accorded the one group of gilts in this observation, the mean age at puberty is 29·5 days less and the mean weight 16·9 lb. higher, than that obtained in Observation 2. It would, therefore, appear that the mean age of 218·03 days is not truly representative of the age at puberty under optimum conditions of growth. The mean age at puberty would in all probability have been a few days less than the established mean of 218·03 days, had the general level of feeding been high enough, so that a mean weight of 200 lb. could have been obtained at 7 months. It can, however, be stated with a fair amount of confidence that, on the average South African farm, bacon pigs are well over seven months by the time they reach a 200 lb. live weight. Numerous farmers have informed the writer that they cannot get their baconers to weigh 200 lb. before the age of 8 months. Inefficient rations, and Ascaris worm infection, were almost invariably found to be responsible for such a condition. The mean age of 218·05 days at puberty, coupled with a mean weight of 177·36 lb. could, therefore, be considered as being fairly representative of conditions obtaining in this country.

Summary and Conclusions.

1. One group of six gilts was fed *ad lib.* and one group of six gilts was fed restricted rations, to determine the influence of growth on the age at sexual maturity.

2. Gilts fed at an optimum level attain sexual maturity at a mean age of 188·5 days with a mean weight of 194·3 lb.; whereas, if growth is retarded through restricted feeding so that the gilt reaches a weight of 100 lb. at seven months, sexual maturity is attained at a mean age of 234·8 days with a mean weight of 118·2 lb.

PART 3.

VI. Oestrus and Associated Phenomena.

Observation 4.

Literature.

McKenzie and Miller (1930) measured the width and height of the vulvas of 25 spotted Poland-China gilts, 21 of which were again measured after farrowing and weaning their litters. They found that the vulva begins to swell the ninth to the tenth day before the onset of oestrus and to subside for some 8 or 9 days immediately after oestrus. This is the only available reference in which conclusions were drawn from actual measurements. McKenzie (1926) reported that " . . . about 2 days (0 to 3½ days) before oestrus the vulva had swollen till at the onset of heat . . . the labia had reached a much greater size". With the passing of oestrus the swelling had subsided, the contraction, frequently, being very marked the day immediately following oestrus. McKenzie and Marshall (1912) briefly referred to the pro-oestrous period by stating that it ". . . . lasts for perhaps 2 or 3 days ".

The duration of the oestrous period and the length of the oestrous cycle, as recorded by different authors, are summarized in Table 23.

TABLE 23.

The Duration of Oestrus and the Length of the Oestrous Cycle According to Different Authors.

Duration of Oestrus		Length of the Oestrous Cycle (Days).	Author.
Gilt.	Sow.		
	1–2 days.....	—	Krallinger & Schott, 1933.
	1–2 days.....	18–25.....	McKenzie, 1926.
	2–3 days.....	—	Haring, 1937.
45 hours.....	65 hours.....	—	McKenzie, 1932.
40–46 hours...	65 hours.....	21–22.....	McKenzie & Miller, 1930a.
—	1–2 days, often longer	21, often 10–14.....	Dettweiler & Muller, 1924.
—	3 days.....	Usually 21.....	Corner & Amsbaugh, 1917.
—	3 days.....	21.....	Corner, 1921.
—	3–4 days.....	Average 21, frequently 18–23, rarely 15–30.	Marshall & Hammond, 1937.
—	1–2 days, sometimes longer	21 days, often longer.....	Kronacher, 1927.
—	1–5 days, average 2–3 days	18–24, average 21.....	Asdell, 1938.
—	2 days, often longer	—	Zorn, 1927.
—	1–2 days.....	—	Schmidt, 1929.
—	2 days.....	19.....	Kupfer, 1928.
—	2–3 days.....	—	Schmaltz, 1921.
—	—	21, S.D. 2½.....	Krallinger, 1937.
—	Average 3, range 2–4 days	Average 20·66, S.D. 2·36, normal range 18–22, extremes 12–28.	Struve, 1911.

In the above summary the duration of oestrus, as recorded by the different authors, was classed as that of the sow, unless otherwise specified.

Struve (1911) who appears to have been one of the earliest workers to record the duration of the oestrous period and of the oestrous cycle, reported that the presence of oestrus is not infrequently overlooked in practice, as the duration may be even less than 12 hours and hence may pass off overnight. McKenzie (1932) and McKenzie and Miller (1930) appear to be the only authors, according to the available literature, who have established a difference in the duration of oestrus between the gilt and the sow. Dettweiler and Müller (1924) were of opinion that the intensity of the expression of oestrus is genetic and that families and breeds differ greatly in this character.

Coitus, allowed at the beginning of oestrus, has the tendency to shorten the duration of that period in the cow (Hammond, 1927; Quinlan *et al.*, 1941). In the cow the onset of oestrus seems to favour the hours of night or the early morning (Anderson, 1944; Bonsma, personal communication). Bisschop, however, in a personal communication states that, from observations conducted at the Armoedsvlakte Research Sub-Station of Onderstepoort, no such tendency was revealed in cattle.

Hammond thinks that "... within the species the length of the cycle and the duration of the subsequent oestrus are correlated", which he shows to hold good for the cow and the mare (Hammond, 1927, 1940). Grant (1933), however,

found that, in the ewe, no such correlation exists between the duration of oestrus and that of the preceding or subsequent cycles. He showed, however, that a negative correlation exists between the duration of oestrus and the duration of both preceding and subsequent interoestrous periods. Hence, the oestrous period is able to vary independently within a relatively constant oestrous cycle and may expand into both preceding and succeeding cycles. The interoestrous period, in the ewe, he found to be more variable than that of the cycle as a whole. No relative literature on the sow could be traced. Krallinger (1937) thinks that cycles longer than 27 days undoubtedly contain a number of " silent " oestrous periods. In the Swiss " country pig ", according to Küpfer (1928), the ovarian cycle is continued throughout the year but, after a certain number of interovulation periods, there is no longer a regular cycle.

Papanicolaou and Stokard (1919) showed that, by underfeeding guinea-pigs, dioestrus is prolonged, this effect being more pronounced if underfeeding occurs late in the period. The prolongation of the oestrous cycle, in all cases of malnutrition, has also been demonstrated for the rat by Long and Evans (1922).

Struve (1911) recorded that, in the Veredeltes Landschwein, oestrus reappears in 4 to 9 days after weaning, on the average in 5 days. Marshall and Hammond (1937) stated that the sow rarely comes in oestrus until 5 to 6 days after weaning, or 6 to 8 weeks after parturition. If a nursing sow does come on heat and is served, she is very rarely fertile unless lactation ceases or unless she is very well fed, due to the coincident demands made by the mammary gland on the nutrition available. Partial separation of dam and litter during the night or part of the day, together with good feeding, will induce oestrus, which treatment should be continued after service for so long as the pigs are being suckled. Long and Evans (1922) reported oestrous changes in the vaginal smear of the rat 3 to 12 days after weaning, reappearance of oestrus being delayed if the litter is large, owing to the drain occasioned by lactation being greater. If, in this species, nursing is delayed, indications of oestrus will occur spontaneously 25 to 40 days postpartum. Lactation, they claimed, inhibits oestrus. They explain the prompter return of oestrus after parturition, as against after weaning, by the assumption that atrophy of the corpus luteum occurs prior to parturition. Asdell (1938) wrote that sows show oestrus 3 to 5 days after farrowing but that they should not be mated then, as a heavy milking sow cannot develop young in the uterus while feeding a litter. Oestrus reappears 3 to 5 days after weaning. Kronacher (1927) claimed that oestrus returns within 6 to 8 weeks, sometimes sooner, after parturition and at the utmost a few days after weaning. Krallinger (1932, 1937) found the interval from weaning to post-weaning oestrus to be subject to great variation, but the majority of cases fall within the period 1 to 14 days after weaning, the mean being 7 days. In many instances, however, oestrus is delayed for six months after weaning, but such cases probably include a number of " silent " oestrous periods. He maintained that oestrus returns sooner after a long than after a short nursing period, but could find no correlation between the intensity of the demand on the dam by the litter, as measured by the weight at four weeks, and the return of postweaning oestrus. Occasionally oestrus appears during the nursing period but without preference for any particular time during that period. He was further of opinion that the return of oestrus after weaning is more protracted in older sows, although positive proof is lacking. The loss in weight of the sow during the suckling period seemed to be of no moment. Dettweiler (1924) wrote that after parturition oestrus returns at the latest after 6 to 8 weeks and often earlier, but usually after weaning. Weaning shortly after farrowing will cause oestrus to reappear within 8 to 10 days.

Selye and McKeown (1934*a* and 1934*b*), as quoted by themselves (1934*c*), proved that, in mice and rats, mechanical stimulation of the nipple, without the withdrawal of milk, prolonged the life of the corpus luteum beyond the usual duration. The stimulus must, however, be continuous. Continuous suckling of normally cyclic rats and mice produces what the authors term " suckling pseudo-pregnancy ", which eventually leads up to proliferation of the mammary gland tissue, actual milk secretion and a " ... prolonged, almost continuous, dioestrus ". This stimulus, however, failed to prevent involution of the udder tissue and retrogression of the corpus luteum, in hypophysectomized animals, after the sixth day of " suckling pseudopregnancy ". In the case of mice and rats the same workers (1934*c*) showed that, if vigorous suckling is maintained by replacing the litters daily with younger and actively suckling litters, vaginal smears indicate a recurrence of the first postpartum oestrus at the usual third week interval, but " ... this oestrus was followed ... not by normal cycles, but by successive periods of dioestrus each of from 12 to 17 days' duration, separated the one from the other by a single appearance of oestrus ... ". Although the suckling stimulus could not prevent involution of the mammary gland tissue indefinitely a state of " ... almost continuous dioestrus for long periods " could be induced thereby. From these studies the authors concluded that " ... the nervous stimulus of nursing probably exerts its trophic effect on the lactating mammary gland by way of the pituitary ".

Hughes *et al.* (1928) and Evans and Bishop (1923) have shown that, in the pig, avitaminosis A causes a more frequent recurrence of oestrus and oestrous periods of longer duration.

(*a*) *Pro-oestrus and Metoestrus.*

Object.—The object was to study the phenomena associated with pro-oestrus, or the period of preparation immediately preceding oestrus, and metoestrus, or the period of waning oestrus, during which the sow begins to lose interest in the boar yet is still prepared to accept service. It was especially desired to study the durations of these two periods and the condition of the vulva in relation thereto. The hope was entertained that this observation would yield information which would be of some practical guidance to the pig breeder.

Material and Method.—The width and length dimensions of the vulva of four Large White and six Large Black females were measured with a calipers, provided with a Vernier scale graded to one-tenth of a millimetre. Two of the Large Blacks had previously had litters, the others were gilts and had just reached puberty. All animals were tested for oestrus every three hours, day and night. Measurements were made daily between 8 and 9 a.m. from the 5th February to the 16th April, 1942. During this period the majority of females had experienced three to four oestrous cycles. A further four Large White gilts and one Large Black gilt, all of which attained puberty towards the end of the observation, were closely observed and the vulvas measured prior to the exhibition of pubertal oestrus. All animals were very docile and measurements were made with the females standing quietly in a corner of the pen.

In addition to the two-dimensional measurements of length and width of vulva, an experienced attendant was detailed to record the state of the vulva, as it appeared to him, as " slightly swollen " (sS), " heavily swollen " (SS) or " not swollen " (ns), without knowledge of the actual measurements. The behaviour of the females towards the boar at the three-hourly tests for oestrus, was recorded. If, during pro-oestrus, interest was shown in the boar yet mounting was refused,

the gilt was recorded as "SB"; in actual oestrus she was recorded as "H": during metoestrus, when the male's attentions were resented but service ultimately accepted, she was recorded as "LH"; when service was persistently refused and oestrus had ceased, she was entered as "OH".

Results.—The data with regard to the swollen condition of the vulva prior to the onset and subsequent to the cessation of oestrus, were combined for the two breeds as there was so indication of any breed differences.

The average period during which the vulva shows increases in size prior to the onset of oestrus, according to the length measurements of 25 instances, is 3·4 days with extremes of 0 to 8 days. That period, according to width measurements in 22 instances, is 3·1 days, with a range of 1 to 9 days. The mean for the two types of determinations is 3·3 days with a range of 0 to 9 days. Over 24 instances the data show that, according to length measurements, the average period of subsidence of the swollen condition of the vulva, after the cessation of oestrus, is 3·1 days with a range of 0 to 8 days. According to width measurements in 26 instances, this period is 3·6 days, with a range of 0 to 7 days. The mean over the two breeds for the two types of measurements is 3·4 days with a range of 0 to 8 days. It will be observed that the results arrived at by measuring either the width or length of the vulva agree closely.

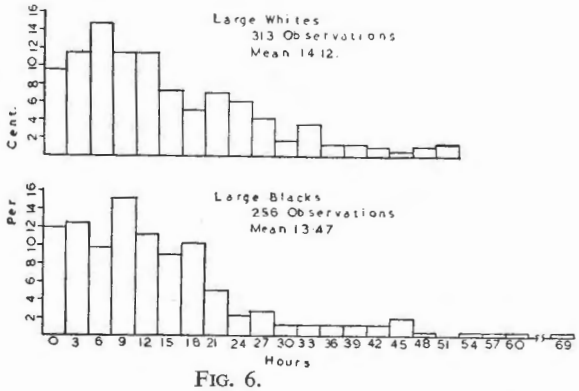

FIG. 6.

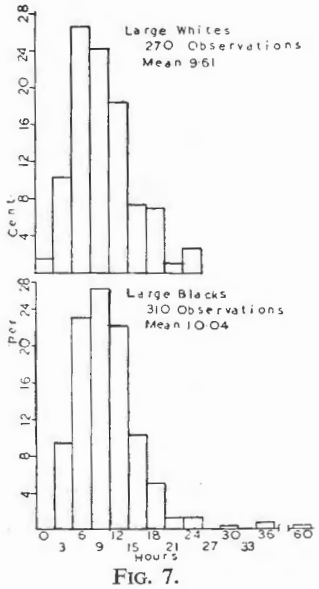

FIG. 7.

FIG. 6.—Frequency distribution of the period of pro-oestrus.

FIG. 7.—Frequency distribution of the period of metoestrus.

By merely observing the condition of the vulva the following results were obtained. The period of swelling before the onset of oestrus amounted to 3·3 days with a range of 1 to 7 days, and the period of subsidence amounted to 3·1 days with a range of 1 to 8 days. It will therefore be observed that the results obtained by actual measurements and by merely observing the condition of the vulva were, for all practical purposes, identical.

The durations of the periods of pro-oestrus and metoestrus, abstracted from the pen records, are presented in frequency classes in Appendix 5, Table II. These frequencies were fitted to binomial and Poisson distributions but the deviations were significant in all cases except for pro-oestrus and that for Large Blacks only, which fitted a Poisson distribution if taken at six-hourly intervals ($X^2 = 3 \cdot 5822$, $n = 6$, $P = > \cdot 70$). For comparative purposes the data were therefore analysed as being of normal distributions and the conclusions arrived at below must be treated as tentative. Details appear in Table 24 and Figures 6 and 7.

TABLE 24.

(*a*)

The Duration of Pro-oestrus.

	Large Blacks.	Large Whites.
Number of observations	256	313
Mean in hours	13·47	14·12
Standard deviation	11·99	11·68
Coefficient of variation	89·01	82·72

(*b*)

The Duration of Metoestrus.

	Large Blacks.	Large Whites.
Number of observations	310	270
Mean in hours	10·04	9·61
Standard deviation	5·65	4·92
Coefficient of variation	56·22	51·20

(*c*)

The Mode and the Range of Pro-oestrus and Metoestrus.

	Post-oestrus.		Metoestrus.	
	Large Blacks.	Large Whites.	Large Blacks.	Large Whites.
Mode, hours	9	6	9	6
Range, hours	0–69	0–51	3–60	0–24

Calculation shows that the mean differences between the two breeds, for both pro-oestrus and metoestrus, are non-significant.

(*b*) *The Duration of Oestrus.*

Object.—The object of this study was to determine the duration of the gilt, sow, postpartum and postweaning types of oestra.

Material and Method.—Observations on oestrus were conducted in a modern piggery (Photo No. 2). The exits to the runs were provided with sliding doors, so that a sow could be conveniently separated from her pen mates whenever necessary. A wooden superstructure was erected in the open runs, 6½ feet high, which carried a roof of straw during the summer months, to protect the animals against excessive heat while under test. Strong electric lamps, inside and outside the pens, provided clear light for work at night.

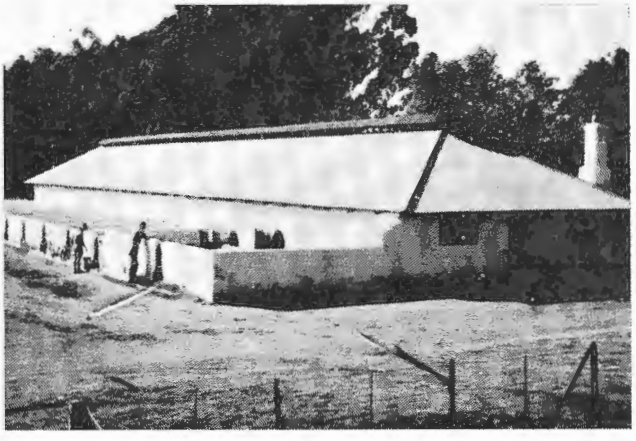

PHOTO NO. 2.—The piggery.

Pen record books were employed in which full details with regard to the oestrous cycle of each female, dates of service, etc., were entered, a sample page of which is presented in Appendix 5, Table III. The sows were brought in to the testing pens on the 17th day of the oestrous cycle, or about three days before the expected day of their next oestrous. After the cessation of oestrus the females were returned to the lucerne paddocks. While on free range all females were kept under close observation for the appearance of oestrus at unusual intervals. All farrowings took place in the farrowing pens and the sows never left their individual pens during the entire nursing period, which lasted 56 days in the majority of cases. After weaning the sows joined those in the general pens where regular testing for oestrus was conducted. Three-hourly observations for the exhibition of postpartum oestrus were begun as soon after parturition as the sow started to move about freely. The method adopted for recording particulars has been explained under Observation 4 (*a*).

Testing for oestrus was carried out by both ordinary and vasectomised boars, five to eight such males being always on hand. As soon as a boar became indifferent towards the sows he was rested and removed to free-range. The boars in use were housed in pens adjoining those of the sows. A six feet portion of the dividing wall was replaced by a strong iron grating, by which the mutual behaviour of the sexes between the testing periods could be studied. (Photo No. 3).

This method provided excellent opportunity for selecting females in pro-oestrus, as they invariably posted themselves before the opening, watching the males, many hours before the onset of oestrus.

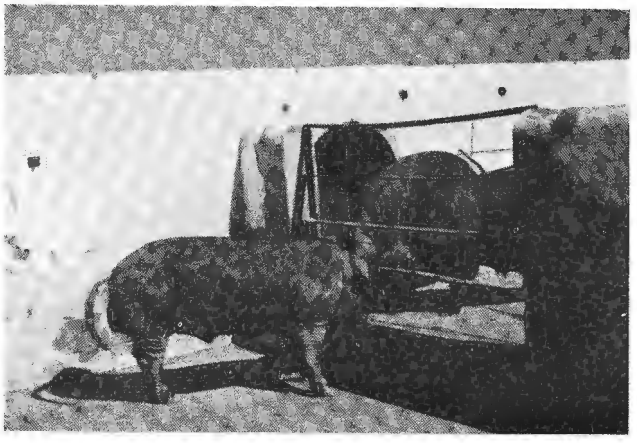

PHOTO No. 3.—Sows in oestrus at the grating separating them from the boar.

One or more boars were always kept in isolation for check-testing sows for oestrus, especially if the teasers were not sufficiently active. Whenever a boar was sluggish and the presence of oestrus could not be definitely determined, the sow was driven to the isolated boar, which, because of his isolation, was usually exceptionally active. Observations were carried out regularly at three hourly intervals, day and night. A sow was only recorded as being in oestrus when she allowed the boar to mount. Actual service is not necessary to establish the presence of oestrus, as a female not in oestrus will definitely not permit mounting by the male. All males were allowed occasional services so as to maintain their interest in the females.

PHOTO No. 4.—A group of Large White gilts used in these observations.

Results.

Duration of Oestrus in the Gilt.—Before attempting a comparison between the duration of the various types of oestra, it is of importance to establish first of all whether, in the gilt, any significant differences exist between the durations of the puberty oestrus and those immediately following. That is, does a tendency exist for the length of the oestrous period to vary as the gilt ages? For this purpose only those instances were utilised in which four consecutive periods were recorded, as periods beyond the fourth were not available in sufficiently large numbers to extend the sequence. The details appear in Appendix 5, Table IV. In view of the finding (reported below) that the duration of oestrus between the various families differ highly significantly, family bias has been eliminated in the analysis of the data as presented in Table 25.

TABLE 25.

Analysis of Variance: The Duration of Oestrus in Hours of the First Four Consecutive Oestrous Periods in the Large Black and Large White Gilt.

Component.	D.F.	Sum Squares.	Mean Square.	F.	Significance.
Periods.....	3	59·38	19·79	0·17	ns
Breeds.....	1	26,510·82	26,510·82	232·09	SS
Interaction.....	3	943·36	314·41	2·75	ss
Error.....	304	34,724·36	114·23	—	—
TOTAL.....	311	62,237·79	—	—	—

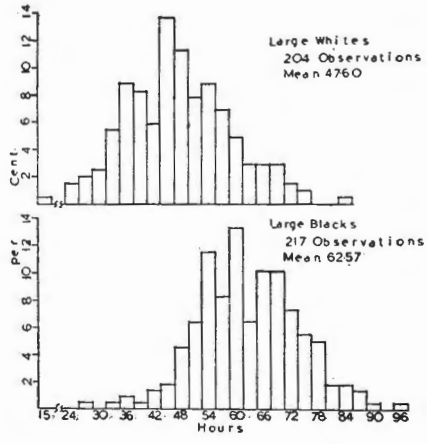

FIG. 8.—Frequency distribution of the duration of oestrus in the gilt.

The analysis shows that the first four consecutive oestrous periods in the gilt do not differ significantly but that the two breeds differ highly significantly.

By utilising all the available data in Appendix 5, Table IV, further particulars have been calculated as presented in Table 26 and Figure 8.

TABLE 26.

Duration of Oestrus in the Gilt.

	Large Blacks.	Large Whites.
Number of observations	217	204
Mean duration in hours	62·57	47·60
Standard deviation	9·17	7·00
Coefficient of variation	14·66	14·71

The mean difference of 14·97 hours proves to be highly significant (t=18·95. For n=419, P=·01, t=2·58).

The Duration of the Gilt, Mature, Postpartum and Postweaning Types of oestra.—The durations of the various types of oestra in the pig are presented in Appendix 5, Table V. For comparative purposes only the first or puberty oestra in gilts were used in the calculations presented in the analysis of variance in Table 27.

TABLE 27.

Analysis of Variance: Duration of Oestrus in Gilts, in Sows, after Parturition and after Weaning.

Component.	D.F.	Sum Squares.	Mean Square.	F.	Significance.
Types	3	7,372·3	2,457·43	13·36	SS
Breeds	1	12,493·1	12,493·10	67·96	SS
Interaction	3	1,256·9	418·97	2·28	ns
Error	373	68,568·7	183·83	—	—
TOTAL	380	89,691·0	236·03	—	—

The analysis shows highly significant differences between types of oestra and between breeds.

The means for all groups appear in Table 28.

TABLE 28.

Mean Duration of Various Types of Oestra in Hours.

Type.	Large. Blacks.	Large Whites.
Gilt (puberty only)	58·50	48·65
Sow	68·19	49·91
Postpartum	68·20	65·42
Postweaning	65·05	57·84

The least significant differences between all types of oestra, within and between the breeds, have been calculated. From that data an inter-type comparison has been prepared, the results appearing in Table 29.

TABLE 29.

Comparative Summary of the Mean Duration of the Various Types of Oestra in Large Black and Large White Pigs.

Type.	Longer than.	Significantly Similar to.	Less than.
	(*a*) LARGE BLACKS.		
Gilt	None	None	Sow, Postpartum, Post weaning.
Sow	Gilt	Postpartum, Post-weaning.	None.
Postpartum	Gilt	Sow, Postweaning	None.
Postweaning	Gilt	Sow, Postpartum	None.
	(*b*) LARGE WHITES.		
Gilt	None	Sow	Postpartum, Post-weaning.
Sow	None	Gilt	Postpartum, Post-weaning.
Postpartum	All	None	None.
Postweaning	Gilt, Sow	None	Postpartum.

(*c*) LARGE BLACKS AND LARGE WHITES.

Large Whites.	Greater than Large Blacks.	Significantly Similar to Large Blacks.	Less than Large Blacks.
Gilt	None	None	All.
Sow	None	None	All.
Postpartum	Gilt	Sow	None.
		Postpartum, Post-weaning	
Postweaning	None	Gilt	Sow, Postpartum, Post-weaning.

In Large Blacks the duration of the gilt oestrus is significantly less than for the sow, the postpartum, and the postweaning oestra, whereas these latter three types do not differ significantly between themselves. In Large Whites the durations of the gilt and sow oestrous periods are significantly less than for the postpartum and postweaning periods; the postpartum oestrus is significantly longer than all the other types; the postweaning oestrus is significantly shorter than the postpartum oestrus only but longer than for the gilt and sow.

The comparative schedule in Table 29 (*c*) shows that, in Large Whites, the durations of both the gilt and sow oestra are less than all the types of oestra in

Large Blacks; that the postpartum oestrus is significantly longer than the gilt oestrus only in Large Blacks and is similar to all the other types in this latter breed. The postweaning oestrous period in the Large White sow is significantly shorter than that of the sow, of postpartum and of postweaning oestrus but is similar to the gilt oestrus in Large Blacks.

Table 30 and Figures 9 and 10 present further details of the durations of the various types of oestra in the two breeds of pigs. All the available data for gilts (Appendix 5, Table IV) have been included in the calculations, hence the means for this type differ slightly from those appearing in Table 28.

TABLE 30.

(*a*)

Particulars of the Duration of Oestrus in Large Black and Large White Pigs.

	Gilt.	Sow.	Postpartum.	Post-weaning.
LARGE BLACKS.				
Number of periods	217	58	45	44
Mean length in hours	62·57	68·19	68·20	65·05
Standard deviation	11·19	11·95	18·90	12·36
Coefficient of variation	17·88	17·52	27·71	19·00
LARGE WHITES.				
Number of periods	204	55	36	37
Mean length in hours	47·60	49·91	65·42	57·84
Standard deviation	11·55	8·76	21·43	14·92
Coefficient of variation	24·26	17·55	32·76	25·79

(*b*)

The Mode and the Range in Hours.

	Gilt.	Sow.	Postpartum.	Post-weaning.
MODE.				
Large Black	60	63	None.	72
Large White	45	48	None.	51 or 54
RANGE.				
Large Black	27–96	42–105	36–132	33–102
Large White	15–84	33–72	30–93	33–84

As in the case of the duration of oestrus, both the mode and the range are represented by higher values in the Large Black than in the Large White breed. The data show that, for Large Blacks, the degree of variation for the gilt, sow and postweaning oestrus, is about of the same order, but that the duration of the pastpartum oestrus is subject to a much larger variation than any one of the other three types. It will further be observed that in the Large White breed, the coefficient of variation is much larger for all types of oestra, except in the case of the sow, than in Large Blacks. In both breeds the duration of the postpartum oestrus, as a type, is normally subject to much greater variation than any of the other types. This fact is very clearly brought out by the relevant histograms in figures 9 and 10. The histograms show that, in both breeds, the expression of a modal value for postpartum oestrus is very unconvincing.

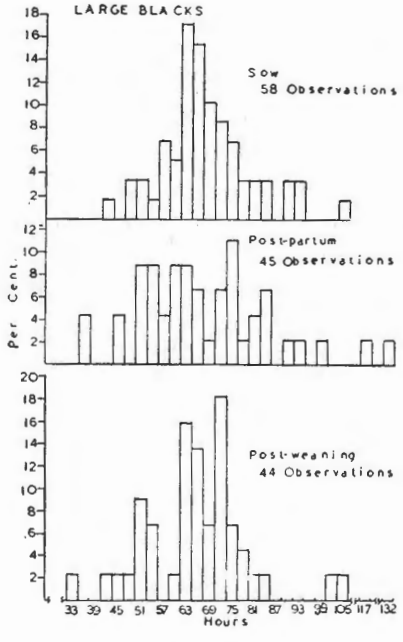

FIG. 9.

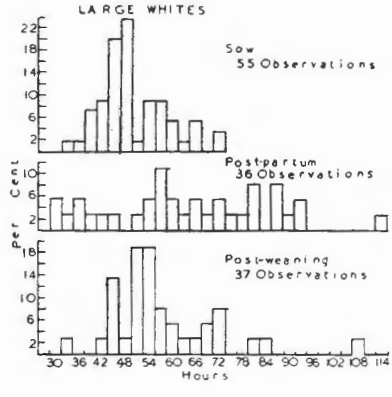

FIG. 10.

FIG. 9.—Frequency distribution of the duration of different types of oestrus in Large Blacks.

FIG. 10.—Frequency distribution of the duration of different types of oestrus in Large Whites.

(*c*) *The Relationship between the Duration of Oestrus and the Length of the Oestrous Cycle—Dioestrus.*

In Appendix 5, Table IV, is listed the duration of oestrus together with that of the dioestrous and inter-oestrus cycles immediately following. Groups of sisters are bracketed. From this data an attempt has been made to establish whether any relationship exists between the duration of oestrus and that of the associated oestrous cycle.

Before attempting such an analysis it is necessary, first of all, to determine whether any correlation in the duration of the oestrus exists within sister groups. The average duration of oestrus for each sister was taken where more than one observation appears and all possible combinations taken into account, with random placing in columns. The calculations show that the correlation coefficient for the duration of oestrus between sisters in Large Blacks is 0·47 and in Large Whites 0·30, both of which prove to be highly significant. Hence, in the calculations which follow, family bias has been eliminated.

The correlation coefficient, as calculated, between the duration of oestrus and the length of the oestrous cycle, was found to be 0·101 for Large Blacks and 0·030 for Large Whites. Although the former breed shows a much higher correlation, both coefficients are non-significant (Large Blacks: $t = 1 \cdot 59$. For $n = 243$, $P = \cdot 05$, $t = 1 \cdot 96$. Large Whites: $t = 0 \cdot 46$. For $n = 234$, $P = \cdot 05$, $t = 1 \cdot 96$).

PHOTO No. 5.—A group of Large Black gilts used in these observations.

Considerably more observations in respect of the length of the oestrous cycle and of dioestrus are available than appear in Appendix 5, Table IV. This is because the length of a number of cycles is known without accurate records of the durations of the associated oestrous periods. All the available data have therefore been used to prepare the frequency distributions presented in Tables 31 (*a*) and (*b*), and Figures 11 and 12.

TABLE 31.

(*a*)

The Length of the Oestrous Cycle.

	Large Blacks.	Large Whites.
Number of observations	295	258
Mean length in days	21·74	20·96
Standard deviation	2·32	3·52
Coefficient of variation	10·67	16·79

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(*b*)

The Length of Dioestrus.

Number of observations	292	248
Mean length in days	19·12	19·42
Standard deviation	2·49	2·71
Coefficient of variation	13·02	13·95

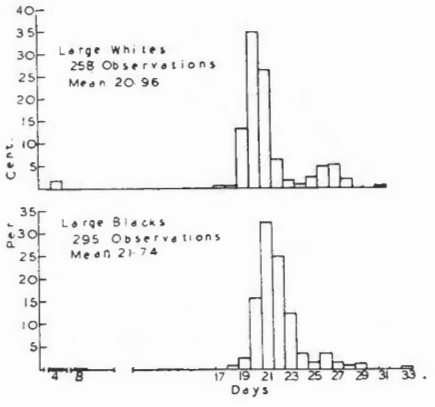

FIG. 11.

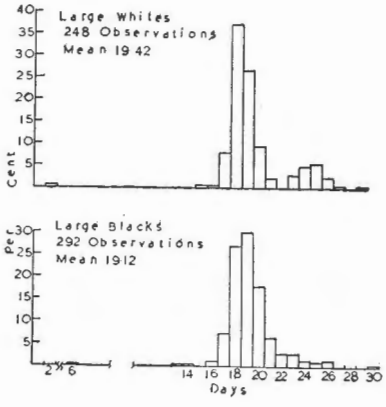

FIG. 12.

FIG. 11.—Frequency distribution of the length of the oestrous cycle.

FIG. 12.—Frequency distribution of the length of dioestrus.

The mean cycle length is 21·74 and 20·96 days in Large Blacks and Large Whites respectively. The mean difference of 0·78 days is highly significant. Large Whites show a much greater variation than Large Blacks. The modal value for Large Blacks is shown at 21 days and the range is 4 to 33 days. For Large Whites the mode is 20 days and the range 4 to 31 days (Figures 11 and 12). In Large Blacks 85 per cent. of oestrous cycles fall within the range of 20 to 23 days, and in Large Whites, 81·5 per cent. fall within the range of 19 to 22 days. Attention is directed to the finding that of the cycles of less than 17 days' duration, only 0·6 per cent. were recorded in Large Blacks and only 1·6 per cent. in Large Whites.

With regard to the length of dioestrus, it is to be observed that the breed mean difference fails to reach significance at the 5 per cent. level. In Large Blacks the mean is 19·12 days, SD. 2·49, the mode is 19 days and the range 2 to 30 days. In Large Whites the mean is 19·42 days, S.D. 2·71, the mode 18 days and the range 2 to 29 days. In Large Blacks only 1·5 per cent. and in Large Whites only 0·8 per cent. of cases fall in the class of less than 15 days.

(*d*) *Postpartum Oestrus.—Litter Size and the Period from Parturition to Postpartum Oestrus.*

Details with regard to postpartum and postweaning oestrus appear in Appendix 5, Table VII.

Appendix 5, Table VIII, shows the size of the litter at parturition and the associated period from parturition to the exhibition of postpartum oestrus. The probable influence of the size of the litter at parturition on this period has been tested out and correlation coefficients of 0·147 and −0·074 obtained for Large Blacks and Large Whites respectively, both values falling far short of significance at the 5 per cent. level. The data, therefore, show that no relationship exists between the size of the litter and the time occupied for the return of the first oestrus after parturition.

Table 32 and Figure 13 present further details in respect of the period between parturition and postpartum oestrus.

TABLE 32.

The Interval: Parturition to Postpartum Oestrus.

	Large Blacks.	Large Whites.
Number of observations	52	29
Mean in hours	41·31	47·59
Standard deviation	9·44	16·42
Coefficient of variation	22·85	34·50

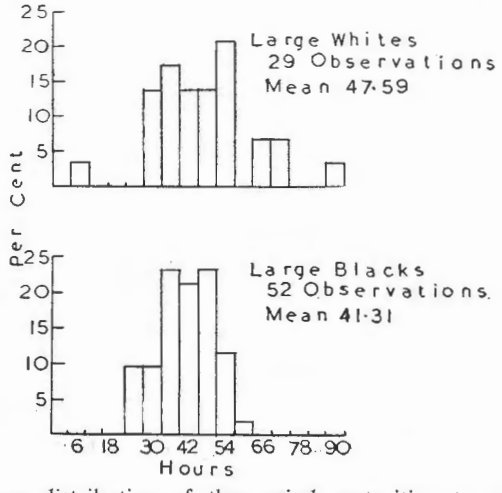

FIG. 13.—Frequency distribution of the period parturition to postpartum oestrus.

The mean difference in the length of the period from parturition to postpartum oestrus between the two breeds was found to be non-significant ($t = 1 \cdot 89$. For $n = 79$, $P = \cdot 05$, $t = 1 \cdot 98$). Calculation further shows that 100 per cent. of Large Black sows were in oestrus within $2\frac{1}{2}$ days (63 hours) after parturition, but only 82·8 per cent of Large White sows showed oestrus within that period. The histograms in figure 13 show that the mode is poorly expressed for both breeds. For Large Blacks, with 52 observations, the mode could be assumed with a high degree of certainty to lie between 36 and 48 hours. The range is 22 to 63 hours. In Large Whites, the mode at 54 hours is unreliable owing to the small number of only 29 observations. The range is 9 to 90 hours. A much greater variation is again shown by the Large White breed.

(*e*) *Absence of Postpartum Oestrus.*

Of the females examined for postpartum oestrus and which, clinically, appeared to be normal, only two Large Black sows (Nos. 57 and 115) out of a total of 54, and only one Large White sow (No. 119) out of a total of 34, failed to exhibit postpartum oestrus. No. 57 had a second litter when she showed the usual postpartum oestrus. A fourth sow, Large White No. 74, failed to show postpartum oestrus after three farrowings, but clinically she was abnormal as a purulent discharge from the vulva was noticed for considerable periods after the birth of each litter; she was therefore discarded. Hence, over both breeds, only 3·4 per cent. of females failed to exhibit oestrus shortly after parturition.

(*f*) *Fertility of the Sow at Postpartum Oestrus.*

An attempt was made to test out the result of Maslov's (1938) work in Russia in which he showed that it was possible to rear three litters within a year from a sow. As gestation in the pig lasts almost four months, this means that the sow should be mated during her postpartum oestrus. Five Large Blacks and eight Large White sows were, therefore, mated during their first oestrus after parturition. The results appear in Appendix 5, Table IX. It will be observed that all matings proved negative.

(*g*) *Postweaning Oestrus. The Influence of the Nursing Period on the Return of Postweaning Oestrus.*

While the pigs, which were to serve as material in these studies, were being produced, litters were generally weaned after a nursing period of roughly eight weeks, but for various reasons a number of litters had to be weaned at periods differing materially from the usual eight weeks. A limited amount of data have, therefore, become available for a study of the influence of the duration of the nursing period on the return of oestrus after weaning.

A valid correlation coefficient for Large Whites could not be calculated, as the available number of suckling periods, differing considerably from the normal of 56 days, was insufficiently large. In the case of the Large Blacks, data are available for 17 suckling periods, ranging progressively from 2 to 74 days (Appendix 5, Table X). From this data a non-significant correlation coefficient of 0·148 was calculated between the duration of the nursing period and the period from weaning to postweaning oestrus ($t = 0 \cdot 580$. For $n = 15$, $P = \cdot 05$, $t = 2 \cdot 13$). Examination of the data in Appendix 5, Table VII, shows that this finding for Large Blacks can safely be assumed to apply with equal force to Large Whites also, as no divergent breed tendencies are indicated.

(*h*) *Interval from Weaning to Post-Weaning Oestrus.*

In view of the above results, all the available data for the duration of the interval from weaning to postweaning oestrus, appearing in Appendix 5, Table VII, have been utilised for the preparation of the frequency distributions presented in Appendix 5, Table XI, and Figure 14.

As in the case of the frequencies for the duration of the pro-oestrous and metoestrous periods, those for the interval from weaning to postweaning oestrus would appear to fit either a binomial or a Poisson distribution. Calculation, however, reveals that the deviations are significant. The distributions were therefore considered to be normal but, in view of the limited number of observations available, the results obtained in Table 33 should be considered as tentative.

TABLE 33.

The Interval from Weaning to Postweaning Oestrus.

	Large Blacks.	Large Whites.
Number of observations	50	39
Mean duration in days	16·08	7·85
Standard deviation	21·43	11·07
Coefficient of variation	133·27	141·01

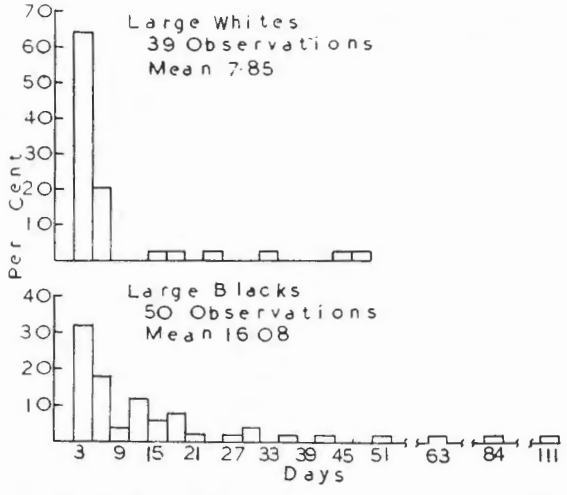

FIG. 14.—Frequency distribution of the period from weaning to post-weaning oestrus.

Calculation shows that the mean difference between the two breeds is highly significant. It is to be observed that the interval for the return of oestrus after weaning in Large Blacks is more than double that for Large Whites. The data further show that this interval is subject to extraordinary variations. The histograms in Figure 14 show distinct modal values at three days for both breeds. Calculation shows that this class frequency includes only 32 per cent. of cases in Large Blacks but 64·1 per cent. of cases in Large Whites.

(i) The Size of the Litter During Nursing and the Return of Post-Weaning Oestrus.

It is of interest to know also whether the size of the litter during nursing has any bearing on the interval weaning-postweaning oestrus. For this purpose only the number of piglets suckled during the greatest portion of the nursing period (as represented by the number weaned) were considered. Furthermore, in view of the conclusion reached above, that the length of the suckling period has no influence on the return of oestrus after weaning, all available nursing periods were included in this study. The data appear in Appendix 5, Table XII. The correlation coefficient between these two variables has been calculated and found to be 0·259 and —0·132 for Large Blacks and Large Whites respectively, both of which prove to be non-significant. (Large Blacks: $t = 1{\cdot}903$. For $n = 47$, $P = {\cdot}05$, $t = 1{\cdot}96$. Large Whites: $t = 0{\cdot}79$. For $n = 35$, $P = {\cdot}05$, $t = 1{\cdot}96$).

(j) *The Loss of Weight of the Sow During the Nursing Period and the Return of Postweaning Oestrus.*

Notwithstanding good management, nursing sows often lose heavily in weight, reaching the weaning stage in a rather emaciated condition. This loss in weight may be as high as 45 per cent. It was thought that this factor may exert a significant influence on the return of oestrus after weaning. Appendix 5, Table XIII, presents the percentage loss or gain in weight of the nursing sow from parturition to weaning, coupled with the relative interval from weaning to post-weaning oestrus. Nursing periods of roughly 8 to 9 weeks duration only were considered. The correlation between the percentage loss of weight of the sow during the nursing period and the interval from weaning to post-weaning oestrus, was calculated. The coefficients obtained are —0·012 and —0·233 for Large Blacks and Large Whites respectively, both of which prove to be non-significant (Large Blacks: t = 0·072. For n = 34, P = ·05, t = 1·96; Large Whites: t = 1·395. For n = 32, P = ·05, t = 1·96). Further details in respect of the percentage loss in weight of the nursing sow are presented in Table 34 and Figure 15.

PHOTO No. 6.—Large Black brood sows on Kikuyu pasture.

TABLE 34.

Percentage Loss in Body Weight of the Nursing Sow during a Suckling Period of 8 to 9 Weeks.

	Large Blacks.	Large Whites.
Number of observations	35	34
Mean percentage loss of weight	11·07	19·32
Standard deviation	9·66	11·68
Coefficient of variation	87·26	60·46

The difference in mean percentage loss in weight between the two breeds proves to be highly significant ($t = 3{\cdot}24$. For $n = 67$, $P = {\cdot}01$, $t = 2{\cdot}58$). For Large Blacks the mode is 10 per cent. and the range varies from a gain of 10·5 per cent. to an extreme loss of 36·3 per cent. For Large Whites there is no mode and the range varies from a gain of 10·77 per cent. to an extreme loss of 45·09 per cent. Six out of 35 Large Black sows, and one out of 34 Large White sows, actually showed higher weights at termination of the nursing period than at parturition. It is to be noted that the only Large White sow (No. 17), which weighed heavier at the end than at the beginning of the nursing period, only suckled one piglet for the greater portion of that interval. The same female also experienced the greatest reduction in weight (45·085 per cent.) of all females in both breeds after rearing seven piglets, at a subsequent farrowing. Attention is drawn to the fact that the mean percentage loss in weight during lactation, in the Large White breed, is almost double of that in Large Blacks.

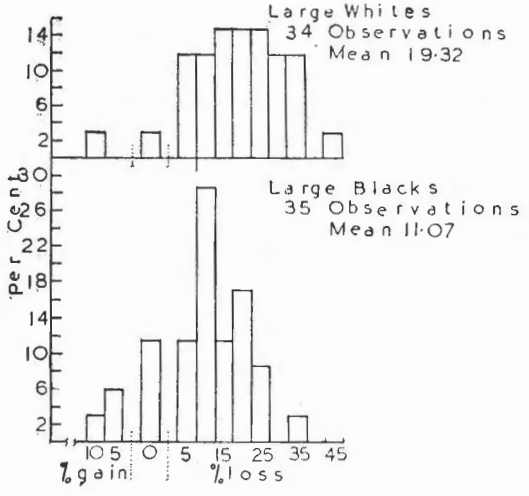

FIG. 15.—Frequency distribution of the percentage loss in weight of the nursing sow during 8 to 9 weeks suckling period.

(k) The Influence of the Size of the Litter Reared on the Loss of Weight of the Sow.

It is of interest to know to what extent the demands on the dam by the litter, as measured by its size, affects the weight of the nursing sow. The data appearing in Appendix 5, Table VII, were utilised for this purpose, only those cases being considered in which the nursing period lasted roughly 8 to 9 weeks. The correlation coefficient, as calculated between these two variables, was found to be 0·610 for Large Blacks and 0·640 for Large Whites, both of which prove to be highly significant.

(l) The Exhibition of Oestrus During the Ordinary Nursing Period of about 8 Weeks.

A total of 75 nursing sows, comprising 41 Large Blacks and 34 Large Whites, were kept under close observation while suckling their young and tested daily for the presence of oestrus. Of this number only 4 sows ever exhibited oestrus

while nursing their litters, excluding, of course, the usual postpartum oestrus. Full details of these sows appear in Appendix 5, Table XIV, from which Table 35 has been prepared.

TABLE 35.

Oestrus during the Nursing Period.

Sow No.	Periodicity of Oestrus Subsequent to Parturition.			Period: Weaning to Post-weaning Oestrus (Days).	Period: Last Nursing Oestrus to Post-weaning Oestrus (days).	Suckling Period (Days).	Litter Size at Weaning.
	1st	2nd	3rd.				
(a) Ordinary nursing period.							
Large Black 13.....	1	23	—	4	40	60	5
Large Black 23.....	1	20	24	9	20	56	3
Large Black 34.....	2	27	23	19	23	56	2
Large White 17.....	2	18	22	2	21	61	1
(b) Delayed nursing period.							
Large Black 54.....	2	128	—	20	26	136	3
Large Black 57.....	2	87	22	10	21	122	2

Large Black No. 13 showed oestrus again 23 days after her first or postpartum oestrus and only again 40 days thereafter or 4 days after weaning. Large Blacks Nos. 23 and 34, and Large White No. 17, exhibited two oestrous periods each (subsequent to their first or postpartum oestrus) at intervals which can be considered within the range of the ordinary oestrous cycle. The intervals intervening between the last nursing oestrus and postweaning oestrus, in all three cases, likewise appear to be equal to the duration of the normal oestrous cycle. Hence, in three of the four cases where oestrus was exhibited during the normal nursing period of about eight weeks, the regular oestrous cycle of roughly three weeks would seem to have again set in subsequent to the postpartum oestrus. The reappearance of the normal oestrous cycle, during the nursing period, was therefore recorded in only 4 per cent. of cases out of the total 75 sows under observation.

(m) The Exhibition of Oestrus during a Delayed Nursing Period.

Only two sows, Large Blacks Nos. 54 and 57, were allowed to suckle their litters for an extended period beyond the usual 8 weeks, in order to determine whether oestrus would appear under such conditions [vide Table 35 (*b*)]. No. 54 exhibited oestrus only once, excluding her postpartum oestrus, and that after having nursed her litter for 130 days. The litter was weaned at 136 days, when it was apparent from the condition of her udder that lactation had ceased, although the piglets still continued to suckle intermittently. She again showed oestrus 26 days after this nursing oestrus, or 20 days after weaning. No. 57 exhibited oestrus for the first time 89 days after parturition, excluding her postpartum oestrus, followed by a second one, 22 days thereafter. Her litter of two was weaned at 122 days, when her milk yield also had reached a very low level.

(n) Induction of Oestrus during the Nursing Period.

In view of the fact that nursing sows rarely exhibit any sexual activity, it was thought advisable to determine whether oestrus could be induced during the nursing period, through a limitation of the suckling stimulus. For this purpose the following sows were available: 3 Large Blacks, 4 Large Whites and 2 Tamworths. Separation of sows and litters was commenced at intervals ranging from 5 to 31 days after parturition. Dams and litters were separated overnight for 12 hours each day, i. e. from 6 p.m. to 6 a.m. Litters were left behind in their pens and the dams all housed together. Testing for oestrus was carried out once daily at 6 p.m.

Details of the sexual history of the sows in this test appear in Appendix 5, Table XV, from which Table 36 has been abstracted.

TABLE 36.

Induction of Oestrus during the Nursing Period by Separating Dams and Litters Overnight.

Sow No.	Periodicity of Oestrus from Parturition during Nursing Period (Days).			Litter Size during Separation Period.	Period: Weaning to Post-weaning Oestrus (Days).	Nursing Period (Days).
	Post-partum.	During Separation.				
	1st	2nd	3rd			
Large Black 18.....	2	67	23	3	15	98
Large Black 23*....	1	20	—	2	—	92
Large Black 105....	3	None	None	7	3	56
Large White 64....	3	None	None	9–8	4	57
Large White 64....	4	None	None	7	9	92
Large White 66....	3	None	None	10–6	4	57
Large White 145...	2	None	None	6–5	4	99
Large White 186...	1	85	None	1	18	91
*T. 86.....	None	35	—	2	—	91
T. 86.....	None	36	24	5	7	91
T. 87.....	None	None	None	4	7	92

* Conceived at first oestrus during separation.

Unfortunately two sows, Large Black No. 23 and Tamworth No. 86, conceived from accidental services during the second oestrus.

It will be observed from Table 36 that, for the two breeds under consideration thus far, two Large Black sows (Nos. 18 and 23) and one Large White sow (No. 186) came in oestrus during the experimental period. On another occasion, while under full-time nursing, No. 23 showed oestrus in periodicities of 20 and 24 days subsequent to her postpartum oestrus, during a normal nursing period of 56 days and, during a further lactation, she experienced oestrus 23 days after her pastpartum oestrus (vide Table 36). This female thus undoubtedly possessed the genetic quality for the exhibition of oestrus while nursing her litter normally. Her reaction during this observation cannot, therefore, be considered as a result of

partial separation from her litter. Of the other two sows, Large Black No. 18 came in oestrus for the first time only after a period of 67 days, and Large White No. 186 only after 85 days after parturition. The data in Appendix 5, Table XV, suggest that, for both sows, the normal oestrous cycle had apparently again set in as a result of the prolonged nursing period, as discussed under "Delayed nursing" above, and not as a result of partial separation from their litters.

With regard to the two Tamworth sows, Nos. 86 and 87, attention is drawn to the fact that both failed to exhibit the usual postpartum oestrus so common to the two other breeds, No. 86 showing the same phenomenon on two occasions. They were full sisters and whether this character was a chance inheritance, or whether it is a breed character, could not be verified due to the small numbers available. It is of interest that No. 86 showed oestrus once, 35 days postpartum (when she conceived) on the first occasion, and twice during 60 days postpartum on the second occasion. Her sister, however, never came in oestrus during the entire lactation of 92 days.

(*o*) *The Onset of Oestrus during the Day and during the Night.*

In order to determine whether, in the pig, the time for the onset of oestrus shows any preference for the day or the night period, all oestrous periods which started between 6 a.m. to 3 p.m. were classed as having occurred during the day, and those which had their onset between 6 pm. and 3 a.m. were classed as having occurred during the night. Observations were carried out at three-hourly intervals, as already explained. The data appear in Table 37.

TABLE 37.

Onset of Oestrus during Day and Night.

Period.	Number of Individuals.		
	Large Blacks.	Large Whites.	Total.
Day	335	214	549
Night	323	237	560
TOTAL	658	451	1,109

$X^2 = 1 \cdot 283$. For $P = \cdot 05$, $X^2 = 12 \cdot 706$.

The Chi-squared test was applied to the data. The analysis reveals that no significant difference exists between the number of oestrous periods which originates during the day and during the night.

(*p*) *"Silent" Oestrus.*

Calculation shows that only 0·6 per cent. of the dioestrous cycles in Large Blacks, and only 1·6 per cent. in Large Whites, were shorter than 17 days. The probability, therefore, is small that an oestrous cycle of 34 days and less will include a "silent" oestrous period. A "silent" oestrus was thus considered as having occurred in cycles of 34 days' duration. The records were carefully studied for all such cycles, the results appearing in Table 38.

TABLE 38.

Oestrous Cycles Containing a "Silent" Oestrus.

Pig No	Oestrous Dates.		Cycle (Days).	No. of Cases.	Total No. Examined.	Per Cent. of Total.
			Large Blacks.			
34.....	1.12.40	9. 1.41	39			
87.....	30.10.41	13.12.41	44			
92.....	29.12.41	6. 2.42	39			
101.....	10.12.41	18. 1.42	39			
110.....	1. 3.42	12. 4.42	42			
143.....	31. 8.42	20.10.42	50			
161.....	21. 1.43	10. 3.43	48			
184.....	14. 3.43	28. 4.43	45	8	592	1·35
			Large Whites.			
128.....	12. 7.42	20. 8.42	39			
131.....	12. 7.42	20. 8.42	39			
142.....	9. 8.42	16. 9.42	38			
147.....	5.10.42	13.11.42	39			
156.....	13. 3.43	22. 4.43	40			
156.....	22. 4.43	30. 5.43	38	6	345	1·74

It will be observed that 592 cycles were examined in the Large Black breed and 345 in the Large White breed. In the former breed, therefore, the total number of cycles which could be considered as being double the ordinary length and hence as containing a "silent" oestrus each, was 8 or 1·35 per cent. and, in the latter breed, 6 or 1·74 per cent. Over the two breeds the percentage of "silent" oestrous periods is 1·49.

(q) The Effect of Coitus on the Duration of Oestrus.

An attempt was made to determine whether coitus has any influence on the duration of oestrus. For this purpose 11 Large Black and 10 Large White females were served by vasectomised boars at the zero hour of oestrus. In addition, it was thought relevant to study, for comparative purposes, the effect of fertile services at the onset of oestrus. A fair number of such fertile services was available from the observation on the Optimum Service Period. The details are presented in Appendix 5, Table XVI. Analysis of variance was applied to the data, the results appear in Table 39.

TABLE 39.

Analysis of Variance: The Influence of Sterile and Fertile Coitus on the Duration of Oestrus.

Component.	D.F.	Sum Squares.	Mean Square.	F.	Significance.
Breeds.....	1	4,375·91	4,375·91	36·82	SS
Groups.....	2	187·64	93·82	0·79	ns
Error.....	90	10,695·18	118·4	—	—
TOTAL	93	15,258·73	—	—	—

The analysis shows that no significant differences exist in the duration of oestra following the absence of coitus, a sterile coitus and a fertile coitus, at zero hour.

(r) *" Split " Oestrus.*

The initial presence of oestrus for a few days, followed by a non-receptive state of short duration, and a subsequent reappearance of oestrus for a further period, has been designated " split " oestrus in the horse (Andrews and McKenzie, 1941). An attempt was made to demonstrate the occurrence of this phenomenon in the pig, the nearest approach to this condition being the following two cases. Large Black No. 215 showed oestrus on 19.6.43, which lasted for 57 hours. On 23.6.43 that is, 4 days later, she was again in a receptive state for a period of 117 hours. The second case was Large White No. 77, which was in oestrus for 45 hours as from 3.2.41, and 4 days later, that is, on 7.2.41, again showed oestrus for a period of 42 hours. These were the only two instances recorded out of a total of 1,109 observations over the two breeds. As the non-receptive intervals were actually much longer than the duration of the average oestrous period, one is hardly justified in suggesting that these two instances were in the nature of a " split " oestrus.

Discussion.

Actual measurements during this study and careful observation over a period of four years, have revealed that, over long periods before the stage of puberty is attained, the vulva will swell and assume a condition identical to that of oestrus. This condition may continue without interruption for as long as two months, but a heavily swollen state at times again changes over to the shrivelled, contracted condition, generally found at the middle of the oestrous cycle. This is especially noticeable in the Large White breed, in which the hightened colour, assumed by the labia during periods of increase in size of the vulva, is very obvious. There is no evidence of any rhythm in these pre-pubertal changes of the vulva. This phenomenon is very probably associated with evolutionary and involutionary conditions in the follicles of the sexually immature gilt, by which the level of oestrin in the blood rises and falls in sympathy.

Once the gilt has reached the stage during which oestrus is exhibited regularly, rhythmic pro-oestrous swellings, followed by metoestrous contractions of the vulva, become normal phenomena. The results have shown that the experienced observer can, from the condition of the vulva, predict the time of the oncoming oestrus with a great measure of confidence by assuming, on the average, that oestrus will be due on the fourth day after the first positive indications of swelling have appeared. Normality in the condition of the labia, after the cessation of oestrus, is reached gradually over a mean period of 3·4 days.

The mean interval of 3·3 days preceding the onset of oestrus, when measurable increases in the size of the vulva can be expected to commence, differ greatly from that of 9 to 10 days as reported by McKenzie and Miller (1936). Only 5 instances, out of a total of 25, were recorded in which this interval exceeded 5 days. Subsidence occupies almost exactly the same period of time (3·4 days) as the pre-oestrous swelling period. The Large Black and Large White breeds of pigs, therefore, differ considerably from the American Spotted Poland-China breed, which served as material for these two authors. However, the general statements by McKenzie (1926) and McKenzie and Marshall (1912), that swelling precedes oestrus by 2 to 3 days, agree very closely with the average interval of 3·3 days as revealed by this study.

The onset of oestrus is, in the majority of instances, gradual and not sudden, although 12·1 per cent. and 9·6 per cent. of cases, in Large Blacks and Large Whites respectively, came in oestrus suddenly. Over the two breeds the pro-oestrous interval lasts, on an average, 13·8 hours and the waning of oestrus 9·8 hours. Whereas in the Large Black breed no females were recorded as having gone out of oestrus suddenly, 4 females, or 1·5 per cent. of the total, in the Large White breed showed a sudden termination of oestrus. During the testing for oestrus, it was customary for the attendant to assume that oestrus would be due at about the third to the fourth three-hourly reading after the first signs of interest in the boar, that is, in about 9 to 12 hours. No significant breed differences in respect of either period could be demonstrated and, although Large Blacks show greater extremes for both pro-oestrus and metoestrus, the data reveal that only a small fraction of the population is involved. No relevant literature on these phases of the cycle could be traced.

A study of the literature reveals the fact that, in the vast majority of instances, there is no evidence that any attempt has been made by authors to determine the duration of oestrus in the sow with any degree of exactness, in fact this interval is almost invariably referred to in terms of "days". The only exceptions would appear to be McKenzie and Miller (1930 *a*) and McKenzie (1932), who were able to supply data in terms of hours, but with what exactness their readings were taken could not be determined from the available references. Only in exceptional instances were breeds specified by the various authors, the general impression conveyed by the literature being that all breeds of pigs react similarly with regard to the duration of the oestrous period. In no single instance could reference be traced in respect of the duration of oestrus in the Large Black or White sow. Comparative studies on breeds do not appear to exist.

Oestrus in the pig could be classified into four distinct types. As the gilt is ordinarily bred at an early age, she rarely experiences more than one to three oestrous cycles before being mated. Hence any oestrous period occurring either at puberty, or those immediately following, may be suitably termed gilt oestrus. The exhibition of oestrus, immediately following parturition and weaning, is a very regular occurrence and these two types are commonly referred to as "post-partum" and "postweaning" oestrus respectively. A fourth type, namely that occurring during the "dry" period in the life of the sow, may be termed the mature or sow oestrus, the latter designation having been adopted in these discussions.

This study has shown that breeds do differ greatly with regard to certain aspects of the ovarian cycle, some of which are certainly unexpected. Breeds differ significantly, not only in respect of the duration of oestrus of the same type, but considerable differences also obtain in respect of the inter-type relationships within the breeds. For instance, the duration of the gilt oestrus in Large Whites is significantly less than in Large Blacks. In Large Blacks the gilt oestrus is highly significantly less than that of the sow, postpartum and postweaning types of oestra, but the latter three types do not differ significantly between themselves. On the other hand, in Large Whites the gilt and sow oestra are similar in duration, but postpartum oestrus is highly significantly longer than all other types, whereas postweaning oestrus is significantly longer than the gilt and sow types only. In the Large White breed, the duration of all types of oestra is significantly less than the corresponding types in the Large Black breeds with the exception of the postpartum oestrus, which is similar to that of the sow, postpartum and post-weaning types in Large Blacks.

McKenzie and Miller's (1930 *a*) finding that the duration of the gilt oestrus is shorter than in the sow, has been confirmed by this study, but only with regard to the Large Black breed, as the results show that this condition does not apply to the Large White breed. These authors apparently used the Hampshire as material, although the available references are not explicit on this point. It should, however, be noted that the difference of about 20 hours between these two types of oestra, as recorded by them, is considerably greater than that of 5·6 hours in the Large Black breed, as established by this investigation. The material differences between the three breeds of pigs under discussion, are therefore apparent.

Struve (1911) mentioned that, as oestrus is often very weakly expressed and may last for no longer than 12 hours in the "Veredeltes Landschwein", its presence is not seldom overlooked in practice. Such a condition could not be confirmed by this study. Out of a total of 697 observations, comprising both breeds and all oestrous types, the minimum oestrous period recorded was afforded by one individual and lasted 15 hours; the second shortest period lasted 24 hours and included three individuals. In view of this and because a low intensity of the expression of oestrus is a rare phenomenon, the chances that an oestrous period will escape unnoticed, must be very small indeed in the Large Black and Large White breeds.

It is impossible to determine from the literature to what extent other breeds of pigs differ with regard to the duration of the oestrous period, but it is clear from the results of this observation that considerable differences could be expected to exist between the numerous breeds in existence in different countries.

The degree of scatter in the duration of the various types of oestra, as measured by the coefficient of variation (Table 30) shows that, in both breeds, the postpartum oestrus is subject to a much greater variability than any of the other types. Although the writer is not in a position to advance a satisfactory physiological explanation for this condition, attention is drawn to the finding, previously discussed, that in the two breeds used in these observations, postpartum oestrus is not associated with mature follicles. The greater degree of variability, as exhibited by this type of oestrus, would seem to indicate greater fluctuations in the level of the follicle-stimulating and estrogenic hormones in circulation immediately after parturition than during any of the other three types of oestra.

The various writers, with very few exceptions, give the length of the oestrous cycle as 21 days, with which the results obtained from this study agree very closely. However, as in almost every other phase of the sexual life of these two breeds, the breed difference for this period is highly significant. It is of interest to note that, whereas the over-all breed mean difference of 18·72 hours (0·78 days) in the length of the cycle is highly significant, the breed mean lengths of the inter-oestrous periods differ insignificantly. Although no attempt has been made to determine whether gilts and sows differ in respect of the length of inter-oestrous period, it should be explained that the greatest majority of observations were derived from gilts. The mean duration of the gilt oestrus in Large Blacks is 14·97 hours longer than in Large Whites and 19·28 hours longer in the case of the sow oestra. It would therefore appear that the difference in the length of the cycle and of oestrus between the two breeds are similar. The insignificant breed differences, in respect of the length of inter-oestrus, should in all probability be ascribed to the above condition. The data would seem to indicate that if breeds differ with regard to the length of the oestrous cycle, they will also differ similarly in the duration of the oestrous period.

The results have shown that, within the breeds, no correlation obtains between the duration of oestrus and the length of the subsequent cycle. This condition in the pig is therefore similar to that in the ewe (Grant, 1933), but differs from that in the cow and mare, in which latter two species Hammond (1937, 1940) has shown that such correlation does exist.

Unlike many other species of mammals, the pig not only has no anoestrus, or seasonal periods of sexual activity and quiescence, but the regularity of the oestrous cycle is very striking. Experimental animals in these studies were kept under close and continuous observation and, as expression of the oestrous state in the pig is invariably very conspicuous and easily detected, the probability that females in oestrus could have been overlooked must have been very small. As these observations were conducted over a period of about five years, any probable seasonal changes in sexual activity should have been revealed, but such could not be established. Even the occasional non-appearance of oestrus in an otherwise regular series of cycles, producing the socalled " silent " oestrus, was very sporadic. As only about 1 per cent. of oestrous cycles were found to be less than 17 days in length, only those cycles exceeding 34 days were regarded as including a " silent " oestrus. Examination of 937 oestrous cycles in both breeds revealed only 14, or 1·49 per cent., of cases which could be considered as double the ordinary cycle length. The range was 39 to 50 days. The assumption, as advanced by Krallinger (1937), that cycles longer than 27 days should be regarded as including a number of " silent " oestrous periods, does not seem to hold good for these two breeds. It would be reasonably safe to assume that only cycles exceeding 34 days in length would include one or more " silent " oestra. Furthermore, the condition in the " Swiss country pig ", as revealed by Küpfer (1928), namely that the oestrous cycle tends to become irregular, certainly does not apply to the Large Black and Large White breeds. Hence, any interruption in the regular chronological sequence of the ovarian cycle in these two breeds must be considered rare.

The presence, in the pig, of the condition known as " split " oestrus in the mare, could not be demonstrated.

Definite information on the interval elapsing between parturition and the reappearance of oestrus could not be obtained from the references. The majority of writers either ignore this period or make indefinite references to it. Asdell (1938) claimed that oestrus reappears 3 to 5 days after parturition, whereas Kronacher (1927), Dettweiler (1924) and Marshall and Hammond (1937) gave this period as 6 to 8 weeks. Experimental evidence on which these statements were based could not be traced. The present investigation has shown that the reappearance of oestrus soon after farrowing is most regular. Observations on 88 sows, including both breeds, have revealed only three sows which failed to show the usual postpartum oestrus. Although the data show that, with regard to the interval parturition-postpartum oestrus, the mean for Large Blacks does not differ significantly from that for Large Whites, it must be explained that in the latter breed the mean is probably not truly representative, due to the much smaller number of observations. While the position with regard to other breeds of pigs is obscure, it is of interest that the only two Tamworth sows available for study failed to show postpartum oestrus. They were full sisters. Was this condition due to a breed effect or merely to individual variation?

The observations on the morphological changes of the ovary have shown that, in the two breeds of pigs used in the blood-lines available for study, postpartum oestrus occurs in the absence of mature follicles and ovulation. This type of oestrus is, therefore, sterile. On the other hand, the Russian worker

Maslov (1938), using a Large White herd as material, demonstrated the practical possibility of raising three litters from a sow in one year. In addition, he obtained increasing fecundity in successive litters, where the sows were managed so as to show increase in weight, and a decreasing fertility in those experiencing a decrease in weight. This supports Marshall and Hammond's (1937) and McKenzie's (1928) advice that, if the sow is mated during the nursing period, she should be well fed. Further colour is lent to the possibility of such a policy by a report in the British journal, "Farmer and Stock Breeder" (1940) of a sow (breed unspecified) which, within one year, gave birth to three litters of 8, 13 and 17 piglets each. A full report of Maslov's work is unprocurable and the above quoted information is based on a "Review" abstract, so that details are unknown. It is therefore not clear as to whether oestrus was induced by partial separation according to the standard plan or whether it occurred spontaneously. However, as gestation in the pig lasts almost four months, it is obvious that his sows must have experienced fertile oestra within a week after farrowing to make three litters within a year possible. By implication this means that, according to the sexual history of this breed as revealed by the present study, Maslov's sows must have been fertile during their postpartum oestra. The report of Maslov's work inspired the writer to test the practical possibilities on the available material, because, if feasible, the results would be far-reaching and may revolutionise pig-production. In consequence a number of sows were mated at postpartum oestrus. After thirteen consecutive negative services were obtained it was decided to investigate the cause of this sterile condition. Examination of the ovary showed that ovulation had not occurred at postpartum oestrus, as reported above.

It is extremely difficult to explain why such fundamental differences should exist, especially with regard to the Large White breed, which served as material both in Russia and here. It may be assumed that the particular blood-lines, used in the present investigations, did not possess the inheritance for the maturation of ova during postpartum oestrus and for the disposition for the easy induction of oestrus through partial separation of dam and litter. To a certain extent this may be granted, but this is far too improbable in view of the fact that similar conditions were obtained in both experimental breeds. Even the Tamworth revealed the same tendency with regard to oestrus during the nursing period. A far more probable explanation would appear to be offered by differences in reactions under widely different environmental conditions of temperatures, humidity, altitude, light intensities, nutrition, etc., between the Northern latitudes and South Africa.

All writers, either by direct statement or by implication, seem to be unanimous that the nursing sow rarely shows sexual activity. This is well supported by the results of this investigation, because only 4 out of 75 nursing sows showed oestrus during that period. In three of these four sows the periodicity of oestrus, subsequent to the postpartum oestrus, could be considered in the nature of the usual three-weekly cycle. It would therefore seem that, if a sow does again come in oestrus after her postpartum oestrus, the tendency would be for the normal cycle to reappear in spite of the inhibitory influence of suckling. As these exceptions occurred in both breeds, the condition is most probably due to individual genetic variation.

Disturbance in the rhythm of the cycle, in the normally cyclic rat and mouse, through mechanical stimulation of the nipple, has been proved by Selye and McKeown (1934 *a*, 1934 *b*). The same authors (1934 *c*) and Long and Evans (1922) have shown that, in the rat, delayed nursing inhibits oestrus. The former authors went to the extent of replacing litters daily with younger and actively

suckling litters. Although only two Large Black sows were tested, the same condition would appear to hold good for the pig, even without the stimulus of vigorous suckling. In one sow oestrus reappeared after a period of 128 days postpartum and after 87 days in the other. In both cases it was obvious that the litters had almost lost interest in their dams, as they were seen to suckle only very occasionally. Although the two factors of suckling and lactation could not be dissociated, it would appear that stimulation of the nipple through suckling was the chief cause for the non-appearance of oestrus. Such a deduction would seem to be supported by the finding that mere mechanical stimulation of the nipple in the non-lactating rat disturbs the normal cycle rhythm (Selye and McKeown). A state of continuous dioestrus cannot, however, be maintained. The results obtained with these two sows therefore support the conclusion of Long and Evans (1922), namely, that if the nursing period is unduly protracted, oestrus will ultimately occur spontaneously.

A sequel to the foregoing discussion is the question of the induction of oestrus during the nursing period. Textbooks on pigs as a rule recommend that the repeated separation of dam and litter overnight will induce oestrus in the nursing sow. Marshall and Hammond (1937) wrote that separation during the night or part of the day, together with good feeding, will produce oestrus. It is exceedingly difficult to account for such a conviction, so universally advocated, but unsupported by experimental evidence. It is, of course, conceivable that the breeds of pigs on which this experience is based differ fundamentally in this respect from those used in these observations, or the condition may be due to environic differences. Of eight nursing Large Black and Large White sows, separated nightly between 6 p.m. and 6 a.m. from their litters, only one showed oestrus, 20 days after her postpartum oestrus or after only 4 days of separation. This sow, however, cannot be considered, as she reacted similarly while under full-time nursing on another occasion. The earliest reappearance of oestrus under these conditions was after 64 days of partial separation, the next and only other instance occurring after 75 days. The remaining six sows never exhibited oestrus, even though the nursing periods continued for over 90 days in some cases. Size of litter might possibly have had some influence on the earlier return of oestrus in the two abovementioned sows, as their respective litters numbered only three and one, while the others ranged from five to ten. In view of the non-significant influence of litter size on the return of oestrus, reported below, this supposition seems doubtful. Two Tamworth sows were also available for this study. One was tested after two different farrowings, the other only once. Separation could only be started after considerable intervals had elapsed, as the appearance of postpartum oestrus was awaited but which never occurred. One of these females came in oestrus after 21 days of separation on one occasion and after 6 days on a second occasion, when her normal oestrous cycle seemed to have again set in while nursing. Her full sister, however, never showed oestrus after parturition or during a partial separation interval of 61 days. It is of importance to point out that oestrus reappeared within a few days after weaning in every instance, even though oestrus was never exhibited during partial separation. The results of this observation, though limited in respect of numbers of individuals, definitely lead to the conclusion that the induction of oestrus within a reasonable period, through partial separation of dam and litter, is not a practical proposition, at least not in the Large Black and Large White breeds of pigs. The Tamworth, apparently, shows the same tendency. It is, however, clear that certain individuals vary radically from the normal, but the circumstances indicate very strongly that in these exceptions oestrus would have returned normally during the nursing period in any case, in spite of separation.

The genetic constitution of this character is, of course, unknown, but it should be possible to establish lines, breeding reasonably pure for this trait, if its presence should prove to be desirable under South African conditions.

Postpartum oestrus, as has been demonstrated, is sterile. Although sows were not intentionally mated during occasional oestra, other than that of postpartum, occurring during the nursing interval to test their fertility, the available evidence does show that fertility is apparently normal during such periods. Two sows were unintentionally served by fertile males while under observation in the abovementioned separation trials, when they both conceived. One Large Black sow conceived to a service on the 22nd day of the nursing period and gave birth to a litter of six piglets, two of which were still-born. A Tamworth sow conceived at the 36th day of nursing, giving birth to a litter of seven, two of which were still-born. Marshall and Hammond (1937) and Asdell (1938) claim that, if the nursing sow does show oestrus, she should not be mated. They contend that the concurrent demands from the mammary gland and the embryos on the available nutrition, militate against the successful development of the embryos. This does not appear to have been demonstrated experimentally in the pig. On the contrary, Maslov's work would seem to indicate that pregnancy while nursing need not result in abnormal atrophic conditions of the embryos, so long as she is kept in a growing condition.

It is a matter of common knowledge that the mare and the cow are as a rule again pregnant in the early stages of lactation; why, then, should the sow be incapable of a similar performance? Maslov has demonstrated the practical possibility of such a policy in a convincing manner.

It is usual to recommend one litter every nine months or, at the utmost, two per year. If, therefore, the sow could be managed so as to rear three litters successfully per annum, the practical advantages that would accrue in respect of reduction of maintenance costs, quicker returns and fewer breeding sows, become obvious. Optimum conditions of nutrition and management will of course, have to be provided. The introduction of such a system of breeding in South Africa, judging by the results of this study, is rendered extremely difficult because of the sterility obtaining at postpartum oestrus and because oestrus cannot easily be induced early in the nursing period. The advisability of the production of bloodlines, through selective breeding, in which the abovementioned defects have been eliminated, or the importation of suitable strains, is indicated. Although a measure of genetic variability does appear to exist for the breeder to work on, the latter policy might yield quicker results.

The results of this study show that neither the length of the nursing period, nor the size of the litter reared, nor the loss of weight of the nursing sow, have any bearing on the interval from weaning to postweaning oestrus. These findings therefore disagree with those of certain authors (Krallinger, 1937; Long and Evans, 1922). Krallinger's opinion that the return of oestrus after weaning is more protracted in older sows could not be verified, but his suspicion that the loss of weight of the sow during nursing has no bearing on this interval is fully borne out.

The correlation between the size of the litter and the percentage loss in weight of the sow from parturition to weaning, has been shown to be highly significant. Such appears only natural, considering that a higher milkyield is required from the dam by the larger litter. Data on the milkyield of the sow is available only for the Large Black breed (Bonsma and Oosthuizen, 1935). If the loss of weight of the nursing sow is directly correlated with her milkyield, then, according to

these observations, Large Whites should be much heavier milkers than the Large Blacks, as the mean percentage loss in weight in the former breed is 19·32 and in the latter only 11·07. Within limits, the sow with the larger litter will undoubtedly yield the most milk, but as the average litter size in Large Whites was 6·6 and in the Large Blacks 5·4, this difference alone could hardly have accounted for the much greater loss in weight in the former breed. It would, therefore, seem reasonable to assume that Large Whites, as a breed, are heavier milk producers than Large Blacks. Only six out of 35 Large Black sows, and only one out of 34 Large White sows, reflected increases in body weights over the suckling interval. Except in the case of one Large Black sow, these sows were nursing litters below the average in size.

Anderson (1944) and Bonsma (1945) have shown that, in the cow, the appearance of oestrus showed preference for the early morning hours or hours of night with which finding, however, Bisschop (1945) disagrees. No such preference exists in the pig.

It has been demonstrated in the cow that coitus, allowed at the onset of oestrus, has the effect of decreasing the duration of the oestrus period (Hammond, 1927; Quinlan, 1941). Observations on the sow revealed that coitus, allowed at the zero hour of oestrus, whether fertile or sterile, has no influence on the duration of this sexual phase.

Some Observations on the Sexual Behaviour of the Sow.

Briefly, the condition of the sow during oestrus, as described by various authors, is as follows:—

The wrinkled, dry condition of the labia of dioestrus gradually transforms to a smooth, swollen state. The vestibule is watery and a slight mucous or sanguineous discharge issues from the vulva. The sow is restless, sniffs at the genitals of her pen-mates, will ride others or will be the recipient of such attentions and moves about while grunting in a peculiar fashion. Coitus is readily accepted. During waning oestrus all these phenomena gradually tone down till normality is again reached (Marshall, 1922; McKenzie, 1924; Marshall and Hammond, 1937; Mumford *et al.*, 1926; Corner and Amsbaugh, 1917).

The above conditions have been largely confirmed by close observation over a period of six years. It has, however, to be stated that a sanguineous discharge, mentioned by a number of writers, must be extremely rare. With only a few exceptions over many hundreds of instances it was not noticed among sows under very close observation. The only exceptions were two or three females which showed a very slight discharge. Even the flow of "heat" mucus is very slight and is rarely obvious.

A female not in oestrus evinces a violent aversion to the attentions of the male, as shown by loud grunts and fierce biting to ward him off. Upon entering the pro-oestrous phase, however, her behaviour changes. Restlessness is an unfailing indication of the approach of oestrus. Pro-oestrus, as previously shown, lasts about 14 hours. It was a matter of common practice to locate such females simply by the fact that they either persisted in standing at the grating separating them from the boar's pen, or otherwise by the fact that they almost invariably leave their pens at the slightest disturbance, while their pen-mates continue to sleep. The switching on of the electric lights or sounds arising from the handling of their pen doors, were sufficient to elicit their immediate attention. During this

sexual phase females will, with only rare exceptions, leave their sleeping quarters and await the arrival of the male at the three-hourly testing intervals. Pro-oestrous sows show great interest in the boar, will nose his testicles and his flanks, resort to friendly biting of his ears and will often mount him, but will consistently refuse reciprocation by the male. Boars soon lose interest in such sows, especially if other in-oestrous females are present. Although it is a very common occurrence for sows not in oestrus to "ride" such pro-oestrous pen-mates, they will not tolerate such treatment by the boar. An intensely in-oestrous sow is a very obvious individual and, as a general rule, the probability of overlooking her is very slight. When she enters the oestrous stage proper her interest in the boar is greatly intensified. She exhibits an extraordinary concern as to his whereabouts and wanders about in her pen keeping up a continuous grunt or singing noise. She usually passes through a phase during which, in the presence of the boar, she seems to be completely oblivious of the existence of everything about her and, assuming a stationary attitude, she will become rigid in every limb with her ears cocked. This latter characteristic is an invariable concomitant of the condition of oestrus in the presence of the male. The individual appears to become totally benumbed, being wholly insensible to beatings with the flat strips of heavy leather customarily used to drive the sows about. In fact such females often had to be forcibly carried into their quarters to separate them from the boars, so as to permit the testing of other sows to be proceeded with.

Nothwithstanding the conditions described above as being usually present, decided variations from the normal were often encountered, such as the following. Two Large White sows, Nos. 46 and 48, while in oestrus during the period 9 to 10.11.40, were regularly "teased" by two young and active Large Black boars, towards which they reacted normally. Then, unexpectedly, they both resented all approaches of these males, even refusing "riding" by the attendant. On being check-tested by another cross-bred vasectomised male, they both immediately stood for him even though his "teasing" was rather feeble. Precautions had to be taken to determine whether a sow had entered into or had passed out of oestrus proper, as is shown by the following instance. Large Black gilt No. 31, having shown interest in two test boars for a period of 30 hours without tolerating actual mounting by them, was immediately retested at a certain hour by returning both males to her pen, when she calmly submitted to one of them. When transferred to a third boar for check-testing, she fiercely resented his approaches, but when brought back to the original two boars, she willingly accepted one of them again. Such psychological antagonisms were often encountered, females occasionally revealing a decided aversion to certain males.

It would appear that the condition of oestrus cannot always be conclusively demonstrated, at least not in some individuals, if unexpectedly confronted with a "teaser". It has been observed that certain sows at times evince a temporary "shyness" under such conditions, although decidedly in oestrus. The condition is transient and the aversion quickly wears off. On the other hand, if the boar be permitted to run with the sows, he readily locates the one in pro-oestrus and transfers his attention to her. She, thereby gradually becoming accustomed to the natural and persistent approaches of the boar, yields to him the moment oestrus proper sets in. Periodic "teasing" apparently does not allow the sow to become "acclimatised" to the "atmosphere" of the boar and hence these exceptions. In order to avoid the probability of such conditions arising and to enable the observer to pick out females in pro-oestrus between the regular three-hourly test periods, a grating was installed between the exercising yards of the boar and the sows, as discussed above.

It has been repeatedly demonstrated that the presence of oestrus can be fairly reliably determined through the practice of " riding ", that is, by carefully placing the palms of both hands on the loin of the sow and gently exerting pressure. In the majority of instances the in-oestrous female will cock her ears and calmly submit to the treatment, while the individual not in oestrus strongly objects to such attentions.

A rather unusual type of behaviour was observed in the case of Large White sow No. 23. She farrowed on 13.10.40 and showed postpartum oestrus on 15.10.40. During this particular oestrus she would emerge from her pen every time the boar entered for the regular three-hourly tests and, even without any attention being paid to her by the male, milk would suddenly commence to flow from all teats, covering the floor in pools of milk.

Summary and Conclusions.

1. The " onset " and " disappearance " of oestrus is gradual in the pig. The mean duration of pro-oestrus is 13·47 hours and 14·12 hours, and of metoestrus 10·04 hours and 9·61 hours, in Large Blacks and Large Whites respectively; the mean differences are non-significant. Increases in the size of the vulva commence, on the average, 3·3 days prior to the beginning of oestrus. The mean interval of subsidence after the cessation of oestrus is 3·4 days, the range is 0 to 8 days. Observation yields results comparable with those obtained by actual measurement of the vulva. In the gilt vulvar swellings tend to precede pubertal oestrus for weeks on end.

2. The mean duration, in hours, of oestrus in the gilt, the sow, at postpartum and at postweaning, respectively, are: Large Blacks, 62·57, 68·19, 68·20, 65·05; Large Whites: 47·60, 49·91, 65·42, 57·84. Significances in mean differences are discussed.

3. In Large Blacks the mean length of the oestrous cycle is 21·74 days, S.D. 2·32, the mode 21 days and the range 4 to 33 days; in Large Whites the mean is 20·96 days, S.D. 3·52, the mode 20 days and the range 4 to 31 days. The mean difference is highly significant. No correlation exists between the duration of oestrus and the subsequent cycle.

4. In Large Blacks the mean length of the inter-oestrous period is 19·12 days, S.D. 2·49, the mode 19 days and the range 2 to 30 days; in Large Whites the mean is 19·42 days, S.D. 2·71 days, the mode 18 days and the range 2 to 29 days. The breed mean difference is non-significant.

5. The mean length of the interval from parturition to postpartum oestrus in Large Blacks and Large Whites, respectively, is: 41·31 hours, S.D. 9·44, and 47·59 hours, S.D. 16·42. Size of litter at parturition and length of interval are uncorrelated. Only 3·4 per cent. of sows fail to experience postpartum oestrus. The postpartum oestrus is sterile.

6. In Large Blacks the length of the nursing period and the interval weaning to postweaning oestrus are uncorrelated. Tentative results show that the mean duration of the interval weaning-postweaning oestrus is 16·08 days, S.D. 21·43, for Large Blacks and 7·85 days, S.D. 11·07, for Large Whites. The mean difference is highly significant. The mode for both breeds is 3 days. Size of litter during the nursing period and the return of postweaning oestrus are uncorrelated.

7. The mean percentage loss of weight in the sow over an 8 to 9 weeks' nursing period in Large Blacks is 11·07 lb., S.D. 9·66; in Large Whites 19·32, S.D. 11·68. The latter breed is probably the heavier milker. Size of litter and loss of weight of the sow are highly correlated.

8. Oestrus during the nursing period was recorded in only 4 per cent. of the population. If the nursing period is unduly protracted, oestrus ultimately appears spontaneously. Normally, oestrus cannot be induced through separation overnight of dam and litter.

9. The onset of oestrus does not favour day or night.

10. " Silent " oestrus in the pig is rare, only 1·49 per cent. of cases being recorded as such. " Split " oestrus is absent.

11. Neither sterile nor fertile coitus at zero hour has any influence on the duration of oestrus.

12. The sexual behaviour of the sow is discussed.

PART 4.

VII. Fertility Studies.

Observations on Certain Aspects of Fertility in the Sow, with Special Reference to the Optimum Service Period.

The series of studies to be discussed in this section was undertaken mainly to determine whether an optimum service period obtains for the pig. While this work progressed much interesting data accumulated, which suggested further additional studies. These will be discussed in the subsequent paragraphs.

According to the general plan of this observation, groups of sows were to be mated at different intervals during the oestrous period and then slaughtered at about 26 days of pregnancy, when the number of embryos were to be determined. The study, however, resolved itself into various related aspects, their relevancy becoming apparent if presented as follows:—

1. The number of ova fertilized in each service group.
2. The incidence of atrophy of the embryo occurring at each of the various service intervals as a result of the particular period of mating.
3. The number of successful matings which result from services allowed at the different time intervals.

It is proposed to review, firstly, the literature covering all aspects of the different observations, then to present the data under appropriate headings and, finally, to relate the results of the separate studies in a comprehensive discussion.

Literature.

Haring (1937), by mating sows at different periods during oestrus, concluded that spermatozoa do not remain fertile in the sow for more than 24 hours. Marshall and Hammond claimed that spermatozoan vitality is low in non-vigorous boars and, for such boars, mating should occur shortly before ovulation to ensure fertility. That the life of the male germ cells in the female genital tract in various species of mammals probably never exceeds 48 hours, have been shown by different writers