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The Environmental Factors on the Lamb Growth, Analytically Studied with Extra-Seasonal-Lambs

III. The Effects of Seasons on the Growth and Development.

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In his studies on problems of meat production, HAMMOND (1960)[1),2)] found out that the different parts of the body and the different tissues of the carcass develop at differential rates, during the growing process from birth to maturity. BRODY (1945)[3)] also reviewed in detail the normal curve of growth in live weight and the various components of the animal body separately, and indicated that in living matters the occuring age changes follow the same fundamental pattern.

Many researches on the subject of growth (LUSH, 1930[4)]; MCMEECAN, 1940[5)]; WALLACE, 1948[6)]; PALSSON and VERGÉS, 1952[7)]; JOUBERT, 1956[8)] etc.) point out that the environmental conditions, particularly that of nutrition have a marked influence on growth.

In the growth and development of Japanese Corriedale lambs, studied by MIMURA (1956)[9)], the growth process could be distinguished into two phases, one the self-accelerating phase showing a straight line until the age of three months and the other, the inhibiting-phase then changing to the functional growth curve. The probable importance of the age of three months was enphasized by MIMURA as the point of inflection in the growth of lambs. MIMURA, although inconclusive, suggested that the growth rate of lambs might be modified by the light rhythm, by nutritional changes and by sexual maturity at the age. But this will be confirmed only, when these environmental factors and the growth pattern have been studied analytically on lambs produced all over a year.

Since ewes in Japan do not come into the mating period until late August, and cease to do so some time in winter, the period of the year during which ewes will be lambing is mainly restricted to spring. After these investigations, for example, BISSONNETTE (1932)[10)], HAMMOND (1938), HAMMOND, Jr. (1944)[11)], SYKES & COLE (1944)[12)], YEATES (1949)[13)], HART (1950)[14)], HAFEZ (1952)[15)], COLE, HART and MILLER (1945)[16)], ROBINSON (1951, 1955)[17),18)], DUTT (1953)[19)], RAESIDE (1956)[20)], GORDON (1958)[21)] and others confirmed that the control of light environment and hormon treatment would probably bring about the ability of year-around production of lambs. The authors reported also in the previous papers of this series

(MIMURA & ASAHIDA, 1959[22]; MIMURA *et al.*, 1964[23]) that twenty-seven lambs under such experiment in 1956-1961 were produced outside the normal lambing season. Although several of these twenty-seven were born smaller and weaker than those that were bred under normal condition as described by MIMURA (1959), twenty-one lambs were reared in the University Farm during six months for male and twelve months for female.

The present studies conducted from 1957 to 1963 mainly with these twenty-one lambs mentioned above and an other eight lambs produced normally during 1959-1960 were aimed at finding out the measures of influence of factors on growth.

MATERIALS AND METHODS

Twenty-one lambs were selected out of twenty-seven produced during 1959-1961 by the treatment above mentioned. An other eight lambs produced under normal condition during 1959-1960 were examined together with the aforesaid twenty-one in the University Farm. The lambs were reared under normal feeding and management until 12 months old, but a certain number of ram lambs were castrated when six months old and could not be used any more for research, because they grew on with little poor gain in live weight.

The lambs researched are described in detail in Table 1. In Table 1 these

Table 1. Lambs investigated in detail, being classified to five groups according to birth date.

Group	Lamb No.	Sex	Date of birth	Birth weight, kg	12th month weight by female and 6th month weight by male, kg	Remarks
Spring lambs	60- 6	♀	Feb. 22, '60	2.7	32.4	twine
	60- 8	♀	Mar. 6, '60	3.1	29.0	
	59- 2	♀	Mar. 31, '59	3.9	35.3	twine
	59- 4	♀	Apr. 20, '59	4.9	33.5	
	60- 1	♂	Feb. 23, '60	4.1	34.0	twine
	60- 3	♂	Feb. 23, '60	3.6	32.4	twine
	60- 5	♂	Feb. 27, '60	5.2	36.5	
	59- 1	♂	Mar. 31, '59	4.2	32.0	twine
Early summer lambs	59- 6	♀	Jun. 7, '59	3.3	36.5	twine
	59- 3	♂	Jun. 7, '59	5.2	29.6	twine
	58- 1	♂	Jun. 13, '58	5.1	35.8	
	58- 3	♂	Jun. 19, '58	4.7	38.0	
Summer lambs	59- 5	♂	Jul. 17, '59	4.5	24.5	
	60- 7	♂	Jul. 30, '60	4.4	23.7	
	60- 9	♂	Jul. 30, '60	4.1	25.5	

Autumn lambs	58- 2	♀	Oct. 3, '58	2.4	22.6*	*6th month weight
	57-12	♀	Oct. 30, '57	1.9	41.2	twine, but the mate died
	57-14	♀	Nov. 29, '57	1.8	34.9	twine
	57-16	♀	Nov. 29, '57	2.6	40.7	twine
	58- 5	♂	Sept. 20, '58	3.2	30.8	twine
	58- 7	♂	Oct. 3, '58	3.0	32.6	
	58- 9	♂	Oct. 13, '58	3.5	38.8	
	57-11	♂	Nov. 9, '57	2.3	—	died after the 3rd month
Winter lambs	57- 2	♀	Dec. 30, '57	2.7	34.0	
	60- 2	♀	Jan. 7, '60	3.3	32.7	twine
	60- 4	♀	Jan. 9, '60	3.0	26.7	twine
	57- 4	♀	Jan. 30, '57	4.0	35.0	
	59-11	♂	Dec. 30, '59	4.8	37.0	
	57- 1	♂	Jan. 18, '57	5.0	41.5	54.0 kg at the 12th month

Remarks: Spring season in Hiroshma is considered during Feb. 21～May 15, mean temp. 5～15°C.
Early summer season is during May 16～July 15, mean temp. 20～25°C.
Summer season is during July 16～Sept. 15, mean temp. 30°C.
Autumn season is during Sept. 16～ Nov. 30, mean temp. 20～10°C.
Winter season is during Dec. 1～ Feb. 20, mean temp. 1～5°C.

lambs are classified into five groups according to their lambing season, the classification was fixed in accordance to the data of Hiroshima Meteorological Observatory.

After weaning until the 3rd or 4th month they were, mostly, grazed on poor pasture and fed with soiling crops twice a day with the addition of 100 g concentrations, after the grazing season they were fed soiling crops, silage and concentrations of 100-300 g.

The growth in live weight and development in linear measurements were taken every months, its biometric constant being found out. Measurements were made of body weight, withers height, body length, rump length, chest depth, chest width, shoulder point width, rump width, thurl width and radius height.

Measurements were also made of the skin area of each lamb on the part tattooed by the method of BURNS (1935)[24] and MIMURA (1956) which was on the right mid-side reported by CARTER (1943)[25]. Wool was clipped immediately after tattooing at the every birth-day or the next day of lambs, then the wool growth on the tattooed part as well as the physiological transformation in the process of growth were also investigated. But these data will be reported in succession.

RESULTS

1. *The growth in live weight*

If the growth curves are investigated after plotting the live weight gains of

spring lambs in Fig. 1, it will be noticed that there are not definitely different ten-

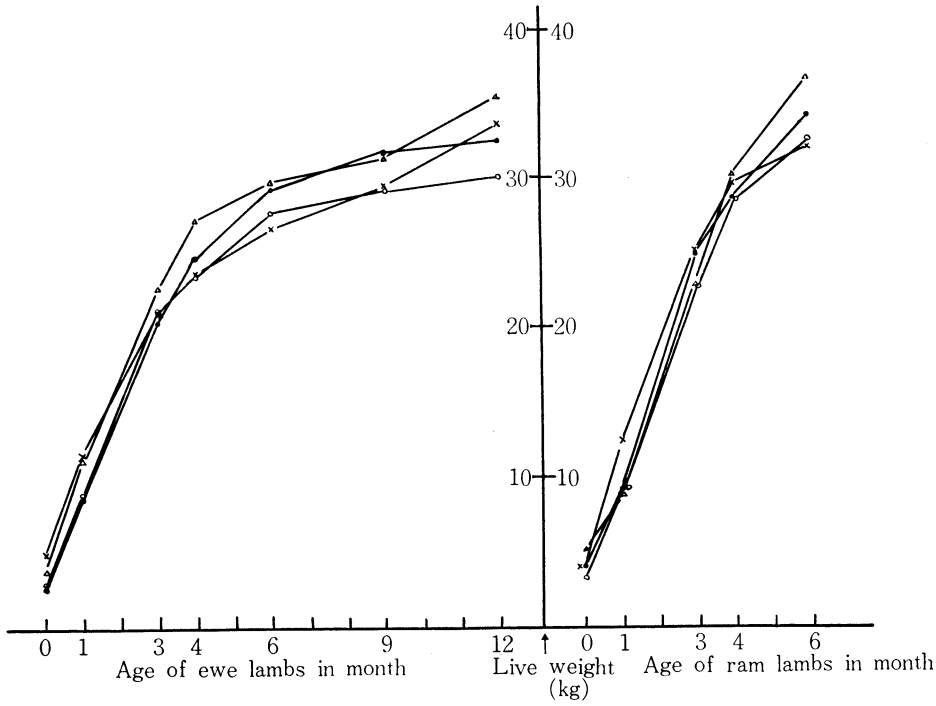

Fig. 1. The growths of spring lambs from birth to the twelfth month for female and from birth to the sixth month for male.
●—●: No. 60-6 (♀), No. 60-1 (♂)
○—○: No. 60-8 (♀), No. 60-3 (♂)
△—△: No. 59-2 (♀), No. 60-5 (♂)
×—×: No. 59-4 (♀), No. 59-1 (♂)

dencies among individual lambs. Same investigations were conducted on lambs of other groups as shown in Figs. 2–5. As the results of these investigations the data No. 58–2 for autumn lambs and No. 60–4 for winter lambs were considered as having to be omitted from the mean data of each season lamb. In ram lamb, No. 59–3 is to be omitted too from the mean data of early summer. No. 57–11 is also omitted as having been lost by a dog's attack.

The mean growth in live weight of each group is described in Tables 2,3 and is visualized in Fig. 6. The following data appear clearly shown as results of mutual comparison.

1) Although remarkably different growths are noticed after the 3rd month, a straight ascending line is observed until the 3rd month of growing in other seasons lambs as same as in spring lambs. The results suggest that the growth rate of the lambs at the period in which the growth is in the accelerating phase as indicated by

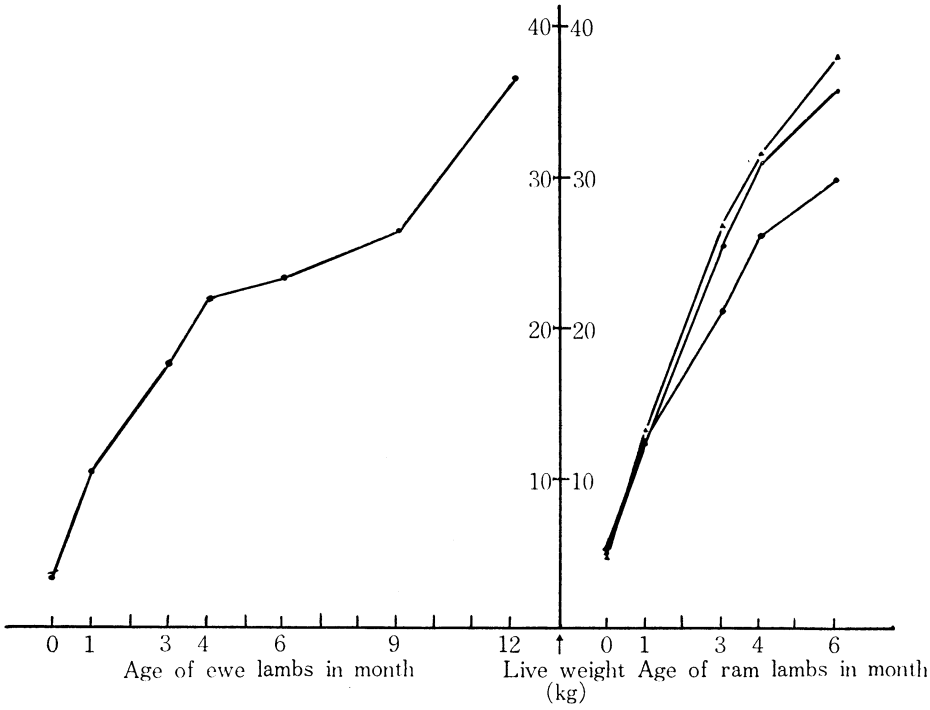

Fig. 2. The growths of early summer lambs from birth to the twelfth month for female and from birth to the sixth month for male.
●—●: No. 59-6 (♀), No. 59-3 (♂) ○—○: No. 58-1 (♂)
△—△: No. 58-3 (♂)

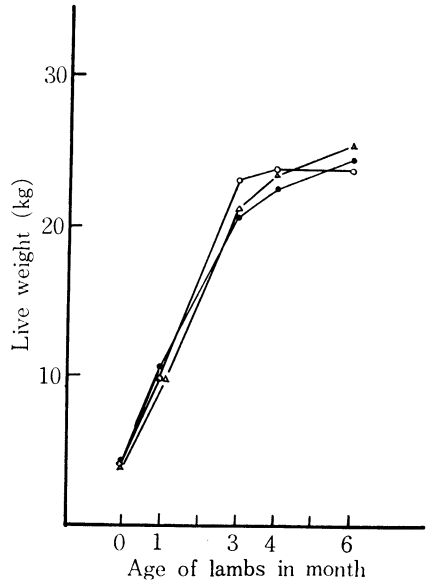

Fig. 3. The growths of summer ram lambs from birth to the sixth month.
●—●: No. 59-5
○—○: No. 60-7
△—△: No. 60-9

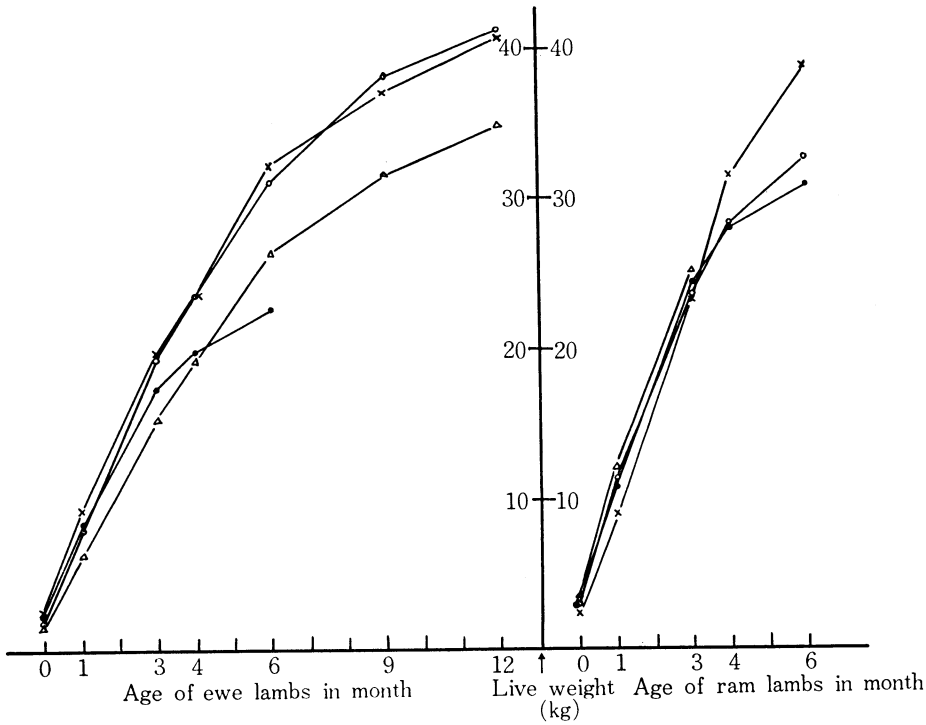

Fig. 4. The growths of autumn lambs from birth to the twelfth month for female and from birth to the sixth month for male.

●—●: No. 58-2 (♀), No. 58-5 (♂)
○—○: No. 57-12 (♀), No. 58-7 (♂)
△—△: No. 57-14 (♀), No. 57-11 (♂)
×—×: No. 57-16 (♀), No. 58-9 (♂)

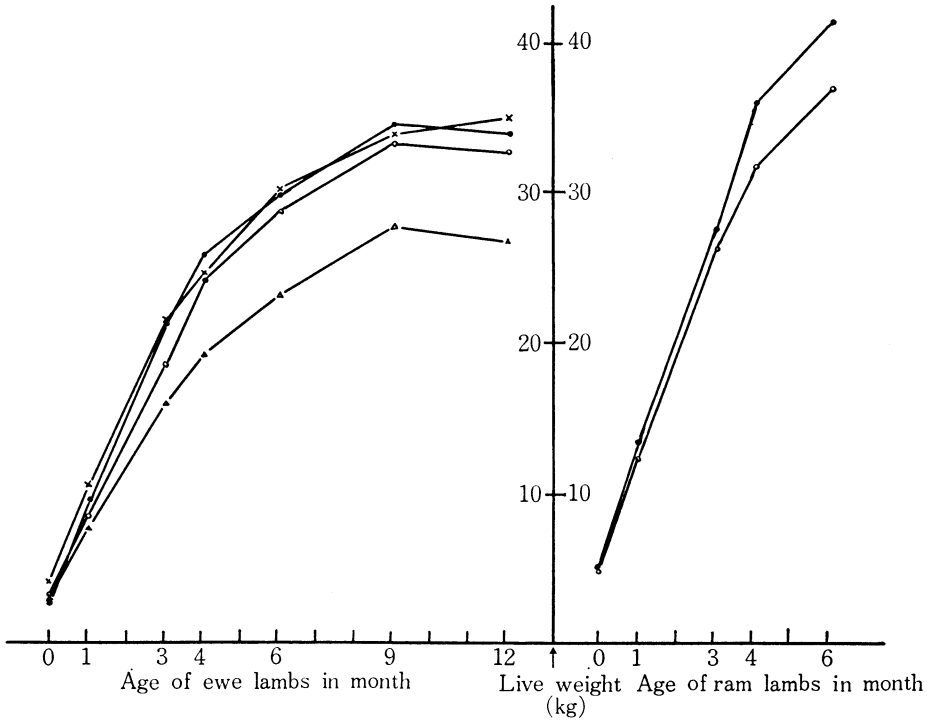

Fig. 5. The growths of winter lambs from birth to the twelfth month for female and from birth to the sixth month for male.
●—●: No. 59-2 (♀), No. 57-1 (♂)
○—○: No. 60-2 (♀), No. 59-11 (♂)
△—△: No. 60-4 (♀)
×—×: No. 57-4 (♀)

Table 2. The mean live weights of ewe lambs (kg).

Group	Age in month after birth							Remarks
	Birth	1	3	4	6	9	12	
Spring lambs	3.9	10.1	21.3	24.4	28.3	29.9	33.3	
Early summer lambs	3.3	10.2	17.3	21.7	22.1	26.2	36.5	
Autumn lambs	2.1	7.9	18.1	22.1	29.8	35.5	38.9	No. 58-2 was omitted
Winter lambs	3.3	9.5	20.4	24.8	29.6	33.9	33.9	No. 60-4 was omitted

Table 3. The mean live weights of ram lambs (kg).

Group	Age in month after birth					Remarks
	Birth	1	3	4	6	
Spring lambs	4. 3	10. 0	23. 9	29. 3	33. 7	
Early summer lambs	4. 9	12. 4	26. 2	31. 3	36. 9	No. 59-3 was omitted
Summer lambs	4. 3	10. 3	21. 6	23. 3	24. 6	
Autumn lambs	3. 2	11. 4	24. 3	28. 8	34. 1	No. 57-11 was omitted
Winter lambs	4. 9	12. 8	27. 0	34. 0	39. 3	

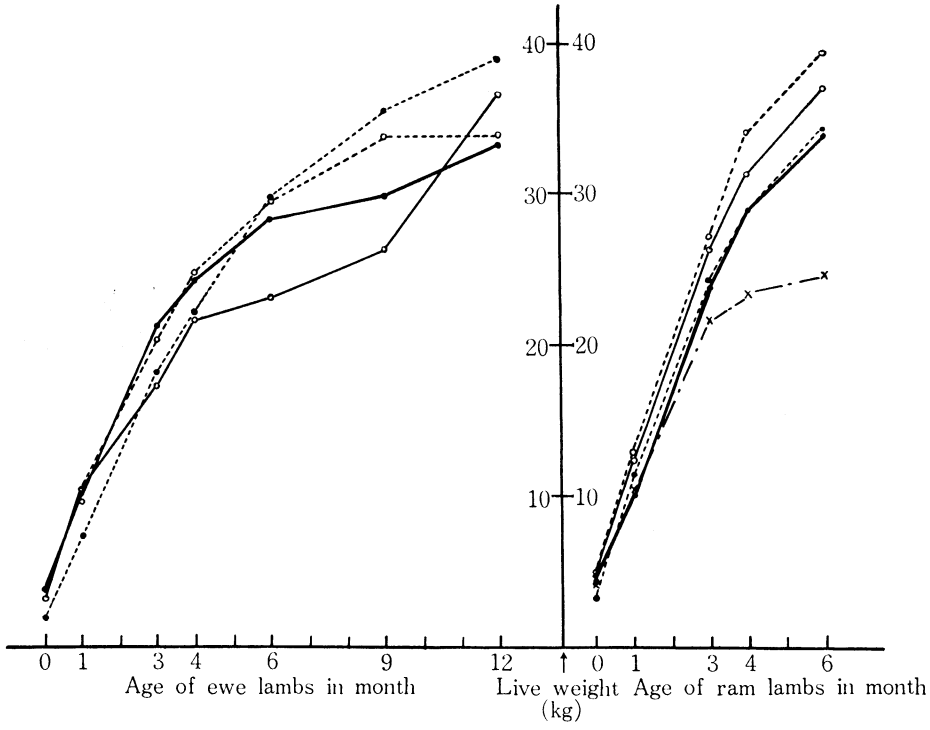

Fig. 6. The mean growths of lambs produced out-side the normal season as compared with the spring lambs produced under normal conditions.
●—●: Spring lambs
○—○: Early summer lambs
×-·-×: Summer lambs
●···●: Autumn lambs
○···○: Winter lambs

BRODY (1945) will be driven up by endogenous factors more than by environmental factors, even when these growth are affected considerably by those environmental

ones.

2) In the case of spring lambs (ewe lambs) the growth rate decreases after the third month, as indicated by MIMURA. But for autumn lambs and winter lambs the rates are keeping steady until the fourth month.

From the fourth month to the ninth month a remarkable rate decrease occurs in the case of early summer- and summer lambs, where·as a higher rate shows for autumn and winter lambs. It is note·worthy that for early summer lambs the growth rate suddenly increases from the 9th month to the 12th month, in which period they were under spring conditions where·as for autumn and winter lambs the rate declines during the same period. This seems to induct that the growth rate of lambs is accelerated under spring conditions and clearly suppressed by summer conditions.

2. *The growth in the skin area on the part tattooed*

The growth in the skin area on the part tattooed from the birth day to the twelfth month (for male to the 6th month) is visualized as the expansion ratio of skin area.

MIMURA (1956) has indicated that there were significant correlations between the ratio and the growth in live weight. Their correlation coefficients are also great as $r=0.65$ for female ($P<.01$) and $r=0.86$ for male ($P<.01$) in the present investigation. The expansion ratios of lambs listed in Tables 2,3 are described in Tables 4,5 and drawn in Fig. 7. The results clearly reveal the same tendencies but

Table 4. The mean expansion ratios of the skin area on the part tattooed of ewe lambs.

Group	Mean expansion ratios of the skin area at the age in month, %							Remarks
	Birth	1	3	4	6	9	12	
Spring lambs	100	198	348	417	472	480	481	
Early summer lambs	100	175	301	304	306	412	510	
Autumn lambs	100	279	468	519	665	744	787	No. 58-2 was omitted
Winter lambs	100	150	281	301	352	412	407	No. 60-4 was omitted

Table 5. The mean expansion ratios of the skin area on the part tattooed of ram lambs.

Group	Mean expansion ratios of the skin area at the age in month, %					Remarks
	Birth	1	3	4	6	
Spring lambs	100	186	356	437	488	
Early summer lambs	100	175	341	376	420	No. 59-3 was omitted
Summer lambs	100	184	290	397	399	
Autumn lambs	100	251	423	474	527	No. 57-11 was omitted
Winter lambs	100	215	364	435	476	

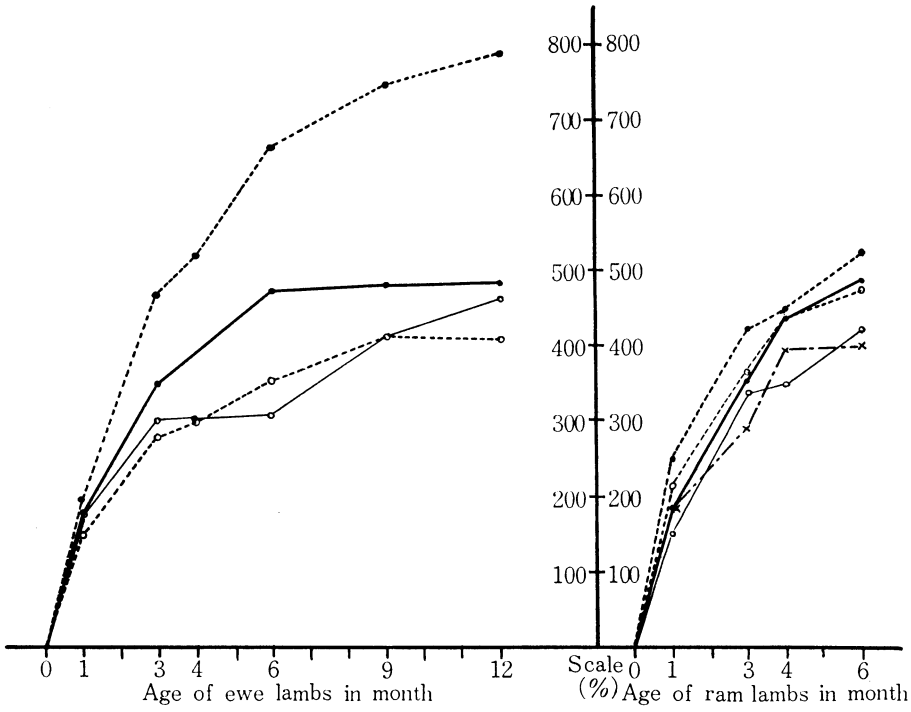

Fig. 7. The mean expansion ratios of the skin area on the part tattooed along the growing of lambs.

●—●: Spring lambs
○—○: Early summer lambs
×-·-×: Summer lambs
●···●: Autumn lambs
○···○: Winter lambs

on a larger scale compared with Fig. 6 and Fig. 7. But, needless to say, it should be noticed that the level of Fig. 7 does not show the same level as the one of Fig. 6 and that the growth in the skin area will not change coincidently with the growth in live weight. We shall take up this problem later.

3. *The development in linear measurements*

The mean withers heights of lambs which are listed in Tables 2 and 3 are described in Table 6, and the mean body lengths are also in Table 7.

As can be seen from Tables 6 and 7, the development in linear measurement will probably change along the different curve lines from the growths in live weight and in the skin area. Although the development of spring lambs agrees naturally with the standards indicated by MIMURA, it is evident that they do not shown the large differences in developmental tendencies between spring lambs and the others ones. The following tendencies can be observed: the development of autumn lambs during the 4^{th}–6^{th} months, winter lambs during 3^{rd}–4^{th} months and of early summer

Table 6. The mean developments in withers height (cm).

Group	Sex	Age in month						
		Birth	1	3	4	6	9	12
Spring lambs	♀	34.4	41.3	50.5	52.2	53.3	55.5	56.2
	♂	34.6	42.1	51.5	52.6	53.9	—	—
Early summer lambs	♀	33.8	40.7	48.0	50.0	51.6	52.0	57.2
	♂	37.0	44.1	52.3	55.0	56.5	—	—
Summer lambs	♀	—	—	—	—	—	—	—
	♂	34.2	41.5	49.1	49.3	52.1	—	—
Autumn lambs	♀	28.1	36.4	48.1	49.5	52.8	54.0	54.7
	♂	32.7	41.5	50.1	53.5	56.6	—	—
Winter lambs	♀	32.9	41.3	49.6	52.6	55.8	56.7	58.0
	♂	36.9	44.7	55.3	56.1	61.1	—	—

Remarks: No. 58-2 in autumn ewe lambs, No. 60-4 in winter ewe lambs, No. 59-3 in early summer ram lambs and No. 57-11 in winter ram lambs were omitted.

Table 7. The mean developments in body length (cm).

Group	Sex	Age in month						
		Birth	1	3	4	6	9	12
Spring lambs	♀	29.5	41.3	54.5	56.5	59.3	60.3	62.0
	♂	26.3	40.0	55.6	58.1	59.8	—	—
Early summer lambs	♀	29.5	41.5	50.5	52.8	53.5	56.0	62.5
	♂	33.5	44.6	55.2	58.7	61.7	—	—
Summer lambs	♀	—	—	—	—	—	—	—
	♂	32.0	43.5	51.8	53.3	55.7	—	—
Autumn lambs	♀	26.0	36.3	50.3	54.2	59.0	60.3	62.3
	♂	25.2	43.3	55.3	58.7	61.5	—	—
Winter lambs	♀	30.3	40.4	52.8	56.9	58.8	59.9	60.6
	♂	34.8	44.8	58.8	62.3	65.3	—	—

Remark: Lambs were same with in Table 6.

lambs during the 9^{th}–12^{th} months have a little higher rates, but the rates of early summer and full summer lambs go by the opposite rules during the 3^{rd}–6^{th} months. This result suggests that environmental factors influence in a lower rate the development in linear measurements than the growths in live weight and skin area. But the result also suggests that the development in linear measurements is, more or less, influenced by lambing seasons. Summer conditions would be, followed by

winter condition, with the effect of suppressing the development of lambs. However spring condition seem to have the opposite effect of raising the development.

4. *Specific growth rate*

To investigate the changes of body proportion during growing period the specific growth rates of body length, rump length, chest depth, shoulder point width and thurl width according to the withers height were calculated and drawn in Figs. 8 and 9 by the methods described by WALLACE (1948) and MIMURA (1956).

With the specific growth rate of body length from Fig. 8, it can be noticed that there are remarkable decreases in winter lambs during the 4^{th}–12^{th} months and increases in autumn lambs during the 4^{th}–12^{th} months. Same tendency can be found in the rate of rump length of winter lambs, although the rates of body length and rump length in early summer lambs decrease remarkably during 4^{th}–6^{th} months.

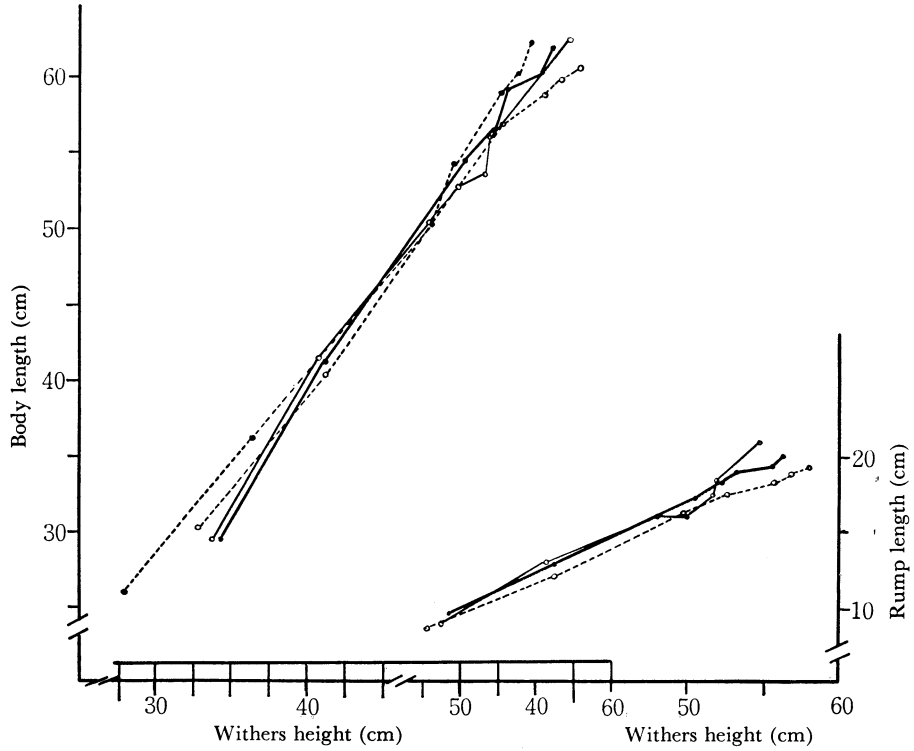

Fig. 8. The mean specific growth rates of body length and rump length according to withers height along the growing of ewe lambs.

●—●: Spring lambs
○—○: Early summer lambs
●···●: Autumn lambs
○···○: Winter lambs
(in rump length the data of autumn lambs were missed)

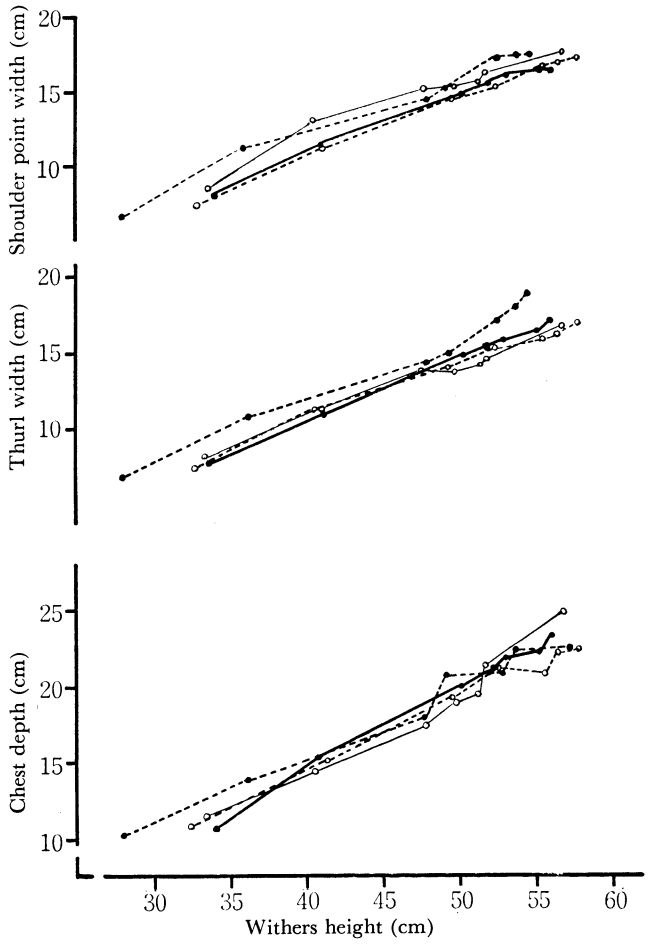

Fig. 9. The mean specific growth rates of shoulder point width, thurl width and chest depth according to withers height along the growing of ewe lambs.

●—●: Spring lambs
○—○: Early summer lambs
●···●: Autumn lambs
○···○: Winter lambs

And when the rates of shoulder point width and thurl width are investigated in order to compare the change along the growing between the fore-quarters and the hind-quarters, the authors find the higher rates of autumn lambs during the 4^{th}–12^{th} months and the lower rate of early summer lambs during 3^{rd}–6^{th} months especially in thurl width.

The results suggests that there would be also considerable effects on body compositions in raising under spring condition and in suppressing under summer condition, especially on the late maturing part.

DISCUSSION

1. *Seasonal effects on the growth and development*

As discussed by HAMMOND (1932) the growth of lambs is influenced by the environmental conditions which are normally constant according to the age of lambs.

From the results of the present experiments in early summer lambs and summer lambs the remarkable decreases of growth rate from the 4^{th} month to the 9^{th} month (in summer ram lambs from the 4^{th} month to the 6^{th} month) against the clear increases from the 9^{th} month to the 12^{th} month, are pointed out. The same changes occur in autumn lambs and winter lambs from the 9^{th} to 12^{th} months against from the 4^{th} to 9^{th} months. It will be, therefore, noticed that the growth rate of lambs is accelerated under spring condition and suppressed under summer condition followed by early autumn and winter conditions. The result suggests that winter and early autumn would be also the suppressing seasons for the growth of lambs as compared with spring season.

In the development in linear measurements lambs show the same tendencies, but the influences of lambing seasons upon the development in linear measurements are considered smaller especially in the early stage than that of the growth in live weighs. The facts seem to be due to the reason suggested by HAMMOND (1960) who indicated that the development of bones, in general, have a priority over the growth in live weight according to their order of development and metabolic rate in early stage.

It is very interesting to note that there was only a general pattern of the growth and development of lambs in the early stage, although they grew up more or less in advantageous or in suppressing circumstances during the different seasons after early stage. PALSSON and VERGÉS (1952) in their intensive studies discussed that the drop in the growth rate after 17^{th} weeks was probably due to three factors: first the natural slowing down of the growth process, secondly a natural fall in the milk yield and thirdly the results of the hot weather. While HAMMOND (1932, 1960) pointed out that among many factors which affect the rate of live weight gain and change occur in body conformations, one of the most important is nutrition and that in the early stage of growing the value of a good milk supply can hardly be overestimated. HAMMOND also noted that the season of the year affects the growth rate in many species, not only in that it determines the type of nutrition available, but also in ways not yet completely known.

In the present experiments the seasons of the year do not change the general pattern of lamb growth in the early stage, probably because the endogenous unknown factors, milk supply and others would overcome the environmental factors. The milk supply would be contributed by the genetical characters of individuals under normal condition, being influenced by the prenatal condition of nutrition as suggested by WALLACE (1948). It must be noticed that the ewes with suckling lambs, generally in Japan, their nutritional levels controlled with concentrations ac-

cording to the quality and quantity of roughages.

MIMURA (1956) has emphasised the third month of lambs as the point of inflection of growth, and the results did not deny the important significance of this third month. But from the fact that the autumn lambs in the present experiments grew up straight to the 4^{th} month, it must be concluded that if the lambs after the third month were under spring season the decrease of growth rate would be relieved. Then it will be correct to say that the growth will slow down at the third or the fourth month correlating to the weaning, sex maturity and other unknown factors of lambs, if one discusses the point of inflection of growth on the lambs produced all over a year.

The summer and early autumn seasons in Japan, especially in the west districts, are characterized by hot and dry weather in which grass and soiling crops are remarkably falling down in quality and quantity and so lambs are rearing under poor nutritional conditions, suffering from sever hot weather. The present results clearly indicate how the growth and development of lambs are considerably affected by environmental factors.

From the present results it seem to derive that autumn lambs may be most advantageous commercially, if the lambs could be produced by treatments outside the normal season.

2. *Seasonal effects on the growth in skin area and body composition*

It is noticed from the results that there was a significant correlation between the expansion ratio of skin area on the part tattooed and the growth in live weight, although the expansion ratio changed during the growing period of lambs on a larger scale than that of growth.

Although the growth in the skin area of lambs is considered as the function of linear measurements, the growth in live weight has a different significance from the development in linear measurement. Because the growth in live weight is not simply due to the development of bones, but mainly correlated to body length, chest depth and chest width as described by MIMURA (1956). And it must be noticed that there is a definite gradient in bone growth. HAMMOND pointed out that while the length of bones is an early maturing part, the thickness of bones is a late maturing one. And he also indicated that in the bones the later developing parts are the upper bones of limbs as compared with its length. These facts are possibly the reason why the changes in skin expansion ratio do not always coincide with the growth in live weight.

WALLACE (1948) proposed the specific growth rate as the indication of changes of body compositions and MIMURA (1956) suggested that the development of rump length against body length and the development of thurl width against shoulder point width are comparatively late developing parts. As shown in Figs. 8 and 9 the results of the present experiments ascertain again these facts. But especially under summer condition suppressing influences are shown in body length, rump length and rump width of winter lambs, and under spring condition advantageous influences are shown in those of autumn lambs as compared with that of lambs produced

under normal season. The results might be probably due to the fact these parts belong to the late maturing parts as pointed out by PALSSON and VERGÉS (1952).

SUMMARY

In order to determine how the environmental factors would affect the growth and development of lambs and to consider whether the growth pattern as described by MIMURA (1956) would be the same or different for lambs produced in normal season and one produced outside the normal season, twenty-one lambs were selected and reared among twenty-seven lambs which had been produced outside the normal season reported by MIMURA (1959, 1964) with eight lambs produced normally. They were reared during twelve months by female and during six months by male. The growth in live weight and the development in linear measurements investigated along with the growing of lambs, and the skin area on the part which was tattooed on the mid-side of lambs by the method reported by BURNS (1935) and MIMURA (1956) was also measured and the growth investigated. After this the lambs were classified into five groups; spring lambs, early summer lambs, summer lambs, autumn lambs and winter lambs according to their lambing seasons, and the data were compared each other.

The results are as follows.

1. Although there are remarkably growth- differences after the the third month, a straight line shows until the lambs grow up to the third month, not only spring lambs but in other season lambs with the exception of autumn lambs. Autumn lambs grow up straight forward until the forth month.
2. The growth and development of lambs after about the 3rd month shows a considerably higher rate under spring condition, and a lower rate under summer condition followed by early autumn and winter conditions.
3. The results, therefore, indicate that the general pattern of growth and development suggested by MIMURA (1956) and the present experiments coincide, but that seasonal effects considerably affect the growth and development of lambs after the early stage. The remarkable decrease of growth rate, for example, in early summer lambs and summer lambs from the 4th to the 9th months against the clear increases from the 9th to the 12th months are pointed out.

The seasons of summer and early autumn in the west districts of Japan are characterized as hot and dry. The growth and development of lambs are suppressed not only by climatic effects, but mainly by nutritional fall in feeding under these seasons. Lambs in Japan are also under-feeding in winter.

4. It is very interesting to observe that the general pattern of growth in early stages was not affected by lambing seasons, probably due to unknown endogenous factors, milk supply and others would overcome the environmental factors. Concerning the exception with autumn lambs from the 3rd month to the 4th month, it must be considered that when the lambs after the 3rd month are under spring condition the decrease of growth rate will be relieved. Then it will be correct to say

that the growth will slow down to about the third month or the fourth month, if one want to discuss the point of inflection of growth on the lambs produced all over a year.

5. There was a significant correlation between the expansion ratio of skin area on the part tattooed and the growth in live weight, although the expansion ratio changed during the growing of lambs on a larger scale than that of the growth.

6. From the investigation of specific growth rate, under summer condition suppressing influences were shown in body length, rump length and rump width of winter lambs, but under spring condition advantageous influences were shown in those of autumn lambs as compared with that of lambs produced under normal season.

7. It is very interesting to observe that from the present results autumn lambs will be most advantageous commercially if the lambs could be produced under treatment.

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REFERENCES

1) HAMMOND, J.: Farm animals, 3rd ed. pp. 1-21, 95-144, Edward Arnold, London (1960).
2) HAMMOND, J.: Growth and development of mutton qualities in the sheep, Edinburgh (1932) cited by HAMMOND, J[1].
3) BRODY, S.: Bioenergetics and growth, pp. 575-740, Reinhold Publ., New York (1945).
4) LUSH, J.L.: Animal breeding plans, 3rd ed. Collegiate Press, Iowa (1945).
5) MCMEEKAN, C.P.: Principles of animal production, Auckland (1945) cited by PALSSON and VERGÉS (1952)[7].
6) WALLACE, L.R.: J. agric. Sci., **38**, 93-153, 243-302, 367-401 (1948).
7) PALSSON, H. & VERGÉS, J.B.: ibid., **42**, 1-92, 93-149(1952).
8) JOUBERT, D.M.: ibid., **47**, 382-428 (1956).
9) MIMURA, K.: J. Fac. Fish. Anim. Husb. Hiroshima Univ., **1**, 203-266 (1956).
10) BISSONNETE, T.H.: Physiol. Zool., **5**, 92 (1932) cited by YEATES, N.T.M. (1949)[13].
11) HAMMOND, J. Jr.: ibid., **34**, 97-105 (1944).
12) SYKES, J.F. & COLE, C.L.: Quart. Bull. Mich. Agric. Exp. Sta., **26**, 250 (1944) cited by YEATES, N.T.M. (1949)[13].
13) YEATES, N.T.M.: J. agric. Sci., **39**, 1-43 (1949).
14) HART, D.S.: ibid, **40**, 143-149 (1950).
15) COLE, H.H., HART, G.H. & MILLER, R.F.: Endocrinology, **36**, 370-380 (1945) cited by ROBINSON, T.J. (1951)[17].
16) HAFEZ, E.S.E.: J. agric. Sci., **42**, 189-265 (1952).
17) ROBINSON, T.J.: ibid., **41**, 6-63 (1951).
18) ROBINSON, T.J.: ibid., **46**, 37-47 (1955).
19) DUTT, R.H.: J. Anim. Sci., **12**, 515-523 (1953).
20) RAESIDE, J.I.: Aust. J. Agric. Res., **7**, 591-607 (1956).
21) Gordon, I.: J. agric. Sci., **50**, 123-151, 152-197 (1958).
22) MIMURA, K. & ASASHIDA, Y.: J. Fac. Fish. Anim. Husb. Hiroshima Univ., **2**, 365-374 (1959).
23) MIMURA, K., ASASHIDA, Y. & MORITA, H.: ibid., **5**, 419-429 (1964).

24) BURNS, R. H.: Proc. 28th Ann. Meet. A.S.A.P. (1935) cited by BURNS, M.: J. agric. Sci., **39**, 64-79 (1949).
25) CARTER, H. B.: Coun. Sci. Ind. Res. Bull., 164, 1, 23 (1943) cited by BURNS, M.: J. agric. Sci., **39**, 64-79 (1949).

季節外生産羊を利用しためん羊発育に及ぼす環境要因の解析的研究

III. 発育および成長に及ぼす季節の影響

三村　耕・朝日田康司

第1報，第2報において短日処理法および短日処理・ホルモン処理併用法により，合計 27 頭の子羊を季節外に生産したことを報告した．これらのうち 21 頭を常法により1年間（雌），6カ月間（雄）飼育し，その発育・成長および皮膚面積の発育を測定した．この結果を試験期間中に行なった正常羊の試験結果と併せ検討することにより，極めて明瞭に子羊の発育および成長に及ぼす季節の影響を解析することができたので報告する．

1. 生後3月令までの早期発育においては，正常羊と季節外生産羊との間に発育パターンに差違はみられなかった。このことから子羊の早期発育においては，内因的要因，母乳（主として同品種・系統では個体的要因に属しまた在胎中の母羊の栄養と関係する）その他の要因が外部環境より強力に作用すること，そしてこの時期が BRODY (1945) のいわゆる accelerating-phase と関連することを暗示している．

2. 三村(1956)の提唱した発育における屈折転向点としての3月令の意義は，秋季生産羊では4月令に延長されていたが，3月令以後春季環境にあったためと理解された．

3. 増体重および体長その他の成長において，3乃至4月令以後はその季節環境によりそれぞれプラス，マイナスの影響をみることができた．特に春季はプラス，夏季次いで冬季はマイナスに作用していた．体高比成長により検討した結果は体型にも影響することが知られた．

4. 皮膚面積増大率は発育における傾向と似ているが，より拡大して示される．

5. 季節外生産羊を産業的に生産できるなら，秋季生産羊が本試験の結果からみて，最も有利な発育・成長をとげるであろうことは興味ある知見と思われる．