PRENATAL DEAD FOETUS OF BALEEN WHALES

TADAYOSHI ICHIHARA

INTRODUCTION

Little is known about the prenatal death of whale foetus, although it is of importance as a part of total prenatal mortality. The total prenatal mortality in mammals indicates the sum of death rate at each stage from ovulation to partrition, that is, the sum of mortality such as unfertilized ova, the reabsorption and the abortion during the development of embryo. In other meaning, prenatal dead foetus is of particular interest in the study on genetical, physiological, pathological and serological factor causing prenatal death. Understanding of these factors is an indispensable preliminary to the prenatal mortality, for the nature and significance of prenatal dead foetus cannot be assessed without this context. There is, however, no intension in this paper to study these particular factors, but some biological observations and discussion on reabsorption are made for the prenatal dead foetus. The pursuit for factors and mutual relations among them should be made in other field.

In am indebted to the members of the Whales Research Institute and the trained inspectors of the Japanese Government, who recorded the foetuses on the factory ships. Especially, Dr. Ichiyo Asami, the Department of Anatomy, Faculty of Medicine, University of Tokyo, Messrs. Seiji Ohsumi and Keiji Nasu, the Whales Research Institute took the valuable photographs and kindly permitted me to include them in this paper.

RECORD OF PRENATAL DEAD FOETUS

The records on prenatal dead foetuses observed aboard the factory ships in the Antarctic expeditions between 1946/47 and 1960/61 season have been arranged. These foetuses were observed by the biologists and trained inspectors, therefore, they do not seem to represent all dead foetuses to be observed in the Japanese expeditions.

In Table 1, the foetuses for each species are indicated with other biological data, particularly with the corpora count in the mother's ovaries. The records in the North Pacific expeditions from 1952 to 1960 are included in the bottom of Table 1. Most of these foetuses observed in the Antarctic are composed of the fin whale and this trend is explained by the evidence that the main catch in the recent Antarctic expeditions

has been the fin whale. In other species, one prenatal dead foetus is observed respectively for the blue, the pigmy blue (Ichihara, 1961) and the sei whale. During the North Pacific expeditions the foetus except the fin whale has not recorded yet. There is no record of prenatal dead foetus in the humpback whale.

TABLE 1. LIST OF DEAD FOETUS

No.	Locality	Positon killed	Species	Mother's length in feet	Date killing mother whale	Dead foetus		Ovaries	
						Sex	Length in feet	Corpora luter	Corpora albicans
1.	Antarctic	62-16 S 98-06 E	Fin	67	Jan. 24, 1959	?	0-5	1	16
2.	〃	67-18 S 145-39 W	Fin	75	Feb. 10, 1958	?	0-10	1	6
3.	〃	48-33 S 39-44 E	Fin	69	Feb. 22, 1961	M	0-10	1	2
4.	〃	63-01 S 108-34 E	Fin	71	Dec. 22, 1950	? F M F	1-4 4-2 7-11 19-11	0	17
5.	〃	57-00 S 93-36 E	Fin	62	Jan. 8, 1960	?	2-1	1	2
6.	〃	67-16 S 172-30 W	Fin	72	Feb. 1, 1951	M M	11-5 (alive) 4-0	over 8	
7.	〃	42-53 S 38-03 E	Fin	68	Feb. 27, 1961	?	5-2	not counted	
8.	〃	55-47 S 13-48 E	Fin	71	Jan. 15, 1961	F	5-11	not counted	
9.	〃	68-12 S 170-03 W	Fin	74	Jan. 10, 1952	F F M	15-0 19-8 5-2 (alive)	1	25
10.	〃	68-05 S 136-06 W	Fin	73	Feb. 5, 1957	?	20 from 15	0	19
11.	〃	74-07 S 177-57 W	Fin	78	Feb. 11, 1954	?	16-4	not observed	
12.	〃	49-01 S 33-48 E	Fin	74	Feb. 8, 1961	?	17-8	1	14
13.	〃	69-12 S 179-46 W	Fin	75	Feb. 14, 1949	M	18-0	1	22
14.	〃	70-11 S 176-14 E	Blue	85	Feb. 15, 1955	F F	8-6 (alive) 4-2	2	17
15.	〃	46-58 S 39-32 E	Pigmy Blue	77	Feb. 8, 1961	?	not measured	not counted	
16.	〃	59-48 S 150-24 E	Sei	50	Feb. 4, 1960	M M	13-1 10-8 (alive)	1	19
17.	North Pacific	52-50 N 164-12 E	Fin	66	July 3, 1957	F	0-8	1	12
18.	〃	54-35 N 165-35 W	Fin	68	July 18, 1954	F	1-1	1	10
19.	〃	55-24 N 171-07 E	Fin	68	June 15, 1959	?	12-0	1	12

Detail of records on these foetuses should be described to know various case of death. All records do not necessary remain in full forms. Some of them are recorded only as the foetus observed is dead, however, the some details described later and the photographs included help the study on the prenatal death in whales.

Record no. 1: A prenatal dead foetus is observed with the amnion and indicated in Fig. 1. The colour of this is turbid pale green as like as boild horse beans.

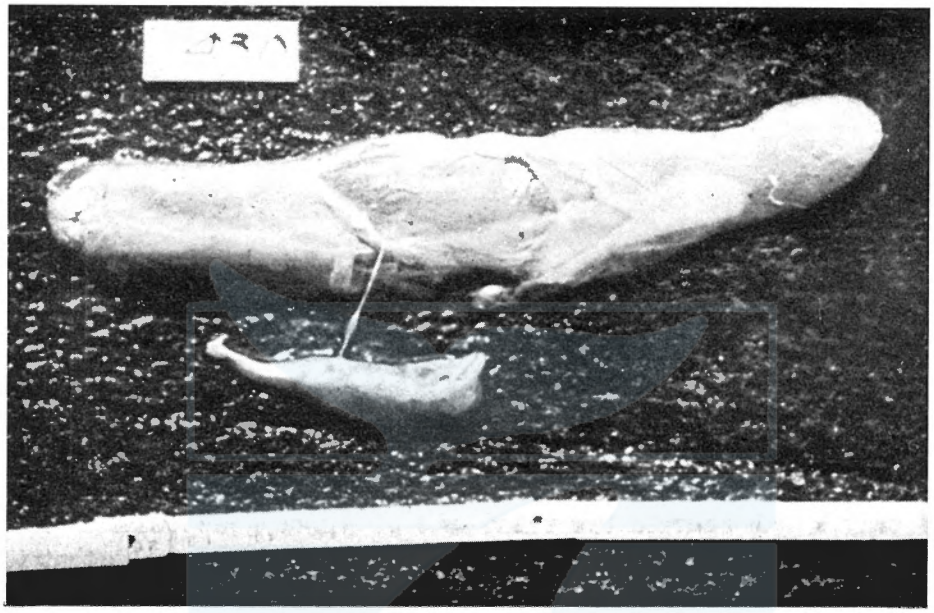

Fig. 1. Prenatal dead foetus of fin whale, recorded as no. 1 in Table 1 (Photo. by Mr. Seiji Ohsumi). The colour of this foetus is turbid pale green as like as boild horse beans.

Record no. 2: A prenatal dead foetus of which sex is unknown is observed. The colour of foetus is dark-green.

Record no. 3: Body of foetus are decomposed but not dissolved.

Record no. 4: Reported by Kimura (1957). Four prenatal dead foetuses are present in both uteri. Since no corpus luteum of pregnancy is present in mother's ovaries, it is impossible to estimate when these foetuses were dead. The most small foetus in 1 foot and 4 inches long is decomposed in the posterior region of body and so sex is unknown. Although the other information is not recorded, it is estimated that these foetuses has resulted neither from the single ovum nor from the multiple ova but each foetus was dead at the respective stage in development and that a fairly long period has been elapsed between the oldest foetus and the recent one. The prenatal death such as record no. 4 is very rare and it may be based on the physiological abnormality in the mother's uterus.

Record no. 5: Abdominal and posterior region of body is dissolved and so sex is unknown.

Record no. 6: Reported already by Kimura (1957). One of two foetuses is alive and the other is a dead male foetus, 4 feet in length. Corpora numbers are counted in one side ovary as no corpus luteum and 8 corpora albicantia. The other side ovary is unfortunately lost. It is not estimated whether the two foetuses have developed either from a single ovum or from different ova.

Record no. 7: A deformed foetus is dead.

Record no. 8: Tail flukes is lost. Dark-blue foetus has an odour of decomposition. Body length, therefore, is not measured accurately and estimated as 180 cm. Real measurement is 160 cm (5 feet 3 inches) in length.

Record no. 9: Reported already by Kimura (1957). One among three foetuses is alive, which is male, 5 feet 2 inches in length. Corpus luteum of 18.0×11.0 cm in diameter is present in the mother's ovary and corresponds to the presence of this foetus. Female prenatal dead foetuses are observed in one uterus. Also judging from the difference of body length between two prenatal dead foetuses, they are supposed to be the monozygotic twins. Kimura (1957) states that the difference of body length between two individuals of monozygotic twins is more than that of dizygotic twins. Fig. 5 in his paper suggests that the difference of 4 feet and 8 inches between body lengths of monozygotc twins in record no. 9 may be expected. At the next oestrus after two female foetuses was dead, the mother whale ovulated one ovum which has resulted in a new embryo. This male embryo has developed to 5 feet 2 inches which corresponds to the foetal length of the late in 6 months after mother whale was conceived. Laws (1959b) indicated that the average duration of gestation is $11^1/_4$ months in the southern fin whale and $10^3/_4$ months in the southern blue. It is concluded that these prenatal dead foetuses have remained in the mother's uterus over 6 months.

Record no. 10: Posterior body is decomposed and tail flukes are dissolved and lost. Therefore, sex is unknown and the accurate body length is not measured. The amnion in the white membraneous thickness sticks on and encircles the anterior body.

Record no. 11: The nearest part to reproductive aperture is particularly decomposed and so sex is unknown.

Record no. 12: The posterior body from the external reproductive aperture to the tail flukes is decomposed and so the sex of the foetus is unknown. Eyes are lost. White amnion sticks on the body and many fissures parallel to the notch of flukes from the tip of snout are present on the surface of body. Accurate body length is not measured but estimated.

Record no. 13: A deformed foetus are dead.

Record no. 14: Two female foetuses are observed in the uterus of the same side. One of them is alive, being 8 feet 5 inches long and the other is dead, 4 feet 5 inches in length. This prenatal dead foetus is yellowish-grey and atrophies in the enervated state, though the

Fig. 2. Two foetuses of the blue whale, recorded as no. 14 in Table 1. Upper foetus is healthy but below is dead.

Fig. 3. Ovaries of mother including two foetuses indicated in Fig. 2. Large corpora lutea are shown in the right ovary. (Photo. by Dr. Ichiyo Asami).

external body is not destroyed generally. Two large corpora lutea, $13 \times 12 \times 14$ cm and $14 \times 15 \times 13$ cm in the respective diametre, are present in the one side ovary where there are 10 corpora albicantia including one comparatively fresh corpora. In the other side ovary, 7 corpora

albicantia including 1–2 fresh corpora are present. There are fairly large cavities in two corpora lutea but they are not measured. Two foetuses and ovaries are indicated in Fig. 2 and 3. The presence of two foetuses in one side uterus suggests that these foetuses are either a monozygotic or a dizygotic twins and the fertilization date is almost the same in either case. As the structure of placenta unfortunately is not observed, it is impossible to examine which two foetuses come from one ovum or two ova.

In relation to this problem, it is necessary to interpret the two corpora lutea in one side ovary. In my examination on multiple ovulations of the baleen whale, there is an evidence that if one fertilized ovum develops, corpora lutea coming from sterilized ova are maintained in ovaries throughout the pregnancy of healthy foetus. This evidence supports the presence of two corpora lutea even if the two foetuses in record no. 14 are the monozygotic twins.

Even if one foetus in the dizygotic twins is dead in the course of development, the two corpora lutea of pregnancy will be maintained throughout pregnancy of the other healthy foetus. This phenominon is very rare in the whale as a monoparous species. In the multiparous species of terrestrial mammals, such phenomina are known well and the total prenatal mortality before and after implantation is estimated by many scientists from the numbers of corpora lutea and of healthy embryos; pig (Hammond, 1921, etc.), sheep (Henning, 1939, etc.), ferret (Robinson, 1921), stoat (Deanesly, 1935) and wild rabbit (Brambell, 1948 etc.).

Record no. 15: A foetus is decomposed and dissolved to green fluid. Therefore, body length is not measured and sex is unknown.

Record no. 16: A prenatal dead foetus is observed in the one side of uterus and a healthy foetus in the other side of uterus. The photograph of a prenatal dead foetus is shown in Fig. 4. The foetus is the full-grown male, 13 feet and 1 inch in length, and near to partrition. Tail flukes bent as indicated in lower left of Fig. 4. The colour of amnion changes whitish-grey and the thickness of it increases. The aminion encircling the foetus body breakes at some parts and on the surface of body there are many fissures parallel to body axis. Dark pigments observed usually on the dorsal region of full-grown foetus vanish and the external body of the foetus appears yellowish-white. Tip of flipper and tip of tail flukes are dissolved and lost as indicated in lower left and right of Fig. 4. Eyes also are lost.

One corpus luteum in the ovary corresponds to the healthy foetus. Since the corpus luteum has regressed to corpus albicans after the death of foetus, it is pointed out that these foetuses have developed from the

different ova. 19 corpora albicantia are counted in both ovaries. At the next oestrus after a foetus was dead, the mother whale ovulated a new ovum which has developed to a foetus of 10 feet 8 inches in length. Since the average duration of gestation is about 12 months and the neonatal length is 4.5 metre (14 feet 9 inches) for the southern sei whale (Matthews, 1938 ; Laws, 1959b), about 10 months and a half have elapsed after conception until the foetus has grown to 10 feet 8 inches. This estimation also supports that the prenatal dead foetus has remained in the mother's uterus over 10 months.

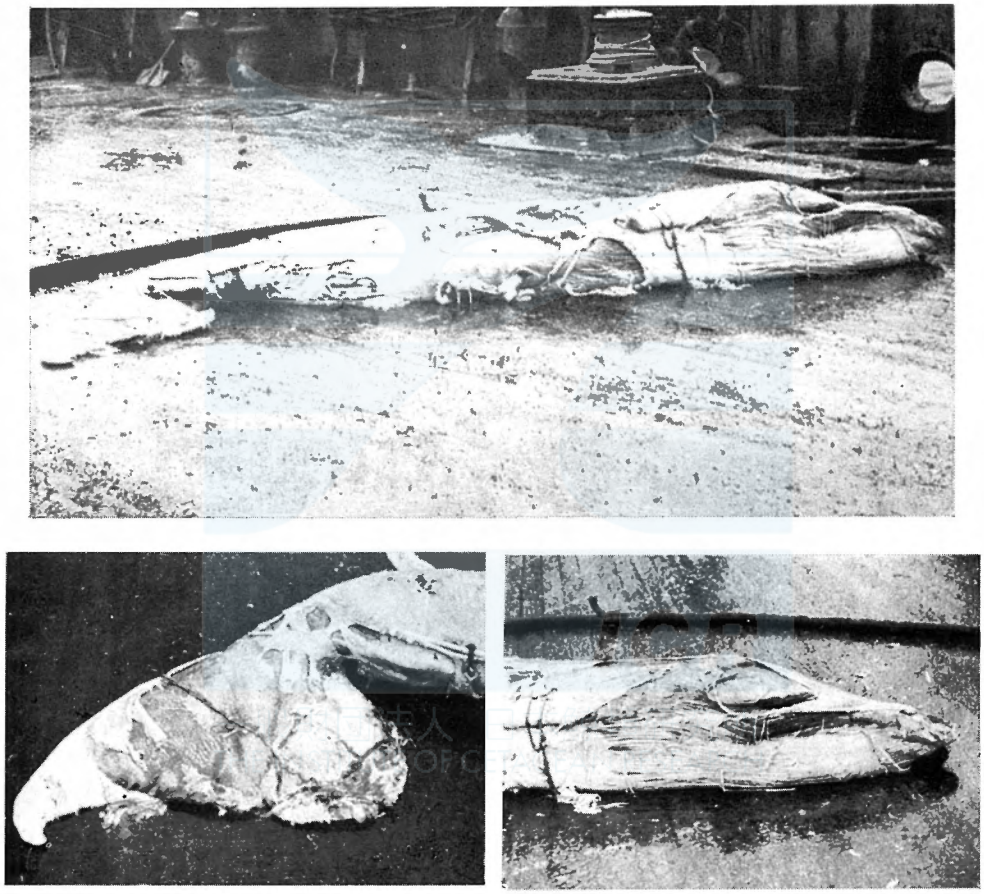

Fig. 4. Prenatal dead foetus of the sei whale, recorded as no. 16 in Table 1.
Lower left: Tail flukes; Lower right: Anterior body part

Record no. 17 and 18 : Dark-green foetuses are dead.

Record no. 19 : A dead foetus is observed. Some parts of body are decomposed and so sex is not examined. Flippers and tail flukes are dissolved and lost, besides eyes also fall off as shown in Fig. 5. The

head of the foetus seems to be deformed. The outside of body appears yellowish-grey. One corpus luteum remains in the corresponding ovary to the uterus including the foetus. 12 corpora albicantia are present in the both ovaries.

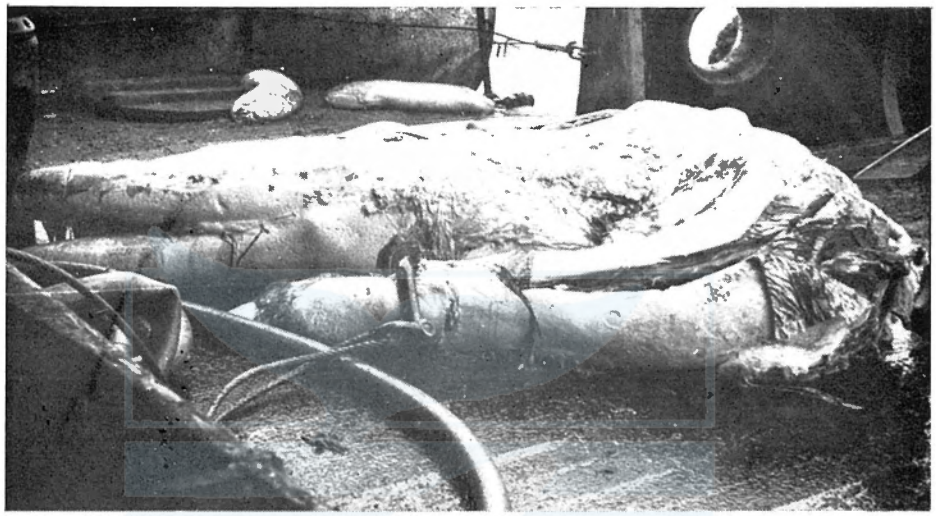

Fig. 5. Prenatal dead foetus of the fin whale, recorded as no. 19 in Table 1. (Photo. by Mr. Keiji Nasu).

DEAD FOETUS AND LIFE OF CORPORA LUTEA

It is pointed out from the records mentioned above that corpus luteum exists in the ovary, although the foetus was dead in the uterus before the mother whale is killed. With regard to whales, corpus luteum remains throughout pregnancy and it regresses gradually to corpus albicans after partrition. In the case that the foetus was dead in the mother's uterus, corpora lutea of pregnancy shrinks in the similar process as partrition from the time of interrupted pregnancy. It is probably accepted that the periods of transformation from corpus luteum to corpus albicans is not always the same in the death of foetus as well as in partrition. It is often observed in the Antarctic whaling season between January and March that corpus luteum of pregnancy regresses to corpus albicans in the ovary of the lactating female. Mackintosh and Wheeler (1929) state that the lactating periods are about 6 months for the southern fin whale. From two evidences mentioned above it seems that corpus luteum of pregnancy regresses to corpus albicans for a few month after partrition. In the case that the dead foetus remains in the uterus, if the placenta is active yet, it is assumed that the corpus luteum of pregnancy is maintained for a fairly long time without

regression. In the record nos. 1, 2, 3, 5, 17 and 18, such assumption may be accepted. It is very doubtful however that the corpora lutea of pregnancy corresponding to the prenatal dead foetuses have remained in the ovaries in the record nos. 12, 13 and 19, for these foetuses was dead long before. In fact, there are no corpora lutea of pregnancy in the record nos. 9, 10 and 16 in which large foetuses are dead. Besides, there are similar informations on the prenatal dead foetuses of fin whales between the record nos. 10 and 19. It is estimated that corpora lutea in the record nos. 12, 13 and 19 result from new ova shed after the foetuses was dead, that is, corpora lutea of ovulation. Measurement of diameters of these corpora are not informed.

OCCURRENCE AND PROCESS OF REABSORPTION

From the records indicated in Table 1 informations on the relation between the frequency of the prenatal dead foetus and the maternal age are obtained. With regard to baleen whales, corpora albicantia remain in the ovary throughout the life span and so the total numbers of corpora indicate the relative age of whale (Mackintosh and Wheeler, 1929; Laws, 1958). In 13 records of the Antarctic fin whale in Table 1, the examples over 10 corpora counts occupy about two-third of total. In the multiparous species of mammals, the number of ova shed increases with the maternal age and the loss of foetus increases with the number of implanted embryos (Brambell, 1948). This fact suggests that the prenatal mortality increases with the maternal age in the multiparous mammals. This evidence is probably applied to the whales as monoparous species.

In the multizygotic foetuses of whale, it is estimated that the death rate is higher more than in the single foetus. Nutrient supply from the maternal body is probably limited not to breed many foetuses. The death of multizygotic foetuses appears more frequently in the last stage than in the early stage of foetal development. Possibly related to this is the fact in the horse, a species in which only about fifteen twin births per thousand occur (Lauprecht, 1932), more than one-half of the twin pregnancies end in an abortion (Wriedt, 1928).

Dead foetus is observed frequently in the early stage and in the late stage of pregnancy as tabulated in Table 1. Length frequency of foetus observed in the Antarctic is indicated in Fig. 6, based on the material of the International Whaling Statistics in 1959/60 Antarctic whaling season. Examing the foetal lengths of fin whales in the International Whaling Statistics covering 1925–58 and composing many thousands of records, Laws (1959a) concludes that there has been no progressive

change in the mean foetal lengths of fin whales from year to year in the Antarctic. In this meaning, the length frequency of fin whale foetus in 1959/60 season seems to represent the foetal length frequency in the Antarctic. In Fig. 6 the length frequency of prenatal dead foetus is plotted at each 3 feet and smoothed with a curve. The section of each gestation month for the fin whale is shown in the bottom of Fig. 6 in order to explain the interrelationship between the periods from conception and the foetal length. Although the percentage frequency of foetal length is skewed positively, there is a peak from 5 to 8 feet of the foetal length. This corresponds from $6^1/_2$ to about 8 months after conception.

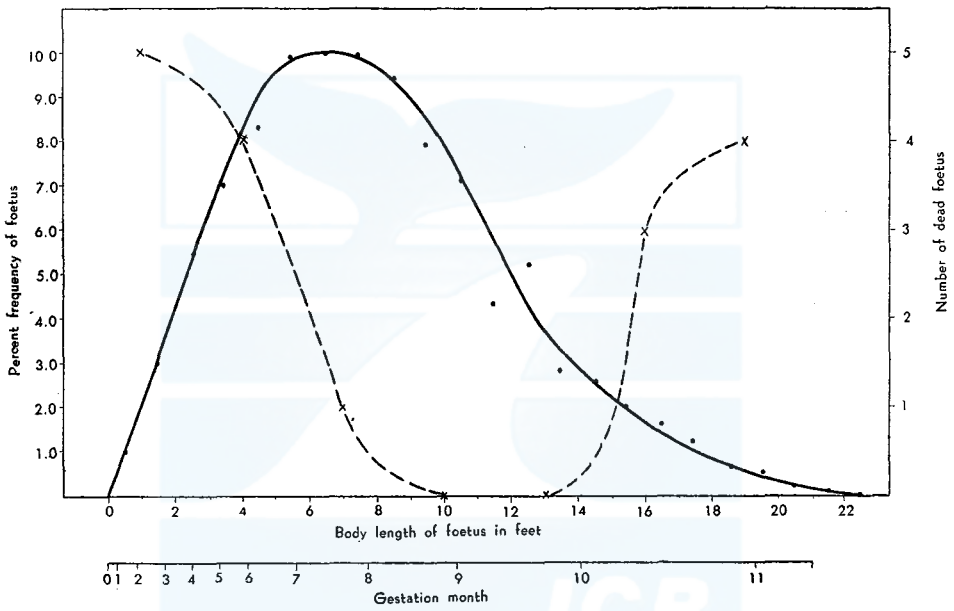

Fig. 6. Relation between length frequency of foetus and length frequency of dead foetus in the Antarctic fin whale.
●——●: Foetus frequency in 1959/60 Antarctic season
×---×: Dead foetus frequency

On the contrary, the prenatal dead foetus occurs frequently both in the early stage and in the late stage of pregnancy. In the curve indicating the length frequency of dead foetus, there is a bottom between 10 and 13 feet which corresponds the foetal length from 9 to 10 gestation months. Fig. 6 suggests why the prenatal dead foetus is not observed frequently in the Antarctic. In order to explain this reason, Fig. 7 is obtained from Fig. 6 by means of dividing the number of prenatal dead foetus by the percent frequency of foetus at the corresponding foetal length. Thus, relative death ratio in the foetal stage is shown against

the foetal length at each feet and against the each gestation month in the Antarctic fin whale. The scale of ordinate in Fig. 7 is an arbitrary one. In the late stage of pregnancy, the death rario in fin whales is about three times higher than in the early stage of pregnancy. It is suggestible that the prenatal dead foetus is observed more frequently in the breeding area—subtropical waters—than in the feeding area—the polar waters. The curve of death ratio based on resorption is similar to that of the other terrestrial mammals.

It is impossible to obtain the real death ratio in fin whales, because the prenatal dead foetuses tabulated in Table 1 have been observed only by the biologists and trained inspectors in the Antarctic expeditions,

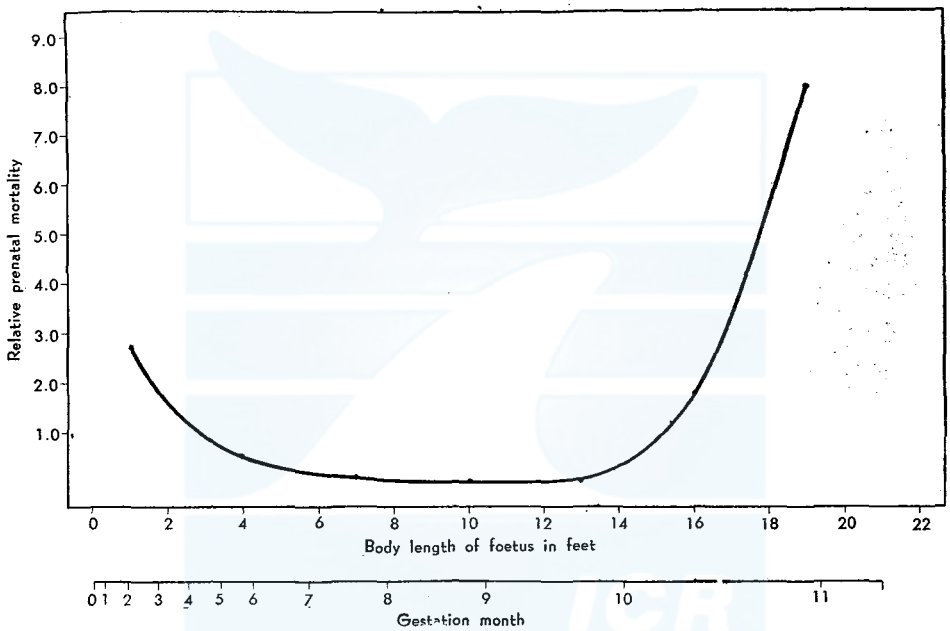

Fig. 7. Relative mortality resulted from reabsorption in the foetal stage of fin whale in the Antarctic.

therefore, these do not represent the all prenatal dead foetuses to be recorded as stated before, and because it is moreover difficult to know the abortion rate in fin whales. 17 records on dead foetuses of fin whale corresponds to 0.14% of 9400 foetuses observed by the Japanese expeditions in the Antarctic between 1946/47 and 1960/61 season. This percentage is the minimum value on the death ratio in the foetal stage of the fin whale. Although it is assumed that the death ratio in the foetal stage of fin whale is not very high, the rigid conclusion is not stated from the materials in this paper.

It is noticeable in Table 1 that 13 female fin whales including prenatal

dead foetuses are recorded from 1946/47 to 1960/61 Antarctic season and that particularly dead foetuses from 4 mother whales are observed in only 1960/61 Antarctic season, indicating the more frequent occurrence than in the other seasons. These mother whales were captured at the locality between 10°E and 40°E in the Antarctic Ocean. In the seasons except 1960/61 season, 3 female fin whales including prenatal dead foetuses were captured between 90°E and 110°E, 4 between 170°W and 180°W, 2 between 130°W and 150°W. This evidence suggests that the occurrence of prenatal dead foetus varies among the localities where mother whales migrate and so depends on the difference of hereditary nature among fin whale populations. Lethal genetic factors as confirmed in the other terrestrial mammals is possibly present in whales.

Prenatal dead foetuses and their membranes are removed from the uterus either by being forcibly expelled relatively intact or by being gradually autolysed or mummified. The former process is called abortion and the latter reabsorption or resorption. In relation to both process, Hammond (1914, 1921) states that in those species which produce only one young at birth, abortion of the foetus results from its death, but in those species in which many young are produced the dead and mummified embryos are carried in the uterus to full term and may be found mixed with the cleanings after birth. Brambell (1948) suggests that both process of occur in most, if not all mammals, but whereas abortion is the commoner in monoparous species, reabsorption is the rule in multiparous forms.

In whales as well as in the other mammals, the possibility of detecting prenatal mortality resulting from abortion at autopsy will be slight. Abortion is a muscular process, analogous to partrition, which, if carried to completion, results in the expulsion of the entire conceptus or conceptuses from the tract. A uterus which has aborted is difficult or, it may be, impossible to distinguish from a post-partum uterus. It is necesary to know the abortion ratio to analyse the death ratio in the foetal stage of whales, however, no information on abortion remains. According to Brambell's statement, abortion is the commoner in whales as monoparous species. It is, however, sure that the foetus being gradually autolysed or mummified is present in whales as indicated in this paper.

The process of reabsorption is a gradual one and its duration and result depend on the stage of development attained by the foetus at the time of death as well as upon other factors. In the case that the whale foetus is dead in the early stage of pregnancy, the foetus seems to be autolysed and reabsorbed later. The process of resorption appears

in the previous chapter for the fin whale and the pigmy blue whale. Early foetus is rapidly and completely disintegrated and results in the green fluid in the mother's uterus as indicated in the record no. 15 in Table 1. Whereas, the foetuses in the late stage of pregnancy may resist complete maceration and their remains become shrivelled and mummified. Disintegration appears in some parts of foetal body in the course of mummification. Tail flukes, flippers and eyes are often lost or deformed in the mummified whale foetus. The embryonic fluids escape from the dead membrances, which collapse and closely invest the embryonic remains as pointed by Brambell (1948). Brambell's conclusion obtained from the study on prenatal mortality of wild rabbit that these changes are characteristic of foetus dying during the life of the mother and that it is easy to distinguish at autopsy between such foetuses and those which survived to the time of the mother's death, even in uteri in which post-mortem changes are advanced, can be applied to the whale foetus.

SUMMARY

The records of prenatal dead foetuses of whales, examined on boad the Japanese factory ships in the Antarctic whaling season from 1946/47 to 1960/61, were arranged and analysed. They are observed in the uteri of mother whales at autopsy and are composed of 17 fin whales, 1 blue whale, 1 pigmy blue whale and 1 sei whale. 3 prenatal dead foetuses of fin whales were observed by biologists in the North Pacific expeditions from 1952 to 1960. The following conclusion is summarized from the observation on these prenatal dead foetuses.

1. It is easy to discriminate at autopsy between the prenatal dead foetus and that which survived to the time of the mother's death.
2. In the uterus of the mother whale, only the prenatal dead foetus resulting in reabsorption or resorption is observed. It is difficult to obtain the information on abortion from the whale migrating in the high latitude waters.
3. The prenatal dead foetus in the early stage of pregnancy is rapidly disintegrated and reabsorbed. The dead foetus in the late stage of pregnancy is mummified and remains in the mother's uterus for a fairly long time.
4. The ratio of resorption is very low for the fin whale, however, it is estimated to occupy more than 0.14% of the all foetuses. It is the lowest from 9 to 10 gestation months for the fin whale and it is higher both below and over such range of gestation months. The prenatal dead foetus is observed more frequently in the late stage than in the

early stage of pregnancy.

5. The prenatal dead foetus of fin whale occurs in the higher frequency in the locality between 10°E and 40°E in the Antarctic. This evidence suggests that the prenatal mortality is different among fin whale populations.

6. The death of multizygtic foetuses is observed more frequently than that in the single foetus.

7. In whales as well as in the multiparous species of the terrestrial mammals, the prenatal mortality seems to increase with the increment of maternal age.

REFERENCES

BRAMBELL, F. W. R. (1948). Prenatal mortality in mammals. *Biol. Rev.*, 23: 370-407.

DEANESLY, R. (1935). The reproductive processes of certain mammals. IX. Growth and reproduction in the stoat (*Mustela erminea*). *Philos. Trans.*, B, 225: 459-92.

HAMMOND, J. (1914). On some factors controlling fertility in domestic animals. *J. Agric. Sci.*, 6: 203.

——— (1921). Further observations on the factors controlling fertility and foetal atrophy. *J. Agric. Sci.*, 11: 337-66.

——— (1941). Fertility in mammals and birds. *Biol. Rev.*, 16: 165-90.

HENNING, W. L. (1939). Prenatal and postnatal sex ratio in sheep. *J. Agric. Res.*, 58: 565-80.

ICHIHARA, T. (1961). Blue whales in the waters around Kerguelen Island. *Norsk Hvalfangst-Tid.*, 50 (1): 1-20.

KIMURA, S. (1957). The twinning in southern fin whale. *Sci. Rep. Whales Res. Inst.*, no. 12: 103-125.

LAUPRECHT, E. (1932). Über die Fruchtbarkeit und das Geschlechtsverhaltnis beim Trakenker Pferde und ihre Beeinflüssung durch das alter der Eltern. *Landw Jb.*, 75: 389.

LAWS, R. M. (1958). Recent investigations on fin whale ovaries. *Norsk Hvalfangst-Tid.*, 47 (5): 225-54.

——— (1959a). On the breeding season of southern hemishere fin whales, *Balaenoptera physalus* (Linn.). *Norsk Hvalfangst-Tid.*, 48 (7): 229-351.

——— (1959b). The foetal growth rates of whales with special reference to fin whale, *Balaenoptera physalus* Linn. *Discovery Rept.*, 29: 281-308.

MACKINTOSH, N. A. and WHEELER, J. F. G. (1929). Southern blue and fin whales. *Discovery Rept.*, 1: 257-540.

MATSUURA, Y. (1940). [On the multiple pregnancies and multiple ovulations of the baleen whales]. *Jap. J. Zool.*, 52 (11): 407-14. (In Japanese).

MATTHEWS, L. H. (1938). The sei whale, *Balaenoptera borealis*. *Discovery Rept.*, 17: 183-290.

ROBINSON, A. (1921). Prenatal death. *Edinb. Med. J.*, 26: 137-51, 209-31.

THE COMMITTEE FOR WHALING STATISTICS (1961). International Whaling Statistics, 46.

WHEELER, J. F. G. (1930). The age of fin whales at physical maturity with a note on multiple ovulations. *Discovery Rept.*, 2: 403-34.

WRIEDT, C. (1928). Vererbung von Zwillingsgeburten bei Pferden. *Züchtungskunde*, 3: 455.