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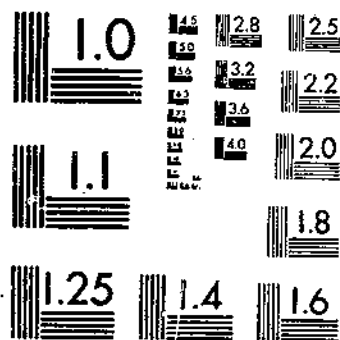
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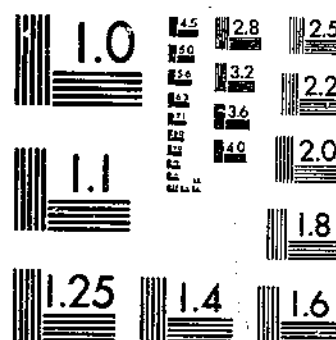
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THE GENETICS, PHYSIOLOGY, AND ECONOMIC IMPORTANCE OF THE MULTINIPPLE  
PHILLIPS, R. W., SCHOTT, R. G., SPENCER, D. A. 1 OF 1

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NATIONAL BUREAU OF STANDARDS-1963-A



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NATIONAL BUREAU OF STANDARDS-1963-A



UNITED STATES  
DEPARTMENT OF AGRICULTURE  
WASHINGTON, D. C.

# The Genetics, Physiology, and Economic Importance of the Multinipple Trait in Sheep<sup>1</sup>

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## CONTENTS

	Page		Page
Introduction .....	1	Data and discussion—Cont'd	
Purpose of the study .....	2	Relation of number of nipples to lamb production .....	7
History of the multinippled sheep ..	2	Udder capacity and anatomy ..	9
Data and discussion .....	5	Summary and conclusions .....	15
Inheritance of the multinipple trait .....	5	Literature cited .....	16
Relation of total number of nipples to number of functional nipples .....	7		

## INTRODUCTION

8-1946  
DEPOSITORY

Few sheep having more than two nipples are observed frequently, but little attention has been given to the multinipple trait in sheep-breeding operations or research. Work initiated by Alexander Graham Bell focused attention on the trait, and the flock founded by him received considerable publicity. His objective was to develop a type of sheep that could produce two or more lambs at a birth and have adequate milk on which to raise them. Investigations with his original flock demonstrated that the number of nipples could be increased by selection, and some success apparently attended efforts to increase the tendency for multiple births.

Castle (5)<sup>2</sup> examined the data accumulated by Bell (7) and concluded that the character, supernumerary nipples, is strongly inherited,

<sup>1</sup> Received for publication September 19, 1945.

<sup>2</sup> Italic numbers in parentheses refer to literature cited, p. 16.

but no detailed analysis was made to determine the mode or degree of heritability. Ritzman (13) studied the problem further and proposed an explanation of the mode of inheritance. It was based on the assumption that additional gland development was correlated with a large number of nipples. The theory proposed included three pairs of genes for gland development and three pairs for nipple number. These genes might be present in varying "dosages," and recombinations could result in offspring having various numbers of nipples and varying degrees of nipple and gland development. Ritzman reports that the theoretical and expected ratios were in rather close agreement.

Popova and Kardymovich (12) studied inheritance of the multi-nipple condition in various breeds of sheep in Russia and concluded that four nipples resulted from the presence of dominant genes  $VV$ , whereas ewes with two nipples had recessive genes  $nn$ . Ewes with intermediate nipple development were assumed to be heterozygous,  $Vn$ . It was assumed that  $V$  might not be completely dominant in all cases, and it was suggested that occurrence of more than four nipples was due to a modifier,  $En$ , which operated only in the presence of  $V$ .

### PURPOSE OF THE STUDY

Two important questions concerning the usefulness of the multi-nipple condition remained unanswered: (1) Are the multinipple trait and the tendency for multinipple births correlated? (2) Do lambs from ewes with more than two nipples obtain more milk and therefore make faster gains than other lambs? To answer these questions and, from the results obtained, to determine whether this trait should be encouraged by selection, whether it is undesirable (in which case ewes possessing it should be eliminated), or whether it is unimportant and therefore may be disregarded in practical breeding operations, a study was begun in 1941 by the United States Department of Agriculture with descendants of the Bell flock.

### HISTORY OF THE MULTINIPPLED SHEEP

Alexander Graham Bell began sheep breeding in 1889, and detailed records on the occurrence of the multinipple condition in his flock date from 1890. His original flock of multinippled animals was apparently selected from nondescript farm flocks in the vicinity of his farm at Beinn Bhreagh, near Baddeck, Nova Scotia and the mutton and wool qualities were not well developed. This observation is borne out by Miller (8), who used a multinippled ram descended from Bell's flock on improved ewes at Rothamsted, England, and discarded the lambs because of their inferior characteristics. Bell's flock was broken up in 1914, but part of it was continued by Mrs. Bell, and Mr. Bell supervised it and another part of the flock, owned by a neighbor, until June 1922, shortly before Bell's death. Details of the management and breeding are given by him (2, 3).<sup>3</sup>

The New Hampshire Agricultural Experiment Station (2, 10) obtained one ram and five ewes from Mrs. Bell's flock in 1923 and eight

<sup>3</sup> Information also is given in the following periodical: BELL, A. G. SHEEP BREEDING EXPERIMENTS ON BEINN BREAGH, Beinn Bhreagh Recorder 10:368-386, 1915. (Typewritten.)

## ERRATA SHEET

Legend under illustration on page 5, should read:

Figure 4.-Average number of nipples, by sire groups, on sires, dams, and offspring in the multinippled flock during more recent years. These data were obtained during 1926-1943, inclusive.

more ewes in 1924. This station had already developed a flock of Southdown  $\times$  Rambouillet sheep and also a group of Rambouillet  $\times$  Oxford sheep, but most of the latter cross had been discarded. Multinippled rams were mated to ewes of the two crosses in an attempt to combine desirable mutton and wool characteristics and the multi-nipple trait. Later on, many of the ewes descending from this cross were mated with a four-nippled Suffolk ram to give the sheep the appearance of a standard breed. This work is described in detail by Ritzman (13, 14).



FIGURE 1.—Representative ewes included in this study. The black-faced ewes have approximately  $\frac{1}{2}$  Suffolk,  $\frac{1}{4}$  Bell multinipple,  $\frac{1}{8}$  Southdown, and  $\frac{1}{8}$  Rambouillet blood. The white-faced ewe has  $\frac{1}{2}$  Bell multinipple,  $\frac{1}{4}$  Southdown, and  $\frac{1}{4}$  Rambouillet blood.

Most of the flock thus formed at the New Hampshire station was purchased by the Bureau of Animal Industry of the United States Department of Agriculture and transferred, late in 1941, to the United States Morgan Horse Farm, Middlebury, Vt. The transferred animals included 15 females of approximately  $\frac{1}{2}$  Bell multinipple,  $\frac{1}{4}$  Southdown, and  $\frac{1}{4}$  Rambouillet blood (referred to later as the "B" animals), and 46 females of approximately  $\frac{1}{2}$  Suffolk,  $\frac{1}{4}$  Bell multinipple,  $\frac{1}{8}$  Southdown, and  $\frac{1}{8}$  Rambouillet blood (the "SB" animals). Most of these ewes had 4 nipples and some had 5 or 6. Representative ewes are shown in figure 1. Rams used on this flock of ewes at Middlebury had 4 nipples, except 1 with 5 nipples. These included 2 SB rams, 1 Suffolk ram that had been used in the flock at New Hampshire, 2 rams resulting from mating the Suffolk to SB ewes, 1 ram resulting from mating a B ram to an SB ewe, and 2 Columbia rams. Typical rams produced or used in the flock are shown in figure 2.

The data used in this study were obtained during 3 years of breeding work at Middlebury, Vt., from the foundation ewes of the Middlebury flock, from their immediate ancestors at the New Hampshire

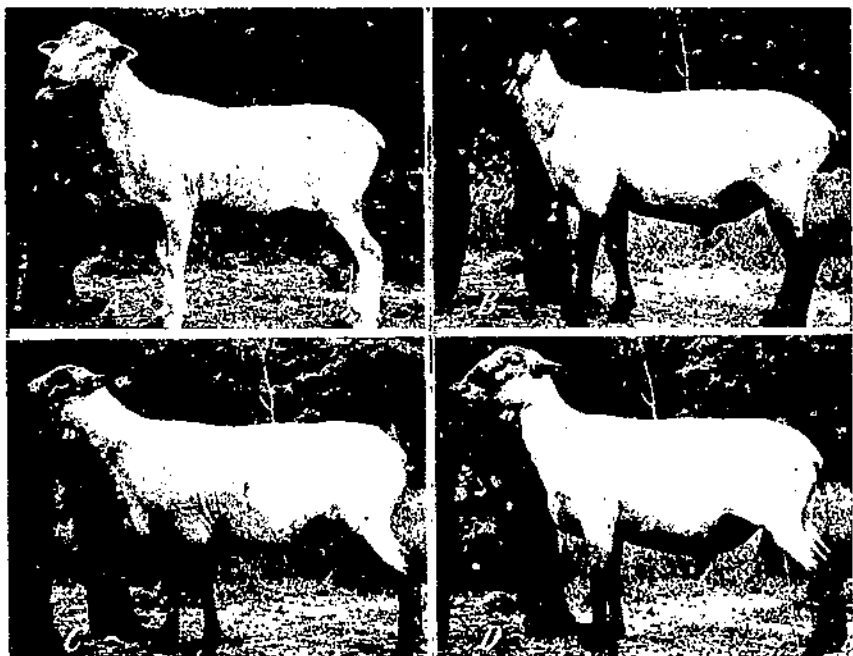


FIGURE 2.—Four rams that were produced or used in the multipipple flock: *A*, Ram of  $\frac{1}{2}$  Bell multipipple,  $\frac{1}{4}$  Southdown, and  $\frac{1}{4}$  Rambouillet blood; *B*, multipippled Suffolk ram used to introduce Suffolk blood into the flock at the New Hampshire station; *C* and *D*, two rams of  $\frac{1}{2}$  Suffolk,  $\frac{1}{4}$  Bell multipipple,  $\frac{1}{8}$  Southdown, and  $\frac{1}{8}$  Rambouillet blood.

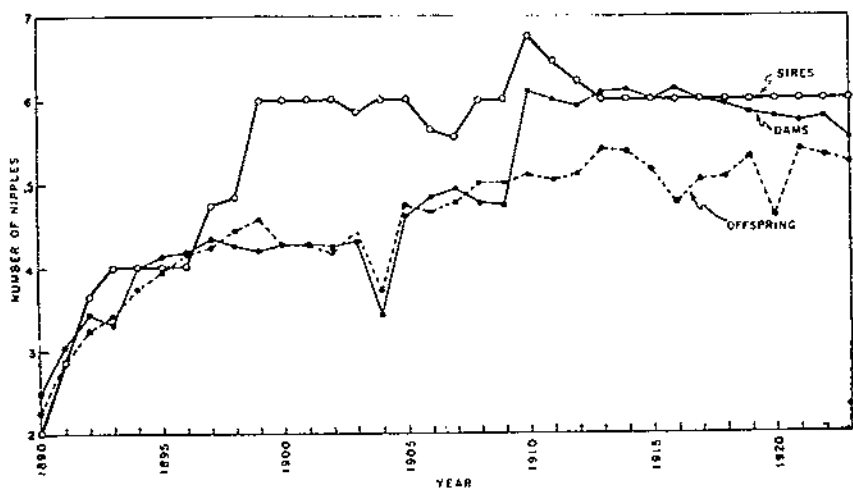


FIGURE 3.—Average numbers of nipples per animal, by years, on sires, dams, and offspring in Bell's original multipippled flock.



station, and from the original Bell flock through data tabulated by Bell (1) and summarized by Castle (5). Details of the methods of obtaining and analyzing the data are given in subsequent sections.

## DATA AND DISCUSSION

### INHERITANCE OF THE MULTINIPPLE TRAIT

The results of selection for the multinipple condition in the original Bell flock are presented in figure 3. They show that it was possible, by selection of rams and ewes, to increase the average nipple number in offspring to approximately four in a comparatively short time. Progress beyond this point was much slower even though rams averaging approximately six nipples were used and the number of nipples on dams averaged six or nearly so from 1910 on.

The numbers of nipples on sires, dams, and offspring in the flock at the Morgan Horse Farm and on part of this flock and its ancestors at the New Hampshire station are shown in figure 4. The rams are

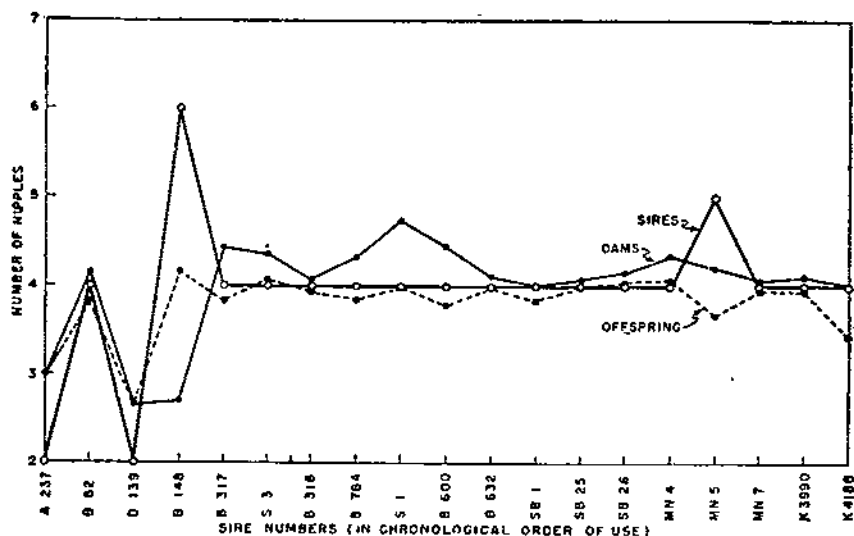


FIGURE 2.—Four rams that were produced or used in the multinippled flock: spring in the multinippled flock during more recent years. These data were obtained during 1926-1943, inclusive.

placed in the chart in order of the first year in which each was used. The periods of use ranged from 1 to 6 years. Ram A 237 was first used in 1926 and rams K 3990 and K 4188 were used in 1943. During the early years at the New Hampshire station, the average numbers of nipples in the flock dropped below the level established by Bell, owing to crossing with types that did not possess the multinipple character. However, by selection of rams and ewes possessing four or more nipples, the number on the offspring was soon stabilized at approximately four.

An analysis of variance was made with the 668 progeny included

in figure 4 to determine the significance of differences between sires in the numbers of nipples on their progeny, after adjustment for numbers of nipples on the ewes to which the sires were mated. The results are presented in table 1. They show that the rams differed significantly in their ability to transmit an increased number of nipples to their offspring.

TABLE 1.—Analysis of variance of the numbers of nipples on dams and their progeny,<sup>1</sup> to determine the significance of differences between sire groups

Source of variation	Degrees of freedom	Sums and squares of products			Errors of estimate		
		$Sx^2$	$Sxy$	$Sy^2$	Sum of squares	Degrees of freedom	Mean square
Total.....	668	789.31	502.01	714.81	276.91	667	-----
Between sire groups.....	18	573.35	489.39	462.80	-----	-----	-----
Within sire groups.....	650	215.76	15.62	251.92	250.79	649	0.387
For test of significance of means adjusted for differences among dams.....					26.12	18	1.450

<sup>1</sup> Progeny at the New Hampshire station and the U. S. Department of Agriculture.

<sup>2</sup>  $F$  value = 3.75, which is highly significant.

The relation between the number of nipples on the dams and the number on their offspring was determined on 668 dam-offspring pairs on a within-sire basis. A ewe was included once for each offspring produced. The coefficient of correlation was  $+0.072$ , and the coefficient of regression was also  $0.072$ . Both of these figures were too small to be significant, but they approached significance at the level of  $P = 0.05$ .

The within-sire dam-progeny correlation may be used as a basis for estimating heritability owing to additive effects of genes. The coefficient of correlation is multiplied by 2. This method and others for estimating heritability are described by Whatley (17). In the present study the estimate of heritability was 14.4 percent. Obviously, this is only a rough approximation since the correlation on which it is based is not sufficiently large to be significant. It is rather low in contrast with Castle's (5) statement that the multinipple character is strongly inherited. However, the present data were obtained on a population in which the number of nipples had become stabilized reasonably well (fig. 4), whereas the data studied by Castle (fig. 3) were obtained when the nipple number was being increased by selection.

The estimates of heritability given in the preceding paragraph were based on the total number of nipples on each dam and her offspring. Data were available on 83 dam-daughter pairs, collected at the New Hampshire station and the Morgan Horse Farm, in which the numbers of functional nipples on both dams and daughters were known. The daughters were sired by 12 rams. An analysis of variance and covariance of the type presented in table 1 showed that the variation between offspring of rams only approached significance. The relation between dams and daughters, as shown by a coefficient of correlation, was 0.13. The coefficient of regression was 0.11. These figures are not significant. Estimates of heritability based on them would be 26 and 22 percent, respectively.

The above estimates of heritability are all based on coefficients of correlation and regression that are too small to be significant and therefore must be regarded as tentative. However, they indicate that variations in nipple number and function were determined in part by heredity in the population studied. These estimates were obtained on a population in which nipple number had been established at a fairly high level by selection. Estimates on animals in which the trait had not been so well fixed, therefore, might be quite different.

#### RELATION OF TOTAL NUMBER OF NIPPLES TO NUMBER OF FUNCTIONAL NIPPLES

Many extra nipples are not functional. This fact is illustrated by the data, given in table 2, on 106 ewes from the New Hampshire station and the Morgan Horse Farm. The coefficient of correlation between total number of nipples and the number of functional nipples was 0.24, which is statistically significant.

TABLE 2.—Relation between total number of nipples and number of functional nipples

Nipples per ewe (number)	Total ewes	Ewes with indicated number of functional nipples					Average number of functional nipples per ewe
		2	3	4	5	6	
		Number	Number	Number	Number	Number	
2	1	1					2.0
3	2	2	0				2.0
4	86	13	18	35			3.5
5	13	3	8	5	5		3.9
6	1	1	0	1	2	0	4.0

#### RELATION OF NUMBER OF NIPPLES TO LAMB PRODUCTION

The vital question, when considering the desirability of the multi-nipple trait, is whether an increased number of nipples is associated with a large lamb crop, an increased rate of growth in lambs, or both. Castle (5) points out that there is not necessarily any relation between number of nipples and twinning, and that there is nothing in the records on Bell's flock to indicate whether or not an increase in milk production accompanied the increase in number of nipples per ewe. Castle doubted whether mere variation in number of nipples would affect materially the amount of milk produced.

The fertility of ewes varies with age. This fact was shown by Johansson (6), who found that fertility increased to the fourth to seventh year of age and then decreased slightly. Kelley (7) reported that Merino ewes produced the largest percentage of twins between 4 and 10 years of age. A similar effect of age was found in the data on multinippled sheep (fig. 5) collected at the New Hampshire station and the Morgan Horse Farm. The average number of lambs per birth increased up to 6 years of age of the ewe and this trend was significant.<sup>4</sup> After 6 years, the level of lamb production declined, but the

<sup>4</sup> For significance of age differences: 2 to 6 years,  $P = < 0.01$ ; 7 to 10 years,  $P = > 0.05$ .

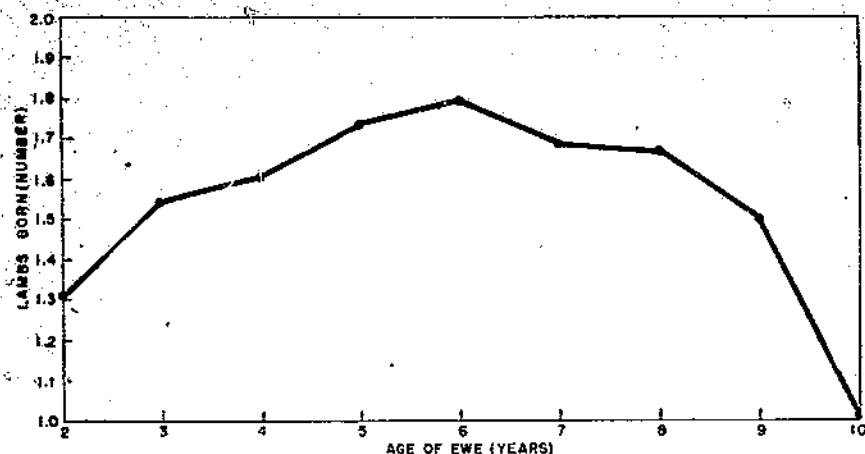


FIGURE 5.—Relation of age of ewe to number of lambs produced at a lambing.

trend was not statistically significant with the small numbers involved (table 3). Therefore, in considering the relation between number of nipples on ewes and number of lambs produced, it was necessary to study the data within each age group.

The relation between number of nipples on ewes and the number of offspring produced at a lambing, in each age group, is shown in table 3. The coefficients of correlation are low, and in only one group (4-year-old ewes) was a coefficient sufficiently large to be significant. Since most of the coefficients are positive, there may be some relation

TABLE 3.—Relation between number of nipples on ewes and number of offspring produced

RELATION OF TOTAL NUMBER OF NIPPLES TO NUMBER OF OFFSPRING				
Age of dam (years)	Number of ewes	Average number of nipples	Average number of lambs produced	Coefficient of correlation between number of nipples and of lambs
2	111	4.15	1.32	0.11
3	96	4.17	1.53	0.15
4	80	4.19	1.60	0.21
5	62	4.21	1.73	0.03
6	42	4.24	1.79	0.01
7	30	4.23	1.67	0.11
8	14	4.13	1.64	0.27
9	4	4.50	1.50	
10	2	5.00	1.00	

RELATION OF NUMBER OF FUNCTIONAL NIPPLES <sup>1</sup> TO NUMBER OF OFFSPRING				
Age of dam (years)	Number of ewes	Average number of functional nipples	Average number of lambs produced	Coefficient of correlation between number of functional nipples and of lambs
2	105	3.5	1.33	-0.004
3	85	3.5	1.54	-0.02
4	70	3.4	1.59	0.29
5	61	3.4	1.74	0.06
6	41	3.4	1.78	0.13
7	30	3.3	1.67	0.20
8	14	3.4	1.61	0.02
9	4	4.2	1.50	
10	2	4.5	1.00	

<sup>1</sup> Significant.

<sup>2</sup> Differences between numbers of ewes in two studies were due to the fact that data on number of functional nipples were not obtained in a few cases.

<sup>3</sup> Highly significant.

between the two characteristics, but it is too low to be of practical value in any selection, for selection for one trait would not result in any material collateral increase in the other. Therefore, development of a multinippled flock by selection would not of itself guarantee larger lamb crops. Popova and Kardymovich (12) studied this problem in a number of Russian breeds and found no correlation between fertility and an increase in number of nipples.

The relation between number of nipples on ewes and the weaning weights of their lambs was determined, this phase of the study being based on records obtained at the Morgan Horse Farm. The weaning weights of all lambs were adjusted to a single-ewe basis, use being made of correction factors obtained from the data themselves, in accord with the results obtained and procedure suggested by Phillips and Dawson (11). The data were analyzed in two ways. In the first analysis each ewe was included once for each offspring produced. The relation was determined for ewes of all ages and also for the 2-year-old group. The numbers of pairs were 186 and 24, respectively. For ewes of all ages, the coefficients of correlation between weaning weights and total number of nipples was  $-0.01$  and between weaning weight and number of functional nipples,  $-0.09$ . For 2-year-old ewes, the coefficients were  $-0.22$  and  $-0.10$ , respectively. In the second analysis, each ewe was included only once and the average of all her offspring was used in calculations. The numbers of pairs were 65 and 23 for ewes of all ages and the 2-year-old ewes, respectively. The coefficients of correlation were  $+0.11$  and  $+0.21$  for ewes of all ages and  $-0.14$  and  $-0.07$  for 2-year-old ewes. None of the coefficients were significant, and there is no indication of a relationship between number of nipples and growth of lambs. If any exists, it might be negative rather than positive, since six of the eight coefficients are negative. These results are in accord with observations by Popova and Kardymovich (12) on several breeds of sheep in Russia. They found no correlation between an increased number of nipples and milk yield.

Bonsma (4) summarized results of other workers on milk yield in sheep and indicates that there is a close relation between milk yield of dam and growth of lambs. Hence, the use of growth rate as an indirect measure of milk yield in the work described seems justified.

One explanation for the unfavorable growth results obtained in the present study is that many of the ewes had two large nipples and two or more smaller ones. Some of the young lambs were unable to nurse the very large nipples, unless given assistance, but the small nipples did not appear to yield enough milk to keep the lambs alive. In a few cases, when large nipples were not nursed, caking of the udders resulted. Another possible explanation is that as the number of nipples increased there was little or no increase in the actual amount of secretory tissue and milk-producing capacity. The studies on the udders, reported on the following pages, were undertaken to obtain information on this point.

#### UDDER CAPACITY AND ANATOMY

The udders of 48 ewes from the Morgan Horse Farm were studied to determine the capacity of all parts of the udders that had functional nipples, and the structure, particularly the relation of extra

nipples to the main part of the udders. These animals included 37 lactating and 6 dry ewes from the multinippled flock and 4 lactating and 1 dry ewe of other types, for comparison.

Studies of udder capacity of lactating ewes were made from 10 to 13 days after lambing. Lambs were left with the ewes until the latter were slaughtered. Each ewe was milked out completely by hand just before slaughter. The udder was removed immediately after slaughter and mounted on a wooden frame of suitable size, so that it was in as nearly a natural position as possible. In determining the capacity, the udder was filled with a 5-percent solution of formaldehyde under pressure, which was obtained by gravity. A series of calibrated glass tubes was used as storage chambers for the fluid. Rubber tubing led from the bottom of each tube to a teat tube, which was inserted in the nipple opening. A string was tied tightly around the nipple to hold the teat tube in place and to prevent leakage. The fluid was then allowed to flow into the udder, all parts being filled at once, for 4 minutes or for a shorter time if the udder filled to capacity and fluid began to seep out through the tissues. The glass storage tubes were all filled to the same level before injections were begun, and this level was about 8 feet 6 inches above the point of injection at the bottom of the udder. The fluid injected into the extra nipples contained dyes of different colors so that the tissue associated with each nipple would be clearly outlined.

The data on the capacities of the various parts of the udders are given in table 4. Extra nipples, with and without openings, were included when determining the average volume injected. In all cases the capacities of the extra nipples were small. Most of the extra nipples that had openings were secreting a small amount of milk, but the small volume of fluid injected indicates that the capacity of these extra nipples was limited. In some of the extra nipples, much of the fluid injected had infiltrated into connective tissue. The real capacity,

TABLE 4.—Average amounts of fluid injected into udders through the primary nipples (designated as No. 1) and secondary nipples (designated as Nos. 2 and 3)<sup>1</sup>

Type of ewe	No. of nipples per sheep	No. of sheep	Amount of fluid injected into nipple No.—						Total fluid injected
			1		2		3		
			Right	Left	Right	Left	Right	Left	
			Cc.	Cc.	Cc.	Cc.	Cc.	Cc.	Cc.
Lactating, from multi-nippled flock.....	4	26	254.8	251.2	3.0	4.6	—	—	514.2
	5	7	227.6	232.7	1.6	2.1	—	0.3	464.3
	6	1	165.8	171.3	11.0	0.8	15.7	0.4	365.0
Lactating:									
Southdale.....	2	1	80.6	96.7	—	—	—	—	177.3
Karakul.....	3	1	275.0	250.2	0	—	—	—	525.8
	4	2	320.8	363.2	5.1	2.1	—	—	691.2
Dry, from multinippled flock.....	2	1	86.9	124.2	—	—	—	—	211.1
	4	2	92.0	72.3	8.1	3.0	—	—	175.4
	5	1	33.4	40.3	7.2	7.2	—	4.2	98.3
	6	2	79.3	75.7	.6	1.5	0	0	157.1
Dry, Karakul.....	4	1	31.0	34.8	0	0	—	—	65.8

<sup>1</sup> Nipple No. 2 is nearer the primary nipple than is nipple No. 3.

therefore, is even more limited than the average indicates. Thus, it appears obvious that lambs would receive little milk when they nursed the extra nipples, and if they nursed these in preference to the large primary nipples, as was observed in some cases, the nutrients obtained would be inadequate for normal growth.

Of the 4-, 5- and 6-nippled ewes, the milk-secreting capacity of the nipples decreased as the number of nipples increased. The numbers of ewes with five or six nipples are too small, however, for this trend to be regarded as significant.

The multinippled sheep are considerably larger than the Southdale type, and the udder capacity of the one lactating Southdale ewe studied was considerably less, as indicated by the data in table 4. Karakul ewes, on the other hand, are more comparable in size to the multinippled ewes and have large udders. The average capacity of the three lactating Karakul ewes studied was greater than that of the ewes from the multinippled flock. Incidentally, all the Karakul ewes used in this study had one or two extra nipples. The only other published information on udder capacity of ewes is that of the United States Bureau of Dairy Industry (16, p. 8), which states that the udders of two ewes of unspecified breeding had an average total capacity of 2.56 pounds (approximately 1,150 cc.). The largest volume observed in an individual sheep in the present study was 1,016 cc.

Swett and coworkers (15) report a significant positive correlation of 0.64 between capacity of the udder, as determined by amount of fluid injected under constant pressure, and the milk-producing ability of the cow. No comparable data are available on sheep, but on the basis of the findings with cattle, the method used in the present study seems justified.

After the udders were filled with fluid the teat tube was replaced with a teat plug. The udders were then frozen so that sections could be made for a study of the internal structure. Sectioning was done with a band saw. Representative udders on the live animals and sections of these udders are shown in figures 6, 7, and 8. In all cases, the photographs of udders on the live animals were taken after parturition when the udders were well filled with milk. The frozen fluid was thawed out of the sections before photographs of these were taken.

In the sections of udders included in figures 6, 7, and 8, little secretory tissue is associated with the extra nipples as compared with the amount associated with the primary nipples. The extra nipples therefore make little contribution to the milk supply of lambs.

The data in table 4 reveal a tendency for extra nipples to appear on the left side. In all 8 ewes that had 5 nipples, the fifth nipple appeared on the left side. However, in the 3-nippled ewe, the third nipple was a small, nonfunctional one located on the right side. Of 7 other 5-nippled ewes for which records were available, 5 had the fifth nipple on the left side. In 1 additional ewe with 3 nipples, the extra one appeared on the left side. Thus in 14 out of 17 ewes, the third or fifth nipple was located on the left side.

The relationship between body weight and total udder capacity was determined for the 37 lactating multinippled ewes. The coefficient of correlation was 0.49, which was highly significant.

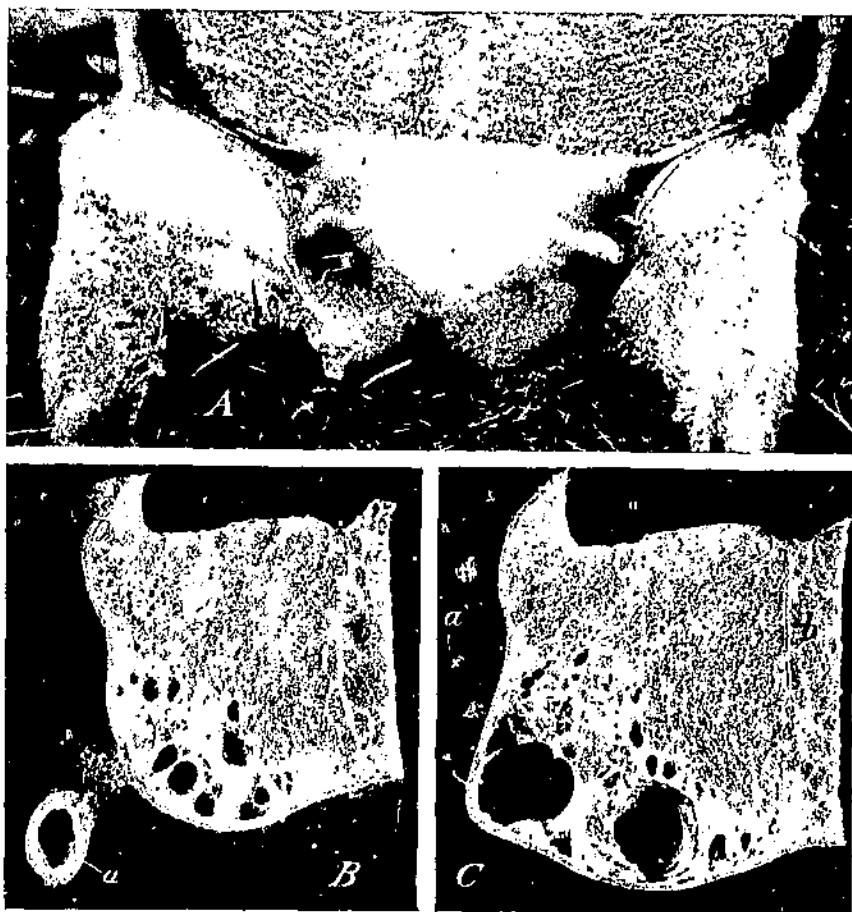


FIGURE 6.—A, Udder of ewe No. 10-SR. This ewe had two extra nipples, neither of which was functional. B, Transverse section through the right half of this udder (as shown on left side in A); a, primary nipple; b, connective tissue. C, Another transverse section through the same side of the udder shown in A; a, secondary nipple; b, connective tissue dividing the right and left halves of the udder. (The extensive secretory tissue shown in the lower left side of C is associated with the primary nipple shown in B.)



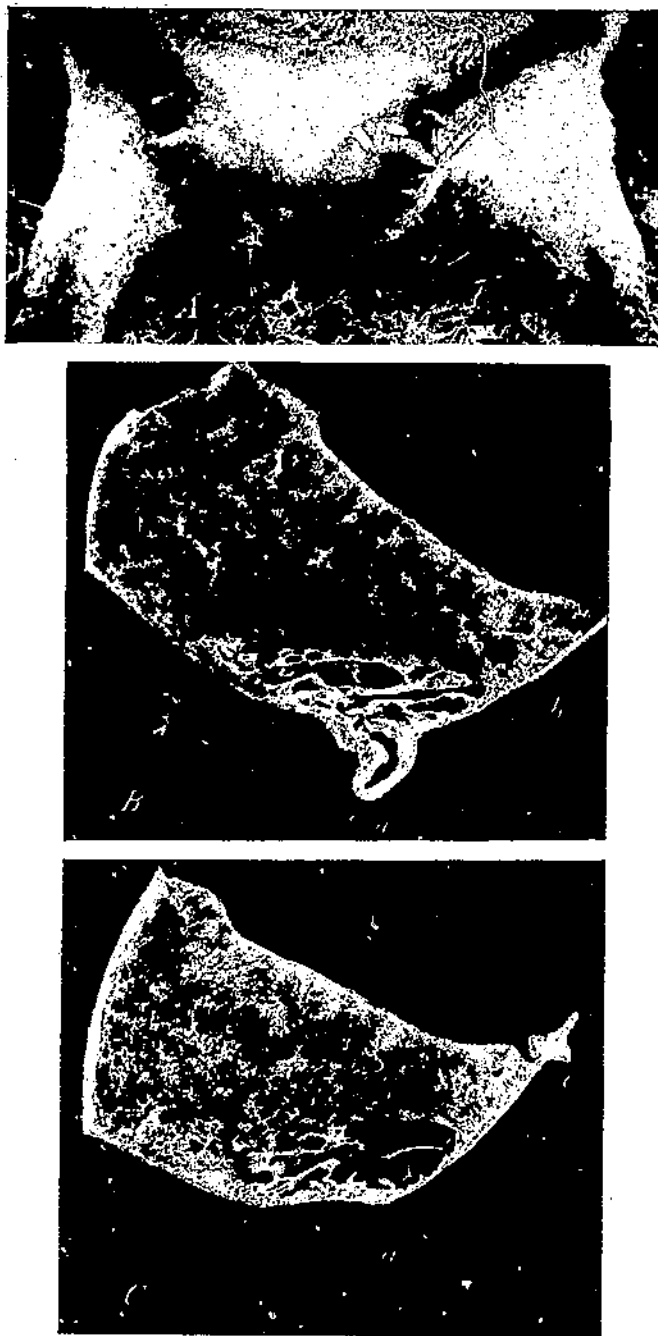


FIGURE 7.—A, The five-nippled udder of ewe No. 155-SB. B and C, Longitudinal sections through the left half, which had three nipples: a, primary nipple; b, the larger extra nipple, which had an opening but a capacity of less than 1 cc. of fluid; c, the smaller extra nipple, which had no opening.

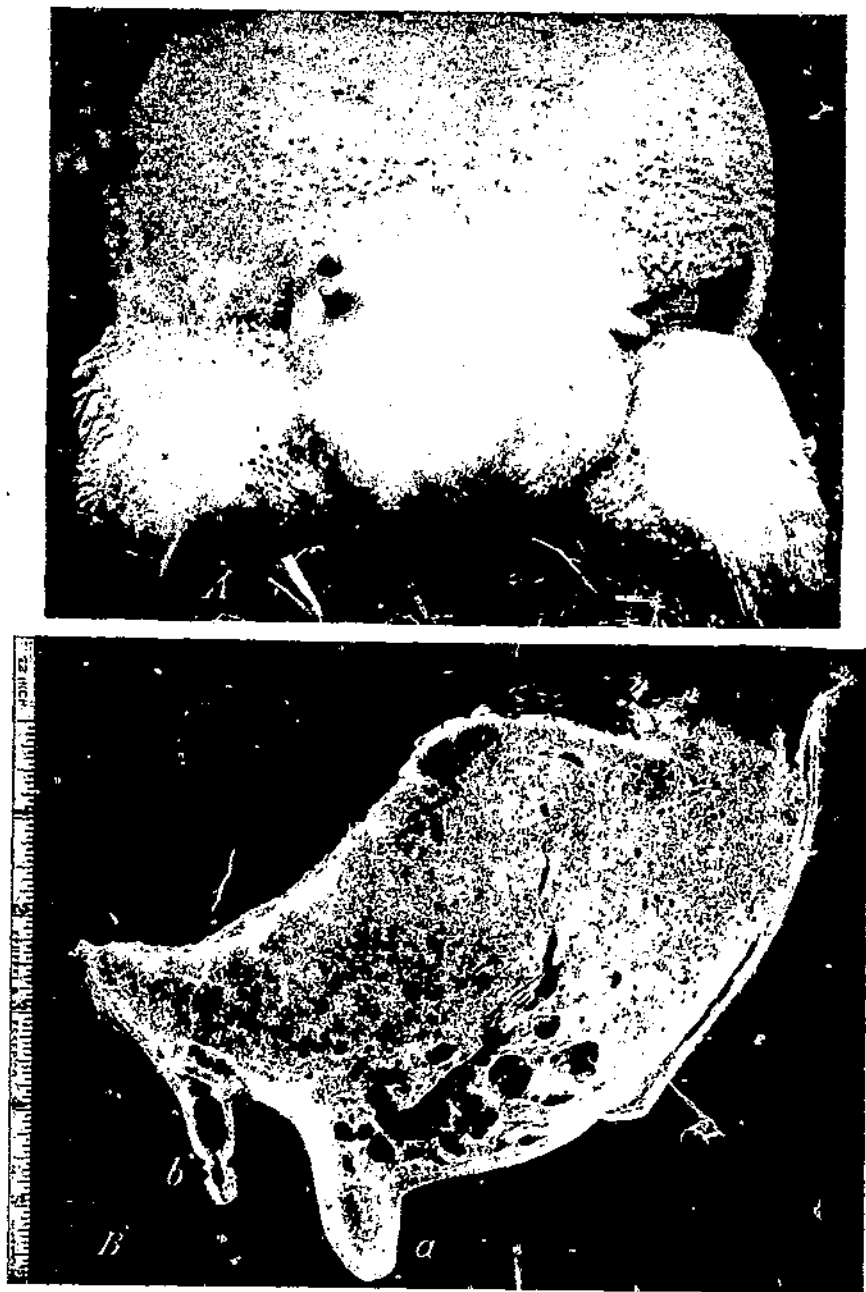


FIGURE 8.—A, The four-nippled udder of ewe No. 22-SR. The extra nipples are rather large but the right one (left as shown) had a capacity of only 1.27 cc. and the left one, (right as shown) 2.54 cc. B, Longitudinal section through the left half of the udder showing primary nipple *a*, and secondary nipple, *b*. Note the connective tissue wall, *c*, separating the teat cistern of *b* from the main part of the udder.

## SUMMARY AND CONCLUSIONS

Ewes having more than two nipples are observed frequently. Work initiated by Alexander Graham Bell focused attention on the multi-nipple trait and stimulated considerable interest in the development of a strain of sheep possessing four or more nipples. Sheep from Bell's flock were obtained by the New Hampshire Agricultural Experiment Station for the development of a multinippled flock, most of which was transferred, late in 1941, to the United States Morgan Horse Farm, Middlebury, Vt. Data obtained on sheep that descended from the strain established by Bell were used in the study described in this bulletin. The principal findings are as follows:

The number of nipples on sheep may be increased rather rapidly, by selection, to 4. Increasing the number beyond this point is difficult, since the number of nipples on offspring in Bell's flock averaged approximately 5 after continued use of rams averaging about 6 nipples for more than 20 years and of ewes averaging more than 5.5 nipples during the latter half of that period.

The multinipple character may be associated to a limited extent with the occurrence of multiple births. The coefficients of correlation were positive but with one exception were not significant and did not indicate a relationship large enough to have practical value in selection.

The relationships between number of nipples and weaning weight of offspring were nonsignificant in all groups studied, but there was a slight tendency for lambs from ewes with the most nipples to be smaller at weaning time.

Studies of the udders showed that extra nipples had very limited capacities as compared with those of the primary nipples and that they had no connection with the primary body of milk-secreting tissue. The extra nipples had little or no secretory tissue associated with their teat cisterns. Hence, the extra nipples could make little contribution to the milk supply of the lamb.

Some difficulties were encountered with multinippled ewes during the nursing period, owing to the tendency of some young lambs to nurse the extra nipples in preference to the larger primary nipples. These lambs got little milk unless they were assisted in nursing the primary nipples.

The results indicate that the multinipple character has no practical value in sheep production and that selection for it should not be recommended. In most flocks this character may safely be disregarded in selection procedures, but if the proportion of multinippled animals is high, selection of rams with only two nipples is recommended as the simplest procedure to reduce the incidence of the multi-nipple character in the flock.

Measures other than the number of extra nipples, such as weight of lambs at weaning time, should be more effective in selection for increased milking capacity in ewes.

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