SOME PHYSIOLOGICAL ASPECTS IN BODY WEIGHT IN RABBITS

By

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Many investigations have treated prenatal and postnatal growth and mean weights at different ages and in different breeds, and they were analysed and studied statistically, genetically, physiologically, chemically and embryologically (1–10, 12–16, 18, 19, 22–25, 27–29, 31). However, few investigations examined the changes in body weight during pregnancy and at parturition (30, 32).

Generally, weighing is of much importance to all animal breeders. It gives an excellent indication of their stock's progress and of impending troubles. The body weight of a normal rabbit is chiefly influenced by nutritional conditions. And the nutritional condition is influenced by rearing conditions according to seasons. In the present study, body weights in the rabbits, reared in the Experimental Farm of Hokkaido University, were recorded to serve in practical rearing of rabbits in Hokkaido.

MATERIALS AND METHODS

The animals included in the present study belong to the Japanese native white breed, which has a mature weight of about 3.5 kg. The number of adult animals used in the present study was 68, including 33 pregnant rabbits. Their young were used also.

The adult male and non-pregnant female animals were weighed individually on every 5th day of each month from June, 1962 to September, 1963. The pregnant rabbits were weighed daily during pregnancy and for about one month after delivery. Their litters were, also, weighed daily for about two months after birth. The weights were recorded between 9 and 9 : 30 a.m. every morning before feeding. Two spring balances with a suitable box, into which rabbits can be placed, were used for weighing young and adult rabbits. The young were weaned on the 40th day after birth.

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The general feeding plan was as follows: Fresh ladino clover, about 1.2–1.5 kg per adult per day, was given from the latter part of May to the middle part of October. During rainy weather, this was changed to oats, about 120–150 g. From the latter part of October to the first part of December, about 120–150 g of oats, about 1.0–1.2 kg of fodder beet and about 1.0–1.5 kg of cabbage were given alternately every three days. From the middle of December to the middle of May, about 1.0–1.2 kg of fodder beet and

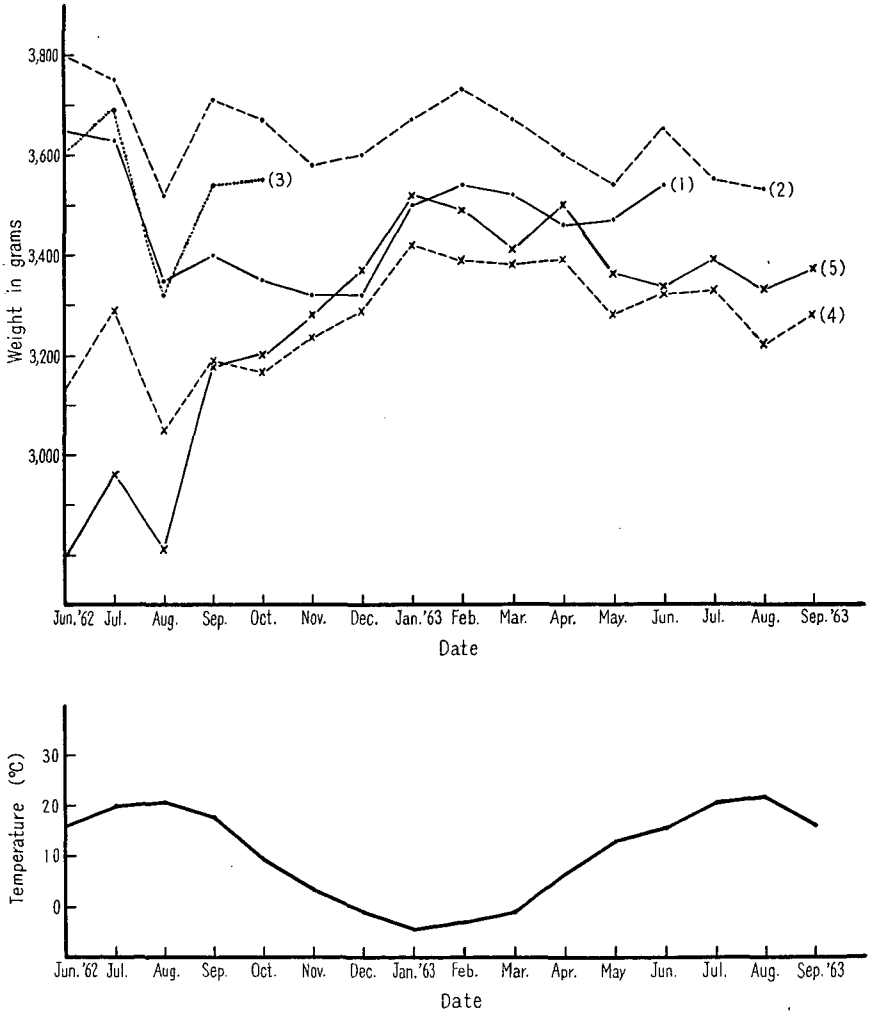

Fig. 1. Seasonal changes in the body weight of adult rabbits and average temperature in Sapporo district through the year.
(1), (2), (3), (4) and (5) show the groups in Table 1.

about 120–150 g of oats were given alternately every two days, and a sufficient amount of hay of orchard grass every day. In addition, the pregnant rabbits and young were given some okara, which is by-product of been curd.

Each adult rabbit was kept separately in its own cage, and the feedstuff was given after weighing.

RESULTS

1. Seasonal variations in the body weight

The adult animals used in this section are summarized in Table 1 and the results of their weighing are shown in Figure 1.

TABLE 1. The animals which were used in weighing through the year

Group	Sex	Number of animals	Month of birth	Age at beginning of weighing	Average body weight (g)
*1	Female	5	July and August, 1957	About 5 years old	3,466
2	Female	3	July, 1958	About 4 years old	3,644
3	Male	8	May and June, 1959	About 3 years old	3,539
4	Male	7	July, 1960	About 2 years old	3,273
5	Male	10	September, 1961	About 9 months old	3,224

The body weight was 3,349 g in average of all groups. There was effective variations through the year and all groups showed similar tendency in their weights. August was the highest in temperature and the weights lowered during this month. After that they gradually increased until January or February, and then, decreased until May. The fact is that there were three peaks in weight according to seasonal divisions as follows: September to October, January to March, and June to July.

2. Changes in body weight during pregnancy

Fifty-five females were mated twice and thirty-three of them were de-

TABLE 2. Pregnant rabbits which used in this study

Group	Date of mating	Number of mated females	Number of pregnant females	Number of non-pregnant females	Average litter size	Average body weight on the first day of pregnancy (g)
I	June 5, 1962	17	10	7	5.7	3,374
II	Sept. 26, 1962	18	6	12	6.1	3,413
III	April 1, 1963	10	8	2	7.0	3,627
IV	July 29, 1963	10	9	1	6.2	3,332

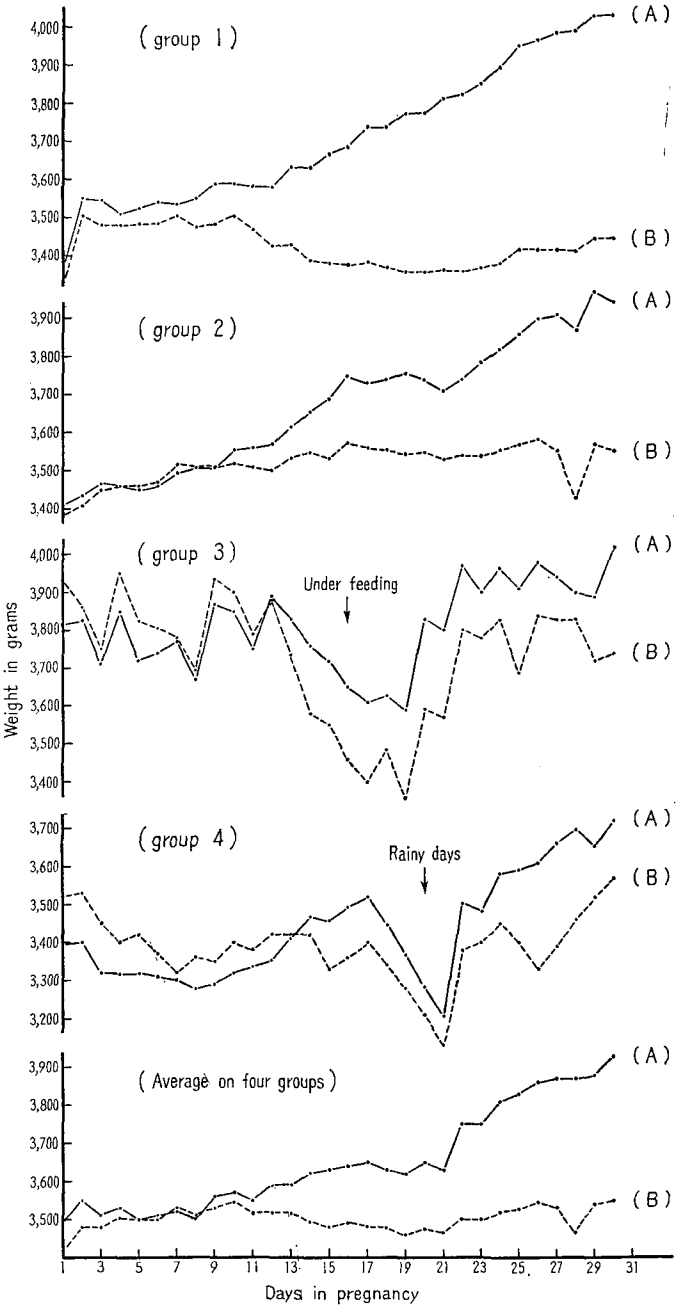

Fig. 2. Changes in body weight during pregnancy.
(A)···pregnant rabbit, (B)···non-pregnant rabbit.

livered. The date of matings and number of females are listed in Table 2.

In groups I and II, rates of pregnancy were very low. Then, 10 mg of progesterone was administered intramuscularly in each rabbit 10 hours after mating to improve the rate of pregnancy in groups III and IV. The changes in body weight of pregnant rabbits are presented in Figure 2. The weights in non-pregnant rabbits were also traced to compare with the pregnant ones, because environmental changes might be expected by the weighing of the non-pregnant rabbit. The day following mating was counted as the first day of pregnancy in the present study.

Groups I and II showed normal developmental curves in weight. Unfortunately, the developmental curves in groups III and IV were irregular, because of some accidental underfeedings. In groups III, fodder beet was not given for about one week in the middle stage of pregnancy. In group IV, rainy days continued for four days in the middle stage of gestation and fresh grass was not given during these days.

Generally, the gestation period is divided into three stages as follows: From the first to the 8th day *post coitum* (*p. c.*), from 9 to about 24 days *p. c.* and from about 25 days *p. c.* to labor. In the first stage, the change in the body weight was similar to that in non-pregnant rabbits and there was no difference between them. During the second stage, the weight in pregnant rabbits increased and the difference between pregnant and non-pregnant rabbits became clear and larger as pregnancy progressed. Especially, in the later part of this stage, the gain of body weight seemed to be marked. In the third stage, the rate of increase in weight was somewhat retarded.

Three average body weights from the first to the 6th day *p. c.* (A), from 12 to 19 days *p. c.* (B), and from 27 to 32 days *p. c.* (C), were made and they were compared each other. The results in each individual are shown in Table 3.

It was estimated from groups I and II that the average gain of weight during pregnancy was near 15%, ranging from 7% to 20%. In groups III and IV, changes in weight showed the effects of underfeeding and rates of gains were 4.5% and 10.5% in average. There were significant differences in C to A ratio at 5% level and in B to A ratio at 1% level among the four groups. However, there were no differences statistically in C to B ratio among them. This means that the developmental rates in body weights were similar among the four groups in the later half of pregnancy, in spite of the temporary decreases in weight during pregnancy in groups III and IV. Generally, it seems that the gain of body weight is about 5% in the middle stage of pregnancy and the remaining 10% increase appears from the middle stage to

TABLE 3. Average body weights in three stages during pregnancy

Group	Average body weight (g)			Ratio (%)		
	1-6 days *p. c.* (A)	12-19 days *p. c.* (B)	27-32 days *p. c.* (C)	C/A	B/A	C/B
I	4,556	4,804	5,146	112.9	105.4	107.1
	3,668	3,751	4,100	111.8	102.3	109.3
	3,953	4,058	4,245	107.4	102.7	104.6
	3,543	3,584	3,950	111.5	101.2	110.2
	3,160	3,384	3,815	120.7	107.1	112.7
	3,890	3,992	4,304	110.6	102.6	107.8
	2,945	3,191	3,464	117.6	108.4	108.6
	3,150	3,292	3,685	117.0	104.5	111.9
	2,840	3,052	3,397	119.6	107.5	111.3
	3,363	3,644	4,010	119.2	108.4	110.0
Average	3,507	3,670	4,038	114.8	105.0	109.4
II	3,503	3,664	3,985	113.8	104.6	108.8
	3,496	3,715	3,938	112.6	106.3	106.0
	3,216	3,495	3,750	116.6	108.7	107.3
	3,618	3,841	4,074	112.6	106.2	106.1
	3,326	3,504	3,707	114.5	105.4	105.8
	3,531	3,854	4,070	115.3	109.1	105.6
Average	3,448	3,679	3,934	113.7	106.7	106.6
III	3,560	3,555	3,448	96.9	99.8	97.0
	3,751	3,671	3,972	105.9	97.9	108.2
	3,605	3,558	3,802	105.5	98.7	106.9
	3,181	3,342	3,800	119.5	105.1	113.7
	3,971	3,991	4,247	107.0	100.5	106.4
	3,693	3,534	3,716	100.6	95.7	105.1
	4,223	4,111	4,207	99.6	97.3	102.3
	4,236	4,040	4,295	101.4	95.4	106.3
Average	3,779	3,725	3,926	104.5	98.8	105.4
IV	2,973	3,174	3,482	117.1	106.8	109.7
	4,346	4,348	4,437	102.1	100.0	102.0
	3,110	3,231	3,276	105.3	103.9	101.4
	3,288	3,361	3,710	112.8	102.2	110.4
	3,383	3,458	3,647	107.8	102.2	105.5
	3,296	3,434	3,635	110.3	104.2	105.9
	3,363	3,588	3,917	116.5	106.7	109.2
	3,158	3,230	3,532	111.8	102.3	109.3
	3,181	3,218	3,515	110.5	101.2	109.2
Average	3,344	3,449	3,663	110.5	103.3	106.9

the end of pregnancy. These ratios in groups I and II were arranged in litter size, and their results are shown in Table 4.

TABLE 4. The ratios among A, B and C in groups I and II, and litter size.

Litter size	Ratio (%)		
	C/A	B/A	C/B
2	107	103	105
3	113	105	107
4	113	106	106
	111	105	106
	(112.0)	(105.5)	(106.0)
5	111	101	110
	111	103	108
	120	107	111
	113	106	106
	(113.7)	(104.2)	(108.7)
6	112	102	109
	117	105	112
	114	105	109
	(114.3)	(104.0)	(110.0)
7	121	107	113
8	118	108	109
	117	109	107
	(117.5)	(108.5)	(108.0)
10	119	108	110
	115	109	106
	(117.0)	(108.5)	(108.0)

( ) ···Average

Table 4 indicates that the rate of the gain of weight during pregnancy become large gradually in accordance with increase in litter size. For convenience in analysing the figures in table 4, they were classified into three groups which were 2–4, 5–6 and 7–10 in litter size. The ratios of C to A and B to A showed significant differences among these three groups at 5%

and 1% levels, respectively. There was no significant difference in the ratio of C to B among them.

The length of the gestation period has been the subject for several examinations. However, there was no examination made to determine the relationship between length of gestation period and body weight. In the present study, grouping of animals was performed in 30, 31 and 32 days according to length of gestation. The results are summarized in Figure 3. Many

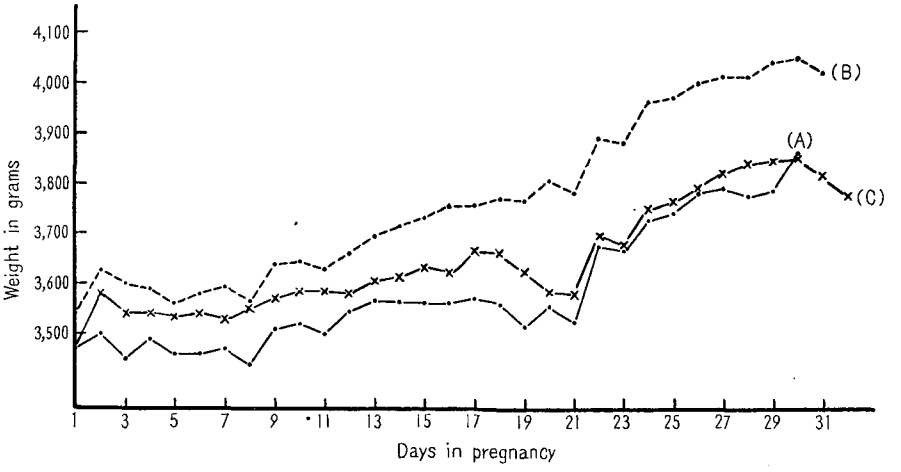

Fig. 3. Changes in body weight during pregnancy and gestation periods.
(A)···Does having a 30 day gestation period (average on 18 animals),
(B)···31 days (average on 12 animals), and (C)···32 days (average on 3 animals).

animals (14 among 18 does) which had a gestation period of 30 days, reached their heaviest weights at the end of pregnancy. In the remaining four does, two animals reached their heaviest weight on the 28th day, one on the 27th day and another on the 26th day of pregnancy. However, of twelve animals which showed a 31 day gestation period, eight reached their heaviest weight on the 30th day, two on the 29th, and two does showed their heaviest weight on the 31st day, after which some decrease was noted. In three rabbits which had a gestation period of 32 days, as an average more decrease was recognizable on the 32nd day. These three rabbits reached their highest weights on the 29th, 30th and 31st day, respectively.

3. Changes in body weight at delivery

As the does were weighed every morning, the interval between last weighing before delivery and the weighing after delivery varied between 0 hour and 24 hours. The weight changes are shown in Table 5 and Figure 4.

TABLE 5. Ratio of decrease in body weight at delivery and litter size

Litter size	Body weight			Ratio of decrease		Heaviest body weight before delivery (G) (kg)	Decrease in body weight (G−E) =(F′) (kg)	Ratio		Duration of pregnancy (day)
	Before delivery (D) (kg)	After delivery (E) (kg)	Decrease (D−E) =(F) (kg)	F/D (%)	Average (%)			F′/D (%)	Average (%)	
1	3.23	3.10	0.13	4.02	4.02	3.33	0.23	6.90	6.90	32
2	4.15	4.00	0.15	3.61	3.61	4.30	0.30	6.97	6.97	32
3	5.17	4.85	0.32	6.18	6.18	5.18	0.33	6.37	6.37	31
4	3.83	3.45	0.38	9.92	8.05	3.83	0.38	9.92	9.76	30
	4.10	3.75	0.35	8.53		4.12	0.37	8.98		31
	4.20	3.96	0.24	5.71		4.42	0.46	10.40		30
5	3.42	3.00	0.42	12.28	8.77	3.42	0.42	12.28	10.11	30
	4.30	3.96	0.34	7.90		4.32	0.36	8.33		31
	3.90	3.54	0.36	9.23		3.97	0.43	10.83		31
	4.42	4.00	0.42	9.50		4.52	0.52	11.50		30
	3.55	3.24	0.31	8.73		3.57	0.33	9.24		30
	3.92	3.58	0.34	8.67		3.98	0.40	10.05		32
	3.72	3.53	0.19	5.10		3.86	0.33	8.54		31
6	3.72	3.32	0.40	10.75	9.33	3.72	0.40	10.75	10.53	30
	4.05	3.54	0.51	12.59		4.05	0.51	12.59		30
	4.12	3.82	0.30	7.28		4.14	0.32	7.72		31
	3.92	3.60	0.32	8.16		4.08	0.48	11.76		31
	3.75	3.55	0.20	5.33		3.88	0.33	8.50		31
	3.78	3.32	0.45	11.90		3.78	0.45	11.90		31
7	3.86	3.42	0.44	11.39	11.20	3.86	0.44	11.39	11.37	30
	3.70	3.30	0.40	10.81		3.70	0.40	10.81		30
	3.67	3.26	0.41	11.17		3.68	0.42	11.41		30
	3.93	3.48	0.45	11.45		3.95	0.47	11.89		30
8	3.88	3.42	0.46	11.85	12.48	3.88	0.46	11.85	12.53	30
	3.48	3.04	0.44	12.64		3.49	0.45	12.89		31
	3.50	3.10	0.40	11.42		3.50	0.40	11.42		30
	4.32	3.76	0.56	12.96		4.32	0.56	12.96		30
	4.42	3.80	0.62	14.02		4.42	0.62	14.02		30
	3.57	3.14	0.43	12.04		3.57	0.43	12.04		
10	4.05	3.54	0.51	12.59	11.37	4.05	0.51	12.59	14.00	31
	3.95	3.64	0.31	7.84		4.32	0.68	15.74		31
	3.65	3.15	0.50	13.69		3.65	0.50	13.69		30
11	3.90	3.32	0.58	14.87	14.87	3.90	0.58	14.87	14.87	30
Average	3.913	3.529	0.383	9.82	—	3.962	0.432	10.94	—	30

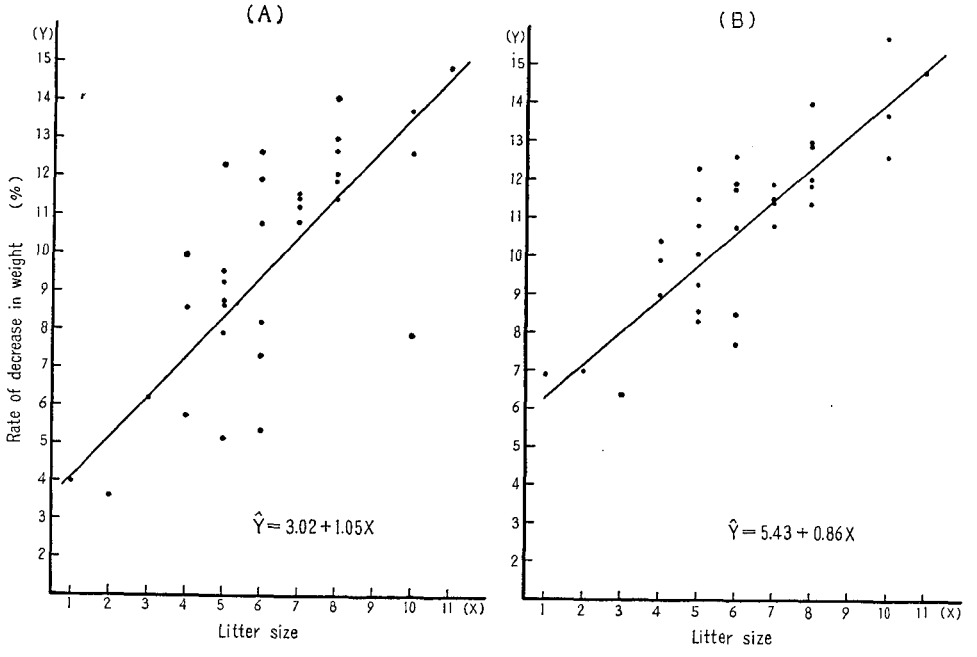

Fig. 4. Rate of decrease in body weight of doe at delivery and litter size. (A)···Ratio of decrease in body weight after delivery to the body weight before delivery, (B)···Ratio of decrease in weight from the heaviest body weight which was reached during pregnancy, to the body weight before delivery.

In general, the fall in the body weight at delivery was proportional to the litter size. In groups of 5, 6, 7 and 8 in litter sizes, their average body weights were 3.89 kg, 3.89 kg, 3.79 kg and 3.86 kg before delivery, respectively. There was no significant difference among them. However, the falls in weight among 4 groups were significant at 5% level. The falls increased gradually in accordance with increase in litter size. This was clearly shown in the ratio of decrease of weight at delivery to weight before delivery. Similar tendency was found in comparison between the heaviest body weight during pregnancy and the weights after delivery. In this case, there was significant difference at 1% level, although there was no significant difference in the heaviest weights among the four groups.

Linear relationships were found between litter sizes and rates of decrease in body weight in both conditions. Their regression formulae were

$$\hat{Y} = 3.02 + 1.05X \text{ and}$$

$$\hat{Y} = 5.43 + 0.86X, \text{ respectively.}$$

The difference between these may be derived from the fact that the does which had small litter sizes had a tendency to have longer gestation periods than those having large litters.

4. Birth weight of the young

The birth weight of the young in the present study did not represent the exact weight at delivery, because the weighing was done only in the mornings. However, their data will be useful for some analyses. The young of three litters were not able to be weighed, because they were born dead. The average weight on 198 young of 30 litters was 57.1 g, ranging from 32 g to 90 g. These young were produced in the four different seasons presented in Table 2. Average weights in each group were 63.6 g, 59.7 g, 51.0 g, and 55.3 g, respectively. These weights were significant at 1% level, although there was no significant difference in litter sizes in each group. In groups I and II, the development in body weight seemed to be normal. The does which belonged in groups III and IV were clearly in underfeeding conditions. These underfeed-

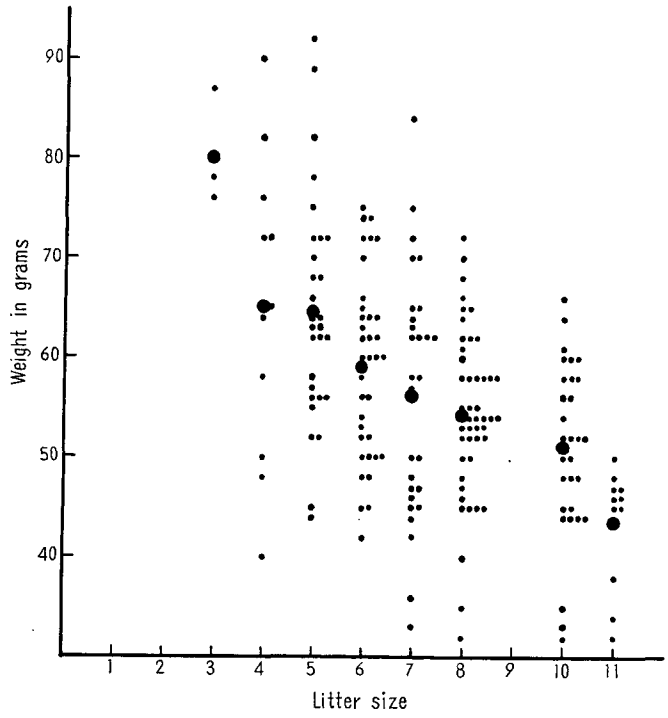

Fig. 5. Weight of young at delivery and litter size.
●···average weight in each litter size.

ings affected the weights of the young, also.

The relationship between birth weight and litter size is presented in Figure 5. The weights of the young became lighter in proportion to increase in litter size. However, total litter weight increased proportionally to the litter size (Figure 6). Their relationships were both linear.

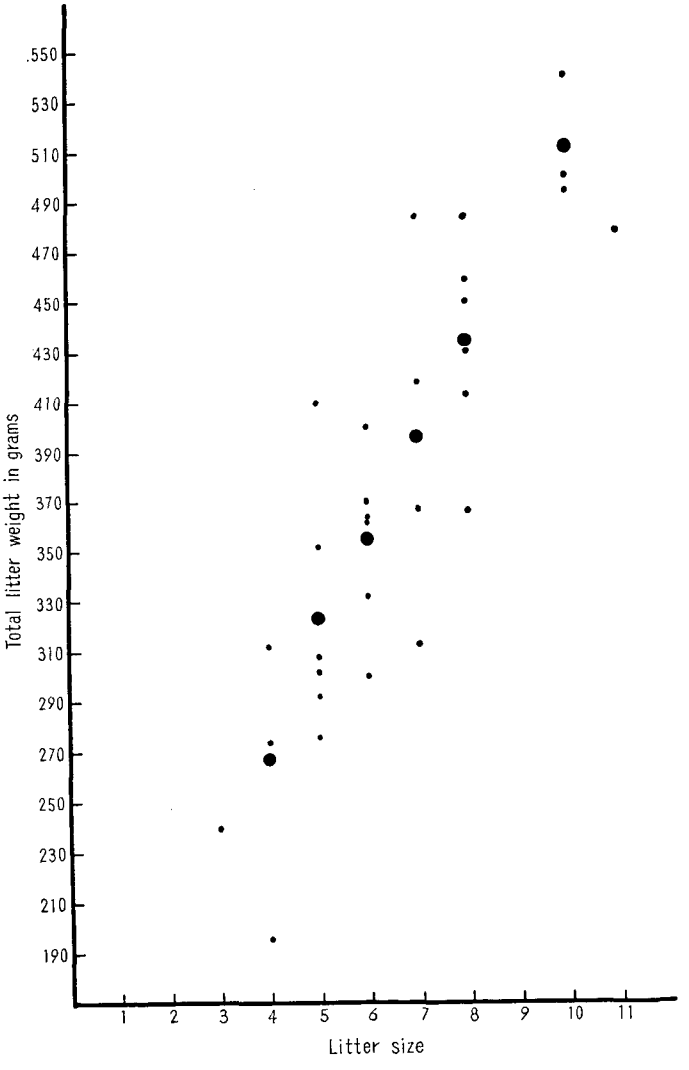

Fig. 6. Total litter weight at delivery and litter size.
●···average weight in each litter size.

In grouping into the following three ranges: Under 3,300 g, 3,300 g to 3,600 g, and over 3,600 g in weight of the does, there seemed to be no correlation between body weight of the does and that of their young. Average weights of the young in these three groups were about 58.9 g, 52.6 g and 58.6 g, respectively.

The effect of the age of the doe to the weight of her young was examined. The data summarized is in Table 6. In the present study, the data was pooled and analysed, although young were produced in four different seasons, ranging from June, 1962 to August, 1963. The does were divided into 4 groups by their ages. There was no significant difference among these four groups in litter size. It seemed that the weights of young increased with advanced age of the mother. Difference among these four groups was significant at 1% level.

TABLE 6. Ages of the does and the average birth weight of their young in each litter

	Year in which does were born			
	1962 (g)	1961 (g)	1960 (g)	1959 (g)
	60.4	68.5	60.5	61.6
	50.0	55.3	69.1	60.6
		70.4	45.7	80.3
		52.4	58.4	
		59.7	56.0	
		44.7	60.5	
		43.4	82.0	
		51.6	55.2	
		49.0	78.0	
		53.7		
		50.1		
		61.6		
		66.6		
		57.3		
		54.0		
		49.4		
Average	53.5	54.2	61.3	65.0

In comparison between 30 day and 31 day in gestation periods, the average weights of young were 55.0 g in the former and 60.4 g in the latter.

There was significant difference between them at 1% level, although there was no significant difference in their litter sizes.

5. Changes in body weight of the doe after delivery

The does were weighed every morning for about one month after delivery. The results are shown in Figure 7. In grouping of four different seasons, the changes in the average weights varied quite a bit in each group. Generally, the weight was gradually decreased until about 30 days after delivery. During the first 3 days after delivery, weights showed some increases in two groups, and in the other groups the weights stayed at the same levels. In group I, the does were affected by a typhoon for about 10 days beginning on the twentieth day after delivery, and their decreases in weight were marked in this period.

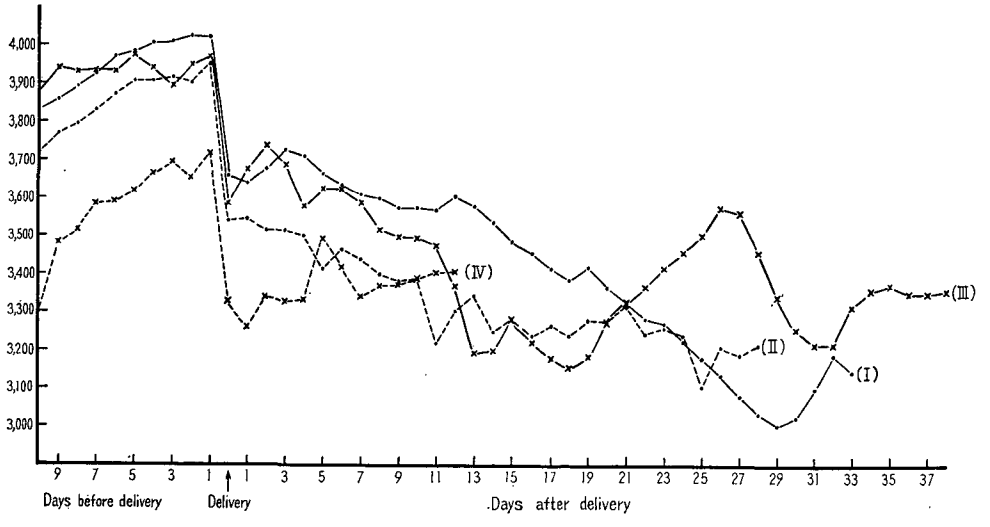

Fig. 7. Changes of the body weights of does after delivery in four groups which bred in different seasons.
I···Does bred in June 5, 1962. II···Does bred in August 26, 1962.
III···Does bred in April 1, 1963. IV···Does bred in July 29, 1963.

The changes in body weight in monthly measurements after delivery are demonstrated in Figure 8. The weights at delivery were heavier than those on the first day of pregnancy in groups I and II. However, in groups III and IV, they showed opposite results. This was the result of underfeeding during pregnancy. One month after delivery, the weights were the lowest. The weight of the does was recovered within two months after delivery, ex-

cept in group III. After that month it increased gradually.

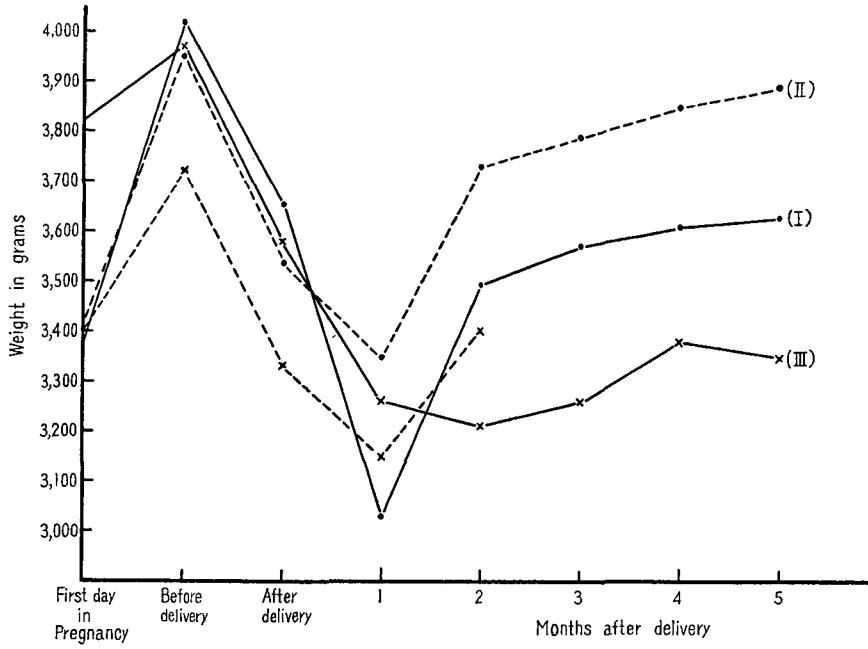

Fig. 8. Changes in body weights in monthly measurement after delivery. Groups I, II, III, and IV are same in Figure 7.

6. Growth in rabbits

Daily weighings of young which were produced in the four different seasons were recorded from birth to 67 days. A growth curve during this period is shown in Figure 9. This curve was made from pooled data of 30 litters in the four groups. From the curve it appears that the growth from birth up to 20 days of age follows a straight line, and that the growth during the period from 20 days to 57 days of age is more rapid than before and follows another straight line. The young which were produced by does of group I, were weighed monthly from birth to 16 months of age. The weighing was started with 50 young of 8 litters and ended with 11 young at 16 months of age because of death, culling and use for other experiments. Their average weights are traced in Figure 10. From birth until 7 months of age the growth was marked and, then, it became slow, although the weights were increased gradually to 16 months of age. More long term observations were performed and the results are shown in Figure 11. It was recognized from this figure that the growth rate is marked until about 8 months of age and

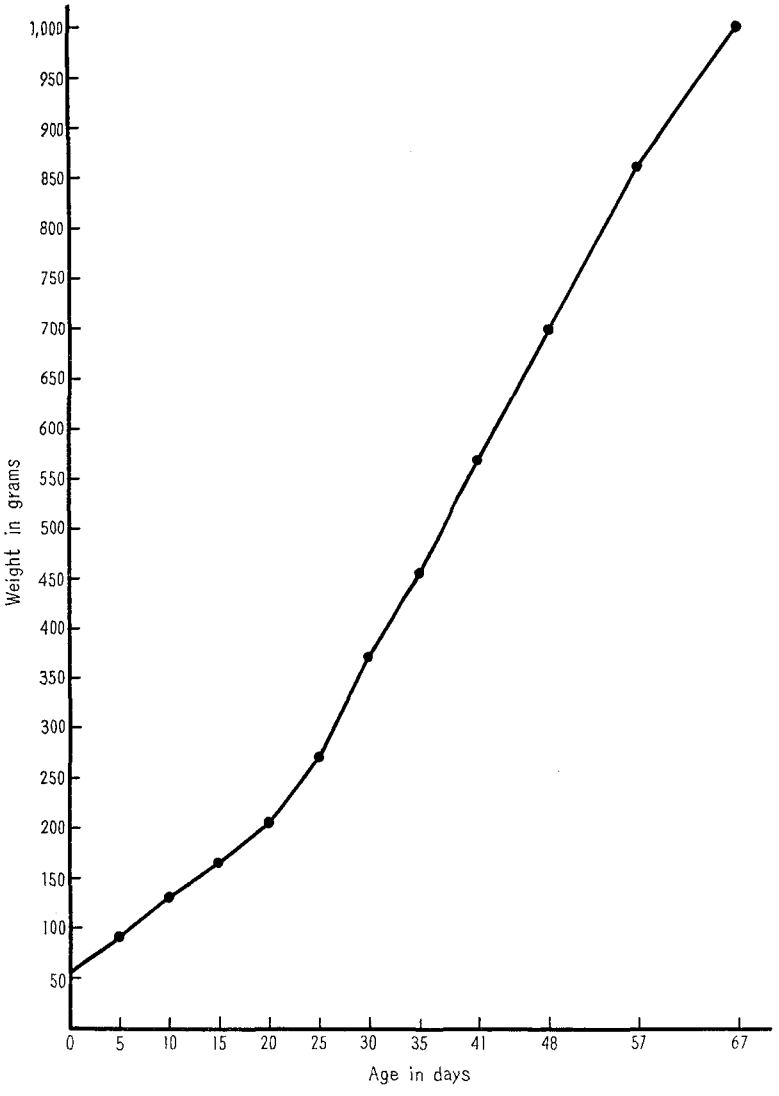

Fig. 9. Growth curve of rabbit young (0–67 days), made from pooled data of four groups.

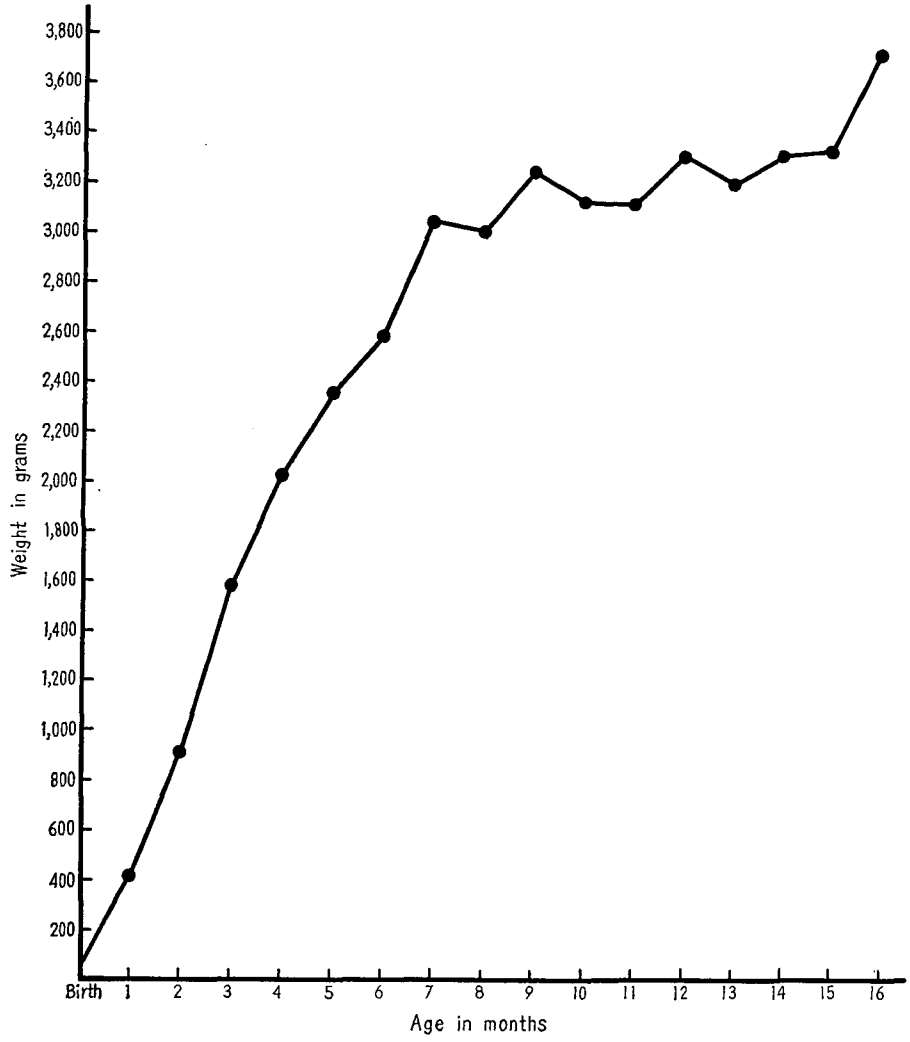

Fig. 10. Growth curve of the young (0–16 months), which produced by does of group I.

that the rate is retarded after that to 16 months of age. At 16 or 18 months of age the body wight reached the heaviest level and the level was held until 3 years of age.

In comparison the weights between males and females, which belonged to group I, male young was 1,988 g on average of 15 and female young was 2,173 g on average of 13 at 128 days of age. The difference was significant

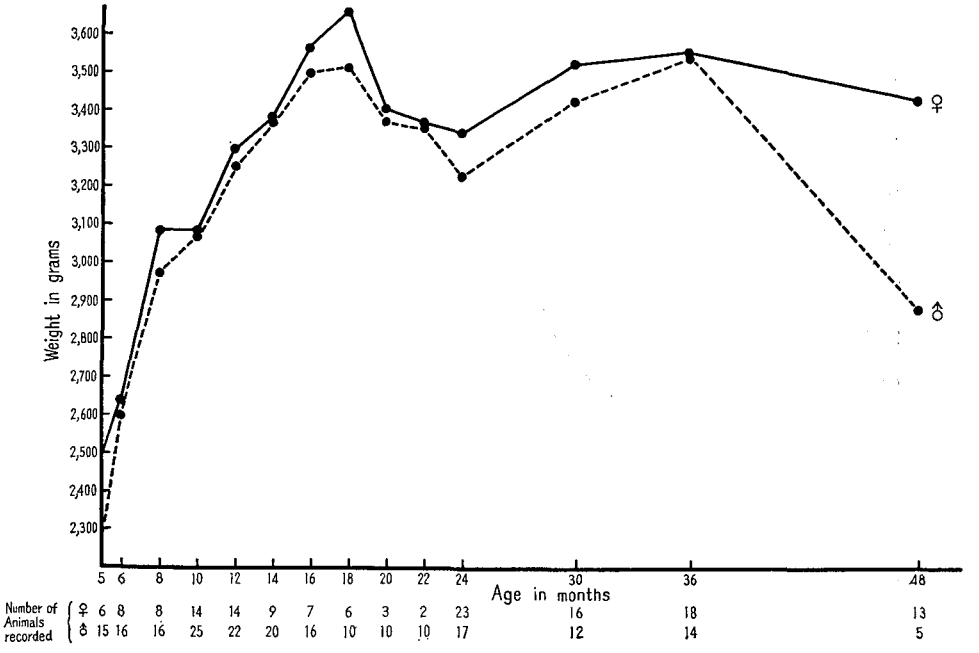

Fig. 11. Growth curves resulting from the data of rabbits in various ages during June, 1962 to September, 1963.

at 5% level. And the average weights at 153 days of age were 2,284 g in male and 2,490 g in female. The difference between them was significant at 1% level.

DISCUSSION

It is well known that the body weight of rabbits is very changeable day-by-day. HABE and TACHIKAWA (11) stated that it is better to take an average on three days running at the same times in the middle of the interval between feeding times, than to take only one measurement. However, in the present study, such consideration was of no use, because the changes in the weight were required and continuous recordings were done.

MIMURA (21) described body temperature and respiration number in Angora and New Zealand white breeds and reported that those factors increased remarkably under severe heat season conditions; and that clipping of Angora rabbits during severely hot weather is recommended, because after clipping the body temperature and respiration number remarkably decrease and gains in the body weight increase effectively and continue for more than 15 days.

The present study showed that seasonal variations exist through the year and some fall in body weight occurs in August when the temperature is highest, and the rabbits are heaviest in February when the temperature is the lowest of the year. It is natural that body weights increase from autumn to winter. After February and until May the weight is decreased. The reason is not clear, but it may be that the rabbits are tired of their feed stuffs. Generally, June to July and September to October are nice seasons for all animals, and the effects of the season are reflected in the body weights to some degree.

By text-book of KOROMOGAWA (20), gain in the body weight is not so large during the period from copulation to 2 weeks later in pregnancy; then the body weight increases gradually reaching the heaviest by the 4th week, followed by some decrease just before delivery. The gain in weight is about 12–13%. YŌDA (32) stated also that it is possible to foresee the day of parturition because parturition occurs within 2 or 3 days after the decrease in weight. Although this was true in some cases in the present study, many rabbits continued to increase until 30 days *p. c.* However, many does which had 31 and 32 days of gestation showed some decrease in weight on the 31st and 32nd day. It may be concluded, then, that the phenomena of decrease in body weight before delivery is related to the gestation length.

In general, the body weight of the pregnant rabbit shows no change during the time from copulation to about 8 days *p. c.* After 9 days *p. c.* the gain in body weight becomes large, and after about 25 days *p. c.* the rate of increase is retarded. Generally speaking, the attachment of the fertilized eggs occurs by the 8th or 9th day *p. c.*, and the placenta is formed after that. By SANDFORD'S description (26), during the first half of pregnancy there is relatively little growth of the embryo, but during the second half the unborn rabbit grows very rapidly. It seemed from the present study that the gain in weight during pregnancy is about 14 or 15% under normal conditions, ranging from 7 to 20%. There is a tendency for the rate of gain in weight to be proportional to the litter size. Of course, this gain in weight varies and is affected by the feeding conditions. Some animals showed lower body weights than those in the beginning of pregnancy due to underfeeding conditions.

VENGE (30) reported that the fall in the weight at delivery is generally proportional to the litter size. This was confirmed in the present study and the ratios of falls at delivery to the weight before delivery ranged from 3.6% to about 15%.

The birth weight of the young and the total litter weight are closely related to the litter size. These relationships were linear in both cases. These facts were recognized by WISHART and HAMMOND (31), in which they con-

sidered them in relation to the pregnancy duration. HAMMOND (13), also, stated that there is but little constant increase in the weight of the individual young due to the prolongation of pregnancy from 31 to 34 days, and there is a large increase in the individual weight due to reduction in the number of young in the litter. In the present study, the pregnancy duration was treated separately, because of the small number of individuals. Concerning the average birth weight on the pregnancy duration, the young which delivered after 31 days of pregnancy were bigger than those delivered after 30 days. HAMMOND and MARSHALL (14) reported that neither the age of the doe nor the condition, *i. e.*, the variation in body weight, of the doe appear to have any effect on the duration of pregnancy. However, there was a tendency for the birth weight to increase with advance in the age of the doe, although there was no correlation between birth weight and mother's weight. The reason is not clear, but in observation of rabbit uteri, IWATA (17) recognized that the uteri of the multiparous rabbits were bigger in size and weight than those of the nulliparous, although there was no difference in the histological structure of the uterus. The development of the uterus may possibly be one of some factors affecting the birth weight of young.

By the data of the Imperial Zootechnical Experiment Station, Chiba-shi, Japan, cited by KOROMOGAWA (20), average ratio in body weight to the weight at copulation on five breeds after delivery was 105.8% ; and the ratio became 97.7% by the second week after delivery and 89.4% by the fourth week. The present data showed that the body weights in normal rabbits decreased gradually until about one month after delivery and the weights recovered after that. The weights after delivery were always heavier than those at copulation and their ratios were 106.7% at delivery, 93.7% after one month, 106.4% after two months, 108.2% after three months, 109.8% after four months and 110.7% after five months. However, in the groups which were underfed during pregnancy, the weights at delivery were lighter than those at copulation.

Many investigations were performed on the growth of young after birth, and MURRAY (22), GOTO (8) and others gave the regression formulae on the postnatal growth of the rabbit. VENGE (29) reported that the growth from birth up to the age of 3 weeks follows a straight line. This fact is agreeable with the results of the present study and during this period the young are fed only by their mothers (20, 29). After this period the young grew more rapidly. This growth rate was retarded after the age of 7 months, although the weight increased gradually reaching the heaviest at about the 18 months of age.

It seems generally that newborn male rabbits are heavier than female

young, and by the approach of sexual maturity female rabbits become slightly heavier than males when full grown, owing chiefly to the earlier arrest of growth in males (4, 6, 28). According to TEMPLETON (28), females of the New Zealand white breed are heavier than males after 14 weeks of age. HIRASHIMA (16), also, recognized this phenomena after 120 days of age. In the present study, females were heavier than males at 153 days of age.

SUMMARY

Body weight in rabbits, reared in the Experimental Farm of Hokkaido University, were recorded from June, 1962 to September, 1963. The body weights of the adult rabbits were changeable according to seasons. Some falls in weight occurred in August in which the highest temperatures of the year were recorded. The rabbits were heaviest in February in which the temperatures were the lowest of the year.

The body weight of the pregnant rabbit showed no change during the time from copulation to about 8 days *post coitum* (*p. c.*). After 9 days *p. c.*, gain in body weight became marked and after about 25 days *p.c.* the rate of increase in weight was retarded. The rate of gain in weight during pregnancy was about 15% under normal conditions, and was proportional to the litter size. There was a tendency for many rabbits to reach their heaviest weight on the 30th day of pregnancy, followed by some decrease in weight before delivery.

Falls in the weight at delivery increased gradually in accordance with increase in litter size. The ratios of falls at delivery to the weight before delivery ranged from 3.6% to about 15%.

The birth weight of the young and the total litter weight were closely related to litter size. The birth weight became lighter in proportion to increase in litter size and the total litter weight increased proportionally to the litter size. Birth weight of young increased with advance of mother's age, although there was no relationship between mother's weight and birth weight of their young. The birth weight of the young was clearly affected by nutritional conditions during pregnancy.

The weights of does reached their lowest one month following delivery, and then recovered the weight in the 2nd month.

The growth from birth up to 20 days of age followed a straight line, and the growth during the period from 20 days to 57 days of age was more rapid than before and followed another straight line. In general, from birth until 7 months of age the growth was marked and, then, the rate of growth was

retarded after 8 months of age. At 16 or 18 months of age the body weight reached its heaviest level and the level was held until 3 years of age.

In average body weight of adult rabbits, females were heavier than males.

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