# PRELIMINARY REPORT ON THE GEOGRAPHICAL DISTRIBUTION OF THE BRYDE'S WHALE IN THE NORTH PACIFIC WITH SPECIAL REFERENCE TO THE STRUCTURE OF FILTERING APPARATUS

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ABSTRACT

Some external characters of the Bryde's whales caught during the summer of 1975 in the waters off Sanriku, northwest Pacific were studied. Although no prominent external characters which may suggest an intraspecific variation in distinguishing the differenciation of possible races were found among the fourteen animals examined, one animal, Sy7518 (12.5 m, male, see Table 6 and Appendix III) showed considerably distinct characters which make the animal be distinguished clearly from the others. It is, however, still obscure whether or not the animal could be said as allopatric forms since no reproductive conditions were examined. It was suggested that one of the most important external characters should be examined for the North Pacific Bryde's whale was the overall morphological characters for the filtering apparatus such as the length of baleen series, whole shape of the apparatus, nature of bristles and the filter area. There found at least two types of Bryde's whales in the regions concerned: the first one is quite less in the number of ventral grooves, lower but broad based in dorsal fin, very coarse and considerably small in its filter area. All of these suggests its closer character to the Bryde's whale proper whereas the second one is almost opposite character to the former in may respects with some intermediate varieties and showed somewhat similarity to sei whale. There seems two more possible populations in the North Pacific Bryde's whales: the first one is largely found in the pelagic waters of the North Pacific, and the other is in the waters off west coast of Kyushu. A possible invasion of the former population into Sanriku, Northwest Pacific is suggested.

*Sci. Rep. Whales Res. Inst.,*
*No. 28, 1976, 1-35.*

## INTRODUCTION

The North Pacific Bryde's whale is one of two mysticete species to be caught currently by Japanese whaling both in pelagic and coastal waters, and provides an important components among the total catches. Although its taxonomical problem against sei whale in the North Pacific region seems to have been settled by establishing the species which occurs and predominates widely over the warmer waters in the Pacific region (e. g. Omura, 1966a; 1974), little has been studied concerning to its general biological characteristics including the diagnosis for the subspecies or the races. A considerable variations in external appearance for the North Pacific Bryde's whales such as the case known in the South African population (Best, 1970; 1974) have been noticed through the previous studies (Omura *et al.*, 1932; Omura and Fujino, 1954; Omura, 1959, 1962), but the matter was left behind from the further consideration. One of such problem may be found in the intraspecific and morphological variations by occurring localities over the world oceans in large and/or small scale, and the variations are, to some extent, possibly related to the difference by local populations or stocks. It is, therefore, the current problem to elucidate whether any racial defference or allomorphological forms could be found in the North Pacific Bryde's whale. Althouh it has been noticed that there must be some differences in the character of baleen plates taken from the Bryde's whales caught in the North Pacific region, little attention was paid for this matter until we got the knowledge from the South African waters. More recently, however, Masaki (1975) compared the baleen plates of North Pacific Bryde's whales with a hope to distinguish their local populations by examining width-length ratio and some morphology for the bulk of baleen plates collected at many localities over the North Pacific regions along with the recovery data of tagged whales. Masaki (1975) considered that there must be at least two possible subpopulations of Bryde's whales in the North Pacific: the first one is restricted in the waters west of 150°E longitude, while the second one is found in the pelagic region lies between 160°E and 160°W longitudes. However, as far as the figures given by Masaki (1975) are concerned, there seems some difference in the pelagic population which could be separated each other somewhere between 170°E and 180° longitutdes. Under these circumstances, the main purpose of our study was to know and, if it was present, was to find out some critical and well representing external characters showing an intraspecific variation by which the racial difference of Bryde's whale population might be suggested. In the course of examining Bryde's whales at the landstations both in Ayukawa and in Onagawa, northern Japan, we noticed that there were some intraspecific differences in the general structure and the nature of filtering apparatus for the Bryde's whales although the present result should be considered still tentative due to so small number of animals observed. The result is presented briefly in this report along with some considerations.

## MATERIAL AND METHOD

During 24 July to 3 August 1975 following number of whales were caught and examined in Sanriku region:

| Land Stn. | Company | Bryde's | Fin |
|---|---|---|---|
| Ayukawa | Taiyo Gyogyo | 9[1] | 1 |
| Ayukawa | Sanyo Hogei | 4 | — |
| Onagawa | Nippon Suisan | 2[2] | — |

1) No observations for one carcass.
2) Examined only baleen plates for one of two carcasses.

A total catch figure for the Bryde's whale at four land stations during baleen whaling season, May to October 1975, was 116 animals (♂45, ♀71) in all, of which the majority (86.2%) was caught during the months of May to July, so the time when we examined the animals was almost near at the end of Bryde's whaling season. One out of fifteen Bryde's whales landed was not examined. Observed result on a fin whale at Taiyo Gyogyo was not treated in this report except an item for Table 2.

An ordinal biological observations on carcasses were carried out as much as possible for 14 animals. However, the observations on carcasses have had to be done by only one person in the field, no measurements of so-called bodily proportions were made except several measurements for minor part of body for the later convenience (Appendix I). In this survey we focussed our observations especially on measuring the structure of filtering apparatus in general since it was supposed that the differenciation of intraspecific variation as an external character in Bryde's whale would likely be well resulted both in feeding habits and in the form or the character of filtering apparatus through the cetacean evolution.

As for counting the number of so-called baleen plates we followed to the suggested definition by Williamson (1973), that is, when the width of baleen plate has three or more times of its thickness at gum level, we counted it as the 'real baleen plates'. Diameter of baleen bristles was measured at three points, tip, middle and base, under the microscope with a aid of micrometer mounted in the eyepiece. To calculate the whole area of filtering apparatus we measured the overall length of baleen series along gum level and also the length from the base of palatal ridge to the tip of baleen plates section by section so as to be figured out the unfold shape of filtering apparatus on the sectioned paper. By this treatment the filter area was calculated by counting the number of unit squares encircled by the figure. Another minor ways of observations and measurements were described elsewhere in the text where it was thought to be necessary.

## RESULT

(1) *General descriptions*

The Bryde's whales examined were consisted of 8 male and 6 female with the body length of ranging 10.1–12.7 m (Av. 11.78 m) in the former and 10.8–14.2 m (Av. 12.93 m) in the latter. All these animals were caught in the whaling ground formed some 140–280 nautical miles east off the coast of Sanriku region where relatively high surface sea temperature of above 23°C prevails during mid summer (Figs. 1-a, 1-b). Shift in the location of Bryde's whaling ground was not found when it was compared with the locations occupied in 1953 operations (Omura and Nemoto, 1955). One female of 14.2 meter (Sy7519 animal) carried a well burried steel tag (No. 0789, Fishery Agency Japan) in the midst of her right side back between blow-holes and dorsal fin. The tag had been shot at 26°08′N, 143°00′E on 8 May 1950 and has been reported as sei whale of 38 feet (11.6 m). Thickness of the blubber ranged 4.0–5.5 cm in six measured animals, and that of mammary gland in two animals was 1.5 cm (Sy7519) and 3.0 cm (Ty7544) respectively. No lactating animals were found. Since carcasses are largely cut opened at their ventral cavity to keep the meat more fresh, the stomach contents, reproduction organs and foetus are washed off and lost very

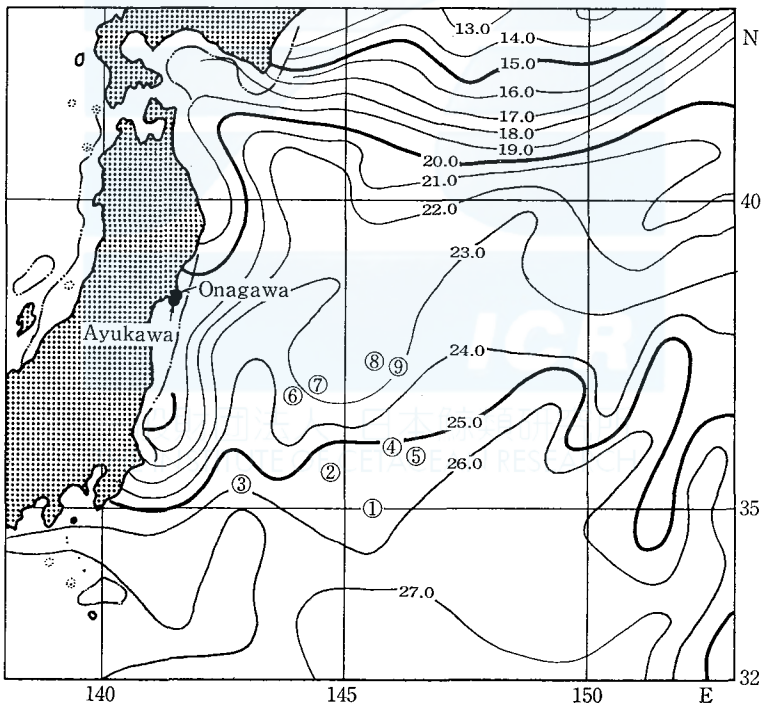


Fig. 1-a. Distribution of surface sea temperature (Japan Meteolological Agency, 1975) and the location of catch in the late July, 1975. (1) Sy7518, (2) Ty7544, (3) Ty7541, (4) Sy 7519, (5) Ty7543, (6) Ns7564, (7) Ns7563, (8) Ty7546, (9) Sy7520.

often while the animal was on the way towing back to the land station. Neither foetuses nor the condition of reproductive organ for female were observed, and consequently the data on the reproductive condition are unavailable in this study. Contrary, weight of testis was obtained from three animals; it was 1.2, 2.1 (Sy7518); 0.4, 0.3 (Ns7563): and 0.2, 0.1 (Ns7564) (Kg) respectively. Comparing these figures with those found in South African waters (Best, 1974), the above animals were adolescence of sexually immature.

Number of ventral grooves was counted at the anterior insertion of flipper on the visible half of body and the number was doubled. The obtained number varied from 50 grooves to 70 (Av. 62) through four animals. It is note worthy that one animal (Sy7518) showed only 50 grooves while another three were over 62.

Abundance of white scar on the epidermis varied considerably by each animals. Number of scar counted in most animals was found somewhere between 15–40 scars on the visible half side of abdomen, and it gave an appearance of moderate state in scarring except two animals which were quite heavily scarred with an appearance of like a newly galvanized iron or zinc plate. One animal (Sy7518), however, was exceptionally smooth in its epidermis with very little number of white scars and, still more, the open pit was completely absent from

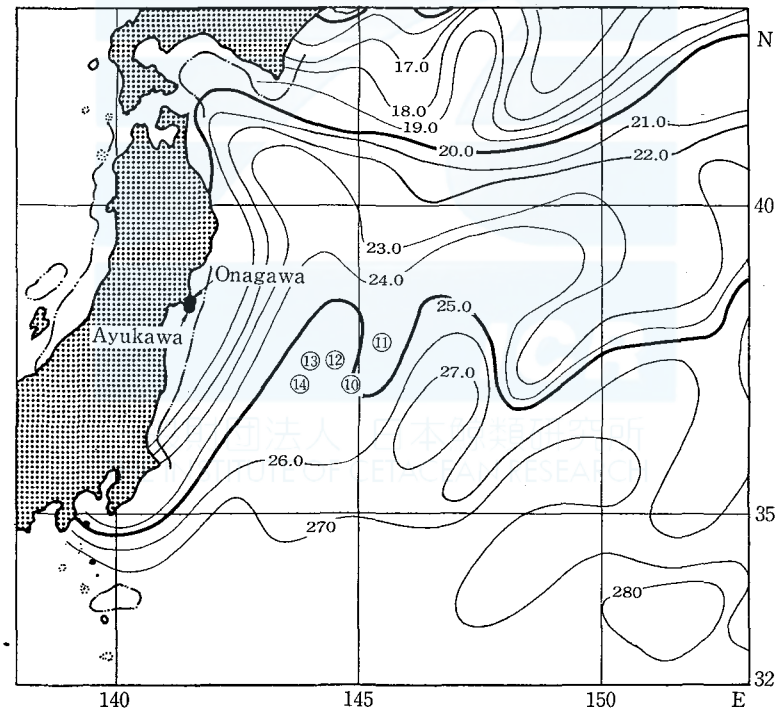


Fig. 1-b. Distribution of surface sea temperature (Japan Meteolological Agency, 1975) and the location of catch in the early August, 1975. (10) Ty7541, (11) Ty7548, (12) Ty7550 (13) Ty7549, (14) Sy7521.

its surface. Usually 1-4 of oval shaped open pits was found in lumber part, flipper and in the upper surface of the rostrum. The measured dimensions of open pit was 8.0×4.5 cm and 3.9×6.7cm or thereabouts, and these sizes for open pits are likely to represent through the animals examined. It is unknown whether the scratched scars were on the under surface of tail flukes.

There found at least three kinds of ectoparasites in some animals though they were not infected altogether on a definite carcass. The parasitic organisms found were *Xenobalanus, Pennella* and stalked barnacles, but both juvenile and adult forms of *Balaenophylus* sp. were found on the surface of larger sized baleen plates in every animals.

Very few of stomach contents were observed, since it was, as mentioned before, also cut open while towed back to the land station. However, four animals had luckily kept some amount of stomach contents. The kind of foodstuff was consisted of young pacific mackerel, *Pneumotophorus japonicus japonicus* of about 13.5-15.6 cm in fork length in three animals. *P. japonicus japonicus* occurs very abundantly over the Sanriku region toward considerable pelagic region (Kawamura, 1973) during northern summer, and even migrates into the Ayukawa harbour. The another one was said to have kept euphausiids. Although no specimen of this euphausiids was collected, it might considered probably be *Euphausia pacifica*, since the bulk of this species occurs in the whaling ground off Sanriku region (Komaki, 1967) and also having been found in the stomach of blue, fin, sei (including Bryde's) and humpback whales (Nemoto, 1959).

Collected ear plug and female reproduction organ are usually sent to the Far Seas Fisheries Research Laboratory, Fisheries Agency, when the whaling season was closed, and the age of whales concerned is not yet known to the authors as of March 1976.

In the observations on the general external appearance of Bryde's whales examined, there found no distinct characteristics which may enable to distinguish from one another. However, as it was suggested before, one animal of 12.5 m female (Sy7518) was found to be rather different in its external characters, viz. so small number of ventral grooves along with smooth and little scarred good looking epidermis. This coasely grooved throat well corresponds to that of 'sei whale' caught in the Bonin Islands whaling ground (Omura *et al.* 1952).

2) *Proportions*

It does not seem to enable in obtaining any conclusive different characters from the present data on body proportions since only several minor measurements were made sporadically (Appendix I). However, some measurements would be worth to be mentioned in connection with the results on the filtering apparatus. To show rather distinct difference in some animals from the rest, we extracted some figures from the overall data and summerized in Table 1.

Measurements other than Table 1 showed very well coincidence with all

TABLE 1. PERCENT FIGURES FOR SEVERAL NUMBER OF MEASUREMENTS AGAINST BODY LENGTH SHOWING THE ANIMAL WHICH LARGELY DIFFERED FROM THE OTHERS.

| Measurements | No. of animal measured | Average (%) | Figures for prominent difference from the average (%) | Animal |
|---|---|---|---|---|
| Length of a row of baleen plates along the gum level | 8 | 21.85 | 19.20 | Sy7518 |
| | | | 17.59 | Sy7521 |
| Length of ridge on the head | 11 | 11.20 | 6.80 | Sy7518 |
| | | | 9.27 | Ty7546 |
| Distance between Yakobson's organ and the tip of snout | 12 | 0.76 | 1.43 | Ty7543 |
| | | | 1.31 | Sy7519 |
| Dorsal fin: (a) anterior edge | 8 | 5.10 | 6.56 | Sy7518 |
| (b) width | 9 | 4.24 | 5.84 | Sy7518 |
| | | | 3.14 | Ty7550 |
| (c) Height | 12 | 2.47 | 1.93 | Ty7546 |
| | | | 2.04 | Ty7550 |
| Flipper: (a) anterior edge | 12 | 12.60 | 14.29 | Ty7547 |
| | | | 14.38 | Ty7550 |
| (b) width | 12 | 2.44 | 1.69 | Ty7548 |

animals examined, and could be discarded from the considerations. As far as Table 1 is concerned, several animals which showed different proportions could be picked up. Among those animals enlisted in Table 1, Sy7518 animal which was very coarsely grooved and smoothly skinned animal, showed significantly different proportions from the others especially in the length of rostrum, palatal ridge, baleen series, and dorsal fin, giving highest frequency in the number of deviated measurements. Proportions for dorsal fin in Sy7518 animal showed very low and broad triangle which was quite characteristic from the others. The dorsal fin of like this shape had been also known in the 'sei whale' of southern type which occurs in the Bonin Islands waters (Omura *et al.* 1952). This animal as going to be metioned later was also different at two most important measurements while majority of the rest were only distinct at more less important ones. Best (1974) suggested the difficulty to distinguish both inshore and offshore forms of Bryde's whales only by a morphometric examinations due to so frequent occurrence of intermediate forms. From the overall results already mentioned, however, it might be considered that there seems to be at least two or three unusual animals which could be distinguished at several measurements on the external characters.

3) *Filtering apparatus*

Filtering apparatus in baleen whales would be one of the most important external characters should be examined closely for the consideration of intraspecific variation or racial problem of whale population until we will have got more biological, physiological, and ecological knowledge on the species concerned. Results obtained are summerized and given in Appendix II.

a) Row of baleen plates

Both the length of a row of baleen plates along gum level and that along palatal ridge are indispensable agents for calculating the area of filtering apparatus. For those animals which had not measured those length above mentioned, it was able to estimate reasonably by drawing the actual unfolded shape of filtering apparatus with the aid of measurements for inside of the filter obtained section by section at every 30 to 50 cm intervals.

The overall length along gum level varied for 190.0–314.0 cm through ten examined animals while the length along palatel ridge was 190.0–285.0 cm. As it was given in Appendix I and Table 1, proportional figures for the length along gum level was small in Sy7518 and Sy7521 animals. Fig. 2 demonstrates

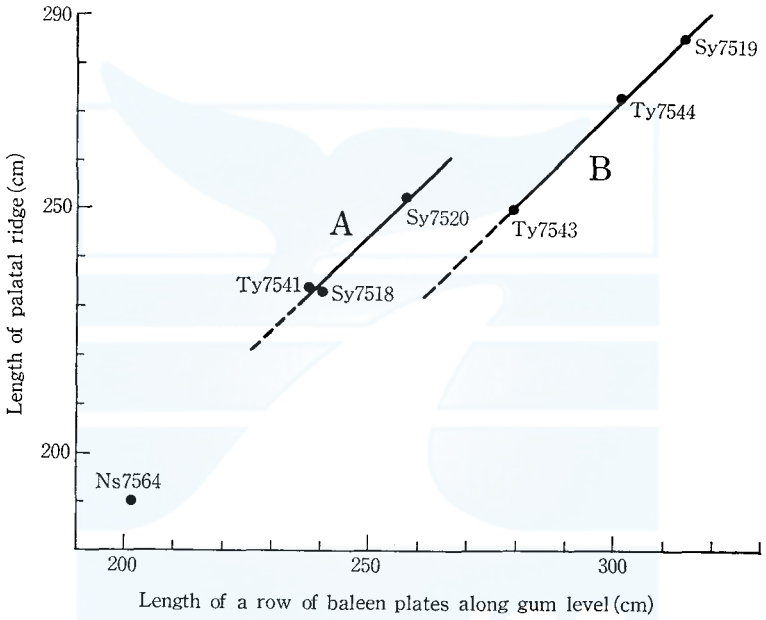


Fig. 2. Length both for a row of baleen plates and for the palatal ridge.

TABLE 2. RATIO FOR THE TRANSVERSE LENGTH OF FILTERING APPARATUS(A) AGAINST ITS MAXIMUM SPREAD ALONG BALEEN SERIES(B).

| | Body length (m) | Animal | B/A |
|---|---|---|---|
| Male | 10.1 | Ns7564 | 0.35 |
| | 12.5 | Sy7518 | 0.37 |
| | 12.6 | Ty7543 | 0.45 |
| | 12.7 | Sy7520 | 0.42 |
| Female | 13.7 | Ty7544 | 0.44 |
| | 14.2 | Sy7519 | 0.40 |
| | 15.3 (Fin) | Ty7542 | 0.42 |

the relationship between both above mentioned lengths. From this figures it is observed that there are two different characters in the general structure of filtering apparatus, that is, rather slender shaped apparatus as shown by the line A in Fig. 2 and more oval shaped one which belongs to the line B. This relationships are more well represented in Table 2. The calculated ratio for the maximum spread connecting tip to tip of both sides of baleen plates against the length of palatal ridge showed that there are two kinds of clearly different figures which are comparable with Fig. 2. Both Ns7564 and Sy7518 animals showed considerable slender shape in their filtering apparatus, but they must be considered separately as being different each other since the former seems to be possibly resulted from its younger age, while the figures for Sy7518 animal, must be noted along with the large enough body length. Although those two different figures are found among male animals, the difference would not be due to the sex.

b) Number of baleen plates and hairs

A total number of so-called baleen plates in a series of baleen plates was counted. The figures as given in Appendix II varied between 254 and 325 plates through eleven animals with 283.5 plates as an approximately averaged number. By comparing these figures with those by Omura *et al.* (1952), majority of the number of baleen plates in the present study was less than 290 plates, and well agrees to that known in the southern type of 'sei whales' from Bonin Islands waters except Ty7541 and possibly Ty7544 animals both of which showed somewhat more ordinal sei-whale-like characteristics. However, the overall variation between each animal seems to be still within an allowable range as Bryde's whale species, and the data provided by Best (1974) for the Bryde's whales of both South African and Chilean waters also suggest variable in that character, though the number of baleen plates of somewhere between 270 and 290 may be a reasonable figures for the Bryde's whales over the many localities.

Quite insufficient data are available for the number of creamy white hairs and plates arranged on the distal end of baleen series as it has been known in fin, minke and some sei whales. As far as the available data are concerned, there was found no clear difference or tendency between animals and also between both right and left baleen series in the amount of creamy white hairs and plates. Intraspecific variation is unlikely to be figured out from this kind of character although there found some noteworthy difference between both right and left sides in Sy7518, Sy7519 and Sy7520 animals. It is, however, still unknown whether those difference or variation are significantly responsible to such a extent as to show a difference of races or allopatric forms.

c) Baleen plates

The shape of cross sectioned beak at cranial to blow-holes was reported as relating agent at least to the morphological difference in both sei and Bryde's whales (Omura, 1962). In connection with this relative angle ($\theta$) which is formed by the outer edge of baleen plate against vertical axis was measured (Table 3). To measure the angle actually, the gum line was adopted as one of two angle

TABLE 3. RELATIVE ANGLE FORMED BY THE LINE AT GUM LEVEL AND THE OUTER EDGE OF BALEEN PLATES.

| | Animal | Body Length (m) | Angle ($\theta$) |
|---|---|---|---|
| Male | Ns7564 | 10.1 | 50.4 |
| | Ns7563 | 11.1 | 53.6 |
| | Ty7547 | 11.2 | 48.5 |
| | Ty7541 | 11.5 | 53.1 |
| | Sy7518 | 12.5 | 49.2 |
| | Ty7549 | 12.5 | 53.6 |
| | Ty7543 | 12.6 | 52.1 |
| | Sy7520 | 12.7 | 49.8 |
| Female | Sy7521 | 10.8 | 47.4 |
| | Ty7548 | 11.2 | 43.6 |
| | Ty7550 | 13.7 | 50.0 |
| | Ty7544 | 13.7 | 53.4 |
| | Ty7546 | 14.0 | 48.8 |
| | Sy7519 | 14.2 | 56.3 |

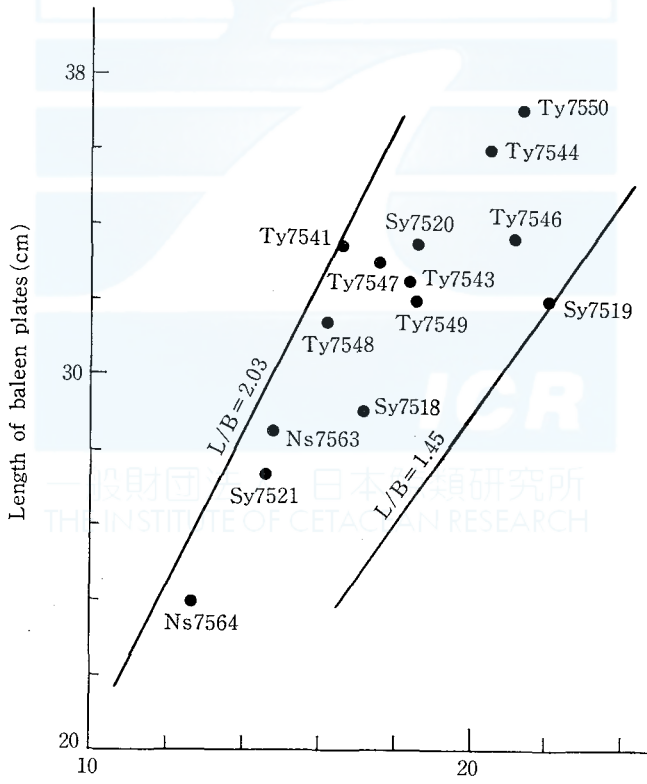


Fig. 3. Width and length of largest baleen plates.

forming basal lines. Consequently, it means that the larger in this angle the more well the baleen plates hanged vertically. The upper and lower extremes for this angle were 56.3° and 43.6° respectively. The general trends in the frequency of this angle seem to change proportionally with the increase or decrease in body length, and this tendency could be considered along with the whole shape of filtering apparatus, viz. length-spread ratios in a series of baleen plates (see Table 2). Some animal showed well horizontally spreading baleen series while another were not. The angle varied so randomly over the examined animals and no significant relationship for the better understanding of an intraspecific variation was found among this characters.

The width-length ratio (=quotient) for the largest baleen plates has been one of the most well examined characters in many previous studies. This figure as given in Appendix II and as demonstrated in Fig. 3 varied between 1.45 and 2.03 with an average of 1.79. From Table 3 and Figs. 4 and 5 which were given by Omura *et al.* (1952), it can be said that the lower the value in this ratio the more closer character is seen as orignally known Bryde's whale itself. In this point of view, following three animals, Sy7518, Sy7519 and Ty7546 showed relatively small width-length ratio than the rest and, consequently, they should be considered to keep somewhat distinguishable character in their baleen shape than the others. Only in Ty7541 animal exceeded in the ratio. Although all the figure obtained was in the range which had been found in Bonin Islands population (Omura and Fujino, 1954) when Fig. 3 is compared with the result as demonstrated by Best (1974), it might be said that the majority of animals in this study carried a similar character with that known in offshore form of the South African waters while those above mentioned three animals were more closer character to one of two forms found in Brasilian waters.

In Bryde's whale, however, there found no only one or two most prominent size of baleen plates but they are found for a section of baleen series consisting of several tenth number of baleen plates to be the same size while their width varies as shown by the function of width-length ratio among them for about 0.5 (Fig. 4). This suggests that it would be very hard to consider and/or try to find out the variations only by means of the width-length ratio of baleen plates unless one gets larger enough difference in that figures.

d) Number of minor baleen plates

Small brush-like baleen plates (=minor plates) are furnished between the inner most end of main plates and the base of palatal ridge (see Williamson, 1973, Fig. 8). The minor baleen plates form also an important filtering meshes on the ceiling of upper jaw. The number of minor plates including a very tiny stump of hairs varied along with both the position of main baleen plates and animals within 5 to 13 plates with three exceptions. Usually the number did not vary much within an animal and may not be so significant character for the purpose of this study (Fig. 5).

e) Baleen bristles

The character of hair-like bristles (=fringes) which finally form straining

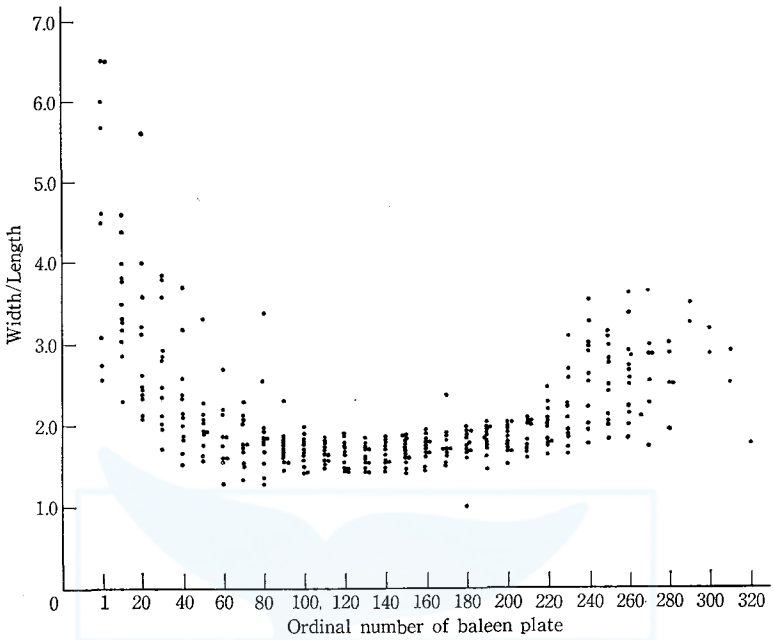


Fig. 4. Variation in the width-length ratio by the part of baleen series.

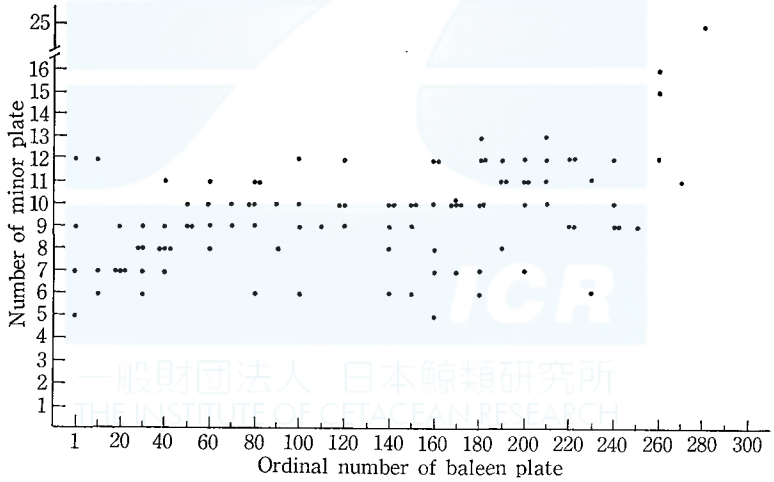


Fig. 5. Variation in the number of minor plates.

meshes of filtering apparatus are considered as to be one of the most important agents should be examined more closely. Since baleen bristles are easily damaged through the sampling and examining process on baleen plates, no measurements on their length were made but examined and measured only their thickness in terms of diameter and the number of bristles per unit length of inner margin of baleen plates.

As it is noticed in the figures on Plate II there were found two kinds of bristles which can be easily distinguished by their appearance: the first one is very long and thick structured in its diameter and streches out straight. This bristles obviously form the main body or structure of the fringe of baleen plates. The second one, on the other hand, is very thinly structured bristles with a trace or an appearance of folding in zigzag shape at one or more angles. This kind of bristles make the filtering apparatus to be more finer netting by entangling with both kind of another bristles from several neighboring baleen plates to result a role as a sort of 'connecting tissue' throughout the baleen series. This thin and zigzagged bristles are very fragile at their angled corners where the bristles are rather flattened like a ribbon string, and are easily damaged by the angles.

By distinguishing above two kinds of baleen bristles, one of author (A. K.) counted their number per unit length of inner edge of baleen plates to give a density which may show the extent of coarseness of netting in filtering apparatus. The determination of density in baleen bristles was made approximately at the halfway of inner margin of the largest baleen plates by sampling all bristles within 2.0 cm length since 1.0 cm as a sampling unit length was considered to be too small for this purpose. The number combined both kinds of bristles varied for 39–85 per 2.0 cm unit length with an average of 60.9 bristles per 2.0 cm. To see the overall result most animal carried the straight and thick bristles of about 1/3 to 1/4 of the number of zigzagged ones. On closer examination, however, it can be noticed that these proportional balance in the number of both kinds of bristles are deformed in both Ty7541 and Sy7518 animals. The former completely lacks the zigzagged bristles and the latter was very little in the number of slightly zigzagged bristles which can be considered almost straight appearance (Fig. 6). The latter was very similar to those found in the animals from Bonin Islands waters previously. In Fig. 6 some additional data which were obtained from another baleen plates of Bryde's whales from various localities were plotted. The result make the authors complicated at their considerations: that is, the all results obtained from our previous collections showed almost or complete lack in the number of zigzagged baleen bristles. They were very similar to the character found in Sy7518 animal. Some of them undoubtedly must have been damaged to result bearing no thin and zigzagged bristles. However, the number of straight bristles as demonstrated in the figure suggests that the animals of previous collection were well luxuriously furnished with straight bristles than the majority of animals in the present study, and only Sy7518 animal corresponds to those figures from the preserved materials. Besides, Ty7541 animal showed also an exceptional character in the number of straight bristles. As far as Fig. 6 is concerned, it can be said that most animals in the present study showed a character of more sei-whale-like Bryde's whales. In Fig. 6 the position where the Bryde's whales from the pelagic waters of the North Pacific or those from the coastal waters off western Kyushu would be placed may be an another interests. This will

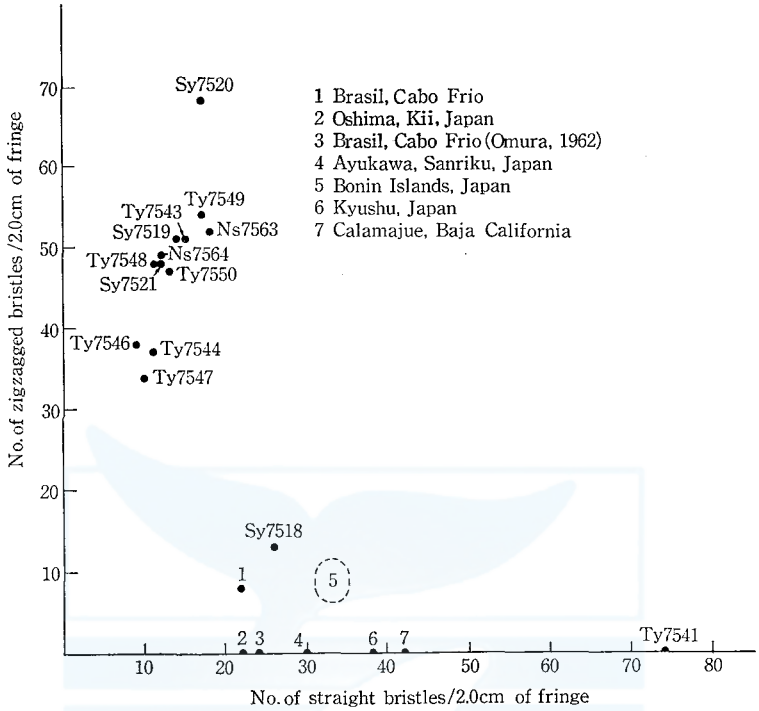


Fig. 6. Density of the two kinds of baleen bristles by the animals from various localities.

TABLE 4. PROVISIONAL CLASSIFICATION FOR THE TYPES OF BALEEN PLATES BASED ON THE MEAN DENSITY OF BRISTLES (NO./2.0 cm).

| Type | Kind of bristles | | Total | Corresponding animal |
|---|---|---|---|---|
| | Straight | Zigzag | | |
| I | 50 | 6.5 | 67 | Ty7541, Sy7518 |
| II | 10 | 36.3 | 43.3 | Ty7547, 7544, 7546 |
| III | 13 | 49 | 62 | Ty7543, 7548, 7550 Ns7564, Sy7519, 7521 |
| IV | 17.3 | 58+ | 76 | Ty7549, Sy7520 Ns7563 |

be mentioned later in *Addendum* and demonstrated in Fig. 12. The result seems very important external character for the better understanding of an intraspecific variations though the matter needs still more accumulation of further evidences. In connection with this the present data concerning to the character in the density of baleen bristles can be summerized by distinguishing the four provisional types of characteristics in the netting of filtering apparatus (Table 4).

Thickness of straight bristles was observed under the micrometer by

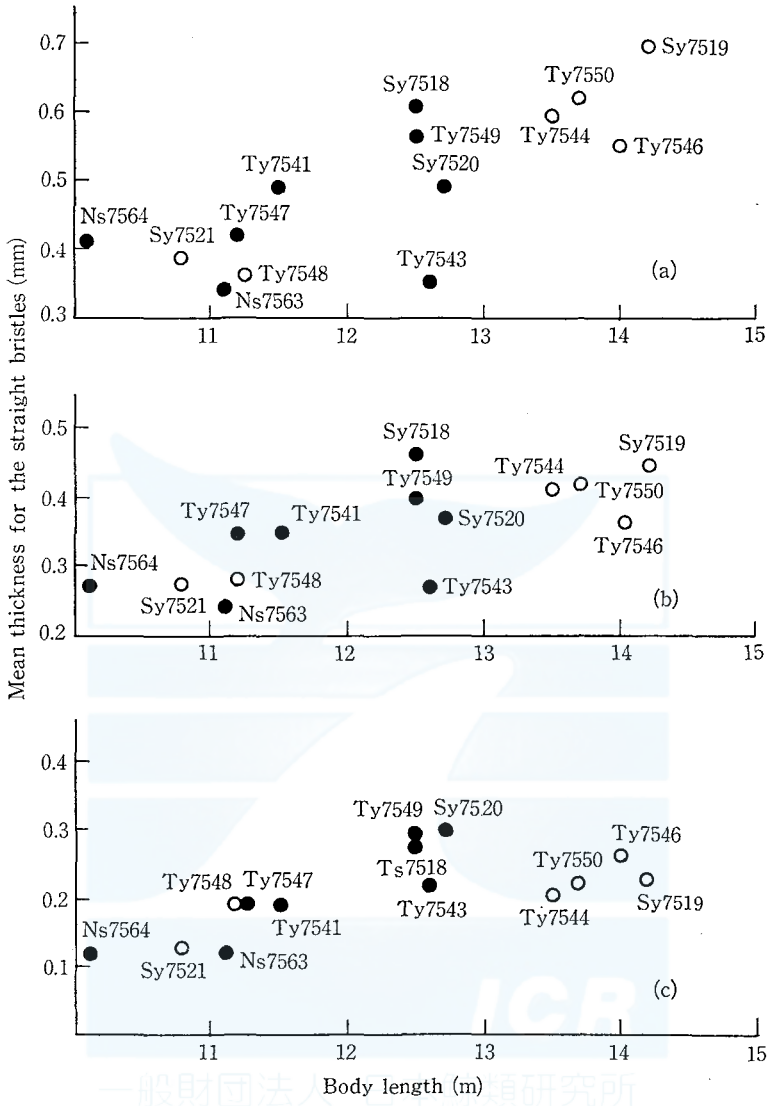


Fig. 7. Thickness of straight baleen bristles at the base (a), middle (b), and at the tip (c) for 14 animals. Shaded circles are males and open ones are females.

measuring their diameter on five pieces of the bristles per animal at their base, middle, and at the tip, and each measurements were averaged. Measurements at the base may give the most reliable figures since those bristles, mere or less, might have possibly been damaged. The straight bristles are tapered toward the tip, and grow thicker with an increase in body length (Fig. 7). Each measurement distributes within some reasonable ranges in many animals with varying trends with their body length. However, as clearly shown in Fig. 7, diameter at the base for Sy7518, Ty7541 and Ns7564 animals were rather unusually thicker

than the rest while Ty7543 animal was quite thin in the diameter. The former two are note worthy for their corresponding figure to the type I of baleen plates which almost or completely lack the zigzagged bristles (see Table 4). Comparing the figures at the base with those at the middle and tip, the latter two animals, Ty7543 and Ns7564, both are considered to be rather normally charactered in the nature of their bristles. No difference by sexes was observed. As far as the Fig. 7 is concerned, the Bryde's whales which bear on no zigzagged bristles are furnished with robust and thicker baleen bristles to give a typical character of general qualities of baleen plates having been known in the 'southern type' of sei whales (Omura and Fujino, 1954). Table 5 shows averaged diameter of bristles, and Table 6 does similar data obtained in the animals from various localities. By comparing those figures, it might be suggested that there were at least two forms of bristles. The first one is very thick bristles of more than 0.5–0.6 mm in diameter at the base, and the second one is more thin bristles less than about 0.5 mm. In connection with the South African animals (Best, 1974), the occurrence of Bryde's whale similar to those offshore form in Japanese waters is evident. Although the details about animals from various localities are not known well, all data suggest similar character to those obtained in present study. Some animals, however, clearly showed their more prominent character with finer netting which can be distinguished easily from the another extremes.

In addition to morphometrical difference, coloration of the bristles was distinct in Sy7518 animal: in this respect the bristles of this animal showed completely creamy white even at the base of bristles while the others showed rather greyish white with brownish coloration at the base.

f) Area of filtering apparatus

The row of baleen plates was measured section by section at both its length from the gum level to the tip of baleen plates and from the base of palatal ridge where the arrangement of minor baleen plates ends to the tip of main plates. Using this two series of measurement, filter areas which are formed by both outer surface of a row of baleen plates (expressed by *So* in Appendix II) and inner surface (expressed by *Si* in Appendix II) were calculated on eleven animals. The filter area for inner surface possibly effects on substantial ability of animals to straining out the foodstuff engulfed, and consequently, it gives much larger figures than that formed by the outer surface. The averaged filter area through examined animals was 1.14 squaremeters for the outer surface while it was 1.82 squares meters for the inner surface respectively. As we can see in the column of *Si/So* in Appendix II, the area for the inner surface keeps 1.46 to 1.76 (Av. 1.61) times larger figures than that for the outer surface. Fig. 8 demonstrates the type of whales by the schema which may be classified by the relationship of the filter area between both outer and inner surfaces. In the schema the ratio for *Si/So* in right whale, for instance, may possibly show close to 1.00 and give a regression of an angle of about 45 degree. When the schema is introduced to the case in Bryde's whale, then the figures can be expressed

TABLE 5. AVERAGED THICKNESS OF BALEEN BRISTLES.

| Animal | Base | | Midst | | Tip | |
|---|---|---|---|---|---|---|
| | Str. | Zig. | Str. | Zig. | Str. | Zig. |
| Ty7541 | 0.49 | 0.45 | 0.35 | 0.30 | 0.19 | 0.22 |
| Ty7543 | 0.35 | 0.28 | 0.27 | 0.25 | 0.22 | 0.18 |
| Ty7544 | 0.59 | 0.48 | 0.41 | 0.32 | 0.21 | 0.18 |
| Ty7546 | 0.54 | 0.41 | 0.38 | 0.32 | 0.26 | 0.21 |
| Ty7547 | 0.42 | 0.27 | 0.35 | 0.26 | 0.19 | 0.19 |
| Ty7548 | 0.36 | 0.30 | 0.28 | 0.22 | 0.19 | 0.16 |
| Ty7549 | 0.56 | 0.35 | 0.40 | 0.29 | 0.29 | 0.22 |
| Ty7550 | 0.62 | 0.45 | 0.42 | 0.28 | 0.22 | 0.20 |
| Sy7518 | 0.60 | 0.44 | 0.46 | 0.32 | 0.28 | 0.32 |
| Sy7519 | 0.69 | 0.37 | 0.45 | 0.26 | 0.23 | 0.17 |
| Sy7520 | 0.49 | 0.28 | 0.37 | 0.26 | 0.20 | 0.19 |
| Sy7521 | 0.39 | 0.27 | 0.27 | 0.20 | 0.13 | 0.14 |
| Ns7563 | 0.32 | 0.23 | 0.24 | — | 0.12 | — |
| Ns7564 | 0.41 | 0.37 | 0.27 | 0.19 | 0.12 | 0.14 |
| Av. | 0.4879 | | | | | |

TABLE 6. THICKNESS OF STRAIGHT BALEEN BRISTLES IN BRYDE'S WHALES FROM VARIOUS LOCALITIES.

| Body length (m) | Sex | Thickness of bristles (mm) | | | Locality |
|---|---|---|---|---|---|
| | | Base | Midst | Tip | |
| — | — | 0.43 | 0.38 | 0.29 | Baja California[1] |
| 12.5 | M | 0.58 | 0.32 | 0.24 | Cabo Frio, Brasil[2] |
| 12.2 | F | 0.55 | 0.48 | 0.27 | Oshima, Kii, Japan |
| 13.1 | F | 0.67 | 0.46 | 0.31 | Bonin Islands |
| 13.1 | M | 0.64 | 0.40 | 0.29 | Cabo Frio, Brasil |
| — | — | 0.35 | 0.24 | 0.18 | Kyushu, Japan |
| 13.4 | F | 0.59 | 0.33 | 0.23 | Ayukawa, Japan |
| — | — | 0.46 (0.19~0.84) | | | South Africa, inshore[3] |
| — | — | 0.49 (0.22~1.11) | | | „ „ offshore[3] |

1) Collected by Dr. R.L. Brownell Jr. Baleen plate was possibly not from the largest part, and no details about the animal are known.
2) For further details, see Omura (1962b).
3) Best (1974).

as given in Fig. 8. As far as the Fig. 8 is concerned, there seems to exist two slightly different groups among the examined Bryde's whales: one shows more closer character to sei whale (suggested by line I) and the other does more likely to Bryde's whale proper (II). One of another data for the filter area in Bryde's whales is available (Nemoto, 1970). By quoting Nemoto's data, Kawamura (1974) figured the filter area of slightly less than 1.7 square meters in

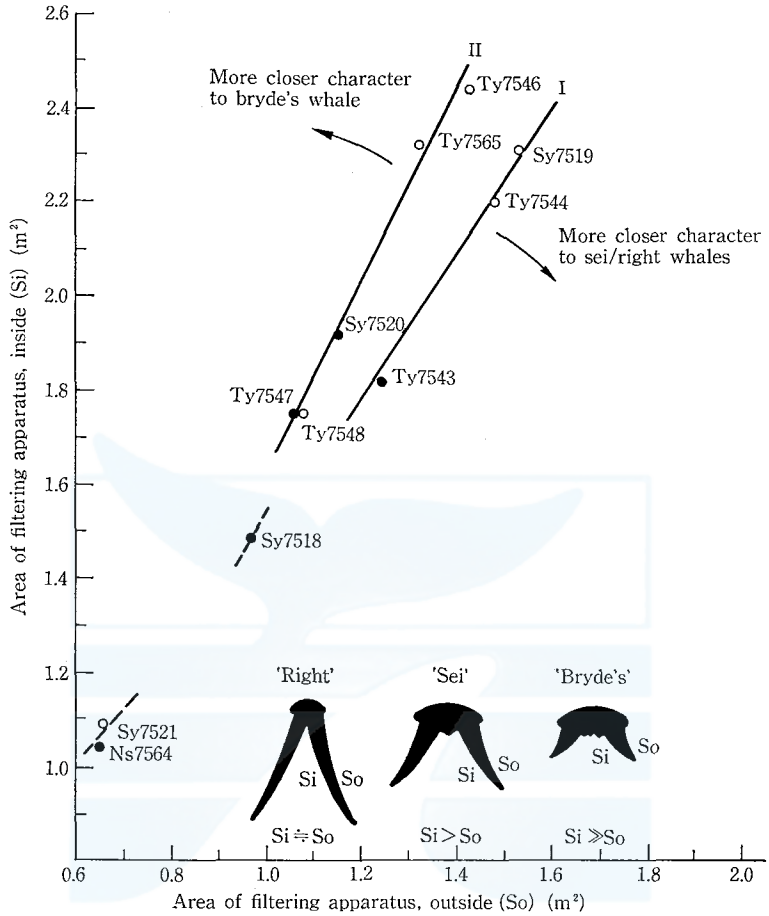


Fig. 8. Filter areas for both outside and inside surfaces along with the schema of showing area size relationships.

15 meter Bryde's whale. This relative figure well corresponds with the area found in Sy7518 animal. If we extraporate this size of whale into the regression as given in Fig. 9, then we will obtain about 2.5 square meters of filter area (see also Kawamura, 1974, Fig. 8-6). What the above mentioned suggests is that there might present at least two different types of Bryde's whales both of which are presumably distinguishable by comparing their filter area. It is still unknown whether above mentioned grouping is valid for distinguishing the intraspecific variation in the North Pacific population of Bryde's whales, those figures for filter area strongly suggest a validity for this purpose of study by accumulating more amount of data.

Fig. 9 demonstrates the relationship between the areas of filtering apparatus for both inner and outer surfaces and their corresponding body length. To see the figure it may be noticed that there are two important characters among

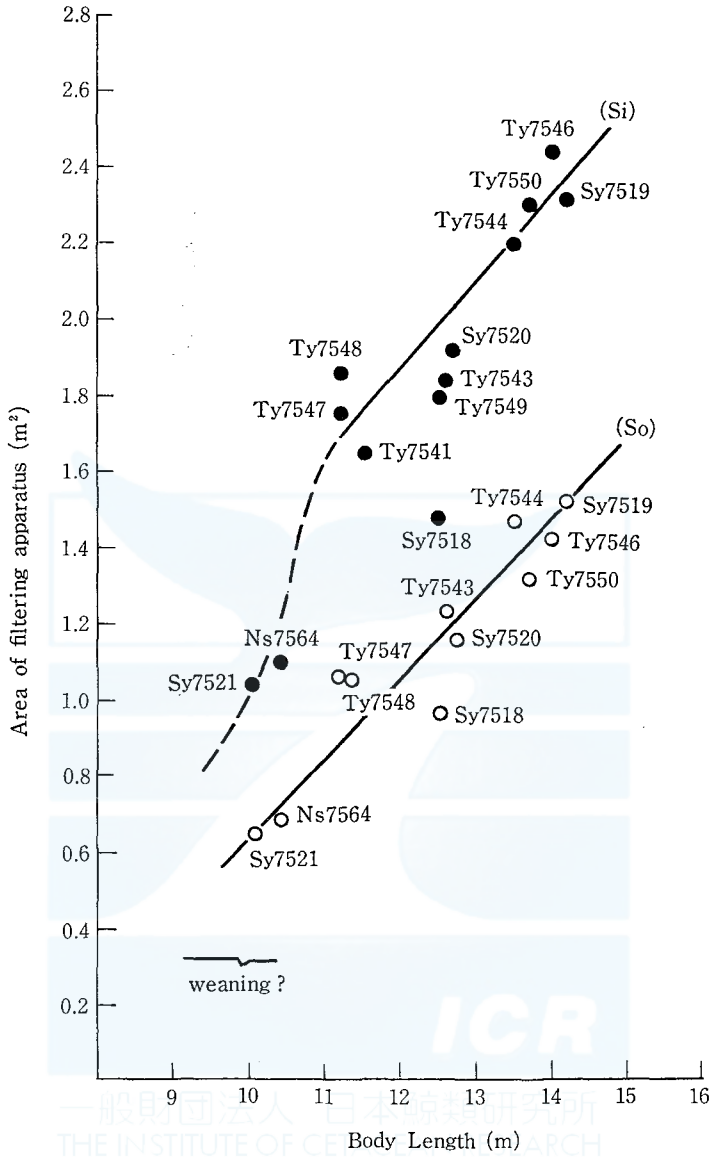


Fig. 9. Area of filtering apparatus against body length. Black spot and (Si) indicate the filter area for inside surface, and open circle and (So) indicate the filter area for outside one.

the examined animals. The first is found in relatively small filter areas compared with body length such as Sy7518 animal. The second one is found in both Sy7521 and Ns7564 animals. It should be noted, however, that these latter two animals do not differ from the relationship shown by the majority at their outer surface area (*So*), but agree well to the regression in general. By

consulting also with the data given in Table 2, the filter area for the inner surface in two above mentioned animals would be on the half way of quite rapid development by growing their width of skull or a corresponding structure at somewhere around 10–11 meters in body length while the filter area of outer surface remains unchanged so much. That is, the smaller animals in their body length are narrower in their skull or head dimensions than the larger animals. Relative increase in the size of head region with growth is a well known evidence through several species of baleen whales (e. g. Mackintosh and Wheeler, 1929; Matthews, 1937, 1938) and, similarly, growth in width of skull could be also considered.

Apart from the main purpose of the present study, it is also suggested by the unusual figure in those above mentioned two animals that they might had been under a quite rapid development in their feeding apparatus. A rapid development in the structure relating to more active feeding, which is said to occur in coincidence with the weaning of animal, has been known both in some dolphins such as *Stenella* (e. g. Perrin 1975a, b) and in baleen whales (Mackintosh and Wheeler, 1929). According to Mackintosh and Wheeler (1929), the southern blue whale weans at 16 m, and relative size of its head increase from 15.3% (13.5 m in body length) to 21.2% (26.5 m). Similarly, mean curve for the growth of baleen plates in fin whale changes steeply pointing upward at 12.0–14.5 m of body length (Mackintosh and Wheeler, 1929).

More recently, Best (1974) reported that a stranded female Bryde's whale of 8.5 m (28 ft) was found to be a calf under suckling with only remains of milk in her stomach. By considering these facts along with the result obtained in this study, it seems then that both Sy7521 and Ns7564 animals might have weaned slightly before of the current season, and supposed to be under a physiological condition between nursing and adolesecence. Their weaning might took place at somewhere around 8–9 meters in body length. From these considerations the difference in the areas of filtering apparatus in both Sy7521 and Ns7564 animals could be supposed quite normal. In summerizing the data concerning to the filter area only one animal, Sy7518 showed a quite small filter area against its body length and it may be one of significant external characters which make the animal be distinguished almost completely from the others.

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## DISCUSSION

As it has been mentioned in the previous sections, the Bryde's whale which occurs in the Sanriku region during mid summer shows to some extent the morphological variations by each animal in its external characters; some showed quite different external characteristics from the others in a measurement or a nature over the general appearance of body while the matter was completely different from each other in another respect of observations. As to the purpose of this study, which aims to find out some valid external characters

for distinguishing the difference of animals by localities the matter seems, therefore, to go into fairly complexities when the animal is examined more closely.

To make the matter more clear the results which have been mentioned elsewhere in the previous sections were summerized in Table 7. From this table, it may be obvious that an animal, Sy7518 was quite distinct in its external characters in many observed respects which enable the animal be distinguished well from the rest. Another two animals, Sy7519 and Ty7541, will come to the next but more less characteristic than the former. The another six animals differed to some extent only in one or two items of observations and/or measurements. When we consider about those results or evidences, it can be said in general that an actually important morphological variation could be found in the difference of the character of filtering apparatus and relating functions or structures such as the number of ventral grooves and filter area.

TABLE 7. DISTINCT EXTERNAL CHARACTERS FOUND IN NINE BRYDE'S WHALES. CONCRETE DETAILS FOR THE PARTICULARS ON THE LEFT COLUMN ARE FOUND IN APPENDICES, TABLE, AND FIGURES GIVEN ELSEWHERE IN THE TEXT.

| | Sy 7518 | Ty 7543 | Sy 7519 | Sy 7521 | Sy 7520 | Ty 7546 | Ty 7541 | Ty 7547 | Ty 7544 | Ns 7564 |
|---|---|---|---|---|---|---|---|---|---|---|
| Scarring | + | | | | | | | | | |
| No. of ventral grooves | + | | | | | | | | | |
| Proportion | + | + | + | | | | | | | + |
| Creamy white baleen series | + | | + | | + | | | | | |
| Length of baleen series | + | | | + | | | | | | |
| Shape of baleen series | + | | | | | | | | | |
| No. of baleen plates | | | | | | | + | + | + | |
| Breadth-length ratio for the largest baleen plate | + | | + | | | + | | | | |
| Density of baleen bristles | + | | | | | | + | | | |
| Thickness of baleen bristles | + | | | | | | + | | | |
| Area for filtering apparatus | + | | | | | | | | | |

As it was shown in Table 4 and Fig. 5, the difference in the density and general appearance of baleen bristles in addition to the filter area may be one of the most important characters which are valid for distinguishing the intraspecific variations at least in the North Pacific Bryde's whales. Unfortunately we have had no occasion to examine the baleen plates and the bristles of both inshore and offshore forms of Bryde's whales in South African waters (Best, 1970; 1974), and it is still unknown whether or not all animals examined in this study belongs to those offshore form. However, as far as the descriptions by Best (1970; 1974) are concerned, the Bryde's whales examined in this study should belong to the offshore form without any exceptions as stated previously by Omura (1959). Since those more sei-whale-like Bryde's whale in the shape

of baleen plates have not been known at present from the North Pacific region,* it may be possible that the animals other than Sy7518 and possibly Ty7541 could be considered as rather an inshore like type of character among the North Pacific Bryde's whales although the habitat for both types of whales, as far as the catch location is concerned, does not seem different from each other.

The recovery of whale tags suggests that most of Bryde's whales occur during winter in the waters of Bonin Islands head directly to Sanriku region in the following northbound migrations but some of them also head to both Kii and Kyushu regions although some animals headed to Kii region may enter finally into the Sanriku region (Omura, 1974). Recent tag recovery suggests that one of Bryde's whales in the south-western of the North Pacific, which was tagged at 02°20′N, 135°26′E, on 4 February 1975 was found to be relating to the so-called North Pacific pelagic stock by recoverying the tag at 29°20′N, 175°20′E on 19 July 1975. The baleen plates which were collected previously in the Bonin Islands waters, as examined and classified by four types in this study (see Table 4), do not include such character of more finer netting with many zigzagged bristles.

According to Omura (pers. comm.) all baleen plates of Bryde's whales examined at Bonin Islands were those robust nature ones with coarse and thicker bristles (see Plate III, figs. 1-2). These characters are considered very similar to those found in Sy7518 animal which is, at present, supposed to be very scarce among the Bryde's whales caught throughout the whaling season in Sanriku region (it occupies the share of only about 7.0 percent of total catch in this study). When we consider this along with whale movements by the recovered tags, there might occur some changes such as niche shifts among Bryde's whale populations that make northward migrations close to the northern Japan. When we assume that majority of Bryde's whales in the Bonin Islands waters migrate up to Sanriku region, then the question arises where those more sei-whale-like Bryde's whales come close to that region and/or whether any possibilities to occur these whales too in the Bonin Islands waters.

## CONCLUSION

Although no decisive conclusion was drawn in this study, it may be said that there occurs at least two types of Bryde's whales in the waters off Sanriku region. It is still unknown whether or not they could be called as allopatric

* There is only one baleen plates which suggests the occurrence of inshore form of Bryde's whale in Japanese waters (see Best, 1974, fig. 4). We examined the same baleen plate again and found that the specimen lacks some inner most part by damage (Breadth: 14.0 cm, Length: 35.0 cm). The bristles of baleen plate were really finer than the ordinal ones (see Table 5 in the text). However, the position from where the specimen was collected is unknown. As it was shown in Fig. 4 in the text the width-length ratio for baleen plates varies much with the position in baleen series, the treatment for this specimen seems better to be held for the time being.

forms untill we will have more information on their reproductive conditions. One of them, however, clearly shows analogous characters with the animals known in Bonin Islands waters, but it occurs with less prominent among the number of migrating animals head to Sanriku region. The external characters which make both types of Bryde's whales be distinguished from each other are very slight, and could not be distinguished by an overall treatment of the data since those chracteristics in external characters might be greatly reduced by dilution through the analysial process.

*Addendum*

In the course of finishing the manuscript there was an opportunity to examine the baleen plates of Bryde's whales caught in both Kyushu and pelagic region of the northern North Pacific through the courtesy of the Far Seas Fisheries Research Laboratory, Fisheries Agency. The obtained result seems to contain some indispensable evidence and worth to be presented here for the further comparison and considerations of concerning to those racial problem in the North Pacific population the Bryde's whales.

One of present authors (A. K.) made the baleen plate measurements on thirty-eight animals from the catch in Kyushu region and thirteen animals from the pelagic waters of the northern North Pacific. As to the thickness and the density of baleen bristles, 17 out of 51 materials were counted and measured their diameter at the base by following similar procedure as having been described in the previous section. Although the number of animals and materials above mentioned consists only a part of total catch figures for both regions, animals to be examined were selected randomly from the bulk of material kept at the above mentioned laboratory, and the result can be considered to represent the whole.

In regard to the relationships between width and length in largest baleen plates, it was clearly shown that the length of baleen plate against its width in the animals from pelagic region of northern North Pacific was undoubtedly larger enough to be distinguished from the majority being found in the animals from the waters off the west coast of Kyushu except one instance (Fig. 10; Plates VI, VII). In the material from Kyushu, there found no such slim shaped baleen plate as mentioned before, and each baleen plate was rather small but furnished with more thicker bristles than the former and robust nature in general. It should be noted that there were no baleen plates which exceeded 31cm or more in their overall length in the materials from Kyushu, and also there were no overlapping figures of baleen plate dimensions between the populations of both the pelagic waters of the North Pacific and the coastal waters off Kyushu. In comparison with the results found in Sanriku region, figures for width-length relationships were shown by encircling them with broken line (Fig. 10 and, see also Fig. 3). With this figure the isolated plots for both North Pacific pelagic and Kyushu are completely filled up by overlapping each other, and make Fig. 10 be completed as to present a series of variation in the shape

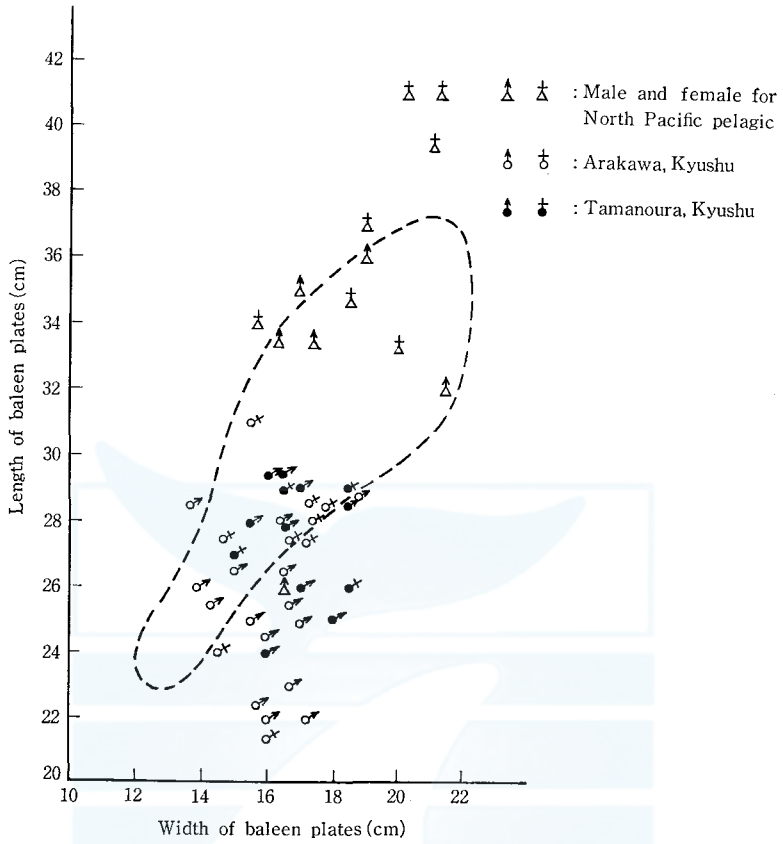


Fig. 10. Width and length relationships of largest baleen plates for the animals caught in the North Pacific pelagic and in the coastal waters off western Kyushu.

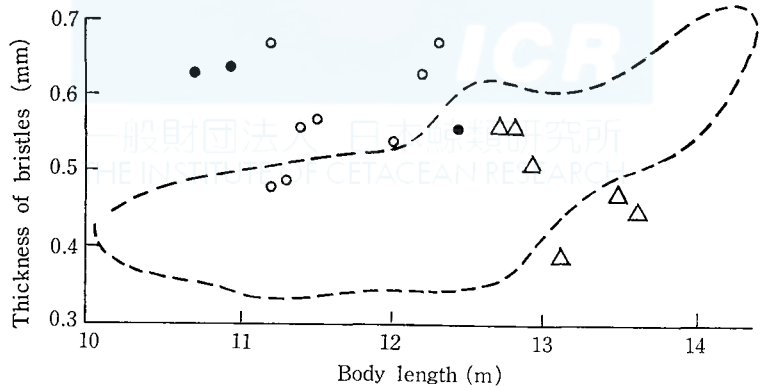


Fig. 11. Thickness of straight baleen bristles at the base for the animals both Kyushu and North Pacific pelagic. Plot distribution for Sanriku region is indicated by an encircle. Shaded circles indicate the animal from Tamanoura, open ones from Arakawa, and triangles are from the North Pacific pelagic.

TABLE 8. THICKNESS AND DENSITY OF BALEEN BRISTLES OF BRYDE'S WHALES BOTH FOR KYUSHU AND FOR THE NORTH PACIFIC PELAGIC REGIONS.

| No. of animal examined | Range of thickness for straight bristles (mm) | No. of straight bristles measured | Averaged thickness (mm) | Averaged no. of bristles/2.0 cm of fringe | | Remarks |
|---|---|---|---|---|---|---|
| | | | | straight | zigzag | |
| 3 | 0.244–0.647 | 44 | 0.437 | 15.0 | 38.0+ | NPP-3N, 1972[1] |
| 3 | 0.388–0.734 | 22 | 0.545 | 8.0 | 32.0 | NPP-3K, 1974[2] |
| 6 | 0.316–0.691 | 66 | 0.491 | 11.5 | 35.0 | Av. for both NPP-3N & NPP-3K |
| 4 | 0.496–0.766 | 30 | 0.635 | 16.25 | 12.25 | JCAK, 1973[3] |
| 4 | 0.334–0.637 | 50 | 0.523 | 16.0 | 20.5 | JCAK, 1974 |
| 3 | 0.453–0.710 | 24 | 0.609 | 9.0 | 20.7 | JCTK, 1974[4] |
| 11 | 0.428–0.704 | 104 | 0.589 | 13.75 | 17.82 | Av. for both JCAK & JCTK |

1) North Pacific, pelagic, Nisshin Maru No. 3.
2) North Pacific, pelagic, Kyokuyo Maru No. 3.
3) Japan, coastal, Arakawa land-station, Kyushu.
4) Japan, coastal, Tamanoura land-station, Kyushu.

of baleen plates from northern to southern regions.

The thickness for straight appearance of baleen bristles and the density of bristles are given in Table 8. The averaged thickness for the pelagic population of the northern North Pacific was 0.491 mm while that for the Kyushu region was 0.589 mm. When these figures along with their body length were compared with those in Sanriku region (Av. 0.488 mm, Table 5), it can be said that the baleen bristles for Kyushu are distinctly thick enough to be separated from those in another regions (Fig. 11), and overall figures for the Sanriku population make complete the thickness distribution for both the North Pacific and Kyushu populations as it was seen in the width-length relationships for baleen plates.

Density of baleen bristles in terms of the number of straight and zigzag shaped bristles per 2.0 cm of baleen fringe differed much between two above mentioned regions: the density for zigzagged bristles in the North Pacific pelagic animals was 35.0 bristles/2.0 cm on average whereas it was only 17.82 bristles/2.0 cm in Kyushu animals. The former seems to correspond to some of types II to IV of baleen plates (Table 4) and the latter would possibly be to type I. An important character in the density of bristles is not the absolute number or abundance of bristles but relative dominancy between straight and zigzagged shape of bristles since baleen fringe is apt to be damaged through many occasions prior to examination. When the number of straight baleen bristles is plotted against that of zigzagged ones, it is clearly noticed that very little number of zigzagged bristles are found in the animals from Kyushu, while they are more prominent in the animals from the pelagic waters of the northern North Pacific. The latter shows well coincidence with the character of baleen bristles found in the animals from Sanriku region (Fig. 12).

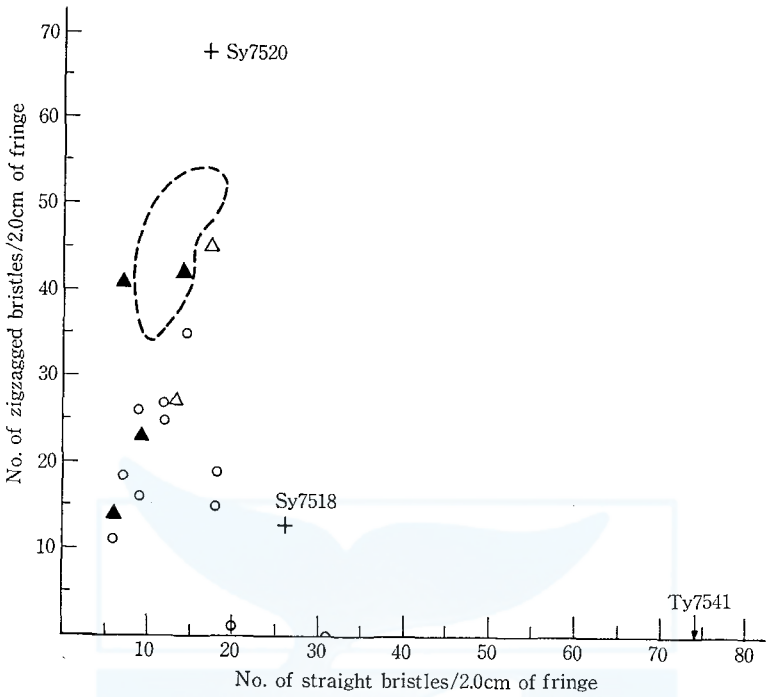


Fig. 12. Density of the two kinds of baleen bristles for the animals from Kyushu and North Pacific pelagic. Corresponding distribution for Sanriku region is indicated by an encircle and cross marks. Open circles indicate the animal from Kyushu and triangles indicate that from the North Pacific pelagic.

TABLE 9. STOMACH CONDITION FOR FIFTY-ONE BRYDE'S WHALES WHICH BALEEN PLATES WERE ADDITIONALLY EXAMINED FOR THE COMPARISON OF PRESENT STUDY.

| | | Sardine | Mackerel | Fish Unknown[1] | Unknown[2] | Euphausiid | Empty |
|---|---|---|---|---|---|---|---|
| Arakawa[3] | May | 1 | | | | | |
| | June | | 2 | | | | |
| | July | | 4 | 3 | 9 | | |
| | August | | 1 | 1 | 3 | | |
| | September | | | | 1 | | |
| Tamanoura | June | | 1 | | 1 | | 1 |
| | July | | 1 | | | | 1 |
| | August | | 1 | 1 | 5 | | 1 |
| North Pacific pelagic[4] | July | | | 1 | | | 2 |
| | August | | | | | 8 | 2 |

1) Unknown kind of stomach contents.
2) Unknown whether there were any food or not.
3) Data for both 1973 and 1974 are combined.
4) Data for both 1972 and 1974 are combined.

The result which was found by treating the materials under grouping each individuals suggests that the filtering apparatus in the animals of the North Pacific pelagic region is structured more finer in its netting than those of Kyushu region, and that the animals in Sanriku region shows an intermediate character as a whole. However, it must be remembered that there were so much variations in the latter animals. To support this tendency the stomach condition for the animals of both North Pacific pelagic and Kyushu is given in Table 9. The kind of food organisms in Kyushu region is represented by mackerel, sardine and some small fishes, which are somewhat similar to that found in Sanriku region, while euphausiids predonimated in the animals caught in pelagic region of the northern North Pacific.

To summerize the result presented as *addendum*, it may be said and speculated to some extent that there must be two possible different populations of Bryde's whales in the northwestern North Pacific region: the first one is characterized by relatively longer and finer netting of baleen bristles, and is found in the pelagic waters of the northern North Pacific where they prey on the euphausiids and small swarming fishes. The second one, on the other hand, is found widely over the waters off western Kyushu, which sometimes extend even to the midst of the Yellow Sea. Animals found there carry very small but more coarse netting in filtering apparatus, which is possibly similar character to that has been found in Sy7518 animals in the Sanriku region. The Bryde's whale population off west Kyushu is possibly consisted of the animals both from southern waters of the western Pacific and of an endemic populations possibly from the Yellow Sea and the East China Sea regions. The animals caught in the Sanriku region show an intermediate external character in an overall treatment by dilution but each animal can be distinguished as to be placed in one of both above mentioned extremes. This suggest a possible mingling of different populations in that region. The Bryde's whales in Bonin Islands keep migratory relationships to Sanriku region, but it is still unknown whether or not they show a similar external characters to those have had been known previously in that region. If there were no niche shifts and Bonin Islands population has been remained unchanged in those region, then a considerable invasion of the North Pacific pelagic population into the Sanriku region must be considered so as to give an intermediate characters for the population in Sanriku region.

## ACKNOWLEDGMENTS

We are much indebted to the whaling land-stations of Taiyo Gyogyo K. K., Nippon Hogei K. K. both in Ayukawa and of Nippon Suisan K. K. in Onagawa for their kind assistance and offering their facilities in collecting the data and materials through this work. Courtesy of the Whales Research Section of the Far Seas Fisheries Research Laboratory, Fisheries Agency in Shimizu made us enable

to compare the result on the animals in Sanriku region with that both in Kyushu and in the pelagic region of the northern North Pacific. Personally, we are indebted to Dr. Seiji Ohsumi of above mentioned laboratory for permitting of our sampling the baleen bristles, and also Mr. Siro Wada of the same laboratory for prepering and assisting our laboratory work in Shimuzu. Without their kind help no data were available for the animals both in Kyushu and in the northern North Pacific, and these circumstances are greatly appreciated.

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APPENDIX I. BODY PROPORTIONS OF THE BRYDE'S WHALES

| Serial No. | Ns7564 | Ty7547 |
|---|---|---|
| Sex | Male | Male |
| Body Length (m) | 10.1 | 11.2 |
| Length, row of baleen plates along gum level | — | — |
| Length, anterior end to largest baleen plates in baleen series | — | 10.8 |
| Length, largest baleen plate | — | — |
| Length, palatal ridge | 18.81 | — |
| Spread of filtering apparatus across both sides (maximum) | 6.53 | 8.75 |
| Width, palatal ridge close to anterior end | 0.84 | 1.07 |
| Ratio, item 6/item 5 | 0.35 | — |
| Spread of arch across both lower jawbones (maximum) | 8.61 | 10.09 |
| Length, side ridges on the head | 12.27 | 13.30 |
| Distance between right and left side ridges at their anterior end | 1.98 | 1.12 |
| Distance between right and left side ridges at their posterior end | 5.34 | — |
| Distance, tip of snout to anterior end of side ridges | — | — |
| Distance between both depressions of Yabobson's organ | 0.12 | 0.09 |
| Distance, tip of snout to Yakobson's organ | 0.64 | 0.67 |
| Distance, Yakobson's organ to anterior end of baleen series | — | — |
| Length, dorsal fin (anterior insertion to tip) | — | 5.00 |
| Length, dorsal fin at base | 3.86 | 3.80 |
| Height, dorsal fin (fin tip to base) | 2.77 | 2.41 |
| Concavity, dorsal fin (deepest part of posterior border to line between fin tip and posterior base) | — | 1.07 |
| Length, flipper (posterior insertion to tip) | 8.81 | 10.09 |
| Length, flipper (anterior insertion to tip) | 11.58 | 14.29 |
| Width, flipper (maximum) | 2.37 | 2.50 |
| Length, fluke (notch to tip) | 11.88 | 12.86 |
| Length, fluke (anterior insertion to tip) | — | 13.93 |
| Width, fluke (shortest distance between anterior border of flukes and notch) | 6.13 | 6.34 |

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CAUGHT OFF SANRIKU, NORTHWESTERN PACIFIC IN 1975.

| Ty7541 Male | Sy7518 Male | Ty7549 Male | Ty7543 Male | Sy7520 Male | Sy7521 Female | Ty7548 Female | Ty7550 Female | Ty7544 Female | Ty7546 Female | Sy7519 Female |
|---|---|---|---|---|---|---|---|---|---|---|
| 11.5 | 12.5 | 12.5 | 12.6 | 12.7 | 10.8 | 11.2 | 13.7 | 13.7 | 14.0 | 14.2 |
| 28.69 | 19.20 | — | 22.14 | — | 17.59 | 21.25 | — | 21.97 | 21.86 | 22.11 |
| 9.91 | 12.96 | — | — | — | 10.83 | 11.88 | — | — | — | — |
| 2.56 | — | — | — | — | — | — | — | — | 4.50 | — |
| 20.35 | 18.64 | — | 19.84 | 19.84 | — | — | — | 19.93 | — | 20.07 |
| — | 6.96 | — | 8.88 | 8.27 | — | 8.57 | — | 8.76 | 8.29 | 8.02 |
| 1.13 | 0.88 | — | 1.03 | 0.94 | 1.11 | 0.76 | 1.02 | 0.88 | 0.93 | 0.94 |
| — | 0.37 | — | 0.45 | 0.42 | — | — | — | 0.44 | — | 0.40 |
| 10.26 | — | 10.96 | — | 9.84 | 11.76 | 9.82 | 10.73 | 9.92 | 10.00 | — |
| 12.69 | 6.80 | — | 11.66 | 11.26 | — | 11.30 | 11.61 | 12.07 | 9.27 | 10.98 |
| — | — | 0.56 | — | 0.39 | — | 1.12 | 1.53 | — | — | 3.09 |
| — | — | — | — | — | — | 3.57 | 2.34 | — | — | — |
| — | 1.36 | — | 1.34 | — | — | — | — | — | — | — |
| 0.13 | 0.16 | 0.10 | 0.91 | 0.12 | — | — | 0.10 | 0.09 | 0.09 | 0.09 |
| 0.65 | 0.52 | 0.76 | 1.43 | 0.59 | — | 0.54 | 0.73 | 0.66 | 0.64 | 1.31 |
| 0.17 | — | — | — | — | — | — | — | — | — | — |
| 5.04 | 6.56 | — | 4.32 | 4.88 | — | 5.58 | — | 4.82 | 4.57 | — |
| 5.04 | 5.84 | — | 3.41 | — | 4.91 | 3.57 | 3.14 | 4.60 | — | — |
| 2.69 | 2.88 | 2.48 | 2.26 | 2.52 | 2.41 | 2.59 | 2.04 | 2.63 | 1.93 | — |
| — | 1.28 | 1.08 | 0.67 | 1.10 | 0.74 | 0.85 | 0.37 | 1.09 | 0.34 | — |
| 8.95 | 8.24 | 9.04 | 8.49 | 9.61 | 7.96 | 8.66 | 10.07 | 8.76 | 8.71 | — |
| 12.08 | 11.52 | 12.72 | 12.14 | 11.57 | 11.85 | 13.26 | 14.38 | 13.14 | 12.79 | — |
| 2.60 | 2.60 | 2.48 | 2.53 | 2.76 | 2.32 | 1.69 | 2.70 | 2.26 | 2.46 | — |
| 12.43 | — | 13.12 | 12.14 | 12.13 | 12.22 | 12.14 | 12.70 | 12.66 | 12.57 | — |
| 12.43 | — | 13.84 | — | 12.91 | 13.15 | 12.95 | 13.14 | — | — | — |
| — | — | 6.24 | 6.26 | 6.46 | 6.20 | 6.25 | 6.35 | 6.22 | 6.07 | — |

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APPENDIX II. MEASUREMENT ON THE FILTERING APPARATUS OF BRYDE'S

| Measurement | | Ns7564 | Sy7521 | Ns7563 |
|---|---|---|---|---|
| Length, total (m) | | 10.1 | 10.8 | 11.1 |
| Length, row of baleen plates along gum level (cm) | | 201.5 | 190.0 | — |
| Length, row of baleen plates along palatal ridge (cm) | | 190.0 | — | — |
| Maximum spread of filtering apparatus across both sides (cm) | | 66.0 | — | — |
| Largest baleen plate | Length: $L$ | 24.0 | 27.5 | 28.5 |
| | With: $W$ | 12.6 | 14.5 | 14.7 |
| | $L/W$ | 1.90 | 1.90 | 1.94 |
| Number of baleen plates (total)[1] | | 261 | 282 | — |
| Number of creamy white hairs and plates (number/length) | Right | — | 15/10.5 | — |
| | Left | — | — | — |
| Number of hair of stump of hairs in baleen series | Anterior | ? | 19 | — |
| | Posterior | 19 | 19 | — |
| Number of minor plates at largest baleen plates[2] | | $10+\alpha_4$ | 12 | — |
| Number of bristles on largest baleen plate (number/2.0 cm)[3] | Straight | 10 | 12 | 18 |
| | Zigzag | 49 | 48 | 52 |
| | Total | 61 | 60 | 70 |
| Averaged thickness of straight baleen bristles (diam. mm) at | Base | 0.41 | 0.39 | 0.34 |
| | Middle | 0.27 | 0.27 | 0.24 |
| | Tip | 0.12 | 0.13 | 0.12 |
| Areas for filtering apparatus ($m^2$) | Outside: *So* | 0.65 | 0.67 | — |
| | Inside: *Si* | 1.04 | 1.10 | — |
| | *Si*/*So* | 1.59 | 1.65 | — |

1) Definition for so-called baleen plates was based on that by Williamson (1973)
2) Number of small brush-like plates which are arranged between main row of blaeen plates and the palatal ridge
3) Length of bristles was not measured due to poor condition of preserved materials for this purpose

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WHALES CAUGHT OFF SANRIKU, NORTHWESTERN PACIFIC IN 1975.

| | | | Serial No. of animal | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Ty7547 | Ty7548 | Ty7541 | Ty7518 | Ty7549 | Ty7543 | Sy7520 | Ty7550 | Ty7544 | Ty7546 | Sy7519 |
| 11.2 | 11.2 | 11.5 | 12.5 | 12.5 | 12.6 | 12.7 | 13.7 | 13.7 | 14.0 | 14.2 |
| — | 238.0 | 237.0 | 240.0 | — | 279.0 | 252+ | — | 301.0 | 298.0 | 314.0 |
| — | — | 234.0 | 233.0 | — | 250.0 | 252.0 | — | 273.0 | — | 285.0 |
| 98.0 | 96.0 | — | 87.0 | — | 112.0 | 105.0 | — | 120.0 | 116.0 | 114.0 |
| 33.0 | 31.5 | 33.5 | 29.0 | 32.0 | 32.5 | 33.5 | 37.0 | 36.0 | 33.7 | 32.0 |
| 17.5 | 16.1 | 16.5 | 17.2 | 18.5 | 18.3 | 18.5 | 21.2 | 20.5 | 21.0 | 22.0 |
| 1.89 | 1.96 | 2.03 | 1.69 | 1.73 | 1.78 | 1.81 | 1.75 | 1.75 | 1.60 | 1.45 |
| 254 | 260+$\alpha_1$ | 325 | 267+$\alpha_2$ | — | 286 | 266 | — | 311+$\alpha_3$ | 293 | 273 or 283 |
| 45/27.0 | 15/8.5 | — | —/57.0 | — | ?/39.0 | —/39.0 | — | 50/22.0 | 24/— | 27/17.0 |
| 38/19.0 | 20/11.0 | 9/2.7 | 27~28/8.0 | — | — | —/19.0 | — | —/26.0 | 23/6.7 | 53/38.0 |
| 18 | 23 | 18 | 22 | — | 23 | 21 | — | 10 | 12 | 17 |
| 21 | — | 14 | — | — | 13 | 21 | 25+$\alpha$ | 17 | 30+$\alpha$ | 21 |
| 7 | 10 | 6 | 12 | — | 7 | 11 | 11 | 13 | 11+$\alpha_4$ | 11 |
| 10 | 12 | 14+59[4] | 26 | 17 | 15 | 17 | 13 | 11 | 9 | 14 |
| 34 | 48 | — | 13[5] | 54 | 51 | ca. 68 | 47[5] | 37[5] | 38 | 51 |
| 44 | 60 | 74 | 39 | 73 | 66 | 85 | 60 | 48 | 47 | 65 |
| 0.42 | 0.36 | 0.49 | 0.60 | 0.56 | 0.35 | 0.49 | 0.62 | 0.59 | 0.54 | 0.69 |
| 0.35 | 0.28 | 0.35 | 0.46 | 0.40 | 0.27 | 0.37 | 0.42 | 0.41 | 0.38 | 0.45 |
| 0.19 | 0.19 | 0.19 | 0.28 | 0.29 | 0.22 | 0.20 | 0.22 | 0.21 | 0.26 | 0.23 |
| 1.06 | 1.06 | — | 0.97 | — | 1.24 | 1.16 | 1.32 | 1.48 | 1.43 | 1.53 |
| 1.75 | 1.76 | 1.65 | 1.50 | 1.81 | 1.82 | 1.92 | 2.32 | 2.20 | 2.44 | 2.31 |
| 1.65 | 1.65 | — | 1.53 | — | 1.46 | 1.66 | 1.76 | 1.49 | 1.71 | 1.51 |

4) 15 thick long bristles and 59 slender ones of straight features
5) Not heavily zigzagged features of almost straight.
Possible number for alpha letter:
$\alpha$=unknown, $\alpha_1$=10-15, $\alpha_2$=20, $\alpha_3$=1-2, $\alpha_4$=1, respectively

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## EXPLANATION OF PLATES

### PLATE I

Fig. 1. Baleen plate of type I (see Table 4 in the text): Sy7518 animal of 12.5 m, male caught at 34-56N, 145-37E on 24 July, 1975. Ayukawa, Sanriku, Japan.
Fig. 2. Baleen bristles of the above animal.
Fig. 3. Baleen plate of type II: Ty7547 animal of 11.2 m, male caught at 37-16N, 144-58E on 1 August 1975. Ayukawa, Sanriku, Japan.
Fig. 4. Baleen bristles of the above animal.

### PLATE II

Fig. 1. Baleen plate of type III: Sy7519 animal of 14.2 m, female caught at 36-00N, 146-12E on 27 July, 1975. Ayukawa, Sanriku, Japan.
Fig. 2. Baleen bristles of the above animal.
Fig. 3. Baleen plate of type IV: Sy7520 animal of 12.7 m, male caught at 37-16N, 146-10E on 30 July, 1975. Ayukawa, Sanriku, Japan.
Fig. 4. Baleen bristles of the above animal.

### PLATE III

Fig. 1. Baleen plate of No. 134 animal of 13.08 m, female caught in the waters of Bonin Islands on 15 May, 1950.
Fig. 2. Baleen bristles of the above animal.
Fig. 3. Baleen plate of Bryde's whale from Kyushu, southwestern Japan. No details about the animal is known.
Fig. 4. Baleen bristles of the above animal.

### PLATE IV

Fig. 1. Baleen plate of No. 16 animal of 12.19 m, female caught at 33-35N, 136-25E on 31 May, 1952. Ohshima, Kii, Japan.
Fig. 2. Baleen bristles of the above animal.
Fig. 3. Baleen plate of No. 19 animal of 13.41 m, female caught at 37-07N, 141-20E on 4 July, 1953. Ayukawa, Sanriku, Japan.
Fig. 4. Baleen bristles of the above animal.

### PLATE V

Fig. 1. Baleen plate of 13.11 m (43 ft), male animal caught at 23-13S, 41-53W on 14 September, 1961. Cabo Frio, Brasil (see also Table 2 in Omura, 1962 for body proportions of this animal).
Fig. 2. Baleen bristles of the above animal.
Fig. 3. Baleen plate of 12.5 m, male animal caught at 22-56S, 41-52W on 27 September, 1960. Cabo Frio, Brasil (see also Omura, 1962). Note completely different shape and character of this specimen from the above shown one.
Fig. 4. Baleen bristles of the above animal.

### PLATE VI

Fig. 1. Baleen plate of 10.9 m, male animal caught at 32-36N, 128-05E on 10 August, 1974, Tamanoura, Kyushu, Japan.
Fig. 2. Baleen bristles of the above animal.
Fig. 3. Baleen plate of 11.2 m, male animal caught at 31-42N, 128-51E, on 13 June, 1973, Arakawa, Kyushu, Japan.
Fig. 4. Baleen bristles of the above animal.

## PLATE VII

Fig. 1. Baleen plate of 13.1 m, female animal caught at 37-41N, 167-05E on 9 July, 1972, pelagic region of the northern North Pacific.
Fig. 2. Baleen bristles of the above animal.
Fig. 3. Baleen plate of 13.6 m, female animal caught at 37-07N, 168-41E on 9 July, 1972, pelagic region of the northern North Pacific.
Fig. 4. Baleen bristles of the above animal.

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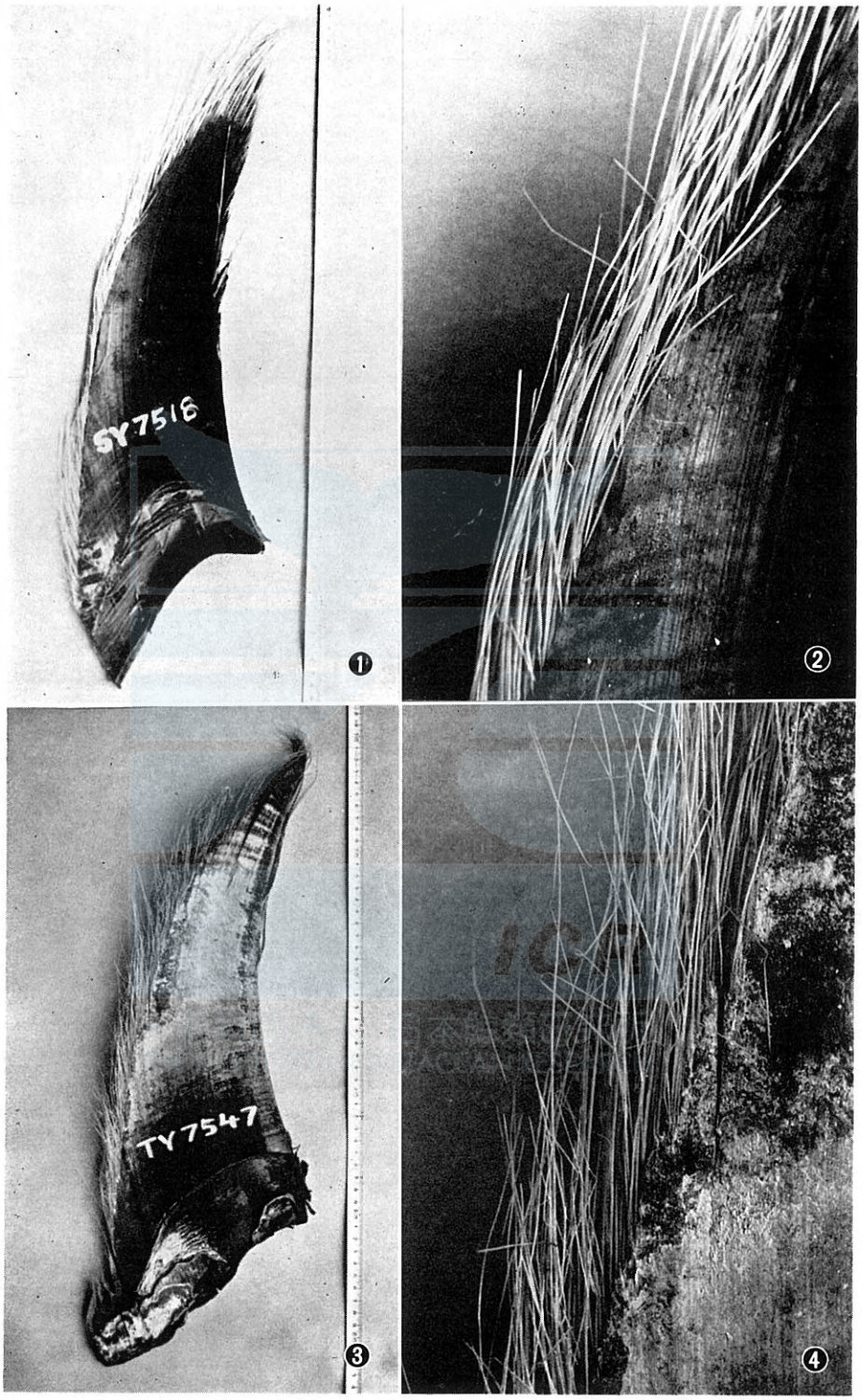
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TY7547
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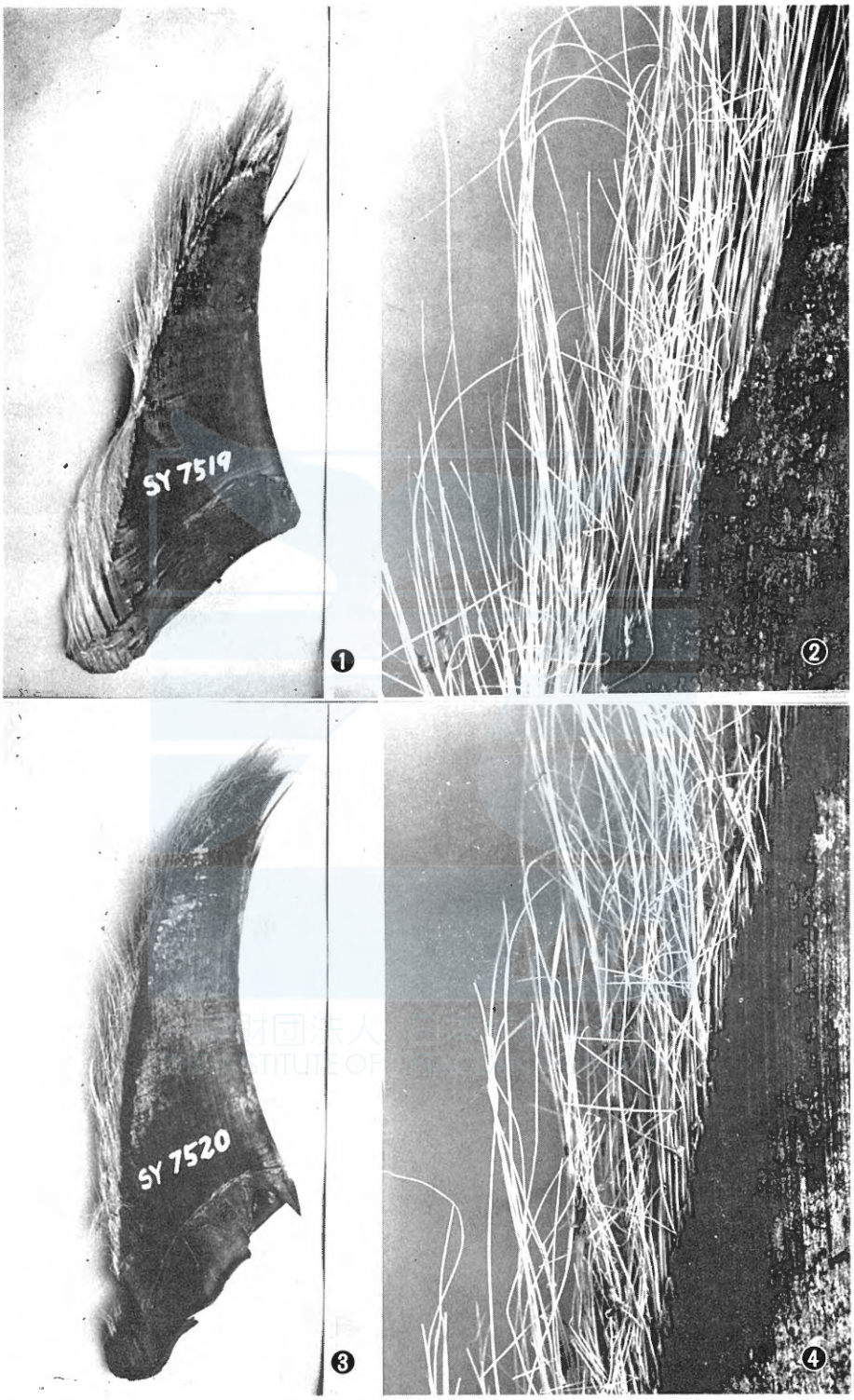
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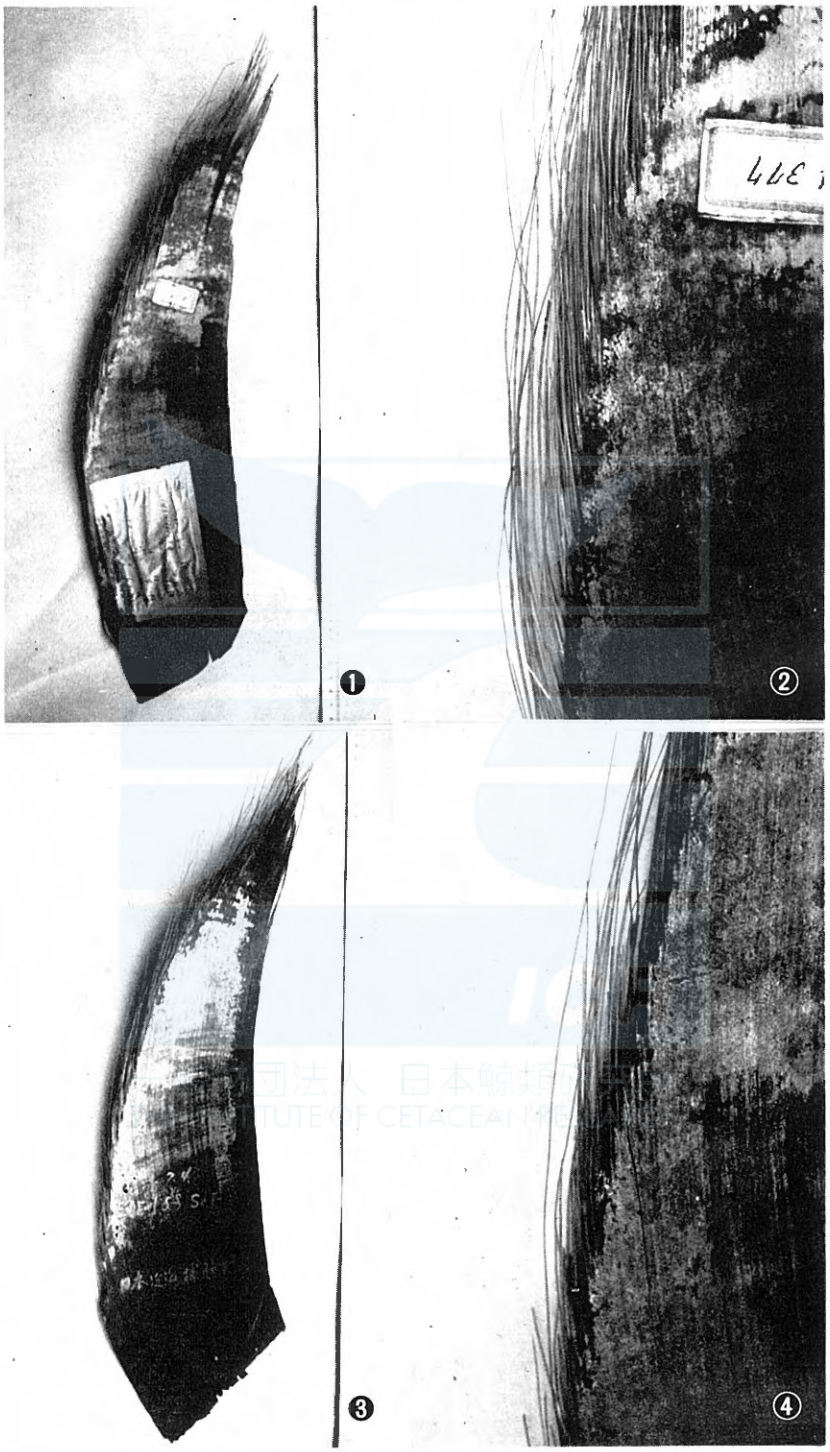
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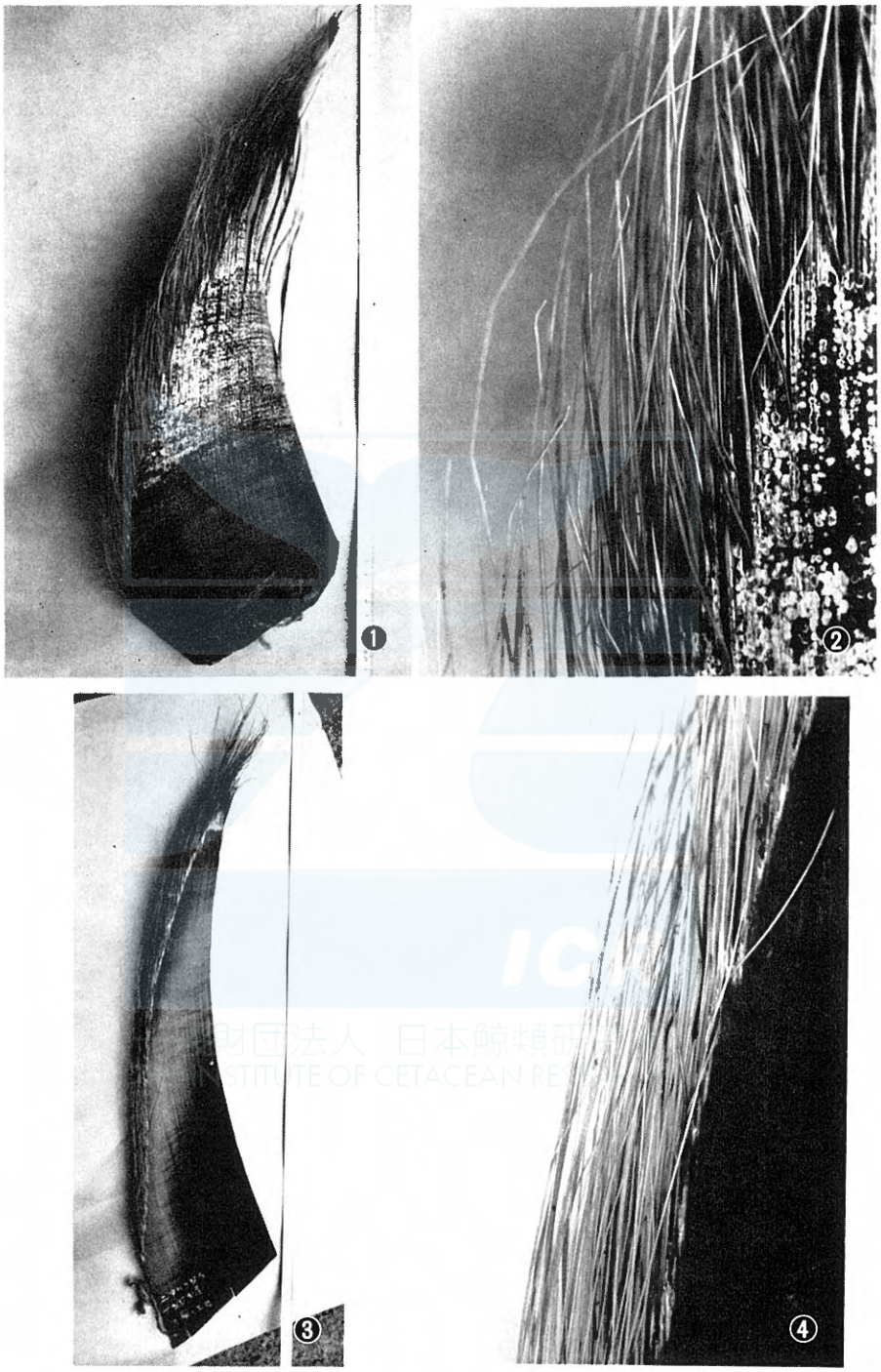
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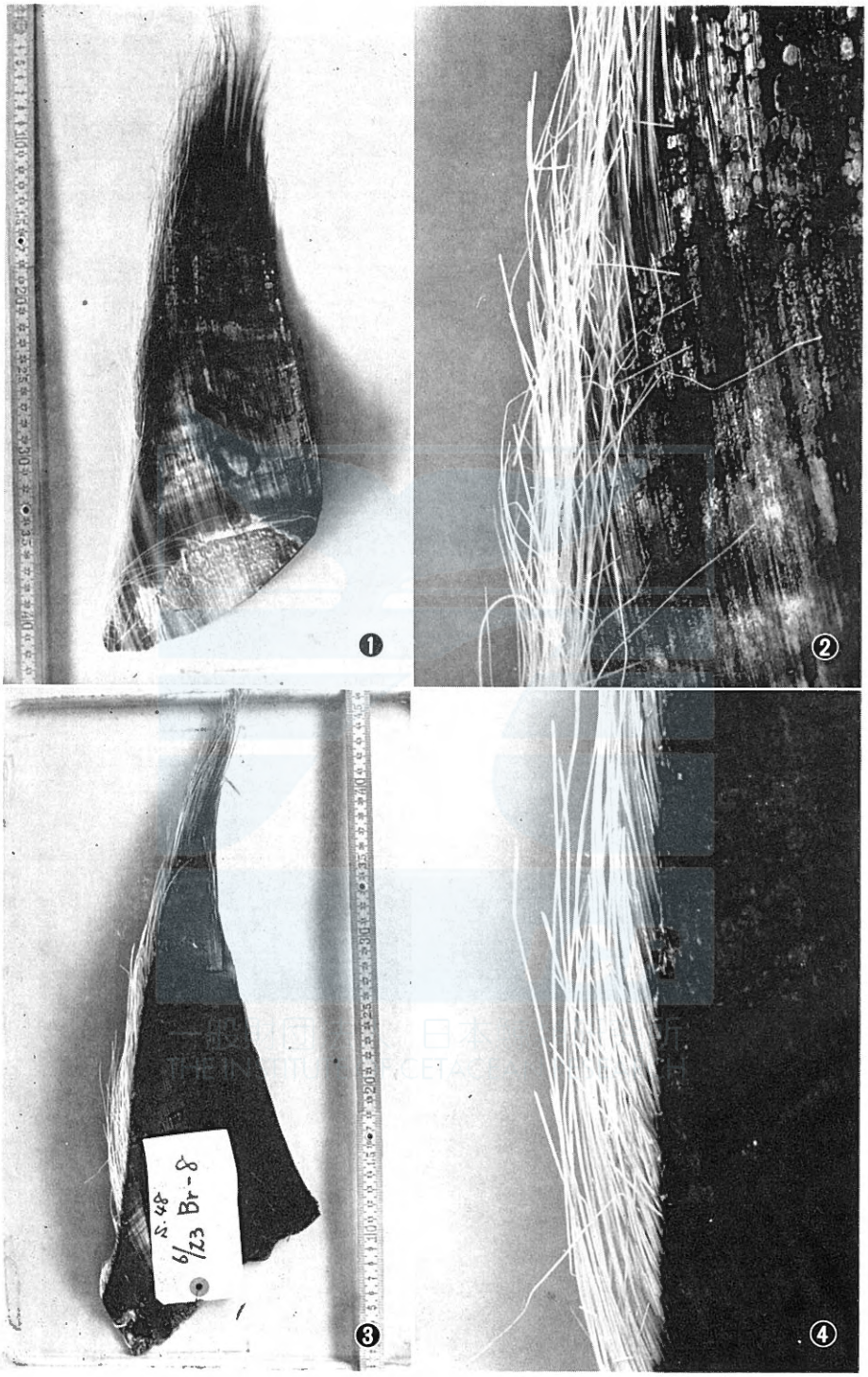
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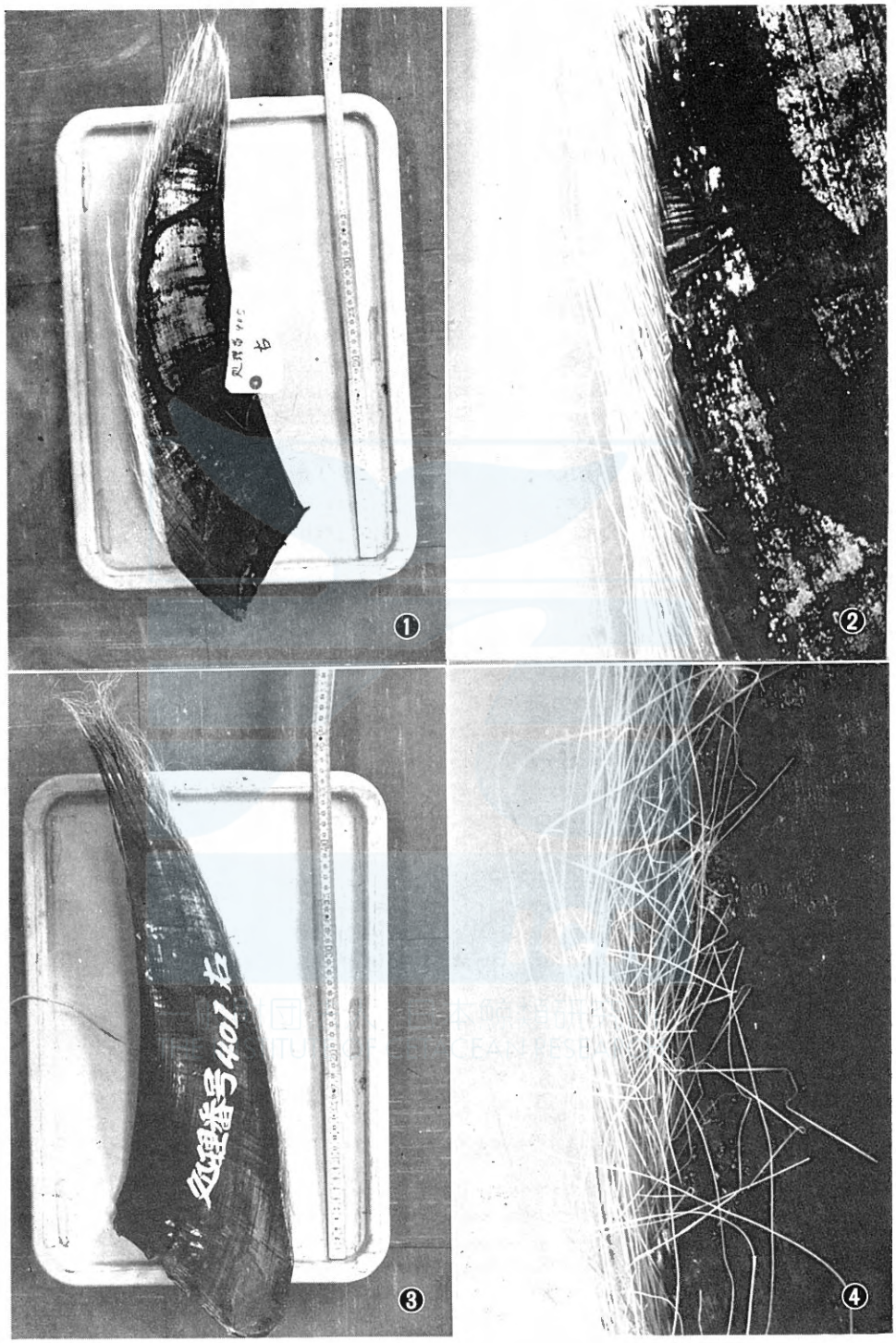
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