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Title RELATIONSHIP OF CERTAIN BLOOD NITROGEN CONSTITUENTS WITH GROWTH IN DIFFERENT GENETIC GROUPS OF SHEEP

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Market lamb production usually requires a short period of time. The success of production is therefore dependent upon the growth rate of the lambs which is influenced by milk yields of the ewes. Different growth potentials of animals result from a difference in their utilization of food. Since metabolism affects the blood constituents which can be measured, it was the objective of this experiment to study the variations of blood amino acid and urea nitrogen levels of lambs and their dams during the suckling period. The relationship between constituents and the relationship of each constituent with weight and age of lambs were studied. Also relationships of blood constituents of ewes with blood constituents, weights and ages of lambs were studied. Five breeds of sheep were used: Willamette, Suffolk, Columbia, Dorset Horn and Border Cheviot. Weights of lambs were recorded at the same time as blood samples were taken from lambs and their dams. The experiment was conducted for seven

two-week periods during the Winter and Spring of 1962.

Blood amino acid and urea nitrogen levels were found to be associated with growth of lambs. Blood amino acid nitrogen levels of lambs were different due to breeds ($P < .01$) but not due to periods, while urea nitrogen levels of the blood were different due to periods and types of birth ($P < .01$). Suffolks showed the highest level of blood amino acid nitrogen, a level of 7.84 mg. whereas Columbias gave a value of 7.23 mg. per 100 ml. of blood which was the lowest level. Twins had lower levels of blood urea nitrogen than singles and both groups showed a steady decrease in the concentrations of urea as they became older and larger. The correlation coefficient between these constituents was highly significant, whereas no relationship was found within periods between either constituent and weights or ages of lambs. Body weight of the lambs was highly correlated with age.

In the case of ewes, blood constituents were associated with milk yields and growth of lambs. Both constituents showed effects of breeds and periods. While blood amino acid levels were not extremely variable, blood urea nitrogen levels markedly increased at the second period then steadily decreased until the end of the experiment. Blood amino acid nitrogen levels of ewes were highly correlated with those of lambs ($P < .01$), while this relationship was not detected for blood urea nitrogen. A negative correlation coefficient between blood urea nitrogen levels of ewes and body weights of lambs was highly significant ($P < .01$) in Willamettes, Suffolks, and Columbias, while in Dorset Horns and Border Cheviots it was not significant. However, the average correlation coefficient within breeds and periods was not significant.

RELATIONSHIP OF CERTAIN BLOOD NITROGEN CONSTITUENTS WITH GROWTH IN DIFFERENT GENETIC GROUPS OF SHEEP

by

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RELATIONSHIP OF CERTAIN BLOOD NITROGEN CONSTITUENTS WITH GROWTH IN DIFFERENT GENETIC GROUPS OF SHEEP

I. INTRODUCTION

For centuries livestock breeders have used individual appearance as a basis for selection. In addition, pedigree has been used as an aid to selection. It was thought that identical pedigrees would indicate identical inheritance; however, in many instances the offspring from the selected animals were not similar to their parents. Outstanding parents were not necessary for the production of the best offspring and, conversely, many good offspring were produced from poor ancestors. The Mendelian Law of Segregation explained this phenomenon.

During recent years interest has increased markedly in the breeding of farm animals for performance rather than appearance. In order to breed animals satisfactorily for performance it first becomes necessary to determine the important factors affecting performance, their relative values, and how they can best be measured. All this is necessary in order to develop a well-balanced program of breeding for performance.

One may think of progeny testing as the best method to measure an individual's merit. Progeny testing, although it can prove the performance of any particular animal, requires the testing of many animals and a rather long period of time in so doing. Actually in livestock production, both numbers and time are limiting factors from the economical standpoint. Keeping animals for a long period of time may involve problems of space, labor, and expense. All of these make progeny testing somewhat impractical.

In lamb production the time limit is set by a short period between the time of birth and market. Any method that could be used to test the efficiency of animals in a short period would be valuable. Animals that reach market weight the earliest will generally produce the most economical gain. A large part of weight gains in fat lamb production is growth. Growth potential of the animal is influenced by heredity, therefore, measuring growth is another way of testing the performance of the animals.

Growth causes a change in body size of the animal but this change is not necessarily true growth. It may be caused by the incorporation of water and fat without any increase in flesh. Thus one can not depend on weight increase alone as true growth. It has been found that there is a relationship between change in skeletal size and growth of the body and there have been many studies of growth using body measurements as a criterion to determine growth (11, p.69-98; 25, p.311-316). Body measurements are complicated and inaccurate due to various factors. Position of the animals during the taking of these measurements is the main factor influencing the fluctuation of these measurements. It is not easy to keep an animal standing in the correct position. Also, in sheep the thick fleece may cause enormous errors in reliability of measurements. It is apparent that additional information is needed before body measurements can be used as an accurate indicator of growth.

As a matter of fact, growth is caused by the utilization of food by the animal. Variations in food metabolism of different animals are reflected by the composition of the urine, and it is reasonable to consider that these metabolic differences are also reflected by the composition of the blood. It has been shown by MacDonald (20, p.48) that there are some differences in the blood composition of Aberdeen Angus and Hereford cattle during the growth period. Because the metabolism of proteins generally affect growth, the present study was conducted to determine if there are any differences in the blood urea and amino acid nitrogen levels during growth in different breeds of sheep. Also this study was designed to see if there was a correlation between the fluctuation in levels of these blood constituents and growth rate of sheep.

II. REVIEW OF LITERATURE

It is well known that one of the most important functions of the blood is to carry the digested nutrients to the body tissues, and in turn to carry away the waste products and deliver them to the excretory organs. Also it is known that this function is influenced by the hormones from the pituitary, thyroid and adrenal glands. The review of literature will cover some studies which reveal the role of blood amino acid---the digested protein, and blood urea which chiefly represents the metabolic end product of protein.

Amino Acid Nitrogen

By the action of the various proteolytic enzymes, the proteins of the diet are broken down to their constituent amino acids in the digestive tract, and the dietary protein is absorbed into the animal's body in the form of the individual amino acids. After the pioneer work of Schoenheimer (30, p.25-46) it is now believed that the amino acids of the diet enter rapidly into biological equilibrium with the amino acids of the body. They are incorporated into newly formed proteins or enter into reactions which supply nitrogen constituents to the tissues. Steel and coworkers (32, p.124-132) did not find any significant change in the concentration of blood amino acids in mice which were fed a diet containing different levels of protein. In another experiment Longenecker and Hause (18, p.46-59) experimenting with dogs, found no relationship between the change in plasma amino acid concentrations after a meal and the amino acid compositions of the protein ingested. They concluded that the changes in the concentration of the plasma amino acids are dependent upon the rate of absorption from the intestinal tract into the blood and upon the rate of removal from the blood by body tissues. Since the individual essential amino acids are removed from the blood by the tissues, it is evident that changes in the plasma amino acid concentration after a meal are dependent upon the amino acid composition of the ingested protein. Kerr, Harwitz and Whipple, as reported by Madden and Whipple (23, p.194-217), found that diet influenced favorably the regeneration of depleted plasma protein in dogs, and that adequate food protein has a qualitative as well as a quantitative significance.

Henderson, Schurr, and Elvehjem (13, p.815-823) found that plasma concentration of free amino acids varied in different levels after fasting. Threonine, proline and tyrosine concentrations declined markedly during the first two to three days and remained low in both the fasted and protein-depleted animals. Histidine decreased slightly for one to two days and then returned to normal or slightly above normal. The lysine content was not affected by deprivation while arginine varied between narrow limits, above and below normal. Charkey and coworkers (1, p.627-632) found an increase of blood amino acid concentration in deprived chicks at two weeks of age. The increase was inversely related to age; however, at six weeks old the chicks still showed a consistent increase in lysine. It was assumed that, "a greater degree of maturity is required for the development of metabolic capabilities toward lysine, similar to that developed earlier in life toward other amino acids". In another experiment with humans, Charkey and coworkers (2, p.469-480) found a reduction in concentration of lysine and other amino acids in the blood, while the blood concentration of leucine and valine increased appreciably during fasting. It was indicated that there was a high degree of relationship between the increase in blood non-protein amino acids and the precursor unavailability by metabolic amination. From these experiments it was pointed out that these relationships may occur in different species and at different ages. While studying three inbred strains of mice Hrubant (14, p.591-608) found significant difference between the genotypes for the blood levels of glutathione, glysine, alpha-alanine and valine-norvaline. Within a strain, a significant difference was found between sexes for the blood levels of arginine, lysine, valine-norvaline and glutamic acid. There were no significant differences between sexes when all of the animals were grouped according to sex and analyzed together. Strain differences were due to their relative proportions of glutathione, homocystine cystine, taurine, glycine, lysine, arginine, alpha-alanine, beta-alanine, valine-norvaline and isoleucine-leucine. A fairly standardized metabolic pattern was found for each inbred strain.

Tether et al. (34, Vol. 4, p.38) detected differences due to breed for blood amino acid nitrogen concentration among the young of three different breeds of rabbits. Both males and females showed a reduction in blood amino acid concentration when the animals approached maturity. Also a difference due to sex was observed in the concentration of adults. It was shown that growth is influenced by the hormones of the anterior pituitary, thyroid, and adrenal glands, through the utilization and metabolism of carbohydrates, proteins and fats. Li (17, p.91-95) injected rats with growth and adrenocorticotropic hormones, and found that growth hormone caused a reduction in the level of plasma-free amino acids while adrenocorticotropic hormone induced an opposite effect. He concluded that the evidence for growth hormones decreasing amino acid level agrees with its effect on protein anabolism. Then it could be expected that adrenocorticotropic hormone elevates the concentration of free amino acid in plasma since this hormone is a specific growth inhibiting agent, acting conversely to growth hormone. MacDonald (20, p.74) and MacDonald and coworkers (21, p.1-34), studying the relationship between blood non-protein nitrogen concentration and rate of growth of Aberdeen Angus and Hereford cattle, found a negative correlation between growth rate and blood amino acid concentration. The concentration increased with the increase in body weight. Blood concentrations of amino acid nitrogen per 100 ml. of blood were different between sexes. The bulls showed a lower concentration than the heifers. MacDonald and White (22, p.259-266) did not find a significant difference in the concentration of amino acid nitrogen in blood of calves grazing on pasture, although the bulls showed higher values than the heifers. In a similar experiment, Williams (36, p.44) found a sex difference in the concentration of blood amino acid nitrogen. The relationship between its concentration and age was found to be nonsignificant. On the other hand, Jessup (15, p.52) could not detect differences in concentrations of amino acid nitrogen due to sex among crossbred lambs. The correlation coefficient between age and concentration also varied among the breeds. Price *et al.* (27, p.XLIV-1-XLIV-9) suggested that the negative relationship between rate of gain and blood amino acid concentration was due to the utilization of amino acid. The faster gaining calves utilized more amino acids for their protein synthesis and left fewer amino acids in the blood than the slower gaining calves.

Urea Nitrogen

As reported by Fearon (5, p.399-439) urea was first detected in blood by Prevost and Dumas in 1823. Urea has been found in the blood of all mammals. Schwartz and McGill (31, p.42-77) gave the normal range of blood urea level as 11 to 25 mg. per 100 ml. of blood, while Folin and Dennis (6, p.29-42) proposed the range of eight to 15 mg. per 100 ml. of blood. McClean and Selling (24, p.31-38) considered that the upper limit of 22 mg. per 100 ml. of blood is still within the limits for normal animals. Fearon (5, p.399-439) pointed out that the distribution of urea is fairly uniform throughout the organism. The concentration of urea in tissues is approximately the same as in the blood. The low urea content in adipose tissue is due to the lack of water content; in contrast the renal tissue has a higher content of urea due to the presence of urine. Ammonia, a product of protein metabolism in mammals, is converted to urea and excreted in urine. According to the urea cycle theory by Krebs and Henseleit (12, p.1039), ornithine is condensed with ammonia and carbon dioxide to form citruline which will react with another molecule of ammonia to produce arginine. Arginine is hydrolized by the enzyme arginase and produces urea and ornithine which goes into the cycle again.

Since urea is the end product of protein metabolism, variations in its level in the blood would suggest the ability of the animal to utilize protein. The entire process, then must be influenced by the hormones which affect growth. Teel and Watkins (33, p.662-685) detected a decrease of urea concentration in blood of dogs after the injection of anterior pituitary extracts. They concluded that this reduction was due to the effect of the growth hormone on the greater rate of utilization of amino acid in building up new protoplasm. Fraenkel-Conrat and coworkers (8, p.200-212) could not detect a significant decrease in blood urea level after the injection of thyrotropic hormone into thyroidectomized rats, whereas the administration of thyroxin into normal rats decreased the concentration of blood urea as did thyrotropic hormone. It was concluded that the effect of the thyrotropic hormone was induced through the thyroid gland.

As shown by MacDonald (20, p.48) blood urea concentrations increased with decreases in rate and efficiency of gain in calves at 500 pounds, but this relation was not detected at 800 pounds of body weight. The highly efficient calves showed a low level of urinary urea. Price and coworkers (27, p.1-9) suggested this relationship between blood urea levels and rate and efficiency of gain is due to the small amount of blood amino acids being deaminated with larger portions of amino acids being used for protein synthesis by the faster gaining calves. Williams (36, p.45) also detected a difference in blood urea concentration in calves due to sex; while Jessup (15, p.51) did not find a difference in blood constituents due to sex in sheep. The concentrations of blood urea were found to be affected by weight.

III. MATERIALS AND METHODS

The data used in this study were from 35 ewes and their 48 lambs at Oregon State University. Five breeds of sheep were used in this study; namely, Border Cheviot, Dorset Horn, Columbia, Suffolk and Willamette (developed at Oregon State University) (Table 1).

General Management

All the lambs were born during February and March of 1962 at Oregon Agricultural Experiment Station. The lambs were allowed to run with their dams on pasture and, in addition, the lambs had access to creep feed. The birth weight of each lamb was recorded as soon as possible after birth, the lambs were identified by ear tag and by branding with paint on the both sides of the body. The rate of growth of all lambs was measured by weighing each lamb every two weeks after birth. The blood samples of the test ewes and their lambs were collected on the same morning between 5:00 and 7:00 A.M., after the weights of the lambs had been recorded, and after the lambs had been separated from their dams for about six hours. The work covered a span of seven two-week periods. The first period was started when the lambs were about one to two

Table 1. Breeds and numbers of animals used in the experiment.

Breed	Number of Lambs		Number of Ewes Raising Lambs	
	Male	Female	Single	Twin
Willamette	6	3	5	2
Suffolk	4	6	4	3
Columbia	5	6	7	2
Dorset Horn	3	6	1	4
Border Cheviot	7	2	5	2

weeks old.

Blood Collection

Ten ml. samples were drawn from the jugular vein of each animal. Stainless steel bleeding needles were used and blood was collected in pyrex tubes using neutral potassium oxalate at a rate of one mg. per ml. in preference to other anticoagulants (12, p.541).

Chemical Methods

The methods used to determine the concentration of amino acid nitrogen and of urea nitrogen in the blood of the test animals were those methods that have been developed and extensively employed for analysing blood of human and other species. For photometric determinations, optical density was determined with a Coleman Model 6A Junior Spectrophotometer employing one cm. cuvettes.

The determination of the concentration of amino acid and urea nitrogen in the blood required the preparation of the protein-free blood filtrate. The filtrate was prepared according to the method of Folin and Wu (7, p.81-110). The amino acid determination used (12, p.565) was based on an original proposal by Folin with improvement by Danielson

(3, p.505-522) and Sahyun (29, p.548-553) and the method of adaptation for photometric measurement by Frame, Russel and Wilhemi (9, p.255-270) and Russel (28, p.467).

Urea was determined according to a method based on an original procedure by Karr (16, p.329-333) using gum ghatti as a stabilizing colloid (19, p.189-195).

IV. RESULTS

Blood amino acid and urea nitrogen concentrations are presented according to breeds, ages or periods, sexes, types of birth and weights of the lambs. The relationships among nitrogenous constituents of the blood and body weights are presented as correlation coefficients between each of the constituents as well as each of the constituents with weight and age. The correlation coefficients of blood amino acid and urea nitrogen of the blood of the dams with blood constituents of lambs and with body weights of lambs are also presented.

Blood Amino Acid Nitrogen of the Lambs

The average concentration of blood amino acid nitrogen of all the lambs for seven periods was 7.47 mg. per 100 ml. of blood. The highest level, 7.84 mg. was found in the Suffolks whereas Columbias gave the lowest value of 7.23 mg. per 100 ml. of blood. The amino acid nitrogen concentrations in the blood of Willamettes, Dorset Horns and Border Cheviots were close to the average for all the animals. The mean concentrations for the five breeds were: Willamettes 7.35, Suffolks 7.84, Columbias 7.23, Dorset Horns 7.45, and Border Cheviots 7.47 mg. per 100 ml.

blood. The differences due to breeds were significant while sex and birth type differences were not found to be significant (Table 2).

Blood Urea Nitrogen of the Lambs

In contrast to blood amino acid nitrogen, the concentration of blood urea nitrogen was not found to be different due to the breeds (Table 3). However, the concentrations were significantly different due to type of birth (single vs. twin) and to periods. Single lambs had higher concentrations than twin lambs, and both groups showed a decrease in blood urea nitrogen levels from the first period. The mean values for the concentration of blood urea nitrogen were 19.06 mg. per 100 ml. of blood for single and 17.95 for twin lambs. The average concentrations of blood urea nitrogen of single and twin lambs in each period are shown in Table 4. No differences were found in blood urea nitrogen levels due to sex.

Weight of the Lambs

Weights of the lambs were significantly different due to breeds, types of birth, and periods, but no sex differences could be observed (Table 5). The mean weights,

Table 2. Analysis of variance of blood Amino Acid Nitrogen concentration of five breeds of lambs.

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Period	6	37925.00	6320.83	1.91
Breed	4	133074.00	33268.50	10.03**
Sex	1	3378.16	3378.16	1.02
Birth Type	1	115.19	115.19	0.03
Error	306	1014772.00	3316.08	

** Indicates significance at the 1% level of probability.

Table 3. Analysis of variance of blood Urea Nitrogen concentration of five breeds of lambs.

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Period	6	17508.00	2918.00	4.64**
Breed	4	4886.00	1221.50	1.94
Sex	1	1554.96	1554.96	2.47
Birth Type	1	6480.79	6480.79	10.30**
Error	306	192592.00	629.39	

** Indicates significance at the 1% level of probability.

Table 4. Blood Urea-N concentrations of lambs, single vs. twin, for seven two-week periods.

Period	Single		Twin	
	Number of Animals	mg. Urea-N per 100 ml. Blood	Number of Animals	mg. Urea-N per 100 ml. Blood
1	17	21.39	20	18.46
2	22	18.55	26	17.22
3	22	18.35	26	17.28
4	22	19.74	26	19.38
5	22	18.42	26	17.35
6	21	18.46	26	18.68
7	21	18.55	22	17.29
Average		19.06		17.95

Table 5. Analysis of variance of weights of five breeds of lambs.

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Period	6	9711842.00	1618640.33	39.74**
Breed	4	638380.00	159595.00	39.19**
Sex	1	89.08	89.08	0.02
Birth Type	1	397096.93	397096.93	97.52**
Error	306	1246022.00	4071.97	

** Indicates significance at the 1% level of probability.

in each period, for single and twin lambs of each breed are shown in Table 6. Both single and twin lambs of the five breeds showed a steady increase in body weight with age, and single lambs were heavier than twin lambs throughout the seven periods. The Suffolk twin lambs were lighter in body weight at the seventh period than that at the sixth period. This was probably due to the slaughtering prior to the seventh period of two pairs of twin lambs which showed high growth rate during each of the previous periods. In general, at the end of the seventh period, the Willamettes had the heaviest body weight as single or twin lambs. They were followed by Suffolks, Columbias, Dorset Horns and Border Cheviots. The Columbia twin lambs had an average body weight less than that of Dorset Horn twins. At the end of the seventh period the mean weights of the single lambs were: Willamette 86.5, Suffolk 81.8, Columbia 77.0, Dorset Horn 70.0 and Border Cheviot 63.0 pounds. The average weights of the twin lambs were: Willamette 71.5, Suffolk 65.5, Columbia 60.5, Dorset Horn 63.5 and Border Cheviot 57.0. The growth curves of these lambs are shown in Figures 1, 2, 3, 4 and 5. Growth curves showed a wide difference in body weight between single and twin lambs, particularly for the Willamettes and Columbias while Suffolks did not show much difference in body weights between single and

Table 6. The average weights of five breeds of lambs, single vs. twin, for seven two-week periods.

Periods		1		2		3		4		5		6		7	
Breeds	Birth Type	No. of lambs	Wt. lb.	No. of lambs	Wt. lb.	No. of lambs	Wt. lb.	No. of lambs	Wt. lb.	No. of lambs	Wt. lb.	No. of lambs	Wt. lb.	No. of lambs	Wt. lb.
Border Cheviot	Single	3	16.90	5	23.78	5	31.70	5	38.00	5	45.00	5	54.60	5	63.00
	Twin	2	12.25	4	16.63	4	23.25	4	30.00	4	38.00	4	49.00	4	57.00
Dorset Horn	Single	-	-- --	1	21.50	1	32.50	1	40.00	1	49.00	1	60.00	1	70.00
	Twin	4	17.95	8	21.69	8	29.13	8	36.13	8	45.63	8	53.13	8	63.50
Suffolk	Single	2	15.35	4	27.70	4	39.25	4	48.25	4	58.50	4	70.25	4	81.75
	Twin	6	19.10	6	27.33	6	37.17	6	46.67	6	56.67	6	66.17	2	65.50
Columbia	Single	7	18.84	7	27.43	7	36.00	7	45.57	7	56.57	6	67.83	6	77.00
	Twin	4	17.20	4	22.05	4	28.25	4	35.75	4	46.00	4	52.00	4	60.50
Willamette	Single	5	19.24	5	30.60	5	42.20	5	52.80	5	64.60	5	75.00	5	86.40
	Twin	4	14.35	4	21.13	4	28.63	4	37.50	4	49.25	4	62.50	4	71.50

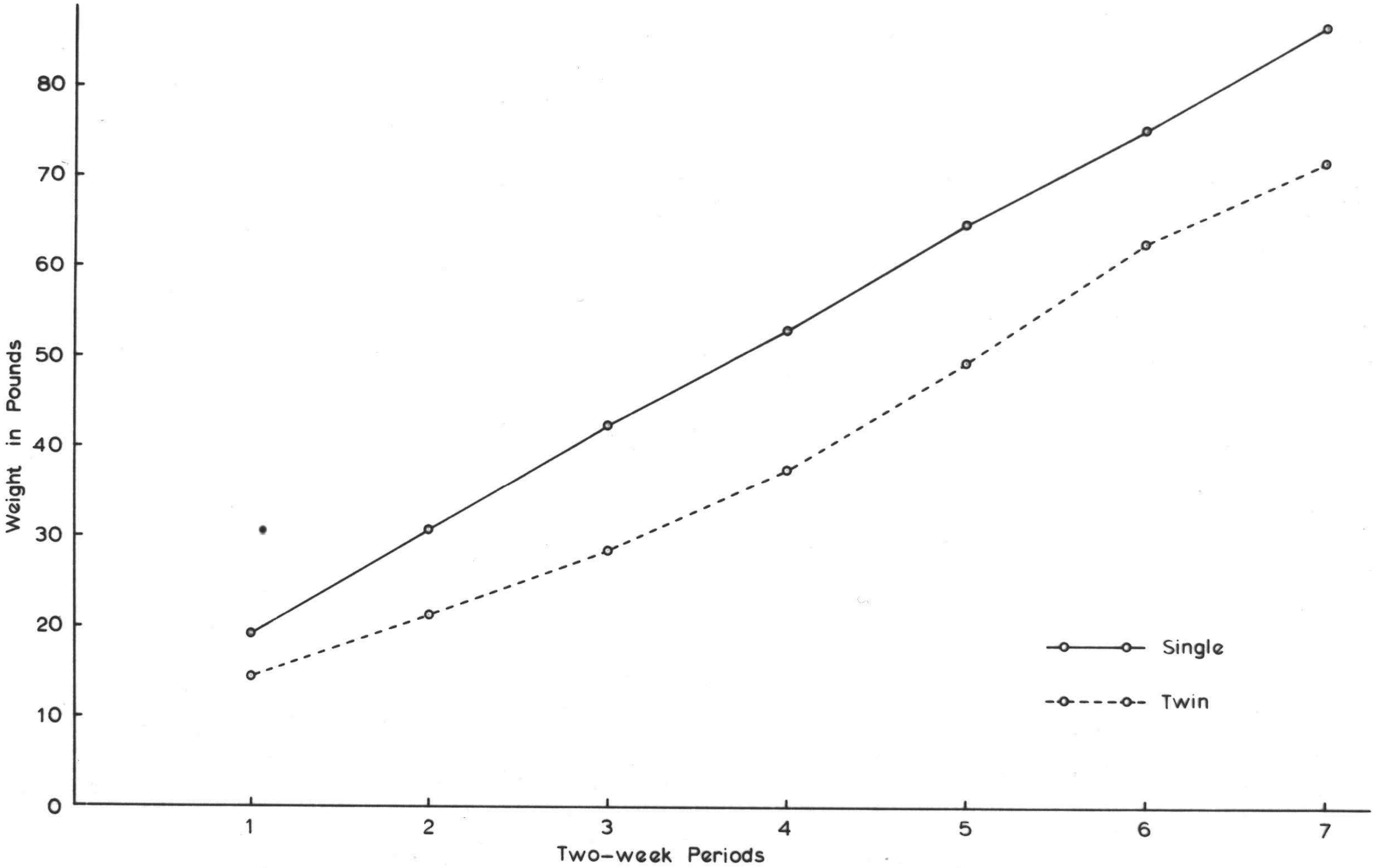

Fig.1 Growth Rate of Willamette Single and Twin Lambs

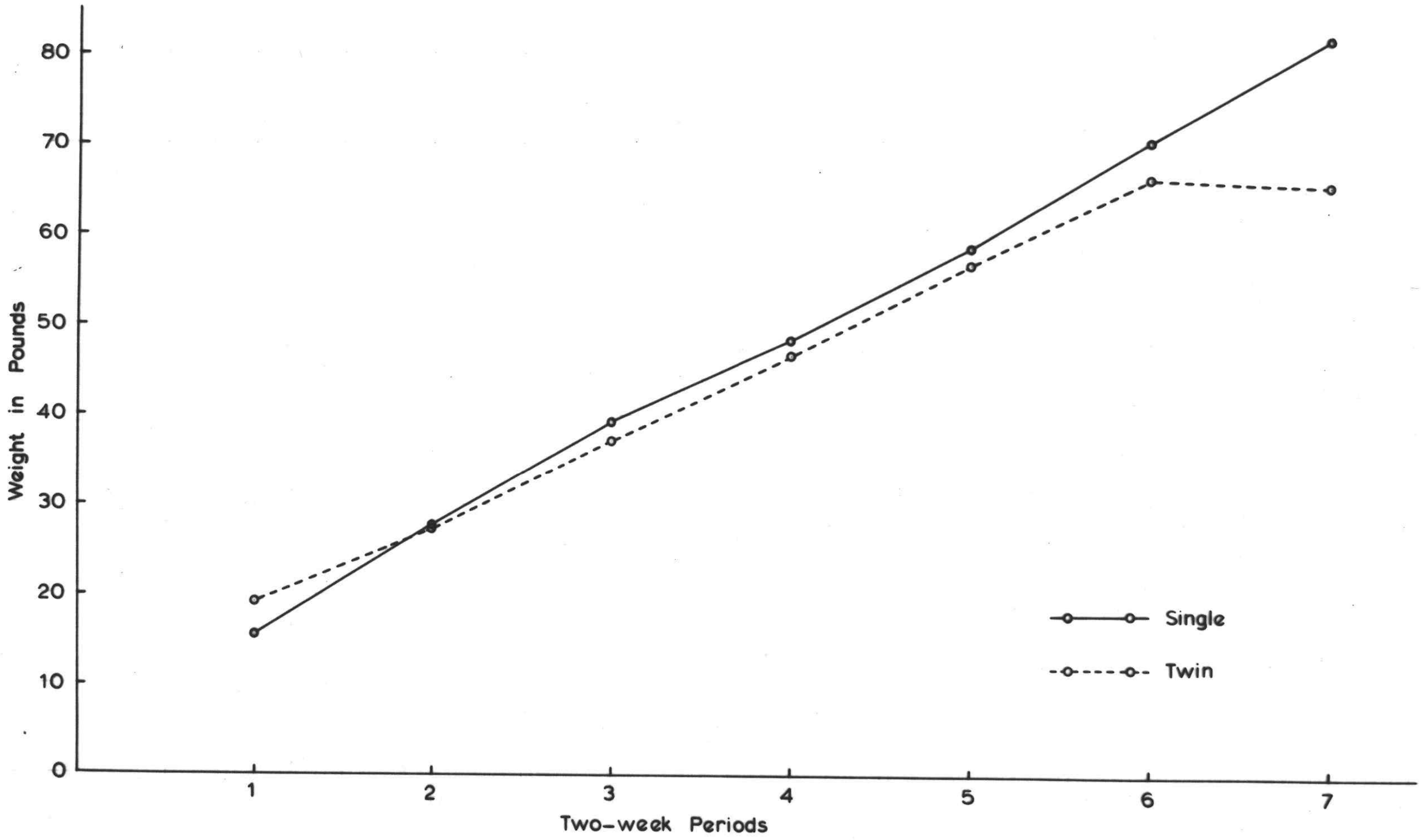

Fig. 2 Growth Rate of Suffolk Single and Twin Lambs

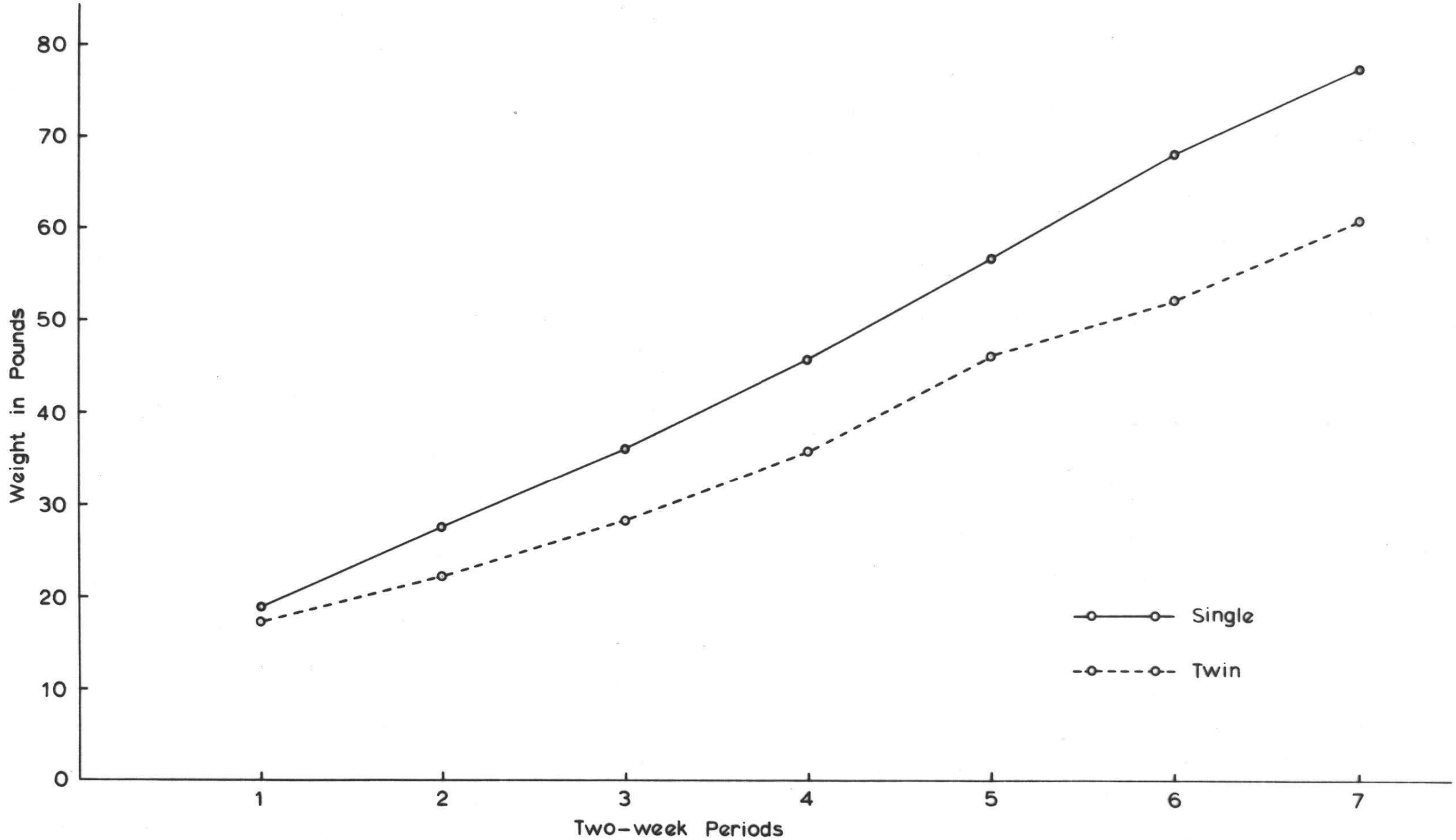

Fig. 3 Growth Rate of Columbia Single and Twin Lambs

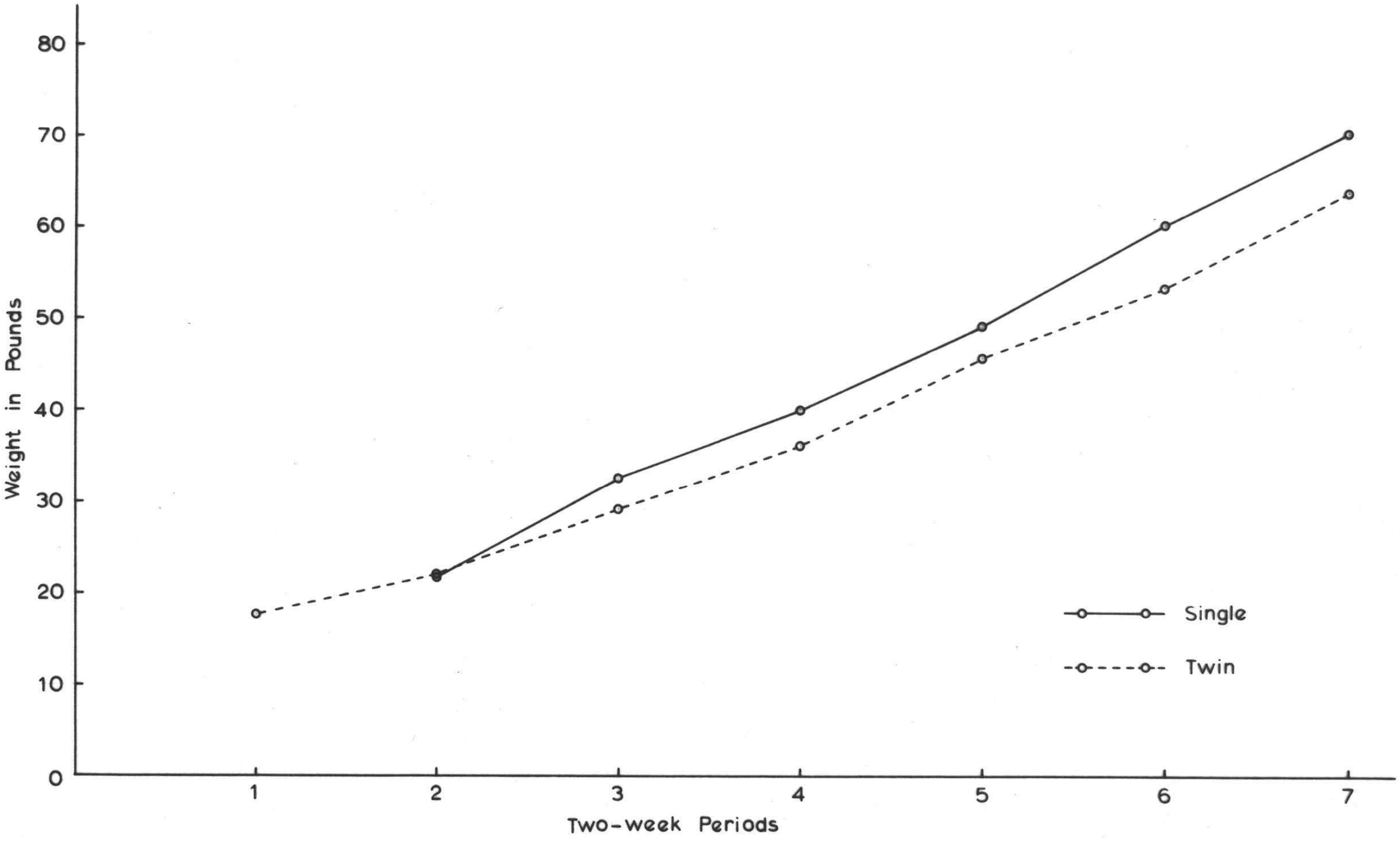

Fig. 4 Growth Rate of Dorset Horn Single and Twin Lambs

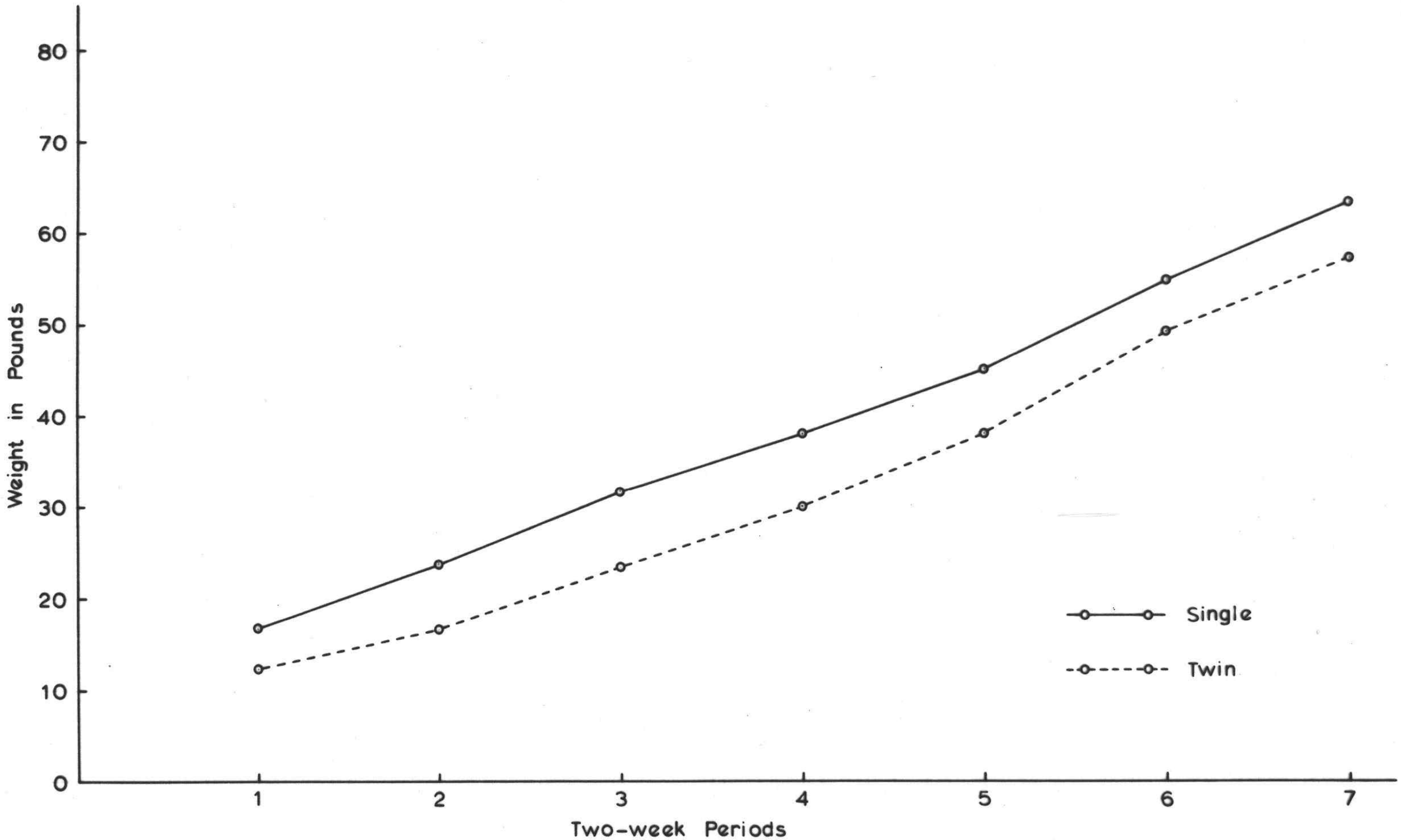

Fig.5 Growth Rate of Border Cheviot Single and Twin Lambs

twin lambs.

Blood Amino Acid and Urea Nitrogen of the Ewes

The concentrations of blood amino acid and urea nitrogen of all the ewes showed highly significant differences due to periods. Except for the Columbias, blood urea nitrogen increased generally at the second period after which all the ewes showed decreases in blood urea nitrogen levels until the end of the experiment. Blood amino acid nitrogen levels, however, were not extremely variable. The differences due to breeds for blood amino acid and urea nitrogen concentrations were significant (Tables 7 and 8). The average blood amino acid and urea nitrogen levels among ewes of the five breeds for each period are shown in Tables 9 and 10.

The Relationship of Blood Constituents with Weight of Lamb and with Blood Constituents of Ewe

Combining all breeds, blood amino acid and urea nitrogen levels of all the lambs were highly correlated, while within the breeds only Border Cheviots showed a significant correlation coefficient between those two blood factors. No

Table 7. Analysis of variance of blood amino acid nitrogen concentration among the five breeds of ewes for seven two-week periods.

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Period	6	93041.00	10506.83	4.22**
Breed	4	28180.00	7045.00	2.83*
Error	178	443022.00	2488.89	

* Indicates significance at the 5% level of probability.
** Indicates significance at the 1% level of probability.

Table 8. Analysis of variance of blood urea nitrogen concentration among the five breeds of ewes for seven two-week periods.

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Period	6	139230.00	23205.00	22.34**
Breed	4	12629.00	3157.25	3.04*
Error	178	184915.00	1038.85	

* Indicates significance at the 5% level of probability.
** Indicates significance at the 1% level of probability.

Table 9. The average blood amino acid nitrogen concentrations among the five breeds of ewes for seven two-week periods.

Periods	1		2		3		4		5		6		7	
Breeds	No. of ewes	Mg. per 100 ml. blood	No. of ewes	Mg. per 100 ml. blood	No. of ewes	Mg. per 100 ml. blood	No. of ewes	Mg. per 100 ml. blood	No. of ewes	Mg. per 100 ml. blood	No. of ewes	Mg. per 100 ml. blood	No. of ewes	Mg. per 100 ml. blood
Border Cheviot	4	7.08	7	7.69	7	7.02	7	6.97	7	7.72	7	7.27	7	7.41
Dorset Horn	2	6.61	5	7.60	5	6.77	5	7.30	5	7.33	5	7.25	5	7.06
Suffolk	5	7.27	7	7.56	7	7.04	7	7.01	5	7.65	5	7.53	4	7.09
Columbia	9	7.04	9	7.33	9	6.86	9	6.57	8	7.06	8	6.80	7	6.97
Willamette	7	7.28	7	7.34	7	7.26	7	7.12	7	7.67	7	7.63	7	7.27

Table 10. The average blood urea nitrogen concentrations among the five breeds of ewes for seven two-week periods.

Periods	1		2		3		4		5		6		7	
Breeds	No. of ewes	Mg. per 100 ml. blood	No. of ewes	Mg. per 100 ml. blood	No. of ewes	Mg. per 100 ml. blood	No. of ewes	Mg. per 100 ml. blood	No. of ewes	Mg. per 100 ml. blood	No. of ewes	Mg. per 100 ml. blood	No. of ewes	Mg. per 100 ml. blood
Border Cheviot	4	23.40	7	24.34	7	20.76	7	20.89	7	20.68	7	17.76	7	16.96
Dorset Horn	2	22.35	5	26.14	5	23.72	5	22.00	5	22.48	5	18.94	5	18.70
Suffolk	5	22.94	7	25.04	7	22.26	7	20.14	5	19.72	5	18.66	4	18.23
Columbia	9	26.17	9	21.71	9	20.84	9	20.96	8	19.24	8	17.18	7	15.67
Willamette	7	24.33	7	24.31	7	20.57	7	25.14	7	19.64	7	16.77	7	15.17

significant correlation coefficients of blood amino acid and urea nitrogen with age and weight were found. The average correlation coefficient within breeds and periods of amino acid nitrogen concentration in the blood of the lambs with that in the blood of the dams was found to be highly significant. Within each of the breeds, regardless of periods, this relationship was not found to exist.

The average correlation coefficient within the breeds and periods, of the weight of lambs with amino acid nitrogen levels of their dams was found to be highly significant; whereas, the correlation coefficient between blood urea nitrogen levels of the dams and weights of the lambs was not found to be significant. No significant correlation coefficient for each breed between blood amino acid nitrogen levels of the dams and weight of the lambs was found. However, the Willamette, Suffolk and Columbia breeds did show a high negative correlation coefficient between weight of lambs and concentration of blood urea nitrogen of the dams. No significant correlation coefficient was found for Border Cheviots and Dorset Horns between blood urea nitrogen of the dams and weight of the lambs.

V. DISCUSSION

Blood Constituents and Weights of Lambs

The average concentration of blood amino acid and urea nitrogen levels were in the normal range for sheep as reported by Dukes (4, p.49). No differences due to sex were found for either of the constituents which is in agreement with a lack of a difference in body weights of the two sexes. The results are in agreement with the findings of Plotka (26, p.28) in a study on the same group of animals. Plotka could not detect any difference due to sex in the amount of thyrotropic hormone of the pituitary glands, whereas significant breed differences were observed. Since the pituitary hormone affects growth through the utilization of amino acids in building up new protoplasm (17, p.91-95), it is reasonable to expect that differences due to breeds for blood amino acid levels would result in breed differences for body weights. The distribution of blood amino acid nitrogen levels appeared to be consistent through the whole period of the experiment. Although Jessup (15, p.52) found fluctuations for these levels in the very young lamb, this did not occur with increasing age in the present study. No variations for blood levels of amino acid nitrogen could be shown to be attributable to periods. However, correlations between its concentration and weight or age could not be detected, whereas the correlation coefficient between weight and age was highly significant. This evidence seems to indicate that blood amino acids were effectively utilized by the young animals through the influence of pituitary hormone. Thus, with increasing ages and weights, young animals still showed no increase in blood amino acid nitrogen levels due to relatively increased utilization of blood amino acids in building up the new protoplasm as the animals approached adult size. On the other hand, MacDonald (20, p.49) found an increase in blood amino acid nitrogen levels of calves when body weights increased from 500 to 800 pounds. It is possible that the lambs used in the present study more nearly resemble calves under 500 lb. body weight physiologically and might not be expected to show an increase in blood amino acids during the period of this study.

Blood urea nitrogen levels showed significant differences due to period with a decrease in the concentration as age and weight increased. The negative correlation coefficients between blood urea nitrogen levels with age and weight were not significant. This is in agreement with blood amino acid nitrogen levels. As the young animals increased in size, the relative increase in the rate of utilization of blood amino acids left small amounts of amino acids to be deamminated and converted to urea in the blood (27, p.XLIV-1-XLIV-9). There was also a highly significant correlation between blood urea and amino acid nitrogen levels. It is interesting to note that when the correlation was made within breeds, only the Border Cheviots showed a significant relationship between the two blood constituents. It appears that the overall relationship between blood amino acid and blood urea levels exists because certain breeds are high while others are low in both. There was not a general relationship between these two blood constituents within the breeds since this relationship was observed only in the Cheviot breed. The results seem to indicate that Border Cheviots, with the low blood amino acid level and slow rate of growth possess a smaller capacity for utilizing blood amino acid than the Suffolks, which had the highest blood amino acid levels and still showed a high rate of growth. Breed differences for concentrations of blood urea nitrogen could not be detected, whereas differences due to period did exist. However, blood urea nitrogen levels showed slightly negative correlations with age and weights which were not significant. Jessup (15, p.57) found no relationship between urea nitrogen level and weight or age. Also, there was a decrease in the mean urea levels between two and six weeks of age followed by increasing values which reached a maximum at ten to 12 weeks. Since blood amino acid nitrogen tended to be consistent throughout all the periods, this seems to indicate that, instead of depending upon breeds, blood urea nitrogen concentrations were dependent upon the concentrations of blood amino acid nitrogen. Twin lambs also have the same genetic potential for growth as single lambs of the same breeds. However, during the suckling period, twin lambs receive a lesser supply of amino acids than single lambs due to the competition for milk between their mates. According to the same genetic potential and different supplies of amino acids, twin lambs would have a smaller amount of urea left in the blood than those of single lambs. This was well supported by the lower levels of blood urea nitrogen in twins compared to single lambs.

Body weights of lambs were observed to be different among the breeds and periods. The correlation between weight and age was highly significant. This is in agreement with the work of Gregory and Castle (10, p.199-211) who found that genetic differences in growth were expressed very early in life of rabbits. They explained that this was due to a different rate of cell division of large and small breeds of animals. Differences were found for body weights due to breed, period and type of birth, while no sex differences were detected. These results are in agreement with blood amino acid and urea nitrogen levels as previously explained. The wide differences in weight between single and twin lambs of the Willamettes and Columbias were probably due to the low milk yields of the dams. In the case of the Suffolks, the average weight of twin lambs was close to that of single lambs. This seems to indicate that Suffolk ewes had good mothering ability and high milk yields. However, Dorset Horn and Border Cheviot single and twin lambs showed a moderate difference between their weights which was not as great as in Willamettes and Columbias.

<u>Blood Constituents of Ewes and Its Correlation with Blood Constituents and Weights of Lambs</u>

The concentrations of blood amino acid and urea nitrogen were different due to breeds and periods. This probably affected milk yields and growth of lambs during the nursing period. Except for Columbias, all the ewes showed a marked increase in blood urea nitrogen levels at the second period after which a steady decrease was observed. This might be caused by an increase in the use of amino acids for energy of milk production in the second period. As milk yields declined, smaller amounts of amino acids were deaminated and used by the animal. Urea, remaining in the blood, then would be lower from the second period until the end of the experiment. In a study on lactation of Suffolk ewes for fourteen complete lactations, Wallace (35, p.93-152) found that milk yields reached its maximum during the second and third week after which it declined steadily. Since the concentration of blood amino acid nitrogen was different due to breeds, and assuming that milk yields were also different, it is reasonable that blood urea nitrogen levels should be different due to a difference in ability to use amino acids for energy of milk production.

The average correlation coefficient within breeds and periods of dam's blood amino acid nitrogen levels with concentrations of blood amino acid of lambs was highly significant, while a non-significant negative correlation was found between dam's blood urea nitrogen level and weights of the lambs. This appears to be in agreement with growth of the lambs. During the early part of the suckling period lambs received their supply of blood amino acids chiefly from the milk of the ewes. The lambs utilized these amino acids to build up new protoplasm and thus increased in body weight. The relationship between blood amino acids of the dam and blood amino acid levels and weights of their lambs were not significant for any breed for all seven periods. This might indicate that later in life the lambs were more independent of their dams and also genetic patterns of the lambs could be expressed more readily. Blood urea of the dams decreased due to a decrease in milk yields while the lambs increased their body weights due to a shift from milk to forage ingestion as a means of obtaining protein. A negative correlation between blood urea nitrogen of the dams and weights of the lambs would be expected to occur. However, the average correlation within a breed and within a period was not significant. Whereas, for all seven periods, Willamettes, Suffolks and Columbias showed a highly negative correlation between body weights of lambs and blood urea nitrogen levels of dams. This was probably caused by the high rate of growth of lambs and at the same time by the rapid decrease in milk yields of dams.

VI. SUMMARY

1. The concentrations of blood amino acid and urea nitrogen were associated with body weights and growth of lambs. While only breeds were different for the levels of blood amino acid nitrogen, blood urea nitrogen concentrations were different due to periods and types of birth.

2. Blood urea nitrogen decreased in concentration as age and weight increased, whereas, amino acid nitrogen of the blood tended to be consistent. Twin lambs had lower levels of blood urea nitrogen than single lambs, and this was probably due to the insufficient supply of amino acids from milk of the dams.

3. The relationship between blood amino acid and urea nitrogen was highly significant although neither constituent was related to age nor body weight.

4. Body weights of lambs were different among breeds and periods. Body weight was highly related to age. Single lambs were heavier than twins throughout the seven periods and the differences were marked in Willamettes and Columbias. This might be because the ewes of these breeds could not supply enough milk for the high growth rate of twin lambs.

5. No sex differences for blood constituents or body weights of lambs were detected. This was probably

due to the fact that during early life the potency of sex hormones were not great enough to show a difference between males and females.

6. In ewes, the concentrations of blood amino acid and urea nitrogen levels were different due to breeds and periods. Milk yields and growth of offspring were probably influenced by these differences.

7. Within a breed and a period, the average correlations between the concentrations of blood amino acid nitrogen of ewes and the blood amino acid levels and weights of the lambs were highly significant.

8. Within breeds, blood urea nitrogen of ewes were highly negatively correlated with body weights of their lambs for the Willamette, Suffolk and Columbia breeds; whereas significant correlations were not detected in Dorset Horns and Border Cheviots. However, when calculated within breeds and periods, the average correlation coefficient was not significant.

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