

Some comments on reproductive conditions in female fur seals*

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Introduction

Japan proposed an improved classification on the items related to "reproductive condition" as a document in the Fourteenth Meeting of the North Pacific Fur Seal Commission held at Washington D. C. in March of 1971. The method of classification applied in the past merely determined the parity and the apparent pregnancy ratio in female seals, but it has not been very useful for the study of reproductive mechanism which contributes to the stock assessment. By the proposed method which is traditional for the mammalian study, the age of sexual maturity and the substantial reproductive condition can be examined from a new angle. Since the content of reproduction varies with the change of population level, the result of research will be reflected on the management of resources.

In accordance with the proposed method, the information on reproductive conditions of females collected by Japan during March and April in 1964-1971 off Sanriku area (in the western Pacific off the northern Japan) were rearranged for this paper. Although a part of biological records collected from 1964 through 1966 were not satisfactory in its accuracy for the present purpose, the data available for examining the fluctuation of reproductive conditions from year to year are adopted in this paper. Unfortunately, the data from 1958 to 1963 were not available for the present purpose.

Terminology of reproductive conditions and their classification methods which have been used by contracting four parties

Glossary of terms used in fur seal research and management (1963) defines the reproductive conditions of female seals as follows.

Immature; A nulliparous female which, by reason of youth, is not capable of reproduction.

Maturity; Sexual maturity in the female is attained when the first implantation takes place. She attains reproductive maturity 2 to 5 years later.

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- Nulliparous (N); Pertaining to a female which has never given birth (or aborted). The corresponding noun is nullipara.
- Barren; Used to describe a sexually mature female which has failed to become pregnant.
- Sterile; Descriptive of a sexually mature animal of either sex which is incapable of producing young.
- Primiparous (P); Pertaining to a female which has given birth (or aborted) only once.
- Multiparous (M); Pertaining to a female which has given birth or has been pregnant more than once. (If her last foetus aborted, she is multiparous (aborted).)

On the basis of above terminology, each country has reported reproductive conditions of females collected in the pelagic research in the next various forms.

Canada

- 1. 1958-1970

<u>Nonpregnant</u>	<u>Pregnant</u>
N. P. M.	P. M.

In some years, the following alternative forms is tabulated together.

Immature	<u>Mature</u>
	Preg., Nonpreg.
or,	<u>P</u>
<u>N</u>	<u>Preg., Missed preg., Aborted'</u>
Imm., Mat. '	
	<u>M</u>
	Preg., Missed preg., Aborted

- 2. 1971

Immature	<u>Mature</u>
	<u>Nonpreg. Preg.</u>
	N. P. M. P. M.

Japan

- | Year | Forms | |
|--------------|---|--------------------------|
| 1. 1958-1967 | <u>Nonpregnant</u>
N. P. M. | <u>Pregnant</u>
P. M. |
| 2. 1968 | <u>Nonpregnant</u>
I. N. P. M. | <u>Pregnant</u>
P. M. |
| 3. 1969-1970 | Frequency distribution of corpus luteum spurium and corpus luteum graviditatis by age was tabulated in the annual report. | |
| 4. 1971 | Proposal of a new method
Immature, <u>Mature</u>
Non ovulation,
False yellow body, (Ovulated but not pregnant)
True yellow body, (Pregnant) | |

In compliance with the agreement of members in the Standing Scientific Committee, a new form is tabulated together with the previous form in the annual report.

USA

1. 1958-1969

N	P	M
	Nonpreg., Preg.	Nonpreg., Preg.
In some years, the next form is tabulated together.		
N	P	
Imm., Mat.	Preg., Missed Preg., Aborted	
M		
Preg., Missed preg., Aborted		

2. 1970

N	P	M
Ovulated	Nonpregnant	Nonpregnant
Yes, No	Ovulated Preg.	Ovulated Prag.
	Yes, No	Yes, No

USSR

1. 1958-1970

Nonpregnant	Pregnant
N. P. M.	P. M.

These different forms are rearranged in three cases.

Firstly, N in nonpregnant (indicated by Canada in 1958-70, by USA in 1958-69, by USSR in 1958-70 and by Japan in 1958-67) includes both sexually immature and mature animals.

Secondly, N in mature and nonpregnant (indicated by Canada in 1971) is interpreted to have the false yellow body in ovaries, but the discrimination between non-ovulation and false yellow body is impossible by P and M in mature and nonpregnant.

Thirdly, the form indicated by USA in 1970 is another expression of Japanese proposal, but it is complicated. No ovulated in N shows sexually immature animals. "No" ovulated of nonpregnant in P and M represents non-ovulation in Japanese proposal. "Yes" ovulated in N, and in P and M indicates false yellow body. On the other hand, pregnant in P and M is synonymous with true yellow body.

It is of most importance to distinguish the sexually immature from the mature females. Such a discrimination can be done in the pelagic research as well as in the land research. In the land research for the breeding season until the departure of seals from breeding islands, it is impossible to diagnose the difference between the false yellow body and the true yellow body, because the implantation takes place from early November to early December in the northern fur seals. In other words, we can not absolutely determine the true pregnancy rate through the land research.

Terminology of reproductive conditions in relation to pelagic research

Terms concerning reproductive conditions should be defined for the diagnosis in the pelagic research.

1. Maturity rate ;

$$\frac{\text{Number of sexually mature females}}{\text{Total females taken (Immature + Mature)}} \times 100$$

2. True pregnancy rate;

$$\frac{\text{Number of pregnant females}}{\text{Sexually mature females}} \times 100$$

3. Apparent pregnancy rate;

$$\frac{\text{Number of pregnant females}}{\text{Total females taken (Immature} \times \text{Mature)}} \times 100$$

This corresponds to pregnancy rate shown by each country in the past pelagic research.

4. Immature; Females which have not ovulated yet.
5. Non-ovulation; Females which had ovulated or experienced pregnancy or parturition in the past but did not ovulate in the previous breeding season.
6. False yellow body; Females which ovulated in the previous breeding season but missed pregnancy.
7. True yellow body; Females which possess functional corpus luteum associated with pregnancy. Include abortion, resorption and existence of dead foetus.

Age of sexual maturity

In the past records of reproductive conditions published by each country, the apparent pregnancy rate is obtained by the research area. However, the true pregnancy rate and the maturity rate are not brought by such records, except for the pelagic researches by Canada in 1971, by USA in 1970 and by Japan in 1968-1971. In order to examine a trend of transition in the age of sexual maturity, the maturity rates by age are shown in Figs. 1-1~8 for samples collected in the Sanriku waters from 1964 through 1971. The figure also indicates the apparent pregnancy rate and the true pregnancy rate, respectively. The maturity rate in female seals of age 4 declines remarkably from 80% in 1964 to 20% in 1970-1971 for the past 8 years. The rate of age 5 in females also decreases gradually from 100% in 1964 to 80% in 1971 but it indicates no sign of variation of the rate for seals of ages 6 and above. The fact that the level of 50% maturity appears in 1966 for seals of age 4 suggests that the age of sexual maturity recently is shifting from age 4 to age 5 in the wintering area of the western Pacific. Diagnosis in the pelagic samples implies that the age of sexual maturity for females wintering off Sanriku is recently elevating from age 3 to age 4 in the breeding season.

Since the major breeding herds from the Robben, Commander and Pribilof origin intermingle in the waters off Sanriku, which of three herds contributes to an increment in the maturity age should be discussed.

On the basis of tag recoveries in the pelagic research, the North Pacific Fur Seal Commission Report on Investigation in 1964-1966 estimates the intermingling ratio off Sanriku for the periods of 1959-1965. In accordance with this method of

estimate, there is no evidence that the female influx of ages 4 and 5 from Pribilof Islands has increased from 1962 through 1965 in the Sanriku waters.

Since 1966, we have no positive evidence that the Pribilof females are dominant in young generation off Sanriku. With regard to the influx of the Commander female off Sanriku, the situation is similar to that of Pribilof seals.

Most of the past pelagic researches carried on in the eastern Pacific where the Pribilof seals inhabit, has not given any biological basis to estimate the age of sexual maturity. From the USA pelagic research in 1970 and the Canadian pelagic research in 1971, however, the maturity rate was 2.2% in age 4, 50.0% in age 5 and 85.2% in age 6. The result of these researches indicates that the Pribilof female seals in the recent years attain the sexual maturity at age 4 on the Islands. It is another problem whether or not the age of maturity in the Pribilof herds has changed for the past long periods. Unfortunately we have no data to check it. Regardless of the maturity age, the pelagic samples from the eastern Pacific show a trend of slight increment in the mean length at ages 4, 5 and 6 from 1958 through 1971.

In Japan Sea where seals of the Robben origin comprise the majority of wintering seals, no direct informations remain to determine the age of maturity but the apparent pregnancy rate is available for the estimation as an indirect method. In the 1960-1964 pelagic research by USSR in Japan Sea, the pregnancy rate was 0.0% for age 3, 46.7% for age 4 and 93.3% for age 5. Since the maturity rate exceeds the apparent pregnancy rate in figures for young females, the Robben female seals seem

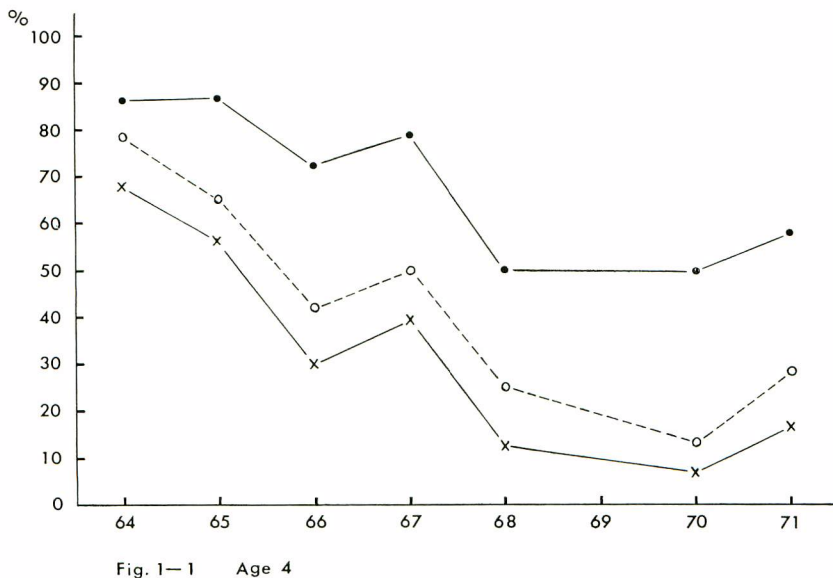


Fig. 1-1 Age 4

Fig. 1. Maturity rate, true pregnancy rate and apparent pregnancy rate by age of female seals collected off Sanriku from 1964 through 1971.

○·····○ Maturity rate ○——○ True pregnancy rate
 ×——× Apparent pregnancy rate

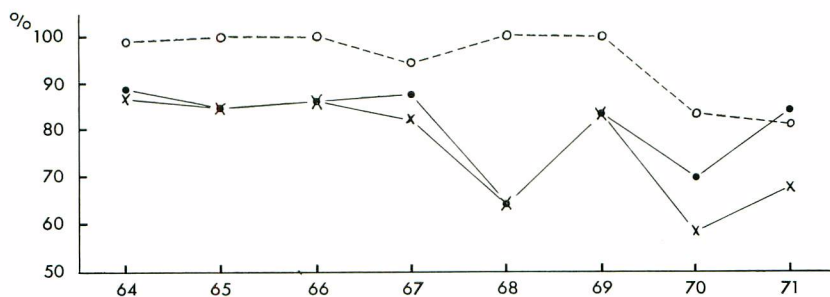


Fig. 1-2 Age 5

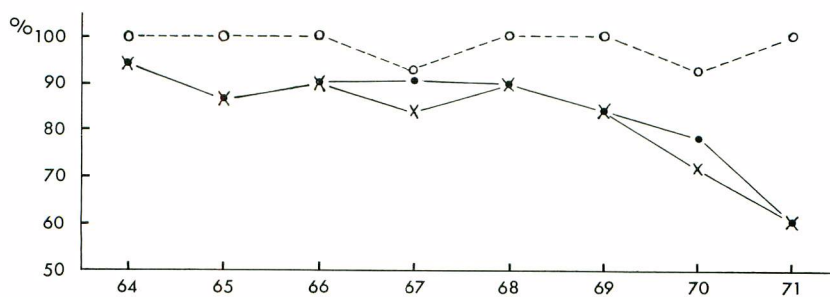


Fig. 1-3 Age 6

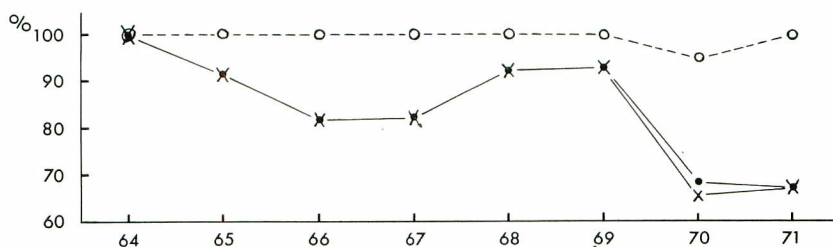


Fig. 1-4 Age 7

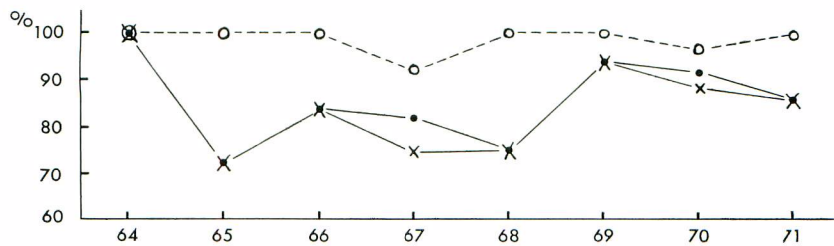


Fig. 1-5 Age 8

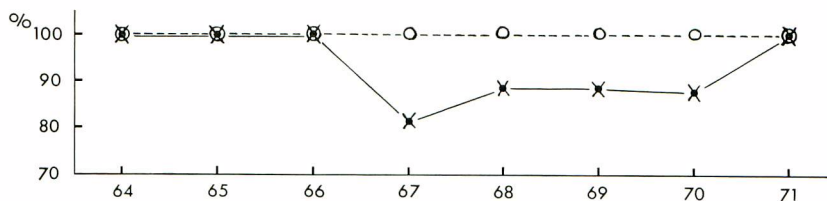


Fig. 1—6 Age 9

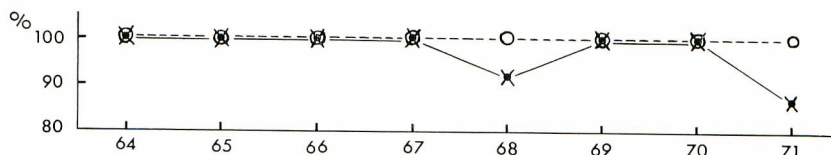
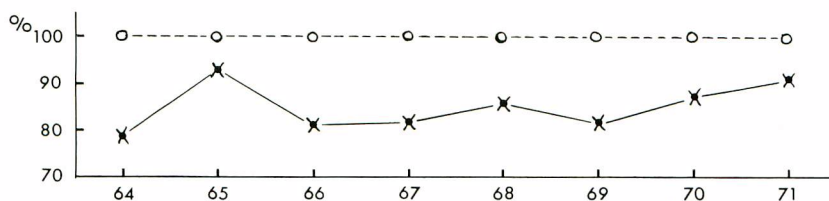


Fig. 1—7 Age 10

Fig. 1—8 Age 10⁺

to have attained the sexual maturity at age 3 on the Island in the above period. We have unsatisfactory data to estimate the maturity age in Japan Sea.

Though the available informations are limited, it is estimated that the Robben seals probably have contributed to the increasing maturity age which has been observed recently in the Sanriku waters. No change in the mean length and weight of animals has been reported for males of ages 3 and 4 which were commercially killed on Robben Island. There is no data to check the change of growth rate in females which are from Robben Island.

Ratio of non-ovulation

Some mature seals do not ovulate in the breeding season and hence they do not have corpus luteum associated with ovulation in their ovaries. The ratio of non-ovulated females against the total mature females shows a constant value with the range from 1% to 6% in 1964-1971 as indicated in Fig. 2. It is reasonable to consider that the ratio is species-specific for the northern fur seals. In Fig. 3, the ratio increases with the advance of month and elevates remarkably in June off Sanriku.

Non-ovulation is not observed in females of age 4 and its ratio indicates an increasing trend with the ages. Fig. 4 gives this trend for seals of ages 5-7, 8-10 and

10 and above which were collected from 1964 through 1971. It is generally acceptable that the ovarian activity declines with the increment of age. The remarkable influx of non-ovulated females in June suggests that their migratory habits are analogous to those of the immature or nonpregnant young females in the wintering area.

True pregnancy rate

Fig. 4 shows the age dependent change of the true pregnancy rate for seals from age 4 to age 10 and above. From 1964 through 1971, the rate has declined remarkably for age 4 and indicated a decreasing trend for ages 5-7. The maximal value of the rate occurs for ages 8-10, and a slight increasing trend has been recorded for age 10 and above. When the true pregnancy rate is examined for mature seals of age 4 and above, however, it gradually declines from 1964 through 1971 as indicated in Fig. 2. It is clear that the yearly decline in the true pregnancy rate for ages 4-7 has a great effect on the recent fall of the pregnancy rate for seals of all ages which migrate to the Sanriku waters. The pregnancy in young females contributes effectively to the reproduction of seal populations. Fig. 3 shows that the true pregnancy rate for age 4 and above gradually declines from January to June.

Since very small portion of the Pribilof seals is impregnated at age 4, the Robben seals contribute greatly to the decline of true pregnancy rate for seals of age 4 which were collected in the Sanriku waters. In recent years, female seals of the Robben origin possibly suffer changes in important two factors concerning the reproduction of population; one is the increase of maturity age and the other is the decrease of pregnancy rate in young generations. When these factors function on the population of seals, we can not expect the increment of number of pups born which is proportional to number of mature females. In fact, the pup production has not increased since 1967 on Robben Island.

Ratio of missed pregnancy

When the ratio of non-ovulation is a constant value for the northern fur seals, there is a negative relationship between the ratio of missed pregnancy and the true pregnancy rate. The occurrence ratio of missed pregnancy against the number of mature females is high for recent years in both sides of the Pacific. The ratio is higher in the eastern Pacific than in the western Pacific. Off Sanriku, the ratio of missed pregnancy is remarkably increasing in seals of age 4, as indicated in Fig. 4. The ratio also shows an increasing trend in seals of ages 5-7.

Female seals which possess the false yellow body in their ovaries fail in impregnation. Missed pregnancy implies no sign of implantation or no sign of pregnancy. Failure of implantation and failure of fertilization comprise two categories in no sign of implantation. CRAIG (1964) states that missed pregnancies are proba-

bly most of ten due to mating failure or to loss or malfunction of the blastocyst. A certain trend in the ratio of missed pregnancy which is observed in seals of age 4 off Sanriku suggests that missed pregnancies probably due to the failure of fertilization on the breeding season. The occurrence of loss or malfunction of the blastocyst is rather species-specific than age-specific, and hence it is difficult to interpret that such an occurrence is characteristically high in young females. If the genetical problems are taken into consideration, the occurrence of loss or malfunction may be different among breeding herds of seals.

Off Sanriku, the true pregnancy rate associated with the first ovulation has changed from 85.7% in 1964 to 62.5% in 1971 for females of age 4 and from 100.0% in 1964 to 80.0% in 1971 for age 5. This pregnancy rate has gradually decreased from year to year in 1964-1971. Examining the follicular cycle of the first ovulation, CRAIG (1964) estimates that the first ovulation in the Pribilof seals probably takes place in September. The reproductive organs of mature males are active in September, though how active they are is not accurately known.

There are two cases in the failure of fertilization. One is the case that female seals succeed in mating but fail in fertilization. The other is the case that female seals have no chance of mating. In animals of the wild life, no chance of mating is generally accepted. Poor chance of mating arises from less number of mature

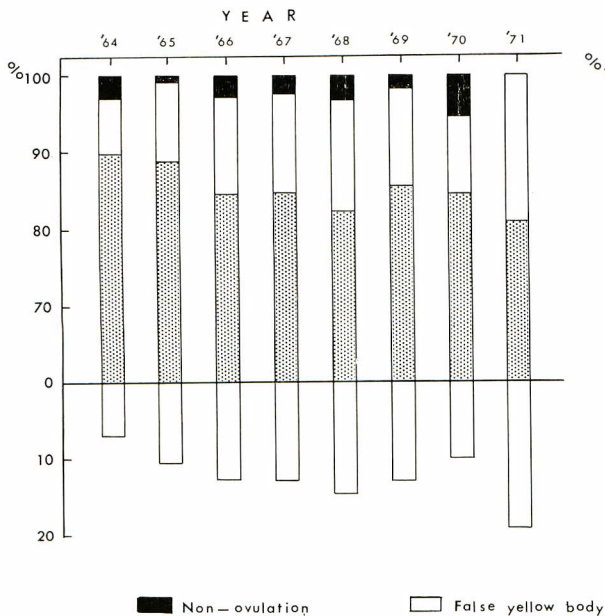


Fig. 2. Percent occurrence of non-ovulation, true yellow body and false yellow body in sexually mature females of ages 4 and above, in 1964-1971. Percent occurrence of false yellow body is drawn out in the lower part.

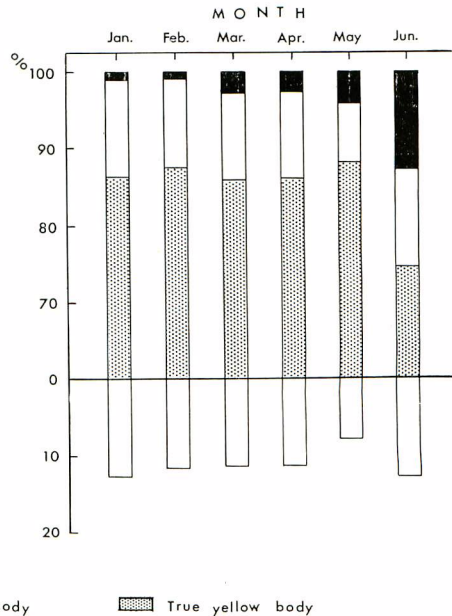


Fig. 3. Monthly percent occurrence of non-ovulation, true yellow body and false yellow body in sexually mature females of ages 4 and above.

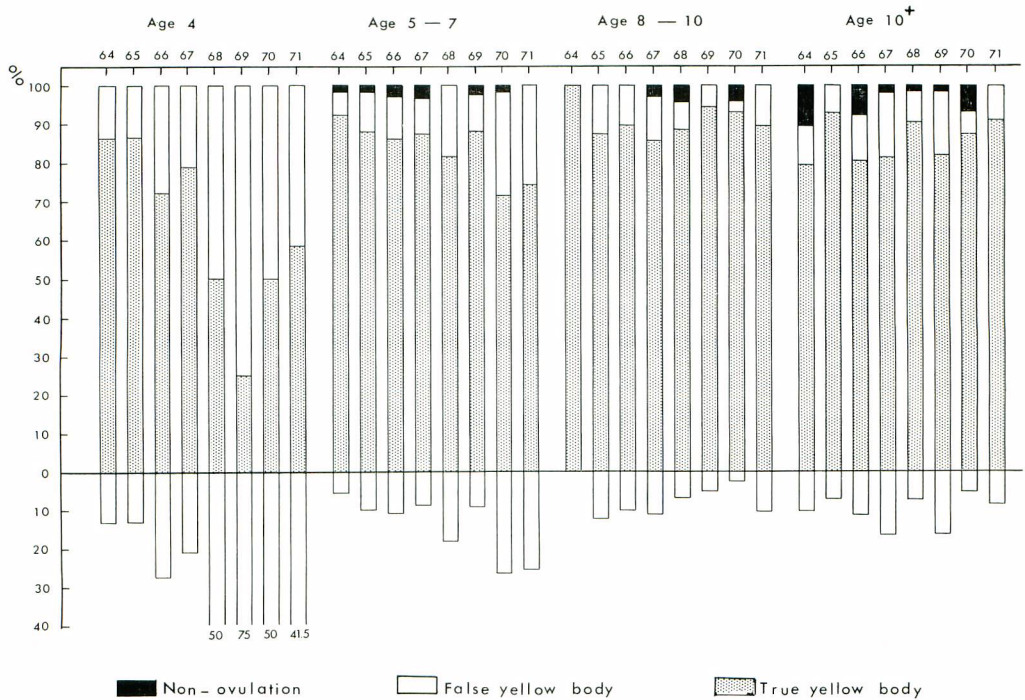


Fig. 4. Percent occurrence of non-ovulation, true yellow body and false yellow body, by year and by age of seals.

males, from excess of mature females and from the disturbance by human in seal rookeries. When the young mature females going on heat later than the main breeding season exceed remarkably mature males in number, chance of no mating becomes higher in the females side. Mature males mentioned here imply not only harem bulls but also idle bulls which attain the sexual maturity.

Unbalance in number or discrepancy in the sexual activity between young mature females and mature males is possibly reflected on the remarkable increment of missed pregnancy in females of ages 4 and 5. In this meaning, the land research is incomplete in relation to the satisfactory stock management of seals. Most of females in missed pregnancy has biologically a potentiality enough to be impregnated.

Conclusion

In the situation in which the level of seal population size varies, the research program concerning the reproductive mechanism is incomplete in the pelagic research as well as the land research. On the basis of the present best informations available, the age of sexual maturity and the structure of reproductive conditions were examined for female seals sampled by Japanese pelagic research off Sanriku in the western Pacific from 1964 through 1971. Conclusive statements are summarized as

follows,

1. The age of sexual maturity is recently elevating from age 3 to age 4. Probably the Robben seal herds significantly contribute to such an increment of age of sexual maturity.
2. Recently, the true pregnancy rate is remarkably decreasing and on the contrary the rate of missed pregnancy is remarkably increasing in young females. The Robben seal herds essentially contribute to this change.
3. The rising trend of the maturity age and the decline of true pregnancy rate are two factors of reproduction related to the level of population. These two factors have a worse effect on the pup production. No increase of pup production on Rodden Island in recent years is possibly affected by these two factors.

Proposed research

In conjunction with the stock management of northern fur seals, we propose the following research.

1. The standardization of research technique for reproductive conditions of female seals is necessary for the land research as well as for the pelagic research. The ratio of missed pregnancy in young seals is higher in the eastern Pacific than in the western Pacific. The research on the reproductive conditions for the Pribilof seal herds should be expedite.
2. The research should be done for the relationship of the level of seal population to food intake per head, individual growth, the age of sexual maturity and to pregnancy rate.
3. In areas which the Robben seal herds stay or migrate, the pelagic research should be continued to obtain biological informations variable with the level of populations. For example, in Japan Sea or Okhotsk Sea.
4. In relation to the reproductive capacity of young mature females, the next research is necessary on land.
 - a. Balance in number or timing in the sexual activity between young mature females and mature males. This research includes whether or not the amount of mature males escaping from the commercial kill is appropriate in number to keep the high reproductive rate of females.
 - b. Effect of disturbance by human in the rookeries on the reproductive activity of young females.
 - c. Distribution and behavior of young females in the rookeries. With regard to a-c items, it is desirable to review and rearrange the effectiveness of the manner of researches so far carried out on land, from the view of stock management.

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雌オットセイの生殖状態についての若干の意見

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要 約

北太平洋のオットセイの保存に関する暫定条約に基く調査について、各国が提出する年次報告の Reproductive condition の報告様式では妊娠経歴と見掛けの妊娠率のみが求められるにすぎず、資源評価に寄与する再生産機構の研究にはあまり役立たなかった。

Reproductive condition の内容を新しい角度から把握し、その内容がオットセイ資源の変動にともなうような変化を示すかを解明すると共にその結果を資源管理面に反映させることを目的で 1971 年に日本は Reproductive condition の分類方法の改正を提案した。提案方法にもとづき 1964-1971 年迄の 3 月～4 月の三陸沖の資料を整理し、次の結果を得た。

この論文で用いた年令は越冬期の年令である。Reproductive condition は前年の繁殖期で査定するため、越冬期の年令より 1 才すくなくなる。

- (1) 成熟率 50% の規準より判断すれば繁殖期における性成熟年令は 3 才から 4 才に移行した。
- (2) 近年、若年の性成熟獣に著しく不妊の率が高まりつつある。これは Robben 系群の Reproductive condition が本質的に反映していると考えられる。
- (3) 性成熟に達した若年獣の資源増加にはたす役割の比重は大きい。
- (4) 無排卵は高令獣ほどその出現率が高い。しかし各年ほぼ一定で 1%～6% である。
- (5) 無排卵獣の越冬域における時期別分布は未成熟獣又は妊娠のしていない若い獣とにている。