ON THE EXTERNAL CHARACTERS OF *GLOBICEPHALA MACRORHYNCHUS* OFF TAIJI, PACIFIC COAST OF JAPAN

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ABSTRACT

The external measurements of 211 short-finned pilot whales off the Pacific coast of Japan and the observation of the pigmentation of some of those individuals are analyzed. They have pigmentation pattern fundamentally common to the genus *Globicephala*. The growth of the trunk is characterized by the highest growth rate of rostrum portion in fetal stage, and that of the region between umbilicus and anus in postnatal stage. On some appendages, the change of growth pattern occurs at parturition and/or after the attainment of sexual maturity of male. *G. macrorhynchus* is morphologically different from *G. melaena* in smaller size of body, and shorter flipper and tail region.

INTRODUCTION

Although the recent existence of the long-finned pilot whale, *Globicephala melaena* (Traill, 1809), is not confirmed, that of the short-finned pilot whale, *G. macrorhynchus* Gray 1846, is known from the coastal waters of Japan (Kasuya, 1975). The species is less common in the Sea of Japan than off the Pacific coast. They are believed to migrate seasonally along the Pacific coast between southwestern Japan and Hokkaido, though the summer resident are present in the southwestern waters. The seasonal movement of the northern range of the species between 34°N and 42°N seems to be related to the movement of the subarctic convergence. In recent years, the driving fishery at Taiji on the Pacific coast of central Japan is the only fishery taking the species constantly in the above range. It is operated usually within a radius of 15 km from Taiji.

The purpose of this study is, based on the sample obtained from the catch of this fishery, to make a brief description of the external morphology of the species and provide some basic data for future analyses of between populations difference of the external characters.

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The present study was started as a graduation thesis of Yonekura under the supervision of Matsui. Later Kasuya joined the study, collected some additional data, reanalysed data, and added a section of external pigmentation.

MATERIALS AND METHOD

All the observations of the colour pattern and the external measurements were obtained from the catch by driving fishery off Taiji (33°35′N, 135°58′E).

The measurements of the body proportions used in this study are as follows. With exceptions of nos. 12 through 19, all the measurements were made parallel to the long axis of the body. Though some of the measurements may differ from those customarily used for whales, it does not mean the recommendation of the present method.

1. Standard length, from the tip of snout to bottom of the notch of tail flukes.
2. Tip of snout to center of eye.
3. Tip of snout to blowhole.
4. Tip of snout to angle of gape.
5. Tip of snout to anterior insertion of flipper.
6. Tip of snout to tip of flipper.
7. Center of eye to center of ear.
8. Bottom of notch of flukes to the apex of dorsal fin.
9. Bottom of notch of flukes to center of anus.
10. Bottom of notch of flukes to center of genital aperture.
11. Bottom of notch of flukes to center of umbilicus.
12. Flipper, straight length from anterior insertion to tip.
13. Flipper, straight length from axilla to tip.
14. Flipper, curvilinear length along anterior edge.
15. Flipper, maximum width.
16. Dorsal fin, length of base.
17. Dorsal fin, height from base to apex.
18. Width of tail fluke at base, from anterior insertion to bottom of fluke notch.
19. Distance between apices of tail flukes.
20. Projection of melon beyond the tip of snout, measuered when anterior end of melon projects over the tip of snout.

The measurements nos. 1 to 19 were made by Yonekura on 143 postnatals and 17 fetuses in eight schools caught from May to November of 1976. The length frequency of these specimens is shown in Fig. 1. The provisional analysis of the growth of *G. macrorhynchus* off the Pacific coast of Japan suggests that the calves are born between 135 and 146 cm, and that the growth stops with large individual variation at a length between 340 and 395 cm in females and between 430 and 525 cm in males (Kasuya, unpublished). The lower boundary of these ranges situates about 10 cm above the mean length at the onset of sexual maturity. However,

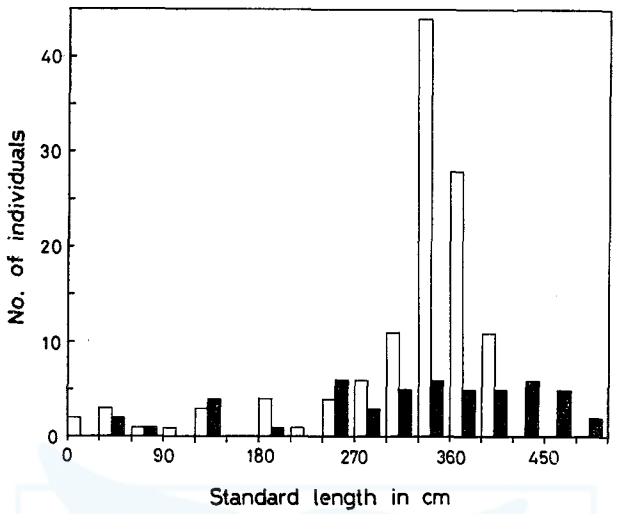

Fig. 1. Length frequency of 160 samples (52 males and 108 females) used for the external measurement nos. 1 through 19. Shaded square indicates male and the white female. Samples smaller than 150 cm in standard length are fetuses.

these figures are based on the body length measured including the projection of melon beyond the tip of snout. The standard lengths corresponding to these ranges are calculated at 337 to 390 cm and 423 to 512 cm respectively. The mode in female frequency in Fig. 1 may indicate the mean asymptotic length.

The observation of colouration was done by Kasuya, and the measurement no. 20 was taken by Kasuya and Matsui on the individuals in four schools caught in February 1980. The purpose of the measurement no. 20 is to analyze the possible sexual dimorphism and to get some clue to convert the "standard length" generally used in this study into the "body length" measured from the anteriormost point of head to fluke notch, which might be commonly used for the short-finned pilot whale. Though the use of the standard length might be adequate for the morphological comparizon between the two species of pilot whales, the accurate measurement is difficult on adult *G. macrorhynchus* because, different from *G. melaena* (Sergeant, 1962a), the anterio-ventral surface of melon directly merges into the tip of snout.

The statistical analyses of the significance of sexual difference of the external measurements are made for each 30 cm length groups, and on the proportion expressed as the percentage of standard length.

PIGMENTATION PATTERN

Except for a few pale areas mentioned below, most of the part of the body of *G. macrorhynchus* is pigmented dark brown on living or freshly dead individuals. This brown colour changes black soon after the death.

The most faint lightly pigmented part is the blaze behind the eye, which is an

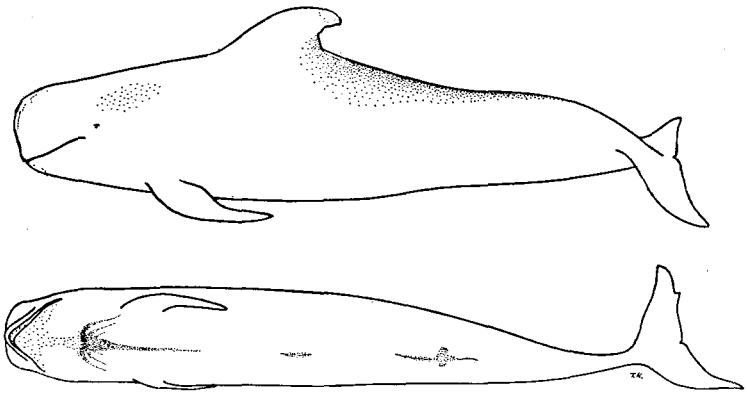

Fig. 2. Body contour and pigmentation of *G. macrorhynchus* off the Pacific coast of Japan. Dotted area indicates paler part of body. Drawings are based on photographs and measurements of an adult female.

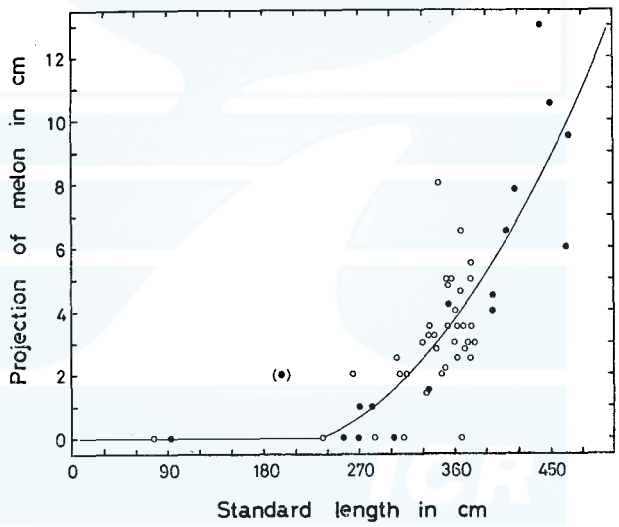

Fig. 3. Relationship between standard length and projection of melon beyond the tip of snout. Open circle indicates female and the closed male. A male in parentheses is not used for the calculation of regression.

oblong patch extending from the posterio-dorsal region of the eye to anterior insertion of dorsal fin. Though this patch was found on all the individuals examined, size and clearness were variable between individuals. This is usually discernible only through very careful observation of wet skin of the freshly killed individuals. It is not frequent to recognize it from a distance even on a live specimen. Though this postorbital patch is not described by Norris and Prescott(1961), it might be universal in the genus of *Globicephala*.

The second is the postdorsal saddle-mark, which has been described on *Globice-*

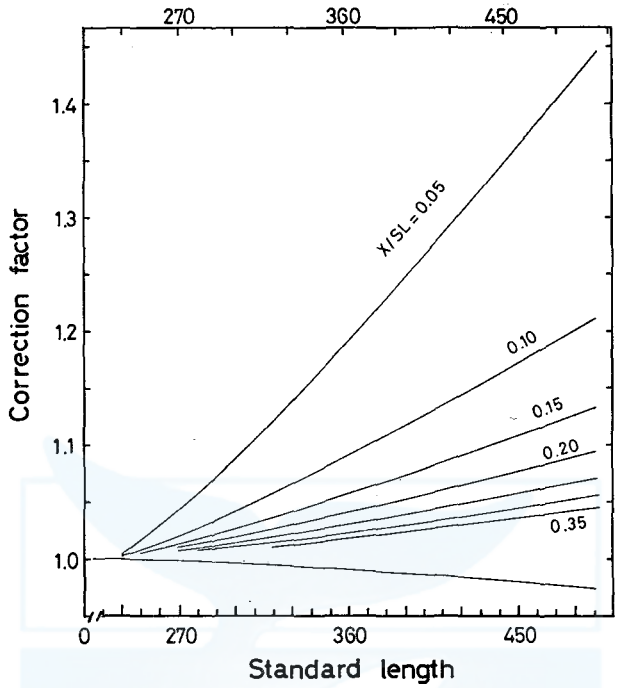

Fig. 4. Correction factors to convert the external proportions expressed as the ratio of standard length into those of body length measured from the protruded tip of melon to fluke notch. The downward line at the bottom is for the measurement not including the protruded melon, and other lines for the measurement including it. X indicates longth from tip of snout, SL the standard length, and the scale at the top the body length converted from standard length.

phala (Norris and Prescott, 1961; Sergeant, 1962a). This has large individual variation and generally conspicuous on adult individuals. Though this mark becomes indiscernible on specimens dead long, it is more conspicuous than the blaze behind eye. This is most clear when observed on live animals and through the water (Plate I, Figs 1 and 2).

The third is the ventral mark. The pattern is principally common to *G. melaena* and *G. macrorhynchus*. The colour, however, seems to be much darker in the later species as mentioned by Sergeant (1962a), and no individual of *G. macrorhynchus* observed in the present study showed such a brightly pale colour of the inguinal region as *G. melaena*.

GROWTH OF TRUNK

Projection of melon

The melon of full term fetus is small and shaped of the ordinary delphinids' melon (Plate II, Fig. 1.), however it seems to start the rapid growth after birth and soon attains the bulbous form. The projection of the front end of the melon

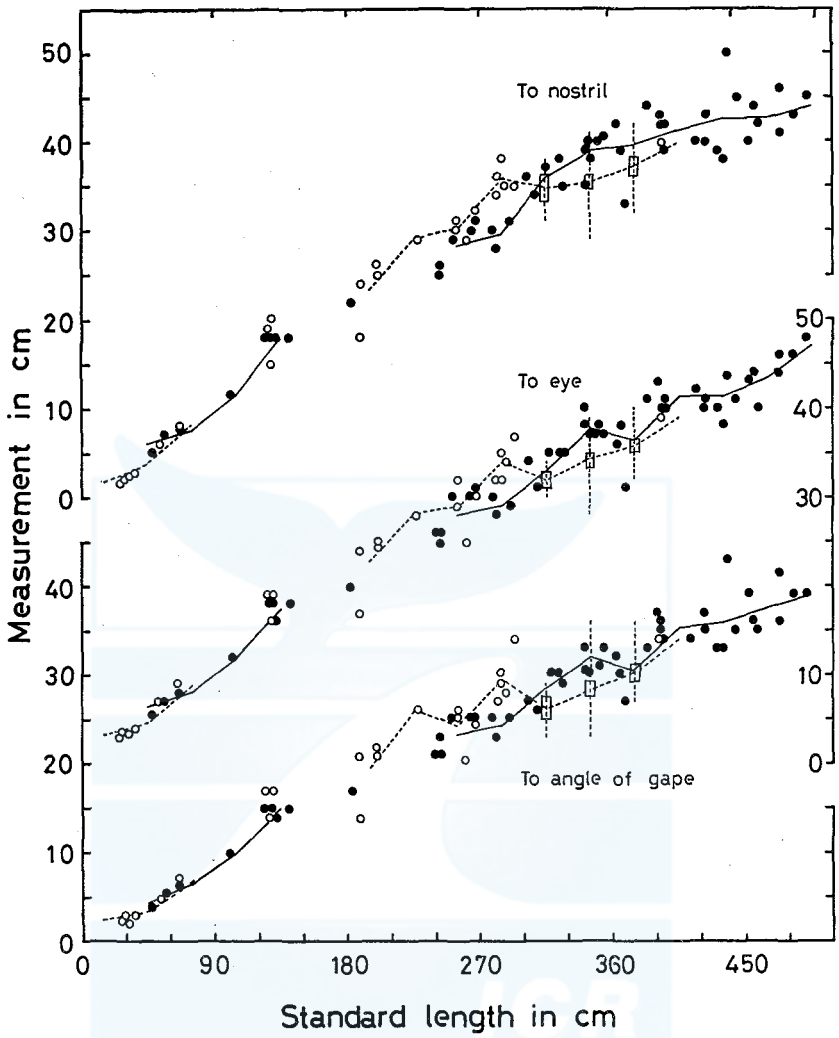

Fig. 5. Measurement nos. 2, 3, and 4, measured from tip of snout and expressed by actual length. Open circle and dotted line indicate female and the closed circle and solid line male. The square and vertical line indicate the range of data and 95% confidence range of the mean based on 10 or more female samples. The scale at the top indicates calculated body length between fluke notch and projected melon.

over the snout occurs at the length of about 240 cm, which correspond to the age of about 2 years (Kasuya, unpublished). The relationship between standard length and the degree of the melon projection is shown in Fig. 3. Both sexes are expressed by the following least squares equations.

$$y = 0 \quad , \quad SL \leqq 236$$
$$y = 1.257 \times 10^{-4} SL^2 - 4.517 \times 10^{-2} SL + 3.649 \quad , \quad SL \geqq 237$$

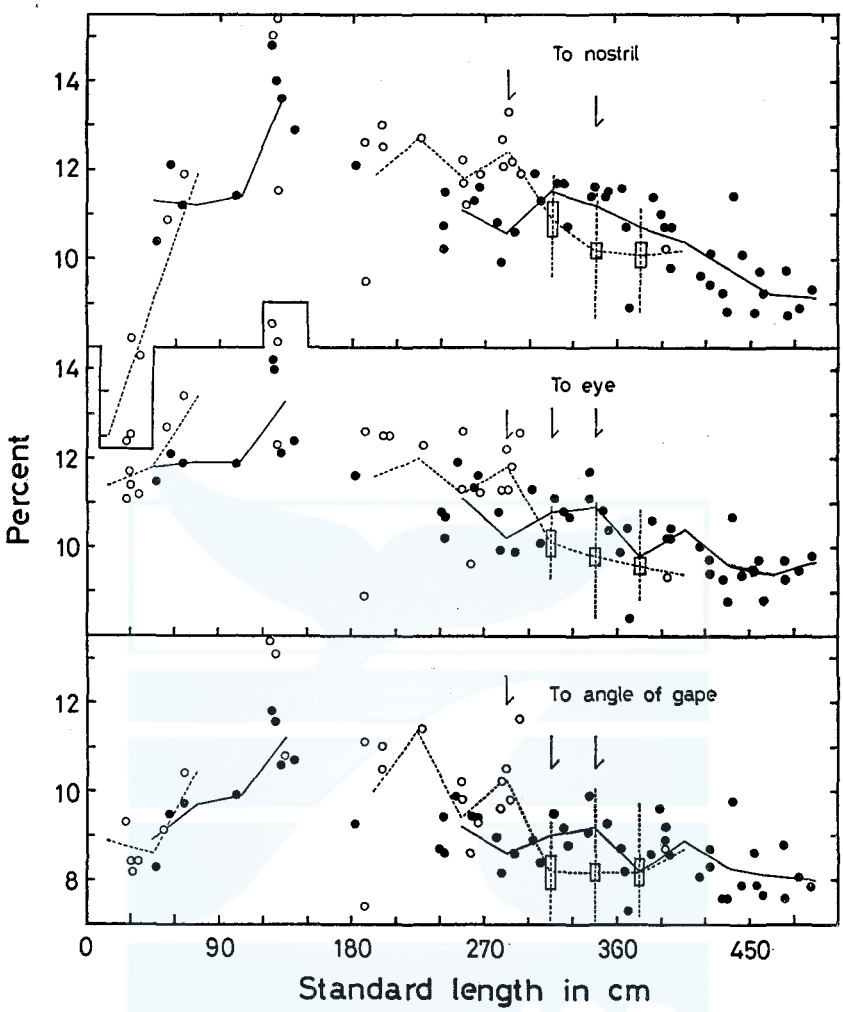

Fig. 6. Measurement nos. 2, 3, and 4, expressed as the percentage of standard length. Arrow indicates the presence of significant sexual difference of mean values ($p<0.05$). For further explanations see Fig. 5.

where SL indicates the standard length in cm, and y the projection of melon beyond the tip of snout. Though it is generally believed in *G. melaena* that the development of a huge melon is one of the secondary sexual characteristics, it is shown on *G. macrorhynchus* that the size of the melon may not be different when compared between sexes of same body length. And even on the adult males exceeding the maximum standard length of the female, the development of melon is on the same line. This suggests that the large size of the melon in the adult male is the simple result of the augmentation of body.

From the above equations the correction factor (r) is calculated in order to convert the measurement expressed as the percentage of "standard length (SL)"

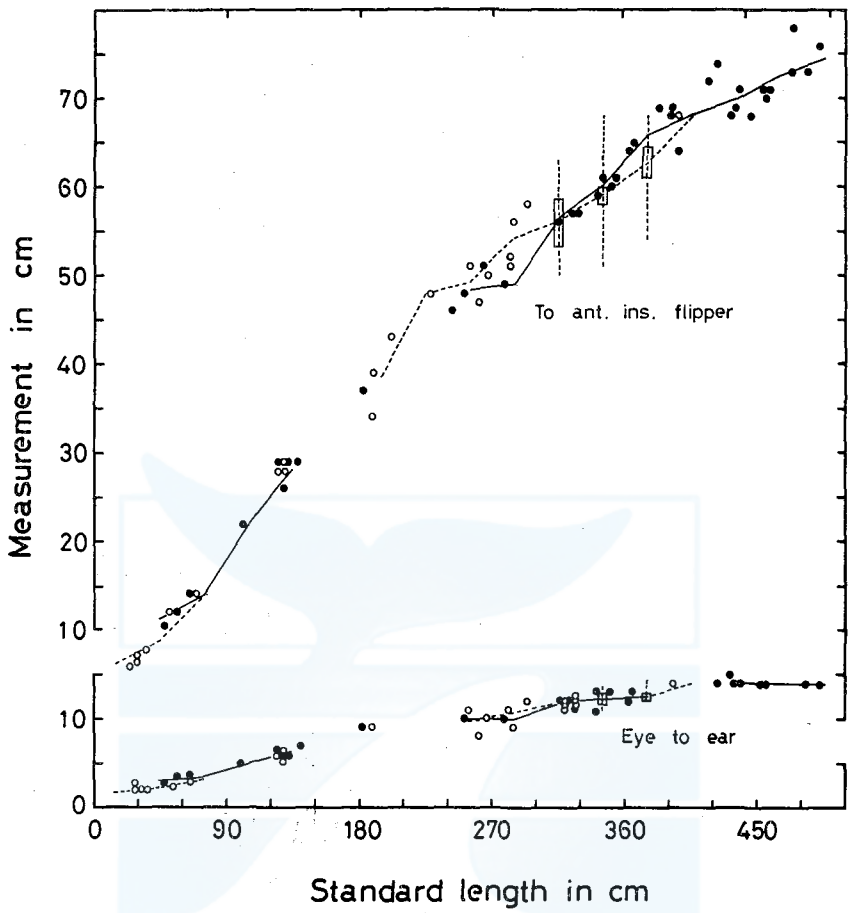

Fig. 7. Measurement nos. 5 and 7, expressed by actual length. For further explanations see Fig. 5.

to that expressed as the ratio of "body length (BL)" measured from the end of projected melon to fluke notch. When the measurement does not include the projection of melon, there is a following equation.

$$r = \left(\frac{1}{BL}\right) \Big/ \left(\frac{1}{SL}\right) = \frac{SL}{y+SL}$$

If the corrected measurement includes the projection of melon, the correction factor r is obtained by the following equation,

$$r = \left(\frac{X+y}{SL+y}\right) \Big/ \left(\frac{X}{SL}\right)$$

where X indicates an actual length measured from the tip of snout excluding the projection of melon. The value of r is shown in Fig. 4 for the selected values of X/SL.

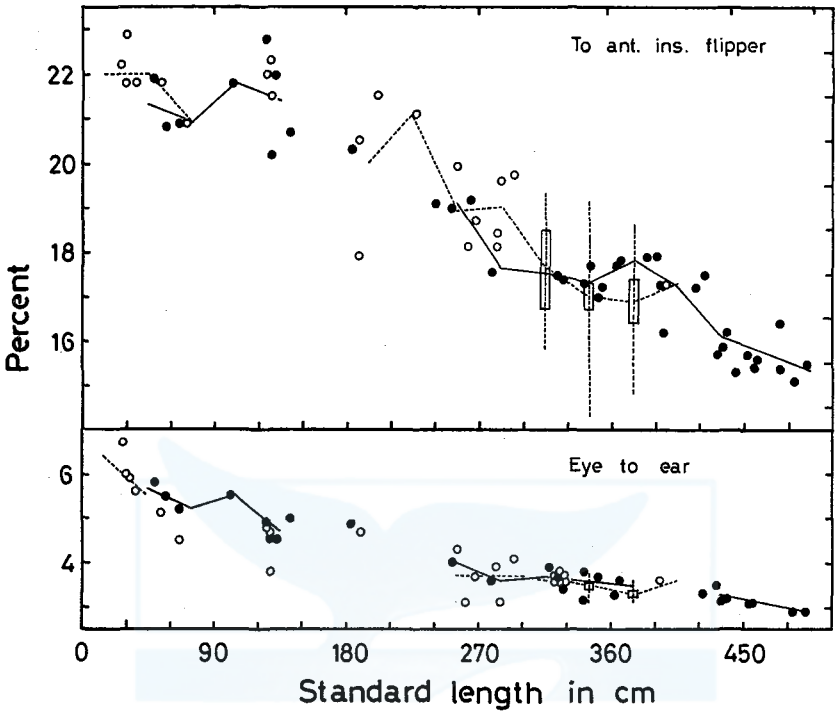

Fig. 8. Measurement nos. 5 and 7, expressed as the percentage of standard length. For further explanations see Fig. 5.

TABLE 1. COMPARISON OF BODY PROPORTION OF *G. MACRORHYNCHUS* BETWEEN FETUS, FULL TERM EETUS, AND FULL GROWN MALE AND FEMALE[1)]

Standard lenth, cm	30 (♂♀)		135 (♂♀)			360 (♀)			465 (♂)		
	cm	%	R	cm	%	R	cm	%	R	cm	%
Projection of melon	0	0		0	0		3.7	1.0		9.8	2.1
Rostrum tip to eye	3.4	11.4	4.4	18.4	13.7	0.89	35.0	9.7	1.4	43.4	9.3
Eye to ear	1.8	6.0	2.4	6.2	4.6	0.98	12.3	3.4	1.3	14.0	3.0
Ear to ant. ins. flipper	1.4	4.8	2.4	4.8	3.6	1.8	13.4	3.7	2.2	15.2	3.3
Flipper to umbilicus	8.7	29.1	3.4	38.7	28.7	1.5	98.3	27.3	2.1	118.4	25.5
Umbilicus to anus	5.5	18.0	3.6	25.5	18.9	2.2	82.1	22.8	3.4	112.0	24.1
Anus to genitals ♂	—	—	—	11.1	8.2	—	—	—	3.5	49.8	10.7
♀	0.54	1.8	6.0	3.8	2.8	2.6	13.7	3.8	—	—	—
Anus to fluke notch	9.2	30.7	3.5	41.4	30.7	1.9	118.9	33.0	2.9	162.0	34.8

[1)] Ratio is shown as the percentage of standard length. R indicates the relative growth rate.

Growth of anterior portion

The characteristic feature of the growth of anterior portion of *Globicephala* is in the rapid growth in the fetal stage, and in the gradual decrease of the rate after the parturition (Sergeant, 1962a). The details of the growth pattern, however,

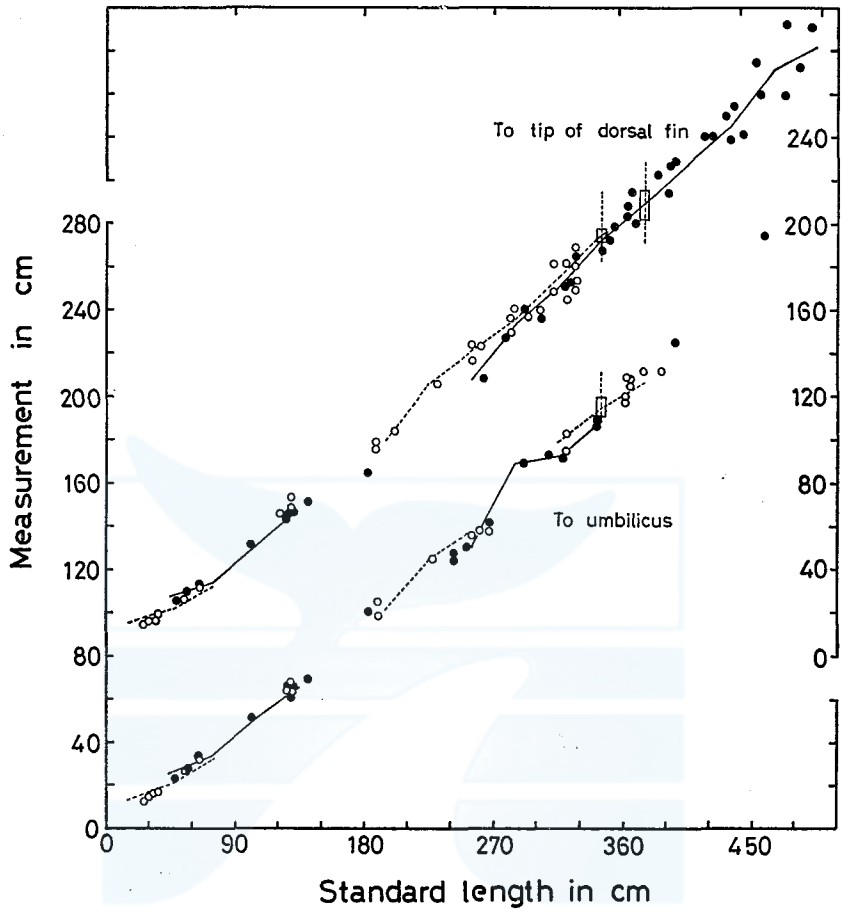

Fig. 9. Measurement nos. 8 and 11, measured from fluke notch and expressed by actual length. For further explanations see Fig. 5.

differ between the portion at the front of eye and that posterior of it.

The position of the nostril changes drastically. In the early fetal stage it situates at about 6% of the standard length from the tip of rostrum namely at the front of eye and of angle of gape, and continues to move posteriory during entire fetal stage. As this movement is much faster than the growth of the rostrum, the nostril finally comes on a level same with that of eye and angle of gape by the stage of 120 to 150 cm in standard length, or the length at birth. At this stage, if calculated combining both sexes, the relative positions of nostril, eye, and angle of gape measured from the tip of rostrum are 13.8%, 13.7%, and 11.7% of standard length respectively. Though the ratio of head region in the standard length continues to decrease after birth, the relative position of these organs remains almost unchanged. Another peculiarity of the growth pattern of the rostrum region is the possible presence of sexual difference in the postnatal growth stage. As shown in Fig. 5, nos-

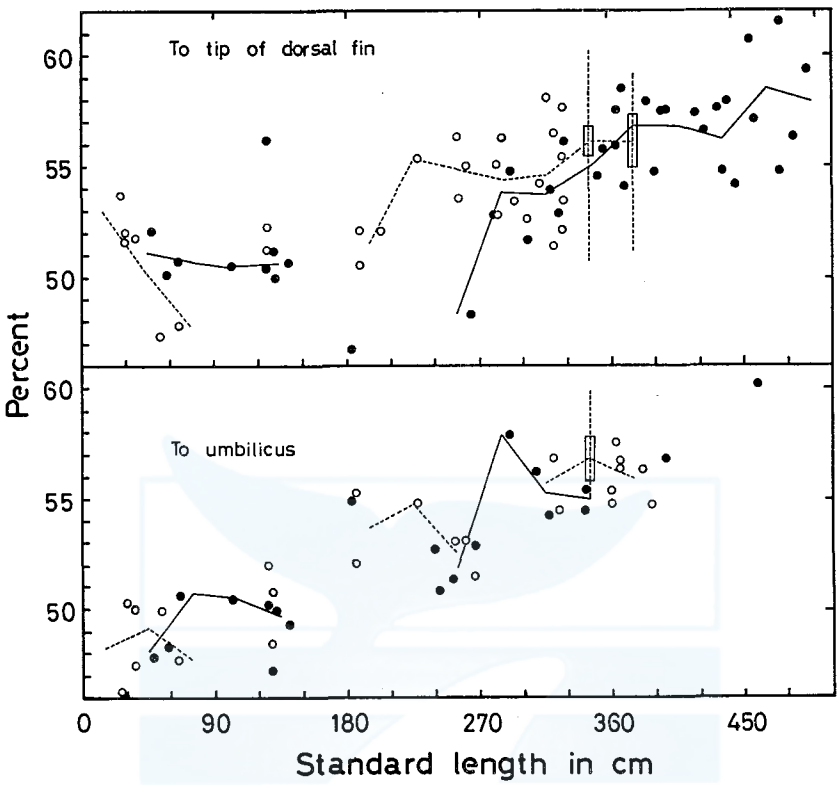

Fig. 10. Measurment nos. 8 and 11, expressed as the percentage of standard length. For further explanations see Fig. 5.

tril, eye, and angle of gape of juvenile females situate posterior to the corresponding positions of the male of the same body length. However their relative position is reversed in the later growth stage. This change occurs at the standard length of 300 to 330 cm. Though the samples are not sufficient for the statistical analysis of all the length groups, the sexual difference is significant in some of the groups (Fig. 6). The growth rate of the rostrum region, which decreases after birth, becomes slightly higher at the standard length of 285 to 375 cm in males. This growth spurt of the rostrum is again followed, after 375 cm, by a stage of relatively slow growth. On the other hand, the spurt occurs in females at smaller body length or from 195 to 285 cm. This will explain the presence of sexual difference in the proportion of rostrum portion at restricted growth stages.

The proportional length between eye and ear also shows a higher relative growth in fetal stage than in the postnatal. No secondary growth spurt nor sexual dimorphism is expected for this part. The increase of the actual length of that section ceases at 330 cm in females and at 420 cm in males. The occipital portion represented by this measurement is, as in the case of neck region, the place where the growth is the smallest in both fetal and postnatal stages (Table 1).

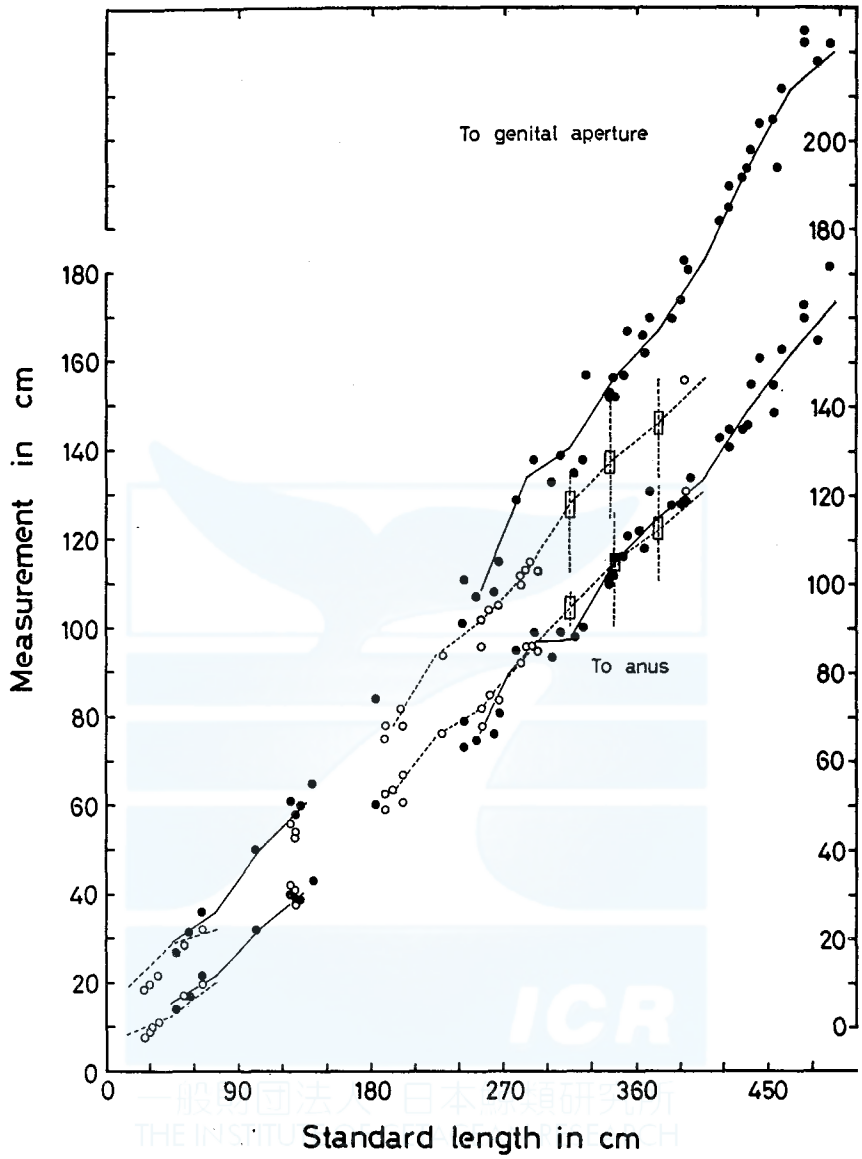

Fig. 11. Measurment nos. 9 and 10, measured from fluke notch and expressed by actual length. For further explanations see Fig. 5.

The growth of the portion between tip of snout and anterior insertion of flipper shows a pattern similar to that of rostrum region. However, the ratio to standard length does not increase even in the fetal stage as observed in the growth of other part of head region, but decreases rather slowly, which is followed by a rapid decrease after parturition. The speed of decrease of the ratio in postnatal stage is higher than that observed on the rostrum portion. This is also an indication that

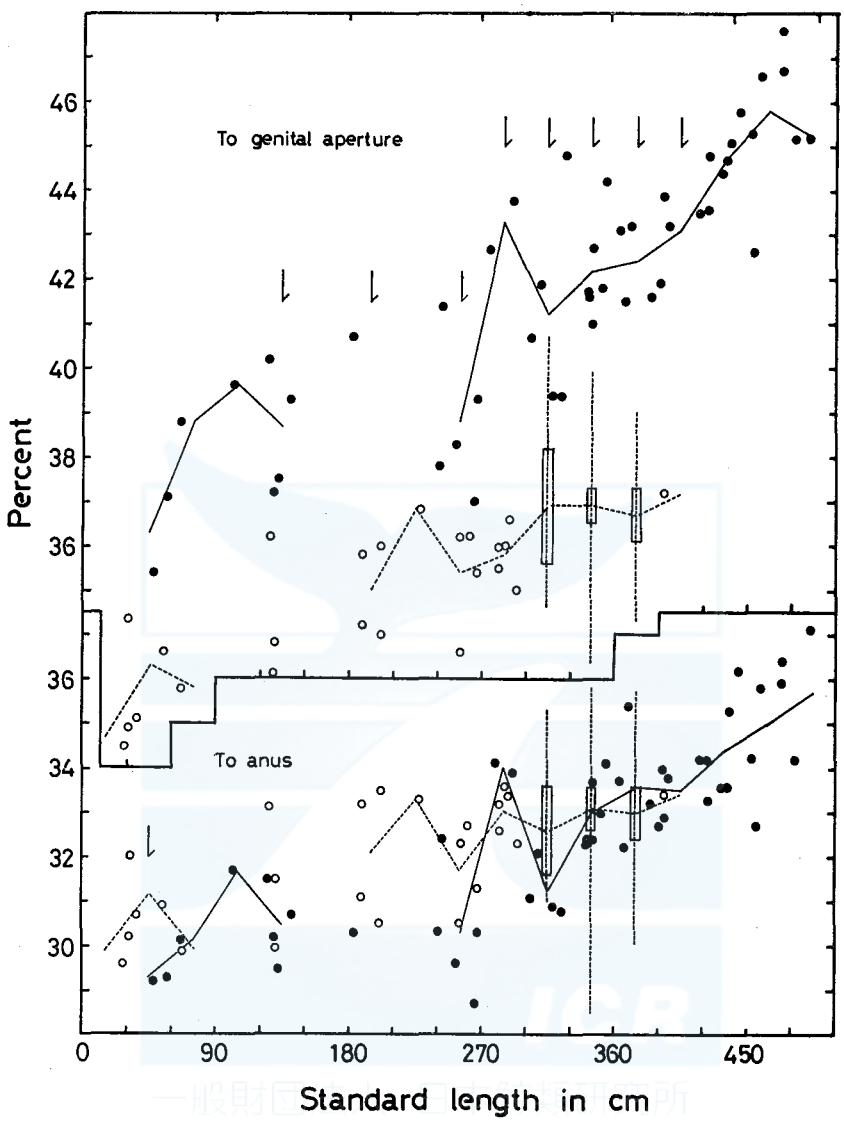

Fig. 12. Measurement nos. 9 and 10, expressed as the percentage of standard length. For further explanations see Fig. 6.

the growth of the portion between eye and anterior insertion of flipper is smaller than its anterior section.

Growth of rear portion

The four measurements on the posterior region of the body, the lengths measured from fluke notch to anus, to genital aperture, to umbilicus, and to apex of dorsal fin show a similar feature in the growth pattern, namely the ratio is constant

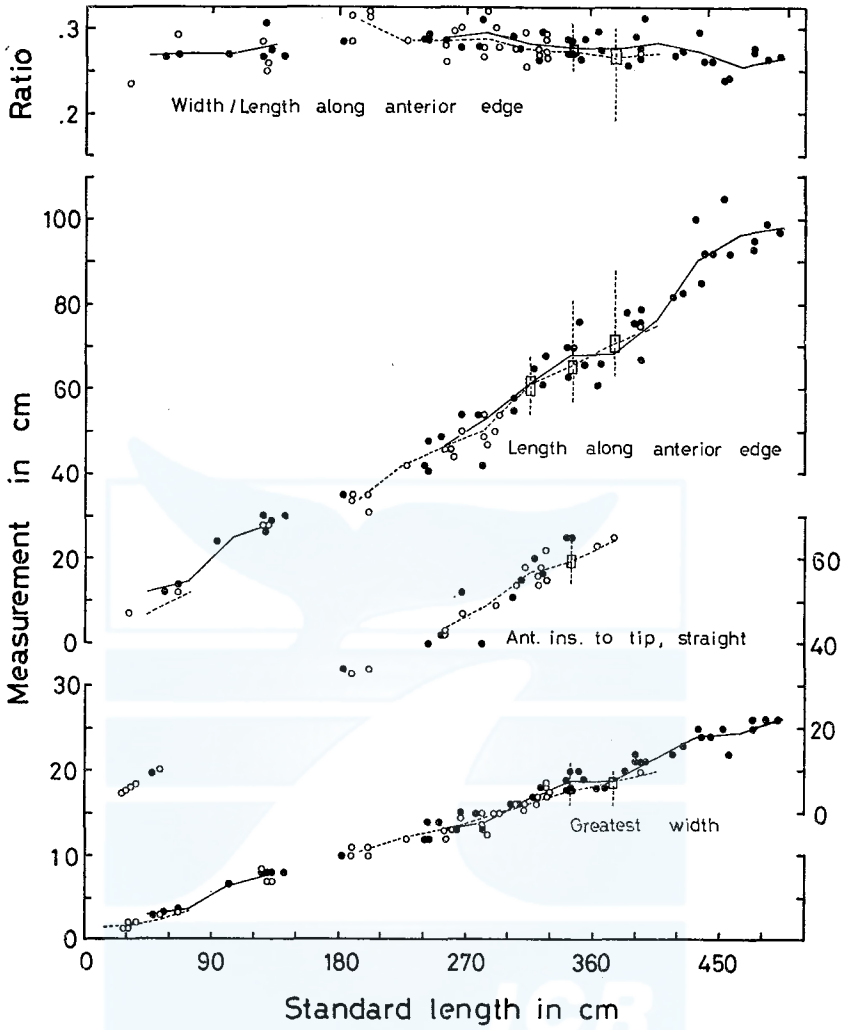

Fig. 13. Dimensions of flipper, measurement nos. 12, 14, and 15. For further explanations see Fig. 5.

or slightly increasing accompanied by the growth of body. This is the reflection of the fact that this portion retains high growth rate until the cessation of growth in body length.

No sexual dimorphim is indicated except for the position of the genital aperture. Though, obstacled by the scarcity of the samples, the between sexes difference of the position is not statistically significant in all the length groups examined (Fig. 12), the difference must appear significant in more length groups when larger samples are accumulated.

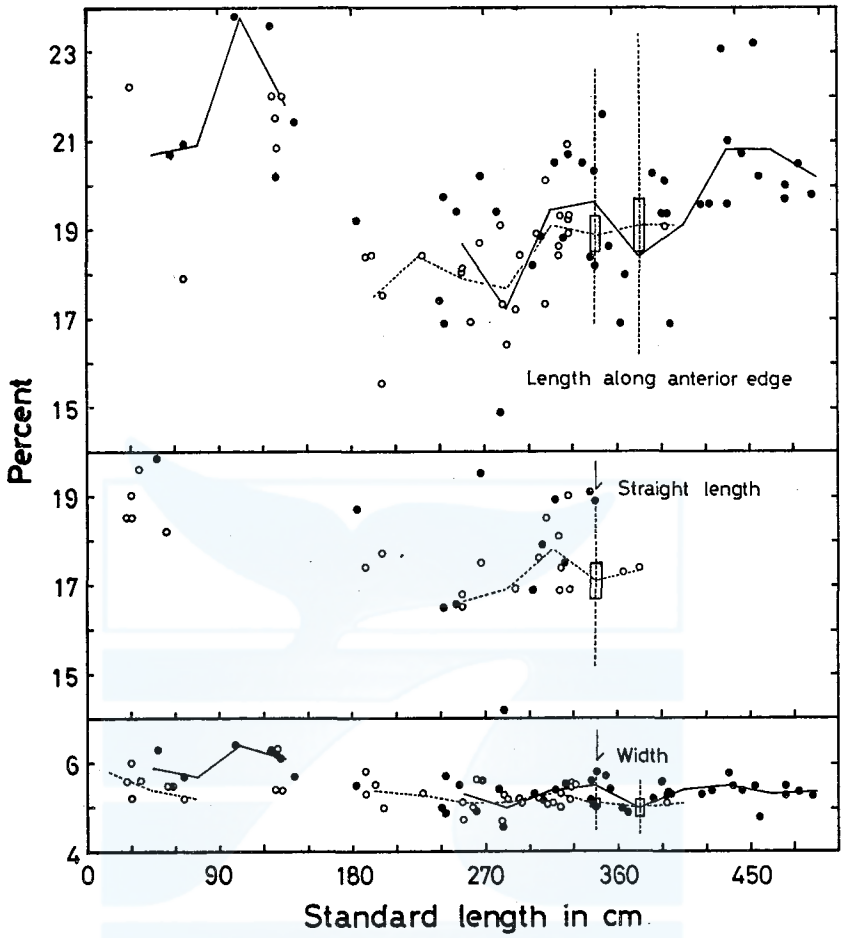

Fig. 14. Dimensions of flipper (measurement nos. 12, 14, and 15) expressed as the percentage of standard length. For further explanations see Fig. 6.

Growth of each segment

The lengthwise dimensions expressed as the percentage of standard length become almost constant, in females, after the length of 330 cm. This lower limit coincides, as mentioned above, with the lower range of the asymptotic length or with the mean length at sexual maturity. Though the corresponding length of the male will be about 420 cm, the body propotion in the male seems to change even after the length. Table 1 shows the mean body proportions calculated from the present data of nearby size (±15 cm). They are mean values at the standard lengths of 30 cm (early fetus), 135 cm (near term fetus), 360 cm (female, approximately at the mean asymptotic length), and 465 cm (male, same as female). This is considered to give a rough idea on the body shape of the species. The position of apex of dorsal fin is not listed, because it situates in any stage of the growth

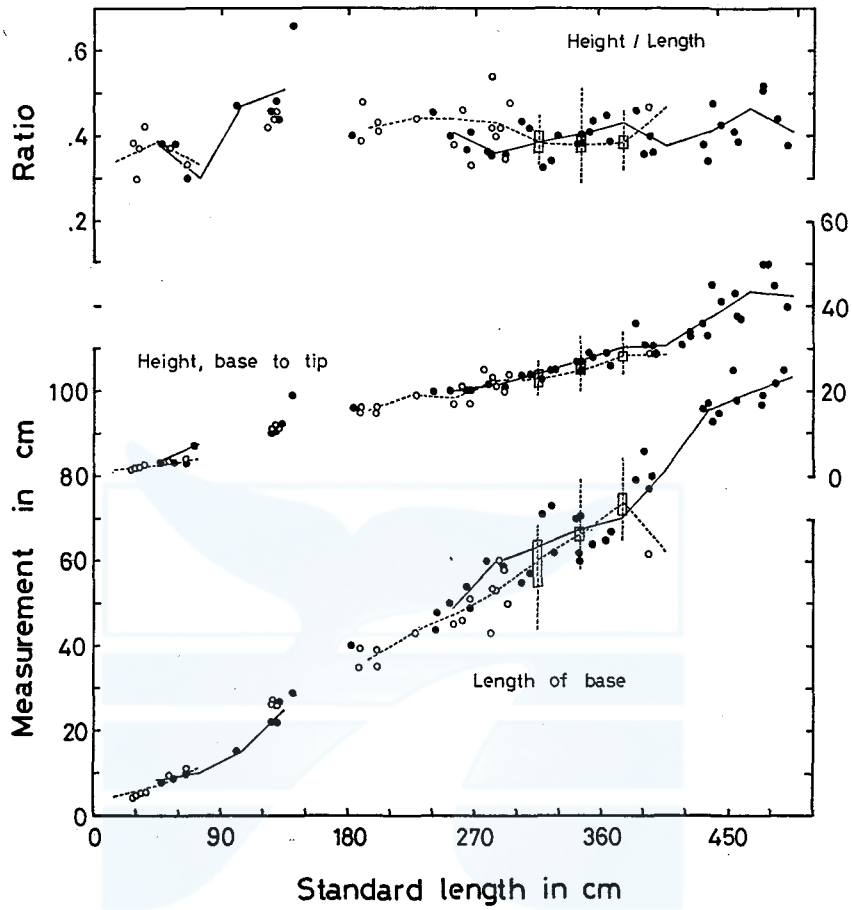

Fig. 15. Dimensions of dorsal fin, measurement nos. 16 and 17. For further explanations see Fig. 5.

nearly at the same level with that of umbilicus. The growth rate of each segment is calculated using the following equation and the data in Table 1,

$$R_X = \frac{X_2 - X_1}{X_1}$$

where R_X indicates the growth rate of segment X, X_1 the length of X segment at the start, and X_2 that at the end. When fetus grows from 30 cm to 135 cm, the highest growth rate is found at the segment between tip of rostrum and eye, and the next highest at the segment from umbilicus to anus which is followed by the segments of tail and of flipper to umbilicus. The growth rate of the segment between anus and genital aperture is not included in this comparison, because it is special and included in the segment between umbilicus and anus. In the postnatal growth stage the feature is same in both sexes and the highest growth rate is observed in the segment between umbilicus and anus, the second highest in the tail seg-

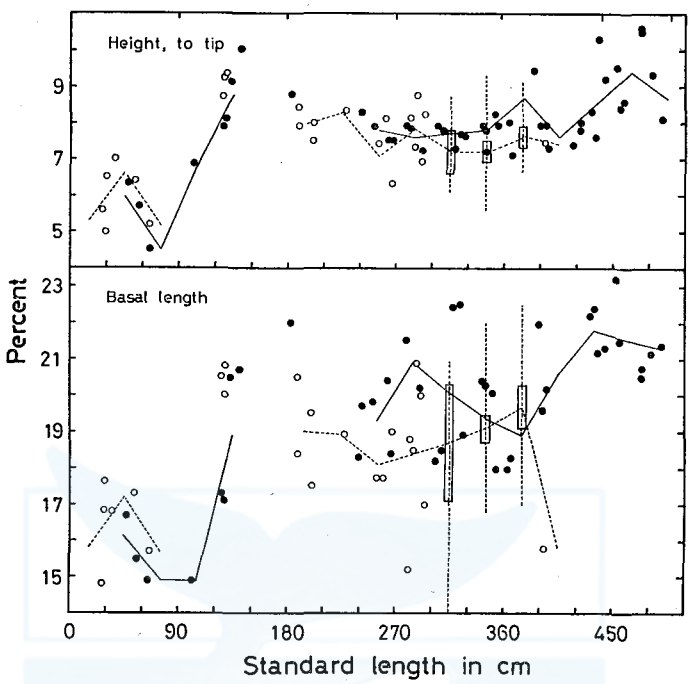

Fig. 16. Dimensions of dorsal fin (measurement nos. 16 and 17) expressed as the percentage of standard length. For further explanations see Fig. 5.

ment, and followed by the segments of ear to flipper and of flipper to umbilicus.

GROWTH OF APPENDAGES

Flipper

Since the straight length of flipper was measured on limited number of samples and the data is entirely lacking in adult males, following analyses are done on the length along anterior edge and on the maximum width. During the fetal stage the length of flipper increases both in actual length and in the ratio of standard length. However the growth in the actual length decreases between the full term fetuses of about 135 cm and newborn calves of 180 cm, and the ratio of the length expressed as percentage of standard length drastically decreases. This is already observed on *G. melaena* in the North Atlantic (Sergeant, 1962a). After this period the ratio again continues a slow increase, until the animal attains the asymptotic length over 330 cm in females and over 420 cm in males.

The width of flipper expressed as the percentage of standard length shows a slight increase during fetal stage. After the birth the ratio decreases until 270 cm in standard length, and then stays almost constant.

The width/length ratio increases in fetal stage and continues to decrease in all the postnatal period.

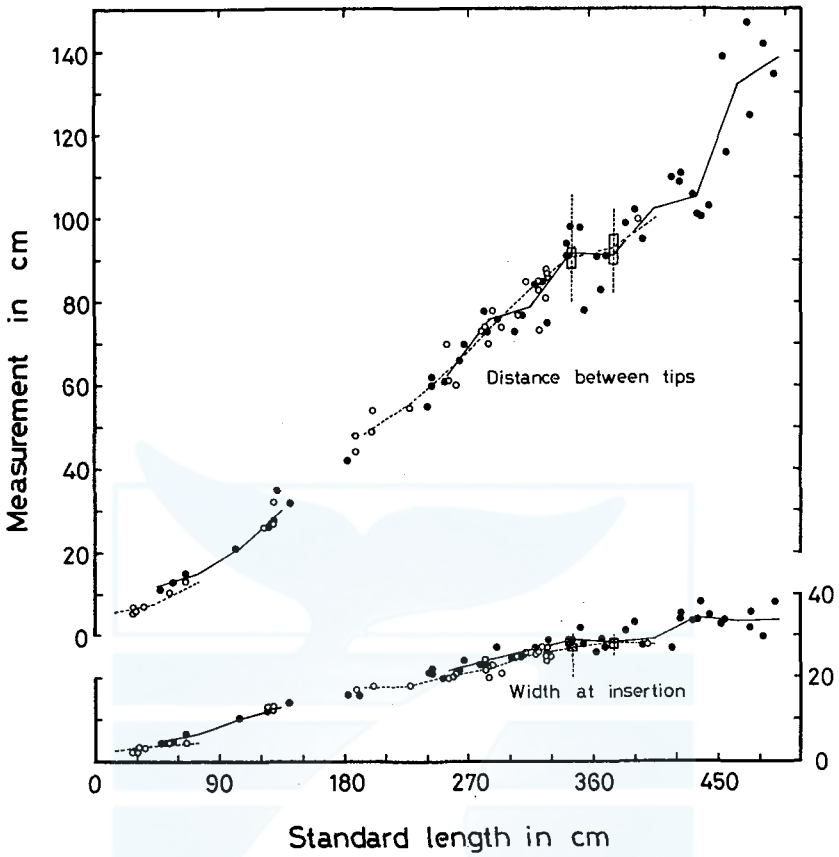

Fig. 17. Dimensions of tail flukes, measurement nos. 18 and 19. For further explanations see Fig. 5.

Sexual dimorphism may not exist even where the difference of the means are statistically significant in the present data.

Dorsal fin

Length of the base of dorsal fin expressed as the percentage of standard length increases rapidly in fetal stage and then stays nearly constant in all the postnatal females and in males below 390 cm. In males the basal length, as in the case of the height mentioned below, shows a rapid increase at about 420 cm, which may correspond to the age of sexual maturity. The decrease of the relative basal length near the parturition indicated by Sergeant (1962a) on *G. melaena* is not detected on the present species.

The relative height of the dorsal fin increases in fetal stage and then continues, in females, to decrease until the maximum body length. In males, on the other hand, the height too shows a rapid growth at 420 cm in standard length. In *G. melaena* the growth of height of dorsal fin is reported to follow the pattern of flipper (Sergeant, 1962a), but it is different in female *G. macrorhynchus*.

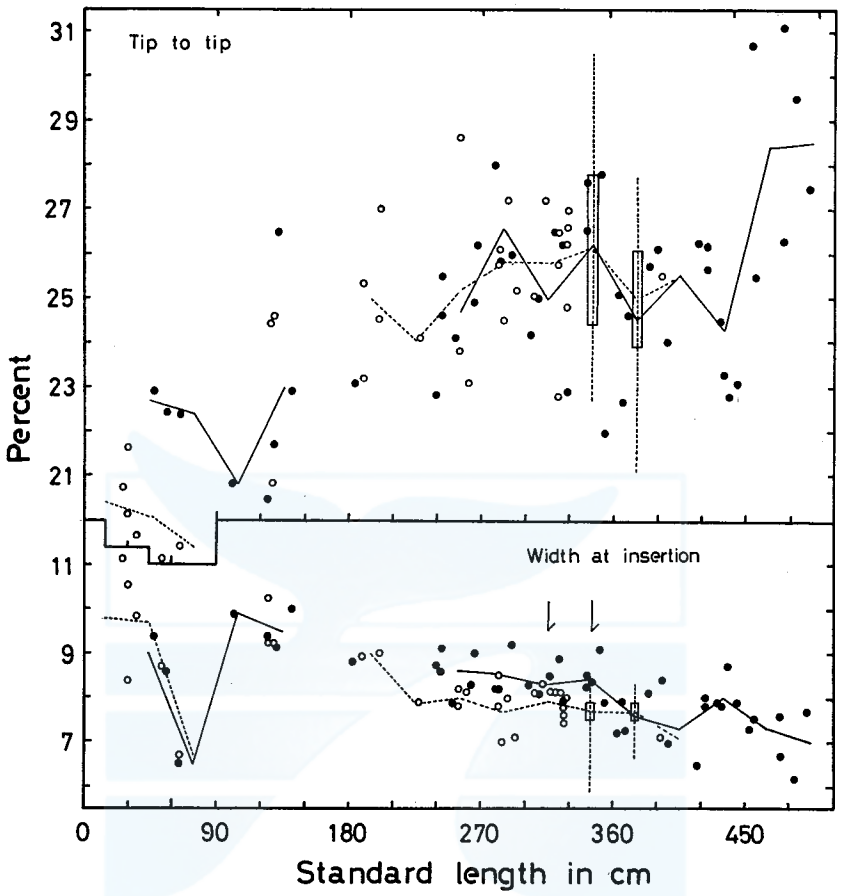

Fig. 18. Dimensions of tail flukes, measurement nos. 18 and 19, expressed as the percentage of standard length. For further explanations see Fig. 6.

The height/length ratio increases in fetal stage, and after birth it stays almost constant.

No sexual dimorphism is detected, when compared between the sexes of the same body length. However, both the height and length of dorsal fin are larger in relation to the standard length in full grown males than the females of corresponding stage.

Tail fluke

Becuase the tail flukes of the fetus are coiled ventrally, the correct measurement of the distance between the apices is difficult to be done. The distance between apices expressed as the ratio of standard length increases rapidly in fetal stage. After birth the ratio stays almost constant in all the females and in males below 450 cm in standard length. In the larger full grown males, the distance between apices expressed as percentage of standard length tends to be larger.

The ratio of the width of tail fluke at insertion shows a constant decrease from early fetal stage to full grown individuals of both sexes. In some of the length groups, the mean of the relative width is significantly smaller in females than in the males of the same body length (Fig. 18). Though such a length range is limited between 300 and 360 cm, the presence of similar trend in smaller length groups suggests that the difference might be proved as significant in other body length groups if more samples are accumulated.

DISCUSSION

A comparison of some important external proportions is made between *G. macrorhynchus* of the present study and *G. melaena* in the western North Atlantic. Only the individuals of adult size were selected from the former species. They are 73 females above 330 cm and 13 males above 420 cm in standard length. The data of *G. melaena* selected are females above 400 cm and males over 500 cm, which are expected to be composed mainly of adult individuals (Sergeant, 1962b).

TABLE 2. COMPARISON OF EXTERNAL PROPORTIONS BETWEEN TWO SPECIES OF *GLOBICEPHALA*

		G. macrorhynchus			*G. melaena*		
		n	range	mean[1)]	n	range	mean[1)]
1. Standard length (cm)	♂	13	424-491	452.6	10	500-610	551.8
	♀	73	334-392	357.5	10	405-472	440.7
2. Tip of snout to eye (%)	♂	13	8.8-10.7	9.5±0.3	9	7.2-9.3	8.3±0.5
	♀	63	8.4-11.0	9.7±0.2	10	9.0-10.6	9.8±0.4
5. Tip of snout to ant. ins. of flipper (%)	♂	12	15.1-17.5	15.8±0.4	9	12.6-14.9	13.7±0.6
	♀	53	14.3-19.0	17.0±0.3	10	14.4-16.3	15.5±0.5
8. Notch of flukes to apex of dorsal fin (%)	♂	11	54.2-61.5	57.4±1.5	8	52.1-57.8	54.6±1.5
	♀	47	51.3-60.1	56.1±0.3	9	48.2-53.1	51.2±1.5
11. Notch of flukes to umbilicus (%)	♂	1	60.2	60.2	8	58.2-68.0	61.2±2.4
	♀	16	54.8-59.9	56.3±0.2	9	57.7-63.2	60.3±1.3
9. Notch of flukes to anus (%)	♂	13	32.7-36.4	34.8±0.3	10	33.9-41.4	38.2±1.3
	♀	65	28.5-35.8	33.0±0.3	10	33.8-37.0	36.1±0.8
12. Flipper, ant. insertion to tip (%)	♂	0			9	24.1-27.4	26.2±0.8
	♀	18	15.8-18.9	16.3±1.8	10	21.9-26.2	23.7±1.0

[1)] Mean and its 95% confidence range are indicated.

The comparison in Table 2 shows no significant difference between the two species in the length from tip of snout to eye, but certainly significant difference in the length of the tail portion. The length of tail is 3.1% (female) to 3.4% (male) shorter in *G. macrorhynchus*. If the proportion of other segment is calculated from Table 2, the length between anus and umbilicus is 23.3% in the female of this species and 0.9% shorter than the same sex of *G. melaena*. The segment between eye and anterior insertion of flipper and that between anterior insertion of flipper and umbilicus are 7.3% and 26.7% in female *G. macrorhynchus* respectively. These

figures are 1.7% and 2.5% larger than correspoding figures of female *G. melaena*. The eye to flipper segment of male *G. macrorhynchus* is 6.3% and also 0.9% larger than the value of *G. melaena*. Though in male *G. macrorhynchus* the position of umbilicus is not accurately calculated, the length between anterior insertion of flipper and anus is 49.4%. This is almost same with the corresponding value of the female 50.0%. Accordingly we conclude that *G. macrorhynchus* has shorter tail and umbilicus to anus egments, and larger eye to umbilicus segment.

In Sergeant (1962a), the measurement no. 8 "Notch of flukes to back of dorsal fin" is specified as "Measured to point vertically below apex of fin". This measurement is considered to be same with our measurement no. 8 "Notch of flukes to apex of dorsal fin meaured parallel to the long axis of body". Then, Table 2 suggests that the tip of dorsal fin of *G. macrorhynchus* is situated 2.8% (male) to 4.9% (female) anterior to the corresponding position of *G. melaena*. This is different from the conclusion obtained by Sergeant (1962a) on the position of the anterior end of the dorsal fin, where no significant difference between the species was detected.

About the appendages, the height of dorsal fin is measured in the present study from the base to the apex. This is not same with the ordinary measurement of vertical height of dorsal fin. Though present method may give a smaller value, the height in the adult *G. macrorhynchus* is from 33 to 50 cm in males and 20 to 34 cm in females. And the similar but different measurements of *G. melaena* in Sergeant (1962a) are slightly smaller than these range giving the value from 34 to 46 cm in males and from 25 to 32 cm in females. This is a suggestion that *G. macrorhynchus* may have the higher dorsal fin. Based on the same principle, we measured the width between the apices of tail flukes which certainly give a smaller figure than the measurement of "Total spread of flukes". Though the difference can be significant in fetuses, it may not be large in the adult. The comparison between Fig. 7 of Sergeant (1962a) and our Fig. 18 shows that the mean values of the distance between apices in *G. macrorhynchus* situate above the range of the total spread of tail flukes of *G. melaena*. This is an indication that the latter species may have smaller tail flukes. No discussion will be necessary on the shortness of the flipper of *G. macrorhynchus* compared to that of *G. melaena* (Table 2).

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REFFRENCES

KASUYA, T., 1975. Past occurrence of *Globicephala melaena* in the western North Pacific. *Sci. Rep. Whales Res. Inst.*, 27: 95–110.

NORRIS, K. S. and J. H. PRESCOTT, 1961. Observations on Pacific cetaceans of Californian and Mexican waters. *Univ. Calif. Publ. Zool.*, 63 (4): 291–402.

SERGEANT, D. E., 1962a. On the external characters of the blackfish or pilot whales (genus *Globicephala*). *J. Mamm.* 43 (3): 395–413.

SERGEANT, D. E., 1962b. The biology of the pilot or pothead whale *Globicephala melaena* (Traill) in Newfoundland waters. *Bull. Fish. Res. Bd. Canada*, 132: 1–84.

APPENDIX EXTERNAL MEASUREMENTS OF *G. MACRORHYNCHUS* OFF TAIJI**

No.	1*	2*	3*	4*	5*	6*	7*	8*	9	10	11	12
Sex	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂
1	48	58	67	101	127	129	132	140	182	241	234	244
2	5.5	7	8	12	18	18	16	18	20	26	26	25
3	5	7	7.5	11.5	18	18	18	18	22	—	26	25
4	4	5.5	6.5	10	15	15	14	15	17	21	21	23
5	10.5	12	14	22	29	26	29	29	37	46	—	—
6	19	20.5	26	44	57	50	58	55	64	83	—	—
7	2.8	3.2	3.5	5	6.2	5.8	6	7	9	—	—	—
8	25	29.5	34	51	64	66	66	71	85	—	—	—
9	14	17	21.5	32	40	39	39	43	60	73	—	79
10	17	21.5	26	40	51	48	50	55	74	91	—	101
11	23	28	34	51	66	61	66	69	100	127	—	124
12	9.5	—	—	—	—	—	—	—	34	—	40	—
13	7	—	—	—	—	—	—	—	26	—	31	—
14	—	12	14	24	30	26	29	30	35	42	41	48
15	3	3.2	3.8	6.5	8	8	8	8	10	12	12	14
16	8	9	10	15	22	22	27	29	40	44	—	48
17	3	3.4	3	7	10	10.5	12	19	16	20	—	—
18	4.5	5	6.5	10	12	—	12	14	16	21	22	21
19	11	13	15	21	26	28	35	32	42	55	62	20

* Fetus. ** For position of measurement see text.

APPENDIX Continued.

No.	13	14	15	16	17	18	19	20	21	22	23	24	25
Sex	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂
1	253	265	267	279	282	292	302	308	317	325	328	341	343
2	30	30	31	30	28	29	34	31	35	35	35	38	40
3	29	30	31	30	28	31	36	34	37	38	35	39	35
4	25	25	25	25	23	25	27	26	30	30	29	31	34
5	48	51	—	49	—	—	—	—	56	57	57	59	—
6	90	92	—	102	—	—	—	—	118	115	107	126	—
7	10	—	—	10	—	—	—	—	12	12	11	13	11
8	—	128	—	147	—	160	156	—	171	172	184	—	—
9	75	76	81	95	—	99	94	99	98	100	—	110	111
10	97	98	105	119	—	128	123	129	125	128	147	142	143
11	130	—	141	—	—	169	—	173	172	—	—	189	187
12	42	—	52	—	40	—	51	55	60	57	—	65	—
13	31	—	40	—	31	—	39	41	46	43	—	50	—
14	49	—	54	54	42	—	55	58	65	61	68	70	18
15	14	13	15	15	13	—	16	16	17	18	—	19	18
16	50	54	49	60	—	59	55	57	71	73	62	70	—
17	20	20	20	22	—	21	24	24	23	25	25	27	—
18	20	22	24	23	23	27	25	25	27	29	26	28	29
19	61	66	70	78	73	76	73	77	84	85	75	94	91

APPENDIX Continued.

No.	26	27	28	29	30	31	32	33	34	35	36	37	38	39
Sex	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂
1	344	346	352	355	362	363	366	370	385	391	392	394	396	418
2	37	37	38	37	36	—	38	31	41	43	40	40	41	42
3	40	38	40	41	42	—	39	33	44	43	42	42	39	40
4	33	30	31	33	32	—	30	27	33	37	36	35	34	34
5	61	—	60	61	64	—	65	—	69	69	—	68	64	72
6	127	—	124	116	117	—	119	—	136	137	—	128	116	142
7	12	—	13	—	12	—	13	—	—	—	—	—	—	—
8	187	—	192	198	208	203	214	200	223	214	—	227	228	240
9	116	112	116	121	122	—	118	131	128	128	128	134	134	143
10	147	142	147	157	156	—	152	160	160	164	—	173	171	182
11	—	—	—	—	—	—	—	—	—	—	—	—	225	—
12	65	—	—	—	—	—	—	—	—	—	—	—	—	—
13	52	—	—	—	—	—	—	—	—	—	—	—	—	—
14	70	63	76	66	61	—	66	—	78	76	76	79	67	82
15	20	17	20	19	18	—	18	—	20	22	21	21	21	22
16	70	62	71	64	65	—	67	—	79	86	77	—	80	—
17	27	25	29	28	29	—	26	—	36	31	31	—	29	31
18	29	—	32	28	26	—	29	27	31	33	—	—	28	27
19	98	—	98	78	91	—	83	91	99	102	—	—	95	110

APPENDIX Continued.

No.	40	41	42	43	44	45	46	47	48	49	50	51	52
Sex	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂
1	424	424	432	434	439	445	453	455	459	473	475	482	491
2	40	41	40	38	47	42	43	44	40	44	46	46	48
3	40	43	39	38	50	45	40	44	42	41	46	43	45
4	35	37	33	33	43	35	39	36	35	36	42	39	39
5	74	—	68	69	71	68	71	70	71	73	78	73	76
6	136	—	156	131	151	151	162	148	153	142	159	155	161
7	14	—	15	14	14	—	14	14	—	—	—	14	14
8	240	—	249	238	254	241	275	260	—	259	292	272	291
9	145	141	145	146	155	161	155	149	163	170	173	165	182
10	190	185	192	194	198	204	205	194	212	225	222	218	222
11	—	—	—	—	—	—	—	—	274	—	—	—	—
12	—	—	—	—	—	—	—	—	—	—	—	—	—
13	—	—	—	—	—	—	—	—	—	—	—	—	—
14	83	—	100	85	92	92	105	92	—	93	95	99	97
15	23	—	—	25	24	24	25	22	—	25	26	26	26
16	—	—	96	97	93	95	105	98	—	97	99	102	105
17	34	33	36	33	45	41	43	38	37	50	50	45	40
18	33	34	34	34	38	35	33	34	—	36	32	30	38
19	109	111	106	101	100	103	139	116	—	147	125	142	135

APPENDIX Continued.

No.	53*	54*	55*	56*	57*	58*	59*	60*	61*	62	63	64	65
Sex	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀
1	27	29.8	30.6	35.8	55	67	127	130	130	190	190	200	200
2	3	3.5	3.5	4	7	9	19	19	16	24	17	25	25
3	1.6	1.8	2.5	2.8	6	8	19	20	15	24	18	26	25
4	2.5	2.5	2.5	3	5	7	17	17	14	21	14	22	21
5	6	6.5	7	7.8	12	14	28	29	28	39	34	43	—
6	10.5	11.5	12	14	21	24	54	55	—	69	62	72	—
7	1.8	1.8	1.8	2	2.8	3	6	6	5	—	9	—	—
8	14.5	15.5	15.8	18.5	26	32	65	68	73	99	96	104	—
9	8	9	9.8	11	17	20	42	41	39	59	63	61	67
10	8.5	9.5	10.5	11.5	18.5	22	46	44	43	65	68	68	72
11	12.5	15	15.5	17	27.5	32	66	63	66	99	105	—	—
12	5	5.5	5.8	7	10	—	—	—	—	—	33	—	34
13	4	4	4.4	5.5	7	—	—	—	—	—	25	—	26
14	—	—	6.8	—	—	12	18	28	27	35	35	31	35
15	1.5	1.8	1.6	2	3	3.5	8	7	7	11	10	10	11
16	4	5	5.4	6	9.5	10.5	26	27	26	85	39	39	35
17	1.5	1.5	2.0	2.5	3.5	3.5	11	12	12	16	15	16	15
18	3	2.5	3.2	3.5	4.8	4.5	13	12	12	—	17	—	18
19	5.6	6	6.6	7	10.5	13	31	32	27	48	44	49	54

APPENDIX Continued.

No.	66	67	68	69	70	71	72	73	74	75	76	77	78
Sex	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀
1	228	254	256	260	268	282	283	286	287	290	294	304	307
2	28	32	29	25	30	32	32	35	34	—	37	30	30
3	29	31	30	29	32	34	36	38	35	—	35	34	31
4	26	26	25	21	25	27	29	30	28	—	34	26	24
5	48	—	51	47	50	51	52	56	—	—	58	56	50
6	84	—	90	—	100	99	96	92	—	—	101	—	—
7	—	—	11	8	10	—	11	9	—	—	12	—	—
8	126	136	144	143	—	149	156	161	—	—	157	160	—
9	76	82	78	85	84	92	94	96	96	—	95	—	98
10	84	92	86	94	95	100	102	103	105	—	103	—	125
11	125	—	136	138	138	—	—	—	—	—	—	—	—
12	—	42	43	—	47	—	—	—	—	49	—	—	54
13	—	30	33	—	35	—	—	—	—	35	—	—	41
14	42	46	46	44	50	54	49	47	—	50	54	—	58
15	12	13	12	13	15	15	13	15	—	15	15	—	16
16	43	45	—	46	51	53	43	53	60	58	50	—	64
17	19	17	—	21	17	22	23	21	25	20	24	—	23
18	18	20	21	21	—	24	22	20	23	—	21	—	25
19	55	70	60	60	—	73	74	70	78	—	74	—	77

APPENDIX Continued.

No.	79	80	81	82	83	84	85	86	87	88	89	90	91
Sex	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀
1	312	313	320	321	322	326	326	327	328	334	334	335	338
2	32	34	33	31	30	33	33	33	32	35	31	38	31
3	37	36	35	33	31	35	35	38	37	37	36	29	34
4	26	29	28	25	23	26	27	28	26	28	26	24	27
5	61	—	57	54	51	56	54	63	58	58	59	—	56
6	107	—	—	103	104	113	108	114	112	107	111	—	115
7	—	—	—	12	12	12	12	11	12	12	12	—	13
8	169	182	—	165	182	174	170	181	189	183	190	190	—
9	110	108	108	101	103	104	101	105	106	110	112	114	113
10	120	118	121	113	116	113	115	117	122	124	125	124	126
11	—	—	—	175	183	—	—	—	—	191	—	192	—
12	—	58	54	58	56	55	62	—	—	59	59	—	64
13	—	43	42	41	42	41	49	—	—	45	44	—	48
14	54	63	59	62	60	63	68	63	62	67	65	62	70
15	16	16	—	17	16	17	18	18	18	18	17	—	18
16	49	44	61	60	56	68	65	66	67	64	71	59	73
17	22	19	20	22	20	27	23	29	24	25	22	21	25
18	—	26	26	26	26	24	25	26	25	28	27	27	25
19	—	85	73	85	83	88	81	87	86	92	91	85	90

APPENDIX Continued.

No.	92	93	94	95	96	97	98	99	100	101	102	103	104	105
Sex	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀
1	338	340	340	341	341	342	342	343	343	344	344	345	345	345
2	30	34	35	35	34	34	32	37	—	—	—	33	33	31
3	30	35	35	37	36	35	35	38	—	—	—	35	37	32
4	23	28	30	29	27	28	25	34	—	—	—	27	26	24
5	—	58	65	63	55	61	56	60	—	—	—	60	59	58
6	—	115	116	115	110	116	110	112	—	—	—	112	111	111
7	—	13	—	12	12	—	12	—	—	—	—	12	—	12
8	197	192	176	188	201	195	—	193	—	192	—	190	198	196
9	110	111	120	110	109	120	111	117	120	—	102	113	112	112
10	120	129	130	126	119	134	123	127	131	—	115	127	129	126
11	—	—	—	—	188	—	—	—	198	—	193	—	—	—
12	—	58	—	—	56	—	54	—	—	—	—	—	—	55
13	—	43	—	—	42	—	42	—	—	—	—	—	—	42
14	—	67	68	67	66	61	57	66	—	—	—	61	71	59
15	—	18	18	19	18	18	17	18	—	—	—	17	18	18
16	60	60	60	66	61	68	65	60	—	—	—	60	58	71
17	22	24	30	25	20	28	25	28	—	—	—	21	26	26
18	—	26	20	28	28	28	25	23	—	—	—	27	26	28
19	—	87	88	92	85	95	81	95	—	—	—	85	93	81

APPENDIX Continued.

No.	106	107	108	109	110	111	112	113	114	115	116	117	118	119
Sex	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀
1	346	347	347	347	347	348	348	352	352	353	353	354	354	354
2	32	35	34	32	—	38	33	38	31	35	33	37	36	32
3	32	40	35	32	—	40	35	39	34	35	35	38	36	35
4	26	29	28	26	—	35	27	32	27	29	28	28	30	26
5	57	60	58	55	—	57	57	66	—	59	60	60	59	58
6	122	125	122	110	—	114	112	123	—	121	112	119	118	113
7	13	12	13	11	—	11	12	11	—	12	13	—	12	13
8	203	188	—	—	192	206	—	—	196	196	191	201	206	190
9	111	119	110	120	—	118	111	115	126	122	119	115	118	122
10	124	129	123	132	—	128	123	130	137	141	132	128	128	138
11	195	—	191	—	—	—	197	—	211	—	—	—	—	—
12	60	—	60	—	—	—	59	—	—	—	61	—	—	64
13	45	—	45	—	—	—	45	—	—	—	43	—	—	47
14	65	74	68	65	—	62	68	—	60	63	67	63	61	70
15	18	19	17	17	—	19	18	—	—	18	18	17	16	18
16	64	70	67	67	—	63	73	70	63	77	69	62	66	72
17	24	24	25	23	—	32	25	27	24	26	22	23	27	21
18	27	28	27	27	—	24	26	—	30	30	28	—	24	25
19	90	106	93	86	—	90	93	—	80	—	101	78	91	104

APPENDIX Continued.

No.	120	121	122	123	124	125	126	127	128	129	130	131	132
Sex	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀
1	354	355	355	353	356	357	357	357	358	358	358	358	360
2	—	35	34	39	34	37	32	—	39	36	34	34	36
3	—	37	35	34	37	33	34	—	41	37	39	37	39
4	—	30	29	33	28	32	27	—	36	29	31	27	31
5	—	64	60	—	51	65	56	—	68	59	62	54	62
6	—	116	115	—	105	120	112	—	—	119	116	110	129
7	—	13	13	—	11	11	13	—	13	13	12	—	13
8	—	198	201	—	189	206	—	189	205	—	215	193	—
9	101	122	122	112	110	120	115	—	123	122	114	112	122
10	125	132	137	125	124	132	130	—	136	137	126	129	135
11	—	—	—	200	—	—	—	—	—	—	—	—	—
12	—	—	—	—	60	—	60	—	—	63	—	58	—
13	—	—	—	—	48	—	45	—	—	47	—	43	—
14	—	67	65	60	67	65	66	—	81	71	64	67	76
15	—	19	17	17	18	18	17	—	21	18	18	18	20
16	—	71	67	65	73	70	65	—	79	—	66	70	69
17	—	33	20	25	25	23	24	—	33	24	32	22	25
18	—	28	29	28	29	—	27	—	29	29	25	28	30
19	—	99	82	91	90	83	89	—	102	94	90	90	96

APPENDIX Continued.

No.	133	134	135	136	137	138	139	140	141	142	143	144	145	146
Sex	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀
1	361	361	361	361	363	364	365	365	365	367	369	369	371	372
2	39	37	—	—	34	35	33	32	32	—	37	37	38	33
3	40	32	—	—	35	35	36	36	32	—	38	41	35	36
4	35	32	—	—	27	28	27	28	29	—	33	29	31	27
5	67	—	—	—	62	60	58	54	—	—	66	63	67	60
6	113	—	—	—	118	121	114	113	—	—	128	122	119	106
7	—	12	—	—	12	12	12	12	—	—	—	13	12	12
8	199	—	198	202	195	202	—	—	—	—	205	218	213	—
9	118	116	111	—	121	125	—	117	—	131	127	127	127	120
10	131	127	124	—	133	140	—	126	—	143	143	138	—	136
11	—	200	198	—	209	—	—	205	—	208	—	—	—	—
12	—	—	—	—	—	63	—	—	—	—	—	—	—	—
13	—	—	—	—	—	47	—	—	—	—	—	—	—	—
14	68	65	—	—	72	68	—	69	—	—	74	67	70	66
15	20	16	—	—	20	18	—	18	—	—	20	18	19	18
16	70	—	—	—	75	73	70	—	—	—	76	—	72	71
17	30	—	—	—	28	24	24	—	—	—	29	31	27	27
18	26	28	—	—	30	28	—	—	28	—	29	29	30	28
19	100	85	—	—	98	95	—	—	86	—	102	100	88	84

APPENDIX Continued.

No.	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Sex	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀
1	373	373	374	374	374	376	377	378	378	381	387	388	388	392
2	39	36	38	36	33	35	37	40	36	34	35	36	36	39
3	37	37	41	36	37	38	41	37	42	39	38	38	—	40
4	35	31	33	30	27	29	30	36	31	28	32	30	31	34
5	65	—	—	60	66	65	—	67	—	59	—	62	68	68
6	122	—	—	116	112	121	—	126	—	123	—	124	123	134
7	—	—	—	13	12	—	—	—	—	12	—	—	14	14
8	215	—	—	214	192	—	—	220	—	204	—	229	223	—
9	121	—	123	126	117	118	—	122	126	132	117	126	130	131
10	136	—	142	140	132	133	—	135	141	146	135	140	144	146
11	—	—	—	—	—	212	—	—	—	—	212	—	—	—
12	—	—	—	—	65	—	—	—	—	—	—	—	—	—
13	—	—	—	—	47	—	—	—	—	—	—	—	—	—
14	67	—	88	66	72	73	—	71	72	73	71	63	78	75
15	20	—	17	18	18	20	—	20	19	20	20	17	19	20
16	65	—	84	73	77	—	—	80	75	74	70	82	66	62
17	30	—	34	28	28	—	78	33	30	—	28	26	20	29
18	30	—	—	30	28	—	30	28	—	25	—	28	28	28
19	95	—	—	83	100	—	—	100	—	91	—	82	91	100

EXPLANATION OF PLATES

PLATE I

Figs 1 and 2. Probable *G. macrorhynchus* showing the saddle mark behind the dorsal fin. 11 June 1975. 40°38′N, 142°15′E. Surface water temperature 15.9°C. (Photo by T. Kasuya)

Fig. 3. Full term fetus, 144 cm, female. 3 June 1980. Taiji. (Photo by T. Kasuya)

Fig. 4. Adult female, 345 cm in body length. The dorsal fin and keel on the dorsal edge of tail peduncle are bent on the right side. 16 January 1976. Taiji. (Photo by T. Kasuya)

Figs 5 and 6. Adult male, 479 cm in body length. 9 October 1976. Taiji. (Photo by T. Kasuya)

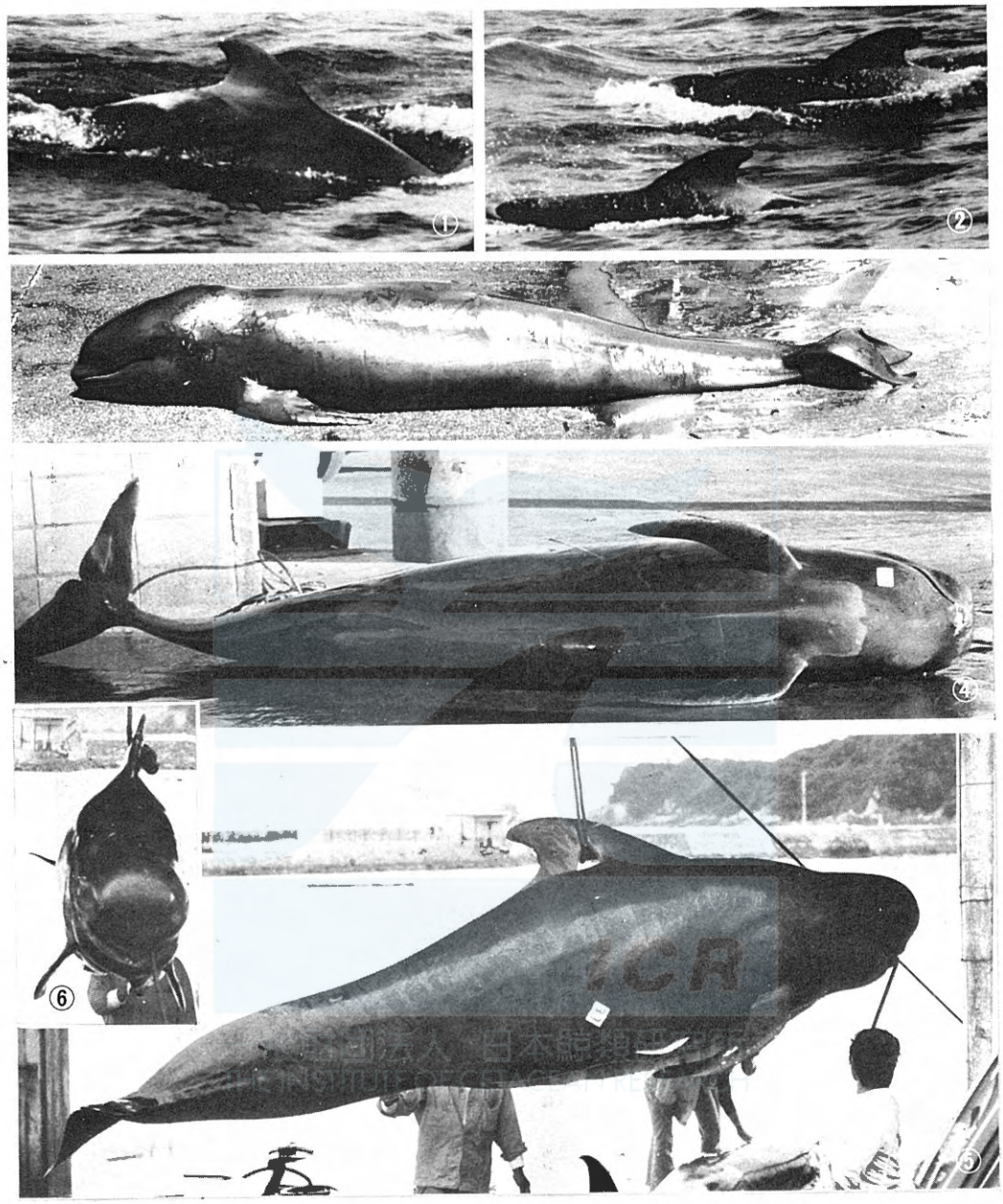
PLATE II

Fig. 1. Same individual as in Plate I, Fig. 1.

Fig. 2. Adult female, 237 cm in body length. 2 June 1980. Taiji. (Photo by T. Kasuya)

Figs 3 and 4. Adult male, 498 cm in body length. 3 June 1980. Taiji. (Photo by T. Kasuya)

Fig. 5. Full grown male, 518 cm in body length. 14 January 1976. Taiji. (Photo by T. Kasuya)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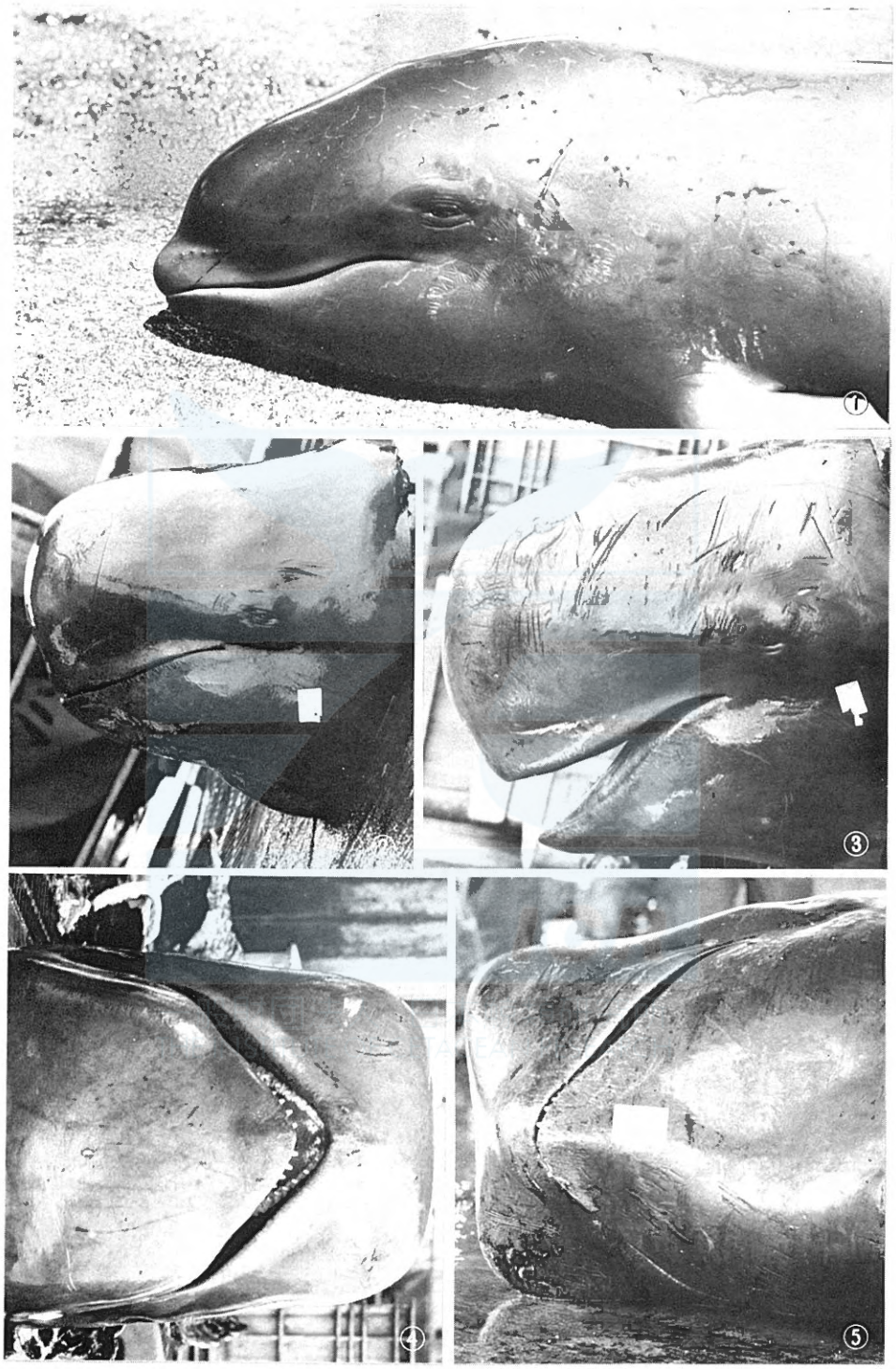
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