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Morzh Karskogo Morîa
(The walrus of the Kara Sea)

by
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Excerpts on morphology, growth, and reproduction translated from the Russian by T. Halpert-Scanderbeg and incorporated into the original English summary by F.H. Fay, December, 1953

The morphological characterization of the walrus of the Kara Sea and Novaya Zemlya, based on the original materials collected by the author in 1930 and 1931 (during his voyage in a hunting expedition), is the first and as yet the only one existing, and it will serve for further investigations in the field of race-diagnostics, when a similar morphological characterization will be given also for the other, presumably distict breeds of the walrus.

The size of the animal is characterized by the following table, in which are given, in centimetres, the horizontal lengths from the tip of the nose to the end of the tail:

Table 1. Measurements of 50 animals

Classes	Body length along the curves of the back cm.(Lc)				Straight line between tip of nose & tip of tail cm.(Lcv)			
	No.	Min.	Med.	Max.	No.	Min.	Med.	Max.
Less than one year	6	150	156	163	4	127	133	145
More than one year	5	175	204	220	9	155	181	196
Juveniles	10	233	262	290	10	212	229	260
2 yr. olds	6	233	245	260	6	212	218	230
Adult females	17	282	293	338	19	240	263.5	280
Adult males	12	310	345	375	9	295	318	350

Difference in length between young and yearlings = 50 cm. Between yearlings and 2-yr. olds = 37 cm. Two-yr. olds to adults = 45 cm. for females, 48 cm. for males. The average difference between males and females at puberty is 30 cm.

The strong difference of sizes between the mature males and females attracts the attention (Fig. 2). The fact cannot be ignored that the maximum sizes of the adult walruses, examined in the Kara Sea, are very far behind those given in literature for the Atlantic walrus in general (N. Smirnov, Wollebaeck and others). Further investigations will elucidate the question of whether this is a result of hunting or must be regarded as a race-feature. The biggest

of the examined walruses (male) reached 350 cm. in length (on a straight line between the extreme points: the tip of the nose and the end of the tail).

No data on the newborn was obtained but by calculations, it is believed that they would measure about 105 cm. at birth (about 39 per cent of adult female or 33 per cent of adult male).

Tried getting body lengths from hides, but because of the character of the skin, it was possible to measure only within plus or minus 40 cm. of the true body length.

The hide surface of the walrus is distinguished by typical foldings, especially developed in the ventral part of the body. These folds (of which there are normally about eight) develop in the embryonic stage. Besides the ventral folds there are analogical creases on the neck, at the base of the anterior fins, in short, on those spots of the body that are the most in movement. Besides the distinctly marked folds the hide shows a dense net of fine cross wrinkles.

Other characteristics peculiar to the integument are the numerous and various traces of chiefly traumatic injuries, which have the appearance of pale angular spots concentrated on the anterior part of the body. Besides that, the hide of the adult males possesses a strongly pronounced tubercularity which there is every reason to regard as a secondary sex feature.

The hair cover thins out very much with age. The young, aged 4-5 months, possess a relatively thick hair-cover over nearly the whole body. The hair is short, fine, and fairly soft (softer than that of the adult seal). The pelage of the yearlings shows almost no difference from that of the young in their first year. As it grows, the hair gradually becomes thinner, and on the mature individuals it normally does not hide the epidermal surface of the skin. The latter - as generally on Pinnipeds - is strongly pigmented - most intensively on young individuals, the hide of which is usually of a black-lead colour with a bluish, or scarcely noticeable lilac tint. As the individual gets older the hue of the hide suffers some modification. There begins to show a difference between the dorsal and ventral sides, the latter acquiring a mainly brown colour. The mature walruses show at the base of the posterior fins and in the armpit a rosy tint, spreading later on to other parts of the body, which indicates the approach of old age. From the numerous pale (whitish) scratches, scars and tumours, the hide takes on a singular, flea-bitten appearance.

The pelage of the young in their first year and of the yearlings is of an intensive brown colour. The young walruses of older age are distinguished by a somehat differentiated hue: the dorsal side is in most cases of a mixed reddish, brownish and greenish colour, conditionally spoken of as olive-green; the ventral side preserves its fallow-brown colour. The general tint of the hide of the mature walrus is a dirty olive one, pale from the mottled, muddy-whitish traces of the wounds. The females are usually somewhat darker and of a more fallow colour than the males. It is interesting to note that the examined walruses considerably differed by their colouring from the walruses of the White Sea encountered in the spring of 1902 by N. Smirnov.

THE SHEDDING OF THE HAIR

The shedding of the hair of the walrus has not as yet been elucidated. In the literature rather cursory remarks are given on the pelage differences of young, immature, and adult individuals, but on the character and the periods of change of the hair-cover information is entirely lacking. Sokolovsky mentions in a few words the shedding of the hair by the young walruses observed in the spring in the Zoological garden. According to our own observations the hair on walruses of different age groups in the summer and autumn months was of extremely varied firmness. Neither very weak hair was found which would come out in tufts at a feeble pull, nor very firm hair which could not be pulled out at a sharp tug.

Out of the 32 walruses, which had been examined for the firmness of the hair - 45% possessed firm hair; 35% fairly firm hair and 20% rather weak hair. No periodicity in the modification of the firmness of the hair-cover during August-September-October was discovered.

The forming of the autumn colonies on the beaches evidently is not connected with the shedding of the hair, although on one of the islands haunted by the walruses and where the catch partly had taken place, in the clefts and cavities of the rocks were found considerable quantities of shed hair. However, as the hair-cover of the walrus is not distinguished by any great firmness, and in the course of time strongly thins out, we deem it more probable that this loss of hair by the walrus is caused through being rubbed off by the movements of the animal over the rough and often sharp-sided surface.

Whether or not this is the case cannot at present be told definitely. Special investigations in future of the shedding of the hair are desirable, accompanied by the study of the histology of the skin at different periods of the year.

MORPHOLOGY OF THE TUSK AND ITS ROLE IN DISTINGUISHING AGE CLASSES

The upper tusks are a significant element in the general morphological characteristics of the species. Being of an irregular growth they furnish a splendid material for the study of the age-and sexual variability.

The tusks have the form of a more or less bent cone, compressed at the sides, with slightly undualting lateral surfaces (seldom quite smooth ones). In consequence of the unequal development of the longitudinal furrows (causing the undualtion of the lateral surfaces) the cross-section of the tusk acquires in the young a bean-like form. In the mature and old walruses it often comes near to the oval.

The deviation of the tusks to the sides, which takes place in the process of growth, is in most cases not rectilinear; it is caused, firstly, by the curvature in the sagittal plane and secondly, by a certain helical turn of the tusk. The position of the tusks in the maxilla shows three principal forms; 1) it is parallely running; 2) the prominent side is turned outward and 3) in rarer cases the prominent side is turned inward.

A wearing-off of the tusks is a rather frequent phenomenon, but it is not exclusively an indication of old age, inasmuch as it occurs with comparatively young individuals too. The wearing off takes place from the ends, slantwise, along the frontal side. Some individuals show a sharpening and polishing of the inner surfaces of the tusks near the rim of the gum. Characteristic for the tusks are the longitudinal cracks on the surface of the dentine.

Measurements taken include:

External length - from the border of the alveolus to the tip

Full length - from the tip of the root to the external tip (when possible).

Diameter - at edge of alveolus both ways (laterally and longitudinally)

Weight

Distances between inner edges of alveoli

Distances between tips of tusks.

Diameter can be used as an indication of length when the tusk is broken.

From the moment of the cutting of the definite tusks, which takes place, evidently, in the fourth month of the animal's life, their further growth depends directly on the general growth of the walrus and their length continually increases with age. The tusks grow during the whole life of the animal and exhibit age differences as well as sexual differences. Between the length of the tusks and the length of the body there is a direct correlative dependence. By a careful analysis of the tusk demensions, then, one should be able to describe the body size and sex of the individual. Figure 13 proves this correlation.

This correlation is broken only with the mature females, the growth of the tusks of which still goes on after the growth of the body has stopped. The tusks of the females, however, do not grow infinitely in thickness; attaining a definite size they cease to grow in girth (Fig. 14. and Table 2.). Owing to this fact, the girth of the tusk is significant only as an indication of her belonging to a certain age-group, but it cannot serve as a more precise indicator of the age of separate individuals.

An animal with less than 9 cm tusk circumference is without doubt a sub-adult, whereas one with over 15 cm tusk circumference can be considered an adult.

The principal distinguishing characteristics of sex are the size of the cross-section of the tusks and their breadth (see fig. 15, 16). The thickness of the tusks of the males is about 58% of their width. The thickness of the tusks of the females is about 68% of their width. Thus the tusks of the females are more rounded than those of the males, which are relatively thinner.

The distance between the inner borders of the alveoli does not vary to any appreciable extent between sexes in the sub-adults. In adults, however, it is slightly greater in old males than females.

The distances between the tips of the tusks (excluding any aberrants) do not vary much between sexes at any age.

DIVISION INTO AGE AND SEX GROUPS

The age and sex division of the walruses has been based on the following indicators:

a) the size of the body (principally variations of length)
b) the size of the tusks
c) the development of the reproductive glands

Table 2. Tusk length as compared to circumference

Males		Females	
Length, alveolus to tip (cm.)	Circumference at alveolus (cm.)	Length, alveolus to tip (cm.)	Circumference at alveolus (cm.)
4.8	4.7	2.5	3.5
6.0	5.7	2.7	3.4
6.0	6.3	3.0	4.0
6.3	7.0	4.5	4.7
6.5	6.5	6.6	5.2
7.0	6.3	7.0	5.5
8.0	5.7	8.5	5.5
8.5	7.0	9.0	7.0
9.0	8.0	10.5	7.0
13.0	8.4	11.0	7.7
13.0	10.4	11.3	6.5
14.0	10.4	12.5	9.6
15.0	11.0	14.5	9.0
16.0	13.0	16.5 (broken)	10.5
18.7	12.0	17.0	9.0
20.5	11.0	22.0	10.6
24.0	16.0	23.0 (broken)	12.0
24.0	16.0	23.5	10.2
25.0	13.0	24.5	10.5
27.0	15.0	24.5	11.0
29.0	19.0	25.0 (broken)	11.0
29.5 (broken)	14.0	25.5	9.5
33.5	16.0	26.0	12.5
34.5	15.5	29.0	11.5
35.0	16.0	30.0	11.5
37.0	17.5	30.0	12.0
38.5	19.5	31.0	11.5
40.0	18.9	31.7	10.2
40.0	20.0	34.5	9.0
43.0	20.5	37.0	12.0
46.0	20.0	40.5	12.5
		44.5	10.0
		52.5	13.4

Table. 3

Stage of growth	No.	Tusk Length (cm) min.	med.	max.	Mean Difference between length of entire tusk and its external part (?)
Young - 3-4 mo.	12	The definitive tusk has not yet appeared or is just breaking through			
Yearlings	9	2.5	3.0	4.8	
Sub Adults	17	6.0	9.9	14.0	13.0
Adult males	15	18.7	32.7	46.0	15.5
Adult females	20	14.5	29.0	52.0	12.0

Table 4. Circumference of tusks -cm.

Age	No.	Min.	Med.	Max.
Young		-	-	-
Sub-adults	18	5.5	8.0	13.0
Adult females	21	9.0	11.0	13.4
Adult males	15	12.0	16.2	20.5

Table 5. Breadth of the tusks - cm.

Age	No.	Min.	Med.	Max.
Sub-adults	19	2.0	2.7	4.0
Adult females	19	3.0	3.7	5.0
Adult males	15	4.5	6.0	7.4

Table 6. Thickness of tusks (cm)

Age	No.	Min.	Med.	Max.
Sub-adult	18	1.4	1.7	2.7
Adult Females	19	1.5	2.5	3.5
Adult Males	15	2.5	3.8	5.5

Table 7. Weight of tusks (grams)

Age	Min.	Med.	Max.
Young	-	5.3	-
Yearling	-	18.3	-
Sub-adult	80	156	270
Adult Females	320	706	1000
Adult Males	410	912	1300

Table 8. Skull measurements (mm)

	in 1st yr.				in 2nd yr.			
	No.	Min.	Med.	Max.	No.	Min.	Med.	Max.
Condylobasal length	8	196.0	207.0	227.0	7	246.0	246.6	288.0
(Cranial breadth?) Mastoid ?	11	151.5	161.0	175.0	7	191.0	197.6	208.5
Zygomatic breadth?)	11	120.0	130.0	137.0	8	142.0	155.5	170.0
Width between exter-nal edges of alveoli	11	68.5	75.1	81.0	8	83.5	96.7	105.0
Tusk length.....							31.4	

Table 9. Comparison of age groups by skull measurements

Age / Condylo basal length	191 to 200	201 to 210	211 to 220	221 to 230	231 to 240	241 to 250	251 to 260	261 to 270	271 to 280	281 to 290
1st yr.	1	5	2	1						
2nd yr.						1	2	1	2	1

Table 16. Comparison of ovary sizes. (mean volumes)

Age / Volume in cc.	Young	Yearling	2-yr.-old	Sub-adult	Adults (?) Smallest	Adults (?) Avg. of Two (?)
5-6	2					
7-8			1			
9-10		2	1		1	
11-12						
13-14		8				
15-16					1	1
17-18			1	1		
19-20					2	
21-22					2	
23-24						
25-26				3	2	1
27-28					2	4
29-30						
31-32						
33-34					4	1
35-36						2
over 36					3	4

The age group of young in their first year is determined by the smallest body sizes, their average lengths amounting to 133 cm. with a maximum of 145 cm. The definite tusks are either entirely hidden in the gum, or have only just cut through the latter. The other teeth, as a rule, are not yet out.

The yearlings are distinguished from the young ~~of the first year~~ by their larger body sizes and more outstanding tusks, the length of which exceeds 25 cm. Besides the upper tusks, the yearlings begin to cut other teeth, the cutting usually being quicker on the mandible. In very rare cases only, over a still uncut tooth is preserved the milk-tooth (one case observed for 7 skulls).

The young in their first year and the yearlings are easily distinguished by their skulls (see Fig. 17 and Tables 8,9).

The division of the young into two age-groups has been supported also by an analysis of the reproductive system, in particular by a comparison of the sizes of the testes and the baccula.

Young females have ovaries about 3.5 cm. long and about 5 cc. volume. Yearling females have ovaries 5.1 cm. long and 12.4 cc. volume. Two-year-olds have ovaries 11 to 13 cm. long and 52 to 57 cc. volume. The bacculum of males in their first year (young) is 13 cm. long, those in their second year (yearlings) 19-20 cm. long; and those in their third year (2-year-olds) larger than the yearlings and up to 30 cm.

REPRODUCTION

The ovaries of the walrus are of rounded oval form, somewhat flattened. Those of the young and immature (sub.-ad.) individuals are elongated; of the adults mostly bag-like and shortened. In general the size increases fairly proportionally to the growth and maturing of the animal. (Table 16.)

The surface of the ovaries of mature individuals is completely smooth, not counting the insignificant papillae of the yellow protruding corpuscles and the tiny bulges of numerous follicles. The surface of the ovaries of the young in their first year is covered all over with closely sown dots. The ovaries of the yearlings preserve the porosity of the surface, though it becomes noticeably finer. Later on the surface, grows dull, and with the approach of the animal

to maturity it gradually becomes smooth and glossy. The surface of the ovaries of young individuals is of a pale-pink, or milky-red colour. The ovaries of older immature animals take on a darker tint. Those of mature individuals are intensively coloured, they are reddish-fallow, brownish-red, redish-violet, the colouring being generally unequal in different parts of the ovary. If there is a corpus luteum, it protrudes in the form of pale yellowish-orange, or reddish-lilac lumen with a tangle of tiny blood vessels in the centre.

Ripe follicles occur in females with young, as well as in the barren ones. It must be mentioned that the folliculi Graafiani occur but on a small number of ovaries.

Ripe ?

The yellow corpuscles (Corpora lutea) are represented by three principal types, according to a definite stage of the cyclic activity of the reproductive organs.

The yellow corpuscle of the first type attains a size of 3/4 of the entire mass of the ovary. It is of an orange fleshy colour, fairly soft, elastical, but easily felt through. The presence of a yellow corpuscle of fresh formation may be determined by the strong swelling of the ovary. This type is natural for females with young. (corpus luteum of pregnancy)

The second type of yellow corpuscle, natural to females who have calved that very year (usually it does not exceed ½ of the whole ovary) is of a pale yellowish-rosy colour, with a strong development of the connective stroma, accompanied by a considerable hardening of the corpuscle. (denerating corpus luteum, post partum)

The third type represents a strongly reduced substance small, white, and tough, and hardened almost to a cartilage: this evidently is a consequence of the female's having been long before with young. In the ovaries of mature females occur simultaneously several yellow corpuscles; these are always in different stages of inverse development. (corpus albicans)

The womb of the walrus is bifid. Immature females and those that have not yet been with young, are distinguished by a feeble development of the muscles of the horn walls of the womb, which possess the capacity of becoming twisted with tension. The womb of completely mature individuals is very muscular and the diameter of its horn exceeds many times the diameter of the horn of immature females.

Sexual Maturity in Females

If you ignore the differences between the reproductive organs of females whose tusk lengths (alveolus to tip) are 6 to 7 cm. and whose body lengths are 200 to 225 cm., and compare this group with 2-year-old males, it is a simple matter to distinguish the next oldest age group (3 year old females). These (3-year-olds) will be the specimens with slightly larger tusks (about 10 cm.), a body length of 240 to 255 cm., and ovaries of about 20 cc. volume. We thus consider No. 33 in this group on the basis of its body length (252 cm.), tusk length (10½ cm.) and ovaries (25 cc. each). It had no corpora lutea but did have some ripe follicles which indicate approaching sexual maturity. In the next breeding season she would have been 4 years old and with tusks not less than 12½ cm. and would have been capable of breeding. Thus the earliest sexual maturity seems to be at four years of age. (It is apparent that Chapsky does not consider "ripe follicles" and "Graffian follicles" synonymous.)

Perhaps the greatest majority of females attain sexual maturity slightly later, as indicated by the absence of sexually mature individuals with tusks less than 15 cm. long in our data. The barren female No. 32 (Table 17) which had only one corpus luteum and showed no signs of pregnancy is, because of its size (260 cm.), considered to be close to 5 years old.

Sexual Maturity of Males

Two-year-olds are characterized by the following: body length - 218, tusk length - 7.5 cm. volume of testis - 50 to 53 cc., and length of bacculum 25 to 26 cm. Comparing these with adults we see that the difference is considerable - a matter of at least 100 cm. more in body length. How, then, are we to determine the age classes in between? If we consider that the body length increases every year by not less than 25 cm. (which is quite probable, since we have seen that growths of 48 cm. and 37 cm. are made between the ages 0 to 1 and 1 to 2, respectively), we must surmise that to reach "mid-growth" (the point of inflection in the sigmoid growth curve) it takes at least 3 more years. Thus sexual maturity of puberty of males is reached at 5 years of age.

Let us now compare this theoretical calculation with the observed material. According to our calculations of annual body increment, animals which have reached 3 full years of age should have body lengths between 243 and 248

Table 18.

Catalog No.	Body Length (cm.) Lcv	Tusk Length (cm)	Testis		Length of Baculum (cm)
			Length (cm)	Volume (cc)	
33/0	243	13.0	-	-	-
16/0	-	13.0	16	130	32
7/0	235	8.5	13	77	33

Table 19.

Catalog No.	Body Length (Cm.)	Tusk Length (cm)	Testis		Length of Baculum (cm)
			Length (cm)	Volume (cc)	
5/0	270	12	18	245	-
38/0	250	16	16	150	-
39/0	260	20.5	16.5	165	42.5
Average	260	17	17	150-245	42.5

Table 17.

No.	Date	Stage of Gestation	Location of Embryo	Ovaries				Tusk Length (cm)
				Right		Left		
				Vol. (cc)	Types & No. of Corpora lutea	Vol. (cc)	Types & No. of Corpora lutea	
1	Aug. 10	Pregnant	Right horn	43	-?-	16	-?-	29
8	Aug. 24	Pregnant	Left horn	20	1-type 3	52	1-type 1 1-type 3	-
19	Aug. 28	Foetus 18 cm long	Right horn	38	1-typel	19	1-type 3	24.5
20	Aug. 28	Barren; accompanied by calf	-	22	1-type 2 1-type 3	16	None	24.5
23	Aug. 29	Foetus 17½ cm long	Right horn	39	1-type 1	-	-?-	24.5
28	Aug. 29	Barren	-	27	None	-	1-type 1	25.5
29	Aug. 29	Barren	-	33	1-type 3	33	1-type 2	25.0
31	Aug. 30	Foetus 16 cm long	Right horn	32	1-type 1 1-type 3	22	1-type 3	23.5
32	Aug. 30	No trace of implantation	-	31	1-type 1	23.5	None	14.5
44	Sept. 6	Foetus 18cm long	Right horn	49	1-type 1	25	2-type 2 (one very small)	Broken
45	Sept. 6	Foetus 18cm long	Right horn	50	1-type 1	22	None	31
"E"	Sept. 19	Barren;accompanied by calf	-	45½	1-type 2	43.5	1-type 3	31

(Note) Type 1 - Corpus luteum of pregnancy

Type 2 - Degenerating corpus luteum (post-partum)

Type 3 - Corpus albicans

cm. (218 + 25, 218 + 30). The tusk length should reach 11 to 12 cm. (7.5 + 4 or 4.5). From the data in Table 18 we can see that these calculations are approximately correct.

Let us now consider the four-year-olds which are in their fifth year of life. Between the third and fourth year they should have grown 20 to 25 cm. in length; therefore they would be expected to measure 263 to 268 cm. body length (Lcv), and the length of the tusks (alveolus to tip) would be not less than 15 cm. Three of the individuals we have examined fall into this group. (Table 19).

The next question which arises is whether this category is the next step below sexual maturity, or is there another year class in between? Let us consider these three animals. Number 5/0 is 25 cm. shorter than the smallest sexually mature animal, and his tusks are 6 cm. shorter. The testes have already reached the size corresponding to sexually mature individuals, but the study of histological sections from the center and periphery of the testes reveals that they are not yet matured.

The testes were fixed in formaldehyde; thus the sections were not of high quality. They were stained with hematoxylin stains, and two types of cells were evident in the testes of No. 5/0. These were: (a) intensely tinted (probably spermatocytes) and (b) paler with intensely tinted nuclei (probably spermatogonia). There were no spermatids or spermatozoa in the three cell layers. In order to compare this specimen to a sexually mature individual, we made a study of the testes of No. 3/0, whose length was 305 cm., tusks 24 cm. volume of testis 225 cc., and bacculum 50 cm. We found four or five cell layers, the first with lightly colored nucleus and ~~intensely tinted nucleus and~~ intensely tinted nucleolus (spermatogonia). There was a considerable amount of mitosis in all the other layers (spermatocytes), and in the center of some of the tubules there were some intensely tinted oval bodies which were probably the heads of spermatozoa which were apparently degenerating.

We thus conclude that No. 5/0 would have reached sexual maturity the following spring.

Next we consider No. 38/0, whose body length differs considerably from No. 5/0. The testis volume is also much smaller. Although no histological examination was made, we have concluded that the degree of sexual "ripeness" is slightly different from No. 5/0, and that puberty would probably not be reached in the next breeding season. It is somewhat more likely that No. 39/0 would mature by

spring. We therefore conclude that males do not reach puberty before they are five years old, and that they may be retarded at least one year.

At the moment of the catch the testicles of walruses that had taken part before in reporduction had only just begun to come out of the state of depression. This disproves with sufficient conclusiveness the erroneous indication in literature of the mating of the walrus in the autumn periods, and at the same time excludes any possibility of a prolonged retardment of the embryogenesis.

The examined females, that had calving the same year did not show any manifest signs of recent parturition. Obviously the calving had taken place, in any case, not later than 6 weeks, or even 2 months before the examination. The first examined females had been caught in August, consequently they could not have given birth to their young later than in July.

The examination of mature females has shown that 50% among them are barren. The investigation was carried out in the course of August-September, therefore the possibility of any error in the diagnosis of barreness is absolutely excluded.

The pregnant females had in every case calves about a year, or a year and a half old, while the calves of the barren ones were undoubtedly in their first year, i.e. offspring of that same year. Thus, for the walrus, the materials show in the aggregate a reproduction-periodicity of two years.

Embryonic development (See Table 17 / Fig. 29 – does not agree with these)

From the measurements of calves taken in August and September we have estimated the length at birth to be about 100 to 105 cm. (lcv) or about 90 cm. from the top of the head to the end of the tail (Figure. 28). On the basis of a 12-month gestation period and assuming an embryonic development similar to man's, the following calculations are made from the observed embryos:

Embryo I. August 19 - Length 11 cm., which is equal to 13 per cent of the size of the newborn (90cm.) and indicated that it was in the first 24 per cent of the embryonic period. Thus it was about 2½ months old and had started its development at the end of May or early June.

Embryo II. August 24 - Length 26½ cm. or 29 per cent of the size at birth. This is whithin the first 35 per cent of embryonic life and is thus about 4 months old, having been conceived about the end of April.

October (see Fig. 28)

Embryo III. ~~September~~ 12 - Length 30 cm. - 5 months old - conceived May 10 to 20.

October

Embryo IV. ~~September~~ 12. - Length about 40 cm. - 5½ months old - conceived from end of April to early May.

The beginning of the embryonic development of the walrus, determined by the method of inverse computation of the age of the embryo (this method, of course, lays no claim to great exactitude) gave the period from the middle of April to the end of May; consequently the period of mating extends over six weeks approximately. The autumn gatherings on the beach are not caused by the reproduction instinct. It is well known that many colonies consist exclusively of single mature males; in other cases, on the contrary, may be observed a predominance of females and young of different ages. To admit that any mating takes place in the autumn means that the calving must be expected not to take place before August, assuming the period of being with young to equal 11-12 months. In this case there ought to be found, about this time, females with very big embryos or having just calved, with every indication of recent parturition; this, however, has never been observed.

Nursing

In the stomachs of calves and yearlings, I have found nothing but milk. In most cases the stomachs were empty. Six yearlings examined all had empty stomachs but one, which had milk in it. The condition of the mammary glands of cows with calves and of barren cows was the same. This indicates that lactation (and therefore nursing) lasts not less than 1½ years.

Care of Young

Specimens 5 to 6 months old can only eat milk. This is clearly evident from captives kept on board ship. Jorgensen (?) noticed that the young catch food from their mother's mouths, and he therefore disagrees with Malmgren's statement that the young feed only on milk for two years. It is probable that the yearlings are taught by their mother to eat mollusks, though they have not yet learned how to get them out of the shells.

Captive calves could not even be force-feed, but yearlings learned very quickly.

In Carl Hagenbeck's zoo (Hamburg) young specimens ate up to 15 kilograms per day of chopped fish.

THE FOOD

Notwithstanding the fairly considerable number of dissections of the walrus made by the author, no significant material on its food could be collected, inasmuch as in most cases the stomachs proved empty.

The examination of the stomachs of 46 individuals gave the following results.

1) In the stomachs of 3 young individuals was found milk.

2) In the stomachs of 4 individuals - a small quantity of some liquid, yellowish mass and rests of food that could not be determined.

3) The stomachs of three individuals contained pieces of skin with fat and fragments of internal organs of young bearded seals.

4) One stomach contained rests of crustacean (Isopoda, probably Mesydothea).

5) In one stomach were found a few gephyrea.

The rest of the stomachs were empty, except one, which contained a few small stones.

There is nothing new in the above given list, except the Isopoda. Of the feeding of the walrus on the bearded seal we possess numerous informations. There are also indications of its feeding on other warmblooded vertebrate animals.

The relation between the walrus and the white whale is not as yet sufficiently clear: the available data are somewhat contradictory. The author, though not seeing any improbability in the attack on the white whale by the walrus, nevertheless believes such cases to be extremely rare and practically not of any importance, inasmuch as no investigator has ever personally found material proof in the stomach of a walrus.

In spite of a rather long list of cases on record, of the walrus feeding on seals and small cetaceans, there is not it would seem, sufficient reason to speak of any great capacity, of the walrus. Remaining essentially a consumer of benthos, in which mollusks play the principal

part, the walrus only occasionally takes seals, evidently chiefly in places where for some reason or other, it experiences difficulty in procuring its principal food.

Crustacea are of much less importance in the food of the walrus than molluses. Now and then are found gephyrea in the stomach. Polycheta and holoturies the walrus evidently takes very seldom. Of its feeding on fishes we possess but one observation. Besides that, on the basis of the presence of guests (Ceramicocephalus phocar) on the walrus, the immediate host of which is Boregadus saida, it must be supposed that the latter plays a certain role in the food-regimen of the walrus.

GEOGRAPHICAL DISTRIBUTION

The geographical distribution of the walrus in the discussed regions shows from year to year, in general outline, the same picture. Towards the beginning of the summer-autumn season there are marked two districts of preponderant distribution of the walrus: one district encompasses the northwestern border of the Kara Sea and the adjacent portion of the Barents Sea, bathing the northeastern extremity of Novaya Zemlya; the other occupies the coastal region of the Yomal shoal-water from White Island to the entrance into Baidaratsk Bay. From the second half of July on (there are no earlier observations) until August, inclusively, the walruses keep in this district, mostly in scattered, separated groups, on the drifting ice.

Later on, from the first days of November, they begin to gather in the coastal zone of Novaya Zemlya, the largest number being attracted toward its northeastern extremity, while the rest of the walruses, somewhat later on (usually towards the beginning of October), swim up to the opposite extremity of the southern island, to the rocks situated near the Kara Strait.

Whether these two groups of walruses represent separate herds (in the present case this term is not meant in a taxonomical sense), or whether they are in fact the same herd, assembling at first at the northern extremity of Novaya Zemlya and then going down to its southern border to occupy some islands in the region of Petukhov Strait, is difficult to decide, there existing no data to go by. However based on some indications not yet clearly defined, the author believes the first supposition to be the more acceptable one, namely that the northern and southern groups do not belong to the same population.

This view is corroborated by the following circumstances:

1) the separation of the districts of the summer haunts:
2) the near dates of their going to the beaches in both districts;
3) the well known difference in the age and sex compostion of the groups
4) the want of any indications of an autumnal migration of walruses in great numbers to the south, along the shores of Novaya Zemlya.

We suppose that the herd, inhabiting the Kara Sea, consists of two separate parts, one of which, keeping in the summer to the southern portion - mainly to the district of Sharapov Tongue (as long as the ice keeps there) - swims in the autumn through the Kara Strait to the rocks of Petukhov Strait. The other herd, of the north-eastern extremity of Novaya Zemlya, goes, to the beaches from the Oran Islands to Cape Sporyi Navolok. In other districts of the western portion of the Kara Sea and in the adjacent portions of the Barents Sea (except the Franz Joseph Archipelago), the walrus, at this season, has nowhere been discovered in significant numbers.

As to the eastern portions of the sea, to judge by the available though as yet quite insufficient data, no large accumulations of walruses are formed there. Generally they occur in these parts in but small numbers. In the shoal-region of the sea, off the continental shores, between Ob Bay and Yenissy Gulf, no walrus has been recorded in recent years by any investigators. In the Piassina Gulf the walrus occurs sporadically.

The question where in fact passes the boundary of the distribution of the walrus, will be answered by special investigations in the field of race diagnostics, based on fresh faunistic data. In any case it may be said that the very fact of the distribution of the Atlantic walrus in the Ob-Yenissy district is an objective proof of the scarcity there of the walrus.

Farther away, in the eastern portion of the sea, along the shores of Khariton Laptev Sea and Western Taimyr as well as on the entire western side of the archipelago of Severnaya Zemlya, the walrus has been recorded in but few cases, and in recent years, only, in connection with the development of the navigation in these regions.

In what relation stand the walruses of the eastern border of the Kara Sea to those, inhabiting its western zones - this question is as yet difficult to decide. As a preliminary working scheme may be given the following explications.

The numerous data gathered since Laptev and Bronchishchev and up to the present time show that the walruses inhabit the Laptev Sea in considerable numbers, and according to the latest observations they remain there also through the winter, using patches of open water and leads in the ice. We may conjecture that they form a special geographic race, an intermediate one between the Atlantic and Pacific races.

In the light of this hypothesis the rare cases of the occurrence of walruses at Severnaya Zemlya, Western Taimyr, and the shores of Khariton Laptev Sea may be explained by their penetrating into these regions partly from the west and partly from the east. It is possible that the junction of the distribution zones of the herds from Novaya Zemlya and East Taimyr lies precisely there and consequently there takes place some mixing of representatives of both herds, the eastern one, near Vilkitsky Strait, probably being the predominant element.

The changes taking place in the geographical distribution of the animal, characterized by its distinctly defined displacement during the summer-autumn season to the shores of Novaya Zemlya, the adjacent portions of the Barents Sea, or to the border regions of the north-eastern portions of the Kara Sea, are the most eloquent proof of the emigration of the walrus for the winter from the Kara Sea. The absence of walruses in this sea during the winter season is confirmed also by direct observations, taken from aboard the steamers that had been ice-bound in the winter in the Kara Sea.

The migration scheme set up by Stuxberg and Smirnov, and confirmed by a series of new facts remains valid, in its general outline, to the present time. The walruses remain on the rocks in the districts chosen by the colonies, till the first shore-ice is formed. Immediately the ice has formed they retreat from the beach, changing the substratum of their resting places. The "northern herd" at this period begins to go down, along the western shore of Novaya Zemlya, to more southerly latitudes and probably reaches the south-eastern regions of the Barents Sea, where it possibly meets with the herd lying on the southern rocks.

Whether this is really the case we cannot as yet definitely say, but one thing is clear to us even now, viz. that in the winter-spring season the walrus normally inhabits the Kanin Kolguev basin off the shores of the southern island of Novaya Zemlya, and now and then appears even in the funnel and neck of the White Sea and at the shores of Eastern Murman.

THE CHARACTER OF THE COLONIES AND THE AGE AND SEX COMPOSITION

In 1931 the walruses in the region of their chief distribution, were lying on the ice in comparatively small groups, generally at short distances from one group to the other. The interspaces between the groups, at the places of greatest concentration, varied between half a mile, approximately, to 12-15 miles, which amounts, translated into time-value, to an average run of from 6-10 minutes to 3 hours of a hunting vessel.

The character of the concentration and the number of individuals in a group evidently do not depend upon the conditions of the ice, only. The cases (by no means rare ones) of occupation of very inconvenient cakes lead to the conclusion that neither the form nor the size of the ice-floe occupied by the walruses are of any account to them.

The sex and age record of the colonies on the ice gives the following picture:

1) Single animals, represented almost exclusively by mature males.
2) Groups, consisting of but 2 individuals - females with their young excepted - occurred seldom.
3) Groups, consisting of a female with her young were a very frequent occurence.
4) Still more numerous were groups of from 3 to 12 animals; their age and sex compostion was distinguished by a considerable diversity.
5) The general age-compostion of the herd, in percentage, after 68 specimens checked:

Juvenes (including yearlings)		30%
out of these males	15%	
" " " females	15%	
Sub-adults		20%
out of these males	6%	
" " " females	14%	
Adults		50%
out of these males	12%	
" " " females	38%	
	100%	100%

The observations of subsequent years have shown that the compostion of the colonies in the north eastern portion of the Kara Sea, at the shores of Novaya Zemlya, is a fairly constant one.

Differing from the exceedingly broken up and scattered colonies on the drifting ice floes, those on the beach represent mighty accumulations of walruses, concentrated at some points along the coast of Novaya Zemlya and the adjacent islands. The character of the ground occupied by them is extremely varied. The animals lie on sandy-shingly beaches, as well as on stony ones, in the latter case indiscriminately on smooth or rough stone. The diversity of the grounds chosen by the colonies bears witness that the walrus, evidently, is quite insensible to the topographical or physical conditions of the beach. The greatest part of the colonies discovered, contained over 50 animals each. Large colonies, consisting of 250-300 head, were found but in three or four places.

Single walruses on the beach were encountered but twice by the author.

The density of disposition of the colonies does not depend on their number. The animals are usually lying in close masses, body against body, which often leads to an erroneous conclusion, concerning the number of the colony. On stony, strongly cut up beaches the walruses, necessarily, dispose themselves less closely massed.

The small groups of walruses lying at but short distances from one another, obviously are a result of the hunting, which has broken up the closeness of their ranks, typical for the walrus colonies.

The compostion of the colonies was determined partly by the results of the hunting and partly by eye. The colonies along the coast of Novaya Zemlya bear a mixed and strongly varied character. In some predominate females with their young, in others both males and females are of about the same number.

Mortality and Population Turnover

Some light will be thrown on the question of the natural death rate by the analysis of the proportion of the mature females and young individuals. We believe the proportion 35:30 to be nearest to reality. In this case 14-15% of mature females remain without offspring, which latter evidently must be regarded as having perished. The total

age and sex analysis gives a greater divergence of numbers between mature females and young. According to these data the natural deathrate in the first and second year comes near to 25%. As, however, the computation of the age-composition by the catch cannot be regarded as a very exact one, and on the other hand, taking into consideration that the offspring of the year has yet to pass the winter, we take in our further calculations, the percentage of the natural mortality for the young in their first and second year, as equal, approximately, to the mean arithmetic value, of the two above given values, i.e. as 18-20 % in respect to the number of offspring per annum.

The greatest % of mortality falls, evidently, on the earliest period of life of the young, which, as yet, is utterly unknown to us. Theoretically we conceive for the young walruses in general the following enemies; the polar bear; the killer whale and perhaps the polar shark. The significance of each of these animals as enemy of the walrus cannot be ascertained. It is characterictical that no case of fragments of walrus hide ever having been found in the stomach of any polar bear, caught in the Kara or Barents Seas, has been recorded. The killer whale and the polar shark occur but seldom in the Kara Sea, thus the influence of these two upon the mortality of the walrus is but insignificant.

An infection with helminthiasis of either young or adult individuals is extremely rare.

A certain role in the mortality of the young walruses is evidently played by the crushing of the same in the colonies on the beach.

We have no knowledge of any epizootics of the walruses. One more factor in the mortality of the young must be mentioned, namely the loss by the young of its mother. The influence of this factor may be ascertained by direct observations of young walruses in their first year, taken on board a hunting vessel. The stopping of lactation begins to show its effect upon them soon after their isolation from the females suckling them. They do not take any other food and speedily become feeble and waste away and finally they inevitably expire. Walruses a year and a half in age stand the change of their natural regimen of food much better. Their being kept on board a ship does not lead to their death. This allows to draw the conclusion that in natural conditions, too, the young in their first year may not survive without their mother, while the yearlings evidently get used to their independent state.

For the determination of the relative numeric value of the annual offspring, we possess, for a point of departure, all the necessary, (though not perhaps not quite exact) data. The proportion between the males and females in the natural group has been taken as 1:1; that for the herd, inhabiting in the summer-autumn season the Kara Sea, as about 1:3. In the first case the mature females amount to about 25% of the fundamental stock, in the second case - to about 35%. Every year half the females approximately bear young (50% are barren), i.e. 12.5% of the theoretically conceivably stock (17.5% of the walrus population of the Kara Sea).

Introducing a correction to the number of theoretically possible over-old individuals, and the number of females remaining barren for two years running, the value of the annual offspring will be expressed approximately by 12% of the fundamental stock of the herd in total, or about 17% of the number of the herd recorded for the Kara Sea.

Taking into account the mortality of the young (20% of the offspring) and the mortality during the subsequent years (death of Sub-ad.) the annual growth of the herd, under the condition of the absence of any hunting, amounts to about 10.5% (or 13% of the population of the Kara Sea, in its north western district).

CATCH PRODUCTS

The hide of the walrus is taken off in one piece from young individuals, or in two parts from large ones. The thickness of the hide noticeably increases with age.

Thickness of hide:

Young in their first year.....	8 mm	(2)
Yearlings.....	13.5 mm	(4)
Older immature individuals.....	20 "	(6)
Mature females.....	22 "	(7)
" males.....	26 "	(8)

The maximum thickness of the hide of the examined animals reached 31 mm.

Average thickness of fat layer for age and sex groups:

Young in their first year.....	26 mm	(2)
Yearlings.....	37 "	(4)
Older immature individuals.....	46 "	(6)
Mature females.....	54.5 "	(6)
" males.....	64 "	(6)

Weight of fat for different age-groups:

Of the young in their first year	15 kg	
" " yearlings	32 "	56 kg
Older immature indivuduals	105 "	
Mature females	135 "	
" males	430 "	230 kg

THE STOCK OF WALRUSES OF THE KARA SEA

The observations taken by the author and the data furnished by the hunting over a period of 5 years in the present stage of arctic sea-mammal hunting served as material for the numerical characterization of the stock of walruses.

Even if this first attempt at determining the stock does not give the desired accuracy in the numerical determination (which in any case is no easy matter, if not an utterly impossible task indeed) it may, at any rate, satisfactorily characterize its general state.

The total number of the stock, in its final aspect, has been recorded as 1200-1300 head. However, though it is difficult to guarantee an even relative accuracy in the recording of the stock for the whole region of its distribution (Novaya Zemlya, Kara Sea), a fundamental stock of 700 head for the principal region of its summer concentration (i.e. the portions of the Kara and Barents Sea bathing the north-eastern extremity of Novaya Zemlya) probably reflects fairly accurately the real state of the herd. From an economic point of view even a considerable variation of the numerical composition of the herd does not make any great difference.

If the exploitation of the walrus may be assumed to last for an infinite length of time (this can only be conceived by the socialistic hunting economics), the exploitation must be comensurate with the rate of the natural annual growth of the herd. Proceeding from the assumption that in 1934 the stock of walruses in the Kara Sea amounted, at a maximum evaluation, to 1200 head, the possible contigent of the catch must not exceed a limit of 100 head. Taking into account the percentage of loss in the hunting and also the possibility of an error in the determination of the stock (which may have been overstated) the hunting programme ought to be limited to 50 head approximately.

From the point of view of the preservation and restoration of the stock of walruses, which at the present

time is in an extremely undermined state, the most rational measure would be an entire interdiction of hunting by hunting vessels for a term of up to 5 years.

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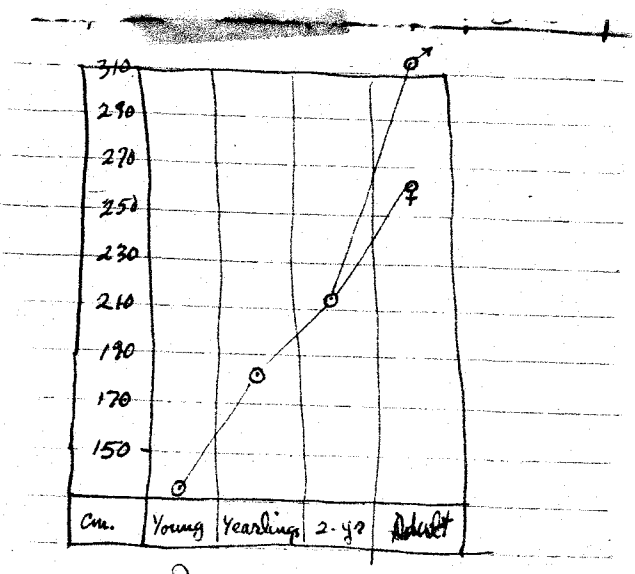


Figure 2

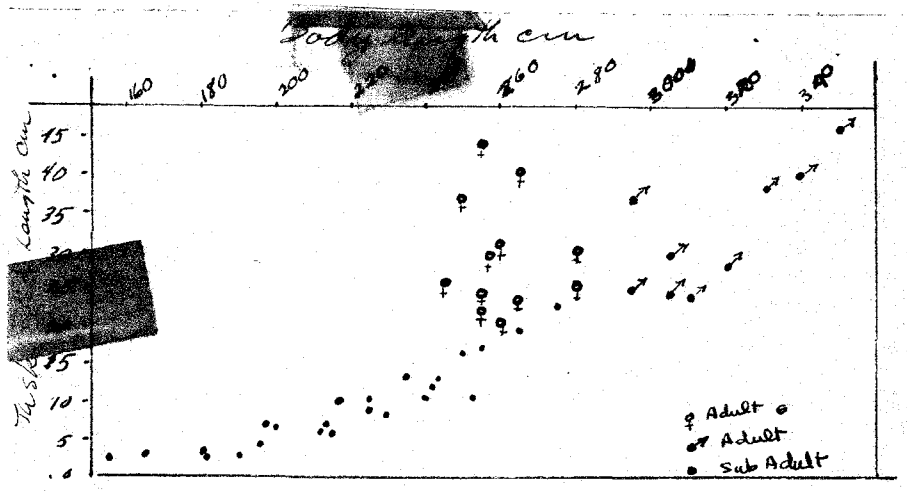
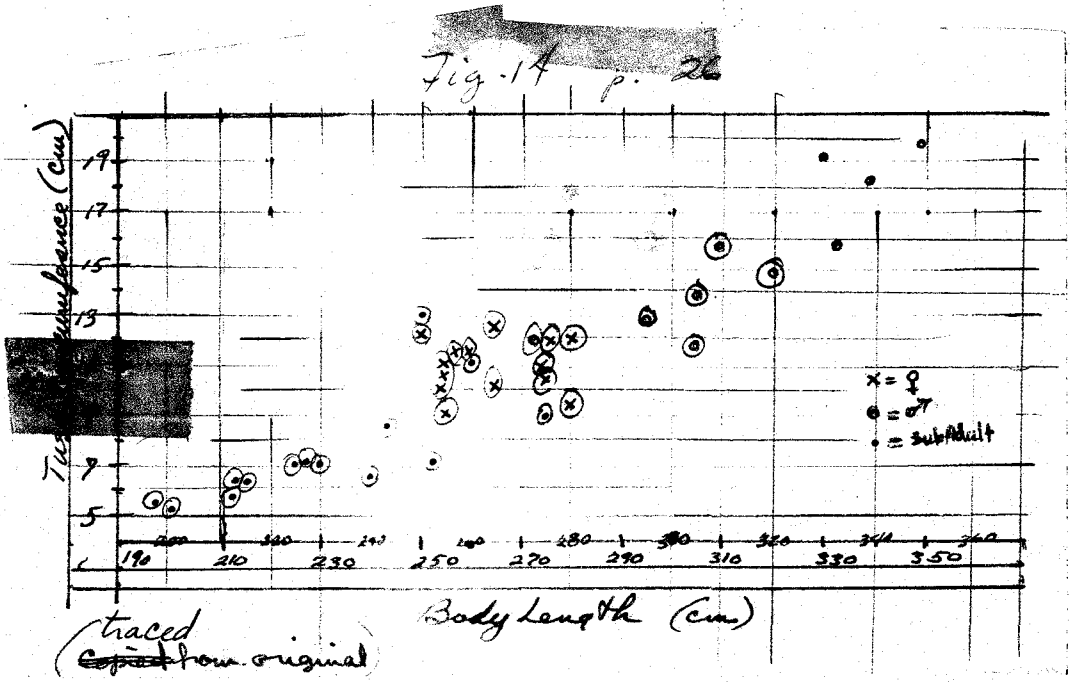


Fig. 13 Traced from the original

Fig. 14 p. 26



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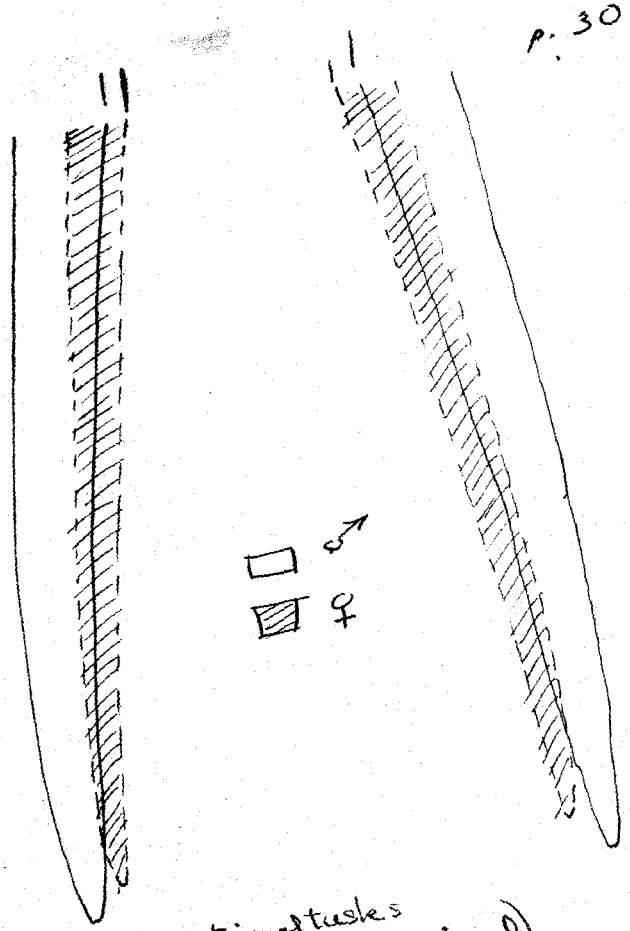


Fig. 15 position of tusks
(traced from original)

p. 31

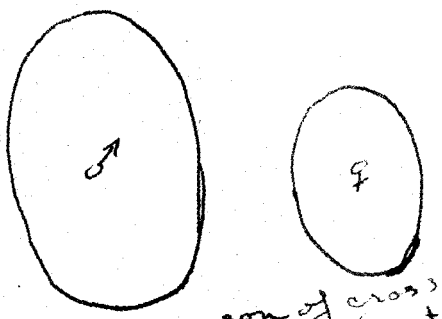


fig16 Comparison of cross sections of tusks (½ nat. size)
(traced from original)

p. 32

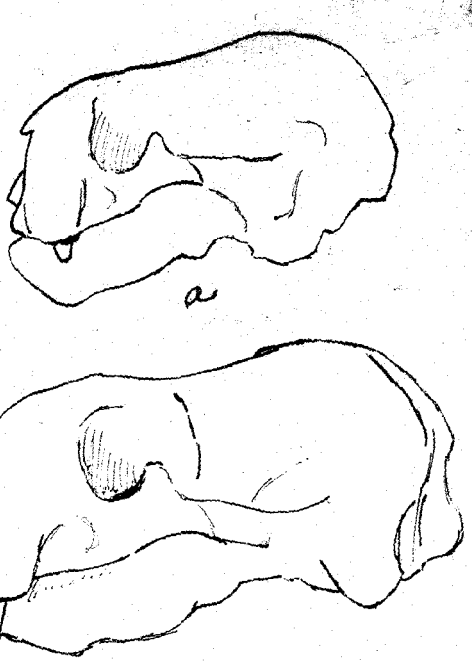


fig. 17 young + yearling
(traced from original)

Figure 23 (Uterus of young ♀)

P. 74

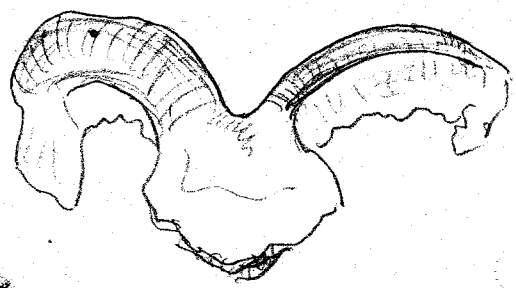


Fig 24 Left thickened – borne once or twice
Right barren.

P. 74

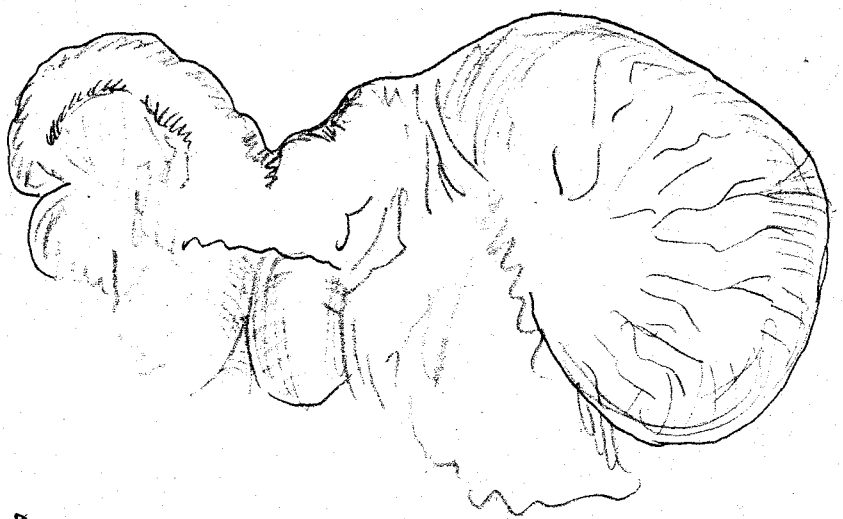
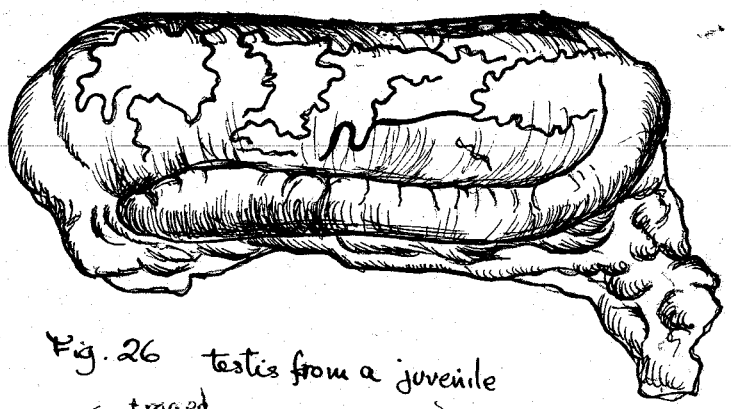
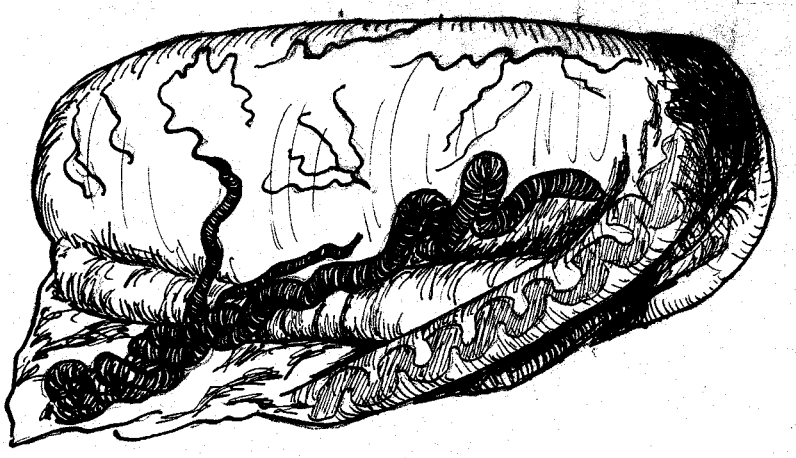


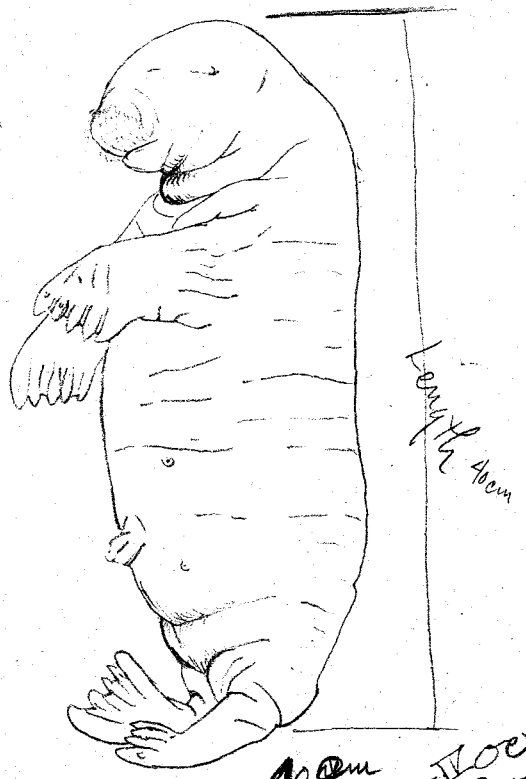
Fig 25. Left horn with foetus
(Aug 28, 1931)



p. 77 Fig. 26 testis from a juvenile
(as ~~copied~~ traced from original)



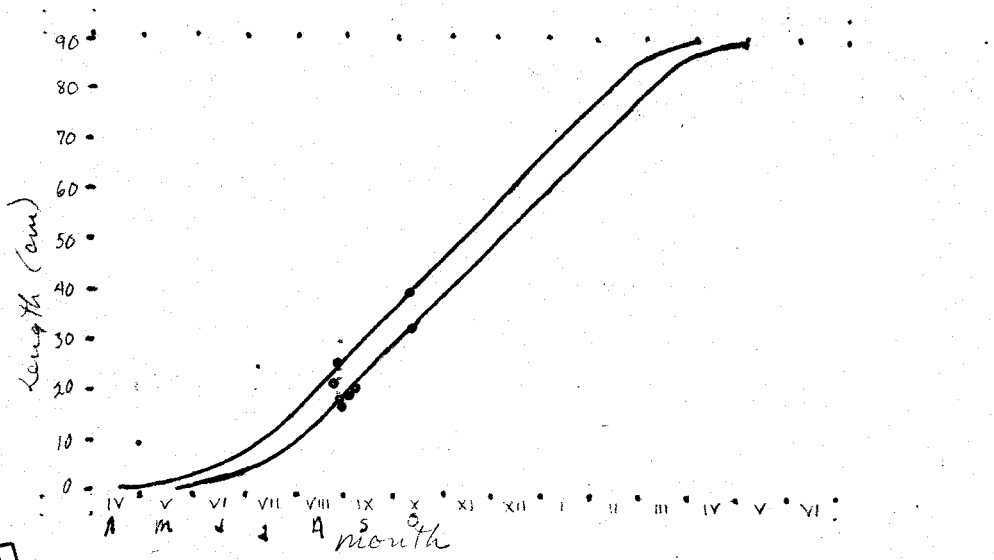
p. 78 Fig. 27. Adolt testis
(As ~~copied~~ traced from original)



p.80

Fig. 28 (traced) 40 cm Embryo #V Oct 12, 1930

traced



p.83

Fig. 29 Embryological development