

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

HIDEO OMURA

INTRODUCTION

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

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

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

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

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

The material collected by the examination of the skeleton of the little piked whale from the coast of Japan are studied in this report, com-

paring to those by different authors on the eastern Pacific and Atlantic specimens.

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

SKULL

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

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

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

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

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

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

1) Sex and age unknown.

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

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

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

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

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

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

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

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

1) 2'' added for breakage

2) 2.4'' added for premaxillae

3) Curved

4) In appendix to Scammon, 1874

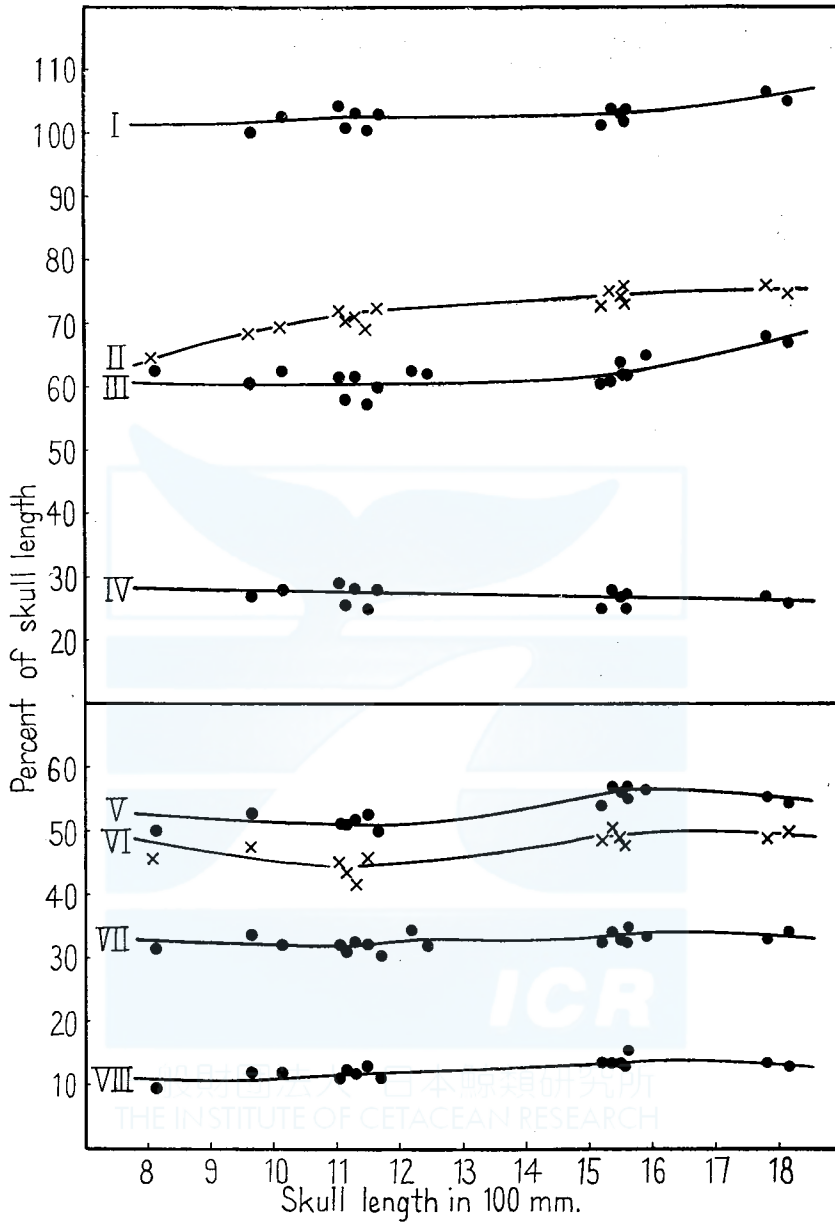


Fig. 1. Growth of various parts of skull in the little piked whale. (Based on material by various authors).

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

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

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

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

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

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

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

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

VERTEBRAL COLUMN

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

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

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

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



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

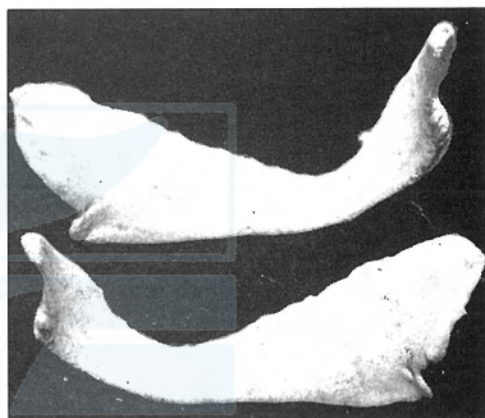


Fig. 3. Malar of the little piked whale from Japan. 25 feet male.

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

In the two skeletons before me there are some individual variations in the shape of the cervicals (pls. 6 and 7). In both specimens the spine of the atlas is strong and that of the axis is reduced to a ridge in the 18 feet male, but in a lesser degree in the 25 feet male. Neural spines are rudimentary on 3rd, 4th, and 5th, better developed on 6th and 7th in both specimens. In the 25 feet male diapophyses are much longer than parapophyses in 2nd to 7th, whereas in the 18 feet male the both

processes are nearly the same length in 3rd. Parapophysis in 7th is reduced to a tubercle in both specimens. Such tubercle is also present on the 1st dorsal, in less developed form. The left diapophysis and parapophysis of the axis in the 18 feet male united, forming a ring, whereas the ring is not completed yet on the right side. In none of the cervicals is this ring present in the 25 feet male. Such ring formation is seemed to have a good individual variation. A series of cervicals of unknown body length and sex, but completely matured, have been kept in our Institute. In this specimen complete rings are formed on both sides of the axis and 5th cervical and one on the right side of the 4th.

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

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

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

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

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

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

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

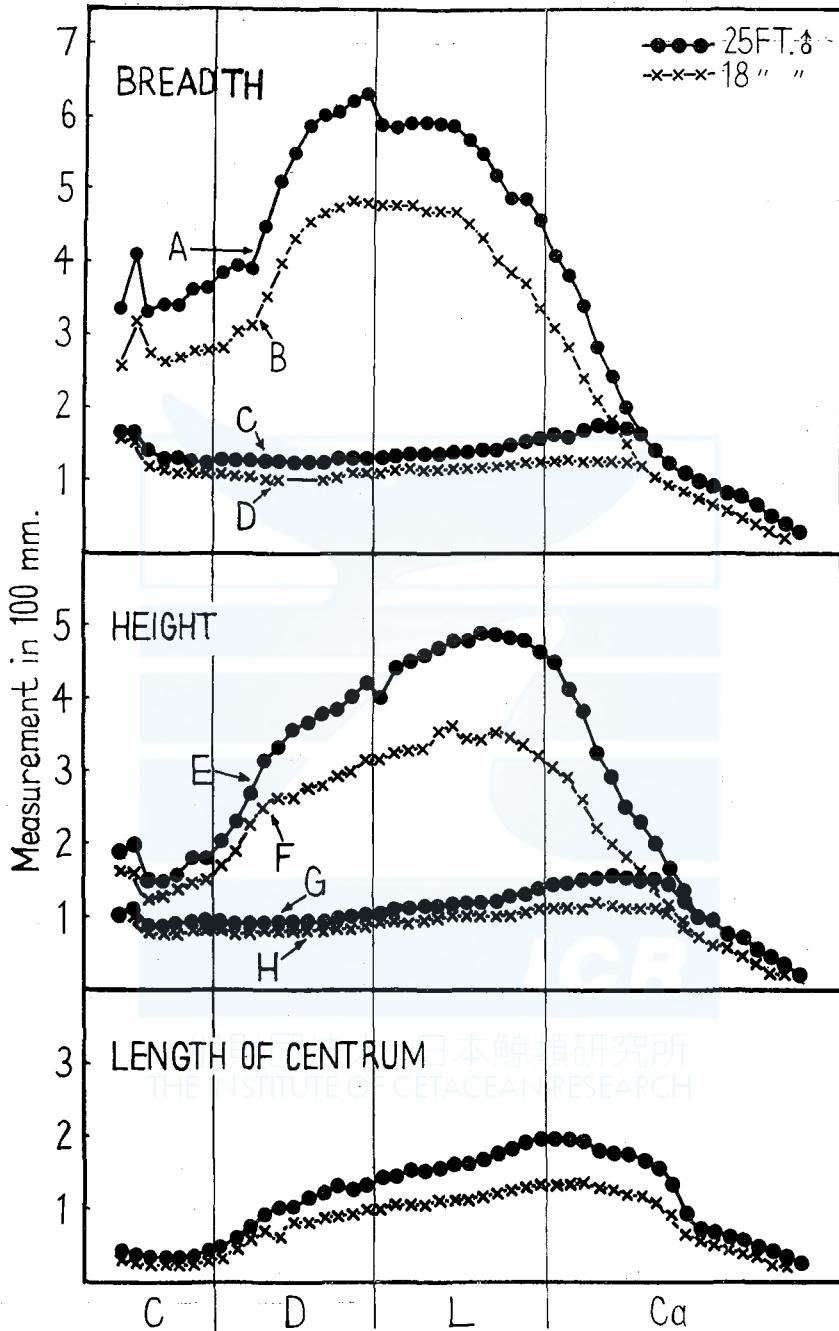


Fig. 4. Dimensions of vertebrae of the little piked whale from Japan. 25 and 18 feet males compared.

A.B; Greatest breadth across transverse processes.

C.D; Breadth of centrum in front.

E.F; greatest height from base of centrum to tip of spinous process.

G.H; Height of centrum in front.

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

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

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

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

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

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

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

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

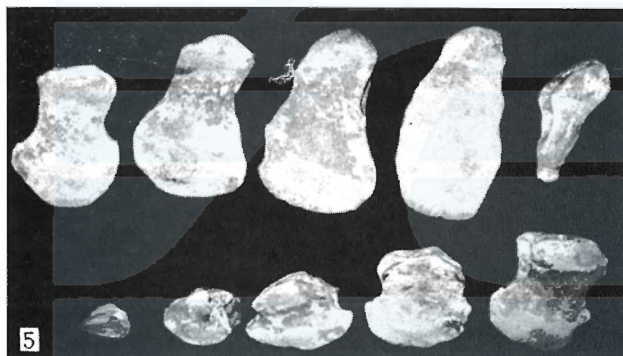


Fig. 5. Chevron bones of the little piked whale from Japan. 25 feet male.

Upper: Right to left 1st-5th.

Lower: " " " 6th-10th.

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

CHEVRON BONE

The number of chevron bones (fig. 5) are 10 in the 25 feet male, 8 in the 18 feet male. The right and left laminae of each chevron are all

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

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

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

1) Dorso-ventrally.

2) Antero-posteriorly.

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

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

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

RIB

The both specimens from Japan have 11 pairs of ribs (pl. 5). The 1st rib is shortest, but with broadly expanded distal end, the 4th longest. The 11th rib on the left side of the 18 feet male is strongly

twisted. A rudiment of capitulum and collum is present on 2nd to 8th. Cowan (1939) states on the ribs of his specimen from British Columbia: 'Ribs 22 in number, 4th rib longest, 3rd heaviest. Combined neck and head not present on 1 and 2, large on 3 and forming a prominent angle on 4 to 8'. There is a rudiment of capitulum and collum also in the 2nd rib of the specimens from Japan, as stated above. Otherwise his statement could be applied to our specimens.

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

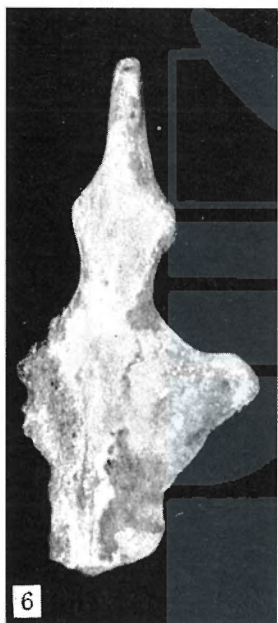


Fig. 6. Sternum of the little piked whale from the coast of Japan. 25 feet male. Ventral view.

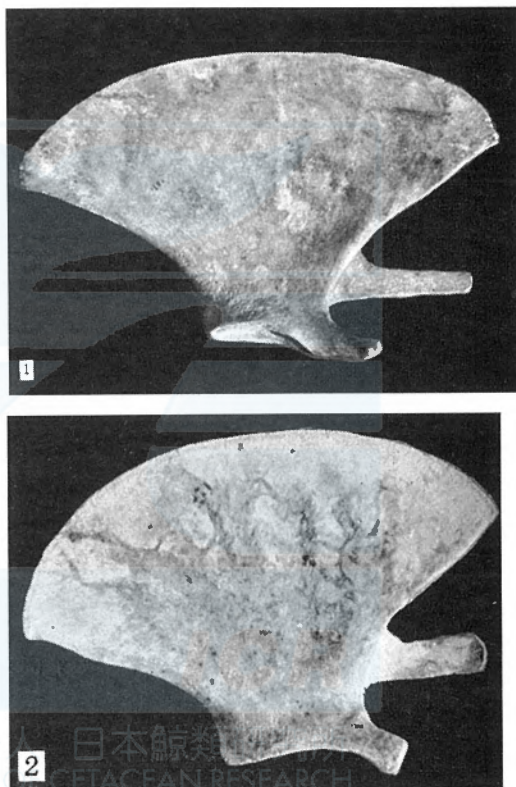


Fig. 7. Scapula of the little piked whale from Japan.

1: 25 feet male. Left side.
2: 18 feet male. " "

STERNUM

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

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

SCAPULA

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

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

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

1) Median

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

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

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

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

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

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

* Right side.

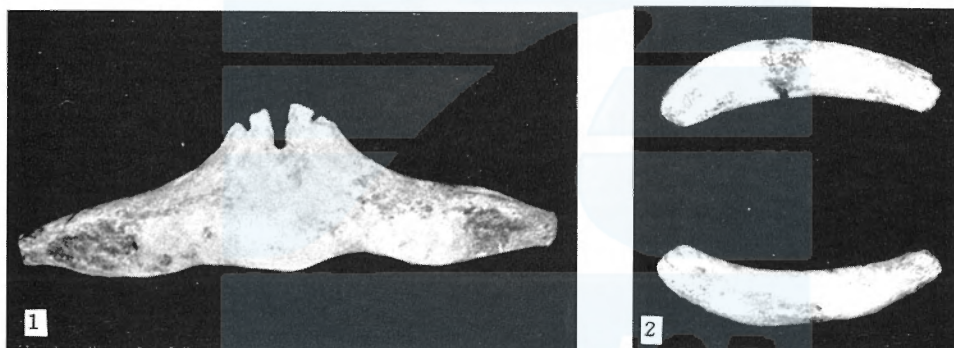


Fig. 8. Hyoid bone of the little piked whale from Japan. 25 feet male.

1: Combined basihyal and thyrohyals.

2: Stylohyals.

HYOID

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

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

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

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

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

1) Damaged.

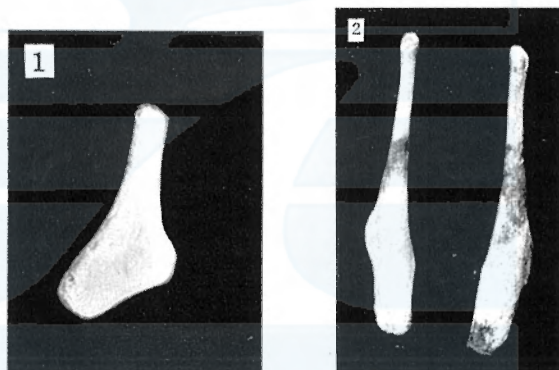


Fig. 9. Pelvic bone of the little piked whale from Japan.
1: 18 feet male.
2: 25 feet male.

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

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

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

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

1) Right missing.

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

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

Note. All length were measured with epiphyses.

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

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



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

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

HUMERUS, RADIUS, AND ULNA

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

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

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

CONCLUSION

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

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

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

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EXPLANATION OF THE PLATES

PLATE 1

- Skull of the little piked whale from the coast of Japan. Dorsal view.
- Fig. 1. 25 feet male.
- Fig. 2. 18 feet male (A).
- Fig. 3. 18 feet male (B).

PLATE 2

- Skull of the little piked whale from the coast of Japan. Ventral view.
- Fig. 1. 25 feet male.
- Fig. 2. 18 feet male (A).
- Fig. 3. 18 feet male (B).

PLATE 3

- Skull of the little piked whale from the coast of Japan. Lateral and posterior view.
- Fig. 1. 25 feet male.
- Fig. 2. 18 feet male. (A).
- Fig. 3. 25 feet male.
- Fig. 4. 18 feet male (A).

PLATE 4

- Mandible of the little piked whale from the coast of Japan.
- Fig. 1. 25 feet male. Dorsal view.
- Fig. 2. 18 feet male (A). Dorsal view.
- Fig. 3. 25 feet male. Lateral and inner view of left mandible.
- Fig. 4. 18 feet male (A). Lateral and outer view of right mandible.

PLATE 5

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

Fig. 1. 18 feet male (A). Right side.

Fig. 2. 25 feet male. Left side.

PLATE 6

Cervical vertebrae of the little piked whale from the coast of Japan. 25 feet male.

Figs. 1-7. 1st-7th cervicals.

PLATE 7

Cervical vertebrae of the little piked whale from the coast of Japan. 18 feet male (A). Anterior view.

Figs. 1-7. 1st-7th cervicals.

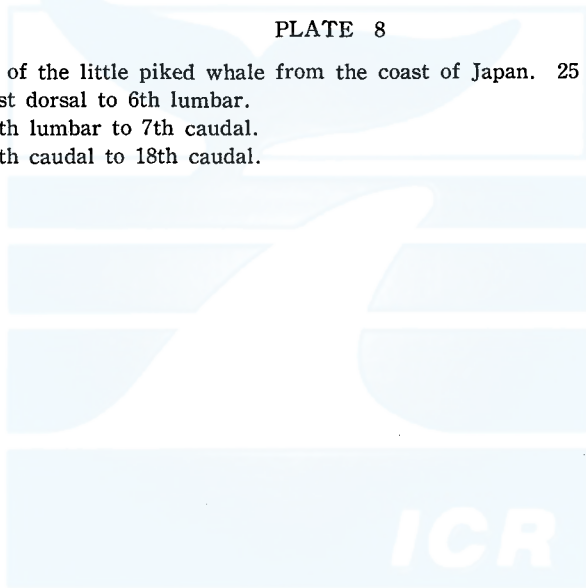
PLATE 8

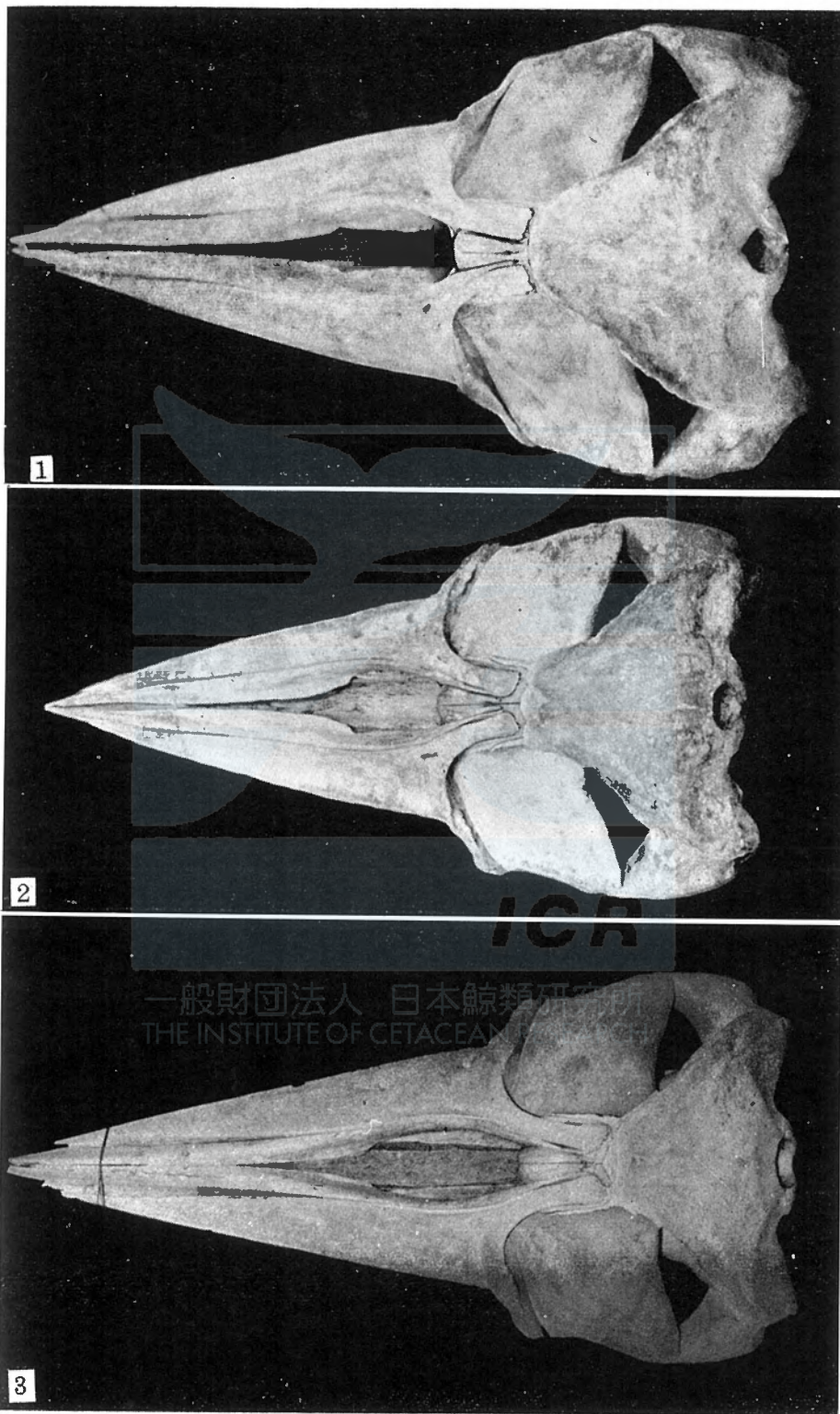
Vertebrae of the little piked whale from the coast of Japan. 25 feet male.

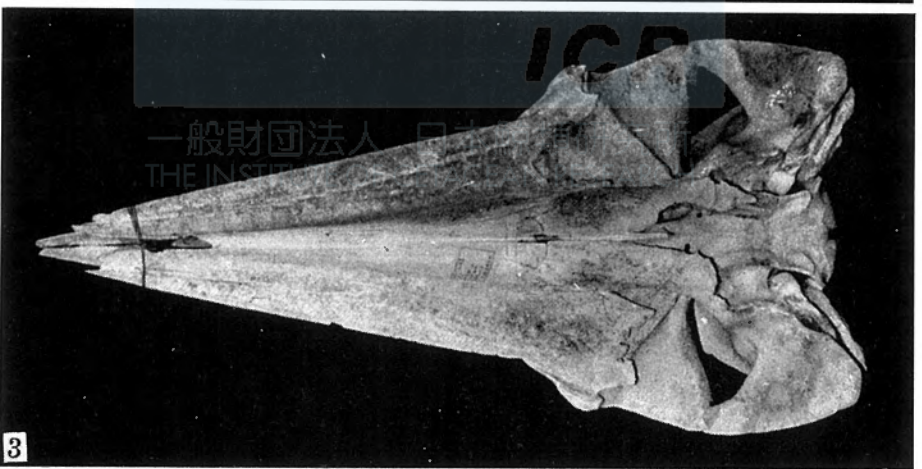
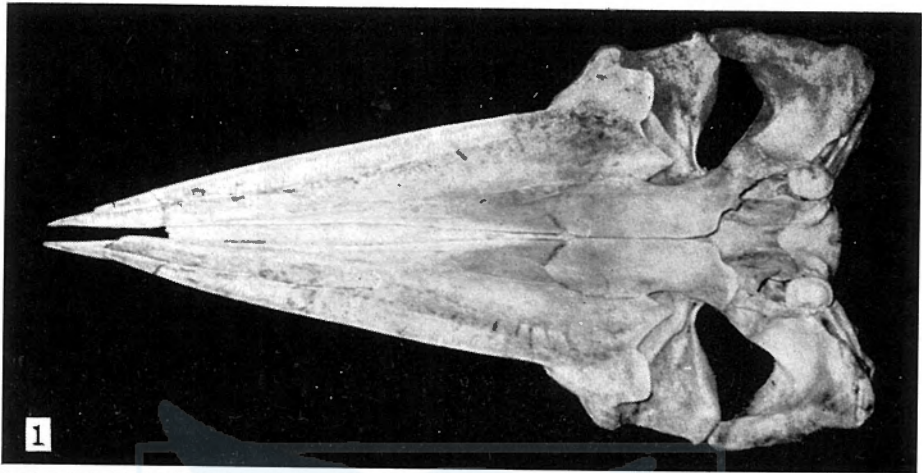
Fig. 1. 1st dorsal to 6th lumbar.

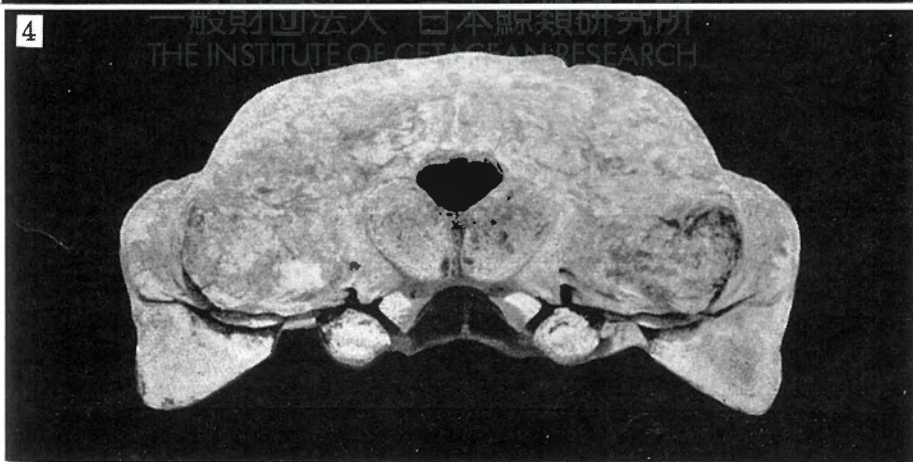
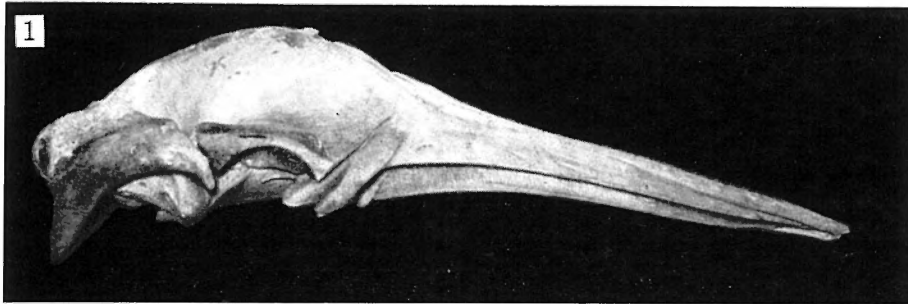
Fig. 2. 7th lumbar to 7th caudal.

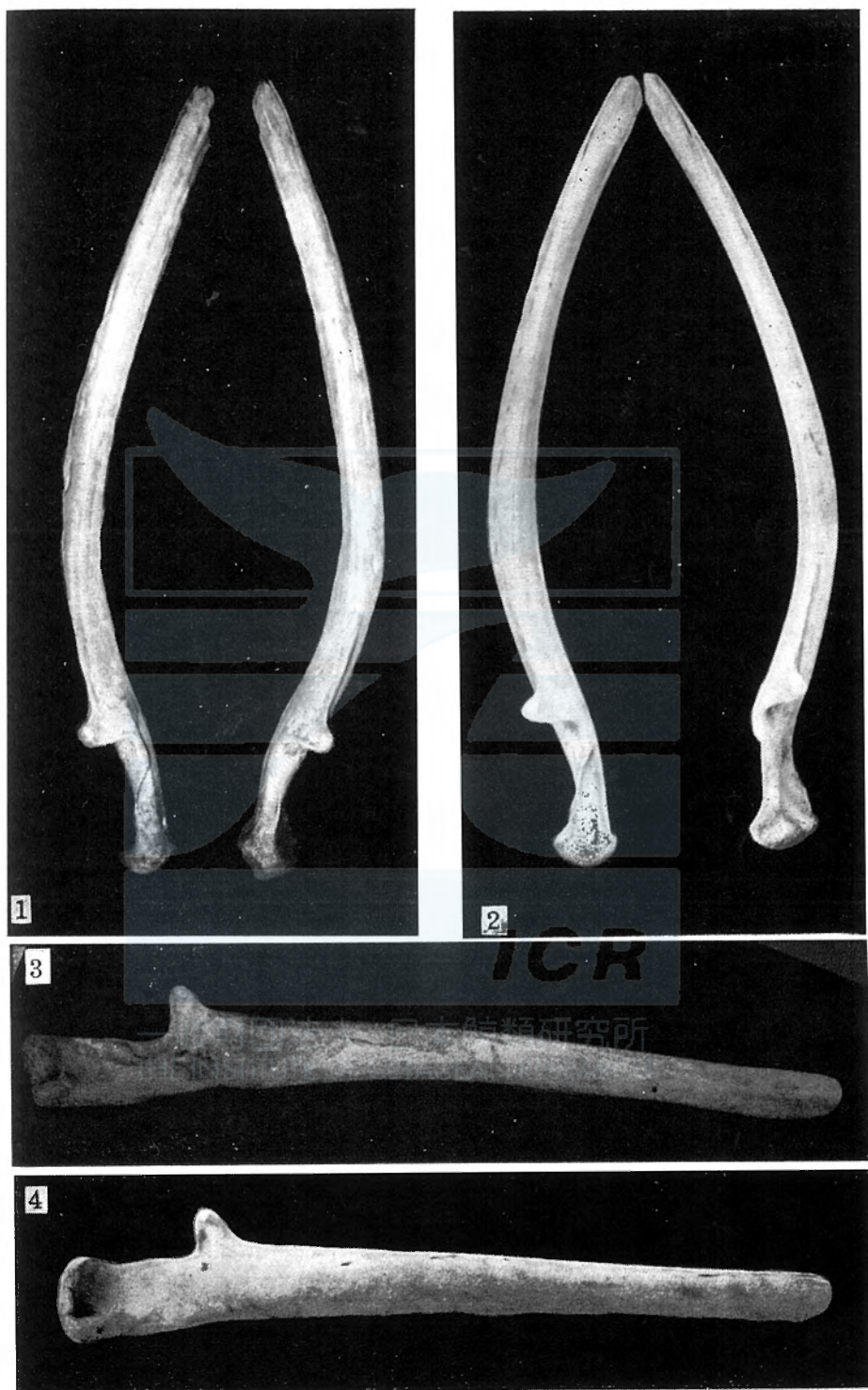
Fig. 3. 8th caudal to 18th caudal.

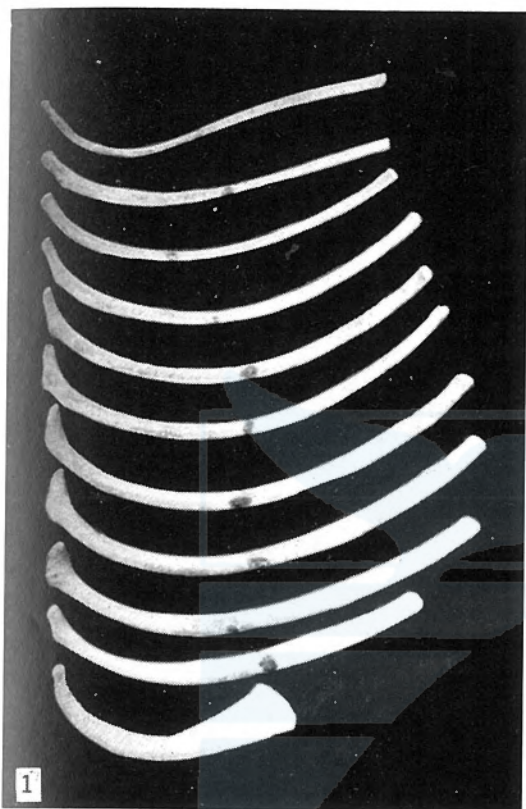






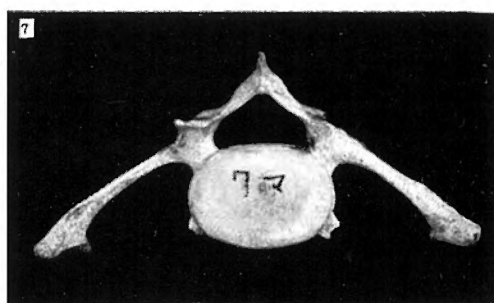
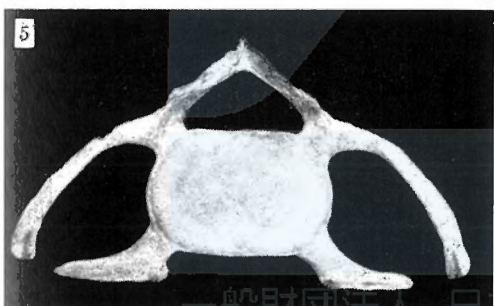
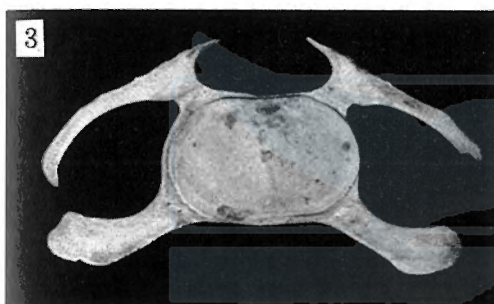
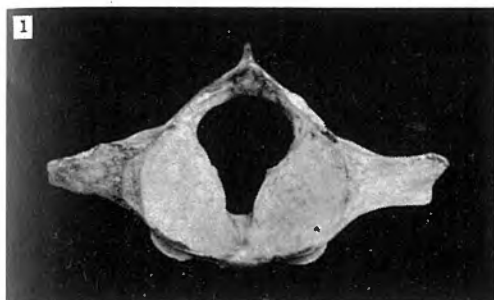


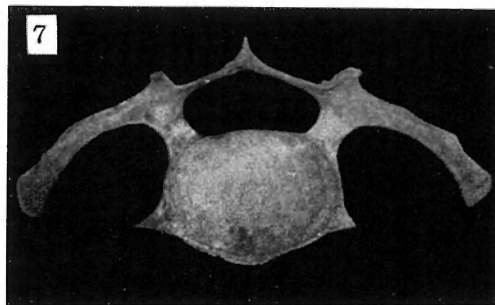
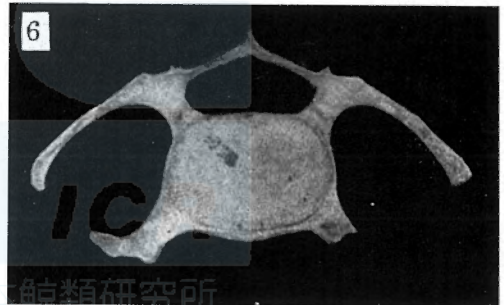
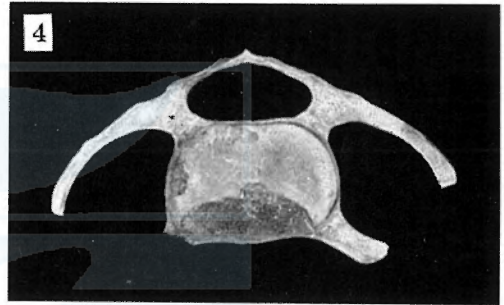
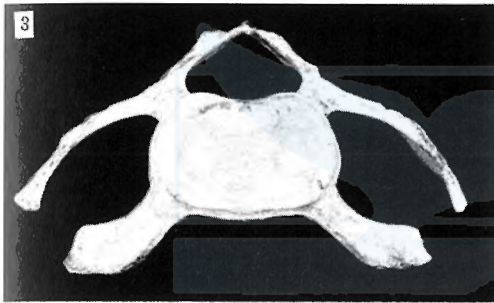


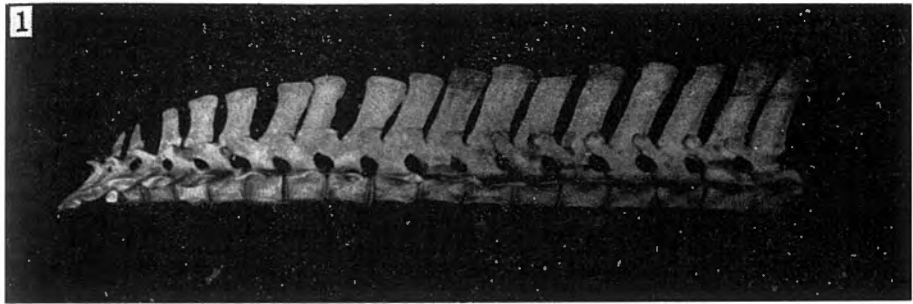


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一般財団法人 日本鯨類研究所
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