J. Fac. Fish. Anim. Husb.
Hiroshima Univ. (1970), 9: 161~175

Studies on the Uteri and Ovaries in Fur Seals

I. Macroscopical Observation with Special Reference to the Multiparaous Changes

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(Tables 1-5; Text-figures 1-5; Figures 1-12)

A fur seal belongs to Mammalia, order Carnivora, suborder Pinnipedia, family Otaridae, genus *Callorhinus ursinus*. There is only one species *Callorhinus ursinus* in this genus[8)12)]. The fur seals, began to be hunted for their furs from the 18th century had been expected to become extinct early in the 20th century. For the purpose of conserving the fur seals, an agreement was reached among Japan, England, U. S. A. and Russia in 1911. In 1957, the Interin Convention on Conservation of Northern Pacific Fur Seals was concluded among Japan, U. S. S. R., Canada, and U. S. A. Nowadays a fur seal is said to be one of wild animals which are most successfully controled by mankind[12)13)14)].

According to the ecological researches on fur seals[1)4)8)12)], adult female land on the regular island to breed one pup in the breeding season once a year. One week after breeding, they appear to be in estrous and to copulate. The main breeding island of the fur seals caught in the western Pacific Ocean off northern Japan is Robben Island. The others are Pribilof Islands, Commander Islands, and Iuril Islands. The breeding season starts early June, when the "harem" are formed, and ends early August. In this period, the parturition of fur seals are observed.

Anatomical investigations of fur seals have been far less than ecological ones. ENDERS *et al.*[3)9)], HARRISON *et al.*[5)6)], CRAIG[2)] reported the anatomical and histological changes of the reproductive tracts of fur seals with reference to the estrous and pregnancy, but systematic researches on the multiparaous changes appeared not to have been done. The fur seal ovaries have old corpora lutea of pregnancy, so-called corpora albicantia, which have been observed in a cow[7)], a whale[10)], and a sea otter[11)] also. In the case of a cow, the corpora albicantia have been used as an indicator of judgement of the parturition history[7)].

In this study, the corpora lutea, corpora albicantia in ovaries and uterine horns of fur seals were observed macroscopically and the relation of these tracts to the parturition were studied.

MATERIALS AND METHODS

The author received the materials from Tokai Regional Fisheries Reseach La-

boratory, Fisheries Agency. These materials are the 10% formalin fixed reproductive tracts of 743 female fur seals caught in the western Pacific Ocean off northern Japan by the laboratory from January to May in 1967. The pregnant uterine horns of the samples were already removed. Twenty-nine individuals from one year to ten years old among them were chosen for this investigation (Table 1).

The ovaries were weighed, measured, and counted for their follicles on the surface and face of the slice, and the shape, colour, size of the other ovarian structures were also observed macroscopically. The uterine horns were observed from outside, were gauged on the central but a little near the uteroabdominal part of the horn and

Table 1. Condition of Fur Seals

Individual Number	Age	Date Taken (1966)	Pregnant (P) or Non-pregnant (Np)	Length (cm)	Weight (kg)
1	1	Feb. 4	Np	89	11
2	2	Feb. 21	Np	92	15
3	3	Mar. 2	Np	105	18.5
4	〃	Mar. 26	Np	105	20
5	4	Jan. 28	P	120	36
6	〃	Feb. 3	Np	114	23.5
7	〃	Apr. 25	P	125	28
8	5	Jan. 13	P	125	26
9	〃	Feb. 17	P	131	36
10	〃	Mar. 12	Np	118	29
11	〃	Mar. 12	Np	120	29
12	〃	Apr. 25	P	122	31
13	〃	May 22	P	136	43
14	6	Jan. 18	P	121	32
15	〃	Feb. 17	P	121	33.5
16	〃	Apr. 5	P	125	35
17	〃	Apr. 25	Np	122	28
18	〃	May 4	Np	125	31
19	7	Jan. 18	P	121	41
20	〃	Feb. 21	P	140	42
21	〃	Feb. 16	P	124	37
22	〃	Apr. 25	Np	125	33
23	8	Mar. 9	P	128	39
24	〃	Apr. 26	P	111.5	23.5
25	〃	May 27	P	137	38.5
26	9	Jan. 28	P	131	43
27	〃	Feb. 21	P	130	32.5
28	〃	Apr. 25	Np	130	37
29	10	Mar. 9	P	124	39

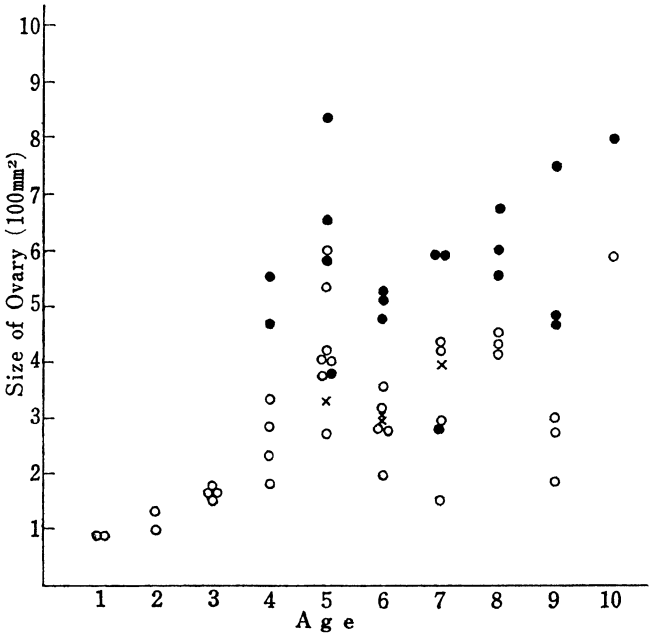
the cross section of this part was observed for the endometrium and the myometrium.

RESULTS AND DISCUSSION

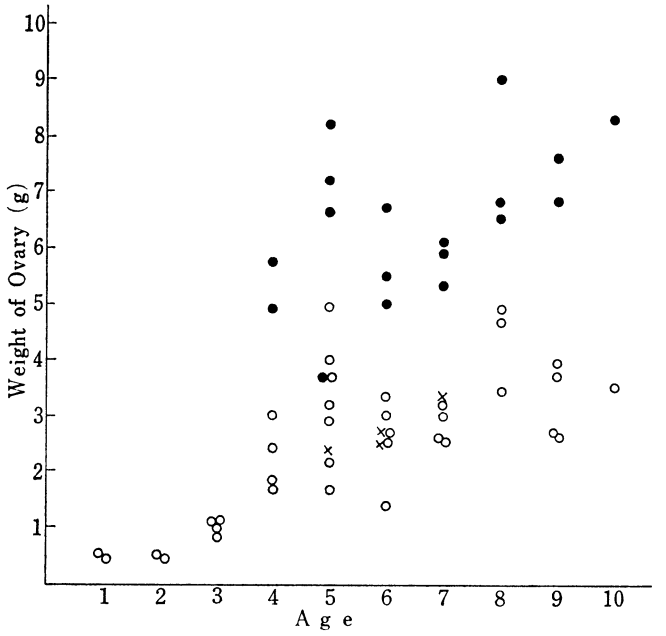
1. General ovarian structures

The ovary of the fur seal is linked to the mesovarium by the ovarian hilus. On the surface of the ovary, only the large follicles were observed. On the face of the slice of the ovary, puncta, various size follicles, corpora lutea, corpora albicantia and white scars were seen in the cortex, and white storoma regarded as connective tissue with many blood vessels were seen in the medulla. The colour of the puncta was white, red, yellow and so forth. The demarcation between cortex and medulla was obscure (Figs. 1, 2). The diameters of the ovary were gauged horizontally and vertically to the hilus. All the pregnant horn side ovaries were larger than the non-pregnant ones. The ovaries tended to enlarge gradually with aging (Text-fig. 1). The same tendency as in the size found in the weight of ovaries (Text-fig. 2).

The follicles were seen in different growth stages. They were the small follicles like a white spot, the large follicles filled with gelatinous substance and the vacuolated follicles with a small amount of such substance. The number of follicles varied from 0 to 57. The diameter of the largest follicle in the non-pregnant horn side ovary was usually larger than the one in the pregnant horn side ovary

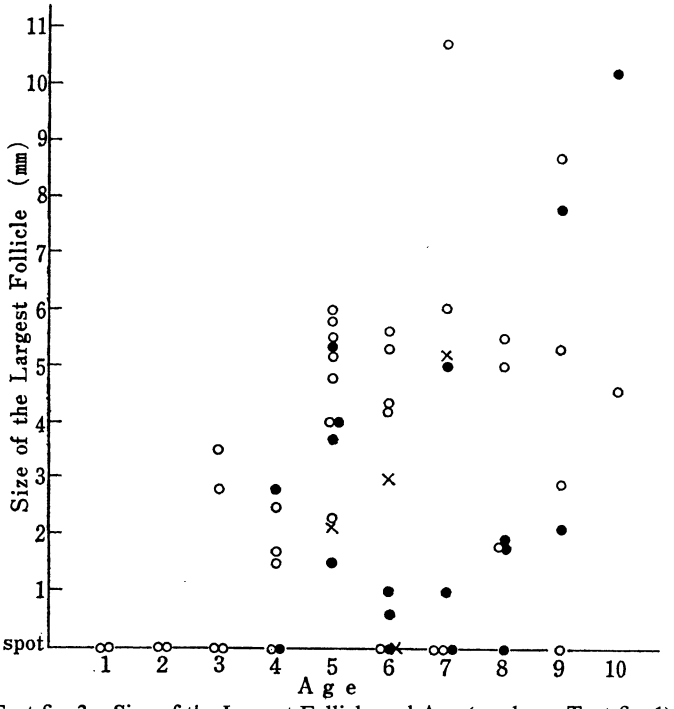


Text-fig. 1. Size of Ovary and Age.
○: Ovary with no corpus luteum, ●: Ovary with corpus luteum of pregnancy, ×: Ovary with corpus luteum of non-pregnancy.



Text-fig. 2. Weight of Ovary and Age (marks as Text-fig. 1).

(Text-fig. 3). The various forms of yellow puncta coloured like corpora lutea, a blood-red punctum, strips of homogeneously or opaquely white structure in the cor-



Text-fig. 3. Size of the Largest Follicle and Age (marks as Text-fig. 1)

tex and transparently white puncta in the medulla were found in the ovary, in addition to corpora lutea, corpora albicantia and white scars, which were reported in the next paragraph.

2. Macroscopical observations of corpora lutea, corpora albicantia and white scars

The macroscopical observations of corpora lutea, corpora albicantia and white scars were collectively shown in Table 2. The center cores in them were a concurrence of white thready structures and looked like a star or a letter of Y or I in the central part of corpora lutea and albicantia. The corpora lutea were globular or nearly globular structures in the surface layer of the ovaries and the demarcations between the corpora lutea and the surrounding tissues were distinct (Fig. 1). Their center cores were generally star-shaped. The largest corpus luteum which occupied three quarters of the section was 23.7 mm in diameter, and the smallest one was 12.9 mm. The center core of the corpus in L2 section of No. 29 was indistinct, as the white thready structures were scattered in the corpus luteum.

A corpus luteum was found in the ovary of four fur seals who had no fetus or showed no sighn of pregnancy. The two fur seals were six years old and the other were five and seven years old. These corpora lutea were named as the corpus luteum of non-pregnancy (Fig. 2). The demarcation of the two corpora lutea had a white edge and were very clear and other had no white edge but were clear. Their diameters were smaller than the corpora lutea of pregnancy; the largest one was 11.9 mm in diameter and the smallest was 7.8 mm. The size and the weight of the four ovaries with the corpora lutea of non-pregnancy were similar to the ovaries without corpus luteum, and were smaller and lighter than the ovaries with corpora lutea of pregnancy (Text-figs. 1, 2).

PEARSON and ENDERS[9] observed the corpora lutea in the nonpregnant seals caught in March and stated that the corpora lutea of non-pregnancy were smaller than the functional corpora at that time of the year. CRAIG[2] also reported a similar instance. The appearance of corpora lutea of non-pregnancy may be explained as follows. Female fur seals mate in August at the latest, but their embryos implant in November. This phenomenon is called delayed implantation[3]. If the embryos fail to implant, the corpus luteum can be found without any sign of pregnancy in the corresponding uterine horn. The alternative explanation for this phenomenon is that luteinization without fertilization occurs after ovulation.

The clearness of the demarcation of 28 corpora albicantia were not definite as compared with the corpora lutea, but most of their center cores were star-shaped as well as the corpus luteum. The largest corpus albicans was 12.7 mm in diameter and was oval-round form in the section L2 of No. 20, the smallest one was 3.2 mm in diameter and round form in R of No. 17. The demarcation of the largest one was a white edge and very clear. Its center core looked like many spreading branches. The largest corpus albicans was yellowish white and had similar structure to the general corpora lutea (Fig. 3). The two corpora albicantia observed in the sections L1 of No. 28, L1 of No. 27 had very similar structures to the largest corpus albicans,

Table 2. Macroscopical Observations of Corpora lutea, Corpora albicantia and White scars

Individual Number	Section	Grouping	Demarcation	Figure	Form of Center core	Diameter	Location
5	R	Corpus luteum of Pregnancy	++	oval	star	21.3	ss
7	R		〃	〃	〃	18.7	〃
8	L		〃	globe	〃	14.1	〃
9	L		〃	oval	〃	23.7	〃
13	R		〃	gourd-shape	〃	12.9	〃
14	R		〃	oval	〃	15.9	〃
16	L1		+	globe	〃	17.5	〃
19	R		++	oval	〃	17.8	〃
20	R		〃	〃	〃	21.7	〃
21	R2		〃	〃	〃	20.5	〃
23	R1		〃	globe	〃	23.5	〃
26	L4		〃	〃	〃	16.1	s
29	L2		〃	oval	ambiguous	23.6	ss
11	L	Corpus luteum of Non-pregnancy	+	〃	star	9.7	〃
17	L		++	globe	〃	11.9	〃
18	L2		〃	oval	〃	8.6	s
22	L123		+	globe	〃	7.8	d
9	R	Corpus albicans	〃	gourd-shape	〃	8.7	ss
11	R		〃	globe	〃	7.0	d
12	L		±	〃	〃	6.7	〃
13	L1		〃	oval	〃	5.4	〃
15	L		+	〃	indistinct	6.3	ss
16	R2		±	long oval	star	9.3	dd
17	R2		〃	globe	〃	3.2	d
18	L1		+	gourd-shape	Y-figure	4.3	dd
18	R1		++	oval	star	9.0	s
19	L1		+	〃	〃	8.2	dd
19	L5		±	〃	〃	5.0	〃
19	R1		−	unform	〃	7.5	ss
20	L1		++	oval	〃	12.7	s
20	R1		+	long oval	〃	10.3	dd
21	L		〃	globe	〃	6.9	s
22	L1		〃	long oval	I-figure	5.0	d
22	R1		±	unform	star	5.3	s
23	L2		−	〃	〃	9.0	dd
26	L1		+	lunette	〃	7.1	s
26	R1		〃	oval	〃	7.8	ss
26	R3		±	square	〃	5.3	s
27	L1		++	globe	〃	8.0	dd
28	L1		〃	〃	〃	8.5	ss
28	R1		〃	gourd-shape	indistinct	12.0	〃
28	R3		±	globe	star	8.4	〃
29	L1		+	gourd-shape	〃	6.3	d
29	R2		++	globe	〃	7.0	ss
29	R2		±	oval	I-figure	4.3	dd
14	L	White scar	+	long oval	indistinct	4.8	ss
21	R1		−	oval	star	4.5	dd
23	L3		〃	unform	I-figure	4.5	〃
23	R2		〃	oval	Y-figure	4.0	〃
25	R1		〃	unform	star	10.5	〃
25	R2		〃	oval	Y-figure	8.3	d
26	L3		〃	〃	〃	3.2	s
27	L2		±	long oval	star	9.5	d
28	L1		−	oval	〃	3.8	dd
29	L2		〃	long oval	〃	7.3	d

L; left, R; right.

Demarcation: ++; Very clear with white edge, +; Clear but no white edge, ±; Slightly clear, −; Not clear, gradually shifted to surrounding tissue.

Location: ss; surface layer of the ovary, s; inner part of cortex, d; very near medulla but inner cortex, dd; in medulla.

but the colour of these two corpora albicantia was opaquely white and their center cores were better developed than in the largest one (Fig. 4).

The corpora albicantia in the 9 sections of R of No. 9, L of No. 12, R of No. 16, R of No. 18, R1 of No. 19, L2 of No. 23, R of No. 26, R1 of No. 28, and R1 of No. 29 had a typical shape; these were comparatively large and varied from 6.7 mm (L of No. 12) to 12.0 mm (R1 of No. 28) in diameter. Though the clearness of their demarcations were various, their center cores were very well-extended radiately (Fig. 5). The diameter of the other corpora albicantia were relatively small and the structures of their center cores were simple. The corpus albicans in R1 of No. 21 was a white long straight structure (10.3 mm in length) with I-figured center core. The white scars were small and opaquely white and had indistinct structures. Most of the I-figured white scars were relatively long, but the white scars of other figures were relatively small. These white scars were distinguished from the strips of white structure described in the sections, because the white scars had the center core (Fig. 4).

Concerning on the old corpora lutea, HARRISON and ENDERS[5)6)] stated that "old retrogressing corpus luteum" was found in the ovaries of the fur seals killed in August. PEARSON and others[9)] observed the ovaries of fur seals collected in October, stated that the corpus luteum of the preceding pregnancy was obvious, and that such corpora as rounded areas of luteal and connective tissue with rays of connective tissue radiating out from them, and measured up to 10×10 mm in cross-section. Furthermore, they stated that other resorbing corpora had a very small core and in cross-section were star-shaped with long arms of connective tissue.

In the present materials the involutional corpora lutea in the early stage could not be observed. But, since the corpora albicantia and the white scars observed in this study were very similar to the old corpora lutea described by HARRISON[5)] *et al.* and PEASON and ENDERS[9)], the corpora albicantia and white scars can be regarded as old corpora lutea.

3. The number of corpora albicantia in each individual

Among 29 female fur seals, 18 fur seals were pregnant. All the pregnant fur seals were older than 4 years old and had a corpus luteum in the right or left ovary. Seven of the nonpregnant fur seals had no corpus luteum but four of them had a

Table 3. Number of Corpora albicantia and Age

Number of Corpora albicantia	Age									
	1	2	3	4	5	6	7	8	9	10
0	1	1	2	3	2			1		
1					4	4				
2						1	3	1	1	
3							1	1		
4									2	1
Total*	1	1	2	3	6	5	4	3	3	1

* total number of individuals is each age

corpus luteum of non-pregnancy stated before. The number of the individuals classified by age and the number of the corpora albicantia were shown in Table 3. The corpora albicantia were seen in the fur seals over five years old, and no fur seal had five or more corpora albicantia in the 29 female fur seals.

It is indicated in the report by the Fisheries Agency[4] that the pregnant fur seals were 32 and 80% of the four and five years old female fur seals respectively. According to the ecological observations[12], three or four years old female fur seals landed at a breeding island to copulate with young male fur seals after the harem disappeared. These results suggested that most female fur seals matured sexually at three or four years old. The ecological observations mentioned above are in good agreement with the results of the present study on appearane of corpora lutea and corpora albicantia.

Until today, parturition experience of a female fur seal has been judged by the presence of corpora albicantia[13]. Since individuals having five or more corpora albicantia, however, were not observed in the 29 female fur seals studied, the corpora albicantia and the white scars seemed to disappear within four years after parturition, holding similar view with CRAIG. Therefore, taking both the disappearance of corpora albicantia and the aforesaid existence of the corpora lutea of non-pregnancy into consideration, the judgement of the parturition experience by the presence of corpora albicantia may not be always correct.

4. Macroscopical observation of fur seal uterine horns

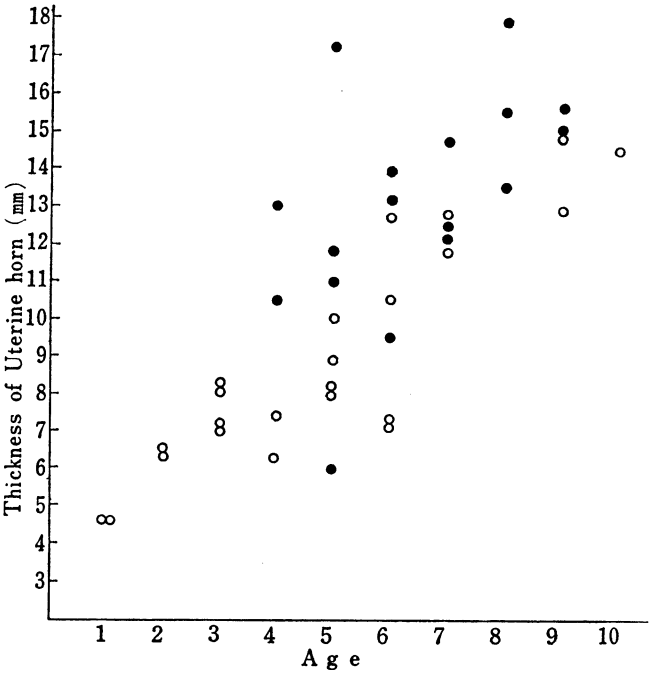
The fur seal uterine horn is bicornated uterus as in many domestic animals. The 40 horns containing both horns of 11 non-pregnant seals and one of the horns of 18 pregnant seals were observed macroscopically. On the transverse section of them, endometrium and myometrium, furthermore, in the broad horns stratum submucosum, stratum vasculare and stratum supravasculare could be distinguished (Figs. 8, 10, 12). A few or many sulci were found on the surface of some them.

Table 4. Extent of Sulcus and Degree of Stratum vasculare

Age	Extent of Sulcus (number of uterine horns)			Degree of Stratum vasculare (number of uterine horns)			
	−	+	++	±	+	++	+++
1	2			2			
2	2			2			
3	4			4			
4	2	2		1	3		
5	5	2	1	4	3	1	
6	4	3		2	1	4	
7	2	1	2			2	3
8	1	1	1			1	2
9		1	3				4
10			1				1

Extent of sulcus: ++; clear and many, +; clear but a few −; no found.
Degree of stratum vasculare: well-developed one (+++) to slightly observable one (±).

These sulci varied in length and were about 1mm in width and depth (Figs. 10, 12). Extent of the sucus, diameter of the horns and degree of development of stratum vasculare were observed. The relation between those results and the fur seals age were shown in Table 4 and Text-figure 4. They suggested the tendency that the

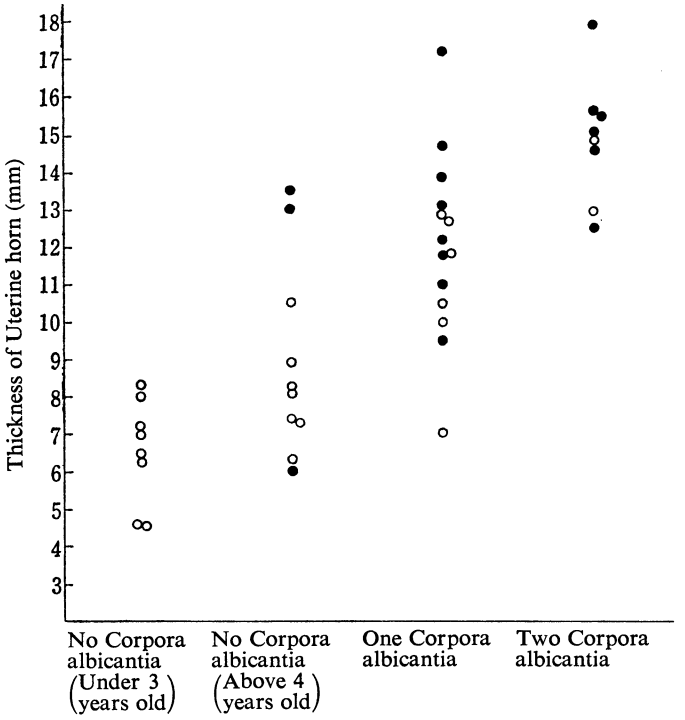


Text-fig. 4. Thickness of Uterine horn and Age
○: Uterine horn in non-pregnant fur seal, ●: Uterine horn in pregnant fur seal.

number of the broader horns and the horns with well-developed stratum vasculare increased gradually with rise of age. The sulcus of uterine horn surface could not be seen in the fur seals under three years old at all.

5. The relation between the number of the corpora albicantia and the structures of uterine horn

The relation between the number of the corpora albicantia in one ovary and the diameter of the horn at the same side with the ovary was shown in Text-figure 5. It indicates the tendency that the ovary with the more corpora albicantia was linked to the broader uterine horns. The relation between the number of corpora albicantia in one ovary and the sulcus or the degree of the development of the stratum vasculare or the degree of the development of the stratum vasculare in the corresponding uterine horn was shown by the horn number in Table 5. It also indicates the same tendency as the one seen in the diameter of the uterine horns, *i. e.* the ovary had the more corpora albicantia, the degree of the development of stratum vasculare and the extent of the sulcus were the more conspicuous in the corresponding



Text-fig. 5. Thickness of Uterine horn and Number of Corpora albicantia (marks as Text-fig. 4).

Table 5. Extent of Sulcus and Degree of Stratum vasculare

Number of Corpora albicantia	Extent of Sulcus (number of uterine horns)			Degree of Stratum vasculare (number of uterine horns)			
	−	+	++	±	+	++	+++
0 (Under 3 years old)	8			8			
0 (Above 4 years old)	9	1		6	3	1	
1	6	6	2	1	4	6	3
2		2	6				8

uterine horn (Figs. 7–12). From the above-mentioned observations, it was presumed that the multiparous changes could be expressed by the macroscopically visible changes of the uterine horns of fur seals. An exact relation between the macroscopically visible changes of the uterine horn and the multiparous changes must be defined in the histological observation of these fur seal uterine horns.

SUMMARY

Gross analyses of the ovaries and uterine horns from 29 female fur seals, collected in western Pacific Ocean, off northern Japan from January to May, were done

to clarify the macroscopically visible changes of the ovaries and uterine horns in pregnancy and after parturition.

1. The corpora lutea of pregnancy, corpora albicantia and white scars in the ovaries were macroscopically distinguished.
2. The judgement of the parturition experience by the presence of corpora albicantia may not be always correct, because the corpora albicantia and the white scars seemed to disappear within four years after parturition and the corpora lutea of non-pregnancy exists.
3. The results of the present study on the appearance of corpora lutea and corpora albicantia supported the view that most female fur seals matured sexually at three or four years old.
4. From the relation between the number of the corpora albicantia and the structures of the uterine horn, it was presummed that the multiparous changes could be expressed by the macroscopically visible changes of the uterine horns of fur seals.

ACKNOWLEDGEMENT

This work was carried out under the guidance of Dr. Norio Kudo and Dr. Makoto Sugimura of the Department of Veterinary Anatomy, Faculty of Veterinary Medicine, Hokkaido University, Sapporo. The author wishes to express his gratitude to Dr. N. Kudo, Dr. M. Sugimura and other members of the Department of Veterinary anatomy for their time, helpful suggestion and for criticism of this manuscript.

He wishes to thank Mr. Tadayoshi Ichihara, Mr. Kazuo Wada and other members of Tokai Regional Fishereis Research Laboratory, Fisheries Agency for furnishing the material for this study.

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オットセイ雌生殖器の研究
I 経産にともなう変化の肉眼的観察

岡本 敏一

オットセイの卵巣の黄体とその退縮過程，子宮の経産にともなう変化を肉眼的に観察した．材料は，1967年1月から5月に水産庁東海区水産研究所が捕獲したオットセイ，1～10才の29個体のものである．

オットセイの卵巣は肉眼的に妊娠性黄体，その陳旧物と思われる白体および白斑が区別される．

白体は，1個体に最大4個しか見られないので，分娩後4年以内に消失と考えられる．さらに非妊娠性黄体の存在を考慮に入れると，白体の存否による妊娠歴の判定は誤まりを生ずる可能性がある．

子宮角の太さ，表面に見られる溝および割面に見られる脈管層の変化と同側卵巣の白体数との関係から，子宮角に経産による何らかの変化があると考える．

EXPLANATION OF PLATES

Plate I

Fig. 1. Right ovary of No. 20 fur seal. Corpus luteum of pregnancy. ×3.
Fig. 2. Left ovary of No. 11. Corpus luteum of non-pregnancy. The demarcation is clear but has no white edge. It is smaller than corpus luteum of pregnnacy. ×3.
Fig. 3. Left ovary of No. 20. The largest corpus albicans in 28 corpora albicantia. It has similar structure to the ordinary corpora lutea. ×3.
Fig. 4. Left ovary of No. 28. Large corpus albicans (upper part) and white scar (arrow). The former is similar structure to the largest one. ×3.
Fig. 5. Right ovary of No. 28. Corpus albicans with typical form. ×3.
Fig. 6. Right ovary of No. 28. Small corpus albicans with rather simple center core. ×3.


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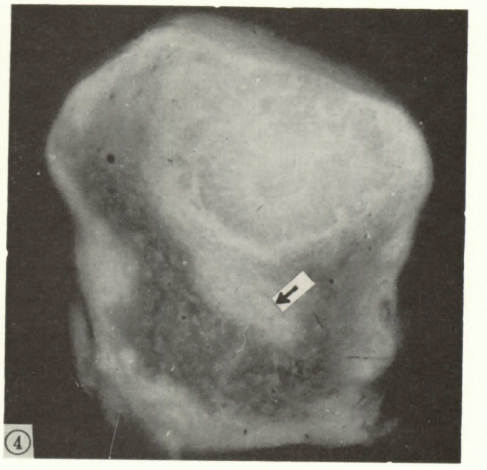
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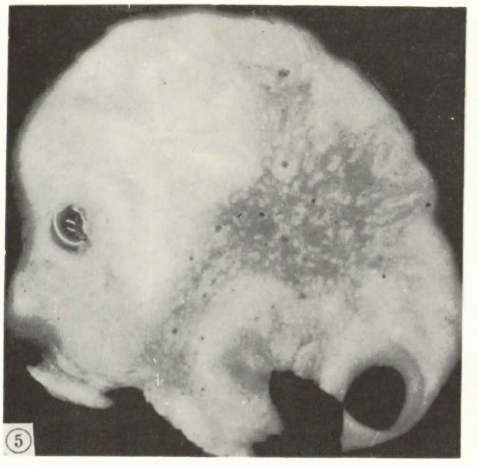
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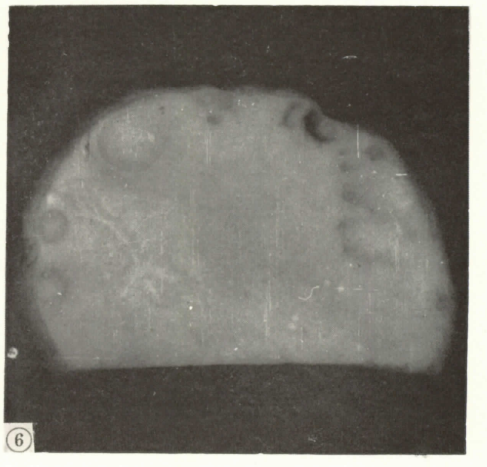
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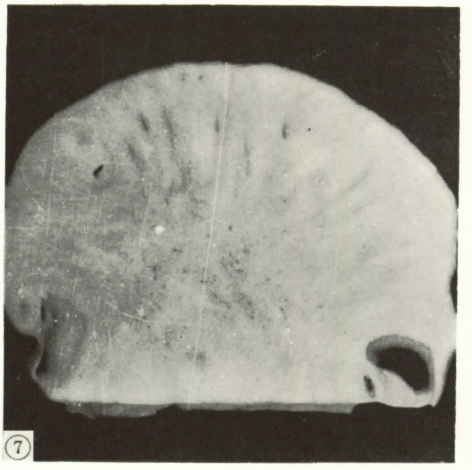
Plate II

Fig. 7. Right ovary of No. 10. No corpus luteum and corpus albicans. ×3.
Fig. 8. Right uterine horn of No. 10. The sulcus is not found and the stratum vasculare is slightly observable. ×3.
Fig. 9. Right ovary of No. 18. Corpus albicans with typical shape and size. ×3.
Fig. 10. Right uterine horn of No. 18. A sulcus is seen (arrow) and the stratum vasculare is stratified. ×3.
Fig. 11. Right ovary of No. 29. Two corpora albicantia. ×3.
Fig. 12. Right uterine horn of No. 29. A few sulci are wide and stratum vasculare are well-developed. ×3.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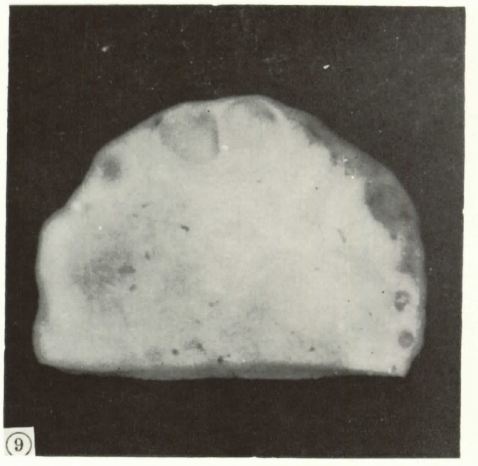
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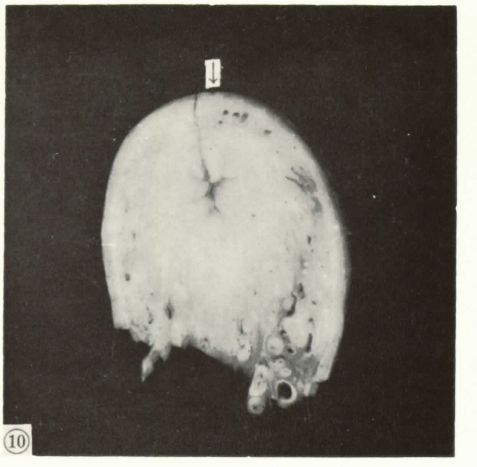
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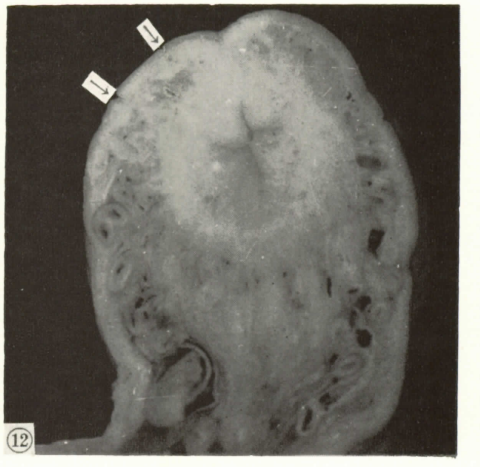
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