the mode of size distribution of females which have twins and triplets is found at a greater length than the common pregnant females. And he supposes that the majority of twins are brought into the world by the mothers that have already attained to a greater length than the average corresponding with their age.

Figure 7 shows the size distribution of 35890 pregnant whales and 304 mothers of multiplets according to I.W.S. (1933/34–1952/53, excluded 1951/52). This figure is almost the same as that by Slijper (1949), and the mode is 72 feet in common pregnant whales, and 75 feet in mothers of multiplets. Mean body length is 71.93 feet in the former and 73.22 feet in the latter.

When I calculate the frequency of multiplets (% of number of multiple pregnancy to total pregnancy) in each body length class (Fig. 8), I find that the frequency of multiplets increases according to the increase of these mother's body length. That is to say, although the frequency is only 0.5 % in 70 feet, it is over 2.0 % in 78 feet. Nevertheless, it decreases in more than 80 feet long, but in this range, the whales examined are very few.

Now, as stated above, the individual variation of body length is fairly large in whales, and apart from mean body length, a big whale is not always relatively old. Therefore, as Slijper states, it is dangerous to discuss the relation between frequency of twins and the age of their mothers from this fact.

There have been many reports on the close relation between the number of corpora lutea in ovaries and the age of whales. I examined the relation between the frequency of twins and the number of corpora lutea of their mother turning my attention to this point. If we choose the number of corpora lutea as the standard of the age, and we get the same phenomena as in man and domestic mammals, the phenomena are known to be usual in mammaria, on the contrary, if so, we can

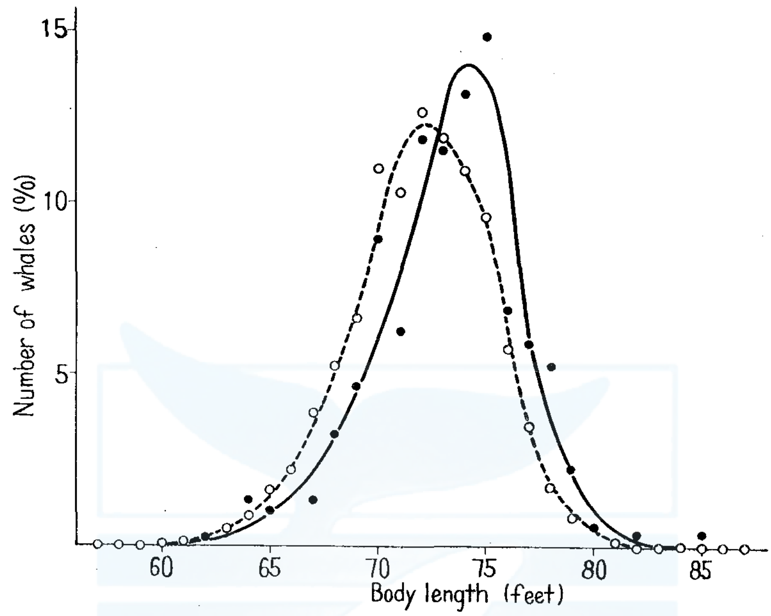

Fig. 7. Size distributions of the common pregnant whales and the multiply pregnant whales.
Solid line····Multiplet, Broken line····Common pregnant whales

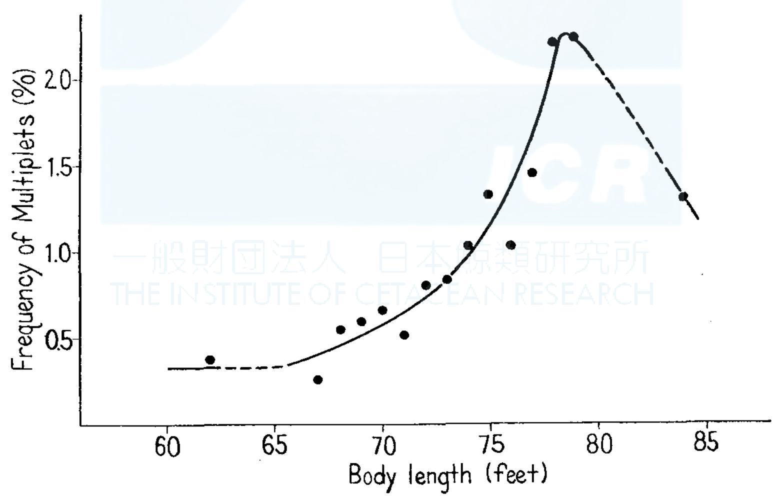

Fig. 8. Variation of the frequency of multiple pregnancy according to the body length.

give one more proof on the accuracy of number of corpora lutea as an age character in whales.

I use the material of biological investigation by Japanese whaling fleets (from 1946/47 to 1954/55). In these material the number of corpora lutea of twins are examined, and in the same time, we can know the number of corpora lutea of common pregnant females. In the first place, the distribution of the number of corpora lutea are got about EZ, TZ and common pregnant whales (Fig. 9). The distribution curve of EZ decreases with the increase of number of corpora lutea, and the curve agrees with that of common pregnant whales. On the other hand, the distribution curve of TZ is clearly different from the above two and it has one mode at 16–20. The each mean number of corpora

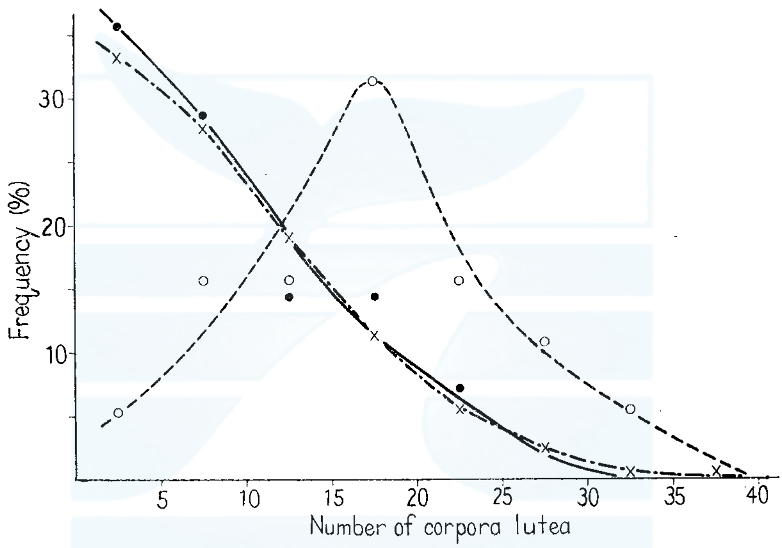

Fig. 9. Composition of the number of corpora lutea in EZ, TZ and common pregnant whales.
Solid line····EZ, Broken line····TZ,
Chain line····Common pregnant whales

lutea is 9.79 in common pregnant females, 9.0 in EZ and 17.3 in TZ. That is to say, the mean number of corpora lutea of EZ is almost the same as that of common pregnant whales, and that of TZ is more than those of the two.

In order to make this relation clear, the frequency of EZ and TZ for the pregnant whales with the number of corpora lutea are calculated. As shown in figure 10, the frequencies of EZ are clearly different from that of TZ. That is to say, the frequency of EZ is constant in every year classes, and the value is about 0.3 %. The frequency of TZ, on the contrary, is low in the few number of corpora lutea, but it increases remarkably with the increase of the number. This shows that the experience of ovulation (age) is the factors for the appearance of TZ.

Such phenomena seen in fin whales resemble closely to the result which was got in man (Endors & Stern, 1948). However, in man the frequency of EZ increase very slightly with the increase of the age, and that of TZ decreases suddenly after 40 years old. In fin whales, the frequency of TZ does not decrease in 31–35 corpora lutea. This fact will show that the sexual activity does not grow weak in these ages. In this connection, whales are regarded to have no climacteric, and there are the female fin whales which have more than 60 corpora lutea in the ovaries.

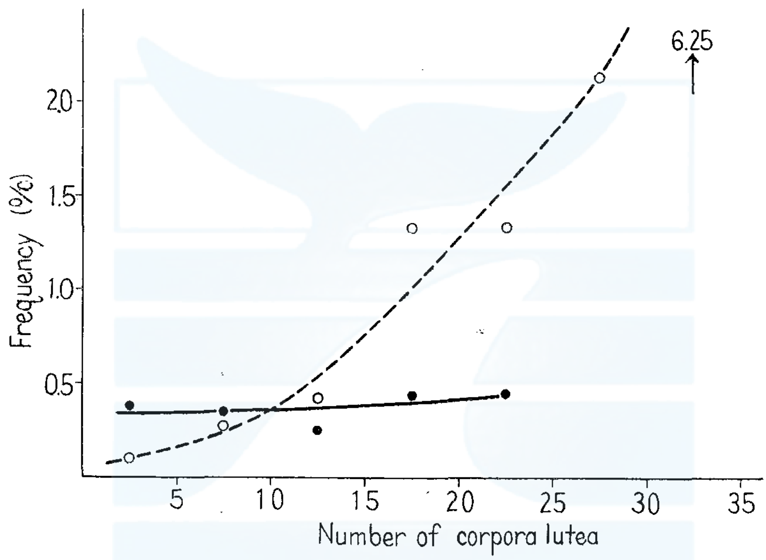

Fig. 10. Frequency of EZ and TZ according to the number of corpora lutea.
Broken line····TZ, Solid line····EZ

As mentioned above, when I use number of corpora lutea as the standard of age, I get the results which are very resemble that in other uniparous mammals. By this fact, I suppose that fin whales ovulate periodically.

The ratio of EZ or TZ in total twins relates with the number of corpora lutea, and most of twins are composed of EZ in few number of corpora lutea. But when the ratio of TZ increase and in more than 26 corpora lutea, almost of all twins will be TZ. (Fig. 11).

The TZ come into existence by the ovulation of two eggs and the fertilization of them. In my examination, the frequency of TZ is high in many number of corpora lutea. Then the following question occures. The mothers of TZ may ovulate more than normal females abnomally in a breeding period, and if so, can we not regard both the mother of TZ and the normal female who have same number of corpora lutea as the same year class ?

In order to answer the question, we must compare them with other age characters which have no relation with the ovulation. In whales, however, reliable age characters have not been taken yet. And the age characters examined in biological investigation of Japanese whaling fleet are generally only body length, white scars the condition of ossification of vertebrae and baleen plates, though recently we have collected ear plug. In them, the former two are considerably valuable in individuals, therefore

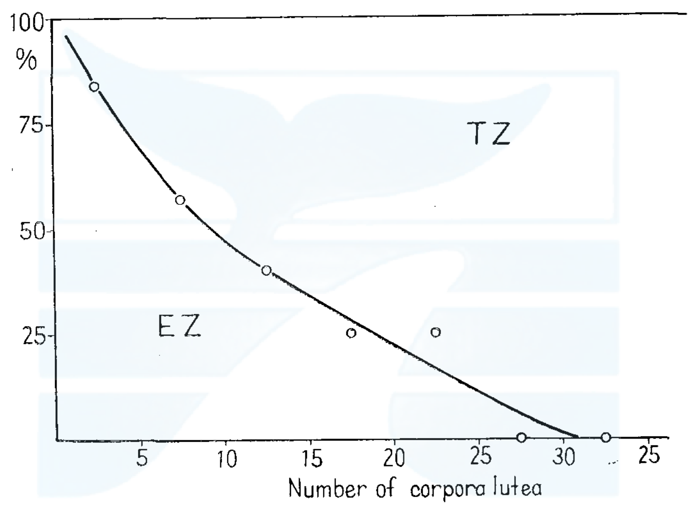

Fig. 11. Relation between the composition of EZ and TZ, and the number of corpora lutea.

they cannot be used. About the ossification of vertebrae, the usefulness for the age character is admitted by many biologists. Wheeler (1930), Peters (1939), Brinkmann (1948) and Kimura (unpublished results) show that the ossification of vertebrare finished in 13–16 corpora lutea in the case of fin whales. If the mother of TZ ovulate more than the common females in a breeding season, the number of corpora lutea in the time of the ossification of them must finish in more than 13–16 corpora lutea.

In Japanese investigations, the ossification of vertebrae is judged by means of observation of the epiphyses in the middle of thorathic and lumber.

The results are shown in table 6. Although the number observed are very few, those who has more than 16 corpora lutea in ovaries are all ossificated. This does not differ from common females. Therefore the females which are pregnant with TZ will not ovulate more than common females, abnormally.

TABLE 6. STAGE OF OSSIFICATION OF VERTEBRAE IN THE MOTHERS OF TZ

Stage of ossification	Number of corpora lutea				
	16	17	22	23	27
aA	2				
AA	2	1	1	1	1

Remarks: a····fused but not completed
A····fully fused

MULTIPLE FOETUSES

Appearances of multiple foetuses are recognized in whales, though they are very rare.

The numbers of multiple foetuses in I.W.S. (from 1933/34 to 1952/53) were already shown in table 2. The example of the fin whale who had more than 7 foetuses has never been reported, although in blue whales there were one example of 7 foetuses (Risting, 1925).

TABLE 7. FREQUENCY OF MULTIPLETS

	Pregnant whales	Twins	Triplets	Quadri-plets	Quintu-plets	Sextu-plets
Actual number	39,947	328	13	4	1	2
Multiplets:Preg. whale		1:121.8	1:3073	1:10000	1:40000	1:20000
Multiplets/Preg. whale		1/121.8	$1/55.4^2$	$1/21.5^3$	$1/14.1^4$	$1/7.25^5$

TABLE 8. COMBINATION OF SEX IN TRIPLETS

♂♂♂	···· 2 cases
♂♂♀	···· 6
♂♀♀	···· 1
♀♀♀	···· 1
?	···· 1

With the increase of the number of foetuses, the frequency of them decrease. About the frequency of multiple foetuses in man, there is Hellin's law, that is, if the frequency of twins is presumed to $1/n$, that of triplets is $1/n^2$, and that of quadriplets is $1/n^3$. But in fin whales, the frequencies of triplets and quadriplets are relatively high as shown in table 7. Therefore, Hellin's law can not be applied to the fin whale.

Triplet: The combination of 11 examples recorded in I.W.S. is shown in table 8. In man, like-sexed triplets are more than unlike-sexed triplets, on the contrary, the latter are more than the former in fin whales. And ♂♂♀ are the most of unlike-sexed triplets. About the number of ova of triplets, 3 examples are recorded by Japanese whaling investigations (Table 9). The first example has only one corpus luteum, so it is probably monozygotic triplets. And it is like-sexed as a matter

TABLE 9. THREE CASES OF TRIPLETS DISCOVERED BY JAPANESE FLEET

Date	Body length	Foetuses	No. of corpora lutea
'39-3-14	68 feet	♂ 8'-2", ♂ 9'-11" ♂ 2'-1"	1+0 (Matsuura, '40) 0+0
'53-2-9	68	♂12'-3", ♂12'-8" ♀12'-4"	2+8 1+4
'52-1-10	74	♀19'-8", ♀15'-0" ♂ 5-2"	1+12 0+13

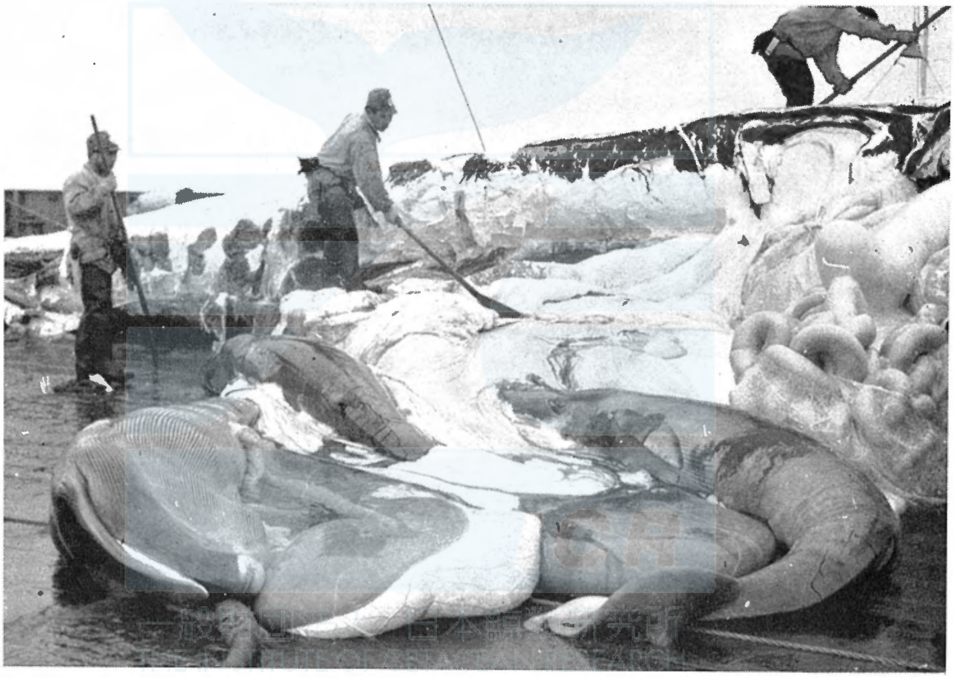

Fig. 12. Trizygotic triplet foetuses of a southern fin whale (*Balaenoptera physalus*, L.) Individuals of No. 26 in Appendix.
Male 12'3" Male 12 8" Female 12'4"
(Photo. by Mr. Setsuo Nishimoto)

of course. The body length of one foetus in this example is very smaller than the others, and it was recorded that the last one had been dead. The second case is exactly trizygotic triplets as shown in figure 12 and 13. The third example is unlike-sexed, in spite of having only one functional corpus luteum. But, in it, the larger two female foetuses are recorded to have been dead before then. Therefore, it is supposed that a couple of twins (♀♀) remains in mother's uterus after they were dead, then by the next ovulation, one male foetus (5′2″) were fertilized. And I consider that the third triplet consists of a couple of dead twins and one single foetus.

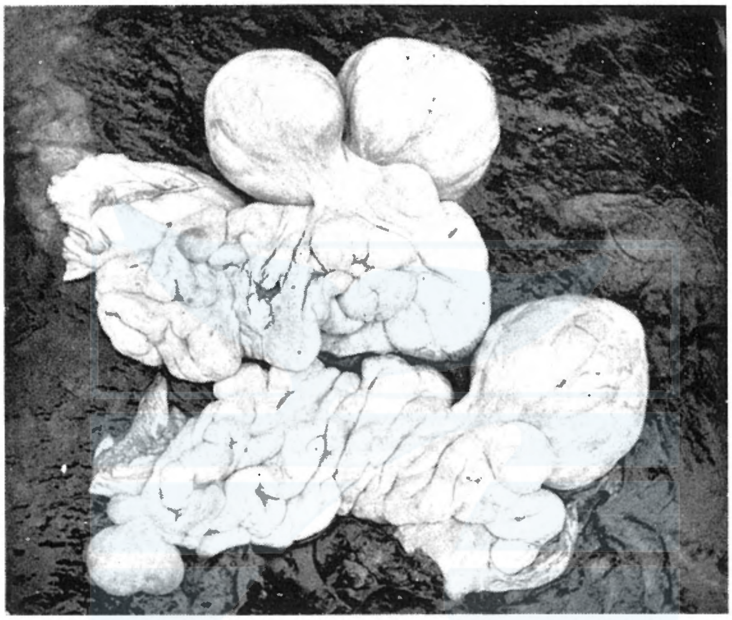

Fig. 13. The ovaries of the mother of trizygotic triplet foetuses (Fig. 12).
Number of corpora lutea

15 {upper 2+8, lower 1+4}

(Photo. by Mr. Setsuo Nishimoto)

The sex ratio of 10 triplets in I.W.S. is 19♂ : 11♀ (63.7 % : 36.3 %), so the rate of male is more than that of the female.

Quadriplet: Four quadriplets are reported in I.W.S. (1933/34–1952/53), and the three records are shown in table 10.

Sex ratio is 8♂ : 3♀ (72.7 % : 27.3 %), so the ratio of male is more than that in triplet. Table 11 shows the relation between number of

TABLE 10. QUADRIPLETS

Date	Body length	Foetuses			
'39-1-27	74 feet	♂ 8′-0″	♂ 8′-0″	♂ 8′-0″	♂ 8′-0″
'50-12-23	71	? 1′-4″	♀ 4′-2″	♂ 7′-11″	♀ 19′-1″
'53-2-10	72	♂ 9′-0″	♂ 10′-0″	♂ 11′-0″	♀ 13′-0″

foetus and the sex ratio. With the increase of the number of foetues, the ratio of males increases. These phenomena are contrary to that in man.

TABLE 11. SEX RATIO OF MULTIPLETS

	♂	♀
Common foetus	50.6%	49.4%
Twin	51.4	48.6
Triplet	63.7	36.7
Quadriplet	72.7	27.3

Quintuplet: Only one quintuplet is reported in I.W.S. The example is shown below.

TABLE 12. A CASE OF QUINTUPLET

Date	Body length	Foetuses				
'48-2-28	79 feet	♂ 6′-8″	♂7′-5″	♂ 7′-6″	♂ 8′-4″	♂ 8′-9″

Sextuplet: 2 case of 6 foetuses are recorded in I.W.S.

TABLE 13. TWO CASES OF SEXTUPLETS

Date	Body length	Foetuses			
'50-2-24	69 feet	♂ 3′-4″	♀ 5′-4″	♀11′-1/2″	♀10′-1/2″
		♀10′-9″	♀10′-11″		
'53-2-21	72	♂ 8′-10″	♀ 8′-0″	♂ 9′-10″	♀ 9′-0″
		♀10′-0″	♀12′-0″		

Jonsgård (1953) reported on the latter case.

DISCUSSION

The existence of TZ in whales is clear because of the existence of unlike-sexed twins. But about EZ only Matsuura (1940) stated on the possibility of it, and Slijper (1949) stated that the twin whose mother had only one functional corpus luteum was not always EZ.

However, we assume the existence of it by calculation using Weinberg's differential method. And according to our material which were got by our biological investigation of whales, the twins whose mothers have only one functional corpus luteum in ovaries are all like-sexed. The difference of two body lengths of a couple of twins are considerably small, and in these cases the one of a pair is not regarded to have been dead. The fact that there is a single foetus whose mother has two functional corpora lutea in ovaries, shows that when two ova are ovulated in the same time and the one is not fertilized or disappeared, the two corpora lutea maintained to be functional even if only the other is fertilized. While, Wheeler (1930) stated, ' A close and somewhat exclusive relation between corpus luteum and foetus. If two ova are fertilized, then two corpora lutea will remain functional, if one corpus is developing then one corpus luteum is sufficient. Perhaps, indeed, the corpus luteum reflects the fate of its own released ovum'. But in his data, one fin whale with unlike-sexed twin foetuses has three functional corpora lutea. The second one with no foetus has two functional corpora lutea. The third one with a foetus has two functional corpora lutea. These facts cannot be explained by his theory, and they are not contradictory to my explanation. In the other hand, as shown in chapter of 'multiple foetuses', there is unlike-sexed triplet foetuses whose mother has only one functional corpus luteum. But in this case, the larger two foetuses clearly have been dead in the uterus before then. So I consider that the corpora lutea of the two foetuses have dwindled and from the next ovum a single small foetus developed. That is to say, after all foetuses in uterus died, the corpora lutea dwindle. On the contrary if there is no dead foetus, the multiple foetuses whose mother has only one functional corpora lutea are monozygotic multiplet.

As stated above, there are a few cases in which dead foetuses remain in their mother's uterus. For example, one (4′-0″) of a couple of twins (♂11′-5″, ♂4′-0″) of which genesis is unknown had been dead. In this case if the number of functional corpora lutea is only one, it is doubtful whether the twin is monozygotic or one foetus developed by the next ovulation after the other died. In such a case we must investigate the condition of placenta.

Furthermore, as there will be such cases in I.W.S. the number of foetuses does not show the true number of multiplet, we should pay attention to the case. It is dangerous when the difference of body length of foetuses is very large.

The morphological studies of twins are important to the basal investigation of races in whales. We must catch the characters which are truly hereditary, and the precise investigation of monozygotic and dizygotic twins makes it clear. However, we have not had the morphological data of twins. This will be the important subject to survey in future.

SUMMARY

1. Using the International Whaling Statistics (1933/34–1952/53) and the results of biological investigation of Japanese whaling fleets in the Antarctic Area V (from 1946/47–1954/55), the twinning in southern fin whales were studied.

2. The frequency of twins is 0.821 % (0.872 %, in total multiplets) of

all pregnant females. The value is seemed to be slightly different in various areas.

3. It is certain that there are monozygotic and dizygotic twins in fin whales.

The ratio of the frequency of monozygotic twins to that of dizygotic is 27.6 % : 72.4 %. The value also is seemed to be different in various areas.

4. The growth of twins is not inferior to the common foetuses.

The difference of body length of two individuals in a couple of twins increases with the growth, and it will be 2 feet long when they are born. The difference of body length between two individuals of monozygotic twins is more than that of dizygotic twins.

In foetal stage, the difference of body length is not recognized between the both sexes.

5. The frequency of twins increases with the increase of their mother's length.

6. The frequency of monozygotic twins is constant in any number of corpora lutea of their mother. On the contrary, the frequency of dizygotic twins increases with the increase of the number of corpora lutea in the ovaries of their mother.

7. The mother of dizygotic twins has not tendency to ovulate more than normal females.

8. The multiplets exist in fin whales. But 7 or more than 7 foetuses have not been reported yet.

Concerning the frequency of multiple foetuses of fin whales, Hellin's law cannot be applied.

The sex ratio of males increase with the increase of the number of foetuses.

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EXPLANATION OF THE APPENDIX

Examples of multiple foetuses discovered by Japanese whaling fleets from 1946/47 to 1954/55.

Remarks 1. Number of corp. lut. A+B A: Corpus luteum graviditatis
B: Corpora albicans

2. Ossification N: not fused n: not fused but not completed
a: fused but not completed A: fully fused
XY X: Thorathic Y: Lumber

APPENDIX

No.	Date captured	Body length of mother (feet)	Foetuses sex and body length (feet-inch)	Number of corp. lut. Left	Right	Total	Diameter of functional corp. lut. (cm)	Ossification
1	7/1/47	70	♂ 5- 1, ♀ 5- 1	1+ 6	2+ 8	17	—	AA
2	5/3/49	75	♀ 10-11, ♀ 11-10	1+ 3	0+ 3	7	—	aa
3	14/3/49	71	♂ 12- 6, ♀ 12- 0	1+ 5	1+ 9	16	(10× ? × ?) (12× ? × ?)	aA
4	23/12/50	71	? 1- 4, ♀ 4- 2, ♂ 7-11, ♀ 19-1	9	8	17	—	AA
5	15/1/51	72	♂ 3- 3, ♂ 3- 4	0+ 2	1+ 2	5	(9 ×10×13)	na
6	16/1/51	74	♀ 5-11, ♀ 6- 0	0+ 3	1+ 5	9	(9 × 9 ×10)	na
7	22/1/51	70	♀ 9- 2, ♂ 11- 7	0+12	2+ 2	16	(12× 9 × 6) (13× 9 × 7)	AA
8	1/2/51	72	♂ 11- 5, ♂ 4- 0(dead)	?	0+ 8	8+	—	AA
9	21/2/51	70	♂ 8- 5, ♂ 8- 7	1+ 3	0+ 2	6	(10×10×13)	na
10	22/2/51	72	♀ 15- 2, lost	2+13	0+12	27	(7 × 8 ×11) (6 × 9 ×11)	AA
11	22/2/51	73	♀ 1- 0, ♀ 0-11	0+ 8	1+ 7	16	—	aa
12	2/1/52	68	♂ 7- 2, ♂ 7- 2	1+ 7	0+ 4	12	(12.5×10.5×9.0)	nN
13	5/1/52	73	♀ 11- 0, ♀ 10- 0	0+ 7	2+ 4	13	—	—
14	9/1/52	69	♀ 5-10, ♀ 4- 6	1+ 3	0+ 4	8	(9 ×11× ?)	—
15	10/1/52	73	♂ 10- 2, ♂ 10- 4	1+10	1+ 4	16	(11×13×11.5) (11.5×12.5×12)	AA
16	10/1/52	74	♀ 19- 8 (dead), ♀ 15-0 (dead), ♀ 5-2	1+12	0+13	26	(18×11× ?)	—
17	11/1/52	68	♂ 9- 1, ♂ 8- 9	1+ 7	0+ 6	14	(10×13.5×15)	aA
18	13/1/52	73	♀ 10- 4, ♀ 10- 2	2+14	0+ 6	22	(9.5×13.5×10) (9 × 7 ×7.5)	AA
19	15/1/52	73	♀ 3- 0, ♂ 2-11	1+ 9	0+ 9	19	(11×12× ?)	—
20	9/2/52	71	♀ 12- 5, ♂ 12- 7	0+11	3+17	31	(11.5×8.5) (13×10) (8×6.5)	—
21	15/2/52	73	♀ 13- 3, ♂ 13- 5	1+ 6	1+ 8	16	(9.5×18×15) (9×15×16)	aA
22	13/2/52	70	♀ 12- 5, ♀ 10- 4	0+11	1+10	22	(12×10)	—
23	26/2/52	74	♀ 14-10, ♂ 14- 2	1+ 0	1+ 8	10	(12×10) (15×12)	—
24	7/1/53	76	♀ 8-11, ♀ 9- 0	1+10	1+ 3	15	—	—
25	15/1/53	71	♂ 3-10, ♂ 3-10	0+ 2	1+ 2	5	(16× ? × ?)	—
26	9/2/53	68	♂ 12- 3, ♂ 12- 8, ♀ 12-4	2+ 8	1+ 4	15	(13× ? × ?)	—
27	12/2/53	70	♀ 8-10, ♀ 8- 0	1+ 0	0+ 0	1	—	—
28	13/2/53	65	♂ 12- 0, ♀ 10- 7	2+ 0	0+ 1	3	—	—
29	13/2/53	76	♀ 13- 0, ♀ 12- 6	1+ 5	1+ 3	10	—	—
30	18/1/54	68	♂ 11- 3, ♂ 10- 6	—	—	—	—	—
31	24/1/54	72	♀ 10- 6, ♂ 10- 9	1+ 4	1+13	19	—	—
32	26/1/54	73	♂ 9- 4, ♂ 9- 3	1+ 4	1+17	23	—	AA
33	26/1/54	76	♂ 6- 9, ♀ 6- 5	1+ 3	1+ 4	9	—	—
34	2/2/54	68	♀ 9- 0, ♀ 5- 9	1+ 0	0+ 0	1	—	—
35	11/2/54	70	♀ 4-10, ♂ 4- 7	4+ 6	5+15	30	—	—
36	24/2/54	70	♀ 10-10, ♀ 10- 5	2+16	0+ 3	21	—	—
37	14/2/55	65	♀ 11- 2, ♂ 10- 1	—	—	—	—	—
38	15/2/55	72	♀ 6- 4, ♀ 7- 0	1+ 0	0+ 1	2	—	—
39	15/2/55	69	♂ 12-10, ♂ 10-11	—	—	—	—	—
40	25/2/55	71	♂ 8- 9, ♂ 8-10	2+ 4	0+ 8	14	—	—

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AN APPLICATION OF LINEAR DISCRIMINANT FUNCTION TO EXTERNAL MEASUREMENTS OF FIN WHALE

TADAYOSHI ICHIHARA

INTRODUCTION

Since the external measurements on various parts of whales were begun with southern blue and fin whales by Mackintosh & Wheeler (1929), these have been carried out in different areas. Fujino (1954) took up the body proportions of fin whales caught in the northern Pacific, the adjacent waters to Japan and the Antarctic Ocean to study their races with relation to numbers of corpora luteum accumulated in female ovaries, since when many whales have been measured by scientists in Japan.

In this paper, it is discussed whether the general shape of fin whale is different or not in various geographical areas. The measurements of the corresponding parts of whales have fairly similar values for the same species taken in the different areas and so there are overlaps to some extent among the frequency distribution curves of these corresponding measurements. Consequently, it is desirable to decrease these overlaps and to find out the differences of the shapes of whales among various areas through the compounds of several external measurements. From this point, I here try to apply the method of Fisher's linear discriminant function to the classification of the general shapes of fin whales in the North Pacific and clarify where helps the discrimination among measurements. This paper follows the report 'On the Body Proportions of the Fin Whales (*Balaenoptera physalus* (L)) caught in the northern Pacific Ocean (I)' by Fujino (1954).

Grateful acknowledgements are due to the Japanese government whaling inspectors and the staff of the whaling companies who cooperated in the investigation. I am also indebted to Dr. Hideo Omura, the director and Mr. Kazuo Fujino, the Whales Research Institute, for their helps and advices during this work. I am also grateful to Dr. Motosaburo Masuyama and Dr. Kosei Takahashi, the Department of Internal Medicine and Physical Therapy, Fuculty of Medicine, the University of Tokyo, for their valuable suggestions in the application of linear discriminant function to this study. Finally, I should like to thank Mr. Shigeo Imamura, the Mitsui Mining Company for his help with the calculation to obtain the discriminant coefficient through I. B. M. Calculation Punch 602 A.

WHALING GROUND AND SEASON

Fin whales have been caught recently in both the adjacent waters to Aleutian Islands and to Japan proper in the North Pacific by the Japanese whaling companies. Their whaling grounds are generally divided into three areas in the present problem as shown in figure 1.

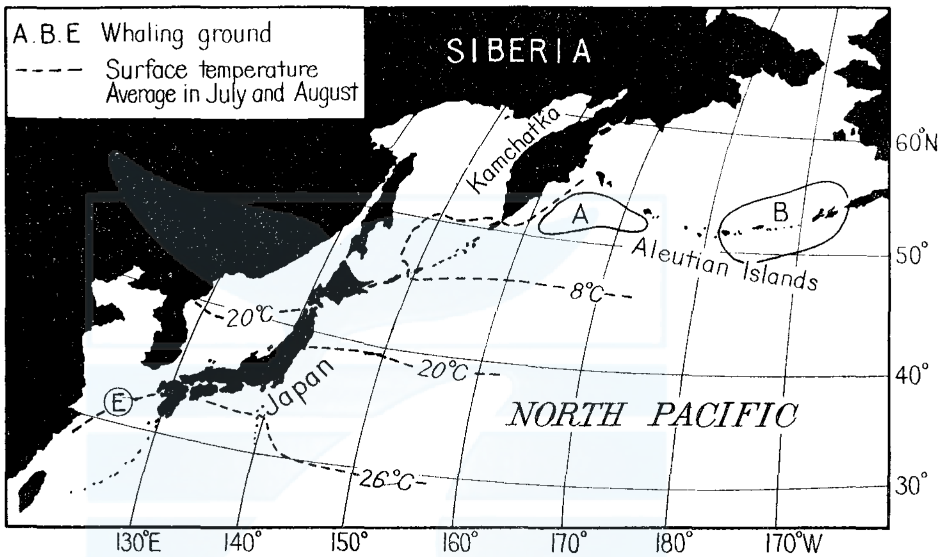

Fig. 1. Distribution of whaling grounds, related to surface temperatures in the North Pacific.

Area A—The west side waters of Aleutian Islands; Area B—The east side waters of Aleutian Islands; Area E—Northern part of East China Sea, i.e., the west side waters of Kyushu which is the southern island in Japan

It is possible to put area A and B as a whaling ground in the northern Pacific. But they are divided here for the convenience of the sample arrangements, because Japanese factory ships acted in the west side waters of Aleutian Islands, area A, in 1952 and 1953. The comparison of general shape of fin whale between A and E is studied in this paper and the materials are based on the results of biological investigations in 1952 and 1953 in area A and in 1955 in area E respectively. Although the details of oceanographical studies affecting the migration of whales are not discussed here, it is necessary to notice the temperatures of water surfaces showing the geographical difference between two areas. The mean temperature of water surface was about 7°C with its range 3 to 11°C in area A, while it was about 27°C with its range 21 to 28°C in area E for the whaling seasons.

The whaling seasons covered September from July in 1952 and October from May in 1953 in area A and the maximum catch was between June and August while these covered October from July and the maximum catch was in August and September in area E in 1955. Therefore Japanese factory ships and the land stations acted for fin whales from May to October in the North Pacific.

It is important to consider the various parts of whales increasing with growth, when their shapes are compared. It is rather difficult to discuss the shape of whales caught in very different seasons, chiefly because there is a close relation between growth of bone and season of migration in whales (Laws & Purves, 1956). As mentioned above, the whales examined are caught in different areas but about the same seasons.

VALIDITY OF SAMPLE

The comparison of size distribution between 1952 and 1953 are necessary in area A, before the discussion on size distributions between area A and E. It is seen in table 1 that the size distributions are remarkably constant in male and female in area A for two years. The modes of length of male fin whales caught are 18 metres and their ranges are 16 to 20 metres, while the modes of female whales caught are 19 metres and their ranges are 17 to 21 metres for two years. There is the same tendency in whales measured as in ones caught. Judging from the length of whales above mentioned, there are no remarkable biases between size distributions in 1952 and 1953.

As shown table 1, it is here possible to put the samples of two years together in area A. In area E, the modes are 17 metres in male and 18 metres in female, and the ranges are 15 to 19 metres in male and 15 to 21 metres in female respectively as seen in the size distributions. So there are larger modes in area A than in area E by 1 metre in the size distributions for both sexes.

It is difficult to discuss the races of fin whales except the difference of their size distributions but their size limits in catch are not looked over, which are 16 metres in area A and 15 metres in area E and affect their apparent size distributions. The relations between individuals caught and ones measured are shown as histograms of their percentages to total at each length of whale in metre in figure 2. The whales are actually selected in catch, especially in measurements, but they are here considered as the random representatives in the whale groups migrating to the same areas.

The methods of measurements for various parts of whales followed

TABLE 1. RELATION BETWEEN WHALES CAUGHT AND WHALES MEASURED IN TWO AREAS IN DIFFERENT YEARS IN THE NORTH PACIFIC

a. Male fin whale

	Area A												Area E			
	1952				1953				1952-3				1955			
Length of whale in metre	Catch Act. no.	%	Whales measured	%	Catch Act. no.	%	Whales measured	%	Catch Act. no.	%	Whales measured	%	Catch Act. no.	%	Whales measured	%
15	—	—	—	—	—	—	—	—	—	—	—	—	20	16.4	16	14.3
16	1	1.0	—	—	4	1.7	1	2.4	5	1.5	1	1.5	28	23.0	27	24.1
17	28	26.9	6	24.0	83	34.9	12	29.3	111	32.5	18	27.3	47	38.4	43	38.4
18	49	47.1	11	44.0	106	44.5	19	46.3	155	45.2	30	45.4	23	18.9	22	19.6
19	25	24.0	8	32.0	43	18.1	9	22.0	68	19.9	17	25.8	4	3.3	4	3.6
20	1	1.0	—	—	2	0.8	—	—	3	0.9	—	—	—	—	—	—
Total	104	100.0	25	100.0	238	100.0	41	100.0	342	100.0	66	100.0	122	100.0	112	100.0

b. Female fin whale

	Area A												Area E			
	1952				1953				1952-3				1955			
Length of whale in metre	Catch Act. no.	%	Whales measured	%	Catch Act. no.	%	Whales measured	%	Catch Act. no.	%	Whales measured	%	Catch Act. no.	%	Whales measured	%
15	—	—	—	—	—	—	—	—	—	—	—	—	12	11.7	9	9.6
16	—	—	—	—	—	—	—	—	—	—	—	—	6	5.8	6	6.5
17	12	11.0	2	13.3	26	11.2	3	6.1	38	11.1	5	7.8	27	26.2	24	25.8
18	22	20.2	3	20.0	62	26.7	14	28.7	84	24.6	17	26.6	35	34.0	32	34.5
19	45	41.3	7	46.7	88	37.9	23	46.9	133	39.0	30	46.8	19	18.4	18	19.4
20	28	25.7	3	20.0	51	22.0	8	16.3	79	23.2	11	17.2	3	2.9	3	3.2
21	2	1.8	—	—	5	2.2	1	2.0	7	2.1	1	1.6	1	1.0	1	1.0
Total	109	100.0	15	100.0	232	100.0	49	100.0	341	100.0	64	100.0	103	100.0	93	100.0

ones of *Discovery Reports* vol. 1 by Mackintosh & Wheeler (1929). The next ten parts showing the general shapes of fin whales are used in this present problem.

1. Total length.
5. Tip of snout to centre of eye.
6. Tip of snout to tip of flipper.
8. Notch of flukes to posterior emargination of dorsal fin.
10. Notch of flukes to centre of anus.
11. Notch of flukes to centre of umbilicus.
12. Notch of flukes to end of ventral grooves.
13. Centre of anus to centre of reproductive aperture.
14. Dorsal fin, vertical height.
15. Dorsal fin, length of base.

The admitted data on the next parts are shown too in figure 3 a, b.

7. Centre of eye to centre of ear.
17. Flipper, tip to anterior end of lower border.
19. Flipper, greatest width.

The next men have responsibilities for the measurements in a respective season and area.

Area A {1952 K. Fujino, 1953 T. Nemoto} The Whales Research Institute

Area E 1955 {K. Mizue, S. Koga} Faculty of Fisheries, the Nagasaki University

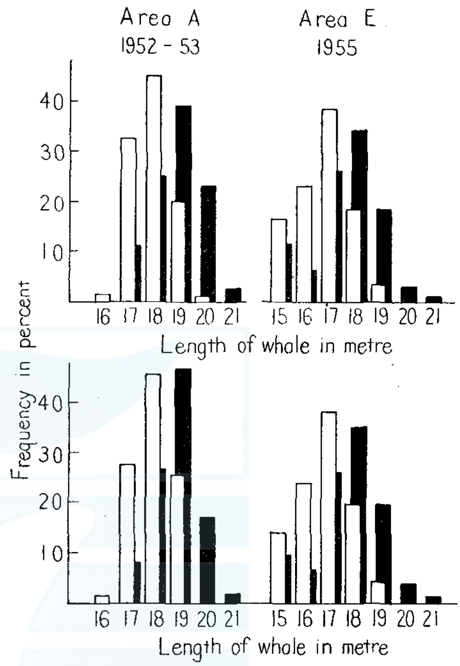

Fig. 2. The histograms showing percentage size frequency distributions of fin whales in two areas in the North Pacific.
The upper: whales caught
The lower: whales measured
[ ]: Male ■: Female

It is important to see the relation between total length and length of various parts of whales, considering changes following growth. If the lengths of various parts are converted to percentages of the total length, their relations are seen in figure 3. The values are plotted as average percentage length of parts against total length of whales in different areas for comparative purposes. Figure 3 is based on the following individuals measured. Individuals in area A contain whales measured in 1954.

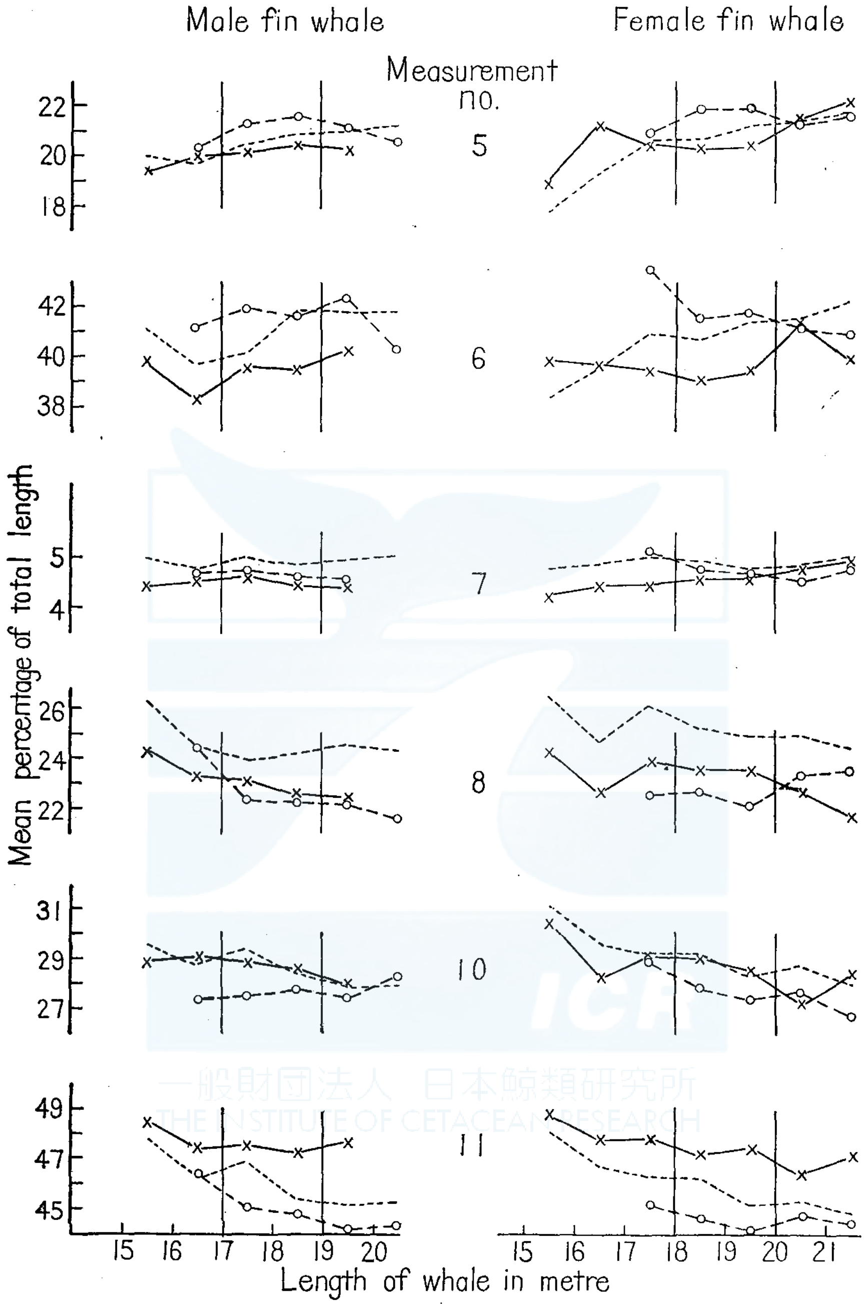

Fig. 3. a. The mean value of each measurement expressed as percentage of total length.

○——○ Whales in area A ------- Whales at South Georgia in the Antarctic.
×——× Whales in area E (Cited from *Discovery Report* vol. 1)

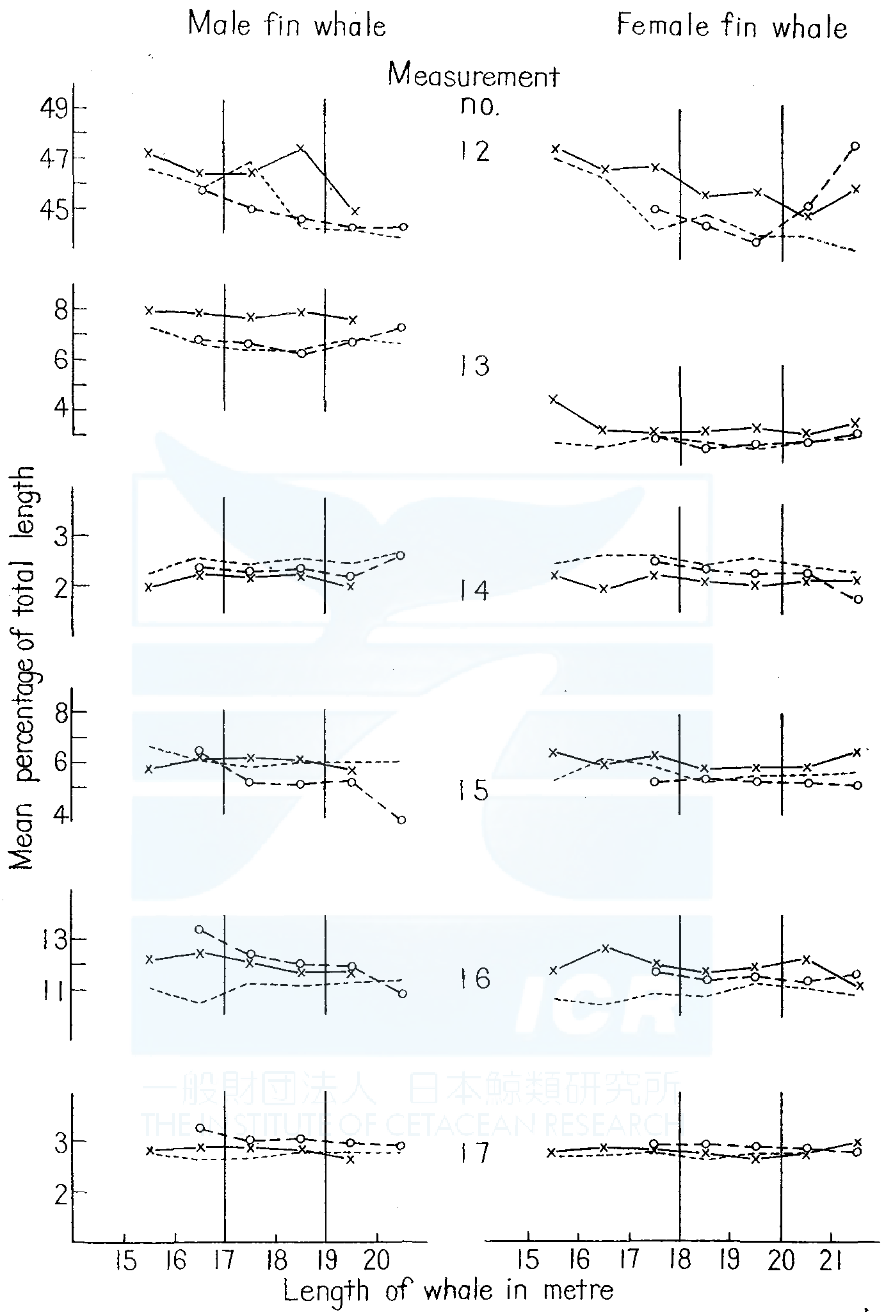

Fig. 3. b. The mean value of each measurement expressed as percentage of total length.

		Male						Female						
		Length of whale in metre						Length of whale in metre						
Area	Year	15	16	17	18	19	20	15	16	17	18	19	20	21
A	1952–54	—	2	18	36–8	18–9	0–1	—	—	6–7	19–20	31–2	12–6	1–2
E	1955	16	27	43	22	4	—	9	6	24	32	18	3	1

It is apparent that there are considerable correlation between the length of some parts and total length of whale for both sexes. Fujino (1954) studied partly this connection using correlation coefficient, and precise studies on the differences of shapes demand the due consideration on those correlations. Unfortunately, there are sparse data for small and large fin whale and yet no accurate method available for determining age of fin whale, so the details of rates of growth for various parts are not here discussed. It is necessary to set up several discriminant formulae for each length layer of both sexes of fin whales to analyse whether the shapes of fin whales are different or not between area A and E, because of those correlations. Furthermore it is necessary to study significant differences of the mean lengths between area A and

TABLE 2. MEAN LENGTH (IN CM) OF FIN WHALE MEASURED IN AREA A AND E

Group	Sex	Range of length of whale	Area A: Mean length of whale	Area A: Individuals measured	Area E: Mean length of whale	Area E: Individuals measured
I	Male	1700–1799	1762	15	1765	30
II	Male	1800–1899	1843	30	1843	20
III	Female	1800–1899	1853	17	1859	26
IV	Female	1900–1999	1949	29	1940	15

E at each length layer of whales before the treatment of samples. The length layers showing maximum numbers of individuals measured are 17, 18 meters in male, 18, 19 metres in female respectively in area A and E as shown in table 1 a, b and figure 2. The actual mean lengths of fin whales measured are tabulated in table 2.

There are no significant differences of mean length between area A and E in the same groups on the 1% level, although there is a little difference in variance. Besides, as all of 10 parts of body must be measured in all individuals for calculations, it is necessary to select actual samples answering this conditions among whales measured. The samples for calculation, therefore, become smaller in table 2 than in table 1, and are 45 whales in group I, 50 in group II, 43 in group III and 44 in group IV in all. The measurements are recorded as the actual length in centimetre well adapted for further use.

STATISTICAL TREATMENT

The method of the linear discriminant function (L. D. F.) by R. A. Fisher is applied to consider the difference of the shape of fin whale between two areas. In the case that there are several measurements for individuals, it is necessary to find out the weight of each measurement as the discriminant coefficient in L. D. F. Furthermore it is desirable to determine a class which an individual belongs to, according to the discriminant value replaced by linear compounds of the measurements.

The discriminant coefficient are determined under the conditions that make it the largest, the difference of the mean discriminant value between two groups to be classified. The theory of L. D. F. is well known as the method of the test for the difference between two mean values, in the case of only one measurement. In other words, the test for the difference between two mean values in a variate is able to be extended to L. D. F. in multivariates. The fundamental conditions are as follows, in the application of the theory above mentioned to the sample of this present problem.

The theory of L. D. F. in large numbers of samples is used for this paper and so it is desirable to take samples more than 100 for each group. However, as the biological investigations on board of the factory ships limit the number of measurements and it is rather difficult to collect large samples in a short time, the calculations here are carried out with 40 to 50 samples in all for each group. The functions set up on such samples are not the population discriminant functions but the sample ones. Therefore, it is necessary to consider the variation based on the sampling errors when we use that discriminant coefficients for the constant discriminant standards and apply them to the method of the classification for individuals. In other words, the sample discriminant coefficients in the small sample approximate gradually to the population ones with further improvement, but those will help us in analysing the measurements to some degree.

As area A is situated in an only part of the extensive northern Pacific, it is natural that different years bring forth the changes of oceanographical conditions. The nutritional level variable affects the rate of growth of aquatic mammals, especially in their younger stages (Laws, 1956), so it is assumable that there are remarkable individual variations in the lengths of parts of fin whales in different years. The means of measurements at each group are tabulated with their 99% confidence limites in table 3 a, b, 4 a and b, for area A and E.

TABLE 3. MEAN LENGTH (AND THEIR 99% CONFIDENT LIMITS) OF BODY PARTS OF FIN WHALES MEASURED IN TWO AREAS IN DIFFERENT YEARS (IN CM)

a. Group I

	Area A				Area E			
	1953			1952	1955			1956
Measurement	Lower limit	Mean	Upper limit	Mean	Lower limit	Mean	Upper limit	Mean
No. 5	350.5	370.6	390.6	374.2	352.2	358.9	365.6	359.5
6	702.3	734.4	766.6	748.3	687.2	703.8	720.4	698.6
8	367.7	396.0	424.3	395.0	403.1	411.7	420.3	395.1
10	470.0	493.9	517.7	475.0	494.4	504.4	514.4	504.3
11	775.2	809.4	843.6	786.7	823.0	838.6	854.2	840.3
12	769.6	813.3	857.1	781.7	803.5	820.4	837.2	817.5
13	111.9	127.2	142.6	122.5	129.4	138.5	147.6	146.9
14	34.2	38.4	42.7	39.2	36.4	38.3	40.1	38.3
15	74.2	88.9	103.6	86.7	101.1	108.7	116.4	109.9
Individuals		9		6		30		21–30 ..
Mean length of whale		1765		1757		1765		—

b. Group II

	Area A				Area E			
	1953			1952	1955			1956
Measurement	Lower limit	Mean	Upper limit	Mean	Lower limit	Mean	Upper limit	Mean
No. 5	389.0	400.8	412.6	389.5	363.5	376.6	389.6	379.5
6	746.4	767.6	788.9	778.5	710.0	724.3	738.5	720.4
8	401.8	413.2	424.5	410.0	399.1	417.3	435.4	435.5
10	491.8	505.8	519.8	519.8	513.5	530.7	547.8	514.5
11	807.4	821.8	836.3	846.4	843.3	865.6	887.9	859.5
12	794.0	811.8	829.7	847.7	816.8	844.1	871.3	855.9
13	109.5	120.3	131.1	122.3	135.6	148.2	160.7	142.0
14	35.7	40.6	45.5	42.0	37.2	40.4	43.6	41.7
15	80.9	88.9	97.0.	98.0	104.1	112.6	121.0	115.5
Individuals		19		11		20		10–11 ..
Mean length of whale		1837		1852		1843		—

.. The various parts of individuals are not measured togather.

The whales in area A have the large variation during two years while they in area E have the smaller variation during two years, chiefly because area E has a more narrow and a more simple oceanographical conditions than area A. It is therefore assumable that area E has the whales of the same population in 1956 as in 1955. It is not safe to say that area A has whales of the same population because of its situation near the Continent of Asia in the northern Pacific, but to

TABLE 4. MEAN LENGTH (AND THEIR 99% CONFIDENT LIMITS) OF BODY PARTS OF FIN WHALES MEASURED IN TWO AREAS IN DIFFERENT YEARS (IN CM)

a. Group III

	Area A				Area E			
	1953			1952	1955			1956
Measurement	Lower limit	Mean	Upper limit	Mean	Lower limit	Mean	Upper limit	Mean
No. 5	391.1	404.1	417.2	405.0	365.1	376.2	387.3	382.1
6	743.8	767.9	791.9	760.0	703.3	724.5	745.7	727.0
8	408.2	420.4	432.5	416.7	427.2	440.2	453.2	430.8
10	504.0	514.3	524.6	514.3	527.3	538.4	549.5	534.5
11	809.1	822.9	836.6	838.3	864.8	878.7	892.5	875.5
12	795.9	815.7	835.6	841.7	835.5	853.8	872.2	851.5
13	39.6	50.4	61.1	58.3	53.9	59.7	65.4	60.9
14	38.7	42.1	45.6	44.7	35.8	38.7	41.6	37.7
15	90.2	103.9	117.6	100.0	102.1	108.5	114.9	111.2
Individuals		14		3		26		14–19 ··
Mean length of whale		1851		1863		1859		—

b. Group IV

	Area A				Area E			
	1953			1952	1955			1956
Measurement	Lower limit	Mean	Upper limit	Mean	Lower limit	Mean	Upper limit	Mean
No. 5	413.2	424.6	435.9	420.8	385.6	398.7	411.8	400.9
6	784.0	807.0	830.0	825.0	738.7	769.3	800.0	767.0
8	407.7	426.7	445.8	428.3	436.2	455.8	475.4	442.0
10	523.2	538.3	553.4	516.7	525.6	551.5	577.3	570.6
11	860.8	873.7	886.6	845.0	898.2	922.4	946.6	899.5
12	846.9	863.3	879.6	838.3	849.1	886.9	924.7	893.9
13	48.1	53.3	58.5	60.0	51.8	64.3	76.7	70.5
14	41.3	44.1	46.9	47.8	35.3	38.5	41.7	42.7
15	93.1	103.5	113.9	96.7	100.8	114.7	128.7	120.7
Individuals		23		6		15		5–9 ··
Mean length of whale		1950		1944		1940		—

·· The various parts of individuals are not measured together.

say there are intermingles to some extent among several populations in such feeding area as the northern Pacific. As the means of measurements by different men are stable arbitrarily in 1952 and 1953, it is considered in this paper that the differences of means follow the sampling errors in area A.

NORMALITY OF EACH MEASUREMENT

The studies on the normal distribution of each measurement for each group usually need several hundreds samples, however, it is difficult to have large numbers of samples in whaling areas and assume the type of their population distributions, especially on the decks of factory ships. Fortunately, there are fairly much measurements at South Georgia in *Discovery Reports* vol. 1, and so it is possible to apply measurements of male fin whales 20 metre long to test their normalities. If each value in *Discovery Reports* vol. 1 is plotted in the normal probability paper, the normality of each measurement for fin whales is generally assumed.

HOMOGENEITY OF VARIANCE

It is not easy to study the homogeneity of variance-covariance matrices of two nine-variates for each group in two areas. However, it is possible here to test the homogeneity of variance for the corresponding measurement between two areas at each group. Wheeler's method are applied to this test and 36 unviased variance ratios to be tested are shown in the following table.

TABLE 5. TEST FOR VARIANCE IN EACH MEASUREMENT

	Degree of freedom		Measurement No.								
	n_1	n_2	5	6	8	10	11	12	13	14	15
Group I	14	29	2.07	—	1.93	1.23	1.17	1.60	—	1.79	—
	29	14	—	1.38	—	—	—	—	2.02	—	1.21
Group II	19	29	1.09	—	—	1.45	1.39	1.82	—	—	—
	29	19	—	2.40*	1.38	—	—	—	1.15	1.66	1.00
Group III	16	25	—	—	2.49	—	—	—	1.40	—	2.05
	25	16	1.90	2.06	—	2.92*	1.74	1.81	—	1.73	—
Group IV	14	28	—	1.20	—	1.72	1.37	2.70*	2.87**	—	—
	28	14	1.21	—	1.35	—	—	—	—	1.42	1.07

* $P<0.05$ ** $P<0.01$

Values show variance ratios.

Where the measurements No. 6 in group II, No. 10 in group III and No. 12 in group IV are significant at 5%, besides No. 13 in group IV at 1% level between two areas. Nevertheless it is safe to say the homogeneity of variance-covariance matrices of two nine variates for each group. Chiefly because, from the results of the experiments in constructed normal populations up to this time, such significant differences of variance between corresponding measurements above mentioned do not result in the remarkable wrong conclusion. In other words, it is possible to calculate further assuming the equality of variance-covariance matrices for each groups in this present problem.

PROCESS OF CALCULATION

Setting up four L. D. F. for group I, II, III and IV, I make here group II a representative among other groups to explain the process of calculation for L. D. F., because there is the largest sample in group II among groups, in which male fin whale 1800–1899 centimetre long are contained. The process of calculation are the same for other groups as for group II.

TABLE 6. MEASUREMENTS IN CM AND DISCRIMINANT VALUES FOR GROUP II IN AREA A

Year	Date Caught		Whale No.	1	5 (X_1)	6 (X_2)	8 (X_3)	10 (X_4)	11 (X_5)	12	13 (X_6)	14	15 (X_7)	Discriminant value $Y_{II \cdot a}$
				Measurement No.										
1952	Sept.	10	261	1805	385	730	390	490	780	850	120	40	120	17.58
	July	22	14	1820	400	771	400	490	790	810	120	36	90	11.17
	Aug.	25	170	1830	360	750	410	510	890	890	110	40	90	15.53
	Sept.	3	222	1830	365	720	430	520	860	880	120	40	80	17.05
	〃	10	259	1854	400	780	400	530	850	840	140	40	110	17.79
	〃	14	276	1856	400	830	420	510	850	850	130	50	90	10.24
	Aug.	13	113	1861	370	765	400	520	850	830	120	45	90	14.41
	Sept.	4	223	1863	370	770	430	520	830	810	120	45	90	13.87
	〃	16	288	1870	400	780	400	530	850	850	130	40	100	15.80
	Aug.	24	162	1890	410	835	420	570	880	850	120	46	120	16.37
	〃	8	83	1894	425	825	410	525	880	865	115	40	98	11.94
1953	July	9	344	1800	390	770	400	500	830	500	130	46	90	13.42
	Sept.	5	576	1800	380	700	440	525	800	770	105	36	90	17.51
	Aug.	9	466	1815	410	755	405	490	820	820	130	55	90	13.94
	Sept.	15	629	1815	385	680	420	500	825	825	125	33	75	17.86
	〃	5	584	1820	430	755	445	505	805	775	115	39	70	11.10
	〃	27	690	1820	395	770	410	480	810	790	145	47	90	13.24
	July	15	380	1830	400	805	390	520	860	880	90	48	110	12.10
	Aug.	9	467	1830	420	780	405	480	805	795	135	43	95	12.30
	Sept.	18	644	1830	415	780	415	490	810	810	130	40	95	12.61
	May	21	3	1830	370	770	440	570	820	800	80	40	70	10.46
	Sept.	16	638	1835	385	755	415	515	825	820	130	44	100	16.47
	July	27	415	1840	400	785	405	515	855	845	115	35	65	9.46
	Aug.	3	451	1840	430	805	405	485	810	805	110	48	85	7.78
	〃	31	567	1840	405	760	400	490	790	790	120	40	110	14.54
	〃	28	533	1845	405	785	390	490	800	795	115	30	85	9.31
	〃	27	525	1860	375	795	390	515	845	845	140	45	95	13.81
	Sept.	9	609	1875	425	770	430	515	810	790	115	43	90	12.91
	July	27	259	1890	400	805	415	520	870	830	120	23	95	12.90
	Sept.	25	670	1890	395	760	430	505	825	810	135	36	90	14.97
Mean	—	—	—	1843	396.7	771.4	411.0	510.8	830.8	825.0	120.0	41.1	92.3	13.61

Measurements in 1952 are cited from *the Scientific Reports of the Whales Research Institute*, No. 9, pp. 152–3.

TABLE 7. MEASUREMENTS IN CM AND DISCRIMINENT VALUES FOR GROUP II IN AREA E

Year	Date Caught		Whale No.	Measurement No. 1	5 (X_1)	6 (X_2)	8 (X_3)	10 (X_4)	11 (X_5)	12	13 (X_6)	14	15 (X_7)	Discriminant value $Y_{II\cdot e}$
1955	Aug.	4	18	1829	444	744	439	518	793	739	147	50	96	17.71*
	〃	7	27	1890	380	701	426	505	884	818	152	40	98	23.02
	〃	11	39	1829	350	732	411	502	853	833	139	43	96	18.34*
	〃	14	42	1829	357	732	441	549	884	865	152	38	96	22.48
	〃	17	53	1829	357	732	426	487	853	798	111	43	103	17.00*
	〃	24	83	1890	375	732	469	549	904	875	142	38	114	24.98
	〃	27	94	1829	357	701	413	502	865	860	164	32	101	23.40
	Sept.	4	110	1859	378	711	426	566	914	873	154	45	119	28.50
	〃	10	130	1829	365	701	406	528	863	853	170	45	93	23.80
	〃	10	135	1859	383	749	469	549	870	853	167	45	129	26.54
	〃	12	142	1829	396	732	421	518	853	840	137	32	109	20.78
	〃	13	148	1859	396	777	385	591	823	815	137	35	114	20.00
	〃	15	158	1829	383	721	401	492	840	823	177	43	121	24.24
	〃	16	159	1829	375	686	350	538	914	886	121	40	129	27.14
	〃	16	162	1829	357	732	426	535	868	865	180	35	119	26.20
	〃	23	194	1829	375	749	406	549	853	835	121	35	119	20.75
	〃	23	195	1890	380	718	426	543	896	926	121	43	134	26.08
	〃	25	201	1829	373	724	431	556	914	894	152	38	109	25.72
	Oct.	5	211	1829	370	723	393	518	800	777	162	45	131	24.21
	〃	5	217	1829	380	688	380	518	868	853	157	43	121	26.83
Mean	—		—	1843	376.6	724.3	417.3	530.7	865.6	844.1	148.2	40.4	112.6	23.38

* Individuals marked have the discriminant values belonging to area A.
Standard discriminant value: $Y_{II\cdot G}=18.50$.
Individual discriminant value: $Y_{II}=b_1X_1+b_2X_2+\cdots+b_7X_7$.

It is convenient to study the significant differences between corresponding means in two areas at each measurement before setting up L.D.F. From the result tested, the measurements Nos. 5, 6, 10, 11, 13, and 15 are significant on the 1% level between two areas. However, it is more necessary to combine six measurements above mentioned with the measurement No. 8 to make the precision for discrimination higher, because only each measurement has little contribution to classification. As all measurements of individuals contribute to calculation in the following procedure, measurements available are shown as $X_{1,2,\cdots,7}$ in table 6 and 7.

If 7 measurements are replaced by a linear compound, L. D. F. is

$$Y=b_1X_1+b_2X_2+\cdots+b_7X_7$$

Then if (Wij) is the matrix of unbiased variance given by the sum of the matrices of variation for each measurement in two areas and (di) is the vector of difference between corresponding measurements in two areas, $(bi)=(W^{ij})(di)$. (W^{ij}) is the reciprocal of (W_{ij}).

The actual length of various parts of fin whales give $(W^{ij})(di)$, so the coefficients of the linear discriminant function are given by the equation.

$$\begin{aligned}
392.489\,b_1+232.686\,b_2+7.505\,b_3-40.642\,b_4-193.089\,b_5+5.278\,b_6+18.159\,b_7 &= -20.116\\
232.686\,b_1+910.694\,b_2+0.599\,b_3+198.720\,b_4+109.122\,b_5-22.745\,b_6+73.923\,b_7 &= -47.117\\
7.505\,b_1+0.599\,b_2+978.370\,b_3+105.203\,b_4+51.896\,b_5+1.068\,b_6-89.849\,b_7 &= 6.250\\
-40.642\,b_1+198.720\,b_2+105.203\,b_3+574.311\,b_4+331.966\,b_5-98.082\,b_6+54.275\,b_7 &= 19.817\\
-193.089\,b_1+109.122\,b_2+51.896\,b_3+331.966\,b_4+997.741\,b_5-49.433\,b_6+43.474\,b_7 &= 34.767\\
5.278\,b_1-22.745\,b_2+1.068\,b_3-98.082\,b_4-49.433\,b_5+416.511\,b_6+17.945\,b_7 &= 28.150\\
18.159\,b_1+73.923\,b_2-89.849\,b_3+54.275\,b_4+43.474\,b_5+17.945\,b_6+172.645\,b_7 &= 20.283
\end{aligned}$$

Solving, $b_1=0,0027$, $b_2=-0.0735$, $b_3=0.0120$, $b_4=0.0427$, $b_5=0.0266$, $b_6=0.0713$, and $b_7=0.1274$. So that the discriminant function is

$$Y_{\text{II}}=0.0027X_1-0.0735X_2+0.0120X_3+0.0427X_4+0.0266X_5+0.0713X_6 +0.1274X_7.$$

Where (W_{ij}) estimates the population variance matrix of the normal population in 7 variates, as if the unviased variance U^2 estimates the population variance in 1 variate. Therefore, it is possible to calculate $\sum bidi$ corresponding to Mahalanobis' D^2 to study the significant difference of the shape of fin whales between area A and E for group II.

$$\sum bidi=b_1d_1+b_2d_2+\cdots+b_7d_7=9.844$$

Let N_1 and N_2 be the samples drawn from two areas, to test for the differences in mean values of Y the statistic is

$$\frac{N_1N_2(N_1+N_2-1-7)}{(N_1+N_2)(N_1+N_2-2)}\cdot\frac{\sum bidi}{7}=\frac{30\times20\times42}{50\times48\times7}\times9.844=14.766$$

which as a variance ratio with 7 and 42 degrees of freedom is significant at 1% level.

In table 6 and 7, Y_{II} given by a linear compound of 7 measurements is tabulated. If the mean values $\overline{Y}_{\text{II}\cdot a}$, $\overline{Y}_{\text{II}\cdot e}$ are obtained for the individuals of two areas, the limit value for the classification is given by the next formula. Standard discriminant value is

$$Y_{II \cdot G} = \frac{\overline{Y}_{II \cdot a} + \overline{Y}_{II \cdot e}}{2}$$

$\overline{Y}_{II \cdot e}$ exceeds $\overline{Y}_{II \cdot a}$ in this present problem and Y of individual deteı-mines which he belongs to area A or E. In other words, if Y oí individual examined exceeds $Y_{II \cdot G}$, he belongs to area E and if $Y_{II \cdot G}$ exceeds his Y he belongs to area A. The area to which individual examined belongs is identified by the standard value $Y_{II \cdot G}$ for group II, so the method of L. D. F. is applied to the classification of individuals.

TABLE 8. THE CHANCE FOR MISCLASSIFICATION FOR GROUP II

Discriminant basis		Chance for misclassification			
Measurement	X	$\|h\|$	σ_Y	$ts=\|h\|/\sigma_Y$	$Pr\{t \geqq ts\}$
No. 5**	X_1	10.058	19.811	0.508	31%
6**	X_2	23.559	30.178	0.781	22
8	X_3	3.125	31.279	0.100	46
10**	X_4	9.909	23.965	0.414	34
11**	X_5	17.384	31.587	0.550	29
12		9.526	36.078	0.264	40
13**	X_6	14.075	20.409	0.690	25
14		0.350	5.801	0.060	50
15**	X_7	10.142	13.139	0.772	22
	$X_{1,2,\ldots,7}$	4.922	3.138	1.569	6

** $P<0.01$

The marks show the significant differences between corresponding mean values in two areas.

However, it is sometimes seen that Y of the individuals belonging to area A exceed $Y_{II \cdot G}$ and $Y_{II \cdot G}$ exceed Y of the individuals belonging to area E. In such a case, the frequency distribution curves of Y_{II} in two areas overlap each other and the overlaping area shows indirectly the probability for wrong classification by L. D. F. The probability for the misclassification are given by

$$ts = \frac{|h|}{\sigma_{YII}}$$

$$h = Y_{II \cdot G} - \overline{Y}_{II.a} = Y_{IIG} - \overline{Y}_{II \cdot e}$$

where σ_{YII} is the standard deviation of Y_{II}.

The frequency distribution curves of $Y_{II \cdot a}$ and $Y_{II \cdot e}$ are normally standarized by $|h|/\sigma_{YII}$. It is shown in table 8 with the chance for misclassification that the degree of precision for identification is higher in the linear compound of 7 measurements than in only one measurement.

The chance of wrong classification is about 6% when 7 measurements are replaced by a linear compound, while it is about 22% in the measurement No. 6, 15 showing the minimum values of the chance for misclassification among all measurements. The frequency distributions of Y for individuals in area A and E are shown in figure 4 as histograms.

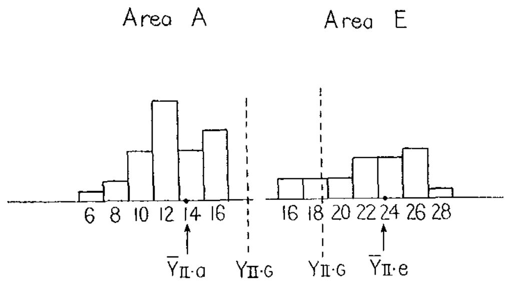

Fig. 4. The distributions of the discriminant values for group II
$Y_{II} = b_1X_1 + b_2X_2 + \cdots + b_7X_7$

The same procedure for calculation as shown above gives us the discriminant coefficients for other groups. The linear discriminant functions given as a compound of 7 measurements are

Group I. $Y_{I} = 0.0320X_1 - 0.0556X_2 + 0.0346X_3 + 0.0031X_4 + 0.0325X_5 + 0.0008X_6 + 0.1201X_7$

Group III. $Y_{III} = -0.0673X_1 - 0.0131X_2 + 0.0464X_3 + 0.0070X_4 + 0.1032X_5 + 0.0835X_6 - 0.3050X_7$

Group VI. $Y_{IV} = -0.0826X_1 + 0.0042X_2 + 0.0646X_3 - 0.0082X_4 + 0.0456X_5 + 0.0583X_6 - 0.3190X_7$

To test for the differences in mean values of Y the statistics are for each group

Group I. $\dfrac{15\times 30\times 37}{45\times 43\times 7}\times 5.834 = 7.171$

Group III. $\dfrac{17\times 26\times 35}{43\times 41\times 7}\times 10.894 = 13.656$

Group IV. $\dfrac{29\times 15\times 36}{44\times 42\times 7}\times 8.708 = 10.542$

Which as variance ratios with 7 and 37 degrees of freedom for group I, 7 and 35 degrees of freedom for group III and, 7 and 36 degrees of freedom for group IV are significant on 1% level. The degrees of precision for classification are tabulated in table 9, a, b, c, for group I, III and IV. The distributions of Y for individuals in area A and E are tabulated in tables 10 to 15 and shown as histograms showing frequency distributions for group I, III and IV in figure 5.

X_7 of female fin whales for group III or IV is measurement No. 14.

TABLE 9. THE CHANCES FOR MISCLASSIFICATION FOR EACH GROUPS

a. group I.

Discriminant basis		Chance for misclassification			
Measurement	X	$\lvert h\rvert$	σ_Y	$ts=\lvert h\rvert/\sigma_Y$	$Pr\{t\geqq ts\}$
No. 5**	X_1	6.567	15.331	0.428	33%
6**	X_2	18.117	31.457	0.576	28
8	X_3	8.067	19.489	0.414	34
10**	X_4	9.034	20.699	0.436	33
11**	X_5	19.134	31.788	0.602	27
12		9.850	36.582	0.269	40
13**	X_6	6.600	16.573	0.398	34
14		0.233	4.116	0.057	50
15**	X_7	10.033	14.753	0.680	25
	$X_{1,2,\cdots,7}$	2.937	2.424	1.210	11

b. group III.

Discriminant basis		Chance for misclassification			
Measurement	X	$\lvert h\rvert$	σ_Y	$ts=\lvert h\rvert/\sigma_Y$	$Pr\{t\geqq ts\}$
No. 5**	X_1	14.051	18.328	0.767	22%
6**	X_2	20.986	34.756	0.604	27
8**	X_3	10.224	20.774	0.492	31
10**	X_4	12.026	17.507	0.687	25
11**	X_5	26.553	23.126	1.148	13
12**		16.776	30.528	0.550	29
13*	X_6	3.945	11.350	0.348	37
14*	X_7	1.967	4.737	0.415	33
15		2.633	13.829	0.190	49
	$X_{1,2,\cdots,7}$	5.447	3.301	1.650	5

c. group IV.

Discriminant basis		Chance for misclassification			
Measurement	X	$\lvert h\rvert$	σ_Y	$ts=\lvert h\rvert/\sigma_Y$	$Pr\{t\geqq ts\}$
No. 5**	X_1	12.531	18.191	0.689	25%
6**	X_2	20.679	37.681	0.549	29
8**	X_3	14.366	28.334	0.507	31
10	X_4	8.837	28.594	0.309	33
11**	X_5	27.321	28.517	0.958	17
12		14.415	25.618	0.563	29
13	X_6	4.806	12.161	0.395	34
14**	X_7	3.215	4.698	0.684	25
15*		6.332	18.568	0.341	37
	$X_{1,2,\cdots,7}$	4.354	2.951	1.475	7

* $P<0.05$ ** $P<0.01$

The marks show the significant differences between corresponding mean values in two areas.

The position of end of ventral grooves is not rather clearer in fin whale than in sei whale and so it is difficult to determine that accurate position in the former. Japanese scientists are unanimous for the determination of this position, however which is arbitrary speaking objectively. Therefore, that measurement No. 12 is not contained within the linear components for L. D. F. In the test for differences between the corresponding measurements Nos. 12 and 13 for group IV in two areas, it is obliged to use Cochran-cox' method because those measurements have different variances in two areas as shown in table 5.

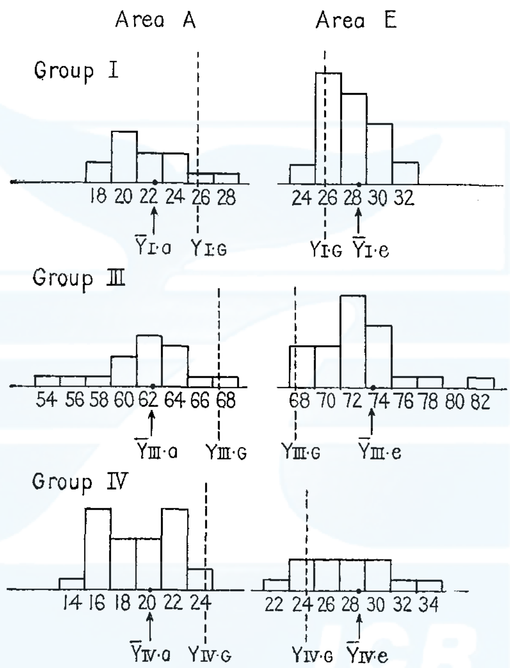

Fig. 5. The distributions of the discriminant values for each group.
$Y = b_1X_1 + b_2X_2 + \cdots + b_7X_7$

DISCUSSION AND CONCLUSION

According to Omura (1950), fin whales are mature over 60 ft. (18.3 metre), or 61 ft. (18.6 metre) long in female and over 58 ft. (17.7 metre) or 59 ft. (18.0 metre) long in male respectively in the adjacent waters to Japan. The length of fin whale at sexual maturity is about the same in the north hemisphere (Jonsgard, 1952), especially in the North Pacific (Matsuura & Maeda, 1942, Pike, 1953) as in the adjacent waters to Japan. In the area E, the data of general biological investigation are now being arranged. It can at least be said, however, that the length of sexual maturity of fin whale does not only exceed the bordor according to Omura, but also it is there fairly smaller (Mizue, 1956).

As there are sparse samples over and below 17 or 18 metres of the length in male fin whale and 18 or 19 metres in female in area A and E, it is difficult to smooth completely the curves in figure 3 for the comparative purposes. However it is assumable that there are the points of infection of curves in area E at 17 or 18 metres in male length and 18 and 19 metres in female length, and which may suggest that the length of whale at sexual maturity in area E is fairly

TABLE 10. MEASUREMENTS IN CM AND DISCRIMINANT VALUES FOR GROUP I IN AREA A

					X_1	X_2	X_3	X_4	X_5		X_6		X_7	Discriminant value
				Measurement No.										
Year	Date Caught		Whale No.	1	5	6	8	10	11	12	13	14	15	$Y_{I\cdot a}$
1952	Aug.	20	135	1728	390	765	380	470	790	770	110	50	90	21.22
	Sept.	10	263	1738	365	740	400	470	730	720	125	35	90	20.47
	〃	14	281	1760	385	780	360	470	780	780	110	40	100	20.31
	Aug.	25	167	1770	400	770	400	480	780	760	130	30	70	19.18
	〃	25	169	1770	340	715	430	510	840	840	120	40	100	26.99*
	July	28	38	1776	365	720	400	450	800	820	140	40	70	21.40
1953	〃	8	338	1720	375	680	415	500	800	830	140	34	105	28.83*
	Sept.	4	571	1755	365	720	370	495	815	815	125	35	80	22.18
	Aug.	27	526	1760	370	725	360	460	875	875	120	40	80	23.55
	June	25	251	1770	380	745	415	510	800	800	140	46	95	24.20
	Sept.	16	637	1770	390	755	370	480	820	770	150	37	80	21.17
	July	26	407	1775	400	785	435	485	770	770	125	41	65	18.64
	Sept.	4	574	1775	350	740	390	475	775	775	125	35	100	22.32
	June	26	257	1780	360	740	410	510	810	865	110	38	110	25.77*
	July	3	304	1780	345	720	399	530	820	820	110	40	95	24.60
Mean	—	—	—	1762	372.0	740.0	395.6	486.3	800.3	800.7	125.3	38.7	88.7	22.73

Measurements in 1952 are cited from *the Scientific Reports of the Whales Research Institute*, No. 9, p. 152.

* Individuals marked have the discriminant values belonging to area E.

smaller than one in the other waters near Japan and the northern Pacific. Because the fin whales in the northern Pacific have the points of infection of curves at 18 metres (a. 59 ft.) or 19 metres (a. 62 ft.), after sexual maturities (Fujino, 1954). The fin whales at South Georgia in the Antarctic have the points of infection of curves soon after sexual maturities at 19.5 metres (a. 64 ft.) in males and 20 metres (a. 66 ft.) in females judging from the figures of external proportions in *Discovery Reports* vol. 1.

It can be said statistically that there are the differences of the general shapes of fin whales between area A and area E in the North Pacific and fin whales have longer heads and shorter tails in area A than in area E. However, it is more desirable to classify whales into two areas through their external measurements. Discussion on this connection are as follows.

TABLE 11. MEASUREMENTS IN CM AND DISCRIMINANT VALUES FOR GROUP I IN AREA E

					X_1	X_2	X_3	X_4	X_5		X_6		X_7	Discriminant value
				Measurement No.										
Year	Date Caught		Whale No.	1	5	6	8	10	11	12	13	14	15	$Y_{1\cdot e}$
1955	Aug.	14	44	1798	380	732	426	487	838	815	137	35	103	27.43
	〃	17	57	1768	357	718	396	502	853	853	137	43	111	27.92
	〃	19	63	1737	352	686	416	500	823	805	119	38	88	26.48
	〃	20	64	1737	340	688	406	518	810	777	114	40	98	26.47
	〃	20	65	1707	370	660	408	505	803	777	131	38	98	28.80
	〃	21	71	1768	352	701	441	518	838	838	139	38	111	29.83
	〃	23	74	1707	337	640	418	487	823	805	114	40	106	30.74
	〃	23	76	1707	340	671	408	487	823	803	114	35	91	26.97
	〃	24	81	1707	370	701	396	469	896	878	134	35	96	28.78
	〃	24	82	1798	340	701	413	533	853	825	142	35	98	27.45
	〃	25	86	1768	375	732	431	487	823	787	137	38	101	26.71
	〃	26	88	1798	355	671	408	507	868	850	139	38	114	31.75
	〃	30	95	1798	365	732	444	543	853	828	126	38	101	27.98
	〃	31	101	1737	355	620	408	533	843	828	131	35	91	31.09
	Sept.	3	107	1707	347	671	406	482	808	808	124	35	83	25.67*
	〃	4	112	1798	352	732	444	549	899	865	139	38	131	32.69
	〃	5	114	1798	347	686	426	518	884	838	152	32	103	30.53
	〃	6	117	1798	360	701	408	518	853	873	124	35	101	28.22
	〃	7	118	1798	360	732	426	487	823	815	162	43	111	27.28
	〃	10	131	1798	373	762	383	505	833	823	167	45	121	26.12
	〃	11	136	1768	373	732	416	495	833	823	182	35	114	28.07
	〃	13	146	1798	370	701	401	487	853	838	152	43	103	28.46
	〃	13	147	1707	350	676	385	492	823	800	164	40	129	30.83
	〃	19	173	1768	378	732	396	487	865	845	109	40	111	28.14
	〃	19	174	1798	368	747	403	505	833	823	116	38	131	28.65
	〃	19	177	1768	345	732	380	497	742	711	159	40	126	24.40
	〃	20	178	1737	357	691	418	502	843	810	157	40	142	33.60
	〃	20	179	1798	388	732	424	502	803	789	144	45	129	29.65
	〃	21	186	1798	355	732	426	490	868	858	152	43	129	30.74
	〃	25	200	1768	355	701	391	540	848	823	139	30	91	26.19
Mean	—	—	—	1765	358.9	703.8	411.7	504.4	838.6	820.4	138.5	38.3	108.7	28.59

* Individuals marked have the discriminant value belonging to area A.
Standard discriminant value: $Y_{I\cdot G}=25.66$.
Individual discriminant value: $Y_I=b_1X_1+b_2X_2+\cdots+b_7X_7$.

The measurements showing the significancy of difierences between area A and E are Nos. 5, 6, 10, 11, 13 and 15 for male fin whale groups I, II, while Nos. 5, 6, 8, 11 and 14 for female fin whale groups III, IV.

Consequently, there are common measurements, Nos. 5, 6, 11, for both sexes, and male whales have 6 common measurements applicable to classification into area A and E, and female whales have 5. As shown in table 8 and table 9 a, b, c, the measurements showing the significant difference are more regular in male than in female, it is seen, however, that there are smaller chances for misclassification in female than in male. The chances for misclassification according to measurement No. 11 are 13% for group III and 17% for group IV respectively, while 27%

TABLE 12. MEASUREMENTS IN CM AND DISCRIMINANT VALUES FOR GROUP III IN AREA A

Year	Date Caught		Whale no.	Measurement No. 1	5 (X_1)	6 (X_2)	8 (X_3)	10 (X_4)	11 (X_5)	12	13 (X_6)	14 (X_7)	15	Discriminant value $Y_{III \cdot a}$
1952	Sept.	16	287	1818	400	755	400	510	820	850	60	47	120	60.62
	〃	10	264	1876	405	760	435	523	825	825	55	42	95	63.56
	Aug.	8	79	1894	410	765	415	510	870	850	60	45	85	66.28
1953	〃	17	477	1810	395	785	420	525	820	835	75	42	125	64.37
	Sept.	4	572	1810	398	740	385	505	800	775	30	38	90	58.39
	〃	5	579	1810	370	705	420	525	835	835	60	40	80	68.00*
	〃	18	646	1835	415	760	415	495	830	830	45	46	85	60.22
	July	28	425	1845	410	780	430	525	825	845	50	43	80	62.02
	〃	2	298	1850	430	790	415	500	800	800	60	52	120	55.18
	〃	19	383	1850	410	800	410	500	800	810	40	46	115	56.32
	〃	8	339	1860	425	770	410	520	850	840	60	38	110	65.11
	June	29	282	1865	410	760	435	515	845	800	45	44	125	63.78
	〃	30	283	1865	380	770	445	540	800	770	60	39	120	64.44
	Sept.	5	577	1865	395	735	410	505	820	800	45	46	85	60.70
	Aug.	25	521	1870	415	820	420	505	835	825	65	40	115	63.75
	July	7	326	1890	405	790	435	520	830	810	30	38	105	62.79
	Sept.	27	689	1895	400	745	435	520	830	845	40	38	100	64.55
Mean	—	—	—	1853	404.3	766.5	419.7	514.3	825.6	820.3	51.8	42.6	103.2	62.36

Measurements in 1952 are cited from the *Scientific Reports of the Whales Research Institute*, No. 9, p. 154.

* Individual marked has the discriminant value belonging to area E.

for group I and 29% for group II respectively. The differences of 1% or 2% for probabilities are out of the question but it is safe to say that female has more reliable measurement No. 11 for classification than male. The measurement No. 6 is remarkably constant for both sexes with 22 to 29% of the chances for misclassification. The measurement No. 5 is applicable to the classification for female with 22 to 25% of chance for misclassification, while it is not for male with 31 to 31%. The measurement No. 15 is applicable to the classification for male with 22 to 25% and contribute remarkably to the calculation for $\sum bidi$ corresponding to

Mahalanobis' D^2, however, it is rather unsatisfactory measurement as it is very difficult to say where the anterior part of the fin begin, although Japanese scientists are unanimous for the determination of those positions. If necessary, it is appropriate to calculate again except No. 15 in the future.

TABLE 13. MEASUREMENTS IN CM AND DISCRIMINANT VALUES FOR GROUP III IN AREA E

					X_1	X_2	X_3	X_4	X_5		X_6	X_7		
				Measurement No.										Discriminant value
Year	Date Caught		Whale No.	1	5	6	8	10	11	12	13	14	15	$Y_{III \cdot e}$
1955	Aug.	5	23	1859	378	777	413	518	838	798	55	32	106	68.49
	〃	6	24	1890	370	671	446	564	884	865	65	38	96	76.06
	〃	6	25	1890	388	739	439	556	868	818	45	32	98	72.04
	〃	7	28	1829	365	732	441	549	884	833	55	35	96	75.66
	〃	9	35	1890	332	701	457	579	914	889	60	32	91	83.31
	〃	16	51	1859	388	701	457	535	838	805	60	38	119	69.56
	〃	17	54	1859	383	762	418	533	884	823	50	38	98	71.18
	〃	23	73	1890	360	732	457	549	884	884	40	40	109	73.60
	〃	26	89	1829	355	732	457	533	865	840	50	38	109	73.31
	〃	26	92	1890	378	793	472	559	899	894	60	45	116	74.05
	〃	30	96	1890	391	762	487	579	899	899	50	40	106	75.11
	〃	30	97	1890	401	732	457	549	884	855	58	40	106	72.34
	〃	31	102	1829	380	718	424	518	884	848	65	32	93	75.22
	Sept.	2	105	1829	393	681	451	535	870	863	60	38	116	72.51
	〃	2	106	1829	370	671	467	533	870	843	60	35	116	75.83
	〃	5	115	1829	378	732	439	518	884	801	58	45	109	71.31
	〃	11	137	1829	434	747	436	518	860	835	81	40	142	68.18*
	〃	11	138	1890	365	767	436	549	884	855	68	43	121	73.36
	〃	16	163	1829	365	657	446	518	838	840	68	32	103	73.55
	〃	22	192	1829	365	671	441	549	884	868	45	45	114	72.21
	〃	24	199	1859	385	732	408	533	868	865	50	30	106	71.77
	〃	27	205	1890	391	732	457	540	843	830	71	43	109	68.89
	Oct.	1	208	1859	365	732	416	530	884	853	71	38	91	74.43
	〃	5	215	1859	340	779	411	549	880	853	68	48	116	71.68
	〃	5	216	1829	365	732	375	502	899	909	55	38	109	72.59
	〃	13	223	1890	396	652	436	502	957	934	83	50	126	79.00
Mean	—	—	—	1859	376.2	724.5	440.2	538.3	878.7	853.8	59.7	38.7	108.5	73.28

* Individual marked has the discriminant value belonging to area A.

Standard discriminant value: $Y_{III \cdot G}=67.82$.

Individual discriminant value: $Y_{III}=b_1X_1+b_2X_2+\cdots+b_7X_7$.

In this paper No. 15 is contained among the linear compounds of 7 measurements. The discussions on the reason why female has less chance for wrong classification than male demand larger samples. Studies on the individual biases of scientists for the measurements are also necessary and these should have been carried out when the method of measurements of various parts of whales were planned. Although some designs of experiments help analysis for these biases, it is a method to study them indirectly through the actual use of the sample

TABLE 14. MEASUREMENTS IN CM AND DISCRIMINANT VALUES FOR GROUP IV IN AREA A

				X_1	X_2	X_3	X_4	X_5		X_6	X_7		
			Measurement No.										Discriminant value
Year	Date Caught	Whale No.	1	5	6	8	10	11	12	13	14	15	$Y_{IV \cdot a}$
1952	Sept. 14	274	1934	450	820	410	500	830	830	50	42	110	16.03
	〃 9	257	1934	420	800	420	510	810	800	60	50	70	16.10
	July 31	49	1940	400	820	420	550	840	810	60	50	70	18.88
	Sept. 14	282	1940	410	860	430	520	870	870	60	45	100	22.08
	〃 15	286	1950	415	810	430	500	900	880	80	45	100	24.15
	July 27	34	1960	430	840	460	520	820	840	50	55	130	16.22
1953	〃 11	361	1910	410	810	400	500	820	820	40	49	110	15.37
	〃 20	388	1915	415	805	435	480	850	830	50	40	90	22.18
	Aug. 28	536	1915	420	815	430	545	875	865	60	46	120	20.76
	June 27	266	1920	415	780	445	570	850	850	50	40	60	21.99
	July 12	368	1920	435	785	430	520	890	880	50	38	150	22.26
	Aug. 3	454	1920	430	875	410	535	870	860	55	45	130	18.78
	〃 31	568	1930	430	800	410	515	855	835	50	38	100	19.89
	Sept. 25	672	1930	395	785	445	535	850	840	55	38	90	24.88*
	〃 25	671	1935	430	850	415	555	885	865	55	50	95	17.92
	〃 5	585	1940	460	820	445	535	875	865	70	38	90	21.67
	July 5	311	1950	400	745	420	515	880	850	75	43	120	23.78
	Sept. 27	692	1950	410	795	390	565	880	860	45	48	85	17.47
	June 28	269	1955	425	750	410	520	885	870	60	41	110	21.04
	Sept. 8	603	1965	475	850	435	540	865	855	55	44	100	16.62
	Aug. 28	530	1965	430	745	410	525	880	880	55	50	110	17.18
	Sept. 15	632	1965	455	745	530	590	850	800	50	57	100	18.44
	July 6	315	1970	430	830	440	550	920	920	40	44	115	22.13
	Sept. 13	624	1970	420	805	460	565	895	870	45	44	90	23.17
	July 8	337	1980	430	810	420	550	910	895	50	40	100	22.16
	Aug. 3	455	1985	400	815	440	530	865	915	60	48	100	22.09
	〃 29	539	1985	405	815	370	525	885	885	65	45	115	19.36
	Sept. 25	655	1985	430	885	450	580	890	880	45	46	100	21.05
	〃 15	634	1995	415	845	375	535	870	865	45	43	100	17.69
Mean	— —	—	1949	423.8	810.7	427.1	533.8	867.8	858.1	54.7	44.9	102.1	20.05

Measurements in 1952 are cited from *the Scientific Reports of the Whales Research Institute*, No. 9, p. 154.

* Individual marked has the discriminant value belonging to area E.

linear discriminant functions already set up. The sparse samples in different years help these studies to some extent in tables 16 to 23.

As tabulated in tables 16, 18, 20, and 22, the discriminant values of sparse samples for each group in area A in 1954, 1955 and 1956 do not exceed the standard discriminant values Y_G, and most of the discriminant values of samples for each group in area E in 1956 exceed Y_G as shown in tables 17, 19, 21 and 23.

It may suggest that the linear discriminant functions already set up for each group are considerably effective. However the discriminant values of many individuals in area B exceed the standard discriminant values Y_G for each group.

TABLE 15. MEASUREMENTS IN CM AND DISCRIMINANT VALUES FOR GROUP IV IN AREA E

Year	Date Caught		Whale No.	Measurement No. 1	X_1 5	X_2 6	X_3 8	X_4 10	X_5 11	12	X_6 13	X_7 14	15	Discriminant value $Y_{IV\cdot e}$
1955	Aug.	8	31	1920	378	732	441	518	884	800	73	35	91	29.49
	〃	11	38	1920	396	777	482	549	929	873	71	43	96	29.97
	〃	23	75	1951	418	808	457	579	914	873	48	43	116	24.40*
	〃	15	46	1951	416	779	457	533	899	863	58	40	129	25.68
	〃	21	67	1981	406	793	477	579	919	825	45	40	111	27.63
	〃	30	98	1981	408	810	469	561	904	894	53	43	116	25.99
	Sept.	1	104	1920	380	747	482	596	980	960	58	35	88	34.90
	〃	8	128	1920	396	762	487	610	945	926	53	32	91	32.92
	〃	14	151	1920	396	767	472	512	957	941	65	43	152	30.52
	〃	17	167	1951	408	774	462	496	914	914	71	43	114	27.46
	〃	17	169	1951	365	681	441	564	955	934	73	40	114	31.62
	〃	20	181	1981	413	823	416	523	894	823	88	35	137	26.66
	〃	22	189	1920	408	793	396	528	868	838	60	35	114	22.80
	〃	24	196	1920	418	793	457	579	960	926	45	32	131	29.77
	Oct.	17	227	1920	375	701	441	549	914	914	103	38	121	31.52
Mean	—	—	—	1940	398.7	769.3	455.8	551.5	922.4	886.9	64.3	38.5	114.7	28.76

* Individual marked has the discriminant value belonging to area A.
Standard discriminant value: $Y_{IV\cdot G}=24.40$.
Individual discriminant value: $Y_{IV}=b_1X_1+b_2X_2+\cdots+b_7X_7$.

Namely, judging from individual discriminant values, there are 3 exceptions which do not belong to area A, among 6 males for group I in area B. Exceptions are 4 among 15 males for group II, 4 among 9 females for group III and 7 among 9 females for group IV in area B. When it is considered further that female has less chance for misclassification than male, the shapes of fin whales are supposed to be different between area A and B. However, if there are no remarkable differences of shapes of fin whales between area A and B, it is possible to say that the sample used for the calculation do not represent fin whales in the northern Pacific and the calculation must be repeated. Unfortunately, there are too sparse data to study this connection in this paper. The sample linear discriminant functions are set in this

TABLE 16. MEASUREMENTS IN CM AND DISCRIMINANT VALUES FOR GROUP I IN THE NORTHERN PACIFIC

Area	Year	Date Caught		Factory ship	Whale No.	1	5 (X_1)	6 (X_2)	8 (X_3)	10 (X_4)	11 (X_5)	12	13 (X_6)	14	15 (X_7)	Discriminant value $Y_{I \cdot ab}$
						Measurement No.										
A	1956	Aug.	18	Ky	1247	1780	350	700	405	490	810	790	120	42	85	24.44
B	1954	Sept.	3	B	848	1792	345	695	430	520	860	860	135	45	90	27.76*
		〃	16	〃	985	1740	370	700	440	530	840	860	100	45	90	27.98*
		July	20	K	751	1740	340	720	420	495	780	770	125	45	100	24.37
	1955	〃	29	Ky	1072	1790	370	750	420	540	820	800	130	50	100	25.11
		〃	30	〃	1101	1760	360	730	400	480	810	800	120	42	80	22.29
	1956	Aug.	1	〃	1073	1780	335	705	395	525	840	825	120	38	95	25.62

* Individuals marked have the discriminant values belonging to area E.

TABLE 17. MEASUREMENTS IN CM AND DISCRIMINANT VALUES FOR GROUP I IN AREA E

Year	Date Caught		Whaling Co.	Whale No.	1	5 (X_1)	6 (X_2)	8 (X_3)	10 (X_4)	11 (X_5)	12	13 (X_6)	14	15 (X_7)	Discriminant value $Y_{I \cdot e}$
					Measurements No.										
1956	July	30	T	33	1798	390	738	380	515	830	—	140	34	89	23.97*
	Aug.	4	〃	44	1737	342	717	375	485	851	825	134	42	100	25.33*
	〃	7	〃	52	1798	405	767	397	460	789	760	128	42	119	25.51*
	〃	8	〃	55	1737	330	664	382	475	851	825	163	33	118	30.29
	〃	9	〃	59	1737	357	674	382	506	850	821	140	43	114	30.16
	〃	9	〃	60	1707	350	649	370	515	830	795	147	34	119	30.90
	〃	10	〃	63	1768	348	749	410	495	861	840	142	38	108	26.28
	〃	11	〃	69	1798	352	742	410	527	866	842	139	46	124	28.98
	〃	13	〃	73	1798	355	733	400	490	810	—	157	46	142	29.47
	〃	15	〃	85	1798	355	737	406	506	845	822	151	34	119	27.87
	〃	15	〃	86	1798	380	737	380	524	910	870	194	43	116	29.62
	〃	19	〃	94	1737	350	677	388	495	843	820	141	34	108	29.00
	〃	21	〃	98	1737	350	627	390	500	865	840	154	33	100	31.63
	〃	22	〃	101	1737	337	647	358	496	830	848	154	42	120	30.24
	〃	25	〃	105	1707	338	670	400	475	819	800	170	37	103	28.00
	〃	28	〃	114	1737	360	687	390	505	825	820	181	39	105	27.95
	〃	29	〃	117	1798	368	667	351	483	884	852	153	36	96	28.71
	〃	11	N	34	1715	365	720	390	490	800	775	130	35	115	26.58
	〃	11	〃	36	1710	345	690	410	520	860	795	140	39	105	29.15
	Sept.	1	〃	59	1710	360	660	410	495	795	725	115	50	120	30.89
	〃	5	〃	62	1720	345	640	430	500	900	875	131	31	100	33.25

* Individuals marked have the discriminant values belonging to area A.

Standard discriminant value: $Y_{I\,G}=25.66$.

Individual discriminant value: $Y_I=b_1X_1+b_2X_2+\cdots+b_7X_7$.

B: Baikal maru, Ky: Kyokuyo maru } Kyokuyo Hogei Co. K: Kinjo maru, T: Land-station } Taiyo Gyogyo Co.

N: Land-station, Nippon Suisan Co.

TABLE 18. MEASUREMENTS IN CM AND DISCRIMINANT VALUES FOR GROUB II IN THE NORTHERN PACIFIC

							X_1	X_2	X_3	X_4	X_5		X_6		X_7	
				Factory ship		Measurement No.										Discriminant value
Area	Year	Date Caught			Whale No.	1	5	6	8	10	11	12	13	14	15	$Y_{II\cdot ab}$
A	1954	June	2	B	59	1898	400	770	440	525	850	880	125	50	70	12.62
		〃	3	〃	61	1890	440	840	420	520	815	815	130	49	70	6.56
	1956	Aug.	19	Ky	1272	1855	385	775	390	490	820	800	125	38	90	11.87
		〃	21	〃	1320	1835	360	745	415	515	860	835	120	41	85	15.45
B	1954	July	1	K	473	1850	370	780	450	510	840	840	120	45	75	11.30
		Aug.	1	〃	895	1840	390	750	430	520	840	830	130	45	80	15.10
		〃	2	〃	908	1860	330	750	430	550	870	860	150	50	80	18.44*
		〃	3	〃	933	1840	350	750	435	535	865	850	130	42	85	16.99
		Sept.	9	B	901	1848	370	750	410	500	810	830	130	43	100	15.70
		〃	19	〃	1030	1800	380	780	410	500	830	830	140	37	90	13.49
		〃	19	〃	1042	1860	380	790	420	540	850	870	130	41	100	15.68
		Aug.	30	〃	806	1861	360	750	390	500	810	790	115	42	110	15.64
		〃	30	〃	807	1865	360	710	395	500	810	780	125	38	100	18.08*
		Sept.	3	〃	840	1861	360	730	440	540	880	900	130	41	80	18.52*
		〃	5	〃	865	1800	380	750	400	490	690	720	120	48	80	8.73
	1955	July	29	Ky	1074	1876	400	820	440	530	830	820	130	41	100	12.81
		〃	31	〃	1115	1820	365	765	400	510	830	810	130	41	110	16.70
	1956	〃	11	〃	511	1850	360	730	415	510	815	790	140	48	100	18.48
		〃	13	〃	572	1860	390	790	415	530	805	770	115	41	100	12.95

* Individuals marked have the discriminant values belonging to area E.

TABLE 19. MEASUREMENTS IN CM AND DISCRIMINANT VALUES FOR GROUP II IN AREA E

						X_1	X_2	X_3	X_4	X_5		X_6		X_7	
			Whaling Co.		Measurement No.										Discriminan value
Year	Date Caught			Whale No.	1	5	6	8	10	11	12	13	14	15	$Y_{II\cdot e}$
1956	Aug.	4	T	41	1829	375	722	455	525	860	830	158	41	109	23.85
	〃	5	〃	42	1829	365	677	410	510	914	890	155	42	112	27.56
	〃	7	〃	53	1829	365	737	430	510	868	835	147	41	122	22.87
	〃	13	〃	75	1859	375	742	410	515	879	850	156	43	117	22.80
	〃	15	〃	84	1829	376	737	373	522	838	802	134	53	134	22.53
	〃	25	T	104	1829	340	673	448	530	870	890	142	36	118	27.76
	〃	10	N	32	1860	405	760	420	510	865	880	130	39	120	19.62
	〃	25	〃	53	1800	400	750	430	500	810	790	115	38	115	16.86*

* Individuals marked have the discriminant values belonging to area A.
Standard discriminant value: $Y_{II\cdot G}=18.50$.
Individual discriminant value: $Y_{II}=b_1X_1+b_2X_2+\cdots+b_7X_7$.

TABLE 20. MEASUREMENTS IN CM AND DISCRIMINANT VALUES FOR GROUP III IN THE NORTHERN PACIFIC

							X_1	X_1	X_3	X_4	X_5		X_6	X_7		Discri-minant value
						Measurement No.										
Area	Year	Date Caught		Fac-tory ship	Whale No.	1	5	6	8	10	11	12	13	14	15	$Y_{III \cdot ab}$
A	1954	May	31	B	34	1860	422	805	410	510	810	810	40	40	70	58.38
B		Sept.	2	〃	838	1825	350	740	460	580	860	820	50	40	85	72.88*
		〃	13	〃	951	1850	390	790	430	530	840	840	60	31	90	69.31*
		〃	21	〃	1057	1890	410	820	430	500	870	890	70	50	100	65.50
		June	8	K	145	1860	330	720	460	500	830	830	30	40	85	69.16*
		July	15	〃	672	1800	350	730	450	500	790	772	45	40	85	64.35
		〃	20	〃	754	1815	345	720	405	525	835	835	50	30	90	71.01*
	1955	〃	29	Ky	1073	1845	395	765	450	540	790	770	40	42	100	60.11
	1956	Aug.	3	〃	1136	1830	365	730	420	515	830	790	55	41	90	66.71
		〃	4	〃	1528	1845	390	765	430	480	810	790	50	47	85	60.48

* Individuals marked have the discriminant values belonging to area E.

TABLE 21. MEASUREMENTS IN CM AND DISCRIMINANT VALUES FOR GROUP III IN AREA E

						X_1	X_2	X_3	X_4	X_5		X_6	X_7		Discri-minant value
					Measurement No.										
Year	Date Caught		Whal-ing Co.	Whale No.	1	5	6	8	10	11	12	13	14	15	$Y_{III \cdot e}$
1956	Aug.	6	T	47	1829	390	737	400	530	835	—	58	38	106	65.79*
	〃	7	〃	51	1859	360	718	430	530	904	885	68	40	133	76.80
	〃	11	〃	72	1829	370	775	415	540	820	795	65	38	111	66.44*
	〃	14	〃	80	1829	376	737	420	534	900	865	53	36	127	74.63
	〃	19	〃	92	1890	368	679	430	540	917	870	49	36	100	77.82
	〃	21	〃	97	1890	380	729	430	530	909	880	79	43	117	75.83
	〃	28	〃	112	1890	390	789	430	550	900	880	66	45	105	71.89
	〃	29	〃	116	1859	390	758	394	530	887	870	77	37	130	72.50
	〃	4	N	19	1800	360	760	380	450	760	730	65	27	75	62.22*
	〃	4	〃	21	1820	384	700	440	510	850	820	66	38	85	70.61
	〃	6	〃	24	1850	380	760	440	540	850	820	54	35	105	70.22
	〃	10	〃	33	1880	400	720	485	550	880	855	55	35	110	74.74

* Individuals marked have the discriminant values belonging to area A.
Standard discriminant value: $Y_{III \cdot G}=67.82$.
Individual discriminant value: $Y_{III}=b_1X_1+b_2X_2+\cdots+b_7X_7$.

paper at any rate but those need other coefficients revised according to the accumulation of data in the future.

The measurements in the present problem do not show the height and width of whales but various parts of whales about parallel to the line from tip of snout to notch of flukes. It is rather difficult to measure accurate height and width for whale but it is possible to represent them in skull measurements, which will be treated in the

TABLE 22. MEASUREMENTS IN CM AND DISCRIMINANT VALUES FOR GROUP IV IN THE NORTHERN PACIFIC

							X_1	X_2	X_3	X_4	X_5		X_6	X_7		
						Measurement No.										Discriminant value
Area	Year	Date Caught		Factory ship	Whale No.	1	5	6	8	10	11	12	13	14	15	$Y_{IV\cdot ab}$
A	1956	Aug.	14	Ky	1211	1945	415	815	445	565	870	850	30	49	100	19.05
		〃	22	〃	1348	1995	415	815	460	555	910	880	60	52	100	22.72
		〃	24	〃	1393	1985	415	855	450	550	870	870	60	40	90	24.28
B	1954	Sept.	8	B	890	1980	405	830	450	550	900	880	50	44	90	24.51*
		〃	20	〃	1054	1950	400	810	440	520	860	840	60	46	120	22.56
		〃	22	〃	1073	1930	380	790	500	610	940	940	70	49	100	32.54*
		Aug.	2	K	909	1940	360	770	455	570	900	910	50	45	95	27.82*
		〃	3	〃	934	1910	380	770	450	580	900	870	90	51	100	26.18
	1955	July	29	Ky	1071	1970	410	820	460	580	910	900	50	52	110	22.36
	1956	〃	6	〃	366	1920	370	810	450	565	910	890	45	32	90	31.49*
		〃	30	〃	1018	1960	380	820	460	560	900	900	80	41	100	29.81*
		Aug.	1	〃	1075	1970	415	835	440	535	895	880	55	39	95	24.84*

* Individuals marked have the discriminant values belonging to area E.

TABLE 23. MEASUREMENTS IN CM AND DISCRIMINANT VALUES FOR GROUP IV IN AREA E

						X_1	X_2	X_3	X_4	X_5		X_6	X_7		
					Measurement No.										Discriminant value
Year	Date Caught		Whaling Co.	Whale No.	1	5	6	8	10	11	12	13	14	15	$Y_{IV\cdot e}$
1956	Aug.	6	T	48	1951	430	795	410	540	860	—	74	47	135	18.42*
	〃	19	〃	93	1951	383	760	453	576	935	918	44	36	105	29.81
	〃	26	〃	107	1981	385	750	413	566	925	925	85	38	125	28.40
	〃	27	〃	111	1920	415	796	407	530	880	907	80	47	120	20.81*
	Sept.	5	N	63	1920	400	770	450	580	910	880	65	35	115	28.68

* Individual marked have the discriminant values belonging to area A.
Standard discriminant value: $Y_{IV\cdot G}=24.40$.
Individual discriminant value: $Y_{IV}=b_1X_1+b_2X_2+\cdots+b_7X_7$.

following papers. Finally, it is more desirable to study the ages at puberty and oestrus cycles of whales in the discussion on their races. Even racial studies on whales demand the determinate evidences available on ages and oestrus cycles.

SUMMARY

The linear discriminant functions (L. D. F.) by R. A. Fisher were applied to consider the differences of general shapes of fin whales between two areas in the North Pacific, and representative 7 measurements in males and females were replaced by linear compounds. The one area

was A, the west side waters of Aleutian Islands and the other area was E, the west side waters of Kyushu which was the southern island in Japan.

Assuming the normality of 7 variates and the homogeneity of the variance-covariance matrices of these two 7 variates, this L. D. F. is known to be the most efficient statistical expression for classification. The validity of these assumptions was statistically checked and no departure from these assumptions was found in this study. The chance of misclassification by using these L. D. F. are 6 to 11% for males and 5 to 7% for females.

With regards to each single variate, measurement No. 5 (Tip of snout to centre of eye), No. 6 (Tip of snout to tip of flipper), No. 10 (Notch of flukes to centre of anus), No. 11 (Notch of flukes to centre of umbilicus), No. 13 (Centre of anus to centre of reproductive aperture), No. 15 (Dorsal fin, length of base) show significant differences between two area for males, and Nos. 5, 6, 8 (Notch of flukes to posterior emargination of dorsal fin), 11, 14 (Dorsal fin, vertical height) for females. However, the chance of misclassification increase, when if we use only one variate.

It is safe statistically to say that there are the different shapes of fin whales between two area in the North Pacific, and fin whales have longer heads and shorter tails in area A than in area E. The sample sizes of area A and area E were 15 and 30 for group I, 30 and 20 for group II, 17 and 26 for group III, 29 and 15 for group IV respectively in this investigation.

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APPENDIX

External measurements of fin whales
The upper figure shows actual length in centimetre
The lower figure shows percentage length to total length
The lower figure in measurement No. 1 is total length in feet

Measurement

No. 1 Total length
3 Tip of snout to blowhole
5 Tip of snout to centre of eye
6 Tip of snout to tip of flipper
7 Eye to ear, centres
8 Notch of flukes to posterior emargination of dorsal fin
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, centres
14 Dorsal fin, vertical height
15 Dorsal fin, length of base
17 Flipper, tip to anterior end of lower border
19 Flipper, greatest width
21 Skull, greatest width
22 Skull length, condyle to tip of premaxilla
24 Length of lower jaw
25 Tip of premaxilla to postglenoid process of squamosal
26 Distance between both postglenoid process of squamosal
27 Length of rostrum
28 Width of rostrum at the base

TABLE 24. THE WEST SIDE WATERS OF ALEUTIAN ISLANDS IN THE NORTHERN PACIFIC, MALE, 1953

Serial no.	Date caught	1	3	5	6	7	8	10	11	12	13	14	15	17	19	21	22	24	25	26	27	28
509	Aug. 24	1690 55	315 **18.6**	335 **19.8**	700 **41.4**	85 **5.0**	430 **25.4**	475 **28.1**	770 **45.5**	760 **44.9**	115 **6.8**	40 **2.4**	115 **6.8**	235 **13.9**	55 **3.3**	190 **11.2**	440 **26.0**	445 **26.3**	430 **25.4**	170 **10.0**	310 **18.3**	140 **8.3**
464	Aug. 8	1695 56	305 **18.0**	350 **20.7**	695 **41.0**	70 **4.1**	400 **23.6**	450 **26.6**	800 **47.2**	790 **46.6**	120 **7.1**	40 **2.4**	100 **5.9**	210 **12.4**	55 **3.2**	195 **11.5**	430 **25.4**	430 **25.4**	435 **25.7**	175 **10.3**	325 **19.2**	125 **7.4**
338	July 8	1720 56	340 **19.8**	375 **21.8**	680 **39.5**	75 **4.4**	415 **24.1**	500 **29.1**	800 **46.5**	830 **48.2**	140 **8.1**	34 **2.0**	105 **6.1**	195 **11.3**	50 **2.9**	185 **10.7**	425 **24.7**	425 **24.7**	425 **24.7**	175 **10.2**	315 **18.3**	125 **7.3**
571	Sept. 4	1755 58	320 **18.2**	365 **20.8**	720 **41.0**	80 **4.6**	370 **21.1**	495 **28.2**	815 **46.5**	815 **46.5**	125 **7.1**	35 **2.0**	80 **4.7**	210 **12.0**	50 **2.9**	195 **11.1**	455 **25.9**	440 **25.1**	455 **25.9**	175 **10.0**	320 **18.2**	120 **6.8**
526	Aug. 27	1760 58	350 **19.9**	370 **21.0**	725 **41.2**	85 **4.8**	360 **20.4**	460 **26.1**	875 **49.7**	875 **49.7**	120 **6.8**	40 **2.3**	80 **4.5**	200 **11.4**	50 **2.8**	185 **10.5**	455 **25.8**	450 **25.6**	450 **25.6**	170 **9.7**	310 **17.6**	125 **7.1**
251	June 25	1770 58	330 **18.6**	380 **21.5**	745 **42.1**	90 **5.1**	415 **23.4**	510 **28.8**	800 **45.2**	800 **45.2**	140 **7.9**	46 **2.6**	95 **5.4**	215 **12.1**	55 **3.1**	215 **12.1**	455 **25.7**	465 **26.3**	455 **25.7**	175 **9.9**	310 **17.5**	148 **8.4**
353	July 10	1770 58	395 **22.3**	430 **24.3**	790 **44.6**	80 **4.5**	405 **22.9**	450 **25.4**	730 **41.2**	720 **40.7**	60 **3.4**	36 **2.0**	110 **6.2**	230 **13.0**	60 **3.4**	215 **12.1**	465 **26.3**	510 **28.8**	495 **28.0**	190 **10.7**	365 **20.6**	130 **7.3**
637	Sept. 16	1770 58	345 **19.5**	390 **22.0**	755 **42.7**	80 **4.5**	370 **20.9**	480 **27.1**	820 **46.3**	770 **43.5**	150 **8.5**	37 **2.1**	80 **4.5**	210 **11.9**	53 **3.0**	210 **11.9**	470 **26.6**	460 **26.0**	470 **26.6**	165 **9.3**	330 **18.6**	130 **7.3**
407	July 26	1775 58	365 **20.5**	400 **22.5**	785 **44.2**	95 **5.3**	435 **24.5**	485 **27.3**	770 **43.4**	770 **43.4**	125 **7.0**	41 **2.3**	65 **3.7**	240 **13.5**	51 **2.9**	200 **11.3**	485 **27.3**	485 **27.3**	485 **27.3**	180 **10.1**	320 **18.0**	130 **7.3**
574	Sept. 4	1775 58	325 **18.3**	350 **19.7**	740 **41.7**	75 **4.2**	390 **2.20**	475 **26.7**	775 **43.6**	775 **43.6**	125 **7.0**	35 **2.0**	100 **5.6**	205 **11.5**	51 **2.9**	175 **9.9**	420 **23.6**	425 **23.9**	425 **23.9**	165 **9.3**	290 **16.3**	110 **6.2**
257	June 26	1780 58	335 **18.8**	360 **20.2**	740 **41.6**	85 **4.8**	410 **23.0**	510 **28.7**	810 **45.5**	865 **48.6**	110 **6.2**	38 **2.1**	100 **5.6**	220 **12.4**	55 **3.1**	220 **12.4**	490 **27.5**	460 **25.9**	490 **27.5**	180 **10.1**	330 **18.5**	140 **7.9**
304	July 3	1780 58	310 **17.4**	345 **19.4**	720 **40.5**	90 **5.1**	399 **22.4**	530 **29.8**	820 **46.1**	820 **46.1**	110 **6.2**	40 **2.2**	95 **5.3**	210 **11.8**	50 **2.8**	190 **10.7**	490 **27.5**	435 **24.4**	490 **27.5**	170 **9.6**	300 **16.9**	130 **7.3**
426	July 28	1790 59	350 **19.6**	385 **21.5**	720 **40.2**	85 **4.8**	400 **22.4**	510 **28.5**	810 **45.3**	790 **44.2**	50 **3.8**	41 **2.3**	90 **5.0**	220 **12.3**	55 **3.1**	200 **11.2**	465 **26.0**	465 **26.0**	470 **26.3**	170 **9.5**	330 **18.4**	125 **7.0**
344	July 9	1800 59	340 **18.9**	390 **21.7**	770 **42.8**	85 **4.7**	400 **22.2**	500 **27.8**	830 **46.1**	830 **46.1**	130 **7.2**	46 **2.6**	90 **5.0**	215 **12.0**	55 **3.1**	210 **11.7**	445 **24.7**	460 **25.6**	450 **25.0**	185 **10.3**	320 **17.8**	140 **7.8**
576	Sept. 5	1800 59	350 **19.5**	380 **21.1**	700 **38.9**	80 **4.4**	440 **24.5**	525 **29.2**	800 **44.5**	770 **42.8**	105 **5.8**	36 **2.0**	90 **5.0**	215 **12.0**	53 **2.9**	205 **11.4**	460 **25.6**	455 **25.3**	465 **25.9**	180 **10.0**	335 **18.6**	130 **7.2**
466	Aug. 9	1815 60	385 **21.2**	410 **22.6**	755 **41.6**	95 **5.2**	405 **22.3**	490 **27.0**	820 **45.2**	820 **45.2**	130 **7.2**	55 **3.0**	90 **5.0**	215 **11.8**	55 **3.0**	210 **11.6**	510 **28.1**	510 **28.1**	505 **27.8**	195 **10.7**	355 **19.6**	135 **7.4**

629	Sept. 15	1815 60	350 **19.3**	385 **21.2**	680 **37.5**	75 **4.1**	420 **23.1**	500 **27.6**	825 **45.5**	825 **45.5**	125 **6.9**	33 **1.8**	75 **4.1**	215 **11.8**	54 **3.0**	215 **11.8**	450 **24.8**	455 **25.1**	460 **25.3**	175 **9.6**	320 **17.6**	125 **6.9**
584	Sept. 5	1820 60	405 **22.2**	430 **23.6**	755 **41.4**	85 **4.7**	445 **24.4**	505 **27.7**	805 **44.2**	775 **42.5**	115 **6.3**	39 **2.1**	70 **3.8**	215 **11.8**	55 **3.0**	210 **11.5**	460 **25.3**	465 **25.5**	470 **25.8**	180 **9.9**	345 **18.9**	130 **7.1**
690	Sept. 27	1820 60	355 **19.5**	395 **21.7**	770 **42.3**	90 **4.9**	410 **22.5**	480 **26.4**	810 **44.5**	790 **43.4**	145 **8.0**	47 **2.6**	90 **4.9**	215 **11.8**	56 **3.1**	235 **12.9**	480 **26.4**	480 **26.4**	475 **26.1**	175 **9.6**	335 **18.4**	125 **6.9**
380	July 15	1830 60	365 **19.9**	400 **21.8**	805 **44.0**	85 **4.6**	390 **21.3**	520 **28.4**	860 **47.0**	880 **48.0**	90 **4.9**	48 **2.6**	110 **6.0**	225 **12.3**	50 **2.7**	215 **11.7**	480 **26.2**	480 **26.2**	485 **26.5**	180 **9.8**	335 **18.3**	135 **7.4**
467	Aug. 9	1830 60	385 **21.0**	420 **22.9**	780 **42.6**	95 **5.2**	405 **22.1**	480 **26.2**	805 **44.0**	795 **43.4**	135 **7.4**	43 **2.3**	95 **5.2**	215 **11.7**	60 **3.3**	215 **11.7**	485 **26.5**	485 **26.5**	495 **27.0**	195 **10.6**	365 **19.9**	135 **7.4**
644	Sept. 18	1830 60	375 **20.5**	415 **22.7**	780 **42.6**	85 **4.6**	415 **22.7**	490 **26.8**	810 **44.2**	810 **44.2**	130 **7.1**	40 **2.2**	95 **5.2**	210 **11.5**	54 **2.9**	215 **11.7**	490 **26.8**	495 **27.0**	500 **27.3**	175 **9.6**	365 **19.9**	135 **7.4**
3	May 21	1830 60	385 **21.0**	370 **20.2**	770 **42.0**	85 **4.6**	440 **24.0**	570 **31.1**	820 **44.8**	800 **43.7**	80 **4.4**	40 **2.2**	70 **3.8**	250 **13.7**	60 **3.3**	220 **12.0**	490 **26.8**	430 **23.5**	— —	— —	— —	— —
638	Sept. 16	1835 60	355 **19.3**	385 **21.0**	755 **41.1**	85 **4.6**	415 **22.6**	515 **28.1**	825 **45.0**	820 **44.7**	130 **7.1**	44 **2.4**	100 **5.5**	215 **11.7**	58 **3.2**	200 **10.9**	470 **25.6**	455 **24.8**	470 **25.6**	170 **9.3**	340 **18.5**	120 **6.5**
415	July 27	1840 60	365 **19.8**	400 **21.7**	785 **42.6**	85 **4.6**	405 **22.0**	515 **28.0**	855 **46.2**	845 **45.9**	115 **6.2**	35 **1.9**	65 **3.5**	235 **12.8**	65 **3.5**	205 **11.1**	485 **26.3**	485 **26.3**	475 **25.8**	185 **10.0**	340 **18.3**	120 **6.5**
451	Aug. 3	1840 60	385 **20.9**	430 **23.3**	805 **43.7**	90 **4.9**	405 **22.0**	485 **26.3**	810 **44.0**	805 **43.7**	110 **6.0**	48 **2.6**	85 **4.6**	205 **11.1**	60 **3.3**	210 **11.4**	520 **28.2**	505 **27.4**	515 **28.0**	190 **10.3**	365 **19.8**	130 **7.1**
567	Aug. 31	1840 60	370 **20.1**	405 **22.0**	760 **41.3**	90 **4.9**	400 **21.7**	490 **26.6**	790 **42.9**	790 **42.9**	120 **6.5**	40 **2.2**	110 **6.0**	220 **11.9**	55 **3.0**	210 **11.4**	490 **26.6**	500 **27.2**	490 **26.6**	195 **10.6**	345 **18.3**	140 **7.6**
532	Aug. 28	1845 61	360 **19.5**	405 **22.0**	725 **39.3**	95 **5.1**	420 **22.8**	500 **27.1**	810 **43.9**	810 **43.9**	125 **6.8**	— —	100 **5.4**	215 **11.7**	55 **3.0**	205 **11.1**	485 **26.3**	465 **25.2**	495 **26.8**	175 **9.5**	350 **19.0**	130 **7.0**
533	Aug. 28	1845 61	375 **20.3**	405 **22.0**	785 **42.5**	95 **5.1**	390 **21.1**	490 **26.6**	800 **43.4**	795 **43.1**	115 **6.2**	30 **1.6**	85 **4.6**	215 **11.7**	55 **3.0**	220 **11.9**	480 **26.0**	485 **26.3**	480 **26.0**	185 **10.0**	365 **19.8**	135 **7.3**
134	June 10	1850 61	390 **21.1**	375 **20.3**	800 **43.3**	85 **4.6**	400 **21.6**	540 **29.2**	830 **44.9**	— —	80 **4.3**	45 **2.4**	90 **4.9**	240 **13.0**	60 **3.2**	— —	— —	— —	— —	— —	— —	— —
272	June 29	1860 61	375 **20.2**	420 **22.6**	710 **38.2**	95 **5.1**	430 **23.1**	550 **29.6**	850 **45.7**	850 **45.7**	40 **2.2**	35 **1.9**	150 **8.1**	225 **12.1**	55 **3.0**	230 **12.4**	510 **27.4**	525 **28.2**	510 **27.4**	195 **10.5**	340 **18.3**	150 **8.1**
525	Aug. 27	1860 61	355 **19.1**	375 **20.2**	795 **42.8**	80 **4.3**	390 **21.0**	515 **27.7**	845 **45.5**	845 **45.5**	140 **7.5**	45 **2.4**	95 **5.1**	215 **11.6**	55 **3.0**	215 **11.6**	455 **24.5**	450 **24.2**	455 **24.5**	185 **10.6**	310 **16.7**	140 **7.5**
609	Sept. 9	1875 62	385 **20.5**	425 **22.7**	770 **41.0**	85 **4.5**	430 **22.9**	515 **27.4**	810 **43.2**	790 **42.1**	115 **6.1**	43 **2.3**	90 **4.8**	245 **13.1**	58 **3.1**	230 **12.3**	500 **26.7**	505 **26.9**	505 **26.9**	180 **9.6**	365 **19.5**	145 **7.7**
354	July 10	1885 62	390 **20.7**	410 **21.8**	785 **41.7**	95 **5.0**	420 **22.3**	540 **28.7**	830 **44.1**	825 **43.8**	60 **3.2**	30 **1.6**	120 **6.4**	225 **11.9**	55 **2.9**	210 **11.2**	495 **26.3**	490 **26.0**	495 **26.3**	190 **10.1**	345 **18.3**	135 **7.2**

TABLE 24. THE WEST SIDE WATERS OF ALEUTIAN ISLANDS IN THE NORTHERN PACIFIC, MALE, 1953 (cont.)

Serial no.	Date caught	1	3	5	6	7	8	10	11	12	13	14	15	17	19	21	22	24	25	26	27	28
640	Sept. 16	1885 62	360 19.1	385 20.4	755 40.1	105 5.6	440 23.4	495 26.3	865 45.9	865 45.9	140 7.4	— —	110 5.8	225 11.9	57 3.0	200 10.6	470 25.0	440 23.4	480 25.5	185 9.8	345 18.3	130 6.9
259	June 27	1890 62	370 19.6	400 21.2	805 42.6	85 4.5	415 22.0	520 27.5	870 46.0	830 43.9	120 6.3	23 1.2	95 5.0	240 12.7	60 3.2	210 11.1	475 25.1	480 25.4	470 24.9	185 9.8	340 18.0	140 7.4
670	Sept. 25	1890 62	360 19.0	395 20.9	760 40.2	90 4.8	430 22.7	505 26.7	825 43.6	810 42.8	135 7.1	36 1.9	90 4.8	230 12.2	53 2.8	220 11.6	490 25.9	475 25.1	490 25.9	185 9.8	340 18.0	135 7.1
5	May 21	1890 62	350 18.5	400 21.2	— —	— —	490 25.9	550 29.1	690 36.5	810 42.8	— —	45 2.4	70 3.7	210 11.1	60 3.2	220 11.6	460 24.3	460 24.3	— —	— —	— —	— —
318	July 6	1900 62	370 19.5	405 21.3	740 38.9	85 4.5	435 22.9	520 27.4	850 44.7	850 44.7	130 6.8	39 2.1	105 5.5	200 10.5	55 2.9	205 10.8	485 25.5	490 25.8	490 25.8	180 9.5	345 18.1	135 7.1
529	Aug. 28	1905 63	390 20.5	420 22.1	685 36.0	90 4.7	405 21.3	530 27.8	850 44.6	840 44.1	115 6.0	40 2.1	110 5.8	230 12.1	60 3.2	230 12.1	505 26.5	485 25.5	510 26.8	190 10.0	360 18.9	145 7.6
527	Aug. 27	1915 63	355 18.5	390 20.4	790 41.2	95 5.0	425 22.2	525 27.4	980 51.2	980 51.2	135 7.0	40 2.1	100 5.2	215 11.2	55 2.9	200 10.4	465 24.3	465 24.3	470 24.5	185 9.7	325 17.0	125 6.5
500	Aug. 23	1925 63	380 19.7	415 21.5	935 48.5	100 5.2	440 22.8	560 29.1	885 45.9	855 44.4	130 6.7	50 2.6	110 5.7	245 12.7	55 2.9	220 11.4	505 26.2	515 26.7	515 26.7	180 9.3	365 18.9	145 7.5
316	July 6	1930 63	370 19.2	410 21.2	830 43.0	85 4.4	430 22.3	500 25.9	820 42.5	800 41.4	120 6.2	44 2.3	130 6.7	240 12.4	60 3.1	210 10.9	495 25.6	495 25.6	500 25.9	180 9.3	340 17.6	135 7.0
583	Sept. 5	1930 63	360 18.6	410 21.2	885 45.8	85 4.4	440 22.8	520 26.9	865 44.8	865 44.8	145 7.5	30 1.6	90 4.7	195 10.1	51 2.6	215 11.1	505 26.2	485 25.1	500 25.9	195 10.1	360 18.6	135 7.0
313	July 5	1940 64	400 20.6	405 20.9	810 41.7	90 4.6	430 22.1	530 27.3	850 43.8	830 42.7	140 7.2	48 2.5	110 5.7	225 11.6	55 2.8	210 10.8	485 25.0	485 25.0	485 25.0	180 9.3	330 17.0	130 6.7
636	Sept. 15	1960 64	375 19.1	395 20.1	835 42.6	90 4.6	430 21.9	525 26.8	850 43.4	850 43.4	120 6.1	46 2.3	90 4.6	230 11.7	59 3.0	230 11.7	475 24.2	460 23.5	480 24.5	185 9.4	340 17.3	130 6.6
639	Sept. 16	1960 64	405 20.7	450 23.0	830 42.3	90 4.6	430 21.9	495 25.2	795 40.5	780 39.8	165 8.4	43 2.2	70 3.6	220 11.2	61 3.1	215 11.0	545 27.8	530 27.0	540 27.5	190 9.7	390 19.9	150 7.7
260	June 27	1980 65	325 16.4	425 21.5	855 43.2	90 4.5	445 22.5	550 27.8	870 43.9	850 42.9	150 7.6	45 2.3	95 4.8	235 11.9	60 3.0	220 11.1	505 25.5	520 26.3	505 25.5	185 9.3	355 17.9	145 7.3
29	May 25	1995 65	370 18.5	400 20.0	780 39.1	90 4.5	440 22.0	560 28.1	750 37.6	— —	130 6.5	45 2.3	110 5.5	— —	— —	240 12.0	510 25.6	490 24.5	— —	— —	— —	— —

TABLE 25. THE WEST SIDE WATERS OF ALEUTIAN ISLANDS IN THE NORTHERN PACIFIC, FEMALE, 1953

Serial no.	Date caught	1	3	5	6	7	8	10	11	12	13	14	15	17	19	21	22	24	25	26	27	28
352	July 10	1710 56	350 **20.5**	380 **22.2**	830 **48.6**	115 **6.7**	385 **22.5**	460 **26.9**	740 **43.3**	755 **44.2**	50 **2.9**	46 **2.7**	130 **7.6**	210 **12.3**	55 **3.2**	200 **11.7**	485 **28.4**	455 **26.6**	480 **28.1**	175 **10.2**	325 **19.0**	130 **7.6**
225	June 8	1780 58	385 **21.6**	395 **22.2**	755 **42.4**	85 **4.8**	430 **24.2**	525 **29.5**	820 **46.1**	820 **46.1**	55 **3.1**	39 **2.2**	110 **6.2**	235 **12.9**	50 **2.8**	200 **11.2**	460 **25.9**	470 **26.4**	470 **26.4**	180 **10.1**	330 **18.5**	130 **7.3**
364	July 12	1790 59	350 **19.6**	365 **20.4**	830 **46.4**	95 **5.3**	300 **16.8**	575 **32.1**	805 **45.0**	800 **44.7**	75 **4.2**	52 **2.9**	60 **3.4**	215 **12.0**	50 **2.8**	190 **10.6**	450 **25.2**	445 **24.9**	450 **25.2**	170 **9.5**	335 **18.7**	135 **7.5**
477	Aug. 17	1810 59	355 **19.6**	395 **21.8**	785 **43.3**	85 **4.7**	420 **23.2**	525 **29.0**	820 **45.3**	835 **46.1**	75 **4.1**	42 **2.3**	125 **6.9**	210 **11.6**	55 **3.0**	200 **11.0**	485 **26.8**	465 **25.7**	480 **26.5**	170 **9.4**	345 **19.0**	130 **7.2**
572	Sept. 4	1810 59	360 **19.9**	398 **22.0**	740 **40.8**	85 **4.7**	385 **21.3**	505 **27.9**	800 **44.2**	775 **42.8**	30 **1.7**	38 **2.1**	90 **5.0**	210 **11.6**	53 **2.9**	195 **10.8**	480 **26.5**	475 **26.2**	480 **26.5**	185 **10.2**	350 **19.3**	135 **7.5**
579	Sept. 5	1810 59	350 **19.3**	370 **20.4**	705 **38.9**	85 **4.7**	420 **23.2**	525 **29.0**	835 **46.1**	835 **46.1**	60 **3.3**	40 **2.2**	80 **4.4**	200 **11.0**	47 **2.6**	200 **11.0**	450 **24.8**	445 **24.6**	455 **25.1**	170 **9.4**	330 **18.2**	130 **7.2**
646	Sept. 18	1835 60	365 **19.9**	415 **22.6**	760 **41.4**	90 **4.9**	415 **22.3**	495 **27.0**	830 **45.2**	830 **45.2**	45 **2.5**	46 **2.5**	85 **4.6**	225 **12.3**	54 **2.9**	200 **10.9**	470 **25.6**	455 **24.8**	470 **25.6**	185 **10.1**	330 **18.0**	130 **7.1**
425	July 28	1845 61	365 **19.8**	410 **22.2**	780 **42.3**	90 **4.9**	430 **23.3**	525 **28.5**	825 **44.7**	845 **45.8**	50 **2.7**	43 **2.3**	80 **4.3**	235 **12.7**	55 **3.0**	210 **11.4**	500 **27.1**	500 **27.1**	505 **27.4**	185 **10.0**	345 **18.7**	120 **6.5**
298	July 2	1850 61	395 **21.4**	430 **23.3**	790 **42.7**	80 **4.3**	415 **22.5**	500 **27.1**	800 **43.3**	800 **43.3**	60 **3.2**	52 **2.8**	120 **6.5**	230 **12.4**	60 **3.2**	215 **11.6**	515 **27.9**	510 **27.6**	510 **27.6**	195 **10.5**	335 **18.1**	135 **7.3**
383	July 19	1850 61	385 **20.8**	410 **22.2**	800 **43.3**	85 **4.6**	410 **22.2**	500 **27.1**	800 **43.3**	810 **43.8**	40 **2.2**	46 **2.5**	115 **6.2**	225 **12.2**	50 **2.7**	215 **11.6**	495 **26.8**	495 **26.8**	495 **26.8**	185 **10.0**	360 **19.5**	140 **7.6**
420	July 28	1855 61	345 **18.6**	365 **19.7**	700 **37.7**	80 **4.3**	450 **24.3**	540 **29.1**	980 **52,8**	1015 **54.7**	50 **2.7**	38 **2.0**	110 **5.9**	200 **10.8**	52 **2.8**	225 **12.1**	425 **22.9**	455 **24.5**	440 **23.7**	185 **10.0**	320 **17.2**	140 **7.5**
339	July 8	1860 61	360 **19.4**	425 **22.9**	770 **41.4**	95 **5.1**	410 **22.1**	520 **28.0**	850 **45.7**	840 **45.2**	60 **3.2**	38 **2.0**	110 **5.9**	230 **12.4**	55 **3.0**	210 **11.3**	515 **27.7**	510 **27.4**	515 **27.7**	185 **10.0**	360 **19.4**	135 **7.3**
282	June 29	1865 61	385 **20.6**	410 **22.0**	760 **40.7**	80 **4.3**	435 **23.3**	515 **27.6**	845 **45.3**	800 **42.9**	45 **2.4**	44 **2.4**	125 **6.7**	210 **11.3**	55 **2.9**	220 **11.8**	490 **26.3**	485 **26.0**	440 **23.6**	185 **9.9**	345 **18.5**	140 **7.5**
283	June 30	1865 61	355 **19.0**	380 **20.4**	770 **41.3**	90 **4.8**	445 **23.9**	540 **28.9**	800 **42.9**	770 **41.3**	60 **3.2**	39 **2.1**	120 **6.4**	215 **11.5**	55 **2.9**	200 **10.7**	475 **25.5**	470 **25.2**	470 **25.2**	175 **9.4**	335 **18.0**	135 **7.2**
577	Sept. 5	1865 61	355 **19.0**	395 **21.2**	735 **39.4**	80 **4.3**	410 **22.0**	505 **27.1**	820 **44.0**	800 **42.9**	45 **2.4**	46 **2.5**	85 **4.6**	190 **10.2**	54 **2.9**	215 **11.5**	480 **25.7**	475 **25.5**	495 **26.5**	185 **9.9**	340 **18.2**	140 **7.5**
521	Aug. 25	1870 61	385 **20.6**	415 **22.2**	820 **43.9**	90 **4.8**	420 **22.5**	505 **27.0**	835 **44.7**	825 **44.1**	65 **3.5**	40 **2.1**	115 **6.1**	220 **11.8**	55 **2.9**	225 **12.0**	500 **26.8**	495 **26.5**	510 **27.3**	195 **10.4**	370 **19.8**	140 **7.5**

TABLE 25. THE WEST SIDE WATERS OF ALEUTIAN ISLANDS IN THE NORTHERN PACIFIC, FEMALE, 1953 (cont.)

Serial no.	Date caught	1	3	5	6	7	8	10	11	12	13	14	15	17	19	21	22	24	25	26	27	28
326	July 7	1890	335	405	790	95	435	520	830	810	30	38	105	225	60	205	485	485	490	180	365	140
		62	**17.7**	**21.4**	**41.8**	**5.0**	**23.0**	**27.5**	**43.9**	**42.8**	**1.6**	**2.0**	**5.6**	**11.9**	**3.2**	**10.8**	**25.7**	**25.7**	**25.9**	**9.5**	**19.3**	**7.4**
33	May 26	1890	370	400	800	90	450	540	760	745	50	40	90	—	—	—	—	—	—	—	—	—
		62	**19.6**	**21.2**	**42.3**	**4.8**	**23.8**	**28.6**	**40.2**	**39.4**	**2.6**	**2.1**	**4.8**	—	—	—	—	—	—	—	—	—
689	Sept. 27	1895	365	400	745	85	435	520	830	845	40	38	100	215	52	205	465	465	470	170	335	130
		62	**19.3**	**21.1**	**39.3**	**4.5**	**23.0**	**27.5**	**43.8**	**44.6**	**2.1**	**2.0**	**5.3**	**11.4**	**2.7**	**10.8**	**24.6**	**24.6**	**24.8**	**9.0**	**17.7**	**6.9**
361	July 11	1910	375	410	810	85	400	500	820	820	40	49	110	240	55	205	510	485	505	185	360	135
		63	**19.7**	**21.5**	**42.4**	**4.5**	**21.0**	**26.2**	**43.0**	**43.0**	**2.1**	**2.6**	**5.8**	**12.6**	**2.9**	**10.7**	**26.7**	**25.4**	**26.5**	**9.7**	**18.9**	**7.1**
388	July 20	1915	385	415	805	90	435	480	850	830	50	40	90	235	55	230	490	505	500	200	360	145
		63	**20.1**	**21.7**	**42.0**	**4.7**	**22.7**	**25.1**	**44.4**	**43.3**	**2.6**	**2.1**	**4.7**	**12.3**	**2.9**	**12.0**	**25.6**	**26.4**	**26.1**	**10.4**	**18.8**	**7.6**
536	Aug. 28	1915	390	420	815	85	430	545	875	865	60	46	120	235	60	225	510	495	520	185	375	140
		63	**20.4**	**21.9**	**42.5**	**4.4**	**22.4**	**28.4**	**45.7**	**45.2**	**3.1**	**2.4**	**6.3**	**12.3**	**3.1**	**11.7**	**26.6**	**25.8**	**27.1**	**9.7**	**19.6**	**7.3**
266	June 27	1920	395	415	780	70	445	570	850	850	50	40	60	210	60	215	505	500	510	195	350	150
		63	**20.6**	**21.6**	**40.6**	**3.6**	**23.2**	**29.7**	**44.3**	**44.3**	**2.6**	**2.1**	**3.1**	**10.9**	**3.1**	**11.2**	**26.3**	**26.1**	**26.6**	**10.2**	**18.2**	**7.8**
368	July 12	1920	395	435	785	90	430	520	890	880	50	38	150	205	55	210	505	510	515	195	250	138
		63	**20.6**	**22.7**	**40.9**	**4.7**	**22.4**	**27.1**	**46.4**	**45.8**	**2.6**	**2.0**	**7.8**	**10.7**	**2.9**	**10.9**	**26.3**	**26.6**	**26.8**	**10.2**	**18.2**	**7.2**
454	Aug. 3	1920	390	430	875	90	410	535	870	860	55	45	130	210	55	210	510	510	510	195	365	135
		63	**20.3**	**22.4**	**45.6**	**4.7**	**21.4**	**27.9**	**45.3**	**44.8**	**2.9**	**2.3**	**6.8**	**10.9**	**2.9**	**10.9**	**26.6**	**26.6**	**26.6**	**10.2**	**19.0**	**7.0**
568	Aug. 31	1930	390	430	800	85	410	515	855	835	50	38	100	215	55	215	505	500	520	190	360	145
		63	**20.2**	**22.3**	**41.4**	**4.4**	**21.2**	**26.7**	**44.3**	**43.3**	**2.6**	**2.0**	**5.2**	**11.1**	**2.8**	**11.1**	**26.2**	**25.9**	**26.9**	**9.8**	**18.6**	**7.5**
672	Sept. 25	1930	355	395	785	90	445	535	850	840	55	38	90	215	53	200	485	475	485	165	355	125
		63	**18.4**	**20.5**	**40.7**	**4.7**	**23.1**	**27.7**	**44.0**	**43.5**	**2.8**	**2.0**	**4.7**	**11.1**	**2.7**	**10.4**	**25.1**	**24.6**	**25.1**	**8.5**	**18.4**	**6.5**
671	Sept. 25	1935	390	430	850	90	415	555	885	865	55	50	95	215	55	230	515	520	520	185	380	145
		64	**20.2**	**22.2**	**43.9**	**4.7**	**21.5**	**28.7**	**45.8**	**44.7**	**2.8**	**2.6**	**4.9**	**11.1**	**2.8**	**11.9**	**26.6**	**26.9**	**26.9**	**9.6**	**19.6**	**7.5**
524	Aug. 27	1940	400	445	—	90	410	475	800	750	60	35	100	230	60	235	525	525	530	195	360	155
		64	**20.6**	**22.9**	—	**4.6**	**21.1**	**24.5**	**41.2**	**38.6**	**3.1**	**1.8**	**5.2**	**11.8**	**3.1**	**12.1**	**27.0**	**27.0**	**27.3**	**10.0**	**185**	**8.0**
585	Sept. 5	1940	420	460	820	90	445	535	875	865	70	38	90	230	54	215	510	500	505	185	370	145
		64	**21.6**	**23.7**	**42.2**	**4.6**	**22.9**	**27.6**	**45.1**	**44.5**	**3.6**	**2.0**	**4.6**	**11.8**	**2.8**	**11.1**	**26.3**	**25.8**	**26.0**	**9.5**	**19.1**	**7.5**
311	July 5	1950	345	400	745	85	420	515	880	850	75	43	120	215	50	210	496	485	495	180	330	130
		64	**17.7**	**20.5**	**38.2**	**4.4**	**21.5**	**26.4**	**45.1**	**43.6**	**3.8**	**2.2**	**6.2**	**11.0**	**2.6**	**10.8**	**25.4**	**24.9**	**25.4**	**9.2**	**16.9**	**6.7**
692	Sept. 27	1950	375	410	795	95	390	565	880	860	45	48	85	200	54	235	480	495	495	165	355	130
		64	**19.2**	**21.0**	**40.8**	**4.9**	**20.0**	**29.0**	**45.1**	**44.1**	**2.3**	**2.5**	**4.4**	**10.3**	**2.8**	**12.1**	**24.6**	**25.4**	**25.4**	**8.5**	**18.2**	**6.7**

269	June 28	1955 64	385 19.7	425 21.8	750 38.4	95 4.9	410 21.0	520 26.6	885 45.3	870 44.5	60 3.1	41 2.1	110 5.6	260 13.3	60 3.1	220 11.3	490 25.1	480 24.6	490 25.1	185 9.5	350 17.9	140 7.2
603	Sept. 8	1965 64	450 22.9	475 24.2	850 43.3	90 4.6	435 22.1	540 27.5	865 44.0	855 43.5	55 2.8	44 2.2	100 5.1	230 11.7	59 3.0	220 11.2	525 26.7	515 26.2	530 27.0	190 9.7	370 18.8	145 7.4
530	Aug. 28	1965 65	390 19.9	430 21.9	745 37.9	90 4.6	410 20.9	525 26.7	880 44.8	880 44.8	55 2.8	50 2.5	110 5.6	235 12.0	60 3.1	210 10.7	515 26.2	520 26.5	515 26.2	190 9.7	385 19.6	135 6.9
632	Sept. 15	1965 65	410 20.9	455 23.2	745 37.9	100 5.1	530 27.0	590 30.0	850 43.3	800 40.7	50 2.5	57 2.9	100 5.1	235 12.0	59 3.0	230 11.7	530 27.0	525 26.7	525 26.7	195 9.9	390 19.9	155 7.9
315	July 6	1970 65	385 19.6	430 21.8	830 42.2	85 4.3	440 22.4	550 27.9	920 46.7	920 46.7	40 2.0	44 2.2	115 5.8	235 11.9	60 3.0	210 10.7	510 25.9	510 25.9	515 26.2	190 9.7	350 17.8	140 7.1
624	Sept. 13	1970 65	385 19.6	420 21.3	805 40.9	90 4.6	460 23.4	565 28.7	895 45.5	870 44.2	45 2.3	44 2.2	90 4.6	230 11.7	55 2.8	220 11.2	500 25.4	500 25.4	500 25.4	195 9.9	375 19.1	140 7.1
136	June 11	1970 65	390 19.8	430 21.8	850 43.2	100 5.1	495 25.1	540 27.4	860 43.7	— —	60 3.0	— —	95 4.8	— —	45 2.3	210 10.7	525 26.7	500 25.4	— —	195 9.9	— —	— —
337	July 8	1980 65	415 21.0	430 21.7	810 40.9	95 4.8	420 21.2	550 27.8	910 46.0	895 45.2	50 2.5	40 2.0	100 5.1	240 12.1	60 3.0	220 11.1	495 25.0	510 25.8	515 26.0	185 9.3	360 18.2	135 6.8
455	Aug. 3	1985 65	370 18.6	400 20.2	815 41.1	100 5.0	440 22.2	530 26.7	865 43.6	915 46.1	60 3.0	48 2.4	100 5.0	245 12.3	60 3.0	220 11.1	515 26.0	510 25.7	515 26.0	190 9.6	375 18.9	145 7.3
539	Aug. 29	1985 65	380 19.2	405 21.4	815 41.1	90 4.5	370 18.6	525 26.5	885 44.6	885 44.6	65 3.3	45 2.3	115 5.8	215 10.8	55 2.8	215 10.8	485 24.4	475 23.9	475 23.9	195 9.8	355 17.9	135 6.8
655	Sept. 25	1985 65	395 19.9	430 21.7	885 44.6	90 4.5	450 22.7	580 29.2	890 44.9	880 44.4	45 2.3	46 2.3	100 5.0	240 12.1	61 3.1	215 10.8	520 26.2	505 25.5	515 26.0	170 8.6	380 19.2	130 6.6
21	May 24	1985 65	380 19.2	410 20.7	840 42.3	90 4.5	470 23.7	555 28.0	605 30.5	875 44.1	— —	40 2.0	90 4.5	250 12.6	55 2.8	210 10.6	480 24.2	470 23.7	— —	— —	— —	— —
634	Sept. 15	1995 66	380 19.0	415 20.8	845 423	100 5.0	375 18.8	535 26.8	870 43.6	865 43.3	45 2.3	43 2.2	100 5.0	245 12.3	59 3.0	225 11.3	510 25.6	500 25.1	510 25.6	190 9.5	360 18.0	140 7.0
20	May 24	2010 66	390 19.4	410 20.4	840 41.8	90 4.5	500 24.9	580 28.9	930 46.3	1030 51.3	60 3.0	40 2.0	90 4.5	240 12.0	55 2.7	210 10.5	480 23.9	490 24.4	— —	— —	— —	— —
258	June 27	2015 66	400 19.8	440 21.8	880 43.6	60 3.0	435 21.6	520 25.8	870 43.2	870 43.2	60 3.0	48 2.4	85 4.2	240 11.9	65 3.2	230 11.4	525 26.0	515 25.5	525 26.0	190 9.4	370 18.4	150 7.4
625	Sept. 13	2015 66	405 20.1	435 21.6	805 39.9	90 4.5	490 24.3	540 26.8	870 43.2	850 42.2	50 2.5	43 2.1	110 5.5	235 11.7	58 2.9	210 10.4	510 25.3	515 25.5	505 25.0	190 9.4	365 18.1	140 6.9
2	May 20	2015 66	420 20.8	450 22.3	— —	100 5.0	500 24.8	570 28.3	930 46.1	— —	70 3.5	— —	90 4.5	— —	— —	235 11.7	550 27.3	540 26.8	— —	— —	— —	— —
144	June 12	2015 66	370 18.4	400 19.8	820 40.7	100 5.0	480 23.8	565 28.0	940 46.6	950 47.1	65 3.2	— —	— —	225 11.2	50 2.5	220 10.9	— —	490 25.0	— —	200 9.9	— —	170 8.4

TABLE 25. THE WEST SIDE WATERS OF ALEUTIAN ISLANDS IN THE NORTHERN PACIFIC, FEMALE, 1953 (cont.)

Serial no.	Date caught	1	3	5	6	7	8	10	11	12	13	14	15	17	19	21	22	24	25	26	27	28
324	July 7	2020 66	380 **18.8**	410 **20.3**	920 **45.5**	90 **4.5**	480 **23.8**	610 **30.2**	940 **46.5**	940 **46.5**	40 **2.0**	58 **2.9**	140 **6.9**	230 **11.4**	55 **2.7**	210 **10.4**	500 **24.8**	495 **24.5**	500 **24.8**	195 **9.7**	360 **17.8**	140 **6.9**
366	July 12	2030 67	415 **20.5**	445 **21.9**	840 **41.4**	100 **4.9**	450 **22.2**	550 **27.1**	900 **44.4**	880 **43.4**	50 **2.5**	38 **1.9**	140 **6.9**	230 **11.3**	55 **2.7**	205 **10.1**	545 **26.9**	540 **26.6**	545 **26.9**	185 **9.1**	390 **19.2**	135 **6.7**
88	June 3	2030 67	330 **16.3**	410 **20.2**	825 **40.7**	90 **4.4**	510 **25.1**	560 **27.6**	890 **43.9**	880 **43.4**	50 **2.5**	— —	110 **5.4**	210 **10.4**	— —	— —	— —	— —	— —	— —	— —	— —
374	July 13	2040 67	415 **20.3**	455 **22.3**	760 **37.2**	100 **4.9**	480 **23.5**	530 **26.0**	880 **43.1**	870 **42.6**	70 **3.4**	38 **1.9**	155 **5.6**	190 **9.3**	60 **2.9**	220 **10.8**	550 **27.0**	535 **26.2**	550 **27.0**	180 **8.8**	400 **19.6**	130 **6.4**
688	Sept. 27	2040 67	420 **20.6**	465 **22.8**	845 **41.4**	100 **4.9**	445 **21.8**	575 **28.2**	910 **44.6**	905 **44.3**	50 **2.5**	58 **2.8**	110 **5.4**	255 **12.5**	60 **2.9**	235 **11.5**	540 **26.5**	540 **26.5**	545 **26.7**	200 **9.8**	385 **18.9**	145 **7.1**
633	Sept. 15	2070 68	440 **21.3**	475 **22.9**	720 **34.8**	100 **4.8**	445 **21.5**	555 **26.8**	870 **42.0**	870 **42.0**	45 **2.2**	39 **1.9**	95 **4.6**	210 **10.1**	54 **2.6**	230 **11.1**	560 **27.0**	550 **26.6**	560 **27.0**	180 **8.7**	410 **19.8**	145 **7.0**
63	June 1	2100 69	430 **20.5**	460 **21.9**	— —	100 **4.8**	470 **22.4**	540 **25.7**	930 **44.3**	960 **45.7**	50 **2.4**	45 **2.1**	100 **4.8**	— —	— —	— —	— —	— —	— —	— —	— —	— —
384	July 18	2120 70	410 **19.4**	450 **21.2**	860 **40.8**	100 **4.7**	525 **24.8**	590 **27.8**	950 **44.8**	1005 **49.6**	80 **3.4**	29 **1.4**	110 **5.2**	250 **11.8**	60 **2.8**	245 **11.6**	535 **25.3**	535 **25.3**	535 **25.3**	195 **9.2**	380 **17.9**	160 **7.6**

All measurements in 1953 were carried out on the deck of Baikal maru.

TABLE 26. THE WEST SIDE WATERS OF ALEUTIAN ISLANDS IN THE NORTHERN PACIFIC, MALE, 1954~1956

1) B: Baikal-maru, 2) Ky: Kyokuyo-maru, 3) K: Kinjo-maru

Factory ship	Serial no.	Date caught	1	3	5	6	8	10	11	12	13	14	15	17	19	21	22	24	25	26	27	28
B[1]	61	June 3 1954	1890 62	400 **21.2**	440 **23.3**	840 **44.4**	420 **22.2**	520 **27.5**	815 **43.1**	815 **43.1**	130 **6.9**	49 **2.6**	70 **3.7**	232 **12.3**	61 **3.2**	230 **12.2**	525 **27.8**	520 **27.5**	520 **27.5**	185 **9.8**	355 **18.8**	140 **7.4**
B	59	June 2 1954	1898 62	355 **18.7**	400 **21.1**	770 **40.6**	440 **23.2**	525 **27.7**	850 **44.8**	880 **46.4**	125 **6.6**	50 **2.6**	70 **3.7**	207 **10.9**	49 **2.6**	215 **11.3**	475 **25.0**	460 **24.3**	475 **25.0**	178 **9.4**	335 **17.7**	135 **7.1**
B	95	June 8 1954	2084 68	375 **18.0**	430 **20.6**	840 **40.3**	450 **21.6**	590 **28.3**	920 **44.2**	920 **44.2**	150 **7.2**	55 **2.6**	80 **3.8**	227 **10.9**	60 **2.9**	235 **11.3**	505 **24.2**	480 **23.0**	505 **24.2**	195 **9.4**	356 **17.1**	140 **6.7**
Ky[2]	40	June 12 1956	1855 61	345 **18.6**	375 **20.2**	790 **42.6**	420 **22.6**	520 **28.0**	830 **44.7**	810 **43.7**	120 **6.5**	35 **1.9**	80 **4.3**	— —	52 **2.8**	208 **11.2**	470 **25.3**	455 **24.5**	468 **25.2**	195 **10.5**	— —	123 **6.6**

Ky	286	June 26	1715	300	350	—	390	485	805	795	145	44	95	—	47	185	400	395	400	160	275	110
		1956	56	**17.5**	**20.4**	—	**22.7**	**28.3**	**46.9**	**46.4**	**8.5**	**2.6**	**5.5**	—	**2.7**	**10.8**	**23.3**	**23.0**	**23.3**	**9.3**	**16.0**	**6.4**
Ky	1247	Aug. 18	1780	330	350	700	405	490	810	790	120	42	85	—	55	205	445	460	445	175	320	130
		1956	58	**18.5**	**19.7**	**39.3**	**22.8**	**27.5**	**45.5**	**44.4**	**6.7**	**2.4**	**4.8**	—	**3.1**	**11.5**	**25.0**	**25.8**	**25.0**	**9.8**	**18.0**	**7.3**
Ky	1272	Aug. 19	1855	360	385	775	390	490	820	800	125	38	90	—	53	190	485	495	490	175	320	120
		1956	61	**19.4**	**20.7**	**41.8**	**21.0**	**26.4**	**44.2**	**43.1**	**6.7**	**2.0**	**4.9**	—	**2.9**	**10.2**	**26.1**	**26.7**	**26.4**	**9.4**	**17.3**	**6.5**
Ky	1320	Aug. 21	1835	330	360	745	415	515	860	835	120	41	85	—	52	200	460	465	460	180	310	130
		1956	60	**18.0**	**19.6**	**40.6**	**22.6**	**28.1**	**46.9**	**45.5**	**6.5**	**2.2**	**4.6**	—	**2.8**	**10.9**	**25.1**	**25.3**	**25.1**	**9.8**	**16.9**	**7.1**
Ky	1370	Aug. 23	1805	365	395	770	395	480	790	790	120	—	—	—	50	220	485	480	490	175	340	130
		1956	59	**20.2**	**21.9**	**42.7**	**21.9**	**26.6**	**43.8**	**43.8**	**6.6**	—	—	—	**2.8**	**12.2**	**26.9**	**26.6**	**27.1**	**9.7**	**18.9**	**7.2**

TABLE 27. THE WEST SIDE WATERS OF ALEUTIAN ISLANDS IN THE NORTHERN PACIFIC, FEMALE, 1954～1956

Factory ship	Serial no.	Date caught	1	3	5	6	8	10	11	12	13	14	15	17	19	21	22	24	25	26	27	28
K[3]	26	May 20	1700	—	340	700	420	490	780	760	45	40	80	200	50	185	420	390	400	150	280	101
		1954	56	—	**20.0**	**41.2**	**24.7**	**28.8**	**45.9**	**44.7**	**2.6**	**2.4**	**4.7**	**11.8**	**2.9**	**10.9**	**24.7**	**22.9**	**23.5**	**8.8**	**16.5**	**6.5**
B	60	June 3	1790	320	365	710	420	520	820	840	50	48	65	190	46	209	465	455	460	154	300	132
		1954	59	**17.9**	**20.4**	**39.7**	**23.5**	**29.1**	**45.8**	**47.0**	**2.8**	**2.7**	**3.6**	**10.6**	**2.6**	**11.7**	**26.0**	**25.4**	**25.7**	**8.6**	**16.8**	**7.4**
B	34	May 31	1860	385	422	805	410	510	810	810	40	40	70	210	55	204	502	495	505	170	365	140
		1954	61	**20.7**	**20.7**	**43.3**	**22.0**	**27.4**	**43.5**	**43.5**	**2.2**	**2.2**	**3.8**	**11.3**	**3.0**	**11.0**	**27.0**	**26.6**	**27.2**	**9.1**	**19.6**	**7.5**
B	114	June 9	1862	—	—	—	—	—	—	—	—	—	—	—	—	217	505	—	500	161	360	128
		1954	61	—	—	—	—	—	—	—	—	—	—	—	—	**11.7**	**27.1**	—	**26.9**	**8.6**	**19.3**	**6.9**
K	7	May 18	2000	360	410	840	460	585	920	950	55	40	110	240	55	215	485	480	490	205	340	150
		1954	66	**18.0**	**20.5**	**42.0**	**23.0**	**29.3**	**46.0**	**48.5**	**2.8**	**2.0**	**5.5**	**12.0**	**2.8**	**10.3**	**24.3**	**24.0**	**24.5**	**10.3**	**17.0**	**7.5**
Ky	42	June 12	1740	310	325	660	425	510	800	790	45	45	99	—	53	195	425	425	430	165	—	120
		1956	57	**17.8**	**18.7**	**37.9**	**24.4**	**29.3**	**46.0**	**45.4**	**2.6**	**2.6**	**5.7**	—	**3.0**	**11.2**	**24.4**	**24.4**	**24.7**	**9.5**	—	**6.6**
Ky	53	June 13	1985	385	410	815	465	550	890	870	55	43	80	—	—	—	—	—	—	—	—	—
		1956	65	**19.4**	**20.7**	**41.1**	**23.4**	**27.7**	**44.8**	**43.8**	**2.8**	**2.2**	**4.0**	—	—	—	—	—	—	—	—	—
Ky	232	June 23	2000	370	410	805	460	540	875	830	55	40	105	—	58	210	505	495	510	200	360	145
		1956	66	**18.5**	**20.5**	**40.3**	**23.0**	**27.0**	**43.8**	**41.5**	**2.8**	**2.0**	**5.3**	—	**2.9**	**10.5**	**25.3**	**24.6**	**25.5**	**10.0**	**18.0**	**7.3**
Ky	250	June 23	1680	235	255	600	380	480	810	800	45	—	95	—	52	205	315	325	345	170	210	120
		1956	55	**14.0**	**15.2**	**35.7**	**22.6**	**28.6**	**48.2**	**47.6**	**2.7**	—	**5.7**	—	**3.1**	**12.2**	**18.7**	**19.3**	**20.5**	**10.1**	**12.5**	**7.1**
Ky	288	June 29	2000	400	450	—	455	560	880	870	55	47	90	—	—	215	520	525	515	200	355	130
		1956	66	**20.0**	**22.5**	—	**22.8**	**28.0**	**44.0**	**43.5**	**2.8**	**2.4**	**4.5**	—	—	**10.8**	**26.0**	**26.3**	**25.8**	**10.0**	**17.8**	**6.5**

TABLE 27. THE WEST SIDE WATERS OF ALEUTIAN ISLANDS IN THE NORTHERN PACIFIC, FEMALE, 1954~1956 (cont.)

Factory ship	Serial no.	Date caught	1	3	5	6	8	10	11	12	13	14	15	17	19	21	22	24	25	26	27	28
Ky	312	July 1 1956	1950 64	350 **17.9**	390 **20.0**	810 **41.5**	435 **22.3**	480 **24.6**	810 **41.5**	— —	50 **2.6**	20 **1.0**	80 **4.1**	— —	52 **2.7**	205 **10.5**	490 **25.1**	— —	490 **25.1**	170 **8.7**	340 **17.4**	125 **6.4**
Ky	1211	Aug. 14 1956	1945 64	375 **19.3**	415 **21.3**	815 **41.9**	445 **22.9**	565 **29.0**	870 **44.7**	850 **43.7**	30 **1.5**	49 **2.5**	100 **5.1**	— —	56 **2.9**	210 **10.8**	485 **24.9**	495 **25.4**	485 **24.9**	180 **9.3**	335 **17.2**	130 **6.7**
Ky	1297	Aug. 20 1956	2025 67	380 **18.8**	400 **19.8**	835 **41.2**	470 **23.2**	590 **29.1**	950 **46.9**	920 **45.4**	40 **2.0**	42 **2.1**	— —	— —	56 **2.8**	230 **11.4**	525 **25.9**	510 **25.2**	520 **25.7**	210 **10.4**	360 **17.8**	145 **7.2**
Ky	1348	Aug. 22 1956	1995 65	385 **19.3**	415 **20.8**	815 **40.9**	460 **23.1**	555 **27.8**	910 **45.6**	880 **44.1**	60 **3.0**	52 **2.6**	100 **5.0**	— —	56 **2.8**	220 **11.0**	525 **26.3**	530 **26.6**	530 **26.6**	190 **9.5**	365 **18.3**	130 **6.5**
Ky	1393	Aug. 24 1956	1985 65	395 **19.9**	415 **20.9**	855 **43.1**	450 **22.7**	550 **27.7**	870 **43.8**	870 **43.8**	60 **3.0**	40 **2.0**	90 **4.5**	— —	55 **2.8**	235 **11.8**	535 **27.0**	535 **27.0**	530 **26.7**	190 **9.6**	350 **17.6**	135 **6.8**

TABLE 28. THE SOUTH EAST SIDE WATERS OF ALEUTIAN ISLANDS IN THE NORTHERN PACIFIC, MALE, 1954~1956

Factory ship	Serial no.	Date caught	1	3	5	6	8	10	11	12	13	14	15	17	19	21	22	24	25	26	27	28
K	603	July 10 1954	1660 55	290 **17.5**	325 **19.6**	680 **40.9**	405 **24.4**	475 **28.6**	785 **47.3**	735 **44.2**	155 **9.3**	46 **2.8**	120 **7.2**	175 **10.5**	48 **2.9**	— —	— —	— —	— —	— —	— —	— —
K	473	July 1 1954	1850 61	340 **18.4**	370 **20.0**	780 **42.2**	450 **24.3**	510 **27.6**	840 **45.4**	840 **45.4**	120 **6.5**	45 **2.4**	75 **4.1**	215 **11.6**	50 **2.7**	210 **11.4**	470 **25.4**	470 **25.4**	455 **24.6**	180 **9.7**	340 **18.4**	140 **7.6**
K	686	July 17 1954	2020 66	395 **19.6**	410 **20.3**	830 **41.1**	470 **23.3**	580 **28.7**	920 **45.5**	895 **44.3**	145 **7.2**	60 **3.0**	140 **6.9**	240 **11.9**	60 **3.0**	210 **10.4**	510 **25.2**	495 **24.5**	500 **24.8**	170 **8.4**	370 **18.3**	135 **6.7**
Ky	341	July 4 1956	1620 53	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	46 **2.8**	170 **10.5**	405 **25.0**	400 **24.7**	405 **25.0**	155 **9.6**	285 **17.6**	105 **6.5**

TABLE 29. THE SOUTH EAST SIDE WATERS OF ALEUTIAN ISLANDS IN THE NORTHERN PACIFIC, FEMALE, 1954~1956

Factory ship	Serial no.	Date caught	1	3	5	6	8	10	11	12	13	14	15	17	19	21	22	24	25	26	27	28
K	672	July 15 1954	1800 59	295 **16.4**	350 **19.5**	730 **40.6**	450 **25.0**	500 **27.8**	790 **43.9**	772 **42.9**	45 **2.5**	40 **2.2**	85 **4.7**	220 **12.2**	50 **2.8**	190 **10.6**	440 **24.5**	440 **24.5**	435 **24.2**	145 **8.1**	315 **17.5**	120 **6.7**

K	145	June 8 1954	1860 61	305 **16.4**	330 **17.8**	720 **38.7**	460 **24.7**	500 **26.9**	830 **44.7**	830 **44.7**	30 **1.6**	40 **2.2**	85 **4.6**	195 **10.5**	50 **2.7**	190 **1.02**	425 **22.9**	410 **22.1**	420 **22.6**	180 **9.7**	300 **16.1**	115 **6.2**
K	56	May 31 1954	2005 66	370 **18.5**	400 **20.0**	830 **41.4**	440 **22.0**	540 **26.9**	870 **43.4**	840 **41.9**	60 **3.0**	45 **2.2**	90 **4.5**	240 **12.0**	60 **3.0**	205 **10.2**	510 **25.4**	520 **25.9**	515 **25.7**	180 **9.0**	345 **17.2**	145 **7.2**
K	32	May 22 1954	2045 67	395 **19.3**	440 **21.5**	875 **42.8**	440 **21.5**	570 **27.9**	890 **43.5**	920 **45.0**	45 **2.2**	35 **1.7**	80 **3.9**	250 **12.2**	60 **2.9**	— —	— —	515 **25.2**	— —	— —	— —	— —
K	69	June 2 1954	2070 68	370 **17.9**	410 **19.8**	860 **41.5**	500 **24.2**	590 **28.5**	930 **44.9**	960 **46.3**	60 **2.9**	40 **1.9**	70 **3.4**	255 **12.3**	60 **2.9**	210 **10.1**	505 **24.4**	500 **24.2**	515 **24.9**	200 **9.6**	360 **17.4**	150 **7.2**
K	687	July 17 1954	2105 69	365 **17.3**	385 **18.2**	835 **39.7**	490 **23.3**	585 **27.8**	845 **40.1**	950 **45.1**	— —	47 **2.2**	110 **5.2**	240 **11.4**	61 **2.9**	235 **11.2**	525 **24.9**	520 **24.7**	520 **24.7**	200 **9.5**	350 **16.6**	145 **6.9**
Ky	366	July 6 1956	1920 63	310 **16.1**	370 **19.3**	810 **42.2**	450 **23.4**	565 **29.4**	910 **47.4**	890 **46.4**	45 **2.3**	32 **1.7**	90 **4.7**	— —	56 **2.9**	275 **14.3**	480 **25.0**	480 **25.0**	490 **25.5**	220 **11.5**	335 **17.4**	140 **7.3**
Ky	1528	Sept. 4 1956	1845 61	365 **19.8**	390 **21.1**	765 **41.5**	430 **23.3**	480 **26.0**	810 **43.9**	790 **42.8**	50 **2.7**	47 **2.5**	85 **4.6**	— —	51 **2.8**	200 **10.8**	500 **27.1**	495 **26.8**	495 **26.8**	185 **10.0**	335 **18.2**	120 **6.5**

TABLE 30. THE NORTH EAST SIDE WATERS OF ALEUTIAN ISLANDS IN THE NORTHERN PACIFIC, MALE, 1954~1956

Factory ship	Serial no.	Date caught	1	3	5	6	8	10	11	12	13	14	15	17	19	21	22	24	25	26	27	28
K	751	July 20 1954	1740 57	320 **18.4**	340 **19.6**	720 **41.4**	420 **24.2**	495 **28.5**	780 **44.9**	770 **44.3**	125 **7.2**	45 **2.6**	100 **5.8**	209 **12.0**	53 **3.0**	170 **9.8**	420 **24.2**	420 **24.2**	420 **24.2**	— —	285 **16.4**	120 **6.9**
B	985	Sept. 16 1954	1740 57	330 **19.0**	370 **21.3**	700 **40.3**	440 **25.3**	530 **30.5**	840 **48.3**	860 **49.5**	100 **5.8**	45 **2.6**	90 **5.2**	219 **12.6**	43 **2.5**	195 **11.2**	410 **23.6**	400 **23.0**	413 **23.7**	176 **10.1**	275 **15.8**	125 **7.2**
B	861	Sept. 5 1954	1760 58	— —	370 **21.0**	755 **42.9**	390 **22.2**	490 **27.8**	690 **39.2**	690 **39.2**	100 **5.7**	41 **2.3**	80 **4.5**	207 **11.8**	49 **2.8**	196 **11.1**	435 **24.7**	428 **24.3**	440 **25.0**	155 **8.8**	310 **17.6**	122 **6.9**
K	743	July 19 1954	1775 58	315 **17.7**	330 **18.6**	690 **38.8**	415 **23.3**	525 **29.6**	850 **47.9**	820 **46.2**	115 **6.5**	36 **2.0**	110 **6.2**	210 **11.8**	49 **2.8**	190 **10.7**	425 **23.9**	420 **23.6**	420 **23.6**	180 **10.1**	300 **16.9**	105 **5.9**
K	896	Aug. 1 1954	1780 59	330 **18.5**	350 **19.7**	670 **37.7**	410 **23.0**	490 **27.5**	800 **45.0**	790 **44.4**	120 **6.7**	— —	100 **5.6**	205 **11.5**	54 **3.0**	190 **10.7**	435 **24.4**	430 **24.2**	440 **24.7**	175 **9.8**	305 **17.1**	120 **6.7**
B	848	Sept. 3 1954	1792 59	315 **17.6**	345 **19.3**	695 **38.8**	430 **24.0**	520 **29.0**	860 **48.0**	860 **48.0**	135 **7.5**	45 **2.5**	90 **5.0**	— —	52 **2.9**	206 **11.5**	426 **23.8**	420 **23.4**	420 **23.4**	171 **9.5**	290 **16.2**	136 **7.6**
B	865	Sept. 5 1954	1800 59	350 **19.5**	380 **21.1**	750 **41.7**	400 **22.2**	490 **27.2**	690 **38.4**	720 **40.0**	120 **6.7**	48 **2.7**	80 **4.4**	207 **11.5**	54 **3.0**	210 **11.7**	450 **25.0**	460 **25.6**	455 **25.3**	172 **9.6**	320 **17.8**	137 **7.6**
B	1037	Sept. 19 1954	1800 59	355 **19.7**	380 **21.1**	780 **43.4**	410 **22.8**	500 **27.8**	830 **46.1**	830 **46.1**	140 **7.8**	37 **2.1**	90 **5.0**	220 **12.2**	53 **3.0**	205 **11.4**	475 **26.4**	475 **26.4**	480 **26.7**	175 **9.7**	340 **18.9**	127 **7.1**

TABLE 30. THE NORTH EAST SIDE WATERS OF ALEUTIAN ISLANDS IN THE NORTHERN PACIFIC, MALE, 1954~1956 (cont.)

Factory ship	Serial no.	Date caught	1	3	5	6	8	10	11	12	13	14	15	17	19	21	22	24	25	26	27	28
K	895	Aug. 1 1954	1840 60	360 **19.5**	390 **21.2**	750 **40.7**	430 **23.3**	520 **28.2**	840 **45.6**	830 **45.1**	130 **7.1**	45 **2.4**	80 **4.3**	205 **11.1**	52 **2.8**	210 **11.4**	— —	440 **23.9**	455 **24.7**	160 **8.7**	320 **17.4**	140 **7.6**
K	933	Aug. 3 1954	1840 60	320 **17.4**	350 **19.0**	750 **40.7**	435 **23.6**	535 **29.1**	865 **47.0**	850 **46.2**	130 **7.1**	42 **2.3**	85 **4.6**	220 **11.9**	54 **2.9**	215 **11.7**	445 **23.9**	— —	435 **23.6**	150 **8.1**	310 **16.8**	135 **7.3**
B	901	Sept. 9 1954	1848 61	340 **18.4**	370 **20.0**	750 **40.6**	410 **22.2**	500 **27.1**	810 **43.8**	830 **44.9**	130 **7.0**	43 **2.3**	100 **5.4**	220 **11.9**	55 **3.0**	210 **11.4**	450 **24.3**	445 **24.1**	450 **24.3**	170 **9.2**	315 **17.0**	123 **6.7**
K	954	Aug. 4 1954	1850 61	330 **17.9**	345 **18.7**	740 **40.0**	430 **23.3**	515 **27.9**	855 **46.3**	830 **44.9**	120 **6.5**	— —	85 **4.6**	208 **11.3**	54 **2.9**	225 **12.2**	450 **24.3**	454 **24.6**	450 **24.3**	165 **8.9**	318 **17.2**	125 **6.8**
K	908	Aug. 2 1954	1860 61	320 **17.2**	330 **17.8**	750 **40.4**	430 **23.1**	550 **29.6**	870 **46.8**	860 **46.3**	150 **8.1**	50 **2.7**	80 **4.3**	225 **12.1**	54 **2.9**	205 **11.0**	425 **22.9**	430 **23.1**	425 **22.9**	180 **9.7**	290 **15.6**	135 **7.3**
B	1042	Sept. 19 1954	1860 61	340 **18.3**	380 **20.4**	790 **42.4**	420 **22.6**	540 **29.0**	850 **45.6**	870 **46.8**	130 **7.0**	41 **2.2**	100 **5.4**	225 **12.1**	58 **3.1**	210 **11.3**	460 **24.7**	440 **23.6**	460 **24.7**	175 **9.4**	320 **17.2**	132 **7.1**
B	806	Aug. 30 1954	1861 61	340 **18.3**	360 **19.3**	750 **40.3**	390 **20.9**	500 **26.9**	810 **43.5**	790 **42.4**	115 **6.2**	42 **2.3**	110 **5.9**	204 **11.0**	53 **2.8**	225 **12.1**	455 **24.4**	455 **24.4**	460 **24.7**	180 **9.7**	325 **17.5**	120 **6.4**
B	840	Sept. 3 1954	1861 61	340 **18.3**	360 **19.3**	730 **39.2**	440 **23.6**	540 **29.0**	880 **47.3**	900 **48.3**	130 **7.0**	41 **2.2**	80 **4.3**	220 **11.8**	52 **2.8**	202 **10.8**	455 **24.4**	440 **23.6**	455 **24.4**	175 **9.4**	325 **17.5**	125 **6.7**
B	807	Aug. 30 1954	1865 61	320 **17.2**	360 **19.3**	710 **38.1**	395 **21.2**	500 **26.8**	810 **43.4**	780 **41.8**	125 **6.7**	38 **2.0**	100 **5.4**	205 **11.0**	50 **2.7**	205 **11.0**	435 **23.3**	435 **23.3**	445 **23.9**	165 **8.8**	315 **16.9**	125 **6.7**
K	953	Aug. 4 1954	1975 65	345 **17.5**	390 **19.7**	805 **40.7**	465 **23.5**	540 **27.3**	890 **45.0**	875 **44.3**	150 **7.6**	41 **2.1**	95 **4.8**	225 **11.4**	57 **2.9**	220 **11.1**	475 **24.0**	498 **25.2**	465 **23.5**	183 **9.3**	345 **17.5**	130 **6.6**
Ky	712	July 12 1955	1915 63	— —	430 **22.5**	880 **46.0**	400 **20.9**	500 **26.1**	820 **42.8**	800 **41.8**	110 **5.7**	34 **1.8**	80 **4.2**	— —	— —	— —	— —	— —	— —	— —	— —	140 **7.3**
Ky	1072	July 29 1955	1790 59	330 **18.4**	370 **20.7**	750 **41.9**	420 **23.5**	540 **30.2**	820 **45.8**	800 **44.7**	130 **7.3**	50 **2.8**	100 **5.6**	205 **11.5**	55 **3.1**	210 **11.7**	450 **25.1**	— —	445 **24.9**	162 **9.1**	310 **17.3**	123 **6.9**
Ky	1074	July 29 1955	1876 62	365 **19.5**	400 **21.3**	820 **43.7**	440 **23.5**	530 **28.3**	830 **44.2**	820 **43.7**	130 **6.9**	41 **2.2**	100 **5.3**	225 **12.0**	53 **2.8**	220 **11.7**	500 **26.7**	— —	495 **26.4**	174 **9.3**	350 **18.7**	132 **7.0**
Ky	1099	July 30 1955	1670 55	310 **18.6**	335 **20.1**	640 **38.3**	400 **24.0**	500 **29.9**	790 **47.3**	760 **45.5**	120 **7.2**	42 **2.5**	100 **6.0**	195 **11.7**	48 **2.9**	185 **11.1**	410 **24.6**	— —	405 **24.3**	140 **8.4**	290 **17.4**	112 **6.7**
Ky	1101	July 30 1955	1760 58	340 **19.3**	360 **20.5**	730 **41.5**	400 **22.7**	480 **27.3**	810 **46.0**	800 **45.5**	120 **6.8**	42 **2.4**	80 **4.5**	200 **11.4**	50 **2.8**	215 **12.2**	445 **25.3**	— —	450 **25.6**	160 **9.1**	315 **17.9**	125 **7.1**
Ky	1115	July 31 1955	1820 60	285 **15.7**	365 **20.1**	765 **42.0**	400 **22.0**	510 **28.0**	830 **45.6**	810 **44.5**	130 **7.1**	41 **2.3**	110 **6.0**	210 **11.5**	49 **2.7**	205 **11.3**	445 **24.5**	— —	450 **24.7**	175 **9.6**	306 **16.8**	123 **6.8**

Ky	1117	July 31	1760	295	345	750	400	510	750	730	160	—	—	200	48	195	415	—	410	160	290	120
		1955	58	16.8	19.6	42.0	22.7	29.0	42.6	41.5	9.1	—	—	11.4	2.7	11.1	23.6	—	23.3	9.1	16.5	6.8
Ky	1147	Aug. 1	1800	—	385	772	410	510	810	790	180	39	90	216	56	210	460	—	455	170	310	123
		1955	59	—	21.4	42.9	22.8	28.3	45.0	43.9	10.0	2.1	5.0	12.0	3.1	11.7	25.6	—	25.3	9.4	17.2	6.8
Ky	1172	Aug. 2	1920	380	410	830	460	570	895	860	180	57	110	230	60	220	500	—	490	180	365	130
		1955	63	19.8	21.4	43.2	24.0	29.7	46.6	44.8	9.4	3.0	5.7	12.0	3.1	11.5	26.0	—	25.5	9.4	19.0	6.8
Ky	386	July 7	1870	355	395	—	440	525	850	835	115	44	90	—	54	215	485	470	490	185	350	140
		1956	61	19.0	21.1	—	23.5	28.1	45.5	44.7	6.1	2.4	4.8	—	2.9	11.5	25.9	25.1	26.2	9.9	18.7	7.5
Ky	419	July 8	1800	355	370	—	395	485	780	765	115	43	100	—	56	210	470	460	475	185	330	130
		1956	59	19.7	20.6	—	21.9	26.9	43.3	42.5	6.4	2.4	5.6	—	3.1	11.7	26.1	25.6	26.4	10.3	18.3	7.2
Ky	511	July 11	1850	340	360	730	415	510	815	790	140	48	100	—	55	185	450	450	450	175	305	135
		1956	61	18.4	19.5	39.5	22.4	27.6	44.1	42.7	7.6	2.6	5.4	—	3.0	10.0	24.3	24.3	24.3	9.5	16.5	7.3
Ky	572	July 13	1860	355	390	790	415	530	805	770	115	41	100	—	52	200	480	480	480	190	330	135
		1956	61	19.1	21.0	42.5	22.3	28.5	43.3	41.4	6.2	2.2	5.4	—	2.8	10.8	25.8	25.8	25.8	10.2	17.7	7.3
Ky	891	July 25	1895	325	360	740	445	565	885	860	155	40	80	—	55	195	450	440	455	175	290	125
		1956	62	17.2	19.0	39.1	23.5	29.8	46.7	45.4	8.2	2.1	4.2	—	2.9	10.3	23.7	23.2	24.0	9.2	15.3	6.6
Ky	912	July 26	1805	325	345	695	410	500	840	790	115	—	—	—	52	205	455	465	460	180	320	130
		1956	59	18.0	19.1	38.5	22.7	27.7	46.5	43.8	6.4	—	—	—	2.9	11.4	25.2	25.8	25.5	10.0	17.7	7.2
Ky	986	July 29	1760	320	345	710	380	500	800	780	130	—	—	—	53	190	435	435	440	175	295	120
		1956	58	18.2	19.6	40.3	21.6	28.4	45.5	44.3	7.4	—	—	—	3.0	10.8	24.7	24.7	25.0	9.9	16.8	6.8
Ky	1073	Aug. 1	1780	315	335	705	395-	525	840	825	120	—	—	—	51	200	425	420	430	170	295	120
		1956	58	17.7	18.8	39.6	22.2	29.5	47.2	46.3	6.7	—	—	—	2.9	11.2	23.9	23.6	24.2	9.6	16.6	6.7

TABLE 31. THE NORTH EAST SIDE WATERS OF ALEUTIAN ISLANDS IN THE NORTHERN PACIFIC, FEMALE, 1954~1956

Factory ship	Serial no.	Date caught	1	3	5	6	8	10	11	12	13	14	15	17	19	21	22	24	25	26	27	28
B	691	Aug. 21	1670	295	322	610	—	480	770	780	50	37	—	214	44	195	410	408	410	157	284	121
		1954	55	17.7	19.3	36.5	—	28.8	46.1	46.7	3.0	2.2	—	12.8	2.6	11.7	24.6	24.4	24.6	9.4	17.0	7.2
K	726	July 19	1770	315	345	680	440	545	790	815	45	38	70	190	50	195	430	425	430	165	305	125
		1954	58	17.8	19.5	38.4	24.9	30.8	44.6	46.0	2.5	2.1	4.0	10.7	2.8	11.0	24.3	24.0	24.3	9.3	17.2	7.1
B	1028	Aug. 18	1780	325	347	730	450	540	780	800	30	45	90	212	50	200	420	415	425	165	290	130
		1954	58	18.3	19.5	41.0	25.3	30.3	43.8	45.0	1.7	2.5	5.1	11.9	2.8	11.2	23.6	23.3	23.9	9.3	16.3	7.3
B	1035	Aug. 18	1795	350	380	745	470	530	810	810	70	43	80	212	51	210	454	450	457	165	310	125
		1954	59	19.5	21.2	41.5	26.2	29.5	45.1	45.1	3.9	2.4	4.5	11.8	2.8	11.7	25.3	25.1	25.5	9.2	17.3	7.0

TABLE 31. THE NORTH EAST SIDE WATERS OF ALEUTIAN ISLANDS IN THE NORTHERN PACIFIC, FEMACE, 1954~1956 (cont.)

Factory ship	Serial no.	Date caught	1	3	5	6	8	10	11	12	13	14	15	17	19	21	22	24	25	26	27	28
B	838	Sept. 2 1954	1825 60	331 **18.1**	350 **19.1**	740 **40.5**	460 **25.2**	580 **31.7**	860 **47.0**	820 **44.9**	50 **2.7**	40 **2.2**	85 **4.6**	231 **12.6**	51 **2.8**	218 **11.9**	425 **23.2**	410 **22.4**	425 **23.2**	185 **10.1**	292 **16.0**	127 **6.9**
B	951	Sept. 13 1954	1850 61	370 **20.0**	390 **21.1**	790 **42.7**	430 **23.2**	530 **28.7**	840 **45.4**	840 **45.4**	60 **3.2**	31 **1.7**	90 **4.9**	226 **12.2**	55 **3.0**	220 **11.9**	500 **27.1**	485 **26.2**	500 **27.1**	185 **10.0**	360 **19.5**	130 **7.0**
K	574	July 20 1954	1815 62	320 **17.6**	345 **19.0**	720 **39.7**	405 **22.3**	525 **28.9**	835 **46.0**	835 **46.0**	50 **2.8**	30 **1.7**	90 **5.0**	200 **11.0**	55 **3.0**	200 **11.0**	430 **23.7**	445 **24.5**	420 **23.1**	160 **8.8**	305 **16.8**	125 **6.9**
B	837	Sept. 2 1954	1886 62	— —	410 **21.7**	800 **42.4**	460 **24.4**	560 **29.7**	890 **47.2**	920 **48.8**	30 **1.6**	— —	110 **5.8**	240 **12.7**	51 **2.7**	210 **11.1**	480 **25.4**	490 **26.0**	480 **25.4**	175 **9.3**	360 **19.1**	135 **7.2**
B	1057	Sept. 21 1954	1890 62	375 **19.8**	410 **21.7**	820 **43.4**	430 **22.7**	500 **26.5**	870 **46.0**	890 **47.1**	70 **3.7**	50 **2.7**	100 **5.3**	205 **10.8**	53 **2.8**	220 **11.6**	500 **26.5**	495 **26.2**	505 **26.7**	185 **9.8**	365 **19.3**	135 **7.1**
K	934	Aug. 3 1954	1910 63	350 **18.3**	380 **19.9**	770 **40.3**	450 **23.5**	580 **30.3**	900 **47.1**	870 **45.5**	90 **4.7**	51 **2.7**	100 **5.2**	230 **12.0**	52 **2.7**	225 **11.8**	465 **24.3**	470 **24.6**	460 **24.1**	170 **8.9**	335 **17.5**	140 **7.3**
B	1073	Sept. 22 1954	1930 63	350 **18.1**	380 **19.7**	790 **40.9**	500 **25.9**	610 **31.6**	940 **48.7**	940 **48.7**	70 **3.6**	49 **2.5**	100 **5.1**	210 **10.9**	52 **2.7**	220 **11.4**	480 **24.9**	480 **24.9**	485 **25.1**	175 **9.1**	345 **17.9**	135 **7.0**
K	909	Aug. 2 1954	1940 64	340 **17.5**	360 **18.5**	770 **39.7**	455 **23.4**	570 **29.4**	900 **46.4**	910 **46.9**	50 **2.6**	45 **2.3**	95 **4.9**	225 **11.6**	52 **2.7**	205 **10.6**	460 **23.7**	450 **23.2**	460 **23.7**	170 **8.8**	315 **16.2**	125 **6.4**
B	1054	Sept. 20 1954	1950 64	360 **18.5**	400 **20.5**	810 **41.6**	440 **22.6**	520 **26.7**	860 **44.1**	840 **43.1**	60 **3.1**	46 **2.4**	120 **6.1**	214 **11.0**	49 **2.5**	210 **10.8**	495 **25.4**	485 **24.9**	495 **25.4**	175 **9.0**	355 **18.2**	135 **6.9**
K	903	Aug. 1 1954	1955 64	365 **18.7**	395 **20.2**	805 **41.2**	460 **23.6**	570 **29.2**	910 **46.6**	980 **50.2**	55 **2.8**	— —	110 **5.6**	220 **11.3**	55 **2.8**	210 **10.8**	490 **25.1**	490 **25.1**	480 **24.6**	185 **9.5**	340 **17.4**	140 **7.2**
B	866	Sept. 5 1954	1962 64	360 **18.4**	390 **19.9**	850 **43.4**	— —	570 **29.1**	880 **44.9**	910 **46.4**	60 **3.1**	48 **2.4**	110 **5.6**	235 **12.0**	53 **2.7**	210 **10.7**	475 **24.2**	475 **24.2**	480 **24.5**	175 **8.9**	340 **17.3**	127 **6.5**
B	890	Sept. 8 1954	1980 65	380 **19.2**	405 **20.5**	830 **41.9**	450 **22.7**	550 **27.8**	900 **45.5**	880 **44.4**	50 **2.5**	44 **2.2**	90 **4.5**	250 **12.6**	54 **2.7**	227 **11.5**	490 **24.7**	490 **24.7**	500 **25.3**	177 **8.9**	345 **17.4**	135 **6.8**
B	1043	Sept. 19 1954	2010 66	385 **19.2**	425 **21.2**	850 **42.3**	510 **25.4**	580 **28.9**	900 **44.8**	900 **44.8**	50 **2.5**	49 **2.4**	120 **6.0**	— —	— —	230 **11.5**	500 **24.9**	495 **24.7**	500 **24.9**	190 **9.5**	360 **17.9**	139 **6.9**
B	1058	Sept. 21 1954	2015 66	390 **19.3**	430 **21.3**	850 **42.2**	470 **23.3**	580 **28.8**	900 **44.6**	870 **43.2**	50 **2.5**	51 **2.5**	120 **6.0**	220 **10.9**	52 **2.6**	235 **11.7**	510 **25.3**	515 **25.5**	515 **25.5**	195 **9.7**	370 **18.4**	136 **6.7**
K	750	July 20 1954	2020 66	370 **18.3**	385 **19.1**	810 **40.1**	490 **24.3**	575 **28.5**	900 **44.6**	870 **43.1**	56 **2.8**	48 **2.4**	77 **3.8**	250 **12.4**	56 **2.8**	225 **11.1**	500 **24.8**	490 **24.3**	480 **23.8**	180 **8.9**	350 **17.3**	130 **6.4**
K	955	Aug. 4 1954	2020 66	370 **18.3**	390 **19.3**	— —	480 **23.8**	585 **29.0**	930 **46.0**	930 **46.0**	65 **3.2**	45 **2.2**	120 **5.9**	235 **11.6**	53 **2.6**	215 **10.6**	470 **23.3**	490 **24.3**	485 **24.0**	175 **8.7**	350 **17.3**	125 **6.2**

K	952	Aug. 4	2030	370	410	850	475	560	910	900	55	50	105	223	56	225	505	490	485	160	355	132
		1954	67	**18.2**	**20.2**	**41.9**	**23.4**	**27.6**	**44.9**	**44.4**	**2.7**	**2.5**	**5.2**	**11.0**	**2.8**	**11.1**	**24.9**	**24.2**	**23.9**	**7.9**	**17.5**	**6.5**
B	1056	Sept. 21	2030	395	437	840	510	580	920	960	60	48	90	220	57	210	530	515	525	180	390	143
		1954	67	**19.5**	**21.5**	**41.4**	**25.1**	**28.6**	**45.4**	**47.3**	**3.0**	**2.4**	**4.4**	**10.8**	**2.8**	**10.4**	**26.1**	**25.4**	**25.9**	**8.9**	**19.2**	**7.0**
B	857	Sept. 4	2074	410	440	910	460	580	910	890	50	53	100	240	64	242	535	500	535	188	378	148
		1954	68	**19.8**	**21.2**	**43.9**	**22.2**	**28.0**	**43.9**	**42.9**	**2.4**	**2.6**	**4.8**	**11.6**	**3.1**	**11.7**	**25.8**	**24.1**	**25.8**	**9.1**	**18.2**	**7.1**
B	954	Sept. 14	2160	430	460	910	510	620	1010	970	60	57	120	250	57	245	570	570	575	200	410	152
		1954	71	**20.7**	**22.2**	**43.8**	**24.6**	**29.9**	**48.7**	**46.8**	**2.9**	**2.7**	**5.8**	**12.1**	**2.7**	**11.8**	**27.4**	**27.4**	**27.7**	**9.6**	**19.8**	**7.3**
Ky	772	July 16	1770	345	370	740	410	510	820	800	70	51	80	—	—	—	—	—	—	—	—	—
		1955	58	**19.5**	**20.9**	**41.8**	**23.2**	**28.8**	**46.3**	**45.2**	**4.0**	**2.9**	**4.5**	—	—	—	—	—	—	—	—	—
Ky	1071	July 29	1970	380	410	820	460	580	910	900	50	52	110	235	56	—	—	—	—	—	—	—
		1955	65	**19.3**	**20.8**	**41.6**	**23.3**	**29.4**	**46.2**	**45.7**	**2.5**	**2.6**	**5.6**	**11.9**	**2.8**	—	—	—	—	—	—	—
Ky	1073	July 29	1845	—	395	765	450	540	790	770	40	42	100	215	52	220	485	—	480	170	340	140
		1955	61	—	**21.4**	**41.5**	**24.4**	**29.3**	**42.8**	**41.7**	**2.2**	**2.3**	**5.4**	**11.7**	**2.8**	**11.9**	**26.3**	—	**26.0**	**9.2**	**18.4**	**7.6**

TABLE 32. NORTHERN PART OF EAST CHINA SEA, MALE, 1955

Serial no.	Date caught	1	3	5	6	7	8	10	11	12	13	14	15	17	19
16	Aug. 4	1524	230	284	518	55	375	434	716	671	—	—	—	—	—
		50	15.1	18.6	34.0	3.6	24.0	28.5	47.0	44.0	—	—	—	—	—
30	Aug. 8	1555	289	324	—	68	—	—	—	—	—	30	76	175	45
		51	18.6	20.8	—	4.4	—	—	—	—	—	1.9	4.9	11.3	2.9
34	Aug. 9	1555	284	312	591	71	365	441	716	703	106	30	78	190	43
		51	18.3	20.1	38.0	4.6	23.5	28.4	46.0	45.2	6.8	1.9	5.0	12.2	2.8
45	Aug. 15	1585	291	327	640	71	406	487	762	742	126	27	86	192	43
		52	18.4	20.6	40.4	4.5	25.6	30.7	48.1	46.8	7.9	1.7	5.4	12.1	2.7
49	Aug. 15	1585	261	291	627	65	365	426	747	793	134	38	91	190	48
		52	16.5	18.4	39.6	4.1	23.0	26.9	47.1	50.0	8.5	2.4	5.7	12.0	3.0
59	Aug. 18	1524	258	291	554	68	—	431	744	718	116	30	71	172	40
		50	16.9	19.1	36.4	4.5	—	28.3	48.8	47.1	7.6	2.0	4.7	11.3	2.6
61	Aug. 19	1524	266	291	569	68	378	449	752	723	119	27	96	185	45
		50	17.5	19.1	37.3	4.5	24.8	29.5	49.3	47.4	7.8	1.8	6.3	12.1	3.0
77	Aug. 23	1524	248	286	564	68	375	449	732	713	114	38	96	185	43
		50	16.3	18.8	37.0	4.5	24.6	29.5	48.0	46.8	7.5	2.5	6.3	12.1	2.8
85	Aug. 25	1524	241	291	610	65	380	457	732	698	106	48	109	190	48
		50	15.8	19.1	40.0	4.3	24.9	30.0	48.0	45.8	7.0	3.1	7.2	12.5	3.1
141	Sept. 12	1555	269	304	640	73	350	441	696	676	157	27	83	195	45
		51	17.3	19.5	41.2	4.7	22.5	28.4	44.8	43.5	10.1	1.7	5.3	12.5	2.9
152	Sept. 14	1585	286	294	627	73	—	464	808	833	121	27	78	197	48
		52	18.0	18.5	39.6	4.6	—	29.3	51.0	52.6	7.6	1.7	4.9	12.4	3.0
164	Sept. 16	1524	243	261	732	63	350	426	793	—	—	—	—	—	—
		50	15.9	17.1	48.0	4.1	23.0	28.0	52.0	—	—	—	—	—	—
185	Sept. 21	1555	253	289	640	68	357	467	772	762	129	35	116	182	45
		51	16.3	15.6	41.2	4.4	23.0	30.0	49.6	49.0	8.3	2.3	7.5	11.7	2.9
226	Oct. 15	1585	304	350	640	76	355	457	—	—	129	30	91	205	45
		52	19.2	22.1	40.4	4.8	22.4	28.8	—	—	8.1	1.9	5.7	12.9	2.8
17	Aug. 4	1646	187	312	554	68	416	510	813	762	137	—	—	172	45
		54	11.4	19.0	33.7	4.1	25.3	31.0	49.4	46.3	8.3	—	—	10.4	2.7
19	Aug. 4	1646	284	317	610	73	441	510	810	762	147	38	114	195	45
		54	17.3	19.3	37.1	4.4	26.8	31.0	49.2	46.3	8.9	2.3	6.9	11.8	2.7
21	Aug. 5	1646	291	347	—	78	—	—	—	—	—	38	71	210	45
		54	17.7	21.1	—	4.7	—	—	—	—	—	2.3	4.3	12.8	2.7
26	Aug. 7	1676	289	322	671	83	426	487	777	706	180	—	93	195	45
		55	17.2	19.2	40.0	5.0	25.4	29.1	46.4	42.1	10.7	—	5.5	11.6	2.7
37	Aug. 10	1646	286	314	625	81	380	457	808	772	131	30	86	195	45
		54	17.4	19.1	38.0	4.9	23.1	27.8	49.1	46.9	8.0	1.8	5.2	11.8	2.7
62	Aug. 19	1615	291	322	620	81	352	474	808	747	124	—	98	195	48
		53	18.0	19.9	38.4	5.0	21.8	29.4	50.0	46.3	7.7	—	6.1	12.1	3.0
90	Aug. 26	1646	289	317	640	71	393	505	752	698	119	43	103	210	48
		54	17.6	19.3	38.9	4.3	23.9	30.7	45.7	42.4	7.2	2.6	6.3	12.8	2.9
99	Aug. 30	1676	332	370	—	78	—	—	—	—	—	—	91	203	50
		55	19.8	22.1	—	4.7	—	—	—	—	—	—	5.4	12.1	3.0
100	Aug. 30	1615	279	317	—	76	368	467	777	754	124	30	88	197	45
		53	17.3	19.6	—	4.7	22.8	28.9	48.1	46.7	7.7	1.9	5.4	12.2	2.8
103	Sept. 1	1646	299	337	640	78	385	469	779	749	119	38	101	200	48
		54	18.2	20.5	38.9	4.7	23.4	28.5	47.3	45.5	7.2	2.3	6.1	12.2	2.9
111	Sept. 4	1676	294	337	640	81	396	487	823	808	134	40	109	180	45
		55	17.5	20.1	38.2	4.8	23.6	29.1	49.1	48.2	8.0	2.4	6.5	10.7	2.7

TABLE 32. NORTHERN PART OF EAST CHINA SEA, MALE, 1955 (cont.)

Serial no.	Date caught	1	3	5	6	7	8	10	11	12	13	14	15	17	19
120	Sept. 7	1676	274	309	610	73	—	487	793	769	126	27	86	190	48
		55	16.3	18.4	36.4	4.4	—	29.1	47.3	45.9	7.5	1.6	5.1	11.3	2.9
133	Sept. 10	1676	195	335	640	76	365	500	805	772	131	—	—	182	45
		55	11.6	20.0	38.2	4.5	21.8	29.8	48.0	46.1	7.8	—	—	10.9	2.7
140	Sept. 12	1676	299	335	640	78	413	444	762	744	121	30	78	200	45
		55	17.8	20.0	38.2	4.7	24.6	26.5	45.5	44.4	7.2	1.8	4.7	11.9	2.7
143	Sept. 12	1646	304	345	615	76	380	492	818	795	142	40	103	233	50
		54	18.5	21.0	37.4	4.6	23.1	29.9	49.7	48.3	8.6	2.4	6.3	14.2	3.1
154	Sept. 14	1676	330	355	671	58	383	492	803	787	114	43	109	197	55
		55	19.7	21.2	40.0	3.5	22.9	29.4	47.9	47.0	6.8	2.6	6.5	11.8	3.3
156	Sept. 15	1615	261	291	610	68	378	411	762	744	—	38	116	182	50
		53	16.2	18.0	37.8	4.2	23.4	25.4	47.2	46.1	—	2.4	7.2	11.3	3.1
157	Sept. 15	1646	253	309	660	76	352	469	772	754	121	35	116	208	50
		54	15.4	18.8	40.1	4.6	21.4	28.5	47.0	45.8	7.4	2.1	7.0	12.6	3.1
160	Sept. 16	1676	314	319	683	76	380	482	813	808	142	35	109	197	50
		55	18.7	19.0	40.8	4.5	22.7	28.8	48.5	48.2	8.5	2.1	6.5	11.8	3.0
182	Sept. 20	1676	289	319	640	71	388	523	805	774	137	40	126	187	45
		55	17.2	19.0	38.2	4.2	23.2	31.2	48.0	46.2	8.2	2.4	7.5	11.2	2.7
184	Sept. 21	1646	289	324	635	78	375	505	808	798	126	38	129	208	50
		54	17.6	19.7	38.6	4.7	22.8	30.7	49.1	48.5	7.7	2.3	7.8	12.6	3.1
191	Sept. 22	1676	314	340	640	78	396	487	803	—	—	32	98	205	50
		55	18.7	20.3	38.2	4.7	23.6	29.1	47.9	—	—	1.9	5.8	12.2	3.0
193	Sept. 22	1646	335	365	671	—	396	457	762	737	—	43	126	182	45
		54	20.4	22.2	40.8	—	24.1	27.8	46.3	44.8	—	2.6	7.7	11.1	2.7
197	Sept. 24	1646	297	322	655	76	388	457	767	744	114	38	101	182	45
		54	18.0	19.6	39.8	4.6	23.6	27.8	46.6	45.2	6.9	2.3	6.1	11.1	2.7
203	Sept. 26	1676	297	324	—	—	—	—	—	—	—	—	—	197	50
		55	17.7	19.3	—	—	—	—	—	—	—	—	—	11.8	3.0
207	Oct. 1	1676	309	335	640	73	388	502	810	779	139	40	121	218	48
		55	18.4	20.0	38.2	4.4	23.1	30.0	48.3	46.5	8.3	2.4	7.2	13.0	2.9
218	Oct. 5	1676	317	322	627	—	335	462	779	739	137	38	116	208	48
		55	18.9	19.2	37.4	—	20.0	27.6	46.5	44.1	8.2	2.3	6.9	12.4	2.9
44	Aug. 14	1797	340	380	732	88	426	487	838	815	137	35	103	200	48
		59	18.9	21.1	40.7	4.9	23.7	27.1	46.6	45.3	7.6	1.9	5.7	11.1	2.7
57	Aug. 17	1768	319	357	718	86	396	502	853	853	137	43	111	220	48
		58	18.0	20.2	40.6	4.9	22.4	28.4	48.2	48.2	7.7	2.4	6.3	12.4	2.7
63	Aug. 19	1737	304	352	686	81	416	500	823	805	119	38	88	210	48
		57	17.5	20.3	39.5	4.7	23.9	28.8	47.4	46.3	6.9	2.2	5.1	12.1	2.8
64	Aug. 20	1737	307	340	688	83	406	518	810	777	114	40	98	205	50
		57	17.7	19.6	39.6	4.8	23.4	29.8	46.6	44.7	6.6	2.3	5.6	11.8	2.9
65	Aug. 20	1707	307	370	660	78	408	505	803	777	131	38	98	218	50
		56	18.0	21.7	38.7	4.6	23.9	29.6	47.0	45.5	7.7	2.2	5.7	12.8	2.9
71	Aug. 21	1768	322	352	701	81	441	518	838	838	139	38	111	213	50
		58	18.2	19.9	39.6	4.6	24.9	29.3	47.4	47.4	7.9	2.1	6.3	12.0	2.8
74	Aug. 23	1707	304	337	640	76	418	487	823	805	114	40	106	203	50
		56	17.8	19.7	37.5	4.5	24.5	28.5	48.2	47.2	6.7	2.3	6.2	11.9	2.9
76	Aug. 23	1707	304	340	671	81	408	487	823	803	114	35	91	205	50
		56	17.8	19.9	39.3	4.7	23.9	28.5	48.2	47.0	6.7	2.1	5.3	12.0	2.9
81	Aug. 21	1407	327	370	701	78	396	469	896	878	134	35	96	208	50
		56	19.2	21.7	41.1	4.6	23.2	27.5	52.5	51.4	7.8	2.1	5.6	12.2	2.9

TABLE 32. NORTHERN PART OF EAST CHINA SEA, MALE, 1955 (cont.)

Serial no.	Date caught	1	3	5	6	7	8	10	11	12	13	14	15	17	19
82	Aug. 24	1798	307	340	701	81	413	533	853	825	142	35	98	218	53
		59	**17.1**	**18.9**	**39.0**	**4.5**	**23.0**	**29.6**	**47.4**	**45.9**	**7.9**	**1.9**	**5.5**	**12.1**	**2.9**
86	Aug. 25	1768	337	375	732	81	431	487	823	787	137	38	101	218	53
		58	**19.1**	**21.2**	**41.4**	**4.6**	**24.4**	**27.5**	**46.5**	**44.5**	**7.7**	**2.1**	**5.7**	**12.3**	**3.0**
87	Aug. 25	1737	307	340	681	78	—	482	798	830	144	35	91	213	48
		57	**17.7**	**19.6**	**39.2**	**4.5**	—	**27.7**	**45.9**	**47.8**	**8.3**	**2.0**	**5.2**	**12.3**	**2.8**
88	Aug. 26	1798	314	355	671	83	408	507	868	850	139	38	114	210	50
		59	**17.5**	**19.7**	**37.3**	**4.6**	**22.7**	**28.2**	**48.3**	**47.3**	**7.7**	**2.1**	**6.3**	**11.7**	**2.8**
91	Aug. 26	1707	314	352	—	78	385	502	810	772	109	38	131	208	50
		56	**18.4**	**20.6**	—	**4.6**	**22.6**	**29.4**	**47.5**	**45.2**	**6.4**	**2.2**	**7.7**	**12.2**	**2.9**
95	Aug. 30	1798	322	365	732	86	444	543	853	828	126	38	101	215	50
		59	**17.9**	**20.3**	**40.7**	**4.8**	**24.7**	**30.2**	**47.4**	**46.1**	**7.0**	**2.1**	**5.6**	**12.0**	**2.8**
101	Aug. 31	1737	309	355	620	78	408	533	843	828	131	35	91	190	48
		57	**17.8**	**20.4**	**35.7**	**4.5**	**23.5**	**30.7**	**48.5**	**47.7**	**7.5**	**2.0**	**5.1**	**10.7**	**2.7**
107	Sept. 3	1707	307	347	671	81	406	482	808	808	124	35	83	182	48
		56	**18.0**	**20.3**	**39.3**	**4.7**	**23.8**	**28.2**	**47.3**	**47.3**	**7.3**	**2.1**	**4.9**	**10.7**	**2.8**
112	Sept. 4	1798	314	352	732	86	444	549	899	865	139	38	131	230	50
		59	**17.5**	**19.6**	**40.7**	**4.8**	**24.7**	**30.5**	**50.0**	**48.1**	**7.7**	**2.1**	**7.3**	**12.8**	**2.8**
114	Sept. 5	1798	314	347	686	83	426	518	884	838	152	32	103	218	53
		59	**17.5**	**19.3**	**38.2**	**4.6**	**23.7**	**28.8**	**49.2**	**46.6**	**8.5**	**1.8**	**5.7**	**12.1**	**2.9**
117	Sept. 6	1798	322	360	701	83	408	518	853	873	124	35	101	218	50
		59	**17.9**	**20.0**	**39.0**	**4.6**	**22.7**	**28.8**	**47.4**	**48.6**	**6.9**	**1.9**	**5.6**	**12.1**	**2.8**
118	Sept. 7	1798	324	360	732	81	426	487	823	815	162	43	111	208	53
		59	**18.0**	**20.0**	**40.7**	**4.5**	**23.7**	**27.1**	**45.8**	**45.3**	**9.0**	**2.4**	**6.2**	**11.6**	**2.9**
121	Sept. 8	1737	304	335	610	81	—	549	884	—	—	43	103	185	48
		57	**17.5**	**19.3**	**35.1**	**4.7**	—	**31.6**	**50.9**	—	—	**2.4**	**5.9**	**10.7**	**2.8**
123	Sept. 8	1737	335	365	732	81	396	487	—	—	147	38	103	213	50
		57	**19.3**	**21.0**	**42.1**	**4.7**	**22.8**	**28.0**	—	—	**8.5**	**2.2**	**5.9**	**12.3**	**2.9**
124	Sept. 8	1768	304	335	—	78	335	549	853	808	83	—	134	230	45
		58	**17.2**	**18.9**	—	**4.4**	**18.9**	**31.1**	**48.2**	**45.7**	**4.7**	—	**7.6**	**13.0**	**2.5**
131	Sept. 10	1798	342	373	762	81	383	505	833	823	167	45	121	213	53
		59	**19.0**	**20.7**	**42.4**	**4.5**	**21.3**	**28.1**	**46.3**	**45.8**	**9.3**	**2.5**	**6.7**	**11.8**	**2.9**
136	Sept. 11	1768	335	373	732	81	416	495	833	823	182	35	114	215	50
		58	**18.9**	**21.1**	**41.4**	**4.6**	**23.5**	**28.0**	**47.1**	**46.5**	**10.3**	**2.0**	**6.4**	**12.2**	**2.8**
139	Sept. 12	1737	332	380	671	81	350	507	868	853	—	43	103	205	50
		57	**19.1**	**21.9**	**38.6**	**4.7**	**20.1**	**29.2**	**50.5**	**49.1**	—	**2.5**	**5.9**	**11.8**	**2.9**
144	Sept. 12	1768	284	330	665	83	411	514	850	838	126	—	—	220	48
		58	**16.1**	**18.7**	**37.6**	**4.7**	**23.2**	**29.1**	**48.1**	**47.4**	**7.1**	—	—	**12.2**	**2.7**
146	Sept. 13	1798	309	370	701	78	401	487	853	838	152	43	103	218	48
		59	**17.2**	**20.6**	**39.0**	**4.3**	**22.3**	**27.1**	**47.4**	**46.6**	**8.5**	**2.4**	**5.7**	**12.1**	**2.7**
147	Sept. 13	1707	317	350	676	83	385	492	823	800	164	40	129	200	48
		56	**18.6**	**20.5**	**39.6**	**4.9**	**22.6**	**28.8**	**48.2**	**46.9**	**9.6**	**2.3**	**7.6**	**11.7**	**2.8**
161	Sept. 16	1707	304	340	640	76	—	581	—	843	139	35	116	220	53
		56	**17.8**	**19.9**	**37.5**	**4.5**	—	**34.0**	—	**49.4**	**8.1**	**2.1**	**6.8**	**12.9**	**3.1**
166	Sept. 17	1798	309	340	688	78	436	535	853	835	152	—	—	213	53
		59	**17.2**	**18.9**	**38.3**	**4.3**	**24.2**	**29.8**	**47.4**	**46.4**	**8.5**	—	—	**11.8**	**2.9**
171	Sept. 18	1707	319	350	701	78	396	—	798	767	147	35	116	208	48
		56	**18.7**	**20.5**	**41.1**	**4.6**	**23.2**	—	**46.7**	**44.9**	**8.6**	**2.1**	**6.8**	**12.2**	**2.8**
173	Sept. 19	1768	350	378	732	86	396	487	865	845	109	40	111	210	50
		58	**19.8**	**21.4**	**41.4**	**4.9**	**22.4**	**27.5**	**48.9**	**47.8**	**6.2**	**2.3**	**6.3**	**11.9**	**2.8**

TABLE 32. NORTHERN PART OF EAST CHINA SEA, MALE, 1955 (cont.)

Serial no.	Date caught	1	3	5	6	7	8	10	11	12	13	14	15	17	19
174	Sept. 19	1798 **59**	335 **18.6**	368 **20.5**	747 **41.5**	83 **4.9**	403 **22.4**	505 **28.1**	833 **46.3**	823 **45.8**	116 **6.5**	38 **2.1**	131 **7.3**	225 **12.5**	50 **2.8**
175	Sept. 19	1737 **57**	284 **16.4**	289 **16.6**	657 **37.8**	78 **4.5**	352 **20.3**	492 **28.3**	— —	— —	129 **7.4**	45 **2.6**	129 **7.4**	213 **12.3**	53 **3.1**
177	Sept. 19	1768 **58**	309 **17.5**	345 **19.5**	732 **41.4**	83 **4.7**	380 **21.5**	497 **28.1**	742 **42.0**	711 **40.2**	159 **9.0**	40 **2.3**	126 **7.1**	192 **10.9**	53 **3.0**
178	Sept. 20	1737 **57**	324 **18.7**	357 **20.6**	691 **39.8**	76 **4.4**	418 **24.1**	502 **28.9**	843 **48.5**	810 **46.6**	157 **9.0**	40 **2.3**	142 **8.2**	243 **14.0**	53 **3.1**
179	Sept. 20	1798 **59**	350 **19.5**	388 **21.6**	732 **40.7**	78 **4.3**	424 **23.6**	502 **27.9**	803 **44.7**	789 **43.9**	144 **8.0**	45 **2.5**	129 **7.2**	223 **12.4**	50 **2.8**
186	Sept. 21	1798 **59**	309 **17.2**	355 **19.7**	732 **40.7**	81 **4.5**	426 **23.7**	490 **27.3**	868 **48.3**	858 **47.7**	152 **8.5**	43 **2.4**	129 **7.2**	220 **12.2**	55 **3.1**
200	Sept. 25	1768 **58**	309 **17.5**	355 **20.1**	701 **39.6**	78 **4.4**	391 **22.1**	540 **30.5**	848 **48.0**	823 **46.5**	139 **7.9**	30 **1.7**	91 **5.1**	223 **12.6**	53 **3.0**
206	Sept. 27	1737 **57**	317 **18.3**	352 **20.3**	640 **36.8**	81 **4.7**	418 **24.1**	— —	— —	— —	— —	35 **2.0**	116 **6.7**	197 **11.3**	50 **2.9**
214	Oct. 5	1737 **57**	327 **18.8**	352 **20.3**	683 **39.3**	— —	396 **22.8**	502 **28.9**	793 **45.7**	762 **43.9**	134 **7.7**	43 **2.5**	116 **6.7**	215 **12.4**	50 **2.9**
18	Aug. 4	1829 **60**	401 **22.0**	444 **24.3**	744 **40.7**	93 **5.1**	439 **24.0**	518 **28.3**	793 **43.4**	739 **40.4**	147 **8.0**	50 **2.7**	96 **5.2**	203 **11.1**	50 **2.7**
27	Aug. 7	1890 **62**	335 **17.7**	380 **20.1**	701 **37.1**	88 **4.7**	426 **22.5**	505 **26.7**	884 **46.8**	818 **43.3**	152 **8.0**	40 **2.1**	98 **5.2**	210 **11.1**	53 **2.8**
39	Aug. 11	1829 **60**	312 **17.1**	350 **19.1**	732 **40.0**	78 **4.3**	411 **22.5**	502 **27.4**	853 **46.6**	833 **45.5**	139 **7.6**	43 **2.4**	96 **5.2**	215 **11.8**	53 **2.9**
42	Aug. 14	1829 **60**	327 **17.9**	357 **19.5**	732 **40.0**	81 **4.4**	441 **24.1**	549 **30.0**	884 **48.3**	865 **47.3**	152 **8.3**	38 **2.1**	96 **5.2**	233 **12.7**	55 **3.0**
53	Aug. 17	1829 **60**	319 **17.4**	357 **19.5**	732 **40.0**	86 **4.7**	426 **23.3**	487 **26.6**	853 **46.6**	798 **43.6**	111 **6.1**	43 **2.4**	103 **5.6**	215 **11.8**	50 **2.7**
83	Aug. 24	1890 **62**	340 **18.0**	375 **19.8**	732 **38.7**	88 **4.7**	469 **24.8**	549 **29.0**	904 **47.8**	875 **46.3**	142 **7.5**	38 **2.0**	114 **6.0**	220 **11.6**	53 **2.8**
94	Aug. 27	1829 **60**	327 **17.9**	357 **19.5**	701 **38.3**	88 **4.8**	413 **22.6**	502 **27.4**	865 **47.3**	860 **47.0**	164 **9.0**	32 **1.7**	101 **5.5**	192 **10.5**	50 **2.7**
110	Sept. 4	1859 **61**	335 **18.0**	378 **20.3**	711 **38.2**	86 **4.6**	426 **22.9**	566 **30.4**	914 **49.2**	873 **47.0**	154 **8.3**	45 **2.4**	119 **6.4**	218 **11.7**	53 **2.9**
130	Sept. 10	1829 **60**	304 **16.6**	365 **19.9**	701 **38.3**	86 **4.7**	406 **22.2**	528 **28.9**	863 **47.2**	853 **46.6**	170 **9.3**	45 **2.5**	93 **5.1**	230 **12.6**	55 **3.0**
134	Sept. 10	1829 **60**	350 **19.1**	380 **20.8**	752 **41.1**	81 **4.4**	411 **22.5**	502 **27.4**	853 **46.6**	838 **45.8**	129 **7.1**	48 **2.6**	164 **9.0**	215 **11.8**	50 **2.7**
135	Sept. 10	1859 **61**	345 **18.6**	383 **20.6**	749 **40.3**	91 **4.9**	469 **25.2**	549 **29.5**	870 **46.8**	853 **45.9**	167 **9.0**	45 **2.4**	129 **6.9**	215 **11.6**	53 **2.9**
142	Sept. 12	1829 **60**	347 **19.0**	396 **21.7**	732 **40.0**	81 **4.4**	421 **23.0**	518 **28.3**	853 **46.6**	840 **45.9**	137 **7.5**	32 **1.7**	109 **6.0**	228 **12.5**	50 **2.7**
148	Sept. 13	1859 **61**	352 **18.9**	396 **21.3**	777 **41.8**	78 **4.2**	385 **20.7**	591 **31.8**	823 **44.3**	815 **43.8**	137 **7.4**	35 **1.9**	114 **6.1**	223 **12.0**	53 **2.9**
158	Sept. 15	1829 **60**	352 **19.2**	383 **20.9**	721 **39.4**	83 **4.5**	401 **21.9**	492 **26.9**	840 **45.9**	823 **50.5**	177 **9.7**	43 **2.4**	121 **6.6**	197 **10.8**	53 **2.9**
159	Sept. 16	1829 **60**	340 **18.6**	375 **20.5**	686 **37.5**	86 **4.7**	350 **19.4**	538 **29.4**	914 **50.0**	886 **53.9**	121 **6.6**	40 **2.2**	129 **7.1**	210 **11.5**	53 **2.9**
162	Sept. 16	1829 **60**	330 **18.0**	357 **19.5**	732 **40.0**	81 **4.4**	426 **23.3**	535 **29.3**	868 **47.5**	865 **52.8**	180 **9.8**	35 **1.9**	119 **6.5**	208 **11.4**	50 **2.7**

TABLE 32. NORTHERN PART OF EAST CHINA SEA, MALE, 1955 (cont.)

Serial no.	Date caught	1	3	5	6	7	8	10	11	12	13	14	15	17	19
172	Sept. 18	1859	380	401	793	76	373	472	762	—	126	40	103	236	50
		61	**20.4**	**21.6**	**42.7**	**4.1**	**20.1**	**25.4**	**41.0**	—	**6.8**	**2.2**	**5.5**	**12.7**	**2.7**
194	Sept. 23	1829	335	375	749	81	406	549	853	835	121	35	119	236	53
		60	**18.3**	**20.5**	**41.0**	**4.4**	**22.2**	**30.0**	**46.6**	**51.1**	**6.6**	**1.9**	**6.5**	**12.9**	**2.9**
195	Sept. 23	1890	350	380	718	78	426	543	896	926	121	43	134	218	50
		62	**18.5**	**20.1**	**38.0**	**4.1**	**22.5**	**28.7**	**47.4**	**49.0**	**6.4**	**2.3**	**7.1**	**11.5**	**2.6**
201	Sept. 25	1829	352	373	—	83	431	556	914	894	152	38	109	205	50
		60	**19.2**	**20.4**	—	**4.5**	**23.6**	**30.4**	**50.0**	**54.3**	**8.3**	**2.1**	**6.0**	**11.2**	**2.7**
211	Oct. 5	1829	340	370	723	71	393	518	800	777	162	45	131	225	55
		60	**18.6**	**20.2**	**39.5**	**3.8**	**21.5**	**28.3**	**49.2**	**47.9**	**8.9**	**2.5**	**7.2**	**12.3**	**3.0**
217	Oct. 5	1829	335	380	688	78	380	518	868	853	157	43	121	203	50
		60	**18.3**	**20.8**	**37.6**	**4.3**	**20.8**	**28.3**	**52.9**	**52.1**	**8.6**	**2.4**	**6.6**	**11.1**	**2.7**
40	Aug. 11	1951	349	383	774	91	441	549	929	904	142	32	101	208	50
		64	**17.9**	**19.6**	**39.7**	**4.7**	**22.6**	**28.1**	**47.6**	**46.3**	**7.3**	**1.6**	**5.2**	**10.7**	**2.6**
68	Aug. 21	1951	352	398	777	86	457	549	906	860	139	43	111	228	—
		64	**18.0**	**20.4**	**39.8**	**4.4**	**23.4**	**28.1**	**46.4**	**44.1**	**7.1**	**2.2**	**5.7**	**11.7**	—
150	Sept. 14	1920	355	396	787	83	431	518	793	772	159	38	126	238	53
		63	**18.5**	**20.6**	**41.0**	**4.3**	**22.4**	**27.0**	**41.3**	**40.2**	**8.3**	**2.0**	**6.6**	**12.4**	**2.8**
155	Sept. 15	1920	365	401	779	83	421	533	945	860	162	40	116	236	50
		63	**19.0**	**20.9**	**40.6**	**4.3**	**21.9**	**27.8**	**49.2**	**44.8**	**8.4**	**2.1**	**6.0**	**12.3**	**2.6**

TABLE 33. NORTHERN PART OF EAST CHINA SEA, FEMALE, 1955

Serial no.	Date caught	1	3	5	6	7	8	10	11	12	13	14	15	17	19
126	Sept. 8	1524	274	304	—	63	365	457	732	732	43	32	91	162	43
		50	**18.0**	**19.9**	—	**4.1**	**24.0**	**30.0**	**48.0**	**48.0**	**2.8**	**2.1**	**6.0**	**10.6**	**2.8**
145	Sept. 13	1555	243	289	645	73	380	441	747	737	91	35	101	203	48
		51	**15.6**	**18.6**	**41.5**	**4.7**	**24.4**	**28.4**	**48.0**	**47.4**	**5.7**	**2.3**	**6.5**	**13.1**	**3.1**
188	Sept. 22	1555	264	297	599	73	383	472	793	749	45	43	137	192	43
		51	**17.0**	**19.1**	**38.5**	**4.7**	**24.6**	**30.4**	**51.0**	**48.2**	**2.9**	**2.8**	**8.8**	**12.3**	**2.8**
213	Oct. 5	1585	253	284	579	65	403	472	793	764	48	30	81	159	43
		52	**16.0**	**17.9**	**36.5**	**4.1**	**25.4**	**29.8**	**50.0**	**48.2**	**3.0**	**1.9**	**5.1**	**10.0**	**2.7**
224	Oct. 14	1524	289	319	591	63	383	487	747	732	58	38	116	170	40
		50	**19.0**	**20.9**	**38.8**	**4.1**	**25.1**	**32.0**	**49.0**	**48.0**	**3.8**	**2.5**	**7.6**	**11.1**	**2.6**
15	Aug. 4	1524	255	286	645	55	340	549	691	660	45	—	—	—	—
		50	**16.7**	**18.8**	**42.3**	**3.6**	**22.3**	**36.0**	**45.3**	**43.3**	**3.0**	—	—	—	—
22	Aug. 5	1555	243	299	945	68	380	408	762	747	45	38	81	200	45
		51	**15.6**	**19.2**	**59.6**	**4.5**	**24.4**	**26.2**	**49.0**	**48.0**	**2.9**	**2.4**	**5.2**	**12.9**	**2.9**
32	Aug. 8	1524	251	1281	640	68	396	464	719	716	43	35	83	182	43
		50	**16.5**	**8.4**	**42.0**	**4.5**	**26.0**	**30.4**	**47.2**	**47.0**	**2.8**	**2.3**	**5.4**	**11.9**	**2.8**
43	Aug. 14	1615	274	307	640	78	365	457	762	737	55	32	91	197	45
		53	**17.0**	**19.0**	**39.6**	**4.8**	**22.6**	**28.3**	**47.2**	**45.6**	**3.4**	**2.0**	**5.6**	**12.2**	**2.8**
79	Aug. 24	1676	322	355	686	81	413	487	823	818	53	35	96	220	50
		55	**19.2**	**21.2**	**40.9**	**4.8**	**24.6**	**29.1**	**49.1**	**48.8**	**3.2**	**2.1**	**5.7**	**13.1**	**3.0**
109	Sept. 4	1646	307	378	686	71	352	467	747	721	53	30	91	205	48
		54	**18.7**	**23.0**	**41.7**	**4.3**	**21.4**	**28.4**	**45.4**	**43.8**	**3.2**	**1.8**	**5.5**	**12.5**	**2.9**

TABLE 33. NORTHERN PART OF EAST CHINA SEA, FEMALE, 1955 (cont.)

Serial no.	Date caught	1	3	5	6	7	8	10	11	12	13	14	15	17	19
129	Sept. 8	1646	304	365	—	73	365	396	793	793	50	38	109	215	45
		54	**18.5**	**22.2**	—	**4.4**	**22.2**	**24.1**	**48.2**	**48.2**	**3.0**	**2.3**	**6.6**	**13.1**	**2.7**
149	Sept. 14	1676	317	345	688	78	391	487	774	747	53	35	93	210	50
		55	**18.9**	**20.6**	**41.1**	**4.7**	**23.3**	**29.1**	**46.2**	**44.6**	**3.2**	**2.1**	**5.5**	**12.5**	**3.0**
176	Sept. 19	1676	309	350	591	65	360	500	830	825	45	27	111	210	50
		55	**18.4**	**20.9**	**35.3**	**3.9**	**21.5**	**29.8**	**49.5**	**49.2**	**2.7**	**1.6**	**6.6**	**12.5**	**3.0**
33	Aug. 8	1737	327	360	640	88	411	502	762	793	58	35	103	157	48
		57	**18.8**	**20.7**	**36.8**	**5.1**	**23.7**	**28.9**	**43.9**	**45.7**	**3.3**	**2.0**	**5.9**	**9.0**	**2.8**
41	Aug. 13	1798	322	355	701	83	426	535	884	808	48	40	103	223	50
		59	**17.9**	**19.7**	**39.0**	**4.6**	**23.7**	**29.8**	**49.2**	**44.9**	**2.7**	**2.2**	**5.7**	**12.4**	**2.8**
48	Aug. 15	1707	314	340	671	81	426	502	815	795	68	35	93	220	48
		56	**18.4**	**19.9**	**39.3**	**4.7**	**25.0**	**29.4**	**47.7**	**46.4**	**4.0**	**2.1**	**5.4**	**12.9**	**2.8**
50	Aug. 16	1737	297	347	640	78	411	477	840	818	63	43	119	197	48
		57	**17.1**	**20.0**	**36.8**	**4.5**	**23.7**	**27.5**	**48.4**	**47.1**	**3.6**	**2.5**	**6.9**	**11.3**	**2.8**
60	Aug. 18	1737	304	340	671	86	426	533	853	825	55	43	98	205	48
		57	**17.5**	**19.6**	**38.6**	**5.0**	**24.5**	**30.7**	**49.1**	**47.5**	**3.2**	**2.5**	**5.6**	**11.8**	**2.8**
69	Aug. 21	1737	345	375	701	78	413	502	823	769	60	32	86	218	53
		57	**19.9**	**21.6**	**40.4**	**4.5**	**23.8**	**28.9**	**47.4**	**44.3**	**3.5**	**1.8**	**5.0**	**12.6**	**3.1**
78	Aug. 23	1798	324	355	701	83	444	530	853	818	53	43	119	223	53
		59	**18.0**	**19.7**	**39.0**	**4.6**	**24.5**	**29.5**	**47.4**	**45.5**	**2.9**	**2.4**	**6.6**	**12.4**	**2.9**
80	Aug. 24	1798	322	360	701	78	426	502	823	789	35	43	109	208	50
		59	**17.9**	**20.0**	**39.0**	**4.3**	**23.7**	**27.9**	**45.7**	**43.9**	**1.9**	**2.4**	**6.1**	**11.6**	**2.8**
84	Aug. 24	1798	297	347	718	78	462	559	884	865	53	35	96	230	50
		59	**16.5**	**19.3**	**39.9**	**4.3**	**25.7**	**31.0**	**49.1**	**48.1**	**2.9**	**1.9**	**5.3**	**12.8**	**2.8**
108	Sept. 3	1707	314	352	671	73	416	487	838	838	48	48	96	190	50
		56	**18.4**	**20.6**	**39.3**	**4.3**	**24.4**	**28.5**	**49.1**	**49.1**	**2.8**	**2.8**	**5.6**	**11.1**	**2.9**
116	Sept. 5	1737	307	337	610	83	411	505	840	803	48	32	103	225	53
		57	**17.7**	**19.4**	**35.1**	**4.8**	**23.7**	**29.1**	**48.4**	**46.2**	**2.8**	**1.8**	**5.9**	**13.0**	**3.1**
119	Sept. 7	1798	342	378	732	83	424	518	853	830	50	32	111	200	53
		59	**19.0**	**21.0**	**40.7**	**4.6**	**23.6**	**28.8**	**47.5**	**46.2**	**2.8**	**1.8**	**6.2**	**11.1**	**2.9**
122	Sept. 8	1737	274	365	671	81	426	487	853	830	48	43	116	220	53
		57	**15.8**	**21.0**	**38.6**	**4.7**	**24.5**	**28.0**	**49.1**	**47.8**	**2.8**	**2.5**	**6.7**	**12.7**	**3.1**
165	Sept. 17	1798	345	391	716	81	411	524	838	810	58	35	116	208	53
		59	**19.2**	**21.7**	**39.8**	**4.5**	**22.9**	**29.1**	**46.6**	**45.0**	**3.2**	**1.9**	**6.5**	**11.6**	**2.9**
170	Sept. 18	1798	340	380	739	65	426	523	848	828	65	53	147	223	50
		59	**18.9**	**21.1**	**41.1**	**3.6**	**23.7**	**29.1**	**47.1**	**46.1**	**3.6**	**2.9**	**8.2**	**12.4**	**2.8**
180	Sept. 20	1768	340	378	723	76	436	500	843	838	40	40	101	213	53
		58	**19.2**	**21.4**	**40.9**	**4.3**	**24.7**	**28.3**	**47.7**	**47.4**	**2.3**	**2.3**	**5.7**	**12.0**	**3.0**
183	Sept. 21	1798	322	365	752	78	436	530	863	833	55	38	103	238	53
		59	**17.9**	**20.3**	**41.8**	**4.3**	**24.2**	**29.5**	**48.0**	**46.3**	**3.1**	**2.1**	**5.7**	**13.2**	**2.9**
187	Sept. 21	1707	314	345	696	73	375	492	823	813	45	38	147	208	50
		56	**18.4**	**20.2**	**40.8**	**4.3**	**22.0**	**28.8**	**48.2**	**47.9**	**2.6**	**2.2**	**8.4**	**12.1**	**2.9**
198	Sept. 24	1798	345	378	721	81	426	549	853	—	—	38	126	228	53
		59	**19.2**	**21.0**	**40.1**	**4.5**	**23.7**	**30.5**	**47.4**	—	—	**2.1**	**7.0**	**12.7**	**2.9**
202	Sept. 26	1798	314	365	742	76	396	535	853	835	60	38	131	213	48
		59	**17.5**	**20.3**	**41.3**	**4.2**	**22.0**	**29.8**	**47.4**	**46.4**	**3.3**	**2.1**	**7.3**	**11.8**	**2.7**
204	Sept. 26	1707	307	335	671	73	396	518	853	830	55	35	103	200	50
		56	**18.0**	**19.6**	**39.3**	**4.3**	**23.2**	**30.3**	**50.0**	**48.6**	**3.2**	**2.1**	**6.0**	**11.7**	**2.9**
209	Oct. 1	1707	304	340	671	73	396	497	813	838	63	35	103	195	45
		56	**17.8**	**19.9**	**39.3**	**4.3**	**23.2**	**29.1**	**47.6**	**49.1**	**3.7**	**2.1**	**6.0**	**11.4**	**2.6**

TABLE 33. NORTHERN PART OF EAST CHINA SEA, FEMALE, 1955 (cont.)

Serial no.	Date caught	1	3	5	6	7	8	10	11	12	13	14	15	17	19
210	Oct. 2	1798	335	370	749	86	416	518	845	830	60	43	116	205	53
		59	**18.6**	**20.6**	**41.7**	**4.8**	**23.1**	**28.8**	**47.0**	**46.2**	**3.3**	**2.4**	**6.5**	**11.4**	**2.9**
212	Oct. 5	1737	304	345	713	83	424	518	850	833	73	—	—	200	48
		57	**17.5**	**19.9**	**41.0**	**4.8**	**24.4**	**29.8**	**48.9**	**48.0**	**4.2**	—	—	**11.5**	**2.8**
23	Aug. 5	1859	352	378	777	86	413	518	838	798	55	32	106	210	53
		61	**18.1**	**19.5**	**40.9**	**4.6**	**22.2**	**27.9**	**45.1**	**42.9**	**3.0**	**1.7**	**5.7**	**11.3**	**2.9**
24	Aug. 6	1890	337	370	671	91	446	564	884	865	65	38	96	213	48
		62	**17.9**	**19.6**	**35.6**	**4.8**	**23.6**	**29.8**	**46.8**	**45.8**	**3.4**	**2.0**	**5.1**	**11.3**	**2.5**
25	Aug. 6	18.90	355	388	739	93	439	556	868	818	45	32	98	236	53
		62	**18.8**	**20.5**	**39.1**	**4.9**	**23.2**	**29.4**	**45.9**	**43.3**	**2.4**	**1.7**	**5.2**	**12.5**	**2.8**
28	Aug. 7	18.29	347	365	732	86	441	549	884	833	55	35	96	218	48
		60	**19.0**	**20.0**	**40.0**	**4.7**	**24.1**	**30.0**	**48.3**	**45.6**	**3.0**	**1.9**	**5.2**	**11.9**	**2.6**
35	Aug. 9	18.90	304	332	701	81	457	579	914	889	60	32	91	230	53
		62	**16.1**	**17.6**	**37.1**	**4.3**	**24.2**	**30.6**	**48.4**	**47.0**	**3.2**	**1.7**	**4.8**	**12.2**	**2.8**
51	Aug. 16	18.59	355	388	701	83	457	535	838	805	60	38	119	241	48
		61	**19.1**	**20.9**	**37.7**	**4.5**	**24.6**	**28.8**	**45.1**	**43.3**	**3.2**	**2.0**	**6.4**	**13.0**	**2.6**
54	Aug. 17	18.59	340	383	762	88	418	533	884	823	50	38	98	225	53
		61	**18.3**	**20.6**	**41.0**	**4.7**	**22.5**	**28.7**	**47.6**	**44.3**	**2.7**	**2.0**	**5.3**	**12.1**	**2.9**
73	Aug. 23	18.90	327	360	732	86	457	549	884	884	40	40	109	213	48
		62	**17.3**	**19.0**	**38.7**	**4.6**	**24.2**	**29.0**	**46.8**	**46.8**	**2.1**	**2.1**	**5.8**	**11.3**	**2.5**
89	Aug. 26	18.29	322	355	732	83	457	533	865	840	50	38	109	215	53
		60	**17.6**	**19.4**	**40.0**	**4.5**	**25.0**	**29.1**	**47.3**	**45.9**	**2.7**	**2.1**	**6.0**	**11.8**	**2.9**
92	Aug. 26	18.90	345	378	793	88	472	559	899	894	60	45	116	230	58
		62	**18.3**	**20.0**	**42.0**	**4.7**	**25.0**	**29.6**	**47.6**	**47.3**	**3.2**	**2.4**	**6.1**	**12.2**	**3.1**
96	Aug. 30	18.90	350	391	762	83	487	579	899	899	50	40	106	220	53
		62	**18.5**	**20.7**	**40.3**	**4.4**	**25.8**	**30.6**	**47.6**	**47.6**	**2.6**	**2.1**	**5.6**	**11.6**	**2.8**
97	Aug. 30	18.90	363	401	732	86	457	549	884	855	58	40	106	215	50
		62	**19.2**	**21.2**	**38.7**	**4.6**	**24.2**	**29.0**	**46.8**	**45.2**	**3.1**	**2.1**	**5.6**	**11.4**	**2.6**
102	Aug. 31	18.29	345	380	718	91	424	518	884	848	65	32	93	208	53
		60	**18.9**	**20.8**	**39.3**	**5.0**	**23.2**	**28.3**	**48.3**	**46.4**	**3.6**	**1.7**	**5.1**	**11.4**	**2.9**
105	Sept. 2	18.29	355	393	681	81	451	535	870	863	60	38	116	197	48
		60	**19.4**	**21.5**	**37.2**	**4.4**	**24.7**	**29.3**	**47.6**	**47.2**	**3.3**	**2.1**	**6.3**	**10.8**	**2.6**
106	Sept. 2	18.29	332	370	671	86	467	533	870	843	60	35	116	195	48
		60	**18.2**	**20.2**	**36.7**	**4.7**	**25.5**	**29.1**	**47.6**	**46.1**	**3.3**	**1.9**	**6.3**	**10.7**	**2.6**
115	Sept. 5	18.29	324	378	732	81	439	518	884	801	58	45	109	218	50
		60	**17.7**	**20.7**	**40.0**	**4.4**	**24.0**	**28.3**	**48.3**	**43.8**	**3.2**	**2.5**	**6.0**	**11.9**	**2.7**
132	Sept. 10	18.59	294	365	747	81	406	485	884	860	30	35	91	228	53
		61	**15.8**	**19.6**	**40.2**	**4.4**	**2.18**	**26.1**	**47.6**	**46.3**	**1.6**	**1.9**	**4.9**	**12.3**	**2.9**
137	Sept. 11	18.29	347	434	747	78	436	518	860	835	81	40	142	228	53
		60	**19.0**	**23.7**	**40.8**	**4.3**	**23.8**	**28.3**	**47.0**	**45.7**	**4.4**	**2.2**	**7.8**	**12.5**	**2.9**
138	Sept. 11	18.90	322	365	767	81	436	549	884	855	68	43	121	215	53
		62	**17.0**	**19.3**	**40.6**	**4.3**	**23.1**	**29.0**	**46.8**	**45.2**	**3.6**	**2.3**	**6.4**	**11.4**	**2.8**
153	Sept. 14	18.59	340	378	686	83	513	426	863	823	78	40	98	233	55
		61	**18.3**	**20.3**	**36.9**	**4.5**	**27.6**	**22.9**	**46.4**	**44.3**	**4.2**	**2.2**	**5.3**	**12.5**	**3.0**
163	Sept. 16	18.29	335	365	657	78	446	518	838	840	68	32	103	215	48
		60	**18.3**	**20.0**	**35.9**	**4.3**	**24.4**	**28.3**	**45.8**	**45.9**	**3.7**	**1.7**	**5.6**	**12.5**	**2.6**
168	Sept. 17	18.59	350	378	732	88	408	561	840	815	50	45	142	243	53
		61	**18.8**	**20.3**	**39.4**	**4.7**	**21.9**	**30.2**	**45.2**	**43.8**	**2.7**	**2.4**	**7.6**	**13.1**	**2.9**
190	Sept. 22	18.90	365	411	774	93	393	502	853	810	58	38	170	218	53
		62	**19.3**	**21.7**	**41.0**	**4.9**	**20.8**	**26.6**	**45.1**	**42.9**	**3.1**	**2.0**	**9.0**	**11.5**	**2.8**

TABLE 33. NORTHERN PART OF EAST CHINA SEA, FEMALE, 1955 (cont.)

Serial no.	Date caught	1	3	5	6	7	8	10	11	12	13	14	15	17	19
192	Sept. 22	18.29	340	365	671	76	441	549	884	868	45	45	114	195	45
		60	**18.6**	**20.0**	**36.7**	**4.2**	**24.1**	**30.0**	**48.3**	**47.5**	**2.5**	**2.5**	**6.2**	**10.7**	**2.5**
199	Sept. 24	18.59	355	385	732	78	408	533	868	865	50	30	106	205	50
		61	**19.1**	**20.7**	**39.4**	**4.2**	**21.9**	**28.7**	**46.7**	**46.5**	**2.7**	**1.6**	**5.7**	**11.0**	**2.7**
205	Sept. 27	18.90	345	391	732	83	457	540	843	830	71	43	109	208	53
		62	**18.3**	**20.7**	**38.7**	**4.4**	**24.2**	**28.6**	**44.6**	**43.9**	**3.8**	**2.3**	**5.8**	**11.0**	**2.8**
208	Oct. 1	18.59	335	365	732	91	416	530	884	853	71	38	91	220	53
		61	**18.0**	**19.6**	**39.4**	**4.9**	**22.4**	**28.5**	**47.6**	**45.9**	**3.8**	**2.0**	**4.9**	**11.9**	**2.9**
215	Oct. 5	1859	327	340	779	86	411	549	880	853	68	48	116	213	48
		61	**17.6**	**18.3**	**41.9**	**4.6**	**22.1**	**29.5**	**47.3**	**45.9**	**3.7**	**2.6**	**6.2**	**11.5**	**2.6**
216	Oct. 5	1829	335	365	732	86	375	502	899	909	55	38	109	218	53
		60	**18.3**	**20.0**	**40.0**	**4.7**	**20.5**	**27.4**	**49.2**	**49.7**	**3.0**	**2.1**	**6.0**	**11.9**	**2.9**
223	Oct. 13	1890	357	396	652	78	436	502	957	934	83	50	126	228	55
		62	**18.9**	**21.0**	**34.5**	**4.1**	**23.1**	**26.6**	**50.6**	**49.4**	**4.4**	**2.6**	**6.7**	**12.1**	**2.9**
225	Oct. 15	1859	352	383	716	78	416	564	1051	1011	65	35	73	213	53
		61	**18.9**	**20.6**	**38.5**	**4.2**	**22.4**	**30.3**	**56.5**	**54.4**	**3.5**	**1.9**	**3.9**	**11.5**	**2.9**
31	Aug. 8	1920	324	378	732	93	441	518	884	800	73	35	91	236	56
		63	**16.9**	**19.7**	**38.1**	**4.8**	**23.0**	**27.0**	**46.0**	**41.7**	**3.8**	**1.8**	**4.7**	**12.3**	**2.8**
38	Aug. 11	1920	335	396	777	88	482	549	929	873	71	43	96	220	58
		63	**17.4**	**20.6**	**40.5**	**4.6**	**25.1**	**28.6**	**48.4**	**45.5**	**3.7**	**2.2**	**5.0**	**11.5**	**2.0**
75	Aug. 23	1951	380	418	808	91	457	579	914	873	48	43	116	241	55
		64	**19.5**	**21.4**	**41.4**	**4.7**	**23.4**	**29.7**	**46.8**	**44.7**	**2.5**	**2.2**	**5.9**	**12.4**	**2.8**
46	Aug. 15	1951	383	416	779	91	457	533	899	863	58	40	129	220	53
		64	**19.6**	**21.3**	**39.9**	**4.7**	**23.4**	**27.3**	**46.1**	**44.2**	**3.0**	**2.1**	**6.6**	**11.3**	**2.7**
56	Aug. 17	1951	365	396	793	—	457	579	914	914	—	50	129	228	53
		64	**18.7**	**20.3**	**40.6**	—	**23.4**	**29.7**	**46.8**	**46.8**	—	**2.6**	**6.6**	**11.7**	**2.7**
67	Aug. 21	1981	365	406	793	91	477	579	919	825	45	40	111	215	58
		65	**18.4**	**20.5**	**40.0**	**4.6**	**24.1**	**29.2**	**46.4**	**41.6**	**2.3**	**2.0**	**5.6**	**10.9**	**2.9**
98	Aug. 30	1981	393	408	810	91	469	561	904	894	53	43	116	218	50
		65	**19.7**	**20.6**	**40.7**	**4.6**	**23.7**	**28.3**	**45.6**	**45.1**	**2.7**	**2.2**	**5.9**	**11.0**	**2.5**
104	Sept. 1	1920	345	380	747	81	482	596	980	960	58	35	88	228	55
		63	**18.0**	**19.8**	**38.9**	**4.2**	**25.1**	**31.0**	**51.0**	**50.0**	**3.0**	**1.8**	**4.6**	**11.9**	**2.9**
127	Sept. 8	1951	365	396	732	88	487	579	975	909	—	38	175	228	60
		64	**18.7**	**20.3**	**37.5**	**4.5**	**25.0**	**29.7**	**50.0**	**46.6**	—	**1.9**	**9.0**	**11.7**	**3.1**
128	Sept. 8	1920	365	396	762	88	487	610	945	926	53	32	91	236	50
		63	**19.0**	**20.6**	**39.2**	**4.6**	**25.4**	**31.8**	**49.2**	**48.2**	**2.8**	**1.7**	**4.7**	**12.3**	**2.6**
151	Sept. 14	1920	347	396	767	88	472	512	957	941	65	43	152	253	60
		63	**18.1**	**20.6**	**39.9**	**4.6**	**24.6**	**26.7**	**49.8**	**49.0**	**3.4**	**2.2**	**7.9**	**13.2**	**3.1**
167	Sept. 17	1951	378	408	774	91	462	492	914	914	71	43	114	218	53
		64	**19.4**	**20.9**	**39.7**	**4.7**	**23.7**	**25.2**	**46.8**	**46.8**	**3.6**	**2.2**	**5.8**	**11.2**	**2.7**
169	Sept. 17	1951	352	365	681	81	441	564	955	934	73	40	114	230	50
		64	**18.0**	**18.7**	**34.9**	**4.2**	**22.6**	**28.9**	**48.9**	**47.9**	**3.7**	**2.1**	**5.8**	**11.8**	**2.6**
181	Sept. 20	1981	357	413	823	86	416	523	894	823	88	35	137	258	50
		65	**18.0**	**20.8**	**41.5**	**4.3**	**21.0**	**26.4**	**45.1**	**41.5**	**4.4**	**1.8**	**6.9**	**13.0**	**2.5**
189	Sept. 22	1920	357	408	793	88	396	528	868	838	60	35	114	223	50
		63	**18.6**	**21.2**	**41.3**	**4.6**	**20.6**	**27.5**	**45.2**	**43.6**	**3.1**	**1.8**	**5.9**	**11.6**	**2.6**
196	Sept. 24	1920	388	418	793	91	457	579	960	926	45	32	131	243	50
		63	**20.2**	**21.8**	**41.3**	**4.7**	**23.8**	**30.2**	**50.0**	**48.2**	**2.3**	**1.7**	**6.8**	**12.7**	**2.6**
227	Oct. 17	1920	350	375	701	83	441	549	914	914	103	38	121	233	53
		63	**18.2**	**19.5**	**36.5**	**4.3**	**23.0**	**28.6**	**47.6**	**47.6**	**5.4**	**2.0**	**6.3**	**13.1**	**2.8**

TABLE 33. NORTHERN PART OF EAST CHINA SEA, FEMALE, 1955 (cont.)

Serial no.	Date caught	1	3	5	6	7	8	10	11	12	13	14	15	17	19
66	Aug. 20	2012	396	439	823	88	457	549	945	919	63	40	103	243	58
		66	**19.7**	**21.8**	**40.9**	**4.4**	**22.7**	**27.3**	**47.0**	**45.7**	**3.1**	**2.0**	**5.1**	**12.0**	**2.9**
70	Aug. 21	2012	388	431	823	96	451	549	929	896	53	38	126	238	55
		66	**19.3**	**21.4**	**40.9**	**4.8**	**22.4**	**27.3**	**46.2**	**44.5**	**2.6**	**1.9**	**6.3**	**11.8**	**2.7**
72	Aug. 21	2042	385	431	853	101	487	540	945	906	58	50	131	264	58
		67	**18.9**	**21.1**	**41.8**	**4.9**	**23.8**	**26.4**	**46.3**	**44.4**	**2.8**	**2.4**	**6.4**	**12.9**	**2.8**
220	Oct. 9	2103	426	464	838	103	457	596	992	967	76	45	137	238	63
		69	**20.3**	**22.1**	**39.8**	**4.9**	**21.7**	**28.3**	**47.2**	**46.0**	**3.6**	**2.1**	**6.4**	**11.3**	**3.0**

TABLE 34. NORTHERN PART OF EAST CHINA SEA, MALE, 1956

1) Taiyo Gyogyo Co. 2) Nippon Suisan Co.

Serial no.	Date caught	1	3	5	6	7	8	10	11	12	13	14	15	17	19	21	22	24	25	26	27	28
1) 89	Aug. 15	1554 **51**	280 **18.0**	315 **20.3**	585 **37.6**	70 **4.5**	353 **22.7**	480 **30.9**	740 **47.6**	750 **48.3**	112 **7.2**	46 **3.0**	115 **7.4**	130 **8.4**	41 **2.6**	180 **11.6**	390 **25.1**	— —	385 **24.8**	140 **9.0**	270 **17.4**	108 **6.9**
130	Sept. 11	1585 **52**	— —	306 **19.3**	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	183 **11.5**	385 **24.3**	— —	382 **24.1**	147 **9.3**	268 **16.9**	115 **7.3**
N2) 25	Aug. 7	1590 **52**	— —	325 **20.4**	630 **39.6**	77 **4.8**	340 **21.4**	450 **28.3**	760 **47.8**	770 **48.4**	110 **6.9**	— —	— —	207 **13.1**	50 **3.1**	193 **12.1**	385 **24.2**	420 **26.4**	392 **24.7**	164 **10.3**	— —	— —
N 31	Aug. 10	1515 **50**	— —	285 **18.8**	590 **38.9**	65 **4.3**	350 **23.1**	425 **28.1**	865 **57.1**	830 **54.8**	105 **6.9**	38 **2.5**	105 **6.9**	188 **12.4**	47 **3.1**	160 **10.6**	340 **22.4**	330 **21.8**	340 **22.4**	135 **8.9**	235 **15.5**	100 **6.6**
N 35	Aug. 11	1550 **51**	— —	315 **20.3**	580 **37.4**	73 **4.7**	370 **23.9**	450 **29.0**	750 **48.4**	710 **45.8**	110 **7.1**	36 **2.3**	110 **7.1**	195 **12.6**	45 **2.9**	180 **11.6**	375 **24.2**	375 **24.2**	370 **23.9**	150 **9.7**	260 **16.8**	110 **7.1**
62	Aug. 10	1646 **54**	250 **15.2**	285 **17.3**	605 **36.8**	75 **4.6**	369 **22.4**	490 **29.8**	817 **49.6**	788 **47.9**	130 **7.9**	37 **2.2**	124 **7.5**	152 **9.2**	50 **3.0**	210 **12.8**	390 **23.7**	387 **23.5**	395 **24.0**	160 **9.7**	260 **15.8**	118 **7.2**
67	Aug. 11	1615 **53**	265 **16.4**	285 **17.6**	575 **35.6**	75 **4.6**	377 **23.3**	490 **30.3**	780 **48.3**	780 **48.3**	117 **7.2**	37 **2.3**	133 **8.2**	138 **8.5**	41 **2.5**	170 **10.5**	372 **23.0**	— —	360 **22.3**	130 **8.0**	240 **14.9**	108 **6.7**
68	Aug. 11	1615 **53**	290 **18.0**	322 **19.9**	685 **42.4**	76 **4.7**	350 **21.7**	480 **29.7**	770 **47.7**	782 **48.4**	140 **8.7**	32 **2.0**	100 **6.2**	147 **9.1**	45 **2.8**	194 **12.0**	425 **26.3**	— —	410 **25.4**	142 **8.8**	290 **18.0**	110 **6.8**
74	Aug. 13	1646 **54**	280 **17.0**	320 **19.4**	666 **40.5**	72 **4.4**	340 **20.7**	405 **24.6**	755 **45.9**	722 **43.9**	109 **6.6**	38 **2.3**	109 **6.6**	144 **8.7**	43 **2.6**	160 **9.7**	412 **25.0**	— —	390 **23.7**	135 **8.2**	— —	— —
78	Aug. 13	1676 **55**	298 **17.8**	322 **19.2**	627 **37.4**	81 **4.8**	380 **22.7**	470 **28.0**	756 **45.1**	730 **43.6**	157 **9.4**	35 **2.1**	106 **6.3**	148 **8.8**	47 **2.8**	197 **11.8**	426 **25.4**	— —	418 **24.9**	148 **8.8**	270 **16.1**	115 **6.9**
81	Aug. 14	1615 **53**	300 **18.6**	325 **20.1**	630 **39.0**	82 **5.1**	352 **21.8**	468 **29.0**	788 **48.8**	745 **46.1**	118 **7.3**	37 **2.3**	116 **7.2**	138 **8.5**	50 **3.1**	192 **11.9**	409 **25.3**	— —	398 **24.6**	192 **11.9**	300 **18.6**	118 **7.3**
82	Aug. 14	1646 **54**	285 **17.3**	323 **19.6**	607 **36.9**	77 **4.7**	374 **22.7**	500 **30.4**	794 **48.2**	764 **46.4**	144 **8.7**	45 **2.7**	113 **6.9**	157 **9.5**	52 **3.2**	205 **12.5**	405 **24.6**	— —	395 **24.0**	156 **9.5**	278 **16.9**	125 **7.6**
90	Aug. 18	1615 **53**	265 **16.4**	304 **18.8**	605 **37.5**	72 **4.5**	380 **23.5**	490 **30.3**	791 **49.0**	760 **47.1**	133 **8.2**	35 **2.2**	112 **6.9**	145 **9.0**	48 **3.0**	175 **10.8**	395 **24.5**	— —	390 **24.1**	137 **8.5**	265 **16.4**	115 **7.1**
99	Aug. 21	1646 **54**	300 **18.2**	330 **20.0**	670 **40.7**	80 **4.9**	378 **23.0**	450 **27.3**	767 **46.6**	743 **45.1**	116 **7.0**	35 **2.1**	103 **6.3**	136 **8.3**	47 **2.9**	170 **10.3**	402 **24.4**	— —	392 **23.8**	145 **8.8**	275 **16.7**	118 **7.2**
102	Aug. 22	1646 **54**	310 **18.8**	347 **21.1**	607 **36.9**	78 **4.7**	368 **22.4**	470 **28.6**	819 **49.8**	840 **51.0**	146 **8.9**	33 **2.0**	120 **7.3**	150 **9.1**	52 **3.2**	194 **11.8**	445 **27.0**	— —	430 **26.1**	150 **9.1**	280 **17.0**	122 **7.4**

TABLE 34. NORTHERN PART OF EAST CHINA SEA, MALE, 1956 (cont.)

Serial no.	Date caught	1	3	5	6	7	8	10	11	12	13	14	15	17	19	21	22	24	25	26	27	28
106	Aug. 25	1615 **53**	289 **17.9**	312 **19.3**	615 **38.1**	73 **4.5**	350 **21.7**	510 **31.6**	775 **48.0**	790 **48.9**	135 **8.4**	43 **2.7**	116 **7.2**	150 **9.3**	50 **3.1**	180 **11.1**	397 **24.6**	— —	386 **23.9**	130 **8.0**	254 **15.8**	105 **6.5**
131	Sept. 2	1676 **55**	— —	300 **17.9**	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	175 **10.4**	390 **23.3**	— —	386 **23.0**	145 **8.7**	260 **15.5**	110 **6.6**
134	Sept. 3	1676 **55**	— —	315 **18.8**	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	210 **12.5**	390 **23.2**	— —	385 **23.0**	170 **10.1**	260 **15.5**	— —
136	Sept. 6	1646 **54**	— —	325 **19.7**	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	180 **10.9**	398 **24.2**	— —	390 **23.7**	140 **8.5**	260 **15.8**	113 **6.9**
N 20	Aug. 4	1655 **55**	— —	345 **20.8**	730 **44.1**	84 **5.1**	390 **23.6**	480 **29.0**	780 **47.1**	750 **45.3**	130 **7.9**	40 **2.4**	88 **5.3**	201 **12.1**	49 **3.0**	190 **11.5**	420 **25.4**	415 **25.1**	420 **25.4**	165 **10.0**	295 **17.9**	120 **7.3**
N 22	Aug. 6	1670 **55**	— —	394 **23.6**	660 **39.5**	64 **3.8**	— —	470 **28.1**	780 **46.7**	760 **45.5**	130 **7.8**	— —	— —	220 **13.2**	52 **3.1**	205 **12.3**	445 **26.6**	465 **27.8**	440 **26.3**	175 **10.5**	310 **18.6**	120 **7.2**
33	July 30	1798 **59**	310 **17.2**	390 **21.7**	738 **41.0**	88 **4.9**	380 **21.1**	515 **28.6**	830 **46.2**	— —	140 **7.8**	34 **1.9**	89 **4.9**	163 **9.1**	52 **2.9**	— —	— —	430 **23.9**	— —	— —	— —	— —
44	Aug. 5	1737 **57**	320 **18.4**	342 **19.7**	717 **41.3**	76 **4.4**	375 **21.6**	485 **27.9**	851 **49.0**	825 **47.5**	134 **7.7**	42 **2.4**	100 **5.8**	157 **9.0**	53 **3.1**	180 **10.4**	445 **25.6**	430 **24.8**	450 **25.9**	155 **8.9**	280 **16.1**	125 **7.2**
46	Aug. 6	1737 **57**	315 **18.1**	370 **21.3**	697 **40.1**	84 **4.8**	380 **21.9**	517 **29.8**	— —	— —	143 **8.2**	37 **2.1**	123 **7.1**	173 **10.0**	51 **2.9**	218 **12.6**	458 **26.4**	425 **24.5**	462 **26.6**	160 **9.2**	300 **17.3**	125 **7.2**
52	Aug. 7	1798 **59**	360 **20.0**	405 **22.5**	767 **42.7**	91 **5.1**	397 **22.1**	460 **25.6**	789 **43.9**	760 **42.3**	128 **7.1**	42 **2.3**	119 **6.6**	155 **8.6**	52 **2.9**	205 **11.4**	475 **26.4**	445 **24.7**	480 **26.7**	160 **8.9**	320 **17.8**	130 **7.2**
55	Aug. 8	1737 **57**	305 **17.6**	330 **19.0**	664 **38.2**	81 **4.7**	382 **22.0**	475 **27.3**	851 **49.0**	825 **47.5**	163 **9.4**	33 **1.9**	118 **6.8**	161 **9.3**	46 **2.6**	200 **11.5**	423 **24.4**	415 **23.9**	428 **24.6**	160 **9.2**	295 **17.0**	122 **7.0**
59	Aug. 9	1737 **57**	340 **19.6**	357 **20.6**	674 **38.8**	85 **4.9**	382 **22.0**	506 **29.1**	850 **48.9**	821 **47.3**	140 **8.1**	43 **2.5**	114 **6.6**	154 **8.9**	49 **2.8**	205 **11.8**	445 **25.6**	416 **24.0**	450 **26.0**	157 **9.0**	310 **17.9**	124 **7.1**
60	Aug. 9	1707 **56**	330 **19.0**	350 **20.5**	649 **38.0**	76 **4.5**	370 **21.7**	515 **30.2**	830 **48.6**	795 **46.6**	147 **8.6**	34 **2.0**	119 **7.0**	156 **9.1**	46 **2.7**	197 **11.5**	425 **24.9**	404 **23.7**	430 **25.2**	146 **8.6**	286 **16.8**	118 **6.9**
63	Aug. 10	1768 **58**	318 **18.0**	348 **19.7**	749 **42.4**	85 **4.8**	410 **23.2**	495 **28.0**	861 **48.7**	840 **47.5**	142 **8.0**	38 **2.1**	108 **6.1**	177 **10.0**	53 **3.0**	210 **11.9**	460 **26.0**	433 **24.5**	437 **24.7**	150 **8.5**	322 **18.2**	125 **7.1**
69	Aug. 11	1798 **59**	330 **18.4**	352 **19.6**	742 **41.3**	84 **4.7**	410 **22.8**	527 **29.3**	866 **48.2**	842 **46.8**	139 **7.7**	46 **2.6**	124 **6.9**	165 **9.2**	57 **3.2**	205 **11.4**	455 **25.3**	— —	445 **24.7**	160 **8.9**	296 **16.5**	125 **7.0**
73	Aug. 13	1798 **59**	320 **17.8**	355 **19.7**	733 **40.8**	83 **4.6**	400 **22.0**	490 **27.3**	810 **45.0**	— —	157 **8.7**	46 **2.6**	142 **7.9**	186 **10.3**	54 **3.0**	214 **11.9**	462 **25.7**	— —	455 **25.3**	165 **9.2**	296 **16.5**	129 **7.2**

79	Aug. 14	1798	—	—	—	—	—	—	—	—	—	—	—	174	51	207	465	—	445	165	325	29
		59	—	—	—	—	—	—	—	—	—	—	—	**9.7**	**2.8**	**11.5**	**25.9**	—	**24.7**	**9.2**	**18.1**	**7.2**
85	Aug. 15	1798	318	355	737	87	406	506	845	822	155	34	119	154	52	220	446	—	428	165	308	128
		59	**17.7**	**19.7**	**41.0**	**4.8**	**22.6**	**28.1**	**47.0**	**45.7**	**8.4**	**1.9**	**6.6**	**8.6**	**2.9**	**12.2**	**24.8**	—	**23.8**	**9.2**	**17.1**	**7.1**
86	Aug. 15	1798	330	380	737	85	380	524	910	870	194	43	116	163	51	213	472	—	460	165	325	127
		59	**18.4**	**21.1**	**41.0**	**4.7**	**21.1**	**29.1**	**50.6**	**48.4**	**10.8**	**2.4**	**6.5**	**9.1**	**2.8**	**11.8**	**26.3**	—	**25.6**	**9.2**	**18.1**	**7.1**
87	Aug. 15	1737	305	340	—	73	—	—	—	—	—	—	—	156	52	—	—	—	—	—	—	—
		57	**17.6**	**19.6**	—	**4.2**	—	—	—	—	—	—	—	**9.0**	**3.0**	—	—	—	—	—	—	—
94	Aug. 19	1737	320	350	677	76	388	495	843	820	141	34	108	155	50	200	430	—	430	148	304	125
		57	**18.4**	**20.1**	**39.0**	**4.4**	**22.3**	**28.5**	**48.5**	**47.2**	**.8.1**	**2.0**	**6.2**	**8.9**	**2.9**	**11.5**	**24.8**	—	**24.8**	**8.5**	**17.5**	**7.2**
98	Aug. 21	1737	310	350	627	86	390	500	865	840	154	33	100	166	52	205	431	—	425	157	300	131
		57	**17.8**	**20.1**	**36.1**	**5.0**	**22.5**	**28.8**	**49.8**	**48.4**	**8.9**	**1.9**	**5.8**	**9.6**	**3.0**	**11.8**	**24.8**	—	**24.5**	**9.0**	**17.3**	**7.5**
101	Aug. 22	1737	300	337	647	78	358	496	830	848	154	42	120	161	53	200	425	—	415	163	290	125
		57	**17.3**	**19.4**	**37.2**	**4.5**	**20.6**	**28.6**	**47.8**	**48.8**	**8.9**	**2.4**	**6.9**	**9.3**	**3.1**	**11.5**	**24.5**	—	**23.9**	**9.4**	**16.7**	**7.2**
105	Aug. 25	1707	313	338	670	81	400	475	819	800	170	37	103	146	48	210	420	—	410	160	280	122
		56	**18.3**	**19.8**	**39.2**	**4.7**	**23.4**	**27.8**	**48.0**	**46.9**	**10.0**	**2.2**	**6.0**	**8.6**	**2.8**	**12.3**	**24.6**	—	**24.0**	**9.4**	**16.4**	**7.1**
114	Aug. 27	1737	320	360	687	79	390	505	825	820	181	39	105	172	49	190	447	—	440	150	305	133
		57	**18.4**	**20.7**	**39.6**	**4.5**	**22·5**	**29.1**	**47.5**	**47.2**	**10.4**	**2.2**	**6.0**	**9.9**	**2.8**	**10.9**	**25.7**	—	**25.3**	**8.6**	**17.6**	**7.7**
117	Aug. 29	1798	325	368	667	81	351	483	884	852	153	36	96	166	53	200	465	—	460	160	320	125
		59	**18.1**	**20.5**	**37.1**	**4.5**	**19.5**	**26.9**	**49.2**	**47.4**	**8.5**	**2.0**	**5.3**	**9.2**	**2.9**	**11.1**	**25.9**	—	**25.6**	**8.9**	**17.8**	**7.0**
126	Sept. 2	1798	325	375	—	87	—	—	—	—	—	—	—	—	—	213	455	—	442	165	285	130
		59	**18.1**	**20.9**	—	**4.8**	—	—	—	—	—	—	—	—	—	**11.8**	**25.3**	—	**24.6**	**9.2**	**15.9**	**7.2**
127	Sept. 2	1707	—	345	—	—	—	—	—	—	—	—	—	—	—	200	438	—	440	152	294	125
		56	—	**20.2**	—	—	—	—	—	—	—	—	—	—	—	**11.7**	**25.7**	—	**25.8**	**8.9**	**17.2**	**7.3**
129	Sept. 2	1798	—	373	—	—	—	—	—	—	—	—	—	—	—	210	470	—	450	157	320	130
		59	—	**20.7**	—	—	—	—	—	—	—	—	—	—	—	**11.7**	**26.1**	—	**25.0**	**8.7**	**17.8**	**7.2**
132	Sept. 3	1768	—	380	—	—	—	—	—	—	—	—	—	—	—	210	470	—	455	170	330	132
		58	—	**21.5**	—	—	—	—	—	—	—	—	—	—	—	**11.9**	**26.6**	—	**25.7**	**9.6**	**18.7**	**7.5**
138	Sept. 6	1768	—	335	—	—	—	—	—	—	—	—	—	—	—	200	410	—	410	152	272	118
		58	—	**18.9**	—	—	—	—	—	—	—	—	—	—	—	**11.3**	**23.2**	—	**23.2**	**8.6**	**15.4**	**6.7**
141	Sept. 7	1798	—	360	—	—	—	—	—	—	—	—	—	—	—	200	450	—	445	167	308	127
		59	—	**20.0**	—	—	—	—	—	—	—	—	—	—	—	**11.1**	**25.0**	—	**24.7**	**9.3**	**17.1**	**7.1**
N 26	Aug. 7	1770	—	385	730	85	400	500	830	790	120	—	—	223	52	215	465	460	474	180	—	—
		58	—	**21.8**	**41.2**	**4.8**	**22.6**	**28.2**	**46.9**	**44.6**	**6.8**	—	—	**12.6**	**2.9**	**12.1**	**26.3**	**22.6**	**26.8**	**10.2**	—	—
N 29	Aug. 9	1740	—	370	—	90	420	520	810	790	135	45	95	—	58	210	460	450	445	190	295	120
		57	—	**21.3**	—	**5.2**	**24.1**	**29.9**	**46.6**	**45.4**	**7.8**	**2.6**	**5.5**	—	**3.3**	**12.1**	**26.4**	**25.9**	**25.6**	**10.9**	**17.0**	**6.9**

TABLE 34. NORTHERN PART OF EAST CHINA SEA, MALE, 1956 (cont.)

Serial no.	Date caught	1	3	5	6	7	8	10	11	12	13	14	15	17	19	21	22	24	25	26	27	28
N 34	Aug. 11	1715 **56**	— —	365 **21.3**	720 **42.0**	85 **5.0**	390 **22.7**	490 **28.6**	800 **46.6**	775 **45.2**	130 **7.6**	35 **2.0**	115 **6.7**	213 **12.4**	51 **3.0**	205 **12.0**	440 **25.7**	430 **25.1**	445 **25.9**	175 **10.2**	— —	— —
N 36	Aug. 11	1710 **56**	310 **18.1**	345 **20.2**	690 **40.4**	85 **5.0**	410 **24.0**	520 **30.4**	860 **50.3**	795 **46.5**	140 **8.9**	39 **2.3**	105 **6.1**	205 **12.0**	51 **3.0**	185 **10.8**	425 **24.9**	425 **24.9**	420 **24.6**	170 **9.9**	290 **17.0**	110 **6.4**
N 59	Sept. 1	1710 **56**	— —	360 **21.1**	660 **38.6**	88 **5.1**	410 **24.0**	495 **28.9**	795 **46.5**	725 **42.4**	115 **6.7**	50 **2.9**	120 **7.0**	205 **12.0**	51 **3.0**	210 **12.3**	445 **26.0**	435 **25.4**	454 **26.6**	185 **10.8**	315 **18.4**	125 **7.3**
N 62	Sept. 5	1720 **57**	— —	345 **20.1**	640 **37.2**	73 **4.2**	430 **25.0**	500 **29.1**	900 **52.3**	875 **50.9**	131 **7.6**	31 **1.8**	100 **5.8**	195 **11.3**	45 **2.6**	175 **10.2**	415 **24.1**	405 **23.5**	420 **24.4**	150 **8.7**	280 **16.3**	105 **6.1**
35	July 31	1859 **61**	360 **19.4**	430 **23.1**	735 **39.5**	88 **4.7**	490 **26.4**	500 **26.9**	880 **47.3**	850 **45.7**	150 **8.1**	— —	— —	157 **8.4**	53 **2.9**	— —	— —	— —	— —	— —	— —	— —
38	Aug. 4	1859 **61**	305 **16.4**	375 **20.2**	728 **39.2**	— —	— —	515 **27.7**	910 **49.0**	889 **47.8**	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —
41	Aug. 4	1829 **60**	330 **18.0**	375 **20.5**	722 **39.5**	78 **4.3**	455 **24.9**	525 **28.7**	860 **47.0**	830 **45.4**	158 **8.6**	41 **2.2**	109 **6.0**	174 **9.5**	54 **3.0**	— —	— —	— —	— —	— —	— —	— —
42	Aug. 5	1829 **60**	320 **17.5**	365 **20.0**	677 **37.0**	80 **4.4**	410 **22.4**	510 **27.9**	914 **50.0**	890 **48.7**	155 **8.5**	42 **2.3**	112 **6.1**	134 **7.3**	51 **2.8**	— —	— —	— —	— —	— —	— —	— —
53	Aug. 7	1829 **60**	330 **18.0**	365 **20.0**	737 **40.3**	81 **4.4**	430 **23.5**	510 **27.9**	868 **47.5**	835 **45.7**	147 **8.0**	41 **2.2**	122 **6.7**	163 **8.9**	55 **3.0**	— —	— —	— —	— —	— —	— —	— —
57	Aug. 8	1829 **60**	335 **18.3**	335 **19.4**	672 **42.2**	87 **4.8**	420 **23.0**	520 **28.4**	830 **45.4**	850 **46.5**	— —	35 **1.9**	104 **5.7**	178 **9.7**	52 **2.8**	220 **12.0**	460 **25.2**	442 **24.2**	465 **25.4**	160 **8.7**	310 **16.9**	125 **6.8**
75	Aug. 13	1859 **61**	355 **19.1**	375 **20.2**	742 **39.9**	90 **4.8**	410 **22.1**	515 **27.7**	879 **47.3**	850 **45.7**	156 **8.4**	43 **2.3**	117 **6.3**	189 **10.2**	54 **2.9**	— —	— —	— —	— —	— —	— —	— —
84	Aug. 15	1829 **60**	345 **18.9**	376 **20.6**	737 **40.3**	87 **4.8**	373 **20.4**	522 **28.5**	838 **45.8**	802 **43.8**	134 **7.3**	53 **2.9**	134 **7.3**	194 **10.6**	54 **3.0**	215 **11.8**	480 **26.2**	— —	472 **25.8**	170 **9.3**	315 **17.2**	129 **7.1**
104	Aug. 25	1829 **60**	316 **16.9**	340 **18.6**	673 **36.8**	81 **4.4**	448 **24.5**	530 **29.0**	870 **47.6**	890 **48.7**	142 **7.8**	36 **2.0**	118 **6.5**	163 **8.9**	50 **2.7**	205 **11.2**	418 **22.9**	— —	420 **23.0**	152 **8.3**	290 **15.9**	125 **6.8**
133	Sept. 3	1859 **61**	— —	380 **20.4**	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	225 **12.1**	475 **25.6**	— —	460 **24.7**	175 **9.4**	330 **17.8**	128 **6.9**
156	Sept. 17	1829 **60**	— —	408 **22.3**	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	218 **11.9**	490 **26.8**	— —	485 **26.5**	185 **10.1**	346 **18.9**	140 **7.7**
N 15	July 29	1810 **60**	— —	380 **21.0**	— —	80 **4.4**	— —	— —	— —	— —	— —	25 **1.4**	78 **4.3**	198 **10.9**	55 **3.0**	190 **10.5**	445 **24.6**	440 **24.3**	450 **24.9**	170 **9.4**	320 **17.7**	105 **5.8**

N 17	July 31	1830	—	385	—	88	—	—	—	—	—	33	109	208	50	215	480	485	470	185	340	130
		60	—	**21.0**	—	**4.8**	—	—	—	—	—	**1.8**	**6.0**	**11.4**	**2.7**	**11.7**	**26.2**	**26.5**	**25.7**	**10.1**	**18.6**	**7.1**
N 32	Aug. 10	1860	—	405	760	82	420	510	865	880	130	39	120	265	60	210	485	475	485	190	320	135
		61	—	**21.8**	**40.9**	**4.4**	**22.6**	**27.4**	**46.5**	**47.3**	**7.0**	**2.1**	**6.5**	**14.2**	**3.2**	**11.3**	**26.1**	**25.5**	**26.1**	**10.2**	**17.2**	**7.3**
N 53	Aug. 25	1800	—	400	750	—	430	500	810	790	115	38	115	225	51	215	470	460	475	195	320	125
		59	—	**22.2**	**41.7**	—	**23.9**	**27.8**	**45.0**	**43.9**	**6.4**	**2.1**	**6.4**	**12.5**	**2.8**	**12.0**	**26.1**	**25.6**	**26.4**	**10.8**	**17.8**	**6.9**
45	Aug. 6	1920	335	375	607	84	450	525	—	—	—	34	117	181	60	240	500	450	495	168	310	135
		63	**17.4**	**19.5**	**31.6**	**4.4**	**23.4**	**27.3**	—	—	—	**1.8**	**6.1**	**9.4**	**3.1**	**12.5**	**26.0**	**23.4**	**25.8**	**8.7**	**16.1**	**7.0**
113	Aug. 28	1920	350	390	739	91	440	560	932	890	164	48	115	188	54	208	480	—	470	160	325	132
		63	**18.2**	**20.3**	**38.5**	**4.7**	**22.9**	**29.2**	**48.5**	**46.4**	**8.5**	**2.5**	**6.0**	**9.8**	**2.8**	**10.8**	**25.0**	—	**24.5**	**8.3**	**17.0**	**6.9**

TABLE 35. NORTHERN PART OF EAST CHINA, SEA, FEMALE, 1956

Serial no.	Date caught	1	3	5	6	7	8	10	11	12	13	14	15	17	19	21	22	24	25	26	27	28
58	Aug. 9	1524	248	278	575	64	340	453	698	713	50	43	114	154	49	205	445	416	450	157	310	124
		50	**16.3**	**18.2**	**37.7**	**4.2**	**22.3**	**29.7**	**45.8**	**46.8**	**3.3**	**2.8**	**7.5**	**10.1**	**3.2**	**13.5**	**29.2**	**27.3**	**29.5**	**10.3**	**20.3**	**8.1**
70	Aug. 10	1585	285	293	585	68	420	505	739	795	72	—	—	142	46	165	380	—	367	135	250	110
		52	**18.0**	**18.5**	**36.9**	**4.3**	**26.5**	**31.9**	**46.6**	**50.2**	**4.5**	—	—	**9.0**	**2.9**	**10.4**	**24.0**	—	**23.2**	**8.5**	**15.8**	**6.9**
89	Aug. 15	1554	280	315	585	70	353	480	740	750	—	46	115	130	41	180	390	—	385	140	270	108
		51	**18.0**	**20.3**	**37.6**	**4.5**	**22.7**	**30.9**	**47.6**	**48.3**	—	**3.0**	**7.4**	**8.4**	**2.6**	**11.6**	**25.1**	—	**24.8**	**9.0**	**17.4**	**6.9**
119	Aug. 30	1524	280	300	640	70	370	440	728	755	63	39	105	135	44	170	386	—	380	140	250	103
		50	**18.4**	**19.7**	**42.0**	**4.6**	**24.3**	**28.9**	**47.8**	**49.5**	**4.1**	**2.6**	**6.9**	**8.9**	**2.9**	**11.2**	**25.3**	—	**24.9**	**9.2**	**16.4**	**6.8**
160	Sept. 19	1554	—	296	—	—	—	—	—	—	—	—	—	—	—	170	373	—	365	135	255	107
		51	—	**19.0**	—	—	—	—	—	—	—	—	—	—	—	**10.9**	**24.0**	—	**23.5**	**8.7**	**16.4**	**6.9**
N 23	Aug. 6	1590	290	325	640	70	385	460	730	705	59	36	90	205	49	165	390	365	380	145	265	105
		52	**18.2**	**20.4**	**40.3**	**4.4**	**24.2**	**28.9**	**45.9**	**44.3**	**3.7**	**2.3**	**5.7**	**12.9**	**3.1**	**10.4**	**24.5**	**23.0**	**23.9**	**9.1**	**16.7**	**6.6**
N 28	Aug. 9	1500	—	305	555	65	—	485	735	720	62	34	—	200	45	165	385	360	380	155	265	115
		50	—	**20.3**	**37.0**	**4.3**	—	**32.3**	**49.0**	**48.0**	**4.1**	**2.3**	—	**13.3**	**3.0**	**11.0**	**25.7**	**24.0**	**25.3**	**10.3**	**17.7**	**7.7**
N 30	Aug. 9	1590	—	310	580	70	370	430	670	650	45	31	75	175	45	170	385	340	380	155	255	100
		52	—	**19.5**	**36.5**	**4.4**	**23.3**	**27.0**	**42.1**	**40.9**	**2.8**	**1.9**	**4.7**	**11.0**	**2.8**	**10.7**	**24.2**	**21.4**	**23.9**	**9.7**	**16.0**	**6.3**
N 64	Sept. 6	1550	—	310	550	76	395	480	740	720	45	39	95	180	45	185	385	380	385	160	265	110
		51	—	**20.0**	**35.5**	**4.9**	**25.5**	**31.0**	**47.7**	**46.5**	**2.9**	**2.5**	**6.1**	**11.6**	**2.9**	**11.9**	**24.8**	**24.5**	**24.8**	**10.3**	**17.1**	**7.1**
N 65	Sept. 6	1505	—	275	620	65	380	460	700	720	40	35	92	170	43	155	340	340	340	155	245	95
		50	—	**18.3**	**41.2**	**4.3**	**25.2**	**30.6**	**46.5**	**47.8**	**2.7**	**2.3**	**6.1**	**11.3**	**2.9**	**10.3**	**22.6**	**22.6**	**22.6**	**10.3**	**16.3**	**6.3**

TABLE 35. NORTHERN PART OF EAST CHINA SEA, FEMALE 1956 (cont.)

Serial no.	Date caught	1	3	5	6	7	8	10	11	12	13	14	15	17	19	21	22	24	25	26	27	28
31	July 30	1676 55	— —	— —	637 38.0	79 4.7	400 23.9	500 29.9	804 48.0	780 46.5	69 4.1	43 2.6	97 5.8	130 7.8	50 3.0	— —	— —	— —	— —	— —	— —	
64	Aug. 10	1676 55	293 17.5	322 19.2	630 37.6	73 4.4	410 24.5	474 28.3	780 46.5	798 47.6	82 4.9	40 2.4	128 7.6	154 9.2	52 3.1	188 11.2	390 23.3	— —	380 22.7	145 8.7	275 16.4	134 8.0
65	Aug. 10	1676 55	334 19.9	365 21.8	575 34.3	77 4.6	373 22.3	532 31.7	828 49.4	805 48.0	— —	39 2.3	107 6.4	165 9.8	55 3.3	210 12.5	430 25.7	— —	430 25.7	160 9.5	307 18.3	— —
76	Aug. 13	1676 55	282 16.8	308 18.4	625 37.3	70 4.2	420 25.1	518 30.9	808 48.2	735 43.9	66 3.9	32 1.9	108 6.4	147 8.8	41 2.4	208 12.4	410 24.5	— —	392 23.4	150 8.9	262 15.6	120 7.2
91	Aug. 19	1615 53	272 16.8	298 18.5	575 35.6	71 4.4	390 24.1	502 31.1	805 49.8	790 48.9	50 3.1	38 2.4	107 6.6	130 8.0	44 2.7	— —	— —	— —	— —	— —	— —	— —
115	Aug. 29	1615 53	298 18.5	325 20.1	645 39.9	69 4.3	360 22.3	498 30.8	750 46.4	765 47.4	52 3.2	36 2.2	98 6.1	150 9.3	47 2.9	165 10.2	410 25.4	— —	405 25.1	140 8.7	290 18.0	118 7.3
148	Sept. 14	1676 55	— —	325 19.4	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	183 10.9	408 24.3	— —	401 23.9	142 8.5	286 17.1	112 6.7
N 49	Aug. 22	1620 53	— —	320 19.8	610 37.7	79 4.9	— —	480 29.6	770 47.5	750 46.3	50 3.1	— —	— —	205 12.7	50 3.1	185 11.4	390 24.1	390 24.1	395 24.4	160 9.9	275 17.0	110 6.8
N 66	Sept. 6	1670 55	— —	350 21.0	665 39.8	80 4.8	415 24.9	520 31.1	780 46.7	740 44.3	40 2.4	37 2.2	100 6.0	195 11.7	48 2.9	190 11.4	430 25.8	420 25.2	425 25.5	170 10.2	305 18.3	115 6.9
32	July 30	1768 58	— —	— —	727 41.1	— —	355 20.1	455 25.7	780 44.1	— —	52 2.9	40 2.3	97 5.5	157 8.9	56 3.2	— —	— —	465 26.3	— —	— —	— —	— —
34	July 30	1737 57	— —	— —	675 38.9	— —	425 24.5	490 28.2	— —	810 46.6	73 4.2	35 2.0	96 5.5	136 7.8	47 2.7	— —	— —	440 25.3	— —	— —	— —	— —
43	Aug. 5	1798 59	345 19.2	365 20.3	722 40.2	83 4.6	403 22.4	490 27.3	843 46.9	802 44.6	74 4.1	38 2.1	143 8.0	148 8.2	51 2.8	— —	450 25.0	443 24.6	452 25.1	— —	295 16.4	135 7.5
66	Aug. 10	1798 59	305 17.0	340 18.9	715 39.8	85 4.7	410 22.8	524 29.1	855 47.6	837 46.6	55 3.1	39 2.2	110 6.1	173 9.6	53 2.9	200 12.2	415 23.1	— —	425 23.6	164 9.1	275 15.3	136 7.6
54	Aug. 7	1768 58	352 19.9	392 22.2	722 40.8	87 4.9	405 22.9	495 28.0	920 52.0	890 50.3	72 4.1	— —	— —	175 9.9	49 2.8	215 12.2	475 26.9	455 25.7	480 27.1	160 9.0	290 16.4	131 7.4
88	Aug. 15	1798 59	327 18.2	355 19.7	702 39.0	78 4.3	414 23.0	538 29.9	876 48.2	865 48.1	74 4.1	31 1.7	110 6.1	155 8.6	46 2.6	180 10.0	437 24.3	— —	430 23.9	150 8.3	310 17.2	122 6.8
95	Aug. 20	1768 58	300 17.0	335 18.9	627 35.5	83 4.7	453 25.6	525 29.7	830 46.9	820 46.4	60 3.4	36 2.0	113 6.4	154 8.7	51 2.9	192 10.9	430 24.3	— —	412 23.3	150 8.5	285 16.1	115 6.5

	109	Aug. 26	1798 **59**	320 **17.8**	360 **20.0**	697 **38.8**	83 **4.6**	432 **24.0**	528 **29.4**	876 **48.7**	870 **48.4**	63 **3.5**	49 **2.7**	94 **5.2**	166 **9.2**	49 **2.7**	209 **11.6**	455 **25.3**	— —	445 **24.7**	152 **8.5**	— —	121 **6.7**
	122	Aug. 31	1798 **59**	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	216 **12.0**	470 **26.1**	— —	455 **25.3**	166 **9.2**	322 **17.9**	129 **7.2**
	144	Sept. 11	1707 **56**	— —	350 **20.5**	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	192 **11.2**	430 **25.2**	— —	425 **24.9**	155 **9.1**	290 **17.0**	125 **7.3**
	155	Sept. 17	1798 **59**	— —	375 **20.9**	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	215 **12.0**	482 **26.8**	— —	478 **26.6**	169 **9.4**	330 **18.4**	130 **7.2**
	157	Sept. 17	1707 **56**	— —	332 **19.4**	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	183 **11.7**	418 **24.5**	— —	410 **24.0**	150 **8.8**	283 **16.6**	115 **6.7**
N	27	Aug. 7	1715 **57**	— —	360 **21.0**	590 **34.4**	84 **4.9**	450 **26.2**	540 **31.5**	820 **47.8**	765 **44.6**	50 **2.9**	50 **2.9**	130 **7.6**	210 **12.2**	50 **2.9**	205 **2.0**	440 **25.7**	430 **25.1**	429 **25.0**	166 **9.7**	— —	— —
N	47	Aug. 20	1775 **59**	— —	— —	— —	85 **4.8**	— —	— —	— —	— —	40 **2.3**	— —	— —	205 **11.5**	53 **3.0**	205 **11.5**	470 **26.5**	450 **25.4**	465 **26.2**	180 **10.1**	315 **17.7**	115 **6.5**
N	50	Aug. 22	1710 **56**	— —	355 **20.8**	710 **41.5**	80 **4.7**	410 **24.0**	520 **30.4**	830 **48.5**	845 **49.1**	50 **2.9**	39 **2.3**	105 **6.1**	120 **7.0**	50 **2.9**	185 **10.8**	430 **25.1**	415 **24.3**	435 **25.4**	165 **9.6**	310 **18.1**	120 **7.0**
N	52	Aug. 24	1760 **58**	— —	355 **20.2**	680 **38.6**	82 **4.7**	440 **25.0**	520 **29.5**	840 **47.7**	795 **45.2**	55 **3.1**	35 **2.0**	110 **6.2**	215 **12.2**	53 **3.0**	— —	— —	420 **23.9**	— —	— —	295 **16.8**	130 **7.4**
	37	Aug. 4	1829 **60**	343 **18.8**	370 **20.2**	647 **35.4**	82 **4.5**	420 **23.0**	540 **29.5**	870 **47.6**	809 **44.2**	— —	— —	— —	169 **9.2**	50 **2.7**	— —	— —	— —	— —	— —	— —	— —
	40	Aug. 4	1890 **62**	350 **18.5**	380 **20.1**	— —	91 **4.8**	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —
	47	Aug. 6	1829 **60**	350 **19.1**	390 **21.3**	737 **40.3**	85 **4.6**	400 **21.9**	530 **29.0**	835 **45.7**	— —	58 **3.2**	38 **2.1**	106 **5.8**	158 **8.6**	55 **3.0**	— —	— —	— —	— —	— —	— —	— —
	51	Aug. 7	1859 **61**	315 **16.9**	360 **19.4**	718 **38.6**	81 **4.4**	430 **23.1**	530 **28.5**	904 **48.6**	885 **47.6**	68 **3.7**	40 **2.2**	133 **7.2**	156 **8.4**	52 **2.8**	182 **9.8**	450 **24.2**	425 **22.9**	442 **23.8**	160 **8.6**	295 **15.9**	120 **6.5**
	56	Aug. 8	1859 **61**	350 **18.8**	370 **19.9**	693 **37.3**	84 **4.5**	420 **22.6**	530 **28.5**	— —	874 **47.0**	47 **2.5**	45 **2.4**	148 **8.0**	178 **9.6**	54 **2.9**	212 **11.4**	465 **25.0**	460 **24.7**	470 **25.3**	160 **8.6**	335 **18.0**	130 **7.0**
	80	Aug. 14	1829 **60**	332 **18.2**	376 **20.6**	737 **40.3**	83 **4.5**	420 **23.0**	534 **29.2**	900 **49.2**	865 **47.3**	53 **2.9**	36 **2.0**	127 **6.9**	178 **9.7**	51 **2.8**	218 **11.9**	470 **25.7**	— —	463 **25.3**	170 **9.3**	328 **17.9**	136 **7.4**
	97	Aug. 20	1890 **62**	340 **18.0**	380 **20.1**	729 **38.6**	84 **4.4**	430 **22.8**	530 **28.0**	909 **48.1**	880 **46.6**	79 **4.2**	43 **2.3**	117 **6.2**	163 **8.6**	54 **2.9**	— —	— —	— —	— —	— —	— —	— —
	103	Aug. 23	1859 **61**	330 **17.8**	370 **19.9**	698 **37.5**	86 **4.6**	470 **25.3**	540 **29.0**	930 **50.0**	900 **48.4**	77 **4.1**	— —	— —	147 **7.9**	49 **2.6**	200 **10.8**	563 **30.3**	— —	560 **30.1**	150 **8.1**	294 **15.8**	120 **6.5**
	110	Aug. 26	1859 **61**	348 **18.7**	400 **21·5**	748 **40.2**	89 **4.8**	425 **22.9**	565 **30.4**	895 **48.1**	895 **48.1**	— —	38 **2.0**	106 **5.7**	155 **8.3**	49 **2.6**	— —	— —	— —	480 **25.8**	— —	348 **18.7**	135 **7.3**

TABLE 35. NORTHERN PART OF EAST CHINA SEA, FEMALE, 1956 (cont.)

Serial no.	Date caught	1	3	5	6	7	8	10	11	12	13	14	15	17	19	21	22	24	25	26	27	28
112	Aug. 28	1890 **62**	350 **18.5**	390 **20.6**	789 **41.7**	87 **4.6**	430 **22.8**	550 **29.1**	900 **47.6**	880 **44.6**	66 **3.5**	45 **2.4**	105 **5.6**	182 **9.6**	58 **3.1**	230 **11.2**	490 **25.9**	— —	485 **25.7**	180 **9.5**	347 **18.4**	124 **6.6**
121	Aug. 31	1859 **61**	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	220 **11.8**	470 **25.3**	— —	470 **25.3**	170 **9.1**	312 **16.8**	— —
124	Aug. 31	1859 **61**	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	213 **11.5**	456 **24.5**	— —	455 **24.5**	173 **9.3**	306 **16.5**	123 **6.6**
143	Sept. 7	1829 **60**	— —	360 **19.7**	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	190 **10.4**	435 **23.8**	— —	435 **23.8**	143 **7.8**	304 **16.6**	121 **6.6**
150	Sept. 14	1829 **60**	— —	378 **20.7**	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	215 **11.8**	475 **26.0**	— —	473 **25.9**	165 **9.0**	322 **17.6**	132 **7.2**
158	Sept. 19	1829 **60**	— —	365 **20.0**	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	186 **10.2**	430 **23.5**	— —	450 **24.6**	150 **8.2**	310 **16.9**	120 **6.6**
N 16	July 29	1830 **60**	— —	390 **21.3**	— —	93 **5.1**	— —	— —	— —	— —	66 **3.6**	38 **2.1**	108 **5.9**	225 **12.3**	51 **2.8**	210 **11.5**	470 **25.7**	440 **24.0**	465 **25.4**	175 **9.6**	325 **17.8**	130 **7.1**
N 19	Aug. 4	1800 **59**	— —	360 **20.0**	760 **42.2**	90 **5.0**	380 **21.1**	450 **25.0**	760 **42.2**	730 **40.6**	65 **3.6**	27 **1.5**	75 **4.2**	220 **12.2**	52 **2.9**	205 **11.4**	465 **25.8**	430 **23.9**	460 **25.6**	185 **10.3**	330 **18.3**	125 **6.9**
N 21	Aug. 4	1820 **60**	— —	384 **21.0**	700 **38.5**	88 **4.8**	440 **24.2**	510 **28.0**	850 **46.7**	820 **45.1**	66 **3.6**	38 **2.1**	85 **4.7**	216 **11.9**	49 **2.7**	215 **11.8**	465 **25.5**	455 **25.0**	470 **25.8**	185 **10.2**	325 **17.9**	120 **6.6**
N 24	Aug. 6	1850 **61**	— —	380 **20.5**	760 **41.1**	93 **5.0**	440 **23.8**	540 **29.2**	850 **45.9**	820 **44.3**	54 **2.9**	35 **1.9**	105 **5.7**	220 **11.9**	52 **2.8**	215 **11.6**	470 **25.4**	475 **25.7**	465 **25.1**	180 **9.7**	320 **17.3**	130 **7.0**
N 33	Aug. 10	1880 **62**	— —	400 **21.3**	720 **38.3**	85 **4.5**	485 **25.8**	550 **29.3**	880 **46.8**	855 **45.5**	55 **2.9**	35 **1.9**	110 **5.9**	230 **12.2**	52 **2.8**	210 **11.2**	485 **25.8**	470 **25.0**	485 **25.8**	175 **9.3**	315 **16.8**	130 **6.9**
39	Aug. 4	1920 **63**	345 **18.0**	393 **20.5**	— —	— —	459 **23.9**	620 **32.3**	915 **47.7**	885 **46.1**	63 **3.3**	49 **2.6**	124 **6.5**	147 **7.7**	51 **2.7**	— —	— —	— —	— —	— —	— —	— —
48	Aug. 6	1951 **64**	370 **19.0**	430 **22.0**	795 **40.7**	94 **4.8**	410 **21.0**	540 **27.7**	860 **44.1**	— —	74 **3.8**	47 **2.4**	135 **6.9**	184 **9.4**	56 **2.9**	— —	— —	— —	— —	— —	— —	— —
61	Aug. 10	1920 **63**	336 **17.5**	361 **18.8**	788 **41.0**	83 **4.3**	423 **22.0**	570 **29.7**	— —	— —	— —	37 **1.9**	116 **6.0**	197 **10.3**	56 **2.9**	195 **10.2**	460 **24.0**	450 **23.4**	465 **24.2**	162 **8.4**	300 **15.6**	120 **6.2**
93	Aug. 19	1951 **64**	368 **18.9**	384 **19.7**	760 **39.0**	94 **4.8**	453 **23.2**	576 **29.5**	935 **47.9**	918 **47.1**	44 **2.3**	36 **1.8**	105 **5.4**	154 **7.9**	60 **3.1**	225 **11.5**	512 **26.2**	— —	500 **25.6**	165 **8.5**	343 **17.6**	136 **7.0**
107	Aug. 26	1981 **65**	350 **17.7**	385 **19.4**	750 **37.9**	85 **4.3**	413 **20.8**	566 **28.6**	925 **46.7**	925 **46.7**	85 **4.3**	38 **1.9**	125 **6.3**	158 **8.0**	56 **2.8**	215 **10.9**	485 **24.5**	— —	476 **24.0**	170 **8.6**	336 **17.0**	132 **6.7**

	111	Aug.	27	1920	375	415	796	89	407	530	880	907	80	47	120	152	55	230	520	—	513	185	368	146
				63	**19.5**	**21.6**	**41.5**	**4.6**	**21.2**	**27.6**	**45.8**	**47.2**	**4.2**	**2.4**	**6.2**	**7.9**	**2.9**	**12.0**	**27.1**	—	**26.7**	**9.6**	**19.2**	**7.6**
	140	Sept.	7	1951	—	393	—	—	—	—	—	—	—	—	—	—	—	210	493	—	490	190	357	137
				64	—	**20.1**	—	—	—	—	—	—	—	—	—	—	—	**10.8**	**25.3**	—	**25.1**	**9.7**	**18.3**	**7.0**
N	57	Sept.	1	1920	—	390	770	90	—	530	880	860	55	—	—	221	53	215	495	460	495	185	335	125
				63	—	**20.3**	**40.1**	**4.7**	—	**27.6**	**45.8**	**44.8**	**2.9**	—	—	**11.5**	**2.8**	**11.2**	**25.8**	**24.0**	**25.8**	**9.6**	**17.4**	**6.5**
N	61	Sept.	3	1950	—	390	800	92	490	570	870	850	65	55	120	235	55	210	475	475	480	190	300	130
				64	—	**20.0**	**41.0**	**4.7**	**25.1**	**29.2**	**44.6**	**43.6**	**3.3**	**2.8**	**6.6**	**12.1**	**2.8**	**10.8**	**24.4**	**24.4**	**24.6**	**9.7**	**15.4**	**6.7**
N	63	Sept.	5	1920	—	400	770	93	450	580	910	880	65	35	115	251	59	—	485	475	485	—	330	—
				63	—	**20.8**	**40.1**	**4.8**	**23.4**	**30.2**	**47.4**	**45.8**	**3.4**	**1.8**	**6.0**	**13.1**	**3.1**	—	**25.3**	**24.7**	**25.3**	—	**17.2**	—
	142	Sept.	7	2073	—	400	—	—	—	—	—	—	—	—	—	—	—	225	510	—	500	170	350	136
				68	—	**19.3**	—	—	—	—	—	—	—	—	—	—	—	**10.9**	**24.6**	—	**24.1**	**8.2**	**16.9**	**6.6**
N	58	Sept.	1	2000	—	420	820	94	455	560	920	899	55	40	115	245	60	240	515	505	520	205	305	130
				66	—	**21.0**	**41.0**	**4.7**	**22.8**	**28.0**	**46.0**	**45.0**	**2.8**	**2.0**	**5.8**	**12.3**	**3.0**	**12.0**	**25.8**	**25.3**	**26.0**	**10.3**	**17.5**	**6.5**

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VERY SMALL EMBRYO OF CETACEA

MASAHARU NISHIWAKI

On November 6, 1956, 397 blue-white dolphins (*Stenell caeruleo-albus*) (197 males and 210 females) were captured by the " driving-in " fishing method at Kawana of Sagami Bay, Shizuoka Pref. The females were classified sexually into immature (12) resting (14) and pregnant (72) stages. Twenty-seven lactating females were observed in both stages.

Observation of the pregnant stage was made by the existence of a functional corpus luteum in their ovaries. When a functional corpus luteum was found in the ovary but no embryo could be found in the uterus easily, the uterus was washed in a little water tank. Then the early stage amnion was found as a white threadlike substance. Under observation with the dissecting microscope, however, it could not be ascertained that this amnion always concealed an embryo. Because in this case the embryo was not large enough to attract our attention. In this way, 28 embryos were collected.

The smallest embryo was measured 4.4 mm. in body length. In this embryo the somite was seven. This report is only an introduction to a comprehensive study on the subject. The details be explained on completion of our anatomical study.

Fig 1. Embryo with amnion.

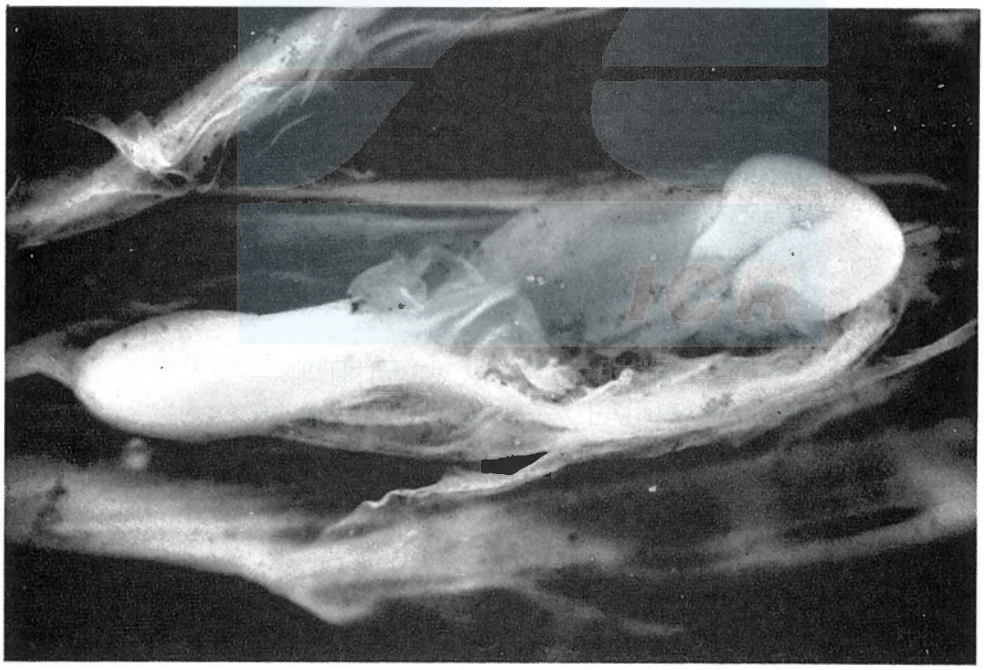


Fig. 2. Enlarged photograph of the embryo.

ONE-EYED MONSTER OF FIN WHALE

MASAHARU NISHIWAKI

On January 21, 1956, a curious foetus was found on the flensing deck of the F/F " Tonan-maru " operating in 64°49′ S, 157°30′ W. This curious foetus was a one-eyed monster (Cyclops) as shown in the photographs. The mother whale was a 70 feet long fin whale which had 1 corpus luteum and 5 corpora albicantia.

When observed carefully, only one eyeball existed on its short and globular shaped upper jaw. There was no depressed part like as eye cavity on the top of the angle of gape. That part projected a little on both sides with roundness. In the human Cyclops usually, the nose is absent or becomes a cylindrical tube positioned upward of the eye. In this monster the head was roundish and the blow-hole could not be found. The tip of the snout possessed a little tubercular process with some pieces of hair. The lower jaw had already the asymmetrical pigmentation that is a peculiarity of the fin whale, but the length of jaw was stocky short. There was no abnormality on the posterior part to the flipper of the body, and so the monster was a male without question. The umbilicus cord was also normal.

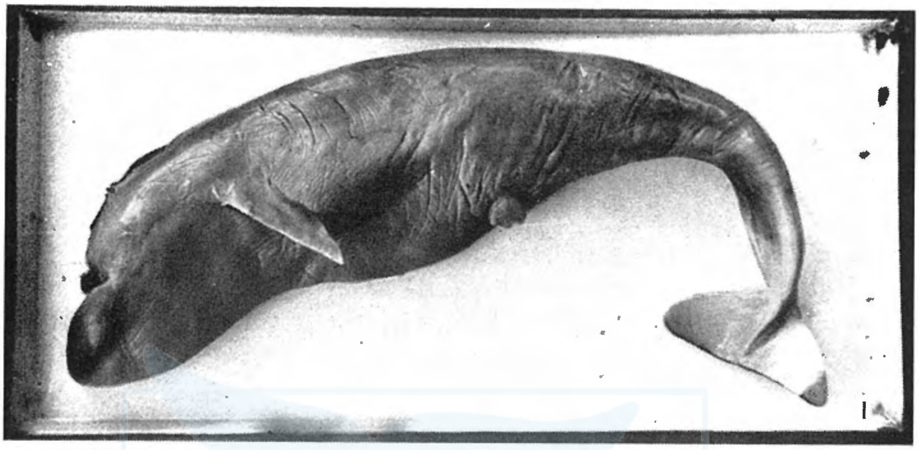
The body measurement data of this monster compared with four normal foetuses of the nearly same stages are shown in Table I.

This monster may be brought to anatomical study, but since this is only one sample at hand, it is felt regretful to cut the body. This monster is now being preserved in 10% fermalin tank of our Institute.

Of course it is not ascertainable as for of the cause of this abnormity, but we should like to believe that this deformity is not due to the atomic explosion. It is hoped the atomic experiments have no connection with the decrease in the whale stock besides the whaling.

TABLE I. MEASUREMENT OF THIS MONSTER AND FOUR NORMAL FOETUSES OF FIN WHALES

Measurement	Monster	Normal foetuses			
	Antarctic	Antarctic		North Pacific	
	10T366♀	10T367♀	10T952♀	K132♀	K602♀
Tip of snout to notch of flukes (Total length)	83.0	96.0	79.0	94.0	93.0
Tip of lower jaw to notch of flukes	88.5	97.5	80.3	—	—
Width of tip of lower jaw	1.5	1.8	—	—	—
Projection of snout beyond tip of lower jaw	5.5	1.5	1.3	—	—
Tip of snout to blowhole	—	14.0	8.5	12.0	11.0
Tip of snout to angle of gape	11.3	22.0	15.0	16.5	15.0
Tip of snout to center of eye	3.2	19.5	13.0	—	—
Diameter of eyeball	2.4	—	—	—	—
Tip of snout to tip of flipper	37.0	39.5	32.5	39.0	37.5
Tip of lower jaw to tip of flipper	42.5	41.0	39.5	—	—
Center of eye to center of ear	7.4	6.5	6.0	—	—
Notch of flukes to posterior emargination of dorsal fin	26.0	25.0	20.0	25.0	24.0
Width of flukes at insertion	7.5	6.5	6.0	—	—
Total spread of tail flukes	17.5	19.5	16.5	—	—
Notch of flukes to tip of flukes	8.7	10.7	8.4	—	—
Notch of flukes to center of anus	31.0	28.5	24.0	30.0	29.5
Notch of flukes to umbilicus	47.0	45.5	36.0	46.0	45.0
Center of anus to center of reproductive aperture	2.5	2.5	1.5	3.0	2.0
Vertical high of dorsal fin	1.5	2.5	1.8	2.0	2.0
Length of base of dorsal fin	4.0	4.0	4.5	3.8	4.5
Axilla to tip of flipper	10.4	—	—	—	—
Anterior end of lower broder to tip of flipper	12.8	11.5	10.0	13.5	13.0
Greatest width of flipper	3.2	3.2	2.5	4.0	3.0



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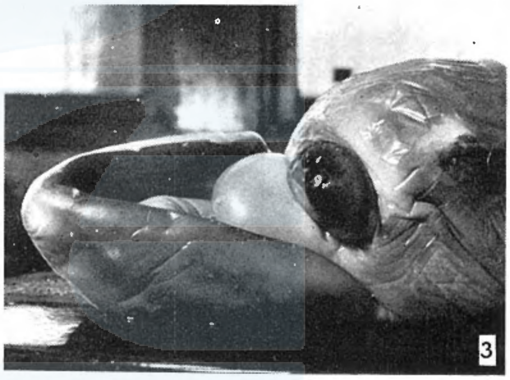

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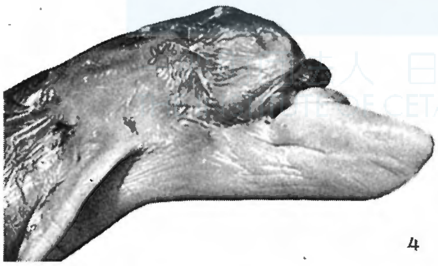

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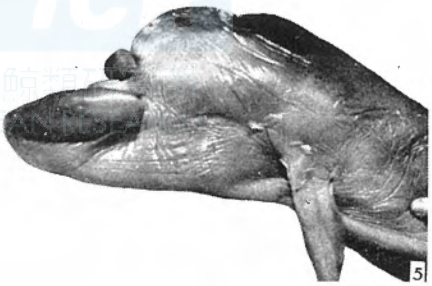

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Explanation of photographs

Fig. 1. Whole body of the monster.
Fig. 2. Frontel view of the head.
Fig. 3. Weird gaze of the one eye.
Fig. 4. Right side of the head.
Fig. 5. Left side of the head.

A CASE OF THE CACHALOT WITH PROTRUDED RUDIMENTARY HIND LIMBS

TEIZO OGAWA* AND TOSHIRO KAMIYA*

Needless to say, no protrusion of the hind limb is seen in all the Cetacea in their postnatal life. Only in the early embryonic stage they show a pair of protruded hind limbs, which but soon disappear (Guldberg, Kükenthal, Ogawa etc.). On the other hand, the existence of a pair of small pelvic bones is known as to nearly all of the Cetacea, lying far apart from the vertebral column on both sides of the genital opening. In the fin and blue whales and in the humpback the femur too is present near the pelvis, and in the right whale even the tibia exists. Of course these bones are deeply buried under the skin, causing no protuberance on the body surface. The circumstance is somewhat similar to the tail of the human being. The tail is well developed in the early embryonic stage of *Homo sapiens*, but disappears in the later stage, leaving as residue only the coccyx and related structures, all of which are concealed under the skin. Therefore, such whales as those having protruded hind limbs in the postnatal life must be an interesting object to study, about equally as the so-called tailed men.

In 1921 R. C. Andrews reported a remarkable case of the humpback whale with a pair of long protruded hind limbs. It was captured in July 1919 near Vancouver Island, British Columbia, Canada, by a ship operating from the whaling station at Kyuquot. The report tells, it was "a female humpback of the average length with elementary legs protruding from the body about 4 feet 2 inches, covered with blubber about one-half an inch thick". One of the legs had been cut off by the crew of the vessel and lost, but the other leg was photographed *in situ* at the whaling station.

The photograph and the skeletal remains, i.e. two bones and two heavy cartilages, were sent from F. Kermode, Director of the Provincial Museum, Victoria, B. C., to R. C. Andrews of the American Museum of Natural History, New York. And the latter author identified the bones as tibia and metatarsal, the cartilages as femur and tarsus, and published his findings on the skeletal remains together with the photograph. He concluded that "the protrusions actually do represent vestigial hind limbs and show a remarkable reversion to the primitive quadripedal condition". With sufficient reason he rejected the idea of a teratological

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case of no reversionary significance.

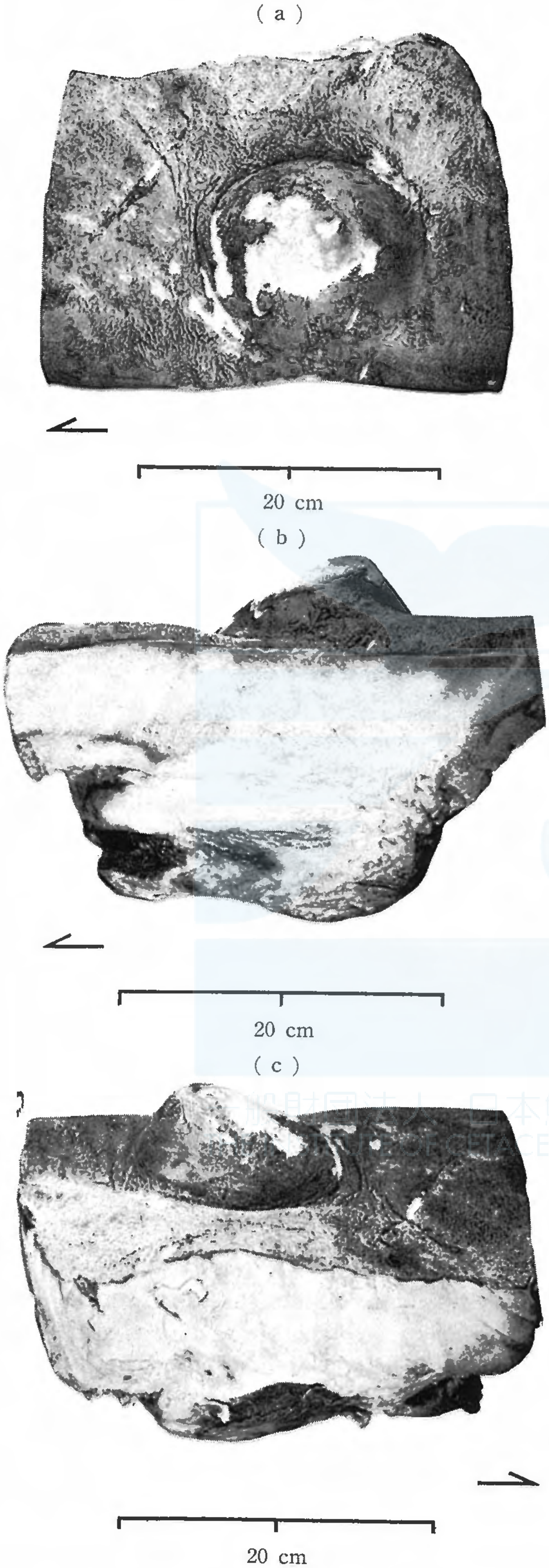
Recently another individual belonging however to the Odontoceti and possessing likewise a pair of protruded hind limbs was encountered in Japan. It was a *Physeter catodon* captured at 3.30 p.m. of November 8th, 1956, by a boat named Daisantoshi-maru of the Nihonkinkai Whaling Company, about 100 miles ES off Kinkwazan (N 37°12′, E 143°35′). According to the report presented from the whaling station, it was a female measuring 10.6 m in length. The protuberances were present on both sides of the genital opening; but to our regret no photograph was taken on the limbs *in situ*. When the body was cut at the Ayukawa whaling station, two skin areas (each area of about 750 qcm) with the protrusion placed near the center were excised with underlying blubber and preserved in formalin at the Whales Museum of Ayukawa.

Shortly after the event, Dr. H. Omura, Director of the Whales Research Institute of Tokyo, visited the museum and noticed the presence of these valuable specimens. They were delivered soon to us for anatomical researches. We wish to say here sincere thanks to Dr. Omura and to the personnel of Ayukawa for their courtesies in allowing us to have the opportunity of studying this precious material.

OBSERVATIONS

The protrusions are nearly of the same size and similar form on both sides (Figs. 1 and 2). They are elevated like a dome, or conical with the tip rounded. On the left side it protrudes a little more sharply than on the right. The summit of the elevation, appearing rather like a plateau, lies not in the middle, but remarkably behind; in other words, the axis of the elevation is directed caudad and ventrad. The anterior slope is longer and wider, while the posterior one is shorter and more rapid. The height measures 5.35 cm on the right side, 6.56 cm on the left. The limbs are therefore in the present case uncomparably shorter than in the Andrews' case. The circumference at the base is on the right side 49.5 cm (anteroposterior diameter 16.6 cm, transverse one 14.0 cm), on the left side the circumference at the base 43.5 cm, (15.0 cm, 13.0 cm). Seeing as a whole, the left limb is relatively more slender; the right one is a little thicker and shorter. The summits show baldness in some extents, where the epidermal covering is lacking and white smooth surface of the corium is exposed externally.

After consulting the Röntgen photographs we searched into the interior of the left limb. The pelvic bone measuring 19.5 cm in length was found there, looking like a hatchet in form, with the edge directed laterad. It seems to run grossly in the anteroposterior direction, but its



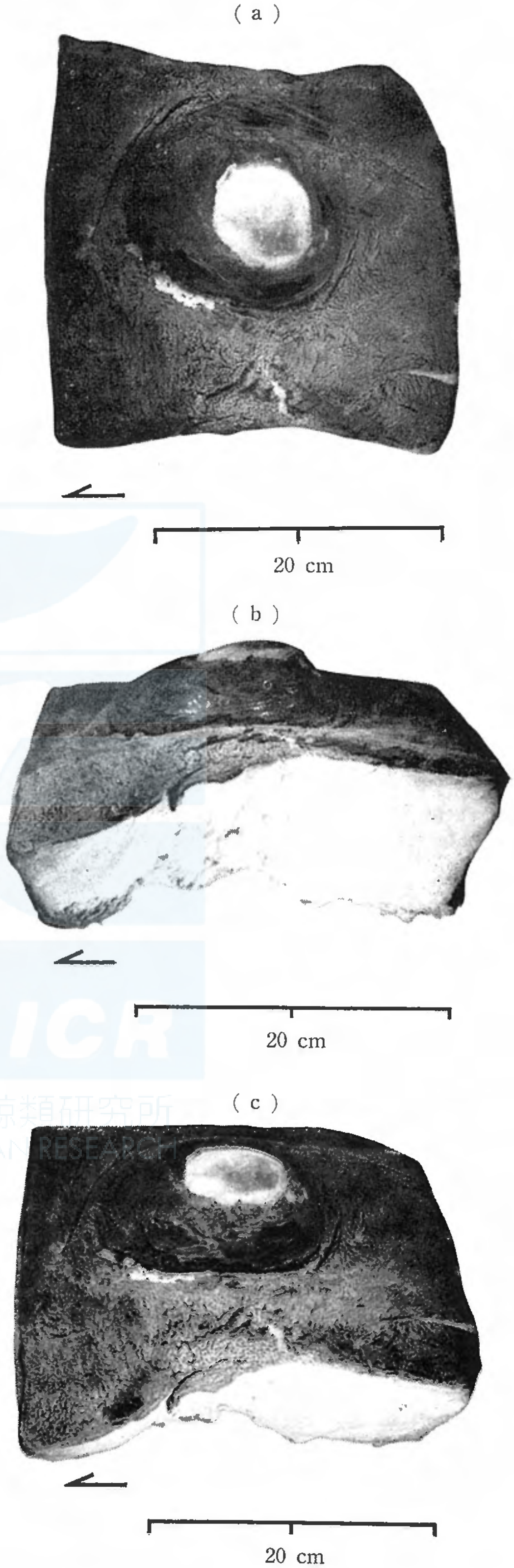


Fig. 1. The left hind limb. (the arrow denotes the anterior direction)

Fig. 2. The right hind limb. (the arrow denotes the anterior direction)

anterior part lies probably more mediad than the posterior. It is narrower in the anterior half, and becomes broader transversely in the posterior half which is still cartilaginous in a large extent (Fig. 3).

Laterad in the neighbourhood of the pelvis, nearly at the middle part of this bone, the femur covered with cartilage is present taking the form of a small ball with the diameter ca. 3 cm (its osseous part 2.2 cm measured on the Röntgen picture). It is easily movable against the pelvis, but no joint is formed between them; their firm connection is attained by the connective tissue and especially by muscles. Concerning the latter, two strong muscular masses are attached to the femur, one coming from anterior and the other from posterior. The anterior mass (M_1 and M_2 in Figs. 3, 4, 5), which corresponds in our opinion seemingly to adductors, takes origin mostly from the anterior half of the pelvis (M_2), the rest comes from somewhere more anterior portion (M_1), possibly from muscles of the abdominal wall, while the posterior mass (M_3 and M_4 in Figs. 3, 4) starts for the small part from the posterior half of the pelvis (M_3), but for the greater part from somewhere more posterior portion (M_4), probably from the caudal musculature. The posterior mass corresponds in our opinion to the ischiofemoral muscles and to such muscles as m. glutaeus maximus.

A pretty wide space triangular in shape (S in Figs. 3, 4) remains between pelvis and femur. This space, bordered fore and behind by the muscular masses mentioned above, is filled with areolar and adipose tissues, while large nerves and vessels pass through there to be distributed further to the hind limb.

Lateroventrally 4.8 cm distant from the femur a mostly cartilaginous stick of the length 13 cm is present. It is only partially ossified. The distal half and the proximal one-fourth are cartilaginous, while the remaining part (the second one-fourth from the proximal end) is ossified and this osseous part (3.5 cm long, 1.8 cm wide) is thicker enlarged chiefly on the anterior side, in comparison with the other cartilaginous portions.

It is difficult to determine whether this stick be corresponding either to tibia, fibula, or both of them fused together, or rather to an isolated distal portion of femur. But we take it provisionally for tibia in view of two slender muscles coming from the femur, and inserting to the anterior surface of the bony part of this stick.

Between femur and tibia no joint like the knee exists, as both bones are not in contact but far (4.8 cm) apart from each other. The distal end of the stick lies in the central part of the protruded hind limb, only 2 cm interior from the surface of the summit. As the thickness

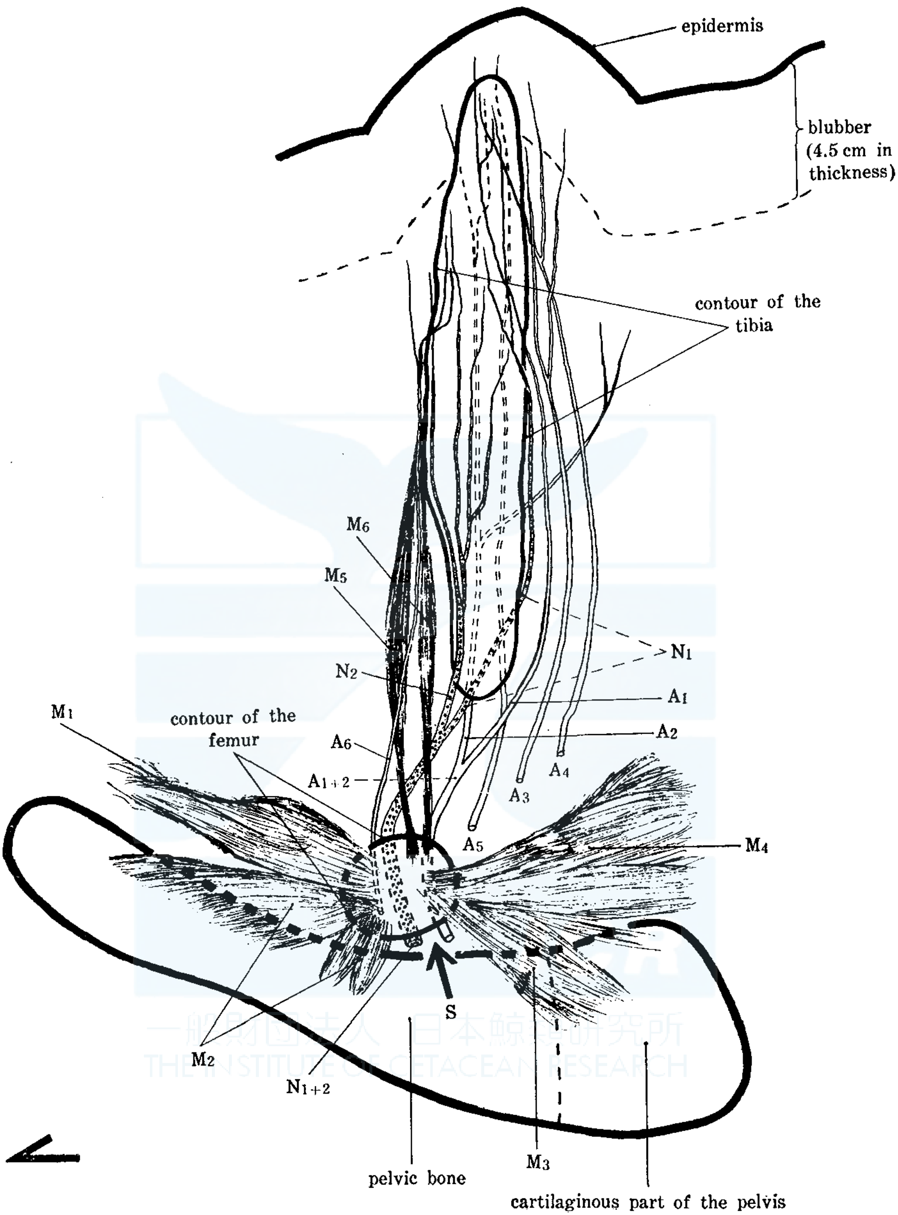


Fig. 3. Schema showing the interior of the left hind limb. (the arrow denotes the anterior direction)

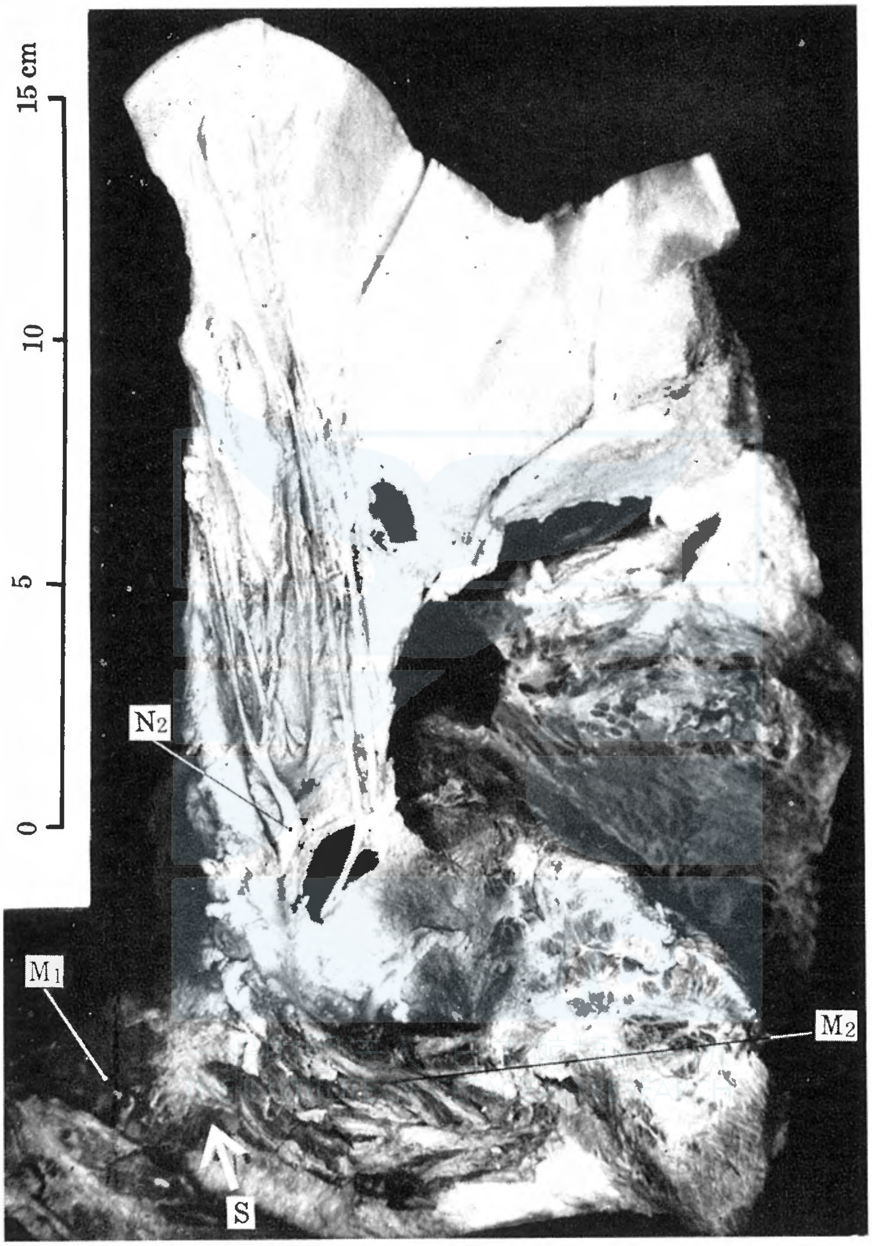


Fig. 4. Interior of the left hind limb, seen from caudal and ventral.

Fig. 5. Interior of the left hind limb, seen from rostral and a little ventral.

of the dermis in the vicinity of the protuberance measures 4.5 cm, the cartilaginous distal extremity is pierced into the skin, so to speak, in a pit on the inner surface of the dermis (Fig. 3).

Two weak muscles (M_5 and M_6 in Fig. 3) are attached to the osseous tibia by intercalation of tendons. For the time being we take these muscles for the rudimentary mm. vasti. A part of the inserting tendons becomes fleshy again and forms a thin muscular plate firmly attached to the anterior surface of tibia (* in Fig. 5). Besides an amount of whitish muscular fibers can be seen, coming somewhere from more superficial part to end also at the bony portion of tibia. We are induced to explain this part of tibia as the tuberositas tibiae. Though these muscles inserting to tibia seem altogether to be homologous with m. quadriceps femoris, no bone is found, which may be identified with the patella.

Our attention was further given to the richneses of nerves and arteries pertaining to the limb. All of them run nearly parallel to the tibia in the proximal-distal direction, but their courses are slightly spiral; especially nerves show more remarkably the spiral course than arteries. At the proximal extremity of the stick two large nerve trunks are seen, one on the anterior side (N_1 in Figs. 3, 5), the other on the posterior side (N_2 in Figs. 3, 4). Both trunks despatch many branches and hence become thinner, but the peripheral continuation of N_1 comes distally to the posterior side of the stick, while the continuation of N_2 attains distally the anterior side of the stick. The "spiral course" is meant by this gradual change of their locations in relation to the tibia. Very probably the tibia rotated around its longitudinal axis during the development and the nerves followed the rotation consistently.

As to large arteries we have counted six of them (A_1, A_2, A_3, A_4, A_5, A_6 in Fig. 3) at the proximal end of the tibia. It is noteworthy, that most of them reach the interior of the protruded hind limb, though they become thinner after issuing branches on the way. Three of the six (A_2, A_5, A_6) run before the tibia, while the remaining three (A_1, A_3, A_4) go behind it, and some of the six arteries show slight tendency of the spiral course. We felt at first queer, why we do not meet with veins in this material, but ascertained afterwards under microscope, that each artery is accompanied by thin-walled venous channels attached intimately to its wall and that these comitant small veins can not easily be recognized by the naked eye.

All of the nerves destined to the hind limb are continuous from a thick trunk (N_{1+2}) passing through the triangular space between pelvis and femur mentioned above (S). Nearly all of the arteries come also from the same space, through only as to one artery (A_4) the same fact was not proven, as it had been destroyed on the way. Nerves and arteries run at first ventral to the pelvis, then dorsal to the femur, to reach further the tibial region.

The skin covering the hind limb was examined histologically and compared with the skin outside but near the elevation. The stratum cor-

Fig. 6. Cross-section of an artery (A_1) with three comitant venous channels. One of them (upper left) shows venous valve.

neum was disjuncted on both localities, certainly a post mortem occurrence. We noticed that at the height of the limb the papillae made of the corium are much slender and grow more densely than in the neighbouring usual skins.

COMMENTS

Compared with the humpback reported by Andrews (1921), the present case is different not only in the kind of the whale, but very much also in the lowness of the protruded hind limbs. The height is in our *Physeter* only 5-6 cm, while in the Andrews' case it was said so long as 4 feet 2 inches, when fresh. It is to be noted, that our case resembles in a much higher degree the bud-like state of the hind limbs in the early Cetacean embryos.

Existence of the hind-limb elevation was at first reported in a 7 mm embryo of *Phocaena communis* by Guldberg of Norway in 1894. Kükenthal, the famous German zoologist, was very much interested in this problem and published later his findings on small embryos of *Megaptera* *nodosa* and *Phocaenoides dalli* (1914). According to him a 32 mm long embryo of *Megaptera* showed very clearly the hind-limb elevation on both sides of the genital tubercle, and it measured 1.2 mm in height and 0.9 mm in width at the base. It was conical, but rounded at the tip, papilla-like, and flat laterally and caudally directed.

In a recent paper of Ogawa (1953) the hind-limb protrusion was mentioned in 14 mm, 20 mm, 24 mm embryos of *Prodelphinus caeruleoalbus* and in a 20 mm embryo of *Megaptera nodosa*. The protrusion was the most conspicuous in the 14 mm *Prodelphinus*. It was rather conical and pointed, the apex being directed caudad and laterad. By adding more materials to observation Ogawa said for the first time the simultaneousness of the disappearance of the hind-limb elevation with the first appearance of the caudal flukes in the Cetacean embryos.

Unquestionably the present case happened to occur by abnormal retention of this early embryonic state, due to some unknown factor, by hindrance to the normal development. Not only the location, but also the form, i.e. conical with the rounded tip directed caudally, seems to agree well between the early Cetacean embryos and the present case of *Physeter*.

In the Andrew's *Megaptera* the hind-limb protrusions were very long, and contained 14.5 inches long tibia and more than 6 inches long metatarsal, moreover two heavy cartilages representing femur and tarsus. This humpback can not be explained merely by the retention of the normal development, but shows more positive tendency of generating the hind limbs. The atavism of the whale back to the quadripedal condition was seen there more pronounced.

But the difference between the two cases is never essential, but rather a problem of quantity. Both mean equally a reversion to the quadripedal ancestors. There can perhaps be no other explanation. In our case of the short hind limbs the partly ossified femur and the 13 cm long, mostly cartilaginous, for the smaller part osseous tibia was found. Guldberg (1899) and Hosokawa (1955) saw histologically neither cartilage nor bone in the hind-limb elevation of the Cetacean embryos, only a mass of mesenchyme cells. In the hind limb of our case further differentiation of the tissues has certainly taken place; it retained the early embryonic state only in location and form, but not in the histological structure.

Upon dissecting the bud-like hind limb we were rather surprised by the relative abundance of arteries and nerves, and on the contrary by the apparent paucity of veins. Microscopic studies revealed however the rich existence of thin-walled venous channels in the very vicinity of the arteries. This relation reminds us of the recent paper of Scholander and Schevill (1955), which deals with the blood-vessels lying deeply in the fins and flukes of *Lagenorhynchus acutus* and *Tursiops truncatus*. According to them, all major arteries are located centrally within a trabeculate venous channel, and this results in two concentric conduits with the warm one inside, which they explained as a heat-conserving counter-current system. Anyway we are interested in seeing the similar vascular relations in the rudimentary hind limb.

The richness of the nerves led us to recall the experiments of Detwiler (1936) and others, who after grafting extremities in the larvae of *Amblystoma* to unusual regions saw hyperplastic growth of the corresponding peripheral neurons. The unusual outgrowth seems to bring forth the adequate development of peripheral nerves even in these warm-blooded, pelagic mammals.

SUMMARY

In a nearly adult female Cachalot captured in November of 1956, off Kinkwazan in Japan, a pair of bud-like vestigial hind limbs were present. The height of the protuberance was 5.35 cm on the right side, 6.56 cm on the left side.

Upon examining the interior of the left limb three partially cartilaginous bones were found. They correspond to pelvis, femur, and possibly to tibia, but no joints exist between them. Pretty strong muscles connect between pelvis and femur, while two weak muscles are extended between femur and tibia. The tibia is a 13 cm long for the greater part cartilaginous, and only partly ossified stick-like body with its distal end inserted into the skin of the hind-limb protuberance.

A number of arteries and nerves run parallel to this tibia distalward and especially the nerves show the tendency of spiral course around the stick. The veins are not easily visible by the naked eye, but they are found attached intimately to the wall of arteries.

This case can be understood by assuming abnormal retention of the early embryonic state, and show very probably an atavism back to the quadripedal condition of the whales' remote ancestors. It can never be a malformation of no phylogenetic significance.

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STUDIES OF THE RELATION BETWEEN THE WHALING GROUNDS AND THE HYDROGRAPHIC CONDITIONS

II. A STUDY OF THE RELATION BETWEEN THE WHALING GROUNDS OFF KINKAZAN AND THE BOUNDARY OF WATER MASSES

MICHITAKA UDA* AND ATSUSHI DAIROKUNO*

The whaling Grounds off Kinkazan are world-known since the active hunting by the American whaling fleets in 19 century and nowadays exploited by the Japanese whalers to the offing about 250 sea-miles from the coast. Uda (1954) has proved already the intimate relation between the distribution of whaling grounds and the sharp boundary of water masses or oceanic front. Proceeding to study the conditions in detail, we have investigated the data obtained from the offing of Kinkazan during the years from 1946 to 1954 by the Japanese whalers. The results are as follows:

1. Generally the whaling grounds were observed near the boundary zone of water masses (frontal zone) corresponding to the sharp temperature gradient of sea water.

2. The whaling grounds shift seasonally and temporarily in accompany with the movement of oceanic front.

3. Oceanic front and whaling grounds shift to north in the offing of Kinkazan in summer and come down to south in autumn.

4. Usually we can find the whaling grounds off Kinkazan within 60 seamiles in the direction between south and east from the center or core of oceanic front.

5. As already reported by Uda (1954) the boundary between the cold upwelling water mass of cyclonic eddy and the warm water mass (anti-cyclonic eddy), forming a cyclonic revolving pattern of the tongues of cold and warm currents corresponds to the center of the most favourable whaling grounds (See e.g. Fig. 1).

It may be due to the plenty concentration of food organisms such as euphausid, copepods, squids and fishes which assembled to the boundary of water masses by the convergence of currents.

6. Sperm whale was frequently seen on the side of cold current zone, and sei whale appeared frequently on the side of warm current zone and especially both densely observed near the tongues of cold and warm currents.

7. The whaling grounds distribute generally around the most re-

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markable oceanic front (sharp boundary) which may be denoted by the steepest horizontal gradient of water temperature (θ°C) i.e. $(\partial\theta/\partial l)_{max.}$ where l is the horizontal distance in sea-miles. First we have estimated the frequency of fronts passing through the half degree rectangle of longitude and latitude.

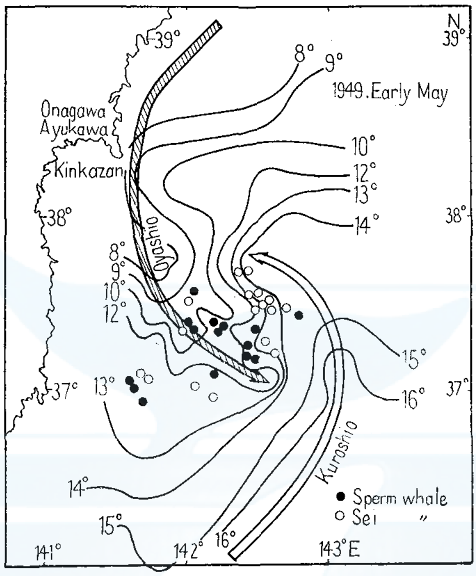


Fig. 1. Typical feature of Oceanographic Pattern of Surface Water Temperature and the Distribution of Whaling Grounds.

For our convenience we can define the 'intensity' of oceanic front

$$S = \partial\theta/\partial l$$

and the 'power' of oceanic front

$$W = \partial\theta/\partial l \times n$$

where n denotes the number of fronts passing through in that rectangle in the period during the period (1946–54) and in actual calculation

$$\partial\theta/\partial l - 0.4°\mathrm{C/SM} \text{ adopted.}$$

and weighted number of n (taking the weight at diagonal max. length 1, and at its corner 0). (The tables neglected).

Fig. 2 shown in each decade compiled in 1946–54. The main whaling ground I (37°–38.5°N, 142°–143.5°E, May–Dec.), the second whaling ground II (38°–39.5°N, Late June–Middle Oct.) and the third ground III (38°–39.5°N, 145.5°–146°E, July–Sept.) are seen from Fig. 2. The location of oceanic fronts were almost always recognized in the north-western side of the whaling grounds.

8. Seasonal variation of whale catch.

a) Sperm whale. During summer and autumn season, the catch of sperm whale reaches its peak twice in the year (from middle July to early September and early October to late November).

b) Sei whale. During the season from late June to late August, the catch of sei whale attains to its peak.

c) Fin whale. From May to September fin whales were caught but in far few number compared to the above 2 species.

9. The movements of the centre of whaling grounds and of the core of oceanic fronts are coupled together as shown in Fig. 4.

LITERATURE

UDA, M. (1954). Studies of the relation between the whaling grounds and the hydrographic conditions (I). *Sci. Rep. Whales Res. Inst.*, no. 9: 179-187.

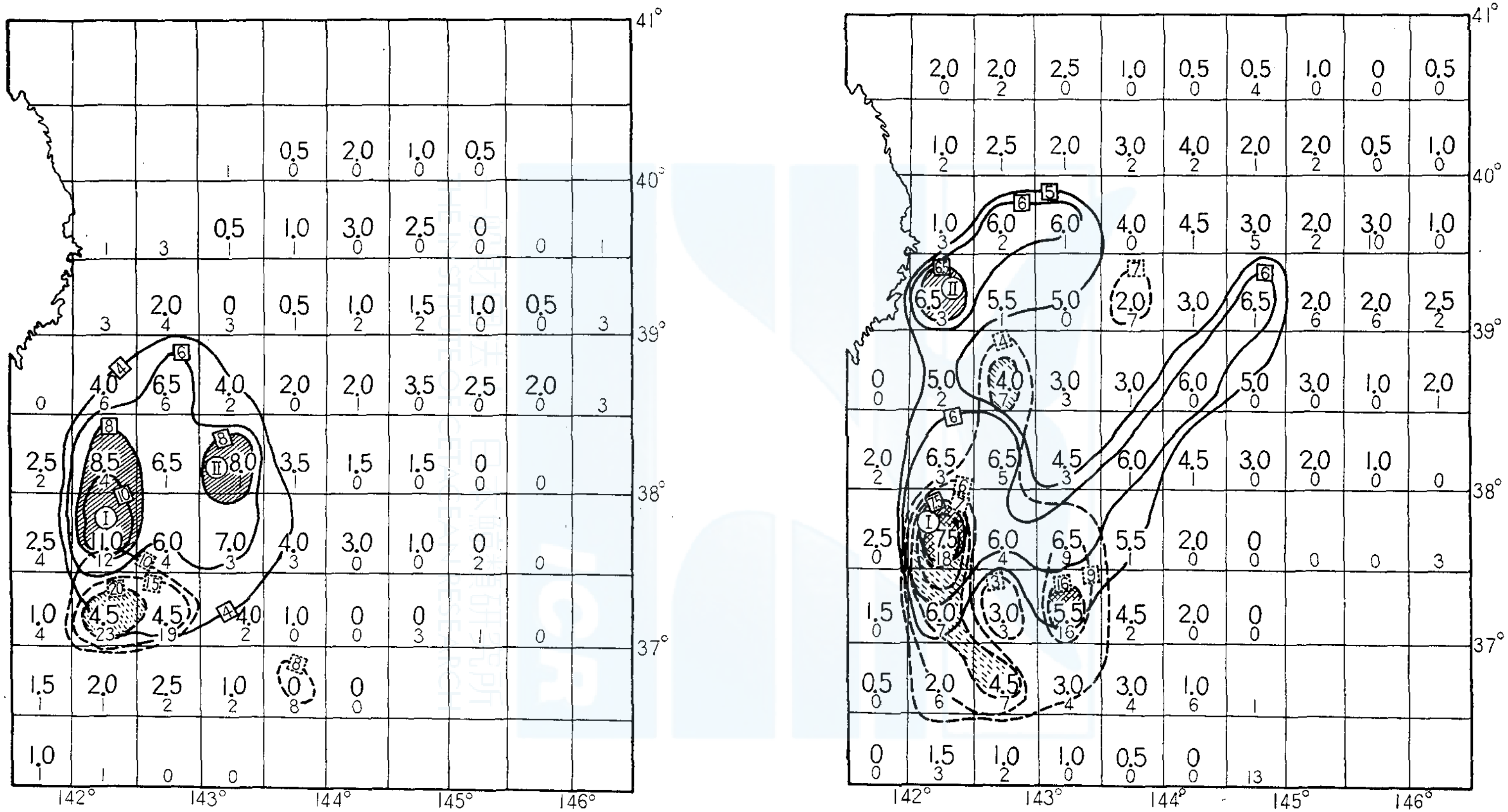


Fig. 2. Frequency Distribution of Oceanic Front (–) and Whaling Ground (- - -).

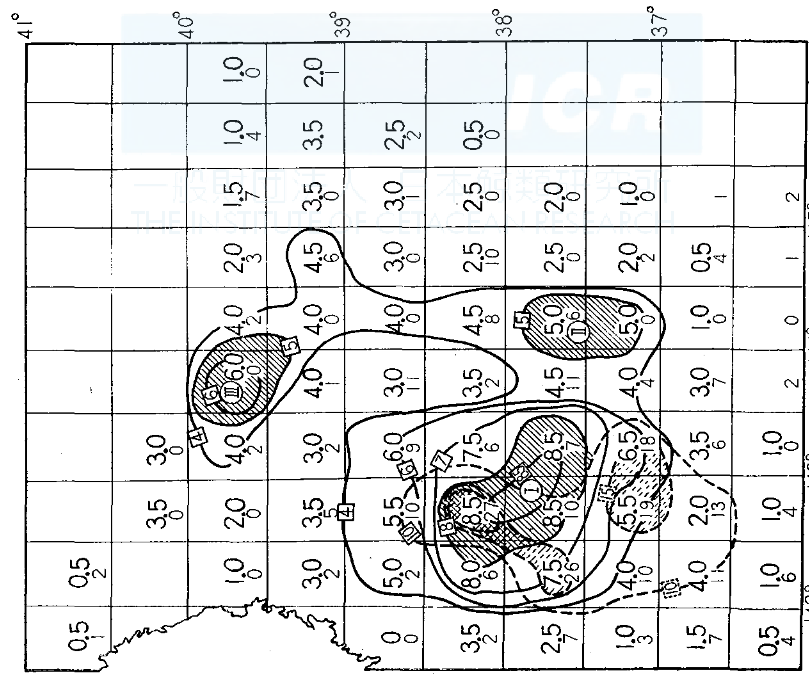
(I) $\partial\theta/\partial l=0.47$ $W_{\mathrm{I}}=\partial\theta/\partial l\times n=0.47\times 11.0=5.17$ 18~10°C

(II) $\partial\theta/\partial l=0.48$ $W_{\mathrm{II}}=\partial\theta/\partial l\times n=0.48\times 8.0=3.84$ 16~8

(I) $S=\partial\theta/\partial l=0.43$ $W_{\mathrm{I}}=\partial\theta/\partial l\times n=0.43\times 7.5=3.23$ max $\theta=18$ min $\theta=10$

(II) $S=\partial\theta/\partial l=0.40$ $W_{\mathrm{II}}=\partial\theta/\partial l\times n=0.40\times 6.5=2.6$ max $\theta=15$ min $\theta=6$

c. Late May (1946-'54)

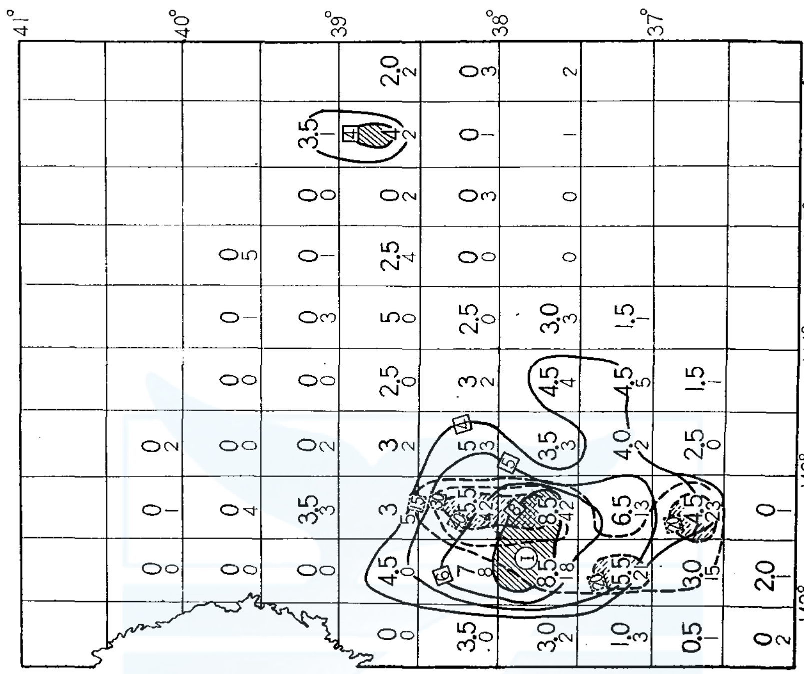


(I) $S=\partial\theta/\partial l=0.47$ $W_{I}=\partial\theta/\partial l\times n=0.47\times 8.5=4$ max θ=20°C min θ=12°C

(II) $S=\partial\theta/\partial l=0.45$ $W_{II}=\partial\theta/\partial l\times n=0.45\times 5.0=2.25$ 〃 =20°C 〃 =15°C

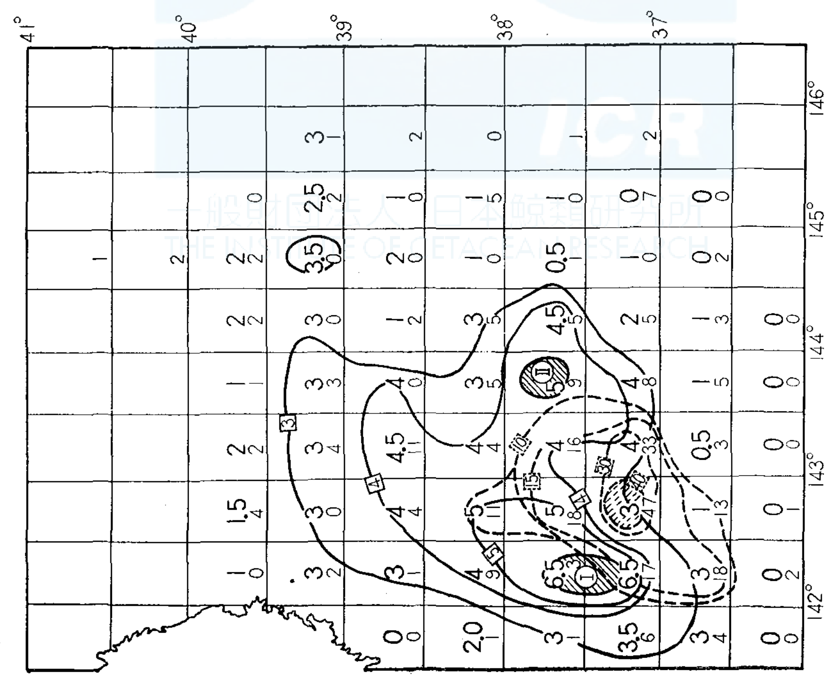
(III) $S=\partial\theta/\partial l=0.4$ $W_{III}=\partial\theta/\partial l\times n=0.4\times 6.0=2.4$ 〃 =14°C 〃 =8°C

d. Early June (1946-'54)



(I) $\partial\theta/\partial l=0.5$ $W_{I}=\partial\theta/\partial l\times n=0.5\times 8.5=4.25$ max θ=20 min θ=14

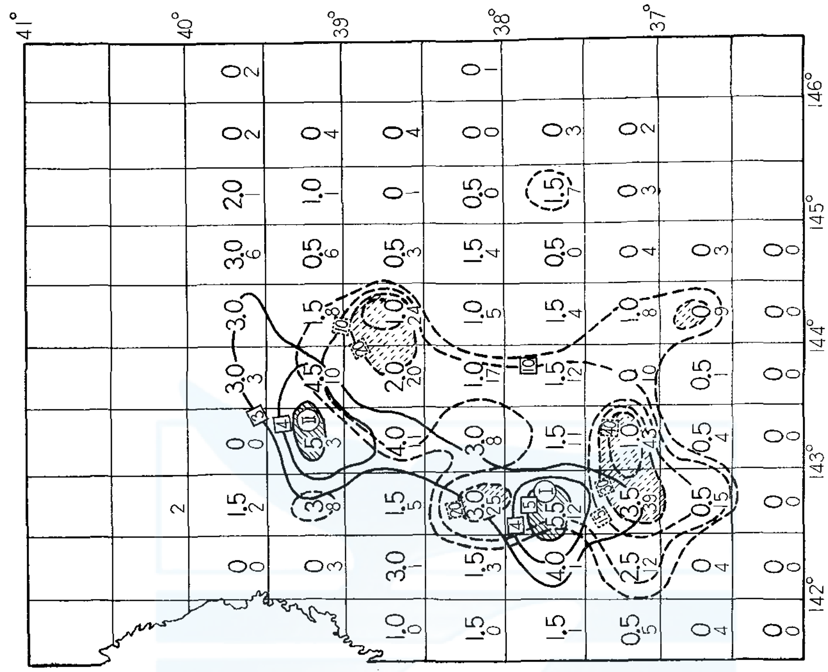
e. Middle June (1946-'54)



(I) $\partial\theta/\partial l=0.58$ $W_{\text{I}}=\partial\theta/\partial l\times n=0.58\times 6.5=3.83$ max $\theta=20$ min $\theta=16$

(II) $\partial\theta/\partial l=0.47$ $W_{\text{II}}=\partial\theta/\partial l\times n=0.47\times 5.0=2.35$ 〃 $=2.22$ 〃 $=16$

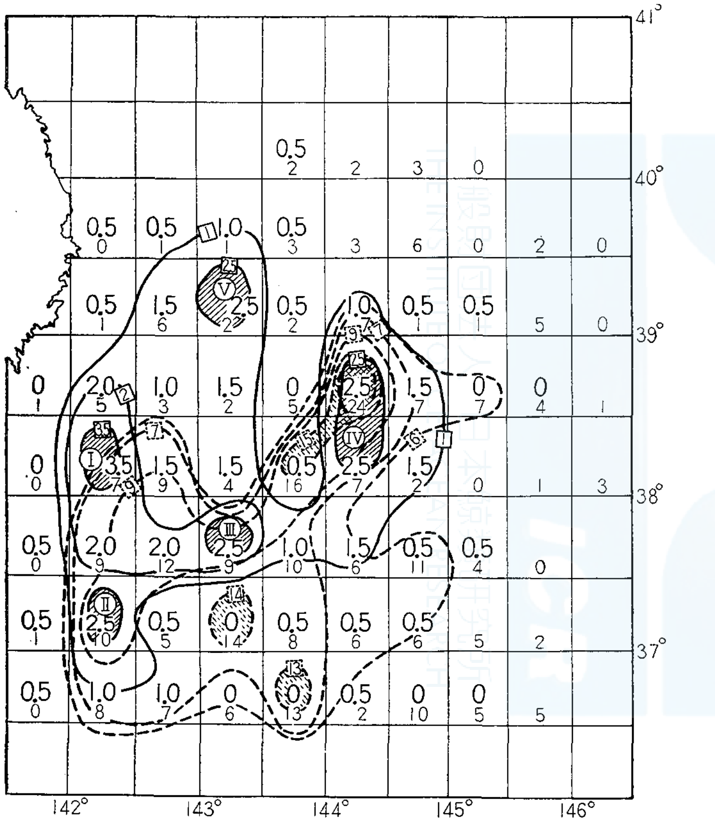
f. Late June (1946-'54)



(I) $\partial\theta/\partial l=0.53$ $W_{\text{I}}=\partial\theta/\partial l\times n=0.53\times 5.5=2.92$ max θ~min θ 22~14

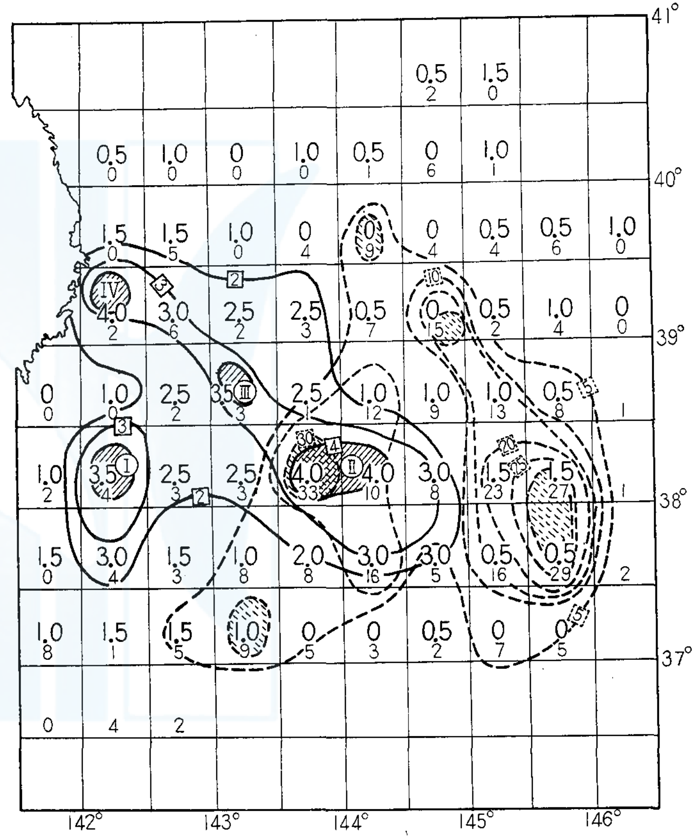
(II) $\partial\theta/\partial l=0.4$ $W_{\text{II}}=\partial\theta/\partial l\times n=0.4\times 5.0=2.0$ max $\theta=18$ min $\theta=14$

g. Early July (1946–'54)



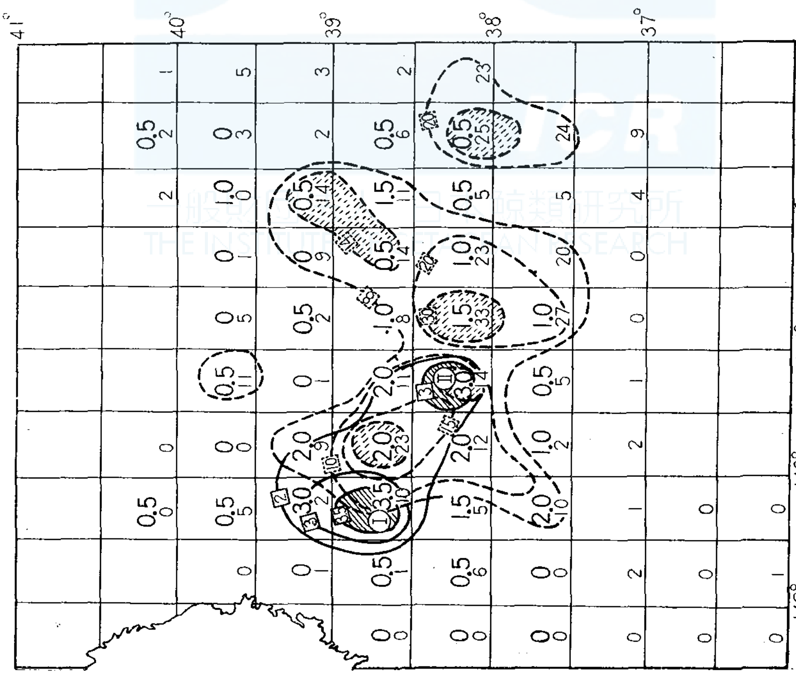
(I)	$\partial\theta/\partial l=0.4$	$W_{\text{I}}=\partial\theta/\partial l\times n=0.4\times 3.5$	max θ=22	min θ=16
(II)	$\partial\theta/\partial l=0.4$	$W_{\text{II}}=\partial\theta/\partial l\times n=0.4\times 2.5$	〃 22	〃 19
(III)	$\partial\theta/\partial l=0.53$	$W_{\text{III}}=\partial\theta/\partial l\times n=0.53\times 2.5=1.33$	〃 24	〃 16
(IV)	$\partial\theta/\partial l=0.45$	$W_{\text{IV}}=\partial\theta/\partial l\times n=0.45\times 2.5$	〃 21	〃 16
(V)	$\partial\theta/\partial l=0.43$	$W_{\text{V}}=\partial\theta/\partial l\times n=0.43\times 2.5$	〃 17	〃 13

h. Middle July (1946–'54)



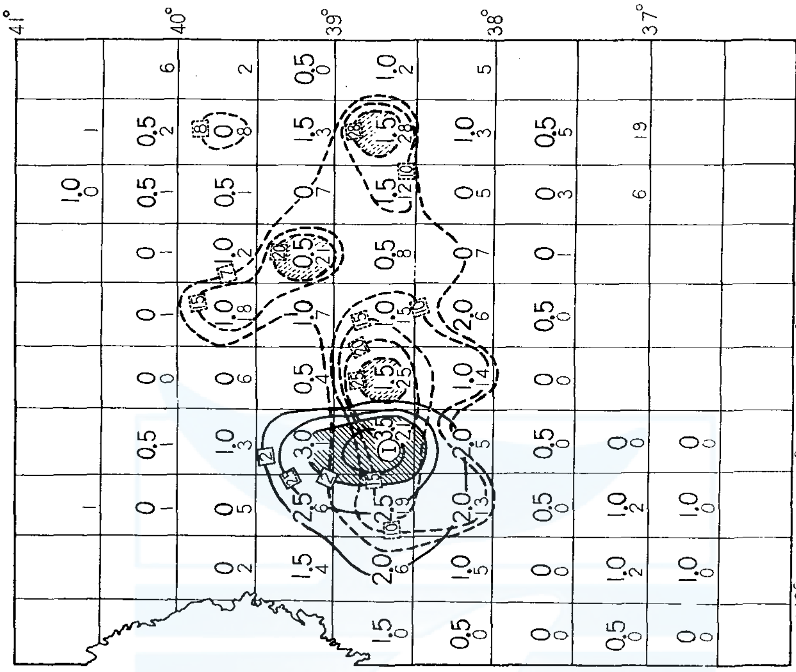
(I)	$\partial\theta/\partial l=0.48$	$W_{\text{I}}=\partial\theta/\partial l\times n=0.48\times 3.5=1.68$	max θ=23	min θ=16
(II)	$\partial\theta/\partial l=0.47$	$W_{\text{II}}=\partial\theta/\partial l\times n=0.47\times 4.0=1.88$	〃 23	〃 16
(III)	$\partial\theta/\partial l=0.40$	$W_{\text{III}}=\partial\theta/\partial l\times n=0.4\times 3.5=1.40$	〃 22	〃 16
(IV)	$\partial\theta/\partial l=0.44$	$W_{\text{IV}}=\partial\theta/\partial l\times n=0.44\times 4.0=1.76$	〃 21	〃 14

i. Late July (1946-'54)



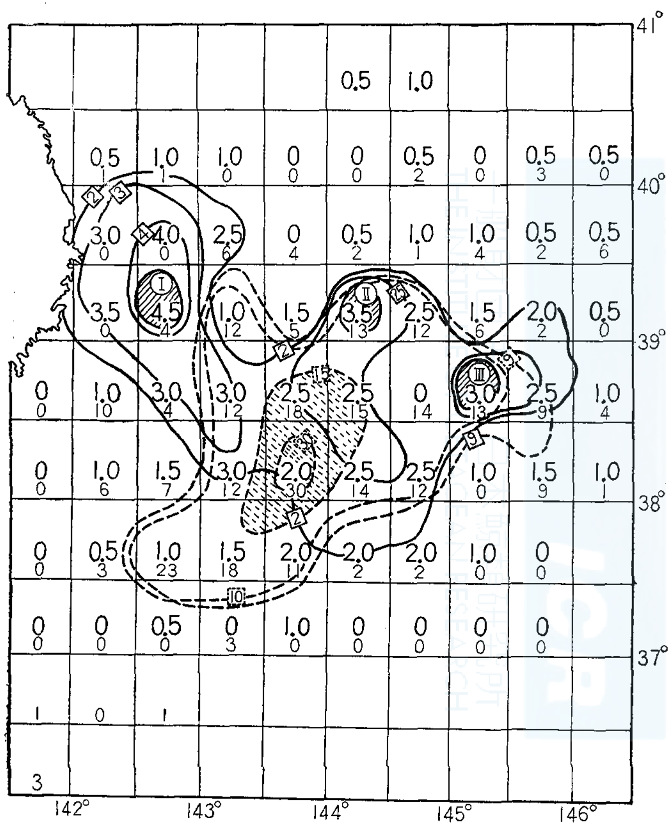
(I) $\partial\theta/\partial l=0.44$ $W_{I}=\partial\theta/\partial l\times n=0.44\times3.5=1.54$ max $\theta=25$ min $\theta=18$
(II) $\partial\theta/\partial l=0.45$ $W_{II}=\partial\theta/\partial l\times n=0.45\times3.0=1.35$ 〃 24 〃 22

j. Early Aug. (1946-'54)



(I) $\partial\theta/\partial l=0.45$ $W_{I}=\partial\theta/\partial l\times n=0.45\times3.5=1.58$ max $\theta=24$ min $\theta=21$

k. Middle Aug. (1946–'54)

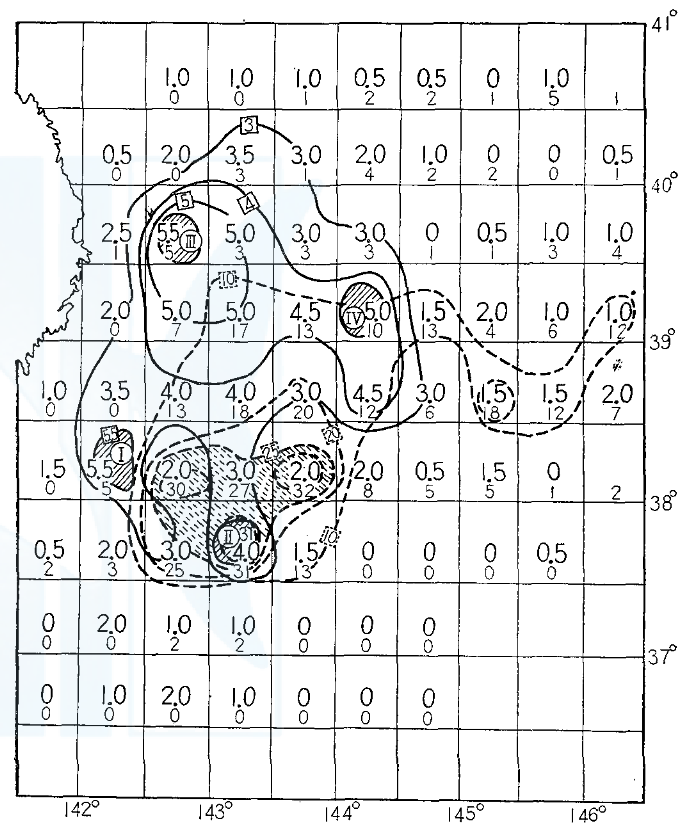


(I) $\partial\theta/\partial l=0.4$ $W_{I}=\partial\theta/\partial l\times n=0.4\times4.5=1.8$ max θ=26 min θ=21

(II) $\partial\theta/\partial l=0.4$ $W_{II}=\partial\theta/\partial l\times n=0.4\times3.5=1.4$ 〃 24 〃 20

(III) $\partial\theta/\partial l=0.4$ $W_{III}=\partial\theta/\partial l\times n=0.4\times3.0=1.2$ 〃 26 〃 20

l. Late Aug. (1946–'54)



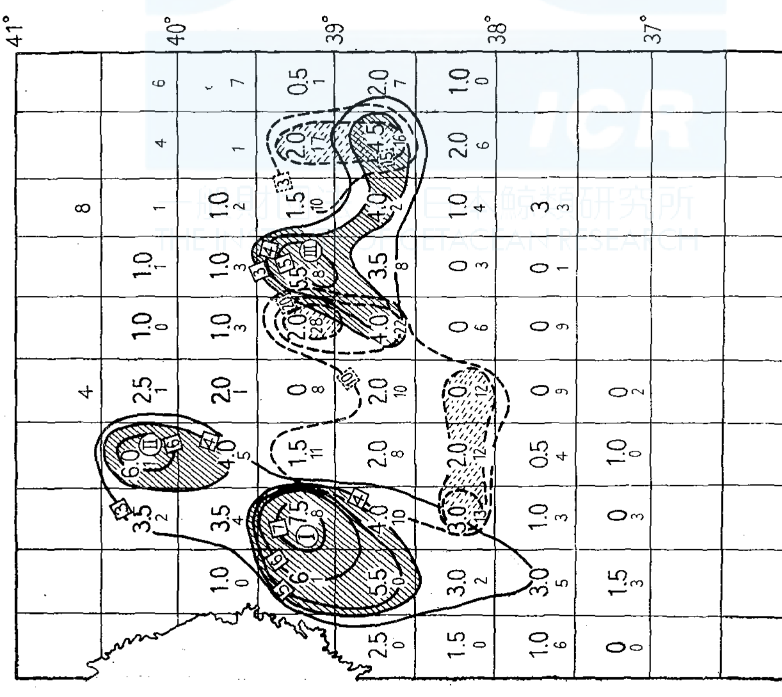
(I) $\partial\theta/\partial l=0.43$ $W_{I}=\partial\theta/\partial l\times n=0.43\times5.5=2.365$ max θ=26 min θ=20

(II) $\partial\theta/\partial l=0.40$ $W_{II}=\partial\theta/\partial l\times n=0.40\times4.0=1.6$ 〃 27 〃 24

(III) $\partial\theta/\partial l=0.42$ $W_{III}=\partial\theta/\partial l\times n=0.42\times5.5=2.31$ 〃 22 〃 20

(IV) $\partial\theta/\partial l=0.40$ $W_{IV}=\partial\theta/\partial l\times n=0.40\times5.0=2.0$ 〃 26 〃 20

m. Early Sept. (1946-'54)

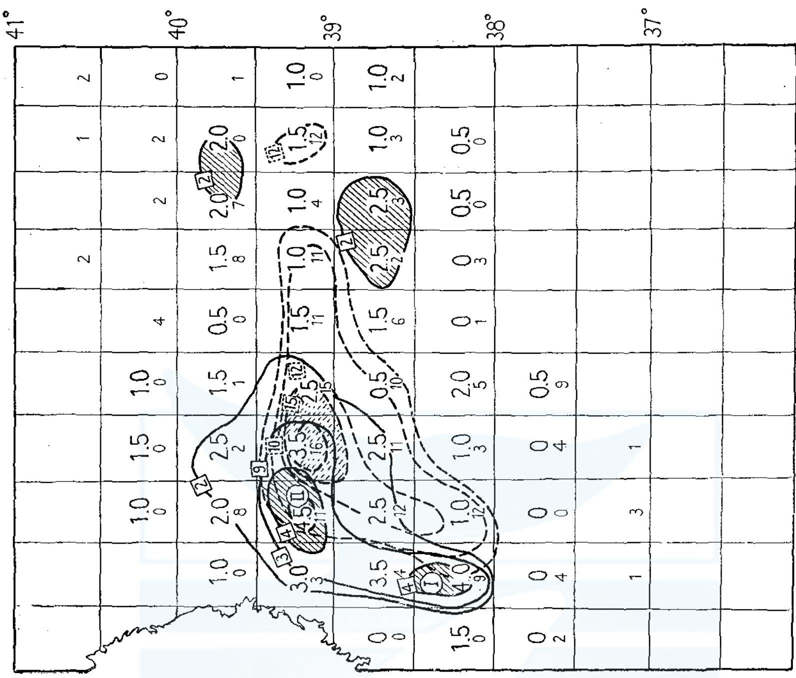


(I) $\partial\theta/\partial l=0.43$ $W_{I}=\partial\theta/\partial l\times n=0.43\times7.5=3.23$ max $\theta=24$ min $\theta=20$

(II) $\partial\theta/\partial l=0.40$ $W_{II}=\partial\theta/\partial l\times n=0.40\times6.0=2.4$ 〃 24 〃 19

(III) $\partial\theta/\partial l=0.40$ $W_{III}=\partial\theta/\partial l\times n=0.40\times5.5=2.20$ 〃 25 〃 23

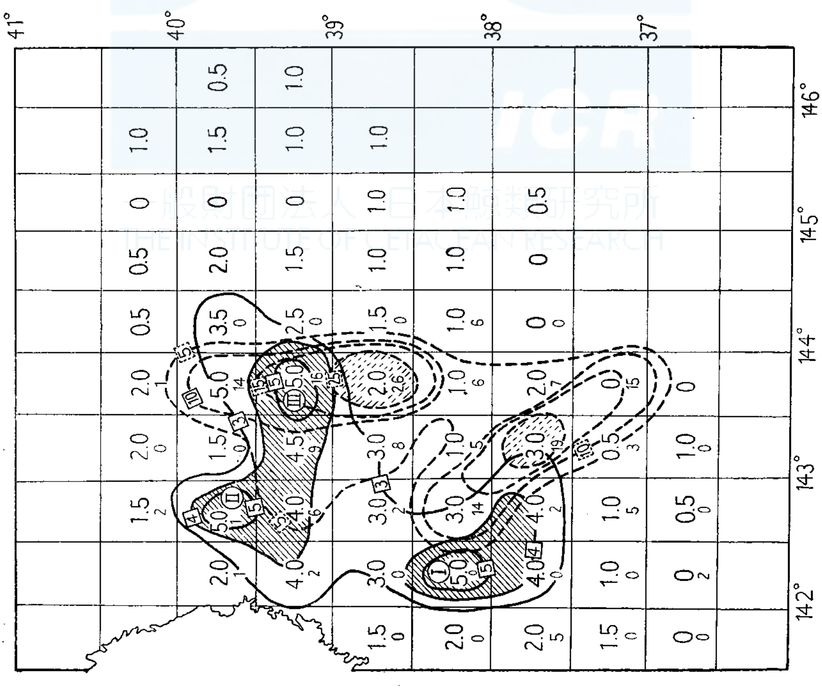
n. Middle Sept. (1946-'54)



(I) $\partial\theta/\partial l=0.43$ $W_{I}=\partial\theta/\partial l\times n=0.43\times4.0=1.72$ max $\theta=24$ min $\theta=20$

(II) $\partial\theta/\partial l=0.50$ $W_{II}=\partial\theta/\partial l\times n=0.50\times4.5=2.25$ 〃 24 〃 20

o. Late Sept. (1946-'54)

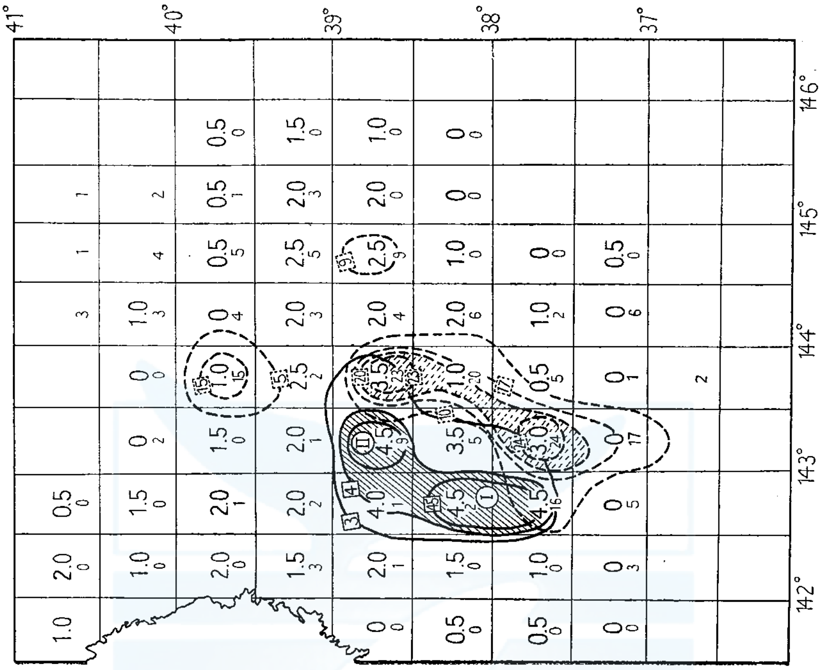


(I) $\partial\theta/\partial l=0.40$ $W_{I}=\partial\theta/\partial l\times n=0.40\times 5.0=2.0$ max $\theta=24$ min $\theta=19$

(II) $\partial\theta/\partial l=0.55$ $W_{II}=\partial\theta/\partial l\times n=0.55\times 5.0=2.75$ 〃 22 〃 18

(III) $\partial\theta/\partial l=0.50$ $W_{III}=\partial\theta/\partial l\times n=0.50\times 5.0=2.50$ 〃 23 〃 18

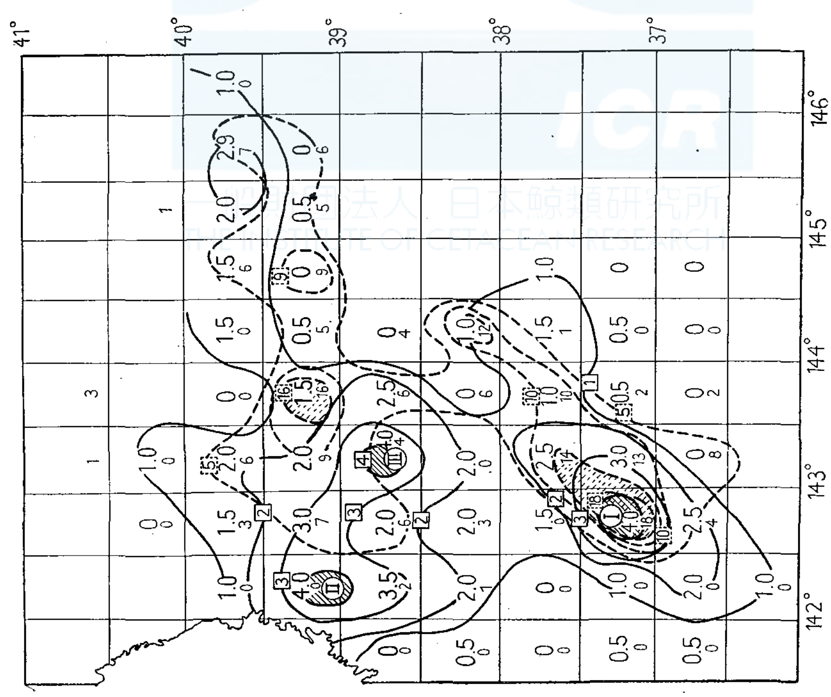
p. Early Oct. (1946-'54)



(I) $\partial\theta/\partial l=0.45$ $W_{I}=\partial\theta/\partial l\times n=0.45\times 4.5=2.045$ max $\theta=22$ min $\theta=16$

(II) $\partial\theta/\partial l=0.40$ $W_{II}=\partial\theta/\partial l\times n=0.40\times 4.5=1.80$ 〃 20 〃 17

q. Middle Oct. (1946–'54)

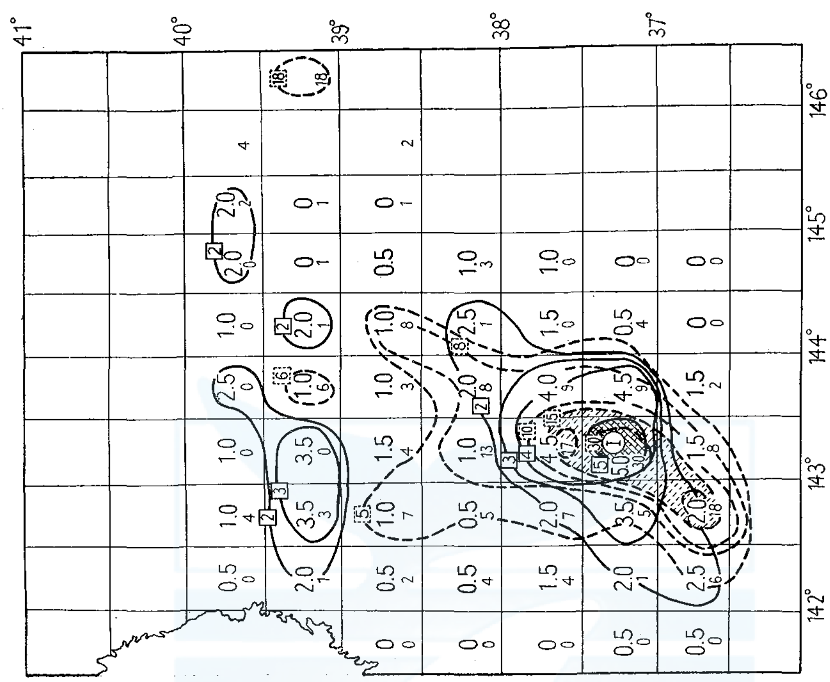


(I) $\partial\theta/\partial l=0.50$ $W_{\mathrm{I}}=\partial\theta/\partial l\times n=0.50\times 4.0=2.0$ max $\theta=22$ min $\theta=16$

(II) $\partial\theta/\partial l=0.40$ $W_{\mathrm{II}}=\partial\theta/\partial l\times n=0.40\times 4.0=1.6$ 〃 19 〃 16

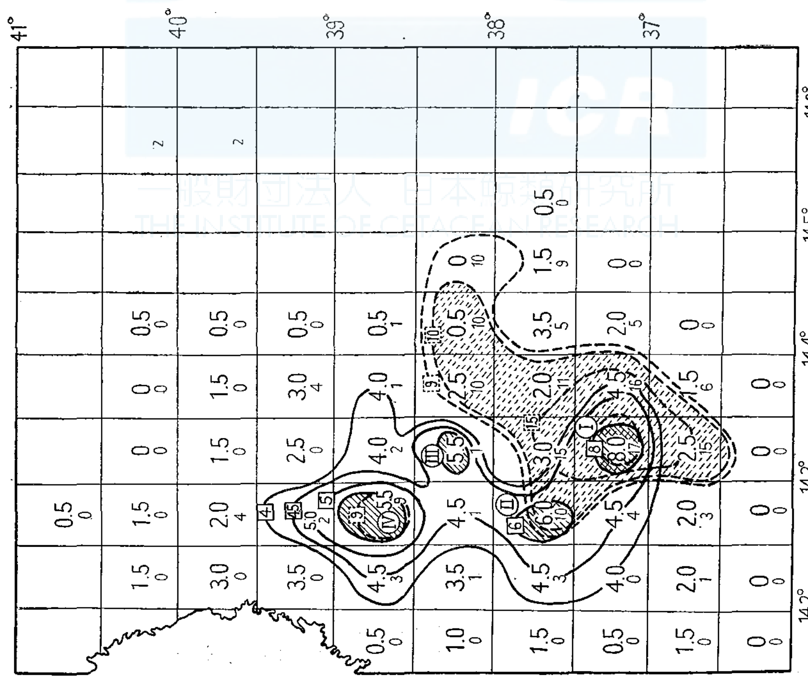
(III) $\partial\theta/\partial l=0.45$ $W_{\mathrm{III}}=\partial\theta/\partial l\times n=0.45\times 4.0=1.8$ 〃 21 〃 16

r. Late Oct. (1946–'54)



(I) $\partial\theta/\partial l=0.63$ $W_{\mathrm{I}}=\partial\theta/\partial l\times n=0.63\times 5.0=3.15$ max $\theta=22$ min $\theta=18$

s. Early Nov. (1946-'54)



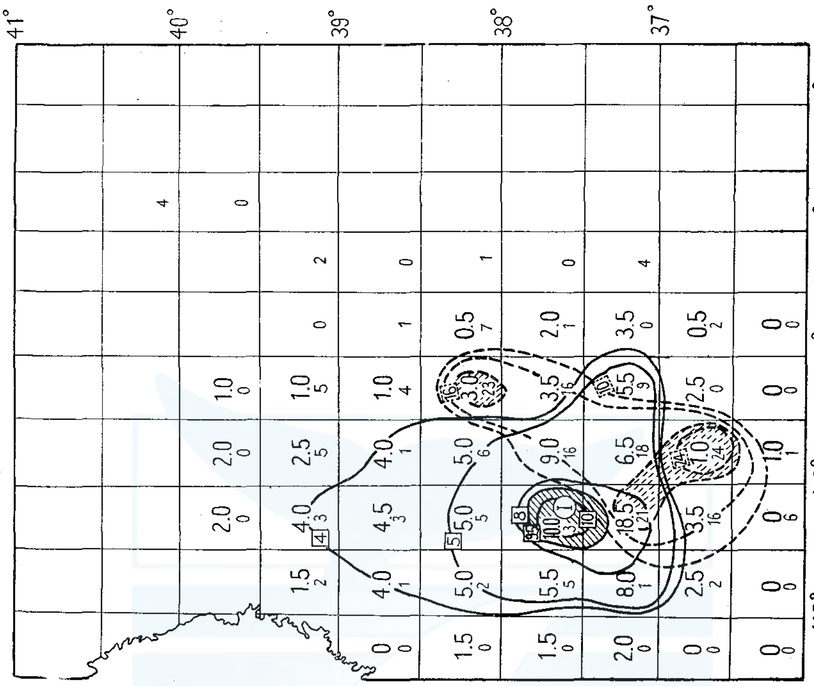
(I) $\partial\theta/\partial l=0.47$ $W_{I}=0.47\times 8.0=3.76$ $\max\theta=22$ $\min\theta=14$

(II) $\partial\theta/\partial l=0.44$ $W_{II}=0.44\times 6.0=2.64$ 〃 20 〃 14

(III) $\partial\theta/\partial l=0.43$ $W_{III}=0.43\times 5.5=2.37$ 〃 20 〃 13

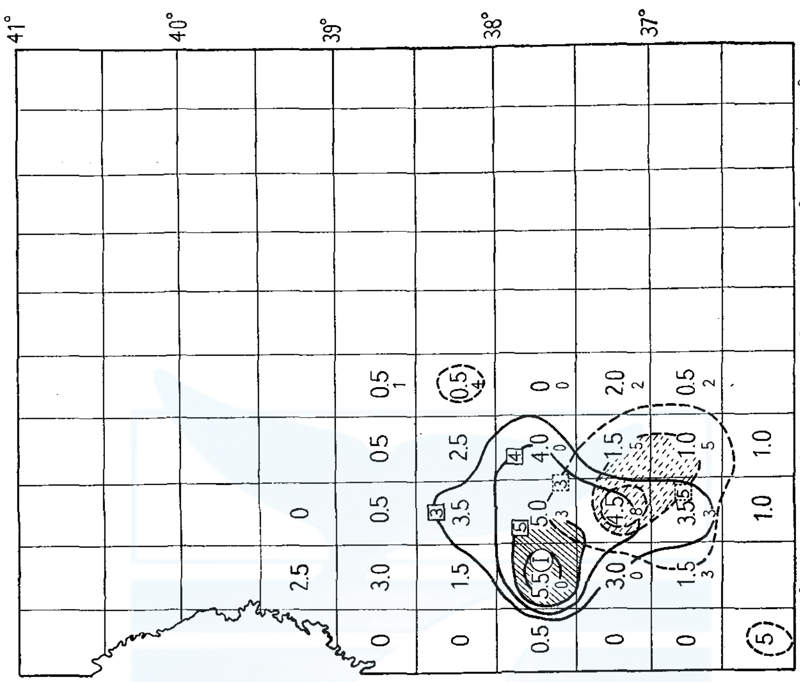
(IV) $\partial\theta/\partial l=0.47$ $W_{IV}=0.47\times 5.5=2.59$ 〃 20 〃 13

t. Middle Nov. (1946-'54)



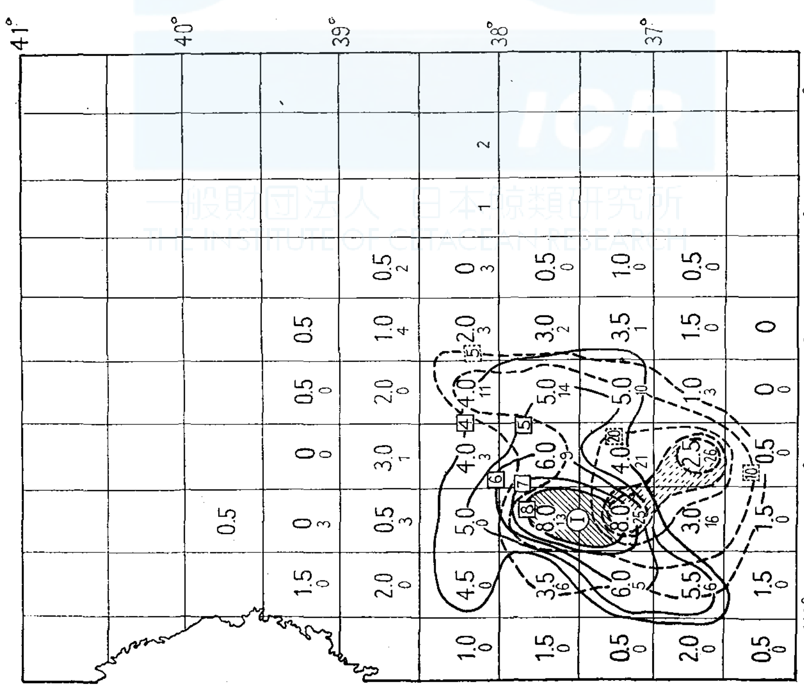
(I) $\partial\theta/\partial l=0.6$ $W_{I}=\partial\theta/\partial l\times n=0.6\times 10.0=6.0$ $\max\theta=20$ $\min\theta=14$

v. Early Dec. (1946–'54)



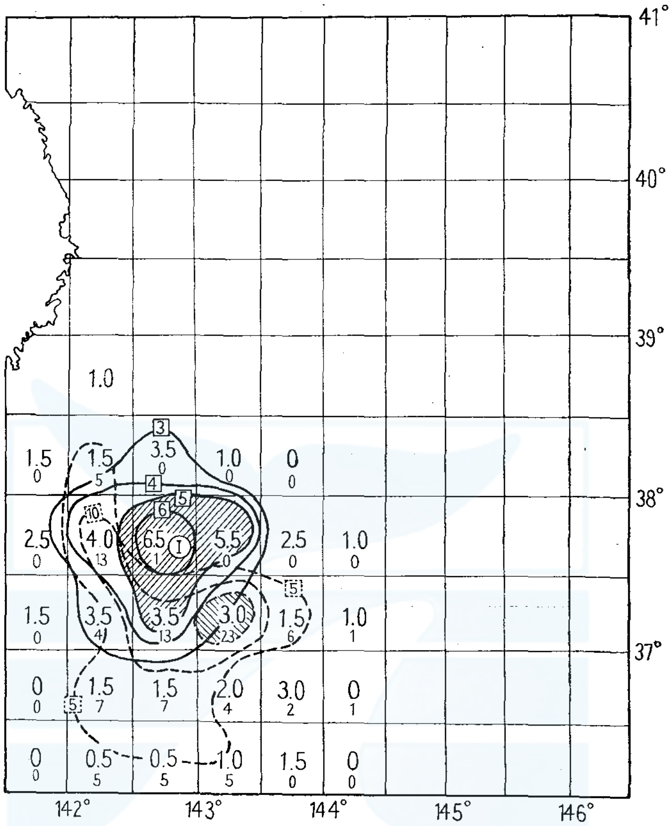
(I) $\partial\theta/\partial l=0.85$ $W_{\mathrm{I}}=\partial\theta/\partial l\times n=0.85\times 5.5=4.68$

u. Late Nov. (1946–'54)



(I) $\partial\theta/\partial l=0.6$ $W_{\mathrm{I}}=\partial\theta/\partial l\times n=0.6\times 8.0=4.8$ $\max\theta=21$ $\min\theta=16$

w. Middle and Late Dec. (1946–'54)



(I) $\partial\theta/\partial l=0.65$

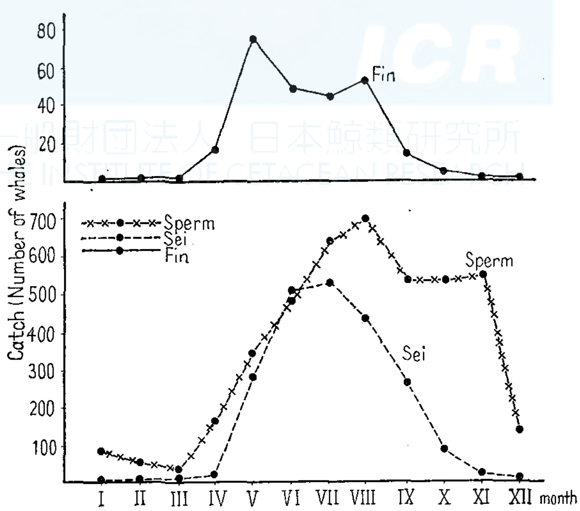


Fig. 3. Seasonal variation of the number of whales caught in each month (1946–1954).

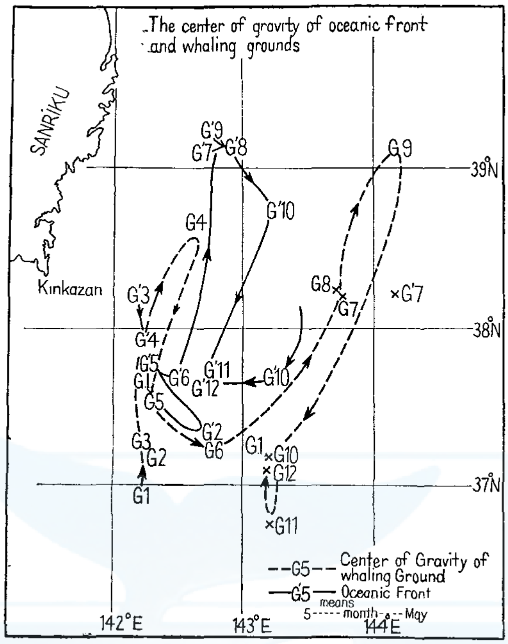


Fig. 4. The center of gravity of oceanic front and whaling grounds.

NOTES ON FISHES FROM THE STOMACHS OF WHALES TAKEN IN THE ANTARCTIC

I. *XENOCYTTUS NEMOTOI*, A NEW GENUS AND NEW SPECIES OF ZEOMORPH FISH OF THE SUBFAMILY *OREOSOMINAE* GOODE AND BEAN, 1895

TOKIHARU ABE*

Since April, 1948, some fishes from the stomachs of whales taken by the Japanese whaling fleets in the Antarctic have been brought back and passed on to the writer for study. The collections include large specimens presenting difficulties in preserving, and this, coupled with other pressing duties, has deferred the preparation of the report of the study. The writer takes pleasure in presenting here the first of a series of papers dealing with these antarctic fishes, and in expressing his sincere thanks to Dr. H. OMURA (Director, Whales Research Institute, Tokyo), Dr. M. NISHIWAKI, Mr. K. FUJINO, Mr. T. NEMOTO (all of the same institute), Mr. T. KAWAKAMI and the other biologists at the Research Division, Fisheries Agency, Mr. K. ŌTSURU (Nihon Suisan Co.) and several other biologists at the whaling companies in Japan for their courtesy and the trouble they have taken. The writer has to thank Miss Y. TAKASHIMA (Tokai Regional Fisheries Research Laboratory) for her help in preparing this paper.

Xenocyttus, New Genus**

Generic type.—*Xenocyttus nemotoi*, new species, described below.

Diagnosis.—The body is deep and compressed, and the caudal peduncle is slender (resembling some of the so-called zeomorph fishes of the genera *Allocyttus*, *Pseudocyttus*, *Cyttosoma*, *Xenodermichhtys*, *Grammicolepis*, *etc.*, on the one hand, and some caproid fishes on the other). Despite pronounced differences in general appearance, the present new genus is, as will be seen below, very closely related to *Oreosoma*, and it is highly probable that the former will prove to be not distinct from the latter, which was introduced by CUVIER in 1829 with *atlanticum* as type. The single specimen upon which he based his discription was only 16 lines (=*ca.* 33 mm***) long. In view of the remarkable changes

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** ξένος=strange; κυττος=an unknown fish (*vide* GÜNTHER, 1860, p. 396, foot-note).

*** According to VAILLANT, 36 mm.

in body shape, and more especially in armature, with advancing age in certain fishes, the writer wishes to give the diagnosis paying special attention to the other characters.

The total number of vertebrae (examined by radiograph) is a little more than 40 (*ca.* 43). The fin-formula of the ventral is I 5 (=4+i, or, all branched); the spine is long, and soft*. The ventral origin is behind the pectoral base; the distance from the former to the anal origin is equal to the length of head and very slightly less than the distance from the ventral origin to the anterior end of the scaled part of the breast. The ventral fins are widely separated from one another, and each fitted in a shallow depression. The lateral line is rather gently curved anteriorly. The belly is very weakly keeled along the mid-ventral line just in advance of the vent for a short distance, but in front of the ventral origins, the ventral surface of the body is almost flat, forming an ill-defined, high isosceles triangle. There are no spiny bucklers on each side of the dorsal and anal bases; they are covered on each side by a low skinny fold which bears very small scales. The dorsal and anal spines are not widely separated from the soft rays of the fins.

The shape and arrangement of scales are very characteristic. They are firmly adherent and spiny excepting for those on the belly. At first sight the shape of scales varies greatly in different parts of the body, but there are gradations between the peculiar scales on the belly and those on the other parts of the body. The former scales are low pyramidal plates of moderate size, each with contour-line-like, concentrically arranged rings on the central part, and each separated from neighboring scales by narrow naked area of varying width (thus forming a mosaic as in the specimen of *Oreosoma atlanticum* described and figured by WAITE, 1912, p. 198, pl. 11). The contour of these scales is either nearly quadrilineal, or nearly pentagonal (or further, nearly circular), and the outskirts of the central elevation is flattened. There is usually a short spine near the posterior margin of each of these scales. The scales on the back and the other parts of the body and head, excepting for the belly, are rough to the touch; they bear one to three distinct spines behind the central elevation and near the posterior margin. Some scales lack these spines, and may be called circular.

The pockets receiving scales are arranged fairly regularlly on the posterior part of the body, but the number of scales below the dorsal

* Probably because of the strong preservative? The writer can not be certain of the rigidity of the spine. In *Zen* the ventral fins lack spine. In the present genus, it is difficult to see whether the outermost fin-ray (which is here regarded as a spine) is divided or not, because only one specimen (which has been in strong formalin) is available. But there seem to be no segments in this ray, and its thickness is much greater than the inner fin-rays.

origin is difficult to count because of the irregular arrangement. Approximatly the number of scales in an oblique row passing the dorsal origin down and backward to the scale just above the lateral line is 1/2 (just in front of the anterior end of the base of the 1st dorsal spine) +2 (smaller than those below)+19–25 (left), and 1/2+2+20–23 (right). The number of scales in the lateral line is *ca.* 110 (to the end of the vertebral column)+*ca.* 6 (left), and *ca.* 107+*ca.* 6 (right). The number of the scale rows from the left orbital rim to the right is *ca.* 17.

Taking into consideration the dissapearance of certain armature in the adult of certain fishes, the presence of three low outgrowths on the belly above the ventral fin on each side of the present specimen should be specifically mentioned here. They are each formed of a few slightly modified scales with a higher projecting part. The hindmost outgrowth is the largest, and fairly widely apart from the middle one, which is also more conspicuous than the anteriormost. On the right side, the anterior two projections are less pronounced than on the left side of the body. The sclaes are the smallest on the interorbital area, in front of the nearly vertical ridge of the operculum, on the pectoral base, and on the folds along the dorsal and anal bases; they are the largest on the belly (excepting for the abdominal projections which are composed of more elevated scales).

The eyes are not so large as in large specimens of the members of *Allocyttus* and *Neocyttus*. The eye-diameter is about 1/3 of the length of head, and almost equal to the interorbital breadth (above eye-centers).

The mouth is not so small as in *Grammicolepidae*, oblique, and protractile. The hind end of the maxillary nearly reaches the vertical through the anterior margin of the eye.

The interorbital area is broad, medially scaled, separated by an extremely fine naked line from the posterior part of the head which is covered by much larger scales. The lateral parts of the interorbital area, namely, the parts just above the eyes, are dark brown, with irregular depressions and with bristle-like projections along the orbital rim. The median broad scaled part just mentioned, like the ground color of the body, is bluish gray. There are few, low spines along the ventral margin of the orbit. The preorbital has shallow concavites, and anteriorly provided with one or two small spines which are directed downwards. The ventral side of the head, snout and jaws are naked. The cheek and postocular parts of the head are scaled, only the hind margin and two diverging long ridges of the operculum, exposed branchiostegal membrane*

* The general appearance of the breast and postero-ventral part of the head resemble that of the figure of *Oreosoma atlaticum* given in CUVIER and VALENCIENNES' 'Histoire naturelle des poissons', pl. 99 (the figures are designated *O. coniferum*).

and neighboring parts of the opercular bones being naked. There is a small knob at the symphysis of the lower jaw. It has three spines directed downward. The posterior end of the lower jaw is angular, and separated from the gular thickening and branchiostegal membrane by a fairly wide concavity. The branchiostegal membrane on each side is ventrally connected with its partner, and free from the isthmus posteriorly.

The gills are three and a half in number, and there is no slit behind the last gill. The pseudobranchiae are well developed. The number of the branchiostegals is seven on each side. The gill-rakers on the first gill-arch are rather soft, and the length of the longest gill-rakers are about one-third of the horizontal eye-diameter. The number of the gill-rakers just mentioned is 5+1+19 (left) and 5+1+18 (right).

Teeth are present on the lower jaw only. They are small, simple, well separted from one another, few in number, and arranged in a single or two (anteriorly only) rows. The vomer, palatines, tongue and inner side of upper jaw bear close-set, tooth-like, slender projections. They are probably papillae.

The upper lip is broad, and inflected inward as a thin skinny flap covering entirely the edge of the premaxillaries. When seen from the ventral side, this skinny fold (which may be called a curtain) narrows at the mid-dorsal point of the upper jaw. The greatest width of the inner portion of this kinny flap is almost equal to the greatest breadth of the skinny membrane just inside of the edge of the premaxillaries (which is commonly met with in *Decapterus*, *Cypselurus*, *etc.*). The tongue is short, slightly concave dorsally, and bears prominent papillae (see above). The nostrils are paired on each side of the head. The posterior nostril is slit-like, stretched nearly vertically, and situated near the anterior margin of the orbit. The anterior nostril is just in front of the posterior one, oblong or kidney-shaped, and its vertical length is smaller than in the latter. A bony roof protrudes between the posterior and anterior nostrils.

Xenocyttus nemotoi, New Species*

'Tsubu-matōdai' (new Japanese name**)
Plates 1 & 2

Material examined.—Holotype (Cat. No. 49756, Zoological Institute,

* The writer takes pleasure in naming this new species after Mr. T. NEMOTO who collected the type specimen.

** Japanese names for antarctic fishes are necessary in order to expedite collecting of additional specimens and gathering information about the habits of these fishes. 'Tsubu' means tubercles; 'matōdai' means John Dory, member of *Zeus*.

Faculty of Science, University of Tokyo=Cat. No. '55-111, ABE), collected by Mr. NEMOTO from the stomach of a fin whale along with numerous euphausids. The whale was killed on January 15, 1955, in 64°32' S and 115°25' E. So far, only the holotype has been available for study.

Description of the holotype.—Total length 162 mm, standard length 140 mm. The belly is swollen because of the stomach contents (contrary to expectation consisting of numerous copepods; this specimen was found along with numerous euphausids as stated above). The general appearance of the specimen is mentioned in the description of the generic characters given above. The following measurements are given in hundredths of the standard length: Greatest depth of body (near dorsal origin) 74.3, greatest breadth of body (belly, above ventral fins; belly is well swollen) 22.1, breadth of body at upper edges of pectoral bases 18.6, breadth of body at anterior ends of lateral lines 15.4, least depth of caudal peduncle 7.1, length of head 35.0, horizontal diameter of eye 12.0 (left) and 11.4 (right), vertical diameter of eye 11.1 (left and right), length of snout 10.0 (left) and 9.6 (right), interorbital breadth (above eye-centers) 11.6, greatest depth of preorbital at the antero-dorsal corner of scaled part of cheek 2.9 (left) and 3.2 (right), length of longest (1st) dorsal spine 12.9, length of longest (*ca.* 15th–20th) dorsal fin-rays *ca.* 11.1, length of longest (1st) anal spine 6.4, length of longest (*ca.* 15th–20th) anal fin-rays *ca.* 11.4, length of ventral spine 18.6 (left) and 19.1 (right), length of longest (outermost) ventral fin-ray 16.6 (left) and 18.6 (right), length of longest (8th from top) pectoral fin-ray 13.6 (left) and 13.2 (right), length of longest (4th–6th from the raker just below the one at the joint of the upper and lower limbs) gill-rakers 3.9 (left) and 4.3 (right), greatest diameter of scales on postero-dorsal part of body *ca.* 1.2, greatest diameter of exposed part of larger scales on belly *ca.* 1.4.

D. VI 35 (all fin-rays unbranched and segmented; hindmost 2 rays close together). A. II 33 (all fin-rays unbranched and segmented; hindmost 2 rays close together). P. 21 (all fin-rays unbranched and segmented) on both sides. V. I 5 (outer 4 soft rays branched; innermost ray unbranched or branched) on both sides. Caudal fin dorsally injured; below the end of lateral line are 7 principal rays, of which upper 6 rays are branched.

The body-wall is thick; the muscles there are white and fairly hard (resembling boiled squid meat) although they are seemingly oily. On the right side of the belly, embedded in these muscles, and just above the posterior margin of the vent, lies a posteriorly curved spine-like bone of a size nearly equal to the longest anal spine. The bone is pointed at the ventral end. The left side of the belly has not been dissected. The peritoneum is blackish. The air-bladder seems to be absent. The pyloric caeca are numerous. The gonads are still very small, but the present example is believed to be a male.

The color in formalin is bluish or pinkish gray, with many rounded, dark blue markings of varying size; some of them are slightly larger than the pupil, and some are much smaller than the latter. The membranes of the ventral fins are blackish. The dorsal and anal spines, and the exposed parts of the bones of the head are brownish orange. Color prior to preservation, according to Mr. NEMOTO, who collected the specimen, was light orange, with blue markings.

Relationships.—Though resembling caproid fishes, *Lampris, Leiognathus, etc.*, at first sight, the present new genus and species is undoubtedly closely related to some zeomorph fishes, and more especially, to *Allocyttus verrucosus* (GILCHRIST) and *Oreosoma atlanticum* CUVIER. In the total number of vertebrae*, *Xenocyttus nemotoi* resembles *Grammicolepis* and *Neocyttus*, and considerably differs from *Zeus*, *Cyttus* and *Caproidae*. As the change with advancing age in the shape of body, armature, relative size of eyes, relative size and number of fin-rays in the ventrals, coloration, *etc.*, are very remarkable in certain fishes, and as there have been some discrepancies in the diagnostic descriptions of the genera of the so-called *Zeidae*, *Grammicolepidae* and *Caproidae*, no pretence is made here to introduction of a new family for *Xenocyttus*, *Oreosoma*, *Allocyttus* and allies. The difference in the number of ventral fin-rays between *Oreosoma atlanticum* described by CUVIER** and the specimen described under the same name as above by WAITE (1912) (which was later named *O. waitei* by WHITLEY) on the one hand, and *Xenocyttus nemotoi* on the other, and the presence of the orifice behind the last gill in WAITE's specimen perplexes the present writer. Furthermore, GILCHRIST's account (1922, p. 71) of the change with advancing age of the coloration, relative depth of body and the development of the enlarged scales (namely, the so-called tubercles) is in the reverse direction if *Oreosoma atlanticum* is presumed to be the young of

* It is regretted that the total number of vertebrae (N) in *Oreosoma* and *Allocyttus* is not known to the writer. This number in *Zeus* and *Cyttus* (31 or 32), *Grammicolepis* (46), *Neocyttus* (40) is cited from REGAN, 1910; that of *Capros aper* (10/12-13) from GÜNTHER, 1860; that of *Antigonia rubescens* (9+11+1) from STARKS, 1902. The present writer has examined the skeleton of *Zeus japonicus* and *Antigonia capros*; N is 31 (=13+18) for the former, and 22 (=10+12) for the latter. There is a slit behind the 4th gill in *A. capros*, whereas it is absent in *Z. japonicus*. V. I 5 (all branched) in *capros*; I 7 (all branched) in *japonicus*.

** VAILLANT, 1893, re-examined the type and another specimens of the species, and corrected the number of ventral fin-rays erroneously given by CUVIER. According to VAILLANT, this number is I 7.

Xenocyttus nemotoi. The adoption of the name *Oreosominae* for *Oreosoma*, *Xenocyttus*, *Allocyttus* and allies (if any) is only for convenience' sake. MYERS' statement (1937, pp. 146 and 147) that he was inclined to think 'there may be more than one family type among them' (the word 'them' refers to the genera usually referred to *Zeidae*) fits for expressing the opinion of the present writer.

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EXPLANATION OF PLATES 1 & 2

PLATE 1

Fig. 1. *Xenocyttus nemotoi*, new genus, new species. Type. Cat. No. 49756, Zoological Institute, Faculty of Science, University of Tokyo.

Fig. 2. Left side of the belly of the same specimen as above, showing three low outgrowths.

PLATE 2

Fig. 1. Dorsal view of the head of the same specimen as above.

Fig. 2. Ventral view of the belly of the same specimen as above.

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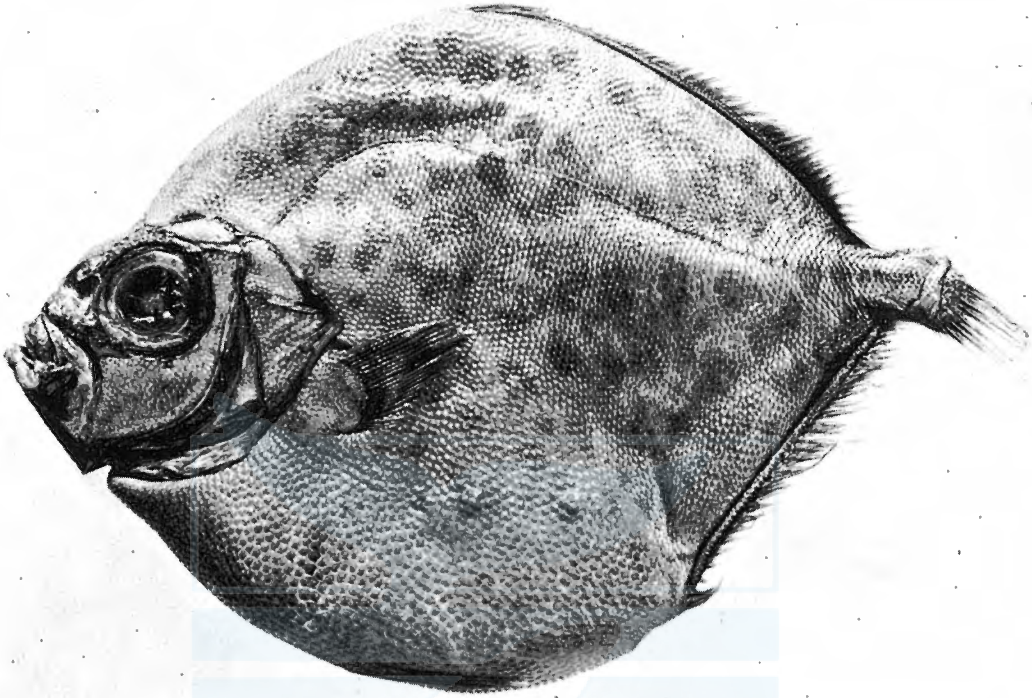

Fig. 1

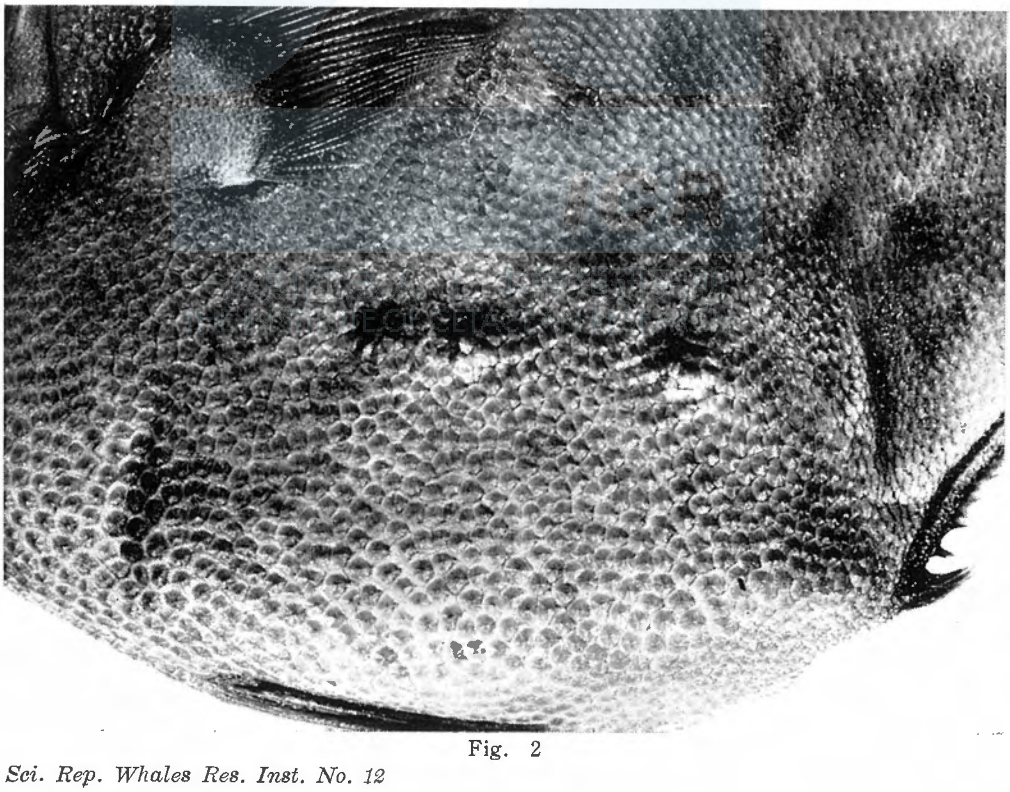

Fig. 2

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Fig. 3

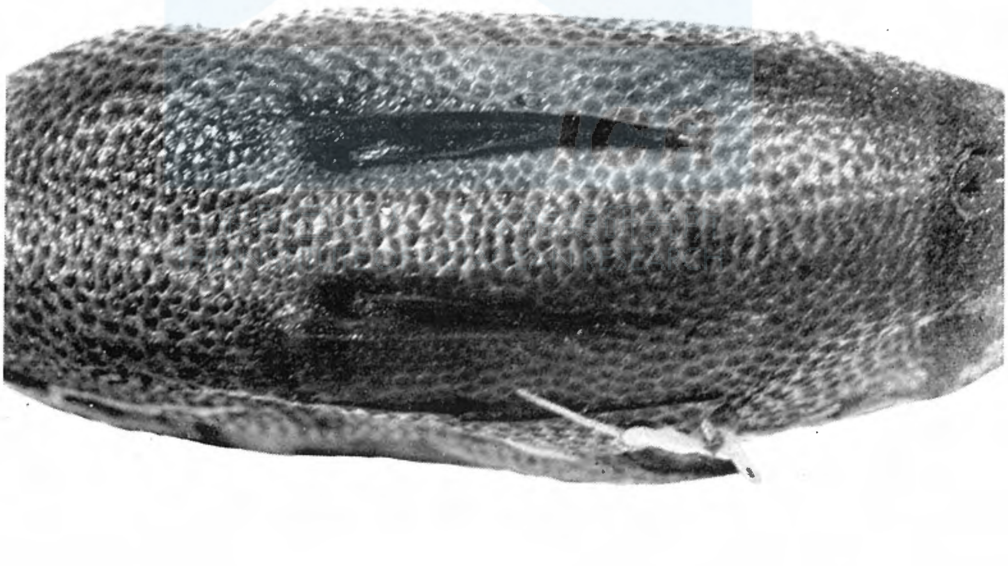

Fig. 4

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ON THE OILS CONTAINED IN VARIOUS BLUBBERS OF NORTHERN ELEPHANT SEAL, *MIROUNGA ANGUSTIROSTRIS*

HIDEO TSUYUKI*

INTRODUCTION

The elephant seal or sea elephant is the largest of all the marine carnivores and belongs to the seal family. There are two species, the Northern and the Southern. The former (*Mirounga angustirostris*) is found off the coast of California, while the latter (*Mirounga leonina*) is distributed over a wide range in the Southern seas.

As to the study on the seal family oil, we find various reports on the seal (*Phoca vitulina*) oil, including Tsujimoto's work on the Saghalien seal oil and Ueno and Iwai's study on the Antarctic seal oil (Bauer & Neth, 1924; Tsujimoto, 1916; Ueno & Iwai, 1939; Williams & Makhrov, 1935).

However, the oil of the elephant seal has remained unexplored to this day, still less the differences in the properties of the oils contained in the various parts of its body.

The writer was fortunate enough to obtain elephant seal oils from various blubbers and examine their properties.

The writer wishes to express his thanks to Dr. H. Oguni and Dr. H. Hosoya who were kind enough to present him the Northern elephant seal oil. He also wishes to express his appreciation to Dr. H. Omura and Prof. A. Shionoya for their kind advices.

MATERIAL

In January, 1955, three Northern elephant seals were caught off the coast of Mexico, and the 'Nihon Dōbutsuen' (Japan Zoological Gardens) bought them in December of that year. Two of them died soon after their arrival in this country, and the third one was shown to the public at the 'Sekai Dōbutsu Hakurankai' (World Animal Exhibition) held in Kyoto, where it also died on the 7th of June, 1956. It was dissected on the 11th of June at the Faculty of Agriculture & Veterinary, University of Nihon in Tokyo (fig. 1). As its internal organs had already been spoiled, there was no proving the cause of its death. Fortunately, however, there was no trace of putrafaction in its blubber.

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The details of the Northern elephant seal used in this experiment are shown in table 1. After its capture, the elephant seal had been usually fed with living mackerel and sometimes with living carp.

Fig. 1. Elephant seal, *Mirounga angustirostris.*

TABLE 1. DETAILS OF ELEPHANT SEAL

Sex	Presumptive years	Presumptive body weight (kg.)	Body length (m.)	Girth of abdomen (m.)	Girth of neck (m.)	Fore flippers (cm.)	Hind flippers (cm.)
Male	5-6	2000	4.40	2.96	1.67	50 52	66 70

EXPERIMENT AND RESULTS

Oils were extracted from various blubbers as shown in table 2 and fig. 2. The sampling methods for oils are shown in table 2.

Physico-chemical studies were conducted with the sample oils, the results of which are shown in table 3.

Unsaponifiable matter and mixed fatty acids were obtained from the oils, and their properties were examined by oridinary methods (tables 3 & 4).

Solid-and liquid fatty acids were separated by the lead-salt alcohol method (Twitchell, 1921), and their properties were examined in an ordinary manner. The melting points of the solid fatty acids were determined in a capillary tube. The results obtained are shown in tables 5 & 6.

The writer of this paper summarized the results obtained as follows :

TABLE 2. KINDS OF BLUBBER AND OIL

Sample	Kinds of blubber	Thickness of blubber (cm.)	Oil content in blubber	Sampling method for oil
A	Dorsal blubber of thoracic and abdominal cavity	7–10	high	Pressing method
B	Blubber of frontal (part betwen eyes)	1- 2	low	Pressing method first and then parching
C	Dorsal blubber of thoracic cavity	10	high	Pressing method first and then parching
D	Dorsal blubber of abdominal cavity	7	high	Pressing method first and then paching
E	Vetral blubber of thoracic and abdominal cavity	—	—	Pressing method
F	Ventral blubber of neck	1- 2	low	Pressing method first and then parching
G	Ventral blubber of thoracic cavity	9	high	Pressing method first and then parching
H	Ventral blubber of abdominal cavity	2	low	Pressing method first and then parching
I	Ventral blubber of pelvis	1- 2	low	Pressing method first and then parching
J	Ventral blubber of hindmost part	below 1	low	Pressing method first and then parching
K	Blubber of tongue	very thin	low	Extracting method with alcohol and ether

(1) The properties of the oils contained in the various blubbers showed only very slight differences. The most remarkable is the difference in the degree of unsaturation of each oil. It is interesting to note that the degree of unsaturation in the tongue oil is very low as in the case of the tongue oil of the sei-whale experimented by Sakai & Mori (1953). The degree of unsaturation of the frontal oil is also very low.

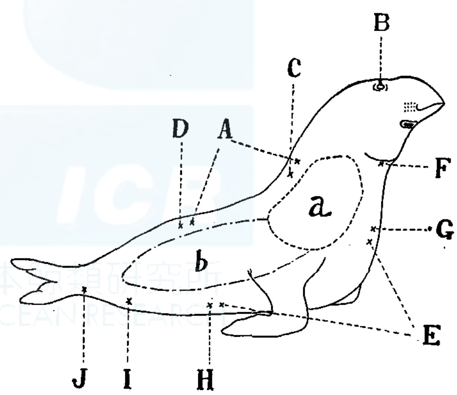

Fig. 2. Blubbers of elephant seal.
a: Thoracic cavity.
b: Abdominal cavity.

(2) The acid value of the sample oils is very high. This seems to be due to the large quantity of fatty acids produced at the time of decomposition of the oil by the action of lypase. Apparently the lypase content in the blubber of the elephant seal is comparatively high, and the fat metabolism in its body seems to be active.

TABLE 3. PROPERTIES OF OILS AND UNSAPONIFIABLE MATTERS

Sample	Appearance (at 25°C.)	$d_{4°}^{15°}$	$N_D^{30°}$	Acid value	Sapon. value	Iodine value	Unsapon. matter (%)	Unsapon. matter	
								Appearance (at 30°C.)	Iodine value
A	Yellowish orange liquid	0.9251	1.4646	13.0	184.9	136.4	1.46	Yellow, viscous liquid	84.2
B	Reddish brown liquid	0.9170	1.4610	27.5	187.4	105.5	0.65	Yellowish brown solid	88.6
C	Reddish brown liquid	0.9195	1.4635	17.5	181.5	130.2	0.66	Yellowish brown solid	117.2
D	Reddish brown liquid	0.9187	1.4626	16.4	188.6	118.0	0.61	Brown solid	98.6
E	Yellowish orange liquid	0.9275	1.4650	11.6	185.3	140.9	1.42	Brownish orange solid	76.3
F	Reddish brown liquid	0.9180	1.4623	23.2	179.3	116.4	1.81	Yellowish brown solid	102.8
G	Brown, viscous liquid	0.9202	1.4641	21.4	182.6	134.2	1.04	Yellow solid	113.9
H	Reddish brown liquid	0.9210	1.4638	20.8	186.9	133.4	1.03	Yellowish brown solid	114.1
I	Reddish brown liquid	0.9173	1.4616	20.9	186.0	110.4	1.08	Yellowish brown solid	109.3
J	Reddish brown liquid	0.9188	1.4630	15.3	184.5	123.1	0.52	Yellow solid	103.1
K	Reddish brown liquid	0.9121	1.4597	28.5	175.6	90.4	1.67	Yellowish brown solid	100.1

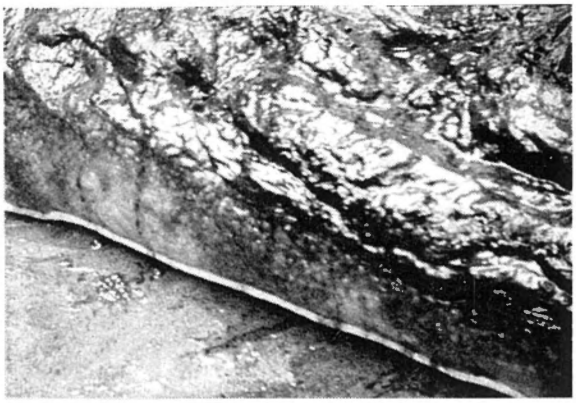

Fig. 3. Dorsal blubber of thoracic cavity of elephant seal.

TABLE 4. PROPERTIES OF MIXED FATTY ACIDS

Sample	Appearance (at 30°C.)	$N_D^{30°}$	Iodine value	Neutralization value	Average molecular weight
A	Yellow liquid	1.4590	138.2	189.6	295.9
B	Reddish orange liquid	1.4552	108.6	193.3	290.3
C	Yellow liquid	1.4578	133.2	187.2	299.7
D	Yellowish orange liquid	1.4565	122.9	195.4	287.1
E	Orange liquid	1.4598	142.8	190.6	294.4
F	Orange liquid	1.4564	120.1	183.9	305.1
G	Yellowish orange liquid	1.4589	136.9	188.3	298.0
H	Yellowish orange liquid	1.4589	135.2	193.1	290.5
I	Yellow liquid	1.4559	113.2	190.2	295.0
J	Yellowish orange liquid	1.4572	126.3	188.2	298.0
K	Yellowish orange liquid	1.4450	94.2	181.5	309.1

TABLE 5. PROPERTIES OF SOLID FATTY ACIDS

Sample	Percent. in mixed fatty acids	Appearance (at 25°C.)	$N_D^{50°}$	Melting point (°C.)	Iodine value	Neutralization value	Average molecular weight
A	25.11	Yellowish white solid	1.4347	42.5-45.0	23.1	211.5	265.3
B	25.07	Dark brown solid	1.4345	42.0-44.5	23.4	207.2	270.8
C	26.43	Yellowish brown solid	1.4350	43.0-45.0	24.6	195.4	287.1
D	30.73	Brown solid	1.4363	45.0-47.0	26.9	202.8	276.7
E	25.05	Yellowish brown solid	1.4355	43.5 46.5	25.6	214.7	261.3
F	33.19	Yellowish brown solid	1.4365	47.5 49.5	27.2	204.3	274.6
G	29.76	Yellowish brown solid	1.4359	45.5-47.5	26.5	209.1	268.3
H	31.51	Yellowish brown solid	1.4368	47.0-48.5	28.1	213.9	262.3
I	26.71	Yellowish brown solid	1.4351	44.0-47.0	25.3	226.1	248.2
J	28.64	Yellowish brown solid	1.4360	43.0-47.0	26.6	207.3	270.7
K	27.77	Brown solid	1.4354	44.0-47.0	25.9	203.5	275.7

TABLE 6. PROPERTIES OF LIQUID FATTY ACIDS

Sample	Percent. in mixed fatty acids	Appearance (at 25°C.)	$N_D^{30°}$	Iodine value	Neutralization value	Average molecular weight
A	74.89	Yellow liquid	1.4598	175.4	181.6	309.0
B	74.93	Yellowish orange liquid	1.4570	136.2	187.5	299.3
C	73.57	Orange liquid	1.4593	170.3	182.9	306.7
D	69.27	Reddish orange liquid	1.4585	164.1	191.8	292.6
E	74.95	Reddish orange liquid	1.4601	180.6	177.1	317.0
F	66.81	Reddish orange liquid	1.4588	165.1	172.9	324.5
G	70.24	Reddish orange liquid	1.4605	183.6	178.4	314.5
H	68.49	Reddish orange liquid	1.4606	182.1	181.7	308.8
I	73.29	Reddish orange liquid	1.4575	144.7	175.9	319.0
J	71.36	Reddish orange liquid	1.4588	166.5	178.6	314.2
K	72.23	Reddish orange liquid	1.4566	120.1	171.9	326.4

(3) The amount of unsaponifiable matter in each oil is comparatively small, registering only about one per cent. This fact seems to show that the blubber of the elephant seal is a pure fat accumulation depot.

(4) There is no remarkable difference in the average molecular weights of the mixed fatty acids obtained from different oils. The average molecular weight is lower in solid fatty acids than in liquid fatty acids.

SUMMARY

The oils contained in various blubbers of Northern elephant seal (*Mirounga angustirostris*) have been studied.

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