An Account of a rare Porpoise, *Feresa* Gray from Japan

By

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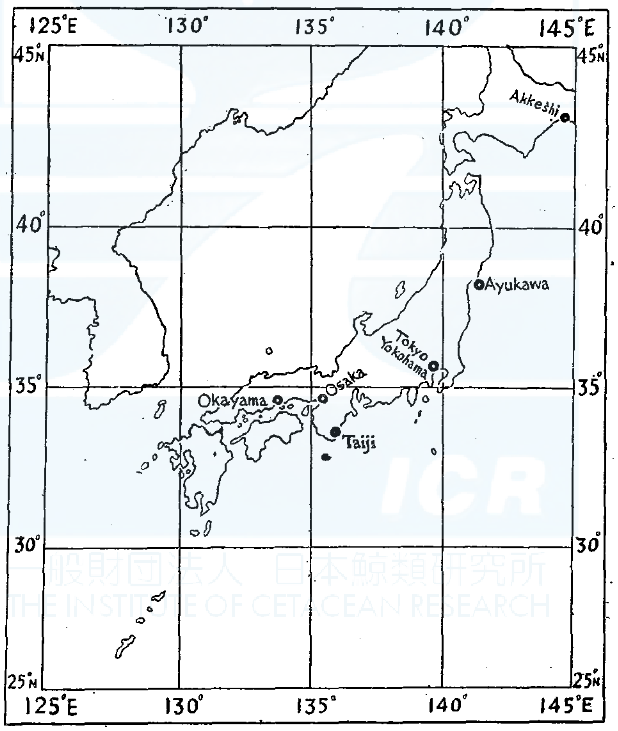
Introduction

In August of 1952 I had a six-day field work at Taiji, Wakayama-Ken (Prefecture), Japan. Taiji has long been noted by the cetologists of this country, and I myself have also been intensely interested in the cetacean fauna of this whaling town of long tradition and history (map). During the stay, three pygmy sperm whales (*Kogia*) came to my study,



and besides, more bone specimens of not less than ten kogiids were partly secured (Yamada, 1954, p. 37). Being contented with the fruitful acquisition of thirteen kogiids, I gave an end to that visit on August 21st and started in the following morning for a two-day trip in the near-by mountainous regions in order to collect snails for my father's study. And it was when I was back again at Taiji in the evening of 23rd that I heard of the capture of a strange and unusual porpoise in that afternoon by a blackfish-boat (*Gondo-Bune*, so they say) "Hama Maru". This animal was later identified as *Feresa intermedia* Gray, which is here reported.

But to my great regret, the animal was instantly flensed before my return there, so I could not examine it while it was fresh. Emphasis was laid, however, on its very rare occurrence, and nobody told its provincial name nor any record of previous capture but one, who said that the same species of porpoise was caught there once in his memory about ten years before. Since the porpoise is not included in the regular cetacean fauna of Taiji, the animal was recorded and processed as the Risso's dolphin, *Grampus griseus* (Cuvier) according to the dominant opinion of the fishers. I had to be satisfied naturally with the acquisition of the skeleton reserved for my study by the courtesy of the Mizutanis who bought the porpoise, but some parts as the hyoid and pelvic bones were missing. According to the gunner who killed the animal, it was solitary at sea.

Shortly after the event, I had a talk with Prof. Dr. Teizo Ogawa of the University of Tokyo, when he suggested me of the possibility that the porpoise in question might eventually be of *Feresa*. The genus was established by J. E. Gray in 1871 and has been known by the two skull specimens at the British Museum (Natural History). The specimen 362a is the type of *F. intermedia* Gray and the other 1672a *F. attenuata* Gray. As I became strongly convinced of this prospect after closer examination of the present skull, especially measurements of it, a question naturally arose if any additions of *Feresa* have been made before now, and I liked to know them if any. I acknowledge in this regard the personal writings of Drs. F. C. Fraser (Brit. Mus.) and Remington Kellogg (U. S. Nat. Mus.) who kindly informed me that no addition had been known after the two type skulls just mentioned. Dr. Fraser later sent me complete photographs of these specimens, which assured me perfectly of the identification. No record of *Feresa* has been known from Japan, and my present account is, in the consequence, the third and the most complete *Feresa* in cetology. This is the reason why I give very detailed measurements in this paper. To the kind backings of the named gentlemen; Prof. Dr. Ryoji Ura of Okayama, director; and to my father Dr. Manabu Yamada whom I owe much in finance, I express my best thanks and sincere compliments.

Notes on the Exterior
(figs. 1–4)

Because of the flensed condition of the present Taiji specimen, only a bit of knowledge was learned about its external characters as well as dimensions. But painstaking examination of the pieces of blubber as well as the skeleton and teeth indicates the animal to be female and full-grown, apparently aged (cf. p. 71). Its total length measures about 235 cm. from the tip of rostrum to the notch of tail flukes by putting the separate cranium and the vertebral bones in order.

Fig. 1 is the reasonable reconstruction to show the general impression of the porpoise, of which every eyewitness testified to its lifelikeness. The animal is said to be relatively slim in comparison with *Grampus*, to which they say that the animal seems near akin. Colour dark gray all over, but both lips are seamed with narrow white bands which expand into a node at the end of rostrum, and in the anal region, another white marking can be seen about 55 cm. long and 10 cm. wide on each side

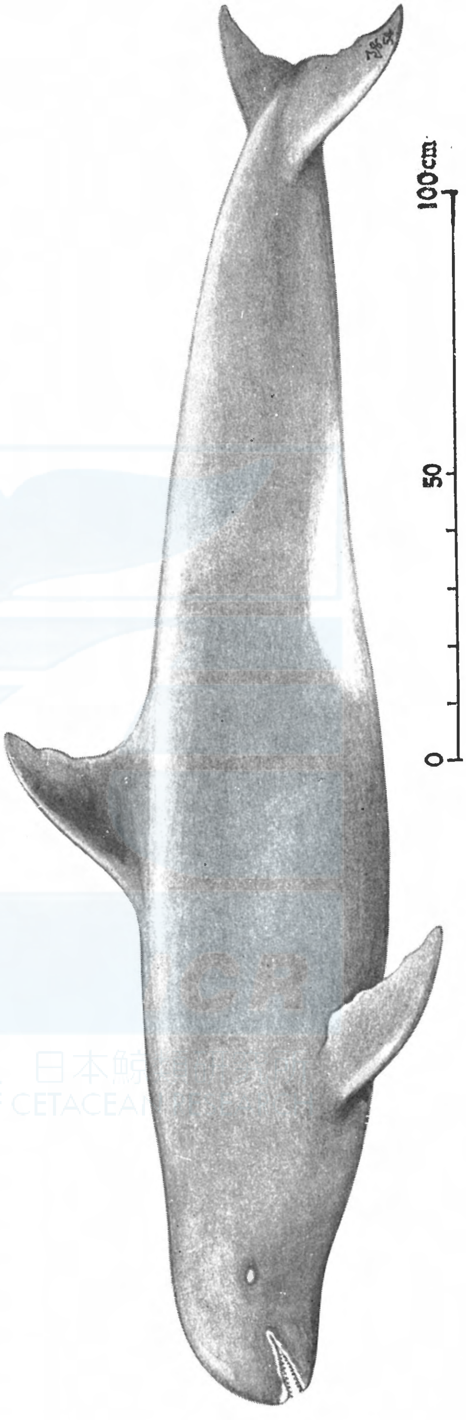


Fig. 1. *Feresa intermedia* Gray, 235 cm. long female from Taiji, after reconstruction.

from the median line, broadest around the genital orifice and tapering toward the tail. In the hyoid and pectoral regions, a somewhat paler colour is noticed, and the under side of tail flukes is also paler than the dorsal side. Two sets of parallel white stripes are distributed on the trunk as commonly seen in many cases of cetacea. The one is less distinct and consists of four stripes with the maximum distance of 8 mm. The other consists of six distinct stripes whose distances vary from 13 to 15mm. Since the distances between the neibouring dental apices of this animal measure about 15 mm. (cf. p. 70), this last set of stripes may probably be regarded to be a bitten injury by other individual of the same porpoise. The dorsal fin (fig. 2) is tall and falcate, but it must be remarked that the position in fig. 1 is arbitrarily fixed and not certified. The flippers are falcate and of moderate length (fig. 3).

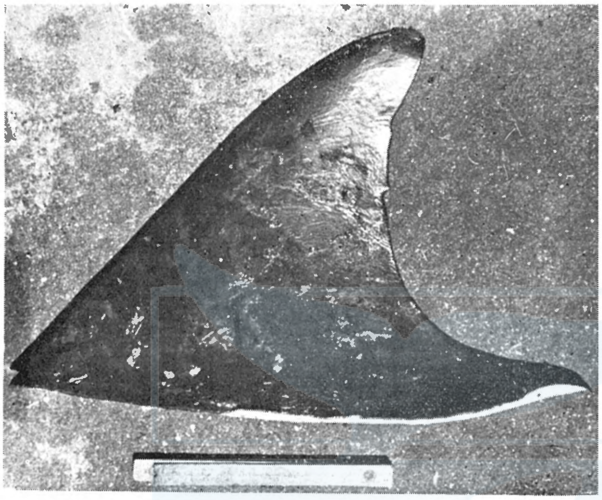


Fig. 2. Dorsal fin.

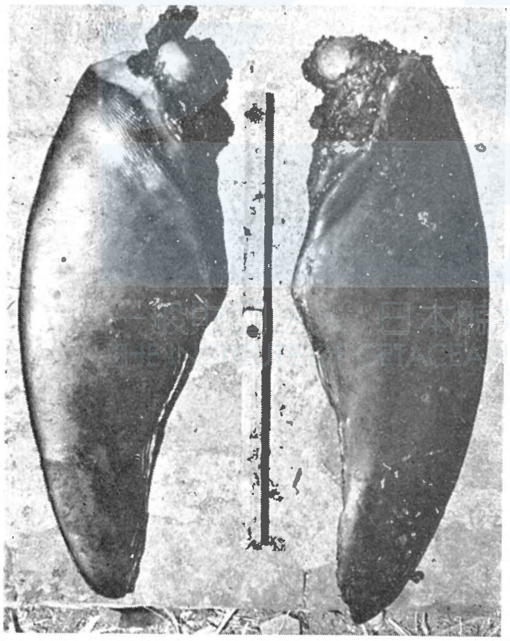


Fig. 3. Flippers, volar view.

The most important matter concerning the external characters of the porpoise is that the animal has no beak. This was absolutely certified through my blubber examination and there can be no doubt as to its correctness. This is important because True (1889, p. 151) placed *Feresa* in his synoptic table next to *Lagenorhynchus*, with a question mark but as "beak distinct, short and rim-like". Therefore, this remark of True is unquestionably erroneous and should be corrected. This opinion seems to be supported by his concurrence in Gray's opinion that the animal might be allied to *Lagenorhynchus electra* Gray (True, 1889, p. 107). This problem on the position of *Feresa* has lacked the sound support until present time, and will be entered in the end of this paper.

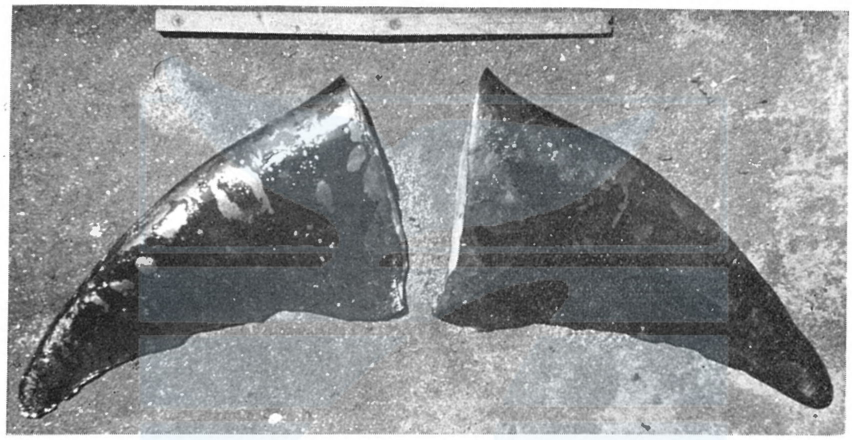


Fig. 4. Tail flukes.

Some dimensions of the exterior known after the blubber examination are given below:

	mm.
Distance between center of eye and ear opening	9.5
Length of left flipper, from head of humerus to extremity	43.5
Length of right flipper	44.3
Greatest breadth of flipper, both sides	14.2
Length of dorsal fin at base	34.0
Height of dorsal fin	23.5
Depth of rear incision of dorsal fin	4.5
Length of left tail fluke	32.0
Length of right tail fluke	34.0
Breadth of fluke at base, both sides	18.0

Osteology

Skull (figs. 5–8, tabs. 1–2): The skull of the present Taiji specimen is illustrated by figs. 5–8, and the dimensions are given in tab. 1. Comparisons are made with the previous two type skulls at the British

Fig. 5a. Skull of *Feresa*, Taiji specimen $\left(\times \frac{2.7}{10}\right)$. Dorsal, lateral and ventral views (top to bottom), posterior view on the opposite page (Fig. 5b).

Museum by tab. 2 through indices. This table is particularly important to identify the specimen because otherwise there are only brief descriptions available to the present comparison. In the meantime, the photographs sent by Dr. Fraser have been of course extraordinarily significant toward the present work.

The skull is robust but very short, only 16.4 per cent of the total body length. The length of the rostrum occupies nearly half of the total condylo-basal length of the skull. The rostrum is as broad, at its base, as 63.6 per cent of the rostrum length, gradually tapering in front. Accordingly, the breadth at base is least of all, though only very slightly less than the second (B. M., 1672a), in proportion to not only the skull length but also to the rostrum length.[1] However, the rostrum resembles the first specimen (B. M., 362a) in its form rather than the second. The second shows the slight lateral expansion of the rostrum near the base, which is however, less developed in the first as well as in the present. And the rostrum of the second seems to taper more sharply than the present because it is narrower at middle of the rostrum in spite of its proportionally broader base, though broader quite slightly. From the tip of the rostrum back to the nasals, the upper surface of the rostrum as well as the posterior portions of the premaxillae are gently bent back, being also concave transversely. This transverse concavity is most noticeable across the base of the rostrum, becoming flat anteriorly and only at the end turning into a convexity. After the photographic comparison, it seems probable that the convex surface of the rostrum is the well marked peculiarity of the present skull. The premaxillae are broad especially toward the end of the rostrum, and between their inner borders there lies a considerable space throughout. In this median space between the premaxillae, the vomer is visible nearly to the end of the rostrum.

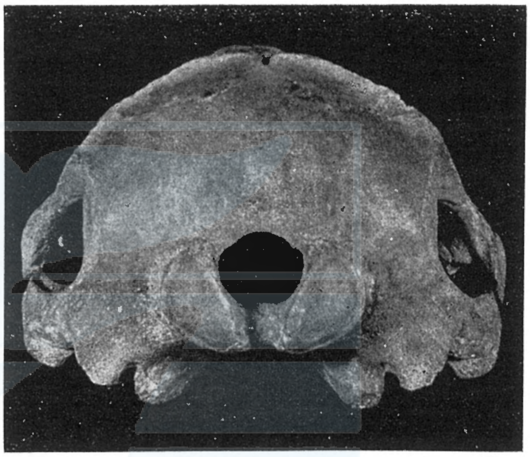


Fig. 5b. Posterior view of skull $\left(\times \frac{2.7}{10}\right)$.

The superior nares open obliquely forward between the posterior

1) Length-breadth rostrum indices: B. M., 362a 69.4; 1672a 63.7.

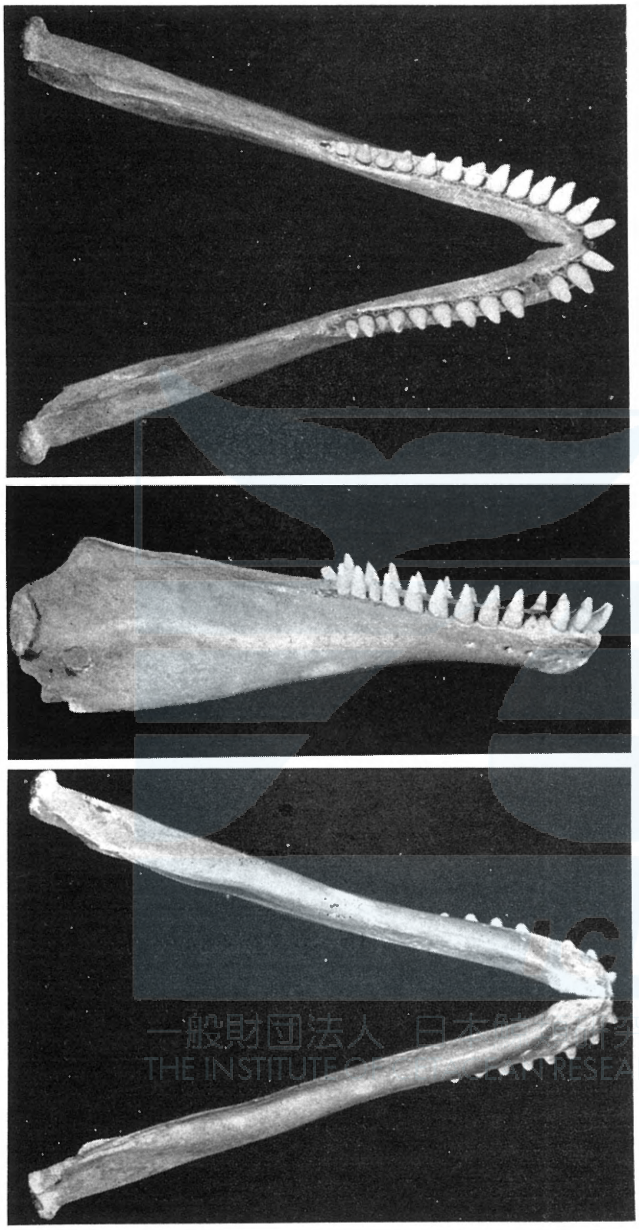


Fig. 6. Mandible of *Feresa*, Taiji specimen $\left(\times\frac{2.7}{10}\right)$. Dorsal, lateral and ventral views (top to bottom).

ends of the premaxillae and along the sloping median crest of the mesethmoid. They are narrowed anteriorly and dislocated slightly to the left together with the nasals as a sign of moderate asymmetry common to all odontocete skulls. The backward telescoping of the supra-orbital plate of the maxillae apparently hesitates to pass back beyond the nasals, which are considerably separated from the occipito-frontal crest. To the result of this, rather large area of the frontal bone is exposed on the vertex. The median suture between the nasals remains still distinct, but between them and the frontal bone, the suture is very obscure, being absorbed almost perfectly. So far as apparent by the comparison through photographs, the synostosis between the nasal and the frontal is, in the present skull, stronger than either of the previous specimens. The post-orbital processes of the frontal are stronger.

Table 1. Skull dimensions of Taiji specimen, 235 cm. long female. Straight dimensions are given unless noticed.

	mm.	per cent of length	per cent of breadth
Total (condylo-basal) length	385	*100.0*	160.3
Length of rostrum (median)	184	47.8	76.7
Breadth of rostrum at base	117	30.2	48.8
Breadth of rostrum at middle	89	23.1	37.1
Premaxillary breadth at middle of rostrum	57	14.8	23.7
Greatest premaxillary breadth proximally	87	22.6	36.3
Greatest premaxillary breadth distally	60	15.6	25.0
Length of left premaxilla	275	71.5	114.5
Length of right premaxilla	301	78.2	125.3
Length of nasal suture line	32	8.3	13.7
Greatest breadth of nasals	55	14.3	22.9
Greatest breadth of superior nares	51	13.3	21.3
Distances from tip of rostrum to			
bottom of maxillary notches*	195	51.6	81.2
anterior end of vomer	39	10.1	16.2
anterior end of presphenoid	164	42.6	68.4
anterior margin of superior nares	228	59.2	95.0
posterior end of mesethmoid	289	75.0	120.3
nasal vertex	295	76.6	122.9
occipito-frontal vertex	349	90.6	145.3
posterior median end of maxillae on palate	177	46.0	73.8
vomerine process between palates and pterygoids	218	56.6	90.8
posterior end of vomer on cranial basis (median)	289	75.0	124.5
bottom of right tubal notch	240	62.3	100.0
Breadth across middle of orbits	216	56.1	90.0
Greatest breadth across supra-orbital plates of maxillae	214	55.6	89.2
Greatest breadth across post-orbital processes	240	62.3	*100.0*
Breadth across zygomatic processes	237	61.5	98.7
Breadth across posterior margins of temporal fossae	155	40.3	64.6
Greatest breadth of cranium at parietal region in temporal fossae	171	44.5	71.3
Length of temporal fossae*	93	24.2	38.7
Depth of left temporal fossa	67	17.4	27.9
Depth of right temporal fossa	76	19.8	31.7
Length of left maxillary tooth row	118	30.7	49.2
Length of right maxillary tooth row	121	31.4	50.4
From last tooth to bottom of maxillary notches*	75	19.5	31.3
Breadth of occipital foramen	40	10.4	16.7
Breadth of occipital condyles	98	25.4	40.8
Length of left condyle	55	14.3	22.9
Length of right condyle	56	14.5	23.3
Height to nasal vertex at status of horizontal supra-orbital plate	177	46.0	73.7
Length of mandible (median)	283	73.7	117.8
Length of mandibular rami*	300	78.0	125.0
Distance from end of mandible to left coronoid process	265	68.8	110.3
Distance from end of mandible to right coronoid process	263	68.3	109.5
Length of symphysis	30	7.8	12.5
Length of left mandibular tooth row	140	36.4	58.6
Length of right mandibular tooth row	142	36.9	59.2
Length of left mandibular hiatus	126	32.7	52.5
Length of right mandibular hiatus	128	33.2	53.3
Depth between angle and coronoid process*	82	21.3	34.2
Breadth across mandibular condyles	210	54.5	87.5

* equal on both sides.

Table 2. Skull proportions in per cent of total skull length.

	B. M., 362a after Gray*		B. M., 1672a after Gray*		Taiji specimen
	mm.	per cent	mm.	per cent	per cent
Total length	362	*100.0*	350	*100.0*	*100.0*
Length of rostrum	173	47.4	168	48.0	47.8
Breadth of rostrum at base	120	33.2	107	30.3	30.2
Breadth of rostrum at middle	89	24.6	75	21.4	23.1
Breadth of premaxillae at middle of rostrum	61	16.9	52	14.9	14.8
Greatest breadth of premaxillae	91	25.1	91	26.0	22.6
From end of rostrum to anterior margin of superior nares	226	62.4	221	63.2	59.2
Breadth across orbits	211	58.3	201	57.4	56.1
Breadth across posterior margins of temporal fossae	153	42.3	173	49.4	40.3
Length of temporal fossae	92	25.4	84	24.0	24.2
Depth of temporal fossae	73	20.2	74	21.1	*l* 17.4 *r* 19.8
Length of maxillary tooth row	129	35.6	127	36.3	*l* 30.7 *r* 31.4
From last tooth to base of maxillary notch	51	14.2	55	15.7	19.5
Length of mandible	289	79.8	280	80.0	73.7
Length of symphysis	30	8.3	34	9.7	7.8
Length of mandibular tooth row	135	37.3	136	38.0	*l* 36.4 *r* 36.9
Depth between angle and coronoid process	79	21.8	73	20.9	21.3

* From True, 1889, p. 107.

The base of the skull is all the same except one remark of longer basi-occipital bone, apparently in relation with the longer neurocranium of the present skull. The results of this are: the smaller angle between the zygomatic processes, the longer expansion of the otic region backward[1)] and the stronger backward bulging of the occipital condyles. The peculiar condyles of the present skull, which bulge out especially at the bottom, may result, in my opinion, the stronger dorsal flexion of the entire head in comparison with the previous specimens. The styloid and very slender jugal processes are broken in the specimen, but their

1) In delphinidae, for example in *Globicephalus* (cf. Yamada, 1953, fig. 16), the otic region expands backward with the advance of age. The backward expansion of the region in the present skull, therefore, may possibly be this type of change rather than the result of the longer neurocranium. The smaller angle between the zygomatic processes also may have a close correlation with the expansion of the otic region.

heads are united with the zygomatic processes near the end. The squamosal bones are the only portion left to rattle considerably. The maxillary alveoli are ten on the left, and eleven on the right. These alveoli are confined to the anterior three-fifths of the maxillary borders, to the shortest range among the three.

Fig. 7. Tympano-perioticum of *Feresa* (nat. size). Complete right bones (right), medial and lateral views (top and bottom); dislocated left bones (left), ectal and ental views (top and bottom); tympanic ossicles: dislocated malleus, incus and stapes (left to right) are shown.

The tympano-periotic bones closely resemble those of *Grampus* and *Globicephalus*, but they are of smaller size (fig. 7). The tympanic bullae are rather rounded at the anterior end, so resemble *Grampus*; whereas the periotic bones are smooth above, particularly toward the anterior end, so resemble *Globicephalus*. The mastoid processes are, however, intermediate between the mentioned two genera, hence rather well developed in the delphinidae family (Yamada, 1953, pp. 19–25, figs. 7–8, 17). Some dimensions (mm.) of the tympano-perioticum are given as follows:

	left	right
Length of bulla	39.0	39.0
Greatest breadth of bulla across proximal involucral end and sigmoid process	29.3	29.0
Breadth of bulla in front of sigmoid process	23.5	23.0
Length of perioticum from anterior end to posterior edge of mastoid articulation	36.2	36.0
Total depth of tympano-perioticum at middle	33.5	33.0

The incus is thicker than those genera, while the stapes is also thicker but less tall (fig. 7).

The mandible is proportionally shorter than the previous specimens, only 73.7 per cent of the skull length. However, this being the median dimension, each ramus is naturally longer than this (78.0 per cent) and approaches nearer to the Gray's measurements, which I hope to be the straight length of the rami instead of the projected length like mine. The form of the present mandible rather resembles the second specimen than the first, but the symphysis is shorter. The mandibular alveoli are thirteen on both sides, but the fourth of the right is embedded and indicates that the tooth was lost some time in the animal's life. The mandibular tooth rows mark the shortest development in spite of the larger number of the teeth.

The dental formula of the present specimen is $\frac{11\text{–}10}{13\text{–}13}$. The teeth are conical and proportionally very large, somewhat larger than the previous specimens (Flower, 1883, p. 510), the crowns being in life about 10 mm. tall out of the gum. The fourth on the right mandible was of course lost in life, and the last of the same series sprouts out of the gum only by the apex. The apices of the first maxillary teeth are bilaterally distant about 30 mm. from each other, and in each row of both jaws, the neibouring apices are distant not more than 15 mm. The most typical teeth of each jaw are illustrated by fig. 8, which shows the divergence especially between the roots. The roots of the mandibular teeth are longer, and develop into the remarkable diameter up to 10 mm. They are, both in the form and size of these major roots, not unlike peanuts. Whereas the maxillary teeth are marked by the refraction at the neck with the roots bent back toward the condyles. The difference is caused by the shallower and more or less obliquely placed alveoli in the maxillae, which are often the case with other delphinids. But the alveoli are relatively very shallow in both jaws and do not support the large roots well.

The all findings about teeth well indicate, together with the high solidity of the entire skull, apparently the highest of all, that the animal is full-grown and probably of late age. It is apparent that this specimen attains the highest maturity of all because the first specimen, which is judged more mature than the second, has the manibular rami ununited. Concerning the greater number of the dentition in the second specimen, Flower wrote that the first, more mature, specimen had seemingly lost some teeth at the end of the series, which are present in the second (loc. cit.). However in my opinion, this may be in the range of individual variation from animal to animal because of the greatest number present in the Taiji specimen in spite of its highest maturity. The attenuate rostrum of the second skull is, according to Flower (loc. cit.), that of the younger animals as seen in *Orca* and *Globicephalus*, but the present skull appears to attach a suspicion also to this opinion, though I agree with him on the general tendency in question.

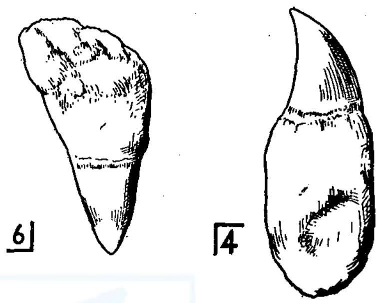


Fig. 8. Typical teeth of *Feresa* (× 1.5). Right maxillary 6th, seen from side and above (left), and left mandibular 4th, rostral view (right).

The hyoid as well as the hyals are all missing.

Vertebrae (figs. 9–12, tab. 3): The total number of the vertebrae of this specimen is 67 with the formula of C_7, D_{12}, L_{16}, Ca_{32}. Fig. 9 and tab. 3 are especially referable to the general account on the vertebrae.

Cervicals: The bodies as well as the neural arches of the first three vertebrae are united, but the third is joined with the second by a partial ankylosis at the bottom of body and the arch (figs. 9–10). The segments posterior to the third inclusive are very thin plates, namely very short, of which the fourth is the thinnest and the rest gradually grow thicker and stronger. The seventh is, however, comparatively thick, being twice in proportion to the fourth and comparable with the second. The neural arches of the posterior thin vertebrae are likewise weak, of which the fifth attains the minimum. The development of the arches shows a close relationship with that of the transverse processes, which extend, as in other cases of cetacea, most remarkably in the first and the second,

Table 3. Dimensions of vertebrae (mm). Note: Since C_{1-3} are consolidated, 1) is length of body C_{1-3} at base; 2) is breadth across articular surfaces of atlas. * Not given, because measuring point is difficult to find.
** United vertebrae, see text.

Vertebra no.		Length of body at center	Height of body at front end	Breadth of body at front end	Total height from anterior bottom	Bilateral breadth of transverse processes	Greatest height of neural canal	Greatest breadth of neural canal
C	1st	39 1)	*	97 2)	90	141	*	48
	2nd	—	—	—	—	102+	—	—
	3rd	—	—	—	—	68	25	36
	4th	3.5	38	36	70	53+	24	31
	5th	4.3	36	35	64	51	24	31
	6th	6	35	38	68	53	24	36
	7th	8	37	41	68	94+	31	43
D	1st	12	36	42	84	108	30	46
	2nd	16	37	43	93	111	29	43
	3rd	22	37	45	102	112	32	43
	4th	23	33	40	105	113	37	42
	5th	26	33	37	102	118	41	43
	6th	30	34	37	98	120	36	42
	7th	31	33	36	101	126	33	40
	8th	32	33	37	102+	133	32	40
	9th	32	34	38	105	141	28	35
	10th	32	35	38	108	155	29	32
	11th	31	37	40	115	178	28	29
	12th	30	35	39	124	198	30	29
L	1st	30	36	40	129	205	31	27
	2nd	30	36	40	133	205	34	26
	3rd	29	37	40	136	205	36	23
	4th	28	36	40	142	203	34	23
	5th	28	36	39	143	199	34	22
	6th	27	37	40	146	194	35	22
	7th	27	38	40	149	192	35	20
	8th	27	38	41	150	188	35	19
	9th	26	37	39	152	178+	36	19
	10th	26	38	41	155	177	35	18
	11th	26	39	39	154	174	34	17
	12th	27	41	42	153	168	34	15
	13th	26	41	42	149+	162	34	14
	14th	27	41	42	130+	161	35	13
	15th	26	44	46	136	160	32	13
	16th	27	43	43	131	158	30	13
Ca	1st	27	43	43	126+	138+	30	12
	2nd)**	61	43	43	124	123+	29	11
	3rd		—	—	—	122+	—	10
	4th	27	46	43	99+	104+	29	9
	5th	28	45	44	110	113	25	8
	6th	27	44	44	108	113+	23	7
	7th	27	45	46	102	110	19	6

(continued)

Table 3 (*continued*). Dimensions of vertebrae (mm).

Vertebra no.	Length of body at center	Height of body at front end	Breadth of body at front end	Total height from anterior bottom	Bilateral breadth of transverse processes	Greatest height of neural canal	Greatest breadth of neural canal
Ca 8th	28	46	45	97	108	15	6
9th	28	45	45	97	101	8	5
10th	28	45	45	90	92	7	5
11th)**	63	45	44	88	86	10	4
12th		—	—	—	77	—	4
13th	29	48	45	77	70	8	4
14th	30	44	46	77	64	9	4
15th	30	49	50	86	51	9	4
16th	30	42	42	69+	49	7	3
17th	31	42	41	66+	44	5	3
18th	31	43	39	67	40	4	3
19th	32	44	36	60		3	3
20th	32	43	35	56+		3	2
21st	30	42	36	50		2	2
22nd	25	38	34	43		1	1
23rd	18	30	37	34			
24th	13	25	37				
25th	12	21	38				
26th	11	18	37				
27th	10	17	33				
28th	9	14	28				
29th	8	12	26				
30th	8	11	22				
31st	7	9	16				
32nd	—	—	—				

but suddenly diminish into weaker apophyses attached to each arch, and develop again in the seventh to a degree comparable with the second.

Dorsals: In this region, the first is only 12 mm. in length of the body at center, and they gradually increase from this to the eighth, the ramaining bodies being nearly equal, varying from 31 to 32 mm. The posterior five are, together with some caudal vertebrae (Ca_{19-20}), the maximum out of all in length of the body. The articular surfaces for the heads of ribs present on the hinder edge of the base of pedicle of the first six arches, of which the sixth is very small, and on the seventh there is a tubercle in the corresponding position. The spinous process of the first is slender and short, and belongs to the left lamina because of the defect of the neural arch just right to the spine. The similar incomplete arches are also the case with the fourth and the seventh cervicals. From the second to the fifth, the spines gradually grow thicker, but are rather club-shaped with pointed ends, while the re-

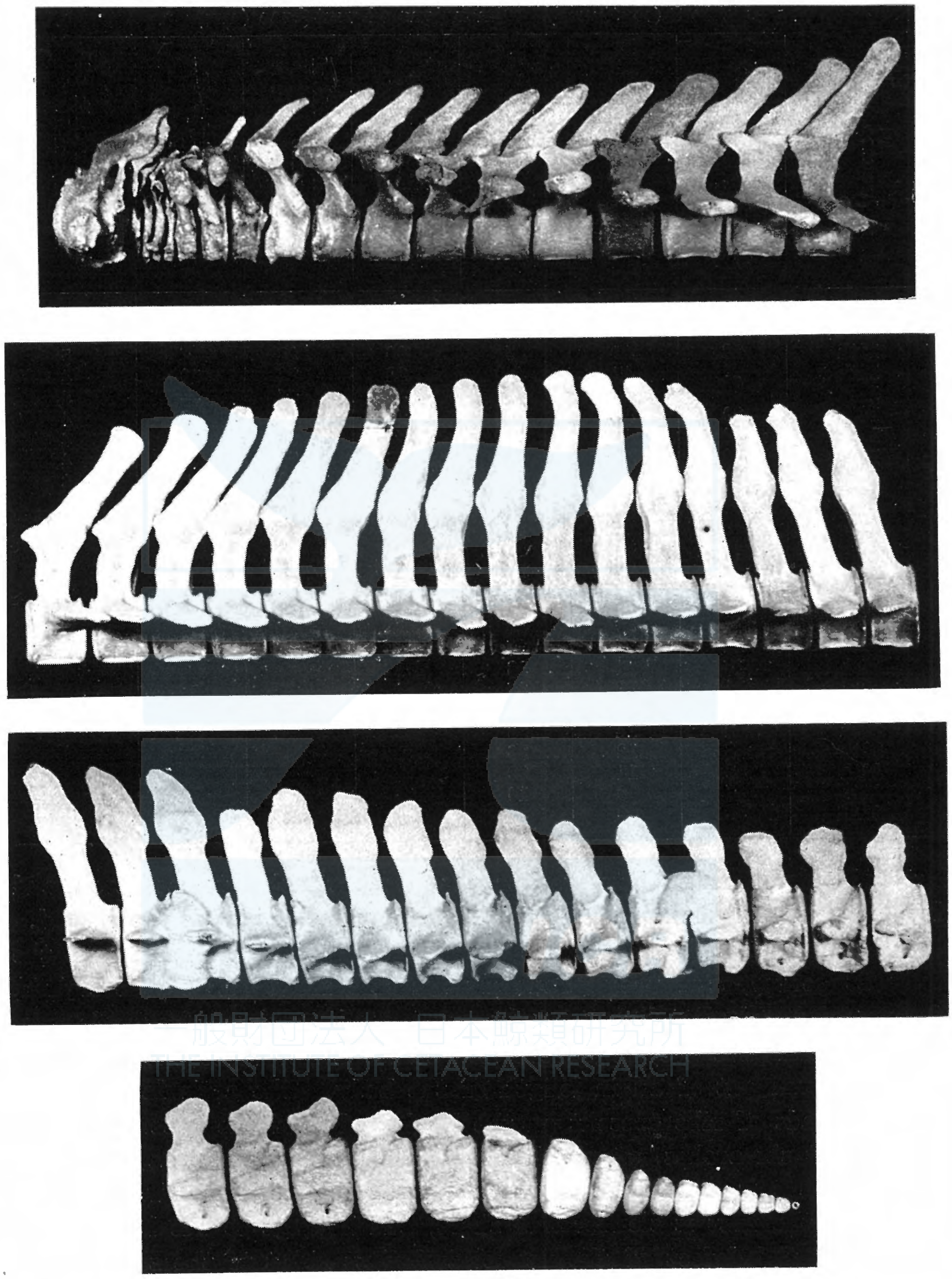


Fig. 9. Vertebrae of *Feresa* $\left(\times \frac{2.4}{10}\right)$. Cervicals and dorsals, lumbars, caudals 1–15, and caudals 16–31 (top to bottom). Left side.

mainder are flat, becoming gradually broader, and the sixth and seventh are transitions. They are all directed caudad with nearly equal inclination and with very gradual prolongation and slow increase in height. The transverse processes arise, in the anterior vertebrae, high up on the side of arch, but their position is gradually lowered toward the end of this region to the upper level of the vertebral body. This descent goes on further into the lumbar region, and it is in the posterior lumbars that the process is lowered to the middle height of the body. In the range of anterior half, the increase in length of the transverse process is very gradual from the first to the sixth in the bilateral expansion. On the extremities of the process, there are the articular surfaces for either tubercles or heads of the ribs. The transverse processes extend obliquely forward at first, but this becomes less marked as it approaches the seventh, and thenceforth the processes become directed more and more backward until the maximum at the twelfth in the entire vertebrae, the rear angle between these processes being 143°.

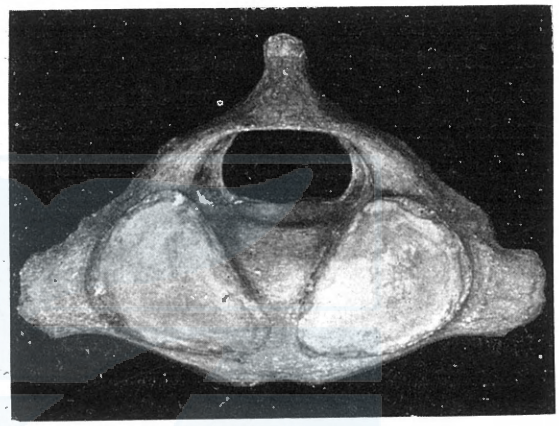


Fig. 10. United cervicals 1–3. Cranial view (ca. $\times \frac{1}{2}$).

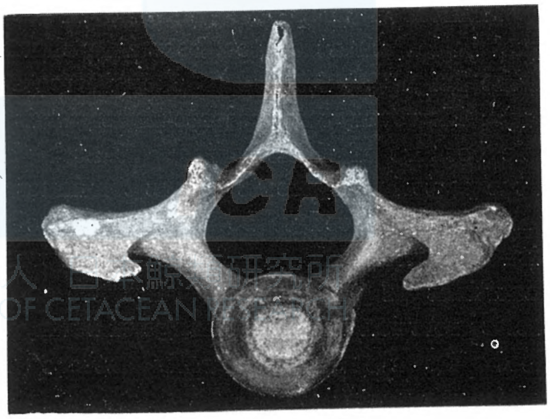


Fig. 11. Dorsal 7th. Cranial view (ca. $\times \frac{1}{2}$).

The seventh dorsal is peculiar for its uncinate transverse process (fig. 11), apparently in concert with its ribs that first lack the neck. The uncinate portion attached to the transverse process is obviously the neck of the seventh rib, which was separated from the costal body and remains ankylosed to the process but without reaching the articular surface on the sixth vertebra. Between the uncinate processes and the articular surfaces on the sixth body, there were probably a pair of cartilaginous connection in existence, which was lost in the course of preparing the specimen. The very small articular surfaces on the sixth are now well understood. The tubercle on the seventh as well as the faint traces of it on the following three, just in the corresponding position of the articulation, probably have some similar relation. However, it is not doubted that this is never a definite nor constant peculiarity confined to *Feresa*.

The development of the zygapophyses as well as the metapophyses is comparatively strong in the thoracic region. The zygapophyses are well developed in the anterior ten dorsals, first marking the lateral borders of the laminae, especially on the posterior edge. As it goes caudad, they ascend gradually along the posterior edge of the pedicles, and to the consequence, approach nearer each other until finally in the ninth, they are almost perfectly joined together, and in the tenth they really join into a single apophysis attached faintly but crest-like to the base of spine at the junction of the pedicles. The metapophyses are first indicated though slightly in the fifth near the medial end of the anterior edge of the transverse process. The first distinct metapophysis is a conical tubercle on the sixth, and from here caudad they gradually ascend as well along the anterior edge of the pedicles, naturally approaching each other but never to join. The metapophyses attain the maximum development at the tenth.

Lumbars: They are uniform in general. The bodies are nearly equal in length at center, becoming shorter very gradually caudad. But in the height at front end, they increase from 36 mm. (L_2) to 44 mm. (L_{15}). However, this increase in height is obviously exaggerated in some scale because of the swelling out at both ends, which occurs especially in the posterior segments. This continues further into the caudal region, where it is noticed to be a pathologic change to disappear again along with the going down of the transverse processes. The dimensional transitions of the lumbar bodies are very common in cetacea, and are in close relation with the change of form, viz., in the anterior segments, the bodies are dorso-ventrally flattened not unlike the shape of heart, and in the posterior, they approach the regular circle with some polygonal signs. The under side of the body is slightly keeled by the longitudinal crest throughout the region. The transverse processes present, in the anterior three, the greatest bilateral breadth in the entire vertebrae (205 mm.), and gradually diminish to the last (158 mm.). They gradually diminish also in breadth from 21 mm. of the anterior to 16 mm. of the last. Their strong backward inclination at the anterior, next after the maximum at the twelfth dorsal, becomes gradually weaker until the eleventh, where the processes extend right transversely. Behind this, they show the mirror-imaged and increasing forward inclination. The neural spines are first directed caudad but gradually become upright as far back as the twelfth, and thenceforth directed gradually forward. Particularly from the tenth to the fifteenth, the spinous apices are bent strongly forward. The tallest spine is of the tenth and stands 116 mm. from base to top. The neural spines arise from rather nearer the front than the hinder end of the bodies but this is less marked in the anterior segments. The metapophyses still present markedly in the first six, but with hardly recognizable traces of the zygapophyses. These apophyses gradually ascend hand in hand on both edges of the spines, to the middle height at the thirteenth, and to the two-thirds height at the last, marking the considerable antero-posterior broadening of the flat spines. From the posterior lumbars through the anterior caudals, the vertebral bodies are distorted forward more or less strongly in concert with the forward inclination of the spines.

Caudals: The bodies of this region increase in length from the first (27 mm.) to the nineteenth and twentieth (32 mm.), after which they again diminish to the end. Therefore, the vertebrae of this specimen show the maximum development of the body length at two points, of which the first in the thoracic region was already stated. In this region, the swelling of the bodies at the ends grows much stronger than the lumbars to a pathologic degree, and really the second and third, and the eleventh and twelfth are respectively consolidated together along the borders of the facing surfaces by the irregularly expanded bone tissues which are suggestive of some pathological changes as osteoma. The bone fragments of the same nature put also some other vertebrae indirectly together, and even some chevron bones are attacked. Because of this change, the height of body is tabled with more or less exaggerations. However, the measurements show that the anterior 21 are nearly equal in height of the body, and very rapid decrease beyond them. From the eighteenth to the twenty-second the bodies are marked by the lateral compression which characterizes this part of the cetacean vertebrae, and the twenty-fourth is the first of the series of the so-called terminal vertebrae which are remarkably broad, compressed and rectangular, the twenty-third being of transitional form. The last segment was a nodule with the diameter of about 5 mm., but because of its high fragility unexpected beforehand, it was smashed between my fingers and never recovered, when I tried to know whether or not it was really that segment at a stage in preparation. The neural spines, which arise closely to the front end of the bodies, gradually diminish in heights to the twenty-second where the spine becomes a low crest-like ridge bearing the last spinal canal. The apophyses attached to the spines are indicated by the broadening of the processes as well as the muscular lines on the side, which appear first on the second spine. They gradually ascend toward the top, resulting the antero-posterior expansion in the posterior low processes. The transverse process is reduced to a low ridge on the fifteenth, the traces of which disappear altogether beyond the eighteenth. The vascular canals, perforating the transverse process at base, first appear in the ninth and continue as far as the penultimate segment.

The chevrons are, with my confidence, 24 in number, of which the first one and the last two are ununited into halves (fig. 12). The first

Fig. 12. Chevrons of *Feresa* (ca. $\times\frac{1}{3}$). Anterior and posterior halves (top and bottom rows). Ununited laminae are shown, right side (top) and left (bottom) each.

pair is strangely long with large articular surfaces very closely located. This is strange to me but apparently not mistaken because of the good correspondence of the articular surfaces on the first caudal vertebra. Whereas the second and third remain small, provided with small articular surfaces. These three chevrons have no spines developed beyond the junction of the laminae, the last four too being the same. The fifth shows a sudden increase in length, and thenceforth the bones gradually increase to the eleventh in order to decrease again. The posterior chevrons are marked by the broad dimensions in the antero-posterior direction.

Ribs and sternum (fig. 13, tabs. 4–5): The present specimen bears

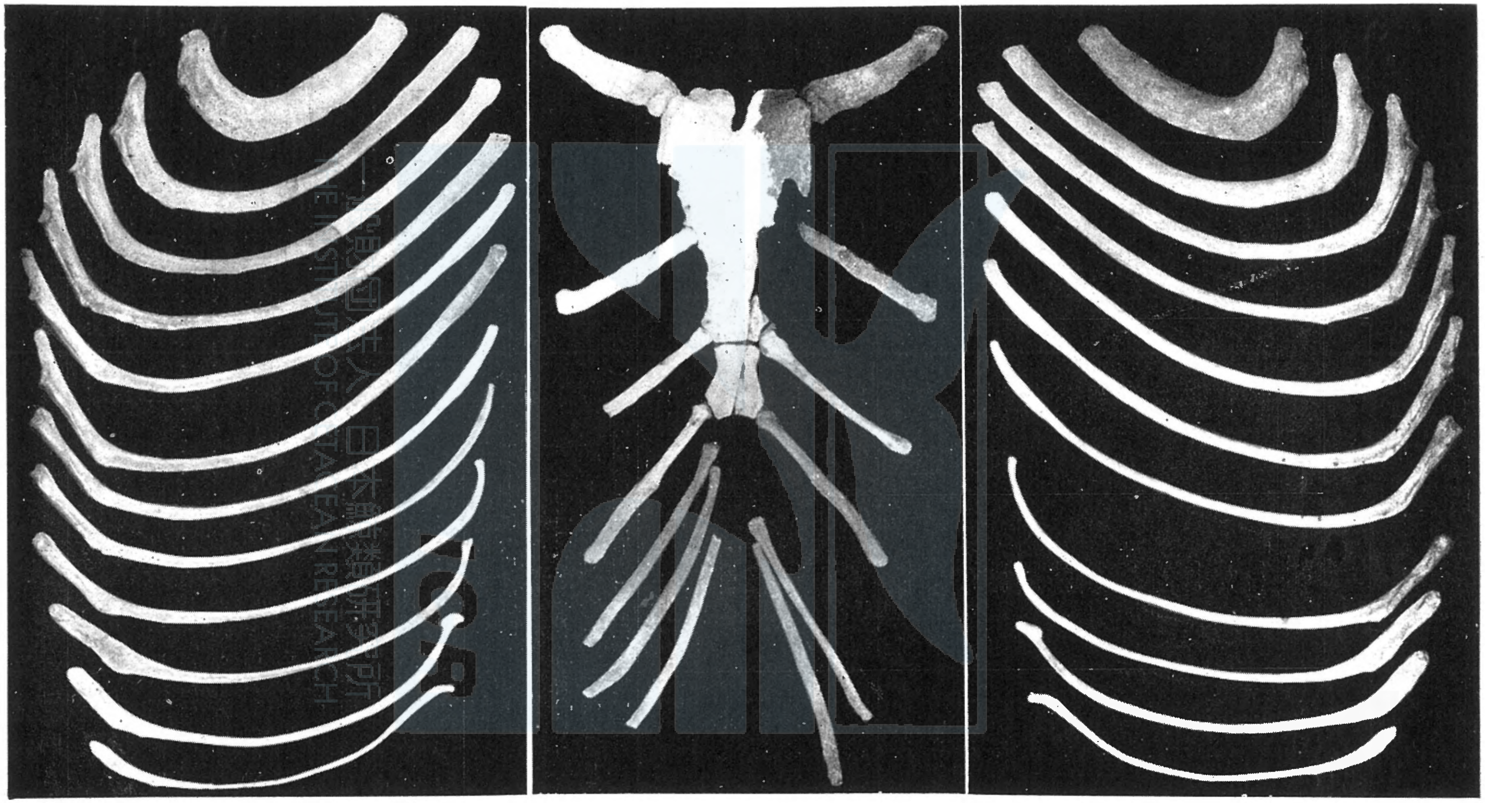


Fig. 13. Ribs and sternum of *Feresa*. Vertebral ribs $\left(\text{ca.} \times \frac{1}{5}\right)$, left and right sides, both visceral view (left and right). Sternum and sternal ribs $\left(\text{ca.} \times \frac{1}{4.5}\right)$, ventral view (center).

Table 4. Dimensions of ribs (mm).

	Rib no.	Length[1]		Breadth at middle	
		left	right	left	right
Vertebral rib[1]	1st	199	197	30	32
	2nd	335	330	17	17
	3rd	390	387	13	13
	4th	415	409	10	10
	5th	420+	412	11	11
	6th	429	413	10	10
	7th	385	384	8	8
	8th	380	—	10	—
	9th	361	365	9	9
	10th	335	333	8	7
	11th	312	320	7	7
	12th	270	274	4	4
Sternal rib	1st	98	93	20	21
	2nd	96+	94	13	12
	3rd	110	77+	8	9
	4th	115	115	9	10
	—[2]	134	140	5	7
	—	148+	154	7	8
	—		120+		7

1) To the vertebral ribs, curvilinear length (along the visceral border) is given instead of distance from end to end.

2) Ordinal number is not identified.

Table 5. Dimensions of sternum.

	mm.
Length of anterior element	147
Length of posterior element (3rd sternbra, median)	43
Greatest breadth of manubrium*	88
Least breadth of manubrium*	50
Least breadth of 2nd sternbra	28
Breadth of 2nd sternbra at posterior end	26
Breadth of 3rd sternbra at anterior end	26
Greatest breadth of 3rd sternbra	34
Least breadth of 3rd sternbra	23
Breadth of 3rd sternbra arcoss posterior articular angles	21
Distance between centers of articular facets, 1st and 2nd (right)	72
Ditto, 2nd and 3rd (right)	56

* The anterior element is broken and arbitrarily put together, hence not actual dismension.

12 pairs of vertebral ribs, but the right side eighth was lost. The anterior six pairs have necks and are two-headed. The necks are generally short in proportion to the total length, but they are well developed, together with the proximal portion to the angle of the posterior ribs without the neck, despite the rapid caudad decrease in breadth of the bodies. With exception of the anterior two or three, of which the first is broadest, most of the ribs are very slender to the extreme of the last. The first is, however, shortest of all, and they gradually increase in length until the maximum at the sixth, and thenceforth diminish to the last. From the first to the ninth, the sternal ends have facets to be covered by cartilage, for the attachment of either the sternal ribs or cartilages. Meanwhile, the remainder have peculiar extremities to expand into unusual swellings which end freely, flattened, directed and pointed caudad.

After examining the vertebral ribs, I have come to expect the presence of eight or nine pairs of the sternal ribs, but only 13 have been secured in the specimen. Four pairs are in the direct and independent connection with the sternum, and exactly identified to be at time of securing the specimen. The first pair is especially thick but short, and with its large head the pair articulates the sternal manubrium near the anterior angle of that bone. The second pair articulates at the border of the first and second sternbrae, the third at the posterior angle of the second, and the forth the third. I identify, next to these four, two more pairs and one single rib to articulate to the end of the third sternbra. From the first to posterior, they grow gradually slender but longer.

The sternum consists of two elements, of which the anterior is seemingly composed of two sternbrae consolidated together, hence the total of three segments is certified. The anterior element bears three pairs of articular facets for the sternal ribs, and across the second facets, a dim trace of the synostosed border is noticed especially on the visceral surface. The longitudinal shallow groove on the ventral surface throughout indicates the primordial median fissure, which is indicated also by a sharp jugular incision as deep as 30 mm. in front. Behind the joint for the first sternal ribs, the manubrium expands greatly toward the sides, with the anterior tubercles ventrad and with the posterior processes caudad. The posterior process on the left is however, sharply pointed longer than the right one, and resembles some true dolphins as *Delphinus* and others which usually bear the similar processes on the manubrium. On the ventral surface of the element, there are, across the median groove, two pairs of tubercles or tuberosities at middle of each halves. Concerning the small posterior element, i.e., the third sternbra, no particular description seems necessary other than the dimensions given in tab. 5.

Pectoral limb (figs. 14–15, tab. 6): Scapula: The form of the present scapula does not differ much from that of other delphinids except the caudal angle, where there are two angles of some distance

Fig. 14. Scapulae of *Feresa* ($\times\frac{1}{3}$). Dorsal view of left and costal view of right (right and left).

(tab. 6). The most noticeable character of the scapula is, however, the peculiar rough nature on the surfaces. The body is so rough that even the dorsal or lateral surface is marked by the irregular and rough elevations as well as impressions. The anterior angle of the blade turns dorsally, and there and along the vertebral border, the surface is marked by a large number of minute but sharply impressed foveae left among the network of bone trabeculae. The costal surface is divided by a noticeable transverse elevation roughly into two triangular fossae. This elevation laterally joins the strong axillary frame along that border, in order to support the glenoid cavity. The anterior fossa exceeds the posterior, and mainly in the former there are at least four distinct ridges, known as the muscular lines for the tendinous intersection of the infrascapular muscle, which run toward the glenoid angle, giving more or less sharp elevation to the surface. In these fossae and along the vertebral border, the blade is very thin and perforations are present in the specimen. The acromion is of nearly equal breadth from base to tip, and turns midway strongly toward the vertebral border. The coracoid process has a narrow neck and expanded extremity. The glenoid cavity is deep.

Table 6. Dimensions of pectoral limb bones (mm).

		left	right
Scapula	Length along vertebral border	200+	211
	Greatest breadth	158	157
	Length of glenoid cavity	36	37
	Breadth of glenoid cavity	28	32
	Length of acromion, along medial border	44	41+
	Greatest breadth of acromion	27	29
	Length of coracoid, from supraglenoid edge to tip	47	50
	Greatest breadth of coracoid	34	34
	Length of caudal angle	50	43
Length of humerus		76	75
Breadth of humerus at distal end		55	53
Length of radius		100	100
Breadth of radius at distal end		51	51
Length of ulna		93	90
Breadth of ulna at distal end		48	48
Length of metacarpus	I	28	29
	II	47	48
	III	50	49
	IV	36	35
	V	33	31

The free bones of the limb are all very broad in proportion to the length. The humerus, radius and ulna nearly resemble those of *Grampus* and *Globicephalus*, being united in this specimen immovably altogether. To the distal end of the ulna, the pisiform bone of triangular form is attached medially, though fused immovably but with a distinct mark of demarcation.

There are only four carpals in the manus, of which the three belong to the procarpus, and the mesocarpus presents only one, i. e., the trapezoid bone. The radial (scaphoid) and ulnar (cuneiform) procarpals are particularly broad. The most remarkable peculiarity of these carpals is, however, the disappearance of the hamate or unciform bone. Con-

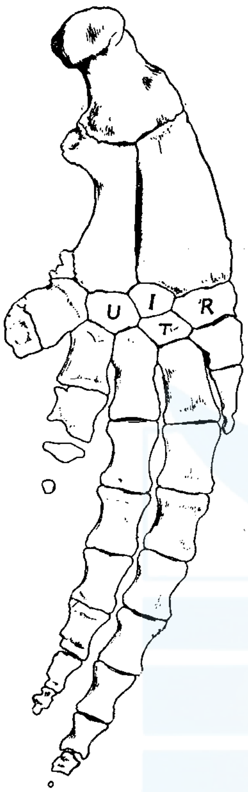


Fig. 15. Bones of left flipper of *Feresa*, volar view ($\times \frac{1}{4}$). Note especially carpals, *R* scaphoid, *I* lunar, *U* cuneiform and *T* trapezoid. No hamate. Pisiform united to ulna.

cerning the carpals of delphinids, Weber presents the following schema[1] (1928, p. 368):

$$\begin{tikzcd}
R \arrow[rr, dash] \arrow[dr, dash] \arrow[dd, dash] & & I \arrow[rr, dash] \arrow[dl, dash] \arrow[dr, dash] & & U \arrow[dl, dash] \arrow[dd, dash] \\
& C_2 \arrow[r, dash] \arrow[d, dash] & C_3 \arrow[d, dash] & C_4 \arrow[d, dash] & \\
M_1 & M_2 & M_3 & M_4 & M_5
\end{tikzcd}$$

which should be modified in *Feresa* into another formula given below.

$$\begin{tikzcd}
R \arrow[rr, dash] \arrow[dr, dash] \arrow[dd, dash] & & I \arrow[rr, dash] \arrow[dl, dash] & & U \arrow[ddll, dash] \arrow[ddl, dash] \arrow[dd, dash] \\
& C_2 \arrow[r, dash] \arrow[d, dash] & C_3 \arrow[d, dash] & & \\
M_1 & M_2 & M_3 & M_4 & M_5
\end{tikzcd}$$

The phalangeal formula of *Feresa* including the metacarpals is: I_3, II_9, III_8, IV_4, V_2.

Because of the particular importance of this specimen, the above formula was certified with a special care, and there can be no doubt as to the correctness. The flippers have been, for this purpose, left on a tray for beetles who have eaten up the soft parts and left some ununited phalanges at the spot. This is also the reason why the manus is illustrated by drawing instead of photograph (fig. 15).

All the metacarpals and the phalanges are perfectly built with exception of the phalanx of the fifth digit on the right, where the phalangeal body is separated from the epiphysis, and this is in turn united with the head of the metacarpus. These bones are all in close contact to each other and really synostosed relations are very popular. The fifth digit is marked above all by the strong medial divergence with very broad metacarpus and phalanx.

Pelvic bone: The vestiges of the pelvic girdle have escaped from the present examination, and are missing in the specimen.

Position of *Feresa*

1827. *Delphinus intermedius* Gray, Ann. Phil., p. 396.

1) *R* scaphoid; *I* lunar; *U* cuneiform; *C* mesocarpals and *M* metacarpals; attached are digit numbers.

1843. *Grampus intermedius* Gray, List of Mamm., p. 106.
1846. *Orca intermedia* Gray, Zool. Ereb. & Terr., p. 34, tab. 8.
1850. Cat. of Cetacea (1st ed.), p. 96.
1866. Cat. of Seals and Whales, 2nd ed., p. 283.
1871. *Feresa intermedia* Gray, Suppl. Cat. of Seals and Whales, p. 78.
1875. *Feresa attenuata* Gray[1], J. du Mus. Godeffroy, Heft 8.

These are the principal synonyms of *Feresa*, of which the last was given to the second specimen (B. M., 1762a). They are interesting not only because all was described by a single cetologist, J. E. Gray on the two skulls, but also because I see, in the course of change, irresolute considerations of the author himself, who finally created an independent genus, *Feresa* Gray in 1871.

However, Gray simultaneously noted the first specimen (B. M., 362a) to have many resemblances to *Lagenorhynchus electra* Gray (1870, p. 77), and wrote: "Indeed, when the animal is known, I should not be at all astonished if it should prove to be a species of *Electra* rather than *Orca*, or perhaps a new genus" (1871, p. 78). Also Flower (loc. cit.) wrote: "the cranium and teeth indicate that it is a connecting link between *Globiceps*, *Grampus* and *Lagenorhynchus*". Since I have no means to examine the specimens of *L. electra*, I knew all about it through literatures including True's monograph (1889., pp. 100–103, pl.

1) This list of synonymy is given after True (1889) with some modifications of myself. True gives the last synonym as *Feresia attenuata* instead of *Feresa*. Flower (1883, 1885) cited Gray (1871 and 1870 respectively) as *Feresia* Gray, which is however never read so in the originals, but *Feresa* Gray (1871 only; subgenus *Feresa* 1870 as indicated by Gray in 1871 seems to me a misunderstanding of Gray himself). Therefore, this is the mistake of Flower which brings this wrong name into the synonymy of *Feresa*. As I could not see the Gray's original description on the second specimen (1875), I liked to know the relations between *Feresa* and *Feresia* in that case. According to the personal information from Dr. Fraser in reply to my inquiry, True is wrong in stating *Feresia attenuata*, hence exclusion of *Feresia* from the above list. I myself too have later learned by the title of Gray's report in 1875 that it was never *Feresia*. But with this correction the synonym given by True is that what should be used. The reason why I mention this is for the confusions possibly caused by the inattentative use of these synonyms. For example, Beddard wrote once as *Feresa* (1900, p. 292), while later as *Feresia* (1923, p. 337). Weber wrote *Feresia* among the important genera in his synoptic table (1928, p. 389) without giving correct *Feresa*. Winge's work (1942) gives *Feresa* in the text (p. 252), but only *Feresia* in the notes (p. 273). The last is understood because this is cited from Flower (1886), but it is never understood that no authors mentioned above give any word of notice concerning the identity of *Feresa* and *Feresia*. The genus is little known, so this seems important, and confusions must be avoided by use of the correct name or by the careful usage of synonymy.

28), but I cannot bring myself to concur in the opinion, though I accept some resemblances in the skull. This is because of the noticeable dispersions in the external characters known after my reconstruction (fig. 1) as well as in the dentition, roughly half-numbered and of very large teeth. I think that the skull of *Feresa* resembles that of *Orca* rather than *L. electra* by putting the special weight in the resembled dentition, both in the number and form. The tall dorsal fin and the white marking on the vent may be other resemblances to *Orca*. In the meantime, the vertebral formula seemingly interlinks between the genera, *Orca*, *Grampus* and *Globicephalus*. In conclusion, all genera to be considered pertaining to the position of *Feresa* are, in my present opinion, *Grampus*, *Globicephalus* and *Orca*, which possibly include *Pseudorca*. And I believe very adequate position of *Feresa* at the independent generic rank. I admire Gray for this reason, and also for his prudence not to have placed our *Feresa* under *Lagenorhynchus*, in spite that he might appeal to do so. With special interest as intense as the authors did in the past (Flower, 1883, p. 510; True, 1889, p. 107), I shall look forward to the future development of our knowledge of this porpoise, and would like to put to it a name, the "Lesser" or "Pygmy Killer".

Distribution

The habitat of *Feresa* has been as well very little known, but it has been expected that the Pacific waters might be the important range because the second specimen was known from the South Seas. The present specimen has unveiled that the Pacific waters are really the principal habitat, expanding its distribution into the wider range which includes the northern part in addition to the South Seas.

Summary

A 235 cm. long female porpoise *Feresa intermedia* Gray was captured on August 23rd, 1952 at Taiji, Wakayama Prefecture, Japan. This is the third, but the first complete *Feresa* specimen. Since our knowledge has been confined to skull (two type specimens B. M., 362a and 1762a), detailed description and measurements are given, being summarized as follows:

Colour dark gray all over, with white marking on the vent, lips seamed with white band. Head very short, caudal portion long. No beak, with rounded forehead but not so strong as *Grampus* and *Globi-*

cephalus. Teeth 11–10 to upper, 13 to each side of lower jaw. Crowns very large, conical. Flippers develop moderately.

Size of skull exceeds two types. This is presumably of highest maturity, but with narrow rostrum and greatest dentition number. Rostrum concave or flat above, and only at end slightly convex. Tympano-perioticum like *Grampus* and *Globicephalus* but somewhat smaller, with well developed mastoid process. Condyles bulge out at bottom stronger backward. Vertebral formula C 7, D 12, L 16, Ca 32, total 67. C_{1-3} united. Articular apophyses well developed. Neural spines bent caudad as far back as the erect one of L_{12}, beyond this forward. Chevrons 24. Vertebral ribs 12 pairs, of which 6 pairs have necks. Mostly very slender. Sternal ribs expected 8–9 pairs, but 13 in the specimen consist of 4 pairs in direct and independent articulation with sternum and not certified posterior ones to close thorax behind the end of sternum. Sternum consists of 3 sternbrae, 2 anteriors united. Manubrium large, with a deep jugular incision at front end. Scapula very thin, roughly waved on both surfaces. Only 4 carpals in manus, because of disappeared hamate. Phalangeal formula I 3, II 9, III 8, IV 4, V 2 including metacarpals. Hyals including hyoid, some sternal ribs and pelvic vestiges are not secured in the specimen.

These findings of exterior as well as osteology well support Gray's opinion as seen in synonymy given by himself, but to kinship of *Feresa* to *Lagenorhynchus electra* mentioned by Gray, Flower and True, I cannot yield. *Grampus*, *Globicephalus*, *Orca* and possibly *Pseudorca* may probably be near allies involved in the consideration of the position of *Feresa*. Proposition of a new name "Lesser" or "Pygmy Killer" to *Feresa* may be an idea. Our Taiji specimen expands its distribution to the Northern Pacific, besides the South Seas of *F. attenuata*.

All photographs are made with Leica with under mentioned lenses and devices. These data are appended as they may eventually help the understanding of figures in respect of the perspective of the specimen.

Figs. 2–4. Elmar 50 mm.
Figs. 12–15. Elmar 50 mm., with focusing stage.
Figs. 7, 10–11. Hektor 135 mm., with focusing bellows and mirror reflex housing.
Figs. 5–6, 9. Telyt 200 mm.

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