

OCCURRENCE AND RUPTURE OF VAGINAL BAND IN THE FIN, SEI AND BLUE WHALES

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The vaginal band is present crossing the entrance of vagina in some baleen whales. It was firstly reported by Mackintosh and Wheeler (1929) on the southern fin whales (*Balaenoptera physalus*) and the blue whales (*B. musculus*). After then, the presence of the band was reported for the southern fin whale (Wheeler, 1930; Laws, 1961), the southern humpback whale (*Megaptera novaeangliae*; Matthews, 1937), the northern fin whale (Ohsumi *et al.*, 1958) and the North Pacific right whale (*Eubalaena glacialis*; Omura, 1958).

As Mackintosh and Wheeler described, the vaginal band is not an abnormality, but is found in fairly large percentage. However, few one have noticed the occurrence of the band in the whales, and there are few data on the subject.

The vaginal band appears to be analogous to the hymen in the mankind. And I think that the occurrence and rupture of the band is useful for the examination of the reproductive behavior and physiology in the whales. In practice, we have rare chances to observe copulation or parturition of whales. But the occurrence and rupture of the vaginal band will represent the experience of copulation or parturition of the whales.

In this point of view, I examined the frequency occurrence of vaginal band and its tag in relation to the development of the whales.

MATERIAL AND METHOD

It is difficult to observe a vaginal band of a whale without insertion of observer's hand into the vulva. Because, in most immature female whales, the genital groove is closed, so that little can be seen of the genitalia. Vaginal band is present accrossing the vulva, and attach at the anterior and posterior borders of the entrance of vulva. Sometimes, mostly in mature females, tag of the vaginal band is found at entrance of vagina. Therefore, I inserted my hand into vagina of the whale before the time of flensing, and palpated the existence of vaginal band or its tag.

Mammary gland was observed and determined its maturity. Immature and pubertal mammary gland is thin and pale pinkish-white in colour, while mature gland is thicker and brown in colour (Ohsumi *et al.*, 1958). A pair of ovaries was observed on the follicle, corpus luteum and corpus albicans.

Then, the five stages of development and sexual maturity of examined whales were divided as follows:

Immature Mammary gland is immature, and the ovaries are rather small. Graafian follicles are too small to be found by naked eyes.

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Prepubertal Mammary gland is immature. Ovaries elongate, and the surface is rather smooth. The development of Graafian follicles leads to the formation of round protuberances. But there is no corpus luteum nor corpus albicans in the pair of ovaries.

Pubertal Mammary gland is still immature, but its colour becomes pinkish. In ovaries, there is at least one corpus luteum or corpus albicans. It is considered that one or more ovulation occurred already in the whale of this stage, but the pregnancy or at least parturition has not experienced. Because in the whale which have never been pregnant or are pregnant for the first time, mammary gland differs from the state of the gland in immature whale only in a slightly better development of the lobes (Mackintosh and Wheeler, 1929).

First pregnant Mammary gland remains in the immature appearance, but the colour becomes pinkish. There is embryo or foetus in the uterus, and of course, there is at least one corpus luteum in the ovaries. As van Lennep and van Utrecht (1953) and Laws (1961) remark that in the whales the lobules alveoli of mammary gland do not develop until the end of pregnancy. First pregnancy is easily distinguishable by observing the mammary gland. We must consider the case of abortion, but it is difficult to find the experience of abortion in the whale.

Multiparous Mammary gland is mature. And there is more than one corpus albicans in the ovaries. Chittleborough (1958) found that in the humpback whales which were very close to the time of parturition, the lobules and labeoli were well developed and colostrum was present in most cases. And after the first lactation, mammary gland becomes quite different from that of the gland which has not yet been functional.

In this stage are included the lactating and resting stages of primiparous animals, because they are not able to distinguish from the multiparous animals except the individual with only one corpus albicans in the ovaries.

The occurrence of vaginal band or tag is summed up in the above five stages of sexual maturity respectively.

The investigations of vaginal band were made on the fin, sei and blue whales on board of factory ships in the Antarctic in 1958/59 season and in the northern part of the North Pacific in 1961 and 1964 seasons. The numbers of individuals examined are as follows:

	Antarctic	North Pacific	Total
Fin whale	70	317	387
Sei whale	—	206	206
Blue whale	2	12	14

OCCURRENCE OF VAGINAL BAND OR ITS TAG

Tables 1, 2, 3 and 4 show the occurrence of vaginal band and its tag in the five stages of sexual maturity for the northern and southern fin whales, northern sei whales and blue whales respectively.

Immature stage

Of the total of 84 immature northern fin whales, the band was present in 35 (41.6%), and in the total of 42 immature southern fin whales, the band was present in 17 (40.5%). The frequency occurrences of vaginal band are similar each other in the northern and southern fin whales. These figures are higher than that which was reported on the southern fin whales by Mackintosh and Wheeler (1929). They reported that the vaginal band was present in 31 (21.4%) of the total of 145 immature females.

TABLE 1. OCCURRENCE OF VAGINAL BAND IN THE FIVE STAGES OF SEXUAL MATURITY FOR THE NORTHERN FIN WHALES

	Band present	Tag present	Band absent	Total
<i>Actual figure</i>				
Immature	35	—	49	84
Prepubertal	24	2	33	59
Pubertal	—	3	5	8
First pregnant	3	8	18	29
Multiparous	—	38	99	137
Total	62	51	204	317
<i>Per cent</i>				
Immature	41.6	0.0	58.4	
Prepubertal	40.7	3.4	55.9	
Pubertal	0.0	37.5	62.5	
First pregnant	10.3	27.6	62.1	
Multiparous	0.0	27.7	72.3	

TABLE 2. OCCURRENCE OF VAGINAL BAND IN THE FOUR STAGES OF SEXUAL MATURITY FOR THE SOUTHERN FIN WHALES

	Band present	Tag present	Band absent	Total
<i>Actual figure</i>				
Immature	17	—	25	42
Prepubertal	8	3	11	22
Pubertal	1	1	—	2
Multiparous	—	1	3	4
Total	26	5	39	70
<i>Per cent</i>				
Immature	40.5	0.0	59.5	
Prepubertal	36.4	13.6	50.0	
Pubertal	50.0	50.0	0.0	
Multiparous	0.0	25.0	75.0	

However, they also described that not all these whales were examined on this structure, but it was definitely not present in 40 immature fin whales. The individuals which were not examined should be excluded in the calculation of the frequency. In their paper, if 71 immature whales were examined on this structure, the frequency occurrence is recalculated to be 43.7%. This figure is similar to my result. In this point of view, the frequency occurrence (14%) of vaginal band in the foetal stage by Mackintosh and Wheeler is also too low, because they reported

five possessed band, while two definitely did not.

Of 22 immature northern sei whales, vaginal band was present in six (27.3%). Matthews (1938) examined seven immature southern sei whales and one (14.3%) possessed the vaginal band. This figure is lower than my result, but his materials are few to be compared the difference of frequencies between the two races.

I confirmed the presence of vaginal band in the immature female blue whale. That is to say, two immature females were examined on this structure and one undoubtedly possessed an unbroken vaginal band. Mackintosh and Wheeler (1929) reported that a blue whale possessed only a tag of vaginal band.

There is no individual which possesses a tag in the immature stage for the examined 150 female whales.

TABLE 3. OCCURRENCE OF VAGINAL BAND IN THE FIVE STAGES OF SEXUAL MATURITY FOR THE NORTHERN SEI WHALES

	Band present	Tag present	Band absent	Total
<i>Actual figure</i>				
Immature	6	—	16	22
Prepubertal	2	4	11	17
Pubertal	—	—	1	1
First pregnant	—	6	12	18
Multiparous	—	40	108	148
Total	8	50	148	206
<i>Per cent</i>				
Immature	27.3	0.0	72.7	
Prepubertal	11.8	23.5	64.7	
Pubertal	0.0	0.0	100.0	
First pregnant	0.0	33.3	66.7	
Multiparous	0.0	27.0	73.0	

TABLE 4. OCCURRENCE OF VAGINAL BAND IN THE THREE STAGES OF SEXUAL MATURITY FOR THE BLUE WHALES

	Band present	Tag present	Band absent	Total
<i>Actual figure</i>				
Immature	1 ^{a)}	—	1 ^{a)}	2
Prepubertal	1 ^{b)}	—	4 ^{c)}	5
Multiparous	—	—	7 ^{a)}	7
Total	2	—	12	14

Remarks: a) Northern whale, b) Southern whale,
c) One southern whale and three northern whales.

Prepubertal stage

There were the individuals of which tag was observed in the prepubertal stage. Of 59 prepubertal northern fin whales, two (3.6%) possessed a tag. However, vaginal band was still present in 24 (40.7%). Mackintosh and Wheeler (1929) also recorded an individual with vaginal band and with enlarged Graafian follicle in the ovary. On the present result, in 22 southern fin whales, three (13.6%) possessed a tag, and eight (36.4%) possessed a band in the prepubertal stage. In the

17 northern sei whales, tag was present in four (23.5%), and two (11.8%) had still vaginal band. Of five blue whales, there was no individual with tag, but one (20%) had unbroken band in this stage.

Pubertal stage

I have small data on the examination of the vaginal band in this stage.

Of the total of eight northern fin whales, three (37.5%) possessed a tag, and there was no individual with band. However, in two southern fin whales, one possessed an unbroken band. Two similar cases were recorded in the southern fin whales by Mackintosh and Wheeler (1929) and Wheeler (1930). One northern sei whale has no sign of vaginal band.

First pregnant stage

It is worth notice that there are individuals with unbroken vaginal band, although they are pregnant. In 29 northern fin whales of the first pregnant stage, three (10.3%) still possessed unbroken vaginal band. Biological data of the three individuals are shown in Table 5. Laws (1961) introduced a similar record by D.F. S. Raitt on a pregnant southern fin whales which had an unbroken vaginal band. These results will show that it is probable that the vaginal band does not always rupture at the time of coition. This problem will be discussed in the following chapter.

TABLE 5. BIOLOGICAL DATA OF THE THREE NORTHERN FIN WHALES WHICH WERE FIRST PREGNANT AND WITH UNBROKEN VAGINAL BAND

Serial no.	Body length (feet)	Age (Years)	Corpora no.	Mammary gland		Foetus
				Maturity	Thickne ^{ss} (mm)	
10NKy 154	58	13	1-0, 0-0	Immature	23	♂ 106 cm
10NKy1413	63	14	0-0, 1-1	Immature	19	♀ 246
10NKy1424	64	—	1-0, 0-0	Pubertal	28	♀ 212

In the northern fin whales, eight (27.6%) were with tag. In 12 northern sei whales, tag was present in six (33.3%), and there was no individual which has unbroken vaginal band. I have no material on this structure for the southern fin whale and for the blue whale of the first pregnant stage.

Multiparous stage

In this stage, the individual with unbroken vaginal band did not occur, but there were the whales with tag.

Of 137 northern fin whales, 38 (27.7%) possessed a tag. According to Mackintosh and Wheeler, in the total of 206 mature southern fin whales, the tag was observed in 14 (6.8%). This frequency occurrence seems to be low, because they described that not all these whales had been examined on this structure. Furthermore, in the present paper, the disappearance of tag according to age will be examined, and the result will show that the rate of disappearance is not so much.

In 148 northern sei whales, 40 (27.0%) possessed a tag. On the other hand, Matthews (1938) reported that a tag had been present in three (5.4%) out of 52 adult southern sei whales.

Seven northern blue whales in this stage were examined on this structure, and all individuals were absent in the vaginal band or tag.

RUPTURE OF VAGINAL BAND AND ITS BIOLOGICAL MEANING

In the previous chapter, the occurrence of vaginal band and tag was shown in each stage of sexual maturity of whales. The occurrence of unbroken band and tag changes according to the development of the stage. I want to discuss on the rupture of the band and its meaning in the sexual behavior and physiology of the whale in the present chapter.

TABLE 6. RATIO OCCURRENCE OF VAGINAL BAND AND TAG IN THE FIVE STAGES OF SEXUAL MATURITY, INCLUDING ALL WHALES EXAMINED

	Band	Tag	Total	Whales examined	Per cent of band and tag to whales examined
<i>Actual no.</i>					
Immature	59	—	59	150	
Prepubertal	35	9	44	103	
Pubertal	1	4	5	11	
First pregnant	3	14	17	47	
Multiparous	—	79	79	296	
Total	98	106	204	607	
<i>Per cent</i>					
Immature	100.0	0.0			39.3
Prepubertal	74.3	25.7			42.7
Pubertal	20.0	80.0			45.4
First pregnant	21.4	78.6			36.2
Multiparous	0.0	100.0			26.6

Table 6 shows the ratios of vaginal band and the tag in the five stages of sexual maturity summarizing the all materials of the three species. In the immature stage, there were 59 females with unbroken vaginal band, but there was no whales with tag. It is considerable from this result that the vaginal band is not broken in this stage, and then copulation will be not took place in this stage. Brown and Norris (1956) observed some sexual play of a infant bottlenose dolphin (*Tursiops truncatus*). However, it is doubtful that a young whale female really copulates or breaks its vaginal band by the sexual play.

Tag appears in the prepubertal stage (26%). This fact will mean that there is a possibility of experience of copulation or sexual play on at least one fourth of whales in this stage, for it can not be considered that the vaginal band cuts off without the result of copulation, considering with the behavior of Balaenopterids. If so, the ovulation will not be related with the stimulus by copulation in these whales, because the experience of ovulation must not be recognized in this stage.

The number of whales examined was small on the pubertal stage. But the percentage of tags increases in this stage (80%), and it is almost the same as that of the first pregnant stage. From this fact, it is estimated that the female whale becomes to copulate commonly in the pubertal stage. There was one fin whale with unbroken vaginal band. However, we cannot regard this whale as an unexperience of copulation, for some of the first pregnant whales have unbroken band, although they obviously have experiences of copulation.

TABLE 7. OCCURRENCE OF VAGINAL BAND AND TAG ACCORDING TO CORPORA NUMBER FOR THE NORTHERN FIN WHALES

No. of corpora	Band	Tag	Absent	Total
0	59	2	82	143
1- 2	3	18	38	59
3- 4	—	12	21	33
5- 6	—	6	18	24
7- 8	—	4	15	19
9-10	—	2	3	5
11-12	—	4	9	13
13-14	—	2	8	10
15-16	—	—	3	3
17-18	—	1	3	4
19-20	—	—	2	2
21-22	—	—	—	—
23-	—	—	2	2
Total	62	51	204	317

TABLE 8. OCCURRENCE OF VAGINAL BAND AND TAG ACCORDING TO CORPORA NUMBER FOR THE NORTHERN SEI WHALES

No. of corpora	Band	Tag	Absent	Total
0	8	4	27	39
1- 2	—	10	20	30
3- 4	—	9	26	35
5- 6	—	8	21	29
7- 8	—	4	18	22
9-10	—	7	7	14
11-12	—	3	12	15
13-14	—	2	5	7
15-16	—	2	6	8
17-18	—	1	2	3
19-20	—	—	1	1
21-22	—	—	1	1
Total	8	50	146*	204

*: Excluded two whales which are multiparous but lost one ovary.

It is very interesting that three fin whales which were first pregnant and had unbroken vaginal band were found. Concerning on this fact, the duration of copulation in the whale is considered to be generally very short. According to the observation in aquariums, (Brown and Norris, 1966; Tavalga and Essapian, 1961), the bottlenose dolphin (*Tursiops truncatus*) lasted only at most ten seconds in copula-

tion. Brown and Norris showed a figure of copulation of the dolphin, and Tavalga and Essapian took some photographs of the same behavior. These figures show that only tip or half of the penis inserted in the vulva. Considering from these observations, it will be convinced that the fertilization can succeed in without the break of vaginal band in the whales.

Primiparous and multiparous whales have no unbroken vaginal band. This means that at the time of parturition the all bands break off.

The percentage of existence of band or tag in the multiparous whales is clearly lower than the whales of other stages. This lets us consider that the tag of vaginal band gradually absorbes accompanying with the time after rupture. Then, I calculated the ratios of band and tag in each age classes. As the age class, I used the number of corpora lutea and corpora albicantia in the ovaries of the examined whale.

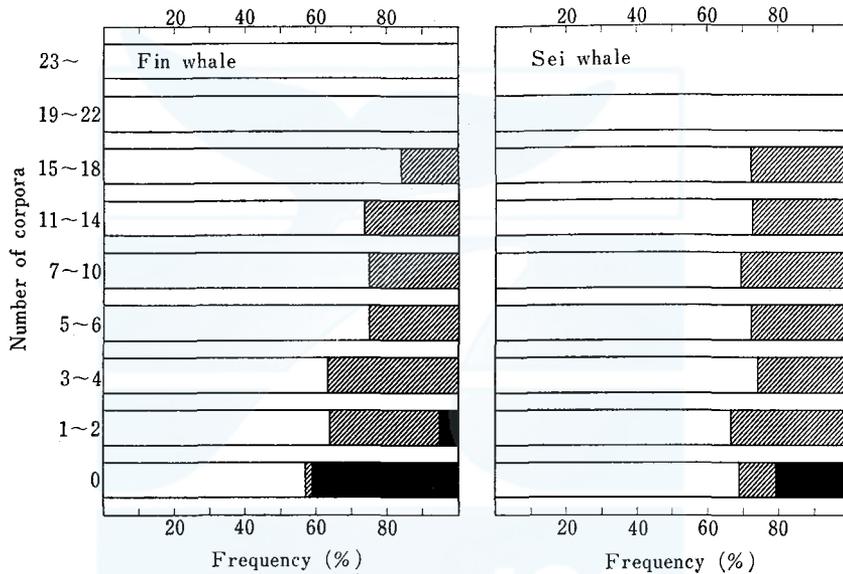


Fig. 1. Change in percentage of frequency occurrence of the female fin and sei whales with vaginal band, tag and band absent accompanying with the increment of corpora number.

Black: Band present, Stripe: Tag present, Blank: Band or tag absent.

Tables 7 and 8 show the number of whales with band, tag and without band in several age classes. And Fig. 1 shows the change of ratio of band and tag to the total whales examined in each age classes accompanying with the increment of corpora number on the fin and sei whales. The frequency occurrence of band and tag tends to decrease with the increase of corpora number. This tendency is more clear in the fin whale than in the sei whale. Although there are relatively few materials on the whales which have many corpora in the ovaries, the tag was not observed for the whales with 19 corpora and over.

This result will confirm that the vaginal band gradually absorbes after its

rupture. However, it seems to take long time by the complete absorption of tag, considering the rate of increment of corpora in the ovaries. The annual rate of increment of corpora number is 1.43 according to Laws (1962) and 0.5 according to Ohsumi (1964).

FREQUENCY OCCURRENCE OF VAGINAL BAND AND DISCUSSION

We can recognize from above chapters that the tag represents the remain of the vaginal band, and the tag gradually disappears in the multiparous stage. Therefore, the multiparous whales should not be used to get the true frequency occurrence of vaginal band in the whales.

In this point of view, I calculated the frequency occurrence of vaginal band (unbroken band plus tag) for each whale populations summing up the immature, prepubertal, pubertal and the first pregnant stages as shown in Table 9. The confidence intervals of 90 per cent are also calculated based on the materials. The figures are also shown in the same Table.

TABLE 9. COMPARISON OF FREQUENCY OCCURRENCE OF VAGINAL BAND AMONG THE THREE SPECIES OF *BALAENOPTERA* IN SUM OF IMMATURE, PREPUBERTAL, PUBERTAL AND FIRST PREGNANCY STAGES

Species Locality	Band or tag present		Band absent		Total	
	No. of whales	Per cent	No. of whales	Per cent		
Fin whale {	Northern Hem.	75	41.7	105	58.3	180
	Southern Hem.	30	45.5	36	54.5	66
Sei whale	Northern Hem.	18	31.0	40	69.0	58
Blue whale {	Northern and	2	27.6	5	72.4	7
	Southern Hem.					
90% confidence interval of per cent frequency						
Fin whale {	Northern Hem.	35.7-47.7		52.3-64.3		
	Southern Hem.	35.9-55.6		44.4-64.1		
Sei whale	Northern Hem.	22.4-41.7		58.3-77.6		
Blue whale {	Northern and	11.1-45.0		55.0-88.9		
	Southern Hem.					

The highest frequency occurrence of the vaginal band is 45.5% in the southern fin whale, and the lowest is 27.6% in the blue whale. However, 90 per cent confidence intervals of the frequency occurrence overlap each other among the four populations. Using chi-square test, under 5 per cent of significant level, the equality of frequencies was not able to be denied.

In conclusion, the vaginal band will occur in from a quarter to a half of the female Balaenopterid whales. It is important to examine the vaginal band for the foetal stage, but I have yet few materials on this stage. It is relatively difficult to examine the vaginal band on the small foetus in the field, and I think it is better to examine the band after fixation with formallin in such cases.

It is obvious that there are vaginal band in other baleen whales, but the frequency occurrence have not yet obtained because of scarcity of the materials.

I have no report on the occurrence of vaginal band for the toothed whales. I have investigated the vaginal band on several toothed whales (Sperm whale, *Physeter catodon*; Baird's beaked whale, *Barardius bairdi*; Bottlenosed dolphin, *Tursiops gilli*), but I have not yet found the vaginal band or its tag.

SUMMARY

1. Vaginal band occurs in the fin, sei and blue whales. The frequency occurrence of it before the rupture is calculated as follows:

North Pacific fin whale:	41.7±6.0%
Antarctic fin whale:	45.5±10.1%
North Pacific sei whale:	31.0±10.7%
North Pacific and Antarctic blue whale:	27.6±17.4%

2. In the immature stage, vaginal band does not rupture, but after prepubertal stage its tag becomes to be present.

3. There is a possibility of experience of copulation or sexual play in the prepubertal and pubertal stages at least in the case of Balaenopterid whales.

4. Vaginal band does not always rupture in copulation, for there were three cases in which the first pregnant fin whales had unbroken vaginal band.

5. Vaginal band disappears gradually after the rupture, but it takes long time by the complete absorption.

6. There have been no record on the occurrence of vaginal band for the toothed whales.

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