

ON SOME PHENOMENA CONCERNING PREGNANCY AND PARTURITION OF THE CETACEA

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I. INTRODUCTION

When at the end of the 18th and the beginning of the 19th century the comparative point of view made its introduction in anatomy and physiology, it was also adapted by other branches of biological and medical science. Comparative gynaecology and obstetrics were started by STEIN (1820) in his inaugural lecture at Bonn, but without doubt the most important classical publication on this subject has been made by KEHRER (1864). Although a great number of scattered treatises on pregnancy and parturition of wild and domestic animals can be found in literature, the number of comparative considerations on this subject has always been very small. Thus the book of DE SNOO (1933-1947) supplied not only a long-felt want, but could also be used as a starting-point for further comparative researches. In 1936 I made already an attempt (SLIJPER, 1936, chapter 16) to work out the principles of DE SNOO with regard to Whales and Dolphins (*Cetacea*); unfortunately, however, with a material that practically consisted only of data about the Toothed Whales (*Odontoceti*).

There has always been a certain mystery about the birth of the Cetacea, for these animals and the Hippopotamus are the only mammals of which the infants are born in the water, so that only very few observations on their birth could be made. This may be the reason why so many strange and curious tales about this event can be found in literature, as for example the old story of the Greenlanders that in the White Whale (*Delphinapterus leucas* (Pall.)) the tail of the unborn young should already project from the vulva of the mother during 4—6 weeks before birth (LÜTKEN, 1888). Apparently the same story was told in recent times by the Greenlanders to PEDERSEN (1931, p. 414) with regard to the Narwhal (*Monodon monoceros* L.).

The first observation of the birth of a Common Porpoise (*Phocaena phocaena* (L.)) was made by JAMES (1914, p. 1061) in the Brighton Aquarium.

MCBRIDE and HEBB (1948) made very careful observations on the birth of three young Bottle-nosed Dolphins (*Tursiops truncatus* (Mont.)) in the Marine Studios, Marineland, Florida, U.S.A. and from one of these events a film could be made. By the very kind mediation of Mr R. J. EASTMAN I am able to reproduce in this paper some photographs that have been made from this film (fig. 8-10, 15). Unfortunately the birth described by JAMES (1914) and two of the births described by MCBRIDE and HEBB (1948) were stillbirths, so that only one description of a normal live-birth can be found in literature. SLEPTZOV (1940) gives some particulars about the birth of a Common Dolphin (*Delphinus delphis* L.), but I have not been able to read his original paper, so that my only information is drawn from a very short abstract. So I do not know whether his description is based on personal observations or not and whether he describes a live-birth or not. It may be expected that in future the Marine Studios at Marineland and the new Lerner Marine Laboratory at Bimini (Bahamas) will be able to give further information about pregnancy and birth of the Bottle-nosed Dolphin.

It is not to be expected, however, that in the near future it will be possible to observe the habits of big whales in an aquarium and consequently our knowledge of these animals must chiefly be based on observations made on dead subjects. During the first Antarctic expedition of the Dutch floating factory "Willem Barendsz" (season 1946-1947) I was able to collect some data on this subject with regard to the largest representatives of the Cetacea, the Blue Whale (*Balaenoptera musculus* (L.)) and the Fin Whale (*Balaenoptera physalus* (L.)). When these animals swim in the water it is quite impossible to see the difference between males and females and consequently always a comparatively large number of pregnant females appears on the deck of the factory-ship. Fig. 1 shows that especially at the end of the season the whale fetuses may be very large, since the length of a new-born Blue Whale is about 7 m and that of a new-born Fin Whale about 6.50 m. The average length of pregnant Blue and Fin Whales is resp. about 26 and 22 m and thus the new-born babies show about 27 and 29 % of the length of their mothers. In Toothed Whales (for example Porpoises and Dolphins) these percentages may even amount to 30—45 %.

2. FREQUENCY OF TWINS

In connection with the great bulk of their babies the Cetacea are uniparous, although twins, triplets and even more fetuses occasionally may be found. Just as in the cow (HÖFLIGER, 1948, p. 116; RICHTER, 1926, p. 106) the maximum number of fetuses that has been observed amounts to 7, whereas in the horse not more than 4 have been described. During the first expedition of the "Willem Barendsz" a twin-pregnancy was observed twice in the Blue Whale. In both cases the fetuses were found in the same uterine cornu; in

the Blue Whale Nr 549 this was the left one. There was only one corpus luteum graviditatis, but this cannot be regarded as a quite reliable indication that the twins were identical, although they were of the same sex. Just as has been observed in other mammals (STOSZ, 1924, p. 622; horse) there was a striking difference in length and development between the foetuses of the twin pairs. Table 1 shows that the longer of the twins always had not only a thicker umbilical cord and a thicker layer of blubber, but that it also showed a more advanced stage of development of some organs. This could be stated especially with regard to the development of the baleen-plates. Out of 11 twin-pairs of the Fin Whale (*Balaenoptera physalus* (L.)), described by BRINKMANN (1948, p. 35) three cases are mentioned in which a similar

Table 1

Some particulars about two pairs of twins observed during the first Antarctic expedition of the f. f. "Willem Barendsz" (1946-1947) in the Blue Whale (*Balaenoptera musculus* (L.))

Number Date Length of mother in m	408 17-2-1946 27,4		549 7-3-1946 25,6	
	A	B	A	B
Foetus:				
Sex	♀	♀	♂	♂
Length in cm	310	362	382	316
Length of umbilical cord in cm	240	180	310	235
Diameter of umbilical cord in cm	9,5	14	17	11
Thickness of blubber at lateral side on the level of the umbilicus in mm	15	20	25	20
Length of ovaria (testes) in mm	132	120	100	80
Length of baleen-ridge on palate in cm			66	52

difference in length and development was shown. During the second expedition of the "Willem Barendsz" (1947-1948) two twins and one triplet were found (fig. 2).

According to PAULSEN (1939), who based his calculation on International Whaling Statistics 1933-1939, the number of twins in % of the total number of foetuses is in

Blue Whales (<i>Balaenoptera musculus</i> (L.))	0,68
Fin Whales (<i>Balaenoptera physalus</i> (L.))	0,93
Sei Whales (<i>Balaenoptera borealis</i> Lesson)	1,09
Humpback Whales (<i>Megaptera nodosa</i> (Bonnat.))	0,39

The percentages of BRINKMANN (1948, p. 35) differ in some respect from these data. According to my opinion, however, this must not be ascribed to the better control, but to the smaller material. In man the percentage of twins is 1,3 (VOÛTE, 1935, p. 49), in the horse 1,1 (RICHTER, 1926, p. 17; LOCHMANN, 1931, p. 14) and in the cow 0,52 (MARWITZ, 1930, p. 64), 0,4-1,9

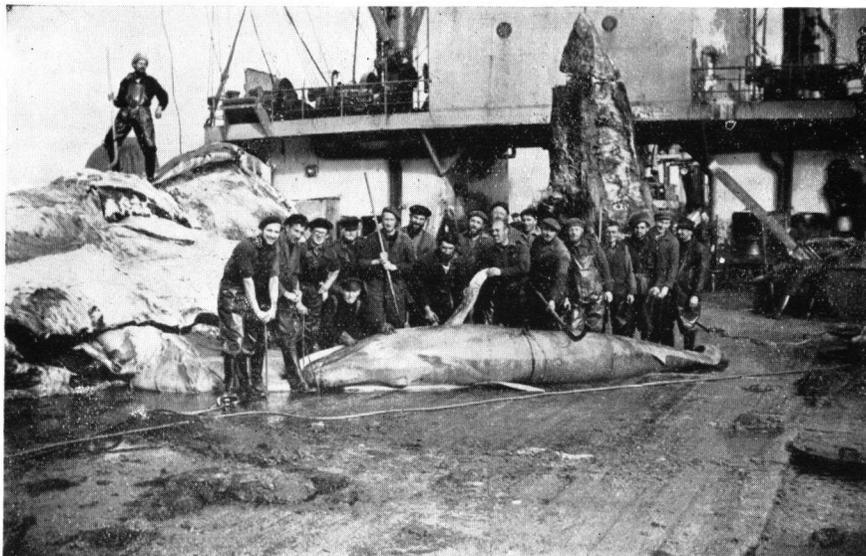


Fig. 1. A 570 cm long female foetus of an Antarctic Blue Whale (*Balaenoptera musculus* (L.)) on the meat-deck of the f.f. "Willem Barendsz" (season 1947--1948 Nr 648). Photograph Dr W. VERVOORT—Leiden.

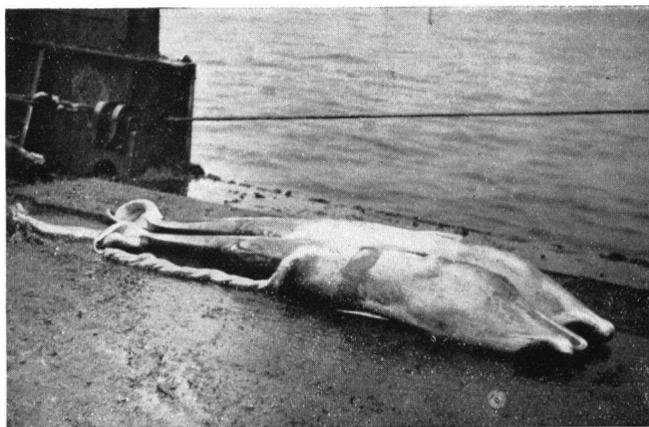


Fig. 2. Twin foetuses of an Antarctic Fin Whale (*Balaenoptera physalus* (L.)). The foetus in front is a 260 cm long female, the other a 295 cm long male. Remark the umbilical cord with an unusually high number of twists. Antarctic whaling season 1947—1948, Nr 463. Photograph Dr W. VERVOORT—Leiden.

(ASDELL, 1946, p. 128), 2.0 (RICHTER, 1926, p. 17) and 2.27 (KRONACHER, 1930, p. 825) according to different authors and different breeds. Thus it can be stated that in the big Whales twins are less frequently born than in man and the big domestic animals, the only uniparous mammals of which statistical information has been obtained. About the *Odontoceti* no reliable data are known.

VOÛTE (1935, p. 57) has shown that in man the summit of the frequency-curve for single births arranged according to the age of the mothers, is found at the 27th year. The greatest percentage of twins, however, is found at the 33d year, so that most twins are born after the period of greatest sexual activity. Moreover it appears that with an increasing number of pregnancies the percentage of twin-births increases. In the cow the greatest percentage of twins is born after the 5th or 6th pregnancy (MARWITZ, 1930, p. 35; LOCHMANN, 1931, p. 18), that is exactly in the period of greatest sexual activity. The same has been found in the horse (LOCHMANN, 1931, p. 16), subject to the condition that the greatest sexual activity of this animal falls on the 5th and the 12th year.

Although there are considerable seasonal variations in the average length of Blue and Fin Whales caught in Antarctic waters (SLIJPER, 1948, fig. 5), the data of International Whaling Statistics 1932-1941 show that the summit of the length-frequency curve of pregnant females is very constantly found at a length of 85 feet (26 m) in the Blue and at a length of 72-73 feet (22.0-23.3 m) in the Fin Whale. Fig. 3 and 4, however, show that the summit of the frequency curve for twins and triples according to the length of their mothers, lies at 88 feet (26.8 m) in the Blue and at 75 feet (23 m) in the Fin Whale. Thus the maximum of twin-births is found at a greater length than the maximum of sexual activity. It coincides very well with the length at which, according to the recent publication of BRINKMANN (1948, p. 37), most of the animals attain physical maturity.

WHEELER (1930, p. 409), however, has already shown that in the big Whales length is an uncertain guide to their relative age, except probably as an average (see also BRINKMANN, 1948, fig. 5 and 6), whereas data about the relation between size and absolute age of the whales have not yet been obtained by the method of RUUD (1945). This means that the above-mentioned facts must be interpreted very cautiously. It might be possible that, just as in the big domestic animals, most whale-foetuses are born in the period of greatest sexual activity, but that the majority of twins are brought into the world by physically well developed mothers, i.e. by mothers that have already attained a greater length than the average corresponding with their age. Definite conclusions can only be drawn if more reliable data are known about the relation between length and absolute age in Whales.

VOÛTE (1935, p. 100) has shown that postnatal mortality of human twins is much greater than the mortality of single-born infants. He thinks this may

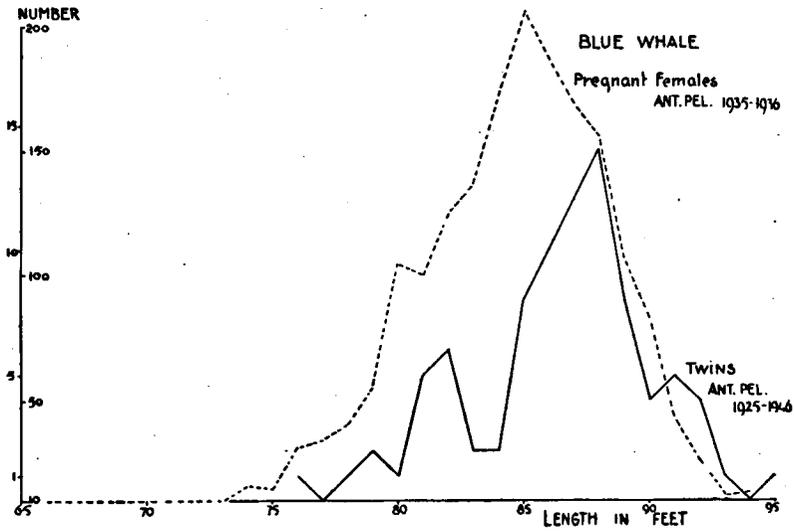


Fig. 3. Curve of the number of pregnant female Blue Whales (*Balaenoptera musculus* (L.)) and of the number of twin births arranged according to the length of the females. The data are derived from International Whaling Statistics.

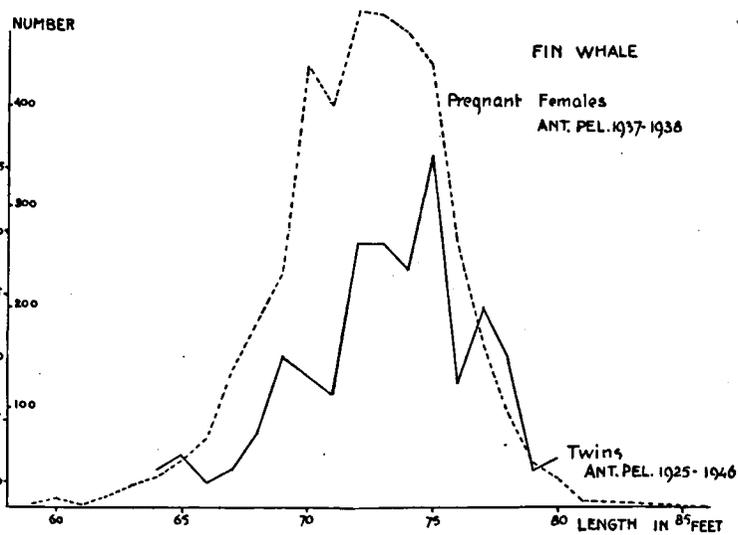


Fig. 4. The same curve as represented in fig. 3, but bearing on the Fin Whale (*Balaenoptera physalus* (L.)).

be explained by the fact that the human uterus simplex has no peristaltic contractions (DE SNOO, 1947) and that consequently it would not be quite well adapted to bear twins. The fact, however, that also in the horse (RICHTER, 1926, p. 105; LOCHMANN, 1931), the cow (MARWITZ, 1930, p. 67) and in those sheep-breeds in which usually only one young is born (RICHTER, 1926, p. 106), the postnatal mortality of twins is unusually high, demonstrates that the relation between the type of uterus and its adaptation to bear twins is not so simple as VOÛTE (1935) means. According to the Cetacea no data about the rate of mortality are known.

Table 2

Position of the foetus and the corpus luteum graviditatis in pregnant *Odontoceti* with regard to the right or left side of the body

Species	Uterushorn which contains foetus	Ovary which contains corpus luteum	References
<i>Phocaena phocaena</i> (L.)	L.	L.	Orig.
	L.	L.	"
	L.		"
	L.		BARTHOLINUS (1654)
	L.	L.	KLAATSCH (1886)
	L.	L.	DAUDT (1898)
	L.	L.	WISLOCKI (1933)
	L.		TEN CATE HOEDEMAEKER (1935)
<i>Delphinus delphis</i> L.	L.		CHABRY et BOULART (1883)
	L.	L.	Letter of KLUMOV
<i>Delphinus spec.</i>	L.	L.	MEIGS (1849)
<i>Tursiops truncatus</i> (Mont.)	L.	L.	WISLOCKI and ENDERS (1941)
<i>Grampus orca</i> (L.)	L.	R.	TURNER (1871)
<i>Pseudorca crassidens</i> (Owen)	L.	L.	COMRIE and ADAM (1938)
<i>Orcella brevirostris</i> Owen	L.		ANDERSON (1878)
<i>Monodon monoceros</i> L.	L.		TURNER (1876)
1)	L.	L.	ARENSEN HEIN (1914)
<i>Stenodelphis blainvillei</i> Gerv.	L.		GERVAIS (1883)
<i>Platanista gangetica</i> Lebeck	L.		ANDERSON (1878)

1) From the condition of the uterus it could be concluded that the animal had been pregnant shortly before. The corpus luteum was a corpus luteum graviditatis in regression.

3. PREVALENCE OF A SPECIAL SIDE OF THE BODY WITH REGARD TO OVULATION AND PREGNANCY

The uterus of the Cetacea is an uterus bicornis. In general descriptions of the order Cetacea, however, the statement may frequently be found, that pregnancy exclusively occurs in the left uterine cornu and that this phenome-

non should be connected with a prevalence in size or function of the left ovary (BOUVIER, 1889, p. 164; WISLOCKI, 1933, p. 81). In the right uterine cornu only a part of the embryonic membranes and the placenta should be found, but never a foetus or a part of the foetus. Now the data collected in table 2 show that, as far as is known at present (there are no data available about *Ziphiidae* and *Physeteridae*), in all different groups of *Odontoceti* the foetus has invariably been found in the left uterine cornu and that the right cornu practically never contains a part of the foetus. A foetus partly lying in the right horn has only been described in *Pseudorca crassidens* (Owen) by COMRIE and ADAM (1938, p. 525 Nr 5).

In table 2 it is further shown that in *Odontoceti* there is a very distinct functional difference between the two ovaries. The fertilized ovum practically only comes from the left ovary and if it comes from the right ovary, it is always implanted in the left uterine cornu. According to WISLOCKI (1933) the left ovary of *Phocaena phocaena* (L.) and *Tursiops truncatus* (Mont.) is always larger than the right one, the left ovary being also the usual site of ovulation. This last statement is confirmed by the still very scanty data of table 3, whereas the descriptions of FRASER (1946, p. 25, *Delphinus delphis*

Table 3

Some data about the number of corpora albicantia in the ovaries of *Odontoceti*.

Species	Length of animal in cm	Number of corpora albicantia in		References
		left	right	
		ovary		
<i>Delphinus delphis</i> L.	213	6	0	FRASER (1946, p. 24)
<i>Pseudorca crassidens</i> (Owen)	420	6	3	COMRIE and ADAM (1938, p. 525)
	440	7	1	
	443	4	3	
<i>Monodon monoceros</i> L.	400	several	0	ARENDSSEN HEIN (1914)

L.), MURIE (1867, p. 285, *Globicephala melaena* (Trail)) and SCOTT and PARKER (1889, *Ziphius cavirostris* Cuv.) show that in immature animals both ovaries have the same size. When, however, sexual maturity is attained, a distinct prevalence in size of the left ovary seems to appear. For in the animals dissected by DAUDT (1898, p. 252, *Phocaena phocaena* (L.)), WISLOCKI (1933, *Tursiops truncatus* (Mont.)), BORDAS (1899, p. 206, *Delphinus delphis* L.) and FRASER (1946, p. 24, *Delphinus delphis* L.) the right ovary was always smaller than the left. That there is no difference in size between the uterine cornua in young and adult but not pregnant females, has been clearly shown by the data of MEEK (1918, p. 186, *Phocaena phocaena* (L.)), DAUDT (1898, p. 251, *Phocaena phocaena* (L.)), BORDAS (1899, p. 205, *Delphinus delphis*

L.), MURIE (1867, p. 285, pl. 38 fig. 73, *Globicephala melaena* (Trail)), COMRIE and ADAM (1938, p. 525, *Pseudorca crassidens* (Owen)), WATSON and YOUNG (1879, pl. 7 fig. 1, *Delphinapterus leucas* (Pall.)), SCOTT and PARKER (1889, *Ziphius cavirostris* Cuv.), VROLIK (1848, p. 110, *Hyperoodon ampullatus* (Forst.)), WEBER (1886, p. 156, *Hyperoodon ampullatus* (Forst.)), BOUVIER (1892, p. 302, p. 8 fig. 13-14) and MATTHEWS (1938, *Physeter macrocephalus* L.). PYCRAFT (1932, p. 807, *Delphinus delphis* L.) and ANDERSON (1878, p. 480, *Platanista gangetica* Lebeck) described an oblique position of the uterine cornua in the abdominal cavity, the right cornu and the right ovary lying more dorsally than the left. This, however, requires further research, especially about a contingent connection with the functional prevalence of the left side.

With the exception of the very general statement of OMMANNEY (1932, p. 405, *Balaenoptera physalus* (L.)) and the description of the female genital organs of *Balaenoptera acutorostrata* Lacép. (TURNER, 1892, p. 60) nor any about the difference in function or size between the ovaries and no data about the position of the foetus in *Mystacoceti* are known from literature. My own measurements made on board the f.f. "Willem Barendsz" confirmed those of TURNER (1892, p. 58, *Balaenoptera acutorostrata* Lacép.) and VROLIK (1838, p. 21; 1838a p. 26, *Balaenoptera physalus* (L.)) that in non-pregnant Baleen Whales the uterine cornua have the same size.

The data about Blue and Fin Whales collected on board the "Willem Barendsz" are shown in table 4 and 5. From these data it appears that in 17 pregnant Blue Whales 60% of the foetuses and in 11 pregnant Fin Whales 64% of the foetuses were found in the right uterine cornu. Among these 28 animals one case was observed in which the left uterine cornu was pregnant but the right ovary showed the corpus luteum graviditatis. Resp. 59% (Blue) and 65% (Fin) of the corpora lutea graviditatis were found at the right ovary. With regard to the number of corpora albicantia it can be stated that there is also a small but distinct prevalence of the right side (52% in the Blue, 57% in the Fin Whale). In the weight of the ovaries there seems to be a prevalence of the left side in the Blue and of the right side in the Fin Whale, but since in man and in the sheep there is no distinct correlation between the activity of the ovary and its weight (LUDWIG, 1932, p. 269; ROUX, 1936, p. 540, table 10), these data may be neglected. So the conclusion can be drawn that in *Mystacoceti* there is a slight but distinct prevalence of the right side.

Now we may ask whether the conditions that have been found in Cetacea, differ from those occurring in other mammals or not. It then appears that an even greater prevalence of one side of the female genital organs than has been observed in *Odontoceti*, occurs in *Monotremata* (left side; ASDELL, 1946, p. 37) and in some *Chiroptera* (right side; *Rhinolophus ferrum equinum insulanus* Barret Hamilton, *Rhinolophus hipposideros minutus* Montagu, *Coe-lura afra* Peters, MATTHEWS, 1937, p. 230, 236; MATTHEWS, 1942, p. 338).

Table 4

Some characteristics of the foetus and the ovaries of Antarctic Blue Whales, *Balaenoptera musculus* (L.), observed on board the f.f. "Willem Barendsz" during the season 1946—1947.

Number	Date	Length of mother in		Uterine cornu which contains foetus ¹⁾	Ovary which contains corpus luteum grav. ¹⁾	Number of corpora albicantia in		Presentation of foetus	Foetus		Length of umbilical cord in		Weight of ovaries without corpus luteum grav. in g		Remarks ³⁾
		Eng. feet	m			left	right		Sex	Length in cm	cm	% of length of foetus	Left ovary	Right ovary	
36	22-12	77	23.5	—	—	—	—								imm.
53	26-12	76	23.2	—	—	0	3						1000	1200	
58	27-12	73	22.4	—	—	—	—						350	310	imm.
62	27-12	76	23.2	—	—	—	—						500	400	imm.
65	28-12	90	27.4		R	6	7	T	♂	155	110	70	3000	4250	
72	29-12	76	23.2	—	—	—	—						295	270	imm.
75	30-12	74	22.6		L	0	0		♀	152	92	60	1750	1350	just adult
91	1-1	84	25.6	R	R	5	2	T	♀	327	240	73	3100	3000	
98	2-1	69	21.0	—	—	—	—						500	400	imm.
107	3-1	82	25.0	—	—	1	0						600	500	
111	4-1	73	22.3	—	—	—	—						320	265	imm.
113	3-1	85	25.9		L	4	1						3000	2750	abort.
118	5-1	78	23.8						♂	86	55	64			
121	5-1	70	21.3	—	—	—	—						98	92	imm.
145	8-1	84	25.6	L	L	1	7	T	♀	240	200	83	4250	4200	
160	11-1	80	24.4	—	—	—	—						1300	1300	imm.
169	15-1	84	25.6	—	—	7	7						1600	1500	
170	15-1	86	26.2	—	—	4	7						2800	3200	
181	17-1	86	26.2		R	9	5						4000	2400	abort.
182	17-1	86	26.2	L	L	6	7	T	♂	459	155	34	3100	2600	
194	18-1	82	25.0		R		4						1400	1700	
201	20-1	81	24.7			2	1						2100	2100	
204	20-1	90	27.4												
207	21-1	89	27.1						♀	149	105	70			
229	26-1	85	25.9					T	♂	471	180	40			
230	27-1	81	24.7						♀	216	150	70			
237	28-1	85	25.9	L	L	6	6		♀	550	280	50	2400	2250	
265	3-2	84	25.6	R	R	4	5	H	♂	272	160	59	3500	2950	
287	5-2	82	25.0	R	R			H	♀	346	180	52	1500	1850	
290	5-2	90	27.4						♀	516	265	51			
318	9-2	89	27.1	—	—	3	1						2000	1150	

1) — = non pregnant.

2) — = immature.

3) imm. = immature;

abort. = abortus, probably during chasing of the animal or post mortem;

abn. lact. = abnormal lactation, fibromyoma in cervix uteri.

Table 4

Some characteristics of the foetus and the ovaries of Antarctic Blue Whales, *Balaenoptera musculus* (L.), observed on board the f.f. "Willem Barendsz" during the season 1946—1947 (continued).

Number	Date	Length of mother in		Uterine cornu which contains foetus	Ovary which contains corpus luteum grav.	Number of corpora albicantia in		Presentation of foetus	Foetus		Length of umbilical cord in		Weight of ovaries without corpus luteum grav. in g		Remarks
		Eng. feet	H			left	right		Sex	Length in cm	cm	% of length foetus	Left ovary	Right ovary	
320	9-2	86	26.2						♂	470	220	47			
328	10-2	80	24.4						♀	295	205	69			
333	11-2	86	26.2						♀	280	225	80			
335	11-2	85	25.9	R	R	1	3	H	♂	365			2300	2400	
349	12-2	82	25.0	L	L	1	0		♂	243	150	62	1000	1000	
357	13-2	92	28.0	R	R	3	3	H	♂	380	240	63	3250	3750	
380	15-2	77	23.5	R	R	0	3		♀	358	250	70	1500	1750	
408	17-2	90	27.4						♀	310	180	59			
									♀	362	240	66			
444	22-2	71	21.6	—	—	—	—						350	340	imm.
485	27-2	82	25.0	R	R	2	0	T	♂	396			3300	2300	
492	28-2	77	23.5						♂	319	225	70			
525	4-3	74	22.6	—	—	—	—						800	800	imm.
526	4-3	82	25.0	R	R	2	2	T	♀	305	185	61	1500	1900	
538	6-3	81	24.7	R	R	0	2	T	♀	332	185	56	3750	3250	
539	6-3	66	20.1	—	—	—	—						120	113	imm.
541	6-3	75	22.9	—	—	1							1800	1500	
546	7-3	87	26.5						♀	663	270	41			
547	7-3	78	23.8	L	L	1	2	T	♂	328	130	39	3100	2200	
549	7-3	84	25.6	L ²)	L				♂	316	325	103			
									♂	382	310	81			
555	9-3	84	25.6	—	—	9	5						3800	4200	
556	9-3	71	21.6	—	—	—	—						600	500	imm.
563	10-3	89	27.1	—	—	7	6						5800	4100	
564	10-3	77	23.5	—	—	1	0						1200	850	
576	12-3	87	26.5						♂	550	280	51			
590	14-3	85	25.9	L	L	1	3	H	♀	400	205	51	2500	2250	
592	14-3	88	26.8	—	—	18	17						3750	2250	abn. lact.
619	17-3	77	23.5	R	R	0	3	H	♀	455	185	40	700	1100	
627	18-3	74	22.6	—	—	—	—						1050	1100	imm.
629	18-3	81	24.7	—	—	1	0						1300	1400	
635	19-3	74	22.6	—	—	—	—						1600	1000	imm.
636	19-3	81	24.7	—	—	2	2						2200	2500	
661	22-3	76	23.2	—	—	—	—						500	600	imm.
667	23-3	90	27.4					H	♀	432	280	67			
696	28-3	81	24.7	—	—	1	2						2000	1800	

Table 5
Some characteristics of the foetus and the ovaries of Antarctic Fin Whales, *Balaenoptera physalus* (L.) observed on board the f.f. "Willem Barendsz" during the season 1946—1947.

Number	Date	Length of mother in		Uterine cornu which contains foetus 1)	Ovary which contains corpus luteum grav. 1)	Number of corpora albicantia in		Presentation of foetus	Foetus		Length of umbilical cord in		Weight of ovaries without corpus luteum grav. in g		Remarks 3)
		Eng. feet	m			left	right		Sex	Length in cm	cm	% of length foetus	Left ovary	Right ovary	
7	18-12	73	22.3		L	2	1	T	♂	135	96	71			
8	19-12	74	22.6		L	3	1	T	♂	135	78	57			
17	21-12	74	22.6		R	6	2		♂	58	43	78			
44	24-12	71	21.6	R		0	1	T	♂	121	84	70	1000	850	
64	28-12	67	20.4	—	—	1	0						380	380	
70	29-12	70	21.3	—	—	—	—						250	245	imm.
71	29-12	63	19.2		R	0	3	T	♀	115	80	70	750	1250	
74	30-12	65	19.8		R	5	1		♀	188	128	68	1750	1350	
78	30-12	75	22.9	R	R	7	10	T	♀	210	165	79	1400	1350	
87	1-1	69	21.0						♂	138	80	62			
135	7-1	70	21.3	R	R	2	8	H	♀	206	125	60	700	750	
159	11-1	72	21.9	R	R	3	1	T	♀	192	120	62	1100	1000	
186	18-1	70	21.3		R	0	2		♀	186	135	72	900	1000	
208	21-1	73	22.3	L	L	12	8	T	♀	126	91	72	1900	1900	
220	24-1	68	20.7						♂	288	150	52			
232	27-1	71	21.7	R	R	5	11	H	♀	229	152	66	2300	2600	
249	1-2	68	20.7						♀	226	113	50			
279	4-2	67	20.4						♀	255	170	69			
281	4-2	70	21.3					H	♂	282	150	53			
319	9-2	77	23.5						♂	306	190	62			
336	11-2	63	19.2	—	—	1	1						450	600	
348	12-2	69	21.0						♀	110	85	77			
366	14-2	71	21.6	L	L	9	12	H	♂	303	130	43	1150	1250	
441	21-2	70	21.3						♀	128	110	85			
450	23-2	73	22.3	L	L	4	2	H	♀	370	150	41	1300	900	
451	23-2	73	22.3	—	—	8	8						1600	1250	
477	26-2	73	22.3	L	R	4	13	H	♂	308	195	63	4100	4000	
520	3-3	76	23.1												
596	15-3	73	22.3	R	R	8	11	H	♂	460	215	47	1700	2000	
597	15-3	71	21.6	—	—	4	6						1300	1500	
598	15-3	72	21.9	—	—	1	1						500	700	
646	20-3	71	21.6	R	L	1	2	H	♂	315	195	62	1950	2400	
648	20-3	72	21.9	—	—	7	19						2000	2800	
744	5-4	68	20.7	—	—	1	0						325	300	
747	5-4	71	21.6	—	—	3	2						900	750	
759	6-4	63	19.2	—	—	0	1						375	500	
761	6-4	71	21.6	—	—	4	2						800	750	

1) — = non pregnant. 2) — = immature. 3) imm. = immature;
 abort. = abortus, probably during chasing of the animal or post mortem;
 abn. lact. = abnormal lactation, fibromyoma in cervix uteri.

Circumstances that resemble those found in *Odontoceti*, have been described of some other *Chiroptera* (right side; *Myotis lucifugus* le Conte, *Myotis myotis* Bechstein, *Tadarida cynocephala* le Conte, ASDELL, 1946, p. 85, 86, 94), but in many other Bats there is no prevalence of a special side, whereas in *Miniopterus dasythrix* Temm. the corpora lutea were invariably found at the left ovary but the blastocysts in the right uterine cornu.

Circumstances that can be compared with those occurring in *Mystacoceti* (prevalence of about 60 % of one side), have been described in the horse (left ovary; ASDELL, 1946, p. 394), in man (LUDWIG, 1932 p. 269; right ovary), in the cow (HÖFLIGER, 1948, p. 12, 76, 116; KEHRER, 1867, p. 68; ASDELL, 1946, p. 341; right ovary, right uterine cornu), the sheep (KEHRER, 1867, p. 68; ASDELL, 1946, p. 363; right ovary, right uterine cornu) and in *Pipistrellus pipistrellus* Schreb. (ASDELL, 1946, p. 89). All the above-mentioned animals are uniparous or only partly biparous, so that prevalence of one special side of the female genital organs appears to be connected with uniparity.

The data published by TAPKEN (1893, p. 4, pig), KEHRER (1867, p. 68, pig, dog, rabbit), ASDELL (1946, p. 317, pig; p. 149, *Oryctolagus cuniculus* (L.); p. 259, *Mus musculus* L.; p. 270, *Rattus rattus* (L.); p. 297, *Cavia porcellus* (L.)), MATTHEWS (1941, *Felis silvestris grampia* Miller), show that in multiparous animals the activity of both ovaria and both uterine cornua appears to be the same. This, however, may also occur in some uniparous mammals, as has been shown by ENDERS, PEARSON and PEARSON (1946, p. 216, *Callorhinus ursinus cynocephalus* (Wahlbaum)) and ASDELL (1946, p. 80, *Eptesicus fuscus* Peale and Beauvois; p. 109, *Macaca mulatta* (Zimmerm.)). Only two statements in literature are known about the *Sirenia*; one describing a foetus of *Trichechus latirostris* (Harlan) in the right and one describing a foetus of *Dugong dugong* (Erxleb.) in the left uterine cornu (WISLOCKI, 1935; TURNER, 1889, p. 642). TURNER (1875, p. 277, 281, 282) and BARKOW (1851) have shown that among *Pinnipedia* the foetus may be found either in the right or in the left cornu.

Transference of ova from the ovary of one side to the cornu of the other has been observed once in an *Odontocete* (table 2) and once in a *Mystacocete* (table 4). This phenomenon has also been mentioned by KEHRER (1867, p. 71, several different mammals), SCHUMANN (1914, p. 645, mammals), ASDELL (1946, p. 172, *Felis silvestris* Schreb.), MATTHEWS (1941, p. 70, *Felis silvestris grampia* Miller), CURSON (1934, p. 133, sheep) and PEARSON (1944, p. 73, *Blarina brevicauda* Say). In the cow migration seldom occurs (HÖFLIGER, 1948, p. 116), but in most other mammals it has been observed comparatively frequently, with the exception, however, of those species in which the process is completely prevented by the anatomical structure of the uterus (*Cavia porcellus* (L.), ASDELL, 1946, p. 297; *Callorhinus ursinus cynocephalus* (Wahlbaum), ENDERS, PEARSON and PEARSON, 1946, p. 216).

4. THE PRESENTATION OF THE FOETUS DURING PREGNANCY AND AT BIRTH

According to an old communication of LÜTKEN (1888), the Greenlanders are said to tell that in the Beluga (*Delphinapterus leucas* (Pall.)) at birth the tail of the infant appears first and that it even projects from the vulva already 4—6 weeks before birth. PEDERSEN'S (1931, p. 414) statement about the Narwhal (*Monodon monoceros* L.) apparently comes from the same source. These statements have never been confirmed, but ESCHRICHT (1849) concludes that tail-presentation is the normal way in which Whales and Dolphins are born and his opinion has exercised a great influence, especially on palaeontological literature (for example ABEL, 1935, p. 13).

In 1936 I made already an attempt to collect data on this subject from observations by myself and from literature (SLIJPER, 1936, chapter 16). Since that time, however, it appeared that descriptions in literature on this head should be dealt with very cautiously and that for example the statement "snout directed caudally", or "snout directed towards vulva" gives no reliable indication of the foetus lying in cephalic presentation. For the cetacean foetus in utero lies in a folded position, the tail being bent under or at the side of the body in a cranial direction (fig. 7). If the uterine cornu itself is not folded, it may be expected that a folded foetus of which the head is directed towards the tail of the mother, will be born in cephalic presentation, provided that it is a nearly full-term foetus. From fig. 5-7 and from many other descriptions in literature it appears, however, that not only the foetus but also the whole uterine cornu may be folded. Thus a foetus with its head in the tubal end of the cornu and its tail directed towards the cervix uteri, will be directed with its snout towards the tail of the mother. Nevertheless such a foetus will be born in tail-presentation. The reverse (cephalic presentation, tail in tubal end of cornu) has not yet been observed in a folded uterus and it is even difficult to understand that such a situation might occur. In connection with these facts, some descriptions in literature appear to be of no value for the determination of the position of the foetus (for example TURNER, 1870, p. 205; NEHRING, 1904, p. 714; PEACOCK, COMRIE and GREENSHIELDS, 1936, p. 103).

From the data collected in table 6 it appears that 20 cases of *Odontoceti* are known in which the position of the foetus in utero or at birth could be determined with absolute certainty. In 4 cases (3 foetuses at full-term and 1 younger foetus) cephalic presentation has been found in utero. In 8 cases the foetus showed tail-presentation in utero, 4 of these foetuses were at full-term, 2 nearly at term, 2 were younger foetuses. Three cases are known of stranded females with the tail of the foetus projecting from the vulva of the mother. Two cases of the last-mentioned position have been described in *Mystacoceti*. ESCHRICHT (1849) gives some particulars about a stranded Humpback Whale (*Megaptera nodosa* (Bonnat.)) in which the tail of the young projected from

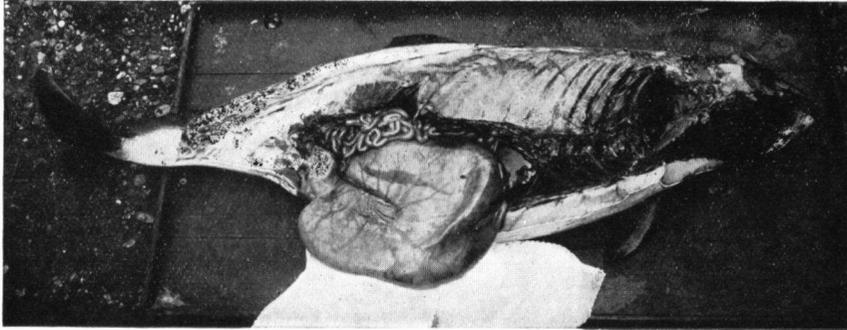


Fig. 5. Dissection of a 155 cm long female Porpoise (*Phocaena phocaena* (L.)), caught 19-3-1937 at DenHelder. The folded left uterine cornu is shown with the caudally directed head of the foetus in the tubal part of the horn. Photograph D. v. d. ZWEEP—Utrecht.

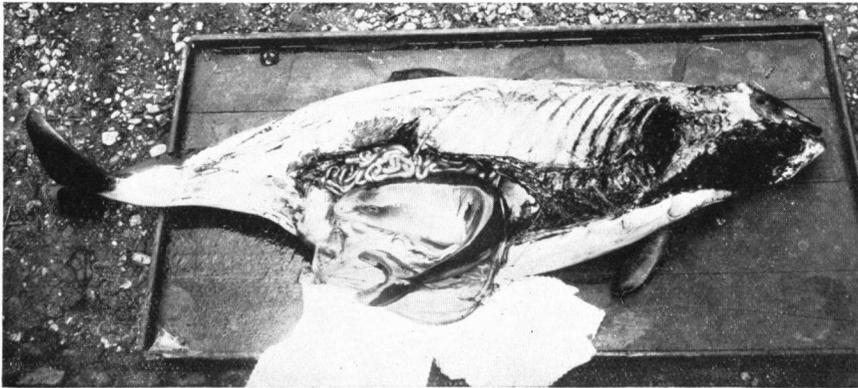


Fig. 6. The same dissection as shown in fig. 5. The thin uterine wall has been cut open. Photograph D. v. d. ZWEEP—Utrecht.



Fig. 7. Detail of photograph fig. 6. Observe the spirally twisted umbilical cord and its epithelial knobs. Photograph D. v. D. ZWEEP—Utrecht.

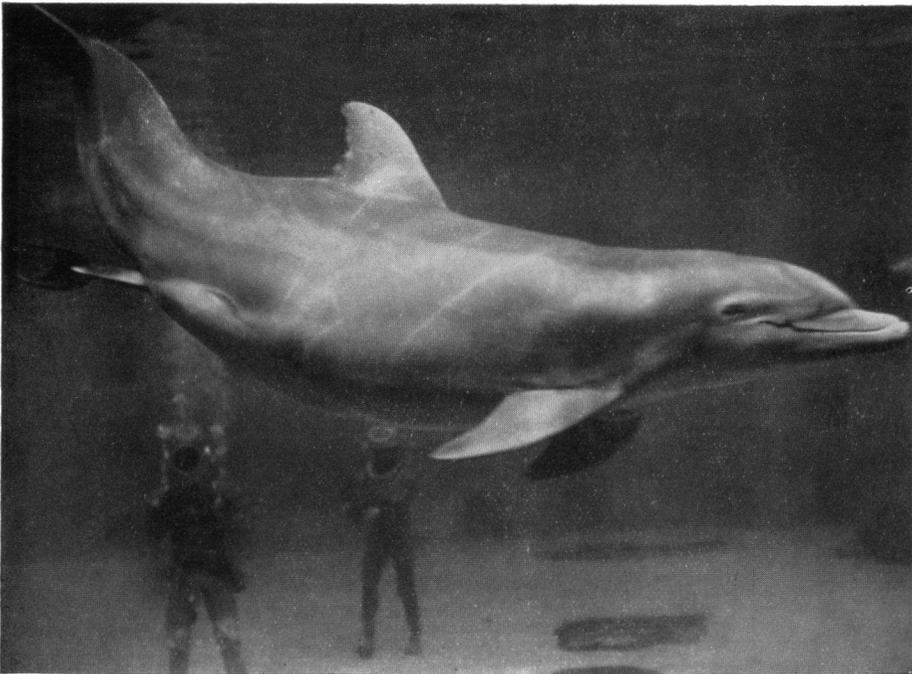


Fig. 8. Birth (stillbirth) of a young Bottle-nosed Dolphin (*Tursiops truncatus* (Mont.)) in the Aquarium of the Marine Studios, Marineland, Florida U.S.A. Photograph taken from a film. Courtesy R. J. EASTMAN.

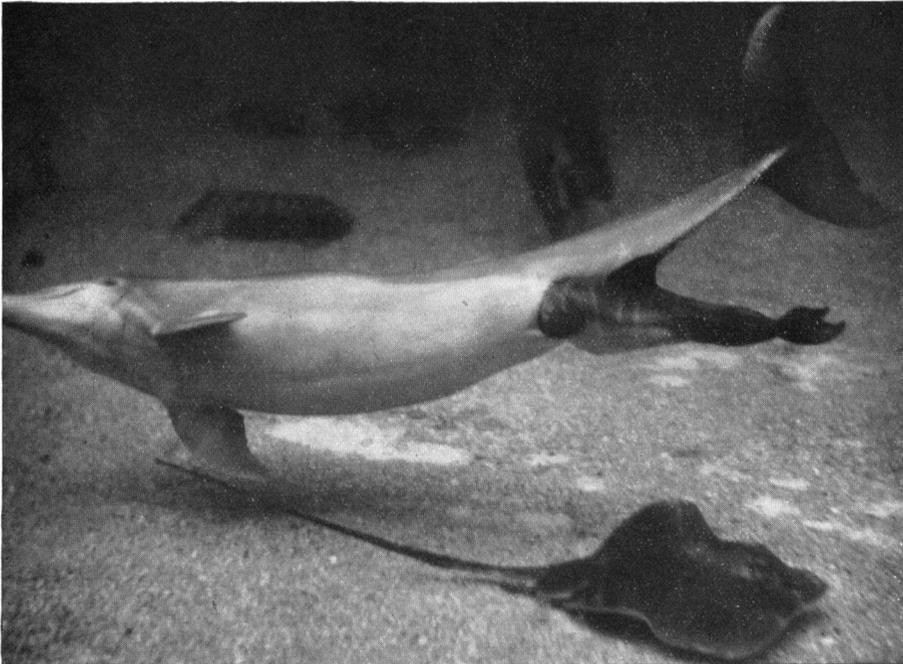


Fig. 9. Birth of a young Bottle-nosed Dolphin at the Marineland Aquarium. See fig. 8. Courtesy R. J. EASTMAN.

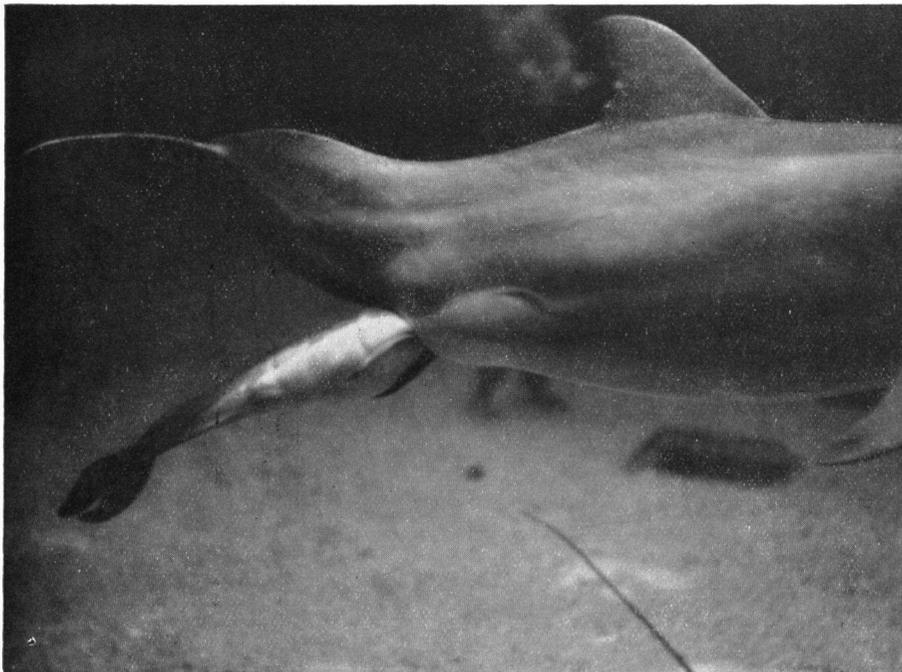


Fig. 10. Birth of a young Bottle-nosed Dolphin at the Marineland Aquarium. See fig. 8. Courtesy R. J. EASTMAN.

Table 6

Review of data known about the presentation of the foetus of Cetacea at birth and during pregnancy.

Species	Total length of foetus in cm 1)	Total length of foetus at birth in cm 2)	Presentation of foetus 3)	Remarks	References
<i>Phocaena phocaena</i> (L.)	44.5	60-80	T		BRAUN (1905)
	55		H	Head of foetus caudally directed	SLIJPER (1936, p. 457, Ex. Z)
	59		T	Uterushorn folded	19-3-1937 den Helder, see figs. 5-7.
	60		T		VAN DEINSE (1946, p. 154, Wijk aan Zee 16-7-1931)
	66		T	Stillbirth Brighton Aquarium	JAMES (1914, p. 1061)
	71		T	Stranded female tail of foetus projecting from vulva	VAN DEINSE (1933, p. 18, 25-6-1932 Katwijk)
	74		H	Uterushorn not folded	SLIJPER (1936, p. 457, Ex. O)
	83		T		STANNIUS (1840, p. 23)
	83		H		26-5-1936 den Helder
	92		T	Uterushorn folded	WISLOCKI (1933)
	+		T	Stranded female tail of foetus projecting from vulva	VAN DEINSE (1946, p. 154, 11-7-1937 Noordwijk)
			H		BARTHOLINUS (1654, p. 216)
			T	General statement about the species	FABRICIUS (1780, p. 47)
<i>Tursiops truncatus</i> (Mont.)	87	125-155	T	Uterushorn folded	WISLOCKI and ENDERS (1941, fig. 1, p. 99)

1) + = foetus at full term.

2) According to different authors.

3) T = tail, H = head. Italics = the statement must be considered as perfectly reliable.

Table 6

Review of data known about the presentation of the foetus of Cetacea at birth and during pregnancy (continued).

Species	Total length of foetus in cm	Total length of foetus at birth in cm	Presentation of foetus	Remarks	References
<i>Delphinus delphis</i> L.	+		T	Stillbirths at Marine Studios Marine-land	} MC BRIDE and HEBB (1948)
	+		T	Live birth at Marine Studios	
	85	90-100	T	Uterushorn folded	
	+		T	General description of birth	SLEPTZOV (1940)
<i>Delphinus spec.</i>	+		H		BELON (1553)
	+		T	Photograph of birth. Tail projecting from vulva	IJSSELING and SCHEYGROND (1943, pl. 48)
<i>Grampidelphis griseus</i> (Cuv.)	+	140	H	Verbal communication of OMMANNEY	SLIJPER (1936, p. 458)
<i>Globicephala melaena</i> (Traill)	170	160-180	H	Head of foetus in vagina	VAN BENEDEN (1860) VAN BENEDEN (1865, p. 853)
			H	General verbal communication of MÜLLER	LÜTKEN (1888, p. 804)
<i>Grampus orca</i> (L.)	91	250	H		TURNER (1871, p. 485)
<i>Pseudorca crassidens</i> (Owen)	110	190	H		} PEACOCK, COMRIE, GREENSHIELDS (1936, p. 104)
	115		H		
<i>Orcella brevirostris</i> Owen	83	90-100	T	Uterushorn folded	ANDERSON (1878, p. 407, pl. 33)
<i>Monodon monoceros</i> L.	165	150-170	H	Uterushorn not folded	TURNER (1876, p. 103)
<i>Delphinapterus leucas</i> (Pall.)	+	160	T	Stranded female, tail of foetus projecting from vulva	DEGERBØL and NIMLSEN (1930)
<i>Platanista gangetica</i> Lebeck	69	90-100	T	Uterushorn folded	ANDERSON (1878, p. 493, pl. 31, 34)
<i>Stenodelphis blainvillii</i> Gerv.		50	T		GERVAIS (1883, p. 761)
<i>Megaptera nodosa</i> (Bonnat.)	425	450-500	T	Stranded female, tail of foetus projecting from vulva	ESCHRICHT (1849)
<i>Balaenoptera acutorostrata</i> Lacép.	+	300	T	Dead female, tail of foetus projecting from vulva	VAN BENEDEN (1865, p. 852)

the vulva. Apparently in this case birth could not be finished, because the flippers had stuck fast to the internal genital organs or perhaps to the pelvis (see also GULDBERG, 1887, p. 137). Although in Cetacea the rod-like pelvic bones are very small and they have no bony connection, the possibility may not be excluded that a birth in tail-presentation may be difficult because of the position of the flippers and because of the fact that the greatest diameter of the foetus is found in the cranial part of the animal.

It is a very remarkable fact, however, that all four births that have been observed occurred in tail-presentation (fig. 8-10; JAMES, 1914, p. 1061, *Phocaena phocaena* (L.); McBRIDE and HEBB, 1948, p. 115, *Tursiops truncatus* (Mont.)). Three of these were stillbirths and JAMES (1914) says that the birth of his Porpoise was very difficult, the mother suffering apparently from heavy pains during labour. This birth took 2½ hours, but the live-birth of a young Bottle-nosed Dolphin observed by McBRIDE and HEBB (1948) lasted about 23 minutes.

During the first expedition of the "Willem Barendsz" some observations on the position of the foetus in Blue and Fin Whales could be made (table 4 and 5). Because of the great bulk of these animals it is not always easy to determine the exact position of the foetus in utero. For if the very thin uterine wall has been cut and the immense masses of amniotic fluid have run away, there sometimes appears already such a big part of the foetus that it attains a nearly stretched position. The general impression, however, could be gained that just as in *Odontoceti* the tail of the foetus is bent under or at the side of its body. In a number of cases it could be stated that the uterine cornu was folded in the same way, as has been shown in fig. 5-7 in the Porpoise. The bending of the foetus was not so sharp as has been observed in *Odontoceti*. Just as in Porpoises and Dolphins, the dorsal fin of the foetus is folded to the right or left side, the flippers are pressed against the chest and the flukes are soft and bent in a ventral direction (fig. 11).

From the 31 data collected in table 4 and 5 it appears now that 44 % of the Blue and 53 % of the Fin Whales were found in cephalic presentation. Although the material is still very scanty, from fig. 12 the impression may be gained that with increasing length of the foetuses the number of cephalic presentations distinctly increases. A comparison of the curves of MACKINTOSH and WHEELER (1929, p. 442, 443, fig. 154-155) shows a very striking increase of the number of cephalic presentations after about 7 months of pregnancy, the duration of pregnancy being 10½ months in the Blue and 11½ months in the Fin Whale.

The same phenomenon has been observed in man and those big domestic animals that usually give birth in cephalic presentation. KEHRER (1867, p. 103) and ZWEIFEL (1895, p. 150) have already pointed out that in man the position of the foetus during the first months of pregnancy is very variable. In the 6th month, however, the percentage of cephalic presentations is already 69 %

and after that it increases up to 97-99%. DE BRUIN (1902, p. 35) and WILLIAMS (1909, p. 380) made the same statement with regard to the horse and cow, whereas COHRS (1934, p. 471) means that the primary position of the foetus in utero can be determined by turning backwards the twists of the

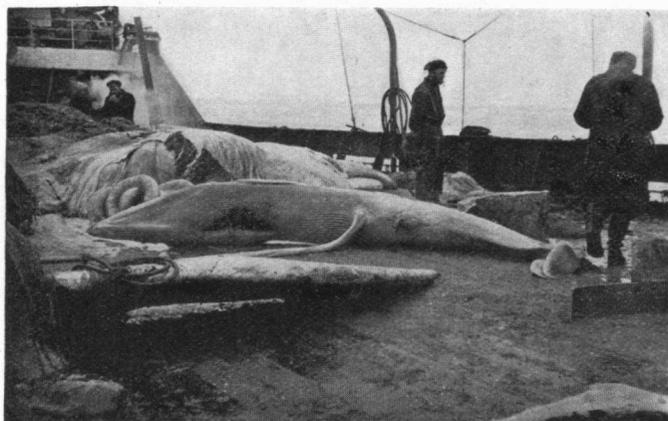


Fig. 11. A 471 cm long male foetus of an Antarctic Blue Whale (*Balaenoptera musculus* (L.)). The throat-grooves are already well developed. Observe the spirally twisted umbilical cord and the ventrally folded flukes. Antarctic season 1946—1947, Nr 229. Photograph Dr W. VERVOORT—Leiden.

umbilical cord. By this way he found that the cow originally shows about 50% cephalic presentations. Corresponding data have been obtained in the sheep by CURSON and QUINLAN (1934a, p. 662). By means of X-ray photographs (1936, p. 228) the same authors found that even during the second

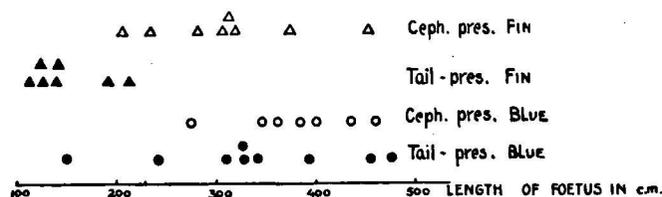


Fig. 12. Diagram showing the relation between the occurrence of cephalic and tail-presentations in foetuses of Antarctic Blue and Fin Whales and the length of these foetuses. Every symbol represents one single case. Material collected during the season 1946—1947 on board the f.f. "Willem Barendsz".

half of pregnancy the position of the sheep-foetus changed at least three times. So it appears that only the position of the foetus during the last month of pregnancy may give an almost reliable impression about its presentation at birth.

Considering Mammals in general, it may be stated that a very high percentage of cephalic presentations at birth (90-100 %) only occurs in uniparous mammals that give birth to infants that are comparatively large or that have comparatively large heads. In man the percentage varies from 97-99 % (DE SNOO, 1947, p. 36) and perhaps the same percentages may be found in other Primates. Cephalic presentations have been described in the following species: *Chiromys madagascariensis* E. Geoffr. (HILL and BURNE, 1922, p. 1149), *Macaca mulatta* (Zimmerm.) (RETTNER et NEUVILLE, 1915; TINKLEPAUGH and HARTMAN, 1931, p. 70, 5 animals, see also 1932, PHILIPP, 1931, p. 1777 and HARTMAN, 1928, p. 190), *Macaca cynomolga* L. (DE SNOO, 1947, p. 45, 16 animals), *Macaca sylvana* L. (SCHUMANN, 1914, p. 653; FROMMOLT, 1931), *Papio cornatus* E. Geoffr. (GILLMAN and GILBERT, 1946, p. 26), *Hylobates concolor* Harlan (RETTNER et NEUVILLE, 1915), *Gorilla gorilla* (Sav. et Wym.) (BOLK, 1922) and *Pan paniscus* Schwartz (FOX, 1929, p. 42; WISLOCKI, 1933a; YERKES and ELDER, 1937; YERKES, 1939). Breech-presentations have been described by POCOCK (1906, *Nemestrinus nemestrinus* (L.), stillbirth) and by RETTNER et NEUVILLE (1915, *Macaca mulatta* (Zimmerm.), 3 cases from literature). With regard to the Ungulates, where the head is born lying on the fore-limbs, statistical data are only known about the big domestic animals. According to KEHRER (1867, p. 104), LANGE (1939) and BARCLAY, FRANKLIN and PRICHARD (1945, p. 120) the percentage of cephalic presentations is 99 % in the horse, 96 % in the cow, 97 % in the sheep and 91 % in the goat. Single cases of births in cephalic presentation have often been observed in different species of wild Ungulates. Apart from the enumeration of SLIJPER (1936, p. 460) and the data of KRUMBIEGEL (1931, p. 259) they are known about *Procavia capensis* Pallas (FOX, 1933, p. 8), *Elephas maximus* L. (CHAPMAN, 1881, p. 414; BENEDICT, 1936, p. 82), *Ovis musimon* Schreb., *Rupicapra rupicapra* (L.), *Alces alces* L., *Lama huanacus* Mol. (LANG, 1945, p. 30), *Odocoileus virginianus gymnotis* (Wieg.) (verbal communication of Dr P. WAGENAAR HUMMELINCK-Utrecht), *Bison bison* (L.) (HEDIGER, 1940, p. 157), and *Giraffa camelopardalis* (L.) (OWEN, 1839, p. 21, two cases; Report Zool. Garden, København, 1942). Very little information could be obtained about other uniparous Mammals. SCHNEIDER (1939) describes the birth of *Choloepus didactylus* L. in cephalic presentation. The same position has been found in nearly full-term fetuses of *Myrmecophaga tridactyla* L. (MAYER, 1839, p. 54), *Choloepus hofmanni* Peters (TURNER, 1876 b, p. 75) and also in *Dasyprocta prymnolopha* Wagner (FOX, 1923, p. 239, only one foetus in utero). With regard to the *Pinnipedia* uteri with nearly full-term fetuses in cephalic presentation have been described by VAN DEN BROEK (1904, *Phoca vitulina* L.) and TURNER (1876 a, *Halichoerus grypus* Fabr.). The same position has been found in a 28 and a 160 cm long foetus of *Dugong dugong* (Erxleb.) (resp. HARTING, 1878 and TURNER, 1889, p. 642). WISLOCKI (1935, pl. 1) shows a tail-presentation on a 44 cm Bijdragen tot de Dierkunde, Afl. 28.

long foetus of *Trichechus latirostris* (Harlan), but this foetus is too small to give any reliable indication about its presentation at birth.

In the multiparous Mammals the comparatively small infants may be born either in cephalic or in breech-presentation. In cephalic presentation the fore-legs may be bent caudally against the abdomen or cranially against the neck (TAPKEN, 1893, p. 6, pig; KEHRER, 1867, p. 44, rabbit). About 50 % cephalic and 50 % breech-presentations have been described in the pig (KEHRER, 1864, p. 104; SMIDT, 1937, p. 52; LANGE, 1939; TAPKEN, 1893, p. 6), cat and dog (KEHRER, 1867, p. 104; LANGE, 1939), *Putorius furo* L. (MURR, 1932, p. 39), *Oryctolagus cuniculus* (L.) (KEHRER, 1867, p. 44; DE SNOO, 1947) and *Rattus norvegicus* (Berkenh.) (*albinus*) (GRIFFITH and FARRIS, 1942). According to GRANZOW (1930, p. 321) in *Cavia porcellus* (L.), however, the infants practically are always born in cephalic presentation, although the foetuses may show breech-presentation until shortly before birth. The number of young is usually 3-4, but in opposition to most other Rodents they are comparatively big and well developed at birth. Unpublished researches of SCHUURMAN (see also DE SNOO, 1947) have shown that about 50 % cephalic presentations may also occur in uniparous or biparous bats (see also EISENTRAUT, 1936, p. 27, EISENTRAUT, 1937 and EMMERT and BURGAETZY, 1918, p. 30).

WILLIAMS (1909, p. 535) and DE SNOO (1947, p. 34) have already pointed out that in mammals that give birth to comparatively large infants or to infants with comparatively large heads, a breech-presentation may be dangerous, since the umbilical cord may be compressed between the foetal body and the pelvis of the mother when the umbilicus or the head of the foetus have entered the pelvic inlet. If in this case the foetus is not artificially extracted, it may quickly die from asphyxia, or it may show respiratory movements and probably aspire mucus or blood. So in man the percentage of stillbirths and the mortality before the 10th day after birth is much larger in breech- than in cephalic presentations.

Several different theories may be found in literature about the factors that cause the very high percentage of cephalic presentations in uniparous Mammals (LANGE, 1939, p. 32). Although none of these theories is quite satisfactory, the considerations about the peristaltic contractions of the uterus (KEHRER, 1864, 1867, p. 104; DE SNOO 1933-1947) appear to give at least partially, an acceptable explanation of the facts. DE SNOO has pointed out that in man and the other Primates there are no peristaltic uterine contractions. The large head, the short neck and the upright position of the mother (in monkeys frequently during the last weeks of pregnancy) should be able to cause a high percentage of cephalic presentations. The other mammals, on the contrary, show during pregnancy distinct peristaltic uterine contractions starting from the tubal end of the uterus. In mammals with a small head and a long neck, as for example the Ungulates, the head should be forced by these peristaltic contractions into the direction of the cervix uteri. The

body-form of most multiparous mammals (moderate size of head and length of neck), however, should be so that either the cranial or the caudal end of the animal should be directed towards the pelvic inlet.

According to the opinion of DE SNOO (1947, p. 93) there are no grounds to suppose that the Cetacea should lack peristaltic uterine contractions and I should like to state here that most of my arguments against his opinion (SLIJPER, 1936, chapter 16) must be withdrawn. On the other hand it must be stated that the shape of the body of the Cetacean is not a quite favourable one to secure cephalic presentation caused by peristaltic uterine contractions. If the very large head without a distinct neck and the very long and mobile tail with its flukes are compared with the body-form of Ungulates, the conclusion may be drawn that peristaltic uterine contractions should favour tail-presentation more than cephalic presentation.

It has been shown that in *Mystacoceti* during the last months of pregnancy there is a distinct tendency to attain a position securing cephalic presentation at birth. Since this cannot be fully explained neither by gravitational forces, nor by the peristaltic contractions, there must be some other factors responsible for this position. Perhaps anti-peristaltic contractions may occur, just as they have been observed in the uterus of the rabbit by KEHRER (1864, p. 14). Probably these unknown factors do not act in the same way in *Odontoceti*, with the result that a considerable number of their babies is born in tail-presentation.

5. THE UMBILICAL CORD

DE SNOO (1947) has shown that the length and strength of the umbilical cord may be very important with respect to the mechanism of birth in the different orders of Mammals. Consequently I collected some data about this subject in the Cetacea. From these data (table 4 and 5) it appears that the average length of the umbilical cord in Blue and Fin Whales amounts to 62 % of the length of the foetal body (tip of snout-notch of flukes). From fig. 13 and 14, however, it appears that this average relative length is of very little value, since it decreases during the second half of pregnancy, the relative length being 80-90 % in foetuses of 1-2 m (about 5-6 months pregnancy) and 40 % in nearly full term foetuses. The data about the cord of the *Odontoceti* (table 7) are rather scanty so that conclusions must be drawn very cautiously. Probably, however, in very small foetuses the cord is comparatively short (± 30 %), then it increases in length during the first half of pregnancy (up to about 80 %) and after that it decreases to about 40 %, so that at birth it has about the same relative length as in *Mystacoceti*. Since in other mammals the length of the cord is always determined in % of the snout-anus length of the foetus, it may be better to express its length in Cetacea in % of the distance between the tip of snout and the anal aperture, this percentage being about 57 %.

In literature no data have been found about the increase or decrease in length of the cord in man and other mammals during pregnancy. From a

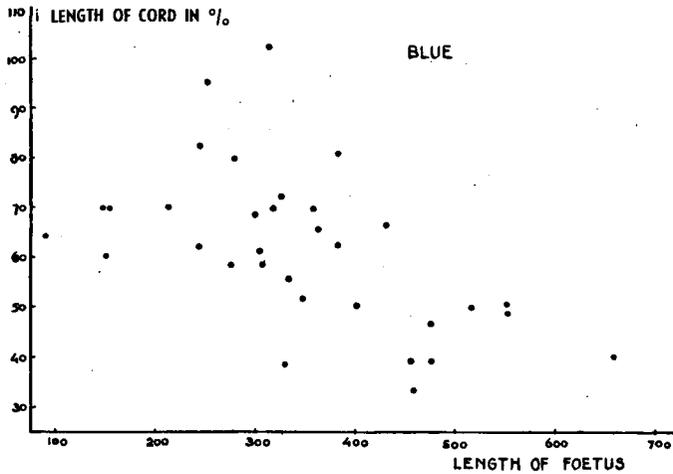


Fig. 13. Diagram showing the relation between the length of the umbilical cord (in % of the length of the foetus) and the length of the foetuses of Antarctic Blue Whales (*Balaenoptera musculus* (L.)). Material collected during the season 1946—1947 on board the f.f. "Willem Barendsz".

review of the literature about the umbilical cord (SLIJPER, 1936, table 34, p. 463 and: DE SNOO, 1947; SHORDANIA, 1929, p. 697, man; KEHRER, 1867,

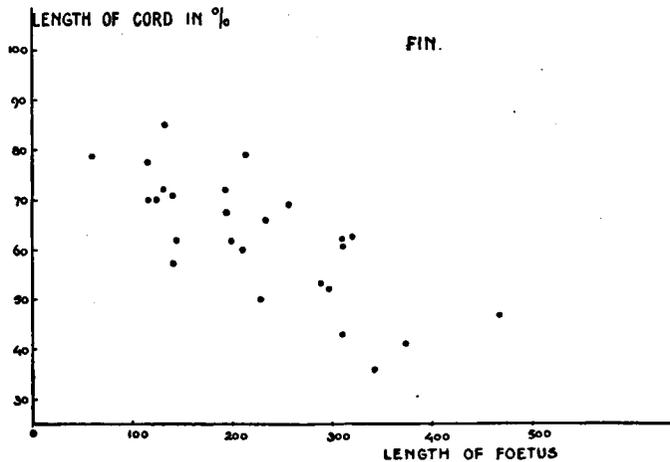


Fig. 14. The same diagram as represented in fig. 13 but bearing on the Fin Whale (*Balaenoptera physalus* (L.)).

p. 79, domestic animals; BARCLAY, FRANKLIN, PRICHARD, 1945, p. 155, domestic animals; HAUPTMANN, 1911, p. 106, horse; FROMMOLT, 1931, *Macaca*

Table 7
The length of the umbilical cord in Odontoceti.

Species	Length of foetus in cm	Length of foetus at birth in cm	Length of umbilical cord in cm	Length of umbilical cord in % of length of foetus	References
<i>Phocaena phocaena</i> (L.)	1,05	60-80	0,25	24	GULDBERG and NANSEN (1894, p. 34)
	1,7		0,6	35	GULDBERG and NANSEN (1894, p. 58)
	25,5		23,0	92	HARTING (1878)
	59,0		30,0	51	Den Helder 19-3-1937
	60,0		27,0	45	KLAATSCH (1886, p. 10)
	74,0		31,0	42	SLIJPER (1936, Ex. O)
	81,0		25,0	30	Den Helder 26-5-1936
<i>Tursiops truncatus</i> (Mont.)	87,0	125-155	33,0	38	WISLOCKI and ENDERS (1941, p. 761)
<i>Delphinus delphis</i> L.	62,0	90-100	33,0	53	FISCHER (1881)
	85,0			66	CHABRY et BOULART (1883)
<i>Delphinus</i> spec.	32,5		22,0	67	MEIGS (1849, pl. 35)
<i>Delphinus</i> spec.	17,0		10,0	59	SLIJPER (1936, table 33)
<i>Grampidelphis griseus</i> (Cuv.)	125,0	140	60,0	48	LE DANOIS (1911, p. 402)
<i>Lagenorhynchus acutus</i> (Gray)	3,0	100-120	0,9	33	GULDBERG and NANSEN (1894, p. 55)
	4,5		1,8	40	The same (p. 17)
<i>Lagenorhynchus albirostris</i> Gray	113,0	100-120	52,0	46	The same (p. 29)
<i>Grampus orca</i> (L.)	40,0	250	31,0	78	The same (p. 57)
	87,5		45,0	51	The same (p. 58)
<i>Pseudorca crassidens</i> (Owen)	110,0	190	60,0	54	PEACOCK, COMRIE, GREENSHIELDS (1936, p. 104)
<i>Orcella brevirostris</i> Owen	86,0	90-100	33,0	38	ANDERSON (1878, p. 403)
<i>Monodon monoceros</i> L.	165,0	150-170	91,4	55	TURNER (1876, p. 103)
<i>Platanista gangetica</i> Lebeck	69,0	90-100	25,4	36	ANDERSON (1878, p. 493)
<i>Kogia breviceps</i> (Blainv.)	19,5	100-110	10,8	57	SLIJPER (1936, table 33)

fascicularis (Raffl.); SCHNEIDER, 1939, p. 522, *Choloepus*), however, it appears that in man, some Primates, the *Insectivora*, *Orycteropus*, the pig and probably also in the *Edentata* the umbilical cord is long (80-120 % of the length of the foetus). In the horse and some Rodents it is shorter (55-80 %), in the cow, the dog, the cat, the elephant, the hippopotamus and some Rodents its length only amounts to 30-55 %, whereas the tapir, the sheep, the goat and several Carnivores have a very short umbilical cord (10-30 %). According to DE SNOO (1947, p. 141) the occurrence of a long cord is only possible in mammals without peristaltic contractions of the uterus, because of the danger that the cord might protrude through the vagina in advance of the foetus, or that it might be wound round its neck or limbs. The foetal death rate of these cord complications in man is very high (MORGAN, 1948, p. 822). Apparently this only applies to the uniparous Mammals, since in some multiparous species with peristaltic uterine contractions a long umbilical cord can be found, as for example in the pig and the *Insectivora*.

Without doubt the Cetacea have a comparatively short umbilical cord. It is shorter than in the horse, has the same relative length as in the cow and some other Ungulates, but it is longer than the cord of the sheep, the goat and all Carnivores.

Now there is a certain connection between the length of the umbilical cord and the way in which it is separated from the new-born animal at birth. In mammals with a long umbilical cord, as man and other Primates, it is not ruptured, neither during nor after the birth of the baby. Except in the case of a sudden pull, in man it can bear a weight of 5-6 kg, i.e. more than the average weight of the baby (BAYER, 1900, p. 1711; SHORDANIA, 1929, p. 697). In apes and monkeys the cord is so long that it enables the new-born baby to move and to cling to the mother's breast. If after some time the placenta is born, this may be fastened to the baby by the umbilical cord for a comparatively long time (TINKLEPAUGH and HARTMAN, 1931, p. 92, 8 hours, *Macaca mulatta* (Zimmerm.); FOX, 1929, p. 41, 24 hours, *Pongo pygmaeus* (Hoppius)). Generally the placenta and a variable part of the cord are eaten by the mother; the remaining part of the cord sticks to the baby and is dried up after some days. Apparently in macaques only the placenta is eaten, the whole cord sticking to the infant. In the pig, however, the cord ruptures during or shortly after birth by the movements of the young animal. In *Chiroptera* the cord enables the baby to cling to the mother's breast, just as in Primates (EISENTRAUT, 1936, 1937).

In the Ungulates the mother assumes either a standing or a recumbent position during birth. In the case of a recumbent position, however, the animal rises almost immediately after the young has been delivered (HEDIGER, 1940, p. 175). The umbilical cord is comparatively weak and ruptures by the weight of the baby (KEHRER, 1867, p. 81). If the mother stands during birth this happens when the new-born falls; if the mother lies, it happens when she

rises (BARCLAY, FRANKLIN and PRICHARD, 1945, p. 120; BENEDICT, 1936, p. 82) or when she turns to lick the infant (in the horse with its comparatively long umbilical cord; WILLIAMS, 1909, p. 365; WRIGHT, 1943, p. 216). In the cow the umbilical cord is so short that it ruptures mostly during the expulsion of the foetus (DE BRUIN, 1902, p. 86; WILLIAMS, 1909, p. 366). The same has been observed by KEHRER (1864, p. 44) in the rabbit.

In the Carnivores the weight of the infant appears to be less than the strength of the umbilical cord (KEHRER, 1867, p. 81; MURR, 1932, p. 39) so that it does not rupture. Usually the placenta comes quickly after the birth of the young and it can be attached to the baby for some time before it is eaten by the mother. The remaining stump of the cord is usually very small.

All descriptions that have been published of the umbilical cord of the Cetacea agree quite well regarding the facts that it consists of two arteries, two veins and an allantoic duct, that the Whartonian gelatine is vascularized, that bundles of smooth muscular fibres may be found, that there may be blind diverticula of the allantoic duct and that the epithelium shows peculiar knob-like thickenings (KLAATSCH 1886; WISLOCKI, 1933; WISLOCKI and ENDERS, 1941). The same characteristics may be observed in the umbilical cord of the Blue and Fin Whale. As in all other Cetacea the cord of these Whales is spirally twisted (fig. 11). Usually 2—4 twists are found (see also GULDBERG, 1887, p. 140, *Megaptera nodosa* (Bonnat.)), although sometimes there may be more (fig. 2, 16; see also ANDERSON, 1878, p. 403, pl. 33, fig. 1, *Orcella brevirostris* Owen, 7 twists). 2—4 twists is less than in man (SHORDANIA, 1929, p. 700, 8—12) but almost the same as in the horse (WRIGHT, 1943, p. 219; STOSZ, 1924, p. 624). In the Blue and Fin Whale the amount of Whartonian gelatine is nearly the same as in the Porpoise (*Phocaena phocaena* (L.)), which is the same or a little more than in Ungulates (BARCLAY, FRANKLIN, PRICHARD, 1945, fig. 108, 109), but distinctly less than in man. In *Tursiops truncatus* (Mont.) (WISLOCKI and ENDERS, 1941, fig. 19) and *Platanista gangetica* Lebeck (ANDERSON, 1878, p. 493, pl. 36) the amount of gelatine is almost the same as in man.

Although I am not able to give exact data about the strength of the cord in Whales and Dolphins, it must be comparatively strong. For it is possible to take up a new-born Porpoise or to pull a Whale foetus on the deck of a factory-ship by their cords.

With regard to the fact that the umbilical cord is comparatively short and that consequently the new-born animal will not be able to make movements of large size if it is still attached to the mother, one may ask how this connection will be broken, since in any case the Baleen Whales (*Mystacoceti*) will not be able to eat the placenta or to bite off the cord. According to SLEPTZOV (1940) the cord of the Common Dolphin (*Delphinus delphis* L.) ruptures immediately after birth, probably by the resistance of the young animal in the water. In the Porpoise observed by JAMES (1914, p. 1062) it

was broken after the mother had swum 20 m or so and MCBRIDE and HEBB (1948, p. 115) saw that their female Bottle-nosed Dolphins whirled as if to bite the umbilical cord, but this had already snapped. On the other hand KHVATOV (1938) reports that the new-born Dolphin may be attached to the mother for even about three days, just as it has been described by PEDERSEN (1931, p. 414, *Monodon monoceros* L.). A recently born Dolphin which is still connected with its mother by the umbilical cord, has already been described by BELON (1553) and RONDELET (1558) and certainly there are some other indications that the separation of mother and child in the Cetacea not always happens in the way of the Ungulates, but at least sometimes in the way of the Primates or the Carnivores. This may be concluded from the fact that I have found several recently born Porpoises (*Phocaena phocaena* (L.)) that had been washed ashore with the umbilical cord and the entire placenta still connected with the baby.

In some Ungulates the cord always ruptures at a special place. In the horse this place can also anatomically be determined, since there is a constriction of the cord at a distance of about 2 cm from the umbilicus. Here the adventitia of the blood-vessels contains less connective-tissue and there is a common layer of circular muscular fibres round about the vessels (HAUPTMANN, 1911, p. 107). In Ruminants the umbilical arteries rupture at an intra-abdominal level (MEYER, 1914, p. 223; BARCLAY, FRANKLIN, PRICHARD, 1945, p. 160), but no special histological differentiation of this place has been described. Macroscopically no indications with regard to a special place of rupture could be found in the big Whales. Microscopical researches did not give any further information about this subject, but up to the present they could only be made in comparatively small foetuses.

SLEPTZOV (1940) thinks that during the first hour after birth the new-born Dolphin cannot swim actively, because of the folded position of its flukes. This, however, has not been confirmed by MCBRIDE and HEBB (1948, p. 115), who state that immediately after birth the infant of the Bottle-nosed Dolphin swam to the surface to breathe for the first time, and that it continued swimming afterwards.

During its rise to the surface the new-born animal may get some help from the mother as I was told by one of the officers of the f.f. "Balaena". Once he observed a whale with a new-born young, some blood being visible on the surface of the water. Three times the young was pushed to the surface by the mother, as if it had to learn to breathe. The same attempts of the mother have been seen with regard to the stillborn infants described by GOODWIN (1947) and MCBRIDE and HEBB (1948) (fig. 15). I can hardly believe that this maternal care should be possible if the young is still connected with the mother by the umbilical cord.

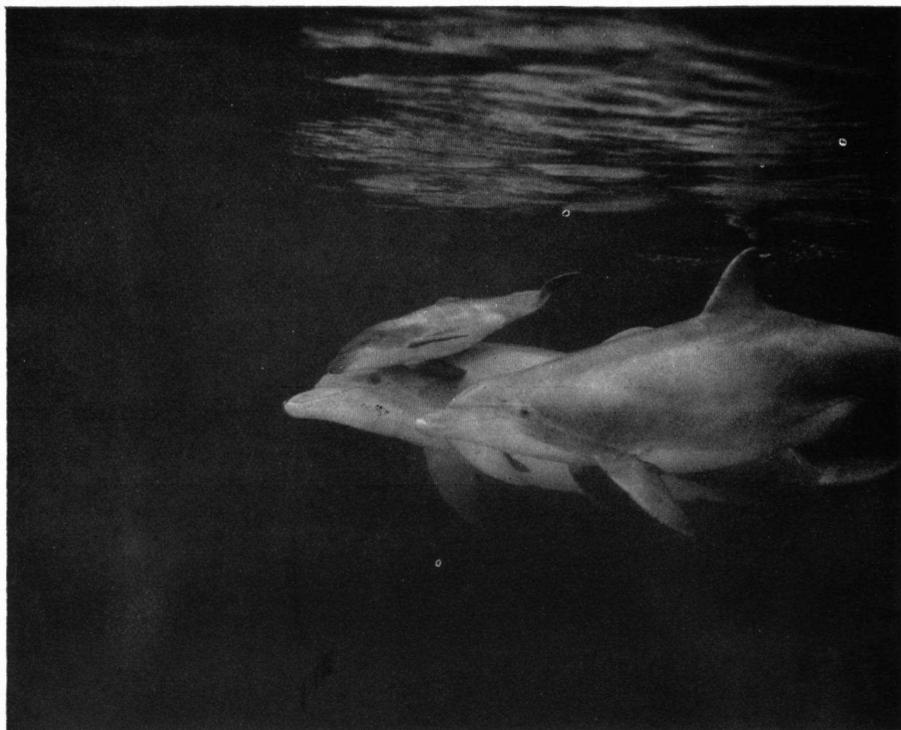


Fig. 15. Two female Bottle-nosed Dolphins pushing a new-born dead young to the surface of the water. Photograph taken from a film made at the Marine Studios, Marineland, Florida U.S.A. Courtesy R. J. EASTMAN.



Fig. 16. Congenital kyphosis and other malformations in a 282 cm long male foetus of the Fin Whale (*Balaenoptera physalus* (L.)). Antarctic whaling season 1946—1947, Nr 281. Photograph Dr W. VERVOORT—Leiden.

6. ABNORMALITIES

Just as in other mammals abnormal or pathological events may occur with regard to pregnancy and birth of the Cetacea. Developmental anomalies of the foetus have been described by DROOGLEEVER FORTUYN (1920; *Tursiops truncatus* (Mont.), foetus with two heads), COLLETT (1886, *Balaenoptera borealis* Lesson, congenital absence of flippers), APPELLÖF (1912, *Balaenoptera acutorostrata* Lacép., distortion of foetus), GULDBERG (1908, *Megaptera nodosa* (Bonnat.), deformation of head), GULDBERG and NANSEN (1894, *Lagenorhynchus acutus* (Gray), similar deformation of head), KORSCHULT (1932, *Monodon monoceros* L., congenital scoliosis), SLIJPER (1936, p. 495, *Lagenorhynchus albrostris* Gray, congenital kyphosis). This enumeration may be continued by the description of a 282 cm long male foetus of the Fin Whale (*Balaenoptera physalus* (L.), Nr 281) which could be observed during the first Antarctic season of the "Willem Barendsz" (4-2-1947). As fig. 16 shows, the animal had a very large hump on its back in the thoracic region, caused by a heavy kyphosis of the vertebral column (this vertebral column is now in the Rijksmuseum van Natuurlijke Historie, Leiden). This anomaly probably caused some other anomalies, as for example the very short lower jaw — this jaw is in *Mystacoceti* always longer than the upper jaw —, the abnormal position of the flippers and the absence of a part of the throat-grooves on the left side of the body.

An intra-uterine rupture of the umbilical cord with expulsion of the placenta and retention of the foetus has been described by JOURDAIN (1880, *Phocaena phocaena* (L.)).

Sometimes it happens that in the carcass of a female whale on the deck of a factory-ship a large and apparently well-functioning corpus luteum graviditatis is found, but that the large uterus contains no foetus. During the first expedition of the "Willem Barendsz" such a case was observed three times in the Blue Whale (*Balaenoptera musculus* (L.)). It may be supposed that in these cases the female had an abortus during the time that she was chased by the catcher, or probably at the moment when she was struck by the harpoon.

A very remarkable case was observed in the 88 feet (26,8 m) long female of the Blue Whale (Nr. 592), caught on the 14th of March 1947 at 64° 36' S.—22° 49' W. In the ovaries 35 corpora albicantia were found, indicating that the animal had already attained a high age. Apparently this female was lactating. The mammary glands were very much swollen (height \pm 40 cm), the nipples protruded from their slits and milk spouted from the nipples when the animal came on the deck. The milk of the left mamma had the usual creamy-white colour, but that of the right was light brown. The same difference in colour could be seen in the mammary glands themselves, the left gland showing the usual pink colour, whereas the right one was almost dark brown. The milk of both glands was thinner than can normally be observed

in whales, and apparently this whale showed a very abnormal lactation. No suckling had been seen by the gunner and the crew of the catcher, so that it is highly probable that this female did not nurse a calf. The uterine horns were not larger than in a normal resting female, but they were highly vascularized. There was no foetus and no corpus luteum graviditatis.

On examining the uterus, a large fibromyoma (45 × 50 cm) was found in its cervical part. The tumour contained a large amount of fat, some small patches were calcified. Probably the condition of this whale may be explained by supposing that the fibromyoma had caused an abortus about three months ago and that this abortus caused the abnormal lactation. According to DUCKERING (1946) in man there is a very distinct relationship between the occurrence of myoma uteri and abortion, whereas an abortion may certainly cause activation of the mammary glands. The fact that it was an old whale is also quite in accordance with conditions in man, where myomata are mostly found in elder pregnant females. According to this explanation of the facts, the corpus luteum graviditatis should have been comparatively small at the time of the abortion, which should have taken place in one of the first months of pregnancy. Then the corpus luteum would have shown a fairly rapid regression, so that at the time at which the animal was caught it was not distinctly different from some of the other young corpora albicantia.

SUMMARY

1. A review is given of some phenomena concerning pregnancy and parturition of the Cetacea, depending on data in literature and on observations made in Antarctic Blue and Fin Whales on board the f.f. "Willem Barendsz" (1946—1947).

2. In *Mystacoceti* the frequency of twins appears to be less than in man and the big domestic animals. The majority of twins is born by females that are longer than the average female in the period of greatest sexual activity. This does not mean, however, that just as in man most twins are born at an elder age than that corresponding with the maximum of sexual activity. It may also be possible that, just as in the big domestic animals, the ages correspond, but that twins are mostly produced by the physically stronger developed females.

3. In *Odontoceti* the left ovary shows a very distinct morphological and functional prevalence. The foetus is exclusively found in the left uterine cornu. In *Mystacoceti* there is a prevalence of about 60 % of the right ovary and the right uterine cornu with regard to ovulation and pregnancy. The above described phenomena have also been observed in other uniparous Mammals, whereas in multiparous Mammals no distinct prevalence of a special side has been found. Transference of an ovum from the ovary of one side to the cornu of the other has been observed twice in Cetacea.

4. In *Mystacoceti* the number of cephalic presentations of the foetus very

distinctly increases during the last months of pregnancy, just as in man and the big domestic animals. There is a great possibility that, just as the other uniparous Mammals, which give birth to comparatively large infants, in *Mystacoceti* a very high percentage of the young is born in cephalic presentation. In *Odontoceti*, on the contrary, a great number of foetuses is apparently delivered in tail-presentation. With regard to their shape and dimensions, such a birth in tail-presentation must be considered as an unfavourable event. An attempt has been made to explain these facts with the aid of the peristaltic uterine contractions. If these contractions act in the same way as in other Mammals, it might be expected that most of the Cetacea should be born in tail-presentation. So it is highly possible that in *Mystacoceti* some other factors are responsible for the high percentage of cephalic presentations.

5. In Cetacea the relative length of the umbilical cord (in % of the length of the foetus) decreases markedly during the second part of pregnancy. At birth its length is about 40 % of the total length of the calf and 57 % of its snout-anus length. As compared with other Mammals the cord of the Cetacea is rather short and this fact may have some influence on the way in which the connection between mother and calf is broken. This may occur by rupture of the cord immediately after birth as in Ungulates. On the other hand it appears to be also possible that, just as in Primates, Carnivores and Chiropteres, the placenta and the cord stick to the baby for some time after birth.

6. Some congenital anomalies of foetal Cetacea are described. Abortus probably may occur during chasing of the big whales or when they are struck by the harpoon. A case of fibromyoma uteri is described in an old female Blue Whale that showed an abnormal lactation. Probably the fibromyoma had caused an abortus some months ago, this abortus causing the lactation.

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