A SKULL OF BALEEN WHALE DREDGED FROM THE INLAND SEA OF JAPAN

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ABSTRACT

A half-broken skull was dredged by a fishing vessel in the Inland Sea of Japan in August 1978. This skull was studied from the taxonomic standpoint and was thought to be a skull of the Bryde's whale, *Balaenoptera edeni*.

INTRODUCTION

It was reported in a local press in Oita Prefecture dated 27 August 1978 a big bone of unknown animal was dredged by a small fishing vessel while the operation of bottom drag net for shrimps and other bottom fish. The bone was so heavy that the fishermen could not haul it on to the deck they ceased fishing operation and brought back the bone, hanging it outside the boat, to the fishing port of Kizuki City (Fig. 1).

The bone was eventually brought to Kizuki-shiritsu Minzoku Shiryokan (Kizuki Municipal Folklore Museum) for preservation and identification of the animal species. At first they consulted with Oita Marine Palace, a nearby aquarium and was told that the bone may be a skull of a whale and examination by specialist is needed. Then they took photographs of the bone from various angles and sent them to Dr Teruo Tobayama of the Kamogawa Sea World for identification of the species, who in turn passed them to the Whales Research Institute.

From the photograph we understood that the bone is half-broken skull of a baleen whale, but identification of the species is very difficult without close observation of the bone. And this is our great concern in the light of rather poor scientific knowledge of whales hitherto obtained from the Inland Sea, though there is a good reason to think that a number of whales came into the Inland Sea and out annually until about less than one hundred years ago (Shindo, 1975; Omura, 1974). Thus we made a trip to Kizuki City, Oita Prefecture, towards the beginning of October 1978.

OBSERVATION

The skull is completely lacking the maxillaries and premaxillaries. Possibly this

is caused by loose articulation of bones in the facial region of the skull of the baleen whales, contrary to the toothed whales. Fortunately the vomer is remaining (Pl. I, Figs 1, 2 and 3). Its upper margin and anterior tip are broken to some extent, but presumably only a few centimeters, and thus protruding forward greatly and giving an impression of a flat rostrum in profile. Nasals are completely lacking (Pl. I, Fig. 1). On the inferior side of the vomer there still attached the palatines, to which pterygoids are also attached, but their posterior ends or hamular processes are broken (Pl. I, Fig. 2).

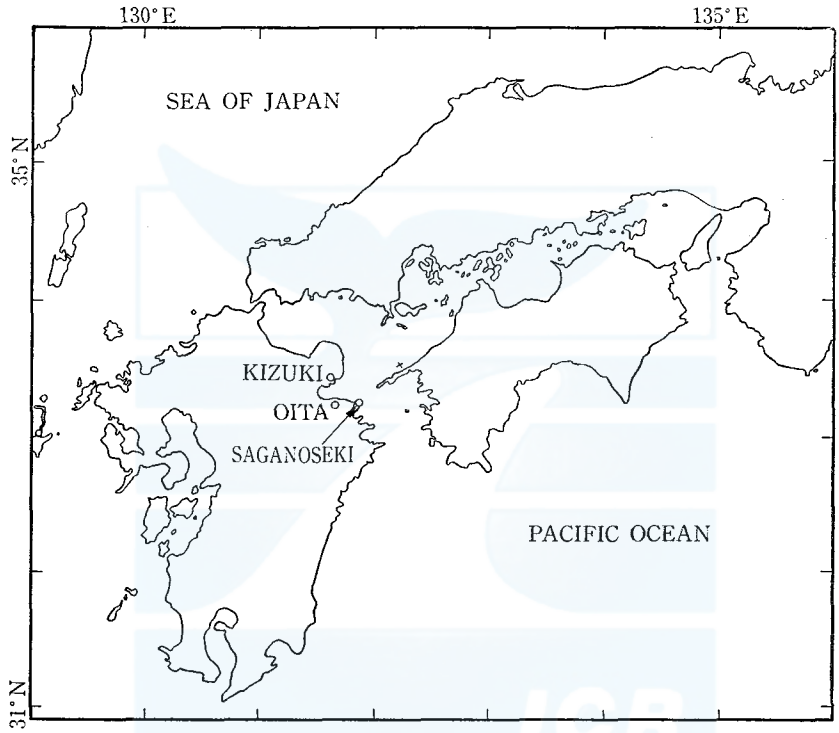

Fig. 1. Chart showing the position where the Kizuki specimen was dredged by a fishing vessel. Marked with a cross.

The brain case of the skull is rather in a good condition. The supraoccipital bone has a broken hole just above the occipital condyles, and its outer margins especially of superior regions are broken to some extent, but still it shows a characteristic feature of the balaenopterid whales, being roughly triangle in posterior view and the surface being relatively flat and having no deep concavity (Pl. I, Fig. 1 and Pl. II). Exo- and basi- occipitals are nearly complete. Temporals are in good condition, except extreme end of the right zygomatic process which is broken slightly. Orbital processes of the frontals are also in good condition, especially in posterior portion and orbits, but the anterior portions are broken. Parietals are also remaining on the lateral sides of the brain case and extend for-

TABLE 1. MEASUREMENTS OF SKULL, KIZUKI SPECIMEN

Measurements	Length in mm	% of breadth
Greatest breadth of skull at zygomatic process	1,287	100.0
Breadth of skull at orbital process of frontal, posterior	1,264	98.2
„ center	1,181	91.8
Breadth of skull at mastoid process of temporal	986	76.6
Length of orbit, right*	195	15.2
„ , left	210	16.3
Length of vomer, from broken tip*	2,125	165.1
Length of palatine, greatest, right	582	45.2
„ , left	583	45.3
„ , along median line	559	43.4
Length of skull from broken tip of vomer to occipital condyle*	2,560	198.9
Breadth of occipital condyle	259	20.1
Height of occipital condyle, right	160	12.4
„ , left	166	12.9
Breadth of foramen magnum	85	6.6
Height „	96	7.5
Height of supraoccipital bone from foramen magnum	623	48.4
Breadth of supraoccipital bone	871	67.7
Vertical height of skull from vertex to vomer	431	33.5
Horizontal length from vertex to occipital condyle	668	51.9

* Least value due to breakage.

TABLE 2. COMPARISON OF THE KIZUKI SPECIMEN TO BRYDE'S, SEI AND MINKE WHALES

Measurements	Kizuki specimen		Bryde's[1]		Sei[1]		Minke[2]	
	Length mm	%	Length mm	%	Length mm	%	Length mm	%
Sex and body length	?		♀45 ft (13.5m)		♀43 ft (12.9m)		♀9.8m	
Condylo-premaxillary length	?		3,480	215.5	3,060	229.4	2,350	187.1
Tip of premax. to anterior end of vomer	?		439	27.2	—	—	290	23.1
Greatest breadth of skull	1,287	100	1,615	100	1,335	100	1,256	100
Breadth of skull at orbit (center)	1,181	91.8	—	—	—	—	1,219	97.1
Breadth of occipital condyle	259	20.1	266	16.5	251	18.8	228	18.2
Height of occipital condyle	163	12.7	174	10.8	167	12.5	143	11.4
Breadth of foramen magnum	85	6.6	53	3.3	84	6.3	79	6.3
Height of foramen magnum	96	7.5	45	2.8	97	7.3	127	10.1
Height of supraoccipital bone from foramen magnum	623	48.4	835	51.7	768	57.5	650	51.8
Length of orbit	210	16.3	234	14.5	233	17.5	207	16.5

[1] Cited from Omura, 1959. [2] Cited from Omura, 1975.

ward beyond the line of the vertex.

We made some measurements of the skull. The greatest breadth of the skull at zygomatic processes of the squamosals, and other measurements concerning breadth of the skull are fairly accurate. Results of the measurements are shown

in Table 1 and these measurements are compared with corresponding measurements of the Bryde's, sei and minke whales in Table 2.

DISCUSSION

In profile the skull of the Kizuki specimen is very flat (Pl. I, Fig. 3). Although it lacks maxillaries and premaxillaries the vomer is remaining in almost all its length, and we can safely assume that the ventral border of the vomer represents that of the rostrum itself. From this fact and combined with other evidence we can deny the possibility of the specimen of being Balaenidae as well as Eschrichtiidae. In Balaenidae the rostrum is curved downwards greatly and roughly Tee shaped in dorsal aspect of the skull, but the Kizuki specimen shows no resemblance of these character. In Eschrichtiidae the rostrum is curved downwards in less extent than Balaenidae but more curved than in Balaenopteridae. Further in Eschrichtiidae the supraoccipital bone presents three deep concavities, and on the superior portion two prominent and peculiar rugosities, and also present similar rugosities upon the basisphenoid and basioccipital bones (Andrews, 1914), but the Kizuki specimen has neither such clear concavity nor rugosity. Thus it is clear that the Kizuki specimen belongs to a species of the family Balaenopteridae.

Among the family Balaenopteridae there are two genera of *Megaptera* (one species) and *Balaenoptera* (five species). We can erase the posibility of the humpback whale, *Megaptera novaeangliae*, because of its slender shape of the Kizuki specimen. The skull of the humpback whale is robust and it has maximum relative zygomatic width in the family Balaenopteridae, or 57–66.9% of the condylo-premaxillary length (Tomilin, 1967). In the Kizuki specimen the ratio is less than $1{,}287/2{,}560\times100=50.3$ (see Table 1). The skull length of 2.56 m is the length from the broken tip of the vomer to the occipital condyles. Probably we can add to this figure some 30–40 cm as the length from the tip of premaxillary to the broken end of the vomer (see Table 2), which makes condylo-premaxillary length to be 2.90–3.00 m, resulting the ratio as small as 43–44%. From this fact alone the possibility of the humpback whale will be erased.

We can safely conclude, therefore, that the Kizuki specimen belongs to a species of the genus *Balaenoptera*, and there remains five species to be considered. First of all we can exclude the possibility of the minke whale, *B. acutorostrata*, because of the size of the skull. The condylo-premaxillary length of the minke whale usually does not exceed 2 m (Tomilin, 1967) and the largest skull ever recorded, 2.35 m in length, was obtained from a 9.8 m female in the Antarctic (Omura, 1975). The minimum estimate of the skull length of the Kizuki specimen is 2.56 m (Table 1), but the actual condylo-premaxillary length would have been 2.90–3.00 m as already stated.

The inferior aspect of the skull of the Kizuki specimen denotes two special features important for the identification of the species (Pl. I, Fig. 2). One is the shape of the palatines. In the Kizuki specimen the mesial border of anterior part

of the palatines situate near the inferior edge of the vomer and in parallel with the skull axis, but in the posterior portion they diverge outwards and the inner edges do not articulate to the inferior edge of the vomer. In the Kizuki specimen the right palatine was broken at its posterior portion along the edge, but in the left palatine the posterior edge is nearly complete, except a semi-round broken hole just anterior to the curved posterior edge. Such a shape of the palatine is usual in all the *Balaenoptera* species except the blue whale, *B. musculus*. The skull of the blue whale differs from those of other *Balaenoptera* in the shape of palatines which terminate abruptly, without forming left and right processes. Such form of the palatines is observed also in the pygmy blue whale, *B. musculus brevicauda* (Omura *et al.*, 1970). In this feature this species is similar to the humpback whale (Tomilin, 1967). From the above it is clear that the Kizuki specimen is not a blue whale.

Another feature of importance is the shape of the vomer at its posterior end. Tomilin (1967) shows that the posterior end of the vomer is greatly expanded in the adult fin whale, *B. physalus*, differing from the sei whale (Fig. 26 of his book). Since no such expansion is observed in the Kizuki specimen it is also possible that this specimen should not be assigned to the fin whale.

Among five species of the genus *Balaenoptera* we have already excluded three species, i.e. the minke, the blue and the fin whales. The remaining two species or the sei whale, *B. borealis*, and the Bryde's whale, *B. edeni*, are very close relatives and it is very difficult to separate the two only from the skull. One feature of the skull of the Bryde's whale is the flat rostrum, compared with somewhat downward bending rostrum of the sei whale (Junge, 1950; Omura, 1959). The shape of rostrum in the Kizuki specimen, presumed from the vomer left on the skull, resembles the Bryde's whale rather than the sei whale (Pl. I, Fig. 3). Another character separating the two species is the state of the front margin of the nasals. The anterior margin is concave in the Bryde's whale, but straight in the sei whale. In the Kizuki specimen, however, nasals are completely lacking and this character is of no use in this case (Pl. I, Fig. 1).

Miller (1924) considers the unusually deep and narrow sulcus formed at the region of juncture between the squamous and articular portion of the squamosal in his Pablo Beach specimen of the pollack whale (No. 236680, US. National Museum) as a specific character of this species or *B. borealis*. According to Junge (1950) this sulcus is narrower and deeper in most specimens of *B. borealis* than it is in *B. physalus* and *B. edeni*. In the Bryde's whale on the coast of Japan this sulcus is less developed than in the sei whale (Omura, 1959). In this respect the Kizuki specinen denotes sulcus of *B. edeni* type, being wide and shallow. In addition, in *B. edeni* the basicranial part of the skull exposed behind the palatine is much longer than broad (Junge, 1950). This also observed in the Kizuki specimen (Pl. I, Fig. 2). It seems that, from the above, the Kizuki specimen shows some characters of the Bryde's whale rather than the sei whale.

There are, however, some doubts in reliability of such skeletal characters. Mead (1977) found, in several specimens, some of the characters generally used to separate *B. borealis* from *B. edeni* either intermediate or contradictory, particularly

the shape of the nasal bones. He examined records of sei whales from the Atlantic coast of the United States and identified the above-mentioned Miller's specimen of the pollack whale (No. 236680, U.S. National Museum) as *B. edeni*. He describes that this was confirmed by an examination of the baleen, which is clearly that of *B. edeni*. The most remarkable difference, however, which separates *B. edeni* from *B. borealis* in the form of vertebrae is the strong backward inclination of the spinous processes in the former (Anderson, 1879; Lönnberg, 1931; Junge, 1950; Omura, 1959). This inclination is observed in vertebrae from about 7th dorsal and increases till its maximum at about 7th lumbar. In the Miller's specimen of Pablo Beach, however, no such backward inclination is observed (Pl. 12 of Miller, 1924). Thus the problem is much complicated and we are not able to conclude whether the Kizuki specimen is really a Bryde's whale or a sei whale.

The sei whale on the coast of Japan, however, does not usually migrate to the south coast of western Japan, but it moves from the Bonin Islands directly to Sanriku and further north. The Bryde's whales, on the other hand, were taken in these regions in the days of old whaling as well as in the days of modern whaling (Omura, 1977). These facts suggest that the Kizuki specimen possibly represents a Bryde's whale, *B. edeni*. Size of this whale is estimated to be 12 m, assuming that the skull is about 25% of the whale body.

Dating of the Kizuki specimen was not made, but there is a record kept at the Japan Whaling Association that two Iwashikujira were taken at Saganoseki (see Fig. 1) in 1926. At present the name Iwashi-kujira only means the sei whale, *B. borealis*, but in these days no distinction was made between the sei and Bryde's whales. In any case this will suggest that the Bryde's whale (or sei whale) usually came into the Inland Sea until about 50 years ago. As far as we know a whaling landstation was established at Saganoseki in 1926, but it was closed soon due to unexpected scarcity of whales coming there.

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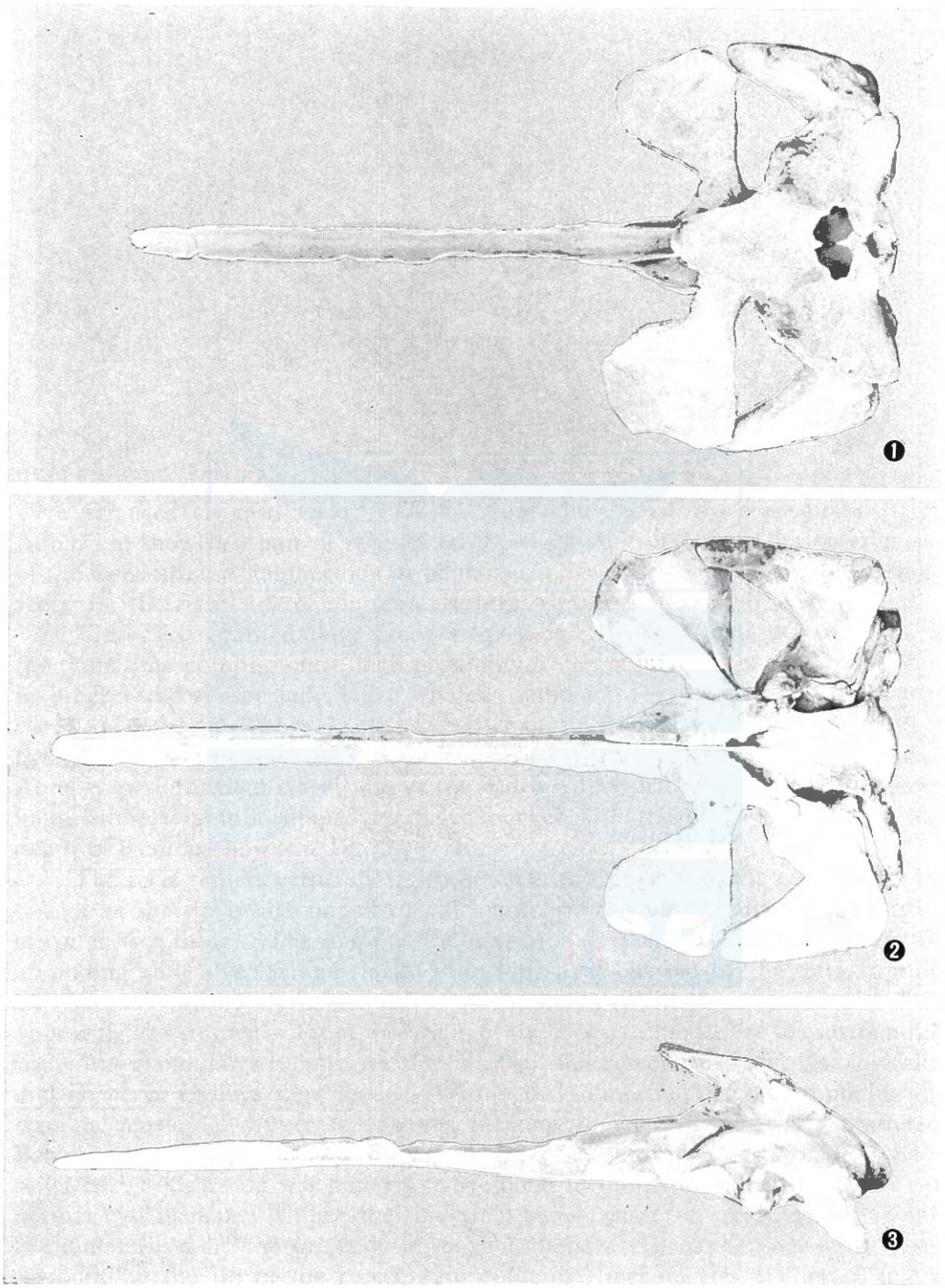
EXPLANATION OF PLATES

PLATE I

Fig. 1. Dorsal view of the Kizuki specimen.
Fig. 2. Inferior view of the Kizuki specimen.
Fig. 3. Lateral view of the Kizuki specimen.

PLATE II

Fig. 1. Posterior view of the Kizuki specimen.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