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ON THE HISTOLOGICAL STRUCTURE OF CETACEAN LUNGS

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ON THE HISTOLOGICAL STRUCTURE OF CETACEAN LUNGS

By F. Haynes, M.A.
and
Alec H. Laurie, M.A.

(Plate I)

The peculiar structure of whale lungs was briefly mentioned in a report on respiration in whales (Laurie, 1933, p. 370) wherein the great quantity of elastic tissue in the lungs of two species of whale was illustrated by photomicrographs. Subsequently further collections of lung tissue were made, particular attention being paid to the freshness of the material. It is not always easy to obtain fresh specimens because of the time that must elapse between the harpooning of the whale and its dismemberment at the whaling station. Sections of lungs have been prepared and stained with Haematoxylin-Eosin and Weigert-Van Gieson. We are indebted to Mr Steggall, assistant at St Bartholomew's Hospital Medical School, for sectioning and staining the material. Lung samples from the following species have been examined:

Fin Whale (*Balaenoptera physalus*),
Humpback (*Megaptera nodosa*),
Sperm Whale (*Physeter catodon*),
Southern Right Whale (*Balaena australis*).

In Plate I (Figs. 1–5) an attempt has been made to show the stained sections as nearly as possible as they appear under high-power magnification. Diagrammatical representation was felt to be undesirable in depicting structures which have been found to show some departures from the usual mammalian form. We are indebted to Professor H. Hartridge, F.R.S., for kindly allowing us to use the micro-projector which he has designed for histological studies. This instrument allows a highly magnified image of the specimen to be thrown on a sheet of paper or Bristol-board, thus facilitating an accurate copy. Figs. 6 and 7 were drawn from direct observation by Haynes, using a 1/12 in. objective, since it was impossible to project an image of such magnification owing to illumination difficulties.

Gross structure of lungs. Before dealing with the stained preparations, a few words may be said about the gross structure of whale lungs. All the species examined show certain features in common. Chief among these is the thickness of the pulmonary pleura, which consists mainly of elastic fibres laid down in much greater profusion than is ever found in the lungs of terrestrial mammals. The pleura varies in thickness in different species, but the average thickness has been found to be of the order of 5 mm.

The lungs are massive, those of a large Blue whale weighing over a ton (Laurie, 1933, p. 404). This weight includes an unknown quantity of blood, but since the lungs were in a collapsed state it is thought that the amount of blood remaining in them was small. It is not practicable to ligature the trachea of a whale before removing the lung, so that all the specimens examined are perforce from collapsed lungs. The degree of collapse is considerable, as is to be expected from the quantity of elastic tissue present both in the pleura and in the lung substance.

The size and weight of whale lungs render anatomical investigation practically impossible, since the difficulties of injecting the vascular system would be immense. We must therefore be content with the foregoing facts and with the observation that the collapsed lung when cut with a knife resembles in texture and appearance a rubber sponge permeated with blood.

Structure of alveoli. These ultimate subdivisions of the bronchioles are the subject of our histological study. In land mammals the air spaces of the alveoli are separated from one another by thin septa consisting of a layer of epithelium bounding each air space, with a capillary network in between. When the alveoli are expanded, as after inspiration, the septa are virtually five cells thick and are composed in cross-section of epithelium, capillary endothelium, blood cells flowing in single file, capillary endothelium again, and epithelium. In the collapsed lung the situation is essentially the same, allowing for some overlap of the cells of epithelium and capillary endothelium. The whole structure is a means of exposing blood to the respiratory gases in the most efficient manner, since rapid diffusion from the gases to the blood and *vice versa* can take place in two directions at once.

In cetacean lungs, on the contrary, a different arrangement is found. The septa are very thick, being largely composed of collagen of indeterminate structure and correspondingly difficult to portray. The collagen is heavily invested with long strands of connective tissue and is sparsely nucleated. Owing to the thickness of the septa a single capillary network cannot serve for two adjacent alveoli, and instead each air space is bounded by a separate capillary network. The most important feature is the complete absence of epithelium. The membrane which separates the blood from the air spaces is very thin capillary endothelium. Occasional nuclei are to be seen adjacent to the air space; their shape is that of endothelial nuclei. In Plate I, fig. 7, a high magnification drawing of a section of lung from a Southern Right whale, the capillary can be seen leaving an arteriole running in the interalveolar stroma. The close network of capillaries surrounding the air spaces is seen to contain red blood corpuscles, though owing to the collapsed state of the specimens and the inevitable post-mortem haemorrhage the capillaries are not altogether filled with blood.

The lack of alveolar epithelium and the exposure of the capillary network to the respiratory gases is believed to be unknown hitherto in the lungs of those land mammals which have been examined. In these latter epithelium is always found. [The lungs of birds are reported to lack epithelial lining (Hartridge, 1936, p. 203).]

It is tempting to speculate on the reason for this peculiarity of structure. It may be that the protection afforded by epithelium is unnecessary to animals living in a dust-free environment. It is at least remarkable that the thin membrane of the capillary can be subjected to the pressures involved in deep diving, which have been discussed (Laurie, 1933, *passim*) without the protection of a lining of epithelium to minimize the danger of rupture. Again, it may be no more than coincidence that whales, which possibly alone among mammals run no risk of oxygen deficiency in their blood (owing to the high pressures at which the pulmonary gases are maintained during diving), should be without epithelial cells which might be responsible for the secretion of oxygen which Haldane and his co-workers found in man under conditions of oxygen shortage (Haldane and Priestley, 1935, pp. 250–96). It is, however, by no means certain whether the epithelial cells are responsible for the secretion of oxygen which these observers found.

SUMMARY

1. Specimens of the lungs of four species of the larger Southern whales have been sectioned and stained.

2. Lungs of all the species examined agree in being massive in texture, in having a thick, highly elastic pulmonary pleura, and in being heavily invested with elastic tissue.

3. Interalveolar septa are thick and composed largely of collagen with elastic fibres. There is no alveolar epithelium, the air spaces being bounded by the endothelium of the capillary network. This condition has not hitherto been found among land mammals.

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Haldane, J. S., and Priestley, J. G., 1935. *Respiration.* Oxford.

Hartridge, H., 1936. *Bainbridge and Menzies' Essentials of Physiology.* London.

Laurie, Alec H., 1933. *Some Aspects of Respiration in Blue and Fin Whales.* Discovery Reports, vii, pp. 363–406, pl. xv.

PLATE I

Lungs of Southern Whales (cf. vol. VII, pl. XV).

Fig. 1. Southern Right whale, stained with Haematoxylin-Eosin. (× 125.)

Fig. 2. Fin whale, stained as fig. 1. (× 125.)

Fig. 3. Sperm whale, stained as fig. 1. (× 125.)

Fig. 4. Humpback whale, stained with Weigert-Van Gieson to show elastic tissue. (× 125.)

Fig. 5. Fin whale, stained as fig. 4. (× 125.)

Fig. 6. Southern Right whale, stained with Haematoxylin-Eosin. (× 300.)

a. Small vein.
b. Arteriole.
c. Capillary endothelium.
d. Endothelial nuclei.
e. Alveolar air space.
f. Red blood corpuscle.
g. Elastic fibres.

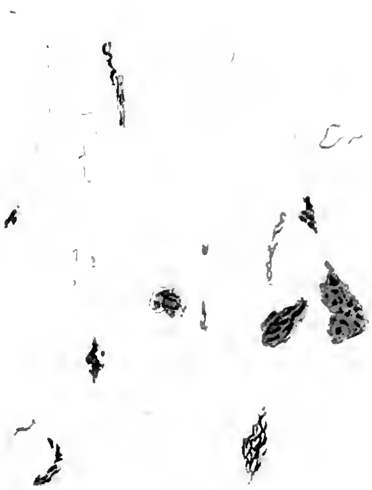
Fig. 7. Southern Right whale, stained with Haematoxylin-Eosin. (× 300.)

a. Arteriole about to merge into capillary network.
b. Arteriole larger than above.
c. Branch from arteriole seen in longitudinal section and connecting directly with the capillary network which bounds the alveolar air space.

1

2

3



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LUNGS OF SOUTHERN WHALES

[*Discovery Reports. Vol. XVII, pp. 7–92, Plate II, December 1937.*]

THE HUMPBACK WHALE, *MEGAPTERA NODOSA*

By

L. HARRISON MATTHEWS, M.A.

CONTENTS

THE HUMPBACK WHALE, *MEGAPTERA NODOSA*

By L. Harrison Matthews, M.A.

(Plate II; Text-figs. 1–84)

INTRODUCTION

During the course of the Discovery investigations sixty-two Humpback whales have been examined, thirty-one each of males and females; this report analyses and discusses the data obtained from them.

The Humpback is a species of whale which has suffered greatly at the hands of the whaling industry, so that it has declined in twenty-five years from being almost the sole object of pursuit to an insignificant fraction of the total world catch. As a consequence Humpback whales are only occasionally available for examination at the southern whaling stations, and the data here considered were accumulated during the work of seven whaling seasons. Small though this series of whales may be, no such detailed set of observations on whales of this species has ever been available for study before.

The information recorded during examination of the whales at the whaling stations consisted of a routine system of measurements of various parts of the body that has been adhered to throughout the investigations, notes on the external characters, baleen, food, internal and external parasites, condition of the genitalia and degree of physical maturity. Very rarely, however, has a complete set of observations been made on any one whale. The information collected is discussed under the appropriate headings below, together with certain information derived from other sources.

I am indebted to my former colleague, Dr Francis C. Fraser, for making available the records of whaling statistics in the British Museum (Natural History), and for assistance in other ways; to Mr Martin A. C. Hinton for kindly reading the manuscript of this report; and to Dr A. S. Parkes for reading the portions dealing with reproduction. It is a pleasure to express my thanks to them and to Dr Kemp.

MATERIAL

Particulars of the data collected by the Discovery staff relating to Humpback whales are shown in Table I. The sources of other information considered together with these are indicated in the appropriate sections below.

The data available have been used for constructing an outline of the biology of this species of whale. Taken alone they may be said, in many points, to be inadequate to provide very definite conclusions. But it is suggested that reference to information given on the biology of allied species, the Southern Blue and Fin whales, worked out from extensive data by Mackintosh and Wheeler (1929), shows that the outline sketched from the data referring to this species may, by analogy, be taken as a true representation of the facts and that the conclusions drawn are correct.

SEX RATIO

The records of the numbers of the sexes occurring at South Georgia and off South Africa are of interest. The figures available are those collected by the expedition, those in the British Museum, and those recorded by Hinton (1925), all of which are used here. Of 1057 whales from South Georgia 45·4 per cent were males and 54·6 per cent were females, whereas of 623 from Natal 55·4 per cent were males and 44·6 per cent were females; and of the total of 1680 whales from both places 49·1 per cent were males and 51·9 per cent were females. The figures from which these totals are derived are shown in Table II.

The sex ratio could therefore be taken to be equal between the sexes for the species as a whole, though it varies in different places. The reason for the preponderance of females in the south and of males in the north, if indeed it is of real significance, is probably to be sought in the whales' habits of breeding and migration. An alternative reason may be that the whales taken were not a representative sample of the population.

It is suggested that the females go north for parturition and pairing, and immediately proceed south again towards the feeding grounds when these are accomplished. The males, on the other hand, probably linger on the breeding grounds off the African coast where they are easily captured, as is mentioned in a later section of this report. Very few sex records of foetuses are available, only twenty-three in all, which are shown in Table III. The numbers are unfortunately too few to give any definite conclusion.

Hinton (1925) concluded that in the southern Humpback the females outnumbered the males by about two to one, and his evidence, the catch of 1913–14 given in Table II, and his foetal records, included in Table III, show this ratio very distinctly. But in view of the additional facts here presented, it can be taken that his results were due merely to insufficient data, and that the sex ratios, though having a preponderance of females in the south, are not nearly so uneven as would appear from the figures available to him. Mörch (1911) states that in the South Shetlands in 1910 bulls were in the majority, but unfortunately his statement is not supported by figures, and for this reason cannot be compared with the detailed records discussed here. Hinton (1925), basing his conclusion on the sex records of foetuses, thought that this preponderance of bulls reported by Mörch was a purely local phenomenon, but, as shown above, the figures available relating to foetuses were insufficient to give a valid conclusion.

EXTERNAL CHARACTERS

BODY PROPORTIONS

The Discovery staff measured sixty-two whales, but the complete series of measurements, as laid down for Fin and Blue whales, was not always taken. A few of the standard measurements were not taken at all, but for the sake of uniformity the standard numbering has been retained, although some gaps are thereby introduced. The data obtained are set out below and may be taken as a fairly good representation of the external proportions of the Humpback whales of South Georgia, and an indication of those of South Africa. There is no indication of any racial difference between the whales from

Table I. *Distribution of Humpback whales examined by the Discovery staff*

Season	South Georgia		South Africa	
	Males	Females	Males	Females
1924–5	2	1	—	—
1925–6	4	13	—	—
1926	—	—	6	2
1926–7	—	—	—	—
1927–8	—	—	—	—
1928–9	1	2	—	—
1929–30	4	3	—	—
1930	—	—	7	3
1930–1	7	7	—	—
Total 62	18	26	13	5

Table II. *Humpback whale. Sex ratio*

Season and place	Males		Females	
	Number	Percentage of total	Number	Percentage of total
South Georgia				
1913–14	20	35·1	37	64·9
1915–16	328	45·4	395	54·6
1916–17	114	48·9	119	51·1
1924–5 to 1930–1	18	40·9	26	59·1
Natal				
1924 (British Museum)	107	57·3	80	42·7
1925 ,,	99	59·4	68	40·6
1926 ,,	56	51·4	53	48·6
1927 ,,	46	54·1	39	45·9
1928 ,,	26	42·6	35	57·4
1926 (Discovery Expedition)	4	100·0	—	—
1930 ,,	7	70·0	3	30·0
Total	825	49·1	855	50·9

Table III. *Humpback whale. Sex ratio of foetuses*

Source of information	Males		Females	
	Number	Percentage of total	Number	Percentage of total
Discovery Expedition	5	55·6	4	44·4
Hinton (1925)	2	22·2	7	77·8
British Museum	3	60·0	2	40·0
Total	10	43·5	13	56·5

the two places; the differences in the figures, where not due to inadequate numbers, are to be explained by the higher proportion of immature whales in the South African catches.

A summary of the analysis of the figures is shown in Table IV, in which the measurements, expressed as percentages of the total length, are given separately for males and females from South Georgia, from South Africa, and as totals. The number of measurements producing each mean value is also shown.

Table IV. *Humpback whale. Mean value of measurements of male and female whales, expressed as percentages of the total length*

Measurement	South Georgia				South Africa				Total			
	Males		Females		Males		Females		Males		Females	
	Mean value	No. of measurements	Mean value	No. of measurements	Mean value	No. of measurements	Mean value	No. of measurements	Mean value	No. of measurements	Mean value	No. of measurements
1. Total length	100	—	100	—	100	—	100	—	100	—	100	—
3. Tip of snout to blow-hole	19·20	18	20·39	24	19·11	10	20·54	5	19·15	28	20·47	29
4. Tip of snout to angle of gape	23·37	15	23·94	24	23·44	8	24·76	4	23·35	23	24·35	28
5. Tip of snout to centre of eye	25·07	18	25·72	25	24·45	13	26·31	5	24·76	31	26·01	30
6. Tip of snout to tip of flipper	64·48	3	63·89	3	59·82	2	64·40	1	62·15	5	64·14	4
7. Centre of eye to centre of ear	4·51	17	4·47	20	4·89	7	4·75	3	4·70	24	4·61	23
8. Notch of flukes to posterior emargination of dorsal fin	33·12	17	33·91	22	32·67	9	32·82	4	32·89	26	33·36	26
9. Width of flukes at insertion	8·42	17	8·40	26	8·41	11	7·86	4	8·42	28	8·13	30
10. Notch of flukes to centre of anus	24·37	18	24·12	26	23·71	11	29·35	5	24·54	29	26·73	31
11. Notch of flukes to umbilicus	43·87	17	42·40	25	41·57	11	43·38	5	42·72	28	42·52	30
12. Notch of flukes to end of system of ventral grooves	42·73	18	40·31	20	42·30	9	44·34	4	42·51	27	42·32	24
13. Centre of anus to centre of reproductive aperture	10·51	17	3·88	26	9·36	9	4·32	5	9·93	26	4·10	31
14. Vertical height of dorsal fin	2·47	16	2·07	22	2·06	9	2·69	3	2·26	25	2·38	25
15. Length of base of dorsal fin	8·39	18	8·74	22	7·39	9	9·79	3	7·89	27	9·13	25
16. Axilla to tip of flipper	26·86	18	27·83	22	26·70	5	27·57	4	26·78	23	27·70	26
17. Anterior end of lower border to tip of flipper	30·51	18	30·76	21	30·53	4	32·42	4	30·52	22	31·59	25
19. Greatest width of flipper	7·34	18	7·24	22	7·29	9	7·09	5	7·32	27	7·17	27
20. Length of severed head from condyle to tip	29·75	13	30·18	19	28·49	5	31·57	3	29·12	18	30·87	22
21. Greatest width of skull	16·09	11	17·24	17	16·43	8	16·20	3	16·26	19	16·27	20

The only measurement that differs widely in the two sexes is no. 13, centre of anus to centre of reproductive aperture; it is nearly two and a half times greater in males than in females. This is due to the penis being more anterior in position than the vulva. In addition smaller differences are indicated in the relative lengths of the head and flipper, both of which are slightly longer in the female than in the male. These differences in relative length are probably due to the fact that the female Humpback reaches a greater total length than the male of corresponding age, and thus depend on body length rather than on sex. There appears to be no significant difference between the body proportions of South Georgian and South African Humpback whales.

Tables V, VI, VII and VIII show the manner in which the body proportions vary with the size of whale. In these tables the mean value of each measurement for each metre of whale length is given, together with the number of measurements producing each mean value, and the range of variation of each value. The figures are given as the actual values in metres in roman type, and expressed as percentages of total length in italic type. The figures expressed as percentages of total length are first discussed: those of the actual values are dealt with in a later section of this report. They may be taken as a basis for the comparison of measurements of Humpback whales from any other part of the world.

The variations of the body proportions according to the length of the whale are shown graphically for measurements nos. 3, 4, 5, 8, 10, 11, 12, 13, 20 and 21 in Figs. 1–20, in which the percentage value of the measurements is plotted against total length of the whale. The curves for each sex are separated and represent the values from South Georgian whales: the values from South African whales are shown for comparison as unjoined points because they are based upon too few measurements to justify the drawing of curves.

Bearing in mind the limited numbers upon which these figures are based it appears that there is no significant difference between the shapes of the curves for males and females, nor between South Georgian and South African whales, except for measurement no. 13, the genito-anal distance, already mentioned. The main point of interest presented by these curves is the fact that those for measurements nos. 3, 4, 5 and 20 (Figs. 1–6, 17, 18) slope upwards from their origin, and those for nos. 10, 11, 12, 13 (Figs. 9–16) slope downwards from their origin, showing that as the whale increases in length the relative size of the head region increases and of the tail region decreases. The rate of growth of the body, therefore, decreases from the head region backwards, a conclusion that differs slightly from that drawn by Hinton (1925) who suggested, from a consideration of the data relating to twenty male Humpbacks examined by Barrett-Hamilton, that the thoracic region was the principal seat of growth. There is some slight indication that at extreme lengths the relative sizes of the head and tail regions become slightly less and greater respectively, an event that may be correlated with the attainment of physical maturity.

The variations that occur in each measurement are shown in Table IX, in which the values of each measurement, expressed as percentages of the total length, are divided into arbitrary groups and the number of values falling into each group is recorded. These data are shown graphically in Figs. 21–37 in which the curves all approximate to normal frequency curves, the least regular ones being those derived from few data, or from measurements taken between ill-defined points and consequently difficult to take uniformly. Only the data from whales taken at South Georgia are included in these tables and figures, and the range of variation in the measurements shown in them indicates a homogeneous population, and no admixture of races with structural differences.

Table V. *Humpback whale. Males, South Georgia*

Measurements: actual values in metres (roman type); expressed as percentages of total length (italic type).

		3. Tip of snout to blow-hole			4. Tip of snout to angle of gape			5. Tip of snout to centre of eye		
	Metre lengths	No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	0–1	4	0·055– 0·14	0·091	4	0·075– 0·190	0·124	5	0·06 – 0·21	0·121
			14·47 –16·47	*15·15*		*18·67 –22·50*	*20·81*		*21·33 –24·71*	*22·46*
Whale	8–9	1	—	1·40	1	—	1·8	1	—	1·95
			—	*16·60*		—	*21·45*		—	*23·21*
	9–10	1	—	1·78	—	—	—	1	—	2·35
			—	*18·15*		—	—		—	*23·95*
	10–11	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	11–12	3	2·12 – 2·32	2·24	3	2·67 – 2·78	2·72	3	2·90 – 2·96	2·93
			18·77 –20·42	*19·61*		*23·00 –24·47*	*23·70*		*25·45 –26·03*	*25·71*
	12–13	4	2·36 – 2·70	2·53	3	2·68 – 3·07	2·86	4	3·02 – 3·50	3·24
			19·24 –21·51	*20·26*		*21·83 –24·46*	*23·11*		*24·60 –27·34*	*25·00*
	13–14	5	2·37 – 2·82	2·62	5	2·98 – 3·42	3·18	5	2·95 – 3·56	3·32
			18·23 –21·45	*19·95*		*22·01 –25·50*	*24·26*		*21·95 –27·06*	*25·34*
	14–15	4	2·85 – 3·10	2·95	3	3·22 – 3·6	3·45	4	3·56 – 4·10	3·76
			20·15 –21·02	*20·54*		*22·75 –24·47*	*23·87*		*25·18 –27·80*	*26·24*

		9. Width of flukes at insertion			10. Notch of flukes to centre of anus			11. Notch of flukes to umbilicus		
	Metre lengths	No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	0–1	4	0·035– 0·080	0·053	4	0·090– 0·225	0·156	4	0·150– 0·380	0·266
			9·21 –10·00	*9·15*		*22·50 –28·95*	*26·15*		*37·50 –48·68*	*44·39*
Whale	8–9	1	—	0·80	1	—	2·10	1	—	3·85
			—	*9·54*		—	*25·00*		—	*45·85*
	9–10	1	—	0·90	1	—	2·52	1	—	4·48
			—	*9·15*		—	*25·63*		—	*45·60*
	10–11	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	11–12	3	0·83 – 0·98	0·92	3	2·78 – 2·88	2·83	3	4·98 – 5·06	5·02
			7·35 – 8·62	*8·08*		*24·59 –24·88*	*24·77*		*43·65 –44·40*	*43·61*
	12–13	4	0·88 – 1·20	0·99	4	2·85 – 2·99	2·91	3	5·05 – 5·35	5·15
			7·16 – 9·27	*7·89*		*22·79 –24·38*	*23·36*		*41·15 –42·63*	*41·65*
	13–14	5	0·92 – 1·08	1·03	5	2·90 – 3·32	3·09	5	5·25 – 5·77	5·53
			7·08 – 8·40	*7·86*		*22·14 –24·74*	*23·56*		*40·38 –44·40*	*42·13*
	14–15	3	1·09 – 1·25	1·16	4	3·36 – 3·46	3·40	4	5·80 – 6·50	6·06
			7·79 – 8·47	*8·04*		*23·39 –24·53*	*23·89*		*37·50 –48·68*	*44·39*

		15. Length of base of dorsal fin			16. Axilla to tip of flipper			17. Anterior end of lower border to tip of flipper		
	Metre lengths	No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	0–1	4	0·030– 0·065	0·043	4	0·080– 0·190	0·130	4	0·100– 0·240	0·160
			5·32 –10·00	*7·71*		*21·05 –22·50*	*21·81*		*25·33 –28·24*	*26·85*
Whale	8–9	1	—	0·55	1	—	2·20	1	—	2·45
			—	*6·55*		—	*26·21*		—	*29·20*
	9–10	1	—	0·85	1	—	2·65	1	—	3·22
			—	*8·65*		—	*27·00*		—	*32·80*
	10–11	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	11–12	3	0·85 – 1·00	0·94	3	2·89 – 3·25	3·02	3	3·39 – 3·50	3·45
			7·32 – 8·79	*8·25*		*25·18 –28·60*	*26·45*		*29·84 –30·79*	*30·21*
	12–13	4	0·80 – 1·40	1·13	4	3·00 – 3·84	3·55	4	3·62 – 4·10	3·90
			6·37 –11·00	*9·11*		*23·90 –31·31*	*28·58*		*28·84 –32·39*	*31·27*
	13–14	5	1·35 – 1·50	1·18	5	3·27 – 3·87	3·48	5	3·70 – 4·41	3·94
			6·33 –11·54	*9·03*		*24·59 –29·41*	*26·71*		*28·29 –33·59*	*30·03*
	14–15	4	1·00 – 1·80	1·29	4	3·40 – 4·40	3·77	4	4·06 – 4·63	4·25
			6·89 –12·20	*8·74*		*23·05 –26·50*	*26·23*		*28·70 –31·91*	*29·59*

Table V. *Humpback whale. Males. South Georgia*

Measurements: actual values in metres (roman type); expressed as percentages of total length (italic type).

	Metre lengths	6. Tip of snout to tip of flipper: No. of measurements	Range	Mean	7. Centre of eye to centre of ear: No. of measurements	Range	Mean	8. Notch of flukes to posterior emargination of dorsal fin: No. of measurements	Range	Mean
Foetus	0–1	3	0·225–0·515	0·390	4	0·03 – 0·06	0·042	4	0·145–0·240	0·192
			57·33 –60·59	*59·04*		*6·67 – 7·89*	*7·28*		*26·47 –40·00*	*34·15*
Whale	8–9	—	—	—	1	—	0·38	1	—	2·85
			—	—		—	*4·53*		—	*33·95*
	9–10	—	—	—	1	—	0·44	1	—	3·2
			—	—		—	*4·47*		—	*32·59*
	10–11	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	11–12	—	—	—	3	0·48 – 0·60	0·52	3	3·75 – 4·14	3·95
			—	—		*4·14 – 5·27*	*4·61*		*33·20 –35·70*	*34·58*
	12–13	1	—	8·44	4	0·57 – 0·60	0·58	4	3·97 – 4·2	4·06
			—	*68·65*		*4·54 – 4·73*	*4·67*		*30·71 –33·40*	*32·32*
	13–14	1	—	8·02	5	0·42 – 0·61	0·55	4	4·00 – 4·51	4·29
			—	*61·65*		*3·23 – 4·66*	*4·18*		*30·77 –34·70*	*32·70*
	14–15	1	—	8·89	3	0·65 – 0·67	0·65	4	4·45 – 4·85	4·68
			—	*63·15*		*4·54 – 4·62*	*4·58*		*31·65 –33·45*	*32·61*

	Metre lengths	12. Notch of flukes to end of system of ventral grooves: No. of measurements	Range	Mean	13. Centre of anus to centre of reproductive aperture: No. of measurements	Range	Mean	14. Vertical height of dorsal fin: No. of measurements	Range	Mean
Foetus	0–1	2	0·360– 0·385	0·372	4	0·030– 0·080	0·051	2	0·010– 0·018	0·014
			45·29 –48·00	*46·14*		*7·50 – 9·41*	*8·53*		*1·33 – 2·12*	*1·72*
Whale	8–9	1	—	3·6	1	—	1·0	1	—	0·25
			—	*42·85*		—	*11·91*		—	*2·98*
	9–10	1	—	4·6	1	—	1·08	—	—	—
			—	*46·80*		—	*10·95*		—	—
	10–11	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	11–12	3	4·92 – 5·06	5·00	3	1·2	1·20	2	0·24 – 0·25	0·245
			42·45 –44·75	*43·81*		*10·34 –10·62*	*10·50*		*2·07 – 2·21*	*2·14*
	12–13	4	4·90 – 5·30	5·11	3	1·18 – 1·31	1·24	4	0·24 – 0·32	0·28
			39·90 –41·44	*40·98*		*9·62 –10·49*	*10·10*		*1·91 – 2·50*	*2·30*
	13–14	5	5·10 – 5·70	5·32	5	1·20 – 1·45	1·32	5	0·26 – 0·37	0·31
			38·93 –43·90	*40·55*		*9·23 –11·15*	*10·09*		*1·98 – 2·85*	*2·37*
	14–15	4	5·50 – 6·50	5·99	4	1·17 – 1·46	1·35	4	0·28 – 0·46	0·37
			37·29 –44·80	*41·73*		*8·33 –10·70*	*9·55*		*1·93 – 3·12*	*2·57*

	Metre lengths	19. Greatest width of flipper: No. of measurements	Range	Mean	20. Length of severed head from condyle to tip: No. of measurements	Range	Mean	21. Greatest width of skull: No. of measurements	Range	Mean
Foetus	0–1	4	0·020– 0·058	0·037	—	—	—	4	0·100– 0·900	0·331
			5·26 – 6·82	*6·14*		—	—		*18·62 –25·00*	*22·28*
Whale	8–9	1	—	0·65	1	—	2·15	1	—	1·45
			—	*7·74*		—	*25·62*		—	*17·20*
	9–10	1	—	0·75	1	—	2·77	1	—	1·75
			—	*7·64*		—	*28·19*		—	*17·80*
	10–11	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	11–12	3	0·75 – 0·91	0·85	2	3·42 – 3·51	3·46	2	1·91 – 2·17	2·04
			6·59 – 7·96	*7·46*		*30·07 –31·05*	*30·56*		*16·79 –19·20*	*17·99*
	12–13	4	0·78 – 1·00	0·88	3	3·55 – 4·10	3·75	2	1·93 – 2·20	2·06
			7·81 – 6·22	*7·07*		*28·74 –32·03*	*30·10*		*15·62 –17·90*	*16·76*
	13–14	5	0·90 – 1·02	0·95	3	4·30 – 4·40	4·36	3	1·85 – 2·41	2·13
			6·92 – 7·75	*7·24*		*32·66 –33·85*	*33·07*		*14·23 –17·95*	*16·17*
	14–15	4	0·92 – 1·08	0·98	4	4·14 – 5·00	4·45	2	2·18 – 2·30	2·24
			6·48 – 7·64	*6·88*		*29·41 –33·90*	*30·97*		*15·44 –15·59*	*15·51*

Table VI. *Humpback whale. Females, South Georgia*

Measurements: actual values in metres (roman type); expressed as percentages of total length (italic type).

	Metre lengths	3. Tip of snout to blow-hole			4. Tip of snout to angle of gape			5. Tip of snout to centre of eye		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	0–1	3	0·105–0·13	0·115	3	0·13–0·15	0·14	4	0·145–0·170	0·161
			15·70–17·11	*16·40*		*19·75–21·50*	*20·52*		*22·10–22·90*	*22·51*
Whale	8–9	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	9–10	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	10–11	4	1·78–2·06	1·89	4	2·00–2·56	2·36	4	2·25–2·80	2·55
			17·65–19·19	*18·28*		*20·00–23·85*	*22·74*		*22·50–26·10*	*24·56*
	11–12	2	2·33–2·39	2·36	2	2·71–2·82	2·76	3	2·75–3·07	2·88
			19·73–21·00	*20·34*		*23·85–23·90*	*23·87*		*23·61–26·95*	*24·82*
	12–13	4	2·53–2·94	2·65	5	2·85–3·38	3·09	4	3·16–3·56	3·32
			19·88–22·97	*21·05*		*22·30–26·41*	*24·58*		*24·85–27·81*	*26·36*
	13–14	8	2·50–3·70	2·88	8	3·00–3·56	3·28	8	3·31–3·80	3·52
			19·01–27·40	*21·41*		*22·81–26·19*	*24·46*		*25·15–27·35*	*26·20*
	14–15	6	2·92–3·23	3·04	5	3·40–3·83	3·53	6	3·75–4·09	3·88
			19·33–22·75	*20·89*		*22·90–26·90*	*24·06*		*25·25–28·79*	*26·67*

	Metre lengths	9. Width of flukes at insertion			10. Notch of flukes to centre of anus			11. Notch of flukes to umbilicus		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	0–1	3	0·055–0·060	0·058	3	0·170–0·190	0·178	3	0·280–0·300	0·286
			7·90–8·59	*8·35*		*25·00–26·56*	*25·58*		*39·50–43·75*	*41·08*
Whale	8–9	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	9–10	1	—	0·90	1	—	2·45	—	—	—
			—	*9·00*		—	*24·50*		—	—
	10–11	3	0·82–0·89	0·84	3	2·54–2·68	2·63	3	4·65–4·70	4·67
			7·81–8·30	*8·07*		*24·79–25·52*	*25·10*		*43·55–45·80*	*44·54*
	11–12	3	0·92–1·10	1·00	3	2·70–2·98	2·84	3	4·60–5·25	5·00
			8·09–9·44	*8·66*		*23·18–25·24*	*24·52*		*39·48–45·25*	*43·07*
	12–13	5	0·97–1·30	1·08	5	2·72–3·22	2·98	5	5·20–5·90	5·47
			7·66–10·32	*8·63*		*21·25–25·30*	*23·67*		*40·62–46·83*	*43·43*
	13–14	8	1·00–1·30	1·07	8	3·00–3·41	3·16	8	5·35–5·96	5·43
			7·60–9·59	*7·98*		*22·10–25·00*	*23·53*		*33·53–43·50*	*40·46*
	14–15	6	1·07–1·28	1·17	6	3·13–3·70	3·41	6	5·55–6·45	5·91
			7·54–9·08	*8·07*		*22·10–24·92*	*23·34*		*39·10–43·43*	*40·50*

	Metre lengths	15. Length of base of dorsal fin			16. Axilla to tip of flipper			17. Anterior end of lower border to tip of flipper		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	0–1	3	0·024–0·050	0·034	3	0·130–0·150	0·143	3	0·155–0·200	0·180
			3·75–7·14	*4·71*		*19·75–21·50*	*20·52*		*24·22–26·45*	*25·67*
Whale	8–9	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	9–10	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	10–11	4	0·78–1·00	0·93	2	2·65–3·18	2·91	2	3·00–3·32	3·16
			7·61–10·00	*8·99*		*25·85–29·65*	*27·75*		*29·27–30·95*	*30·11*
	11–12	2	0·90–0·94	0·92	3	3·10–3·25	3·17	3	3·30–3·75	3·58
			7·92–7·96	*7·94*		*26·61–27·87*	*27·34*		*29·00–32·19*	*30·84*
	12–13	4	1·00–1·37	1·15	4	3·25–3·67	3·53	3	3·62–4·07	3·91
			7·86–10·70	*9·17*		*26·00–28·90*	*28·16*		*28·96–32·00*	*30·98*
	13–14	7	0·67–1·55	1·05	7	3·34–4·25	3·68	8	3·78–4·41	4·04
			4·91–11·88	*7·86*		*24·76–30·55*	*27·47*		*28·73–31·74*	*30·05*
	14–15	5	1·20–1·60	1·41	6	3·93–4·37	4·14	5	4·36–5·10	4·64
			8·46–10·77	*9·71*		*26·85–29·33*	*28·44*		*30·75–34·23*	*31·81*

Table VI. *Humpback whale. Females, South Georgia*

Measurements: actual values in metres (roman type); expressed as percentages of total length (italic type).

	Metre lengths	6. Tip of snout to tip of flipper: No. of measurements	Range	Mean	7. Centre of eye to centre of ear: No. of measurements	Range	Mean	8. Notch of flukes to posterior emargination of dorsal fin: No. of measurements	Range	Mean
Foetus	0–1	3	0·36 – 0·43	0·40	2	0·05 – 0·06	0·055	3	0·220– 0·250	0·233
			56·25 –58·60	*57·15*		*6·58 – 8·57*	*7·57*		*32·90 –34·38*	*33·39*
Whale	8–9	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	9–10	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	10–11	—	—	—	4	0·44 – 0·51	0·47	4	2·56 – 3·66	3·28
			—	—		*4·11 – 4·86*	*4·56*		*23·85 –34·86*	*31·65*
	11–12	—	—	—	2	0·48 – 0·49	0·485	2	3·80 – 3·98	3·89
			—	—		*4·07 – 4·31*	*4·19*		*33·41 –33·76*	*33·58*
	12–13	1	—	8·24	2	0·53 – 0·61	0·57	4	4·06 – 4·43	4·17
			—	*66·60*		*4·24 – 4·94*	*4·59*		*31·72 –34·80*	*33·17*
	13–14	1	—	8·4	6	0·55 – 0·68	0·62	7	4·13 – 4·50	4·31
			—	*61·99*		*4·18 – 5·02*	*4·50*		*30·90 –33·25*	*32·29*
	14–15	1	—	9·40	6	0·63 – 0·76	0·69	5	4·35 – 4·90	4·62
			—	*63·09*		*4·34 – 5·10*	*4·50*		*29·94 –32·89*	*31·84*

	Metre lengths	12. Notch of flukes to end of system of ventral grooves: No. of measurements	Range	Mean	13. Centre of anus to centre of reproductive aperture: No. of measurements	Range	Mean	14. Vertical height of dorsal fin: No. of measurements	Range	Mean
Foetus	0–1	3	0·320– 0·330	0·323	3	0·015– 0·030	0·021	3	0·003– 0·010	0·006
			43·40 –50·00	*46·35*		*2·34 – 4·29*	*3·08*		*1·89 – 2·27*	*2·06*
Whale	8–9	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	9–10	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	10–11	4	4·40 – 4·81	4·59	4	0·42 – 0·62	0·52	4	0·19 – 0·27	0·23
			42·86 –43·55	*44·32*		*3·92 – 5·90*	*4·99*		*1·77 – 2·63*	*2·22*
	11–12	2	5·08 – 5·38	5·23	3	0·35 – 0·70	0·51	2	0·20 – 0·25	0·22
			44·70 –45·60	*45·15*		*3·00 – 5·93*	*4·44*		*1·76 – 2·12*	*1·94*
	12–13	3	5·05 – 5·18	5·10	5	0·32 – 0·69	0·48	4	0·22 – 0·25	0·23
			39·77 –40·60	*40·25*		*2·54 – 5·58*	*3·70*		*1·78 – 1·96*	*1·86*
	13–14	6	4·73 – 5·57	5·15	8	0·38 – 0·53	0·45	7	0·26 – 0·35	0·25
			34·60 –42·35	*38·41*		*2·80 – 3·92*	*3·39*		*1·90 – 2·60*	*2·28*
	14–15	5	5·33 – 6·30	5·73	6	0·35 – 0·58	0·48	5	0·28 – 0·32	0·30
			37·58 –42·42	*33·41*		*2·35 – 3·90*	*3·30*		*1·89 – 2·27*	*2·06*

	Metre lengths	19. Greatest width of flipper: No. of measurements	Range	Mean	20. Length of severed head from condyle to tip: No. of measurements	Range	Mean	21. Greatest width of skull: No. of measurements	Range	Mean
Foetus	0–1	3	0·035– 0·045	0·040	—	—	—	3	0·140– 0·150	0·146
			5·47 – 5·93	*5·71*		—	—		*18·45 –23·43*	*21·12*
Whale	8–9	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	9–10	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	10–11	3	0·76 – 0·80	0·77	3	3·00 – 3·27	3·11	3	1·67 – 2·04	1·87
			7·33 – 7·45	*7·39*		*29·14 –30·45*	*29·62*		*15·90 –19·00*	*17·84*
	11–12	2	0·85 – 0·90	0·87	3	3·35 – 3·50	3·42	2	1·90 – 2·19	2·04
			7·20 – 7·92	*7·76*		*28·40 –30·05*	*29·49*		*16·31 –19·25*	*17·78*
	12–13	4	0·87 – 0·97	0·91	2	3·80 – 3·83	3·81	2	2·11 – 2·25	2·18
			6·96 – 7·70	*7·25*		*30·10 –30·40*	*30·25*		*16·88 –17·66*	*17·51*
	13–14	7	0·87 – 1·00	0·92	6	3·85 – 4·47	4·11	6	2·01 – 2·47	2·25
			7·38 – 6·44	*6·68*		*29·28 32·15*	*30·49*		*15·29 –17·75*	*16·66*
	14–15	6	1·00 – 1·17	1·06	5	4·35 – 4·77	4·50	4	2·36 – 2·44	2·39
			6·71 – 8·05	*7·14*		*29·29 –33·60*	*31·06*		*15·89 –17·02*	*16·41*

Table VII. *Humpback whale. Males, South Africa*

Measurements: actual values in metres (roman type); expressed as percentages of total length (italic type).

Metre lengths	3. Tip of snout to blow-hole: No. of measurements	Range	Mean	4. Tip of snout to angle of gape: No. of measurements	Range	Mean	5. Tip of snout to centre of eye: No. of measurements	Range	Mean
Whale 8–9	1	—	1·65	1	—	1·85	1	—	2·00
		—	*20·65*		—	*23·15*		—	*25·00*
9–10	4	1·75– 1·86	1·82	4	2·16– 3·12	2·40	4	2·32– 2·39	2·36
		18·35–19·19	*18·68*		*20·43–32·19*	*24·49*		*23·94–24·60*	*24·18*
10–11	1	—	1·95	1	—	2·44	1	—	2·53
		—	*17·80*		—	*22·29*		—	*23·11*
11–12	2	2·05– 2·40	2·22	2	2·70– 2·88	2·79	3	2·90– 3·07	2·97
		17·83–20·15	*18·09*		*23·48–24·21*	*23·84*		*25·22–25·95*	*22·32*
12–13	2	2·35– 2·60	2·47	—	—	—	3	2·85– 3·50	3·21
		18·35–20·47	*19·41*		—	—		*22·35–27·56*	*25·23*
13–14	—	—	—	—	—	—	1	—	3·53
		—	—		—	—		—	*26·85*

Metre lengths	9. Width of flukes at insertion: No. of measurements	Range	Mean	10. Notch of flukes to centre of anus: No. of measurements	Range	Mean	11. Notch of flukes to umbilicus: No. of measurements	Range	Mean
Whale 8–9	1	—	0·70	1	—	2·05	1	—	3·45
		—	*8·75*		—	*25·65*		—	*43·10*
9–10	4	0·71– 1·00	0·82	2	2·30– 2·55	2·42	4	4·00– 4·30	4·17
		7·16–10·08	*8·41*		*23·74–25·71*	*24·72*		*41·90–43·40*	*42·74*
10–11	1	—	0·95	1	—	2·55	1	—	4·60
		—	*8·66*		—	*20·36*		—	*42·00*
11–12	3	0·92– 1·00	0·95	3	2·75– 3·00	2·85	3	4·65– 5·20	4·88
		7·97– 8·69	*8·15*		*21·95–25·22*	*23·70*		*37·65–43·65*	*40·59*
12–13	2	1·02– 1·04	1·03	3	2·95– 3·35	2·20	2	4·70– 5·35	5·02
		8·03– 8·14	*8·08*		*23·23–26·19*	*25·15*		*36·75–42·13*	*39·44*
13–14	—	—	—	1	—	2·98	—	—	—
		—	—		—	*22·66*		—	—

Metre lengths	15. Length of base of dorsal fin: No. of measurements	Range	Mean	16. Axilla to tip of flipper: No. of measurements	Range	Mean	17. Anterior end of lower border to tip of flipper: No. of measurements	Range	Mean
Whale 8–9	1	—	0·50	—	—	—	—	—	—
		—	*6·25*		—	—		—	—
9–10	4	0·71– 1·10	0·88	3	2·17– 3·12	2·65	3	2·85– 3·20	3·07
		7·15–11·09	*9·02*		*22·74–31·22*	*26·99*		*29·87–32·21*	*30·64*
10–11	1	—	0·70	1	—	3·15	—	—	—
		—	*6·39*		—	*28·76*		—	—
11–12	2	1·0 – 1·10	1·05	1	—	2·8	1	—	3·5
		8·40– 9·57	*8·98*		—	*24·35*		—	*30·42*
12–13	1	—	0·8	—	—	—	—	—	—
		—	*6·30*		—	—		—	—
13–14	—	—	—	—	—	—	—	—	—
		—	—		—	—		—	—

Table VII. *Humpback whale. Males, South Africa*

Measurements; actual values in metres (roman type); expressed as percentages of total length (italic type).

	Metre lengths	6. Tip of snout to tip of flipper: No. of measurements	6. Range	6. Mean	7. Centre of eye to centre of ear: No. of measurements	7. Range	7. Mean	8. Notch of flukes to posterior emargination of dorsal fin: No. of measurements	8. Range	8. Mean
Whale	8–9	—	—	—	1	—	0·40	1	—	2·55
			—	—		—	*5·00*		—	*31·89*
	9–10	1	—	5·85	2	0·47–0·51	0·49	4	3·10–3·60	3·31
			—	*61·35*		*4·92–5·40*	*5·16*		*32·25–37·13*	*33·01*
	10–11	—	—	—	1	—	0·55	1	—	3·65
			—	—		—	*5·02*		—	*33·34*
	11–12	1	—	6·70	2	0·50–0·56	0·53	2	3·75–4·00	3·87
			—	*58·30*		*4·35–4·71*	*4·53*		*32·50–33·62*	*33·10*
	12–13	—	—	—	1	—	0·60	1	—	3·95
			—	—		—	*4·72*		—	*31·10*
	13–14	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—

	Metre lengths	12. Notch of flukes to end of system of ventral grooves: No. of measurements	12. Range	12. Mean	13. Centre of anus to centre of reproductive aperture: No. of measurements	13. Range	13. Mean	14. Vertical height of dorsal fin: No. of measurements	14. Range	14. Mean
Whale	8–9	1	—	3·38	1	—	0·70	1	—	0·13
			—	*42·30*		—	*8·75*		—	*1·65*
	9–10	4	4·05–4·48	4·27	4	0·80–0·95	0·86	4	0·15–0·26	0·20
			41·75–45·16	*43·62*		*8·25–9·57*	*8·82*		*1·57–2·62*	*2·04*
	10–11	1	—	4·65	1	—	1·00	1	—	0·22
			—	*42·45*		—	*9·14*		—	*2·01*
	11–12	2	4·6–5·0	4·8	2	1·10–1·30	1·20	2	0·20–0·25	0·225
			40·00–42·00	*41·00*		*9·57–10·93*	*10·25*		*1·68–2·17*	*1·92*
	12–13	1	—	5·35	1	—	1·25	1	—	0·34
			—	*42·13*		—	*9·84*		—	*2·68*
	13–14	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—

	Metre lengths	19. Greatest width of flipper: No. of measurements	19. Range	19. Mean	20. Length of severed head for condyle to tip: No. of measurements	20. Range	20. Mean	21. Greatest width of skull: No. of measurements	21. Range	21. Mean
Whale	8–9	1	—	0·58	1	—	2·26	1	—	1·27
			—	*7·26*		—	*28·28*		—	*15·89*
	9–10	4	0·55–0·72	0·67	3	2·75–3·15	2·91	4	1·40–1·70	1·57
			5·68–7·54	*6·83*		*28·38–33·00*	*26·70*		*14·11–17·29*	*16·33*
	10–11	1	—	0·85	—	—	—	—	—	—
			—	*7·76*		—	—		—	—
	11–12	2	0·78–0·90	0·84	1	—	3·63	2	1·90–1·92	1·91
			6·56–7·83	*7·19*		—	*30·40*		*16·14–16·52*	*16·33*
	12–13	1	—	0·94	—	—	—	1	—	2·2
			—	*7·40*		—	—		—	*17·19*
	13–14	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—

Table VIII. *Humpback whale. Females, South Africa*

Measurements: actual values in metres (roman type); expressed as percentages of total length (italic type).

Whale Metre lengths	3. Tip of snout to blow-hole: No. of measurements	Range	Mean	4. Tip of snout to angle of gape: No. of measurements	Range	Mean	5. Tip of snout to centre of eye: No. of measurements	Range	Mean
8–9	—	—	—	—	—	—	—	—	—
		—	—		—	—		—	—
9–10	3	1·75– 2·00	1·90	3	2·20– 2·45	2·28	3	2·36– 2·70	2·51
		18·45–20·20	*19·43*		*22·18–24·79*	*23·35*		*24·89–27·30*	*25·73*
10–11	—	—	—	—	—	—	—	—	—
		—	—		—	—		—	—
11–12	1	—	2·5	1	—	2·95	1	—	3·1
		—	*22·18*		—	*26·18*		—	*27·51*
12–13	—	—	—	—	—	—	—	—	—
		—	—		—	—		—	—
13–14	—	—	—	—	—	—	—	—	—
		—	—		—	—		—	—
14–15	1	—	2·8	—	—	—	1	—	3·6
		—	*20·00*		—	—		—	*25·70*

Whale Metre lengths	9. Width of flukes at insertion: No. of measurements	Range	Mean	10. Notch of flukes to centre of anus: No. of measurements	Range	Mean	11. Notch of flukes to umbilicus: No. of measurements	Range	Mean
8–9	—	—	—	—	—	—	—	—	—
		—	—		—	—		—	—
9–10	2	0·80– 0·87	0·83	3	2·32– 2·65	2·45	3	3·92– 4·65	4·35
		8·06– 8·79	*8·42*		*24·17–26·79*	*25·13*		*41·25–46·95*	*44·52*
10–11	—	—	—	—	—	—	—	—	—
		—	—		—	—		—	—
11–12	1	—	0·84	1	—	2·8	1	—	4·9
		—	*7·45*		—	*24·84*		—	*43·48*
12–13	—	—	—	—	—	—	—	—	—
		—	—		—	—		—	—
13–14	—	—	—	—	—	—	—	—	—
		—	—		—	—		—	—
14–15	1	—	1·08	1	—	5·33	1	—	5·9
		—	*7·72*		—	*38·10*		—	*42·15*

Whale Metre lengths	15. Length of base of dorsal fin: No. of measurements	Range	Mean	16. Axilla to tip of flipper: No. of measurements	Range	Mean	17. Anterior end of lower border to tip of flipper: No. of measurements	Range	Mean
8–9	—	—	—	—	—	—	—	—	—
		—	—		—	—		—	—
9–10	2	0·85– 1·00	0·94	3	2·65– 2·73	2·70	3	3·11– 3·20	3·17
		8·57–10·1	*9·33*		*27·42–27·92*	*27·64*		*31·35–33·70*	*32·46*
10–11	—	—	—	—	—	—	—	—	—
		—	—		—	—		—	—
11–12	1	—	1·15	1	—	3·1	1	—	3·65
		—	*10·20*		—	*27·51*		—	*32·39*
12–13	—	—	—	—	—	—	—	—	—
		—	—		—	—		—	—
13–14	—	—	—	—	—	—	—	—	—
		—	—		—	—		—	—
14–15	—	—	—	—	—	—	—	—	—
		—	—		—	—		—	—

Table VIII. *Humpback whale. Females, South Africa*

Measurements: actual values in metres (roman type); expressed as percentages of total length (italic type).

Metre lengths	6. Tip of snout to tip of flipper: No. of measurements	Range	Mean	7. Centre of eye to centre of ear: No. of measurements	Range	Mean	8. Notch of flukes to posterior emargination of dorsal fin: No. of measurements	Range	Mean
Whale 8–9	—	— —	— —	—	— —	— —	—	— —	— —
9–10	1	— —	6·12 *64·4*	2	0·47– 0·5 *4·74– 5·06*	0·48 *4·90*	2	3·40– 3·50 *34·27–35·39*	3·45 *34·83*
10–11	—	— —	— —	—	— —	— —	—	— —	— —
11–12	—	— —	— —	1	— —	0·52 *4·61*	1	— —	3·55 *31·50*
12–13	—	— —	— —	—	— —	— —	—	— —	— —
13–14	—	— —	— —	—	— —	— —	—	— —	— —
14–15	—	— —	— —	—	— —	— —	1	— —	4·5 *32·15*

Metre lengths	12. Notch of flukes to end of system of ventral grooves: No. of measurements	Range	Mean	13. Centre of anus to centre of reproductive aperture: No. of measurements	Range	Mean	14. Vertical height of dorsal fin: No. of measurements	Range	Mean
Whale 8–9	—	— —	— —	—	— —	— —	—	— —	— —
9–10	3	3·9 – 4·60 *41·10–46·47*	4·33 *44·31*	3	0·39– 0·45 *4·03– 4·55*	0·41 *4·17*	2	0·20– 0·27 *2·02– 2·72*	0·235 *2·37*
10–11	—	— —	— —	—	— —	— —	—	— —	— —
11–12	1	— —	5·0 *44·37*	1	— —	0·47 *4·17*	1	— —	0·34 *3·02*
12–13	—	— —	— —	—	— —	— —	—	— —	— —
13–14	—	— —	— —	—	— —	— —	—	— —	— —
14–15	—	— —	— —	1	— —	0·65 *4·64*	—	— —	— —

Metre lengths	19. Greatest width of flipper: No. of measurements	Range	Mean	20. Length of severed head from condyle to tip: No. of measurements	Range	Mean	21. Greatest width of skull: No. of measurements	Range	Mean
Whale 8–9	—	— —	— —	—	— —	— —	—	— —	— —
9–10	3	0·69– 0·73 *7·27– 7·38*	0·71 *7·33*	2	2·95– 3·41 *29·74–34·45*	3·18 *32·09*	2	1·64– 1·90 *16·53–19·19*	1·77 *17·86*
10–11	—	— —	— —	—	— —	— —	—	— —	— —
11–12	1	— —	0·84 *7·45*	1	— —	3·5 *31·06*	1	— —	1·64 *14·55*
12–13	—	— —	— —	—	— —	— —	—	— —	— —
13–14	—	— —	— —	—	— —	— —	—	— —	— —
14–15	1	— —	0·91 *6·49*	—	— —	— —	—	— —	— —

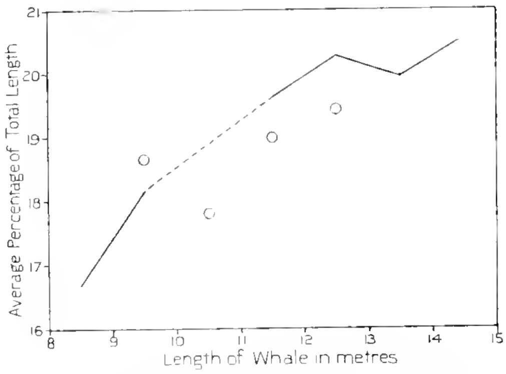

Fig. 1. Male Humpback whales. Measurement no. 3. Tip of snout to blow-hole.

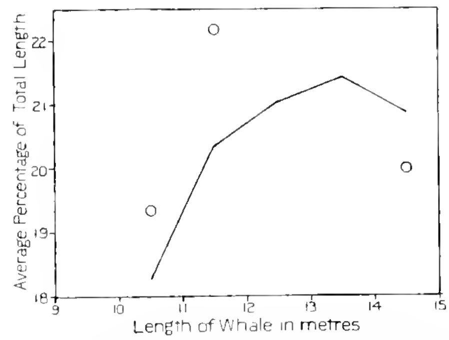

Fig. 2. Female Humpback whales. Measurement no. 3. Tip of snout to blow-hole.

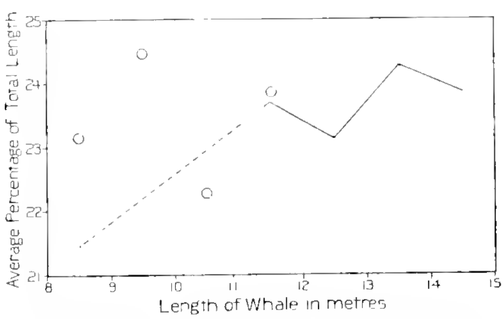

Fig. 3. Male Humpback whales. Measurement no. 4. Tip of snout to angle of gape.

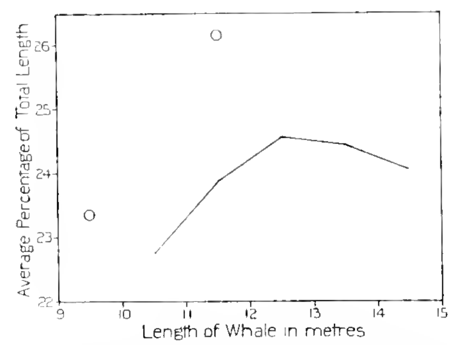

Fig. 4. Female Humpback whales. Measurement no. 4. Tip of snout to angle of gape.

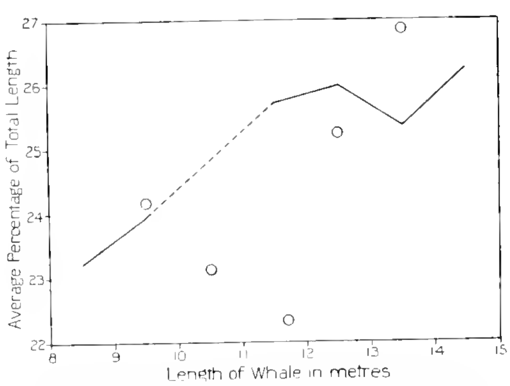

Fig. 5. Male Humpback whales. Measurement no. 5. Tip of snout to centre of eye.

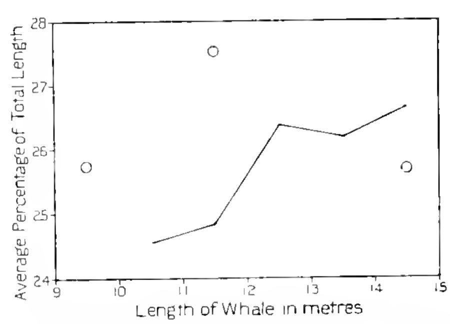

Fig. 6. Female Humpback whales. Measurement no. 5. Tip of snout to centre of eye.

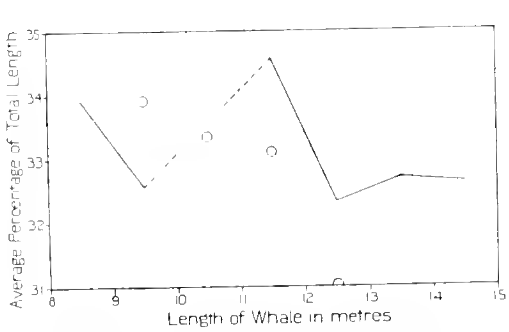

Fig. 7. Male Humpback whales. Measurement no. 8. Notch of flukes to posterior emargination of dorsal fin.

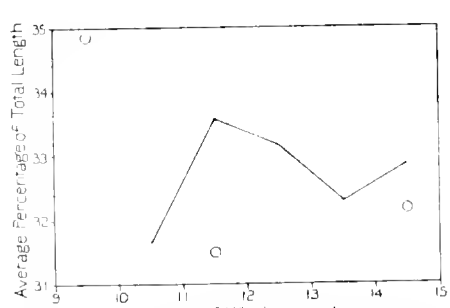

Fig. 8. Female Humpback whales. Measurement no. 8. Notch of flukes to posterior emargination of dorsal fin.

The graphs are from data obtained at South Georgia. Data from South Africa are indicated by ○.

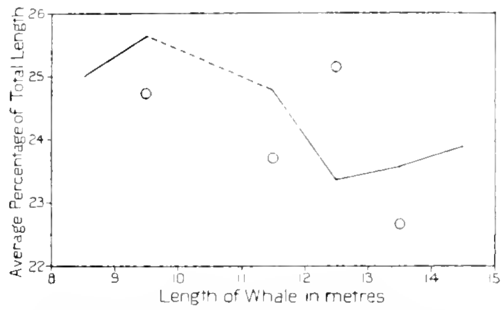

Fig. 9. Male Humpback whales. Measurement no. 10. Notch of flukes to centre of anus.

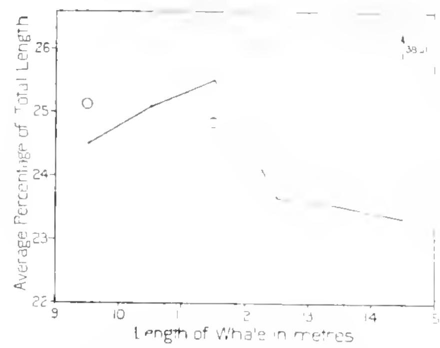

Fig. 10. Female Humpback whales. Measurement no. 10. Notch of flukes to centre of anus.

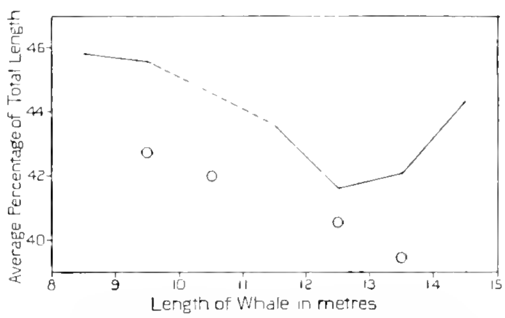

Fig. 11. Male Humpback whales. Measurement no. 11. Notch of flukes to umbilicus.

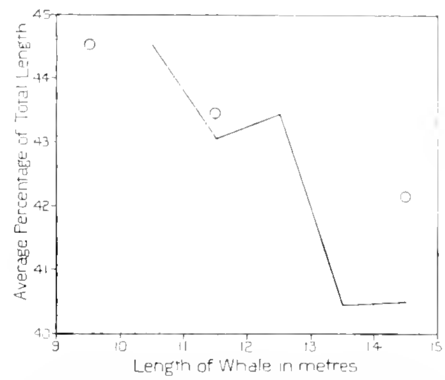

Fig. 12. Female Humpback whales. Measurement no. 11. Notch of flukes to umbilicus.

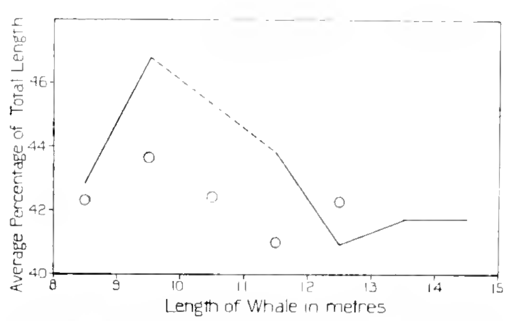

Fig. 13. Male Humpback whales. Measurement no. 12. Notch of flukes to'end of system of ventral grooves.

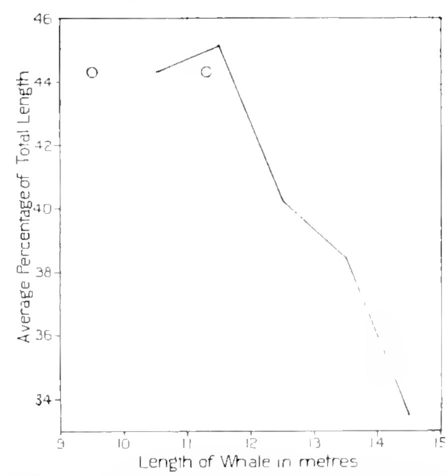

Fig. 14. Female Humpback whales. Measurement no. 12. Notch of flukes to end of system of ventral grooves.

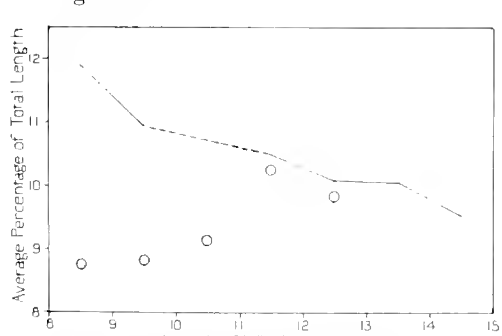

Fig. 15. Male Humpback whales. Measurement no. 13. Centre of anus to centre of reproductive aperture.

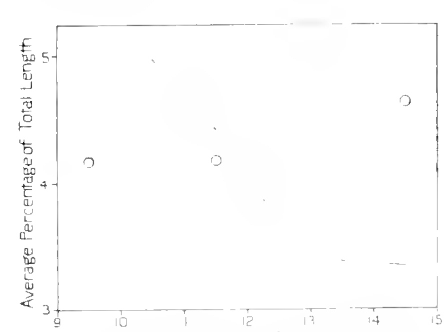

Fig. 16. Female Humpback whales. Measurement no. 13. Centre of anus to centre of reproductive aperture.

The graphs are from data obtained at South Georgia. Data from South Africa are indicated by ○.

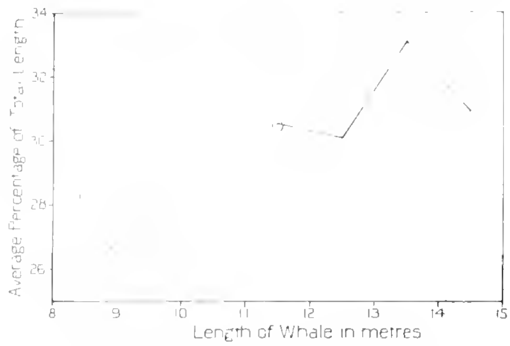

Fig. 17. Male Humpback whales. Measurement no. 20. Length of severed head from condyle to tip.

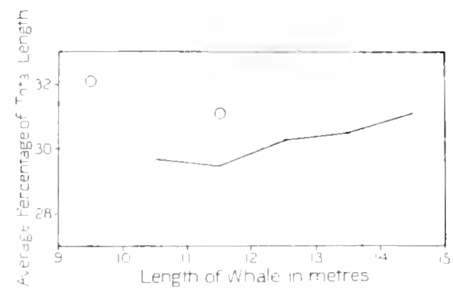

Fig. 18. Female Humpback whales. Measurement no. 20. Length of severed head from condyle to tip.

Fig. 19. Male Humpback whales. Measurement no. 21. Greatest width of skull.

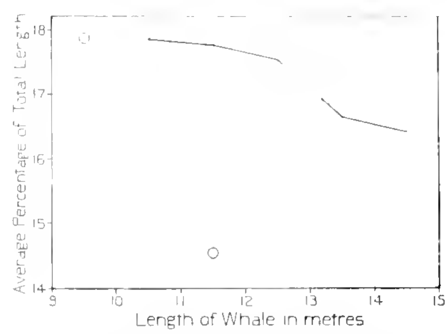

Fig. 20. Female Humpback whales. Measurement no. 21. Greatest width of skull.

The graphs are from data obtained at South Georgia. Data from South Africa are indicated by ○.

COLOUR

The general coloration of the Humpback whale is black above and white below, but, as is well known, a great variety of individual variation in the respective amounts of black and white occurs, no two specimens being identical in colour. Lillie (1915) classified the coloration of the New Zealand Humpback whales on which he worked into four main and three intermediate types. His figure illustrating the four main types is here reproduced for reference (Fig. 38), the three intermediate types being 1–2, 2–3, 3–4. Lillie shows that the black dorsal coloration tends to creep down round the sides in three bands which coalesce in the extreme type, one behind the flipper and over the posterior part of the ventral grooves, one below the dorsal fin, and one a short distance proximal to the insertion of the tail flukes. His colour groups are stages in the progressive covering of the ventral surface by the encroachment of the dorsal black pigment over the flanks and belly.

The analysis of the coloration of the Humpback whales examined by the Discovery staff from South Georgia and South Africa (treated together), compared with Lillie's Terra-Nova Expedition New Zealand whales, is given in Table X. The Discovery data refer to fifty-three specimens, twenty-five males and twenty-eight females: those of the Terra-Nova refer to thirty specimens, seventeen males and thirteen females. Lillie's

Table IX. *Humpback whales. Variation of measurements. South Georgia*

3. Tip of snout to blow-hole

Range of values (% of total length)	No. of readings ♂	♀
17–18	0	2
18–19	3	1
19–20	5	5
20–21	5	6
21–22	4	5
22–23	0	2

4. Tip of snout to angle of gape

Range of values (% of total length)	No. of readings ♂	♀
20–22	2	2
22–24	7	3
24–26	6	1
32–33	0	1

5. Tip of snout to centre of eye

Range of values (% of total length)	No. of readings ♂	♀
21–22	1	0
22–23	0	1
23–24	2	2
24–25	3	3
25–26	4	5
26–27	4	9
27–28	4	3
28–29	0	1

7. Centre of eye to centre of ear

Range of values (% of total length)	No. of readings ♂	♀
3·0–3·5	1	0
3·5–4·0	1	0
4·0–4·5	4	7
4·5–5·0	10	9
5·0–5·5	1	4

8. Notch of flukes to posterior emargination of dorsal fin

Range of values (% of total length)	No. of readings ♂	♀
23–24	0	1
29–30	0	1
30–31	2	2
31–32	0	3
32–33	5	5
33–34	6	7
34–35	2	3
35–36	1	0

9. Width of flukes at insertion

Range of values (% of total length)	No. of readings ♂	♀
7·0– 7·5	5	0
7·5– 8·0	3	12
8·0– 8·5	5	7
8·5– 9·0	1	0
9·0– 9·5	2	3
9·5–10·0	1	2
10·0–10·5	0	1

10. Notch of flukes to centre of anus

Range of values (% of total length)	No. of readings ♂	♀
21–22	0	1
22–23	3	6
23–24	6	6
24–25	7	5
25–26	2	8

11. Notch of flukes to umbilicus

Range of values (% of total length)	No. of readings ♂	♀
33–35	0	1
39–41	3	9
41–43	7	5
43–45	5	7
45–47	2	3

12. Notch of flukes to end of system of ventral grooves

Range of values (% of total length)	No. of readings ♂	♀
36–38	1	4
38–40	4	5
40–42	5	2
42–44	3	4
44–46	4	3
46–48	1	1

13. Centre of anus to centre of reproductive aperture

Range of values (% of total length)	No. of readings ♂	♀
2–3	—	4
3–4	—	14
4–5	—	3
5–6	—	4
8–9	1	—
9–10	5	—
10–11	9	—
11–12	2	—

14. Vertical height of dorsal fin

Range of values (% of total length)	No. of readings ♂	♀
1·75–2·00	3	8
2·00–2·25	4	7
2·25–2·50	3	4
2·50–2·75	1	3
2·75–3·00	4	0
3·00–3·25	1	0

15. Length of base of dorsal fin

Range of values (% of total length)	No. of readings ♂	♀
4–6	0	2
6–8	6	6
8–10	7	8
10–12	4	6
12–14	1	0

16. Axilla to tip of flipper

Range of values (% of total length)	No. of readings ♂	♀
23–25	3	2
25–27	8	3
27–29	3	11
29–31	3	5
31–33	1	0

17. Anterior end of lower border to tip of flipper

Range of values (% of total length)	No. of readings ♂	♀
27–29	6	0
29–31	6	10
31–33	5	8
33–35	1	1

19. Greatest width of flipper

Range of values (% of total length)	No. of readings ♂	♀
6·0–6·5	2	1
6·5–7·0	6	7
7·0–7·5	3	11
7·5–8·0	7	3

20. Length of severed head from condyle to tip

Range of values (% of total length)	No. of readings ♂	♀
25–27	1	0
27–29	2	1
29–31	5	13
31–33	4	4
33–35	2	1

21. Greatest width of skull

Range of values (% of total length)	No. of readings ♂	♀
14–15	1	0
15–16	3	5
16–17	2	5
17–18	4	4
18–19	0	1
19–20	1	2

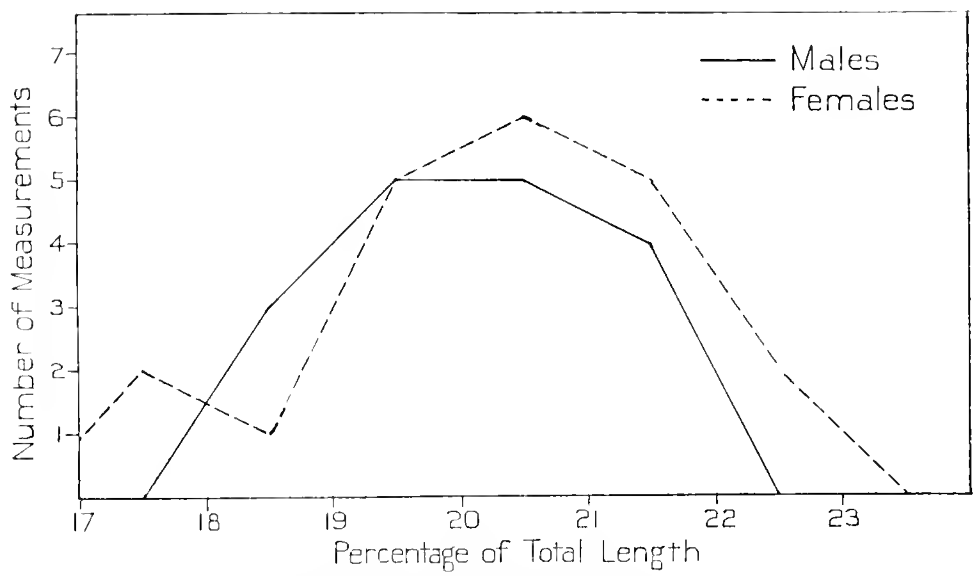

Fig. 21. Humpback whales. Variation of measurement no. 3. Tip of snout to blow-hole.

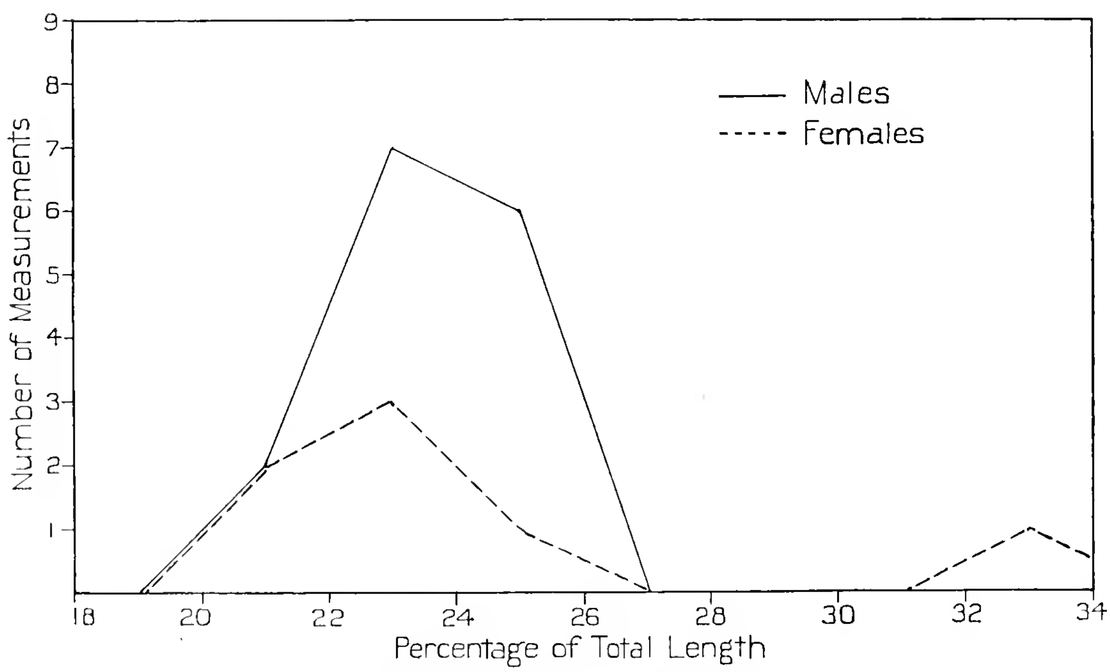

Fig. 22. Humpback whales. Variation of measurement no. 4. Tip of snout to angle of gape.

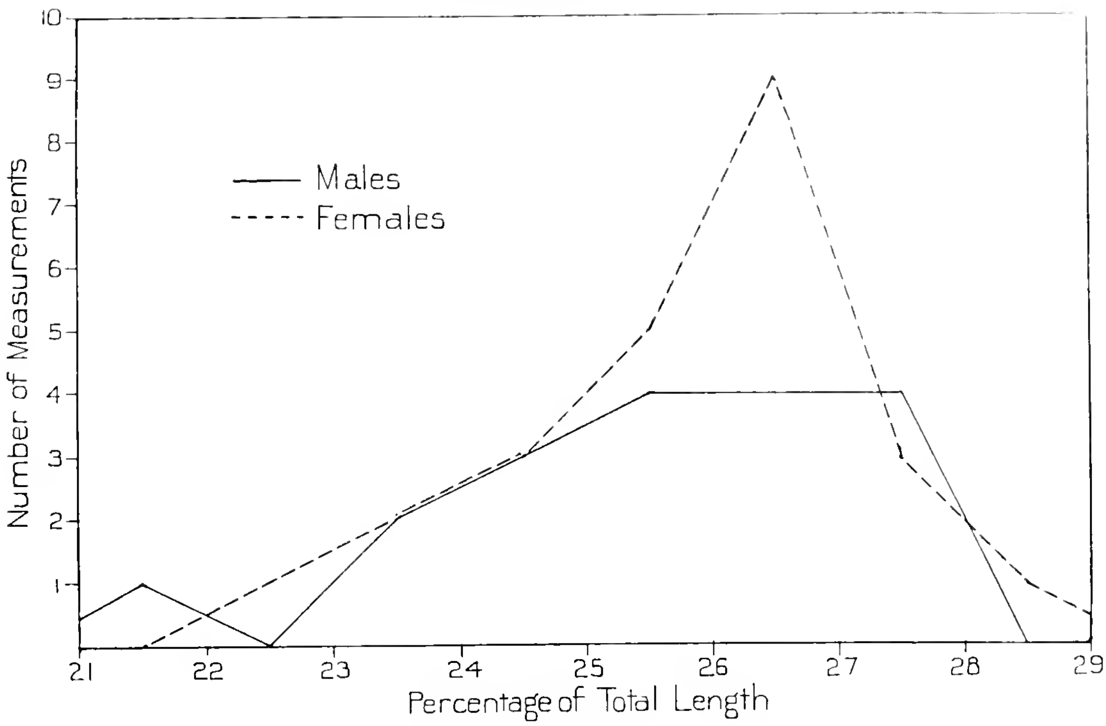

Fig. 23. Humpback whales. Variation of measurement no. 5. Tip of snout to centre of eye.

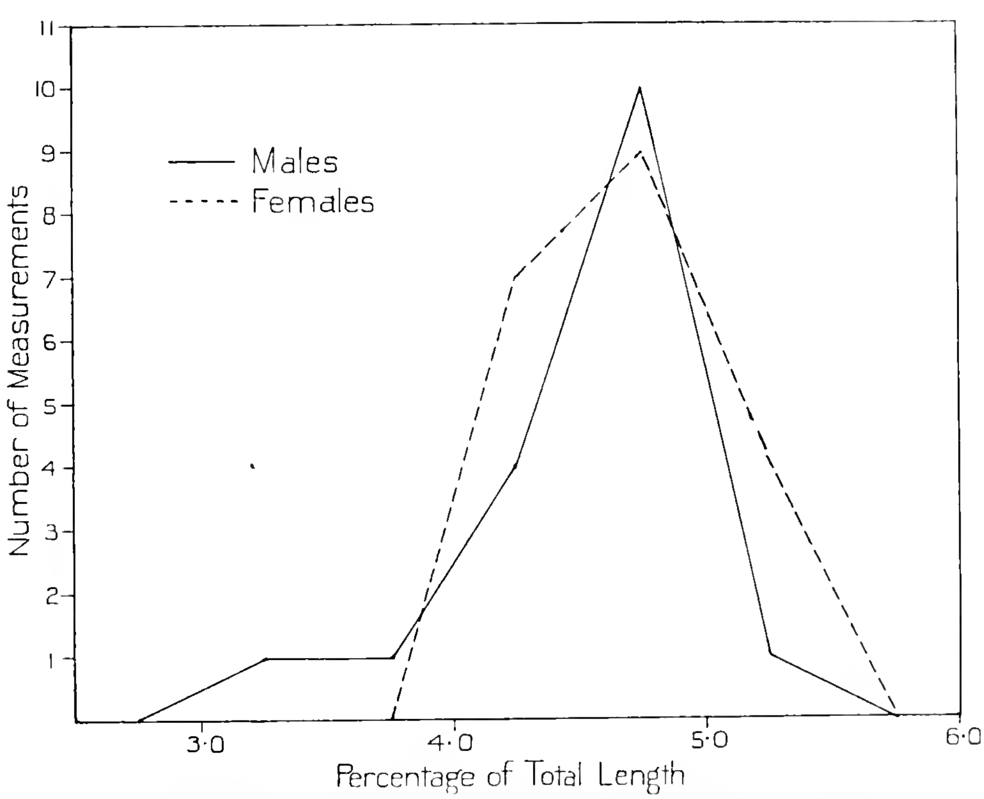

Fig. 24. Humpback whales. Variation of measurement no. 7. Centre of eye to centre of ear

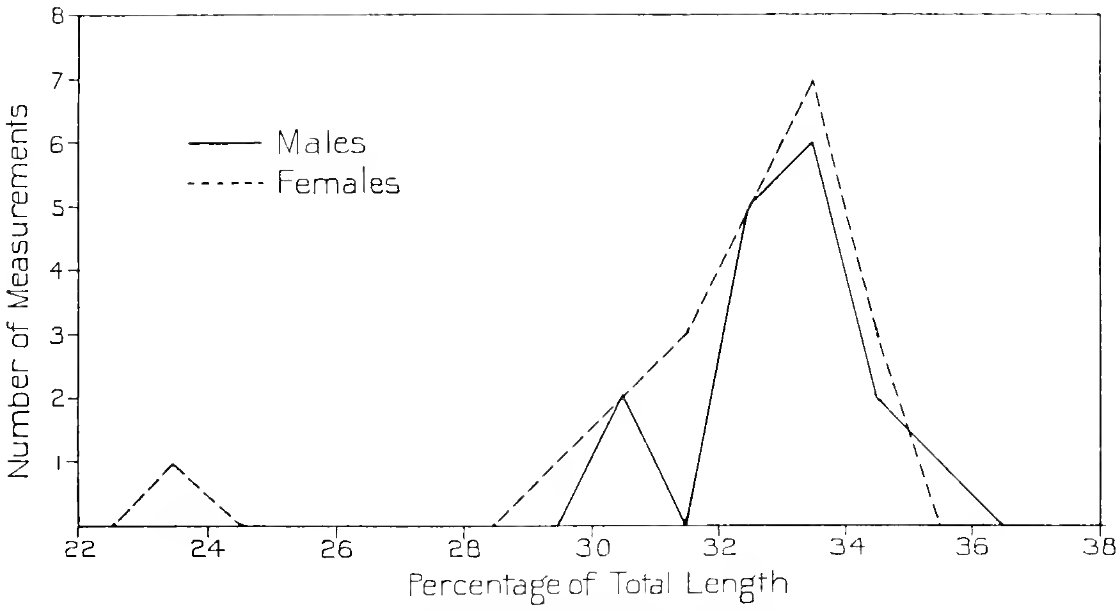

Fig. 25. Humpback whales. Variation of measurement no. 8. Notch of flukes to posterior emargination of dorsal fin.

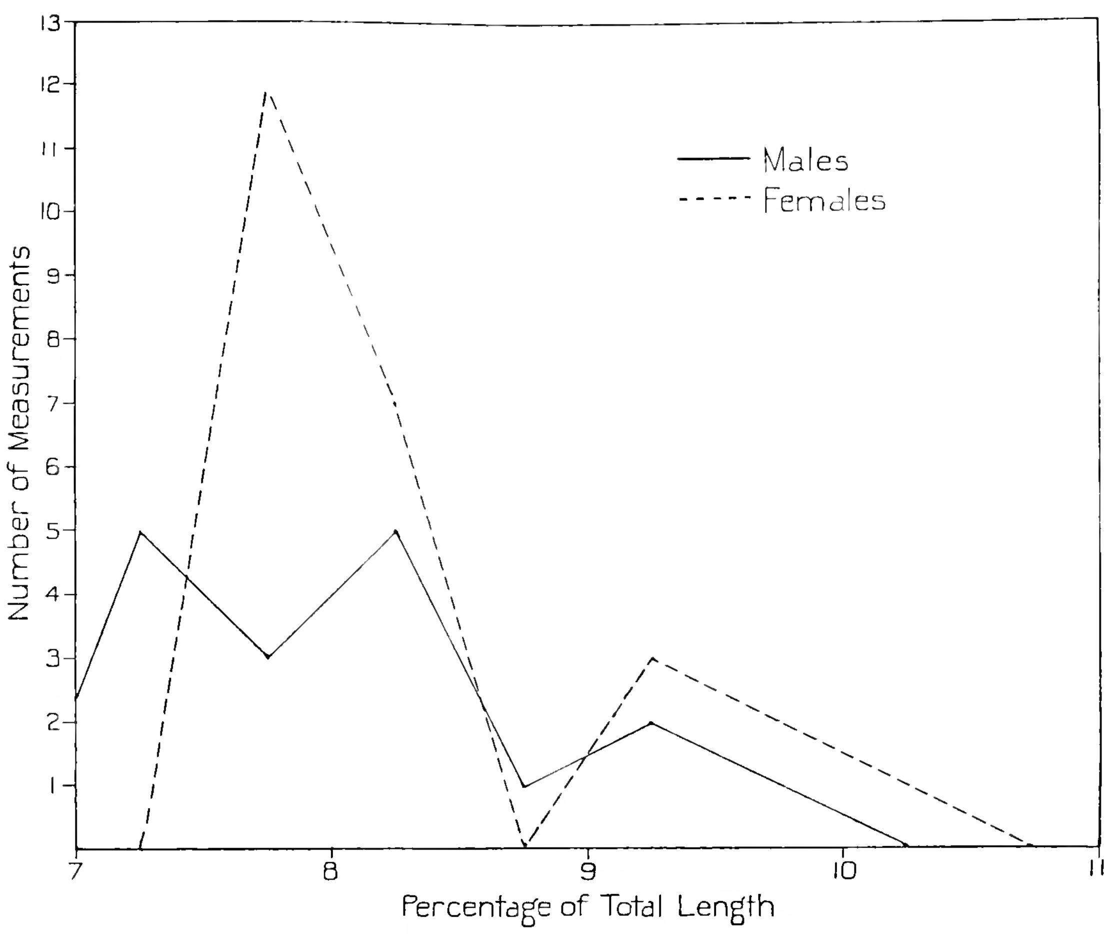

Fig. 26. Humpback whales. Variation of measurement no. 9. Width of flukes at insertion.

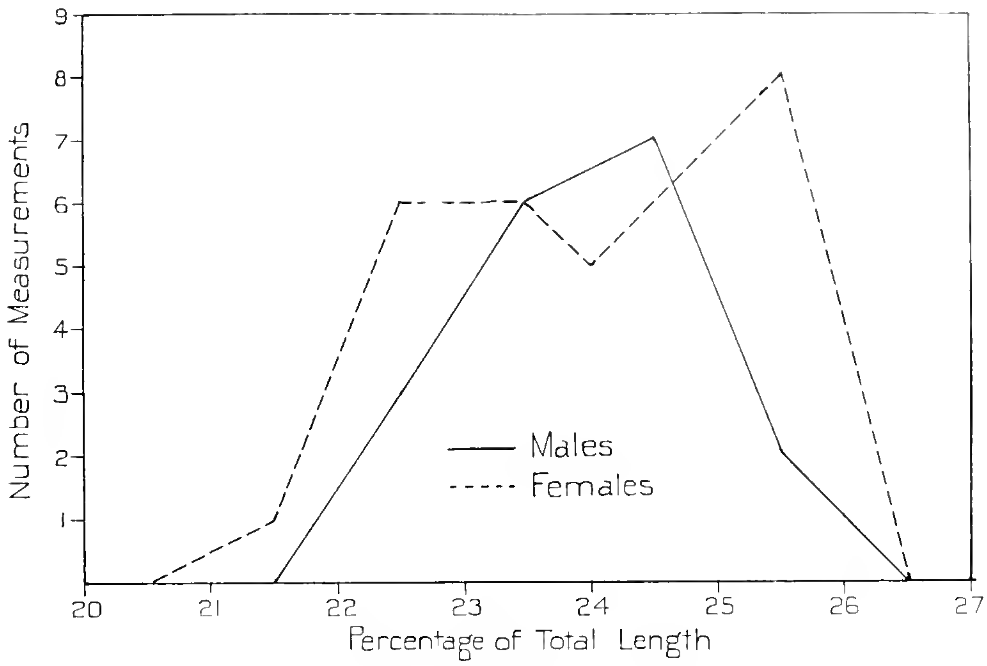

Fig. 27. Humpback whales. Variation of measurement no. 10. Notch of flukes to centre of anus.

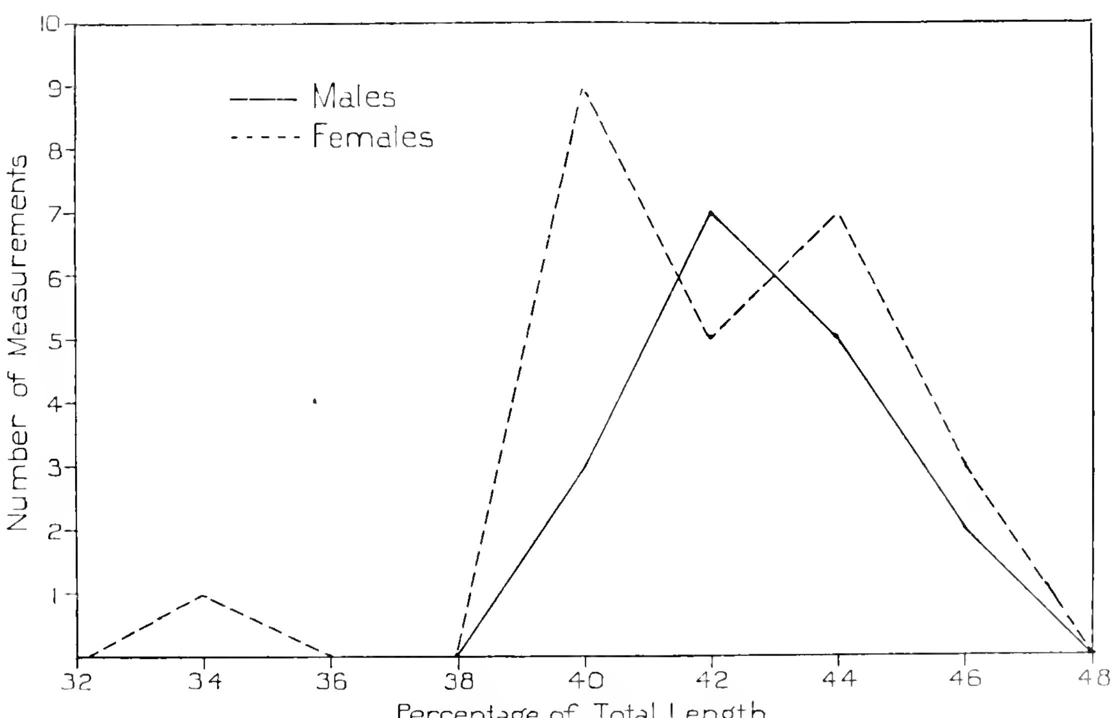

Fig. 28. Humpback whales. Variation of measurement no. 11. Notch of flukes to umbilicus.

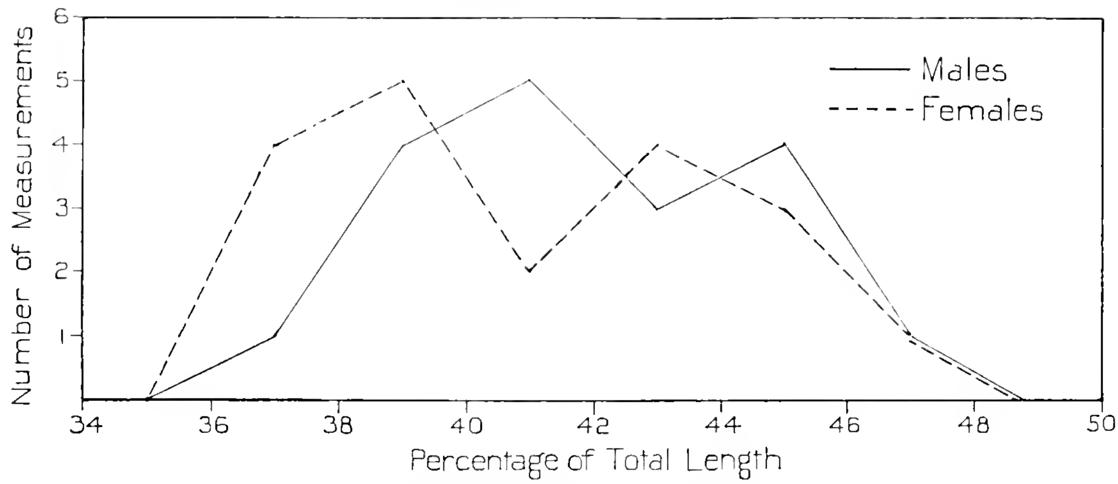

Fig. 29. Humpback whales. Variation of measurement no. 12. Notch of flukes to end of system of ventral grooves.

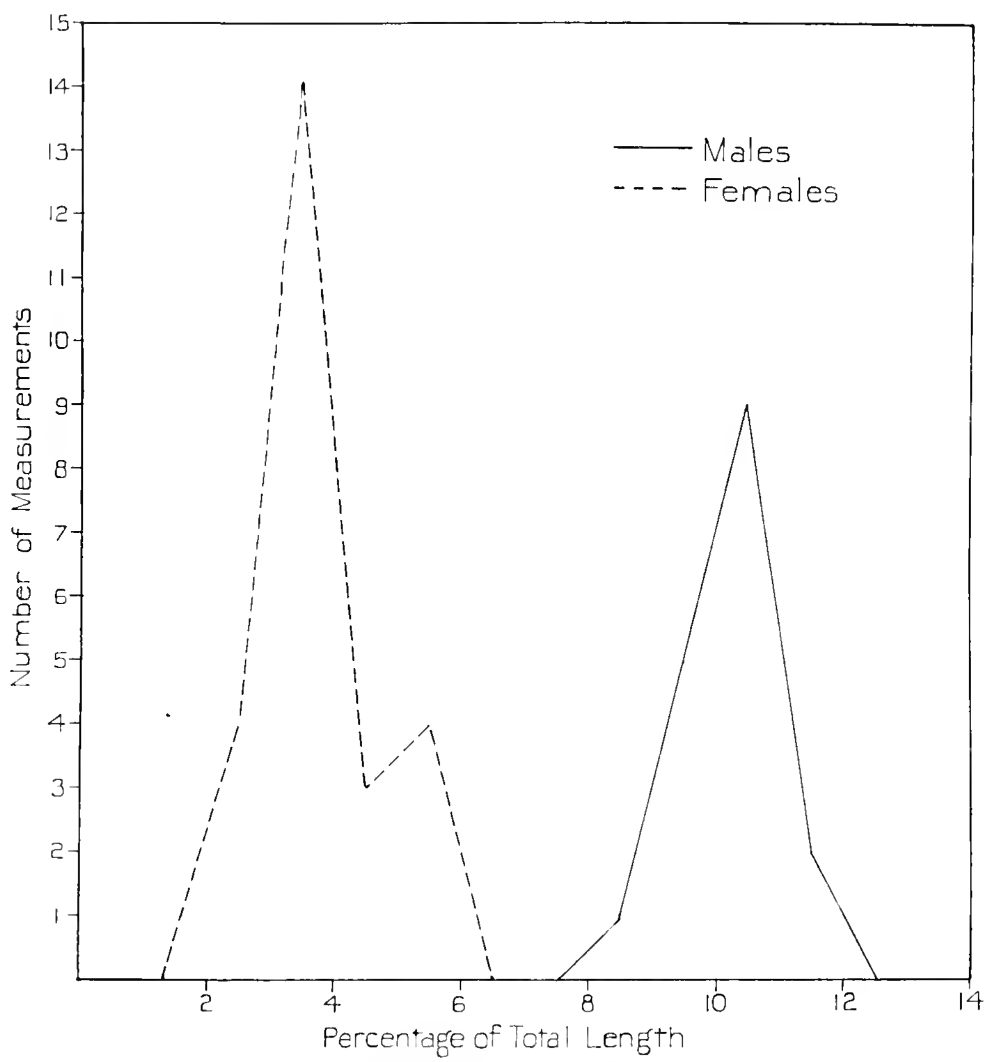

Fig. 30. Humpback whales. Variation of measurement no. 13. Centre of anus to centre of reproductive aperture.

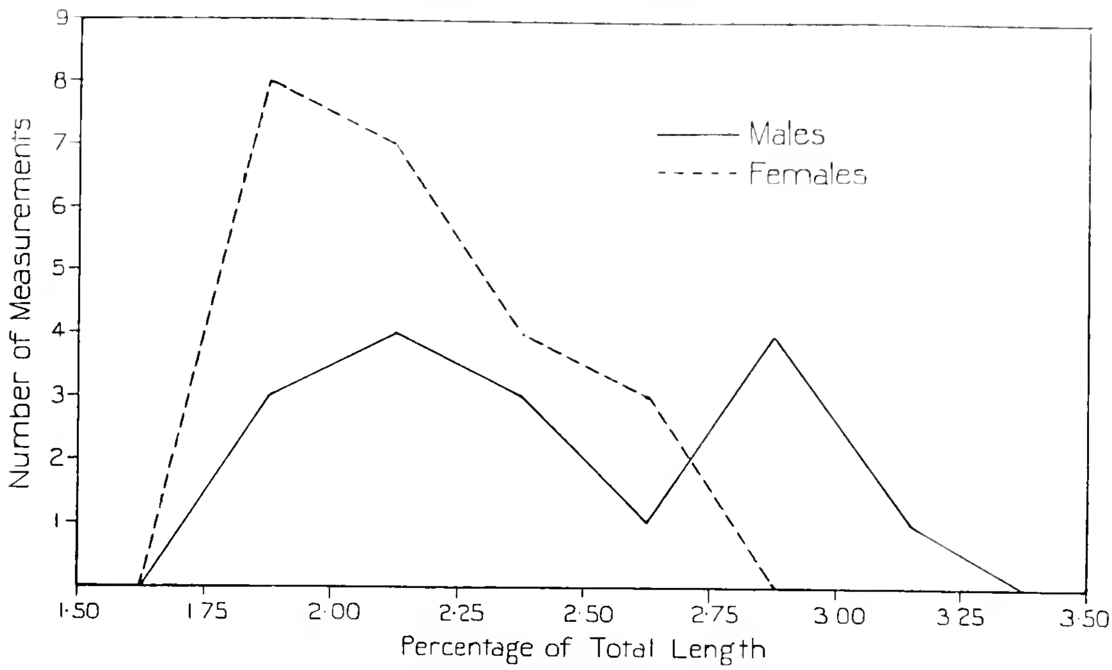

Fig. 31. Humpback whales. Variation of measurement no. 14. Vertical height of dorsal fin.

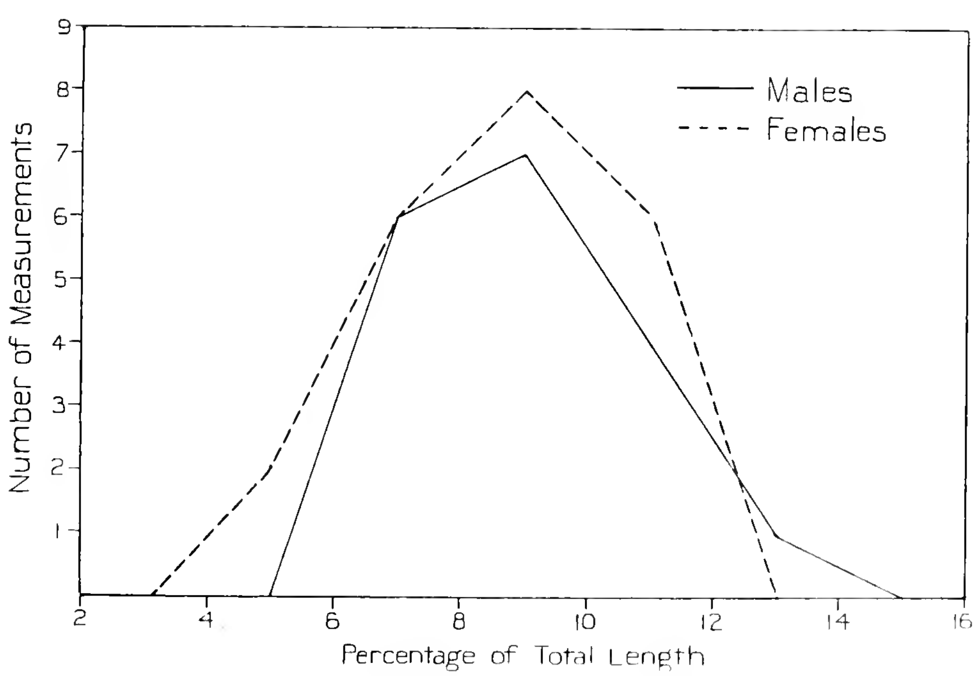

Fig. 32. Humpback whales. Variation of measurement no. 15. Length of base of dorsal fin.

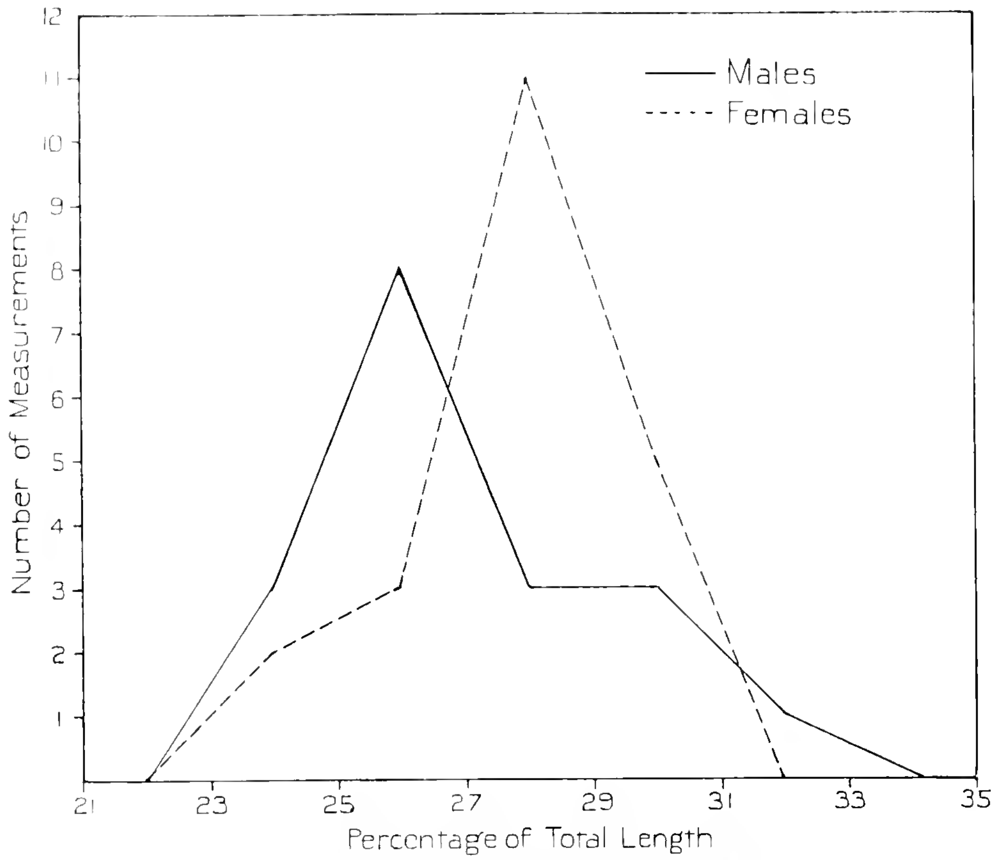

Fig. 33. Humpback whales. Variation of measurement no. 16. Axilla to tip of flipper.

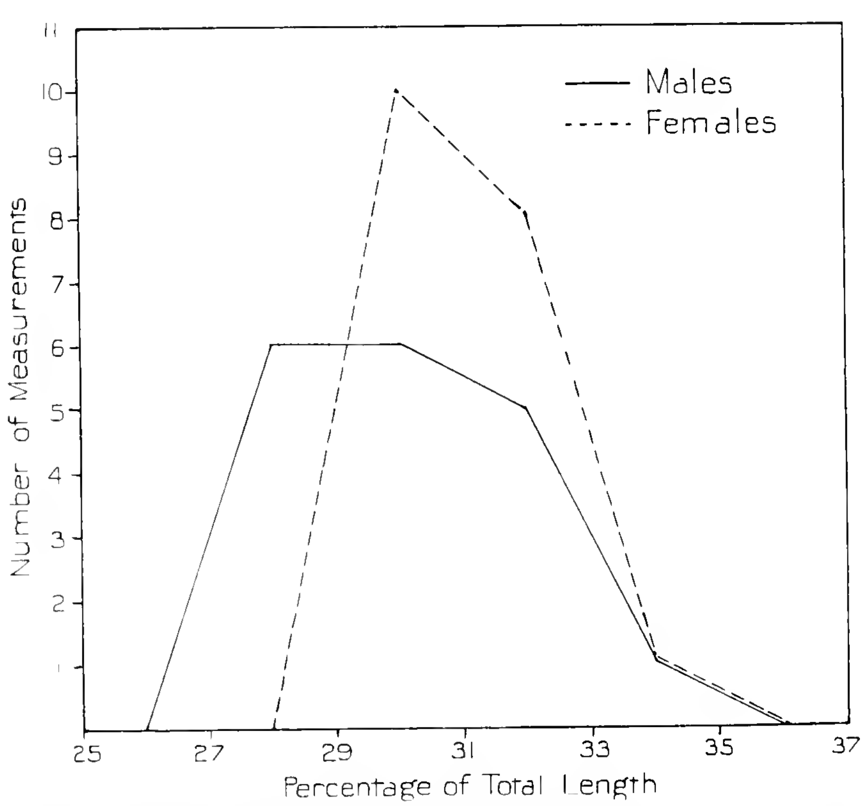

Fig. 34. Humpback whales. Variation of measurement no. 17. Anterior end of lower border to tip of flipper.

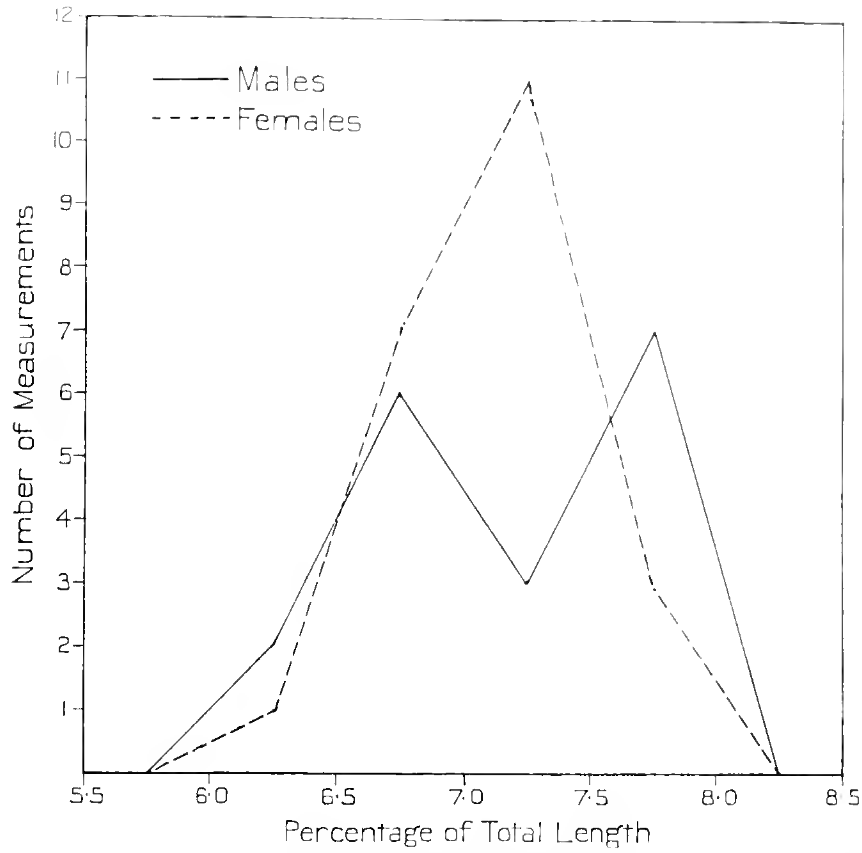

Fig. 35. Humpback whales. Variation of measurement no. 19. Greatest width of flipper

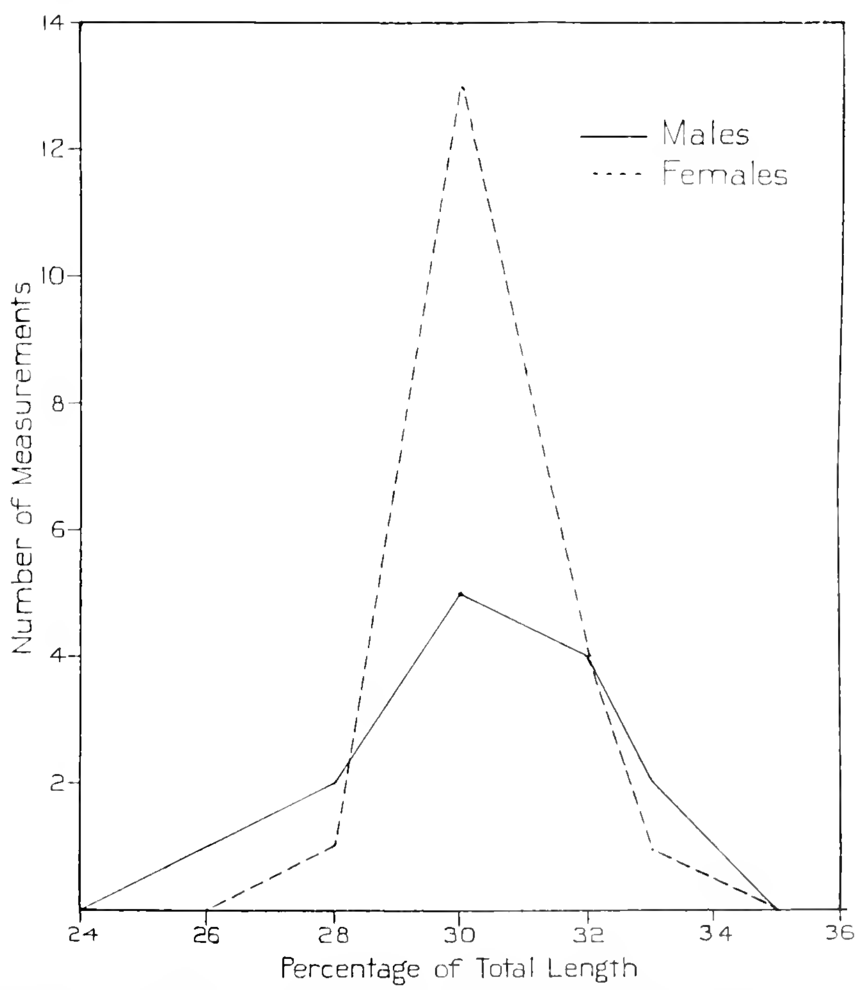

Fig. 36. Humpback whales. Variation of measurement no. 20. Length of severed head from condyle to tip.

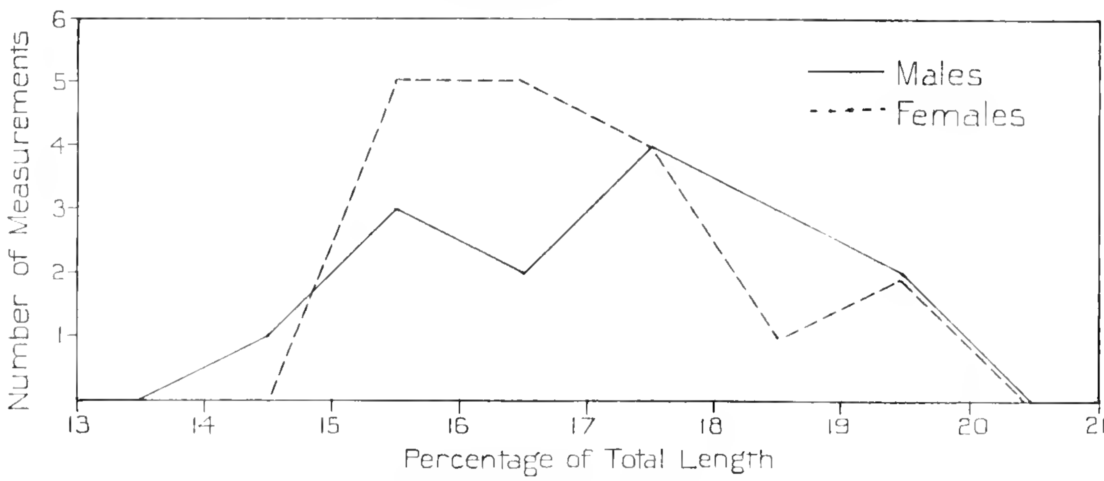

Fig. 37. Humpback whales. Variation of measurement no. 21. Greatest width of skull.

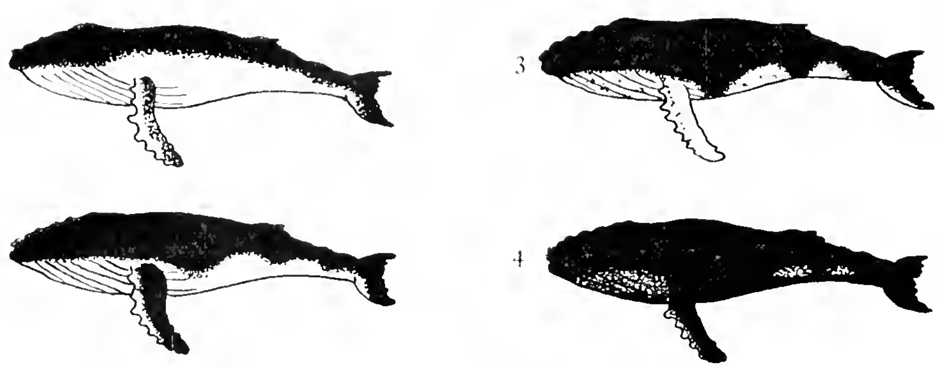

Fig. 38. Humpback whale. Types of colour pattern. (After Lillie, 1915.)

Table X. *Humpback whales. Percentage occurrence of colour groups*

Colour group	South Georgia and South Africa			New Zealand		
	Males (25)	Females (28)	Total (53)	Males (17)	Females (13)	Total (30)
1	4·0	0·0	1·8	5·9	0·0	3·3
1–2	0·0	0·0	0·0	23·5	23·0	23·2
2	12·0	3·6	7·5	17·6	7·7	13·3
2–3	4·0	0·0	1·8	17·6	7·7	13·3
3	8·0	3·6	5·6	11·8	30·5	20·0
3–4	12·0	32·0	22·6	11·8	30·5	20·0
4	60·0	61·0	60·2	11·8	0·0	6·6

figures are here converted into percentages. From the table it will be seen that the South Georgian and South African whales are more commonly darkly coloured than otherwise, though it is of interest to notice that the lightest coloured male and female both occur in South Africa. On the other hand, this does not indicate that the South African whales are generally lighter, for most of the South African whales of both sexes occur in group 4. The number of Humpback whales examined in South Africa is not great enough to warrant separate tabulation, but dark coloration appears to prevail there as in the South Georgian whales. There is, however, a considerable colour difference between the Discovery whales from South Georgia and South Africa and the Terra-Nova whales from New Zealand. In New Zealand Lillie found that the extremes of coloration were rarest and the intermediates commonest, in marked contrast to the Discovery whales in which the dark end of the colour scale is by far the commonest. The Discovery and Terra-Nova whales agree, however, in that the females tend to be darker than the males. These colour differences point to the possibility of some degree of segregation between the South Atlantic, Indian Ocean, and New Zealand herds of Humpback whales. In this connexion Mörch (1911) makes an interesting statement regarding the coloration of Humpback whales at South Georgia, in the days of the great Humpback fishery there (1910 and 1911). He says, "at certain times all the Humpbacks that are brought in have the belly nearly white; this variety may then disappear and those caught for some time may have the belly marbled; schools with the belly entirely dark may then put in an appearance, succeeded by the first variety and so on". If the information given to Mörch was correct, it certainly points to a high degree of segregation of colour types, and it is to be regretted that further particulars as to the sex, average length, and so on of these colour groups are not available.

In all Humpback whales the black areas are marked with streaks, spots, rings and circles of white, and the white areas with similar markings of black. These markings are usually particularly numerous near the borders of the areas of the respective colours. Only in those examples which are practically black all over are these small markings of the opposite colour nearly absent. A splash of white on each side of the under surface of the snout is a common and fairly constant marking in about one-third of the whales. It occurs in 28 per cent of males and 35·6 per cent of females, and was recorded only in the heavily pigmented whales of groups 3–4 and 4. A variation of group 4 was recorded in which the flukes have a greater or less proportion of white on the under surface. Spots or flecks of white on the under surface of the flukes of whales of group 4 occurred in 12 per cent of males and 7 per cent of females, while the greater part of the under surface of the flukes was white in 8 per cent of males and 14 per cent of females (Plate II, figs. 1 and 2). The outer surface of the flipper was white in 16 per cent of males (of colour groups 3–4 and 4), but this colour pattern did not occur at all in females. Haldane (1905), however, records a black female with white outer side to the flipper and gives a good photograph of a black male with white flippers. The whales he examined were landed at the Shetland Islands. Kellog (1929) gives a photograph of a black male with flippers white on both sides, taken at Newfoundland.

In several instances the whales of the lighter coloured groups, in which the ventral groove area is white, had the ridges between the grooves white and the furrows of the grooves black. Haldane (1905) notes this as occurring also in Shetland whales.

Detailed information as to the development of colour in the foetus is not available, as all the foetuses examined by the Discovery staff were small, none over 0·85 m. in length. From foetuses of whales nos. 321 (0·64 m.), 2033 (0·51 m.), 3426 (0·4 m.), however, it would appear that pigmentation starts dorsally on the head and upper jaw and spreads towards the tail and ventral surface.

True (1904) discusses the theory of Rawitz (1897) that the young whales are dark in colour and become whiter as they get older, and agrees that the limited information available to him tends to support it. The present series of whales, however, does not; for the lightest coloured male is only 9·2 m. and the lightest female 9·5 m., in length; while the largest male, 14·75 m. long, and the largest two females both 14·9 m. long, all belong to the colour group 4.

The colour of the narrow ridge-like palate situated between the two sets of baleen is white or very light greyish white, with nearly always a patch of darker grey pigment at the posterior end of it. The tongue is white or very light grey.

The general coloration of the southern and northern Humpback whales thus appears to be the same, but unfortunately no data are available as to the relative frequencies of occurrence of the various colour groups in the northern whales, so that no comparison can be made between them and the southern whales, similar to that here made between the South Atlantic and South African, and the New Zealand herds.

Hinton (1925) points out the possibility of the differently coloured Humpbacks forming separate races. He classifies his material into three categories, white bellied, marble bellied, and black bellied, and finds that there are indications of slight differences between the three colour classes in some of their relative measurements. He points out that the examination of further material is required before any definite conclusion as to the existence of different races can be drawn. He deals with only a small number of observations, and it must be admitted that the additional material discussed here gives no grounds for supposing that any constant difference in relative dimensions is associated with any colour phase. The slight differences found in Hinton's material concern chiefly the relative dimensions of the head and post umbilical regions, but as is shown above these dimensions are a function of body length and consequently cannot be correlated with differences in colour.

On the other hand, there does seem to be some degree of segregation in colour, in that certain colour classes occur in differing proportions in different localities, although members of all classes appear to occur in all localities. As pointed out above, the South Georgian and South African Humpbacks appear to be darker than the New Zealand ones. Olsen (1914–15) records that the black-bellied class is commonest at Port Alexander, Angola and that this class is least common among the whales landed at whaling stations of the northern hemisphere. He adds "a special feature of the southern Humpback is that the flipper is nearly always dark coloured above, and of the above-mentioned one hundred and fifteen [caught during the period August 1st to October 8th 1911 at Port Alexander] only six had white flippers, but this in the northern hemisphere is the rule". This proportion is 5·2 per cent and does not greatly differ from the proportion with white flippers recorded in the present series, which is 16 per cent of males or 7·5 per cent of all whales.

Goodall (1913) records that all the whales he saw at Durban were of the marble-bellied class, and in consequence Hinton postulates that from the South Georgian feeding grounds the black-bellied schools migrate up the west coast of Africa, the marble-bellied schools up the east coast, and the white-bellied ones perhaps up the east coast of America. The present series gives no support to this suggestion, because of the four Humpbacks, of which colour notes are available, taken at Saldanha Bay on the west coast of South Africa, three belonged to the class "marble-bellied" and one to the class "black-bellied"; and of the eleven from Durban six were black-bellied, three white-bellied and two marble-bellied. Further, Olsen (1914–15) says, "these [three colour] varieties do not keep apart in small lots but mingle together. Thus of one pair one would often be black and the other light bellied", and "having regard to the extraordinary variability of the Humpback in the matter of colour, one can scarcely attribute much systematic importance to this character".

With this last sentence one cannot but agree, adding only the reservation that in different parts of the world the proportions of the various colour classes appear to differ more or less constantly within the schools, in which all the colour classes occur and are mixed. Unfortunately, it is now impossible, owing to the small numbers of Humpbacks taken on the southern whaling grounds, to investigate the statement made by Mörch (1911) and reported by Risting (1912), which appears to be based upon hearsay and not upon direct observation, that the schools at South Georgia were commonly each composed of whales of one colour group only.

HAIR

Hair occurs in the Humpback whale on the dorsal surface of the snout, on the chin and on the mandibles. Data relating to the hairs are available from seven Humpback whales only, and are tabulated in Table XI. On the snout the hairs are rooted in tubercles, three or four on each side of the blowholes, about five in the median line, and two rows, an inner and an outer, on each side of the edge of the snout, with from four to fourteen hairs in each row. The tubercles of the inner and outer marginal rows are frequently arranged alternately. Fig. 39 shows the arrangement of the hairs on the snout in the foetus of whale no. 3573. The lowest number of hairs on one side of the snout recorded in the present series is nine, and the highest is twenty-

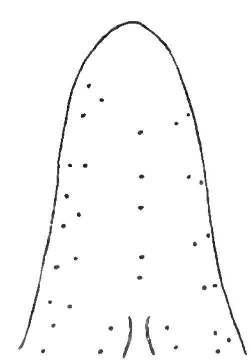

Fig. 39. Humpback whale. Arrangement of hair on the dorsal surface of the snout of foetus of whale no. 3573.

seven, the latter from whale no. 2000, which must have been an exceptionally hairy whale, for the hairs on the chin and mandibles were also above the average in number.

The hairs on the chin are arranged in two groups, one at the tip of the jaw and the other paired, on a group of tubercles a short distance below the first. The hairs in the median group, which may be up to 2·5 cm. long, are usually arranged irregularly,

Table XI. *Humpback whales. Occurrence of hair*

Whale no.	Sex	Hair on chin	Hair on mandible	Hair on head
361	Male	20. Median group in three irregular lines. Paired groups, 5 right, 4 left	—	—
335	Female	20 in median group in two lines of 10 each. Paired groups, 4 right, 5 left	—	—
96	Female	21 in median group	"Numerous"	"Numerous"
94	Female	25 total number	"Considerable number scattered on mandible"	—
2042	Male	30 in median group in two lines of 15 each	Right 2, left 1	Left side 9
2000	Female	40 in median group in two lines of 20 each	One side 11	One side 27
2033	Female	—	One side 8	—

though sometimes in three or four lines, and number from twelve to forty. The hairs in the lateral groups on each side of the median line are rooted in tubercles and number from four to five on each side. The mandibular hairs are placed on tubercles arranged along the ramus of the jaw, and number from two to eleven on each side.

It will be noted from the above description that there is considerable individual variation in the number of hairs present, the arrangement of which appears to differ in no way from those of the northern Humpback whales, as described by True (1904) and others.

VENTRAL GROOVES

The ventral grooves are spaced proportionately very much farther apart in the Humpback than in the other Balaenopteridae and consequently are fewer in number. The average of nine counts, excluding the short grooves at the insertion of the flippers, in the present series is twenty-eight, maximum thirty-six, minimum twenty-one. These may be compared with the corresponding figures (Mackintosh and Wheeler, 1929) for Blue whales, average ninety, maximum one hundred and eighteen, minimum seventy, and Fin whales, average eighty-four, maximum one hundred and six, minimum sixty-eight. The numbers of ventral grooves found in the present series are shown in Table XII.

Lillie (1915) records the grooves in the New Zealand Humpback as "about twenty-four" between the flippers. On the other hand Millais (1906) gives the number of grooves as eighteen to twenty-six in the northern Humpback, but does not state how many specimens were examined to arrive at this figure. The present data average above this value, but are too scanty to allow one to conclude definitely that the southern Humpbacks have more ventral grooves than the northern ones.

Table XII. *Humpback whale. Numbers of ventral grooves*

No. of ventral grooves	Males	Females
21	2	—
22	—	—
28	—	1
30	—	1
32	2	1
36	—	1
Average no.	26	31
Maximum	32	36
Minimum	21	28

At the posterior end the median grooves run back to the umbilicus, while the lateral ones are progressively shorter the farther they are from the median line. Between the umbilicus and the genital aperture, especially in females, there is frequently a short, transverse, curved groove arranged with its convexity directed forwards (Fig. 40). On the other hand, Fig. 41 shows a shallow median groove joining the umbilicus to the

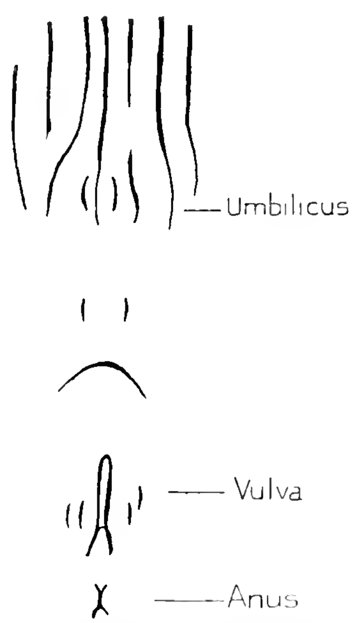

Fig. 40. Humpback whale. Female. Transverse curved groove between umbilicus and genital aperture.

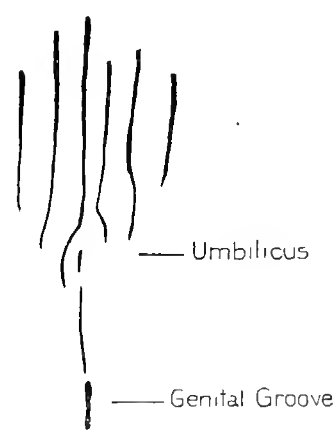

Fig. 41. Humpback whale. Male. Shallow median groove joining umbilicus and genital groove.

genital aperture in a male. One or two irregular shallow grooves may be present in the female, on each side of the mammary grooves. At the anterior end of the series the grooves towards the centre join together in the middle line short of the chin, while the outer grooves run to the edge of the mandible, so that a median ridge is formed below the chin. This is noted by Struthers (1889), who compares it to a second chin, and later authors have sometimes referred to this protuberance as the "cut-water". In consequence of the median grooves stopping short of the chin a number of short grooves anastomose on each side, giving the appearance, as noted by Millais (1906), of crossing like tramlines.

BALEEN

The baleen of the Humpback whale is very coarse in texture, with coarse bristles at the inner edges of the plates. The colour of the plates varies from grey to almost black, and the bristles are white to greyish white. In many specimens some of the anterior plates or their outer edges are white. When white plates are present together with a white splash on the side of the snout, as described above, the position of the white plates corresponds with that of the white splash. For example whale no. 793, a male, had thirty-five white and partly white plates on the left side and thirty-eight on the right, corresponding in position with white splashes on the snout. White plates may, however, be present when the splash is absent and *vice versa*. Struthers (1889), also quoted by True (1904), records the occurrence of white plates at the anterior end of the series.

The records of only two counts of the number of plates are available, one from a male 8·4 m. long with 320 plates on the right side and the other from a female 11·8 m. long with 361 plates on one side. Hinton (1925) gives a count made on a humpback 7·44 m. long at South Georgia of "about three hundred plates on each side". Millais (1906) counted three hundred and twenty-five plates on each side in a northern Humpback at the Shetlands, a figure which agrees with the present data, but quotes Scammon as giving five hundred and forty plates in a female 52 ft. (approximately 16 m.) long, which would mean only two hundred and seventy plates on each side. With this may be compared a record made at South Georgia by the late Major Barrett-Hamilton and published by Hinton (1925) of a female Humpback 13·93 m. long with "about two hundred and fifty plates on each side". True (1904) gives no first hand counts of baleen plates in northern Humpbacks, but quotes Eschricht as giving "about four hundred plates on each side" in Greenland Humpbacks.

Fig. 42 shows the length of baleen plotted against the total length of the whale. With the figures of the present series are included eight measurements of baleen taken at South Georgia in the season 1913–14 and published by Hinton (1925). The baleen varies from 18 cm. in length in a whale 7·25 m. long to 107 cm. in length in a whale 14·66 m. long, thus agreeing with the recorded data (Struthers, 1889; Millais, 1906; True, 1904) regarding the northern Humpback. The solid line in the figure represents the growth curve of the baleen as obtained from the plotted points, the dotted portion represents the growth in the foetus and calf and joins the smallest measured baleen to the origin, which is somewhere above a foetus-length value of 0·84 m., because none of the foetuses examined was greater than that length, and in none of them was there any trace of developing baleen. The sudden spurt in the growth of the baleen between the lengths of 7 and 8 m. represents the accelerated growth at the time of weaning, when a plank-

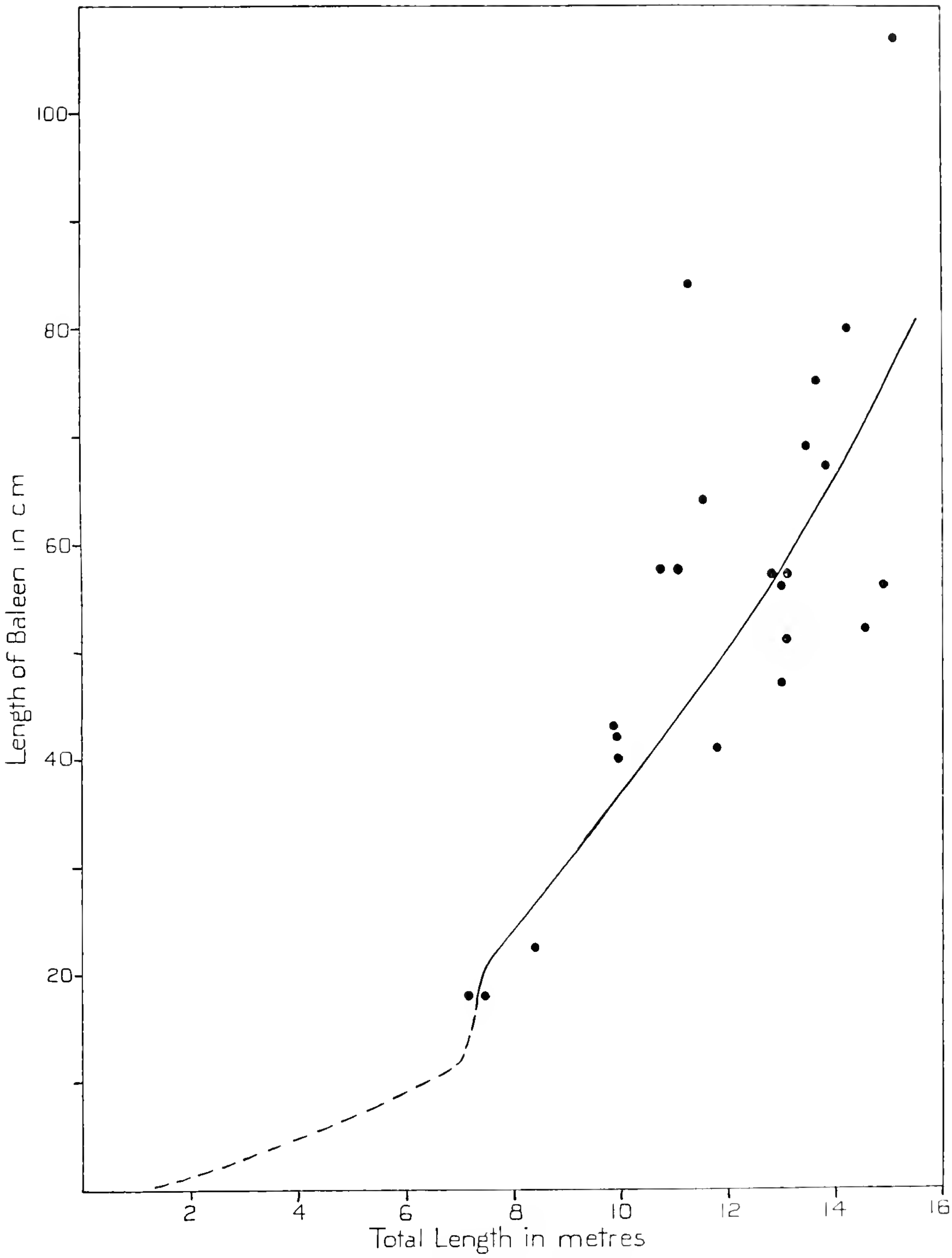

Fig. 42. Humpback whale. Length of baleen plotted against total length of whale.

tonic diet is started and the baleen becomes functional. The stomachs of the two young whales with baleen 18 cm. long contained a yellow substance which was probably partly digested milk, and certainly was not krill, so that they may be counted as sucking calves, a conclusion that is supported by the baleen length and its position in this figure.

Only one record of the width of the baleen is available, from a male whale 9·83 m. long. In this the baleen was 43 cm. in length and 12·5 cm. in width, the width being 29 per cent of the baleen length. In Fig. 43 the spacing of the baleen plates is plotted against the length of the whale and shows a regular increase with length and no sexual or racial differentiation.

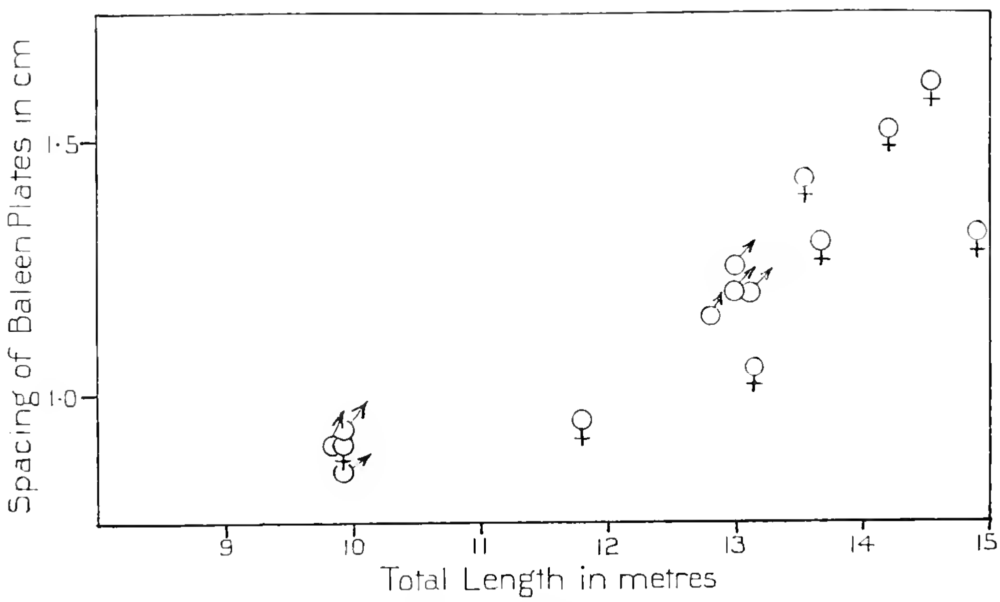

Fig. 43. Humpback whale. Spacing of baleen.

POSSIBLE DIFFERENCES BETWEEN NORTHERN AND SOUTHERN RACES

In none of the characters considered above can any constant differences from those of Humpback whales taken in the northern hemisphere be detected. It would appear that every point that has been used hitherto in differentiating races, subspecies or species of Humpbacks comes within the range of normal variation when a full series of specimens is examined. Some of the measurements of body proportions that have been thus used are shown above to be functions of length, and therefore useless as racial criteria unless specimens of similar length are compared, which has not been done. Hinton (1925) shows that there is no real difference in length between Humpbacks of the northern and southern hemispheres. He also says that in the south the females outnumber the males, whereas the opposite is the case in the north, a statement which is not borne out by fuller evidence, at least as far as the south is concerned. The only difference that can be found between the whales of the north and the south is a physiological one: the difference in the time and direction of their migrations and in the time of their breeding seasons. But even this difference cannot be taken as separating physiological races, for Hinton (1925) points out the possibility of southern whales sometimes joining the northern schools. As is shown in a later section of this report, breeding, though mainly restricted to a season of about three months, extends to a lesser degree throughout the year. Consequently a southern female, impregnated at the usual time, joining a northern school would not appear as a striking anomaly if examined, although she would be in a widely different stage of pregnancy from the majority of northern whales. In fact, if she joined in the migration of the northern schools she would by that become one of the "northern race", so even the physiological difference is merely an outcome of locality.

FOOD

Table XIII shows the stomach contents of fifty Humpback whales from South Georgia and South Africa. It shows quite clearly that in general the Humpbacks at South Georgia are feeding, whilst those on the coasts of South Africa are not. It must be remembered that Humpbacks are now only taken at South Georgia when there is a scarcity of other species of whale, a scarcity which is frequently correlated with a scarcity of krill, and consequently it is not surprising that out of thirty-three stomachs examined six were empty and thirteen contained very little food. The krill found in the stomachs of Humpback whales at South Georgia consists entirely of *Euphausia superba* in various stages of growth. Four typical analyses of stomach contents are given in Table XIV. On the South African coasts, however, the Humpback whale stomachs were found to be entirely empty of krill, not even containing the small species of euphausians found in the stomachs of Fin and Blue whales. Two stomachs, on the other hand, contained fish remains. One, that of a male no. 793, 9·92 m. in length, taken 25. vi. 26, was crammed with fishes noted as "? Clupeoids", while the other, that of a female no. 1101, 11·27 m. in length, taken 20. ix. 26, was filled with a pasty mass of fish scales and bones. Olsen (1914–15) gives a photograph taken at Saldanha Bay of a Humpback whale stomach filled with fishes about the size of herrings. The food of the southern Humpback whale appears thus to be similar to that of the northern race, which, according to Millais (1906), consumes quantities of capelan when krill is not available.

It has been shown elsewhere (Matthews, 1932) that off the coast of Patagonia the Humpback feeds on the shoals of the pelagic *Grimothea* post-larva of *Munida gregaria*, in company with Sei whales; and that off the Pacific coast of Mexico an allied crustacean, *Pleuroncodes planipes*, which also swarms near the surface of the sea, is eaten.

BLUBBER

Data relating to the blubber are recorded from fifty-seven Humpbacks and are summarized graphically in Figs. 44–47. Figs. 44 and 45 show the thickness of blubber plotted against the total length of whale, South Georgian and South African whales being plotted separately. These graphs show that above a total length of about 10 m. the thickness of the blubber varies with the total length in both localities. South African females in the present series are thinner than those from South Georgia, but the males

Table XIII. *Humpback whale. Stomach contents of fifty whales from South Georgia and South Africa*

Place and date	Krill (*Euphausia*) in stomach: Full	Half full	Very little	Empty	Fishes in stomach
South Georgia					
1925 March	—	—	2	—	—
Dec.	1	—	—	—	—
1926 Jan.	—	—	3	1	—
Feb.	3	—	—	—	—
1928 Dec.	2	1	1	—	—
1929 Dec.	1	1	—	—	—
1930 Feb.	1	—	—	—	—
March	—	1	1	—	—
Dec.	—	1	—	—	—
1931 Jan.	—	—	5	5	—
Feb.	—	1	—	—	—
March	1	—	1	—	—
Saldanha Bay					
1926 June	—	—	—	—	1
Aug.	—	—	—	1	—
Sept.	—	—	—	1	1
Durban					
1926 July	—	—	—	4	—
1930 July	—	—	—	6	—
Aug.	—	—	—	2	—
Sept.	—	—	—	1	—

Table XIV. *Humpback whales. Analysis of krill (Euphausia superba) found in stomach contents at South Georgia*

Whale no.	Sex	Length m.	Date	Numbers of *Euphausia superba* in 1·5 to 6·0 cm. classes. Percentages of total number in sample in italic type: 1·5	2·0	2·5	3·0	3·5	4·0	4·5	5·0	5·5	6·0	Total sample of contents
2713	Male	13·00	2. xii. 29	—	—	—	—	6	19	62	255	194	—	536
								1·0	*3·5*	*11·5*	*48·0*	*36·0*		*100*
2873	Female	13·05	29. xii. 29	—	—	74	315	155	50	2	2	—	—	598
						12·4	*52·5*	*26·0*	*8·3*	*0·3*	*0·3*			*100*
3108	Female	12·35	2. ii. 30	—	—	—	—	—	14	21	61	33	2	131
									10·7	*16·0*	*46·5*	*25·0*	*1·5*	*100*
3697	Male	11·60	17. iii. 30	1	35	142	71	9	1	—	—	—	—	259
				0·4	*13·5*	*54·5*	*27·5*	*3·4*	*0·4*					*100*

are fatter. The differences here shown are probably due to lack of sufficient data, and if the figures for males and females are combined, the curve shows very little difference between South Georgian and South African whales and probably more nearly represents the truth. These curves for the Humpback differ considerably from those for Sei,

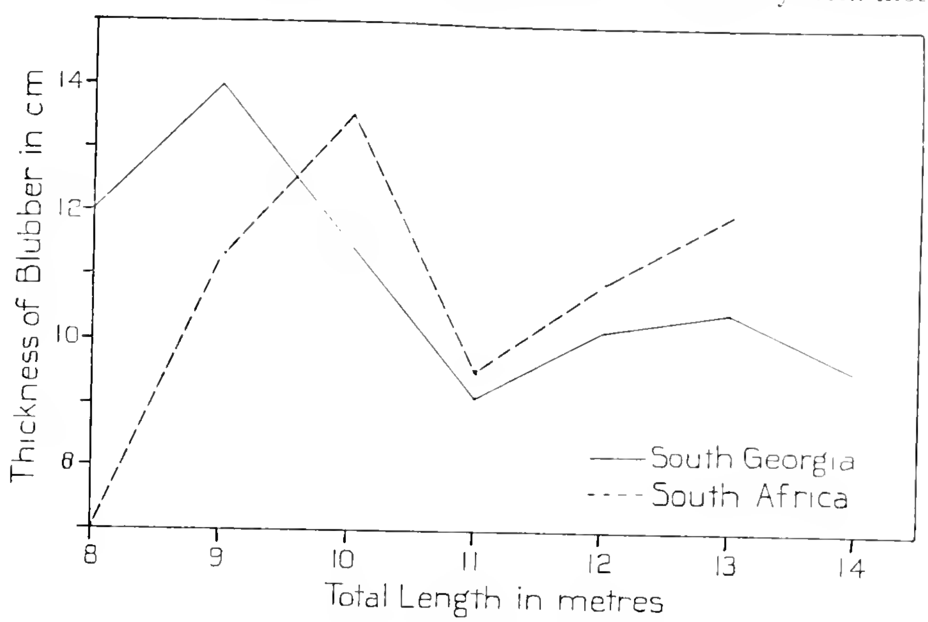

Fig. 44. Humpback whale. Males. Thickness of blubber.

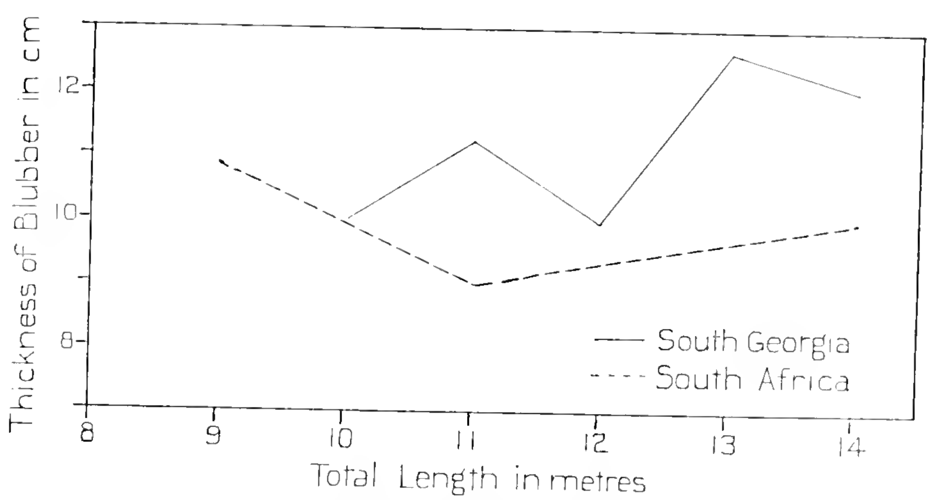

Fig. 45. Humpback whale. Females. Thickness of blubber.

Fin and Blue whales, of which the animals on the South African coast are much thinner than those from South Georgia, and the reason probably lies in the readiness with which the Humpback feeds on fish and other food when krill is not to be found.

A very striking point shown by these figures is the great thickness of blubber in immature whales, especially males under 10 m. in length, from both South Georgia and South Africa. A young male Humpback between 9 and 10 m. in total length has blubber actually thicker than when it is an adult 13–14 m. long, and is not only relatively fatter. While the whale is growing from 8 to 10 m. in length the thickness of the blubber is increasing very fast, but between the lengths of about 10 and 11 m. it decreases again as rapidly. A similar state of the blubber is indicated by the curve for females, but is shown less plainly because much fewer small female Humpbacks were measured than males.

In Figs. 46 and 47 the thickness of the blubber expressed as a percentage of the total

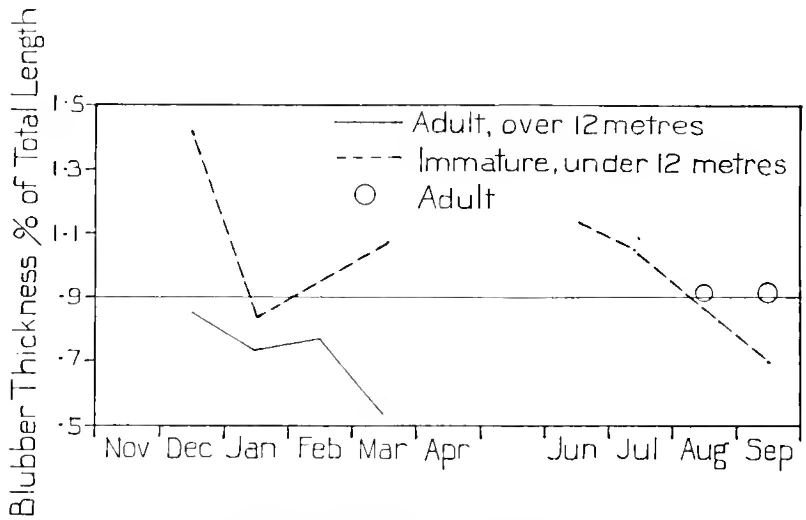

Fig. 46. Humpback whale. Males. Seasonal variation in fatness.

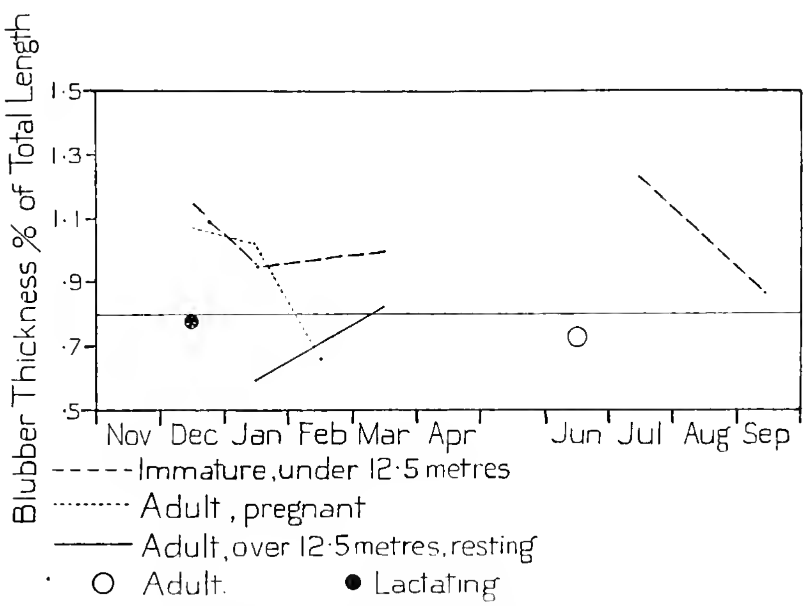

Fig. 47. Humpback whale. Female. Seasonal variation in fatness.

length is plotted by months. Immature males under 12 m. long are plotted separately from mature ones over 12 m. long in Fig. 46: immature females under 12·5 m. long, mature but not pregnant females, and pregnant females are separated in Fig. 47. In both charts the horizontal line represents the average blubber thickness of all whales.

These figures show the marked fatness of immature whales of both sexes and indicate that a decrease in fatness takes place towards the end of the season both at South Georgia and South Africa, but they do not help to give any reason for the great fatness of the smaller whales. Immature whales of other species, Sei and to a lesser extent Fin and Blue, show a similar, if not so striking, greater fatness than the adults.

The curves in Fig. 47 also show the increased fatness of pregnant whales, with a decrease towards the end of the South Georgia season. With those in Fig. 46 they further show a lesser fatness for adult males and females, with a decrease in fatness towards the end of the season in the former. It must be noted, however, that the figures for South Georgia may differ from those that would be obtained from a longer series of observations, because Humpbacks are only taken there by special permission during the times of scarcity of other species of whale.

PARASITES

EXTERNAL

Humpback whales are notoriously infested with external parasites or semi-parasites; the following list shows those recorded from the present series:

CRUSTACEA.
- CIRRIPEDIA.
  - *Coronula* sp.
  - *Conchoderma* sp.
- AMPHIPODA.
  - *Paracyamus* sp.

PROTOZOA.
- *Haematophagus* sp.

DIATOMS.
- *Cocconeis* sp.
- *Licmophora*.

Of these perhaps only *Paracyamus* is a true parasite, the other animals and plants merely using the whale as a substratum. Of the Cirripedes *Coronula* was present in larger or smaller numbers on all Humpbacks examined. This barnacle occurs in greatest numbers on the knob under the chin, round the genital and anal apertures, and on the knobs of the flippers and flukes. It occurs in lesser numbers on the ventral grooves, the surface of the head, and scattered over the sides, but rarely on the dorsal surface of the body. Characteristic circular scars with radiating lines in them mark the sites where *Coronula* has formerly grown, and are commonly present in some numbers on Humpbacks. Olsen (1914–15) makes the interesting observation that at Port Alexander during the northward migration the Humpbacks are thickly infested with *Coronula*, but that on the southward migration they are nearly all clean or infected with small barnacles only. He suggests that the barnacles are killed by the fresher water off the Congo and drop off, and in further illustration of this supposed phenomenon states that mariners used to bring their ships into these waters to clear them of Cirripedes.

Conchoderma is not quite so frequent on the Humpback as *Coronula*, and occurred in 85 per cent of the whales examined. It nearly always grows only on the shells of *Coronula* and not directly on the epidermis of the whale. The heaviness of *Conchoderma* infection varies from one or two individuals to thick clusters on the *Coronula* on all parts of the body.

Paracyamus boopis was found on all Humpbacks on which it was sought: the infection is not usually very heavy. The parasites occurred in greatest numbers around the genitalia, among the Cirripedes, and between the ventral grooves: they are scattered over the rest of the body in lesser numbers.

Patches of diatom film are recorded from only six Humpbacks, all from South Georgia: in a further sixteen which were examined for film it was found to be absent. The patches were not large and in no case formed a film covering all or most of the body. Patches were noted on the head and jaw twice, on the tail and flukes three times, and on the back once. In all cases the film consisted of *Cocconeis wheeleri* (Hart), a species first described in 1935 and hitherto found only on Humpbacks, with occasionally a few *Navicula* sp. There is only one note on this subject in the South African observations on Humpbacks, and it records that diatom film, though searched for, was not present. Observations are too few to establish any correlation between the presence of patches of film and the fatness of the whale. A thick growth of *Licmophora Lyngbyei* was found on the shells of *Coronula* infesting Humpbacks at South Georgia in nearly every case when it was looked for.

The ciliate protozoan *Haematophagus* is recorded at South Georgia as present on the baleen in eighteen whales and absent in six: it was not recorded from the South African series, where it was definitely absent in one instance.

Like other whales, the Humpback, while in temperate and tropical waters, is subject to attack by some unknown predator, parasite or disease, which removes semi-ovoid pieces of blubber from the body surface, making oval pits which slowly heal, leaving a white or grey scar. Table XV gives the particulars about the pits or scars on those Humpbacks in which their presence was noted. The most striking point of these observations is the low incidence of attack in this species in comparison with the other rorquals, in which the skin is sometimes completely covered with scars, and in consequence has a silvery grey appearance at a short distance. This is all the more remarkable as the attack occurs in warmer seas, where the Humpbacks follow a leisurely migration in coastal waters; one can only surmise that the comparative immunity in this species is correlated with its coast-frequenting habits, in contrast with the more offshore habits of the swifter and more active rorquals.

The table shows, as would be expected, that fewer pits and scars are found on the smaller immature whales, but, as mentioned in a later section where the age attained by Humpback whales is discussed, the presence of several ages of old scars is of little or no help in showing the approximate age of individual whales. The occurrence of scars on Humpbacks at South Georgia merely indicates, what is already known, that the whales have migrated from lower latitudes.

Lillie (1915) noted the presence of open wounds on the Humpbacks at New Zealand, and states that the whalers told him that the wounds were more numerous on the whales during their southern migration, after their visit to more northern waters.

INTERNAL

Intestinal parasites were only found in one Humpback whale of the series. This was a male examined at Durban which had a few nematode worms, immature specimens of an *Anisakis* sp., in the stomach (Baylis, 1929).

On the other hand the kidneys of this whale are frequently infested with nematode worms. They occurred in both sexes and were found in twenty-three out of thirty-five whales examined for them. In addition they were also present in the urethra and penis of four male Humpbacks. The species is probably a *Crassicauda* (? *boopis*).

No other internal parasites were found in the Humpback whales at South Georgia or South Africa.

Table XV. *Humpback whale. Occurrence of open pits and scars on the body surface*

Whale no.	Length m.	Sex	Date	Place	Scars and pits
D. 4	9·55	Male	24. vii. 36	Durban	A few open pits
D. 15	8·0	Male	29. vii. 26	Durban	Many open pits
2042	9·83	Male	28. xii. 28	S. Georgia	A few old healed scars on flanks and tail
2768	14·07	Male	15. xii. 29	S. Georgia	Four young scars on right side. No old scars
3205	14·5	Male	11. iii. 30	S. Georgia	One or two scars only
D. 58	9·93	Male	4. vii. 30	Durban	Two ages of old scars
D. 62	10·95	Male	8. vii. 30	Durban	A few clean open pits on left side. Largest 7 × 4·5 × 2·5 cm.
D. 84	9·7	Male	16. vii. 30	Durban	Seventeen healed or healing pits on right flank
D. 99	11·9	Male	24. vii. 30	Durban	One sloughing pit, 8 × 3·5 × 3 cm., on right side. No others and few scars of one age only
D. 129	13·15	Male	6. viii. 30	Durban	Very few pits or scars. One open pit with healed edges on left side. One age of old scars
D. 130	12·75	Male	6. viii. 30	Durban	A few small open pits with healed edges on left side. Very few old scars of two ages
3570	13·41	Male	18. i. 31	S. Georgia	One age of old scars
3571	11·37	Male	18. i. 31	S. Georgia	Two ages of scars: grey
3697	11·6	Male	17. iii. 31	S. Georgia	No scars seen
1101	11·27	Female	20. ix. 26	Saldanha Bay	Fair number of scars and a few healing pits
1125	9·92	Female	25. ix. 26	Saldanha Bay	No pits: one or two scars
2873	13·05	Female	29. xii. 29	S. Georgia	Left side: four new scars, no old ones
3108	12·35	Female	2. ii. 30	S. Georgia	A few old scars
D. 49	14·0	Female	27. vi. 30	Durban	A few healing pits, and open pits with healed edges
D. 90	9·5	Female	18. vii. 30	Durban	A few pits
D. 95	9·9	Female	22. vii. 30	Durban	Right flank: four sloughing pits. One age of old scars
3426	14·2	Female	6. xii. 30	S. Georgia	Three ages of scars
3569	12·72	Female	18. i. 31	S. Georgia	Two ages of scars: white and deep
3572	13·16	Female	18. i. 31	S. Georgia	Very few scars of one age
3573	13·5	Female	18. i. 31	S. Georgia	Three ages of scars: appeared not very old
3582	11·38	Female	19. i. 31	S. Georgia	Two ages of scars

REPRODUCTION

THE MALE

External genitalia. The external genitalia of the Humpback are similar in general arrangement to those of the Blue and Fin whales described by Mackintosh and Wheeler (1929). The penis of the male Humpback whale is situated in a groove about 10 per cent of the body length anterior to the anus. In form it does not differ from that of the Fin and Blue whales but it is commonly unpigmented and is smaller, being from 1·25 to 2·5 m. in length in the adult.

Testes. Observations on the testes are recorded from twenty-two Humpback whales. The data available are length, breadth and depth of testis in the complete series; results of the examination of smears prepared from testis and epididymis in four; and from a further five histological material was preserved from which sections were prepared.

The measurements of length, breadth and thickness when multiplied together give a value rather in excess of the true volume of the testis, but may be used as an index of the comparative size of the organ. The volume, in thousands of c.c., is plotted against the total length of the whale in Fig. 48. This shows that the volume of the testis increases

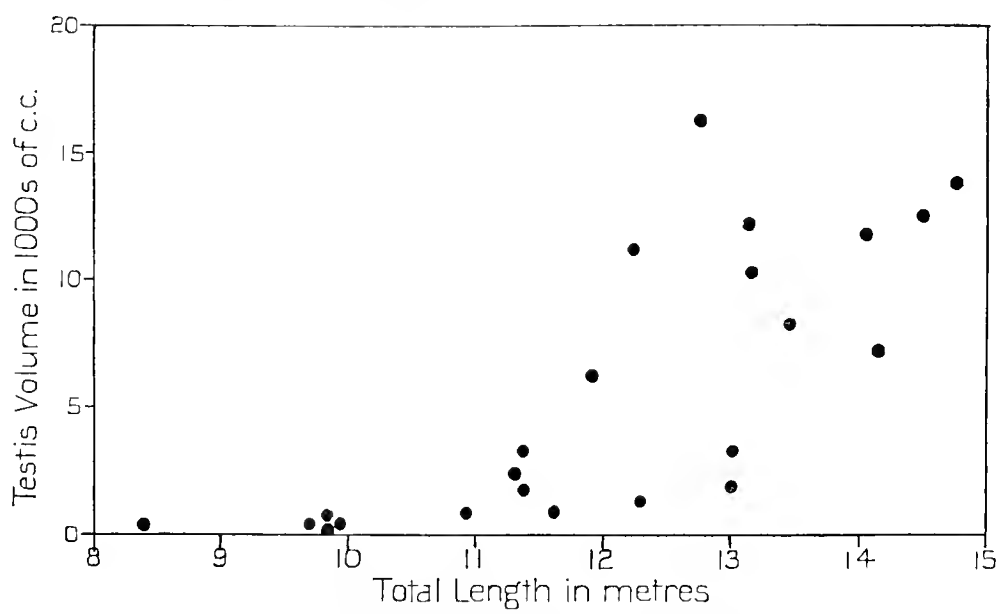

Fig. 48. Humpback whale. Males. Variation of testis weight with body length.

little until a length of about 11 m. is reached. Maturity is reached at about a length of 12 m., and between 11 and 12 m. total length the testes tend to increase in size. After maturity is reached no further correlation between volume of testis and length of whale can be traced, some of the large testes appearing to be in no greater state of activity than some of the small ones. Further, no correlation can be established between volume of testis and season of the year. The histological appearances of the immature, inactive mature, and active mature testes are closely similar to those found in the Blue and Fin whales.

The sexual cycle. Data as to the histological condition of the testes are available from nine whales. Though this number is very inadequate a detailed consideration of the information allows some tentative conclusions to be drawn. The results of an examination of these testes are summarized as follows:

No. 408. Length 13·0 m. 22. i. 26. South Georgia. Testis volume 3330 c.c. Adult. The material appears to have undergone post-mortem changes. The interstitial tissue appears to be swollen and the tubules distorted. The tubules are loosely filled with cells and a few of them are clear of cells towards the centre. No sign of activity is apparent in the cells and no spermatozoa are to be found.

No. 3205. Length 14·5 m. 11. iii. 30. South Georgia. Testis volume 12,500 c.c. Weight 9·5 kg. Adult. Testes not active. The lumen of nearly all the tubules is clear, but a few are loosely packed with cells. No spermatozoa or dividing cells.

No. 94. Length 8·4 m. 16. iii. 25. South Georgia. Testis volume 395 c.c. Immature. The tubules lined with a layer of small cells and filled with large cells. No spermatozoa or signs of activity.

No. D. 99. Length 11·9 m. 24. vii. 30. Durban. Testis volume 6100 c.c. Weight 4 kg. Adult. Smear from the testis showed very few spermatozoa and that from the epididymis contained none. The epididymis contained a thick fluid filled with epithelial cells.

No. D. 129. Length 13·15 m. 6. viii. 30. Durban. Testis volume 10,100 c.c. Adult. A smear from the testis showed a few spermatozoa and that from the epididymis showed a fair number.

No. D. 130. Length 12·75 m. 6. viii. 30. Durban. Testis volume 16,400 c.c., weight 8·5 kg. Adult. The smear from the testis showed a few spermatozoa and that from the epididymis showed very few.

No. 2768. Length 14·07 m. 15. xii. 29. South Georgia. Testis volume 11,700 c.c., weight 8 kg. Adult. The lumen of nearly all the tubules quite clear and a single row of cells lining the wall. A very few tubules contained loosely packed cells, some of which are in early stages of division, but no spermatozoa. No spermatozoa found in the epididymis.

No. 2848. Length 12·27 m. 26. xii. 29. South Georgia. Testis volume 11,300 c.c. Adult. No spermatozoa present in smears from testis or epididymis.

No. 2042. Length 9·83 m. 28. xii. 28. South Georgia. Testis volume 600 c.c. Immature. Tubules lined with small cells and lumina filled with large cells. No activity.

Of the nine male Humpbacks detailed above two are immature; of the adults one was killed in January, one in March and two in December at South Georgia; and one in July, and two in August at Durban, South Africa.

No spermatozoa or signs of activity of the testes were found in any of the South Georgia whales, but spermatozoa were present in all those from Durban, though not plentifully. It would appear, then, that the time of the male sexual season lies, probably, between March and December.

THE FEMALE

External genitalia. The reproductive aperture of the female Humpback is situated at a distance of about 4·0 per cent of the body length from the anus. It is tightly closed, though patent, in immature females, but data from mature females are too scanty to correlate its condition in them with the stages of the reproductive cycle.

On two occasions remains of a vaginal band crossing the entrance of the vagina were found. In neither of these was the band complete, but was represented by a tag attached anteriorly. Both of these whales were mature, one pregnant, the other lactating. Thirty-one female Humpbacks were examined for this structure; the two in which it was present thus give a proportion of 6·4 per cent, which may be compared with the corresponding figure of 6·80 per cent in which tags were found in adult Fin whales.

Internal genitalia. There is a general similarity between the internal genitalia of the Humpback and the Blue and Fin whales. As a long series of data relating to the reproductive processes of this species is not available, the most profitable method of examining the material to hand will be to discuss the observations on each female individually, in order to arrive at a tentative conclusion as to the series of events in the sexual cycle. Before examining the breeding, however, the various organs of the genitalia are reviewed and notes on the conditions found in this species are given.

Ovaries. The development and anatomy of the ovaries is similar to that of the Blue and Fin whales and consequently need not be described minutely here. They are, however, relatively smaller than in those species, and in the immature stages each pair weighs less than 2 lb., and seldom more than $1\frac{1}{2}$ lb. The ovary weights of immature and mature, but not pregnant, Humpbacks are plotted against body lengths in Fig. 49, where each point represents the weight of the pair of ovaries from one whale. This diagram shows

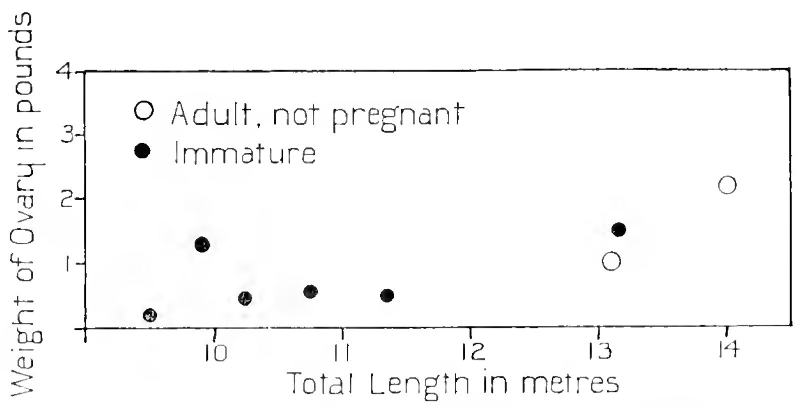

Fig. 49. Humpback whale. Females. Variation of ovary weight.

that the weight of the immature ovaries is fairly constant up to a body length of about 12·5 m. At this length sexual maturity is reached and indications of increasing weight are then shown. They probably continue to increase thereafter with increasing body length and then to diminish in size in the oldest whales, as in other species, but the data are not sufficient to provide evidence for this.

As in other Balaenopterid whales, when maturity is reached the ripening follicles project from the surface of the ovary, one follicle usually being larger than the rest. When ovulation occurs a corpus luteum is formed which remains large and functional during pregnancy. After pregnancy, or soon after ovulation if pregnancy does not take place, the corpus luteum rapidly becomes fibrous and shrinks in size, and then undergoes a process of degeneration so slow that traces of even the oldest corpora lutea probably persist throughout the life of the whale. It has been found convenient in the course of the Discovery investigations to designate the functional corpus luteum of ovulation or pregnancy "corpus luteum *a*" and the degenerating corpus luteum remaining after pregnancy or unsuccessful ovulation "corpus luteum *b*"; this terminology is followed here. The corpus luteum of pregnancy becomes a corpus luteum *b* at parturition, but that of ovulation not followed by pregnancy has no definite point at which it becomes a corpus luteum *b*. While young and functional it is classified as a corpus luteum *a* but when older and degenerating as a corpus luteum *b*. The transition is obviously gradual with no sharp dividing line between the stages. Old corpora lutea *b* are, strictly, corpora albicantia. There are thus two kinds of corpus luteum *b*, unfortunately undistinguishable, but of very distinct origin, those representing a former pregnancy and those representing ovulation not followed by pregnancy. The differences between corpora lutea *a* and *b* are fully described by Mackintosh and Wheeler (1929).

Fig. 50, which may be compared with the similar figures for Fin and Blue whales

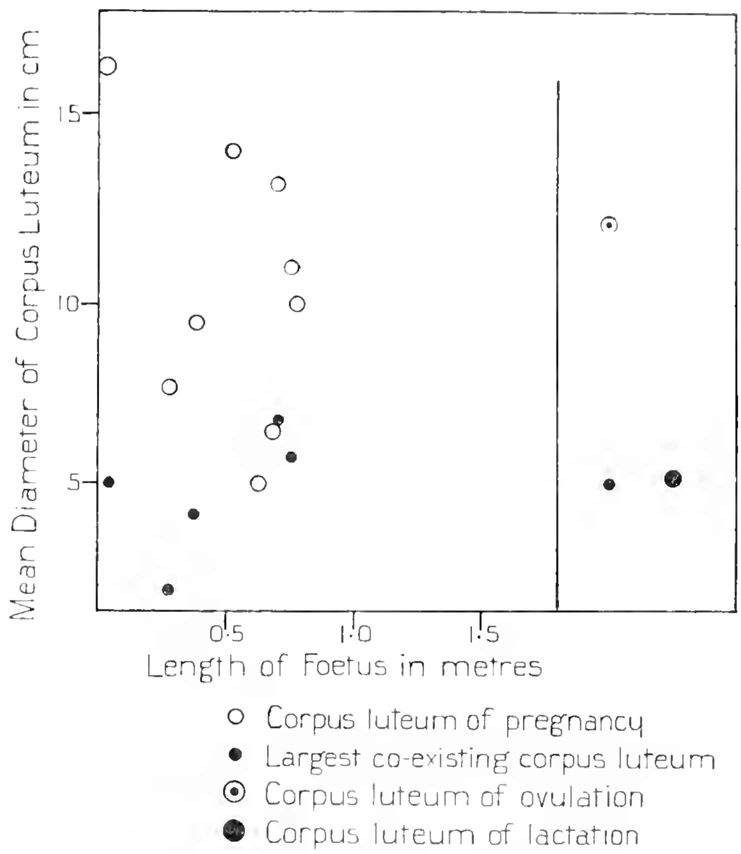

Fig. 50. Humpback whale. Females. Size of corpora lutea.
The points to the right of the vertical line represent values obtained from non-pregnant whales.

given by Mackintosh and Wheeler (1929), shows the size of corpora lutea *a* and *b* plotted against the length of the foetus. Observations are only available from early stages of pregnancy, but the fact emerges that in the Humpback the corpora lutea, both those of ovulation and pregnancy (corpora lutea *a*) and those persisting during lactation and during later pregnancies (corpora lutea *b*) tend to be distinctly larger than in the Fin whale, being intermediate in size between those of the Fin and Blue whales. This is rather unexpected considering how much greater is the size of those species than that of the Humpback, and that the ovaries of the latter are smaller.

Uterus. The routine measurement of the width of the uterine cornua was taken in some of the female Humpbacks examined. It is to be regretted that this measurement was taken in so few mature whales. This measurement is plotted against lengths of whale in Fig. 51, immature, resting, and lactating whales being separated: pregnant whales are not included. This figure shows a gradual increase of width of the uterine cornua with increasing body length, and an indication is given of the increased rate of growth as sexual maturity is reached at a length between 12 and 13 m. No material from Humpbacks is available for an examination of the uterine mucosa, but there is no reason for thinking that it is different in kind from that established as occurring in Blue and Fin whales.

Mammary glands. The mammary glands, as in all Balaenopterids, are situated under the blubber on each side of the middle line just anterior to the reproductive aperture, so that their posterior ends and the teats lie alongside it. Few measurements of the gland

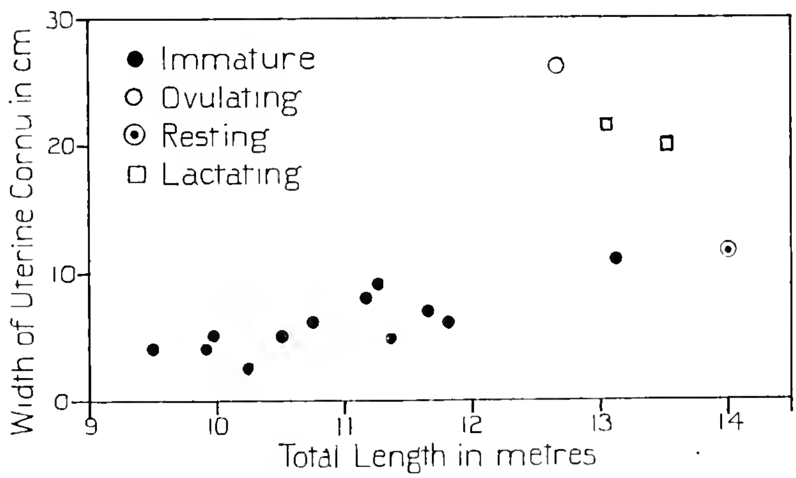

Fig. 51. Humpback whale. Females. Variation in size of uterus.

are available from mature whales, but Fig. 52 summarizes the observations recorded. Here the thickness of the gland at its widest part is plotted against the length of the whale, four states of the gland being recognized: non-parous, resting, intermediate, and lactating. The non-parous class includes both immature whales and whales that have recently become mature and are pregnant for the first time, but in which the gland has never lactated. It will be seen that the thickness of the gland in this class varies between 2 cm. and just under 5 cm., with possibly a slight tendency towards the higher values with increasing length of body. This thickness is greater than that found in Fin and Blue whales, in which the immature gland is not usually over 2 cm. thick at its widest part. The resting class consists of those which have lactated but in which the gland is involuted and not active. In this class it varies between 5 and 10 cm. in thickness, again a greater thickness than that found in corresponding Fin and Blue whales, where the resting gland is 5–6 cm. deep. The intermediate class contains those whales in which the gland is becoming active preparatory to lactation just before parturition, or in which it has not quite reached the resting stage towards the end of the lengthy period of involution. Only one whale is here placed in that class, and it is referred to it with some doubt, as although it is noted that the gland contained no milk, but a brown sticky fluid, the whale was pregnant with a 0·75 m. foetus. The fluid in the gland may possibly have been due to a pathological state, but this point is discussed further below. The thickness of the gland in this whale was only slightly above the minimum for the involuted state. The lactating class requires no explanation: the thickness of the gland was recorded in only one whale, from whose nipples the milk was spouting in a stream when it was drawn up on the flensing plan. In this the thickness was 15 cm., as thick as the lactating gland in many Blue whales.

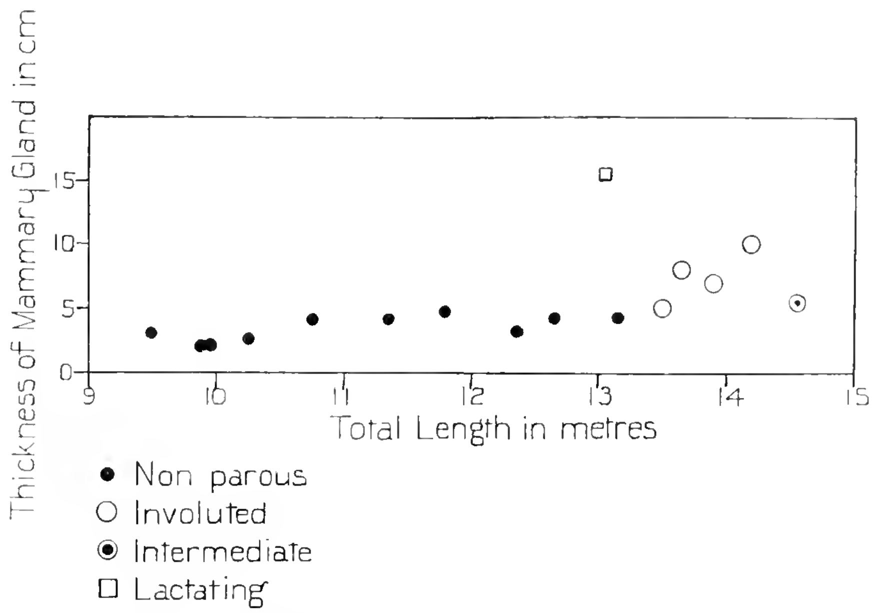

Fig. 52. Humpback whale. Females. Size of mammary gland.

The great thickness of the mammary glands in all their stages when compared with those of Fin and Blue whales is striking, especially when it is borne in mind that the length of the gland is not much less than in those species. The length in Fin and Blue whales is given as about 2 m.: no measurements of length are recorded in the present series, but Lillie (1915) records that in a 40 ft. humpback at New Zealand the gland was $5\frac{1}{2}$ ft. long (approximately 12·25 m. body length: 1·7 m. gland length). It appears then that the mammary gland of the Humpback will produce much more milk in proportion to the length of the whale than in whales of the genus *Balaenoptera*. This point is discussed further in a later section in connection with the growth of the young.

Gestation and breeding season. In addition to the records of foetal length collected in South Georgia and South Africa, particulars relating to a few pregnant female Humpback whales from the South Indian Ocean are available. In the season 1932–3 Mr A. H. Laurie examined a series of whales on board the Southern Whaling and Sealing Company's floating factory 'Southern Princess' in that area. In the month of November 1932 nineteen female Humpback whales were captured, and details of eight are given in Table XVI. In the British Museum statistics relating to whaling there is an extensive list of dated records of foetal Humpback whales, given here in Table XVII.

Table XVI. *Female Humpback whales examined on board floating factory 'Southern Princess'*, 1932

Whale no.	Date	Length m.	Foetus length m.
S.P. 154	12. xi. 32	13·07	♀ 0·22
S.P. 161	13. xi. 32	13·05	♀ 0·24
S.P. 192	15. xi. 32	13·68	♀ 0·20
S.P. 202	15. xi. 32	13·68	—
S.P. 203	16. xi. 32	13·68	—
S.P. 252	18. xi. 32	14·28	♂ 0·31
S.P. 392	26. xi. 32	13·38	—
S.P. 411	27. xi. 32	14·28	—

Table XVII. *Humpback whales. British Museum records of foetuses*

Date	Place	Length m.	Date	Place	Length m.
Sept. 2, 1908	South Georgia	0·047	Nov. 22, 1916	South Georgia	0·03
2, 1908	,,	0·126	22, 1914	,,	0·25
Oct. — 1911	Saldanha Bay	0·070	24, 1916	,,	0·05
— 1911	,,	0·070	24, 1913	,,	1·52
2, 1912	New Zealand	0·061	25, 1913	,,	0·152
5, 1912	Port Alexander	0·092	25, 1913	,,	0·229
10, 1911	Saldanha Bay	0·105	25, 1916	,,	0·36
14, 1914	South Georgia	0·13	26, 1914	,,	0·25
15, 1912	Saldanha Bay	0·114	27, 1914	,,	0·20
23, 1908	South Georgia	0·114	27, 1916	,,	0·23
26, 1908	,,	0·151	27, 1914	,,	0·25
31, 1914	,,	0·08	27, 1914	,,	0·42
Nov. 1, 1912	Saldanha Bay	0·21	30, 1915	,,	0·61
2, 1912	,,	0·058	30, 1920	,,	1·22
3, 1925	South Georgia	0·05	Dec. 3, 1915	,,	0·15
3, 1911	Saldanha Bay	0·062	3, 1915	,,	0·46
4, 1915	South Georgia	0·08	3, 1920	,,	2·44
5, 1912	Saldanha Bay	0·28	4, 1914	,,	0·31
6, 1915	South Georgia	0·015	9, 1914	,,	1·22
6, 1916	,,	0·20	10, 1920	,,	1·83
7, 1911	Port Alexander	0·48*	11, 1914	,,	0·23
		0·50*	13, 1915	,,	0·92
13, 1925	South Georgia	0·92	16, 1925	,,	2·44
14, 1916	,,	0·08	17, 1919	,,	1·22
15, 1917	,,	1·52	19, 1925	,,	0·39
16, 1920	,,	0·31	19, 1913	,,	0·407
18, 1914	,,	0·25	19, 1916	,,	0·61
18, 1914	,,	0·25	19, 1919	South Shetlands	0·92
20, 1915	,,	0·31	20, 1913	South Georgia	0·14
20, 1916	,,	0·31	22, 1915	,,	0·46
20, 1918	,,	2·44	22, 1915	,,	0·61
21, 1914	,,	2·13	23, 1918	,,	0·28

* Twins.

Table XVII (*contd.*)

Date	Place	Length m.
Dec. 23, 1915	South Georgia	0·31
23, 1918	,,	0·34
23, 1915	,,	0·61
24, 1913	,,	0·28
24, 1915	,,	0·31
24, 1918	,,	0·31
24, 1914	,,	0·61
26, 1914	,,	0·61
30, 1915	,,	0·61
30, 1913	,,	0·635
30, 1915	,,	0·46
31, 1914	,,	0·20
31, 1919	,,	0·31
31, 1925	,,	0·31
31, 1913	,,	0·432
31, 1925	,,	0·69
31, 1926	South Shetlands	0·92
Jan. —, 1913	South Georgia	0·148
3, 1917	,,	0·92
4, 1915	,,	0·20
4, 1921	,,	0·61
5, 1914	,,	0·61
5, 1916	,,	0·92
7, 1914	,,	0·533
7, 1916	,,	1·83
8, 1914	,,	0·47
8, 1915	,,	0·61
9, 1926	,,	0·49
10, 1926	,,	0·51
14, 1923	,,	0·61
14, 1926	,,	0·92
15, 1926	,,	0·61
15, 1914	,,	0·635
15, 1917	,,	1·83
16, 1915	,,	2·65
17, 1916	,,	0·15
18, 1926	,,	0·31
18, 1917	,,	1·83
19, 1926	,,	0·23
19, 1926	,,	0·39
19, 1926	,,	0·79
19, 1920	South Shetlands	0·61*
		1·52*
21, 1923	South Georgia	0·61
21, 1923	,,	0·61
23, 1921	,,	0·31
24, 1923	,,	0·61
24, 1926	,,	1·07
27, 1915	,,	0·13
28, 1916	,,	0·46
28, 1916	,,	1·22

Date	Place	Length m.
Jan. 28, 1916	South Georgia	1·52
Feb. , 1910	South Shetlands	0·763
, 1910	,,	0·763
1, 1923	South Georgia	3·05
2, 1916	,,	1·22
2, 1916	,,	2·65
2, 1916	,,	3·35
3, 1920	,,	0·84
3, 1926	South Shetlands	2·13
4, 1926	,,	1·22
5, 1926	,,	0·46
6, 1926	South Georgia	0·69
7, 1923	South Shetlands	0·36
13, 1923	,,	0·40
13, 1923	,,	1·22
19, 1921	South Georgia	0·92
21, 1927	South Shetlands	0·61
22, 1927	,,	0·61
28, 1905	South Georgia	1·45
Mar. 4, 1923	South Shetlands	1·83
5, 1923	,,	1·52
8, 1916	South Georgia	3·05
13, 1923	South Shetlands	1·52
14, 1905	South Georgia	1·23
14, 1923	,,	2·44
26, 1927	South Shetlands	1·83
Apr. 3, 1927	,,	1·52
5, 1927	,,	1·83
May 7, 1918	South Georgia	0·46
7, 1921	,,	0·92
20, 1915	,,	0·92
20, 1916	,,	2·65
23, 1915	,,	0·31
June 10, 1916	,,	4·57
15, 1916	,,	4·57
July 1, 1927	Natal	4·04
14, 1920	South Africa	4·11
18, 1927	Natal	4·41
19, 1928	Cape Province	4·44
24, 1912	New Zealand	4·11
Aug. 2, 1914	Linga-linga	5·11
3, 1928	Natal	3·05
3, 1911	Port Alexander	3·65
3, 1922	Natal	4·57
3, 1922	,,	4·57
7, 1922	,,	4·26
20, 1911	Port Alexander	2·44*
		3·65*
22, 1911	,,	2·80*
		5·00*
23, 1927	Cape Province	4·57

* Twins.

A few records from South Georgia and elsewhere given by Hinton (1925) are also included in the present analysis. If now the lengths of all recorded foetuses are plotted against months the scatter-diagram in Fig. 53 is obtained. When the average lengths are plotted by months the curve shown in Fig. 54 is produced. This shows that a pregnancy starting in September terminates in the following August when the foetus reaches a

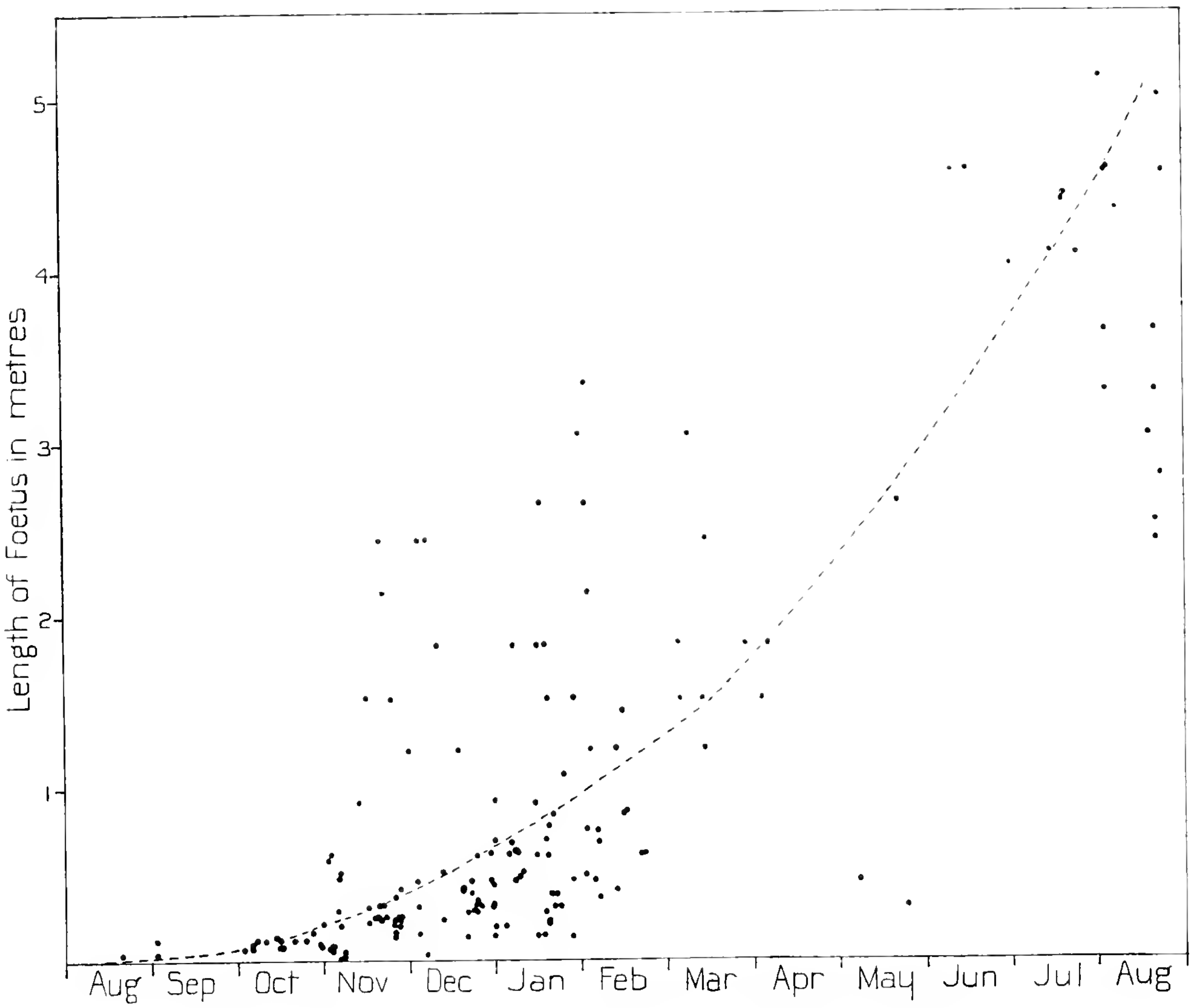

Fig. 53. Humpback whale. Length of foetuses plotted against date of occurrence.

length of about 4·5–5·0 m., and that gestation takes about eleven months. The length of the young at birth is taken as about the mean of the longest foetus and the smallest recorded living young. From Fig. 53, on which the curve in Fig. 54 is superimposed, it appears that the bulk of pregnancies start in the months August to November inclusive, but the points below the average line in May and those far above it from December to March inclusive show that, in addition, a small proportion of pregnancies start in the months of December to June. Lactation will therefore take place from August onwards: one lactating whale is recorded for December and one for March from

South Georgia. The latter whale, lactating in March, shows that the breeding season in this species is, like that in other whales, considerably prolonged, so that all females are not in the same stage of pregnancy at the same time. In other words the course of pregnancy is not to be indicated in Fig. 53 by the dotted line but by a wide area lying on each side of it.

The period of lactation is about five months; this value is derived partly from facts which have already been given and partly from facts discussed later on. Fig. 42

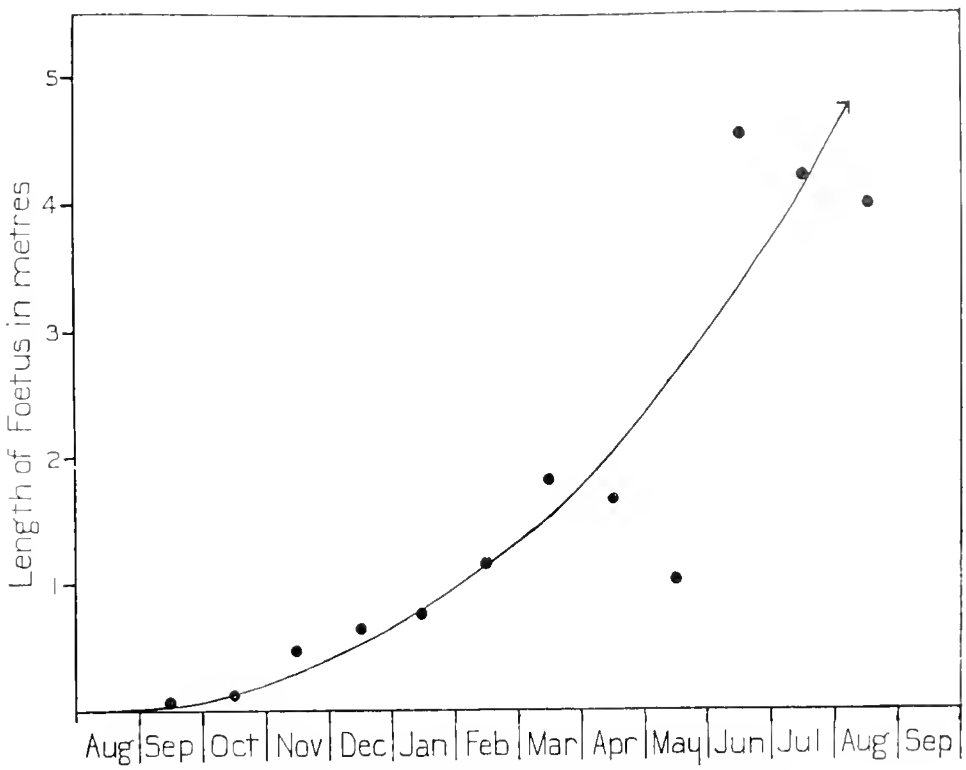

Fig. 54. Humpback whale. Average monthly foetal length.

(baleen lengths) shows that weaning takes place at a length of 7·5–8 m. Fig. 61 shows that the calf reaches this length at an age of about five months after birth, which period is, therefore, the duration of lactation.

If, in Fig. 53, lines are drawn parallel to the average line but taking their origin at monthly intervals on each side of it, the points are divided up into a number of groups representing pregnancies starting in each month. When these pregnancies are counted and plotted by months the curve in Fig. 55 is obtained, which shows the frequencies of pairing by months. This indicates that the breeding season covers the months of August to November inclusive, with its highest intensity in September, and that a small amount of breeding occurs throughout the year. If the curve is replotted with the time scale shifted eleven months later, the curve showing the frequency of births in Fig. 56 is obtained, which shows that the majority of births occur in August. It should be noted that some, but not all, of the minority of pregnancies starting out of the regular breeding season may be those of whales, belonging to the schools of the northern hemisphere, which have crossed the equator and joined those of the southern hemisphere, and are consequently in a stage of pregnancy different from that of the majority of their companions. This possibility has been mentioned above and is discussed further in a later

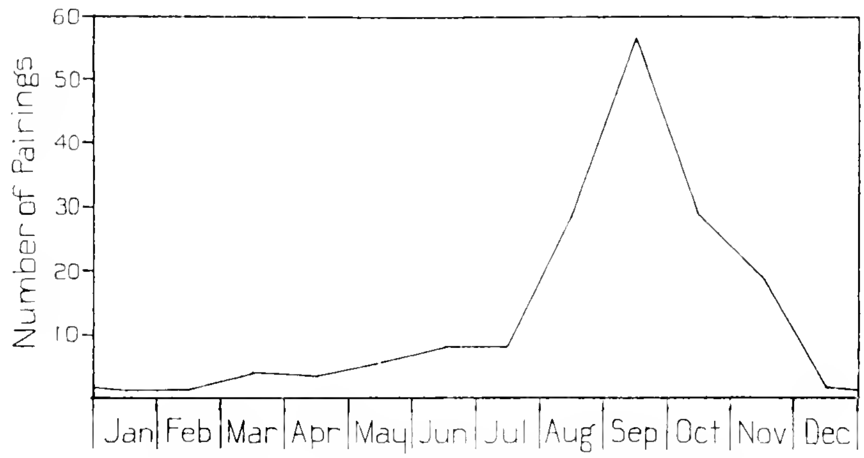

Fig. 55. Humpback whale. Pairing frequencies by months.

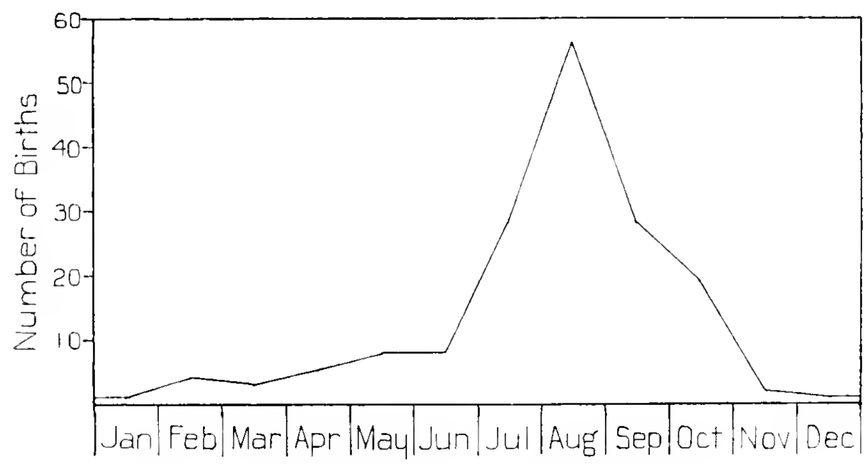

Fig. 56. Humpback whale. Birth frequencies by months.

section. A further possibility to be noted is that some of the small amount of breeding outside the main season may be due to renewed breeding by cows that have lost their calves.

Sexual cycle. The results of the examination of nineteen female Humpback whales are now given, before considering the course of the sexual cycle. The whales are arranged according to the dates of their capture.

No. 317. Length 14·1 m. 9. i. 26. South Georgia. Pregnant. This whale was very rotten, but was pregnant with a foetus 0·68 m. in length, and one ovary contained a corpus luteum *a*, 6·6 cm. in mean diameter.

No. 321. Length 14·9 m. 10. i. 26. South Georgia. Pregnant. Foetus, female 0·64 m. long. The ovary containing the corpus luteum *a* (not measured) had no other corpora lutea and no scars. The other ovary contained one corpus luteum *b*, 5·3 cm. in mean diameter, and was scarred. This whale had therefore probably become pregnant at the second ovulation of the previous sexual cycle, the corpus luteum *b* being too large to be that of a previous pregnancy. The scars in one ovary may indicate corpora lutea *b* of previous sexual cycles or pregnancies, but the whale was badly decomposed and no further observations on the ovaries or on the mammary glands are available, so that this point cannot be ascertained.

No. 345. Length 12·6 m. 13. i. 26. South Georgia. Resting. One ovary contained a corpus luteum *b* noted as "rather large". There were numerous follicles up to 20 mm. in diameter beneath the surface. The whale was not lactating. The vulva was somewhat swollen and the uterus measured 26 cm. across. This whale had, then, recently reached maturity, but had missed pregnancy at the first ovulation of the first sexual cycle and was in dioestrus preparatory to ovulating for the second time.

No. 355. Length 13·15 m. 13. i. 26. South Georgia. This whale was very rotten, but was noted as not lactating.

No. 373. Length 12·5 m. 18. i. 26. South Georgia. Pregnant. One ovary contained a corpus luteum *a* of mean diameter 10·5 cm., and one corpus luteum *b* of 4·4 cm.; it weighed two pounds. The other ovary had no scars and no follicles showing. Ovaries are noted as "very small". The whale was pregnant, but the foetus had been lost subsequent to capture and the membranes only were found. The vulva was slightly congested and not completely closed. The whale was not lactating and the mammary grooves were closed. The corpora lutea and the length of the whale showed that this whale had recently reached maturity and had become pregnant at the second ovulation of the first sexual cycle.

No. 3569. Length 12·72 m. 18. i. 31. South Georgia. Pregnant. One ovary weighed 1 lb. 12 oz. and contained a corpus luteum *a* of mean diameter 7·8 cm. and 9½ oz. weight. It also contained corpus luteum *b* of mean diameter 2·5 cm. The other ovary weighed eleven ounces and contained no corpora lutea. No follicles were visible in either ovary. The whale was pregnant with a foetus 0·28 m. in length. The uterus was 22 cm. across the pregnant cornu, and 16 cm. across the non-pregnant one. The mammary gland was 4 cm. thick and had never lactated. This whale was therefore a young adult that had become pregnant at the second ovulation of the first sexual cycle.

No. 3573. Length 13·5 m. 18. i. 31. South Georgia. Pregnant. One ovary weighed 3 lb. 10 oz., and contained a corpus luteum *a* of 13 cm. mean diameter and 2 lb. 5 oz. in weight. It contained five corpora lutea *b* of mean diameter 5, 4, 3·5 cm. and less. Some small follicles were visible below the surface. The other ovary weighed 1 lb. 8 oz. and contained five corpora lutea *b* of mean diameter 6·5, 3, 3 cm. and less. The whale was pregnant with a 0·7 m. foetus. The non-pregnant uterine cornu was 22 cm. across. The mammary gland was 5 cm. deep and involuted. This whale had therefore been pregnant at least once before, and probably more than once.

No. 386. Length 18·5 m. 20. i. 26. South Georgia. Pregnant. One ovary weighed four pounds and contained a corpus luteum *a* of mean diameter 9·5 cm. and four corpora lutea *b* of mean diameter 4·5, 3, 2·2 and 1·2 cm. Some follicles up to 20 mm. in diameter were present. The other ovary contained two corpora lutea *b* of mean diameter 3·2 and 1·7 cm. It contained one follicle 15 mm. in diameter and some smaller ones below the surface. A foetus 0·38 m. long was present. The whale was not lactating, but the mammary gland is noted as "well developed", which, with the state of the corpora lutea, almost certainly indicates that it was involuted and that the whale was a multipara.

No. 387. Length 13·55 m. 20. i. 26. South Georgia. Pregnant. One ovary contained a corpus luteum *a* and one corpus luteum *b*. The other contained three corpora lutea *b*. A foetus 0·85 m. long was present. No further data are available. This whale had probably been pregnant at least once previously.

No. 388. Length 13·55 m. 20. i. 26. South Georgia. This whale was badly decomposed but is noted as not pregnant.

No. 7487. Length 12·8 m. 2. ii. 26. South Georgia. Pregnant. No observations on the ovaries are available. A foetus 0·5 m. long was present, and there was mucus in the vagina. The mammary grooves were closed and the gland is noted as "well developed". This probably means that the gland was involuted, in which case this whale had been pregnant previously, but, in view of its size, probably not more than once.

No. 3108. Length 12·35 m. 2. ii. 30. South Georgia. Pregnant. One ovary weighed 1 lb. 10 oz. and contained a corpus luteum *a* of 10 cm. mean diameter and 14 oz. weight. The other ovary weighed 12 oz. No corpora lutea *b* were present in either ovary, but there were some follicles up to 10 mm. in diameter visible below the surface in both. A foetus 0·76 m. long was present: the pregnant cornu of the uterus was 41 cm. across and the non-pregnant one 23·5 cm. The mammary gland was 3 cm. thick and had never lactated. This whale was therefore pregnant at the first ovulation of the first sexual season.

No. 516. Length 14·53 m. 6. ii. 26. South Georgia. Pregnant. One ovary contained a corpus luteum *a*, 11 cm. in mean diameter, and two corpora lutea *b* of 6 and 3 cm. mean diameter. The other ovary was not examined. A foetus 0·75 m. long was present. The vulva was swollen and congested and contained mucus. The mammary grooves were closed and there was no milk; the mammary gland was 5·6 cm. thick and contained a brown sticky fluid which may have been pathological in origin, or may have indicated the last stages of involution from the previous pregnancy, for the whale had probably been pregnant before as shown by the two corpora lutea *b* in one ovary, together with the total length of the whale.

No. 3206. Length 13·9 m. 11. iii. 30. South Georgia. Ovulating. One ovary weighed 5 lb. 14 oz. and contained a corpus luteum *a* 12 cm. in mean diameter and 1 lb. in weight. It also contained three corpora lutea *b* (not measured). The other ovary weighed 4 lb. 13 oz. and contained seven corpora lutea *b* of mean diameter 5·3, 3 cm. and less. No foetus was present and the mammary gland was 7 cm. thick and involuted. This whale was therefore a multipara and had just ovulated.

No. 96. Length 13·55 m. 16. iii. 25. South Georgia. Lactating. This whale was lactating, the mammary gland being "greatly swollen" and milk spouting from it on the flensing plan. The uterus was 20 cm. across. Further details are lacking.

No. D. 49. Length 14·0 m. 27. vi. 30. Durban, South Africa. Resting. One ovary weighed 1 lb. 2 oz. and contained four corpora lutea *b* of mean diameter 4, 3 cm. and less. No follicles were visible. The other also weighed 1 lb. 2 oz. and contained five corpora lutea *b*, the largest, which was the youngest in either ovary, of mean diameter 5 cm. The others were old and resorbed. No follicles were visible on the surface. The uterine cornua measured 11·5 cm. across on the right side and 11 cm. on the left. This whale was therefore a multipara in anoestrus, probably between pregnancy and the next dioestrous cycles.

No. 3426. Length 14·2 m. 6. xii. 30. South Georgia. Pregnant. One ovary weighed 5 lb. 14½ oz. and contained one corpus luteum *a* of mean diameter 16 cm. and four pounds weight. It also contained thirteen corpora lutea *b* of mean diameter 5·3, 3·5, 2·6 cm. and less. A few follicles up to 35 mm. in diameter projected on the surface. The other ovary weighed 1 lb. 6 oz. and contained one corpus luteum *b* of 4 cm. mean diameter, and six old corpora lutea *b*, not measured. There were a few projecting follicles up to 35 mm. in diameter. The largest corpus luteum *b* in this ovary was of about the same age as the corpus luteum *b* measuring 3·5 cm. in mean diameter in the other ovary. A foetus 0·04 m. in length was present, the pregnant cornu of the uterus measuring 50 cm. across and the non-pregnant one 44 cm. The mammary gland was 10 cm. thick and involuted. This whale was a multipara and had probably been pregnant on several occasions, as indicated by the thickness of the involuted mammary gland and the size of the non-pregnant uterine cornu. Pregnancy was possibly established at the first ovulation of the last sexual cycle. The two corpora lutea of approximately the same age represent either a simultaneous ovulation or, more probably that the whale had ovulated once unsuccessfully, and become pregnant at the second ovulation of the previous dioestrous cycle. It is of interest to note that in spite of previous pregnancies a tag representing the remnant of the vaginal band was present in this whale.

No. 2033. Length 13·66 m. 27. xii 28. South Georgia. Pregnant. One ovary contained a corpus luteum *a* of mean diameter 14 cm., and two corpora lutea *b* not measured. The other contained two corpora lutea *b*. Some small follicles were visible in both ovaries. A foetus 0·51 m. long was present. The vagina was congested and vulva open, possibly owing to decomposition. The whale was not lactating and the mammary gland was 8 cm. thick and involuted. The whale had therefore been pregnant previously and the present pregnancy had probably been established at the first ovulation of the last sexual cycle.

No. 2873. Length 13·05 m. 29. xii. 28. South Georgia. Lactating. One ovary weighed 9 oz. and contained one corpus luteum *b* of mean diameter 5·5 cm. Some follicles 5 mm. in diameter were present below the surface. The other ovary weighed seven ounces and contained no corpora lutea. The uterine cornu on the side of the ovary with the corpus luteum was 20 cm. across and the other one 22·5 cm. This whale was lactating, the mammary gland being 15 cm. thick and milk spouting from the nipples when the whale was drawn up on the flensing plan. An anterior tag, representing the remains of the vaginal band, was present. This whale was, therefore, nursing her first calf and pregnancy had taken place at the first ovulation of the first sexual season.

Of these whales, nine are multipara, three pregnant or lactating for the first time, and five uncertain. At South Georgia for December there are three whales, one lactating, one in very early pregnancy and one in slightly later pregnancy. For January there are ten whales, seven in early pregnancy and three resting. For February there are three whales all in early pregnancy. For March there are two whales, one ovulating, the other lactating. At Durban, South Africa, there is one whale in anoestrus in June.

The cause of the prolongation of the breeding season mentioned above is no doubt the fact that this species, like other whales, is polyoestrous and that females frequently do not become pregnant at the first ovulation of the sexual cycle, and may experience several dioestrous cycles before pregnancy occurs. The polyoestrous nature of the cycle is shown by whale no. 3569 which was pregnant for the first time, as shown by the non-parous condition of the mammary gland, but had more than one corpus luteum in the ovary. Fig. 57 is a scatter diagram of the number of corpora lutea in the ovaries plotted

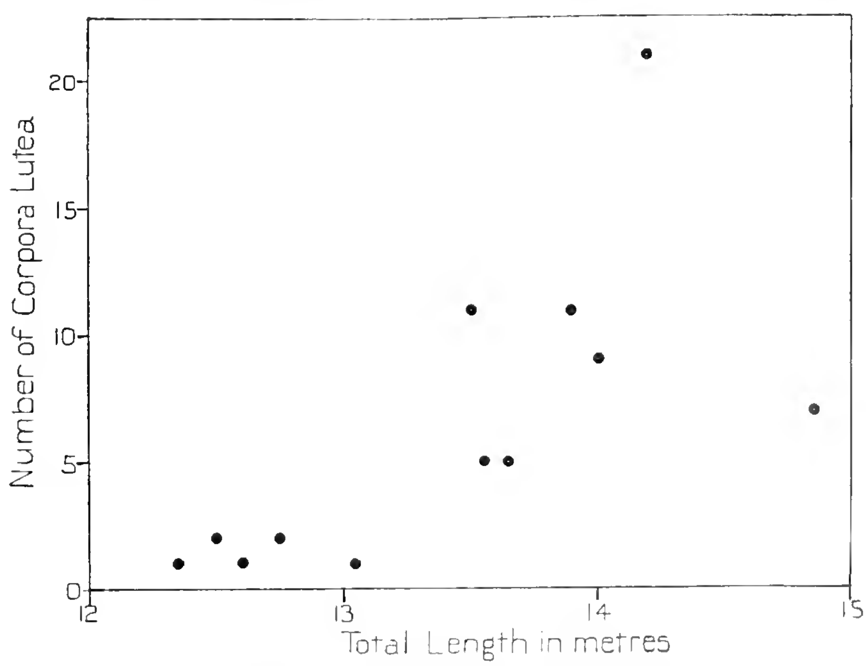

Fig. 57. Humpback whale. Females. Number of corpora lutea in the ovaries.

against total lengths of the whales examined. From these the data in Table XVIII are obtained; and from them, though they are scanty, there is some indication of a grouping of numbers near 1, 5 and 10, which points to the possibility of an average of four di-oestrous cycles with five ovulations for each sexual cycle succeeding the first.

The evidence hitherto available indicates two possibilities, either (*a*) that the Humpback whale breeds every year or, (*b*) that it breeds once every two years. If it breeds once every two years lactation in some individuals would be expected to overlap early pregnancy in others, and this in fact is recorded, for the only two lactating Humpbacks examined occurred in December and March respectively when other individuals were in early pregnancy. Moreover, if lactation takes about five months, and pregnancy lasts about eleven months, the breeding cycle will obviously take more than a year for its completion and breeding can only take place either once every two years with a gap of anoestrus between sexual seasons, or, if anoestrus is reduced in duration, twice every three years. The latter possibility would explain the simultaneous occurrence of ovulating, pregnant and lactating whales.

Table XVIII. *Humpback whale. Females. Frequency of numbers of corpora lutea*

No. of Corpora lutea	Frequency of occurrence	No. of Corpora lutea	Frequency of occurrence
1	3	8	—
2	2	9	1
3	—	10	—
4	—	11	2
5	2	12	—
6	—	21	1
7	1		

On the other hand, lactation is shorter in this species than in the rorquals, and growth of the calf is more rapid, probably owing to the large size of the mammary gland when compared with that of other species. It would thus be possible for an early parturition in July to be followed by five months' lactation and a further pregnancy in the following January. This possibility is further upheld by a consideration of whale no. 516 taken in February at South Georgia. This whale was pregnant, but the mammary gland, though not lactating, contained a "brown sticky fluid" which may have represented the last stages of involution after the previous lactation. Further, whale no. 3206, taken in early March 1930 at South Georgia, was not pregnant but had just ovulated, and may thus have been in oestrus after several unsuccessful dioestrous cycles, an assumption which is strengthened by the presence in the ovaries of eleven corpora lutea, the largest measuring 5·3 cm. in diameter. This whale appears more likely to have been a late breeder of the 1925–6 season than a very early one of the 1926–7 season.

On the whole, the evidence from the female Humpback whales points to the possibility of breeding occurring twice every three years in some, if not all, individuals. But to set against this there is the fact that none of the adult males examined, admittedly few, showed any signs of sexual activity in December, January or March at South Georgia, while those examined in South Africa in July and August did.

The curves produced from the large collection of foetal lengths must be relied upon, rather than the information relating to the small series of males, and the conclusion reached from a consideration of these is that the majority of female Humpback whales breed once every two years, with a period of anoestrus between lactation and the following pregnancy, but that a minority go into oestrus and are impregnated after lactation during the months when the majority are in anoestrus. This conclusion is further supported by a consideration of Figs. 55 and 56, which show a small proportion of pairings and births in all months apart from the main seasons. Some of these may be cows that have lost their calves after birth and have come into oestrus again. The occurrence of the minority breeding twice every three years has probably given rise to the belief, widespread amongst whalers and others, that all Humpbacks breed every year. Risting (1928) mentions a female Humpback 46 ft. long that was brought into Hangklip Whaling Station (Cape Province) on 15 November 1913, and was accompanied by a calf 29 ft. long, and contained a foetus 5 in. long. This is the only case of which he is aware which indicates with certainty that Humpbacks can breed in successive years.

Further, Ommanney (1933) states that he was informed that off the Bay of Islands, New Zealand, many of the females on their southward migration are accompanied by newly born sucking calves about 15 ft. long and are also carrying foetuses about 2 in. in length. In addition Hinton (1925) records from South Georgia in the season 1913–14 one pregnant female that was nursing and three pregnant females in which some milk was present in the mammary glands.

Olsen (1914–15) also records two females taken at Saldanha Bay in October 1911 which contained foetuses about 70 mm. long and were in full lactation, from which he rather hastily concludes that Humpbacks produce a young one every year. He further states that the females are exhausted by parturition and remain quietly on their breeding grounds for about a month before pairing and starting the southern migration. He thus gives a period of about four weeks between parturition and pairing. This is probably far from correct, for as Hinton (1925) states "no female [Humpback whale] normally experiences oestrus during the essential part of the sucking period; on the approach of the time for weaning the calf oestrus may happen and an ovum be shed: and if impregnation takes place at this time the calf is quickly weaned. There is, so far as I know, no evidence at all of pregnancy during the early stages of suckling."

An examination of the statistics from whaling stations shows that a period of anoestrus normally occurs in many female Humpbacks. Table XIX shows the numbers of male, female, and pregnant female humpback whales taken at Natal in the years 1924–8. Even allowing for hasty examination and the overlooking of many of the smaller foetuses the very low proportion of pregnancies recorded points towards the likelihood of many of the females being in anoestrus. This view is further strengthened by the data given on pp. 60–63, in which the records of a careful examination of female Humpback whales by members of the expedition are analysed. It is unfortunate that so few female whales of this species were available for careful study.

It is necessary to go back to the seasons 1915–16 and 1916–17 to obtain data from the southern whaling stations, because Humpback whales have been protected on the southern grounds since then. Records for these years are given in Table XX, where again the proportion of recorded pregnancies is very small, though it may in part be due to careless examination. Even the records of careful examinations made by the Discovery staff show a high proportion of non-pregnant whales (Table XXI). These records are

Table XIX. *Catches of male, female, and pregnant female Humpback whales at Natal* 1924–8

Year and month	Males	Females	Pregnant females
1924 May	1	—	
June	16	11	
July	31	18	1
Aug.	6	7	1
Sept.	31	28	
Oct.	22	14	
1925 May	—	1	
June	19	16	—
July	35	21	—
Aug.	13	14	
Sept.	13	10	1
Oct.	19	5	—
1926 May	2	4	—
June	9	9	—
July	21	13	—
Aug.	9	9	—
Sept.	10	15	1
Oct.	5	2	—
1927 May	1	1	
June	4	10	
July	14	8	2
Aug.	5	5	
Sept.	10	5	
Oct.	12	8	—
1928 May	—	3	—
June	7	9	—
July	5	10	—
Aug.	5	4	1
Sept.	7	2	—
Oct.	2	6	—

Table XX. *Catches of male, female and pregnant female Humpback whales at South Georgia*, 1915–16 *and* 1916–17

Season and month	Males	Females not pregnant	Pregnant females
1915–16 Oct.	1	10	—
Nov.	43	50	3
Dec.	71	68	5
Jan.	88	95	5
Feb.	31	33	3
Mar.	40	49	1
April	12	23	—
May	36	41	1
June	6	6	2
1916–17 Oct.	1	—	—
Nov.	32	37	8
Dec.	36	32	1
Jan.	29	27	3
Feb.	7	7	—
Mar.	1	—	—
April	7	1	2
May	1	1	—

Table XXI. *Humpback whale. Females examined by the Discovery Staff*

Month	Pregnant	Lactating	Ovulating	Not recorded as pregnant or lactating: presumably resting	Resting
January	7			—	4
February	3			—	—
March		1	1	—	
June	—	—		—	2
July	1	—	—		—
August	1	—	—	—	1
November	5	—		14	1
December	2	1	—	—	—

difficult to reconcile with whalers' statements, reported by Risting, to the effect that the female Humpbacks caught off South Georgia and the South Shetlands in the summer are nearly all pregnant, or with that obtained from Captains C. A. Larsen and Thoralf Sörlle (*Report Interdepartmental Committee on Research, etc.*, 1920, p. 91) that about 75 per cent of female Humpbacks taken at South Georgia were pregnant. But as Risting shows, these statements of whalers as to yearly breeding have not much value, because the majority of the Humpbacks referred to were caught when the whole carcase was not utilised and was generally discarded after the blubber had been removed: even after more modern methods were introduced nothing resembling a careful examination was undertaken. Hinton (1925) points out that Risting evidently thinks, and has good grounds for so thinking, that Humpbacks bear a young one in alternate years only.

The oestrous cycle of the female Humpback whale may therefore be summarized diagrammatically as in Fig. 58, in which the main cycle is shown as occurring once every two years, and the broken line represents a possible post-lactation oestrous which occurs occasionally, and is usually found in those individuals which have given birth early in the season of parturition.

GROWTH

Examination of the genitalia showed that female Humpbacks become sexually mature at a length of about 12·5 m. and males at a length of about 12 m. The shortest mature female recorded was 12·35 m. long and the shortest mature male 11·9 m.

If all records of Humpback whales less than 12·5 m. in length are plotted by months, a scatter diagram as shown in Fig. 59 is produced. In this figure there are included nineteen immature whales recorded by Hinton (1925) from South Georgia. There appear to be in this diagram two fairly well-defined age groups, those 10–12 m. long and those 6–9 m. long. If now the average length by months is calculated, those under 9 m. in length being separated from those over 9 m. for the months of November to March inclusive, and the averages are plotted on an extended time scale with the low November to March values on the left, the curve in Fig. 60 is produced.

The group in Fig. 59 under 9 m. in length represents calves of the current season, that above 9 m. in length those of the previous season. In Fig. 60 the part of the curve on the left-hand side of the month of August represents calves less than a year old, that on the right-hand side those over a year old. Olsen (1914–15) makes a statement that

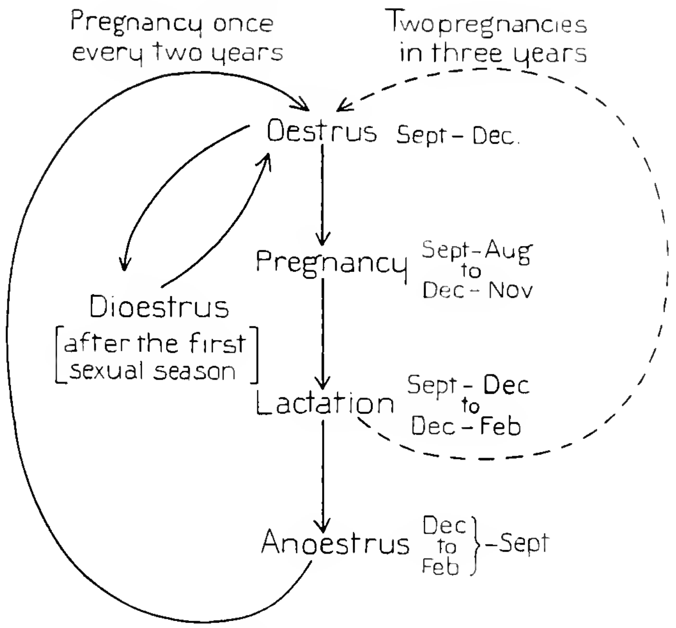

Fig. 58. Humpback whale. Diagram of oestrous cycle.

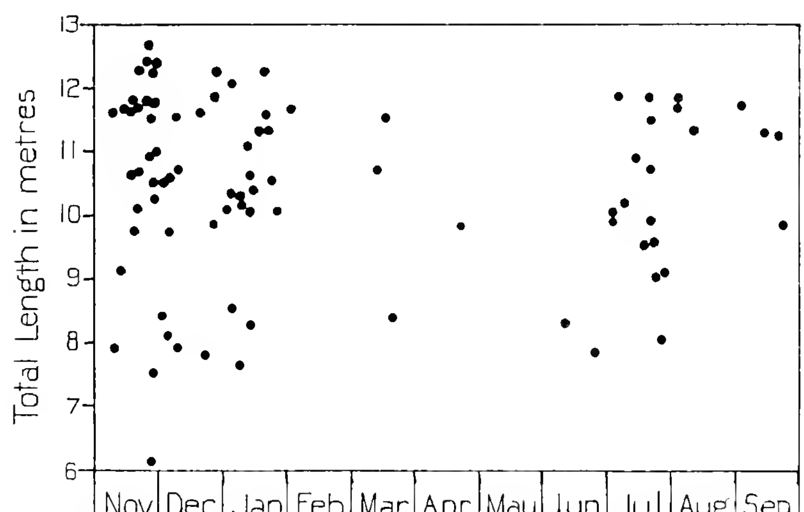

Fig. 59. Humpback whale. Lengths and dates of immature whales.

agrees with this conclusion: speaking of the Humpbacks arriving off the coast of South Africa on their northward migration, he says that they are often accompanied by calves of the previous year about 30 ft. (9·15 m.) long, and he further states that between the north and south migrations nearly all the Humpbacks caught at Durban are 30–35 or 40 ft. (9·15–10·67 or 12·2 m.) long and are sexually immature individuals one to two years old.

Returning now to Fig. 54 and combining that curve with this, the result shown in Fig. 61 is produced which shows that sexual maturity is reached at the age of about twenty to twenty-two months and that Humpback whales first breed towards the end of their second year. The accuracy of the curve in Fig. 61 formed by joining the curves in Figs. 59 and 60 is upheld by the statement of Olsen (1914–15) that on their southern migration the female Humpbacks are accompanied by calves about 5 m. or more in length and that calves killed off Port Alexander in August were 6·5 m. in length. Engle

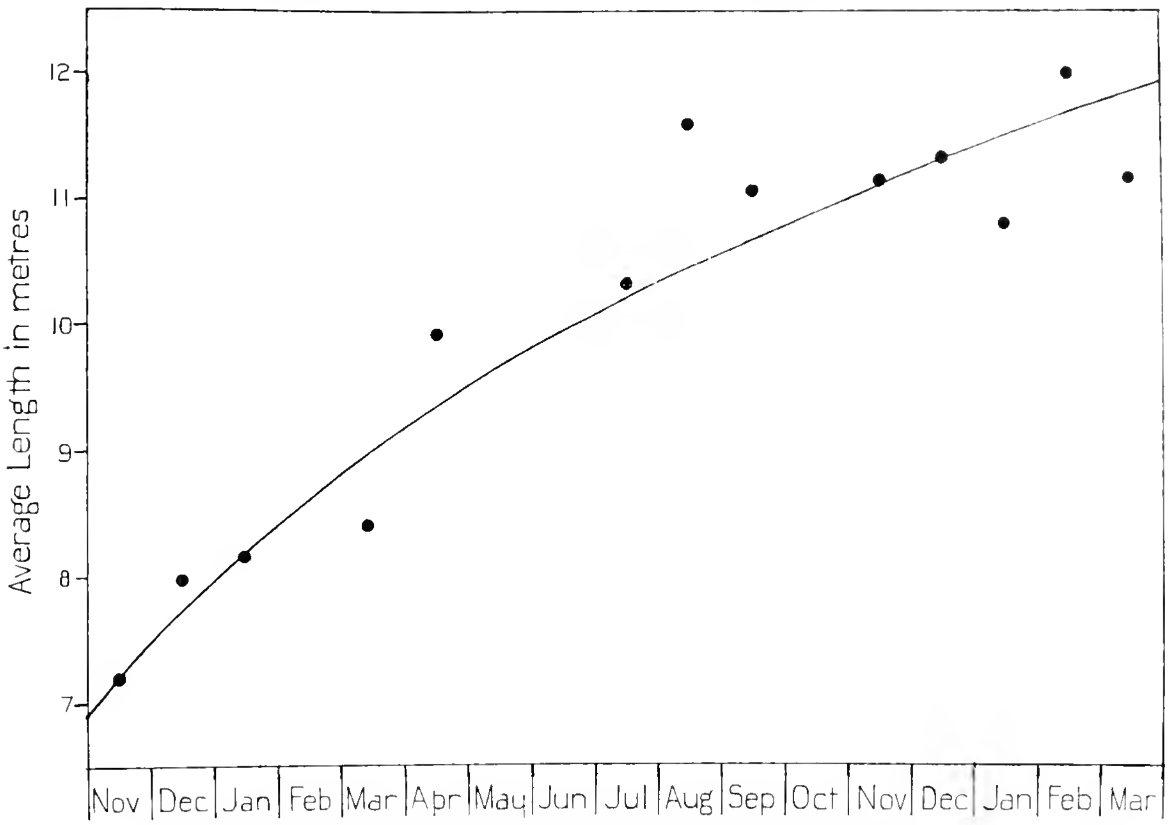

Fig. 60. Humpback whale. Average lengths of immature whales by months.

(1927), who examined a few Humpbacks in California, suggested that these whales become sexually mature while they are yet quite young, a suggestion which is here shown to be correct.

The age classes of Humpback whales cannot be deduced from the number of corpora lutea in the ovaries, as can those of the Blue, Fin and Sei whales, because of the shortness of the complete breeding cycle in this species and the indication already shown that pregnancy may sometimes occur twice every three years, or at least that an extra pregnancy may be interpolated in a more usual two-year cycle. The most that can be said is that the whales with the lowest numbers of corpora lutea (one or two) are in their second year and aged from eighteen months to two years. The classes shown by numbers of corpora lutea after this age may be separated by one and a half years in some cases and two years in others, so that taking into account also the paucity of the data, no indication can be given of the ages of the older whales by this means (cf. Wheeler, 1930).

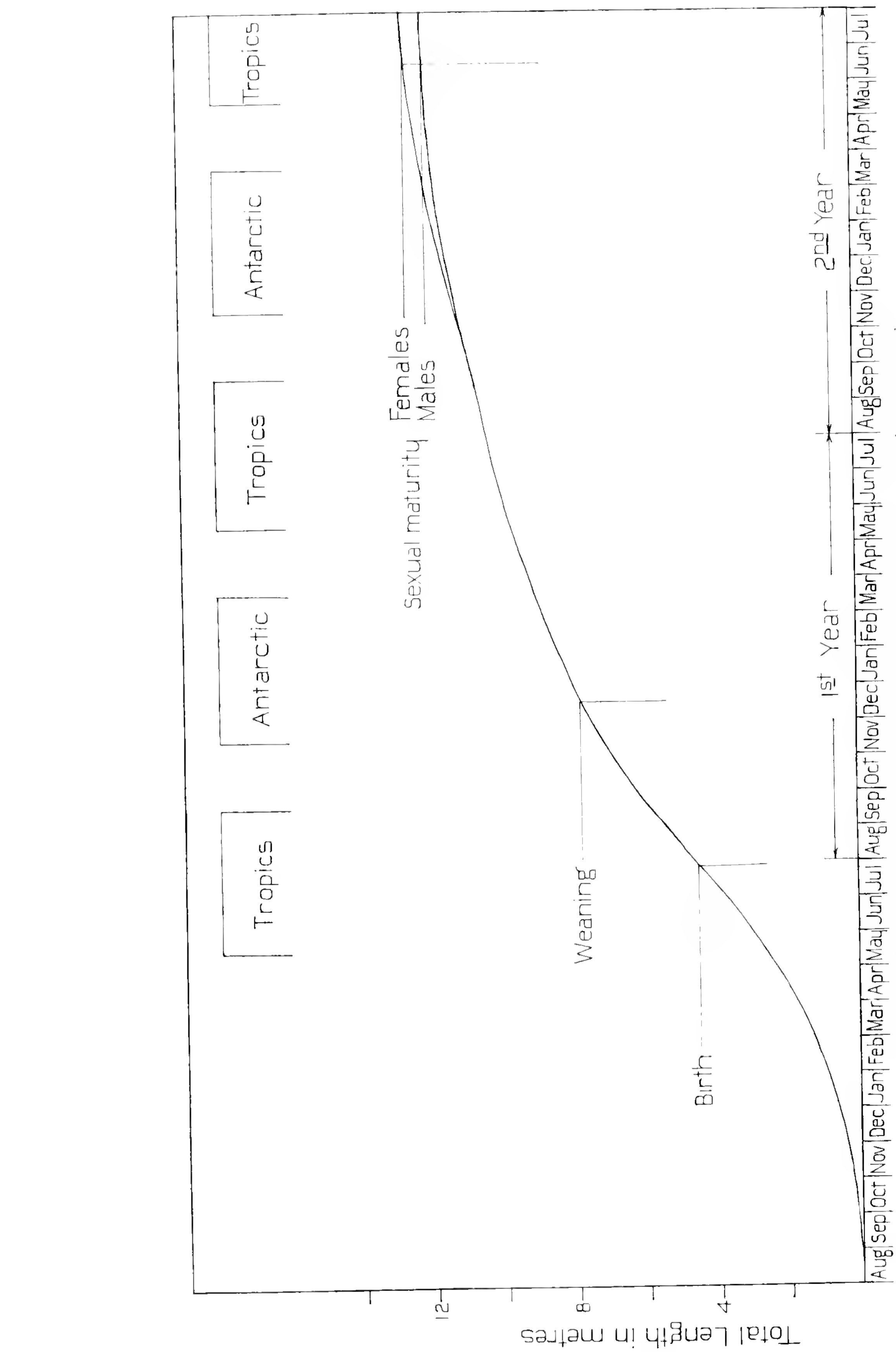

Fig. 61. Humpback whale. Growth of Humpback whale from conception to maturity.

As in other rorquals, growth in length continues after sexual maturity is reached, and does not stop until the epiphyses of the vertebrae are fused to the bodies. Ankylosis of the epiphyses takes place first at each end of the vertebral column and later in its middle part. The results of the examination of a few vertebral columns are shown in Table XXII. In this table also the numbers of different ages of scars present on the skin are recorded, as also is the age, in breeding seasons, of the females. The age in years can only be given in the case of females in their first breeding season and in them it is one and a half to two years.

The oldest whale appears to be no. 3426, in which all the epiphyses were ankylosed and which had twenty-one corpora lutea in its ovaries. If its breeding seasons had been spaced at every two years this whale would be ten years old, but some of the seasons may have been spaced at only eighteen-month intervals, in which case its age would be less than ten years. If it had bred as frequently as possible, that is, twice every three years, it would be eight years old. However, it may safely be said that growth is complete and the epiphyses are fused by the age of ten years and may be so before that age is reached. Hinton (1925) states "complete fusion is, perhaps, to be regarded as a sign of middle age, if not of senility". If fusion is complete at ten years of age the former alternative would appear the more likely. Whales nos. 3206 and 3573 were both in their third breeding season, but 3206 was much nearer physical maturity than 3573: the posterior lumbar epiphyses were ankylosed and the anterior and thoracic ones, though not ankylosed, were separated from the bodies of the vertebrae by thin cartilage only, whereas in 3573 none of the epiphyses were ankylosed and all were separated from the vertebral bodies by thick cartilage. Here again the difference may be due to one or more of the past breeding seasons of whale no. 3573 being spaced at only eighteen-month intervals from the preceding ones, thus making its number of breeding seasons equal to that of no. 3206, though its duration of life had been shorter.

The particulars of surface scars recorded in Table XXII show that data regarding the amount of scarring visible are too scanty to give any indication of the age of the whale, because the older scars become very confused and partly obliterated.

Two direct observations on the length of life of Humpback whales are recorded by Ommanney (1933). Both occurred in New Zealand waters and were due to the recovery of harpoons, of types that were clearly recognizable, after intervals of eighteen and seven years respectively, in the same localities in which they were lost.

Referring now to Tables V, VI, VII and VIII, which show (in roman type) the values of the measurements of different parts of the body according to the length of the whale, an indication of the relative rates of growth of the various parts may be obtained. If the mean values of the various measurements are plotted against the total length of the whale on a double logarithmic scale the results shown in Figs. 62–78 are obtained. Measurements of the South Georgia whales only are used, and the values for males and females are distinct. In each of these figures, even though they are constructed from scanty data, the points are obviously falling about a straight line, and in some of them the approximation is very close. This being so it may be taken that the rates of

Table XXII. *Humpback whales. Age and ankylosis of vertebral epiphyses*

Whale no.	Length m.	Sex	Date	Ankylosis of vertebral epiphyses	Age in years or breeding seasons	Scars on surface
3108	12·35	Female	2. ii. 30	L. 14–15. Not ankylosed. Cartilage thick Th. 5–6. Not ankylosed. Cartilage thick	1½–2 years	Few
3206	13·9	Female	11. iii. 30	L. 14–15. Ankylosed. No sign of join L. 4–5. Not ankylosed. Cartilage thin Th. 7–8. Not ankylosed. Cartilage thin	3 breeding seasons	—
3426	14·2	Female	6. xii. 30	C. 1–L. 15. Ankylosed. Join just visible L. 13–14. Ankylosed. Join visible L. 8–9. Ankylosed. Join visible Th. 8–9. Ankylosed. Join visible	5 breeding seasons	3 ages: old
3569	12·72	Female	18. i. 31	L. 14–15. Not ankylosed. Cartilage thick L. 7–8. Not ankylosed. Cartilage thick Th. 9–10. Not ankylosed. Cartilage thick	1½–2 years	2 ages: white and deep (new)
3573	13·5	Female	18. i. 31	L. 14–15. Not ankylosed. Cartilage thick L. 10–11. Not ankylosed. Cartilage thick Th. 8–9. Not ankylosed. Cartilage thick	3 breeding seasons	3 ages: appeared not very old
2713	13·0	Male	2. xii. 29	Th. 12–13. Not ankylosed. Cartilage thick	—	—
2768	14·07	Male	15. xii. 29	L. 6–7. Ankylosis nearly complete Th. 11–12. Not ankylosed. Cartilage thick Th. 1–2. Not ankylosed. Cartilage thick	—	Four new: no old
2848	12·27	Male	26. xii. 29	L. 14–15. Not ankylosed. Cartilage thick Th. 14–15. Not ankylosed. Cartilage thick Th. 6–7. Not ankylosed. Cartilage thick	—	—
3205	14·5	Male	11. iii. 30	L. 13–14. Not ankylosed. Cartilage thin Th. 14–15. Not ankylosed. Cartilage thick Th. 8–9. Not ankylosed. Cartilage thick	—	One or two only
D. 62	10·95	Male	8. vii. 30	C. 2–3. Not ankylosed. Cartilage thick	—	Few only
D. 84	9·7	Male	16. vii. 30	C. 1–2. Not ankylosed. Cartilage thick	—	About 17 on one side
D. 99	11·9	Male	24. vii. 30	C. 1–2. Not ankylosed. Cartilage thick Th. 11–12. Not ankylosed. Cartilage thick	— —	One age: few —
D. 129	13·15	Male	6. viii. 30	C. 1–2. Not ankylosed. Cartilage thick Th. 7–8. Not ankylosed. Cartilage thick	—	One age of old and a few new ones
D. 174	11·35	Male	9. ix. 30	C. 1–2. Not ankylosed. Cartilage thick	—	—
3564	14·13	Male	18. i. 31	L. 14–15. Ankylosed. Join visible L. 9–10. Ankylosed. Join visible Th. 14–15. Not ankylosed. Cartilage thin Th. 6–7. Not ankylosed. Cartilage thin	— — — —	— — — —
3570	13·41	Male	18. i. 31	L. 14–15. Not ankylosed. Cartilage thick Th. 12–13. Not ankylosed. Cartilage thick	—	One age
3616	13·16	Male	3. ii. 31	L. 13–14. Ankylosed. Join visible L. 9–10. Ankylosed. Join visible L. 3–4. Not ankylosed. Cartilage thick Th. 9–10. Not ankylosed. Cartilage thick	— — — —	— — — —

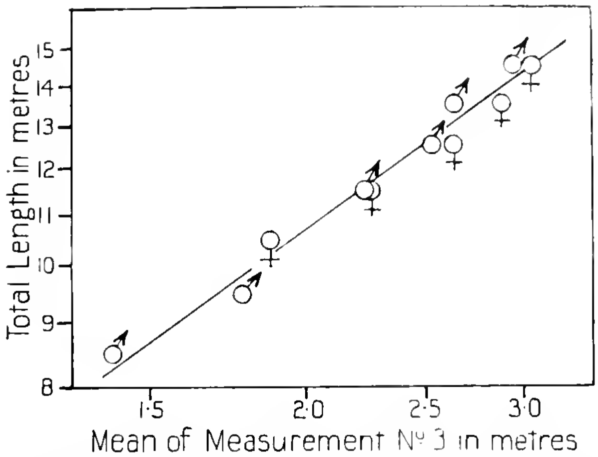

Fig. 62. Humpback whale. Logarithmic plotting of total length against measurement no. 3. Tip of snout to blow-hole.

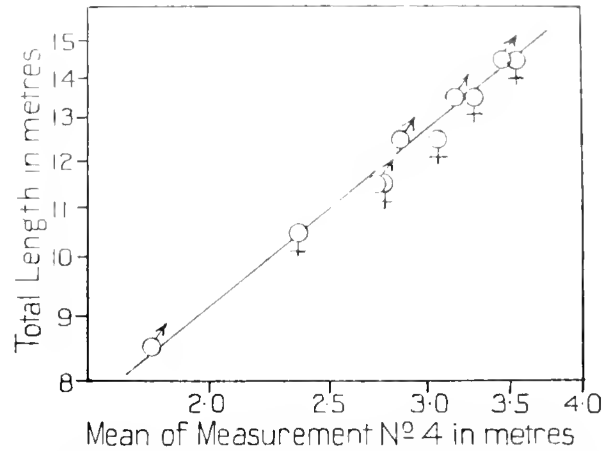

Fig. 63. Humpback whale. Logarithmic plotting of total length against measurement no. 4. Tip of snout to angle of gape.

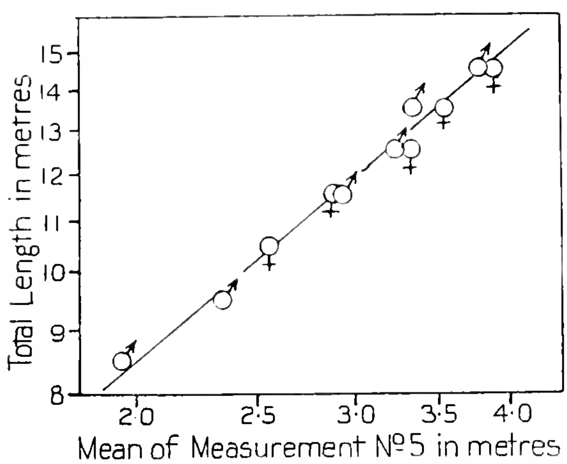

Fig. 64. Humpback whale. Logarithmic plotting of total length against measurement no. 5. Tip of snout to centre of eye.

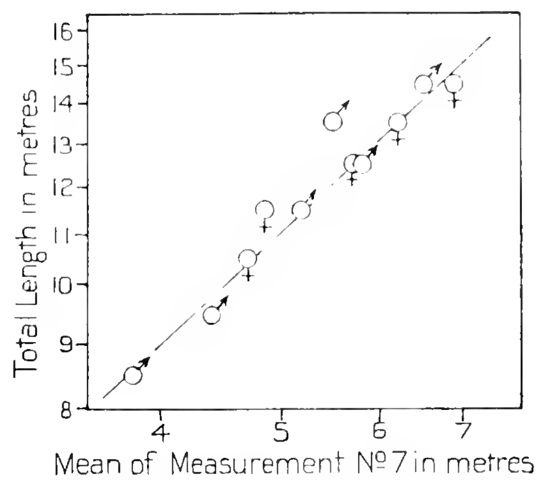

Fig. 65. Humpback whale. Logarithmic plotting of total length against measurement no. 7. Centre of eye to centre of ear.

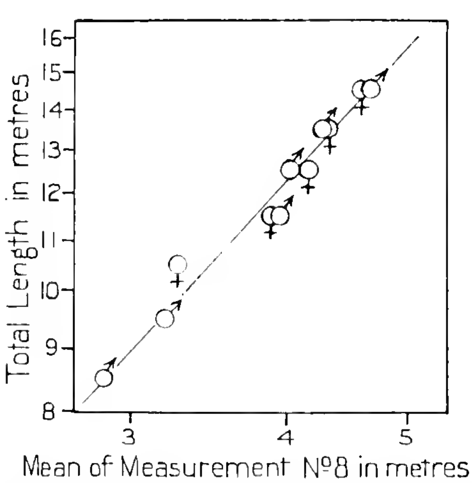

Fig. 66. Humpback whale. Logarithmic plotting of total length against measurement no. 8. Notch of flukes to posterior emargination of dorsal fin.

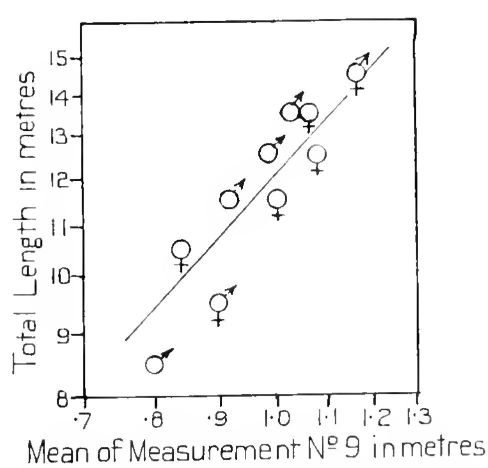

Fig. 67. Humpback whale. Logarithmic plotting of total length against measurement no. 9. Width of flukes at insertion.

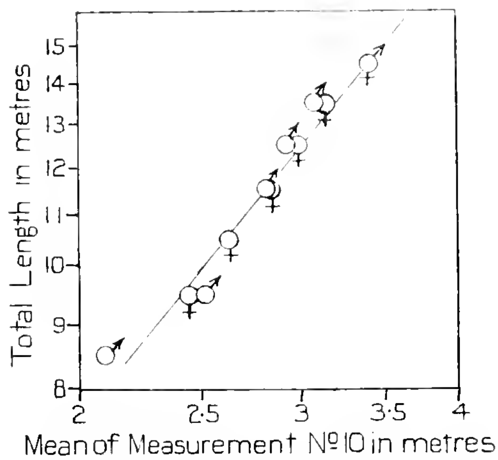

Fig. 68. Humpback whale. Logarithmic plotting of total length against measurement no. 10. Notch of flukes to centre of anus.

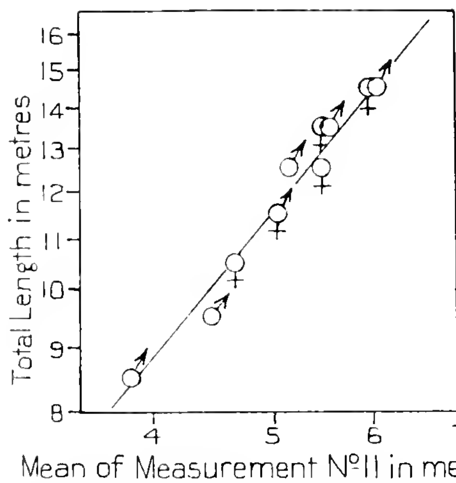

Fig. 69. Humpback whale. Logarithmic plotting of total length against measurement no. 11. Notch of flukes to umbilicus.

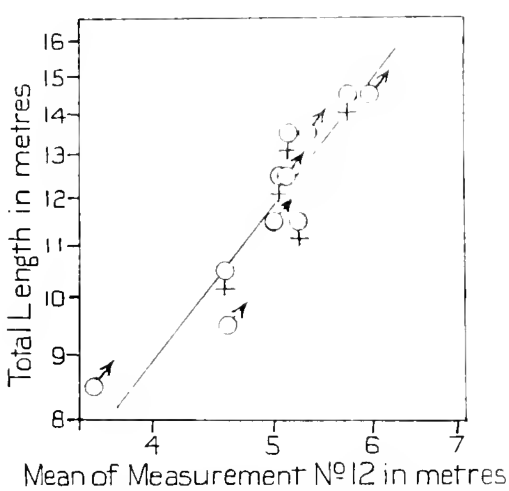

Fig. 70. Humpback whale. Logarithmic plotting of total length against measurement no. 12. Notch of flukes to end of system of ventral grooves.

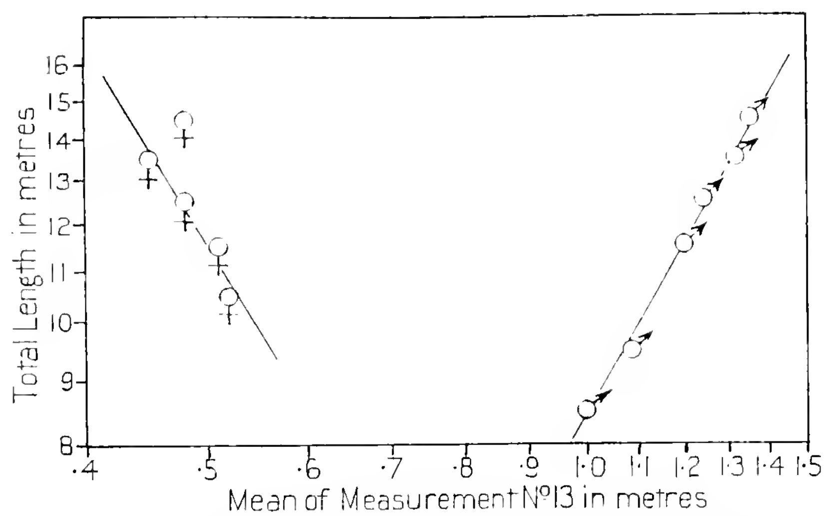

Fig. 71. Humpback whale. Logarithmic plotting of total length against measurement no. 13. Centre of anus to centre of reproductive aperture.

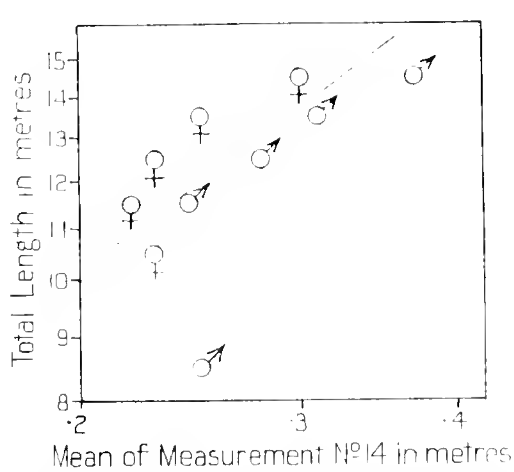

Fig. 72. Humpback whale. Logarithmic plotting of total length against measurement no. 14. Vertical height of dorsal fin.

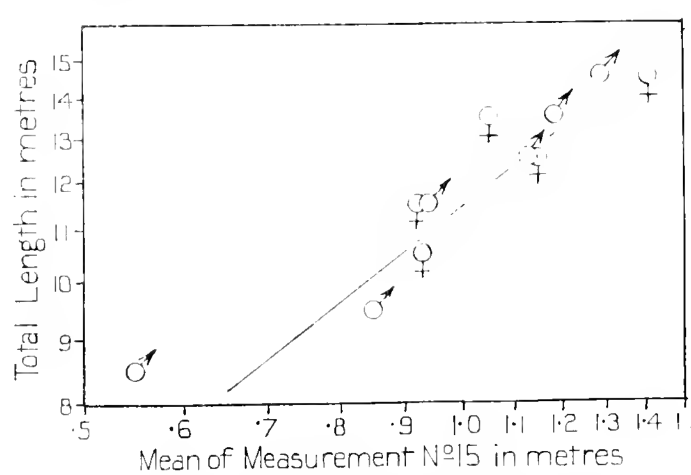

Fig. 73. Humpback whale. Logarithmic plotting of total length against measurement no. 15. Length of base of dorsal fin.

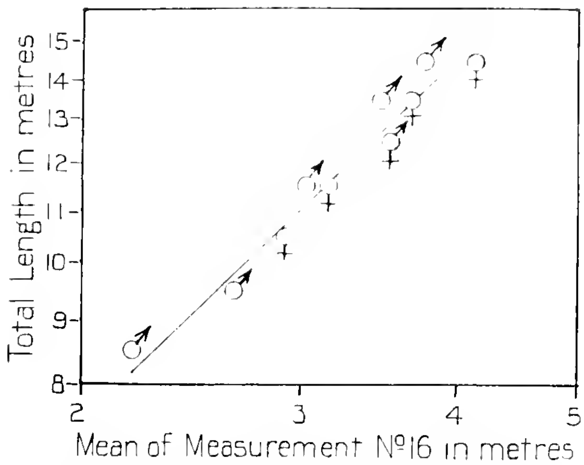

Fig. 74. Humpback whale. Logarithmic plotting of total length against measurement no. 16. Axilla to tip of flipper.

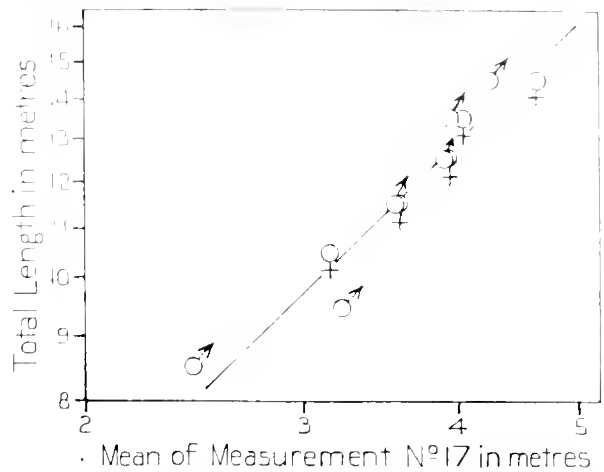

Fig. 75. Humpback whale. Logarithmic plotting of total length against measurement no. 17. Anterior end of lower border to tip of flipper.

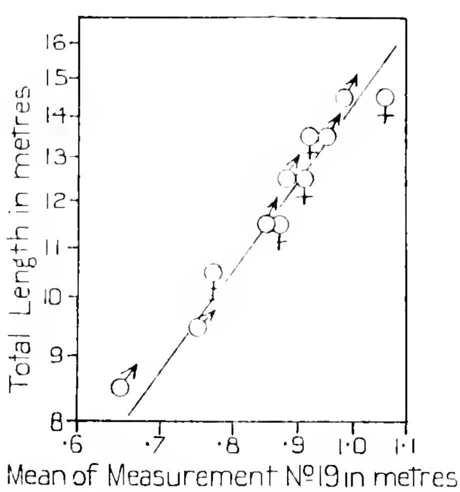

Fig. 76. Humpback whale. Logarithmic plotting of total length against measurement no. 19. Greatest width of flipper.

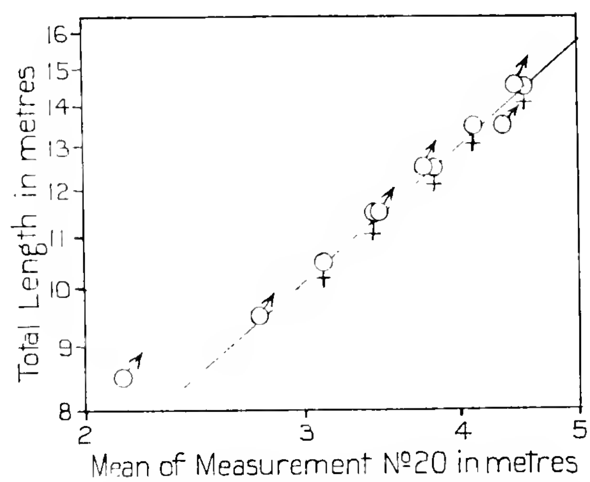

Fig. 77. Humpback whale. Logarithmic plotting of total length against measurement no. 20. Length of severed head from condyle to tip.

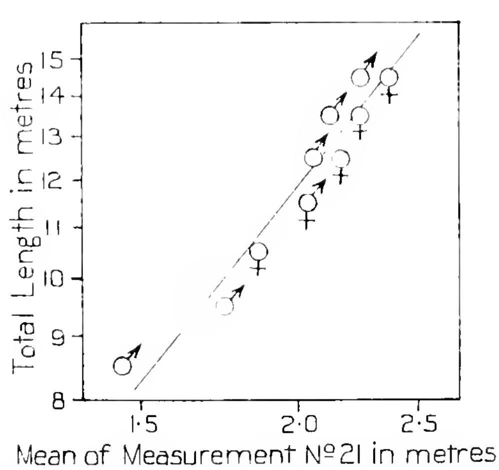

Fig. 78. Humpback whale. Logarithmic plotting of total length against measurement no. 21. Greatest width of skull.

growth of the various parts of the body relative to the total length satisfy the equation $y = bx^k$ where x equals the total length, y equals the length of the part, and b is the fractional coefficient (the value of y when x equals 1). The tangent of the angle which the line makes with the x axis equals k, the growth coefficient. The value of k thus obtained is given for each measurement in Table XXIII. Values of k over unity indicate an increasing rate of relative growth and those less than unity the converse. That is to say, in the case of a value over unity, the greater the total length, the greater the rate of relative growth, and *vice versa*. The values of k greater than unity are those of measurements nos. 3, 4, 5, 7 and 20 relating to the head region, nos. 14 and 15 relating to the dorsal fin and nos. 16 and 17 relating to the flipper. Those less than unity are nos. 8, 10, 11 and 12 relating to the tail region, nos. 9 and 21 relating to width of body, no. 16 the width of the flipper, and no. 13 the genito-anal distance.

Table XXIII. *Humpback whale. Growth coefficient of the body measurements to satisfy the equation* $y = bx^k$

Measurement	Growth coefficient (k)
3. Tip of snout to blow-hole	1·38
4. Tip of snout to angle of gape	1·23
5. Tip of snout to centre of eye	1·19
7. Centre of eye to centre of ear	1·08
8. Notch of flukes to posterior emargination of dorsal fin	0·92
9. Width of flukes at insertion	0·93
10. Notch of flukes to centre of anus	0·81
11. Notch of flukes to umbilicus	0·84
12. Notch of flukes to end of system of ventral grooves	0·79
13. Centre of anus to centre of reproductive aperture:	
Male	0·56
Female	−0·60
14. Vertical height of dorsal fin	1·37
15. Length of base of dorsal fin	1·32
16. Axilla to tip of flipper	1·05
17. Anterior end of lower border to tip of flipper	1·03
19. Greatest width of flipper	0·73
20. Length of severed head from condyle to tip	1·50
21. Greatest width of skull	0·80

The indications of different growth rates for different parts of the body discussed in an earlier section are here shown much more precisely, and it is of interest to note that, with the exception of measurement no. 20, the more anterior the measurement the greater is the value of the growth coefficient. This increase in value is doubtless correlated with the development of the anterior part of the skull to accommodate the baleen apparatus. Corresponding with the increasing relative growth rate of the anterior part of the body there is a decreasing rate for the posterior part, so that the whole growth of the whale may be said to be directed largely towards developing the feeding mechanism.

The height, and length of base, of the dorsal fin both have an increasing rate with increasing size, as does the length of the flipper, the width of which, however, has a decreasing rate so that as it gets longer it gets relatively narrower.

Measurements nos. 9, width of flukes at insertion, and 21, greatest width of skull, both have a value of k below unity. These measurements are transverse to the long axis of the whale and their values show that the relative rates of transverse growth at the extremities decrease with increasing length.

The value of k for measurement no. 13, the genito-anal distance, is below unity for males, as would be expected in view of the fact that this measurement is situated in the posterior region of the body. In the female, however, not only is the value of k for this measurement less than unity, but it is also negative in sign, showing that the measurement not only becomes relatively, but absolutely, smaller with increasing total length of the whale, and that the rate of decrease diminishes with increasing length. It is suggested that the decrease in length of this measurement is correlated with increasing size of the vulva as breeding seasons succeed each other, so that the vulva encroaches on the genito-anal distance. The last point in Fig. 71 may indicate that this increase in vulvar size stops with the attainment of physical maturity.

MIGRATION

The migrations of the Humpback whale have been more observed than those of any other species, because of its habit of haunting inshore waters when on the move from north to south, and *vice versa*, along the coasts of the southern continents. The suggestion of Risting (1912) that the Humpback whales are not distributed throughout the oceans, but are bound intimately to definite highways formed by certain of the great ocean currents, appears to be correct.

The figures of the total catch of Humpbacks at Natal for seasons 1918–28 inclusive are plotted by months in Fig. 79, which shows a very distinct bimodal graph. The first peak in July represents the migration towards the north, and the second peak in September represents the return migration to the south. According to Harmer (1931) a similar bimodal graph (July and October) is obtained when the catches made at Angola, West Africa, are plotted by months, and the two peaks represent the migration to the north and back again. Olsen (1914–15) states that the main body of Humpbacks does not strike the southern extremity of the coast of South-West Africa but approaches the shore to the north of Saldanha Bay, and then follows the coast northwards, a statement which is borne out by the figures of the whaling returns from the whaling stations of South Africa.

On the coasts of Australia similar migrations take place. Dakin (1934) gives interesting information on the migration of Humpbacks there. In Western Australia whaling started in 1912 between latitudes 25° and 26° S, and the whales taken were mostly Humpbacks. In July and the first half of August all the whales were travelling northwards and the return migration started about August 24. In 1913, at Norwegian Bay, the northward migration started on June 24 and continued throughout July. By August 17 the return migration had reached its peak. In 1914 the north-bound whales arrived on June 25, but the date of the return migration is not mentioned, though fishing continued until the end of September. On the east coast of Australia whaling was carried on at Jervis Bay in about latitude 35° S in 1913, and the northward migration of Humpbacks started in July. Hunting continued until October, but no information is available as to the return migration.

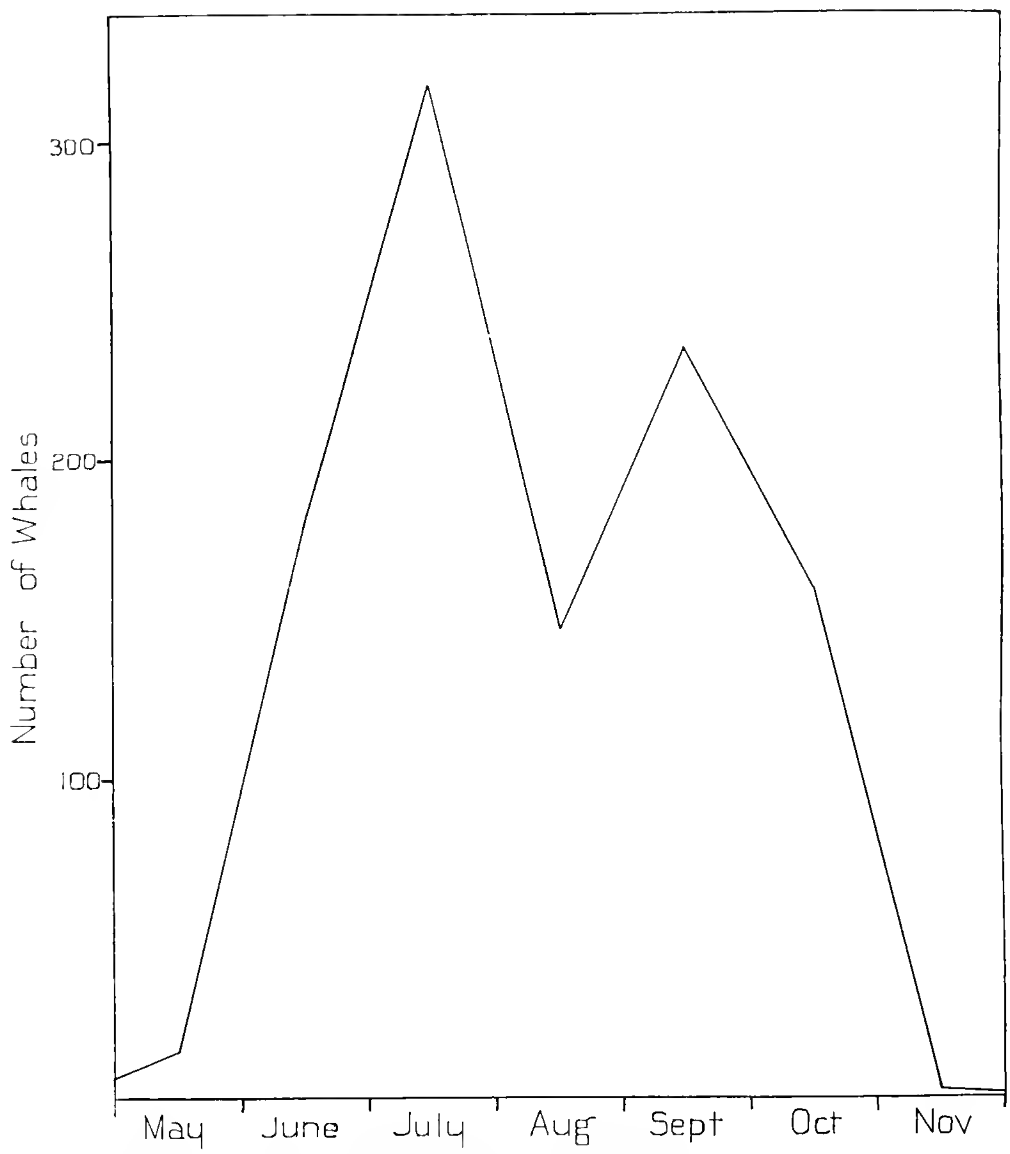

Fig. 79. Humpback whale. Monthly catches at Natal for seasons 1918–28.

Lillie (1915) shows that in New Zealand, at the Bay of Islands, the northern migration takes place in the last half of April, May, and the first half of June. There is a slack period in the whaling from July to September: after the middle of September the southward migration takes place, and continues through October and November. He also states that the period July to September, when Humpbacks are absent from New Zealand waters, used to be the busy time for the whalers at Norfolk Island.

Similar north and south migrations are known to occur on the coasts of South America though figures are not available to illustrate them. In the French Congo, nearly on the equator, according to Harmer (1931), the season graph is unimodal (July–August), and the reason suggested for this is that the Congo region represents the northern limit of the migration and is visited, but not passed, by the Humpbacks. Similarly Olsen (1914–15) shows that the season graph at Linga Linga, Inhambane, Portuguese East Africa (23–30° S), is unimodal for the same reason.

Turning now to southern localities, Fig. 80 shows the season graph for seasons 1915–16 and 1916–17 at South Georgia, and 1923–4 and 1925–6 at South Shetland. Humpbacks

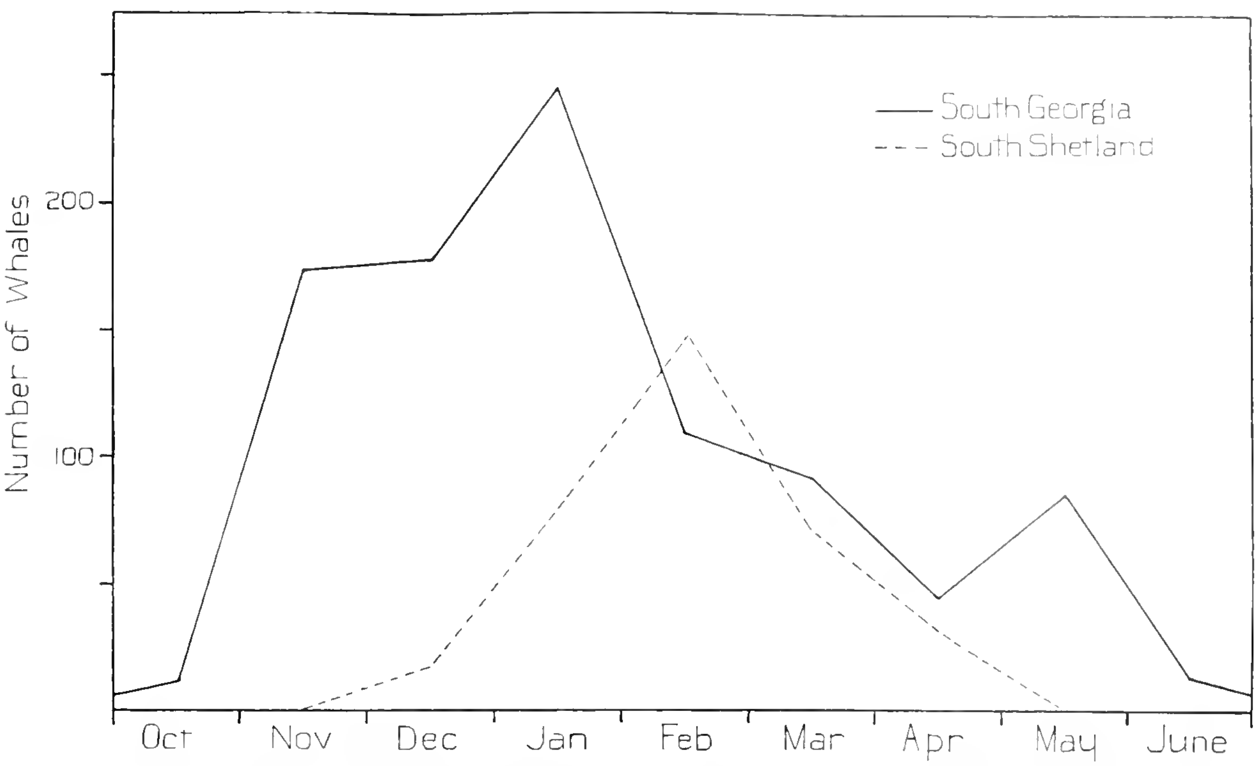

Fig. 80. Humpback whale. Monthly catches at South Georgia for seasons 1915–16 and 1916–17, and at South Shetlands for seasons 1923–4 and 1925–6.

have not formed an important part of the catch since those years in South Georgia, and consequently the figures are very scanty for later seasons and are not included here. This graph again is bimodal, with the first peak in January and a second smaller one in May. The first peak undoubtedly represents the arrival of the whales on their migration from the north, and the second one may represent the latter part of the return migration from further south. The season graph for the South Shetlands is, however, unimodal, from which the conclusion may be drawn that this region represents the southern limit of the migration.

It must be remembered, however, that the migration towards the north does not include all Humpback whales, because up to the season 1917–18 several of the whaling companies at South Georgia continued whaling during the winter, and in most winter seasons up to that date a considerable number of Humpback whales was taken. Speaking of the northern Humpbacks Ingebrigtsen (1929) says, "It is mainly the adult animals of both sexes that take part in the great breeding and food migrations, while the younger animals are more erratic in their migrations." When the Humpback occurred in South Georgian waters in large numbers, in the days of the great Humpback fishery there, according to Hinton (1925), it used to appear off the island first in October; the largest herds used to arrive in November and remain during December and January; and by the middle of May they were all gone. The latter remark needs qualifying, for, as shown above, a fair number of Humpbacks was at one time taken during the winter at South Georgia.

If we now compare Figs. 79 and Figs. 55 and 56 it is evident that the peak in Fig. 56 falls between the peaks in Fig. 79, showing that parturition occurs at the northern limit of the migration in the month of August and pairing takes place during the first part of the migration to the south. Olsen (1914–15) states that the virgin females go north for pairing, and that it is rare to see pairing taking place off the coast of South Africa, though the graph in Fig. 55 shows that it undoubtedly occurs.

Figs. 81 and 82, in which the length frequencies of both sexes of Humpback whales are plotted for several seasons at South Georgia and South Africa, show that the com-

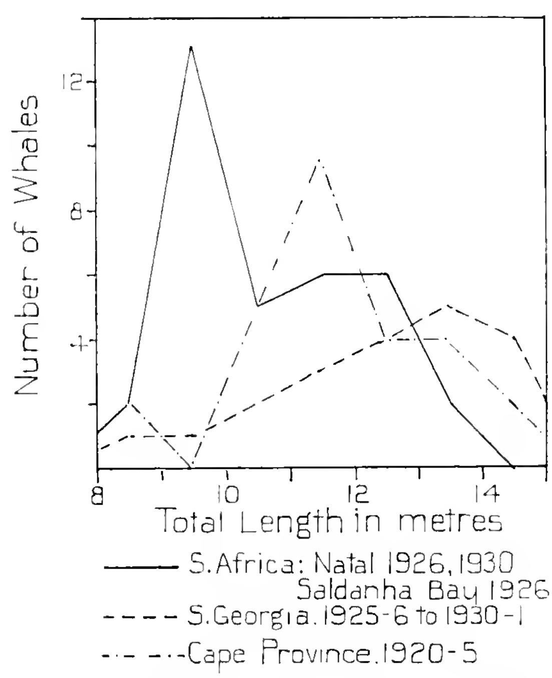

Fig. 81. Humpback whale. Males. Length frequencies in the catches at South Georgia and South Africa.

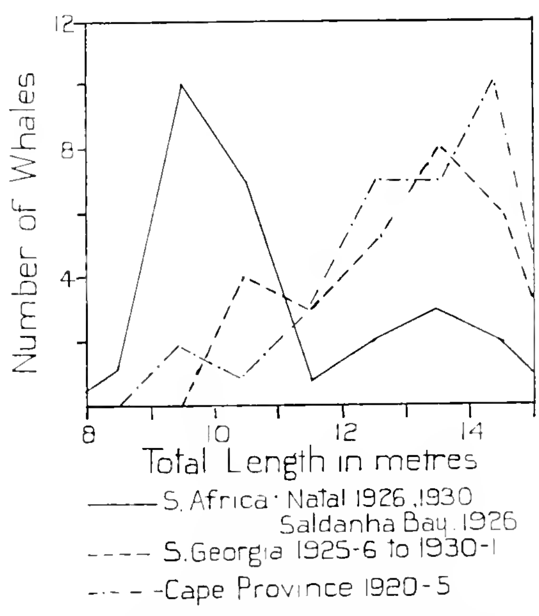

Fig. 82. Humpback whale. Females. Length frequencies in the catches at South Georgia and South Africa.

position of the whale populations is very different in the two places. The graphs are bimodal for females in both places, and for males in Natal, but unimodal for males at South Georgia and Cape Province. In the bimodal curves the first peaks represent immature, and the second ones mature, whales. It is therefore evident that the proportion of immature whales is small on the southern migration, but that off the coasts of South Africa immature whales form a much greater part of the population. This is borne out by the statement of Olsen (1914–15) that between the periods of migration the whales caught at Durban are nearly all sexually immature and one to two years old; and that the whales arriving off the south-west coast of Africa on the northward migration are often accompanied by young of the previous season about 30 ft. long, which leave their parents and form schools of their own, roaming about in the waters of that region while the adult whales continue their migration to the north. This statement is supported by the data collected by the Discovery staff in South Africa. The lengths of all the Humpbacks examined there are shown in Table XXIV. The figures from

Table XXIV. *Humpback whale. Lengths of whales examined in South Africa*

Place and date	Length in m.		Place and date	Length in m.	
	Males	Females		Males	Females
Saldanha Bay			Durban		
1926 June	9·92	11·27	1930 June	—	14·0
Aug.	12·70	—	July	9·93	9·5
Sept.	—	9·92		10·95	9·9
				9·7	—
Durban				11·9	—
1926 July	12·8	—	Aug.	13·15	—
	11·5	—		12·75	—
	9·55	—		11·35	—
	8·0	—			

Durban for 1930 are particularly interesting: in June the one whale examined was sexually mature, in July none of the six seen were, but in August sexually mature whales appear again.

Townsend (1935) gives a chart in which are plotted the position and date of capture of 2883 Humpback whales taken by American whalers during the nineteenth century and first decade of the twentieth. This shows that Humpbacks were taken in the northern hemisphere between latitudes 40° N and 10° N, mostly in October to March inclusive, and in the southern hemisphere between latitudes 40° S to 10° N, mostly in June to September inclusive. The incidence of this whaling agrees closely with what would be expected from a consideration of the conclusions drawn above as to the times and course of the annual migrations of the Humpback. From an examination of this chart it appears that the southern Humpback regularly passes north of the equator for a distance of several degrees of latitude during its migration. It has been suggested that this species, sometimes at least, passes through the tropics from the temperate regions of one hemisphere to those of the other, and this appears to be very possible. Hinton (1925) says that southern Humpbacks that have passed well over the equator may meet herds of northern whales remaining in tropical waters later than the majority of their fellows, and may migrate with them to the north. He uses this hypothesis to explain the peculiarities of the species described as *M. bellicosa* by Cope in 1871, and of an individual caught off Iceland in 1867 and described by Hallas, on the supposition that they are southern Humpbacks which have strayed into the northern hemisphere and are to be distinguished structurally from the northern race. As has been shown above, there is little reason to think that the Humpbacks of the northern and southern hemispheres can be distinguished, and if even occasional migration from one hemisphere to the other be granted, the consequent mixing of blood would appear to decrease the chances of differentiation. Hinton (1925) states that there is no evidence of migration from the northern to the southern hemisphere: but if migration in the reverse direction is possible, there would appear to be no valid reason why it should not occur, and every probability that occasionally it does.

The migration of the Humpback whale can, then, be summarized as a southern feeding migration, as far south as there is open water in the southern summer, followed by a migration towards the north which is pursued mainly in the coastal waters of the continents. The northward migration reaches the neighbourhood of the equator in August, when most of the females give birth to their calves, and the return migration begins at once; pairing takes place during its course and is, for the most part, over by the end of the year when the whales are on their southern feeding grounds. Some Humpbacks are present on the South Georgia whaling grounds during the winter and may be non-migrating individuals which have spent the summer farther to the south. The migration is not restricted only to breeding whales, but includes immature as well as mature whales, pregnant as well as non-pregnant females.

DESTRUCTION OF THE STOCKS OF HUMPBACKS

Whenever new whaling grounds have been opened up the Humpback whale has always been the predominant species in the catch for the first few years, and has then rapidly declined in numbers. This is partly due to the fact that when whaling was started, in, for instance, South Georgia and South Africa, the plant then available was not suitable for dealing with any numbers of the larger species of whale. After a few years, when better facilities were installed, fewer Humpbacks were taken. Nevertheless the taking of the larger species coincided with a definite decrease in the numbers of Humpbacks available.

It must be remembered that the Humpback is a slow moving, coast-frequenting species of whale which is comparatively easy to catch. When feeding or pairing they are very easy to approach: as Risting (1912) says, "a Humpback in the midst of krill appears to have no thought for anything but provisions, and an enamoured humpback forgets all regard to caution". The whalers state that the decrease in its numbers is due to its being frightened away from its former haunts, but there seems to be no valid reason why this species should be more easily frightened than any other, unless it is very attached to certain definite lines of migration. There appears to be some evidence in support of this possibility as shown by the recovery of lost harpoons in the localities where they were lost eighteen and seven years before, as mentioned above, p. 71. Dr Francis C. Fraser (1937, *in litt.*) compares the decrease of Humpbacks with that of the North Atlantic Right whale, and points out that the numbers of the latter taken in the Bay of Biscay are not sufficient to account for its disappearance from that region. A similar argument applies to the decrease of the Greenland Right whale in the Spitzbergen "bay fishery". He adds, "there may be something in the whalers' theory that the animals are actually frightened away". The decrease in numbers, however, is probably due partly to excessive slaughter, because the Humpbacks have never returned in their former huge numbers to South Georgia. Their capture is now prohibited there, except under special licence, given only when other species are very scarce. Figs. 83 and 84 show the numbers of Humpbacks taken off South Georgia and South Africa during the years 1909–27 and 1923–7 respectively: figures for South Africa from 1908 onwards, when

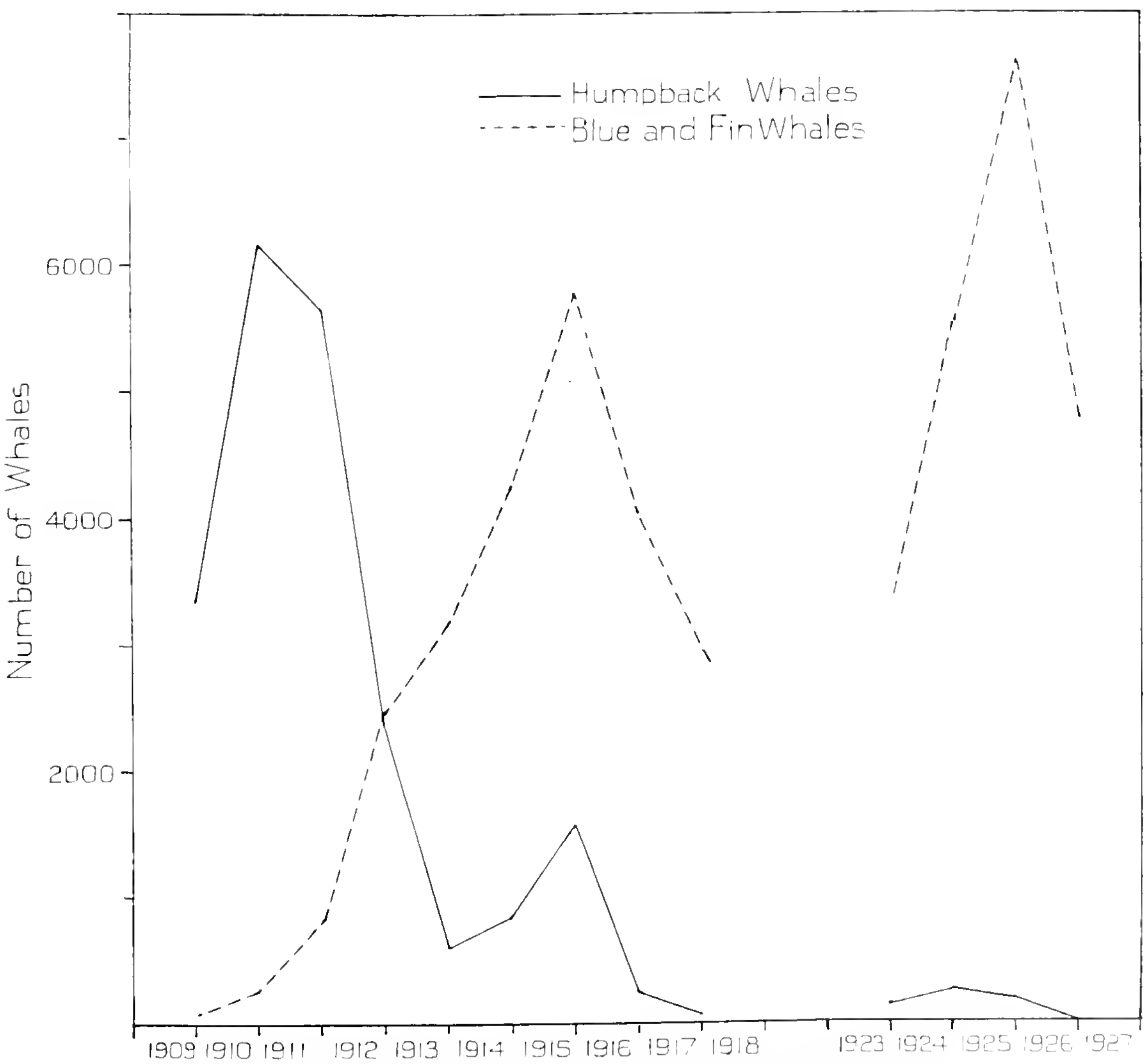

Fig. 83. South Georgia. Catches of Humpback, Blue and Fin whales.

very large numbers were taken, are not available. Fig. 84 represents catches made after the great destruction of Humpbacks in the early days of the fishery; in these figures the catches of Fin and Blue whales are also shown for comparison, and the rise of the one fishery with the decline of the other is very evident.

It is of interest to note that the whaling companies which carried on operations off the coast of Western Australia in the years 1913–16 repeated the course of events that had occurred in other fields, and stopped working after only four seasons' hunting. The catches were: for 1913, 654 whales; for 1914, 1900 whales; for 1915, less than 900; for 1916, less than 200; and it was obvious that the whales were taken on their way to and from their breeding grounds a little to the north (cf. Wheeler, 1934). The result of the inroads made on the numbers of breeding whales, together with other considerations, such as the fact that other species were not numerous on these grounds, and that ships could be more profitably engaged in the freight market than in whaling during the latter part of the Great War, led to the abandonment of Western Australian whaling.

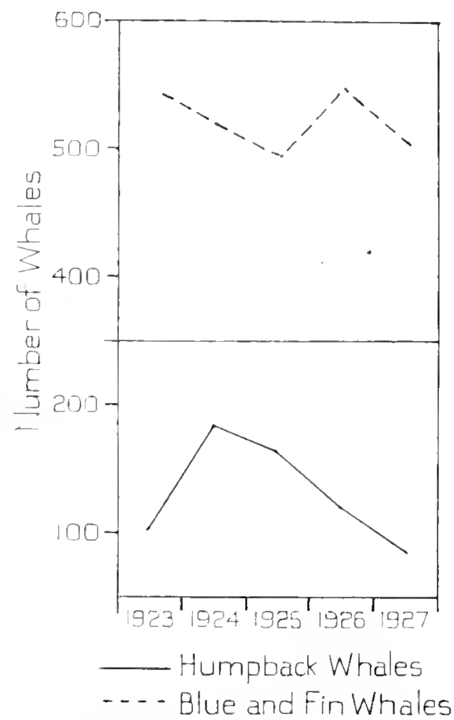

Fig. 84. Natal. Catches of Humpback, Blue and Fin whales.

The reason for the great decrease in numbers of Humpback whales, off the South African coast at any rate, is not far to seek. Reference to Figs. 81 and 82 shows that most of the catch at the South African whaling stations consists of immature whales, and in addition it has been shown above that whaling in these localities is conducted during the breeding migration, so that it is small wonder that a species so harassed is becoming scarcer.

In southern seas the catch consists predominantly of mature animals on their feeding migration, and the decrease in numbers there is probably due not only to excessive slaughter on the southern grounds but also to the killing of large numbers of breeding and pregnant whales in temperate and tropical latitudes.

The second peak in Fig. 83 shows the burst of intensive whaling carried on during the Great War, and for the rest the steady decline in numbers can only be attributed to the whalers killing off the easily captured species before turning their attention to the larger and more active ones. Mr G. Rayner informs me that during recent whaling-marking voyages of the R.R.S. 'William Scoresby' large schools of Humpback whales were seen in the far south, in the regions where pelagic whaling is pursued. When larger species are not available the whalers take these Humpbacks, and with their modern equipment they are able to deal with very large numbers of them in a short space of time. The probability of a serious decrease in the numbers of Blue whales in the near future makes the outlook for the continued presence of large schools of Humpbacks in those regions very uncertain.

The only chance for the Humpback whale to regain its numbers is for the capture of it to cease everywhere for a number of years, and thereafter for its pursuit to be restricted to a limited number on the southern whaling grounds only.[1]

SUMMARY

This report discusses the results of the examination of sixty-two Humpback whales at the southern whaling stations during the course of the Discovery investigations.

The extensive statistics in the British Museum relating to whaling are also used in conjunction with the data collected by the Discovery staff.

The sex ratio of the Humpback appears to be nearly even, although some degree of segregation of sexes may occur in certain places or at certain times.

A series of standard measurements was carried out on the whales and the resulting figures are discussed. The body proportions of the southern Humpback whales are established, and their range of variation is recorded. As far as comparative evidence is available there is no indication of structural difference between the Humpback whales of the northern and southern hemispheres.

The colour pattern of the species can be divided into groups. Whales of all colour groups occur everywhere, but there are considerable indications of the predominance of one or more colour groups in particular localities.

Hair appears on several parts of the head, the hairs being placed mostly on tubercles, and varying from eighteen to thirty-four in number on the snout.

The ventral grooves are fewer in number than in the whales of the genus *Balaenoptera*, and vary from twenty-one to thirty-six. They appear to be in all respects similar to those of northern Humpbacks.

The baleen is coarse, and grey to black in colour. A number of white plates commonly occur at the anterior end of the series and are frequently associated with an adjacent white splash on the darkly pigmented snout. On plotting the baleen length against total length of whale a sharp rise in the rate of growth is found between the body lengths of 7 and 8 m., at which size the calf is weaned.

The external characters of southern Humpbacks, like the body proportions, do not appear to differ materially from those of northern examples of the species.

The food of Humpbacks at South Georgia is exclusively krill, *Euphausia superba*, but off the coast of Africa it commonly consists of small fishes. Nearly all whales at South Georgia are feeding, but off South Africa very few of them are.

The blubber of the Humpback is comparatively thicker than that of other species. The blubber of immature whales is not only relatively but absolutely thicker than it is

[1] Since this report was written the International Whaling Conference has reached an agreement, which, if ratified by the various governments concerned, will give the Humpback whale much more protection than it has previously enjoyed.

when they become adult. The blubber of South African and South Georgian Humpbacks, unlike that of the whales of genus *Balaenoptera*, differs little in thickness. Pregnant whales, also, have blubber above the average in thickness. A decrease in blubber thickness is found at the end of the whaling seasons both at South Georgia and South Africa.

The external parasites of Humpback whales are *Paracyamus*, *Coronula* and *Conchoderma*, all of which are usually present. Several species of diatom, including *Cocconeis wheeleri* which has not been found on other whales, occurred sparingly in patches on the surface of the skin.

Only one Humpback contained intestinal parasites—a species of nematode worm. Another species of nematode, however, occurs commonly in the kidney and is also sometimes found in the urethra of males.

The external and internal genitalia of both sexes are described. The histological state of the testes was examined in nine whales and the results indicate a male sexual season occurring between March and December.

Dated records of foetal lengths show that the period of gestation is about eleven months and that the young are born at a length of about 4·5–5 m. Lactation lasts about five months and weaning takes place when the calf is about 7·5–8 m. in length.

The main part of the pairing season occurs from August to November, with its peak in September: consequently most births take place from July to September with a maximum in August. A few pregnancies, however, start in all months of the year, showing that oestrus may occur outside the main breeding season.

The results of a detailed examination of the internal genitalia of nineteen female Humpbacks are given in full. From these, and other data, it is concluded that the species breeds usually once every two years, but that occasionally, when a whale breeds early in the season, an extra pregnancy is interpolated in the normal cycle so that two pregnancies occur in three years.

The numbers of old corpora lutea in the ovaries indicate a polyoestrous sexual cycle with an average of four dioestrous cycles and five ovulations at each cycle succeeding the first.

Sexual maturity is reached at an age of twenty to twenty-two months and breeding first occurs at the end of the second year after the birth of the whale. Physical maturity, as shown by ankylosis of the epiphyses of the vertebral column, is reached at or before the age of ten years. The recovery of an identifiable harpoon shows that Humpback whales can reach an age of at least eighteen years.

Logarithmic plotting of mean values of body measurements against total length shows that the growth rates of the various parts of the body increase with increasing body length from the posterior towards the anterior end. It is therefore suggested that the whole growth of the whale is mainly directed towards development of the feeding mechanism, represented by the baleen and mouth. One measurement, the genito-anal distance of the female, is found to decrease not only relatively, but absolutely, with increasing body length.

The migrations of the Humpback whale, which are fairly well understood, consist of a feeding migration to the south in the southern summer and a breeding migration to the north in the winter. Parturition and pairing occur mainly in tropical and sub-tropical waters. On its northward migration the species regularly crosses the equator, at least on the west coast of Africa, for a distance of about 10° of latitude. Occasional migration of individuals from the schools of the southern hemisphere to those of the northern hemisphere is extremely probable.

The great destruction of the stock of Humpback whales during the last thirty years is attributable solely to excessive slaughter both during the feeding and breeding migrations. The stock can only return to its former abundance, on which modern whaling in the south was founded, if the Humpback whale is afforded complete and world-wide protection for a long period of years. If, thereafter, the stock is to be maintained, catching would have to be carefully controlled, and restricted to the whaling grounds of the far south.

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APPENDIX

MEASUREMENTS OF BODILY PROPORTIONS OF THE HUMPBACK WHALES EXAMINED IN SOUTH GEORGIA AND SOUTH AFRICA

All measurements are in metres.

Date	Whale no.	Sex	1 Total length, tip of snout to notch of flukes	2 Projection of lower jaw beyond tip of snout	3 Tip of snout to blow-hole	4 Tip of snout to angle of gape	5 Tip of snout to centre of eye	6 Tip of snout to tip of flipper	7 Centre of eye to centre of ear	8 Notch of flukes to posterior emargination of dorsal fin	9 Width of flukes at insertion	10 Notch of flukes to centre of anus	11 Notch of flukes to umbilicus	12 Notch of flukes to end of system of ventral grooves	13 Centre of anus to centre of reproductive aperture
16. iii. 25	94	♂	8·4	—	1·4	1·8	1·95	—	0·38	2·85	0·8	2·1	3·85	3·6	1·0
10. xii. 25	284	♂	12·8	—	2·7	—	3·5	—	0·6	4·2	1·2	2·95	—	5·3	0·55
12. i. 26	340	♂	14·75	—	3·1	3·6	4·1	—	0·67	4·76	1·25	3·45	5·8	5·5	1·35
16. i. 26	361	♂	13·1	—	2·6	3·1	3·42	—	0·61	4·21	1·1	2·9	5·6	5·1	1·3
22. i. 26	408	♂	13·0	—	2·65	3·1	3·48	—	0·42	4·0	0·92	3·05	5·25	5·1	1·2
27. i. 26	449	♂	12·55	—	2·7	3·07	3·42	—	0·57	3·98	0·96	2·86	5·35	5·2	1·31
24. vi. 26	793	♂	9·92	—	1·85	2·16	2·39	—	0·51	3·35	1·0	2·55	4·2	4·48	0·9
6. viii. 26	918	♂	12·70	—	2·6	—	3·5	—	0·6	3·95	1·02	2·95	5·35	5·35	1·25
22. vii. 26	D 1	♂	12·8	—	2·35	—	3·3	—	—	—	1·04	3·35	4·7	—	—
23. vii. 26	D 3	♂	11·5	—	2·05	2·7	2·9	6·7	0·5	3·75	1·0	2·75	4·65	4·6	1·1
24. vii. 26	D 4	♂	9·55	—	1·75	2·25	2·35	5·85	0·47	3·1	0·82	—	4·0	4·1	0·8
29. vii. 26	D 15	♂	8·0	—	1·65	1·85	2·0	—	0·4	2·35	0·7	2·05	3·45	3·38	0·7
28. xii. 28	2042	♂	9·83	—	1·78	2·13	2·35	—	0·44	3·2	0·9	2·52	4·48	4·6	1·08
2. xii. 29	2713	♂	13·0	—	2·37	2·98	3·23	4·75	0·58	4·51	1·08	3·19	5·77	5·7	1·45
15. xii. 29	2768	♂	14·07	—	2·86	—	3·67	5·35	0·65	4·45	—	3·45	5·93	5·73	1·17
26. xii. 29	2848	♂	12·27	—	2·36	2·68	3·02	4·6	0·58	4·1	0·92	2·99	5·05	5·05	1·25
11. iii. 30	3205	♂	14·5	—	3·0	3·55	3·76	—	—	4·85	1·14	3·46	6·5	6·5	1·46
4. vii. 30	D 58	♂	9·93	—	1·84	2·07	2·39	—	—	3·2	0·71	3·11	4·3	4·44	0·95
8. vii. 30	D 62	♂	10·95	—	1·95	2·44	2·53	—	0·55	3·65	0·95	2·55	4·6	4·65	1·0
16. vii. 30	D 84	♂	9·7	—	1·86	3·12	2·32	—	—	3·6	0·76	2·3	4·2	4·05	0·8
24. vii. 30	D 99	♂	11·9	—	2·4	2·88	3·07	—	0·56	4·0	0·95	3·0	5·2	5·0	1·3
6. viii. 30	D 129	♂	13·15	—	—	—	3·53	—	—	—	—	2·98	—	—	—
6. viii. 30	D 130	♂	12·75	—	—	—	2·85	—	—	—	—	3·32	—	—	—
9. ix. 30	D 174	♂	11·35		—	—	2·95	—	—	—	0·92	2·8	4·8	—	—
18. i. 31	3564	♂	14·13	—	2·85	3·22	3·56	—	0·65	4·68	1·09	3·36	6·02	6·25	1·42
18. i. 31	3570	♂	13·41	—	2·66	3·42	2·95	—	0·53	4·45	1·08	3·32	5·7	5·5	1·27
18. i. 31	3571	♂	11·37		2·32	2·78	2·96	—	0·6	3·96	0·98	2·83	4·98	5·03	1·2
19. i. 31	3577	♂	12·28		2·37	2·83	3·04	—	0·58	3·97	0·88	2·85	5·05	4·9	1·18
19. i. 31	3583	♂	11·3	—	2·12	2·67	2·9	—	0·5	3·75	0·83	2·78	5·02	5·06	1·2
3. ii. 31	3616	♂	13·16	—	2·82	3·34	3·56	—	0·61	—	0·98	3·01	5·36	5·2	1·41
17. iii. 31	3697	♂	11·6	—	2·28	2·67	2·95	—	0·48	4·14	0·96	2·88	5·06	4·92	1·2
16. iii. 25	96	♀	13·55	—	3·0	3·45	3·6	—	—	4·5	1·3	3·0	5·45	5·05	0·45
9. i. 26	317	♀	14·1	—	3·1	—	3·9	—	0·65	4·47	1·28	3·13	5·64	5·33	0·53
10. i. 26	321	♀	14·9	—	2·88	3·45	3·87	—	0·7	4·9	1·15	3·45	5·85	5·6	0·5
13. i. 26	345	♀	12·6	—	—	3·1	—	—	—	—	1·3	2·85	5·9	—	0·32
13. i. 26	355	♀	13·15	—	2·5	3·0	3·35	—	0·66	4·37	1·0	3·32	5·35	5·25	0·47
18. i. 26	373	♀	12·5	—	2·59	2·9	3·31	—	0·53	4·1	1·15	3·13	5·26	5·05	0·42
20. i. 26	386	♀	14·85	—	2·98	3·4	3·75	—	0·75	4·88	1·14	3·7	6·45	6·3	0·55
20. i. 26	387	♀	13·55	—	2·85	3·18	3·6	8·4	0·68	4·46	1·03	3·07	5·45	5·0	0·38
20. i. 26	388	♀	14·9	—	3·15	3·5	3·84	9·4	0·76	—	1·26	3·67	5·95	—	0·35
22. i. 26	407	♀	10·5	—	1·94	2·45	2·6	—	0·51	3·66	0·82	2·68	4·65	4·5	0·62
27. i. 26	453	♀	10·0	—	1·78	2·0	2·25	—	0·47	3·35	0·9	2·45	—	4·4	0·45
2. ii. 26	487	♀	12·8	—	2·94	3·38	3·56	—	—	4·06	0·98	2·72	5·2	5·09	0·41
2. ii. 26	488	♀	11·65	—	—	—	2·75	—	—	—	1·1	2·7	4·6	—	0·35
6. ii. 26	516	♀	14·53		2·92	3·48	3·87	—	0·63	4·35	1·16	3·35	6·0	5·8	0·58
20. ix. 26	1101	♀	11·27	—	2·5	2·95	3·1	—	0·52	3·55	0·84	2·8	4·9	5·0	0·47
25. ix. 26	1125	♀	9·92		1·95	2·2	2·48	—	0·47	3·4	0·8	2·4	4·5	4·5	0·4
20. xii. 28	2000	♀	11·8		2·33	2·60	2·82	—	0·48	3·98	1·0	2·98	5·25	5·38	0·7
27. xii. 28	2033	♀	13·66		2·90	3·23	3·56	—	0·63	4·13	1·11	3·02	4·58	4·73	0·47
29. xii. 29	2873	♀	13·05	—	2·65	3·25	3·42	—	0·56	4·33	1·03	3·03	5·44	—	0·38
2. ii. 30	3108	♀	12·35	—	2·55	2·9	3·25	4·67	0·61	4·12	0·97	2·98	5·4	—	0·69
11. iii. 30	3206	♀	13·9	—	2·95	3·5	3·8	—	—	—	1·06	3·32	5·96	—	0·5
27. vi. 30	D 49	♀	14·0	—	2·8	—	3·6	—	—	4·5	1·08	5·33	5·9	—	0·65
18. vii. 30	D 90	♀	9·5	—	1·75	2·2	2·36	6·12	—	—	—	2·32	3·92	3·9	0·39
22. vii. 30	D 95	♀	9·9	—	2·0	2·45	2·7	—	0·5	3·5	0·87	2·65	4·65	4·6	0·45
6. xii. 30	3426	♀	14·2	—	3·23	3·83	4·09	—	0·65	4·52	1·07	3·14	5·55	5·63	0·38
9. i. 31	3529	♀	10·25	—	1·81	2·44	2·55	—	0·47	3·55	0·83	2·54	4·7	4·81	0·6
18. i. 31	3569	♀	12·72	—	2·53	2·85	3·16	—	—	4·43	1·03	3·22	5·59	5·18	0·55
18. i. 31	3572	♀	13·16	—	2·5	3·04	3·31	—	0·55	4·25	1·0	3·41	5·72	5·57	0·47
18. i. 31	3573	♀	13·5	—	3·7	3·16	3·54	—	0·66	4·17	1·06	3·13	5·55	5·32	0·53
19. i. 31	3582	♀	11·38	—	2·39	2·71	3·07	—	0·49	3·8	0·92	2·86	5·15	5·08	0·5
9. iii. 31	3692	♀	10·72	—	2·06	2·56	2·8	—	0·44	2·56	0·89	2·68	4·67	4·67	0·42
							Foetuses								
	Parent No.														
9. i. 26	317	?	0·68	—	—	—	—	—	—	—	—	—	—	—	—
10. i. 26	321		0·640	·005	0·105	0·13	0·145	0·36	—	0·22	0·055	0·17	0·28	0·32	0·015
20. i. 26	386	♂	0·38	—	0·055	0·075	0·085	0·225	0·03	0·145	0·035	0·11	0·185	—	0·035
20. i. 26	387	♂	0·85	—	0·14	0·19	0·21	0·515	0·06	0·225	0·08	0·225	0·38	0·385	0·08
6. ii. 26	516	♀	0·75	—	0·11	0·14	0·16	0·43	0·05	0·24	0·06	0·2	0·35	0·36	0·06
2. ii. 30	3108		0·76	—	0·13	0·15	0·17	0·28	0·05	0·25	0·06	0·19	0·3	0·33	0·02
6. xii. 30	3426	♂	0·4	—	0·06	0·09	0·09	—	0·03	0·16	0·04	0·09	0·15	—	0·03
18. i. 31	3586	♂	0·28	—	—	—	0·06	—	—	—	—	—	—	—	—
18. i. 31	3573		0·7	—	0·11	0·15	0·16	0·41	0·06	0·23	0·06	0·175	0·28	0·32	0·03
18. i. 31	3576	?	0·77	—	—	—	0·17	—	—	—	—	—	—	—	—

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
Vertical height of dorsal fin	Length of base of dorsal fin	Axilla to tip of flipper	Anterior end of lower border to tip of flipper	Length of flipper along curve of lower border	Greatest width of flipper	Length of severed head from condyle to tip	Greatest width of skull	Skull length, condyle to tip of premaxilla	Length of flipper from head of humerus to tip	Depth of tail at dorsal fin	Depth of body	Depth of body at dorsal fin	Notch of flukes to tip	Spread of flukes	Locality
0·25	0·55	2·2	2·45	2·6	0·65	2·15	1·45	—	—	—	—	—		—	South Georgia
0·32	1·4	3·6	4·1	—	1·0	4·1	—	—	—	—	—	—	—	—	,,
0·46	1·8	3·4	4·25	—	1·0	5·0	2·3	—	—		—	—	—	—	,,
0·26	1·22	3·5	3·7	—	0·95	—	—	—	—		—	—	—	—	,,
0·37	1·5	3·5	3·8	—	0·9	4·4	1·85	—	—	—	—	—	—	—	,,
0·24	0·8	3·0	3·62	—	0·78	—	—	—	3·97	—	—	—	—	—	,,
0·2	1·1	2·68	3·16	—	0·72	2·85	1·4	—	—	1·8	—	—	—	—	Saldanha Bay
0·34	0·8	—	—	—	0·94	—	—	—	—	2·25	—	—	—	—	,,
—	—	—	—	—	—		2·2	3·5	—	—	—	—	—	—	Durban
0·25	1·1	2·8	3·5	4·1	0·9	—	1·9	—	—	—	—	—	—	—	,,
0·15	0·75	2·17	2·85	3·2	0·72	3·15	1·6	—	—	—	—	—	—	—	,,
0·13	0·5	—	—	—	0·58	2·26	1·27	—	—	—	—	—	—	—	,,
—	0·85	2·65	3·22	—	0·75	2·77	1·75	—	—	—	—	—	—	—	South Georgia
0·27	1·0	3·27	3·95	—	0·96	—	—	—	—	—	—	—	—	—	,,
0·32	1·13	3·54	4·07	—	0·92	4·14	—	—	—	—	—	—	—	—	,,
0·29	1·0	3·84	3·93	—	0·83	3·55	1·93	—	—	—	—	—	—	—	,,
0·28	1·0	4·4	4·63	—	0·94	4·45	—	—	—	—	—	—	—	—	,,
0·26	0·71	7·12	3·2	—	0·68	—	1·7	—	—	—	—	—	—	—	Durban
0·22	0·7	3·15	—	—	0·85	—	—	—	—	—	—	—	—	—	,,
0·19	0·97	—	—		0·55	2·75	1·59	—	—	—	—	—	—	—	,,
0·2	1·0	—	—	—	0·78	3·63	1·92	—	—	—	—	—	—	—	,,
—	—	—	—		—	—	—	—	—	—	—	—	—	—	,,
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	,,
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	,,
0·42	1·25	3·75	4·06	—	1·08	4·22	2·18	—	—	—	—	—	—	—	South Georgia
0·3	0·85	3·3	3·85	—	0·93	4·38	2·41	—	—	—	—	—	—	—	,,
—	1·0	3·75	3·50	—	0·75	3·42	1·91	—	—	—	—	—	—	—	,,
0·3	1·35	3·8	3·95	—	0·92	3·6	2·2	—	—	—	—	—	—	—	,,
0·25	0·98	2·89	3·39	—	0·9	3·51	2·17	—	—	—	—	—	—	—	,,
0·37	1·35	3·87	4·41	—	1·02	4·3	2·15	—	—	—	—	—	—	—	,,
0·24	0·85	2·92	3·46	—	0·91	—	—	—	—	—	—	—	—	—	,,
0·28	0·7	—	3·95	4·05	1·0	4·2	2·4	—	—	2·1	—	—	—	—	,,
0·32	1·5	3·93	4·45	—	1·0	4·55	2·4	—	—	—	—	—	—	—	,,
0·3	1·45	4·0	4·65	—	1·0	—	—	—	—	—	—	—	—	—	,,
—	—	3·64	4·03	—	0·97	—	—	—	—	—	—	—	—	—	,,
0·35	0·9	3·63	3·91	—	0·88	3·85	2·01	—	—	—	—	—	—	—	,,
0·24	1·2	3·25	3·62	—	0·87	3·8	2·11	—	—	—	—	—	—	—	,,
0·28	1·6	4·35	4·65	—	1·0	4·35	2·36	—	—	—	—	—	—	—	,,
0·29	1·5	3·38	4·05	—	0·96	4·0	2·15	—	—	—	—	—	—	—	,,
—	—	4·37	5·1	—	1·08	4·45	2·38	—	—	—	—	—	—	—	,,
0·25	1·0	—	—	—	0·77	3·06	1·67	—	—	—	—	—	—	—	,,
0·21	1·0	—	—	—	—	—	—	—	—	1·6	—	—	—	—	,,
0·23	1·37	—	—	—	—		—	—	—	—	—	—	—	—	,,
—	—	3·1	3·75	—	—	3·5	1·9	—	—	—	—	—	—	—	,,
0·3	1·3	4·15	—	—	1·17	4·4	2·44	—	—	—	—	—	—	—	,,
0·34	1·15	3·1	3·65	—	0·84	3·5	1·64	—	—	1·45	—	—	—	—	Saldanha Bay
0·27	0·85	2·72	3·11	—	0·73	2·95	1·64	—	—	1·4	—	—	—	—	,,
0·25	0·94	3·25	3·70		0·85	3·35	—	—	—	—	—	—	—	—	South Georgia
0·26	0·67	3·75	4·20	—	0·93	4·30	2·30	—	—	—	—	—	—	—	,,
0·3	1·55	3·83	3·86	—	—	—		—	—	—	—	—	—	—	,,
0·22	1·05	3·57	—	—	0·88	—	—	—	—	—	—	—	—	—	,,
0·28	0·95	4·25	4·41	—	0·93	4·47	2·47	—	—	—	—	—	—	—	,,
—	—	—	—	—	0·91	—	—	—	—	—	—	—	—	—	Durban
—	—	2·65	3·2	—	0·69	—	—	—	—	—	—	—	—	—	,,
0·2	1·0	2·73	3·2	—	0·73	3·41	1·9	—	—	—	—	—	—	—	,,
0·3	1·2	4·08	4·36	—	1·1	4·77	—	—	—	—	—	—	—	—	South Georgia
0·27	0·78	2·65	3·0	—	0·76	3·0	1·9	—	—	—	—	—	—	—	,,
0·25	1·0	3·67	4·07	—	0·92	3·83	2·25	—	—	—	—	—	—	—	,,
0·3	1·1	3·64	3·78	—	0·88	3·88	2·2	—	—	—	—	—	—	—	,,
—	—	3·34	4·18	—	0·87	—	—	—	—	—	—	—	—	—	,,
0·2	0·9	3·17	3·3	—	0·9	3·42	2·19	—	—	—	—	—	—	—	,,
0·19	0·95	3·18	3·32	—	0·8	3·27	2·04	—	—	—	—	—	—	—	,,
							Foetuses								
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	,,
0·003	0·024	0·13	0·155	—	0·035	—	0·15	—	—	—	—	—	0·075	0·15	,,
—	0·03	0·08	0·1	—	0·02	—	0·09	—	—	—	—	—	—	0·075	,,
0·018	0·065	0·19	0·24	—	0·058	—	0·185	—	—	—	—	—	0·145	0·27	,,
0·01	0·04	0·16	0·19	—	0·045	—	0·14	—	—	—	—	0·14	0·105	0·2	,,
0·005	0·03	0·15	0·2	—	0·045	—	0·14	—	—	—	—	0·125	0·105	—	,,
—	0·04	0·09	0·11	—	0·027	—	0·1	—	—	—	—	—	0·05	—	,,
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	,,
0·01	0·05	0·15	0·185	—	0·04	—	0·15	—	—	—	—	0·08	0·08	—	,,
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	,,

PLATE II

Fig. 1. Female Humpback whale (No. 317) of colour group 3–4. The underside of the tail flukes is white, as is also the inner surface of the flipper.

Fig. 2. Anterior view of whale No. 317 shown in Fig. 1.

1

2

THE HUMPBACK WHALE

[*Discovery Reports. Vol. XVII, pp. 93–168, Plates III–XI, March 1938.*]

THE SPERM WHALE, *PHYSETER CATODON*

By

L. HARRISON MATTHEWS, M.A.

CONTENTS

THE SPERM WHALE, *PHYSETER CATODON*

By L. Harrison Matthews, M.A.

(Plates III–XI; Text-figs. 1–67)

INTRODUCTION

EIGHTY-ONE Sperm whales have been examined during the course of the Discovery investigations and the data obtained from them are set out and discussed in this report.

On the southern whaling grounds the Sperm whale is an unimportant fraction of the annual catch of whales, but at Durban, Natal, it is taken in some numbers. Two visits were paid to the Durban whaling stations by members of the Committee's scientific staff, and important information relating to the Sperm whale was then collected.

Although much has been written on the Sperm whale, both from the anatomical and general natural history points of view, little, if any, exact work on the biology of the species has been published. It is hoped that this report will provide a start in remedying the deficiency in our knowledge of the life of this whale.

The information recorded during examination of the whales at the whaling stations consisted of the routine system of measurements of various parts of the body that has been adhered to throughout the investigations, notes on the external characters, teeth, food, internal and external parasites, condition of the genitalia and degree of physical maturity. Very rarely, however, has a complete set of observations been made on any one whale. The information collected is discussed under the appropriate headings below, together with certain information derived from other sources.

It is with pleasure that I express my thanks to those friends who have given me the benefit of their assistance and criticism in compiling this report: in particular I am indebted to Dr S. Kemp, Dr A. S. Parkes, Dr Francis C. Fraser and Mr Martin A. C. Hinton.

MATERIAL

Of the eighty-one Sperm whales examined, sixty-seven were males and fourteen females. Particulars of the distribution of these in place and time are shown in Table I. Further information, contained in the British Museum whaling statistics, has also been used and is referred to in the appropriate sections below.

The information derived from the females is of particular interest because no exact data regarding the breeding of this species have been collected previously, and, although the numbers are regrettably few, it has been possible to arrive at a number of tentative conclusions on this subject. They are put forward as tentative conclusions only, but it is felt that with them a definite start has been made in elucidating the biology of the Sperm whale.

The information collected concerning this species of whale has accumulated slowly because comparatively few Sperm whales are taken on the whaling grounds of the far south, and visits by members of the scientific staff to regions where it is more frequently taken have been few. The data collected by the committee's staff and discussed in this report were obtained during the work of six seasons (1925–31).

Table I. *Sperm whale. Distribution of whales examined*

Date		Males		Females
		South Georgia	South Africa	South Africa
1926	June	—	1	—
	July	—	2	—
	Aug.	—	—	1
1927	Mar.	1	—	—
	Apr.	3	—	—
1928	Mar.	11	—	—
	Apr.	9	—	—
	Oct.	2	—	—
	Nov.	1	—	—
1929	Jan.	1	—	—
	Mar.	3	—	—
1930	Jan.	3	—	—
	Feb.	4	—	—
	Mar.	3	—	—
	June	—	8	2
	July	—	5	—
	Aug.	—	7	6
	Sept.	—	—	5
	Nov.	1	—	—
1931	Jan.	1	—	—
	Feb.	1	—	—
Total		44	23	14

SEX RATIO

Owing to the fact, discussed below, that on the southern grounds only male Sperm whales are found, to the fact that elsewhere there is selective hunting of the males by the whalers, and to the absence of extensive sexed foetal records, it is unfortunately impossible to come to any conclusion regarding the sex ratio of this species. It is, however, known that the Sperm whale is polygamous and, further, that in far north and far south latitudes the population consists of males only. If, then, the males in high latitudes represent the surplus males which have been unable to secure schools of cows, it appears possible that the sex ratio is fairly even, or at least not differential in favour of the females. The few sexed foetal records shown in Table II, do not contradict this suggestion.

Table II. *Sperm whale. Foetuses examined at South African Whaling Stations*

Date		Males	Females	Too small for sex determination
1926	Aug.	—	1	—
1930	Aug.	2	1	—
	Sept.	1	—	1
Total		3	2	1

EXTERNAL CHARACTERS

BODY PROPORTIONS

The standard series of measurements was taken from eighty-one Sperm whales, but in many the series was not complete for each measurement. Measurement No. 12, "Notch of flukes to end of system of ventral grooves", applicable only to balaenopterid whales, was omitted, but the standard numbering has been retained for the sake of uniformity, so that No. 12 is missing. Measurement No. 2, "projection of lower jaw beyond tip of snout", has been altered to "projection of snout beyond tip of lower jaw", because the lower jaw does not project as in the whalebone whales. The data obtained are set out below and may be taken as a fairly good representation of the external proportions of the Sperm whale, especially in the male. The figures derived from South Georgia and South Africa have been combined, because it is now generally accepted that there are no specific or subspecific differences between Sperm whales from different places, and the present figures, shown below, confirm this view. The measurements are shown in the Appendix (p. 165).

A summary of the analysis of the figures is shown in Table III, in which the average measurements, expressed as percentages of the total length, are given separately for males and females. The number of measurements producing each mean is also shown.

These average measurements show clearly the considerable sexual differences in this species. In all the measurements relating to the head and anterior part of the body the percentage values are markedly smaller in the female than in the male, and to set against this the values for the posterior part of the body, as shown by the values for measurements Nos. 10 and 11, are greater. The flipper of the female, too, is proportionately slightly longer than that of the male, as shown by measurements Nos. 16 and 17. The values for the measurements of the dorsal fin in the female are derived from too few examples for comparison to be made. In addition, the values for measurement No. 13, the genito-anal distance, are very much smaller in the female than in the male, owing to the close approximation of the genital and anal apertures within a single groove of the body surface, as recorded below. The female Sperm whale then, is considerably longer in the tail region, when compared with the male, and shorter in the head region.

Table III. *Sperm whale. Mean values of measurements of male and female whales expressed as percentages of total length*

Measurement	Males		Females	
	Mean value	No. of measurements	Mean value	No. of measurements
1. Total length	100·00	—	100·00	—
2. Projection of snout beyond tip of lower jaw	6·99	60	4·46	10
3. Tip of snout to blow-hole	4·19	27	—	—
4. Tip of snout to angle of gape	24·00	48	16·19	10
5. Tip of snout to centre of eye	28·27	49	20·72	12
6. Tip of snout to tip of flipper	49·09	36	26·46	7
7. Centre of eye to centre of ear	3·02	24	3·11	4
8. Notch of flukes to posterior emargination of dorsal fin	40·80	53	39·16	9
9. Width of flukes at insertion	6·23	60	7·19	10
10. Notch of flukes to centre of anus	27·98	60	31·09	13
11. Notch of flukes to umbilicus	47·09	64	53·82	12
13. Centre of anus to centre of reproductive aperture	11·56	63	1·97	8
14. Vertical height of dorsal fin	2·00	37	2·35	3
15. Length of base of dorsal fin	8·15	30	10·00	1
16. Axilla to tip of flipper	6·55	50	7·12	11
17. Anterior end of lower border to tip of flipper	8·73	53	9·01	12
18. Length of flipper along curve of lower border	9·14	29	—	—
19. Greatest width of flipper	4·40	50	4·55	12
20. Length of severed head from condyle to tip	35·40	47	27·42	5
21. Greatest width of skull	16·73	6	—	—
22. Skull length, condyle to tip of premaxilla	29·69	4	—	—
23. Length of flipper from head of humerus to tip	9·11	5	—	—
24. Depth of body at dorsal fin	13·82	5	—	—
25. Height of head	15·55	18	12·16	4

Tables IV and V show the manner in which the body proportions vary with the size of whale. In these tables the mean value of each measurement for each metre of whale length is given, together with the numbers of measurements producing each mean, and the range of variation of each value. The figures are given as the actual values in metres in roman type, and expressed as percentages of total length in italic type. The figures expressed as percentages of total length are first discussed: those of the actual values are dealt with in a later section of this report.

The variations of the body proportions according to the length of the whale are shown graphically for measurements Nos. 4, 5, 6, 7, 8, 9, 10, 11, 13, 16, 17, 20, 21 and 25, in Figs. 1–14, in which the percentage value of the measurements is plotted against the total length of the whale. Curves for each sex are shown separately, but those for the female are necessarily short owing to the small range of total length shown by the females examined. The variations of measurements Nos. 2 and 3, 14 and 15, 18 and 19, are not shown graphically. Nos. 2 and 3 are short measurements taken from the tip of the snout, a point not easy to define; Nos. 14 and 15 relate to the length and height of the dorsal fin, more properly termed a dorsal hump in this species, the boundaries of which are very vague and difficult to determine. The values obtained for these measurements are therefore very variable from whale to whale and scarcely comparable: when plotted they give very irregular curves which appear to be of little value. The values for measurements Nos. 18 and 19 also give curves which appear to be of little significance.

The sexual differences in the body proportions are brought out clearly by these figures, in practically all of which the curve for the values from the females is very distinct from that for the males. The curve for the females is above that for the males in Figs. 4, 5, 7 and 8 showing measurements Nos. 7, 8, 10 and 11, indicating that for these measurements the values in the female are relatively greater than in the male. These measurements relate to the tail region (notch of flukes to dorsal fin, to anus, to umbilicus) and to the distance between the centre of the eye and the centre of the ear. For measurements Nos. 16 and 17 shown in Figs. 10 and 11 the values for the males given are irregular curves, and those for the females do not differ widely. These measurements relate to the size of the flipper.

In the curves for the remaining measurements, Nos. 4, 5, 6, 9, 20 and 25, relating to the head and anterior end of the body, shown in Figs. 1, 2, 3, 12 and 14, those of the females are below those of the males, indicating that for these measurements the values for the females are comparatively smaller than those from the males. Similarly the curves show that the values for measurements Nos. 9, width of flukes at insertion (Fig. 6) and 13, the genito-anal distance (Fig. 9), are comparatively smaller in females than males.

A further point of interest presented by these curves is the fact that those for measurements Nos. 4, 5, 6, 7, 20 and 25 (Figs. 1–4, 12–14) in general slope upwards from their origin and those for measurements Nos. 8, 9, 10, 11 and 13 (Figs. 5–9) slope downwards from their origin, showing that as the whale increases in length the relative size of the head region increases and that of the tail region decreases. The rate of growth of the body, therefore, decreases from the head region backward. There is some slight indication that at extreme lengths the relative sizes of the head and tail regions become slightly less and greater respectively, an event that may be correlated with the attainment of physical maturity. These conclusions apply only to the males because the figures for the females are too few to give curves long enough for their general trend to be gauged.

The variations that occur in each measurement are shown in Table VI, in which the values of each measurement, expressed as percentages of the total length, are divided into arbitrary groups and the number of values falling into each group is recorded. These data are shown graphically in Figs. 15–31, in which the curves all approximate to normal frequency curves, each showing one large peak. Only in Figs. 24 and 31, for measurements Nos. 11 and 25, notch of flukes to umbilicus, and height of head, are there indications of a pronounced shelf or second peak; but the irregularities of these two figures can scarcely be taken to be of any great significance. The data for males only are included in

Table IV. *Sperm whale. Males. Measurements. Actual values in metres (roman type): expressed as percentages of total length (italic type)*

	Metre lengths	2. Projection of snout beyond tip of lower jaw			3. Tip of snout to blow-hole			4. Tip of snout to angle of gape		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	0–1	—	—	—	—	—	—	1	—	0·02
			—	—		—	—		—	*10·00*
	2–3	1	—	0·14	—	—	—	1	—	0·40
			—	*5·39*		—	—		—	*15·39*
	3–4	1	—	0·21	—	—	—	1	—	0·45
			—	*6·67*		—	—		—	*14·28*
Whale	8–9	1	—	0·62	—	—	—	1	—	1·77
			—	*7·05*		—	—		—	*20·10*
	9–10	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	10–11	1	—	0·80	—	—	—	1	—	2·05
			—	*7·40*		—	—		—	*18·95*
	11–12	2	0·78– 0·84	0·81	—	—	—	1	—	2·30
			7·78– 8·41	*8·09*		—	—		—	*19·50*
	12–13	2	0·60– 0·67	0·64	—	—	—	2	2·20– 2·65	2·42
			4·95– 5·44	*5·19*		—	—		*17·85–21·90*	*19·87*
	13–14	6	0·60– 1·30	0·91	—	—	—	3	2·88– 3·80	3·19
			4·32– 9·54	*6·63*		—	—		*20·20–27·80*	*23·13*
	14–15	9	0·76– 1·11	0·89	5	0·40– 0·62	0·54	6	3·02– 3·60	3·23
			5·22– 7·44	*6·18*		*2·78– 4·27*	*3·69*		*20·80–24·13*	*22·31*
	15–16	24	0·75– 1·60	1·07	13	0·45– 0·84	0·67	19	3·32– 4·50	3·84
			4·99–10·22	*6·99*		*2·85– 5·59*	*4·33*		*16·12–27·72*	*24·79*
	16–17	7	1·05– 1·46	1·30	4	0·58– 0·95	0·69	9	3·70– 4·60	4·14
			6·55– 9·38	*7·92*		*3·61– 5·63*	*4·18*		*22·70–27·20*	*25·20*
	17–18	8	1·02– 1·51	1·29	5	0·67– 0·86	0·74	6	4·20– 4·52	4·35
			5·98– 8·82	*7·51*		*3·91– 5·04*	*4·33*		*24·25–26·42*	*25·31*

	Metre lengths	5. Tip of snout to centre of eye			6. Tip of snout to tip of flipper			7. Centre of eye to centre of ear		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	0–1	1	—	0·03	1	—	0·08	—	—	—
			—	*15·00*		—	*40·00*		—	—
	2–3	1	—	0·50	1	—	1·00	1	—	0·10
			—	*19·21*		—	*38·45*		—	*3·85*
	3–4	1	—	0·57	1	—	1·21	—	—	—
			—	*18·08*		—	*38·40*		—	—
Whale	8–9	1	—	2·10	1	—	3·15	—	—	—
			—	*23·80*		—	*35·75*		—	—
	9–10	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	10–11	1	—	2·56	1	—	4·22	—	—	—
			—	*23·65*		—	*39·10*		—	—
	11–12	2	2·75– 3·01	2·88	1	—	5·00	—	—	—
			23·25–25·30	*24·28*		—	*42·40*		—	—
	12–13	2	2·90– 3·10	3·00	1	—	5·15	—	—	—
			23·60–25·55	*24·57*		—	*41·75*		—	—
	13–14	5	3·60– 3·80	3·68	2	5·92– 6·10	6·01	1	—	0·35
			26·45–27·95	*27·00*		*43·35–44·53*	*43·94*		—	*2·56*
	14–15	6	3·70– 4·39	3·35	7	5·80– 6·78	6·32	5	0·41– 0·48	0·46
			24·80–29·42	*26·46*		*39·19–45·44*	*43·33*		*2·75– 3·39*	*3·18*
	15–16	17	4·15– 5·23	4·60	14	6·14– 7·47	6·91	10	0·44– 0·55	0·49
			26·18–32·79	*29·78*		*39·12–47·36*	*44·59*		*2·84– 3·47*	*3·19*
	16–17	9	4·20– 5·20	4·78	8	7·17– 8·20	7·35	4	0·46– 0·55	0·51
			25·80–31·20	*29·11*		*43·75–48·61*	*45·64*		*2·78– 3·25*	*3·12*
	17–18	6	4·90– 5·49	4·35	5	7·38– 7·98	7·68	4	0·49– 0·65	0·55
			28·60–31·30	*30·06*		*44·20–45·50*	*44·91*		*2·81– 3·71*	*3·21*

Table IV. *Sperm whale. Males. Measurements. Actual values in metres (roman type): expressed as percentages of total length (italic type)*

	Metre lengths	8. Notch of flukes to posterior emargination of dorsal fin: No. of measurements	8. Range	8. Mean	9. Width of flukes at insertion: No. of measurements	9. Range	9. Mean	10. Notch of flukes to centre of anus: No. of measurements	10. Range	10. Mean
Foetus	0–1	1	—	0·09	1	—	0·02	1	—	0·055
			—	*45·00*		—	*10·00*		—	*27·50*
	2–3	1	—	1·03	—	—	—	1	—	0·92
			—	*39·60*		—	—		—	*35·40*
	3–4	1	—	1·45	—	—	—	1	—	1·07
			—	*46·10*		—	—		—	*34·00*
Whale	8–9	1	—	3·55	1	—	0·59	1	—	2·67
			—	*40·30*		—	*6·69*		—	*30·40*
	9–10	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	10–11	1	—	4·00	1	—	0·80	1	—	3·35
			—	*36·10*		—	*7·41*		—	*31·00*
	11–12	2	4·40– 4·50	4·45	2	0·92– 0·96	0·94	2	3·50– 3·65	3·57
			37·35–37·90	*37·62*		*7·79– 8·09*	*7·94*		*29·60–30·75*	*30·15*
	12–13	2	4·40– 4·70	4·55	2	0·92– 0·95	0·94	2	3·75– 3·95	3·85
			36·30–38·25	*37·27*		*7·60– 7·70*	*7·65*		*30·90–32·20*	*31·55*
	13–14	6	4·65– 5·15	4·88	6	0·95– 1·09	0·99	6	7·70– 4·50	4·05
			34·05–37·10	*35·71*		*7·02– 7·84*	*7·30*		*27·60–32·95*	*29·63*
	14–15	9	4·45– 5·30	5·07	9	0·97– 1·12	1·05	10	4·00– 4·82	4·30
			30·94–37·15	*34·97*		*6·76– 7·72*	*7·21*		*26·85–32·30*	*29·63*
	15–16	17	4·20– 5·55	4·96	21	0·97– 1·20	1·07	25	4·20– 5·40	4·50
			26·00–35·00	*33·87*		*6·33– 7·52*	*6·90*		*27·41–38·49*	*28·67*
	16–17	9	5·00– 6·15	5·28	12	0·55– 1·30	1·04	12	4·30– 5·00	4·66
			30·23–36·75	*32·21*		*3·40– 7·85*	*6·30*		*26·60–32·50*	*28·54*
	17–18	6	5·35– 6·00	5·60	6	1·00– 1·28	1·15	7	4·62– 5·05	4·78
			31·36–34·60	*32·56*		*5·84– 7·49*	*6·71*		*26·40–28·85*	*27·68*

	Metre lengths	11. Notch of flukes to umbilicus: No. of measurements	11. Range	11. Mean	13. Centre of anus to centre of reproductive aperture: No. of measurements	13. Range	13. Mean	14. Vertical height of dorsal fin: No. of measurements	14. Range	14. Mean
Foetus	0–1	1	—	0·11	1	—	0·025	—	—	—
			—	*55·00*		—	*12·50*		—	—
	2–3	1	—	1·37	1	—	0·30	—	—	—
			—	*52·68*		—	*11·52*		—	—
	3–4	1	—	1·57	1	—	0·30	—	—	—
			—	*49·89*		—	*9·54*		—	—
Whale	8–9	1	—	4·50	1	—	1·20	—	—	—
			—	*51·10*		—	*13·65*		—	—
	9–10	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	10–11	1	—	5·35	1	—	1·60	—	—	—
			—	*49·50*		—	*14·80*		—	—
	11–12	2	5·50– 6·20	5·80	1	—	1·40	—	—	—
			46·60–52·20	*49·40*		—	*11·85*		—	—
	12–13	2	6·20– 6·20	6·20	2	1·35– 1·65	1·50	—	—	—
			50·40–51·25	*50·82*		*11·80–13·40*	*12·10*		—	—
	13–14	6	6·05– 6·95	6·51	5	1·50– 1·80	1·64	1	—	0·39
			43·50–51·05	*45·83*		*10·95–13·14*	*12·13*		—	*2·85*
	14–15	10	6·37– 7·89	7·05	10	1·51– 1·94	1·70	8	0·20– 0·45	0·30
			44·39–52·70	*48·50*		*10·47–13·00*	*11·63*		*1·34– 3·04*	*2·04*
	15–16	23	6·82– 7·85	7·25	24	1·45– 2·20	1·79	16	0·16– 0·42	0·34
			44·52–51·10	*46·85*		*9·46–14·10*	*11·48*		*1·03– 2·69*	*2·17*
	16–17	12	6·90– 8·28	7·63	12	1·60– 2·40	1·89	8	0·12– 0·41	0·25
			42·70–50·00	*46·39*		*10·00–12·65*	*11·64*		*0·74– 2·48*	*1·74*
	17–18	7	7·72– 8·90	7·99	7	1·65– 1·95	1·84	4	0·26– 0·46	0·37
			44·10–50·80	*46·29*		*9·69–11·15*	*10·67*		*1·49– 2·68*	*2·17*

Table IV. *Sperm whale. Males. Measurements. Actual values in metres (roman type): expressed as percentages of total length (italic type)*

	Metre lengths	15. Length of base of dorsal fin: No. of measurements	Range	Mean	16. Axilla to tip of flipper: No. of measurements	Range	Mean	17. Anterior end of lower border to tip of flipper: No. of measurements	Range	Mean
Foetus	0–1	—	—	—	1	—	0·02	1	—	0·0225
			—	—		—	*10·00*		—	*11·25*
	2–3	—	—	—	1	—	0·22	1	—	0·32
			—	—		—	*8·47*		—	*12·31*
	3–4	—	—	—	1	—	0·28	1	—	0·41
			—	—		—	*8·00*		—	*13·00*
Whale	8–9	—	—	—	1	—	0·70	1	—	0·92
			—	—		—	*7·94*		—	*10·45*
	9–10	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	10–11	—	—	—	1	—	0·77	1	—	1·15
			—	—		—	*7·13*		—	*10·32*
	11–12	—	—	—	2	0·82– 1·06	0·94	2	0·90– 0·92	0·91
			—	—		*6·95– 8·48*	*7·71*		*7·59– 7·78*	*7·68*
	12–13	—	—	—	1	—	0·99	2	1·05– 1·19	1·12
			—	—		—	*8·19*		*8·52– 9·81*	*9·16*
	13–14	1	—	1·10	4	0·88– 1·17	1·00	4	0·92– 1·32	1·17
			—	*8·00*		*6·45– 8·72*	*7·36*		*6·85– 9·40*	*8·47*
	14–15	5	1·30– 2·00	1·49	9	0·70– 1·20	0·89	8	1·18– 1·41	1·29
			9·03–13·40	*10·19*		*4·73– 8·36*	*6·21*		*8·12– 9·56*	*8·92*
	15–16	12	1·25– 2·01	1·55	19	0·70– 1·50	0·96	21	1·20– 1·56	1·34
			8·13–12·60	*10·07*		*4·42– 9·49*	*6·21*		*7·58– 9·86*	*8·12*
	16–17	7	0·55– 2·45	1·37	9	0·84– 1·18	1·05	11	1·28– 1·54	1·44
			3·40–14·82	*8·33*		*5·08– 7·11*	*6·47*		*8·03– 9·60*	*8·75*
	17–18	5	1·45– 1·73	1·62	4	1·08– 1·38	1·16	4	1·40– 1·56	1·51
			8·50–10·10	*9·40*		*5·91– 8·10*	*6·65*		*8·20– 9·17*	*8·85*

	Metre lengths	18. Length of flipper along curve of lower border: No. of measurements	Range	Mean	19. Greatest width of flipper: No. of measurements	Range	Mean	20. Length of severed head from condyle to tip: No. of measurements	Range	Mean
Foetus	0–1	—	—	—	1	—	0·01	—	—	—
			—	—		—	*5·00*		—	—
	2–3	—	—	—	1	—	0·15	—	—	—
			—	—		—	*5·77*		—	—
	3–4	—	—	—	1	—	0·07	—	—	—
			—	—		—	*2·22*		—	—
Whale	8–9	—	—	—	1	—	0·46	—	—	—
			—	—		—	*5·45*		—	—
	9–10	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	10–11	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	11–12	—	—	—	2	0·55– 0·65	0·60	2	3·55– 3·75	3·65
			—	—		*4·66– 5·47*	*5·06*		*31·60–32·80*	*32·20*
	12–13	—	—	—	2	0·56– 0·66	0·61	2	3·94– 4·00	3·97
			—	—		*4·56– 5·44*	*5·00*		*32·50–32·50*	*32·50*
	13–14	—	—	—	4	0·58– 0·72	0·63	2	4·70– 4·80	4·75
			—	—		*4·24– 5·27*	*3·65*		*34·40–35·10*	*34·75*
	14–15	6	1·28– 1·47	1·35	7	0·63– 0·69	0·66	7	4·68– 5·40	4·96
			8·82– 9·89	*9·41*		*4·26– 4·75*	*4·53*		*32·75–36·23*	*34·34*
	15–16	12	1·25– 1·60	1·41	20	0·62– 0·77	0·69	23	4·84– 6·22	5·51
			7·90–10·13	*9·11*		*4·18– 4·95*	*4·01*		*31·60–39·17*	*35·59*
	16–17	7	1·32– 1·60	1·46	9	0·68– 0·80	0·74	6	5·65– 6·58	6·02
			8·04– 9·98	*8·91*		*4·11– 5·00*	*4·99*		*34·50–39·00*	*36·58*
	17–18	4	1·55– 1·60	1·56	5	0·88– 1·65	0·76	5	6·21– 6·60	6·43
			9·34– 9·06	*9·15*		*4·20– 5·14*	*4·62*		*35·56–38·40*	*37·31*

Table IV. *Sperm whale. Males. Measurements. Actual values in metres (roman type): expressed as percentages of total length (italic type)*

	Metre lengths	21. Greatest width of skull			22. Skull length, condyle to tip of premaxilla			23. Length of flipper from head of humerus to tip		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	0–1	—	— —	— —	—	— —	— —	—	— —	— —
	2–3	—	— —	— —	—	— —	— —	—	— —	— —
	3–4	—	— —	— —	—	— —	— —	—	— —	— —
Whale	8–9	1	— —	2·82 *32·10*	—	— —	— —	—	— —	— —
	9–10	—	— —	— —	—	— —	— —	—	— —	— —
	10–11	—	— —	— —	—	— —	— —	—	— —	— —
	11–12	—	— —	— —	—	— —	— —	—	— —	— —
	12–13	—	— —	— —	—	— —	— —	—	— —	— —
	13–14	—	— —	— —	—	— —	— —	—	— —	— —
	14–15	1	— —	2·20 *15·33*	—	— —	— —	—	— —	— —
	15–16	1	— —	2·30 *14·55*	1	— —	4·80 *30·30*	1	— —	1·40 *9·14*
	16–17	3	2·00– 2·12 *12·35–13·05*	2·07 *12·80*	3	4·65– 4·90 *28·55–30·30*	4·78 *29·48*	3	1·42– 1·57 *8·76– 9·63*	1·48 *9·12*
	17–18	—	— —	— —	—	— —	— —	1	— —	1·55 *9·06*

	Metre lengths	24. Depth of body at dorsal fin			25. Height of head		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	0–1	1	— —	0·05 *5·00*	1	— —	0·22 *11·00*
	2–3	1	— —	0·57 *21·92*	1	— —	0·35 *13·45*
	3–4	—	— —	— —	1	— —	0·38 *12·06*
Whale	8–9	—	— —	— —	1	— —	1·35 *15·30*
	9–10	—	— —	— —	—	— —	— —
	10–11	—	— —	— —	1	— —	1·55 *14·35*
	11–12	—	— —	— —	2	1·70– 1·80 *14·40–15·18*	1·75 *14·79*
	12–13	—	— —	— —	2	1·63– 1·83 *13·25–15·70*	1·73 *14·47*
	13–14	—	— —	— —	4	2·00– 3·15 *14·70–15·75*	2·31 *15·12*
	14–15	—	— —	— —	2	2·15– 2·20 *15·35–15·35*	2·17 *15·35*
	15–16	4	1·14– 2·60 *7·60–16·75*	2·07 *13·43*	5	2·49– 2·70 *15·70–18·00*	2·58 *16·72*
	16–17	1	— —	2·60 *15·38*	1	— —	2·90 *17·30*
	17–18	—	— —	— —	—	— —	— —

Table V. *Sperm whale. Females. Measurements. Actual values in metres (roman type): expressed as percentages of total length (italic type)*

	Metre lengths	2. Projection of snout beyond tip of lower jaw			4. Tip of snout to angle of gape			5. Tip of snout to centre of eye		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	1–2	—	—	—	1	—	0·20	1	—	0·30
			—	—		—	*12·90*		—	*19·35*
	3–4	1	—	0·19	—	—	—	1	—	0·59
			—	*6·23*		—	—		—	*19·34*
Whale	9–10	6	0·35– 0·65	0·46	6	1·44– 1·75	1·59	6	1·82– 2·10	2·01
			3·56– 6·70	*4·74*		*16·20–18·20*	*16·60*		*18·59–21·80*	*20·49*
	10–11	4	0·26– 0·60	0·39	4	1·50– 1·70	1·62	6	2·00– 2·40	2·17
			2·60– 5·66	*4·02*		*14·65–16·80*	*15·56*		*19·55–22·40*	*20·95*
	11–12	—	—	—	1	—	1·90	1	—	2·46
			—	—		—	*16·80*		—	*21·80*

	Metre lengths	6. Tip of snout to tip of flipper			7. Centre of eye to centre of ear			8. Notch of flukes to posterior emargination of dorsal fin		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	1–2	1	—	0·61	1	—	0·07	1	—	0·50
			—	*39·35*		—	*4·51*		—	*32·25*
	3–4	1	—	1·23	1	—	0·11	1	—	1·37
			—	*40·33*		—	*3·61*		—	*44·92*
Whale	9–10	4	3·50– 3·80	3·63	—	—	—	4	3·80– 3·95	3·87
			35·70–39·50	*37·14*		—	—		*38·40–39·80*	*39·26*
	10–11	3	3·63– 4·00	3·81	3	0·30– 0·32	0·31	4	3·95– 4·20	4·09
			36·25–37·60	*36·72*		*2·80– 3·20*	*3·02*		*38·40–39·60*	*39·12*
	11–12	—	—	—	1	—	0·38	1	—	4·40
			—	—		—	*3·36*		—	*38·90*

	Metre lengths	9. Width of flukes at insertion			10. Notch of flukes to centre of anus			11. Notch of flukes to umbilicus		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	1–2	1	—	0·17	1	—	0·54	1	—	0·85
			—	*10·97*		—	*34·85*		—	*54·80*
	3–4	1	—	0·28	1	—	1·06	1	—	1·58
			—	*9·18*		—	*34·75*		—	*51·80*
Whale	9–10	4	0·70– 0·76	0·73	6	2·75– 3·50	3·11	5	4·70– 5·60	5·30
			7·21– 7·90	*7·29*		*28·30–36·05*	*31·83*		*48·30–56·70*	*53·98*
	10–11	5	0·66– 0·85	0·75	6	2·50– 3·40	3·14	6	5·10– 6·05	5·58
			6·47– 8·01	*7·21*		*27·97–32·00*	*30·02*		*48·95–55·40*	*53·19*
	11–12	1	—	0·75	1	—	3·75	1	—	6·15
			—	*6·62*		—	*33·10*		—	*54·40*

Table V. *Sperm whale. Females. Measurements. Actual values in metres* (*roman type*)*: expressed as percentages of total length* (*italic type*)

	Metre lengths	13. Centre of anus to centre of reproductive aperture			14. Vertical height of dorsal fin			15. Length of base of dorsal fin		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	1–2	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	3–4	1	—	0·04	1	—	0·07	1	—	0·35
			—	*1·31*		—	*2·30*		—	*11·48*
Whale	9–10	4	0·17–0·25	0·21	1	—	0·22	—	—	—
			1·75–2·55	*2·19*		—	*2·26*		—	—
	10–11	3	0·12–0·21	0·15	2	0·20–0·28	0·24	1	—	1·00
			1·19–1·93	*1·45*		*1·99–2·80*	*2·39*		—	*10·00*
	11–12	1	—	0·30	—	—	—	—	—	—
			—	*2·65*		—	—		—	—

	Metre lengths	16. Axilla to tip of flipper			17. Anterior end of lower border to tip of flipper			18. Length of flipper along curve of lower border		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	1–2	1	—	0·12	1	—	0·18	—	—	—
			—	*7·75*		—	*11·61*		—	—
	3–4	1	—	0·28	1	—	0·40	1	—	0·42
			—	*9·80*		—	*13·11*		—	*13·77*
Whale	9–10	6	0·57–0·77	0·67	6	0·70–1·00	0·88	—	—	—
			5·92–7·93	*6·87*		*7·30–10·25*	*9·03*		—	—
	10–11	5	0·75–0·85	0·78	6	0·75–1·10	0·95	—	—	—
			7·01–7·79	*7·42*		*7·01–10·35*	*8·99*		—	—
	11–12	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—

	Metre lengths	19. Greatest width of flipper			20. Length of severed head from condyle to tip			21. Greatest width of skull		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	1–2	1	—	0·07	—	—	—	—	—	—
			—	*4·51*		—	—		—	—
	3–4	1	—	0·19	—	—	—	1	—	0·43
			—	*6·23*		—	—		—	*14·10*
Whale	9–10	6	0·44–0·49	0·46	2	2·70–2·70	2·70	—	—	—
			4·61–4·95	*4·78*		*27·20–27·80*	*27·50*		—	—
	10–11	6	0·45–0·55	0·48	3	2·80–2·90	2·86	—	—	—
			4·20–5·03	*4·32*		*26·20–28·60*	*27·36*		—	—
	11–12	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—

Table V. *Sperm whale. Females. Measurements. Actual values in metres* (*roman type*)*: expressed as percentages of total length* (*italic type*)

	Metre lengths	22. Skull length, condyle to tip of premaxilla			24. Depth of body at dorsal fin			25. Height of head		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	1–2	—	—	—	1	—	0·32 *20·61*	1	—	0·19 *12·26*
	3–4	—	—	—	1	—	0·50 *16·39*	—	—	—
Whale	9–10	—	—	—	—	—	—	1	—	1·25 *12·60*
	10–11	—	—	—	—	—	—	3	1·20–1·31 *11·75–12·35*	1·27 *12·01*
	11–12	—	—	—	—	—	—	—	—	—

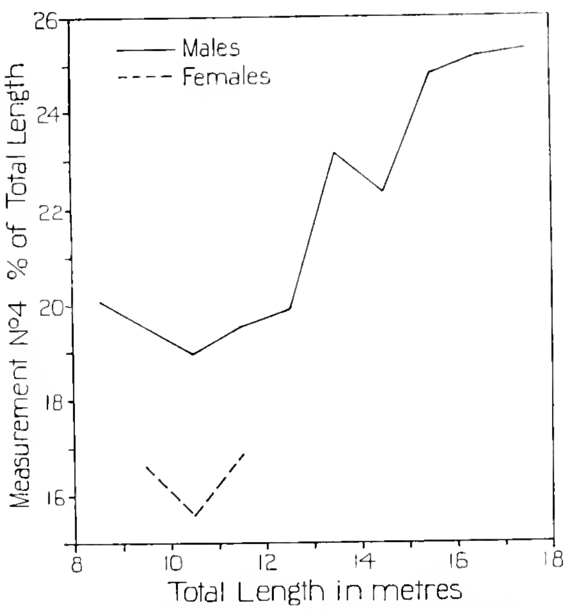

Fig. 1. Sperm whale. Measurement No. 4. Tip of snout to angle of gape.

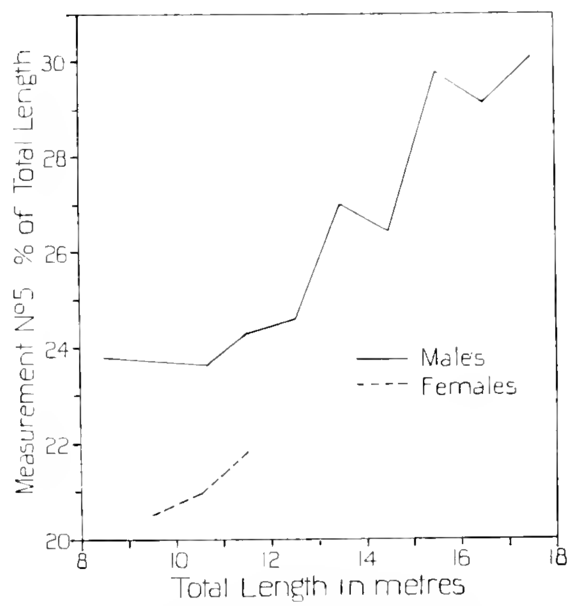

Fig. 2. Sperm whale. Measurement No. 5. Tip of snout to centre of eye.

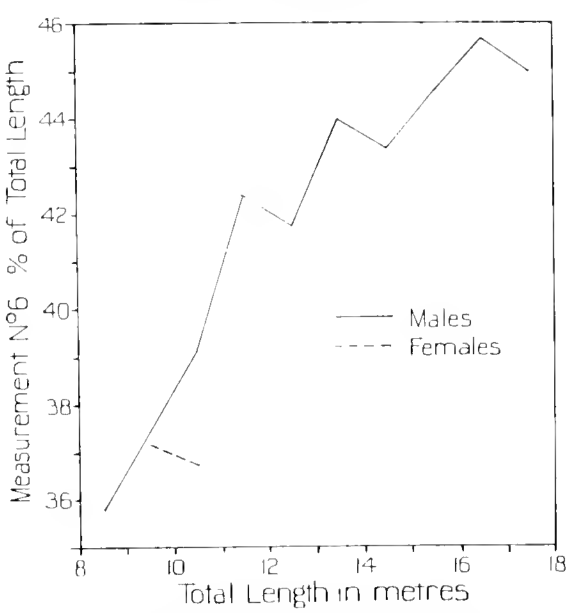

Fig. 3. Sperm whale. Measurement No. 6. Tip of snout to tip of flipper.

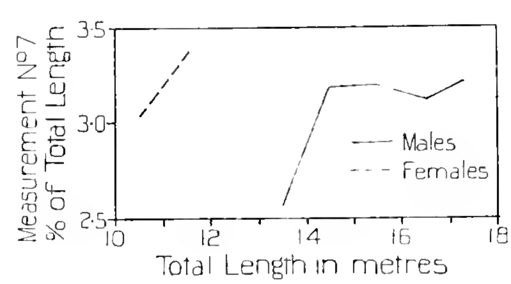

Fig. 4. Sperm whale. Measurement No. 7. Centre of eye to centre of ear.

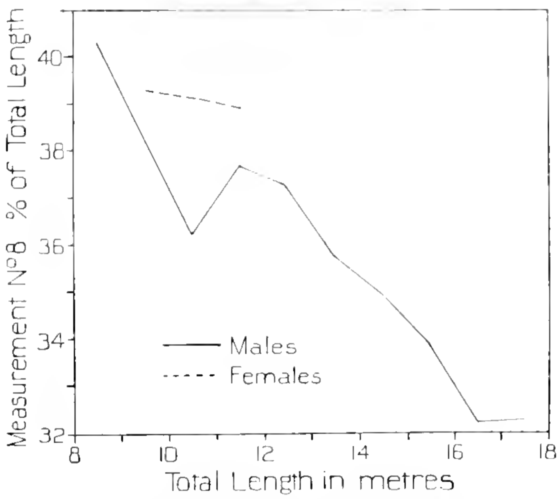

Fig. 5. Sperm whale. Measurement No. 8. Notch of flukes to posterior emargination of dorsal fin.

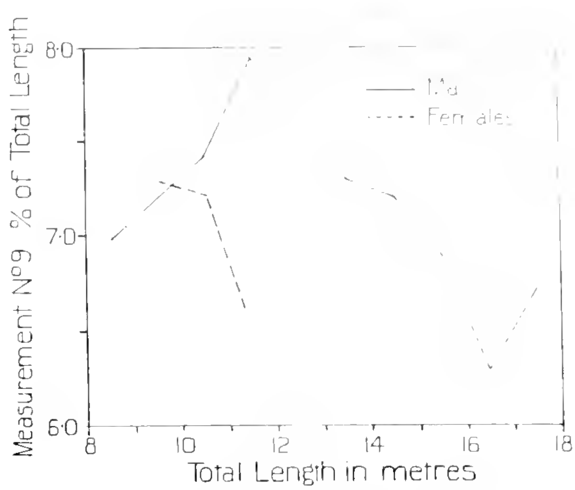

Fig. 6. Sperm whale. Measurement No. 9. Width of flukes at insertion.

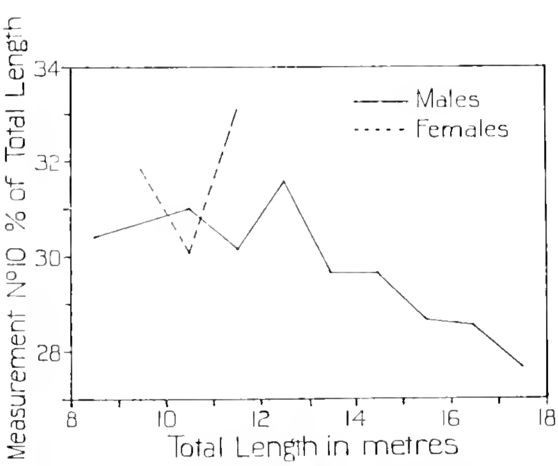

Fig. 7. Sperm whale. Measurement No. 10. Notch of flukes to centre of anus.

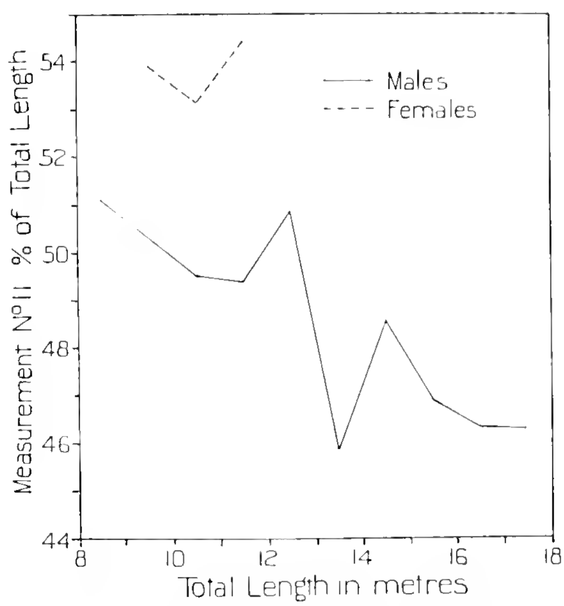

Fig. 8. Sperm whale. Measurement No. 11. Notch of flukes to umbilicus.

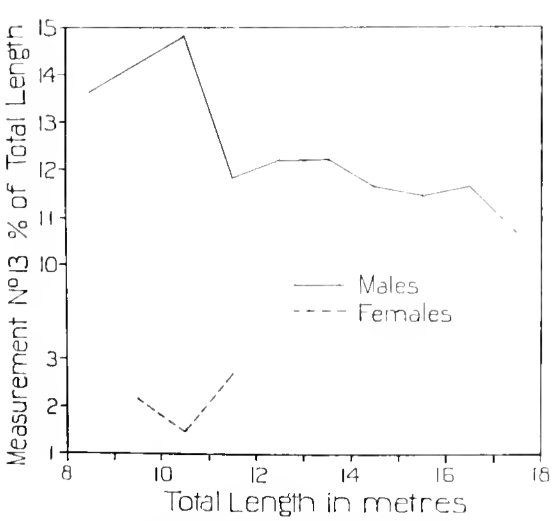

Fig. 9. Sperm whale. Measurement No. 13. Centre of anus to centre of reproductive aperture.

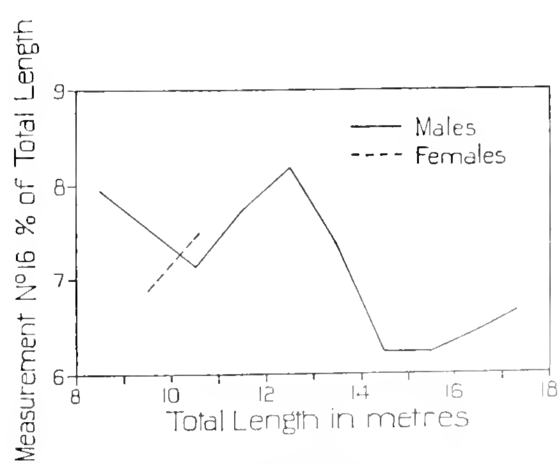

Fig. 10. Sperm whale. Measurement No. 16. Axilla to tip of flipper.

Fig. 11. Sperm whale. Measurement No. 17. Anterior end of lower border to tip of flipper.

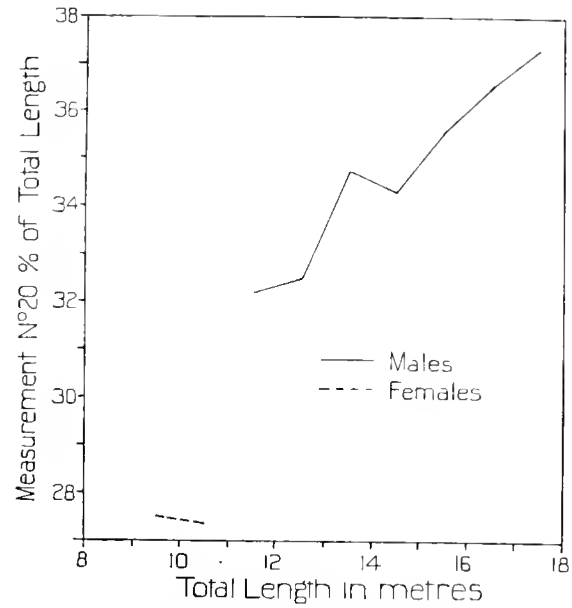

Fig. 12. Sperm whale. Measurement No. 20. Length of severed head from condyle to tip.

Fig. 13. Sperm whale. Measurement No. 21. Greatest width of skull.

Fig. 14. Sperm whale. Measurement No. 25. Height of head.

this table and these figures, and include those obtained from whales both at South Georgia and South Africa; they indicate a homogeneous population and no admixture of races with structural differences.

COLOUR

The coloration was recorded in seventy Sperm whales, sixty males and ten females. In 70 per cent of these whales the colour was a nearly uniform slate grey or dark bluish grey all over the body, with the exception of specific white or light grey markings; in 25·7 per cent the colour was considerably lighter on the under surface of the head and lower jaw, and in 4·3 per cent it was conspicuously lighter over the greater part of the ventral surface (Plate IV, figs. 1–3).

In 91·5 per cent of the whales white or light-coloured markings were present. A white or light grey marking of greater or lesser extent occurred in the umbilical region in 78·2 per cent of whales examined. This took the form of a white splash, usually including the umbilicus within its border, in 32·7 per cent. It was generally triangular in shape with its apex directed forward (Plates III, fig. 3; VI, fig. 1). In 67 per cent there was present an umbilical whorl of light grey or whitish colour, composed of patches or flecks of light pigment arranged in two lines meeting at or near the umbilicus, diverging to embrace the genital aperture, and fading away into the background colour of the body at the posterior border of it (Plate VI, fig. 2). When both the umbilical whorl and the umbilical white splash were present, a combination which occurred in 21·4 per cent, the angles of the base of the umbilical splash were continued into the limbs of the umbilical whorl.

The light grey flecking of the umbilical whorl sometimes extended in area so that the flanks were covered to a greater or lesser extent with light grey flecks. This condition was recorded in 24·3 per cent (Plate VI, figs. 2 and 3). The posterior part of the ventral surface was similarly covered in 4·1 per cent. The area of light flecks extended on to the flukes in 7 per cent and was always more pronounced on the under than the upper

Table VI. *Sperm whale. Males. Variation of measurements*

2. Projection of snout beyond tip of lower jaw		3. Tip of snout to blow-hole		4. Tip of snout to angle of gape		5. Tip of snout to centre of eye		6. Tip of snout to tip of flipper	
Range of values (% of total length)	No. of readings	Range of values (% of total length)	No. of measurements	Range of values (% of total length)	No. of measurements	Range of values (% of total length)	No. of measurements	Range of values (% of total length)	No. of measurements
4·0– 5·0	3	2·5–3·0	2	15·0–17·0	2	21·0–23·0	4	33·0–35·0	1
5·0– 6·0	12	3·0–3·5	2	17·0–19·0	2	23·0–25·0	7	35·0–37·0	0
6·0– 7·0	17	3·5–4·0	8	19·0–21·0	5	25·0–27·0	8	37·0–39·0	3
7·0– 8·0	14	4·0–4·5	6	21·0–23·0	10	27·0–29·0	16	39·0–41·0	3
8·0– 9·0	10	4·5–5·0	4	23·0–25·0	18	29·0–31·0	11	41·0–43·0	7
9·0–10·0	3	5·0–5·5	3	25·0–27·0	10	31·0–33·0	3	43·0–45·0	18
10·0–11·0	1	5·5–6·0	2	27·0–29·0	1			45·0–47·0	7
								47·0–49·0	1

7. Centre of eye to centre of ear		8. Notch of flukes to posterior emargination of dorsal fin		9. Width of flukes at insertion		10. Notch of flukes to centre of anus		11. Notch of flukes to umbilicus	
Range of values (% of total length)	No. of measurements	Range of values (% of total length)	No. of measurements	Range of values (% of total length)	No. of measurements	Range of values (% of total length)	No. of measurements	Range of values (% of total length)	No. of measurements
2·50–2·75	2	25·0–27·0	2	3·0–4·0	1	24·0–26·0	5	41·0–43·0	2
2·75–3·00	5	27·0–29·0	0	4·0–5·0	1	26·0–28·0	31	43·0–45·0	19
3·00–3·25	8	29·0–31·0	12	5·0–6·0	1	28·0–30·0	21	45·0–47·0	23
3·25–3·50	8	31·0–33·0	14	6·0–7·0	23	30·0–32·0	6	47·0–49·0	9
3·50–3·75	1	33·0–35·0	12	7·0–8·0	31	32·0–34·0	1	49·0–51·0	8
		35·0–37·0	11	8·0–9·0	1	34·0–36·0	0	51·0–53·0	3
		37·0–39·0	1			36·0–38·0	1		
		39·0–41·0	1						

Table VI. *Sperm whale. Males. Variation of measurements*

13. Centre of anus to centre of reproductive aperture		14. Vertical height of dorsal fin		15. Length of base of dorsal fin		16. Axilla to tip of flipper		17. Anterior end of lower border to tip of flipper	
Range of values (% of total length)	No. of measurements	Range of values (% of total length)	No. of measurements	Range of values (% of total length)	No. of measurements	Range of values (% of total length)	No. of measurements	Range of values (% of total length)	No. of measurements
9·0–10·0	4	0·5–1·0	2	3·0– 5·0	1	4·0– 5·0	5	6·0– 7·0	1
10·0–11·0	17	1·0–1·5	4	5·0– 7·0	2	5·0– 6·0	10	7·0– 8·0	5
11·0–12·0	25	1·5–2·0	8	7·0– 9·0	7	6·0– 7·0	21	8·0– 9·0	29
12·0–13·0	8	2·0–2·5	14	9·0–11·0	14	7·0– 8·0	8	9·0–10·0	21
13·0–14·0	6	2·5–3·0	8	11·0–13·0	3	8·0– 9·0	5	10·0–11·0	2
14·0–15·0	3	3·0–3·5	1	13·0–15·0	3	9·0–10·0	1		

19. Greatest width of flipper		20. Length of severed head from condyle to tip		25. Height of head	
Range of values (% of total length)	No. of measurements	Range of values (% of total length)	No. of measurements	Range of values (% of total length)	No. of measurements
3·5–4·0	1	31·0–33·0	7	13·0–14·0	1
4·0–4·5	19	33·0–35·0	13	14·0–15·0	4
4·5–5·0	25	35·0–37·0	14	15·0–16·0	9
5·0–5·5	6	37·0–39·0	9	16·0–17·0	1
		39·0–41·0	3	17·0–18·0	2
				18·0–19·0	1

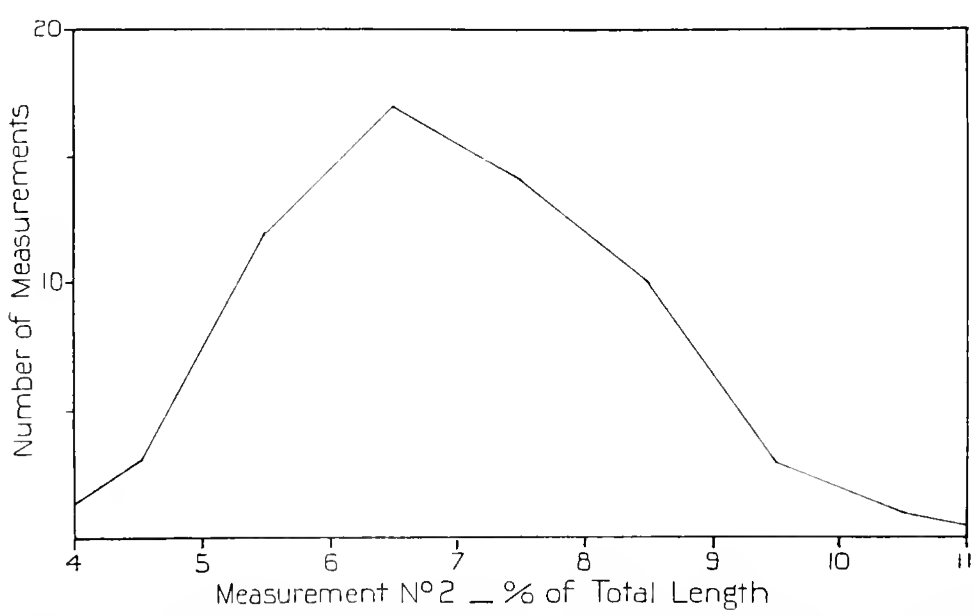

Fig. 15. Sperm whale. Variation of measurement No. 2. Projection of snout beyond tip of lower jaw.

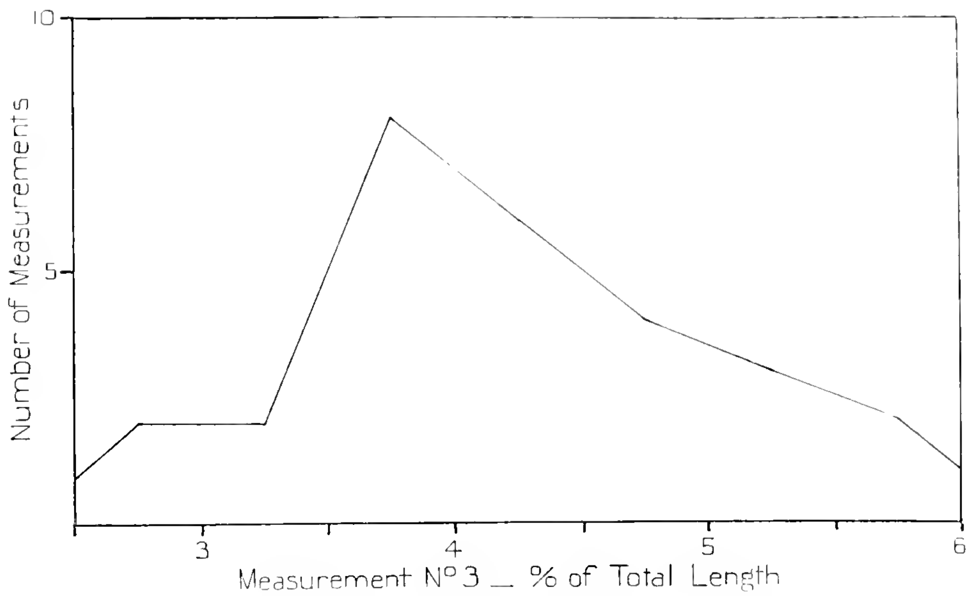

Fig. 16. Sperm whale. Variation of measurement No. 3. Tip of snout to blow-hole.

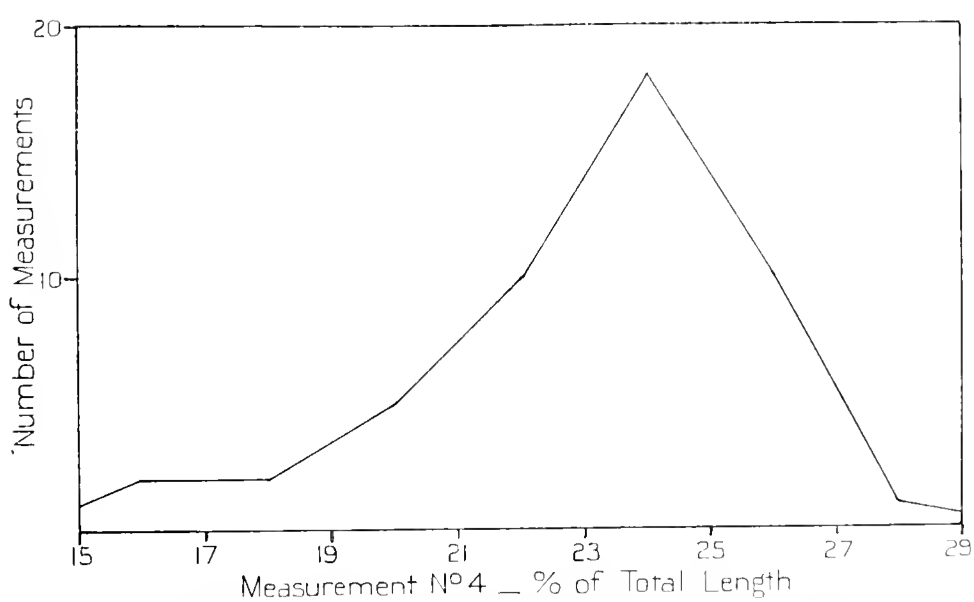

Fig. 17. Sperm whale. Variation of measurement No. 4. Tip of snout to angle of gape.

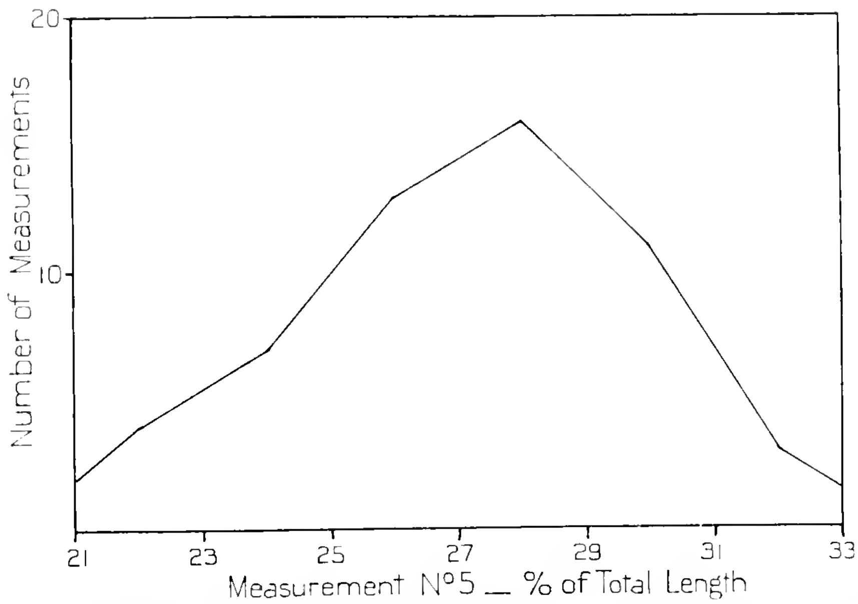

Fig. 18. Sperm whale. Variation of measurement No. 5. Tip of snout to centre of eye.

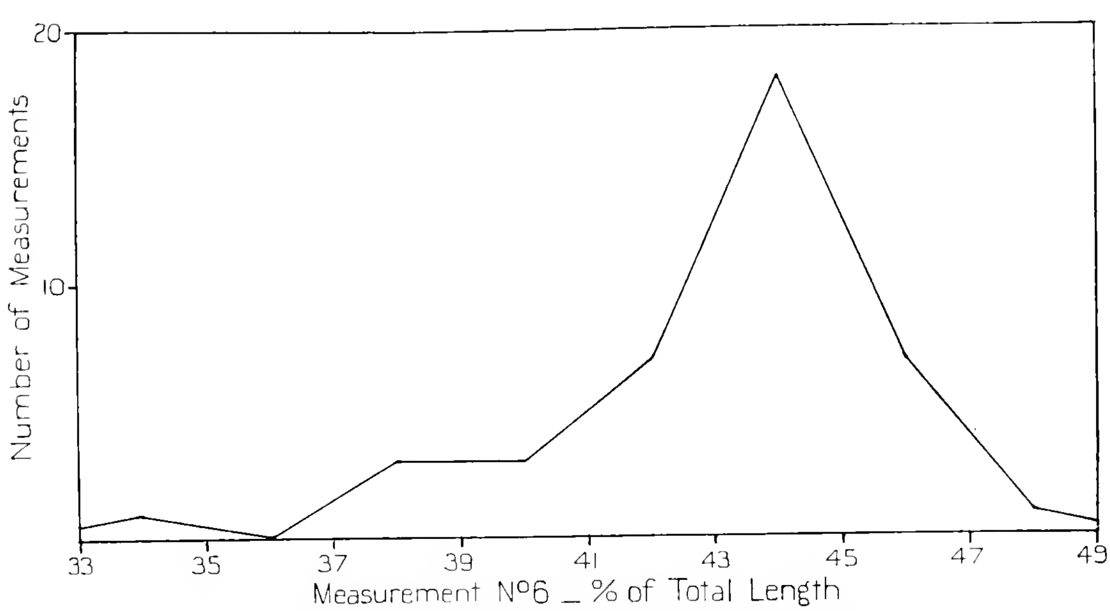

Fig. 19. Sperm whale. Variation of measurement No. 6. Tip of snout to tip of flipper.

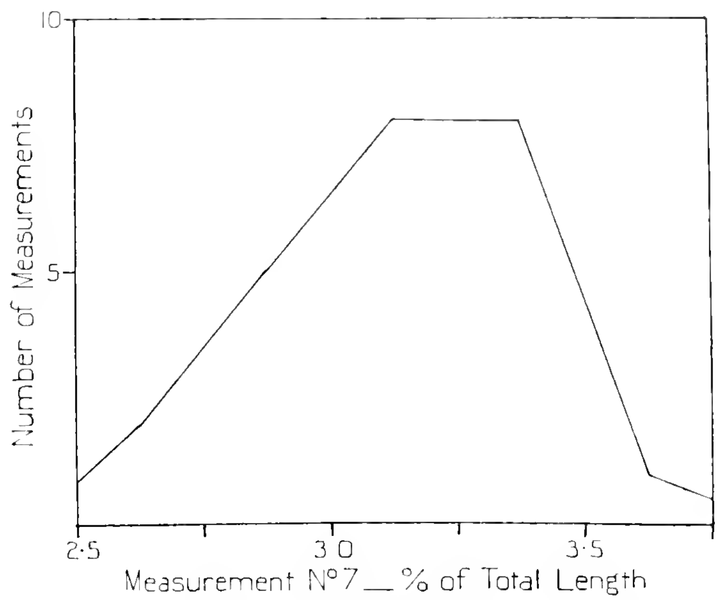

Fig. 20. Sperm whale. Variation of measurement No. 7. Centre of eye to centre of ear.

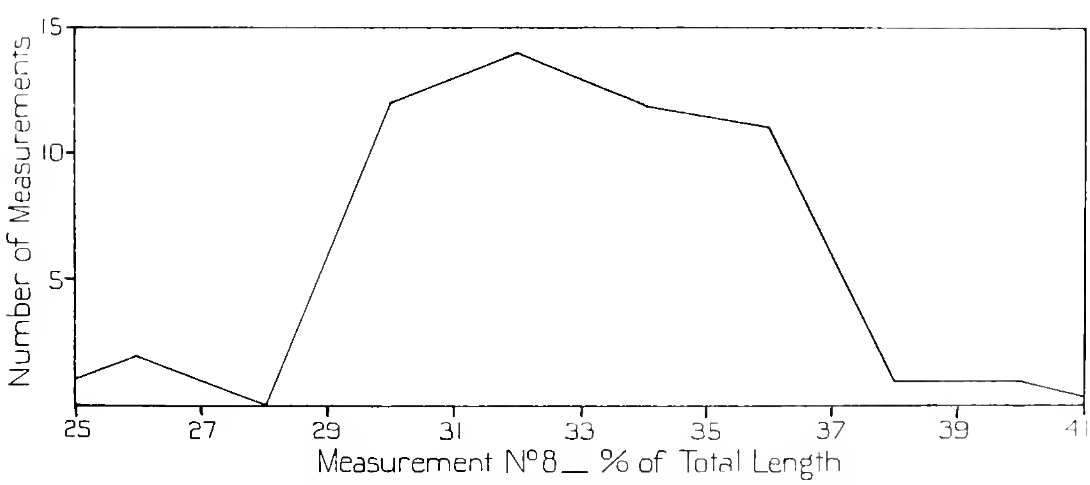

Fig. 21. Sperm whale. Variation of measurement No. 8. Notch of flukes to posterior emargination of dorsal fin.

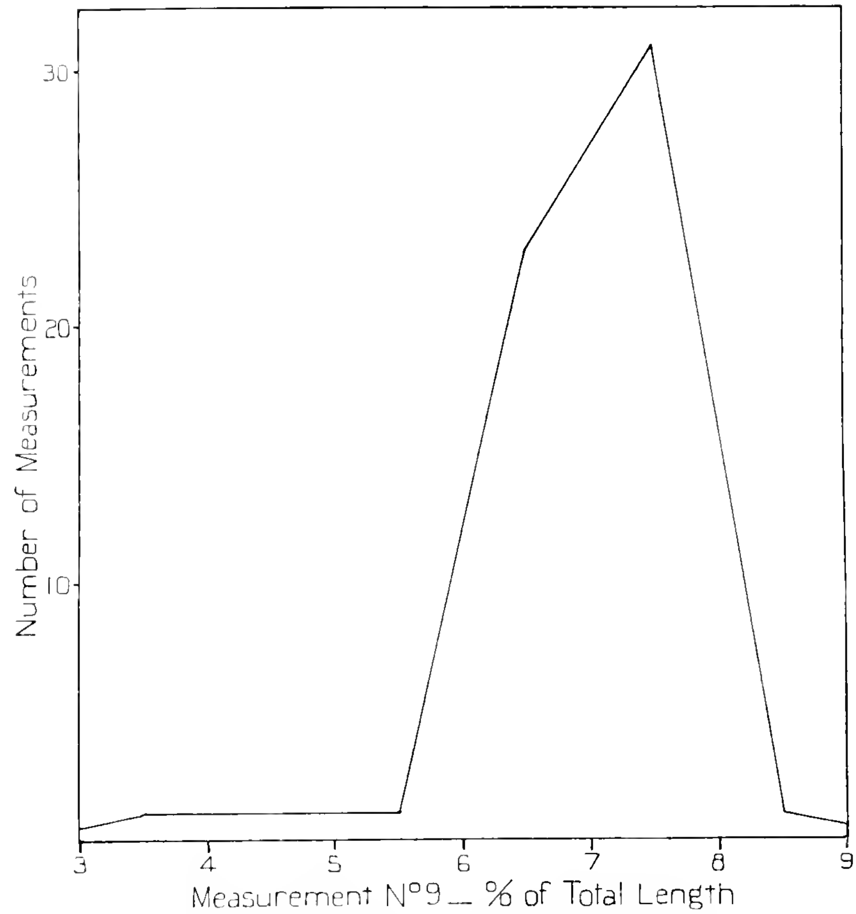

Fig. 22. Sperm whale. Variation of measurement No. 9. Width of flukes at insertion.

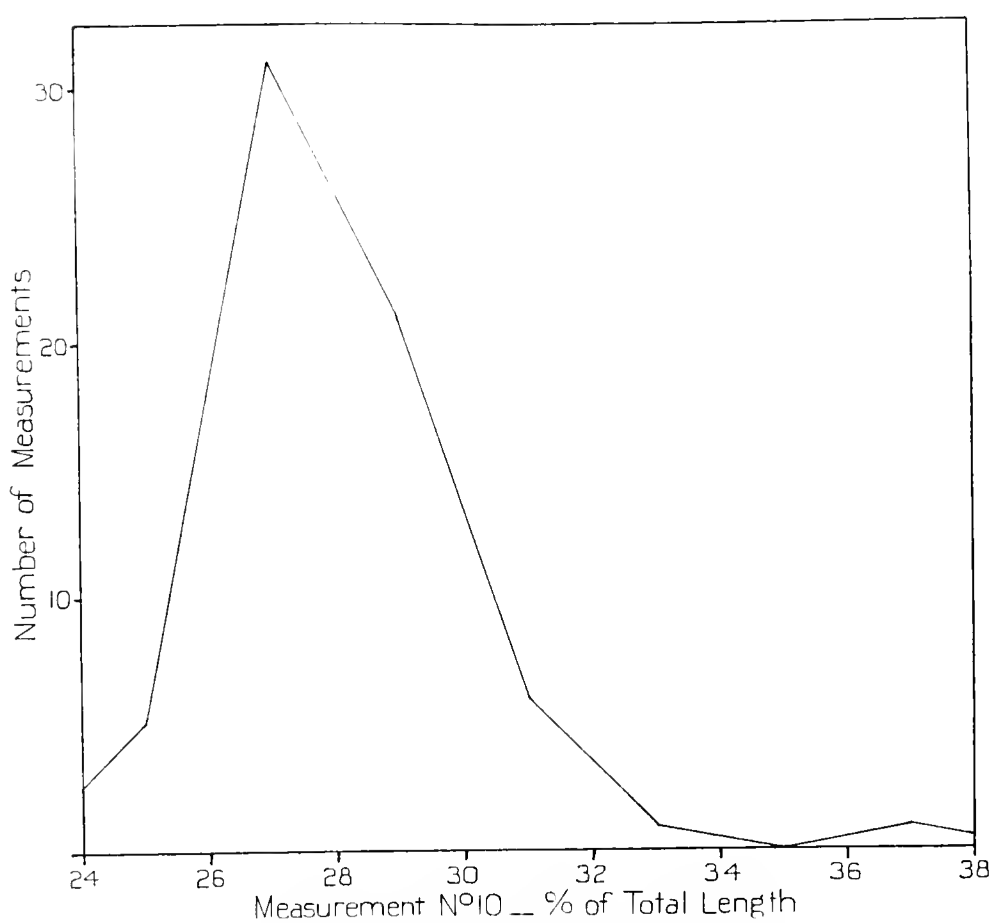

Fig. 23. Sperm whale. Variation of measurement No. 10. Notch of flukes to centre of anus.

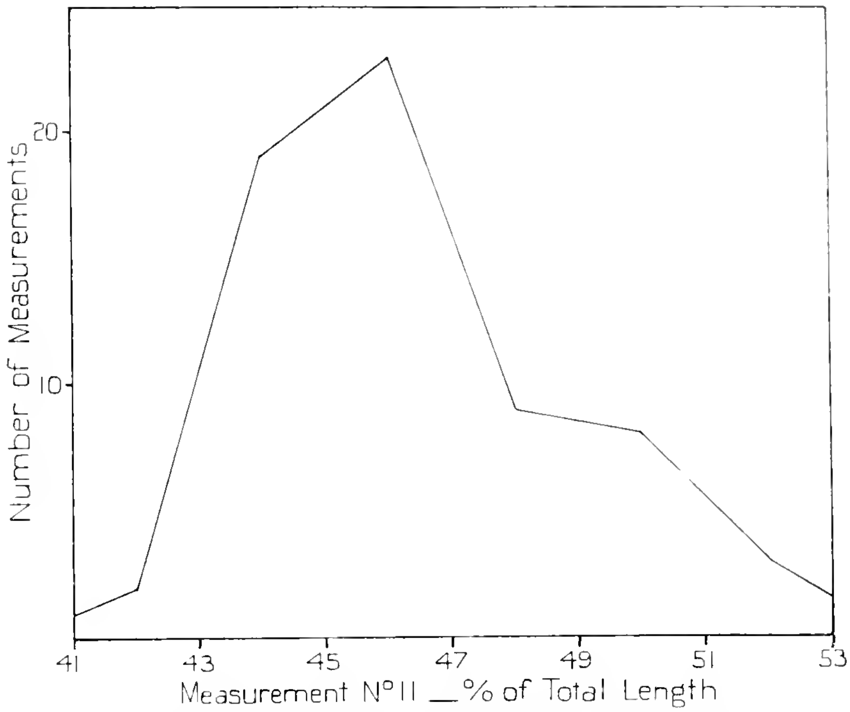

Fig. 24. Sperm whale. Variation of measurement No. 11. Notch of flukes to umbilicus.

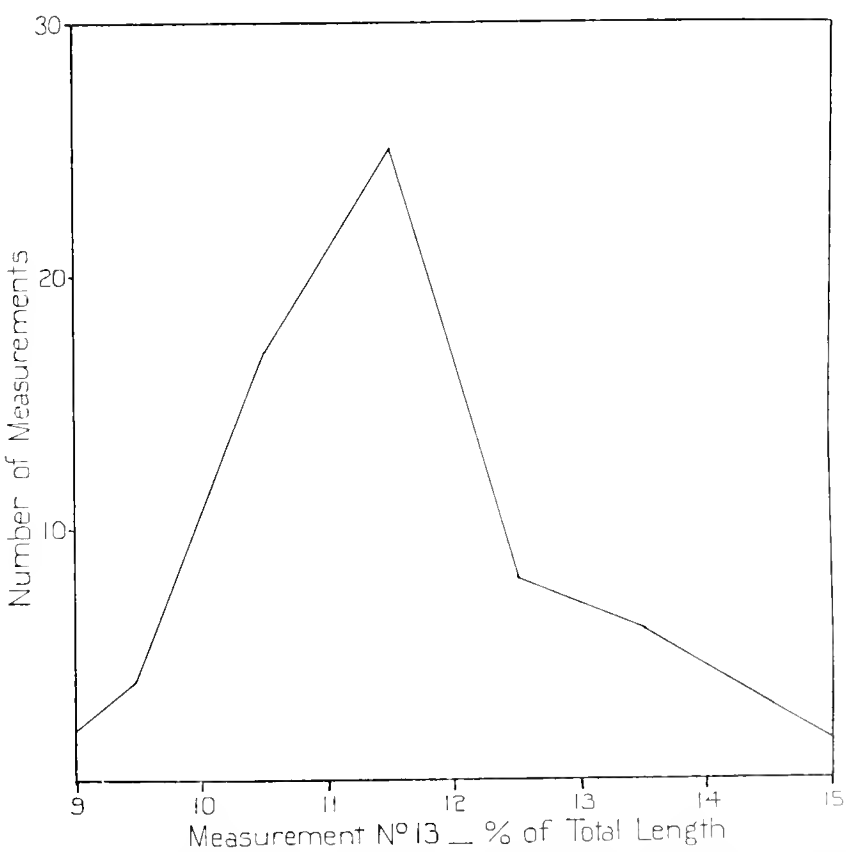

Fig. 25. Sperm whale. Variation of measurement No. 13. Centre of anus to centre of reproductive aperture.

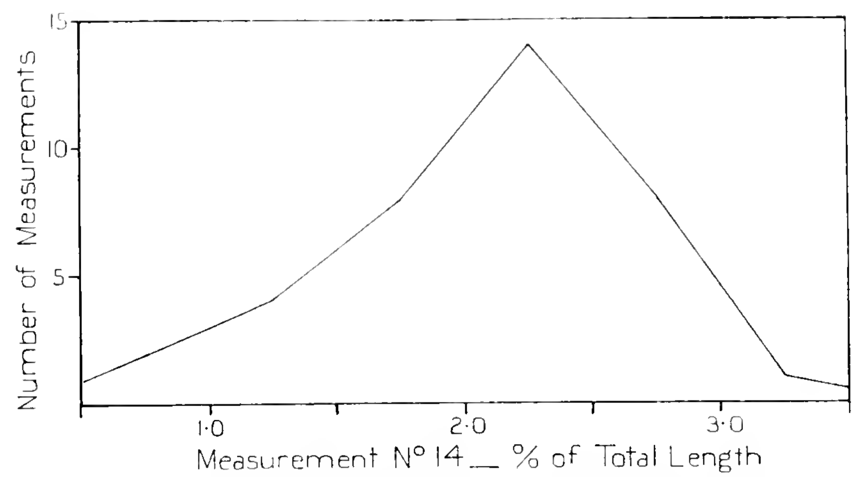

Fig. 26. Sperm whale. Variation of measurement No. 14. Vertical height of dorsal fin.

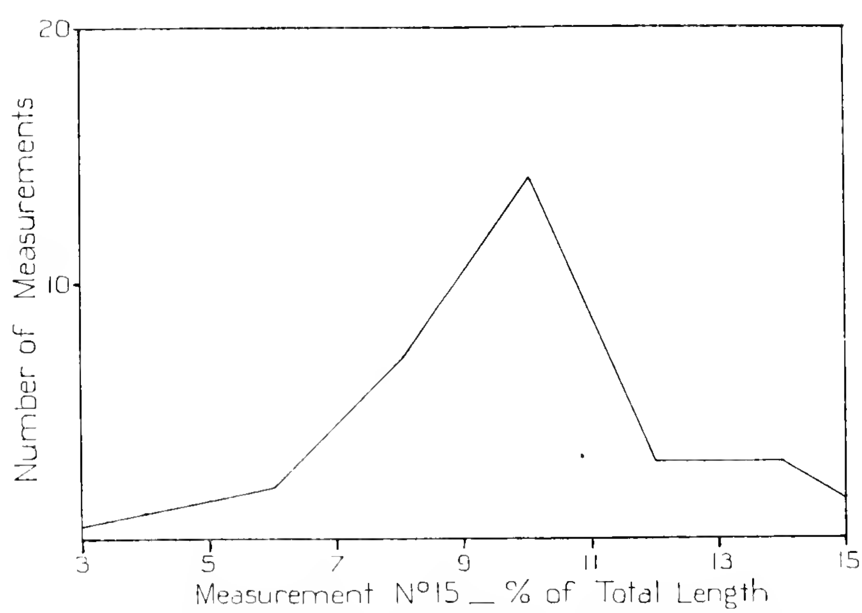

Fig. 27. Sperm whale. Variation of measurement No. 15. Length of base of dorsal fin.

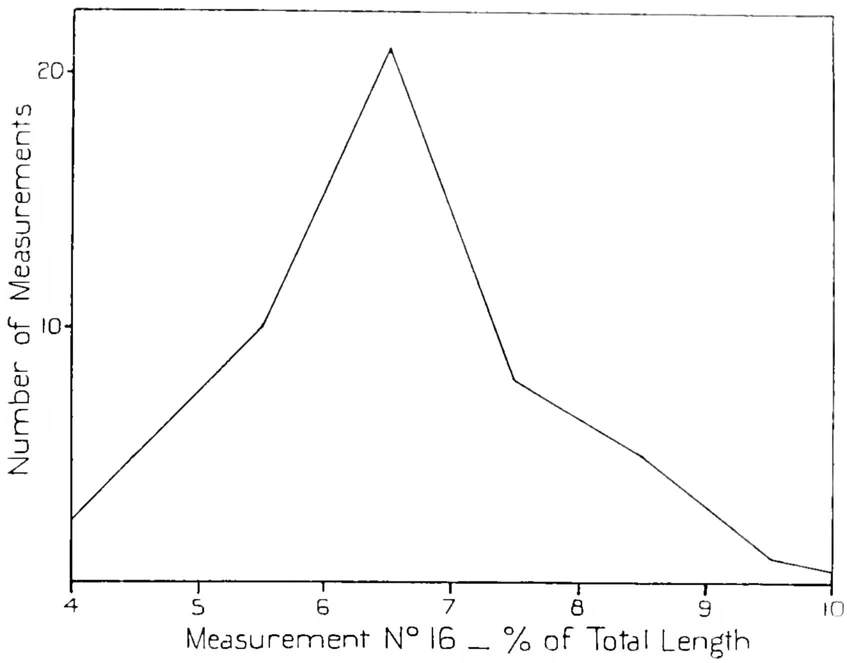

Fig. 28. Sperm whale. Variation of measurement No. 16. Axilla to tip of flipper.

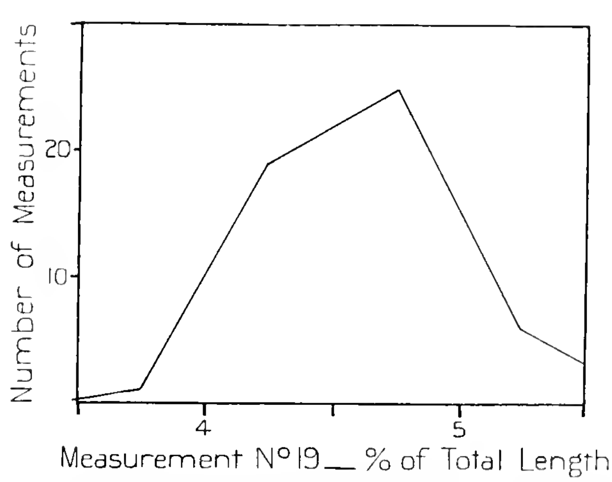

Fig. 29. Sperm whale. Variation of measurement No. 19. Greatest width of flipper.

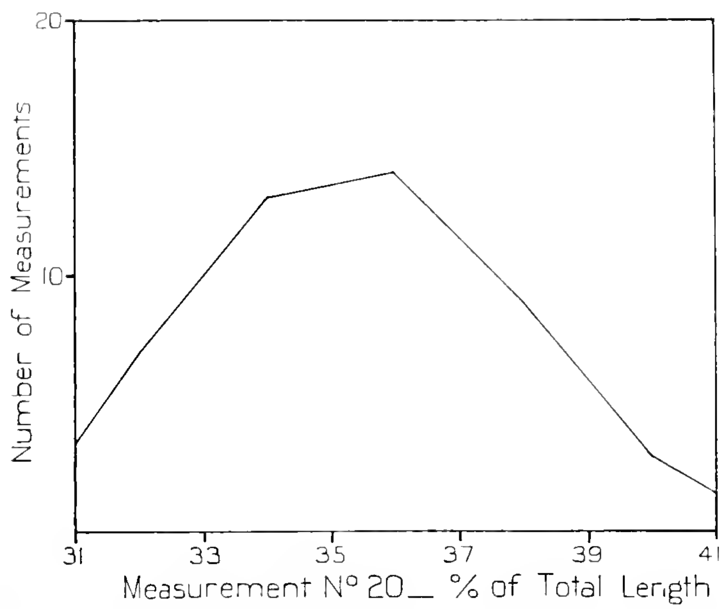

Fig. 30. Sperm whale. Variation of measurement No. 20. Length of severed head from condyle to tip.

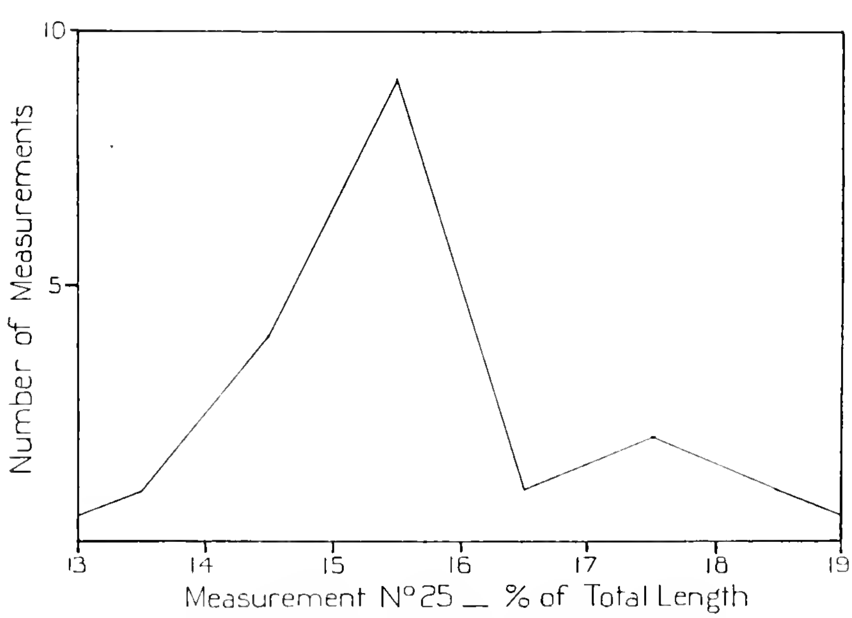

Fig. 31. Sperm whale. Variation of measurement No. 25. Height of head.

surface of them. In 2·8 per cent light flecks were also present on the sides of the dorsal hump. On the ventral surface of the tail a light grey or white post-anal marking occurred in 7 per cent (Plate III, fig. 3).

The lower jaw was frequently white or very light in colour; in some cases dark pigment was present in the median line but failed to reach the alveolar margins, while in others the whole jaw from the gape was unpigmented (Plate III, fig. 3). A wholly or partly white jaw occurred in 17 per cent, while in a further 20 per cent the upper lips and alveolar margins of the lower jaw were sufficiently unpigmented to appear white when the mouth was closed (Plate VI, figs. 1–3; Plate VII, fig. 2).

A white marking occurred on the front surface of the head in 25·6 per cent of Sperm whales. This marking took the form of a series of white and dark flecks and streaks arranged in a spiral fashion converging on a central point in the light area (Plate V). This head whorl appears to be the marking referred to by Beale (1839): "'old bulls', as the fully grown males are called by whalers, have generally a portion of grey on the nose immediately above the fore part of the upper jaw, and they are then said to be 'grey headed'." The marking is not confined to old bulls, however, as it was present in two small males, 13·6 and 13·9 m. long, and in two females, 10·1 and 10·6 m. long, at Durban, as well as in larger bulls at Durban and South Georgia.

In the foetus pigmentation starts before a length of 0·5 m. is reached. At this stage the colour is pink and the unpigmented areas are paler. They occur on the sides and under surface of the head and as pale lines extending from the dorsal hump to the notch of the flukes and from the genital groove to the anus. At 1·5 m. in length the dorsal pigmentation has become brown, and the ventral surface, sides of head and lower jaw are creamy yellow. Light areas occur on the tail behind the anus and on the under surface of the flukes. At 2·5 m. in length the pigment has become slate grey but has not extended much in area, while at 3·1 m. the dorsal coloration of each side joins ventrally between the anus and the flukes, the rest of the ventral surface still being white or light grey.

Pigmentation thus starts dorsally and extends down the sides to meet ventrally, the sides of the head, the lower jaw and the under surface of the flukes, being late in receiving their pigment. The white umbilical splash, the umbilical whorl, the light coloration at the genital groove, the white lips and lower jaw frequently occurring in the adult are therefore probably congenital, and due to irregularities in the extension of the pigmented areas and not to age. In this connexion it is of interest to note that in the calf Sperm whale 4·04 m. in length, probably recently born, described from Bermuda by Wheeler (1933), there was a large white umbilical splash, and the fleckings of the umbilical whorl extended some way up the flanks and round the genital aperture to coalesce behind it. The area covered by the umbilical whorl in this calf appears to be larger in proportion than in the adult and points to the possibility of further extension of dark pigment after birth.

On the other hand, the whorl on the front surface of the head was not noted in any of the foetuses examined, and it may therefore possibly be developed later in life, although it cannot be taken as a sign of old age as suggested by Beale (1839).

The pigmentation of the foetus, darker above and lighter below, and the persistence of light ventral patches in some adults points to the descent of the Sperm whale from ancestors of the more usual dolphin pattern of coloration.

BODY SURFACE, PALATE AND TONGUE

The body surface of the adult Sperm whale does not present the smooth appearance found in the Fin whales. On the back, and on the flanks between the flippers and the tail flukes, a corrugated appearance is presented which may be more or less developed (Plate VI, fig. 3). The corrugations are formed by a number of shallow ridges, some 15 cm. apart, running fore and aft, and when well developed produce a very irregular surface to the body. On the ventral surface the corrugations are frequently strongly developed as three or four ridges which have their greatest height below the insertion of the flippers and extend from a short distance posterior to the jaw to the region of the umbilicus (Plate VII, fig. 1; Plate IX, fig. 1). The ridges are irregular in shape and may give off branches and anastomose. The corrugations are present also on the outer surfaces of the flippers and produce an appearance as of the bones of the digits causing projections on the surface, though dissection shows that the ridges do not necessarily occur over the bones.

The dorsal fin is small and hump-like, so that it is difficult to determine its anterior and posterior borders, while between it and the tail flukes a number of lesser humps and corrugations are present, the ridge of the tail thus showing an irregular outline in profile (Plate VI, fig. 3). The lesser humps are usually four or five in number and 15–20 cm. in height. On the ventral surface just behind the anus a rather larger hump is of constant occurrence (Plate VI, fig. 2; Plate IX, fig. 2).

Below the angle of the gape a groove is present on each side of the lower jaw, running a short way on to the throat (Plate X, fig. 1). These throat grooves are not very prominent and may be supplemented by three or four smaller grooves on each side, while a median groove as large or larger than the paired throat grooves may be present between, and a little posterior to, the paired grooves. The grooves are represented in the foetus of 3·0 m. in length by twelve to fifteen shallow irregular grooves on the throat (Plate IX, fig. 1). In addition a pair of transverse grooves may be present running for about 1 m. outwards at the posterior termination of the longitudinal grooves. There are nine records, eight positive and one negative, of the transverse throat grooves in the observations.

The palate and upper surface of the tongue of the Sperm whale are very light grey, almost white (Plate VIII, fig. 2). The under surface of the tongue is usually pink, but occasionally a shade of grey slightly darker than the upper surface. In four whales small patches of dark pigment were observed on the palate.

TEETH

The lower jaw of the Sperm whale carries from twenty to thirty teeth on each side, the number on each side not necessarily being equal (Plate VIII, fig. 2; Plate IX, fig. 3; Plate X, fig. 1). When the mouth is closed the tips of the teeth fit into sockets in the upper jaw near the outer margin of the palate (Plate VII, fig. 3). In about 50 per cent of whales examined rudimentary teeth were also present in the upper jaw, from one to seven a side being present, though in one instance there were eleven on one side. They are small curved teeth either completely embedded, or with the tips only cutting the gum, and are usually placed internally to the sockets which accommodate the tips of the lower teeth (Plate VII, fig. 3). Occasionally they occur in the sides of the sockets, in which position they are usually much worn down by contact with the lower teeth. No significant difference in the number of lower or upper teeth has been found between the Sperm whales from South Georgia and South Africa, nor is there any sexual difference in the number of lower teeth. It appears however that in the females the upper teeth are not developed so frequently as in the males, and that when they are present they are fewer in number. No correlation has been found between the number of teeth present and the length of the whale. Table VII shows the occurrence of teeth in the whales examined.

Table VII. *Sperm whale. Occurrence of teeth in upper and lower jaws*

No. of teeth	Right side: No. of whales: Males S. Georgia	Males S. Africa	Females S. Africa	Left side: No. of whales: Males S. Georgia	Males S. Africa	Females S. Africa
	Upper jaw: rudimentary teeth					
0	20	11	6	14	11	8
1	2	—	2	4	1	1
2	—	3	—	6	2	—
3	4	2	—	6	1	—
4	2	—	—	1	—	—
5	3	1	—	1	1	—
6	3	1	—	—	1	—
7	1	1	—	2	1	—
11	—	—	—	1	—	—
	35	19	8	35	18	9
	Lower jaw: functional teeth					
14	—	—	—	—	—	1
18	—	2	—	—	—	—
19	—	—	—	—	1	—
20	—	—	—	3	2	1
21	6	3	—	3	4	—
22	10	6	4	7	4	2
23	2	3	—	5	1	3
24	7	1	—	4	3	—
25	7	—	1	6	—	1
26	2	2	—	5	3	—
27	1	—	1	—	—	—
	35	17	6	33	18	8

At birth the teeth are not erupted, nor were they present in the young sucking calf described by Wheeler (1933). According to Bennett (1836), who states that, "when the young cachalot has attained a length of 34 feet, its teeth are perfectly formed, though not visible until it exceeds 28 feet", the teeth are erupted between the lengths of 8·6 and 10·4 m. Even allowing for differences in the method of measuring total length, these lengths appear to be excessive. The smallest Sperm whale of the present series had erupted teeth. It was a male 8·8 m. in length. The smallest female, though only 9·5 m. long, had a full set of teeth and was pregnant and therefore adult or at least sexually mature. On the other hand, in an immature male 10·4 m. in length, though the teeth were erupted, they were only 2 cm. in height. It would therefore appear that the teeth erupt slowly. On three occasions, all in male South African whales, teeth with secondary cusps which gave the appearance of double teeth were observed in the lower jaw.

The lips of the upper jaw are frequently notched or abraded by the teeth through lateral movement of the lower jaw.

In none of the body proportions or other characters examined above does there appear to be any difference between the Sperm whales of the northern and southern hemispheres.

SPERMACETI

Nowadays the spermaceti is not usually preserved separately from the oil at the whaling stations. In the old pelagic Sperm whaling industry the spermaceti was dipped out of the head with buckets and casked by itself. The present procedure is to boil the spermaceti with the head and part of the meat. Plate VIII, fig. 1 is a photograph of the spermaceti being run from the head into a boiler on a floating factory. The head lies to the left, and the open top of the boiler can be seen in the lower right-hand corner. The man in the centre has just cut off the anterior part of the head, allowing the contained spermaceti to gush out into the boiler.

FOOD

The stomachs of nearly all Sperm whales examined contained the remains of cephalopods, only eleven, out of the seventy-four from which data were recorded, being empty. Table VIII summarizes the information collected. The Sperm whales, as was to be expected, were found to be feeding both at South Georgia and off the African coast, thus differing from the balaenopterid whales which feed little off South Africa owing to the scarcity of euphausians. The stomachs examined at South Georgia appear to contain cephalopod beaks much more frequently than those from South Africa: no satisfactory explanation has been found for this, nor for the fact that some stomachs contained only a few, and others several hundreds of beaks. The size of the cephalopods usually eaten does not appear to be very large, the general run averaging probably not more than about 1 m. in body length. Very large cephalopods were represented only by beaks in the stomachs and scars on the skin; no soft parts were found. Nearly all male Sperm whales carry scars caused by the suckers and claws of large squids, scars caused by suckers up to 10 cm. in diameter being common. The claw marks take the form of scratches 2–3 m. in length and appear to be of more frequent occurrence than sucker marks (Plate VIII, fig. 3; Plate X, fig. 2). In female Sperm whales it is uncommon to find scars caused by large cephalopods. It thus appears that the females, being much smaller than the males, usually feed on small cephalopods and do not attack the large ones as do the males.

In addition to cephalopods, seven stomachs contained the remains of fishes, some of considerable size. Beale (1839) states that fishes are only eaten in inshore waters: whether this is correct or not they evidently form only a small part of the diet. The same author states that the Sperm whale when feeding remains still and opens its mouth, letting the lower jaw hang down, and swallows the cephalopods which are attracted by the white teeth and light-coloured lining of the mouth. The great activity and agility of cephalopods leads one to think that there may be some truth in this theory, which is supported by the fact that in the Mediterranean and elsewhere cephalopods are caught on unbaited hooks painted white. Although seldom seen, or taken in zoological collecting gear, cephalopods of many species must be very abundant in the upper layers of the sea, as is shown by the stomach contents of Sperm whales and also by those of seals and oceanic birds (Matthews, 1929).

BLUBBER

Data on the blubber are available from seventy-three Sperm whales, mostly males. The blubber thickness was measured on the flank and varied between 8·5 and 15·5 cm.: the dorsal blubber is thicker than this and was measured in a few whales, the thickest recorded being 33 cm. Figs. 32 and 33 show the relation between blubber thickness and

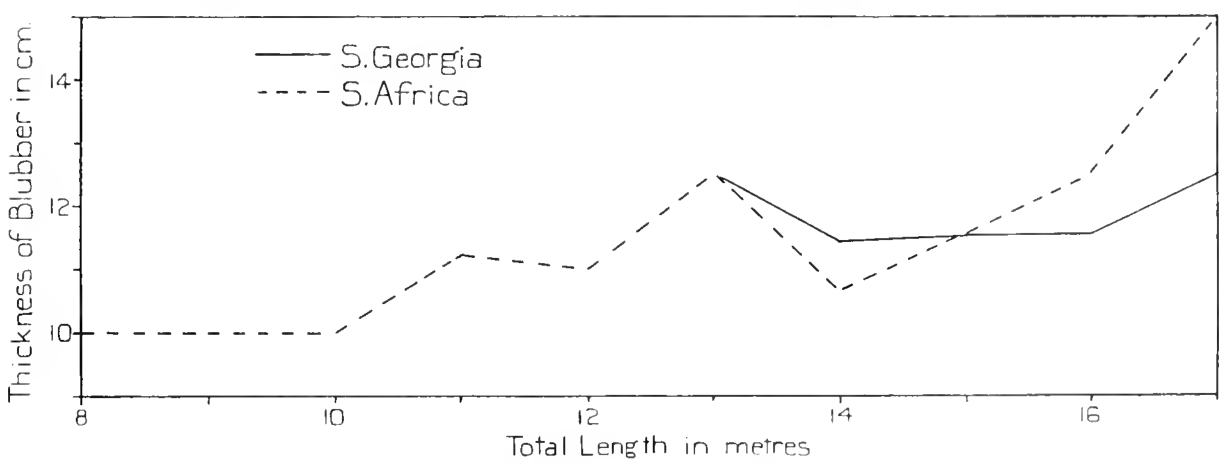

Fig. 32. Sperm whale. Males. Thickness of blubber and total length.

length of whale for males and females. The catches of males at South Georgia are separated from those at South Africa in Fig. 32: Fig. 33 shows females from South Africa only, because they are not found at South Georgia. These figures show that blubber thickness appears to increase fairly constantly with length for adults of both sexes, but that in immature whales, of which males only were examined, the blubber is proportionately thicker. This is shown with greater clearness in Fig. 34, where blubber

Table VIII. *Sperm whale. Stomach contents, and cephalopod scars on skin*

Whale no.	Date	Sex	Length m.	Stomach empty	Cephalopod beaks	Cephalopod soft parts	Other food	Cephalopod scars on skin
						SOUTH AFRICA. SALDANHA BAY		
758	17. vi. 26	♂	13·70	+	—	—	—	Many sucker marks 2 cm. in diameter on upper jaw: some on lower
932	10. viii. 26		10·00	–	Present	Remains present	—	No record
						SOUTH AFRICA. DURBAN		
D 20	30. viii. 26	♂	15·80	–	Present	Remains present	Elasmobranch vertebrae	No record
D 22	16. vi. 30	♂	15·60	+	—	—	—	No marks round mouth. Some long healed scratches on head
D 23	16. vi. 30	♀	10·90	–	Few: very small	—	—	Sucker scars on chin 2 cm. in diameter. Many healed scratches
D 24	17. vi. 30	♂	9·92	–	Few: small	—	—	No record
D 25	17. vi. 30	♀	10·40	–	Few: small	—	—	No sucker marks. A few healed scratches
D 26	17. vi. 30	♂	17·80	+	—	—	—	No sucker marks. Head covered with very long white healed scratches
D 36	22. vi. 30	♂	14·00	–	—	Cephalopod: body, 50 cm.; long arm, 51 cm.; remains of several smaller	—	Sucker marks on head: 2 cm. diameter
D 37	22. vi. 30	♂	13·65	–	Few: small	Few small remains	Few teleost centra	No cephalopod marks
D 38	22. vi. 30	♂	15·00	–	—	Remains of ten to twelve: bodies, 7 to 40 cm.; long arms up to 50 cm.	—	A few very old sucker scars, 2·5 to 3 cm. in diameter
D 50	28. vi. 30	♂	15·82	–	Few	Very few remains: small. A few eye-lenses	—	No cephalopod marks
D 51	28. vi. 30	♂	15·40	–	—	Remains of six to eight, 20–24 cm. long, and one much longer	—	No sucker marks: many white healed scratches on head
D 80	15. vii. 30	♂	12·10	–	—	Remains of two or three: body 120 cm.; short arm 33 cm., diam. at base 8 cm.; large cup-shaped pedunculate suckers	—	No record
D 81	15. vii. 30	♂	11·85	–	—	Remains of four or five: medium size	Part of teleost vertebral column	No sucker marks. Many white healed scratches on head
D 108	29. vii. 30	♂	13·40	–	—	Remains of twenty-five. Largest: body 37 cm.; long arm 68 cm.	—	A few sucker scars, 2 cm. diameter, on lower jaw. Many scratches on head
D 109	29. vii. 30	♂	13·60	–	—	Remains of fifteen: body 47 cm.; long arm 120 cm.; width across fins 31 cm.	—	A few sucker scars, 3 to 4 cm. diameter. Many scratches
D 110	29. vii. 30	♂	13·60	–	No record	No record	—	No sucker marks. Many scratches on head
D 114	1. viii. 30	♂	12·30	–	—	Few remains	—	No sucker marks. A few scratches on head
D 117	2. viii. 30	♂	15·90	–	—	Remains of six	—	No sucker marks. A few large healed scratches
D 120	3. viii. 30	♂	14·35	–	—	Remains of about twelve: fair sized	—	No sucker marks: few scratches
D 121	3. viii. 30	♂	16·75	–	—	Remains of four or five	—	No sucker marks: few scratches
D 150	26. viii. 30	♂	11·80	–	—	Remains of about twenty: fair sized	—	No sucker marks: a few scratches on head
D 151	26. viii. 30	♀	9·70	–	Many	Remains of seven: large. Also many eye lenses	—	No record
D 152	26. viii. 30	♀	10·10	–	—	Remains of fifteen	—	No sucker marks or scratches
D 153	26. viii. 30		9·70	+	—	—	—	No record
D 155	26. viii. 30	♂	10·80	–	—	Remains of one large and five or six small	—	No sucker marks; a few scratches on head
D 156	26. viii. 30		11·30	–	—	Remains of fifteen or sixteen	—	No sucker marks or scratches
D 157	26. viii. 30		9·80	+	—	—	—	No sucker marks or scratches
D 158	26. viii. 30		9·95	–	Present	Eye lenses present	—	No sucker marks or scratches
D 159	26. viii. 30	♂	8·80	–	—	Remains of about twelve	—	No record
D 176	11. ix. 30		9·50	+	—	—	—	No marks or scratches
D 177	11. ix. 30		10·90	+	—	—	—	No record
D 178	11. ix. 30	♀	10·20	+	—	—	—	No scars
D 179	11. ix. 30	♀	10·60	+	—	—	—	No scars
D 180	11. ix. 30	♀	9·90	–	—	Remains of two: arms of one, 40 cm.; head diameter 10 cm.; suckers spaced far apart	—	No record
						SOUTH GEORGIA		
1606	29. iii. 27	♂	14·90	–	—	Remains of three large, several small. A few buccal masses	Three large fishes: some fish bones	Sucker marks 2 to 7 cm. in diameter on head above jaw. Several long scratches running towards mouth
1649	12. iv. 27	♂	14·35		No record	No record	—	Sucker marks, three 2 cm. in diameter on head, and a series of scratches

1728	11. iii. 28	♂	15·40	–	Few	—	—	Several sucker marks and many scratches under head
1729	11. iii. 28	♂	15·57	–	Numerous	Parts of several	—	Several sucker marks and many scratches on head
1730	11. iii. 28	♂	15·32	–	Many	Full of remains: some 1 to 2 m. long, many smaller	—	Many scratches on snout and head
1731	11. iii. 28	♂	15·70	–	Few	—	—	No record
1741	20. iii. 28	♂	16·57	–	Numerous	—	Small amount unidentified remains	Numerous scratches on head and snout
H 3	26. iii. 28	♂	16·15	–	Many	—	—	No record
H 4	26. iii. 28	♂	16·26	–	—	Full of well-preserved remains	—	Sucker marks present
H 5	27. iii. 28	♂	16·20	–	—	Fairly full of small cephalopods	—	Many deep sucker marks and scratches on jaws and round mouth
1752	27. iii. 28	♂	14·38	–	Few	—	—	No record
1753	28. iii. 28	♂	16·53	–	Few	—	—	No record
1756	28. iii. 28	♂	15·45	–	Moderate number	—	Fish bones present	No record
1758	2. iv. 28	♂	15·82	–	Few	—	—	A few sucker marks and scratches chiefly on head
1759	2. iv. 28	♂	15·17	–	Present	—	—	A few sucker marks and scratches chiefly on head
1760	2. iv. 28	♂	15·03	–	—	Remains present	—	A few sucker marks and scratches chiefly on head
1766	19. iv. 28	♂	14·92	–	Large number	Fair amount of remains	—	A few rows of sucker marks on head. A few large single ones up to 8 cm. diameter
1767	19. iv. 28	♂	15·03	–	Large number	Fair amount of remains	—	A few scars on snout
1768	19. iv. 28	♂	17·11	–	Numerous: all sizes	—	—	A few old sucker marks and scratches on snout
1769	19. iv. 28	♂	15·95	+	—	—	—	Sucker marks and scratches present: large on dorsal surface
1770	19. iv. 28	♂	17·13	–	Many	Some remains: one bright red inside mantle	—	No record
1771	21. iv. 28	♂	15·47	–	Several	Remains of one, large	—	No record
1829	20. x. 28	♂	17·47	–	Few up to 5 cm. in diameter	Remains of one small head. A few eye lenses	—	A few sucker marks on head and body. Scratches on end of snout
1830	22. x. 28	♂	17·08	–	Several	Remains of a few, small	—	No record
1879	5. xi. 28	♂	17·02	–	Large number	Several arms. Two squid "pens" 6 ft. and 4 ft. 6 in. long	—	A few sucker marks up to 6 cm. in diameter on back. Many sucker marks and scratches on head
2208	22. i. 29	♂	16·03	–	Few, mostly small	Some remains	—	A few sucker marks and scratches
2478	19. iii. 29	♂	14·14	–	Many	Some remains	—	Many scratches and a few sucker marks on head and snout
2479	19. iii. 29	♂	14·91	–	—	Remains of many	—	Many scratches and a few sucker marks on head and snout
2480	19. iii. 29	♂	14·52	–	Many	—	—	Scratches and sucker marks on head and snout
2931	8. i. 30	♂	13·64	+	—	—	—	No record
2994	15. i. 30	♂	17·50	–	Many: small and large	Remains of two or three: arms up to 80 cm. A few eye lenses	—	Sucker marks numerous
3011	21. i. 30	♂	15·60	–	Few: one large, twelve small	Many spermatophores	—	No record
3129	10. ii. 30	♂	16·57	–	Several	Remains of five or six: arms up to 50 cm.	—	Sucker marks, two series. Many scratches round jaws
3130	10. ii. 30	♂	16·53	–	Many: some large	—	—	Many scratches round jaws
3170	27. ii. 30	♂	15·15	–	Six to seven hundred, mostly small: one pair large	Remains of four or five: arms about 30 cm.	—	Sucker marks 1 cm. in diameter on upper jaw. A few scratches
3171	27. ii. 30	♂	15·35	–	About a hundred	Remains of eight or ten: arms 40–50 cm.	—	No record
3193	7. iii. 30	♂	15·00	–	A few, small	Remains of one, small: arms 20 cm.	—	No record
3255	31. iii. 30	♂	16·50	–	A few	—	—	No record
3256	31. iii. 30	♂	15·50	–	About forty	Remains of two, small	Vertebral column of a fish, about 2 ft. long	No record
3292	7. ix. 30	♂	16·00	–	Few: large	Remains present	—	Deep healed scratches, and sucker marks 1·5 cm. in diameter, round mouth
3613	30. i. 31	♂	15·95	–	—	A few remains	Remains of a large teleost skull and the first few vertebrae	No scars
3654	14. ii. 31	♂	15·06	–	—	Remains of two: mantle 35 cm.	—	No record

thickness expressed as a percentage of body length is plotted by months, immature males under 12 m. long being plotted separately from the mature ones over 12 m. long. Immature whales were only found at South Africa and are very noticeably fatter than adults. They thus resemble the immature balaenopterid whales, especially the Humpback and to a lesser degree the Sei, Fin and Blue whales. Both immature and adult whales at South Africa show a decline in fatness towards the end of the southern summer, and mature whales as well as immature ones are above the average fatness (indicated by the horizontal line in Fig. 34) at the beginning of the season. In male Sperm whales, at South Georgia, indications are shown of a rise in fatness until the middle of the season, followed by a drop towards the end.

The fatness of female Sperm whales is shown graphically by months in Fig. 35, which relates only to South African whales. The average fatness is greater than in males: pregnant whales tend to be fatter and lactating ones thinner than the average, and resting whales are intermediate. There is not, however, the marked fatness in pregnant whales and leanness in lactating ones that is found in the balaenopterid whales.

PARASITES

EXTERNAL

The commonest external parasite of the Sperm whale is the amphipod *Cyamus*. It was present in twenty-two out of the thirty-eight whales regarding which notes on the external parasites are available. It was usually present in greatest numbers in the umbilical and genital regions, and occurred scattered over the rest of the body in smaller numbers. The open pits in the blubber, referred to below, were also a favourite position for *Cyamus*.

Penella was only recorded once from this species, a male at Durban carrying two very small *Penella*, one on the flank and one on the head.

One large male Sperm whale at South Georgia was infested with *Coronula* of small size. The barnacles, up to 2 cm. in diameter, were scattered irregularly all over the body. Stalked barnacles of an undetermined species were found on the lower jaw of one male at South Georgia.

A pathological condition of the skin of the head was observed in two male whales at South Georgia and was noted as "? fungoid growth".

Diatom films were frequently present on the skin of male Sperm whales at South Georgia, but were not observed on the whales at South Africa. Of the twenty-three whales examined for diatom film, nineteen carried patches of greater or lesser extent. The film usually occurred as patches on the head, less frequently on the flanks, flukes and back. *Cocconeis ceticola* appeared to be the dominant species, but two species of *Navicula*, and *Nitzschia closterium* were also recorded. The presence of diatom film proves that the whales carrying it have been at least a month in the Antarctic Zone, as shown by Hart (1935).

Sperm whales, like the Whalebone whales, while in temperate and tropical waters are subject to attack by some unknown agent which removes semi-ovoid pieces of blubber

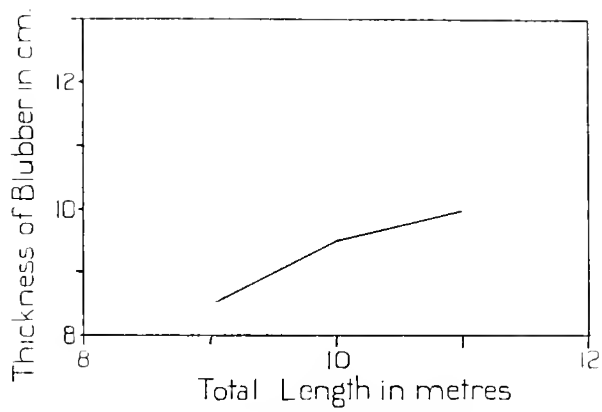

Fig. 33. Sperm whale. Females. Thickness of blubber and total length.

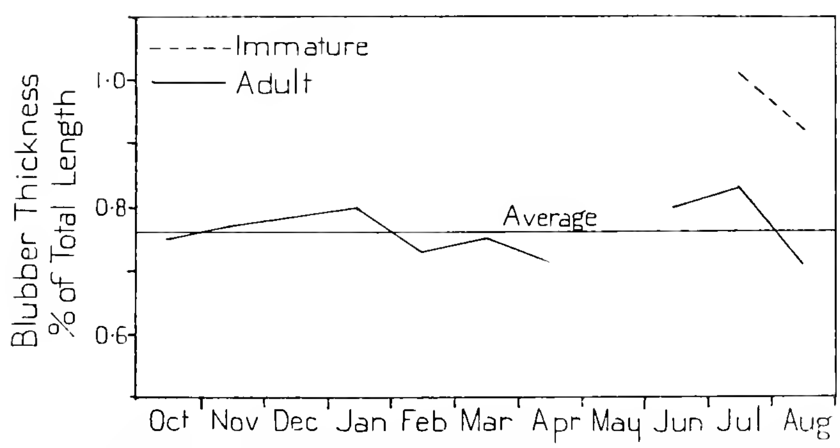

Fig. 34. Sperm whale. Males. Blubber thickness expressed as percentage of total length, by months.

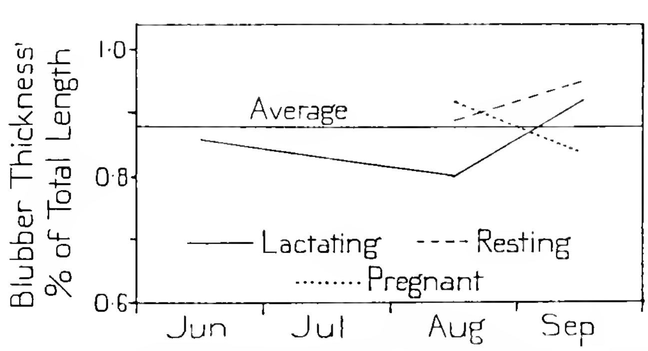

Fig. 35. Sperm whale. Females. Blubber thickness expressed as percentage of total length, by months.

from the surface of the body, leaving open pits which are later healed over, leaving light-coloured scars. All Sperm whales examined at African whaling stations had a greater or lesser number of these open pits in various stages of healing, from new clean ones to light-coloured depressed scars. All those examined at South Georgia bore the scars left after the healing of the pits, but never open pits. The scars were always numerous, but were, perhaps, not quite so plentiful as those found on the Rorquals. Several ages of scars were often recognizable, but owing to the confusion of the older and less distinct ones their presence gave little help in determining the ages of Sperm whales. When found on whales in far southern latitudes, they serve as little more than an indication of migration from warmer waters.

INTERNAL

Nematode worms occurred very commonly in the alimentary tract of Sperm whales both at South Georgia and South Africa. They were found in seventy-four whales out of seventy-eight in which the presence or absence of internal parasites was noted. They were most frequent and often very numerous in the stomach, but were also found occasionally in the intestine and in the oesophagus. Their presence in the latter organs may have been due to wandering from the stomach after the death of the whale. Nematodes from Sperm whales at Durban, Saldanha Bay and South Georgia have been identified as *Anisakis physeteris* and, in addition, a new species, *A. catodontis* (Baylis, 1929), was collected at Saldanha Bay. Specimens of nematodes were preserved, however, only on a few occasions. Only once have other kinds of intestinal worms been recorded: in a female at Saldanha Bay which contained a few "*Echinorhynchus* sp." (probably a *Bolbosoma* sp.).

The only other internal parasite recorded from the present series of Sperm whales is *Phyllobothrium physeteris*, which, in an encysted state, infests the blubber. There are fifty-four positive and only four negative records of its occurrence, and it was found both at South Georgia and South Africa. Infection was sometimes very heavy and the cysts were scattered throughout the blubber, no region being specially selected by the parasite (Plate X, fig. 3).

REPRODUCTION

THE MALE

External genitalia. The reproductive aperture lies at a distance of 11 per cent of the body length from the anus (Plate VI, fig. 2). The penis is large in proportion to the size of the whale when compared with that of the Rorquals, and is usually completely pigmented: less frequently, pigment is present only towards the distal end (Plate III, fig. 3).

Testis. The testis of the Sperm whale is similar in general appearance to that of the Rorquals, but is considerably smaller, the approximate volume obtained by multiplying together the length, breadth and depth in mature Sperm whales averaging 8460 c.c. When the volume of the testis is plotted against the length of the whale as in Fig. 36, a much closer correlation between volume and total length is seen than in the Whalebone whales, though there is very considerable variation for any given length. Few immature Sperm whales have been examined, but the graph shows an increase in size of testis after a length of about 12 m. is reached, which is the length at which sexual maturity is attained. No seasonal variation in size can be traced.

The histological appearance of the testis in this species is similar to that in the Whalebone whales, but the tubules in adult whales appear to be always in a greater state of activity than in those species. Only one specimen of inactive testis material is available for examination. This occurs in the testis of an adult whale (No. 1606, 14·9 m. long). Sections show that part of the testis is active and is separated by connective tissue trabeculae from another portion in which the tissue is completely inactive. In the active part the tubules are large, nearly empty, and there is little interstitial tissue. In the other part the tubules are full of cells and there is much interstitial tissue. The cells lining the

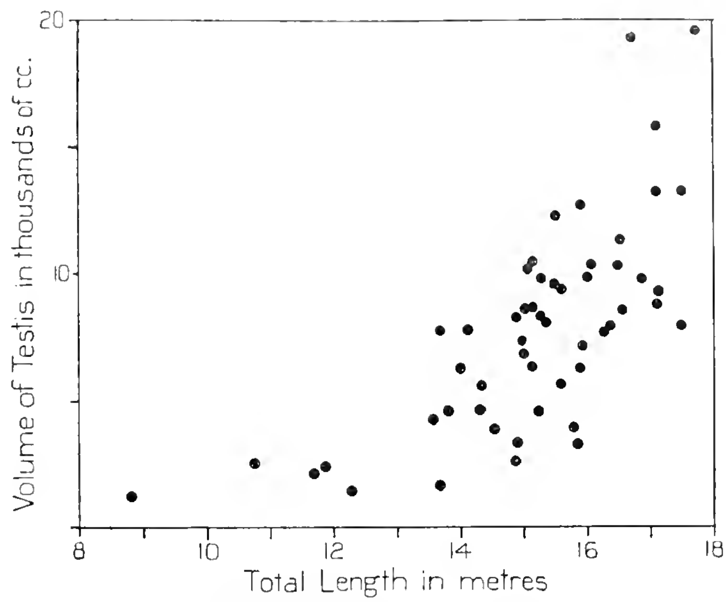

Fig. 36. Sperm whale. Males. Volume of testis plotted against total length.

tubules of the inactive part appear to be larger than those found in the Whalebone whales, but the large cells filling the tubules are similar (Plate XI, fig. 1). Spermatozoa appear to be much more plentiful in the testis of this species than in the Whalebone whales, there being nearly always a fair number to be seen in the tubules of the testis in adult whales (Plate XI, figs. 2 and 3).

The sexual cycle. Material and observations are available from a series of thirty-six Sperm whales. As described above, the histological details of the testis of the Sperm whale are very similar to those of the Whalebone whales. In examining sections of the testis in the present series the specimens have been classified as active, in which the spermatic tubules are full of cells in various stages of division and have no, or only small, clear spaces in their lumina; resting, in which the tubules are lined with a comparatively thin layer of cells and have very large spaces occupying nearly the whole of the lumen; and intermediate, in which there is some activity but the tubules are not packed full of dividing cells as in the active stage. Spermatozoa are to be found in varying numbers in all the stages, and not always in the greatest numbers in the most active stage, which is characterized more by the intensity of cell division than by the presence of quantities of fully developed spermatozoa. Spermatozoa are not present in striking numbers at any stage, but they appear to be present more frequently and in greater quantity than in the corresponding states found in the Whalebone whales. The results of the histological examination of the material of the present series of whales are here presented in detail according to the season of the year and the state of activity of the testis.

January. South Georgia

No. 2994. Length 17·50 m. 15. i. 30. Active, all tubules well filled with cells and without spaces, but not many spermatozoa present.

No. 3011. Length 15·60 m. 21. i. 30. Intermediate, tubules with very large central spaces, but nearly all with a fair number of spermatozoa.

February. South Georgia

No. 3654. Length 15·06 m. 14. ii. 31. Active, smears prepared from testis and epididymis both showed many spermatozoa.

No. 3129. Length 16·57 m. 10. ii. 30. Active, tubules fairly full of cells, but some with small central spaces. Spermatozoa plentiful.

No. 3170. Length 15·15 m. 27. ii. 30. Active, but less so than No. 3129. Tubules similar but spermatozoa scarce.

No. 3130. Length 16·53 m. 10. ii. 30. Intermediate, most tubules with fairly large spaces. Spermatozoa present in fair numbers.

No. 3171. Length 15·35 m. 27. ii. 30. Intermediate, very similar to No. 3130, but spermatozoa almost absent.

March. South Georgia

No. 1756. Length 15·45 m. 28. iii. 28. Active, tubules large and closely packed with cells, no spaces. Spermatozoa numerous.

No. 2479. Length 14·91 m. 19. iii. 29. Active, tubules as No. 1756. Spermatozoa abundant.

No. 2480. Length 14·52 m. 19. iii. 29. Active, tubules well filled, but many with spaces. Spermatozoa moderate in numbers.

No. 1752. Length 14·38 m. 27. iii. 28. Active, tubules well filled, but many with fairly large spaces. Spermatozoa numerous.

No. 2478. Length 14·14 m. 19. iii. 29. Intermediate, nearly all tubules with fairly large spaces. Spermatozoa not very plentiful.

No. 3193. Length 15·00 m. 7. iii. 30. Resting, tubules with large spaces. Spermatozoa very few.

No. 1606. Length 14·90 m. 29. iii. 27. Resting, tubules with very large spaces. Spermatozoa practically absent. Part of this testis, however, was composed of typically immature tissue.

April. South Georgia

No. 1759. Length 15·17 m. 2. iv. 28. Active, all the tubules tightly packed with cells. Spermatozoa fairly numerous.

No. 1769. Length 15·95 m. 19. iv. 28. Active, most of the tubules tightly packed, though some were completely empty. The empty tubules may be the result of an accident in manipulation, but the preparation shows no signs of bad fixation. Spermatozoa plentiful.

No. 1758. Length 15·82 m. 2. iv. 28. Active, all the tubules fairly well filled though most of them have small central spaces. Spermatozoa fairly plentiful.

No. 1771. Length 15·47 m. 21. iv. 28. Intermediate, tubules well lined, but nearly all with large spaces. Spermatozoa numerous.

No. 1770. Length 17·13 m. 19. iv. 28. Resting, nearly all the tubules with large spaces. Spermatozoa in moderate numbers.

June. Durban, South Africa

No. D 37. Length 13·65 m. 22. vi. 30. Smear. Active, fair numbers of spermatozoa in testis; few in epididymis.

No. D 26. Length 17·80 m. 17. vi. 30. Smear. Active, very few spermatozoa in testis but many in epididymis.

No. D 50. Length 15·82 m. 28. vi. 30. Smear. Active, very few spermatozoa in testis, but a fair number in epididymis with very abundant epithelial cells.

No. D 51. Length 15·40 m. 28. vi. 30. Smear. Intermediate, few spermatozoa in either testis or epididymis.

No. D 38. Length 15·00 m. 22. vi. 30. Smear. Intermediate, few spermatozoa in testis and very few in epididymis.

No. D 36. Length 14·00 m. 22. vi. 30. Smear. Resting, very few spermatozoa in testis and a few in epididymis.

No. D 22. Length 15·60 m. 16. vi. 30. Smear. Resting, very few spermatozoa in testis and none in epididymis.

July. Durban, South Africa

No. D 109. Length 13·60 m. 29. vii. 30. Smear. Active, very few spermatozoa in testis but many in epididymis.

No. D 110. Length 13·90 m. 29. vii. 30. Smear. Intermediate, few spermatozoa in either testis or epididymis.

No. D 108. Length 13·40 m. 29. vii. 30. Smear. Resting, very few spermatozoa in either testis or epididymis.

No. D 81. Length 11·85 m. 15. vii. 30. Smear. Resting, few spermatozoa in testis and very few in epididymis, but abundant epithelial cells in latter. This whale had only just reached sexual maturity.

August. Durban, South Africa

No. D 117. Length 15·90 m. 2. viii. 30. Smear. Intermediate, very few spermatozoa in testis but a fair number in epididymis.

No. D 120. Length 14·35 m. 3. viii. 30. Smear. Resting. Very few spermatozoa in either testis or epididymis.

No. D 121. Length 16·75 m. 3. viii. 30. Smear. Resting, very few spermatozoa in testis, none in epididymis.

October. South Georgia

No. 1829. Length 17·47 m. 20. x. 28. Active, most of the tubules well filled, but many with fairly large spaces. Spermatozoa abundant.

No. 1830. Length 17·08 m. 22. x. 28. Resting, tubules all with very large spaces and few cells. Spermatozoa in moderate numbers.

November. South Georgia

No. 1879. Length 17·02 m. 5. xi. 28. Intermediate, tubules fairly well lined, but nearly all with large spaces. Spermatozoa fairly abundant.

The examination of this material, collected in all months of the year except May, September and December, does not indicate any definite sexual season in the male

Sperm whale. The testes were active and spermatozoa were present in some individuals in all these months. In fact, those in which the testes were active tended to outnumber those which showed signs of lower activity. It is interesting to note that spermatozoa could be found in the testes of all males at South Georgia and that in many the testes were in full activity, because females are not found in these waters at all, so there could be no question of breeding there. From a teleological point of view this activity in the testes of the South Georgian Sperm whales is quite useless to the species. It is plain, therefore, that any evidence regarding the time of the breeding season must be looked for in the data regarding the female Sperm whale. It can be concluded that unless evidence of an unexpected character should be forthcoming at a later date regarding the state of the testes in May, September or December, there is no definite sexual season or cycle in the male Sperm whale, but that breeding is possible at any time of the year.

THE FEMALE

External genitalia. The genital groove includes both the anus and the vulva, which are separated within the groove by a fleshy corrugated pad. So striking is this common groove that in the field log books it was noted as the "cloacal groove". The two openings within the groove are about 0·2 m. apart in the adult. A large clitoris lies at the anterior end of the vulva. The nipples lie about 0·17–0·2 m. on either side of the fleshy pad which lies within the groove of the adult (Plate IX, fig. 1).

Ovaries. The ovaries of the Sperm whale are very different from those of the Whalebone whales. The surface of the ovaries is smooth and the old corpora lutea do not usually project above the surface (Plate XI, fig. 4). Old corpora lutea (*b*, or corpora albicantia) appear as yellowish or dark markings on the surface, with usually whitish triangular ridge-like scars. Corpora lutea of ovulation or pregnancy (corpora lutea *a*) project from the surface of the ovary but are not constricted off from it by a neck (Plate XI, fig. 5). The weight of the ovary is small: of those examined in non-pregnant whales none weighed over $1\frac{1}{2}$ lb. Fig. 37 shows the ovary weight plotted against body length in ovulating and resting non-pregnant Sperm whales. Though numbers are small, a correlation between the two measurements is evident, and the points are noticeably more regularly arranged than in the corresponding graph for Whalebone whales (Mackintosh and Wheeler, 1929, figs. 120, 121). No values for immature whales are available.

Fig. 38 shows the mean diameter of the corpora lutea plotted against the length of foetus, corpora lutea *a* (of ovulation and of pregnancy), and the largest corpora lutea *b* persisting during pregnancy, being separated. The values are much lower than those for Whalebone whales, probably in correlation with the smaller size of the ovaries in this species; and the limited figures available do not indicate any marked diminution in size of either corpora lutea *a* or coexisting corpora lutea *b* up to the time when the foetus measures 3 m. in length.

Uterus. Very few measurements of the uterus are available. In a lactating female, in which ovulation had not taken place since parturition, and in which the uterus was fully involuted, the uterine cornua measured 12 and 13 cm. across respectively. This measurement is taken transversely across the collapsed uterine cornu when lying on a flat surface; it is thus greater than the true diameter. In another which was near the end of lactation and in the ovaries of which no corpus luteum *a* was found, the

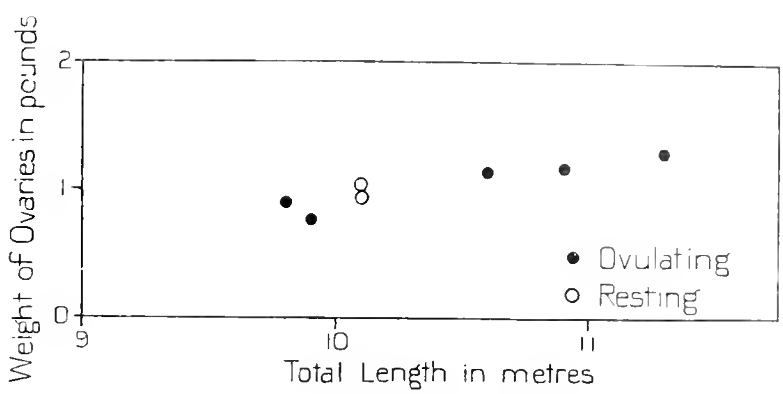

Fig. 37. Sperm whale. Females. Weight of ovaries plotted against total length. Non-pregnant whales.

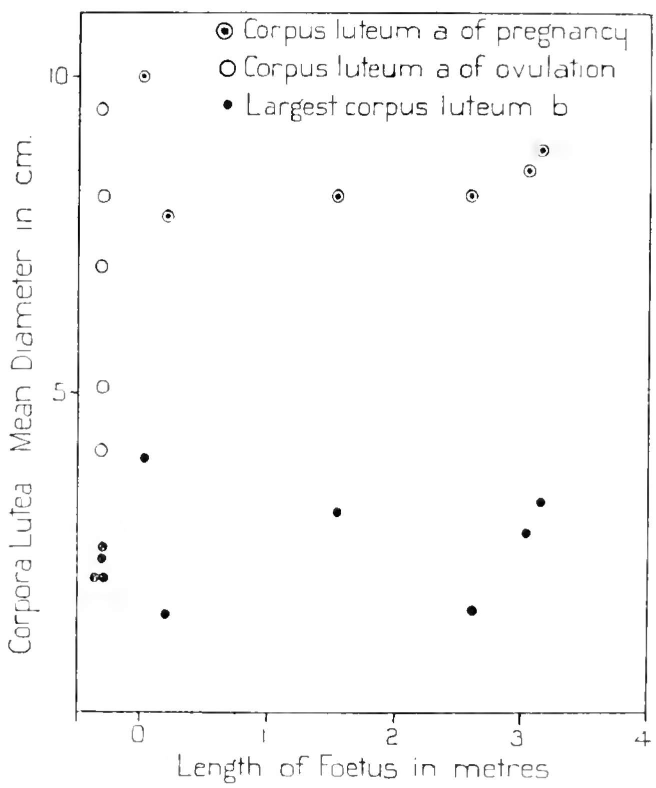

Fig. 38. Sperm whale. Females. Mean diameter of corpora lutea in pregnant and ovulating whales.

uterus was 24 cm. across. This specimen, however, was badly decomposed, so there is the possibility of some doubt as to the exact state of the ovaries. In two whales which were ovulating the uterine cornua both measured 17 cm. across and in another they measured 18 and 19 cm. respectively. In a female pregnant with a foetus 0·2 m. long the pregnant cornu was 25 cm. across and the non-pregnant one 23 cm. In another female pregnant with a foetus 2·6 m. long the pregnant cornu was 54 cm. across and the non-pregnant one 49 cm. These figures give an average of about 17·5 cm. as the width across the uterus in ovulating whales, and some 5 cm. less in the resting state.

Mammary glands. The mammary glands are situated on each side of the median line, with the nipples rather under 0·2 m. to each side of the vulvo-anal groove. Only one whale was examined in which lactation was actively taking place; in all others the gland was either involuted or near the end of lactation. Table IX shows the thickness of the gland in the specimens measured. The involuted mammary gland thus varies from 5 to 12 cm. in thickness. In only one of the whales with non-involuted mammary glands was lactation more than slight, but in them the thickness was also from 5 to 12 cm. The involuted gland in Fin and Blue whales is from 5 to 10 cm. thick, and in full lactation it is 15–30 cm. When the small size of the female Sperm whale is taken into consideration (none of these whales measured more than 11·3 m. long, the average length being 10·1 m.) the size of the mammary gland in proportion to the size of the body is seen to be very large when compared with the former species. The Sperm whale therefore resembles the Humpback whale in the comparatively large size of the mammary gland, which one presumes gives a correspondingly large quantity of milk when in full lactation.

Table IX. *Sperm whale. Thickness of mammary gland*

Whale no.	Mammary gland thickness cm.	Activity	Stage of sexual cycle	Foetus length m.
D 153	5·0	Involuted	Pregnant	1·55
D 156	5·0	Involuted	Ovulating	—
D 176	5·5	Involuted	Pregnant	0·015
D 158	7·0	Involuted	Pregnant	2·60
932	10·0	Involuted	Pregnant	3·05
D 179	10·0	Involuted: had recently lactated	? Very early pregnancy	Not found
D 177	12·0	Involuted	Ovulating	—
D 178	12·0	Involuted	Pregnant	3·15
D 25	5·0	Lactating slightly	Resting (end of lactation)	—
D 180	5·0	Lactating slightly	Ovulating	—
D 23	10·0	Lactating	Lactating	—
D 151	10·0	Lactating very slightly (end of lactation)	Pregnant	0·20
D 152	10·0	Lactating slightly	Resting (end of lactation)	—
D 157	12·0	Lactating but not freely	Ovulating	—

Table IX shows also that the end of lactation frequently overlaps the beginning of the next sexual cycle and may even continue into the beginning of the next pregnancy. This may be compared with the events found in Blue and Fin whales in which there appears to be a definite resting period between the end of lactation and the beginning of the next sexual cycle.

Gestation and breeding season. There are in the British Museum (Natural History) the dated records of the lengths of seventy-four foetal Sperm whales, collected from various whaling stations. These are shown in Table X. The lengths of these foetuses together with those of the foetuses examined by the Discovery staff, are plotted against

Table X. *Sperm whale. British Museum records of foetuses*

Date	Place	Length m.	Date	Place	Length m.
Apr. 20, 1927	Natal: Durban	3·96	July 31, 1927	Cape Province	3·55
May 16, 1928	Cape Province	1·75	Aug. 10, 1926	,,	2·90
16, 1928	,,	0·92	10, 1927	Natal: Durban	1·67
21, 1928	,,	1·65	10, 1927	,,	1·37
21, 1928	,,	2·72	15, 1928	,,	2·44
25, 1927	,,	1·33	15, 1928	,,	2·59
25, 1927	,,	2·36	15, 1928	,,	2·67
26, 1918	Saldanha Bay	0·42	15, 1927	Cape Province	3·40
26, 1918	,,	0·42	19, 1922	Natal	3·05
31, 1926	Gibraltar	3·88	Sept. 10, 1928	Natal: Durban	1·83
June 15, 1928	Cape Province	2·55*	10, 1928	,,	3·05
		2·18*	11, 1928	,,	2·65
15, 1928	,,	2·44	19, 1918	Natal	2·65
21, 1927	Natal: Durban	1·22	21, 1918	,,	2·44
21, 1920	South Africa	2·65	28, 1927	Natal: Durban	3·58
22, 1927	Cape Province	1·42	28, 1927	,,	3·90
22, 1927	,,	1·83	Oct. 5, 1927	,,	3·50
22, 1927	,,	2·65	8, 1927	,,	3·73
23, 1927	,,	1·05	10, 1927	,,	3·35
23, 1927	,,	1·30	16, 1928	,,	2·13
23, 1927	,,	1·83	16, 1928	,,	3·05
23, 1927	,,	2·38	16, 1928	,,	3·65
24, 1927	,,	1·22	18, 1927	,,	1·83
24, 1927	,,	2·13	18, 1927	,,	3·35
24, 1927	,,	3·05	18, 1927	,,	3·65
24, 1927	,,	3·05	19, 1928	,,	2·44
July 1, 1928	,,	1·72	Nov. 3, 1927	,,	0·08
1, 1928	,,	2·21	3, 1927	,,	3·35
3, 1914	Natal	1·83*	17, 1925	South Georgia	1·10
		2·21*	26, 1928	Natal: Durban	4·26
5, 1927	Cape Province	2·01	28, 1927	,,	0·11
5, 1927	,,	2·03	28, 1927	,,	0·31
6, 1927	,,	2·06	Dec. 13, 1927	,,	3·65
6, 1927	,,	2·44	13, 1927	,,	3·96
24, 1928	Natal: Durban	2·65	13, 1927	,,	3·35
30, 1920	South Africa	2·03	13, 1927	,,	3·96
31, 1927	Cape Province	1·52	14, 1927	,,	3·35
31, 1927	,,	3·55	14, 1927	,,	3·96

* Twins.

months in Fig. 39. In this scatter diagram it will be seen that the points fall into three groups: the majority near the centre of the diagram, two isolated points at the left-hand top, and a third group at the right-hand bottom. If, now, the points of the central group, and those points of the third group representing foetuses under 1 m. in length, are averaged by months separately, and the averages are plotted on a 2-year time scale, with the averages for the third group on the left, the diagram shown in Fig. 40 is produced. From this diagram the length of the period of gestation may be deduced as about 16 months. If the line from Fig. 40 is now superimposed on Fig. 39 it is found that the

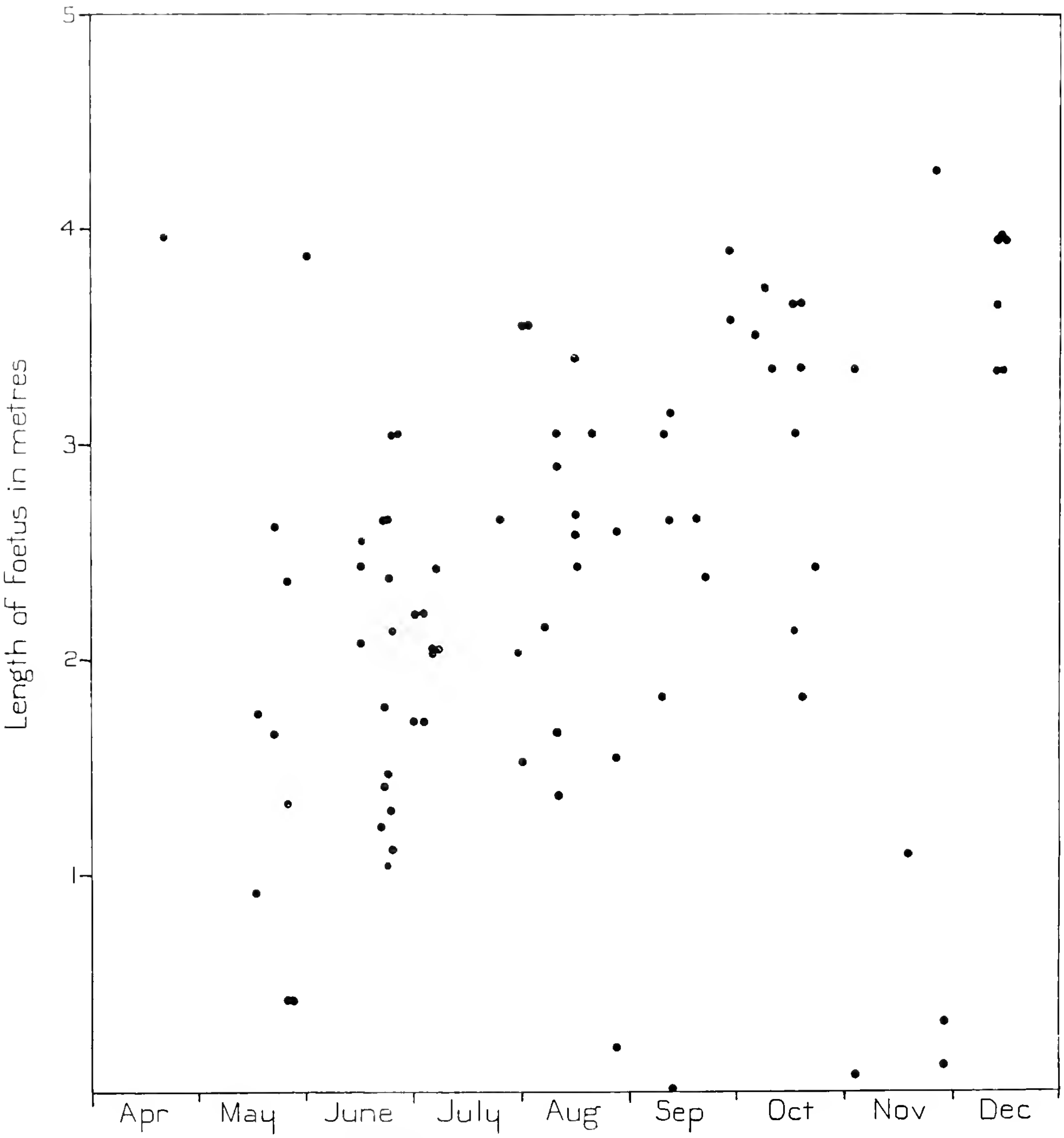

Fig. 39. Sperm whale. Foetal lengths by months.

points extend on each side of the line for about $3\frac{1}{2}$ months, so that if lines are drawn parallel to the average line, and at that distance from it on each side, the diagram in Fig. 41 is produced, which shows a breeding season in which pairing extends over

7 months but is mainly concentrated into 5 months. The two isolated points on the left of Fig. 39 now fall into position on the right in this diagram; in other words, in Fig. 39 the central group of points represents the current season, the left-hand group represents

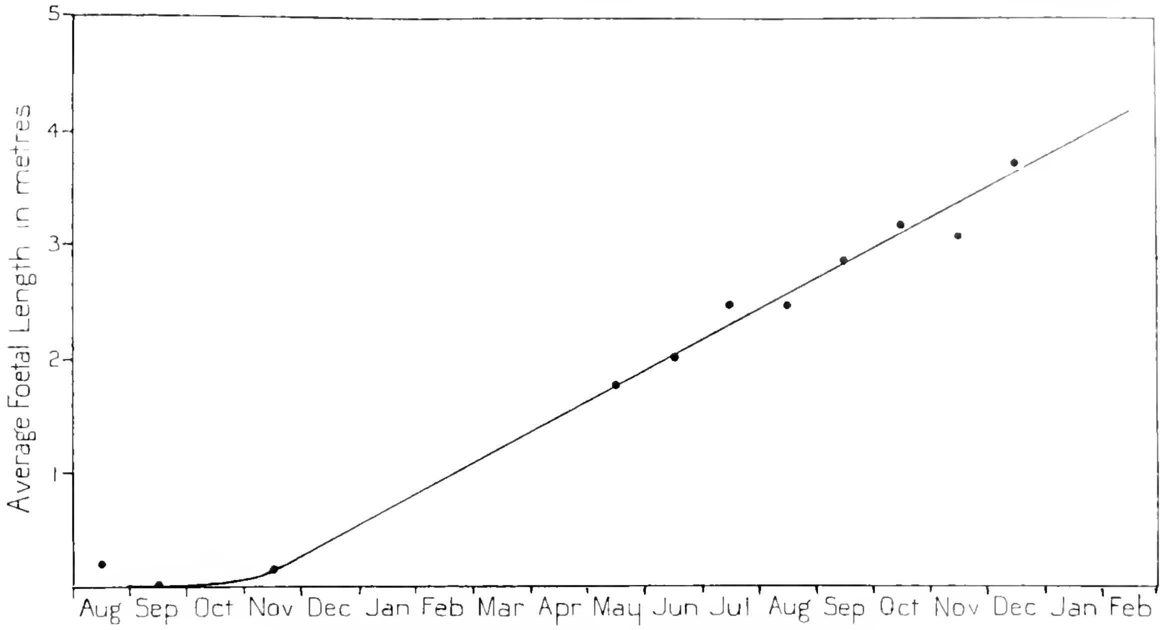

Fig. 40. Sperm whale. Average foetal lengths by months.

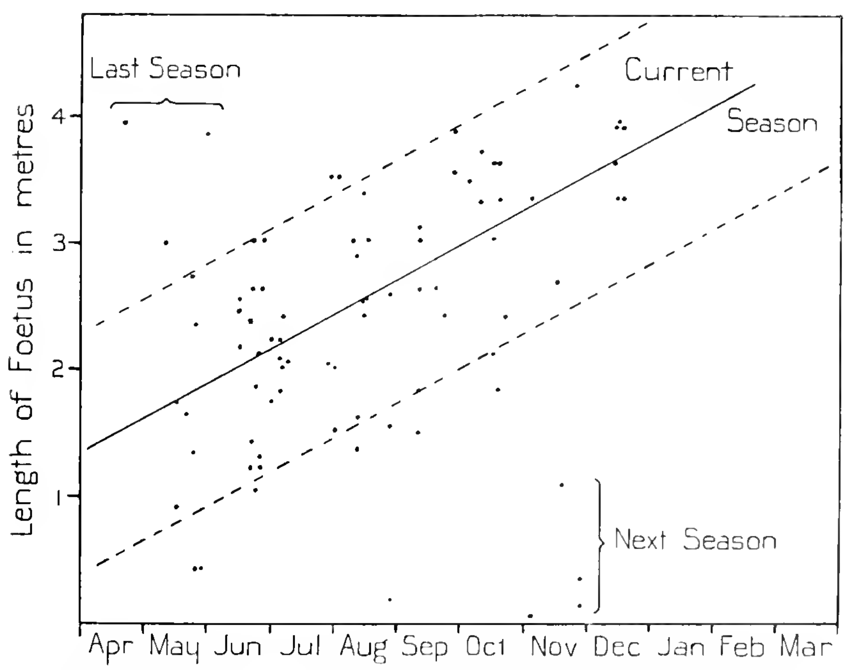

Fig. 41. Sperm whale. Foetal lengths by months, and breeding seasons.

late breeders of the last season and the right-hand group represents the beginning of the next season.

If in Fig. 41 lines are drawn parallel to the average line, but taking their origin at monthly intervals on each side of it, the points are divided up into a number of groups representing pregnancies starting in each month. When the pregnancies are counted and plotted against months, the curve shown in Fig. 42 giving the frequencies of pairing by months, is obtained. This makes it clear that the majority of pairings take place in the months of August to December inclusive, with the maximum in October. By plotting the same curve with the time scale shifted 15 months later the curve of birth frequencies shown in Fig. 43 is obtained. This shows the season of parturition extending from December to April, with the maximum in February.

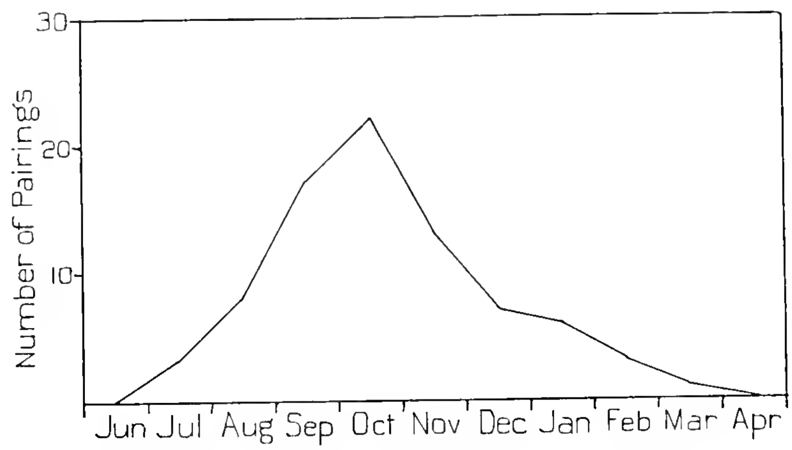

Fig. 42. Sperm whale. Pairing frequencies by months.

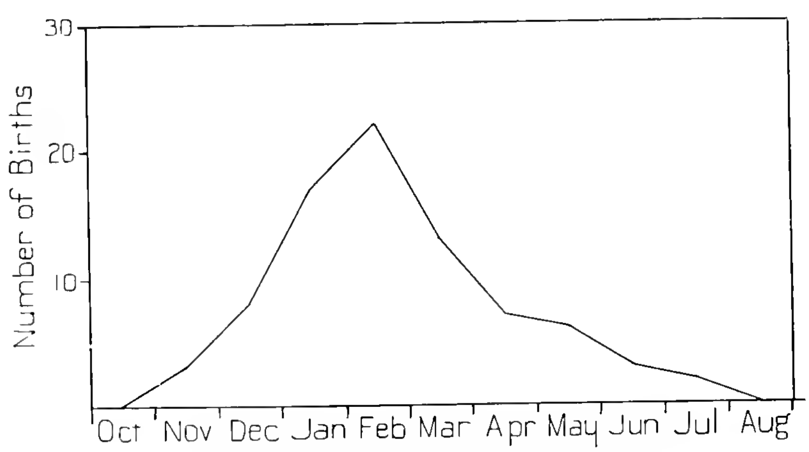

Fig. 43. Sperm whale. Birth frequencies by months.

The length of the foetus at birth is about 4 m. or a little more: the largest foetus recorded was 4·26 m. long and the length of a newly born calf (Wheeler, 1933) was 4·04 m.

Sexual cycle. Only fourteen female Sperm whales have been examined, and consequently the data for these are given in detail before the events of the sexual cycle are discussed on general lines. All were examined at South African stations.

No. D 23. Length 10·7 m. 16. vi. 30. Durban. Lactating. One ovary weighed 1 lb. and contained three corpora lutea *b* of mean diameter 2·25, 1·75 cm. and less. Some follicles were visible below the surface. The other ovary weighed 14 oz. and contained two corpora lutea *b*, one of mean diameter 1·25 cm. and the other small and old. The uterus was involuted, and the mammary gland was lactating. The largest corpus luteum *b* was that of the last pregnancy, and the four older ones probably represent at least one previous pregnancy.

No. D 25. Length 10·4 m. 17. vi. 30. Durban. Resting(?). One ovary showed three corpora lutea *b*, two of mean diameter about 1 cm. and the other very small. The other ovary showed no indications of corpora lutea. The ovaries were, however, badly decomposed, and their exact state is a matter of some doubt. The uterine cornu measured 24 cm. across and the mammary gland was lactating slightly. The whale was probably resting at the end of lactation, but the size of the uterus points towards the possibility of approaching ovulation.

No. 932. Length 10·0 m. 10. viii. 26. Saldanha Bay. Pregnant. One ovary contained a corpus luteum *a* of mean diameter 8·5 cm. and four corpora lutea *b* of mean diameters 2·5, 2·3, 1·6, 1·5 cm. The other ovary contained six corpora lutea *b* of mean diameters 2·8, 2·1, 1·8, 1·6, 1·1 and 0·9 cm. Both ovaries contained many tiny follicles of 3–4 mm. diameter. The whale was pregnant with a foetus 3·05 m. long and was not lactating. This whale was evidently a multipara.

No. D 151. Length 9·7 m. 26. viii. 30. Durban. Pregnant. One ovary weighed 1 lb. 9 oz. and contained a corpus luteum *a* of mean diameter 7·8 cm. and 11 oz. weight. It contained two corpora lutea *b* of mean diameter 1·7 and 1·4 cm. No follicles were visible in it. The other ovary weighed 1 lb. 1 oz. and contained five corpora lutea *b*, the largest two measuring 2·0 and 1·5 cm. in mean diameter and being younger than the corpus luteum *b* measuring 1·7 cm. in diameter in the other ovary. The remaining corpora lutea were old and small. A few follicles were visible below the surface of the ovary. A foetus 0·2 m. long was present. The pregnant cornu of the uterus measured 25 cm. across and the non-pregnant one 23 cm. The vulva was filled with mucus. The mammary gland was lactating very slightly. This whale was a multipara and lactation from the previous pregnancy was overlapping the beginning of the present one.

No. D 152. Length 10·1 m. 26. viii. 30. Durban. Resting. The ovaries weighed 1 lb. each. One contained nine corpora lutea *b*, the largest of mean diameter 2·7 cm., the rest old and resorbed. The other ovary contained four corpora lutea *b*, all old and resorbed. A few follicles up to 15 mm. in diameter were visible below the surface. Lactation was slight and the nipples were protruded. This whale, a multipara, was near the end of lactation, and the approach of the next sexual cycle was indicated by the presence of enlarging follicles.

No. D 153. Length 9·7 m. 26. viii. 30. Durban. Pregnant. One ovary weighed 1 lb. 5 oz. and contained a corpus luteum *a* of mean diameter 8·1 cm., and one corpus luteum *b* of mean diameter 2·1 cm. The other ovary weighed 9 oz. and contained one corpus luteum *b* of mean diameter 2·8 cm. No follicles were visible in either ovary. A foetus 1·55 m. long was present. The vulva was full of mucus and the mammary gland was involuted. This whale, although it had only ovulated three times, was in at least its second pregnancy, and possibly its third.

No. D 156. Length 11·3 m. 26. viii. 30. Durban. Ovulating. One ovary weighed 1 lb. 8 oz. and contained a corpus luteum *a* of mean diameter 4·1 cm. containing a large cavity and composed of young luteal tissue. Many follicles up to 30 and 40 mm. in diameter projected from the surface. Four old corpora lutea *b* were also present. The other ovary weighed 1 lb. 3 oz. and contained seven corpora lutea *b*, all old and resorbed. A fair number of follicles up to 25 mm. in diameter projected from the surface of the ovary. The uterine cornua both measured 17 cm. across and the mammary glands were involuted. This whale, a multipara, had just ovulated and may have been in the earliest stages of pregnancy.

No. D 157. Length 9·8 m. 26. viii. 30. Durban. Ovulating. One ovary weighed 15 oz. and contained a corpus luteum *a* of mean diameter 5·1 cm. with a large cavity and composed of very young luteal tissue. There were three corpora lutea *b*, the largest of mean diameter 2·1 cm., the others old and small. No follicles were visible. The other ovary weighed 14 oz. and contained four old resorbed corpora lutea *b*. Some follicles up to 15 mm. in diameter were visible below the surface. No foetus was found. The vulva was swollen and the mammary glands were lactating, but not freely. This whale, as No. D 156, was therefore a multipara which had just ovulated or was in the earliest stages of pregnancy.

No. D 158. Length 9·95 m. 26. viii. 30. Durban. Pregnant. One ovary weighed 1 lb. 14 oz., and contained a corpus luteum *a* of mean diameter 8·1 cm. and one corpus luteum *b* of mean diameter 1·75 cm. No follicles were visible. The other ovary weighed 8 oz. and contained two corpora lutea *b*, both old and resorbed and older than the corpus luteum *b* on the other ovary. One large follicle about 40 mm. in diameter projected on the surface. A foetus 2·6 m. long was present. The pregnant cornu of the uterus measured 54 cm. across and the non-pregnant one 49 cm. The vulva was open and full of mucus. The mammary glands were involuted. This whale was probably about halfway through pregnancy, and the reason for the presence of the large follicle in one ovary is difficult to find. It was probably an enlarged follicle remaining over from the previous sexual cycle and in process of resorption.

No. D 176. Length 9·6 m. 12. ix. 30. Durban. Pregnant. One ovary contained a corpus luteum *a* 10 cm. in mean diameter and 11 oz. in weight. There was one corpus luteum *b* of mean diameter 2·3 cm.; no follicles were visible. The other ovary weighed 13 oz. and contained two corpora lutea *b*, one 4·0 cm. diameter, the other old and resorbed. A foetus 1·5 m. long was present. The mammary glands were involuted. This whale had been pregnant before.

No. D 177. Length 10·9 m. 12. ix. 30. Durban. Ovulating. One ovary weighed 1 lb. 8 oz. and contained a corpus luteum *a* 8·1 cm. in mean diameter and 10 oz. in weight. There were four old resorbed corpora lutea *b*. No follicles were visible. The other ovary weighed 13 oz. and contained eight corpora lutea *b*, the largest two of mean diameter 2·4 and 2·0 cm. respectively, the rest old and resorbed. The mammary glands were involuted and no foetus was found. This whale was a multipara and had either just ovulated or was in the earliest stages of pregnancy.

No. D 178. Length 10·2 m. 12. ix. 30. Durban. Pregnant. One ovary weighed 1 lb. 4 oz. and contained a corpus luteum *a* 8·8 cm. in mean diameter and 11 oz. in weight. The largest of the three corpora lutea *b* was 3·3 cm. in mean diameter. No follicles were visible. The other ovary weighed 9 oz. and contained one corpus luteum *b*, old and resorbed. No follicles were visible. A foetus 3·15 m. long was present and the mammary glands were involuted. This whale, a multipara, was advanced about three-quarters through pregnancy.

No. D 179. Length 10·6 m. 12. ix. 30. Durban. Pregnant(?). One ovary weighed 1 lb. 1 oz. and contained a corpus luteum *a* of mean diameter 9·5 cm. and 13 oz. in weight. There were four corpora lutea *b*, the largest 3·1 cm. in mean diameter, the rest old and resorbed. No follicles were visible. The other ovary weighed 10 oz. and contained four corpora lutea *b*, all old and resorbed. Several small follicles projected on the surface. One uterine cornu measured 30 cm. across, and the other, not measured, was noted as "not congested". The mammary gland was involuted but had recently lactated. No foetus was found, but it appears very likely that this whale was in an early stage of pregnancy because it had recently ovulated, and in addition, one cornu of the uterus was so greatly enlarged.

No. D 180. Length 9·9 m. 12. ix. 30. Durban. Ovulating. One ovary weighed 15 oz. and contained a corpus luteum *a* 7 cm. in mean diameter and 6 oz. in weight. There was one corpus luteum *b* of mean diameter 3·3 cm. No follicles were visible. The other ovary weighed 10 oz. and contained one corpus luteum *b* of mean diameter 2·6 cm.: no follicles were visible. No foetus was found. The uterine cornu on the side of the corpus luteum *a* was 19 cm. across and the other 18 cm. The mammary glands were lactating slightly. This whale was ovulating or in a very early stage of pregnancy, and had been pregnant at least once before, although she had only ovulated twice previously.

Of these whales two were lactating, seven were pregnant, three were ovulating while lactation had not yet finished, and two were ovulating or in very early pregnancy after lactation had finished. It is therefore evident that ovulation takes place at or a little before the end of lactation, and thus pregnancy starts again very shortly after the nursing of the last calf is finished. Fig. 44 shows the number of corpora lutea in the ovaries

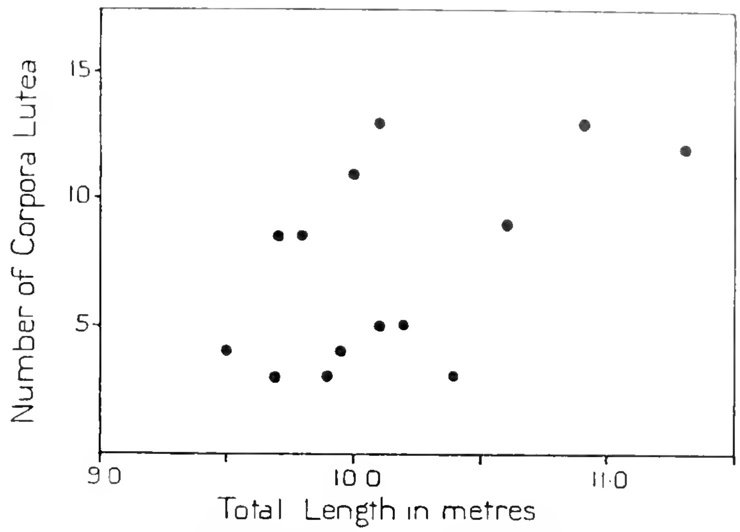

Fig. 44. Sperm whale. Females. Number of corpora lutea in ovaries plotted against total length.

plotted against length of whale. It shows a small degree of correlation between these values for the extremes of whale length, but little for intermediate lengths. There is also some indication of horizontal grouping about the levels of 4, 8·5 and 12 corpora lutea. This is shown more plainly in Table XI in which the frequencies of corpus luteum number are tabulated. It must be remembered that all these whales, with one doubtful exception, are at least in their second breeding season, so that a large series of whales including individuals in their first breeding season would show a further group at 1–2 corpora lutea. The data, though few, point to the probability that the Sperm whale has a dioestrous cycle of about four ovulations at each oestrus after the first.

Table XI. *Sperm whale. Frequency of numbers of corpora lutea*

No. of corpora lutea	No. of whales	No. of corpora lutea	No. of whales
1	—	8	2
2	—	9	1
3	3	10	—
4	2	11	1
5	2	12	1
6	—	13	2
7	—		

The information gained from a careful examination of female Sperm whales by members of the Discovery staff points strongly to the conclusion that there is no long period of anoestrus in this species, but that oestrus recurs immediately the calf is weaned. The fact that the Sperm whale is polygamous and each band of females is attended by the proprietor bull (or less frequently bulls) which, it is said, jealously guards it, points to the probability that few, if any, females escape impregnation as soon as they come into oestrus. The indications of a dioestrous cycle of four ovulations show the possibility that ovulation and pairing do not always result in pregnancy, a phenomenon known in other animals, e.g. the hedgehog (Deansley, 1934). If that is the case it may also be possible that oestrus is sometimes entirely unsuccessful and that the whale then experiences a period of anoestrus. This is shown by the dotted line in the diagram of the oestrous cycle in Fig. 45.

The period of gestation has been shown to be about 16 months; the period of lactation is likely to be not less than about 6 months, judging by analogy from the balaenopterid whales in which its length is known to be from 5 to 7 months in various species. If that is so, pregnancy and lactation will together last at least 22 months. This will bring the whale into its next pairing season at the end of lactation, a conclusion which is in agreement with the facts found in the examination of the series of female whales.

The records of commercial whaling have been examined to find if possible any indication of a period of anoestrus. Those from Natal, which is the only whaling ground where Sperm whales formed an important part of the catch from which data are available, are given for 3 years in Table XII. These figures are, however, disappointing when examined in this connexion, because the statistics are only roughly collected at the whaling stations and only the obvious pregnancies are noted. Consequently, it is impossible to state whether the female whales not noted as pregnant were lactating, ovulating, resting, or in the earlier stages of pregnancy. The technique of dismembering the whale carcass at the Natal whaling stations differs considerably from that at the southern whaling stations, and consequently an examination of the abdominal contents is difficult, and doubtless many pregnancies are overlooked. And it must further be remembered that, surprising as it may seem, the whalers in general cannot tell a male whale from a female, and that many a male which does not happen to have the penis extruded when it is drawn up on the flensing plan is recorded as a female. However, the very low numbers of pregnancies recorded may indicate the occurrence of a period of anoestrus, the possibility of which is discussed above. To set against this is the fact that the whalers at Durban say that after September practically every female Sperm whale contains a foetus, a statement that is widely at variance with the figures supplied by them to the British Museum and shown in Table XII.

The sexual cycle of the female Sperm whale may, therefore, be summarized as in Fig. 45, breeding occurring every other year, gestation lasting 16 months, lactation at least 6, and anoestrus being either absent or of very short duration. The scheme of the sexual cycle outlined here must be taken as the best that can be done until further evidence is forthcoming, and it is put forward tentatively on that basis.

Table XII. *Sperm whale. Catches of males, females and pregnant females at Natal,* 1925, 1926 *and* 1928

Date		Males	Females	Pregnant females
1925	May	19	2	—
	June	6	—	—
	July	24	—	—
	Aug.	51	31	6
	Sept.	100	72	8
	Oct.	53	73	8
	Nov.	23	30	—
1926	Apr.	2	10	—
	May	21	2	1
	June	28	—	—
	July	10	—	—
	Aug.	51	40	7
	Sept.	23	47	4
	Oct.	9	26	2
1928	Apr.	7	4	—
	May	12	—	—
	June	22	—	—
	July	27	—	1
	Aug.	60	32	3
	Sept.	34	31	3
	Oct.	59	18	4
	Nov.	57	48	1
	Dec.	2	8	—

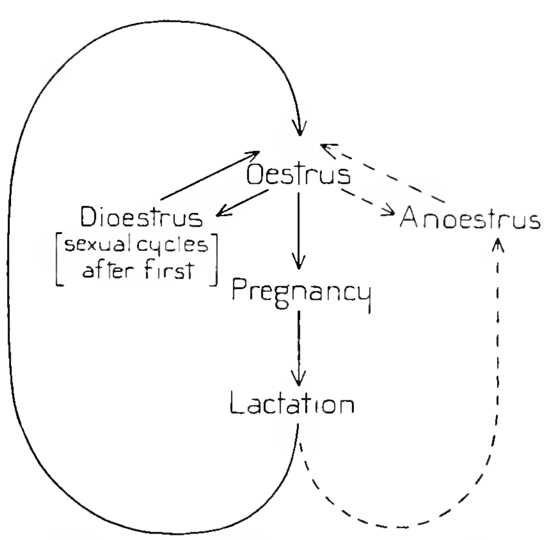

Fig. 45. Sperm whale. Female, oestrous cycle.

GROWTH AND AGE

The smallest female Sperm whale examined was 9·5 m. long and was pregnant in its second breeding season. Sexual maturity is therefore reached at some length shorter than this, probably between 9·0 and 9·5 m. long. The smallest mature male examined was 11·85 m. long, and its testis and epididymis contained very few spermatozoa: it is judged to have only just reached sexual maturity. Two males were mature at 12·1 m. long, and three others 11·75, 12·50 and 12·30 m. long respectively were doubtful. The largest sexually immature male was 11·70 m. long and two of 11·50 m. were doubtfully mature. All those over 13 m. in length were mature. Sexual maturity may, therefore, be taken to be reached by the male between the lengths of 11·5 and 12·5 m.

Data affording evidence on the rate of growth of the Sperm whale between birth and sexual maturity are very scanty. Only a few immature whales, which were all males, have been examined and their lengths are shown in Table XIII. If these figures are plotted on Fig. 46 in a position about 18 months after birth they fall into place round a projection of the ante-natal growth line. The average value for them, 10·81 m., is plotted in the mean date position at *A*. It is possible to plot these figures also in a position a year earlier, when the average value would come at position *B*. But it is likely that the first alternative is the right one, because not only does point *A* fall on to the projection of the growth line, whereas point *B* does not, but if point *B* is accepted it is necessary to assume an extremely rapid rate of growth during suckling. This does not seem to be justified because not only does it require the length of the young to be doubled in 6 months, but it makes the growth curve take a sudden upward direction immediately after birth, and this does not happen in the growth curves for those balaenopterid whales in which it is known. Point *A*, therefore, appears to be the correct one.

Table XIII. *Sperm whale. Immature whales examined at Durban*

Whale no.	Date	Length m.
D 24	17. vi. 30	9·92
D 80	15. vii. 30	12·10
D 81	15. vii. 30	11·85
D 150	26. viii. 30	11·80
D 155	26. viii. 30	10·80
D 159	26. viii. 30	8·80
D 181	12. ix. 30	10·40

Sexual maturity is reached by the male at a length of 11·5 to 12·5 m., and from Fig. 46 we find that this corresponds to an age of about 22 months after birth. Growth in this sex continues after sexual maturity is reached, and at the age of 3 years there is no sign of physical maturity having been attained.

The females become sexually mature at a much shorter length than the males, between 9·0 and 9·5 m. long. If they do so at the same age as the males their growth must be much slower, as shown by the dotted line passing through point *D* in Fig. 46. On

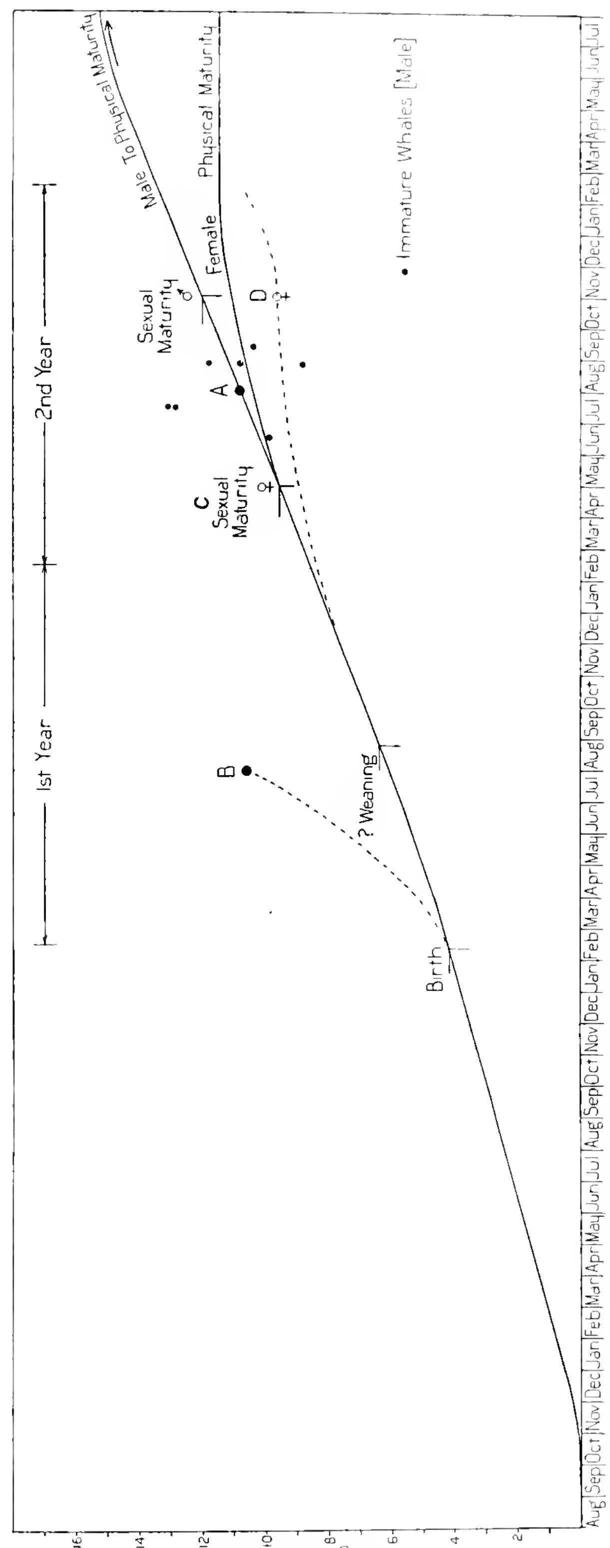

Fig. 46. Sperm whale. Mean growth curve from conception to age $2\frac{1}{2}$ years from birth.

the other hand, if their rate of growth is the same as that of males, they will become mature at a considerably earlier age as shown at point *C*. Growth continues after sexual maturity is reached until a length of about 11·5 m. is attained. At this length physical maturity is reached and growth stops. The lower unbroken line in Fig. 46 shows the growth of the female after sexual maturity. That this line correctly indicates the true course of events in the female is shown by the fact that if the dotted one is accepted the line will have to take a sharp upward curve after point *D* to allow of growth to physical maturity, whereas it should gradually stop rising, as does the upper line. We may, therefore, say that the female Sperm whale reaches sexual maturity at an age of about 15 months from birth, and physical maturity not before 2 years from birth. The early onset of breeding in the female Sperm whale, the length of pregnancy and lactation, and the absence of resting periods intervening between pregnancies, may account in part for the small size of the female when compared with the male.

Referring now to Table XI in which the commonest frequencies of corpus luteum number are shown to be about 1, 4, 8 and 12, it is seen that the ages of the oldest whales recorded, which are only in their fourth breeding season, cannot be more than $9\frac{1}{2}$ years. This is arrived at by assuming pregnancy to start at the end of the previous lactation; if any period of anoestrus had been experienced, the age would be correspondingly greater.

Sperm whales, like the Whalebone whales, reach sexual maturity before growth ceases, as is seen from Table XIV, which shows the state of fusion of the vertebral epiphyses. In only two of the females had the process of ankylosis of the epiphyses even started. In D 179, 10·6 m. long, the caudal and posterior lumbar epiphyses were completely ankylosed, but the anterior lumbar and the thoracic epiphyses were still separated from the bodies of the vertebrae by thick cartilage. In D 156, 11·3 m. long, all the epiphyses throughout the column were completely ankylosed. This whale was the largest female Sperm whale examined. Growth in the female evidently ceases at a length of about 11·0 to 11·5 m.

Of the twenty-five males in which the vertebral column was examined there were only two in which any stage of ankylosis of the epiphyses was present. These were No. 3171, 15·35 m. long, in which the posterior lumbar epiphyses were ankylosed with no sign of the join, but the posterior thoracic ones were still separated from the bodies of the vertebrae by thin cartilage; and No. D 121, 16·75 m. long, in which the lumbar and posterior thoracic epiphyses were all ankylosed with no sign of the join. The latter whale was the largest of the series but No. 3129, 16·57 m. long, is little shorter and showed no sign of ankylosis in the posterior thoracic vertebrae, in which the epiphyses were separated from the bodies of the vertebrae by thick cartilage. Growth in the male Sperm whale evidently does not normally stop before a length of about 15·5 m. is reached, and probably continues until the whale is 16·5 to 17·5 m. or a little more in length. If the age groups shown for Sperm whales at Natal in Fig. 57, and discussed below, are spaced at yearly intervals, as seems probable, the age of the youngest members of the class of largest whales will be about 5 years. Only two whales of this class showed

Table XIV. *Sperm whale. Ankylosis of vertebral epiphyses and occurrence of skin wounds*

Whale no.	Length m.	Date	Sex	Vertebral epiphyses	Cartilage between vertebral bodies and epiphyses	Scars on skin
D 22	15·60	16. vi. 30	♂	10–11 L. Unfused	Thick	Some small open pits and three ages of scar
D 24	9·92	17. vi. 30	♂	1–2 C. ,,	,,	No record
D 36	14·00	22. vi. 30	♂	1–2 C. 5–6 Th. ,,	,,	One open pit on head: a few healing
D 37	13·65	22. vi. 30	♂	Mid. caud. 3–4 Th. ,,	,,	No record
D 38	15·00	22. vi. 30	♂	10–11 L. 2–3 Th. ,,	,,	A few healing pits, one sloughing. One healing and many old crescent wounds
D 50	15·82	28. vi. 30	♂	2–3 Th. 3–4 L. 5–6 L. 11–12 L. ,,	,,	Two open pits on head
D 51	15·40	28. vi. 30	♂	4–5 Th. 2–3 C. ,,	,,	A few healing pits
D 80	12·10	15. vii. 30	♂	4–5 Th. 4–5 L. 8–9 12 L.–1 C. ,,	,,	No record
D 81	11·85	15. vii. 30	♂	3–4 Th. 12 L.–1 C. ,,	,,	Two ages of old scars: very few open pits
D 108	13·40	29. vii. 30	♂	9–10 L. 12 L.–1 C. ,,	,,	Three sloughing pits. 5 × 4 × 3 cm. One age of old scars. Many old crescent wounds
D 109	13·60	29. vii. 30	♂	1–2 Th. 9–10 L. 12 L.–1 C. ,,	,,	One open pit with healed edges. Old scars of two ages very confused
D 117	15·90	2. viii. 30	♂	4–5 Th. 4–5 L. 12 L.–1 C. ,,	,,	A few healing pits and crescentic wounds
D 150	11·80	26. viii. 30	♂	Ant. caud. ,,	,,	One open pit with healed edges
D 155	10·80	26. viii. 30	♂	3–4 Th. 11–12 L. ,,	,,	A few sloughing pits
D 159	8·80	26. viii. 30	♂	Post. thor. Post. caud. ,,	,,	No record
3011	15·60	21. i. 30	♂	Thick cartilages throughout		A few at anterior end of body
3129	16·57	10. ii. 30	♂	1–2 Th. Unfused	Thick	One or two on sides. Nearly all crescentic and old
3170	15·15	27. ii. 30	♂	6 Th.–1 L. 8–9 L. ,,	,,	Two ages of scars: the younger not completely healed
3193	15·00	7. iii. 30	♂	1–2 Th. 4–5 Th. ,,	,,	Three ages of crescentic scars, the youngest new
3255	16·50	31. iii. 30	♂	4–5 L. 12 L.–1 C. ,,	,,	No record
3292	16·00	7. xi. 30	♂	1–2 Th. 4–5 Th. 10–11 L. 12 L.–1 C. ,,	,,	Four ages of scars on head
3613	15·95	30. i. 31	♂	3–4 Th. 12 L.–1 C. ,,	,,	Many healed scars on head
3171	15·35	27. ii. 30	♂	2–3 Th. ,, 10–11 L. Fused	Thin No sign	Some new crescent wounds and healing open pits. Scars of at least one older age
D 121	16·75	3. viii. 30	♂	2–3 Th. 11–12 L. 12 L.–1 C. ,,	No sign	No record
D 23	10·70	16. vi. 30		12 L.–1 C. Unfused	Thick	No record
D 25	10·40	17. vi. 30		12 L.–1 C. ,,	,,	Three ages of old scars and a few sloughing pits
D 151	9·70	26. viii. 30		Ant. caud. ,,	,,	No record
D 152	10·10	26. viii. 30		Ant. caud. Mid. thor. ,,	,,	A few open pits with healed edges and old white crescent wounds
D 153	9·70	26. viii. 30		Ant. caud. ,,	,,	One large open pit
D 157	9·80	26. viii. 30		Ant. caud. ,,	,,	Two open pits with healed edges, just sloughed, right side head
D 158	9·95	26. viii. 30		Ant. thor. Post. caud. ,,	,,	A few almost healed pits
D 176	9·60	12. ix. 30		Ant. thor. Ant. caud. ,,	,,	A few old scars, possibly two ages
D 177	10·90	12. ix. 30		1–2 Th. Post. caud. ,,	,,	No record
D 178	10·20	12. ix. 30		Ant. thor. Mid. caud. ,,	,,	No record
D 179	10·60	12. ix. 30		1–2 Th. 6 Th.–1 L. ,, 11–12 L. 12 L.–1 C. Fused	,, No sign	No pits
D 180	9·90	12. ix. 30		Ant. thor. Mid. lumb. Unfused	Thick	No record
D 156	11·30	26. viii. 30		2–3 Th. 11–12 L. Fused	No sign	A few sloughing pits. One open pit with healed edges

signs of ankylosis, so it may be concluded that physical maturity is not reached until an age well above this, probably 6–8 years at least. Ankylosis of the vertebral epiphyses, therefore, seems in the Sperm whale to be a sign of old age and to occur at an age of about 8 or 10 years in both sexes.

Table XIV also shows that in the Sperm whale, as in other species, the scars on the skin become so confused that the number of different ages of scars gives no indication of the age of the whale.

The data in Tables IV and V, which show the average values of the measurements of different parts of the body according to the length of the whale (in roman type), are plotted on a double logarithmic scale in Figs. 47–63, where the points derived from males are separated from those derived from females. With Humpback whales similar plotting of the corresponding data gave straight-line curves, or very close approximations to them, and a similar result was expected when the Sperm whale data were thus treated. But this was found to be so only for certain measurements, Nos. 6, 10, 11 and 20 (Figs. 47–50). Of the remaining measurements some, Nos. 4, 5, 7, 8, 9, 13, 17, 19 and 25 (Figs. 51–59), show a much less close approach to a straight line or form a straight line in only part of the curve; and others, Nos. 2, 14, 15 and 16 (Figs. 60–63), are very irregular. The very irregular diagrams are of measurements referring to the dorsal fin, the flipper, and the projection of the snout beyond the tip of the jaw—measurements the limits of which are vague and difficult to determine accurately, as explained above. Their irregularity is thus probably due to inaccurate measuring.

The four measurements which show a fairly good approximation to a straight line when plotted on a double logarithmic scale may be taken to show that the rates of growth of the appropriate parts of the body relative to the total length satisfy the equation $y = bx^k$, where x is the total length, y the length of the part, b the fractional coefficient (the value of y when x equals 1), and k is the growth coefficient. The values of k for these four measurements are shown in Table XV. Values of k over unity indicate an increasing rate of relative growth and those less than unity, the converse. Values of k for measurements Nos. 10 and 11, relating to the posterior part of the body, are below unity, and those for measurements Nos. 6 and 20, relating to the anterior part, are over unity. From this we may conclude that with increasing total length the relative growth rates of the anterior and posterior regions of the body increase and decrease respectively, and lead to the enormous relative size of the head in the adult bull Sperm whale.

The remaining graphs, Figs. 51–59, show that some parts of the body follow a relative growth rate that satisfies this simple equation only during part of their growth, and that, for the rest the relative growth rates appear to be very irregular, so that no simple relationship can be traced. It is difficult to suggest any reason for this irregularity in relative growth rates when compared with the striking regularity found in the Humpback whale.

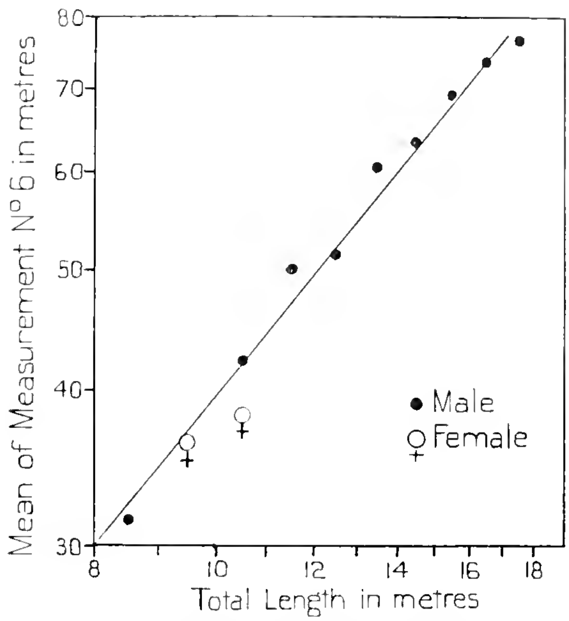

Fig. 47. Sperm whale. Logarithmic plotting of total length against measurement No. 6. Tip of snout to tip of flipper.

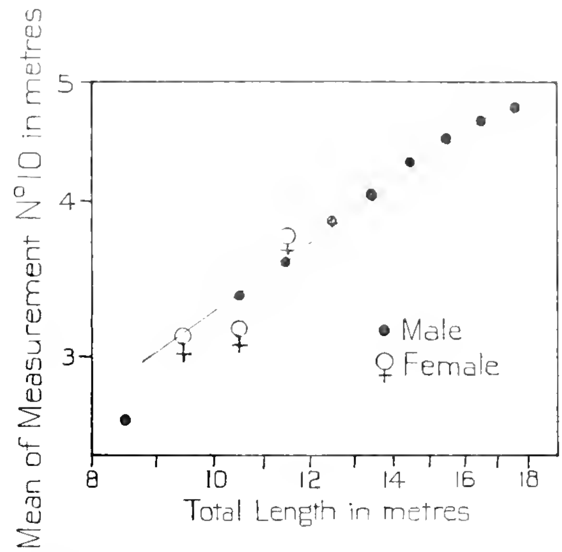

Fig. 48. Sperm whale. Logarithmic plotting of total length against measurement No. 10. Notch of flukes to centre of anus.

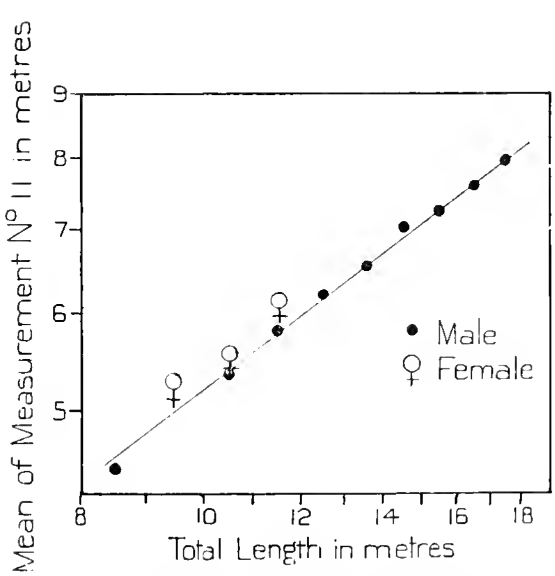

Fig. 49. Sperm whale. Logarithmic plotting of total length against measurement No. 11. Notch of flukes to umbilicus.

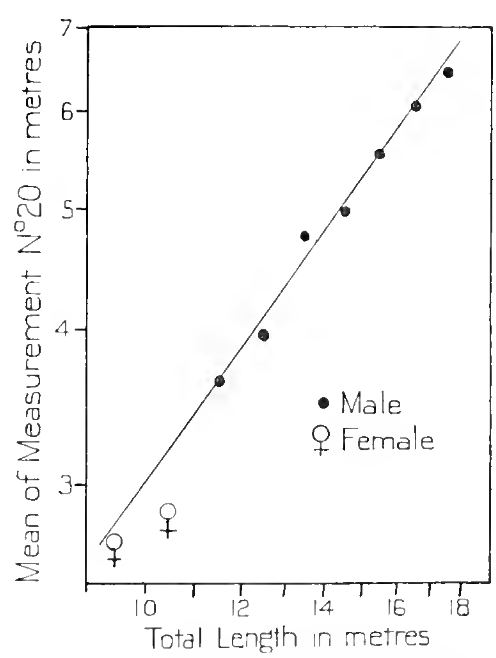

Fig. 50. Sperm whale. Logarithmic plotting of total length against measurement No. 20. Length of severed head from condyle to tip.

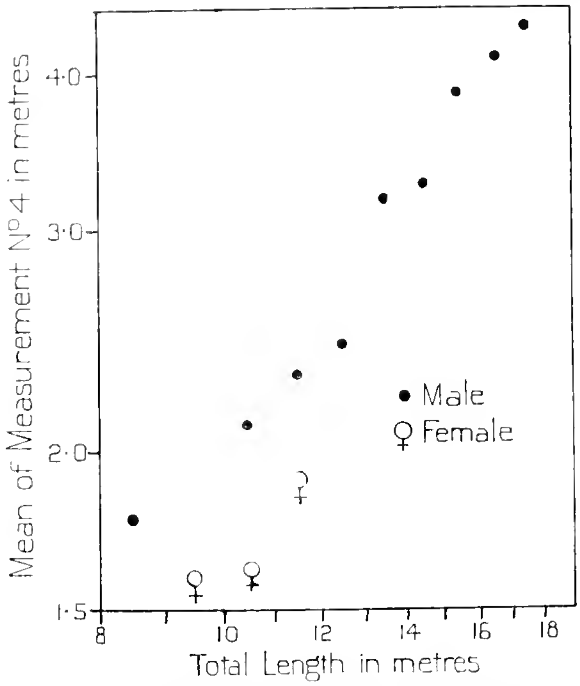

Fig. 51. Sperm whale. Logarithmic plotting of total length against measurement No. 4. Tip of snout to angle of gape.

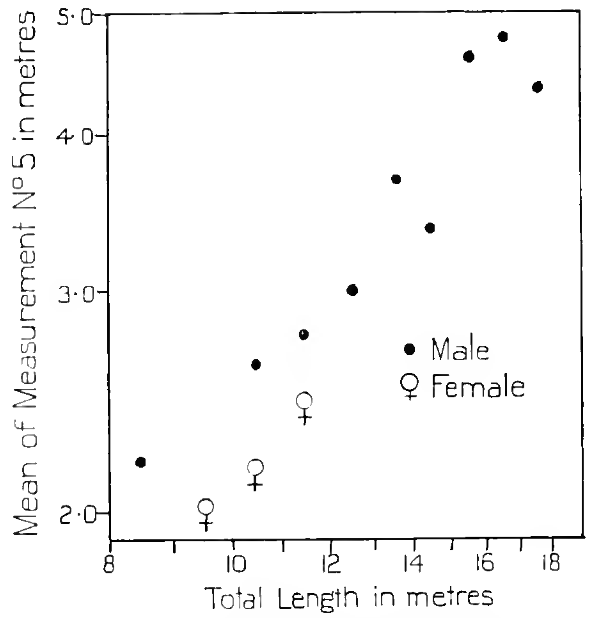

Fig. 52. Sperm whale. Logarithmic plotting of total length against measurement No. 5. Tip of snout to centre of eye.

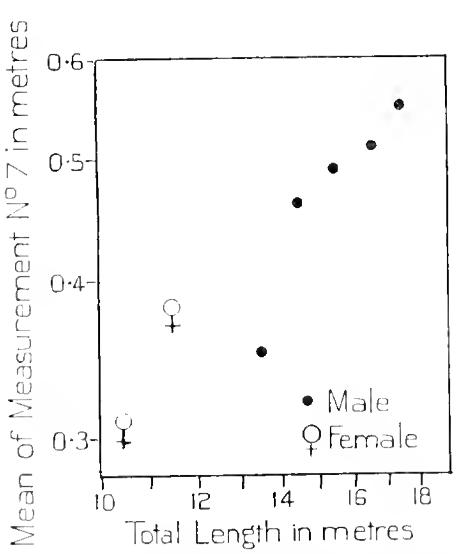

Fig. 53. Sperm whale. Logarithmic plotting of total length against measurement No. 7. Centre of eye to centre of ear.

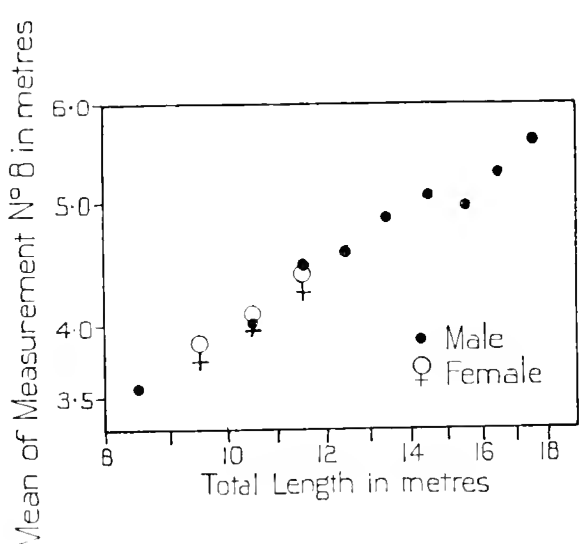

Fig. 54. Sperm whale. Logarithmic plotting of total length against measurement No. 8. Notch of flukes to posterior emargination of dorsal fin.

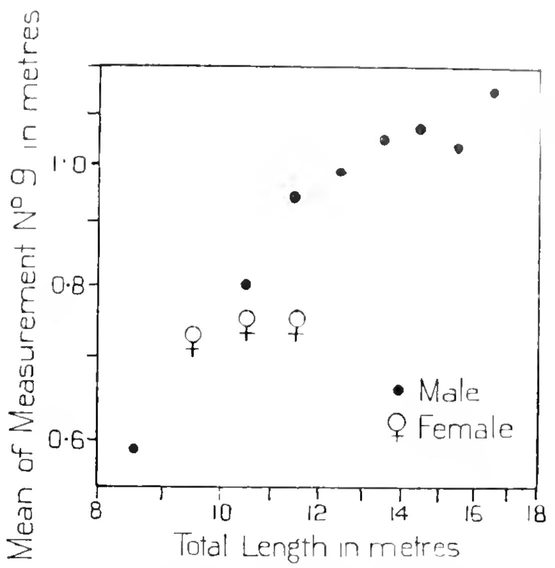

Fig. 55. Sperm whale. Logarithmic plotting of total length against measurement No. 9. Width of flukes at insertion.

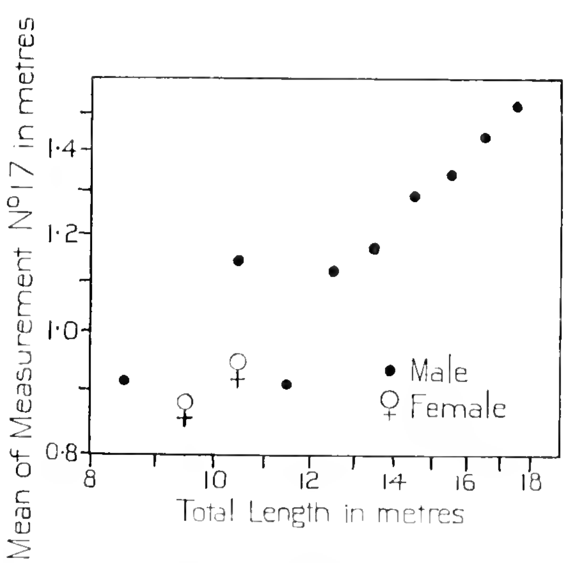

Fig. 57. Sperm whale. Logarithmic plotting of total length against measurement No. 17. Anterior end of lower border to tip of flipper.

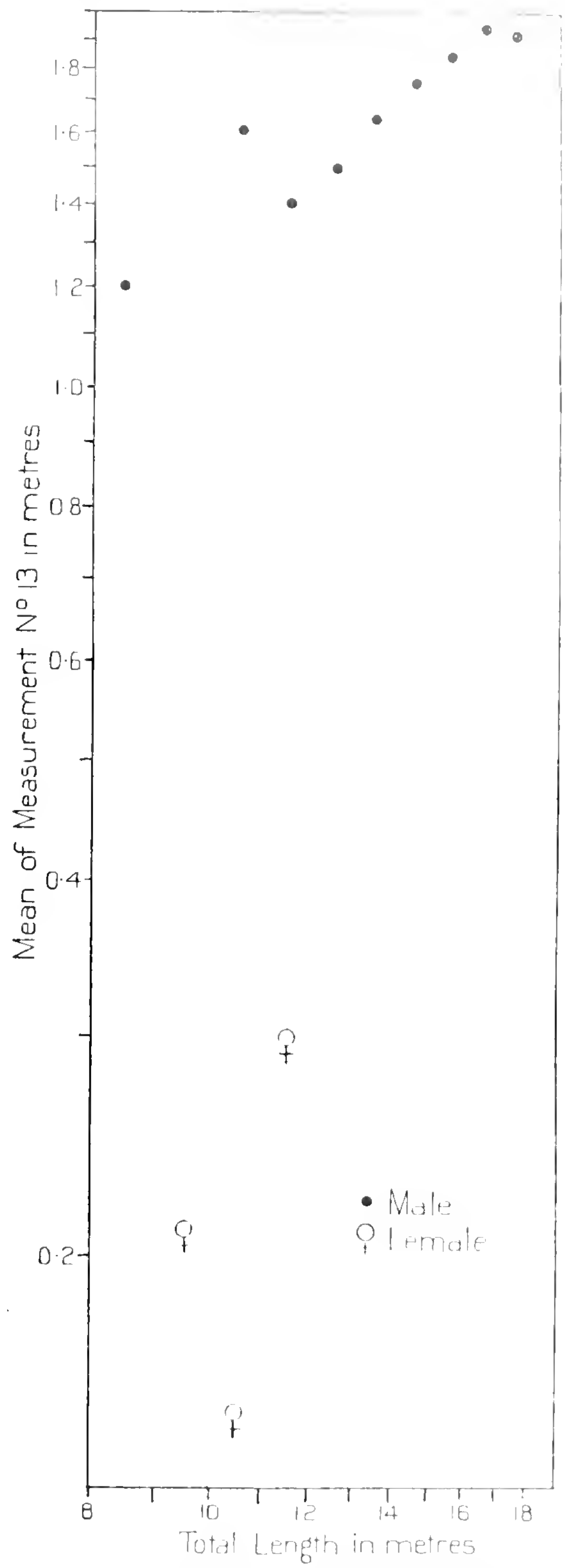

Fig. 56. Sperm whale. Logarithmic plotting of total length against measurement No. 13. Centre of anus to centre of reproductive aperture.

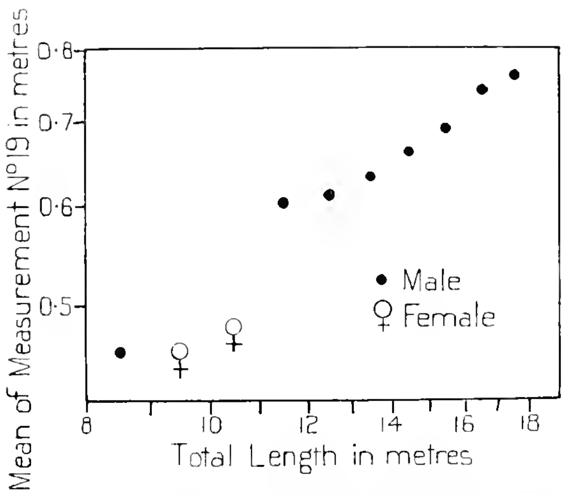

Fig. 58. Sperm whale. Logarithmic plotting of total length against measurement No. 19. Greatest width of flipper.

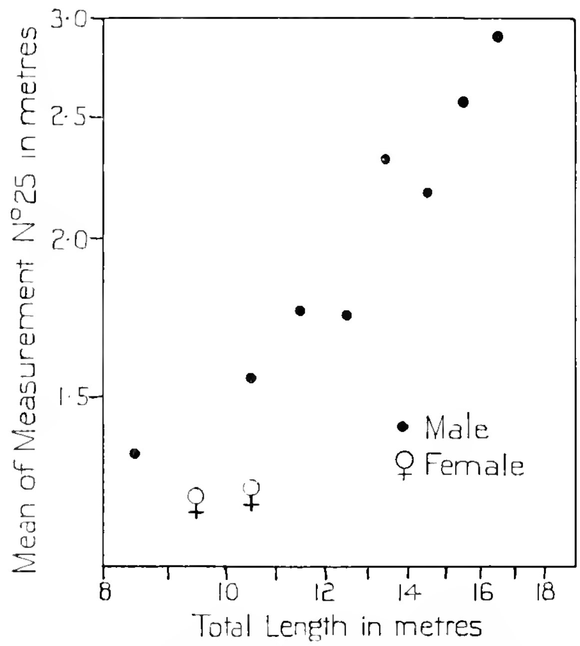

Fig. 59. Sperm whale. Logarithmic plotting of total length against measurement No. 25. Height of head.

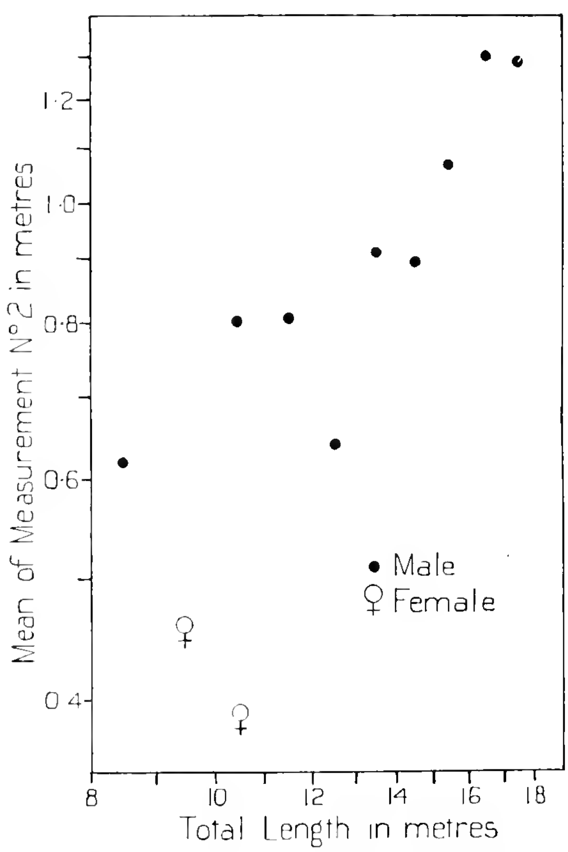

Fig. 60. Sperm whale. Logarithmic plotting of total length against measurement No. 2. Projection of snout beyond tip of lower jaw.

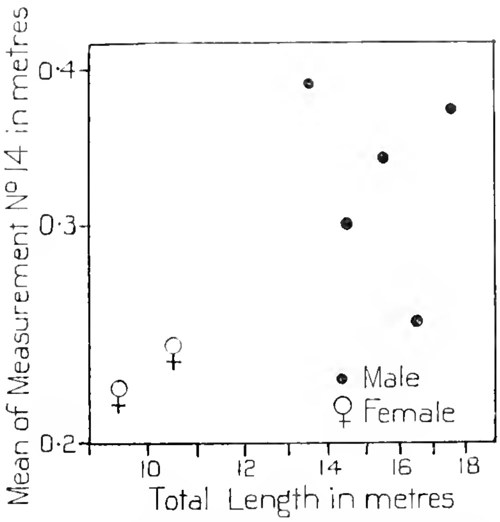

Fig. 61. Sperm whale. Logarithmic plotting of total length against measurement No. 14. Vertical height of dorsal fin.

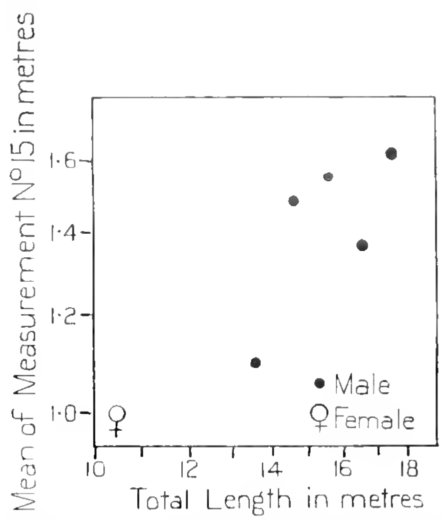

Fig. 62. Sperm whale. Logarithmic plotting of total length against measurement No. 15. Length of base of dorsal fin.

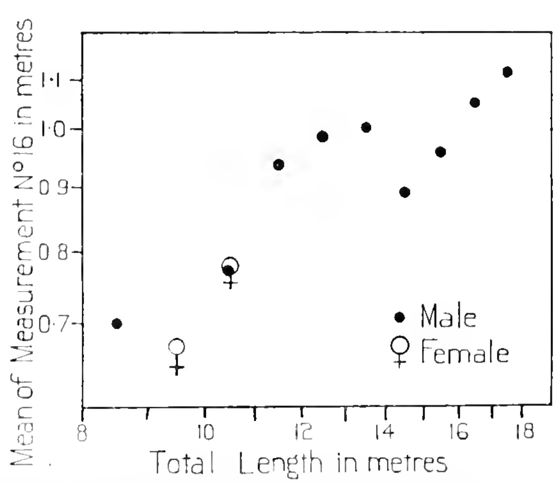

Fig. 63. Sperm whale. Logarithmic plotting of total length against measurement No. 16. Axilla to tip of flipper.

Table XV. *Sperm whale. Growth coefficients of body measurements to satisfy the equation* $y = bx^k$

Measurement	Growth coefficient
10. Notch of flukes to centre of anus	0·73
11. Notch of flukes to umbilicus	0·76
6. Tip of snout to tip of flipper	1·48
20. Length of severed head from condyle to tip	1·35

MIGRATION

The migrations of the Sperm whale are not nearly so clearly defined as those of the Whalebone whales. At all times of the year it is found plentifully in the tropics, and males only are found in lesser numbers in higher latitudes at certain seasons. A consideration of the season graphs for catches of Sperm whales at South Georgia and Natal will throw some light on the seasonal movements of this species of whale.

Fig. 64 shows the numbers of male and female Sperm whales caught during each month at Natal for seasons 1918–26 and 1928 and at Cape Province for seasons 1920–5, and Fig. 65 shows the monthly catches of Sperm whales at South Georgia for seasons 1926/7–1930/1 and South Shetland for seasons 1923/4 to 1925/6 inclusive. At South Georgia all the Sperm whales are males, and it is seen that there are some indications of bimodality in the graph, with the largest peak in March: at the South Shetlands the bimodality is more marked. The corresponding curve for male Sperm whales at Natal shows a gradual rise from April to July with a high peak in August and September. On comparing the two curves it is seen that the peaks occupy successive positions on the time scale, and that male Sperm whales appear off the coast of Natal after the height of the peak has been passed at South Georgia; and the peak for Natal is reached at a time when there are no Sperm whales at South Georgia. The inference to be drawn is that the male Sperm whales which appear in some numbers in South Georgian waters in the early months of the year are on their way to lower latitudes, and that the earlier lower peak in the figure for South Georgia represents whales that are migrating southwards towards the end of the year and continue their journey towards the south beyond South Georgia. They go beyond the South Shetlands too, as shown by the curve for that locality. The first peak may represent a migration down the coast of South America. That they go well into the Antarctic and stay for some time is upheld by an examination of the amount of diatom film present on the whales in different months. Hart (1935) has shown that a stay of at least a month in the Antarctic Zone is necessary for the development of the diatom film. Table XVI shows the amounts of film observed and shows that infection is absent or slight in the first part of the season and heavy in the second part. This strengthens the view that the whales taken in the early part of the season are on their way farther south, and that those taken in the latter part of the season have been present in the Antarctic Zone for some time and are probably on their way north again. It is of interest to note that the first peak in Fig. 65 occurs in those months in which the curve in Fig. 42 reaches its maximum, and that these southerly migrating males, though in full sexual activity, have left the region frequented by the females at the height of the pairing season to pursue their migration alone.

It must be remembered, however, that these migrations are performed by a portion only of the Sperm whale population of the oceans, for Sperm whales are plentiful in the tropics at all times of the year.

Turning now to the curve showing monthly catches of female Sperm whales at Natal, it is seen to be bimodal with a low peak in April and a high one in September.

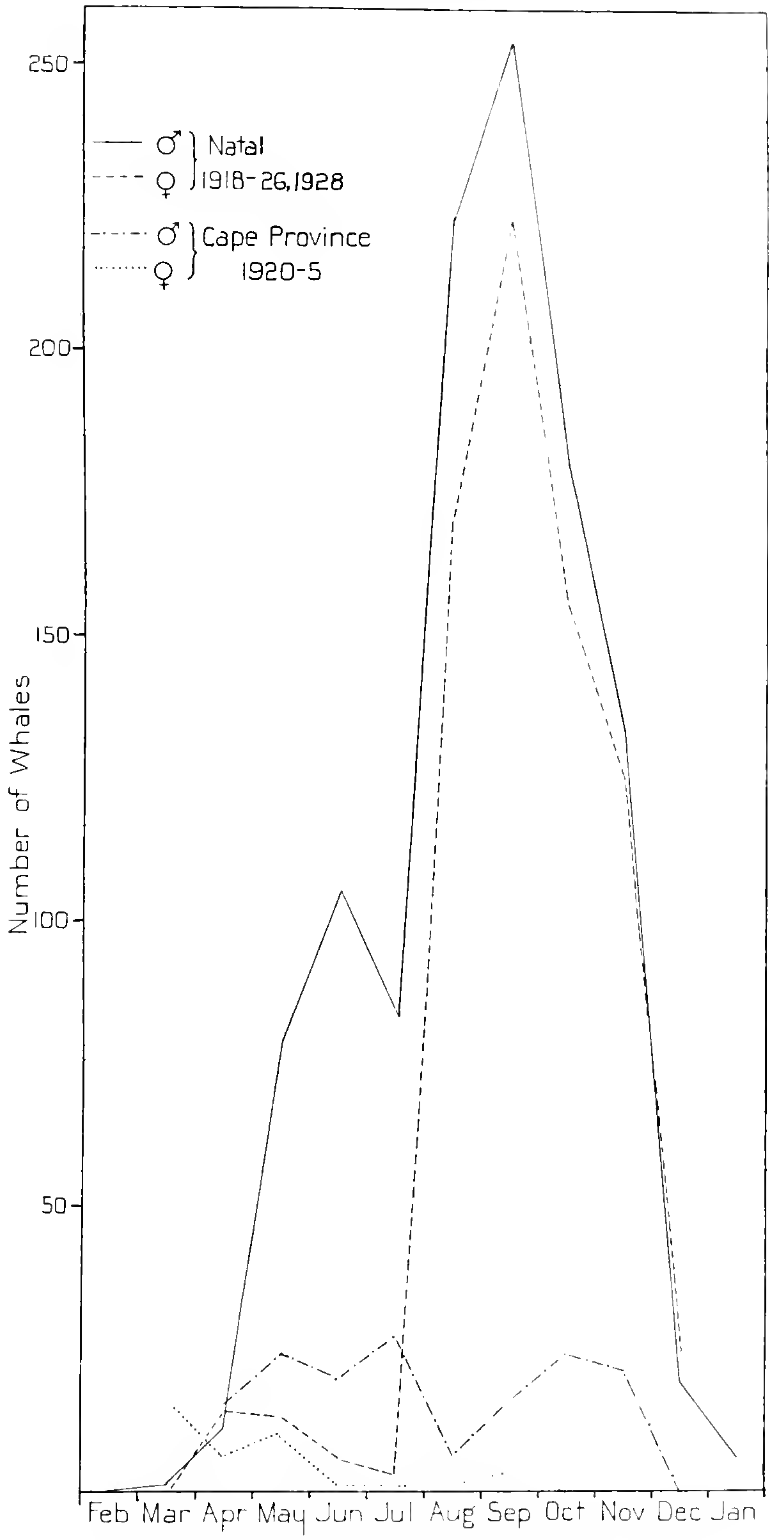

Fig. 64. Sperm whale. Monthly catches at South Africa.

The whalers of Natal are of the opinion that there is a decided migration of Sperm whales from the north in the early (southern) spring, and that it is then that females are taken in large numbers. If this is so it may be inferred that the smaller peak in April

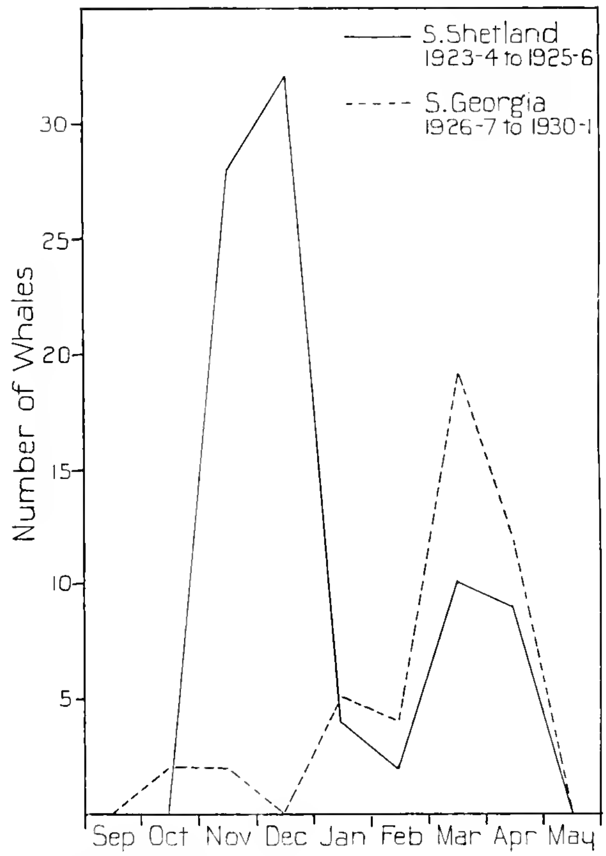

Fig. 65. Sperm whale. Males. Monthly catches at South Georgia and the South Shetlands.

Table XVI. *Sperm whale. Occurrence of diatom film on whales at South Georgia*

Month	Diatoms absent	Film slight, or in early stage of development	Diatom film fully developed
Oct.	—	2	—
Jan.	1	1	—
Feb.	1	2	—
Mar.	1	—	6
Apr.	—	—	5

represents a return migration towards the equatorial waters in autumn. The figures must, however, be accepted with great caution, because Sperm whales are not taken off Natal when Blue and Fin whales are available, and further, male Sperm whales are always taken in preference to females because of the small size of the latter. Now the drop in the curve for female Sperm whales and the shelf in the curve for males occur in those months when the catch of Blue and Fin whales off Natal is greatest. Fig. 66, showing the total monthly catches of Sperm whales for seasons 1925, 1926 and 1928 and of Blue and Fin whales for seasons 1922 and 1930, brings out this point clearly. It is, therefore, quite possible that the true state of affairs would be represented by even unimodal curves taking their origin in March showing a peak in August and a return to zero in January. If the drop in the curve at the end of the year indicates a movement towards the south, it will be seen by reference to Figs. 42–43 that the main pairing season

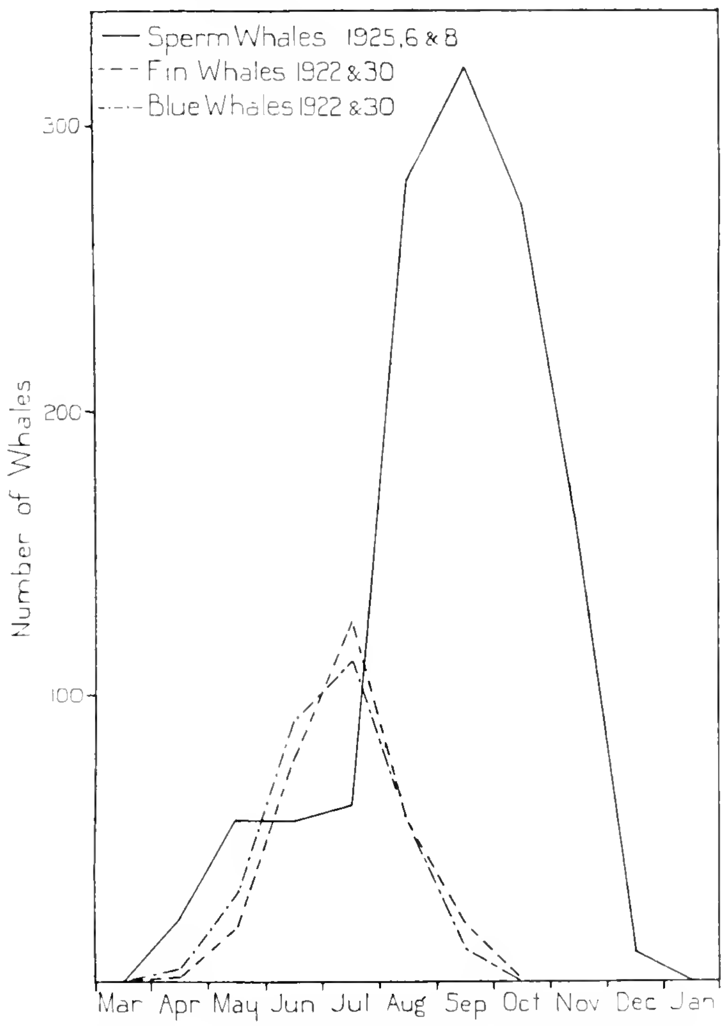

Fig. 66. Catches of Sperm, Blue and Fin whales. Natal.

is during this southern journey, and that the chief time for parturition occurs when the whales are to the south of Natal, and that both seasons are practically over before the return migration in the following March, April and May. If this really is so, it forms a striking contrast to the Whalebone whales in which the breeding migration takes place in the opposite direction towards the north; but it must be remembered that the southern movement of Sperm whales may merely be a spreading of the population from warmer waters where large numbers may remain, so that parturition may be occurring in low latitudes, among whales which have remained behind, at the same time as among those which have migrated.

It has been suggested that the old bulls which migrate by themselves into high latitudes are old ones which have been driven out of the schools by younger and more vigorous ones. The latter part of this hypothesis appears to be likely because they are nearly all of large size, but examination of the state of ankylosis of the epiphyses of the vertebral column reveals the fact that they are by no means always fully adult, in fact the majority have not reached complete physical maturity, and they, therefore, cannot be aged

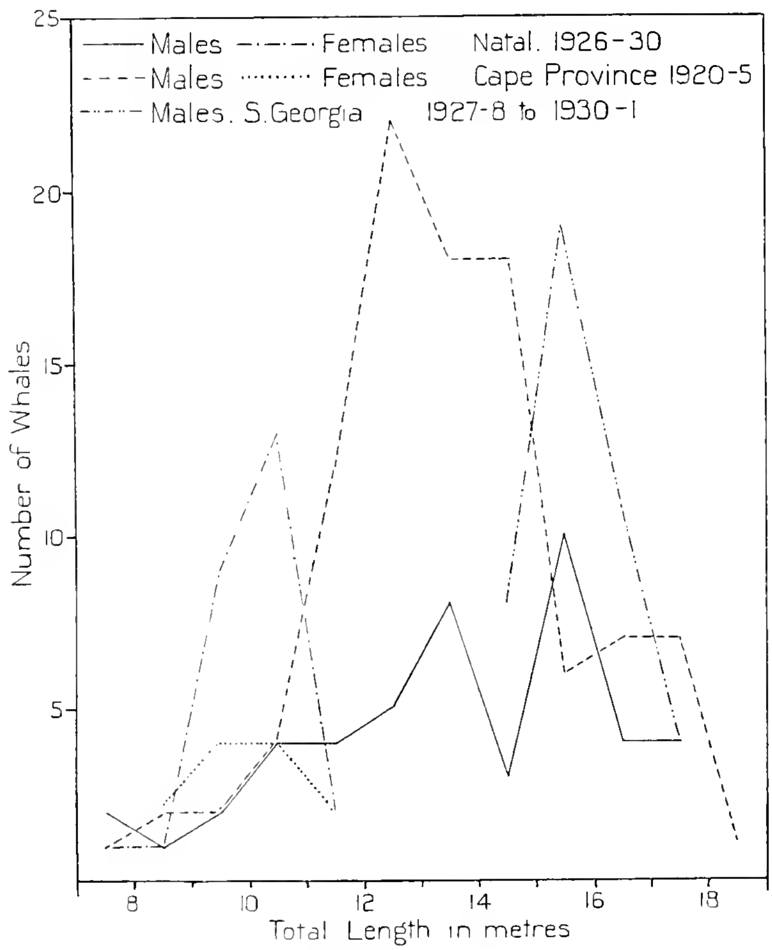

Fig. 67. Sperm whale. Length frequencies.

individuals. The large size of South Georgia males compared with that of those taken off South Africa is well shown in Fig. 67. It is of interest to note that a female Sperm whale was captured off South Georgia in November 1925, and a newly born young one was thrown ashore off the west of Ireland in September 1916, showing that very rarely the female Sperm whale strays into high latitudes with the males. Salvesen (1914) gives a photograph of a Sperm whale on the flensing plan at Leith Harbour, South Georgia, and labels it as a female. It is not a female, however, but a male with the penis not extruded, as is shown by the separate genital and anal apertures. Its size in comparison with the men grouped round it also shows that it is not a female. In the statistics for seasons 1923/4–1925/6 from the South Shetlands, eight female Sperm whales appear. These are all incorrectly recorded, because their lengths are given as between 50 and 60 ft., a length which no female Sperm whale reaches. They are all males. As mentioned above, whalers are sometimes surprisingly incorrect in identifying the sex of whales. There appears to be some reason for believing that competition for the possession of the females is considerable between the males, for, in addition to the well-known belief of the whalers that each school of cows is accompanied by from one to three proprietor bulls, Lillie (1915) gives the record, and a figure, of thirty-six bulls and one cow stranded on Perkin Island, Tasmania, in February 1911, when, it is alleged, the bulls pursued the cow into shallow water so that the entire school was stranded.

Townsend (1935) gives interesting charts plotting the position and time of capture of 36,908 Sperm whales taken by American whalers between 1761 and 1920, and the general conclusion to be drawn from a study of these charts is that Sperm whales are present at all times in tropical and equatorial waters, but that in the months of April to September inclusive the vast majority were taken from the equator northwards to temperate regions, and from October to March inclusive, from the equator southwards to temperate regions. Smaller numbers were taken in north temperate latitudes in the months April to September and vice versa. A general movement towards the equator from temperate regions in the winter season of each hemisphere is thus indicated.

An examination of the length frequencies of Sperm whales in Fig. 67 shows that though the catches of males at South Georgia are entirely composed of sexually mature and large bulls of one age class, the catches of males off Natal are quite different. There are two well-marked age classes, with indications of a third. The largest number of males belongs to the same age class as those taken at South Georgia, but nearly as many of a smaller class are taken as well. This class consists of sexually mature whales which are, however, on the average, 2 m. shorter than those of the older class. If the males which migrate alone into high latitudes are in fact, as has been alleged, driven out of the schools by younger males, this second age class of males, from 13–14 m. long, would appear to be the one which drives the older ones away on their solitary journey. There is also some indication of a third age class at 10–11 m. of length: this class consists of males that are sexually immature. Lesser numbers of still younger ones are taken. The second age class is the one forming the bulk of the catch at Cape Province. The females all fall into one class, as shown by their length, from which it is concluded that after reaching sexual maturity female Sperm whales grow very slowly, though, as has been shown above, growth does not entirely cease until long after sexual maturity is attained.

The general outline of the movements of the Sperm whale to be gleaned from the information available, meagre as it is, is that the headquarters of the species is the tropics, that in summer in the northern and southern hemispheres there is movement towards the north or south respectively, that pairing takes place during this migration and the females give birth to their young in subtropical and temperate waters. Further, a small proportion of the males, though fully active sexually, leave the females at the height of the pairing season and migrate alone to high northern or southern latitudes before returning to temperate waters again and joining in the general movement of the schools towards the equator during the winter.

WHALING AND THE SPERM WHALE

The Sperm whale forms an important part of the catch only on the Natal, Chile (37–40° S), and Japan whaling grounds (Harmer, 1928); elsewhere the numbers caught are insignificant compared with the numbers of Whalebone whales. The world catch probably does not exceed 2000–2500 Sperm whales a year: it was 2238 for season 1934/5 and summer 1935 together. The reason why the whaling industry pays so little attention to the Sperm whale is that Sperm oil is not suitable for the processes of hardening by which the oil from Whalebone whales is converted into edible fat. Further, a very small proportion of Sperm oil contaminates other whale oil and renders it unsuitable for hardening, with the consequence that Sperm oil has to be boiled out and stowed separately. Occasional Sperm whales are, in fact, a decided embarrassment to a whaling station that is engaged in converting a good supply of Whalebone whales.

The world stock of Sperm whales is thus not seriously drawn upon by the whaling industry, for the number taken annually is at present less than the annual catch in the days of the old American whaling industry of the last century. Harmer (1928) points out that this industry became extinct after the use of petroleum as an illuminant became general, but shows that it started to decline after 1837, more than 20 years before the introduction of petroleum, so that the decline could only be due to over-fishing. He adds that the Sperm whale is one of the species about which immediate anxiety need not be felt, though there is no evidence that the immense numbers formerly reported are still to be found.

The Sperm whale is the species of whale which, owing to its habits, affords the best opportunity for a really scientific and rational regulation of its capture. The species is polygamous, and consequently the capture of bulls only, if not excessive, would in no way damage the stock. Further, a portion of the stock, the older bulls, segregates itself from the schools of cows and immature animals, thus providing proper quarry for the whaling industry and releasing it from the trouble of selecting those whales suitable for capture. The older bulls, being naturally larger in size, are the ones specially suitable for use by the industry.

It would remain then, to ascertain the approximate latitude that limits the southern or northern migration of the cows and immature whales and to confine the capture of Sperm whales to latitudes higher than those, where practically all are full-grown solitary bulls in good condition. This latitude appears to be in the neighbourhood of 40° N and S. The slaughter of cows in lower latitudes appears to be quite indefensible, for not only may they be pregnant or lactating, but, owing to their small size, their oil yield is low. The demand for Sperm oil is, however, small in comparison with that for the oil of Whalebone whales, so that it is doubtful whether a Sperm whale fishery conducted on rational lines would be of any interest to the whaling industry.

The figures for the last few seasons in the Antarctic may however be of some significance. From season 1919/20–1931/2 inclusive the average catch of Sperm whales by all companies was 41·3 per year, the lowest total being 3 in 1921/2 and the highest 73 in 1929/30. But for seasons 1932/3–1934/5 the catches showed a marked increase, being 107, 666 and 577 for the three seasons respectively. The increasing attention being paid to Sperm whales in the Antarctic may be correlated with the increased intensity of pelagic whaling and a decrease in the numbers of other species.

Since this report was begun the International Conference on the Whaling Industry has reached an agreement which affords protection to the Sperm whale for the first time. It will be illegal to take Sperm whales less than 35 ft. in length, so that the cows will be almost entirely eliminated from the catch. The species will receive further protection by the imposition of close seasons on the various whaling grounds.

SUMMARY

This report discusses the results of the examination of eighty-one Sperm whales at the southern whaling stations during the course of the Discovery investigations.

The statistics in the British Museum (Natural History) relating to whaling have also been used in conjunction with the data collected by the Committee's scientific staff.

No indication of an uneven sex ratio has been found, though the sexes are to some extent segregated by the habit of adult males migrating alone to latitudes higher than those frequented by the females.

A series of standard measurements was carried out on the whales and the resulting figures are discussed. The body proportions of the Sperm whale are established, and their range of variation is recorded. The measurements give no indication of any likelihood of the Sperm whale being divisible into subspecies or geographical races.

The colour of the Sperm whale is a uniform dark bluish grey with certain unpigmented areas of common but not universal occurrence. The form and frequency of occurrence of the unpigmented areas is recorded.

A number of small throat grooves are commonly present below the angle of the gape, and the surface of the body is marked by a number of irregular corrugations that may be strongly developed.

Twenty to thirty teeth are present in each side of the lower jaw; they fit into corresponding sockets in the upper jaw. In about half the whales examined, rudimentary teeth, from one to eleven on each side, were present in the upper jaw.

The food of the Sperm whale both at South Georgia and off the South African coasts consists of cephalopods and fishes. Cephalopod remains are often very abundant in the whales' stomachs, and usually represent animals of small size. Remains of very large cephalopods are uncommon. Scars on the skin of the whales made by the suckers and claws of large cephalopods are commoner than the remains of the corresponding animals in the stomachs.

The blubber is considerably thicker than that of balaenopterid whales. It increases in thickness with increasing total length, but in immature whales it is proportionately

thicker than in adults. Both at Natal and South Georgia the blubber thickness appears to decrease towards the end of the whaling seasons. Pregnant whales are fatter, and lactating ones leaner, than the average, but the difference in this species is not so marked as in balaenopterid whales.

Cyamus is the only common external parasite of Sperm whales. *Penella* and *Coronula* are each recorded once only. Patches of diatom film were frequent on Sperm whales at South Georgia, showing that the whales had spent some time in Antarctic waters.

Nematode worms very commonly infest the alimentary tract of Sperm whales and occur most frequently in the stomach. The only other internal parasite commonly recorded is *Phyllobothrium physeteris*, which is nearly always to be found encysted in the blubber.

The external and internal genitalia of both sexes are described. The histological state of the testes was examined in thirty-six whales, and the results indicate that there is no definite sexual season in the male.

Dated records of foetal lengths show that the period of gestation is about 16 months and that the young are born at a length of about 4 m. The data do not provide direct evidence as to the length of the period of lactation, but a fresh pregnancy frequently begins before the end of lactation.

The main part of the pairing season occurs from August to December, with its peak in October. Consequently, most births take place from December to April with a maximum in February.

The results of a detailed examination of the internal genitalia of fourteen female Sperm whales are given in full. From these it is concluded that breeding takes place once every 2 years, that lactation probably lasts more than 6 months, and that a period of anoestrus is not normally experienced by the female Sperm whale.

The numbers of old corpora lutea in the ovaries indicate a polyoestrous sexual cycle with an average of three dioestrous cycles and four ovulations at each cycle succeeding the first.

Sexual maturity is reached at an age of not more than 2 years in the male, and considerably less, about 15 months, in the case of the female. Physical maturity is probably not reached before an age of 8–9 years, possibly more, in both sexes. Physical maturity as shown by ankylosis of the vertebral epiphyses is very uncommon in the present series of whales.

Logarithmic plotting of mean values of body measurements against total lengths indicates that the relative growth rates of the anterior part of the body increase and of the posterior part decrease with increasing total length. The majority of the body measurements, however, do not show the simple relation between the relative growth rates of the parts and the total length that is found in some balaenopterid whales.

The headquarters of the Sperm whale is the tropics, but in summer there is a movement towards the temperate regions of the hemisphere concerned. Pairing mainly takes place during this migration and the females give birth to their young in subtropical and temperate waters. A small proportion of the males, though fully active sexually, leave the females at the height of the pairing season and migrate alone into high latitudes, later returning to temperate waters and joining the general movement of the schools towards the equator during winter.

The Sperm whale is not an important constituent of the world catch of whales, and forms a considerable portion of the catch in only a few places. Because this species is polygamous, and because the larger bulls segregate themselves during their solitary migration into high latitudes, the unrestricted capture of Sperm whales north and south of latitudes 40° N and 40° S respectively would be unlikely to affect adversely the world stock of Sperm whales, provided all Sperm whales between those latitudes were protected. The Sperm whale appears to be the species of whale which, owing to its habits, is the most suitable for exploitation on rational lines such as these. It is, however, at present of little economic importance. The International Agreement signed in 1937 will give almost complete protection to the cows.

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APPENDIX

MEASUREMENTS OF BODY PROPORTIONS

All measurements are in metres

Date	Whale no.	Sex	1 Total length, tip of snout to notch of flukes	2 Projection of snout beyond tip of lower jaw	3 Tip of snout to blow-hole	4 Tip of snout to angle of gape	5 Tip of snout to centre of eye	6 Tip of snout to tip of flipper	7 Centre of eye to centre of ear	8 Notch of flukes to posterior emargination of dorsal fin	9 Width of flukes at insertion	10 Notch of flukes to centre of anus	11 Notch of flukes to umbilicus
17. vi. 26	758	♂	13·70	1·07	—	—	—	6·10	—	4·80	1·03	3·85	6·40
30. vii. 26	D 20	♂	15·80	1·10	0·45	3·80	4·45	7·20	0·55	5·20	1·15	4·75	7·40
30. vii. 26	D 21	♂	16·90	1·40	0·65	4·60	5·20	7·85	0·55	5·40	1·17	4·60	7·90
29. iii. 27	1606	♂	14·90	0·95	—	—	—	—	—	—	1·09	4·00	6·75
12. iv. 27	1649	♂	14·35	1·00	—	—	—	—	—	5·27	—	4·27	6·37
13. iv. 27	1656	♂	15·85	0·80	—	3·50	4·15	6·20	0·53	4·20	—	4·80	7·85
13. iv. 27	1657	♂	14·80	—	—	—	3·80	5·80	0·48	5·30	1·00	4·20	7·05
11. iii. 28	1728	♂	15·40	1·00	0·78	3·90	—	6·75	—	5·10	1·06	4·46	7·25
11. iii. 28	1729	♂	15·37	1·25	0·71	4·26	—	7·28	—	4·65	1·08	4·25	7·00
11. iii. 28	1730	♂	15·32	1·27	0·55	4·00	—	7·04	—	5·02	0·97	4·20	6·82
11. iii. 28	1731	♂	15·70	1·00	0·65	4·35	—	—	—	4·89	1·05	4·40	7·42
20. iii. 28	1741	♂	16·87	1·33	0·95	4·50	—	8·20	—	5·10	1·15	4·87	7·54
26. iii. 28	H 3	♂	16·15	—	—	3·87	5·02	7·37	—	5·00	0·74	4·30	6·90
26. iii. 28	H 4	♂	16·26	—	—	3·70	4·20	7·20	—	5·20	0·73	4·55	7·45
27. iii. 28	H 5	♂	16·20	—	—	4·10	4·20	7·20	—	5·00	0·55	4·35	7·30
27. iii. 28	1752	♂	14·38	0·90	0·40	—	—	6·30	—	4·45	1·05	4·15	6·99
28. iii. 28	1753	♂	16·53	1·46	0·60	4·20	5·10	7·62	—	5·26	1·14	4·48	7·60
28. iii. 28	1756	♂	15·45	1·10	0·55	3·75	4·54	7·17	—	4·90	1·10	4·52	7·20
2. iv. 28	1758	♂	15·82	0·84	0·54	2·55	4·50	6·52	0·45	—	1·05	4·70	7·53
2. iv. 28	1759	♂	15·17	1·23	0·74	3·63	4·25	6·78	0·44	4·98	1·07	4·53	7·00
2. iv. 28	1760	♂	15·03	1·20	0·84	3·78	4·40	6·90	0·48	4·90	0·98	4·20	6·97
19. iv. 28	1766	♂	14·92	1·11	0·57	3·60	4·39	6·78	0·48	4·79	1·10	4·28	6·86
19. iv. 28	1767	♂	15·03	0·75	0·76	3·32	4·24	6·14	—	5·13	1·02	4·33	7·22
19. iv. 28	1768	♂	17·11	1·51	0·70	4·52	5·28	7·62	—	5·36	1·16	4·70	7·76
19. iv. 28	1769	♂	15·95	1·18	0·79	4·25	5·23	7·47	—	5·15	1·20	4·45	7·33
19. iv. 28	1770	♂	17·13	1·30	0·67	4·22	4·90	7·76	—	5·59	1·00	4·62	7·74
21. iv. 28	1771	♂	15·47	1·07	0·66	—	—	—	—	—	1·10	4·37	—
20. x. 28	1829	♂	17·47	1·26	0·69	4·36	5·18	7·98	0·49	5·92	1·19	5·05	8·12
22. x. 28	1830	♂	17·08	1·15	0·80	4·43	5·03	7·38	0·52	5·35	1·28	4·78	7·95
5. xi. 28	1879	♂	17·02	1·02	0·86	4·40	5·20	7·65	0·56	5·39	1·20	4·75	7·78
22. i. 29	2230	♂	16·03	1·15	0·58	3·99	4·50	7·17	0·52	5·20	1·11	4·73	7·71
19. iii. 29	2478	♂	14·14	0·78	0·60	3·13	3·74	6·15	0·48	5·05	0·97	4·28	7·06
19. iii. 29	2479	♂	14·91	0·82	0·50	3·33	3·70	6·68	0·41	5·20	1·11	4·82	7·89
19. iii. 29	2480	♂	14·52	0·76	0·62	3·02	3·75	6·18	0·48	5·25	1·12	4·49	7·35
8. i. 30	2931	♂	13·64	0·83	—	2·91	3·57	5·92	0·35	4·95	0·96	4·50	6·74
15. i. 30	2994	♂	17·50	1·24	—	—	5·49	—	0·65	—	—	4·64	7·72
21. i. 30	3011	♂	15·60	0·95	—	—	5·00	—	0·46	—	1·15	4·46	7·43
10. ii. 30	3129	♂	16·57	1·54	—	—	5·05	—	—	—	1·30	4·95	8·28
10. ii. 30	3130	♂	16·53	—	—	—	5·00	—	0·46	—	1·25	4·95	8·00
27. ii. 30	3170	♂	15·15	1·00	—	—	4·40	—	0·50	—	1·04	4·40	6·95
27. ii. 30	3171	♂	15·35	0·90	—	—	4·70	—	0·53	—	1·02	4·35	7·25
7. iii. 30	3193	♂	15·00	1·00	—	—	4·45	—	0·46	—	1·10	4·70	7·68
31. iii. 30	3255	♂	16·50	1·15	—	—	4·75	—	0·53	—	1·20	5·00	8·10
31. iii. 30	3256	♂	15·50	—	—	—	4·55	—	0·53	—	1·00	4·78	7·15
16. vi. 30	D 22	♂	15·60	1·60	—	4·50	4·95	—	—	—	—	5·40	—
17. vi. 30	D 24	♂	9·92	—	—	—	—	—	—	—	—	—	—
17. vi. 30	D 26	♂	17·30	1·45	—	4·20	—	—	—	6·00	1·10	4·90	8·90
22. vi. 30	D 36	♂	14·00	0·80	—	3·10	—	—	—	5·20	1·00	4·20	6·70
22. vi. 30	D 37	♂	13·65	1·30	—	3·80	3·80	—	—	4·65	1·00	3·95	6·50
22. vi. 30	D 38	♂	15·00	1·40	—	4·00	—	—	—	3·90	1·05	4·50	7·10
28. vi. 30	D 50	♂	15·82	0·80	—	3·90	4·61	—	—	5·55	1·16	4·60	7·50
28. vi. 30	D 51	♂	15·40	1·12	—	3·90	4·70	7·20	—	5·40	1·10	4·25	6·95
15. vii. 30	D 80	♂	12·10	0·60	—	2·65	3·10	—	—	4·40	0·92	3·75	6·20
15. vii. 30	D 81	♂	11·85	1·00	—	—	3·01	—	—	4·50	0·96	3·65	6·20
29. vii. 30	D 108	♂	13·40	0·85	—	—	3·75	—	—	4·75	0·95	3·70	6·40
29. vii. 30	D 109	♂	13·60	0·78	—	—	3·60	—	—	4·95	0·96	4·10	6·95
29. vii. 30	D 110	♂	13·90	0·60	—	2·88	3·70	—	—	5·15	1·09	4·20	6·05
1. viii. 30	D 114	♂	12·30	0·67	—	2·20	2·90	5·15	—	4·70	0·95	3·95	6·20
2. viii. 30	D 117	♂	15·90	0·95	—	3·75	5·10	—	—	5·30	—	4·50	7·50
3. viii. 30	D 120	♂	14·35	0·95	—	3·20	3·85	6·35	—	5·10	1·05	4·35	7·50
3. viii. 30	D 121	♂	16·75	1·45	—	4·30	—	—	—	6·15	1·15	4·60	7·60
26. viii. 30	D 150	♂	11·80	0·92	—	2·30	2·75	5·00	—	4·40	0·92	3·50	5·50
26. viii. 30	D 155	♂	10·80	0·80	—	2·05	2·56	4·22	—	4·00	0·80	3·35	5·35
26. viii. 30	D 159	♂	8·80	0·62	—	1·77	2·10	3·15	—	3·55	0·59	2·67	4·50
7. xi. 30	3292	♂	16·00	1·05	—	4·00	—	7·30	—	5·30	—	4·60	7·20
30. i. 31	3613	♂	15·95	1·30	—	4·00	—	7·36	—	5·13	1·01	4·45	7·18
14. ii. 31	3654	♂	15·06	1·04	0·66	3·95	—	6·75	—	5·12	1·02	4·25	7·13
10. viii. 26	932	♀	10·00	0·26	—	—	2·06	3·63	0·32	—	—	—	—
16. vi. 30	D 23	♀	10·70	—	—	—	2·40	—	0·30	4·10	—	3·40	5·60
17. vi. 30	D 25	♀	10·40	0·35	—	—	2·20	—	0·32	4·10	0·75	3·20	5·10
26. viii. 30	D 151	♀	9·70	0·45	—	1·60	1·95	3·60	—	—	0·73	2·75	4·70
26. viii. 30	D 152	♀	10·10	0·35	—	1·70	2·20	—	—	3·95	0·76	3·15	5·45
26. viii. 30	D 153	♀	9·70	0·65	—	1·68	2·05	3·62	—	3·87	0·70	3·50	5·30
26. viii. 30	D 156	♀	11·30	—	—	1·90	2·46	—	0·38	4·40	0·75	3·75	6·15
26. viii. 30	D 157	♀	9·80	0·35	—	1·44	1·82	3·50	—	3·85	—	3·15	5·50
26. viii. 30	D 158	♀	9·95	0·37	—	1·66	2·07	—	—	3·95	—	3·15	5·40
12. ix. 30	D 176	♀	9·60	0·56	—	1·75	2·10	3·80	—	—	0·76	2·90	—
12. ix. 30	D 177	♀	10·90	—	—	1·60	—	—	—	—	0·75	2·50	6·05
12. ix. 30	D 178	♀	10·20	—	—	1·50	2·00	3·80	—	—	0·66	3·22	5·50
12. ix. 30	D 179	♀	10·60	0·60	—	1·70	2·15	4·00	—	4·20	0·85	3·40	5·80
12. ix. 30	D 180	♀	9·90	0·40	—	1·45	2·05	—	—	3·80	0·75	3·25	5·60

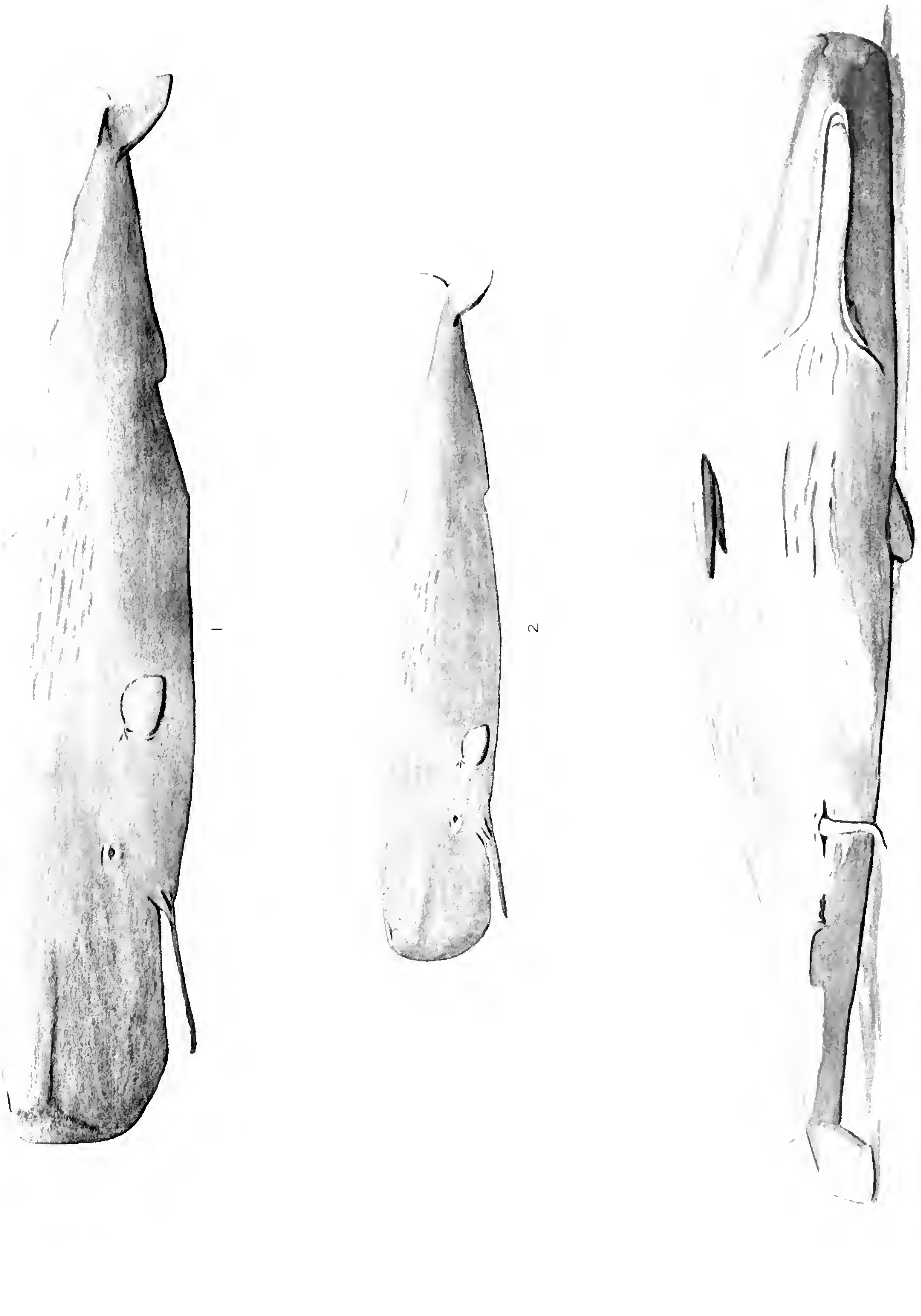
13 Centre of anus to centre of reproductive aperture	14 Vertical height of dorsal fin	15 Length of base of dorsal fin	16 Axilla to tip of flipper	17 Anterior end of lower border to tip of flipper	18 Length of flipper along curve of lower border	19 Greatest width of flipper	20 Length of severed head from condyle to tip	21 Greatest width of skull	22 Skull length, condyle to tip of premaxilla	23 Length of flipper from head of humerus to tip	25 Height of head	Locality
1·80	—	1·10	—	—	—			—				Saldanha Bay
1·55	0·40	1·35	1·14	1·56	1·60	0·76	5·00	2·30	4·80			Durban
1·90	0·30	1·20	1·05	1·50	1·55	0·70	—	—				,,
1·80	0·20	—	—	—	—	—	—	—				South Georgia
1·51	0·27	—	1·20	—	1·36	—	4·90	2·20				,,
1·50	0·30	—	0·70	1·45	—	0·74	5·30	—				,,
1·55	0·45	—	0·70	1·30	—	0·63	—	—			2·75	,,
1·78	0·38	1·60	—	1·25	1·32	0·68	5·49	—			—	,,
1·75	0·34	1·25	0·95	1·40	1·45	0·66	5·90		—			,,
1·60	0·31	1·35	1·03	1·26	1·35	0·65	5·60			1·40		,,
2·04	0·36	1·47	—	—	—	—	6·15	—	—	—		,,
2·40	0·37	1·40	—	—	—	—	6·58	—	—	—	—	,,
1·74	0·12	0·55	1·01	1·38	1·40	0·75	—	2·10	4·90	1·45		,,
1·90	0·12	1·00	1·07	1·48	1·51	0·75	—	2·12	4·65	1·57	—	,,
2·05	0·34	0·90	0·98	1·32	1·32	0·69	—	2·00	4·80	1·42		,,
1·63	0·33	1·30	0·85	1·30	1·33	0·64	5·21	—	—	—	—	,,
2·02	0·41	2·45	0·84	1·28	1·33	0·68	5·93	—	—	—		,,
1·58	0·38	1·65	0·90	1·43	1·50	—	5·57	—	—	—	—	,,
1·68	0·38	1·85	0·85	1·20	1·25	0·70	5·35	—	—	—	—	,,
1·55	0·39	1·79	0·74	1·40	1·43	0·74	5·35	—	—	—	—	,,
1·75	0·38	1·45	0·75	1·35	1·42	0·69	5·23	—	—	—	—	,,
1·70	0·30	2·00	0·80	1·31	1·37	0·66	5·40	—	—	—	—	,,
2·04	0·34	1·45	0·74	1·24	1·30	0·63	5·13	—	—	—	—	,,
1·86	0·45	1·60	1·08	1·53	1·55	0·88	6·57	—	—	1·55	—	,,
1·84	0·26	2·01	0·82	1·43	1·45	0·74	6·22	—	—	—	—	,,
1·86	0·46	1·73	1·08	1·56	1·60	0·72	—	—	—	—	—	,,
—	—	—	1·05	1·33	1·40	0·70	5·59	—	—	—	—	,,
1·90	0·26	1·70	—	—	—	—	6·21	—	—	—	—	,,
1·86	0·32	1·45	1·09	1·40	1·55	0·77	6·40	—	—	—	—	,,
1·65	—	1·63	1·38	1·56	1·56	0·79	6·38	—	—	—	—	,,
1·90	0·38	2·10	1·13	1·54	1·60	0·76	5·65	—	—	—	—	,,
1·79	0·24	1·40	0·92	1·35	1·40	0·66	4·68	—	—	—	—	,,
1·94	0·34	1·40	0·89	1·41	1·47	0·67	4·93	—	—	—	—	,,
1·68	0·26	1·34	0·95	1·18	1·28	0·69	—	—	—	—	—	,,
1·72	0·39	—	0·88	1·18	—	0·58	4·70	—	—	—	—	,,
1·95	—	—	—	—	—	—	6·60	—	—	—	—	,,
1·85	0·42	—	1·50	—	—	—	—	—	—	—	—	,,
1·80	—	—	1·18	1·48	—	0·79	—	—	—	—	—	,,
1·91	—	—	—	—	—	—	—	—	—	—	—	,,
1·75	0·40	1·45	—	1·35	—	0·75	5·39	—	—	—	—	,,
2·00	0·17	—	1·12	1·39	—	0·73	5·36	—	—	—	—	,,
1·73	—	—	0·95	1·38	—	0·70	4·84	—	—	—	—	,,
1·87	0·25	—	1·16	1·47	1·50	0·72	5·70	—	—	—	—	,,
1·80	0·16	—	1·05	1·40	1·42	0·73	5·40	—	—	—	—	,,
2·20	—	—	—	—	—	—	—	—	—	—	—	Durban
—	—	—	—	—	—	—	—	—	—	—	—	,,
1·80	—	—	—	—	—	—	—	—	—	—	—	,,
1·60	—	—	0·95	1·25	—	0·65	4·90	—	—	—	2·15	,,
1·50	—	—	0·95	1·32	—	0·72	4·80	—	—	—	2·15	,,
1·45	—	—	—	1·25	—	0·62	5·70	—	—	—	2·70	,,
1·80	—	—	1·00	1·20	—	0·62	5·45	—	—	—	—	,,
1·70	—	—	—	1·30	—	—	5·85	—	—	—	2·70	,,
1·35	—	—	0·99	1·19	—	0·66	3·94	—	—	—	1·83	,,
—	—	—	1·06	0·90	—	0·65	3·75	—	—	—	1·80	,,
1·65	—	—	1·17	0·92	—	0·62	—	—	—	—	2·05	,,
1·60	—	—	1·00	1·28	—	0·61	—	—	—	—	2·00	,,
—	—	—	—	—	—	—	—	—	—	—	2·05	,,
1·65	—	—	—	1·05	—	0·56	4·00	—	—	—	1·63	,,
1·75	—	—	0·94	1·33	—	0·70	5·34	—	—	—	2·50	,,
1·70	—	—	0·83	1·26	—	0·65	4·70	—	—	—	2·20	,,
1·75	—	—	—	1·39	—	0·73	6·50	—	—	—	2·90	,,
1·40	—	—	0·82	0·92	—	0·55	—	—	—	—	1·70	,,
1·60	—	—	0·77	1·15	—	—	3·55	—	—	—	1·55	,,
1·20	—	—	0·70	0·92	—	0·46	—	2·82	—	—	1·35	,,
1·60	—	—	1·08	1·43	—	0·80	5·78	—	—	—	—	South Georgia
1·70	—	—	1·02	1·35	—	0·77	5·80	—			2·53	,,
1·85	—	—	1·05	1·29	—	0·63	5·65	—	—		2·49	,,
0·67	0·28	1·00	—	0·87	—	0·46	—	—	—	—		Saldanha Bay
—	—	—	0·75	0·75	—	0·45	2·80	—			—	Durban
—	—	—	—	—	—	—	—	—	—		—	,,
0·22	—	—	0·74	0·87	—	0·47	2·70	—	—		—	,,
0·12	0·20	—	0·75	0·95	—	0·50	2·90	—				,,
0·17	0·22	—	0·77	1·00	—	0·46	—	—	—	—	—	,,
0·30	—	—	—	—	—	—		—		—		,,
0·25	—	—	0·62	0·90	—	0·44	—	—		—	—	,,
0·22	—	—	0·67	0·94	—	0·46		—	—	—		,,
—	—	—	0·57	0·70	—	0·45	—	—	—	—	—	,,
0·21	—	—	0·85	1·00	—	0·55		—	—	—	1·30	,,
—	—	—	0·75	0·95		0·45	—	—	—	—	1·20	,,
0·13	—	—	0·80	1·10	—	0·50	2·90	—	—		1·31	,,
—	—	—	0·67	0·90	—	0·49	2·70	—	—	—	1·25	,,

PLATE III

Fig. 1. Adult male Sperm whale 17 m. long.

Fig. 2. Adult female Sperm whale 11·3 m. long.
Both drawn on the same scale, from the average measurements of the species.

Fig. 3. Sperm whale. Adult male. Showing absence of pigmentation on upper lips, lower jaw, round umbilicus, genital aperture and on post-anal region of tail. Flecks of white also extending on to flanks. Sketched at Leith Harbour, South Georgia. 13. i. 27.



THE SPERM WHALE

PLATE IV

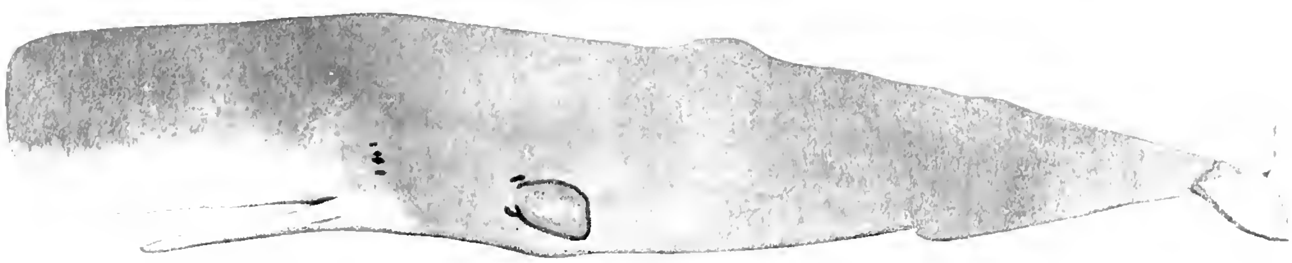
Background colour of the Sperm whale

Fig. 1. All black.

Fig. 2. Lighter on under surface of head and lower jaw.

Fig. 3. Light on whole of ventral surface.

1



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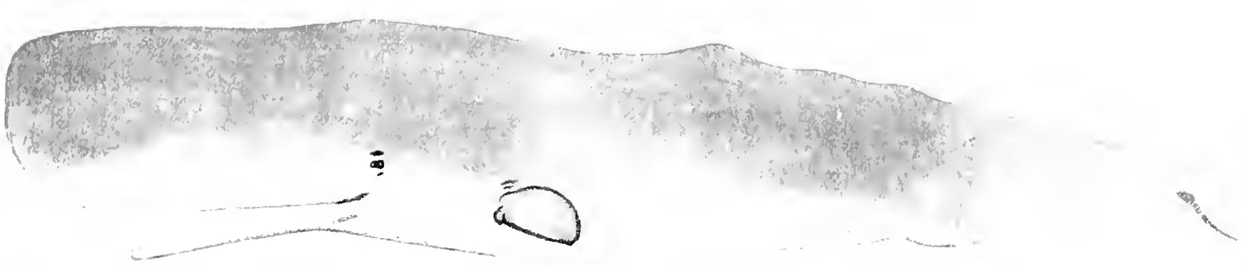

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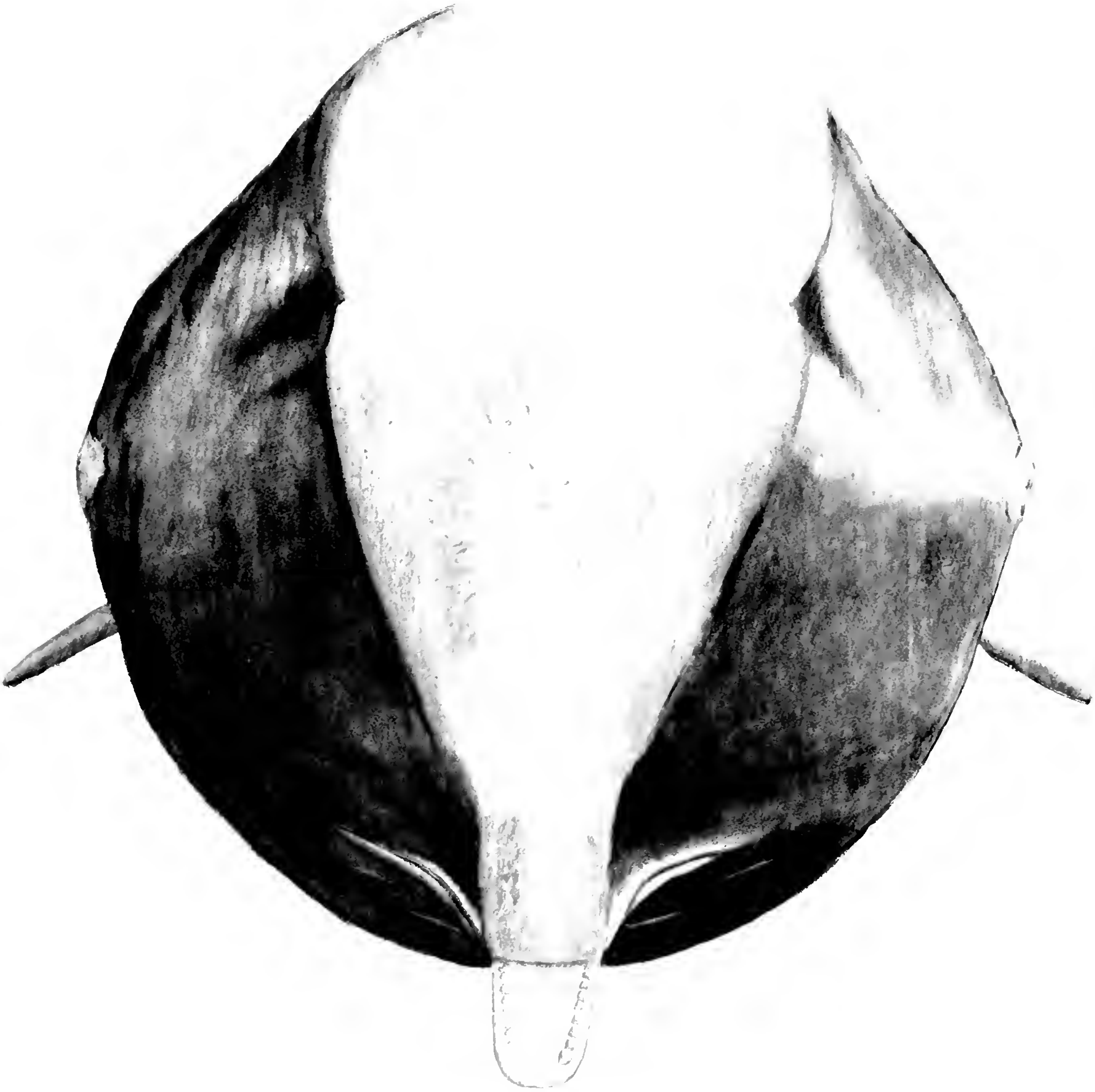
THE SPERM WHALE

PLATE V

Head-on view of adult male Sperm whale. Absence of pigment on anterior lower part of head, and head whorl of darker and lighter pigment flecks.



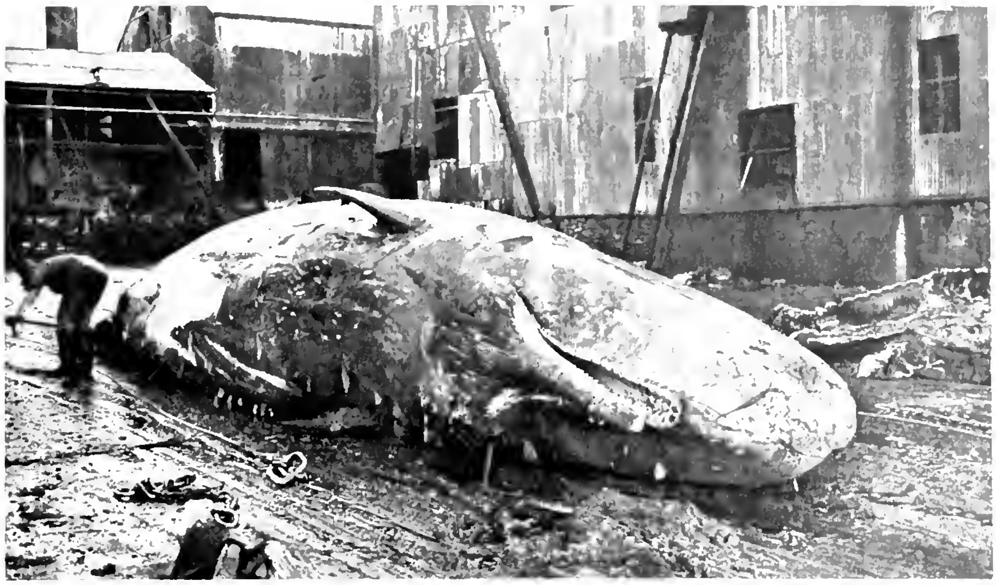
THE SPERM WHALE

PLATE VI

Fig. 1. Female Sperm whale, Saldanha Bay, 1926. Note white umbilical splash, white lips, and throat grooves.

Fig. 2. Male Sperm whale, South Georgia, 1926. Genito-anal region. Note white umbilical splash extending on to flanks, corrugated surface of body, post-anal ventral hump.

Fig. 3. Male Sperm whales, Durban, 1930. Note white splash on flank of farther whale; on nearer whale corrugated body surface, dorsal fin and smaller dorsal humps posterior to it.



N. A. Mackintosh phot. 1

N. A. Mackintosh phot. 2

F. D. Ommanney phot. 3

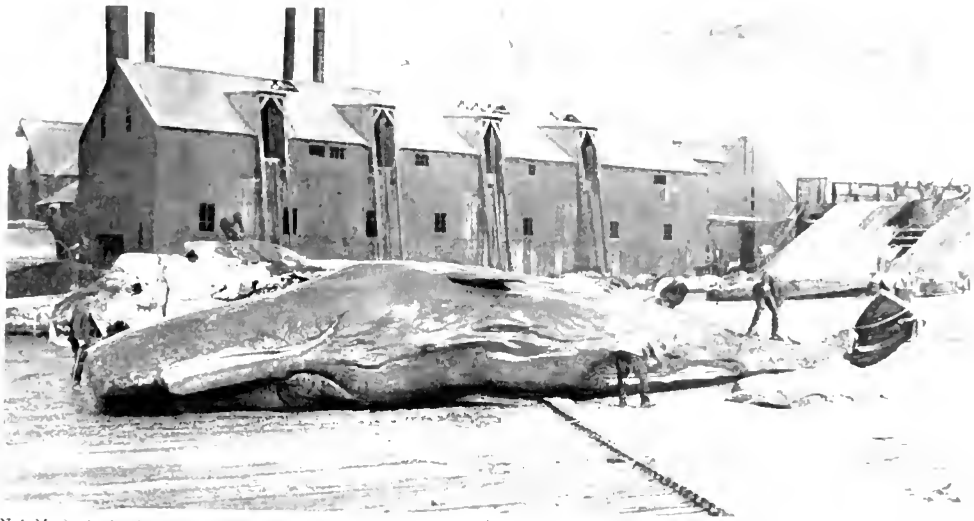
THE SPERM WHALE

PLATE VII

Fig. 1. Male Sperm whale, South Georgia, 1926. Note throat grooves and corrugations on flank and ventral surfaces.

Fig. 2. Female Sperm whales, Durban, 1930. Note white lips of both jaws of right-hand whale; blow-hole, dorsal fin and corrugations on flank of left-hand whale.

Fig. 3. Palate of male Sperm whale, South Georgia, 1925. Note sockets for teeth of lower jaw, and rudimentary teeth (shown by arrows). The anterior end is at the right.



N. A. Mackintosh phot.

1

F. D. Ommanney phot.

2

L. H. Matthews phot.

3

THE SPERM WHALE

PLATE VIII

Fig. 1. Male Sperm whale, South Georgia, 1925. Drawing the spermaceti from a Sperm whale's head. The man in the middle has just cut off the anterior part of the head allowing the spermaceti to gush out into the boiler seen at the lower right-hand corner.

Fig. 2. Male Sperm whale, South Georgia, 1925. The start of flensing alongside a floating factory. Note lower jaw, palate and tongue: notches in upper lip cut by teeth of lower jaw (the sockets into which the teeth fit when the mouth is closed are within the lips).

Fig. 3. Male Sperm whale, South Georgia, 1926. Flensing in progress. Note white scratches made by cephalopod claws on skin nearest camera.

1

2

3

THE SPERM WHALE

L.H. Matthews phot.

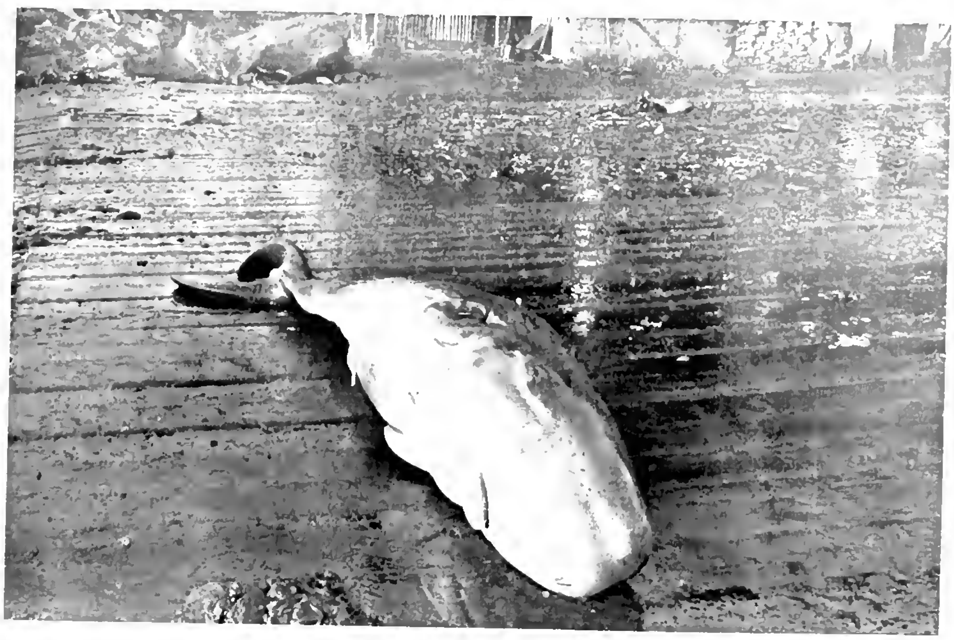
PLATE IX

Fig. 1. Sperm whale. Female foetus. Saldanha Bay, 1926. Note throat grooves, corrugations on ventral surface, common genito-anal groove with mammary grooves on each side of it. A stream of blood oozes from the anus.

Fig. 2. The same, anterior view. Note the post-anal ventral hump.

Fig. 3. Male Sperm whale, South Georgia, 1925. Mouth and lower jaw. Note white inner surface of lower jaw, but pigmented lips on both jaws. A strip of blubber has been detached from the lower jaw, as the process of flensing begins.

1



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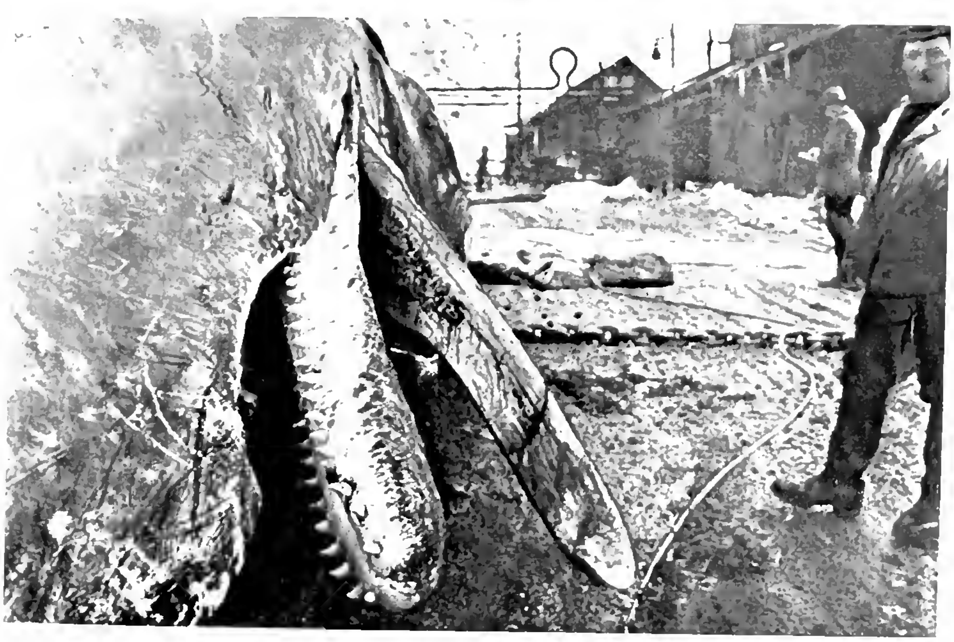


N. A. Mackintosh phot.

3

THE SPERM WHALE

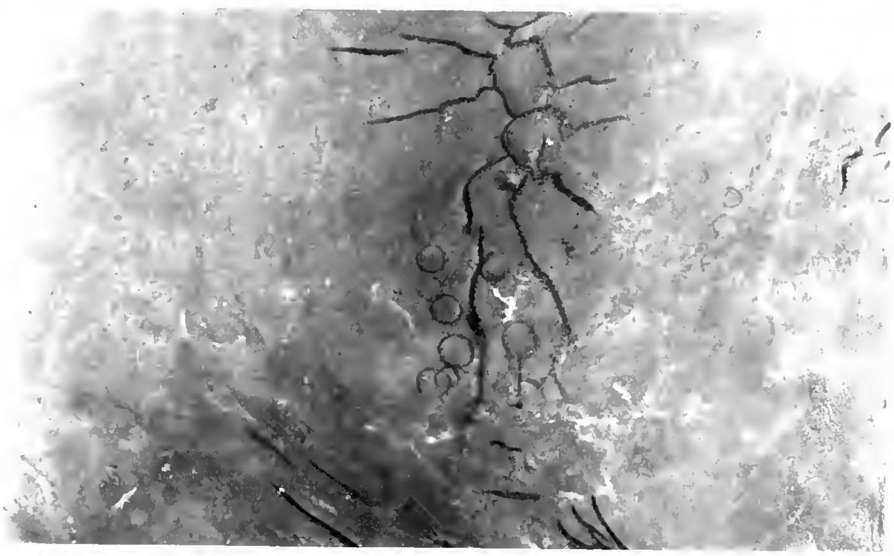
PLATE X

Fig. 1. Male Sperm whale, Durban, 1926. Note white lips of both jaws, large and small throat grooves.

Fig. 2. Male Sperm whale, South Georgia, 1925. Circular marks of cephalopod suckers on skin of whale. The cracks in the skin have been made since death.

Fig. 3. Sperm whale. Cysts of *Phyllobothrium physeteris* in the blubber. Approximately ½ natural size.

1



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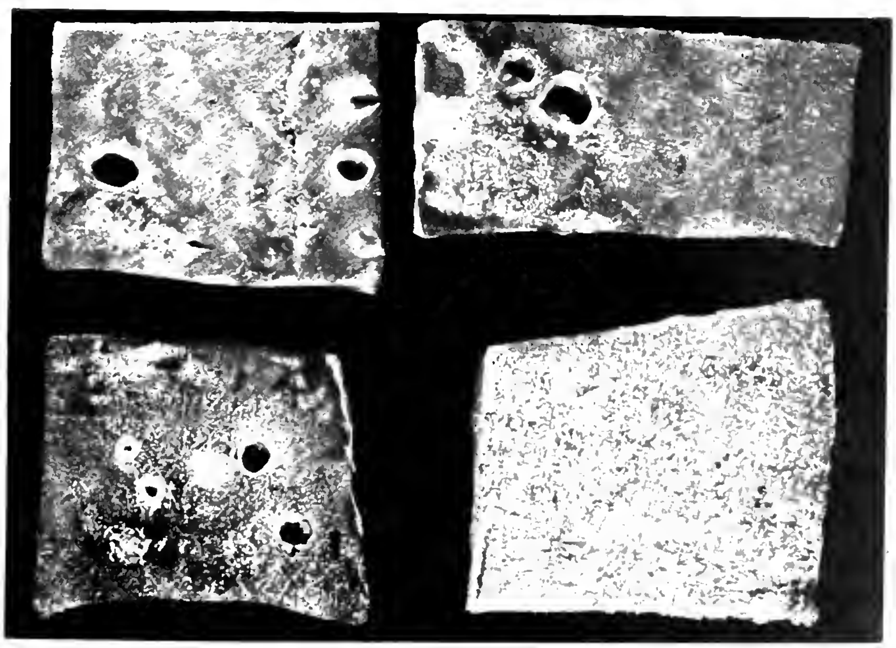


L. H. Matthews phot.

3

THE SPERM WHALE

PLATE XI

Fig. 1. Sperm whale. Microphotograph of section of completely inactive testis tissue. × 50.

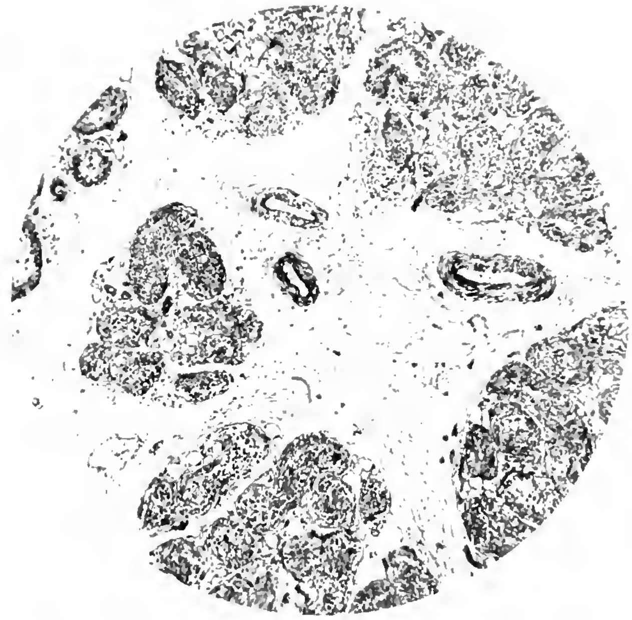
Fig. 2. Sperm whale. Microphotograph of section of adult testis, active stage, tubules full of dividing cells. × 50.

Fig. 3. Sperm whale. Microphotograph of section of adult testis, resting stage, tubules with large clear spaces. × 50.

Fig. 4. Sperm whale. Ovaries of non-pregnant Sperm whale. Note smooth surface. Approximately $\frac{1}{4}$ natural size.

Fig. 5. Sperm whale. Ovaries of pregnant Sperm whale. The corpus luteum *a*, at the top on the right hand, is not constricted off by a neck. Corpora lutea *b* appear as low swellings. Approximately $\frac{1}{4}$ natural size.

1



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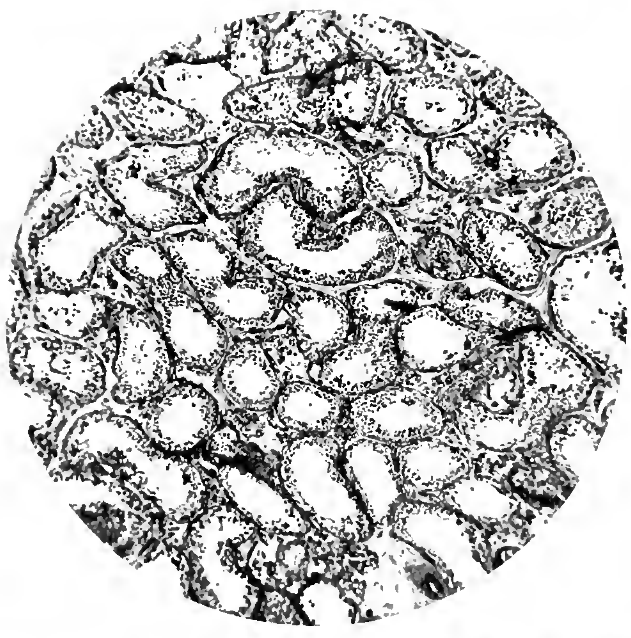

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THE SPERM WHALE

[*Discovery Reports*. *Vol. XVII*, *pp.* 169–182, *Plates XII–XVII*, *April*, 1938.]

NOTES ON THE SOUTHERN RIGHT WHALE, *EUBALAENA AUSTRALIS*

By

L. HARRISON MATTHEWS, M.A.

NOTES ON THE SOUTHERN RIGHT WHALE, *EUBALAENA AUSTRALIS*

By L. Harrison Matthews, M.A.

(Plates XII–XVII)

INTRODUCTION

Zoologists rarely have the opportunity of examining specimens of the Southern Right whale nowadays, and in consequence it seems desirable to place on record the few notes that have been collected on this species during the Discovery investigations.

The Southern Right whale formerly occurred in very large numbers in the southern oceans, and was particularly numerous in coastal waters of the southern part of the African and American Continents, Australia and New Zealand, and of all the islands between 30 and 60° S. It was the subject of a large fishery which, by the destruction of the females and young on the breeding grounds, reduced the numbers of the species to so low an ebb that its capture was abandoned. According to Harmer (1928) 193,522 Southern Right whales were captured from 1804 to 1817, an average of 13,823 annually. Ommanney (1933) gives an interesting account of the old Right whale industry of New Zealand.

Townsend (1935) gives a chart showing the position of capture of 6262 Southern Right whales by American whale ships between 1785 and 1913. The majority of the positions lie between 30 and 50° S, with outliers up to 20 and 57° S. An inspection of the chart shows that hunting started at the northern range of the species in June and July and gradually worked southwards during the season, so that the highest southern latitudes were hunted mostly in February and March. Most of the whaling took place in the South Atlantic, Indian and South Pacific Oceans between latitudes 30 and 40° S from October to January inclusive. It was not confined to coastal waters, so that the plotted positions form a well-defined band right across the oceans of the world between these latitudes. Later in the season, from January to March, hunting was carried on farther south and was particularly intensive around the Crozets and Kerguelen.

Harmer (1928) states that it seems probable that the several species of Southern Right whale that have been described should all be referred to as a single species, which is closely allied to, but possibly distinct from, the Biscay whale. The latter opinion is supported by the statement of Townsend (1935) that as far as the Right whales are concerned the region between 30° N and 30° S represents a vacant tropical belt, and that there were no records in the logs of the 1670 whaling voyages that he examined to indicate any mingling of Northern and Southern Right whales. Allen (1908) gives a very complete survey of the literature of Right whales, and believes that there are at least four species of Right whale in the oceans of the world, a view that has yet to be substantiated. If the Northern and Southern Right whales eventually turn out to be the same species they will provide a very striking example of discontinuous distribution.

The Southern Right whale still occurs in the southern oceans in small numbers, but its hunting has been prohibited in the Dependencies of the Falkland Islands for many years. Hinton (1925) states that in 1914 Barrett-Hamilton was told that Right whales were taken when found with other species, but that they usually kept to themselves to the north-west of South Georgia and were not worth specially hunting there. During the seasons 1909/10–1917/18 the numbers of Right whales taken in the Dependencies of the Falkland Islands varied from nine to ninety-nine each season with a total of 397 for the nine seasons (*Rep. Interdep. Committee*, 1920). Although the species is not protected in South African waters, there are only four records of its capture in Cape Province during the seasons 1920–7, the four whales being two females with their accompanying calves.

MATERIAL

On two occasions while the Discovery staff was working at South Georgia, Right whales were killed by mistake and brought into the whaling station, where they were examined. These were whales Nos. 503 and 3560. A further specimen was taken by special permission and brought into Leith Harbour, South Georgia, where its skeleton was prepared for the British Museum (Natural History). Though not examined in the flesh by the scientific staff a number of measurements are available from this whale. The skeleton was afterwards lost; while awaiting shipment an avalanche from the nearby mountain overwhelmed the old part of the whaling station at Leith Harbour where it lay.

In 1926 a female Southern Right whale and her calf were killed and brought into the whaling station at Saldanha Bay, Cape Province, where they were examined by members of the staff. These are whales Nos. 1019 and 1020. Finally, the writer was able to keep a Right whale under observation for some time at close quarters in one of the bays at the northern end of South Georgia in 1925, and the observations and sketches then made are here reproduced (Plate XVII).

MEASUREMENTS

A number of the standard series of measurements, used for Blue and Fin whales, were taken, together with a few extra ones. They are set out in Table I, and may serve as a basis of comparison with the measurements of Right whales from other localities.

COLOUR

Colour notes were made on whales Nos. 1019, 1020 and 3560. They are as follows:

No. 1019, adult female: general colour black. An asymmetrical pure white irregular patch over the abdomen with a further white patch extending from it on the left side. Demarcation from the black very sharp (Plate XII, fig. 2).

Table I. *Southern Right whale. Measurements of five whales (metres)*

Date	Whale no.	Sex	1. Total length, tip of snout to notch of flukes	3. Tip of snout to blow-hole	4. Tip of snout to angle of gape	5. Tip of snout to centre of eye	6. Tip of snout to tip of flipper	7. Centre of ear to centre of eye	9. Width of flukes at insertion	10. Notch of flukes to centre of anus	11. Notch of flukes to umbilicus	13. Centre of anus to centre of reproductive aperture	16. Axilla to tip of flipper	Place
4. ii. 26	503	♂	13·54	2·89	—	3·38	—	—	1·01	3·2	5·45	0·9	—	South Georgia
26. viii. 26	1019	♀	15·23	3·70	—	4·09	—	—	1·13	4·6	7·55	0·55	2·03	South Africa
26. viii. 26	1020	♂	6·5	1·0	—	1·24	—	0·28	0·75	2·09	3·65	—	1·02	South Africa
14. i. 31	3560	♀	14·4	2·82	3·1	3·43	—	—	—	4·77	7·8	0·35	2·12	South Georgia
25. xi. 26	Leith	♂	12·32	2·7	—	3·74	5·21	—	1·22	—	—	1·5	2·06	South Georgia

Date	Whale no.	Sex	17. Anterior end of lower border to tip of flipper	18. Length of flipper along curve of lower border	19. Greatest width of flipper	20. Length of severed head from condyle to tip	21. Greatest width of skull	22. Skull length, condyle to tip of premaxilla	23. Length of flipper from head of humerus to tip	24. Depth of body at anus	Penis, length	Penis, circumference at base	Length of eye	Place
4. ii. 26	503	♂	2·66	2·8	1·35	3·88	2·62	—	—		—	—		South Georgia
26. viii. 26	1019	♀	2·5	2·62	1·24	4·7	—	—	—	—		—		South Africa
26. viii. 26	1020	♂	1·16	1·23	0·67	—	—	—	—		—			South Africa
14. i. 31	3560	♀	2·28	—	1·2	—	2·43	3·85	—	1·8	—	—		South Georgia
25. xi. 26	Leith	♂	2·59	2·97	1·35		2·44	3·56	2·82		2·24	0·33	0·064	South Georgia

No. 1020, calf, male: black except for a large white patch (almost symmetrical) on the belly. The patch of an entirely different shape from that of the mother (Plate XIII, fig. 1).

No. 3560. Adult female: uniform dark slate-grey. A stellate patch of white at the umbilicus (Plate XIII, fig. 2).

The occurrence of the conspicuous white marking on the belly of these whales is of interest because the colour of the Right whale is usually said to be black all over, though both Allen (1908), Andrews (1908, 1909) and Collett (1909) mention small spots and large ventral patches of white as occurring sometimes on the Northern Right whale. Lonneberg (1906) records white patches on two out of seven Southern Right whales examined at South Georgia.

BALEEN

The baleen of the Right whale is very long when compared with that of balaenopterid whales (Plate XII, fig. 1; Plate XIV, fig. 1; Plate XV, figs. 1 and 2). The longest plate measured in the present series was 2·04 m. in length. Hinton (1925) records a plate measured by Barrett-Hamilton in South Georgia as 2·21 m. long. The detailed measurements of the baleen of the whales of the present series are shown in Table II. The baleen of the calf, No. 1020, is noted as being in an almost rudimentary condition; it was only 17 cm. long. That of whale No. 3560 was dark grey in colour. The bristles were black and of fine texture. They were very long and drooped from their insertions upon the plates. Plate XVI, fig. 2, shows two plates of Southern Right whale baleen from South Georgia. Their length is 1·86 m. and 2·05 m. respectively: they were taken some years prior to 1924.

The number of plates is recorded only in whales Nos. 1019 and 3560, in which there were 235 and 227 plates respectively on one side of the jaw.

Table II. *Southern Right whale. Baleen*

Whale no.	Sex	Total length, metres	Number of plates one side	Spacing, cm.				Length, cm.				Width at base, cm.	Length of base inserted in jaw, cm.
				Region not stated	At front	At centre	Near gape	Longest External	Longest Internal	Sixth plate external	Twentieth plate, external		
503	♂	13·54	—	—	—	—	—	180	—	—	—	30	20
1019	♀	15·23	235	2·3	—	—	—	204	—	—	—	—	—
1020	♂	6·5	—	—	—	—	—	17	—	—	—	—	—
3560	♀	14·4	227	—	1·2	1·7	1·4	200	184	12·0	15·0	—	—

HAIR

Hair occurred on the head of all four whales examined.

No. 503. An ill-defined group of hairs on the chin, about ¼ in. long and rather fine.

No. 1019. Hairs scattered over a relatively large area on the chin. Some hairs also present on the snout in front of a callosity at the anterior end.

No. 1020. Numerous hairs on the chin.

No. 3560. A small tuft of hairs about 0·8 cm. in length was seen on the rostrum.

Hair groups occur, then, on the chin and the tip of the snout. They were not noted on the side of the jaw, or on the mid-line of the rostrum. This is further referred to in the next section on the bonnet.

BONNET

A characteristic feature of the Right whale is the presence on the snout of a large callosity known to the old hand-harpoon whalers as the bonnet. This, and other callosities, are plainly seen in the photographs (Plate XII, fig. 1; Plate XIII, fig. 2; Plate XIV, fig. 1; Plate XV, fig. 1). They are all nearly circular or oval in outline. The bonnet is the largest and most anterior of the median dorsal callosities. A group of very much smaller callosities occupies the mid-line of the rostrum between the bonnet and the blow-hole, behind which lies a further small pair. On each side of the lower jaw there is a further group of callosities. The most anterior is the largest, and it is roughly kidney-shaped with a small circular callosity occupying the notch (Plate XII, fig. 1; Plate XIV, fig. 1; Plate XV, fig. 1). A line of small callosities runs back towards the gape from this large anterior one. In whale No. 3560 the largest of the callosities was 1 m. in diameter, this measurement referring apparently to the bonnet. On the mandible the patches were smaller and nearly circular. They were fairly regularly spaced at distances from one another of about 20 cm. Finally, there is a callosity on each side of the head just above the eye. In size it is intermediate between that of the bonnet, the anterior lower jaw callosities and the smaller ones on the rostrum and jaw. Lonneberg (1906) illustrates the position of the callosities in this species. Callosities similar in appearance and distribution are described from the Northern Right whale by Andrews (1909). Ridewood (1901) examined a dried specimen of the bonnet of a Southern Right whale, presented to the British Museum in 1864, and prepared microscopic sections of it. He found it was composed of a mass of closely packed fibres set at right angles to the surface of the skin. The bases of the fibres were hollow, for the accommodation of vascular papillae. He points out the essential similarity of the structure to that of the hoof of the horse, the horn of the rhinoceros and parts of the horns of oxen and goats. This author well summarizes what was known of the bonnet, as follows:

> This wart or bonnet on the snout has been the object of many ingenious speculations. Gray mentioned it as the opinion of a foreign zoologist, whose name is not disclosed, that the bonnet is an excrescence formed by the adhesion of the barnacles called *Coronula*. A second opinion of the same authority is that it is caused by the irritation of the whale-louse. Mr Holdsworth suggested that it was a natural development, and was possibly characteristic of the species; while Owen considered it as due to disease of the outer layers of integument. Beddard, in his recent *Book of Whales*, states that "it gives one the impression that it is a pathological structure, a kind of corn, perhaps produced by the animal rubbing itself against rocks, as this species has been observed to do in order to get rid of the barnacles which are apt to infest it.
>
> It is an interesting fact that the bonnet appears to be confined to the Southern Right whale. Gray has expressed his inability to find mention of this structure in any account of the Greenland whale; and the experienced whaling captain, Mr Robert Kinnes of Dundee, writes, in a letter dated October 4th 1900, "that the Greenland whale has no excrescence on its nose". What is still further of interest is the fact that in the whale figured by Gray in Dieffenbach's *Travels in New Zealand*, vol. II, as *Balaena antipodarum*, there is a prominence on the front of the lower jaw as well as on the front of the upper one.

Ridewood concludes that the bonnet of the Southern Right whale would appear to be a circumscribed area of skin, where, for some reason not apparent, the cornified layers fail to rub off at their normal rate, but remain and accumulate to produce a hard mass, projecting above the general surface of the epidermis as a kind of corn. I have been unable, after examining microscopic sections prepared from well-preserved material, to find any essential difference between the structure of one of the smaller callosities and that of normal skin, except that the outer cornified layers are thicker.

On two occasions different members of the Discovery Staff, when examining Right whales, noted that the callosities on the mandible "may have marked the position of hairs" (whale No. 503, 26. viii. 26), and "their appearance suggested that they may have been occupying the position of hair follicles" (whale No. 3560, 14. i. 31). The callosities occupy just those positions where hair groups would be found in other whales, and the opinions expressed above, being those of men who have examined many hundreds of whales, strongly support the suggestion that the bonnet and other callosities represent hair groups of other whales. The callosity over the eye would thus represent the eyebrow, a feature unknown in other species.

The occurrence of fully developed callosities in whale No. 1020, a sucking calf, shows that they are congenital and not developed after adult life is reached, as do those recorded in a foetus by Lonneberg (1906). In view of the fact that the callosities are the centres of the heavy infection by cyamids that is always found on this species of whale (see below, external parasites), one wonders whether there may not be some truth in the suggestion that they form a basis for some sort of commensal relationship between parasite and host. The advantage to the parasite of these thickened areas both for protection and food is evident from their concentration in them. The advantage to the host is more problematical, but it seems possible that the localization of the parasites on special areas of thickened epidermis may save the host the irritation presumably caused by such large numbers, were they scattered at random on the thinner parts of the skin.

Allen (1908) speaks of "the well-known function of this structure [the bonnet], as the nidus of parasitic crustacea, by which its growth is promoted, if not originally caused". This view cannot be correct, for it has been shown above that the bonnet and other callosities were present in a young calf; further, the situation and relative size of the bonnet and other callosities is constant, and parasitic crustacea, though concentrated in them, are not confined to the callosities. Again, why do not other species, especially the Humpback, which are also infested with cyamids, have callosities?

Andrews (1909) gives excellent photographs of the callosities and their associated swarms of parasites in the Northern Right whale. They are exactly similar in every respect to those of the present series of whales. Lonneberg (1906) also illustrates callosities of the Southern Right whale from South Georgia.

PALATE AND TONGUE

No. 1019. The whole palate, from the oesophagus almost to the tip of the snout, is a narrow pinkish strip, of a uniform width of about 3 in., and with a groove at the anterior end. The whole of the tongue is quite smooth, colour bluish-grey with some insignificant spots and streaks of white.

No. 1020. Palate about the same, or slightly wider than in the mother (No. 1019).

No. 3560. The palate was white in colour and flat. Under the tip of the snout between the anterior baleen plates it widened out to a spatulate area 32 cm. in width. No Jacobson's organs were seen on the snout (Plate XV, figs. 1 and 2). The tongue was comparatively small, but was very thick and muscular. Its surface was smooth and its colour white, with grey-blue flecks laterally (Plate XV, fig. 1).

BLUBBER

The blubber is thick in comparison with the size of the whale (Plate XIV, fig. 2). It is noted in No. 1019 as being much softer than in Blue and Fin whales. In this whale its thickness on the back above the shoulders was 14 cm., above the umbilicus 25 cm., half-way between the notch of the flukes and the blow-hole 36 cm., and on the flank opposite the anus 22 cm.

In No. 1020 the blubber was 9 cm. thick on the flank opposite the anus.

No further notes on the blubber are recorded.

PARASITES

EXTERNAL

All the Right whales examined were very heavily infested with the isopod *Cyamus*. The parasites are found in particularly large numbers on the callosities of the head, but are not confined to them. Detailed notes are as follows:

No. 1019. Very thick swarms of cyamids in the genital groove, on each side of the chin, and on the callosities of the mandible, above the eye, and round the blow-hole. The greater part of the body almost free from parasites. No other parasites were observed.

No. 1020. Numerous masses of cyamids all over the head and thorax, especially on the lips, above and below the eye, on the rostrum, and ventrally between the flippers and on the tail.

No. 3560. Patches of the skin [the callosities] were heavily infected with cyamids of every age and size. The cyamid patches were very greatly thickened and proliferated areas of the epidermis in which myriads of the cyamids burrowed, so that the deeper individuals were almost completely buried. No diatom film was seen.

In addition to cyamids, cirripedes are recorded from one whale: the note for No. 503 reading "a mass of encrusted barnacles and lice on each side of the chin".

No scars, such as are found on other whales, made by an unknown agent in the seas of lower latitudes, were recorded from the whales of the present series. There is no record, positive or negative, regarding three of them, but of the fourth, No. 3560, it is noted that no pits or scars of any sort were seen on the surface of the skin.

INTERNAL

There is no note on the internal parasites relating to whales Nos. 503 and 1020. It is recorded that no worms were found in No. 1019. Intestinal parasites were, however, present in whale No. 3560. They appeared to be the familiar trematode, *Ogmogaster* sp., and the Tetrabothriid, *Tetrabothrius affinis*, usually found in Blue and Fin whales.

FOOD

Little information has been gathered as to the food of the species from the present series of whales. The stomachs of whales Nos. 1019 and 3560 were empty, but that of No. 509 is recorded as containing some fairly fresh food [krill, *Euphausia superba*] and a lot of darkish fluid. The stomach and oesophagus of No. 1020, a calf, were full of fresh looking milk. The writer has recorded elsewhere (Matthews, 1932) how the Southern Right whale feeds on shoals of the pelagic *Grimothea* post-larva of *Munida gregaria* off the coast of Patagonia.

GENITALIA

THE MALE

The penis of whale No. 503 was pigmented, and was noted as "blunt with a kind of short, blunt flagellum". It would thus appear to differ considerably in structure from that of the Balaenopterid and Sperm whales. The testis measured 110 × 50 × 36 cm. The penis of whale No. 1020 was completely retracted. The genital groove was comparatively very long, being 83 cm. in length; starting as a shallow groove it gradually deepened as it ran backwards (Plate XIII, fig. 1). The anus is well separated from this groove and lies nearly a metre posterior to it in the adult. Collett (1909) gives a photograph of a Northern Right whale, with penis extruded, which well displays the length of the genital groove.

THE FEMALE

The genital aperture, as in the Sperm whale, occupies a common groove with the anus (Plate XII, fig. 2; Plate XVI, fig. 1). Immediately in front of it lies a large unilobular clitoris. There was no vaginal band or tag in whale No. 3560, and there is no note on the subject from whale No. 1019.

The uterine cornu in whale No. 1019 was 33 cm. across and was noted as not much congested. This whale was lactating.

Whale No. 3560 was in anoestrus and the ovaries were resting. They contained four old corpora lutea.

The ovaries of whale No. 1019 were large. One contained seven corpora lutea *b*, one 8·5 × 7 × 6 cm., and one 3 × 2·5 × 2 cm. There were five others, all very old and resorbed. There was one protruding follicle 15 mm. in diameter. The other ovary contained six corpora lutea *b*, one 3·5 × 3 × 2·5 cm., and another 3 × 3 × 2·5 cm. The other four were very old. This ovary contained tiny follicles only.

The large corpus luteum in the first ovary was that of the pregnancy that had recently terminated in parturition. The other recent corpus luteum and the two in the other ovary are likely to have been those of unsuccessful dioestrous cycles in the same sexual season. If the sexual season in this species thus consists of about three dioestrous cycles and four ovulations, the other nine old corpora lutea in the ovaries represent at least two previous pregnancies. They probably actually represent three previous pregnancies, because in all other species of whale in which the sexual cycle is known, the first sexual season usually consists of one ovulation only and dioestrous cycles do not occur until the second and subsequent sexual seasons. The nine old corpora lutea would thus represent one ovulation for the first pregnancy, and four for each of the subsequent ones, and the calf that was killed with this whale would have been her fourth.

Whale No. 3560 had been pregnant at least once before, as is shown by the mammary gland, which was involuted after functional activity. The ovaries contained four old corpora lutea, and if the first pregnancy was represented by one only, the other three would represent a second pregnancy, and the probability is in favour of the latter suggestion.

According to Millais (1906) the Northern Right whale bears a young one once every two years and suckles it for twelve months. The present series of whales gives no information on this subject, but if the period of gestation is comparable to that in other whales there is no reason to think that they breed oftener than once every two years, though the period of lactation mentioned seems excessive. There appears, however, to be a period of anoestrus between lactation and the next pregnancy judging from the resting ovaries of whale No. 3560; but the presence of a follicle already 15 mm. in diameter in one of the ovaries of whale No. 1019, while she was still in full lactation, points to the probability that this period is of short duration.

The nipples lie on either side of the cloacal groove and are situated within short mammary grooves, with small subsidiary grooves bordering them (Plate XII, fig. 2; Plate XVI, fig. 1). In whale No. 3560 they were situated 25 cm. on each side of the centre of the genital groove.

The mammary gland in whale No. 3560, which was involuted after functional activity, measured 35 cm. in length and 7 cm. in thickness. That of whale No. 1019, which was in full lactation, was 25 cm. thick. The teats in this whale were everted and milk was running from them (Plate XII, fig. 2).

MATURITY

Three of these whales were obviously sexually mature, Nos. 503 (male) and 1019 and 3560 (females). The vertebral column was examined in only one of these, No. 3560, which had been pregnant at least once and probably twice. In it the epiphyses were unfused throughout the vertebral column, showing that the species, like all the other large whales, reaches sexual maturity long before it reaches physical maturity.

OTHER NOTES

For whale No. 1020, the calf of No. 1019, there are the following additional notes:
Length of eye slit, 12 cm.

Diameter of orifice of ear, about 2 mm.

The skin very thick, 2 cm. on the flank opposite the anus. The greater part of the edge of the lower lip rough in outline. The latter note probably refers to the irregular edge of the lower lip, which is seen in Plate XII, fig. 1; Plate XIII, fig. 2; Plate XV, fig. 1.

Whale No. 3560, 14. i. 31: the skeleton and skull of this specimen is in the British Museum (Natural History), and bears the registered number 1934. 7. 23. 1.

BEHAVIOUR

The following note, and the sketches illustrating it in Plate XVII, were made on December 29, 1925, when the writer was in the sealer 'Don Ernesto', at anchor in Undine Harbour, South Georgia.

As we were preparing to go ashore a Right whale appeared inside the bay. It was over by the west point at the entrance to the bay, by the natural arch [see Chaplin, 1932, chart 3]. It appeared to be playing in quite shallow water, and was constantly springing nearly clear of the water and falling back: then it would roll on its side, bringing a flipper clear and whacking the water with it. Then it would swim round with the snout and tail both above the surface and dive, bringing the tail flukes clear of the water in doing so. It kept blowing with a very loud tinny noise, sounding as though it was blowing at the end of a very long drain-pipe. The spout is double, and forwardly directed, V-shaped. I at once got the cinema camera rigged in the hopes that it would come closer, but some of the sealers left in the pram to go ashore and it followed them right into the beach, much to their concern. It was definitely following them and appeared to be very inquisitive about them. They tried to drive it away by splashing the water with the oars and shouting, but to no effect. However, it did not capsize them, though they could have touched it from the boat, and they only had a few inches of free-board. When they got ashore it went back to the mouth of the bay and started playing about in the kelp where we first saw it. Then it continued its antics for some time in the centre of the mouth of the bay, and came inside again close to the shore on the other side [by the rocks running out to O'Connor Island]. Soon, however, it went out and round towards Kul Harbour. I did not see it again.

The remarks of Collett (1909) on the diving, breaching and blowing of the Northern Right whale are similar.

SUMMARY

This report records the observations made on the few examples of the Southern Right whale which were examined by the scientific staff of the Discovery Committee.

The measurements of five whales are tabulated: two adult males, two adult females and a male calf.

The colour of the whales examined was uniformly dark, almost black, with a fairly large unpigmented area on the belly. The baleen plates number about 230 on each side and are very long, up to 2·2 m. in length. They are black in colour, as are the bristles, which are of fine texture.

Hair groups of some size occur on the tip of the snout and the chin.

The bonnet on the end of the snout and the other callosities between the tip of the snout and the blow-hole, above the eye, and on the lower jaw are described. They appear to be developed at the site of groups of hair follicles, and microscopically present an appearance similar to that of the rest of the skin. Their association with masses of cyamid parasites is described.

The palate is a narrow ridge between the baleen plates, with an expanded area at its anterior end. The tongue is comparatively small and muscular.

The blubber is thick, and softer than that of other large whales.

Right whales are very heavily infested with cyamid parasites, which occur particularly on the callosities of the head, but are not confined to them. Barnacles are the only other external parasite recorded.

Internal parasites similar to those of Blue and Fin whales were found in one Right whale at South Georgia.

The food of this whale at South Georgia is the same krill, *Euphausia superba*, eaten by other whales.

Notes on the internal and external genitalia of both sexes are given. From an examination of the ovaries and mammary glands it is concluded that the Southern Right whale is polyoestrous, with two to three dioestrous cycles and three to four ovulations at each sexual season after the first.

The species, like other whales, reaches sexual maturity long before it reaches physical maturity.

Notes on the behaviour of the Southern Right whale, observed at close quarters when it was playing in shallow water in a bay of South Georgia, are given.

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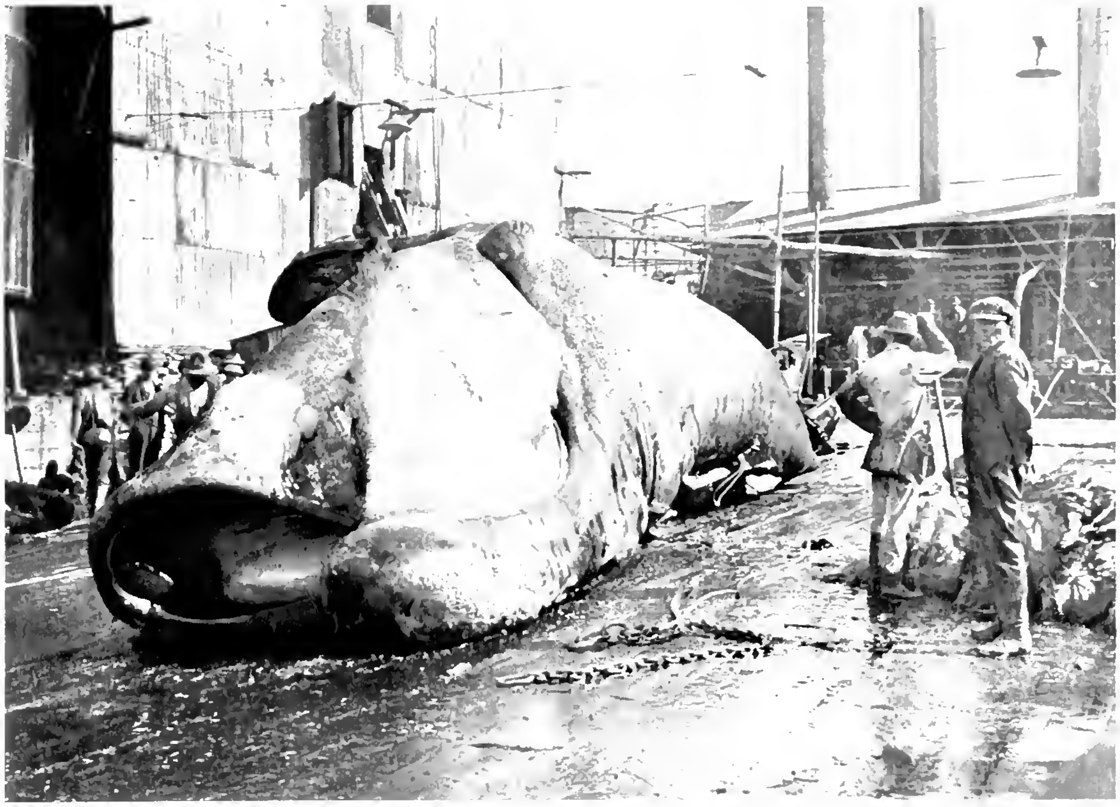
PLATE XII

Fig. 1. Whale No. 1019, female. Dorsal view. Note baleen, head callosities, outline of lip and tongue. The roughness of the skin above the eye is caused by seabirds pecking the carcase.

Fig. 2. Whale No. 1019, female. Ventral view of posterior region. Note white patches anterior to vulvo-anal groove. A stream of milk runs down from the lower of the everted nipples.



N A Mackintosh phot 1

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THE SOUTHERN RIGHT WHALE

PLATE XIII

Fig. 1. Whale No. 1020, male calf. Ventral view. Note splash of white colour, and long genital groove widely separated from anus.

Fig. 2. Whale No. 3560, female. Ventral view. Note vulvo-anal groove, white splash at umbilicus, and callosities on each side of the chin.

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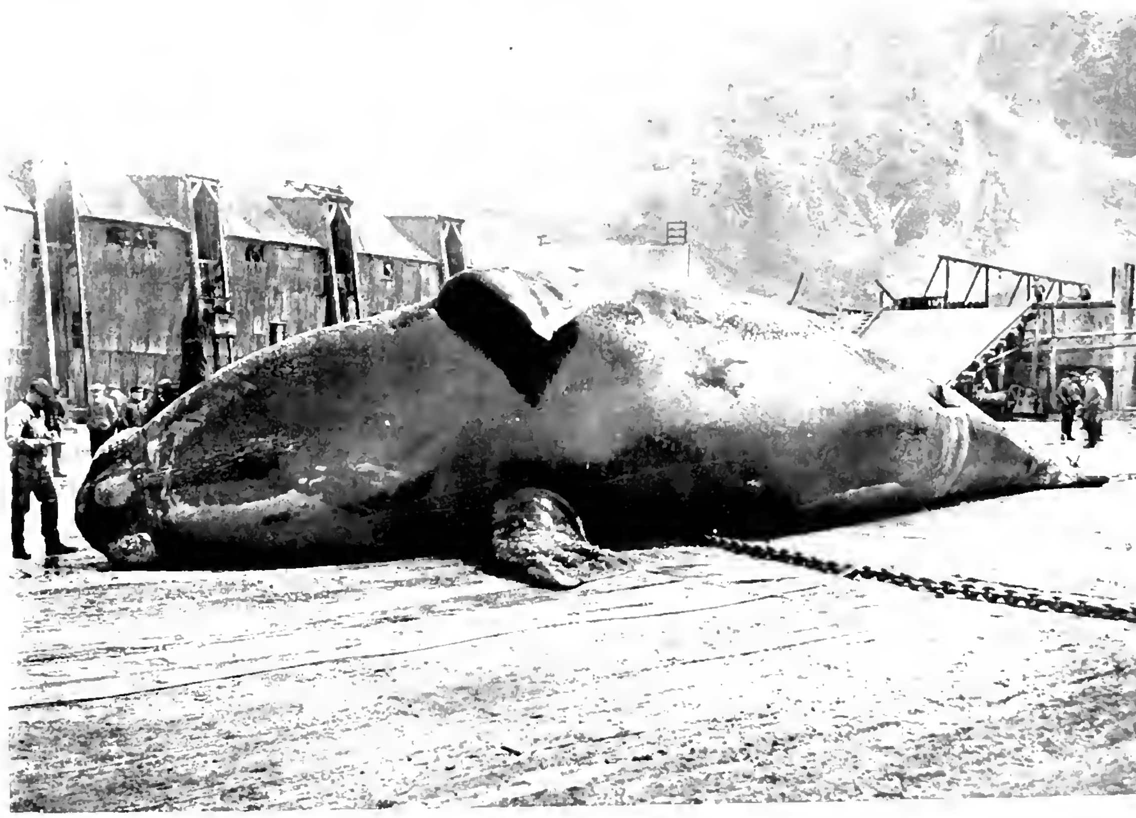

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THE SOUTHERN RIGHT WHALE

PLATE XIV

Fig. 1. Whale No. 3560, female. Dorsal view. Note baleen, tongue, and callosities on upper and lower jaws and above the eye. The line of small marks on the jaw and running back from the eye are caused by sea birds pecking the carcase.

Fig. 2. Whale No. 3560, female. Dorsal view. The flensing process has just started. Note thickness of the blubber. The bonnet lies at the extremity of the strip of blubber which is being pulled off at the left-hand edge of the photograph.

A. Saunders phot.

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A. Saunders phot.

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THE SOUTHERN RIGHT WHALE

PLATE XV

Fig. 1. Whale No. 3560, female, showing mouth and associated structures. The marks on the uppermost part of the jaw are caused by sea birds pecking the carcase.

Fig. 2. Whale No. 3560, female. View of baleen plates and palate after removal of lower jaw and tongue.

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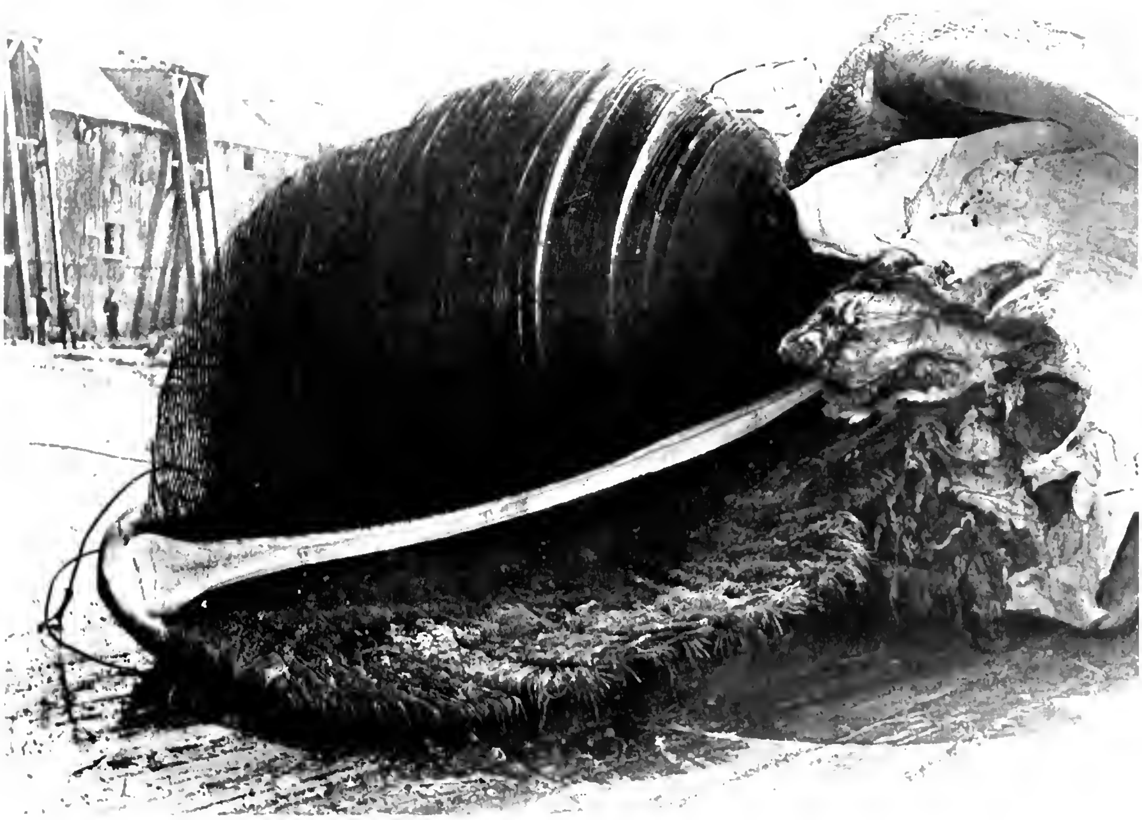

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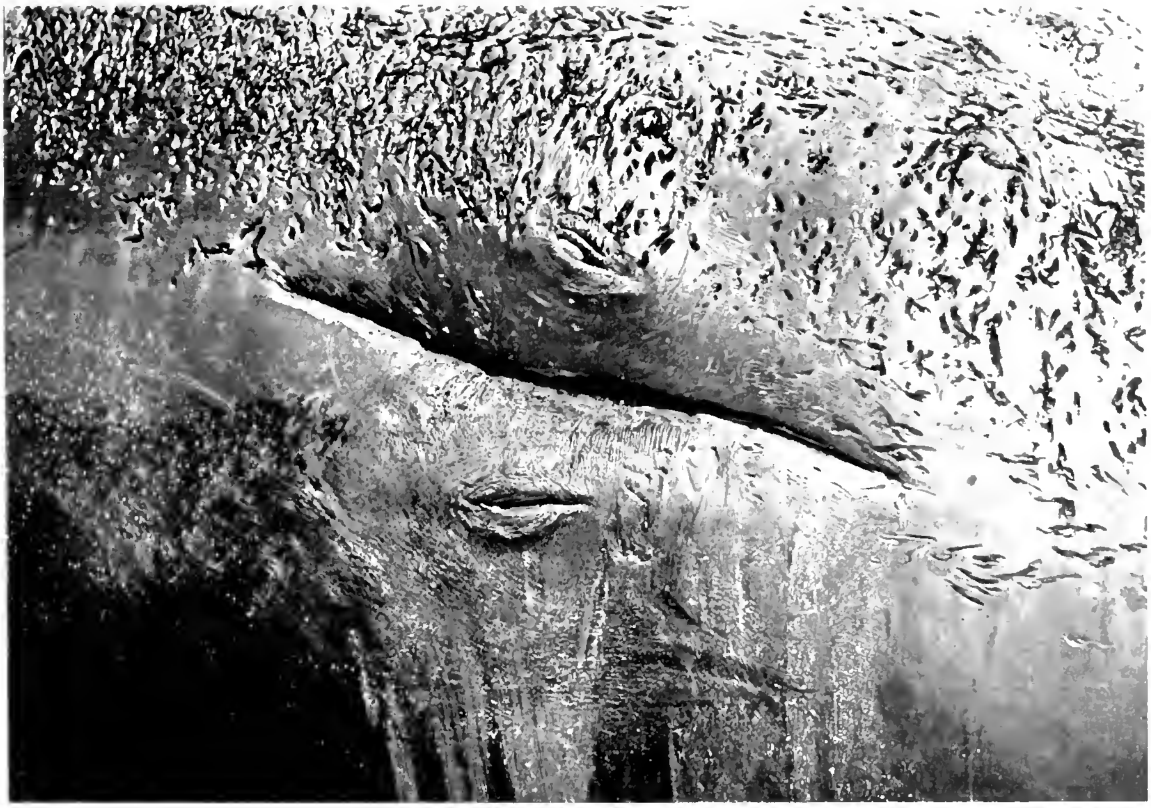
THE SOUTHERN RIGHT WHALE

PLATE XVI

Fig. 1. Whale No. 3560, female. Vulvo-anal groove, mammary grooves and nipples. The anterior end lies to the left. The marks on the skin are caused by sea birds pecking the carcase.

Fig. 2. Baleen plates of the Southern Right whale from South Georgia. Scale of feet.



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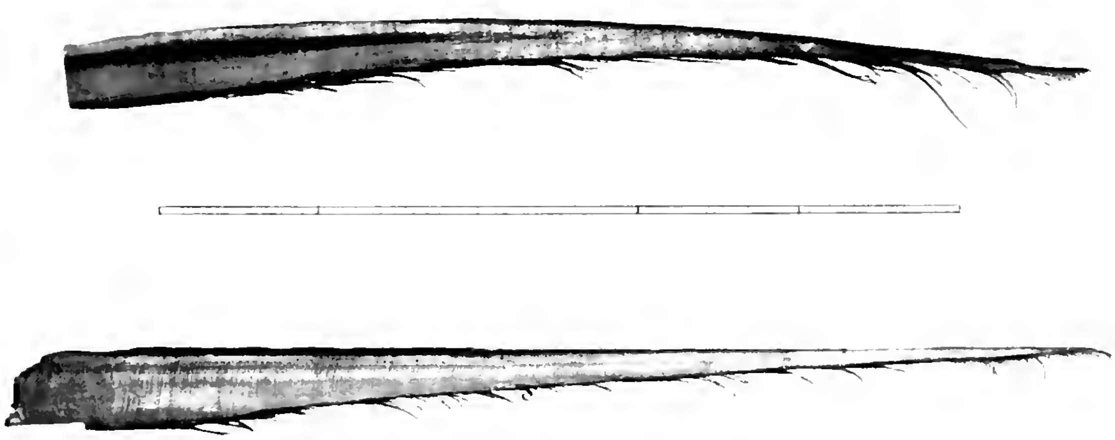

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THE SOUTHERN RIGHT WHALE

PLATE XVII

Sketches of a living whale made at Undine Bay, South Georgia, 29. xii. 25

Figs. 1, 2. The tail brought clear of the water as the whale dives. It is moving towards the observer.

Fig. 3. The whale breaching: jumping nearly clear of the water and then falling back.

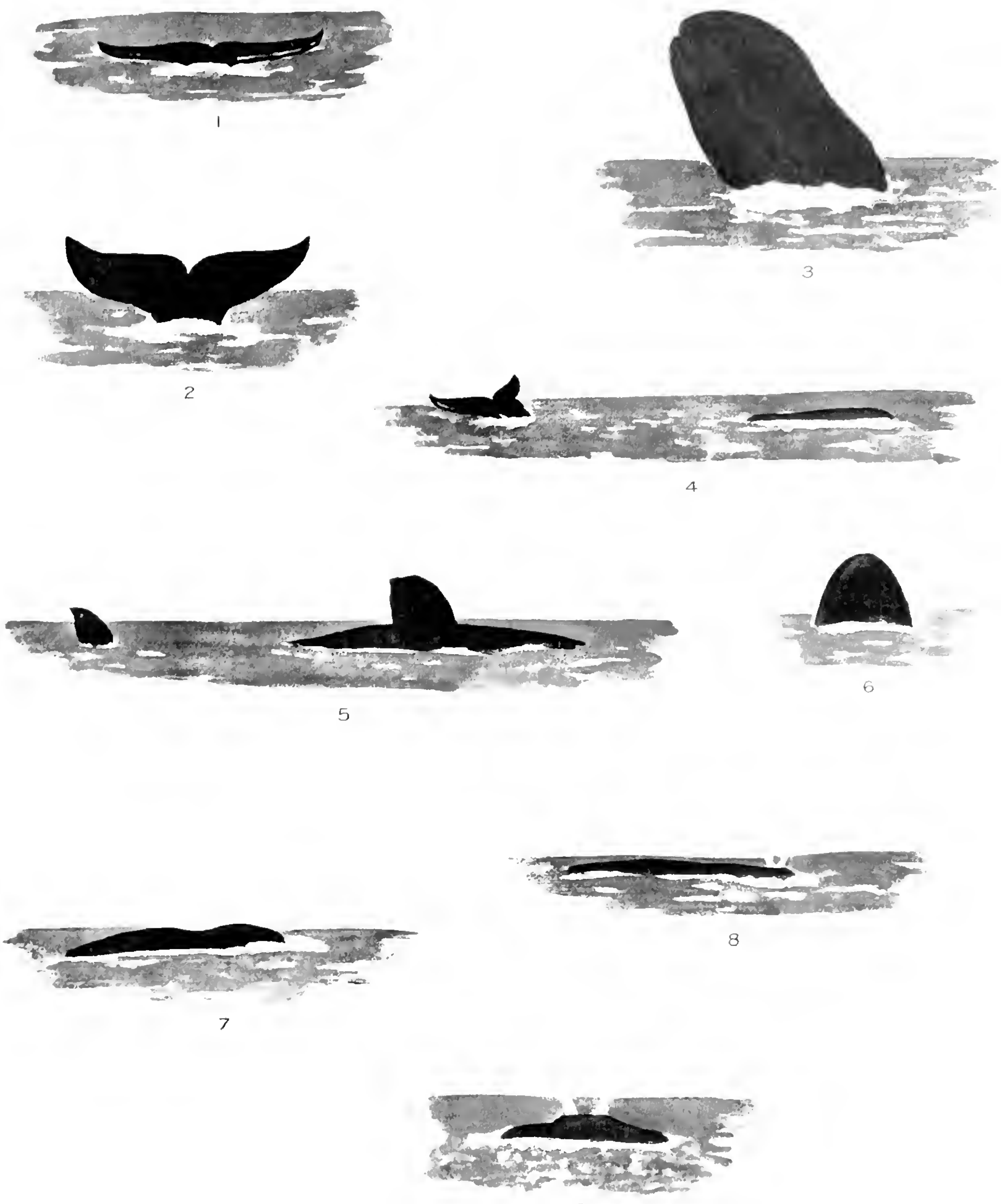
Fig. 4. Swimming with snout and tail out of the water.

Fig. 5. Rolling on its side before hitting the water with the flipper.

Fig. 6. The head raised out of the water.

Figs. 7, 8. Blowing: direction of movement obliquely away from the observer towards the right.

Fig. 9. Blowing: view from behind.



THE SOUTHERN RIGHT WHALE

[*Discovery Reports*. *Vol. XVII*, *pp.* 183–290, *Plates XVIII, XIX*, *June* 1938.]

THE SEI WHALE, *BALAENOPTERA BOREALIS*

BY

L. HARRISON MATTHEWS, M.A.

CONTENTS

THE SEI WHALE, *BALAENOPTERA BOREALIS*

By L. Harrison Matthews, M.A.

(Plates XVIII, XIX; Text-figs. 1–113)

INTRODUCTION

Two hundred and twenty Sei whales have been examined during the course of the Discovery investigations; sixty-five males and one hundred and fifty-five females. This report analyses and discusses the data obtained from them.

The Sei whale is a species of whale that is not of great economic importance on most of the whaling grounds of the world, though it is taken in some numbers in a few places. In the areas where the work has been done it forms only a small fraction of the total catch, so that data have been slow in accumulating. The information here considered was collected during the course of six whaling seasons.

The information recorded during examination of the whales at the whaling stations consisted of the routine system of measurements of various parts of the body that has been adhered to throughout the investigations, notes on the external characters, baleen, food, internal and external parasites, condition of the genitalia and degree of physical maturity. Frequently, however, the set of observations has not been complete on any one whale. The information collected is discussed under the appropriate headings below, together with certain information derived from other sources.

Once again it is a pleasure to record my thanks to those friends to whom I am indebted for assistance and criticism in compiling this report, and especially to Dr S. Kemp, Dr A. S. Parkes, Mr Martin A. C. Hinton and Dr Francis C. Fraser.

MATERIAL

Particulars of the date and place of capture of the Sei whales in the present series are given in Table I. Table II shows similar information about the fifty-six foetuses examined. Statistics in the British Museum (Natural History) recording the catches of Sei whales, and information about foetuses, have also been used in this report: they are referred to in the appropriate sections below.

The material, though not very extensive, appears to be sufficient to provide a good foundation for an outline of the biology of this species of whale.

SEX RATIO

The sex ratio of the adult whales shown in Table I is 29·5 per cent of males. This figure, however, does not represent the true sex ratio in nature, for consideration of the figures and their origin shows that it is unlikely that the sample is representative.

Table I. *Sei whale. Date and place of whales examined*

Date		Males		Females	
		South Georgia	South Africa	South Georgia	South Africa
1926	July	—	2	—	—
	Aug.	—	1	—	5
	Sept.	—	2	—	1
	Oct.	—	—	—	1
1927	Feb.	—	—	6	—
	Mar.	5	—	27	—
	Apr.	9	—	15	—
1928	Mar.	6	—	9	—
	Apr.	1	—	—	—
1929	Feb.	5	—	19	—
	Mar.	3	—	25	—
	Apr.	3	—	5	—
1930	Feb.	1	—	8	—
	Mar.	5	—	13	—
	Apr.	8	—	7	—
	June	—	2	—	—
	July	—	1	—	—
	Aug.	—	3	—	2
1931	Feb.	6	—	10	—
	Mar.	2	—	2	—
		54	11	146	9

Table II. *Sei whale. Foetuses examined*

Date		South Georgia		South Africa
		Males	Females	Sex undetermined
1926	Sept.	—	—	1
1927	Feb.	2	—	—
	Mar.	5	3	—
	Apr.	1	1	—
1928	Mar.	3	1	—
1929	Feb.	6	4	—
	Mar.	5	4	—
	Apr.	1	—	—
1930	Feb.	3	1	—
	Mar.	4	2	—
	Apr.	—	1	—
1931	Feb.	5	2	—
	Mar.	—	1	—
		35	20	1

Turning first to the data relating to foetuses, there are records of fifty-five foetuses examined by the Discovery staff and of an additional fourteen in the British Museum statistics. Of the total of sixty-nine foetuses forty-five were males and twenty-four females, giving a proportion of 65·3 per cent of males. The data are further analysed in Table III which shows the proportions of the sexes for each metre of total length. The proportion of males varies from 50·0 to 83·4 per cent with an average of 63·9 per cent.

Table III. *Sei whale. Sex of foetuses*

Metre lengths	Males	Females	Total	Males per cent of total
0–1	5	1	6	83·4
1–2	6	5	11	54·5
2–3	18	8	26	69·3
3–4	15	9	24	62·5
4–5	1	1	2	50·0
Total	45	24	69	65·3

Table IV. *Sei whale. Sex ratio*

Metre lengths	Males	Females	Total	Males per cent of total
10–11	0	1	1	—
11–12	2	1	3	66·6
12–13	5	6	11	45·5
13–14	13	4	17	76·5
14–15	29	23	52	55·8
15–16	15	61	76	19·8
16–17	1	57	58	1·7
17–18	0	2	2	0
Total up to 15	49	35	84	58·4
Total above 15	16	120	136	11·8
Grand total	65	155	220	29·5

Coming now to the whales and examining them similarly for each metre of total length, the result shown in Table IV is obtained. Ignoring the class of 10–11 m. total length, in which there is only one record, it is seen that up to a total length of 15 m. the proportion of males varies from 76·5 to 45·5 per cent with an average of 61·1 per cent. The total number of whales up to 15 m. in total length is eighty-four, of which forty-nine were males and thirty-five females, giving a proportion of 58·4 per cent of males.

Up to a total length of 15 m., therefore, the sex ratio of the whales is similar to that of the foetuses, namely, 58·4 per cent of males compared with 65·3 per cent for foetuses, with average percentages for each metre of total length of 61·1 and 63·9 per cent respectively. The sex ratio below 15 m. of total length may thus be said to be about 60 per cent of males for all Sei whales and foetuses (Fig. 1). Above a total length of 15 m. the sex ratio of whales caught drops very suddenly and varies from 19·8 per cent of males to zero. There are 136 whales above this length and of them only sixteen were males, giving a proportion of 11·8 per cent of males. The reason for this sudden falling off in numbers of males is that the females normally reach a greater length than the males, as is shown graphically in Fig. 2, in which the numbers of whales examined is plotted against total length. Up to a total length of 15 m. the sample is probably representative of the population, but above that length it consists almost entirely of females. The whalers naturally select the largest whales, the females, for capture, and consequently the figures as a whole are not representative of the total population; but if the sex ratio is worked out from data obtained from whales up to 15 m. in total length, which may be expected to show the proportions of males and females more correctly, it is seen that the sex ratio is about 60 per cent of males and not 29·5 per cent as would appear if the total catch only is considered. These figures show the sex ratio among whales of similar length, but not necessarily of similar age. The proportion of males is probably less than 60 per cent among whales of similar age. The males stop growing at a length of about 15 m. and consequently are removed from the length classes of their contemporary females when the latter grow longer than 15 m. The length classes near, but under, 15 m. must therefore contain the males of an age equal to that of the females over 15 m. in length. Among whales of similar age, therefore, the primary sex ratio found in the foetuses is probably steadily declining from the high proportion of males to something nearer equality as the whales grow older.

It is of interest to note that D'Arcy Thompson (1919) found that of the 1291 Sei whales landed at Scottish whaling stations from 1908 to 1914, 55·3 per cent were males, and this in the total catch, not making allowance for selective hunting.

The sex ratio in the Sei whale thus appears to show very clearly an excess of males from early stages of foetal life, and unless there is a differential foetal mortality in the earliest stages, it must be due to the sex ratio at conception being unbalanced. In some other mammals, such as the pig and man, an unbalanced sex ratio in favour of the male is known, and Parkes (1926) in discussing this concluded "that the excess of males at conception is probably brought about by virtue of the male-producing spermatozoa being more efficient fertilising agents than the female-producing spermatozoa, the actual difference being probably in activity and vitality". This difference between the *X* and *Y* spermatozoa would appear to offer a satisfactory explanation of the unbalanced sex ratio in favour of the male in the Sei whale. It is of interest to note that Laurie (1937) finds a foetal sex ratio of 53·6–54·4 per cent of males in the Blue Whale.

EXTERNAL CHARACTERS

BODY PROPORTIONS

The standard series of measurements was taken from 220 whales, but from many the series is not complete for each measurement. A few of the standard measurements were not taken at all, but for the sake of uniformity the standard

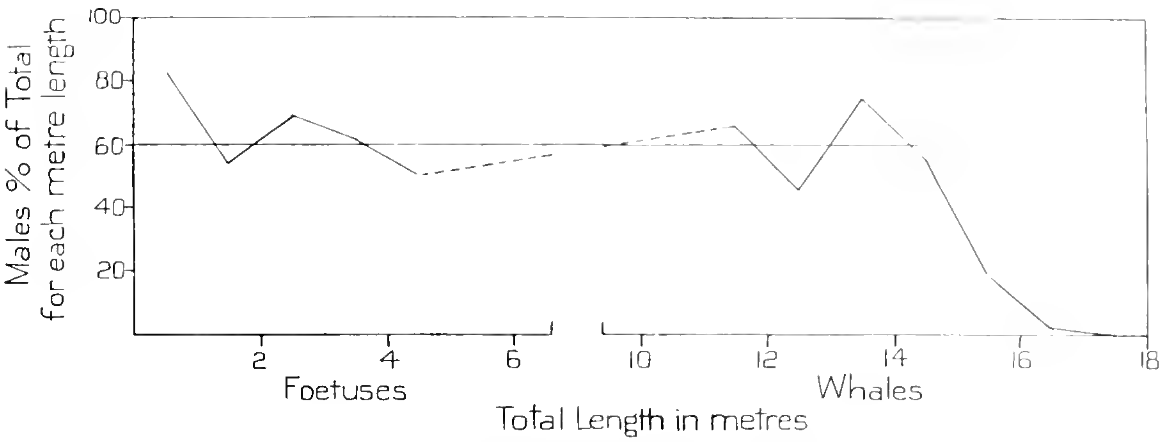


Fig. 1. Sei whale. Sex ratio and total length.

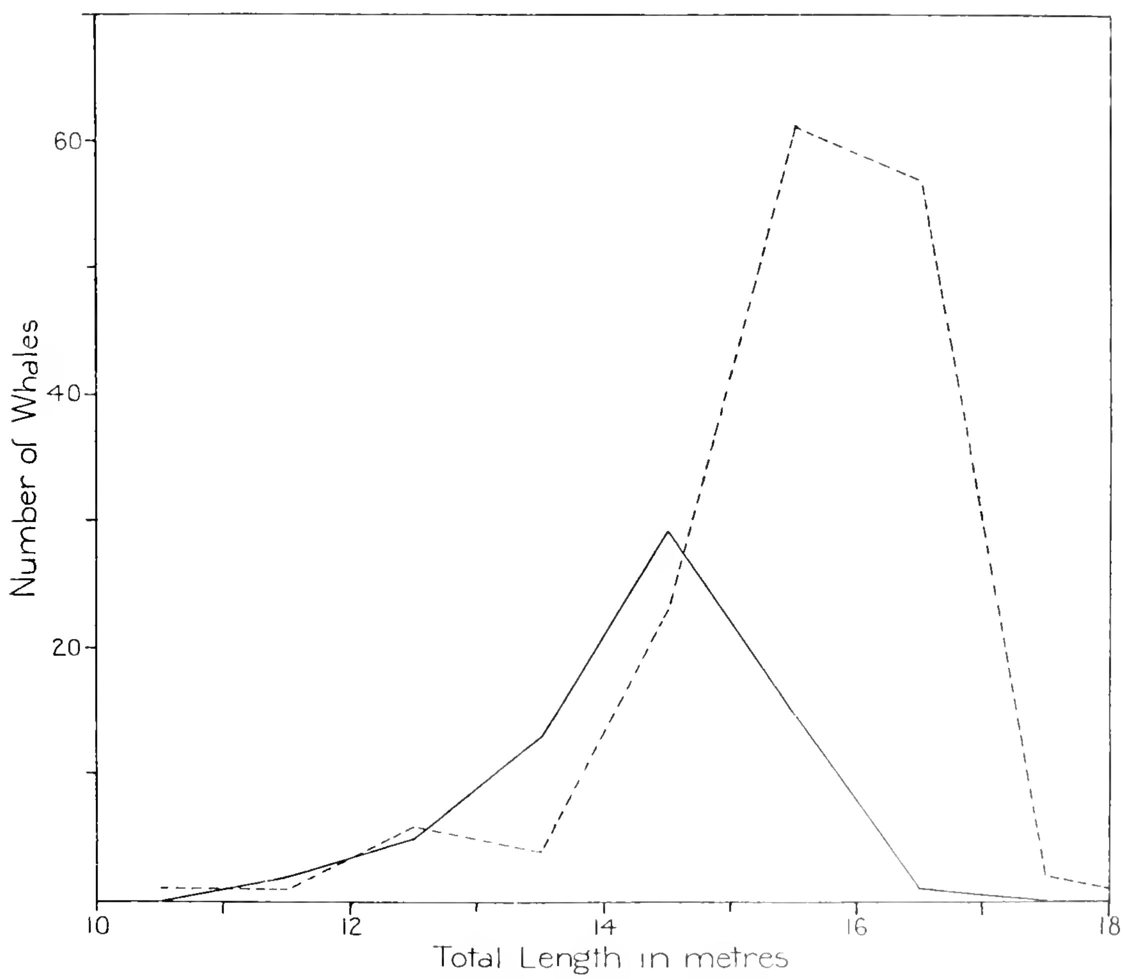


Fig. 2. Sei whale. Length frequencies. Solid line, males; pecked line, females.

numbering has been retained, although some gaps are thereby introduced. The data obtained are set out below and may be taken as a fairly good representation of the external proportions of the Sei whales of South Georgia and an indication of those of South Africa. There is no indication of any racial difference between the whales of the two places; the differences in the figures, where not due to inadequate numbers, are to be explained by the higher proportion of immature whales in the South African catches.

A summary of the analysis of the figures is shown in Table V, in which the measurements, expressed as percentages of the total length, are given separately for males and females from South Georgia, from South Africa, as totals, and for male and female foetuses.

The only measurement which differs widely in the two sexes is No. 13, centre of anus to centre of reproductive aperture; it is 2·7 times greater in males than in females. This is due to the penis being more anterior in position than the vulva. The only other measurement showing appreciable difference in the two sexes is No. 6, tip of snout to tip of flipper, and is slightly greater in females than in males. The lengths of the flipper do not differ materially in the two sexes, nor does measurement No. 3, tip of snout to blow-hole: therefore the difference in measurement No. 6 must be due to the distance between the blow-hole and the insertion of the flipper being slightly greater in the female than in the male. This view is upheld by a consideration of measurements Nos. 4 and 5, tip of snout to angle of gape and tip of snout to centre of eye, which show a corresponding slightly greater proportion in females than in males.

Tables VI, VII, VIII and IX show the manner in which the body proportions vary with the size of whale. In these tables the mean value of each measurement for each metre of whale length is given, together with the number of measurements producing each mean value and the range of variation of each value. The figures are given as the actual values in metres in roman type, and expressed as percentages of total length in italic type. The figures expressed as percentages of total length are first discussed: those of the actual values are dealt with in a later section of this report.

The variations of the body proportions according to the length of the whale are shown graphically for measurements Nos. 3–21 and 24 in Figs. 3–42, in which the percentage value of the measurements is plotted against total length of the whale. The curves for each sex are presented separately. Those derived from South Georgia whales are distinguished from those derived from South African whales. In every figure the curve for South Georgia whales is considerably more representative than that for South African whales because it is derived from a much greater number of measurements.

Although constructed from a fairly good number of measurements these figures are all characterized by their great irregularity when compared with similar figures derived from the measurements of Blue, Fin and Humpback whales. There appears, however, to be no significant difference between the shapes of the curves for males and females, nor between those for South Georgia and South African whales, except for measurements No. 6, tip of snout to tip of flipper, and No. 13, the genito-anal distance, noted above.

Table V. *Sei whale. Mean value of body measurements expressed as percentages of total length*

Measurement	Males						Females						Foetuses. South Georgia			
	S. Georgia		S. Africa		Total		S. Georgia		S. Africa		Total		Male		Female	
	Mean value	No. of measurements	Mean value	No. of measurements	Mean value	No. of measurements	Mean value	No. of measurements	Mean value	No. of measurements	Mean value	No. of measurements	Mean value	No. of measurements	Mean value	No. of measurements
1. Total length	100·00	—	100·00	—	100·00	—	100·00	—	100·00	—	100·00	—	100·00	—	100·00	—
3. Tip of snout to blow-hole	16·15	44	16·38	10	16·19	54	16·69	115	16·26	7	16·65	122	13·93	32	13·72	19
4. Tip of snout to angle of gape	19·21	37	18·97	7	19·14	44	19·72	87	19·46	5	19·70	92	18·36	29	18·13	17
5. Tip of snout to centre of eye	19·49	53	19·25	12	19·39	65	19·93	136	19·73	9	19·91	145	18·19	32	18·54	18
6. Tip of snout to tip of flipper	36·93	37	41·45	7	37·88	44	40·38	72	41·41	5	40·40	77	43·00	27	43·10	18
7. Centre of eye to centre of ear	5·27	45	5·38	7	5·28	52	5·26	122	5·57	7	5·28	129	6·70	31	6·74	18
8. Notch of flukes to posterior emargination of dorsal fin	30·74	46	31·10	8	30·78	54	30·79	121	31·10	5	30·81	126	32·99	31	32·49	18
9. Width of flukes at insertion	5·98	39	5·99	11	5·98	50	5·86	106	6·04	7	5·86	113	7·52	30	7·78	17
10. Notch of flukes to centre of anus	27·33	53	27·94	11	27·41	64	27·05	143	24·71	9	26·90	152	29·03	32	27·29	18
11. Notch of flukes to umbilicus	47·65	51	50·14	11	48·15	62	48·00	137	48·12	6	48·00	143	46·30	32	45·05	17
12. Notch of flukes to end of system of ventral grooves	54·89	42	54·49	7	54·89	49	54·49	116	54·44	5	54·49	121	52·55	32	50·89	17
13. Centre of anus to centre of reproductive aperture	7·06	49	6·67	10	7·00	59	2·76	140	2·58	7	2·75	147	6·37	31	2·25	18
14. Vertical height of dorsal fin	3·47	46	3·54	8	3·48	54	3·42	121	3·77	7	3·44	128	4·17	31	3·93	17
15. Length of base of dorsal fin	6·40	36	6·92	8	6·49	44	6·27	105	6·75	7	6·35	112	6·84	32	6·43	17
16. Axilla to tip of flipper	8·97	32	9·25	11	9·03	43	8·95	98	9·05	6	8·96	104	10·37	32	10·96	18
17. Anterior end of lower border to tip of flipper	12·12	24	11·65	9	11·99	33	12·41	77	11·99	7	12·40	84	15·41	31	15·55	17
18. Length of flipper along curve of lower border	12·23	18	11·89	7	12·13	25	12·66	58	12·42	7	12·63	65	16·05	24	15·61	13
19. Greatest width of flipper	2·66	33	2·79	9	2·68	42	2·67	96	2·72	7	2·67	103	3·34	31	3·59	17
20. Length of severed head from condyle to tip	23·89	48	22·85	2	23·84	50	24·49	109	24·36	6	24·48	115	—	—	—	—
21. Greatest width of skull	10·78	41	10·15	4	10·73	45	10·53	109	9·72	5	10·51	114	12·78	14	13·54	7
22. Skull length: condyle to tip of premaxilla	—	—	—	—	—	—	—	—	23·69	3	23·69	3	—	—	—	—
24. Depth of body at dorsal fin	13·29	14	10·48	5	12·56	19	12·89	18	11·56	5	12·61	23	12·73	2	—	—

Table VI. *Sei whale. Males. South Georgia. Measurements*

Actual value in metres (roman type): expressed as percentages of total lengths (italic type)

	Metre lengths	3. Tip of snout to blow-hole			4. Tip of snout to angle of gape			5. Tip of snout to centre of eye		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	1–2	6	0·17– 0·28	0·23	6	0·23– 0·38	0·30	6	0·24– 0·40	0·31
			13·60–14·07	*13·86*		*17·15–19·10*	*18·08*		*18·28–20·10*	*18·93*
	2–3	14	0·31– 0·40	0·36	13	0·41– 0·51	0·47	10	0·45– 0·53	0·49
			12·73–15·42	*14·19*		*14·91–20·68*	*18·54*		*15·68–20·62*	*18·49*
	3–4	11	0·38– 0·52	0·44	10	0·51– 0·87	0·61	15	0·41– 0·71	0·56
			12·13–14·85	*13·19*		*16·06–25·13*	*18·07*		*16·47–18·99*	*17·73*
	4–5	1	—	0·53	1	—	0·69	1	—	0·72
			—	*12·94*		—	*16·85*		—	*17·59*
Whale	11–12	1	—	1·36	1	—	2·36	1	—	2·25
			—	*11·38*		—	*19·74*		—	*18·82*
	12–13	1	—	2·00	—	—	—	1	—	2·45
			—	*15·87*		—	—		—	*19·44*
	13–14	10	2·00– 2·30	2·17	8	2·55– 2·78	2·64	11	2·45– 2·81	2·65
			14·96–16·68	*15·90*		*18·39–20·19*	*19·17*		*18·61–21·38*	*19·54*
	14–15	24	2·12– 2·95	2·38	21	2·50– 3·04	2·77	27	2·62– 3·20	2·83
			14·32–19·88	*16·38*		*17·51–20·89*	*19·05*		*18·58–21·60*	*19·47*
	15–16	7	2·35– 2·68	2·54	7	2·89– 3·19	2·99	12	2·80– 3·17	2·96
			14·72–17·62	*16·52*		*18·10–20·95*	*19·52*		*17·72–20·81*	*19·29*
	16–17	1	—	2·64	—	—	—	1	—	3·05
			—	*16·35*		—	—		—	*18·89*

	Metre lengths	9. Width of flukes at insertion			10. Notch of flukes to centre of anus			11. Notch of flukes to umbilicus		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	1–2	6	0·09–0·15	0·12	6	0·35– 0·56	0·46	6	0·68– 0·92	0·78
			6·29–7·88	*7·35*		*26·13–29·50*	*28·24*		*44·22–50·90*	*45·82*
	2–3	13	0·16–0·23	0·19	14	0·55– 1·00	0·74	14	0·89– 1·33	1·16
			6·91–9·26	*7·69*		*23·70–40·00*	*28·80*		*38·32–50·00*	*45·49*
	3–4	10	0·20–0·29	0·25	11	0·80– 1·11	0·95	11	1·25– 1·82	1·57
			6·67–8·00	*7·28*		*25·63–31·55*	*29·91*		*41·67–52·00*	*43·01*
	4–5	1	—	0·31	1	—	1·15	1	—	1·91
			—	*7·58*		—	*28·12*		—	*46·70*
Whale	11–12	1	—	0·74	1	—	3·23	1	—	5·86
			—	*6·18*		—	*27·00*		—	*49·00*
	12–13	1	—	0·77	1	—	3·45	1	—	6·30
			—	*6·11*		—	*27·38*		—	*50·50*
	13–14	9	0·77–0·91	0·84	11	3·59– 3·87	3·72	11	6·20– 6·98	6·63
			5·79–6·62	*6·13*		*25·55–28·10*	*27·69*		*47·60–50·36*	*44·77*
	14–15	21	0·81–0·94	0·86	27	3·56– 4·38	3·98	27	6·56– 7·46	7·06
			5·55–6·52	*5·91*		*25·35–30·00*	*27·46*		*46·60–51·73*	*48·75*
	15–16	6	0·88–0·94	0·91	12	3·91– 4·47	4·13	10	6·50– 7·95	7·32
			5·66–6·11	*5·88*		*25·65–28·01*	*26·84*		*42·65–49·80*	*47·45*
	16–17	1	—	0·92	1	—	4·65	1	—	8·00
			—	*5·70*		—	*29·80*		—	*49·52*

Table VI. *Sei whale. Males. South Georgia. Measurements*

Actual value in metres (roman type): expressed as percentages of total lengths (italic type)

	Metre lengths	6. Tip of snout to tip of flipper			7. Centre of eye to centre of ear			8. Notch of flukes to posterior emargination of dorsal fin		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	1–2	5	0·61–0·91	0·79	6	0·09–0·13	0·11	5	0·41–0·58	0·50
			44·25–48·50	*45·86*		*6·53–7·88*	*7·11*		*30·20–33·33*	*31·86*
	2–3	11	0·88–1·29	1·08	13	0·15–0·20	0·17	14	0·72–1·00	0·84
			35·00–46·98	*41·73*		*5·93–7·29*	*6·71*		*30·70–35·38*	*32·78*
	3–4	10	1·00–1·71	1·34	11	0·19–0·26	0·21	11	1·03–1·20	1·12
			33·33–47·70	*42·89*		*6·00–6·98*	*6·35*		*32·17–36·39*	*33·73*
	4–5	1	—	1·79	1	—	0·27	1	—	1·35
			—	*43·75*		—	*6·60*		—	*33·00*
Whale	11–12	1	—	3·87	1	—	0·65	1	—	3·63
			—	*32·91*		—	*5·44*		—	*33·50*
	12–13	1	—	4·20	1	—	0·66	1	—	3·75
			—	*33·33*		—	*5·24*		—	*29·76*
	13–14	10	4·00–5·89	5·21	10	0·65–0·75	0·72	10	4·00–4·49	4·19
			30·42–42·78	*38·28*		*4·94–5·56*	*5·28*		*29·13–32·31*	*30·89*
	14–15	16	4·60–6·14	5·35	23	0·70–0·92	0·78	24	3·50–4·72	4·49
			31·76–41·35	*36·71*		*4·39–6·21*	*5·26*		*25·00–33·32*	*30·47*
	15–16	9	4·65–6·58	5·77	9	0·70–0·90	0·78	9	4·32–6·50	4·74
			30·10–42·81	*36·66*		*4·64–5·81*	*5·19*		*28·31–36·40*	*30·74*
	16–17	—	—	—	1	—	0·81	1	—	5·15
			—	—		—	*5·02*		—	*31·90*

	Metre lengths	12. Notch of flukes to end of system of ventral grooves			13. Centre of anus to centre of reproductive aperture			14. Vertical height of dorsal fin		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	1–2	6	0·65–1·08	0·87	6	0·06–0·12	0·10	6	0·05–0·09	0·06
			49·24–56·25	*53·08*		*3·02–7·41*	*6·14*		*3·43–4·44*	*4·01*
	2–3	14	1·05–1·51	1·32	13	0·12–0·20	0·17	13	0·09–0·14	0·11
			44·60–56·00	*51·62*		*5·17–7·64*	*6·43*		*3·14–5·09*	*4·25*
	3–4	11	1·42–2·06	1·68	11	0·16–0·25	0·21	11	0·11–0·17	0·13
			47·33–58·80	*53·08*		*5·33–7·80*	*6·39*		*3·02–4·86*	*3·82*
	4–5	1	—	2·21	1	—	0·26	—	—	—
			—	*54·10*		—	*6·36*		—	—
Whale	11–12	1	—	6·74	1	—	1·00	1	—	0·35
			—	*56·35*		—	*8·35*		—	*2·93*
	12–13	—	—	—	1	—	0·60	1	—	0·46
			—	—		—	*4·76*		—	*3·65*
	13–14	9	7·00–7·99	7·53	11	0·72–1·12	0·98	11	0·40–0·70	0·53
			53·40–57·90	*55·53*		*5·26–8·14*	*7·25*		*2·92–5·08*	*3·85*
	14–15	22	7·50–8·67	8·04	24	0·88–1·20	1·04	23	0·45–0·64	0·53
			46·09–57·11	*54·85*		*6·02–8·03*	*7·21*		*3·10–4·32*	*3·17*
	15–16	9	7·80–9·21	8·38	11	0·82–1·20	1·03	9	0·42–0·70	0·56
			50·77–57·70	*54·68*		*5·31–7·74*	*6·66*		*2·75–4·64*	*3·63*
	16–17	1	—	8·88	1	—	1·10	1	—	0·80
			—	*55·00*		—	*6·82*		—	*4·06*

Table VI (*contd.*). *Sei whale. Males. South Georgia. Measurements*

Actual value in metres (roman type): expressed as percentages of total lengths (italic type)

	Metre lengths	15. Length of base of dorsal fin			16. Axilla to tip of flipper			17. Anterior end of lower border to tip of flipper		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	1–2	6	0·07–0·12	0·10	6	0·12–0·20	0·16	6	0·16–0·31	0·24
			5·60–6·28	*6·02*		*9·60–10·37*	*9·94*		*12·80–15·58*	*14·81*
	2–3	14	0·12–0·23	0·18	14	0·23–0·33	0·28	14	0·32–0·47	0·40
			5·94–8·38	*6·91*		*10·00–12·00*	*10·78*		*13·45–16·78*	*15·45*
	3–4	11	0·19–0·33	0·24	11	0·32–0·43	0·37	10	0·44–0·62	0·53
			5·78–8·45	*7·32*		*10·50–12·00*	*11·02*		*14·59–17·56*	*15·65*
	4–5	1	—	0·21	1	—	0·47	1	—	0·66
			—	*5·14*		—	*11·50*		—	*16·12*
Whale	11–12	1	—	0·70	—	—	—	—	—	—
			—	*5·86*		—	—		—	—
	12–13	—	—	—	1	—	1·18	—	—	—
			—	—		—	*9·37*		—	—
	13–14	8	0·79–1·10	0·97	9	1·14–1·50	1·27	7	1·65–1·83	1·74
			5·94–8·00	*7·06*		*8·59–10·77*	*9·14*		*12·07–13·30*	*12·70*
	14–15	20	0·68–1·19	0·93	15	1·10–1·74	1·37	12	1·53–1·98	1·72
			4·72–8·07	*6·40*		*7·63–11·75*	*9·32*		*10·48–13·36*	*11·79*
	15–16	6	0·65–1·17	0·91	7	1·20–1·35	1·28	5	1·76–1·97	1·88
			4·25–7·68	*5·84*		*7·72–9·13*	*8·44*		*11·69–12·93*	*12·17*
	16–17	1	—	0·85	—	—	—	—	—	—
			—	*5·26*		—	—		—	—

	Metre lengths	21. Greatest width of skull			24. Depth of body at dorsal fin		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	1–2	4	0·17–0·30	0·22	1	—	0·20
			13·14–15·08	*13·07*		—	*10·05*
	2–3	6	0·29–0·38	0·32	1	—	0·37
			10·71–13·82	*12·54*		—	*15·42*
	3–4	4	0·36–0·43	0·39	—	—	—
			10·91–13·40	*11·95*		—	—
	4–5	—	—	—	—	—	—
			—	—		—	—
Whale	11–12	1	—	1·32	—	—	—
			—	*11·03*	—	—	—
	12–13	1	—	1·30	—	—	—
			—	*10·32*		—	—
	13–14	9	1·30–1·68	1·49	1	—	1·90
			9·89–12·77	*11·02*		—	*14·45*
	14–15	20	1·33–1·97	1·57	10	1·51–2·13	1·93
			9·50–13·47	*10·76*		*10·78–14·89*	*13·29*
	15–16	9	1·50–1·83	1·64	2	1·98–1·98	1·98
			9·60–11·76	*10·65*		*13·16–13·16*	*13·16*
	16–17	1	—	1·74	1	—	2·00
			—	*10·79*		—	*12·39*

Table VI (*contd.*). *Sei whale. Males. South Georgia. Measurements*

Actual value in metres (roman type): expressed as percentages of total lengths (italic type)

	Metre lengths	18. Length of flipper along curve of lower border			19. Greatest width of flipper			20. Length of severed head from condyle to tip		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	1–2	3	0·26– 0·32	0·29	6	0·04–0·07	0·05	—	—	—
			15·09–16·08	*15·64*		*2·80–3·52*	*3·15*		—	—
	2–3	11	0·34– 0·50	0·41	14	0·07–0·10	0·09	—	—	—
			13·82–17·84	*14·07*		*3·14–3·75*	*3·39*		—	—
	3–4	9	0·45– 0·66	0·56	10	0·10–0·13	0·12	—	—	—
			15·00–18·19	*16·37*		*3·27–3·71*	*3·37*		—	—
	4–5	1	—	0·68	1	—	0·15	—	—	—
			—	*16·62*		—	*3·67*		—	—
Whale	11–12	—	—	—	—	—	—	2	2·80– 2·90	2·85
			—	—		—	—		*24·25–24·79*	*24·52*
	12–13	—	—	—	1	—	0·33	2	2·96– 3·05	3·00
			—	—		—	*2·62*		*23·68–24·21*	*23·94*
	13–14	6	1·65– 1·90	1·77	10	0·34–0·49	0·38	9	3·10– 3·36	3·27
			12·07–13·83	*12·93*		*2·44–3·56*	*2·80*		*23·36–25·09*	*24·02*
	14–15	8	1·23– 1·98	1·69	14	0·33–0·43	0·38	22	3·10– 3·78	3·42
			8·32–13·36	*11·69*		*2·35–3·06*	*2·57*		*22·09–25·50*	*23·88*
	15–16	4	1·76– 2·00	1·90	8	0·40–0·43	0·41	12	3·48– 3·85	3·65
			11·69–12·93	*12·31*		*2·51–2·77*	*2·64*		*22·03–25·27*	*23·72*
	16–17	—	—	—	—	—	—	1	—	3·77
			—	—		—	—		—	*23·35*

Table VII. *Sei whale. Females. South Georgia. Measurements*

Actual value in metres (roman type): expressed as percentages of total lengths (italic type)

	Metre lengths	3. Tip of snout to blow-hole			4. Tip of snout to angle of gape			5. Tip of snout to centre of eye		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	0–1	1	—	0·08	1	—	0·10	1	—	0·12
			—	*15·70*		—	*19·61*		—	*22·54*
	1–2	3	0·15–0·32	0·23	3	0·28–0·38	0·30	3	0·25–0·41	0·49
			11·54–16·65	*14·13*		*19·79–21·53*	*20·67*		*18·85–21·34*	*20·09*
	2–3	8	0·31–0·41	0·36	8	0·40–0·52	0·46	8	0·42–0·52	0·49
			12·07–16·08	*13·98*		*16·73–18·61*	*17·71*		*17·58–20·80*	*18·63*
	3–4	7	0·43–0·56	0·48	5	0·60–0·64	0·62	6	0·60–0·72	0·64
			11·08–14·93	*13·00*		*16·18–17·54*	*17·01*		*15·30–18·23*	*15·27*
Whale	12–13	3	1·88–2·10	1·98	3	2·35–2·37	2·36	3	2·38–2·47	2·43
			15·60–16·28	*15·98*		*18·37–19·50*	*19·00*		*19·14–19·81*	*19·57*
	13–14	2	2·19–2·35	2·27	1	—	2·69	3	2·60–2·73	2·66
			16·80–17·09	*16·94*		—	*19·88*		*19·12–19·85*	*19·21*
	14–15	17	2·20–2·70	2·41	14	2·28–3·07	2·80	20	2·57–3·10	2·89
			15·21–18·80	*16·58*		*16·25–20·83*	*19·29*		*17·45–21·05*	*19·58*
	15–16	48	2·33–2·90	2·59	38	2·74–3·45	3·06	58	2·85–3·45	3·01
			14·73–18·78	*16·59*		*17·96–21·66*	*19·81*		*18·11–22·12*	*19·89*
	16–17	43	2·49–2·97	2·76	30	2·89–3·47	3·23	50	3·00–3·57	3·28
			15·39–18·32	*16·82*		*18·06–21·47*	*19·82*		*18·75–22·70*	*20·18*
	17–18	2	2·85–2·90	2·87	1	—	3·42	2	3·40–3·52	3·46
			16·68–16·96	*16·82*		—	*20·05*		*19·88–20·61*	*20·24*

	Metre lengths	9. Width of flukes at insertion			10. Notch of flukes to centre of anus			11. Notch of flukes to umbilicus		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	0–1	1	—	0·05	1	—	0·13	1	—	0·22
			—	*8·84*		—	*25·50*		—	*43·15*
	1–2	3	0·11–0·16	0·14	3	0·37–0·44	0·39	3	0·62–0·95	0·78
			8·08–8·34	*8·23*		*26·01–30·20*	*28·21*		*45·60–49·49*	*47·44*
	2–3	8	0·16–0·25	0·19	8	0·65–0·86	0·73	7	1·07–1·34	1·18
			6·27–8·78	*7·49*		*24·91–30·90*	*28·00*		*40·06–48·25*	*45·23*
	3–4	5	0·26–0·31	0·27	6	0·86–1·28	1·01	6	1·50–2·00	1·64
			6·11–9·32	*7·73*		*22·81–34·73*	*29·01*		*38·20–50·65*	*44·22*
Whale	12–13	3	0·74–0·80	0·76	3	3·35–3·70	3·50	3	5·89–6·40	6·14
			5·81–6·50	*6·15*		*28·00–37·81*	*31·50*		*48·80–49·90*	*49·43*
	13–14	2	0·77–0·80	0·78	3	3·68–3·77	3·73	3	6·35–6·68	6·48
			5·68–5·82	*5·75*		*27·39–27·70*	*27·59*		*46·70–48·60*	*47·59*
	14–15	14	0·78–0·95	0·86	19	3·75–4·20	3·98	16	6·79–7·30	7·10
			5·34–6·59	*5·96*		*25·59–28·50*	*27·45*		*48·35–56·75*	*50·15*
	15–16	44	0·78–1·04	0·90	61	3·75–4·54	4·24	61	6·80–7·84	7·44
			5·05–6·65	*5·80*		*21·10–29·05*	*26·75*		*42·63–51·00*	*47·75*
	16–17	41	0·85–1·10	0·96	55	4·10–4·70	4·39	52	6·70–8·70	7·77
			5·26–6·56	*5·86*		*25·30–28·20*	*27·05*		*41·61–53·70*	*47·60*
	17–18	2	0·97–1·02	0·99	2	4·59–4·70	4·64	2	8·00–8·23	8·11
			5·67–5·98	*5·82*		*26·88–27·49*	*27·18*		*46·78–48·20*	*47·49*

Table VII. *Sei whale. Females. South Georgia. Measurements*

Actual value in metres (roman type): expressed as percentages of total lengths (italic type)

	Metre lengths	6. Tip of snout to tip of flipper			7. Centre of eye to centre of ear			8. Notch of flukes to posterior emargination of dorsal fin		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	0–1	1	— —	0·28 *54·90*	1	— —	0·04 *7·84*	1	— —	0·19 *37·29*
	1–2	3	0·55–0·81 *37·50–47·90*	0·69 *42·50*	3	0·10–0·14 *7·30–7·99*	0·13 *7·66*	3	0·39–0·66 *30·00–34·40*	0·53 *32·30*
	2–3	8	0·81–1·14 *35·70–46·43*	1·10 *42·05*	8	0·12–0·20 *5·28–7·30*	0·14 *6·60*	8	0·72–0·96 *30·14–33·91*	0·84 *32·10*
	3–4	6	1·14–2·30 *32·96–67·30*	1·51 *43·04*	6	0·20–0·26 *5·88–6·59*	0·23 *6·25*	6	1·10–1·31 *30·42–33·70*	1·20 *32·53*
Whale	12–13	2	5·00–5·02 *40·60–41·60*	5·01 *41·10*	2	0·65–0·65 *5·27–5·39*	0·65 *5·33*	3	3·78–4·25 *31·37–33·99*	3·96 *32·25*
	13–14	2	5·64–5·75 *41·00–42·49*	5·69 *41·74*	3	0·75–0·79 *4·95–5·58*	0·73 *5·35*	2	4·13–4·26 *30·50–30·99*	4·19 *30·74*
	14–15	9	4·95–6·90 *34·74–46·40*	6·00 *40·74*	16	0·70–0·86 *4·90–5·77*	0·77 *5·31*	15	4·31–4·80 *29·72–33·29*	4·57 *31·40*
	15–16	30	5·89–6·92 *38·58–44·40*	6·05 *41·09*	54	0·66–0·97 *4·14–6·22*	0·80 *5·23*	52	4·00–5·15 *25·08–36·00*	4·71 *30·31*
	16–17	27	6·24–7·35 *38·30–43·75*	6·84 *41·85*	45	0·78–0·94 *4·77–5·75*	0·86 *5·28*	47	4·55–5·50 *28·00–34·30*	4·96 *31·11*
	17–18	2	7·05–7·25 *41·23–42·45*	7·15 *41·84*	2	0·84–0·88 *4·91–5·16*	0·86 *5·03*	2	5·15–5·15 *30·12–31·75*	5·15 *30·93*

	Metre lengths	12. Notch of flukes to end of system of ventral grooves			13. Centre of anus to centre of reproductive aperture			14. Vertical height of dorsal fin		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	0–1	—	— —	— —	1	— —	0·02 *2·94*	—	— —	— —
	1–2	3	0·73–1·04 *50·80–56·15*	0·88 *53·71*	3	0·04–0·04 *1·82–2·69*	0·04 *2·25*	3	0·05–0·08 *3·46–4·85*	0·07 *4·15*
	2–3	8	1·18–1·52 *46·41–54·29*	1·33 *51·00*	8	0·04–0·09 *1·89–3·21*	0·06 *2·28*	8	0·07–0·12 *2·93–4·37*	0·10 *3·86*
	3–4	6	1·65–2·22 *42·50–57·64*	1·83 *49·55*	6	0·07–0·10 *1·56–2·72*	0·08 *2·10*	6	0·13–0·17 *3·35–4·31*	0·14 *3·92*
Whale	12–13	3	6·91–7·35 *56·99–57·35*	7·09 *57·14*	3	0·30–0·37 *2·33–3·00*	0·34 *2·74*	3	0·47–0·50 *3·64–4·15*	0·48 *3·89*
	13–14	2	7·35–7·50 *54·15–54·60*	7·42 *54·37*	3	0·36–0·47 *2·66–3·46*	0·40 *2·94*	2	0·46–0·53 *3·34–3·92*	0·49 *3·63*
	14–15	15	7·46–8·25 *51·09–57·42*	7·94 *54·99*	17	0·30–0·50 *2·11–3·42*	0·40 *2·76*	17	0·38–0·62 *2·59–4·31*	0·53 *3·98*
	15–16	52	7·50–9·10 *47·02–57·63*	8·26 *54·35*	61	0·30–0·55 *1·94–3·59*	0·41 *2·75*	51	0·40–0·75 *2·47–4·76*	0·54 *3·47*
	16–17	42	8·30–9·70 *50·40–62·41*	8·72 *54·45*	54	0·55–0·60 *1·81–3·43*	0·45 *2·76*	46	0·43–0·90 *2·57–5·56*	0·55 *3·26*
	17–18	2	8·90–9·29 *52·05–54·30*	9·09 *53·17*	2	0·45–0·50 *2·63–2·93*	0·47 *2·78*	2	0·49–0·63 *2·87–3·68*	0·56 *3·27*

Table VII (*contd.*). *Sei whale. Females. South Georgia. Measurements*

Actual value in metres (roman type): expressed as percentages of total lengths (italic type)

	Metre lengths	15. Length of base of dorsal fin: No. of measurements	Range	Mean	16. Axilla to tip of flipper: No. of measurements	Range	Mean	17. Anterior end of lower border to tip of flipper: No. of measurements	Range	Mean
Foetus	0–1	1	—	0·02	1	—	0·11	1	—	0·13
			—	*2·94*		—	*21·59*		—	*25·50*
	1–2	3	0·07–0·15	0·11	3	0·10–0·21	0·17	3	0·15–0·28	0·23
			5·38–8·88	*7·01*		*7·36–11·24*	*9·82*		*11·54–15·96*	*14·02*
	2–3	8	0·12–0·21	0·17	8	0·23–0·32	0·27	8	0·33–0·47	0·39
			5·03–7·56	*6·47*		*7·20–11·68*	*10·20*		*13·33–17·15*	*15·06*
	3–4	5	0·20–0·32	0·25	6	0·37–0·45	0·40	5	0·54–0·66	0·57
			5·63–8·11	*6·73*		*10·19–11·49*	*10·82*		*14·43–16·70*	*15·22*
Whale	12–13	3	0·75–0·85	0·79	2	1·09–1·21	1·15	2	1·47–1·58	1·52
			6·08–6·58	*6·32*		*9·09–9·83*	*9·46*		*12·21–12·82*	*12·51*
	13–14	2	0·90–1·05	0·97	3	1·21–1·27	1·23	2	1·73–1·74	1·74
			6·65–7·64	*7·14*		*8·80–9·34*	*9·06*		*12·64–12·78*	*12·71*
	14–15	16	0·80–1·30	1·02	12	1·23–1·42	1·35	11	1·55–1·92	1·78
			5·56–8·74	*6·36*		*8·43–9·89*	*8·49*		*10·62–13·22*	*12·23*
	15–16	44	0·63–1·50	0·94	43	1·00–1·75	1·44	33	1·56–2·07	1·58
			4·11–9·43	*6·29*		*6·52–11·22*	*8·97*		*10·09–13·74*	*12·06*
	16–17	38	0·88–1·30	1·05	36	1·25–1·72	1·47	27	1·74–2·53	2·04
			5·30–8·10	*6·15*		*7·69–10·56*	*9·04*		*10·87–15·27*	*12·89*
	17–18	2	1·09–1·15	1·12	2	1·38–1·83	1·61	2	1·96–2·27	2·11
			6·38–6·73	*6·55*		*8·07–10·72*	*9·39*		*11·46–13·29*	*12·37*

	Metre lengths	21. Greatest width of skull: No. of measurements	Range	Mean	24. Depth of body at dorsal fin: No. of measurements	Range	Mean
Foetus	0–1	1	—	0·11	—	—	—
			—	*21·59*		—	—
	1–2	2	0·25–0·25	0·25	—	—	—
			13·03–14·78	*13·90*		—	—
	2–3	3	0·24–0·33	0·29	—	—	—
			10·58–13·10	*12·10*		—	—
	3–4	—	—	—	—	—	—
			—	—		—	—
Whale	12–13	2	1·29–1·44	1·36	1	—	1·43
			10·71–11·69	*11·20*		—	*11·61*
	13–14	3	1·40–1·47	1·44	—	—	—
			10·85–10·19	*10·57*		—	—
	14–15	15	1·45–1·68	1·56	4	1·72–2·05	1·91
			10·15–11·44	*10·78*		*11·90–14·26*	*13·16*
	15–16	49	1·47–1·94	1·66	7	1·65–2·65	2·10
			9·40–12·46	*10·42*		*10·34–16·64*	*13·51*
	16–17	38	1·55–2·09	1·73	6	1·67–2·29	1·98
			9·53–12·04	*10·60*		*10·34–14·11*	*12·19*
	17–18	2	1·70–1·71	1·71	—	—	—
			9·94–10·01	*9·97*		—	—

Table VII (*contd.*). *Sei whale. Females. South Georgia. Measurements*

Actual value in metres (roman type): expressed as percentages of total lengths (italic type)

	Metre lengths	18. Length of flipper along curve of lower border			19. Greatest width of flipper			20. Length of severed head from condyle to tip		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Foetus	0–1	—	—	—	1	—	0·03	—	—	—
			—	—		—	*5·88*		—	—
	1–2	2	0·16– 0·28	0·22	3	0·04–0·07	0·05	—	—	—
			11·92–16·56	*14·24*		*3·08–3·65*	*3·43*		—	—
	2–3	6	0·34– 0·49	0·43	7	0·07–0·10	0·09	—	—	—
			14·12–17·88	*16·01*		*3·09–4·02*	*3·47*		—	—
	3–4	5	0·56– 0·68	0·59	6	0·12–0·14	0·13	—	—	—
			14·72–17·22	*15·73*		*3·19–3·55*	*3·42*		—	—
Whale	12–13	1	—	1·47	2	0·32–0·38	0·35	2	2·95– 2·99	2·97
			—	*12·21*		*2·66–3·08*	*2·87*		*24·28–24·50*	*24·39*
	13–14	2	1·75– 1·75	1·75	3	0·34–0·43	0·38	3	3·20– 3·53	3·32
			12·72–12·93	*12·82*		*2·51 . 3·13*	*2·79*		*23·54–25·66*	*24·40*
	14–15	7	1·74– 1·95	1·85	12	0·35–0·45	0·40	14	3·30– 3·88	3·45
			11·90–13·28	*12·58*		*2·39–3·07*	*2·77*		*22·95–26·31*	*25·15*
	15–16	25	1·65– 2·14	1·94	45	0·36–0·56	0·42	49	3·25– 4·30	3·81
			10·38–14·00	*12·41*		*2·34–3·53*	*2·73*		*21·57–27·56*	*24·51*
	16–17	21	1·85– 2·79	2·15	32	0·38–0·48	0·43	39	2·88– 4·24	3·99
			11·19–15·45	*12·97*		*2·31–2·95*	*2·56*		*17·65–25·99*	*24·39*
	17–18	2	2·04– 2·30	2·17	2	0·42–0·47	0·44	2	4·10– 4·25	4·17
			11·93–13·47	*12·70*		*2·46–2·75*	*2·60*		*23·98–24·90*	*24·44*

Table VIII. *Sei whale. Males. South Africa. Measurements*

Actual value in metres (roman type): expressed as percentages of total length (italic type)

	Metre lengths	3. Tip of snout to blow-hole: No. of measurements	Range	Mean	4. Tip of snout to angle of gape: No. of measurements	Range	Mean	5. Tip of snout to centre of eye: No. of measurements	Range	Mean
Whale	11–12	1	—	1·75	1	—	2·2	1	—	2·15
			—	*15·49*		—	*19·45*		—	*19·05*
	12–13	4	1·95– 2·35	2·07	3	2·30– 2·40	2·35	4	2·30– 2·45	2·39
			15·65–19·26	*16·79*		*18·85–19·53*	*19·07*		*18·85–19·91*	*19·36*
	13–14	3	2·15– 2·25	2·18	2	2·49– 2·50	2·50	2	2·50– 2·57	2·53
			15·73–16·17	*16·00*		*18·65–18·80*	*18·72*		*18·73–19·32*	*19·02*
	14–15	—	—	—	—	—	—	2	2·73– 2·80	2·77
			—	—		—	—		*18·89–19·58*	*19·23*
	15–16	2	2·45– 2·55	2·50	1	—	2·80	3	2·86– 3·83	3·26
			16·33–16·78	*16·55*		—	*18·67*		*18·56–20·39*	*19·34*

	Metre lengths	9. Width of flukes at insertion: No. of measurements	Range	Mean	10. Notch of flukes to centre of anus: No. of measurements	Range	Mean	11. Notch of flukes to umbilicus: No. of measurements	Range	Mean
Whale	11–12	1	—	0·75	1	—	3·28	1	—	5·65
			—	*6·53*		—	*29·05*		—	*50·00*
	12–13	4	0·65–0·76	0·73	4	3·10– 3·55	3·26	4	5·60– 7·70	6·31
			5·22–6·23	*5·91*		*25·40–35·50*	*28·69*		*45·85–61·80*	*50·99*
	13–14	2	0·78–0·80	0·79	2	3·50– 3·70	3·60	2	6·30– 6·45	6·37
			5·86–5·99	*5·93*		*26·32–27·72*	*27·02*		*47·27–48·31*	*47·84*
	14–15	2	0·85–0·85	0·85	2	3·87– 3·97	3·92	2	6·60– 6·97	6·78
			5·88–5·94	*5·91*		*27·09–27·47*	*27·28*		*46·15–48·24*	*47·19*
	15–16	—	0·91–0·92	0·92	2	4·12– 4·20	4·16	2	7·33– 8·90	8·11
			6·05–6·07	*6·06*		*27·05–28·00*	*27·57*		*48·87–58·55*	*53·71*

	Metre lengths	15. Length of base of dorsal fin: No. of measurements	Range	Mean	16. Axilla to tip of flipper: No. of measurements	Range	Mean	17. Anterior end of lower border to tip of flipper: No. of measurements	Range	Mean
Whale	11–12	1	—	0·70	1	—	0·95	1	—	1·45
			—	*6·20*		—	*8·41*		—	*12·83*
	12–13	3	0·70–1·10	0·90	4	1·00– 1·60	1·17	3	1·15– 1·62	1·42
			5·62–8·80	*7·24*		*8·03–12·80*	*9·49*		*9·24–12·36*	*11·17*
	13–14	2	0·95–1·00	0·98	2	1·18– 1·26	1·22	2	1·49– 1·57	1·53
			7·12–7·52	*7·32*		*8·87– 9·44*	*9·15*		*11·16–11·80*	*11·48*
	14–15	—	—	—	2	1·20– 1·23	1·21	1	—	1·65
			—	—		*8·39– 8·51*	*8·45*		—	*11·54*
	15–16	2	0·95–0·98	0·97	2	1·35– 1·39	1·37	2	1·80– 1·82	1·81
			6·25–6·53	*6·39*		*9·00– 9·14*	*9·07*		*11·84–12·13*	*11·98*

Table VIII. *Sei whale. Males. South Africa. Measurements*

Actual value in metres (roman type): expressed as percentages of total lengths (italic type)

	Metre lengths	6. Tip of snout to tip of flipper			7. Centre of eye to centre of ear			8. Notch of flukes to posterior emargination of dorsal fin		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Whale	11–12	1	—	4·70	1	—	0·65	1	—	3·60
			—	*41·60*		—	*5·75*		—	*31·87*
	12–13	2	5·10–5·35	5·22	2	0·68–0·70	0·69	3	3·55–3·98	3·74
			41·00–43·49	*42·24*		*5·46–5·60*	*5·53*		*28·86–31·84*	*30·13*
	13–14	2	5·50–5·55	5·53	2	0·69–0·74	0·71	2	4·15–4·40	4·27
			41·20–41·73	*41·46*		*5·17–5·56*	*5·36*		*31·09–33·08*	*32·08*
	14–15	1	—	5·80	1	—	0·73	1	—	4·53
			—	*40·14*		—	*5·05*		—	*31·35*
	15–16	1	—	6·15	1	—	0·76	1	—	4·65
			—	*41·00*		—	*5·07*		—	*31·00*

	Metre lengths	12. Notch of flukes to end of system of ventral grooves			13. Centre of anus to centre of reproductive aperture			14. Vertical height of dorsal fin		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Whale	11–12	1	—	6·30	1	—	0·85	1	—	0·45
			—	*55·70*		—	*7·52*		—	*3·98*
	12–13	3	6·60–7·00	6·78	4	0·60–0·90	0·80	3	0·40–0·44	0·41
			53·09–56·00	*54·66*		*4·92–7·20*	*6·46*		*3·21–3·52*	*3·32*
	13–14	2	6·75–7·40	7·07	2	0·90–1·00	0·95	2	0·48–0·49	0·49
			50·56–55·64	*53·05*		*6·77–7·49*	*7·13*		*3·60–3·68*	*3·64*
	14–15	—	—	—	2	0·75–1·03	0·89	—	—	—
			—	—		*5·25–7·13*	*6·19*		—	—
	15–16	1	—	8·35	1	—	1·00	2	0·50–0·57	0·53
			—	*55·67*		—	*6·67*		*3·33–3·75*	*3·54*

	Metre lengths	18. Length of flipper along curve of lower border			19. Greatest width of flipper			20. Length of severed head from condyle to tip		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Whale	11–12	1	—	1·27	1	—	0·31	—	—	—
			—	*11·23*		—	*2·74*		—	—
	12–13	2	1·49–1·50	1·50	4	0·30–0·50	0·36	1	—	2·80
			11·97–12·29	*12·10*		*2·40–4·10*	*2·94*		—	*22·50*
	13–14	2	1·51–1·58	1·55	2	0·37–0·37	0·37	—	—	—
			11·31–11·85	*11·58*		*2·77–2·78*	*2·78*		—	—
	14–15	—	—	—	1	—	0·35	—	—	—
			—	—		—	*2·45*		—	—
	15–16	2	1·84–1·87	1·86	1	—	0·40	1	—	3·48
			12·26–12·30	*12·28*		—	*2·63*		—	*23·20*

Table VIII (*contd.*). *Sei whale. Males. South Africa. Measurements*

Actual value in metres (roman type): expressed as percentages of total lengths (italic type)

	Metre lengths	21. Greatest width of skull			24. Depth of body at dorsal fin		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean
Whale	11–12	1	—	1·17	1	—	1·25
			—	*10·36*		—	*11·06*
	12–13	1	—	1·30	1	—	1·30
			—	*10·44*		—	*10·44*
	13–14	—	—	—	2	1·34–1·40	1·37
				—		*10·04–10·53*	*10·28*
	14–15	1		1·50	—	—	—
			—	*10·49*		—	—
	15–16	1	—	1·40	1	—	1·55
			—	*9·33*		—	*10·33*

Table IX. *Sei whale. Females. South Africa. Measurements*

Actual value in metres (roman type): expressed as percentages of total length (italic type)

	Metre lengths	3. Tip of snout to blow-hole			4. Tip of snout to angle of gape			5. Tip of snout to centre of eye		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Whale	10–11	1	—	1·72	1	—	2·03	1	—	2·09
			—	*16·46*		—	*19·43*		—	*20·00*
	11–12	1	—	1·66	1	—	2·08	1	—	2·17
			—	*14·37*		—	*18·01*		—	*18·79*
	12–13	2	1·96–2·04	2·00	1	—	2·40	3	2·28–2·42	2·35
			16·03–16·79	*16·40*		—	*19·75*		*18·69–19·92*	*19·27*
	13–14	1	—	2·20	1	—	2·67	1	—	2·73
			—	*16·48*		—	*20·00*		—	*20·45*
	14–15	1	—	2·65	1	—	3·00	2	2·80–3·07	2·93
			—	*17·79*		—	*20·13*		*20·00–20·60*	*20·30*
	15–16	1	—	2·77	—	—	—	—	—	—
			—	*16·94*		—	—		—	—
	16–17	—	—	—	—	—	—	1	—	3·25
			—	—		—	—		—	*19·94*

Table IX. *Sei whale. Females. South Africa. Measurements*

Actual value in metres (roman type): expressed as percentages of total lengths (italic type)

	Metre lengths	6. Tip of snout to tip of flipper			7. Centre of eye to centre of ear			8. Notch of flukes to posterior emargination of dorsal fin		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Whale	10–11	—	—	—	1	—	0·59	1	—	3·20
			—	—		—	*5·65*		—	*30·62*
	11–12	1	—	4·60	1	—	0·64	1	—	3·68
			—	*39·83*		—	*5·54*		—	*31·86*
	12–13	2	4·94–5·10	5·02	2	0·67–0·68	0·68	1	—	3·80
			40·39–41·98	*41·18*		*5·51–5·56*	*5·53*		—	*31·28*
	13–14	1	—	5·50	1	—	0·78	1	—	4·15
			—	*41·20*		—	*5·84*		—	*31·09*
	14–15	1	—	6·50	1	—	0·80	—	—	—
			—	*43·63*		—	*5·37*		—	—
	15–16	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	16–17	—	—	—	1	—	0·90	1	—	5·00
			—	—		—	*5·52*		—	*30·67*

Table IX (*contd.*). *Females. South Africa. Measurements*

Actual value in metres (roman type): expressed as percentages of total lengths (italic type)

	Metre lengths	9. Width of flukes at insertion			10. Notch of flukes to centre of anus			11. Notch of flukes to umbilicus		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Whale	10–11	1	—	0·67	1	—	3·00	1	—	5·70
			—	*6·41*		—	*28·71*		—	*49·47*
	11–12	1	—	0·70	1	—	3·33	1	—	5·77
			—	*6·06*		—	*28·83*		—	*49·96*
	12–13	2	0·70–0·79	0·75	3	3·37–3·46	3·42	2	5·70–5·93	5·81
			5·72–6·50	*6·11*		*27·74–28·29*	*28·07*		*46·91–48·49*	*47·70*
	13–14	1	—	0·80	1	—	3·65	1	—	6·35
			—	*5·09*		—	*27·34*		—	*47·57*
	14–15	1	—	0·93	2	3·70–4·00	3·85	—	—	—
			—	*6·24*		*26·41–26·85*	*26·63*		—	—
	15–16	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	16–17	1	—	0·88	1	—	4·25	1	—	7·55
			—	*5·40*		—	*26·07*		—	*46·32*

	Metre lengths	15. Length of base of dorsal fin			16. Axilla to tip of flipper			17. Anterior end of lower border to tip of flipper		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Whale	10–11	1	—	0·90	1	—	1·05	1	—	1·35
			—	*8·61*		—	*10·05*		—	*12·92*
	11–12	1	—	0·83	1	—	1·03	1	—	1·37
			—	*7·19*		—	*8·92*		—	*11·86*
	12–13	2	0·65–0·95	0·75	2	1·04–1·05	1·05	2	1·40–1·50	1·45
			5·31–7·82	*6·56*		*8·50–8·64*	*8·57*		*11·45–12·35*	*11·90*
	13–14	—	—	—	1	—	1·15	1	—	1·60
			—	—		—	*8·61*		—	*11·89*
	14–15	1	—	0·75	1	—	1·43	1	—	1·86
			—	*5·03*		—	*9·60*		—	*12·48*
	15–16	1	—	1·00	—	—	—	—	—	—
			—	*7·49*		—	—		—	—
	16–17	1	—	0·95	—	—	—	1	—	1·80
			—	*5·83*		—	—		—	*11·04*

Table IX (*contd.*). *Sei whale. Females. South Africa. Measurements*

Actual value in metres (roman type): expressed as percentages of total length (italic type)

	Metre lengths	12. Notch of flukes to end of system of ventral grooves			13. Centre of anus to centre of reproductive aperture			14. Vertical height of dorsal fin		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Whale	10–11	1	—	5·63	1	—	0·27	1	—	0·44
			—	*53·88*		—	*2·58*		—	*4·21*
	11–12	1	—	6·70	1	—	0·27	1	—	0·49
			—	*58·01*		—	*2·34*		—	*4·24*
	12–13	1	—	6·30	2	0·33–0·34	0·34	2	0·45–0·50	0·48
			—	*51·85*		*2·72–2·78*	*2·75*		*3·68–4·12*	*3·90*
	13–14	1	—	7·45	1	—	0·35	1	—	0·49
			—	*55·81*		—	*2·62*		—	*3·67*
	14–15	—	—	—	1	—	0·34	1	—	0·50
			—	—		—	*2·28*		—	*3·36*
	15–16	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	16–17	1	—	8·90	1		0·45	1	—	0·51
			—	*52·66*		—	*2·76*		—	*3·13*

	Metre lengths	18. Length of flipper along curve of lower border			19. Greatest width of flipper			20. Length of severed head from condyle to tip		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Whale	10–11	1	—	1·39	1	—	0·30	1	—	2·55
			—	*13·30*		—	*2·87*		—	*24·40*
	11–12	1	—	1·44	1	—	0·32	1	—	2·65
			—	*12·47*		—	*2·77*		—	*22·94*
	12–13	2	1·46– 1·57	1·51	2	0·31–0·33	0·32	1	—	2·94
			11·94–12·92	*12·43*		*2·55–2·70*	*2·62*		—	*24·20*
	13–14	1	—	1·61	1	—	0·35	1	—	3·40
			—	*12·06*		—	*2·62*		—	*25·47*
	14–15	1	—	1·94	1	—	0·44	1	—	3·70
			—	*13·02*		—	*2·98*		—	*24·83*
	15–16	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	16–17	1	—	1·83	1	—	0·42	1	—	3·95
			—	*11·23*		—	*2·58*		—	*24·33*

Table IX (*contd.*). *Females. South Africa. Measurements*

Actual value in metres (roman type): expressed as percentages of total length (italic type)

	Metre lengths	21. Greatest width of skull			22. Skull length: condyle to tip of premaxilla			24. Depth of body at dorsal fin		
		No. of measurements	Range	Mean	No. of measurements	Range	Mean	No. of measurements	Range	Mean
Whale	10–11	—	—	—	—	—	—	1	—	1·35
			—	—		—	—		—	*12·92*
	11–12	1	—	1·10	1	—	2·59	1	—	1·30
			—	*9·52*		—	*22·42*		—	*11·26*
	12–13	1	—	1·22	1	—	2·89	1	—	1·45
			—	*10·04*		—	*23·79*		—	*11·13*
	13–14	1	—	1·36	1	—	3·32	1	—	1·53
			—	*10·19*		—	*24·87*		—	*11·46*
	14–15	1	—	1·42	—	—	—	—	—	—
			—	*9·53*		—	—		—	—
	15–16	—	—	—	—	—	—	—	—	—
			—	—		—	—		—	—
	16–17	1	—	1·52	—	—	—	1	—	1·80
			—	*9·33*		—	—		—	*11·04*

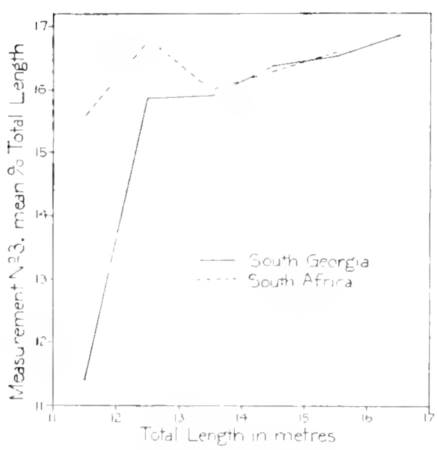


Fig. 3. Sei whale. Males. Measurement No. 3. Tip of snout to blow-hole.

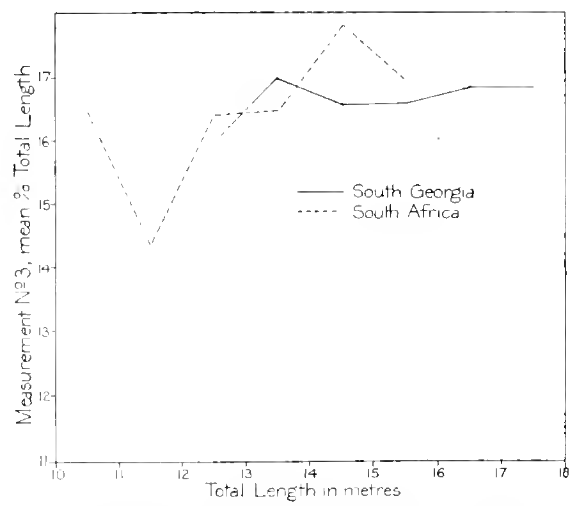


Fig. 4. Sei whale. Females. Measurement No. 3. Tip of snout to blow-hole.

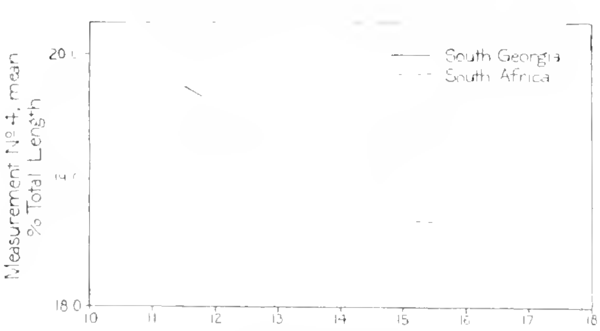


Fig. 5. Sei whale. Males. Measurement No. 4. Tip of snout to angle of gape.

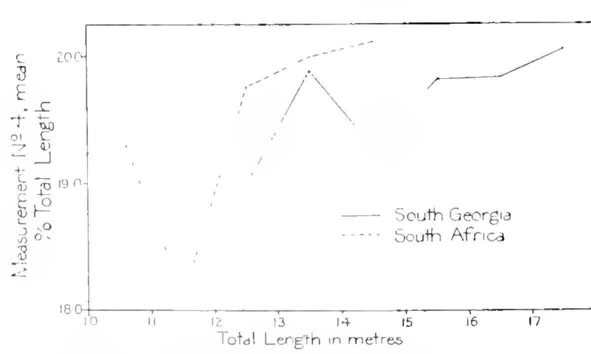


Fig. 6. Sei whale. Females. Measurement No. 4. Tip of snout to angle of gape.

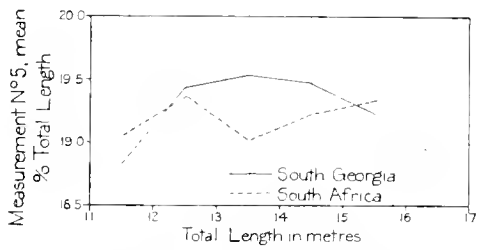


Fig. 7. Sei whale. Males. Measurement No. 5. Tip of snout to centre of eye.

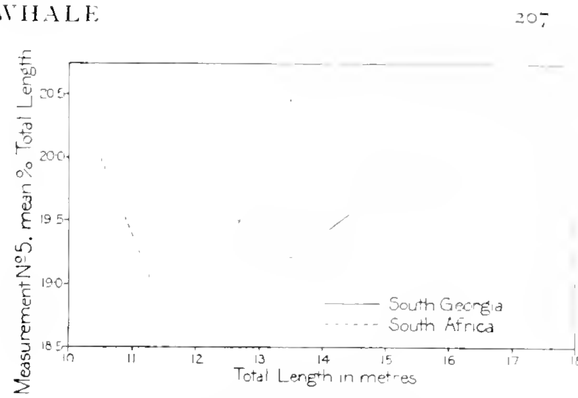


Fig. 8. Sei whale. Females. Measurement No. 5. Tip of snout to centre of eye.

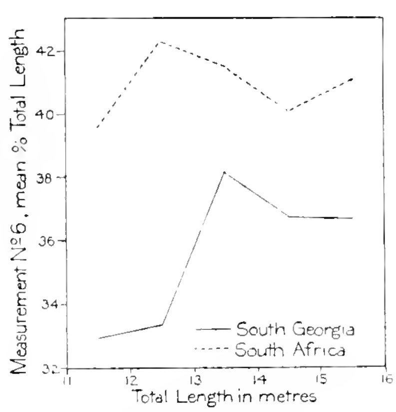


Fig. 9. Sei whale. Males. Measurement No. 6. Tip of snout to tip of flipper.

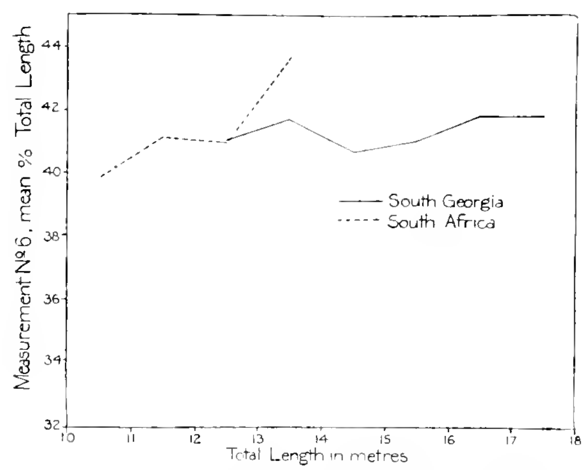


Fig. 10. Sei whale. Females. Measurement No. 6. Tip of snout to tip of flipper.

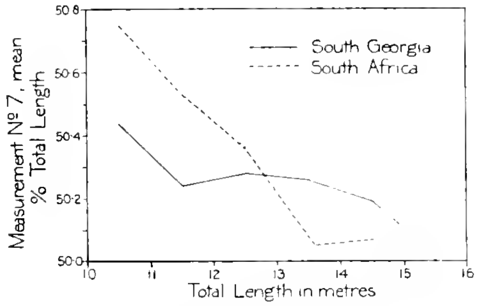


Fig. 11. Sei whale. Males. Measurement No. 7. Centre of eye to centre of ear.

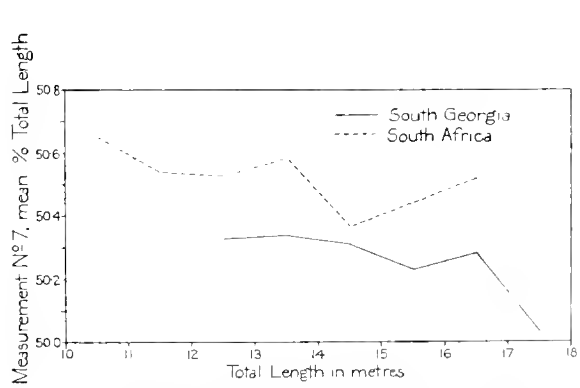


Fig. 12. Sei whale. Females. Measurement No. 7. Centre of eye to centre of ear.

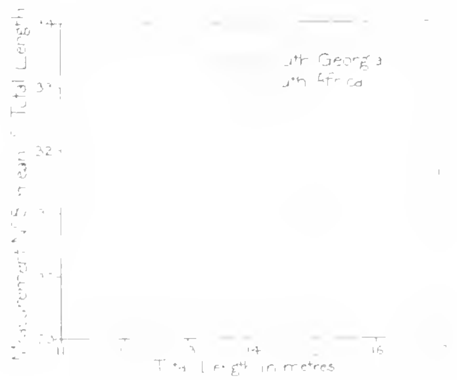


Fig. 13. Sei whale. Males. Measurement No. 8. Notch of flukes to posterior emargination of dorsal fin.

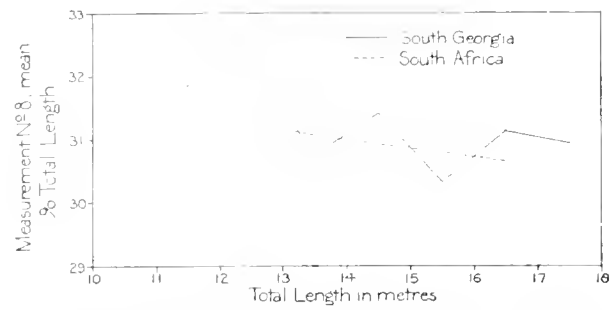


Fig. 14. Sei whale. Females. Measurement No. 8. Notch of flukes to posterior emargination of dorsal fin.

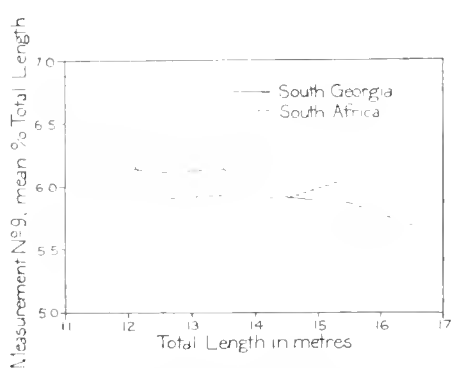


Fig. 15. Sei whale. Males. Measurement No. 9. Width of flukes at insertion.

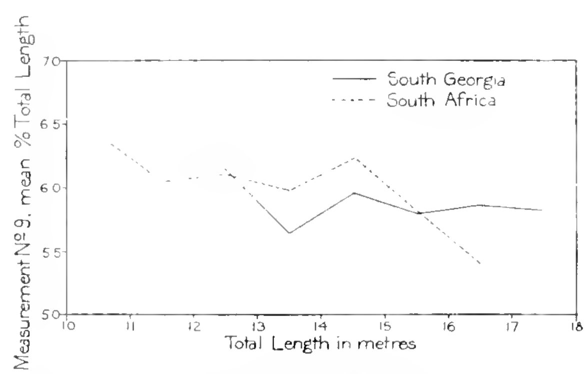


Fig. 16. Sei whale. Females. Measurement No. 9. Width of flukes at insertion.

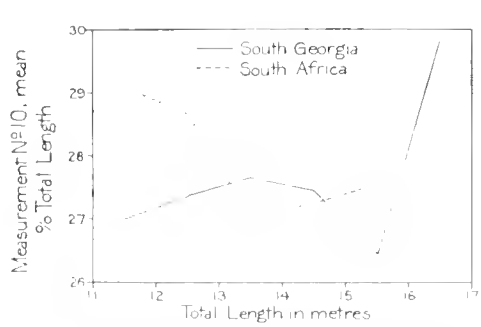


Fig. 17. Sei whale. Males. Measurement No. 10. Notch of flukes to centre of anus.

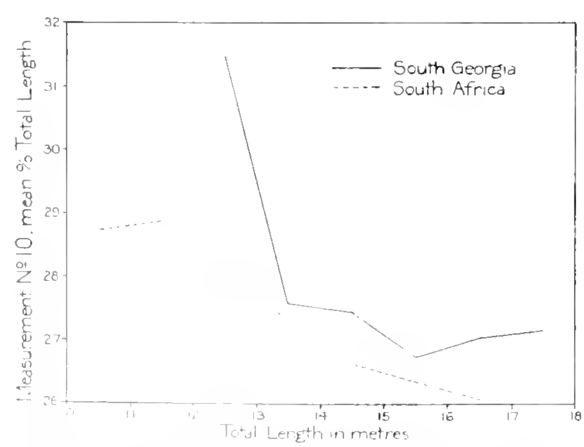


Fig. 18. Sei whale. Females. Measurement No. 10. Notch of flukes to centre of anus.

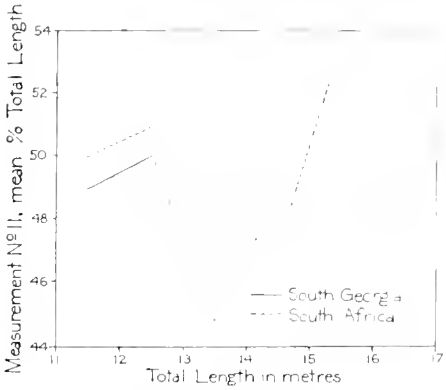


Fig. 19. Sei whale. Males. Measurement No. 11. Notch of flukes to umbilicus.

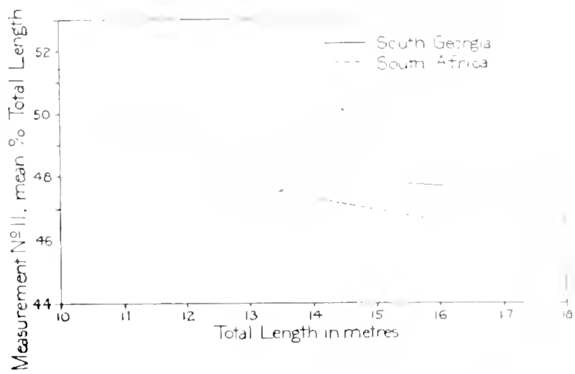


Fig. 20. Sei whale. Females. Measurement No. 11. Notch of flukes to umbilicus.

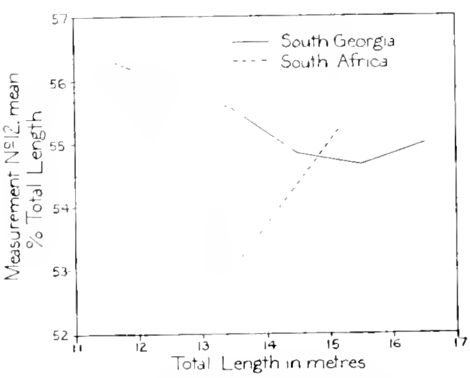


Fig. 21. Sei whale. Males. Measurement No. 12. Notch of flukes to end of system of ventral grooves.

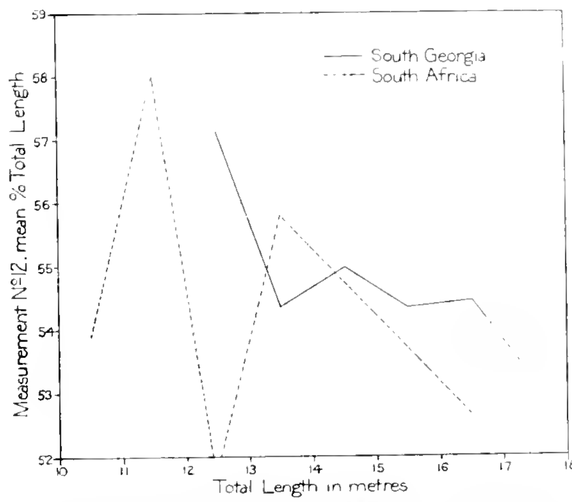


Fig. 22. Sei whale. Females. Measurement No. 12. Notch of flukes to end of system of ventral grooves.

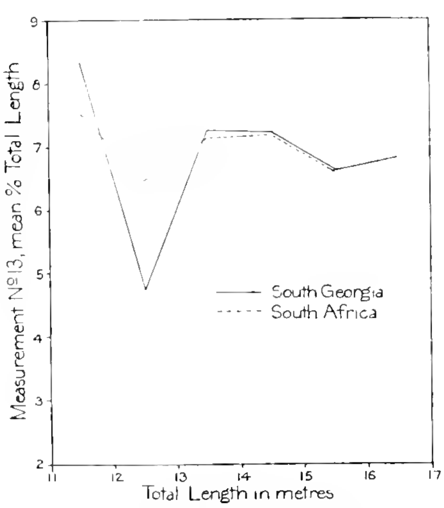


Fig. 23. Sei whale. Males. Measurement No. 13. Centre of anus to centre of reproductive aperture.

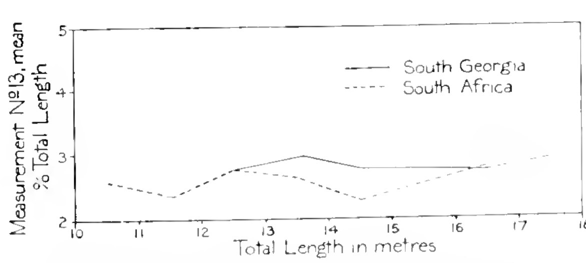


Fig. 24. Sei whale. Females. Measurement No. 13. Centre of anus to centre of reproductive aperture.

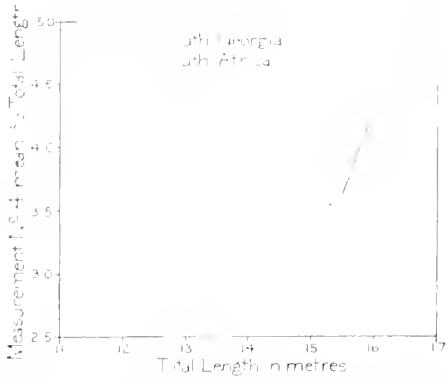


Fig. 25. Sei whale. Males. Measurement No. 14. Vertical height of dorsal fin.

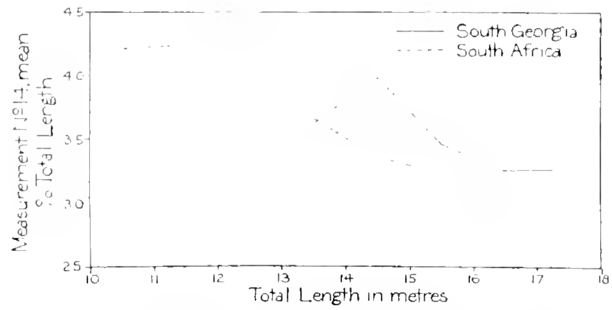


Fig. 26. Sei whale. Females. Measurement No. 14. Vertical height of dorsal fin.

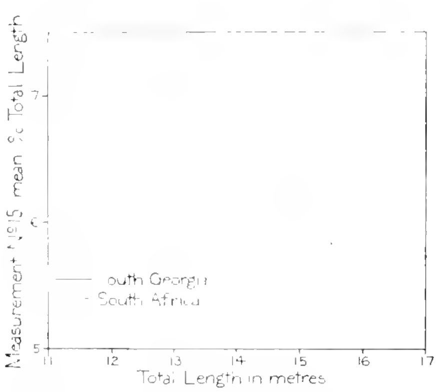


Fig. 27. Sei whale. Males. Measurement No. 15. Length of base of dorsal fin.

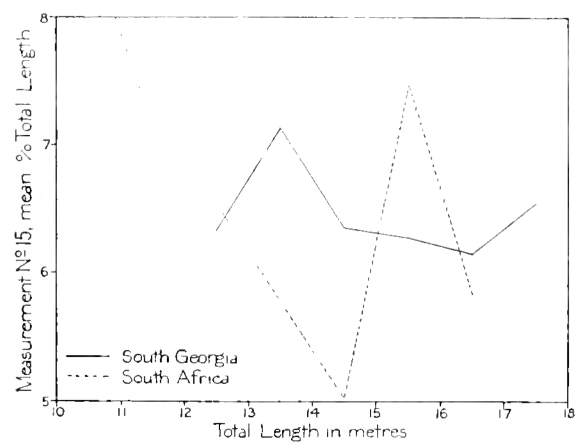


Fig. 28. Sei whale. Females. Measurement No. 15. Length of base of dorsal fin.

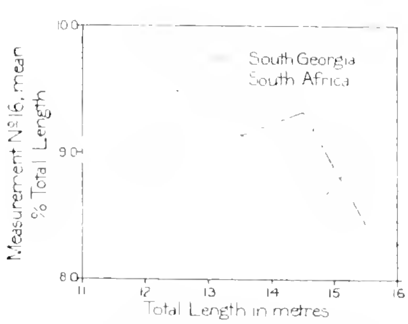


Fig. 29. Sei whale. Males. Measurement No. 16. Axilla to tip of flipper.

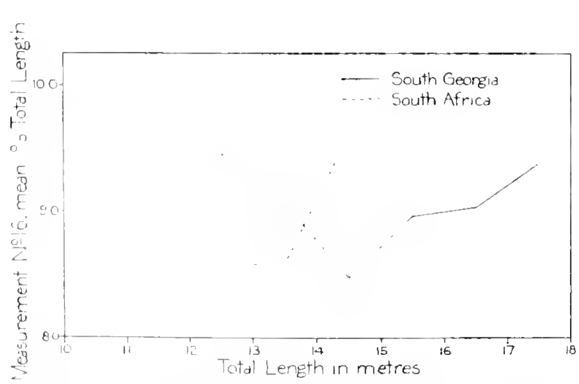


Fig. 30. Sei whale. Females. Measurement No. 16. Axilla to tip of flipper.

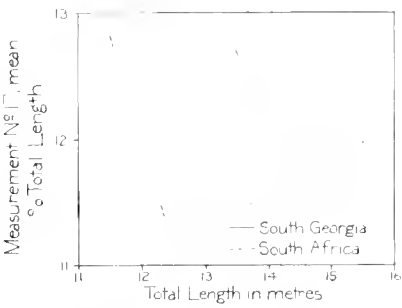


Fig. 31. Sei whale. Males. Measurement No. 17. Anterior end of lower border to tip of flipper.

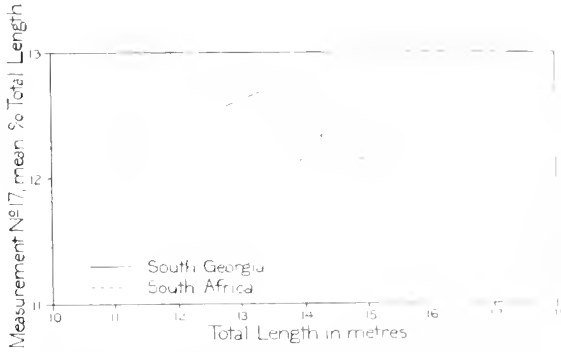


Fig. 32. Sei whale. Females. Measurement No. 17. Anterior end of lower border to tip of flipper.

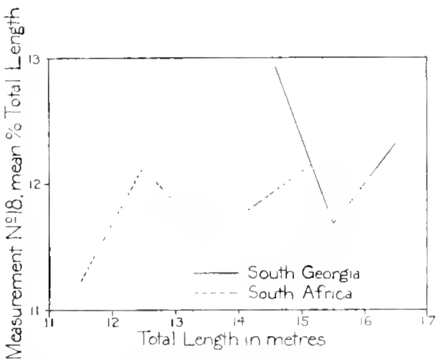


Fig. 33. Sei whale. Males. Measurement No. 18. Length of flipper along curve of lower border.

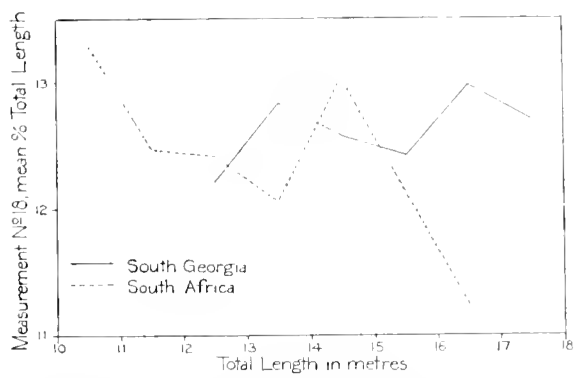


Fig. 34. Sei whale. Females. Measurement No. 18. Length of flipper along curve of lower border.

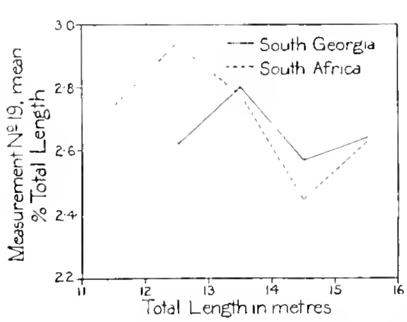


Fig. 35. Sei whale. Males. Measurement No. 19. Greatest width of flipper.

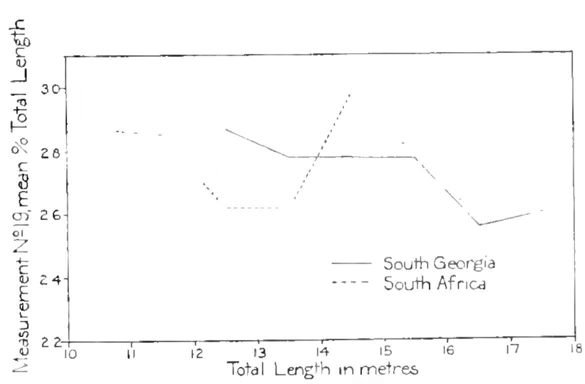


Fig. 36. Sei whale. Females. Measurement No. 19. Greatest width of flipper.

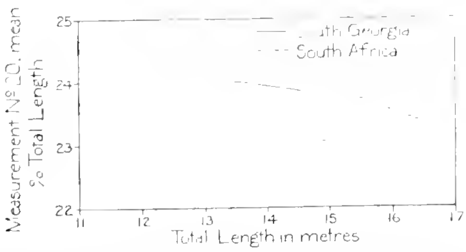


Fig. 37. Sei whale. Males. Measurement No. 20. Length of severed head from condyle to tip.

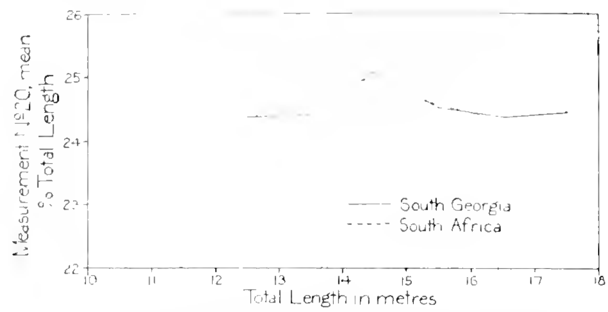


Fig. 38. Sei whale. Females. Measurement No. 20. Length of severed head from condyle to tip.

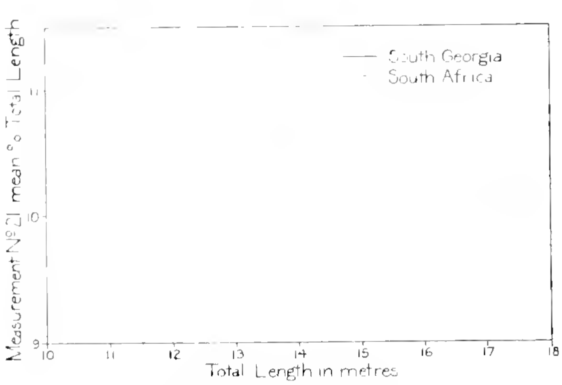


Fig. 39. Sei whale. Males. Measurement No. 21. Greatest width of skull.

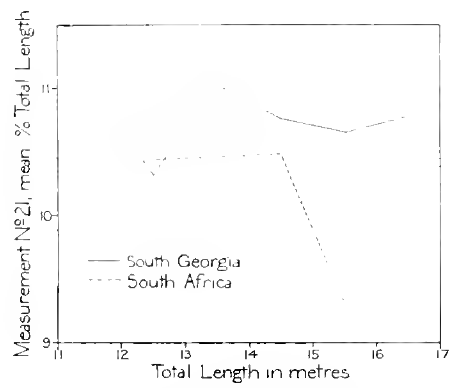


Fig. 40. Sei whale. Females. Measurement No. 21. Greatest width of skull.

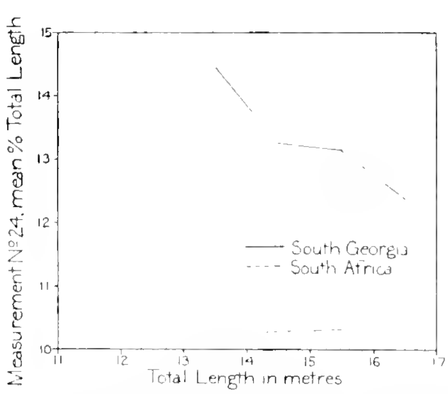


Fig. 41. Sei whale. Males. Measurement No. 24. Depth of body at dorsal fin.

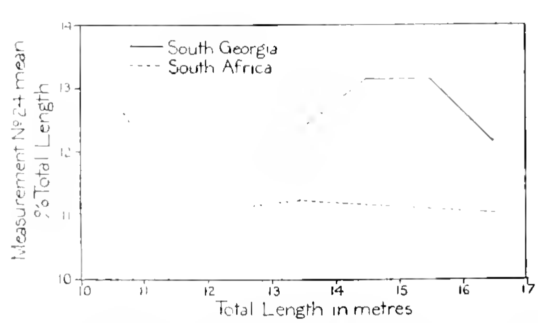


Fig. 42. Sei whale. Females. Measurement No. 24. Depth of body at dorsal fin.

It is of interest to note that in these figures there does not occur that pronounced tendency for curves relating to the anterior part of the body to slope upwards from their origin and those relating to the posterior part to slope downwards, as has been found in other balaenopterid whales. In the curves for measurement No. 3, tip of snout to blow-hole, Figs. 3 and 4, there is some slight tendency for the curves to take a general upward slope from their origin, as there is also in those for measurement No. 6, tip of snout to tip of flipper, Figs. 9 and 10. Conversely in the curves relating to females only for measurements Nos. 10 and 12, notch of flukes to anus and to end of system of ventral grooves respectively, Figs. 18 and 22, there is a general downward slope. But on the whole there is a very marked absence of the general upward or downward slope of the curves so characteristic of those based upon the measurements of other species. The conclusion to be drawn is that in the Sei whale growth is much more evenly distributed throughout the body and that marked differential growth in favour of the anterior region does not occur to anything like the extent that it does in the larger whales.

The variations that occur in each measurement are shown in Table X, in which the values of each measurement, expressed as percentages of the total length, are divided into arbitrary groups and the number of values falling into each group are recorded. These data are shown graphically in Figs. 43–61 in which the curves all approximate closely to normal frequency curves, the least regular ones being those derived from few data, or from measurements taken between ill-defined points and consequently difficult to take uniformly. Only the data from whales taken at South Georgia are included in these tables and figures: those from South African whales are omitted as being too few in number. The curves relating to data from females are the most accurate because they are constructed from nearly three times as many measurements as those relating to males. The range of variation in the measurements shown in these figures indicates a homogeneous population, and no admixture of races with structural differences.

COLOUR

Colour notes were made on ninety-six Sei whales, twenty-four males and seventy-two females. No colour differences between the sexes were observed.

The coloration of the Sei whale shows considerable variation. Dorsally the colour is some shade of grey, usually rather lighter than in the Fin whale, but in 11·5 per cent of the whales examined it was conspicuously darker. Ventrally the colour is light. On the ventral grooves there is always a white area of greater or lesser extent. This white area runs from the chin backwards, and when fully developed covers the whole of the ventral grooves but does not extend on to the mandible. More usually, however, it stops short of the posterior end of the grooves, but only rarely is its posterior margin sharply defined; more commonly it fades gradually into the posterior ventral coloration to be described below. The white area may fail to reach the posterior end of the ventral grooves by a distance of 1–3 m. (Pl. XVIII, figs. 1 and 2), while one instance occurred in which it extended only for a distance of 1·5 m. from the chin, forming a large white

Table X. *Sei whale. Variation of measurements. South Georgia*

3. Tip of snout to blow-hole

Range of values (% of total length)	No. of measurements ♂	No. of measurements ♀
11·0–12·0	1	0
12·0–13·0	0	0
13·0–14·0	0	0
14·0–15·0	4	3
15·0–16·0	13	19
16·0–17·0	20	58
17·0–18·0	5	27
18·0–19·0	0	9
19·0–20·0	1	0

4. Tip of snout to angle of gape

Range of values (% of total length)	No. of measurements ♂	No. of measurements ♀
16·0–17·0	0	1
17·0–18·0	2	1
18·0–19·0	16	15
19·0–20·0	15	43
20·0–21·0	6	22
21·0–22·0	0	4
22·0–23·0	0	1

5. Tip of snout to centre of eye

Range of values (% of total length)	No. of measurements ♂	No. of measurements ♀
17·0–18·0	1	2
18·0–19·0	20	13
19·0–20·0	24	59
20·0–21·0	3	39
21·0–22·0	2	18
22·0–23·0	0	2

6. Tip of snout to tip of flipper

Range of values (% of total length)	No. of measurements ♂	No. of measurements ♀
37·0–38·0	0	1
38·0–39·0	1	4
39·0–40·0	6	6
40·0–41·0	6	15
41·0–42·0	7	23
42·0–43·0	2	10
43·0–44·0	0	1
44·0–45·0	0	1

7. Centre of eye to centre of ear

Range of values (% of total length)	No. of measurements ♂	No. of measurements ♀
4·0–4·5	1	1
4·5–5·0	10	19
5·0–5·5	25	74
5·5–6·0	9	27
6·0–6·5	1	2
6·5–7·0	0	0

13. Centre of anus to centre of reproductive aperture

Range of values (% of total length)	No. of measurements ♂	No. of measurements ♀
1·5–2·0	—	3
2·0–2·5	—	24
2·5–3·0	—	81
3·0–3·5	—	27
3·5–4·0	—	4
4·0–5·0	2	—
5·0–6·0	4	—
6·0–7·0	17	—
7·0–8·0	28	—
8·0–9·0	3	

14. Vertical height of dorsal fin

Range of values (% of total length)	No. of measurements ♂	No. of measurements ♀
2·5–2·8	1	6
2·8–3·1	2	20
3·1–3·4	11	31
3·4–3·7	10	28
3·7–4·0	12	20
4·0–4·3	3	7
4·3–4·6	3	5
4·6–4·9	1	2
4·9–5·2	2	1

15. Length of base of dorsal fin

Range of values (% of total length)	No. of measurements ♂	No. of measurements ♀
4·0–4·5	0	3
4·5–5·0	2	1
5·0–5·5	3	6
5·5–6·0	6	20
6·0–6·5	6	24
6·5–7·0	10	30
7·0–7·5	5	9
7·5–8·0	2	7
8·0–8·5	3	3
8·5–9·0	1	1
9·0–9·5	0	1

16. Axilla to tip of flipper

Range of values (% of total length)	No. of measurements ♂	No. of measurements ♀
5·0–6·0	1	0
6·0–7·0	0	1
7·0–8·0	4	4
8·0–9·0	14	40
9·0–10·0	10	43
10·0–11·0	3	9
11·0–12·0	1	1

17. Anterior end of lower border to tip of flipper

Range of values (% of total length)	No. of measurements ♂	No. of measurements ♀
10·0–10·5	1	1
10·5–11·0	0	5
11·0–11·5	4	9
11·5–12·0	6	12
12·0–12·5	7	18
12·5–13·0	3	19
13·0–13·5	3	11
13·5–14·0	0	2

Table X. *Sei Whale. Variation of measurements. South Georgia*

8. Notch of flukes to posterior emargination of dorsal fin

Range of values (% of total length)	No. of measurements ♂	♀
25·0–26·0	1	1
26·0–27·0	0	0
27·0–28·0	0	2
28·0–29·0	2	5
29·0–30·0	11	34
30·0–31·0	14	35
31·0–32·0	14	31
32·0–33·0	4	7
33·0–34·0	2	4
34·0–35·0	0	1

9. Width of flukes at insertion

Range of values (% of total length)	No. of measurements ♂	♀
5·0–5·5	0	11
5·5–6·0	22	68
6·0–6·5	15	22
6·5–7·0	2	6

10. Notch of flukes to centre of anus

Range of values (% of total length)	No. of measurements ♂	♀
24·0–25·0	0	3
25·0–26·0	3	12
26·0–27·0	11	52
27·0–28·0	31	46
28·0–29·0	5	22
29·0–30·0	2	2
30·0–31·0	1	0

11. Notch of flukes to umbilicus

Range of values (% of total length)	No. of measurements ♂	♀
41·0–42·0	1	1
42·0–43·0	0	1
43·0–44·0	0	2
44·0–45·0	0	4
45·0–46·0	0	3
46·0–47·0	5	21
47·0–48·0	7	41
48·0–49·0	20	37
49·0–50·0	11	18
50·0–51·0	7	7
51·0–52·0	1	1
52·0–53·0	0	0
53·0–54·0	0	1

12. Notch of flukes to end of system of ventral grooves

Range of values (% of total length)	No. of measurements ♂	♀
47·0–48·0	0	1
48·0–49·0	0	0
49·0–50·0	0	1
50·0–51·0	1	3
51·0–52·0	2	2
52·0–53·0	1	11
53·0–54·0	4	19
54·0–55·0	12	33
55·0–56·0	7	21
56·0–57·0	8	17
57·0–58·0	5	7
58·0–59·0	0	1

18. Length of flipper along curve of lower border

Range of values (% of total length)	No. of measurements ♂	♀
11·0–11·5	2	4
11·5–12·0	7	11
12·0–12·5	6	7
12·5–13·0	5	17
13·0–13·5	3	14
13·5–14·0	1	2
14·0–14·5	0	2

19. Greatest width of flipper

Range of values (% of total length)	No. of measurements ♂	♀
2·2–2·3	0	1
2·3–2·4	2	6
2·4–2·5	2	7
2·5–2·6	8	19
2·6–2·7	8	22
2·7–2·8	5	19
2·8–2·9	5	11
2·9–3·0	1	8
3·0–3·1	1	4
3·1–3·2	0	1

20. Length of severed head from condyle to tip

Range of values (% of total length)	No. of measurements ♂	♀
21·5–22·0	0	2
22·0–22·5	4	2
22·5–23·0	5	2
23·0–23·5	4	5
23·5–24·0	10	17
24·0–24·5	11	27
24·5–25·0	6	20
25·0–25·5	3	19
25·5–26·0	2	10
26·0–26·5	0	3
26·5–27·0	0	0
27·0–27·5	0	1

21. Greatest width of skull

Range of values (% of total length)	No. of measurements ♂	♀
9·0– 9·5	0	3
9·5–10·0	6	14
10·0–10·5	12	31
10·5–11·0	8	32
11·0–11·5	11	19
11·5–12·0	2	8
12·0–12·5	2	2
12·5–13·0	1	1
13·0–13·5	1	0

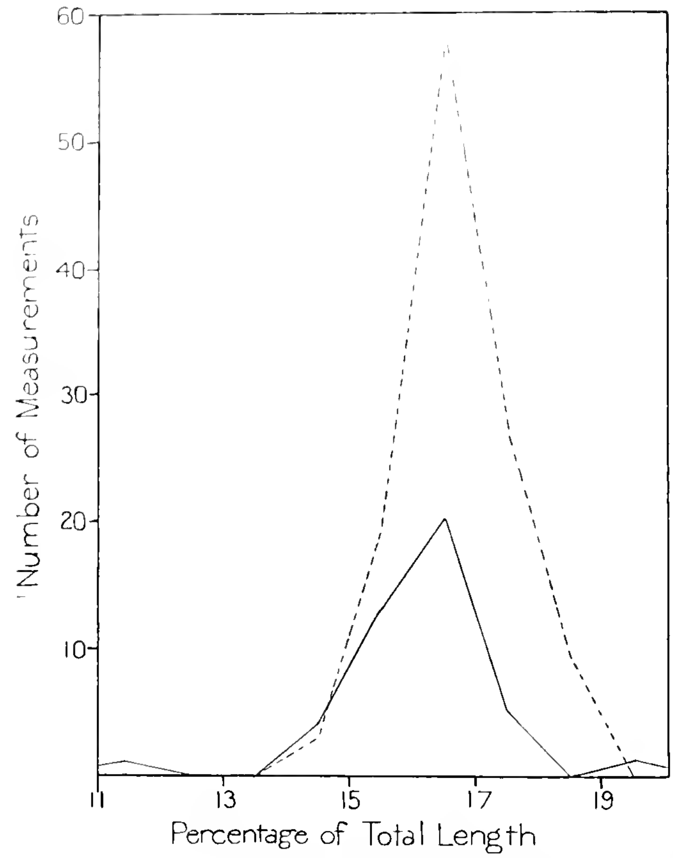


Fig. 43. Sei whale. Variation of measurement No. 3. Tip of snout to blow-hole.

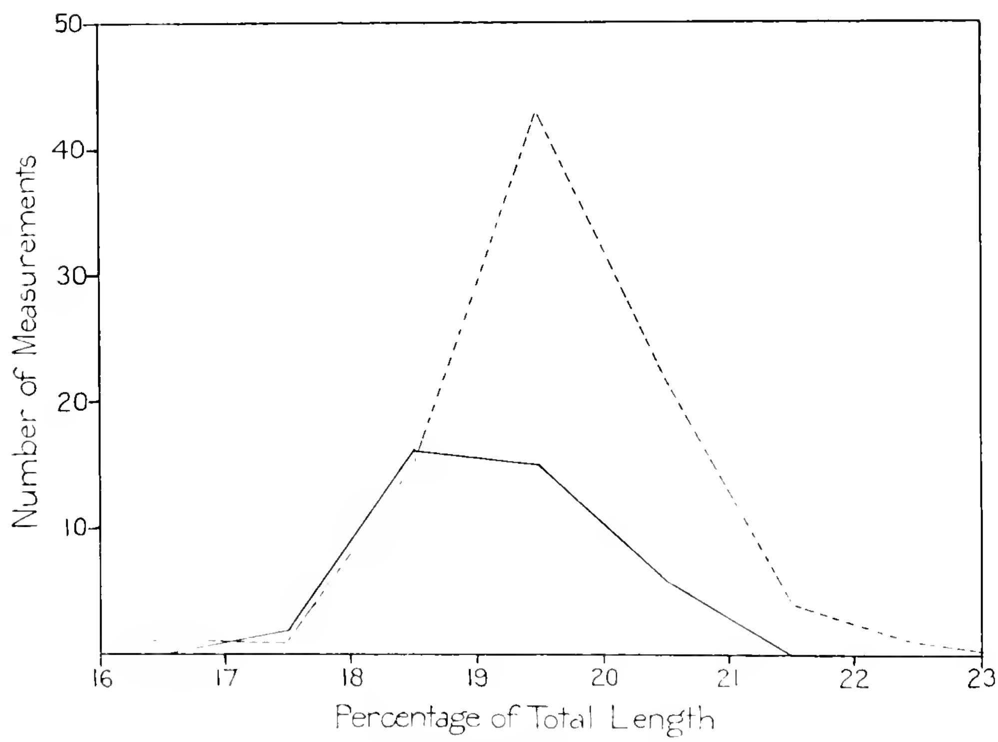


Fig. 44. Sei whale. Variation of measurement No. 4. Tip of snout to angle of gape.

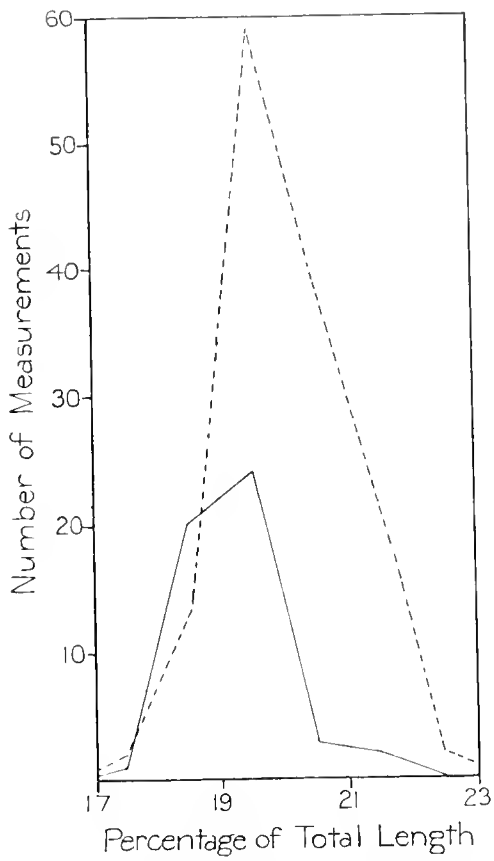


Fig. 45. Sei whale. Variation of measurement No. 5. Tip of snout to centre of eye.

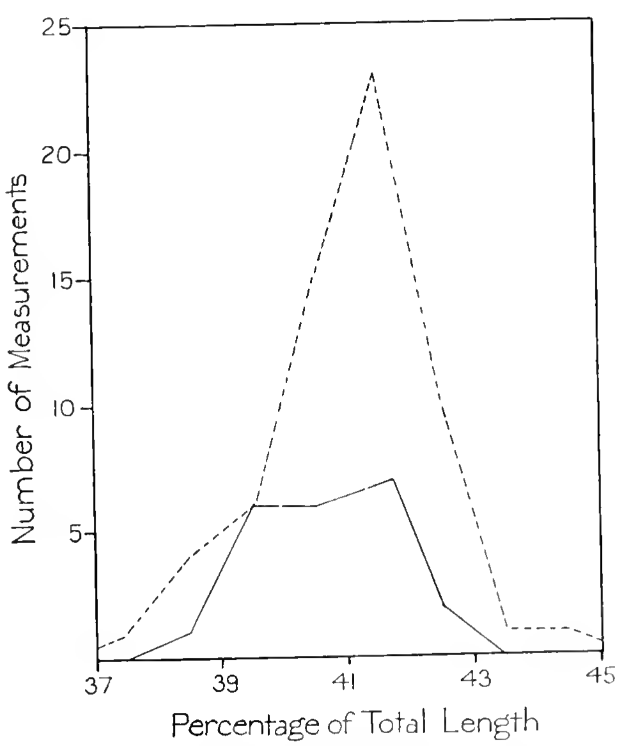


Fig. 46. Sei whale. Variation of measurement No. 6. Tip of snout to tip of flipper.

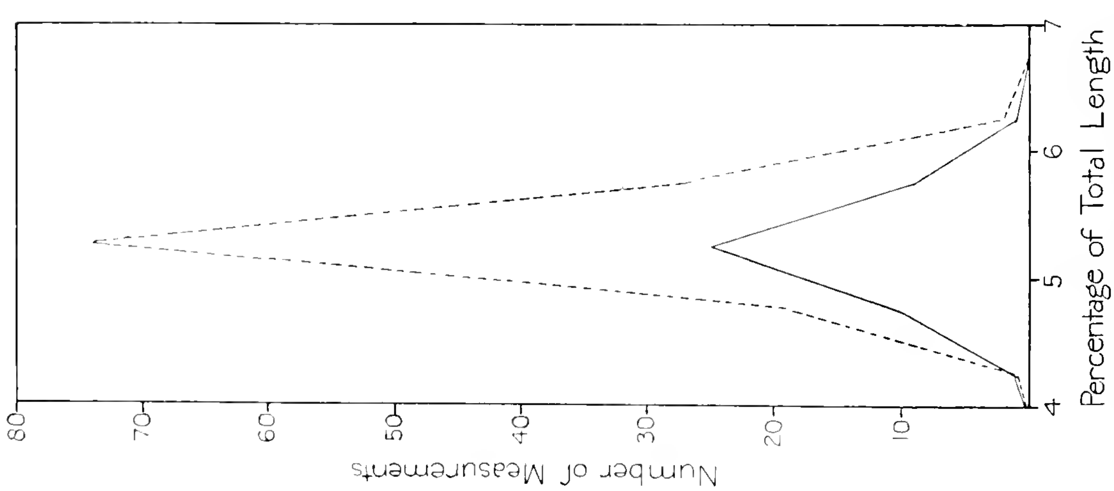


Fig. 47. Sei whale. Variation of measurement No. 7. Centre of eye to centre of ear.

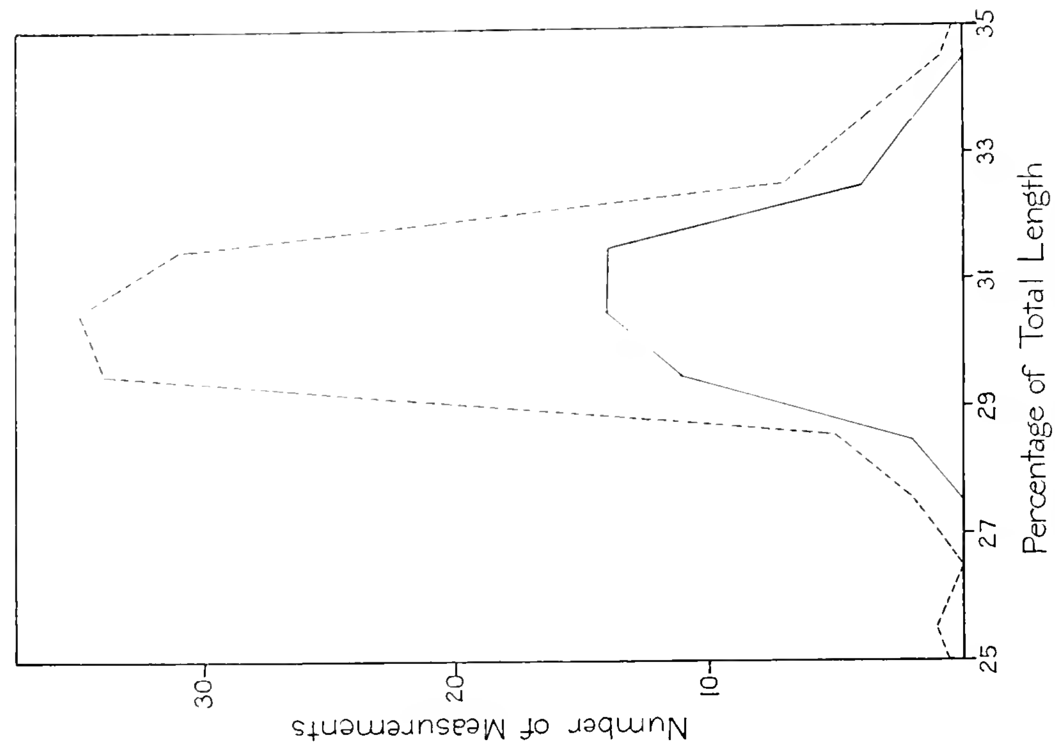


Fig. 48. Sei whale. Variation of measurement No. 8. Notch of flukes to posterior emargination of dorsal fin.

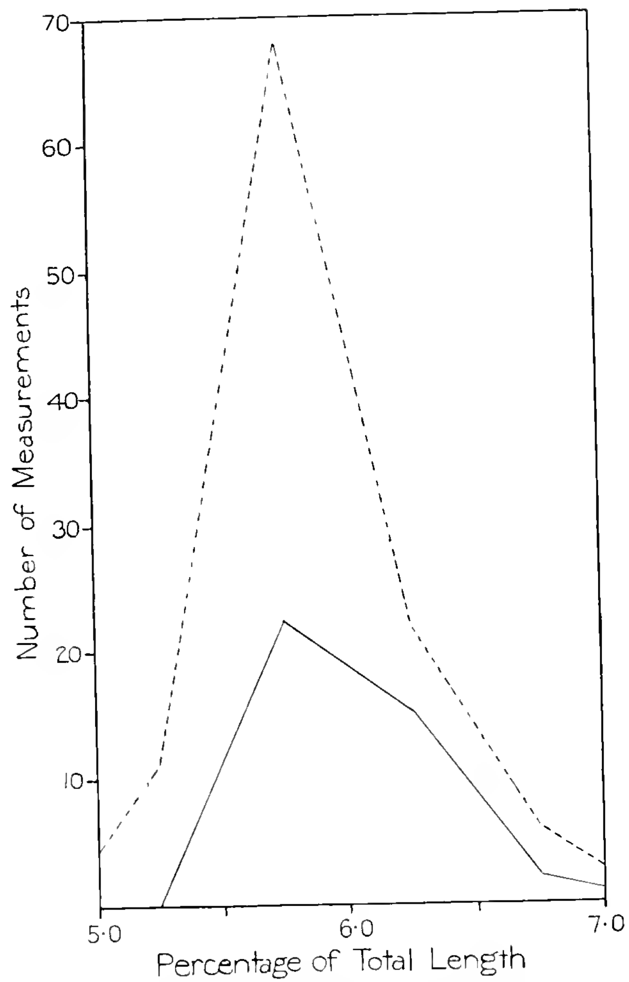


Fig. 49. Sei whale. Variation of measurement No. 9. Width of flukes at insertion.

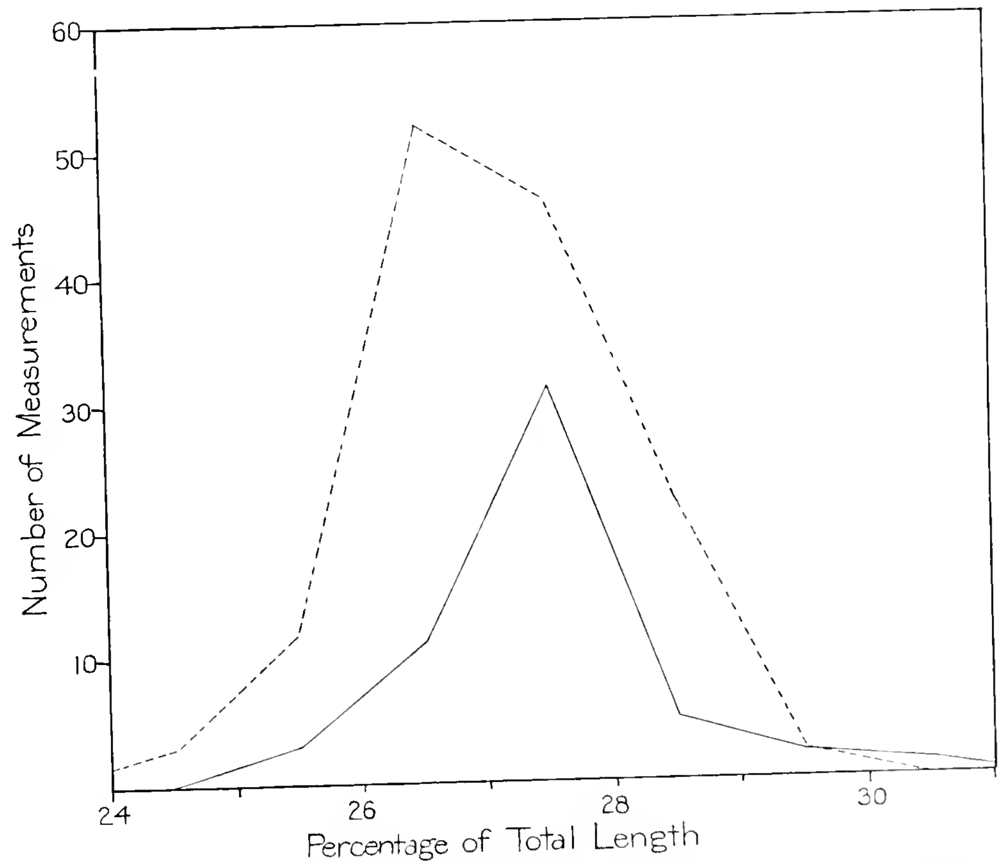


Fig. 50. Sei whale. Variation of measurement No. 10. Notch of flukes to centre of anus.

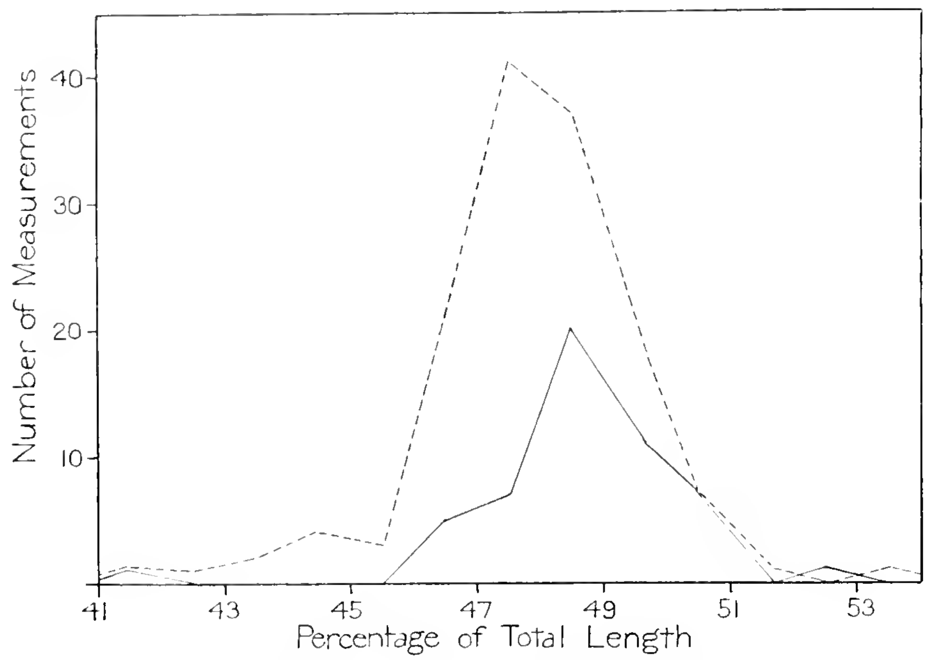


Fig. 51. Sei whale. Variation of measurement No. 11. Notch of flukes to umbilicus.

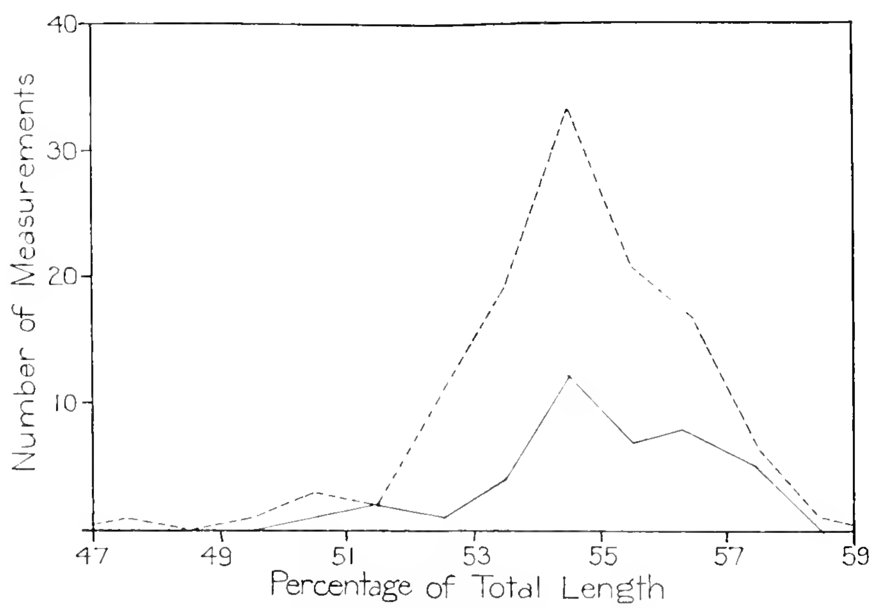


Fig. 52. Sei whale. Variation of measurement No. 12. Notch of flukes to end of system of ventral grooves.

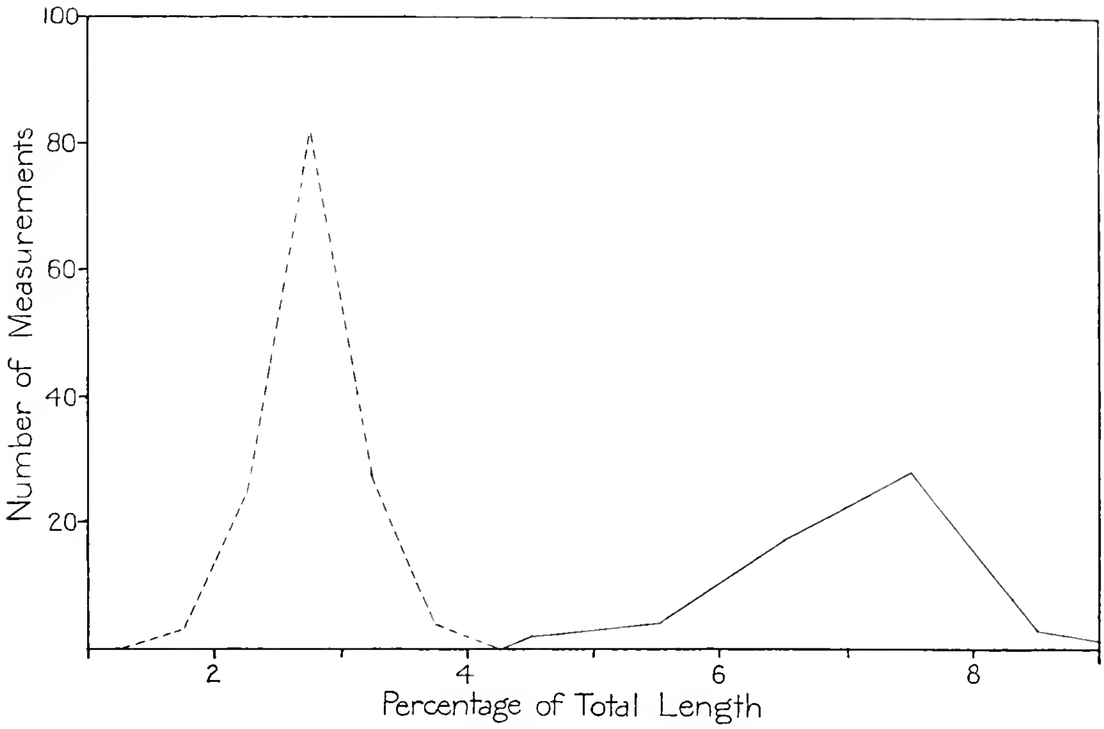


Fig. 53. Sei whale. Variation of measurement No. 13. Centre of anus to centre of reproductive aperture.

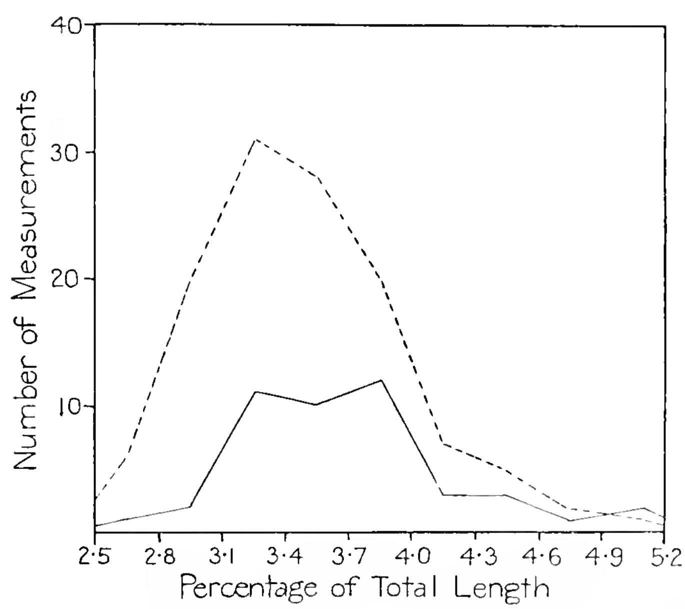


Fig. 54. Sei whale. Variation of measurement No. 14. Vertical height of dorsal fin.

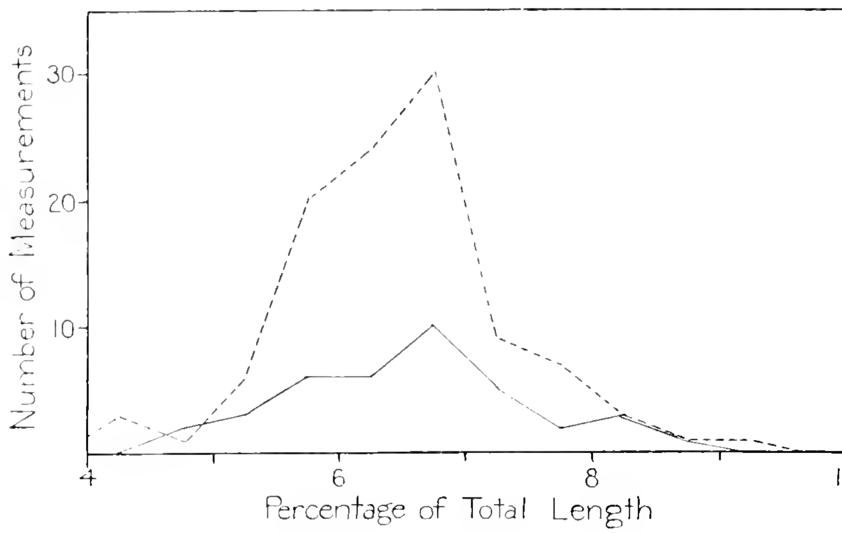


Fig. 55. Sei whale. Variation of measurement No. 15. Length of base of dorsal fin.

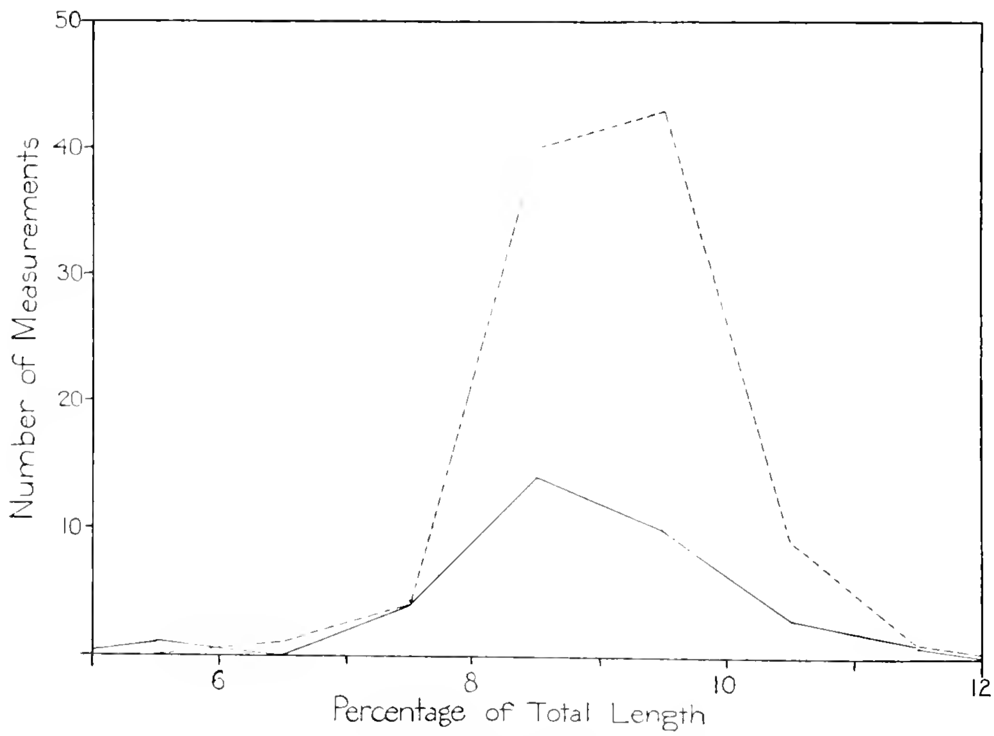


Fig. 56. Sei whale. Variation of measurement No. 16. Axilla to tip of flipper.

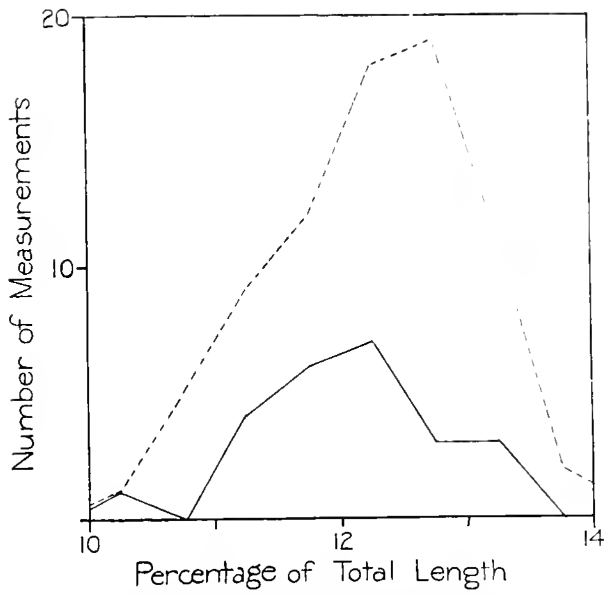


Fig. 57. Sei whale. Variation of measurement No. 17. Anterior end of lower border to tip of flipper.

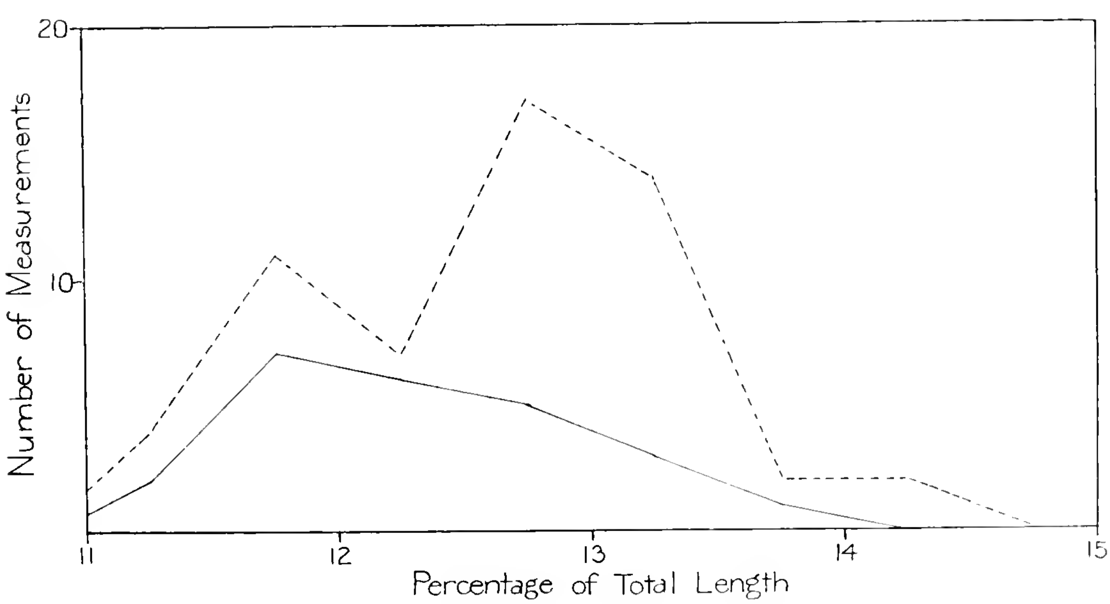


Fig. 58. Sei whale. Variation of measurement No. 18. Length of flipper along curve of lower border.

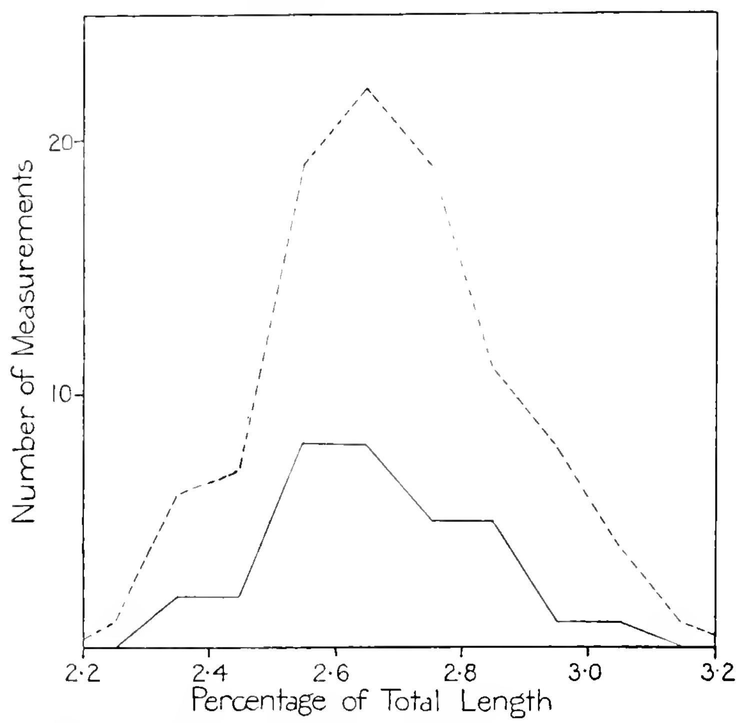


Fig. 59. Sei whale. Variation of measurement No. 19. Greatest width of flipper.

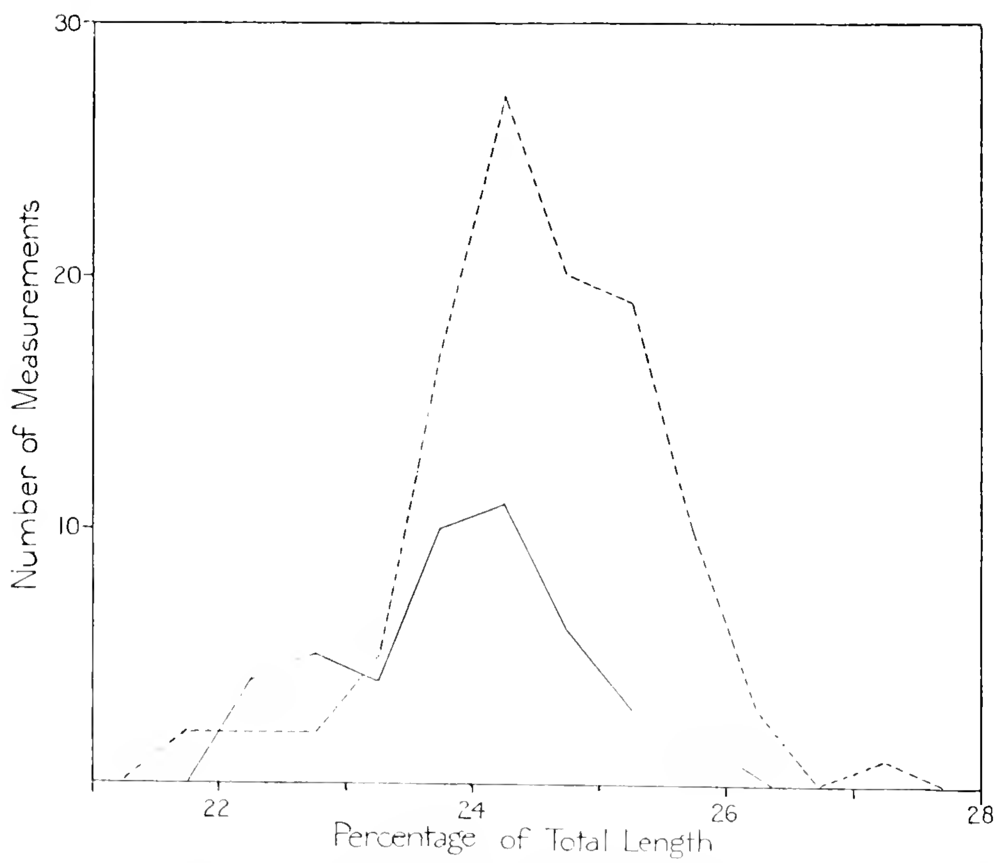


Fig. 60. Sei whale. Variation of measurement No. 20. Length of severed head from condyle to tip.

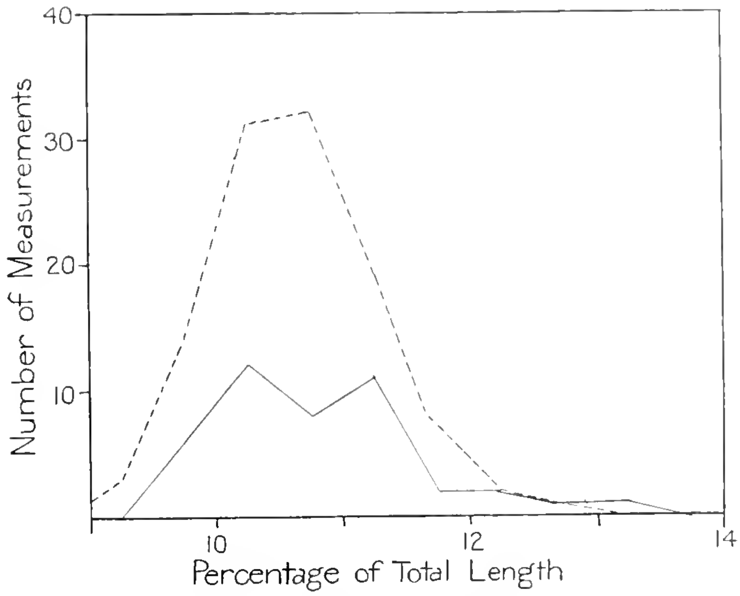


Fig. 61. Sei whale. Variation of measurement No. 21. Greatest width of skull.

spot on the anterior part of the ventral groove area. The white area was developed to the maximum in 20 per cent of the whales examined, and was small in 30 per cent. The lateral margins of the white area are usually very indefinite, the white colouring fading gradually into the grey of the dorsal surface and of the mandible. The width of the white area is frequently restricted by encroachment of pigment from the dorsal surface. The dark or pigmented areas spread downwards over the sides of the ventral grooves to a greater or lesser extent, and not only is the line of division indistinct but it is frequently also very irregular so that tongues and irregular shaped areas of pigment extend on to the sides of the white area. In extreme cases, which occur in about 12 per cent of Sei whales, the white area is thus reduced to a narrow median streak of irregular outline.

At the posterior end of the white area two white streaks occurred in 25 per cent of the whales examined, running outwards and forwards from the middle line towards the insertion of the flippers, forming a more or less well defined anchor-shaped mark (Pl. XVIII, fig. 2). The formation of the anchor can also be regarded as being produced by encroachment of two tongues of pigment, one on each side, over the posterior part of the white area. In one case the anchor mark was found to be entirely separated from the ventral white area by the joining of the two pigmented tongues, so that a white chevron mark with the apex directed posteriorly was formed (Pl. XVIII, fig. 2). In 12 per cent of the whales examined, the occurrence of scattered spots and irregular pigmented areas, often of indefinite outline, was noted in the ventral white area. Posterior to the ventral grooves the ventral coloration is some shade of light grey which merges indefinitely and gradually into the darker grey of the dorsal surface. The light grey colour covers the under-surface of the belly, tail and flukes, and in 14 per cent extends for some distance over the flanks and side of the tail. Some white areas occur occasionally within the light grey area: most frequently, in about 15 per cent, on the umbilicus and round the genital aperture (Pl. XVIII, fig. 2). The under surface of the flukes in 6 per cent of the whales was marked by longitudinal striations of grey on a lighter background. The under surface of the flipper varies from white to light grey and is occasionally almost as dark as the upper surface.

On the dorsal surface of the body a light grey marking occurred in 8 per cent of the whales. This appears as a light V-shaped area over the shoulders with the apex directed forward, situated on the back above the insertion of the flippers. This marking is very similar to the corresponding one present in Fin whales, but the apex of the V tends to be less sharp so that the shape sometimes is closer to that of the letter U. In the foetus there is a very pale area above and in front of the shoulder joint, with a very clear posterior margin which crosses the humerus, but is not continued past the flipper.

Many examples of the Sei whale are also like the Fin whale in having a white streak running back from the ear for some inches in a backward and downward direction. A dark mark running backwards and upwards from the posterior side of the eye also frequently occurs. It appears never to be so well marked as in the Fin whale, and fades into the dorsal coloration after a course of some inches or a foot in length. It was sufficiently well marked to be specially noted in 7 per cent of the whales examined. In these it appeared as a broad band of darker colour running up and back from the eye, while there were indefinite indications of two others on each side of the posterior part of the groove area, which would have formed chevron marks if they had been continued to meet in the middle line. Their arms, however, merged into the general body colour.

Small light-coloured spots of irregular outline giving an appearance similar to that of new galvanized iron, were found in 15 per cent of the whales examined, on the flanks and side of the tail. In many cases they were so thick that the regions covered by them had a light silvery grey appearance. Andrews (1916) gives a good photograph of these markings.

In about 4 per cent of the whales a white splash on the under surface of the anterior border of the maxilla, similar to that frequently present in Humpback whales, was observed.

The distribution of the colour in the Sei whale is usually symmetrical, or at least not markedly asymmetrical, though the margins of the pigmented and unpigmented areas are irregular and indefinite. In about 10 per cent the coloration was definitely asymmetrical, the whole of the pigment being shifted slightly to the right as in the Fin whale. The asymmetry becomes specially evident in those individuals in which the white area on the ventral grooves is considerably restricted laterally, so that a narrow strip of white occurs on the grooves, the greater part of it on the left side of the median line. If, as appears likely, the asymmetrical coloration of the Fin whale is associated with the habit of swimming and feeding slightly on the right side, a similar association would be expected in the Sei whale, though Millais (1906) states definitely, and emphasizes his statement with italics, that when feeding this species does not turn on the right side. Perhaps a smaller degree of asymmetry in the Sei whale is associated with a less pronounced development of the habit of turning on to the side.

The smallest foetus regarding which colour notes are available measured 1·3 m. in length. In this the top of the head and snout were pigmented, except for large areas round each eye. The outer surface of the left mandible was lightly, and the surface of the flippers and the tip of the dorsal fin were fairly heavily, pigmented. The dorsal surface, and the posterior margin of the ventral surface, of the flukes were pigmented. The rest of the body was very pale.

In the next largest foetus, measuring 1·69 m. in length, the pigment was general over the dorsal surface of the body, with pigmented areas over each eye and an unpigmented V-shaped area on the back with the apex at the level of the insertion of the flippers and directed forward. The dorsal surface of the flippers and the margin of the ventral surface of the flukes were pigmented.

From this size onwards the adult pigmentation is reached by the extension and darkening of the areas of pigment already present. The V-shaped light area on the back is late in attaining its full coloration, so that it is more marked in the foetus than in the adult. Between the lengths of 2 and 3 m. the under surface of the flippers receives its pigmentation, if it is to be present, apparently on the right side first.

The colour of the palate is pale pink or white with a small area of grey pigment at the posterior end. The grey area usually fades gradually into the unpigmented anterior part, but the line of demarcation is sometimes sharp. The grey area varies in size and intensity of coloration and is sometimes much reduced centrally, so that it forms a small median area with two streaks running forward on each side. In only one out of seventy-six whales for which data relating to the palate were recorded was the posterior grey patch on the palate absent. In addition to the posterior grey patch an anterior grey patch of small extent was present in 6·5 per cent of the Sei whales and occurred in both sexes.

The tongue is dark slate-grey in colour, usually lighter on the under surface, but occasionally darker. The colour is not always of even intensity all over the surface of the tongue, but may vary so as to appear slightly blotched, or lighter at the margins.

HAIR

Hair occurs in the Sei whale on the upper surface of the head, on the ramus of the jaws and on the chin.

On the upper surface of the head the hairs occur in three series, a marginal line on each side, a group on each side of the blow-hole, and a pair of lines, one on each side of and close to the median line. The marginal lines are constant in their occurrence, but the submedian lines or the blow-hole groups may be absent. The number of hairs present on the upper surface of the head on one side varies from two to ten and averages six.

On the ramus of the jaws the hairs are arranged in one or two lines, which may be rather irregular, and in one whale three lines of hair were noted. The arrangement of the hairs in two lines is thus similar to that frequently found in Fin whales, whereas in Blue whales the presence of two lines has not been recorded. The number of hairs on the ramus of the jaw on one side varies from five to eighteen and averages ten.

The hair on the chin is arranged in two irregular vertical rows, the number of hairs in the two rows frequently being equal and seldom differing by more than four or five. The number of hairs on the chin varies from fourteen to forty-four and averages twenty-eight.

Table XI shows the occurrence of hair on the chin, mandible, and head in the present series of Sei whales.

VENTRAL GROOVES

The arrangement of the ventral grooves in the Sei whale differs from that in the Fin and Blue whales in that at their posterior extremity the grooves end evenly well anterior to the umbilicus (Pl. XVIII, figs. 1 and 2). No examples were recorded in which they ran back as far as the umbilicus, and only one in which a median groove joined the umbilicus and genital groove. The outside lateral groove sometimes runs into the angle of the gape anteriorly.

The number of grooves varies from forty to sixty-two, the average being forty-seven, which may be compared with the corresponding figures of eighty-nine for Blue whales and eighty-six for Fin whales. The smaller number of grooves in the present species is correlated with its smaller size. Table XII gives the number of grooves recorded in fifty-eight Sei whales. In the female two or three small subsidiary grooves are present on each side of the mammary grooves.

BALEEN

The baleen of the Sei whale is characteristically of fine texture, and the reason for this is apparent when the number of plates present and the size of the whale are considered. The number of baleen plates on one side of the mouth averages 342 in this species, nearly the same number as is found in Blue whales (average 348) and not greatly fewer than that found in the Fin whale (average 363). As the size of the mouth is very much smaller in the Sei whale than in the other species (the tip of the snout to the angle of the gape averages about 2·9 m. in Sei whales, 4·25 m. in Blue whales and 4·0 m. in Fin whales), while the number of baleen plates is nearly the same, the texture of the baleen is necessarily much finer (Pl. XIX, fig. 1). Table XIII gives the numbers of plates present in one side of the mouth in thirty-seven Sei whales.

The colour of most of the baleen plates is dark, nearly black, and the bristles at the inner edges of the plates are white or greyish white and fine and silky in texture. At the anterior end of the series, however, a number of white plates are frequently present, on one or both sides. When the white spot on the anterior part of the margin of the upper jaw, described above, is present, the white baleen plates are situated so that they hang immediately below it. Table XIV summarizes the colour notes collected regarding the baleen of Sei whales. Whale D. 119, landed at Durban, in which the baleen plates were

Table XI. *Sei whale. Hair*

No. of hairs on chin	Males		Females	
	South Africa	South Georgia	South Africa	South Georgia
12–15	—	1	—	1
16–19	—	—	—	3
20–23	—	1	—	4
24–27	—	3	1	10
28–31	—	3	—	12
32–35	—	2	—	6
36–39	—	1	—	4
40–44	—	1	—	1
Average no.	—	28	26	28
Maximum	—	44	26	40
Minimum	—	14	26	14
No. of hairs on one side of mandible				
4– 7	—	3	—	4
8–11	1	4	—	21
12–15	—	2	2	5
16–19	—	—	1	1
Average no.	10	10	13	10
Maximum	10	13	16	18
Minimum	10	5	11	6
No. of hairs on upper surface of head, one side				
2	—	—	—	1
3	—	—	—	1
4	—	—	—	3
5	—	—	—	2
6	—	—	—	2
7	—	2	—	5
8	—	2	—	3
9	—	2	—	2
10	—	—	—	1
Average no.	—	8	—	6
Maximum	—	9	—	10
Minimum	—	7	—	2

Table XII. *Sei whale. Ventral grooves*

No. of ventral grooves	Males		Females	
	South Georgia	South Africa	South Georgia	South Africa
40–44	6	1	9	—
45–49	2	—	12	—
50–54	3	—	17	—
55–59	1	—	2	—
60–64	2	—	1	2
Average no.	47	42	41	61
Maximum	60	42	60	62
Minimum	40	42	40	60

Table XIII. *Sei whale. Baleen*

No. of baleen plates on one side	Males		Females	
	South Georgia	South Africa	South Georgia	South Africa
290–299	—	—	2	—
300–319	1	—	3	—
320–339	3	—	6	1
340–359	2	1	6	—
360–379	—	—	8	—
380–399	1	—	2	—
400–410	1	—	—	—
Average no.	345	356	343	326
Maximum	402	356	380	326
Minimum	300	356	296	326

Table XIV. *Sei whale. Colour of baleen*

Whale no.	Sex	Length metres	Colour of baleen
905	♂	15·2	On the right side: 30 small dark plates anteriorly, followed by 36 white ones and then 290 dark ones. Left side: 40 small dark plates anteriorly, followed by 15 white ones; the rest dark
939	♀	11·55	A few posterior plates on each side tipped with white
952	♀	10·45	Twenty white plates near tip of snout on each side
1074	♀	16·3	External edges of all plates pigmented
1164	♀	13·35	A few white plates on each side near the tip of the snout; the rest dark
1526	♀	17·1	Twenty white plates at anterior end on right side; eight on left; opposite white splashes on snout
1530	♀	15·75	No white plates
1754	♀	15·63	Several white plates at anterior end of series on right side
48	♀	15·58	A small patch of white baleen, 13 cm. wide, a few plates from the tip of the snout on the right side
3248	♀	14·6	About 45 white plates at the anterior end of the series on the right side
D 119	♂	14·3	Many plates on both sides with white strips 3–4 cm. wide on their inner edges

edged with white internally, was not examined until it was largely dismembered, a matter for regret, as it was reported by the whaling foreman to be a "Bryde's whale". The remains examined, however, were all indistinguishable from the typical Sei whale except for this streak in the baleen. Pl. XIX, fig. 2, shows a plate of this baleen, which except for the coloration is typical Sei whale baleen.

Where white plates occur together with the white spot on the side of the snout they coincide in position with it, but white plates commonly occur without the white spot, and, on the other hand, one case is recorded in which the white spot was present but all the plates were pigmented. In all whales in which white plates were present on one side only it was the right side on which they occurred: the numbers are not sufficient to draw definite conclusions, but this may be an indication of a tendency to asymmetry as is found in the Fin whale. The number of white plates present varies from nil to the greatest recorded number of forty-five on one side, though Collett (1886) records up to fifty-eight in the Sei whale of the northern hemisphere. This may be compared with the condition found in the Fin whale where the average number of white plates on the right side is 152, maximum 200 and minimum 68.

The width of the longest baleen plates at their base has been recorded in twenty-four Sei whales, all from South Georgia: these measurements are given in Table XV. From these figures it is seen that the width of the baleen of this species is very much less, varying from 28 to 50 per cent of its length, than in the Blue and Fin whales, where the corresponding figures are 67–106 per cent and 60–73 per cent respectively. The figures show an increase in breadth, together with increase in the percentage value, as the whales increase in total length from 12 to 16 m., showing that the baleen increases

Table XV. *Sei whale. Baleen width*

Males			Females		
Whale length metres	Baleen. Width cm.	Baleen. Width per cent of baleen length	Whale length metres	Baleen. Width cm.	Baleen. Width per cent of baleen length
13·29	17	33·3	12·05	17	39·4
13·67	15	30·5	13·53	16	28·0
13·74	20	40·8	14·37	17	30·9
13·78	15	31·2	14·87	23·5	37·9
14·04	18	36·0	15·07	28	50·9
15·22	19	34·5	15·20	27	41·0
15·27	33	42·4	15·26	26·5	46·5
			15·73	32	38·0
			15·74	26	40·6
			15·83	25	36·8
			15·95	27	45·0
			15·98	22	33·8
			16·20	25	37·2
			16·22	26	41·9
			16·29	21	33·8
			16·35	18	30·0
			16·42	16	25·0

in width more quickly than in length between these total lengths, but the figures for 16 m. and above show a decrease. The data are insufficient to draw generalizations, but the values for whales 16 m. and more in length may indicate the effects of wear in older whales, in which a decrease in breadth, both absolute and expressed as a percentage of length, may be produced by the inner edges of the plates becoming more and more frayed out into bristles with increasing age and use.

The spacing of the baleen plates was recorded in a number of whales. Fig. 62 shows the spacing plotted against whale length and indicates an increase in spacing from 0·8 cm. in 11 m. whales to 1·5 cm. in 17 m. whales. These figures may be compared with those of Blue whales, 1·0–2·5 cm., and Fin whales 1·0–1·8 cm. Here again the reason for the fineness of texture of Sei whale baleen is shown, because the spaces between the plates are not much less than in Fin whales, while the number of plates is little less than in that species and the length of jaw is much smaller. The figures show no difference between male and female or South African and South Georgian Sei whales.

The length of the longest baleen plates is plotted against the total length of the whale in Fig. 63. The plotted points show that the longest baleen plates vary from 35 cm. in 10 m. whales to 80 cm. in 17 m. whales. The growth curve obtained from these points is shown as a solid line, while the dotted portion is obtained by analogy from the known facts that occur in the Blue whale. This shows a gradual increase in baleen length followed by a sudden spurt where it joins the solid line. The sudden spurt represents the accelerated growth of baleen at weaning, when a diet of milk is changed for one of krill: weaning probably takes place between the lengths of 8 and 9 m.

NORTHERN AND SOUTHERN SEI WHALES COMPARED

The descriptions given of the details of the external characters of the Sei whale from South Georgia and South Africa do not indicate any specific difference from the northern Sei whale (Collett, 1886; Andrews, 1918) nor any differentiation into separate southern races. Andrews (1918) gives an extensive description of the Sei whales taken at Japan and shows that they do not differ even subspecifically from the Sei whales of the North Atlantic described by Haldane (1904–10), Collett (1886) and Millais (1906). Whales from these seas appear to be specifically identical with the present series, so that the Sei whale is undoubtedly cosmopolitan. This is at variance with the view expressed in 1915 by Hinton (1925) that "it is highly improbable that the southern Sei whale is identical with *Balaenoptera borealis*. The latter is a plankton-eating species normally frequenting the eastern part of the north Atlantic from 20° N northwards." From the limited material available to him he concluded that the southern Sei whale was a little larger than the so-called Bryde's whale and smaller than the true Sei whale. The figures of the present series, however, do not substantiate this, for they show that the southern Sei whale is, if anything, a little larger than the Sei whale of the northern hemisphere. This difference is doubtless due to a higher proportion of immature specimens included in the figures of the northern catches.

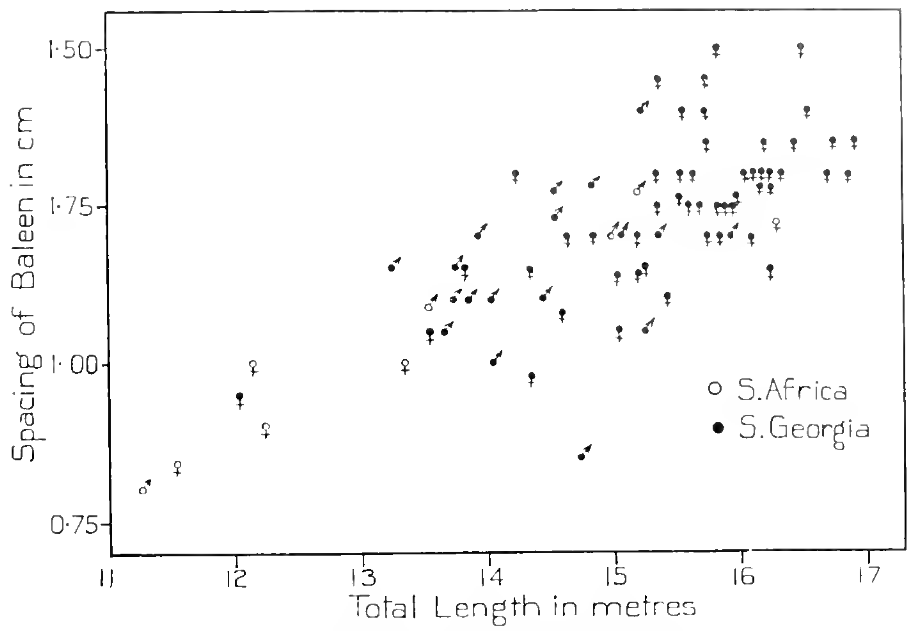


Fig. 62. Sei whale. Spacing of baleen plates.

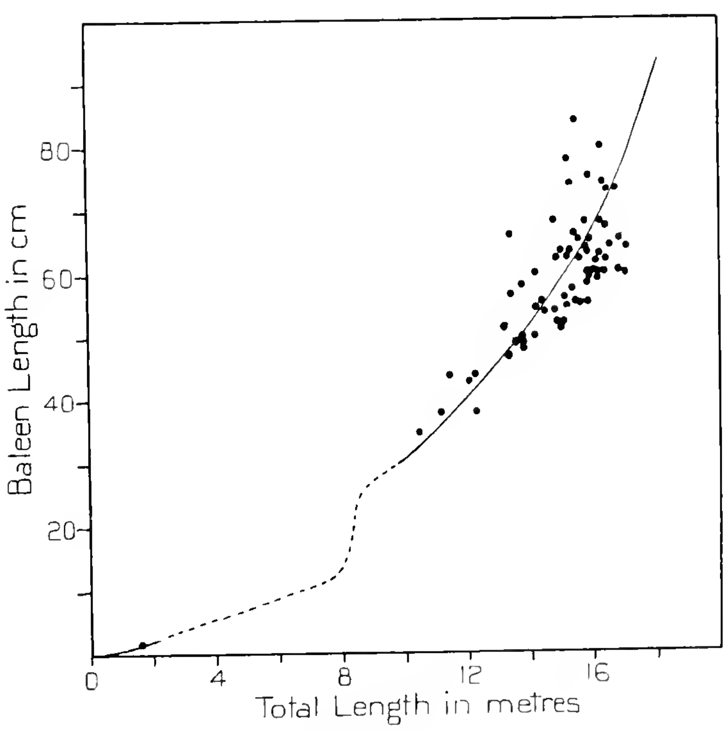


Fig. 63. Sei whale. Baleen lengths according to total length.

FOOD

The food of the Sei whale at South Georgia consists entirely of the *Euphausia superba* krill that is eaten by the other species of balaenopterids. Table XVI summarizes the information obtained from the examination of 171 stomachs. The rather high proportion of empty stomachs, and stomachs with little krill, at South Georgia is no doubt due to the fact that Sei whales are not taken when the larger species of whale are abundant, and consequently are usually brought in to the whaling stations only when there is a shortage of krill in the surrounding waters. This table, therefore, tends to show the periods when krill was scarce on the whaling grounds, rather than the type of krill in its periods of abundance. On the whole it may safely be stated that the Sei whales at South Georgia are either feeding or in quest of food.

On the other hand, the few records from South Africa show that food is very scarce there. In none of the stomachs examined was krill found: only two contained any traces of food at all. In these two stomachs a small quantity of remains of "tiny Crustacea" were recorded. It would appear probable that these two whales had been feeding upon copepods, as do the northern Sei whales according to Millais (1906), who states that they feed exclusively on small crustacea such as *Euphausia inermis*, *Calanus finmarchicus* and *Temora longicornis*. In South Georgian waters, however, no preference for smaller crustacea is shown, as the accompanying analysis of five stomach contents given in Table XVII demonstrates.

It has been shown elsewhere (Matthews, 1932) that off the Patagonian coast the Sei whale feeds almost exclusively on the crustacean *Munida gregaria* and its pelagic post-larval stage, *Grimothea*, which occurs in swarms near the surface of the sea and is known as "lobster krill". On the Pacific coast of Mexico, too, this whale feeds on shoals of an allied crustacean, probably *Pleuroncodes planipes*.

Collett (1886) records that the northern Sei whales off the Norwegian coast feed largely on *Calanus finmarchicus*, and correlates the fine texture of the baleen with the small size of this crustacean, but he also states that the Sei whale feeds as well on the larger krill, *Thysanoessa inermis*, that is eaten by Blue whales in that locality.

BLUBBER

Data of the blubber are recorded from 107 Sei whales, mostly for the months of February, March and April, at South Georgia. When the average thickness of the blubber is plotted against the total length of the whale the curves shown in Figs. 64 and 65 are obtained for each sex respectively. These show that on the whole the thickness of the blubber depends upon the total length of the whale, and also that the Sei whales in South African waters are thinner than those at South Georgia, having blubber about 1·5 cm. on the average less in thickness. There appears to be little significant difference in blubber thickness between the sexes, but the difference in blubber thickness between South African and South Georgian whales is found in both. This difference is very much more marked in the Sei whale than it is in the Fin and

Table XVI. *Sei whale. Food*

Place and date	Stomach: Full	Stomach: Half full	Stomach: Contained little	Stomach: Empty	*E. superba* L, large M, medium S, small
South Georgia					
1927 Feb.	—	—	—	2	—
	3	1	—	—	M
Mar.	1	—	—	—	L
	9	—	2	—	L–M
	2	—	—	—	M
	1	—	—	—	S and M
	—	—	—	3	—
Apr.	1	—	—	—	L
	3	—	—	—	L–M
	7	—	2	—	M
	1	—	—	—	S–M
	—	—	—	1	—
1928 Mar.	1	—	4	7	—
Apr.	—	—	—	1	—
1929 Feb.	—	2	6	9	—
	1	2	—	—	L and M
	—	—	2	—	S–M
Mar.	4	1	8	7	—
	1	—	—	—	L
	1	1	1	—	M–L
	—	—	1	—	M–S
Apr.	2	—	1	2	—
	—	—	2	—	M
	—	—	1	—	M–S
1930 Feb.	—	—	1	2	—
	—	—	1	—	L
	1	1	1	—	M
Mar.	—	—	2	4	—
	—	2	1	—	L
	—	—	1	—	M–L
	—	1	5	—	M
Apr.	—	—	4	4	—
	1	—	—	—	M–L
	—	1	3	—	M
1931 Feb.	—	—	3	10	—
	—	—	1	—	L
	1	—	1	—	M
Mar.	—	—	—	3	—
	—	—	1	—	S
South Africa					
Saldanha Bay					
1926 July	—	—	—	1	—
Aug.	—	—	—	6	—
	—	—	2	—	"Tiny crustacean remains"
Durban					
1926 July	—	—	—	1	—
1930 June	—	—	—	2	—
July	—	—	—	1	—
Aug.	—	—	—	5	—

Table XVII. *Sei whale. Analysis of stomach contents*

Whale no.	Sex	Length metres	Date	*E. superba.* Percentages of total samples in 2·5 cm. to 6·0 cm. length groups							
				2·5 cm.	3·0 cm.	3·5 cm.	4·0 cm.	4·5 cm.	5·0 cm.	5·5 cm.	6·0 cm.
3161		15·92	23. ii. 30	—	0·1	37·0	52·0	9·4	0·7	0·5	—
3189	[illegible]	16·15	7. iii. 30	—	—	10·0	73·0	13·1	3·3	1·0	—
3214		15·75	13. iii. 30	—	2·7	19·0	56·5	17·1	3·7	0·6	0·1
3260	[illegible]	16·55	1. iv. 30	0·1	6·8	27·8	47·3	13·8	3·4	0·5	—
3623	[illegible]	14·8	10. ii. 31	0·6	22·6	27·4	38·4	8·3	2·7	—	—

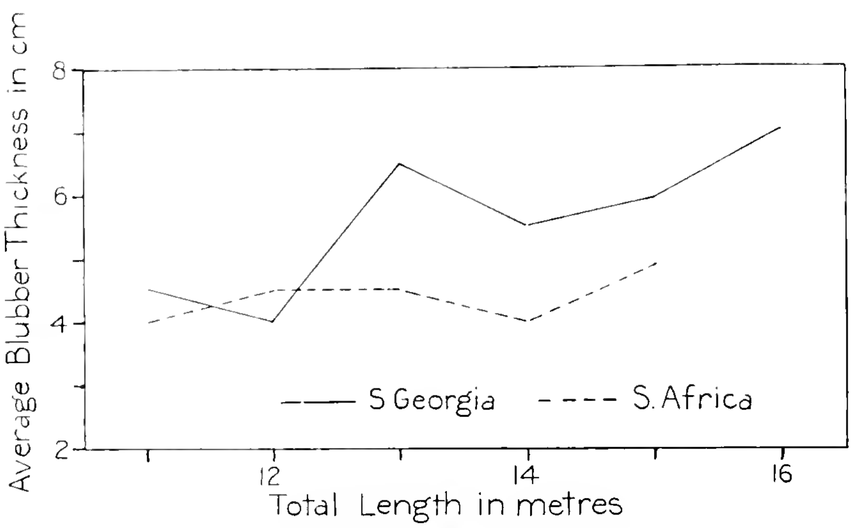


Fig. 64. Sei whale. Males. Mean blubber thickness.

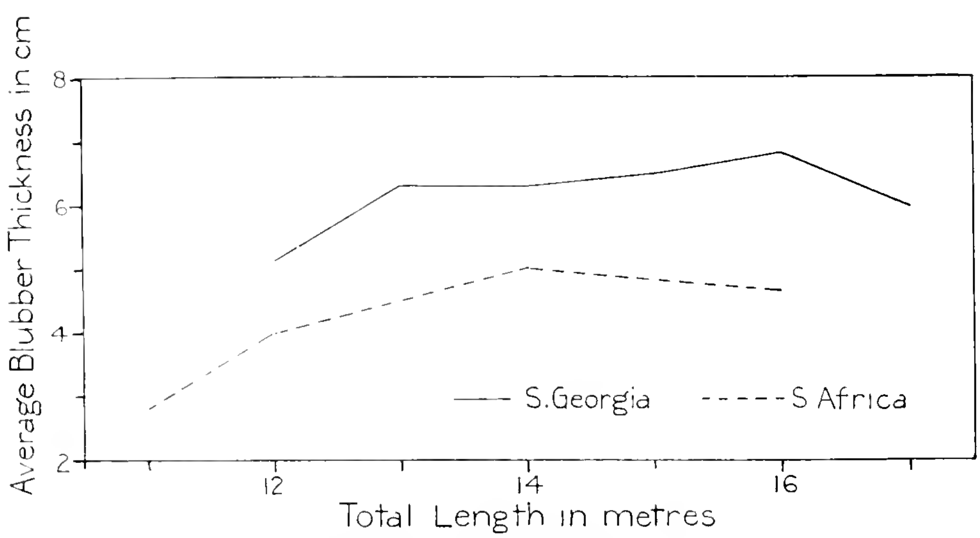


Fig. 65. Sei whale. Females. Mean blubber thickness.

Blue whales (Mackintosh and Wheeler, 1929), so that it appears that this species makes an even poorer living in South African waters than do the latter.

The average thickness of the blubber expressed as a percentage of the total length is plotted by months, for male Sei whales in Fig. 66 and for females in Fig. 67. In Fig. 66 immature and mature males are plotted separately, and in Fig. 67 immature, mature pregnant, and mature but not pregnant females are plotted separately. The length of 14 m. has been taken for separating immature from mature males and 14·5 m. for females. The horizontal line in these figures is at the level of the mean blubber

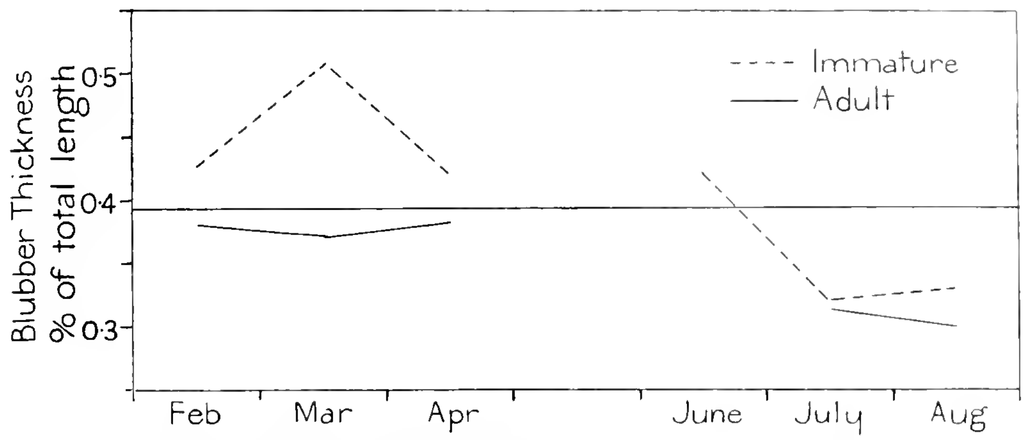


Fig. 66. Sei whale. Males. Mean blubber thickness by months.

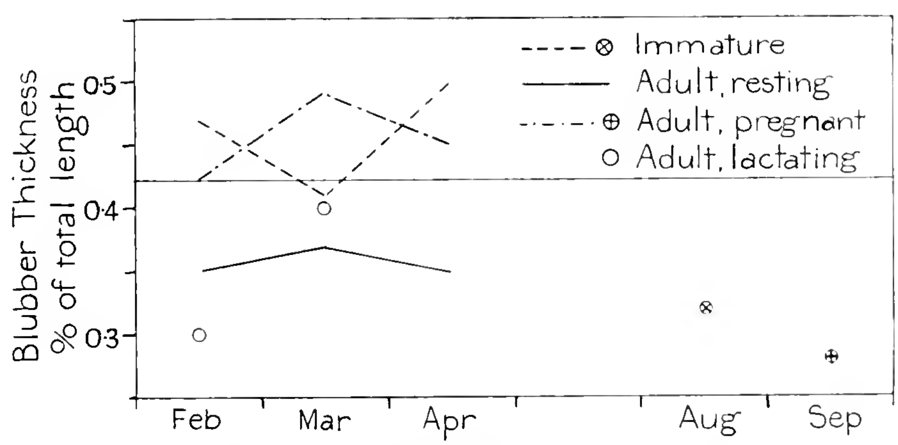


Fig. 67. Sei whale. Females. Mean blubber thickness by months.

thickness for each sex as a whole. These figures show again the thinness of the South African whales when compared with those from South Georgia, and also that immature Sei whales of both sexes are constantly fatter than the mature males, and mature but not pregnant females, in both localities.

It must be remembered that Sei whales are only taken at South Georgia when there is a scarcity of the larger and more profitable Fin and Blue whales; that is, when there is a scarcity of krill. Consequently, the curves of fatness do not show the increase towards the end of the South Georgian season well marked in those for Fin and Blue whales. If the figures for a series of seasons, good as well as bad, were available, the curves would probably show this increase. It is also possible that the corresponding curves for Fin and Blue whales would take a similar form to the present curves for Sei whales if data from bad seasons only, when whales and krill were scarce, were selected.

In South African waters, on the other hand, where there is not usually any abundance of large whales, the fatness curves for Sei whales approximate more closely to those for Fin and Blue whales. They show a decrease in value as the season advances, although they are already low when compared with the South Georgian figures. The greater fatness of immature Sei whales when compared with adults, well shown by the figures, is also found, to a much less extent, in Fin and Blue whales. This is shown in the graphs given by Mackintosh and Wheeler (1929), where owing to its smaller prominence it calls for no further comment than that the young whales appear to fatten considerably towards the end of the season. This fatness of immature whales, which occurs also in the Humpback, appears to be difficult to account for; it may be due to recent suckling although none of the whales classed as immature were calves, and when food was present in the stomachs it was the same as that of the fully mature ones.

In Fig. 67 pregnant females are plotted separately, and as in Fin and Blue whales, they are noticeably fatter than resting or lactating females. Lactating females are too few in numbers for a curve of any value to be produced, but the isolated points show that those measured were thinner than the average. Here again this species is in agreement with the Fin and Blue whales. Data for South Africa are very scanty but it is of interest to note that the only pregnant female measured was the thinnest whale of the whole series, in sharp contrast with the Fin and Blue whales in which pregnant females on the African coast are fatter than the pregnant females of corresponding length at South Georgia.

PARASITES

EXTERNAL

Large ectoparasites are very uncommon on Sei whales. *Penella* was found on only six whales out of 141 examined for external parasites, three from South Africa and three from South Georgia. Of the South African whales one carried two old *Penella* stumps and two others adult *Penella*. Of the South Georgian whales two carried one old stump each and the other four adult *Penella* in the region of the shoulder.

Cirriped parasites are recorded from only one Sei whale, taken at Saldanha Bay. A single specimen of *Xenobalanus globicipitis* was found on the flank.

Balaenophilus, on the other hand, commonly infests the baleen of Sei whales. It was searched for in 116 whales at South Georgia and was found to be present in 100 and absent in only sixteen, the infection varying from very slight to very heavy. *Balaenophilus* was looked for in only three whales at South Africa and was absent in one, but heavy infections of the nauplius stage were present in two Sei whales at Durban.

The ciliate protozoan *Haematophagus*, also, is commonly found on the baleen of Sei whales. Of seventy-two whales at South Georgia which were examined for *Haemato-*

phagus, sixty-one were found to be infested and only eleven free. Only one observation is recorded from South Africa, in which a Sei whale examined at Durban was found to be free from *Haematophagus*.

Complete or thick diatom films have not been observed on the skin of Sei whales. Eighty-eight observations were made on this point at South Georgia and eighty of them were negative. In the remaining eight cases small or scattered patches were found on the flukes, tail, jaws or snout in seven, and a very thin film of wider distribution in one.

Scrapings were taken from the skin, usually from some part of the head, in a number of whales from which the diatom film was absent. The scrapings always contained spores and frequently a few frustules of diatoms. *Cocconeis ceticola* was the commonest species represented, while *Lycmophora Lyngbyei*, *Fragilaria antarctica*, *Navicula* spp. and others were represented in lesser numbers.

No variation in infection of *Balaenophilus* or *Haematophagus* could be correlated with season or with size, condition or sex of whale. The significance of the diatom film and its frequent absence is discussed below in the section on migration.

All Sei whales in higher latitudes bear marks caused by the healing of the open pits in the skin, of unknown origin, which are acquired by whales in warmer waters. Whenever a note was made on this subject (165 whales) the finding was positive, and no whale was found free from them. At the African whaling stations open pits and wounds in all stages of healing were found in addition to the scars of old ones. The greatest number of different ages of scars recognized was five, but old scars become very confused and confluent so that it is impossible to recognize older groups of scars. Owing to this indistinctness of old scars no indication of the whale's age is given by them, as is shown below. Scars on whales in higher latitudes merely prove, if proof were necessary, that the whales bearing them have migrated from warmer seas. Open pits were never found at South Georgia, but only healed scars.

Lillie (1915) found open wounds on a Sei whale taken at New Zealand and Collett (1886) also records skin marks on northern Sei whales that appear to be nothing but these scars of healed wounds. Andrews (1918) confuses these scars with the comma marks left by *Penella*. He appears to have been mislead into thinking that the scars were caused by *Penella* through finding the parasites growing in some of the scars, an association which was quite accidental.

INTERNAL

Internal parasites are almost invariably found in Sei whales; they were absent in only three out of 192 whales examined for them.

The commonest parasite is the acanthocephalan, *Bolbosoma turbinella*, which lives in the intestine, though in two whales it was found in the stomach. In 70 per cent of the occurrences the infection was noted as heavy or very heavy. It is of interest to note that this species has not been recorded from Blue and Fin whales and that the corresponding species found in them was not found in the Sei whale.

The cestode *Tetrabothrius affinis* is nearly as commonly found, and is usually present together with *Balaenoptera turbinella*. Its presence was noted in 158 out of 192 whales examined, and the infection was heavy in 33 per cent. It was found only in the intestine. *B. turbinella* and *Tetrabothrius affinis* occur with equal frequency in Sei whales at South Georgia and at South Africa.

In the seasons 1928–9 and 1930–1 at South Georgia a closer examination was made for internal parasites, and in the 115 Sei whales examined in these seasons the following additional parasites were found:

Tetrabothrius ?wilsoni (= *Oriana wilsoni*) in the intestine on three occasions.

A large dibothriid cestode, apparently unnamed, occurred sometimes in quantity in the intestine in twenty cases. This parasite is very much commoner in Fin and Blue whales.

On two occasions *Priapocephala grandis* was found in the intestine.

The trematode *Ogmogaster plicatus* was found in the rectum of five whales.

Seventeen whales had nematode worms in the kidney and ten males had nematodes in the erectile tissue of the penis and in the urethra.

Lastly, nematode worms were found encysted in the wall of the stomach in one whale.

REPRODUCTION

THE MALE

External genitalia. The penis of the Sei whale, cylindrical and tapering to a point, is lodged in a median groove situated at a distance of about 7·0 per cent of the body length in front of the anus. It is normally retracted within the groove, but after death it frequently becomes extruded when the whale is drawn up out of the water on to the flensing plan. It is large in proportion to the size of the animal, being as large as that of the Fin whale and measuring up to 1·86 m. in length. It is usually pigmented only at the base, or else entirely unpigmented.

Testes. The approximate volume of the testes, in thousands of c.c., obtained by multiplying together the length, breadth and depth, is plotted against the total length of the whale in Fig. 68. The curve is that for the mean values of volume for every half metre increase of total length. The volume of the testis increases slowly before maturity is reached between 13 and 14 m. of total length, after which the volume increases greatly. The mean volume of the testis is nearly proportional to the size of the whale, but individual variation is very great. No correlation can be traced between this wide variation and either the age or condition of the whale, or the season of the year. Testes of small size frequently appear to be in quite as high a state of activity as the largest. The largest testis volume recorded for this species, 20,280 c.c., is rather more than a third of that found in Fin and Blue whales.

Sexual cycle. Histological material from the genitalia is available from twenty-four adult male Sei whales, and the results of its examination are shown in Table XVIII. The minute structure of the testis is essentially similar to that of the Fin and Blue whales and consequently need not be particularized here.

The data in Table XVIII cannot be said to indicate any definite season of activity in the male sexual cycle, during February, March and April at least. In the majority of the testes, sections show the tubules well filled with cells, many of them in various stages of division, but few spermatozoa are present. On the other hand, smears from testis and epididymis give interesting results when compared with sections. In two cases sections showed the tubules with large spaces practically empty of cells, but

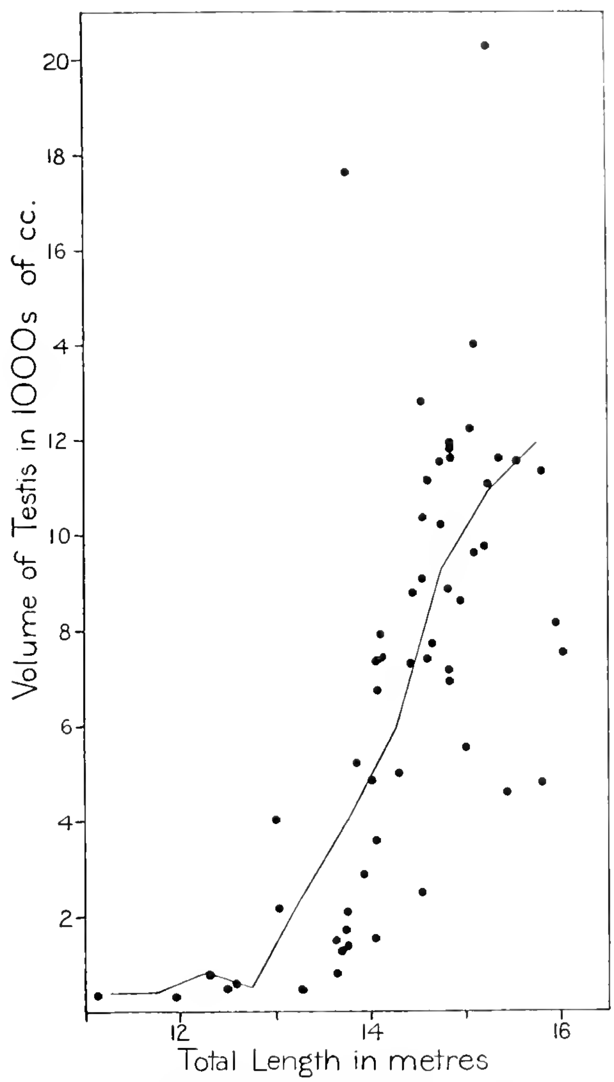


Fig. 68. Sei whale. Males. Volume of testis.

smears showed that the epididymis contained many spermatozoa. In no case were spermatozoa numerous in the epididymis in whales in which the testis tubules were full of cells and apparently in full activity.

Only four specimens were examined during July, August and September; in three of them spermatozoa were present in fair numbers or large quantities, while in the fourth, though none were present in the testis, by analogy with whales Nos. 3270 and

3182 many were probably present in the epididymis. None of these whales, therefore, seem to be definitely inactive.

The testis appears to be active in some whales at all times of the year, or at least in the months of February, March, April, July, August and September, and indications of a seasonal sexual cycle must be sought for rather in the female than in this sex.

Table XVIII. *Sei whale. Males. Histological activity of testis and epididymis*

Place and date	Whale no.	Length metres	Testis volume c.c.	Testis section: tubules	Testis section: dividing cells	Testis section: spermatozoa	Smear: spermatozoa in testis	Smear: spermatozoa in epididymis
SOUTH GEORGIA								
Feb.	3169	14·62	7,700	—	—	—	Many	Many
	3620	14·82	6,950	—	—	—	Moderate number	Few
	3623	14·80	11,925	—	—	—	Few	Few
Mar.	3216	14·10	7,950	Full	Many	None	Few	Few
	3217	14·80	8,800	Full	Many	Hardly any	Very few	Very few
	3208	14·60	7,400	Full	Many	Fair number	None	None: many epithelial cells
	3182	14·77	11,525	Empty	None	None	—	Many
	3225	15·10	9,625	Full	Many	Fair number	Very few	Very few
	1738	15·37	11,600	Full	Many	Many	—	—
	3691	15·55	11,500	—	—	—	Many	Many
	1619	14·95	8,600	Full	Many	Many	—	—
	1601	15·80	4,800	Full	Many	Very few	—	—
Apr.	3272	16·15	7,500	Full	Many	Fair number	Very few	Fair number
	3273	14·80	11,600	Full	Many	Practically none	Very few	Very few
	3275	14·60	11,100	Full	Many	None	None	Very few
	3257	14·55	12,800	Full	Many	One or two	Very few	Very few: many epithelial cells
	3262	14·15	6,775	Full	Many	None	None	None: epithelial cells only
	3271	14·55	9,050	Full	Many	Few	None	Very few
	3270	14·42	8,750	Empty	None	None	Very few	Many
	2540	15·95	8,109	—	—	—	—	Many
SOUTH AFRICA								
Saldanha Bay July	905	15·20	9,750	Large spaces	None	Few	—	—
Durban Aug.	D 119	14·30	5,025	—	—	—	Few	Fair number: many epithelial cells
	D 140	15·25	11,050	—	—	—	Fair number	Fair number
Saldanha Bay Sept.	1143	15·00	5,500	Full	Many	Many	—	—

THE FEMALE

External genitalia. In form and arrangement the external genitalia of the female Sei whale are very similar to those of the Fin whale. The vulva is a median groove placed at an average distance of 2·7 per cent of the body length in front of the anus. A vaginal band is present occasionally. Sixty-two whales were examined for this structure; a band was present in one out of seven immature whales (14·3 per cent) and a tag representing the remains of the band was present in three out of fifty-two adult whales examined (5·45 per cent). These figures may be compared with those from the Fin whale in which the band is present in 21·4 per cent of immature whales, and a tag in 6·8 per cent of adults.

The teats are place in the mammary grooves, situated one on each side of the vulva.

In one female Sei whale a deep groove ran from the genital groove to the umbilicus. It was pregnant (whale No. 1754) and a similar groove was present in the foetus, which measured 3·68 m. in length.

A number of observations were recorded on the state of the vulva and vagina in Sei whales, but it is difficult to make definite correlations between the conditions found and the stages of the oestrous cycle. The data are summarized in Table XIX from which it will be seen that only broad conclusions can be drawn. The figures show the numbers of whales examined in each group. Dealing first with the vulva, it is tightly closed, though structurally patent, in all immature whales, but open in varying degrees in resting, ovulating and lactating whales. In pregnant whales it is nearly twice as frequently open as closed. It was noted as congested in some whales in all conditions except lactation, most frequently in pregnant whales.

The vagina was found to be congested more often than not in whales in all conditions, most frequently in resting whales. In many immature and pregnant whales it contained mucus, and in two instances in the latter class the mucus was sufficiently thick to be described as a plug.

Table XIX. *Sei whale. Females. Condition of external genitalia*

Condition	Vulva			Vagina			
	Open	Closed	Congested	Not congested	Congested	Containing mucus	Plug of mucus
Immature	—	6	1	1	4	3	—
Resting	13	—	2	2	17	1	—
Pregnant	7	4	4	1	15	7	2
Ovulating	1	—	1	—	1	1	—
Lactating	1	—	—	—	2	—	—

Ovaries. The appearance and structure of the ovaries of the Sei whale are similar to those of the Blue and Fin whales. It is practically certain that ovulation at oestrus is spontaneous and does not depend upon pairing taking place. This conclusion is drawn from the occurrence of non-pregnant whales with young corpora lutea in the ovaries, the alternative explanation of which is that pairing is frequently unsuccessful. The newly formed corpus luteum is large and easily distinguished from the older ones which persist in the ovary for a very long time before they are completely resorbed, if indeed they ever are. In these investigations, for convenience in reference, the corpus luteum of ovulation or pregnancy, which when present is always the youngest corpus luteum in the ovaries, is referred to as the corpus luteum *a*, and the older corpora lutea in various stages of resorption are designated corpora lutea *b*. The corpora lutea *a* of pregnancy become early corpora lutea *b* at parturition, but the corpora lutea *a* of sterile ovulation degenerate gradually into corpora lutea *b* with no definite line of demarcation. Old corpora lutea *b* are, strictly, corpora albicantia. The length, breadth and thickness of the corpora lutea were measured and the average of these three measurements is taken as the mean diameter in this report.

Fig. 69 is a scatter diagram of the mean diameter of corpora lutea *a* plotted against lengths of the corresponding foetus. In those cases where data were available the largest

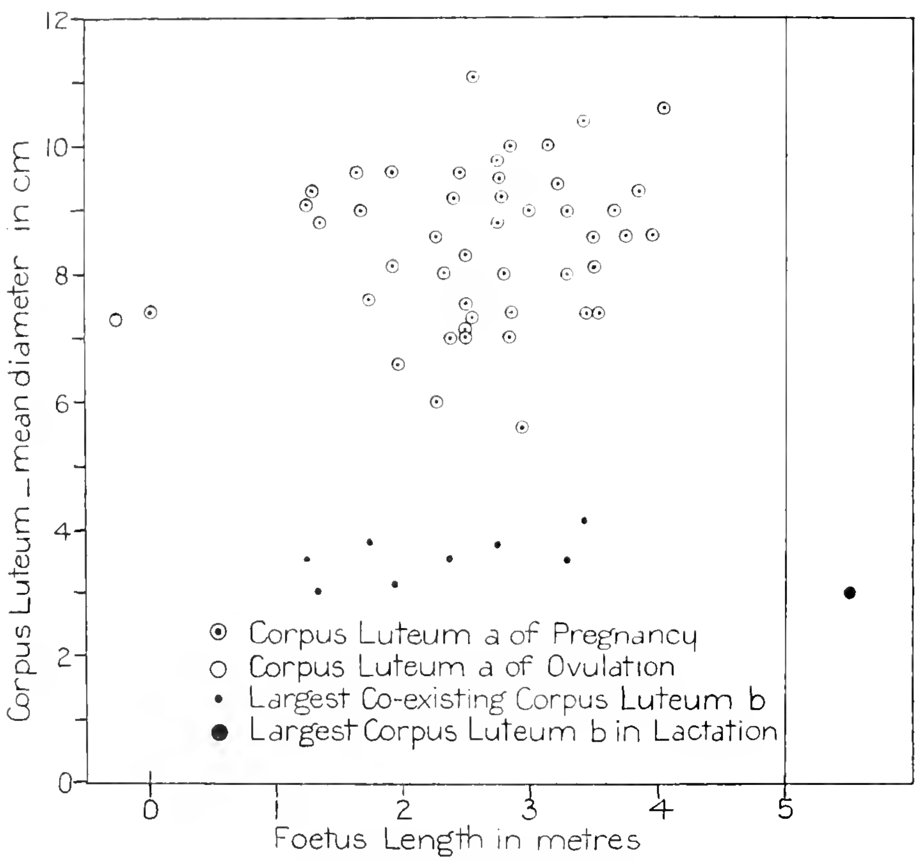


Fig. 69. Sei whale. Females. Mean diameter of corpora lutea, and foetus lengths.

co-existing corpora lutea *b* have also been plotted, and two isolated points give some indication of the size of the corpus luteum at ovulation and during lactation. It will be noted that the size of the corpora lutea *a* increases slightly but steadily from ovulation until the foetus reaches a length of about 4 m., beyond which foetus length data are lacking. During lactation, however, the size of the corpus luteum has shrunk rapidly, so that it is no larger than the persisting corpora lutea *b* of the previous oestrous cycle and pregnancy. The mean diameter of the corpus luteum *a* for foetus lengths from 1 to 4·5 m. averages 8·55 cm. with a maximum of 11·1 cm. and a minimum of 5·1 cm. The only recorded corpus luteum *a* of ovulation measures 7·3 cm. in mean diameter.

The mean diameter of the largest corpus luteum *b* co-existing in the ovaries with a corpus luteum *a* is 3·22 cm., with a maximum of 4·1 cm. and a minimum of 2·1 cm. The only recorded corpus luteum of lactation is 3·0 cm. in mean diameter, so that it has almost completely degenerated into a true corpus luteum *b*.

Data of the ovary weights are few for this species, but the figures available are plotted in Fig. 70 against total body length, immature, mature, resting, lactating, ovulating and pregnant whales being separated. It will be seen that until maturity is reached, at about 14·5 m. total length, the weight of the ovaries increases slowly with body length, but that after maturity is reached the relation between ovary weight and total length

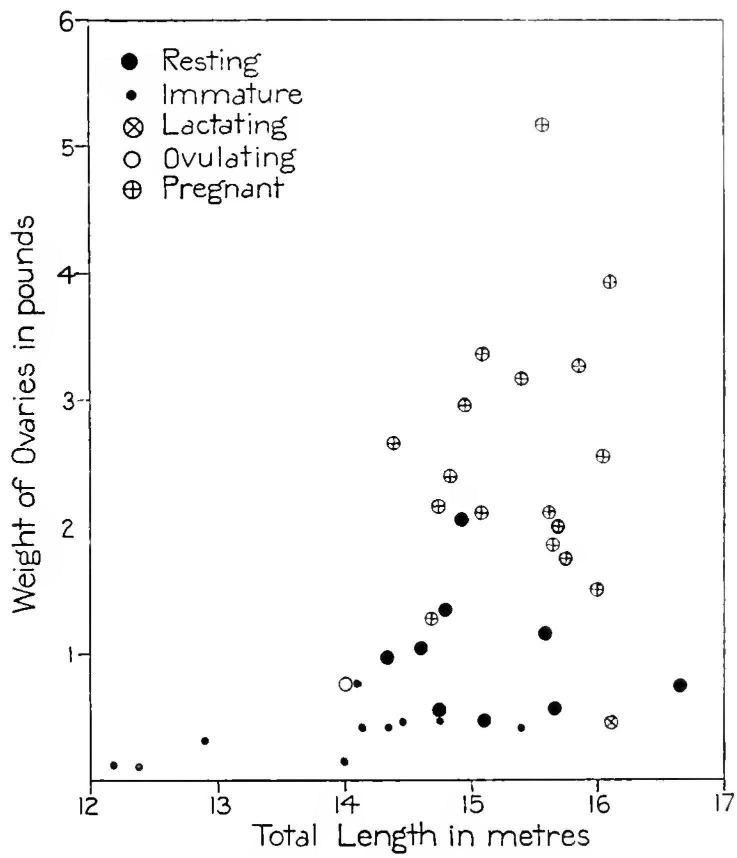


Fig. 70. Sei whale. Females. Ovary weights.

is not preserved so closely and wide variations occur. A decline in weight in the largest whales is indicated, similar to that which probably occurs in the other species of balaenopterid whale. The presence of large corpora lutea makes the weight in pregnant whales average over twice that in resting whales. The weight of the ovaries in this species is very much less than in the Fin and Blue whales, the heaviest non-pregnant ovaries weighing little over 2 lb., whereas non-pregnant ovaries of over 9 and 14 lb. have been recorded for the other two species respectively.

Fig. 71 shows the number of corpora lutea in the ovaries plotted against the total length of whale. Though the ovaries of the smallest whales contain only a small number of corpora lutea, those of the largest do not contain the greatest numbers. This is to be explained by the persistence of the corpora lutea through several sexual seasons, and probably throughout the life of the whale, so that adult whales of similar length but different ages will have different numbers of corpora lutea in their ovaries.

Uterus. The distance across the uterine cornu was measured in seventy-four Sei whales and the figures obtained are plotted against total length of whale in Fig. 72. The measurement was taken from side to side across the collapsed cornu when lying on a flat surface. It is thus rather greater than the true diameter. Measurements from immature, mature but resting, ovulating and lactating whales are separated. This

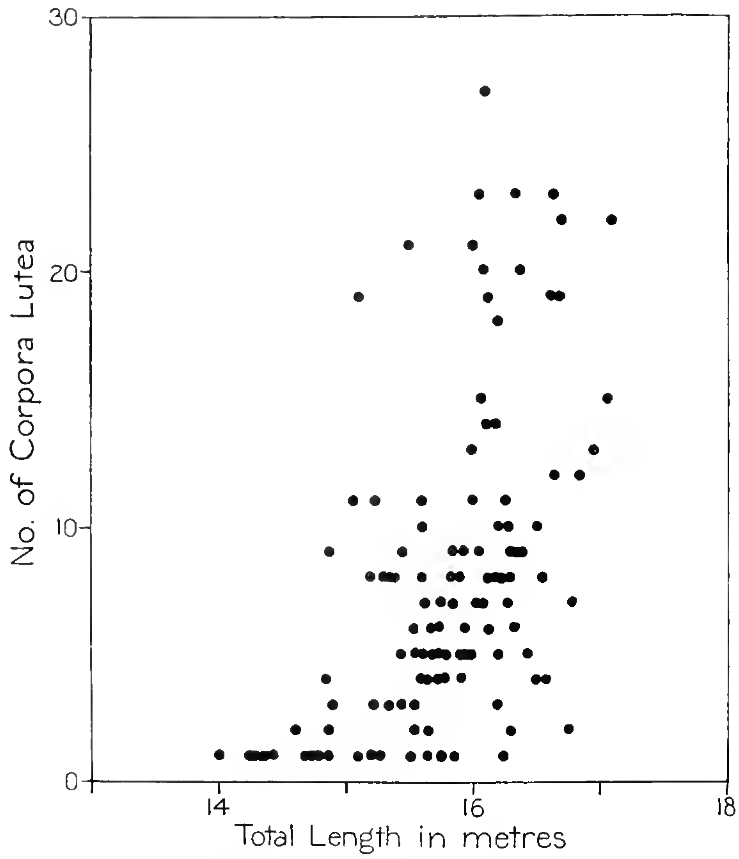


Fig. 71. Sei whale. Females. Numbers of corpora lutea.

distance increases slowly with total length of the whale up to the attainment of sexual maturity at about 14·5 m., after which it is increased, often considerably, and rarely returns to less than about 10 cm. From the data available no correlation can be traced between the size of the uterus and the stage of the sexual cycle through which the whale is passing.

Mammary glands. The situation of the mammary glands on either side of the mid-ventral line, with the teats at each side of the genital groove, is similar to that of other balaenopterid whales. The thickness of the gland in cm. is plotted against total length of whale in Fig. 73, three stages of activity being represented, non-parous, involuted and lactating. The non-parous gland varies in thickness from 2 to 4 cm. and rarely is

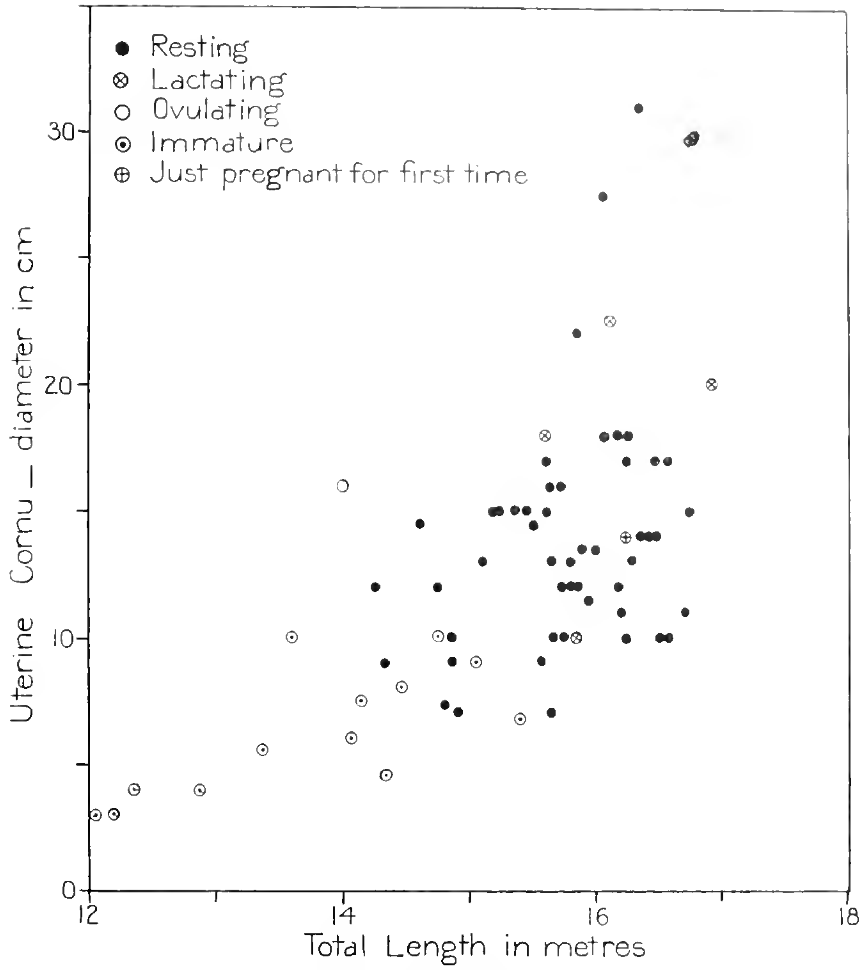


Fig. 72. Sei whale. Females. Mean diameter of uterine cornua.

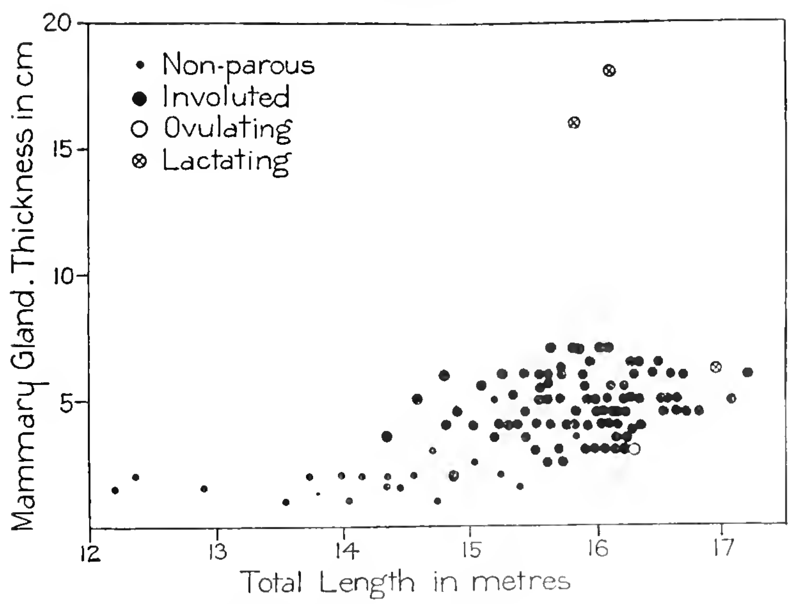


Fig. 73. Sei whale. Thickness of mammary gland.

as thick as 5 cm.; it is usually less than 2·5 cm. In the involuted state it varies from 2·5 to 9·0 cm. and has not been found as thick as 10 cm. The two values for the lactating gland are 16 and 18 cm., as thick as the lactating gland frequently is in Fin and Blue whales. Even in the involuted state the average thickness would appear to be greater than in Fin and Blue whales where it is 5–6 cm.

The overall length of the gland in whale No. 2474 was 1·70 m. (thickness 16 cm.) and it was lactating only moderately. The length of the gland in Fin and Blue whales is given as about 2 m., so that, taking into account the greater length of those species, it would appear that the mammary gland in the Sei whale is much larger in proportion and will presumably give a proportionately larger quantity of milk. This may in part account for the greater fatness of immature whales mentioned above.

Gestation, breeding season and sexual cycle. Data relating to Sei whales at South Georgia are very few except for the months of February, March and April. This does not necessarily mean that Sei whales are not present on the South Georgian whaling grounds except in these months, but that the larger species are then in reduced numbers, because Sei whales are of no interest to whalers when larger whales are available. Nevertheless, restricted though the data are, several facts of importance emerge from a consideration of them.

Table XX shows the numbers and condition of female Sei whales examined in those months for the seasons 1927–31, together with a few records from South Africa for the months of August, September and October. An inspection of these figures shows a very striking decrease in proportion of pregnant whales and increase in proportion of resting whales as the season at South Georgia advances. These changes are shown graphically in Fig. 74, in which the percentages of the total catch formed by pregnant and resting whales are plotted by months. In February pregnant whales form 57 per cent of the catch and resting whales 24 per cent. In March the proportions are roughly equal, being 44 and 40 per cent respectively, and in April resting whales form 78 per cent of the catch and pregnant whales only 12 per cent. The conclusion to be drawn from these figures is that there must be a steady flow of Sei whales passing through the South Georgian whaling grounds in these months and that pregnant whales in the main arrive first and are leaving throughout the early part of the year. Their place may perhaps be taken by fresh arrivals of resting whales or their withdrawal alone may increase the proportion of the latter.

Table XX. *Sei whale. Sexual condition of females examined*

Month		Immature	Resting	Ovulating	Pregnant	Lactating
South Georgia	Feb.	6	10	2	24	0
	Mar.	8	31	1	28	3
	Apr.	2	18	0	3	0
South Africa	Aug.	4	1	1	0	0
	Sept.	0	0	0	1	0
	Oct.	1	0	0	0	0

Fig. 75 is a scatter diagram of the lengths of foetuses plotted for the months under consideration and shows the progress of pregnancy in the gravid whales at South Georgia during the time when they are leaving the grounds in ever greater numbers. Returning now to Table XX it will be seen that in South Africa in August one whale is recorded as ovulating and in September one was found with a very early (2 mm.) pregnancy. Table XXI shows the series of dated records of 151 foetal lengths taken from the statistics in the British Museum, and Table XXII shows the records of foetuses collected by the Expedition. Fig. 76 is a scatter diagram constructed from all these data combined. The average foetal length, when plotted by half-monthly periods, produces the curve shown in Fig. 77, which indicates a length of gestation of about 12 months, if the young are born at a length of about 4·5 m., as shown by the lengths of the largest foetuses recorded. Taking the data in Table XX, together with Figs. 76 and 77, the conclusion drawn is that pairing in the main takes place in the months of May, June, July and August in lower latitudes, that there is a southern migration during the summer months, followed by a return migration to warmer waters in March

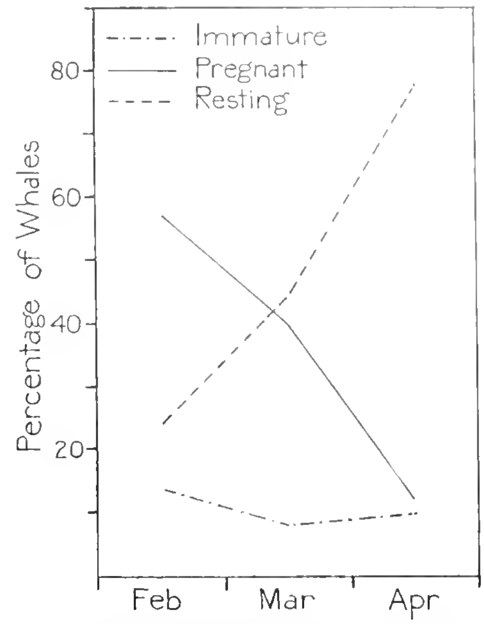


Fig. 74. Sei whale. Proportions of immature, resting and pregnant whales.

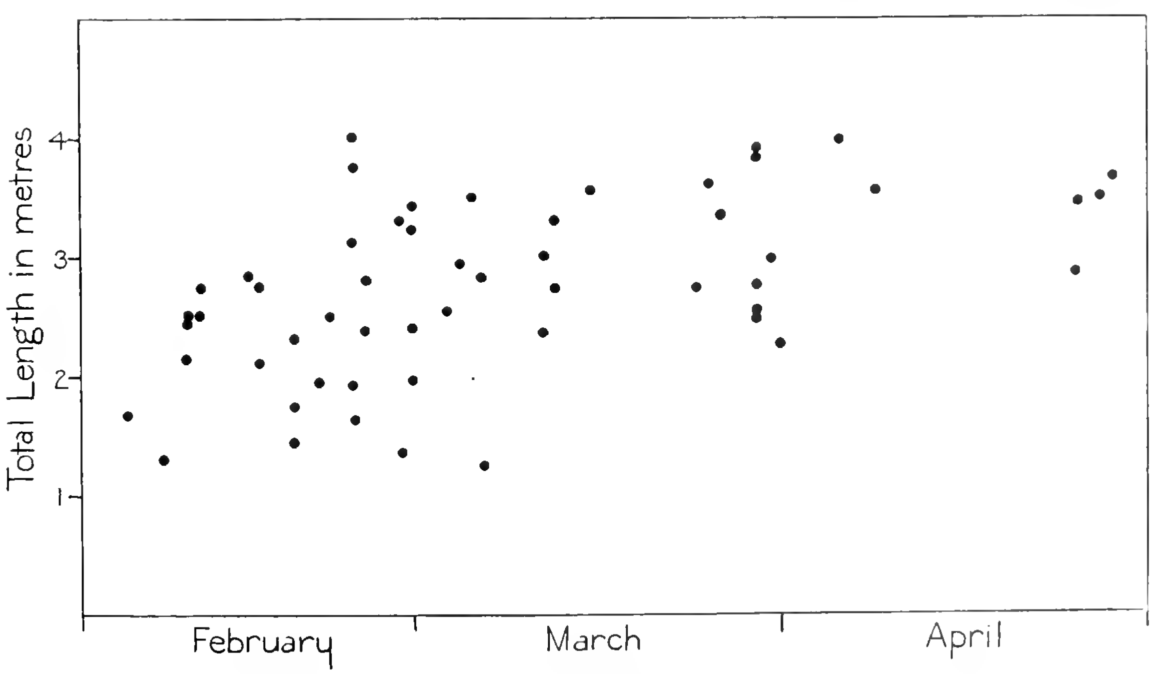


Fig. 75. Sei whale. Foetal lengths for February to April. South Georgia.

Table XXI. *Sei whale. Foetal records in the British Museum (Nat. Hist.) statistics*

Date	Length metres	Place	Date	Length metres	Place
Aug. 11, 1927	0·02	Cape Province	Mar. 9, 1921	2·44	South Georgia
11, 1927	0·08	,,	9, 1928	2·65	,,
11, 1927	0·08	,,	10, 1928	3·35	,,
27, 1928	0·23	,,	11, 1927	2·44	,,
Sept. 6, 1928	0·29	,,	11, 1927	2·83	,,
Oct. 2, 1927	0·61	,,	11, 1921	3·05*	,,
8, 1920	0·98	,,		3·05*	,,
9, 1920	0·35	,,	11, 1928	3·65	,,
9, 1926	0·36	,,	12, 1928	2·13	,,
9, 1926	0·39	,,	12, 1928	2·44	,,
9, 1926	0·46	,,	12, 1928	3·65	,,
15, 1926	0·46	,,	12, 1927	2·67	,,
16, 1926	0·05	,,	13, 1921	1·22	,,
24, 1928	3·35	,,	13, 1928	1·52	,,
29, 1928	0·61	,,	13, 1928	1·52	,,
29, 1928	0·61	,,	13, 1928	2·65	,,
30, 1928	0·46	,,	13, 1928	3·35	,,
30, 1928	0·66	,,	13, 1928	3·65	,,
Nov. 1, 1928	0·08	,,	13, 1928	3·96	,,
1, 1928	0·66	,,	13, 1928	3·96	,,
1, 1928	0·72	,,	14, 1928	3·05	,,
1, 1928	1·07	,,	15, 1927	3·05	,,
2, 1928	0·66	,,	15, 1927	3·05	,,
3, 1928	0·15	,,	16, 1918	1·52	,,
3, 1928	0·92	,,	16, 1928	1·83	,,
3, 1928	1·00	,,	16, 1920	2·44	,,
3, 1928	1·22	,,	16, 1920	3·05	,,
5, 1928	0·61	,,	17, 1927	1·52	,,
6, 1928	0·08	,,	17, 1927	2·13	,,
9, 1928	0·46	,,	19, 1921	1·22	,,
14, 1928	0·74	,,	19, 1927	2·13	,,
Jan. 28, 1926	1·83	South Georgia	19, 1921	2·65	,,
Feb. 14, 1923	1·52	,,	20, 1927	1·83	,,
15, 1923	1·83	,,	20, 1927	2·13	,,
15, 1923	2·13	,,	20, 1927	2·13	,,
17, 1920	1·83	,,	20, 1927	2·65	,,
20, 1927	1·83	,,	21, 1927	2·13	,,
20, 1927	2·13	,,	22, 1927	2·65	,,
22, 1920	2·44	,,	23, 1928	2·59	,,
22, 1918	3·05	,,	24, 1928	1·22	,,
24, 1927	2·65	,,	24, 1927	1·83	,,
25, 1920	3·05	,,	24, 1928	2·44	,,
Mar. 3, 1921	4·26	,,	25, 1928	2·44	,,
3, 1927	1·52	,,	25, 1927	2·44	,,
3, 1927	1·83	,,	25, 1927	2·44	,,
3, 1927	2·44	,,	25, 1927	3·05*	,,
6, 1921	1·22	,,		3·05*	,,
6, 1921	2·65	,,	25, 1927	3·65	,,
6, 1921	3·65	,,	25, 1927	4·88	,,
7, 1918	2·44	,,	26, 1927	2·44	,,
7, 1927	1·83	,,	26, 1927	3·05	,,
7, 1928	2·65	,,	26, 1928	4·26	,,
7, 1928	3·65	,,	27, 1919	2·57	,,
7, 1928	3·96	,,	28, 1927	3·35	,,
8, 1927	2·44	,,	29, 1928	3·35	,,
9, 1921	2·13	,,	29, 1927	3·65	,,

* Twins.

Table XXI. *Sei whale. Foetal records in the British Museum (Nat. Hist.) statistics*

Date	Length metres	Place	Date	Length metres	Place
Mar. 30, 1927	2·44	South Georgia	Apr. 16, 1923	1·83	Cape Province
30, 1927	2·44	,,	18, 1922	2·44	South Georgia
30, 1928	3·35	,,	18, 1922	2·44	,,
31, 1927	2·83	,,	19, 1927	4·26	,,
Apr. 1, 1927	2·13	,,	20, 1927	3·65	,,
1, 1927	3·96	,,	20, 1927	4·26	,,
2, 1918	3·65	,,	22, 1927	3·65	,,
6, 1927	2·44	,,	25, 1927	2·65	,,
Apr. 6, 1922	2·44	,,	25, 1927	2·65	,,
6, 1927	3·65	,,	25, 1927	3·05	,,
6, 1927	3·65	,,	26, 1927	2·13	,,
6, 1927	3·65	,,	27, 1927	1·83	,,
8, 1927	2·44	,,	27, 1927	3·35	,,
8, 1927	2·83	,,	28, 1923	3·05	Cape Province
8, 1927	3·65	,,	May 2, 1927	4·57	South Georgia
9, 1927	3·05	,,	3, 1927	4·26	,,
10, 1920	0·76	,,	4, 1920	0·39	Cape Province
11, 1928	3·65	,,	4, 1920	4·68	South Africa
12, 1928	3·35	,,	23, 1922	2·44	South Georgia
15, 1922	2·44	,,			

Table XXII. *Sei whale. Foetuses examined by the Expedition*

Parent whale no.	Date	Foetus		Parent whale no.	Date	Foetus	
		Length metres	Sex			Length metres	Sex
1074	7. ix. 26	0·002	—	2494	23. ii. 29	4·09	♂
1523	28. ii. 27	1·99	♂	2505	24. ii. 29	2·37	♂
1524	28. ii. 27	2·40	♂	2518	27. iii. 29	3·33	♀
1530	3. iii. 27	2·55	♀	2527	30. iii. 29	3·83	♂
1537	12. iii. 27	3·00	♂	2528	30. iii. 29	3·88	♀
1577	13. iii. 27	2·75	♂	2530	30. iii. 29	2·78	♀
1578	16. iii. 27	3·55	♀	2541	5. iv. 29	3·98	♂
1607	30. iii. 27	2·54	♂	H 2	26. iii. 28	3·60	♀
1608	30. iii. 27	2·50	♂	3157	20. ii. 30	1·92	♀
1615	31. iii. 27	3·00	♂	3160	21. ii. 30	2·50	♂
1636	8. iv. 27	3·55	♀	3161	24. ii. 30	2·80	♂
1744	25. iii. 28	3·46	♂	3168	27. ii. 30	3·30	♂
1746	25. iii. 28	2·87	♂	3177	4. iii. 30	2·95	♀
1749	27. iii. 28	3·50	♂	3183	5. iii. 30	3·50	♂
1754	28. iii. 28	3·68	♀	3189	7. iii. 30	2·83	♂
2295	4. ii. 29	1·69	♀	3192	7. iii. 30	1·25	♂
2307	7. ii. 29	1·30	♀	3214	13. iii. 30	3·30	♂
2318	9. ii. 29	2·45	♂	3249	25. iii. 30	2·74	♀
2319	9. ii. 29	2·16	♂	3260	1. iv. 30	2·27	♀
2342	14. ii. 29	2·85	♀	3618	9. ii. 31	2·50	♂
2351	15. ii. 29	2·11	♀	3621	10. ii. 31	2·50	♀
2352	15. ii. 29	2·76	♂	3630	10. ii. 31	2·75	♂
2358	18. ii. 29	2·32	♂	3671	18. ii. 31	1·75	♂
2360	18. ii. 29	1·45	♀	3685	27. ii. 31	1·35	♂
2387	23. ii. 29	1·65	♂	3688	28. ii. 31	3·21	♂
2484	23. ii. 29	3·15	♂	3689	28. ii. 31	3·42	♀
2485	23. ii. 29	1·92	♂	3694	12. iii. 31	2·39	♀
2488	23. ii. 29	3·77	♀				

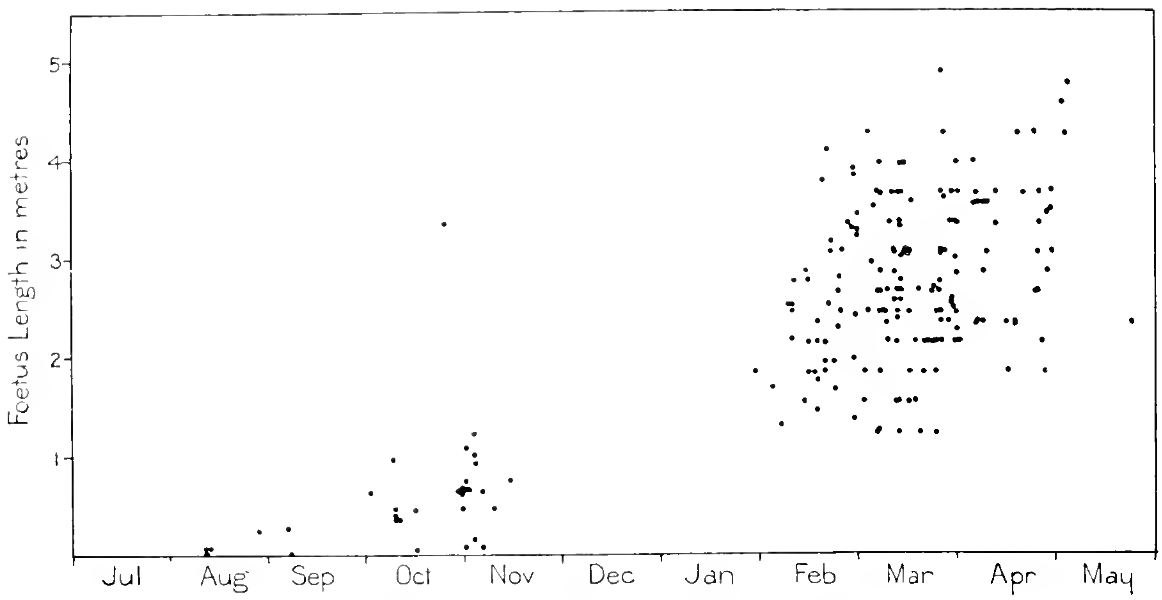


Fig. 76. Sei whale. Scatter diagram of foetal lengths.

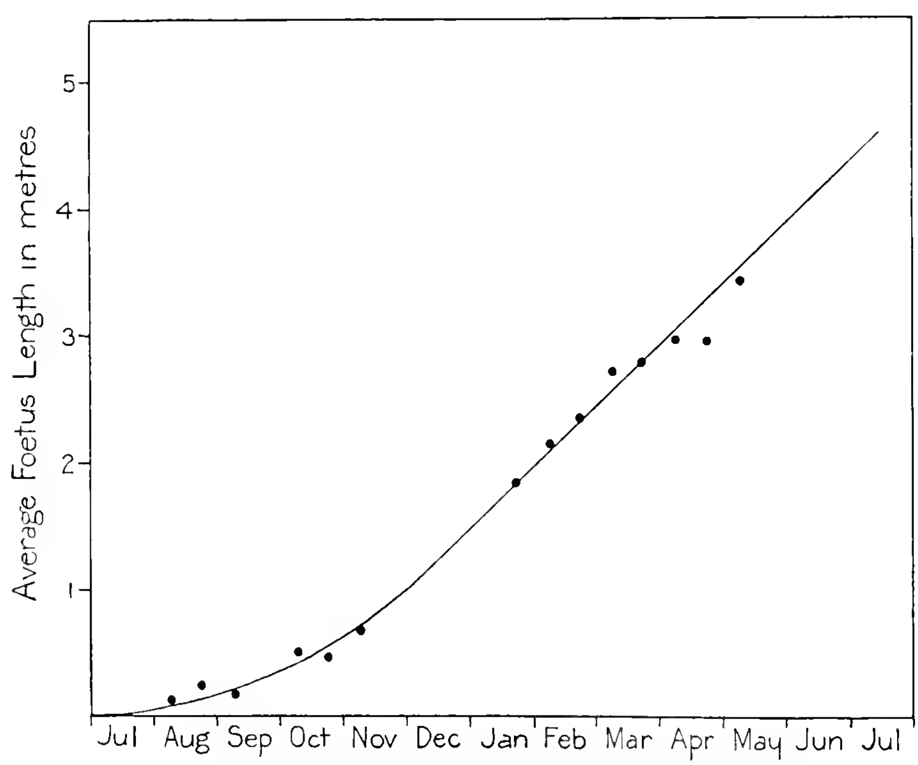


Fig. 77. Sei whale. Mean foetal length by half months.

and April. Parturition and lactation appear to take place in temperate latitudes and lactation generally appears to be completed by the time the whales arrive on the southern feeding grounds after the spring migration. There is thus a definite, if rather prolonged, breeding season. Risting (1928) discusses the results obtained from an examination of ninety-five Sei whale foetuses from the Norwegian seas and finds that the majority of pairings took place from November to March, that is during the northern winter, an exact parallel to the conclusion here arrived at about the southern Sei whale.

Only three whales from South Georgia are recorded as lactating, all in the month of March, and they are all noted as only lactating slightly. These are presumably whales that paired late in the previous season and had given birth so late that lactation was not quite complete by the time that they arrived on the southern grounds. Similarly, the

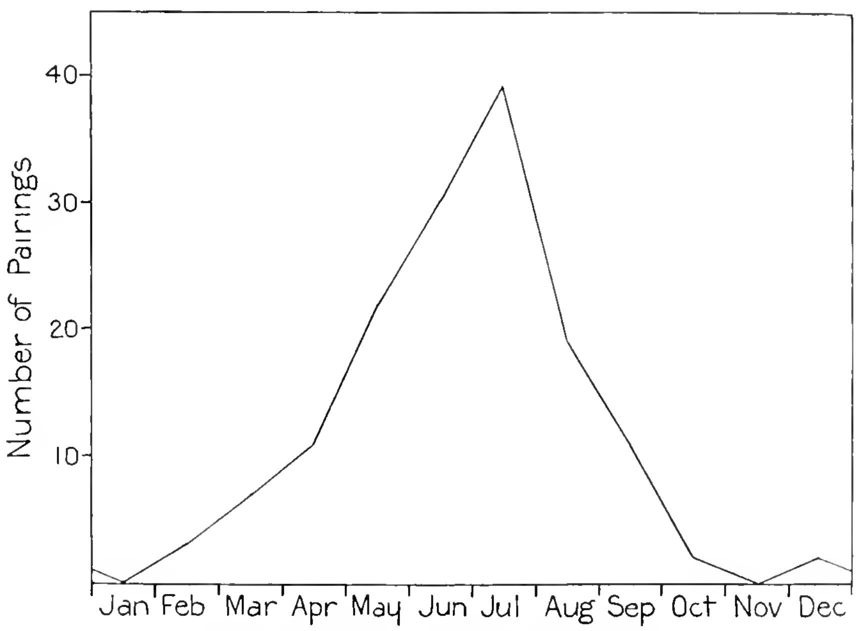


Fig. 78. Sei whale. Pairing and birth frequency.

one carrying a 3·35 m. foetus, taken at South Africa in October, was probably a late breeder. These late breeders may be whales that have lost their calves and come into oestrus at abnormal times. With these whales may be compared three recorded as ovulating, two in February and one in March, which, if paired on the southern grounds, would produce such examples of late pregnancy in the following season. It is also of interest in this connexion to note that whale No. 2370, taken on 19 February 1929, was reported by the gunner to have paired immediately before capture.

Further information on the breeding season is given by Fig. 78. If on Fig. 76 the curve in Fig. 77 is superimposed, and lines are drawn parallel to it but taking their origin at monthly intervals on each side of it, the points are divided up into groups representing pregnancies starting in each month. When these pregnancies are counted and the numbers plotted by months the curve in Fig. 78 is produced. This shows that pairing mainly takes place in the months of May to August inclusive, with a maximum in July, and also that a few pairings take place in other months outside the main breeding season. The same curve also shows the frequencies of births, because the period of gestation, as shown above, is approximately 12 months. Parturition and pairing are thus taking place on the same grounds at the same time, but of course, amongst different whales, for the parturient whales will not be pairing until the following season some twelve months later.

According to Figs. 77 and 78 few births take place in southern waters, for parturition does not commonly occur until May, taking a length between 4 and 5 m. as that of the young at birth. If parturition thus occurs from about May to August, lactation appears to be completed and the mammary gland to be completely involuted for the most part by the end of January, which gives a mean period of suckling of about 5 months.

There now remains for consideration the large proportion of resting whales present on the South Georgian whaling grounds in the months of February, March and April. The percentage of the total catch represented by resting whales increases steadily during these months, showing that they remain behind later than the pregnant whales which leave earlier, and may or may not have their numbers augmented by fresh arrivals. Measurements of the mean diameter of the largest follicles in the ovaries of resting whales are plotted by months as a scatter diagram in Fig. 79. From this and from Fig. 80, where these data are summarized as the average mean diameter for each month, it is seen that the size of the largest follicle in the ovaries of resting whales is on the whole increasing steadily through the season. The conclusion to be drawn is that these whales are mostly maturing follicles which will be discharged later on in the season in more northern waters to give rise to the pregnancies of the following season. Further, the presence of the two distinct classes of whales, pregnant and resting, on the southern whaling grounds in the earlier months of the year, is to be explained by concluding that the female Sei whale breeds only once every two years and that anoestrus usually lasts from the finish of lactation towards the end of the year until the second half of the following year, after the northward migration.

Referring now to Fig. 81, which shows the frequencies of the occurrences of various numbers of corpora lutea in the ovaries, it will be seen that peaks occur for the numbers 1, 5, 8, 11, 19, 23 and 27. If the number 14, which appears to be absent only because of insufficient data, is interpolated, the peaks fall at distances of 3 to 5, which can be interpreted as showing that at each oestrus from two to four dioestrous cycles, with three to five ovulations, occur before pregnancy supervenes. Of the seventeen whales having one corpus luteum, only nine had corpora lutea *a*. Eight of these were pregnant, and the other appeared to have missed fertilization, because no foetus could be found in spite of a very careful search. The remaining eight were all resting, and four at least of these had been pregnant previously, as shown by the involuted state of the mammary glands. No information is available about the mammary glands of the other four, but in one of them there was a vaginal tag, showing that pairing at least had taken place, though whether it resulted in pregnancy it is now impossible to state. At their first

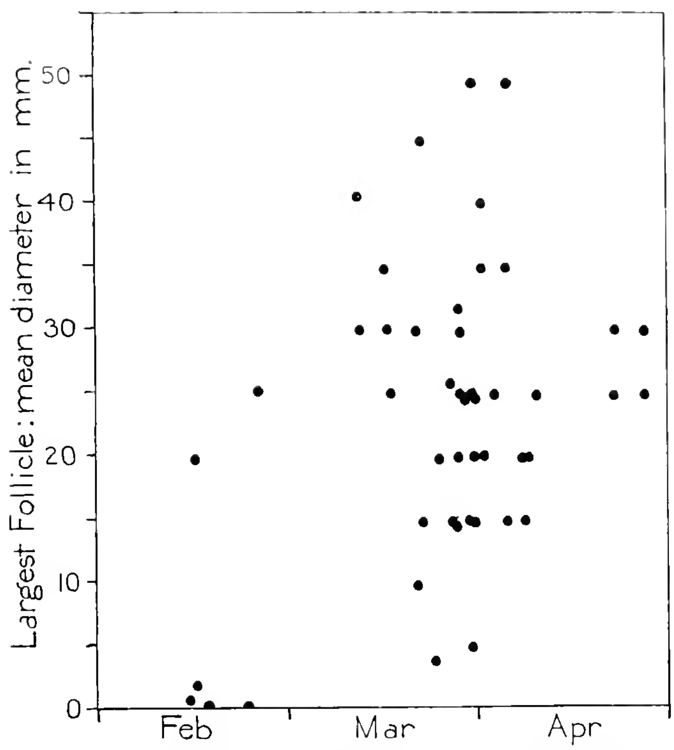


Fig. 79. Sei whale. Resting females. Size of largest follicle.

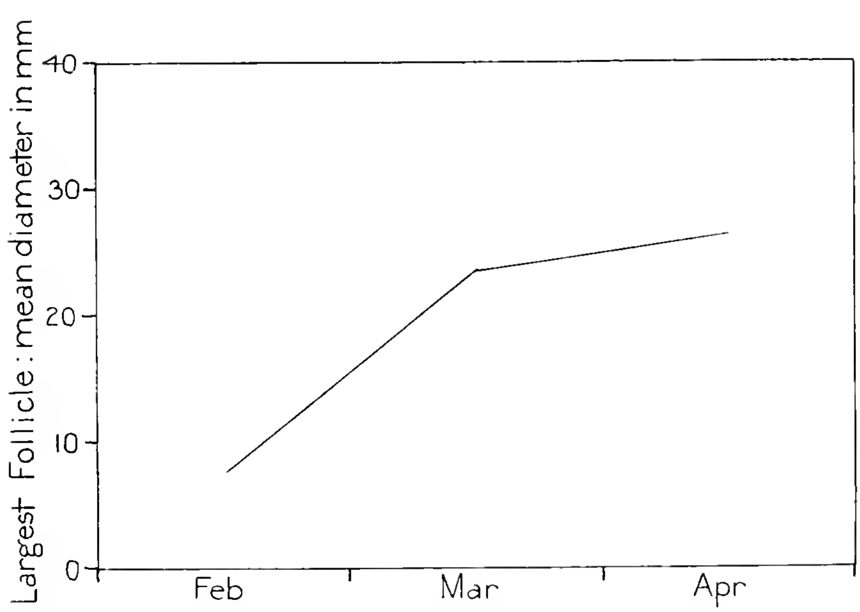


Fig. 80. Sei whale. Resting females. Mean size of largest follicle.

oestrus, therefore, the majority (12 out of 17 = 70 per cent) of these Sei whales became pregnant at the first ovulation, but thereafter Fig. 81 suggests that there is an average of three dioestrous cycles at each oestrus.

The breeding season appears to be determined by the physiological condition of the females only because, as has been shown above, no marked seasonal activity of the male structures has been found. It is probable that oestrus lasts for some time and is made up of any number up to 4 dioestrous cycles, until fertilization takes place. The unfruitful cycles are presumably due to absence of males from the neighbourhood of the female at the time of oestrus, though they may no doubt be due to unsuccessful matings, or other unknown factors.

The sexual cycle of the female Sei whale may therefore be summarized diagrammatically as in Fig. 82 which represents two years of the whale's life.

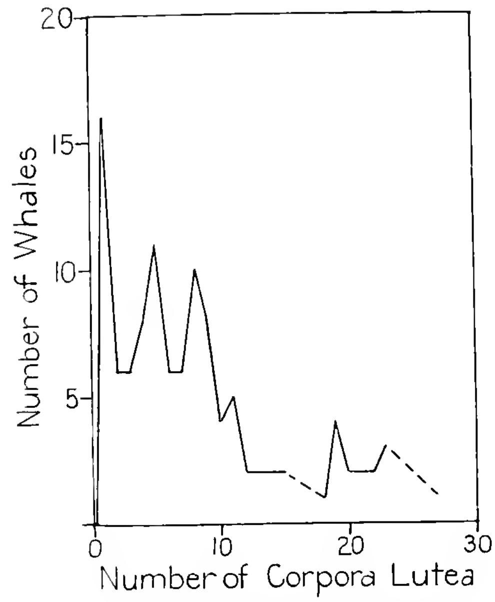


Fig. 81. Sei whale. Females. Frequency of corpus luteum numbers.

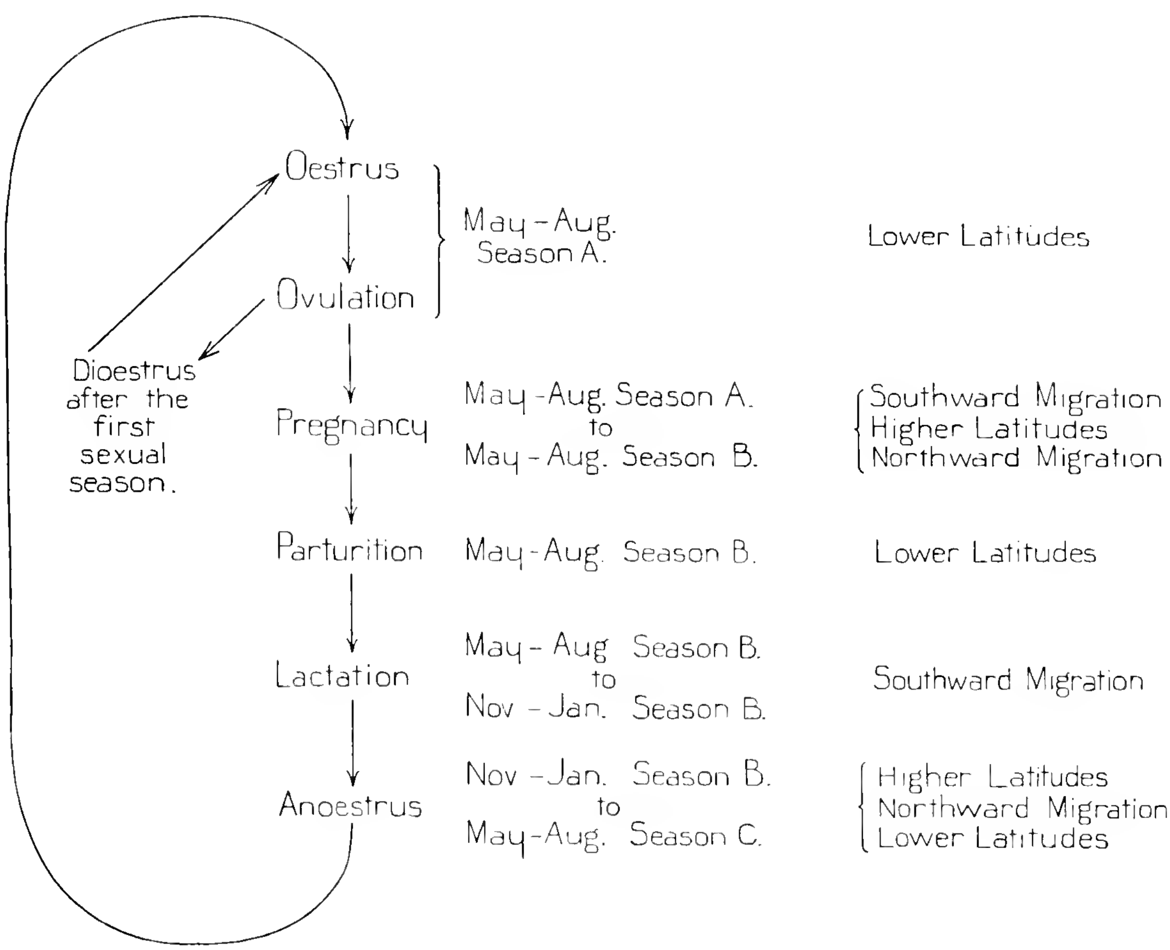


Fig. 82. Sei whale. Females. Oestrous cycle.

GROWTH AND AGE

The female Sei whale becomes mature shortly after reaching a length of 14 m. Only six pregnant females less than 15 m. long are recorded, their measurements ranging from 14·38 to 14·87 m. The smallest mature female Sei whale was 14·0 m. long and had recently ovulated for the first time. There was only one corpus luteum in the ovaries and no foetus was found in spite of a careful search. The majority, then, reach maturity at about 14·5 m. of total length, a few between 14 m. and this length, and some not until longer. Reference to Fig. 68 shows that the male Sei whale reaches sexual maturity between the lengths of 13 and 14 m. and the length of 13·5 m. may be taken as the average length. The smallest two males examined for sexual maturity measured 14·10 and 14·15 m. respectively. In both of these, sections showed the

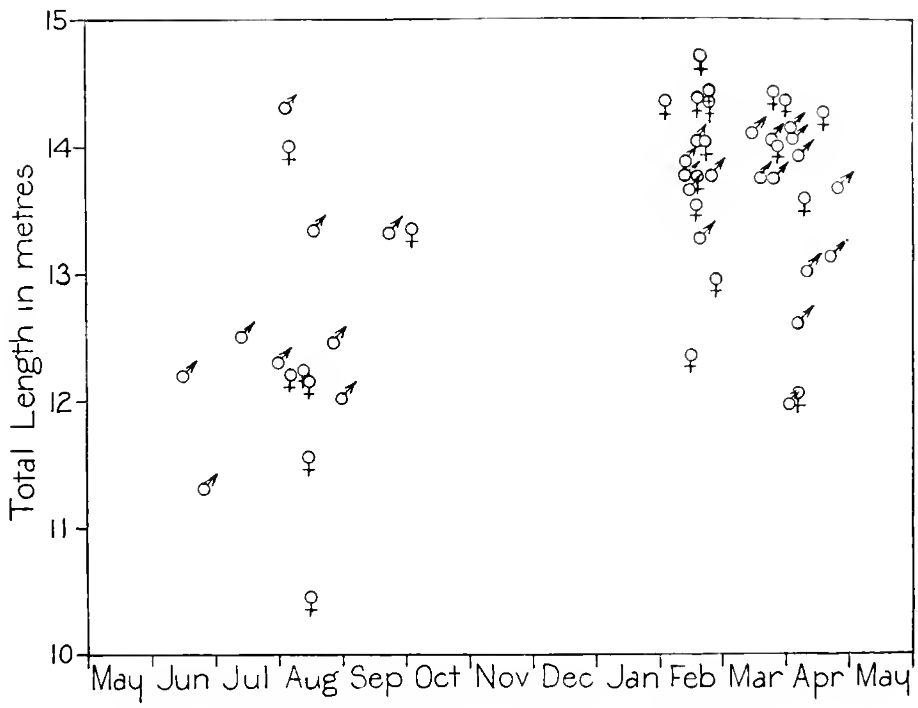


Fig. 83. Sei whale. Lengths of immature whales by months.

tubules of the testes full of dividing cells, but smears showed only a few spermatozoa in the testis and epididymis of the first, and none in those of the second. These whales were evidently young adults. On the other hand, some males had not reached full sexual maturity at considerably greater lengths.

Data relating to calf Sei whales are not available, but a number of immature whales of larger size have been examined. Fig. 83 is a scatter diagram of the lengths of all Sei whales recorded as immature, plotted by months, and shows a definite increase in length between June and April. Fig. 84 is the curve obtained by plotting the average length of these immature whales by months, and if this curve is combined with that of Fig. 77 on an extended time scale, the result shown in Fig. 85 is produced. From this it is deduced that the period of most active growth is about 18 months, and that a calf born at 4·5 m. in length in July becomes mature in the early part of the next year but one, and breeds for the first time some 6 months later at the age of 2 years.

Referring now to Fig. 81, in which the peaks suggest breeding seasons spaced at intervals of 2 years, it is seen that the first peak appears to represent whales aged about 2 years, the second those aged 4 years, the third 6 years, and so on up to a maximum of 14 years, so that it may be said, according to this interpretation, that a Sei whale aged 15 years is an old one and that few captured exceed that age.

The Sei whale, like other whales, reaches sexual maturity before growth is complete. A number of observations on the state of physical maturity in Sei whales have been collected and are presented in Table XXIII. Growth in length does not stop until

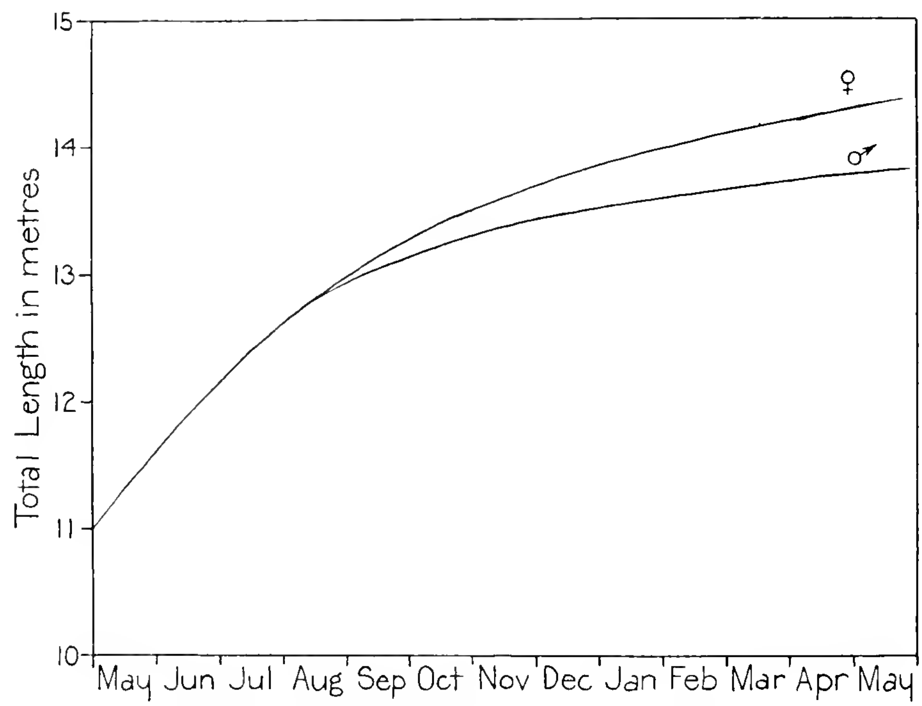


Fig. 84. Sei whale. Mean length of immature whales.

all vertebral epiphyses are ankylosed to the centra of the vertebrae. The ankylosis starts at each end of the vertebral column and proceeds centrally so that the middle and anterior thoracic vertebrae are the last to continue growth. The stage of ankylosis reached in several vertebrae in each whale is recorded in Table XXIII, which also shows the approximate age of the females, as deduced from the number of corpora lutea in the ovaries. The number of distinct ages of scars on the skin that were recognizable is also given.

Ankylosis of the epiphyses of the anterior caudal and lumbar vertebrae starts at an age of about 4–5 years and progresses slowly towards the head. The process may be complete by the age of 10–11 years, but in whale No. 3269 some of the thoracic epiphyses were not fused at an age of 11–12 years. In the last female of the series aged 14–15 years

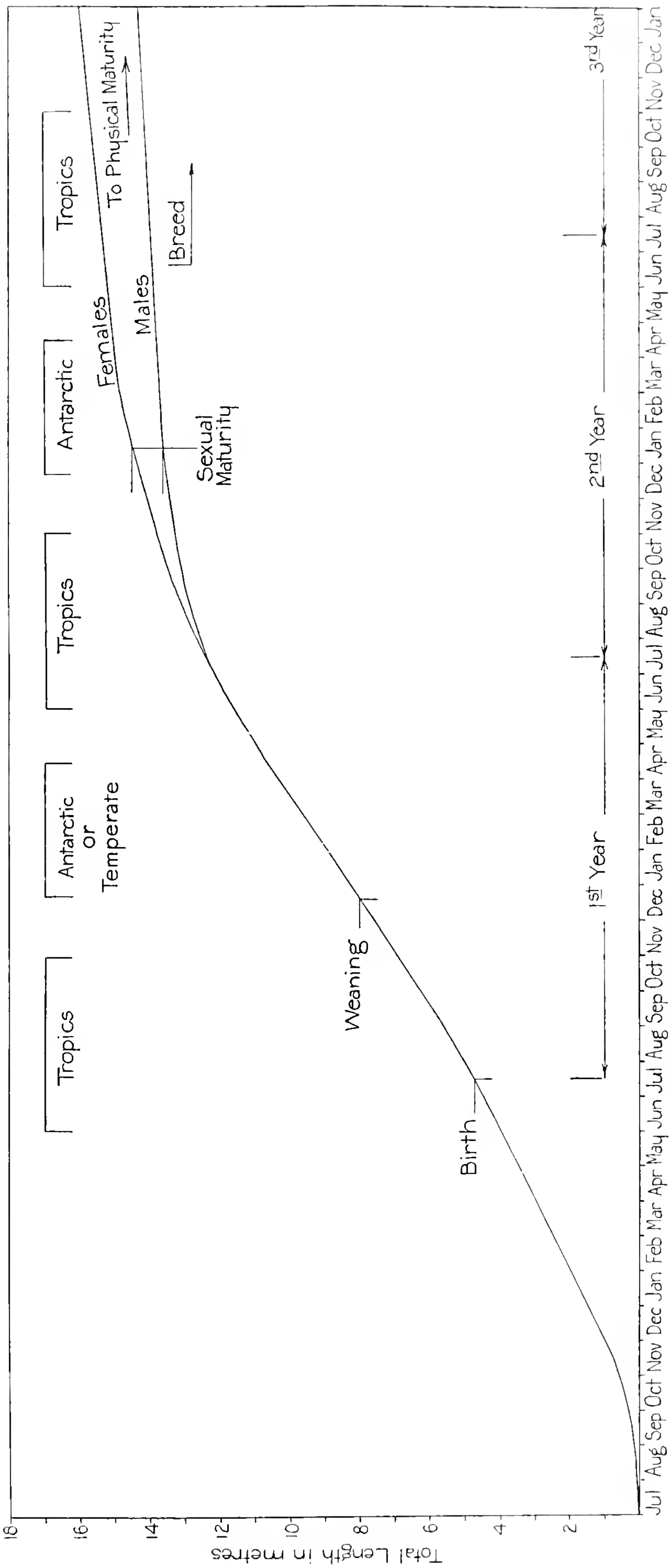


Fig. 85. Sei whale. Mean growth curve, conception to $2\frac{1}{2}$ years from birth.

Table XXIII. *Sei whale. Vertebral epiphyses*

Whale no.	Length metres	Date	Vertebral epiphyses		Approx. age from corpora lutea. Years	No. of ages of skin scars
			FEMALES			
D 123	14·00	5. viii. 30	L. 15–C. 1	Not ankylosed: cartilage thick	2	5
			Th. 13–14	„ „		
3185	14·17	6. iii. 30	L. 15–C. 1	Not ankylosed: cartilage thick	2	3
			Th. 7–8	„ „		
3124	15·25	13. iii. 30	L. 13–14	Not ankylosed: cartilage thick	2	3
			Th. 6–7	„ „		
3248	14·60	25. iii. 30	L. 15–C. 1	Not ankylosed: cartilage thick	2	4
			Th. 13–14	„ „		
			Th. 5–6	„ „		
3258	14·38	1. iv. 30	L. 14–15	Not ankylosed: cartilage thick	2	4
			L. 3–4	„ „		
			Th. 5–6	„ „		
3259	14·75	1. iv. 30	L. 15–C. 1	Not ankylosed: cartilage thick	2	4
			Th. 14–L. 1	„ „		
			Th. 4–5	„ „		
3266	14·80	3. iv. 30	L. 14–15	Not ankylosed: cartilage thick	2	4
			L. 13–14	„ „		
			Th. 6–7	„ „		
3669	15·68	18. ii. 31	L. 14–15	Not ankylosed: cartilage thick	2	5
			L. 10–11	„ „		
			Th. 4–5	„ „		
3685	16·35	27. ii. 31	L. 14–15	Not ankylosed: cartilage thick	3	4
			L. 8–9	„ „		
			L. 2–3	„ „		
			Th. 6–7	„ „		
3688	15·42	28. ii. 31	L. 15–C. 1	Not ankylosed: cartilage thick	3	2
			L. 7–8	„ „		
			Th. 9–10	„ „		
3694	15·57	12. iii. 31	L. 15–C. 1	Not ankylosed: cartilage thick	4	3
			L. 5–6	„ „		
3614	15·80	25. ii. 30	L. 15–C. 1	Not ankylosed: cartilage thick	—	3
			Th. 9–10	„ „		
3157	15·53	20. ii. 30	L. 12–13	Not ankylosed: cartilage thick	4	5
			Th. 7–8	„ „		
3621	15·45	10. ii. 31	L. 15–C. 1	Ankylosed: join just visible	4	3
			L. 9–10	„ „		
			L. 2–3	„ „		
			Th. 6–7	Not ankylosed: cartilage thick		
3618	16·16	9. ii. 31	L. 15–C. 1	Ankylosed: join visible	5	4
			L. 9–10	„ „		
			L. 6–7	„ „		
			Th. 4–5	Not ankylosed: cartilage thick		
3630	15·61	10. ii. 31	L. 15–C. 1	Not ankylosed: cartilage thick	5	5
			L. 7–8	„ „		
			Th. 6–7	„ „		
3161	15·92	23. ii. 30	L. 14–15	Not ankylosed: cartilage thick	5	4
			Th. 13–14	„ „		
			Th. 6–7	„ „		
3177	16·22	4. iii. 30	L. 14–15	Not ankylosed: cartilage thick	6	4
			Th. 4–5	„ „		

Table XXIII. *Sei whale. Vertebral epiphyses (contd.)*

Whale no.	Length metres	Date	Vertebral epiphyses		Approx. age from corpora lutea. Years	No. of ages of skin scars
3252	15·45	31. iii. 30	L. 14-15	Ankylosed: join visible	6	5
			L. 9-10	,, ,,		
			Th. 13-14	Not ankylosed: cartilage thick		
			Th. 5-6	,, ,,		
3268	15·60	10. iv. 30	L. 15-C. 1	Ankylosed: join visible	6	5
			Th. 13-14	Not ankylosed: cartilage thin		
			Th. 6-7	,, ,,		
3274	16·20	19. iv. 30	L. 14-15	Not ankylosed: cartilage thick	6	4
			Th. 14-L. 1	,, ,,		
			Th. 4-5	,, ,,		
3671	16·07	18. ii. 31	L. 13-14	Ankylosed: no sign of join	9	4
			L. 7-8	Not ankylosed: cartilage thin		
			Th. 10-11	Not ankylosed: cartilage thick		
3189	16·15	7. iii. 30	L. 15-C. 1	Ankylosed: no sign of join	10	5
			L. 5-6	Ankylosed: join visible		
			Th. 6-7	Not ankylosed: cartilage thin		
3260	16·55	1. iv. 30	L. 6-7	Ankylosed: join visible	11	4
			Th. 8-9	,, ,,		
			Th. 5-6	,, ,,		
3689	16·60	28. ii. 31	L. 15-C. 1	Ankylosed: join visible	11	3
			L. 7-8	,, ,,		
			L. 1-2	,, ,,		
			Th. 3-4	,, ,,		
3226	15·10	17. iii. 30	Th. 14-L. 1	Ankylosed: no sign of join	11	5
			Th. 5-6	,, ,,		
3269	16·70	10. iv. 30	L. 12-13	Ankylosed: no sign of join	12	5
			Th. 4-5	Not ankylosed: cartilage thin		
3693	16·10	12. iii. 31	L. 14-15	Ankylosed: join visible	15	4
			L. 4-5	,, ,,		
			Th. 9-10	Ankylosed: join just visible		
			MALES			
3145	14·05	17. ii. 30	L. 15-C. 1	Not ankylosed: cartilage thick	—	4
			L. 8-9	,, ,,		
			Th. 4-5	,, ,,		
3208	14·60	12. iii. 30	L. 13-14	Not ankylosed: cartilage thick	—	4
			L. 1-2	,, ,,		
			Th. 5-6	,, ,,		
3262	14·15	3. iv. 30	L. 15-C. 1	Not ankylosed: cartilage thick	—	4
			Th. 13-14	,, ,,		
			Th. 5-6	,, ,,		
3270	14·42	10. iv. 30	L. 15-C. 1	Not ankylosed: cartilage thick	—	4
			Th. 5-6	,, ,,		
D 10	12·20	10. vi. 30	L. 13-14	Not ankylosed: cartilage thick	—	—
			Th. 6-7	,, ,,		
D 119	14·30	3. viii. 30	L. 13-14	Not ankylosed: cartilage thick	—	3
			Th. 6-7	,, ,,		
3673	14·85	18. ii. 31	L. 15-C. 1	Not ankylosed: cartilage thick	—	—
			Th. 2-3	,, ,,		
3684	15·18	27. ii. 31	L. 15-C. 1	Not ankylosed: cartilage thick	—	—
			L. 12-13	,, ,,		
			Th. 5-6	,, ,,		

Table XXIII. *Sei whale. Vertebral epiphyses (contd.)*

Whale no.	Length metres	Date	Vertebral epiphyses		Approx. age from corpora lutea. Years	No. of ages of skin scars
			MALES			
3695	13·87	12. iii. 31	L. 15–C. 1	Not ankylosed: cartilage thick	—	5
			L. 4–5	,, ,,		
			Th. 4–5	,, ,,		
3272	16·15	15. iv. 30	L. 13–14	Not ankylosed: cartilage thick	—	4
			Th. 12–13	,, ,,		
			Th. 5–6	,, ,,		
3216	14·10	14. iii. 30	L. 15–C. 1	Not ankylosed: cartilage thin	—	4
			L. 1–2	,, ,,		
			Th. 5–6	,, ,,		
3271	14·55	15. iv. 30	L. 14–15	Ankylosed: join visible	—	4
			Th. 14–L. 1	Not ankylosed: cartilage thick		
			Th. 6–7	,, ,,		
3691	15·55	5. iii. 31	L. 15–C. 1	Ankylosed: join visible	—	2
			L. 7–8	,, ,,		
			Th. 9–10	Not ankylosed: cartilage thick		
3273	14·80	17. iv. 30	L. 14–15	Ankylosed: join visible	—	4
			Th. 14–L. 1	Not ankylosed: cartilage thick		
			Th. 5–6	,, ,,		
3619	14·62	9. ii. 31	L. 15–C. 1	Ankylosed: join visible	—	4
			L. 12–13	Not ankylosed: cartilage thick		
			L. 2–3	,, ,,		
3620	14·80	10. ii. 31	L. 12–13	Ankylosed: join visible	—	3
			L. 7–8	,, ,,		
			Th. 8–9	,, ,,		
			Th. 3–4	Not ankylosed: cartilage thick		
3257	14·55	1. iv. 30	L. 13–14	Ankylosed: no sign of join	—	5
			Th. 12–13	Not ankylosed: cartilage thin		
			Th. 4–5	,, ,,		
3275	14·60	19. iv. 30	L. 13–14	Ankylosed: no sign of join	—	4
			Th. 5–6	Not ankylosed: cartilage thin		
D 140	15·25	15. viii. 30	L. 15–C. 1	Ankylosed: join visible	—	3
			L. 12–13	Not ankylosed: cartilage thin		
			L. 9–10	,, ,,		
			L. 6–7	Not ankylosed: cartilage thick		
			Th. 10–11	,, ,,		
			Th. 2–3	Ankylosed: join visible		
			Th. 1–2	,, ,,		
3623	14·80	10. ii. 31	L. 15–C. 1	Ankylosed: join just visible	—	3
			L. 12–13	,, ,,		
			L. 4–5	Ankylosed: join visible		
			Th. 6–7	,, ,,		
3225	15·10	17. iii. 30	Th. 13–14	Ankylosed: join visible	—	5
			Th. 5–6	,, ,,		

all of the epiphyses were fused, though a join in some of the thoracic vertebrae was still just visible.

Whale No. D 140, a male and consequently of unknown age, well shows the process of ankylosis proceeding from both ends of the vertebral column. The caudal and posterior lumbar epiphyses were ankylosed, as were the anterior thoracic. The middle lumbar epiphyses were separated from the bodies of the vertebrae by thin cartilage, and those of the anterior lumbar and posterior thoracic by thick cartilage.

As will be seen from the table the number of recognizable ages of scars gives little, if any, indication of the age of the whale. Each distinct age of scars may represent a migration into warmer waters, but after a few years the older scars become very indistinct and confused, so that no conclusions of any value can be drawn from their presence. The migrations of this species are, too, as shown below, less extensive than those of the larger Rorquals, so that different ages of scars may be produced without the occurrence of lengthy southward migrations between them. This is seen in whale D 123 which was aged about 2 years, but carried 5 recognisable ages of scars.

Turning now to Tables VI, VII, VIII and IX, which show the mean values of the measurements of different parts of the body according to the length of the whale (in roman type), an indication of the relative rates of growth of the various parts may be obtained. If the mean values of the various measurements are plotted against the total length of the whale on a double logarithmic scale, the results shown in Figs. 86–104 are obtained. Measurements for South Georgian whales only are used, and the values for males and females are distinguished. In each of these figures the points are obviously falling about a straight line, and in some of them the approximation is very close. This being so, it may be taken that the rates of growth of the various parts of the body relative to the total length satisfy the equation $y=bx^k$, where x is the total length, y the length of the part, b the fractional co-efficient (the value of y when $x=1$) and k the growth co-efficient. The values of k for each measurement are shown in Table XXIV. Values of k over unity indicate an increasing rate of relative growth and those less than unity the converse. In only three cases has k a value over unity, for measurement No. 3, tip of snout to blow-hole; No. 6, tip of snout to tip of flipper; and No. 15, length of base of dorsal fin. The latter may be dismissed as of little significance because the measurement is taken between ill-defined points and is thus liable to considerable error. The first, however, measurement No. 3, shows that as the whale increases in total length the relative rate of growth of the rostrum increases: the second, measurement No. 6, appears to indicate a high growth rate not only in the rostrum but also in the anterior thoracic region. The difference in the relative growth rates shown by the Sei whale, when compared with those of other balaenopterid whales, particularly the Humpback whale, are striking. In them there is a very marked increase in the relative growth rates of the anterior part of the body, and decrease in those of the posterior part, as total length increases. In the Sei whale, however, nearly all the measurements show a decreasing relative growth rate with increasing length, so that the body proportions of large and small whales are not greatly different, as was shown in an earlier section when considering the percentage values of the body measurements. This relative consistency of proportions is rather unexpected in view of the characteristic change of proportions found in other whalebone whales. In them the growth of the whale appears to be largely concentrated on developing the mouth and baleen apparatus.

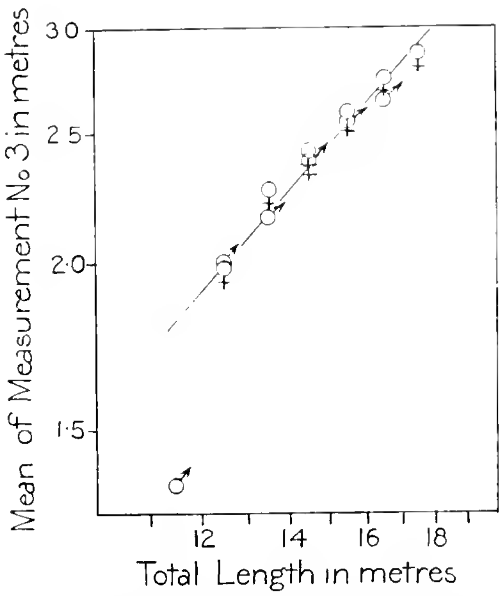


Fig. 86. Sei whale. Logarithmic plotting of total length against measurement No. 3: tip of snout to blow-hole.

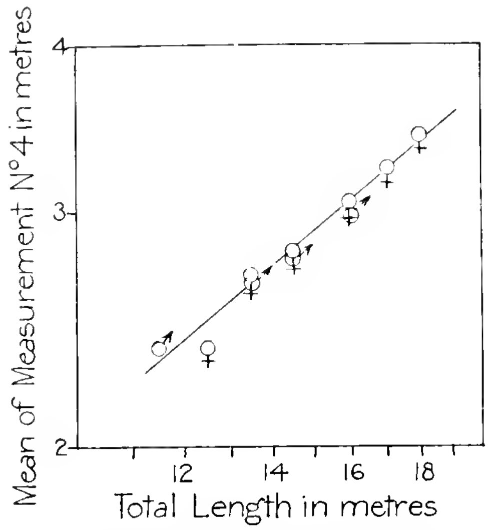


Fig. 87. Sei whale. Logarithmic plotting of total length against measurement No. 4: tip of snout to angle of gape.

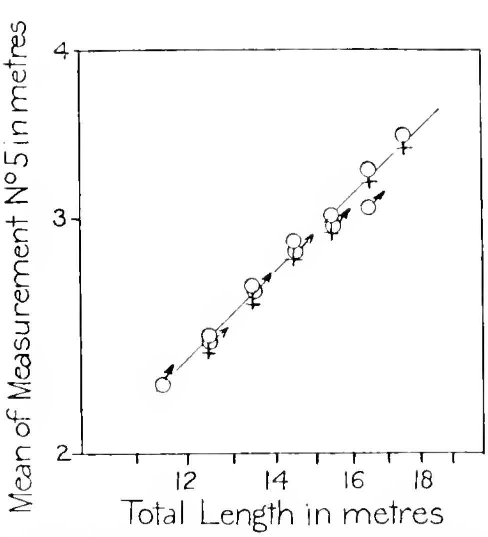


Fig. 88. Sei whale. Logarithmic plotting of total length against measurement No. 5: tip of snout to centre of eye.

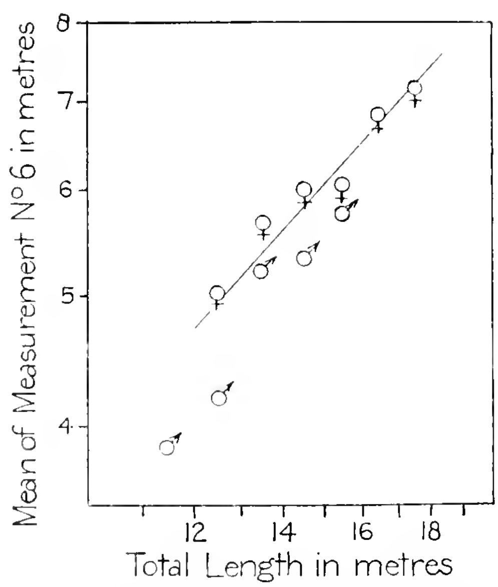


Fig. 89. Sei whale. Logarithmic plotting of total length against measurement No. 6: tip of snout to tip of flipper.

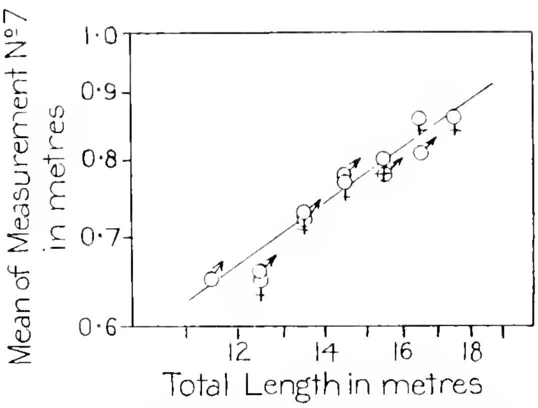


Fig. 90. Sei whale. Logarithmic plotting of total length against measurement No. 7: centre of eye to centre of ear.

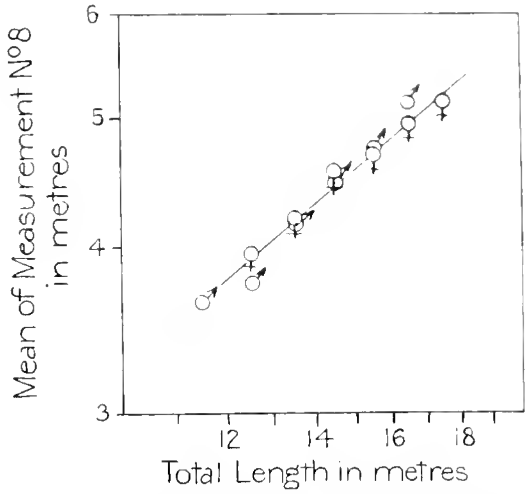


Fig. 91. Sei whale. Logarithmic plotting of total length against measurement No. 8: notch of flukes to posterior emargination of dorsal fin.

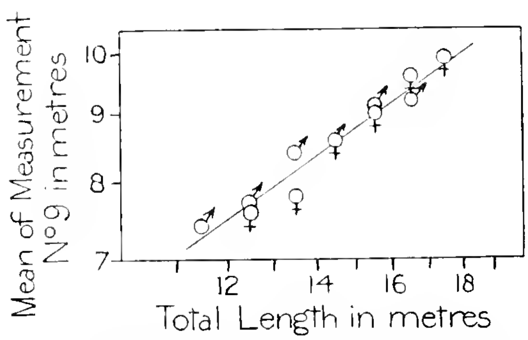


Fig. 92. Sei whale. Logarithmic plotting of total length against measurement No. 9: width of flukes at insertion.

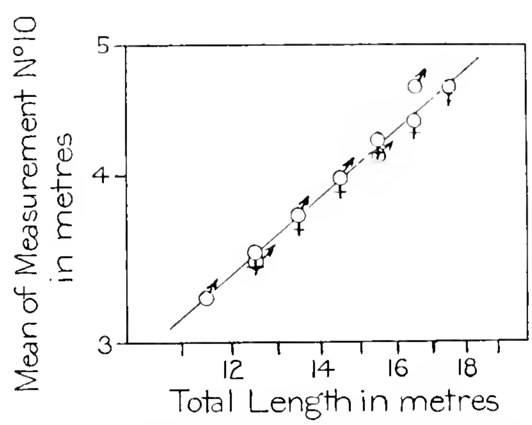


Fig. 93. Sei whale. Logarithmic plotting of total length against measurement No. 10: notch of flukes to centre of anus.

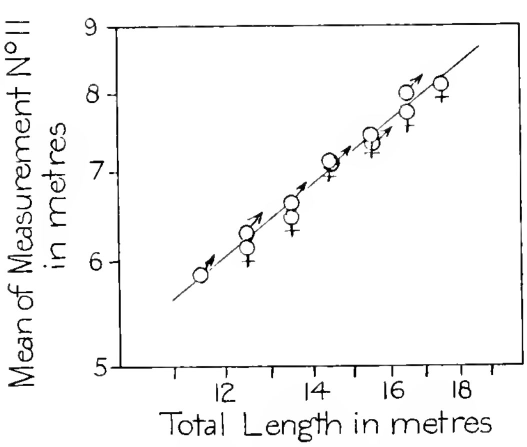


Fig. 94. Sei whale. Logarithmic plotting of total length against measurement No. 11: notch of flukes to umbilicus.

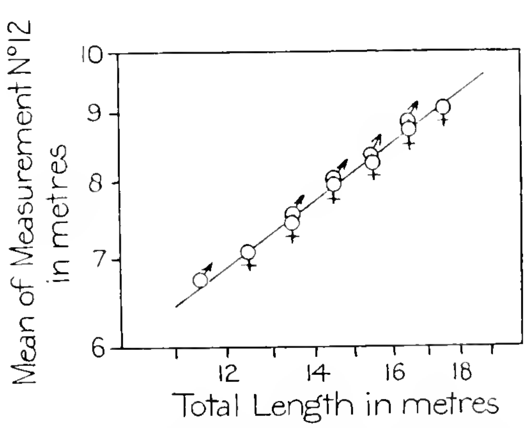


Fig. 95. Sei whale. Logarithmic plotting of total length against measurement No. 12: notch of flukes to end of system of ventral grooves.

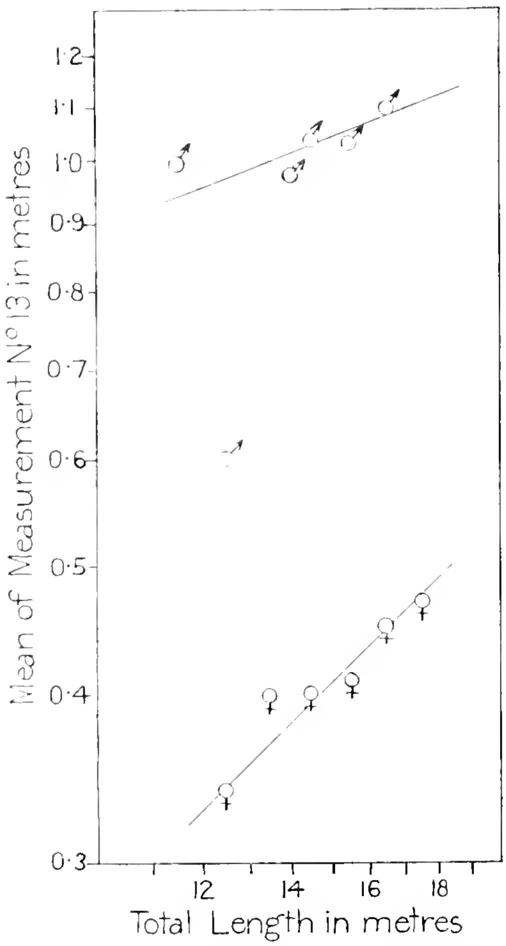


Fig. 96. Sei whale. Logarithmic plotting of total length against measurement No. 13: centre of anus to centre of reproductive aperture.

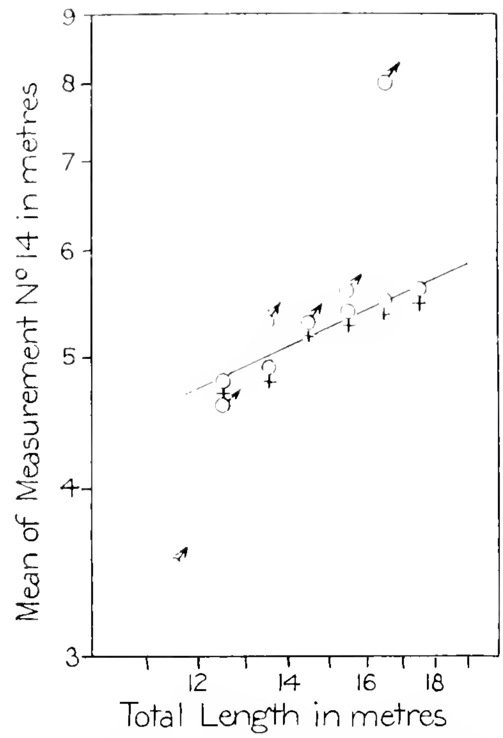


Fig. 97. Sei whale. Logarithmic plotting of total length against measurement No. 14: vertical height of dorsal fin.

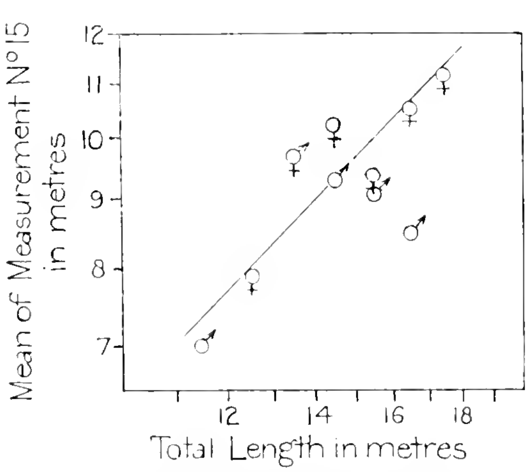


Fig. 98. Sei whale. Logarithmic plotting of total length against measurement No. 15: length of base of dorsal fin.

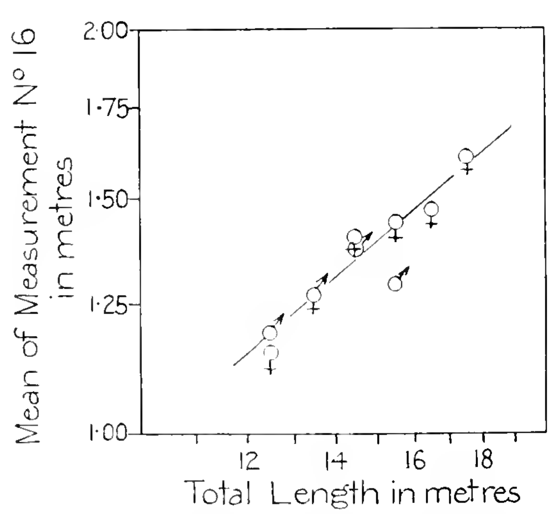


Fig. 99. Sei whale. Logarithmic plotting of total length against measurement No. 16: axilla to tip of flipper.

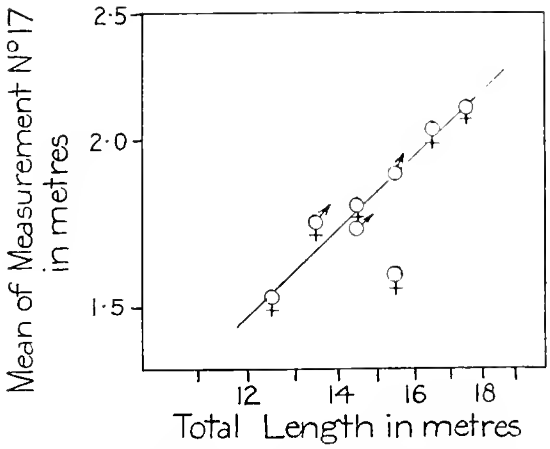


Fig. 100. Sei whale. Logarithmic plotting of total length against measurement No. 17: anterior end of lower border to tip of flipper.

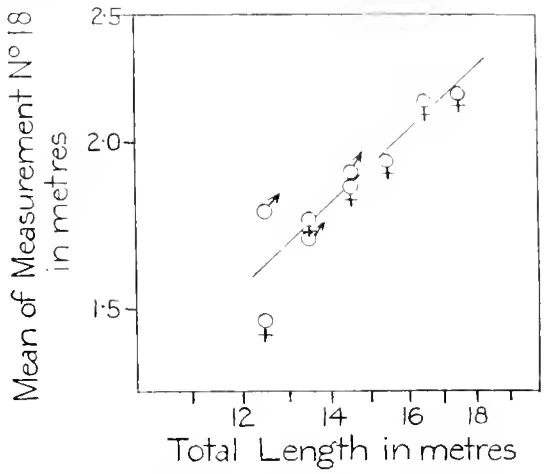


Fig. 101. Sei whale. Logarithmic plotting of total length against measurement No. 18: length of flipper along curve of lower border.

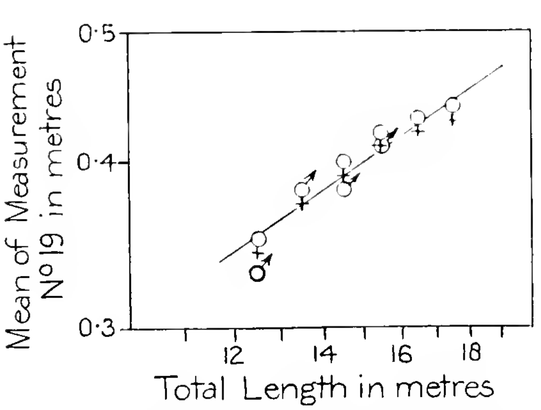


Fig. 102. Sei whale. Logarithmic plotting of total length against measurement No. 19: greatest width of flipper.

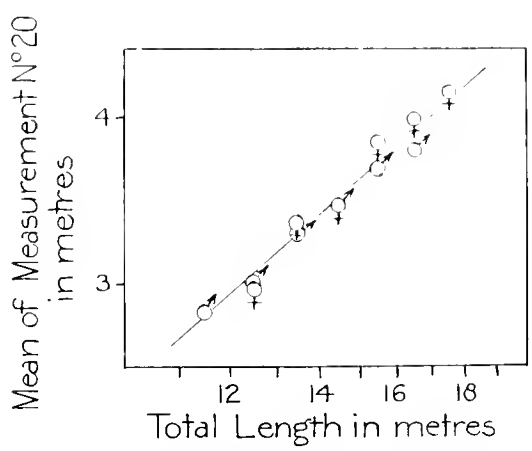


Fig. 103. Sei whale. Logarithmic plotting of total length against measurement No. 20: length of severed head from condyle to tip.

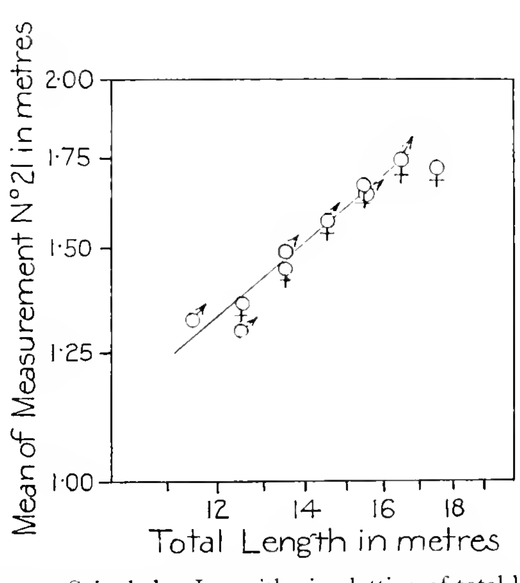


Fig. 104. Sei whale. Logarithmic plotting of total length against measurement No. 21: greatest width of skull.

Table XXIV. *Sei whale. Growth coefficients*

Measurement	Growth coefficient
3. Tip of snout to blow-hole	1·12
4. Tip of snout to angle of gape	0·84
5. Tip of snout to centre of eye	0·97
6. Tip of snout to tip of flipper	1·07
7. Centre of eye to centre of ear	0·71
8. Notch of flukes to posterior emargination of dorsal fin	0·84
9. Width of flukes at insertion	0·70
10. Notch of flukes to centre of anus	0·89
11. Notch of flukes to umbilicus	0·81
12. Notch of flukes to end of system of ventral grooves	0·73
13. Centre of anus to centre of reproductive aperture:	
Male	0·36
Female	0·98
14. Vertical height of dorsal fin	0·36
15. Length of base of dorsal fin	1·02
16. Axilla to tip of flipper	0·81
17. Anterior end of lower border to tip of flipper	0·97
18. Length of flipper along curve of lower border	0·93
19. Greatest width of flipper	0·68
20. Length of severed head from condyle to tip	0·88
21. Greatest width of skull	0·84

In the present species the only measurement with a conspicuously increasing relative growth rate is likewise that of the anterior part of the head, so that in it, too, the mouth and feeding mechanism becomes relatively larger with increasing total length. But an increasing relative growth rate is not found in any similar degree in any of the other parts, and this is perhaps to be explained by the smaller total size reached by the Sei whale. Owing to its smaller size the body volume is proportionately very much less than in the other species, and consequently a proportionately much smaller baleen apparatus is able to capture a supply of food sufficient for supporting it. It seems doubtful whether it can be said that the kind of food consumed by the Sei whale accounts for the differing proportions, because, although the Sei whale feeds at times on very much smaller plankton than the other species and its baleen appears to be specially adapted for it, in the Antarctic and sub-Antarctic regions it has always been found to be feeding on the same krill that is eaten by the other species.

MIGRATION

In the South Georgian whaling returns the occurrence of the Sei whale is always almost entirely restricted to the months of February, March and April. Fig. 105 is a typical unimodal graph of the numbers of whales taken during the seasons 1927–8 to 1930–1 inclusive, plotted by months. Harmer (1931) gives a graph of the occurrence of 1318 individuals during the sixteen seasons 1913–14 to 1928–9, which is essentially similar: 93·1 per cent of the whales occurred in these three months and only 6·9 per cent in the rest of the year.

This well marked unimodal graph confined to these months, at first sight appears to indicate that there is a very definite migration of Sei whales into South Georgian waters in the early months of the year. But such a conclusion must be drawn with caution. Admittedly, the peak in the graph shows the presence of Sei whales on these grounds, but the converse is not necessarily true: it means that Sei whales were not captured but not necessarily that they were not there.

The whaling season at South Georgia usually opens with a wave of Blue whales passing southwards, succeeded by a wave of Fin whales following at about a month's interval. Early in the new year in many seasons the main body of the Fin whales has passed on and there is consequently a relative scarcity of these larger species on the whaling grounds. It is then that the whalers turn their attention to the Sei whales, which are much too small to be of any interest to them while there are plenty of the larger

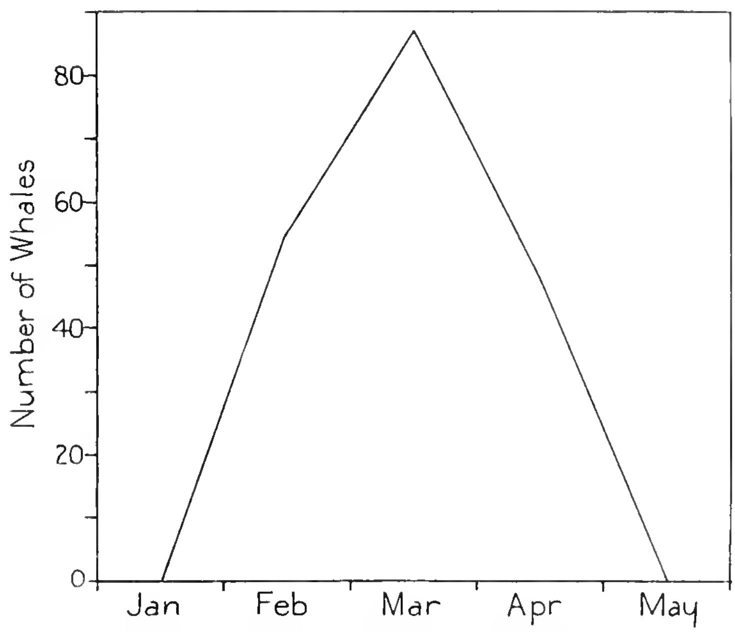


Fig. 105. Sei whale. Monthly catches at South Georgia, 1927–31.

species available. Consequently the peak in the graph may indicate the absence of Fin and Blue whales rather than the great influx of Sei whales.

Nevertheless Sei whales, like the Fin and Blue whales, undoubtedly pursue a southward feeding migration during the southern summer and a northward one to warmer waters for breeding in the winter; but if more extensive figures were available it is possible that the graph of their occurrence would not have so sharp and well marked a peak as has that derived from the figures of the whaling catch.

The Sei whale scarcely appears at all in the whaling returns from places farther south, so that the unimodal graph of its occurrence at South Georgia is probably a correct indication of the approximate latitude in which the return towards the north occurs. It may be mentioned also that the whalers believe that with the arrival of the Sei whales the best part of the season for Blue and Fin whales is over; but as pointed out above, this belief is not necessarily entirely correct because the whalers refrain from taking any Sei whales which are available while the larger species are numerous. In addition, in seasons when whaling slackens off in the early months of the year owing to the small numbers of Blue and Fin whales present, there is frequently a marked return of the larger species and improvement in the catch towards the end of the season. It is of interest to note that Collett (1886) states that the whalers at Varangerfjord said that when the Sei whale came in the Blue whale left the coast and went out to sea.

A further point which confirms the likelihood that the season graph gives a correct indication of the occurrence of the Sei whale at South Georgia is the general absence of a skin film of diatom in this species. Hart (1935) found that in fifty-two Sei whales examined for the presence of diatom film only ten were infected, and of these only one sufficiently heavily for a patch of film to be visible to the naked eye. He has also shown that at least a month is required to develop the film in Antarctic waters, so that the conclusion to be drawn from his observations is that only one of these whales could be definitely said to have spent more than one month in high latitudes.

The graph does not represent simply the end point of a southward migration from which the whales return to the north after a stay of a month or two. Reference to Fig. 74 shows that the composition of the Sei whale population during these 3 months is constantly changing. In February the majority of the females are pregnant; in April the majority are resting; in March the numbers of the two classes are approximately equal. The proportion of immature whales is fairly constant throughout the period. This means either that the pregnant females arrive and depart first, or else that after the arrival of the first schools, in which the females are mostly pregnant, there is a further arrival of schools in which the majority of the females are not pregnant, so that the earlier population is greatly diluted by the non-pregnant females. In either case the pregnant females arrive first, though data are insufficient to show which of the two alternatives relating to the subsequent movements of the schools is correct. It may be suggested that the resting whales are later in arriving on the South Georgian grounds because they have been delayed in lower latitudes by lactation, and that the pregnant ones, having been unhampered by sucking calves, have been able to leave the north sooner.

The southward migration, as in the case of the Blue and Fin whales, is undoubtedly a feeding migration. The appearance of Sei whales in South Georgian waters coincides with the departure of either species and the deduction would appear likely that the food of Sei whales then becomes abundant and that of the other species scarce. This theory is further supported by the known habits of Sei whales in the northern hemisphere, where they feed on copepods and for which diet they appear to be specially suited by their fine baleen. But examination of the stomach contents merely reveals that the Sei whales of South Georgia are feeding on the same *Euphausia superba* as are the Fin and Blue whales. The March influx of Sei whales cannot, therefore, be due to the seasonal abundance of any special food. Can it be that the Sei whale, being smaller than the Fin and Blue whales, merely takes a longer time to travel the same distance from warmer waters and so is late in arriving on the South Georgian grounds? A further possibility may be that the distribution of whales is directly influenced by sea temperature, a supposition in support of which some evidence is accumulating. Sei whales in general frequent warmer waters than the Blue and Fin whales, and it is possible that they approach South Georgia only when the temperature is high enough. Maximum temperatures are reached in South Georgian waters in March, as shown by Fig. 106 constructed from figures kindly supplied by Dr G. E. R. Deacon. Comparison of Figs. 105 and 106 shows an appearance of direct correlation.

Turning now to the returns from the South African whaling stations, Figs. 107 and 108 show the season graphs for Cape Province and Natal respectively for a number of seasons. Fig. 107 shows three peaks, but is really to be regarded as bimodal because an inspection of the figures from which it is constructed shows that in each season there are only two peaks, but that in some seasons the second peak appears later than in others. The two peaks in the autumn are thus due to combining the figures for several seasons and must be taken together as representing one peak in the autumn in any one season. The graph, then, is markedly bimodal and shows a northward migration in May and a return southward in any of the months from August to October. Farther to the north on the west coast of Africa the figures from Angola show only a unimodal curve, indicating that the main body of the whales does not pass on beyond this point.

The curve in Fig. 108 for Natal is unimodal with its peak in June. A peak in this month would be expected from a consideration of Fig. 107, for the whales may be expected to be about a month later in arriving so far up the East coast after they have been in the neighbourhood of the Cape in greatest numbers in May. But the absence of any second peak in later months is unexpected. Natal cannot represent the most northerly point reached in the northward migration, because if it did the peak would occur later in the season, in July and August. The only explanation of the unimodal curve appears to be that the whales pass through the Natal grounds on their way north, but that on their return migration they do not, probably keeping far off shore, out of reach of the whalers, when on their way south.

Comparison of these figures with Fig. 78 shows that the main season for parturition and pairing occurs while the whales are in the waters north of Cape Province. The breeding season is, however, widely spread through the months of May to August inclusive, so that parturition and pairing are taking place during the whole of the time that the species is migrating up the coast of Africa and back again. It would appear that the widespread breeding season in this species is, partly at least, correlated with the fact that Sei whales do not occur so near the pole as other species, and consequently the migration is not so extensive to the south, though towards the equator they appear to go as far as any species, and occur in the returns from the French Congo and Ecuador.

A further point to be noted with regard to this species is that its occurrence in African waters is frequently very irregular in successive seasons; in some years it appears plentifully and in others it is conspicuously scarce. No explanation of this phenomenon

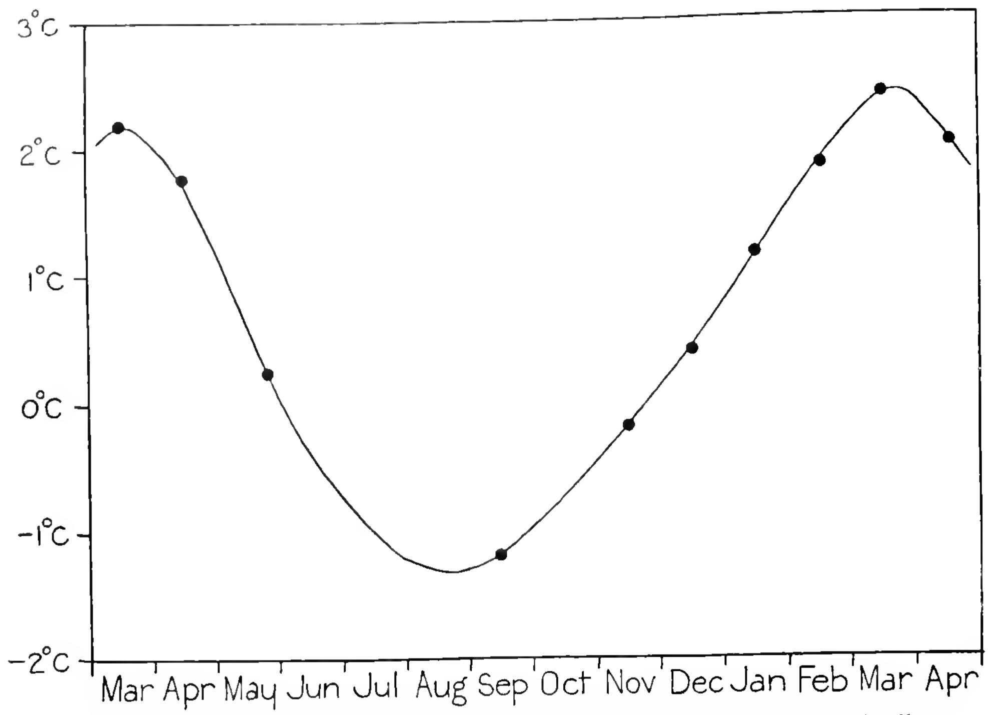


Fig. 106. Monthly sea temperatures at South Georgia from March 1928 to April 1929.

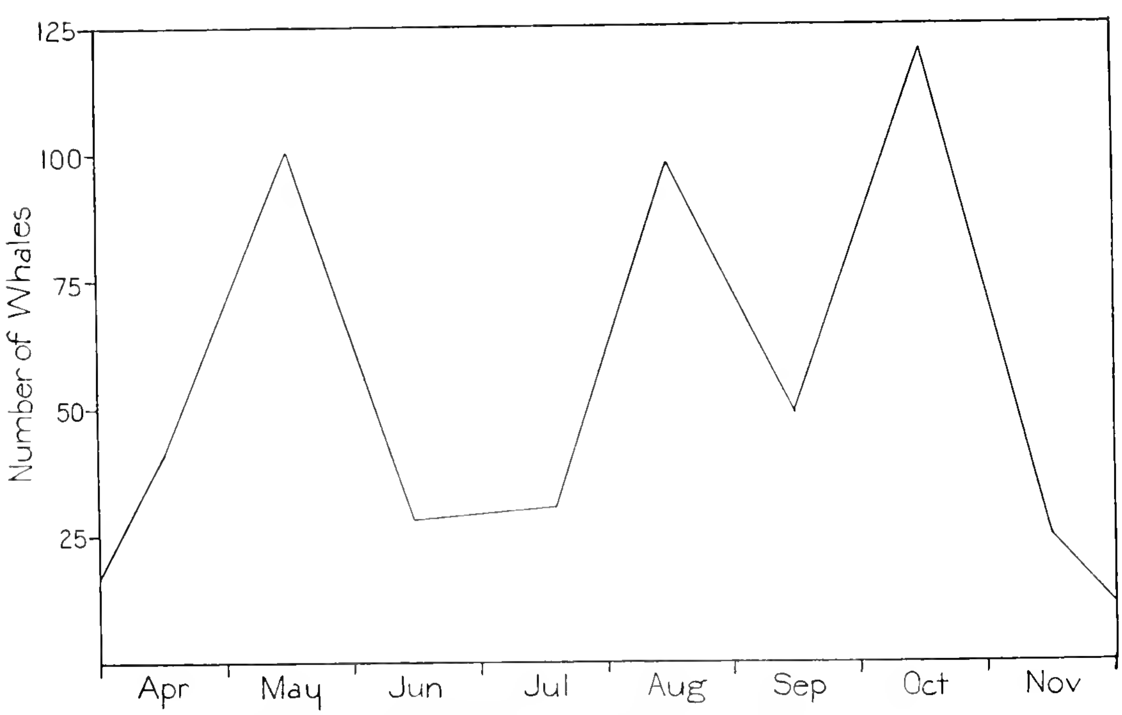


Fig. 107. Sei whale. Monthly catches at Cape Province, 1920–5.

can be given until further information is available, but it is suggested that it may be connected with the variations from year to year in the ocean currents of these regions. It must be remembered, however, that the numbers of Sei whales taken in any season depend partly on the numbers of other species available to the whalers. Further the Sei whale has been almost notorious for suddenly appearing in large numbers on whaling grounds where it was previously scarce. For instance, it is said to have appeared at South Georgia for the first time in season 1913–14; and to have first arrived in great numbers off the Hebrides and Shetlands in the northern hemisphere in 1906. But it appears possible that the accounts of these sudden appearances are based on inac-

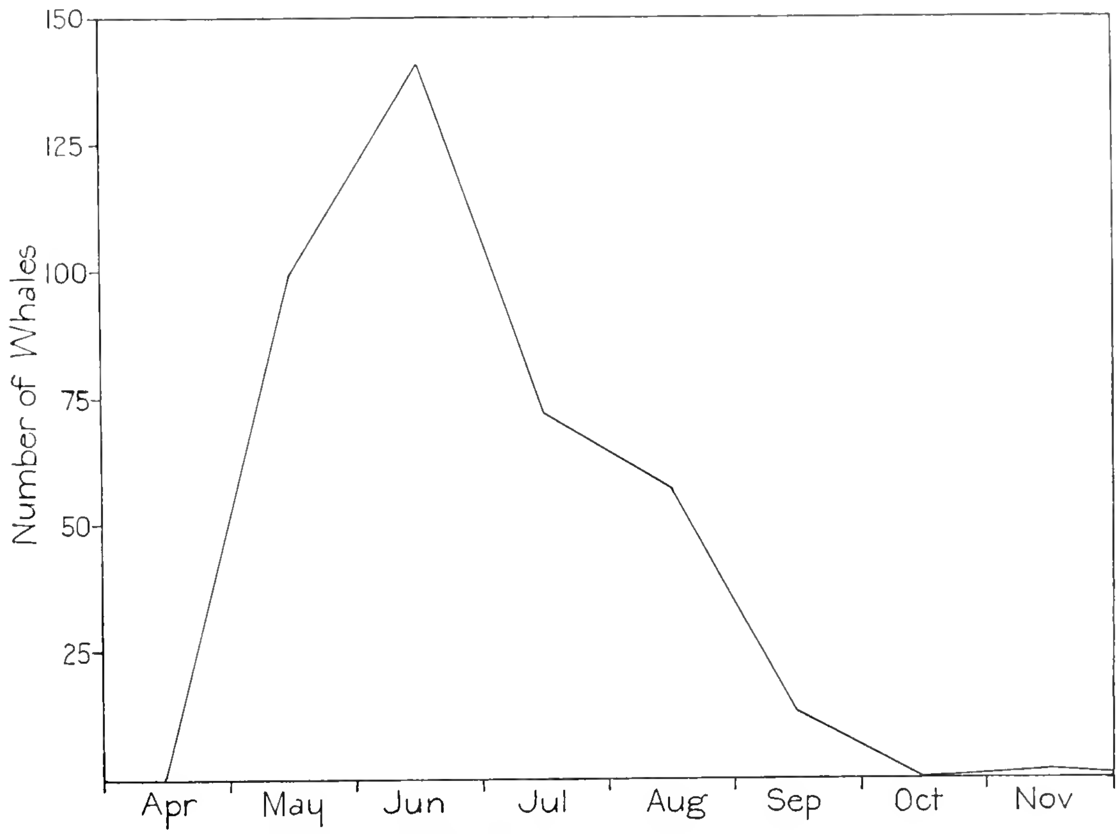


Fig. 108. Sei whale. Monthly catches at Natal, 1918–26.

curate observation. In the early days of whaling at South Georgia, Right whales and Humpbacks were so plentiful that the comparatively low powered catchers had no cause to seek for whales at any great distance from the whaling stations. The reason for the sudden abundance of Sei whales at the Scottish whaling stations is given by Haldane (1909) as the extension of fishing outside a previous 40-mile limit. He says, "*B. borealis* was more abundant, *B. musculus* scarcer than last year; the reason given for this is that during the time of the 40-mile limit there were plenty of *B. musculus* within the limit, doubtless feeding on the herring which were abundant on the west coast of Shetland, while beyond the 40 miles *B. borealis* were plentiful and *B. musculus* not so numerous." In both these localities, then, the apparent abundance may have been due merely to extended hunting. A similar explanation may lie behind the unexpected appearance of numbers of Sei whales in whaling returns elsewhere, such as those summarized by Kellog (1929). If, on the other hand, these unexpected appearances really occur, they will probably be found to coincide with the occurrence of unusually high sea temperatures.

Figs. 109 and 110 give the length frequencies of both sexes of the Sei whale in the whaling catches at South Georgia and South Africa for several seasons. The curves for

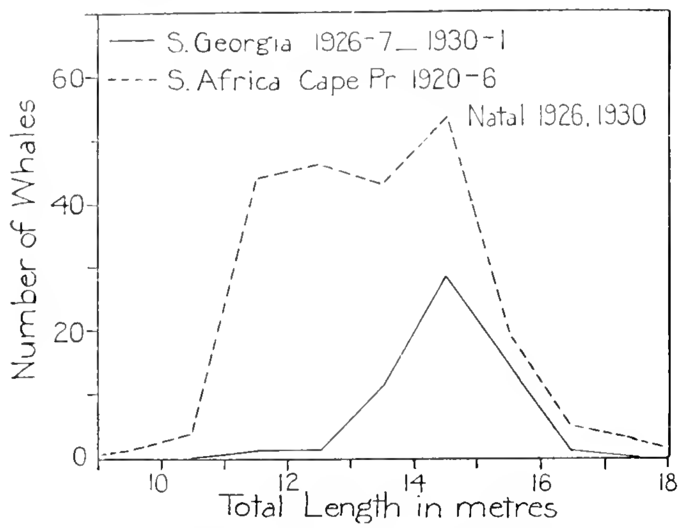


Fig. 109. Sei whale. Males. Length frequencies.

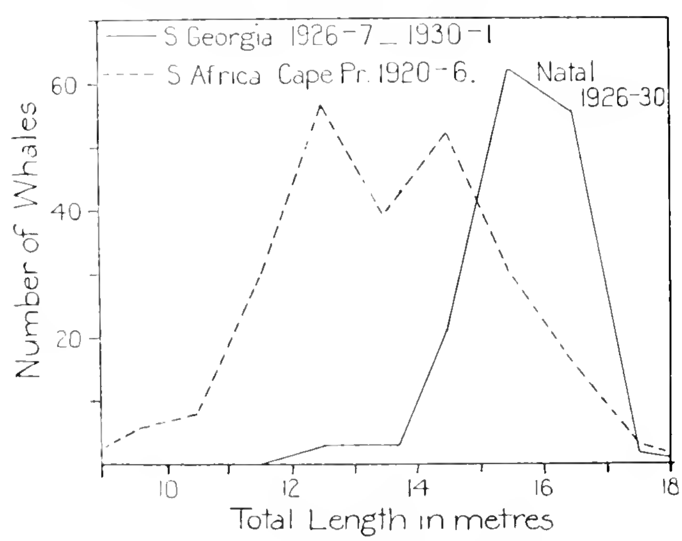


Fig. 110. Sei whale. Females. Length frequencies.

South Georgia show a great preponderance of adult whales of both sexes, but the curves for South Africa are quite different. They are bimodal, especially for the females, and show that the catches are composed of a very high proportion, more than 50 per cent, of immature whales. Immature males and those which have just reached sexual maturity preponderate and there is a second peak in the graph showing a group of older and fully adult animals. The females fall into two well-marked groups, those which are immature and those which have just reached sexual maturity. There is no older age group than the latter, and consequently few females that are more than just sexually mature occur. These figures show unmistakably that few immature whales of either sex take part in the southward migration, in which most of the Sei whales belong to age groups older than that of whales which have just reached sexual maturity.

ECONOMIC STATUS

The Sei whale is not at present of any great economic importance on any of the whaling grounds except Japan and Korea, and the west coast of Norway (Harmer 1928). It was taken in some numbers in the seasons 1927–8 and 1928–9 by a whaling expedition operating off the coast of Patagonia. This is due primarily to its small size (the oil yield of six Sei whales is rated by Risting (1928) as equal to that of one Blue whale) and further to the fact that in African waters it is usually in very poor condition. Consequently, Sei whales are never taken when other, more profitable, species are available. Nevertheless, the economic importance of the Sei whale is likely to increase greatly in the near future, now that the stocks of the larger species are definitely declining and that the end of the commercial exploitation of the Blue whale, at least, appears to be in sight. When the whaling industry seriously turns its attention to the Sei whale it is to be expected that the species will very quickly be reduced to the same level of scarcity as the larger species, because the hunting will be all the more intensive in order to catch the large numbers necessary to produce the quantity of oil hitherto obtained.

Figs. 111, 112 and 113 show the numbers of Sei whales taken at South Georgia, Cape Province and Natal for several successive seasons. The catches of Fin and Blue whales taken are also given for comparison, and it is of interest to note that in every season in which the figures show a peak for Sei whales it is correlated with a drop in the curve for the larger species. These results are undoubtedly due to selective hunting and demonstrate the caution with which figures of the commercial catch of Sei whales must be accepted as showing the numbers of the species actually on the whaling grounds.

The general stock of Sei whales is doubtless at present little disturbed by commercial whaling and is in a state comparable with that of the stocks of the larger whales before the exploitation of the southern whaling fields. A great decline in numbers may be expected if the species is taken in large quantity. The decline will be all the more rapid if the species is captured in numbers off the coasts of South Africa, where the whales are taken while on their breeding migration. In this area there are large numbers of immature whales, and their poor condition will lead to the capture of excessive numbers in order to make up the desired quantities of oil.

Since this report was written the International Whaling Convention has, however, put forward proposals for the further protection of this species, together with other whales.

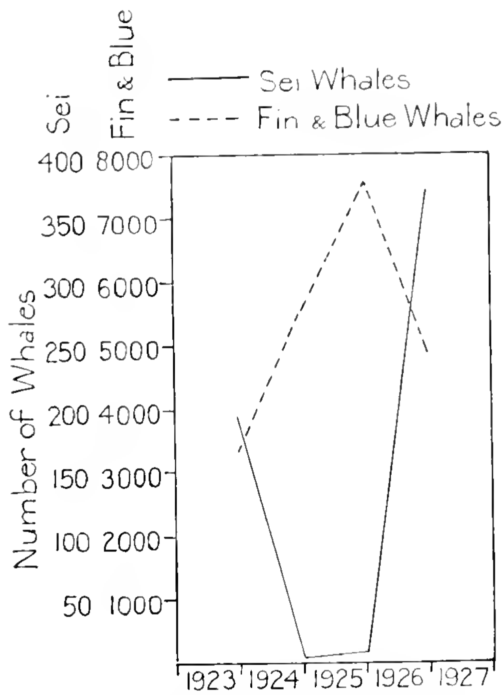


Fig. 111. Catches of Sei, Blue and Fin whales. South Georgia.

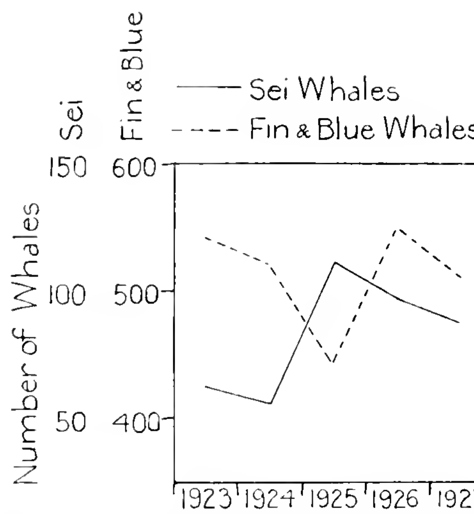


Fig. 112. Catches of Sei, Blue and Fin whales. Natal.

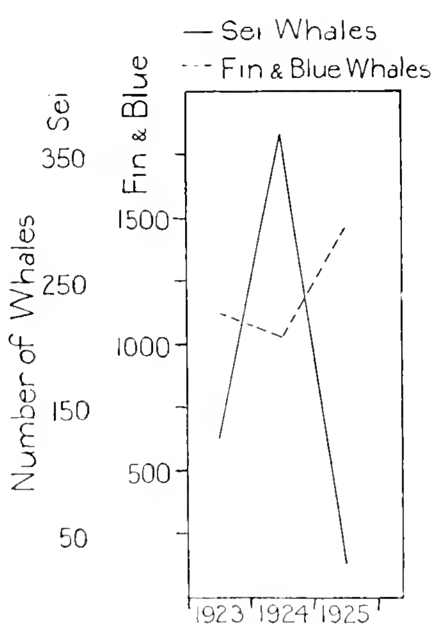


Fig. 113. Catches of Sei, Blue and Fin whales. Cape Province.

SUMMARY

This report discusses data from two hundred and twenty Sei whales examined at the southern whaling stations by the staff of the Discovery Committee.

The extensive statistics in the British Museum (Natural History) relating to whaling have also been used in conjunction with the data collected by the committee.

The sex ratio of the Sei whale shows that males comprise about 60 per cent of the population. This proportion appears to be constant from an early stage of foetal life, though it is obscured in the whaling returns by the high proportion of the larger females selectively captured by the whalers.

A series of standard measurements was carried out on the whales and the resulting figures are discussed. The body proportions of the southern Sei whales are established, and their range of variation is recorded. As far as comparative evidence is available there is no indication of structural differences between the Sei whales of the northern and southern hemispheres, the Atlantic or Pacific oceans.

The rather wide range of variation in the colour of the species is described, and a tendency towards asymmetrical coloration in a small proportion of the whales is recorded.

Hair appears in this whale on the upper part of the head, the ramus of the jaw and on the chin. The numbers and distribution of the hairs are recorded.

The arrangement of the ventral grooves in the Sei whale differs from that in the Fin and Blue whales in that at their posterior end the grooves stop well anterior to the umbilicus. They vary in number from forty to sixty-two.

The baleen is very fine in texture and nearly black in colour. A number of white plates commonly occur near the anterior end of the series and are frequently associated with an adjacent white splash on the darkly pigmented snout. By plotting the baleen length against the total length of the whale it is judged that weaning occurs when the calf is 8–9 m. in length.

The external characters of the southern Sei whales, like the body proportions, do not appear to differ materially from those of northern Atlantic or Pacific examples of the species.

The food of Sei whales at South Georgia is exclusively krill, *Euphausia superba*, but off the coasts of Africa smaller planktonic crustacea are sometimes taken. Nearly all the whales at South Georgia were feeding, but very few off South Africa.

The thickness of the blubber in Sei whales from South Africa is less than in those from South Georgia. This difference is more marked than in other species of whale that have been examined. The present species does not show the marked improvement in fatness towards the end of the season at South Georgia that is shown by larger species. Immature Sei whales of both sexes are constantly fatter than mature ones. Pregnant females are fatter and lactating ones thinner than the average.

Large external parasites are very uncommon on Sei whales. A few *Penella*, and a cirripede, only have been noted. *Balaenophilus* very commonly infests the baleen, as

does the protozoan *Haematophagus*. Diatom film was very rarely noted, but scrapings from the skin showed the frequent presence of several species of diatom and their spores in small numbers. Like other whales the species is subject in the warmer seas to attack by an unknown agent which cuts out ovoid pieces of blubber, leaving wounds which slowly heal.

A considerable list of internal parasites is recorded. Intestinal parasites were almost invariably present in the Sei whale, the commonest being two species of cestode.

The external and internal genitalia of both sexes are described. Histological material from the testis was examined in twenty-four males and the results indicate that there is no sexual season in the male, and that some males are fertile at all times of the year.

Dated records of foetal lengths show that the period of gestation is about 12 months, and that the young are born at a length of about 4·5 m. Lactation lasts about five months and weaning takes place when the calf is 8–9 m. in length.

The main part of the pairing season occurs from May to August with its peak in July. As the period of gestation is about 12 months the season of parturition is the same. A few pregnancies, however, start in other months of the year, showing that oestrus may occur outside the main breeding season, perhaps sometimes owing to the loss of calves.

The results of a detailed examination of the internal genitalia of a full series of Sei whales indicate that the species breeds once every two years, with a period of anoestrus of about 6 to 7 months between the end of lactation and the beginning of the next pregnancy.

The numbers of old corpora lutea in the ovaries indicate a polyoestrous sexual cycle, with an average of three dioestrous cycles of four ovulations at each cycle succeeding the first.

Sexual maturity is reached at an age of about 18 months, and breeding first occurs at the end of the second year after the birth of the whale. Fusion of the epiphyses of the vertebrae starts at an age of 4 to 5 years and is usually complete at an age of 10 to 11 years, when physical maturity is reached. The oldest whale of the present series was aged about 15 years.

Logarithmic plotting of the mean values of body measurements against total length of whale does not show the marked concentration of growth in the head region that is found in other species. The relative growth rates of various parts of the body show on the whole a simple relationship to the total length, but the growth is much more evenly distributed throughout the body than in some other species. The absence of the disproportionate growth of the anterior end, seen in larger whales, is probably correlated with the small size of the species and the lower food requirement.

The migrations of the Sei whale consist of a feeding migration to the south in the southern summer and a breeding migration towards the north in the winter. Parturition and pairing occur mainly in tropical and sub-tropical waters. Lactation is mainly finished by the time the whales arrive on their southern feeding grounds. Pregnant whales are the first to arrive at and leave the southern grounds, and are followed by whales in anoestrus. The neighbourhood of South Georgia represents the approximate southern range of the migration, and individual whales do not usually stop there for more than one month. Sei whales occur in greatest abundance in South Georgian waters when the sea temperature is at its highest. Accounts of the sudden appearance of large numbers of Sei whales on grounds where they were formerly scarce are mentioned, but there is some doubt as to the accuracy of the observations on which such statements are based.

The Sei whale has not yet been of much economic importance on most of the world's whaling grounds, particularly in the Antarctic. But it is suggested that when the serious diminution in numbers of the larger and more profitable species, which appears to be imminent, arrives, this species will suffer considerably and will be in danger of being reduced to a very small remnant in a short time.

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APPENDIX

MEASUREMENTS OF BODY PROPORTIONS OF THE SEI WHALES EXAMINED IN SOUTH GEORGIA AND SOUTH AFRICA

All measurements are in metres

Date	Whale no.	Sex	1 Total length, tip of snout to notch of flukes	2 Projection of lower jaw beyond tip of snout	3 Tip of snout to blow-hole	4 Tip of snout to angle of gape	5 Tip of snout to centre of eye	6 Tip of snout to tip of flipper	7 Centre of eye to centre of ear	8 Notch of flukes to posterior emargination of dorsal fin	9 Width of flukes at insertion	10 Notch of flukes to centre of anus	11 Notch of flukes to umbilicus
29. vii. 26	D 16	♂	12·45	—	1·95	2·35	2·40	5·10	0·68	3·70	0·65	3·30	7·70
28. vii. 26	905	♂	15·20	—	2·55	—	3·10	—	—	—	0·92	—	8·90
17. viii. 26	958	♂	13·35	—	2·15	2·49	2·50	5·50	0·69	4·15	0·80	3·70	6·45
27. ix. 26	1143	♂	15·00	—	2·45	2·80	2·86	6·15	0·76	4·65	0·91	4·20	7·33
27. ix. 26	1145	♂	13·30	—	2·15	2·50	2·57	5·55	0·74	4·40	0·78	3·50	6·30
5. iii. 27	1556	♂	14·45	—	2·25	2·53	2·73	5·80	0·73	4·53	0·85	3·97	6·97
29. iii. 27	1601	♂	15·80	—	—	—	2·80	4·80	0·77	5·00	—	4·15	7·40
31. iii. 27	1617	♂	15·50	—	—	—	2·95	4·95	0·90	4·60	—	4·20	7·50
31. iii. 27	1619	♂	14·95	—	—	—	3·00	4·75	0·80	4·57	—	3·95	7·20
31. iii. 27	1620	♂	14·60	—	—	—	2·90	4·75	0·82	4·60	—	4·00	6·85
1. iv. 27	1621	♂	14·00	—	—	—	2·70	4·65	—	3·50	—	3·90	6·95
5. iv. 27	1625	♂	12·60	—	2·00	—	2·45	4·20	0·66	3·75	0·77	3·45	6·30
6. iv. 27	1630	♂	14·90	—	—	—	2·90	—	0·77	4·42	—	4·07	7·20
8. iv. 27	1634	♂	13·00	—	—	—	2·78	4·30	0·71	4·20	—	3·60	6·20
9. iv. 27	1640	♂	15·10	—	—	—	2·85	5·00	0·70	4·50	—	4·15	7·45
23. iv. 27	1673	♂	13·15	—	2·00	—	2·45	4·00	0·65	4·00	0·80	3·60	6·40
25. iv. 27	1678	♂	14·80	—	2·30	—	2·75	4·70	0·82	4·66	—	3·90	7·40
25. iv. 27	1679	♂	13·70	—	2·05	—	2·55	4·25	0·70	4·25	—	3·73	6·90
26. iv. 27	1681	♂	15·45	—	—	—	2·85	4·65	—	—	—	4·05	7·30
14. iii. 28	1734	♂	14·75	—	2·35	2·97	2·82	5·90	0·70	4·38	0·85	3·95	7·24
14. iii. 28	1736	♂	14·55	—	2·42	2·84	2·82	5·70	—	4·25	0·86	3·94	7·07
14. iii. 28	1737	♂	14·55	—	2·48	3·04	2·97	5·94	0·80	4·52	0·86	4·00	7·39
14. iii. 28	1738	♂	15·37	—	2·59	2·97	3·09	6·58	0·75	4·67	0·94	4·25	7·43
26. iii. 28	H 1	♂	15·27	0·25	2·55	2·93	2·89	—	0·80	4·32	—	4·00	—
27. iii. 28	1750	♂	14·42	—	2·33	2·67	2·79	5·76	0·83	4·38	0·85	3·75	7·46
16. iv. 28	1763	♂	15·05	—	2·50	3·06	3·03	6·08	0·77	4·62	0·89	4·00	7·17
11. ii. 29	2327	♂	15·22	—	2·68	3·19	3·17	6·30	0·79	4·61	0·93	3·91	6·50
16. ii. 29	2356	♂	13·67	—	2·26	2·66	2·63	5·39	0·73	4·11	0·87	3·84	6·80
18. ii. 29	2363	♂	14·83	—	2·95	2·98	3·03	6·14	0·75	4·48	0·93	4·13	7·12
19. ii. 29	2373	♂	13·29	—	2·20	2·57	2·60	5·45	0·74	4·18	0·77	3·59	6·42
26. ii. 29	2408	♂	13·78	—	2·30	2·71	2·81	5·72	0·74	4·23	0·86	3·61	6·62
19. iii. 29	2470	♂	13·76	—	2·25	2·78	2·75	5·89	0·75	4·18	0·83	3·86	6·69
23. iii. 29	2498	♂	13·74	—	2·22	2·68	2·75	5·70	0·72	4·00	0·91	3·65	6·60
27. iii. 29	2517	♂	14·04	—	2·30	2·50	2·62	—	0·70	4·47	0·86	3·87	6·76
1. iv. 29	2532	♂	14·04	—	2·22	2·57	2·62	5·40	0·75	4·34	0·78	3·56	6·56
5. iv. 29	2536	♂	13·91	—	2·12	2·63	2·64	5·74	0·74	4·49	0·81	3·87	6·66
5. iv. 29	2540	♂	15·95	—	2·35	2·89	2·92	6·29	0·79	4·67	0·92	4·47	7·95
17. ii. 30	3145	♂	14·05	—	2·23	2·68	2·72	—	0·70	4·52	0·84	3·88	6·83
5. iii. 30	3182	♂	14·77	—	2·28	2·72	2·79	—	0·78	4·72	0·87	4·11	7·16
12. iii. 30	3208	♂	14·60	—	2·35	2·78	2·76	—	0·74	—	0·92	4·38	7·17
14. iii. 30	3216	♂	14·10	—	2·17	—	2·72	—	0·79	4·70	0·82	3·96	7·05
14. iii. 30	3217	♂	14·80	—	2·53	2·95	3·20	—	7·50	4·35	0·85	4·10	7·25
17. iii. 30	3225	♂	15·10	—	2·52	2·94	3·00	—	—	5·50	0·90	4·05	7·05
1. iv. 30	3257	♂	14·55	—	2·40	2·80	2·86	—	—	—	0·90	3·95	7·20
1. iv. 30	3261	♂	11·97	—	1·36	2·36	2·25	3·87	0·65	3·63	0·74	3·23	5·86
3. iv. 30	3262	♂	14·15	—	2·22	2·67	2·75	4·60	0·70	—	0·83	3·93	7·13
10. iv. 30	3270	♂	14·42	—	2·44	—	2·78	—	—	4·22	0·94	4·00	7·10
15. iv. 30	3271	♂	14·55	—	2·45	2·77	2·84	4·80	0·74	4·22	0·81	4·00	7·10
15. iv. 30	3272	♂	16·15	—	2·64	—	3·05	—	0·81	5·15	0·92	4·65	8·00
17. iv. 30	3273	♂	14·80	—	2·12	2·68	2·75	4·87	0·78	4·66	0·83	4·12	7·10
19. iv. 30	3275	♂	14·60	—	2·47	2·75	2·95	—	0·85	4·47	0·89	3·83	6·80
10. vi. 30	D 10	♂	12·20	—	2·35	2·30	2·30	—	—	—	0·76	3·10	5·60
24. vi. 30	D 40	♂	11·30	—	1·75	2·20	2·15	4·70	0·65	3·60	0·75	3·28	5·65
12. vii. 30	D 74	♂	12·50	—	2·00	—	2·43	—	0·70	3·98	0·76	3·55	6·20
1. viii. 30	D 112	♂	12·30	—	2·00	2·40	2·45	5·35	—	3·55	0·75	3·10	5·75
3. viii. 30	D 119	♂	14·30	—	2·25	—	2·80	—	—	—	0·85	3·87	6·60
15. viii. 30	D 140	♂	15·25	—	—	—	3·83	—	—	—	—	4·12	—
9. ii. 31	3619	♂	14·62	—	2·40	2·87	2·93	5·84	0·76	4·57	0·86	4·07	7·12
10. ii. 31	3620	♂	14·82	—	2·62	2·74	2·77	—	0·92	—	—	4·05	7·04
10. ii. 31	3623	♂	14·80	—	2·53	2·90	3·00	6·05	0·70	4·50	0·85	4·10	7·30
10. ii. 31	3629	♂	13·75	—	2·17	2·58	2·65	5·65	—	4·28	0·85	3·77	6·64
18. ii. 31	3673	♂	14·85	—	2·37	2·78	2·78	5·88	0·85	4·71	0·84	4·17	7·21

12	13	14	15	16	17	18	19	20	21	22	23	24	
Notch of flukes to end of system of ventral grooves	Centre of anus to centre of reproductive aperture	Vertical height of dorsal fin	Length of base of dorsal fin	Axilla to tip of flipper	Anterior end of lower border to tip of flipper	Length of flipper along curve of lower border	Greatest width of flipper	Length of severed head from condyle to tip	Greatest width of skull	Skull length, condyle to tip of premaxilla	Length of flipper from head of humerus to tip	Depth of tail at dorsal fin	Locality
6·60	0·85	0·40	0·70	1·00	1·15	1·49	0·32	2·80	1·30	—	—	1·30	Durban
—	—	0·57	0·95	1·39	1·80	1·87	0·40	—	—	—	—	—	Saldanha Bay
6·75	1·00	0·48	0·95	1·26	1·49	1·51	0·37	—	—	—	—	1·34	,,
8·35	1·00	0·50	0·98	1·35	1·82	1·84	—	3·48	1·40	—	—	1·55	,,
7·40	0·90	0·49	1·00	1·18	1·57	1·58	0·37	—	—	—	—	1·40	,,
7·85	1·03	0·59	0·90	1·23	—	—	—	—	—	—	—	—	South Georgia
—	1·05	0·53	—	1·22	—	—	—	3·48	1·55	—	—	—	,,
7·87	1·20	0·55	—	—	—	—	0·43	3·52	1·50	—	—	—	,,
8·30	1·20	0·52	—	—	—	—	—	—	—	—	—	—	,,
7·50	1·07	0·54	—	1·40	—	—	—	—	—	—	—	—	,,
—	1·10	—	—	1·27	—	—	0·36	3·20	1·33	—	—	—	,,
—	0·60	0·46	—	1·18	—	—	0·33	3·05	1·30	—	—	—	,,
8·07	0·98	0·50	—	—	—	—	—	—	—	—	—	—	,,
7·00	1·00	0·51	—	1·40	—	—	0·37	3·34	1·66	—	—	—	,,
8·30	1·10	0·70	—	1·35	—	—	0·40	3·60	1·64	—	—	—	,,
7·50	0·90	0·50	—	1·50	—	—	0·37	3·10	1·30	—	—	1·90	,,
—	0·90	0·64	—	1·57	—	—	0·40	3·35	1·55	—	—	—	,,
—	0·72	0·40	—	1·20	—	—	0·35	3·20	1·40	—	—	—	,,
—	0·82	—	—	1·23	—	—	0·40	3·55	1·60	—	—	—	,,
8·17	1·08	0·55	1·19	1·20	1·70	1·73	0·37	3·58	1·55	—	—	—	,,
8·10	1·10	0·53	0·80	—	—	—	—	3·59	1·63	—	—	—	,,
8·31	1·05	—	1·00	—	1·67	1·69	0·39	3·61	1·61	—	1·94	—	,,
8·73	1·07	0·60	1·05	1·35	1·84	1·86	0·40	3·75	—	—	—	—	,,
8·55	0·85	0·42	0·65	—	—	—	—	3·56	1·70	—	—	—	,,
8·19	1·05	0·48	0·68	1·10	1·76	1·82	0·41	3·47	—	—	—	—	,,
8·15	1·00	0·55	0·75	1·20	1·74	1·76	0·40	3·69	—	—	1·98	—	,,
7·98	0·92	—	1·17	1·33	1·92	1·97	0·42	3·85	1·75	—	—	—	,,
7·92	1·03	0·50	1·04	1·22	1·64	1·65	0·36	3·29	1·51	—	—	—	,,
8·10	1·11	0·46	0·80	1·43	1·93	1·98	0·43	3·78	1·60	—	—	—	,,
7·20	0·96	0·51	0·79	1·14	1·70	1·72	0·37	3·25	1·52	—	—	—	,,
7·99	1·12	0·55	0·95	1·22	1·80	1·81	0·39	—	—	—	—	—	,,
7·75	1·07	0·70	1·10	1·25	1·78	1·80	0·39	3·36	1·54	—	—	—	,,
7·35	0·95	0·54	0·92	1·29	1·83	1·90	0·49	—	—	—	—	—	,,
7·69	1·02	0·50	0·85	—	1·62	1·64	0·33	3·10	1·34	—	—	—	,,
7·72	1·05	0·45	0·90	1·22	1·60	1·65	0·43	3·26	1·47	—	—	—	,,
7·63	1·05	0·54	0·97	1·27	1·72	1·74	0·34	3·32	1·42	—	—	—	,,
9·21	1·13	0·51	0·90	1·45	1·95	2·00	0·40	3·54	1·53	—	—	—	,,
7·70	1·07	0·45	0·94	—	—	—	—	—	—	—	—	—	,,
8·15	1·15	0·59	0·99	—	—	—	—	3·49	1·52	—	—	—	,,
—	0·88	—	—	1·58	1·78	1·82	0·40	3·43	1·53	—	—	2·13	,,
7·90	1·00	0·58	0·95	—	—	—	—	3·15	1·52	—	—	2·10	,,
8·30	1·00	0·57	1·10	—	—	—	—	3·66	1·80	—	—	2·05	,,
7·80	1·10	0·50	0·95	—	—	—	—	3·68	1·70	—	—	—	,,
—	—	0·50	0·80	—	—	—	—	3·45	1·59	—	—	1·51	,,
6·74	1·00	0·35	0·70	—	—	—	—	2·90	1·32	—	—	—	,,
—	—	0·50	0·80	—	—	—	—	—	—	—	—	—	,,
7·90	1·00	—	—	—	—	—	—	3·62	1·38	—	—	1·90	,,
7·85	1·00	0·52	0·96	—	—	—	—	3·46	1·60	—	—	2·00	,,
8·88	1·10	0·80	0·85	—	—	—	—	3·77	1·74	—	—	2·00	,,
8·00	1·14	0·60	1·10	1·74	1·82	1·23	0·38	3·35	1·60	—	—	2·05	,,
7·85	1·06	0·47	0·80	—	—	—	—	3·67	—	—	—	—	,,
—	0·60	—	—	1·00	—	1·50	0·50	—	—	—	—	—	Durban
6·30	0·85	0·45	0·70	0·95	1·45	1·27	0·31	2·80	1·17	—	—	1·25	,,
7·00	0·90	0·44	1·10	1·60	1·49	—	0·30	2·96	—	—	—	—	,,
6·75	0·85	0·40	0·90	1·10	1·62	—	0·33	—	—	—	—	—	,,
—	0·75	—	—	1·20	1·65	—	0·35	3·40	1·50	—	—	—	,,
—	—	—	—	—	—	—	—	—	—	—	—	—	,,
8·10	1·05	0·63	1·17	1·37	1·53	—	0·38	3·62	1·97	—	—	1·72	South Georgia
—	—	—	—	1·27	1·75	—	0·35	3·53	1·67	—	—	—	,,
8·42	0·92	0·56	0·90	1·35	1·64	—	0·38	3·62	1·65	—	—	—	,,
7·48	1·00	0·55	1·00	1·26	1·68	—	0·37	3·26	1·42	—	—	—	,,
8·03	1·03	0·48	0·95	1·33	1·69	—	0·37	—	1·43	—	—	—	,,

Date	Whale no.	Sex	1 Total length, tip of snout to notch of flukes	2 Projection of lower jaw beyond tip of snout	3 Tip of snout to blow-hole	4 Tip of snout to angle of gape	5 Tip of snout to centre of eye	6 Tip of snout to tip of flipper	7 Centre of eye to centre of ear	8 Notch of flukes to posterior emargination of dorsal fin	9 Width of flukes at insertion	10 Notch of flukes to centre of anus	11 Notch of flukes to umbilicus
27. ii. 31	3684	♂	15·18	—	—	—	3·00	—	—	—	—	4·10	—
5. iii. 31	3691	♂	15·55	—	2·60	3·00	3·04	6·30	0·78	4·67	0·88	4·22	7·40
12. iii. 31	3695	♂	13·87	—	2·15	2·55	2·62	—	0·70	—	0·84	3·79	6·98
10. viii. 26	931	[illegible]	12·23	—	1·96	—	2·35	4·94	0·68	—	0·70	3·46	5·93
13. viii. 26	939	[illegible]	11·55	0·10	1·66	2·08	2·17	4·60	0·64	3·68	0·70	3·33	5·77
15. viii. 26	947	[illegible]	12·15	—	2·04	2·40	2·42	5·10	0·67	3·80	0·79	3·37	5·70
16. viii. 26	951	[illegible]	14·90	—	2·65	3·00	3·07	6·50	0·80	—	0·93	4·00	—
16. viii. 26	952	♀	10·45	—	1·72	2·03	2·09	—	0·59	3·20	0·67	3·00	5·17
7. ix. 26	1074	[illegible]	16·30	—	2·77	—	3·25	—	0·90	5·00	0·88	4·25	7·55
3. x. 26	1164	[illegible]	13·35	—	2·20	2·67	2·73	5·50	0·78	4·15	0·80	3·65	6·35
22. ii. 27	1492	♀	15·90	—	2·85	—	3·40	6·30	0·73	4·60	0·90	4·20	7·50
24. ii. 27	1499	[illegible]	16·20	—	2·70	—	3·35	6·80	0·87	5·10	0·96	4·70	8·70
25. ii. 27	1507	[illegible]	15·20	—	2·55	2·98	3·05	—	0·86	—	0·89	4·26	7·12
27. ii. 27	1518	[illegible]	16·10	—	2·70	3·10	3·18	6·75	0·86	4·80	0·90	4·25	6·70
28. ii. 27	1523	[illegible]	16·00	—	2·55	—	3·15	—	0·85	5·00	1·05	4·50	7·90
28. ii. 27	1524	♀	15·70	—	2·60	—	3·20	6·30	0·83	4·75	0·90	4·15	7·70
1. iii. 27	1526	♀	17·10	—	2·90	—	3·40	7·05	0·84	5·15	0·97	4·70	8·00
3. iii. 27	1530	[illegible]	15·75	—	2·65	3·04	3·14	6·45	0·84	4·90	1·04	4·33	7·50
3. iii. 27	1535	♀	15·75	—	2·62	3·07	3·14	—	0·88	5·05	0·94	4·20	7·35
5. iii. 27	1555	♀	16·40	—	2·80	—	3·42	—	0·82	4·90	0·97	4·40	7·50
7. iii. 27	1559	♀	16·80	—	2·80	—	3·53	7·35	0·83	4·90	0·93	4·39	7·80
9. iii. 27	1560	[illegible]	16·10	—	—	—	3·30	6·72	0·89	—	0·90	4·13	7·03
12. iii. 27	1567	♀	16·00	—	2·60	—	3·20	—	0·88	4·90	—	4·50	7·85
12. iii. 27	1572	♀	15·60	—	2·60	—	—	—	0·86	4·30	—	4·10	7·38
13. iii. 27	1575	♀	15·90	—	—	—	—	—	0·90	—	—	4·35	7·75
13. iii. 27	1577	♀	16·63	—	2·96	—	—	—	0·89	5·26	0·95	4·55	7·95
16. iii. 27	1578	♀	15·95	—	2·70	—	—	—	0·86	4·80	0·90	4·10	7·60
16. iii. 27	1579	♀	16·30	—	2·60	—	—	—	—	—	0·96	4·30	7·55
16. iii. 27	1581	♀	16·65	—	2·80	—	—	—	0·80	5·00	0·97	4·40	7·90
16. iii. 27	1582	♀	16·50	—	2·65	—	—	—	0·88	5·00	—	4·50	7·60
29. iii. 27	1599	[illegible]	15·55	—	—	—	3·05	—	0·85	—	—	4·15	7·50
29. iii. 27	1602	♀	15·05	—	—	—	2·90	—	0·77	4·20	—	3·90	7·38
29. iii. 27	1604	♀	16·07	—	—	—	3·20	—	0·90	4·80	—	4·25	0·77
30. iii. 27	1607	♀	16·55	—	—	—	3·45	—	0·91	—	—	4·35	7·40
30. iii. 27	1608	♀	16·35	—	2·30	—	3·10	—	0·85	5·20	—	4·39	7·60
31. iii. 27	1610	♀	15·56	—	—	—	3·00	—	—	—	—	4·20	7·30
31. iii. 27	1611	[illegible]	15·90	—	—	—	3·15	—	0·84	4·57	—	3·90	7·55
31. iii. 27	1612	♀	15·60	—	—	—	3·13	—	0·84	4·50	—	4·10	6·90
31. iii. 27	1613	♀	14·85	—	—	—	2·97	—	0·84	4·65	—	3·95	7·20
31. iii. 27	1614	♀	15·50	—	—	—	3·10	—	0·87	4·60	—	4·20	7·50
31. iii. 27	1615	♀	15·30	—	—	—	3·25	—	0·85	—	—	4·20	7·30
31. iii. 27	1616	♀	15·62	—	—	—	3·32	—	—	—	—	4·15	6·95
31. iii. 27	1618	♀	16·05	—	—	—	3·15	—	0·87	4·90	—	4·15	7·70
1. iv. 27	1622	♀	15·80	—	—	—	3·28	—	0·90	4·60	—	4·15	7·55
5. iv. 27	1624	♀	16·20	—	—	—	3·25	—	—	4·55	—	4·10	—
8. iv. 27	1633	♀	15·75	—	—	—	3·15	—	0·80	4·82	—	4·30	7·15
8. iv. 27	1635	♀	15·77	—	—	—	3·02	—	0·78	4·90	—	4·20	7·70
8. iv. 27	1636	♀	16·20	—	—	—	3·22	—	0·87	—	—	4·30	7·70
9. iv. 27	1637	♀	13·60	—	—	—	2·60	—	0·76	—	—	3·68	6·35
9. iv. 27	1639	♀	16·80	—	—	—	3·30	—	0·90	5·00	—	4·70	8·40
19. iv. 27	1658	[illegible]	15·60	—	—	—	3·45	—	0·97	—	—	4·20	7·40
22. iv. 27	1667	[illegible]	14·25	—	—	—	2·95	4·95	—	—	—	3·75	—
22. iv. 27	1671	♀	16·25	—	—	—	3·22	—	—	4·97	—	4·30	7·80
25. iv. 27	1675	♀	15·90	—	2·35	—	2·88	—	—	—	—	4·45	7·70
25. iv. 27	1676	[illegible]	15·95	—	2·35	—	2·90	—	0·80	4·00	—	3·85	6·80
25. iv. 27	1677	[illegible]	15·30	—	2·50	—	3·10	—	0·72	4·70	—	3·95	7·35
26. iv. 27	1682	[illegible]	16·30	—	—	—	3·38	—	0·90	4·83	—	4·15	7·60
26. iv. 27	1683	♀	16·00	—	—	—	3·20	—	0·88	5·00	—	4·30	7·60
14. iii. 28	1735	♀	14·60	—	2·32	2·95	2·88	5·98	0·76	4·35	0·78	4·02	7·20
22. iii. 28	1742	♀	16·37	—	2·92	3·28	3·23	7·09	0·87	4·83	0·95	4·47	8·04
25. iii. 28	1744	♀	16·00	—	2·60	2·80	3·00	6·24	0·83	4·75	0·93	4·45	7·88

12	13	14	15	16	17	18	19	20	21	22	23	24	
Notch of flukes to end of system of ventral grooves	Centre of anus to centre of reproductive aperture	Vertical height of dorsal fin	Length of base of dorsal fin	Axilla to tip of flipper	Anterior end of lower border to tip of flipper	Length of flipper along curve of lower border	Greatest width of flipper	Length of severed head from condyle to tip	Greatest width of skull	Skull length, condyle to tip of premaxilla	Length of flipper from head of humerus to tip	Depth of tail at dorsal fin	Locality
—	—	—	—	—	—	—	—	3·76	—	—	—	—	South Georgia
8·67	1·05	0·68	—	1·34	1·85	—	0·40	3·81	1·83	—	—	—	,,
—	1·05	0·47	1·00	—	—	—	—	3·28	1·68	—	—	—	,,
—	0·34	0·45	0·65	1·04	1·40	1·46	0·33	—	—	—	—	—	Saldanha Bay
6·70	0·27	0·49	0·83	1·03	1·37	1·44	0·32	2·65	1·10	2·59	—	1·30	,,
6·30	0·33	0·50	0·95	1·05	1·50	1·57	0·31	2·94	1·22	2·89	—	1·45	,,
—	0·34	0·50	0·75	1·43	1·86	1·94	0·44	3·70	1·42	—	—	—	,,
5·63	0·27	0·44	0·90	1·05	1·35	1·39	0·30	2·55	—	—	—	1·35	,,
8·90	0·45	0·51	0·95	—	1·80	1·83	0·42	3·95	1·52	—	—	1·80	,,
7·45	0·35	0·49	1·00	1·15	1·60	1·61	0·35	3·40	1·36	3·32	—	1·53	,,
8·60	0·45	0·43	1·50	1·25	1·60	1·65	0·40	4·20	1·60	—	—	—	South Georgia
8·70	0·35	0·50	1·10	1·40	2·02	2·04	0·41	3·97	1·70	—	—	—	,,
7·65	0·34	—	—	1·37	1·75	1·81	0·40	3·82	—	—	—	—	,,
8·30	0·40	0·52	0·90	1·42	1·95	2·04	0·41	3·93	1·65	—	—	1·70	,,
8·60	0·40	—	1·10	1·28	1·74	2·79	0·43	3·65	1·75	—	—	2·20	,,
8·40	0·45	0·56	1·05	—	—	—	—	3·75	1·73	—	—	—	,,
8·90	0·45	0·63	1·15	1·38	1·96	2·04	0·42	4·10	1·70	—	—	—	,,
8·40	0·50	0·75	0·90	1·39	1·89	1·91	0·39	3·84	1·58	—	—	—	,,
8·20	0·45	0·68	1·10	—	—	—	—	3·90	1·75	—	—	—	,,
8·65	0·50	0·62	1·05	—	—	—	—	—	1·80	—	—	—	,,
8·90	0·47	—	1·0	1·70	2·20	2·28	—	4·13	1·90	—	—	—	,,
—	0·37	—	—	1·32	1·84	1·86	0·45	3·98	1·67	—	—	—	,,
—	0·40	0·82	—	1·35	—	—	0·45	3·85	1·75	—	—	—	,,
—	0·40	0·63	—	1·35	—	—	0·46	3·80	1·70	—	—	—	,,
—	0·40	—	—	—	1·73	1·75	0·43	—	—	—	—	—	,,
9·00	0·45	0·62	0·95	1·30	—	—	—	—	—	—	—	—	,,
8·80	0·50	0·60	1·05	—	—	—	—	—	—	—	—	1·95	,,
—	0·40	—	—	—	—	—	—	3·76	1·80	—	—	—	,,
9·20	0·45	0·54	0·90	—	—	—	—	4·15	1·70	—	—	1·80	,,
8·95	0·40	0·50	1·10	—	—	—	—	3·95	1·80	—	—	—	,,
—	0·30	—	—	1·30	—	—	—	3·70	1·75	—	—	—	,,
7·90	0·40	0·48	—	1·27	—	—	—	3·67	1·60	—	—	—	,,
8·75	0·55	0·50	—	1·40	—	—	—	—	—	—	—	—	,,
—	0·30	—	—	1·45	—	—	0·40	4·30	1·75	—	—	—	,,
8·80	0·50	0·60	—	1·40	—	—	0·42	3·80	1·70	—	—	—	,,
—	0·40	—	—	1·30	—	—	0·41	3·60	1·50	—	—	—	,,
8·30	0·40	0·53	—	1·50	—	—	0·44	—	1·60	—	—	—	,,
8·15	0·35	0·69	—	1·40	—	—	—	3·80	1·47	—	—	—	,,
8·18	0·40	0·57	—	1·30	—	—	0·40	3·65	1·58	—	—	—	,,
8·60	0·30	0·48	—	1·28	—	—	0·39	3·80	1·63	—	—	—	,,
—	0·35	—	—	—	—	—	0·42	3·85	1·68	—	—	—	,,
8·35	0·48	0·52	—	1·44	—	—	0·41	3·95	1·67	—	—	—	,,
9·00	0·43	0·52	—	1·50	—	—	0·44	3·87	1·70	—	—	—	,,
8·50	0·40	0·55	—	1·50	—	—	0·46	4·05	1·75	—	—	—	,,
—	0·45	0·50	—	1·35	—	—	0·42	4·10	1·60	—	—	—	,,
—	0·47	—	—	1·44	—	—	0·42	3·82	1·60	—	—	—	,,
9·10	0·45	—	—	1·31	—	—	0·42	3·77	1·53	—	—	—	,,
9·10	0·50	—	—	—	—	—	0·41	—	—	—	—	—	,,
—	0·47	—	—	1·27	—	—	0·34	3·20	1·45	—	—	—	,,
—	0·50	0·60	—	1·35	—	—	0·42	4·10	1·60	—	—	—	,,
—	0·45	—	—	1·75	—	—	0·45	4·30	1·80	—	—	—	,,
—	0·30	—	—	—	—	—	—	3·35	1·45	—	—	—	,,
—	0·55	0·53	—	1·25	—	—	—	—	—	—	—	—	,,
—	0·35	—	—	—	—	—	—	3·55	1·50	—	—	—	,,
7·50	0·40	0·48	—	—	—	—	0·36	3·55	1·50	—	—	1·65	,,
8·20	0·35	0·60	—	1·25	—	—	0·40	3·85	1·60	—	—	—	,,
—	0·45	0·55	—	—	—	—	—	4·18	1·65	—	—	—	,,
—	0·45	0·53	—	1·36	—	—	—	—	—	—	—	—	,,
7·46	0·5	0·52	0·85	—	—	—	—	3·49	1·50	—	—	—	,,
9·17	0·40	0·56	1·00	1·56	—	2·56	—	4·16	—	—	—	—	,,
8·72	0·48	0·53	0·70	—	—	—	—	—	—	—	—	—	,,

Date	Whale no.	Sex	1 Total length, tip of snout to notch of flukes	2 Projection of lower jaw beyond tip of snout	3 Tip of snout to blow-hole	4 Tip of snout to angle of gape	5 Tip of snout to centre of eye	6 Tip of snout to tip of flipper	7 Centre of eye to centre of ear	8 Notch of flukes to posterior emargination of dorsal fin	9 Width of flukes at insertion	10 Notch of flukes to centre of anus	11 Notch of flukes to umbilicus
25. iii. 28	1746		15·56	—	2·82	3·23	3·20	6·46	0·82	4·53	0·82	3·95	6·92
26. iii. 28	H 2		15·33	0·03	2·47	2·81	2·95	6·40	0·92	4·50	—	3·25	—
27. iii. 28	1749		16·26	—	2·73	3·26	3·33	6·85	0·88	4·77	0·95	4·34	7·62
27. iii. 28	1751		16·34	—	—	—	—	—	—	—	—	—	—
28. iii. 28	1754		15·63	—	2·55	3·04	3·07	—	0·80	4·80	0·93	3·98	7·40
31. iii. 28	H 8		15·58	0·17	2·70	3·16	3·21	6·44	0·85	4·50	—	4·05	7·23
4. ii. 29	2295	[illegible]	14·37	—	2·26	2·70	2·78	6·05	0·78	4·66	0·86	3·85	6·95
7. ii. 29	2307	[illegible]	16·84	—	2·95	3·45	3·53	6·98	0·92	4·91	1·00	4·46	7·84
9. ii. 29	2318	[illegible]	15·86	—	2·68	3·25	3·19	6·62	0·80	4·81	0·92	4·54	7·50
9. ii. 29	2319	[illegible]	15·53	—	2·70	3·34	3·33	6·73	0·82	4·71	0·93	4·12	7·33
14. ii. 29	2343	[illegible]	16·20	—	2·61	3·10	3·13	—	0·87	5·09	0·96	4·47	7·60
15. ii. 29	2345	[illegible]	16·31	—	2·73	3·38	3·24	6·25	0·83	4·95	0·95	4·60	8·00
15. ii. 29	2351	[illegible]	15·45	—	2·50	2·90	2·87	—	0·77	4·61	0·97	4·33	7·42
15. ii. 29	2352	[illegible]	16·78	—	2·79	3·36	3·31	6·62	0·86	5·05	1·10	4·42	7·62
16. ii. 29	2353	[illegible]	15·83	—	2·72	3·31	3·37	6·81	0·83	4·67	0·92	4·18	7·52
16. ii. 29	2354	[illegible]	15·95	—	2·62	3·16	3·26	6·57	0·85	4·77	0·91	4·25	7·42
18. ii. 29	2357	[illegible]	13·75	—	2·35	—	2·73	5·64	0·79	4·26	0·80	3·77	6·68
18. ii. 29	2358	[illegible]	14·38	—	2·70	2·85	2·71	5·75	0·77	4·50	0·88	4·09	6·95
18. ii. 29	2360	[illegible]	14·69	—	2·55	2·95	2·96	6·45	0·72	4·80	0·83	4·11	7·14
19. ii. 29	2370	[illegible]	16·29	—	2·75	3·10	3·23	6·60	0·83	5·13	0·96	4·52	8·03
19. ii. 29	2374	[illegible]	15·07	—	—	—	—	5·92	0·76	4·88	0·88	4·30	7·55
23. ii. 29	2387	[illegible]	15·98	—	2·74	3·12	3·20	6·50	0·80	5·01	0·99	4·19	7·52
25. ii. 29	2399	[illegible]	15·74	—	2·86	3·13	3·32	6·40	0·80	5·15	0·94	4·48	7·71
26. ii. 29	2405	[illegible]	16·35	—	2·64	3·12	3·23	6·79	0·90	5·02	0·97	4·39	7·73
26. ii. 29	2406	[illegible]	16·42	—	2·67	3·18	3·27	6·58	0·87	5·05	1·03	4·56	7·80
16. iii. 29	2464	[illegible]	13·53	—	2·19	2·69	2·66	3·75	0·75	4·13	0·77	3·75	6·42
17. iii. 29	2468	[illegible]	15·07	—	2·49	2·91	2·97	6·35	0·80	4·75	0·87	4·22	7·33
19. iii. 29	2474	[illegible]	15·84	—	2·55	2·98	3·00	6·24	0·84	4·75	0·82	4·27	7·45
22. iii. 29	2484	[illegible]	15·20	—	2·57	—	3·08	6·73	0·84	4·76	1·01	4·17	7·42
22. iii. 29	2485	[illegible]	16·10	—	2·75	3·35	3·38	6·95	0·79	4·85	0·95	4·50	7·72
22. iii. 29	2486	[illegible]	14·88	—	2·47	3·04	3·07	6·90	0·86	4·72	0·90	4·05	7·20
22. iii. 29	2487	[illegible]	16·50	—	2·72	3·26	3·30	6·96	0·85	4·88	1·00	4·42	8·0
22. iii. 29	2488	[illegible]	15·38	—	2·35	2·98	3·02	6·25	0·80	—	0·90	4·08	7·60
22. iii. 29	2490	[illegible]	15·22	—	2·67	3·08	3·23	5·90	—	4·43	0·88	3·91	7·03
23. iii. 29	2494	[illegible]	16·15	—	2·63	3·21	3·28	6·44	0·84	4·74	0·91	4·39	7·77
24. iii. 29	2505	[illegible]	17·08	—	2·85	3·42	3·52	7·25	0·88	5·15	1·02	4·59	8·23
24. iii. 29	2506	[illegible]	16·24	—	2·67	3·28	3·25	6·60	0·86	4·73	0·96	4·35	7·80
26. iii. 29	2510	[illegible]	16·20	—	2·72	3·17	3·23	6·65	0·90	5·10	0·97	4·44	7·64
27. iii. 29	2514	[illegible]	16·22	—	2·70	3·21	3·30	6·66	0·85	4·78	0·91	4·43	7·73
27. iii. 29	2516	[illegible]	16·15	—	2·86	3·42	3·50	7·06	0·83	4·97	0·93	4·21	7·75
27. iii. 29	2518	[illegible]	15·91	—	2·61	3·12	3·23	6·43	0·66	4·93	0·89	4·40	7·84
28. iii. 29	2520	[illegible]	16·57	—	2·65	3·20	3·17	7·00	0·79	5·16	0·92	4·68	8·26
28. iii. 29	2521	[illegible]	15·72	—	2·51	2·99	3·05	6·39	0·81	4·81	0·85	4·31	7·70
28. iii. 29	2522	[illegible]	14·52	—	2·36	2·81	2·85	5·95	0·80	4·31	0·82	3·78	6·79
28. iii. 29	2523	[illegible]	16·07	—	2·88	3·35	3·40	7·04	0·92	4·87	0·99	4·40	7·75
30. iii. 29	2526	[illegible]	16·93	—	2·79	3·29	3·34	7·17	0·84	5·11	1·04	4·55	7·91
30. iii. 29	2527	[illegible]	15·75	—	2·55	3·07	3·20	6·53	0·75	4·70	0·93	4·37	7·65
30. iii. 29	2528	[illegible]	15·26	—	2·40	2·94	3·04	5·89	0·80	4·59	0·85	4·32	7·45
30. iii. 29	2529	[illegible]	15·60	—	2·48	2·99	3·09	6·39	0·82	4·69	0·92	4·26	7·44
30. iii. 29	2530	[illegible]	14·87	—	2·35	2·90	2·89	6·20	0·80	4·68	0·92	4·11	7·19
1. iv. 29	2531	[illegible]	15·37	—	2·69	3·27	3·28	6·41	0·84	4·47	0·89	4·11	7·24
5. iv. 29	2541	[illegible]	16·18	—	2·83	3·32	3·44	7·04	—	4·90	0·97	4·22	7·57
5. iv. 29	2542	[illegible]	15·82	—	2·68	3·15	3·27	6·51	0·85	4·70	0·91	4·12	7·59
5. iv. 29	2543	[illegible]	15·65	—	2·52	3·04	3·09	6·07	0·79	4·83	0·93	4·26	7·48
6. iv. 29	2545	[illegible]	12·05	—	1·88	2·35	2·38	5·02	0·65	3·78	0·74	3·35	5·89
20. ii. 30	3157	[illegible]	15·33	—	2·64	3·00	3·00	—	0·76	4·80	0·80	4·30	7·57
21. ii. 30	3160	[illegible]	14·70	—	—	—	2·95	—	—	—	—	4·15	—
24. ii. 30	3161	[illegible]	15·92	—	2·65	3·45	3·23	—	0·79	4·70	0·92	4·34	7·70
25. ii. 30	3162	[illegible]	14·35	—	2·25	2·70	2·77	—	0·76	4·50	0·86	4·00	7·30
25. ii. 30	3163	[illegible]	14·45	—	2·20	2·67	2·70	—	0·73	4·60	0·93	4·00	7·00
25. ii. 30	3164	[illegible]	15·80	—	2·63	—	3·10	—	—	4·70	0·90	4·20	7·50
27. ii. 30	3168	[illegible]	16·20	—	2·92	—	3·32	—	0·78	5·10	1·00	4·50	—

12	13	14	15	16	17	18	19	20	21	22	23	24	
Notch of flukes to end of system of ventral grooves	Centre of anus to centre of reproductive aperture	Vertical height of dorsal fin	Length of base of dorsal fin	Axilla to tip of flipper	Anterior end of lower border to tip of flipper	Length of flipper along curve of lower border	Greatest width of flipper	Length of severed head from condyle to tip	Greatest width of skull	Skull length, condyle to tip of premaxilla	Length of flipper from head of humerus to tip	Depth of tail at dorsal fin	Locality
8·40	0·40	0·52	0·78	1·31	1·73	1·84	0·41	—	—	—	—	—	South Georgia
7·56	0·55	0·46	0·63	1·44	—	—	—	3·72	1·52	—	—	—	,,
—	0·45	0·59	1·10	1·55	2·04	2·06	0·38	4·14	—	—	—	—	,,
—	—	—	—	—	—	—	—	—	—	—	—	—	,,
8·60	0·46	0·50	0·90	—	—	—	—	3·75	—	—	—	—	,,
7·90	0·38	0·48	0·65	1·47	1·71	1·76	0·56	3·95	1·94	—	—	—	,,
7·86	0·38	0·62	1·20	1·32	1·81	1·83	0·40	3·44	1·54	—	—	—	,,
9·21	0·48	0·58	1·08	1·42	—	—	0·44	4·24	1·82	—	—	—	,,
8·32	0·42	0·51	0·94	1·40	1·85	1·87	0·42	3·98	1·70	—	—	—	,,
8·50	0·40	—	1·02	1·58	2·06	2·08	0·39	4·21	1·66	—	—	—	,,
8·70	0·45	0·50	1·05	—	—	—	—	3·89	1·76	—	—	—	,,
9·21	0·46	0·48	1·08	1·40	1·95	—	0·48	2·88	1·69	—	—	—	,,
8·27	0·48	0·52	1·04	—	1·98	—	0·47	—	—	—	—	—	,,
8·45	0·60	0·65	1·18	1·59	2·15	—	0·47	4·02	1·78	—	—	—	,,
8·68	0·43	0·68	1·22	1·37	1·88	1·95	0·44	4·01	1·73	—	—	—	,,
8·63	0·45	0·61	1·10	1·45	1·86	1·88	0·43	3·89	1·75	—	—	—	,,
7·50	0·37	0·46	1·05	1·21	1·74	1·75	0·43	3·53	1·40	—	—	—	,,
8·16	0·45	0·43	1·07	1·40	1·90	—	0·40	3·30	1·59	—	—	—	,,
7·96	0·47	0·38	1·02	1·41	1·92	1·95	0·45	3·62	1·68	—	—	—	,,
9·41	0·47	0·71	0·90	1·50	2·02	2·04	0·44	3·85	1·80	—	—	—	,,
8·46	0·45	0·55	0·78	1·14	1·83	1·90	0·39	3·25	1·60	—	—	—	,,
8·67	0·47	0·49	1·00	1·57	1·99	2·02	0·44	3·87	1·68	—	—	—	,,
8·89	0·47	0·52	1·25	1·58	2·07	2·11	0·45	3·88	1·84	—	—	—	,,
8·54	0·44	0·53	1·15	1·50	2·25	2·33	0·46	3·93	1·69	—	—	—	,,
9·25	0·43	0·52	1·00	1·45	2·10	2·12	0·44	3·90	1·62	—	—	—	,,
7·35	0·36	0·53	0·90	1·22	1·73	1·75	0·37	3·25	1·47	—	—	—	,,
8·53	0·50	0·55	1·00	1·35	2·07	2·11	0·44	3·69	1·58	—	—	—	,,
8·94	0·46	0·55	1·04	1·52	2·04	2·09	0·42	3·65	1·55	—	—	—	,,
8·30	0·48	0·56	0·99	1·37	1·83	1·97	0·43	3·75	1·68	—	—	—	,,
9·20	0·55	0·48	1·15	1·52	2·10	2·15	—	4·04	1·82	—	—	—	,,
8·24	0·45	0·59	1·30	1·32	1·75	1·78	0·45	3·72	1·51	—	—	—	,,
7·25	0·42	0·63	1·10	1·57	2·22	2·27	0·45	4·03	1·65	—	—	—	,,
—	0·42	—	0·97	1·40	1·86	1·88	0·38	—	—	—	—	—	,,
8·09	0·43	0·55	1·05	1·42	2·00	2·00	0·45	3·89	1·67	—	—	—	,,
8·89	0·41	0·59	1·05	1·40	2·06	2·09	0·42	—	—	—	—	—	,,
9·29	0·50	0·49	1·09	1·83	2·27	2·30	0·47	4·25	1·71	—	—	—	,,
9·04	0·45	0·43	0·98	1·52	2·16	2·18	0·48	4·02	1·55	—	—	—	,,
8·85	0·50	0·48	1·05	1·53	1·85	1·89	0·40	4·03	1·67	—	—	—	,,
8·71	0·45	0·62	1·16	1·43	1·98	2·03	0·42	3·82	1·59	—	—	—	,,
8·63	0·44	0·46	1·02	—	1·82	1·85	0·47	4·07	—	—	—	—	,,
9·06	0·52	0·58	0·93	—	—	—	—	—	—	—	—	—	,,
9·26	0·50	0·53	0·99	1·58	2·14	2·18	0·43	—	—	—	—	—	,,
8·62	0·42	0·47	0·92	1·45	1·92	2·05	0·42	3·71	1·63	—	—	—	,,
7·73	0·43	0·54	0·95	1·39	1·72	1·74	0·39	—	—	—	—	—	,,
8·76	0·49	0·62	1·30	1·50	2·08	2·10	0·45	4·15	1·77	—	—	—	,,
9·26	0·43	0·54	1·15	1·47	2·07	2·12	0·42	4·07	1·67	—	—	—	,,
8·61	0·48	0·56	1·02	1·59	2·07	2·14	0·42	3·85	1·55	—	—	—	,,
8·67	0·45	0·55	1·00	1·31	1·77	1·81	0·41	3·64	1·50	—	—	—	,,
8·70	0·42	0·56	0·99	1·26	1·81	1·83	0·39	3·66	1·52	—	—	—	,,
8·16	0·38	0·50	1·00	1·36	1·90	1·95	0·42	3·64	1·54	—	—	—	,,
8·39	0·47	0·60	1·25	1·47	1·95	1·97	0·43	3·80	1·74	—	—	—	,,
8·81	0·47	0·56	1·00	1·67	2·06	2·10	0·44	4·14	1·63	—	—	—	,,
8·62	0·43	0·49	0·79	—	1·99	2·06	—	3·94	1·66	—	—	—	,,
8·45	0·45	0·60	0·88	—	—	—	0·44	3·85	1·58	—	—	—	,,
6·91	0·35	0·50	0·76	1·09	1·47	1·47	0·32	2·95	1·29	—	—	—	,,
8·60	0·34	0·55	0·85	1·00	1·86	1·88	0·36	3·80	1·64	—	—	—	,,
—	—	—	—	—	—	—	—	—	—	—	—	—	,,
8·40	0·45	0·70	1·00	1·60	1·93	—	0·43	4·00	1·65	—	—	2·65	,,
8·15	0·44	0·54	1·00	1·42	1·76	—	0·39	3·38	1·60	—	—	1·72	,,
7·70	0·35	0·60	1·10	1·30	1·60	—	0·37	3·47	1·62	—	—	1·85	,,
8·25	0·45	0·50	0·90	1·42	1·95	—	0·41	3·98	1·75	—	—	—	,,
8·90	0·43	0·55	1·20	—	—	—	—	—	—	—	—	—	,,

			1	2	3	4	5	6	7	8	9	10	11
Date	Whale no.	Sex	Total length, tip of snout to notch of flukes	Projection of lower jaw beyond tip of snout	Tip of snout to blow-hole	Tip of snout to angle of gape	Tip of snout to centre of eye	Tip of snout to tip of flipper	Centre of eye to centre of ear	Notch of flukes to posterior emargination of dorsal fin	Width of flukes at insertion	Notch of flukes to centre of anus	Notch of flukes to umbilicus
27. ii. 30	3169	♀	12·90	—	2·10	2·37	2·47	—	—	4·25	0·75	3·70	6·40
4. iii. 30	3177	♀	16·22	—	2·72	3·22	3·31	—	0·87	4·98	0·91	4·41	7·57
5. iii. 30	3183	♀	15·91	—	2·48	2·90	2·94	—	—	4·90	0·95	4·40	7·63
6. iii. 30	3185	♀	14·17	—	2·50	2·82	2·85	—	0·70	—	0·85	3·94	6·90
7. iii. 30	3189	♀	16·15	—	2·77	3·34	3·37	—	—	—	0·85	4·23	7·80
7. iii. 30	3192	♀	16·50	—	2·54	3·02	3·10	—	0·85	5·07	1·00	4·60	8·00
13. iii. 30	3214	♀	15·25	—	2·35	2·74	2·85	—	0·74	5·10	0·93	4·43	7·78
15. iii. 30	3220	♀	14·72	—	2·38	—	2·57	—	0·80	4·48	0·80	3·95	7·25
17. iii. 30	3226	♀	15·10	—	2·60	3·00	3·12	—	0·80	4·48	0·89	4·00	7·40
22. iii. 30	3242	♀	15·40	—	2·33	2·78	2·85	—	0·86	4·8	0·80	4·35	7·65
25. iii. 30	3244	♀	14·00	—	—	—	—	—	—	—	—	—	—
25. iii. 30	3248	♀	14·60	—	2·37	—	2·90	—	0·75	—	—	3·90	—
25. iii. 30	3249	♀	14·40	—	2·28	2·7	2·69	—	—	4·40	0·95	4·08	7·20
31. iii. 30	3252	♀	15·45	—	2·46	—	2·98	—	0·83	4·62	0·78	4·12	7·35
1. iv. 30	3258	♀	14·38	—	2·30	—	2·75	—	0·78	4·80	0·88	4·00	7·20
1. iv. 30	3259	♀	14·73	—	2·65	3·07	3·10	—	0·75	4·50	—	4·20	7·30
1. iv. 30	3260	♀	16·55	—	2·97	—	3·50	—	—	5·15	0·94	4·47	7·87
3. iv. 30	3266	♀	14·80	—	2·40	2·80	2·90	—	—	—	—	—	—
10. iv. 30	3268	♀	15·60	—	2·82	3·27	3·36	—	—	—	0·94	4·18	7·48
10. iv. 30	3269	♀	16·70	—	2·94	—	3·55	—	—	—	0·94	4·49	7·84
19. iv. 30	3274	♀	16·20	—	2·78	—	3·20	—	—	—	0·92	4·50	7·70
5. viii. 30	D 123	♀	14·00	—	—	—	2·80	—	—	—	—	3·70	—
5. viii. 30	D 124	♀	12·20	—	—	—	2·28	—	—	—	—	3·44	—
9. ii. 31	3618	♀	16·16	—	2·94	3·47	3·57	7·28	0·86	4·81	0·96	4·36	7·68
10. ii. 31	3621	♀	15·45	—	2·90	2·97	3·08	6·47	0·83	4·82	0·92	4·00	7·29
10. ii. 31	3630	♀	15·61	—	2·53	2·94	3·09	—	0·82	5·00	0·83	4·30	7·46
14. ii. 31	3653	♀	12·32	—	1·98	2·36	2·44	5·00	0·65	3·87	0·80	3·45	6·15
18. ii. 31	3669	♀	15·68	—	2·60	3·01	3·11	6·56	0·73	4·91	0·95	4·51	7·60
18. ii. 31	3671	♀	16·07	—	2·49	3·11	3·15	—	0·84	5·08	0·88	4·30	7·54
19. ii. 31	3676	♀	14·03	—	2·61	2·28	2·70	5·77	0·76	4·62	0·84	4·00	6·94
27. ii. 31	3685	♀	16·35	—	2·62	3·05	2·18	—	0·94	5·11	0·95	4·62	8·07
28. ii. 31	3688	♀	15·42	—	2·55	3·05	3·15	6·41	—	4·66	0·91	4·09	7·34
28. ii. 31	3689	♀	16·60	—	2·94	3·24	3·41	7·23	—	5·50	0·97	4·56	8·37
12. iii. 31	3693	♀	16·10	—	2·95	3·34	3·43	7·05	0·91	4·82	0·98	4·30	7·67
12. iii. 31	3694	♀	15·57	—	2·51	3·15	3·25	6·92	0·87	4·83	0·94	4·25	7·61

12 Notch of flukes to end of system ventral grooves	13 Centre of anus to centre of reproductive aperture	14 Vertical height of dorsal fin	15 Length of base of dorsal fin	16 Axilla to tip of flipper	17 Anterior end of lower border to tip of flipper	18 Length of flipper along curve of lower border	19 Greatest width of flipper	20 Length of severed head from condyle to tip	21 Greatest width of skull	22 Skull length, condyle to tip of premaxilla	23 Length of flipper from head of humerus to tip	24 Depth of tail at dorsal fin	Locality
7·35	0·30	0·47	0·85	—	—	—	—	—	—	—	—	—	South Georgia
8·62	0·50	0·55	1·10	—	—	—	—	—	—	—	—	2·29	,,
8·87	0·40	0·64	0·95	1·27	1·90	1·98	0·43	—	—	—	—	—	,,
7·85	0·48	—	—	—	—	—	—	—	1·62	—	—	—	,,
—	0·47	0·90	—	—	—	—	—	—	—	—	—	—	,,
9·25	0·38	0·70	1·00	—	—	—	—	—	—	—	—	—	,,
8·65	0·44	0·43	1·20	1·28	1·74	—	0·40	3·30	1·53	—	—	2·53	,,
8·05	—	0·51	1·10	1·40	1·85	1·88	0·41	3·55	1·58	—	—	—	,,
8·45	0·45	0·46	0·90	—	—	—	—	—	—	—	—	2·04	,,
8·70	0·37	0·55	0·80	—	—	—	—	—	—	—	—	1·90	,,
—	—	—	—	—	—	—	—	—	—	—	—	—	,,
—	0·34	0·54	0·85	1·23	1·55	—	0·35	—	—	—	—	—	,,
—	0·36	0·45	0·80	—	—	—	—	—	—	—	—	—	,,
8·45	0·47	0·41	0·91	—	—	—	—	—	—	—	—	2·00	,,
8·25	0·42	0·50	1·10	—	—	—	—	3·46	1·50	—	—	2·05	,,
8·40	0·36	0·55	1·10	—	—	—	—	3·88	1·65	—	—	2·00	,,
9·70	0·43	0·60	1·10	—	—	—	—	—	—	—	—	2·25	,,
—	—	0·53	1·00	—	—	—	—	—	—	—	—	—	,,
—	0·43	0·53	1·06	—	—	—	—	—	—	—	—	—	,,
8·98	0·46	—	—	1·72	1·89	—	0·42	4·00	1·70	—	—	—	,,
—	0·33	—	—	—	—	—	—	4·06	1·88	—	—	—	,,
—	—	—	—	—	—	—	—	—	—	—	—	—	Durban
—	—	—	—	—	—	—	—	—	—	—	—	—	,,
8·75	0·48	0·76	1·27	—	1·92	—	—	4·22	2·09	—	—	1·67	South Georgia
8·61	0·43	0·40	1·00	—	1·56	—	0·42	3·73	1·85	—	—	—	,,
8·72	0·46	0·50	0·85	—	—	—	—	—	1·80	—	—	—	,,
7·03	0·37	0·48	0·75	1·21	1·58	—	0·38	2·99	1·44	—	—	1·43	,,
8·67	0·44	0·52	1·00	—	—	—	—	3·89	1·81	—	—	—	,,
8·77	0·42	0·53	1·00	—	—	—	—	—	1·70	—	—	—	,,
7·76	0·35	0·60	0·85	1·31	1·79	—	0·41	3·37	1·52	—	—	—	,,
8·68	0·48	0·65	1·00	—	—	—	—	3·91	1·75	—	—	—	,,
8·38	0·42	0·57	1·10	1·49	1·87	—	0·43	3·80	1·76	—	—	—	,,
9·22	—	0·60	0·88	1·65	2·18	—	0·48	4·15	1·79	—	—	—	,,
8·84	0·38	0·55	1·03	1·70	1·85	—	0·42	4·12	1·98	—	—	—	,,
8·60	0·45	0·56	0·92	1·42	1·95	—	0·42	4·03	1·83	—	—	—	,,

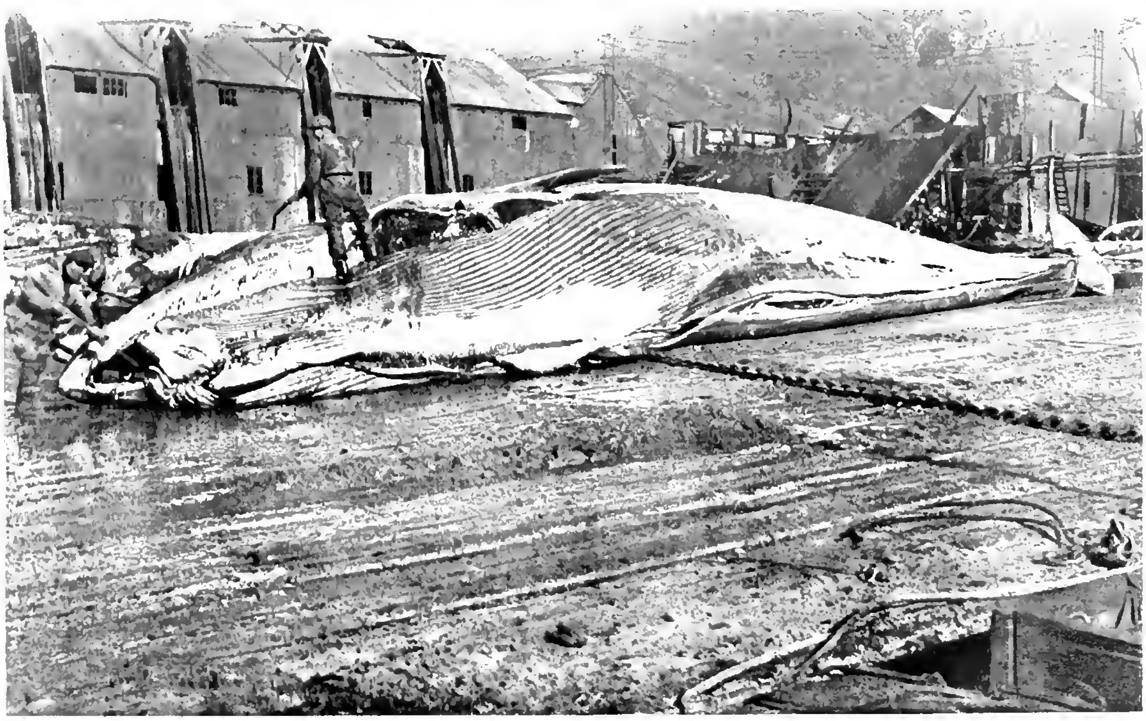
PLATE XVIII

Fig. 1. Sei whale. Female. Ventral view, showing body proportions and distribution of pigmentation. Note ventral grooves stopping short of umbilicus.

Fig. 2. Sei whale. Female. Ventral view. Note distribution of pigment, anchor mark or chevron on posterior part of ventral grooves, and white umbilical splash.

N. A. Mackintosh phot.

1



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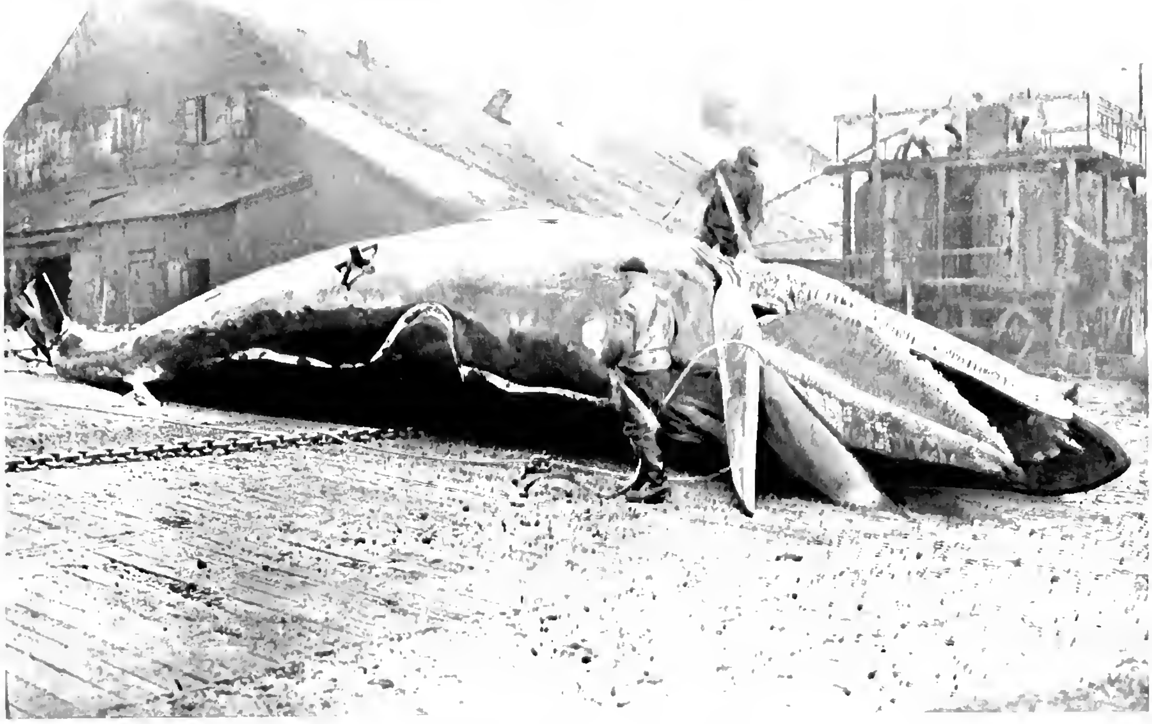
2

THE SEI WHALE

PLATE XIX

Fig. 1. Sei whale. Female. Dorsal view. Removal of a dorsal strip of blubber has begun, exposing the baleen on one side. Owing to the small size of the whale the harpoon has gone right through the body and the head has exploded outside the whale; the barbs are seen on the upper side.

Fig. 2. Sei whale. A plate of baleen from a Sei whale at Durban. Note the characteristic fine bristles. The white inner margin is abnormal and led to the whale from which this plate was taken being reported as a "Bryde's whale" by the station foreman.



N. A. Mackintosh phot. 1

F. D. Ommanney phot. 2

THE SEI WHALE

[*Discovery Reports. Vol. XVII, pp. 291–344, July 1938.*]

LARVAE OF DECAPOD CRUSTACEA

PART V. NEPHROPSIDEA AND THALASSINIDEA

By
ROBERT GURNEY, D.Sc.

CONTENTS

LARVAE OF DECAPOD CRUSTACEA

PART V. NEPHROPSIDEA AND THALASSINIDEA

By Robert Gurney, D.Sc.

(Text-figs. 1–39)

INTRODUCTION

In the following paper I have dealt with larvae from the Discovery Collections, from the Barrier Reef Expedition and from plankton collected by Prof. P. A. Buxton at Samoa, and I am most grateful to the Discovery Committee, Mr F. S. Russell and Prof. Buxton for the privilege of handling so rich a material.

Included in it are larvae which can be definitely referred to the Upogebiidae and the Laomediidae, but the majority belong to what I may call the Axiid-Callianassid group. Detailed examination of the larvae of this group has shown such a baffling combination of the characters supposed to be those of Axiidae and Callianassidae respectively that it has proved impossible to draw any distinction between them. The examination of this material has consumed much time, but the result has been so inconclusive that it has seemed very doubtful if any useful purpose would be served by publishing descriptions of these larvae. For the decision to do so I offer the following reasons. In the first place it seems unlikely that it will be possible to add very much to our basic knowledge of Thalassinid development since the adults are generally most difficult to obtain, and also knowledge of the first stage alone, if it cannot be connected up with later stages, will not carry us very far. Again, though obtaining the first post-larval stage by moult from the larva will yield valuable information, it is not likely to be conclusive, since the adult characters are so far from being attained at this stage. I have a few post-larval specimens of Thalassinidea, but am unable to determine the genus of any of them with certainty.

I feel that the only means of approach to an understanding of Thalassinid larvae, and therewith to contribute to knowledge of the relationship of the adults, is by trying to group all the types of larvae that can be discovered according to such characters as seem to have generic or family value, in the hope that a happy chance may place one group or another in its proper systematic position. One thing seems practically certain—that our present knowledge of the adults is quite inadequate to account for the types of larvae known. The larva is easily captured, the adult may not be, and it is probable that many more adult species remain to be discovered, and that some of them will represent new genera or families.

In attempting to identify larvae in preserved material the only clues to systematic position are our knowledge of larvae of which the identity has already been established, and those features of the adult which appear late in larval life. It is most unfortunate that descriptions of the adult are so often inadequate in substance if not in length, and many pages of painful detail may contain no reference to the gill formula which is of such fundamental importance. For example, the two genera *Laomedia* and *Callianidea* have been known for about a century, but I have found no full statement of the gill formula of either. When one's efforts to find the systematic position of a larva fail, it is some comfort to discover that the highest authorities on the systematics of the adults are sometimes equally at a loss. For instance, *Metaxius* Bouvier, which may be a synonym of *Meticonaxius* De Man, was referred to the Axiidae by De Man in 1925 and to the Callianassidae in 1928, while *Callianassa coeca* Balss is regarded by De Man as a synonym of *Meticonaxius monodon* De Man.[1]

I have thought it well to include in this report two remarkable forms which may be said to contribute evidence of the relationship of Axiidae to Nephropsidea. One of them is referred provisionally to *Nephrops*, while the other is a post-larval stage of *Enoplometopus*, a genus which is now regarded as an Axiid, but has previously been included in the Nephropsidae.

NEPHROPSIDEA

Nephrops sp.? (Figs. 1–2)

Barrier Reef St. 7.

Length 4·8 mm.

Rostrum long, triangular in section, with ventral ridge and lateral margins serrated. Carapace with dorsal ridge in front, pointed anterior angle, but no other spines. Ab-

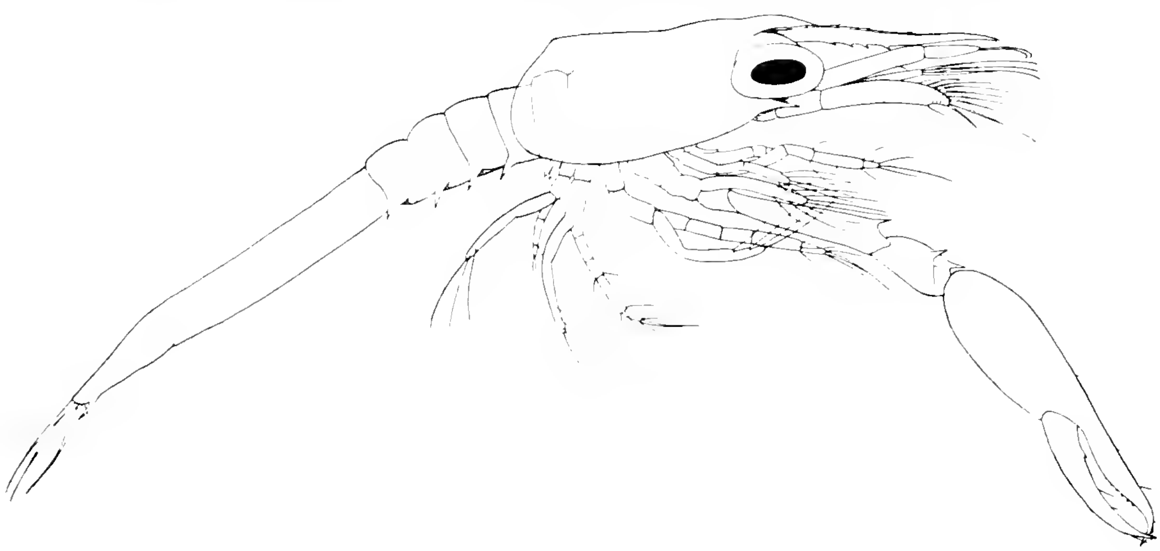


Fig. 1. *Nephrops* sp. ?

dominal somites 2–5 without dorsal spines, but with sharply pointed pleural spines. Somite 6 not separated from telson, longer than rest of abdomen. Telson triangular,

[1] According to De Man (1928, p. 30) *Metaxius* has epipods on legs 1–4, and he includes it in his new subfamily Callianideinae.

with spine at each angle; posterior margin straight, with median spine; spine 2 reduced; formula 8+8.

Antennal scale with one outer and fourteen inner and terminal setae, distal part with four distinct segments; basis without ventral spine; endopod with three nearly equal terminal setae.

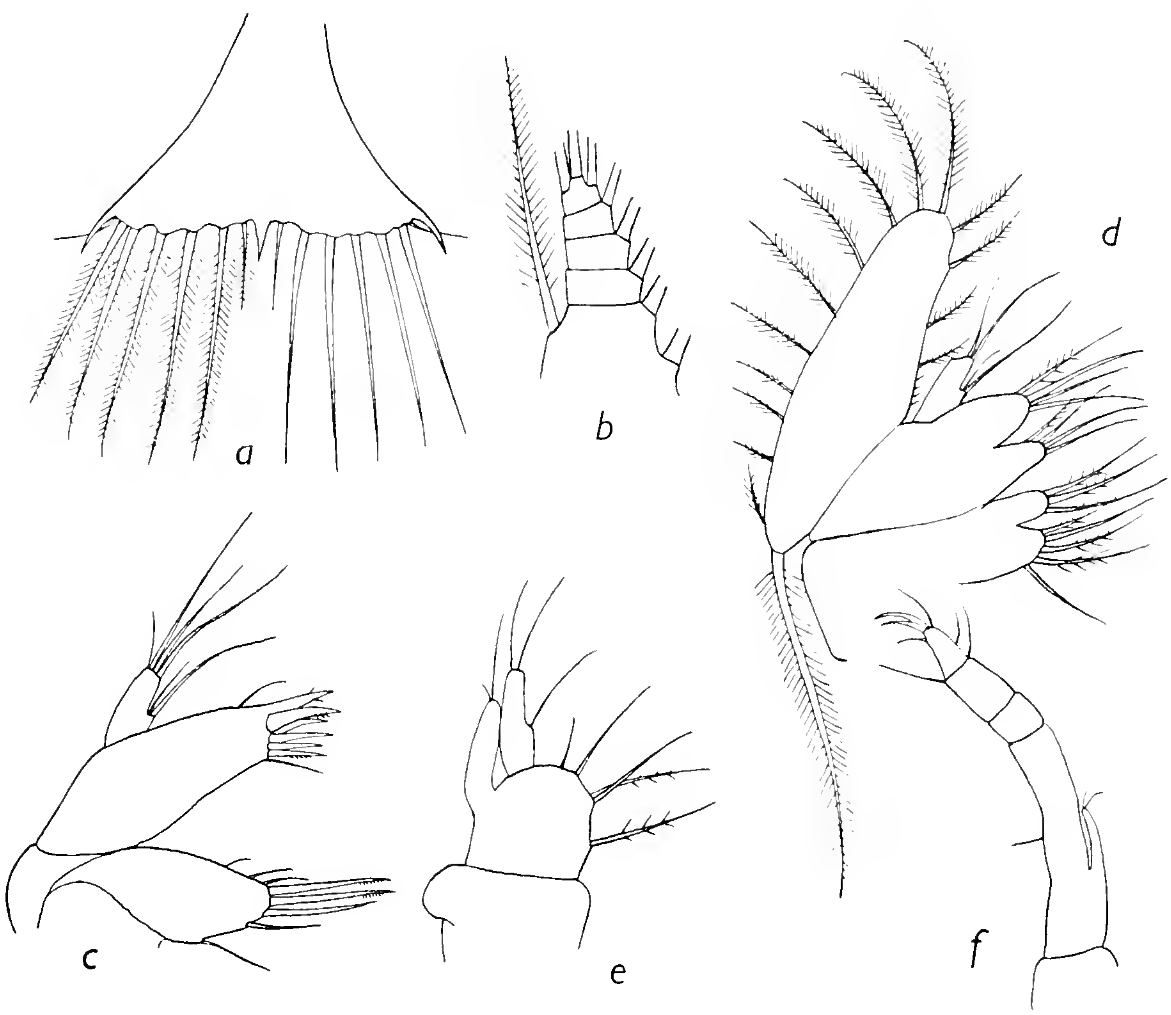


Fig. 2. *Nephrops* sp.?

a. Telson. *b.* Part of antennal scale. *c.* Maxillule.
d. Maxilla. *e.* Maxillipede 1. *f.* Maxillipede 2.

Mandible without palp. Maxillule with small unsegmented palp. Maxilla with four inner lobes; endopod very small, unsegmented, with one small inner lobe; exopod very large in front, but not produced proximally; one very large seta at proximal end and fifteen marginal setae.

Maxillipede 1 with very small rudiment of epipod; endopod and exopod very small, the former unsegmented. Maxillipede 2 with exopod reduced to a minute non-functional vestige; ischium and merus not separated and fused with basis. Maxillipede 3 with ischium and merus and basis fused; exopod with six setae, functional but small.

Legs 1–4 with large exopods, with 8, 8, 8, 6 setae. Leg 1 very large, with fully developed chela. Legs 2–4 of simple larval type. Leg 5 a small bilobed rudiment. Gills and pleopods absent.

There can, I think, be little doubt that this larva belongs to the genus *Nephrops* or to a closely allied genus. The precocious development of the chelae of leg 1, combined with the reduction of the exopods of maxillipedes 1 and 2, is unknown except in *Nephrops* and *Homarus*. In *Nephrops* these exopods are much more reduced than they are in *Homarus*, and they are remarkably like those of the larva here described. On the other hand, the long rostrum, presence of three setae on the endopod of the antenna, and the form of the telson are characters which would otherwise point clearly to the Thalassinidea. The telson, indeed, is exactly the same as that of *Callianassa* and of some larvae presumed to be Axiidae. This larva is a link between the Nephropsidae and Axiidae, and points to the conclusion that the Nephropsid larva, which has been so modified by shortening of development, has been derived from one of the Axiid-Callianassid type.

The possibility that this larva may belong to *Nephropsis* cannot be excluded; but the genus is apparently confined to deep water and its larva is unlikely to occur within the Barrier Reef.

Enoplometopus sp. (Figs. 3, 4)

Discovery St. 690. 3° 17′ S, 29° 57′ W. Twelve specimens.
1580. 8° 44′ S, 41° 50′ E. One specimen.

Smallest specimen: rostrum 5·6 mm.; thorax and abdomen 11 mm. Largest specimen about 24 mm. in total length.

Rostrum much longer than antennule, broad and deeply hollowed at base, the raised lateral margin bearing a few small teeth and continued, in larger specimens, backwards as a ridge bearing three or four small teeth; anterior part laterally compressed, with teeth on dorsal and ventral margins. Carapace, in the larger specimens, with faintly marked cervical and branchiocardiac grooves and a well-marked ridge in posterior region parallel to ventral margin; no supra-orbital spines.

Abdominal somites with dorsal ridge, and acutely pointed epimera on somites 2–5. Telson narrow, parallel-sided, with a small spine at each posterior angle, between which there is a triangular projection bearing a long median spine and seven or eight setae on either side. No anal spine.

Antennule without stylocerite; branches very long, the outer one very slender. Antenna with large scale; basis with small outer spine.

Mandibular palp of three segments; incisor and molar parts not separated. Maxillule without exite; endopod slender, with three segments. Maxilla with small two-segmented palp.

Maxillipede 1 with endopod of two segments; exopod widened at base, with a fringe of setae; epipod large. Maxillipede 2 with basis and ischium partly fused; with epipod and large podobranch. Maxillipede 3 with ischium and merus not fused.

Leg 1 an extremely large chelate limb; legs 2 and 3 not chelate, leg 2 having the propod slightly produced and bearing a stout spine. Each leg bears a large exopod.

Pleopods on somites 2–5 with appendix interna; pleopod 1 absent. Uropods without suture.

Fig. 3. *Enoplometopus* sp.

a. Side view. *b*. Part of telson. *c*. Maxillule.
d. Maxilla. *e*. Part of leg 2.

Gill formula

	Mxp. 2	Mxp. 3	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5
Epipod	+	+	+	+	+	+	–
Podobranch	–	+	+	+	+	+	–
Arthrobranch	–	2	2	2	2	2	–
Pleurobranch	–	–	1	1	1	1	1

According to De Man (1916) the genus includes four species:

E. occidentalis (Randall), Indo-Pacific.

E. antillensis (Lütken), West Indies.

E. dentatus Miers, St Helena. Possibly identical with *E. antillensis*.

E. longirostris De Man, Amboina.

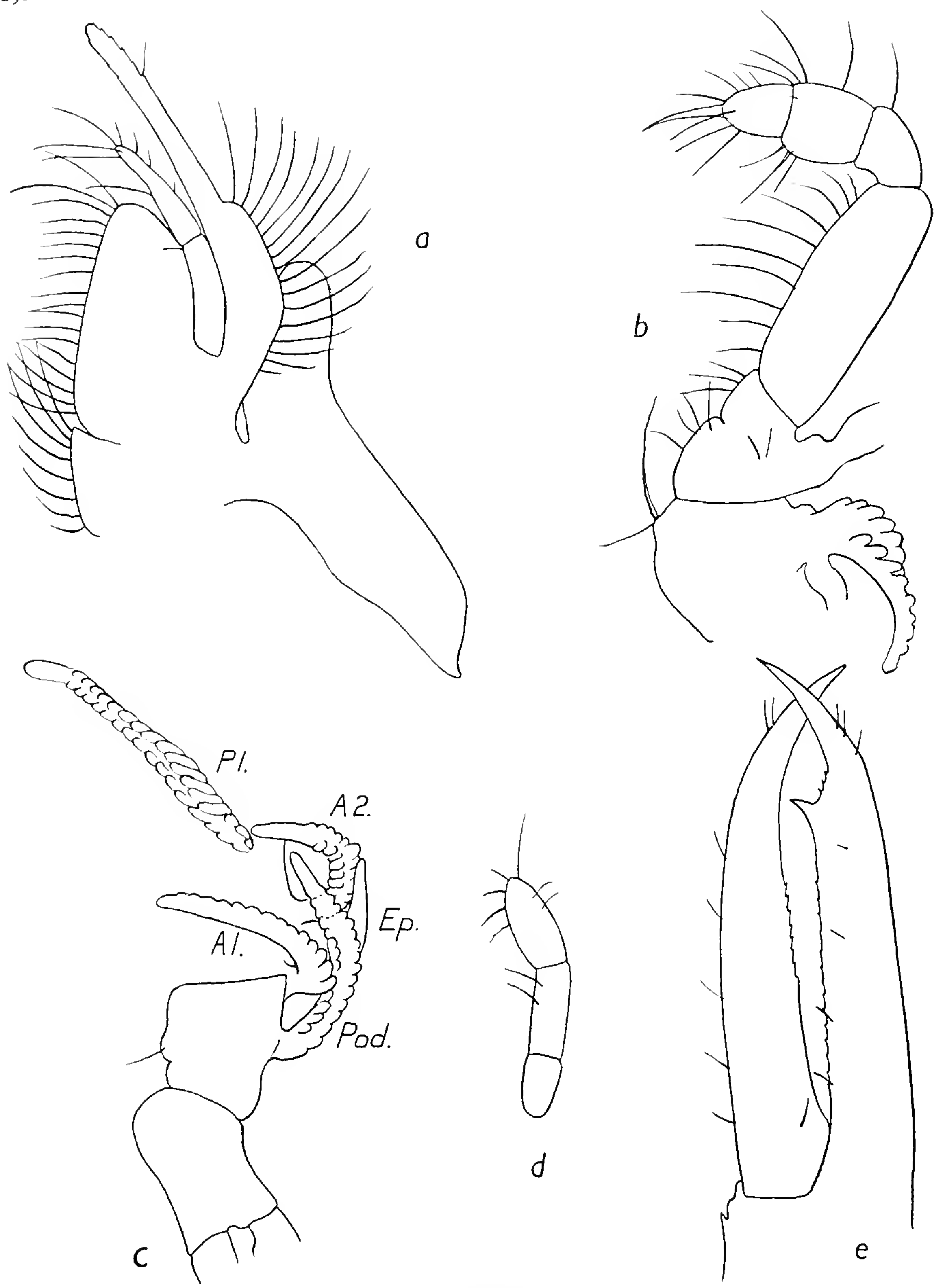


Fig. 4. *Enoplometopus* sp.

a. Maxillipede 1. *b*. Maxillipede 2. *c*. Gills etc. of leg 4.
d. Mandible palp. *e*. Part of chela.

The young post-larval species here described resembles very closely *E. longirostris* De Man, having ventral teeth on the rostrum and much the same form of abdominal pleura.

Although there are several references to and descriptions of these species, the gill formula appears to be still unknown.

The genus has been regarded by Bouvier, De Man, Ortmann and others as a member of the Nephropsidae, but Miers noted that it was probably nearly related to *Eutrichocheles* Wood-Mason. The latter, which was also included in the Nephropsidae, has been shown by Chopra (1933) to belong to the Axiidae, a position also given to it by Balss (1933, p. 87). Chopra indeed finds *E. modestus* to be so near to *Calocaris* that it might almost be included in that genus. That being so, it would seem natural to assign the same position to *Enoplometopus*.

There is, indeed, little difference between Nephropsidae and Axiidae, but the fact that *Enoplometopus* has chelae upon leg 1 only may be taken as sufficient to exclude it from the former. An important character which distinguishes Nephropsidae from Axiidae is the absence in the former of the appendix interna from the pleopods, and to this point De Man alone refers. He states that *E. occidentalis* has no appendix interna; but it is well developed in my own post-larval specimens.

The gill formula of these specimens is unusually complete, since there are not only podobranchs on legs 1–4, but also pleurobranchs. The pleurobranchs are generally reduced, or even absent, in Thalassinidea; but *Iconaxiopsis* may have a formula almost as complete as that of Nephropsidae, and in neither family is a pleurobranch found on leg 1. In respect to the gills, therefore, this species is more primitive than either, and no systematic conclusion can be drawn from the fact.

Associated with these specimens at St. 690 were late larvae described below which I regard as belonging to the Axiidae. These larvae agree with *Enoplometopus* in the form and length of the rostrum, the possession of a well-developed exopod on leg 5, and particularly in the form of the telson, and one is tempted to regard them as belonging to the same species; but the fact that leg 2 has a well-developed chela seems to make such an identification impossible. It is contrary to all experience that a structure such as this should appear in the larva and be lost in the adult. At the same time it is very remarkable that so many post-larval specimens should be found in the same collection as numerous advanced larvae so closely resembling them and yet of a different species.

THALASSINIDEA

AXIIDAE AND CALLIANASSIDAE

The only species of Axiidae of which the larvae are certainly known are *Axius stirhynchus* and *Calocaris macandreae*, the former described by Webb (1921, p. 406) and the latter by Sars, Björck and Bull (1933). In *Axius stirhynchus* there are only two larval stages, the third stage being post-larval; but it is not altogether clear how many there are in *Calocaris*. I have seen two myself, but Bull has described an earlier and Björck a later stage, so that there may be four, although the larva is further advanced on hatching than that of *Axius stirhynchus*, and it seems never to be an active swimmer. In *A. stirhynchus* the mouth-parts are normal and functional, whereas they are almost without setae and presumably not functional in *Calocaris*.

The large size of the eggs in most of the species in which the eggs have been referred to points to a general prevalence of shortened development, and this is carried to an extreme in *Eiconaxius parvus*, in which the young leave the egg in almost the adult form (Bate). This appears to occur also in *Axius plectorhynchus*, according to Hale (1927), but in this species there must be individual differences in this respect, since I find in some eggs which Mr Hale has been good enough to send me a larva not more advanced than that of *A. stirhynchus* (see pp. 303–4).

In these circumstances it is perhaps rash to attribute to the Axiidae any larvae which do not show abbreviated metamorphosis and the characters common to the two species known. It is, however, impossible to escape the conclusion that these species are not typical of the family and that some larvae of very different form must be attributed to it. In *Calocaris alcocki* the eggs are small, according to a figure by Alcock and Anderson, and there may well be other species with a normal larva.

Larvae are common in plankton from the Atlantic and Indo-Pacific oceans which are evidently Thalassinidea, but certainly do not belong to the Laomediidae nor to the Upogebiidae. As a number of types are represented which are generally found in both oceans the Thalassinidae may probably be excluded. Moreover, as there is but one genus of Thalassinidae with three known species, its inclusion would not widen the field of choice appreciably. There remain only the Axiidae, Axianassidae and Callianassidae. The genus *Axianassa* Schmitt (with one species) is included in the Laomediidae by De Man, but allotted a special family by Schmitt and Balss. As nothing is known about its development it must be left out of account.

When one is attempting to assign larvae to a position in an adult system it is necessary to attach most importance to those adult characters which are discernible in the larva. For this reason it is the last stages only which can be used, and it is to these stages almost entirely that reference is made in this paper.

Judging from the species of which the larvae are known we may establish the following categories:

(1) Epipods present; leg 5 with exopod; four pairs of pleopods; telson broadly triangular, with convex margin, median spine and numerous marginal spines, spine 2 reduced to a hair (= "C. II" type of telson). Larval life abbreviated ... ... *Axius* and allies.

(2) Epipods absent. Leg 5 without exopod; three or four pairs of pleopods; telson of "C. II" type. Larval life abbreviated ... ... *Callianassa* type II (Gurney, 1937).

(3) Epipods absent; leg 5 without exopod; three pairs of pleopods;[1] telson less than three times as long as wide, lateral spines 1–3 small and near posterior angle, spine 4 long, posterior margin straight or concave, spine formula 8, 1, 8 ("C. I" type of telson). Abdomen usually with large spine on somite 2 and somites 3–5 with pronounced ridge. Development not abbreviated ... ... *Callianassa* type I (e.g. *C. subterranea*).

[1] There is good reason to believe that Sars' figure (1884) showing four pleopods in *C. subterranea* is incorrect.

I have already shown (1924) that there are larvae which do not fit into any of these categories and must yet be found a place within an Axiid-Callianassid group, and many more examples are given here. While it is obviously impossible to identify these larvae, it should be possible to give them some sort of natural grouping and to suggest their approximate systematic position.

The salient characters available for systematic purposes are these:

(1) *Gill formula.* The gill formula should provide an excellent character, but unfortunately it cannot be entirely trusted. Gills and epipods are well developed in the last stage, but, in *Axius stirhynchus*, the pleurobranchs do not appear even in the first post-larval stage, so that, though their presence would be a very positive clue (see Gurney, 1924, p. 148) their absence in the larva proves nothing. On the other hand, it appears to be generally true that epipods, if present in the adult, are traceable in the larva, and their presence or absence should have weight; but I do not feel entirely confident that this is so. In the series of larvae dealt with here epipods are sometimes so well developed that they show traces of podobranchs, and these forms, which also have an exopod on leg 5, can be safely excluded from the Callianassidae; but there are some without epipods which in other respects so exactly resemble those that have them that a division on this ground does not seem to be justified. None the less, in view of the fact that epipods are present in all Axiidae and absent from all Callianassidae (except *Callianidea*), I have used this as a fundamental point of cleavage.

(2) *Pleopods.* Until recently it was possible to say that the presence of a pleopod on somite 2 was a main distinguishing feature of the Axiid larva, but Callianassid larvae have now been discovered which have this pleopod (Gurney, 1937*b*). It may well be that only those Callianassids with abbreviated development have four pairs of pleopods, and that those larvae with normal development which have three should be placed among the Callianassidae. There remains some element of doubt, since, in the specimen described as D. XIII, it is suggested that the pleopod on somite 2 may develop later than the others.

(3) *Exopod on leg 5.* Since *Axius* and *Calocaris* have only a vestigial exopod it is quite possible that other Axiidae may have lost it altogether, and in this series of larvae there is evidence that this may happen. There is, however, no evidence that any Callianassid larvae of type I ever has this exopod, and its presence may still be regarded as characteristic of Axiidae. On the other hand, among the species described in Group II C, with abbreviated development, there is one which has an exopod on leg 5 and no epipods, so that in this group no distinction is possible.

(4) *Telson.* The statement of known larval characters shows that precisely the same form of telson is found in *Axius* and in *Callianassa* type II. Many of the species dealt with here show a type of telson which is strikingly different from either of the types previously known. In its extreme form, as in D. I, it is long and narrow, spines 1–4 are widely spaced and lateral, and the posterior margin is greatly produced and bears more than the normal four spines on either side of the median spine. I have called this a

telson of "A type". There is no transition between it and the telson of "C. II"[1] type, but every gradation between it and "C. I" type, both in shape and in the position of the lateral spines. It is found in its typical form in all the species of Group I, except perhaps in B.R. II which is transitional. In Group II (without epipods) it is seen in all species which have an exopod on leg 5 and also in those with four pairs of pleopods; but it gives place to a telson of C. I type in all those with three pairs of pleopods and no exopod on leg 5 (Group II B) with one exception—B.R. VI. Species D. XIII may be another exception, but it is not fully developed and may actually be the young stage of D. X.

(5) *Abdominal spines*. There is so great a variety in dorsal armature that no definite deductions can be drawn therefrom. If *Axius* and *Calocaris* are typical of the Axiidae we should expect Axiid larvae to have no dorsal spines on somites 2–5, or that they should be small and perhaps paired. As between them and *Callianassa* type II, in which these spines may be reduced or absent, no difference can be found. In *Callianassa* of type I, however, the dorsal spine of somite 2 is very large and hollowed, and somites 3–5 have a pronounced ridge which may be serrated. These characters are found in all the species of Group II B, which may safely be referred to *Callianassa*, but they are also repeated in species of Group II A, with four pairs of pleopods and exopod on leg 5, which certainly cannot be *Callianassa*.

(6) In the following descriptions I have noted the presence in most species of a seta placed either on the edge or on the ventral surface of the antennal scale near its base. This seta may be long and plumose, or it may be reduced to a minute hair and so difficult to see that it may sometimes have been overlooked. It is found in *Axius stirhynchus* and in *A. plectorhynchus*, but not in *Callianassa subterranea*. Its occurrence in larvae in each of the groups into which I have divided them shows that it cannot be used to distinguish between Axiidae and Callianassidae; it may in fact be evidence of the common relationship of all, since it is not found, so far as I know, in any other Thalassinidea.

Having regard to the difficulty in applying any of these characters I have refrained from attempting to assign any of these larvae to their true position; but I think it probable that the whole of Group I belong to the Axiidae and Groups II B and C to the Callianassidae. Group II A remains quite uncertain. It must be remembered that the genus *Callianidea* is not yet accounted for, and it may well be that it has a larva transitional between Axiidae and Callianassidae.

Since the larval genus *Oodeopus* Bate covers the whole range of Axiid-Callianassid larvae it might be a convenience to make use of this name; but I have preferred to use no names and to designate the larvae simply with a letter and number, the former indicating their provenance—Discovery or Barrier Reef.

Before proceeding to deal with the unnamed Axiid-Callianassid larvae I give here a description of the unhatched larva of *Axius plectorhynchus*, since it is important to add to our knowledge of the development of named species of the group.

[1] For description of "C. I" and "C. II" types of telson, see p. 300.

Axius plectorhynchus (Strahl) (Fig. 5)

Hale, 1927, p. 84.

Hale writes: "The eggs are very large; the young do not pass through a metamorphosis, but hatch in the form of the parent, and cling to the swimmerets of the mother for some time." Mr Hale was unable to send me specimens of the newly hatched young, but I am indebted to him for a number of eggs from which the young could be extracted.

Eggs: 3·0 × 2·5 mm.

Rostrum broad, flattened, bent down under head. Telson deeply bilobed, with seven cuticular processes on either lobe. Under the cuticle can be seen the setae of the

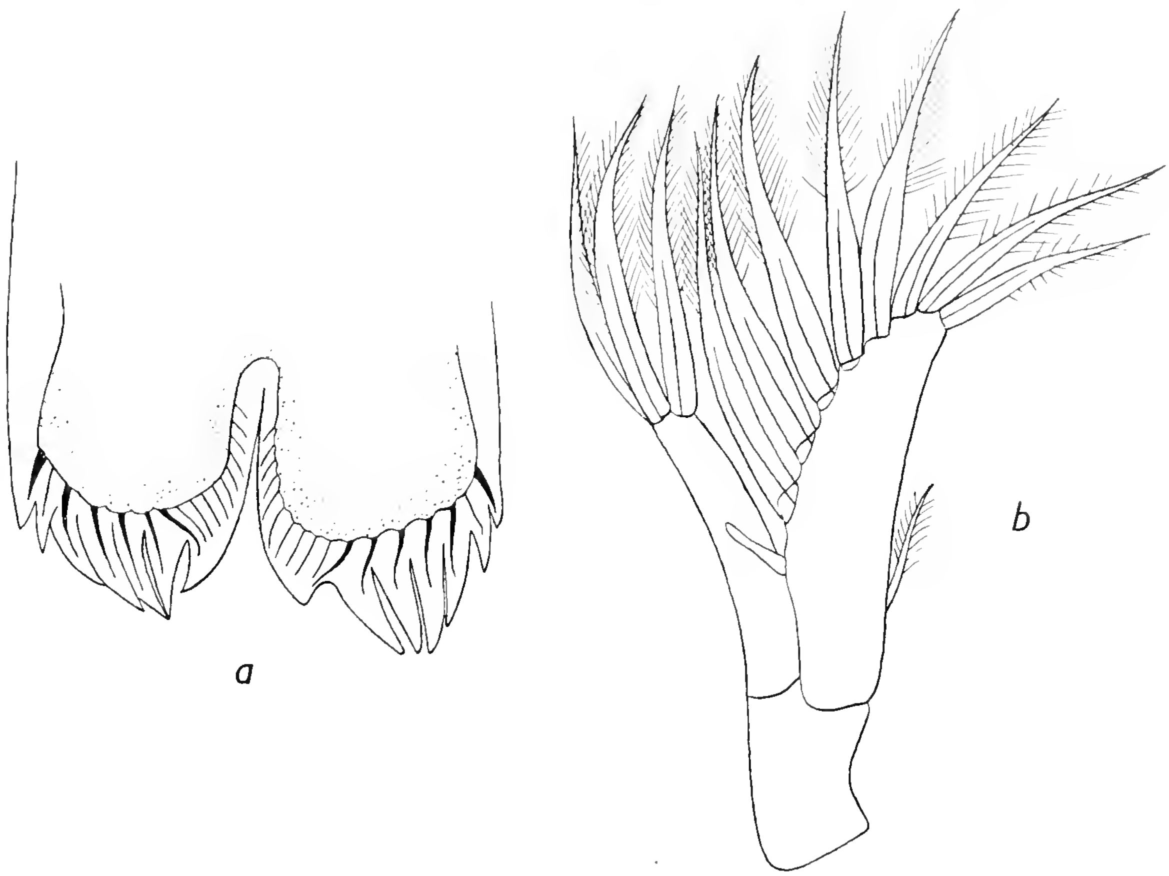


Fig. 5. *Axius plectorhynchus* Prezoea.
a. Telson. *b.* Antenna.

future telson. These seem to be distinguishable into an outer series of seven, corresponding to the processes of the embryonic cuticle, and with the second reduced to a small hair; and ten more smaller setae along the inner margin of the lobe.

Antennule unsegmented, without setae. Antennal scale with eight large feathered setae, and a small unfeathered seta on inner margin, and one seta on outer margin near base; endopod with three large apical feathered setae.

Mouth-parts apparently rudimentary. Mandible with large palp. There are three pairs of biramous maxillipedes, the setae enclosed within the embryonic cuticle. Behind these is a large swelling within which rudiments of legs can be faintly seen, but they are very small, and I have been unable to separate them. Four pairs of pleopods can be traced under the skin. Uropods absent.

It is evident that the larvae which should have hatched from these eggs would be not more advanced than those of *A. stirhynchus*. Hale's observation seems to show that there is poecilogeny in this species, the eggs of some individuals hatching at a very much later stage than those of others. This is a point which should be investigated further, since those instances of poecilogeny which have been recorded hitherto (*Palaemonetes*, *Synalpheus*) have proved to have been founded upon mistaken identification of the parents.

Key to the Axiid-Callianassid larvae

1. Epipods present on legs 1–4 ... Group I, **2**
   Epipods absent ... Group II, **10**
2. Dorsal spines on abdomen unpaired ... Group I A, **3**
   Some of these spines in pairs ... Group I B, **6**

Group I A (p. 306)

3. Somite 2 without dorsal spine ... D. IV
   Somites 2 and 3 without spine ... B.R. II
   Somite 2 with dorsal spine ... **4**
4. Spine formula of telson 13, 1, 13 ... D. I
   Spine formula 11, 1, 11 ... D. II
   Spine formula 8, 1, 8 ... **5**
5. Abdominal pleura rounded, dorsal spine of somite 2 not large ... D. III
   Pleura pointed behind; dorsal spine very large ... B.R. I

Group I B (p. 312)

6. Somite 2 without dorsal spine ... **7**
   Somite 2 with single dorsal spine ... **8**
   Somite 2 with a pair of dorsal spines ... D. IX
7. Margin of carapace with close-set spines in front and behind ... D. VIII
   Margin with close-set spines in front only ... B.R. III
8. Pleura of somite 2 pointed ... D. VI
   Pleura all rounded ... **9**
9. Margin of carapace with close-set spines in front and behind ... D. VII
   Margin with close-set spines in front only ... D. V

Group II

10. Telson of "A" type, with four pairs of pleopods ... Group II A, **11**
    Telson of "A" type, with three pairs of pleopods ... Group II B, **15**
    Telson of "C. I" type, with three pairs of pleopods ... Group II C, **16**
    Telson of "C. II" type ... Group II D, **20**

Group II A (p. 318)

11. Leg 5 with well developed exopod ... **12**
    Leg 5 with exopod vestigial, or none ... **13**
12. Telson with spine formula 11, 1, 11 ... D. X
    Telson with spine formula 8, 1, 8 ... D. XI
13. Leg 5 without exopod, carapace with denticulate dorsal ridge ... B.R. V
    Leg 5 with vestigial exopod; carapace without this ridge ... **15**
14. Telson about four times as long as wide ... D. XII
    Telson about 2½ times as long as wide ... B.R. IV

Group II B (p. 323)

15. Telson with spine formula 11, 1, 11 ... ... D. XIII
Telson with spine formula 8, 1, 8 ... ... B.R. VI

Group II C (p. 325)

16. Abdominal somites 3–5 with serrated dorsal ridge 17
This ridge not serrated 19
17. Median spine of telson much shorter than adjacent spines ... ... D. XV
This spine much longer than adjacent spines 18
18. Carapace margin closely serrated in front, posterior margin of telson straight ... D. XIV
Carapace with about seven marginal spines, margin of telson concave ... ... D. XVI
19. Eye round, somite 6 without lateral spines ... ... B.R. VII
Eye pointed, somite 6 with lateral spines ... ... B.R. VIII

Group II D (p. 327)

20. Leg 5 with small exopod ... ... B.R. IX
Leg 5 without exopod 21
21. Exopods on maxillipedes 1–3 only, four pairs of pleopods ... ... B.R. XI
Exopods on legs 1–4, three pairs of pleopods 22
22. With large dorsal spine on somite 2, mouth parts not rudimentary ... ... D. XVII
With small dorsal spine on somite 2, mouth parts rudimentary ... ... B.R. X

Distribution of larvae of the Axiid-Callianassid Group. Discovery Stations

Station	Position	Species																
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII
278	Cape Lopez, 00° 36′ S, 8° 42′ E	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
406	Simon's Bay, Cape Province	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
421	34° 42′ S, 18° 39′ E	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
680	22° 36′ S, 30° 01′ W	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
688	09° 26′ S, 29° 50′ W	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
689	05° 59′ S, 29° 49′ W	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
690	03° 17′ S, 29° 57′ W	+	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.
701	14° 39′ N, 25° 51′ W	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
705	00° 03′ N, 30° 36′ W	+	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
707	6° 44′ S, 33° 33′ W	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
708	10° 20′ S, 34° 54′ W	+	.	.	.	.	.	+	+	.	+	.	.	.	+	+	.	.
709	14° 01′ S, 36° 30′ W	+	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
711	24° 40′ S, 41° 30′ W	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
1373	31° 13′ S, 31° 48′ E	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1374	31° 46′ S, 29° 46′ E	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1375	34° 30′ S, 26° 19′ E	+	+	.	.	.	+	.	.	.	+	.	.	.	.	.	+	.
1555	39° 51′ S, 18° 41′ E	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1571	29° 24′ S, 40° 33′ E	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
1573	24° 35′ S, 39° 53′ E	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1574	21° 44′ S, 40° 33′ E	+	.	.	.	.	+	.	.	+	+	.	+	.	.	.	.	.
1575	18° 32′ S, 41° 35′ E	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
1576	14° 42′ S, 42° 22′ E	+	.	.	.	.	+	.	.	+	.	+	+	.	.	.	.	.
1578	11° 25′ S, 42° 03′ E	+	.	.	+	.	+	.	.	+	+	+	.	.	.	.	.	.
1580	8° 44′ S, 41° 50′ E	+	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
1581	7° 42′ S, 44° 14′ E	+	+	+	+	.	+	.	.	.	+	.	.	.	.	.	.	.
1585	00° 06′ S, 49° 45′ E	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
1586	02° 39′ N, 50° 46′ E	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1588	07° 09′ N, 52° 19′ E	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
1589	11° 32′ N, 52° 03′ E	+	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.

GROUP I

With epipods and with exopod on leg 5

Group I A

Dorsal spines unpaired

With the exception of species B.R. II this group may be regarded as reasonably uniform, and in all probability belonging to the Axiidae. Species B.R. II, with its short rostrum, reduced exopod on leg 5 and telson of Callianassid form, can only be included here by reason of its possession of epipods and four pairs of pleopods. On the other hand, the absence of dorsal spines on somites 2 and 3 seems definitely to exclude it from *Callianassa* type I. Its position remains problematical. A very similar form has been described by me (1924, p. 145). In this species pleurobranchs were seen on legs 2–4, and it was suggested that it might belong to *Iconaxiopsis*. It may be possible to distinguish three types of Axiid larvae:

(1) Telson of "A" type. Exopod of leg 5 long.
(2) Telson of "C. I" type. This exopod vestigial.
(3) Telson of "C. II" type. This exopod vestigial. Example: *A. stirhynchus*.

It may be that types (2) and (3) are also distinguished by absence of some of the dorsal abdominal spines.

Thalassinid D. I (Fig. 6)

Oodeopus intermedius, Bate, 1888, pl. 143, fig. 1.
"Atlantis" St. 1121. 35° 53′ N, 62° 45′ W.

Rostrum 4·9 mm.; body 10·9 mm.

Rostrum very long, narrow; basal part hollowed above but with median dorsal ridge, serrated; distal part slender, smooth. Carapace with a few teeth on anterior ventral margin. Somite 2 of abdomen with large dorsal spine, shorter than somite 3 and not greatly larger than spines of somites 3–5. Pleura of somites 2–4 with sharp ventral point. Anal spine large.

Telson parallel-sided, nearly four times as long as wide; with four widely spaced lateral spines, anterior spine about middle; distal part produced and tapering to the large median spine, with nine small spines on either side. Spine formula 13, 1, 13.

Eye oval, black. Antenna: basis with very long outer spine and small inner spine; scale with plumose seta on under side near base. Mandible with unsegmented palp. Maxillule with palp slender, unsegmented, with eight setae. Maxilla with palp slender of three segments.

Maxillipede 1 with endopod of four segments, with outer seta on segment 1. This seta is, in the forms here dealt with, generally on the anterior face and turned inwards, so that it is invisible from the posterior face. It is probably always present, but may be overlooked.

Leg 1 with chelae equal; dactyl about four-fifths length of palm; palm nearly twice as long as wide. Leg 5 with exopod nearly as long as merus. Epipods and two arthrobranchs on legs 1–4. Four pairs of pleopods on somites 2–5.

This form is very common in the Discovery material and, as will be seen from the table of distribution, it is found in the Atlantic as far north as 14° 39′ N and also up the east coast of Africa to 6° 05′ N. In spite of this wide range I am unable to find any definite specific differences. If it were not for the fact that leg 2 is chelate this form

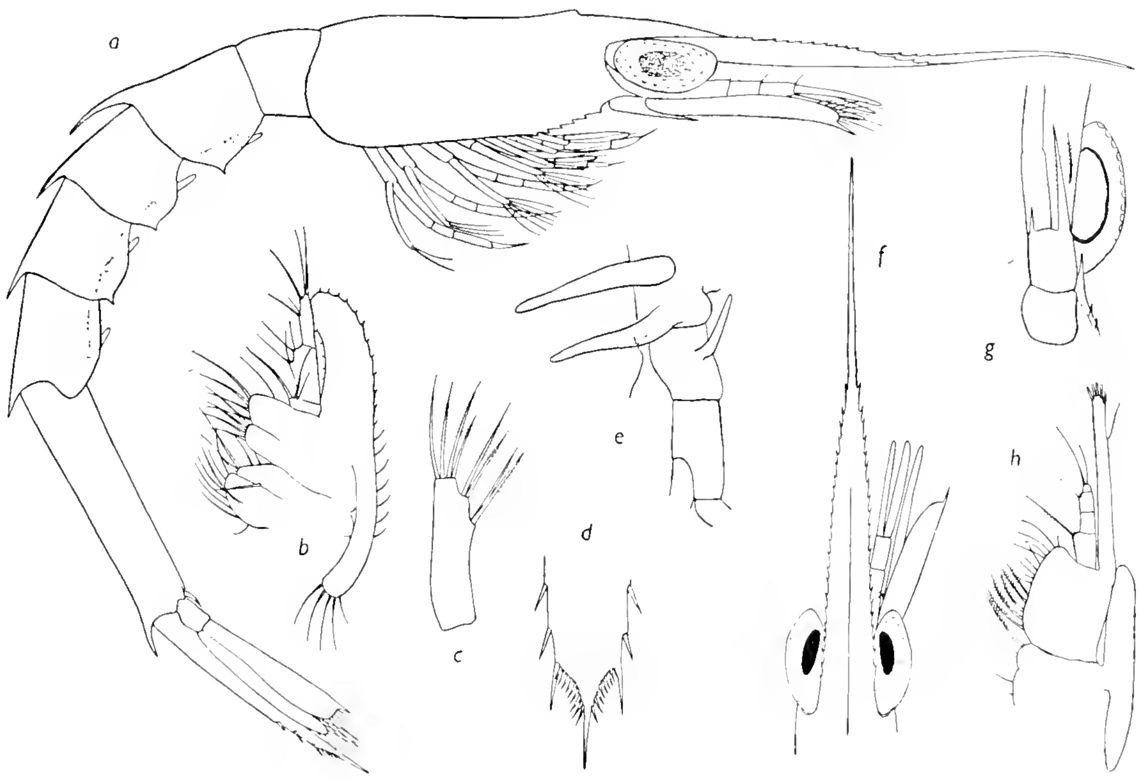


Fig. 6. *Thalassinid* D. I.

a. Side view. St. 689. *b.* Maxilla. St. 688. *c.* Palp of maxillule. St. 688.
d. Part of telson. St. 688. *e.* Part of leg 4. St. 688.
f. Head and rostrum. Atlantis St. 1121. *g.* Antenna. St. 1121. *h.* Maxillipede 1. St. 1121

might well be claimed as the larva of *Enoplometopus*, especially as it was taken in the same collections. It differs from all the other forms described in having more numerous species on the telson and in the slender unsegmented palp of the maxillule.

Thalassinid D. II (Fig. 7)

Discovery St. 1375.

Rostrum 4·45 mm.; body 12·45 mm.

Rostrum very long and narrow, with short unserrated point. Carapace with a few marginal spines. Abdomen: somite 2 with very large hollowed dorsal spine; somites 3–5 with small hollowed spines. Pleura of somite 2 with ventral point, the rest rounded.

Telson nearly four times as long as wide; spines 1–3 widely spaced, 3 and 4 close together; posterior margin produced, with seven spines on either side; formula 11, 1, 11.

Eye very narrow oval. Antenna with long outer and short inner spine on basis; scale with seta at base.

Maxillule with palp slender of two segments. Maxilla with palp of three segments. Maxillipede 1 with outer seta on segment 1 of endopod.

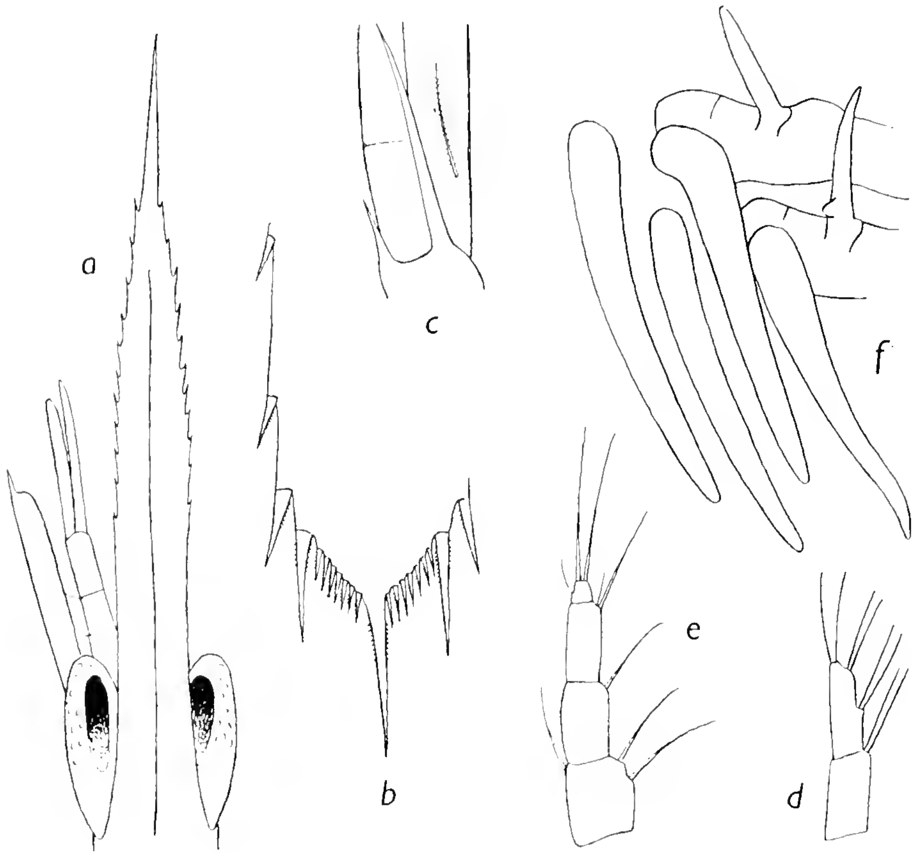


Fig. 7. Thalassinid D. II.

a. Head and rostrum. St. 1375. *b*. Telson. St. 1375. *c*. Antenna. St. 1375. *d*. Palp of maxillule. St. 1580. *e*. Endopod of maxillipede 1. St. 1580. *f*. Gills of legs 3 and 4. St. 1580.

Legs 1 and 2 chelate. Exopod of leg 5 as long as merus. Epipods, with rudiments of podobranchs, and a pair of very large arthrobranchs on legs 1–4. Pleopods on somites 2–5 with rudiment of appendix interna.

Though much less common than the preceding species, the distribution is about the same, extending in the Atlantic to 14° N and to the equator off east Africa. The large epipods, with rudiments of podobranchs, point definitely to an Axiid genus. The extreme elongation of the arthrobranchs is a unique feature.

Thalassinid B.R. I (Fig. 8)

Barrier Reef St. 54.

Rostrum 3 mm.; body 6·0 mm.

Rostrum very much longer than antennule, serrated nearly to end. Carapace with a few blunt marginal spines. Abdomen: somite 2 with dorsal spine longer than somite 3; somites 3–5 with small spines. Pleura of somites 3–5 with sharp posterior point and minute marginal teeth.

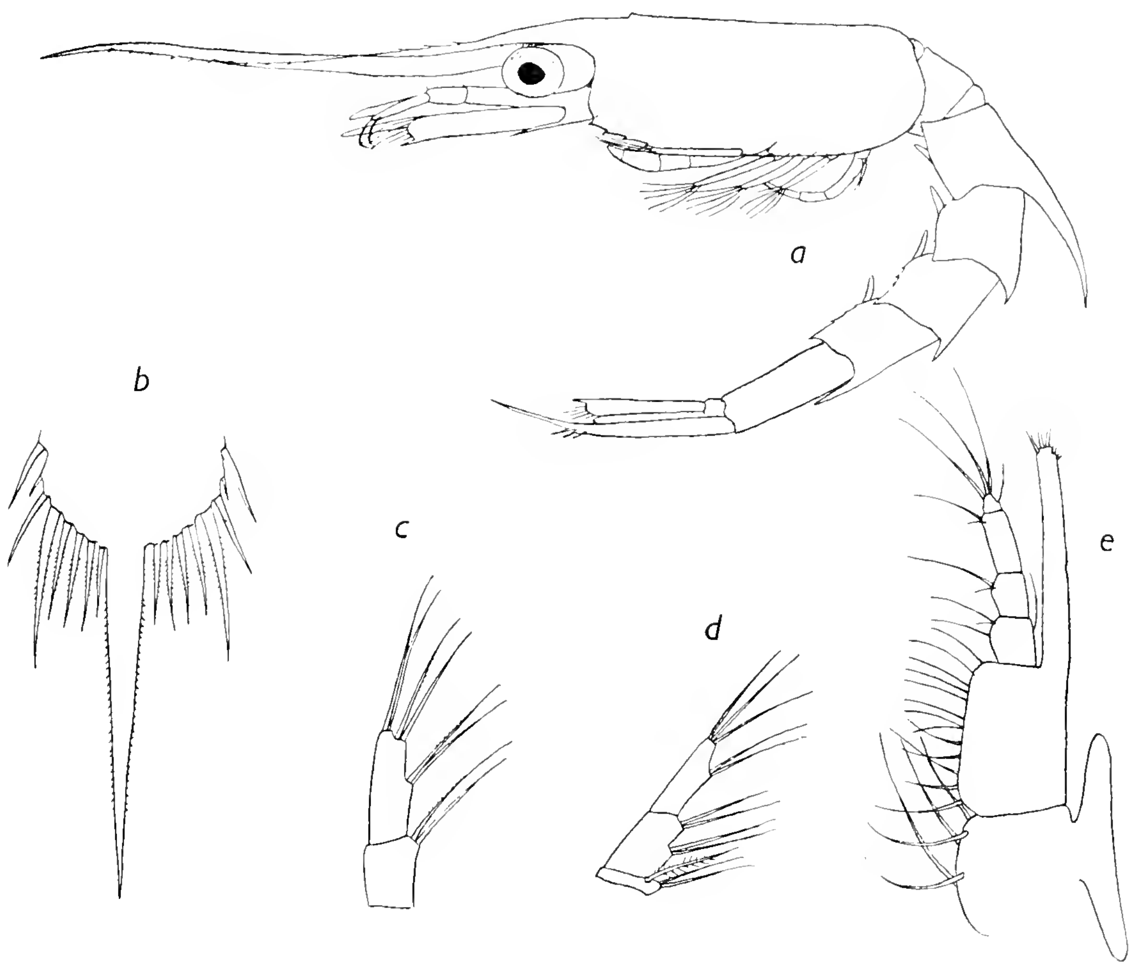


Fig. 8. Thalassinid B.R. I.

a. Side view. *b*. Part of telson. *c*. Palp of maxillule.
d. Palp of maxilla. *e*. Maxillipede 1.

Telson about three times as long as wide, slightly wider at end, spines 1–4 closely crowded at posterior angle, spine 2 very small; posterior margin convex, with enormous median spine and four spines on either side; formula 8, 1, 8.

Antenna with small inner spine on basis; scale without outer basal seta. Maxillule with palp of two segments. Maxilla with palp of three segments. Maxillipede 1 with outer seta on segment 1 of endopod.

Legs 1 and 2 chelate, small. Leg 5 with setose exopod. Epipods and a pair of arthrobranchs on legs 1–4. Pleopods on somites 2–5.

The large dorsal spine on somite 2 and the position of spines 1–3 near the end of the telson are characters more of *Callianassa* than of *Axius*, but the great length of the rostrum, presence of epipods and exopod on leg 5 justify its position in this group.

Thalassinid D. III (Fig. 9)

Discovery St. 1581.

Rostrum 2·3 mm.; body 6·73 mm.

Rostrum slender, tapering, serrated nearly to end. Margin of carapace with ten small spines. Abdomen: somites 2–6 with subequal dorsal spines; pleura rounded.

Telson nearly three times as long as wide; distal margin slightly produced, with very long median spine and four spines on either side; spine formula 8, 1, 8.

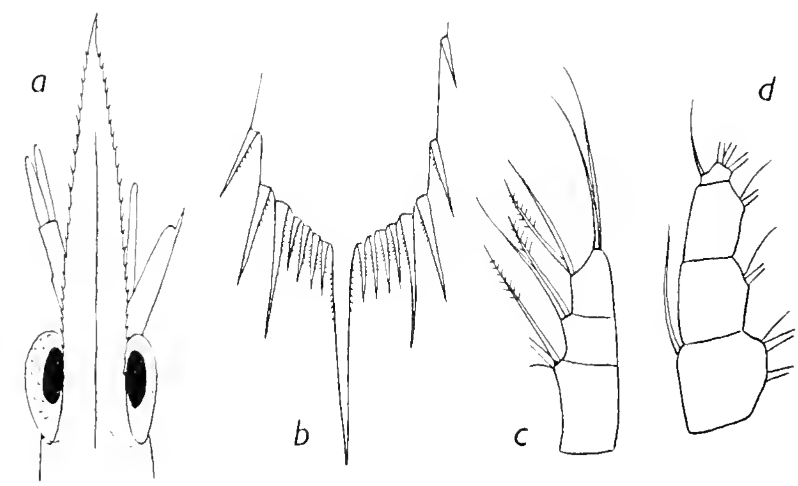


Fig. 9. Thalassinid D. III. St. 1581.

a. Rostrum. *b*. Telson. *c*. Palp of maxillule. *d*. Endopod of maxillipede 1.

Eye narrow, oval. Antenna with small inner spine on basis, and outer basal seta on scale. Palp of maxillule and maxilla of three segments. Maxillipede 1; endopod stout, with outer seta on segment 1.

Chelae of leg 1 very large. Leg 5 with long exopod. Epipods present on legs 1–4. Pleopods on somites 2–5.

Thalassinid D. IV (Fig. 10)

Discovery Sts. 1578, 1581.

Rostrum 2·06 mm.; body 9·72 mm.

Rostrum short, broad, tapering, without teeth at end. Carapace with about five large marginal spines. Abdomen: somite 2 without dorsal spine; somites 3–5 with subequal spines. Pleura of somites 2–5 with two ventral points.

Telson three times as long as wide, distal margin slightly prominent with long median spine and four spines on either side; spine formula 8, 1, 8.

Eye oval. Antenna: basis with long outer and inner spines; scale without outer basal seta. Maxillule with palp slender, of two segments. Maxilla with palp of three segments. Maxillipede 1 with outer seta on segment 1.

Chelae not very large. Leg 5 with long exopod. Epipods with rudiment of podobranch on legs 1–3, without podobranch on leg 4. Four pairs of pleopods.

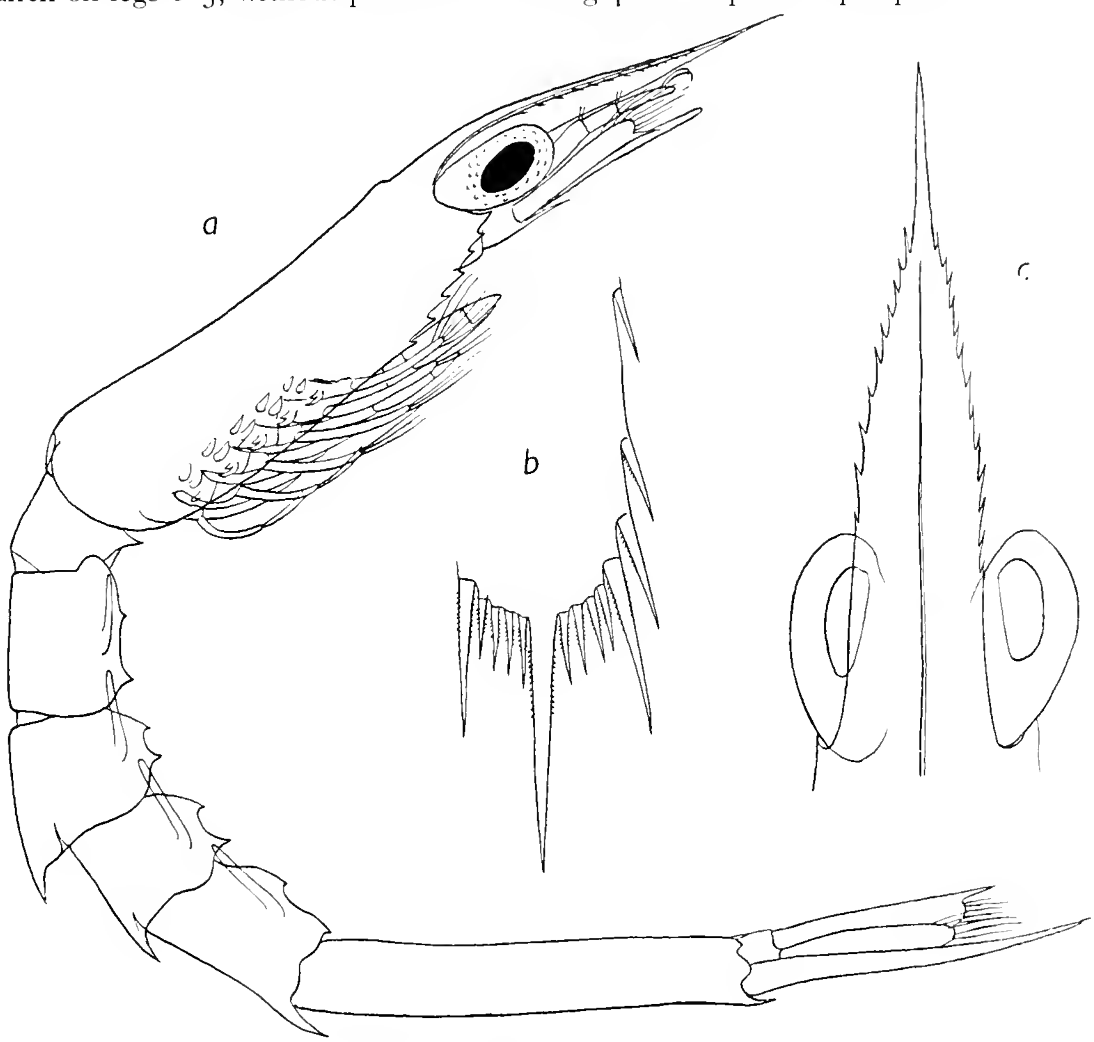


Fig. 10. Thalassinid D. IV. St. 1581.

a. Side view. *b.* Telson. *c.* Head and rostrum.

Thalassinid B.R. II (Fig. 11)

Barrier Reef St. 46.

Rostrum 1·15 mm.; body 4·0 mm.

Rostrum very broad, scarcely longer than antennule. Carapace with close-set marginal spines in front. Abdomen: somites 1–3 without spines; somites 4 and 5 with dorsal spine.

Telson twice as long as wide, spines 1 and 2 wide apart, but near angle; posterior margin convex, with long median spine and four spines either side. Spine formula 8, 1, 8.

Eye oval, black. Antenna: basis with inner spine, outer spine not very long; scale without outer basal seta. Palp of maxillule of two segments, that of maxilla of three. Maxillipede 1 with outer seta on segment 1.

Chela of leg 1 much larger than leg 2. Leg 5 with minute exopod without setae. Epipods on legs 1–4. Four pairs of pleopods.

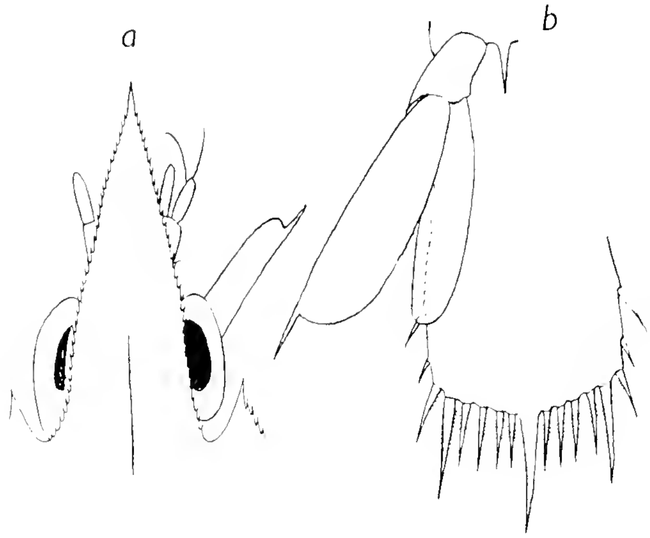


Fig. 11. Thalassinid B.R. II.
a. Head and rostrum. *b.* Telson.

Group I B

Dorsal spines on some abdominal somites paired

The six species included in this group all agree in having a telson of "A" type and well developed exopod on leg 5. In having some of the dorsal spines in pairs they resemble *Axius stirhynchus*, and there can be very little doubt that they may be assigned to Axiidae.

Thalassinid D. V (Fig. 12)

Discovery St. 711.

Rostrum 2·65 mm.; body 7·07 mm.

Rostrum broad, tapering, not greatly longer than antennule. Carapace with close-set small marginal spines in front. Abdomen: somite 2 with large dorsal spine; somites 3–5 with a pair of small dorsal spines, or somite 3 without spines. Pleura rounded.

Telson three times as long as wide, slightly produced distally, with spine formula 8, 1, 8.

Eye oval. Antenna with large inner and outer spines on basis; scale with outer basal seta. Maxillule: palp short and stout, of two segments. Maxilla with palp of three segments. Maxillipede 1 with outer seta on segment 1.

Leg 1 not fully developed. Leg 5 with long exopod. Epipods present on legs 1–4. Four pairs of pleopods.

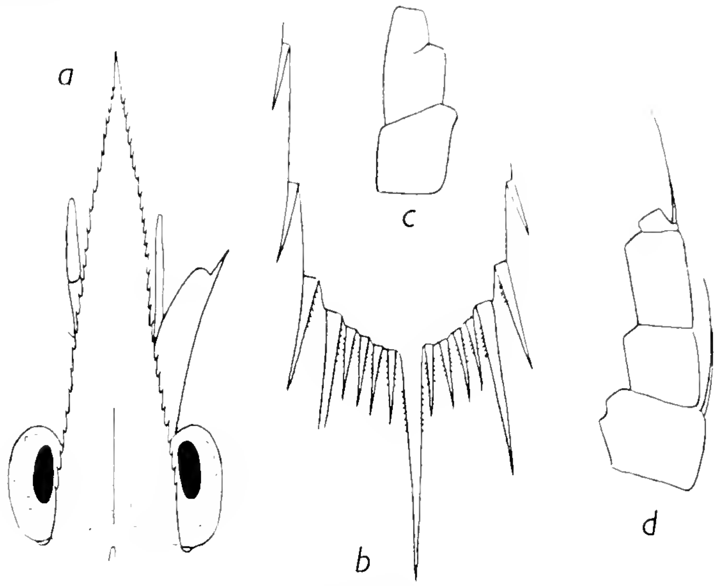


Fig. 12. Thalassinid D. V. St. 711.

a. Rostrum. *b*. Telson.
c. Palp of maxillule. *d*. Endopod of maxillipede 1.

Thalassinid D. VI (Fig. 13)

Discovery Sts. 1574, 1576.

Rostrum 2·45 mm.; body 6·45 mm.

Rostrum rather narrow, tapering, with slender smooth apical part. Carapace with ten small marginal spines. Abdomen: somite 2 with large dorsal spine, somites 3–5

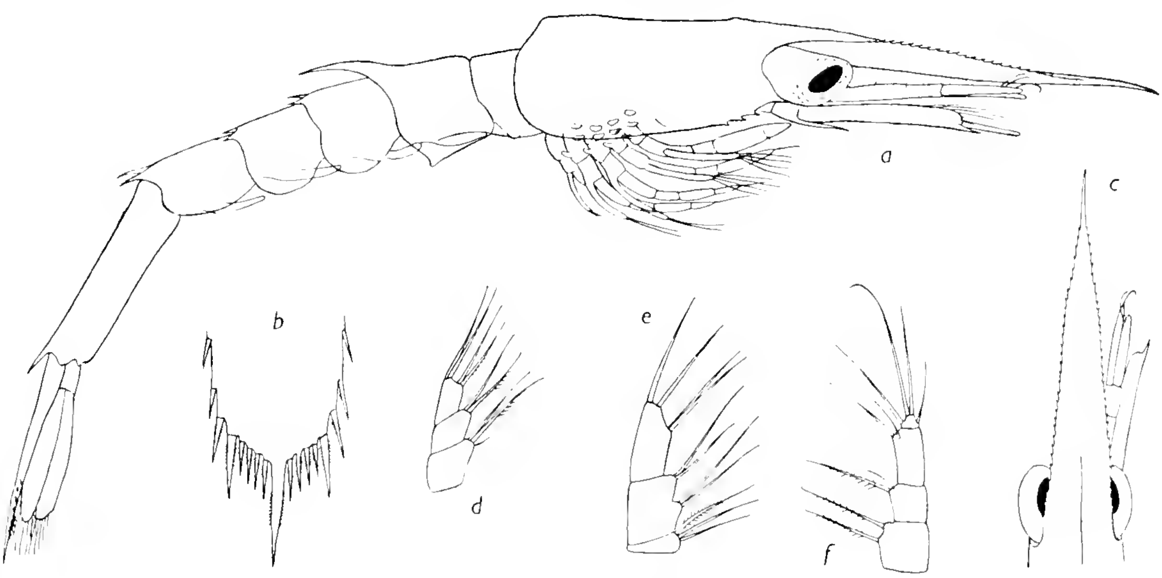


Fig. 13. Thalassinid D. VI. St. 1574.

a. Side view. *b*. Telson. *c*. Head and rostrum.
d. Palp of maxillule. *e*. Palp of maxilla. *f*. Endopod of maxillipede 1.

with a pair of dorsal spines. Pleura of somite 2 with blunt ventral point, the rest rounded.

Telson about three times as long as wide; posterior margin convex, with long median spine; spine formula 8, 1, 8.

Eye oval. Antenna with small inner spine on basis, scale with outer basal seta. Maxillule and maxilla with palp of three segments. Maxillipede 1 without outer seta on segment 1.

Leg 1 chelae not fully formed. Leg 5 with exopod. Epipods on legs 1 and 2; gills not yet developed. Four pairs of pleopods.

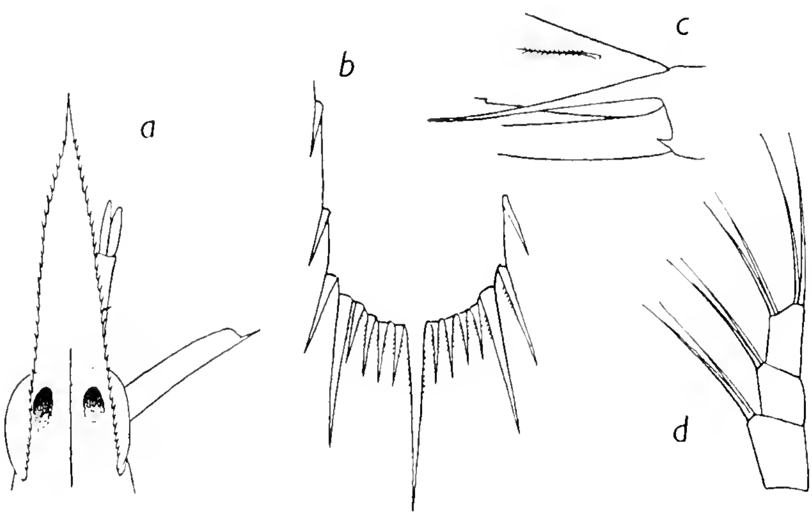


Fig. 14. Thalassinid D. VII. St. 708.

a. Head and rostrum. *b.* Telson. *c.* Antenna. *d.* Palp of maxillule.

Thalassinid D. VII (Fig. 14)

Discovery St. 708.

Rostrum 2·06 mm.; body 5·95 mm.

Rostrum rather broad, tapering, serrated to end, not much longer than antennule. Carapace with close-set small marginal spines in front and behind. Abdomen: somite 2 with large dorsal spine; somite 3 with small dorsal pair; somites 4 and 5 with a pair of very small dorsal and a pair of larger dorso-lateral spines. Pleura rounded.

Telson about three times as long as wide; posterior margin convex, with median spine not much longer than spine 4; spine formula 8, 1, 8.

Eye oval. Antenna with inner spine of basis very small; scale with outer basal seta. Palp of maxillule and maxilla of three segments. Maxillipede 1 with outer seta on segment 1.

Chelae not fully formed. Leg 5 with exopod. Epipods developing on legs 1–4. Four pairs of pleopods.

Thalassinid D. VIII (Fig. 15)

Discovery St. 708.

Rostrum 1·88 mm.; body 5·28 mm.

Rostrum not much longer than antennule, rather broad, serrated to end. Carapace with close-set marginal spines in front, smooth behind. Abdomen: somite 2 without spine; somites 3–5 with a pair of small dorsal spines. Pleura rounded.

Telson less than three times as long as wide; posterior margin slightly convex, median spine rather short; spine formula 8, 1, 8.

Eye nearly round. Antenna with small inner spine on basis; scale without outer basal seta. Palp of maxillule and maxilla of three segments. Maxillipede 1 with outer seta on segment 1.

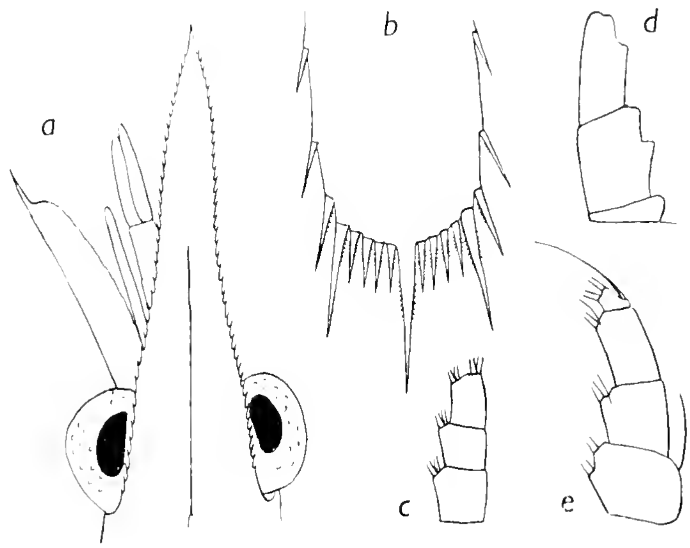


Fig. 15. Thalassinid D. VIII. St. 708.

a. Head and rostrum. *b*. Telson. *c*. Palp of maxillule.
d. Palp of maxilla. *e*. Endopod of maxillipede 1.

Chelae not fully formed. Leg 5 with exopod. Epipods on legs 1–4. Pleopods not visible.

The last four species are represented only by specimens not fully developed.

Thalassinid D. IX (Fig. 16)

Oodeopus geminidentatus Bate.

Discovery St. 1576.

Rostrum 2·6 mm.; body 6·75 mm.

Rostrum much longer than antennule, slender, with smooth end. Carapace with very large spine at anterior angle and close-set marginal spines in front and behind. Abdomen: somites 2–5 with subequal pairs of dorsal spines. Pleura 2–5 with strong ventral blunt process.

Telson nearly four times as long as wide; posterior margin produced, with very long median spine; spine formula 8, 1, 8.

Eye oval. Antenna with very small inner spine on basis; scale with outer basal seta. Maxillule and maxilla with palp of three segments. Maxillipede 1 with outer seta on segment 1.

Leg 1 chela very large. Leg 5 with long exopod. Epipods on legs 1–4. Four pairs of pleopods.

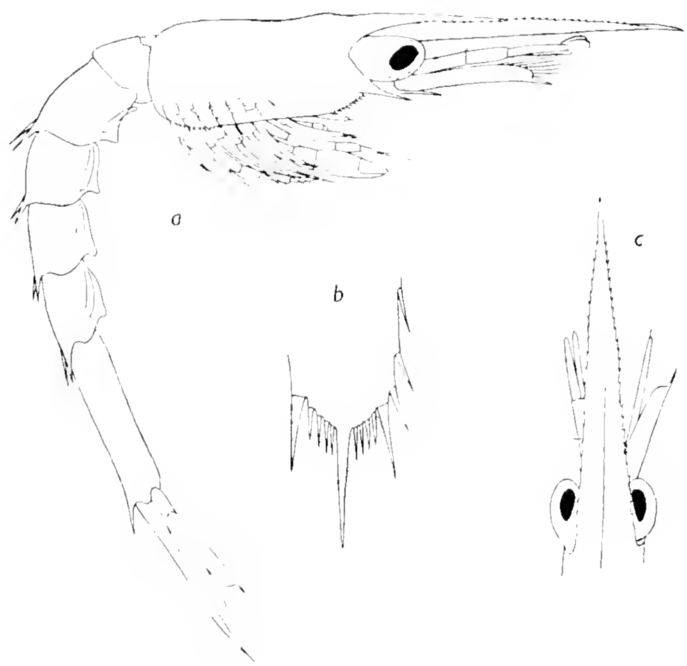


Fig. 16. Thalassinid D. IX. St. 1576.

a. Side view. *b.* Telson. *c.* Rostrum.

Thalassinid B.R. III (Fig. 17)

Barrier Reef Sts. 46, 49.

Rostrum 2·0 mm.; body 5·35 mm.

Rostrum broad at base, tapering, not greatly longer than antennule. Carapace with close-set marginal spines in front. Abdomen: somite 2 without spines; somites 4 and 5 with dorsal pair.

Telson parallel-sided, three times as long as wide; spines 1–4 widely separated; posterior margin convex with long median spine and four spines either side; spine formula 8, 1, 8.

Eye nearly round, black. Antenna: basis with very long outer and very small inner spine; scale without outer basal seta. Palp of maxillule and maxilla of three segments. Maxillipede 1 with outer seta on segment 1.

Chelae of legs 1 and 2 of fair size. Leg 5 with exopod as long as ischium, with five setae. Epipods on legs 1–4. Four pairs of pleopods.

In stage III the telson widens towards the end and spines 1–4 are close together near the posterior angle.

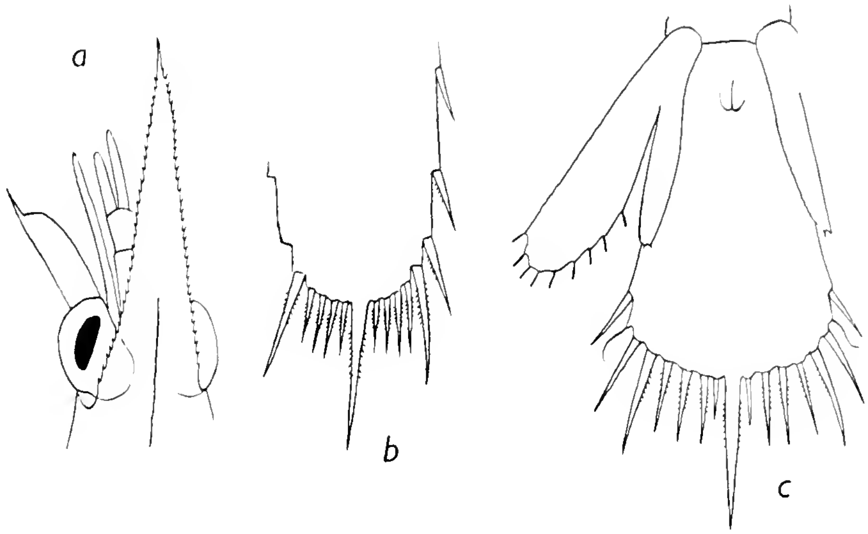


Fig. 17. Thalassinid B.R. III.

a. Rostrum. *b*. Telson. *c*. Telson, stage III.

GROUP II

Without epipods

Group II includes species of which the only common character is the absence of epipods, and it is doubtful whether too much importance has not been attached to this fact. Group II A seems to be really closely allied to Group I A, and to belong to the Axiidae, though species B.R. V is difficult to place. The telson is of an intermediate type, and the arrangement of the posterior spines is unlike that of any other form.

Group II B is purely artificial, since species D. XIII is probably a young form of D. X, and B.R. VI appears to be a Callianassid, though with a telson of quite typical "A" type.

Group II C consists of species which are almost certainly *Callianassa* of type I; in fact D. XIV has most of the characters of *C. subterranea*.

Group II D is again doubtful, but the assumption is made that the absence of epipods is sufficient to determine them as Callianassidae. At the same time such an assumption presents great difficulties. In the first place no *Callianassa* of this type is known with an exopod on leg 5, and in *C. laticauda* exopods are present only on legs 1 and 2. The fact that the mouth parts are rudimentary, whereas they are fully developed in European species, is not a serious difficulty, since they are rudimentary also in some *Callianassa* described from the Red Sea (Gurney, 1937*b*).

While it may probably be accepted that species D. XVII and B.R. X, which have no exopod on leg 5 and three pairs of pleopods, are actually species of *Callianassa* the other two are uncertain. Species B.R. IX has an exopod on leg 5 and four pairs of pleopods and, if it were not for the absence of epipods, would be regarded as an Axiid. Species B.R. XI has lost the exopods from all the legs, and so has gone further in reduction than any known Callianassid. It has also a very remarkable character, namely the rudimentary endopod of maxillipede 3, seated low down on the basis, a character which I supposed was confined to the Upogebiidae, Laomediidae and Anomura. If it is properly placed among the Axiid-Callianassid group this character ceases to have the systematic importance I have attached to it.

Group II A

Telson of "A" type with four pairs of pleopods.
Exopod of leg 5 reduced or absent

Thalassinid D. X (Figs. 18, 19)

Discovery St. 690.

Rostrum 4·2 mm.; body 9·94 mm.

Rostrum long, slender, with long narrow smooth distal part. Carapace with small spine at anterior angle and few marginal teeth. Abdomen: somite 2 with dorsal spine longer than somite 3; somites 3–6 slightly ridged, with small spines. Pleura all rounded.

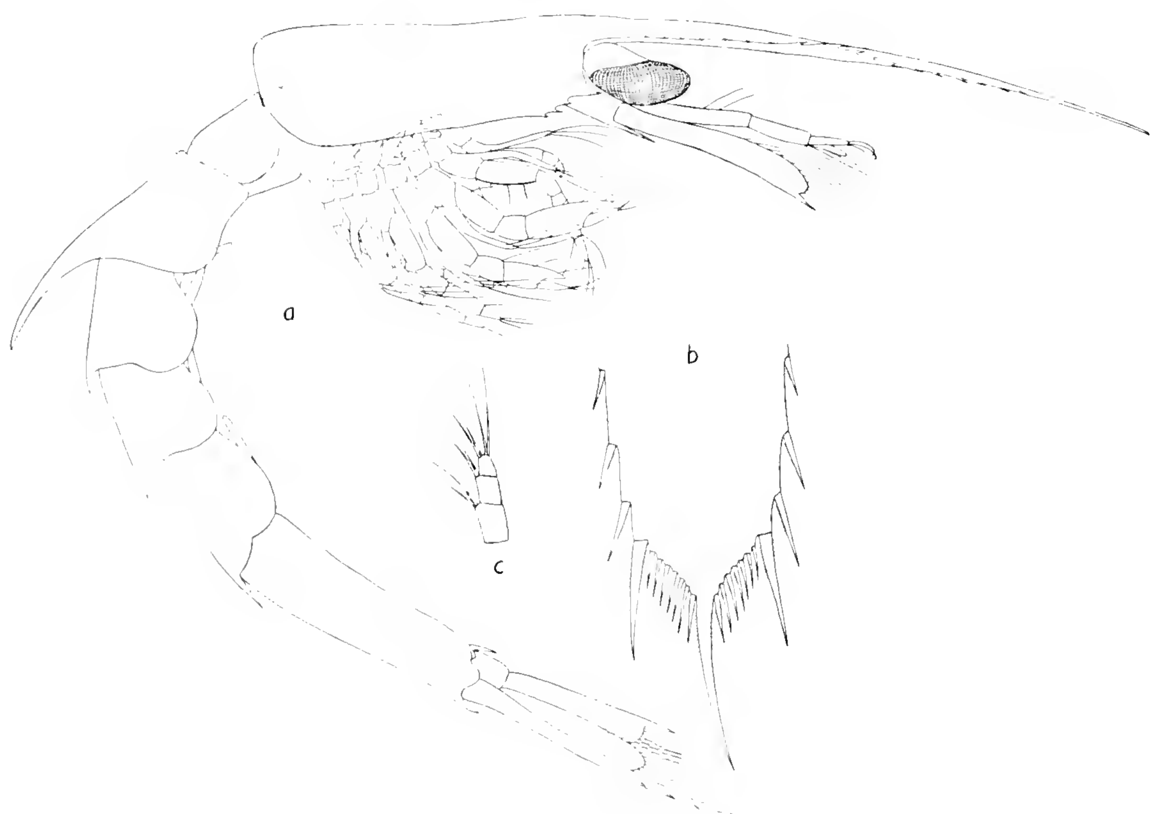


Fig. 18. Thalassinid D. X. St. 690.

a. Side view. *b*. Telson. *c*. Palp of maxillule.

Telson nearly four times as long as wide, with four rather widely spaced lateral spines; distal margin produced, with seven spines on either side of the median spine; spine formula 11, 1, 11.

Eye oval. Antenna without inner spine on basis; scale with outer basal seta. Maxillule with palp usually of two segments. Maxilla with palp of three segments. Maxillipede 1 with outer seta on segment 1.

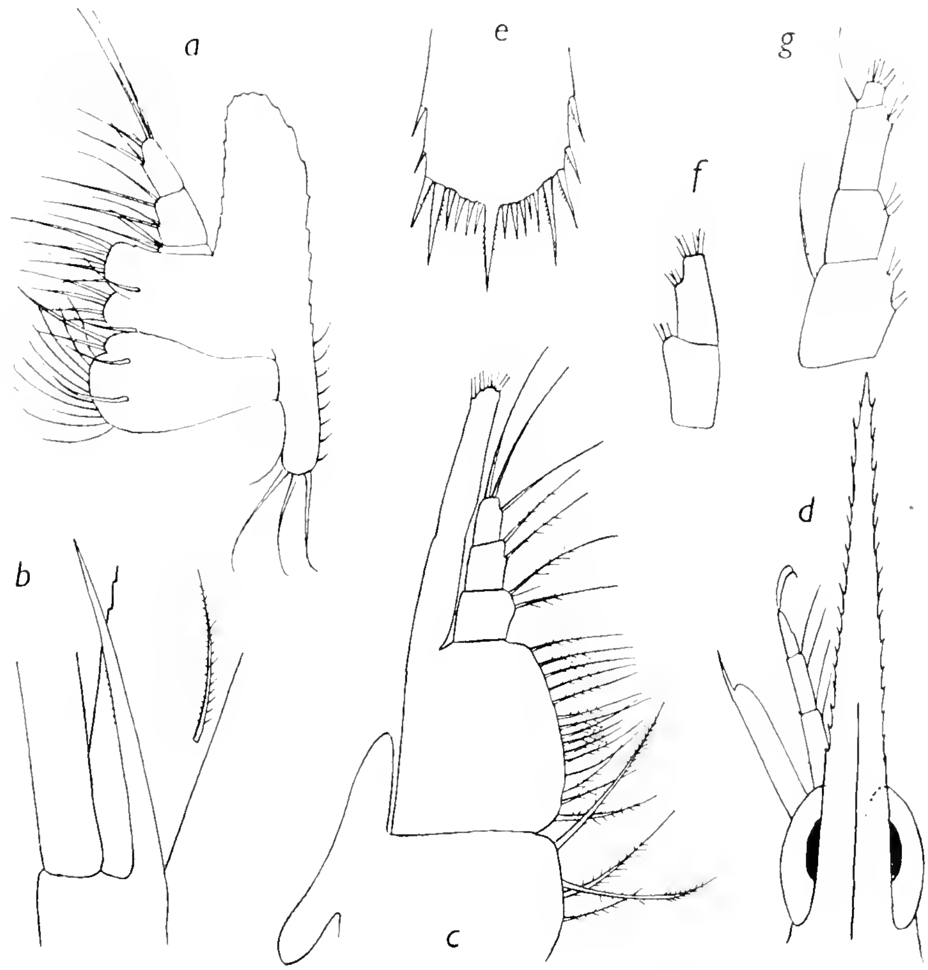


Fig. 19. Thalassinid D. X. St. 690.

a. Maxilla. *b*. Antenna. *c*. Maxillipede 1. *d*. Rostrum. St. 708. *e*. Telson. St. 708. *f*. Palp of maxillule. St. 1581. *g*. Endopod of maxillipede 1. St. 1581.

Chelae of leg 1 large. Leg 5 with very small setose exopod. Epipods absent. Four pairs of pleopods.

This form is as widely distributed and nearly as common as species D. I. Small differences found suggest that more than one species may be included:

(1) Specimens from the Indian Ocean, while agreeing in general characters with those from Atlantic differ in small details. Those from Sts. 1574, 1578 and 1589 have six spines on each side of the median telson spine, and are, on the whole, larger.

(2) Specimens from Sts. 1581, 1585 and 1589 have the rostrum not constricted distally, and four spines on each side of the median spine.

(3) One specimen from St. 1585 has the pleura of somite 2 pointed, eyes narrower, and rostrum more slender; also five spines on each side of the median telson spine.

A young specimen, presumably of this form, has rostrum without the bare apical part and the end of the telson not produced and with four spines on either side of the median spine, fig. 10 *d, e*. It is to be supposed that the form of the telson changes considerably during growth.

Thalassinid D. XI (Fig. 20)

Discovery St. 1576.

Rostrum 3 mm.; body 8·2 mm.

Rostrum rather broad, tapering, much longer than antennule. Carapace with few marginal spines. Abdomen: somite 2 with very large dorsal spine; somites 3–5 slightly ridged. Pleura all rounded.

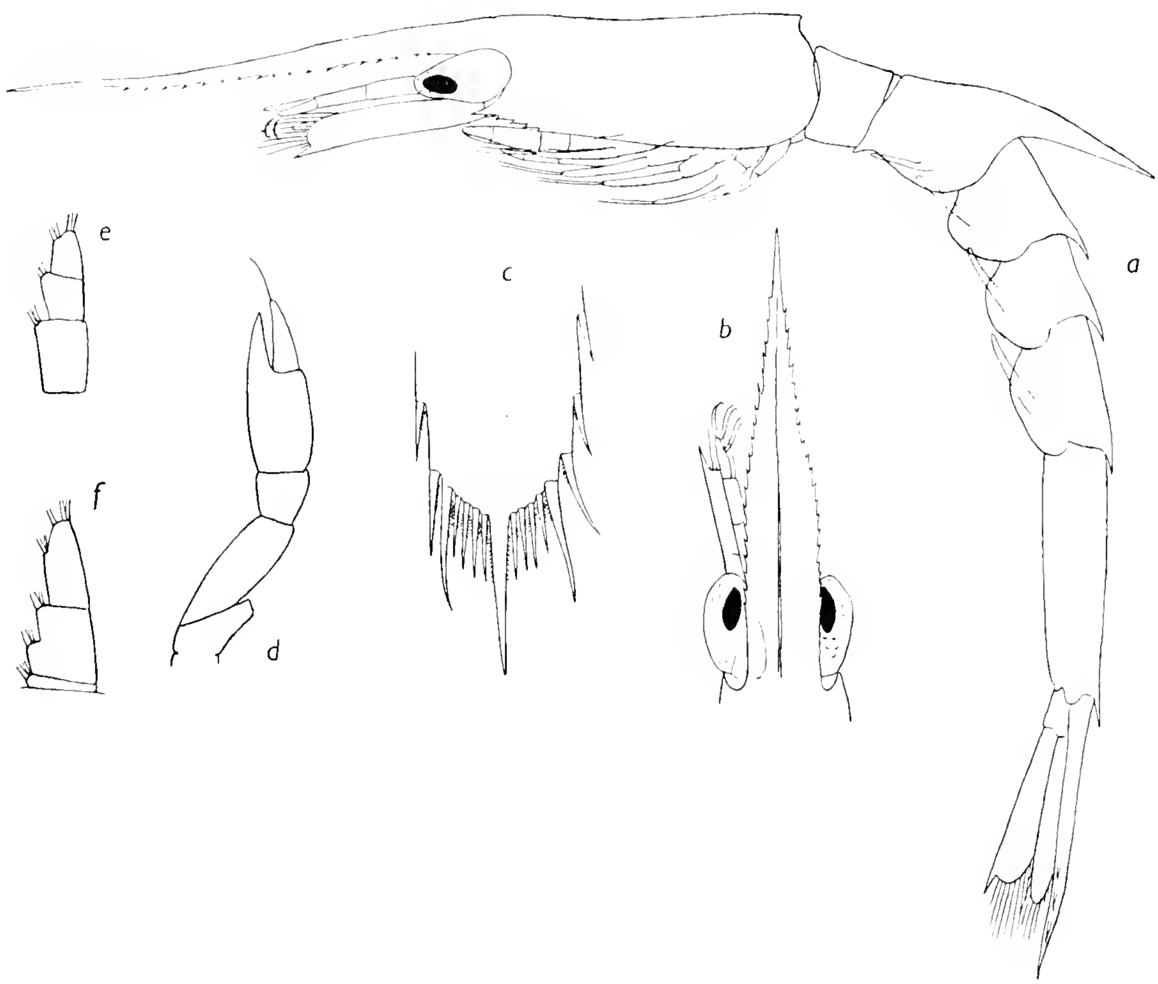


Fig. 20. Thalassinid D. XI. St. 1576.

a. Side view. *b*. Rostrum. *c*. Telson.
d. Chela of leg 1. *e*. Palp of maxillule. *f*. Palp of maxilla.

Telson nearly four times as long as wide; lateral spines widely spaced; distal margin produced, with four spines on either side of the very long median spine; spine formula 8, 1, 8.

Eye oval. Antenna without inner spine on basis; with outer basal seta on scale. Maxillule and maxilla with palp of three segments. Maxillipede 1 with outer seta on segment 1.

Leg 1 chela large. Leg 5 with small exopod. Epipods absent. Four pairs of pleopods.

Thalassinid D. XII (Figs. 21, 22)

Discovery Sts. 1574, 1576.

Rostrum 2·4 mm.; body 7·79 mm.

Rostrum broad, not much longer than antennule, constricted at end into a short smooth point. Carapace with about nine marginal spines. Abdomen: somite 2 with large, deeply hollowed, dorsal spine; somites 3–5 with small hollowed spines. Pleura all rounded.

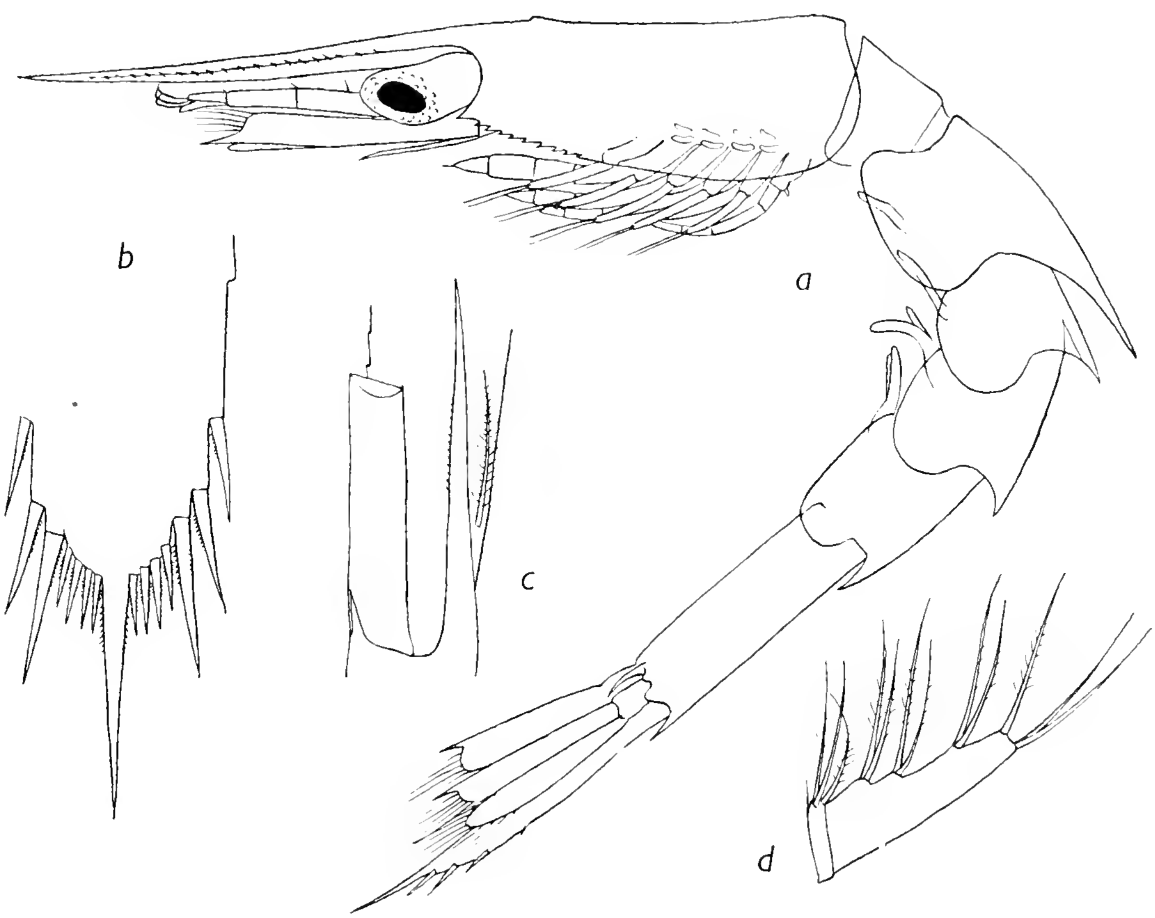


Fig. 21. Thalassinid D. XII. St. 1574.

a. Side view. *b*. Telson.
c. Antenna. *d*. Palp of maxilla.

Telson nearly four times as long as wide with four large widely spaced lateral spines; distal margin produced, with four spines on either side of the very large median spine; spine formula 8, 1, 8.

Eye oval. Antenna: basis with small inner spine; scale with outer basal seta. Maxillule with palp of two segments; maxilla with small basal segment distinct, the rest not distinctly segmented. Maxillipede 1 with outer seta on segment 1.

Chelae of leg 1 stout. Leg 5 with vestigial exopod. Epipods absent. Four pairs of pleopods.

A specimen from St. 1576 very closely resembles this species, but differs in several details. The dorsal spines are smaller; the proportional length of the spines of the telson is not the same, and the chela of leg 1 is much stouter. There is also no seta on the antennal scale.

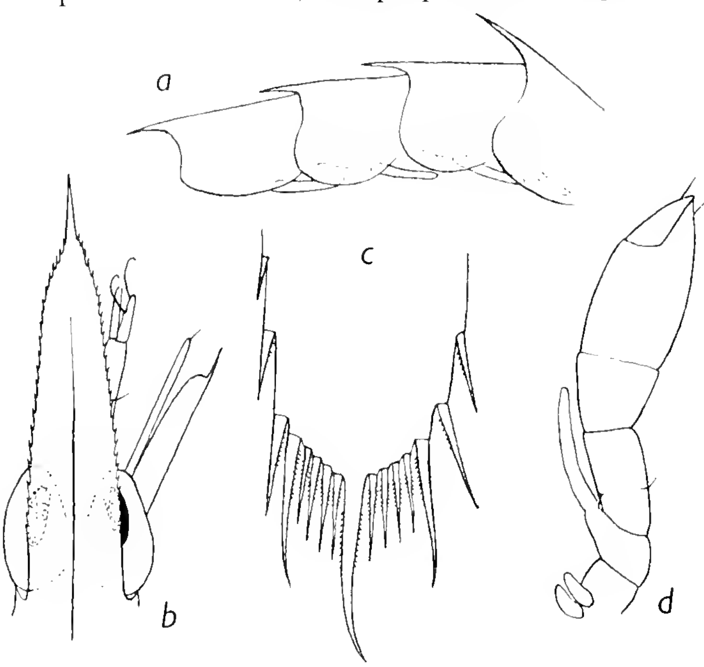


Fig. 22. Thalassinid D. XII. St. 1576.

a. Abdomen. *b*. Rostrum.
c. Telson. *d*. Chela, leg 1.

Two specimens from St. 1580 cannot be distinguished from the form described except that there is no trace of an exopod on leg 5.

Thalassinid B.R. IV

Barrier Reef St. 50.

Rostrum 1·75 mm.; body 5·95 mm.

Rostrum broad, tapering, much longer than antennule. Carapace with seven small marginal spines. Abdomen: somite 2 with very large hollowed spine; somites 3–5 with small spines and slight ridge. Pleura rounded.

Telson three times as long as wide, parallel-sided; posterior margin convex, with very long median spine; spine formula 8, 1, 8.

Eye oval. Antenna: basis with small inner spine; scale with outer basal seta. Palp of maxillule and maxilla of three segments. Maxillipede 1 with outer seta on segment 1; epipod bilobed.

Chelae of legs 1 and 2 large. Leg 5 with minute exopod. Epipods absent. Four pairs of pleopods.

Thalassinid B.R. V (Fig. 23)

Barrier Reef St. 54.

Rostrum 1·35 mm.; body 4·93 mm.

Rostrum broad, not much longer than antennule. Carapace with close-set marginal spines in front and a dorsal ridge armed with spinules. Abdomen: somite 2 with very large hollowed spine; somites 3–5 with smooth ridge and small spines. Pleura rounded.

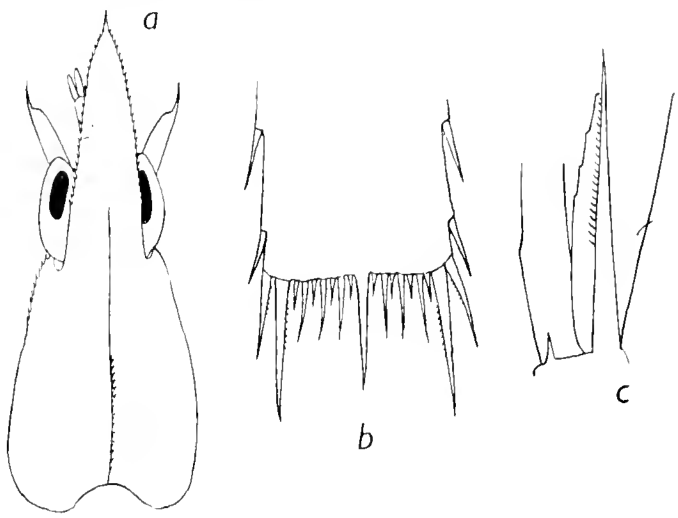


Fig. 23. Thalassinid B.R. V.
a. Thorax, dorsal. *b.* Telson. *c.* Antenna.

Telson about twice as long as wide, slightly widening distally; posterior margin straight. Spines 1 and 2 widely separated, spine 4 very long; median spine shorter than spine 4, with seven spines on either side alternately long and short; spine formula 11, 1, 11.

Eye oval. Antenna: basis with very long outer and very small inner spine; scale with a minute hair near base. Palp of maxillule and maxilla of three segments. Maxillipede 1 with outer seta on segment 1, epipod small, not bilobed.

Chelae of legs 1 and 2 large. Leg 5 without exopod. Epipods absent. Four pairs of pleopods.

Group II B

Telson of "A" type; three pairs of pleopods

Thalassinid D. XIII

Discovery St. 705.

Rostrum 2 mm.; body 6·85 mm.

Rostrum broad, little longer than antennule. Carapace with few large marginal teeth. Abdomen: somite 2 with very large dorsal spine; somites 3–5 with small spines. Pleura all rounded.

Telson three times as long as wide, with four widely-spaced lateral spines; distal margin not produced, with seven spines on either side of median spine; spine formula 11, 1, 11.

Eye oval. Antenna without inner spine on basis; with outer basal seta on scale. Palp of maxillule and maxilla of three segments. Maxillipede 1 with outer seta on segment 1.

Chelae not fully developed. Leg 5 with small exopod. Epipods absent. Three pairs of pleopods.

As the three specimens are all young it is possible that the pleopod on somite 2 may appear late. If this is so they may be referable to species D. X.

Thalassinid B.R. VI (Fig. 24)

Barrier Reef St. 44.

Rostrum 1·0 mm.; body 3·7 mm.

Rostrum broad, scarcely longer than antennule. Carapace with small, close-set teeth. Abdomen: somite 2 with large hollowed spine; somites 3–5 with low smooth ridge and small posterior point. Pleura all rounded.

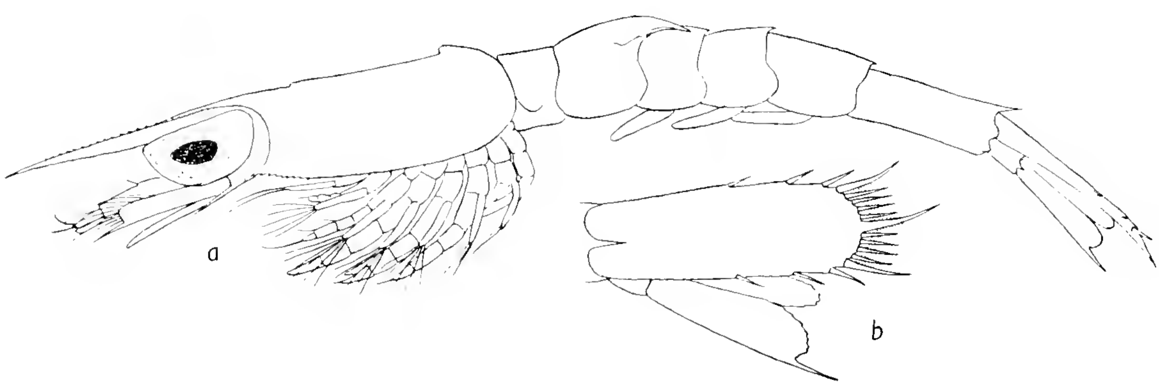


Fig. 24. Thalassinid B.R. VI.
a. Side view. *b.* Telson.

Telson three times as long as wide; lateral spines widely spaced; posterior margin convex, with four spines on either side of the median spine; spine formula 8, 1, 8.

Eye pale, slightly pointed. Antenna: basis with small inner spine; scale without outer basal seta. Palp of maxillule and maxillae of three segments. Maxillipede 1 with outer seta on segment 1.

Legs 1 and 2 with large chelae. Leg 5 without exopod. Epipods absent. Three pairs of pleopods.

STAGE I. Total length 2·35 mm.

Rostrum cylindrical with terminal spicules. Telson as in *Callianassa*, triangular, with median spine shorter than spine 7.

Group II C

Telson of C I type; leg 5 without exopod

Callianassa? D. XIV (Fig. 25)

Discovery St. 278.

Rostrum 1·2 mm.; body 4·37 mm.

Rostrum broad, not much longer than antennule, with narrow bare tip; dorsal ridge continuing on to carapace. Carapace closely serrated in front. Abdomen: somite 2 with very large dorsal spine reaching half way along somite 4; somites 3–5 with coarsely serrated dorsal ridge. Pleura all rounded.

Telson less than twice as long as wide, widening to end; spines 1 and 2 very small and near outer angle; posterior margin straight; spine formula 8, 1, 8.

Eye nearly round. Antenna with small outer setae at base of exopod: basis with small inner spine. Palp of maxillule and maxilla of three segments. Maxillipede 1 with outer seta on segment 1.

Legs without epipods. Leg 5 without exopod. Three pairs of pleopods.

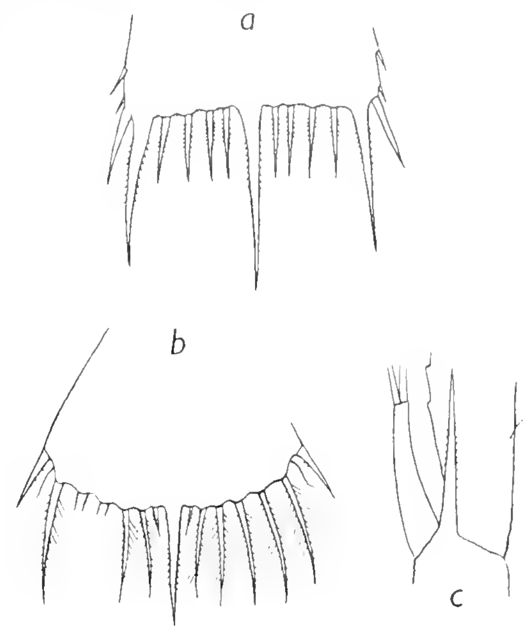


Fig. 25. Thalassinid D. XIV.
a. Telson. *b*. Telson stage II. *c*. Antenna, stage II.

Callianassa? D. XV (Fig. 26)

Discovery St. 708.

Rostrum 1·24 mm.; body 3·90 mm.

Rostrum very broad, scarcely longer than antennule. Carapace with close-set marginal spines in front. Abdomen: somite 2 with dorsal spine reaching end of somite 4; somites 3–5 with coarsely serrated dorsal ridge.

Telson less than twice as long as wide; lateral spines 1–4 close together at angle; posterior margin concave, with minute median spine and four spines on either side; spine formula 8, 1, 8.

Eye oval, rather pointed, pale. Antenna: basis without inner spine; scale with outer basal seta. Palp of maxillule and maxilla of three segments.

Chelae of legs 1 and 2 not fully formed, fairly large. Leg 5 without exopod. Epipods absent. Three pairs of pleopods.

Callianassa? D. XVI

Discovery St. 1375.

Rostrum 1·65 mm.; body 6·86 mm.

Rostrum broad, parallel-sided, considerably longer than antennule. Carapace with seven marginal spines. Abdomen: somite 2 with very large dorsal spine; somites 3–5 with serrated ridge.

Telson less than twice as long as wide; lateral spines 1–4 close to angle; posterior margin concave, with long median spine and four spines on either side.

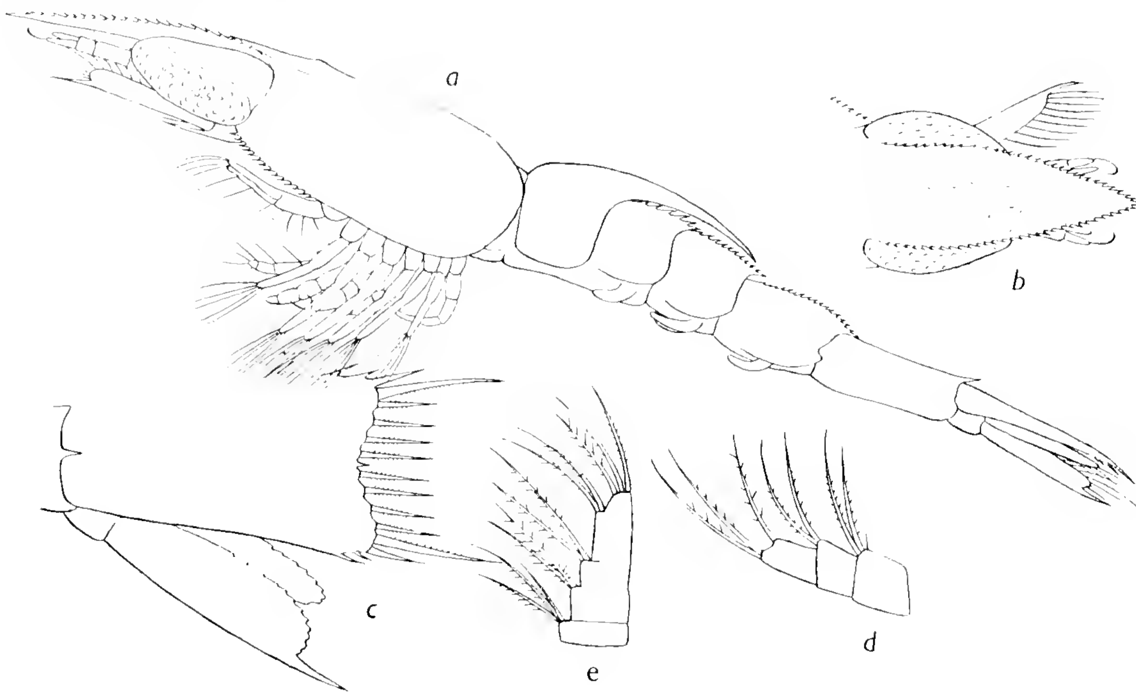


Fig. 26. Thalassinid D. XV. St. 708.

a. Side view. *b.* Rostrum. *c.* Telson.
d. Palp of maxillule. *e.* Palp of maxilla.

Eye oval, pointed, black. Antenna with small inner spine on basis; scale with long outer basal seta. Palp of maxillule and maxilla of three segments. Maxillipede with outer seta on segment 1.

Chelae of legs 1 and 2 not very large. Leg 5 without exopod. Epipods absent. Three pairs of pleopods.

Callianassa? B.R. VII (Fig. 27)

Barrier Reef St. 65.

Body 4·84 mm.

Rostrum broad, not much longer than antennule. Carapace with close-set spines in front. Abdomen: somite 2 with very large dorsal spine reaching to somite 4; somites 3–5 with slight smooth ridge and small posterior point.

Telson three times as long as wide, widening slightly to end, spines 1–3 widely separated;

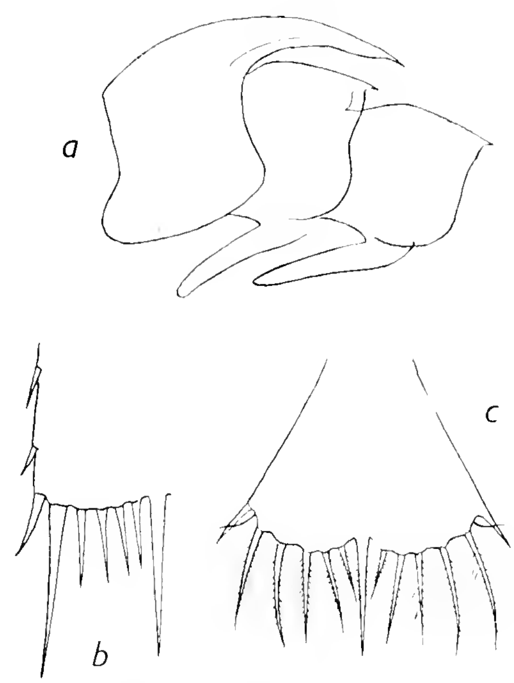


Fig. 27. Thalassinid B.R. VII.

a. Abdominal somites 2–4. *b.* Telson.
c. Telson, stage I.

posterior margin slightly concave, with long median spine and four spines either side; spine formula 8, 1, 8.

Eye rather pointed, black. Antenna: basis with inner spine; scale with long outer basal seta. Palp of maxillule and maxilla of three segments. Maxillipede 1 with outer seta on segment 1.

Chela of leg 1 large, dactyl longer than palm. Leg 5 without exopod. Epipods absent. Three pairs of pleopods.

Callianassa? B.R. VIII (Fig. 28)

Barrier Reef St. 44.

Rostrum 1·35 mm.; body 4·85 mm.

Rostrum rather broad, nearly parallel-sided. Carapace with small close-set spines in front. Abdomen: somite 2 with enormous dorsal spine curving over somite 3 and reaching middle of somite 4; somites 3–5 with high smooth ridge. Pleura rounded.

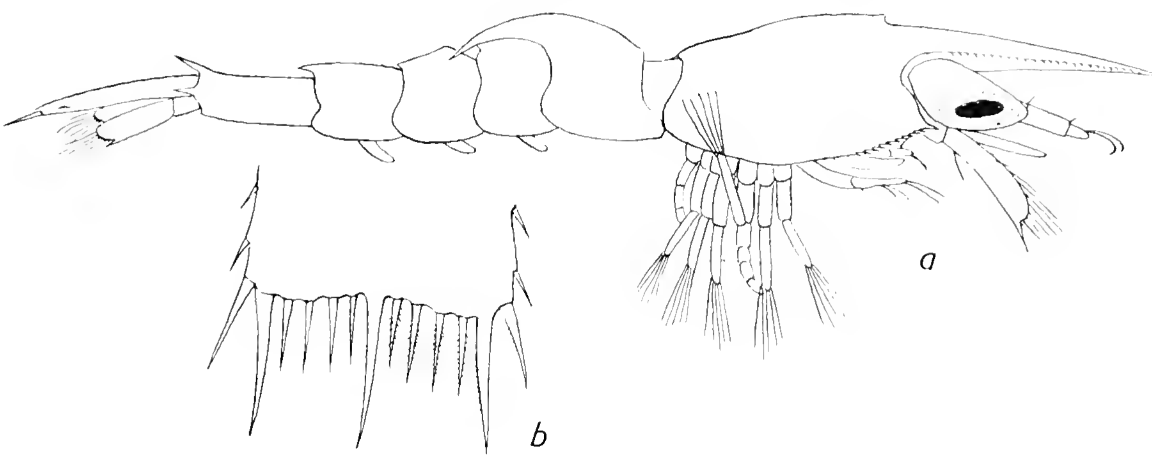


Fig. 28. Thalassinid B.R. VIII.
a. Side view. *b*. Telson.

Telson: length about $1\frac{1}{2}$ times width; lateral spines widely spaced; posterior margin slightly concave.

Eye rather pointed, black. Antennal scale with long basal seta on outer edge. Palp of maxillule and maxilla of three segments. Maxillipede 1 with outer seta on segment 1; epipod a small papilla.

Chelae of legs 1 and 2 not fully formed. Leg 5 without exopod. Epipods absent. Three pairs of pleopods.

Group II D

Telson of C II type

Callianassa? D. XVII (Fig. 29)

Discovery St. 406.

Rostrum 1·25 mm.; body 5·85 mm.

Rostrum rather narrow, little longer than antennule. Carapace with nine marginal spines. Abdomen: somite 2 with long dorsal spine as long as somite 3;

somites 3–5 with small spines, dorsal ridge very slight and smooth. Pleura rounded.

Telson wide, triangular, with 15, 1, 15 spines, spine 2 reduced to a hair; marginal spines decreasing in length towards the middle.

Eye round, small, black. Antennal scale with outer basal seta. Palp of maxillule and maxilla of three segments. Maxillipede 1 with outer seta on segment 1 and numerous setae on segments 2 and 3; exopod with eleven apical setae; epipod large.

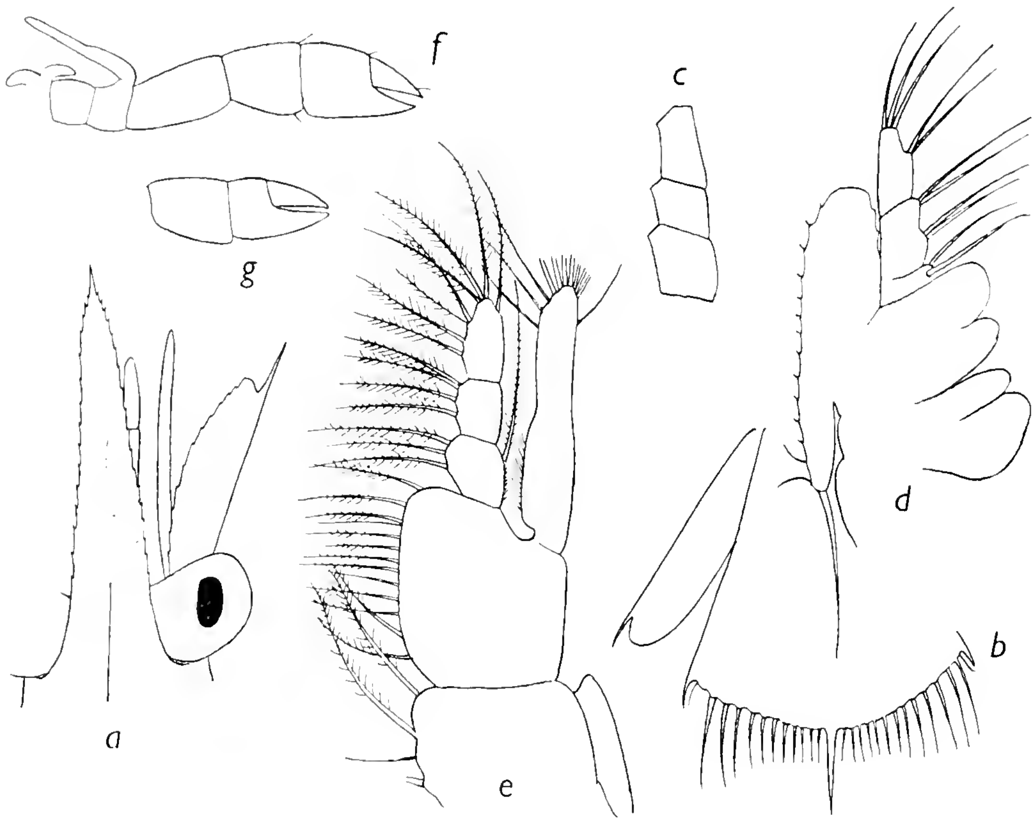


Fig. 29. Thalassinid D. XVII. St. 406.

a. Rostrum. *b*. Telson. *c*. Palp of maxillule. *d*. Maxilla. *e*. Maxillipede 1. *f*. Leg 1. *g*. Leg 2.

Legs 1 and 2 with large chelae, the palm wider than long. Legs 3 and 4 with propod rather broad. Leg 5 without exopod. Epipods absent. Pleopods on somites 3–5 very stout. Uropods large.

Callianassa? B.R. IX (Fig. 30)

Barrier Reef St. 46.

Total length 6·4 mm.

Rostrum narrow, serrated, not much longer than antennule. Carapace with small spine at anterior angle and three small marginal spines. Abdomen: somites 1–5 without spines; somite 6 with a small dorsal spine.

Telson wide, triangular, with 15, 1, 15 spines, spine 2 reduced to a hair.

Antenna: basis with very small inner and outer spines; scale broad with small apical spine and no basal outer seta. Mandible rudimentary, with palp. Maxillule rudimentary, without setae. Maxilla with well developed exopod, but laciniae and palp without setae. Maxillipede 1 with large bilobed epipod; endopod unsegmented, very small; coxa and basis without setae. Maxillipedes 2 and 3 with endopods unsegmented, without setae.

Legs 1–5 with exopods. Legs 1 and 2 with large chelae. Epipods absent from maxillipedes 2 and 3 and legs. Four pairs of pleopods, 4 and 5 with rudiment of appendix interna. Uropods traceable under skin.

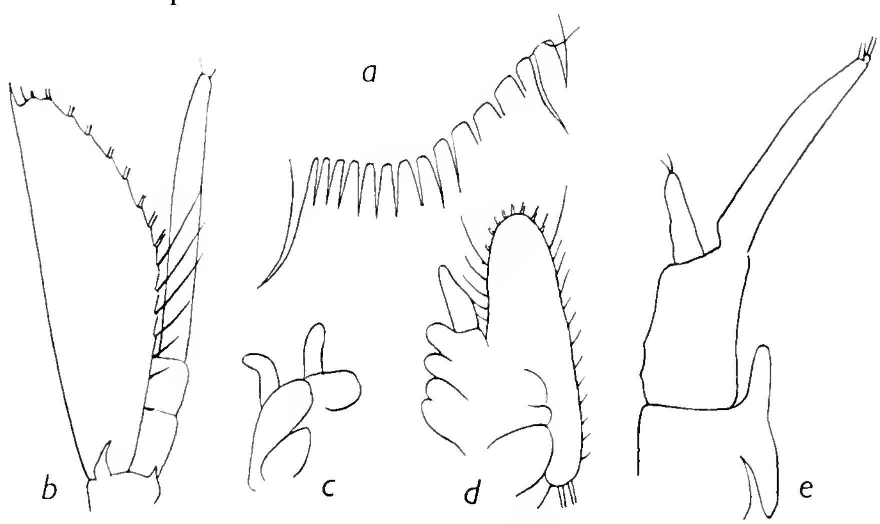


Fig. 30. Thalassinid B.R. IX.

a. Part of telson. *b.* Antenna. *c.* Mandible and maxillule. *d.* Maxilla. *e.* Maxillipede 1.

Callianassa? B.R. X

Barrier Reef St. 49.

Total length 6·8 mm.

Rostrum rather narrow, scarcely longer than antennule. Carapace with a few small marginal teeth. Abdomen: somites 2–5 with small dorsal spines, slightly ridged.

Telson broad, triangular, with 19, 1, 19 spines.

Eye round, black. Antenna: basis with small outer and minute inner spines; scale without outer basal seta. Mouth parts rudimentary.

Legs 1 and 2 with rather small chelae. Leg 4 with small exopod; leg 5 without exopod. Epipods absent. Three pairs of large pleopods.

Callianassa? B.R. XI (Fig. 31)

Barrier Reef St. 49.

Total length 5·7 mm.

Abdomen: somites 4–6 with small dorsal spines, not ridged.

Telson broad, triangular, with 14, 1, 14 spines.

Antenna: basis with small inner and outer spines; scale broad, without outer basal seta. Mouth parts rudimentary. Endopods of maxillipedes 2 and 3 rudimentary, seated low down on basis. Exopods on maxillipedes 1–3 only.

Chelae of legs 1 and 2 large. Epipods absent. Four pairs of pleopods, that of somite 2 very small. Uropods absent.

UPOGEBIIDAE

The development of the European species *Upogebia littoralis*, *U. stellata* and *U. deltaura* has been described by Sars, Cano and Webb, and these species, though distinguishable as larvae, differ only in very small details. The same is true also for larvae which I have attributed to *U. danai*.[1] Larvae which are easily recognizable as belonging to the Upogebiidae are not uncommon in the Discovery and Barrier Reef plankton, and the uniformity of structure is very striking, having regard to the great range of difference found in Axiid-Callianassid group. There are, however, two forms of larva which require description, the one because it departs to some extent from the typical form and the other by reason of its abbreviated metamorphosis. For convenience of comparison I include figures of the normal type of larva.

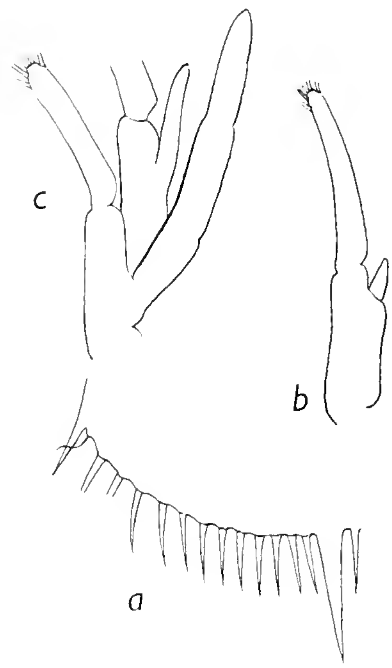


Fig. 31. Thalassinid B.R. XI
a. Telson. *b*. Maxillipede 1. *c*. Maxillipedes 2 and 3.

Upogebia sp. B.R. I (Fig. 32)

Barrier Reef, St. 46.

STAGE III. Length 4·4 mm.

General form as in *U. deltaura*. Abdomen without spines; pleura rounded. Telson widening towards end, width about four-fifths of length; posterior margin slightly concave, with very small median spine and a spine formula of 8, 1, 8; spine 2 reduced to a hair and spine 4 large, not jointed to telson.

Antenna, basis with two small spines, exopod without outer seta near base, with large apical spine; endopod as long as exopod.

Mandible without palp. Maxillule, palp of three segments, laciniae rather widely separated. Maxilla with four large inner lobes; endopod unsegmented; exopod small, with very small proximal process. Maxillipede 1, endopod of five segments, with outer setae on segments 1–3; inner setae strong and coarsely feathered. Maxillipede 2, endopod of five segments, without outer setae on segments 1–4. Maxillipede 3, endopod rudimentary, with long plumose seta near base.

Legs large, with exopod on legs 1–3; leg 1 not chelate. Pleopods on somites 2–5. Uropods, endopod without setae.

[1] Miss Hart's description of the larva of *U. peigettensis* (1937) was received after the paper was in proof.

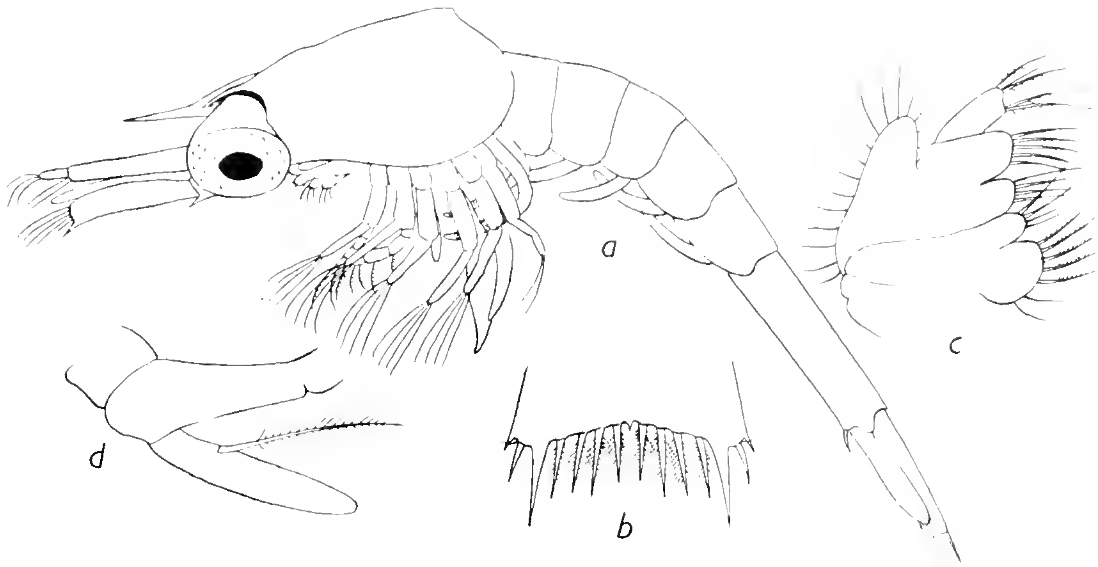


Fig. 32. Upogebia B.R. I, stage III

a. Side view. *b*. Part of telson. *c*. Maxilla. *d*. Maxillipede 3.

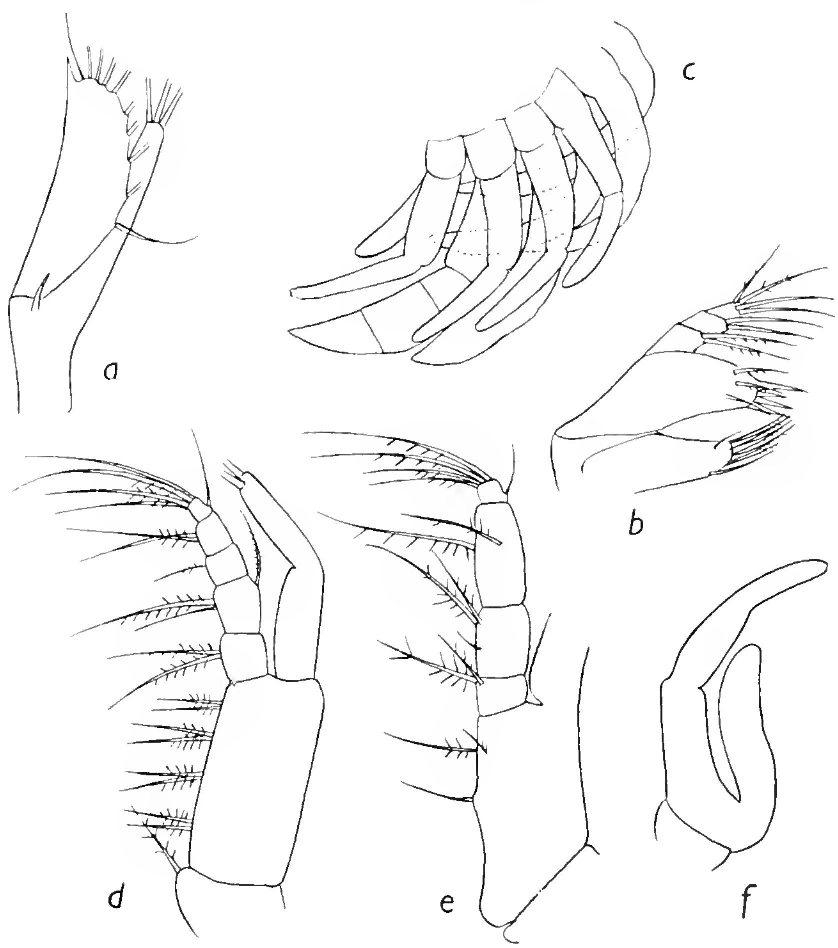


Fig. 33. Upogebia D. I. St. 91.

a. Antenna. *b*. Maxillule. *c*. Maxillipede 3 and legs. *d*. Maxillipede 1. *e*. Maxillipede 2. *f*. Maxillipede 3.

Upogebia D.I. (Fig. 33)

Discovery St. 91. False Bay, South Africa.

STAGE I. Length 4·15 mm.

General form as in *U. deltaura*. Abdomen without spines. Telson of triangular shape, with 7+7 spines and a small spine ventrally near anus.

Antennule unsegmented. Antenna, exopod with small spine and ten setae; endopod stout, with three apical setae.

Maxillule, palp of three segments. Maxilla, palp small, unsegmented, with five setae; four large inner lobes; exopod with narrow proximal part bearing small setae. Maxillipede 1 endopod of five segments, segment 2 with outer seta. Maxillipede 2, endopod of four segments, without outer setae. Maxillipede 3, endopod rudimentary; exopod without setae.

Legs 1–3 with exopods without setae, endopods of all legs large. Pleopods large, on somites 2–5.

In European *Upogebia* there may be four stages, but there are commonly only three, so that development is slightly abbreviated. In *U. savignyi* an inert larval form hatches from the egg (Gurney, 1937*a*) and moults very soon into the adult form. In the species described here abbreviation of development has not gone quite so far. The antennules, antennae and telson are those of a normal stage I larva, but the legs and pleopods are as advanced as in the last stage of *U. deltaura* for instance. It is probable that the first moult would, as it does in *U. savignyi*, give rise to the post-larva. The difference between the two consists simply in the larva retaining its activity.

Upogebia B.R. II (Fig. 34)

Barrier Reef St. 49.

This larva is a normal Upogebiid, except in one respect, namely that it has dorsal spines on all the abdominal somites except the first. The complete absence of spines from the abdomen is a characteristic feature of all Upogebiid larvae hitherto known; but it can no longer be taken as a character holding good for the group as a whole.

LAOMEDIIDAE

The family Laomediidae is one of rather special interest in view of the extreme rarity of the species. Each of the three genera *Laomedia*, *Jaxea* and *Naushonia* is represented by a single species, and of each very few specimens are known. The genus *Axianassa*, Schmitt, likewise with one species only, is included in the family by De Man.

The development of *Jaxea nocturna* is well known (Cano, 1891; Caroli, 1924, etc.), and that of *Naushonia crangonoides* has been described by Thompson (1903); but nothing is known of the development of *Laomedia* or *Axianassa*. I have described (1924, p. 156) a larva which was assumed to belong to this family; but I have now seen other specimens of the same form from the Discovery material and am convinced that this identification was wrong. It appears to be a Pagurid.

I have recorded (1924, p. 150) the occurrence of larvae of a species of *Jaxea* from New Zealand, and have now found the same form in plankton from Samoa. Two new forms of larva, one of which may belong to a new species of *Naushonia*, have been found in the Discovery and Barrier Reef plankton, and they show two steps in the evolution of the elongated head region which is so marked in *Jaxea*.

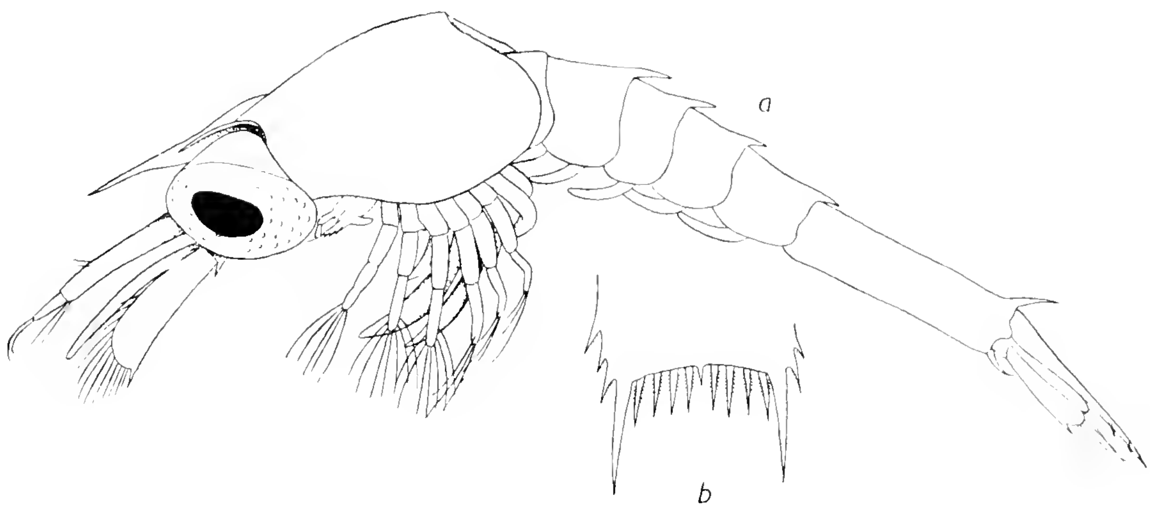


Fig. 34. Upogebia B.R. II.
a. Side view. *b.* Telson.

Jaxea S. I (Fig. 35)

Samoa.

STAGE I. Length 3·55 mm.

Head region produced into a long "neck", without rostrum; abdomen: somite 1 with small lateral blunt process, somites 2–5 with sharp pleural hooks. Telson deeply hollowed, with spine formula 7+7; spine 2 represented by a small hair not easily seen from above.

Antennule unsegmented, with inner spine-like process in place of endopod. Antenna: endopod with three long setae, and scale with ten setae; basis with large ventral spine.

Left mandible and paragnath sickle-shaped. Maxillule very small, with unsegmented palp and few spines on laciniae. Maxilla with minute lobe representing endopod and four reduced inner lobes; exopod with only three setae in the specimen examined, and without basal process; the whole appendage elongated and of three distinct segments.

Maxillipedes 1 and 2 with endopod slender, of four segments; exopod with four setae. Maxillipede 3 a small rudiment.

The larva described by me from New Zealand (1924, p. 150) had a well developed rostrum and rudiments of two pairs of legs, while maxillipede 3 was much larger. It is possible that there are two species differing slightly in degree of development at hatching. The two forms agree in having a pointed lateral process on abdominal somite 1 which appears to be lacking in *J. nocturna*. In stage II the New Zealand form has a telson spine formula 10+10, whereas it is 12+12 in specimens of *J. nocturna* from Alexandria. There are differences also in the telson of later stages, and there can be little doubt that the species from New Zealand is distinct.

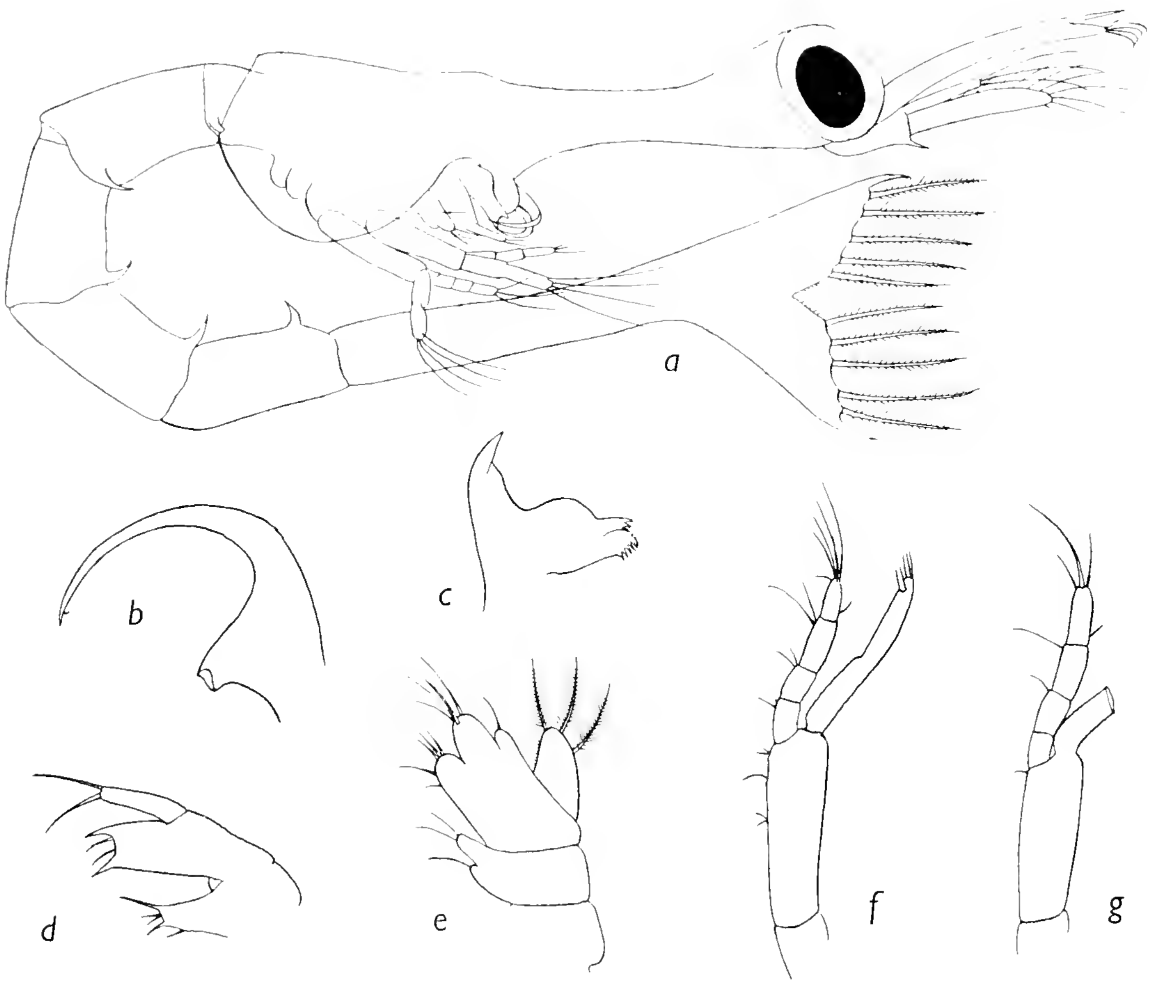


Fig. 35. *Jaxea* sp. Samoa. Stage I.

a. Side view. *b.* Left mandible. *c.* Right mandible.
d. Maxillule. *e.* Maxilla. *f.* Maxillipede 1. *g.* Maxillipede 2.

Naushonia? B.R. I (Figs. 36, 37)

Samoa.

Stage I. Length 2·3 mm.

Rostrum small, slender, upturned at end. Abdominal somites without spines, but somite 5 with a small papilliform process ventrally on either side. Telson deeply hollowed in middle, with spine at angle and five long feathered setae on either side; spine 2 reduced to a minute hair.

Antennule unsegmented. Antennal scale unsegmented, with ten setae; endopod nearly as long as scale, with three long apical setae; basis with ventral spine.

There is no elongated "neck" as in *Jaxea*, but the upper lip is further back from the antenna than is usual.

Mandibles asymmetrical, the left one transformed into a long curved spine; the left lobe of the paragnath produced into a similar, but longer and more slender, spine. Maxillule with unsegmented palp and widely separated laciniae. Maxilla with endopod reduced to a minute papilla; proximal inner lobe apparently absent; exopod small, without proximal extension. Between maxilla and maxillipede 1 there is a ventral swelling which is no doubt the glandular organ seen by Claus in *Jaxea* and by Thompson in *Naushonia*.

Maxillipedes 1 and 2 with endopod of four segments, without outer setae on segments 1–3; inner setae small and slender, without coarse feathering; exopods with four setae. Maxillipede 3 a simple rudiment with minute papilla representing exopod.

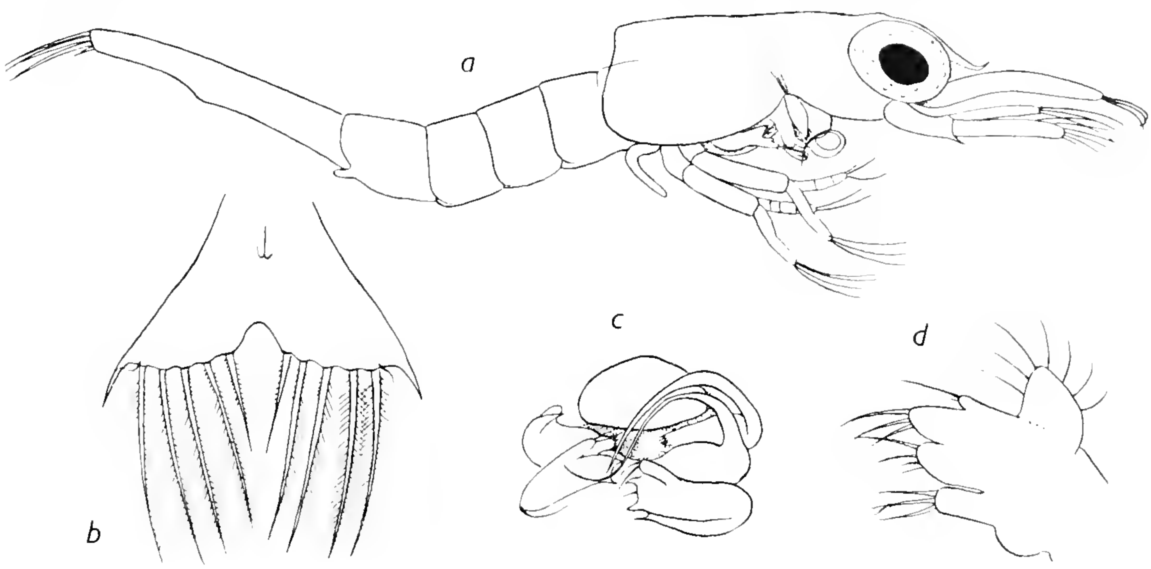


Fig. 36. *Naushonia*? B.R. I. Samoa. Stage I.
a. Side view. *b.* Telson. *c.* Mandible etc. *d.* Maxilla.

Barrier Reef St. 44.

Stage IV? Length 4·55 mm.

Rostrum small, curving downwards between the eyes. Head elongated, the space between antennae and upper lip nearly one-third the length of rest of carapace. Abdomen as in stage I. Telson parallel-sided, a little less than twice as long as wide, with three very minute lateral spines, a large spinous process at each angle, and ten plumose setae on posterior margin. There is no median spine.

Antennal scale without apical spine; endopod longer than scale.

Mandible on left side sickle-shaped, on right with ventral pointed process and minute rudiment of palp. Maxillule as stage I. Maxilla with four inner lobes, with few setae; exopod with narrow bare proximal part.

Maxillipede 3 and legs 1–3 with setose exopods; endopods rudimentary, seated low down on basis. Legs 1 and 2 not chelate. Maxillipede 1 with epipod and rudiment of an arthrobranch; maxillipede 3 to leg 4 with epipod and two gills, decreasing in size backwards.

Four pairs of minute pleopods. Uropods large, exopod without spine.

This larva agrees in stage I so closely with that of *Naushonia crangonoides* as described by Thompson that I had no hesitation in supposing it to belong to that genus. The only difference between them lies in the absence of pleural spines from the abdomen and the presence of papilliform processes on somite 5 in the Samoan form. The later stage from the Barrier Reef, which seems to belong to the same species, differs in the

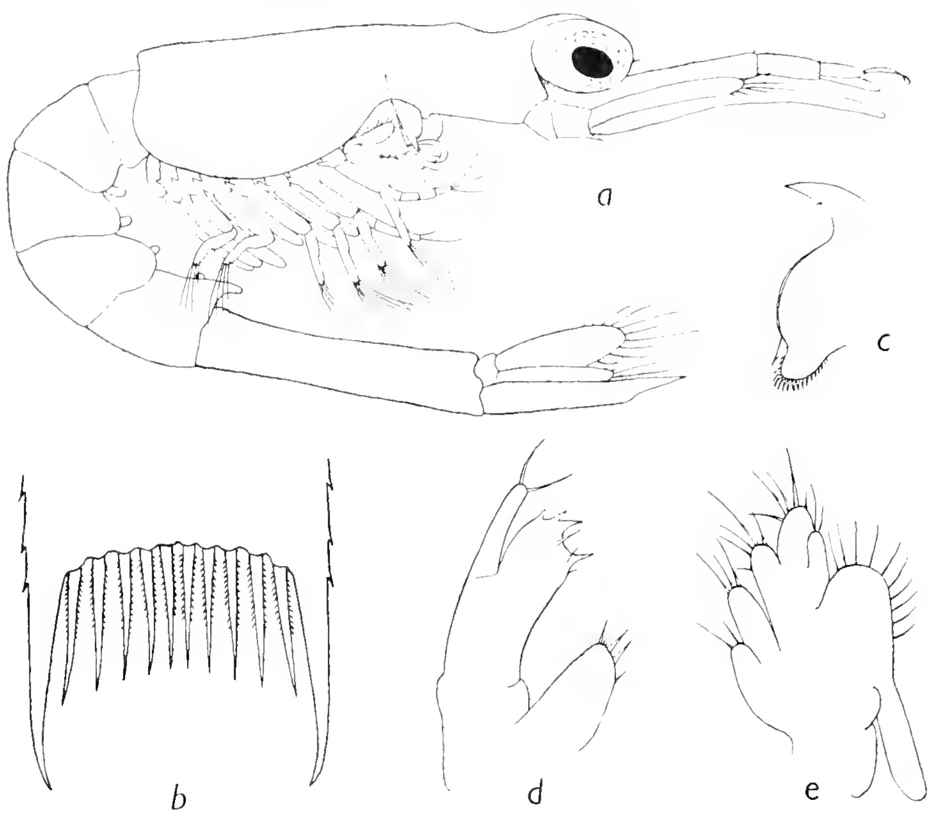


Fig. 37. *Naushonia*? B.R. I. Stage IV?

a. Side view. *b.* Telson. *c.* Right mandible.
d. Maxillule. *e.* Maxilla.

same way from *N. crangonoides*, but also lacks the exopod shown by Thompson on leg 4, and has the head region distinctly more elongated. There are also small differences in the telson, though the general form of it is the same. The presence of a rudimentary arthrobranch on maxillipede 1 is a point of considerable importance, since it is present in *Jaxea* and *Naushonia* but not, so far as is known, in other Thalassinidea. The larva may be said to resemble *Naushonia* more closely than it does *Jaxea*, and may well belong to that genus; but I am inclined to think that the differences are more than specific, and that it actually belongs to a distinct genus.

Thompson (1903) pointed out the close resemblance between both larva and adult of *Naushonia* and *Jaxea*. Previously there had been some doubt as to its position and, even so late as 1920, De Man included *Naushonia* in the Crangonidae, evidently not having seen Thompson's paper. There can be no doubt that Thompson was right, and the structure of the larva alone, apart from that of the adult, would be sufficient to prove the relationship of *Naushonia* to *Jaxea*.

Laomediidae D. I. (Fig. 38)

Discovery St. 708.

Length 5·7 mm.

Rostrum broad at base, abruptly narrowing into a sharp distal part. Carapace without marginal spinules. Abdominal somites 2–4 with small pleural points; somite 5

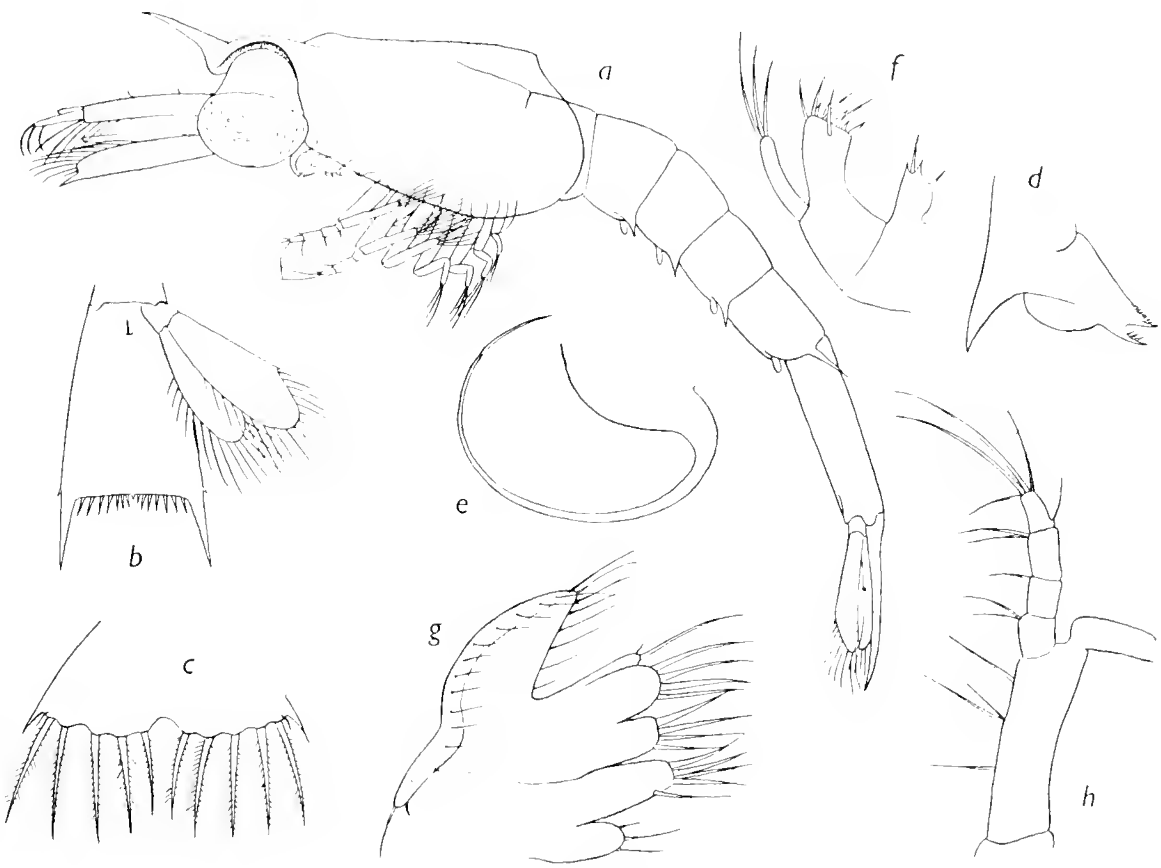


Fig. 38. *Laomediid* D. I.

a. Side view. *b*. Telson. *c*. Telson, stage I. *d*. Right mandible. *e*. Paragnath. *f*. Maxillule. *g*. Maxilla. *h*. Maxillipede 1.

with a pair of lateral spines. No anal spine. Telson about $1\frac{1}{2}$ times as long as wide, with small outer spine near end and large spine at each angle; posterior margin straight, with very small median spine and 7 or 8 short spines on either side.

Antennule unsegmented, with numerous setae along inner margin. Antenna with endopod about as long as scale; scale with distal spine; basis with two small ventral spines.

Mandible asymmetrical, that on left sickle-shaped; right mandible with cutting part pointed and molar part forked. Paragnath on left produced into a very long curved spine. Maxillule with palp unsegmented; laciniae widely separated. Maxilla with four well developed inner lobes; palp minute; exopod large, with slender proximal part. Maxillipedes 1 and 2 with endopods of four segments, without outer setae on segments 1–3, inner setae without coarse feathering; coxa very small and basis elongated. Maxillipede 3 and legs with rudimentary endopods seated low down on basis; exopods on legs 1–4, leg 1 chelate, leg 2 not chelate.

Pleopods very small, on somites 2–5.

A precisely similar form, in the same stage, was taken at Barrier Reef St. 49, and a specimen in stage I at Samoa.

STAGE I. Length 2·4 mm.

Rostrum and general form as in later stage. Telson slightly hollowed behind, with outer spine, reduced spine 2 and a formula of 7+7.

Antennule unsegmented, without spine-like process seen in *Jaxea*. Antenna: exopod with ten setae and small apical spine; endopod long and stout, with three apical setae; basis with one small ventral spine. Maxillipedes 1 and 2 functional; maxillipede 3 and leg 1 rudimentary.

This very interesting new form has the same peculiar form of mandibles and maxillules as *Jaxea* and *Naushonia* and must certainly belong to a closely allied genus; but it differs from both in having no elongation of the head region and in the presence of an exopod on leg 4, and of a small median spine on the telson. The general form so closely resembles that of *Upogebia* that its real position was not realized until it was examined in detail.

The occurrence of larvae apparently specifically identical at points so widely separated as the western Atlantic and Samoa is remarkable, but a similar wide distribution has been noted above for certain Axiid-Callianassid larvae. The known distribution of adult Decapods is generally much more restricted, but *Stenopus hispidus* is known to range from the West Indies to Hawaii, and *Calocaris macandreae* has been recorded from Ceylon and New Zealand.

Menon (1933) has described as a member of the Upogebiinae a larva which is remarkably like the one dealt with here. The general form is the same, and it has the lateral spines on somite 5, but no pleural spines on somites 2–4. The telson is exactly the same, and the maxillule and maxilla very much alike; but it lacks the sickle-shaped left mandible and the exopod on leg 4. The presence of epipods on the legs and of an appendix interna on the pleopods in the post-larval stage makes reference to the Upogebiidae impossible, and its position must remain in doubt. The combination of characters given would exclude it from any of the families of Thalassinidea at present known.

CONCLUSION

While no doubt has been expressed as to the validity of the Thalassinidea as a group, there have been differences of opinion as to its systematic position. The Axiidae, lacking the *linea thalassinica*, and with, in some cases, an almost complete series of gills and other primitive characters, so closely approach the Nephropsidea that Bouvier, for example, has gone so far as to describe *Calocaris* as an "Homaride fouisseur", and to say "aucun de ses caractères si ce n'est l'absence de pinces sur les pattes de la troisième pair, ne permet de distinguer les Thalassinidea des Homaridea." If it is somewhat extravagant to say this of the Thalassinidea as a whole, it is more or less true of the Axiidae alone and this close relationship was recognized by Claus (1885, p. 59). Beurlen (1930, p. 386) emphasizes the primitive characters of the Axiidae, which go back to the Jurassic, and suggests derivation of Callianassidae from them through the Cretaceous *Protocallianassa*. Ortmann and Boas also regarded the whole group as closely related to the Homaridea, but Borradaile and Calman treat them as Anomura. Bouvier dismisses those characters which seem to indicate Anomuran affinities as due to evolution towards a burrowing habit.

It is necessary to determine what light, if any, the larvae throw upon the question.

Taking the Thalassinidea as a whole it is impossible to frame any definition for the larvae which is at all precise. The following summary of characters common to all is subject to so many exceptions that it can hardly be called a definition.

(1) Abdomen commonly with median dorsal spines.
(2) Telson usually with median spine.
(3) Spine 2 of telson reduced to a hair in early stages.
(4) Endopod of antenna normally with three apical setae.
(5) Exopods, with rare exceptions, on three or more legs.
(6) Pleopods absent from somite 1.

All these characters are also found in *Homarus*, and point to a close relation with Nephropsidea. On the other hand closer analysis of the larval characters of the three families about which we have some knowledge leads to the conclusion that the Thalassinidea are not a homogeneous group, and I have already (1924) suggested that there are two series of genera which may be regarded as Homarine and Anomuran respectively.

While the larvae of *Axius stirhynchus* and *Callianassa subterranea* present many obvious differences, there is very much less difference between the former and *C. laticauda*, and we know now the larvae of undoubted *Callianassa* which still further close the gap between them (Gurney, 1937). As has been shown above there are many larvae which I have assigned to Axiidae and Callianassidae which form an unbroken series between *C. subterranea* and larvae of unknown species which must belong to Axiidae though they differ so much from *Axius stirhynchus*.

The larvae of Axiidae and Callianassidae cannot by any means be distinguished, though within the large group so formed it is possible to distinguish subgroups which may eventually prove to correspond to valid systematic divisions.

So far as our knowledge goes the larvae of Upogebiidae and Laomediidae have well marked characters common to all the species known, and in both families very markedly different from those of the Axiid-Callianassid group. They resemble each other in some important respects, so that two groups of larvae may be defined as follows:

Homarine group

Axiidae and Callianassidae

(1) Rostrum long, flattened, with serrated edges.
(2) Abdominal somites usually with dorsal spines.
(3) Telson with large median spine at all stages.
(4) Exopods on leg 4 or legs 4 and 5, with rare exceptions when development is abbreviated.
(5) Endopod of maxillipede 3 functional and normally placed. (With one doubtful exception, p. 330.)

Anomuran group

Upogebiidae and Laomediidae

(1) Rostrum small and round.
(2) Abdomen without dorsal spines. (For exception, see p. 332.)
(3) Median spine on telson small or absent; always absent in stage 1.
(4) Exopods on legs 3 or legs 3 and 4, never on leg 5.
(5) Endopod of maxillipede 3 rudimentary and seated at base of basipod.

The last character is that upon which the greatest stress has been laid as evidence of relation to Anomura, but it is disputable. In *Homarus*, and also in some Caridea, there is a tendency for the exopod to be carried on an extension of the basipod, and the condition found in these Thalassinids might be regarded as simply a further development of this modification. On the other hand, there is no parallel, outside the Thalassinidea and Anomura,[1] for the rudimentary condition of the endopod, or for its position quite at the base of the segment. It seems there is not only extension of the basipod, but also a shifting of the endopod, and the position is so peculiar that it must have phylogenetic significance.

A difference between the two groups which is not easily defined, but is quite evident, concerns the whole form of maxillipedes 1 and 2. In the Homarine group coxa and basis of maxillipede 1 are broad, and in both appendages the endopod is weak and armed with rather delicate setae. In the Anomuran group coxa and basis are slender, and the latter elongated, while the endopod is stronger and armed with stiff setae which may be coarsely plumose. The structure is exactly the same in Anomura such as *Galathea* and *Eupagurus*.

[1] In *Stenopus* maxillipede 3 is normal, but the legs have the unformed endopods seated low down as in Anomura.

Claus (1884) pointed out that the sternal artery of the Pagurid larva differs from that of the "Macrura" so far as concerns the origin from it of the arteries to the maxillipedes, and that, in this respect, *Upogebia* resembles the Pagurids.

This suggestion of a separation of the Thalassinidea into two distinct groups involves a cleavage within the family Callianassidae between the Callianassinae and Upogebiinae which will not be readily accepted, and demands support by evidence from adult structure. This evidence can, I believe, be given.

In the first place I should point out that, especially in animals of burrowing habit, such as these are, it is unsafe to attach much importance to general facies, and would call attention, in illustration of the illusory nature of general form, to the independent acquisition of the Crab form on quite different lines of evolution.

The characters which unite the two subfamilies are given thus by Borradaile:

(1) *Linea thalassinica* present, except in *Callianidea*.[1]
(2) Fixed antennal thorn present.
(3) Antennal scale present, though vestigial.
(4) Abdominal pleura small.
(5) No suture on uropods.
(6) No podobranchs on legs.

The following differences between them are given by Balss:

	Callianassinae	Upogebiinae
(1) Rostrum	Very small or absent	Large
(2) Pereiopod 1	Unequal	Equal
(3) *Appendix interna*	Present	Absent

As between *Callianassa* and *Upogebia* the following may be added:

	Callianassa	*Upogebia*
(4) Antennal scale	Scarcely traceable	Distinct
(5) Leg 2	Chelate	Simple
(6) Maxillule	Exite small	Exite very large
(7) Maxillipede 1	Endopod vestigial	Endopod large
(8) Maxillipede 1	Propod very long	Propod short
(9) Maxillipede 3	Without exopod	With exopod
(10) Epipods:		
Maxillipede 1	Large	None
Maxillipede 2	Vestigial	Fairly large
Maxillipede 3	None	Vestigial

It is admitted that none of these additional differences seem very important, except perhaps with regard to the maxillule. It is apparently characteristic of all Thalassinidea that the maxillule has a coxal exite, but in *Axius*, *Callianassa* and *Calocaris*[2] it is merely

[1] De Man (1928) makes a new subfamily for *Callianidea*.

[2] I have seen this exite in *A. stirhynchus*, *C. macandreae*, *Thalassina anomala*, and three species of *Callianassa*. I have not been able to examine *Jaxea*.

a small papilliform process, whereas it is a large membranous plate, recalling the exopod of the maxilla, in *Upogebia* (fig. 39).

So far as I am aware this exite is found among Decapoda only in Euphausiacea, in *Caridina* alone among Caridea, and in Anomura. In the latter it is large in *Eupagurus* and very large indeed in *Galathea* and *Porcellana*.

Whatever importance is allowed to the differences, it seems that the resemblances have very much less weight. The only important characters are the presence of the *linea thalassinica*, and the reduction of the gills. The former cannot have much significance in Borradaile's opinion in view of its absence in *Callianidea*. It appears to be a modification associated with breathing in burrows, and it is interesting to note the observation of Pearse (1911) on *Thalassina* that the sides of the carapace move on the

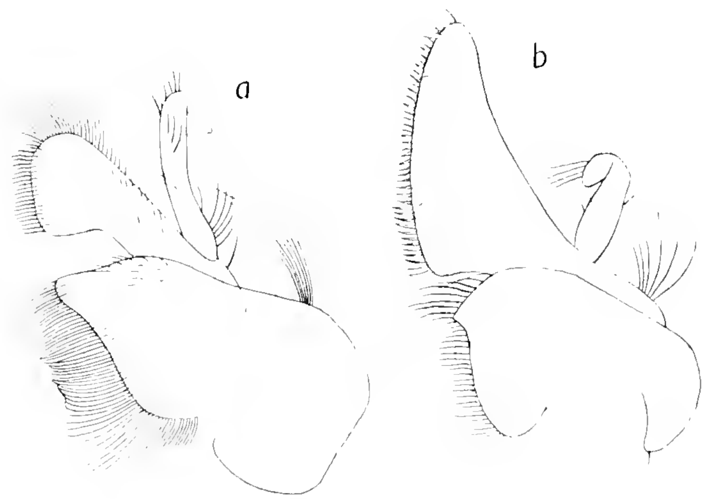
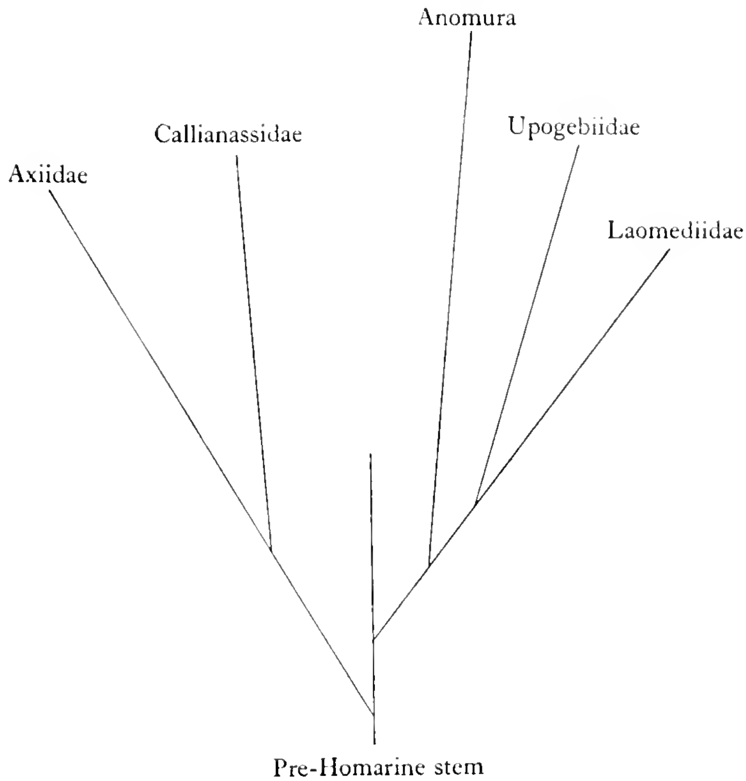


Fig. 39. Maxillule of adult.
Upogebia stellata (*a*), and *Callianassa truncata* (*b*).

hinge of this line as if panting for breath. The agreement in loss of epipods and podobranchs cannot be so readily dismissed; but the gill formula may vary so much as between related genera that agreement is not a very sound basis to build upon. The presence or absence of an *appendix interna* is a point of difference of serious importance. It is present in *Axiidae* and *Callianassa* and appears to be a feature of the ancestral Decapod, though lost in Nephropsidea.

While, then, the Upogebiinae and Callianassinae have a superficial similarity, there is more ground, even on adult characters, for separating than for uniting them. In view of the fundamental differences in larval structure it is legitimate to assume that they are not so closely related as has been supposed, and should be regarded as distinct families. This conclusion is more or less in agreement with the table of relationship given by Boas (1880, p. 110); but the following scheme is, perhaps, a better expression of the probabilities.



KEY TO THE FAMILIES OF THALASSINIDEA

1.	Appendix interna of pleopods present	2
	Appendix interna of pleopods absent	4
2.	Epipods on legs	3
	No epipods on legs	Callianassidae
3.	Pleopods without branchial filaments	Axiidae
	Pleopods with branchial filaments	Callianideidae
4.	Epipods on legs	5
	No epipods on legs	Upogebiidae
5.	Uropods with suture	Laomediidae
	Uropods without suture	6
6.	Antennal scale present; leg 1 chelate	Axianassidae
	Antennal scale absent; leg 1 subchelate	Thalassinidae

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