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Early Embryonic Mortality in Strain Crossed Gilts

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ABSTRACT

In an earlier investigation (Squiers, Dickerson, and Mayer, 1952), the Missouri Station reported that the bulk of the embryonic deaths in swine occurred prior to the 25th day of gestation. In this investigation an effort was made, in preliminary exploratory experiments, to study embryos as early as the 8th day of gestation, but reliable and accurate observations proved unobtainable before the 17th day. Hence, observations in subsequent experiments were confined to two periods: (1) the 17th day and (2) the 25th day after mating.

Ovulation rate was studied in a total of 91 gilts slaughtered at the 17th and 25th days after mating. The average rate was found to be 11.69 in this group of gilts. Crosses of line VI Polands exceeded the line II Poland crosses in ovulation rate by an average of 1.29 ova and the difference was highly significant ($P < .01$).

A second objective in this investigation was a search for factors, which could be observed in the live animal, indicative of the ovulation rate. If a factor of this type could be found, it would be of invaluable aid in the selection of gilts with a high ovulation rate. Age at breeding influenced ovulation rate, giving a positive correlation ($P < .01$). Body length and backfat thickness were also positively correlated with ovulation rate ($P < .05$).

Embryonic mortality in 32 gilts slaughtered at the 17th day of gestation was 25.1 percent; whereas, in 40 gilts slaughtered at the 25th day after mating, the embryonic mortality was 33.63 percent. Thus, three-fourths of the mortality had occurred by the 17th day.

Age at breeding and backfat thickness were significantly correlated with the number of normal embryos, but the correlation between body length and normal embryos was not significant. Since the correlation between ovulation rate and the number of normal embryos was found to be highly significant, it is suggested that ovulation rate may be a breed characteristic whereas the number of normal embryos may be more closely related to the condition of the gilt at the stage in gestation when the observations were made.

Intra-uterine migration was apparent in 41.7 percent of the gilts studied. The distribution of the embryos in the two horns of the uterus was nearly equal if only normal, viable embryos were considered, but the distribution was found to be somewhat unequal if both dead and live embryos were counted. These findings suggest that intra-uterine migration of ova does exist and that it apparently is a mechanism for allocating optimum space for each developing embryo.

Gross abnormalities of the genital organs occurred in 8 gilts or 5.40 percent of the 148 gilts studied.

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Early Embryonic Mortality in Strain Crossed Gilts

ELMER H. LERNER, D. T. MAYER, JOHN F. LASLEY*

One basic requisite for profitable production of swine is an adequate number of pigs at parturition. Considerable progress has been made in the development of production methods favoring maximum litter size. But until the last few years, little knowledge of the endocrinological and physiological factors controlling litter size has been available.

Recent investigations at the Missouri Station and elsewhere have resulted in the following conclusions: (1) that litter size is controlled primarily by the extent of early embryonic mortality; (2) that the number of ova shed by a sow and the possession of sufficient intra-uterine space to assure the unhindered development of all fertilized ova affects embryonic mortality and litter size; and (3) that neither morphological abnormalities of the female genitalia nor the relative fertility of the boar has an appreciable effect upon litter size. The percentage of genital abnormalities in the sow is low. The boar has been shown to be either sterile or capable of fertilizing most of the viable ova shed by the female.

This investigation is one in a series on the endocrinological and physiological factors that are involved in embryonic mortality and indirectly determine ultimate litter size. Previous studies had indicated that the bulk of the embryonic deaths had occurred prior to the twenty-fifth day of gestation. An attempt was made to ascertain the exact time that the embryonic death occurred by slaughtering the gilts and sows at intervals between the first and the twenty-fifth day. By comparing the number of potential pigs present in the uteri of the slaughtered animals with the actual number of pigs farrowed by litter-mate control animals, an estimate could be made of the stage of gestation at which the highest percentage of fetal mortality usually occurs. The results, when related to physiological and endocrinological observations, should suggest factors influencing embryonic viability and the maintenance of the greatest number of viable embryos throughout the gestation period. Crew (1925-1926) and Warwick (1926) found that intra-uterine migration of ova occurred in the sows they studied. Since intra-uterine migration of ova might be an important factor in the determination of litter size in swine, this process was studied in the present investigation.

*This work was conducted as part of the Missouri Project of the Regional Swine Breeding Laboratory, Bureau of Animal Industry, United States Department of Agriculture, with the encouragement of W. A. Craft, Director of the Laboratory.

REVIEW OF LITERATURE

This review includes only selected portions of publications pertinent to the investigation and necessary for a better understanding of the material reported.

Basic to an understanding of the literature reviewed are several physiological assumptions utilized by most of the investigators:

1. The number of functional corpora lutea on the ovaries provides an indication of the number of ova shed during an estrous period.

2. The second provides the accepted method for the determination of embryonic mortality. The number of embryos lost or failing to survive is the difference between the number of functional corpora lutea and the number of viable embryos present in the uterus at the time of slaughter. This, of course, includes lost or defective ova.

3. The number of corpora lutea minus the number of pigs farrowed gives a number representing the lost or defective ova plus embryonic mortality during the entire gestation period.

The possibility exists that all of the ova released from the follicles are not fertilized. Corner (1921a) was able to recover 213 (96.8 percent) of the ova from the Fallopian tubes of 26 sows whose ovaries contained a total of 220 corpora lutea. The loss of ova may be ascribed to their disappearance in the body cavity or to their incomplete recovery from the tubes. However, Corner's results substantiate the reliability of the corpora lutea count as an index of the number of ova released from the ovaries.

Squiers, *et al.* (1952) recovered, approximately 25 hours after coitus, 80 percent of the ova shed by 52 gilts and found that 95 percent of these had been cleaved. They used the cleavage as a criterion for fertilization. They found that 37 of the 52 sows from which cleaved ova were recovered had all of their ova fertilized. The inference here would be that fertilization, if it takes place at all, is not a major consideration in fetal mortality.

A further observation by Squiers, *et al.*, was that 23 percent of the ova could not be accounted for 25 days after mating. Five percent of the ova were considered lost due to non-fertilization. Regressing embryos found at 25 days accounted for 7 percent of the death loss. The total loss represented a fetal mortality of 35 percent on the 25th day after mating; the remaining 65 percent apparently represented normal embryos.

Corner (1923) recovered 1044 embryos from sows in which 1306 ova were shed. This represented a 20 percent loss in ova. The recovery took place in sows at the stage when the embryos were 8 to 40 mm. long. In the same experiment, Corner found 235 embryos, in their third week of growth, resulting from 320 corpora lutea. Of this group, 31.3 percent of the ova were missing or were represented by abnormal embryos. Other observations showed that a total of 104 ova were released in 10 sows examined on or before the 10th day of gestation. Fifteen (14.4 percent) of these were present as degenerating blastocysts, 10 (9.6 percent) as unsegmented ova, and 24 (23 percent) were not found. This represents a 47.0 percent mortality by the 10th day of gestation. In view of his previous finding of 20 percent mortality in later stages of gestation, it is suggested that experimental error in observation on a small number of animals may account for the high mortality in the latter groups.

Hammond (1914) found an average of 14.3 ± 0.39 (range 11 to 19) corpora lutea in 18 young sows and an average of 19.77 ± 1.26 (range 13 to 24) corpora lutea in 9 old sows. A group of 7 animals from which he recovered the reproductive tracts had an average of 18 corpora lutea and 15.3 fetuses in the uterus of which 2.1 were atrophied. This left an average of 2.7 unaccounted ova. The fetal mortality in this case was 26.7 percent.

In a later observation, Hammond (1921) found 32.6 percent fetal mortality in 22 sows. These animals had been slaughtered between the 14th and 60th day of gestation.

Warwick (1928) calculated the percent of ova lost at various stages of gestation. He concluded that the loss tended to increase as gestation advanced. Uteri from sows in the 20th to 40th-day period of gestation had from 20 to 25 percent of the ova missing. Degenerating embryos were found to be most common in the earlier stages.

Crew (1925-1926), using 27 pregnant sow uteri, found an average litter size of 7.9. The average number of corpora present was 13, giving a 33 percent mortality. In attempting to determine the possible cause of fetal mortality, the embryos in the right and left uterine horns of 102 animals were classified separately. The mortality observed in the right horn was 26 percent and that of the left horn was 26.6 percent. Since the fetal mortality was more prevalent among male embryos, the author concluded that the prenatal mortality might be genetic in nature. It should be noted that the embryos in the right horn numbered 527 and in the left 501, which is a fairly equal distribution. The mortality rate was also approximately equal in each horn of the uterus.

Warwick (1926) studied 469 uteri in an investigation of intra-uterine migration of ova. The right ovary had released 44.72 percent of the ova and the left ovary 55.28 percent. The fetuses, however, were quite equally distributed in the right and left uterine horns. The right side of the uterus contained 50.05 percent of the fetuses while the left contained 49.95 percent. Migration of ova had occurred in 42.35 percent of the animals.

Corner (1921a) found no migration of recently ovulated ova. After examination of many cases, he concluded that the number of embryos became equalized within the two horns of an individual animal. Corner believed this migration took place as a result of peristaltic action of uterine musculature.

Rathnasabapathy, *et al.* (1956) reported that intra-uterine migration was found in 15 of the 42 gilts studied; the transference always occurring from the uterine horn on the side where the ovary possessed the larger number of corpora lutea to the horn on the side of the ovary with the lesser number of corpora lutea.

In a review of factors affecting fertility in swine, Phillips and Zeller (1941) summarized the fetal death loss during gestation. They determined that 31.3 percent of the ova shed in sows were lost between estrus and farrowing.

Corner (1921b) was, in one case, able to recover 6 vesicles from a sow with 7 corpora lutea. Two of these were entirely normal, two were normal in texture but were collapsed and cup-shaped, two were abnormal, while one was unsegmented. The possible causes of early fetal mortality were ascribed to: (a) pathological changes inherent in the germ-cells, (b) faults due to germ-cells, and (c) injuries which might affect the ovum during passage from the ovary to the uterus. Concerning the last cause cited, he mentioned the possibility of chemically abnormal secretions from apparently normal uteri.

Warnick, *et al.* (1949) showed that embryonic death was responsible for repeat breeding in 23.9 percent of the gilts and 67.4 percent of the sows studied.

Wilson, *et al.* (1948) found that 25.8 percent of the ova ovulated were either not fertilized or failed to develop into embryos.

Rathnasabapathy, *et al.* (1956) reported a highly significant positive correlation between the number of normal embryos at 15 days of gestation and the length of the uterus ($P < .01$; $r = .552$). They showed further that an optimum of 350 to 450 mm. of uterine space per individual embryo should be made available if the embryos are to survive and develop normally. A smaller uterine space than this, they reported, was bound to enhance fetal atrophy and more space, alone, would not assure additional survival. These investigators concluded that overcrowding, or a primary or secondary uterine deficiency, was one of the most important and immediate causes of embryonic mortality.

In the animal breeding laboratories at the Missouri station, endocrine studies have accompanied the work on embryonic mortality. The significance of progesterone in the reproductive processes influencing embryonic mortality has been investigated. The level of progesterone can be detected as such in the tissues, or its metabolic products, pregnanediol and other pregnane derivatives, can be found in the urine. Glasgow and Mayer (1956) obtained a significant correlation coefficient of 0.51 between the level of pregnanediol present in sows' urine at the 25th day to the 39th day of gestation and the number of viable embryos present at that time. A significant correlation coefficient of 0.62 also existed between the level of urinary pregnanediol and the percent of the ova shed which were implanted and maintained as viable embryos to the 25th day of gestation. Recent studies by Gawienowski and Mayer (1956) showed that the actual progesterone content of the ovaries was not correlated with the number of viable embryos found in the uterus. No conclusions regarding the significance of this finding can be made at present. However, the work of both groups of investigators suggests that the contribution of placental and adrenal glands to the pregnane derivatives in sow urine warrants consideration.

Glasgow and Mayer (1956) had found a decreased level of pregnanediol excretion at the time when the embryonic mortality was greatest. Interestingly, Bredeck and Mayer (1956) showed that the urinary estrogens in sow urine were increasing during the period when pregnanediol excretion was at a minimum. Results of the work on endocrine factors in embryonic mortality raise several questions related to their effect on uterine growth and to their role in providing an optimum environment for maximum embryonic survival.

On review of the literature, it may be seen that the most extensive mortality occurs during early gestation. It may also be noted that there is unequal distribution of corpora lutea on the right and left ovaries. Nevertheless, there is a tendency for the embryos to become equally distributed in the right and left uterine horns. Though mortality occurs, it is in such a way as to retain the equalization of viable embryos between the two uterine horns.

MATERIALS AND METHODS

Animals

A total of 104 gilts were used in this study. All were progeny of line II Polands (II) by line VI Polands (VI) or crosses of one of these lines with one of the following: Scholtz Poland (OBP), Iowa Cross (I), Corzatt Hampshire (OBH), line V Hampshire (V), Mitchell Duroc (OBD), Oklahoma "T" Duroc (T), Beltsville Landrace (BLR), Iowa Landrace (ILR), or Yorkshire (Y). This gave a total of 19 groups.

Methods

The gilts were checked for estrus by placing three boars with the herd once a day. A gilt was considered in estrus when she would willingly receive a boar. The gilts in estrus were separated from the test boar before mating could take place, and then mated with a boar of non-related orgin, where feasible, in order to eliminate any possible effect of inbreeding on the resulting embryos.

An attempt was made to recover embryos at the earliest possible date and still retain accuracy in the counting. Gilts were slaughtered 8 to 25 days after mating. No embryos were recovered before the 12th day. Those embryos recovered from 12 to 16 days were too small and too similar in appearance to their surrounding chorionic tissue to ascertain the correct number. Attempts to flush these early embryos from the uterus with physiological saline solution resulted in a tangle of chorionic tissue. It was extremely difficult to separate the embryos from their chorionic tissue in these instances. The 17th day after mating was finally decided upon as the period when embryos could be recovered without difficulty and accurate observations and counts would be possible.

Alternate gilts within a group were slaughtered at 17 days of gestation. The rest were slaughtered at 25 days of gestation. Reproductive tracts were recovered at time of slaughter (Figures 1 and 2) and refrigerated until they could be dissected and studied.

To detect abnormalities of the vagina and cervix, all dissections were initiated at the vulva. The vagina and then the cervix were laid open. Each uterine horn was opened separately; the number of embryos in each horn was recorded.

The embryos were separated into three distinct morphological classifications.

I. *Resorbed Embryos:* Embryos showing visible signs of degeneration were recorded as resorbed embryos. In addition, those cases in which only the amniotic sac and surrounding chorionic membranes were found, were recorded under this classification.

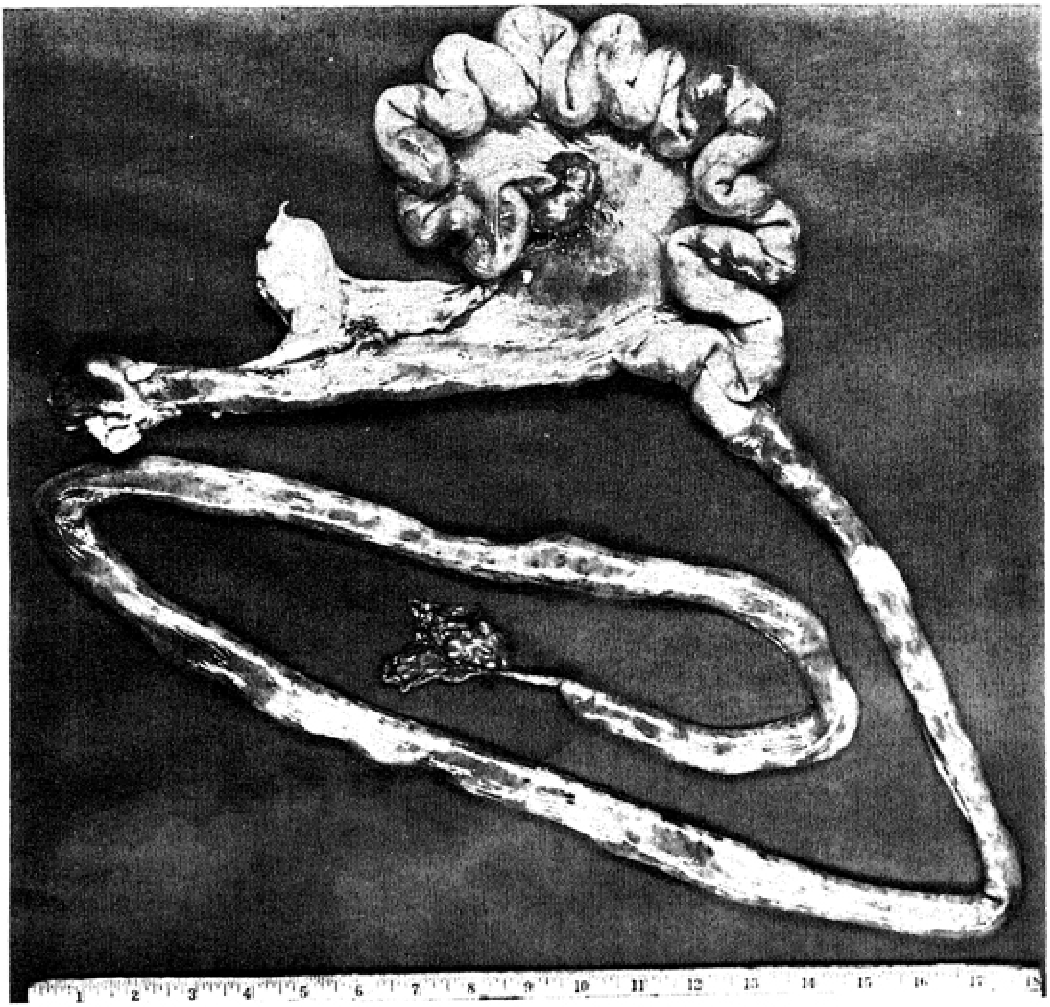

Fig. 1—Normal reproductive tract 18 days after breeding. Right broad ligament trimmed off.

II. *Retarded Embryos:* Embryos which were visibly smaller by approximately one-third or more than other embryos in the same uterus. This classification was used because the initiation of resorption or mummification could not be detected macroscopically.

III. *Normal Embryos:* The remaining embryos were classified as normal.

Ovaries were separated at their hili from the rest of the reproductive tract. The corpora lutea were then dissected from each ovary. Weight of each ovary and the weight and number of its corpora lutea were recorded.

This procedure enabled the calculation of ovulation rate of the entire experimental group and embryonic mortality of the group at the 17th and 25th days of gestation. A comparison of the ovulation rates and fetal mor-

Fig. 2—Normal reproductive tract 26 days after breeding. Right broad ligament trimmed off.

tality resulting from line II and line VI crosses was also made. Intra-uterine migration and the presence of gross abnormalities of the reproductive tract were also studied.

RESULTS

Ovulation

The maximum number of pigs any gilt or sow will normally farrow is primarily limited by the number of ova shed, if intra-uterine space and the physiological functions of the uterus are at an optimum level. Hence, one phase of the present investigation was concerned with the determination of ovulation rate. The criterion of ovulation rate or number of ova shed by any experimental animal is generally accepted as the number of functional corpora lutea present in both ovaries at the time the observations are made.

In this investigation, 91 gilts were slaughtered and their corpora lutea were studied. A total of 1064 corpora lutea were counted with an average of 11.69 corpora lutea per gilt. The 72 gilts of this group from which embryos had been recovered had an average of 11.37 corpora lutea per gilt. In the remaining 19 gilts, the average number of corpora lutea was 12.89. Eight of these 19 gilts were classified as nonpregnant, and in this group the average corpora lutea count was 15.00 (Table 1).

Table 2 presents data on ovulation rate and corpora lutea weights of those gilts from which embryos were recovered. It shows that the lowest average of any one group was 9 corpora lutea in the IIxOBP outcross

TABLE 1. OVULATION RATE

	Number of Animals	Mean number corpora lutea per gilt
Gilts from which embryos were recovered	72	11.38
Exploratory gilts	11	11.36
Gilts not settled	8	15.00
All gilts	91	11.69

TABLE 2. MEAN OVULATION RATE AND WEIGHTS OF CORPORA LUTEA BY CROSSES FOR GILTS FROM WHICH EMBRYO COUNTS WERE OBTAINED

		Mean	Mean Number corpora:		Average weight of corpus (gm.)	
Breeding*	No. gilts	corpora per gilt	right horn	left horn	right horn	left horn
IIxVI	2	10.00	5.0	5.0	.34	.39
IIxOBP	6	9.00	2.7	6.3	.66	.49
VIxOBP	4	11.75	7.0	4.8	.42	.45
IIxI+	5	9.80	5.0	4.8	.48	.42
VIxI+	5	12.80	5.0	7.8	.50	.48
IIxOBH	2	10.00	3.0	7.0	.51	.50
VIxOBH	5	14.60	5.6	9.0	.37	.38
IIxV	4	11.75	5.8	6.0	.49	.49
VIxV	2	12.00	6.5	5.5	.36	.38
IIxOBD	3	11.67	5.0	6.7	.44	.47
VIxOBD	6	11.50	4.5	7.0	.50	.50
IIxT	5	9.80	5.0	4.8	.48	.44
VIxT	5	11.00	4.2	6.8	.49	.49
IIxBLR	4	12.50	6.2	6.2	.45	.64
VIxBLR	2	13.50	5.5	8.0	.62	.68
IIxILR	5	11.60	5.2	6.4	.51	.59
VIxILR	3	11.67	8.7	3.0	.58	.54
IIxY	2	10.00	3.5	6.5	.43	.40
VIxY	2	11.50	4.5	7.0	.35	.39
Mean	72	11.37	5.08	6.29	.47	.48

* See Experimental Animals, MATERIALS AND METHODS, for explanation of these terms.

gilts. The highest average ovulation rate was 14.6 in the gilts of the VIx OBH cross. Although the distribution of corpora lutea on the left and right ovaries was somewhat unequal (44.7 percent on the right, 55.3 percent on the left), it was noticed that the average corpus luteum weights on either side were nearly identical; .47 gm. on the right, and .48 gm. on the left ovary. The range of average corpus luteum weights from group to group varied as much as 100 percent or more.

The line VI crosses showed the highest ovulation rate (Table 3). These gilts produced offspring with the highest ovulation rate when crossed with the line V Hampshire, outbred Hampshire, and Beltsville Landrace; ovulation averages for the offspring were 14.50, 14.17 and 13.50, respectively. Among the line II crosses, ovulation rates were highest in those with line V Hampshire and Beltsville Landrace. The average ovulation rate observed in line II females was 11.04 while that of the line VI females was 12.33. This total mean difference of 1.29 corpora lutea was highly significant.

TABLE 3. OVULATION RATE OF GILTS FROM CROSSES WITH POLAND LINES II AND VI

Parent Line	No. gilts		Mean age at estrus (days)		Avg. per gilt		Avg. per gilt: II and VI combined
	II	VI	II	VI	II	VI	
Poland							
VIxII	4	4	206.5	206.5	10.75	10.75	10.75*
OBP	6	5	213.3	223.8	9.00	11.60	10.18
I+	6	6	193.0	200.8	9.67	12.17	10.92
Hampshire							
OBH	3	6	197.7	214.2	11.33	14.17	13.22
V	6	4	202.0	186.8	14.17	14.50	14.30
Duroc							
OBD	5	6	197.6	189.3	11.40	11.50	11.45
T	5	5	205.6	204.6	9.80	10.67	10.27
Landrace							
BLR	5	2	203.0	205.0	12.20	13.50	12.57
ILR	6	5	203.7	190.8	11.33	12.80	12.00
Yorkshire	4	2	206.0	209.5	10.75	11.50	11.00
Mean	50	45	202.9	201.8	11.04	12.33	11.69*

* The 4 litters of IIxVI were included only once in the grand mean, but were included in both the II and VI means.

Factors Related To Ovulation Rate

Certain body characteristics of gilts were studied in an endeavor to find factors which might be indicative of the rate of ovulation. Three of those most easily studied were average carcass backfat thickness, carcass length, and age at breeding. The carcass backfat thickness was an average of measurements, in millimeters, taken at three points opposite the vertebral column. These points were: (1) where the first rib joins the vertebrae, (2) where the last rib joins the vertebrae, and (3) just opposite the last lumbar vertebrae. The body length was a straight line measurement in millimeters from the anterior edge of the first rib to the anterior edge of the "aitch" bone. Age at breeding was computed in days.

Backfat thickness and body length, it was thought, might possibly be indicators of endocrine function. A comparison between groups showed that the group with the highest average backfat thickness (VIxOBD) did not necessarily have the largest number of corpora lutea (Table 4).

TABLE 4. MEANS OF FACTORS STUDIED BY CROSSES

Lines crossed	Age at breeding (days)	Number corpora lutea	Body length (mm.)	Back-fat (mm.)	Number normal embryos
IIxVI	206.5	10.75	757.2	40.6	8.00
IIxOBP	213.3	9.00	745.0	48.4	6.67
VIxOBP	223.8	11.60	745.0	53.8	8.25
IIxI+	193.0	9.67	777.7	45.2	5.40
VIxI+	200.8	12.17	769.8	41.3	8.40
IIxOBH	197.7	11.33	795.3	42.8	7.00
VIxOBH	215.0	14.60	750.3	47.3	8.00
IIxV	202.0	14.17	801.0	52.0	7.75
VIxV	186.5	14.50	763.8	51.5	10.50
IIxOBD	197.6	11.40	795.4	55.2	7.00
VIxOBD	191.0	11.50	785.4	57.8	8.67
IIxT	205.6	9.80	787.2	45.6	8.20
VIxT	204.6	11.00	773.6	52.5	9.40
IIxBLR	203.0	12.20	823.4	45.7	9.50
VIxBLR	205.0	13.50	828.5	54.4	11.00
IIxILR	203.7	11.33	809.2	43.6	7.80
VIxILR	190.8	12.80	801.0	44.4	7.33
IIxY	206.0	10.75	766.8	45.0	5.50
VIxY	188.5	11.50	745.5	43.6	9.00
No. gilts	90*	90*	86**	86**	72***
Average	202.12	11.69	778.44	47.9	7.99

* 90 gilts on which both age at breeding and numbers of corpora lutea were available.

** Body length and backfat measurements available on 86 of the 90 gilts also having data on age at breeding and corpora lutea count.

*** Embryos recovered from 72 gilts.

Group VIxOBH, whose backfat thickness of 47.3 mm. was slightly below the average for all the groups, had the highest average number of corpora lutea. Thickness of backfat and number of corpora were significantly correlated ($r = -0.28$) within groups (Table 5). The regression coefficient of number of corpora on thickness of backfat in mm. was 0.15. This would indicate that approximately 1.5 additional corpora lutea might be expected for every cm. of additional backfat.

TABLE 5. CORRELATION AND REGRESSION COEFFICIENTS FOR CORPORA LUTEA NUMBERS ON FACTORS STUDIED

	Age at breeding (days)		Backfat thickness (mm.)		Body length (mm.)	
	r	b	r	b	r	b
Between groups	.042	.0064	.082	.020	.14	.0088
Within groups	.38**	.067	.28*	.15	.24*	.028
Total	.25*	.042	.167	.059	.182	.016

* P < .05
** P < .01

Body length was also correlated significantly with corpora lutea numbers within groups. In this case a slightly lower correlation coefficient of 0.24 was obtained. The regression coefficient was found to be 0.028. Thus, for every additional cm. in body length among animals within the same group, the number of corpora lutea increased 0.28.

The correlation of age at breeding with the number of corpora lutea found in the ovaries of a gilt within any cross studied was highly significant ($r = 0.38$). Within these crosses, for every 10 days additional age at breeding there were 0.67 additional corpora lutea.

An analysis of variance between crosses was made for the number of corpora lutea, after running variation linearly associated with age at breeding, with backfat thickness and with body length (Table 6A). Where age was held constant, no significant difference was found between the 19 groups (Table 6B). However, when backfat or body length was held constant, a significant difference (F test) was found to exist between groups.

TABLE 6 A. UNADJUSTED VARIATION BETWEEN AND WITHIN CROSSES FOR FACTORS TESTED

	Age at breeding (days)		Backfat thickness (mm.)		Body length (mm.)		Corpora lutea	
	DF	M.Sq.	DF	M.Sq.	DF	M.Sq.	DF	M.Sq.
Between crosses	18	451.11**	18	145.10**	18	2163.39**	18	8.22
Within crosses	53	173.17	51	13.78	51	585.76	53	5.00

TABLE 6 B. VARIATION BETWEEN AND WITHIN CROSSES FOR NUMBER OF CORPORA LUTEA PER GILT

	Age constant		Backfat constant		Body length constant	
	DF	M.Sq.	DF	M.Sq.	DF	M.Sq.
Between crosses	18	5.57	18	10.92*	18	10.27*
Within crosses	65	4.84	65	5.21	65	5.35

** P < .01
* P < .05

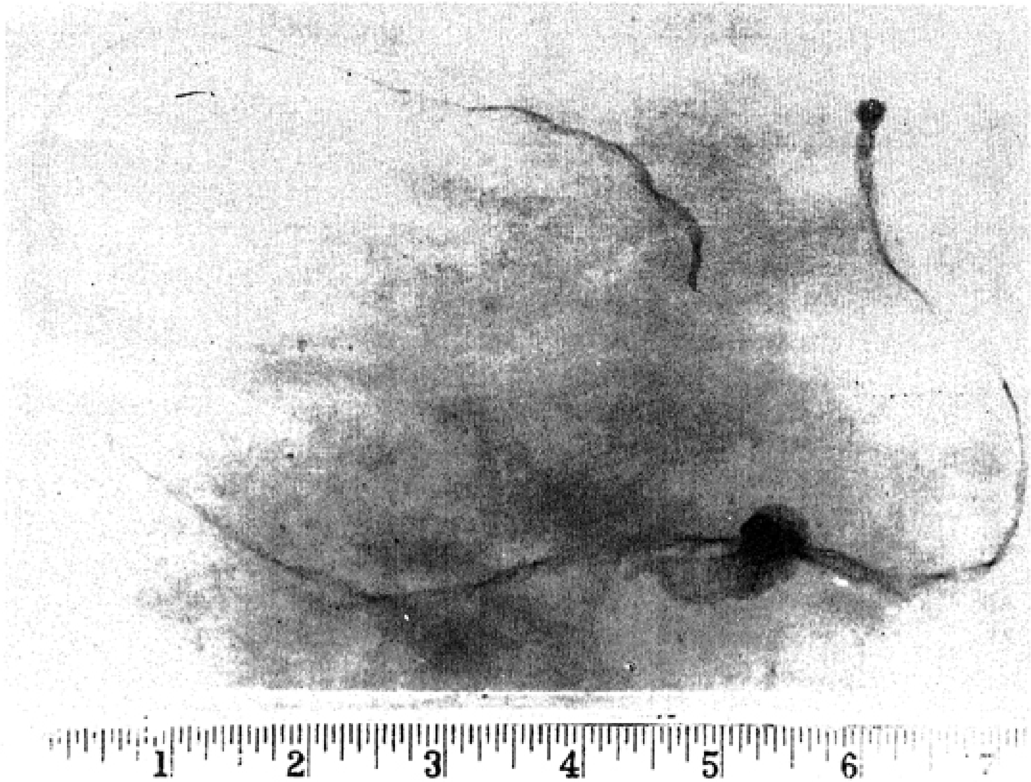

Fig. 3—Normal 18-day embryo complete with allantois and chorionic tissue.

Fetal Mortality.

The difference between the percentage fetal mortality at the 17th day and that of the 25th day after breeding was studied. All embryos other than those classified as retarded or resorbed were considered to be normal. The proportion of ova represented by normal embryos was higher by 8.56 percent in uteri of gilts slaughtered on the 17th day than in those slaughtered on the 25th day of gestation.

At the 17th day, a total of 279 embryos (average, 8.72 per gilt) were recovered from 32 gilts (Figure 3). Of these, 275 were considered normal, two were retarded, and two were resorbing. The 32 gilts mentioned had 25.07 percent mortality from 367 ova shed (Table 7).

The retarded and resorbed embryos together accounted for only 1.09 percent of the total fetal mortality. Embryos at 17 days were small enough that errors could be expected when they were examined with the naked eye. Where doubt as to their classification existed, they were examined further and compared with normal embryos of about the same age under a dissecting microscope.

TABLE 7. FETAL MORTALITY AT 17TH AND 25TH DAY AFTER MATING

Breeding	No. gilts 17 (days)	No. gilts 25 (days)	Average number corpora lutea 17 (days)	Average number corpora lutea 25 (days)	Average number embryos recovered 17 (days)	Average number embryos recovered 25 (days)	Average number normal embryos recovered 17 (days)	Average number normal embryos recovered 25 (days)	Total No. retarded embryos 17 (days)	Total No. retarded embryos 25 (days)	Total No. resorbed embryos 17 (days)	Total No. resorbed embryos 25 (days)
IIxVI	2	0	10.00		9.00		8.00		1		1	
IIxOBP	3	3	11.00	7.00	8.00	5.67	6.00	5.33				1
VIxOBP	1	3	12.00	11.67	12.00	9.33	12.00	7.00		5		2
IIxI+	1	4	8.00	10.25	3.00	6.75	3.00	6.00				3
VIxI+	3	2	11.00	15.50	8.33	9.50	8.00	9.00	1			1
IIxOBH	1	1	12.00	8.00	6.00	8.00	6.00	8.00				
VIxOBH	3	2	14.33	15.00	11.00	4.00	11.00	3.50		1		
IIxV	2	2	13.00	10.50	6.50	9.00	6.50	9.00				
VIxV	1	1	9.00	15.00	10.00	12.00	10.00	11.00				1
IIxOBD	1	2	12.00	11.50	9.00	7.50	9.00	6.00		1		2
VIxOBD	1	5	10.00	11.80	10.00	8.80	10.00	8.40				2
IIxT	2	3	9.50	10.00	9.50	8.00	9.50	7.33		2		
VIxT	4	1	11.25	10.00	9.50	9.00	9.50	9.00				
IIxBLR	1	3	16.00	11.33	12.00	8.67	12.00	8.67				
VIxBLR	0	2		13.50		12.00		11.00		1		1
IIxILR	4	1	12.00	10.00	9.00	9.00	8.75	4.00			1	5
VIxILR	1	2	10.00	12.50	10.00	11.00	10.00	10.50				1
IIxY	0	2		10.00		7.00		5.50				
VIxY	1	1	11.00	12.00	10.00	8.00	10.00	8.00		1		2
Total	32	40	367.00	452.00	279.00	332.00	275.00	300.00	2	11	2	21
Average			11.47	11.30	8.72	8.30	8.59	7.50				

TABLE 8. FETAL MORTALITY IN CROSSES WITH POLAND LINES II AND VI

	No. gilts		Average corpora lutea per gilt			Average total embryos per gilt			Average normal embryos per gilt			Total retarded embryos		Total resorbed embryos	
	II	VI	II	VI	Total	II	VI	Total	II	VI	Total	II	VI	II	VI
Poland															
VI and II	2	2	10.00	10.00	10.00	9.00	9.00	9.00	8.00	8.00	8.00	1	1	1	1
OBP	6	4	9.00	11.75	11.22	6.83	10.00	8.10	6.67	8.25	7.30		5	1	2
I+	5	5	9.80	12.80	11.30	6.00	8.80	7.40	5.40	8.40	6.90		1	3	1
Hampshire															
OBH	2	5	10.00	14.60	13.29	7.00	8.20	7.86	7.00	8.00	7.71		1		
V	4	2	11.75	12.00	11.83	7.75	11.00	8.83	7.75	10.50	8.67				1
Duroc															
OBD	3	6	11.67	11.50	11.56	8.00	9.00	8.67	7.00	8.67	8.11	1		2	2
T	5	5	9.80	11.00	10.40	8.60	9.40	9.00	8.20	9.40	8.80	2			
Landrace															
BLR	4	2	12.50	13.50	12.83	9.50	12.00	10.33	9.50	11.00	10.00		1		1
ILR	5	3	11.80	11.67	11.62	9.00	7.67	8.50	7.80	7.33	7.62			6	1
Yorkshire	2	2	10.00	11.50	10.75	7.00	9.00	8.00	5.50	9.00	7.25	1		2	
Total	38	36	402.00	437.00	819.00	298.00	331.00	611.00	278.00	313.00	575.00	5	9	15	9
Average			10.58	12.14	11.37*	7.84	9.19	8.49*	7.32	8.69	7.99*				

* The 2 litters of IIxVI were included only once in the grand mean, but were included in both the II and VI means.

Embryos recovered at the 25th day after breeding were much easier to classify, since an enormous development had taken place within the period of only one week (Figures 4 and 5). The total number of corpora lutea from 40 gilts slaughtered at the 25th day was 452 (Table 7). The embryonic mortality rate was 33.63 percent, with 120 ova unaccounted for, 11 retarded, and 21 resorbed or in the process of resorption. The retarded or resorbing embryos together formed 7.08 percent of the embryonic mortality.

Since the ovulation rate of crosses of line VI polands was markedly higher than that for the crosses of line II Polands, their embryo counts would also be expected to be higher. Table 8 shows this was true. The average total embryo recovery (including retarded and resorbed) was 1.35 higher for line VI than for line II crosses (9.19 vs. 7.84). Total recovery of embryos for line VI crosses (75.74 percent) slightly exceeded that for line II crosses (74.13 percent).

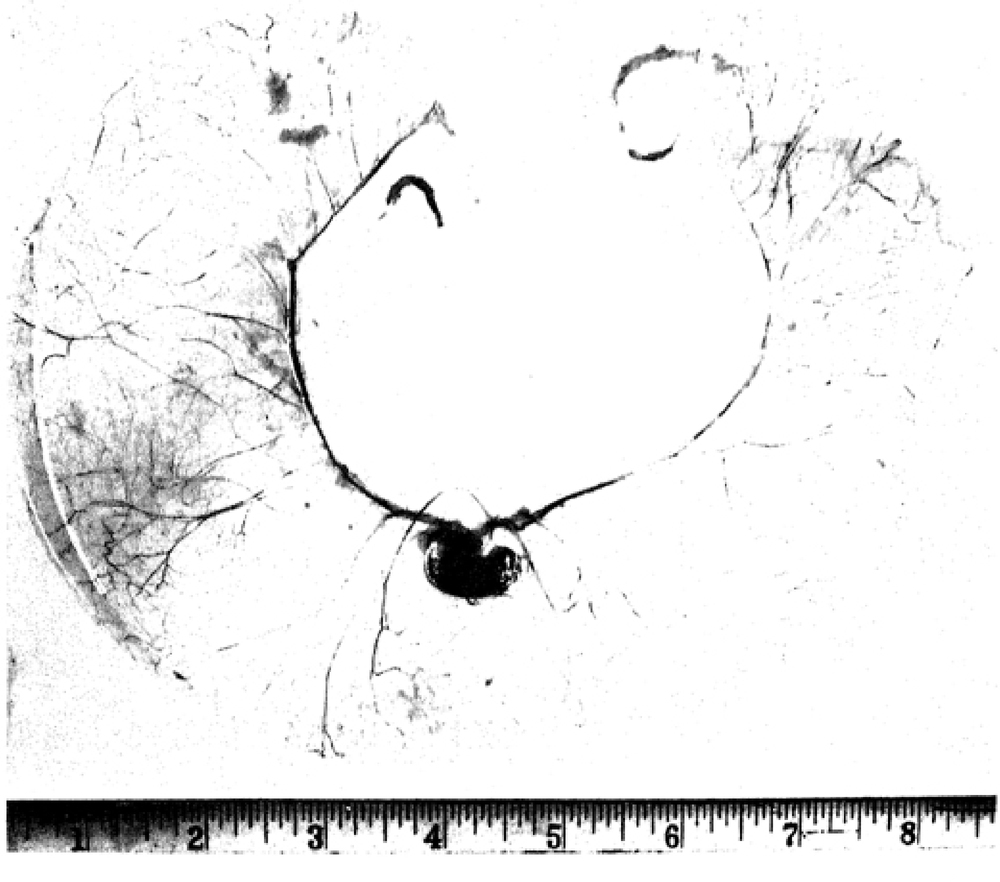

Fig. 4—Normal 26-day embryo complete with distended chorion.

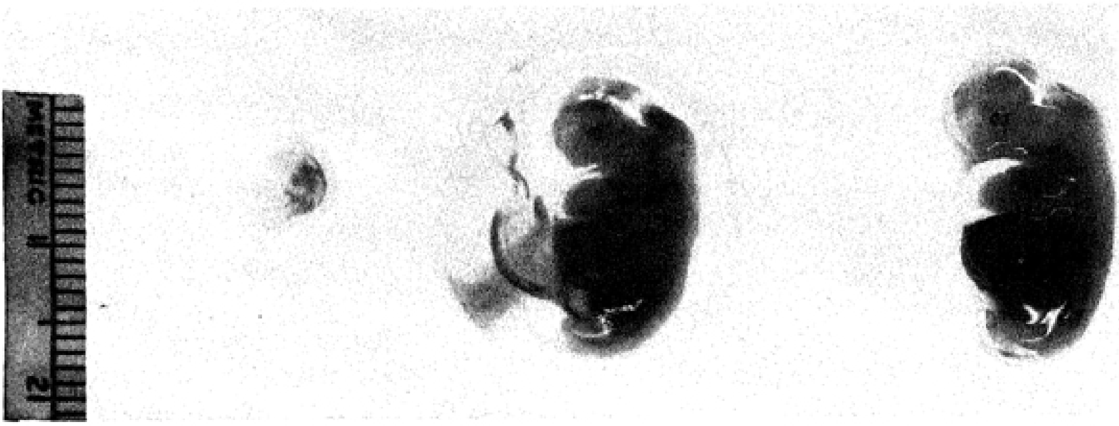

Fig. 5—Left, normal 26-day old embryo encased in amnion. Right, normal 26-day old embryo with amnion removed.

However, recovery of normal embryos was 71.62 percent for gilts of line VI crosses compared to 69.15 percent for gilts of line II crosses, a slightly larger difference. Retarded plus resorbed embryos for line VI crosses comprised 4.12 percent of all ova shed, whereas in line II crosses the percentage was 4.98. Apparently, the superiority of line VI crosses in number of embryos per gilt was largely due to their higher rate of ovulation.

Factors Related to Fetal Mortality

The carcass characteristics tested for a possible relationship with ovulation rate, were also tested to see if a parallel relationship with fetal mortality might also exist. This was accomplished by correlating age at breeding, backfat thickness, or body length, separately, with the number of normal embryos present within and between groups.

The age at which the gilts were bred was significantly correlated ($r = .32$) with the number of normal embryos present in gilts within groups (Table 9). The number of embryos increased by 0.9 for each additional 10 days increase in age at the time of breeding.

TABLE 9. CORRELATION AND REGRESSION COEFFICIENTS FOR NORMAL EMBRYO NUMBERS ON FACTORS STUDIED

	Corpora		Age at breeding (days)		Backfat thickness		Body length (mm.)	
	r	b	r	b	r	b	r	b
Between groups	.53*	.47	.016	.0022	.13	.028	.241	.014
Within groups	.52**	.86	.32*	.090	.31*	.30	.024	.0044
Total	.50**	.72	.22	.049	.17	.086	.089	.010

* $P \leq .05$
** $P \leq .01$

TABLE 10 A. UNADJUSTED VARIATION BETWEEN AND WITHIN CROSSES FOR FACTORS TESTED

	Corpora lutea		Age at breeding (days)		Backfat thickness (mm.)		Body length (mm.)		Normal embryos	
	DF	M.Sq.	DF	M.Sq.	DF	M.Sq.	DF	M.Sq.	DF	M.Sq.
Between crosses	18	8.22	18	451.11**	18	145.10**	18	2163.39**	18	6.56
Within crosses	53	5.00	53	173.17	51	13.78	51	585.76	53	13.72

** $P \leq .01$

TABLE 10 B. VARIATION BETWEEN AND WITHIN CROSSES FOR NORMAL EMBRYOS PER GILT

	Corpora lutea		Age constant		Backfat constant		Body length constant	
	DF	M.Sq.	DF	M.Sq.	DF	M.Sq.	DF	M.Sq.
Between crosses	18	5.49	18	10.29	18	8.83	18	6.49
Within crosses	52	10.24	52	12.43	50	12.25	50	13.53

The correlation between backfat thickness and total numbers of normal embryos present in gilts within groups was significant (r = .31). There was an increase of 0.3 normal embryos for every 1 mm. gain in average backfat thickness.

An extremely low correlation coefficient of 0.024 (not significant) was obtained between body length and total normal embryos in gilts within groups. This proved to be somewhat surprising in view of the low, but significant, correlation obtained when testing body length with number of corpora lutea on both an inter-and intra-group basis. This would suggest that possibly the physiological conditions causing greater body length might be favorable to a higher ovulation rate but not favorable to the survival of a larger number of embryos. This point needs further study.

Differences between crosses in number of normal embryos were analyzed, after removing variation linearly associated with number of corpora lutea, age at breeding, backfat thickness and body length. In no case were there significant differences between crosses in the total number of normal embryos recovered per gilt (Table 10).

Intra-Uterine Migration of Ova

In the process of evolution, nature has devised many unique phenomena to aid in the perpetuation of a species. Among swine, one of the more interesting is the ability of the uterus to space fertilized, dividing ova within the uterus. In this way, the developing embryo is somewhat assured of a fair share of its nutrients without the keen competition of its neighboring litter mates. In the present study, the actual space limitations of each developing embryo were not studied. Only the distribution of embryos between the right and left uterine horns was observed.

In the 72 gilts from which embryos were recovered, it was found that the right ovaries produced 366 or 44.69 percent of the corpora lutea, while the left ovaries produced 453 or 55.31 percent of the corpora lutea (Table 11). On the other hand, the total number of embryos of all types observed in the right uterine horn was 309 (50.57 percent) and in the left horn 302 (49.43 percent), representing approximately equal distribution of embryos between the two horns. Embryonic mortality did not destroy, but enhanced the equality of embryonic distribution in the two uterine horns. The right uterine horns in these gilts contained a total of 289 normal embryos and the left horns a total of 286 normal embryos. This represents a distribution of 50.26 percent of normal embryos in the right horn and 49.74 percent in the left horn. Thus, normal embryos were more equally distributed between the two horns than normal plus abnormal

TABLE 11. INTRA-UTERINE MIGRATION IN SWINE

Breeding	No. gilts used	No. gilts in which intra-uterine migration apparent	Total corpora right ovaries	Total corpora left ovaries	Total embryos right horn	Total embryos left horn	Normal embryos right horn	Normal embryos left horn
IIxIV	2	2	10	10	8	10	7	9
IIxOBP	6	2	16	38	23	18	22	18
VIxOBP	4	3	28	19	19	21	14	19
IIxI+	5	0	25	24	16	14	15	12
VIxI+	5	2	25	39	24	20	23	19
IIxOBH	2	1	6	14	6	8	6	8
VIxOBH	5	2	28	45	22	19	21	19
IIxV	4	3	23	24	17	14	17	14
VIxV	2	1	13	11	11	11	10	11
IIxOBD	3	0	15	20	11	13	10	11
VIxOBD	6	2	27	42	27	27	25	27
IIxT	5	3	25	24	24	19	22	19
VIxT	5	1	21	34	22	25	22	25
IIxBLR	4	0	25	25	19	19	19	19
VIxBLR	2	1	11	16	11	13	10	12
IIxILR	5	3	26	32	22	23	20	19
VIxILR	3	2	26	9	13	10	13	9
IIxY	2	1	7	13	7	7	6	5
VIxY	2	1	9	14	7	11	7	11
Total	72	30	366	453	309	302	289	286
Average		.417	5.08	6.29	4.29	4.19	4.01	3.97

embryos.

Although the process of equalization of embryos by intra-uterine migration is not in itself a perfect mechanism, its supplementation by embryonic mortality makes the process of balancing the embryo numbers within the two horns of the uterus even more efficient. The fact that this migration was apparent in 41.7 percent of the gilts studied suggests that intra-uterine migration may take place in the majority of the normal animals in which there is an unequal distribution of ovulations from the right and left ovaries.

Gross Abnormalities

The productivity of a herd of breeding swine is partially influenced by the types of gross abnormalities of the reproductive tracts which are present in the gilts and sows. Some abnormalities may preclude the production of any pigs, others may allow the fertilization and development of ova from only one ovary.

Five abnormal reproductive tracts were found in a total of 104 gilts. Three others were found in a later search for possible abnormalities occurring among 44 gilts used in a carcass data study. Of 148 gilts studied, 5.40 percent were found to contain abnormalities of their reproductive tracts.

Two of the abnormal reproductive tracts were infantile and were not developed beyond the stage usually found in prepubertal pigs.

Another gilt had a left ovary which contained two large persistent follicles accompanied by several apparently functional corpora lutea. The right ovary had several corpora lutea as well as some small follicles (Figure 6). Upon aspiration of the two large follicles on the left ovary, about 5 m. of follicular fluid were obtained.

A comparatively rare abnormality of two cervices in the same reproductive tract was observed (Figures 7 and 8). The initial division started about 4 inches inside the vagina. The division of the reproductive tract began about 2 inches posterior to the site where the cervical tissue started. Thus, each uterine horn had its own cervix. The left uterine horn was gravid and contained six embryos which resulted from seven ovulations on the left ovary. The right uterine horn was nongravid and its ovary contained no ovulation points but did contain the many small follicles usually observed in normal pregnant gilts.

The last abnormal reproductive tract observed had the left uterine horn missing (Figure 9). A fimbria distended with fluid, a completely normal ovary, and a Fallopian tube which ended blindly in the broad ligament, were present on the left side of the genital tract. The right side was apparently normal, but its Fallopian tube was blocked and was distended with fluid.

One of the abnormal reproductive tracts observed in the carcass data study had a segment of the right uterine horn missing (Figure 10). Ducts, which contained no lumen and were encased by the broad ligament, began at the approximate bifurcation point of a normal gilt and followed each uterine horn very closely until they ended near the tubo-uterine junctions. About midway on the external surface of the cervix, an outgrowth of tissue, similar in appearance to that of the uterus, started and followed the posterior edge of the right broad ligament to the point from which it was cut from the carcass. This tissue contained a lumen about ¼ inch in diameter. The lumen started "blind" in the wall of the cervix and continued through the outgrowth to where it had been cut from the carcass.

The ovaries of the second abnormal reproductive tract observed in the carcass data study had hard, smooth, bean-shaped ovaries with a cluster of about six small follicles at the end of each. These ovaries were entirely encased in the broad ligament. The Fallopian tubes were about one-half the length of those found in normal gilts and were blocked. The

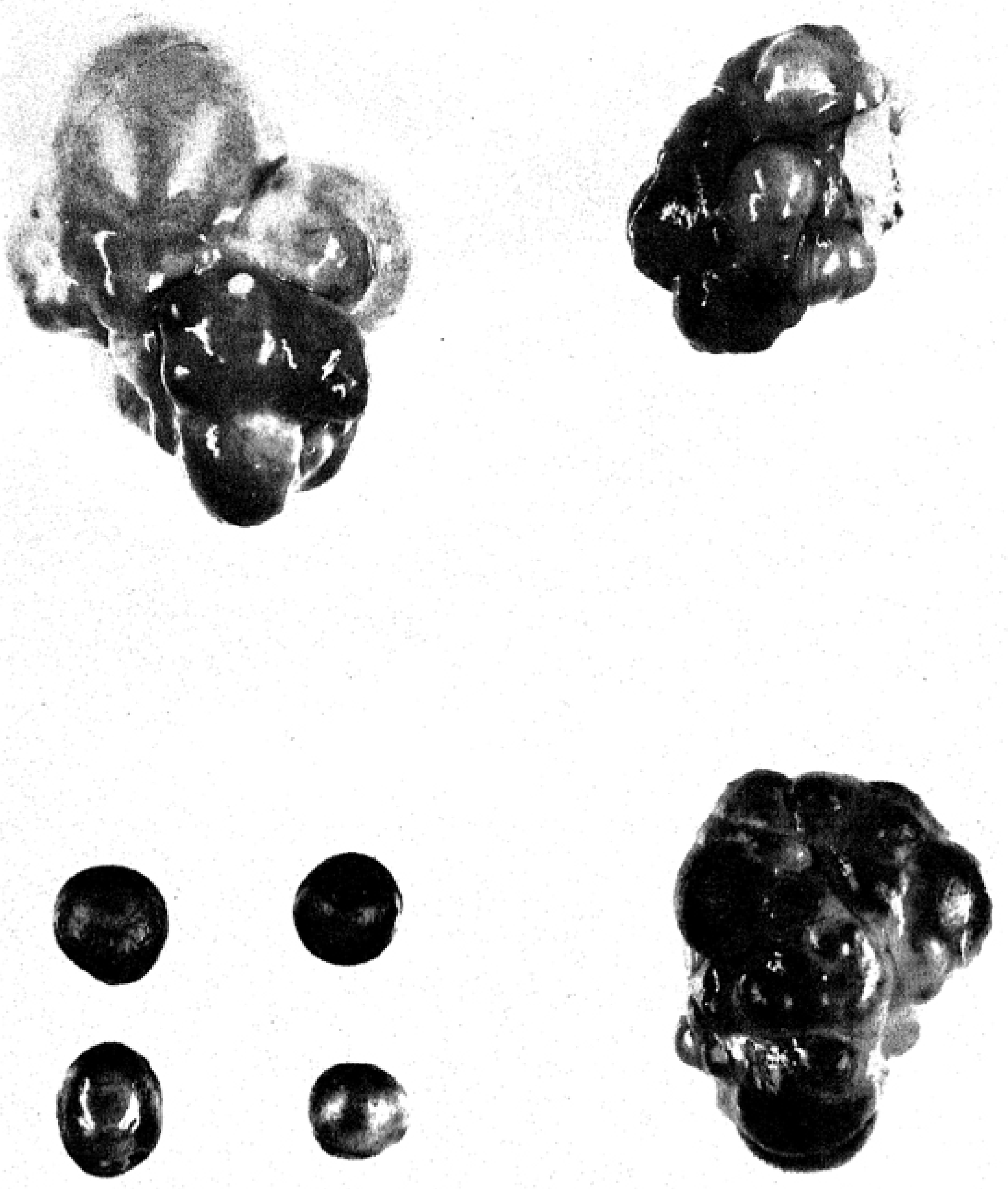

Fig. 6—Upper left, cystic ovary; upper right, normal ovary of same gilt; lower left, corpora trimmed from normal ovary; lower right, normal ovary showing corpora intact.

uterine horns were exceedingly tortuous with segments folded back and adhered one to the other.

The last abnormal reproductive tract had the left uterine horn, Fallopian tube and ovary missing.

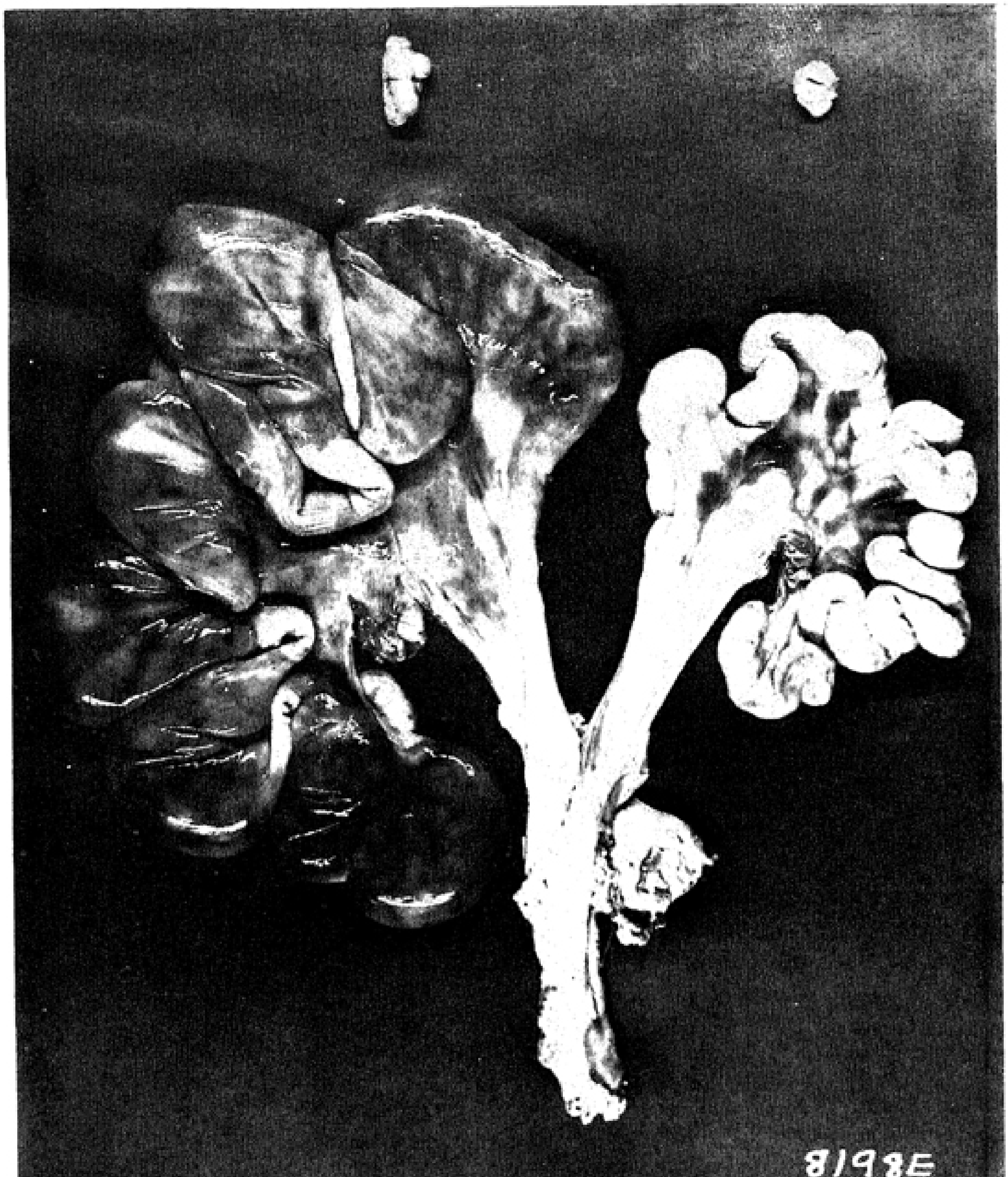

Fig. 7—Reproductive tract with cervix on each uterine horn. Left horn gravid.

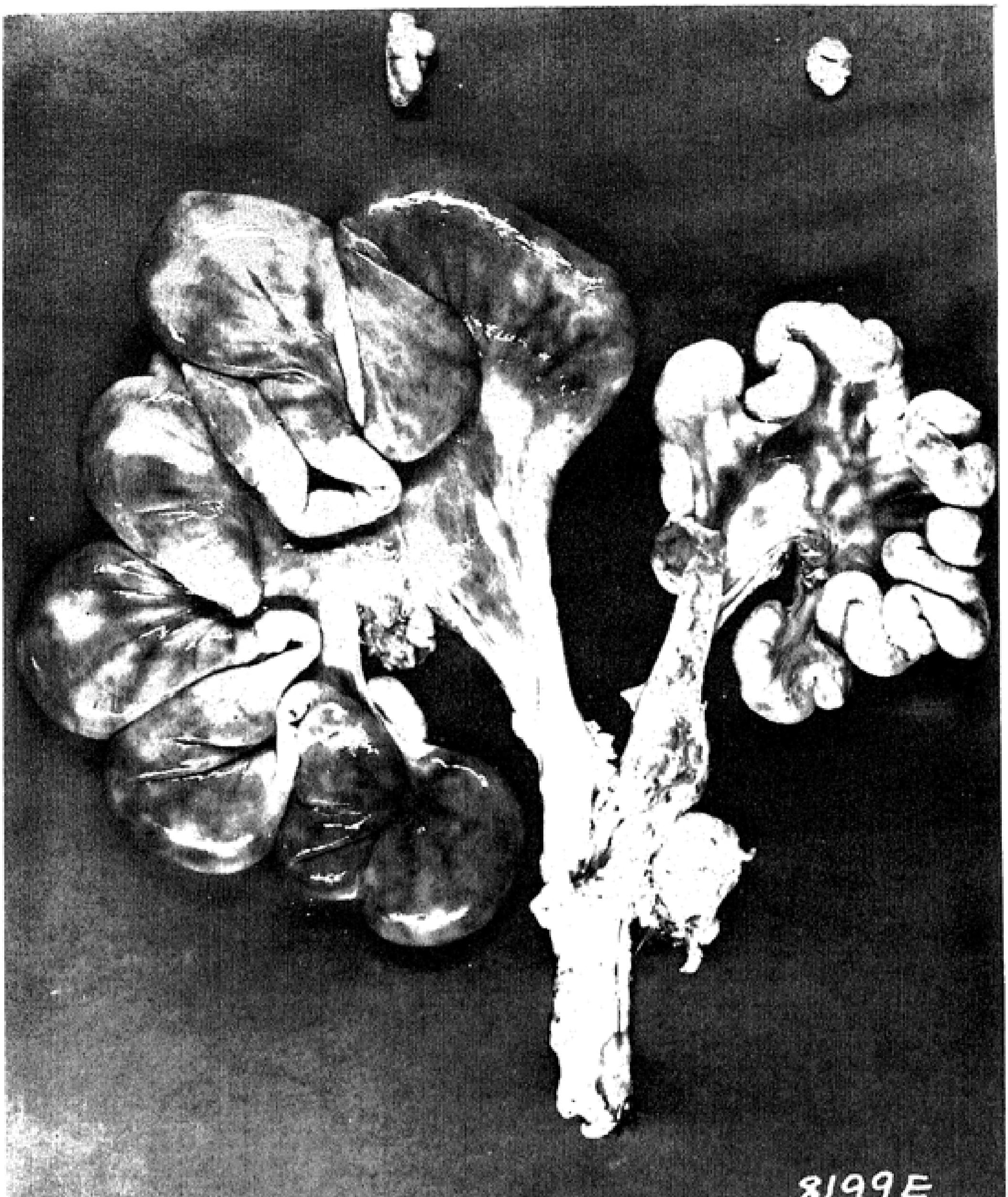

Fig. 8—Same reproductive tract as Figure 7. Right cervix opened to show cervical tissue.

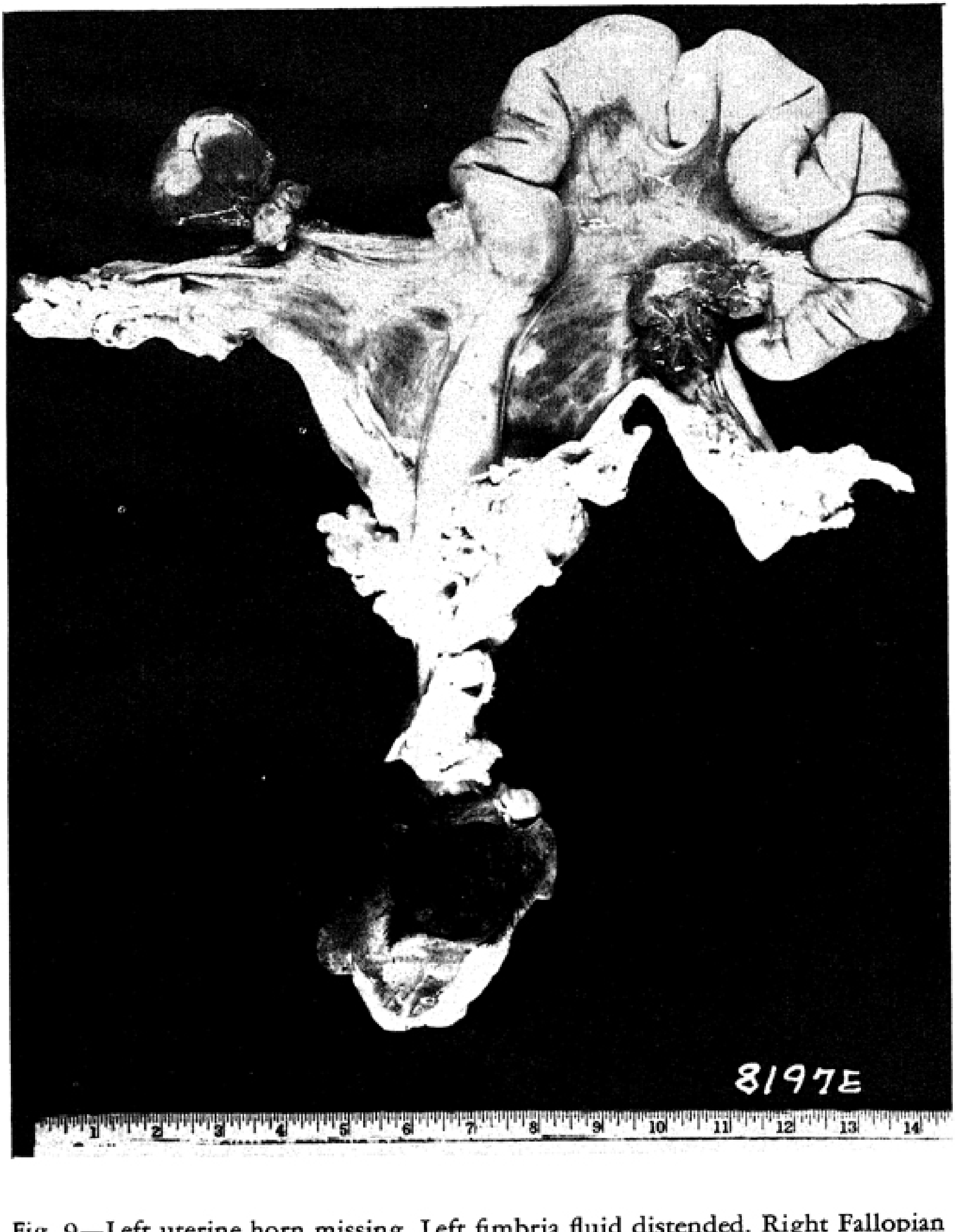

Fig. 9—Left uterine horn missing. Left fimbria fluid distended. Right Fallopian tube fluid distended.

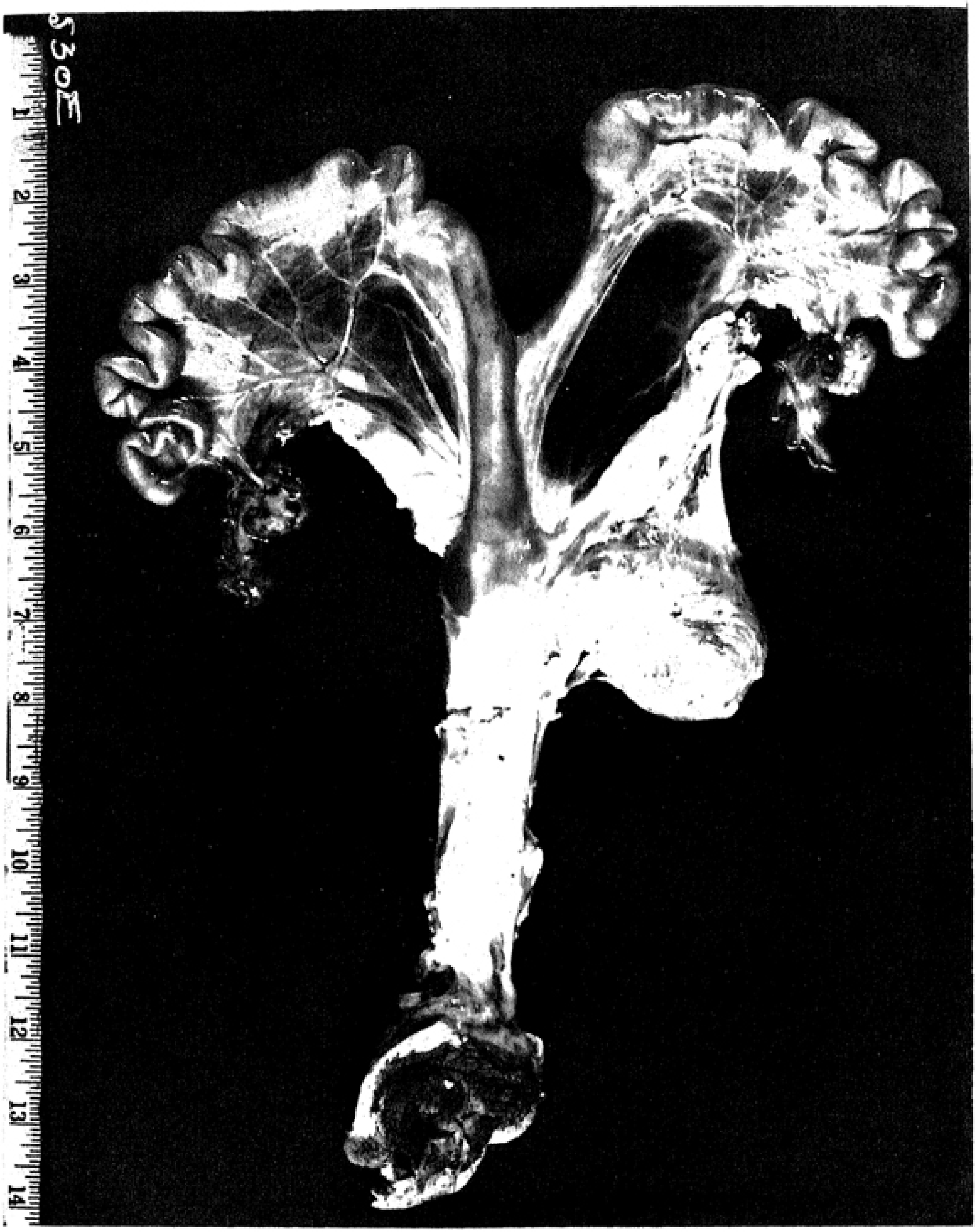

Fig. 10—Segment of right uterine horn missing. Uterine tissue growth initiated about midway on right side of cervix.

DISCUSSION

Embryonic mortality is of economic importance because it may be a major factor in the determination of litter size in swine. Prior to any endeavors aimed at the determination of the physiological processes involved in embryonic mortality or the development of specific therapeutic measures which might alter the incidence of embryonic death, exploratory research is necessary. The chief aim of this investigation was to obtain additional information regarding the incidence of mortality among fertilized ova during early stages of gestation. The influence of genetic variation between various crosses and of variation in age at breeding, backfat thickness, and body length on both ovulation rate and fetal mortality was of secondary interest.

This investigation was begun as a comparison of the embryonic mortality up to the 25th day after breeding with that occurring prior to some earlier stage of gestation. After exploring the time of gestation at which the normal and abnormal embryos could be counted with accuracy, the 17th day after breeding was chosen for the comparison.

The average ovulation rate of gilts slaughtered at the 25th day was found to be 11.30 while that at the 17th day was 11.47. It was found that the former group experienced a total embryonic mortality of 33.63 percent while the latter group had an embryonic mortality of 25.07 percent. This was a difference of 8.56 percent embryonic mortality between the 17th and 25th day.

These results showed that approximately one-fourth of the embryonic mortality (8.56 percent) occurred during the last one-third of the period between mating and the 25th day of gestation. The other two-thirds of the total mortality had taken place prior to the 17th day. It is uncertain whether the mortality during the first 17 days is distributed equally throughout that period or whether it occurs primarily at some critical stage early in the gestation period.

Squier's (1950) data showed that only 95 percent of the ova shed were actually fertilized. His observations were made 24 hours after mating. Assuming that 5 percent of the ova were unfertilized in the present study, then, only 28.6 percent of the total mortality of 33.6 percent can be attributed to actual intra-uterine embryonic mortality. Further, 8.56 percent of the 28.6 percent total intra-uterine mortality occurred during the

8-day period between the 17th and 25th day. The remainder (20.1 percent) of the intra-uterine mortality occurred during the 16-day period from 24-hours to the 17th day. Thus it appears that intra-uterine deaths were occurring at a somewhat greater rate during stages of gestation prior to the 17th day.

A comparison of these results with work done by others shows some striking similarities. Squiers (1950) found a mean ovulation rate of 11.3 corpora lutea per gilt (slaughtered 25 days after breeding) and a mean of 7.3 pigs per litter. This indicated a 35.4 percent embryonic mortality of which 7.09 percent consisted of regressing embryos. In the present investigation, where gilts were slaughtered 25 days after breeding, means of 11.3 corpora lutea and 7.5 pigs per gilt were found; total mortality was 33.63 percent, of which 7.08 percent was represented by retarded and resorbing embryos.

Warwick (1928) found that the percentage of ova represented by degenerate fetuses was 7.43 at 20 days and 4.25 percent at 30 days. Hammond (1924) found 32.6 percent total embryonic mortality in sows slaughtered at 14 to 60 days of gestation. In 30 animals killed three weeks after conception, Corner (1923) found the embryonic mortality to be 31.3 percent. Crew (1925-1926) found the embryonic mortality of 27 pregnant sows to be 33 percent.

This study also tested the ovulation rate and early fetal mortality of crosses of line II and line VI Poland strains with other strains. The average ovulation rate of line VI crosses was 12.14, compared to 10.58 percent for line II crosses. Their embryonic mortalities were 28.48 and 30.85 percent respectively. The line VI Poland x outbred Hampshire cross showed the highest ovulation rate, whereas the line VI Poland x Beltsville Landrace showed the highest number of viable embryos recovered.

As mentioned in the Results, correlations were obtained for variation among gilts of the same cross as follows: (1) backfat thickness with number of corpora lutea ($r = 0.28$), (2) body length and corpora lutea ($r = 0.24$), (3) backfat thickness and number of normal embryos recovered ($r = 0.31$). None of these correlations were spectacular but nevertheless they were significant. On the other hand, an exceptionally low, non-significant correlation ($r = 0.024$) was found to exist between body length and number of normal embryos recovered.

The lack of correlation between body length and number of embryos is difficult to explain, especially in view of the highly significant correlation ($r = 0.52$) obtained between corpora lutea numbers and normal embryos recovered. A possible interpretation might lie in the idea that body length and corpora numbers are more highly related as breed characteristics while embryonic mortality is affected more by the vitality and vigor of the gilt during the short period immediately prior to and during gestation.

Squiers (1950) found that there was a highly significant correlation of 0.31 between age at breeding and ovulation rate of gilts. The regression of number of ova on age in days was 0.035. He also found a highly significant correlation coefficient of 0.33 existing between age at breeding and litter size at 25 days. The regression coefficient showed that 0.05 more pigs might be expected for every day of increase in age at breeding.

In this study, the correlation coefficient between age at breeding and ovulation rate was 0.38. The regression of number of ova on age in days was 0.067. The correlation between age at breeding and normal embryos recovered ($r = 0.32$) was much closer to that found by Squiers. However, the regression coefficient calculated here was somewhat higher (0.09). These differences could be due solely to sampling errors, since our study included approximately one-half as many gilts as were used in Squiers' work.

Any mechanism which assists the embryos to survive will have an important influence on litter size at farrowing. Other workers have shown intra-uterine migration to be a mechanism whereby embryos are equalized between the two horns of the uterus. Among the animals in this study, it was observed that 44.7 percent of the ova were shed from the right ovaries. The left ovaries released 55.3 percent of the ova. Of the total embryos recovered at 17 and 25 days, 50.6 percent were from the right and 49.4 percent from the left uterine horn. The percentages of resorbed and retarded embryos in the two horns were similar; the percent of normal embryos was 50.3 in the right uterine horn and 49.7 in the left uterine horn. Some uterine migration had occurred in 41.7 percent of the gilts.

Warwick (1926), in a study of 469 uteri, found that the right ovaries had released 44.7 percent of the ova while 50.1 percent of the fetuses lay in the right uterine horn. The left ovaries had 55.3 percent of the ovulation points and the left uterine horn contained 49.9 percent of the fetuses. Migration of ova had occurred in 42.4 percent of the animals in this study.

Crew (1925-1926), on the other hand, obtained data from a group of animals which ovulated approximately the same number of ova from each ovary (51.1 percent from the right, 48.9 percent from the left). The resulting embryos tended to remain equalized between the two horns. This balance was upset only slightly by a difference of 0.4 percent in the number of normal embryos recovered.

There are two logical paths for this migration of ova between horns. One is through the body cavity; the other is through the uterine horns themselves. Corner (1921b) recovered 213 tubal ova from 26 sows with 220 ovulation sites. He found that the number of ova in each Fallopian tube agreed with the number of corpora lutea on the ovary on that side of the reproductive tract. He concluded that the migration was through the uterine horn. Warwick (1926) demonstrated by unilateral ovariectomy that intra-uterine migration did take place in the sow.

SUMMARY

1. Ovulation rate was ascertained by a determination of the number of functional corpora lutea in a total of 91 gilts slaughtered at the 17th and 25th days after breeding. The rate was 11.69.

2. Comparisons were made between crosses of inbred line II Polands and line VI Polands with other strains. Crosses of line VI Polands exceeded those of the line II Poland crosses by an average of 1.29 ova. This difference was highly significant ($P < .01$).

3. Age at breeding was positively correlated with ovulation rate ($P < .01$) as were backfat thickness and body length ($P < .05$).

4. An analysis of variance showed highly significant differences existing between gilts from the various crosses in age at breeding, backfat thickness, and body length. The variation between groups for number of corpora lutea was not significant, however.

5. It was found that the 17th day after breeding was about as early as embryos could be recovered and recognized with a fair degree of accuracy. Embryonic mortality in 32 gilts slaughtered at this time was 25.1 percent, compared to 33.63 percent in 40 gilts slaughtered 25 days after breeding. This was a difference of 8.53 percent. Thus, the majority of the mortality had occurred before the 17th day.

6. The number of normal embryos at both the 17th and 25th days after breeding was higher in line VI Poland than in line II Poland crosses. Since the embryonic mortality was very nearly equal in the two lines, it may be assumed that superiority of the line VI Polands was due to a higher ovulation rate in these crosses.

7. Age at breeding and backfat thickness were significantly' correlated with the number of normal embryos ($P < .05$). On the other hand, body length was not significantly correlated with the number of normal embryos. Since the correlation between the ovulation rate and number of normal embryos was highly significant ($P < .05$), this might suggest that ovulation rate is a breed characteristic whereas the number of normal embryos is more closely related to the condition of the gilt at that stage of gestation.

8. The variations between gilts from the various crosses in number of embryos at 17th and 25th days were not significant.

9. Intra-uterine migration was apparent in 41.7 percent of the gilts studied. In this study, 44.7 percent of the corpora lutea were found on the right and 55.3 percent on the left ovary. Of the total embryos recovered, 50.6 percent were in the right and 49.4 percent were in the left uterine horns. Embryonic mortality enhanced the equalization of the normal embryos between the two horns since 50.3 percent were found on the right and 49.7 percent on the left. These data suggest that intra-uterine migration of ova does exist and that its purpose may be to allow optimum spacing for each developing embryo.

10. Of 148 gilts studied, 8 or 5.40 percent were observed to have gross abnormalities of their reproductive tracts. Two gilts had infantile tracts, a third gilt had persistent follicles on one ovary, a fourth had one absent uterine horn, a fifth had two separate cervices, a sixth had a 3-inch section missing from one uterine horn, a seventh had improperly developed ovaries, Fallopian tubes, and uterine horns, and an eighth had an absent left ovary, Fallopian tube and uterine horn.

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