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SEX RATIO IN PIGS

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SEX RATIO IN PIGS

BY

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INTRODUCTION

There are slight but consistent deviations from equality in the sex ratio among animals in general. There is usually a higher percentage of males than females among a population at birth. The sex ratio is important as it partially regulates the degree in which selection can be practiced.

In pigs there appears to be more males than females among the offspring. Since a much larger percentage of females than males has to be saved for replacements each generation any decrease in percentage of females would cause a marked decrease in the selection intensity among females.

Observations sometimes leave the impression that certain families or groups of individuals have distorted sex ratios. It is not uncommon to hear some breeders make the statement that certain individuals or groups of individuals in their stock are male or female "getters". There sometimes seems to be a higher percentage of males born during one season than another.

The aim of the problem reported in this paper is to find the sex ratio of the pigs farrowed at the Oklahoma Agricultural and Mechanical College and Experiment Station from the accumulative records from 1925 to April 1, 1939, to study the influence of the seasons upon the sex ratio of pigs, and to determine if there is any significant tendency for the progeny of a sow or boar to contain a high percentage of either male or female pigs.

REVIEW OF LITERATURE

Sex Ratio in Pigs

Lush, Hetzer, and Culbertson (12) analyzed the data from 506 litters containing 3,639 pigs, all of which were produced by gilts about one year old at time of farrowing. All litters were farrowed in April and May, except nine in June, one in July and three in August. The sex ratio of this population was 51.1 ± 0.6 percent males.

Carmichael and Rice (1) working with 720 litters, containing 5,840 pigs, found that there were 2,933 males and 2,824 females with the sex on 183 not recorded, which is a sex ratio of 51.9 percent males to 48.1 percent females. Their data are given in table 1. There seemed to be no noticeable correlation between litter size and sex, a higher percentage of males being found in a majority of different sized litters rather than merely a tendency for this sex to predominate in those of certain sizes. Of 4,363 pigs on which the sex and length of gestation period were recorded, 2,289 were males and 2,074 were females. The sex ratio of this group was 52.5 percent males to 47.5 percent females. There tended to be no correlation between the length of gestation period and sex of the progeny. To study the influence of age of dam upon the sex ratio of pigs, 5,595 pigs were grouped on the basis of the age of their dams. In this population there were 2,922 males and 2,673 females, which is a sex ratio of 52.2 percent males to 47.8 percent females. These data are shown in table 2. There is no significant difference between

Table 1
Relation of Size of Litter to Sex of Pigs.*

No. of pigs per litter	Total No. studied	No. of pigs of each sex		No. sex not recorded
		Females	Males	
1	6	2	4	-
2	30	15	15	-
3	57	30	20	-
4	180	97	82	1
5	305	137	157	11
6	420	195	213	12
7	623	255	347	21
8	784	374	397	13
9	684	331	329	24
10	910	449	432	19
11	638	292	326	20
12	480	237	226	17
13	338	149	179	10
14	224	101	105	18
15	75	29	45	1
16	48	11	21	16
18	18	8	10	-
20	20	12	8	-
Total	5,840	2,724	2,933	183
Percent of each		48.1	51.9	
No. in litters of 8 pigs or less	2,405	1,105	1,242	
No. in litters of more than 8 pigs	3,435	1,619	1,691	

* Taken from Carmichael, W. J., and Rice, John B. Variations in Farrow: With Special Reference to Birth Rate in Pigs. Ill. Agri. Exp. Sta. Bul. 226:86, (1920).

the sex of the pigs of young and old sows. In only one case was there a reversal of the sex ratio and that was in the 8 year old group which had only 7 pigs.

Table 2
Relation of Age of Dam to Sex of Pigs.*

Age of dam (years)	No. of females	No. of males
1	547	580
1½	497	544
2	487	530
2½	331	347
3	298	327
3½	162	167
4	143	145
4½	88	89
5	48	59
5½	19	34
6	37	24
6½	11	17
7	1	6
8	4	3
Total	2,673	2,922
Percent	47.8	52.2

* Taken from Carmichael, W. J., and Rice, John B. Variations in Farrow: With Special Reference to Birth Weight in Pigs. Ill. Agri. Exp. Sta. Bul. 226:9, (1920).

Hushby (7) observed in 203 litters which contained 1,748 pigs, a sex ratio of 51.9 percent males to 48.1 percent females. The adult sow seemed to be more fertile than gilts. The mortality rate was higher among the large litters.

McKenzie (13), working with Duroc-Jersey swine, registered or eligible for registration, found that in a population

of 2,011 pigs there were 1,034 males and 977 females, including 90 dead males and 75 dead females. Of all pigs born 51.42 percent were males and 54.55 percent of all pigs born dead were males.

Sinclair and Syrotuck (20) found the proportion of males to females in 277 farrowings containing 2,533 pigs, to be 53.69 percent males to 46.31 percent females. To study the influence of age of dam upon the sex of pigs, they grouped the 277 litters according to age of dam. Their data are given in table 3, showing the age of dam, number of sows farrowing, number of pigs, and the percent of males and of females. The ratio between the two sexes tends to remain quite constant with sows of various ages. In no case was there more females than males.

Table 3

The Influence of Age of Sow on the Sex Ratio.*

Age (years)	No. of sows	No. of pigs farrowed	Percent males	Percent females
1	101	819	53.48	46.52
2	77	747	54.09	45.91
3	51	495	54.75	45.25
4	33	329	51.37	48.63
5	15	143	54.45	45.55
Total or av.	277	2,533	53.69	46.31

* Taken from Sinclair, R. D., and Syrotuck, M. Age as a Factor in Swine Reproduction. Sci. Agri. 8:494,

McPhee, Russell, and Zeller, (14) found that a high proportion of boar pigs was a serious obstacle in the Poland

China inbreeding experiment. In the spring of 1923 there were 28 male and 8 female pigs farrowed. The following year the distribution of sexes was more evenly balanced but there was still a high percentage of males. The 189 first generation pigs consisted of 111 males and 88 females, which is 58.73 ± 2.41 percent males. The 64 second generation inbreds consisted of 39 males and 25 females or 60.93 ± 4.11 percent males. The proportion of males among the noninbred Poland China hogs was 52.35 ± 1.31 percent. The proportion of boars among the combined first and second generations inbreds was 59.29 ± 2.04 percent. The difference between this and the proportion of males among the noninbred Beltsville Poland China stock is 6.94 ± 2.42 percent which is just on the border line of significance. If the comparison is made with the figure 52.34 ± 0.22 the difference is slightly greater than three times its probable error and might therefore be considered significant. Observations on the sex ratio in the groups of other inbred swine raised at the Beltsville station have failed to verify the results obtained with the Poland China breed. This points to the fact that this is a peculiarity of this single inbred line.

Krallinger (10) found the sex ratio of 47,505 pigs to be 50.57 ± 0.23 percent males. Litters of individual sows and boars showed considerable variation in the sex ratio and it was concluded that the individuals of both sexes carried factors which tended to modify the sex ratio. The smaller litters (2 to 10) showed 1.08 ± 0.46 percent more males than the larger litters (11 to 20). The season of the year did not

show a definite relation to the fluctuations in the sex ratio. The percentage of males in first litters appeared to be slightly greater than the percentage in succeeding litters, although the difference was not statistically significant.

Crew (4) gives the following figures showing the wastage among pigs between birth and weaning. The secondary sex ratio, or the ratio at birth, among 2,336 pigs is 50.71 percent males to 49.29 percent females, where as that among the 1,489 which lived till weaning time had fallen to 48.56 percent males to 51.44 percent females. The percentage loss among the males was 38.6 and that among the females was 33.7.

Severson (19) analyzed the data from 393 litters, containing 3,779 pigs of five pure breeds, the sex ratio was 52.3 percent males to 47.7 percent females. The data in table 4 shows the number of sows farrowing, number of pigs, and the percent males and females by breeds. In no breed was there more males than females.

Table 4
Showing Number of Pigs and Sex Ratio by Breeds.*

Breed	Sows farrowing	No. of pigs	Percent		Av. litter size	Dead at birth
			Males	Females		
Yorkshire	78	913	53.6	46.4	11.7	3.6
Durocs	70	707	51.9	48.1	10.7	3.3
Chester White	81	775	51.1	48.9	9.6	3.0
Berkshire	82	711	52.0	48.0	8.7	1.4
Poland China	82	673	52.5	47.5	8.2	7.0
Total or av.	393	3,779	52.3	47.7	9.6	3.6

* Taken from Severson, A. Prolificacy of Sows and Mortality of Pigs. Am. Soc. An. Prod., Proc. p68, (1925).

Parkes (16) studied 583 pig fetuses of all ages, and found 331 to be males and 252 to be females, giving a male percentage of 56.8, which is higher than the approximate equality between the sexes that seems to exist at birth.

Parkes states that:

"These 583 fetuses when classified by weight (0-100 gms., 101-300 gms., 301- gms.) gave the following percentages of males for the respective groups; 59.1, 57.0, and 53.2. In other words, the percentage of males decrease as gestation proceeds, a result which can only be brought about by a differential mortality of males and females. It would appear that the percentage at conception was approximately 60 percent or 150 males per 100 females."

In studying the influence of time of mating during the oestrus cycle on the sex ratio of pigs, Krallinger and Schott, (11), made tests of 394 sows of which 46 were allowed to mate a few hours after onset of heat and the rest on the following day. They found that there was no significant variation in fertility, the number of litters produced per 100 matings being 65.8 for late and 63 for early matings. If summer matings are considered separately, however, early matings show a higher percent of fertility (67.5) than late ones (63.8). The average litter size was 10.05 for late and 9.83 for early matings, and the average number of young per mating 6.61 and 6.20. The sex ratio was 53.3 percent males to 46.7 percent females for the early matings and 53.9 percent males to 46.1 percent females for the late matings. They concluded that the time of mating has no effect on fertility and sex ratio.

Sex Ratio in Cattle

Roberts (17) obtained data from Private Herd Books for a study of 4,912 calves of the Dairy Shorthorn and Welsh Black Cattle. The sex ratio for the two breeds was 49.82 percent males to 50.18 percent females. There was a higher preponderance of males in the Welsh Black Cattle than the Dairy Shorthorn breed. Of 2,087 Shorthorn calves 1,028 were males for a ratio of 49.26 percent males to 50.74 percent females, as compared to 2,825 Welsh Black calves of which 1,419 were males, making a sex ratio of 50.22 percent males to 49.78 percent females. Considerable variation of the ratio was found from herd to herd. One herd had only 43.28 percent males to 56.72 percent females while in another there was 58.18 percent males to 41.82 percent females. He also reported one herd with 286 calves over a period of 9 years with a ratio of 50.00 percent males to 50.00 percent females. The ratio for the months of March to August, inclusive, is compared to that of the other six months. There were 2,889 calves born in the March-August period of which 1,406 were males and 1,483 were females making a sex ratio of 48.67 percent males to 51.33 percent females. During the other period there were 2,023 calves born which included 1,041 males and 982 females for a ratio of 51.46 percent males to 48.54 percent females. Thus in the season of a higher birth rate a lower percentage of males was obtained. This varied a little if the two breeds were regarded separately, although to a greater degree in the Welsh Black Cattle. The data in table 5 shows the percentage of males by periods for the two breeds.

Table 5
Percent Males by Periods for Dairy Shorthorn and
Welsh Black Cattle.*

Breed	Period	Percent males	Period	Percent males
Welsh Shorthorn	Mar.-Aug.	48.59	Sept.-Feb.	52.15
	Mar.-Aug.	48.74	Sept.-Feb.	50.00

* Taken from Roberts, E. J. Some Observations on the Secondary Sex Ratio in a group of Dairy Shorthorn and Welsh Black Cattle. Jour. Agri. Sci. 20:362, (1930).

Morgan and Davis (15) found that in 1,358 calves there were 730 males and 628 females or 53.75 percent males and 46.25 percent females. The proportion of male calves born during the summer (May to October) was 55.13 percent to 52.44 percent during the winter. The abortion rate was slightly lower during the summer, 11.88 percent, as compared with 13.24 percent during the winter.

In a study of the gestation time of Holstein-Friesian cows, Knott (9) reported that of 2,824 gestations of single births, 1,441 calves were males and 1,383 were females making a sex ratio of 51.02 percent males to 48.98 percent females, or 104.2 to 100. Of 86 sets of twins the ratio was 52.31 percent males to 47.69 percent females.

Data gathered by Roberts and Yapp (18) for 8,196 calves shows no evidence that a given sire produces a great preponderance of one sex in his offspring. There was 49.12 percent males among the population. The percentage of males among the dairy breeds was 48.40 while the Herefords had

50.45 percent males. The data in table 6 shows the number of calves, the number of males and females, and the percent males by breeds.

Table 6
Data Showing the Number of Calves Born
and the Sex Ratio by Breeds.*

Breed	No. of calves	No. of males	No. of females	Percent males
Holstein-Friesian	3,250	1,580	1,670	48.62
Ayrshire	680	333	347	48.97
Guernsey	782	349	433	44.63
Jersey	606	312	294	51.49
Hereford	2,878	1,452	1,426	50.45
Total or av.	8,196	4,026	4,170	49.12

* Taken from Roberts, Elmer, and Yapp, W. W. No Preponderance of Sex in Sires Offspring. Ill. Sta. Report. p 175 (1928).

A Wisconsin study (22) in which 124,000 births were tabulated and classified showed the ratio of male calves born was 51.50 percent males to 48.50 percent females, with no significant variation in this respect between the several breeds that were studied. No evidence was found to show that a cow or bull had more male calves when a particular parent is young or old. The ratio between male and female calves remains practically constant regardless of age of sire or dam. There was no significant difference in effect of season of year on the sex ratio. Of all twin calves born 49.07 percent were males and 50.93 percent were females. This is probably

explained by so large a number of males born so early in the gestation period that they fail to live. It has been demonstrated that in the case of abortions and stillbirths in many species of mammals that more males than females are thus expelled from the mother's uterus prematurely or dead. Data secured in this study show a ratio for aborted calves of 58.86 percent males to 41.14 percent females.

Jewell, as quoted by Parkes (16), investigated the foetal sex ratio among cattle and found that the sex ratio of 1,000 fetuses was 55.20 percent males to 44.80 percent females, which is a much higher figure than any which has been found for calves at birth. This result indicates that the cow falls in with the better known cases where intrauterine mortality falls preponderantly upon the males. This also indicates that in the cow the percent males at conception is very much above the percent males at birth.

Sex Ratio in Sheep.

Johansson (8) obtained records of 13,241 lambs from mothers with complete lambing records, including stillbirths and found that 49.30 ± 0.435 percent were males or 97.2 males to 100 females. The sex ratio was practically the same for all the breeds studied, for lambs born at different seasons of the year, and irrespective of the age of the mother. The sex ratio for single births and for twins was almost identical. The percentage of males among triplets was slightly lower although the difference was not significant. A sexually selective mortality was found to occur during the later

stages of pregnancy and during the first month after birth. The sex ratio for 305 stillborn lambs being 55.77 ± 2.858 percent males and for 1,088 lambs which died during the first month after birth, 54.32 ± 1.510 percent males.

Chapman and Lush (2) studied the records of 1,019 lambs 216 of which were born as singles, 722 as twins, and 81 as triplets. Among the singles 47.7 percent were males, among the twins 49.6 percent were males and among the triplets 40.7 percent were males. Four hundred and ninety-three of the 1,019 lambs were males, which is 48.4 percent of the total. The difference in the percentages of males found among singles, twins and triplets were not statistically significant. About five percent of the lambs were stillborn. Almost the same proportion were stillborn among the singles and twins. Twenty-two of the stillborn lambs were male and 27 were female--an insignificant difference between the two sexes in prenatal mortality.

Henning (6) reports that among a population of 1,742 lambs there was 875 males and 867 females which is 50.20 ± 1.20 percent males. Of 1,294 males born as twins 645 were males and 649 were females which is a sex ratio of 49.84 percent males to 50.16 percent females. To study the ratio of males to females among sheep fetuses records were collected for 972 prenatal lambs. This population included 495 males and 477 females which is 50.9 ± 1.60 percent males.

Sex Ratio in Horses, Mules and Hinnies.

In studying the sex ratio among horses Craft (3) found that in a population of 1,249 foals, there were 656 males and 593 females for a sex ratio of 52.52 ± 0.95 percent males to 47.48 ± 0.95 percent females. In this population there were 1,207 live born single birth foals, 626 males and 581 females; 20 stillborn males and 8 stillborn females; 14 sets of twins, 3 pairs of males, 4 pairs of one male and one female each and 7 pairs for which the sex was not recorded. The sex ratio for the liveborn foals was slightly lower than for the whole population being 51.9 percent males to 48.1 percent females. The sex records collected for 1,416 mules, 627 males and 789 females, sired by 98 different jacks showed the sex ratio to be 44.28 percent males to 55.72 percent females. There seemed to be no evident tendency for a certain jack as compared to others to sire a preponderance of foals of one sex.

In response to an inquiry made by Dr. Craft for information concerning the sex ratio of hinnies (the progeny from the female ass, or jennet mated to the stallion), Mr. Lynch of the Department of Agriculture, Dublin, Ireland states:

"Regarding the sex ratio among hinnies it would appear from the reports furnished by our local offices after examination of upwards of 1,000 animals that females predominate. The percentage works out at 58 percent females and 42 percent males. On the other hand in the mules the number of males appears in excess of females, the proportion being 61 percent males and 39 percent females."

ANALYSIS OF DATA

Material

Data were collected on 362 litters, containing 2,917 Duroc-Jersey pigs farrowed in the experimental herd at the Oklahoma Agricultural Experiment Station from 1925 to April 1, 1939. Complete farrowing records were available showing the date of farrowing, the number of pigs per litter, the litter number and the sex of each pig except in those cases where the pig was so badly deteriorated that the sex could not be determined.

During the same period 314 litters of pigs were farrowed in the college herd. This group was made up of Poland Chinas, Berkshires, Hampshires, Duroc Jerseys and Chester Whites. The Chester White breed was added to the herd in 1934. Due to incomplete records; either the date of farrowing, the breeding, or the sex of some of the pigs not having been recorded only 265 litters, containing 2,314 pigs, could be used in the study.

The sex ratio was calculated for the 627 litters containing 5,231 pigs, as a group, by breeds and for the stillborn pigs. The pigs were grouped by litter size to study the influence of litter size upon the sex ratio.

Records of sows having three or more farrowing records available were grouped according to litter number so as to study the influence of litter number upon sex ratio.

The records of the boars having sired 10 or more litters each were studied to see if there was a tendency for a boar

to sire a preponderance of one sex among his progeny. The same study was made for sows having 3 or more farrowing records available.

All litters on which the farrowing date was available were grouped by months to study the influence of the months and season of farrowing upon the sex ratio.

Method of Statistical Analysis

The significance of ^{this} data was tested statistically according to the methods set forth by Snedecor (21) and Fisher (5).

Chi square was used to measure the goodness of fit in the sex ratio of each group of litters having 5, 6, 7 and 8 pigs each according to Snedecor.

The variance in the percentage of males was analyzed according to Fisher.

Discussion and Results

Data were collected and analyzed for 627 litters or 5,231 pigs. In this population there were 2,762 males and 2,456 females with sex on 13 not recorded, making a sex ratio of 52.93 percent males to 47.07 percent females. The data in table 7 shows the number of pigs, the percentage of males and the number of pigs per litter by breeds. In only one case was there a reversal of the sex ratio and that was among the Polands.

Table 7

Data Showing the Number of Pigs
and the Percent Males by Breeds.

Breed	No. of litters	No. of pigs	No. of males	No. of females	Percent males	Pigs per litter
Durocs	421	3,481*	1,845	1,623	53.20	8.27
Hampshires	63	531	270	261	50.85	8.43
Berkshires	62	525	291	234	55.43	8.45
Polands	63	526	259	267	49.24	8.33
Chester White	18	168	97	71	57.74	9.33
Total or av.	627	5,231	2,762	2,456	52.93	8.34

* Sex on 13 not recorded.

The farrowing records of 62 sows which had had three or more litters were analyzed to see if there was any significant variation in the sex ratio between their first, second, third and fourth litters. The first litter group had the highest percent males with 56.1 percent as compared with 52.21 percent for the third litter group which was the lowest percentage of males for any group as is shown in table 8.

It is shown in this table that gilts average about one pig less per litter than at succeeding farrowings. The analysis of variance applied to this study shows there is no significant tendency for a higher preponderance of males among any one group of litters (first, second, third or fourth) for the same sows, as can be seen in table 9.

Table 8

Comparison of Sex Ratio and Number of Pigs in the First, Second, Third and Fourth litters.

Litter number	No. of litters	No. of pigs	No. of males	No. of females	No. not rec.	Percent males	Av. litter size
1	58	428	239	187	2	56.10	7.38
2	62	496	270	225	1	54.55	8.00
3	62	523	272	249	2	52.21	8.44
4	35	291	155	133	3	53.62	8.31
Total or average	217	1,736	936	794	8	54.10	8.01

Table 9

Analysis of Variance for Percentage of Males Between First, Second, Third or Fourth Groups of Litters.

Source of variance	Degrees of freedom	Sum of squares	Variance or mean sq.
Total	216	68,736.39	
Between groups	3	363.04	121.01
Within groups	213	68,373.34	321.00

The 62 sows on which farrowing records were available for three or more litters had a total of 233 litters containing 1,888 pigs. Sixteen of these litters were not used in the above study because they were the fifth, sixth, or seventh litters. In the population of 1,888 pigs there was 1,012 males and 867 females, with sex for 9 not recorded. The sex ratio for this group was 53.86 percent males to 46.14 percent females. The data in table 10 shows that there is no significant difference between sows.

Table 10
Analysis of Variance on the Basis of Percentage
of Males per Litter for Sows.

Source of variance	Degrees of freedom	Sum of squares	Variance or mean sq.
Total	232	101,066.43	
Between sows	61	23,914.42	392.04
Within sows	171	77,152.01	451.18

The records of the progeny of 11 boars, that had sired 10 or more litters each were analyzed to determine whether or not the individual boar has a tendency to sire a preponderance of offspring of one sex among his progeny. These 11 boars sired 203 litters, containing 1,640 pigs of which there were 869 males and 764 females, with 7 not recorded. The percent of males among this population was 53.21±6.41. The data in table 11 shows that only in two cases was there a reversal of

the sex ratio, having more males than females. Boar No. 51A₄ sired 52 litters, containing 385 pigs, which had a sex ratio of 49.74 percent males to 50.26 percent females. He was sired by 751A₃ which sired 24 litters, containing 180 pigs, which had a sex ratio of 58.66 percent males to 41.34 percent females. The table also shows the number of litters, the number of pigs and the average litter size for each boar. The analysis of variance applied to this study showed no significant tendency for a boar to sire a high percentage of offspring of either sex among his progeny.

Table 11

Data on Progeny of 11 Boars, Showing Number of Litters, Number of Pigs and the Sex Ratio of the Pigs.

Boar No.	No. of litters	Pigs sired	No. of males	No. of females	No. not rec.	Percent males	Litter size
234A ₂	23	176	95	81	-	53.98	7.65
751A ₃	24	180	105	74	1	58.66	7.50
51A ₄	52	385	191	193	1	49.74	7.40
811A ₆	16	137	70	67	-	51.09	8.56
792B ₄	15	113	68	43	2	61.62	7.53
375	10	87	44	43	-	50.57	8.70
536	12	18	62	56	-	52.54	9.83
013	10	80	45	35	-	56.25	8.00
S.A.	16	128	70	55	3	56.00	8.00
Su.A.	14	127	67	60	-	52.76	9.07
N.P.S.A.	11	109	52	57	-	47.17	9.91
Total or av. 203		1,640	869	764	7	52.21	8.08

A total of 627 litters was studied, classified and divided on the basis of litter size, the first class having 3 pigs or less per litter and a separate class for each size litter up to 15 pigs or more per litter. All litters of 15 pigs or more were included in the same class due to the small number of such litters. The percentage of males among the population of 5,231 pigs was 52.93, and only in the class of 4 pigs per litter was there more females than males, the ratio being 48.15 percent males to 51.85 percent females for the 27 litters, 108 pigs, as is shown in the data in table 12. This was the smallest number of pigs in any class. The highest percentage of males was in the second smallest group, the class of 3 or less in which there were 111 pigs, 66 males and 42 females with the sex on 3 not recorded, making the sex ratio 61.11 percent males to 38.89 percent females.

The largest number of litters in any class was the 10 pig litter class which had 32 litters containing 320 pigs. The sex ratio for this group was 51.22 percent males to 48.78 percent females, as is shown by the data in table 12. In only one case among the litters of 8 pigs or less was there either a reversal of the sex ratio or a smaller percentage of males than was found for the average of the entire population. In the classes of 9 pigs or more, in no case was there a reversal of the sex ratio in only in two classes was there more males than the average for the population.

There were 310 litters which had 8 pigs or less and 317 litters with 9 pigs or more. The sex ratio for the 1,802 pigs

Table 12
Classification by Litter Size.

Lit. size	No. lit	No. pigs	No. M	No. F	No. not rec.	% M	Stillborn M	Stillborn F	% M	% pigs born dead
3 or less	47	111	66	42	3	61.11	1	2	33.33	2.78
4	27	108	52	56	-	48.15	1	3	25.00	3.70
5	44	220	117	103	-	53.18	14	9	60.87	10.45
6	53	318	178	140	-	55.97	10	17	37.04	8.49
7	67	469	258	209	2	55.25	18	15	54.55	7.03
8	72	576	327	248	1	56.87	11	12	47.83	4.00
9	76	684	349	333	2	51.17	18	8	69.23	3.81
10	82	820	419	399	2	51.22	20	12	62.50	3.91
11	71	781	399	382	-	51.09	23	27	57.50	6.40
12	43	516	261	245	1	50.68	17	20	45.95	7.17
13	21	273	138	134	1	50.74	11	6	64.71	6.25
14	14	196	113	83	-	57.65	15	6	71.43	10.71
15 and over	10	159	85	73	1	53.80	13	8	61.90	12.66
Total or av.	627	5,231	2,762	2,456	13	52.93	172	145	54.26	6.07
8 or less	310	1,802	998	798	6	55.57	35	58	48.67	6.29
9 or over	317	3,429	1,764	1,658	7	51.55	117	87	57.35	5.96

in the first group is 55.57 percent males to 44.42 percent females as shown in table 12. In the 317 litters, 3,429 pigs, there was 1,764 males and 1,658 females with 7 pigs not recorded, for a sex ratio of 51.55 percent males to 48.45 percent females. This is the same result as that reported by Carmichael and Rice who found a higher preponderance of males

in the litters of 8 pigs or less than in those of larger numbers. There being a smaller percentage of males among the larger litters than the small may be partially due to more males dying during the gestation period and being reabsorbed in the uterus. Parkes found that the percentage of males decreased as the gestation period advanced.

The sex ratio of 317 stillborn pigs, 172 males and 145 females, was 54.26 percent males to 45.74 percent females. This compares quite closely with that of McKenzie who found 54.56 percent of the stillborn pigs to be males. The percent of stillborn pigs was 6.07 which is 2.47 percent higher than that reported by Severson who found 3.6 percent. The percentage of stillborn pigs among litters of 8 pigs or less was 6.29 percent which is slightly, though not significantly, higher than that of those litters having 9 pigs or more which was 5.96 percent.

Litters of 6 pigs each were divided on the basis of sex ratio within the litter. Among this population of 318 pigs, 53 litters, there were 178 males and 140 females which is a sex ratio of 55.97 percent males to 44.03 percent females. Chi square was tried on this group to test the goodness of fit of the binomial distribution on the basis of the sex ratio given above and was found to fit quite closely as may be seen from table 13. The Chi square value of 2.9787 is highly significant as one would expect the sex ratio to vary more than this 80 percent of the time. Chi square was also applied to see if there was a significant deviation from a ratio of

50 percent males to 50 percent females. The value of 7.0657 is not significant as more variation would be expected over 30 percent of the time. This group could have been taken from a population with a sex ratio of 56 percent males to 50 percent females. The same studies were made for the groups of litters of 5, 7 and 8 pigs each. The results compare quite closely with that of the above study.

Table 13

Application of Chi square to Litters of 6 Pigs Each.

Pigs of each sex per litter*	No. of litters observed	For 55.97% males :		For 50% males	
		No. of litters expected	Chi square	No. of litters expected	Chi square
A ₆	2 ⁿ	1.63	.0840	.83	1.6493
A ₅ B	8	7.70	.0116	4.97	1.8473
A ₄ B ₁	16	15.11	.5242	12.42	1.0319
A ₃ B ₃	13	15.90	.5289	16.56	.7653
A ₂ B ₄	9	9.38	.0154	12.42	.9417
A B ₅	5	2.95	1.4246	4.97	.0002
B ₆	-	0.39	.3900	.83	.8300
Total	53	53.06	2.9787	53.00	7.0657

* A= males B= females

To study the influence of month on the sex ratio 622 litters were classified on the basis of the month in which they were farrowed. The data in table 14 shows that in only

two cases was there a reversal of the sex ratio, January, which had only 39.13 percent males in five litters and July, with 49.33 percent males in 19 litters. June with only 13 litters had 61.54 percent males in a population of 67 pigs for the highest percentage of males of any month.

Table 14

Data on Litters Grouped by Months, Showing Number of Litters, Number of Pigs, and Percent Males.

Month	No. of litters	No. of pigs	No. of males	No. of females	No. not rec.	Percent males
Jan.	5	46	18	28	-	39.13
Feb.	51	418	222	196	-	53.11
Mar.	138	1,123	583	539	1	51.96
April	111	958	523	433	2	54.71
May	52	447	233	214	-	52.13
June	13	67	40	25	2	61.54
July	19	150	74	76	-	49.33
Aug.	64	527	291	234	2	55.43
Sept.	76	670	357	313	-	53.28
Oct.	62	567	285	276	6	50.80
Nov.	18	155	83	72	-	53.55
Dec.	13	80	43	37	-	53.75
Total or av.	622	5,208	2,752	2,443	13	52.97

The 622 litters were grouped according to the month in which they were farrowed to study the sex ratio by seasons. The April-June period contained 176 litters in which there were 796 males and 672 females which is 54.22 percent males. The October-December group had the lowest percentage of males

which was only 51.63 percent. The data in table 15 shows the number of litters, number of pigs and the percent males for each season.

Table 15
Data Showing Number of Litters, Number of Pigs,
and Percent Males, by Seasons.

Season	No. of litters	No. of pigs	No. of males	No. of females	No. not rec.	Percent males
Jan.-Mar.	194	1,587	823	763	1	51.89
Apr.-June	176	1,472	796	672	4	54.22
July.-Sept.	159	1,347	722	623	2	53.68
Oct.-Dec.	93	802	411	385	6	51.63
Total or av.	622	5,208	2,752	2,443	13	52.97

The analysis of variance applied to this study showed that there is no significant difference in the sex ratio between seasons, as may be seen in the data in table 16.

Table 16
Analysis of Variance on the Basis of
Percentage of Males per Litter for Seasons.

Source of variance	Degrees of freedom	Sum of squares	Variance or mean sq.
Total	621	213,865.94	
Between seasons	3	1,089.84	363.28
Within seasons	618	211,776.10	342.68

SUMMARY AND CONCLUSIONS

1. The sex ratio for the population of 5,231 pigs was 52.93 percent males to 47.07 percent females.
2. There is no significant tendency for a sow or boar to have a higher preponderance of males than females among his or her offspring.
3. There is no significant difference between the sex ratio of the first, second, third, or fourth litters.
4. Small litters (8 pigs or less) seem to have a tendency to have a higher preponderance of males than does the larger litters (9 pigs or over), however this difference is not significant.
5. The application of Chi square to the different medium sized litters shows a close fit of the binomial distribution on the basis of the sex ratio figured for the size litter.
6. The application of Chi square showed no significant deviation from a ratio of 50 percent males to 50 percent females among any of the groups of litters to which it was applied.
7. There is no significant variation between the months or seasons of the year.

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