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Studies on the Little Piked Whale from the Coast of Japan

By

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Introduction

The little picked whale, lesser rorqual, or minke, *Balaenoptera acutorostrata*, is called in Japan usually as "Koiwashi-kujira" or "Minku". The direct translation of the former is lesser sei whale and the latter is derived without doubt from the Norwegian minke. It has been hunted in the waters around Japan from the fairly old times by the usual catcher boats, in addition to their main catch of other baleen whales and sperm whale. However, towards the end of the nineteen twenties, some fishermen at Ayukawa, Miyagi prefecture, inaugurated small type whaling to take little piked whale with motor vessel equipped with harpoon-gun, which remained until the war as a modest industry in these localities.

After the end of the war, the situation of foodstuff made whaling of such type a paying industry, and consequently number of vessels engaged had increased with a result of expanded areas of operation and increased catch of the little piked whale. The Fisheries Agency of Japanese Government placed this whaling under its control in 1947 and simultaneously the catch of the little piked whale has been confined only to those motor vessels operated by fishermen, no licence being issued to the large type catcher boat, which hitherto caught some minkes occasionally. The yearly catch is now amounted to about 400 whales, very fewer in number when compared with that in Norway.

The little piked whale has a worldwide distribution, inhabiting both in the Atlantic and the Pacific, ranging northward to arctic and on the south penetrating Ross and other antarctic seas. It has been named *Balaenoptera acutorostrata* Lacépède 1803–1804, however, this name is applied only to the North Atlantic whale, since the Pacific one has been called *Balaenoptera davidsoni* by Scammon in 1872. But, as regards the difference between those two forms, only a few reports have been supplied. Cowan (1939) had studied two specimens from the eastern Pacific externally as well as internally and describes "Should the above differences be substantiated there would be grounds for recognizing *B. davidsoni* as a subspecies of *B. acutorostrata*" though he says

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* Fisheries Agency of Japanese Government.

further " but in the light of present knowledge taxonomic recognition of a Pacific species is apparently not justified ". Since then no further study on this matter has been carried out by any author.

Recently the little piked whale from the Atlantic has been studied extensively by Jonsgård (1951), based upon the measurements and observations of a great number of whales. But, as regards the little piked whale from the Pacific rather scanty reports such as those by Fry (1935), Matsuura (1936), Cowan (1939), Clifford (1946), Scheffer and Slipp (1948), and Scattergood (1949) has been appeared since Scammon (1872). These accounts are based mainly on one or few more stranded whales or returns from whalers.

We tried to collect as many material of the little piked whale from the western Pacific as we can for these several years. In the light of the present knowledge mentioned above, we feel it is better to publish them now, though they are still very incomplete. So this report should be deemed as preliminary one. Further studies will appear when more measurements or observations be carried out in future.

Sincere thanks are due to the whalers, who assisted us greatly in collecting material as well as in our field work at their land stations.

Material

The material at disposal for the present study is as follows:

1. Whaler's reports, in which particulars are given with respect to each whale treated at land station as to the date and approximate position of taking, the sex of the whale, its length, stomach contents and, if it contains a fetus, the length and sex, if ascertainable, of the fetus. From 1948 to 1954 such particulars have been reported for 2,264 whales, excluding several reports more or less incompletely filled. Among these particulars it is probable that fetus is not always reported correctly. Undoubtedly most of the smallest fetuses have been overlooked. We do not, therefore, pay much attention to the negative information that a fetus was not present. The stomach contents may sometimes have been reported incorrectly, especially as regards krill and copepods, both having been confused. But regarding of the other particulars we are confident that they have been informed in good order, at least on the whole.

2. The samples, such as testes, ovaries or baleen plates forwarded to us by whalers. These samples are rather few in number. In some occassions whalers were requested to measure the weights of testes and ovaries. A few people is deemed to have weighed accurately, though

most of whalers had reported more or less incompletely or nil.

3. Material obtained from the examination of whales treated at land stations by biologists. Body proportions and other scientific observations were carried on only for 23 little piked whales, most of them were examined at Abashiri, a land station facing to the Okhotsk sea, by H. Sakiura, one of the present authors. We are very regret that the material from the examination of whales by biologist is still insufficient at present. It is hoped more material of such nature be collected in future.

External Characters

The little piked whale from the coast of Japan is similar in general appearance and coloration to those reported by other authors for Pacific or Atlantic species, having the very distinct white band across the dorsal surface of the flippers and the yellowish-white baleen plates. Dorsal surface of the body is uniformly black and underparts including most of lower mandible and lower surface of flukes, white. The extension of black pigments on the sides differ individually, most remarkably being noted in the region of shoulder. In some whales pigments in this region extend downward considerably and reaching nearly to the ventro-lateral line (plate 1, upper, plate 2, lower) whereas black area ends at a position not far down from the flippers in some whales (plate 2, upper). The distinct white band on the outer surface of the flipper differs also individually in its broadness. Some has broader band (plate 2, upper) and some narrower (plate 2, lower), but it seems that there is always a slight projection of white area anteriorly, as seen in the whales shown in plate 2. Such projection of white area is not observed from a little piked whale stranded on Florida (Moore and Palmer, 1955. Plate 1). Anterior border of the white band is quite distinct, but posterior one is shading into pale color.

As regards other coloration, Cowan (1939) describes that "on the side of the body in the region touched by the tip of the flexed pectoral there is a large area of blue-gray that extends upward on to the dorsolateral surface." This coloration occurs also in our specimen, and sometimes very remarkable. In a whale shown in plate 2 (upper), the white area of the belly in the region after flipper extends upward, drawing a curve pointing backward at first and then forward, shading into gray gradually, and finally meets with that on the other side at a point on the dorso-lateral line. It is thought that this marking is a character of the little piked whale.

In addition to this marking, certain pale streaks occur about the head and shoulders. A similar pale streak reaching backwards from the ear in fin whale is occur also in the little piked whale. Similar streaks are also observed on the both sides of the blowhole.

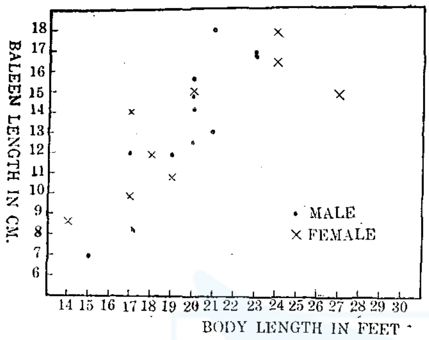

Fig. 1. Relation between length of baleen (in cm) and animal's total length (in feet).

The color of baleen plate is yellowish-white, with a diffuse pinkish area close to the gum, caused by blood pigments. In fig. 1 we have plotted the length of the largest baleen plate against the body length. The relation between length of baleen and animal's total length shows no remarkable difference from that of Atlantic individuals as reported by Jonsgård (1951, figs. 2 and 3).

In 1953 the measurements on the following body proportions were made of 23 animals.

1. Body length, tip of snout to notch of flukes.
2. Lower jaw, projection beyond tip of snout.
3. Tip of snout to blowhole (centre).
4. Tip of snout to angle of gape.
5. Tip of snout to centre of eye.
6. Tip of snout to tip of flipper.
7. Centre of eye to centre of ear.
8. Notch of flukes to posterior emargination of dorsal fin.
9. Width of flukes at insertion.
10. Notch of flukes to centre of anus.
11. Notch of flukes to umbilicus.
12. Notch of flukes to end of ventral grooves.
13. Centre of anus to centre of reproductive aperture.
14. Vertical height of dorsal fin.
15. Length of base of dorsal fin.
16. Flipper, tip to axilla.
17. Flipper, tip to anterior end of lower border.
18. Flipper, greatest width.
19. Head length, condyle to tip of snout.
20. Greatest width of skull.
21. Skull length, condyle to tip of premaxilla.
22. Skull height.
23. Tail flukes, notch to tip.
24. Length of lower jaw.

All of these measurements are listed in the appended table, in centimeter of actual length and for measurements 2 to 24 also expressed in percentages of the animal's total lengths.

In table I, we gave here the maximum and minimum measurements as well as the calculated means for males and females, all expressed as percentages. For the convenience of comparison to those in the Atlantic, we cited in table I also the corresponding figures from Jonsgård (1951). Further, we have plotted in figs. 2–16 each percentages according to body length, as well as ranges and means of Atlantic animals for the sake of comparison on the left side of each figure.

Judged from the above mentioned table and figures, we can safely conclude, in the body proportions of the little piked whale from the coast of Japan, that

1. apart from the measurement 13 (Centre of anus to centre of reproductive aperture), no essential difference is noted between male and female, as in the other baleen whale or little piked whale from the Atlantic, and
2. there is no measurement which separates completely or at least considerably from that from the Atlantic, all of them being overlapped in major parts,
3. but there are some differences, however slightly, between the animals from the Atlantic and Pacific in the following measurements:

a) Length from tip of snout to centre of eye (fig. 4). This length is nearly the same length of tip of snout to angle of gape. The little piked whale from the coast of Japan has a shorter mouth, though head length itself shows no significant difference (fig. 15).

b) Tip of snout to tip of flipper (fig. 5). All the measurements for Pacific animals distribute within the range of those for Atlantic, but the means are somewhat shorter for both sexes.

c) Notch of flukes to posterior emargination of dorsal fin (fig. 7). The Pacific animal has a more posteriorly situated dorsal fin. No measurement does not exceed the mean for the Atlantic.

d) Centre of anus to centre of reproductive aperture (fig. 11). The Pacific animal shows a shorter distance, especially in female.

e) Vertical height of dorsal fin (fig. 12). The Pacific animal has a higher dorsal fin.

f) Flipper, tip to axilla (fig. 13). The Pacific animal has a shorter flipper, though in it's width no difference is observed (fig. 14).

g) Tail flukes, notch to tip (fig. 16). Somewhat higher value is noted in whales from the Pacific.

In other words, the little piked whale from the coast of Japan has

Table I. Body proportions of
(Expressed as percentages

Measurements	Males		
	Pacific		
	No.	Range	Mean
1. Body length in cm.	8	582–799	725
2. Lower jaw, projection beyond tip of snout.	5	0.89– 2.51	1.78
3. Tip of snout to blow hole (centre).	8	11.68–13.66	12.79
4. Tip of snout to angle of gape.	4	13.57–19.04	16.10
5. Tip of snout to centre of eye.	8	14.21–18.40	15.89
6. Tip of snout to tip of flipper.	6	37.46–42.20	39.81
7. Centre of eye to centre of ear.	7	4.64– 6.20	5.18
8. Notch of flukes to posterior emargination of dorsal fin.	7	24.27–29.11	26.97
9. Width of flukes at insertion.	6	6.09– 7.41	6.90
10. Notch of flukes to centre of anus.	6	25.43–27.88	26.68
11. Notch of flukes to umbilicus.	5	47.42–49.27	48.04
12. Notch of flukes to end of ventral grooves.	6	46.04–56.97	54.63
13. Centre of anus to centre of reproductive aperture.	7	5.68– 7.68	6.77
14. Vertical height of dorsal fin.	5	3.00– 4.81	4.13
15. Length of base of dorsal fin.	6	6.05–10.14	8.42
16. Flipper, tip to axilla.	3	8.06–10.03	9.12
17. Flipper, tip to anterior end of lower border.	5	11.84–19.65	14.50
18. Flipper, greatest width.	4	3.44– 3.74	3.54
19. Head length, Condyle to tip of snout.	2	22.28–22.68	22.48
20. Greatest width of skull.	2	10.72–12.71	11.72
21. Skull length, Condyle to tip of premaxilla.	—	—	—
22. Skull height.	—	—	—
23. Tail flukes, notch to tip.	5	13.37–15.86	14.33
24. Length of lower jaw.	3	21.13–23.02	21.91

1) Taken from Jonsgård (1951).
2) Tip of snout to the anterior end of the blow hole.
3) Notch of flukes to the nearest part of the anterior margin of the flukes.

Balaenoptera acutorostrata
against body length).

			Females					
Atlantic[1]			Pacific			Atlantic[1]		
No.	Range	Mean	No.	Range	Mean	No.	Range	Mean
24	488-828	658	15	461-857	723	75	480-914	735
13	1.15- 2.45	1.84	11	0.76- 2.51	1.54	21	0.88- 2.41	1.56
20	11.86-14.10[2]	13.01	15	11.71-14.90	13.27	52	10.97-14.85[2]	13.18
—	—	—	10	13.32-18.69	16.06	—	—	—
24	17.05-20.00	18.33	15	13.32-18.59	15.84	75	15.73-19.33	18.05
24	36.87-46.50	43.57	14	39.48-44.50	41.69	73	36.76-46.47	43.43
24	4.91- 6.19	5.55	14	4.66- 5.93	5.37	74	4.64- 6.19	5.50
24	27.76-33.29	29.97	15	23.48-28.86	27.30	73	26.35-32.13	29.29
24	6.46- 8.10[3]	7.03	13	7.05- 8.32	7.45	75	5.81- 7.49[3]	6.77
24	24.75-28.46	26.23	15	23.92-29.28	26.52	75	18.67-30.13	25.99
23	43.31-50.08	46.79	15	42.26-48.37	46.17	74	37.33-52.01	46.00
24	47.73-56.48	52.19	15	45.60-60.47	53.75	74	43.48-58.67	51.54
24	6.00- 8.48	7.27	15	2.11- 3.40	2.74	75	2.71- 4.08	3.41
24	3.33- 4.58	3.94	10	3.15- 4.96	4.22	72	2.93- 4.44	3.60
—	—	—	11	5.86- 8.75	7.36	—	—	—
23	9.00-14.40	10.19	14	7.29-11.42	8.92	75	8.78-12.38	9.99
—	—	—	14	9.41-15.75	12.06	—	—	—
24	3.40- 4.18	3.70	12	3.54- 3.97	3.83	75	3.20- 3.94	3.65
20	20.77-24.80	23.25	4	21.78-22.86	22.52	51	20.54-25.81	22.50
—	—	—	4	10.88-12.77	11.69	—	—	—
—	—	—	1	—	20.39	—	—	—
—	—	—	1	—	6.29	—	—	—
24	13.17-15.36	14.05	13	13.83-16.93	15.30	74	12.00-15.38	13.90
—	—	—	8	20.92-22.59	21.63	—	—	—

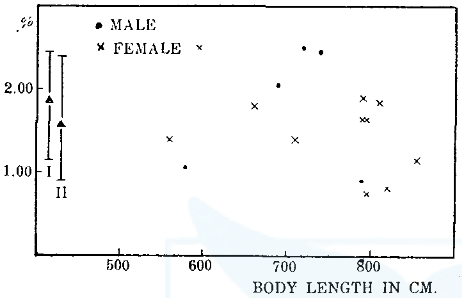

Fig. 2. Lower jaw, projection beyond tip of snout.
● Male
× Female
I Range and mean of Atlantic male
II 〃 〃 female

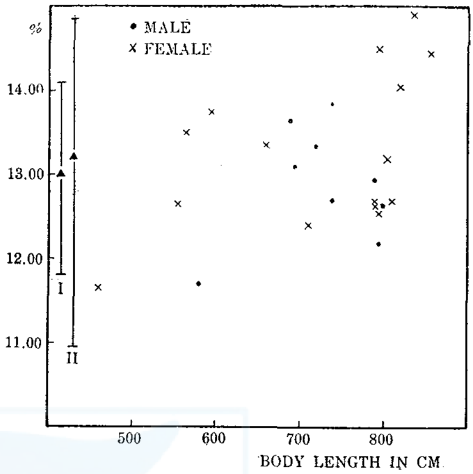

Fig. 3. Tip of snout to blow hole (centre).
● Male
× Female
I Range and mean of Atlantic male
II 〃 〃 female

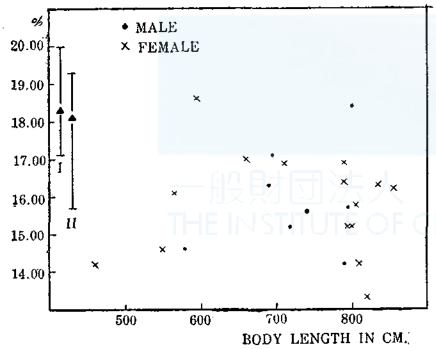

Fig. 4. Tip of snout to centre of eye.
● Male
× Female
I Range and mean of Atlantic male
II 〃 〃 female

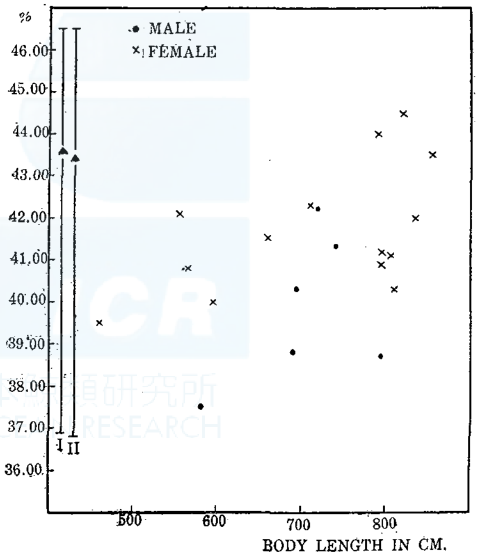

Fig. 5. Tip of snout to tip of flipper.
● Male
× Female
I Range and mean of Atlantic male
II 〃 〃 female

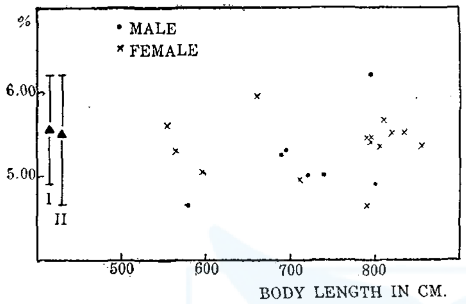

Fig. 6. Centre of eye to centre of ear.
● Male
× Female
I Range and mean of Atlantic male
II 〃 〃 female

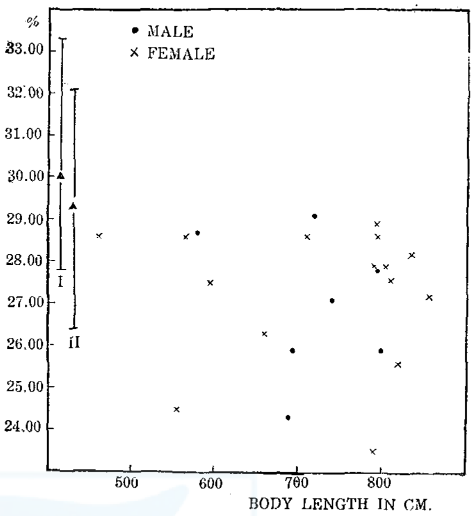

Fig. 7. Notch of flukes to posterior emargination of dorsal fin.
● Male
× Female
I Range and mean of Atlantic male
II 〃 〃 female

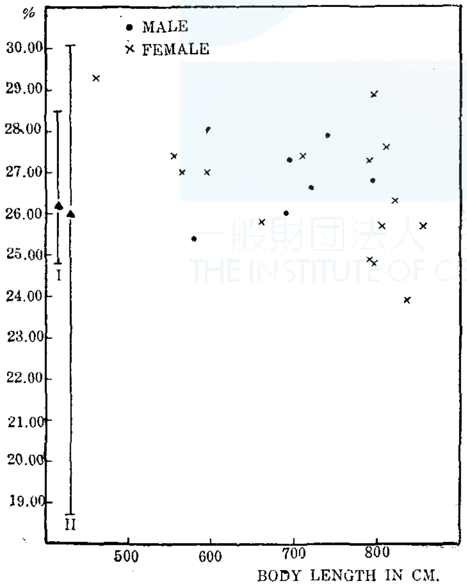

Fig. 8. Notch of flukes to centre of anus.
● Male
× Female
I Range and mean of Atlantic male
II 〃 〃 female

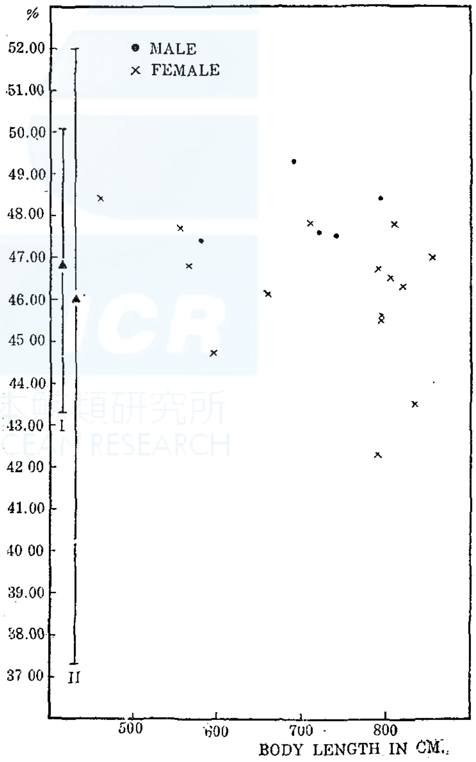

Fig. 9. Notch of flukes to umbilicus.
Male ●
× Female
I Range and mean of Atlantic male
II 〃 〃 female

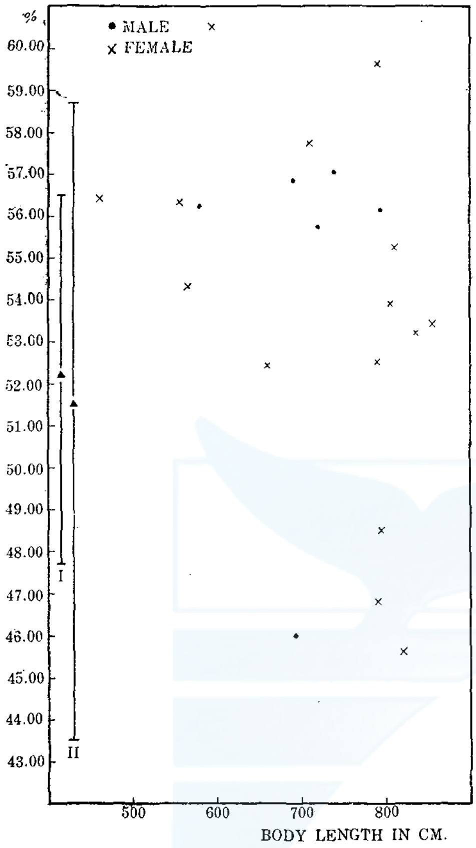

Fig. 10. Notch of flukes to end of ventral grooves.

● Male
× Female
I Range and mean of Atlantic male
II 〃 〃 female

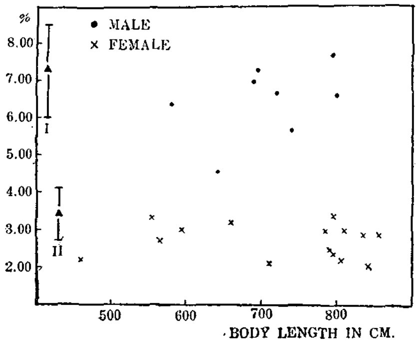

Fig. 11. Centre of anus to centre of reproductive aperture.

● Male
× Female
I Range and mean of Atlantic male
II 〃 〃 female

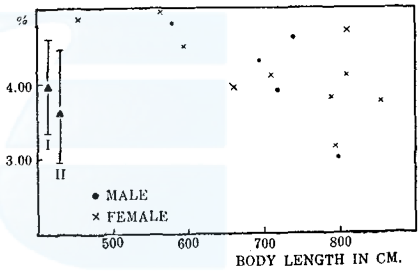

Fig. 12. Vertical height of dorsal fin.

● Male
× Female
I Range and mean of Atlantic male
II 〃 〃 female

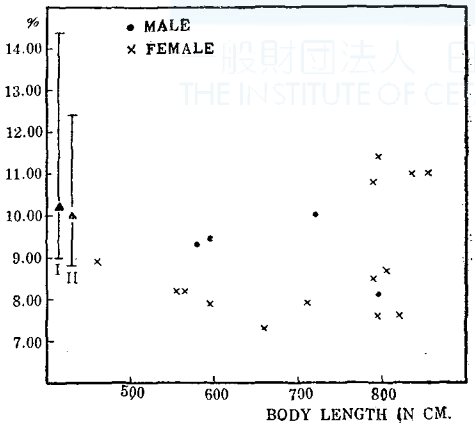

Fig. 13. Flipper, tip to axilla.

● Male
× Female
I Range and mean of Atlantic male
II 〃 〃 female

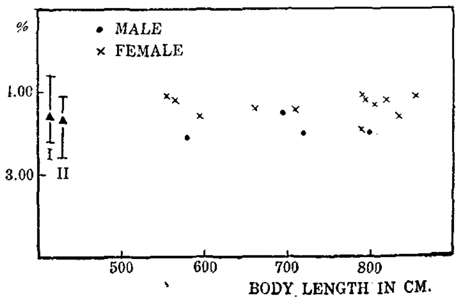

Fig. 14. Flipper, greatest width.

● Male
× Female
I Range and mean of Atlantic male
II 〃 〃 female

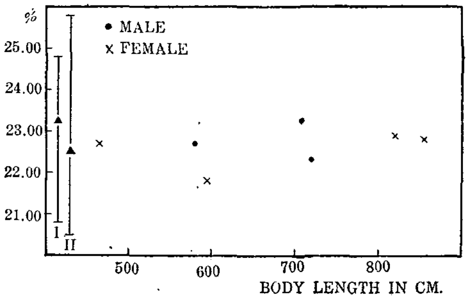

Fig. 15. Head length, condyle to tip of snout

● Male
× Female
I Range and mean of Atlantic male
II 〃 〃 female

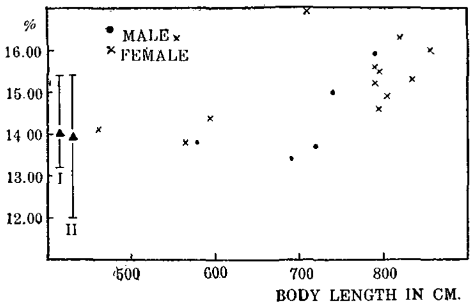

Fig. 16. Tail flukes, notch to tip.

● Male
× Female
I Range and mean of Atlantic male
II 〃 〃 female

a shorter mouth, a more posteriorly situated, but higher dorsal fin, more shorter flippers, more broader (or longer) tail flukes, and a more posteriorly situated genital aperture. We can not conclude at present whether or not such differences are significant. More material and their

Table II. Body proportions of *Balaenoptera acutorostrata* from Pacific ocean measured by different authors. (Expressed as percentages against body length)

Measurements	Japan	Snohomish river (Scattergood, 1949)	Puget sound (Scattergood, 1949)	Los Angeles (Fry, 1935)	Sooke, B.C. (Cowan, 1939)	Puget sound (Scammon)[1]
Body length in cm	461–857	478	399	318	457	823
Tip of snout to blowhole (centre)	11.68–14.90	12.50	12.42	12.8	11.11	13.58
Tip of snout to angle of gape.	13.32–19.04	15.96	16.56	16.6	—	—
Tip of snout to centre of eye.	13.32–18.59	16.76	17.20	17.6	16.67	—
Notch of flukes to posterior emargination of dorsal fin.	23.48–29.11	26.86	27.37	30.0	20.00[2]	33.33[2]
Notch of flukes to centre of anus.	23.92–29.52	—	22.93	28.7	26.11	30.86
Vertical height of dorsal fin.	3.00– 4.96	3.72	4.14	—	4.44	3.09
Length of base of dorsal fin.	5.86–10.14	6.12	6.37	—	—	—
Flipper, greatest width	3.44– 3.97	—	—	—	3.61	4.01

1) Quoted from Cowan (1939).

2) Notch of flukes to dorsal.

statistical treatment are needed in future in order to get to the final conclusion.

We do not think, however, such differences are due to the difference in body length or age. Average body lengths of 24 males and 75 females measured by Jonsgård are 658 and 735 centimeters respectively. The corresponding figures for our specimens are 725 and 723 centimeters.

In table II the measurements of the little piked whales in the Pacific by different authors are given, shown as percentages to the total length. In summarizing in this table, we have converted feet and inches of other authors into centimeters and calculated the percentages of each measurement to the total body length, because they give only actual measurements in feet and inches with a exception of Fry (1935), who shows also percentages in addition to feet and inches in his paper. Scattergood (1949) describes that Clifford (1946)* has also reported body proportion of the little piked whale from the Pacific coast, but we could not able to quote it in this table, because of lacking of his paper. As regards our measurements, we give here only the maximum and minimum values of males and females.

The underlined figures in table II show that these measurements do not fall within the range of our material. Although there are some occasions of such case, all of them show any remarkable difference, except those measurements by Cowan (1939) and Scammon (quoted from Cowan) in the line "Notch of flukes to posterior emargination of dorsal fin." It is quite natural that such difference may occur, since they measured "Notch of flukes to dorsal" instead of "Notch to posterior emargination of dorsal fin". We do not think that there is any significant difference between Scammon's whale and ours, regarding of the position of dorsal fin. But even taking account of the different position measured, Cowan's figure of 20.00 per cent is quite unique, compared with others. Cowan presents photograph of his whale, standing on the head perpendicularly, the tail being hanged upward by wire. Scheffer and Slipp (1948) give also similar photograph of the whale measured by Scattergood. Comparing these two photographs, we can easily conclude that the Cowan's whale is a exceptional one whose dorsal fin situated more posteriorly rather at an unusual position.

Cowan (1939) says that "There is a suggestion that Pacific individuals may be found to differ from Atlantic individuals in the slightly more posteriorly position of the dorsal fin, narrower flukes, and in proportional differences in form of the scapula and sternum. Pacific individuals may have fewer baleen plates, on the other hand the observed dif-

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* Carl, G. Clifford, 1946: Sharp-headed Finner Whale stranded at Sydney, Vancouver Island, British Columbia. Murrelet. vol. 27, no. 3.

ference may merely be the result of individual or age variation. Should the above differences be substantiated there would be grounds for recognizing *Balaenoptera davidsoni* as a subspecies of *Balaenoptera acutorostrata* Lacépède, but in the light of present knowledge taxonomic recognition of a Pacific species is apparently not justified".

It may true, as already stated, that the dorsal fin situated more posteriorly in the little piked whale from the Pacific coast than Atlantic individual, but it may also without doubt that this difference in position is not so great as supposed by Cowan. Judged from our measurement No. 23 (Tail flukes, notch to tip), though we did not measured total spread of tail flukes, it is not probable that Pacific individual have narrower flukes.

As regards the number of baleen plates, also Scattergood (1949) reports that "The number of baleen plates on each side of the jaw in the Pacific specimens has been reported as 270 (Scammon, Tomilin), 231 (Cowan 1939), and 285 (Carl 1946). My two specimens had 256 and 272 plates. It would appear that the Pacific whales have slightly fewer baleen plates than those of the Atlantic." We have only scanty material on this matter at present, 6 whales having been observed. They are 266, 275, 277, 282, 285, and 295, never cxceeding 300. According to Jonsgård (1951), the baleens of the Atlantic minke whale number 270 to 348 (mean: 304) on each side. It is probable, therefore, that the Scattergood's suggestion that the Pacific whales have slightly fewer baleen plates than those of the Atlantic may true. And we think this fact is linked with the more shorter length of the mouth in the Pacific animals. But these numbers of baleen plates are again overlapping from each other, as other differing characters do.

It is highly probable, therefore, that there would not be grounds for recognizing *Balaenoptera davidsoni* as a subspecies of *B. acutorostrata*, on the contrary to the suggestion by Cowan (1939), though there remains still some doubt in skeletal characters. These differences in external characters should be deemed as differences according to different stocks or racial nature.

Occurrence and Migration

The catch reports from the whalers from 1948 to 1954 are tabulated in table III, which should not taken as a complete catch statistics, because such roports on which sex or body length are filled more or less incompletely have been omitted. But such instances are few and we are confident that this table gives an idea concerning the occurrence and abundance of the little piked whale in the waters adjacent to Japan. As seen in fig. 17, which shows actual catch position of each whale taken in the years 1953 and 1954, we have divided the grounds in the coastal waters of Japan into 6 major areas. The catch of the little piked whale in each area is not spread out to a wide ground, but more or less concentrating, usually having one concentration in each area. The little piked whale comes very near to the coast, and never taken in off shore seas over 100 nautical miles. In the Area II the catch is almost exclusively limitted within comparatively narrow bay, called Wakasawan. Also in Area I the catch has been carried on

Table III. Catch records of Little Piked Whale from the Coast of Japan. (1948-1954).

Years	Sex	Areas							Sex ratio
		I	II	III	IV	V	VI	Total	
1948	Male	56	—	—	27	58	—	1) 143	53.96
	Female	38	—	—	53	31	—	122	46.04
	Total	94	—	—	80	89	—	265	
1949	Male	19	—	—	11	61	—	91	49.73
	Female	30	—	—	31	31	—	92	50.27
	Total	49	—	—	42	92	—	183	
1950	Male	8	2	13	15	59	42	2) 141	60.26
	Female	9	3	0	34	27	19	3) 93	39.74
	Total	17	5	13	49	86	61	234	
1951	Male	9	54	6	14	87	8	4) 179	53.59
	Female	13	27	2	70	41	2	155	46.41
	Total	22	81	8	84	128	10	334	
1952	Male	25	122	8	19	89	1	264	54.55
	Female	19	22	0	96	81	2	220	45.45
	Total	44	144	8	115	170	3	484	
1953	Male	35	55	36	27	75	9	237	58.66
	Female	17	30	4	55	57	4	167	41.34
	Total	52	85	40	82	132	13	404	
1954	Male	22	13	32	57	22	25	171	47.50
	Female	16	11	4	123	22	12	5) 189	52.50
	Total	38	24	36	180	44	37	360	
Total	Male	174	246	95	170	451	85	6) 1,226	
	Female	142	93	10	462	290	39	7) 1,038	
	Total	316	339	105	632	741	124	2,264	
	Sex ratio								
	Male	55.06	72.57	90.48	26.90	60.86	68.55	54.15	
	Female	44.94	27.43	9.52	73.10	39.14	31.45	45.85	

1) Includes 2 little piked whales taken in other area (south side of Honshu & Shikoku)
2) 〃 2 〃 〃 〃
3) 〃 1 〃 〃 〃
4) 〃 1 〃 〃 〃
5) 〃 1 〃 〃 〃
6) 〃 5 〃 〃 〃
7) 〃 2 〃 〃 〃

within the narrow waters along the coast, most of them having been taken within 3 nautical miles from the shore.

As seen from table III, the highest catch was attained in Area V (North-east coast of Honshu) during these 7 years, and next to it in Area IV (Okhotsk Sea). Regarding of other areas the catches are the order of Areas II, I, VI, III, but the catches in these areas are very fewer than in other two areas. Before the war some little piked whales were taken also in the Yellow Sea, coast of Korea, and Kuril Island's waters, as reported by Matsuura (1936), and especially in the south-east coast of Korea motor-vessels equipped with harpoon gun had been operating until the end of the war with successful results. Of

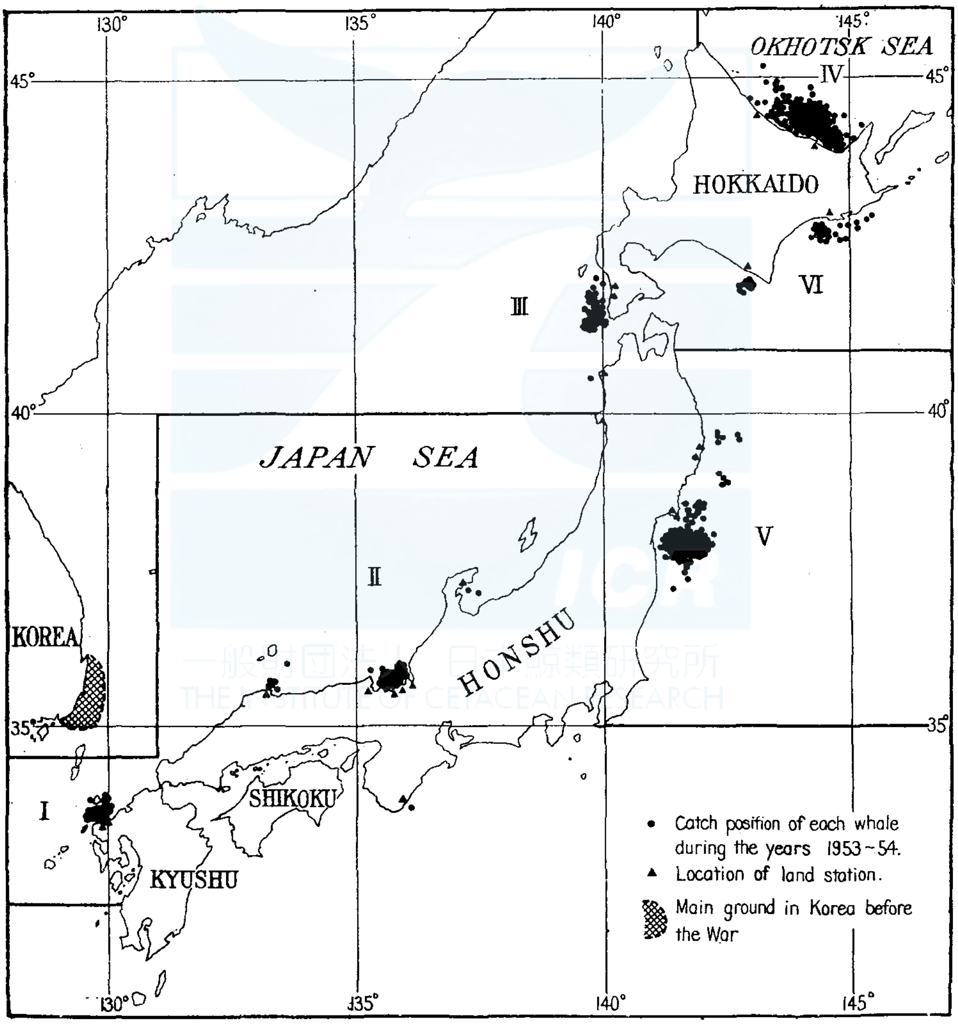

Fig. 17. Whaling Ground for the Little Piked whale around Japan.

such whaling we have no information now.

In the south coast of Honshu and Shikoku a very few whales are taken, total catch in these seven years being amounted only 7 whales. Several small type catcher boats have been operating in these waters too, for the purpose of taking small sized toothed whales, accordingly we think only few little piked whales will travel in these regions of the sea. A little piked whale was caught by a fish trap net in Suruga bay towards the end of November 1955 and was kept in captivity over one month. A note on this whale is published by Messrs. Nemoto and Kimura elsewhere in the present issue.

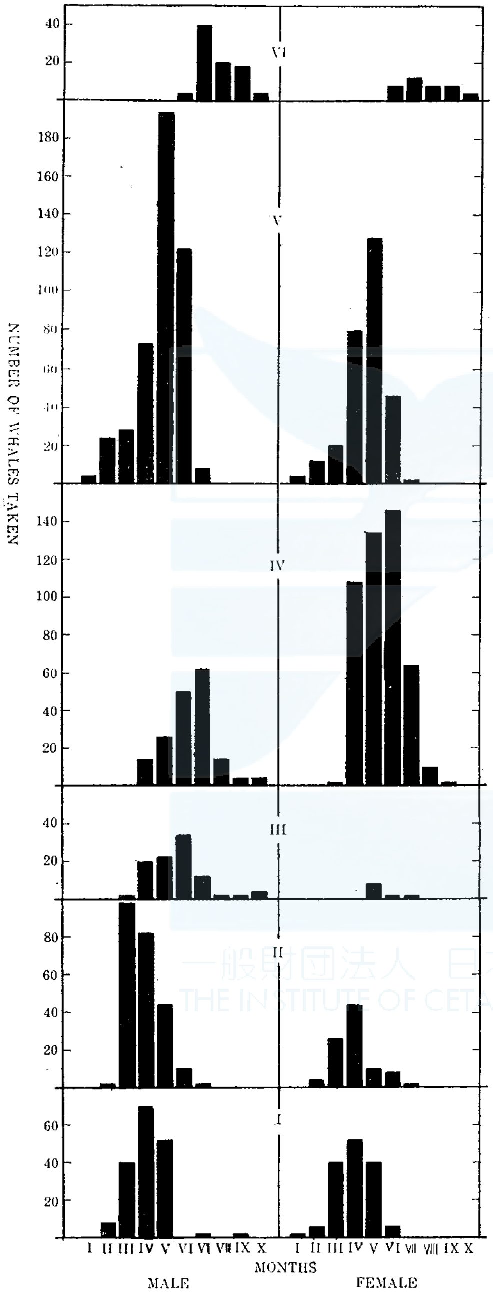

Fig. 18. Monthly catch of little picked whale in each area. (1948-54)

The sex ratio of the little piked whale taken in the waters adjacent to Japan is shown in table III. A slightly more males are taken as a whole than femals, percentages for males and females being about 54 and 46 per cent respectively. In Area IV, the northernmost ground, this ratio of sex is quite striking, about 27 per cent males and 73 per cent females. In other areas, on the contrary, males occupy a preponderant part of the catch over females, especially in Areas II, III, V, and VI. This fact will suggests that the little piked whale migrate in segregated groups, such as males and females.

In fig. 18 the monthly catch of the little piked whale is shown according to each area and sex in actual numbers of whales taken. This figure does not show the true status on the occurrence of the little piked whale in the waters around Japan, because the catch of this species of whale has been restricted within 6 months of February to the end of July since 1952, though there was no restriction of season in the previous years. In strict speaking, therefore, the catch reports should be treated here dividing into two groups, one prior to 1952 and the other later years, but because the catch itself has not been so great as in Norway we treated those reports as a whole, from which we believe, still a general conception regarding of the occurrence or movement be gained. We give the actual number of whales taken in this figure, instead of percentages, in order to show the abundance of whales too, but separately according to both sexes in each area.

As shown in fig. 18 the main catch of the little piked whale is attained as a whole in a period from April to July. Some whales are also taken in August and September. These whales were taken in the seasons prior 1952. The main seasons for respective areas are March to May (Areas I and II), April to July (Areas III and IV), April to June (Area V). and July to Septemper (Area VI).

We are confident that the histograms in fig. 18 reflect the occurrence of the little piked whale in the waters around Japan with some exceptions. There are some possibilities in Areas IV and VI that some more whales are taken in the months August, September, and October, if the catch is permitted also in these months. On the other hand we think that such catch may never be so great as to exceed the peaks shown in these histograms.

We conclude, therefore, that the little piked whales migrate into the waters around Japan early in the spring from the south, most frequently staying in the spring (in southern grounds) and summer (in northern grounds), and leave in the autumn to the south. We conclude further that there are two different stocks in the waters around Japan, the one in the waters west of Honshu (Japan sea) and the other in the east coast of Honshu. The former migrates to the north in the spring in the order of Areas I, II, III, and finally enters into Area IV (Okhotsk sea), wherein staying during the summer, and then travels back to the south following the similar route, but in the offing in the autumn. The latter stock immigrates in Area V early in the spring, staying there during the spring, and going north into Area VI. It is probable that this stock of east side goes father north along the coast of Kuril Islands until east coast of Kamchatka (Bering sea), because the fact that also in these waters the little piked whale occur has been established by other authors (see Scattergood, 1949).

In table IV the body length of the little piked whales taken in the

Table IV. Body Length Frequency of Little Piked Whale
from the Coast of Japan (1948–54).

Body Length in Feet	Actual number			Per cent		
	Male	Female	Total	Male	Female	Total
12	2	5	7	0.16	0.48	0.31
13	4	9	13	0.32	0.86	0.57
14	14	16	30	1.14	1.54	1.33
15	37	46	83	3.01	4.43	3.67
16	41	43	84	3.34	4.14	3.71
17	56	43	99	4.56	4.14	4.37
18	81	79	160	6.60	7.61	7.07
19	62	48	110	5.05	4.63	4.86
20	78	87	165	6.36	8.38	7.29
21	70	72	142	5.70	6.93	6.27
22	63	45	108	5.13	4.33	4.77
23	115	54	169	9.38	5.20	7.46
24	178	64	242	14.51	6.16	10.69
25	207	87	294	16.88	8.38	12.99
26	135	136	271	11.01	13.10	11.97
27	64	114	178	5.22	10.98	7.86
28	14	65	79	1.14	6.26	3.49
29	5	23	28	0.40	2.21	1.24
30	0	2	2	0	0.19	0.09
Total	1,226	1,038	2,264			
Average length	22.31	22.35	22.33			

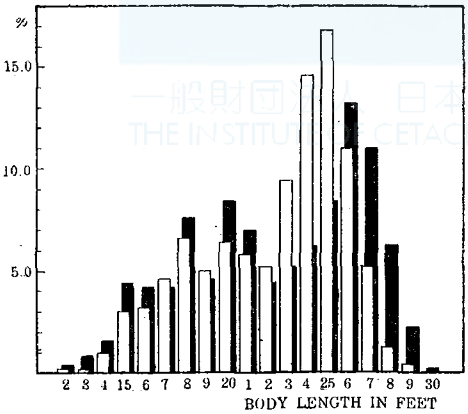

Fig. 19. Body length frequency of little piked whale from the coast of Japan (1948–54).

consecutive seven years ending 1954 are shown in actual numbers as well as in percentages. Fig. 19 shows the body length frequencies based on table IV. As seen from the table and figure the smallest and biggest animals taken are 12 (male and female) and 30 (female) feet respectively. According to Harmer (1927), Fraser (1934), and Stephenson (1951) the biggest animal from the Atlantic ocean attains a body length of over 30 feet. However, of the

99 whales examined by Jonsgård (1951) the largest is a female of 914 cm (29 feet 11 inches). Accordingly we suppose that there may occur no substantial difference in length between the animals from the two oceans, if the body length is measured correctly, in a straight line parallel with the whale's body from the tip of the snout to the notch between the tail flukes. No whale of exceeding 30 feet in length has been reported from the Pacific.

As shown in fig. 19 the body length frequencies in males and females draw bimodal curves, having their maxima at 18 and 25 feet in males, and at 20 and 26 feet in females. The lower maxima in both sexes denote apparently immature groups and the higher mature. These maxima are higher in females by 1–2 feet than males. The biggest female is 30 feet, whereas 29 feet in male. Thus, in the little piked whale female is bigger than male by one or two feet.

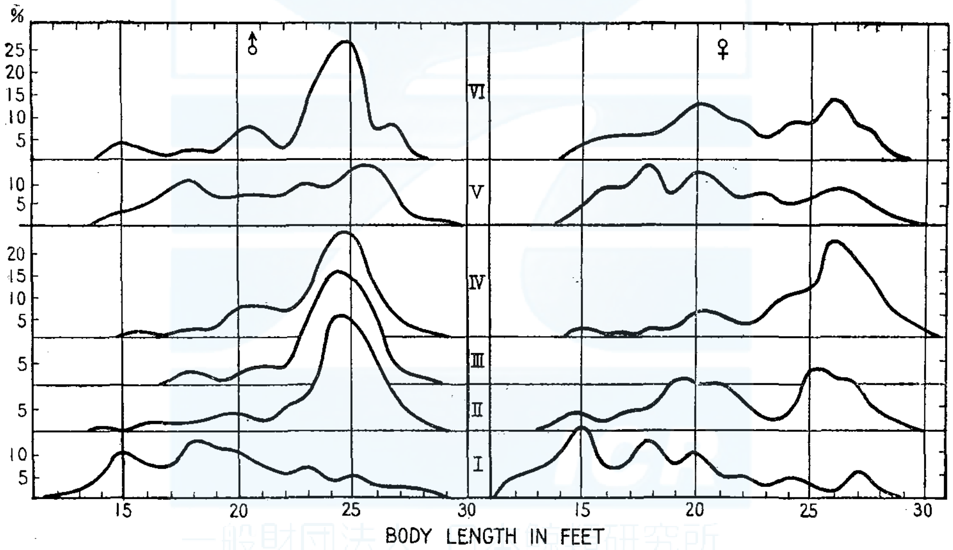

Fig. 20. Body length frequencies shown as percentages of total catch in each area (1948–54).

In fig. 20 the frequency-curves of body length in different areas are shown. At a glance we see that these curves resemble to those given by Jonsgård (1951, fig. 7) for Norwegian minkes. In the waters around Japan too, there are certain characteristic differences with regard to the size of the animals according to the areas. In Area I the catches were dominated by immature animals of about 20 feet or more shorter, having their peaks at 15 and 18 feet, both in males and females. In Area II the catch was consisted chiefly by mature animals of 24 and 25 feet in males, whereas in females there noted two peaks, one at about

20 feet (adolescent) and the other at 25–27 feet (full grown). In Area III the curve for males resemble to those in Area II. We can not draw any curve for females in this area, because the catch of females in these seven years account only ten whales. The catches in Area IV were strongly dominated by mature animals both in males and females, having their maxima at 24–25 feet in males and at 26 feet in females. However, there are also second maxima at 21–22 feet (adolescent) both in males and females.

In Area V the catches were consisted of both immature and mature animals, but more immature whales were contained in the catch of females. These frequency-curves in Area VI are similar to those in Area II, both in males and females.

The immature whales of about 15 feet in length, which dominate the catch in Area I, are deemed without doubt to those who have been weaned quite recently. As already stated elsewhere in this report, we are confident that there are two stocks of the little piked whales in the waters around Japan, one in the west coast of Honshu and the other in the east. Since there is no group of small immature animals of about 15 feet in the catch of Area V, we think that such whales remain more southern waters in the eastern stock. And since there is no such grounds for the eastern stock which correspond to Areas III and IV, where the catches are strongly dominated by mature males and females, it is highly probable that mature animals, more females than males, travel farther north, beyond Area VI, to the seas of high latitude and probably along the coast of Kuril Islands and Kamchatka.

We conclude, therefore, that the little piked whales immigrate to the waters around Japan in segregated groups, such as immature animals, mature males and mature females, and that the immature animals, especially males, remain in the southern waters and only mature animals and a part of adolescent whales travel to the northern feeding grounds.

With regards to the whaling in Korea nothing has been reported since the termination of the war. However, a considerable number of the little piked whales were taken before the war in the ground on the south-east coast, which is shown in fig. 17. It is suggested, in the light of the present knowledge, that the catch in this ground also be dominated by immature animals. Matsuura (1936) reports size distribution of the little piked whale in Yellow sea, in which no whale below 20 feet is contained. We think, however, the figures in his report are not the true reflection of the stock there, because these whales were taken by usual whaling catchers for larger species. It is quite natural for such catchers to avoid the taking of small whales of less than 20 feet.

As regards the southern limit of migration, we have no scientific evidence at present. Some whalers say that the little piked whale has been observed rather frequently in the waters near Okinawa. This information may throw some light to this problem.

Food

As to the food of the little piked whale from the Atlantic ocean Stephenson (1951) states that "off the English coast, the captured whales had been feeding on herring and mackerel." Jonsgård (1951) also describes that "in Nowegian coastal waters different species of fish play a greater role as food for the minke whale." Thus it seems that fish is the most favorable food for the little piked whale. However, Jonsgård continues further "we think it may be safely concluded that the minke whale in high Arctic waters feeds mainly on krill, in this case *Thysanoessa inermis*. Even in the cases where a mixed diet was found, krill formed the major part of the content, which seems to suggest that the herring, capelin, or small cod found together with the krill have been feeding on the same krill swarms as the whale and have been taken, therefore, more or less, accidentally."

In the coastal waters of Japan krill plays more or less a greater role as food for the little piked whale, especially in Area IV, the northernmost ground in the Okhotsk sea.

In table V the reports from the whalers for 1953 and 1954 as to the food of the little piked whale are tabulated. There may be some cases where the kind of food has been miss-identified. However, we think that such cases may occur rather in few occasions where the food concerns not with commercial fish.

As seen from this table the instances where krill is eaten are most numerous. However, we are not confident as to the "krill" (in Japanese Ami) reported by whalers means always euphausiids. Since there is no Japanese word corresponding to Norwegian "rφdaaten," copepods are often reported as Ami (krill). Of the 17 whales, investigated by us of their stomach contents at Abashiri (Area IV) in 1953, 3 were empty, 5 were with krill (mostly in rich), 2 were with krill and some fish bones, 2 were with copepods, 2 were with mixed diet of krill and copepods, and rest 3 with fish. Of the 3 whales which had fish in their stomach, each one instance of Alaska pollack (*Theragra chalcogramma*) and sand lance (*Ammodytes personatus*) have been observed. The rest was the mixed diet of the both species.

Also in Area I, southernmost ground, the little piked whale feeds in some extent on krill. In spring krill swarms in these waters and

Tableh V. Stomach contents of Little Piked Whale
from the Coast of Japan.

Area	Kind of Food	1953	1954
I	Krill (or Copepods)	29	5
	Fish, Sand lance (*Ammodytes personatus*)	4	6
	Fish, Iwashi1)	12	15
	Other fishes	1	—
II	Krill (or Copepods)	62	12
	Fish, Sand lance	9	3
	Fish, Iwashi1)	3	2
	Krill (or Copepods)+Fish, Sand lance	2	1
	Squid	1	—
III	Krill (or Copepods)	2	2
	Fish, Iwashi1)	2	—
	Fish, Hokke (*Pleurogrammus azonus*)	34	30
	Squid	1	—
IV	Krill (or Copepods)	44	119
	Fish, Sand lance	13	16
	Fish, Iwashi1)	1	5
	Fish, Alaska pollack (*Theragra chalcogramma*)	12	12
	Fish, Cod (*Gadus macrocephalus*)	1	—
	Small fish, not identified	2	—
	Krill (or Copepods)+Fish, Sand lance	4	13
	Krill (or Copepods)+Fish, Alaska pollack	3	2
	Krill (or Copepods)+Fish, Herring	—	1
	Fish, Sand lance+Fish, Iwashi1)	1	—
	Fish, Sand lance+Fish, Alaska pollack	1	—
	Fish, Saury pike (*Cololabis saira*)+Squid	—	1
V	Krill (or Copepods)	79	10
	Fish, Sand lance	27	23
	Fish, Iwashi1)	12	3
	Fish, Mackerel	—	2
	Small fish, not identified	3	—
	Squid	2	—
VI	Krill (or Copepods)	—	14
	Fish, Iwashi1)	—	16
	Fish, Alaska pollack	9	—
	Fish, Cod	4	—

1) Collective name of sardine (*Sardinops melanosticta*), anchovy (*Engraulis japonica*), and round herring (*Etrumeus micropus*). But mostly anchovy in these cases.

are taken by fishermen by nets of fine meshes for human consumption. The Tsukudani, a kind of conserved food cooked with sugar and soy beans souse, of krill is a traditional food in Japan. According to whalers in the year more krill abundant, more whales come to these waters.

Among fishes found in the stomach of the little piked whales, sand lance plays a greater role, particularly in Area V. Large fish of this species of about 15 cm or more in length are present in good quantity in the stomach. The little piked whale in this area comes very near to shore pursueing this fish, and it is not very seledom that the whale be taken by fish trap net.

Most of the fish reported as Iwashi are thought to belong to anchovy (*Englaulis japonica*), though there are few records of Oba-Iwashi, which means full-grown sardine (*Sardinops melanosticta*). It is noted that Hokke (*Pleurogrammus azonus*) is reported only from Area III, but this fact coincides well with the abundance of this fish in these waters.

In Areas IV and VI also Alaska pollack (*Theragra chalcogramma*), cod (*Gadus macrocephalus*), or herring (*Clupea pallasi*) have been recorded besides above mentioned kinds of fish. Squids too are eaten, though in few occasions, by the little piked whales.

Reproduction and Growth

Of the 13 whales examined by us of their ovaries, 5 were immature and 8 were registered as mature, having one or more corpora lutea of pregnancy or ovulation in their ovaries. The largest immature whale was 709 cm (23′3″) in length and had a ripening follicle of 8 mm diameter in its ovaries. Among the whales examined by us the greatest diameter of Graafian follicle was recorded as 15 mm in the little piked whale. The smallest mature whale was 788 cm (25′10″) in length, but this whale contained one functional corpus luteum (fetus not present) and 12 corpora albicantia in its ovaries. In fig. 21 the relation between body length and number of corpora lutea are shown, and from this figure it is clear that females of 26 feet in length or more larger are all mature. But we can not conclude at what body length the female little piked whale reaches sexual maturity in average from this figure alone, because we have no data concerning 24 or 25 feet. We have investigated, therefore, the records of 111 fetuses obtained during the years 1948 to 1954. Instances of pregnancy according to their respective body lengths are as follows :

Body length	Instances of pregnancy
23 feet	2
24 〃	2
25 〃	7
26 〃	44
27 〃	28
28 〃	20
29 〃	6
30 〃	2

As seen from the above the smallest pregnant female is 23 feet. Matsuura (1936) reports 8 records of pregnant females from the waters adjacent to Japan, and amongst them the whales of 23 Shaku (1 Shaku= 0.99421 foot) are the smallest. But such instances are deemed rather few, though we have no negative evidence, except one examined by us as already mentioned. Jonsgård (1951) describes that sexual maturity is attained at length of about 24 feet in the female for the whale from the Norwegian waters. We may conclude that the average body length at which sexual maturity is attained is about 24 feet in the female little piked whale from the coast of Japan, not differing from the figure established for the whale from the Atlantic ocean.

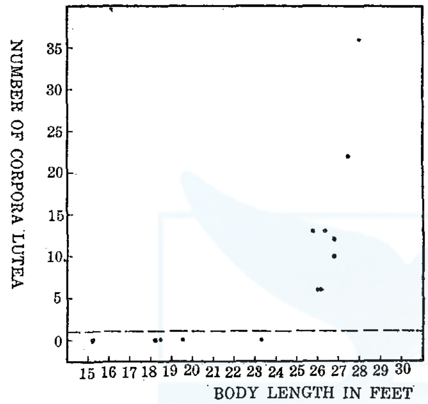

Fig. 21. Relation between number of corpora lutea and the length of female little piked whale.

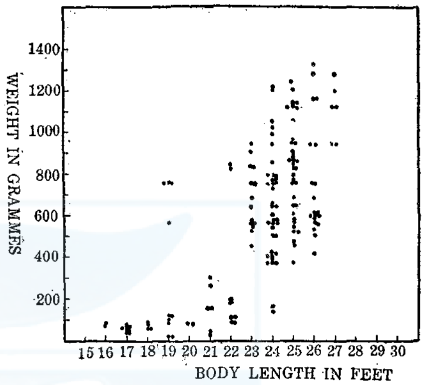

Fig. 22. Relation between weight of testis and the length of male little piked whale.

We have plotted the weights of testes against the corresponding body lengths in fig. 22. There are two groups roughly, the one being less than 200 grams and the other heavier than 300 grams. Evidently the former represents immature group, and the latter mature. The smallest mature male is 19 feet long, and the largest immature may 24 feet. Males of 23 feet long and over are evidently mature. Jonsgård (1951) reports that one pair of testes weighing more than 225 gr. seem to be mature. Since weight of each testis is plotted in fig. 22, our weight shuld be doubled in order to compare roughly to that given by Jonsgård. Individual weight less than 200 gr. in fig. 22 seem to be slightly heavier than those reported by Jonsgård. We are not confident that our measurements are always correct in critical point, because these data have been supplied mainly from the whalers, not having measured by us. Jonsgård states that the male attain sexual maturity at a length of about 22 feet, 2 feet smaller than the female. There are 4 whales in fig. 22 which registered at 22 feet (each dot denotes the weight of each testis instead of one pair of testes). One is obviously mature, two are apparently immature, and the rest one is very doubtful whether or not mature. We think that the average body length at which sexual maturity is attained in male is 22 or 23 feet for the little piked whale from the coast of Japan.

In fig. 23 body lengths of fetuses are plotted according to their respective dates. This material has been obtained during the period from 1948 to 1954. The records of fetuses thus obtained are confined almostly within 5 months from March to July, because of the restriction of the period of taking imposed on whaling. We added here, therefore, the records reported by Matsuura (1936), in the days of no such restriction.

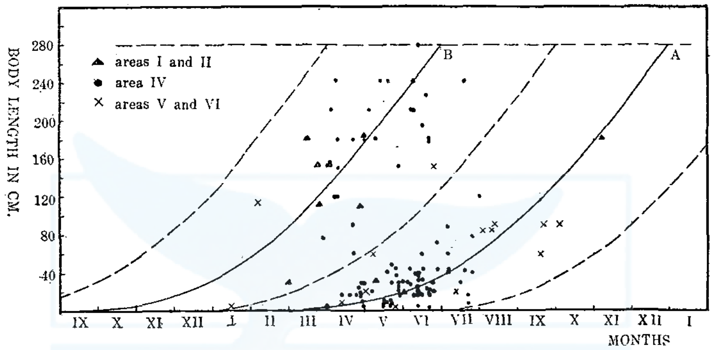

Fig. 23. Length of fetuses and months of their occurrence in waters around Japan, showing the approximate rate of growth.

▲ areas I and II

● area IV

× areas V and VI

As seen from fig. 23 there are roughly two groups of fetuses even in the same period, the one is smaller and the other bigger. The line A is a supposed growth curve for the smaller group of the fetuses. The body length at which the birth takes place is supposed at 280 cm. We think this supposition may correct in the light of the present knowledge. According to the line A most of pairing take place at the end of February or beginning of March, and most whales give birth to their calves at the end of December or beginning of January, having the period of conception of about 10 months. This curve coincide fairly well with the growth curve of fetuses given by Stephenson (1951) for the little piked whale from the Atlantic ocean, if we shift the line A a month earlier.

But, as seen in this figure there present another group of fetuses, the bigger, far apart from the line A. The occurrence of such fetuses from the coast of Japan has already been shown by Matsuura (1936, fig. 4) and Stephenson (1951, fig. 14), though no details are discussed in their reports. We have examined 8 mature females at Abashiri (Area IV) from 13th to 16th June 1953, in which 6 were pregnant. The other two had contained functional corpus luteum in their ovaries, but no fetus was present. It was ascertained after careful observation, cutting open through their uterine cornua. No resting whale was observed. The biggest fetus has been recorded as 279 cm (9′2″) and was deemed as just before parturition. The smallest one was at the early stage of pregnancy and the sex of the fetus could not determined. It is apparent that the 2 whales which contained no fetus were just after ovulation, and may be at a very early stage of pregnancy or in pairing. Thus, we have observed a biggest fetus of just before parturition, a very small one, and two cases of very early stage of pregnancy or in pairing within a very short period of five days, even in the northernmost ground.

The line B is drawn parallel to the line A with an interval of six months. Hatched lines were drawn also parallel to those solid lines, but with an interval of three months. Apparently the line B denote the average growth curve for the fetuses of another group, the bigger. Pairing and parturition, in this case, take place at about Aug.–Sept. and June–July respectively.

It is apparent that the period of pairing is of long duration in both cases. Jonsgård (1951) reports for the little piked whale from the Atlantic that the pairing-season must be of rather long duration from about January to the end of May. Since the little piked whale from the coast of Japan has two seasons of pairing within 12 months and each one lasts for long period, pairing may occur actually throughout the whole year. Stephenson (1951) describes as to the little piked whale from the Atlantic that the sizes of young stranded whales suggest that birth can occur at any season of a year. His opinion has not been justified by Jonsgård, but our material suggests that it may be applied to the whales from the coast of Japan.

It is clear, as stated above, that the little piked whale from the coast of Japan has two seasons of pairing, but it is hardly thought that these fact is based upon different habit of breeding between the two stocks, namely eastern and western stocks of Honshu. We have plotted with different symbols in fig. 23 the fetuses from different areas. Same symbols are seen in both groups A and B, presenting a negative evidence.

We conclude, therefore, that the ovulation takes place at least twice a year in the little piked whale from the coast of Japan, the first ovulation mostly in Feb.–Mar. and the second mostly in Aug.–Sept. with an interval of six months, and impregnation may occur in both cases.

We have calculated the numbers of individuals belonging to both groups with a result that the ratio of A-group to B is roughly 2 to 1. But, we should remind here the fact that a great number of small fetuses, which belong to A-group in the period of whaling permitted, may have been overlooked. Accordingly we conclude further that females get impregnated mostly at the first ovulation, having its peak in February and March, and those females who had not been impregnated at the first ovulation may have fetuses at the second ovulation, 6 months later from the first.

In any case, it may probable that mature female gives birth a young within more shorter time than 24 months, which is thought generally be applied to other baleen whales. This is suggested by our examination of ovaries, however few in number. Of the 8 mature females, no resting whale was observed. Jonsgård (1951) states that paucity of resting females in the material leads to the conclusion that the majority of mature females bring forth a young one once a year for the little piked whale in the Norwegian waters. His conclusion may be applied also for the whale from the coast of Japan, but slightly changed. Namely, in the little piked whale from the coast of Japan mature females mostly bring forth a calf once a year, but there are some cases where they give birth to their young after an interval of 18 months from the previous parturition.

The material at our disposal can yield only a small amount of information about the growth after birth. It is seen from fig. 20 that there are peaks in the body length frequency curves in respective areas roughly at 15, 18, 20–21, 23, and 24–25 (male) or 25–26 (female) feet. The small whales of about 15 feet in length are probable to have weaned recently. These constitute the 0-year class, or about half a year old. From 15 feet upwards the intervals of successive peaks are 2–3 feet. Two or there feet growth is hardly taken as an annual growth for the little piked whale, comparing with more rapid growth, about 6 feet within 6 months, in the period prior half a year old is attained, and in the light of the present knowledge that birth may occur also in summer. We may ascribe, therefore the second group of about 18 feet long to the I-year, class, or a year old, and the third group of about 20–21 feet in length also to the I-year class, but actually one and a half year old. In this way, the fourth group of about 23 feet may be deemed as II-year class of about 2 year old. The groups of 24–25 feet in males and 25–26 feet in females are apparently consisted of mature animals, and may be of different ages, older than 2 years old. Sexual maturity may be attained at an age of 2 years. This assumption coincides well to that of Jonsgård (1951) for the little piked whale from the Atlantic ocean. There may be no remarkable difference in growth or age between the animals from the different two oceans. But of course, more evidence is needed before this can be regarded as firmly established.

Summary

1. The little piked whale from the coast of Japan has been studied using material obtained from the biological examinations of whales treated at land station as well as the information supplied by the whalers during the years 1948 to 1954.

2. The little piked whale from the coast of Japan has a shorter mouth, a more posteriorly situated, but higher dorsal fin, more shorter flippers, more broader tail flukes, and a more posteriorly situated genital aperture than the whale from the Atlantic ocean. The Pacific whale has slightly fewer baleen plates than that from the Atlantic. We think, however, that these differences in external characters should be deemed as differences according to different stocks or racial nature, because such measurements from both oceans are overlapping in major parts. The grounds for recognizing *Balaenoptera davidsoni* as a subspecies of *B. acutorostrata* have not been justified from the external characters.

3. It is thought that there are two different stocks of the little piked whale in the waters around Japan, the one to the waters west of Honshu (Japan sea) and the other in the east coast of Honshu. Both stocks migrate into the waters around Japan early in the spring from the south, most frequently staying in the spring (in southern grounds) and summer (in northern grounds), and leave in the autumn to the south.

4. The little piked whale immigrates to the waters around Japan in segregated groups, such as immature animals, mature males and mature females. The immature animals, expecially males, remain in the southern waters. Only mature animals, dominated by females, and a part of adolescent whales travel to the northern feeding grounds of high latitude.

5. The little piked whale from the coast of Japan feeds on krill or copepods as well as various kinds of fish. Among fish sand lance (*Ammodytes personatus*) and anchovy (*Engraulis japonica*) play a greater role.

6. The sexual maturity is thought to be attained at a body length of 24 feet in female and 22–23 feet in male, and at an age of 2 years in both sexes.

7. The ovulation takes place at least twice a year in the little

piked whale from the coast of Japan, the first ovulation mostly in Feb.–Mar. and the second mostly in Aug.–Sept. with an interval of six months. Most mature females get impregnated at the first ovulation and those females who had not been impregnated at the first ovulation may have fetuses at the second ovulation.

8. The period of pairing is of long duration and may occur throughout the whole year. The gestation is supposed to last about 10 months.

Most of the mature females may bring forth a calf once a year, but there are some cases where they give birth to their young after an interval of 18 months from the previous parturition.

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Appendix Table

Measurements of Body Proportions.

1. Total length.
2. Lower jaw, projection beyond tip of snout.
3. Tip of snout to blowhole (centre).
4. Tip of snout to angle of gape.
5. Tip of snout to centre of eye.
6. Tip of snout to tip of flipper.
7. Centre of eye to centre of ear.
8. Notch of flukes to posterior emargination of dorsal fin.
9. Width of flukes at insertion.
10. Noch of flukes to centre of anus.
11. Notch of flukes to umbilicus.
12. Notch of flukes to end of ventral grooves.
13. Centre of anus to centre of reproductive aperture.
14. Vertical height of dorsal fin.
15. Length of base of dorsal fin.
16. Flipper, tip to axilla.
17. Flipper, tip to anterior end of lower border.
18. Flipper, greatest width.
19. Head length, condyle to tip of snout.
20. Greatest width of skull.
21. Skull length, condyle to tip of premaxilla.
22. Skull height.
23. Tail flukes, notch to tip.
24. Length of lower jaw.

Body Proportions of Little Piked
upper figures:
lower figures:

No.	Date, killed	Land station	Sex	Measure-									
				1	2	3	4	5	6	7	8	9	10
1	12 Jun. 1953	Abashiri	M	582	6 1.03	68 11.68	79 13.57	85 14.60	218 37.46	27 4.64	167 28.69	42 7.22	148 25.43
2	24 Jul. 1953	Kushiro	〃	688	14 2.03	94 13.66	131 19.04	112 16.28	267 38.81	36 5.23	167 24.27	51 7.41	179 26.02
3	21 Jul. 1953	Abashiri	〃	695	— —	91 13.09	— —	119 17.12	280 40.29	37 5.32	180 25.90	— —	190 27.34
4	13 Jun. 1953	〃	〃	718	18 2.51	96 13.37	128 17.83	109 15.18	303 42.20	36 5.01	209 29.11	48 6.69	191 26.60
5	15 Jun. 1953	〃	〃	739	18 2.44	94 12.72	103 13.94	115 15.56	306 41.41	37 5.01	200 27.06	52 7.04	206 27.88
6	16 Jun. 1953	〃	〃	788	7 0.89	102 12.94	— —	112 14.21	— —	— —	— —	48 6.09	— —
7	22 Jun. 1953	Ayukawa	〃	794	— —	97 12.22	— —	125 15.74	307 38.67	43 6.20	221 27.83	55 6.93	213 26.83
8	18 Jul. 1953	Kushiro	〃	799	— —	101 12.64	— —	147 18.40	— —	39 4.88	207 25.91	— —	— —
9	23 Jun. 1953	Ayukawa	F	461	— —	54 11.71	— —	66 14.32	182 39.48	— —	132 28.63	33 7.16	135 29.28
10	24 Jul. 1953	Kushiro	〃	554	— —	70 12.64	— —	84 15.16	233 42.06	31 5.59	136 24.54	45 8.12	152 27.44
11	12 Jun. 1953	Abashiri	〃	564	8 1.42	76 13.48	79 14.01	91 16.13	230 40.78	30 5.32	161 28.55	42 7.45	152 26.95
12	10 Jun. 1953	〃	〃	597	15 2.51	82 13.74	94 15.75	111 18.59	239 40.03	30 5.03	164 27.47	43 7.20	155 25.96
13	24 Jul. 1953	Kushiro	〃	658	12 1.82	88 13.37	123 18.69	112 17.02	273 41.49	39 5.93	173 26.29	— —	170 25.83
14	14 Jun. 1953	Abashiri	〃	709	10 1.41	88 12.41	118 16.64	120 16.93	300 42.31	35 4.94	203 28.63	59 8.32	194 27.36
15	13 Jun. 1953	〃	〃	788	15 1.90	100 12.69	133 16.88	133 16.88	336 44.04	43 5.46	185 23.48	63 7.99	215 27.28
16	16 Jun. 1953	〃	〃	791	13 1.64	100 12.64	— —	130 16.43	— —	43 5.44	221 27.94	57 7.21	197 24.91
17	14 Jun. 1953	〃	〃	794	6 0.76	115 14.48	121 15.24	121 15.24	327 41.18	37 4.66	227 28.59	56 7.05	197 24.81
18	16 Jun. 1953	〃	〃	797	13 1.63	100 12.55	— —	121 15.18	326 40.90	43 5.40	230 28.86	57 7.15	230 28.86
19	16 Jun. 1953	〃	〃	803	— —	106 13.20	150 18 68	127 15.82	330 41.10	43 5.35	224 27.90	61 7.60	206 25.65
20	15 Jun. 1953	〃	〃	812	15 1.85	103 12.68	— —	115 14.16	327 40.27	46 5.67	224 27.59	— —	224 27.59
21	14 Jun. 1953	〃	〃	818	7 0.86	115 14.06	109 13.32	109 13.32	364 44.50	45 5.50	209 25.55	60 7.33	215 26.28
22	15 Jun. 1953	〃	〃	836	— —	117 14.90	130 15.51	136 16.27	351 41.99	46 5.50	236 28.23	60 7.18	200 23.92
23	13 Jun. 1953	〃	〃	857	10 1.17	124 14.47	136 15.87	139 16.22	373 43.52	46 5.37	233 27.19	61 7.12	230 25.67

Whale from the Coast of Japan.
length in centimeters.
percentage against body length.

ments

11	12	13	14	15	16	17	18	19	20	21	22	23	24
276	327	37	28	48	54	77	20	132	74	—	—	80	123
47.42	56.19	6.36	4.81	8.25	9.28	13.23	3.44	22.68	12.71	—	—	13.75	21.13
339	391	48	—	—	—	—	—	—	—	—	—	92	—
49.27	56.83	6.98	—	—	—	—	—	—	—	—	—	13.37	—
—	320	51	30	66	—	106	26	—	—	—	—	—	160
—	46.04	7.34	4.32	9.50	—	15.25	3.74	—	—	—	—	—	23.02
342	400	48	28	57	72	90	25	160	77	—	—	98	155
47.63	55.71	6.69	3.90	7.94	10.03	12.53	3.48	22.28	10.72	—	—	13.65	21.59
351	421	42	34	64	—	—	—	—	—	—	—	111	—
47.50	56.97	5.68	4.60	8.66	—	—	—	—	—	—	—	15.02	—
—	—	—	—	—	—	—	—	—	—	—	—	125	—
—	—	—	—	—	—	—	—	—	—	—	—	15.86	—
384	445	61	—	48	64	94	—	—	—	—	—	—	—
48.36	56.05	7.68	—	6.05	8.06	11.84	—	—	—	—	—	—	—
—	—	53	24	81	—	157	28	—	—	—	—	—	—
—	—	6.63	3.00	10.14	—	19.65	3.50	—	—	—	—	—	—
223	260	10	—	27	41	67	—	—	51	94	29	65	100
48.37	56.40	2.17	—	5.86	8.89	14.53	—	—	11.06	20.39	6.29	14.10	21.69
264	312	18	27	45	50	61	22	—	—	—	—	90	—
47.67	56.32	3.25	4.87	8.12	8.20	11.01	3.97	—	—	—	—	16.25	—
264	306	15	28	43	46	65	22	128	72	—	—	78	118
46.81	54.26	2.66	4.96	7.62	8.16	11.52	3.90	22.70	12.77	—	—	13.83	20.92
267	361	18	27	45	58	71	22	130	72	—	—	86	125
44.72	60.47	3.01	4.52	7.54	7.92	11.89	3.69	21.78	12.06	—	—	14.41	20.94
303	345	21	28	45	48	70	25	—	—	—	—	—	—
46.05	52.43	3.19	4.26	6.84	7.29	10.64	3.79	—	—	—	—	—	—
339	409	15	29	49	56	68	27	—	—	—	—	120	155
47.81	57.68	2.11	4.09	6.91	7.90	9.59	3.81	—	—	—	—	16.93	21.86
333	470	20	—	—	85	92	31	—	—	—	—	120	178
42.26	59.64	2.54	—	—	10.79	11.67	3.93	—	—	—	—	15.23	22.59
369	415	24	30	55	67	94	28	—	—	—	—	123	—
46.65	52.47	3.03	3.79	6.95	8.47	11.88	3.54	—	—	—	—	15.55	—
361	385	27	25	48	60	88	—	—	—	—	—	123	—
45.47	48.49	3.40	3.15	6.05	7.56	11.08	—	—	—	—	—	15.49	—
363	373	19	—	—	91	102	31	—	—	—	—	116	—
45.55	46.80	2.38	—	—	11.42	12.80	3.89	—	—	—	—	14.55	—
373	433	18	33	67	70	99	31	—	—	—	—	120	—
46.45	53.92	2.24	4.11	8.34	8.72	12.33	3.86	—	—	—	—	14.94	—
388	448	24	38	65	—	—	—	—	—	—	—	—	—
47.78	55.17	2.96	4.68	8.00	—	—	—	—	—	—	—	—	—
379	373	19	—	—	62	77	32	187	89	—	—	133	182
46.33	45.60	2.32	—	—	7.58	9.41	3.91	22.86	10.88	—	—	16.26	22.25
364	445	24	—	—	92	123	31	—	—	—	—	128	177
43.54	53.23	2.87	—	—	11.00	14.71	3.71	—	—	—	—	15.31	21.17
403	458	25	32	75	94	135	34	195	—	—	—	137	185
47.02	53.44	2.92	3.73	8.75	10.97	15.75	3.97	22.75	—	—	—	15.99	21.59

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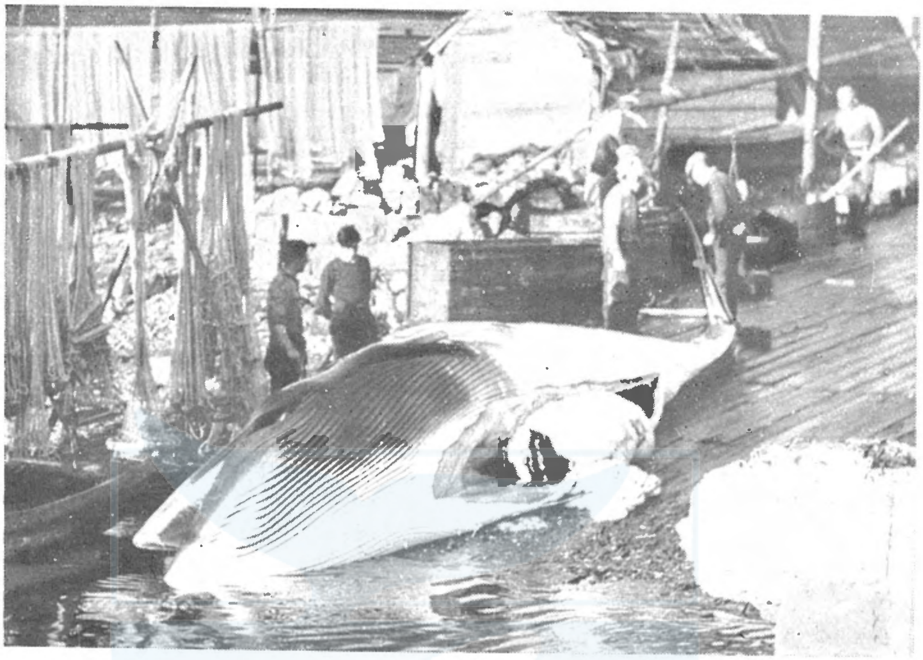
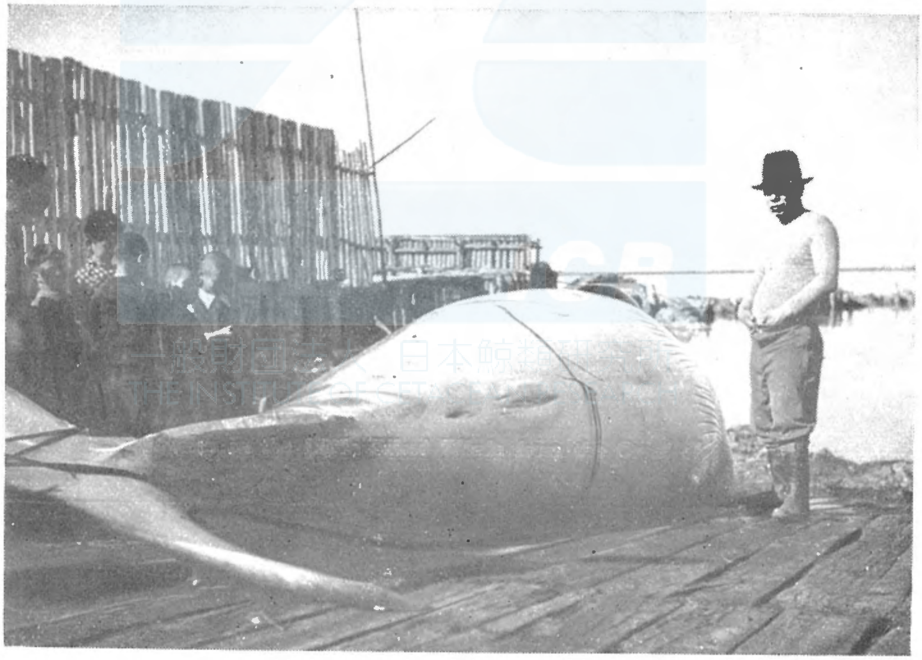


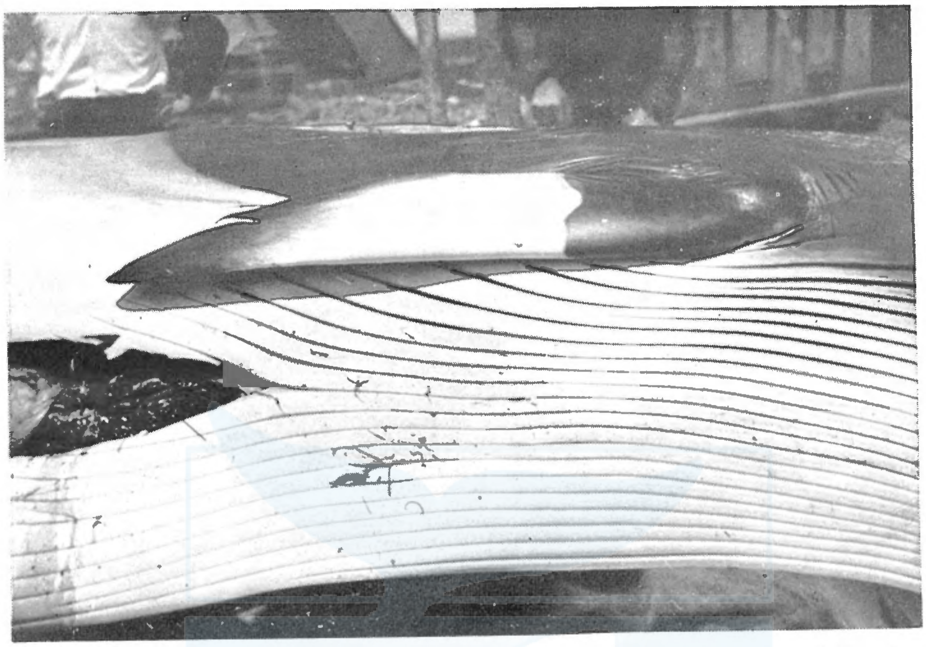
(Photo by Sakiura)



(Photo by Sakiura)

Plate I.

Ventral view of the little piked whale from the coast of Japan. At Abashiri land station in Hokkaido.



(Photo by Sakiura)

(Photo by Sakiura)

Plate II.

White band on the outer surface of the flipper of the little piked whale. Upper, broader band. Lower, narrower band. At Abashiri land station in Hokkaido.

(Photo by Sakiura)

Plate III.

A fetus of the little piked whale. 279 cm. male. At Abashiri land station.

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On the Sexual Maturity of the Sperm Whale (*Physeter catodon*) found in the North Pacific.

By

MASAHARU NISHIWAKI
TAKASHI HIBIYA* and SEIJI KIMURA

Introduction

Since 1954, sperm whales have been caught by Japanese whaling fleets in the northern parts of the North Pacific. The whaling ground is the waters of the coasts of Aleutian Islands: 175°E–164°W Long and 50°N–56°N Lat. as shown in fig. 1. Before these whalings operated, the data of the biological investigations of the sperm whales in this area had not been got by us. It is interesting ecologically to study the sexual condition, for the school of whales in this area is composed of males alone, furthermore, the comparison of sexual maturity between this school and that in the adjacent waters to Japan (Nishiwaki and Hibiya, 1951, 1952). So, we would like to report as the fourth report on the sexual maturity of the sperm whales.

Our greatful thanks are due to the inspectors and biologist named

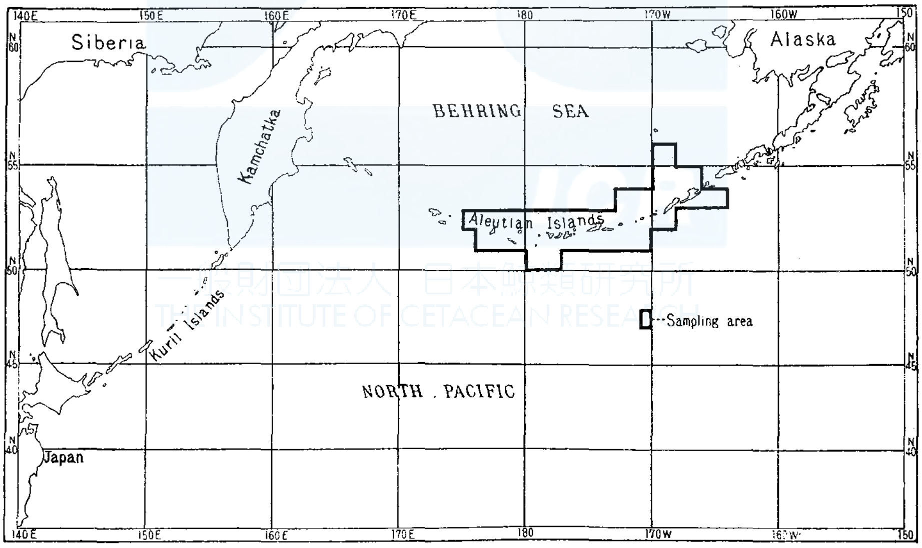

Fig. 1. Location of Sampling area.

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* The Laboratory of Fishery Zoology, Faculty of Agriculture, the University of Tokyo.

below for their immense cooperation in collecting the material and data for this study.

Government Inspector:	Mr. S. Nishimoto, Mr. T. Kawakami, Mr. N. Ikeda, Mr. K. Iguchi.
Biologist:	Mr. K. Fujino.

We wish also to express our thanks to Miss K. Ogura who rendered much assistance in the preparation of histological preparats.

Material and Method

The material for this study are 1060 male sperm whales which were caught and examined their testes in 1954 and 1955. And the histological examination was made on the 106 whales of them.

As the size limit of sperm whale is 38 feet by the case of factory ship whaling, the investigation was made on the individuals 38–57 feet in body length. In them, the samples for histological examination were collected more in small lengthed individuals than large ones (fig. 2), and in the same length relatively light testes were collected many (fig. 6). Therefore the samples were not collected at random.

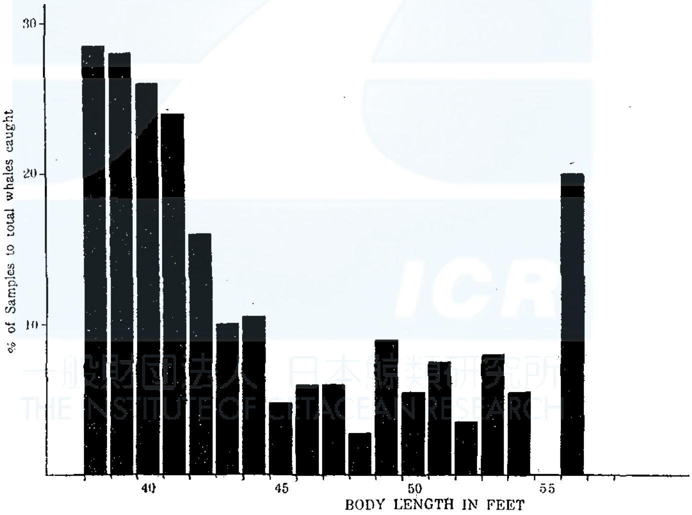

Fig. 2. The ratio of samples to total whales caught in each body length.

The period of the investigation and sampling was from the latter part of May to the latter part of September.

As mentioned above, all the sperm whales caught in the area are males, and we could not investigate the female whales.

The method for the present study is the same as was used in the previous works (Nishiwaki and Hibiya, 1951, 1952).

Tests weight at spermatozoa formation

The lightest weight of testis measured was 0.7 kg. and the heaviest was 13.5 kg. And, the lightest weight of sampled testes was 0.8 kg. and the heaviest was 8.7 kg.

Based on the result of the microscopic examination, those testes in which spermatozoa were found are classified as mature and those in which no spermatozoa were found are classified as immature.

In all testes which were assumed to be mature judged by the condition of seminiferous tubules, spermatozoa were formed, excluded one case of which weight of testis was 1.0 kg. In other testis (1.4 kg.) of this individual spermatozoa were clearly found. And there were several testes which were mature in parts and were immature in other parts. These testes were found in those of relatively light weighted testes.

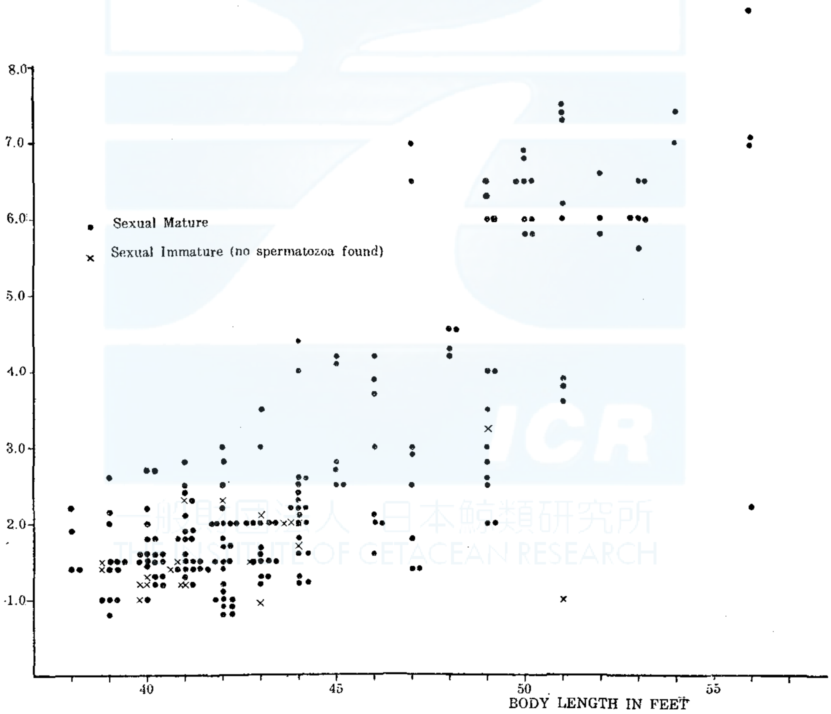

Fig. 3. The weight of testes examined and the body length in the male sperm whales

As shown in fig. 3, the heaviest weight of immature testis was 3.3 kg. but most immature testes were under 2.3 kg. The mature testes were found over 0.8 kg. There were 12 individuals of which one testis was mature but the other one was immature. In one case of them the weights of the right and left testis differed markedly: the two testes weighed 3.8 kg. and 1.0 kg. But in most of them the two testes weighed very close or slightly different.

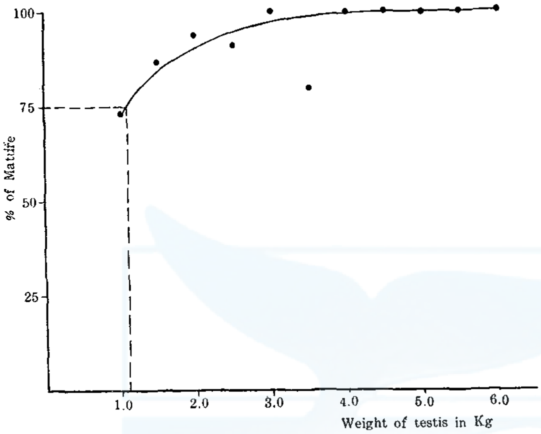

Fig. 4. The percentage of mature testes occurred for each 0.5 kg. testis-weight class.

Table 1. Number of mature and immature testis occurred for each 0.5 kg. testis-weight class

Weight of Testis	Number of testis examined			Percent of +
	Total	—	+	
1.0	26	7	19	73.1
1.5	54	7	47	87.0
2.0	43	3	40	93.0
2.5	21	2	19	90.5
3.0	10		10	100.0
3.5	5	1	4	80.0
4.0	10		10	100.0
4.5	4		4	100.0
5.0	1		1	100.0
5.5	1		1	100.0
6.0	13		13	100.0
6.5	8		8	100.0
7.0	5		5	100.0
7.5	4		4	100.0
8.0				
8.5	1		1	100.0
—	206	20	186	—

The result of histological determination of maturity was classified by 0.5 kg. testis weight classes (table 1). In fig. 4 is shown the percentage that mature testes occurred for each testis-weight. The graph indicates that 75 % of the testes are mature at the weight of 1.1 kg. Although it is not enough because we could not get the testes-weight class under 1.0 kg., we regard this figure as the average testis weight of the male sperm whale in the Aleutian waters at the attainment of sexual maturity.

Body length at sexual maturity

We determined those whose both testes were histologically immature as sexually immature individual. The result of determination of maturity by the individuals sampled was classified by 1 foot body length classes. (table 2). The percentage of mature individuals for each body length is shown in fig. 5. As the smallest percentage of maturity is 85 % (in 39 feet), we consider that almost individuals are sexually mature over the 38 feet (limited size for whaling).

Therefore if 75 % mature body length is regarded as the body length at sexual maturity, that will be under 38 feet. As stated above, these material were not collected at random from each body length of captured whales, and their testes weight were lighter on the average than the total whales caught excluded 38 and 39 feet. Therefore over 40 feet actually mature rate will be higher than the data.

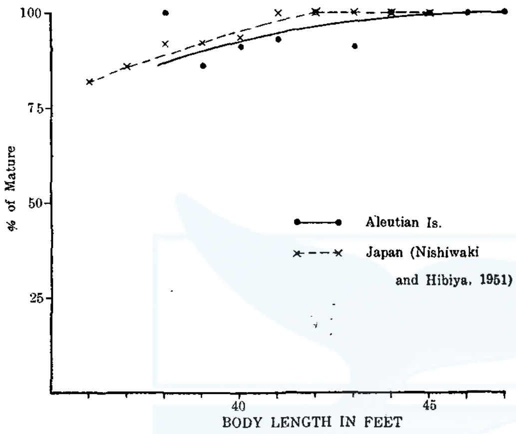

Fig. 5. The percentage of mature whales occurred for each body length class.

Table 2. Number of mature and immature whales occurred for each body length class.

Body Length	Number of whales examined			Percent of +
	Total	—	+	
38 feet	2		2	100.0
39	7	1	6	85.7
40	12	1	11	91.7
41	13	1	12	92.3
42	14		14	100.0
43	9		9	100.0
44	11	1	10	90.9
45	3		3	100.0
46	4		4	100.0
47	4		4	100.0
48	2		2	100.0
49	7		7	100.0
50	5		5	100.0
51	5		5	100.0
52	2		2	100.0
53	3		3	100.0
54	1		1	100.0
55				
56	2		2	100.0
—	106	4	102	—

Discussion

The body length of the male sperm whale at sexual maturity has been calculated by some reporters (table 3).

Table 3. The body length of the male sperm whale at sexual maturity, calculated by some reporters.

Body Length at sexual maturity	Locality	Reporter
37′9″∼41′0″	Antarctic water	Matthews (1937)
41′	〃	Nishiwaki (1955)
42′	South-east coast of Kamchatka	Matsuura and Maeda (1942)
under 38′ (35′∼37′)	Coast of Japan	Nishiwaki and Hibiya (1951, '52)
36′	Coast of British Columbia	Pike (1954)
35′	Coast of Kuril Is. and Kamchatka	Sleptsov 1955)

In the value of the whale found in the North Pacific, the result of Matsuura and Maeda (1942) is specially high, but that was based on observations with the naked eye; and the number of wnales observed, was not so large, so that their conclusion can hardly be difinite. The results of other reporters (Nishiwaki and Hibiya (1951, 1952), Pike (1954), Sleptsov (1955)) are almost the same.

However, they are not enough to determine the thorough body length at sexual maturity, because the limited size for whaling has been established to be 35 feet in coastal whaling and to be 38 feet in factory ship whaling.

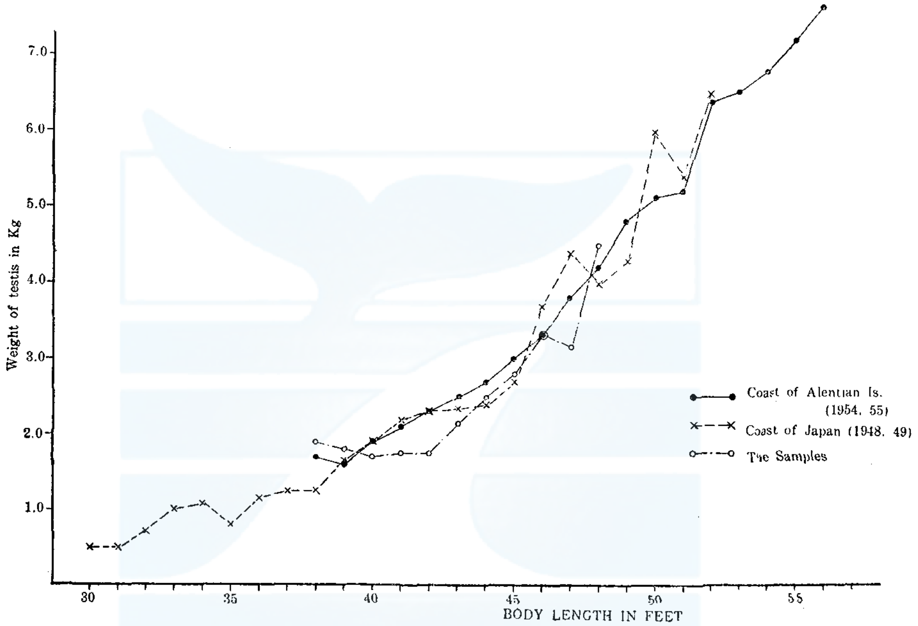

Fig. 6. Geometrical mean weight of heavier testis of the both testes and body length in sperm whales caught in adjacent water to Aleutian Islands and Japan.

Fig. 6 shows the relationship between body length of male sperm whale and the geometrical mean weight of heavier testis of the both testes. And fig. 5 shows the relationship between the body length and the sexual maturity by the histological examination of the testes. According to the two figures, we cannot find the difference between the school found in the waters of Aleutian Island and that found in the adjacent waters to Japan. It is dangerous to estimate the identity of the two stocks, but the body length of the male sperm whales at sexual maturity will be the same in various waters of the North Pacific.

Now, the school of the sperm whales in the adjacent waters to Japan is so-called "harem", on the other hand the school in the waters of Aleutian Island is composed of "lone bull". Judging from the sameness in the condition of testes of the two schools, the "lone bull" will be not sexually impotent and they are not always composed of old whales.

The body length of which testis is 1 kg. (75 % of sexual maturity) is estimated to be 35 feet as shown in fig. 6. Therefore the body length at sexual maturity may be the same. However, for the sexual maturity of the male sperm whales, microscopic observations are absolutely necessary. And in our examination the variation of immature testes weight is considerably wide, so it is dangerous to separate mature and immature whales by means of only the weight of their testes.

The body length of the male sperm whale at sexual maturity found in the Antarctic waters is over 38 feet (Matthews (1937), Nishiwaki (1955)). And the 75 % mature testis is 1.5 kg. in weight (Nishiwaki (1955)), these values differ from that of the North Pacific, but according to our data in the curves of mean testes weight of north and south hemispheres we cannot find the difference. On this subject we will investigate further.

Mackintosh & Wheeler (1929) and Chittlebolough (1955) stated that there was seasonal variation in testes of blue, fin and humpback whales. Our investigation had been taken place during the month of May to September. But we found individuals which have dense spermatozoa in seminiferous tubules in their testes and there are some one which has very dilute spermatozoa in seminiferous tubules. Furthermore we havn not taken the samples of other seasons. So we cannot discuss the seasonal variation of sexual activity in male sperm whales.

Conclusion

The school of sperm whales taken in the coast of Aleutian Islands consist of lone bulls. And by the investigation of testes sampled from the school, it is estimated that the testis becomes mature at the average weight of 1.1 kg., and almost individuals over 38 feet in body length attain sexual maturity. It is not clear that from where the school migrates, but when we compare the school with that found in the waters to Japan, there is no difference in the two.

The above mentioned body length is smaller than the body length at which the male sperm whales in the Antarctic waters attain sexual maturity. On this subject, further studies will be necessary.

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On the Body Proportions of the Sperm Whales (Physeter catodon)

By

KAZUO FUJINO

Proportions of the various parts of body were examined on the sperm whales taken from the Antarctic, Bonin Islands and the Adjacent waters of Japan in the last several years basing upon the series of measurements used in the Discovery Investigations (1938).

According to Matthews (1938), Matsuura and Maeda (1942), Omura (1954) and Nishiwaki and Hibiya (1951 and 1952), any racial differences have not been pointed out in the external characters and the body length at which sexual maturity is attained between the sperm whales from the Antarctic and those from the Adjacent waters of Japan. After comparing the data obtained by the present investigation and the results of Matthews and Matsuura-Maeda, any differences by areas were not observed in the body proportions.

The author is much indebted to Messrs. Keijiro Maeda, Haruyuki Sakiura, Setsuo Nishimoto and Katsunari Ozaki of the Japanese Government Whaling Inspectors who helped the author immensely in the field work and to the staffs of the whaling companies who cooperated in the present investigation. The author's sincere thanks are also due to Dr. Hideo Omura who directed this investigation.

Materials which were examined are shown in table I. As those on females are not taken in the Antarctic, the data in the report of Matthews (1938) concerning the females of southern hemisphere are used for comparison to those from other areas.

Table I Number of whales examined in each area

Area	Male	Female	Total
Antarctic	50	0	50
Bonin Is.	34	2	36
Adj. w. of Japan	68	30	98
Total	152	32	184

Size distributions of the sperm whales examined are fairly different each other according to area as shown in table II. In males, those from the Antarctic are the biggest, those from Bonin Islands moderate and those from the Adjacent waters of Japan the smallest.

In females those from Bonin Islands are about 10–11 metres and those from the waters adjacent to Japan between 10–11 and 11–12 metres.

Table II Size distribution of the sperm whales examined

Body length in metres	Antarctic		Bonin Is.		Adjacent waters of Japan	
	Male	Female	Male	Female	Male	Female
10–11	0	0	1	2	8	17
11–12	0	0	6	0	16	13
12–13	0	0	9	0	15	0
13–14	9	0	4	0	12	0
14–15	17	0	5	0	5	0
15–16	17	0	8	0	9	0
16–17	7	0	1	0	3	0
Total	50	0	34	2	68	30
Average length	14.94	—	13.50	10.50	12.93	10.93

As the numberings of the measurement of the various parts are retained for the sake of uniformity with the reports of Matthews except for nos. 23, 24 and 25, " Notch of flukes to posterior end of ventral grooves," applicable only to balaenopterid whales, was omitted. Nos. 23, 24 and 25 mean " Length of skull," " Length from tip to notch of tail flukes " and " Total spread of flukes, i.e., distance between both tips " respectively.

As the size distributions of whales examined in the various areas are, as already stated, different from each other and the proportions might vary with increasing of total length, data are compared in each metre of body length. Table III shows the average values and the standard deviations of the proportions.

Table III Mean values $\bar{x}$ and standard deviations σ of the proportions expressed as percentages of the body length

No. 2 Projection of snout beyond tip of lower jaw

Male										Female						
B.L. (m)	Antarctic			Bonin			Japanese coastal			B.L. (m)	Bonin			Japanese coastal		
	n*	$\bar{x}$	σ	n*	$\bar{x}$	σ	n*	$\bar{x}$	σ		n*	$\bar{x}$	σ	n*	$\bar{x}$	σ
10∼	0	—	—	1	7.20	0.00	7	5.15	0.92	10∼	2	3.85	0.25	10	3.45	0.51
11∼	0	—	—	6	6.05	0.75	13	5.22	1.00	11∼	0	—	—	11	3.44	0.57
12∼	0	—	—	8	7.11	1.06	15	6.00	0.93	12∼	0	—	—	0	—	—
13∼	9	6.08	1.12	3	6.46	1.25	9	6.08	0.95	13∼	0	—	—	0	—	—
14∼	17	6.77	1.11	5	8.40	0.87	4	7.30	0.52	14∼	0	—	—	0	—	—
15∼	16	7.05	1.03	8	8.61	0.79	9	7.08	0.75	15∼	0	—	—	0	—	—
16∼	7	7.21	0.93	1	8.50	0.00	2	7.30	0.50	16∼	0	—	—	0	—	—
To.	49			32			59			To.	2			21		

* n: number of whales examined

Table III (cont.)

No. 3 Tip of snout to blow-hole

	Male										Female					
B.L. (m)	Antarctic			Bonin			Japanese coastal			B.L. (m)	Bonin			Japanese coastal		
	n	x̄	σ	n	x̄	σ	n	x̄	σ		n	x̄	σ	n	x̄	σ
10～	0	—	—	1	4.20	0.00	7	3.80	0.38	10～	2	4.35	0.75	9	3.63	0.47
11～	0	—	—	6	3.80	0.71	13	3.68	0.66	11～	0	—	—	11	3.94	0.44
12～	0	—	—	9	3.91	0.94	15	3.44	0.15	12～	0	—	—	0	—	—
13～	3	3.63	0.24	3	4.13	0.85	9	4.13	0.24	13～	0	—	—	0	—	—
14～	16	4.37	0.75	4	4.05	0.56	5	3.80	1.10	14～	0	—	—	0	—	—
15～	16	4.20	0.71	7	4.51	0.65	9	4.36	0.80	15～	0	—	—	0	—	—
16～	7	3.73	0.68	1	4.80	0.00	2	4.00	0.00	16～	0	—	—	0	—	—
To.	42			31			60			To.	2			20		

No. 4 Tip of snout to angle of gape

	Male										Female					
B.L. (m)	Antarctic			Bonin			Japanese coastal			B.L. (m)	Bonin			Japanese coastal		
	n	x̄	σ	n	x̄	σ	n	x̄	σ		n	x̄	σ	n	x̄	σ
10～	0	—	—	1	18.80	0.00	8	19.50	2.12	10～	2	15.50	1.00	10	16.40	1.05
11～	0	—	—	5	20.10	0.80	13	20.35	1.03	11～	0	—	—	11	17.14	1.77
12～	0	—	—	9	22.94	1.50	14	21.36	1.36	12～	0	—	—	0	—	—
13～	9	23.61	1.42	4	23.50	2.24	9	22.50	1.49	13～	0	—	—	0	—	—
14～	17	25.27	1.99	5	25.50	2.10	4	23.50	1.23	14～	0	—	—	0	—	—
15～	16	24.50	1.37	8	26.50	1.23	8	24.37	0.78	15～	0	—	—	0	—	—
16～	7	25.21	1.03	1	26.20	0.00	2	25.50	0.00	16～	0	—	—	0	—	—
To.	49			33			58			To.	2			21		

No. 5 Tip of snout to centre of eye

	Male										Female					
B.L. (m)	Antarctic			Bonin			Japanese coastal			B.L. (m)	Bonin			Japanese coastal		
	n	x̄	σ	n	x̄	σ	n	x̄	σ		n	x̄	σ	n	x̄	σ
10～	0	—	—	1	23.20	0.00	8	23.24	1.69	10～	2	19.60	0.50	11	19.71	0.88
11～	0	—	—	6	23.24	1.56	14	23.37	1.18	11～	0	—	—	12	19.97	1.81
12～	0	—	—	9	26.30	1.89	15	24.87	1.79	12～	0	—	—	0	—	—
13～	9	27.25	1.12	4	26.80	2.24	10	25.20	1.22	13～	0	—	—	0	—	—
14～	17	28.24	1.52	5	29.30	1.85	5	25.80	0.95	14～	0	—	—	0	—	—
15～	17	28.21	1.28	8	29.23	1.09	9	27.25	1.32	15～	0	—	—	0	—	—
16～	7	28.51	1.59	1	28.80	0.00	2	28.05	0.50	16～	0	—	—	0	—	—
To.	50			34			63			To.	2			23		

Table III (cont.)

No. 6 Tip of snout to tip of flipper

B.L. (m)	Male									B.L. (m)	Female					
	Antarctic			Bonin			Japanese coastal				Bonin			Japanese coastal		
	n	x̄	σ	n	x̄	σ	n	x̄	σ		n	x̄	σ	n	x̄	σ
10~	0	—	—	1	39.40	0.00	8	40.05	0.97	10~	2	33.85	0.75	10	35.30	1.10
11~	0	—	—	6	41.05	1.32	14	39.95	1.76	11~	0	—	—	10	36.15	1.92
12~	0	—	—	9	42.96	1.44	14	41.48	1.81	12~	0	—	—	0	—	—
13~	9	43.86	1.17	4	45.25	2.09	10	42.65	1.90	13~	0	—	—	0	—	—
14~	16	44.73	1.58	5	44.50	1.13	5	44.10	1.44	14~	0	—	—	0	—	—
15~	17	45.00	1.55	8	45.55	1.61	9	44.08	0.90	15~	0	—	—	0	—	—
16~	6	45.38	1.82	1	44.80	0.00	2	43.80	1.50	16~	0	—	—	0	—	—
To.	48			34			62			To.	2			20		

No. 7 Centre of eye to centre of ear

B.L. (m)	Male									B.L. (m)	Female					
	Antarctic			Bonin			Japanese coastal				Bonin			Japanese coastal		
	n	x̄	σ	n	x̄	σ	n	x̄	σ		n	x̄	σ	n	x̄	σ
10~	0	—	—	1	3.00	0.00	1	3.10	0.00	10~	2	2.70	0.00	3	3.27	0.66
11~	0	—	—	5	3.44	0.51	3	3.73	0.41	11~	0	—	—	3	3.07	0.34
12~	0	—	—	8	3.35	0.40	1	3.30	0.00	12~	0	—	—	0	—	—
13~	3	3.27	0.09	3	3.10	0.00	0	—	—	13~	0	—	—	0	—	—
14~	13	3.17	0.23	4	3.05	0.26	2	3.10	0.30	14~	0	—	—	0	—	—
15~	11	3.15	0.27	7	3.04	0.32	3	3.53	0.19	15~	0	—	—	0	—	—
16~	6	3.27	0.25	0	—	—	0	—	—	16~	0	—	—	0	—	—
To.	33			28			10			To.	2			6		

No. 8 Notch of flukes to posterior emargination of dorsal fin

B.L. (m)	Male									B.L. (m)	Female					
	Antarctic			Bonin			Japanese coastal				Bonin			Japanese coastal		
	n	x̄	σ	n	x̄	σ	n	x̄	σ		n	x̄	σ	n	x̄	σ
10~	0	—	—	1	34.80	0.00	8	34.37	0.93	10~	2	35.50	1.00	11	36.05	1.83
11~	0	—	—	6	33.50	1.63	11	33.41	1.73	11~	0	—	—	11	35.59	2.61
12~	0	—	—	8	33.13	3.03	14	33.71	1.57	12~	0	—	—	0	—	—
13~	9	32.06	2.37	4	31.75	1.78	10	32.00	0.81	13~	0	—	—	0	—	—
14~	17	32.62	2.11	5	33.70	2.64	5	32.30	2.48	14~	0	—	—	0	—	—
15~	16	31.63	1.08	8	30.75	1.56	9	33.39	1.73	15~	0	—	—	0	—	—
16~	7	31.07	1.68	1	28.50	0.00	2	31.00	0.50	16~	0	—	—	0	—	—
To.	49			33			59			To.	2			22		

Table III (cont.)

No. 9 Width of flukes at insertion

B.L. (m)	Male									B.L. (m)	Female					
	Antarctic			Bonin			Japanese coastal				Bonin			Japanese coastal		
	n	x̄	σ	n	x̄	σ	n	x̄	σ		n	x̄	σ	n	x̄	σ
10～	0	—	—	1	8.20	0.00	8	7.37	0.25	10～	2	7.80	0.50	10	7.10	0.85
11～	0	—	—	6	7.05	0.48	14	7.25	0.42	11～	0	—	—	12	7.14	0.72
12～	0	—	—	9	7.25	0.28	15	7.17	0.60	12～	0	—	—	0	—	—
13～	0	—	—	3	7.80	0.71	11	7.09	0.60	13～	0	—	—	0	—	—
14～	0	—	—	5	7.30	0.55	5	6.60	0.97	14～	0	—	—	0	—	—
15～	0	—	—	7	7.08	0.37	8	7.18	1.17	15～	0	—	—	0	—	—
16～	0	—	—	1	8.80	0.00	2	6.70	0.00	16～	0	—	—	0	—	—
To.	0			32			63			To.	2			22		

No. 10 Notch of flukes to centre of anus

B.L. (m)	Male									B.L. (m)	Female					
	Antarctic			Bonin			Japanese coastal				Bonin			Japanese coastal		
	n	x̄	σ	n	x̄	σ	n	x̄	σ		n	x̄	σ	n	x̄	σ
10～	0	—	—	1	30.90	0.00	7	31.50	1.85	10～	2	34.00	0.75	10	32.20	2.69
11～	0	—	—	6	30.00	1.80	14	30.36	2.00	11～	0	—	—	10	31.40	1.14
12～	0	—	—	9	28.40	1.34	15	29.96	1.55	12～	0	—	—	0	—	—
13～	9	29.60	1.37	4	29.75	1.30	10	29.30	2.48	13～	0	—	—	0	—	—
14～	17	28.50	1.19	5	28.10	0.80	5	28.30	1.72	14～	0	—	—	0	—	—
15～	17	29.07	1.99	8	27.50	1.42	9	28.17	1.15	15～	0	—	—	0	—	—
16～	6	28.00	1.39	1	27.40	0.00	2	29.95	0.05	16～	0	—	—	0	—	—
To.	49			34			62			To.	2			20		

No. 11 Notch of flukes to umbilicus

B.L. (m)	Male									B.L. (m)	Female					
	Antarctic			Bonin			Japanese coastal				Bonin			Japanese coastal		
	n	x̄	σ	n	x̄	σ	n	x̄	σ		n	x̄	σ	n	x̄	σ
10～	0	—	—	1	50.30	0.00	8	50.12	2.00	10～	2	53.00	0.75	10	51.10	4.72
11～	0	—	—	6	48.67	1.57	14	49.53	2.19	11～	0	—	—	11	52.05	3.15
12～	0	—	—	9	46.39	1.85	15	50.03	1.78	12～	0	—	—	0	—	—
13～	9	47.72	1.47	4	47.75	1.64	10	49.10	2.58	13～	0	—	—	0	—	—
14～	16	46.50	1.50	5	46.30	0.98	4	48.75	2.38	14～	0	—	—	0	—	—
15～	17	46.32	1.33	8	43.88	2.12	9	46.61	0.99	15～	0	—	—	0	—	—
16～	7	45.21	1.28	1	45.20	0.00	2	47.00	0.50	16～	0	—	—	0	—	—
To.	49			34			62			To.	2			21		

Table III (cont.)

No. 13 Centre of anus to centre of reproductive aperture

B.L. (m)	Male									B.L. (m)	Female					
	Antarctic			Bonin			Japanese coastal				Bonin			Japanese coastal		
	n	x̄	σ	n	x̄	σ	n	x̄	σ		n	x̄	σ	n	x̄	σ
10～	0	—	—	1	10.30	0.00	7	11.07	1.76	10～	1	1.80	0.00	10	2.50	1.10
11～	0	—	—	6	10.33	1.09	13	11.58	1.07	11～	0	—	—	11	2.50	1.35
12～	0	—	—	8	10.63	1.27	14	11.79	1.22	12～	0	—	—	0	—	—
13～	9	11.39	0.74	4	9.25	1.64	10	11.60	1.30	13～	0	—	—	0	—	—
14～	17	11.09	1.33	5	9.90	0.80	1	12.50	0.00	14～	0	—	—	0	—	—
15～	17	10.85	3.15	8	8.50	2.12	9	11.06	1.17	15～	0	—	—	0	—	—
16～	7	10.64	0.83	1	10.90	0.00	2	10.00	0.50	16～	0	—	—	0	—	—
To.	50			33			56			To.	1			21		

No. 14 Vertical height of dorsal fin

B.L. (m)	Male									B.L. (m)	Female					
	Antarctic			Bonin			Japanese coastal				Bonin			Japanese coastal		
	n	x̄	σ	n	x̄	σ	n	x̄	σ		n	x̄	σ	n	x̄	σ
10～	0	—	—	1	1.90	0.00	7	1.94	0.35	10～	2	2.10	0.10	6	2.07	0.22
11～	0	—	—	6	1.83	0.18	13	2.09	0.43	11～	0	—	—	7	2.23	0.29
12～	0	—	—	7	1.89	0.18	12	1.82	0.49	12～	0	—	—	0	—	—
13～	3	2.07	0.25	4	2.25	0.67	10	2.04	0.50	13～	0	—	—	0	—	—
14～	6	1.97	0.27	5	2.08	0.32	5	2.48	1.00	14～	0	—	—	0	—	—
15～	9	2.04	0.42	8	2.12	0.42	7	2.17	0.31	15～	0	—	—	0	—	—
16～	5	2.04	0.21	1	2.50	0.00	2	3.10	1.30	16～	0	—	—	0	—	—
To.	23			32			56			To.	2			13		

No. 15 Base length of dorsal fin

B.L. (m)	Male									B.L. (m)	Female					
	Antarctic			Bonin			Japanese coastal				Bonin			Japanese coastal		
	n	x̄	σ	n	x̄	σ	n	x̄	σ		n	x̄	σ	n	x̄	σ
10～	0	—	—	1	9.20	0.00	8	8.75	1.39	10～	2	8.50	3.00	7	8.64	1.25
11～	0	—	—	6	9.00	1.39	13	9.19	1.81	11～	0	—	—	8	8.50	1.00
12～	0	—	—	8	8.00	1.23	12	8.67	1.87	12～	0	—	—	0	—	—
13～	4	9.25	1.64	4	8.50	1.23	10	9.60	1.92	13～	0	—	—	0	—	—
14～	8	8.75	1.72	7	9.60	2.04	5	7.90	1.62	14～	0	—	—	0	—	—
15～	12	8.92	1.11	8	7.88	1.11	9	7.83	1.83	15～	0	—	—	0	—	—
16～	5	8.90	1.02	1	9.30	0.00	2	9.00	0.50	16～	0	—	—	0	—	—
To.	29			35			59			To.	2			15		

Table III (cont.)

No. 16 Axilla to tip of flipper

	Male										Female					
B.L. (m)	Antarctic			Bonin			Japanese coastal			B.L. (m)	Bonin			Japanese coastal		
	n	$\bar{x}$	σ	n	$\bar{x}$	σ	n	$\bar{x}$	σ		n	$\bar{x}$	σ	n	$\bar{x}$	σ
10~	0	—	—	1	6.90	0.00	3	6.47	0.47	10~	2	6.80	0.50	3	6.63	0.47
11~	0	—	—	6	6.39	0.67	8	6.74	0.47	11~	0	—	—	3	6.97	0.47
12~	0	—	—	7	6.80	0.83	8	7.05	0.62	12~	0	—	—	0	—	—
13~	9	6.63	1.11	4	6.43	0.13	5	6.60	0.25	13~	0	—	—	0	—	—
14~	16	6.73	0.92	5	6.60	0.40	4	7.68	1.14	14~	0	—	—	0	—	—
15~	15	6.94	1.12	8	6.30	0.25	8	6.58	0.75	15~	0	—	—	0	—	—
16~	6	8.13	1.41	0	—	—	2	7.55	0.75	16~	0	—	—	0	—	—
To.	46			31			38			To.	2			6		

No. 17 Flipper, tip to anterior end of lower border

	Male										Female					
B.L. (m)	Antarctic			Bonin			Japanese coastal			B.L. (m)	Bonin			Japanese coastal		
	n	$\bar{x}$	σ	n	$\bar{x}$	σ	n	$\bar{x}$	σ		n	$\bar{x}$	σ	n	$\bar{x}$	σ
10~	0	—	—	1	9.90	0.00	3	8.45	0.23	10~	2	8.85	0.75	3	9.47	0.08
11~	0	—	—	6	8.97	0.75	9	9.36	0.60	11~	0	—	—	3	9.47	0.08
12~	0	—	—	7	9.23	0.68	8	9.36	0.77	12~	0	—	—	0	—	—
13~	9	9.52	0.35	4	9.05	0.56	5	9.40	0.49	13~	0	—	—	0	—	—
14~	17	9.30	1.02	5	9.00	0.51	4	10.30	1.97	14~	0	—	—	0	—	—
15~	17	8.89	0.81	8	8.49	0.43	8	9.37	0.96	15~	0	—	—	0	—	—
16~	6	8.71	1.95	0	—	—	2	10.05	1.25	16~	0	—	—	0	—	—
To.	49			31			39			To.	2			6		

No. 18 Length of flipper along curve of lower border

	Male										Female					
B.L. (m)	Antarctic			Bonin			Japanese coastal			B.L. (m)	Bonin			Japanese coastal		
	n	$\bar{x}$	σ	n	$\bar{x}$	σ	n	$\bar{x}$	σ		n	$\bar{x}$	σ	n	$\bar{x}$	σ
10~	0	—	—	1	10.70	0.00	0	—	—	10~	2	9.10	0.50	0	—	—
11~	0	—	—	5	9.20	0.86	0	—	—	11~	0	—	—	0	—	—
12~	0	—	—	3	9.46	0.63	0	—	—	12~	0	—	—	0	—	—
13~	3	9.97	0.63	3	9.13	0.47	0	—	—	13~	0	—	—	0	—	—
14~	6	9.63	0.24	4	9.17	0.55	0	—	—	14~	0	—	—	0	—	—
15~	9	9.36	0.69	7	8.75	0.44	0	—	—	15~	0	—	—	0	—	—
16~	4	8.67	0.96	0	—	—	0	—	—	16~	0	—	—	0	—	—
To.	22			23			0			To.	2			0		

Table III (cont.)

No. 19 Greatest width of flipper

B.L. (m)	Male									B.L. (m)	Female					
	Antarctic			Bonin			Japanese coastal				Bonin			Japanese coastal		
	n	$\bar{x}$	σ	n	$\bar{x}$	σ	n	$\bar{x}$	σ		n	$\bar{x}$	σ	n	$\bar{x}$	σ
10~	0	—	—	1	5.10	0.00	3	4.73	0.34	10~	2	4.60	0.20	3	4.67	0.03
11~	0	—	—	6	4.53	0.41	7	4.71	0.28	11~	0	—	—	3	4.73	0.25
12~	0	—	—	7	4.57	0.53	7	4.49	0.14	12~	0	—	—	0	—	—
13~	9	4.78	0.15	4	4.55	0.30	4	4.65	0.17	13~	0	—	—	0	—	—
14~	15	4.56	0.29	5	4.56	0.15	2	4.70	0.30	14~	0	—	—	0	—	—
15~	16	4.63	0.24	7	4.40	0.15	6	4.57	0.29	15~	0	—	—	0	—	—
16~	6	4.60	0.23	0	—	—	1	4.30	0.00	16~	0	—	—	0	—	—
To.	46			30			30			To.	2			6		

No. 20 Length of severed head, from condyle to tip

B.L. (m)	Male									B.L. (m)	Female					
	Antarctic			Bonin			Japanese coastal				Bonin			Japanese coastal		
	n	$\bar{x}$	σ	n	$\bar{x}$	σ	n	$\bar{x}$	σ		n	$\bar{x}$	σ	n	$\bar{x}$	σ
10~	0	—	—	1	30.40	0.00	7	29.95	1.25	10~	1	25.60	0.00	13	27.31	1.49
11~	0	—	—	6	30.22	1.31	12	31.22	1.15	11~	0	—	—	11	27.95	1.35
12~	0	—	—	8	32.16	1.90	13	32.03	1.40	12~	0	—	—	0	—	—
13~	3	35.30	0.41	4	32.93	2.25	10	32.40	1.22	13~	0	—	—	0	—	—
14~	5	35.80	1.23	5	34.80	0.95	4	33.30	0.79	14~	0	—	—	0	—	—
15~	9	35.08	1.78	8	36.24	0.99	3	35.30	0.71	15~	0	—	—	0	—	—
16~	4	37.17	1.82	1	38.90	0.00	2	35.55	1.75	16~	0	—	—	0	—	—
To.	21			33			51			To.	1			24		

No. 21 Greatest width of skull

B.L. (m)	Male									B.L. (m)	Female					
	Antarctic			Bonin			Japanese coastal				Bonin			Japanese coastal		
	n	$\bar{x}$	σ	n	$\bar{x}$	σ	n	$\bar{x}$	σ		n	$\bar{x}$	σ	n	$\bar{x}$	σ
10~	0	—	—	1	12.60	0.00	4	12.67	0.90	10~	2	11.35	0.25	13	12.38	0.68
11~	0	—	—	6	12.96	0.80	11	12.85	0.97	11~	0	—	—	7	12.87	0.57
12~	0	—	—	9	13.02	0.48	13	13.03	0.85	12~	0	—	—	0	—	—
13~	8	13.30	0.56	4	13.30	0.94	8	13.55	0.75	13~	0	—	—	0	—	—
14~	16	13.46	0.77	5	13.90	0.49	3	13.47	0.85	14~	0	—	—	0	—	—
15~	17	13.15	0.89	8	13.61	0.71	5	13.50	0.40	15~	0	—	—	0	—	—
16~	6	13.71	0.61	1	13.00	0.00	2	14.05	0.13	16~	0	—	—	0	—	—
To.	47			34			46			To.	2			20		

Table III (cont.)

No. 22 Length of skull, from condyle to tip

B.L. (m)	Male									B.L. (m)	Female					
	Antarctic			Bonin			Japanese coastal				Bonin			Japanese coastal		
	n	$\bar{x}$	σ	n	$\bar{x}$	σ	n	$\bar{x}$	σ		n	$\bar{x}$	σ	n	$\bar{x}$	σ
10~	0	—	—	1	26.20	0.00	5	27.10	1.47	10~	2	24.00	0.50	13	24.27	1.25
11~	0	—	—	6	26.17	0.89	11	27.50	1.71	11~	0	—	—	8	25.37	0.93
12~	0	—	—	9	27.61	1.73	13	27.42	1.86	12~	0	—	—	0	—	—
13~	9	29.06	1.50	4	27.25	1.48	9	27.61	1.60	13~	0	—	—	0	—	—
14~	16	29.81	1.83	5	28.30	1.47	5	29.00	1.53	14~	0	—	—	0	—	—
15~	17	30.38	1.53	8	30.50	1.60	6	30.00	0.96	15~	0	—	—	0	—	—
16~	7	30.79	1.03	1	30.40	0.00	3	30.17	0.47	16~	0	—	—	0	—	—
To.	49			34			52			To.	2			21		

No. 23 Height of skull

B.L. (m)	Male									B.L. (m)	Female					
	Antarctic			Bonin			Japanese coastal				Bonin			Japanese coastal		
	n	$\bar{x}$	σ	n	$\bar{x}$	σ	n	$\bar{x}$	σ		n	$\bar{x}$	σ	n	$\bar{x}$	σ
10~	0	—	—	1	10.20	0.00	2	9.55	0.25	10~	2	9.35	0.25	11	9.52	0.40
11~	0	—	—	4	10.17	0.42	7	10.23	0.53	11~	0	—	—	7	9.80	0.54
12~	0	—	—	9	10.63	0.85	10	10.25	0.11	12~	0	—	—	0	—	—
13~	9	9.74	0.65	3	10.47	0.24	9	10.19	0.94	13~	0	—	—	0	—	—
14~	14	9.45	0.40	5	10.00	0.51	2	10.30	1.00	14~	0	—	—	0	—	—
15~	15	9.73	0.51	7	11.08	0.82	3	10.43	0.48	15~	0	—	—	0	—	—
16~	7	9.23	0.63	1	10.90	0.00	2	10.80	0.50	16~	0	—	—	0	—	—
To.	45			30			35			To.	2			18		

No. 24 Tail flukes, tip to notch

B.L. (m)	Male									B.L. (m)	Female					
	Antarctic			Bonin			Japanese coastal				Bonin			Japanese coastal		
	n	$\bar{x}$	σ	n	$\bar{x}$	σ	n	$\bar{x}$	σ		n	$\bar{x}$	σ	n	$\bar{x}$	σ
10~	0	—	—	1	14.60	0.00	8	14.17	0.82	10~	2	13.60	0.00	10	13.85	0.99
11~	0	—	—	6	13.21	0.57	13	14.14	1.28	11~	0	—	—	11	14.07	0.89
12~	0	—	—	9	14.08	0.86	14	13.84	0.98	12~	0	—	—	0	—	—
13~	3	13.46	1.18	4	14.43	0.22	10	13.85	1.24	13~	0	—	—	0	—	—
14~	8	13.67	1.09	5	12.80	1.55	4	13.05	1.15	14~	0	—	—	0	—	—
15~	6	13.13	0.38	6	13.88	1.10	8	13.49	1.52	15~	0	—	—	0	—	—
16~	4	12.93	0.22	1	14.20	0.00	2	13.05	0.75	16~	0	—	—	0	—	—
To.	21			32			59			To.	2			21		

Table III (cont.)

No. 25 Tail flukes, total spread

B.L. (m)	Male									B.L. (m)	Female					
	Antarctic			Bonin			Japanese coastal				Bonin			Japanese coastal		
	n	x̄	σ	n	x̄	σ	n	x̄	σ		n	x̄	σ	n	x̄	σ
10~	0	—	—	1	27.70	0.00	0	—	—	10~	2	27.75	0.25	0	—	—
11~	0	—	—	4	28.75	1.30	0	—	—	11~	0	—	—	0	—	—
12~	0	—	—	5	27.30	1.72	0	—	—	12~	0	—	—	0	—	—
13~	3	26.50	2.11	4	29.00	0.87	0	—	—	13~	0	—	—	0	—	—
14~	2	26.50	1.00	4	24.25	2.86	0	—	—	14~	0	—	—	0	—	—
15~	6	23.83	1.08	3	26.50	0.82	0	—	—	15~	0	—	—	0	—	—
16~	3	26.50	0.82	0	—	—	0	—	—	16~	0	—	—	0	—	—
To.	14			21			0			To.	2			0		

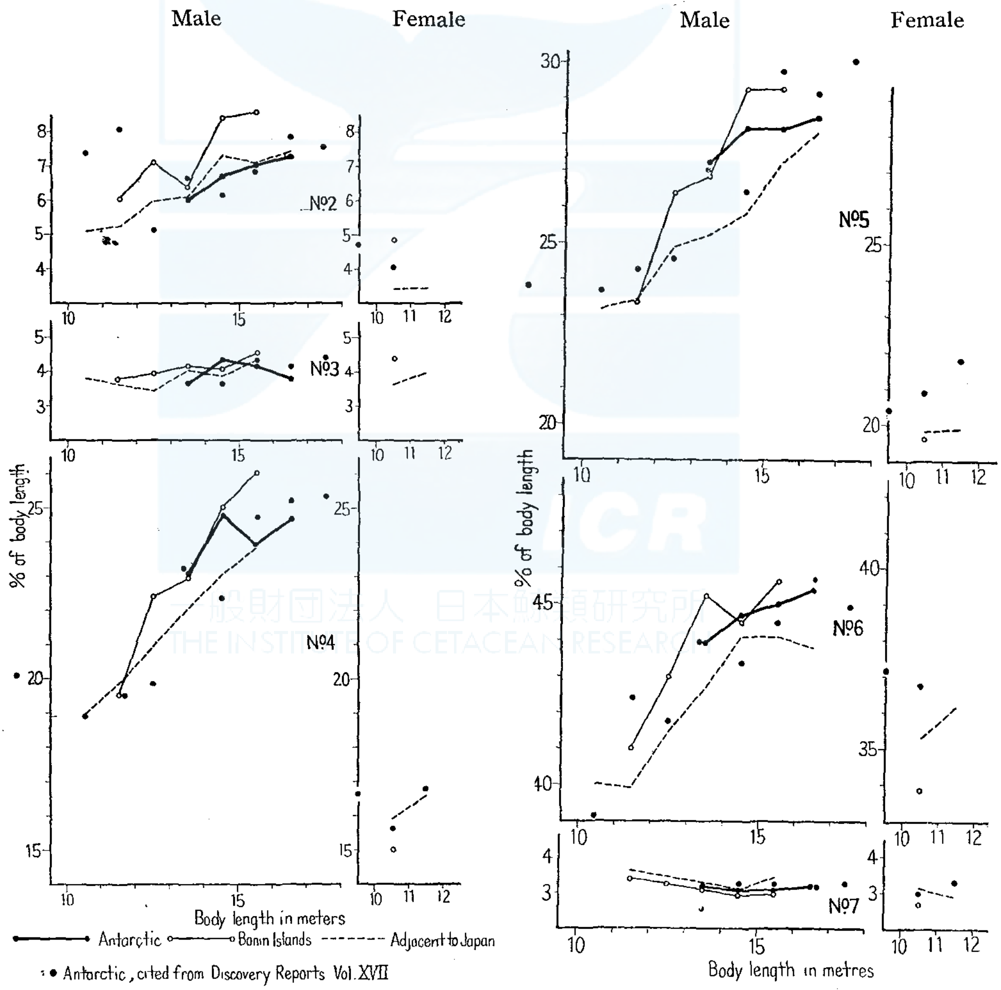


Fig. 1 Comparison of the body proportions between the Antarctic, Bonin Islands and Japanese coastal Sperm whales

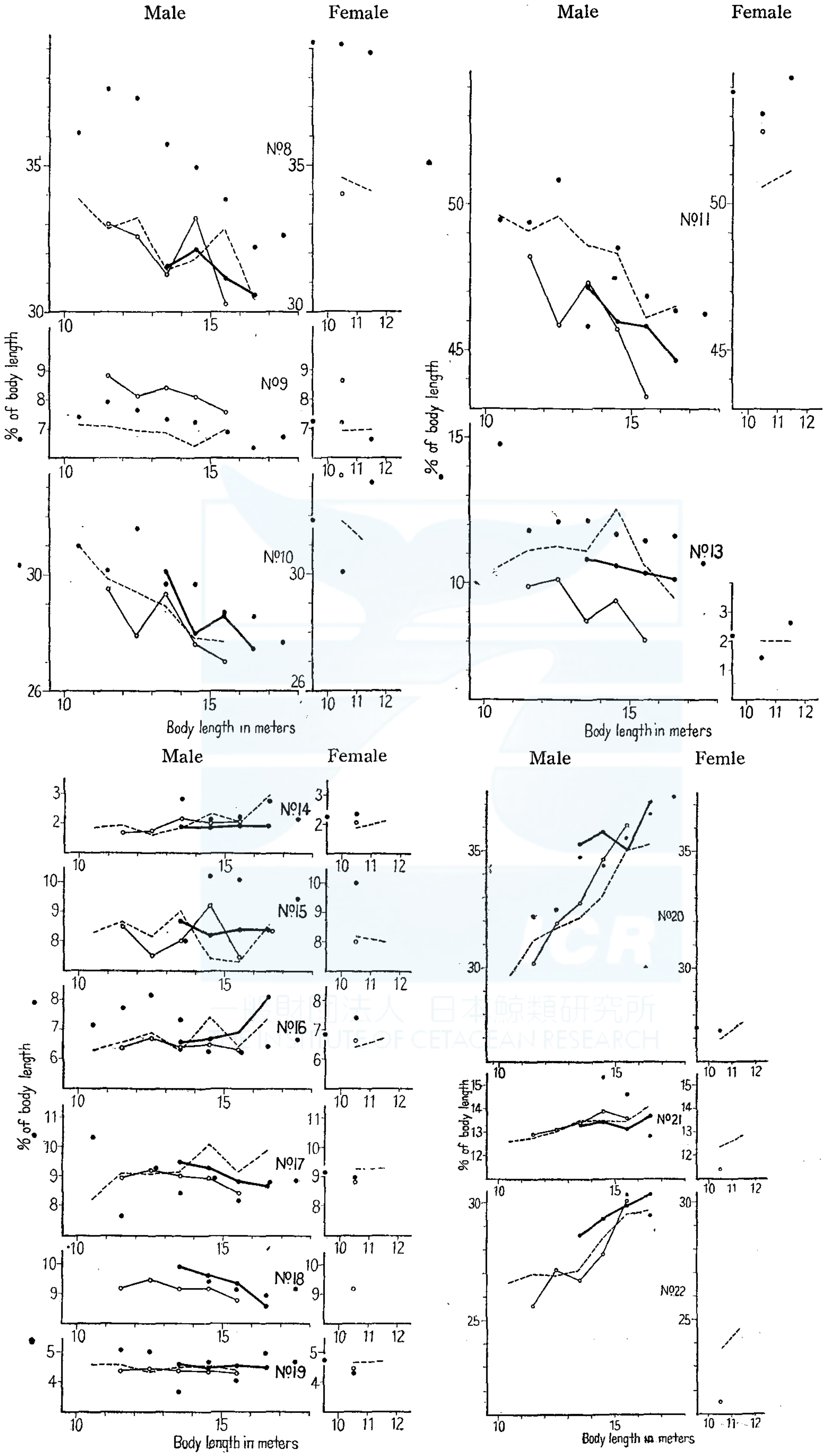
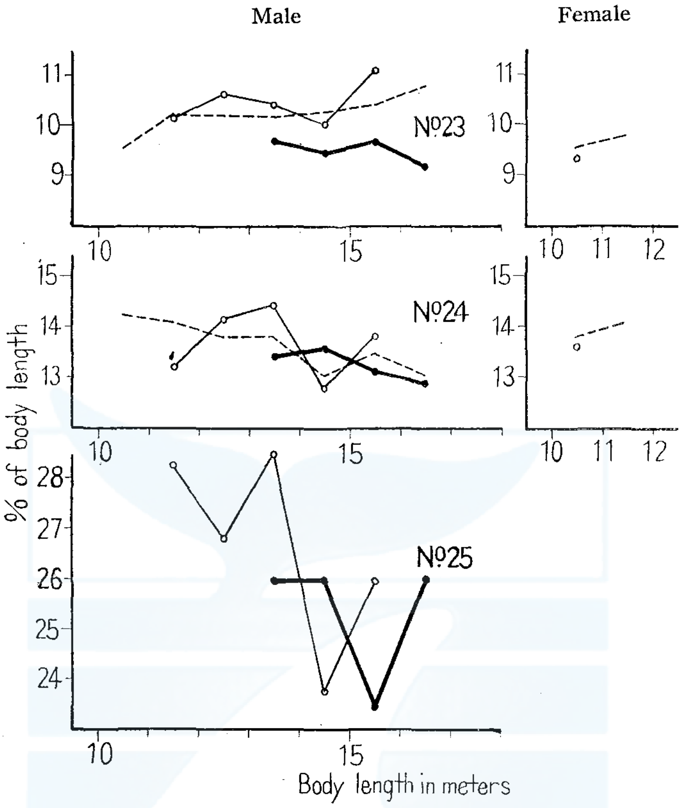

Male
Female
Male
Female
35
30
10
15
No8
35
30
10
11
12
9
8
7
No9
10
15
10
11
12
30
26
No10
30
26
10
15
Body length in meters
% of body length
50
45
No11
50
45
10
15
10
11
12
15
10
No13
3
2
1
10
15
Body length in meters
10
11
12
% of body length
Male
Female
Male
Femle
3
2
No14
10
9
8
No15
8
7
6
No16
11
10
9
8
No17
10
9
No18
5
4
No19
10
15
Body length in meters
10
11
12
% of body length
35
30
No20
15
14
13
12
No21
30
25
No22
10
15
Body length in meters
10
11
12

Fig. 1 (cont.)

Fig. 1. (cont.)



Comparisons according to area are shown in fig. 1. From this figure, no significant difference is noted in any items both in males and females except for no. 8, "Notch of flukes to posterior emargination of dorsal fin." This difference in no. 8, is deemed to be attributed to the obscurity in definition of this measurement and not to be available for comparison.

As regards the differences in males and females, Matthews states, "The curve for the females is above that for the males in the measurement nos. 7, 8, 10 and 11, indicating that for these measurements the values in the female are relatively greater than in the male. In the curves for the measurements, nos. 4, 5, 6 and 20, relating to the head and anterior end of the body, those of the females are below those of the males, indicating that for these measurements the values for the female are comparatively smaller than those from the males. Similarly the curves show that the values for measurements nos. 9, width of flukes at insertion and 13, the genito-anal distance, are comparatively smaller in females than males."

Sexual differences in this study are seen in the following items.

In nos. 2, "Projection of snout beyond tip of lower jaw," 4, "Tip of snout to angle of gape," 5, "Tip of snout to centre of eye," 6, "Tip of snout to tip of flipper," 13, "Centre of anus to centre of reproductive aperture," 20, "Length of severed head, from condyle to tip" and 22, "Length of skull, from condyle to tip of premaxilla," males are bigger than females, but in nos. 8, "Notch of flukes to posterior emargination of dorsal fin," 10, "Notch of flukes to centre of anus" and 11, "Notch of flukes to umbilicus" males smaller. That is to say, males have bigger head part and smaller caudal region than in females. Projection of snout developed more remarkably in males, and the position of the reproductive aperture also shows sexual difference as in balaenopterid whales. As regards the dorsal fin, it is noted to situate more anteriorly in females. These are consistent with the Matthews opinion, however, in measurement nos. 7, "Centre of eye to centre of ear," and 9, "Width of flukes at insertion" the differences in sex have not been concluded in our study up to now.

In other points, i.e. nos. 14, "Vertical height of dorsal fin," 15, "Base length of dorsal fin," 16, "Axilla to tip of flipper," 17, "Flipper, tip to anterior end of lower border," 18, "Length of flipper along curve of lower border," 19, "Greatest width of flipper," 21, "Greatest width of skull," 23, "Height of skull" and 24, "Tail flukes, tip

Table IV Correlation between body length and the dimensions of various parts of body

a. Males

No. 2 Projection of snout beyond tip of lower jaw

x y	10～	11～	12～	13～	14～	15～	16～	To.
3.1～	1	1						2
3.6～								
4.1～		2		2	1	1		6
4.6～	2	2	3	3				10
5.1～	1	7	4	5	1			18
5.6～	2	3	3	2	3	1	1	15
6.1～	1		2	2	4	5	1	15
6.6～		2	3	1		5	2	13
7.1～	1	2	6	4	6	7	1	27
7.6～				1	5	4	2	12
8.1～			1	1	4	5	3	14
8.6～			1			2		3
9.1～					1	2		3
9.6～					1	1		2
Total	8	19	23	21	26	33	10	140

Remarks x: body length in metres
y: % of various parts against body length

No 3 Tip of snout to blow-hole

x y	10～	11～	12～	13～	14～	15～	16～	To.
1.6～					1			1
2.1～		1	1				1	3
2.6～		2	4			1		7
3.1～	2	4	8	2	4	4	1	25
3.6～	3	6	5	6	6	8	4	38
4.1～	3	5	3	6	4	6	3	30
4.6～			2		7	7	1	17
5.1～		1	1	1	2	5		10
5.6～					1	1		2
Total	8	19	24	15	25	32	10	133

Table IV (cont.)

a. Males

No. 4 Tip of snout to angle of gape

y \ x	10~	11~	12~	13~	14~	15~	16~	To.
14.0~	1							1
15.0~								
16.0~								
17.0~								
18.0~	2	1	1					4
19.0~	2	8		1	1			12
20.0~	2	3	5	2	1			13
21.0~	2	6	9	2	1	1		21
22.0~			1	5	1	2		9
23.0~			4	5	6	4	1	20
24.0~			2	5	6	10	2	25
25.0~			1		7	8	4	20
26.0~				2	1	4	3	10
27.0~					1	2		3
28.0~						1		1
29.0~					1			1
Total	9	18	23	22	26	32	10	140

No. 5 Tip of snout to centre of eye

y \ x	10~	11~	12~	13~	14~	15~	16~	To.
19.0~	1							1
20.0~	1							1
21.0~	1	4	1					6
22.0~	1	6	1					8
23.0~	4	3	4	3				14
24.0~	1	4	6	4	2	1		18
25.0~		3	4	3	1	1	1	13
26.0~			2	7	6	5	1	21
27.0~			3	2	6	4	1	16
28.0~			2	2	5	16	4	29
29.0~			1	2	3	4	2	12
30.0~					2	2	1	5
31.0~					1	1		2
32.0~					1			1
Total	9	20	24	23	27	34	10	147

No. 6 Tip of snout to tip of flipper

y \ x	10~	11~	12~	13~	14~	15~	16~	To.
36.0~		1						1
37.0~		2						2
38.0~	1	1	2					4
39.0~	3	4	2					9
40.0~	3	5	3	3				14
41.0~	2	4	4	3	2	3	1	19
42.0~		3	6	4	2	1	1	17
43.0~			2	3	5	7		17
44.0~			3	3	6	5	2	19
45.0~			1	6	6	8	2	23
46.0~				1	5	7	2	15
47.0~						3	1	4
Total	9	20	23	23	26	34	9	144

No. 7 Centre of eye to centre of ear

y \ x	10~	11~	12~	13~	14~	15~	16~	To.
2.5~		1				2		3
2.7~			1		5	3	1	10
2.9~	1		1		3	4		9
3.1~	1	1	2	5	5	1	2	17
3.3~		2	3	1	5	10	2	23
3.5~		1	1		1		1	4
3.7~		1				1		2
3.9~								
4.1~		2	1					3
Total	2	8	9	6	19	21	6	71

No. 8 Notch of flukes to posterior emargination of dorsal fin

y \ x	10~	11~	12~	13~	14~	15~	16~	To.
27.0~				1	1	1		3
28.0~						2	2	4
29.0~				2		2		4
30.0~			1	2	4	5	4	16
31.0~		4	6	7	7	15	3	42
32.0~			4	5	5	4		18
33.0~	4	6	3	2	4	2		21
34.0~	2	3	3	4	1	2	1	16
35.0~	3	3	3		1			10
36.0~			1		3			4
37.0~		1						1
38.0~					1			1
39.0~								
40.0~			1					1
Total	9	17	22	23	27	33	10	141

No. 9 Width of flukes at insertion

y \ x	10~	11~	12~	13~	14~	15~	16~	To.
4.1~						1		1
4.6~								
5.1~					1			1
5.6~			1	1	2			4
6.1~	2	3	2	1		1	2	11
6.5~		6	8	7	2	3		26
7.1~	4	9	10	2	3	9		37
7.6~	2	2	2		1			7
8.1~	1		1	3	1			6
8.6~						1	1	2
Total	9	20	24	14	10	15	3	95

Table IV (cont.)

a. Males

No. 10 Notch of flukes to centre of anus

x y	10~	11~	12~	13~	14~	15~	16~	To.
25.0~					2	2	1	5
26.0~		1		1	1	4		7
27.0~		2	4	4	6	7	3	26
28.0~		2	2	5	9	12	1	31
29.0~	1	5	9	6	7	5	4	37
30.0~	3	1	5	3	2	3		17
31.0~	2	6	2	2		1		13
32.0~	1	2	1	1				5
33.0~			1					1
34.0~		1						1
35.0~	1			1				2
Total	8	20	24	23	27	34	9	145

No. 11 Notch of flukes to umbilicus

x y	10~	11~	12~	13~	14~	15~	16~	To.
40.0~						1		1
41.0~						1		1
42.0~					1	1	1	3
43.0~			2			2		4
44.0~				1	2	3	1	7
45.0~	1		1	2	4	7	4	19
46.0~		1	3	3	7	11	3	28
47.0~		4	3	5	7	5	1	25
48.0~		3	3	5	2	3		16
49.0~	2	3	5	3				13
50.0~	3	3	3	1	1			11
51.0~	2	2	2	1	1			8
52.0~	1	2	1	1				5
53.0~		1	1	1				3
54.0~		1						1
Total	9	20	24	23	25	34	10	145

No. 13 Centre of anus to centre of reproductive aperture

x y	10~	11~	12~	13~	14~	15~	16~	To.
6.0~				1		2		3
7.0~	1				1	2		4
8.0~			2		1	4		7
9.0~		3	2	2	3	2	3	15
10.0~	3	7	3	7	7	11	4	42
11.0~	2	4	6	8	5	8	3	36
12.0~	1	3	8	4	6	4		26
13.0~	1	2	1			1		5
14.0~				1				1
Total	8	19	22	23	23	34	10	139

No. 14 Vertical height of dorsal fin

x y	10~	11~	12~	13~	14~	15~	16~	To.
1.1~			3	1				4
1.3~	1	2	1					4
1.5~		3	2	1	4	4	1	15
1.7~	3	5	4	5	4	4	1	26
1.9~	2	2	5	4	1	5	1	20
2.1~	1	2	2	2	2	5	3	17
2.3~		1	1	2	3	2		9
2.5~	1	4				2	1	8
2.7~			1					1
2.9~						2		2
3.1~				1				1
3.3~				1				1
3.5~					1			1
3.7~					1			1
3.9~								
4.1~								
4.3~							1	1
Total	8	19	19	17	16	24	8	111

No. 15 Base length of dorsal fin

x y	10~	11~	12~	13~	14~	15~	16~	To.
5.0~			2		3	2		7
6.0~	1	2	2	3	1	3		12
7.0~	1	3	2	2	3	8	1	20
8.0~	3	5	10	2	5	6	3	34
9.0~	3	3	1	4	3	8	3	25
10.0~		4		4	1		1	10
11.0~	1		3	2	4	2		12
12.0~		2		1				3
Total	9	19	20	18	20	29	8	123

No. 16 Axilla to tip of flipper

x y	10~	11~	12~	13~	14~	15~	16~	To.
4.6~				1	1			2
5.1~			1		1	1		3
5.6~	1	3		1	2	4		11
6.1~		5	4	7	5	14	1	36
6.6~	3	1	3	8	7	6	2	30
7.1~		5	4		4	2	1	16
7.6~			2		2	1		5
8.1~			1		1	1	1	4
8.6~					2	1	1	4
9.1~				1				1
9.6~						1	2	3
Total	4	14	15	18	25	31	8	115

Table IV (cont.)

a. Males

No. 17 Flipper, tip to anterior end of lower border

y ╲ x	10~	11~	12~	13~	14~	15~	16~	To.
6.6~						1	2	3
7.1~					3	2	1	6
7.6~		1				2		3
8.1~	2	3	2	1	1	6		15
8.6~	1	1	5	2	5	12	1	27
9.1~		6	3	10	8	7		34
9.6~	1	2	2	3	4	1	2	15
10.1~		2	2	2	2	1		9
10.6~			1			1		2
11.1~							1	1
11.6~					2		1	3
12.1~					1			1
Total	4	15	15	18	26	33	8	119

No. 18 Length of flipper, along curve of lower border

y ╲ x	10~	11~	12~	13~	14~	15~	16~	To.
7.6~		1					1	2
8.1~					1	2	2	5
8.6~		1	1	2		6		10
9.1~		1	1	1	4	4		11
9.6~		1		2	5	3		11
10.1~		1	1				1	3
10 6~	1			1		1		3
Total	1	5	3	6	10	16	4	45

No. 19 Greatest width of flipper

y ╲ x	10~	11~	12~	13~	14~	15~	16~	To.
3.3~			1					1
3.5~								
3.7~		1						1
3.9~						1		1
4.1~		2	1	1	4	3	1	12
4.3~	1		3	2	6	8	2	22
4.5~	1	4	5	5	4	10	2	31
4.7~		2	3	6	5	3	1	20
4.9~		4		3	3	4	1	15
5.1~	2		1					3
Total	4	13	14	17	22	29	7	106

No. 20 Length of severed head, from condyle to tip

y ╲ x	10~	11~	12~	13~	14~	15~	16~	To.
27.0~		1						1
28.0~	2		1					3
29.0~	3	5	3	1				12
30.0~	1	1	2	1				5
31.0~	1	9	7	5				22
32.0~	1	1	4	1	2	1		10
33.0~		1	2	3	2	2	1	11
34.0~			1	3	5	5	1	15
35.0~			1	3	3	3		10
36.0~					1	7		8
37.0~					1		3	4
38.0~						2	1	3
39.0~							1	1
Total	8	18	21	17	14	20	7	105

No 21. Greatest width of skull

y ╲ x	10~	11~	12~	13~	14~	15~	16~	To.
11.1~		1				1		2
11.6~	2	1	3	1		1		8
12.1~		4	3	1	1	3		12
12.6~	1	6	4	5	6	3	2	27
13.1~	1	2	6	4	8	11	2	34
13.6~	1	1	5	5	1	7	1	21
14.1~		1	1	3	6	1	4	16
14.6~				1	1	3		5
15.1~		1			1			2
Total	5	17	22	20	24	30	9	127

No 22. Length of skull, from condyle to tip

y ╲ x	10~	11~	12~	13~	14~	15~	16~	To.
24.0~	2	2	3					7
25.0~		3	3	3	1			10
26.0~	2	4	2	4	2			14
27.0~	1	5	3	3	1	2		15
28.0~			6	4	7	5		22
29.0~		2	4	5	6	5	3	25
30.0~		1	1	2	4	7	5	20
31.0~				1	3	9	2	15
32.0~	1				1	2	1	5
33.0~					1	1		2
Total	6	17	22	22	26	31	11	135

Table IV (cont.)

a. Males

No. 23 Height of skull

y \ x	10～	11～	12～	13～	14～	15～	16～	To.
8.1～				1			2	3
8.6～				2	2	1		5
9.1～	1	1	1	2	9	5	2	21
9.6～	1	3	4	5	6	6	3	28
10.1～	1	5	8	5	2	6	1	28
10.6～		1	3	4	1	4	1	14
11.1～		1	2	2	1	2	1	9
11.6～						1		1
12.1～			1					1
Total	3	11	19	21	21	25	10	110

No. 24 Tail flukes, tip to notch

y \ x	10～	11～	12～	13～	14～	15～	16～	To.
9.6～					1	1		2
10.1～		1						1
10.6～								0
11.1～				1				1
11.6～		1	1	1	1		1	5
12.1～		1	1		2		1	5
12.6～	1	4	1	1	3	5	1	16
13.1～	1		4	1	2	6	1	15
13.6～	2	3	7	3	5	2	2	24
14.1～		3	3	7		2	1	16
14.6～	4	2	3	2	2	3		16
15.1～	1	1	2					4
15.6～		2	1		1	1		5
16.1～				1				1
16.6～		1						1
Total	9	19	23	17	17	20	7	112

No. 25 Tail flukes, total spread

y \ x	10～	11～	12～	13～	14～	15～	16～	To.
20.0～					1			1
21.0～						1		1
22.0～					1			1
23.0～				1		2		3
24.0～			1			2		3
25.0～					1	2	1	4
26.0～			1		1	1	1	4
27.0～	1	2	1	1	2	1	1	9
28.0～			1	4				5
29.0～		1	1					2
30.0～		1		1				2
Total	1	4	5	7	6	9	3	35

b. Females

No. 2 Projection of snout beyond tip of lower jaw

y \ x	10～	11～	Total
2.6～	2	4	6
3.1～	5	2	7
3.6～	2	3	5
4.1～	3	2	5
Total	12	11	23

No. 3 Tip of snout to blow-hole

y \ x	10～	11～	Total
3.1～	5	2	7
3.6～	4	5	9
4.1～		3	3
4.6～	1	1	2
5.1～	1		1
Total	11	11	22

No. 4 Tip of snout to angle of gape

y \ x	10～	11～	Total
12.0～		1	1
13.0～			
14.0～	2		2
15.0～	2	1	3
16.0～	6	1	7
17.0～	1	5	6
18.0～	1	2	3
19.0～		1	1
Total	12	11	23

Table IV (cont.)

b. Females

No. 5 Tip of snout to centre of eye

x y	10~	11~	Totai
15.1~		1	1
15.6~			
16.1~			
16.6~			
17.1~			
17.6~			
18.1~	1	1	2
18.6~	1	1	2
19.1~	4		4
19.6~	3	3	6
20.1~	3	1	4
20.6~		1	1
21.1~		2	2
21.6~	1	1	2
22.1~		1	1
Total	13	12	25

No. 6 Tip of snout to tip of flipper

x y	10~	11~	Total
32.6~		1	1
33.1~			
33.6~	2		2
34.1~	2	1	3
34.6~	2	1	3
35.1~	3		3
35.6~	1	1	2
36.1~	1	2	3
36.6~			
37.1~		1	1
37.6~	1		1
38.1~		2	2
38.6~			
39.1~		1	1
Total	12	10	22

No. 7 Centre of eye to centre of ear

x y	10~	11~	Total
2.5~		1	1
2.7~	4		4
2.9~			
3.1~		1	1
3.3~		1	1
3.5~			
3.7~			
3.9~			
4.1~	1		1
Total	5	3	8

No. 8 Notch of flukes to posterior emargination of dorsal fin

x y	10~	11~	Total
31.0~		2	2
32.0~			
33.0~	2	1	3
34.0~	3	1	4
35.0~	2	2	4
36.0~	1	2	3
37.0~	3	1	4
38.0~	2		2
39.0~		2	2
Total	13	11	24

No. 9 Width of flukes at insertion

x y	10~	11~	Total
5.1~	1		1
5.6~			
6.1~		2	2
6.6~	4	5	9
7.1~	4	3	7
7.6~	1		1
8.1~	1	1	2
8.6~	1	1	2
Ttoal	12	12	24

No. 10 Notch of flukes to centre of anus

x y	10~	11~	Total
28.0~	2		2
29.0~	1	2	3
30.0~		1	1
31.0~	2	3	5
32.0~	2	4	6
33.0~	1		1
34.0~	1		1
35.0~	2		2
36.0~	1		1
Total	12	10	22

Table IV (cont.)

b. Females

No. 11 Notch of flukes to umbilicus

y \ x	10～	11～	Totrl
42.0～	1		1
43.0～	1	1	2
44.0～			
45.0～			
46.0～			
47.0～			
48.9～	1		1
49.0～		1	1
50.0～	1		1
51.0～	1	1	2
52.0～	3	3	6
53.0～		4	4
54.0～	1		1
55.0～	1		1
56.0～	2	1	3
Total	12	11	23

No. 13 Centre of anus to centre of reproductive aperture

y \ x	10～	11～	Total
0.0～		1	1
1.0～	4	4	8
2.0～	6	2	8
3.0～		3	3
4.0～			
5.0～	1	1	2
Totol	11	11	22

No. 14 Vertical height of dorsal fin

y \ x	10～	11～	Total
1.7～	2	1	3
1.9～	2	1	3
2.1～	3	3	6
2.3～	1	1	2
2.5～			
2.7～		1	1
Total	8	7	15

No. 15 Base length of dorsal fin

y \ x	10～	11～	Total
5.0～	1		1
6.0～	1		1
7.0～	1	3	4
8.0～	2	3	5
9.0～	2	1	3
10.0～	1	1	2
11.0～	1		1
Total	9	8	17

No. 16 Axilla to tip of flipper

y \ x	10～	11～	Total
6.1～	3	1	4
6.6～			
7.1～	2	2	4
Total	5	3	8

No. 17 Flipper, tip to anterior end of lower border

y \ x	10～	11～	Total
8.1～	1		1
8.6～			
9.1～	2	2	4
9.6～	2	1	3
Total	5	3	8

No. 18 Length of flipper along curve of lower border

y \ x	10～	Total
8.6～	1	1
9.1～		
9.6～	1	1
Total	2	2

Table IV (cont.)

b. Females

No. 19 Greatest width of flipper

x y	10～	11～	Total
4.3～	1	1	2
4.5～	2		2
4.7～	2	1	3
4.9～		1	1
Total	5	3	8

No. 20 Length of severed head, from condyle to tip

x y	10～	11～	Total
24.6～	2		2
25.1～			
25.6～	2	2	4
26.1～	1	1	2
26.6～	3	1	4
27.1～	2	1	3
27.6～	1		1
28.1～		2	2
28.6～	1	2	3
29.1～	1	1	2
29.6～	1	1	2
Total	14	11	25

No. 21 Greatest width of skull

x y	10～	11～	Total
11.1～	3		3
11.6～	3	1	4
12.1～	4	1	5
12.6～	2	1	3
13.1～	3	4	7
Total	15	7	22

No. 22 Length of skull, from condyle to tip

x y	10～	11～	Total
21.0～	1		1
22.0～	1		1
23.0～	4	1	5
24.0～	4	2	6
25.0～	5	3	8
26.0～		2	2
Total	15	8	23

No. 23 Height of skull

x y	10～	11～	Total
8.6～	2		2
9.1～	4	3	7
9.6～	6	2	8
10.1～	1	1	2
10.6～		1	1
Total	13	7	20

No. 24 Tail flukes, tip to notch

x y	10～	11～	Total
12.1～		1	1
12.6～	2		2
13.1～	2	1	3
13.6～	6	4	10
14.1～		3	3
14.6～	1		1
15.1～		1	1
15.6～		1	1
16.1～	1		1
Total	12	11	23

No. 25 Tail flukes, total spread

x y	10～	Total
25.0～		0
26.0～		0
27.0～	2	2
Total	2	2

to notch," no significant difference is noted. The variations of proportion with increasing total length are summarized from those on the Antarctic, Bonin Island and the Adjacent waters of Japan into table

IV. As already shown in table II, body lengths of whales examined range from 10 to 17 metres. It is not seen from table IV that in this range of body length the curves of proportion of the various parts show the complexity which is noted in the balaenopterid whales at about the body length at which physical maturity is attained (Fujino, 1954). Therefore, it is not able from these curves to assume the body length at which physical maturity is attained in males. In females, number of data is too scanty to discuss on this point. Regression lines are given on nos. 5, 6, 20 and 22 representing the head region and nos. 10 and 11 which represent the caudal part of the body by the formulae I to VI.

Formula I. No. 5: Tip of snout to centre of eye... $y=0.07x^{1.53}$
„ II. No. 6: Tip of snout to tip of flipper.................... $y=0.19x^{1.31}$
„ III. No. 20: Length of severed head, from condyle to tip of snout.. $y=0.11x^{1.43}$
„ IV. No. 22: Length of skull, from condyle to tip of premaxilla.. $y=0.12x^{1.34}$
„ V. No. 10: Notch of tail flukes to

Table V Standard length of various part of the sperm whale body

measurement number	Body length in metres						
	10.5	11.5	12.5	13.5	14.5	15.5	16.5
5	2.41 (23.0)	2.77 (24.1)	3.15 (25.2)	3.54 (26.2)	3.96 (27.3)	4.37 (28.2)	4.81 (29.2)
6	4.19 (39.9)	4.72 (41.0)	5.26 (42.1)	5.82 (43.1)	6.39 (44.1)	6.98 (45.0)	7.57 (45.9)
10	3.26 (31.0)	3.50 (30.4)	3.73 (29.8)	3.95 (29.3)	4.17 (28.8)	4.39 (28.3)	4.60 (27.9)
11	5.45 (51.9)	5.79 (50.3)	6.13 (49.0)	6.45 (47.8)	6.76 (46.6)	7.08 (45.7)	7.38 (44.7)
20	3.13 (29.8)	3.57 (31.0)	4.02 (32.2)	4.49 (33.3)	4.97 (34.3)	5.47 (35.3)	5.98 (36.2)
22	2.75 (26.2)	3.10 (27.0)	3.47 (27.8)	3.85 (28.5)	4.23 (29.2)	4.63 (29.9)	5.03 (30.5)

upper figures: length in metres.
lower figures: % of body length.

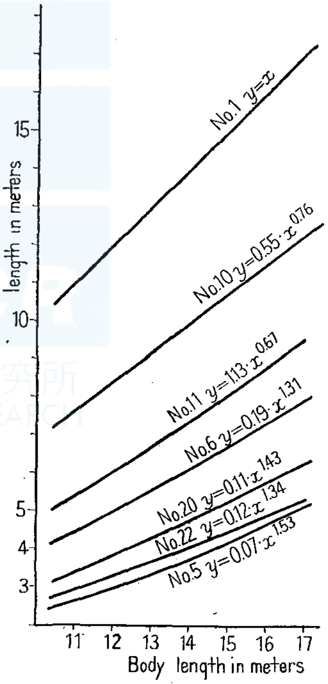


Fig. II Standard dimensions of various parts of body of the sperm whales centre of anus..............$y=0.55x^{0.76}$

„ VI. No. 11 : Notch of flukes to umbilicus..$y=1.13x^{0.67}$

Standard length of various parts calculated from these formulae are shown in Table V as the percentage against body length. These are drawn in Fig. II also.

Summary

1) As regards the body proportions of the sperm whales taken from the Antarctic, Bonin Islands and the Adjacent waters of Japan, no difference according to area is noted.

2) Differences in males and females are seen in the following points:

a) Males have bigger head and smaller caudal part than in females.

b) Males have more posteriorly situated dorsal fin than in females.

c) As regards nos. 2, "Projection of snout beyond tip of lower jaw" and 13, "Centre of anus to centre of reproductive aperture," males bigger than in females.

3) Standard length of various parts of body on male sperm whales may be given by the following equations.

No. 5 : Tip of snout to centre of eye...........$y=0.07x^{1.53}$

No. 6 : Tip of snout to tip of flipper...........$y=0.19x^{1.31}$

No. 10 : Notch of tail flukes to centre of anus...$y=0.55x^{0.76}$

No. 11 : Notch of flukes to umbilicus............$y=1.13x^{0.67}$

No. 20 : Length of severed head, from condyle to tip of snout.....................$y=0.11x^{1.43}$

No. 22 : Length of skull, from condyle to tip of premaxilla.........................$y=0.12x^{1.34}$

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Appendix

Measurement of Body Proportions of the Sperm Whales.
(upper figures: actual length in meters)
(lower figures: % against body length)

Measurement No. 1 Total length, from tip of snout to notch of tail flukes (upper figures in meters, lower figures in feet)
No. 2 Projection of snout bejond tip of lower jaw.
No. 3 Tip of snout to blow-hole.
No. 4 Tip of snout to angle of gape.
No. 5 Tip of snout to centre of eye.
No. 6 Tip of snout to tip of flipper.
No. 7 Centre of eye to center of ear.
No. 8 Notch of flukes to posterior emargination of dorsal fin.
No. 9 Width of flukes at insertion.
No. 10 Notch of flukes to centre of anus.
No. 11 Notch of flukes to umbilicus.
No. 13 Centre of anus to centre of reproductive aperture.
No. 14 Vertical height of dorsal fin.
No. 15 Base length of dorsal fin.
No. 16 Axilla to tip of flipper.
No. 17 Flipper, tip to anterior end of lower border.
No. 18 Length of flipper along curve of lower border.
No. 19 Greatest width of flipper.
No. 20 Length of severed head from condyle to tip.
No. 21 Greatest width of skull.
No. 22 Length of skull, from condyle to tip of premaxilla.
No. 23 Height of skull.
No. 24 Tail flukes, tip to notch.
No. 25 Tail flukes, total spread.

I. Antarctic, males, 1950.

Serial No.	Date, killed	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	22	23	24	25
H*	Dec. 5	13.05	0.76	—	2.75	3.40	5.50	—	4.35	—	4.25	6.50	1.45	—	—	0.84	1.24	—	0.62	—	1.80	3.60	1.30	—	—
155		**43**	**5.8**	—	**21.1**	**26.1**	**42.1**	—	**33.3**	—	**32.6**	**49.8**	**11.1**	—	—	**6.4**	**9.5**	—	**4.8**	—	**13.8**	**27.6**	**10.0**	—	—
H	Dec. 11	13.15	0.78	—	3.15	3.77	5.90	—	4.50	—	3.80	6.30	1.50	—	—	0.82	1.20	—	0.60	—	1.90	4.00	1.26	—	—
195		**43**	**5.9**	—	**24.0**	**28.7**	**44.9**	—	**34.2**	—	**28.9**	**47.9**	**11.4**	—	—	**6.2**	**9.1**	—	**4.6**	—	**14.4**	**30.4**	**9.6**	—	—
H	Dec. 11	13.20	0.56	—	2.90	3.45	5.65	—	4.50	—	3.90	6.45	1.50	—	—	0.83	1.25	—	0.64	—	1.70	4.10	1.40	—	—
192		**43**	**4.2**	—	**22.0**	**26.1**	**42.8**	—	**34.1**	—	**29.5**	**48.9**	**11.4**	—	—	**6.3**	**9.5**	—	**4.8**	—	**12.9**	**31.1**	**10.6**	—	—
H	Dec. 2	13.32	0.70	—	3.20	3.55	5.95	—	3.65	—	3.80	6.55	1.60	—	—	0.88	1.36	—	0.64	—	1.70	3.85	1.40	—	—
111		**44**	**5.3**	—	**24.0**	**26.7**	**44.7**	—	**27.4**	—	**28.5**	**49.2**	**12.0**	—	—	**6.6**	**10.2**	—	**4.8**	—	**12.8**	**28.9**	**10.5**	—	—
H	Dec. 5	13.40	0.98	—	3.12	3.90	6.10	—	4.00	—	3.70	6.00	1.45	—	—	0.91	1.29	—	0.61	—	1.80	3.80	1.30	—	—
152		**44**	**7.3**	—	**23.3**	**29.1**	**45.5**	—	**29.9**	—	**27.6**	**49.8**	**10.8**	—	—	**6.8**	**9.6**	—	**4.6**	—	**13.4**	**28.4**	**9.7**	—	—
N**	Dec. 10	13.80	1.00	0.50	3.29	3.65	5.98	0.43	4.30	1.00	4.22	6.53	1.44	0.25	1.40	1.28	1.32	1.47	0.62	4.78	1.75	3.89	1.23	1.66	3.17
103		**45**	**7.2**	**3.6**	**23.8**	**26.5**	**43.4**	**3.1**	**31.2**	**7.2**	**30.6**	**47.3**	**10.4**	**1.8**	**10.1**	**9.2**	**9.6**	**10.7**	**4.5**	**34.6**	**12.7**	**28.2**	**8.9**	**12.0**	**23.0**
H	Dec. 2	13.95	0.70	—	3.00	3.65	5.90	—	4.55	—	4.20	6.75	1.65	—	0.90	0.70	1.30	—	0.68	—	1.80	4.30	1.30	—	—
104		**46**	**5.0**	—	**21.5**	**26.2**	**42.3**	—	**32.6**	—	**30.1**	**48.0**	**11.8**	—	**6.5**	**5.0**	**9.3**	—	**4.9**	—	**12.9**	**30.8**	**9.3**	—	—
N	Dec. 12	13.95	1.11	0.46	3.67	3.95	6.33	0.46	4.75	1.13	4.11	6.63	1.69	0.34	1.25	0.97	1.29	1.30	0.66	4.95	—	3.70	1.42	1.97	3.79
119		**46**	**8.0**	**3.3**	**26.3**	**28.3**	**45.4**	**3.3**	**34.1**	**8.1**	**29.5**	**47.5**	**12.1**	**2.4**	**9.0**	**7.0**	**9.3**	**9.3**	**4.8**	**35.5**	—	**26.5**	**10.2**	**14.1**	**27.2**
N	Dec. 10	13.96	0.87	0.52	3.35	3.72	6.14	0.44	4.24	1.00	4.08	6.48	1.42	0.28	1.42	0.92	1.30	1.40	0.68	4.98	1.90	4.09	1.25	1.97	3.98
102		**46**	**6.2**	**3.7**	**24.0**	**26.6**	**44.0**	**3.1**	**30.4**	**7.2**	**29.2**	**46.3**	**10.2**	**2.0**	**10.2**	**6.6**	**9.3**	**10.0**	**4.9**	**35.7**	**13.6**	**29.3**	**9.0**	**14.1**	**28.5**
H	Nov. 24	14.00	1.00	0.55	3.80	4.15	6.40	—	4.50	—	4.00	6.40	1.30	—	—	1.00	1.30	—	0.60	5.30	1.85	4.45	1.45	—	—
21		**46**	**7.1**	**3.9**	**27.1**	**29.6**	**45.7**	—	**32.1**	—	**28.6**	**45.7**	**9.3**	—	—	**7.1**	**9.3**	—	**4.3**	**37.9**	**13.2**	**31.8**	**10.4**	—	—
N	Nov. 27	14.11	1.00	0.75	3.00	4.30	—	0.46	4.55	1.15	4.24	6.75	1.75	0.30	1.20	0.70	1.00	1.38	—	—	1.90	4.20	1.30	—	—
9		**46**	**7.1**	**5.3**	**20.3**	**30.5**	—	**3.3**	**32.2**	**8.2**	**30.0**	**47.8**	**12.4**	**2.1**	**8.5**	**4.9**	**7.1**	**9.8**	—	—	**13.5**	**29.8**	**9.2**	—	—
H	Dec. 17	14.15	1.00	0.50	3.40	3.80	6.25	0.45	5.15	—	4.20	6.70	1.65	—	—	0.98	1.48	—	0.68	—	1.85	4.00	1.35	—	—
204		**46**	**7.8**	**3.5**	**24.0**	**26.9**	**44.2**	**3.2**	**36.4**	—	**29.7**	**47.4**	**11.7**	—	—	**6.9**	**10.5**	—	**4.8**	—	**13.1**	**28.3**	**9.5**	—	—
N	Dec. 12	14.33	1.03	0.55	3.52	3.93	6.50	0.43	4.50	1.03	4.08	—	1.08	0.35	1.60	1.00	1.35	1.38	0.68	4.98	1.92	4.10	1.26	1.77	—
113		**47**	**7.2**	**3.8**	**24.5**	**27.4**	**45.3**	**3.0**	**31.4**	**7.2**	**28.5**	—	**7.5**	**2.4**	**11.2**	**7.0**	**9.4**	**9.6**	**4.7**	**34.7**	**13.4**	**28.6**	**8.8**	**12.3**	—
H	Dec. 19	14.35	1.20	0.48	3.35	3.80	6.20	0.40	5.30	1.15	3.75	6.40	1.60	—	—	1.00	1.42	—	0.67	—	1.85	3.75	1.30	1.95	—
208		**47**	**8.4**	**3.3**	**23.3**	**26.5**	**43.2**	**2.8**	**36.9**	**8.0**	**26.1**	**44.6**	**11.2**	—	—	**7.0**	**9.9**	—	**4.7**	—	**12.9**	**26.1**	**9.1**	**13.6**	—
H	Dec. 19	14.40	1.16	0.70	3.71	4.10	6.56	0.40	4.42	—	3.90	6.70	1.80	—	—	0.77	1.25	—	0.60	—	2.05	4.30	1.35	—	—
213		**47**	**8.1**	**4.9**	**25.8**	**28.5**	**45.6**	**2.8**	**30.7**	—	**27.1**	**46.5**	**12.5**	—	—	**5.3**	**8.7**	—	**4.2**	—	**14.2**	**29.9**	**9.4**	—	—

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* H: Hashidate-maru fleet ** N: Nisshiin-maru fleet

I. Antarctic, males, 1950 (cont.)

erial No.	Date, killed	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	22	23	24	25
H 203	Dec. 17	14.55 **48**	0.85 **5.8**	0.65 **4.5**	3.35 **23.0**	3.85 **26.5**	6.20 **42.6**	0.45 **3.1**	5.20 **35.7**	— —	4.10 **28.2**	6.80 **46.7**	1.65 **11.3**	— —	— —	1.00 **6.9**	1.33 **9.1**	— —	0.67 **4.6**	— —	1.85 **12.7**	4.10 **28.2**	1.40 **9.6**	— —	— —
N 112	Dec. 11	14.63 **48**	1.15 **7.8**	0.71 **4.8**	3.92 **26.8**	4.50 **30.7**	6.86 **46.8**	0.48 **3.3**	4.55 **31.1**	1.16 **7.9**	4.30 **29.4**	6.80 **46.4**	1.52 **10.4**	0.25 **1.7**	1.20 **8.2**	0.99 **6.8**	1.31 **8.9**	1.33 **9.1**	0.73 **5.0**	5.00 **34.1**	2.06 **14.1**	4.48 **30.5**	1.40 **9.5**	2.00 **13.6**	3.96 **27.0**
H 202	Dec. 17	14.65 **48**	0.80 **5.5**	0.75 **5.1**	3.35 **22.9**	3.95 **26.9**	6.50 **44.4**	— —	4.50 **30.7**	— —	4.30 **29.4**	6.90 **47.1**	1.50 **10.2**	— —	— —	0.95 **6.5**	1.40 **9.6**	— —	0.62 **4.2**	— —	1.90 **12.9**	4.30 **29.4**	1.30 **8.9**	— —	— —
N 166	Dec. 19	14.66 **48**	0.64 **4.4**	0.71 **4.8**	2.90 **19.8**	4.56 **31.1**	6.80 **46.8**	0.51 **3.5**	4.58 **31.2**	0.95 **6.5**	4.13 **28.2**	6.70 **45.7**	1.67 **11.4**	0.23 **1.6**	1.30 **8.9**	1.00 **6.8**	1.34 **9.1**	1.38 **9.4**	0.62 **4.2**	— —	2.26 **15.4**	4.30 **29.3**	1.46 **9.9**	2.04 **15.9**	3.70 **25.2**
H 81	Nov. 30	14.70 **48**	0.95 **6.5**	— —	3.75 **25.5**	4.15 **28.2**	6.60 **44.9**	0.45 **3.1**	4.55 **31.0**	1.10 **7.5**	4.35 **29.6**	7.10 **48.3**	1.50 **10.2**	— —	1.05 **7.1**	1.10 **7.5**	1.53 **10.4**	— —	— —	— —	1.95 **13.3**	4.80 **32.7**	1.40 **9.5**	1.90 **12.9**	— —
H 37	Nov. 27	14.80 **49**	0.95 **6.4**	0.60 **4.1**	3.83 **25.9**	4.30 **29.1**	6.10 **41.2**	— —	4.60 **31.1**	— —	4.20 **28.4**	6.90 **46.6**	1.60 **10.8**	— —	— —	0.73 **4.9**	1.08 **7.3**	— —	0.65 **4.4**	— —	1.95 **13.2**	4.60 **31.1**	— —	— —	— —
H 205	Dec. 19	14.82 **49**	0.90 **6.1**	0.65 **4.4**	3.50 **23.6**	3.95 **26.7**	6.25 **42.2**	0.45 **3.0**	5.45 **36.8**	1.08 **7.3**	4.25 **28.7**	7.10 **47.9**	1.85 **12.5**	— —	— —	1.06 **7.2**	1.33 **9.0**	— —	0.70 **4.7**	— —	1.90 **12.8**	4.10 **27.7**	1.40 **9.4**	2.18 **14.7**	— —
H 3	Nov. 23	14.90 **49**	1.15 **7.7**	0.70 **4.7**	3.80 **25.5**	4.30 **28.9**	6.90 **46.3**	— —	4.70 **31.5**	— —	4.15 **27.9**	7.20 **48.3**	1.65 **11.1**	— —	— —	0.84 **5.6**	1.35 **9.1**	— —	0.63 **4.2**	5.35 **35.9**	1.90 **12.8**	4.20 **28.2**	1.45 **9.7**	— —	— —
H 79	Nov. 30	14.90 **49**	0.90 **6.0**	0.85 **5.7**	3.50 **23.5**	4.10 **27.5**	6.65 **44.6**	0.45 **3.0**	4.90 **32.9**	— —	4.20 **28.2**	7.00 **47.0**	1.80 **12.1**	— —	0.80 **5.4**	1.30 **8.7**	1.75 **11.7**	— —	0.65 **4.4**	— —	1.90 **12.8**	5.05 **33.9**	— —	— —	— —
N 65	Dec. 3	14.94 **49**	0.90 **6.0**	0.50 **3.4**	3.74 **25.0**	4.06 **27.2**	6.95 **46.5**	0.47 **3.1**	4.60 **30.8**	0.93 **6.2**	4.33 **29.0**	6.80 **45.1**	1.47 **9.8**	0.28 **1.9**	1.56 **10.5**	1.20 **8.0**	1.38 **9.2**	1.45 **9.7**	0.73 **4.9**	— —	— —	— —	— —	2.00 **13.4**	— —
N 125	Dec. 13	14.97 **49**	1.07 **7.2**	0.55 **3.7**	3.74 **25.2**	4.17 **28.1**	6.65 **44.9**	0.50 **3.4**	4.63 **31.2**	1.28 **8.6**	3.82 **25.8**	6.45 **43.5**	1.78 **12.0**	0.26 **1.8**	1.37 **9.2**	0.94 **6.3**	1.39 **9.4**	1.48 **9.9**	0.66 **4.5**	5.42 **36.5**	2.18 **14.7**	4.68 **31.6**	1.43 **9.6**	1.90 **12.8**	— —
N 74	Dec. 3	15.04 **49**	1.03 **6.7**	0.62 **4.1**	3.37 **22.4**	4.55 **30.3**	7.00 **46.6**	0.51 **3.4**	4.88 **32.5**	1.12 **7.5**	4.05 **27.0**	6.63 **44.1**	1.54 **10.2**	0.31 **2.1**	1.40 **9.3**	1.01 **6.7**	1.36 **9.0**	1.39 **9.3**	0.67 **4.5**	5.76 **38.3**	2.20 **14.8**	4.90 **32.6**	1.49 **9.9**	1.91 **12.7**	3.20 **21.3**
N 121	Dec. 12	15.18 **50**	1.05 **6.9**	0.80 **5.2**	3.79 **25.0**	4.28 **28.2**	6.74 **44.4**	0.50 **3.3**	5.07 **33.4**	1.14 **7.5**	4.30 **28.3**	6.95 **45.8**	1.60 **10.5**	0.27 **1.8**	1.16 **7.6**	0.94 **6.2**	1.31 **8.6**	1.33 **8.7**	0.72 **4.7**	5.48 **36.1**	2.04 **13.4**	4.39 **28.9**	1.64 **10.8**	1.91 **12.6**	3.54 **23.3**
H 53	Nov. 27	15.20 **50**	0.92 **6.1**	0.55 **3.6**	3.60 **23.7**	3.96 **26.1**	6.30 **41.4**	— —	— —	— —	4.40 **28.9**	7.05 **46.4**	1.70 **11.2**	— —	— —	0.84 **5.5**	1.30 **8.6**	— —	0.65 **4.3**	— —	1.82 **12.0**	4.20 **27.6**	1.51 **9.9**	— —	— —

I. Antarctic, males, 1950 (cont.)

Serial No.	Date, killed	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	22	23	24	25
N	Nov. 27	15.24	—	0.50	3.34	4.23	6.90	0.52	4.80	1.10	4.60	7.00	1.40	0.30	1.40	1.03	1.44	1.50	0.75	5.20	2.00	4.50	1.42	—	—
10		**50**	—	**3.3**	**21.9**	**27.8**	**45.3**	**3.4**	**31.5**	**7.2**	**30.2**	**45.9**	**9.2**	**1.9**	**9.2**	**6.7**	**9.5**	**9.9**	**4.9**	**34.1**	**13.1**	**29.5**	**9.3**	—	—
H	Nov. 24	15.25	0.95	0.90	3.70	4.30	6.85	—	4.75	—	4.35	7.15	1.75	—	—	1.15	1.50	—	—	—	2.00	4.75	—	—	—
4		**50**	**6.2**	**5.9**	**24.3**	**28.2**	**44.9**	—	**31.1**	—	**28.5**	**46.9**	**11.5**	—	—	**7.5**	**9.8**	—	—	—	**13.1**	**31.1**	—	—	—
H	Nov. 28	15.30	1.25	0.70	3.90	4.30	7.15	—	4.56	—	4.35	7.10	1.30	—	1.14	0.90	1.40	—	0.69	—	2.25	4.70	1.50	—	—
63		**50**	**8.2**	**4.6**	**25.5**	**28.1**	**46.7**	—	**29.0**	—	**28.4**	**46.4**	**8.5**	—	**7.5**	**5.9**	**9.2**	—	**4.5**	—	**14.7**	**30.7**	**9.8**	—	—
H	Nov. 30	15.45	1.35	—	4.15	4.45	7.30	0.46	4.65	—	3.90	6.70	1.60	—	—	0.96	1.45	—	0.67	—	2.10	4.85	1.45	—	—
97		**51**	**8.7**	—	**26.9**	**28.8**	**47.2**	**3.0**	**30.1**	—	**25.2**	**43.4**	**10.4**	—	—	**6.2**	**9.4**	—	**4.3**	—	**13.6**	**31.4**	**9.4**	—	—
H	Dec. 3	15.45	1.20	0.75	4.00	4.40	7.05	0.40	4.60	—	4.40	7.15	1.90	—	1.50	—	1.40	—	0.76	—	1.90	4.50	—	—	—
117		**51**	**7.8**	**4.9**	**25.8**	**28.5**	**45.6**	**2.6**	**29.7**	—	**28.5**	**46.2**	**12.3**	—	**9.7**	—	**9.1**	—	**4.9**	—	**12.3**	**29.1**	—	—	—
H	Nov. 27	15.50	0.70	0.65	3.80	4.40	7.00	—	5.05	—	4.60	7.30	1.60	—	—	0.96	1.28	—	0.66	—	2.00	4.65	1.55	—	—
36		**51**	**4.5**	**4.2**	**24.5**	**28.4**	**45.2**	—	**32.6**	—	**29.7**	**47.1**	**10.3**	—	—	**6.2**	**8.3**	—	**4.3**	—	**12.9**	**30.0**	**10.0**	—	—
N	Nov. 30	15.57	1.15	0.57	3.77	4.43	7.06	0.50	5.08	1.18	4.30	6.98	1.62	0.38	1.25	1.40	1.10	1.34	0.73	5.38	2.06	4.49	1.50	2.09	3.87
36		**51**	**7.4**	**3.7**	**24.2**	**28.5**	**45.3**	**3.2**	**32.6**	**7.6**	**27.6**	**44.8**	**10.4**	**2.4**	**8.0**	**9.0**	**7.1**	**8.6**	**4.7**	**34.6**	**13.2**	**28.8**	**9.6**	**13.4**	**24.8**
N	Dec. 17	15.60	1.18	0.60	4.10	4.47	7.15	0.45	4.98	1.08	4.50	7.21	1.70	0.25	1.74	1.12	1.63	1.69	0.72	5.02	1.80	4.78	1.38	1.96	3.80
159		**51**	**7.6**	**3.8**	**26.3**	**28.7**	**45.8**	**2.9**	**31.9**	**6.9**	**28.8**	**46.2**	**10.9**	**1.6**	**11.5**	**7.2**	**10.4**	**10.8**	**4.6**	**32.2**	**11.5**	**30,6**	**8.8**	**12.6**	**24.4**
N	Dec. 2	15.62	1.10	0.60	3.80	4.31	6.90	0.43	5.37	1.11	4.88	7.58	1.62	0.26	1.37	1.51	1.06	1.26	0.74	5.20	2.10	4.80	1.48	2.04	4.02
62		**51**	**7.0**	**3.8**	**24.3**	**27.6**	**44.1**	**2.7**	**34.4**	**7.1**	**31.2**	**48.5**	**10.4**	**1.7**	**8.8**	**9.7**	**6.8**	**8.1**	**4.7**	**33.3**	**13.4**	**30.7**	**9.5**	**13.1**	**25.7**
H	Nov. 29	15.85	0.95	0.75	4.05	4.50	7.20	—	4.75	—	4.45	7.45	1.85	—	—	1.00	1.40	—	0.71	5.80	2.20	5.30	1.60	—	—
64		**52**	**6.0**	**4.7**	**25.6**	**28.4**	**45.4**	—	**30.0**	—	**28.1**	**47.0**	**11.7**	—	—	**6.3**	**8.8**	—	**4.5**	**36.6**	**13.9**	**33.4**	**10.1**	—	—
H	Dec. 12	15.85	1.15	0.55	3.95	4.55	7.20	—	5.00	—	4.50	7.25	1.90	—	1.20	—	1.38	—	0.70	—	2.05	4.85	1.60	—	—
200		**52**	**7.3**	**3.5**	**24.9**	**28.7**	**45.4**	—	**31.5**	—	**28.4**	**45.7**	**12.0**	—	**7.6**		**8.7**	—	**4.4**	—	**12.9**	**30.6**	**10.1**	—	—
N	Nov. 27	15.87	1.26	0.63	3.80	4.75	6.65	0.47	5.05	1.08	4.53	7.70	1.70	0.47	1.50	1.24	1.45	1.48	0.67	—	2.15	5.05	1.60	2.17	—
11		**52**	**7.9**	**4.0**	**24.0**	**29.9**	**41.9**	**3.0**	**31.8**	**6.8**	**28.5**	**48.5**	**10.7**	**3.0**	**9.5**	**7.8**	**9.1**	**9.3**	**4.2**	—	**13.5**	**31.8**	**10.1**	**13.7**	—
N	Dec. 18	15.87	1.12	0.53	—	3.87	6.92	0.52	4.98	0.98	4.80	7.58	1.78	0.26	1.44	1.05	1.39	1.46	0.70	5.34	2.08	4.56	1.47	—	—
160		**52**	**7.1**	**3.3**	—	**24.4**	**43.6**	**3.3**	**31.4**	**6.2**	**30.2**	**47.8**	**11.2**	**1.6**	**9.1**	**6.6**	**8.8**	**9.2**	**4.4**	**33.6**	**13.1**	**28.7**	**9.3**	—	—
N	Dec. 3	15.89	1.20	0.65	3.64	4.57	7.27	0.53	5.07	1.30	4.71	7.45	1.89	0.32	1.37	0.98	1.47	1.57	0.77	5.65	1.97	4.92	1.47	—	3.76
75		**52**	**7.5**	**4.1**	**22.9**	**28.8**	**45.8**	**3.3**	**31.9**	**8.2**	**29.6**	**46.9**	**11.9**	**2.0**	**8.7**	**6.2**	**9.3**	**9.9**	**4.9**	**35.7**	**12.4**	**31.1**	**9.3**	—	**23.7**

I. Antarctic, males, 1950 (cont.)

Serial No.	Date, killed	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	22	23	24	25
N	Nov. 27	16.00	1.31	0.70	3.91	5.00	7.55	0.54	4.86	1.16	4.45	7.20	1.80	0.30	1.37	1.57	1.17	1.34	0.76	6.30	2.30	5.10	1.60	2.08	4.12
7		**53**	**8.1**	**4.4**	**24.2**	**31.0**	**46.8**	**3.4**	**30.3**	**7.2**	**27.8**	**45.0**	**11.2**	**1.9**	**8.3**	**9.8**	**7.3**	**8.3**	**4.7**	**39.3**	**14.3**	**31.8**	**10.0**	**13.0**	**25.7**
N	Nov. 26	16.15	1.35	0.40	4.10	4.80	7.60	0.53	5.15	1.16	4.40	7.20	1.70	0.35	1.26	1.56	1.09	1.28	0.71	—	2.30	4.80	1.50	2.25	4.36
6		**53**	**8.4**	**2.5**	**25.1**	**29.7**	**47.1**	**3.3**	**31.9**	**7.2**	**27.2**	**44.6**	**10.5**	**2.2**	**7.8**	**9.7**	**6.7**	**7.9**	**4.4**	—	**14.3**	**29.7**	**9.3**	**13.9**	**27.0**
N	Nov. 30	16.15	1.11	0.52	4.10	4.60	7.20	0.50	4.91	1.15	4.78	7.48	1.55	0.34	1.68	1.43	1.06	1.32	0.68	6.00	2.30	5.05	1.36	—	—
35		**53**	**6.9**	**3.2**	**25.8**	**28.5**	**44.6**	**3.1**	**30.4**	**7.1**	**29.6**	**46.2**	**9.6**	**2.1**	**10.4**	**8.9**	**6.6**	**8.2**	**4.2**	**37.2**	**14.2**	**31.3**	**8.4**	—	—
H	Nov. 23	16.20	1.30	0.70	4.35	4.65	7.30	—	5.60	—	4.20	6.95	1.75	—	—	1.21	1.94	—	0.73	6.09	—	5.20	1.38	—	—
1		**53**	**8.0**	**4.3**	**26.9**	**28.7**	**45.1**	—	**34.6**	—	**25.9**	**42.9**	**10.8**	—	—	**7.5**	**12.0**	—	**4.5**	**37.6**	—	**32.1**	**8.5**	—	—
H	Dec. 4	16.20	1.20	0.70	4.25	4.70	7.50	0.45	4.55	—	—	7.40	1.80	—	—	1.05	1.55	—	0.80	—	2.05	5.00	1.60	—	—
136		**53**	**7.4**	**4.3**	**26.2**	**29.0**	**46.3**	**2.8**	**28.1**	—	—	**45.7**	**11.1**	—	—	**6.5**	**9.6**	—	**4.9**	—	**12.7**	**30.9**	**9.9**	—	—
N	Nov. 26	16.30	1.02	0.59	3.83	4.52	6.83	0.53	5.00	—	4.70	7.50	1.50	0.26	1.55	—	—	—	—	—	2.15	4.90	1.50	1.90	—
5		**54**	**6.2**	**3.6**	**23.5**	**27.7**	**41.8**	**3.2**	**30.6**	—	**28.8**	**45.9**	**9.1**	**1.6**	**9.5**	—	—	—	—	—	**13.1**	**30.0**	**9.1**	**11.6**	—
N	Dec. 4	16.60	0.97	0.60	4.08	4.17	—	0.60	5.16	1.30	4.86	7.75	1.87	0.36	1.48	1.10	1.60	1.73	0.77	5.67	2.20	4.95	1.58	2.24	4.32
76		**54**	**5.8**	**3.6**	**24.6**	**25.1**	—	**3.6**	**31.1**	**7.8**	**29.3**	**46.7**	**11.3**	**2.2**	**8.9**	**6.6**	**9.6**	**10.4**	**4.6**	**34.2**	**13.3**	**29.8**	**9.8**	**13.5**	**26.0**

II. Bonin Islands, Males, 1950

Serial No.	Date, killed	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	22	23	24	25
29	Apr. 22	10.87 **36**	0.78 **7.2**	0.46 **4.2**	2.05 **18.9**	2.53 **23.3**	4.29 **39.5**	0.32 **2.9**	3.80 **35.0**	0.89 **8.2**	3.37 **31.0**	5.48 **50.4**	1.12 **10.3**	0.21 **1.9**	1.00 **9.2**	0.75 **6.9**	1.03 **9.9**	1.16 **10.7**	0.55 **5.1**	3.32 **30.5**	1.37 **12.6**	2.85 **26.2**	1.11 **10.2**	1.59 **14.6**	3.02 **27.8**
30	〃 23	11.00 **36**	0.59 **5.4**	0.42 **3.8**	— —	2.33 **21.2**	4.42 **40.2**	0.24 **2.2**	3.87 **35.2**	0.83 **7.5**	3.42 **31.1**	5.35 **48.6**	1.01 **9.2**	0.17 **1.5**	0.90 **8.2**	0.65 **5.9**	0.84 **7.6**	0.88 **8.0**	0.42 **3.8**	3.50 **31.8**	1.33 **12.1**	2.69 **24.5**	1.10 **10.0**	1.28 **11.6**	— —
31	〃 23	11.04 **36**	0.79 **7.2**	0.39 **3.5**	2.17 **19.7**	2.52 **22.8**	4.46 **40.4**	0.36 **3.3**	3.85 **34.9**	0.70 **6.3**	2.95 **26.7**	5.08 **46.0**	1.18 **10.7**	0.20 **1.8**	1.00 **9.1**	0.65 **5.9**	0.90 **8.2**	0.99 **9.0**	0.51 **4.6**	3.06 **27.7**	1.36 **12.3**	2.73 **24.7**	1.12 **10.1**	1.58 **14.3**	3.22 **29.2**
42	〃 23	11.04 **37**	0.64 **5.8**	0.50 **4.5**	2.23 **20.2**	2.48 **22.5**	4.54 **41.1**	0.40 **3.6**	3.85 **34.9**	0.85 **7.7**	3.32 **30.1**	5.48 **49.6**	1.21 **11.0**	0.21 **1.9**	1.12 **10.1**	0.68 **6.2**	0.99 **9.0**	1.05 **9.5**	0.55 **5.0**	3.46 **31.3**	1.59 **14.4**	2.88 **26.1**	1.11 **10.1**	1.60 **14.5**	3.15 **28.5**
22	〃 19	11.52 **38**	0.65 **5.6**	0.29 **2.5**	2.47 **21.4**	2.92 **25.3**	4.90 **42.5**	0.47 **4.1**	3.67 **31.9**	0.75 **6.5**	3.40 **29.5**	5.72 **49.7**	1.41 **12.2**	0.18 **1.5**	1.00 **8.7**	0.71 **6.2**	1.06 **9.2**	1.10 **9.5**	0.52 **4.5**	3.45 **29.9**	1.61 **14.0**	3.13 **27.2**	— —	1.16 **10.1**	3.21 **27.9**
21	〃 19	11.52 **38**	0.63 **5.5**	0.49 **4.3**	2.26 **19.6**	2.65 **23.0**	4.58 **39.8**	0.39 **3.4**	3.83 **33.2**	0.81 **7.0**	3.64 **31.6**	5.54 **48.1**	1.09 **9.5**	0.17 **1.5**	0.70 **6.1**	0.87 **7.6**	1.13 **9.8**	1.20 **10.4**	0.54 **4.7**	3.50 **90.4**	1.44 **12.5**	3.08 **26.7**	— —	1.78 **15.5**	3.56 **30.9**
274	June 3	11.95 **39**	0.80 **6.7**	0.50 **4.2**	2.50 **20.9**	3.00 **25.1**	5.10 **42.7**	— —	4.10 **34.3**	0.80 **6.7**	3.75 **31.4**	6.10 **51.0**	1.50 **12.6**	0.23 **1.9**	1.30 **10.9**	0.90 **7.5**	1.15 **9.6**	— —	0.50 **4.2**	3.75 **31.4**	1.50 **12.6**	3.09 **25.9**	1.27 **10.6**	1.55 **13.0**	— —
32	〃 24	12.00 **39**	0.73 **6.1**	0.57 **4.7**	2.61 **21.7**	3.02 **25.2**	5.53 **46.1**	0.32 **2.7**	4.85 **40.4**	0.90 **7.5**	3.47 **28.9**	5.56 **46.3**	1.38 **11.5**	0.20 **1.7**	1.00 **8.3**	0.62 **5.2**	1.05 **8.7**	1.22 **10.2**	0.57 **4.7**	3.92 **32.7**	1.60 **13.3**	3.40 **28.3**	1.11 **9.2**	1.60 **13.3**	3.17 **26.4**
33	〃 24	12.30 **40**	0.88 **7.2**	0.30 **2.4**	2.83 **23.0**	3.07 **25.0**	5.92 **48.1**	0.37 **3.0**	4.15 **33.7**	0.87 **7.1**	3.56 **28.9**	5.78 **47.0**	1.13 **9.2**	0.19 **1.5**	1.01 **8.2**	0.90 **7.3**	1.06 **8.6**	1.10 **8.9**	0.60 **4.9**	3.92 **31.9**	1.63 **13.3**	3.39 **27.6**	1.34 **10.9**	1.80 **14.6**	3.65 **29.7**
149	May 17	12.39 **41**	1.09 **8.8**	0.53 **4.3**	2.60 **21.0**	2.90 **23.4**	5.15 **41.6**	0.52 **4.2**	3.82 **30.8**	0.90 **7.3**	3.65 **29.4**	5.70 **46.0**	1.05 **8.5**	0.24 **1.9**	1.15 **9.3**	0.76 **6.1**	1.18 **9.5**	— —	0.59 **4.8**	3.54 **28.6**	1.56 **12.6**	3.15 **25.4**	1.29 **10.4**	1.72 **13.9**	— —
117	〃 9	12.45 **41**	0.63 **5.1**	0.34 **2.7**	3.06 **24.6**	3.36 **27.0**	5.34 **42.9**	— —	3.90 **31.3**	0.92 **7.4**	3.65 **29.3**	5.85 **47.0**	1.39 **11.2**	0.23 **1.8**	0.73 **5.9**	0.94 **7.6**	1.13 **9.1**	— —	0.42 **3.4**	3.92 **31.5**	1.52 **12.2**	3.79 **30.4**	1.30 **10.4**	1.89 **15.2**	3.63 **29.2**
146	〃 17	12.50 **41**	— —	0.49 **3.9**	2.86 **22.9**	3.20 **25.6**	5.29 **42.3**	0.40 **3.2**	4.20 **33.6**	0.88 **7.0**	3.79 **30.3**	5.37 **43.0**	— —	— —	1.05 **8.4**	— —	— —	— —	— —	— —	1.55 **12.4**	3.00 **24.0**	1.24 **9.9**	1.53 **12.2**	3.06 **24.5**
218	〃 26	12.70 **42**	0.90 **7.1**	0.60 **4.7**	3.25 **25.6**	3.60 **28.3**	5.70 **44.9**	0.45 **3.5**	— —	0.90 **7.1**	3.60 **28.3**	6.30 **49.6**	1.60 **12.6**	0.26 **2.0**	0.78 **6.1**	1.00 **7.9**	1.35 **10.6**	— —	0.65 **5.1**	4.47 **35.2**	1.75 **13.8**	3.55 **28.0**	1.55 **12.2**	1.80 **14.2**	— —
219	〃 26	12.70 **42**	0.90 **7.1**	0.65 **5.1**	3.15 **24.8**	3.75 **29.5**	5.60 **44.1**	0.43 **3.4**	4.05 **31.9**	1.00 **7.9**	4.01 **31.6**	6.00 **47.2**	1.14 **9.0**	0.27 **2.1**	1.10 **8.7**	— —	— —	— —	— —	4.36 **34.3**	1.71 **13.5**	3.60 **28.3**	1.45 **11.4**	1.80 **14.2**	— —
118	〃 11	12.73 **42**	0.83 **6.5**	0.50 **3.9**	2.73 **21.4**	3.63 **28.5**	5.45 **42.8**	0.43 **3.4**	4.06 **31.9**	0.94 **7.4**	3.54 **27.8**	5.82 **45.7**	1.51 **11.9**	— —	— —	0.77 **6.0**	1.10 **8.6**	— —	0.55 **4.3**	3.92 **30.8**	1.69 **13.3**	3.61 **28.4**	1.46 **11.5**	1.86 **14.6**	— —
34	Apr. 24	12.95 **42**	1.03 **8.0**	0.43 **3.3**	2.85 **22.0**	3.24 **25.0**	5.55 **42.9**	0.41 **3.2**	4.05 **31.3**	1.00 **7.7**	3.56 **27.5**	5.69 **43.9**	1.38 **10.7**	0.22 **1.7**	1.10 **8.5**	0.86 **6.6**	1.15 **8.9**	1.18 **9.1**	0.58 **4.5**	4.20 **32.4**	1.63 **12.6**	3.42 **26.4**	1.32 **10.2**	1.80 **13.9**	3.55 **27.4**

II. Bonin Islands, Males, 1950 (cont.)

Serial No.	Date, killed	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	22	23	24	25
116	May 9	13.05	1.09	—	2.98	3.35	5.57	0.41	4.06	1.08	4.13	6.56	0.89	0.45	0.79	0.92	1.30	—	0.56	3.85	1.53	3.32	1.38	1.86	3.73
		43	**8.4**	—	**22.8**	**25.7**	**42.7**	**3.1**	**31.1**	**8.3**	**31.6**	**50.2**	**6.8**	**3.4**	**6.1**	**7.0**	**10.0**	—	**4.3**	**29.5**	**11.7**	**25.4**	**10.6**	**14.3**	**28.6**
52	〃 5	13.08	0.98	0.60	3.25	3.65	5.93	0.40	3.85	—	3.92	6.23	1.40	0.26	1.13	0.79	1.20	1.26	0.60	4.62	1.82	3.48	1.38	1.94	4.00
		43	**7.5**	**4.6**	**24.8**	**27.9**	**45.3**	**3.1**	**29.4**	—	**30.0**	**47.6**	**10.7**	**2.0**	**8.6**	**6.0**	**9.2**	**9.6**	**4.6**	**35.3**	**13.9**	**26.6**	**10.6**	**14.8**	**30.6**
38	Apr. 26	13.32	—	0.46	3.48	3.93	6.10	—	4.16	0.90	3.82	6.23	1.25	0.23	1.24	0.87	1.13	1.16	0.56	4.66	1.90	3.88	1.39	1.90	3.80
		44	—	**3.5**	**26.1**	**29.5**	**45.8**	—	**31.2**	**6.8**	**28.7**	**46.8**	**9.4**	**1.7**	**9.3**	**6.5**	**8.5**	**8.7**	**4.2**	**35.0**	**14.3**	**29.1**	**10.4**	**14.3**	**28.5**
37	〃 24	13.84	0.75	0.55	2.88	3.32	5.73	0.43	4.70	1.15	3.94	6.45	1.44	0.24	1.36	0.94	1.18	1.20	0.68	4.40	1.85	3.75	1.45	1.95	3.90
		45	**5.4**	**4.0**	**20.8**	**24.0**	**41.4**	**3.1**	**34.0**	**8.3**	**28.5**	**46.6**	**10.4**	**1.7**	**9.8**	**6.8**	**8.5**	**8.7**	**4.9**	**31.8**	**13.4**	**27.1**	**10.5**	**14.1**	**28.2**
120	May 11	14.00	1.04	0.65	3.42	4.15	6.15	—	4.67	1.42	4.08	6.65	1.52	0.25	1.20	0.95	1.27	1.29	0.62	5.04	2.02	4.10	1.42	1.96	—
		46	**7.4**	**4.6**	**24.4**	**29.6**	**43.9**	—	**33.4**	**10.1**	**29.1**	**47.5**	**10.9**	**1.8**	**8.6**	**6.8**	**9.1**	**9.2**	**4.4**	**36.0**	**14.4**	**29.3**	**10.1**	**14.0**	—
25	Apr. 21	14.02	1.35	0.49	3.40	3.88	6.15	0.38	4.69	1.05	3.92	6.54	1.50	0.29	1.09	0.85	1.13	1.18	0.61	4.70	1.85	3.53	1.37	1.94	3.90
		46	**9.6**	**3.5**	**24.3**	**27.7**	**43.9**	**2.7**	**33.5**	**7.5**	**28.0**	**46.6**	**10.7**	**2.1**	**7.8**	**6.1**	**8.1**	**8.4**	**4.4**	**33.5**	**13.2**	**25.2**	**9.8**	**13.8**	**27.8**
28	〃 22	14.06	1.17	0.63	3.32	3.85	6.11	0.48	5.47	1.01	3.92	6.53	1.33	0.23	1.68	1.00	1.35	1.40	0.65	4.81	1.99	3.99	1.33	1.83	3.75
		46	**8.3**	**4.5**	**23.6**	**27.4**	**43.5**	**3.4**	**38.9**	**7.2**	**27.9**	**46.4**	**9.5**	**1.6**	**11.9**	**7.1**	**9.6**	**10.0**	**4.6**	**34.2**	**14.2**	**28.4**	**9.5**	**13.0**	**26.7**
26	〃 22	14.85	1.36	—	4.33	4.92	6.87	0.40	4.60	1.00	4.12	6.62	1.20	0.34	1.10	0.92	1.33	1.36	0.72	5.35	1.96	4.26	1.49	1.45	3.03
		49	**9.2**	—	**29.2**	**33.1**	**46.3**	**2.6**	**31.0**	**6.7**	**27.7**	**44.6**	**8.1**	**2.3**	**7.4**	**6.2**	**9.0**	**9.2**	**4.8**	**36.0**	**13.2**	**28.7**	**10.0**	**9.8**	**20.4**
40	〃 28	14.90	1.28	0.50	3.86	4.25	6.74	0.48	4.83	1.00	4.12	6.85	1.61	0.35	1.35	0.93	1.30	—	0.68	5.16	2.10	4.38	1.63	2.05	4.10
		49	**8.6**	**3.4**	**25.9**	**28.5**	**45.2**	**3.2**	**32.4**	**6.7**	**27.6**	**46.0**	**10.8**	**2.3**	**9.1**	**6.2**	**8.7**	—	**4.6**	**34.6**	**14.1**	**29.4**	**10.9**	**13.8**	**27.5**
41	〃 28	15.15	1.23	0.82	3.98	4.55	7.04	0.42	4.55	1.08	4.26	6.95	1.86	0.29	1.43	0.92	1.30	1.33	0.67	5.52	2.10	4.75	1.78	2.12	—
		50	**8.1**	**5.4**	**26.3**	**30.0**	**46.5**	**2.8**	**30.0**	**7.1**	**28.1**	**45.9**	**12.3**	**1.9**	**9.4**	**6.1**	**8.6**	**8.8**	**4.4**	**36.4**	**13.9**	**31.4**	**11.7**	**14.0**	—
119	May 11	15.15	1.22	0.55	3.89	4.26	6.72	—	4.30	1.27	3.88	6.29	1.33	0.45	1.50	0.99	1.21	1.30	0.68	5.50	2.00	4.77	1.80	1.96	—
		50	**8.1**	**3.6**	**25.7**	**28.1**	**44.4**	—	**28.4**	**8.4**	**25.6**	**41.5**	**8.8**	**3.0**	**9.9**	**6.5**	**8.0**	**8.6**	**4.5**	**36.3**	**13.2**	**31.5**	**11.9**	**12.9**	—
23	Apr. 19	15.18	1.17	—	4.25	4.58	7.04	0.45	4.27	1.14	3.95	6.45	1.37	0.31	0.93	0.95	1.22	1.34	—	5.80	2.26	4.74	—	1.94	3.83
		50	**7.7**	—	**28.0**	**30.2**	**46.4**	**2.9**	**28.1**	**7.5**	**26.0**	**42.5**	**9.0**	**2.0**	**6.1**	**6.3**	**8.0**	**8.8**	—	**38.2**	**14.9**	**31.2**	—	**12.8**	**25.2**
24	〃 20	15.19	1.33	0.61	3.75	4.38	7.14	0.50	4.76	1.03	4.06	6.78	1.10	0.32	1.16	0.97	1.37	1.42	0.66	5.55	2.09	4.10	1.53	2.09	—
		50	**8.8**	**4.0**	**24.7**	**28.8**	**47.0**	**3.3**	**31.3**	**6.8**	**26.7**	**44.6**	**7.2**	**2.1**	**7.6**	**6.4**	**9.0**	**9.3**	**4.4**	**36.5**	**13.8**	**27.0**	**10.1**	**13.8**	—
148	May 17	15.20	1.43	0.72	4.23	4.33	6.55	0.50	4.62	—	4.50	6.10	1.05	0.25	1.25	1.05	1.45	—	0.62	5.26	2.15	4.80	1.65	—	—
		50	**9.4**	**4.7**	**27.8**	**28.5**	**43.1**	**3.3**	**30.4**	—	**29.6**	**40.1**	**6.9**	**1.6**	**8.2**	**6.9**	**9.5**	—	**4.1**	**34.6**	**14.1**	**31.6**	**10.9**	—	—
36	Apr. 24	15.24	1.41	0.71	3.98	4.49	7.04	0.40	4.95	1.10	4.41	6.98	1.31	0.36	1.03	0.95	1.24	1.49	0.64	5.45	2.00	4.40	1.65	—	—
		50	**9.3**	**4.7**	**26.1**	**29.5**	**46.2**	**2.6**	**32.5**	**7.2**	**28.9**	**45.8**	**8.6**	**2.4**	**6.8**	**6.2**	**8.1**	**9.8**	**4.2**	**37.8**	**13.1**	**28.9**	**10.8**	—	—
35	〃 24	15.40	1.47	0.55	4.32	4.83	7.35	0.46	4.77	1.00	4.20	7.16	1.03	0.32	1.12	0.91	1.31	1.36	0.66	5.67	2.05	5.00	1.90	2.02	4.00
		51	**9.5**	**3.6**	**28.1**	**31.4**	**47.7**	**3.0**	**31.0**	**6.5**	**27.3**	**46.5**	**6.7**	**2.1**	**7.3**	**5.9**	**8.5**	**8.8**	**4.3**	**36.8**	**13.3**	**32.5**	**12.3**	**13.1**	**26.0**

II. Bonin Islands, Males, 1950 (cont.)

Serial No.	Date, killed	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	22	23	24	25
27	〃 22	15.74	1.18	0.82	4.02	4.33	6.78	0.44	4.88	1.15	4.08	6.83	1.15	0.25	1.22	0.98	1.30	1.33	0.70	5.51	1.96	4.50	1.62	2.49	4.27
		52	7.5	5.2	25.5	27.5	43.1	2.8	31.0	7.3	25.9	43.5	7.3	1.6	2.8	6.2	8.3	8.4	4.4	35.0	12.5	25.6	10.5	15.8	27.1
147	May 17	16.20	1.37	0.78	4.24	4.67	7.25	—	4.62	1.10	4.44	7.32	1.76	0.40	1.50	—	—	—	—	6.30	2.11	4.92	1.77	2.30	—
		53	8.5	4.8	26.2	28.8	44.8	—	28.5	6.8	27.4	45.2	10.9	2.5	9.3	—	—	—	—	38.9	13.0	30.4	10.9	14.2	—

III. Bonin Islands, Females, 1950

Serial No.	Date, killed	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	22	23	24	25
43	Apr. 29	10.75	0.52	0.42	1.58	2.08	3.75	0.30	3.75	1.00	3.78	5.83	—	0.24	1.25	0.78	1.04	1.05	0.52	2.75	1.22	2.55	0.98	1.50	2.90
		35	4.8	3.9	14.7	19.3	34.9	2.8	34.9	9.3	35.2	54.2	—	2.2	11.6	7.3	9.7	9.8	4.8	25.6	11.3	23.7	9.1	14.0	27.0
39	〃 26	10.94	0.45	0.55	1.75	2.25	3.65	0.29	3.95	0.90	3.50	5.55	0.20	0.22	0.62	0.70	0.90	0.94	0.47	2.79	1.28	2.43	1.04	1.50	3.00
		36	4.1	5.0	16.0	20.6	33.4	2.7	36.1	8.2	32.0	50.7	1.8	2.0	5.7	6.4	8.2	8.6	4.3	25.5	11.7	22.2	9.5	13.7	27.4

IV. Japanese coastal, males, 1950 & 1951

Area[1], Company[2], Serial No.	Date, Killed	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	22	23	24	25
HT220	Aug. 14	10.68	—	—	2.16	2.38	4.43	—	3.71	0.82	3.43	5.49	1.26	0.23	0.67	0.74	0.93	—	0.54	3.14	—	—	—	1.57	—
	1950	35	—	—	20.2	22.3	41.5	—	34.7	7.7	32.1	51.4	11.8	2.2	6.3	6.9	8.7	—	5.1	29.4	—	—	—	14.7	—
HT190	〃 11	10.70	0.58	0.45	2.08	2.20	4.10	—	3.75	0.77	—	5.25	1.30	0.20	1.00	—	—	—	—	3.10	—	—	—	1.43	—
	〃	35	5.4	4.2	19.4	20.6	38.3	—	35.0	7.2	—	49.1	12.1	1.9	9.3	—	—	—	—	29.0	—	—	—	13.4	—
HT198	〃 〃	10.70	0.63	0.42	2.29	2.66	4.29	—	3.75	0.80	3.43	5.29	1.14	0.18	0.98	—	—	—	—	3.44	1.45	2.96	1.03	1.48	—
	〃	35	5.9	3.9	21.4	24.9	40.1	—	35.0	7.5	32.1	49.4	10.7	1.7	9.1	—	—	—	—	32.2	13.6	27.7	9.6	13.8	—
HT199	〃 〃	10.70	0.66	0.33	2.27	2.50	4.30	—	3.56	0.82	3.80	4.84	0.85	0.28	1.20	—	—	—	—	3.35	1.41	2.80	—	1.66	—
	〃	35	6.2	3.1	21.2	23.4	40.2	—	33.3	7.7	35.5	45.2	7.9	2.6	11.2	—	—	—	—	31.3	13.2	26.2	—	15.5	—
SKi 18	July 4	10.72	0.60	0.40	2.10	2.50	4.20	0.33	3.80	0.80	3.20	5.40	1.40	—	0.95	0.64	0.90	—	0.46	—	—	3.45	—	1.60	—
	1951	35	5.6	3.7	19.6	23.3	39.2	3.1	35.4	7.5	29.8	50.4	13.1	—	8.9	6.0	8.4	—	4.3	—	—	32.2	—	14.9	—
HT197	Sept. 25	10.75	0.38	0.35	1.60	2.05	4.45	—	3.60	0.70	3.30	5.60	—	0.19	0.90	—	—	—	—	3.10	1.25	2.60	—	1.40	—
	〃	35	3.5	3.3	14.9	19.1	41.4	—	33.5	6.5	30.7	52.1	—	1.8	8.4	—	—	—	—	28.8	11.6	24.2	—	13.0	—
HT197	Aug. 11	10.75	0.50	0.41	2.18	2.57	4.32	—	3.64	0.79	3.26	5.33	1.16	0.18	0.95	0.75	0.91	—	0.49	3.16	—	—	—	1.60	—
	〃	35	4.7	3.8	20.3	23.9	40.2	—	33.9	7.3	30.3	49.6	10.8	1.7	8.8	7.0	8.5	—	4.6	29.4	—	—	—	14.9	—
HT171	〃 8	10.80	0.53	0.46	1.95	2.30	4.25	—	3.60	0.69	3.30	5.60	1.20	0.15	0.82	—	—	—	—	3.20	1.30	2.65	1.00	1.48	—
	〃	35	4.9	4.3	18.1	21.3	39.4	—	33.3	6.4	30.6	51.9	11.1	1.4	7.6	—	—	—	—	29.6	12.0	24.5	9.3	13.7	—
HT200	Aug. 11	11.00	0.52	0.42	2.18	2.45	4.00	—	3.70	0.79	3.60	5.77	1.20	—	—	—	—	—	—	3.44	1.43	3.00	1.00	—	—
	〃	36	4.7	3.8	19.8	22.3	36.4	—	33.6	7.2	32.7	52.5	10.9	—	—	—	—	—	—	31.3	13.0	27.3	9.1	—	—
HT161	〃 3	11.10	0.55	0.47	2.10	2.40	4.20	0.45	3.80	0.75	3.45	5.55	1.40	0.20	0.80	0.75	1.00	—	0.50	3.25	1.25	2.80	1.15	1.35	—
	〃	36	5.0	4.2	18.9	21.6	37.8	4.1	34.2	6.8	31.1	50.0	12.6	1.8	7.2	6.8	9.0	—	4.5	29.3	11.3	25.2	10.4	12.2	—
HT177	〃 8	11.20	0.47	—	2.30	2.70	4.60	—	3.95	0.74	3.60	6.00	1.20	0.14	1.00	—	—	—	—	3.55	1.50	3.25	1.15	1.54	—
	〃	37	4.2	—	20.5	24.1	41.1	—	35.3	6.6	32.1	53.6	10.7	1.3	8.9	—	—	—	—	31.7	13.4	29.0	10.3	13.8	—
HT249	〃 24	11.28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3.55	1.50	3.10	1.12	—	—
	〃	37	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	31.5	13.3	27.5	9.9	—	—
HT144	July 29	11.30	0.85	0.38	2.48	2.90	4.80	0.42	3.82	0.75	3.20	5.45	1.50	0.19	1.00	0.80	1.04	—	0.55	3.84	1.45	3.00	1.25	1.54	—
	〃	37	7.5	3.4	21.9	25.7	42.5	3.7	33.8	6.6	28.3	48.2	13.3	1.7	8.9	7.1	9.2	—	4.9	34.0	12.8	26.6	11.1	13.6	—
HN214	Aug. 3	11.30	—	0.30	—	2.82	4.70	0.35	—	0.83	3.85	6.15	1.30	0,28	1.00	0.84	1.18	—	0.57	—	1.60	3.28	—	1.88	—
	〃	37	—	2.7	—	25.0	41.6	3.1	—	7.3	34.1	54.4	11.5	2.5	8.9	7.4	10.4	—	5.0	—	14.2	29.0	—	16.6	—
HT175	Aug. 8	11.30	0.61	0.38	2.25	2.60	4.40	—	3.80	0.74	3.50	5.90	1.50	0.27	1.21	—	—	—	—	3.35	—	—	—	1.62	—
	〃	37	5.4	3.4	19.9	23.0	38.9	—	33.6	6.5	31.0	52.2	13.3	2.4	10.7	—	—	—	—	29.6	—	—	—	14.3	—
HT359	Sespt 26	11.50	0.53	0.47	2.30	2.70	4.70	—	4.30	0.82	3.45	5.90	—	0.15	0.80	—	—	—	—	3.60	—	—	—	1.82	—
	〃	38	4.6	4.1	20.0	23.5	40.9	—	37.4	7.1	30.0	51.3	—	1.3	7.0	—	—	—	—	31.3	—	—	—	15.8	—

IV. Japanese coastal, males, 1950 & 1951 (cont.)

Area1), Company2), Serial No.	Date, killed	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	22	23	24	25
HT206	Aug. 13 1951	11.59 38	0.51 4.4	0.43 3.7	2.46 21.2	2.82 24.3	4.55 39.3	— —	— —	0.87 7.5	3.44 29.7	5.79 50.0	1.25 10.8	0.30 2.6	1.20 10.4	— —	1.07 9.2	— —	— —	3.64 31.4	1.50 12.9	3.17 27.4	1.22 10.5	1.82 15.7	— —
TH214	Aug. 14 1950	11.59 38	0.63 5.4	0.45 3.9	2.22 19.2	2.62 22.6	4.36 37.6	— —	3.60 31.1	0.80 6.9	3.40 29.3	5.50 47.5	1.30 11.2	0.24 2.1	0.90 7.8	0.75 6.5	1.05 9.1	— —	0.53 4.6	3.65 31.5	— —	— —	— —	1.55 13.4	— —
HT132	June 23 1951	11.63 38	0.38 3.3	0.40 3.4	2.30 19.8	2.65 22.8	4.70 40.4	— —	3.70 31.8	0.82 7.1	3.30 28.4	5.70 49.0	1.35 11.6	0.24 2.1	0.73 6.3	0.73 6.3	1.20 10.3	— —	0.52 4.5	— —	1.40 12.0	3.20 27.5	— —	1.75 15.0	— —
HT133	June 23 1951	11.89 39	0.65 5.5	0.40 3.4	2.30 19.3	2.55 21.4	4.65 39.1	— —	4.00 33.6	0.73 6.1	3.30 27.8	5.60 47.1	1.20 10.1	0.20 1.7	1.15 9.7	0.75 6.3	1.00 8.4	— —	0.50 4.2	— —	1.55 13.0	3.20 26.9	— —	1.50 12.6	— —
ST 26	July 27 1951	11.89 39	0.80 6.7	0.36 3.0	2.55 21.4	2.80 23.5	4.70 39.5	— —	3.75 31.5	0.85 7.1	3.70 31.1	5.80 48.8	1.30 10.9	0.30 2.5	1.50 12.6	0.86 7.2	1.07 9.0	— —	— —	— —	1.50 12.6	2.90 24.4	— —	1.50 12.6	— —
HT207	Aug. 13 1950	11.89 39	0.69 5.8	0.48 4.0	2.57 21.6	2.88 24.2	4.96 41.7	— —	— —	0.90 7.6	3.32 27.9	5.62 47.3	1.45 12.2	0.30 2.5	1.13 9.5	— —	— —	— —	— —	3.57 30.0	— —	— —	— —	1.55 13.0	— —
HT213	〃 14 1950	11.89 39	0.62 5.2	0.60 5.0	2.53 21.3	2.79 23.5	4.95 41.6	— —	3.95 33.2	0.89 7.5	3.50 29.4	5.85 49.2	1.25 10.5	0.20 1.7	1.45 12.2	0.77 6.5	1.09 9.2	— —	0.58 4.9	3.85 32.4	— —	— —	— —	1.82 15.3	— —
HT248	〃 24 1950	11.89 39	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	— —	3.75 31.5	1.82 15.3	3.63 30.5	1.25 10.5	— —	— —
HT126	June 20 1951	12.19 40	0.70 5.7	0.50 4.1	2.45 20.1	2.60 21.3	4.75 39.0	— —	3.85 31.6	0.88 7.2	4.10 33.6	6.30 51.7	1.30 10.7	0.35 2.9	0.85 7.0	— —	— —	— —	— —	— —	1.45 11.9	3.15 25.8	— —	1.85 15.2	— —
HT 74	June 22 1951	12.19 40	0.80 6.6	0.45 3.7	— —	2.95 24.2	5.50 45.1	0.40 3.3	4.10 33.6	0.85 7.0	3.50 28.7	5.70 46.7	— —	0.35 2.9	1.35 11.1	1.05 8.6	1.20 9.8	— —	0.56 4.6	— —	1.70 13.9	3.40 27.9	— —	1.70 13.9	— —
HT183	Aug. 9 1950	12.20 40	0.90 7.4	0.33 2.7	2.90 23.8	3.35 27.5	5.25 43.0	— —	4.20 34.4	0.90 7.4	3.75 30.7	6.50 53.3	1.35 11.1	0.15 1.2	1.45 11.9	— —	— —	— —	— —	3.80 31.1	1.71 14.0	3.57 29.3	1.26 10.3	— —	— —
HT193	〃 11 1950	12.20 40	0.88 7.2	0.36 3.0	2.89 23.7	3.38 27.7	5.28 43.3	— —	4.25 34.8	0.89 7.3	3.72 30.5	6.45 52.9	1.40 11.5	0.17 1.4	1.38 11.3	0.86 7.0	1.02 8.4	— —	0.56 4.6	3.86 31.6	1.70 13.9	3.55 29.1	1.30 10.7	1.98 16.2	— —
HT204	〃 13 1950	12.20 40	0.60 4.9	0.39 3.2	2.50 20.5	2.90 23.8	5.00 41.0	— —	4.00 32.8	0.79 6.5	3.60 29.5	6.20 50.8	1.70 13.9	0.15 1.2	1.05 8.6	0.91 7.5	1.28 10.5	— —	0.60 4.9	3.60 29.5	1.49 12.2	2.94 24.1	1.21 9.9	1.61 13.2	— —
HT212	〃 14 1950	12.20 40	0.60 4.9	0.45 3.7	2.65 21.7	3.05 25.0	5.20 42.6	— —	4.10 33.6	0.83 6.8	3.40 27.9	5.90 48.4	1.50 12.3	0.19 1.6	0.72 5.9	0.85 7.0	1.24 10.2	— —	0.54 4.4	4.00 32.8	— —	— —	— —	1.66 13.6	— —
HT235	〃 19 1950	12.20 40	0.80 6.6	0.40 3.3	2.50 20.5	2.85 23.4	4.75 38.9	— —	4.37 35.8	0.98 8.0	3.72 30.5	6.07 49.8	1.45 11.9	0.24 2.0	1.00 8.2	0.75 6.1	1.14 9.3	— —	0.55 4.5	3.65 29.9	1.45 11.9	3.25 26.6	1.25 10.2	— —	— —
HT208	〃 13 1950	12.51 41	0.68 5.4	0.35 2.8	2.69 21.5	2.85 22.8	5.18 41.4	— —	4.40 35.2	0.92 7.4	4.00 32.0	6.15 49.2	1.10 8.8	0.24 1.9	1.00 8.0	0.90 7.2	1.22 9.8	— —	0.54 4.3	3.75 30.0	1.46 11.7	3.22 25.7	1.29 10.3	1.60 12.8	— —

IV Japanese coastal, males, 1950 & 1951 (cont.)

Area1), Company2), Serial No.	Date, killed	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	22	23	24	25
TH209	〃 13	12.51	0.90	0.39	2.62	2.93	—	—	4.60	0.74	3.70	6.10	1.50	0.22	0.78	—	—	—	—	3.77	1.62	3.10	12.3	1.50	—
	1950	**41**	**7.2**	**3.2**	**20.9**	**23.4**	—	—	**36.8**	**5.9**	**29.6**	**48.8**	**12.0**	**1.8**	**6.2**	—	—	—	—	**30.1**	**13.0**	**24.8**	**9.8**	**12.0**	—
HT227	〃 17	12.51	0.75	0.50	2.70	3.25	5.10	—	4.05	0.87	3.78	6.48	1.55	0.15	0.90	0.80	1.06	—	0.56	3.95	1.75	3.45	1.35	1.73	—
	1950	**41**	**6.0**	**4.0**	**21.6**	**26.0**	**40.8**	—	**32.4**	**7.0**	**30.2**	**51.8**	**12.4**	**1.2**	**7.2**	**6.4**	**8.5**	—	**4.5**	**31.6**	**14.0**	**27.6**	**10.8**	**13.8**	—
HT223	〃 16	12.81	0.65	0.55	2.80	3.40	5.40	—	—	1.05	3.90	6.35	1.55	0.29	1.10	0.88	1.14	—	0.54	4.30	1.80	3.80	1.35	1.90	—
	1950	**42**	**5.1**	**4.3**	**21.9**	**26.5**	**42.2**	—	—	**8.2**	**30.4**	**49.6**	**12.1**	**2.3**	**8.6**	**6.9**	**8.9**	—	**4.2**	**33.6**	**14.1**	**29.7**	**10.5**	**14.8**	—
HT228	〃 17	12.81	0.90	0.45	2.95	3.10	5.35	—	4.12	0.90	3.72	6.42	1.30	—	—	—	—	—	—	4.05	1.70	3.73	1.25	1.70	—
	1950	**42**	**7.0**	**3.5**	**23.0**	**24.2**	**41.8**	—	**32.2**	**7.0**	**29.0**	**50.1**	**10.1**	—	—	—	—	—	—	**31.6**	**13.3**	**29.1**	**9.8**	**13.3**	—
HT229	〃 17	12.81	0.70	0.45	2.65	3.15	5.10	—	4.50	0.86	3.73	6.38	1.60	—	—	—	—	—	—	4.10	1.65	3.65	1.30	1.69	—
	1950	**42**	**5.5**	**3.5**	**20.7**	**24.6**	**39.8**	—	**35.1**	**6.7**	**29.1**	**49.8**	**12.5**	—	—	—	—	—	—	**32.0**	**12.9**	**28.5**	**10.1**	**13.2**	—
HT231	〃 17	12.81	0.75	0.41	2.80	3.30	5.30	—	4.20	0.82	3.50	6.25	1.65	—	—	—	—	—	—	4.35	—	—	—	1.77	—
	1950	**42**	**5.9**	**3.2**	**21.9**	**25.8**	**41.4**	—	**32.8**	**6.4**	**27.3**	**48.8**	**12.9**	—	—	—	—	—	—	**34.0**	—	—	—	**13.8**	—
HT418	Oct. 12	12.85	0.61	0.39	2.73	3.51	5.20	—	4.00	0.90	3.82	6.50	1.43	0.25	1.10	—	—	—	—	4.12	1.70	3.60	—	1.77	—
	1950	**42**	**4.7**	**3.0**	**21.2**	**27.3**	**40.5**	—	**31.1**	**7.0**	**29.7**	**50.6**	**11.1**	**1.9**	**8.6**	—	—	—	—	**32.1**	**13.2**	**28.0**	—	**13.8**	—
HT205	Aug. 13	13.12	0.63	0.57	2.90	3.20	5.30	—	4.01	0.81	3.86	6.36	1.40	0.30	1.48	—	—	—	—	4.20	1.63	3.81	1.45	1.77	—
	1950	**43**	**4.8**	**4.3**	**22.1**	**24.4**	**40.4**	—	**30.6**	**6.2**	**29.4**	**48.5**	**10.7**	**2.3**	**11.3**	—	—	—	—	**32.0**	**12.4**	**29.0**	**11.1**	**13.5**	—
HT123	June 14	13.21	0.95	0.60	2.90	3.35	6.00	—	—	1.10	3.85	6.80	1.85	0.29	1.41	—	—	—	—	—	—	—	—	2.15	—
	1951	**43**	**7.2**	**4.5**	**22.0**	**25.4**	**45.4**	—	—	**8.3**	**29.1**	**51.5**	**14.0**	**2.2**	**10.7**	—	—	—	—	—	—	—	—	**16.3**	—
HT181	Aug. 9	13.25	0.73	0.55	2.75	3.15	5.40	—	4.45	0.93	3.96	6.56	1.60	0.16	1.00	—	—	—	—	4.10	1.70	3.40	1.45	1.86	—
	1951	**43**	**5.5**	**4.2**	**20.8**	**23.8**	**40.8**	—	**33.6**	**7.0**	**29.9**	**49.5**	**12.1**	**1.2**	**7.5**	—	—	—	—	**30.9**	**12.8**	**25.7**	**10.9**	**14.0**	—
HT180	〃 9	13.40	0.60	0.55	2.65	3.20	5.40	—	4.20	1.00	3.86	6.05	1.60	0.16	1.00	0.82	1.15	—	0.62	4.45	1.85	3.75	1.45	1.92	—
	1950	**44**	**4.5**	**4.1**	**19.8**	**23.9**	**40.3**	—	**31.3**	**7.5**	**28.8**	**45.2**	**11.9**	**1.2**	**7.5**	**6.1**	**8.6**	—	**4.6**	**33.2**	**13.8**	**28.0**	**10.8**	**14.3**	—
HT182	〃 9	13.40	0.65	—	2.95	3.45	5.60	—	4.35	0.90	4.15	7.00	1.55	0.27	1.66	—	—	—	—	4.20	1.75	3.95	1.30	1.95	—
	1951	**44**	**4.9**	—	**22.0**	**25.7**	**41.8**	—	**32.5**	**6.7**	**31.0**	**52.2**	**11.6**	**2.0**	**12.4**	—	—	—	—	**31.3**	**13.1**	**29.5**	**9.7**	**14.6**	—
HN297	〃 27	13.40	0.88	0.58	3.25	3.70	6.12	—	4.40	0.91	3.70	7.15	1.21	0.20	0.89	0.87	1.23	—	0.59	4.65	1.95	3.90	1.50	—	—
	1951	**44**	**6.6**	**4.3**	**24.3**	**27.6**	**45.7**	—	**32.8**	**6.8**	**27.6**	**53.4**	**9.0**	**1.5**	**6.6**	**6.5**	**9.2**	—	**4.4**	**34.7**	**14.6**	**29.1**	**11.2**	—	—
HT202	Aug. 13	13.42	0.69	0.52	3.10	3.30	5.80	—	4.20	0.91	3.65	6.40	1.55	0.24	1.30	0.94	1.28	—	0.64	4.42	1.92	3.45	1.37	1.86	—
	1950	**44**	**5.1**	**3.9**	**23.1**	**24.6**	**43.2**	—	**31.3**	**6.8**	**27.2**	**47.7**	**11.6**	**1.8**	**9.7**	**7.0**	**9.5**	—	**4.8**	**32.9**	**14.3**	**25.7**	**10.2**	**13.9**	—
HT211	〃 14	13.42	0.72	0.53	3.15	3.33	5.75	—	4.22	0.90	3.67	6.44	1.63	0.23	1.25	0.93	1.25	—	0.65	4.48	—	—	—	1.85	—
	1950	**44**	**5.4**	**3.9**	**23.5**	**24.8**	**42.8**	—	**31.4**	**6.7**	**27.3**	**48.0**	**12.1**	**1.7**	**9.3**	**6.9**	**9.3**	—	**4.8**	**33.4**	—	—	—	**13.8**	—
HT230	〃 17	13.42	—	—	—	—	—	—	4.33	0.81	—	—	—	—	—	—	—	—	—	4.22	—	—	—	1.50	—
	1950	**44**	—	—	—	—	—	—	**32.3**	**6.0**	—	—	—	—	—	—	—	—	—	**31.4**	—	—	—	**11.2**	—

IV. Japanese coastal, males, 1950 & 1951 (cont.)

Area[1], Company[2], Serial No.	Date, Killed	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	22	22	23	23	25
HT251	〃 26	13.42	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4.21	1.83	3.51	1.31	—	—
	1950	**44**	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**31.4**	**13.6**	**26.2**	**9.8**	—	—
HT203	July 30	13.70	—	0.61	—	3.61	6.18	—	4.60	1.04	4.07	6.66	1.75	0.47	0.75	0.98	1.50	—	—	—	—	4.10	1.25	2.07	—
	1950	**45**	—	**4.5**	—	**26.3**	**45.1**	—	**33.6**	**7.6**	**29.7**	**48.6**	**12.8**	**3.4**	**5.5**	**7.2**	**10.9**	—	—	—	—	**29.9**	**9.1**	**15.1**	—
HT203	Aug. 13	13.73	0.86	0.49	3.20	3.70	6.60	—	4.40	0.96	3.70	6.60	1.10	0.31	—	—	—	—	—	4.60	1.83	3.70	1.28	1.79	—
	1950	**45**	**6.3**	**3.6**	**23.3**	**26.9**	**48.1**	—	**32.0**	**7.0**	**26.9**	**48.1**	**8.0**	**2.3**	—	—	—	—	—	**33.5**	**13.3**	**26.9**	**9.3**	**13.0**	—
HN300	Aug. 27	14.05	1.07	0.50	3.37	3.57	6.40	—	4.60	1.00	4.15	7.05	1.75	0.21	1.15	1.08	1.40	—	0.69	4.60	2.03	3.95	1.60	1.90	—
	1950	**46**	**7.6**	**3.6**	**24.0**	**25.4**	**45.5**	—	**32.7**	**7.1**	**29.5**	**50.2**	**12.5**	**1.5**	**8.2**	**7.7**	**10.0**	—	**4.9**	**32.7**	**14.4**	**28.1**	**11.4**	**13.5**	—
HT350	Sept. 24	14.25	1.07	0.65	3.35	3.70	6.30	—	4.80	0.80	3.65	6.70	—	0.53	0.90	1.20	1.70	—	—	4.90	—	4.35	—	1.70	—
	1950	**47**	**7.5**	**4.6**	**23.5**	**26.0**	**44.2**	—	**33.7**	**5.6**	**25.6**	**47.0**	—	**3.7**	**6.3**	**8.4**	**11.9**	—	—	**34.4**	—	**30.5**	—	**11.9**	—
HT351	〃 24	14.50	1.10	0.68	3.55	3.80	6.25	—	4.95	0.75	4.10	6.55	—	0.50	0.78	1.28	1.76	—	—	4.90	—	4.40	—	1.78	—
	〃	**48**	**7.6**	**4.7**	**24.5**	**26.2**	**43.1**	—	**34.1**	**5.2**	**28.3**	**45.2**	—	**3.4**	**5.4**	**8.8**	**12.1**	—	—	**33.8**	—	**30.3**	—	**12.3**	—
HN 68	June 18	14.67	—	0.50	—	4.00	6.70	0.50	4.00	1.15	4.00	—	—	2.25	1.00	0.85	1.10	—	0.65	—	2.00	4.40	—	—	—
	1951	**48**	—	**3.4**	—	**27.3**	**45.7**	**3.4**	**27.3**	**7.8**	**27.3**	—	—	**1.5**	**6.8**	**5.8**	**7.5**	—	**4.4**	—	**13.6**	**30.0**	—	—	—
HT158	Aug. 3	14.90	0.90	0.58	3.20	3.70	6.20	0.42	5.00	0.90	4.50	7.60	—	0.22	1.40	—	—	—	—	4.80	1.80	4.00	1.40	2.20	—
	1950	**49**	**6.0**	**3.9**	**21.5**	**24.8**	**41.6**	**2.8**	**33.6**	**6.0**	**30.2**	**51.0**	—	**1.5**	**9.4**	—	—	—	—	**32.2**	**12.1**	**26.8**	**9.4**	**14.8**	—
HT122	June 14	15.05	1.00	0.80	3.90	4.50	7.00	—	4.15	1.10	4.10	7.00	1.80	0.38	1.24	0.90	1.30	—	0.69	—	—	—	—	2.20	—
	1951	**49**	**6.6**	**5.3**	**25.9**	**29.9**	**46.5**	—	**27.6**	**7.3**	**27.2**	**46.5**	**12.0**	**2.5**	**8.2**	**6.0**	**8.6**	—	**4.6**	—	—	—	—	**14.6**	—
HT 49	June 30	15.30	0.97	0.65	3.60	4.00	6.40	—	5.30	1.05	4.25	7.30	1.75	—	0.85	1.30	1.63	—	—	—	—	—	—	2.21	—
	1950	**50**	**6.3**	**4.2**	**23.5**	**26.1**	**41.8**	—	**34.6**	**6.9**	**27.8**	**47.7**	**11.4**	—	**5.6**	**8.5**	**10.7**	—	—	—	—	—	—	**14.4**	—
HT248	July 30	15.32	1.10	0.52	3.80	4.17	7.25	0.58	5.00	1.09	4.25	6.90	1.75	—	0.90	0.98	1.15	—	0.70	—	—	—	—	2.20	—
	1950	**50**	**7.2**	**3.4**	**24.8**	**27.2**	**47.3**	**3.8**	**32.6**	**7.1**	**27.7**	**45.0**	**11.4**	—	**5.9**	**6.4**	**7.5**	—	**4.6**	—	—	—	—	**14.4**	—
HT243	Aug. 22	15.56	0.95	0.65	4.03	4.51	6.85	—	4.90	—	4.10	7.10	1.95	0.28	1.00	1.08	1.40	—	0.72	5.67	2.12	4.85	1.68	2.08	—
	1950	**51**	**6.1**	**4.2**	**25.9**	**29.0**	**44.0**	—	**31.5**	—	**26.4**	**45.6**	**12.5**	**1.8**	**6.4**	**6.9**	**9.0**	—	**4.6**	**36.4**	**13.6**	**31.2**	**10.8**	**13.4**	—
HT155	Aug. 1	15.60	0.95	0.74	3.70	4.10	6.80	0.52	4.80	0.70	4.40	7.20	1.70	0.34	0.85	1.05	1.41	—	0.72	5.40	2.10	4.70	1.70	2.10	—
	1950	**51**	**6.1**	**4.7**	**23.7**	**26.3**	**43.6**	**3.3**	**30.8**	**4.5**	**28.2**	**46.2**	**10.9**	**2.2**	**5.4**	**6.7**	**9.0**	—	**4.6**	**34.6**	**13.5**	**30.1**	**10.9**	**13.5**	—
HT186	Aug. 11	15.65	1.07	0.77	3.80	4.40	6.80	—	4.90	1.15	4.55	7.55	1.60	0.27	1.38	1.00	1.40	—	0.76	5.48	2.19	4.45	1.57	2.28	—
	1950	**51**	**6.8**	**4.9**	**24.3**	**28.1**	**43.5**	—	**31.3**	**7.3**	**29.1**	**48.2**	**10.2**	**1.7**	**8.8**	**6.4**	**8.9**	—	**4.9**	**35.0**	**14.0**	**28.4**	**10.0**	**14.6**	—
HN 50	May 17	15.65	1.30	0.80	3.80	4.10	6.90	0.50	4.90	1.40	4.32	7.20	1.78	0.31	1.15	—	—	—	—	—	2.00	4.60	—	—	—
	1951	**51**	**8.3**	**5.1**	**24.3**	**26.2**	**44.1**	**3.2**	**31.3**	**8.9**	**27.6**	**46.0**	**11.4**	**2.0**	**7.3**	—	—	—	—	—	**12.8**	**29.4**	—	—	—
HN 69	June 18	15.85	1.30	0.70	—	4.10	6.90	—	5.00	1.10	4.80	7.20	1.40	0.35	1.20	0.90	1.20	—	—	—	2.20	4.70	—	—	—
	1951	**52**	**8.2**	**4.4**	—	**25.9**	**43.5**	—	**31.5**	**6.9**	**30.3**	**45.4**	**8.8**	**2.2**	**7.6**	**5.7**	**7.6**	—	—	—	**13.9**	**29.7**	—	—	—

IV. Japanese coastal, males, 1950 & 1951 (cont.)

Area1), Company2), Serial No.	Date, Killed	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	22	23	24	25
HT125	June 20	15.90	1.15	0.45	3.75	4.20	6.80	—	5.09	1.15	4.55	7.60	1.70	0.42	1.50	1.00	1.35	—	0.62	—	—	4.80	—	2.15	—
	1951	**52**	**7.2**	**2.8**	**23.6**	**26.4**	**42.8**	—	**32.0**	**7.2**	**28.6**	**47.8**	**10.7**	**2.6**	**9.4**	**6.3**	**8.5**	—	**3.9**	—	—	**30.2**	—	**13.5**	—
HT163	Aug. 5	16.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.30	4.90	1.90	—	—
	1950	**52**	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**14.4**	**30.6**	**11.9**	—	—
HT226	〃 17	16.17	1.24	0.65	4.12	4.85	7.35	—	5.05	1.05	4.75	7.55	1.65	0.29	1.55	1.10	1.40	—	0.69	6.05	2.23	4.95	1.70	2.00	—
	〃	**53**	**7.7**	**4.0**	**25.5**	**30.0**	**45.5**	—	**31.2**	**6.5**	**29.4**	**46.7**	**10.2**	**1.8**	**9.6**	**6.8**	**8.7**	—	**4.3**	**37.4**	**13.8**	**30.6**	**10.5**	**12.4**	—
HT414	Oct. 11	16.95	1.14	0.67	4.35	4.45	7.15	—	5.10	1.10	5.00	8.05	1.60	0.75	1.40	1.43	1.88	—	—	5.72	—	5.00	—	2.35	—
	〃	**56**	**6.7**	**4.0**	**25.7**	**26.3**	**42.2**	—	**30.1**	**6.5**	**29.5**	**47.5**	**9.4**	**4.4**	**8.3**	**8.4**	**11.1**	—	—	**33.7**	—	**29.5**	—	**13.9**	—

Remaks 1) H: Pacific coast of Hokkaido 2) T: Taiyo gyogyo Co. K: Kyokuyo hogei Co.
S: Sanrika area N: Nihon suisan Co. Ki: Kinkai hogei Co.

V. Japanese coastal, females, 1950 & 1951

Area[1], Company[2], Serial No.	Date, Killed	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	22	23	24	25
HT172	Aug. 8	10.60	0.40	0.37	1.75	2.10	3.75	0.30	3.80	0.72	3.30	5.40	0.30	—	—	—	—	—	—	2.90	1.25	2.50	0.95	1.47	—
	1950	**35**	**3.8**	**3.5**	**16.5**	**19.8**	**35.4**	**2.8**	**35.8**	**6.8**	**31.1**	**50.9**	**2.8**	—	—	—	—	—	—	**27.4**	**11.8**	**23.6**	**9.0**	**13.9**	—
HT179	〃 9	10.60	0.37	0.53	2.00	2.30	3.70	—	3.95	0.72	3.30	5.90	0.30	—	—	—	—	—	—	3.15	1.40	2.75	1.05	1.47	—
	1950	**35**	**3.5**	**5.0**	**18.9**	**21.7**	**34.9**	—	**37.3**	**6.8**	**31.1**	**55.7**	**2.8**	—	—	—	—	—	—	**29.7**	**13.2**	**25.9**	**9.9**	**13.9**	—
HT234	〃 19	10.68	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.80	1.30	2.57	1.05	—	—
	1950	**35**	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**26.2**	**12.2**	**24.1**	**9.8**	—	—
HT236	〃 19	10.68	—	—	—	—	—	—	4.15	—	—	—	—	—	—	—	—	—	—	2.86	1.39	2.75	1.05	—	—
	1950	**35**	—	—	—	—	—	—	**38.9**	—	—	—	—	—	—	—	—	—	—	**26.8**	**13.0**	**25.7**	**9.8**	—	—
HT237	〃 19	10.68	0.35	0.40	1.75	1.95	3.90	—	4.02	0.55	3.80	5.20	0.25	0.23	1.00	—	—	—	—	2.75	1.40	2.65	1.05	1.35	—
	1950	**35**	**3.3**	**3.7**	**16.4**	**18.3**	**36.5**	—	**37.6**	**5.5**	**35.6**	**48.7**	**2.3**	**2.2**	**9.4**	—	—	—	—	**25.7**	**13.1**	**24.8**	**9.8**	**12.6**	—
HT238	〃 19	10.68	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.20	2.75	1.00	—	—
	1950	**35**	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**11.2**	**25.7**	**9.4**	—	—
HT239	〃 19	10.68	0.45	0.35	1.75	2.00	3.60	—	3.96	0.73	3.95	4.50	0.20	—	—	—	—	—	—	2.65	1.33	2.42	1.08	1.50	—
	1050	**35**	**4.2**	**3.3**	**16.4**	**18.7**	**33.7**	—	**37.1**	**6.8**	**37.0**	**42.1**	**1.9**	—	—	—	—	—	—	**24.8**	**12.5**	**22.7**	**10.1**	**14.0**	—
HT170	〃 8	10.70	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.85	1.33	2.48	—	—	—
	1950	**35**	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**26.6**	**12.4**	**23.2**	—	—	—
HT176	〃 8	10.70	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.85	1.23	2.50	0.95	—	—
	1950	**35**	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**26.6**	**11.5**	**23.4**	**8.9**	—	—
HT146	July 30	10.72	0.32	0.40	1.70	2.10	3.80	0.45	—	0.95	3.70	4.65	0.30	0.26	0.95	0.77	0.98	—	0.50	2.95	—	—	—	1.58	—
	1950	**35**	**3.0**	**3.7**	**15.9**	**19.6**	**35.4**	**4.2**	—	**8.9**	**34.5**	**43.4**	**2.8**	**2.4**	**8.9**	**7.2**	**9.1**	—	**4.7**	**27.5**	—	—	—	**14.7**	—
HT168	Aug. 8	10.80	0.35	—	1.70	2.15	3.80	—	3.80	0.71	3.20	5.70	0.20	0.19	1.00	—	—	—	—	3.15	1.35	2.70	1.00	1.45	—
	1950	**35**	**3.2**	—	**15.7**	**19.9**	**35.2**	—	**35.2**	**6.6**	**29.6**	**52.8**	**1.9**	**1.8**	**9.3**	—	—	—	—	**29.2**	**12.5**	**25.0**	**9.3**	**13.4**	—
HN285	〃 23	10.80	0.38	0.38	1.83	2.17	4.10	—	4.20	0.85	3.50	6.10	0.60	0.23	1.15	0.70	1.04	—	0.49	3.00	1.40	2.65	1.04	1.45	—
	1950	**35**	**3.5**	**3.5**	**16.9**	**20.1**	**38.0**	—	**38.9**	**7.9**	**32.4**	**56.0**	**5.6**	**2.1**	**10.6**	**6.5**	**9.6**	—	**4.5**	**27.8**	**13.0**	**24.5**	**9.6**	**13.4**	—
HT109	June 3	10.87	0.37	0.41	1.85	2.10	3.75	—	3.70	0.79	3.10	5.70	0.30	0.18	0.95	—	—	—	—	—	—	—	—	1.50	—
	1951	**36**	**3.4**	**3.8**	**17.0**	**19.3**	**34.5**	—	**34.0**	**7.3**	**28.5**	**52.4**	**2.8**	**1.7**	**8.7**	—	—	—	—	—	—	—	—	**13.8**	—
HK 50	Aug. 19	10.90	0.45	0.35	1.60	2.10	3.90	0.30	3.70	0.80	3.60	6.10	0.20	—	0.65	0.70	1.00	—	0.50	—	—	—	—	1.40	—
	1950	**36**	**4.1**	**3.2**	**14.7**	**19.3**	**35.8**	**2.8**	**33.9**	**9.3**	**33.0**	**56.0**	**1.8**	—	**6.0**	**6.4**	**9.2**	—	**4.6**	—	—	—	—	**12.8**	—
HT108	June 3	10.97	0.30	0.37	1.87	2.21	3.80	—	3.63	0.78	3.10	5.80	0.25	0.22	0.86	—	—	—	—	—	—	—	—	1.80	—
	1951	**36**	**2.7**	**3.4**	**17.0**	**20.1**	**34.6**	—	**33.1**	**7.1**	**28.3**	**52.9**	**2.3**	**2.0**	**7.8**	—	—	—	—	—	—	—	—	**16.4**	—
HT233	Aug. 19	10.98	—	—	—	—	—	—	3.80	—	—	—	—	—	—	—	—	—	—	3.15	1.48	2.78	—	—	—
	1950	**36**	—	—	—	—	—	—	**34.6**	—	—	—	—	—	—	—	—	—	—	**28.7**	**13.5**	**25.3**	—	—	—

V. Japanese coastal, females, 1950 & 1951 (cont.)

Area[1]), Company[2]), Serial No.	Date, Killed	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18	19	20	21	22	23	24	25
HT242	〃 21	10.98	—	—	—	2.10	—	—	—	—	—	—	—	—	—	—	—	—	—	2.75	1.28	2.40	1.00	—	—
	1950	**36**	—	—	—	**19.1**	—	—	—	—	—	—	—	—	—	—	—	—	—	**25.0**	**11.7**	**21.9**	**9.1**	—	—
HT147	July 30	11.00	0.30	0.35	1.35	1.70	3.75	—	4.33	0.80	3.60	4.75	0.35	0.24	1.00	0.80	1.02	—	0.52	2.90	—	—	—	1.48	—
	1950	**36**	**2.7**	**3.2**	**12.3**	**15.5**	**34.1**	—	**39.4**	**7.3**	**32.7**	**43.2**	**3.2**	**2.2**	**9.1**	**7.3**	**9.3**	—	**4.7**	**26.4**	—	—	—	**13.5**	—
HT169	Aug. 8	11.00	0.37	—	—	2.20	4.00	—	4.00	0.96	3.60	5.90	0.30	—	—	—	—	—	—	3.15	1.30	2.80	1.05	1.60	—
	〃	**36**	**3.4**	—	—	**20.0**	**36.4**	—	**36.4**	**8.7**	**32.7**	**53.6**	**2.7**	—	—	—	—	—	—	**28.6**	**11.8**	**25.5**	**9.5**	**14.5**	—
HT187	〃 11	11.00	0.41	0.51	2.00	2.17	3.60	—	4.10	0.73	3.22	5.72	0.15	0.21	0.85	—	—	—	—	3.10	1.45	2.85	1.05	1.53	—
	〃	**36**	**3.7**	**4.6**	**18.2**	**19.7**	**32.7**	—	**37.3**	**6.6**	**29.3**	**52.0**	**1.4**	**1.9**	**7.7**	—	—	—	—	**28.2**	**13.2**	**25.9**	**9.5**	**13.9**	—
HT188	〃 11	11.00	0.48	0.41	2.17	2.28	4.23	—	3.50	0.70	3.32	5.75	0.10	0.23	0.85	—	—	—	—	3.28	1.46	2.92	1.06	1.52	—
	〃	**36**	**4.4**	**3.7**	**19.7**	**20.7**	**38.5**	—	**31.8**	**6.4**	**30.2**	**52.3**	**0.9**	**2.1**	**7.7**	—	—	—	—	**29.8**	**13.3**	**26.5**	**9.6**	**13.8**	—
HT191	〃 11	11.00	0.47	0.36	1.83	2.23	—	—	3.70	0.74	3.53	5.81	0.31	—	—	0.68	1.03	—	0.55	3.25	1.44	2.90	1.10	1.57	—
	〃	**36**	**4.3**	**3.3**	**16.6**	**20.3**	—	—	**33.6**	**6.7**	**32.1**	**52.8**	**2.8**	—	—	**6.2**	**9.4**	—	**5.0**	**29.5**	**13.1**	**26.4**	**10.0**	**14.3**	—
HT189	〃 11	11.30	0.38	0.45	1.93	2.10	3.91	—	3.55	0.70	3.39	5.85	0.20	0.24	1.13	—	—	—	—	2.92	—	—	—	1.56	—
	〃	**37**	**3.4**	**4.0**	**17.1**	**18.6**	**34.6**	—	**34.1**	**6.2**	**30.0**	**51.8**	**1.8**	**2.1**	**10.0**	—	—	—	—	**25.8**	—	—	—	**13.8**	—
HN290	Aug. 25	11.30	0.42	0.46	1.93	2.38	4.43	0.38	3.85	0.95	—	6.00	0.65	0.32	1.00	—	—	—	—	3.18	1.50	2.90	—	—	—
	〃	**37**	**3.7**	**4.1**	**17.1**	**21.1**	**39.2**	**3.4**	**34.1**	**8.4**	—	**53.1**	**5.8**	**2.8**	**8.9**	—	—	—	—	**28.1**	**13.3**	**25.7**	—	—	—
HT167	〃 8	11.40	0.32	0.45	1.95	2.10	4.25	0.38	4.50	0.80	3.60	5.60	0.20	—	—	—	—	—	—	3.10	1.45	2.75	1.15	1.78	—
	〃	**37**	**2.8**	**3.9**	**17.1**	**18.4**	**37.3**	**3.3**	**39.5**	**7.0**	**31.6**	**49.1**	**1.8**	—	—	—	—	—	—	**27.2**	**12.7**	**24.1**	**10.1**	**15.6**	—
HT135	June 23	11.40	0.45	0.45	1.80	2.25	4.10	—	4.15	0.77	3.55	6.10	0.45	0.27	0.91	—	—	—	—	—	—	—	—	1.55	—
	〃	**37**	**3.9**	**3.9**	**15.8**	**19.7**	**36.0**	—	**36.4**	**6.8**	**31.1**	**53.5**	**3.9**	**2.4**	**8.0**	—	—	—	—	—	—	—	—	**13.6**	—
HT174	Aug. 8	11.60	0.32	0.48	2.05	2.45	4.20	—	4.25	0.80	3.75	6.55	0.20	0.20	1.00	—	—	—	—	3.10	—	—	—	1.75	—
	〃	**38**	**2.8**	**4.1**	**17.7**	**21.1**	**36.2**	—	**36.6**	**6.9**	**32.3**	**56.5**	**1.7**	**1.7**	**8.6**	—	—	—	—	**26.7**	—	—	—	**15.1**	—
HT195	〃 11	11.60	0.33	0.44	2.07	2.55	—	—	—	0.86	—	—	—	—	—	—	—	—	—	2.97	1.40	2.75	1.25	1.64	—
	〃	**38**	**2.8**	**3.8**	**17.8**	**22.0**	—	—	—	**7.4**	—	—	—	—	—	—	—	—	—	**25.6**	**12.1**	**23.7**	**10.8**	**14.1**	—
HK 51	〃 19	11.70	—	0.48	2.20	2.60	4.50	0.30	4.15	0.85	3.45	6.05	0.35	—	0.95	0.86	1.13	—	0.52	—	—	—	—	1.46	—
	〃	**38**	—	**4.1**	**18.8**	**22.2**	**38.5**	**2.6**	**35.5**	**7.3**	**29.5**	**51.7**	**3.0**	—	**8.1**	**7.4**	**9.7**	—	**4.4**	—	—	—	—	**12.5**	—
HT250	〃 24	11.90	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3.43	—	2.95	1.12	—	—
	〃	**39**	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	**28.8**	—	**24.8**	**9.4**	—	—


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On the Serological Constitution of the Fin Whales
II. Further Studies on Blood Groups

By

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Introduction

Blood groups of the fin whales, *Balaenoptera physalus*, have been classified into four types (Bp system) as stated in the previous report (Fujino, K. 1953)1). After further investigation on the antigen which is contained in the erythrocytes of fin whales, two kinds of new agglutinogens, i.e. Ju1 and Ju2, were found by agglutination between immune antiserum and erythrocytes of fin whales. By the existence of these antigens blood cells of fin whales were classified, independently to Bp system, into three kinds, namely Ju1Ju2, Ju1 and Ju2, and consequently they were classified into twelve kinds as the combination of Bp and Ju systems. Furthermore, besides the four kinds of antigens belonging to Bp and Ju systems a new agglutinogen "X" was found in Bp2Ju1 and OJu1 type fin whale blood cells by immune antiserum, but the correlation between X-antigen and the already known blood groups has not been enough examined up to the present.

After examing the blood groups of fin whales caught from the northern part of the North Pacific Ocean in the years 1954 and 1955 in relation to the Bp and the Ju systems, remarkable differences were seen in frequency of the occurrence of these blood groups between the fin whales from ground off Kamchatka and those from ground off Alaska. In the present report, the results obtained in these two years are discussed in reference to those stated in the previous report.

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Material and Method

Preservation of the erythrocytes of whales: The erythrocytes of whales used as immune antigen were preserved for the purpose of adsorption test of antiserum in classification of blood groups. When collecting the blood, following solution, 1/10 volume of blood, was added to the blood as preservative, and then such material was kept in ice-box.

Na-chloride	8.5 g.
Na-citrate	50.0 g.
Guanofuracin	5.0 g.
(5-Nitro-2-furfurylidene-aminoguanidine Hydrochloride)	
Aqua.........................	1000.0 ml.

When the blood was collected in fresh condition and was preserved by this method, the erythrocytes was kept in good condition available for adsorption test during three weeks or more, which is the required period for production of antibody in normal (seven times') immunization. After several times' cleaning with salt solution, these preserved erythrocytes are used for agglutination and adsorption test. In this case, no effect of guanofuracin was recognized on these reactions. In all other respects with regard to erythrocytes of human being, immune animal, immunizing method, collecting and preserving method of anti-serum, testing methods of agglutination and adsorption tests, the materials and methods were just the same as in the previous work.

Experiment and Result

a) *Classification of Ju system blood groups.* When a rabbit is immunized with O type cells belonging to Bp system, immune antibodies against these cells are produced in the rabbit serum. By the cross reaction of this immune antiserum with several kinds of O cells belonging to Bp system, two kinds of new agglutinogens, i.e. Ju1 and Ju2 which are different from the antigens of Bp system, were found. Two examples of the cross reaction (agglutination) are shown in table 1.

Table 1

Cross reactions (agglutination) of immune antisera of rabbits immunized with O cells by several kinds of O cells belonging to Bp system

a) In case of anti-428 (OJu1) erythrocytes immune serum

* **	No. 170	No. 171	No. 172	No. 177	No. 178	No. 179
No. 170	−	−	−	−	−	−
No. 171	+	−	+	+	+	−
No. 172	−	−	−	−	−	−
No. 177	−	−	−	−	−	−
No. 178	−	−	−	−	−	−
No. 179	+	−	+	+	+	−
Blood group	Ju1	Ju2	Ju1	Ju1	Ju1Ju2	Ju2

b) In case of anti-867 (OJu2) erythrocytes immune serum

* **	No. 170	No. 171	No. 172	No. 177	No. 178	No. 179
No. 170	−	+	−	−	+	+
No. 171	−	−	−	−	−	−
No. 172	−	+	−	−	+	+
No. 177	−	+	−	−	+	+
No. 178	−	−	−	−	−	−
No. 179	−	−	−	−	−	−
Blood group	Ju1	Ju2	Ju1	Ju1	Ju1Ju2	Ju2

Remark: * cells used for agglutination. ** cells used for adsorption.

When a rabbit is immunized with the fin whale blood cells which belong to OJu1, the anti-Ju1 and the species specific agglutinins are produced in the serum of the rabbit. If the latter antibody is adsorbed away with OJu2 corpuscles, the anti-Ju1 immune antibody is obtained. The anti-Ju2 immune antibody is also obtained by the same operation. By the agglutination between these immune antibodies and erythrocytes, it was proved that the two kinds of agglutinogens, namely Ju1 and Ju2, exist in the blood corpuscles of fin whales. By these antigens, the blood groups of fin whales were classified independently to Bp system into three kinds, namely Ju1Ju2, Ju1 and Ju2, and in consequence they were classified into following twelve kinds of types by the combination of Bp and Ju systems.

Table 2
Blood groups of fin whales in Bp and Ju systems

Bp system Ju system	Bp1Bp2	Bp1	Bp2	O
Ju1Ju2	Bp1Bp2Ju1Ju2	Bp1Ju1Ju2	Bp2Ju1Ju2	OJu1Ju2
Ju1	Bp1Bp2Ju1	Bp1Ju1	Bp2Ju1	OJu1
Ju2	Bp1Bp2Ju2	Bp1Ju2	Bp2Ju2	OJu2

b) *New agglutinogen X detected by immune antibody.* When a rabbit is immunized with the blood cells which belong to OJu1 group, anti-Ju1 antiserum is produced by the immune animal. After examing the adsorption test of this antiserum with several kinds of OJu1 blood cells, it was proved that a new antigen "X", which belonged to neither Bp nor Ju systems in already known classification, was contained in the OJu1 type blood cells of fin whales. This antigen X is also detected in Bp2Ju1 type cells besides in OJu1 cells, but the existence of this antigen in other kinds of cells belonging to Bp and Ju systems has not been examined completely yet up to the present.

c) *Preparation of reagents (standard sera).* As the existences of antigens of Ju system and X are confirmed positively, in case of preparation of the reagent (standard serum) regarding to Bp system blood groups, it is necessary to make clear whether Ju1 or Ju2 antigens are contained in the erythrocytes of immune antigen and to select the cells not containing X antigen as immune antigen.

1) Anti-Bp1 immune antiserum. When a rabbit is immunized with the fin whale blood cells, which belong to Bp1Ju1 group without X antigen, three kinds of immune antibodies, namely anti-Bp1, anti-Ju1 and species specific antibodies, are produced in the serum of the rabbit. If the anti-Ju1 and species specific antibodies are adsorbed away from this antiserum with OJu1 type cells, the anti-Bp1 antibody may be obtained. In case of using Bp1Ju2 and OJu2 cells as the immune and adsorbing antigens respectively, the anti-Bp1 antibody is also to be obtained by the same operation.

2) Anti-Bp2 immune antiserum. In case of preparation of anti-Bp2 immune antiserum, Bp2Ju1 cells without X antigen and OJu1 cells are used as the immune antigen and the adsorbing antigen respectively in the same operation as stated in the previous paragraph 1). When the Bp2Ju2 cells without X antigen and OJu2 cells are used as the immune and adsorbing antigens respectively, the anti-Bp2 antibody is also to be obtained.

3) Anti-Ju1 immune antiserum. As already stated in section a), in case of preparation of anti-Ju1 immune antiserum OJu1 cells without X antigen are used as immune antigen and OJu2 cells are used for adsorption of species specific antibody.

4) Anti-Ju2 immune antiserum. If OJu2 cells without X antigen and OJu1 cells are used as immune and adsorbing antigens respectively, anti-Ju2 antibody is to be obtained in the same operation.

5) Anti-X immune antiserum. After being a rabbit immunized with OJu1 cells with X antigen, anti-X, anti-Ju1 and species specific antibodies are produced in the serum of this rabbit. If the latter two kinds of antibodies are adsorbed away by the OJu1 cells without X antigen, anti-X antibody may be obtained alone. In case of using Bp2Ju1 cells with X antigen and Bp2Ju1 cells without X antigen as the immune and adsorbing antigens respectively, the anti-X antibody is also to be made by the same treatment as abovestated.

d) *Agglutinin titer of immune antibody.* Each one example of agglutinin titer of immune antibody which was obtained by the stated operations is shown in table 3.

Table 3
Agglutinin titer of immune antibody

Immune rabbit No. Sex	Immune rabbit Serum type & A^{+} or A^{-}	Immune antigen	Immune antibody	Agglutinin titer Antigen Bp1	Bp2	Ju1	Ju2	X
29 M	o', A^{+}	No. 45, Bp1Ju2	Anti-Bp1, Anti-Ju2 agglu.	160	0	0	320	0
30 M	α', A^{-}	No. 1562, Bp2Ju2	Anti-Bp2, Anti-Ju2 ,,	0	800	0	400	0
31 F	o', A^{-}	No. 428, OJu1	Anti-Ju1 ,,	0	0	160	0	0
30 M	α', A^{-}	No. 1562, Bp2Ju2	Anti-Bp2, Anti-Ju2 ,,	0	800	0	400	0
32 F	α', A^{-}	No. 480, Bp2Ju2X^{+} a)	Anti-Bp2, Anti-Ju2, Anti-X ,,	0	200	0	400	20

Remark *a*) X antigen in No. 480 cells had not been examined prior to immunization. However, judging from the existence of anti-X antibody in the immune antiserum, the positive proof of X antigen in this cells may be assumed. X^{+} means the blood group possessing X antigen.

It is seen from this table that the anti-X antibody shows a remarkably low titer in comparing with those of the anti-Bp and anti-Ju antibodies.

Table 4
Blood group frequencies of fin whales taken from the northern part of the North Pacific Ocean
(upper figures: actual number of whales
lower figures: percentage of total number)

a) Catch in the year 1954
A-ground

Bp system \ Ju system	Ju1Ju2 male	Ju1Ju2 female	Ju1 male	Ju1 female	Ju2 male	Ju2 female	Total
Bp1Bp2	2	1	5	7	2	0	17
	1.0		3.8		0.6		5.4
Bp1	5	3	11	11	5	5	40
	2.5		7.0		3.2		12.7
Bp2	1	1	27	33	9	8	79
	0.6		19.0		5.4		25.0
0	6	5	80	58	20	11	180
	3.5		43.7		9.7		56.9
Total	14	10	123	109	36	24	316$^{a)}$
	7.6		73.5		18.9		100.0

B-ground

Ju system / Bp system	Ju1Ju2		Ju1		Ju2		Total
	male	female	male	female	male	female	
Bp1Bp2	0	0	0	0	0	0	0
	0.0		0.0		0.0		0.0
Bp1	0	0	0	0	0	0	0
	0.0		0.0		0.0		0.0
Bp2	1	0	20	17	1	1	40
	0.3		9.4		0.5		10.2
0	1	0	160	189	2	1	353
	0.3		88.8		0.7		89.8
Total	2	0	180	206	3	2	393[b]
	0.6		98.2		1.2		100.0

Remark: In the year 1954 no available data were taken from C-ground.
a) 56.0% of total catch of this ground. *b)* 67.2% of total catch of this ground.

b) Catch in the year 1955.
A-ground

Ju system / Bp system	Ju1Ju2		Ju1		Ju2		Total
	male	female	male	female	male	female	
Bp1Bp2	0	0	1	1	0	0	2
	0.0		1.8		0.0		1.8
Bp1	0	0	2	1	2	0	5
	0.0		2.6		1.8		4.4
Bp2	1	0	8	1	2	0	12
	0.9		7.9		1.8		10.6
0	2	0	37	46	4	5	94
	1.8		73.5		7.9		83.2
Total	3	0	48	49	8	5	113[c]
	2.7		85.8		11.5		100.0

B-ground

Ju system / Bp system	Ju1Ju2		Ju1		Ju2		Total
	male	female	male	female	male	female	
Bp1Bp2	0	0	0	0	0	0	0
	0.0		0.0		0.0		0.0
Bp1	0	0	0	0	0	0	0
	0.0		0.0		0.0		0.0
Bp2	1	1	131	135	4	1	273
	0.2		25.7		0.5		26.4
0	2	3	400	349	3	4	761
	0.5		72.4		0.7		73.6
Total	3	4	531	484	7	5	1034[d]
	0.7		98.1		1.2		100.0

C-ground

Ju system / Bp system	Ju1Ju2		Ju1		Ju2		Total
	male	female	male	female	male	female	
Bp1Bp2	0	0	0	0	0	0	0
	0.0		0.0		0.0		0.0
Bp1	0	0	0	0	0	0	0
	0.0		0.0		0.0		0.0
Bp2	0	0	9	6	1	0	16
	0.0		46.9		3.1		50.0
0	1	0	8	6	0	1	16
	3.1		43.8		3.1		50.0
Total	1	0	17	12	1	1	32[e)]
	3.1		90.7		6.2		100.0

Remark: *c)* 76.4% of total catch of this ground.
d) 87.9% ,, ,, ,,
e) 91.4% ,, ,, ,,

e) *Frequencies of Bp and Ju systems' blood groups.* By using the stated reagents frequencies of occurrence of the blood groups regarding to Bp and Ju systems were investigated on the fin whales taken from the northern part of the North Pacific Ocean in the years 1954 and 1955. These results are shown in table 4 separately by Whaling grounds A, B and C of the northern part of the North Pacific Ocean noted in figure 1.

From this table, the following differences may be seen between fin whales from A ground and those from B ground taken in both years 1954 and 1955.

I. As to Bp systems, in the case of A ground Bp1 factor (Bp1 and Bp1Bp2 groups) occurs 18.0% of 316 whales in the year 1954 and 6.2% of 113 whales in the year 1955, on the contrary to this fact, however, no Bp1 factor is seen in the B ground.

II. As regards Ju systems, Ju1 blood group occurs more predominantly than Ju2 group both in the A and B grounds. The ratios of occurrence of Ju2 factor (Ju2 and Ju1Ju2 groups), which show 26.5% and 14.2% in the years 1954 and 1955 respectively as to the A ground, are deemed to be by far higher than those of the B ground, namely 1.8% and 1.9% in the years 1954 and 1955 respectively.

In the C ground, only 32 whales were examined on blood groups, so the data of this ground are not sufficient to compare the occurrence of blood groups with others in relation to differentiation of races.

Occurrence ratio of X antigen is examined on the blood cells be-

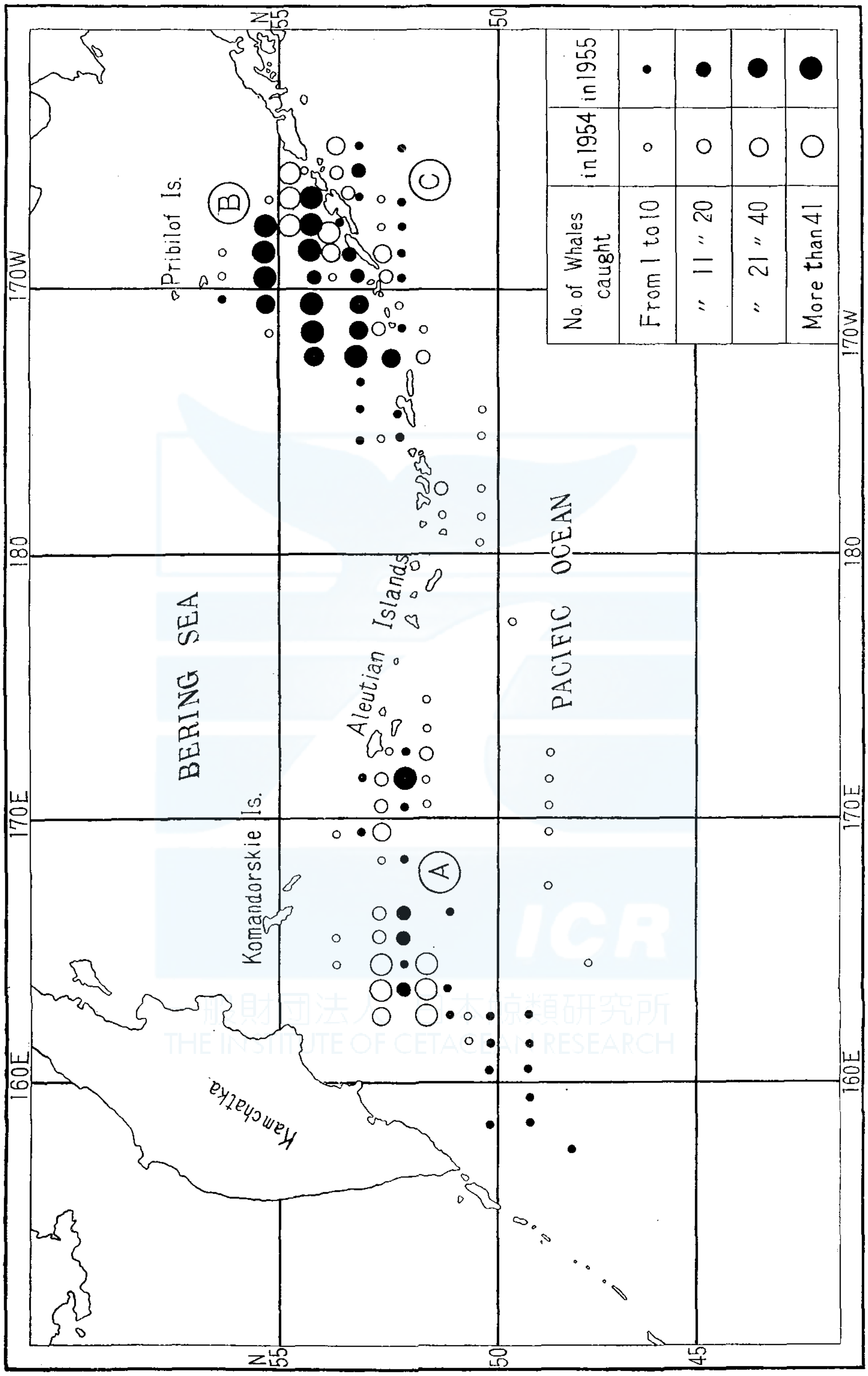

Fig. 1 North Pacific Whaling Grounds in the Japanese Whaling Expedition in the Years 1954 and 1955.

longing to Bp2Ju1 and OJu1 groups only. The results are shown in table 5. As to the other blood cells except Bp2Ju1 and OJu1 groups, no available detection of X antigen is carried out, but the X antigen must occur in their blood cells also.

Table 5
Frequency of occurrence of X antigen

X antigen Bp and Ju system	X^+		X^-		Total
	male	female	male	female	
Bp2Ju1	2	1	0	2	5
	8.6		**5.7**		**14.3**
OJu1	5	6	14	5	30
	31.4		**54.3**		**85.7**
Total	7	7	14	7	35
	40.0		**60.0**		**100.0**

Remark, upper fig.: actual number of whales examined.
lower fig.: percentage of total number examined.

Discussion

a) *Purification of standard reagents.* In the present report, the author states that the blood groups of fin whales can be classified by the Ju system independently to Bp system which was noted in the previous report (Fujino, 1953). Accordingly, in case of judgement of blood groups belonging to Bp and Ju systems, four kinds of standard reagents, namely anti-Bp1, anti-Bp2, anti-Ju1 and anti-Ju2 reagents, should be used for testing after treatments of purification which are stated in section 3-c). That is to say; in the latter case of anti-Ju1 and anti-Ju2 sera it is necessary that the species specific antibody is merely adsorbed away from the immune antibody prior to use, but in the former case of anti-Bp1 and anti-Bp2 sera, anti-Ju1 and anti-Ju2 antibodies should be still more adsorbed away from the immune antiserum besides species specific antibody.

In case of judgement of blood groups which was stated in the previous report, as the Ju system blood groups are not known yet, such purification of standard reagents was not considered. Consequently the following tests should be carried out on these standard reagents and on the adsorbing cells which was used in these investigations as related to accuracy of judgement of blood types. That is to say:

I. Which kinds of antigens of Ju system, namely Ju1 or Ju2, had been contained in the blood cells being used as the immune antigen in case of preparation of anti-Bp1 and anti-Bp2 reagents? In other words, which kinds of antibodies in relation to Ju system blood groups, namely anti-Ju1 or anti-Ju2 antibodies, has been contained in anti-Bp1 and anti-Bp2 reagents?

II. In the case of adsorption of species specific antibody from the antisera which contain anti-Bp1 and anti-Bp2 antibodies, following question is to be risen. That is, whether the erythrocytes being used was suitable or not as related to adsorption of anti-Ju antibody, in other words, whether anti-Ju antibody was adsorbed away completely or not.

As regards I, some examinations were carried out on the sera which were prepared in the year 1952 and was preserved since then. Consequently, in the anti-Bp1 and anti-Bp2 immune antisera, the existence of anti-Ju2 antibody was not recognized, but anti-Ju1 antibody was detected positively alone. Then the antibodies being contained in the two kinds of these immune antisera are as follows:

(1) Anti-Bp1 blood cells immune No. 11 rabbit serum
=anti-Bp1+anti-Ju1+species specific antibodies.
(2) Anti-Bp2 blood cells immune No. 12 rabbit serum
=anti-Bp2+anti-Ju1+species specific antibodies.

Following remarkable declines of agglutinin titers of these antibodies took place during the interval of three years' preservation.

After preservation agglutinin titers are 20 times in anti-Bp1 and 40 times in anti-Jul antibodies of heading (1), and are 80 times in anti-Bp2 and 40 times in anti-Ju1 antibodies of heading (2), while in the time of preparation the agglutinin titers of anti-B1 and anti-Bp2 antidodies were 320 and 1280 times respectively (Fujino, 1953), that is fairly high titers in comparing with those after preservation.

Agglutinin titer of anti-Jul antibody in the time of preparation had not been examined, but such declines of those may be assumed to take place.

As to II, matters are noted as follows. In case that the species specific antibodies were adsorbed away from the abovestated (1) and (2) antisera, the erythrocytes used for adsorption have been selected according to not only agglutination test but also to cross reaction test with anti-Bp1 and anti-Bp2 reagents. Consequently, it may be safely said that judgement of Bp system blood groups, which was stated in the previous report (1953), have not been affected by the occurrence of the antigens belonging to Ju system.

As yet, X antigen is confirmed to occur merely in OJu1 and Bp2Ju1 type blood cells, but it may be presumable that this X antigen occurs in other kinds of cells also. Accordingly, as stated in section 3-c), in case of preparation of reagents blood cells without X antigen should be used as immune antigen. As X antigen had not been known in the years 1952 and 1954, no attention in purification of antibody, as related to anti-X antibody, has been rendered on the reagents used in these years. Therefore, the existence of anti-X antibody should be examined on these antisera. First, the reagents which was prepared in 1952 did not react positively with X antigen even in the case of using the not diluted sera. However, as it has not been clear whether the declines of titer of anti-X antibody took place as in the other antibodies or not, no information can be received on existence of anti-X antibody in the time of preperation in 1952. Secondly, as regards the reagents being prepared in the year 1954, anti-X agglutinin was detected in anti-Bp2Ju2 immune antiserum (table 3. Anti-X serum). But its titer is very low and reaches up to no more than 20 times. On the other hand, the agglutinin titers of anti-Bp2 and anti-Ju2 antibodies which are contained in this anti-Bp2Ju2 serum reach up to 200 and 400 times respectively, and then this antiserum was always diluted by 50 or 100 times in any case of use. Accordingly, the anti-X antibody of abovestated reagent has never reacted positively with X antigen.

Consequently, it is unlikely supposed that in case of using the anti-Bp2Ju2 reagent judgement of blood type is confused by X-antigen and the frequencies of occurrence of blood groups result in uncertainty.

From the abovestated facts, followings may be supposed. As the sufficient attention was not rendered on purification of antibody in case of preparation of antiserum in the year 1952, it is supposed to be insignificant that the results of occurrence of blood groups in 1952 are compared with those in the years 1954 and 1955 when the purification of antibody was considered in relation to anti-Ju and anti-X antibodies.

According to the facts which was stated in this section, it seems to the author that the following problem is important in future investigation. That is: when the frequencies of occurrence of blood groups are investigated, simultaneously purification of antibody should always be taken into consideration. For the purpose of this problem, it is necessary to detect the unknown antigens and to study on the correlation between titer and dilution rate of antibody and on the declines of titer being derived from preservation regarding to the already known antibody.

b) *Differentiation of breeding populations.* The conception, that the frequency of occurrence of blood groups is significant as indicator of races of animals, bases theoretically on the fact that blood group is a kind of hereditary charactor[2)3)4)5)]. It has been already confirmed that blood group is a hereditary charactor in some mammals[6)] as well as in human being, and in what way are inherited these blood groups into their calves. It may be analogized from this that the Bp and Ju systems of blood groups of fin whales are also hereditary charactors.

As regards the fin whales being taken from the grounds, i.e. A, B and C, of the northern part of North Pacific, no clue by which these fin whales can be separated into different breeding populations has been obtained.7)8) As stated in section 3-e), however, marked differences were seen in the frequencies of occurrence of blood groups related to Bp and Ju systems between the fin whales from A ground and those from B ground in the years 1954 and 1955. According to this fact, it may be assumed that the fin whales from the grounds A and B belong to the separate breeding populations respectively, but in order to reach a definite conclusion the theoretical proof, that is, the statistical treatment basing upon the formality of inheritance, must be obtained. However, as the fin whales has huge body, it is not able to make clear the parentages in inheritance by the breeding of whales. Therefore, a part of the formality of inheritance may be merely confirmed according to the correlation between cows and calves. Embryological study of blood groups and statistical treatment on which the abovestated conceptions have their grounds will be discussed in future occasion.

Conclusion

(1) The existence of the two kinds of antigens, namely Ju1 and Ju2, which differ from those of Bp system (Fujino, K., 1953), was confirmed positively by using the immune sera which were produced by the rabbits being immunized with the fin whale erythrocytes. Consequently, the blood groups of fin whales were classified independently to Bp system into three kinds, i.e. Ju1Ju2, Ju1 and Ju2, and the existence of twelve kinds of blood groups were proved as follows.

Bp system Ju system	Bp1Bp2	Bp1	Bp2	O
Ju1Ju2	Bp1Bp2Ju1Ju2	Bp1Ju1Ju2	Bp2Ju1Ju2	OJu1Ju2
Ju1	Bp1Bp2Ju1	Bp1Ju1	Bp2Ju1	OJu1
Ju2	Bp1Bp2Ju2	Bp1Ju2	Bp2Ju2	OJu2

(2) Frequencies of occurrence of Bp and Ju system blood groups were investigated on the fin whales taken from the ground A, B and C of the northern part of the North Pacific Ocean in the years 1954 and 1955. In what follows these results are noted separately by the grounds of A (off Kamchatka), B (northern side of eastern Aleutian Islands) and C (southern side of eastern Aleutian Islands).

I. Bp system blood groups (figures in per cent).
A-ground (316 whales examined in 1954)
Bp1Bp2 : 5.4, Bp1 : 12.7, Bp2 : 25.0, O : 56.9
,, (113 whales examined in 1955)
Bp1Bp2 : 1.8, Bp1 : 4.4, Bp2 : 10.6, O : 83.2
B-ground (393 whales examined in 1954)
Bp1Bp2 : 0.0, Bp1 : 0.0, Bp2 : 10.2, O : 89.8
,, (1034 whales examined in 1955)
Bp1Bp2 : 0.0, Bp1 : 0.0, Bp2 : 26.4, O : 73.6
C-ground (no whales examined in 1954)
,, (32 whales examined in 1955)
Bp1Bp2 : 0.0, Bp1 : 0.0, Bp2 : 50.0, O : 50.0
II. Ju system blood groups (figures in per cent)
A-ground (316 whales examined in 1954)
Ju1Ju2 : 7.6, Ju1 : 73.5, Ju2 : 18.9
,, (113 whales examined in 1955)
Ju1Ju2 : 2.7, Ju1 : 85.8, Ju2 : 11.5
B-ground (393 whales examined in 1954)
Ju1Ju2 : 0.6, Ju1 : 98.2, Ju2 : 1.2
,, (1034 whales examined in 1955)
Ju1Ju2 : 0.7, Ju1 : 98.1, Ju2 : 1.2
C-ground (no whales examined in 1954)
,, (32 whales examined in 1955)
Ju1Ju2 : 3.1, Ju1 : 90.7, Ju2 : 6.2

In these results, the marked differences are seen in the frequencies of blood groups both in Bp and Ju systems between fin whales from A-ground and those from B-ground. Details are as follows.

As regards Bp system, in the A ground Bp1 factor (Bp1 and Bp1Bp2 groups) occurs 18.0 per cent of 316 whales in 1954 and 6.2 per cent of 113 whales in 1955, but contrary to this fact no Bp1 factor is seen in the B ground in both years.

As to Ju system, Ju1 blood type occurs more predominantly than Ju1 type both in the A and B grounds. The frequencies of occurrence of Ju2 factor (Ju2 and Ju1Ju2 groups), which shows 26.5 per cent and 14.2 per cent in the years 1954 and 1955 respectively as to the A ground, are deemed to be by far higher than those, namely 1.8 per cent in 1954 and 1.9 per cent in 1955, of the B ground.

As yet no clue by which these fin whales being taken from the A and B grounds are separated into different breeding populations has been obtained. According to these differences in the frequencies of Bp and Ju blood groups, however, it may be assumed that the fin whales from the A and B grounds belong to the separate breeding populations respectively. But in order to reach a definite conclusion, the statistical treatment must be rendered in future occasions.

(3) The existence of the new antigen X which differs from the antigens belonging to Bp and Ju system is confirmed positively by using the antibody which is produced by the rabbit being immunized with the blood cells of fin whales. Up to the present this antigen X occurred merely in the OJu1 and Bp2Ju1 type blood cells, but the correlations with Bp and Ju systems have not been made clear.

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On the Diatoms of the Skin Film of Whales in the Northern Pacific

By

Takahisa NEMOTO

Introduction

It is well known that diatoms infect the skin film of whales. Whales with heavy diatom infections are called by whalers as ' Algae Whales ' (Japan) or ' Sulphur bottom ' (Alaska, on blue whales). But comparatively few studies have been carried out on the subject of diatom infections of whales as compared with many excellent works on planktonic and littoral diatoms in the sea. Those works have been mostly done in the southern hemisphere. Hart (1935) describes in detail of these previous works. He also makes clear the correlation between the fatness of whales and diatom infections, and the problems of movements of whales suggested by Bennett (1920) to some extent. Karcher (1940) and Omura (1950, a) studied the variation and the fluctuation of these diatom (*Cocconeis ceticola* Nelson !) infections of whales according to the species, the sex, the age and the locality of whales taken, and inform that the tendency of diatom infections differs markedly among these groups of whales in addition to the seasonal variation of the infection. In recent years, Hustedt (1952) describes 3 new species, *Stauroneis olimpica*, *Lycmophora Onassis*, and *Nitzschia Barkleyi* from antarctic humpback whales and contributes greatly to the present knowledge of the diatom infection on whales.

In the northern Pacific, Amemiya (1916) observed the diatom (he wrote as *Navicula* sp.) infection on a fin whale (*Balaenoptera physalus*) treated at a landstation in Japan, though he did not study taxonomically. Further, Hollis (1939) describes the presence of *C. ceticola* Nelson on whales captured in the Alaskan waters. Perhaps it may be the first description of *C. ceticola* Nelson from the northern hemisphere.

Since 1942 Japanese biologists have been collecting material on diatom infections of whales following the method adopted by the Discovery (Mackintosh and Wheeler, 1929 ; Hart, 1935 ; Omura 1952, *et al.*) and some samples of diatom on the skin of whales have been collected on factory ships of Japanese whaling expeditions. A similar research has been performed also at various coastal whaling stations in Japan. Works on above data collected through many whaling seasons in the northern Pacific waters have been published for respective seasons in official reports of Japanese whaling expeditions, in addition to other studies of whales taken (Matsuura and Maeda, 1942; Sakiura and others, 1953, *et al.*). Some observations based on the material collected at various landstations prior 1951 were also reported by Omura (1952).

The present paper deals essentially with the constituents of the diatom films on whales captured in the northern Pacific. Some planktonic species found in the film, which is thought as attached accidentally, are also included in the present paper too. Studies on more broader problems as to the correlation between the diatom infection and the movement of whales, studied firstly by Bennett (1920), will appear in future publications.

I wish to express my grateful thanks to Dr. Hideo Omura, the Director of the Whales Research Institute in Tokyo for his valuable suggestions rendered during the course of this work. My sincere thanks are also due to Mr. Hideaki Takano, a member of Tokai Regional Fisheries Research Laboratory for the fruitful discussion of the problems, and to Mr. Shigeo Sakata of Department of Radiology, Faculty of Medicine, the University of Tokyo, for the preparation of electron microscopical studies, and to Dr. Morizo Hirata, of the Professor of Faculty of Science, the University of Tokyo, for constant guidance in studying electron-micrographs.

Material and Method

The material at disposal for present study is obtained on factory ships by the following men in the respective seasons.

1953	" Baikal-maru "	Mr. Yasutake Nozawa Mr. Iwao Takayama Mr. Takahisa Nemoto
1954	" Kinjo-maru "	Mr. Setsuo Nishimoto Mr. Takehiko Kawakami Mr. Seiji Kimura
1955	" Kinjo-maru "	Mr. Tamenaga Nakazato Mr. Zenya Takahashi

Samples of diatoms have been collected by the inspectors or biologists listed above during the flensing of whales from the various parts of whales' body after the observations on degree of infection were made. Skins of whales with diatom patches were cut off from the body and then fixed directly with 5 % formalin sea water. Some other materials were collected by myself at coastal whaling stations, Monbetsu and Abashiri facing to the Okhotsk Sea, and Kushiro facing to the Pacific Ocean, during the months of August and September 1954. These samples were treated as above mentioned.

For the identification of the species, the diatom materials are boiled in hydrochloric acid in the usual way, and the part of them are examined before boiling with acid. Mountings are made of the lakeside cement and T.M.M. (Tsumura & Iwahashi, 1955). The rest of materials, including some new species named by me, have been kept in the collection of Whales Research Institute in Tokyo for the further examination in future. Both phase-microscope and electron-microscope are used besides the ordinary light-microscope. Electron-micrographs are taken by S. Sakata and by the operator of Hitachi Central Research Laboratory of Hitachi Co., Ltd. In the taxonomical arrangement, I have followed the order established by Hustedt (1930). I have used some technical terms proposed by Hustedt and Aleem (1952). The locations described after species show the localities of whales taken.

Notes on the Species

Genus **Melosira** Ag.

Melosira sulcata (Ehr.) Kütz. (Hustedt, 1928, Kieselalg. p. 276, fig. 119). Rare. Perhaps removed from plankton.

Bering Sea. Adjacent waters to Near Islands.

Genus **Thalassiosira** Cleve

Thalassiosira Nordenskiöldi Cleve (Hustedt, 1928, Kieselalg. p. 321, fig. 157). Rare. Removed from littoral plankton.

Okhotsk Sea.

Genus **Coscinodiscus** Ehr.

Coscinodiscus anguste-lineatus A. Schmidt (Hustedt, 1928, Kieselalg. p. 391, fig. 203). Rare.

Bering Sea. Adjacent waters to Near Islands.

C. Kützingi A. Schmidt (Hustedt, 1928, Kieselalg. p. 398, fig. 209). Rather common.

Bering Sea. Adjacent waters to Andreanof Islands.

C. radiatus Ehr. (Hustedt, 1928, p. 420, fig. 225). Rare.

Adjacent waters to Japan. Adjacent waters to Near Islands, Rat Islands, Andreanof Islands, Fox Islands.

C. weilesii Gran & Angst (Gran & Angst, 1930. p. 448, fig. 26). Rare.

Adjacent waters to Near Islands.

The flagments of *Coscinodiscus* species are sometimes found among the patches of diatom films on whales. Hart (1935) describes one species *Coscinodiscus*, *C. spiralis* Karsten, from whales in the antarctic waters, and thinks it is accidental presence. Few perfect specimens of cells of *Coscinodiscus* has been observed in the northern Pacific waters, suggesting that *Coscinodiscus* species may adhere whales apart from their planktonic life by chance like some other *Coscinodiscus* found in littoral mudy flats. (Hustedt & Aleem, 1952, p. 179).

Genus ***Detonula*** Schütt

Detonula confervacea (Cleve) Gran (Hustedt, 1929, Kieselalg. p. 554, fig. 315). Rare.

Adjacent waters to Andreanof Islands.

Genus ***Leptocylindrus*** Cleve

Leptocylindrus minimus Gran (Hustedt, 1929, Kieselalg. p. 560, fig. 321). Rather rare.

Adjacent waters to Fox Islands.

Genus ***Rhizosolenia*** Ehr.

Rhizosolenia styliformis Brightwell (Hustedt, 1929, Kieselalg. p. 585 fig. 333). Only few flagments are found.

Okhotsk Sea. Bering Sea. Adjacent waters to Andreanof Islands.

Genus ***Chaetoceros*** Ehr.

Chaetoceros atlanticus Cleve (Hustedt, 1930, Kieselalg. p. 641, fig. 364). Rare.

C. densus Cleve (Hustedt, 1930, Kieselalg. p. 651, fig. 368).

C. concavicornis Mangin (Hustedt, 1930, Kieselalg. p. 665, fig. 376).

Only fragments of above planktonic species are found, and accurate systematizations are difficult, because most of them are broken. The setae of *Chaetoceros* species are also occasionaly found on whales.

Genus ***Biddulphia*** Gray

Biddulphia aurita (Lyngh.) Bréb. (Hustedt, 1930, Kieselalg. p. 846, fig. 501). Rare.

Bering Sea. Okhotsk Sea.

B. mobilensis Bailey (Lebour, 1930, p. 147, fig. 134). Rare.

Adjacent waters to Japan.

Genus **Lycmophora** Ag.

Lycmophora abbreviata Ag. (Hustedt, 1931. Kieselalg. p. 66–67, fig. 590). Rare.

Adjacent waters to Andreanof Islands.

Broken specimens of *Lycmophora* species are occasionary found. It is, however, difficult to identify their species as perfect specimens are seldom met with.

Hart (1935) and Hustedt (1952) report *Lycmophora* species consisting diatom films on the whales from antarctic waters.

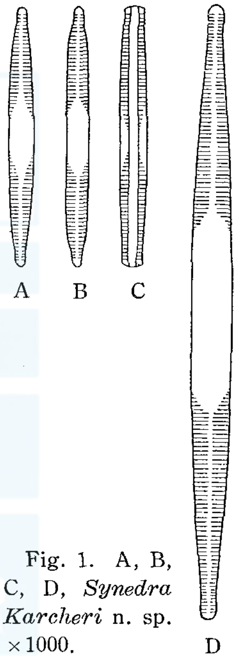


Fig. 1. A, B, C, D, *Synedra Karcheri* n. sp. ×1000.

Genus **Rhaphoneis** Ehr.

Raphoneis amphiceros Ehr. (Hustedt, 1931. Kieselalg. p. 174, fig. 680). Rare. Comparatively small size specimens (14 μ !) are observed.

Adjacent waters to Andreanof Islands.

Genus **Synedra** Ehr.

Synedra Camtschatica Grun. (Hustedt, 1932. Kieselalg. p. 214–215. fig. 708). Only few perfect specimens are found on sperm whales.

Bering Sea. Adjacent waters to Andreanof Islands.

The thickened cellwall of central area of found specimens is longer than those described by Hustedt. The specimens seem rather to resemble to the indistinct figure by O'meara (1874, pl. 8, fig. 5). Transapical striae of the valves are about 13 in 10 μ (12–14 in 10 μ after Hustedt, 1932). This value is 15–20 in 10 μ by Gemeinhardt (1926, p. 28) which is estimated to be rather too heigh. The variety forms bearing such many striations have never been observed in the past. The variety forms of this species will be reported when further examination is finished.

S. tabulata (Ag.) Kütz. (Hustedt, 1932. Kieselalg. p. 218, fig. 710). Rather common on sperm whales.

Adjacent waters to Fox Islands, Andreanof Islands.

S. Hennediyana Greg. (Hustedt, 1932. Kieselalg. p. 222–223, fig. 713). Only few flagments, the central portion of the valve, are found on a sperm whale. Okuno (1942) reports this species from more warmer waters adjacent to Japan.

Adjacent waters to Andreanof Islands.

Synedra Karcheri **spec. nov.** Valva angusta lineari lanceolata, apicibus rotundis capitatis, circiter 45–80 μ longa, 4–6 μ lata. Pseudoraphe angusta, area centrali longa elliptica lanceolata. Striis delicatis ad pseudoraphen perpendicularis, 12–14 in 10 μ. (Fig. 1, A, B, C, D).

Valves slender linear lanceolate with rounded capitate ends, 45–80 μ long, 4–6 μ broad. Pseudraphe narrow, central area long elliptic lanceolate. Striae delicate perpendicular to the pseudraphe, about 12–14 in 10 μ.

The figures of *Synedra Karcheri* bear some resemblance to those of *Fragilaria islandica* Grun. (V. Heurck, 1881, pl. 45, fig. 37; Hustedt, 1931, Kieselalg. p. 146–147, fig. 660). The former is distinguised from the latter by numbers of striations, the lack of intercalary bands and the longer central area. Striae of *Synedra Karcheri* are between 12–14 in 10 μ, on the other hand, those of *Fragilaria islandica* between 16–18 in 10 μ (Hustedt, 1931, Kieselalg.) or 14–15 in 10 μ (Grunow, in V. Heurck, 1881, pl. 45). Occasionaly found, on sperm whales.

Adjacent waters to Andreanof Islands.

Genus **Thalassionema** Grun.

Thalossionema nitzschinoides Grun. (Hustedt, 1932. Kieselalg. p. 244–245, fig. 725). Rare. Perhaps it adhered whales incidentally from the planktonic inhabitancy.

Adjacent waters to Japan.

Genus **Thalassiothrix** Cleve & Grun.

Thalassiothrix longissima Cleve & Grun. (Hustedt, 1932. Kieselalg. p. 247, fig. 726). Few flagments and cells recruited from plankton (Hustedt & Aleem, 1951) are found among the patch of *Cocconeis ceticola*.

Bering Sea. Okhotsk Sea.

T. Frauenfeldii Grun. (Hustedt, 1932. Kieselalg. p. 247–248, fig. 727). Few flagments are found too.

Adjacent waters to Japan.

Genus **Cocconeis** Ehr.

Cocconeis costata Greg. (Hustedt, 1932. Kieselalg. p. 332, fig. 785). Few specimens are found. Some questions of *C. costata* on the indistinct point are discussed in the following description.

Adjacent waters to Andreanof Islands.

C. costata var. *pacifica* form. *plana* **form. nov.** Synonym, *C. imperatrix* A. Schmidt (1894, Atl. pl. 189, fig. 12). Cells are solitary, valves are elliptical oval. The raphe-valve possesses straight raphe, the axial area is very narrow, the central area is enlarged transversely to a narrow fascia in the median portion, sometimes does not so. The raphe is surrounded transapical costae consist of two lines of puncta about 6–10 in 10 μ crossed by a blank line, punctations about 12–14 in 10 μ. Rapheless-valve possesses a narrow pseudraphe which is somewhat fusiform, and strong costae on the surface. Two lines of punctions, 12–16 in 10 μ, are found along the inner margins of costae. Apical axis of cell 10–40 μ, transpical axis of cell 7–20 μ. Often found among the patch of *Gomphonema* spp. and *Navicula* spp. (Fig. 2, A, B, C, D)

Bering Sea Adjacent waters to Andreanof Islands.

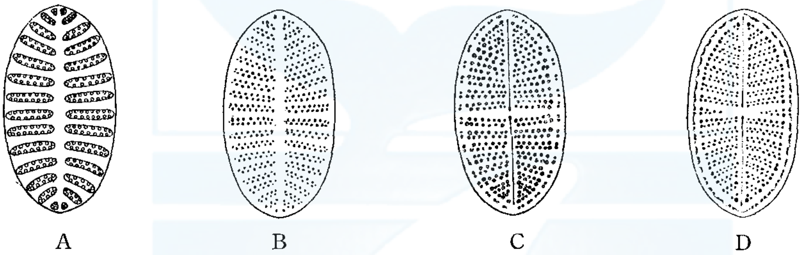


Fig. 2. *Cocconeis costata* var. *pacifica* form. *plana* n. fo. ×1000.
A, B, Rapheless-valve. C, D, Raphe-valve.

The illustrations and descriptions on *C. costata* referred to are following. (Gregory, 1855, p. 39, pl. 4, fig. 10 ; Gregory, 1857, p. 68, pl. 1, fig. 27 ; A. Schmidt, 1894, Atl. pl. 189, figs. 6–7 ; V. Heurck, 1881, pl. 30, figs. 11–12 ; Wolle, 1894, pl. 33, fig. 10 ; Cleve, 1895, p. 182 ; Peragallo, 1997, p. 10, pl. 2, fig. 10 ; Mann, 1907, p. 329 ; Boyer, 1927, p. 250 ; Hustedt, 1932. Kieselalg. p. 332, fig. 785 ; Mills, 1933, p. 414 ; Okuno, 1954 a, p. 19, pl. 2, fig. 3), and those on *C. costata* var. *pacifica* are followings (Grunow 1867, p. 11, pl. 1, fig. 10 ; V. Heurck, 1881, pl. 30, figs. 13–14 ; Cleve, 1895, p. 182).

Cleve (1895) and Mann (1907) describe *C. imperatrix* (A. Schmidt, 1894, pl. 189, figs. 11–15) as the synonym of *C. costata* or *C. costata* var. *pacifica* in their papers. Boyer (1927) also quotes Cleve's description on the synonymy of *C. costata* var. *pacifica* in his remarks. On the other hand, Hart (1935) and Hendey (1937) consider *C. imperatrix* is uniform species separated from *C. costata*. Besides, Hart (1935) consideres *C. scutellum* var. *ampliata* Grun. (V. Heurck, 1881, pl. 29, figs. 4–5) should be included in the synonym of *C. imperatrix*, however, the figure of *C. scutellum* var. *ampliata* (Rapheless-valve, V. Heurck, pl. 29, fig. 4) seems not to be so closely related to *C. imperatrix*, if *C. imperatrix* is the distinguishing species.

In the account for *C. imperatrix* A. Schmidt, the description in the atlas is as follows.

> 12 älmlich V.H. XXX. 14, *C. costata* var. *pacifica* Grun. Aber die Oberschale 13 weicht von den Oberschalen unseren Form bedeutend ab. Cleve zieht 11–15 zu *C. costata* var *pacifica* Grun. dem meine älteren *Cocconeis*-Bilder vorgelegen haben, bezeichnete 10 und 11 als. *C. costata* form. *maxima*.

After the examination of above many figures of *C. costata* and *C. costata* var. *pacifica*, I consider that one figure of *C. imperatrix* A. Schmidt (A. Schmidt, 1894, Atl. pl. 189, fig. 12) is perfectly coinside with the figure of *C. costata* var. *pacifica* Grun. (V. Heurck, 1881, pl. 30, fig. 14) except the structure of the margin of the raphe-valve, and other figures of *C. imperatrix* by A. Schmidt are nearly the same as the description and the illustrations of *C. imperatrix* by Hendey (1937, p. 342, pl. 10, figs. 8–9). The distinguishing traits of raphe-valve between *C. costata* and *C. costata* var. *pacifica* are rather indistinct. *C. costata* var. *pacifica* form. *plana* bears remarkable resemblance to *C. costata* var. *pacifica* Grun. but with no lines on the rapheless-valve, that is, the median area of each side of the rapheless-valve is not crossed by a longitudinal lines as illustrated by Grunow (1867, 1881 in V. Heurck !). Two lines of puncta consisting striae of rapheless-valve are almost pallarel and spaces between the two lines are not so expanded as Hendey's figures. Cleve (1895) and Boyer (1927) also describe that lower valve (raphe-valve) with a well defined margin separated from the faintly costate surface by a blank line. I consider this distinct blank line, and the want of longitudinal lines on the rapheless-valve may be the valid key to the identification of the species.

Boden (1950, p. 410, fig. 91) reports *C. costata* with one illustration of somewhat rhomboid form, the costae of which reached the margin. This figure rather resembles to the figure of *C. imperatrix* illustrated by A. Schmidt and Hendey (1937, pl. 10, fig. 8), differs considerably from *C. costata* from the antarctic waters (Okuno, 1954, a, p. 19, pl. 2, fig. 3) in size and outline of valves. The size of valves of *C. costata* and *C. costata* var. *pacifica* typical elliptical forms, are in the range of 8–50 μ, which are far smaller than *C. imperatrix*. On the other hand, the size of *C. imperatrix* is in ranges 80–150 μ by Hendey (1937), averaging 60 μ by Hart, with exception of that (20–30 μ !) by Barkley (1940). These variations of valves and the synonymy of *C. costata* must be treated after further investigation on many materials. So, I left *C. imperatrix* untouched in this report for future.

C. scutellum var. *stauroneiformis* W. Smith (Hustedt, 1932. Kieselalg. p. 339, fig. 792). This typical neritic diatom, *C. scutellum* var. *stauronei-*

formis, is found on the skins of whales among other species. It never be considered as the true constituent of diatom films.

Adjacent waters to Andreanof Islands.

C. ceticola Nelson (Bennett & Nelson, 1920, p. 352–357 ; Mills, 1933, p. 413 ; Hart, 1935, p. 256, pl. 2, figs. 1–4 ; Hendey, 1937, p. 341–342 ; Hollis, 1939, p. 17 ; Kalcher, 1940, p. 14–34, phs. 1–4 ; Barkley, 1940, p. 70, fig. 8 ; Omura, 1950, p. 4 ; Okuno, 1954, b, p. 271–277, figs. 1–2, pls. 3–4).

Nelson (1920), Hendey (1937) and Okuno (1954, b) give full account on this characteristic species from the antarctic whales.

Cells are solitary, but found often forming diatom films on whales. Valves are strongly concavo-convex. The rapheless-valve possesses a narrow straight pseudraphe which is dilated slightly in the median area of the valve, forming a small lanceolate hyaline area. The surface of rapheless-valve is covered with subradiated striae, consists of lines of punctations, about 11–16 in 10 μ. The raphe-valve possesses a strong sigmoid raphe, which is surrounded by a narrow axial area which dilated towards the centre of the valve to form an oblique stauros that tapers to a fine point as it approaches the valve margin. The raphe-valve surface is covered with extremely fine striae, consisting of two series of punctations, about 10–15 in 10 μ along the margin of the valves, 16–20 in 10 μ along the axial area. Apical axis of the valve, 13–38 μ, transapical axis of the valves 7–24 μ. The size of valves from the northern hemisphere does not differ from the antarctic one. (Fig. 3, A, B, C. Pl. 1. C, D)

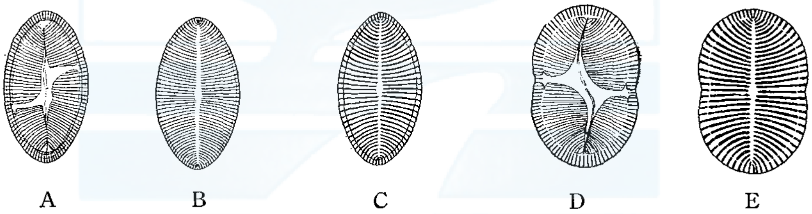


Fig. 3. A, B, C, *Cocconeis ceticola* Nelson ×1000;
A, Raphe-valve. B, C, Rapheless-valve.
D, E, *C. ceticola* fo. *constricta* n. fo. ×1000.

Bering Sea. Adjacent Sea to Near Islands, Rat Islands, Andreanof Islands, Fox Islands, Pribilof Islands. Okhotsk Sea ! British Columbia (Pike).

Above stated structures are also fully described by Okuno (1954 b) with electron-microscopical observations. This famous parasitic diatom is well known its wide distribution on the skins of various species of whales. Hollis (1939) first reports its presence on whales captured at Alaskan coast, the identification of this species is made by P.S. Conger. Many Japanese biologists have observed this *Cocconeis* species and dealt with the subject of migration of whales in connection with the stages of infection by diatoms' patches since the year 1942 (Matuura & Maeda, 1942, *et al.*). But the identification of *C. ceticola* has not been carried on. Perhaps all these *Cocconeis* diatoms described by them may belong to the most popular species *C. ceticola* with exception of those on sperm whales (*Physeter catodon*). *C. ceticola* forms yellowish-brown diatom patches and films on many different portions of various whales, especially on lower jaws of fin whales (*Balaenoptera physalus*) as in the antarctic waters. The dispositions of these diatom patches, the size of diatoms, the variation of seasonal growth, vary considerably throughout the whaling season, and the investigation of these fluctuations will add something to the knowledge of the migration of the northern whales.

This species has not been reported as a pelagic form in the northern Pacific. Endo (1905), Akatsuka (1914) and Skvortozow (1929, 1931. a.b, 1932. a. b) never report from Japanese coast, Kisselew (1937) from Bering Sea, Gran & Angst (1930) and Cupp (1943) also report none of them from west coast of America. Their very few fortuitous inclusion in the tow nets (Nelson, 1920) has also never been noticed by quantitative studies on diatoms by Aikawa (1933), Takano (1954) and many other research workers. But, as the parasitic form, not only on many large species of whales, but also on the small species of whales, such as the killer whales (*Orcinus orca* ; Bennett, 1920), the bottle-nose (*Hyperoödon rostratus* ; Bennett, 1920), the baired beaked whales (*Berardius bairdi* ; Pike, 1953) and the dolphins (*Lagenorhynchus cruciger*, *Cephalorhynchus commersoni* ; Hart, 1935) their occurrences have been considered.

Barkley (1940) reports *C. ceticola* in stomacks of *Euphausia superba* Dana (1940, p. 80, fig. 8), and I have also found *C. ceticola* in digestive guts of *E. superba* from the stomacks of the whales captured in the Kerguelen Sea area (Area IV) by the Japanese whaling expedition in 1955 to 56.

C. ceticola form. *constricta* **form. nov.** Cells are solitary often form yellowish brown patches on sperm whales. Valves are broadly oval, constricted at the median margin of the valve. The oblique stauros which reaches the margin of the valves are wider than the original form of *C. ceticola*. The structures of the valves by electron microscopical studies are nearly the same as the original types of *C. ceticola*, but the margin of valves where oblique stauros reaches. Apical axis of the cell, 10–40 μ, transapical axis of the cell 7–30 μ. (Fig. 3, D, E, pl. 1, A, B, pl. 2).

Bering Sea. Adjacent waters to Rat Islands, Andreanof Islands, Fox Islands.

The median constriction of valves of *Cocconeis* species as a variety form has never been reported though close examination of variety forms of some *Cocconeis* species fully carried out in the past (Geitler, 1932, on *C. placentula*).

Geuus **Rhoicosphenia** Grun.

Rhoicosphenia Pullus M. Schmidt (A. Schmidt, 1899, Atl. pl. 213, figs. 24–26 ; Aleem, 1949, p. 435, fig. 7, X–A′). Rare. Perhaps accidental appearance from the littoral form adjacent waters to Andreanof Islands. Aleem (1949) describes this fine species, " Cells small, with intercalary bands and septa, girdle view mostly a curved rectangle although slightly wedge-shaped, Valves linear 10–20 μ long. about 3–4 μ broad. Striae parallel 15–20 in 10 μ."

Adjacent waters to Andreanof Islands.

I have found few specimens among *Gomphonema Kamtchaticum* and *C. ceticola* form. *constricta*. Aleem (1949) reports this from British south coast, he notes, however, Schmidt's species seemed to have been obtained from a fresh water habitat. So further examination is necessary on this point.

Genus **Stauroneis** Ehr.

Stauroneis olympica Hustedt (Hustedt, 1952, p. 288, figs. 1–5). Valves are linear lanceolate, apices are rounded with the deep intruded pseudsepta at the ends. The raphe is straight, the axial area is very narrow, the central area is narrow crossband. Transapical striae are perpendicular to the raphe, 30–35 in 10 μ, indistinctly punctate. Apical axis of the valve 15–30 μ, transapical axis 1.5–2 μ.

Adjacent waters to Andreanof Islands.

Stauroneis olympica was first reported by Hustedt (1952) from the antarctic humpback whales (*Megaptera novae-angliae* (Borowski)) in the Ross Sea area. While, many *Stauroneis* specimens perhaps belong to the same species have been found on whales from the northern Pacific. As the taxonomical distinctions by further examinations are firmly coincide with those of *S. olympica* by Hustedt, I describe these as *S. olympica*. It constitutes parasitic diatom patches on whales' skin like *C. ceticola*. I have observed *S. olympica* on a blue whale (*Balaenoptera musculus*) and sperm whales. I have also found *S. olympica* Hustedt in digestive guts of *Euphausia superba* from the stomacks of whales caught in Kerguelen Sea area by Japanese whaling expedition in 1955 to 56.

Stauroneis aleutica **spec. nov.** Valva angusta lineari lanceolata, apicibus modice rotundis, pseudoseptis apicibum profundis, circter 28–45 μ longa, 3.1–4 μ lata. Raphe directa, area axiali angustissima, area centrali modice lata. Striis transapicalibus ad raphen perpendicularibus, circiter 30 in 10 μ, punctis inconspicuis (Fig. 4, A, B, C. Pl. 2, Pl. 3).

Valves narrow linear lanceolate with rather rounded apices with deep pseudsepta at the ends, 28–42 μ long, 3.1–4 μ broad. Raphe straight, axial area very narrow, central area rather broad fascia. Transapical striae perpendicular to the raphe about 30 in 10 μ, indistinctly punctate.

This species bears remarkable resemblance to *S. olympica* Hustedt (1952), it may be distinguished by bearing broader stauros edges of which is not so thickened as *S. olympica.* Comparatively common on sperm whales.

Bering Sea. Adjacent waters to Aleutian Islands.

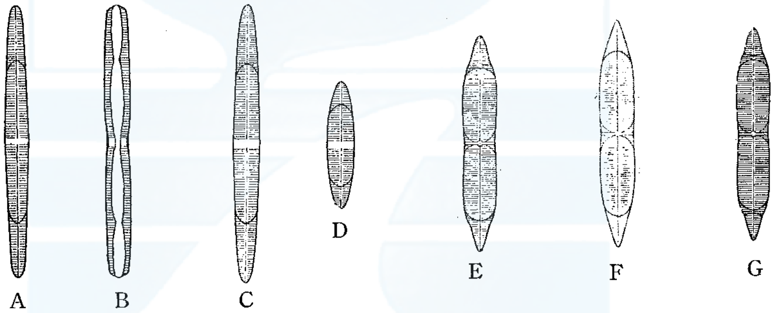


Fig. 4. A, B, C, *Stauroneis aleutica* n. sp. ×1000; D, *S. aleutica* fo. *brevis* n. fo. ×1000; E, F, G, *Stauroneis Omurai* n. sp. ×1000.

S. aleutica form. *brevis* **form. nov.** Valves are very short, the ratio length : breadth are 4 to 5, 12–20 μ long, 3–4 μ broad. The numbers of striae are about 30, the same as the original species. Often found among the patches of original species. (Fig. 4, D. Pl. 3)

Bering Sea. Adjacent waters to Andreanof Islands.

Stauroneis Omurai **spec. nov.** Valva lineari lanceolata, apicibus rostratis. Pseudoseptis apicibum modice profundis, circiter 20–30 μ longa, 4–5 μ lata. Raphe directa, area axiali angustissima, area centrali lineari angustissima. Striis transapicalibus ad raphen perpendicularibus, circiter 30 in 10 μ, punctis inconspicuis. (Fig. 4, E. F. G, Pl. 4).

Valves linear lanceolate with rostrate ends, with rather deep pseudsepta at the ends, 20–30 μ long, 4–5 μ broad. Raphe straight, axial area narrow, central area very narrow linear fascia. Transapical striae perpendicular to the raphe about 30 in 10 μ, indistinctly punctate.

This species is named in hour of Dr. Hideo Omura, the Director of the Whales Research Institute in Tokyo.

The colour of the diatom patch of *S. Omurai* varies according to their parasitic condition on skin films of whales. I have observed *S. Omurai* also among the patch of *C. ceticola*, not the variety form of *C. ceticola* form. *constricta* ! Not so common as *Stauroneis olympica* and *S. aleutica*.

Bering Sea. Adjacent waters to Near Islands, Andreanof Islands.

S. Omurai bears some resemblance to fresh water diatoms, *Stauroneis parvula* Grun. (Hustedt, 1930, p. 260, fig. 417 a), *S. Smithii* Grun. (Hustedt, 1930, p. 261, fig. 420) and *S. tenera* Hustedt (1937, p. 225, figs. 19–21) as Hustedt describes in his remarks on *S. tenera*, and as well as to *S. ignorata* Hustedt (1939, figs. 58–60). *S. Omurai* may be distinguished from above species by numbers of striation and the narrower stauros and uniform median subconstriction of the valves.

Hustedt (1953) describes one *Navicula* sp. reported by Hart (1935) would perhaps be the synonym of *Stauroneis olympica* Hustedt. But *S. olympica* seems to be a more slender form than the *Navicula* sp. illustrated by Hart (1935), so I consider the *Navicula* sp. of Hart should belong to the fixed variation, if not another *Stauroneis* species. Judging from the outline of valves and the position of pseudsepta, it resembles rather to *S. Omurai* than *S. olympica* Hustedt.

Genus **Navicula** Bory

Some *Navicula* species found on whales all belong to the **Navicula lineolatae** Cleve (Cleve, 1895, p. 10).

Navicula ammophila Grun. var. *intermedia* Grun. (Cleve, 1895, p. 30). Valves are linear lanceolate. Axial and central areas are indistinct. Striae are 12–13 in the middle. Occasionally found.

Adjacent waters to Andreanof Islands.

N. arenaria Donk. (Donkin, 1871–2, p. 56, pl. 8, fig. 8). Rare. Perhaps accidental adhereance.

Adjacent waters to Andreanof Islands.

N. cancellata Donk. (Cleve, 1895, p. 30). Rare. *N. cancellata* often reported from Japanese coast. Perhaps accidental adherance.

Adjacent waters to Japan.

***Plumosigma* gen. nov.**

Valva sigmoidea, plana, raphe sigmoidea, striis leniter radiantibus.

Valves sigmoid, flat. Raphe sigmoid. Striae radiate, not oblique, not longitudinal, not perpendicular to the raphe. *Plumosigma* belongs to subfamily **Naviculeae** (**Naviculeae**, Hustedt, 1933, Kieselalg. p. 434).

Plumosigma Hustedti **spec. nov.** Valva sigmoidea, apicibus rotundis, circiter 15–20 μ longa, 5–7.5 μ lata. Raphe sigmoidea centrali, area axiali nulla, area centrali parva. Striis delicatissimis in media parte valvae leniter radiantibus, 35–45 in 10 μ (Fig. 5. A, B, Ph. 1, a. b, Pl. 5).

Valves sigmoid with rounded ends, 15–20 μ long, 5–7.5 μ broad. Raphe sigmoid, axial area absent, central area small. Striae excessively faint, slightly radiate in median portion of valves, 35–45 in 10 μ.

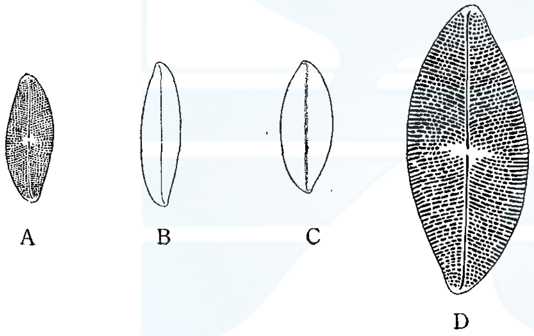
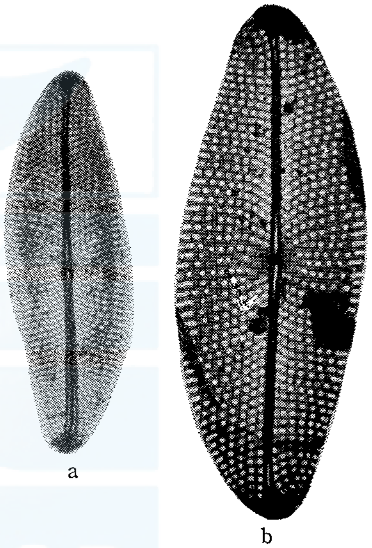


Fig. 5. A, B, *Plumosigma Hustedti* n. sp. ×1000, C, *Plumosigma rimosum* n. sp. ×1000, D, *P. rimosum* n. sp. ×2000.



Ph. 1. Electron-micrographs of *Plumosigma Hustedti* n. sp. a. Notice the two lines of raphe of slided valves of a cell at the lower end of the cell. ×3300 (200 KV). b. ×3500 (50 KV).

Plumosigma rimosum **spec. nov.** Valva elliptica sigmoidea, apicibus acutis, circiter 12–18 μ longa, 3.5–7 μ lata. Raphe leniter sigmoidea centrali, area axiali nulla, area centrali minima, Structura delicatissima, striis tenuissimis, leniter radiantibus, 50–70 in 10 μ (Fig. 5. C, D. Pl. 6, 7.).

Valves elliptic, sigmoid, with acute ends, 12–18 μ long, 3.5–7 μ broad. Raphe sigmoid, axial area absent, central area excessively small. Structure extremly delicate, Striae excessively faint slightly radiate in the median portion of valves, difficult to observe with light-microscope, 50–70 in 10 μ.

The form of *Plumosigma* bears some resemblance to some species of *Navicula*, *Cocconeis* and small forms of *Gyrosigma* or *Pleurosigma*. *Navicula laevis* Cleve-Eular (1922, p. 71, pl. 1, fig. 11) and *Cocconeis binotata* var. *atlantica* Grun. (1867, pl. 1 fig. 11, b) have confusing valves to *Plumosigma rimosum* in the first impression, and the hyaline minimum form of *Gyrosigma* and *Pleurosigma* seems to like *Plumosigma Hustedti*.

The structures of *Plumosigma* are extremly delicate as it is very difficult to examine them fully with light-microscope. To solve this surface structures completely, electron microscope is used on samples boiled with acid, some were applied 'shadowing' with Chrome. The striae of the valves solved by electron-microscopes are all disposed in radiately rows, not in longitudinal and perpendiculary rows, or oblique and perpendiculary rows like *Gyrosigma* or *Pleurosigma*.

Cleve (1894, 1895) fully describes other flat sigmoid Naviculoid diatoms, deviding into 2 genera *Pleurosigma* W. Smith (1853) and *Gyrosigma* Hassal (1845). It is a appropriate argument, *Gyrosigma* is named for the formes with the puncta in transverse and longitudinal rows, and *Pleurosigma* for the forms with the puncta disposed in transverse and oblique rows of which, though, Hendey (1937, p. 348) does not agreed. This classification has been properly accepted by Hustedt (1930, 1933, Kieselalg.) and others.

On the value of the characteristic sigmoid flexure of the valves, in systematization of diatoms is discussed by Cleve too (1894, p. 6). According to his description, this characteristic is subject to great variation, and some different forms of diatoms belonging to other genera are sigmoid, as *Navicula Räeana*, *Navicula Sigma*, and *Caloneis staurophora*. He also find a sigmoid valve of *Frustulia Lewisiana* and one of *Navicula cincta* var. *Heufleri*, so he concludes the sigmoid flexure of the valve can only be regarded as a specific character. Cleve corrects the name *Pleurosigma staurophorum* Grun. (Cleve & Grunow, 1880, p. 61) to the Genus *Caloneis*, because it has the distinct longitudinal lines and the striae which are not distinctly punctate. *Staurosigma asiaticum* Tempère & Brun (Brum & Tempère, 1889, p. 56, pl. 9, fig. 1) is also placed in *Caloneis* by Cleve. The above conclusion by Cleve, however, may be a subject for consideration. The latter distinction (1894, p. 47), "the striae, which are not distinctly punctate" can not be maintained, because closer examinations on striae of some *Caloneis* species, reveal fine puncta consisting striae (Hustedt, 1930, p. 213, *et. al.*). The meaning of the words 'not distinctly punctate' is very difficult to define. For example, Meister (1912, p. 110) states, "Streifen fein, nicht punctiert" in the description of the Genus *Caloneis*, on the other hand Cleve states (1894,

p. 46), "not distinctly (rarely finely) punctate.", Hustedt also states (1933, Kieselalg. p. 438) "Transapical streifen zart punctiert order gestrichelt." These descriptions may be due to specific characters of different species treated by the above authors. Accordingly, this distinction 'punctate distinctly or not' is not so important as to set sigmoid valves and raphe at naught. I consider the sigmoid flexure of the valve of *Caloneis staurophorum* (Grun.) Cleve will be the Key which defines its proper Genus instead of the aspect of the striation.

Navicula Räeana Cast. (*Pinnulaia Räeana* by Castracan) has sigmoid valves, raphe and radiate striae, frustule of which is twisted as Cleve's description. The valve after the figure of Castracan (1886, pl. 15, fig. 3) seems not so sigmoid compared with the distinctly sigmoid raphe. It is perhaps attributable to the contorted valves, which seems to be not so sigmoid from right above view. The frustules of this *Navicula* are not so flat as *Plumosigma* although above some distinctions are confusing.

Other diatoms with the sigmoid raphe, that are, *Scoliopleura* Grun., *Scoliotropis* Cleve, *Eucocconeis* Cleve and some species of *Achnanthes* Bory are also may confusing. The last two, however, belong to **Monoraphidinea** and valves of *Scoliopleura* and *Scoliotropis* are not usually sigmoid (Cleve, 1894, p. 72; Hustedt, 1933, Kieselalg. p. 437, *et al.*). So above species completely differ from the species of *Plumosigma*.

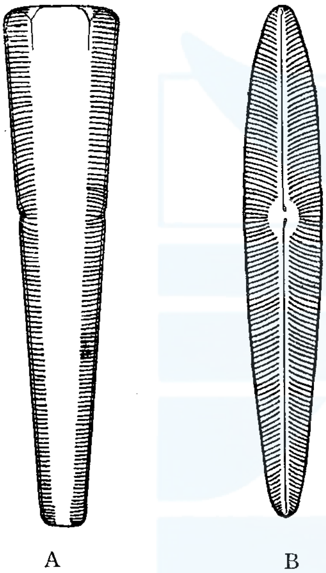


Fig. 6. A, B. *Gomphonema Kamtschaticum* Grun. ×1000.

Genus **Gomphonema** Agardh

Gomphonema Kamtschaticum Grun. (A. Schmidt, Atl. pl. 213, figs. 46–51; Cleve, 1894, p. 188–189). Cells are solitary. Valves are elongated clavate with rounded and narrower basis. Rache is straight, the axial area is distinct and narrow, the central area is dilated around the central nodules, the central area rounded oval without stigma. Valves surface are furnished with transverse striae, 12–17 in 10 μ, very finely punctata, radiate in the middle of the valve. Apical axis of cell 40–100 μ, greatest transapical axis 8–15 μ. (Fig. 6, A, B).

Adjacent waters to Andreanof Islands.

G. Kamtschaticum constitutes yellowish brown diatom patches on sperm whales in the Bering Sea and adjacent waters to Andreanof Islands. These patches bear some resemblance to those of *C. ceticola*, though they seem to be more coarse texture when observed by naked eyes. Elenkin (1914) states that *G. Kamtschaticum* has been found in many localities and he points out that it is not a characteristic species of Kamtschatic region. It is clear that *G. Kamtschaticum* distributes widely in the northern Atlantic and Pacific according to the reports by Cleve & Grunow (1880), Cleve (1895), Gran (1900), Östrup (1910, 1916) and others.

Accordingly, its adherence on whales does not necessarily mean the lapse of time since the arrival of sperm whales at Aleutian waters, on the contrary to the fact often reported as regards the infection of *Cocconeis ceticola*. While, generally speaking, *G. Kamtschaticum* may propagates on sperm whales after whales had arrived to the neighboring waters of Bering Sea from the warmer southern seas. Accordingly the presence of this species on the skin may suggest something about the movement of the whales.

G. Kamtschaticum has never been reported from Japanese coast. One vague specimen *G. Kamtschaticum* var. *Japonica* Skvortozow (1929, fig. 27 ; 1932. b) found on the sea weed belonging *Laminaria* sp. is perhaps a synonym of the well known littoral diatom *G. exiguum* Kützing.

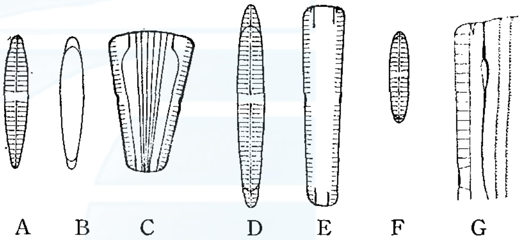


Fig. 7. *Gomphonema Harti* n. sp.
A—F, ×1000,
G, Upper end of the cell. ×2000.

G. Kamtschaticum var. *californica* Grun. (V. Heurck, 1881, pl. 25, fig. 28 ; Cleve, 1894, p. 189). Striae are not so radiate as *G. Kamtschaticum*. Comparatively small forms have been found.

Bering Sea. Adjacent waters to Andreanof Islands.

Gomphonema Harti **spec. nov.** Valva liniari lanceolata claviforma, apicibus rotundis, circiter 12–30 μ longa, 3–5 μ lata. Septis apicibum profundis distinctis. Raphe directa, area axiali angusta, area centrali lata. Striis transapicalibus ad raphen perpendicularibus, 14–16 in 10 μ, quattuor striis mediis radiantibus, punctis conspicuis (Fig. 7. A—G.).

Valves linear lanceolate clavate with rounded ends, with distinct deep septa at both ends, 12–30 μ long, 3–5 μ broad. Raphe straight, axial area narrow, central area broad fascia. Transpical striae perpendicular to the raphe, 14–16 in 10 μ, median two paires of them radiate, distinctly punctate. Östrup (1910) describes a somewhat confusing species

Gomphonema boreale Östrup (p. 239 ; pl. 2, fig. 5) with broad central area forming transverse fascia, but this has only 8 striae in 10 μ on valves, neither septum nor intercalary bands. Skvortozow (1929) also describes *Gomphonema* of this type, *G. Okamurai* Skvortozow with 7–8 striae in 10 μ from the Siberian coast of Japan Sea, on which accounts for septum bulding and intercalary bands are also lacking.

This new form of *Gomphonema Harti* bears a striking resemblance to *Gomphonema Aestuarii* Cleve (Le Diatomiste, Vol. 2, p. 55, pl. 3, fig. 4). Cleve states in his original description (Le Diatomiste, Vol. 2, p. 55) " A la base de la valve inferieure se trouve un diaphragme distinct." He describes *G. Aestuarii* for the second time in his Synopsis of the Naviculoid Diatoms (1894, p. 188).

" V. linear, narrow, slightly clavate with obtuse end and basis. L 0.02 to 0.028 ; B. 0.002 to 0.0035 mm. Axial area indistinct ; central area broad transverse fascia. Striae parallel (the median radiate) 20 in 0.01 mm. Ends of the valve with rudimentary diaphragms."

These distinctions nearly coincide with above description on *G. Harti* except the numbers of striae and the presence of septum building and intercalary bands. However, the means of diaphragms in his description is very indistinct. The figure illustrated in plate (Le Diatomiste Vol. 2, pl. 3, fig. 4), a valve of *G. Aestuarii*, has a partition line on the base of the valve which perhaps means " diaphragm ", but no figure of girdle view of *G. Aestuarii* is illustrated by Cleve. So it is uncertain whether diaphragms mean septum or pseudseptum. Unfortunately I cannot refer the description on *G. Aestuarii* by Östrup (Mar. Faroe, p. 536, quoted by Mills (1933–34) in his Index,) this argument may be incomplete.

Agardh (1824) and others (Smith, 1853–56 ; Müller, 1886 ; De Toni, 1891–94 ; Cleve, 1894 ; Boyer, 1916, 1927 ; Elmore, 1921 ; Kokubo 1955 et al.) have described no account for septa in *Gomphonema* species. But Schütt (1896, p. 136) and Karsten (1928, p. 286) state " Zwishenbänder mit Septen " like in their descriptions on the genus *Rhoicosphenia* Grunow. But this description may be questionable because their illustrated figures of *Gomphonema geminatum* (Lyngh.) Agardh (This combination is corrected as *Didymosphenia geminata* (Lyngh.) M. Schmidt,) described by Smith, (1853, pl. 27, fig. 235, a, b !) has neither septum nor intercalary bands. On the other hand, Hustedt states (1930, p. 340), " Zwishen-bänder oft vorhanden, Septen fehlen." in his descriptions on **Gomphocymbelloideae** and, " Ohne Zwichen bänder und Septen." also in the description on the genus *Gomphonema* (1930, p. 367).

All figures of *Gomphonema* species illustrated in the past have possessed no septum except some vague figures with questionable septum-like structures on girdle bands. The figures of *Gomphonema herculeana* var. *septiceps* M. Schmidt (A. Schmidt. Atl. pl. 215, figs. 13, 14), *G. dubravicense* Pant. (Atl. pl. 216, figs. 24, 25) and *G. scapha* M. Schmidt have septum-like structures on upper ends of valves drawn as partition lines. Skvortzow also describes often these septum-like partition lines on valves in his illustrations. But almost all of them are considered not to be true septum buildings. The figure of *G. lanceolatum* illustrated by Skvortzow (1937, pl. 14, fig. 25) has this partition line, but those by Hustedt (1930), Schönfeldt (1913) and others have none of them.

Accordingly this distinct septum building may be the valid mark in systematization of *Gomphonema*-like diatoms. I propose to place *Gomphonema* with septa in *Pseudogomphonema*, the new subgenus of the genus *Gomphonema*. Heretofore, the Genus *Gomphonema* is devided into two groups, *Asymmetrica* and *Symmetrica* by Grunow (V. Heurck, 1880–81, pls. 23–25) or *Stigmatica* and *Astigmatica* by Cleve (1894, p. 179, 180) and others. These classifications may be maintained under above subdivision of the genus.

Genus *Nitzschia* Hassall

Nitzschia tubicola Grun. (V. Heurck, 1880–81, pl. 69, fig. 14). Valves are narrow lanceolate with acute ends, not constricted in the middle, 25–50 μ long, 3.5–4.5 μ broad in widest point. The kiel is excessivelly eccentric, kielpuncta are very strong distinctly observed, 7–13 in 10 μ, very irregularly disposed, the two median ones are remote. Transapical striae are extremly fine 35–45 in 10 μ, indistinctly punctate (Fig. 8).

Fig. 8. *Nitzschia tubicola* Grun. × 1000.

The description in Synopsis of V. Heurck is following "7 à 10 points carénaux en 0.01 mm,—Stries transversales tres fines—Se rencontre souvent en abondance dans les gaînes des Schizonemées."

Occasionaly found among *Navicula* spp and *Cocconeis ceticola* fo. *constricta*.

Adjacent waters to Andreanof Islands.

N. closterium (Ehr.) W. Smith (Cupp, 1943, p. 200, fig. 153). only few specimens are found. Cupp reports (1943) this species very common in the littoral zone of west coast of North America. *N. closterium* is also observed by Hart (1935) on whales in the antarctic waters.

Discussion

The greater part of diatoms found on skin films of whales belong to the PENNATAE (Schütt, 1896), and some less significant species of CENTRICAE (Schütt, 1896) have been observed incidentally. The latter perhaps never propagate themselves on whales' skin films. Among the many species of PENNATAE, some of which are considered to be fortuitous appearances.

The vast majority of the diatom forming the films belongs to the one species *Cocconeis ceticola*, as often reported from the southern hemisphere (Hart, 1935. Kalcher, 1940). *C. ceticola* is found on many whales, especially on blue, fin and sei whales (*Balaenoptera borealis*), whereas *C. ceticola* form. *constricta* is mostly common on sperm whales. On the other hand, it is seldom to find the original form of *C. ceticola* on sperm whales. In that case few original types of *C. ceticola* found on sperm whales belong to comparatively large type specimens. As sperm whales differ considerably from the so-called baleen whales in morphological and physiological points, this variation of *C. ceticola* must be partly due to the affection by the condition of skin films of sperm whales in some ways. The photographs of *C. ceticola* by Kalcher (1940, fig. 3–4) are not the typical form of *C. ceticola*. It is suggested that they might be collected from skins of sperm whales. Hart (1935, p. 260, pl. 11, figs. 5–7) describes new form of *C. Wheeleri* on the antarctic humpback whales, which is larger than *C. ceticola* Nelson. On this species, Okuno (1954, b) states that "the size of valves is not so important to separate the species from *C. ceticola*", because he found the variation of sizes of *C. ceticola* extending from 13 to 37.5 μ long, covering over that of *C. Wheeleri* reported by Hart. Thus, Okuno describes *C. Wheeleri* as a synonym of *C. ceticola* in his report for want of full account for the structure of valves in original description. In addition, *C. Wheeleri* has been found only on humpback whales by Hart, Okuno's deduction must be noted to suggest that *C. Wheeleri* may be one variety form of *C. ceticola* on humpback whales alike *C. ceticola* form. *constricta* on sperm whales. The intermediate form between *C. ceticola* and *C. ceticola* form. *constricta* is also found on sperm whales to which Kalcher's illustrations are closely related. It belongs to rather the large type, and the median constriction of valves are scarcely observed.

The tendency that *C. ceticola* ejects another diatoms to form diatom patches of itself except few diatoms and some of accidental appearances is very interesting. One of the few exceptional diatoms is *Stauroneis Omurai* **spec. nov.** which is found among *C. ceticola* in faily abundance. Usually, the commensality of *C. ceticola* and other species has seldom observed in contrast to *C. ceticola* form. *constricta* constitutes the diatom colonies with other species of diatoms, *Gomphonema Kamtscha-*

ticum, *C. costata* var *pacifica* form. *plana*, *Navicula* spp., and *Synedra* species. Hart (1935) states the appearances of ' other species ' decreased in number in contrast to *C. ceticola* propagated on whales as the time proceeded in the whaling season. Such conclusion may be partly attributable to the exclusive feature of the organism of propagation of *C. ceticola*.

Above findings support the view that it must be the most comfortable condition for *C. ceticola* to adhere to whales' skin films. Planktonic occurrence of *C. ceticola* may be transient.

In addition to *C. ceticola*, following species are considered as real parasitic forms and true constituents of diatom patches on whales.

Cocconeis ceticola form. *constricta* **form. nov.**
Stauroneis olympica Hustedt
S. Omurai **spec. nov.**
S. aleutica **spec. nov.**
Plumosigma Hustedti **spec. nov.**
P. rimosum **spec. nov.**

Above species may be observed in their few chances of planktonic forms separate from whales in future investigation. Among them, *Stauroneis olympica*, *Stauroneis aleutica* and *Plumosigma rimosum* are comparatively abundant. *Stauroneis Omurai* and *Plumosigma Hustedti* are somewhat rare species. The seasonal appearance and variations of adhesive percentage of the above species are not so regularly as those of *C. ceticola*. Aspects of diatom patches of the above species seem to be attacked by some skin deseases, especially the case of *Stauroneis* species. Kalcher (1940) reports those brown wounds caused by *Navicula* species (?) (may be *Stauroneis* species !). Severely inflammed wounds by *Stauroneis* species on whales are frequently observed on blue and sperm whales in the northern Pacific.

The following species are the fortuitous, to constitute barren diatom patches on skins of whales.

Cocconeis costata Greg.
C. costata var. *pacifica* form. *plana* **form. nov.**
Synedra Karcheri **spec. nov.**
S. tabulata Kütz.
Gomphonema Kamtchaticum Grun.
G. Kamtchaticum var. *californica* Grun.
G. Harti **spec. nov.**

Cocconeis costata, *C. costata* var. *pacifica* form. *plana*, *Gomphonema Kamtchaticum* have observed most popularly, *Synedra Karcheri* and *S. tabulata* are not so frequent. Some of them are often found as planktons by close examination in the northern Pacific.

The accidental appearances of planktonic diatoms recruited from their planktonic inhabitancy may be followings.

Melosira sulcata
Thalassiosira Nordenskiöldi
Coscinodiscus anguste-lineatus
C. Kützingi
C. radiatus
C. weilesii
Detonula confervacea
Leptocylindrus minimus
Rhizosolenia styliformis
Chaetoceros atlanticus
C. densus
C. concavicornis
Biddulphia aurita
B. mobilensis
Raphoneis amphiceros
Synedra Camtschatica
S. Hennediyana
Thalassionema nitzschinoides
Thalassiothrix longissima
T. Franenfeldii
Cocconeis scutellum var. *stauroneiformis*
Rhoicosphenia Pullus
Nitzschia tubicola
N. closterium

Above species are all fortuitously occurring on whales recruited from their plankton inhabitancy. These planktonic diatoms are considered to live in the patches of diatoms until finally they die, not propagating in themselves. So they bear no significance as constituents of diatom patches. But the dominant numbers of the neritic diatoms are included in the above lists. *C. scutellum* var. *stauroneiformis, Tharassionema nitzschinoides* are the most popular littoral diatoms from Japan coast. It is considered that they gain access to the whales while they are lying waiting to be flensed (Hart, 1935, p. 256) in the case of landstations.

More variety of diatoms are found especially on sperm whales than baleen whales. This phenomenon may partly due to the coarse texture of skin films of sperm whales compared with those of baleen whales. Besides, sperm whales are the most skillfull divers, and dive so deep the water that they often catch crabs and fish from the bottom of the sea. A chance of attachment of diatom pieces from there can be considered on the case of sperm whales, though these species reported by Bailey (1856), Skvortzow (1932, c) and other workers have scarecely been observed by myself.

Summary

The first systematic study of the diatoms constituting the diatom patches on the skin of whales in the northern Pacific waters is stated. Including 1 new genus, 6 new species, 3 new forms, 43 species which occur on the skin of whales are described. Comparatively rare genus and species : *Plumosigma, Synedra Karcheri, Cocconeis costata* var. *pacifica* fo. *plana, C. ceticola* fo. *constricta, Stauroneis Omurai, S.*

***aleutica*, *S. aleutica* fo. *brevis*, *Gomphonema Harti*, *Plumosigma Hustedti*, *P. rimosum* are new genus, species and forms of them.**

These parasitic and adhesive diatoms are somewhat similar to those found in the marine littoral diatom samples of the northern hemisphere. Perhaps adhesive micro-organisms on another matters hold more abundant diatoms of unfamiliar species and some littoral forms compared with planktonic diatoms in the sea.

The organism of these parasitic diatoms on organic matters must be studied in future investigations.

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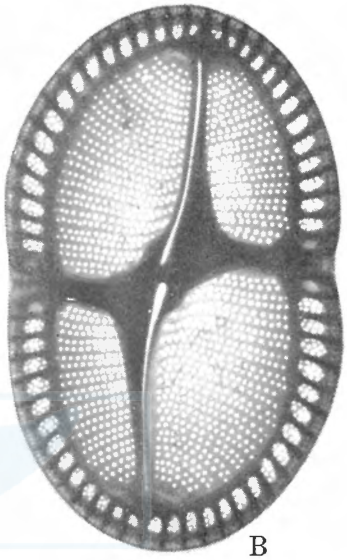
A



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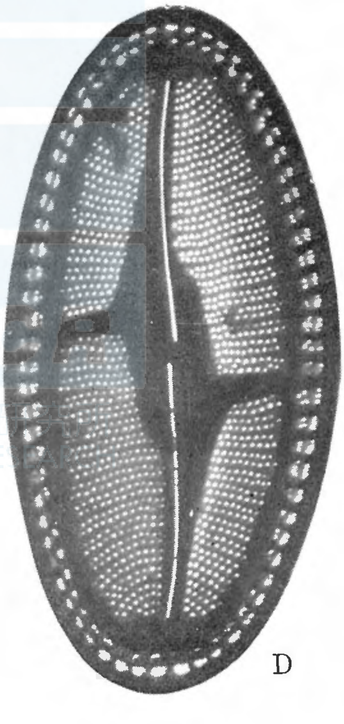

D

Explanation of Plate I.

Electron micrographs of *C. ceticola* and *C. ceticola* form. *constricta* form. nov.

A. Electron micrograph of rapheless-velve surface of *C. ceticola* form. *constricta* (×3200) prepared by Hitachi Central Research Inst. with the heigh tension electron-microscope (228 KV).

B. Electron micrograph of raphe-valve of *C. ceticola* form. *constricta* (×3300) prepared by H.C.R.I. with the heigh tension electron-microscope (200 KV).

C. D. Electron micrographs of raphe-valves of *C. ceticola* (×3000) applied shadowing with Chrome prepared by S. Sakata, Department of Radiology, Faculty of Medicine, the University of Tokyo.

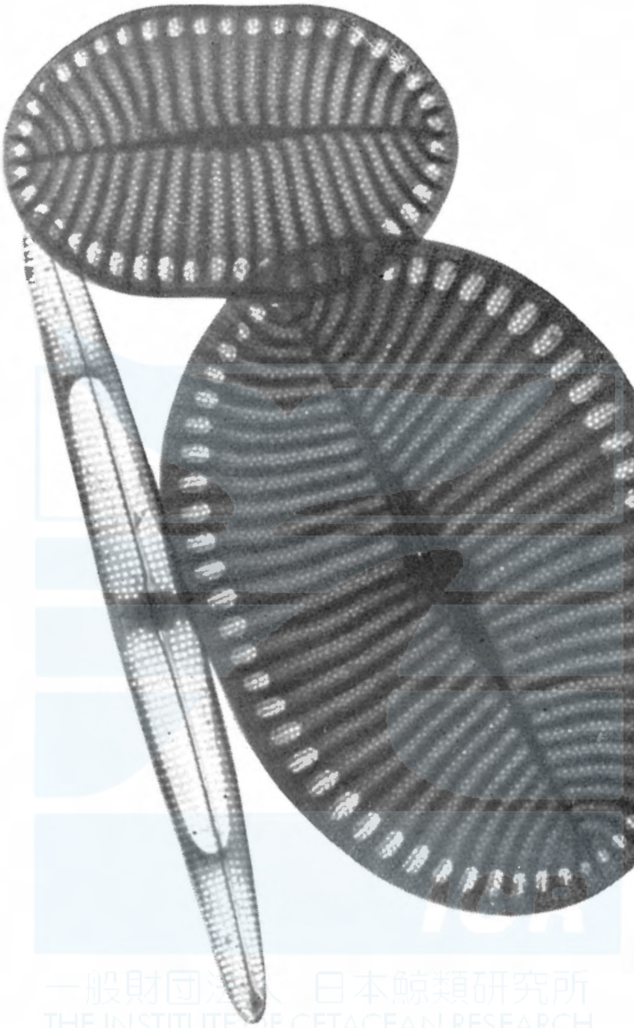

Plate II. Electron micrographs of rapheless-valves of *C. ceticola* form. *constricta* form. nov. and *Stauroneis aleutica* spec. nov. (×3400) by H.C.R.I. with the heigh tension electron-microscope (200 KV).

Plate III. Electron micrographs of *Stauroneis aleutica* spec. nov. and *S. aleutica* form. *brevis* form. nov. prepared by S. Sakata. Applied shadowing with Chrome.

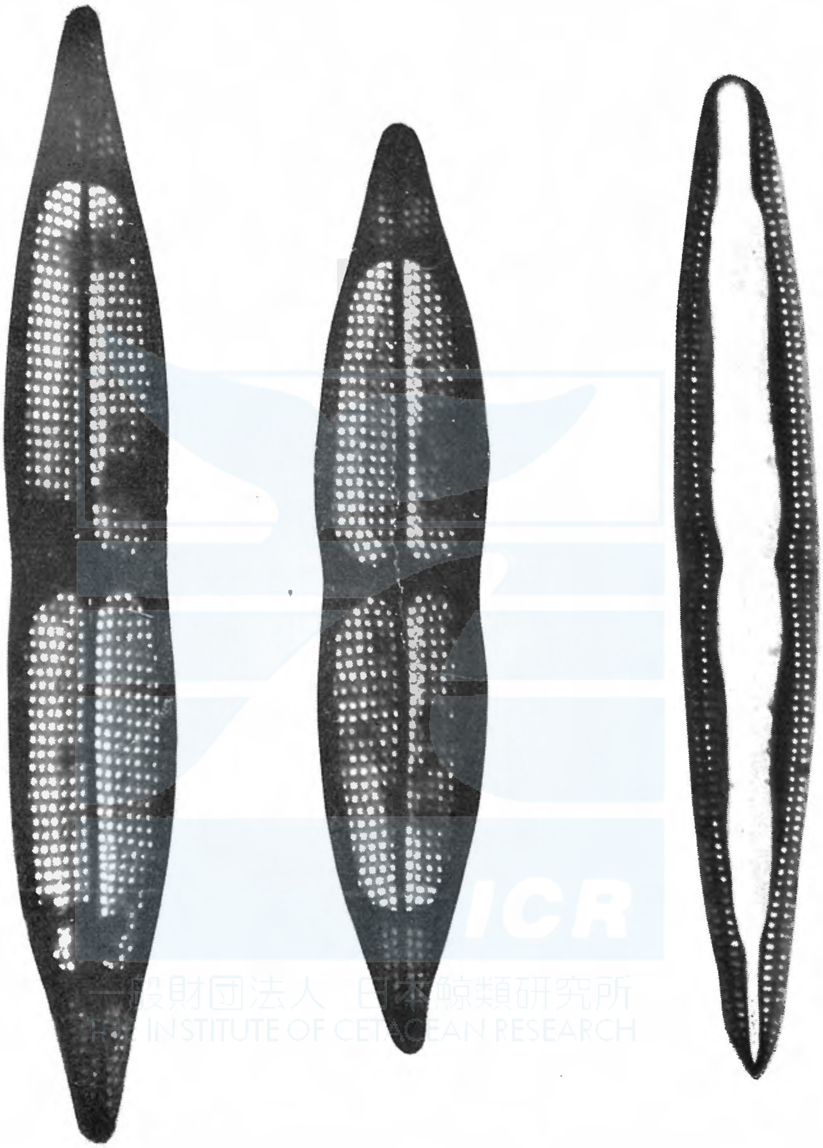

Plate IV. Electron micrographs of *Stauroneis Omurai* spec. nov. prepared by S. Sakata (×5000). Applied shadowing with Chrome.

Plate V. Electron micrograph of *Plumosigma Hustedti* spec. nov. prepared by S. Sakata (×9000). Applied shadowing with Chrome.

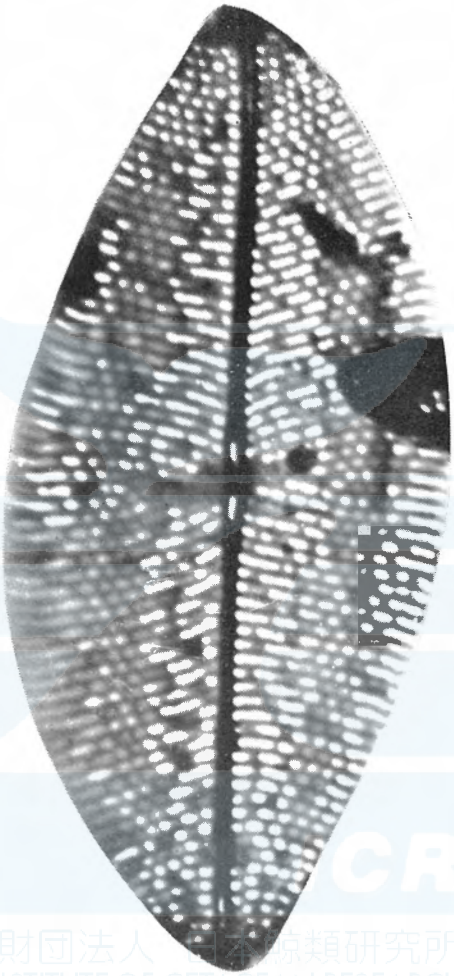

Plate VI. Electron micrograph of *Plumosigma rimosum* spec. nov. prepared by S. Sakata (×8000).

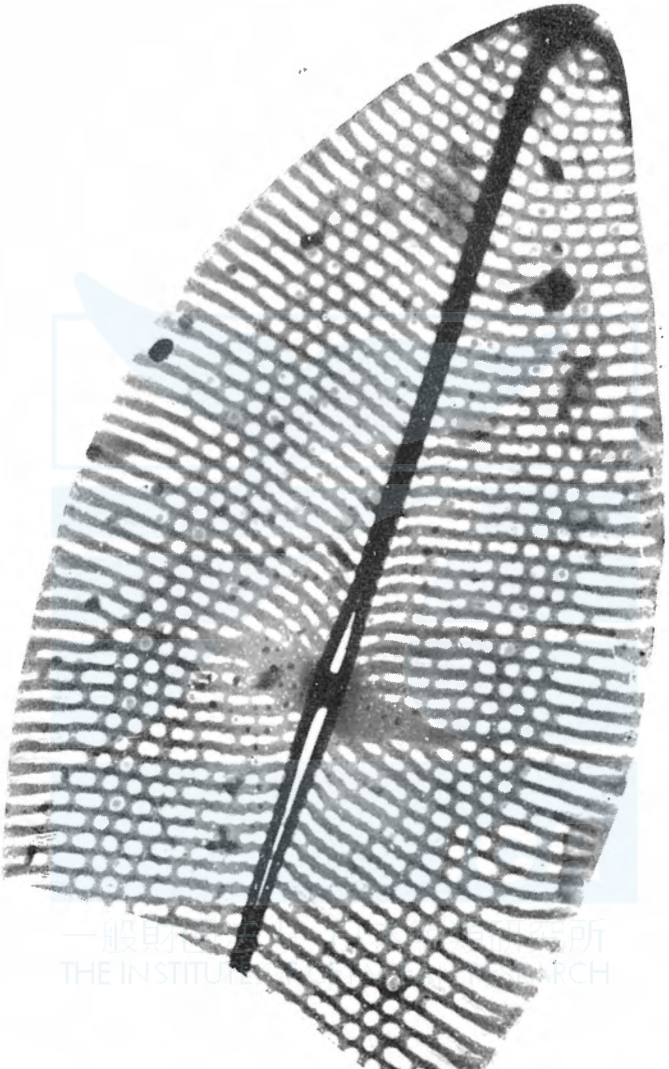

Plate VII. Electron micrographs of *Plumosigma rimosum* prepared by S. Sakata (×15000).

On a Skin Disease and a Nematode Parasite of a Dolphin, *Tursiops truncatus* (Montagu, 1821)

By

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(Tokyo University of Fisheries)

Present paper deals with a skin disease due to a fungus and nematode parasite both found in a bottle-nosed dolphin, *Tursiops truncatus* (MONTAGU, 1821) which died in a pond of Yatsu Pleasure-ground at Yatsu sea-shore of Chiba Pref.

The animal was a female, 266 cm in length, 180 kg. in weight and was captured at the sea-shore of above-mentioned place on July in 1954 and attacked by a skin disease on December of that year, since then the animal gradually grew weak and died in the middle of the next month.

At first the skin became relaxation and on January of next year numerous nodules appeared on the skin.

Besides the skin disease, the animal was showing slight scoliosis. By the dissection, myositis caused by a bacterial infection and two cestode larvae were found at the part, moreover acute pnemonia was found. The scoliosis may be arisen from these pathological conditions.

A swimming pool merely divided by wire-netting and with the bottom of mud has been used to rearing the animal. Therefore the keeping condition was not fitted for the animal in various point. As the food, fish-flesh have been used. Probably, the unsuitable rearing made the animal weaken and lead to the diseases.

We have been studied the skin disease and nematode parasite of stomach, by used the materials preserved in formalin which obtained from the animal at the autopsy.

The investigation proved that the skin disease was due to a parasitic fungus and the nematode parasite was a larval form belonging to the genus *Anisakis*.

The skin disease should be diagnosed as Dermatomyosis accompanied with acute inflammaticula.

Probably fungoid diseases in sea mammalia may not yet unrecorded except only following note in the Discov. Rep. Vol. 17, p. 126—MATTHEWS, L. H.: "A pathological condition of the skin of the head was observed in two male whales at South Georgia and was noted as fungoid growth?"

Although, it seems that there is no relation between the skin disease and the nematode parasite, we wish to report here the results of the studies.

We wish to acknowledge our indebtedness to Dr. M. NISHIWAKI of the Whales Research Institute who have kindly placed the materials our disposal on which the present study was based and we must express our hearty thanks to Dr. Hideo OMURA the Director of the Institute, who kindly offered them facilities for the publication of the report.

Skin Disease of a Bottle-Nosed Dolphin

1. Materials and Methods

The block of affected skin of a bottle-nosed dolphin, *Tursiops truncatus* (MONTAGU, 1821) preserved in formalin were used for the study. The materials were sectioned under celluloidin or parrafin method, and stained with Mayer's acid haemalaum and eosin, Heidenhains iron-haematoxylin, and other staining methods.

Besides the study by sectioned preparations, we studied the parasite separated from the skin tissue by dissecting the materials soaked in 3% H_2O_2 or 10% HNO_3 or 10% NaOH solution for a while to make them softened.

2. Macroscopic Figures (pl. I, figs. 1–2)

Numerous discrete conical nodules measured 21–36 × 16–27 mm in diameter, 5–8 mm in height were observed on the skin of latter half of the trunk. They were somewhat soft, and coloration was not discriminated compared with the normal skin. In the center of well developed nodule remained the tissue in columnar surrounded by peripheral eroded tissue.

The cut-section of the nodules showed no fundamental differences in the findings compared with that of normal skin but it was tainted partially by blood cells.

3. Microscopic Figures (pl. I, figs. 3–4)

The outline of structure of normal skin as follows: The epidermis, *stratum germinativum* consisting from pavement epithelium in the upper layer, somewhat polygonal or cylindrical cells in the middle layer and undifferentiated cells in the basal part and with thin *stratum semicorneum*. From the thin corium layer, corium-papillae with blood capillaries are projected into the *stratum germinativum* and there is a cavity filled with colloidal substances at the end of each papilla.

The corium is consisting from the network of fibrous connective tissue with blood capillaries.

The subdermal tissue is very thick and consisting from fatty and fibrous connective tissue.

The lesion was characterized by proliferation of epithelial tissue and swelling of corium-papillae. Somewhat swollen cells occurred in the upper to middle layer of the lesion and some of them became necrotic and showed vacuolated degeneration, chromatolysis and picnosis. And the layer showed at places longitudinal running plicae originating from the disintegration of the cells under the tissue pressure.

The proliferated cells occurring in the middle to lower layer were cylindrical or spindle form and not discriminative in general configuration to those of epithelial cells of normal skin but in the central part they became spindle and arranged more compact.

As shown pl. I, fig. 3 the tissue underlying the degraded tissue showed numerous cavities arosed by liquefy of the proliferated tissue.

The corium-papillae extremely enlarged and ruptured completely and filled by blood cells especially polynuclear leucocytes. Some of them contained the like of thrombus.

The skin disease was assignable to a parasitic fungus inhabited in the epidermis, and it was found mainly in the upper layer of the lesion.

4. Morphological Characters of the Fungus (pl. II. figs. 1–5)

Pl. II. fig. 1 shows the general configuration of the fungus. It grows penetrating and branching in the epithelial tissue of the lesion. The mycelium is divided by septae and measuring 2.1–6.4μ in diameter.

Vesicular bodies formed by swelling of the mycelium at the distal ends were observed in the upper layer of the lesion. They were measured 14.7–48.6$\mu \times$14.1–37.1μ in size and contained coiled mycelium which was well stainable with haematoxylin. They may be copulatory organ of the fungus (pl. II. fig. 2).

The spore formation was observed on the hyphae found in collapsed parts or tissue cavities of lesion. The spores were numerous, well developed, and covered with brownish thick-wall, and were almost circular or ovid or rearly spindle form. The circular or ovid spores were 3.6–11.4$\mu \times$3.0–6.7μ, the spindles 9.9–12.0$\mu \times$2.6–3.9μ in size (pl. II. fig. 3).

They were pleurogenous and isolated or clustered on the vegetative mycelium (pl. II. fig. 4).

Germination of the spores was observed in the lesion. The germ tubes were well stained with eosin and measured 2.1–2.9μ in diameter (pl. II. fig. 3).

The arthrospore was formed at the tip of mycelium and each cell was circular or ovid and 6.5–12.0 μ × 6.4–8.6 μ in size (pl. II. fig. 5).

Judging from the above-mentioned characters, the fungus may be placed in the genus *Trichophytum* MALM. 1848 according to the classification of CLEMENTS and SHEAR (The Genera of Fungi, p. 231, 1931). The specific determination requires further studies.

5. Summary

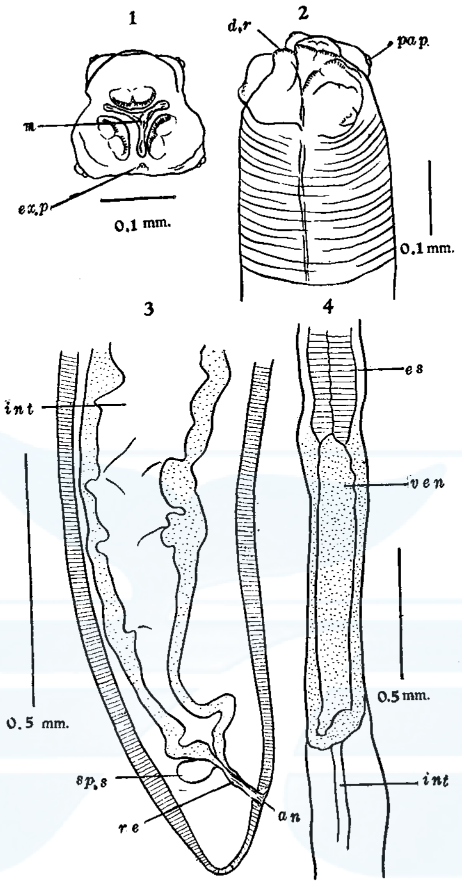
We studied a fungoid skin disease found in a bottle-nosed dolphin, *Trusiops truncatus* (MONTAGU, 1821) which died in a rearing pond at Yatsu Pleasure ground, Yatsu sea shore of Chiba pref.

1. The disease formed many characteristic conical nodules ruptured at the tip on the skin.
2. The nodules consisted of the proliferated epithelial cells and the extremely enlarged corium-papillae filled with blood cells, especially polynuclear leucocytes and were found parasitized by a kind of parasitic fungus. The proliferation of the epithelial cells was caused by the fungus, which was found in the epithelial tissue of the lesion.
3. The fungus was parasitic type and was identified with the genus *Trichophytum* MALM. 1848 previsionally.

Nematode parasite

Forty-one individuals of all immature specimens were obtained from the stomach of the same host.

The morphological characters of the parasite (textfigs. 1–4) are as follows: Body 17.0–30.0 mm. in length, 0.4–0.6 mm. in breadth; cuticle presented a series of fine rings and a pair of cervical papillae at the level of 0.4–0.7 mm. from anterior end. Head truncated, consisting of three large lips; dorsal lip nearly tetragonal provided with double papillae at the both corner; two subventral lips nearly triangular with double papillae at outside; each lip with dentigerous ridge and indented in the middle; interlabia absent; mouth triangular; Esophagus divided into an anterior muscular part and a posterior straight ventriculus, the former measured 2.32-3.38 mm × 0.17–0.28 mm the latter 1.11–1.25 mm × 0.20–0.28 mm. Intestine straight and thick walled with numerous fold; rectum short; anus situated 0.16–0.21 mm. from posterior end. Nerve ring situated 0.3–0.4 mm. from anterior end. Excretory pore located between subventral lips; reproductive organ undeveloped but origin of spicule sac with 0.06–0.08 mm × 0.04–0.06 mm in size observed under the rectum. Tail bluntly conical with numerous caudal papillae.



Textfig. *Anisakis* sp. parasitic in the stomach of the bottle-nosed dolfin, *Tursiops truncatus* (MONTAGU, 1921)

Fig. 1. Head, end view
Fig. 2. Head, ventral view
Fig. 3. Posterior extremity
Fig. 4. Ventriculus

an, anus; d. r, dentigerous ridge; es, esophagus; ex. p, excretory pore; int, intestine; m, mouth; pap, papillae; re, rectum; sp. s, spicule sac; ven, ventriculus.

Judging from the characteristics of the head of the nematode, it may be immature form of *Anisakis catodontis* BAYLIS, 1929. Summary: A larval form of nematode parasite obtained from the stomach of *Trusiops truncatus* (MONTAGU, 1821) was descrived to be identified with the genus *Anisakis*.

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PLATE

Explanation of Plate I.

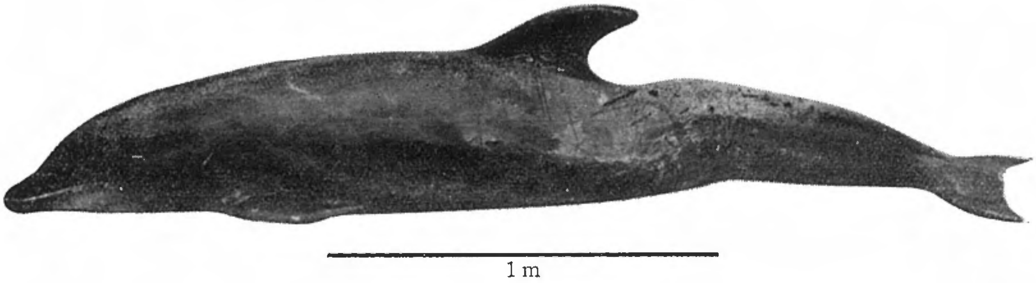
1. Showing the general configuration of the diseased bottle-nosed dolphin, *Tursiops truncatus* (MONTAGU, 1821).

2. Showing the well developed lesion.

3. Showing the longitudinal section of the lesion, stained with van Gieson's stain; EP, proliferated epithelial tissue; P1, normal corium-papilla; P2, abnormal corium-papilla.

4. Showing the enlarged corium-papilla filled with blood cells especially polynuclear leucocytes stained with Mayer's acid heamalaum and eosin.

1



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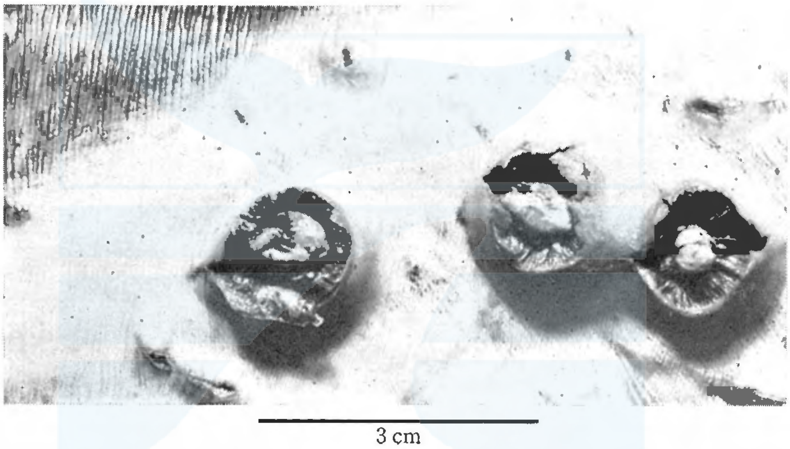

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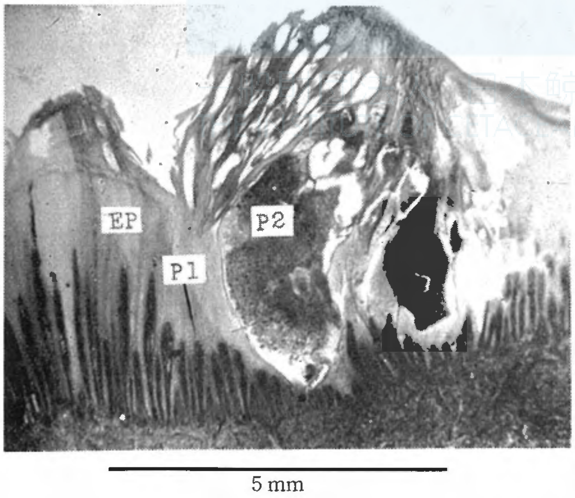

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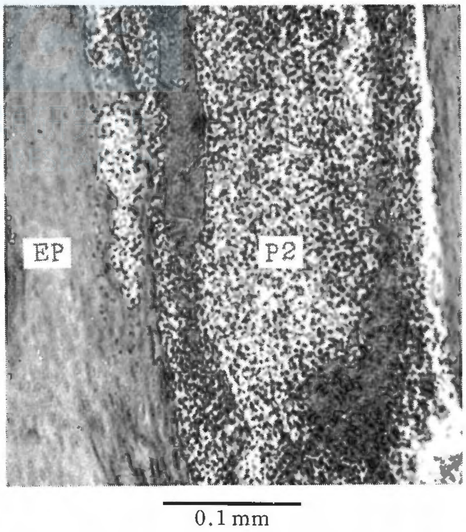


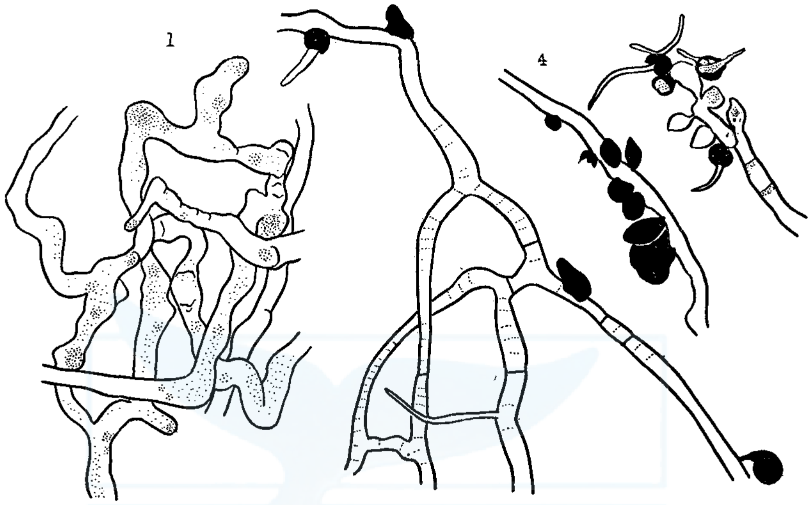
Explanation of Plate II.

Showing the general configuration of the genus *Trichophytum* sp., found parasitic in the skin of *Tursiops truncatus* (MONTAGU, 1821).

1. Mycelium in the epithelial tissue.
2. Copulatory organ.
3. Aleurispores and the germinating spores.
4. Aleurispores.
5. Arthrospores.

1

4



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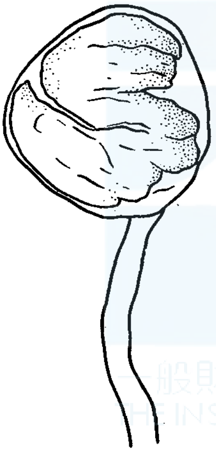

3

5

0.05 mm
for Figs. 1. 2. 3. 4. 5.

0.01 mm
for Fig. 3.


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Descriptions on Unidentified Species of Dibranchiate Cephalopods.

I. An Oegopsiden Squid belonging to the Genus *Architeuthis*

By

Eiji Iwai

(Laboratory of Fisheries Zoology, Faculty of Agriculture, Tokyo University)

In recent years some authors have reported on the Cephalopods found in Japan and its adjacent waters. However since 1929, no attempt has yet been made to present a monograph of the species found in these areas. Furthermore, as the preliminary records, treated only the species of the coast and bay and a few pelagic members, it is believed that many unidentified species still exist in the ocean.

The present specimens belonging to Oegopsids have not been hitherto catalogued in Japan. In many respects, these specimens resemble the squids of the genus *Archteuthis* and it is thought to be a young type of *A. japonica*, but on the other hand striking differences were seen, especially on the structure of the gladius and the horny ring found on the arm suckers.

As mentioned by Pfeffer and Robson, it is very difficult to determine the species in Architeuthidae, because of the following reasons.

(1) Only a few specimens belonging to the family were obtained up to the present.

(2) Almost all the squids described were those found, either partially digested or destroyed in the digestive canal of the whale, or those found stranded in the storm.

(3) Most of the reports are limited to the description of giant, mature squids.

(4) In some of the species, sexual dimorphism etc. are seen.

From the above reasons, Pfeffer stated that the fifteen known species of Architeuthidae could better be divided into 3 groups, i. e. *Nordpazifische, Nordatlantische und Südliche Formen*, and discussed from the viewpoint of geological variations. In the North Pacific, only a single species was reported by Pfeffer and others.

The two specimens described here were found in the digestive canal, perhaps in the stomach of the sperm whale, captured near the Bonin Islands in the summer of 1952. In this paper the author has tried to describe the specimens, by discussing their resemblances and differences with *A. japonica* and other Oegopsids.

The author has much pleasure in acknowledging his indebtedness to Dr. M. NISHIWAKI, who kindly supplied the specimens, to Prof. M. ISHIKAWA and Y. SUYEHIRO for their invaluable advice and guidance, and to Assoc. Prof. T. HIBIYA for his kind assistance in reading the proofs of this paper.

General Observations

Mantle: Body rather small, subfusiform as seen in general squids and its length reaches 3½ to 4 times the maximum breadth taken at the anterior orifice. From the opening the mantle gradually tapers posteriorly, forming a straight line at each lateral margins to the origin of the fin, whence it becomes much narrower and continues to the extremity as a slender spit-like process, but not conical as seen in *Ommastrephes* (plates I and II). According to SASAKI's description on *Architeuthis japonica*, the maximun breadth of the mantle is at about one-third of the length from the anterior end; however, PFEFFER described that it is broadest at the orifice.

Actual measurements of the specimens after preservation in formalin are given in table 1.

The mantle is rather thick, fleshy and smooth; on all its surface,

Table 1. Morphological measurements of the two specimens

Body portion			No. 1		No. 2	
Mantle:	dorsal length	(mm)	92		104	
	maximum breadth	(〃)	26		26	
Head :	dorsal length	(〃)	24		26	
	breadth	(〃)	25		26	
	height	(〃)	17		18	
			left	right	left	right
Arms :	length of the first	(〃)	53	56	54	54
	the second	(〃)	65	66	61	60
	the third	(〃)	63	65	61	60
	the fourth	(〃)	58	58	56	56
	formula		2≒3>4>1		2≒3>4>1	
Fin :	length	(〃)	44		52	
	breadth	(〃)	64		61	
	length/breadth	(%)	69		85	
Fin length/Body length		(〃)	48		50	
			left	right	left	right
Tentacle:	length	(mm)	105	*166	121	119
	club	(〃)	23	23	23	22

* most elongated

devoided of any kinds of tubercles or folds. Purple-coloured chromatophores are as common as in any other squids. No luminous organs are present. Antero-ventral margin of the mantle is slightly concaved between the faint projections of the either sides of the funnel base; dorsally the margin forms an obtuse angle of about 170° at the middle, while in SASAKI's description it is said to form an angle of 120°.

Fin: Fin is typically terminal, and is about half the length of the mantle; its breadth is decidedly longer than its length. The shape of the fin is very characteristic. It is more or less heart-shaped, but with an acute posterior extremity and quite resembling that of *A. japonica*. Anteriorly its origin is somewhat auriculated on both sides of the body, and the antero-lateral margin is clearly convex, the convexity being continued to the round ear-shaped lateral angle too. The post-lateral margin is nearly straight except at the projected region.

Head: Head is roughly cubical in shape; the ventral surface is flat, whereas the dorsal and lateral sides are rounded. Breadth of the head is a little narrower than the mantle and its length is about one-fourth of the body length. The posterior end of the head is obviously marked off from the neck by a distinct constriction at both funnel bases. Eyeballs comparatively large, and the perforated openings are also wide; at the interspaces between the third arm and the tentacle, is situated a very distinct sinus, the dorsal wall of which is more or less thickened (fig. 11). According to MITSUKURI and IKEDA, the "lacrymal gland" of *A. japonica* is much smaller than in these specimens.

Funnel excavation is deep, and is limited by a clear-cut horse-shoe shaped fold, which widens into a broad thick membrane holding the funnel laterally at the posterior region. Olfactory crest is not conspicuous; this organ may be composed of more than 10 fold-like streaks running longitudinally at the lateral side of the head.

Nuckal cartilage: Nuckal cartilage spatulate, but on its structure a little difference was observed when compared with that of *A. japonica* given in SASAKI's description.

The anterior one-third of the nuckal cartilage is quadrangular in shape with its corners rounded, and its length is twice the breadth. The posterior end narrows gradually and finally ends in a spoon-shaped expansion. There are two median parallel ridges gently raised from the surface, which gradually flattens towards the posterior end. In the crest between these ridges a shallow groove was observed. The nuckal cartilage is 1.3 cm long and the maximum breadth is 0.4 cm.

Funnel: Funnel is relatively large, and especially expanded at the base; its distal end being somewhat tubular, and a little recurved ventrally. The funnel organ consists of dorsal and ventral pads. Among these, the dorsal pads are remarkably distinct and are V-shaped. They are placed beyond the anus and form an apex in the central region of funnel. The ventral pads were not clearly seen in these samples. The funnel valve is wide, tongue-like and situated inside the siphon, a little distance from the orifice, sticking to the dorsal wall.

Articulations: The whole appearance of the funnel cartilage is slender as a bamboo-leaf, as shown in fig. 9, with a deep, broad groove at a little dorsal to the median line; the measurements are 1.3 cm in length and 0.3 cm in breadth. The ventral side of the crest is faintly elevated. Anterior end of the cartilage is more or less sharp pointed and a little recurved to the outside, but the posterior end of the cartilage is blunt and turned to the inside. Mantle cartilage almost the same with that of other species in Architeuthidae (fig. 10); its length nearly one and half times that of the funnel cartilage and is linear and keeled. Its posterior part is a little broad and gently decreased in height posteriorly.

Arms: Arms are more or less equal in length, shorter than the mantle and its length order is $2 \doteqdot 3 > 4 > 1$; while in *A. japonica* its length exceeds that of the head and body length, and its order is $4 \doteqdot 3 > 2 > 1$. All arms roughly quadrangular shaped in cross-section, tapering towards the tip evenly. At its lateral sides, slightly compressed, but clearly round on the aboral surface. The web only develops on the outer sides of the ventral arms; the dorsal side much broader than the ventral and widens towards the base. According to MITSUKURI and IKEDA, webs are not seen on all arms. Protective membranes which are well-developed in *A. japonica* are not recognized in these specimens, this may be the result of digestion.

Arm suckers: Arm suckers are large relative to the length of arms. They are subspherical in shape and arranged in two rows throughout.

On the whole, the suckers on the ventral arms are decidedly smallest, the diameter being about half that of the suckers of the other arms. The suckers, excepting those on the ventral arms are almost of the same size at particular levels. It may be said that the suckers are the largest on the two second arms, and consist of about 40 series of suckers. The proximal 20 series are recognized with the naked eyes and the rest are minute, in the distal region. The suckers on these arms become larger gradually and the largest on the 7th or 8th series, and then diminish in size distally. The number and arrangement of the suckers on the other arms are about the same with that of the second arms.

A remarkable difference with that of *A. japonica*, is that, on the horny ring of each sucker in *A. japonica* a row of teeth are present.

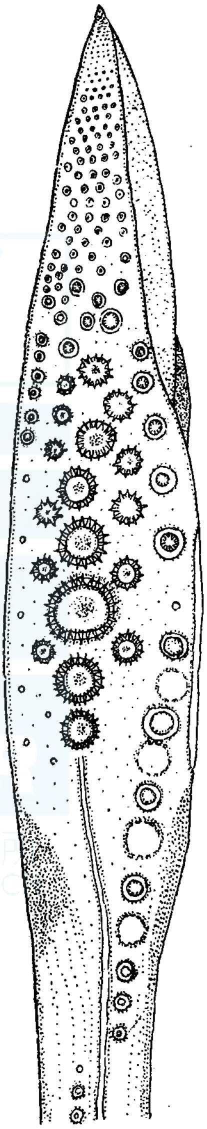
However, in these samples teeth are completely absent.

Tentacles: The structure of the tentacle is most characteristic and is not seen in other Oegopsids. The length of the tentacle reaches to that of the head and body, but much shorted than the tentacle of *A. japonica*. The width is a little narrower than the arms. The club is feebly expanded and somewhat lanceolate and sharp pointed at its distal extremity, protected by a flap of thin membrane at the edge. The length of the club is about 1/5 to 2/9 of the tentacle. Regarding the structure of the tentacle, the most striking characters are the arrangement and structure of suckers on the hand portion (fig. 5 and text-fig. 1).

Tentacular suckers: The suckers are arranged in 5 rows, and the middle ones are much larger than the lateral ones. Of the middle ones, the centro-basal 3 suckers are extraordinarily large, measuring up to 2 mm in dia. These suckers are flat typically basin-shaped, and each sessiled by a very short, but thick stalk. On the margins of the horny ring of the largest sucker, 26 teeth triangular in form are situated at regular intervals and it is all projected outside from the chitinous margin. Of these teeth, the ventral one is larger than the dorsal one.

Next in size to the horny ring in the middle row, the order is as second, first, fourth and fifth row respectively. i.e. the size of the horny rings becomes smaller gradually in the order of the rows shown above. The teeth too, found on these horny rings become proportionately smaller in relation to its horny ring. From the above description it is apparent that the suckers of the rows which are ventral most (i.e. the 5th row) are the smallest in size.

Further to this, the author observed that these suckers of the fifth row, towards the distal end, lose their proper positions and insert themselves more in the distal region



Text-fig. 1. The arrangement of variable suckers on each region of the tentacular club. ×5.

in the company of the suckers of the fourth row. So the disposition of the suckers on the boarder line, between the hand region and the distal region, is more or less disturbed, and it becomes a question to determine to which region the suckers belong decisively. In respect to this character, these specimen agree with the squids of the genus *Meleagloteuthis*. In *A. japonica*, however, the hand of the tentacular club has suckers in 4 oblique rows, of which the suckers of the two median rows are much larger than those of the marginal rows. Nevertheless, they are all basin formed.

The suckers known as the fixing apparatus on the carpal organ (carpal region) are eleven in number. They have smooth horny rings and pads are found in the interspaces of these suckers. The suckers decrease in size proximally.

The distal region of the tentacular club is composed of about 40 series of minute suckers arranged in 4 or 5 rows. Its horny rings are toothless.

An interesting fact is that along the two-thirds of the linear groove, running in the median line inside the tentacular stem from the end of the carpal organ to the base are situated 14 suckers and pads, which are nearly equal in size to the distal suckers, with smooth horny rings.

Gladius: Gladius thin, feather-like as shown in fig. 8; the maximum breadth is a little shorter than one-eighth the length of the sample. Rhachis carinated on the back, but the keel does not appear through the mantle at its dorsal median line. The vane attached to the posterior seven-eighth of the rhachis, is much broad, its widest part being at a distance of one-fourth the length of the gladius from the anterior end. From here it becomes slender gradually towards the posterior end. Secondary development can be seen out of the lateral vanes. The tip of the given specimens being damaged, the structure of the posterior part was not observable. However the author doubts, whether the end cone distinctly recognized in *A. japonica* is also found in these specimen. Ribs are firm and are dark amber coloured in formalin solution.

Discussion

As stated above, these specimen have similarities and agree very well with the descriptions of *A. japonica* in many points, i.e. (1) in the external appearance of the mantle and the fin, (2) the structure of the articulating cartilage, (3) in the arrangement of suckers on all arms, (4) the basemental structure of the tentacular club and its stem, and (5) the fixing apparatus. But on the other hand, many differences were also seen and are summalized in table 2.

Table 2.

	A. japonica (adult)	The specimens
Hand region of tentacular club	consists of 4 rows of suckers	consists of 5 rows of suckers and 3 ones of the central row much larger than the others
Arms	much longer than body length and arm formula; 4≒3>2>1	not longer than body length and arm formula; 2≒3>4>1
Horny rings of arm suckers	all with dentation	not any teeth
Fin	decidedly longer than breadth	length shorter than breadth
Gladius	forms an end-cone at the posterior extremity	not formed

In addition to this, some of the results, established by the comparison of these samples with *A. japonica* seem also to be applicable to other species of this genus.

It may be thought that these different characters, especially of the fin, arm order, and the arrangement of the tentacular suckers, could have originated as a result of morphological variations during growth of the same species. These samples were at first believed to be a young type of *A. japonica,* with resemblances to locality.

However, will it be possible to explane for the formation of teeth on the whole margins of the horny ring on all arm suckers, and for the fundamental difference on the structure of the gladius? In these respects, the author hestiated to draw a conclusion.

Still more, comparing these specimens with other Oegopsids, results obtained were as follows.

These specimens differ:

From Branchioteuthidae in:

(1) The structure of the tentacular club.
(2) The presence or absence of the fixing apparatus.
(3) The teeth of the horny ring on the arm suckers.
(4) The form of the gladius.

From Histioteuthidae in:

(1) The mantle structure and (2) the body form.

From Enoploteuthidae and Onychoteuthidae in:

(1) The horny ring of the arm suckers and (2) the surface structure of the mantle.

And from other families, differences are clearly recognized at a glance. It is very difficult to conclude to which species in *Architeuthis* these specimens belong at present and regards on this point, will be discussed and reported in some future.

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Plate I.

Fig. 1. Dorsal view of the specimen No. 1. ×4/5.

Fig. 2. The same, ventral view; dissected. ×4/5.

Plate II.

Fig. 3. Dorsal view of the specimen No. 2. ×3/4.

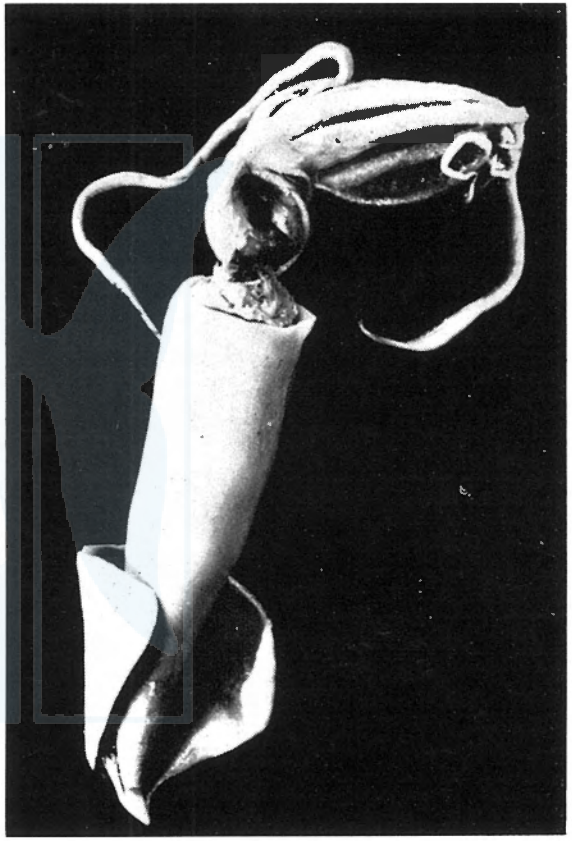

Fig. 4. The same, ventral view. 3/4.

Plate III.

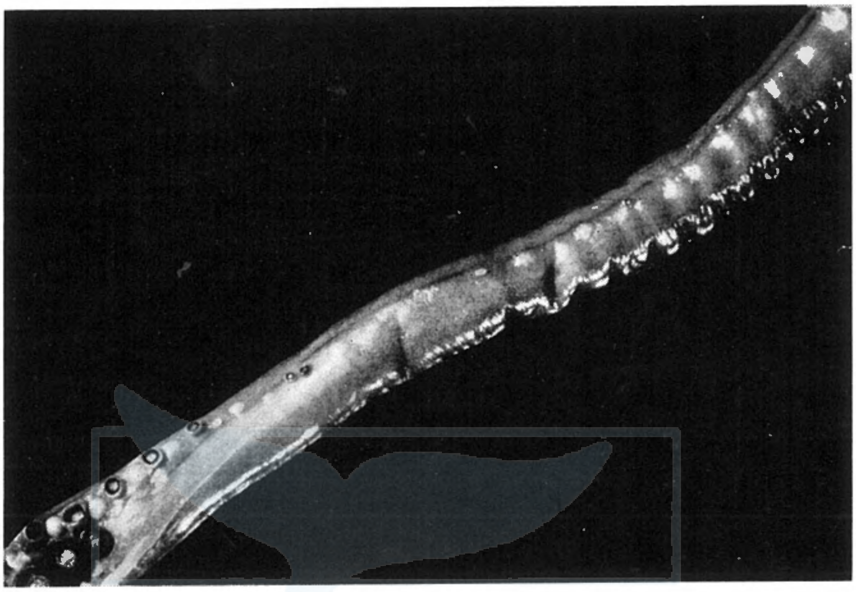

Fig. 6. Right tentacular stem. $\times 3^{1}/_{5}$.

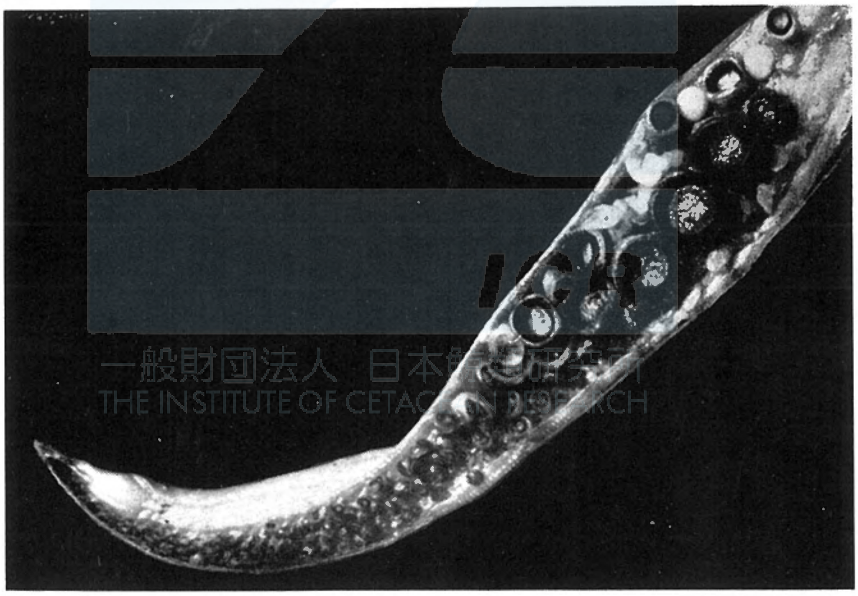

Fig. 5. Right tentacular club. ×5.

Plate IV.

Fig. 7. Suckers of right arms. ×4.

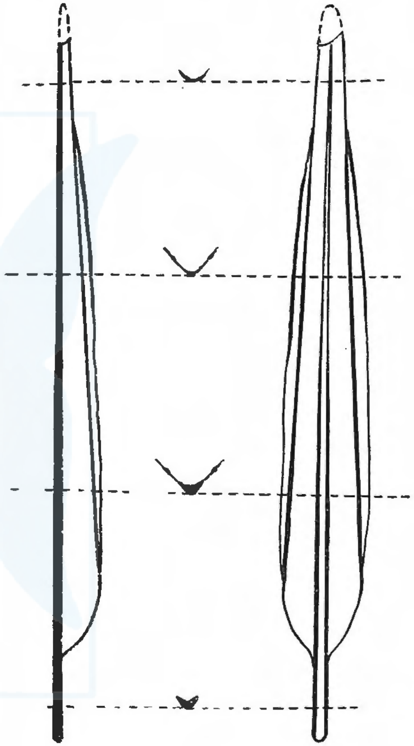

Fig. 8. Gladius. ×1.

Plate V.

Fig. 9. Funnel cartilage. ×4.

Fig. 10. Mantle cartilage. ×3.

Fig. 11. Head, lateral view. ×$2^1/_2$

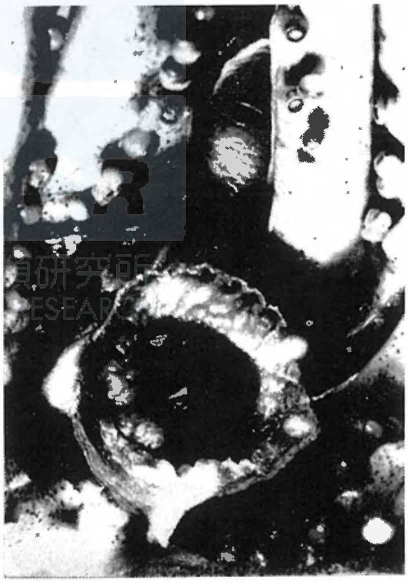

Fig. 12. Mouth part. ×3.

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Descriptions on Unidentified Species of Dibranchiate Cephalopods.

II. A Cranchiidae Squid of the Genus *Taonius*.

By

EIJI IWAI

(Laboratory of Fisheries Zoology, Faculty of Agriculture, Tokyo University.)

A good specimen of this deep-sea squid was given to the author through the kindness of the Whale Research Institute.

As would be described later in this paper, a member of characters go to prove definitely that this species belongs to the genus *Taonius* of the family Cranchiidae. Two of the striking characters are its elongated form and the soft gelatinous like nature of the body. Many other characteristics were observed while comparing it with the known species *Taonius pavo*. As the present writer is not aware of any literature of this specimen and its differences and similarities with other known species, he has made and effort to publish here the observations he made on this unidentified species.

The sample was obtained from the stomach contents of the sperm whale caught near Kamchatka in the North Pacific in the summer of 1951.

The writer wishes to express his sincere gratitude to Dr. M. NISHIWAKI for supplying the sample, to Prof. M. ISHIKAWA and Y. SUYEHIRO for the valuable guidance rendered during the course of the work and last but not the least to Assoc. Prof. T. HIBIYA for reading the proof of this paper.

General descriptions of the specimen

Mantle and its surface: Mantle texture remarkably characteristic; very soft and gelatinous as in *Chiroteuthis*. The body form of this specimen is much elongated, subfusiform, and its length is about 7 times the maximum breadth, which is perhaps at the anterior portion of the mantle. From this region the mantle gradually tapers behind near up to the beginning of the fin and then becomes narrower rapidly, to continue as the filiform end-process (figs. 1 and 2). In this point, the sample almost resembles *Taonius pavo*. The 'Schwanzfaden' as described by PFEFFER on the VERRILL's and JOUBIN's specimens of *T. pavo*, does not exist in this sample.

In table 1 are collected the results of the morphological measurements made on the sample.

Table 1. Morphological measurements of the specimen examined.

Body parts		Length	
Mantle;	ventral length	428 mm	
	breadth at the anterior margin	63	
Fin;	length	164	
	maximum breadth	76	
Head;	length	47	
	breadth except the eyes	27	
	height	33	
		left	right
Arms;	length of the first	94	*76
	the second	124	120
	the third	120	123
	the fourth	114	113
Eyes;	diameter	37	
Fin length/Mantle length		39%	
Fin length/Fin length		218%	

* the tip broken

It is a very striking fact that on the surface of the mantle are densely scattered white hemispherical crystalline tubercles of about 5 to 7 mm. dia. and many black large and smallpi gment spots of less than 5 mm. quite differing from the chromatophores in the general squids (fig. 3). They are about the same in arrangement and number at both dorsal and ventral surfaces of the mantle except at the attaching portion of the fin, and on the whole they become more abundant, distinct and larger as the anterior mantle margin is approached. However, no tubercles are recognized on the surface of the fin and the mantle region situated along the fin. On the other hand, black-coloured pigments do not at all exist on the ventral side of the fin and the distribution on the dorsal surface is limited only to the gladius region. It is of great importance to note that there is not a single line of chitinous tubercle on either side of the ventral aspect of the mantle.

As in general Cranchiids, the anterior margin of the mantle is firmly fused with the head by the cartilaginous articulations, indirectly at both the funnel bases and directly at the nuckal region. At these points, the mantle is faintly convex with a dune crescentwise angle.

Fin: As regards the combined outline of the fin, it is a little elongated and gold-coin shaped with a projected extremity; its length is decidedly more than twice the maximum breadth. Since there is no appearance of the anterior insertion, lateral angles and auriculating lobes are not distinctly recognized.

Head: The head proper excluding the projecting eyes is rather narrow and triangular shaped when looked from the ventral side; on all its surface, no kinds of tubercles or folds are found. There is a clear demarcating constriction between the head and arm regions. The dorsal surface is roundish and smooth. The ventral side is almost totally occupied by the expansion of the funnel. The eyes are enormously large, and projected from the lateral surface of the head by means of a short but thick peduncle ; the diameter of the eye reaches about 35 mm. and it is about 30 mm. in height. In SASAKI's text-fig. 145, the eyes are not so much protruded as in this specimen.

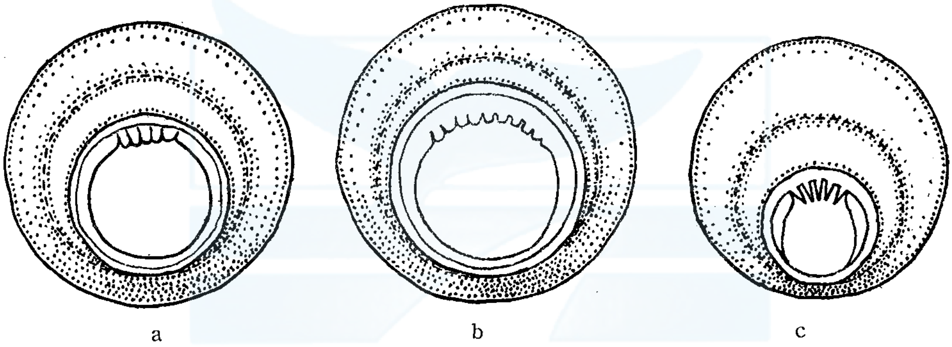
At the posterior margin of the eyes, olfactory tubercles are situated in *T. pavo*, while in this specimen a gelatinous substance surrounded by a yellow-coloured band in formalin fixing solution is found near the same place. The author is not certain whether this is the same as the olfactory tubercles of *T. pavo*.

The funnel covers almost the whole ventral region of the head and is between two linear elevations of the cephalic cartilage running along both the ventral margins, and is especially expanded at the base in longitudinal directions. The figure of this is shown in fig. 5; the distal part, free from the head, is much longer, when compared with common squids and its orifice is vertically opened. The funnel groove is not well differentiated. The olfactory crest is also not distinct.

Arms: Arms not equal in length and are rather short. The length is about one-fourth the length of the mantle ; their order of length being $2 \doteqdot 3 \doteqdot 4 > 1$. The thickness of the arms are more or less alike, and are round in cross-section. The arm tapers gradually from the base towards the tip, and its distal end is blunt.

The keel nor the web are developed in any one arm. However, protective membranes are well developed and extend from the proximal base to the distal extremity along the two sides. The dorsal membrane is much smaller than the ventral one. The width of the ventral membrane reaches about 10 mm on each arm. SASAKI, however, in his description has said that the proximal half of the third arm is slightly keeled and the dorsal outer surface of the fourth arm is webbed. The trabeculae are thickened.

Arm suckers: Arm suckers are globular and relatively large. They are arranged in 2 rows throughout. They begin from the basal end and are distribute at some intervals at the proximal region, but are crowded at the distal portion (fig. 6). The suckers are almost the same in size and structure at similar regions in each arm. The suckers are smallest on the ventral arms. Choosing the lateral third arm for the description of suckers, there are about 50 pairs of suckers arranged in 2 distinct rows. The suckers of the 9th or 10th series are the largest and those following are similar in size. Again the suckers of the 17th or 18th series are remarkably large and those that follow become gradually smaller in size. However, when the size of the distal suckers compared with those of other common squids are comparatively larger. A similar feature is observed in all the other three arms (fig. 4). SASAKI's specimen had 20 pairs or more of suckers.



Text-fig. 1. The structure of 3 kinds of horny rings on the suckers of the left third arm. (a) The proximal one; 1st series. ×20. (b) The central one; 13th series. ×20. (c) The distal one; 25th series. ×20.

Generally, the structure of horny ring is related in its proportion to the size of its bearing sucker. Namely, three kinds of teeth were seen (text-fig. 1). The proximal horny ring is provided with 3 to 5 square-cut teeth produced from the higher wall of the horny ring. The teeth of the other horny rings are also produced from the same higher wall region. The teeth of the proximal horny ring are closely set by each other with deep crests.

The central horny ring which is the largest has about 7 to 12 teeth, much broader and shorter than the former, so much so that they are easily over-looked if carelessly observed. It was also observed that some erotion into the wall usually occurred near the marginal teeth and sometimes an irregular bridge at the opposite side of the teeth region was seen.

In SASAKI's specimen, teeth was produced on the whole margin of the horny ring and it numbered about 20 to 30. But according to VERRILL's and JOUBIN's descriptions, teeth were present only at the higher wall as in this specimen.

On the distal horny ring, situated after the 20th series of suckers, the number of teeth is considerably decreased to 4～6 and its form becomes conspicuously sharp and triangular in shape. Besides these, a few anomalous plate-like teeth were also seen at both lateral sides of the horny ring.

Tentacles: PFEFFER described that tentacles are easily broken. To my regret they were completely lost in this specimen.

Buccal membrane: The buccal membrane is rather thick, broad and supported with 8 ribs, of which the dorsal and ventral ones are united at the base and are *T*-shaped. They are further fastened to the dorsal side of the second arm and to the ventral side of the third arms. The outer lip is well developed.

Gladius: The gladius is dark amber-coloured and clearly perceptible from the back of the mantle. It extends over the whole length of it. The basemental structure of the gladius resembles well with that of *T. pavo.* The anterior half of its gladius is followed behind in equal width, and while leaving the middle region, it spreads by degrees posteriorly and then from the origin of the fin, it rapidly tapers, forming a filiform end-cone at the distal end.

Conclusion

In M. SASAKI's monograph on the Dibranchiate Cephalopods, single species belonging to the genus *Taonius*, in the sea-around Japan was represented. In foreign countries, several species were described since STEENSTRUP's introduction of this genus in 1861. Later, it was clarified that they belong respectively to other new genera, expecting the species which is quite similar to *T. pavo.* As far as the author is aware of, there are no other species of the genus *T. pavo* anywhere. The author believes that the specimen described here is the only species of this genus ever found, in view of the following reasons:

(1) Is most elongated.
(2) Length of mantle, fin, head and arms is proportionately similar to that of *T. pavo.*
(3) Galert-like consistency of body constitution.
(4) Non-stalked large eyes.
(5) Structure of lanceolate gladius.

On the other hand, remarkable difference with *T. pavo* were also seen as shown by following characters.

(1) Existence of white tubercles and many kinds of pigment spots on the surface of the mantle.

(2) Situation of teeth on the horny ring of each sucker and its number,
(3) Absence of olfactory tubercles.
(4) The curious tongue-like shape of the funnel and its vertical opening.

Among these, it is the most notable fact that the specimen has Calcium hyaline tubercles which are not found in other *Taoniinae* squids and appearance of them suggests the close phylogenical relationship to the *Cranchiinae* squids.

Many important questions remain unanswered and due to the lack in number of the samples, it seem almost impossible to establish a new species now. However the author hopes that the work on this unidentified species would be continued by others interested, and definite conclusions come to later with the establishment of the new species.

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Plate I.

Fig. 1. Ventral view of the specimen. ×1/4.

Fig. 2. The same, dorsal view. ×1/4.

Plate II.

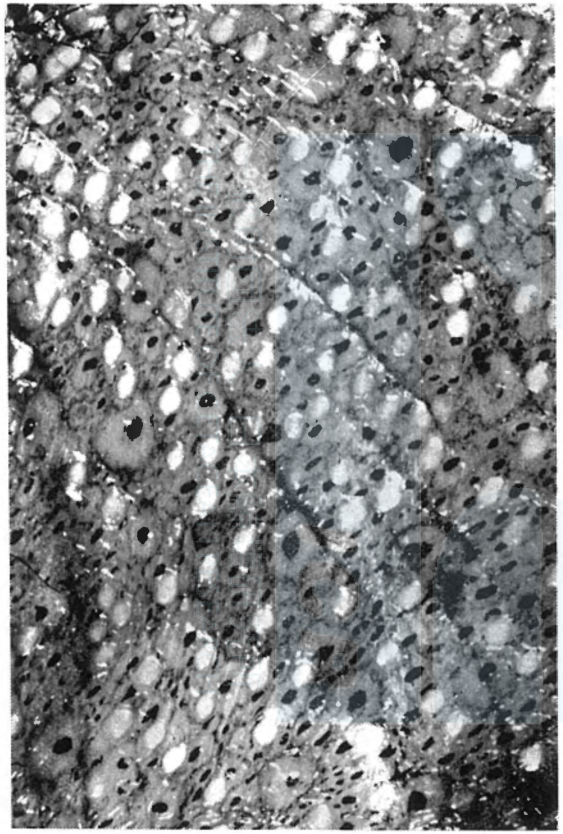

Fig. 3. Mantle, surface view. ×4.

Fig. 4. Right arms, inner view. ×1.

Plate III.

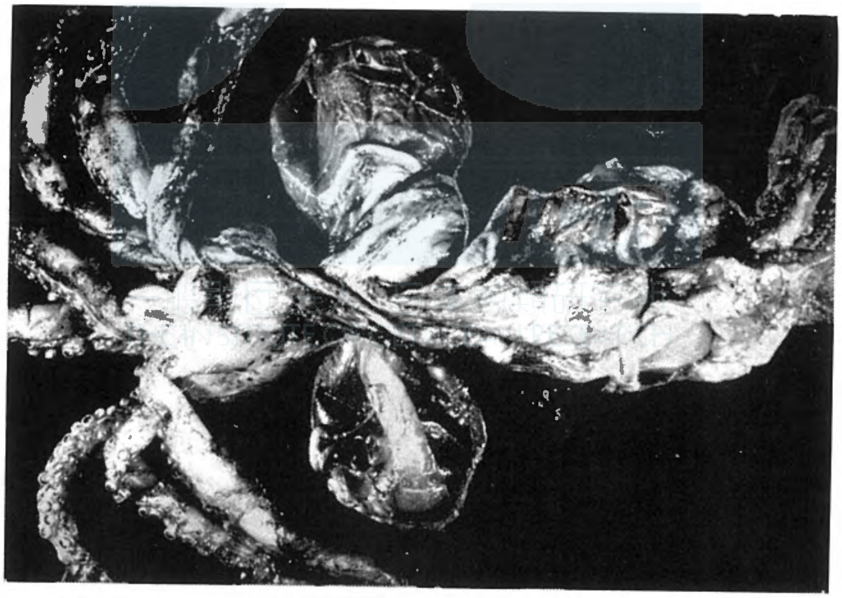

Fig. 5. Head, ventral view. ×3/4.

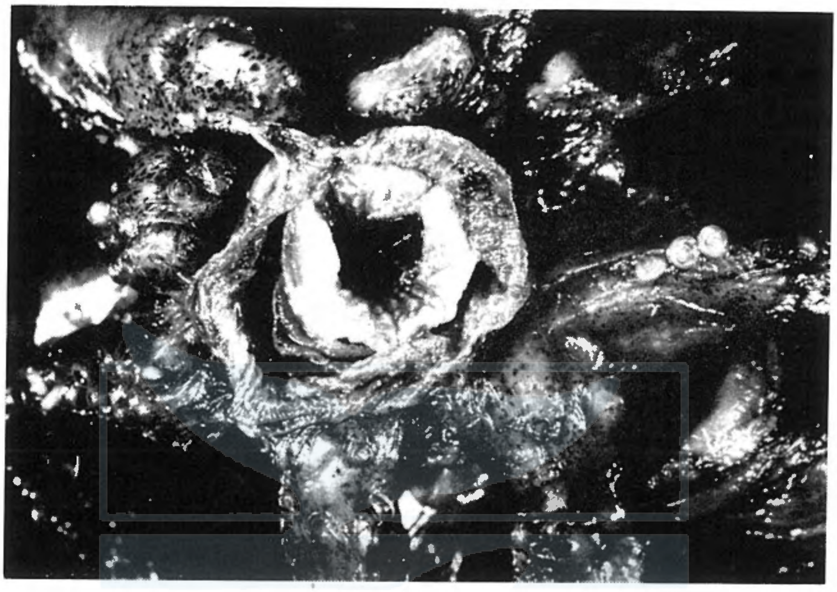

Fig. 6. Mouth part. ×3.

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Studies of the Whaling Grounds in the Northern Sea-Region of the Pacific Ocean in Relation to the Meteorological and Oceanographic Conditions. (Part I)

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and

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Introduction

Hitherto there were very few researches on the environmental conditions of whale shoaling and whaling. M. Uda already reported on the concentration of whales in the core of cyclonic eddies along the frontal boundary of different water masses in the adjacent seas of Japan[1]. In the present paper the relation between the northern whaling grounds in 1954 and weather conditions (cyclone, sea-fog etc.) together with sea-conditions was studied.

I. Whaling Conditions in Relation to the Passage of Cyclone.

1) Cyclone hitted to the whaling grounds in the Northern Sea Region of Pacific Ocean.

The cyclones in question may be divided into two types i.e. cyclones started from Siberia and those appeared in the neighbouring waters of Japan.

First in the beginning period of whaling season, cyclone occurs frequently in the region adjacent to the Maritime Province of Siberia. In the middle season of whaling, the path moves to north a little. The former enters in the Bering Sea after passing through Saghalien and Kurile Islands, and the latter proceeds into the Bering Sea through the Kamchatka Peninsula, after crossing the Okhotsk Sea. All of these cases do not accompany with their storms in general. Especially the cyclones appeared in the vicinity of Kamchatka Peninsula in the period from June to July, are rarely accompanied by storms.

2) Cyclone originated in the adjacent waters of Japan.

Those cyclones in the temperate latitudes developing during their procession to NE direction arrive in Bering Sea and are accompanied by storms.

3) Relation between the whaling conditions and the cyclone.

The amount of whaling catch was analysed by the statistical method already taken in case of yellow-tail[2] by M. Uda.

Taking the day of nearest approach by the cyclone center to the mother boat of a whaling set as zero day, and denoting those 2 days and 1 day before the zero day, 2 days and 1 day, after the zero day as -2, -1, $+1$ and $+2$ respectively and then the distribution curve of the amount of whaling catch for each 5 days was plotted in fig. 1.

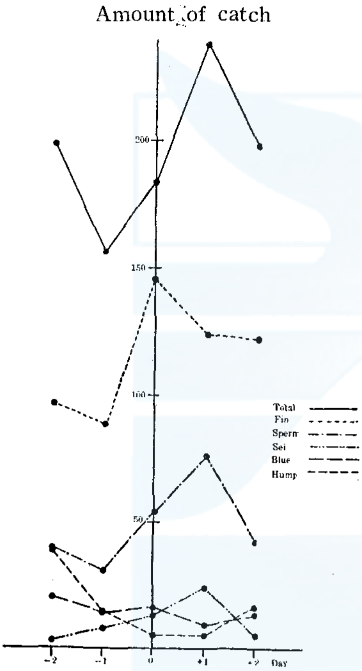

Fig. 1. The amount of whale catch accumulated for each species on -2, -1, 0, $+1$ and $+2$ respectively.

The analysis was made on the data during the 20 days in 1954, which is too few to get concrete results and only capable to infer trend of the matter.

First as a general consideration, for each species of whales the amount of catch was summed up separately on the -2, -1, 0, $+1$ and $+2$ day. Then as we see in fig. 1 and table 1 on the $+1$ day the catch shows its maximum and on the -1 day its minimum showing almost similar value on the -2 and $+2$ day. On the zero day the amount of whale catch is more abundant than that of the -1 day and lower than those of the $+2$ and -2 day. Accordingly on the days adjacent to the $+1$ day after the cyclone passage, it shows favourable whaling conditions.

Such considerations were paid for each species of whales. Fin whale and sperm whale having abundant catch show the tendency similar to the total catch, i.e. on the -1 day, it shows the minimum catch and on the $+1$ day the maximum.

Although for humpback whale and blue whale, the relations are obscure. Owing their poor catches, for humpback whale the curve seems to show the maximum on about the -2 day and the minimum on the $+1$ day and similar curve for the catch of blue whale, however for sei whale the case almost reverse to those of blue whale and humpback whale, i.e. the curve showing the minimum on the -2 day and the maximum on the $+1$ day.

4) On the relation between the shoaling amount of whales and the cyclone.

The shoaling amount of whales should be conjectured by their catches together with the oceanographic and meteorological conditions. Here we can put the following relational formula on the amount of whale catch.

$$F=K.\ V.\ S.\ O. \qquad \ldots(1)$$

where F: amount of the whale catch.
V: the rate of discovery by ordinary look-out.
S: shoaling amount of whales.
O: rate of whaling operation.
K: proportional constant, depending on the characteristics of planktonic, topographic and other elements of the whaling ground.

Since the amount of the whale catch is varied by the approach of the cyclone, the writers studied this relation statistically during the whaling season in 1954.

Hence the shoaling amount of whales is the fundamentally important factor to determine the amount of catch.

The rate of whaling operation and rate of discovery can be known easily, and the amount of catch is known too. Thereby, the writers intended to carry quantitative analysis on the shoaling condition of whale in relation to cyclone passage.

(*a*) *The shoaling condition of whale: S*

It is evident that due to the influence of the cyclone, the sea condition become unfavourable, whereas (S) increase with the approach of the cyclone, and is proportional to (F).

(*b*) *The rate of discovery by ordinary look-out: V*

When the cyclone approaches to the whaling ground, the southerly wind blows and arouses the dense sea-fog, so that the rate of discovery decreases. Since naturally the amount of catch (F) may be proportional to (V), it may be lowered as the consequence of the (F)-decrease in spite of the shoaling amount of whales (S) increases.

(*c*) *The rate of whaling operation: O*

The rate of operation including the meaning of the rate of gun hits and it may be the main factors of the rate of whaling. Here, we may assume the ability of gunners as constant. The rate of gun hits is inversely proportional to the sea condition such as wind-wave or swell. While the rate of whaling operation is also inversely proportional to the sea condition.

Since this can apply not only to the case of whaling, but also to the cases of other fisheries, so the fishing operation in general are influenced negatively by the sea condition due to the cyclone passage.

In the above mentioned formulation, however, $F=K.S.V.O.$ can not represent well the shoaling condition of whales as affected one by the sea condition, but in the first approximation this equation was adopted and tentatively studied. It is obvious that the rate of gun hits is the function of the sea condition. Thus (F) is considered to be inversely proportional to the rate of whaling operation (O) (accordingly rate of whaling). Consequently, we can estimate the shoaling amount of whales (S) by the computed value of F/KVO. The rate of operation (O) is determined by sea condition (W), hence, the (O) is inversely proportional to (W), i.e. $O \propto \frac{1}{W}$.

$$\therefore \quad F=K'.V.\frac{1}{W}S. \qquad \text{. . .(2)}$$

$$\text{or} \quad S=\frac{FW}{K'V} \qquad \text{. . .(2)}'$$

The curve of (S) estimated by (2)′, named as "The Whale Shoaling Curve" is shown in fig. 2, using the average of sea conditions, the rate of discovery and amount of catch are obtained for the days of the cyclone in table 1.

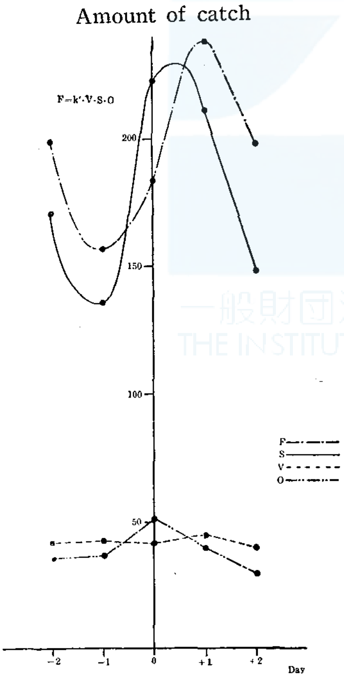

Fig. 2. The whale shoaling curve.

Accordingly,

$$\left.\begin{array}{l} 199=K'\times 4.2\times S_{-2}/3.6 \\ 157=K'\times 4.3\times S_{-1}/3.7 \\ 184=K'\times 4.2\times S_{0}/5.1 \\ 238=K'\times 4.5\times S_{+1}/4.0 \\ 198=K'\times 4.0\times S_{+2}/3.0 \end{array}\right\} \begin{array}{l} S_{-2}:S_{-1}:S_{0}:S_{+1}:S_{+2} \\ =170.6:135.1: \\ \quad 223.4:211.6:148.5 \end{array}$$

Table 1. The value of W. V. and F. in before and after days of the cyclone passage.

Day	−2	−1	0	+1	+2
(W)	3.6	3.7	5.1	4.0	3.0
(V)	4.2	4.3	4.2	4.5	4.0
(F)	199	157	184	238	198

Glancing in fig. 2, We can see at once that the shoaling amount of whales decreases on the days of about −1 and +2, and shows the maximum value on the day of about

+1 and the minimum on the −1 day. Perhaps it occurs because before the cyclone approach, the rate of discovery became to fall down to low level and also the sea became worse. We can suppose, however, that the shoaling of whales does not decrease, by the approach of cyclone. The amount of the whaling catch before and after the cyclone passage, summed up for the species separately.

The total amount of catch (−2, −1, +1 and +2 day) is 540 individuals of whales on the before days, 620 of whales on the after days (the amount of catch on the zero day involved in the both periods). The total heads in the after days are about 7% more than that in the before days.

As shown in fig. 2, on the before days, the curve of the rate of discovery falls with the rise of curve of the sea condition, bad condition to the whaling operation. It may be reasonable that we can not expect better catch on the before days than that on the after days of the cyclone passage. Similarly the catch for each species of whale is shown separately for the −2, −1, 0, +1 and +2 day in table 1, table 2 and fig. 3.

Table 2. The amount of whale catch accumulated for each species on −2, −1, 0, +1 and +2 day respectively.

	Around the nearest day (0 day) of cyclone				
Day / Sp. whal.	−2	−1	0	+1	+2
Humpback	39	15	5	5	16
Sei	3	8	13	24	5
Blue	20	14	16	9	13
Sperm	40	31	54	76	42
Fin	97	89	96	124	122
Total No. of indiv.	199	157	184	238	198

	The catch of 0 day added to both		its percentage	
Sp. whale.	Before days	After days	%	%
Humpback	59	26	69.4	30.6
Sei	24	42	36.4	63.6
Blue	50	38	56.8	43.2
Sperm	125	172	42.1	57.9
Fin	282	342	45.2	54.8
Total No. of indiv.	540	620	46.5	53.4

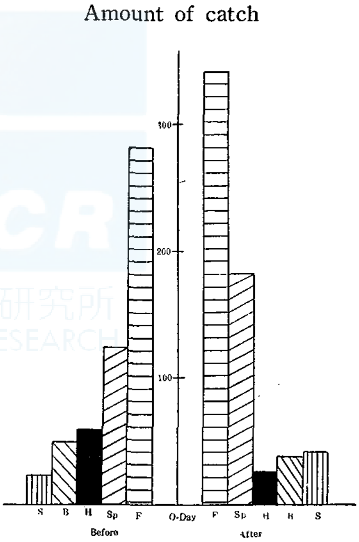

Fig. 3. The amount of whale catch accumulated for each species on before and after days of the cyclone passage.

(i) Fin whale (*Balaenoptera physalus*)

The abundance of the catch on the before and after days of the cyclone passage is 282 and 342 respectively.

The percentage for total catch before and after days of the cyclone passage is 45.2% and 54.8% respectively. In this case the one in the after days are 9.6% more than that in the before days.

(ii) Humpback whale (*Megaptera nodosa*)

The abundance of the catch on the before and after days is 59 and 26 respectively, (i.e. 69.4% and 30.6%). Therefore in the former days it is 38.8% more than that in the latter days, which is seemingly opposite phenomenon to the other species, but the data too few to certify the conclusion.

(iii) Sei whale (*Balaenoptera borealis*)

On the before and the after days of the cyclone passage, the amount of the accumulated catch and its percentage are 24, 42 and 36.4%, 63.6% respectively. In the after days, however, it shows some what good catch, but also in this case, data too few to conclude it.

(iv) Blue whale (*Balaenoptera musculus*)

During the before and the after days of the cyclone passage, the heads of the whale catch are 50 and 38, and its percentages are 56.8% and 43.2% respectively. On the before days, it is 13.6% more than that in the after days.

(v) Sperm whale (*Physeter catodon*)

The abundance of the catch on the before and after days of the cyclone passage is 125 and 172 (i.e. 42.1% and 57.9%) respectively. On the after days, it is 15.8% more than that on the before day.

II. Whaling Conditions in Relation to Weather Elements especially to Sea Fog, and to the Distribution of Dichothermal Water.

(1) Whaling Grounds in the North-Eastern Sea Region of Japan in Relation to Sea Fog in Summer of 1953.

Basing on the data obtained by the whaling catcher boats, one of the authors (M. Uda) plotted the charts of whaling grounds for each decade during the period from the beginning of July to the end of August in 1953 in which the isotherms, the distribution of the rate of fog occurrence (% of fog observed stations among the whole stations in the 1° rectangle of latitude and longitude) and the localities of whale caught included. (See Fig. 4a, b, c, d, e and f).

We can find at once the relative abundance of whales in the dense fog zones corresponding to the boundaries of cold and warm water masses and to the southward extending cold current areas. The limit of the sea-fog zone lies very near to the Oyasio Front (water tempera-

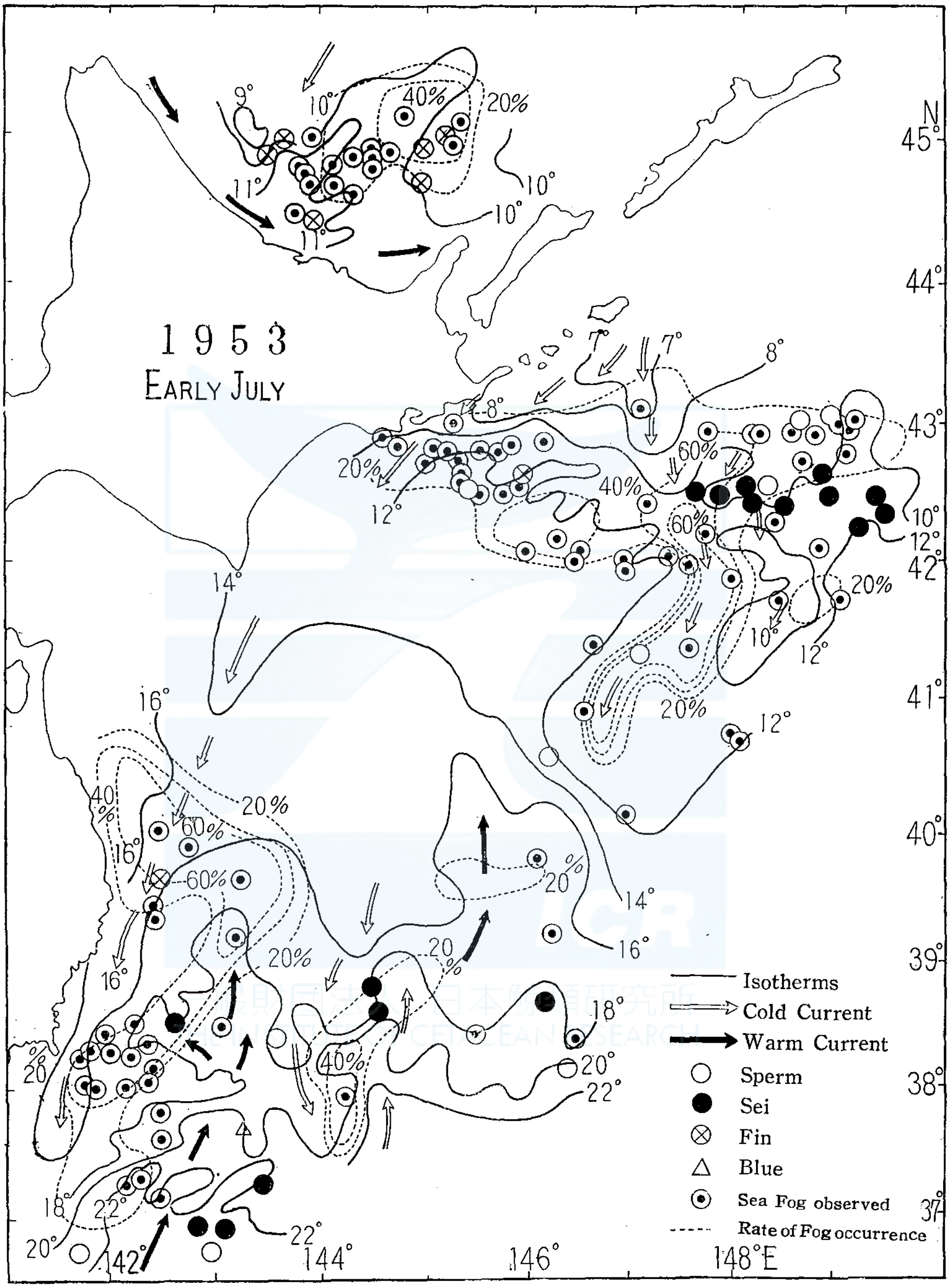

Fig. 4. (a) The distribution of whaling grounds in the North-Eastern Sea Region, water temperature, cold-warm water masses and sea-fog.

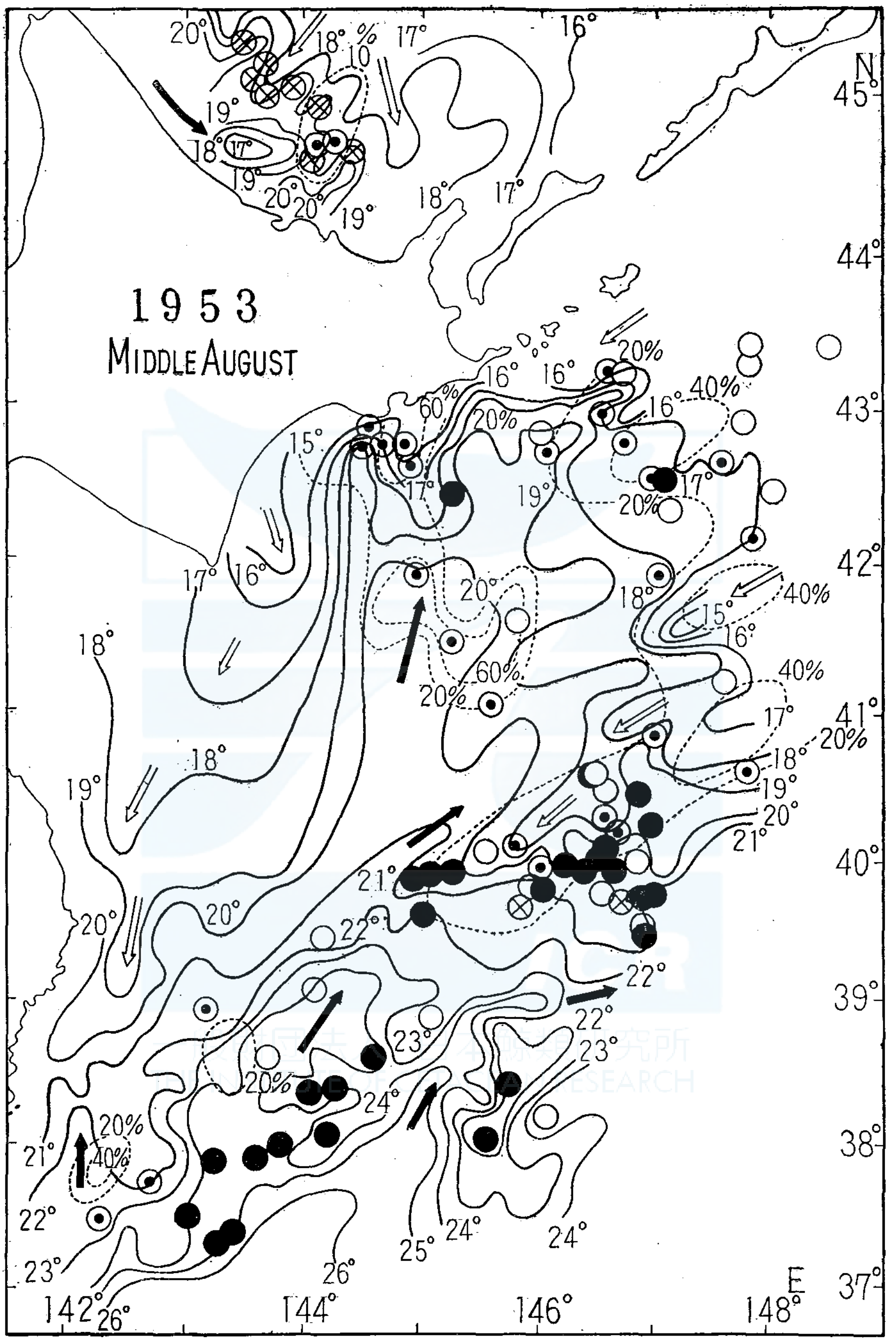

Fig. 4. (b) The distribution of whaling grounds in the North-Eastern Sea Region, water temperature, cold-warm water masses and sea-fog. (Notice) Notations used in the map are the same as in Fig. 4a.

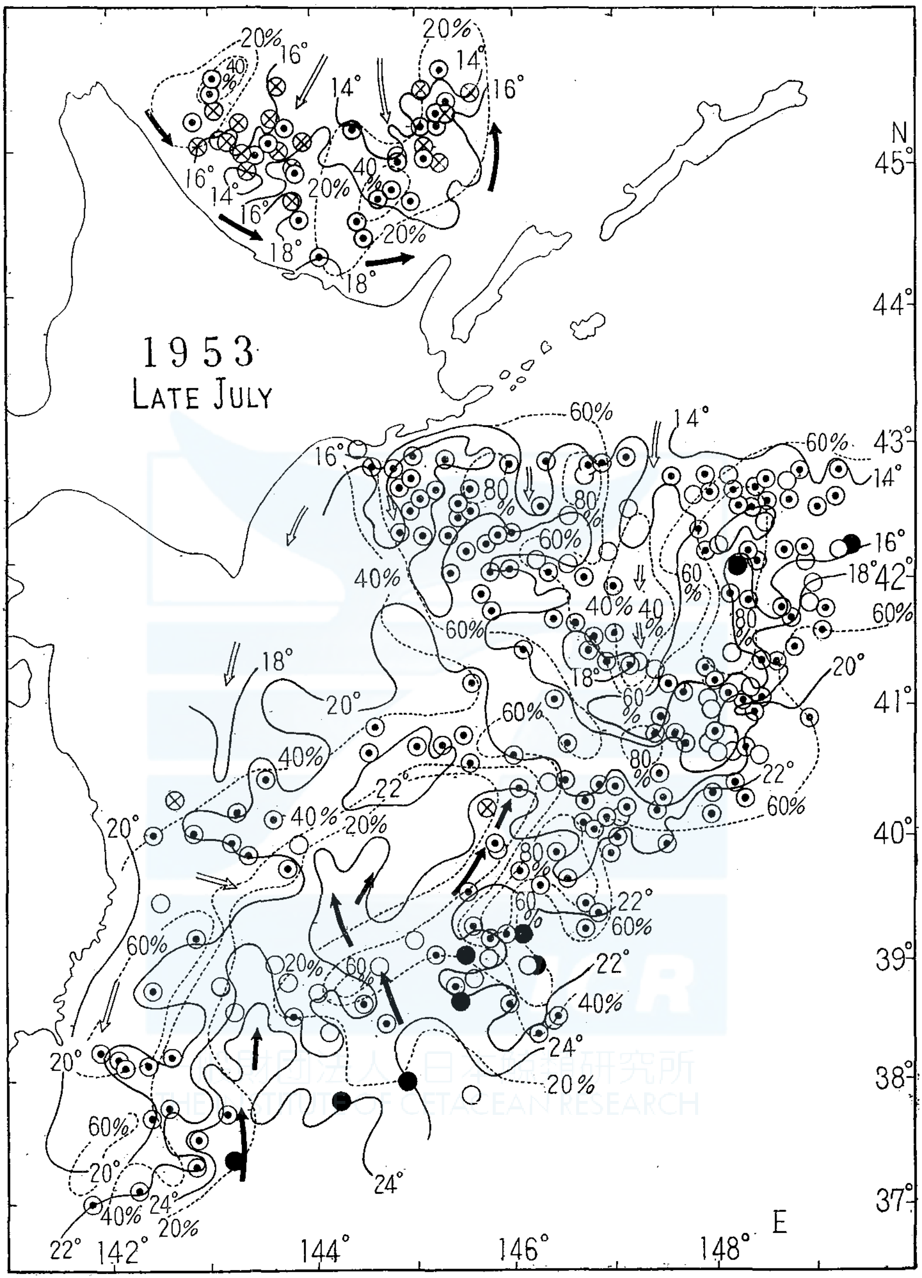

Fig. 4. (c) The distribution of whaling grounds in the North-Eastern Sea Region, water temperature, cold-warm water masses and sea-fog.
(Notice) Notations used in the map are the same as in Fig. 4 a.

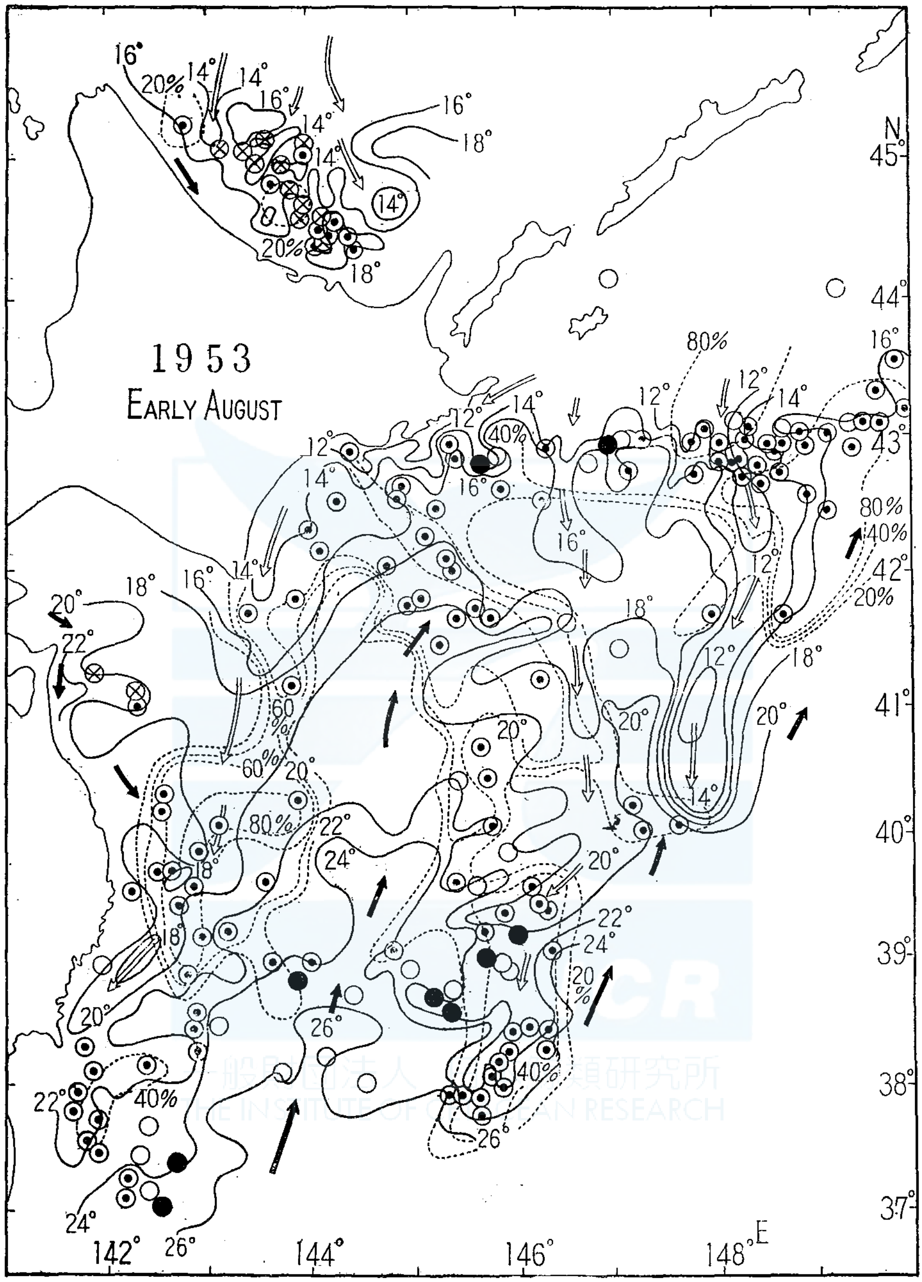

Fig. 4. (d) The distribution of whaling grounds in the North-Eastern Sea Region, water temperature, cold-warm water masses and sea-fog.
(Notice) Notations used in the map are the same as in Fig. 4 a.

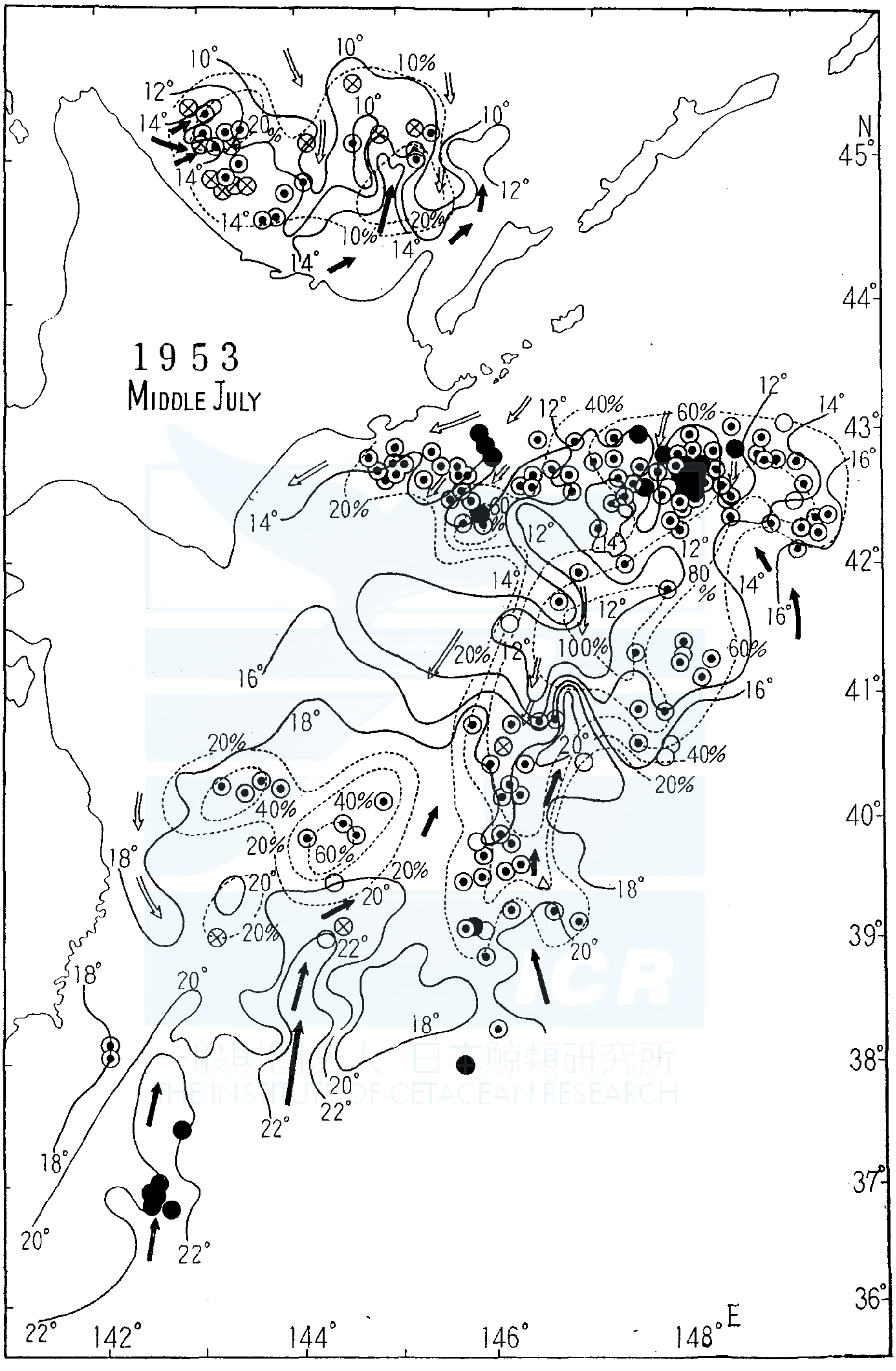

Fig. 4. (e) The distribution of whaling grounds in the North-Eastern Sea Region, water temperature, cold-warm water masses and sea-fog.
(Notice) Notations used in the map are the same as in Fig. 4 a.

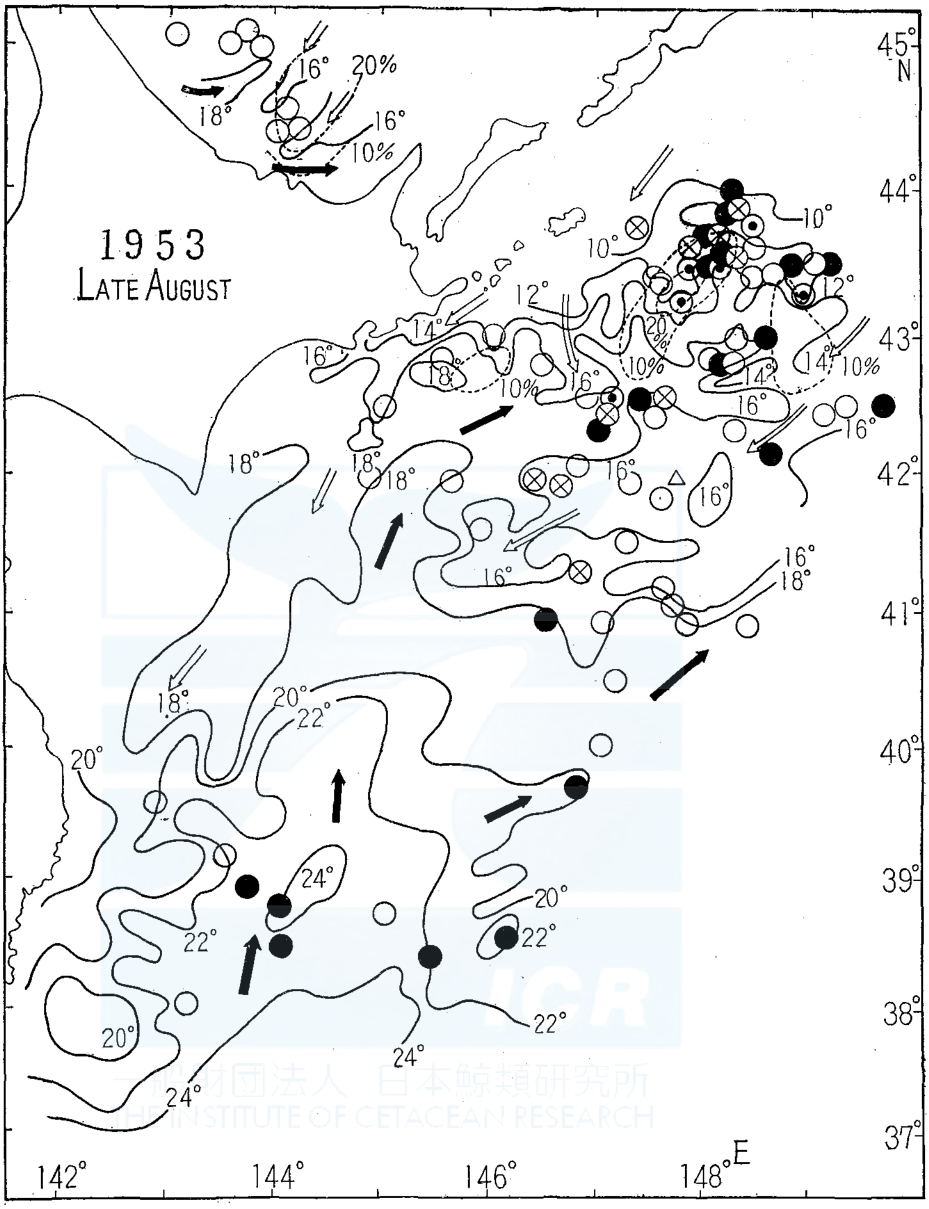

Fig. 4. (f) The distribution of whaling grounds in the North-Eastern Sea Region, water temperature, cold-warm water masses and sea-fog.
(Notice) Notations used in the map are the same as in Fig. 4 a.

ture lower than 20°C), Sea-fog occurs rarely in the zone near to Kurosiwo Front and also in the area of water temperature higher than 20°C. The rate of discovery for whales and the rate of gun-hit on whales are inversely proportional to the degree of visibility, consequently proportional to the frequency of sea-fog occurrence.

During the occurrence of sea-fog the sea (wind-wave) is not rough in general. However, the shoals of whales found and the amount of the whale catch concentrate to the zone of plenty food organisms (such as squids for sperm whales, copepods and euphausia for fin-, sei- whales etc.) which has densely multiplied and assembled together.

In conclusion since the shoal of densely concentrated whales migrates there, notwithstanding the lower rate of discovery due to the bad visibility, the catch of whales increases consequently.

(2) Whaling Grounds in the Northern Pacific Ocean near Aleutian Islands in 1954 in Relation to the Weather Conditions.

By our inspection in tables 3, 4, 5, 6 and 7 (based on the data supplied by the Mother Whaling Ship Kinzyō-maru, Baikal-maru, the catcher boat Kōyō-maru and Seki-maru), we can find clearly the whale catch in the whaling season from middle May to middle September corresponding to the dense sea-fog season and the main whaling grounds lies at about dense sea-fog districts. The weather elements corresponding to the

Table 3. Number of Whale Caught for Each Weather Element
in the Adj. Waters of Aleutian Is. in 1954.
(The Whaling Mother Boat Kinzyō-maru)

Weather / Month	B	BC	C	O	F (Mist included)	D
May		5		39	14	1
June		36	34	216	175	29
July			23	201	80	
Aug.		16	8	84	134	
Total		57	65	540	403	30
Observed Chance		4	10	68	57	4
No. per Chance		14	6.5	8	7.2	7.5

Table 4. Number of Whales Caught for Each Weather Element
in the Adj. Waters of Aleutian Is. in 1954.
(The Whaling Mother Boat Baikal-maru)

Weather / Month	B	BC	C	O	F	D	Sum
May		22		23		1	46
June				190	65	11	266
July			24	177	98	32	307
Aug.		121		23	41	7	216
Sept.		48		157	37	12	250
Total		191	24	570	241	63	1085
Obs. Chance		22	2	86	40	12	
No. per Chance		8.7	12	6.6	6.0	5.2	

Table 5. The Difference betw. Air Temp. and Water Temp.
(Air Temp.-Water Temp.) °C.
(Kōyō-maru) (7. May–27. Sept. in 1954)

Weather / Month	B	BC	C	O	F	D	R
May		2.8	—	1.7	4.3	−1.3	—
June				2.9	3.7	3.6	
July				3.4	3.4	3.2	
Aug.		3.3	4.3	1.3	2.1	−0.7	−0.6
Sept.		2.9		2.4	1.3	2.1	3.5
Mean		3.0	4.3	2.3	3.0	1.4	1.5

Table 6. Number of Whales discovered in the Adj. Waters of Aleutian in 1954.
(The Catcher Boat Seki-maru)

Visibility / Month	1	2	3	4	5	6	7	8	9, 10
May	1	1	5	3	22	1	32	7	215
June	3	0	1	17	23	31	24	35	304
July	5	48	119	10	124	12	62	116	439
Aug.		12			3	1			226
Total	9	61	125	30	172	47	118	158	1284
	70		155		219		276		

Table 7. Number of Whales discovered in the Northern Waters in 1954.
(The Whaling Research Boat Kōyō-maru)

Species / Visibility	Fin	Sei	Humpback	Sperm	Blue	Sum (No. per each chance)
0	0	0	1	1	—	2 (1)
1	2	2	0	2	0	6 (2)
2	5	5	11	2	0	23 (3)
3	36	2	5	4	0	47 (2.5)
4	9	0	34	11	0	54 (4.5)
5	26	17	3	6	1	53 (2.6)
6	181	6	53	18	0	258 (7)
7	116	6	10	5	0	137 (6)
8	243	21	74	19	1	357 (6)
9	174	9	1	4	0	188 (24)
10	0	2	0	0	0	2 (1)
Total	792	70	192	72	1	

most frequent catch are overcast, cloudy, mist, fog, foggy drizzle in the period of (May), June, July, (Aug.), (Sept.). The whaling grounds were occupied mainly by fin whales, mingling with sperm whales and humpback whales. Of course the whale catch increases with the increase of visibility. In the case of Kōyō-maru shows its maximum in the range of visibility 6–9 Fin whale occupies its main part, and Humpback the next, Sperm whale and Sei whale in the same order, and in the case of Seki-maru the catch gradually increasing with visibility.

In this sea-region the difference between air temperature and water temperature is commonly 1°–4°C (about 3°C) and during the season June-July usually the value more than 3°C corresponding to the fog-region.

(3) The Distribution of Dichothermal Water and Whaling Ground in 1954. (See Fig. 5 a, b).

The author (M. Uda) studied recently the fluctuation of Oyasiwo current in relation to the atmospheric circulation and to the distribution of the (represented by the dichothermal water) dichothermal waters in the north Pacific ocean during the years 1933–1953[3]. Glancing at Fig. 5 a, b for that in summer of 1954 in the adjacent waters of Aleutian Islands, we can recognize the main localities of whaling grounds lying at the fronts of the cold watermass and the mixed warm water mass, such western (I), central (II) and eastern (III) whaling grounds in the waters adjacent to Aleutian Islands, where planktons are abundant in those regions[4]. (See Fig. 5 b).

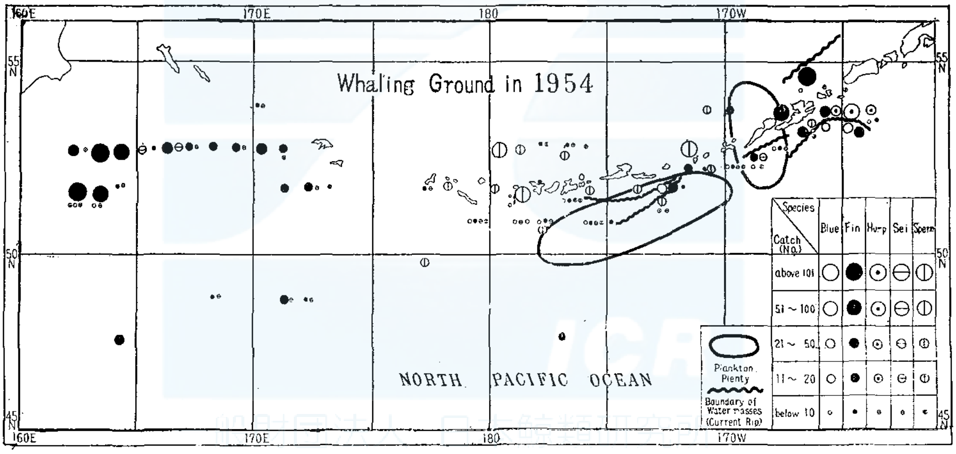

Fig. 5. (a) Whaling grounds in the Northern Sea-Region of the Pacific Ocean in 1954.

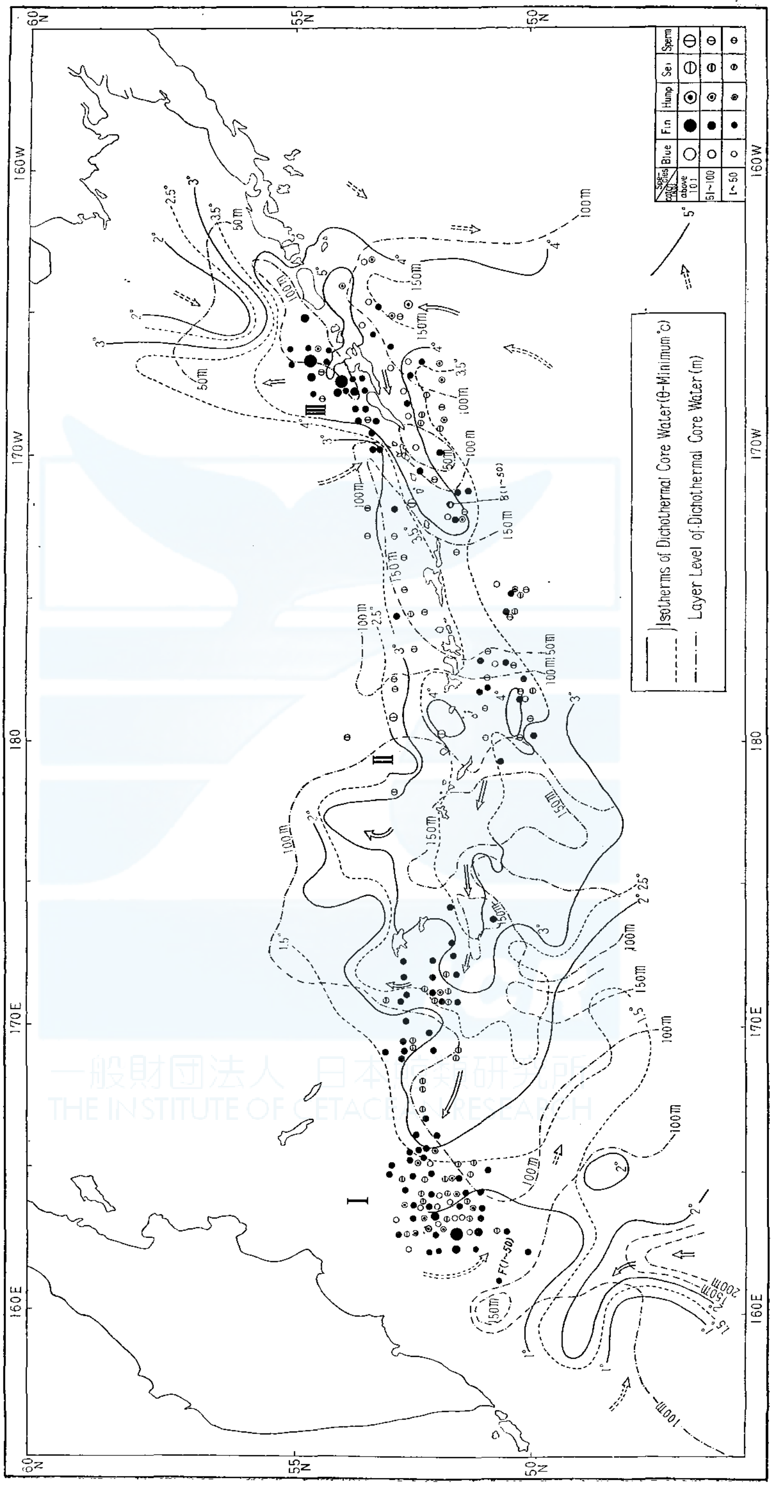

Fig. 5. (b) The distribution of dichothermal core water (θ-minimum °C), layer level of dichothermal core water (*m*) and localities caught in 1954.

Summary

(1) Cyclones hitted to the whaling grounds in the Northern Sea-Region of Pacific Ocean may be divided into two types i.e. (i) cyclones started from the Siberian Continent and (ii) those originated in the adjacent waters of Japan.

(2) In general, on the days adjacent to a day after the passage of cyclone it shows favourable whaling condition, and contrary to it adjacent to a day before the passage of cyclone it shows poor whaling condition.

(3) At first we established the relational formula on the amount of whale catch $F=K.V.S.O.$ and concluded the following: Shoaling condition of whales on the days after the passage of cyclone was better than that on the days before the passage of cyclone.

(4) Concerning whaling grounds in the North-Eastern Sea-Region of Japan we found the relative abundance of whales in the dense fog corresponding to the boundary zone of cold and warm waters.

(5) Generally whaling period in the Northern Pacific Ocean near Aleutian Is. corresponds to the dense sea-fog season and its main whaling ground lies at about denser sea-fog districts.

(6) Main localities of whaling ground in the adjacent waters of Aleutian Islands were found near at the boundary of the dichothermal water masses (intermediate cold water.)

Literature

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Note on a Minke Whale Kept Alive in Aquarium

By

SEIJI KIMURA and TAKAHISA NEMOTO

Mito Aquarium, in the suburbs of Numazu city, Sizuoka prefecture, is famous in having a special pool to keep some large fish or dolphins in the utmost part of a small inlet. Striped porpoises (*Lagenorhynchus obliquidens* Gill) and bottle-nosed dolphins (*Tursiops truncatus truncatus* (Montague)) are now favourites in the pool.

Recently, a minke whale (*Balaenoptera acutorostrata* Lacépède) had been kept for about a month in this aquarium. As the keeping of baleen whale in an aquarium is very rare, we would like to report a short note on this whale with some records of observations made by us and submarine photographs taken by the Mainichi Press Co.

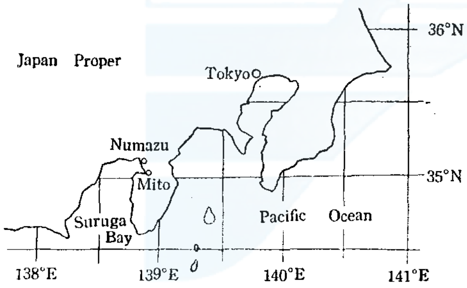


Fig. 1. Location of Mito Aquarium

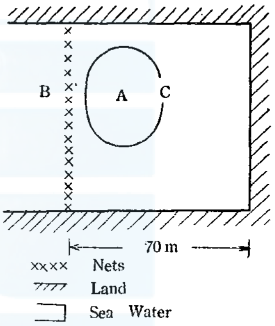


Fig. 2. Plan of the keeping pool.

The minke whale was caught by Osiki-ami (a kind of fixed net for fish) placed at 2 km. in front of the aquarium on November 26th 1955.

The whale was brought to the pool, hanged between two boats, after being wrapped up in nets, and towed by a motor boat. It took about an hour to take the whale to the aquarium and the whale is said as very gentle during the time of transportation. As shown in fig. 2, the pool is square in its shape (one side about 70 m. long), three sides are surrounded by land and the one, facing to the sea, is blocked with nets of synthetic fibres, through which the sea water circulates. A breakwater has been built in front of the pool in order to prevent the nets from any damage caused by waves. The deepest point of the pool is 12 m. deep, and the shallowest point is 4 m. at high tide, 1 m. at low tide.

Thus the minke whale was brought to the same pool, where two striped porpoises had already been kept. The minke whale was estimated to be about 20 feet long and its sex could not be determined. It had been very gentle and swam generally anti-clockwise along the circle shown in fig. 2 until finally escaped from the pool after about a month. The whale seemed very healthy, showing no sign of wound or desease. Its dorsal fin inclined slightly to left side of the body.

Mr. Hanajima, in charge of that aquarium, had tried in vain to feed the whale with flesh of anchovy every day, but it was often observed that many small mackerels kept in the pool gathered in the middle part of the pool and bounded up in the morning, suggesting that they had been attacked by the whale as in the case of other baleen whales. Some decreased number of mackerels observed might be attributable to whale's consumption.

Some observations on respiration were made of this whale consecutively through a day in December 1955. The whale was swimming, usually following the same route of anti-clockwise in the deepest part of the pool (A in fig. 2), repeating respirations always at about the point C shown in fig. 2 after 2 or 3 run. Such regularity in the place of respiration may partly be attributed to the bottom condition of the pool. The whale had repeated somewhat rhythmical respirations, though no conspicuous periodicity had been observed. Intervals between respirations became shorter after a long dive, and vice versa.

The intervals between respirations decreased gradually as night comes, but increased again after midnight. The peak was observed at one o'clock (fig. 4). However, we can not draw any difinite conclusion from this fact whether this is really due to the whale's relaxation. We had never observed any other sign of the relaxation of porpoises in swimming, though they were seemed slightly inactive through the midnight. Our observation was endorsed by the members attending there and we are of the opinion that the whale had never breaked the swimming for sleeping throughout the period of the keeping, contrary to some other dolphins observed in Marine Studios, Marineland, Florida.

Towards the end of December three bottle-nosed dolphins were brought to the same pool. A few days after, to our regrets, the minke whale has escaped from the aquarium, breaking the nets at the position B shown in fig. 2 at a time before dawn on January 2nd of this year and no body noticed it until the morning. We wonder if the escape of the minke be attributable to the nuisance caused by the dolphins. It is informed, however, that no change had been observed in the behavior of the minke even after the arrival of the dolphins.

Thus, the minke whale was kept alive for 37 days in that aquarium. This is not the first experience for the aquarium, because they already had two similar cases before. The first minke whale was kept about 20 years ago for nearly three months, and in the latter half of that

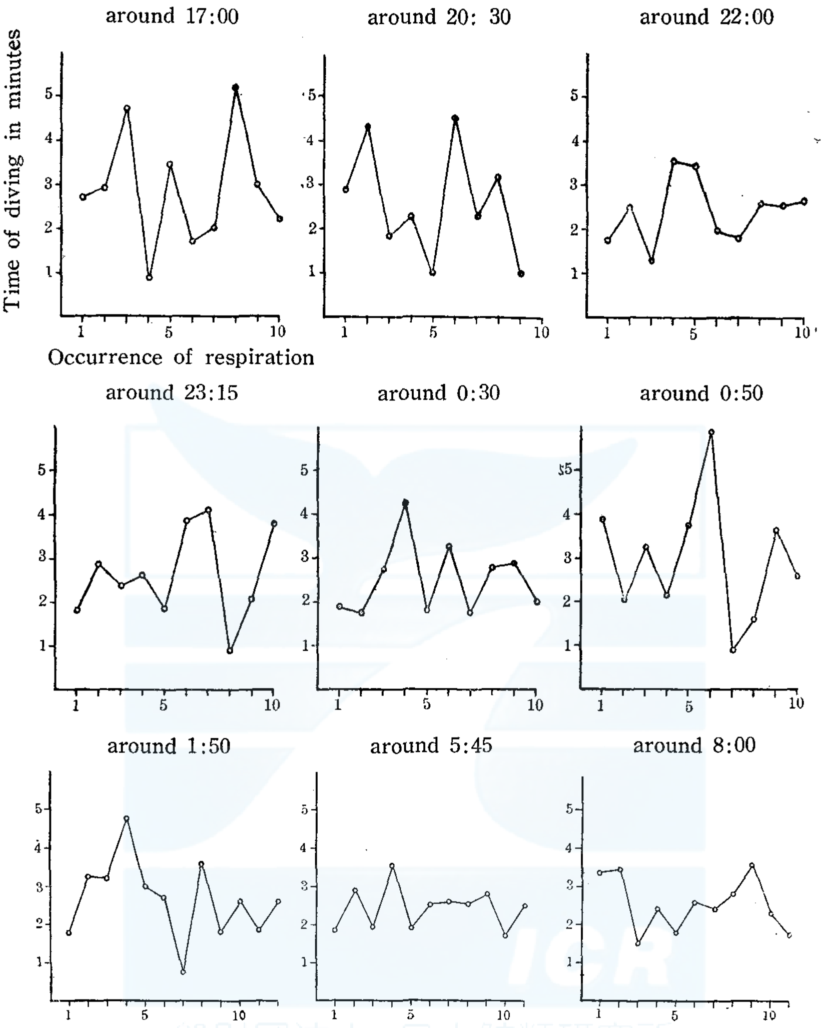


Fig. 3. Intervals between respirations.

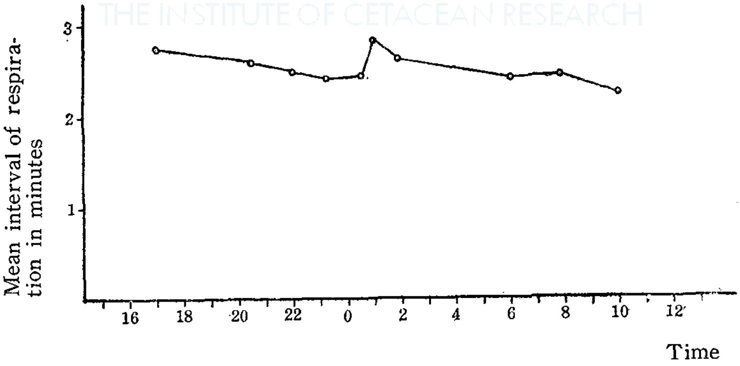
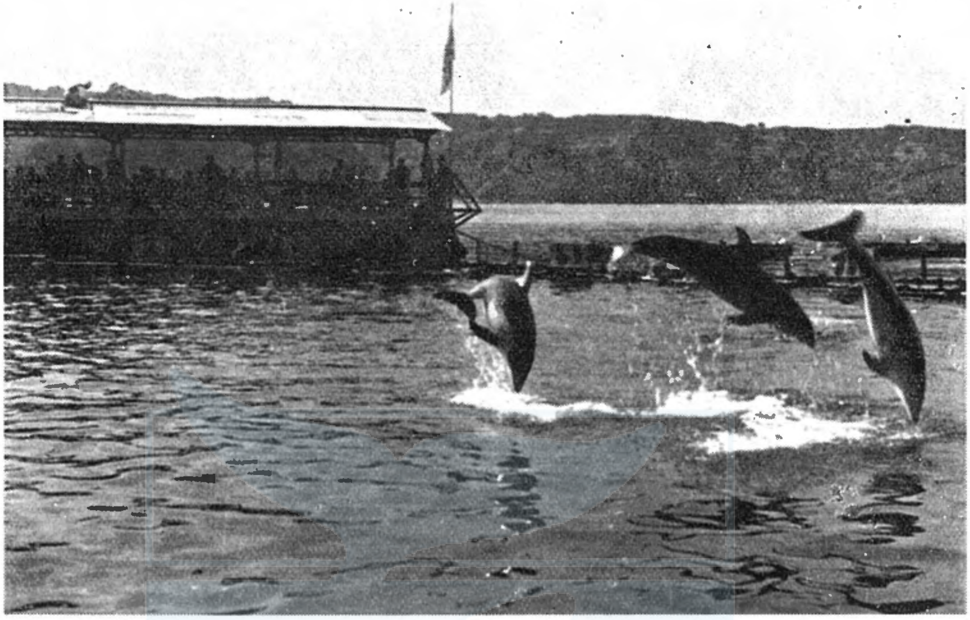


Fig. 4. Change of mean interval time between respiration according to the time of a day.

term it is said that the minke had fed on food. The second minke whale, a calf of several weeks old, had been kept in May 1954 until died after 2 weeks.

We wish to express our thanks to Mr. Jisaku Hanajima, the manager of Mito Aquarium, who accorded many facilities to us. We are also indebted to the Mainichi Press Company for the splendid submarine photographs shown in plates III–V.



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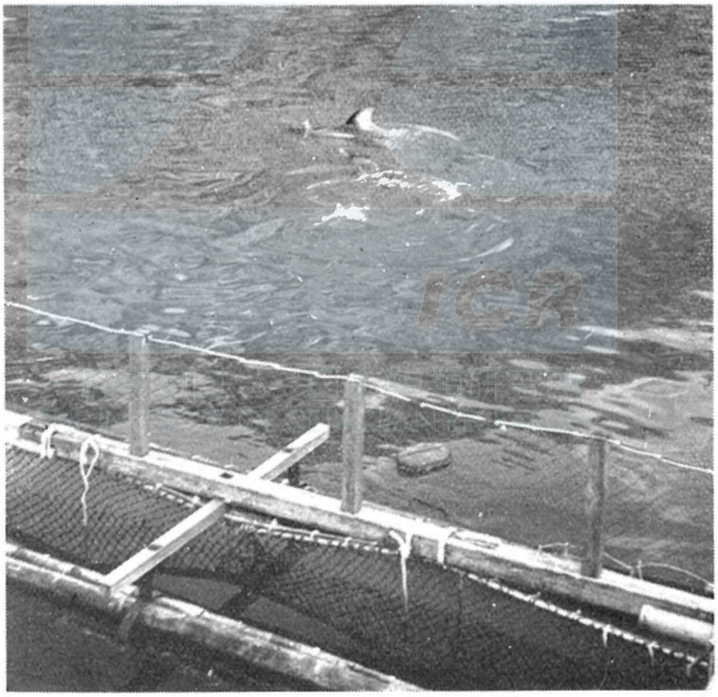

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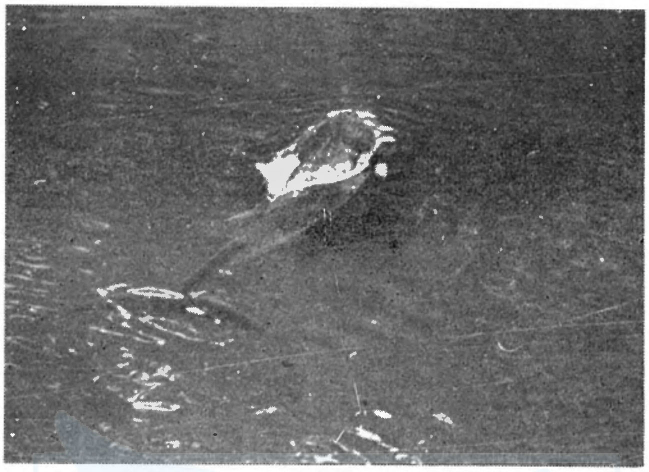
Plate I. Keeping pool of the Mito Aquarium
1. Jumping of striped porpoises
2. Net (by the courtesy of Mr. T. Kawakami)



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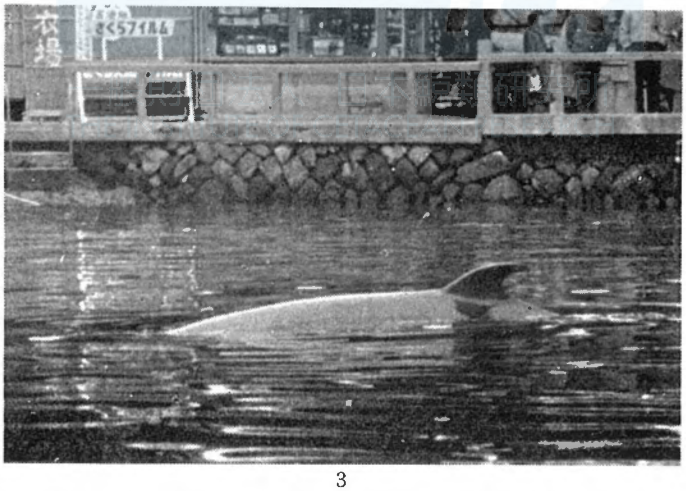

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Plate II. The minke whale in respirating.
(1: by the courtesy of Mr. T. Kawakami)

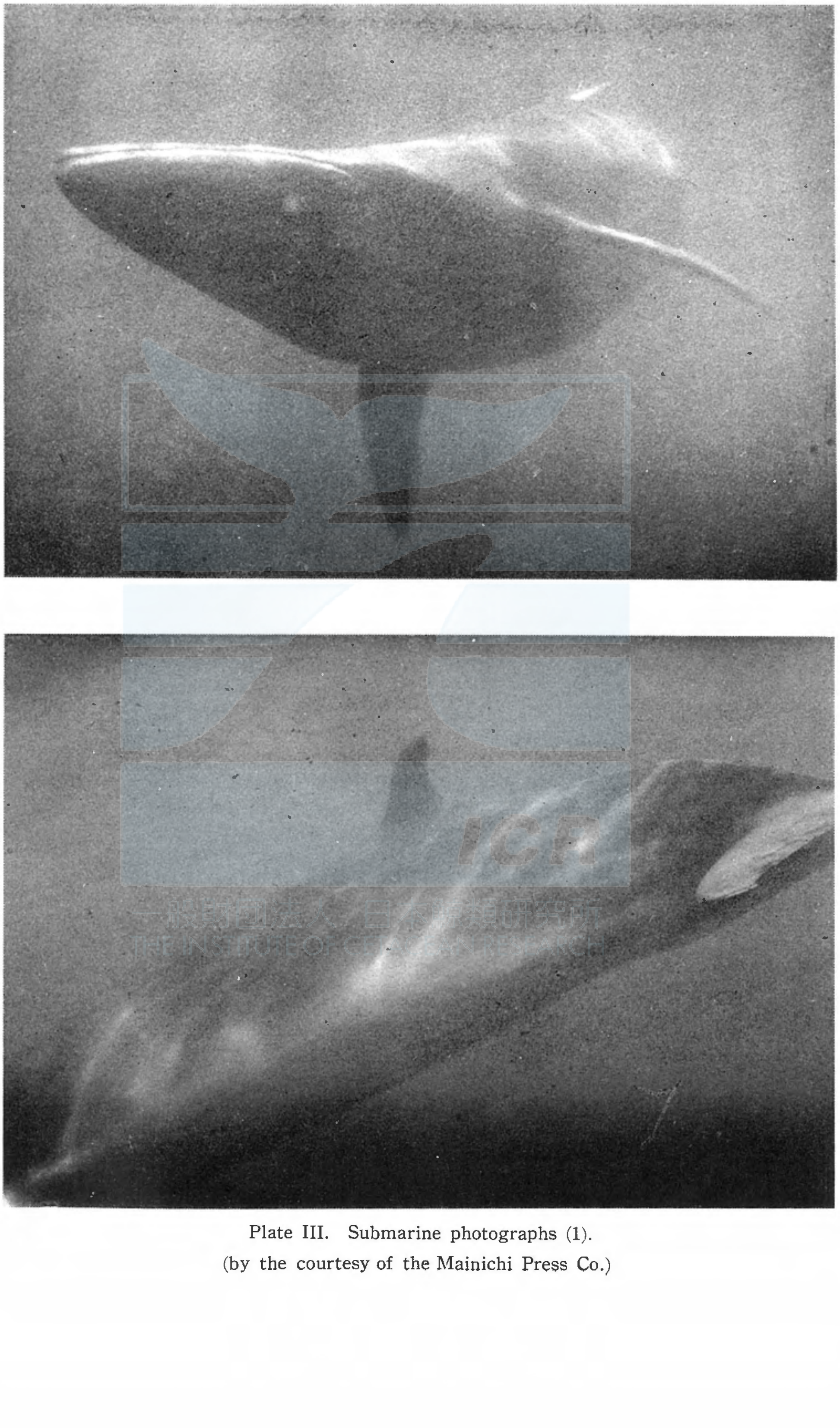

Plate III. Submarine photographs (1).
(by the courtesy of the Mainichi Press Co.)

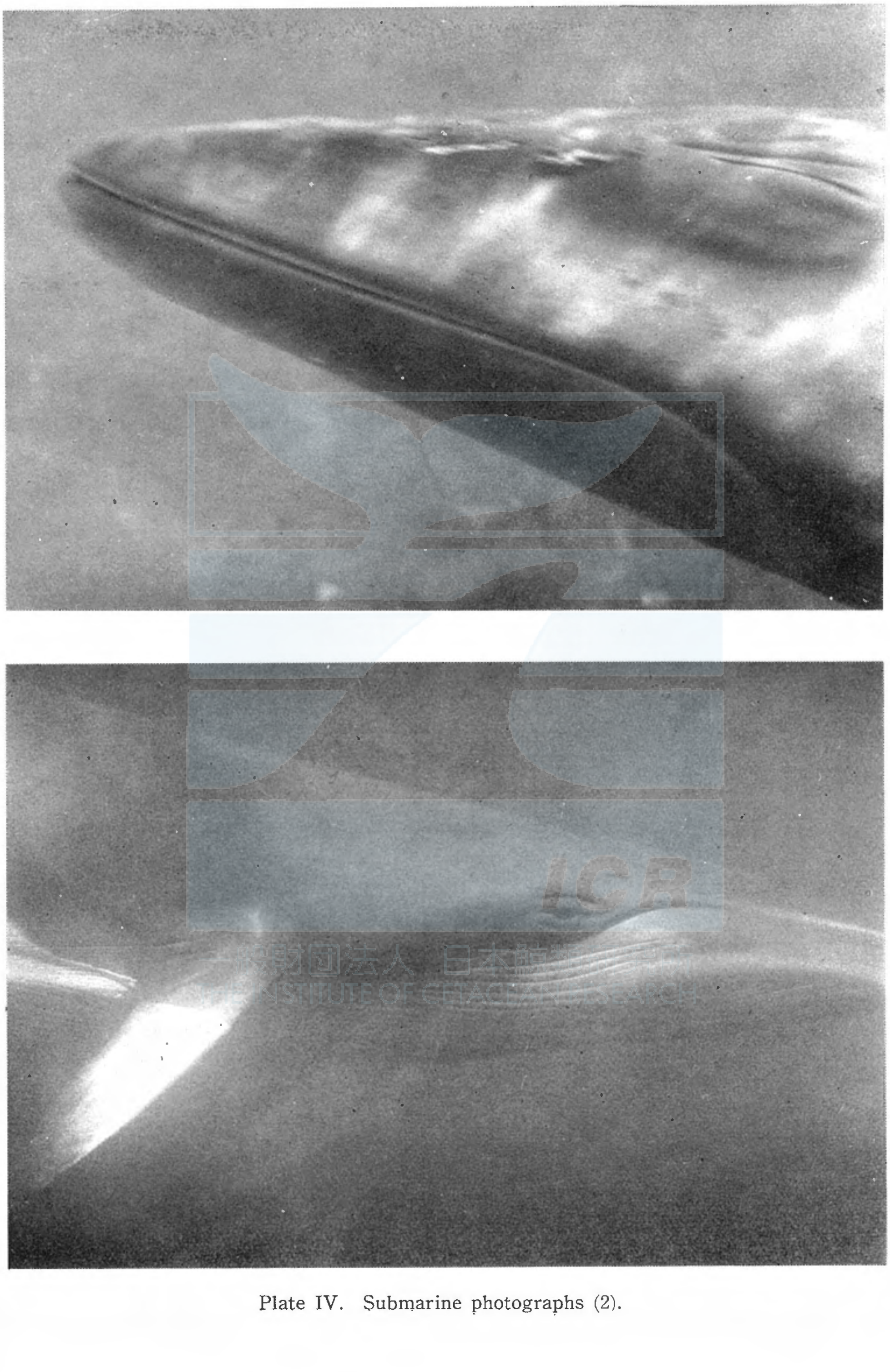

Plate IV. Submarine photographs (2).

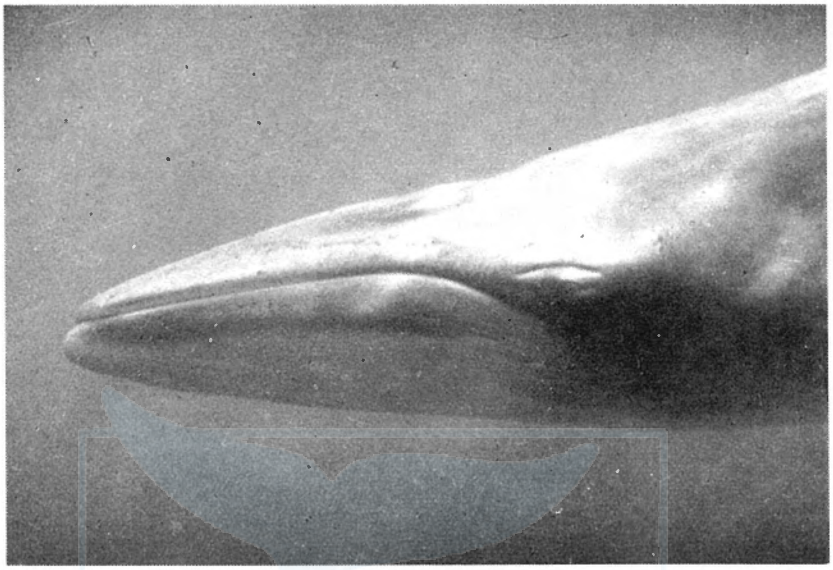

Plate V. Submarine photographs (3).

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A Characteristic Property of Whale Oils concerning the Absorption of Gases

I. On the Absorption of Carbon Dioxide by Whale Oils

By

YASUTARO ISHIKAWA

(Hiroshima University)

A peculiar thing about whales is the fact that a special organ, *spermaceti*, is present only in sperm whales and that a large amount of wax is present both in the sperm oil and body oil. None of other animals are known to possess *spermaceti* or any organs similar to it. As for the presence of a large amount of wax, similar presence is known in a sperm porpoise but in none of the other whales, in which the oil is largely constituted of glycerides as in other mammals.

First of all, studies about oils and fats in the food of sperm whales must be referred, but studies in this direction are comparatively few. According to E. André and H. Canal,[1] the amount of unsaponified matter in the oil of a squid (*Todarus sagittatus L. K.*) is comparatively large but it does not contain higher alcohols. M. Tsujimoto and H. Kimura[2] have shown that the oil of a squid (*Omnastrephes soloani pacificus*) contains a small amount of unsaponified matter, so that the amount of higher alcohols, even if present, would probably be small. It follows, therefore, that the higher alcohols present as a component of the large amount of wax in the sperm whale do not come directly from the oil taken as food and it seems more pertinent to assume that such alcohol is synthesized in the body of sperm whales by some process. Aside from such a process, a doubt arises about the physiological significance of the presence of wax, in this animal.

On the other hand, it is known that sperm whales are able to dive much deeper and stay submerged much longer than the other whales. Would it be irrational to place some correlation between this fact and the presence of a large amount of wax? Such presumptive correspondence was an incentive for the present work.

Here we may assume a third physiological function of the oil as a gas reservoir and gas exchange matter, besides those as an energy source and heat insulating matter. It seemed of interest, then, to find out how the three kinds of gases concerned with respiration, oxygen,

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1) E. André et H. Canal: Compt. rend., **183**, 152 (1926).

2) M. Tsujimoto and H. Kimura: J. Chem. Ind. (Japan), **30**, 865 (1927).

nitrogen and carbon dioxide, are absorbed in sperm oil and other oils and fats.

In the present series of experiments, tests were made with the absorption of carbon dioxide in three kinds of whale oils, in comparison with a few kinds of vegetable oils, water and other experimental materials. After describing the apparatus and procedure used, some remarks on test materials will be made, and the results obtained, will be offered.

Apparatus and Procedure

The apparatus used for the present series of experiments is schematically shown in Fig. 1. The main portion consists of a pressure-vessel, **A**; gas reservior, **C**; and a manometer, **D**. Their relative position is not changed during the course of the whole experiment.

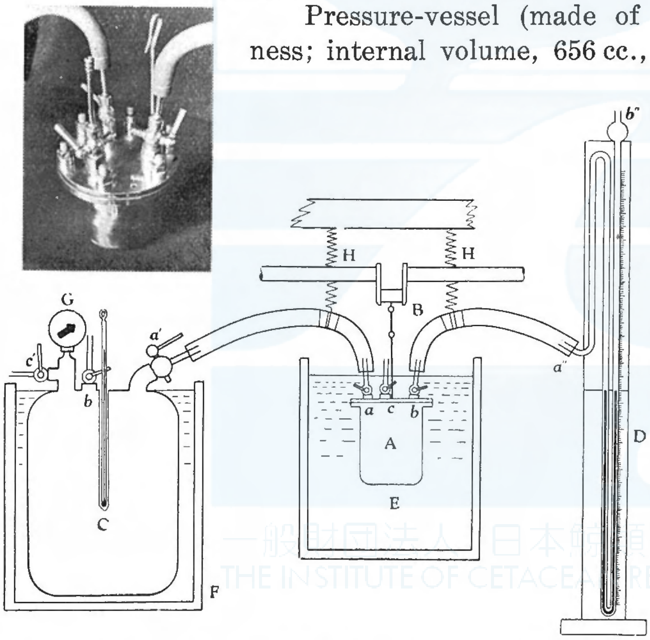

Fig. 1. Apparatus used for the Measurement of Gas Absorption.

A: Pressure-vessel. B: Crank.
C: Gas reservoir. D: Manometer.
E and F: Water tanks with water being kept at 35°C.
G: Pressure gauge. H: Spring.

Pressure-vessel (made of steel of 5 mm. thickness; internal volume, 656 cc., plated with chromium) is to hold the liquid to be tested. This is suspended from the crank **B** of the crank shaft (1 inch in dia.). The vessel is provided with three outlet-tubes; ***a***, ***b*** and ***c***, each with a stop-cock. Tube ***a*** is tightly connected to the gas reservoir and ***b*** to the manometer, each through a thick-walled rubber tubing (internal dia., 3 mm., external dia., 22 mm.). The gas reservoir **C** is about 40 liter capacity and is also provided with three outlets each with a stop-cock, and a pressure gauge. After removal of the internal air, test gas is led into reservoir, until of desired pressure. The pressure-vessel, **A** and the gas reservoir, **C** are each immersed in water tanks, **E** and **F**, respectively. The temperature of water in tanks, was ajusted at 35±0.5°C. The capacity of the each water tanks is about 70 l. The mercury manometer, **D** is of an open type, 2.2 m. in height, and graduated in 1 mm. intervals.

One of the most indipensable conditions for the carrying out of this experiment, is that the pressure-vessel, **A** and the manometer, **D** must be completely isolated from the outside air, as one pressure system. In other words, there must be no leaks in joints, cocks and in other parts. In the present series of experiments, pressure test under 3 atm. pressure, during six hours, indicated that the decrease of pressure was only about 2 to 3 mm. Hg. The stop-cocks were made of gun metal, quite closely ground, and secured with a strong spring. The other indispensable condition is the constancy of the movement of the pressure-vessel, which required some device. For exsample, rubber tubings were suspended from above with a spring so as to avoid their contact with other parts and also to avoid the effect of weight of the rubber tubing on the motion. These precautions seem to have effected constancy of the movement, at least, as far as the results of the present series of experiments are concerned.

The materials to be tested for gas absorption were taken at 100 gs. in each experiment. This sample is placed in the vessel, **A** and suctioned under 1–2 mm. Hg to effect deaeration. In non-volatile liquid, excluding water, deaeration can be carried out for as long as desired. No special experiments were made to find out how much deaeration was sufficient in each material. However, insufficient deaeration would show the effect in experimental results (in the absorption velocity and the amount of maximal absorption). In general, liquids which absorb gas rapidly, also liberate the gas rapidly. This seems perfectly clear to the author. Deaeration of a liquid in a boiling water bath, during twice the time it took until maximal absorption, was found to be sufficient to insure constancy in absorption tests. The time length of deaeration was determined according to this standard. This deaeration in a boiling water bath is followed by suction for 30–40 minutes, in the water tank **E**, maintained at 35°C.

In the case of water,. however, the foregoing deaeration cannot be carried out, because water is volatile. Destilled water thoroughly boiled, is placed in a bottle and cooled under reduced pressure. From this, 102 cc. is taken into the pressure-vessel, closed, and suctioned up to 40 mm. Hg in the water tank **E**, maintained at 35°C. When this pressure is reached, the cock *c* is closed and the vessel is allowed to stand for 1 hour in this state, during which the pressure inside the vessel rises to about twice the original by the vapor pressure of water. Finally, the vessel is evacuated to the highest degree, for exactly

1 min., and the next procedure is started. The question here, is how much water is lost by this procedure. It was found, through weighing the water in the vessel at the end of the test, that 99–99.5 gs. of water still remain in the vessel.

The apparatus is now ready with the vessel **A**, containing the material to be tested, completely deaerated and maintained under 1–2 mm.Hg, suspended from a crank **B**, and immersed in water with top of the tubes barely visible. Other cocks are all closed but only *a* and *b* are open. Then the cock *a′* is gradually opened to send the gas from the gas reservoir into the pressure-vessel until the mercury in the manometer reaches the desired height. Cock *a′* is then closed, followed immediately by the closing of cock *a*, by which the pressure-vessel, **A** and the manometer, **D** constitute one isolated system. This instant, another operater reads the manometer at the time 0, switches on the motor, and starts the stop watch, and the manometer is read punctually with passage of time. The crank shaft is revolved at 77–78 r.p.m., at a voltage of 100–110 V.

The uncertainness about this experimental procedure are the impossibility of taking an accurate reading at the time 0 and the possibility of gas absorption, starting at the time of the introduction of the gas into the vessel, even before the periodical motion of the vessel begins. It is not clear about the second point, but it has been observed that the fall of pressure is extremely gradually in a static state, and that a marked fall occurs as soon as the movement started. It may be added that a period of 20–30 sec. elapsed for the introduction of gas, until of desired pressure. As for the first point, it is actually difficult to take an accurate reading, since there is present a vertical oscillation of the mercury and the surface tends to fall with time. But the readings after 10 sec. and later can be made with accuracy by practice. The determination of the pressure value at the outset was made on the following assumption: As will described later, it is proved that, if we plot logarithms of the pressure value which decreasing with time, against logarithms of time, the curve obtained, in all of the cases become linear. Based on the assumption, the value of pressure at the time 0, can be computed. The value so obtained was found to agree approximately with the observed value, when the absorption velocity was small. But the discrepancy between them showed 6 mm. Hg, at the maximum, when the velocity was greater.

The foregoing measurements were made with each of the materials under various pressure-lebels. Five lebels were chosen for each material, that is, near (but a little higher) 1, 2 and 3 atm. pressure in their initial pressure values, and two intermediate lebels between those.

We attempt to set the initial pressure P_i as near as possible, between the corresponding lebels of each material, values of P_i and P_f (final pressure) are listed in cols. 2 and 3 respectively, of Tab. 2. In the present report, we always use the absolute pressure, i.e. the differential pressure of the manometer added with the atm. pressure at the time, in mm. or cm.Hg. In some materials, tests were made under three P_i lebels, omitting the two intermediate lebels,

As described above, in the present series of experiments, the decrease of pressure was measured under constant volume.

If we write P_i and $P_i-\Delta P$, for the pressure value at the time 0 and t respectively, and V (which is constant) for the real volume of the vessel, the gas at the time t, will be in a state of $P_i-\Delta P$, V., then the following equation hold for the same state of the equal amount of gas, at the time t

$$(P_i-\Delta P)V=P_i\ (V-\Delta V)$$

or

$$\Delta V=\frac{V}{P_i}\Delta P \qquad \text{.........................(1)}$$

where ΔV stands for the decrease in volume, when the absorption is assumed to occur under constant pressure P_i. Furthermore we have

$$\Delta V_0=\frac{T_0}{T}\frac{1}{P_0}V\cdot\Delta P \qquad \text{.....................(2)}$$

where ΔV_0 represents the decrease in volume under standard condition. This decrease is to be considered as the volume of gas absorbed by the materials during the time t. $\frac{T_0}{T}\frac{1}{P_0}$ is a common constant disregarding the materials. V becomes also constant with respect to the material chosen, that is,

$$V=V_1-V_2$$

V_1 denotes the whole capacity of the vessel, which is found to be 684±3 cc., including the inner space of rubber- and glass tubings. 684 cc. is taken as the basis of the computation. $V_2=100/d$, where d is the specific gravity of the liquids tested.

Therefore ΔV_0 can be obtained by multiplying ΔP with these constant factors.

Experimental Materials

The main purpose of the present study is the examination of carbon dioxide absorption by whale oils. Three kinds of whale oil*; sperm oil,

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* Kindly supplied by the Taiyo Fisheries Co., Ltd.

body oil of sperm whale and whale oil from fin whale, were chosen as the material. The first two are from sperm whale, and contain a large amount of higher alcohol esters. The other is from fin and blue whales, or it may contain the oil from sei whale. This point is unknown to the author but at least the oil comes from baleen whales and the majority of it, is constituted from glycerides, as is clear from table 1. Distilled water was chosen as the material. Water is the most common and the most important physiological substance and it seemed suitable to study it in comparison with oils. In this sense, approximately 1% saline solution was also added.

Table 1. Physical and Chemical Natures of the Materials

Materials	Specific Gravity D_4^{35}	Index of Refraction	Viscosity (35°) Redwood (sec.)	Acid Value	Saponification Value	Iodine Value	Unsaponified Matter %
Dist. Water	0.994	—	9.2	—	—	—	—
ca. 1% Saline Solution	1.005	—	—	—	—	—	—
Sperm Oil	0.860	n_D^{40} 1.4525	27.8	1.36	145.5	56.56	33.66
Sperm Body Oil	0.875	n_D^{40} 1.4586	32.8	2.18	141.0	72.64	31.74
Whale Oil	0.917	n_D^{20} 1.4728	47.3	1.95	197.4	99.10	0.46
Olive Oil	0.907	n_D^{18} 1.4695	64.2	2.12	192.0	87.23	0.58
Camellia Oil (commercial)	0.903	n_D^{15} 1.4692	57.8	2.13	192.1	79.37	0.80
Camellia Oil (extracted)	0.904	n_D^{15} 1.4677	55.9	1.85	190.5	81.23	0.93
Castor Oil	0.965	n_D^{15} 1.4790	410.7	2.01	190.1	86.84	0.48
Oleic Acid	0.891	n_D^{18} 1.4588	28.9	—	—	89.09	—
Oleyl Alcohol	0.811	n_D^{15} 1.4602	33.5	—	—	93.50	92.8
Liquid Paraffin	0.874	—	96.5	—	—	—	—

Several kinds of vegetable oil were tested in comparison with whale oil, because they are contrasting in their presence and were assumed to be rather contrasting in their functions. Olive oil was chosen as a common vegetable oil, camellia oil as that with low viscosity and castor oil as that with extremely high viscosity. Special attention was paid to the viscosity because, higher the viscosity, the smaller would be the internal motion against mechanical force and this might become a factor to decrease the absorption velocity. On the other hand, there is also a possibility that an oil with high viscosity might have ability to absorb larger amount of gas. Two kinds of camellia oil were tested because the commercial camellia oil had been unexpectedly found to have a very small absorption velocity, in spite of a low viscosity. Because of the doubt about its purity, oil was extracted from the seeds of *Camellia japonica L.* in this Laboratory.

Further, oleic acid and oleyl alcohol were chosen, as these were the components of oils and fats. Glycerin, the other component of the oil, was omitted because its absorption velocity was extremely small, far smaller than that of castor oil. From only one experiment, its saturation value was supposed to be about that of water. Liquid paraffin was chosen as one of the materials, because this was expected as a matter of poor absorption. Physical and chemical properties of the materials used in the present study are listed in table 1.

Results

Maximal Amount of Carbon Dioxide, absorbed by 100 gs. of Various Materials :

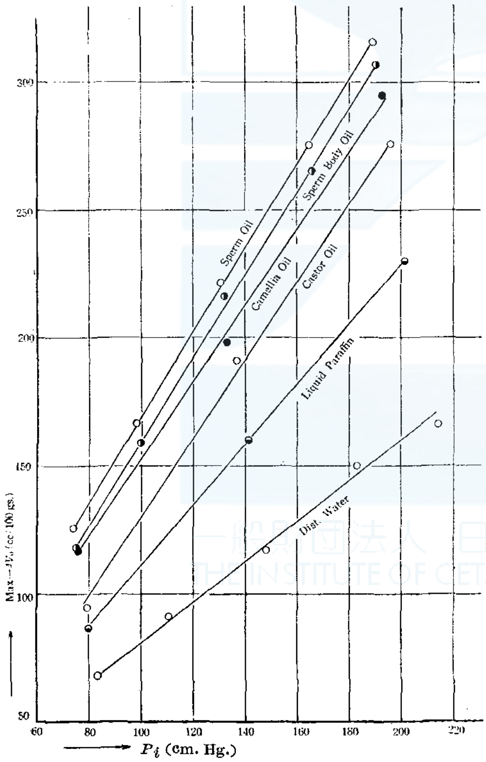

Fig. 2a. Relationship between Maximal Volume of CO_2 (cc/100 gs.) and Final Pressure (cm.Hg), in Various Materials.

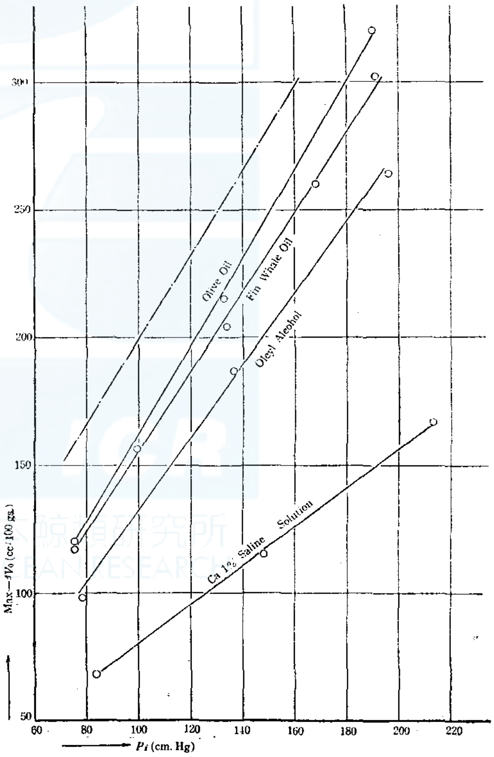

Fig. 2b. Relationship between Maximal Volume of CO_2 (cc/100 gs.) and Final Pressure (cm.Hg), in Various Materials. (Broken line drawn parallel to the line for sperm oil).

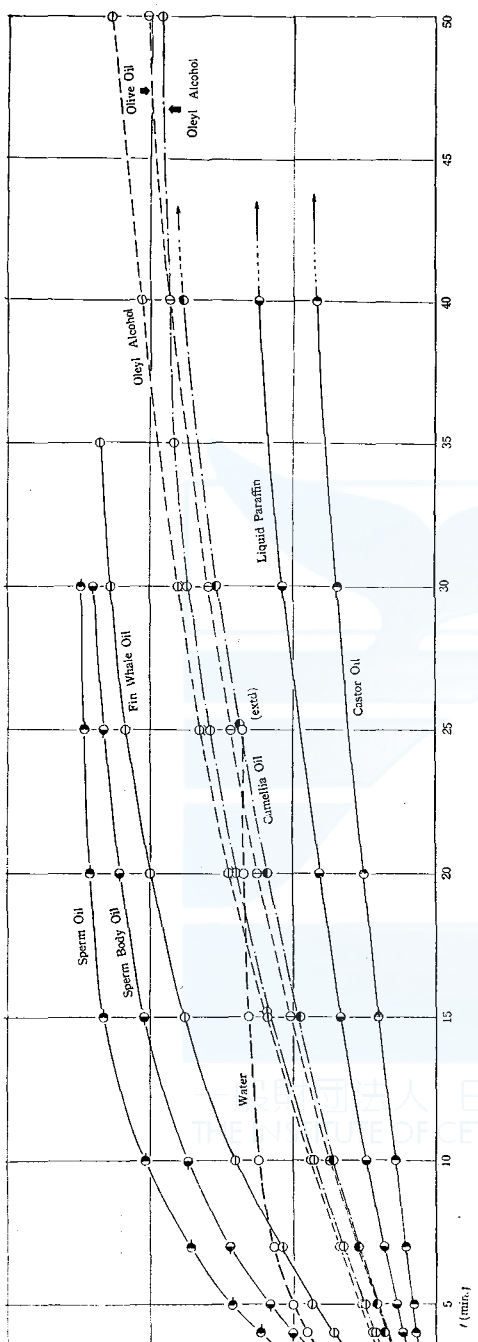

Fig. 3. Absorption Curves for Each Material under around 1 Atm. Pressure (P_i=927–936 mm. Hg).

A few preliminary tests suggested that there would be no great difference in the solubility of CO_2 in oils and fats and other materials tested in the present series of experiments, with the exception of water. Therefore heavy attention was not paid to this point, and no measurements were carried out for so long as required until a true saturation was reached. Nevertheless, the measurements were made until the velocity $\frac{d}{dt}(\Delta V_0)$ becomes fairly small in all the cases. The duration of the time elapsed in each measurement differed to a great extent with each material, as shown in col. 4 of tab. 2. Even if the maximal value of ΔV_0 in these experiments does not represent the saturated value, it may be taken as a value comparatively near it.

Figs. 2a and 2b give the graphs with max-ΔV_0 (in cc./100 gs. of material) plotted against the P_f (in cm. Hg). fig. 2 has been separated into two portions but there is no special significance in that, except that in some materials, their curves fall so near to each other that they can not be represented on one graph. Even by such treatment, curves for oleic acid and the comm. camellia oil had to be

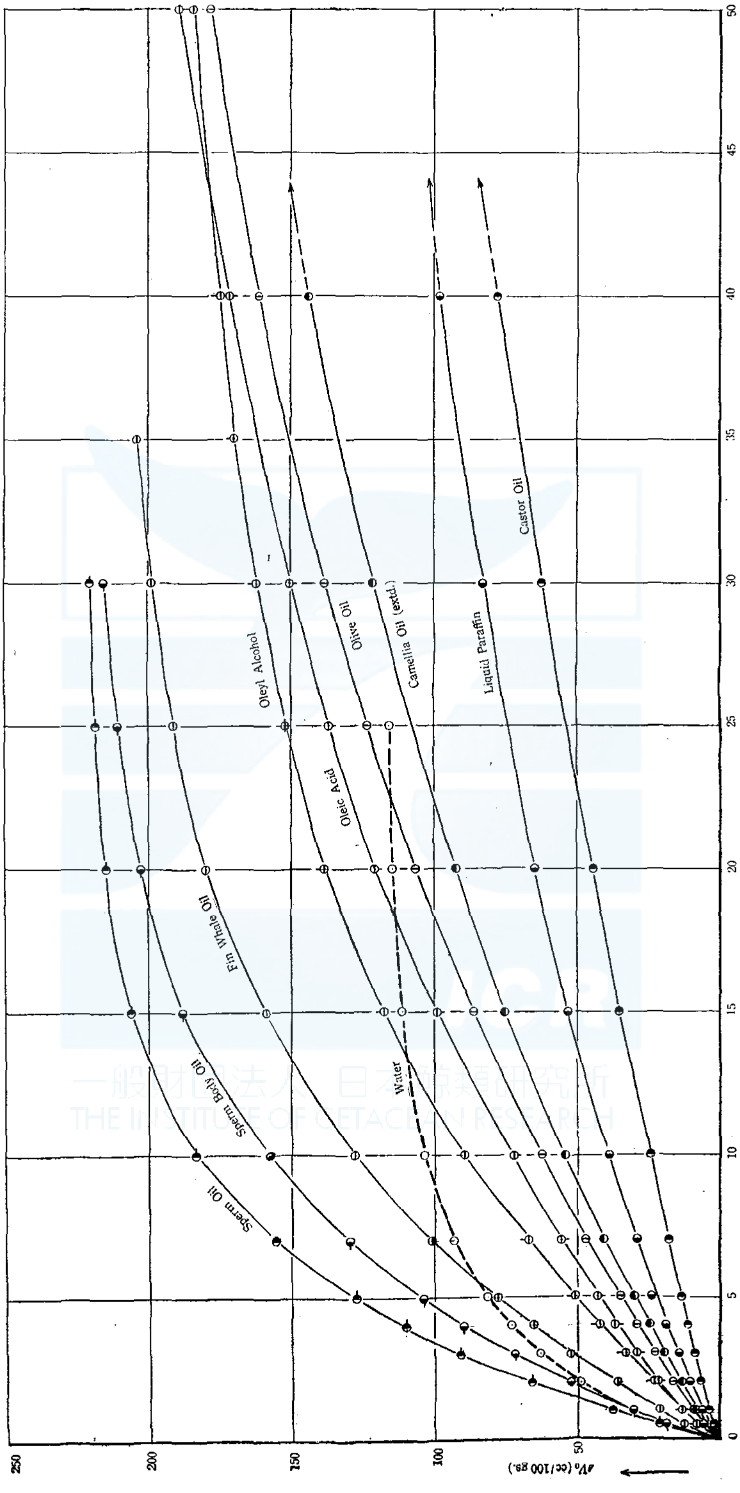

Fig. 4. Absorption Curves for Each Material under around 2 Atm. Pressure (P_i=1640-1656 mm.Hg).

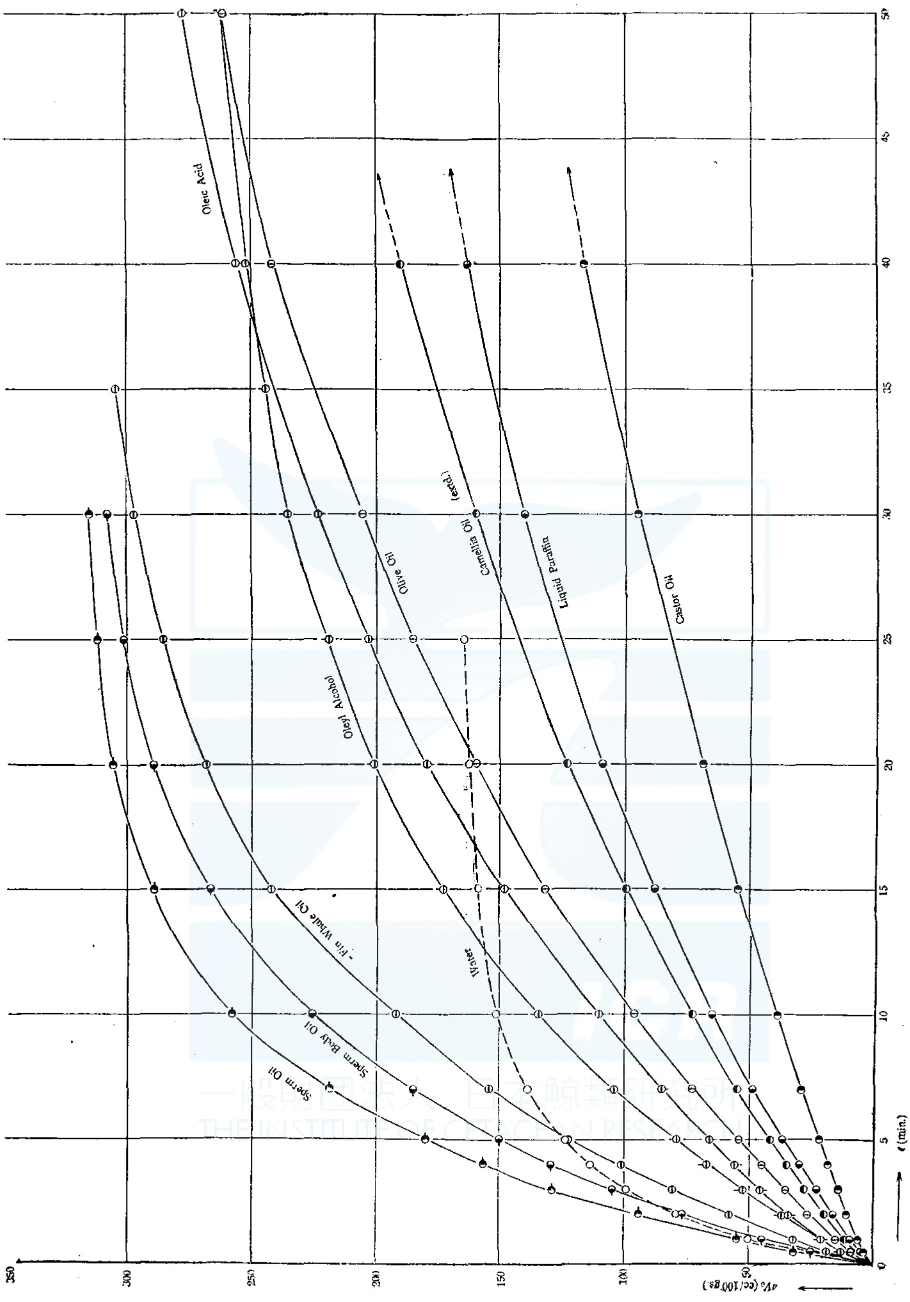

Fig. 5. Absorption Curves for Each Material under around 3 Atm. Pressure ($P_i=2361$–2382 mm.Hg).

discarded. It may be seen from figs. 2a and 2b that the value of Max-ΔV_0 had a tendency to show a linear regression against P_f. The gradient of the straight line is 1.78 cc./cm.Hg in sperm oil, and values approximating it, with sperm body oil, olive oil, oleic acid, camellia oil and fin whale oil. Even in castor oil, whose absolute value of Max-ΔV_0

is small, there seemed to be no great difference in the gradient of the line. On the other hand the gradient of the curve in water is 0.78 cc./cm. Hg, being 1/2 or less of that of the materials listed above. The curve of ca. 1% saline water completely overlapped that of the dist. water.

If the equation; Max-ΔV_0=c. P_f can be postulated, then it means that Max-ΔV_0 (and perhaps solubility also) is proportional to the pressure, in each material, and solubilty of CO_2 in water would be about one-half of that of the foregoing oily substances, irrespective of the pressure. In any case, it is clear, that the solubility of carbon dioxide in oily substances is not so markedly different with the kind of oils and fats, as long as the duration of time required until saturation, is not taken into account. On the other hand, the time required to reach the saturation differs vastly with different kind of oils.

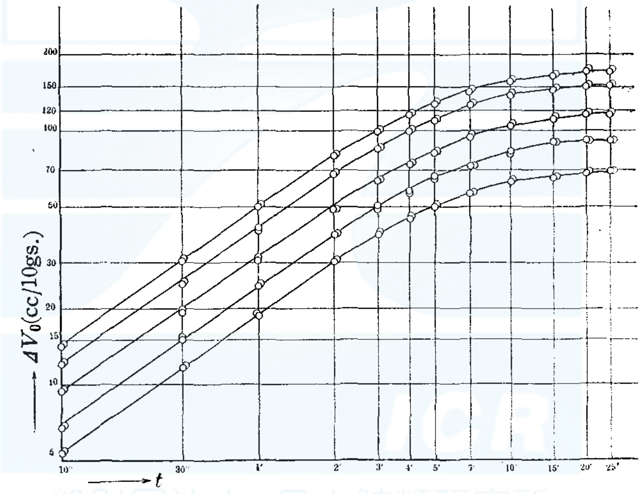

Fig. 6. Absorption Curves for Dist. Water under various Pressure lebels. ΔV_0: Volume of CO_2 (cc/100 gs.) absorbed. t: time (sec.). Pressure lebels (mm.Hg) from top to bottom: 2382–2139, 2061–1841, 1656–1483, 1240–1106, 934–838.

Absorption Curve of Carbon Dioxide, by 100 gs. of Various Materials:

It is seen from the preceding section, that the rapidity of absorption differs with each material. The main purpose of the present section is to follow the absorption curve of carbon dioxide in several oils, including whale oils and other liquid materials, and to find from it, the characteristic difference between them as to such properties as how rapid they can absorb gases. The values of ΔV_0 (in cc.) obtained were all transformed into logarithms and these plotted against the logarithm of t's (in sec.), because to find out the experimental formula. But it may be necessary to show the raw curves. In the transformed curves, it seems that all materials give almost similar results, as long as the special attention was not paid to the ordinate scale.

Fig. 3 shows the absorption curves of various materials under around 1 atm. pressure, and figs. 4 and 5 respectively give those under around 2 and 3 atm. pressure. In each figure, the curves for comm. camellia oil and 1% saline water were omitted, because they were entirely approximate to the curves of extd. camellia oil and dist. water, respectively, In each figure, P_i agrees almost wholly (tab. 2, col. 2). It will be seen from these diagrams, that the gradient of the curves for three kinds of whale oils is markedly larger than that of the other materials, at the earlier interval of t.

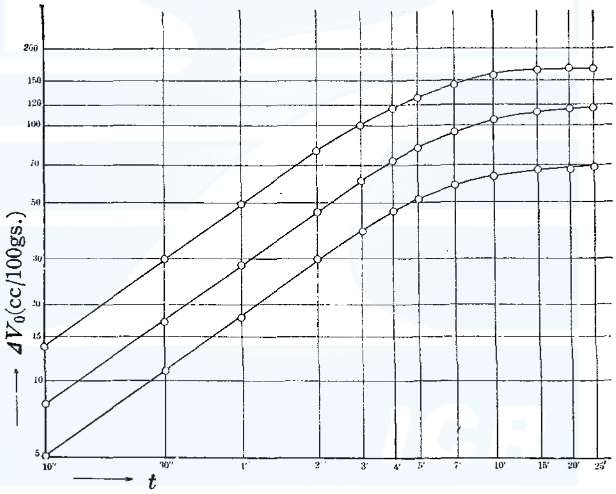

Fig. 7. Absorption Curves for 1.04% Saline Solution under various Pressure lebels. $\varDelta V_0$: Volume of CO_2 (cc/100 gs.) absorbed. t: time (sec.). Pressure lebels (mm. Hg), from top to bottom: 2379–2135, 1650–1481, 935–835.

When we speak about a rapid or slow absorption of a material, it seems that the time required until saturation, is concerned. In other words, mean absorption velocity until saturation, is the point in question. It may be possible to characterize a material by this comparison. However, it seems that the velocity $\frac{d}{dt}(\Delta V_0)$ at the earlier interval of t indicates more acutely the difference between materials as to the absorption of gases, than their mean velocity.

In the following we will write $(\Delta V_0)'$ instead of $\dfrac{d}{dt}(\Delta V_0)$.

In figs. 6 to 16, each diagram shows the absorption curves of each material under various pressure lebels. It is clear, in these diagrams that log ΔV_0 in any of the curves is a linear function of log t, in the interval where t is comparatively small. With increase of t, the curve shows a common tendency to bend down towards t-axis.

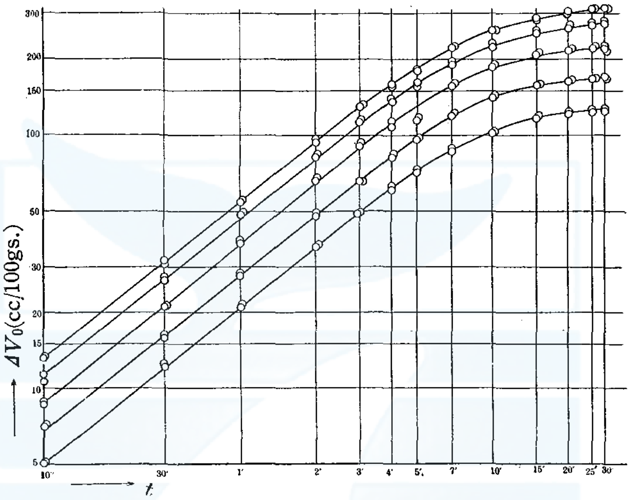

Fig. 8. Absorption Curves for Sperm Oil under various Pressure lebels. ΔV_0: Volume of CO_2 (cc./100 gs.) absorbed. t : time (sec.). Pressure lebels (mm.Hg) from top to bottom: 2364–1890, 2060–1644, 1640–1306, 1233–982, 927–738.

For the interval where linear relation holds, the equation can be stated in the form

$$\log \Delta V_0 = a + b \log t \quad \text{……………………}(1)$$

or

$$\Delta V_0 = a' t^b \quad \text{………………………}(2)$$

where ΔV_0 is the volume (in cc.) of CO_2 absorbed by 100 gs. of each material up to the time t (in sec.), a ($=\log a'$) and b will be parameters dependents upon the material and pressure lebel.

It may be offered some experimental formulae which would hold for these curves over the whole interval, in which the measurements were made. For example,

$$\Delta V_0 = a' t^b (1+\varepsilon)^{-t} \quad \text{……………………}(3)$$

or

$$\Delta V_0 = a' t^b (1-\varepsilon t) \quad \text{……………………}(4)$$

where ε is a very small positive number. By making a suitable selection of ε, it is possible to obtain a good agreement between the observed and calculated values. However, as mentioned above, our purpose is to compare $(\Delta V_0)'$ of each material, in the earlier interval of t, and by which to characterize the materials. For this purpose, it is not necessary to be concerned with the equation (3) or (4), and is sufficient to do with the equation (2).

Table 2. Miscellaneous data from the Experiment

Materials	Pressure lebel		Time length of measurement (min.)	in formula $\Delta V_0=a't^b$			Ratio of $a'b$ to that of caster oil	
	P_i (mm.Hg)	P_f (mm.Hg)		a'	b	$a'b$		
Dist. Water	934*	834*	25	1.10	0.69	0.76	12.6	12.4
	1240	1106		1.43		0.99		
	1656	1483		1.82		1.26	12.6	
	2061	1841		2.42		1.67		(mean)
	2382	2139		2.95		2.04	12.0	
ca. 1% Saline Solution	935*	835*	25	1.02	0.70	0.71	11.8	11.5
	1650	1481		1.61		1.12	11.2	
	2379	2135		2.80		1.96	11.5	
Sperm Oil	927	738	30	0.83	0.79	0.66	11.0	11.0
	1233	982		1.10		0.87		
	1640	1306		1.49		1.18	11.8	
	2060	1644		1.86		1.47		
	2364	1890		2.13		1.68	10.0	
Sperm Body Oil	928	750	30	0.70	0.78	0.55	9.2	9.1
	1234	995		0.94		0.73		
	1647	1322		1.23		0.96	9.6	
	2054	1655		1.54		1.20		
	2364	1902		1.83		1.43	8.4	
Whale Oil	930	755	35	0.44	0.80	0.35	5.8	6.1
	1228	995		0.59		0.47		
	1648	1343		0.81		0.65	6.5	
	2065	1677		1.05		0.87		
	2361	1912		1.26		1.01	5.9	
Olive Oil	932	753	100	0.21	0.80	0.17	2.8	2.8
	1649	1328		0.37		0.30	3.0	
	2375	1896		0.56		0.45	2.6	
Camellia Oil (extd.)	932	758	130	0.18	0.82	0.15	2.5	2.2
	1642	1331		0.28		0.23	2.3	
	2367	1926		0.39		0.32	1.9	
Camellia Oil (comm.)	936	757	130	0.17	0.82	0.14	2.3	2.0
	1648	1333		0.26		0.21	2.1	
	2366	1903		0.34		0.28	1.6	
Castor Oil	933	793	240	0.075	0.82	0.06	1.0	1.0
	1647	1365		0.127		0.10	1.0	
	2366	1958		0.205		0.17	1,0	
Oleic Acid	927	743	100	0.40	0.73	0.29	4.8	4.7
	1649	1319		0.67		0.49	4.9	
	2362	1889		1.03		0.75	4.4	
Oleyl Alcohol	936	786	60	0.24	0.81	0.19	3.1	3.6
	1651	1366		0.49		0.40	4.0	
	2364	1960		0.76		0.62	3.6	
Liquid Paraffin	932	802	180	0.12	0.82	0.10	1.7	1.7
	1651	1410		0.21		0.17	1.7	
	2362	2015		0.33		0.27	1.6	

* Pressure values are obtained by subtracting 42 mm.Hg, the saturated vapor pressure of dist. water at 35°C, from total pressure. In the case of ca. 1% saline solution, 40 mm.Hg is subtracted.

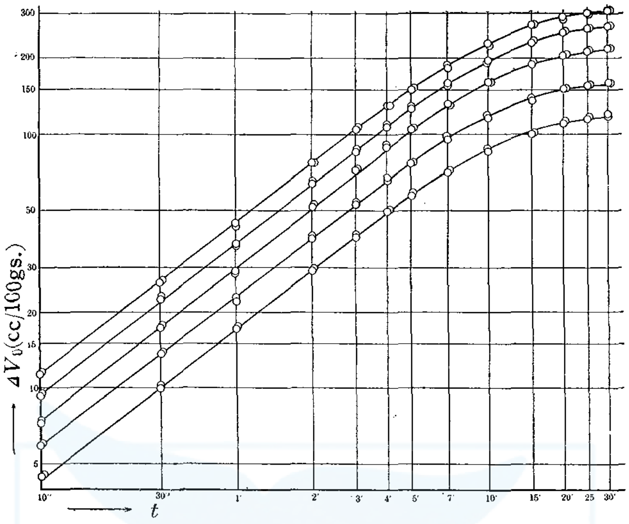

Fig. 9. Absorption Curves for Sperm Whale Body Oil under various Pressure lebels. ΔV_0: Volume of CO_2 (cc/100 gs.) absorbed. t: time (sec.). Pressure lebels (mm.Hg), from top to bottom: 2364–1902, 2054–1655, 1647–1322, 1234–995, 928–750.

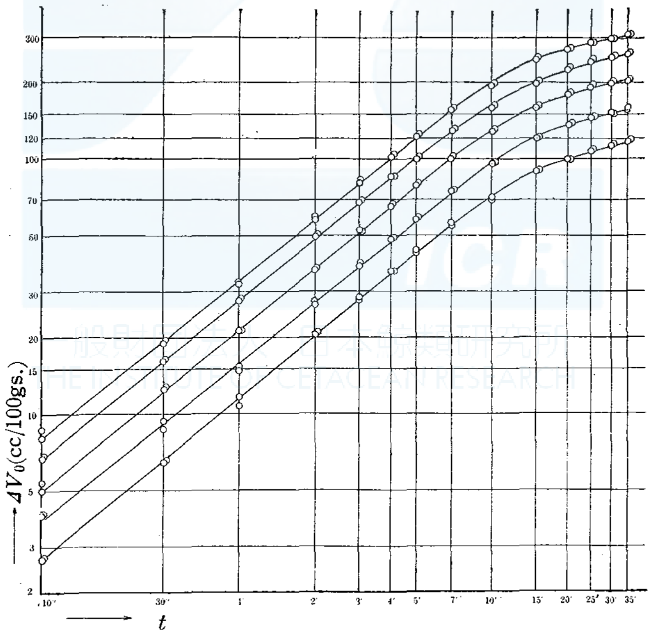

Fig. 10. Absorption Curves for Fin Whale Oil under various Pressure lebels. ΔV_0: Volume of CO_2 (cc/100 gs.) absorbed. t : time (sec.). Pressure lebels (mm.Hg), from top to bottom: 2361–1912, 2065–1677, 1648–1343, 1228–995, 930–755.

With 44 curves in fig. 6 to fig. 16, a' and b were determined according to the equation (1). The values of a' and b thus obtained for each material under various pressure lebels, are listed in col. 5 and 6 of tab. 2. In order to exmaine the difference between the value of log ΔV_0 obtained, and that calculated from equation (1), standard deviation from regression was computed for each curve. The mean value of them with 44 transformed curves was 0.010 with standard deviation of 0.003.

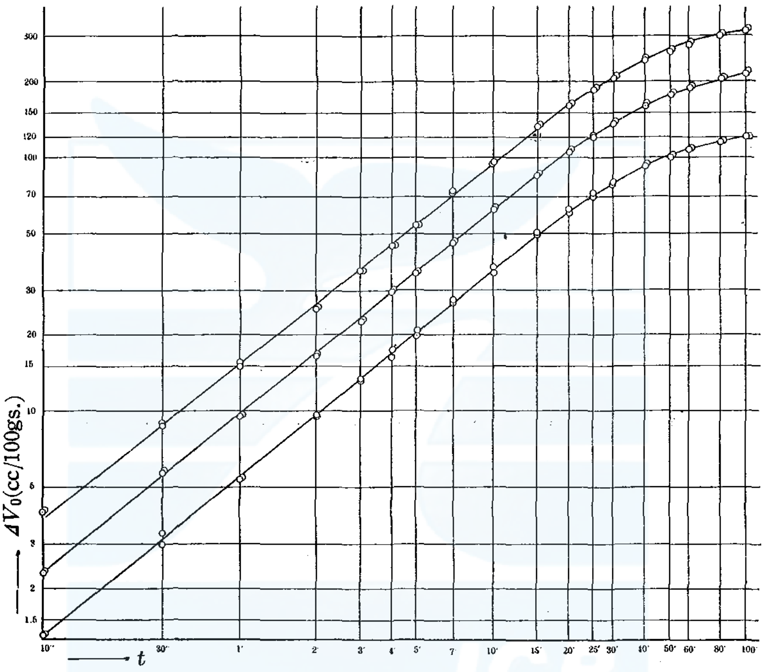

Fig. 11. Absorption Curves for Olive Oil under various Pressure lebels. ΔV_0: Volume of CO_2 (cc/100 gs.) absorbed. t: time (sec.). Pressure Lebels (mm.Hg), from top to bottom: 2375–1896, 1649–1328, 932–753.

From equation (2), we obtain

$$(\Delta V^0)'=a'bt^{b-1}\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

This equation (5) represents the absorption velocity of each material in the linear portion of the curve. If the value of b were a common constant for all materials, then the absorption velocity $(\Delta V_0)'$ will proportional to $a'b$ at any value of t, that is, $a'b$ will represent the velocity constant and therefore its magnitude under definite P_i, will characterize the materials. It is seen from col. 6 in tab. 2 that a constant b has been obtained within the same material irrespective of pressure lebel. But the value of b is not the same throughout all materials. It is the smallest (0.69) in dist. water and is 0.73 for oleic acid. With the exception of these, the values are 0.78 to 0.82 in all the other oily substances.

Owing to the unevenness of b, $a'b$ cannot represent a true velocity constant. But within the oily materials except water and oleic acid the values of b fairly approach to each other, then $a'b$ can stand for a velocity constant approximately, within these materials. It may be added that $a'b$ is $(\Delta V_0)'$ itself when $t=1$, and therefore that at the earliest interval of t, $(\Delta V_0)'$ of each material will be approximately proportional to its own $a'b$. In this sence, $a'b$ also is to be considered as a *measure* which characterizes a material, as to the absorption velocity of carbon dioxide. The values of $a'b$ are given in col. 7 of tabl. 2.

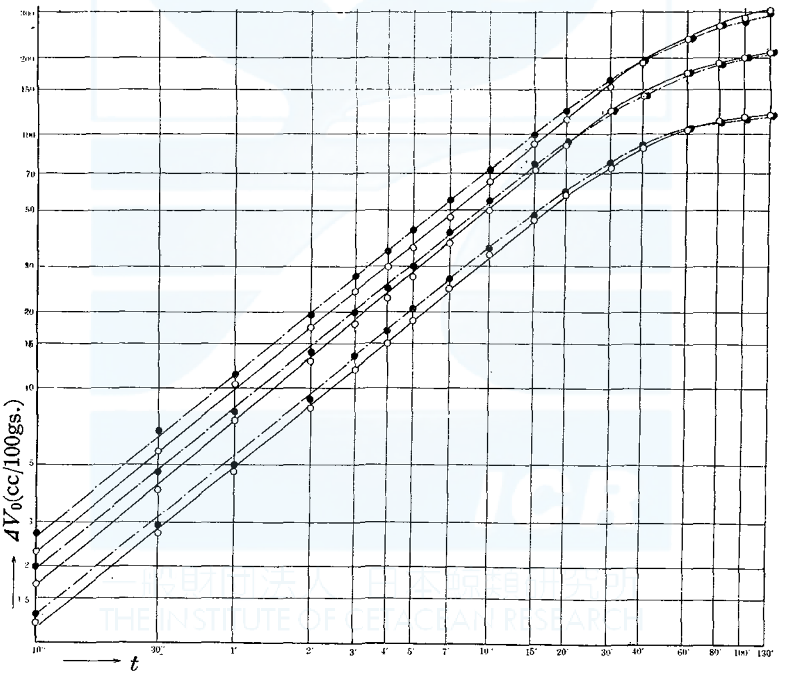

Fig. 12. Absorption Curves for Camellia Oil under various Pressure lebels.

—·—·—·—·— Extd. Pressure lebels (mm.Hg), from top to bottom: 2367-1926, 1642-1331, 932-758.

———————— Comm. Pressure lebels (mm.Hg), from top to bottom: 2366-1903, 1648-1339, 936-757.

In fig. 17, the values of $a'b$ of each material have been plotted against the initial pressure, P_i. It seemed highly probable that the values of $a'b$ would indicate a linear regression against P_i. Since there are too few points which determine these straight lines, it is dangerous to make some conclusion immediately, but the fact that this tendency is observed in the majority of these materials, constitutes a strong basis for the assumption that a linear regression might hold for each material (with the exception of water, which showed a somewhat hyperbolic curve). In other materials, almost without exception, the curves showed linear regression. In this case, all these curves must pass the origin (0, 0), because under P_i (absolute pressure)$=0$, any absorption cannot occur and therefore the following equation will be hold for each curve in fig. 17.

$$a'b=\alpha P_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

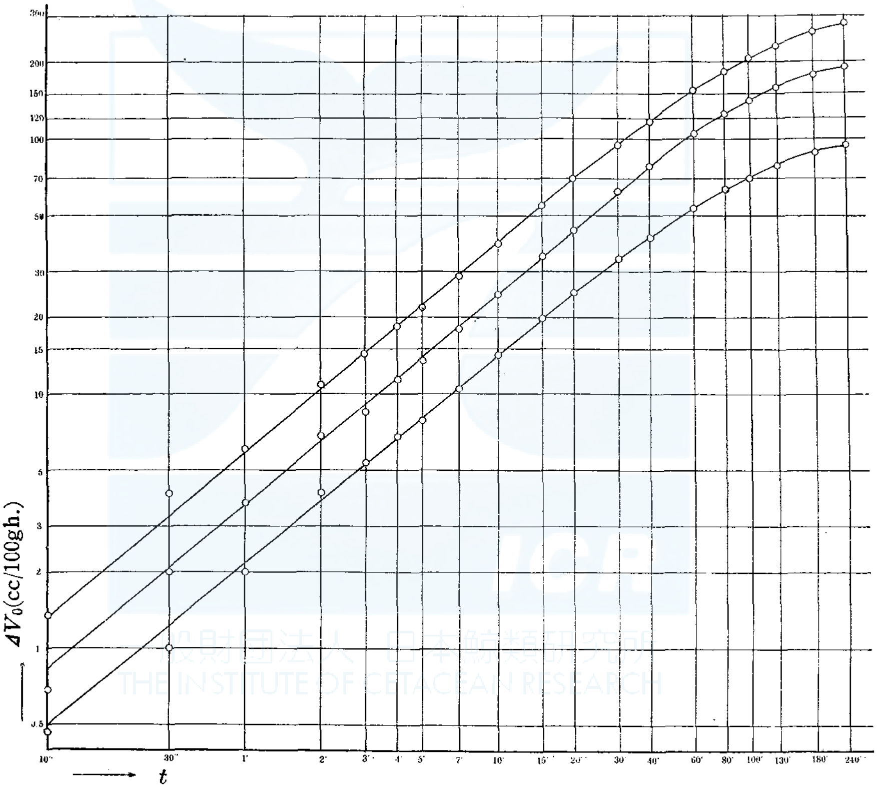

Fig. 13. Absorption Curves for Castor Oil under various Pressure lebels. ΔV_0: Volume of CO_2 (cc/100 gs.) absorbed. t: time (sec.), Pressure lebels (mm.Hg), from top to bottom: 2366–1958, 1647–1365, 933–793.

If this equation can be established for each material, α will be the better *measure* to characterize the material, than $a'b$. Because α is a parameter dependent only on the kind of materials. On the contrary $a'b$ dependent on the materials and also on the pressure lebels. The col. 8 in tab. 2 shows the ratio of $a'b$ for each material, under each P_i, to that of castor oil under corresponding P_i. It is clear from equation (6) that these values directly indicate the ratio of α, because, the ratio of α is equal to the ratio of $a'b$ at a definite P_i. Castor oil was chosen as the standard, since its $a'b$ happened to be the smallest. The values listed in col. 9 show fairly good agreement for all the materials. The value of ratio thus obtained, seems to be adequate *measure* to characterize a material as to the absorption velocity of gases.

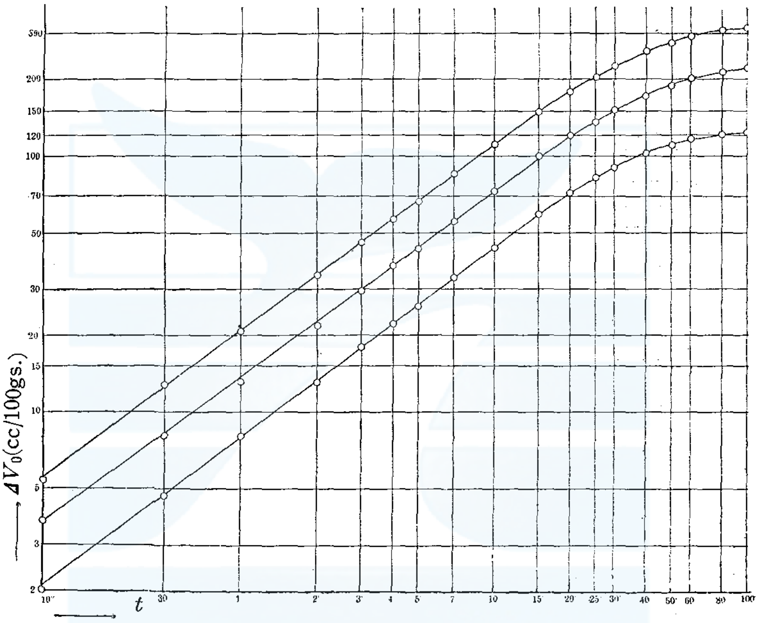

Fig. 14. Absorption Curves for Oleic Acid under various Pressure lebels. ΔV_0: Volume of CO_2 (cc/100 gs.) absorbed. t: tlme (sec.). Pressure lebels (mm.Hg), from top to bottom: 2362–1889, 1649–1319, 927–743.

It is clear that $a'b$ and α both quantities dependent upon the mechanical conditions, and the ratio of α may be also dependent on such. But it may be permitted to make hopefull assumption that this value is independent of the motion of the vessel. Because, if the conditions of the motion affect α of one material, the same conditions would probably affect α of the other materials, in the same degree.

Comment

The results of the present series of experiments seem to indicate that there is no great difference in the maximal quantity of carbon dioxide, absorbed by oils and oily substances. There is almost no difference, between the value of sperm oil after 30 mins. and that of olive oil after 100 mins. under every pressure lebels. If the duration of time required to reach the maximal quantity is not taken into account, the values of whale oils, vegetable oils and oleic acid do not show any great difference under corresponding pressure lebels. The maximal ΔV_0 of oleyl alcohol is fairly smaller than that of other oily substances. The maximal ΔV_0 of castor oil seems far smaller than that of the other oily substances, even after 240 mins., but it is still not clear whether this oil will show the same degree absorption as the other oily substances after a much longer period, or whether the solubility is characteristically small in this oil. On the contrary, the maximal ΔV_0 of water is clearly far smaller than that of others, being 1/2 or less under each of the pressure lebels.

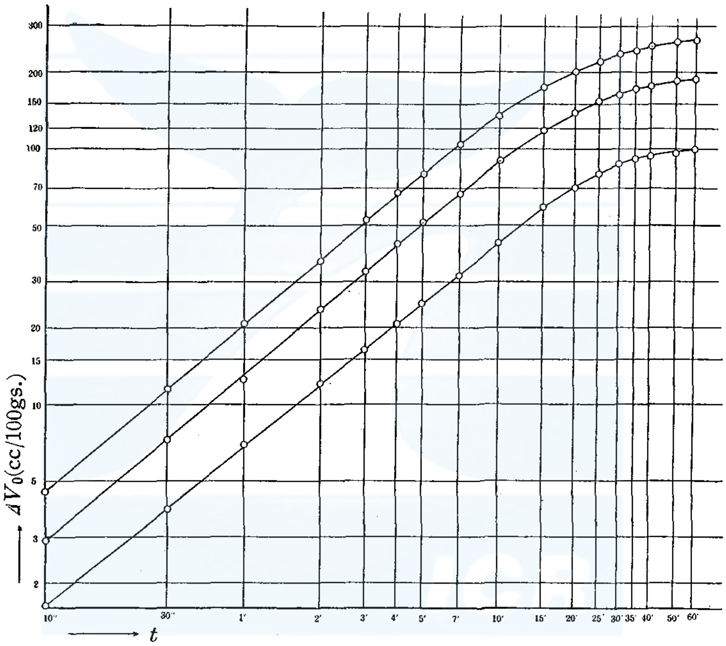

Fig. 15. Absorption Curves for Oleyl Alcohol under various Pressure Lebels. ΔV_0: Volume of CO_2 (cc/100 gs.) absorbed. t: time (sec.). Pressure lebels (mm.Hg), from top to bottom: 2364–1960, 1651–1366. 936–786.

On the other hand, it has been found that there exists a great difference in the absorption velocity of these materials. Taking castor oil as the standard, the velocity, 1 sec. after the outset is about 12 times faster in water, about 11 times in sperm oil, about 9 times in sperm whale body oil, and about 6 times in fin whale oil. In general, the absorption velocity of vegetable oils is small, the value of this ratio being about 2.8 in olive oil and about 2.0 in camellia oil. The striking fact revealed by these experiments is the prominently great velocity of carbon dioxide absorption by whale oils, compared to vegetable oils.

The relationship between viscosity and absorption velocity is not necessarily parallel. The viscosity of camellia oil is lower than that of olive oil, but the absorption velocity is smaller in the former. The viscosity of oleic acid is about the same as that of sperm oil, but their is a great difference in their velocity of absorption. The velocity at 1 sec. of the sperm oil is 2.4 times greater than that of oleic acid and about 3.0 times greater at 60 sec.. Therefore, low viscosity is not the sole factor for making the absorption velocity greater. The effect of viscosity on absorption velocity is not to be denied but some other physical properties ascribable to the molecular structure of the substance seem to be more responsible. Based on the assumption that a higher

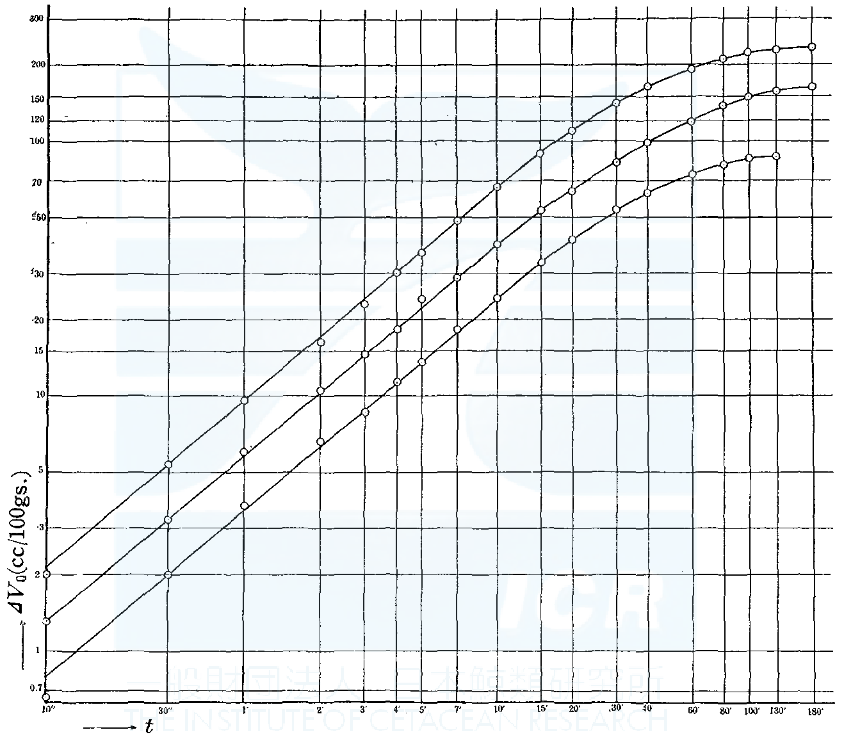

Fig. 16. Absorption Curves for Liquid Paraffin under various Pressure lebels. ΔV_0: Volume of CO_2 (cc/100 gs.) absorbed. t: time (sec.). Pressure lebels (mm.Hg), from top to bottom: 2362–2015, 1651–1410, 932–802.

alcohol, one of the components of wax, may be the one responsible, tests were made with oleyl alcohol but it was found that its absorption velocity was about the same as that of oleic acid.

The present study seems to be not very suggestive in the theoretical aspect of this question. The more theoretical expression of the data of this experiment will be

$$\frac{d}{dt}(\Delta V_0)=-\beta(A-\Delta V_0)$$

in this equation, A will represent the saturation quantity, which is a function of P, T and the kind of materials, and β will be a parameter, perhaps, only dependent on the kind of materials and not on P, at a definite T. If the measurements were carried out, under constant pressure, not under constant volume, this equation would probably hold for the experimental results. However, in the present study, this equation did not hold in this original form, any correction term is necessary to insert. Because A dose not become a constant but varies with time throughout one measurement. For this reason, the data were related to the experimental formula.

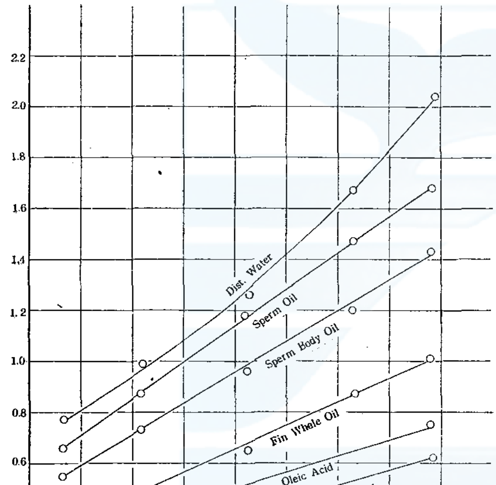

Fig. 71. Relationship between coefficient $a'b$ in the equation $\frac{d}{dt}(\Delta V_0)=a'bt^{b-1}$ and initial pressure P_i (cm.Hg).

Apart from this physical problem, the author wishes to take up the physiological significance of the fact that an oily substance of different velocity in carbon dioxide absorption is present in different living things. In this sense, the third physiological function of oils, besides its function as the energy source and insulation matter, seems to be suggested.

Summary

1) Absorption of carbon dioxide was studied with 12 kinds of substances, i.e., distilled water, ca. 1% saline solution, sperm oil, sperm

whale body oil, fin whale oil, olive oil, commercial and laboratory-extracted camellia oil, castor oil, oleic acid, oleyl alcohol and liquid paraffin.

2) Decrease of pressure, ΔP, caused by absorption was measured with each material at constant temperature (35°C) and constant volume, under five different pressure levels, i.e. under around 1, 2, and 3 atmospheric pressures and two intermediate levels. The volume of carbon dioxide absorbed, ΔV_0 (in cc./100 gs. of the material) at a standard state was obtained from ΔP.

3) From the experimental results obtained, following conclusions were drawn:

a) Maximal absorption of carbon dioxide by each material was found to be approximately proportional to pressure.

b) No great difference was found to exist in the maximal absorption of carbon dioxide between individual oils and oily substances. It was also found that the maximal absorption of carbon dioxide by water, under various pressure levels, was about one-half of that of oily substances.

c) There is a great difference in the velocity of carbon dioxide absorption between various materials which, when compared at the earliest velocity (velocity 1 second after outset), was in the decreasing order of distilled water, ca. 1% saline solution, sperm oil, sperm whale body oil, fin whale oil, oleic acid, oleyl alcohol, olive oil, camellia oil, liquid paraffin, and castor oil. The absorption velocity are strikingly great in the three kinds of whale oils and water.

4) As a *measure* for characterizing these materials in regard to the velocity of carbon dioxide absorption, the value of α or the ratio of α was proposed.

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