THE GROWTH OF TWO SPECIES OF THE HARBOUR SEAL IN THE ADJACENT WATERS OF HOKKAIDO

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ABSTRACT

We studied the growth of *P. v. largha*, pagophilic seal, and *P. kurilensis*, pagophobic seal, in the southern Sea of Okhotsk and in the waters around Hokkaido from 1968 to 1971.

P. v. largha: Adult type coat and white coat were observed in the fetus stage. Parturition occurred from mid March and the end of March. Moulting of the white coat and weaning occurred 2–3 weeks after birth. The thickness of blubber was 4.5–5.1 cm in pups on the ice floe and decreased to 2.6 cm after the ice melted. The fully grown body length was 170 and 161 cm in males and females respectively.

P. kurilensis: Parturition occurred in the later half of May, and birth length was 98.2 cm. Weaning occurred 4 weeks after birth. The thickness of blubber was thinner than that of *P. v. largha*. The fully grown body length was 186 and 169 cm in males and females respectively.

INTRODUCTION

It is today noted that there are 5 subspecies of the harbour seal (*Phoca vitulina*) in the northern hemisphere; *P. v. vitulina* in the eastern Atlantic, *P. v. concolar* in the western Atlantic, *P. v. mellonae* in the Seal Lake, Canada, *P. v. richardi* in the eastern Pacific, *P. v. largha* in the western North Pacific.

In the western North Pacific, more than 10 specific or subspecific names were reported for the harbour seal, but they were reduced to only one *P. v. largha* by Scheffer (1958). However, recently by morphological and ecological studies, Belkin (1964) reported new species of *Phoca* named *P. insularis*, which is the same seal reported previously as *P. ochotensis kurilensis* by Inukai (1942a). Concerning the specific name of the new seal, McLaren (1966) used *P. kurilensis* instead of *P. insularis*, recognizing the priority of the name *kurilensis*. Therefore, there exist two species of *Phoca*, *P. v. largha* and *P. kurilensis*, in the western North Pacific.

In Hokkaido, it is noted that both of the above mentioned two species are caught annually by commercial sealing or by fishing net (Naito, 1971). Biological studies of these seals in the waters around Hokkaido and in the southern Sea of Okhotsk were made fragmentarily by Inukai (1942 a, b), Wilke (1954), Nishiwaki and Nagasaki (1960), Belkin (1964) and Belkin *et al.* (1969). Nevertheless, there are still many general biological problems not yet solved.

It is noted that *P. v. largha* is a pagophilic seal and *P. kurilensis* is a pagophobic seal (Belkin, 1964; Belkin *et al.*, 1969). The present study was focussed to reveal

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unknown aspects of the growth of the seals, some of which may be related to such ecological difference between two species.

In the present study, we follow McLaren (1966), and use the name *P. kurilensis*.

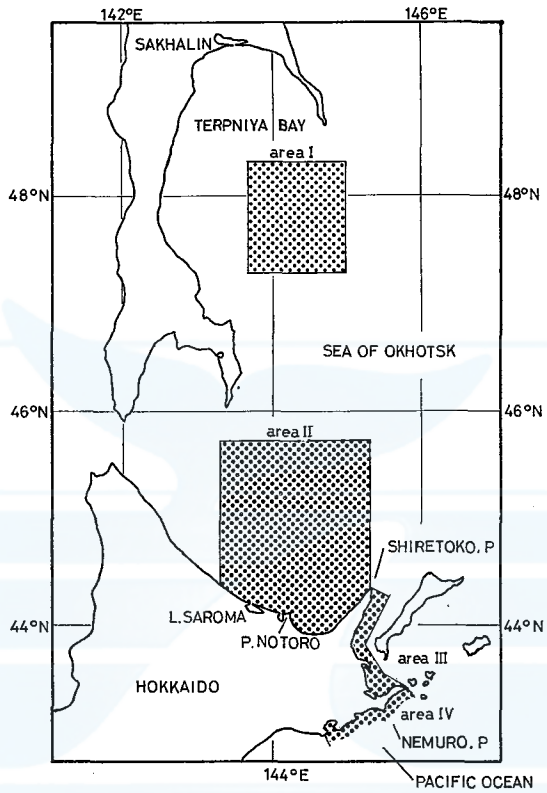

Fig. 1. Sampling areas for *P. v. largha* and *P. kurilensis* in the southern Sea of Okhotsk and the Pacific coast of Nemuro Peninsula.

MATERIALS AND METHODS

In the southern Sea of Okhotsk and the north east coast of Hokkaido, field surveys were made between 1968 and 1971. In the present study, the area surveyed was divided into the following 4 areas according to the sealing area (Fig. 1): I) the mouth of Terpeniya Bay of Sakhalin, II) the Kitami-Yamato bank, Lake Saroma, and Point Notoro, III) the area between Shiretoko Peninsula and Nemuro Peninsula, IV) the Pacific coast of Nemuro Peninsula. Studies of *P. v. largha* were made mainly in areas I, II, III, and studies of *P. kurilensis* were made in area IV. In area I, studies were performed on a sealing boat from the end of April to the beginning of May in 1971. In area II, studies were made from December in 1968 to March in 1969 at Lake Saroma and Point Notoro, and also made on a sealing boat in Kitami-Yamato bank from mid April to the beginning of May in 1969 and 1970. In area III, studies were

made from December in 1968 to March in 1969. In area IV, studies were made in May and June in 1969, 1970 and 1971, and in October in 1969. In this area, field observations of *P. kurilensis* were also made at Moyururi Island and other places in 1969 and 1971. *P. kurilensis* was chiefly caught in area IV in May and June. However, some of this species appeared in area III and were caught by fishing net occasionally (Salmon set net). *P. v. largha* seemed not to appear in area IV in May and June except for pups or very young seals, but some appeared in area IV and were caught by the fishing net in Autumn.

Through these studies, body length was measured from the tip of the snout to the end of the tail in a straight line along the body axis in cm. Concerning the seals collected on board, measurements were mostly made before rigor mortis occurred. Some were measured in the condition of rigor mortis, and yet they were not so much curved that we could not measure in a straight line along the body axis. In small embryos (under 100 mm) the length was measured along the curved body axis from the tip of the snout to the end of the tail in mm by using the universal projector, and the length of middle sized embryos (100–400 mm) was measured by using the divider. Large embryos (over 400 mm) were measured same as postnatal seals. Reproductive organs were preserved in 10% formalin. In some cases, they were preserved in 10% formalin after preservation in a freezer.

For age determination, canine teeth were taken from the skulls or lower jaws after connective tissues rotted in the laboratory, and then they were cut longitudinally by grinder and their surface was polished by wetstone. After they were glued to the transparent plastic plate, the half of the remaining tooth was ground again to become about 0.1 mm in thickness. The growth layers were observed by the binocular microscope in reflected and transmitted light. In the present study, age determination was made following the method of McLaren (1958), Mansfield and Fisher (1960), and Bigg (1969). In the seal under 7–8 years of age, both cementum and dentine growth layers were examined, but only cementum growth layers were examined after 7–8 years of age. Ages were calculated from number of growth layers, assuming that every collected *P. v. largha* was born at the end of March and *P. kurilensis* was born in mid May respectively.

PRENATAL GROWTH AND PURTURITION

The prenatal growth of *P. v. largha* and *P. kurilensis* is almost unknown. Tikhomirov (1971) reported the length of near-term fetuses of *P. v. largha* from the Bering Sea. There are no record of fetus of *P. kurilensis*. However, Scheffer and Slipp (1944) and Bigg (1969) reported the prenatal growth of *P. v. richardi* from Washington State and the southern Vancouver Island.

Concerning the parturition Tikhomirov (1971) in the Bering Sea, Wilke (1954) in the southern Sea of Okhotsk, Belkin (1964) and Belkin *et al.* (1969) in the southern Kurile Islands reported on *P. v. largha*, and Inukai (1942a), Belkin (1964) and Belkin *et al.* (1969) stated on *P. kurliensis* from the southern Kurile Islands. In the present study, mating season, growth of fetus in body length, parturition season and birth

length were investigated.

Phoca vitulina largha

In area II from the 12th to the 16th of April in 1969, we collected 9 paired females which were on ice floes with males and pups together. Couples of ovaries were collected from 5 out of 9 paired females. The condition of these ovaries was compared with that of single females which were alone on ice floes and were captured from the 17th of April to the 2nd of May. As seen in Table 1, paired females were

TABLE 1. CONDITION OF OVARIES IN THE SINGLE FEMALE AND THE PAIRED FEMALE OF *P. V. LARGHA*.

	Single	Pair
Period of catch	April 17th—May 2nd	April 12th–17th
Number of specimens	23	5
Specimens with large follicles and no newly formed corpus luteum in ovaries	6	2
Specimens with follicle changing to corpus luteum in ovaries	0	1
Specimens with newly formed corpus luteum in ovaries	23	2
Mean diameter of maximum-sized follicle (length+width/2; mm)	5.0	12.7

classified into three groups according to the condition of ovaries. 1) two paired females had large follicles and no corpus luteum in their ovaries, which indicated that fertilization had not occurred yet. 2) one paired female had the large follicle which was partly changing to the tan-color corpus luteum, and partly contained the opaque gelatin like structure. This follicle indicated that the ovary was just after the fertilization. 3) two paired females had the newly formed corpus luteum in their ovaries, and this indicated that fertilization had already occurred. The mean diameter of maximum sized follicles of 5 paired females was 12.5 mm. On the other hand, in the single females only newly formed corpus luteum was found in the ovaries, and this indicated that fertilization was over. The mean diameter of maximum sized follicles was 5.0 mm and was less than half of that of paired females. From these facts, it is indicated that the paired females were in the mating season, and in the single females mating season was over. In the present study, it was difficult to know exactly when the beginning of the mating season occurred, however, it may be supposed that mating occurred from early April to mid April.

Concerning the growth of fetus, we examined 20 fetuses of *P. v. largha* collected from survey area II and III. Figure 2 shows that body length of fetuses increased in accordance with time. In this study, the time of implantation is unclear, so the gestation period is also unclear. The fetuses collected in mid October, about 5 months before parturition season, were 175–268 mm in body length and the final stage fetuses collected in later half of March, just before birth, was 780–925 mm. The growth rate seemed to be same in both sexes.

Pups having an umbilical cord may indicate that they were born within the past few days, and from such pups parturition season and birth length would be estimated. In this study we could not collect pups with an umbilical cord, but 4 final stage fetuses were caught which were estimated that they would be born within a few days. These fetuses appeared from the 16th to the 27th of March and did not appear after the 27th of March. Therefore, it seemed that parturition occurred from the mid to the end of March. According to other studies, Wilke (1954) reported from the same area as our area II that parturition may occur in the early half of

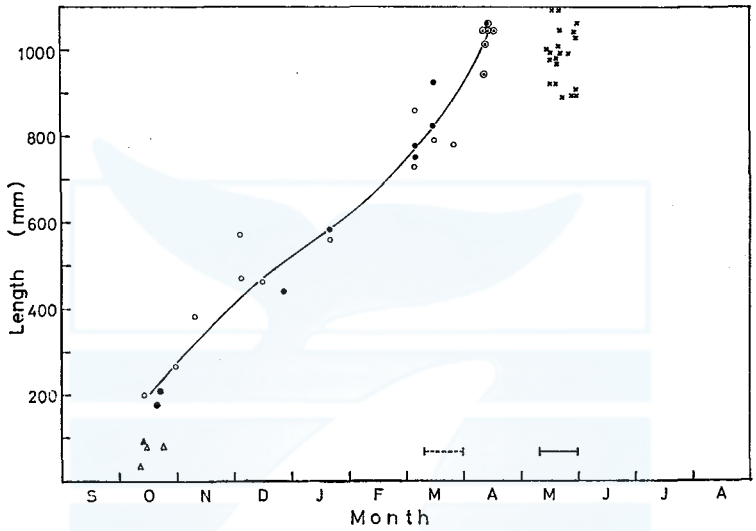

Fig. 2. Prenatal growth of *P. v. largha* and *P. kurilensis* in standard length. ●, ○, males and females of *P. v. largha*; ⊙, new born pups with white coat; ▲, △, males and females of *P. kurilensis*; ×, new born pups with umbilical cord; ——, time of parturition of *P. v. largha*; – – –, time of parturition of *P. kurilensis*.

March, the earliest record of parturition was in late January and the latest was on the 15th of April. Belkin (1964) suggested that pups were born on ice floes from the end of March to mid April in the southern Kurile Islands. However, Belkin *et al.* (1969) suggested that new born pups were observed from early March to the end of March in the same area.

In the present study, birth length was estimated from following considerations. 1) the largest fetus and the smallest new born pup may indicate the birth length. 2) growth curve and parturition season also indicate the birth length. According to 1), birth length was assumed to be 933 mm, since the largest fetus was 925 mm and the smallest new born pup was 940 mm. According to 2), birth length was estimated to be about 850 mm. Since the new born pup was not captured just after birth, the result of the first was relatively large. Therefore, we employed the second result.

Phoca kurilensis

Concerning the mating season, 4 couples out of 67 population were observed to copulate at hauling ground area of Moyururi Island from the 9th to 13th of June in 1969. While copulations were rarely observed in 75 population from 22nd to 27th of June in 1971 at the same hauling ground area. From these data, it is concluded that mating occurs in June, but is difficult to estimate the mating period exactly.

There was no report previously on the prenatal growth of this seal. In the present study, the length of 4 fetuses collected in October from Nemuro Peninsula was 95 mm in males, and 85, 84 and 39 mm in females (Fig. 2). In these fetuses no pigmentation was observed (Plate I).

To estimate the parturition season and the birth length, the appearance of pups with umbilical cords was investigated. Figure 3 shows that parturition of this seal may occur from the middle to the end of May in the Pacific coast of Nemuro Peninsula and the mean body length at birth is 98.2±3.2 cm. The birth length of this species is much larger than that of *P. v. largha* indicated in the present study and that of *P. v. richardi* shown by Bigg (1969). Inukai (1942b) and Belkin (1964) and Belkin *et al.* (1969) suggested that parturition of this seal occurs in mid May and copulation occurs in July in the southern Kurile Islands.

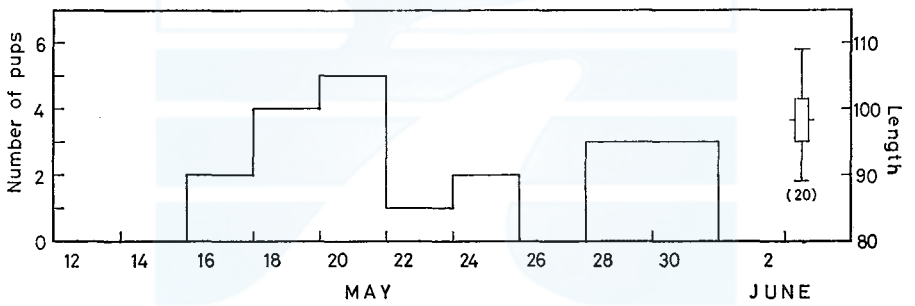

Fig. 3. Frequency of new born pups with umbilical cord, at two days intervals, and birth length(total 20 pups). Vertical line, range ; box, standard error ; horizontal line in box, mean.

POSTNATAL GROWTH

I. Moulting of white coat and weaning

It is generally believed that only *P. v. largha* of all 5 subspecies bears the creamy white coat in its early pup stage for several weeks after birth, and also weaning seems to occur subsequently with moulting of this coat. However, the moulting and weaning season are still unknown. As for *P. v. largha*, Wilke (1954) suggested the time of moulting in the southern Sea of Okhotsk, but the weaning seasons are not obvious. Concerning weaning of *P. kurilensis*, Belkin (1964) and Bilkin *et al.* (1969) suggested from his finding in the southern Sea of Okhotsk.

Phoca vitulina largha

In the fetuses collected in October, clear pigmentation was observed (Plate I). Scheffer and Slipp (1944) traced three progressive changes in type of pelage in *P. v. richardi*: 1) an early, sparse fetal coat, perhaps the forerunner of the third coat, 2) a long, silky white lanugo coat, and 3) a short varigated coat. The first fetus on which appeared fetus pelage according to Scheffer's 1), was caught in early November. From early December, about 3.5 months before parturition season, the fetus began to show the white lanugo coat, which corresponded with Scheffer's 2) change (Plate I). There are no records of pups which have the fetus coat corresponding to Scheffer's 3) change. The near-term fetus of *P. v. largha* do not shed the white lanugo coat, but continue to bear after birth. Stutz (1966) reported the changes of lanugo coat in the fetus of *P. v. richardi*. Firm and dirty white or pale yellowish-grey hair corresponding to Scheffer's 2) change, which resist tugging, appeared characteristic of fetus at about half term. As the fetus neared parturition, this hair become looser enough to be scraped from the skin, and almost near-term fetus lost their lanugo coat. This near-term fetus seemed to exhibit the same pelage as Scheffer's 1) change.

From the catch record of pups captured in area I from the 27th of April to the 4th of May in 1971, and in area II from the 13th of April to the 12th of May in 1969, the time of moulting of the white coat and the time of weaning were considered (Table 2). In order to know the moulting season of the white coat, three pups stages were considered from the condition of white coat: 1) stage of complete white coat, 2) stage of a partial white coat, 3) stage of moulting the white coat.

In area II, as shown in Table 2, pups were considered in the moulting season of their white coat in mid April, and it seemed that the moulting season was over at the

TABLE 2. FREQUENCY OF PUPS OF *P. V. LARGHA* IN THE THREE MOULTING STAGES. PARENTHESIS SHOWS PERCENTAGE.

	Number of pups in white-coat stage	Number of pups in second stage of moulting	Number of pups in final stage of moulting
Area II			
1969 Apr. 12	1	0	0
Apr. 13	2	1	1
Apr. 14	3 (45.4)	4 (27.3)	1 (27.3)
Apr. 15	2	1	4
Apr. 16	2	0	0
Apr. 23	0	0	2
May 2	0 (0)	1 (20)	2 (80)
Area I			
1971 Apr. 27	0	1	6
Apr. 28	0	0	5
Apr. 29	0	0	6
Apr. 30	0	0	2
May 1	0	0	1
May 2	0	0	4
May 3	0	0	3
May 4	0	0	7

end of April. In area I, there were no catch records of pups bearing completely white coat from the 27th of April to the 4th of May in 1971. Almost all pups captured in this area had shed their white coat. Therefore, we can suggest that the moulting season was already over at the end of April and the beginning of May in area I in this year. According to Wilke (1954), pups of this subspecies landed by hunters at Abashiri in late April were in the moulting stage, and three stages classified above have been reported. As it is possible to think that Wilke also treated the pups from the same area as area II, the time difference in the moulting season may be related to the ice conditions in each year.

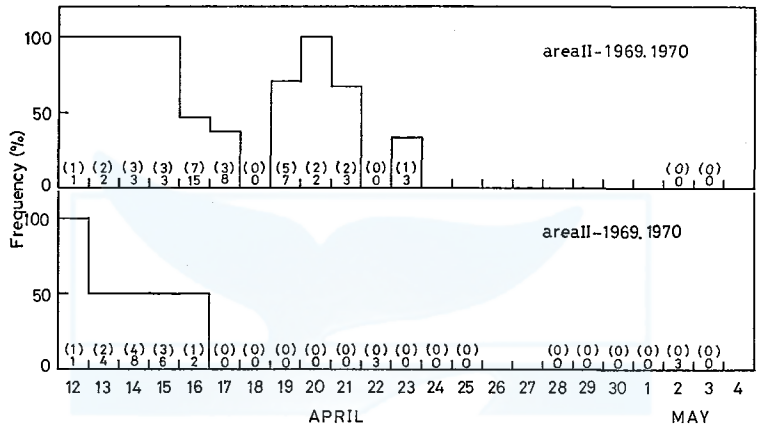

Fig. 4. Frequency of appearance of lactating females (above) and pups cared by its mother (below) in *P. v. largha*. Number in the parenthesis shows the number of lactating females out of total number of sexual mature females, and the number of pups cared by its mother out of total number of pups.

TABLE 3. FREQUENCY OF PUPS OF *P. v. largha* WITH MOTHER IN RELATION TO THREE MOULTING STAGES.

	complete white coat stage	partly moulted stage	completely moulted stage
No. of pups with mother	9	1	0
Total No of pups	10	7	10
Percentage (%)	90	14.3	0

Since the parturition season in area II was considered from mid March to the end of March in 1969, it is considered that moulting of the white coat occurred two or three weeks after birth in this year. This period from birth to moulting is the same as that of King's suggestion (1964).

Time of weaning was estimated by the appearance of pups that were caught with their mothers and the appearance of the lactating females in area II (Fig. 4). In this study, a lactating female was determined when milk secretion was found in the mammary glands. This figure shows that pups with their mothers appeared by mid April, and may indicate that frequency of appearance of lactating females is decreasing from mid April to the end of April in 1969 and 1970. Therefore, it could be suggested that weaning occurs in mid April in area II. We also studied weaning in relation

to moulting of the white coat. As shown in Table 3, weaning occurs simultaneously with moulting of the white coat. Since the parturition season in area II was considered to be from mid March to the end of March in 1969, as described above, it is considered that weaning occurred after two or three weeks from birth.

Phoca kurilensis

Inukai (1942b) reported that new born *P. kurilensis* in the southern Kurile Islands had the white coat, yet Belkin (1964) and Belkin *et al.* (1969) opposing Inukai, said that pups of the same seal do not have the white coat. In this study, 20 pups with umbilical cords were observed and the same result as Belkin was obtained.

In some cases, however, pups with lanugo coats were observed. One pup captured in the 20th of May 1969 had a grey long lanugo coat except for the head and flippers (Plate I), and also a pup captured the 25th of May in 1970 had such a coat a little on its back. These facts may indicate that near-term fetuses have lanugo coats. Although we have no record of a lanugo coat fetus, we obtained the information from a fisherman that near-term fetuses which have such a coat were removed from their mother seals caught in mid March by fishing net. This may suggest that pups normally shed their coat in the uterus before birth. The same occurrance was found in *P. v. richardi* in the Alaska Peninsula by Stutz (1966) and Burns (1970). The pups born in early parturition season in late May, retain all or most of their lanugo coat for a short period after birth. Fisher (1952) has reported the yellowish coat pup of *P. v. richardi* born in the peak of parturition on June 8, 1946 from the Skeena River. In the present study, pups with lanugo coats were born not in early but in mid parturition season.

The weaning season of this seal was estimated from the following three investigations: 1) existence of milk in the stomach of pup, 2) appearance of lactating females, 3) appearance of pups together with their mothers in the hauling ground area (Table 4 and 5). Table 4 seems to show that pups of which the stomachs had contained some amount of milk, appeared in May and the beginning of June, and disappeared at the end of June. Table 5 may show that lactating females appeared

TABLE 4. FREQUENCY OF SUCKLING PUPS OF *P. KURILENSIS*.

Date	Number of pups of which stomach contains milk	Number of pups of which stomach contains no milk	Total
May 16	2	0	8
May 20	1	0	1
May 21	1	0	1
May 22	1	0	0
May 24	1	0	1
May 31	0	1	1
Jun. 1	3	0	9
Jun. 2	3	0	3
Jun. 21	0	1	1
Jun. 27	1	3	4
Jun. 28	0	1	1

TABLE 5. FREQUENCY OF LACTATING FEMALES OF *P. KURILENSIS*.

Date	Number of lactating females	Number of nonlactating females	Total
May 13	1	0	1
May 16	2	0	2
May 18	1	0	1
May 22	1	0	1
May 25	1	0	1
May 29	2	0	2
May 30	1	0	1
Jun. 7	1	0	1
Jun. 16	1	0	1
Jun. 27	0	1	1

till mid of June.

The appearance of suckling pups in the hauling ground area was observed at Moyururi Island. From the 9th to the 13th of June in 1969, all 4 pups were observed in suckling and being cared for by their mothers. From the 22nd to the 26th of June in 1971, 4 pups out of 7 rarely suckled, but they were observed to swim with their mothers, and the other remaining three pups were observed in groups without their mothers. From these three investigations, we conclude that weaning of this seal begins to occur at the end of June. Belkin *et al.* (1969) suggested that the pups caught at mid May and the 8th of August in 1963 had milk (100–450 g) in their stomachs and their suckling continue till August, however, his result may be too long compared with this result.

II. Thickness of blubber in early stage of pups

Bigg (1969) and Tikhomirov (1971) suggested that the body weight of pups become double their birth weight during the suckling period. This remarkable increase in their body weight is mostly due to the increase in thickness of blubber. In this study, comparison of the blubber thickness between ice breeding *P. v. largha* and land breeding *P. kurilensis* was made. The thickness of blubber was measured at the middle point between the mammae and the umbilicus where the blubber seems to be the thickest.

Phoca vitulina largha

Measurement of blubber thickness was made on pups caught in area I, II and III (Fig. 5). In area I, 21 pups were caught on ice floes from the 27th of April to the 2nd of May in 1971. Most pups captured here had already lost their white coats except one which still partly had its white coat, and it was estimated that weaning had already occurred but not so long time before. Their mean blubber thickness was 5.1 cm, and seemed to be still in maximum condition. In area II, 9 pups were caught on ice floes from the 12th of April to the 2nd of May in 1969. Seven of these 9 pups were on the point of weaning and moulting the white coat, but 2 pups had

already shed their coats. The mean blubber thickness was 4.5 cm and estimated to be in the thickest condition. Seven pups were caught in area III from the 22nd of May to the 27th of June in 1970 and 1971. The mean blubber thickness was 2.6 cm. All pups were caught not on the ice floe, but in water by fishing net.

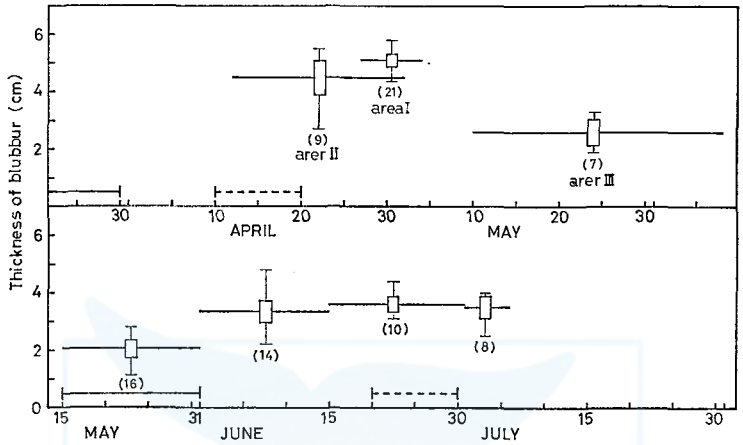

Fig. 5. Change of blubber thickness in pups of *P. v. largha* (above) and *P. kurilensis* (below). Vertical line, range ; box, standard error ; horizontal line in box, mean and sampling period ; foot horizontal line, time of parturition ; foot brocken line, time of weaning.

As seen in figure 5, pups on the ice floe (area I and II) had the pretty thicker blubber than pups in swimming life stage (area III). However, it is not clear as to what is reason why blubber thickness seen in pups of area III is much thinner than in pups of area I and II. The following reasons should be considered: Pups consume their blubber by swimming in the cold water (−1 to 0°C) after weaning. Concerning the difference of blubber thickness of pups found between area I and II, we could not discuss for the sake of short data. Tikhomirov (1971) reported that the mean value of 8–12 day-old pups caught on the 15-20th of April was 26.3 kg and of 1.2–2 month-old pups caught at the end of May and June was 23.9 kg. In addition, the rapid growth in body length during the first month from birth were reported (Tikhomirov, 1971). These facts suggest that decrease in weight is due to decrease in blubber thickness.

Phoca kurilensis

Sixty-five pups were caught on the Pacific coast of Nemuro Peninsula from the 16th of May to the 6th of July in 1969, 1970 and 1971. Figure 5 shows the blubber thickness of 48 pups out of 65 pups that were measured. As shown in figure 5, the mean blubber thickness of pups with umbilical cord caught in later half of May was 2.1 cm, and it was increased rapidly until 3.4 cm in early half of June. The maximum condition of the blubber thickness may occur in the end of June simultaneously with the beginning of weaning. The difference of maximum

thickness of blubber between two species is related to the difference in breeding environment. As described above, pups of *P. kurilensis* are born on narrow rocky shores and they begin to swim with their mothers just after birth differing from pups of *P. v. largha* which do not swim before weaning. Therefore, pups of *P. kurilensis* may regularly consume their blubber by swimming, and therefore remarkable accumulation may not occur.

III. Growth of ovaries and testes

As the index of sexual maturity, weight of ovaries and testes, and existence of the newly formed corpus luteum in ovaries and sperm in testes and epididymis were examined in relation to age. Data collected from area I, II, III during April and May, were examined not in each but altogether. The testes were weighed together with the epididymis. Concerning *P. kurilensis*, it was difficult to describe the sexual maturity owing to scanty of data.

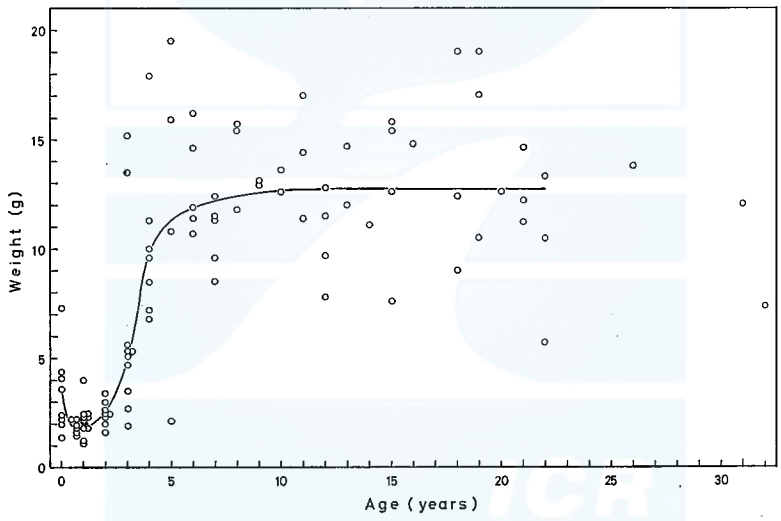

Fig. 6. Growth in the weight of the ovaries of *P. v. largha*. Total number is 102.

In growth of weight of ovaries and testes, 102 specimens from females and 61 specimens from males were used in figure 6 and figure 7 respectively. As shown in these figures, decrease in weight was observed in both ovaries and testes during the first year. Actually, however, these decreases of weight seemed to have occurred within short period after birth. The same occurrence was reported by Tikhomirov (1971). After that, sharp increase in weight was shown in both ovaries and testes from 1–2 years of age to 4–5 years of age. Then, weight of these organs increase gradually until 10 years of age.

Existence of the newly formed corpus luteum was examined in 26 females out of 102 females described above. As seen in Table 6, females from 2–7 years of age

were used, and the corpus luteum was observed in 20% of females at 3 years of age. All of 6 females at 4 years of age had the corpus luteum in their ovaries. Similary, existence of sperm in testes and epididymises was examined in 15 males from 1–8 years of age. Table 6 shows that 20% males of 3 years of age and 50% males of 4 years of age were matured, and all of males matured from 5 years of age.

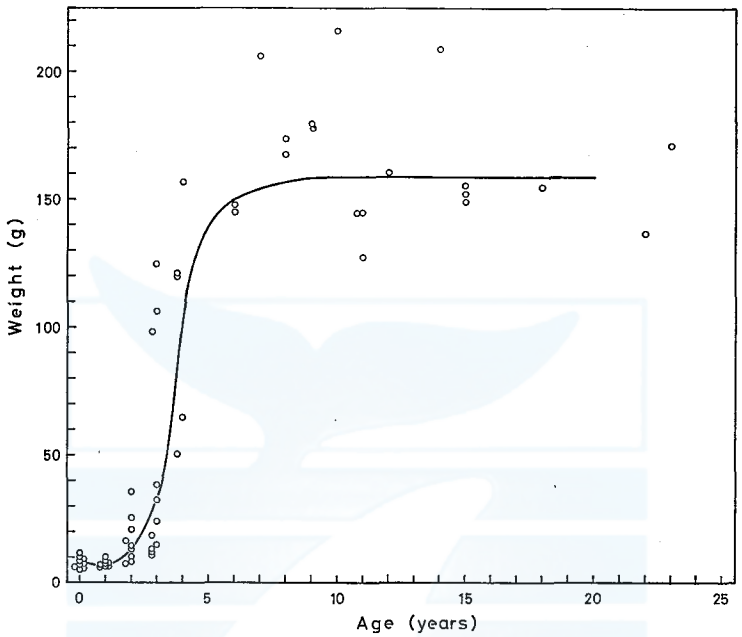

Fig. 7. Growth in the weight of the testes of *P. v. largha*. Total number is 61.

TABLE 6. AGES AT SEXUAL MATURITY IN BOTH SEXES OF *P. V. LARGHA*.

Age	Females		Males	
	Number of specimens	Number of mature females	Number of specimens	Number of mature males
1			1	0
2	6	0	1	0
3	5	1	5	1
4	6	6	4	2
5	2	2	1	1
6	4	4	1	1
7	3	3	1	1
8			1	1

From these data, it is difficult to estimate the age of sexual maturity in both sexes exactly, but it is approximately considered that females and males of this species reach sexual maturity from 3 years of age and mostly mature at 5–6 years of age.

IV. Growth of body length

Postnatal growth was well shown by Tikhomirov (1971) in *P. v. largha* from the Bering Sea and Bigg (1969) in *P. v. richardi* from the southern coast of Vancouver Island and Alaska. In addition, Belkin (1964) and Belkin *et al.* (1969) reported about *P. kurilensis*, in the Kurile Islands.

Phoca vitulina largha

In this chapter, data collected from areas I, II, III were summed up to describe the postnatal growth of body length. The number of specimens used here was 150 in males and 176 in females. The growth curves are shown in figure 8, which were drown by eye, but as for the growth curve of females, the following growth formula was approximately applied by using Walford's graphic methods:

$$O<t<2 \qquad l_t=132(1-e^{-0.88(t+0.50)}),$$
$$t\geqq 2 \qquad l_t=161(1-e^{-0.26(t+4.0)}) \quad (t,\ \text{ages};\ l_t,\ \text{length}).$$

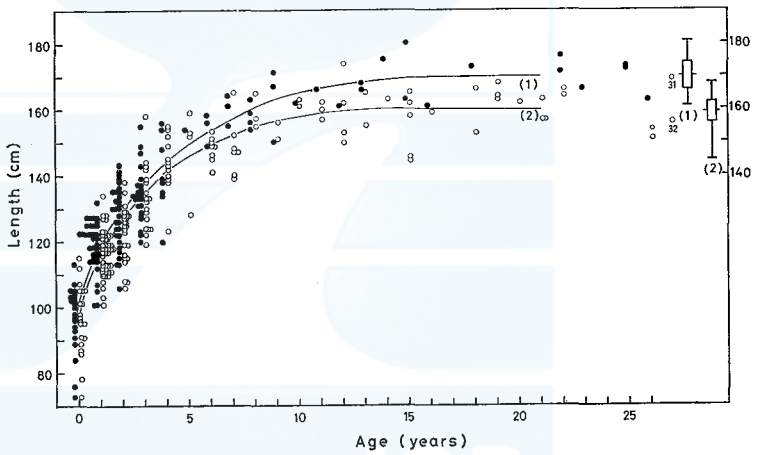

Fig. 8. Postnatal growth in body length of *P. v. largha*, males (1) and females (2). Total number is 150 in males and 176 in females. Vertical line, range– box, standard error ; horizontal line in box, mean.

Concerning the final growth length, mean body length was obtained from the seals over 15 years of age, since the formula did not fit accurately with plots from about 15 years of age. In this figure, the mean length at 0 years age was 97 cm in males and 96 cm in females, which were calculated from the length of pups collected about one month after birth during April and May. Since birth length was presumed to be about 85 cm in former chapter, it was assumed that pups grow more than 10 cm during the first month after birth. The mean length at 1 years of age was 119 cm in males and 117 cm in females, and pups grow 34 cm for males and about 32 cm for females during the first year. About 35 % of the body length growth during the first year seemed to be attained in the first month after birth. The growth rate in

the first year observed in the present study is the same as Bigg (1969) showed in *P. v. richardi*, but little lower than *P. v. largha* shown by Tikhomirov (1971).

From birth to 5 years of age, both sexes grow at about similar rate. The growth continue until 14–15 years of age in males and 10–11 years of age in females. Finally attained body length of the seals over 15 years of age was 169.9±4.0 cm for males and 159.0±3.1 cm for females, and the finally attained body length of females was 94.1 % of males.

According to Tikhomirov (1971), *P. v. largha* continues growing until 9 years of age in males and 8 years of age in females, and physically matured body length was 168 cm in males and 162 cm in females. Sexual mature body length of females is 96.4 % of males. Bigg (1969) suggested that *P. v. richardi* continued growing until 9–10 years of age in males and 5 years of age in females. He also reported that fully grown body length was 161.1 cm and 147.7 cm in males and females respectively, and sexual mature body length of females is 92.3 % of males.

Concerning the longevity, the oldest seal was 26 years of age in males and 32 years of age in females, and it seemed that females live longer than males. In another study, it was found 29 years of age and 35 years of age in male and female respectively for *P. v. largha* (Tikhomirov, 1971).

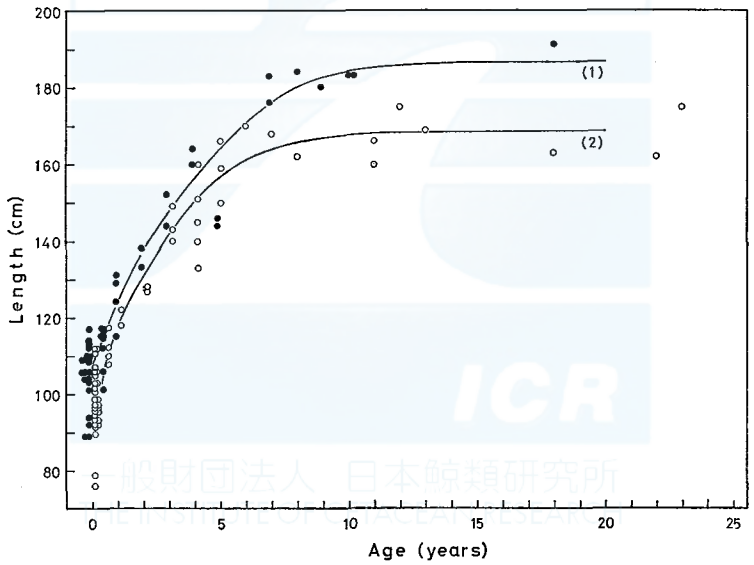

Fig. 9. Postnatal growth in body length of *P. kurilensis*, males (1) and females (2). Total number is 49 in males and 57 in females.

Phoca kurilensis

Most of these data were collected from area IV, and a few from the southern part of area III. The number of specimens used here was 49 males and 57 females, which were collected from area IV. The extent of growth is shown in figure 9, which was drawn by eye. In this figure, the mean length at 0 years of age was 109.7 cm in

males and 108.7 cm in females, which was based on the pups collected about a month after birth during May and June. Since the birth length of this species was 98.2 cm as shown former chapter, new born pups grow about 10–11 cm in length during the first month. Concerning specimens over 2 years of age, we are short of data to describe precisely the growth aspect, but we can discuss the general tendency. Males and females grow at about the same rate until 5–6 years of age, and from this age onward dimorphism in body length seems to become clear. By 9–10 years of age, males attain nearly the final growth length, and females attain such length by 7–8 years of age. The maximum body length observed was 191 cm in males and 175 cm in females. Final growth length is assumed to be about 186 cm in males and 169 cm in females, and the final growth length of females was 90.9% of males. This ratio was smaller than that of *P. v. largha*, and *P. v. richardi* according to calculation based on Bigg (1969). Belkin *et al* (1969) suggested that the mean length of sexual mature males was 174 cm and 160 cm in females, and the maximum was 181 cm and 180 cm in males and females respectively. They (1969) also recognized the clear dimorphism in body length in immature seals, describing the mean length of 3 males and 7 females as 139.6 cm and 126.4 cm respectively.

Concerning longevity, it is difficult to discuss with these scanty data.

DISCUSSION

In the present study, we obtained some new facts on prenatal and postnatal growth in *P. v. largha* and *P. kurilensis*.

It was appeared that mating season and parturition season of *P. kurilensis* occurred 2 months later than that of *P. v. largha*, and the birth length of *P. kurilensis* is larger than that of *P. v. largha*. After the parturition, pups of pagophilic *P. v. largha* bears white coat for 2–3 weeks and live on ice floes without swimming. Weaning occurs simultaneously with moulting of white coat 2–3 weeks after birth. Concerning the weaning, it is exactly unknown whether weaning occurs suddenly or gradually. If weaning occurred suddenly, pups would suddenly have the completely independent life and would not have the swimming life with their mothers, furthermore they would not learn the feeding from their mothers. Table 3 may show that departure from the mother occurs quickly as moulting begins to occur. So that, pups may be left alone on ice floes and have the completely independent life. It is also unknown whether pups have swimming life soon after weaning or some time after weaning. If they remained on ice floes, they would be carried by ice floes and their distribution would spread. On the other hand, pups of pagophobic *P. kurilensis* do not have the white coat when they were born. They have the swimming life with their mothers soon after birth, and their suckling is chiefly performed in the water. Weaning occurs about 4 weeks after birth. This period is longer than that of *P. v. largha*. It is also exactly unknown whether weaning occurs suddenly or gradually. However, observation that pups were found with their mothers without showing the suckling behavior may indicate that weaning occurs gradually in this species, and pups may learn the feeding from their mothers.

Concerning the early stage of life, we also studied the thickness of blubber. In *P. v. largha*, pups on ice floes have the thicker blubber and pups in the water have the thinner blubber. This result seems to indicate that change in blubber thickness is due to change in nutritional condition of pups during suckling and weaning period. the other hand, pups of *P. kurilensis* had the thinner blubber as compared with *P. v. largha*. The difference in blubber thickness between two species seems to be related with the difference in nutritional condition of life in early stage described above.

Concerning the growth of body length, sexual dimorphism in body length was observed clearly in *P. kurilensis* as Belkin *et al.* (1969) reported.

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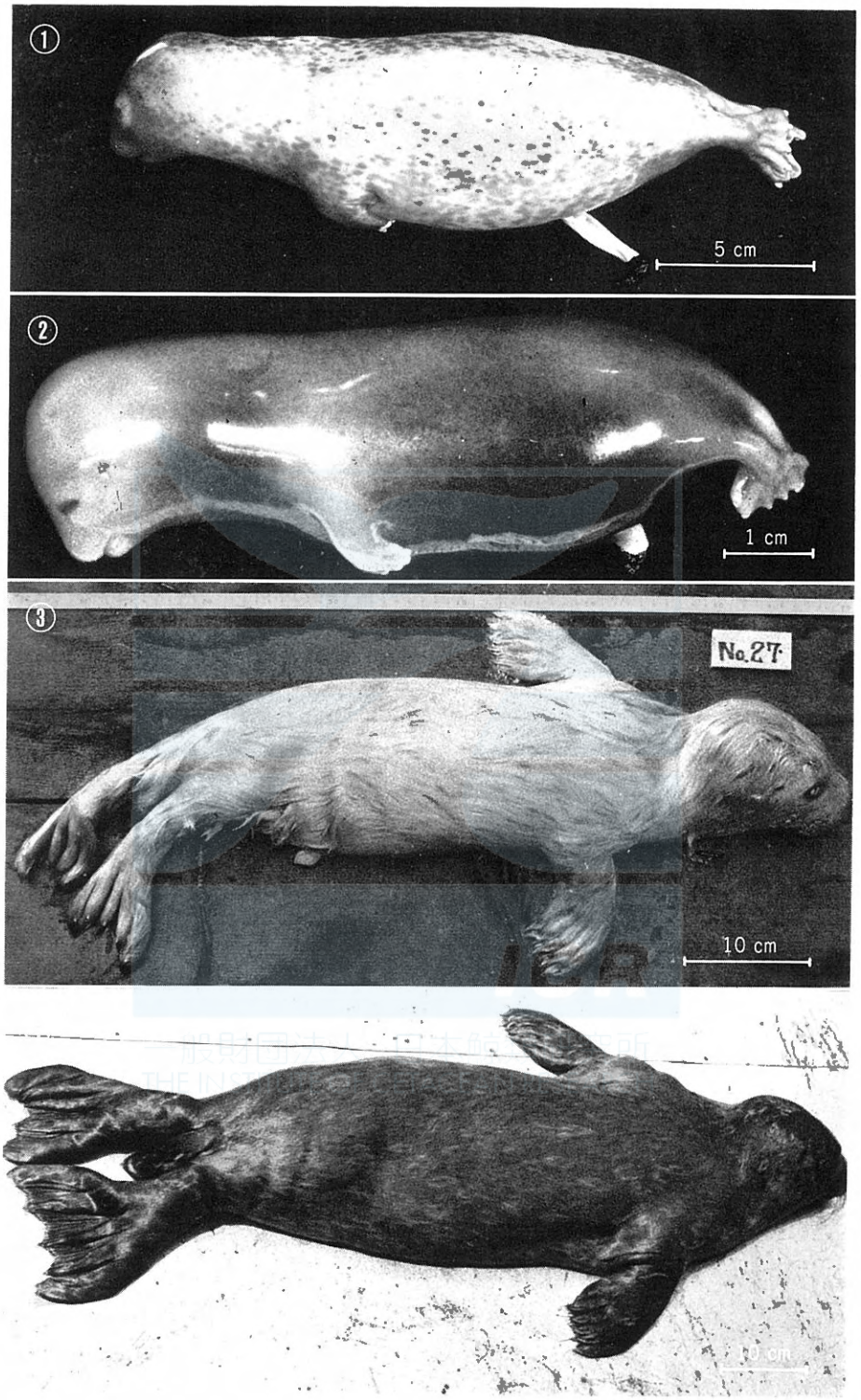
EXPLANATION OF PLATE I

Fig. 1. A female embryo of *P. v. largha*, 20 cm in length, about 5 months before birth (collected on 14th of October).

Fig. 2. A male embryo of *P. kurilensis*, 9.5 cm in length, about 7 months before birth (collected on 14th of October).

Fig. 3. A male white coat embryo of *P. v. largha*, 58.5 cm in length, about 2 months before birth (collected on 19th of January).

Fig. 4. A new born male pup of *P. kurilensis* with umbilical cord which beared grey lanugo coat, 89 cm in length (collected on 20th of May).


①
5 cm
②
1 cm
③
No.27
10 cm