

# On the Body Weight of Sperm and Sei Whales located in the Adjacent Waters of Japan

By Hideo Omura

## I. Introduction

Because whales have such huge bodies and measuring of body weight is not easy, there have been extremely few data concerning it hitherto. As for the Antarctic, on blue whales, there are only two results. (a report in Norsk Hvalfangst-Tidenda and another on measurements taken by Capt. Srille in South Georgia). Even for the Arctic, the only data to date are reports by Dr. Lukas on 1 blue whale and by Zenkovic on 3 fin whales, 2 humpback whales, 1 grey whale and 2 sperm whales. Attention to these data has also been called by Laurie, Peters and Brandt.

Till now, the 11 instances abovementioned have been the only available data concerning the body weight of whales. However, information concerning body weight is very important from both the biological and the practical whaling point of view. So lately we have made every possible endeavour to carry on such measuring and have succeeded in collecting considerable quantity of data. This report is on the body weight of sperm and sei whales located in the adjacent waters of Japan. A separate report on whales in the Antarctic Ocean will probably be made elsewhere.

Regarding the whales found in the adjacent waters of Japan, 3 sperm and 7 sei whales, 10 in total, were measured on board the "Kaiko-maru", the mother ship of the Nihon Suisan Co. Ltd. which operated in the adjacent waters of Bonin Island in 1948; and 10 sperm whales and 16 sei whales, 26 whales in all, were measured at the Kamaishi Plant of the Nihon Suisan Co. Ltd., in 1949. The present report is based on all of the above, namely 13 sperm whales and 23 sei whales.

Sincere thanks are expressed to Mr. Yutaka Nakano, chief of working division of the "Kaiko-maru" and all member of its crew and Mr. G. Nakamura, chief of Kamaishi Plant and his staff who did the work of weighing the whales, as well as Mr. H. Sakiura and Mr. S. Nishimoto, whaling inspectors of Fisheries Agency, who directed the weighing operation.

## II. Method

When flensing the whales both on board the "Kaiko-maru" and at the

Kamaishi Plant, the whale carcasses were divided into blubber, meat, bones, internal organs etc., which were further cut up and then weighed with the use of a 50 kg scale. Blood was not weighed. This process of measurement was an extremely complicated job and took so long (4 to 5 hours) to finish one whale that it was carried out when only a few whales were caught. Owing to the long time taken and dissection into small blocks, there was some loss in weight; so the figures given in this report are probably smaller than the actual weights. However, the percentage of discrepancy for the total body weight is very small and hence serves as a fairly satisfactory data for studying the general trend.

The weighing result is as shown in the appendix table.

The items in it are as follow.

**a. Sperm whales**

Though Meat was weighed separately by dorsal meat, thoracic plate and meat around ribs, etc., they were collected into the single item "Meat" in this table.

Though Blubber was weighed by head and abdominal blubber etc., they were totalled into the single item "Blubber" in this table. It was so done because there was no clear cut border between them. And this weight of blubber includes tail flukes, fin and flipper blubber, but not bones.

"Others" among bones includes all bones not specifically indicated by name. "Others" among Internal organs includes all organs not specifically indicated, and includes fat of internal organs.

The final item "Others" includes tendon and spermaceti case just under head blubber, and white gelatinous matter around it (commonly called "white-horse" or "junk") and caudal tendon, as well as tongue, scraps of bones and meat, etc., that are left after dissecting.

**b. Sei whales**

Mostly same as in the case of sperm whales, with the following differences: Blubber includes ventral grooves and meat attached to it. The single item "Others" includes caudal tendon, baleen plates and tongue. Such is the general classification used. Strictly speaking, however, it cannot be said that all the whales recorded in this table have been so classified. For instance, tongue, being used for food in Japan, was weighed with meat through carelessness, and could not be separated afterward. And the cartilage in the upper jaw bone was in some cases included in the final item "Others". As

this cartilage too is used for food, it was carelessly removed from skull and could not later be added to it. There was thus some lack of uniformity owing to carelessness in measuring. Taken as a whole, however, it is not believed that it will make a very great difference.

**Sperm whale** (*Physeter catodon* Linnaeus)

Of the 13 whales measured, 11 were males and 2 females. No difference between male and female could be recognized. As shown in Fig. 1, their body weight can be indicated on a chart by a single curve. And on logarithmic section paper, it can be indicated by one straight line. Accordingly, taking  $L$  as body length (in feet),  $W$  as body weight (in metric tons),  $a$  as a certain constant and  $b$  as increasing ratio of body weight to body length, the relation between body length and weight is shown by the following equation :

$$W = aL^b$$

Calculating  $a$  and  $b$  from the actually measured values,  $a=0.000137$  and  $b = 3.18$ . So the relation between the body weight and length of sperm whales is shown by the following equation :

$$W = 0.000137 L^{3.18}$$

In the same way, calculating  $a$  and  $b$  for each part of meat and blubber weighed, the following equations were obtained.

Meat :  $W = 0.0000367 L^{3.24}$

Blubber :  $W = 0.0000452 L^{3.18}$

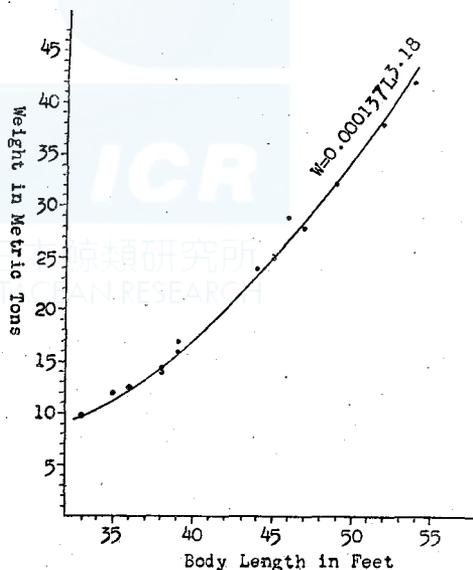
Bones :  $W = 0.000041 L^{2.88}$

Internal organs :  $W = 0.0038 L^{1.64}$

Figs. 2 to 5 show the actually measured values and the above curve for each part.

As seen in the above equations, the largest increasing ratio of weight for body length is on meat. Blubber shows the same ratio as on the total body weight. The least is on internal organs, and next on bones.

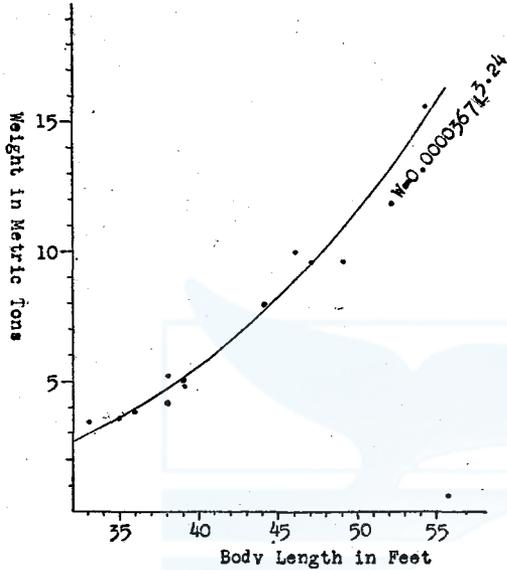
Fig. 1. Sperm whale, Total weight.



The least is on internal organs, and next

As the appendix table shows, bones was further classified into skull, back jaw and rib and internal organs was divided into heart, lung, stomach, liver, kidney and intestines. Spermaceti, too, was weighed separately. But they showed so much fluctuation that it was difficult to obtain an equation like the above on the basis of the data obtained. I think, this was due to the fact that while the actual measurement was generally accurate for the major classification, the minor classification may not always have been strictly made. For instance, as bones were measured in such a size that they could be thrown into the boiler, it cannot be said with certainty that no misclassification took place. Nor do I believe that the classification of internal organs was

Fig. 2. Sperm whale, weight of meat.



classification took place. Nor do I believe that the classification of internal organs was

Fig. 3. Sperm whale. Weight of blubber

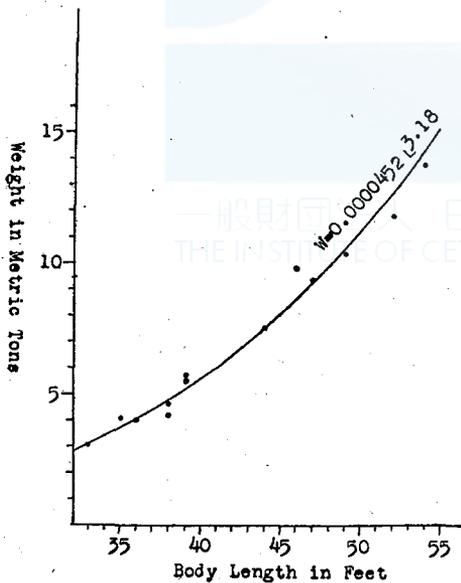


Fig. 4. Sperm whale. Weight of bones

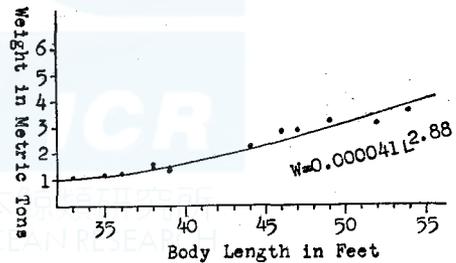
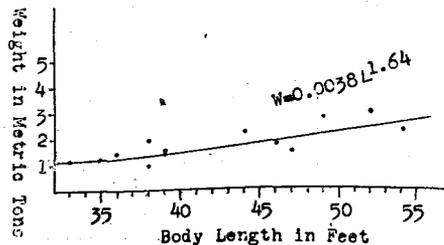


Fig. 5. Sperm whale.  
Weight of internal organs.



always strictly carried out. Therefore, in order to produce equations like the above on these individual parts, further strict measurement would be necessary.

On the basis of the above equations, the total body weight and the percentage of weight of each part for it were calculated for whales whose body length were 30, 35, 40, 45 and 50 ft., as shown in Table 1. "Others" in this table indicates total body weight minus weight of meat, blubber, bones and internal organs.

Table 1. Standard weight of Sperm whales

Body length in feet.	Total Weight (metric tons)	Meat %	Blubber %	Bones %	Internal organs %	Others %
30	6.820	32.8	33.0	10.9	14.8	8.5
35	11.140	33.1	33.0	10.3	11.6	12.0
40	17.030	33.4	33.0	9.9	9.5	14.2
45	24.770	33.7	33.0	9.6	7.9	15.8
50	34.630	33.9	33.0	9.3	6.7	17.1
55	46.890	34.1	33.0	9.0	5.8	18.1

As seen in Table 1, the items of parts whose ratio to the total body weight increases with the body length are "Meat" and "Others." Since the principal things included in "Others" are spermaceti, its case, junk, etc., the above fact means that the ratio of head part to body weight increases with the increase in body length. For blubber always shows the same percentage. While bones and internal organs decrease in percentage as the body length increases.

#### Sei Whales (*Balaenoptera borealis* Lesson)

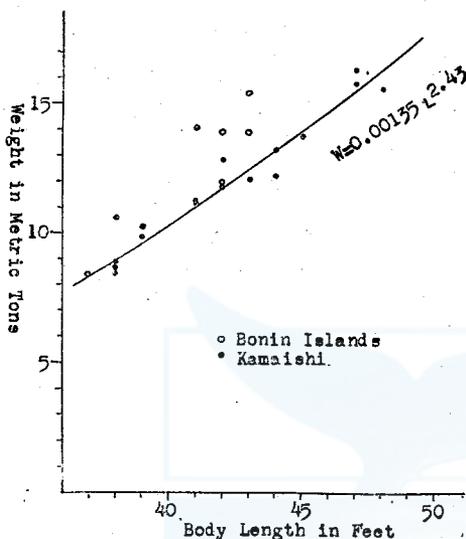
The relation between body length and total weight of sei whales is shown in Fig. 6. As can be seen therein, sei whales, even of same body length, show considerable differences in weight. Especially, some whales located in Bonin Island Area are far heavier than those located in Kamaishi. This agrees with the results of our biological investigation for the last 2 years. (The details will be reported separately) According to this investigation, the adjacent waters of Bonin Island are more abundant in food for sei whales than the waters off Kamaishi. It has further been found that the body length at which sexual maturity is reached is shorter in the case of sei whales located in the adjacent waters of Bonin Island than in the case of those found around Kamaishi.

From such facts, we can see that there may be considerable differences

in weight even among sei whales of same body length.

The weight of each part is shown in Fig. 7 to Fig. 10. There is no

Fig. 6. Sei whale. Total weight.



notable difference on meat and internal organs between whales found in Bonin Island area and those found near Kamaishi. However, on blubber there is a considerable difference, while on bone the Bonin Island whales are much heavier. On the average, the blubber weight constitutes 25.4% of the total body length in the case of Bonin Island whales, and only 17.7% in the case of whales around Kamaishi, as Fig. 6 shows. It can thus be seen that the difference in body weight in the two cases is mainly

due to the difference in the weight of blubber.

Fig. 7. Sei whale. Weight of meat.

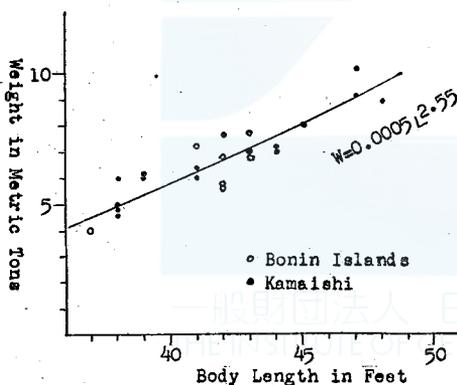


Fig. 8. Sei whale. Weight of blubber.

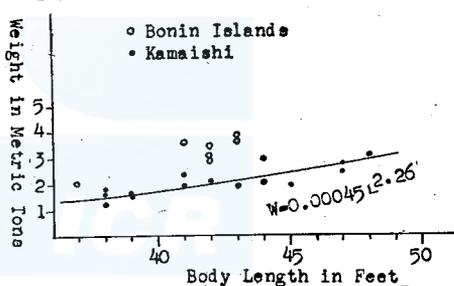


Fig. 9. Sei whale. Weight of bones.

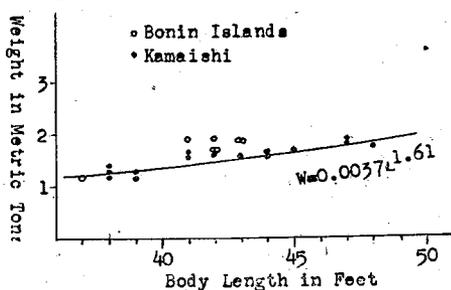
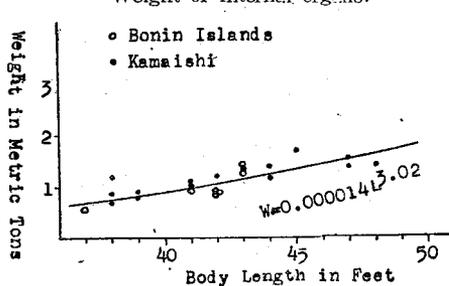


Fig. 10. Sei whale.  
Weight of internal organs.



Next, I will study this point in further detail. Although in the appendix table blubber is indicated simply as "Blubber" without any subdivision, here it is fortunately classified into head, blubber, body blubber, ventral grooves, tail flukes, etc. Their figures are shown in Table 2.

Table 2. Sei whales. Weight of blubber  
(unit : metric tons)

Location	Head blubber	Body blubber	Ventral grooves	Tail flukes	Total	Remarks
Bonin Is.	3.010 13.23%	9.360 41.12%	9.510 41.78%	0.880 3.87%	22.760 100.00%	Total of 7 whales
Kamaishi	3.350 9.86%	18.122 53.32%	10.527 30.97%	1.988 5.85%	33.987 100.00%	Total of 16 whales

As shown in this table, the percentage of the various subdivisions of blubber to the total weight of blubber differs greatly. The most remarkable one is ventral grooves, heavier about by 10 % in whales located in Bonin Island area than those in Kamaishi. Head blubber and body blubber follow it. The former is heavier in Bonin Island area and the latter in Kamaishi. If measurement is not incorrect, this fact must mean that whales located in Bonin Island area have a heavier head part than those in Kamaishi. As already mentioned, our investigation showed that the whales of the two areas differed in the body length at which they attained sexual maturity. From this point, it would appear that sei whales located in the adjacent seas of Japan should probably be classified into two local races, viz. southern and northern types. However, whether proportions of the various parts of the body also differ between the two races is an unknown question until actual measurements have been taken. And it is planned to do just that in the near future.

The difference of weight of ventral grooves, unless there is a striking difference in thickness, probably depends upon whether the groove comes close to the umbilicus or ends short of it. But this too must be verified by future investigation.

Thus, the weight of the various subdivisions of blubber shows some differences which are probably due to differences between local race. But the differences in the total weight of blubber is probably due largely to differences in food between the two whaling grounds.

Since, as stated above, there seem to be essential differences between

sei whales located in Bonin Island area and those near Kamaishi, the two should probably not be considered together. Rather should the data be collected separately for the two, and their results compared. But on whales located in the Bonin Island area, data are not sufficient yet especially as no whale of 44 feet or over in body length has been measured. Leaving that to such time as when more data has been collected, therefore, the study here will be confined to whales located in Kamaishi.

By the same method as was used in the case of sperm whales, the equations showing body length and weight of sei whales located around Kamaishi were calculated as follow. All the curves in Figs. 6 to 10 concerning whales located around Kamaishi, \_\_\_\_\_ there being none included from the Bonin Island area.

$$\begin{aligned} \text{Total weight} & : W = 0.00135 L^{2.43} \\ \text{Meat} & : W = 0.0005 L^{2.55} \\ \text{Blubber} & : W = 0.00045 L^{2.26} \\ \text{Bones} & : W = 0.0037 L^{1.61} \\ \text{Internal organs} & : W = 0.00014 L^{3.02} \end{aligned}$$

As seen in the above equations, on sei whales, the highest ratio of increase is on internal organs, next meat, blubber and bones. Based on these equations, standard body weight of sei whales located in Kamaishi was calculated as shown in Table 3.

Table 3. Standard weight of Sei whales caught off Kamaishi

Body length (in feet)	Total weight (metric tons)	Meat %	Blubber %	Bones %	Internal organs %	Others %
35	7.630	56.7	18.2	14.8	8.4	1.9
40	10.550	57.7	17.8	13.4	9.1	2.0
45	14.050	58.5	17.4	12.1	9.8	2.2
50	18.150	59.2	17.1	11.1	10.4	2.2
55	22.880	59.9	16.9	10.3	11.0	1.9

### III. Conclusions :

In the adjacent waters of Bonin Island and Kamaishi in 1948 and 1949, body weight was measured on 13 sperm whales and 23 sei whales. Studying these data, it was found that the relation between body length and weight on sperm whales could be expressed by the following equations.

$$\begin{aligned} \text{Total weight} & : W = 0.000137 L^{3.18} \\ \text{Meat} & : W = 0.0000367 L^{3.24} \end{aligned}$$

$$\begin{aligned} \text{Blubber} & : W = 0.0000452 L^{3.18} \\ \text{Bones} & : W = 0.000041 L^{2.88} \\ \text{Internal organs} & : W = 0.0038 L^{1.64} \end{aligned}$$

In the case of sei whales there was a different tendency in body weight between whales located in Bonin Island area and those in Kamaishi. The blubber, in particular, was heavier in the former than in the later. Studying this in greater detail, it was found that ventral grooves which was a part of blubber was heavier, and among other parts head blubber was heavier, while the other parts were lighter. It is, therefore, presumed that these two differ in body proportion.

According to the results of another investigation, it seems appropriate to classify these two as belonging different local races; so it is essential that the relation between body length and weight should also be studied separately for the two. However, as data are insufficient yet for whales located in Bonin Island area, that will be left to the future. On sei whales located in Kamaishi, the relation between body length and weight is as follows:

$$\begin{aligned} \text{Total weight} & : W = 0.00135 L^{2.43} \\ \text{Meat} & : W = 0.0005 L^{2.55} \\ \text{Blubber} & : W = 0.00045 L^{2.26} \\ \text{Bones} & : W = 0.0037 L^{1.61} \\ \text{Internal organs} & : W = 0.00014 L^{3.02} \end{aligned}$$

#### Literatures

1. Brandt, K.: Whale oil. An economic analysis. 1941.
2. Laurie, A. H.: Some aspects of respiration in blue and fin whales. Discovery Reports. VII. pp 363~406, 1933
3. Oomura, H.: Whales in the adjacent waters of Japan. (to be published later)
4. Peters, N.: Der neue deutsche Wolfang. 1938.
5. Zenkovic, B. A.: Weighing of whales. Comptes Rendus de l'Acad. d. Sc. de l'URRS. 1937.

## Weight of Various Parts of Sperm Whale

Body length in feet	Sex	Meat	Blubber	Bones						Internal		
				Skull	Back	Jaw	Ribs	Others	Total	Heart	Lung	Stomack
33	♂	3,478	3,029	409	466	29	138	52	1,094	41	85	111
35	♂	3,611	4,116	466	423	33	163	113	1,203	52	89	89
36	♀	3,880	3,972	439	493	34	156	74	1,196	41	134	145
38	♂	5,204	4,212	508	556	45	168	74	1,351	60	100	118
38	♀	4,210	4,687	550	581	41	178	82	1,432	85	205	193
39	♂	4,870	5,647	581	526	45	206	111	1,469	70	150	145
39	♀	5,045	5,677	566	545	45	208	112	1,476	89	182	93
44	♂	7,960	7,611	1,080	743	81	222	157	2,283	100	260	130
46	♂	10,110	9,870	1,210	950	120	340	130	2,750			
47	♂	9,730	9,370	1,270	1,050	110	350	150	2,930			
49	♂	9,715	10,425	1,310	1,310	104	353	198	3,275	117	167	212
52	♀	11,860	11,850	1,360	970	126	431	249	3,136	134	185	280
54	♂	15,560	13,940	1,570	1,250	220	340	170	3,550			

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Unit : Kirogrammes.

Liver	Organs				Sperm-Aceti	Others	Total	Date and Place, Catch
	Kidney	Intest	Others	Total				
156	104	205	478	1,180	520	550	9,851	22 Aug. '49 Kamaishi
156	48	205	542	1,181	710	1,110	11,931	23 Aug. '49 Kamaishi
192	180	222	586	1,500	680	734	11,962	22 Aug. '49 Kamaishi
182	52	203	279	994	1,180	1,336	14,277	11 Aug. '49 Kamaishi
235	150	276	873	2,017	1,040	452	13,838	19 Sep. '49 Kamaishi
260	71	242	704	1,642	1,110	1,376	16,114	4 Sep. '49 Kamaishi
235	64	230	652	1,545	1,080	1,990	16,814	26 Sep. '49 Kamaishi
328	100	279	1,091	2,288	1,710	2,046	23,898	14 Oct. '49 Kamaishi
350		350	1,060	1,760	2,390	2,040	28,920	21 Apr. '48 Bonin Is.
350		350	800	1,500	2,550	2,080	28,160	24 Apr. '48 Bonin Is.
284	150	297	1,613	2,840	2,150	3,827	32,232	13 Sep. '49 Kamaishi
390	148	426	1,397	2,960	2,760	5,147	37,713	23 Apr. '49 Kamaishi
370		370	1,530	2,270	2,810	3,600	41,730	21 Apr. '48 Bonin Is.

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## Weight of Various Parts of Sei Whale

Body length in feet	Sex	Meat	Blubber	Bones					Total
				Skull	Back	Jaw	Ribs	Others	
38	♂	5,131	1,273	352	600	97	171	49	1,269
38	♀	4,724	1,704	383	532	89	141	60	1,205
38	♀	6,061	1,830	427	550	156	151	63	1,347
38	♀	4,956	1,736	459	545	171	134	86	1,395
39	♂	6,155	1,675	364	618	97	185	63	1,327
39	♀	6,061	1,674	424	493	85	134	60	1,196
41	♂	6,460	1,959	470	714	164	174	118	1,640
41	♂	6,058	2,421	516	618	148	193	93	1,568
42	♀	7,714	2,192	454	695	156	174	114	1,593
43	♀	7,053	1,985	500	668	145	193	82	1,588
44	♀	7,135	2,946	460	733	168	193	118	1,672
44	♀	7,220	2,062	503	678	151	197	90	1,619
45	♀	8,133	2,044	500	760	151	193	105	1,709
47	♀	9,202	2,808	594	729	222	218	152	1,915
47	♀	10,340	2,530	588	790	160	208	149	1,895
48	♀	8,958	3,148	480	760	178	197	126	1,741
37	♀	4,040	2,040	290	580	90	140	40	1,140
41	♀	7,240	3,620	520	860	170	280	90	1,920
42	♂	5,820	3,100	440	760	180	250	90	1,720
42	♂	5,770	2,930	490	750	170	220	90	1,720
42	♂	6,970	3,510	510	820	200	260	110	1,900
43	♀	6,940	3,670	500	800	190	260	100	1,850
43	♀	7,700	3,890	490	820	210	240	90	1,850

Unit : Kilogrammes

Heart	Internal Organs						Total	Others	Total	Date and Place, Catch
	Lung	Stomach	Liver	Kidney	Intest.	Others				
29	71	68	104	34	223	175	704	150	8,527	3 Aug. '49 Kamaishi
41	71	99	130	45	268	186	840	110	8,583	16 Aug. '49 "
48	89	111	156	41	203	557	1,205	166	10,609	27 Aug. '49 "
34	85	77	68	41	186	217	708	127	8,892	27 Sep. '49 "
41	79	101	130	37	355	180	923	173	10,253	7 Aug. '49 "
45	81	104	156	41	201	180	808	163	9,902	24 Aug. '49 "
48	74	126	130	37	259	458	1,132	186	11,377	10 Aug. '49 "
37	89	97	130	60	209	446	1,068	169	11,284	14 Oct. '49 "
64	126	71	134	52	230	562	1,239	204	12,942	20 Sep. '49 "
48	108	130	119	68	193	712	1,378	213	12,217	9 Oct. '49 "
68	138	160	182	68	314	454	1,384	179	13,316	16 Aug. '49 "
48	111	111	289	52	202	391	1,204	234	12,339	5 Oct. '49 "
68	138	145	260	71	372	647	1,701	209	13,796	14 Sep. '49 "
48	77	115	156	52	479	608	1,535	302	15,762	19 Sep. '49 "
60	145	130	205	68	203	574	1,385	208	16,358	4 Oct. '49 "
60	156	134	185	60	260	532	1,387	323	15,557	24 Jul. '49 "
			100		150	290	540	630	8,390	12 Apr. '48 Bonin Is.
			150		220	570	940	400	14,120	16 Apr. '48 "
			100		190	570	860	480	11,980	13 Apr. '48 "
			110		190	610	910	440	11,770	15 Apr. '48 "
			130		220	550	900	590	13,870	15 Apr. '48 "
			140		240	870	1,250	200	13,910	14 Apr. '48 "
			130		190	1,070	1,390	600	15,430	16 Apr. '48 "