# RELATIVE GROWTH OF THE FIN WHALE, *BALAENOPTERA PHYSALUS* (LINN.)

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## INTRODUCTION

Hetherto, the growth of whales have been mainly studied as the function of time. It is natural to regard time as a factor concerning the growth, because the growth is related to time. But as stated by Shimizu (1959), the significance of the astronomical time for the life is merely relative to the nature of life itself and in the relation between the life and environment.

Calendar age does not represent the true age of the life (Hammond, 1950) On the other side, the age study of whales has been developing recently, but the true age of whales is not known except the whales which are born and are kept in the aquarium. That is to say, we cannot know even if the calendar age in the whales. Therefore, it is not complete to study the growth of whales only as the function of the astronomical time, and it will be reasonable to study of growth as the function of the condition of growing system itself.

Now, Huxley (1932) showed experientially that if $x$ and $y$ are supposed to presume as the two portions in the same growing system, the relation of the two is represented as the following formula: $y=bx^{\alpha}$ ($b$ and $\alpha$ are constant). In this formula, term of time is not included and the time is only a latent factor. We can say that relative growth stands on the biological time. The formula $y=bx^{\alpha}$ is called allometry formula.

In the study of the absolute growth, only the increase in quantity is examined accompanying the process of time. However, the portion of living body is merely the portion as the general harmony of the living body, and the symmetry of living body changes every moment. According the study of relative growth we can examine the relation between the two portions and the development of the form in the growing system.

In the whales, the body proportions have been measured by many taxonomists, but most of them have not measured in the consideration of relative growth. Mackintosh & Wheeler (1929) measured the many portion of the body of southern blue and fin whales for the purpose of the separation of races. And they showed the change of body proportion with the increase of body length. This will be the first sign of the idea on the relative growth.

Matthews (1937, 1938a, b) measured the body parts on the southern humpback, sperm and sei whales, and he adopted the allometry formula for the measurements. After then, there have been fairly many reports on the body proportion of whales. Limiting the fin whales, Matsuura & Maeda (1842) measured the body proportion on the fin whale caught in the adjacent waters to Kamtchatka Penninsula. Fujino (1954) compared the body proportions among the fin whales in the northern Pacific, adjacent water to Japan, and the Antarctic. Ichihara (1957) studied the differency of the stocks between the northern Pacific and the East China Sea fin whales applying the linear decriminent function.

Above reports are all works mainly to compare the change of proportion on the subject to separate the stocks and the comparison is took place only in the small range in the growing system, that is to say, in mainly the adult whales over weaning.

Mackintosh & Wheeeler (1929) measured the body proportions of foetuses, but they stated that they did not discuss on the foetuses because of the scanty of samples. Zemskiy (1950) reports on the body proportion of the southern fin whale foetuses. Laboratory of the Enoshima Aquarium reports the change of body proportion of four stages in growing system (middle and large foetuses, calves and adults) of the bottlenosed dolphins. Shimizu (1959) discusses the $\alpha$-values of alometry formula in the foetal stage and adult stage of the blue whales using the data by Mackintosh & Wheeler (1929).

I have studied the growth of fin whales, and in this report, the relative growth of fin whales will be discussed.

Hitherto, many measurements of body proportion of fin whale have been reported in the adult stages. But in the foetal stages, the data on the subject have been scanty. Now, I have measured the body parts of the foetuses in the North Pacific and the Antarctic. And I could study the relative growth in the wide ranges of the growing system. I did dot study the relative growth of fin whales in the earlier developemental stages under 10 cm long in body length in this paper, I will report on this subject in future.

Meanwhile, the body proportions are compared between the Antarctic and the northern Pacific fin whales chiefly in the foetal stages. Lastly, interspecies relative growth is also compared within the six species classified in the *Balaenopteridae*, that is to say, *Balaenoptera musculus*, *B. physalus*, *B. edeni*, *B. borealis*, *B. acuto-rostrata* and *Megaptera novaeangliae*.

## MATERIALS AND METHODS

Mackintosh & Wheeler (1929) appointed 26 measurement body parts of the blue and fin whales from South Georgia and South Africa, and measured the straight length of these parts in parallel with the body axis. Matsuura & Maeda (1952) and Fujino (1954) adopted the same body parts as the Mackintosh & Wheeler on the study of body proportion of the North Pacific fin whales.

TABLE 1. MEASUREMENT NUMBER AND THEIR BODY PARTS

| Measurement No. | Body parts measured |
|---|---|
| 1 | Total length |
| 3 | Tip of snout to blow-hole |
| 5 | Tip of snout to center of eye |
| 6 | Tip of snout to tip of flipper |
| 7 | Center of eye to center of ear |
| 8 | Notch of flukes to posterior emargnation of dorsal fin |
| 9 | Flukes, width at insertion |
| 10 | Notch of flukes to center of anus |
| 11 | Notch of flukes to umbilicus |
| 12 | Notch of flukes to end of system of ventral grooves |
| 13 | Center of anus to center of reproductive aperture |
| 14 | Vertical height of dorsal fin |
| 15 | Length of base of dorsal fin |
| 17 | Anterior end of lower border to tip of flipper |
| 19 | Greatest width of flipper |
| 25 | Flukes, notch to tip |

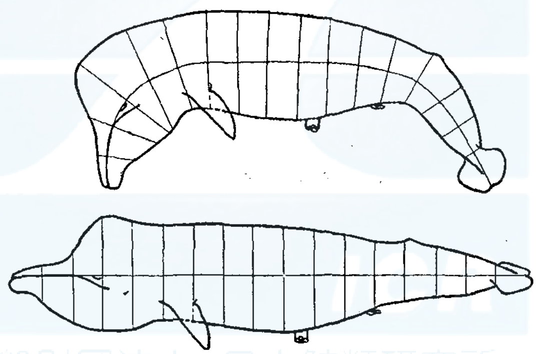


Fig. 1. Modification of the shape of small foetus for the measurement of body proportions. Female fin whale foetus, 18.6 cm long.

In this paper, I also use the same body parts and method as Mackintosh & Wheeler for the purpose of the comparing my data with the previous reports. The body parts measured in this paper are as shown in Table 1. In this paper, the body parts which are discussed from now on, will be represented by the measurement number as shown in this table.

Measurements are took place newly on the over 10 cm long foetuses of fin whales caught by Japanese fleets in the North Pacific and the Antarctic. On the fin whale foetuses over one meter long, the body length are able to be measured by the straight length between the tip of snout and the notch of flukes. And the body axis are recognized as the straight line. But as the heads are bend under one meter long foetuses and tails are bend under 20 cm in body length, the body axis become curved. In these shape the comparison of the proportion cannot be took place, therefore I straightened the body axis as shown in Fig. 1 and measured the body parts.

TABLE 2. NUMBER OF FIN WHALE FOETUSES MEASURED

| Body length (cm) | Antarctic | | | Northern Pacific | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Males | Females | Total | Males | Females | Total | Males | Females | Total |
| 1～125 | 2 (2) | 3 (2) | 5 (4) | — | 3 (3) | 3 (3) | 2 | 6 | 8 |
| 26～50 | 4 | 4 | 8 | 3 (2) | 2 (1) | 5 (3) | 7 | 6 | 13 |
| 51～75 | 8 (2) | 5 (2) | 13 (4) | 6 | 3 | 9 | 14 | 8 | 22 |
| 76～100 | 7 (1) | 6 (1) | 13 (2) | 9 | 6 | 15 | 16 | 12 | 28 |
| 101～125 | 5 | 4 | 9 | 5 | 5 | 10 | 10 | 9 | 19 |
| 126～150 | 3 | 5 | 8 | 8 | 10 | 10 | 11 | 15 | 26 |
| 151～200 | 7 | 8 | 15 | 12 | 16 | 28 | 19 | 24 | 43 |
| 201～250 | 4 | 8 | 12 | 3 | 5 | 8 | 7 | 13 | 20 |
| 251～300 | 6 | 7 | 13 | 8 | 4 | 12 | 14 | 11 | 25 |
| 301～350 | 2 | 6 | 8 | 3 | 2 | 5 | 5 | 8 | 13 |
| 351～400 | 6 | 3 | 9 | 1 | 2 | 3 | 7 | 5 | 12 |
| 401～450 | 2 | 5 | 7 | — | 1 | 1 | 2 | 6 | 8 |
| 451～500 | 1 | 2 | 3 | — | 1 | 1 | 1 | 3 | 4 |
| 501～550 | 1 | 1 | 2 | — | — | — | 1 | 1 | 2 |
| Total | 58 | 67 | 125 | 58 | 60 | 118 | 116 | 127 | 243 |

( ): formalin fixed

Over one meter long foetuses are measured on board the factory ship soon after the extraction from the uterus of the mothers. In under one meter long foetus, there are some individuals measured after 5–10% formalin fixation.

Data on the foetus measurements in this paper are shown in Appendix I and II. And table 2 shows the number of foetuses which are measured for this paper classified the body length classes. Total foetuses measured are 243. Mackintosh & Wheeler (1929) measured the body proportion on the 80 fin foetuses, and Zemskiy (1950) also measured on the 66 foetuses. But in their papers individual measurements are not shown, and I cannot use the data.

On the measurement of the adult fin whales, I use the data given by Mackintosh & Wheeler (1929) in South Georgia and the data given by Fujino (1954) in the northern part of the North Pacific. For the study of the interspecies relative growth, I adopt the measurement data given by the following authors.

| | |
|---|---|
| Mackintosh & Wheeler (1929): | *Balaenoptera musculus B. physalus* |
| Omura, Nishimoto & Fujino (1952): | *B. edeni.* |
| Mathews (1938, 1937): | *B. borealis, Megaptera novaeangliae* |
| Omura & Sakiura (1956): | *B. acuto-rostrata* |

And 19 measurement data on *Balaenoptera acuto-rostrata* from the coast of Japan are newly shown in Appendex III.

## ALLOMETRY FORMULA

### RELATIVE GROWTH BETWEEN TWO MEASUREMENTS OF THE SOUTHERN FIN WHALES

Huxley (1932) showed experimentially that if the two parts in the growing system is $x$ and $y$, the relation between the two is shown by $y=bx^{\alpha}$.

Logalismic relation of above formula is shown as follows:

$$\log y = \log b + \alpha \log x$$

As this is a linear function, we will get straight line if the measurement figures of the portion of $x$ and $y$ put on the logalismic section paper.

Then, the measured figures are plotted in the logalismic section papers according my data on foetuses and the table (p. 324–5) by Mackintosh and Wheeler (1929) on adult fin whales in the Antarctic. On using the table by Mackintosh and Wheeler, I changed the percent of body length into the mean length in the every one meter classes. The range of body length is from 10 cm till 2,500 cm.

Fig. 2 shows the relative growths between body length and Nos. 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 19 and 25, between No. 14 and No. 15 (on the shape of back fin), between No. 17 and No. 19 (on the shape of flipper) and between No. 9 and No. 25 (on the shape of flukes). Except the measurement of No. 13, there is no sexual differentiation between males and females in the allometry. Mackintosh & Wheeler (1929) already state that the only marked difference in body proportion between sexes is that shown by measurement No. 13 on the adult fin whales. Moreover, it is clear in this paper that this phenomenon is also seen in the relative growth of the foetal stage. And in over 10 cm long fin whale foetuses, marked difference in relative growth between sexes is shown in measurement No. 13.

Individually relative growths are examined as follows:

1. *No. 1–No. 3.* This shows the four-phasic allometry. The critical points are seen in the body lengths of 110 cm, 1,140 cm and 2,100 cm.
2. *No. 1–No. 5.* This shows also the four-phasic allometry. The critical points are seen in the body lengths of 110 cm, 1,200 cm and 2,000 cm.
3. *No. 1–No. 6.* In the foetal stage, the relative growth shows mono-

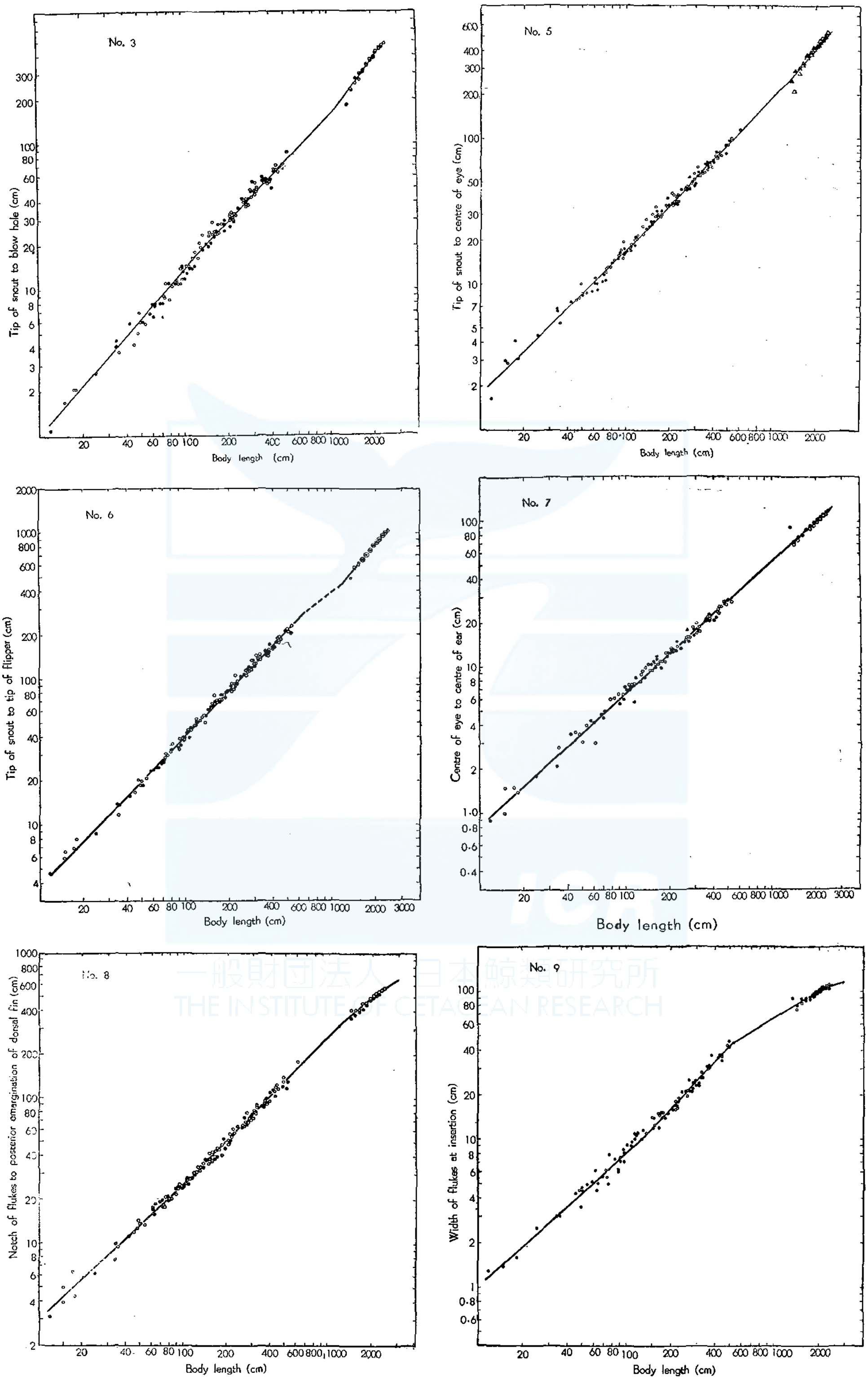



Fig. 2. Relative growths of the external measurements in the Antarctic fin whales Open circle: female, closed circle: male.

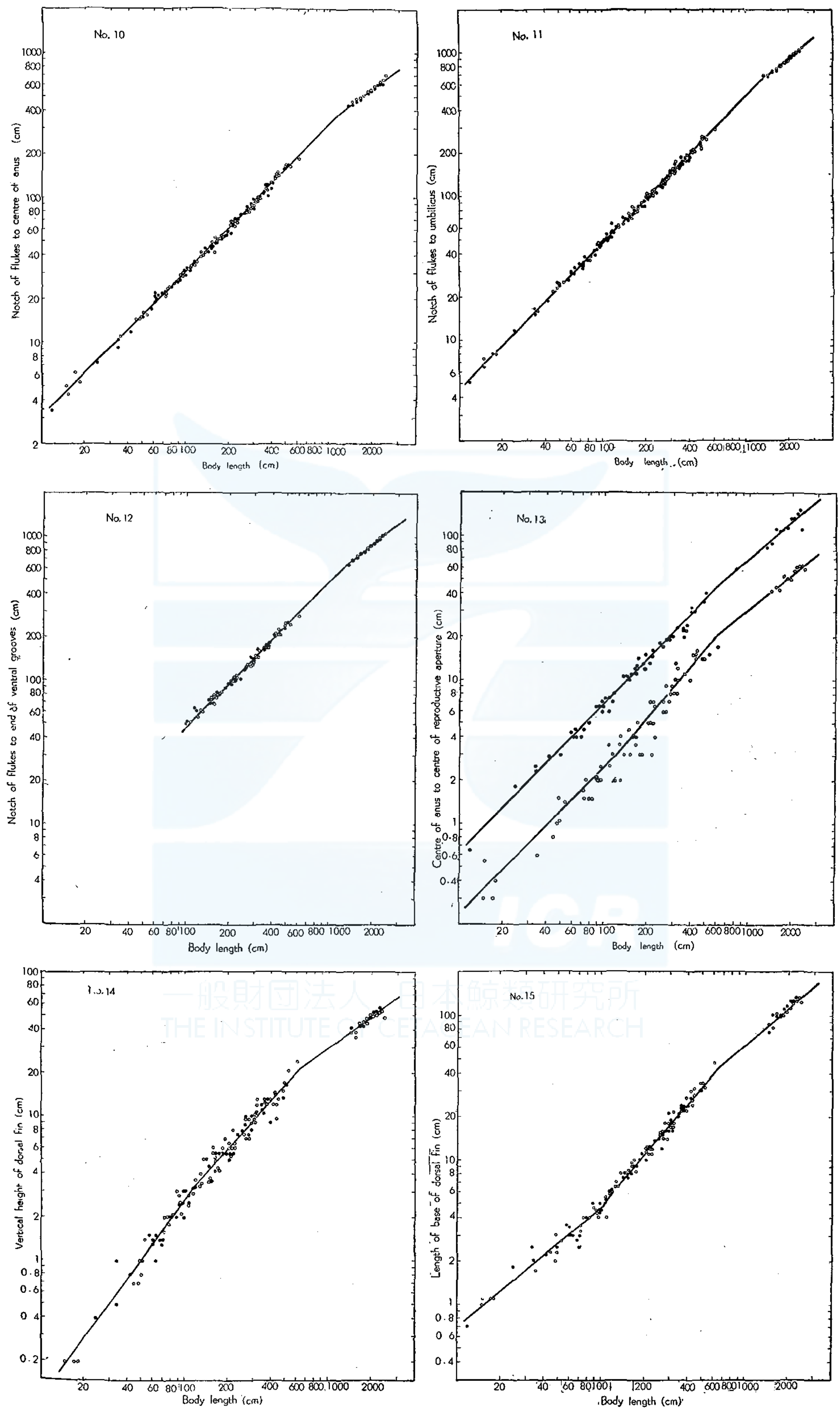

No. 10
Notch of flukes to centre of anus (cm)
Body length (cm)
No. 11
Notch of flukes to umbilicus (cm)
Body length (cm)
No. 12
Notch of flukes to end of ventral grooves (cm)
Body length (cm)
No. 13
Centre of anus to centre of reproductive aperture (cm)
Body length (cm)
Vertical height of dorsal fin (cm)
Body length (cm)
No. 15
Length of base of dorsal fin (cm)
Body length (cm)

Fig. 2. (Cont.)

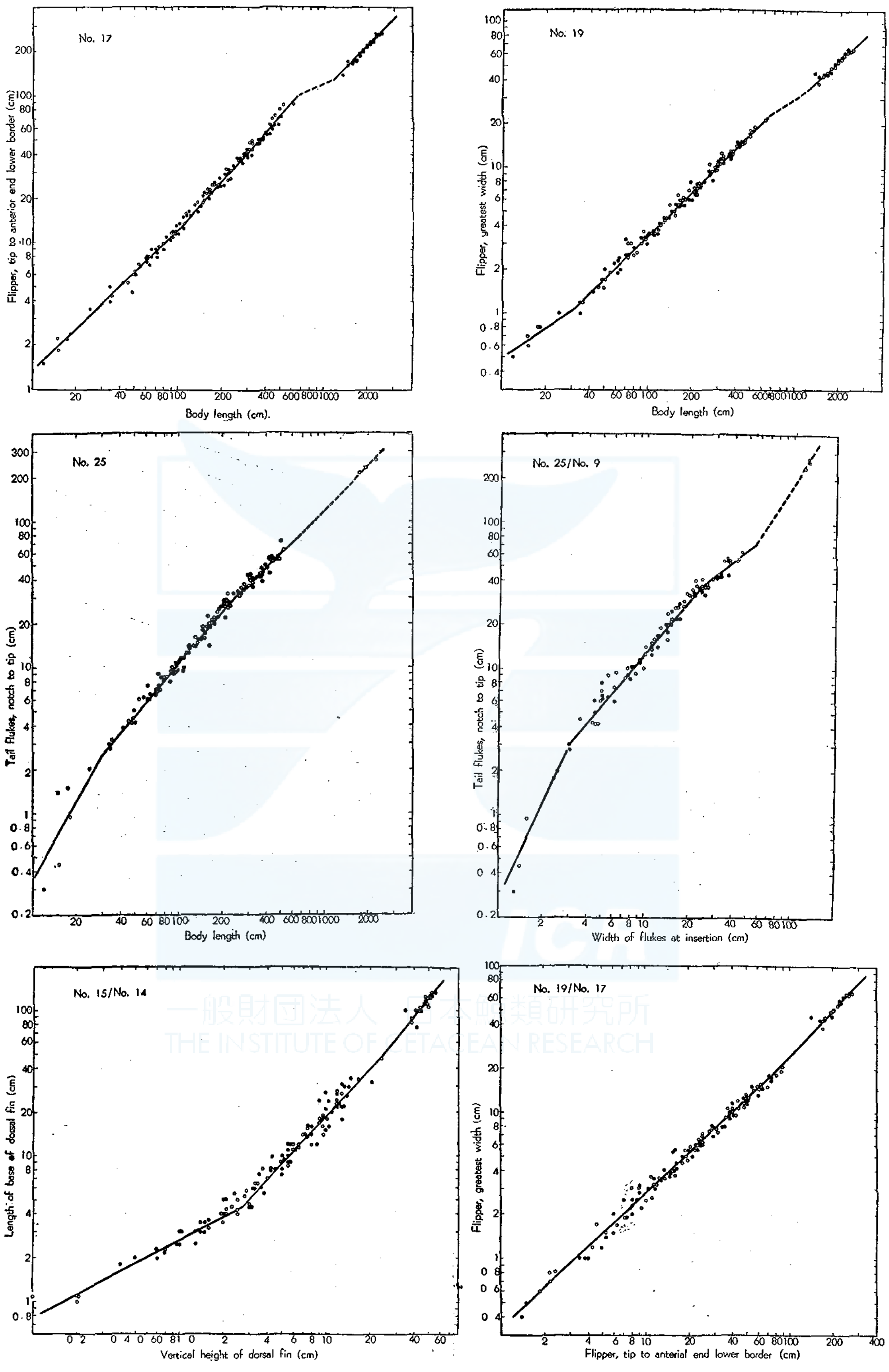

No. 17
Flipper, tip to anterior end lower border (cm)
Body length (cm).
No. 19
Flipper, greatest width (cm)
Body length (cm)
No. 25
Tail flukes, notch to tip (cm)
Body length (cm)
No. 25/No. 9
Tail flukes, notch to tip (cm)
Width of flukes at insertion (cm)
No. 15/No. 14
Length of base of dorsal fin (cm)
Vertical height of dorsal fin (cm)
No. 19/No. 17
Flipper, greatest width (cm)
Flipper, tip to anterial end lower border (cm)



Fig. 2. (Cont.)

phasic allometry and in the adult stage, it shows the diphasic allometry having one critical point in the body length of 2,000 cm. But the allometries of the foetal stages and adult stages are discontinuous. Because it will be the lack of the data in the suckling stage. The allometry formula of the similar animals as the whales cannot be discontinuous. Comparing the relative growth of other measurements, it will be reasonable to put one allometry between 650 cm and 1,200 cm of body length, which represent the body lengths at birth and weaning respective into the relative growth of No. 1–No. 6.

Consequently, the relative growth between No. 1 and No. 6 will be the four-phasic allometry having three critical points in the body lengths of 650 cm, 1,200 cm and 2,000 cm.

4. *No. 1–No. 7.* In the range of body length studying in this paper, there is no critical point. Therefore, it is monophasic allometry.
5. *No. 1–No. 8.* This shows the four-phasic allometry. Critical points are seen in 105 cm, 1,120 cm and 2,100 cm of No. 1.
6. *No. 1–No. 9.* This is the four-phasic allometry, having three critical points in the body length of 120 cm, 530 cm and 2,050 cm.
7. *No. 1–No. 10.* It shows the triphasic allometry. Critical points exist in the body length of 110 cm and 1,120 cm.
8. *No. 1–No. 11.* It shows the diphasic allometry. The body length of 1,160 cm is the critical point.
9. *No. 1–No. 12.* As shown in the future paragraph, the posterior end of ventral grooves of the fin whale appears fairly in the body length of over 90 cm long. And the ventral grooves accomplish the development in over 120 cm long body length. Therefore, the posterior ends of ventral grooves are able to be measured in the individuals over about 90 cm long. This relative growth shows the diphasic allometry having one critical point in the body length of 1,200 cm.
10. *No. 1–No. 13.* Difference of allometry between the sexes in only this relative growth. However, the critical points of the both sexes exist in the almost same body length each other. That is to say, the relative growth between No. 1 and No. 13 shows the triphasic allometry having the critical points in the body lengths of 120 cm, and 600 cm.
11. *No. 1–No. 14.* It shows the triphasic allometry, having two critical points in the body length of 120 cm and 650 cm.
12. *No. 1–No. 15.* Triphasic allometry, critical points: 106 cm and 650 cm.
13. *No. 1–No. 17.* In foetal stage, the relative growth shows the diphasic allometry, having one point in the body length of 107 cm, and in the adult over 1,300 cm long it shows the monophasic allometry.

The relative growth in the foetal stage is discontinuous to that in the adult stage. As similar as the relative growth between No. 1 and No. 6, there is no data on the measurement of suckling stage, it is natural to consider one monophasic allometry in the stage. Then, the relative growth between No. 1 and No. 17 will be represented as the four-phasic allometry, having three critical points at the body lengths of 107 cm, 650 cm and 1,200 cm.

14. *No. 1–No. 19.* It shows the triphasic allometry having critical points in the body length of 30 cm, and 120 cm in the foetal stages. And in the adult stage over 1,300 cm long, it is represented as the monophasic allometry. However, as No. 1–No. 17, in the suckling stage, these two allometries are discontinuous. The total relative growth will be the five phasic allometry, adding the two critical points in the body length of 650 cm and 1,200 cm.

15. *No. 1–No. 25.* In the foetal stage, the relative growth shows the triphasic allometry, having two critical points in the body length of 30 cm and 250 cm. But because of the cutting half of tail flukes pulling the carcase by catcher boat, we have not always chance to in measure No. 25. Therefore, Mackintosh & Wheeler (1929) did not measured this portion for the adult whales. I got chances to measure No. 25 for three female fin whales in the Antarctic. Recording the three measurements, the relative growth between No. 1 and No. 25 seems to show the four-phasic allometry having three critical points in the body lengths of 30 cm, 250 cm and 650 cm.

16. *No. 14–No. 15.* This shows the triphasic allometry. The co-ordinates of the critical points are 2.7 cm; 4.6 cm and 20.2 cm; 44 cm. These figures correspond to the body lengths of 106–120 cm and 650 cm respectively.

17. *No. 17–No. 19.* The relative growth between No. 1 and No. 17 shows the four-phasic allometry, and those between No. 1 and No. 19 shows the five-phasic allometry. However, the relative growth between No. 17 and No. 19 shows the diphasic allometry. The co-ordinate of the critical point is 70 cm and 17 cm. These value do not include in any value of critical points in the relative growths between No. 1 and No. 17 or between No. 1 and No. 19. 70 cm in the No. 17 is the value before birth and 17 cm in the No. 19 is those after birth. Considering both values, the time at birth seems to be the critical point in the relative growth between No. 17 and No. 19.

18. *No. 9–No. 25.* In the foetal stage, this shows the triphasic allometry having two critical points in the values correspond to the body lengths of 30 cm and 250 cm. Although the data are incomplete,

the relative growth seems to be the monophasic allometry. Therefore, the relative growth between No. 9 and No. 25 will be the four-phasic allometry.

Classifying the above eighteen relative growths in the growing system of fin whales over 10 cm long, the result is as follows:

| | |
|---|---|
| Monophasic allometry : | No. 1–No. 7. |
| Diphasic allometry : | No. 1–No. 11, No. 1–No. 12, No. 17–No. 19. |
| Triphasic allometry : | No. 1–No. 10, No. 1–No. 14, No. 1–No. 15, No. 14–No. 15. |
| Four-phasic allometry : | No. 1–No. 3, No. 1–No. 5, No. 1–No. 6, No. 1–No. 8, No. 1–No. 9, No. 1–No. 17, No. 1–No. 25, No. 9–No. 25. |
| Five-phasic allometry : | No. 1–No. 19. |

## COMPARISON OF THE RELATIVE GROWTHS OF THE ANTRACTIC FIN WHALES TO THOSE OF THE NORTH PACIFIC FIN WHALES

It has been considered that the southern fin whales are separated racially from the northern fin whales. Matsuura & Maeda (1942) compared the body proportions of the North Pacific fin whales to those of the southern fin whales and they deduced that both belong to the different races. But they did not compare the body proportion in the same body length classes. Fujino (1954) compared the body proportion of adult fin whales caught in the Japanese coast, northern part of the North Pacific and the Antarctic in each body length classes. And he concluded that no remarkable differences were recognized between the Japanese coastal fin whales and those in the northern Pacific, and the Antarctic fin whale have a larger head and smaller caudal part than the northern Pacific fin whales af ter attaining of sexual maturity, and northern Pacific fin whales possesses more posteriorly situated and smaller dorsal fin, and bigger flippers than the former. Ichihara (1957) compared the body proportion between the northern Pacific fin whales and East China Sea fin whales in the North Pacific by means of the linear discriminent function, and he concluded that there were different shapes of fin whales between the two areas in the North Pacific and fin whales had longer heads and shorter tails in the northern Pacific than in East China Sea.

Above results are all obtained by studying the adult stage of fin whales. I compared the relative growth of fin whales between the Antarctic and the North Pacific, chiefly northern part of the North Pacific from the foetal stage till adult stage. Table 3 shows the average values of each measurements in each body length classes of the foetuses. And the relative growths between two measurements are shown in Fig. 3.

Considering from the figure, the differences of the relative growths

TABLE 3. AVERAGE VALUES OF THE MEASUREMENTS IN EACH BODY LENGTH CLASSES OF THE FIN WHALES

| Body length (cm) | | No. 3 (cm) | No. 5 (cm) | No. 6 (cm) | No. 7 (cm) | No. 8 (cm) | No. 9 (cm) | No. 10 (cm) | No. 11 (cm) | No. 12 (cm) | No. 13 (cm) | No. 14 (cm) | No. 15 (cm) | No. 17 (cm) | No. 19 (cm) | No. 25 (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10~15 | N | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | S | 1.65 | 2.33 | 5.35 | 1.4 | 4.1 | 1.4 | 4.2 | 6.25 | none | ♂ 1.225<br>♀ 0.388 | 0.2 | 0.85 | 1.85 | 0.6 | 0.85 |
| 16~20 | N | 2.00 | 2.97 | 7.61 | 1.4 | 4.86 | 1.73 | 5.60 | 8.30 | none | ♂ —<br>♀ 0.53 | 0.16 | 1.07 | 2.43 | 0.77 | 1.02 |
| | S | 1.90 | 3.50 | 6.80 | 1.25 | 5.2 | 1.45 | 5.325 | 7.05 | none | ♀ 0.425 | 0.43 | 1.1 | 2.025 | 0.7 | 0.975 |
| 21~25 | N | — | — | — | — | — | — | — | — | — | ♂ 1.8 | 0.4 | 1.8 | 3.5 | 1.0 | 2.0 |
| | S | 2.70 | 4.50 | 8.80 | 1.8 | 6.3 | 2.5 | 7.2 | 11.8 | none | ♂ 1.85 | 0.26 | 1.45 | 3.35 | 1.10 | 1.70 |
| 26~30 | N | 2.92 | 3.65 | 11.45 | 2.2 | 6.70 | 2.05 | 7.80 | 11.8 | none | ♂ 1.85 | 0.26 | 1.45 | 3.35 | 1.10 | 1.70 |
| | S | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 31~40 | N | 3.43 | 4.17 | 13.80 | 2.70 | 9.10 | 3.10 | 10.93 | 16.4 | none | ♂ 2.10<br>♀ 0.88 | 0.56 | 1.66 | 4.70 | 1.35 | 3.05 |
| | S | 4.13 | 6.17 | 13.23 | 2.45 | 8.93 | 2.93 | 10.30 | 15.9 | — | ♂ 2.40<br>♀ 0.60 | 0.75 | 2.066 | 4.53 | 1.13 | 3.00 |
| 41~50 | N | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | S | 4.42 | 8.32 | 18.3 | 3.53 | 13.0 | 4.0 | 14.16 | 22.48 | none | ♂ 2.85<br>♀ 1.10 | 0.84 | 2.40 | 5.44 | 1.602 | 4.38 |
| 51~60 | N | 6.75 | 9.00 | 22.25 | 4.0 | 13.5 | 4.5 | 16.6 | 26.3 | none | ♀ 1.25 | 1.30 | 2.75 | 6.25 | 1.50 | 5.2 |
| | S | 6.05 | 8.11 | 20.88 | 3.8 | 13.85 | 4.566 | 16.1 | 25.5 | none | ♂ 4.30<br>♀ 1.35 | 1.23 | 3.00 | 7.066 | 1.93 | 5.466 |
| 61~70 | N | 7.80 | 11.00 | 27.25 | 4.70 | 14.57 | 6.5 | 20.88 | 32.58 | none | ♂ 4.5<br>♀ 1.8 | 1.50 | 3.33 | 8.33 | 2.28 | 6.6 |
| | S | 7.60 | 10.04 | 25.14 | 3.97 | 17.92 | 5.26 | 22.1 | 30.9 | none | ♂ 4.12 | 1.36 | 3.2 | 7.78 | 2.36 | 6.48 |
| 71~80 | N | 9.50 | 12.83 | 30.75 | 5.45 | 19.41 | — | 24.11 | 38.08 | none | ♂ 5.28<br>♀ 2.0 | 1.72 | 4.83 | 10.0 | 2.65 | 8.25 |
| | S | 8.97 | 12.41 | 30.20 | 5.16 | 15.62 | 5.54 | 22.82 | 36.35 | none | ♂ 4.75<br>♀ 1.67 | 1.73 | 3.36 | 8.83 | 2.68 | 7.81 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 81～90 | N | 11.77 | 15.45 | 37.8 | 5.80 | 22.11 | — | 27.5 | 42.87 | 46.5 | ♂ 5.75<br>♀ 2.25 | 2.38 | 4.50 | 12.17 | 3.28 | 10.3 |
| | S | 10.90 | 15.10 | 34.17 | 6.3 | 22.16 | 6.46 | 26.16 | 40.0 | none | ♂ 6.5<br>♀ 1.8 | 2.36 | 4.56 | 11.06 | 2.86 | 8.0 |
| 91～100 | N | 12.19 | 16.09 | 38.34 | 6.76 | 24.41 | 8.0 | 29.58 | 46.58 | 51.5 | ♂ 6.75<br>♀ 2.50 | 2.23 | 4.55 | 12.3 | 3.36 | 10.16 |
| | S | 15.60 | 16.86 | 38.87 | 6.35 | 24.77 | 7.29 | 29.03 | 46.15 | 45.25 | ♂ 6.5<br>♀ 2.16 | 2.49 | 4.43 | 11.82 | 3.30 | 9.71 |
| 101～150 | N | 18.25 | 23.43 | 54.30 | 8.56 | 33.02 | 11.1 | 38.95 | 43.2 | 64.6 | ♂ 9.08<br>♀ 3.42 | 3.62 | 6.15 | 16.2 | 4.44 | 14.97 |
| | S | 17.35 | 21.56 | 51.90 | 8.37 | 31.61 | 9.92 | 39.71 | 59.49 | 62.20 | ♂ 8.99<br>♀ 3.11 | 3.485 | 6.10 | 15.75 | 4.17 | 15.47 |
| 151～200 | N | 24.80 | 30.70 | 74.00 | 10.89 | 43.48 | 14.87 | 52.08 | 82.18 | 78.87 | ♂ 11.59<br>♀ 4.70 | 4.06 | 8.65 | 23.27 | 5.98 | 21.92 |
| | S | 25.60 | 31.4 | 73.87 | 11.09 | 43.08 | 13.39 | 51.30 | 80.80 | 79.51 | ♂ 12.7<br>♀ 3.79 | 5.10 | 8.97 | 23.23 | 5.98 | 18.45 |
| 201～250 | N | 34.00 | 39.7 | 99.20 | 14.2 | 56.89 | 18.37 | 68.37 | 96.33 | 100.85 | ♂ 16.34<br>♀ 5.00 | 6.13 | 12.34 | 32.95 | 7.76 | 30.0 |
| | S | 29.10 | 38.7 | 92.42 | 13.45 | 55.8 | 16.6 | 67.30 | 103.50 | 101.60 | ♂ 15.46<br>♀ 5.31 | 6.18 | 11.72 | 29.20 | 7.19 | 27.23 |
| 251～300 | N | 41.7 | 49.82 | 122.0 | 18.47 | 72.25 | 22.84 | 86.51 | 132.21 | 128.10 | ♂ 20.14<br>♀ 8.25 | 8.63 | 16.09 | 39.42 | 10.06 | 34.96 |
| | S | 41.8 | 49.4 | 122.6 | 16.40 | 70.95 | 21.15 | 84.32 | 129.05 | 127·85 | ♂ 19.00<br>♀ 7.43 | 8.42 | 15.71 | 39.00 | 9.64 | 34.90 |
| 301～350 | N | 52.2 | 61.5 | 149.2 | 18.34 | 90.75 | — | 105.81 | 164.08 | 164.45 | ♂ 22.35<br>♀ 11.00 | 9.41 | 20.31 | 47.82 | 12.99 | — |
| | S | 49.0 | 59.0 | 141.3 | 20.25 | 83.21 | 28.50 | 99.25 | 138.00 | 156.09 | ♂ 23.00<br>♀ 10.16 | 10.77 | 18.76 | 46.06 | 11.60 | 39.83 |
| 351～400 | N | 57.0 | 70.5 | 164.0 | 21.00 | 98.74 | 36.00 | 119.83 | 184.09 | 178.20 | ♂ 22.00<br>♀ 11.00 | 11.00 | 21.62 | 54.15 | 13.32 | 47.00 |
| | S | 56.0 | 66.4 | 157.8 | 23.50 | 95.51 | 28.21 | 116.00 | 178.80 | 172.20 | ♂ 23.41<br>♀ 10.50 | 11.75 | 23.01 | 53.90 | 13.90 | 43.85 |
| 401～450 | N | 75.0 | 87.0 | 203.5 | 25.00 | 125.00 | — | 145.00 | 226.50 | 219.50 | ♂ —<br>♀ 20.5 | 15.25 | 29.5 | 64.5 | 16.50 | — |
| | S | 66.7 | 81.5 | 186.0 | 25.60 | 120.30 | 36.33 | 145.90 | 219.90 | 214.50 | ♂ 32.33<br>♀ 14.67 | 13.87 | 29.37 | 68.20 | 15.55 | 53.40 |
| 451～600 | N | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | S | 79.0 | 97.5 | 221.0 | 28.00 | 124.30 | 39.50 | 168.02 | 253.80 | 247.80 | ♂ 40.00<br>♀ 15.00 | 18.50 | 32.00 | 79.40 | 18.50 | 66.50 |

N: Northern Pacific fin whale foetuses　　S: Antarctic fin whale foetuses

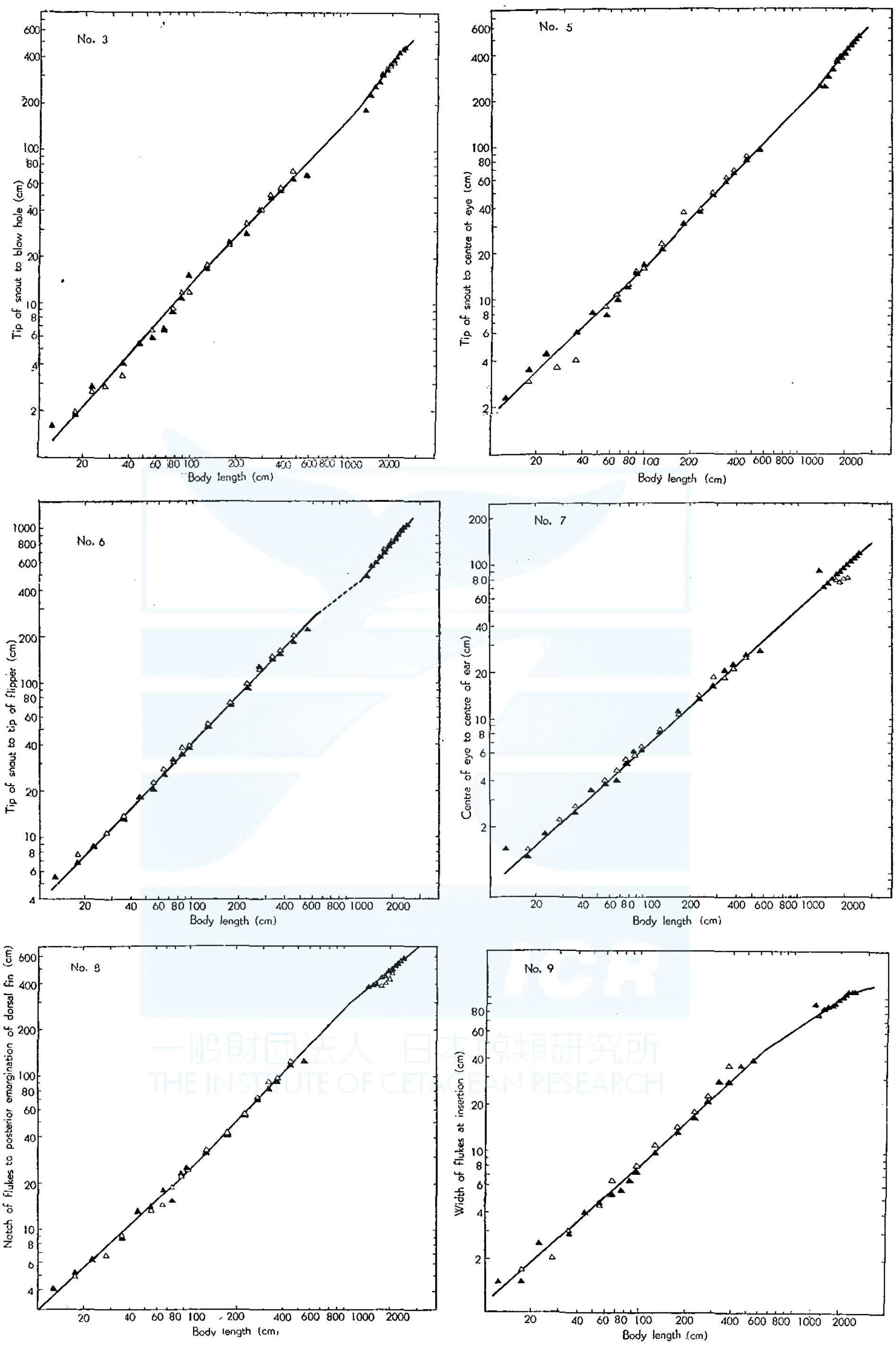





Fig. 3. Comparison of the relative growths between the Antarctic and the North Pacific fin whales.
Closed triangle: Mean values of the Antarctic fin whales in each body length classes. Open triangle: Mean values of the North Pacific fin whales in each body length classes.

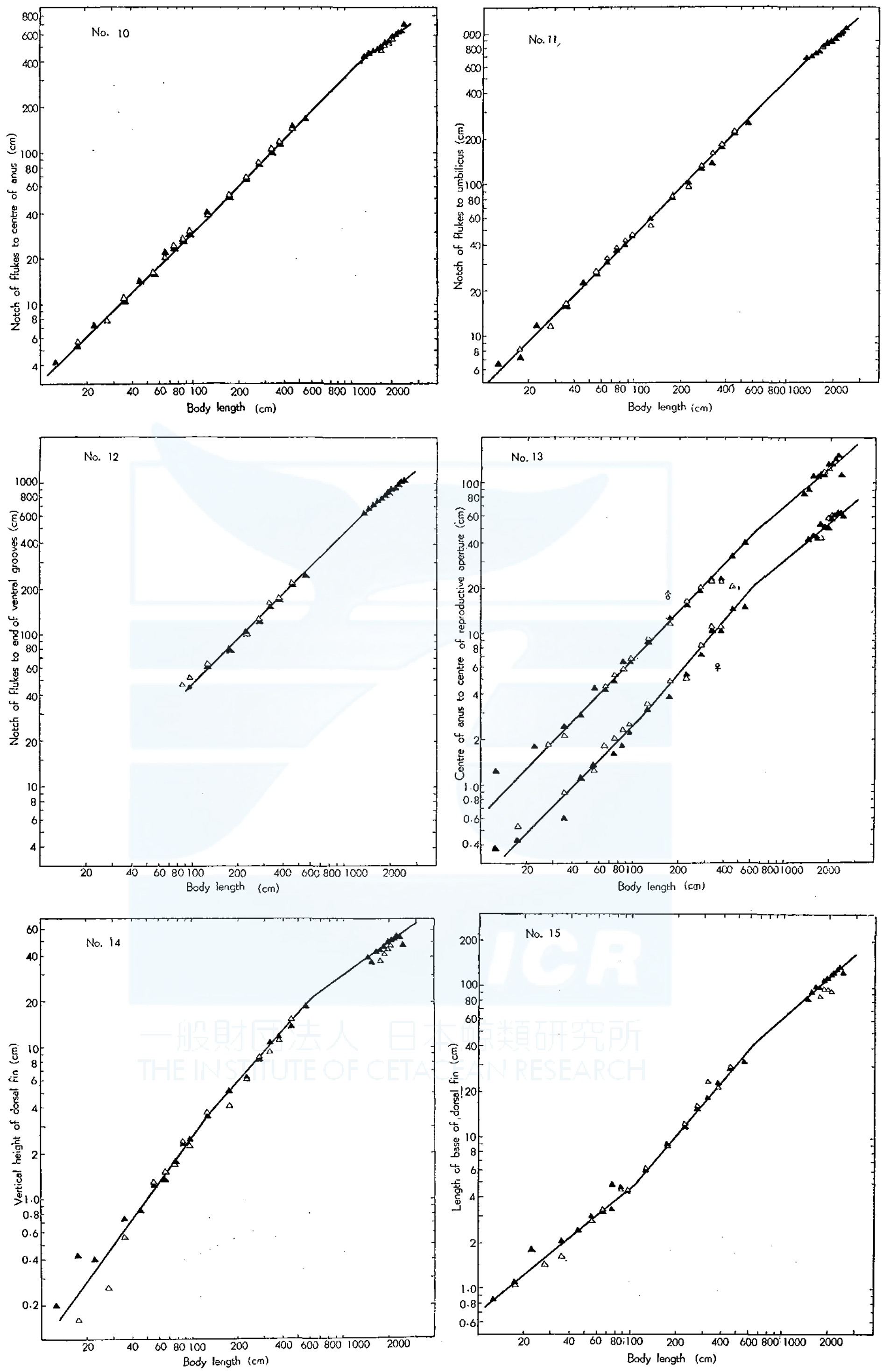

No. 10
Notch of flukes to centre of anus (cm)
Body length (cm)
No. 11
Notch of flukes to umbilicus (cm)
Body length (cm)
No. 12
Notch of flukes to end of ventral grooves (cm)
Body length (cm)
No. 13
Centre of anus to centre of reproductive aperture (cm)
Body length (cm)
No. 14
Vertical height of dorsal fin (cm)
Body length (cm)
No. 15
Length of base of dorsal fin (cm)
Body length (cm)

Fig. 3. (Cont.)

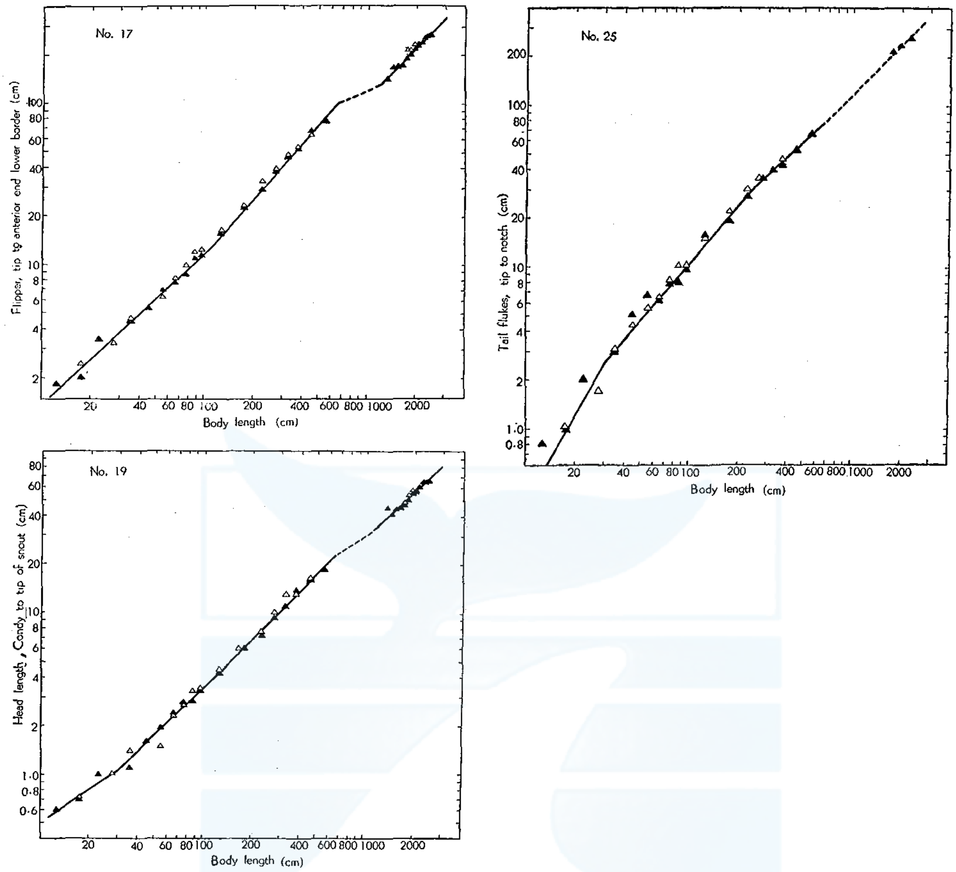



Fig. 3. (Cont.)

are not recognized between the Antarctic and the North Pacific fin whales at least in the foetal stage. Concerning on this subject, Ohsumi, Nishiwaki & Hibiya (1958) state that growth rate of foetuses for the northern Pacific fin whales is closely similar to that of other regions: coast of Japan, the North Atlantic and the Antarctic.

I may conclude that there is no racial difference in growth rates and external form of fin whales at least in the foetal stage.

For the relative growth of the adult stage between No. 1 and other measurements, the differences between two races are almost not recognized in the Nos. 3, 5, 6, 11, 12, 13 and 19. The differences are recognized in the relative growth between No. 1 and Nos. 7, 8, 10, 14, 15 and 17. Measurements Nos. 7, 8, 10, 14 and 15 of the North Pacific fin whales are smaller than those of the Antarctic fin whales in the same body length classes. And No. 17 of the former is larger than the latter. This will mean that the racial difference appears in the adult stage. It seems to be concerned with the facts that the $\alpha$-values in the allometry formula of the measurement Nos. 7, 8, 10, 14 and 15 are smaller than 1.0, and the $\alpha$-value of the No. 17 is larger than 1.0, as calculated in the following paragraph. Meanwhile, considering the tendency that the parts which is different in the two races are variable by the habit as shown in Chapter 3, it will be recognized that the two races are different in these measurement parts.

### THE CRITICAL POINTS AND ITS RELATION TO THE GROWING STAGE OF THE FIN WHALE

As stated in the first paragraph, the relative growths of fin whales over 10 cm long have in general some critical points. The all external body parts do not grow in the same ratio, but change their rates of growth. Arranging the body length of critical points in these relative growths in Fig. 4, the body length of critical points are classified into six groups of 30 cm, 100-120 cm, 300 cm, 550-650 cm, 1,100-1,200 cm and 2,000-2,100 cm. The allometries which have a critical point in the body length of 30 cm are No. 1-No. 19, No. 1-No. 25 and No. 9-No. 25. And the allometries which have a critical point in the body length of 300 cm are No. 7-No. 25 and No. 9-No. 25. These groups are relatively few.

However, eleven allometries have a critical point in the body length of 100-120 cm, eleven allometry have a critical point in the body length of 550-650 cm, nine allometry have a critical point in the body length of 1,100-1,200 cm, and five examples have a critical point in the body length of 2,000-2,100 cm. No allometry has critical points in the other body length.

Co-ordinating the above results, most external parts of the fin whale change their allometries in the body length of 100-120 cm, 550-650 cm, 1,100-1,200 cm and 2,000-2,100 cm. And few parts change in the body length of 30 cm and 300 cm. Then, the relative growth of the external parts of the Antarctic fin whales over 10 cm long are classified in the following stages.

| | *Body length* |
|---|---|
| Ia-stage | 10～ 30 cm |
| Ib-stage | 30～ 115 cm |
| IIa-stage | 115～ 300 cm |
| IIb-stage | 300～ 650 cm |
| III-stage | 650～1,200 cm |
| IV-stage | 1,200～2,100 cm |
| V-stage | 2,100～ cm |

As it is considered that the morphological, physiological and ecological change have relation to the allometry, I examined the morphological and ecophysiological changes in the growth of fin whale.

*Development of body colour*

Mackintosh & Wheeler (1929), Slijper (1958) and others report on the development of the body colour in the fin whales. In this paper, the development of colouration based on these reports and my observation are discussed. Pigment appears before the first stage of the development of ventral grooves. Before the foetus grows to be 40 cm long, it is present as a darkening of the skin on the top of head, left side of lower jaw and the posterior margin of the upper surface of flukes. Then the pigment appears in the skin of the posterior margin of the upper surface of flipper and the posterior margin of the dorsal fin. At this stage rest of the body are pinkuish red.

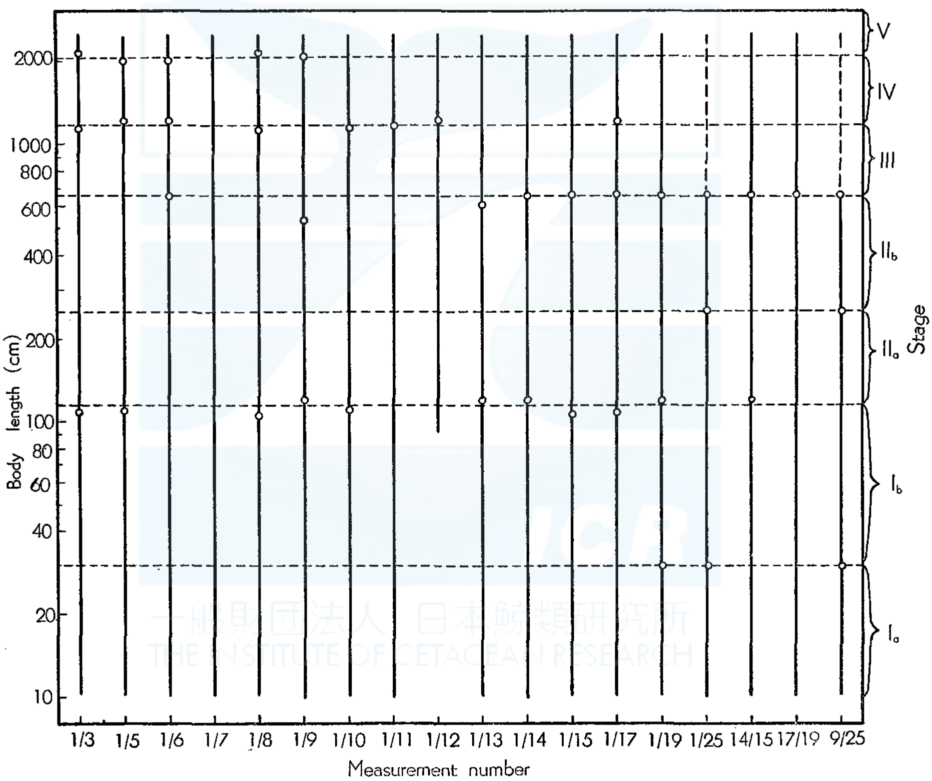





Fig. 4. Critical points and the stages of growth in the Antarctic fin whales. Open circle: critical point.

As the pigment spreads backward from the neck over the dorsal surface, the pale dorsal V-mark appears soon after growing to 1.0 m long. And soon it becomes even more prominent than in adult whale. The development of colouring spreads downwards over flanks. At 1.2 m the lower jaw is well pigmented and the asymmetry of colouring is already distinguishable.

In the body side from umbilicus till anus, the pigmentation takes place relatively slowly in the body side from umbilicus till anus, and the back pigmentation appears lastly.

Table 4 shows the developmental stage of colouration and the individuals observed their body colour. I observed a 282 cm long individual of which the pigmentation was complete. And there was a 322 cm long foetus in which pigmentation was yet not complete.

TABLE 4. THE DEVELOPMENT OF BODY COLOUR

| Developement of body colour | Examples | Range |
|---|---|---|
| Not complete | 194 cm ♀, 212 cm ♂, 239 cm ♀ | ~239 cm |
| Almost complete | 222 cm ♀, 262 cm ♀, 265 cm ♂, 268 cm ♀, 294 cm ♀, 322 cm ♀ | 222~322 cm |
| Complete | 282 cm ♀, 307 cm ♀, 318 cm ♀ | 282~ cm |

TABLE 5. THE PROCESS OF DEVELOPMENT OF VENTRAL GROOVES AND THE BODY LENGTH IN THE ANTARCTIC FIN WHALE FOETUSES

| Stage | Examples | Range |
|---|---|---|
| Not appeared | 19.6 cm ♀, 35.7 cm ♀, 48 cm ♀, 50.5 cm ♀, 61 cm ♂, 70 cm ♀ | ~ 70 cm |
| Appeared at the axilla | 60.5 cm ♀, 73 cm ♀, 77 cm ♂ | 60~ 77 cm |
| Appeared at the lower jaw | 73.5 cm ♀, 83 cm ♀, 91.5 cm ♂, 96 cm ♀, 97 cm ♂ | 73~ 97 cm |
| Many furrows, but not yet joined | 91 cm ♀, 94.5 cm ♀, 102 cm ♂, 104 cm ♂, 107 cm ♀, 109 cm ♂, 110 cm ♀, 114 cm ♀, 116 cm ♀, 118 cm ♂ | 91~118 cm |
| Completed | 115 cm ♂, 127 cm ♂, 130 cm ♀, 132 cm ♀, 135 cm ♂, 141 cm ♀, 1353 cm ♀, 155 cm ♂ | 115~ cm |

It is recognized that 3.0 m is the mean body length which is complete in pigmentation. In the foetal stage, the colour is still rather paler than the adult.

In conclusion, the body lengths estimated as the developmental stages of the colouration are as follows:



40 cm : Appeared the pigmentation.
300 cm : Completed the colourations.
650 cm : Birth.

*Development of the ventral grooves*

The ventral grooves always end evenly near the umbilicus in the adult fin whales. On the development of the ventral grooves in the fin whale, Mackintosh & Wheeler (1929) state that the ventral grooves usually appear by the time the foetus reaches 1.0 m. Zemskiy (1950) also states that the ventral grooves appear in the 1.0 m long foetuses. In this stage it is difficult to observe the grooves. In the over 1.5 m long foetuses, the grooves becomes distinctly similar to the adult.

According to my observation for the Antarctic fin whale foetuses, the ventral grooves is not appeared by the time the foetus reaches 60 cm long. They are appeared at the axilla in the foetuses from 60 cm till 80 cm long. As the foetuses grow, the sharrower furrows appeared in the axilla increase in the number and develop downward.

On the other hand, sharrow furrows are is appeared in the front of the lower jaw firstly in the 73 cm foetus. They are appeared firstly on the center in the front of lower jaw and increase in number along the anterior margin of lower jaw.

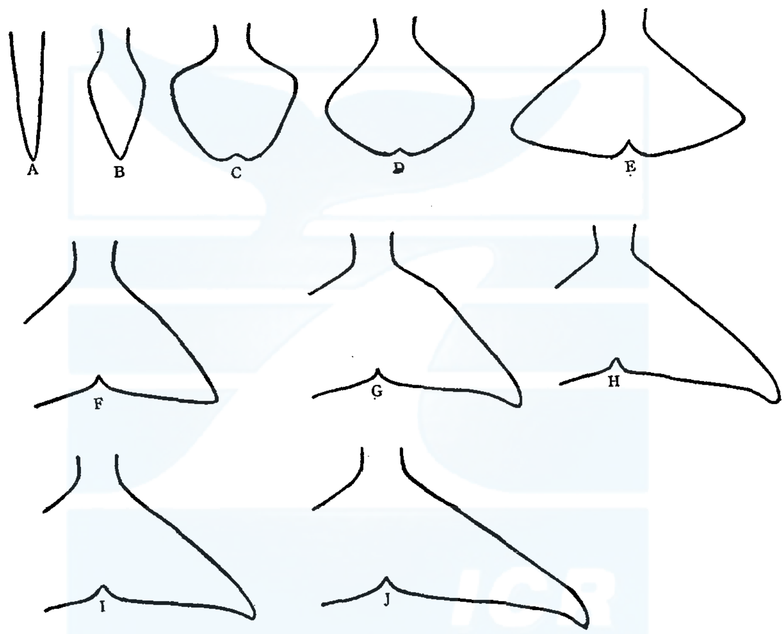



Fig. 5. Development of the tail flukes in fin whales.
A: 6.7 cm, B: 12.0 cm ♂, C: 17.9 cm ♀, D: 24.7 cm ♂,
E: 54.0 cm ♀, F: 69.3 cm ♂, G: 89.5 cm ♀, H: 214 cm ♀,
I: 527 cm ♀, J: 1920 cm ♀



In a word, the ventral grooves develop at the axilla and the front of lower jaw. They are appeared earlier and faster at the former than at the latter. The grooves appeared in the two parts increase in number and meanwhile spread downwards and backwards.

The furrows appeared in the two parts are not joined by the time foetuse reached in 115 cm. And the ventral grooves are completed by 140 cm. The grooves in the joined area are often show Y-shaped furrows.

Table 5 shows the body lengths in the process of development of ventral grooves in the Antarctic fin whale foetuses. In conclusion, the body lengths considered as the developmental stages of the ventral grooves are as follows:

60– 80 cm : present the furrows
115–140 cm : complete the ventral groove

*Development of the flukes*

One of the characteristic development of whales is the tail flukes. Fig. 5 shows the developmental stages of theAntarctic fin whales. Before the time when foetus reaches 8 cm long, the tip of tail is merely conical. But by the time when they grow to 10 cm long, the projection of skin is present on the side of tail. As development goes by the projection changes its shape. By the time when the foetuses grow to 80 cm long, the shapes of flukes become similar to the adult stage.

TABLE 6. DEVELOPMENTAL STAGES OF BALEEN PLATES IN THE ANTARCTIC FIN WHALE FOETUS

| Stage | Examples (Body length in cm) | Range of body length |
|---|---|---|
| I | ♀ 91, ♂ 109, ♂ 112, ♂ 116, ♀ 122, ♀ 153, ♂ 155, ♀ 157, ♀ 166, ♀ 172 | ~175 cm |
| II | ♀ 177, ♂ 212, ♀ 215, ♂ 219, ♂ 239, ♀ 251 | 175~260 cm |
| III | ♀ 262, ♀ 282, ♀ 294, ♂ 297, ♀ 307, ♂ 315 | 260~315 cm |
| IV | ♀ 318, ♀ 322, ♂ 354, ♂ 358, ♂ 361, ♀ 361, ♂ 377, ♀ 427, ♀ 431 | 315~430 cm |
| V | ♀ 441, ♀ 447, ♀ 488, ♀ 495, ♀ 527 | 430~650 cm |

The distinctive feature in the foetal stage is that the flukes are folded ventrally at insertion. In the development of tail flukes the body lengths considered as the critical stage are as follows:

9 cm : Projection appears
80 cm : Shape is almost complete
650 cm : Birth

*Development of the baleen plates*

The first rudiments of the plates are found after the fin whale foetus reaches to the length of 175 cm. Their plain strip of a soft whitish material appears. In this condition, rudimental teeth are still burried in the cavity of maxilla. The strip grows in thickness and in the foetuses between 260 cm and 315 cm, the rudimentary teeth are absorbed, the cavity becomes flat over 315 cm. Minute transverse ridges appear on this strip and later develop into baleen plates. The terminal bristles of baleen plates appear after foetus reaches to the length of 430 cm. Table 6 shows the classification of the developmental stages of baleen plates. In I-stage, rudiments of plates do not found yet. The plain strip appears in II-stage. In the III-stage, the rudimental teeth are absorbed.

IV-stage is recognized as the time when ridges appear on the strip. In V-stage bristles appear on the tip of baleen plates. According to Mackintosh & Wheeler (1929), rate of growth in baleen plates suddenly increases when the whale measures about 13 m. In short, the body lengths estimated as the remarkable stages in the development of baleen plates are as follows:

| | |
|---|---|
| 175 cm: | Rudiments of baleen plates appear |
| 260–315 cm: | Rudimental teeth are absorbed |
| 430 cm: | Bristles appear on the top of baleen plates |
| 1300 cm: | Baleen plates suddenly increase in length |

*Body length at birth*

Laws (1959) reviews the previous papers on the growth of foetuses in the whales. I picked up the body length at birth of fin whales in the previous papers. Hinton (1925) describes that in the southern fin whales, body length at birth is to be 610 cm. Mackintosh & Wheeler (1929) and Laws (1959) state that the mean lengths at birth are estimated to be 6.5 m for the southern fin whales.

Ohsumi, Nishiwaki & Hibiya (1958) describe that growth rate of foetuses for the northern Pacific fin whale is closely similar to that of other regions:—Coast of Japan, the North Atlantic and the Antarctic. And they estimate that the mean body lengths at birth is supposed to be 21 feet (6.4 m). It will be summarized that foetal growth rates of fin whales in the both hemispheres are closely similar one another, and the mean lengths at birth are about 6.5 m.

Kimura (1957) reports the twinning of fin whale foetuses and suggests that the difference of body lengths will be 2 feet (60 cm) long at birth, and in the foetal stage, there is no sex difference in the rate of foetal growth.

*Body length at weaning*

The knowledge on the weaning of fin whales has been scanty. According to the paper by Mackintosh & Wheeler (1929), nursing period is estimated six months and the body length at weaning is 12 m for the southern fin whales.

The humpback whales in the Australian waters have been studied most in the baleen whales on the weaning. Chittleborough (1958) reports that the nursing period is $10\frac{1}{2}$ months and the body length at weaning is estimated to be about 29 feet. The body length at birth is recognized as 14 feet (Chittleborough, 1958), so the length at weaning correspond to twice of the length at birth. If the ratio is able to be adopted on *Balaenoptera*, the body length at weaning will be about 13 m (6.5 m × 2) for the fin whales. This value is similar to that by Mackintosh &

Wheeler (1929). Tavolga and Essapian (1955) report that in *Trusiopus truncatus* which are fed in a aquarium, the weaning period is not so distinct, and there are some periods when they eat fishes and drink milk.

*Body length at sexual maturity*

By the time at sexual maturity, body lengths of fin whales become to be different in the sexes and the races. Mackintosh (1942) calculates the body lengths at sexual maturity and describes that they are 19.2 m in males and 19.9 m in females for the southern fin whales.

Ohsumi, Nishiwaki & Hibiya (1958) report that in the fin whales from the northern parts of the North Pacific the sexual maturity attains at 58 feet (17.7 m) in males and 61 feet (18.6 m) in females. On the fin whales from the East China Sea which are recognized as one of the independent races in the North Pacific, the body length at sexual maturity is estimated to be 56 feet (17.1 m) in males and 59 feet (18.0 m) in females respectively.

*Body length at physical maturity*

On the southern fin whales, Mackintosh & Wheeler (1929) report that the body lengths at physical maturity are 21.0 m in males and 22.0 m in females. Nishiwaki (1952) gets the similar result.

Ohsumi, Nishiwaki & Hibiya (1958) describe that the average length at physical maturity is 62 feet (18.9 m) in males and 66 feet (20.1 m) in female fin whales from the the northern Pacific. The physical maturity is determined by the completion of the occification of vertebral column (Wheeler, 1930). However, Fujino (1954) states that the skull grows after the so called physical maturity.

Summarizing the above results and the discussing the relation between the critical points in the allometry formula and the stage of growth in the Antartic fin whales, the following relations are obtained:

30 cm: The first stage of the development of body colour.
115 cm: Completion of the development in the ventral grooves.
300 cm: Absorption of rudimental teeth, completion of development of body colour in the foetal stage.
650 cm: Birth.
1,200 cm: Weaning.
2,100 cm: Sexual maturity—Physical maturity.

As stated in the previous paragraphs, the most allometries change in the body lengths of 115, 650, 1,200 and 2,100 cm. These body lengths are important for the embriology and ecology of the fin whales. Body length of 115 cm which is the end of the I-stage is correspond to the time of completion of development of the ventral grooves, and in this stage, the development of the outer style is almost complete. 650 cm is correspond to the body length at birth. After that time fin whales change in their ecology. They must swim just after birth. Therefore, the parts for swimming should change in their shapes. In fact, the body portion which have the critical point in this body length are measurement Nos. 6, 9, 14, 15, 17, 19 and 25. These portions are all concerned with the swimming. However, although No. 13 is not concerned directly for the purpose, this measurement changes its allometry in the body length. The body length of 1,200c m is correspond to the weaning period. Food habit of fin whale changes bordering the period, measurement Nos. 3 and 5 of which allometries have critical point in this body length are concerned in the shape of month. No. 12 is concerned in the length of ventral grooves. Nemoto (1959) records the relation between food habit and the ventral grooves. Nos. 6, 8, 10 and 17 are concerned in the movement of whales. It is considerable to change the movement according to the change of food habit.

2,100 cm is the body length at maturity. It will be considered that the whale body change for adaptation of movement and feeding because the body length approach to the maximum. Nos. 3 and 5 are concerned in the feeding, and Nos. 6, 8, and 9 are concerned in the movement. These measurement have critical point in the body length.

## ALLOMETRY FORMULA AND $\alpha$-VALUE

In the allometry formula: $y=b\chi^{\alpha}$, $b$ equals to $y$ when $x=1$. And $b$ is influenced by the first quantity of $y$. Symbol $b$ is named as the "initial growth index". Symbol $\alpha$ shows the relation between the growths of the two portions ($x$ and $y$) and is named as "relative growth coefficient". That is to say, $\alpha$ shows the specific growth rate between the two portions.

Symbol $\alpha$ is more important biologically than $b$. Except the monophasic allometry, we consider that $b$ has not any biological meaning.

The meaning of the $\alpha$-value is as follows:

1. $\alpha>1.0$. It means that growth of $y$ exceeds that of $x$. This allometry is named *possitive allometry*.
2. $\alpha=1.0$. $y$ and $x$ grow in the name rate. This is named as *isometry*.
3. $\alpha<1.0$. It means that growth of $y$ is inferior to that of $x$, and named *negative allometry*. Negative allometry includes the following three cases.
   i. $0<\alpha<1.0$
   ii. $\alpha=0$ Although $x$ grows, $y$ stands still.

iii. $\alpha < 0$ Although $x$ grows, $y$ decreases absolutely.

In the allometry of the external form in fin whales, there is no example as 3ii or 3iii. However, according to the paper by Matthews (1937) in the allometry formula of humpback whales between No. 1 and No. 13, $\alpha$-value of adult females is $-0.60(\alpha < 0)$. Table 7 shows the $\alpha$-value in the each stages of the allometry between No. 1 and various measure-in ments.

TABLE 7. $\alpha$-VALUES IN THE ALLOMETRY FOR MULLA FOR THE ANTARCTIC FIN WHALES

| Measurement No. | Stage Ia | Ib | IIa | IIb | III | IV | V | Mean |
|---|---|---|---|---|---|---|---|---|
| 3 | 1.13 | 1.13 | 1.05 | 1.05 | 1.05 | 1.41 | 0.94 | 1.11 |
| 5 | 0.97 | 0.97 | 1.05 | 1.05 | 1.05 | 1.36 | 0.85 | 1.04 |
| 6 | 1.04 | 1.04 | 1.04 | 1.04 | 0.83 | 1.13 | 1.02 | 1.02 |
| 7 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | ..90 | 0.90 | 0.90 |
| 8 | 0.93 | 0.93 | 1.04 | 1.04 | 1.04 | 0.85 | 0.65 | 0.93 |
| 9 | 0.89 | 0.89 | 1.07 | 1.07 | 0160 | 0.60 | 0.31 | 0.78 |
| 10 | 1.00 | 1.00 | 0.99 | 0.99 | 0.99 | 0.83 | 0.83 | 0.95 |
| 11 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 0.86 | 0.86 | 0.97 |
| 12 | — | — | 1.01 | 1.01 | 1.01 | 0.82 | 0.82 | 0.93 |
| 13 ♂ | 1.03 | 1.03 | 1.07 | 1.07 | 0.87 | 0.87 | 0.87 | 0.97 |
| 13 ♀ | 1.02 | 1.02 | 1.20 | 1.02 | 0.82 | 0.82 | 0.82 | 0.97 |
| 14 | 1.29 | 1.29 | 1.16 | 1.16 | 0.72 | 0.72 | 0.72 | 1.01 |
| 15 | 0.82 | 0.82 | 1.16 | 1.16 | 0.86 | 0.86 | 0.86 | 0.93 |
| 17 | 0.96 | 0.96 | 1.13 | 1.13 | 0.44 | 1.04 | 1.04 | 0.96 |
| 19 | 0.68 | 0.96 | 1.02 | 1.02 | 0.65 | 0.98 | 0.98 | 0.90 |
| 25 | 1.85 | 1.18 | 1.18 | 1.14 | 1.02 | 1.02 | 1.02 | 1.20 |

TABLE 8. RANGE OF $\alpha$-VALUES IN THE GROWING STAGE

| | Stage Ia | Ib | IIa | IIb | III | IV | V | Total |
|---|---|---|---|---|---|---|---|---|
| 0.31~0.40 | — | — | — | — | — | — | 1 | 1 |
| 0.41~0.50 | — | — | — | — | 1 | — | — | 1 |
| 0.51~0.60 | — | — | — | — | 1 | 1 | — | 2 |
| 0.61~0.70 | 1 | — | — | — | 1 | — | 1 | 3 |
| 0.71~0.80 | — | — | — | — | 1 | 1 | 1 | 3 |
| 0.81~0.90 | 3 | 3 | 1 | 1 | 5 | 8 | 8 | 39 |
| 0.91~1.00 | 4 | 5 | 1 | 1 | 1 | 1 | 2 | 15 |
| 1.01~1.01 | 4 | 4 | 9 | 9 | 6 | 2 | 3 | 37 |
| 1.11~1.20 | 1 | 2 | 5 | 5 | — | 1 | — | 14 |
| 1.21~1.30 | 1 | 1 | — | — | — | — | — | 2 |
| 1.31~1.40 | — | — | — | — | — | 1 | — | 1 |
| 1.41~1.50 | — | — | — | — | — | 1 | — | 1 |
| 1.51~1.60 | — | — | — | — | — | — | — | — |
| 1.61~1.70 | — | — | — | — | — | — | — | — |
| 1.71~1.81 | — | — | — | — | — | — | — | — |
| 1.81~1.90 | 1 | — | — | — | — | — | — | 1 |
| Total | 15 | 15 | 16 | 16 | 16 | 16 | 16 | 110 |
| Mean | 1.04 | 1.01 | 1.07 | 1.07 | 0.87 | 0.94 | 0.91 | 0.97 |

The highest $\alpha$-value is given in the Ia-stage of the allometry between No. 1 and No. 25, and it is 1.85. On the contrary, the lowest is given in the V-stage of the allometry between No. 1 and No. 9 ($\alpha=0.31$).

Most of $\alpha$-values are included in the range between 0.81 and 1.20. So, the range is very narrow. $\alpha$-value seems to vary according to the growing stages. The frequencies of $\alpha$-value of 16 measurements are given in Table 8. The average $\alpha$-values in each stages are maximum II-stage and minium in V-stage.

Arranging the measurements from anterior to posterior Nos. 3, 5, 6, 11, 10, 8, and 9, and the $\alpha$-values of each measurements are connected in five stages (Fig. 6). In II-stage, $\alpha$-values are not so different each other, but in IV- and V-stage, there are difference of $\alpha$-values between anterior portions and posterior portions, and $\alpha$-values are higher in the anterior than in the posterior. Similar phenomena are shown in I-stage, but the tendency is not so remarkable as in IV- and V-stage. In III-stage, the $\alpha$-values of Nos. 6, 11 and 9 are relatively lower than the others.

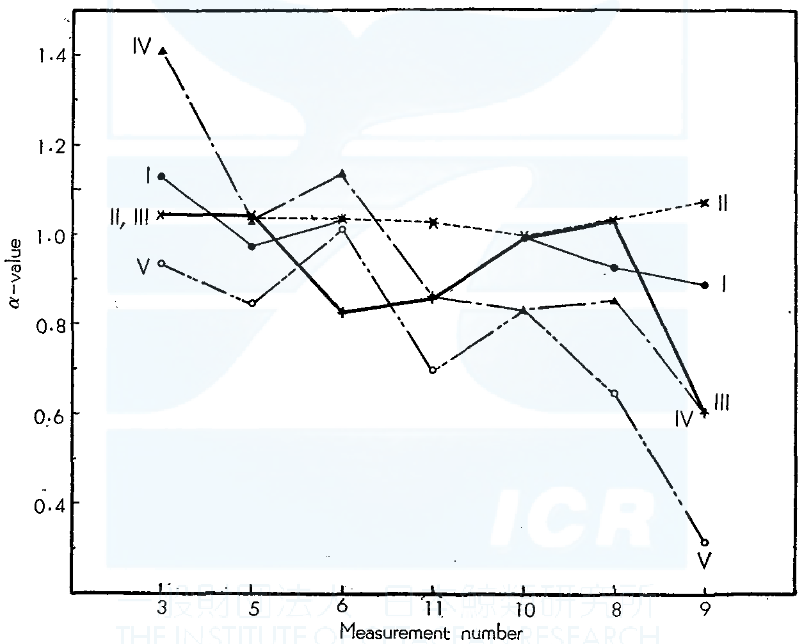



Fig. 6. Variation of $\alpha$-values in five stages for measurement numbers 3, 5, 6, 11, 10, 8 and 9.

Averaging the $\alpha$-values of each measurement among the all stages, the averages decrease in order from anterior to posterior.

Fig. 7 shows the variation of $\alpha$-values of each measurement in the five stages.

1. $\alpha$-value is maximum in I-stage and decrease in order.
   i) Nos. 10, 11 and 12: Until the III-stage, the allometry is almost isometry, but then turns negative allometry.

ii) No. 14: The allometry shows positive allometry till the II-stage. Moreover, $\alpha$-value in I-stage is larger than II-stage.

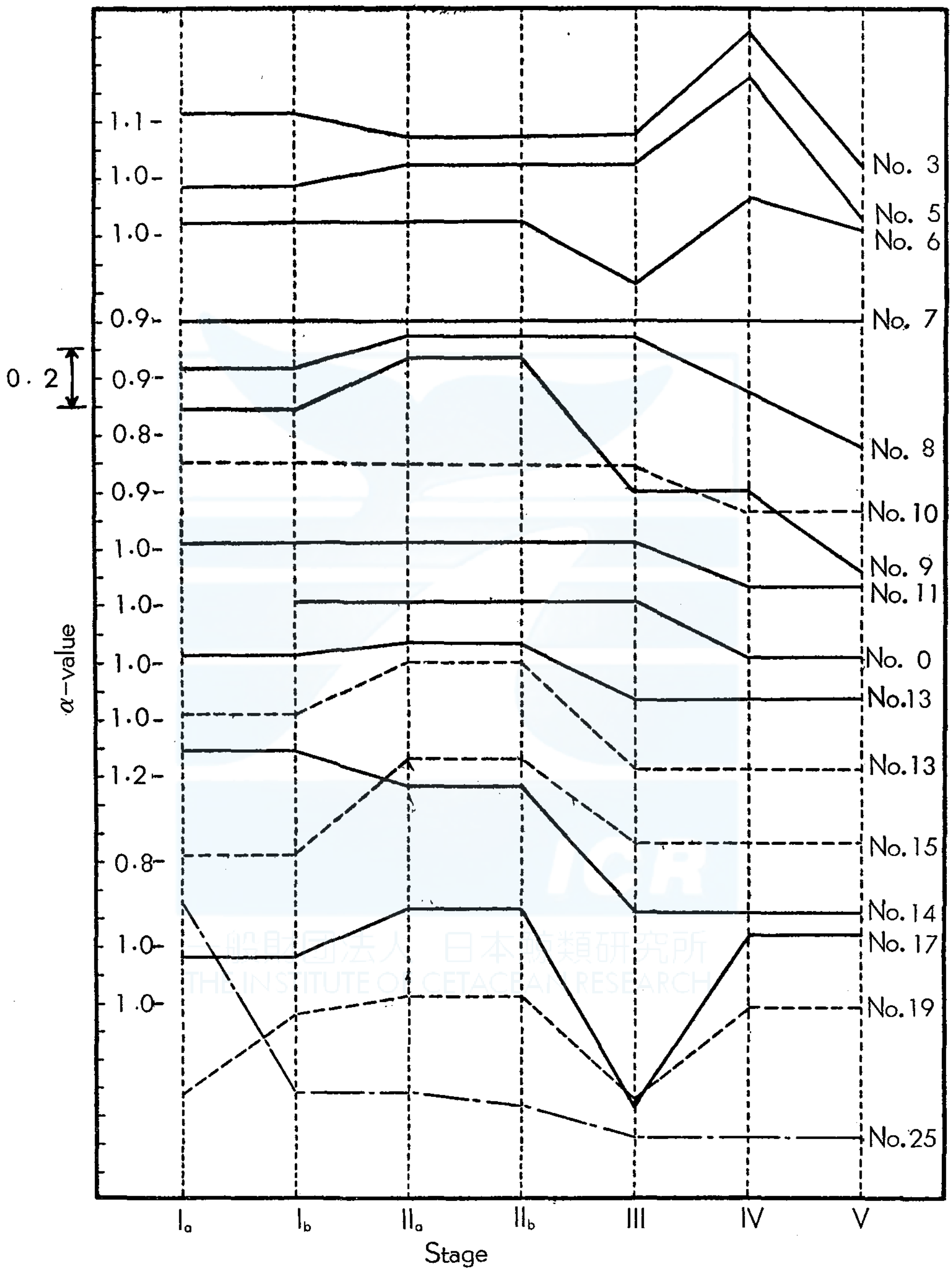



Fig. 7. Variation of $\alpha$-values of each measurements according to the growing stages.

However, after than it shows negative allometry.

iii) No. 25 : The allometry shows the decreasing positive allometry until II-stage. After then, it shows isometry.

2. The parts of which $\alpha$-value increase as time goes by.

There is not in fin whales.

3. $\alpha$-values are high in younger stage, then decrease in some time and again increase.

iv) No. 17 : Negative allomety in I-stage. Isometry in II-stage, $\alpha$-value decrease suddenly after IV-stage, it becomes again positive allometry.

v) No. 19 : Negative allometry in I-stage, isometry in II-stage, in III-stage suddenly decrease. After then it becomes again isometry.

4. Reverse growth to the above (3).

vi) No. 5 : In I-stage, it shows the negative allometry near the isometry ($\alpha=0.97$), but in II-, III- and IV-stages it becomes positive allometry. Especially, $\alpha$-value in IV- stage is very high ($\alpha=1.36$). In V-stage it becomes again negative allometry.

vii) No. 8 : Negative allometry in I-stage. Positive in II- and III-stage. Negative in IV- and V-stage.

viii) No. 9 : Negative allometry in I-stage, positive in II-stage. After III-stage, it shows negative allometry, and $\alpha$-value decrease remarkably.

ix) No. 13 : $\alpha$-value of females is different to that of males. But the tendencies are similar each other. Nearly isometry in I-stage. Positive in II-stage. After then it becomes negative allometry.

x) No. 15 : Positive allometry in II-stage. But negative in I-III- and V-stages.

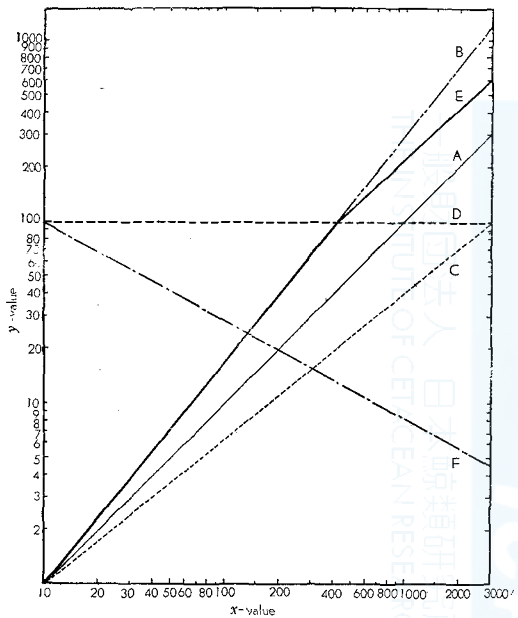
5. Almost constant allometry throughout the growing stages.

xi) No. 7 : Negative allometry ($\alpha=0.90$) throughout all stages.

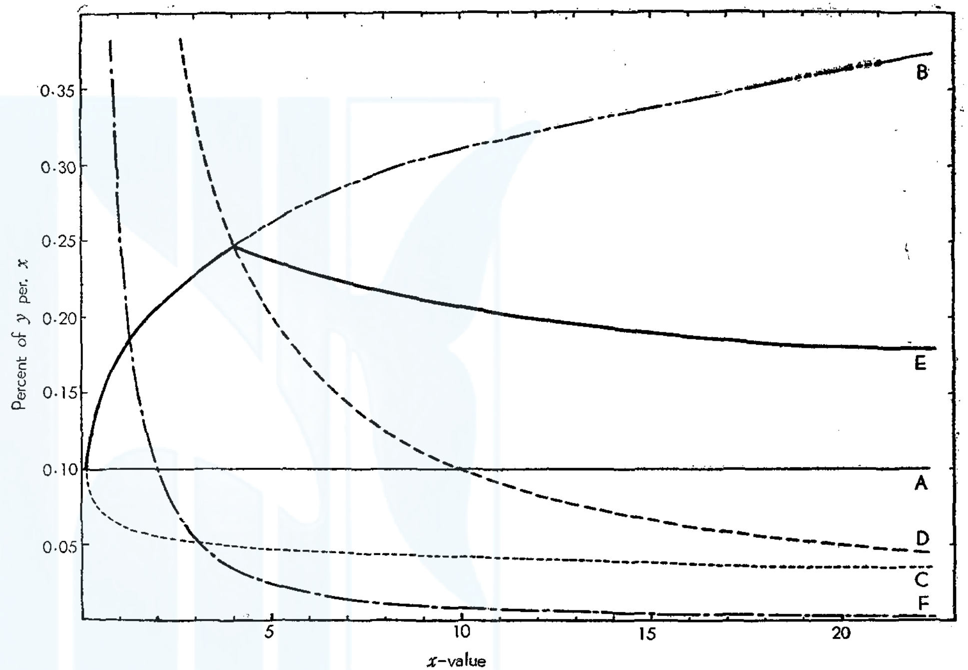
6. Complicated allometry.

xii) No. 3 : Although it shows the positive allometry from I-stage till IV-stage, $\alpha$-values are low in the stages of II and III. And $\alpha$-value increases suddenly. It become negative allometry in V-stage.

xiii) No. 6 : $\alpha$-value is constant until II-stage and it shows positive allometry. However it becomes negative allometry in III-stage. In IV-stage it becomes again positive allometry, after then $\alpha$-value decreases in V-stage and becomes isometry.




a. Allometry




b. Proportion

Fig. 8. Relation between the allometry and proportion.
A: $\alpha=1.0$, B: $\alpha=1.25$, C: $\alpha=0.80$, D: $\alpha=0$,
E: $\alpha=1.25$ (untill $x=420$) and $\alpha=0.80$ (after $x=420$),
F: $\alpha=-0.50$

TABLE 9. MEAN VALUES OF THE BODY PROPORTIONS IN EACH BODY LENGTHCLASSES FOR THE FIN WHALE FOETUSES

| Body length classes (cm) | Sex | No. 3 (%) | No. 5 (%) | No. 6 (%) | No. 7 (%) | No. 8 (%) | No. 9 (%) | No. 10 (%) | No. 11 (%) | No. 12 (%) | No. 13 (%) | No. 14 (%) | No. 15 (%) | No. 17 (%) | No. 19 (%) | No. 25 (%) | No. 25 /No. 9 | No. 14 /No. 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10~25 | ♀ | 11.1 | 17.3 | 41.0 | 8.0 | 26.2 | 9.3 | 30.6 | 45.6 | — | 2.8 (5) | 0.97 | 6.1 | 13.2 | 4.3 | — | — | — |
| | ♂ | 9.7 | 16.9 | 41.4 | 7.1 | 26.1 | 10.5 | 28.1 | 44.5 | — | 5.8 (4) | 0.80 | 6.4 | 13.5 | 4.2 | — | — | — |
| | Total no. | 10 | 10 | 8 | 9 | 6 | 6 | 9 | 9 | — | | 9 | 9 | 9 | 8 | — | — | — |
| | Mean | 10.5 | 17.1 | 41.2 | 7.7 | 26.2 | 9.7 | 29.5 | 45.3 | — | | 0.91 | 6.2 | 13.3 | 4.3 | — | — | — |
| 26~50 | ♀ | 10.7 | 16.7 | 39.0 | 7.7 | 27.4 | 8.7 | 31.7 | 48.2 | — | 2.4 (7) | 1.7 | 5.2 | 12.3 | 3.4 | 8.8 | 1.02 | 0.31 |
| | ♂ | 11.7 | 17.8 | 39.9 | 7.7 | 26.3 | 8.5 | 29.2 | 47.1 | — | 6.7 (7) | 1.4 | 5.4 | 12.5 | 3.7 | 9.2 | 1.02 | 0.35 |
| | Total no. | 10 | 12 | 15 | 9 | 14 | 11 | 13 | 12 | — | | 10 | 13 | 9 | 14 | 11 | 9 | 11 |
| | Mean | 11.2 | 17.1 | 39.5 | 7.7 | 26.7 | 8.6 | 30.6 | 47.7 | — | | 1.6 | 5.3 | 12.4 | 3.5 | 9.0 | 1.02 | 0.33 |
| 51~75 | ♀ | 12.3 | 17.0 | 41.0 | 7.0 | 25.4 | 8.5 | 30.7 | 47.8 | — | 2.4 (7) | 2.5 | 5.2 | 12.0 | 3.7 | 10.7 | 1.12 | 0.47 |
| | ♂ | 12.7 | 16.0 | 40.5 | 6.94 | 26.6 | 8.7 | 31.2 | 48.4 | — | 6.7 (13) | 2.2 | 5.0 | 12.4 | 3.5 | 10.1 | 1.13 | 0.45 |
| | Total no. | 22 | 23 | 21 | 13 | 21 | 12 | 22 | 22 | — | | 20 | 22 | 22 | 20 | 17 | 11 | 21 |
| | Mean | 11.9 | 16.3 | 40.7 | 7.0 | 26.2 | 8.6 | 31.0 | 48.3 | — | | 2.3 | 5.1 | 12.2 | 3.6 | 10.2 | 1.16 | 0.46 |
| 76~100 | ♀ | 12.8 | 17.5 | 40.9 | 7.2 | 25.6 | 8.3 | 31.1 | 48.0 | — | 2.5 (12) | 2.4 | 4.8 | 13.0 | 3.6 | 10.7 | 1.30 | 0.52 |
| | ♂ | 13.1 | 17.2 | 40.3 | 6.8 | 25.8 | 8.0 | 360. | 48.2 | — | 6.7 (12) | 2.6 | 4.8 | 12.5 | 3.4 | 10.2 | 1.24 | 0.49 |
| | Total no. | 25 | 25 | 26 | 17 | 27 | 11 | 24 | 26 | — | | 25 | 20 | 24 | 25 | 18 | 10 | 24 |
| | Mean | 13.0 | 17.3 | 40.6 | 7.0 | 25.7 | 8.1 | 30.8 | 48.2 | — | | 2.5 | 4.8 | 12.8 | 3.5 | 10.5 | 1.27 | 0.51 |
| 101~125 | ♀ | 14.4 | 17.8 | 42.3 | 7.0 | 25.2 | 8.9 | 30.5 | 47.4 | 48.2 | 2.6 (10) | 2.9 | 5.0 | 13.1 | 3.3 | 10.6 | 1.30 | 0.56 |
| | ♂ | 13.3 | 16.7 | 42.3 | 1.9 | 25.0 | 8.5 | 30.2 | 47.3 | 51.5 | 6.5 (10) | 2.8 | 4.5 | 13.6 | 3.3 | 11.1 | 1.28 | 0.56 |
| | Total no. | 20 | 20 | 18 | 17 | 20 | 10 | 20 | 19 | 10 | | 18 | 19 | 18 | 18 | 13 | 12 | 18 |
| | Mean | 13.9 | 17.4 | 42.3 | 6.9 | 25.1 | 8.6 | 30.3 | 47.4 | 49.8 | | 2.8 | 4.8 | 13.4 | 3.3 | 10.9 | 1.29 | 0.56 |
| 126~150 | ♀ | 14.3 | 18.1 | 42.1 | 6.8 | 26.0 | 8.7 | 30.7 | 46.1 | 47.7 | 2.6 (15) | 2.8 | 4.7 | 13.3 | 3.3 | 11.5 | 1.35 | 0.59 |
| | ♂ | 14.1 | 17.7 | 42.0 | 6.8 | 25.3 | 9.2 | 29.8 | 47.1 | 48.2 | 7.2 (11) | 2.9 | 4.7 | 13.2 | 3.4 | 11.4 | 1.22 | 0.60 |
| | Total no. | 26 | 26 | 25 | 20 | 24 | 7 | 27 | 24 | 21 | | 25 | 24 | 22 | 24 | 15 | 7 | 23 |
| | Mean | 14.2 | 17.9 | 42.1 | 6.8 | 25.8 | 8.8 | 30.3 | 46.5 | 47.9 | | 2.8 | 4.7 | 13.3 | 3.3 | 11.5 | 1.35 | 0.59 |
| 151~200 | ♀ | 14.8 | 18.1 | 42.8 | 6.4 | 26.6 | 3.4 | 30.6 | 46.8 | 45.8 | 2.6 (23) | 2.8 | 5.0 | 13.6 | 3.5 | 12.1 | 1.41 | 0.53 |
| | ♂ | 14.4 | 17.9 | 42.4 | 6.6 | 24.9 | 8.2 | 30.0 | 47.1 | 46.8 | 6.8 (16) | 2.6 | 5.2 | 13.5 | 3.4 | 11.8 | 1.41 | 0.53 |
| | Total no. | 43 | 43 | 41 | 31 | 42 | 25 | 42 | 41 | 35 | | 43 | 41 | 36 | 31 | 31 | 25 | 40 |
| | Mean | 14.6 | 18.0 | 42.6 | 6.5 | 25.8 | 8.3 | 30.4 | 47.0 | 46.3 | | 2.7 | 2.7 | 13.6 | 12.0 | 12.0 | 1.41 | 0.53 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 201～250 | ♀ | 14.5 | 18.0 | 43.0 | 6.3 | 25.7 | 8.2 | 30.9 | 47.3 | 46.3 | 2.5 (12) | 2.9 | 5.7 | 13.5 | 3.4 | 12.7 | 1.57 | 0.52 |
| | ♂ | 14.7 | 17.9 | 43.0 | 6.1 | 25.4 | 8.2 | 30.0 | 47.2 | 45.8 | 7.1 (7) | 2.8 | 5.3 | 13.9 | 3.4 | 12.0 | 1.46 | 0.52 |
| | Total no. | 19 | 19 | 18 | 14 | 18 | 12 | 22 | 19 | 16 | | 18 | 18 | 16 | 18 | 14 | 11 | 18 |
| | Mean | 14.6 | 17.9 | 43.0 | 6.2 | 25.6 | 8.2 | 30.5 | 47.3 | 46.1 | | 2.8 | 5.4 | 13.7 | 3.4 | 12.4 | 1.52 | 0.52 |
| 251～300 | ♀ | 15.1 | 17.8 | 42.8 | 6.1 | 25.6 | 8.0 | 30.5 | 46.8 | 45.3 | 2.8 (11) | 3.0 | 5.7 | 14.1 | 3.5 | 12.5 | 1.59 | 0.52 |
| | ♂ | 15.4 | 17.6 | 43.3 | 6.0 | 25.6 | 8.4 | 31.0 | 48.3 | 47.1 | 7.1 (14) | 3.2 | 5.8 | 14.1 | 3.6 | 12.7 | 1.49 | 0.56 |
| | Total no. | 23 | 25 | 24 | 21 | 23 | 17 | 21 | 22 | 18 | | 22 | 23 | 21 | 22 | 18 | 16 | 23 |
| | Mean | 15.3 | 17.7 | 43.2 | 6.0 | 25.6 | 8.2 | 30.8 | 47.3 | 46.2 | | 3.1 | 5.8 | 14.1 | 3.6 | 12.6 | 1.53 | 00.4 |
| 301～350 | ♀ | 15.6 | 18.2 | 43.5 | 6.0 | 26.2 | 8.1 | 30.8 | 48.5 | 48.1 | 3.3 (8) | 3.1 | 5.9 | 14.6 | 3.6 | 12.8 | 1.55 | 0.55 |
| | ♂ | 15.5 | 19.0 | 44.9 | 6.1 | 26.5 | — | 32.5 | 47.7 | 49.4 | 6.9 (4) | 3.1 | 6.3 | 14.2 | 3.7 | 11.9 | — | 0.52 |
| | Total no. | 13 | 13 | 11 | 7 | 13 | 5 | 11 | 11 | 10 | | 14 | 13 | 12 | 11 | 8 | 5 | 13 |
| | Mean | 15.6 | 18.5 | 44.1 | 6.1 | 26.3 | 8.1 | 31.3 | 48.2 | 48.4 | | 3.1 | 6.0 | 14.4 | 3.6 | 12.6 | 1.55 | 0.54 |
| 351～400 | ♀ | 14.8 | 17.6 | 43.0 | 5.9 | 25.9 | 9.4 | 32.4 | 49.2 | 47.5 | 2.8 (4) | 3.2 | 6.4 | 14.5 | 3.6 | 12.7 | 1.37 | 0.51 |
| | ♂ | 15.5 | 18.5 | 43.0 | 5.8 | 26.3 | 8.5 | 32.0 | 48.0 | 47.5 | 6.8 (7) | 3.3 | 6.0 | 14.7 | 3.5 | 11.6 | 1.40 | 0.48 |
| | Total no. | 12 | 12 | 12 | 9 | 11 | 6 | 11 | 12 | 9 | | 10 | 12 | 11 | 11 | 8 | 6 | 11 |
| | Mean | 15.2 | 18.0 | 43.0 | 5.8 | 26.1 | 8.8 | 32.1 | 48.6 | 47.5 | | 3.2 | 3.2 | 14.6 | 3.5 | 12.0 | 1.38 | 0.49 |
| 401～450 | ♀ | 15.2 | 18.6 | 42.4 | 5.8 | 27.0 | 8.3 | 32.4 | 49.0 | 48.1 | 3.5 (5) | 3.2 | 6.6 | 14.6 | 3.6 | 12.6 | 1.54 | 0.46 |
| | ♂ | 13.7 | 18.0 | 42.9 | 5.2 | 26.9 | 8.6 | 31.9 | 48.0 | 49.1 | 7.6 (2) | 2.9 | 6.4 | 15.5 | 3.5 | 11.2 | 1.21 | 0.55 |
| | Total no. | 8 | 8 | 7 | 7 | 7 | 5 | 9 | 8 | 7 | | 7 | 7 | 7 | 8 | 7 | 5 | 7 |
| | Mean | 14.8 | 18.4 | 42.4 | 5.7 | 27.0 | 8.3 | 32.8 | 48.8 | 48.3 | | 3.2 | 6.6 | 14.7 | 3.6 | 12.2 | 1.47 | 0.47 |
| 451～500 | ♀ | 15.8 | 18.3 | 43.4 | 5.6 | 27.3 | 8.7 | 33.1 | 50.8 | 49.4 | 2.9 (3) | 3.2 | 6.5 | 15.3 | 3.4 | 11.3 | 1.36 | 0.50 |
| | ♂ | 15.0 | 16.3 | 44.3 | 6.0 | 24.9 | 9.5 | 32.8 | 48.9 | 47.8 | 7.2 (1) | 2.8 | 6.2 | 15.5 | 3.6 | 11.3 | 1.20 | 0.45 |
| | Total no. | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 4 | 4 | | 4 | 4 | 4 | 4 | 3 | 3 | 4 |
| | Mean | 15.6 | 17.7 | 43.6 | 5.7 | 26.7 | 9.0 | 33.0 | 50.8 | 49.0 | | 3.1 | 6.4 | 15.4 | 3.5 | 11.3 | 1.31 | 0.49 |
| 501～550 | ♀ | 16.5 | 18.8 | 44.0 | 5.3 | 25.1 | 8.5 | 31.5 | 48.8 | 46.1 | 2.9 (1) | 3.9 | 6.1 | 16.5 | 3.6 | 12.0 | 1.40 | 0.64 |
| | ♂ | 14.3 | 19.1 | 41.8 | — | 23.2 | — | 33.7 | 50.6 | 50.0 | 7.9 (1) | 3.3 | — | 14.3 | 3.6 | 14.5 | — | — |
| | Total no. | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 2 | | 2 | 1 | 2 | 2 | 2 | 1 | 1 |
| | Mean | 15.4 | 18.9 | 42.9 | 5.3 | 24.2 | 8.5 | 32.6 | 49.7 | 48.1 | | 3.6 | 6.1 | 15.4 | 3.6 | 13.3 | 1.40 | 0.64 |

## PROPORTIONS

### RELATION BETWEEN $\alpha$-VALUE AND THE PROPORTION

As the proportion is the ratio of a portion to other portion, it is of course related with the relative growth. In other word, proportion and relative growth are inside and outside each other to represent the growth of portions.

Fig. 8 a, b show the relation between the relative growth and proportion. If $\alpha$-value is larger than 1.0, proportion always increases with the increase of $x$ (B-line). When $\alpha$ equals to 1.0, proportion is constant (A-line). When $\alpha$ is less than 1.0, proportion decreases with the increase of $x$ (C-, D-, F-line).

At the point when $\alpha$ which is larger than 1.0 changes the value which is less than 1.0, the critical point is clearly recognized in the proportion (E-line). However, when $\alpha$ changes its values in the range which is larger than 1.0 or less than 1.0, the critical points are not distinct.

The larger $\alpha$-value is in the range in which $\alpha$ is larger than 1.0, the more remarkable the proportion increases. On the contrary, the less $\alpha$-value is than 1.0, the remarkable the proportion decreases. Even if $\alpha$-value is constant, the rate of increase or decrease of proportion is large, when $x$ is small quantity. But as $x$ increase, the rate becomes to decrease.

### VARIATIONS OF PROPORTION ACCORDING TO BODY LENGTH IN FOETAL STAGE

Fifteen measurements expressed as percentage of the body length (body proportions) according to the body length of the fin whale foetuses are shown in Fig. 9. And meanwhile, No. 14/No. 15 and No. 25/No. 9 according to body length are also shown in this figure. Table 9 shows the mean body proportions in each body length classes.

As discussed in the above paragraph, body proportions are able to be calculated with the allometry formula and if the body proportions are calculated with the actual measurements, they should agree with those which are calculated with the allometry formula. However, the both do not always agree with each other.

For example, although proportion of measurement No. 11 should be a increasing curve by the calculation with the allometry line, the mean proportion shows a waving curve having a peak in body length of 70 cm and a valley in the body length of 140 cm. Proportion of measurement No. 12 calculated with allometry line is a similar curve as No. 11. However, the actual mean proportion is a convex curve having a valley

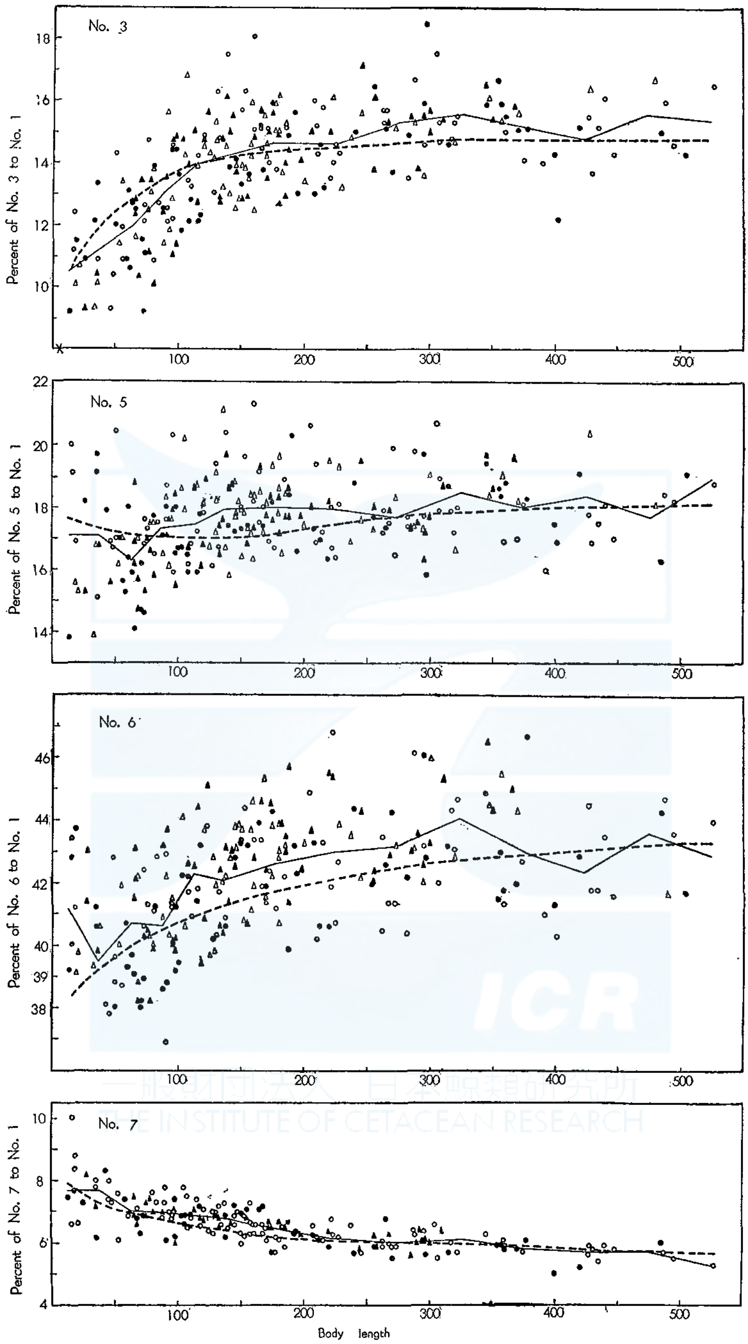



Fig. 9. Variation of the proportions of measurements in the fin whale foetuses. Open circle: Antarctic female, closed circle: Antarctic male, Open triangle: North Pacific female, closed circle: North Pacific male, Solid line: Mean proportion in each body length class, Broken line: Proportion calculated from allometry.

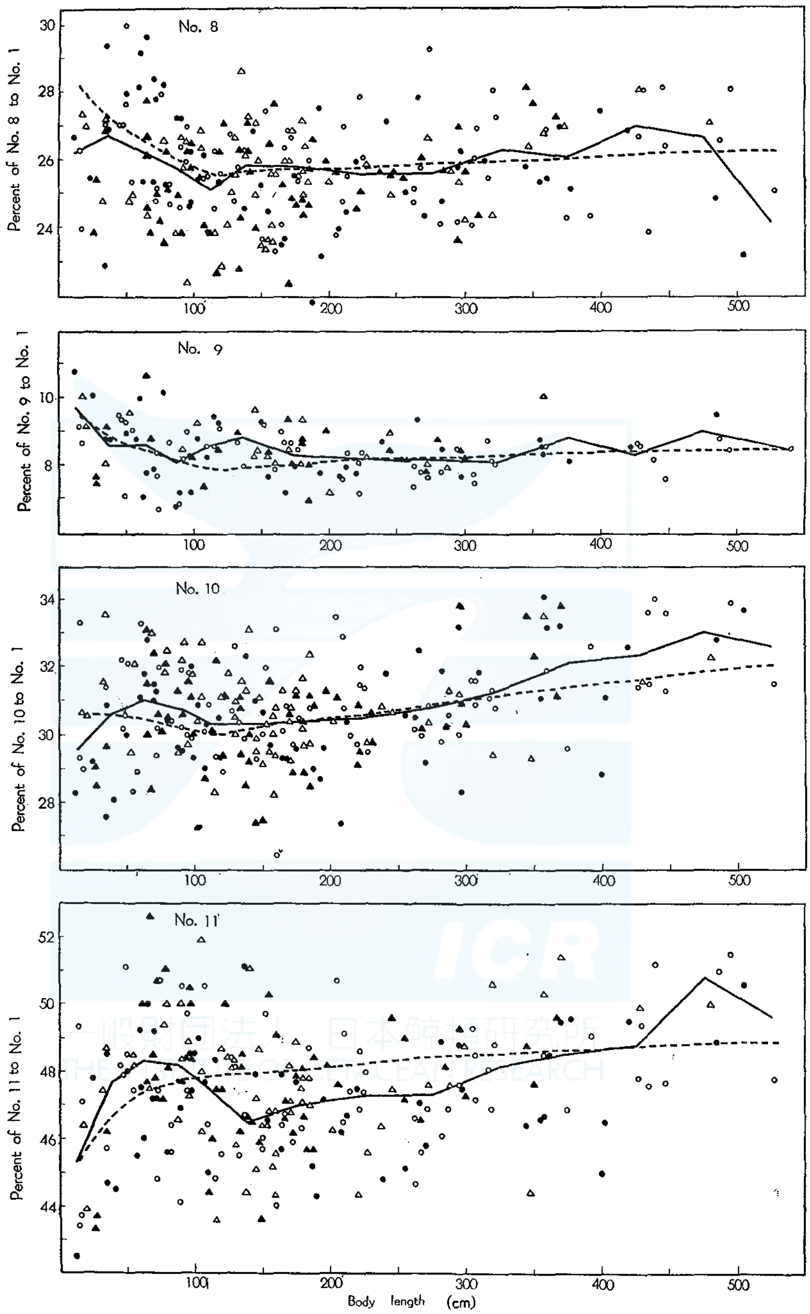

No. 8
Percent of No. 8 to No. 1
30
28
26
24
100
200
300
400
500
No. 9
Percent of No. 9 to No. 1
10
8
No. 10
Percent of No. 10 to No. 1
34
32
30
28
No. 11
Percent of No. 11 to No. 1
52
50
48
46
44
Body length (cm)

Fig. 9. (Cont.)

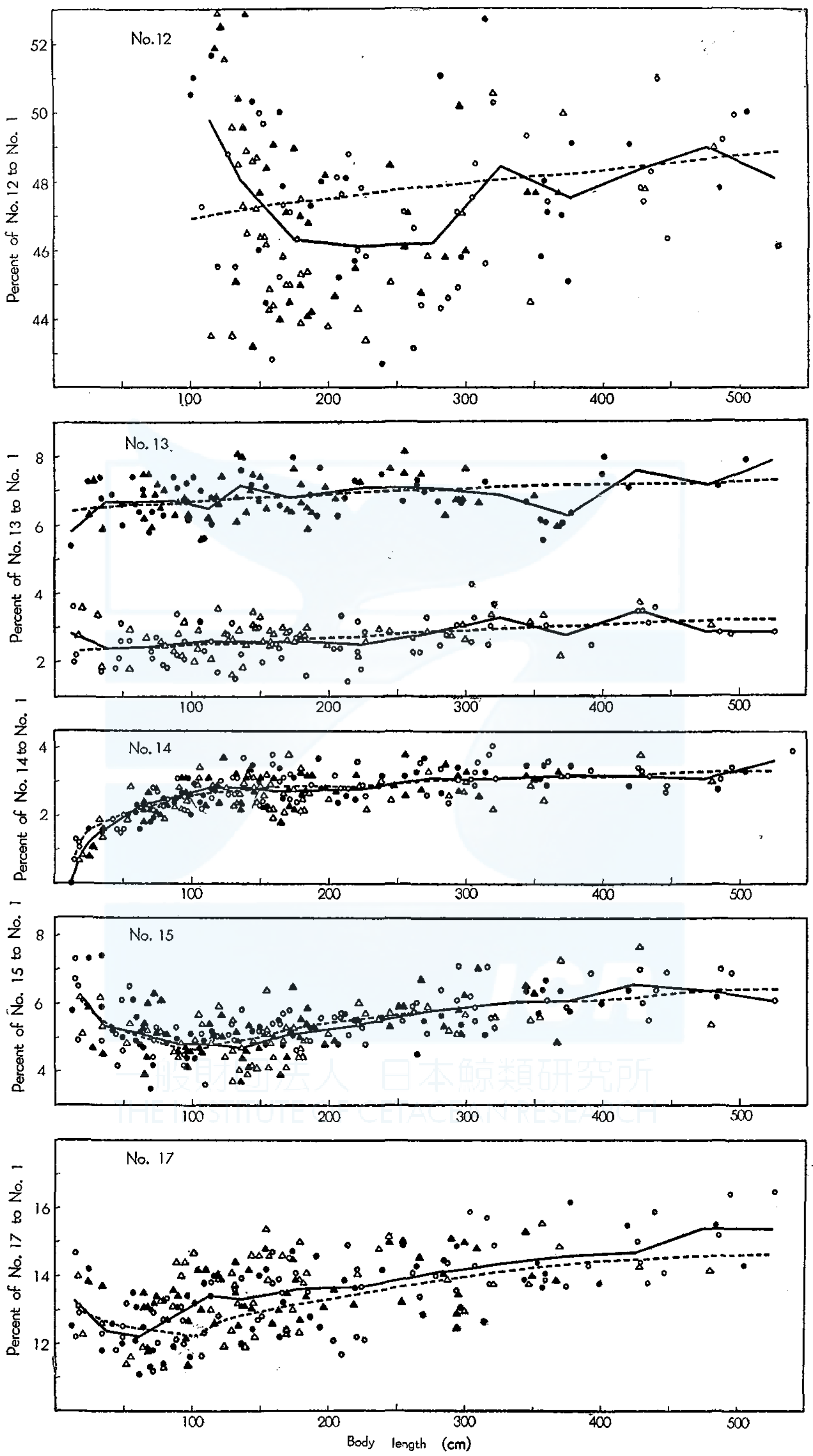

No. 12
Percent of No. 12 to No. 1
52
50
48
46
44
100
200
300
400
500
No. 13
Percent of No. 13 to No. 1
8
6
4
2
No. 14
Percent of No. 14 to No. 1
4
2
No. 15
Percent of No. 15 to No. 1
8
6
4
No. 17
Percent of No. 17 to No. 1
16
14
12
Body length (cm)

Fig. 9. (Cont.)

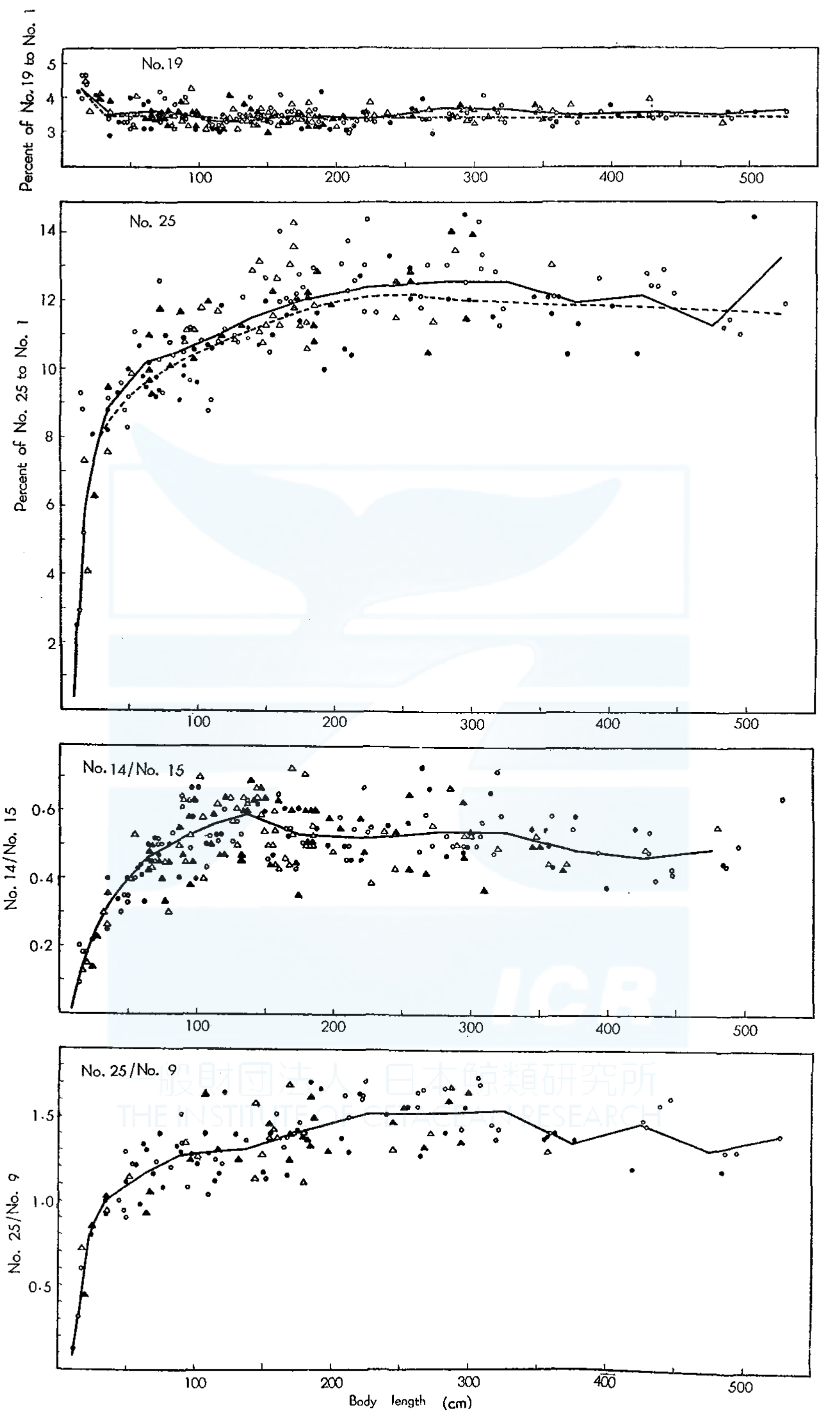

No. 19
Percent of No. 19 to No. 1
5
4
3
100
200
300
400
500
No. 25
Percent of No. 25 to No. 1
14
12
10
8
6
4
2
No. 14/No. 15
No. 14/No. 15
0·6
0·4
0·2
No. 25/No. 9
No. 25/No. 9
1·5
1·0
0·5
Body length (cm)

Fig. 9. (Cont.)

in the body length of 220 cm. And after the point, the rate of increase of the latter is larger than the former.

In the measurement No. 17, the both proportions fairly agree with each other, but the curve of proportion calculated with allometry has a valley in the body length of 110 cm, on the contrary, the mean proportion has a valley in the body length of 60 cm.

Zemskiy (1950) calculated the body proportions of the southern fin whale foetuses according to the body length from 49.5 cm to 569 cm.

The external parts measured by him are as follows.

1) From tip of snout to umbilicus (No. 1 minus No. 11.)
2) From tip of snout to anus (No. 1 minus No. 10).
3) Girth in thoracic region at the level of the thoracic flipper. Not measured in this paper.
4) Girth of body at the level of anus. Not measured in this paper.
5) From tip of snout to ear (No. 5 plus No. 7).

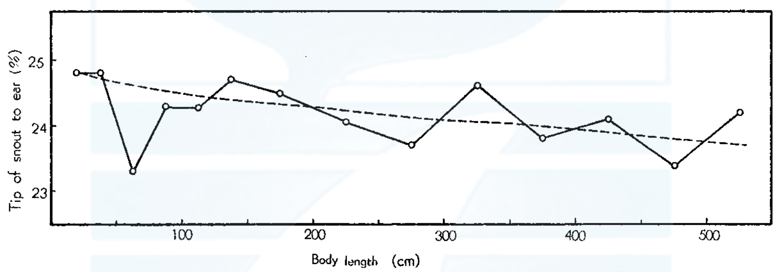



Fig. 10. Variation of the proportion of the length of head (No. 5+No. 7) in the fuetal stage of fin whales.

Then Zemskiy states that both male and female embryos, the proportions of the different parts of the body remain almost constant throughout the whole of the period of development studied, and that it is possible that the earliest stages disproportion is present, but that this has disappeared by the time when the foetus reaches to 50 cm in body length.

And he shows the figures of proportions as follows:

| *Measurement by Zemskiy* | *Mean* (%) | *Maximum* (%) | *Minimum* (%) |
|---|---|---|---|
| 1 | 52.4 | 57.1 | 47.5 |
| 2 | 68.7 | 74.6 | 68.7 |
| 5 | 24.7 | 26.7 | 23.8 |

Now, according to my result, the proportion of the above three measurements are not constant. In the measurement No. 1 by Zemskiy, the proportion in the time when body length of 50 cm is reached is 52.9%. Then the proportion decreases and becomes to 51.1% by the time when body length of 500 cm is reached. In measurement No. 2 by Zemskiy, the

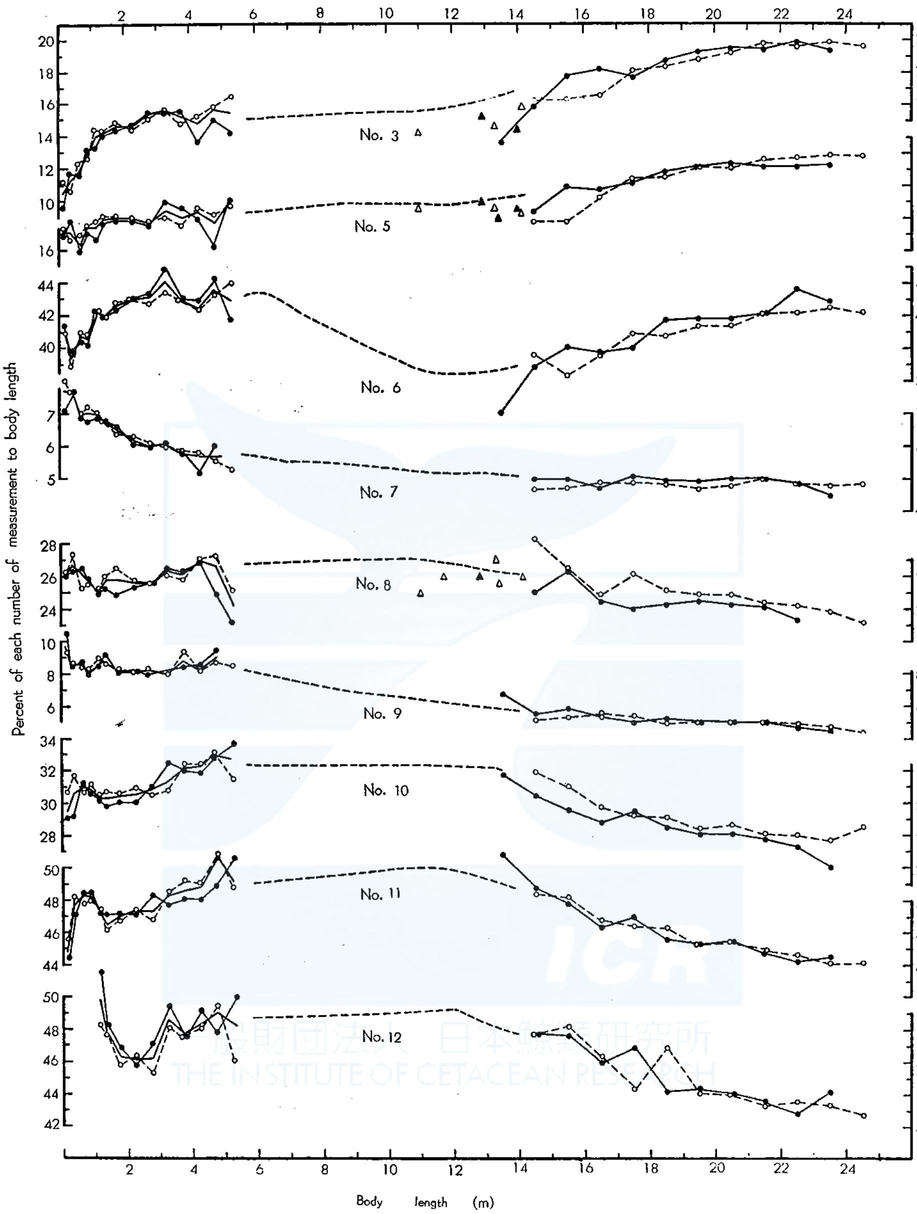



Fig. 11. Variation of body proportions throughout life of the Antarctic fin whale. Open circles and line: female. Closed circles and thin solid line: males. Open triangle: North Atlantic female. Closed triangle: North Atlantic males. Broken curve: estimated variation of body proportion calculated from allometry. Circles over 13 m: After Mackintosh & Wheeler (1929). Triangle: After True (1904).

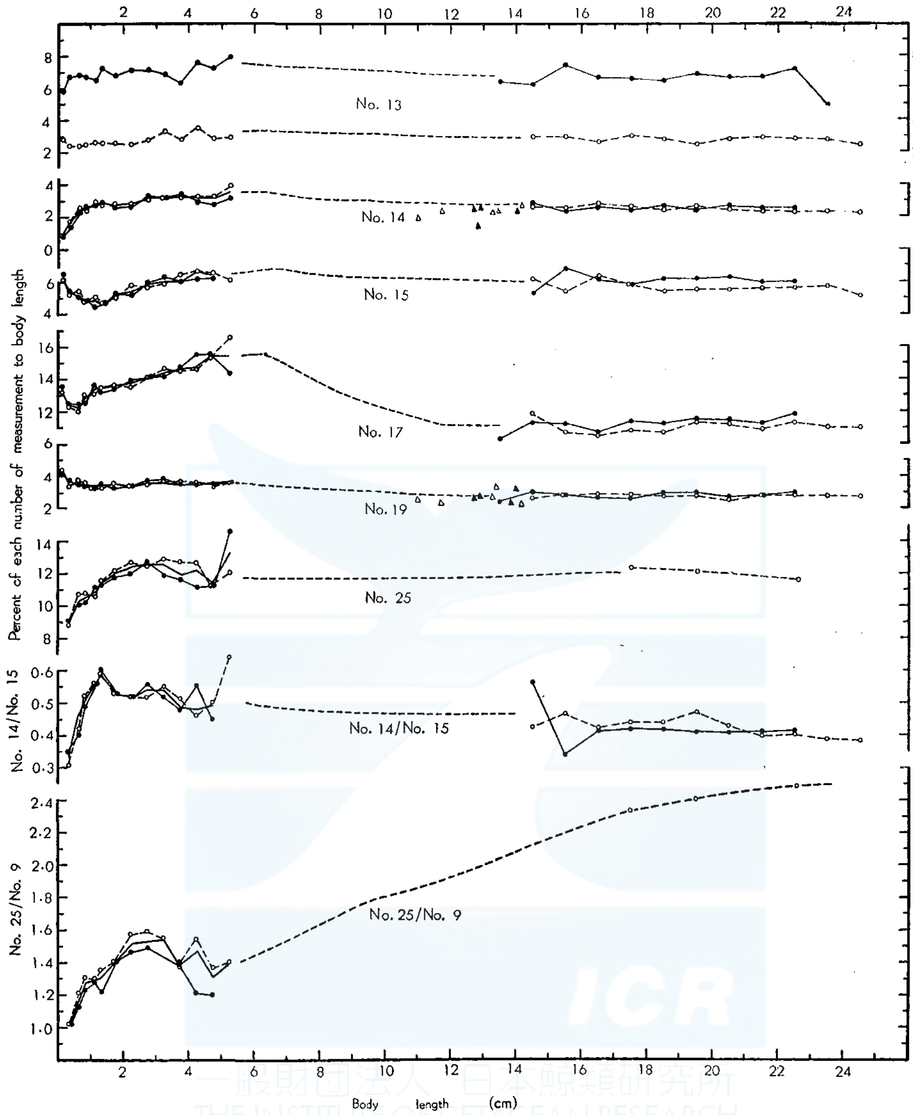



Fig. 11. (Cont.)

proportion is 69.2% in body length of 50 cm. After then it increases to be 69.8% in the body length of 110 cm. And after then it decreases to be 67.2% by the time when body length of 500 cm is reached. Measurement No. 5 by Zemskiy is considered to agree with the measurement No. 5 plus No. 7 of this paper. Fig. 10 shows the variation of proportion of No. 5 plus No. 7 according to the body lengths. From this figure the proportion of measurement No. 5 by Zemskiy is 24.5% in 50 cm long foetuses, and it decreases gradually to become 23.8% by the time body length of 500 cm is reached.

Mackintosh & Wheeler (1929) show a table of body proportions for each measurements of fin whale foetuses in each 1.0 m body length classes. But they did not discuss on the proportion of foetuses. And they did not classify narrow body length classes chiefly in small body length, so the variation of proportions in the small body length is not compare with my results.

By the matter that it may, Mackintosh & Wheeler's figures do not show that proportions are constant in the foetal stage as shown by Zemskiy, and they agree with my result in general. Comparing the both Mackintosh & Wheeler's and my results in detail, both do not always agree each other (Nos. 5 and 9). Besides, in Nos. 11, 12 and 19, variations of proportions are reverse each other.

## VARIATIONS OF BODY PROPORTIONS THROUGHOUT THE LIFE HISTORY OF THE FIN WHALE

It will be important to study the ratio of external measurements throughout the life history of the fin whale. Now, I recorded the body proportions of the measurements in Fig. 11. The body proportions in foetal stage are given in the Table 9. Those in the adult stage over 13 m are cited after the table of Mackintosh & Wheeler (1929). As the data on the proportions of the individuals from 600 cm till 1,300 cm are very few, proportions are calculated from the figures of the relative growth.

True (1904) presented several measurements on the external parts of fin whales from the North Atlantic. I recorded the measurement of five individuals less than 1,415 cm in Fig. 11.

*No. 3.* Proportion increases remarkably until the body length of 110 cm (from 10% till 14%). After then it increases slowly until 12 m (15.8%). From 12 m till 21 m, the rate of increase of proportion again enlarges (19.5% in 21 m). After 21 m it seems to decrease a little. The proportion of the North Atlantic fin whales is lower than that is calculated by means of relative growth.

*No. 5.* In the body length of 10 cm, the proportion is 17.6%, and then decreases until 17.0% in 120 cm. After then it increases slowly until the body length of 12 m (18.8%). From 12 m the rate of increase of proportion becomes large and it becomes 21.4% in 21 m. After then it becomes almost constant.

*No. 6.* This proportion varies remarkably. It increase from 40% to 43.4% by the body length of 6.5 m. After the length it decrease reversely until 12 m (38.4%). From the length it again increase, and by the time the body length is reached 12 m long, it becomes 42.7%. As

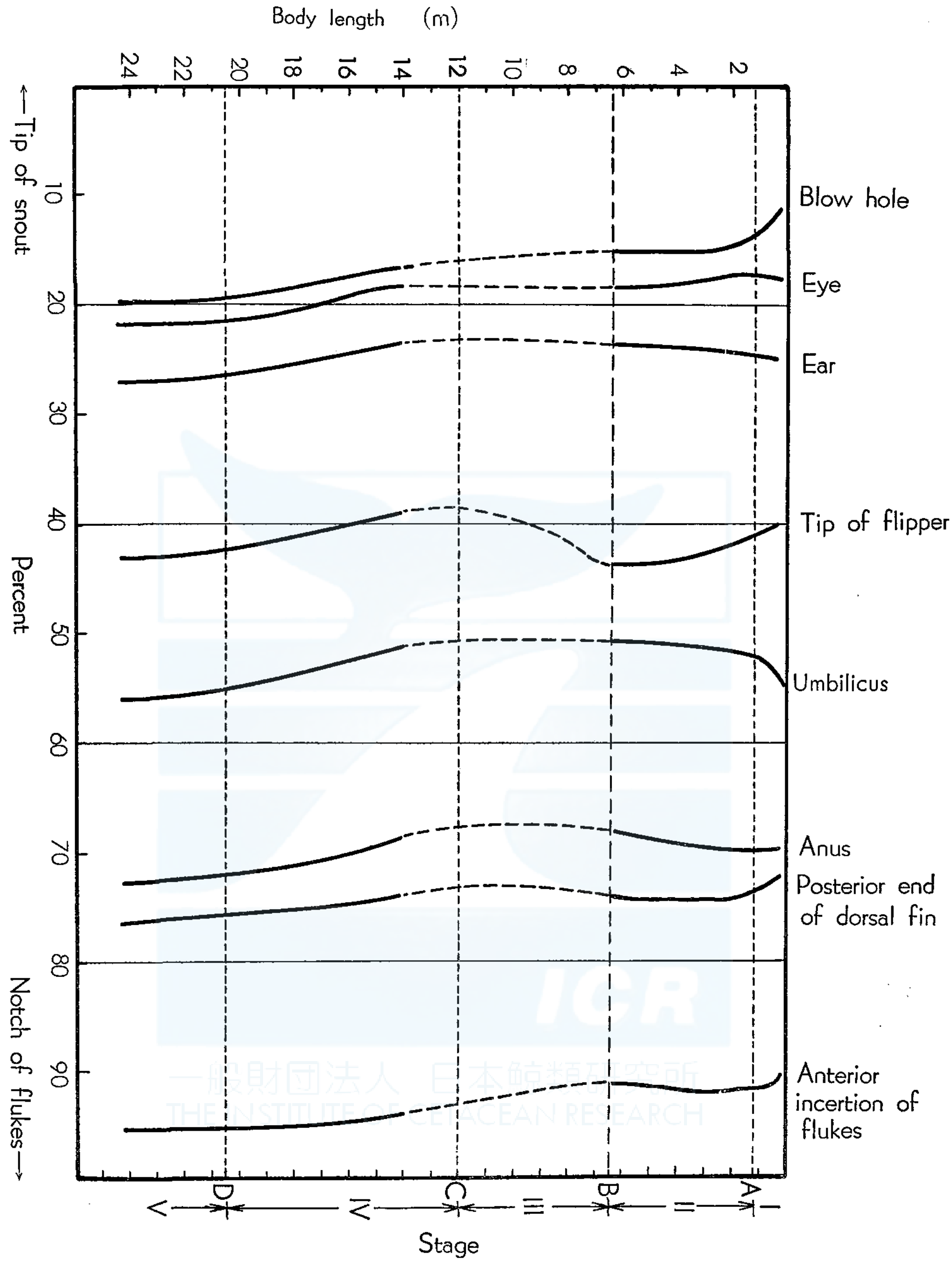



Fig. 12. Variation of the position of external parts accompanying to the growth in body length of the Antarctid fin whale.

shown in the proportion of No. 17, this phenomenon is closely related to the variation in the proportion of the length of flipper.

*No. 7.* This proportion continous to decrease throughout the life history. It is 8.1% in the body length of 10 cm, but it becomes to be 4.7% in 24 m.

*No. 8.* Decreases until 110 cm, and at that time it is 25.5%. After then it increases to be 27.0% in 11 m. After 11 m it again decreases. The proportion is 23.6% in the body length of 24 m.

*No. 9.* It is 10% at 10 cm and it decrease until 7.9% in the body length of 120 cm. In 530 cm it becomes to be 8.5%. After then it continuously decreases and it is 4.6% in 24 m.

*No. 10.* On the variation of the proportion in the foetal stage was already described in the previous paragraph. The proportion has a peak (31.0%) at the body length of 75 cm and a valley (30.3%) at 120 cm. After then it increases to become to 32.3% by the time the body length is reached 12 m. Over the length it decreases reversely and it is 26.9% at 24 m.

*No. 11.* The mean proportion at 10 cm is 44.5% and has a peak (48.3%) at 75 cm, and a valley (46.5%) in 130 cm. After 12 m, it decreases slowly and it is 44% at 24 m. Calculating the proportion with the allometry formula, there is no peak or valley and continuously increases in the foetal stage.

*No. 12.* This proportion is present from body length of 0.9 m. It has a valley in the body length of 225 cm. The proportion in this body length is 46.1%. After then it increase until 12 cm (49.2%). Then it begins to decrease, and it is 43% at 24 m.

*No. 13.* Although the proportions are different between males and females, they are almost constant throughout the life. Merely in foetal stage, they increase a little, and after then they decrease also a little. In 50 cm, the proportions are 6.5% in males and 2.4% in females. In 650 cm, they are 7.5% and 3.5% in males and females respectively. They become to be 6.6% and 2.8% respectively in adult stage.

*No. 14.* Dorsal fin does not develop until the body length grows 10 cm long. The proportion increases from that time till birth. At birth (650 cm) it will be 3.6%. After then it decreases slowly. It is 2.2% at 24 m.

*No. 15.* The proportion decreases from 20 cm till 110 cm. And it is 4.6% at 110 cm. Next, it increase to be 6.8% in 650 cm. After birth it again decrease, In 24 m, it is 5.7%.

*No. 17.* The mean percent of the measurement has a valley (12.2%) at the body length of 60 cm. Calculating it from the allometry, it should have a valley in 107 cm. After then it increases until the time at birth. The proportion is 15.5% in 650 cm. Then it decreases remarkably until the time at weaning. And at weaning, it will be 11.2%. After that time it becomes almost constant.

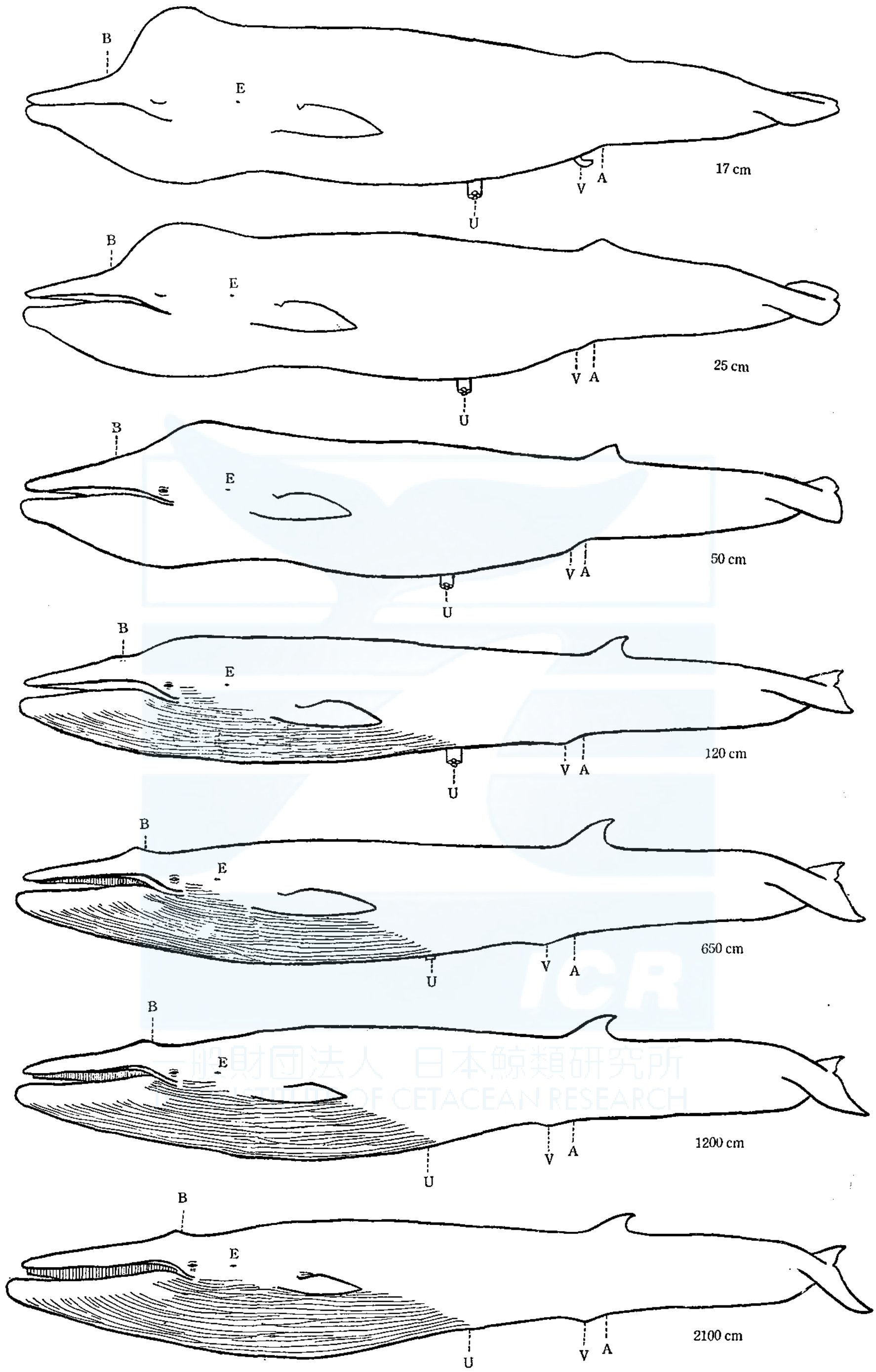



Fig. 13. Variation of the external form in the female fin whales.
A: Anus, B: Blow hole, E: Ear, U: Umbilicus, V: Vagina opening

*No. 19.* The variation of the proportion of this measurement is not so remarkable. It decreases until 30 cm. At that length it is 3.5%. After then, it increases until the time at birth, then turns to decrease until the time at weaning. After weaning it is almost constant. In 24 m, the proportion is 2.8%.

*No. 25.* The mean proportion increases until 325 cm. At that length it is 12.6%. Calculating the proportion from the allometry it becomes maximum (12.3%) at 250 cm. After then it decreases until the time at birth. It is estimated to be 11.7% at that time. Because there are only three measurements in the adult stage, the variation of the proportion is not confirmed, but it seems to increase a little.

*No. 14: No. 15.* The ratio of the height of dorsal fin to the length of base of the dorsal fin increases rapidly with the body length until the time the body length reaches 140 cm. The maximum ratio is 0.59. After then it decreases gradually, and it becomes to be 0.40 at 24 m.

*No. 25: No. 9.* The ratio of the length of tail flukes (notch to tip) to the width at insertion of flukes varies remarkably according to the increase of body length. Although it is only 1.0 at 40 cm, it increase to be 1.55 at 300 cm. After the length, it decreases until the time at birth. After then it increases again and becomes to be 2.5 at 24 m.

## VARIATION OF THE PROPORTIONS OF THE SEVERAL PARTS ALONG THE BODY AXIS

From the anterior end of the body, I arranged the following portions along the body axis:

Blow hole (No. 3), eye (No. 5), ear (No. 5+No. 7), tip of flipper (No. 6), umbilicus (No. 11), anus (No. 10), posterior emargination of dorsal fin (No. 8), and anterior emargination of flukes (No. 9).

Fig. 12 shows the variation of the proportions of the above portions throughout the growth of fin whales.

In the foetal stage, the proportion of both anterior and posterior portion increase with the increase of body length. And the ratio from ear to umbilicus decreases relatively. In this stage, the tip of flipper spreads remarkably posteriorly. In the sucking stage (650–1,200 cm), the anterior emargination of flukes shrinks posteriorly and the tip of flipper removes anteriorly. The other portions do not vary so remarkably.

After weaning, all portions remove posteriorly. As stated by Mackintosh & Wheeler (1929), anterior parts relatively increase as the body length increase, and the posterior parts show correspondingly decrease. The proportions of middle parts (ear—anus) do not vary, so remarkably, but they remove posteriorly accompanying the increase of head and decrease of tail.

Fig. 13 shows the side-view of fin whales in the body lengths of 17 cm, 25 cm, 50 cm, 120 cm, 650 cm, 1200 cm and 2,100 cm.

## COMPARISON OF THE RELATIVE GROWTHS AMONG THE SIX SPECIES BELONGED TO *BALAENOPTERIDAE*

### COMPARISON OF THE BODY PROPORTIONS AMONG THE FIVE SPECIES BELONGED TO *BALAENOPTERAE*

It is regarded that there is five species: blue whale (*Balaenoptera musculus*), fin whale (*B. physalus*), sei whale (*B. borealis*), Bryde's whale (*B. edeni*), minke whale (*B. acuto-rostrata*) belonged to *Balaenoptera*.

The external characters and the body lengths at sexual maturity are different among the five species. And in the same species, they are also different among the races.

In the above chapter, I studied the variation of the proportions over the body length of 10 cm. And I found that the proportions vary as the increase of body length. Then I thought that the whales may have the form adapted best to the body length at that time. For example, the proportion of the height of dorsal fin (No. 14) decreases as the increase of body length after the time of birth. This will mean that the smaller whales need to have heigher dorsal fin, and accompanying the increase of body length, they become to need the lower dorsal fin.

Standing on this idea, I examine the relation between the differentiation of the proportions among five species which are different in body length at sexual maturity and the variation of the body proportions accompanying the body length of fin whales.

The data which are used in this chapter are all the mean proportions of the different external measurements in the adult stage. And the authors, localities, ranges of body lengths and the body lengths at sexual maturity of the species are shown in Table 10.

Fig. 14 shows the mean proportions and the range of the proportions in the five species. In this figure whale species are arranged according to the body length at sexual maturity in principle. However, *B. borealis* and *B. edeni* are exchanged. Because *B. borealis* is near *B. acuto-rostrata* morphologically, and *B. edeni* is near *B. physalus*.

Used data include immature whales as well as mature whales. As shown in the variation of the proportions of fin whales, proportions vary with the body length. Therefore, it will be given the better result if the comparison is limited to the matured whale. But because of the relative scanty of the dada, I used all the data. The materials are considered to be given all from the individuals after weaning.

TABLE 10. DATA ON MEASUREMENT FOR THE SIX SPECIES OF *BALAENOPTERIDAE* WHICH ARE DISCUSSED IN THIS REPORT

| Species | Authors | Locality | | Measured individuals | Range of body length measured (m) | Body length at sexual maturity (m) |
|---|---|---|---|---|---|---|
| Genus *Balaenoptera* | | | | | | |
| *B. musculus* | Mackintosh & Wheeler (1929) | South Georgia | Females | 268 | 16~29 | 23.5[a] |
| | | | Males | 256 | 17~27 | 22.6[a] |
| *B. physalus* | Mackintosh & Wheeler (1929) | South Georgia | Females | 257 | 14~25 | 19.9[b] |
| | | | Males | 360 | 13~24 | 19.2[b] |
| *B. edeni* | Omura, Nishimoto & Fujino (1952)[a] | Bonin Islands[g] | Females | 113 | 12.2~14.2 | 12.5[c] |
| | | | Males | 85 | 12.2~14.3 | 12.3[c] |
| *B. borealis* | Matthews (1938b) | South Georgia | Females | 137 | 12.1~17.1 | 14.5[d] |
| | | | Males | 53 | 11.3~16.2 | 13.5[d] |
| *B. acuto-rostrata* | Omura & Sakiura (1956) and Ohsumi (1960) | Coast of Japan | Females | 20 | 4.61~8.57 | 7.3[e] |
| | | | Males | 22 | 4.86~7.98 | 6.7~7.0[e] |
| Genus *Megaptera* | | | | | | |
| *M. novaeangliae* | Matthews (1960) | South Georgia | Females | 26 | 10~15 | 11.0[f] |
| | | | Males | 18 | 11~15 | 11.9[g] |

*a*) Identified as *B. edeni* by Omura (1959) *b*) Mackintosh (1942) *c*) Nishiwaki, Hibiya & Ohsumi (1954) *d*) Matthews (1938b)
*e*) Omura & Sakiura (1956) *f*) Chittleborough (1955b) *g*) Chittleborough (1955a)

*No. 3.* Proportion is smaller in the smaller species. And it agrees well with the variation of the proportion in the fin whale after weaning.

*No. 5.* It shows the same tendency as No. 3.

*No. 6.* The smaller the species is, the smaller the proportion is, but

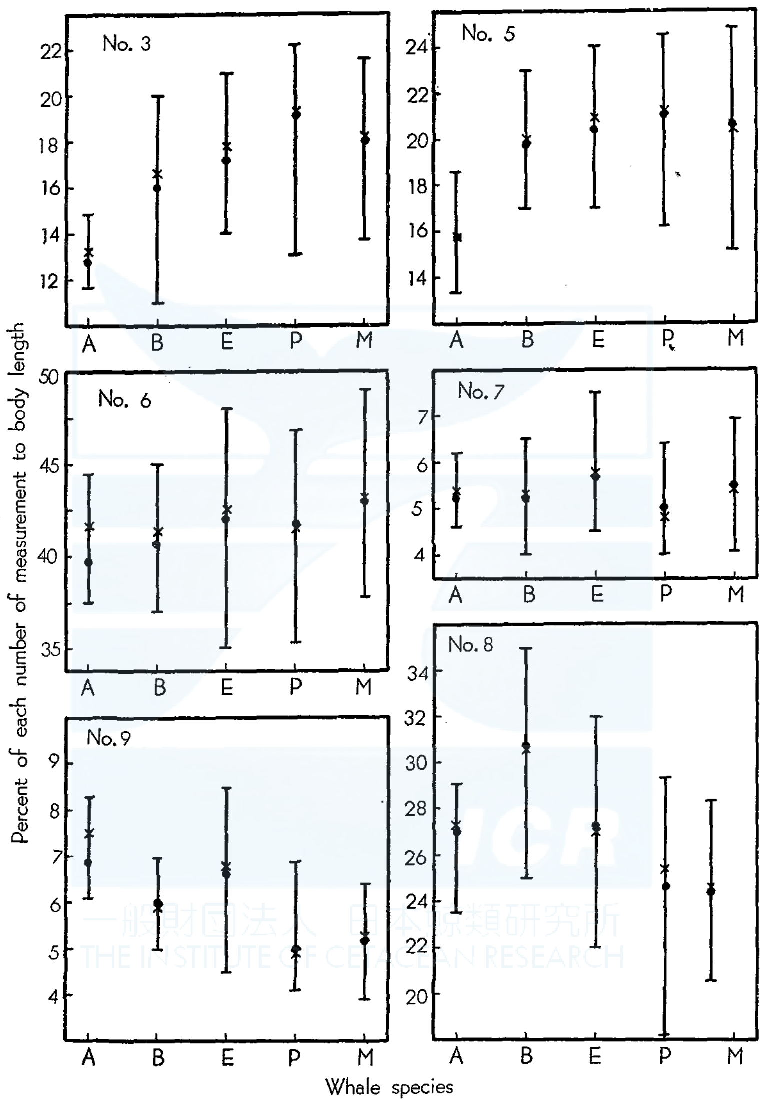



Fig. 14. Comparison of mean body proportions among the five species belonged to *Balaenoptera*.

|——|: range of proportion, Cross: mean proportion of female closed circle: mean proportion of male, A: *Balaenoptera acuto-rostrata* from coast of Japan, B: *B. borealis* from the Antarctic, E: *B. edeni* from Bonin Istands, P: *B. physalus* from the Antarctic, M: *B. musculus* from the Antarctic.

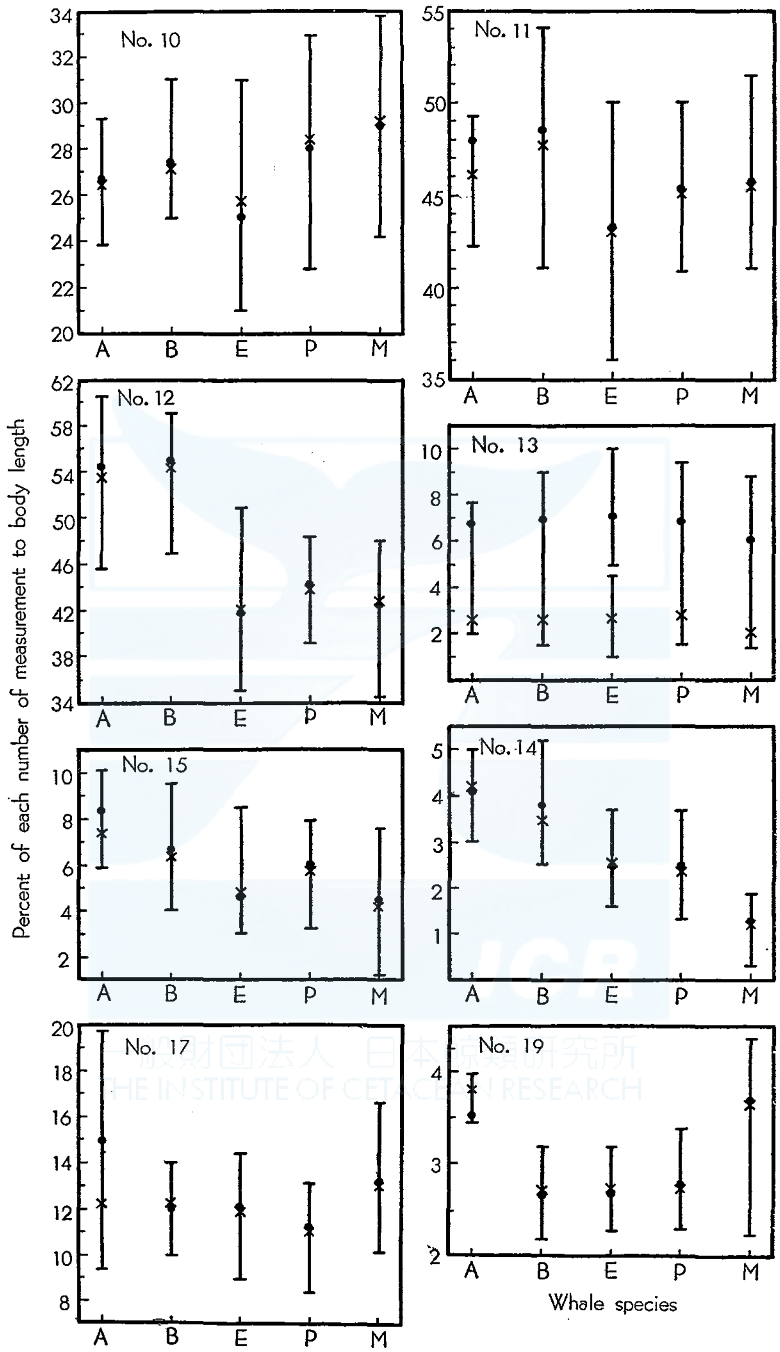

No. 10
No. 11
No. 12
No. 13
No. 14
No. 15
No. 17
No. 19
Percent of each number of measurement to body length
A B E P M
Whale species
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Fig. 14. (Cont.)

it is not so remarkable as the variation of proportion in the fin whale.

*No. 7.* It is almost constant among all species. The tendency resembles to that of the fin whale.

*No. 8.* Except that the proportion of *B. acuto-rostrata* is smaller than that of *B. borealis*. The tendency resembles the variation of the proportion in the fin whale.

*No. 9.* If the proportions of *B. borealis* and *B. edeni* are not exchanged, the difference of proportion resembles to the variation in the fin whale.

*No. 10.* It does not agree with the variation in the fin whale. Proportion of *B. edeni* is the smallest.

*No. 11.* Except *B. edeni*, smaller species seem to have larger proportions, but the tendency is not clear. Proportion value of *B. edeni* is the smallest.

*No. 12.* The tendency that the proportions of smaller species are larger than that of larger species, resembles to the variation of fin whales. But this measurement is classified clearly into two groups. *B. acuto-rostrata* and *B. borealis* are belonged to one group and *B. edeni*, *B. physalus*, *B. musculus* are belonged to another group.

*No. 13.* Proportions are different between males and females. And they are almost constant among the five species. This tendency resembles to the variation of the proportion as the increase of body length of the fin whale.

*No. 14.* The smaller the species is, the larger the proportion is. And this tendency agrees with the variation in the fin whale. But the tendency of the former is more remarkable than the latter.

*No. 15.* Excluding *B. edeni*, the tendency is the same as No. 14. Proportion value of *B. edeni* is relatively small.

*No. 17.* The proportion is constant in all body length after weaning. But there are differentiations in the proportions of five species.

*No. 19.* The proportion is almost constant in the fin whale after weaning. But this measurement is classified into two groups of species. The proportion of one group in which *B. acuto-rostrata* and *B. musculus* are included is larger than that of another group into which *B. borealis*, *B. edeni* and *B. physalus* are belonged.

By the above examination, it is found that the differences of body proportions among the five species belonged into *Balaenoptera* agree fairly with the variations of same proportions of the fin whale accompanying the growth in many parts.

But there are some parts which have different tendency from the variations of the proportion in the fin whale.

## COMPARISON OF THE RELATIVE GROWTH AMONG SIX SPECIES BELONGED TO *BALAENOPTERIDAE*

Range and mean value of the proportions were studied in the above paragraph. At that time the factor of body lengths is only represented by arranging the species in order of the body length at sexual maturity. And then *B. borealis* and *B. edeni* are exchanged each other.

Proportions should vary as the increase of body lengths, but this does not represented in above figure. Now, the relative growth will be more ideal for the purpose of comparison of the proportion in the same length.

Fig. 15 shows the relative growths between body length and the 14 measurements in the adult stage of six species belonged to *BALAENOPTERIDAE.*

*No. 3.* The relative growths of five species belong to *Balaenoptera* put all in order on almost one straight line. On the contrary, the relative growth of *Megaptera* is off the straight line of *Balaenoptera.*

*No. 5.* The same as No. 3.

*No. 6.* Five relative growths of the species belonged to *Balaenoptera* are all in a straight band and are different clearly from that of *Megaptera.* However, the allometry formulas of the five species are somewhat different each other.

*No. 7.* Although *Balaenoptera* species are different each other in allometry, they are included one straight band. The relative growth of *Megaptera* is little off the band.

*No. 8.* The relative growths of this measurement are different in each species. Those of *B. acuto-rostrata, B. edeni, B. physalus* and *B. musculus* are incruded almost in one straight band. But the relative growth of *B. borealis* is off the band, and agrees with that of *Megaptera.*

*No. 9.* *B. musculus, B. physalus* and *B. borealis* are included in one band, but only *B. edeni* is excluded off the band, and its allometry formula is very different from other species. *B. acuto-rostrata* is included almost on the above band, but the a-value of the allometry formula is larger than other species. *Megaptera* shows another allometry.

*No. 10.* Except the relative growth of *M. novaeangliae* all relative growths are included in one straight band, but the allometry formulas are different each other. The smaller species have larger $\alpha$-values.

*No. 11.* The six relative growths are divided into two straight band groups. That is to say, *B. musculus, B. physalus* and *B. borealis* are belonged to one group, and *B. edeni, B. acuto-rostrata* and *M. novaeangliae* are belonged to another group.

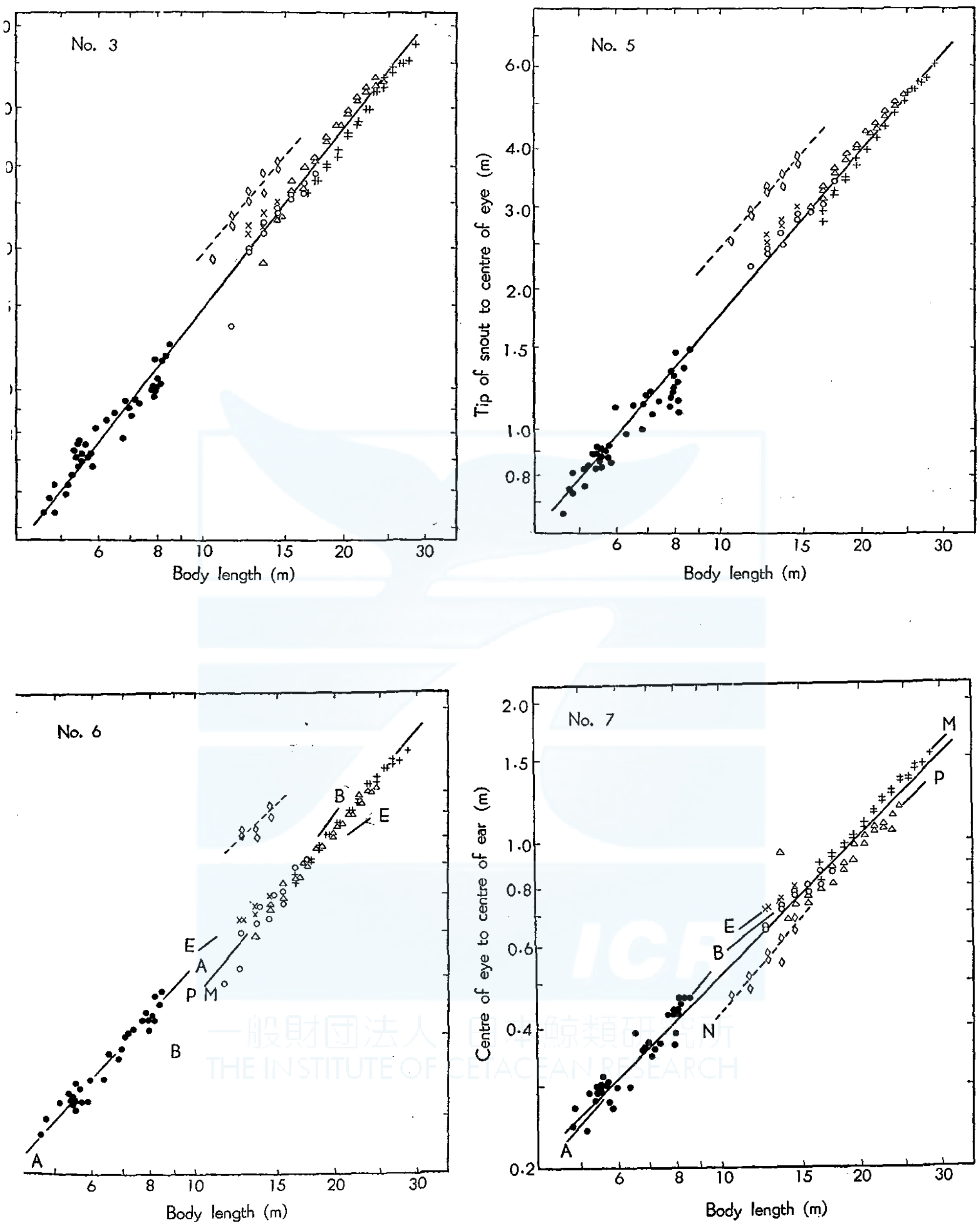


Fig. 15. Relative growths of the external measurements in the six species belonged to *Balaenopteridae*.

Closed circle: *Balaenoptera acuto-rostrata*, Open circle: *B. porealis*, Triangle: *B. physalus*, Cross: *B. musculus*, Inclined cross: *B. edeni*, Rhomb: *Megaptera novaeangliae*.

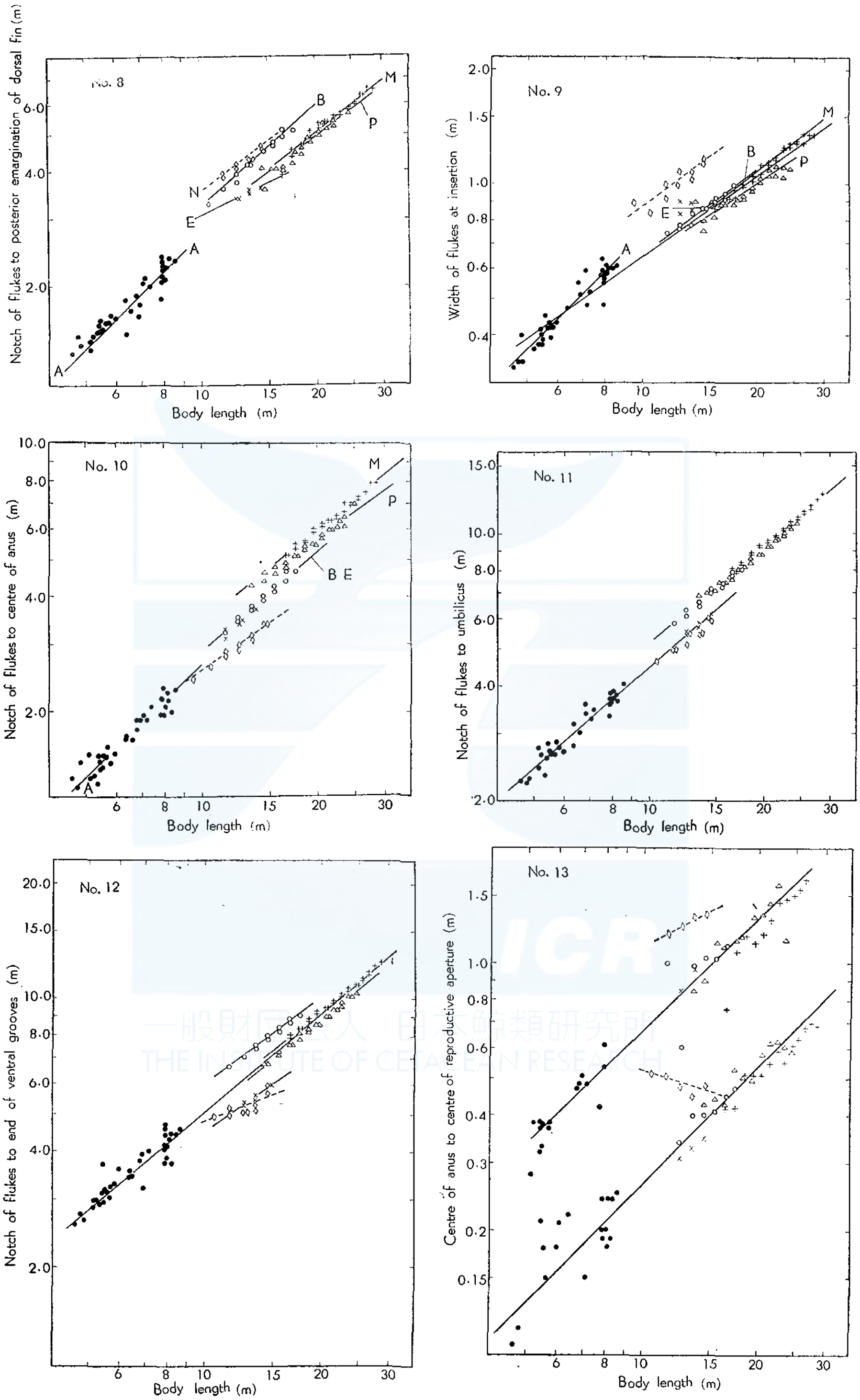
No. 8
Notch of flukes to posterior emargination of dorsal fin (m)
Body length (m)
A
E
N
B
M
P
No. 9
Width of flukes at insertion (m)
Body length (m)
A
E
B
M
P
No. 10
Notch of flukes to centre of anus (m)
Body length (m)
A
M
P
B E
No. 11
Notch of flukes to umbilicus (m)
Body length (m)
No. 12
Notch of flukes to end of ventral grooves (m)
Body length (m)
No. 13
Centre of anus to centre of reproductive aperture (m)
Body length (m)

Fig. 15. (Cont.)

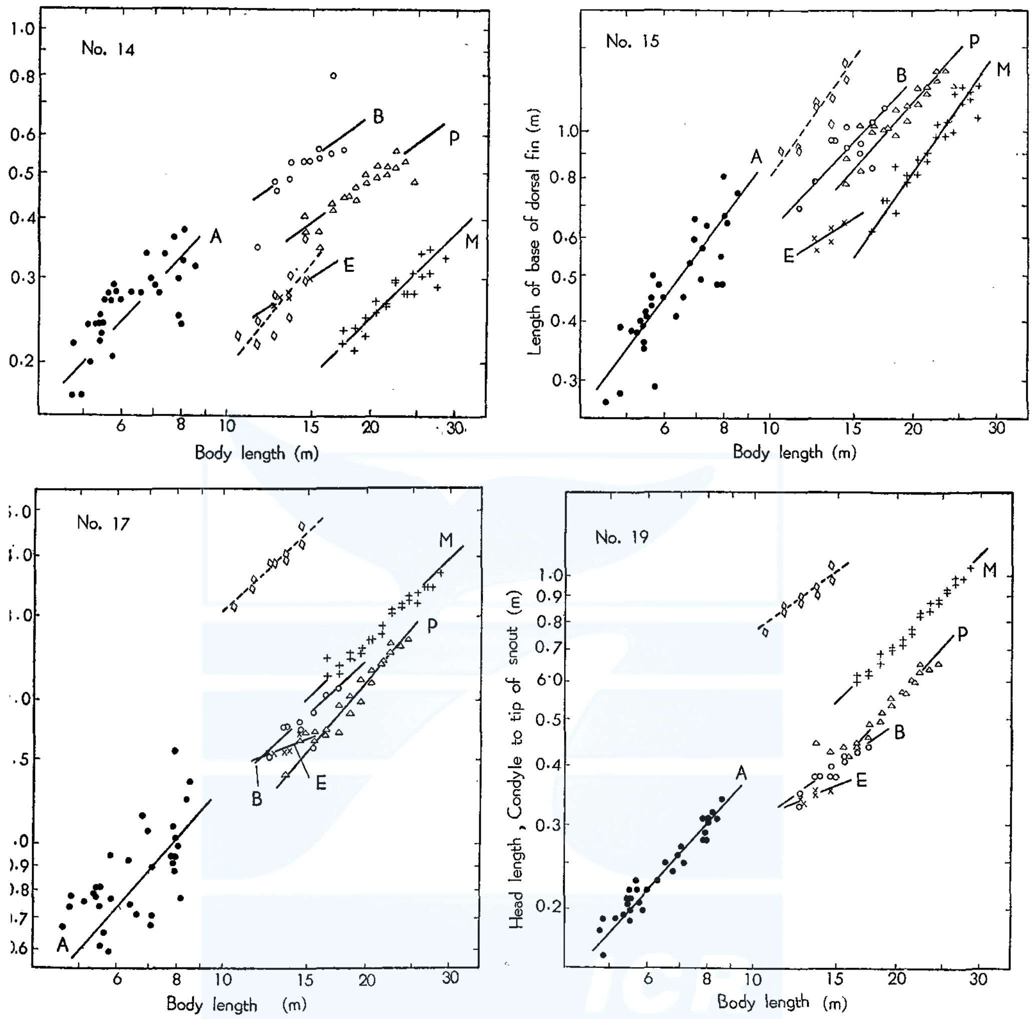


Fig. 15. (Cont.)



*No. 12*. *B. musculus*, *B. physalus* and *B. acuto-rostrata* is included in one straight band. *M. novaeangliae* and *B. edeni* compose almost one band, although they are different in the allometry formula.

*B. borealis* do not belong into any bands. Comparing the length of ventral grooves in the same body length, *B. edeni* will have the shortest grooves, and *M. novaeangliae* and *B. edeni* have the longest grooves in the six species.

*No. 13*. Although the relative growth of females is different from that of males in all species, those of both sexes in five *Balaenoptera* species are included into a straight band each other. On the contrary *M. novaeangliae* does not belong into any band. Especially, the $\alpha$-value of the allometry in females is less than 0 (Matthews, 1937). This means that the distance between anus and vagina becomes to shorten absolutely with the increase of body length.

*No. 14.* The relative growths are very different among the six species. But although *M. novaeangliae* and *B. edeni* is different in allometry formula, they are included into the almost one band.

Comparing the height of dorsal fin in the body length of 10 m, *B. borealis* is the heighest, and the height of dorsal fin becomes lower in order of *B. acuto-rostrata*, *B. physalus*, *B. edeni*, *M. novaeangliae* and *B. musculus*.

The smaller the whale species is, the larger $\alpha$-value of allometry formula seems to become.

*No. 15.* The relative growths are very different each other among the six species. Smaller species may have larger height and base of dorsal fin in the same body length. But only *B. edeni* has small base of dorsal fin and have small $\alpha$-value in the allometry formula in spite of small species.

*No. 17.* Five species are included into a relatively wide straight band. *B. musculus* has longer flipper than *B. physalus* in the same body length. *M. novaeangliae* is very different from the band of *Balaenoptera*, and has longer flipper.

*No. 19.* The relative growths of five species in *Balaenoptera* are divided into two groups. *B. musculus* and *B. acuto-rostrata* are included in one group, and *B. physalus*, *B. borealis* and *B. edeni* compose another group. However, although they are different in their allometry formulas, the former group has wider width than the latter in the same body length. The relative growth of *M. novaeangliae* is distant from the *Balaenoptera* groups, and *M. novaeangliae* has very wide flipper.

Summarizing the examination on the relative growths of *BALAENOPTERIDAE*, conclusion is as follows:

Excepted Nos. 8, 11, 12, 14 and 15, *Megaptera* shows different relative growth from those *Balaenoptera*. Therefore, the two genera are clearly separated by means of relative growth.

Next, in five species belong to *Balaenoptera*, the relative growths are classified as follows:

1. Measurements of which relative growths of all species are included in a relatively narrow straight band.

   Nos. 3, 5, 7 and 13.

2. Measurements of which relative growth of all species are included in a relatively wide straight band.

   Nos. 6, 9, 10 and 17.

3. Measurements of which relative growths of each species arrange scatteringly.

Nos. 8, 11, 12, 14, 15 and 19.

The first group is head portions and the distance between reproductive apparature and the anus. And it may be regarded that these measurements are strongly connected with genealogy.

The third group is concerned with the external portions of shape of dorsal fin, umblicus, length of ventral grooves and width of flipper. It may be considered that these measurements are related with the beheavior of each species. The second group is concerned with the length of flipper, and shape of flukes. The group shows a relatively wide band. And the second group is the middle between the first and the third group. This may mean that the measurements belonged to the second group is connected with the genealogy and mean while with the beheavior.

It is interesting that the relative growth of the portions concerning to the length of skull agree with each other, and those which are concerned with movement are scattering each other.

And it may be noticeable that the portions of *Megaptera* which are not so different from the allometry of *Balaenoptera* agree with the third group of *Balaenoptera* except No. 19.

## CONCLUSION

It may be needful for us to study the growth of whales not only as the function of time, but also as the function of the condition of growing system itself.

So I studied the variation of the external form of fin whales in the growing system from the body length of 10 cm by means of relative growth.

The result is as follows:

1. Sixteen external portions are newly measured for 243 fin whale foetuses from the Antarctic and the northern part of the North Pacific (Appendix I).

2. Drawing the relative growths between body length and other 15 measurements, between No. 14 and No. 15, between No. 17 and No. 19 and between No. 9 and No. 25 in the growing system from the body length of 10 cm until 2,500 cm for the Antarctic fin whales, I get one monophasic allometry (No. 1/No. 7), three diphasic allometry (No. 1/No. 11, No. 1/No. 12, No. 17/No. 19) four triphasic allometry (No. 1/No. 10, No. 1/No. 14, No. 1/No. 15, No. 14/No. 15), eight four-phasic allometry (No. 1/No. 3, No. 1/No. 5, No. 1/No. 6, No. 1/No. 8, No. 1/No. 9, No. 1/No.

17, No. 1/No. 25, No. 9/No. 25) and one five-phasic allometry (No. 1/No. 19).

The means that the external portions of fin whale do not grow in constant ratio throughout the life, and the growth ratios changes several times in general.

3. Except the measurement No. 13 (distance between anus and reproductive apparature), these is no sexual difference between males and females.

4. The differences of relative growths are not recognized between the Antarctic and the North Pacific fin whales at least in the foetal stage.

5. Critical points in the relative growths of the external characters are classified into six body length groups. That is to say, all critical points stand on the body lengths of 30 cm, 100–120 cm, 300 cm, 550–650 cm, 1100–1200 cm and 200–2100 cm. And the relative growths of fin whales over 10 cm long are classified into the five stages. The end of Ia-stage (30 cm) is the first stage of the development of body colour.

In 115 cm which is the body length at the end of I-stage, the ventral grooves develop as similar as those of adult. The end of IIa-stage (300 cm) is equal to the stage of absorption of rudimental teeth and completion of development of body colour.

From 300 cm till 650 cm is regarded as the IIb-stage in the relative growth of fin whales, and the end of this stage is equal to the time at birth. The sucking period is III-stage of the relative growth. There is a critical point at the body length of the time at weaning (1200 cm). The body lengths between 1200 cm and 2100 cm is regarded as IV-stage. The end of IV-stage (2100 cm) is equal to the time of maturity. Therefore, the variation of the allometry is related with the morphological and ecological variation in the life. And the critical points exist in the growing stages when the fin whale varies largely in its development or beheavior.

6. The range of $\alpha$-values in the allometry formulas is between 0.31 and 1.85. And most of $\alpha$-values included in the range between 0.81 and 1.20. $\alpha$-values are not constant throughout life, and the changes are classified into six types (116 p.).

7. In the foetal stage, the proportion of the anterior and posterior portion increase with the growth in body length tip of flipper spreads remarkably posteriorly. In the sucking stage, the anterior emagination of flukes shrinks posteriorly and the tip of flipper removes anteriorly. The other portions do not vary so remarkably. After weaning, all portions remove posteriorly, anterior parts relatively increase and posterior parts shows correspondingly decrease.

8. Difference of body proportions among the five species in *Balaenoptera* agree fairly with the variation of the proportions accompanying the growth of body length in many external parts. And this may mean that whales have the form adapted best to the body length at that time.

9. Except Nos. 8, 11, 12, 14 and 15, *Megaptera* shows different relative growth from those of *Balaenoptera*. The two genera are clearly separated by means of relative growth. In adult *Balaenoptera* species the head portions show almost same relative growth. However, the relative growth of Nos. 8, 11, 12, 14, 15 and 19 are different in the species each other.

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## APPENDIX I. MEASUREMENTS OF THE ANTARCTIC FIN WHALE FOETUSES

### A. FEMALES

| No. 1 | No. 3 | No. 5 | No. 6 | No. 7 | No. 8 | No. 9 | No. 10 | No. 11 | No. 12 | No. 13 | No. 14 | No. 15 | No. 17 | No. 19 | No. 25 | Serial No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 2.2 | 3.0 | 6.0 | 1.5 | 5.0 | 1.5 | 5.0 | 7.4 | none | 0.3 | 0.2 | 1.0 | 2.2 | 0.7 | 1.4 | 10T 1 |
| 15.2 | 1.7 | 2.9 | 6.6 | 1.0 | 4.0 | 1.4 | 4.45 | 6.6 | none | 0.55 | 0.66 | 1.1 | 1.85 | 0.6 | 0.45 | 12T 60 |
| 17.5 | 2.1 | 4.1 | 7.0 | 1.5 | 6.4 | 1.5 | 6.2 | 8.0 | none | 0.3 | 0.2 | 1.1 | 2.2 | 0.8 | 1.5 | 10T 154 |
| 35 | 3.8 | 5.3 | 12.0 | 2.8 | 9.5 | 2.8 | 11.0 | 16.0 | none | 0.6 | — | 1.7 | 4.3 | 1.2 | 3.2 | 10T 124 |
| 45.5 | 4.2 | 7.6 | 17 | 3.6 | 12.2 | 4.3 | 14.5 | 21.7 | none | 0.8 | 0.7 | 2.3 | 5.3 | 1.5 | 4.3 | 13T 589 |
| 48 | 5 | 8 | 20.5 | 3.5 | 13 | 4.5 | 14.5 | 23 | none | 1.0 | 0.7 | 2.0 | 4.6 | 1.7 | 4.2 | 13T 349 |
| 49 | 7 | 10 | 19 | — | 14.5 | 3.5 | 15 | 25 | none | 1.5 | 1.0 | 3.0 | 6.0 | 1.5 | 4.5 | 10N 331 |
| 50.5 | 6 | 8.6 | 20 | 3.1 | 14 | 4.7 | 16.2 | 24.5 | none | 1.3 | 0.8 | 2.3 | 6.3 | 1.7 | 4.2 | 13T 529 |
| 54.0 | 5.9 | 8.4 | 20.9 | 4.0 | 13.7 | 4.9 | 15.3 | 25.6 | none | 1.4 | 1.4 | 3.5 | 7.1 | 1.9 | 6.0 | 12N 201 |
| 73 | 8.8 | 12.8 | 31.0 | — | 18.1 | 6.1 | 22.1 | 34.6 | none | 1.1 | 1.6 | 3.2 | 9.4 | 2.4 | 7.5 | 12K 885 |
| 73 | 9.0 | 12 | 29 | — | 18 | 5.5 | 21 | 32 | — | 1.5 | 2.0 | 3.5 | 8 | 3 | 9.0 | 10N 101 |
| 75 | 11.0 | 13 | 31 | — | 21 | 5 | 24 | 38 | — | 2.0 | 2.0 | 4.0 | 9 | 3 | 7.0 | 10N 163 |
| 79 | 8.5 | 13 | 32.5 | 6.0 | 20 | 5.5 | 24 | 36 | — | 1.5 | 1.8 | — | 10 | 2.5 | 8.5 | 10T 952 |
| 83 | 10.3 | 14.5 | 35.5 | 6.1 | 20.5 | 7.2 | 25.5 | 38.5 | — | 1.5 | 2.1 | 4.0 | 11 | 2.6 | 8.6 | 13T 165 |
| 89.5 | 11.2 | 15.8 | 33.0 | 6.5 | 22.0 | 6.2 | 27.0 | 39.5 | — | 2.1 | 3.0 | 4.7 | 11.7 | 3.0 | 18.2 | 12K 458 |
| 91 | 11 | 17 | 39 | — | 24 | 7.5 | 29 | 46 | — | 2 | 2.8 | 4.5 | 11 | 3.6 | 10 | 13T 255 |
| 94.5 | 11.5 | 15 | 39 | — | 25.5 | 8.5 | 30 | 47 | — | 2 | 2.1 | 4.3 | 12 | 3.2 | 9.2 | 13T 351 |
| 96 | 14 | 19.5 | 39.5 | — | 25 | 6.0 | 28.5 | 45.5 | — | 2.5 | 2.5 | 4.0 | 11.5 | 3.2 | 10.7 | 10T 367 |
| 108 | 14.5 | 17.5 | 45 | 7.5 | 27.5 | 6.8 | 32.5 | 54.5 | 51 | 3.5 | 2.4 | 5.5 | 12.5 | 3.5 | 9.5 | 10T 97 |
| 110 | 14.5 | 18.5 | 45 | 7.5 | 28 | 9.5 | 34 | 51 | — | 2.5 | — | 4.0 | 13.5 | 3.5 | 10.0 | 13T 198 |
| 116 | 16.5 | 20.0 | 48.5 | 7.7 | 30.5 | 10 | 34 | 52 | — | 3.0 | 2.9 | 5.7 | 16 | 3.7 | 12.5 | 13T 22 |
| 121 | 18 | 21.5 | 53 | — | 31 | 11 | 35 | 55 | 55 | 2.0 | 3.6 | 6.0 | 15.5 | 4.0 | 13.5 | 13T 156 |
| 127 | 16.5 | 20.5 | 51.0 | 8.0 | 34 | 8.5 | 39 | 61.5 | 62 | 3.5 | 3.3 | 6.5 | — | 4.3 | 14 | 10T 1438 |
| 129 | 21 | 25 | 52 | 9 | 32 | 10 | 42 | 62 | — | 4 | 4 | 7 | — | 4.5 | 14 | 10N 288 |
| 132 | 19.5 | 22 | 55 | 9.5 | 34 | 11.5 | 40 | 60 | 60 | 2.0 | 3.4 | 6.5 | 18 | 4.5 | 16 | 13T 134 |
| 137 | 24 | 28 | 56 | 10 | 36 | 11 | 41 | 64 | — | 3 | 5 | 8 | 19 | 5.5 | 15 | 10N 137 |
| 150 | 23.5 | 27.0 | 65 | 9.5 | 35.5 | 9.5 | 45 | 68.5 | 75.0 | 4.5 | 3.5 | — | 19.0 | 5 | 19 | 10T 93 |
| 153 | 25 | 30 | 68 | 9.5 | 42 | 14 | 49 | 76 | 76 | 3.0 | 3.7 | 8.0 | 19.5 | 4.7 | 16 | 13T 133 |
| 159 | 24 | 29 | 69 | 10 | 37 | 12.5 | 42 | 70 | 68 | 4.0 | 5.5 | 8.5 | 22 | 5.5 | 19 | 13T 13 |
| 160 | 29 | 34 | 77 | 10.5 | 43 | 11.5 | 53 | 84.5 | — | 4 | 6 | — | 23.5 | 6.5 | 22.5 | 10T 243 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 166 | 25 | 29 | 72 | — | 40 | 15 | 50 | 77 | 75 | 4 | 4.9 | 9.0 | 23 | 6.0 | 20 | 13T | 129 |
| 167 | 24 | 30 | 70 | 10.5 | 44 | 14.5 | 51.5 | 78 | 79 | 3.5 | 5.2 | 9.5 | 22.5 | 6.0 | 20 | 13T | 40 |
| 172 | 24 | 29 | 73 | 11 | 46 | 15 | 51 | 79 | 81 | 5 | 4.3 | 10 | 25 | 6.2 | 21 | 13T | 969 |
| 177 | 24.5 | 29.5 | 73 | 11 | 45 | 15 | 54 | 82 | 82 | 3 | 4.2 | 8.2 | 25 | 6.0 | 22 | 13T | 183 |
| 185 | 28 | 35 | 78 | 11 | 48 | 14 | 57 | 90 | — | 3 | 6 | — | 25 | 7 | 24 | 10N | 290 |
| 206 | 33 | 42.5 | 92.5 | 13.5 | 49 | 14 | 69 | 104.5 | 99 | 5.0 | 6.5 | 11.5 | 25.0 | 6.8 | 27 | 10T | 368 |
| 210 | 30 | 35.5 | 84.5 | 13 | 52 | 13 | 69 | 103 | 100 | 5.0 | 5.5 | 12 | 24.5 | 6.3 | 29 | 10T | 535 |
| 211 | 32 | 41 | 82 | — | 57 | 16 | 65 | 98 | — | 7 | 6 | 12 | — | 6.5 | 26 | 10N | 236 |
| 215 | 34 | 37 | 93 | 13 | 55 | 18 | 64 | 102 | 105 | 3 | 6 | 11 | 32 | 7.2 | 27 | 13T | 587 |
| 222 | 30 | 37 | 104 | 15 | 62 | 18 | 71 | 108 | 102 | 5 | 8 | 12 | 31.5 | 7.8 | 29 | 13T | 8 |
| 222 | 31 | 40 | 93 | — | — | 16 | 70 | 104 | — | 7 | — | — | 27 | 7.5 | 26 | 10N | 144 |
| 226 | 33 | 37 | 92 | — | 59 | 19 | 71 | 107 | 108 | 4 | 6.5 | 12 | 31 | 7.7 | 32.5 | 13T | 44 |
| 227 | 32.5 | 41 | 97 | 14 | — | 14 | 67 | 109 | 104 | 6.5 | 6.0 | 11 | 27.5 | 7.5 | 26.5 | 10T | 307 |
| 262 | 41 | 47 | 106 | 15.5 | 66 | 19.5 | 79 | 122 | 122 | 7 | 7.5 | 15.5 | — | 8.8 | 32 | 13T | 101 |
| 262 | 40 | 45 | 114 | 16 | 65 | 21 | 80 | 117 | 113 | 6 | — | 15 | 37 | 10.5 | 31 | 13T | 554 |
| 268 | 42 | 47 | 111 | 16 | 69 | 21 | 80 | 123 | 119 | 6 | 9.5 | 16 | 36 | 9.2 | 35 | 13T | 1028 |
| 273 | 38 | 45 | 113 | 16 | 80 | 21 | 84 | 128 | — | 9 | 7 | 14 | — | — | — | 10N | 299 |
| 282 | 38 | 49 | 114 | — | 68 | 22 | 84 | 130 | 125 | 7 | 9.5 | 18 | 39.5 | 10 | 37 | 13T | 184 |
| 288 | 48 | 57 | 113 | 18.5 | 74 | 19 | 88 | 131.5 | 128.5 | 8.0 | 7 | 14 | 41.5 | 9.5 | — | 10T | 171 |
| 294 | 53 | 68 | 160 | 21.5 | 91 | 23 | 111 | 176 | 169 | — | 12 | 22 | 51.5 | 12.5 | 47.5 | 13T | 327 |
| 305 | 53.5 | 63 | 149 | 20 | 73.5 | 24 | 96.5 | 150.5 | 145 | 8 | 9.5 | 19 | 48.5 | 12.5 | 44 | 10T | 293 |
| 307 | 45 | 55 | 129 | 17 | 83 | 24 | 97 | 149 | 149 | 13 | 10.2 | 18 | 44 | 10.5 | 41 | 13T | 1337 |
| 307 | 47 | 58 | — | — | 80 | 23 | 95 | 145 | — | 10 | 9 | 17 | — | — | 40 | 10N | 239 |
| 318 | 47 | 57 | 141 | 19 | 81 | 28 | 99 | 153 | 145 | 8 | 12 | 23 | 50 | 11.5 | 41 | 13T | 220 |
| 320 | 49 | 55 | 138 | — | 90 | 26 | 100 | 150 | — | 10 | 13 | 18 | 44 | 12 | 36 | 10N | 166 |
| 322 | 50 | 58 | 141 | 17.5 | 88 | 26 | 99 | 157 | 162 | 12 | 10 | 17 | 48 | 10.7 | 38 | 13T | 353 |
| 361 | 54 | 61 | 149 | 22 | 97 | 31 | 115 | 175 | 171 | 11 | 13 | 22 | 50 | 13 | 44 | 13T | 517 |
| 375 | 53 | 68 | 160 | 21.5 | 91 | 23 | 111 | 176 | 169 | — | 12 | 22 | 51.5 | 12.5 | 47.5 | 10T | 465 |
| 393 | 55 | 63 | 161 | 33 | 96 | 25 | 128 | 193 | — | 10 | 13 | 27 | 56 | 14 | 50 | 10T | 341 |
| 427 | 66 | 76 | 190 | 24 | 112 | 37 | 134 | 204 | 204 | 15 | 14.5 | 30 | 64 | 15 | 55 | 13T | 1454 |
| 431 | 69 | 73 | 180 | 25 | 121 | 37 | 145 | 213 | 204 | 15 | 14 | 26 | 62 | 14.5 | 54 | 13T | 531 |
| 435 | 66 | 76 | 182 | 23.5 | 104 | 25 | 137 | 207 | 210 | 14 | 9.5 | 24 | 60 | 15 | 54.5 | 10T | 840 |
| 441 | 71 | 80 | 192 | 26 | 124 | 36 | 150 | 226 | 225 | 16 | 12 | 28 | 70 | 15 | 57.5 | 13T | 750 |
| 447 | 64 | 76 | 186 | 26 | 118 | 34 | 140 | 213 | 207 | — | 13 | 31 | 43 | 15.5 | 55 | 13T | 1392 |
| 488 | 78 | 90 | 218 | 28 | 130 | 43 | 164 | 249 | 240 | 14 | 15 | 34 | 74 | 16.5 | 56 | 13T | 1551 |
| 495 | 72 | 90 | 216 | 27 | 139 | 42 | 168 | 255 | 247 | 14 | 17 | 34 | 81 | 18 | 55 | 13T | 1513 |
| 527 | 87 | 99 | 232 | 28 | 132 | 45 | 166 | 252 | 243 | 15 | 20.5 | 32 | 87 | 19 | 63 | 13T | 1486 |

## APPENDIX I. MEASUREMENTS OF THE ANTARCTIC FIN WHALE FOETUSES

### B. MALES

| No. 1 | No. 3 | No. 5 | No. 6 | No. 7 | No. 8 | No. 9 | No. 10 | No. 11 | No. 12 | No. 13 | No. 14 | No. 15 | No. 17 | No. 19 | No. 25 | Serial No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12.0 | 1.1 | 1.65 | 4.7 | 0.9 | 3.2 | 1.3 | 3.4 | 5.1 | none | 0.65 | none | 0.7 | 1.5 | 0.5 | 0.3 | 11T 87 |
| 24.7 | 2.1 | 4.5 | 8.8 | 1.8 | 6.3 | 2.5 | 7.2 | 11.8 | none | 1.8 | 0.4 | 1.8 | 3.5 | 1.0 | 2.0 | 12T 355 |
| 34 | 4.5 | 6.5 | 14 | — | 10 | 3.0 | 10.5 | 16.5 | none | 2.5 | 1.0 | 2.5 | 4.0 | 1.0 | 3.0 | 10N 240 |
| 34 | 4.1 | 6.7 | 13.8 | 2.1 | 7.8 | 3.0 | 9.4 | 15.2 | none | 2.3 | 0.5 | 2.0 | 5.0 | 1.2 | 2.8 | 13T 9 |
| 42 | 5.9 | 7.5 | 16 | 3.5 | 11.3 | 3.2 | 11.8 | 18.1 | none | 2.9 | 0.8 | 2.2 | 5.3 | 1.4 | 3.9 | 10T 100 |
| 50 | 6.0 | 8.5 | 19 | — | 14 | 4.5 | 15 | 24 | none | 3.0 | 1.0 | 2.5 | 6.0 | 2.0 | 5.0 | 10N 293 |
| 58.0 | 6.3 | 8.9 | 23.6 | 4.3 | — | 5.1 | 16.8 | 26.4 | none | 4.3 | 1.5 | 3.5 | 7.8 | 2.2 | 6.2 | 12N 164 |
| 61 | 6.5 | 10 | 24 | 4.2 | 17.2 | 6.1 | 19 | 30 | none | 4 | 1.4 | 3.4 | 7.4 | 1.9 | 6.0 | 13T 318 |
| 61 | 8 | 11 | — | 3 | 17.8 | 5.2 | 20.3 | 29 | none | — | 1.3 | 3 | 8 | 2.3 | 7.5 | 10T 410 |
| 63 | 8.0 | 10 | 25 | — | 16 | 4.5 | 20 | 29 | none | 4.0 | 1.0 | 3.0 | 7.0 | 2.5 | 6.0 | 10N 1132 |
| 64 | 8.0 | 9 | 25 | — | 19 | 5.0 | 21 | 32 | none | 4.5 | 1.5 | 3 | 8 | 2.0 | 6.5 | 10N 54 |
| 69.3 | 8.0 | 10.2 | 26.5 | 4.7 | 19.7 | 5.5 | 21.8 | 34.1 | none | 4.0 | 1.6 | 3.6 | 9.0 | 3.1 | 6.4 | 12N 1335 |
| 71 | 6.5 | 11.5 | 27 | 4.5 | 18 | 4.8 | 22 | 33.5 | none | — | 1.3 | 2.5 | 8.0 | 2.5 | 7 | 10T 1387 |
| 72 | 8 | 10.5 | 28 | 5 | 20 | 4.7 | 22.5 | 34 | none | 4.5 | 1.4 | 3.0 | 8.5 | 2.5 | 6.8 | 10T 1438 |
| 77 | — | — | — | — | 21 | 7.8 | — | — | none | — | — | — | — | — | 8.5 | 13T 387 |
| 79 | 11 | 14 | 33 | — | 20 | 5.0 | 24 | 36 | none | 5.0 | 2 | 4 | 9 | 2.8 | 8 | 10T 330 |
| 88 | 11 | 15 | 34 | — | 24 | 6.0 | 26 | 42 | — | 6.5 | 2.0 | 5.0 | 10.5 | 3.0 | 8.0 | 10N 957 |
| 91.5 | — | 16.5 | 35.5 | 5.1 | 25.0 | 7.0 | 27.0 | 43 | 40.5 | 6.5 | 2.5 | — | 12.0 | 3.2 | 9.0 | 10T 16 |
| 97 | 14 | 16 | 38 | 6.0 | 25.5 | 7.0 | 31 | 47 | — | 6.0 | 3.0 | 4.5 | — | 3.0 | — | 10N 516 |
| 97 | 14 | 17.5 | 40 | — | 24 | 8.0 | 29 | 46 | — | 7 | 2.5 | 4.3 | 13 | 3.4 | 10.3 | 13T 67 |
| 99 | 13.5 | 16.5 | 39 | 7.3 | 24.5 | 7.0 | 29 | 48 | 50 | 6.5 | 2.0 | 5.0 | 11.5 | 3.5 | 9.5 | 10T 316 |
| 102 | 12 | 17 | 43 | 7 | 26 | 9.0 | 31.5 | 50 | 52 | 7.5 | 3.0 | 4.5 | 13.5 | 3.5 | 11.0 | 13T 4 |
| 107 | 13 | 17 | 39.5 | 7 | 28 | 7.5 | 31 | 51 | — | 7.5 | 2.5 | 5 | — | 3.5 | 11.5 | 10T 240 |
| 109 | 14 | 18 | 46 | 7.5 | 26 | 9 | 33 | 49 | — | 6 | 2.8 | 5.3 | 15 | 3.4 | 11.5 | 13T 610 |
| 116 | 14 | 18.5 | 48 | 5.8 | 38.1 | 11 | 34 | 65 | 64 | 7 | 3.2 | 6.0 | 15.5 | 3.5 | 12.5 | 13T 124 |
| 118 | 14.5 | 21 | 51 | 8.5 | 30 | 11 | 36 | 57 | 61 | 8 | 3.2 | 6.0 | 16.5 | 4.1 | 14 | 13T 23 |
| 138 | 19 | 24 | 56 | 8.5 | 34 | 9.5 | 44.5 | 70.5 | — | 10.5 | — | — | 16.5 | 4.5 | 15.5 | 10T 369 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 145 | 20.5 | 25.0 | 62 | 10.5 | 39 | 10 | 42.5 | 69.5 | 73 | 10.5 | 5 | 7.5 | 18 | 5 | 15.5 | 10T | 130 |
| 150 | 20 | 26 | 65 | 10.5 | 38 | 14 | 46 | 69 | 69 | 10 | 4.5 | 8 | 21 | 5 | 18 | 13T | 77 |
| 155 | 21 | 27 | 67 | 11 | 38 | 12 | 46 | 72 | 69 | 11 | 3.5 | 7.5 | 15.5 | 5.5 | 17 | 13T | 585 |
| 164 | 25 | 31.5 | 72 | 11.5 | 38.5 | 11 | 48 | 75 | 82 | 12 | 5.5 | 9 | 20 | 5.5 | 19 | 10T | 165 |
| 167 | 23 | 29 | 70 | 12 | 39.5 | 12 | 49 | 80 | 80 | 11 | 4.2 | 8 | 22 | 5.5 | 14 | 13T | 553 |
| 176 | 28 | 32 | 78 | 10 | 45 | 14 | 52 | 84 | — | 14 | 5.5 | 9 | 26 | 5.5 | 20 | 10N | 508 |
| 188 | 28 | 34.5 | 75 | 12.5 | 41 | 12 | 54.5 | 85 | 89 | 13 | 5.5 | 10 | 24 | 6 | 22 | 10T | 188 |
| 192 | 30 | 39 | 83 | 12 | 53 | 15 | 55 | 85 | — | 12 | 7 | — | 28 | 8 | 25 | 10N | 333 |
| 196 | 25.5 | 32.5 | 83 | 12.5 | 45.5 | 13 | 58 | 92.5 | 94 | 15 | 5.5 | 11.0 | 24.5 | 6 | 16 | 10T | 1177 |
| 208 | 27 | 36 | 90 | 13 | 50 | 16 | 57 | 96 | 94 | 13 | 5.0 | 10 | — | 6.5 | 22 | 13T | 76 |
| 212 | 31 | 36 | 86 | 13 | 52 | 17 | 64.5 | 99 | 102 | 145 | 5.5 | 12 | 29.5 | 6.8 | 22 | 13T | 312 |
| 219 | 29 | 36 | 89 | 13 | 57 | 17 | 65 | 104 | 100 | 16 | 5.5 | 12 | 30 | 7.8 | 28 | 13T | 400 |
| 239 | 36 | 45 | 106 | 13.5 | 65 | 21 | 76 | 107 | 102 | 18 | 7.5 | 13.5 | 34 | 7.9 | 32 | 13T | 160 |
| 255 | 42 | 45 | 107 | 15 | 64 | 21 | 78 | 120 | 120 | 17 | 8 | 14 | 38 | 9.5 | 33 | 13T | 10 |
| 265 | 40 | 46 | 113 | 18 | 74 | 25 | 86 | 130 | — | 19 | 8.7 | 12 | 38 | 9 | 32 | 13T | 1208 |
| 271 | 37 | 54 | 120 | 15 | 66 | — | 79 | 124 | — | 19 | 10 | 15 | 35 | 8 | — | 10N | 391 |
| 282 | 42 | 50 | 119 | — | 70 | 24 | 90 | 138 | 144 | 19 | 7.5 | 16 | 41 | 9.5 | 34 | 13T | 1 |
| 295 | 47 | 58 | 136 | 18 | 76 | 22 | 98 | 144 | 139 | 20 | 10 | 21 | 44 | 11 | 43 | 10T | 99 |
| 297 | 55 | 47 | 127 | 16.5 | 78 | 28 | 84 | 141 | 136 | 20 | 8 | 16 | 39 | 10.2 | 36 | 13T | 154 |
| 315 | 46 | 59 | 136 | 18 | 82 | 22.5 | 100 | 170 | 166 | 23 | 10.5 | 16 | 40 | 11.5 | 36.5 | 10T | 313 |
| 345 | 55 | 67 | 155 | 30 | 89 | 22.5 | 107 | 160 | 170 | 23 | 12 | 22 | 48 | 12.5 | 42 | 10T | 99 |
| 354 | 59 | 66 | 147 | 21 | 90 | 31 | 110 | 165 | 162 | 22 | 11 | 20 | 51 | 12 | 43 | 13T | 169 |
| 358 | 57 | 66 | 154 | 21 | 88 | 30 | 122 | 167 | 172 | 20 | 12.5 | 23 | 49 | 11.5 | 42 | 13T | 1057 |
| 361 | 56 | 68 | 151 | 21 | 92 | 31 | 120 | 175 | 170 | 22 | 10.5 | 24 | 51 | 12 | 44 | 13T | 395 |
| 370 | 56 | 63 | 155.5 | 21 | 100 | 24 | 123 | 183 | 174 | 22.5 | — | 23.5 | — | — | 39 | 10T | 273 |
| 377 | 57 | 69 | 176 | 23 | 95 | 31 | 102 | 187 | 185 | 24 | 13 | 22 | 61 | 13 | 43 | 13T | 856 |
| 400 | 57 | 70 | 165 | 21 | 110 | — | 115 | 180 | — | 30 | 9 | 24 | 55 | 15 | — | 10N | 335 |
| 402 | 49 | 68 | 162 | — | — | 26 | 125 | 187 | — | 32 | — | — | — | 14 | 48 | 10T | 480 |
| 420 | 64 | 80 | 180 | 22 | 113 | 36 | 137 | 208 | 206 | 30 | 12 | 27 | 65 | 14.5 | 44 | 13T | 1530 |
| 485 | 68 | 79 | 215 | 29 | 121 | 46 | 159 | 237 | 232 | 35 | 13.5 | 30 | 74 | 17.5 | 55 | 13T | 1400 |
| 504 | 71 | 96 | 210 | — | 117 | 34 | 170 | 255 | 252 | 40 | 16.5 | — | 77 | 18 | 73 | 10T | 1484 |

APPENDIX II. MEASUREMENTS OF THE NORTHERN PACIFIC FIN WHALE FOETUSES

A. FEMALES

| No. 1 | No. 3 | No. 5 | No. 6 | No. 7 | No. 8 | No. 9 | No. 10 | No. 11 | No. 12 | No. 13 | No. 14 | No. 15 | No. 17 | No. 19 | No. 25 | Serial No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17.9 | 1.8 | 2.8 | 7.0 | 1.5 | 4.9 | 1.8 | 5.5 | 8.3 | none | 0.48 | 0.14 | 1.1 | 2.5 | 0.80 | 1.3 | 56Ky 516 |
| 18.3 | 2.1 | 3.1 | 8.0 | 1.4 | 4.4 | 1.6 | 5.3 | 8.0 | none | 0.3 | 0.2 | 1.1 | 2.4 | 0.8 | 0.95 | 54K 516 |
| 19.6 | 2.1 | 3.0 | 7.8 | 1.3 | 5.3 | 1.8 | 6.6 | 8.6 | none | 0.7 | 0.15 | 1.0 | 2.4 | 0.7 | 0.8 | 59Ky 27 |
| 32.3 | 3.0 | 4.5 | 12.7 | — | 8.8 | — | 10.2 | 15.3 | none | 1.1 | 0.6 | 2.0 | — | — | — | 54K 611 |
| 35.7 | 3.6 | 6.0 | 9.9 | 2.8 | 9.7 | 2.9 | 12.0 | 17.4 | none | 0.65 | 0.5 | 1.9 | 4.5 | 1.3 | 2.7 | 59Ky 89 |
| 52.5 | 6 | 8.5 | 21 | 4 | 13 | 4.5 | 15.5 | 25.5 | — | 1.5 | 1.0 | 2.5 | 6 | 1.7 | 5.2 | 54K 391 |
| 56 | 7.7 | 9.5 | 23.5 | — | 14 | — | 18 | 27 | none | 1 | 1.6 | 3 | 6.5 | 2.3 | — | 54B 153 |
| 67.5 | 7.8 | 11.5 | 28.5 | 4.8 | 16.5 | — | 22.3 | 32.0 | none | 1.8 | 1.5 | 3.5 | 8.0 | 2.3 | — | 57Ky 688 |
| 77 | 10 | 13.5 | 31 | — | 20.5 | — | 24.5 | 38 | none | 2 | 1.8 | 4 | 11 | 2.7 | — | 55Ky 4 |
| 80 | 11 | 14 | 32 | — | 21 | — | 26 | 40 | none | 2 | 1.5 | 5 | 9.5 | 2.8 | — | 54B 38 |
| 88 | 10 | 14.5 | 36 | 6 | 21 | — | 26 | 41 | — | 2 | 2.0 | 4 | 11.5 | 3.0 | — | 54K 899 |
| 90 | 14 | 16.5 | 36 | 7 | 24 | — | 29 | 45 | none | 2.5 | 2.5 | 4 | 13 | 3.5 | — | 54K 30 |
| 93 | 11 | 15 | 37.5 | 6.5 | 24 | 8 | 29.5 | 45 | — | 2 | 2.0 | 4.5 | 13 | 3 | 10 | 54K 602 |
| 94 | 12.0 | 16.5 | 39.0 | 6.5 | 25 | — | 30 | 46 | — | 3.0 | 2.0 | 3.8 | 13.5 | 4 | 10.5 | 54K 132 |
| 102 | 15 | 19 | 45 | 7 | 26 | 9.5 | 31 | 49 | — | 2.0 | 3.0 | 5.0 | 15 | 3.5 | 12 | 54K 600 |
| 104 | 17.5 | 21 | 48 | 8 | 28 | — | 34 | 54 | — | 3 | 6.5 | 6 | 16 | 4 | — | 54K 145 |
| 106 | 15 | 19 | 43 | 7 | 28 | — | 33 | 49 | — | 2.5 | 2.0 | 5.0 | 13.5 | 3.5 | — | 54K 455 |
| 115 | 16.0 | 21.5 | 51 | 8.5 | 27.5 | — | 32.5 | 50.0 | 50.0 | 3.0 | 3.4 | 5.5 | 15.0 | 3.7 | 13.5 | 54K 322 |
| 119 | 17.5 | 21.5 | 52.0 | 8.5 | 27.3 | — | 37.0 | 58.0 | 63.0 | 4.3 | — | 7.0 | 16.5 | 4.0 | — | 57K 580 |
| 126 | 18 | 21 | 50 | 8 | 31 | — | 40 | 61 | 65 | 3.5 | 3.5 | 5.5 | 15 | 4.7 | — | 54K 7 |
| 128 | 18 | 22 | 51 | 9 | 32 | — | 39 | 62 | — | 3.5 | 4.0 | 7.0 | 18.0 | 4.0 | 14.0 | 54K 139 |
| 129 | 19 | 23.5 | 54 | — | 33 | — | 40 | 62 | 64 | 2 | 2.9 | 4.8 | 16 | 4.5 | — | 54B 167 |
| 131 | 20 | 25 | 56 | 9 | 35 | — | 39 | 60 | 57 | 3.5 | 3 | 6 | 18 | 4.5 | — | 54K 348 |
| 136 | 18 | 28.5 | 57 | 9 | 39 | — | 43 | 66 | 66 | 4.0 | 3.5 | 5.5 | 18 | 4.5 | — | 54K 29 |
| 137.5 | 20 | 23 | 58 | 9.5 | 36 | — | 43 | 61 | 65 | 2.5 | 4.0 | 6.5 | — | — | — | 56Ky 442 |
| 139 | 18 | 22 | 59.5 | 9.0 | 38 | — | 46 | 71 | 68 | 3.5 | 4.5 | 5.5 | 16.5 | 4.5 | 18 | 54K 471 |
| 144 | 18 | 25.5 | 62 | 9.5 | 36 | 12 | 42.5 | 65 | 70 | 4.5 | 4.5 | 7 | 19 | 5.3 | 19 | 54K 907 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 144 | 20 | 27 | 63 | 10 | 39 | 14 | 43 | 68 | 68 | 5 | 4.0 | 6.0 | 21 | 5 | 16 | 54K | 372 |
| 148 | 19 | 27 | 65 | 10.5 | 38.5 | 12.5 | 46 | 72 | 72 | 4.5 | 3.5 | 6 | 18 | 5 | 16 | 54K | 911 |
| 151 | 21 | 27 | 66 | 9.0 | 35.5 | — | 44 | 70 | 70 | 5.0 | 4.3 | 8.0 | 22 | 5.4 | 17 | 54K | 130 |
| 152 | 21 | 27 | 62 | 10.5 | 35.5 | — | 46 | 70.5 | 70.5 | 4 | 4.0 | 8.0 | — | — | — | 54K | 52 |
| 156 | 21 | 27 | 77 | — | 37 | 13 | 46 | 73 | 72 | — | 5.0 | 10 | 24 | 5.5 | 18 | 54K | 487 |
| 157 | 25 | 29 | 70 | 11.5 | 37 | — | 48 | 71 | — | 4 | 3.5 | 8 | — | — | — | 54K | 478 |
| 158 | 22.5 | 27 | 65 | 10.5 | 40.5 | — | 44.5 | 70 | 70 | 4.5 | 3.5 | 6.5 | 22 | 5.0 | — | 54K | 129 |
| 158 | 23 | 29 | 69 | 10 | 38 | 14 | 47 | 74 | 71 | 4 | 4.5 | 7.5 | 23 | 5.5 | 20 | 54K | 757 |
| 160 | 20 | 26 | 67 | 10.5 | 41 | 13 | 47 | 73 | 71 | 4.5 | 3.0 | 7.0 | — | — | 18 | 54K | 923 |
| 168 | 26 | 31 | 76 | 11.0 | 44 | — | 49 | 81 | 77 | 5 | 3.5 | 8.0 | 24.5 | 6.3 | 22 | 54K | 386 |
| 169 | 24 | 29 | 70 | 11.0 | 44 | — | 52.0 | 79.0 | 76 | 4.5 | 4.5 | 8.5 | 21.0 | 5.9 | 23 | 54K | 382 |
| 171 | 25 | 31 | 71 | 10.5 | 46 | 14.5 | 52 | 80.5 | 77 | 5.0 | 6.5 | 9.0 | 21 | 6.5 | 24.5 | 54K | 627 |
| 176 | 28 | 34 | 77 | 10.0 | 45 | — | 55 | 86 | 82 | 4.5 | 5.0 | 9.5 | 23 | 6.0 | 20.0 | 54K | 344 |
| 179 | 29 | 35 | 77 | — | 46 | — | 54 | 85 | 85 | 5 | 6.0 | 8.5 | 22 | 6.2 | — | 54B | 67 |
| 180 | 27 | 33.5 | 79 | — | 45 | 14.5 | 53.5 | 86 | 81.5 | 5 | 4.0 | 8.0 | 25 | 6.5 | 20.5 | 54K | 574 |
| 180 | 27 | 32 | 77 | 11 | 49 | 17 | 57 | 86 | 79 | 5 | 4.0 | 8.0 | 27 | 7.0 | 19 | 54K | 945 |
| 182 | 25 | 30 | 74 | 12 | 48 | — | 59 | 89 | — | 5 | 4.5 | 9.0 | 25 | 6.0 | — | 54K | 596 |
| 185 | 28 | 34 | 80 | 9 | 47 | — | 55 | 87 | 84 | 5.5 | 5.0 | 9.0 | 26 | 6.5 | 22.0 | 54K | 127 |
| 201 | 27 | 35 | 87 | — | 51 | 14.5 | 61 | 93 | 88 | 5 | 5.0 | 10.5 | — | 6.5 | — | 56Ky | 187 |
| 223.5 | 36 | 43.5 | 101.5 | 14.0 | 56 | — | 66 | 99 | 99 | 5 | 6.5 | 13.5 | 31.5 | 8.8 | — | 57Ky | 521 |
| 228 | 30 | 41 | 100 | — | 56 | 16 | 68 | 104 | 99 | 6 | 5 | 13 | — | 8.0 | — | 56Ky | 186 |
| 237 | 35 | 40 | 103 | 15 | 61 | — | 73 | 110 | — | 7 | 7 | 13 | 35 | 8.5 | — | 54K | 383 |
| 244 | 38 | 43 | 103 | 14 | 61 | 22 | 75 | 116 | 110 | 7 | 6 | 14 | 37 | 8.5 | 29 | 54K | 976 |
| 273 | 43 | 50 | 118 | 16 | 73 | 22 | 83 | 130 | 125 | 8 | 9 | 16 | — | — | 31 | 54K | 922 |
| 288 | 44 | 50 | 124 | 18 | 74 | 23 | 90 | 137 | — | 8 | 7.5 | 15 | 40 | 10 | 39 | 54K | 902 |
| 295 | 40 | 51 | 124 | 19 | 75 | — | 92 | 144 | 139 | 9 | 8 | 15 | 37 | 10 | — | 54B | 654 |
| 300 | 47 | 57 | 138 | 14 | 73 | — | 83 | 128 | 124 | 8 | 9 | 17 | 39 | 10 | — | 54B | 320 |
| 320 | 47 | 53 | 137 | 13 | 78 | — | 94 | 162 | 162 | 11 | 7 | 18 | 44 | 11 | — | 54B | 436 |
| 348 | 56 | 64 | 155 | 22 | 92 | — | 102 | 155 | 155 | 11 | 10 | 19 | 48 | 13 | — | 54B | 688 |
| 358 | 55 | 68 | 163 | 21 | 96 | 36 | 120 | 180 | — | 12 | 9 | 20 | 56 | 13 | 47 | 54K | 950 |
| 370 | 58 | 71 | 164 | — | 100 | — | 125 | 190 | 185 | 10 | 12 | 27 | 55 | 14 | — | 54B | 1054 |
| 427 | 70 | 87 | 207 | 25 | 120 | — | 135 | 213 | 204 | 16 | 16 | 33 | 61 | 17 | — | 54B | 685 |
| 480 | 80 | 87 | 200 | — | 130 | — | 155 | 240 | 235 | 15 | 14.5 | 26 | 68 | 16 | — | 54B | 890 |

## APPENDIX II. MEASURE OF THE NORTHERN PACIFIC FIN WHALE FOETUSES

### B. MALES

| No. 1 | No. 3 | No. 5 | No. 6 | No. 7 | No. 8 | No. 9 | No. 10 | No. 11 | No. 12 | No. 13 | No. 14 | No. 15 | No. 17 | No. 19 | No. 25 | Serial No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26.8 | 2.5 | 4.1 | 11.1 | 2.2 | 6.4 | 2.0 | 7.8 | 11.6 | none | 1.7 | 0.22 | 1.6 | 3.7 | 1.1 | 1.7 | 54K 918 |
| 27.5 | 2.6 | 3.2 | 11.8 | — | 7.0 | 2.1 | 7.8 | 12.0 | none | 2.0 | 0.3 | 1.3 | 3.0 | 1.1 | — | 56Ky 137 |
| 35.7 | 3.7 | 6.0 | 14.2 | 2.6 | 9.6 | 3.3 | 10.6 | 16.5 | none | 2.1 | 0.57 | 1.6 | 4.9 | 1.4 | 3.4 | 56Ky 51 |
| 65 | 8 | 11 | 27 | — | 16 | 7 | 19.5 | 31 | — | 4.5 | 1.2 | 2.5 | 8.8 | 2.2 | 6.5 | 56K 594 |
| 65 | 6.5 | 10.5 | 28 | 4.5 | 17 | — | 20.5 | 32.5 | — | 4.0 | 1.4 | 3.5 | 8.5 | 2.3 | 6.3 | 54K 79 |
| 66.5 | 8.5 | 12.5 | 28 | 5.0 | 18.5 | — | 22.0 | 35 | — | 5.0 | 1.6 | 3.5 | 9.0 | 2.4 | 7.3 | 54K 78 |
| 67 | 9 | 10.5 | 26 | — | 16 | — | 19 | 32 | — | 5 | 1.8 | 4 | 8 | 2.3 | — | 54K 63 |
| 68 | 7 | 10 | 26 | 4.5 | 18 | 6 | 22 | 33 | — | 4 | 1.5 | 3 | 8 | 2.3 | 6.3 | 54K 450 |
| 72 | 8 | 11 | 29 | 5 | 18 | 11 | 22 | 36.5 | — | 5 | 2 | 4.5 | 9.5 | 2.5 | 8.5 | 54K 413 |
| 76.5 | 9.5 | 13 | 30 | 5.8 | 18.5 | — | 23 | 36 | — | 5.5 | 1.6 | 4.0 | 9.5 | 2.6 | — | 54K 36 |
| 78.5 | 10.5 | 13 | 30 | 5.8 | 18.5 | — | 25.2 | 40 | none | 5.1 | 1.6 | 4.8 | 10.5 | 2.8 | — | 56Ky 587 |
| 79 | 8.0 | 12.5 | 31.5 | 5.5 | 20.0 | — | 24 | 38 | — | 5.5 | 1.8 | 4.0 | 10.0 | 2.5 | 8.5 | 54K 32 |
| 88 | 11.0 | 15 | 38 | 6.2 | 22 | — | 27.5 | 42.0 | 42.0 | 5.5 | 2.2 | 4.0 | 12.0 | 3.4 | 10.3 | 54K 57 |
| 89.8 | 12.1 | 15.8 | 39.2 | 4.0 | 21.5 | — | 27.5 | 43.5 | 51.0 | 6.0 | 2.8 | 6.0 | 12.0 | 3.2 | — | 56Ky 598 |
| 95 | 14 | 17 | 38 | — | 25 | — | 30 | 48 | — | 8 | 2.6 | 4.5 | 11.5 | 3.3 | — | 54B 125 |
| 96 | 10.6 | 15 | 38.5 | 6.8 | 21.5 | — | 28.5 | 44.5 | 51.5 | 6.5 | 2.3 | 6.0 | — | — | — | 56Ky 449 |
| 97 | 11.0 | 15 | 39 | 7 | 25 | 8 | 29 | 47 | — | 6 | 2 | 4.5 | 1 | 3 | 10 | 54K 750 |
| 98 | 14.5 | 18 | 39 | 7 | 26 | — | 30.5 | 49 | — | 6.5 | 2.5 | 4.0 | 12.5 | 3.5 | — | 54K 31 |
| 108 | 15.0 | 18 | 46 | 7 | 26 | 8 | 31 | 48 | 48 | 6 | 2.5 | 5 | 14 | 3.5 | 13 | 54K 756 |
| 113 | 17 | 21 | 48 | 8 | 27 | — | 34 | 52 | — | 7 | 3.5 | 6 | 16 | 3.5 | — | 54K 465 |
| 118 | 15 | 19 | 46.5 | 8 | 31 | 10 | 38 | 56 | (60) | 8.0 | 3.5 | 7.5 | 15 | 3.7 | 13 | 54K 479 |
| 119 | 17.5 | 21.5 | 52.0 | 8.5 | 27.3 | — | 37 | 58 | 63 | 4.3 | — | 7.0 | 16.5 | 4.0 | — | 56K 580 |
| 122 | 19 | 23 | 55 | — | 33 | — | 38 | 61 | 6 | 9 | 4.5 | 7 | 17 | 5 | — | 54B 199 |
| 132 | 17 | 23 | 56 | 9 | 32 | — | 41 | 61 | 6 | 8 | 3.5 | 7.5 | 19 | 5 | — | 54K 761 |
| 133 | 17 | 22 | 54 | 8 | 35 | 12 | 41 | 64 | 6 | 9 | 3 | 6.5 | 18 | 4.5 | 15 | 54K 737 |
| 136 | 20 | 24 | 55 | — | 33 | — | 40 | 66 | 6 | 11 | 3 | 5 | 17 | 4.6 | — | 54B 145 |
| 137 | 22 | 27 | 59 | — | 36 | — | 39 | 64 | 68 | 11 | 3.8 | 6 | 18 | 5 | — | 54B 183 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 140 | 21 | 26 | 58 | — | 38 | — | 42 | 74 | 74 | 9 | 4.5 | 6.5 | 17 | 4.5 | — | 54B | 1022 |
| 142 | 22 | 26.5 | 61.0 | 9.3 | 36.5 | — | 41.5 | 66.0 | 66 | 10 | 4.7 | 7.5 | 20.2 | 5.0 | — | 56Ky | 646 |
| 146 | 20 | 26 | 62 | — | 35 | — | 40 | 67 | 63 | 11 | 4 | 6 | 19 | 5.2 | — | 56K | 114 |
| 149 | 19 | 24.5 | 56 | — | 31 | — | 41 | 65 | 71 | 11 | 4.5 | 7 | 16 | 4.5 | — | 54B | 103 |
| 155 | 20 | 26 | 63 | 10.5 | 41 | 13 | 49 | 78 | 75 | 10 | 3.5 | 8 | 23 | 5.5 | 19 | 54K | 541 |
| 159 | 23.5 | 27.5 | 68 | — | 44 | — | 49 | 78 | 78 | 8 | 5 | 8 | 20 | 5.3 | — | 55Ky | 3 |
| 166 | 26 | 32 | 74 | — | 42 | — | 52 | 77.5 | 73 | — | 3 | 6.5 | 21.5 | 5.5 | — | 55Ky | 18 |
| 170 | 23.0 | 30 | 72 | 11.0 | 38.0 | 16 | 52 | 80 | 80 | 11.0 | 4.5 | 7.5 | 23.0 | 6.0 | 20 | 56Ky | 729 |
| 173 | 26 | 31.5 | 77 | 11.5 | 43 | 15 | 50 | 80 | 77 | 11 | 4 | 9.0 | 25 | 6 | 21 | 54K | 567 |
| 176.5 | 27.5 | 31.0 | 74.5 | 11.5 | 43.5 | — | 55 | 84.5 | 86.5 | 13.5 | 4 | 11.5 | — | — | — | 56Ky | 586 |
| 180 | 27 | 33 | 79 | 12 | 44 | 15 | 52 | 84 | 81 | 12 | 4.5 | 9 | 25 | 6 | 21 | 54K | 567 |
| 181 | 23.0 | 31 | 75 | — | 45 | 16 | 55 | 87 | 85 | 13 | 6 | 10 | 23 | 6 | 22 | 54K | 754 |
| 186 | 24 | 33 | 80 | 12 | 48 | 15 | 53 | 85 | 82 | 11 | 5 | 11 | 25 | 6.5 | 20 | 54K | 730 |
| 186 | 26 | 33 | 80 | — | 46 | 13 (21) | 58 | 90 | 87 | 12 | 6 | 10 | 17.5 | 6 | 21 | 56Ky | 246 |
| 188 | 27 | 35 | 86 | — | 50 | 16 | 58 | 86 | 83 | 12 | 6 | 10 | 19.5 | 6.5 | 24 | 56Ky | 246 |
| 198 | 28 | 35 | 84 | 12.5 | 51.5 | 18 | 62 | 95.5 | 95.5 | 14 | 5.5 | 9.5 | 26 | 6.8 | 23.5 | 54Ky | 889 |
| 206 | 31 | 37 | 90 | — | 53 | — | 64 | 98 | 92 | 14 | 5.5 | 10 | 28 | 3.5 | — | 56Ky | 776 |
| 220 | 33 | 40 | 100 | 14 | 54 | — | 64 | 125 | 100 | 16 | 7 | 12 | 29 | 8 | — | 54B | 646 |
| 246 | 42 | 48 | 109 | 14 | 63 | 21 | 76 | 122 | 118 | 14 | 7 | 13 | 37 | 6 | 31 | 56Ky | 947 |
| 254 | 35 | 44 | 107 | 15 | 65 | — | 78 | 120 | 117 | 19 | 6.5 | 15 | 38 | 9.5 | 32 | 56Ky | 444 |
| 255 | 41 | 46 | 108 | 16 | 65 | 21 | 76 | 125 | 120 | 21 | 9.8 | 15 | 34 | 9 | 33 | 56Ky | 936 |
| 268 | 41 | 48 | 115 | 17 | 70 | 21 | 81 | 125 | 120 | 20 | 7.5 | 18 | 39 | 10 | 28 | 54K | 918 |
| 284 | 44 | 49 | 122 | 16 | 73 | 25 | 86 | 137 | 130 | 18 | 10 | 15 | 40 | 10 | 40 | 54K | 615 |
| 291 | 40 | 51 | 127 | 17.5 | — | — | — | — | — | — | — | — | 44 | 11 | — | 54K | 948 |
| 295 | 35 | 48 | 156 | 18 | 70 | — | 91 | 119 | 119 | 20 | 8 | 17 | 38 | 11 | — | 54B | 428 |
| 296 | 46 | 51 | 126 | 19 | 80 | 25 | 100 | 146 | 149 | 20 | 9.5 | 15 | 40 | 11 | 34 | 56Ky | 934 |
| 300 | 45 | 53 | 130 | 18 | 77 | 25 | 91 | 142 | 138 | 23 | 10 | 19 | 45 | 11 | 42 | 54K | 738 |
| 311 | 48 | 58 | 141 | 20 | — | — | — | 170 | 177 | 20.7 | 8 | 22 | 46 | 11 | — | 54K | 687 |
| 346 | 56 | 67 | 158 | — | 96 | — | 114 | 166 | 162 | — | 11 | 22 | 52 | 13 | — | 54B | 1056 |
| 350 | 54 | 65 | 155 | — | 97 | — | 113 | 167 | 167 | 24 | 11 | 22 | 49 | 12 | — | 54B | 954 |
| 367 | 58 | 72 | 165 | — | 100 | — | 114 | 182 | 175 | 22 | 12 | 18 | 51 | 13 | — | 54B | 1057 |

## APPENDIX III. MEASUREMENTS OF ADULT MINKE WHALES FROM THE COAST OF JAPAN

### A. FEMALES

| No. 1 | No. 3 | No. 5 | No. 6 | No. 7 | No. 8 | No. 9 | No. 10 | No. 11 | No. 12 | No. 13 | No. 14 | No. 15 | No. 17 | No. 19 | No. 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 478 | 58 | 74 | 197 | 24.5 | 147 | 34 | 128 | 222 | 273 | 11 | 22 | — | 74 | 18 | 68 |
| 512 | 59 | 82 | 213 | 24 | 138 | — | 153 | 276 | 288 | — | 24 | 38 | 76 | 19 | 68 |
| 578 | — | 92 | — | — | — | 39.5 | — | — | — | — | 20.5 | 29 | 59.5 | 20.5 | 81 |
| 639 | — | — | 245 | — | 139 | — | 171 | 318 | 353 | 22 | — | — | 75 | — | 65 |
| 790 | 100 | 118 | 295 | — | 238 | 59 | 270 | 437 | 460 | 20 | 37 | 60 | 119 | 29 | 120 |

### B. MALES

| No. 1 | No. 3 | No. 5 | No. 6 | No. 7 | No. 8 | No. 9 | No. 10 | No. 11 | No. 12 | No. 13 | No. 14 | No. 15 | No. 17 | No. 19 | No. 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 486 | 54 | 81 | — | — | — | 34 | — | — | — | — | 17 | 28 | 46 | 16 | 68 |
| 486 | 62 | 73 | 186 | 27 | 139 | 40 | 148 | 228 | 263 | — | 17 | 39 | 78 | 19 | 74 |
| 514 | 62 | 76 | 135+No. 17 | — | 142 | — | 133 | 242 | 298 | — | — | — | — | — | — |
| 522 | 65 | 84 | 142+No. 17 | 29 | 148 | 37 | 135 | 264 | 298 | 38 | 20 | 38 | — | — | 74 |
| 535 | 74 | 89 | 205 | 28 | 141 | 38 | 129 | 231 | 293 | 37 | 24 | 40 | 83 | 19.5 | 76 |
| 542 | 68 | 83 | 231 | 29 | 152 | 41 | 146 | 260 | 294 | 38 | 24 | 39 | 79 | 21 | 74 |
| 545 | 71 | 87 | 223 | 30 | 157 | 40 | 142 | — | 370 | 21 | 22 | 34 | 78 | 20.5 | 75 |
| 545 | 76 | 89 | 239 | 29 | 154 | 38 | 152 | 283 | 312 | 32 | 25 | 36 | 81 | 21 | 90 |
| 550 | 77 | 92 | 228 | 29 | 162 | 39 | 143 | 270 | 318 | 33 | 24 | 41 | 81 | 19 | 77 |
| 552 | 72 | 85 | 216 | 30 | 153+ | — | 148+ | 270 | — | 38 | 23 | 42 | 75 | 20 | 82 |
| 570 | 71 | 90 | 226 | 30 | 161 | 43 | 161 | 285 | 322 | 38 | 27 | 50 | 95 | 23 | 90 |
| 577 | 72 | 87 | — | 27.5 | — | 42 | — | — | — | — | — | — | — | — | 82 |
| 633 | 85 | 98 | 278 | 30 | 183 | 47 | 170 | 278 | 341 | — | 28 | 41 | 93 | 23 | 140 |
| 680 | 78 | 100 | 283+ | 36 | 189 | 55 | 190 | 357 | 382 | 47 | 34 | 53 | 114 | 24 | 106 |

## EXPLANATION OF PLATES

All figures are the fin whale foetuses from the Antarctic.

### PLATE I

A: Male, 25 cm long (No. 13T606)
B: Female, 45.5 cm long (No. 13T589)
C: Female, 50.5 cm long (No. 13T529)
D: Female, 83 cm long (No. 13T165)

### PLATE II

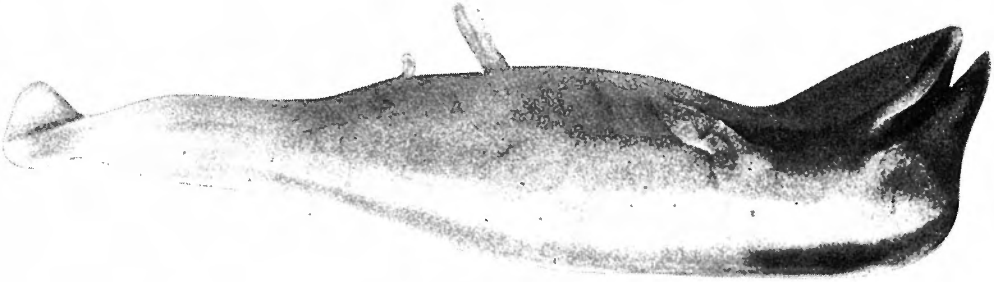
E: Male, 97 cm long (No. 13T67)
F: Male, 116 cm long (No. 13T124)
G: Female, 121 cm long (No. 13T156)
H: Female, 167 cm long (No. 13T40)

### PLATE III

I: Male, 155 cm long (No. 13T585)
J: Male, 239 cm long (No. 13T160)
K: Female, 262 cm long (No. 13T101)

### PLATE IV

L: Female, 427 cm long (No. 13T1454)
M: Male, 485 cm long (No. 13T1400)

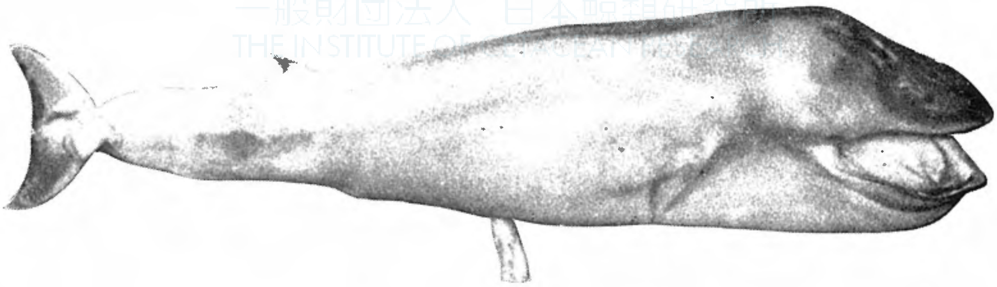


A

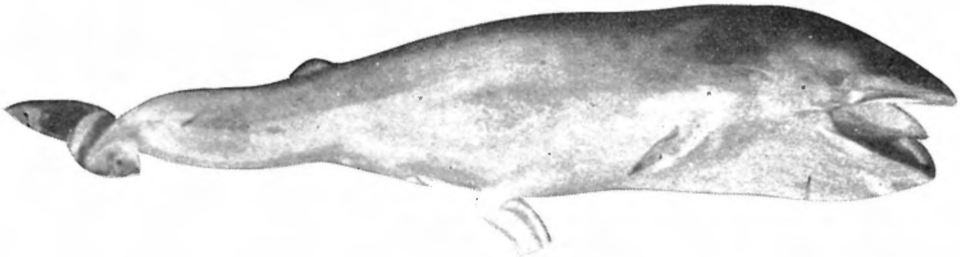
B

C





D

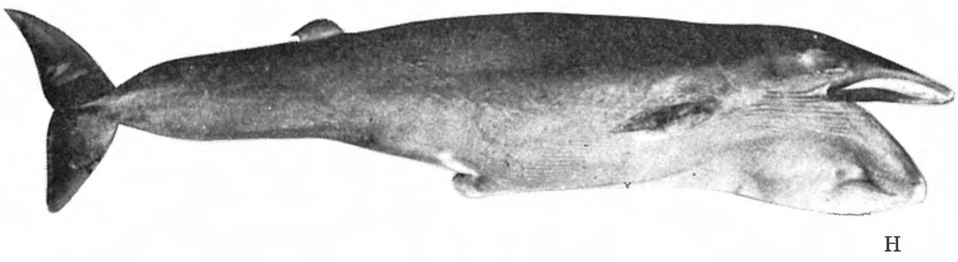


E

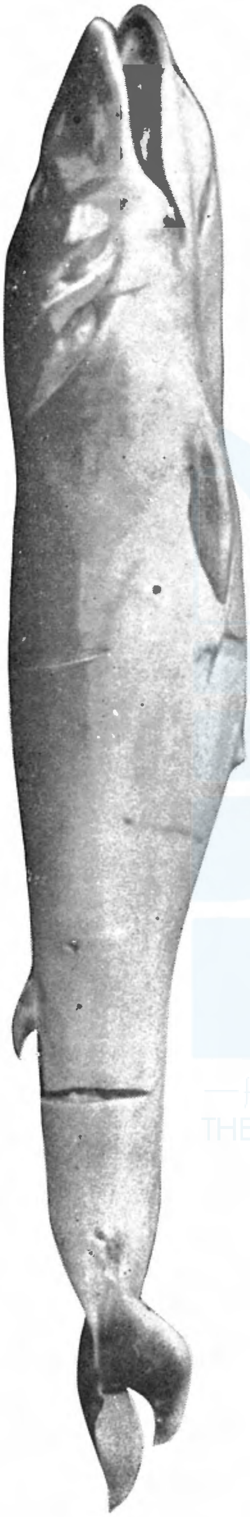
F

G



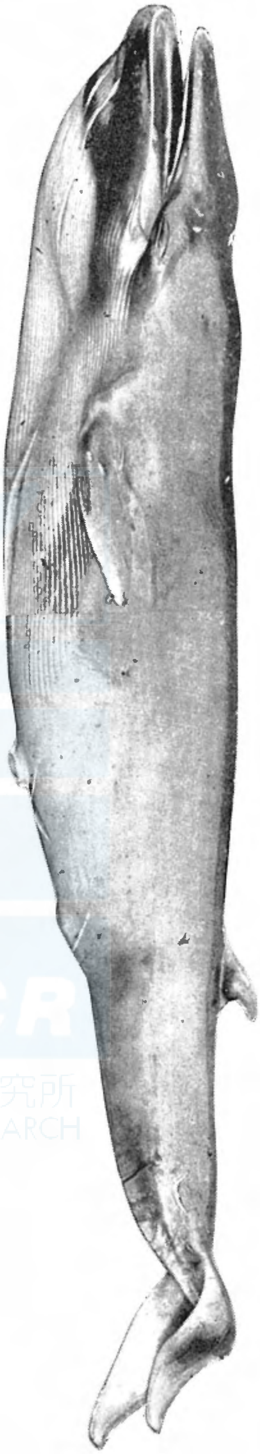


H

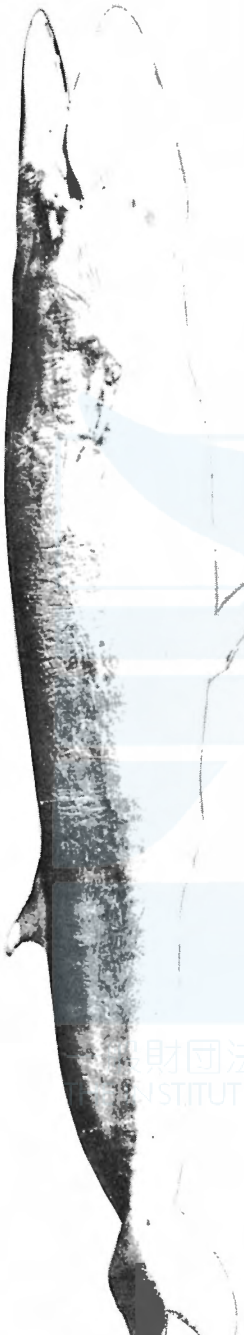


I

J



K



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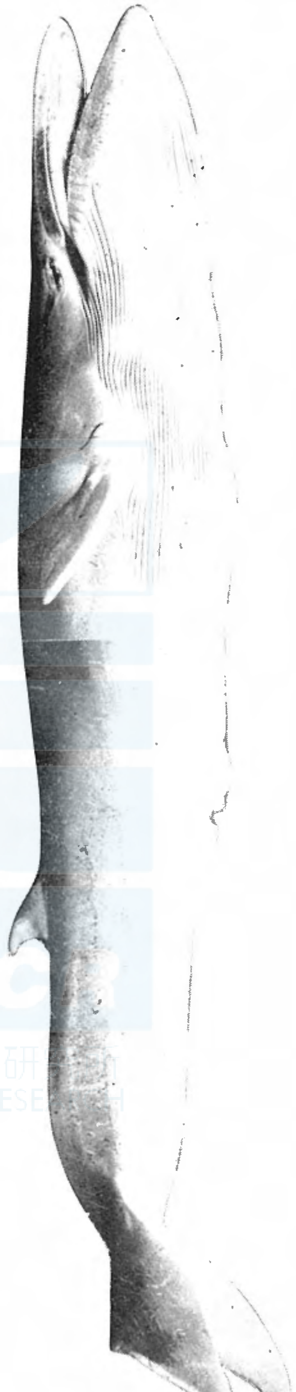

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