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To the Graduate Council:

I am submitting herewith a thesis written by Thomas E. Byrum entitled "Some Factors Affecting the Age of Puberty in Swine." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Husbandry.

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SOME FACTORS AFFECTING THE AGE OF PUBERTY IN SWINE

A THESIS

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The Graduate Council
of
The University of Tennessee
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Thomas E. Byrum

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CHAPTER I

INTRODUCTION

The attainment of sexual maturity in the female is generally stated to be a gradual process. The rate of growth and function of the female reproductive tract is controlled by the hormones secreted by the anterior pituitary gland. The factors affecting the release of the pituitary gonadotrophins are incompletely understood. Work, particularly, with birds and certain laboratory animals has shown that light is one important factor influencing the release of the gonadotrophic hormones. Also, there is evidence suggesting that light and temperature or a combination of these environmental factors may affect the time of beginning of the breeding season in ewes. Likewise, there is some evidence that the presence of the ram with ewes near the beginning of the breeding season increases the number of ewes coming in heat.

This experiment was initiated to study some of the factors influencing the age of puberty in swine. Vocational Agriculture teachers throughout the state have made complaints that students with swine projects were reporting difficulties in getting gilts bred at the proper age. Normally, gilts should be bred when they are approximately eight months of age. It was in reaction to these inquiries that a preliminary experiment was initiated to test the effect of the level of protein in the growing ration of gilts on the

age at first estrus. In this trial, similar breeding difficulties were experienced until the boars were turned with the gilts; shortly thereafter, breeding activity began. On the basis of this preliminary data, an experiment was designed to further test the effect of presence of the boars in stimulating first estrus.

CHAPTER II

LITERATURE CITED

Underwood et al. (1944) reported that placing rams with ewes approaching the beginning of the breeding season stimulated a higher percentage of the ewes to show estrus within a shorter period of time, than occurred in groups without rams. This stimulation occurred only if the ewes were approaching the breeding season; furthermore, no stimulating effect was observed if the rams remained with the ewes throughout the year.

Schinckel (1954) turned vasectomised teaser rams with ewes early in the breeding season, fourteen to sixteen days prior to introducing the breeding rams, and found that 42.2 per cent of the teased group lambed in the first week of the lambing season as compared to only 12.9 per cent in a non-teased group. The highest per cent (40.6) of lambing for the non-teased group occurred during the third week. He also reported that three years combined data, when all ewes were teased fourteen to sixteen days prior to mating, was in close agreement with the above mentioned data. From these data, it was suggested that the presence of the ram tended to synchronize the estrous cycles in a great proportion of the ewes. This was noted only when the ewes were teased early in the breeding season and was not observed once the breeding season had been established. The results were explained by pointing out that during late anestrus

follicular development and ovulation does occur but such ovulations are not accompanied by estrus. This supports the theory of Hammond et al. (1942) that estrus only accompanies ovulation in the presence of a waning corpus luteum.

Yeates (1948) studied the effect of light on breeding of grade Suffolk ewes. By regulating the hours of light, with artificial lights, he was able to completely reverse the normal breeding season of English sheep.

Hafez (1952) exposed anestrus ewes of different breeds to constant light ratios to induce or inhibit estrus. It was found that the onset of the breeding season was hastened by fifty-seven days when ewes were exposed to eight hours of light and sixteen hours of darkness per day. By breaking the light periods to four hours of light and eight hours of darkness, then repeating this cycle, he found that the breeding season started twenty-seven days earlier. Light induced estrus appeared after the onset of ovulation. It was also noted that under artificial light, the different breeds started and ended the breeding seasons in almost the same order as they did under natural conditions.

Dutt and Bush (1955) subjected ewes to temperatures of 45 to 48 degrees F and found the average time of onset of estrus to be eight weeks earlier than in the control ewes. They also noted that the lambing was thirty-six days earlier for the treated group.

Ioset (1956) analyzed the breeding records of ewe flocks maintained by the University of Tennessee Agriculture Experiment Station. The data used in this study covered a period of six years; strong indications were found that the presence of the ram, shortly prior to the beginning of the breeding season, increased fertility during the early part of the breeding season. It was noted that when rams were turned with the ewes early in the breeding season (July 1-15) there was a higher conception rate during the subsequent third and fourth weeks than during the first two weeks. However, when the rams were not turned in until August, or later, the low conception rate during the first sixteen days was not observed. He concluded that the presence of rams, when introduced to ewes in the transition period from the non-breeding to the breeding season, acted as an exteroceptive stimulus to reproductive activity. Native, north-western, three-quarter Dorset and California-bred-type ewes showed a low conception rate during the first sixteen days of the breeding season, as compared to southwestern, high grade Hampshires and pure-bred Hampshire ewes.

Robertson et al. (1951) found that full feeding a high protein ration (twenty per cent protein) to gilts, significantly increased the age of puberty over the lots fed a low protein ration (fifteen per cent). It was also indicated that full-fed gilts on both high and low levels of protein tended to reach puberty earlier than the limited fed gilts. Full-fed gilts were significantly heavier at

puberty than limited fed gilts. High protein gilts were five pounds heavier at puberty than the low protein gilts on pasture, but were twenty-four pounds lighter in dry lot. High protein fed gilts tended to ovulate more eggs than the low protein fed gilts if on pasture, but fewer eggs if in dry lot.

To test the effect of plane of nutrition on age at puberty, Christian and Nofziger (1952) studied the effects of a high plane of nutrition as compared to a low plane of nutrition on reproductive performance in swine. The low plane groups received seventy per cent of the feed intake of the high plane groups. The gilts were checked daily, beginning at 120 days of age, with vasectomised boars to determine the age at puberty and the length of subsequent estrus cycles. At 150 pounds, both groups were put on a breeding ration until bred, then returned to their respective nutritional planes. The average age at puberty for the high plane gilts was 170.2 days as compared to 166.8 days for the low plane groups. At puberty, the high plane groups averaged fifty pounds heavier than the low plane groups. The high plane gilts ovulated an average of 1.7 more eggs, but the fertilization rate was 3.3 per cent higher in the low plane groups.

Self et al. (1955) fed Chester White and Poland China gilts on full or limited feed intakes. The full-fed gilts received rations ad libitum while the limited-fed gilts received approximately two-thirds of the amount concurrently received by the full-fed gilts. In two separate trials full-fed gilts were significantly older at puberty

than the limited-fed groups. In trial I, the Chester White gilts reached puberty at a mean of 225 days as compared to 206 days for the Poland China gilts. This difference was highly significant in one trial but non-significant in a second trial.

According to Amoroso, Heape's (1901) observations on captive animals in zoos led him to suggest that in various species the presence of the male stimulated the female to estrus; while that of the female stimulates the male to rut. Amoroso also stated that Beach (1948) emphasized that teasing or heckling by the male mink was a factor contributing to early breeding in the female mink.

CHAPTER III

PROCEDURE

Thirty-eight purebred gilts, seventeen Hampshire and twenty-one Durocs, of an average initial weight of 41 pounds, were used in this experiment. These gilts were divided into ten comparable lots on the basis of weight, breed and litter. Six lots were assigned to be fed in dry lot in the barn and four were to be fed on pasture. Each ration was replicated in the barn lots and on pasture.

The composition of the basal ration and the treatments of gilts are shown in Tables I and II, respectively. Ration I was considered the high level protein ration initially containing a calculated eighteen per cent protein. This ration was fed to two barn lots (1 and 4) and two pasture lots (7 and 9) at the levels of eighteen, sixteen, and fourteen per cent protein to weight intervals of 41 to 75 pounds, 76 to 150 pounds and from 151 pounds up, respectively. Two barn lots (3 and 6) were limited fed ration I to produce gains comparable to those of lots (2 and 5) self fed the low protein ration. Ration II, a twelve per cent protein ration, was fed to two barn lots (2 and 5) and two pasture lots (8 and 10); it was lowered to ten and eight per cent protein at the same weight levels as for those receiving ration I. Pasture lots had access to a fall seeded oat pasture. All lots had free access to water.

TABLE I

COMPOSITION OF THE BASAL RATION

Items	41 to 75 lbs.	76 to 150 lbs.	151 lbs. up
<u>Ration I</u>			
Per cent protein	18	16	14
Corn	71.15	74.15	80.15
S.B.O.M.	16.00	14.00	10.00
Meat meal	8.00	7.00	5.00
Alfalfa meal	3.00	3.00	3.00
Salt	0.50	0.50	0.50
Limestone	0.50	0.50	0.50
Dicalcium phosphate	0.50	0.50	0.50
B-Vitamin	0.50	0.50	0.50
B ₁₂	0.10	0.10	0.10
Aureofac 2A	0.20	0.20	0.20
	<u>100.00</u>	<u>100.00</u>	<u>100.00</u>
<u>Ration II</u>			
Per cent protein	12	10	8
Corn	86.15	89.15	95.15
S.B.O.M.	6.00	4.00	0.00
Meat meal	3.00	2.00	0.00
Alfalfa meal	3.00	3.00	3.00
Salt	0.50	0.50	0.50
Limestone	0.50	0.50	0.50
Dicalcium phosphate	0.50	0.50	0.50
B-Vitamin	0.05	0.05	0.05
B ₁₂	0.10	0.10	0.10
Aureofac 2A	0.20	0.20	0.20
	<u>100.00</u>	<u>100.00</u>	<u>100.00</u>

TABLE II

TREATMENT OF GILTS

Lot Number	Number of Gilts	Treatment	Boar or no Boar ^a
<u>Dry lot</u>			
1	3	High level protein	No boar
2	4	Low level protein	No boar
3	4	High level protein, hand fed	No boar
4	3	High level protein	With boar
5	4	Low level protein	With boar
6	4	High level protein, hand fed	With boar
<u>Pasture</u>			
7	4	High level protein	With boar
8	4	Low level protein	With boar
9	4	High level protein	No boar
10	4	Low level protein	No boar

^aBoars were placed with gilts February 26, 1957.

All lots were started on the respective rations on November 13, 1956. The gilts were individually weighed at fourteen-day intervals up to the time the boars were placed with the designated lots. On February 26, 1957, when the average age of the gilts was 173.8 days, the boars were placed in barn lots (4, 5, and 6) and pasture lots (7 and 8). Hereafter, gilts in lots containing a boar will be designated as B gilts and those in lots not containing a boar will be designated as NB gilts. The feeding phase of the experiment terminated on this date and all gilts were placed on rations normally fed the swine herd.

Barn gilts, with boars, were placed in adjacent pens approximately fifty feet from the gilts without boars. However, the latter group was within hearing distance of the boars. The barn pens were five feet wide and twenty feet long with concrete floors. Pasture lots with boars were located on the opposite side of a slight ridge out of sight and hearing of lots without boars. The distance between the two groups was approximately one hundred yards.

The criterion for determining estrus in NB gilts was swelling of the vulva. In lots with boars, willingness to stand for the male and swelling of the vulva were used as indications of estrus. When vulval swelling was noted in NB gilts, they were driven to a pen containing a boar for breeding. If the gilt would not accept the boar, she was returned to her respective pen and checked again at twelve-hour intervals until bred or swelling of the vulva subsided. All lots were observed twice daily, morning and afternoon.

Gilts showing estrus were slaughtered three to five days after breeding and the reproductive tracts removed for detailed study. The ovaries were examined and the number of corpora lutea recorded. The oviducts were trimmed free of the mesosalpings, flushed with physiological saline and the flushings examined under a binocular dissecting microscope (30X). If no eggs were recovered from the oviducts, the uterine horns were flushed and examined in the same manner.

At the end of thirty-eight days after introduction of the boars in the designated lots, all gilts, not having come in heat, were slaughtered at East Tennessee Packing Company and the reproductive tracts returned to the laboratory for detailed study. The uterus of each gilt was classified as normal or small on the basis of diameter, length and degree of vascularity of uterine horns. This classification was purely subjective in nature. For the purpose of statistical analyses, all gilts which had not exhibited estrus prior to the time of slaughter were considered to be in heat as of the time of slaughter.

CHAPTER IV

RESULTS AND DISCUSSION

The data on average initial and final weights, average daily gains and average age at time of introduction of the boars to the designated lots are shown in Table III. The differences in average daily gains were not statistically significant. Only the difference between the lots on the high protein as compared to the low protein ration approached statistical significance at the five per cent level of probability. Gilts in the pasture lots fed the low level protein ration made average daily gains within 0.03 pounds of the high protein fed gilts. It is probable that the gilts fed the low level protein ration received sufficient protein from the winter oat pasture to compensate for the difference in protein between rations.

The data on estrual phenomena is influenced by level of protein in the ration and the presence of boars are shown in Table IV. The number of gilts coming into estrus was not influenced by level of protein or presence of the boar in the dry lot groups. Equal numbers of gilts came into heat in the B and NB groups, six out of eleven (54.5 per cent) in each case; however, the average interval* from introduction of the boars to estrus was 11.7 and 29.5 days for the B and NB groups, respectively. This difference of approximately

*Hereafter, reference to interval to estrus will refer to figures based only on those gilts actually showing estrus.

GROWTH PERFORMANCE OF GILTS

^aBoars placed with gilts in these lots on February 26, 1957.

^bAverage weight and age at the time the boars were placed with respective lots.

^cAverage number of days up to February 26, 1957, at which time the boars were placed with gilts.

EFFECT OF PRESENCE OF BOARS ON ESTRUAL OVULATION PHENOMENA

***Significant at the 1% level of probability as compared to NB treatment.

aHP, high protein ration; LP, low protein ration; HPHF, high protein ration hand fed.

^bNumber in parenthesis indicates number per lot.

cNumber of days from date boars were placed in lots 4, 5, 6, 7 and 8 until gilts were bred and is based on those gilts showing estrus.

^dBased on number showing estrus.

eighteen days was not significant on this small number of animals.

The level of protein in the ration exerted no measurable effect on the time of occurrence of estrus in the pasture gilts. Seven of eight gilts (87.5 per cent) on pasture came into estrus at an average interval of 11.4 days after introduction of the boar. None of the eight pasture NB gilts showed estrus during the thirty-eight-day observation period. This difference was highly significant ($P < .01$).

A comparison of the average intervals to estrus for the drylot and pasture B gilts shows that the interval from introduction of the boar to estrus was 11.7 and 11.4 days, respectively. This difference was not significant. A comparison of the intervals for NB gilts coming in estrus, in drylot and on pasture shows that the average interval was 29.5 days for the drylot gilts (54.5 per cent in estrus), whereas none of the pasture NB gilts exhibited estrus. A possible explanation for the difference in behavior of these two groups of gilts would be the closer proximity of the drylot NB gilts to the boars. As indicated in the description of the experimental procedure, these gilts were approximately fifty feet from the closest boar with the B gilts. They were definitely within hearing distance of the boars. Being within hearing distance but not within sight of the boars apparently exerted some stimulatory effect, although a longer period of time (18 days) for expression of estrus was required by these gilts. The NB gilts on pasture were not within sight or hearing of a boar since they were separated from the pasture B lots by a

distance of approximately 100 yards and an intervening ridge. Thus, it can be assumed that there was a complete absence of the boar stimulatory effect.

The number of gilts in estrus by breeds and the average interval to estrus is shown in Table V. Of the NB gilts in the barn, one of five Durocs came into estrus as compared to five of six Hampshires. The interval for the one Duroc gilt was thirty-six days as compared to the average of 28.2 days for the five Hampshire gilts. A similar situation occurred in the drylot B gilts except the average interval to estrus was much shortened in the Hampshire gilts. The interval for the Duroc gilt was 24 days as compared to the average of 9.2 days for the five Hampshire gilts. The B gilts of both breeds had a shorter interval to estrus than the NB gilts. The weighted mean number of days to estrus for the NB lots was 29.5 days as compared to 11.7 days for the B lots; however, this difference was not significant on this limited number of gilts.

On pasture, no Duroc or Hampshire gilts in the NB lots came into estrus. However, in the B lots four of five Duroc gilts came into estrus with an average of 14.0 days. Three of three Hampshires bred with an average number of days to estrus of 8.0. There was no difference between the average number of days to estrus of dry lot and pasture lots with boars, the weighted means being 11.7 and 11.4, respectively. The Durocs in the B groups on pasture, bred earlier (14.0 days) than Durocs in barn lots (24.0 days).

TABLE V

NUMBER OF GILTS IN ESTRUS BY BREED AND AVERAGE INTERVAL TO ESTRUS

Breed	No Boar			With Boar		
	Number of Gilts	Number Coming in Estrus	Average Number of Days to Estrus	Number of Gilts	Number Coming in Estrus	Average Number of Days to Estrus
<u>Dry lot</u>						
Duroc	5	1	36	6	1	24.0
Hampshire	6	5	28.2 ± 7.06	5	5	9.2 ± 3.19
Total	11	6	29.5 ± 6.94	11	6	11.7 ± 6.83
<u>Pasture</u>						
Duroc	5	0	--	5	4	14.0 ± 2.16
Hampshire	3	0	--	3	3	8.0 ± 5.19
Total	8	0	--	8	7	11.4** ± 3.46

**Significant at P < .01.

Gilts with boars, when slaughtered, had higher ovulation rates (average 10.3 corpora lutea) than gilts without boars (average 8.0 corpora lutea). Recovery of eggs from gilts in pasture lots was slightly higher than gilts in dry lot. However, none of these differences were significant ($P < .05$).

The average egg recovery in this experiment was very unsatisfactory. The reason for this low rate of recovery is unknown. However, in counting corpora lutea, definite rupture points were not found in many instances. It is quite possible that such corpora lutea represent follicles in which the ova were entrapped. Such low recovery rates were not experienced in this laboratory in preceeding studies.

When the uteri of the gilts not showing estrus were classified at the time of slaughter as to normality of development, no consistent relationship between protein feeding level or boar influence was apparent. However, a definite breed difference in frequency of undeveloped tracts was evident; eight Durocs as compared to one Hampshire gilt were recorded as having small uteri.

Burrows (1945) has pointed out that sight, hearing, smell, cutaneous sensations and possibly other feelings conveyed by direct nervous pathways or through the less direct circuits of the brain, may have pronounced effects on the gonadotropic activity of the pituitary gland. However, little is known of the relative importance of such factors in farm animals.

The reports of Underwood et al. (1944), Schnickel (1954), and Ioset (1956) concerning the effects of presence of the ram on initiation of the breeding season in ewes can be interpreted as evidence of an extroceptive factor which can play an important part in early season fertility in sheep.

CHAPTER V

SUMMARY

Thirty-eight Duroc and Hampshire gilts were used in the study of effect of level of protein in the growing ration and presence of the boar on age at first estrus.

Sixty-eight per cent of the gilts in lots with boars exhibited first estrus during a 38-day observation period as compared to only 32 per cent of the gilts in lots not containing boars. Gilts with boars, in dry lot, had an average interval to estrus of 11.7 days as compared to 29.5 days for gilts without boars. None of the pasture gilts, without boars, exhibited estrus as compared with seven of eight gilts showing estrus in the pasture lots with boars.

A breed difference in response was noted in that the Hampshire gilts had a shorter average interval to estrus than did the Duroc gilts (9 and 16 days, respectively). Eight Durocs as compared to one Hampshire were recorded as having small uteri on the basis of subjective grading. Gilts with boars when slaughtered had higher ovulation rates than gilts with no boar.

On the basis of the data obtained in this study it is strongly suggested that the presence of the boar with gilts may significantly lower the age at first estrus as compared to the average age of first estrus in gilts not with boars.



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