RESEARCH BULLETIN 694 APRIL, 1959

UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
J. H. LONGWELL, Director

Inheritance of Nipple Numbers In Swine and the Relationship To Performance

A. D. ALLEN, L. F. TRIBBLE AND J. F. LASLEY

(Publication authorized April 10, 1959)

COLUMBIA, MISSOURI

ABSTRACT

The inheritance of nipple numbers in swine was investigated in Landrace, Poland and Duroc inbred lines and in crossbred Landrace x Poland swine. Results indicated that nipple numbers were affected by heredity, as evidenced by an overall heritability estimate of 39 percent based on the intra-sire regression of offspring on dam, significant breed differences, and 4.47 percent heterosis determined by comparing the mean of inbred Landrace and Polands with the mean of the F1 cross.

Although significant gross correlations were found between nipple numbers and the size and weight of the litters at farrowing and weaning, these correlations were low and in most cases the significance was lost when they were calculated on a within-breed basis. This suggested that the correlations between nipple numbers and performance of the litters were more a breed than an individual characteristic.

CONTENTS

Introduction	**3**
Review of Literature	**3**
Materials and Methods	**4**
Results	**5**
Discussion	**11**
Summary	**14**
Bibliography	**16**

This bulletin is a report of research under Project 3, "Improvement of swine through breeding", Department of Animal Husbandry in cooperation with the Regional Swine Breeding Laboratory, A.H.R.D., A.R.S., U.S. Department of Agriculture.

Inheritance of Nipple Numbers In Swine and the Relationship To Performance

A. D. ALLEN, L. F. TRIBBLE AND J. F. LASLEY

INTRODUCTION

The mode of inheritance of different economic traits in farm animals has been the objective of many experiments in animal breeding. Such knowledge is necessary if improvements through selection and breeding are to be made in important economic traits in farm animals. Nipple number in swine is a suitable trait for such studies because it probably is affected by a relatively small number of genes and is not affected greatly by environment.

The number of nipples in swine is an important economic trait. Very rarely does a sow wean more pigs than the number of functional nipples she possesses. Many investigators have also hypothesized that a relationship exists between litter size in any given species of mammals and the number of nipples possessed by the females of that species. If a relationship of this type exists, it would be a simple matter to select for nipple number to improve performance.

The objectives of this study were to determine the mode of action of genes affecting nipple number and to determine if nipple number was correlated with the size and weight of litters at farrowing and weaning.

REVIEW OF LITERATURE

Many investigators have studied nipple numbers in swine, using large numbers of animals. Most of these studies have dealt with the possible mode of inheritance and the relation of nipple number to sow performance.

Nachtsheim (1924, 1925) described seven pairs of nipples placed in the symmetrical positions as normal nipples. The first pair was located immediately behind the connection of the ribs with the sternum and the last pair, in the inguinal region. Five of these seven pairs of nipples were almost always present. These were the first, third, fourth, fifth and seventh pairs.

Any of the individual nipples, could be small at birth, Nachtsheim found. This was especially true of the seventh pair which were missing on one side. This was attributed by the investigator to a disturbance in embryonic development rather than to actual genetic differences.

The genetic foundation for the existence of regular pairs of teats was assumed by Nachtsheim (1942) to be the same in all races of domestic swine he examined. The variability in the presence and development of the second and

sixth pairs was very great. Whether the second pair was inherited separately from the sixth pair or whether factors necessary for it's development are not necessary for the development of the sixth pair was not determined.

The greater number of teats was dominant in matings of two animals of different teat numbers according to Nachtsheim (1924). He was of the opinion that several pairs of genes were involved and were rather common in all races of swine examined except the European wild swine which consistently had only five pairs of teats.

Taketomi, Niwa and Miyazono (1954) found definite breed differences in teat numbers in several breeds of swine. Numbers varied from an average of 12.74 in Middle Whites to an average of 14.23 in Chinese swine. They suggested that the complementary action of dominant genes was important in nipple number inheritance.

The relationship between nipple numbers and number of young produced at parturition has been of interest to many investigators. A relationship does seem to exist between species, in a general sort of way, since cows have four functional nipples and usually produce one young whereas sows have large numbers of nipples and usually farrow large numbers of pigs. Pearl (1913) noted that in most species the mean size of the litter is approximately two individuals below the mean number of teats possessed by the dam.

Bell (1904) found that nipple numbers in sheep could be increased by selection but there was no correlated increase in the tendency for multiple births. The results of the studies of Phillips, Schott and Spencer (1945) with sheep were in close agreement with those of Bell. Goertzen and Ibsen (1951) obtained similar results with guinea pigs. Studies with swine have led to similar conclusions although in some instances low and significant correlation coefficients have been observed (Pearl, 1913; Parker and Bullard, 1913; Konopinski, 1932; and Korkman, 1947).

MATERIALS AND METHODS

The swine used in these experiments were maintained at the Missouri Agricultural Experiment Station in cooperation with the Regional Swine Breeding Laboratory. The sows were bred and farrowed at the University of Missouri Experimental Swine Breeding Farm.

Litters farrowed during the Fall of 1952, Spring of 1953, and the Fall of 1953 were used as a source of data to study the influence of the number of teats of the sow on the size and performance of her litter. A total of 108 sows which farrowed 928 pigs was studied. Fourteen of these were inbred Durocs; 30 were Landrace x Poland crosses; 31 were inbred Polands; 33 were inbred Landrace sows. The ages of these sows ranged from 12 to 30 months at the time of farrowing.

Sixty-one sows which were bred to 18 boars were used in the nipple inheritance studies. Included in this group were 20 inbred Landrace, 18 inbred Poland, 18 Landrace x Poland crosses, and five inbred Duroc sows. The inbred Poland and the inbred Landrace sows produced purebred pigs. The Landrace x Poland crossbred sows were bred to inbred Duroc boars and the inbred Duroc sows to Landrace x Poland crossbred boars. A total of 555 pigs, of which 282 were males and 273 females, were farrowed in the 61 litters included in this study.

The inheritance of nipple number was investigated by counting the nipples of each pig at birth and comparing this number with the number of nipples possessed by the dam. Inverted nipples were included; otherwise, only the normal nipples were counted in this study. Nipples which had no indication of being attached to a gland were disregarded. No record was kept of the anal teats. The sex of each pig was recorded as well as the number of nipples on each side of the median line.

RESULTS

The influence of sex on nipple numbers in swine. The influence of the sex of the individuals on the number of nipples they possessed is shown in Table 1. In all of the matings studied, males possessed slightly more nipples, on the average, than females, although the difference was not statistically significant in any one breed or cross or when all breeds and crosses were grouped together. The average difference between the sexes when all data were grouped was 0.07 nipples in favor of the male pigs.

TABLE 1--SEX DIFFERENCES IN THE NUMBER OF NIPPLES OF THE PROGENY BY DIFFERENT MATINGS

Breed or Cross Sire	Dam	Sex of Offspring	Avg. No. of Nipples	Diff. in Favor of Males*
Landrace	Landrace	Female	13.67	
		Male	13.70	0.03
Poland	Poland	Female	12.59	
		Male	12.64	0.05
Duroc	Landrace x Poland	Female	12.38	
		Male	12.56	0.18
Landrace x Poland	Duroc	Female	11.88	
		Male	11.94	0.06
Total all Breeds and Crosses		Female	12.85	
		Male	12.92	0.07

* None of the differences between sexes are statistically significant.

The influence of heredity on nipple numbers in swine. Nipple number in swine is an excellent trait in which to study the influence of heredity on variations in different populations. In all probability, environment would be responsible for little of the variations in this trait, and if this is true, differences between breeds and crosses in nipple numbers should be mostly genetic. There-

fore, it seems important to compare the breeds used in this study to see if they varied significantly in the numbers of nipples they possessed.

The average numbers of nipples of sows of the various breeds and crosses, together with standard deviations and coefficients of variation, are shown in Table 2. Landrace sows possessed an average of 13.45 nipples, which was the largest number for any breed or cross in the study. The Landrace sows were followed closely by the crossbred Landrace x Poland sows with 13.33. The least amount of variation was found within the Landrace breed as shown by a coefficient of variation of 6.17 percent; the greatest amount was found in the Polands with a coefficient of variation of 8.54 percent.

TABLE 2--NIPPLE NUMBERS IN SOWS OF DIFFERENT BREEDS AND CROSSES

Breed or Cross	Number of Sows	Average Nipple Number	Standard Deviation	Coefficient of Variation %
Landrace	33	13.45	0.83	6.17
Poland	31	12.06	1.03	8.54
Duroc	14	11.00	0.88	8.00
Landrace x Poland	30	13.33	0.95	7.13
All Breeds	108	12.70	1.28	10.08

Note: Durocs had a highly significant smaller number of nipples ($P < .01$) than all other breeds and crosses. Landrace and Landrace x Poland sows did not vary significantly in nipple numbers, but both possessed a larger number of nipples ($P < .01$) than either the Polands or the Durocs.

The significance of differences between nipple numbers in the sows of the different breeds was tested by calculating the standard error of the mean differences from the standard error of the mean. These calculations showed that the Duroc sows possessed a significantly smaller number of nipples ($P<.01$) than any of the other sows in the group; the Polands contained a smaller number of nipples than either the Landrace or the Landrace x Poland crossbred sows. No significant difference was noted between the two latter groups in nipple numbers. These results show that there are definite breed differences in nipple numbers and these differences are most likely due to heredity.

Since inbred Landrace and inbred Poland sows as well as sows from the reciprocal crosses between these two breeds were used in this study, it was possible to obtain an estimate of heterosis effects on nipple numbers in swine. This was done by comparing the average number of nipples in the Landrace x Poland sows with the average of the sows from the two parental breeds. The average nipple number in the Landrace x Poland crossbred sows exceeded the average of the two parental lines by 0.57 nipples or by 4.47 percent. Thus, it would seem that heterosis was involved and since heterosis is due to non-additive gene action, genes with dominance, overdominance or epistatic effects must have an influence on nipple number in swine.

The number of nipples in individual pigs from different matings is summarized in Table 3. As was true with data on sows in Table 2, the Landrace

TABLE 3--NIPPLE NUMBERS IN PIGS FROM DIFFERENT MATINGS

Breed or Cross	Number of Pigs	Average Nipple Number	Standard Deviation	Coefficient of Variation %
Landrace	199	13.68	0.78	5.70
Poland	154	12.53	1.03	8.22
Duroc x (L x P)	169	12.47	0.98	7.86
(L x P) x Duroc	33	11.90	0.85	7.14
All Breeds and Crosses	555	12.87	1.10	8.55

Note: All differences were highly significant ($P < .01$) except between Polands and Duroc x (L x P) crossbred pigs.

again possessed a significantly larger number of nipples ($P<.01$) than any of the other breeds or crosses. The other breeds and crosses also differed significantly in nipple numbers except the Polands and the Duroc x (L x P) pigs.

The frequency distribution curves for nipple numbers in each breed and cross are shown in Figure 1. The reciprocal crosses between the Duroc and the Landrace x Poland crossbreds were combined since the breeding of the pigs was similar. The inbred Landrace pigs again showed less variation in nipple numbers, as did the Landrace sows, and the Poland pigs again showed more variation in nipple numbers than the other breeds and crosses studied. The modal group for the inbred Landrace was 14 nipples with 66.8 percent of the pigs possessing this number. The frequency distribution was skewed to the right which would suggest that selection for nipple number within the Landrace line had been practiced either intentionally or unintentionally.

Both the inbred Polands and the reciprocal crosses between the Landrace x Polands and the Durocs showed a more nearly normal frequency distribution curve with a wider range from the modal group. In the Polands, the modal group was 12 nipples with only 40.26 percent of the pigs possessing this number. The modal group was also 12 in the reciprocal cross between the Durocs and the crossbred Landrace x Polands but only 38.60 percent of the pigs fell within this group with 31.18 percent in the group possessing 13 nipples.

Heritability of nipple number in swine. Heritability estimates for a trait give an indication of the amount of progress that could be made in selection and the portion of the phenotypic variations that is due to additive gene action. The latter is particularly true if the heritability estimate is calculated on the basis of the intra-sire regression of offspring on dam.

Data were available for computing the separate heritability estimates for each of the breeds and crosses in this study. These estimates are summarized in Table 4. Heritability estimates of approximately 59 percent were obtained from data on inbred Landrace and inbred Poland pigs. Those on the reciprocal crosses of the Durocs and the Landrace x Polands were either very low or negative.

Possibly these heritability estimates were low because the genotype for nipple numbers in the dams in these cases could be far different than in the offspring, especially if serveral pairs of genes with different phenotypic expressions

Figure 1—Frequency Distribution Curves for Pigs of Different Breeds and Crosses.

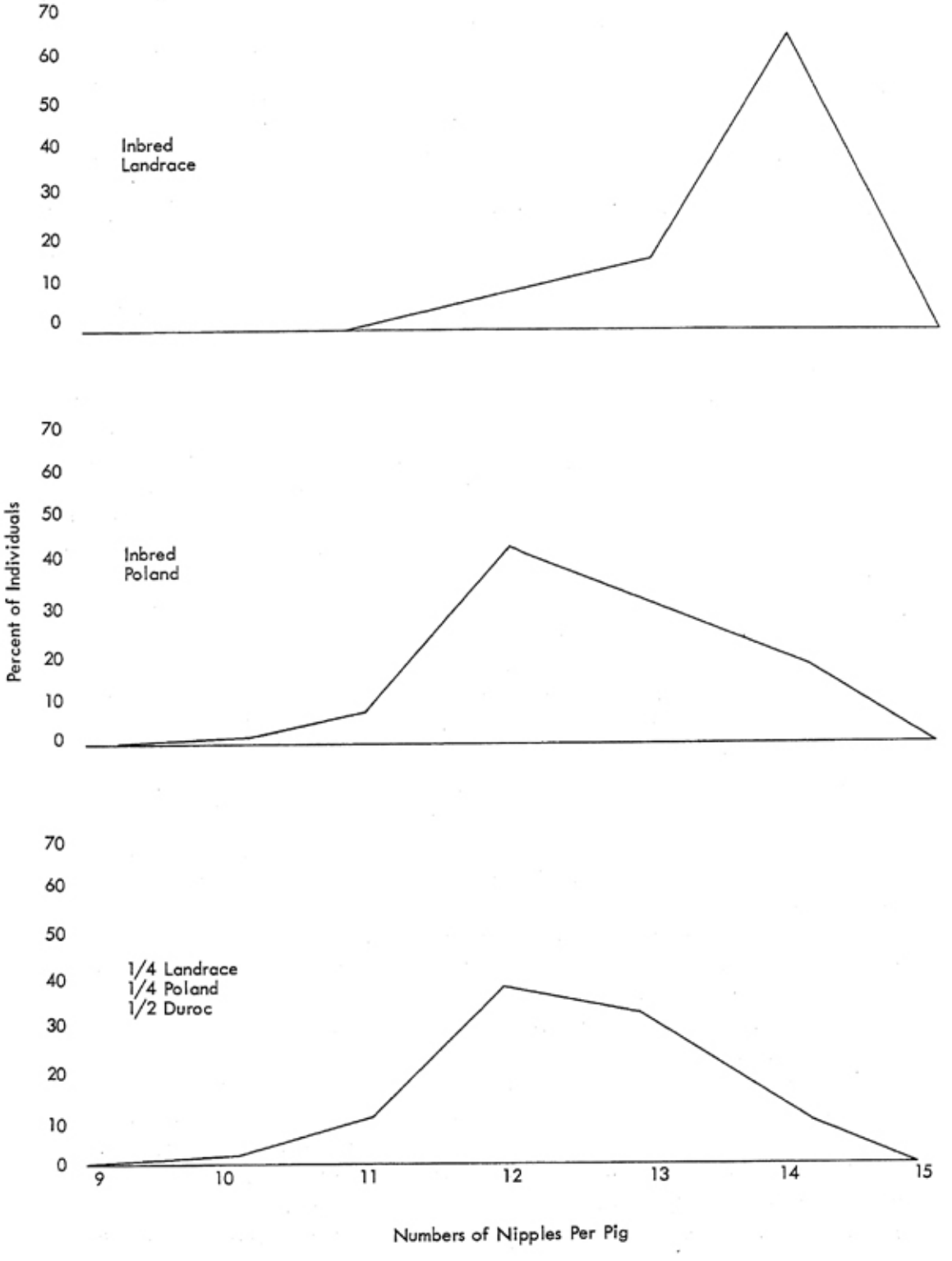

TABLE 4--HERITABILITY ESTIMATES OF NIPPLE NUMBER BY BREED AND CROSS

Breed or Cross Sire	Dam	Total Number of Offspring	Estimate of Heritability*
Landrace	Landrace	199	.586
Poland	Poland	154	.588
Duroc	Landrace x Poland	169	-.240
Landrace x Poland	Duroc	33	.026
All Breeds and Crosses Combined		555	.386

* From intra-sire regression of offspring on dam.

alone and in different combinations were involved. Interactions between genes in the expression of nipple numbers could be responsible for these low heritability estimates in the reciprocal crosses.

When heritability estimates were calculated by pooling data from all breeds and crosses, an estimate of 38.6 percent was obtained. This leads to the conclusion that variations in nipple numbers in swine are probably affected to a certain extent by additive gene action, as well as genes with non-additive effects, and by environment.

Relationship between nipple number and size of litter. Sows are often selected for a large number of nipples in the belief that this will influence the size of their litters. This was investigated in three breeds of swine and one cross between the breeds.

The Landrace sows possessed the largest average number of nipples of any breed or cross observed and farrowed the second largest average number of pigs per litter. The crossbred Landrace x Poland sows had the largest litters. (Table 5).

TABLE 5--THE AVERAGE NUMBER OF NIPPLES IN SOWS OF DIFFERENT BREEDS AND CROSSES AND THE NUMBER OF PIGS IN THEIR LITTERS AT BIRTH, 21 DAYS AND 56 DAYS FOR ALL BREEDS AND CROSSES

	Landrace	Poland	Duroc	Landrace x Poland
No. of Sows	33	31	14	30
Number of nipples	13.45	12.06	11.00	13.33
Average number of pigs farrowed	8.55	7.65	8.08	9.87
Average pigs per litter at 21 days	7.06	5.48	6.14	8.50
Average pigs per litter at 56 days	6.88	5.35	5.86	8.33

The Duroc sows did not substantiate the hypothesis. They had fewer nipples on the average than sows of any of the other lines or crosses but exceeded the Polands in number of pigs farrowed. No change in the rank of the sows for nipple numbers and pigs per litter occurred at either 21 or 56 days after farrowing.

Correlation coefficients between the numbers of nipples in the sows and the numbers of pigs per litter at birth, 21 days and 56 days are shown in Table 6. The gross correlations between nipple numbers and the number of pigs per lit-

TABLE 6--ZERO ORDER COEFFICIENTS OF CORRELATION BETWEEN TOTAL NIPPLE NUMBERS OF SOWS AND THE SIZE OF THEIR LITTERS AT BIRTH, 21 AND 56 DAYS OF AGE

Coefficient of Correlation of Nipple Numbers in Sows with:	Coefficient of Correlation for:		
	Gross	Between Breeds	Within Breeds
	n = 107	(n = 3)	n = 104
Pigs per litter at birth	.29*	.66	.21*
Pigs per litter at 21 days	.35***	.72	.16
Pigs per litter at 56 days	.34***	.74	.14

* Probability of chance occurrence less than .05
** Probability of chance occurrence less than .01
*** Probability of chance occurrence less than .001

ter at farrowing were significant ($P<.05$) when data from all sows were pooled, regardless of breed or cross. This correlation was still significant when the data were analyzed on a within-breed basis to remove breed effects. The correlations were low, however, and it is doubtful if selection for nipple numbers in sows would have any corresponding effect on litter size at farrowing.

The gross correlations between nipple numbers in the sows and the number of pigs per litter at both 21 and 56 days of age were very highly significant ($P<.001$) when data were pooled for all sows. But when breed effects were removed the correlation coefficients were much lower and not significant. The relatively large, but not significant, between-breed correlation coefficients suggest that much of the significance in the gross correlation coefficients was due to breed rather than to individual covariance between the two traits.

Relationship between nipple number in sows and the weight of their pigs and their litters. Data relative to this phase of the study are summarized in Tables 7 and 8. The correlations between nipple number and the average weight of the pigs were not significant at birth, 21 days or 56 days of age. All of the correlation coefficients calculated on a within-breed basis were negative although all were very low and not significant. The trend, then, was for sows within the breeds that had the most nipples to have pigs which weighed the least at birth, 21 days and 56 days, although the difference was so small as to be almost negligible.

TABLE 7--THE NUMBER OF NIPPLES IN SOWS OF VARIOUS BREEDS AND CROSSES AND THE WEIGHT OF THEIR PIGS AND THE LITTERS AT BIRTH, 21 DAYS AND 56 DAYS OF AGE

	Landrace	Poland	Duroc	Landrace x Poland
Number of Sows	33	31	14	30
Average number of nipples per sow	13.45	12.06	11.00	13.33
Average birth weight of pigs	3.25	3.89	3.14	3.42
Average 21 day weight of pigs	12.91	14.02	11.04	13.75
Average 56 day weight of pigs	41.44	45.12	35.58	45.49
Average litter weight at birth	27.60	29.13	25.16	33.18
Average litter weight at 21 days	89.02	74.96	66.44	114.06
Average litter weight at 56 days	280.72	236.13	219.21	374.47

TABLE 8--CORRELATION BETWEEN NIPPLE NUMBERS IN SOWS OF VARIOUS BREEDS AND CROSSES AND THE AVERAGE WEIGHTS OF THEIR PIGS AND THE TOTAL WEIGHTS OF THEIR LITTERS AT BIRTH, 21 AND 56 DAYS OF AGE

Trait Total Nipple Number was Correlated with:	Coefficient of Correlation for:		
	Gross	Between Breeds	Within Breeds
Average weight per pig at birth	-.16	-.25	-.11
Average weight per pig at 21 days	.05	.42	-.11
Average weight per pig at 56 days	.07	.30	-.01
Weight per litter at birth	.23*	.51	.17
Weight per litter at 21 days	.42**	.79	.16
Weight per litter at 56 days	.38**	.74	.15

* Probability of chance occurrence less than .01.
** Probability of chance occurrence less than .001.

The total or gross correlations between nipple numbers in the sows and the weight of the litter were highly significant at birth ($P<.01$) and very highly significant at 21 and 56 days of age ($P<.001$). When calculated on a within breed basis, however, all of these correlation coefficients were much smaller and not significant. The corresponding between-breed correlations were relatively high, indicating that there was a tendency for the breeds with the most nipples to have litters that weighed the most at birth, 21 days and 56 days of age. For individual sows within a breed, however, there was a trend in this direction but it was not great enough to be of importance.

DISCUSSION

In this study it was found that nipple numbers did not vary significantly between different sexes although in all groups the males had slightly more nipples on the average than the females. For the different breeding groups as a whole, the male pigs possessed an average of 0.07 more nipples than the females. The results of this study are in agreement with those of other workers in that males possess more nipples on the average than females but the difference is seldom significant (Parker and Bullard, 1913; Nachtsheim, 1924; and Taketomi, Niwa, and Miyazono, 1954).

The results obtained in this study show very definitely that different types of gene action affect the phenotypic expression of nipple numbers in swine. There were definite and highly significant differences in nipple numbers in the different inbred lines used in this study. Breed differences must be largely genetic differences, although it is not possible to estimate the relative importance of the different kinds of gene action involved. Among the Landrace, Poland, Duroc and Landrace x Poland hogs tested, Landrace pigs and sows possessed the largest number of nipples and the Durocs and fewest.

Taketomi, Niwa and Miyazono (1954) also reported a significant difference between breeds in nipple numbers. They found an average of 14.04 nipples in

Berkshires and 14.23 in Chinese swine; whereas, in two lines of Middle Whites the averages were 12.74 and 12.77 nipples per pig. They also found a greater variance in nipple number in the offspring of the Berkshires than in those of the Middle Whites. Efficiency of selection for number of nipples was greater in the Middle Whites than in the Berkshires. They thought that perhaps this was due to greater dominant and epistatic effects in the Berkshire breed.

Nachtsheim (1924) was of the opinion that a larger number of nipples was dominant in matings of two animals of different normal nipple numbers, but that dominance was apparently dependent on the presence of several pairs of genes. In this study it was also found that the F1 offspring of the Landrace x Poland cross averaged closer to the Landrace in nipple numbers with the Landrace parental line averaging 13.45 nipples per sow and the Polands 12.06. By comparing the mean of the two parental lines with the mean of the F1 progeny, it was estimated that heterosis amounted to 4.47 percent. This means that genes with non-additive effects, such as those with dominance, overdominance and epistasis, were involved in the inheritance of nipple number.

Much less variation was noted in nipple numbers in inbred Landrace than in either inbred Polands or crossbred Landrace x Poland x Duroc pigs. The greatest variation was noted in the inbred Polands with the distribution being rather close to a normal frequency distribution curve. Nipple numbers for the crossbred pigs also showed a fairly consistent normal frequency distribution curve. The Landrace, on the other hand, showed a definite skewness to the right with over two-thirds of the pigs possessing 14 nipples.

The significance of these findings is not completely understood, but is seems that there was greater genetic variation within the inbred Polands and in the crossbred pigs for nipple numbers than in the inbred Landrace. This is based on the assumption that the major portion of the variations was due to genes and not to environment. Another point of interest in this study was that the Landrace, in addition to showing a skewed distribution for nipple number, showed less variation in this trait. If this is true the question arises whether or not there is less genetic variation for other traits of economic importance in this line. This will be investigated at a later time and if it should prove true, possibly variations in nipple numbers in an inbred line or breed could be used as an indication of the homozygosity for other traits.

A relatively high heritability estimate for nipple numbers of about 59 percent was found in the inbred Polands and the inbred Landrace. Since the calculations were based on the intra-sire regression of offspring on dam, this should be heritability in the narrow sense and would be a measure to a great extent of additive gene action. This study suggests that nipple number in swine is affected by both additive and non-additive gene action. Probably the same could be true of other traits of economic importance.

The fact that the heritability estimates were far from one-hundred percent suggests that possibly environment does have considerable influence on nipple

numbers. Possibly gene interactions as well as gene and environmental interactions are also of considerable importance. At least, these results suggest that causes of variations in nipple numbers are complex rather than simple.

The investigation of the relation of nipple numbers in the sow to the performance of her pigs failed to reveal any important correlations. A significant, but low correlation, was found between nipple number and number of pigs farrowed, on a within-breed basis.

The correlation between nipple number and number of pigs per litter at 21 and 56 days of age was highly significant ($P<.001$) when the gross correlation was calculated, but on a within-breed basis both correlation coefficients were very low and not significant. This suggests that the significant gross correlation was due to differences in breeds with the breeds possessing the most nipples producing largest litters at 21 and 56 days of age. The significant correlation between nipple numbers and number of pigs at farrowing does not necessarily mean that this is a cause and effect relationship. More likely, both are correlated because some of the same genes affect both traits or the genes affecting both traits are carried on the same chromosomes.

The results of this study do not suggest that one could make any great improvement in litter size at farrowing by selecting for larger numbers of nipples in the parent stock.

No significant correlation could be found between nipple number in the sow and the average weight of the pigs at birth and at 21 and 56 days of age. Significant correlations were found, however, between nipple number in the sow and the average weight of the pigs at birth, and at 21 and 56 days of age. When breed effects were removed by covariance and the correlations determined on a within-breed basis, they were very low and not significant, suggesting that the correlations were breed rather than individual characteristics. Thus, in this study, the breeds with the largest average number of nipples also had the heaviest litters at birth, at 21 days of age, and at 56 days when the pigs were weaned.

The results obtained in this study were very similar to those obtained by other workers. Several have found a significant correlation between nipple numbers and litter size and weight, but the coefficients of correlation have been low without exception (Bullard, 1913; Konopinski, 1932; and Korkman, 1947).

A significant correlation between nipple numbers and litter size in a population of swine would probably be due to some of the same genes affecting the two traits although further study is needed for proof of this point. On a species basis, there does seem to be a correlation between nipple number and the number of young born. Animals which bear litters possess a large number of nipples whereas those which produce a single offspring such as cattle and horses only possess from two to four functional nipples. Within a species, however, the association is not too great.

The work of Bell (1904) with sheep showed that nipple number could be increased by selection, but this increase in nipple number was not accompanied

with any great increase in the tendency for multiple births. The results of Phillips, Schott and Spencer (1945) were in close agreement with Bell's results.

The study reported in this bulletin indicated that the correlation between nipple number and fertility and milk producing ability of sows was more a breed than an individual characteristic.

These observations suggest that within populations the progression from individuals to breeds to species is accompanied by an increasingly larger correlation between nipple number in the dam and the number of young born.

Averages for the different breeds of swine in this study showed that nipple numbers were adequate for the number of young farrowed. Even in the crossbred Landrace x Poland sows where litter size at farrowing averaged 9.87 pigs, there was still an excess of 3.46 nipples over the number of pigs farrowed. Some sows within this cross, however, possessed fewer nipples than the average and in individual cases the number of pigs farrowed exceeded the number of nipples the sow possessed. In such cases, unless other means are used to care for the extra pigs, litter size at weaning will not exceed the number of functional nipples possessed by the sow. In actual practice, however, this is not an important problem.

SUMMARY

The number of nipples per sow was investigated in inbred Landrace, inbred Durocs, inbred Polands and the reciprocal crosses of the Durocs and the Landrace x Poland F_1 individuals. Breeds and crosses were found to differ significantly in the number of nipples they possessed. The inbred Landrace averaged 13.45, which was the highest. The inbred Durocs averaged 11.00 nipples, which was the lowest.

The mode of inheritance of nipple numbers was also investigated. The heritability estimate for nipple numbers was found to be 39 percent when individuals from all groups were pooled and the intra-sire regression of offspring on dam computed. Heritability estimate within both the inbred Landrace line and the inbred Poland line was 59 percent. Heritability estimates within reciprocal crosses of the Durocs and the Landrace x Poland crossbreds were either very low or negative. The high overall heritability estimate for all breeds and crosses combined suggests that additive genes have an important part to play in the inheritance of this trait.

A comparison of the average of nipple numbers in the Landrace x Poland F_1 cross with the average of the two inbred parental lines showed that the F_1 cross exceeded the mid-parent value by 0.57 nipples or 4.47 percent. This value is often referred to as the percentage of heterosis and suggests that genes with non-additive action are also involved in the inheritance of this trait in swine.

The within breed and gross coefficients of correlation between nipple number in sows and the size of the litter farrowed were significant ($P<.05$) but low. No significant coefficient of correlation between nipple number in the sow and

the performance of her pigs was found, although a large number of nipples tended to be associated with lighter average pig weights at birth and at 21 and 56 days of age.

A significant gross correlation was noted between the nipple numbers in the sows and the total weights of the litters at birth and at 21 and 56 days of age. When breed effects were held constant by the covariance technique, however, the coefficients of correlation were low and not significant. This would suggest that the correlations noted were more a breed than an individual characteristic.

From the practical standpoint, this study suggests that selection for an increased number of nipples would be effective. Even if this is true, however, the breeder cannot expect much increase in the size of the litter farrowed or the weight of the litter weaned.

BIBLIOGRAPHY

Bell, A. G., 1904.
The multi-nipple sheep of Beinn Bhreagh, Science, 19, 767-768.

Goertzen, B. L., H. I. Ibsen, 1951.
Supernumerary Mammae in Guinea Pigs, J. of Heredity, 42, 307-311.

Konopinski, T., 1932.
Poszukiwania wspolzaleznoscue pomiedzy liczba sutek u macion d lloscia urodzonych prosiat, Rosc. Nauk, Roln. Lesn. 28, 277-300.

Korkman, N., 1947.
Causes of Variation in the Size and Weight of Litters from Sows, Acta. Agr. Suecana, 2, 253-310.

Nachtsheim, H., 1925.
Study of the Variation and Inheritance of the Teats of Swine, Zf. Tierz. U. Zuchtgbiol 2, 113.

Nachtsheim, H., 1924.
Studies on the Inheritance of Swine: The Inheritance of Teat Number, A. F. Induk., Abs. u. Vererb. 33:307-311.

Parker, G., and C. Bullard, 1913.
On the Size of Litters and the Number of Nipples in Swine. Proc. of the Am. Acad. of Arts and Science 49, 399-426.

Pearl, R., 1913.
On the Correlation Between the Number of Mammae of the Demand Size of Litter in Mammals. I. Interracial Correlations. II. Intraracial Correlation in Swine, Proc. Soc. Exp. Biol. Med. 11:27.

Phillips, R. W., R. G. Schott and D. A. Spencer, 1945.
The Genetics, Physiology and Economic Importance of the Multinipple Trait in Sheep, U.S.D.A. Tech. Bul. 909.

Taketomi, M., T. Niwa, and Y. Miyazono, 1954.
On the Inheritance of Number of Nipples in Swine, Bul. of the Nat. Inst. of Agr. Sci., Series G, No. 9, Nov., 1954.