ON THE BALEEN FILTER AREA IN THE SOUTH PACIFIC BRYDE'S WHALES

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ABSTRACT

The baleen filter area of the South Pacific Bryde's whale was examined, and found that the total filter area in terms of square meters was 1.43–1.99 (Av. 1.75) in male, 1.19–2.40 (Av. 1.95) in female, while it was 1.04–1.92 (Av. 1.64) in male, 1.10–2.44 (Av. 2.02) in female in the North Pacific animals. The averaged filter area per unit body length (m^2/m body length) of being combined both sexes was 0.136 in the South Pacific animals while it was 0.145 in the North Pacific animals. It was indicated that the South Pacific animals are smallest in the filter area of Bryde's whale ever examined, and they are possibly separated from the North Pacific populations occurring in both northern pelagic and coastal waters.

INTRODUCTION

It has been known that Bryde's whales in the North Pacific show a polymorphic, a considerable variety on both the whole structure and shape of filtering apparatus, and details of baleen plates (Kawamura and Satake, 1976 ; Omura, 1977). Although Kawamura and Satake (1976) did not find any conclusive morphological differences among a possible localized populations except one supposition that there seems to exist two or three characteristic groups of animals in the North Pacific region. The differences which made them be separated were the shape of baleen plates such as the width *versus* length quotient and the total filter area, which may roughly correspond to those ' offshore ' and ' inshore ' types found in the South African waters (Best, 1977). Two of them possibly mingle with each other in the waters off Sanriku, northern Japan. The baleen plates of the Bryde's whales occurring in the pelagic waters of the North Pacific are relatively slender with finer bristles than the animals usually occur in the waters around Bonin Islands and in the East China Sea region, *i.e.*, the filtering apparatus in the former animal is structured more alike to that of sei whale while the latter two are more alike a ' traditional ' Bryde's whale treated in the previous reports (Omura *et al.* 1952 ; Kawamura and Satake, 1976, Figs 8, 10 and Table 8). Since filtering apparatus in baleen whales is supposed to be an organ closely related to feeding strategies by an inter- and/or intra-specific relationships under various state of feeding environments (e.g. Kawamura, 1974), possible morphological changes acquired through the adapation for the existence might be found. It seems, therefore, to be an interest to examine and compare the filter area of Bryde's whales came from various localities with a

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hope to find characteristics by each local population since there exist very few information concerning the identity of Bryde's whale populations throughout the warmer waters over the world.

MATERIAL AND METHOD

The material dealt with in this report was obtained from the animals caught under the scheme of special permission in the tropical South Pacific between New Zealand and Fiji Islands during 1976/77 season (Ohsumi, 1977) (Fig. 1). Their food was consisted exclusively of euphausiids, *Euphausia diomedae*, *E. recurva* and *Thysanoessa gregaria*, and the general feeding habits have been reported previously (Kawamura, 1977), where he discussed considerable nutritional availability for baleen whales

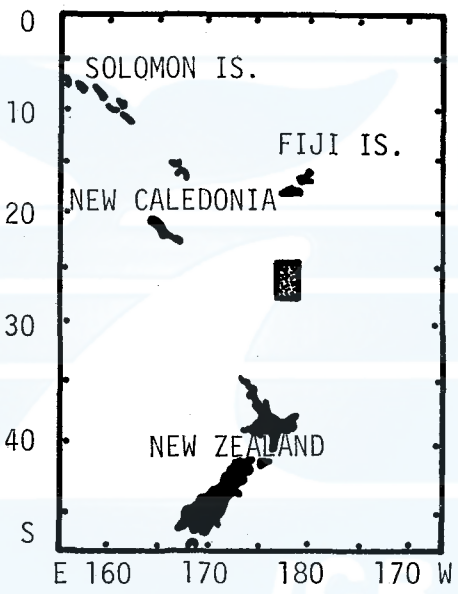

Fig. 1. Sea area of catch for the Bryde's whales, 30 October–5 November, 1976.

even in the tropical seas. The filtering apparatus and some related measurements for a total of 22 out of 113 animals caught by the *Tonan Maru No. 2* operation in the waters mentioned above were measured by the ship's personnel. The measurements obtained were: 1) length of a row of baleen plates along both palatal ridge and gum level, 2) spread of baleen rows between both sides at their widest position, 3) distance from anterior end of baleen row to the largest baleen plates, and 4) length of baleen plates including minor plates along the meshed filter surface by an interval of every 30 cm so as to be calculated the whole inside filter area by reappearing the unfold filter shape. The particulars of measurements concerned were given in Appendix Table 1 along with the proportions against body length. Data and figures for the North Pacific Bryde's whales used in this report were quoted

from Kawamura and Satake (1976).

RESULT AND DISCUSSION

In order to examine the shape of oral cavity in horizontal plane two dimensions were figured (Fig. 2). The length of a row of baleen plates along gum level keeps fairly constant and proportional growth with the length of palatal ridge. As far as these figures are concerned, there found no significant differences in this relationships between the North Pacific and South Pacific animals. However, when we see the quotient for maximum spread between both sides of baleen rows *versus* length of palatal ridge, it is observed on the whole that the South Pacific animals show a trend of more prominent oval shaped oral cavity or more larger hunging angle in baleen row (Fig. 3). The hanging angle (θ) for the North Pacific animals ranged 43°–56° (Kawamura and Satake, 1976, Table 3), and the South Pacific animal seems to be angled more largely in the overall filter shape. In this connection, it is noteworthy that there were two males whose relative spread of baleen row was more than a half of its across along the principal axis. No definite defferences were

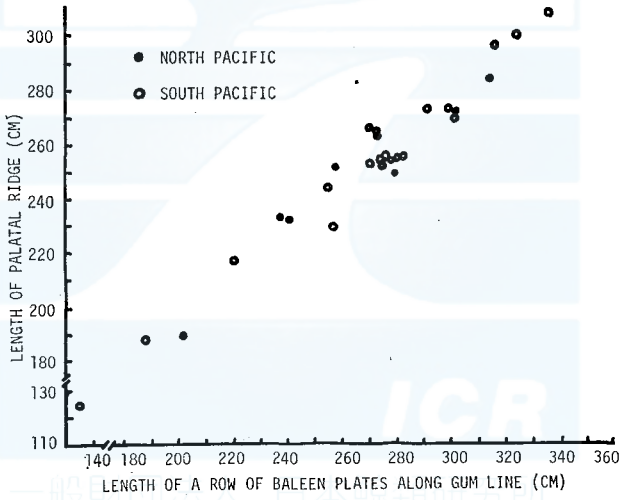

Fig. 2. Two dimensions related to the shape of oral cavity in horizontal plane.

observed in this relationships between both sexes.

The filter area for the North Pacific animals develops proportionally with their body length in the animals of larger than 11 m, while it was significantly small in the younger animals (Kawamura and Satake, 1976, Fig. 9). Concerning this discontinuous developmental figures, Kawamura and Satake (1976) suggested a possible rapid development of filtering apparatus around weaning period. On the other hand, the filter area for the South Pacific animals showed fairely constant development (Fig. 4). It is, however, observed that the filter area in many South Pacific animals was in the midst of both outside and inside filter area for the North

Pacific animals.

Comparing these figures, it was clearly noticed that the absolute values for the filter area in the South Pacific animals were appreciably smaller, say, 0.2–0.3 m², than that known in the North Pacific ones. To make smooth the variations possibly due to the different composition of body length between northern and southern populations, the filter area per unit of body length was calculated (Fig. 5). The values expressed by square meters of filter area per 1 m body length again showed a clearly smaller relative filter area in the South Pacific animals, and this trend may become more clearer especially in the animals larger than 12.5 m, *i.e.*, the larger the animal, the smaller relative filter area per unit of body length.

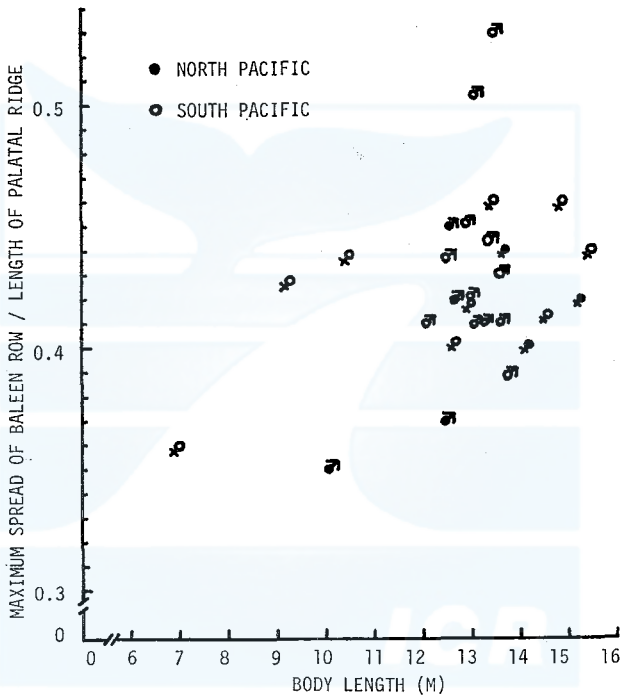

Fig. 3. Quotient between the spread of both baleen rows and the length of oral cavity. An oval shape of baleen rows in their horizontal arrangements is more prominent in the South Pacific animal than that of the North Pacific, which suggests a possible larger trend in hunging angle of each baleen plate in the South Pacific animal than the North Pacific.

The averaged relative filter area for both the North and South Pacific animals was 0.145 and 0.136 (m²/m body length) respectively. Two instances of relative small filter area (0.046 and 0.094 m²/m body length for Nos 79 and 80 in Appendix Table 1) though not by far the extent found in the North Pacific animals, may again make us confirm a very rapid development of filtering apparatus around weaning period.

Although the number of animals and/or materials examined to date is still very few, it seems to be clear that the development of filter area in the South Pacific Bryde's whales may relatively be poorer by the magnitudes of 6.2–10.3% smaller than the North Pacific animals in terms of relative filter area per unit of body length. Comparing the total filter area for Bryde's whales with that of another baleen whale species by interporating the data onto Fig. 8-6 by Kawamura (Kawamura, 1974), it is observed that the Bryde's whales are intermediately characterized between sei and fin whales, and the figures for the former animals may correspond to

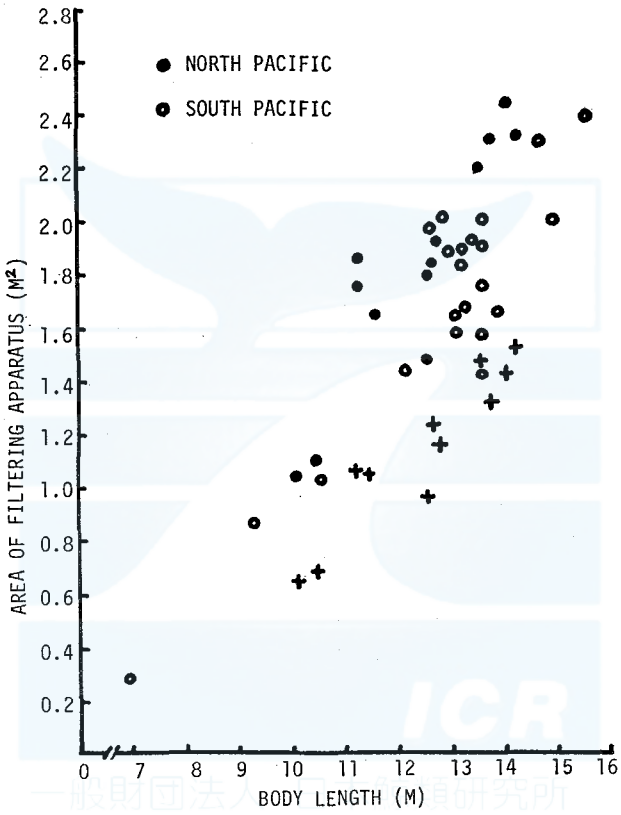

Fig. 4. Total filter area for both the North Pacific and the South Pacific Bryde's whales. An outer surface filter area for the North Pacific animal is shown by the cross.

that of humpback and minke whales. The general food habits of baleen whales (e.g. Nemoto and Kawamura, 1977) may well describe the result due to these characteristics in the structure of feeding apparatus.

So far as the result from 120 Bryde's whales in the South Pacific and the Coral Sea, and 105 animals in the Indian Ocean are concerned, they fed solely upon euphausiids, *Euphausia diomedeae*, *E. recurva*, and *Thysanoessa gregaria* (Kawamura, 1977), while the 'offshore' form Bryde's whales in the South African waters has

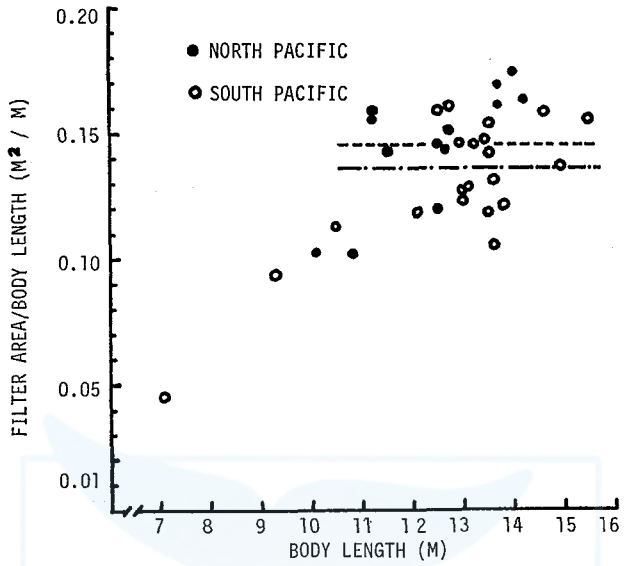

Fig. 5. Filter area per unit of body length shows an appreciably more poorer developments of filtering apparatus in the South Pacific Bryde's whales than in the North Pacific animals. Averages for both the North Pacific and the South Pacific animals were 0.145 (N=13, broken line) and 0.136 (N=20, chain line) respectively. The unusual and relatively smaller figures for [two young animals (see Nos 79 and 80 animals in Appendix Table 1) were excluded in taking an average.

been reported to feed mainly upon *Euphausia lucens*, *E. recurva*, *Nyctiphanes capensis*, *Thysanoessa gregaria* and several species of micronektonic fish (Best, 1977). To see the dominancy of *E. recurva* in the stomach of fin, sei, humpback and pygmy blue whales in addition to Bryde's whales at Durban (Bannister and Baker, 1967), *E. recurva* may be considered to play an important role in the nutritional ecology of baleen whales widely over the warmer sea region. The coincidence with the food habits in both above mentioned Bryde's whale populations may suggests that the animals in the South Pacific are very similar to ' offshore ' form, and they must be similar ' form ' to the animals occurring in the waters of Bonin Islands and southern coastal regions. However, the former animals are possibly be separated morphologically from those occur in the pelagic North Pacific although Ohsumi (1977) thinks the latter can also be reffered to the ' offshore ' form. On the other hand, Nemoto and Kawamura (1977) gives a figure in the order of selection of food by baleen whales as 88.9% of Bryde's whales fed upon euphausiids and the rest 11.1% was composed of fish diet. This may suggests the animal to be similar to ' offshore ' form. However, the food item of baleen whales itself is so variable with the change of feeding ground under the multi-specific structure such as the North Pacific (see Kawamura, 1973 ; Nemoto and Kawamura, 1977), and hardly be determined by the morphological character alone. The clear difference in the size and shape of North Pacific pelagic form from those in the southern coastal

waters of Japan indicates the former animals, if not entirely, could be separated from the latter as well as the South Pacific Bryde's whales which also could be separated from the northern population by their appreciably smaller filter area.

REFERENCES

BANNISTER, J. L. and A. de C. BAKER, 1967. Observations on food and feeding of baleen whales at Durban. *Norsk Hvalfangst-Tid.*, No. 4 : 78–82.

BEST, P. B., 1977. Two allopatric forms of Bryde's whale off South Africa. *Rep. int. Whal. Commn*, (Special issue 1): 10–38.

KAWAMURA, A., 1973. Food and feeding of sei whale caught in the waters south of 40°N in the North Pacific. *Sci. Rep. Whales Res. Inst.*, 25: 219–236.

KAWAMURA, A., 1974. Food and feeding ecology in the southern sei whale. *Sci. Rep. Whales Res. Inst.*, 26: 25–143.

KAWAMURA, A., 1977. On the food of Byde's whales caught in the South Pacific and Indian Oceans. *Sci. Rep. Whales Res. Inst.*, 29: 49–58.

KAWAMURA, A. and Y. SATAKE, 1976. Preliminary report on the geographical distribution of the Bryde's whale in the North Pacific with special reference to the structure of filtering apparatus. *Sci. Rep. Whales Res. Inst.*, 28: 1–35.

NEMOTO, T. and A. KAWAMURA, 1977. Characteristics of food habits and distribution of baleen whales with special reference to the abundance of North Pacific sei and Bryde's whales. *Rep. int. Whal. Commn*, (Special issue 1): 80–87.

OHSUMI, S., 1977. Bryde's whales in the pelagic whaling ground of the North Pacific. *Rep. int. Whal. Commn*, (Special issue 1): 140–149.

OMURA, H., 1977. Review of the occurrence of Bryde's whale in the Northwest Pacific. *Rep. int. Whal. Commn*, (Special issue 1): 88–91.

OMURA, H., S. NISHIMOTO, and K. FUJINO, 1952. Sei whales (*Balaenoptera borealis*) in the adjacent waters of Japan. *Japan Whaling Assoc.*, 80 p.

APPENDIX TABLE 1. Measurements on filtering apparatus for the South Pacific Bryde's whales caught

1.	8	15	45	59	60	62	68	71	72	73	74
2.	30 X	30 X	31 X	1 XI	1 XI	2 XI	2 XI	2 XI	2 XI	2 XI	2 XI
3.	25–06	23–32	24–49	24–32	25–00	24–42	24–38	24–49	24–45	24–49	24–48
	177–34	177–50	177–48	177–19	177–40	177–18	177–27	177–24	177–25	177–26	177–18
4.	M	M	M	F	M	F	M	F	F	M	M
5.	13.4	13.2	13.6	15.5	13.0	13.0	12.1	13.5	14.9	13.1	12.5
6.	Nil	Nil	Nil	Eu+	Eu卌	Eu卅	Eu卅	Eu卅	Eu艹	Nil	Eu卅
7.	—	—	—	None	—	108 (M)	—	None	None	—	—
8.	4.0	3.5	4.0	5.0	4.5	4.0	3.5	4.0	5.0	3.5	4.5
9.	278	300	276	336	273	274	255	273	316	276	274
	20.75	**22.73**	**19.85**	**21.68**	**21.00**	**21.08**	**21.07**	**20.22**	**21.21**	**21.07**	**21.92**
10.	255	273	267	319	265	255	244	243	294	254	252
	19.03	**20.68**	**20.58**	**20.38**	**19.62**	**20.17**	**20.07**	**19.48**	**19.73**	**19.39**	**20.16**
11.	112	112	140	110	107	99	99	120	136	103	110
	8.36	**8.48**	**9.03**	**8.46**	**8.23**	**8.18**	**8.18**	**8.89**	**9.12**	**7.86**	**8.80**
12.	187	195	218	180	159	155	155	208	246	195	165
	13.96	**14.77**	**14.06**	**13.85**	**12.23**	**12.81**	**12.81**	**15.41**	**16.51**	**14.89**	**13.20**
13.	1.97	1.92	1.79	2.40	1.65	1.59	1.44	2.08	2.04	1.67	1.99
14.	0.15	0.15	0.15	0.13	0.12	0.12	0.12	0.15	0.14	0.13	0.16

Key to the numbers, 1 to 14, in the appendix table

1. Ser. No.
2. Date of catch (day/month)
3. Position of catch (south latitude and east longitude)
4. Sex
5. Body length of animal (m)
6. Stomach contents
7. Body length of foetus (sex)
8. Thickness of blubber (cm)
9. Length, row of baleen plates along gum level (cm)
10. Length, row of baleen plates along palatal ridge (cm)
11. Maximum spread of filtering apparatus across both baleen rows (cm)
12. Length, anterior end of baleen row to largest baleen plates (cm)
13. Total area of filtering apparatus (m^2)*
14. Total area of filtering apparatus/Body length (m^2/m body length)

* Total inside surface filter area corresponds to ' Si ' given in Kawamura and Satake (1976, Appendix II and Fig. 8)

by the *Tonan Maru No. 2* fleet in 1976. Percentage proportions to the body length is given in bold faces.

75	76	77	79	80	86	87	88	93	95	104
2 XI	2 XI	3 XI	3 XI	3 XI	3 XI	3 XI	3 XI	3 XI	3 XI	4 XI
24–30	24–47	24–50	24–45	24–49	25–02	25–08	25–08	24–52	24–37	25–35
177–39	177–15	177–22	177–28	177–26	177–15	177–11	177–11	178–08	178–04	178–30
F	M	M	F	F	M	M	M	F	M	F
10.5	13.8	13.5	7.1	9.3	13.1	13.5	13.6	14.6	12.9	12.7
Eu+	Eu++	Eu+	Nil	Eu+	Eu+	Nil	Eu++	Eu+	Eu+	Eu+
None	—	—	None	None	—	—	—	None	—	None
4.0	4.5	3.5	3.5	3.0	4.0	4.5	4.5	5.5	4.5	3.5
220	291	273	135	189	258	282	270	322	280	302
20.95	**21.09**	**20.22**	**19.29**	**20.32**	**19.69**	**20.89**	**19.85**	**22.05**	**21.71**	**23.78**
219	273	—	125	187	230	255	253	300	255	270
20.86	**19.78**	—	**17.86**	**20.11**	**17.56**	**18.89**	**18.60**	**20.54**	**19.77**	**21.26**
96	106	107	45	80	116	135	103	124	115	110
9.14	**7.68**	**7.93**	**6.43**	**8.60**	**8.85**	**10.00**	**7.57**	**8.49**	**8.91**	**8.66**
150	190	188	80	118	177	193	185	230	169	210
14.29	**13.77**	**13.93**	**11.43**	**12.69**	**13.51**	**14.29**	**13.60**	**15.75**	**13.10**	**16.54**
1.19	1.67	1.59	0.33	0.88	1.83	1.92	1.43	2.33	1.89	2.03
0.11	0.12	0.12	0.05	0.09	0.14	0.14	0.11	0.16	0.15	0.16

APPENDIX TABLE 2. Comparison of proportions and filter area between the North Pacific and South Pacific Bryde's whales. Averaged figure is given in parenthesis.

Locality	North Pacific* (Japan, coastal)	South Pacific** (Pelagic)
Period of catch	24 VII–3 VIII 1976	30 X–4 XI 1976
No. of animal examined, male	7	13
„ „ female	6	9
Body length, male	10.1–12.7(11.87)	12.1–13.8(13.18)
„ „ female	10.8–14.2(12.93)	10.5–15.5(13.53)
Length, row of baleen plates along gum level, male	19.20–22.14(20.65)	19.69–22.73(20.91)
„ „ female	17.59–22.11(20.96)	20.22–23.78(21.57)
Length, row of baleen plates along palatal ridge, male	18.64–20.35(19.50)	17.56–20.38(19.50)
„ „ female	19.93–20.07(20.00)	19.48–21.26(20.30)
Maximum spread of filtering apparatus across both baleen rows, male	6.53–8.88(7.88)	7.57–10.00(8.40)
„ „ female	8.02–8.76(8.41)	8.23–9.14(8.79)
Length, anterior end of baleen row to largest baleen plates, male	9.91–12.96(11.22)	12.81–14.89(13.79)
„ „ female	10.83–11.88(11.36)	12.23–16.54(14.97)
Total filter area, male	1.04–1.92(1.64)	1.43–1.99(1.75)
„ „ female	1.10–2.44(2.02)	1.19–2.40(1.95)
Total filter area/Body length, male	0.103–0.156(0.137)	0.105–0.159(0.133)
„ „ female	0.102–0.174(0.154)	0.113–0.160(0.143)

* Based on data by Kawamura and Satake (1976)

** Figures for those unusually smaller animals (Nos 79 and 80, see Appendix table 1) were excluded from the calculation on right column.