

From the Department of Obstetrics and Gynaecology, Faculty of Veterinary Medicine, Swedish University of Agricultural Sciences, Uppsala, Sweden.

STUDIES ON THE OESTRUS AND OVARIAN ACTIVITY DURING FIVE SUCCESSIVE OESTROUS CYCLES IN GILTS*

By

Anne-Marie Andersson and Stig Einarsson

ANDERSSON, A.-M. and S. EINARSSON: *Studies on the oestrus and ovarian activity during five successive oestrous cycles in gilts.* Acta vet. scand. 1980, 21, 677—688. — The object of the investigation was to study a number of gilts during their first six heats in respect of duration and external signs of oestrus in relation to ovarian function. The study comprised 11 crossbred gilts (Swedish Landrace × Yorkshire). Heat control was done twice daily and comprised a careful inspection of the vulva and check of the standing reflex with and without a vasectomized boar. The ovaries were inspected after the first, third and fifth heats by laparoscopy. Blood samples for progesterone determination were taken once a week during the whole observation period. The genital organs were examined after slaughter.

All gilts came in heat regularly during the whole period. Reddening and swelling of the vulva were observed during a significantly longer time in the first and second than in the subsequent pro-oestrous periods. The length of oestrus did not vary significantly in successive heats. The duration of the standing reflex was consistently shorter when the heat control was done in the absence of a boar. All gilts had low progesterone values before their first observed heat. The progesterone level in the blood during the five oestrous cycles studied varied in a cyclical pattern. The number of corpora lutea increased from heat 1 to 5.

gilts; successive oestrous cycles; pro-oestrus; oestrus; cycle length; progesterone; ovarian activity.

Crossbred gilts (Swedish Landrace × Swedish Yorkshire) usually have their first heat at about six months of age (*Karl-bom et al.* 1980, to be published).

During the immediately succeeding heats the number of ovulating follicles increases (*Anderson & Melampy* 1972). To

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ensure good fertility, therefore, it is recommended that serving/insemination is done at the earliest at the third heat. It has recently been shown, furthermore, that the uterus is not fully developed until the second heat (*Schnurrbusch & Erices 1979*), which adds further support to this recommendation.

A wide-spread notion among Swedish pig breeders is that, after attainment of sexual maturity, gilts cease to exhibit regular oestrus. Whether this observation is correct or is due to diminishing external oestrous symptoms, possibly in combination with failure to keep a watch on the occurrence of oestrus, is unknown.

The object of this investigation was therefore to study gilts during their first six heats in respect of external signs, duration and interval between heats in relation to ovarian function.

MATERIALS AND METHODS

Twelve crossbred gilts (Swedish Landrace \times Swedish Yorkshire) were purchased at about two months of age (mean weight 22 kg) for use in the present trial. One of them was eliminated after the third heat owing to limb weakness. The others were in a good state of health during the entire period of the trial.

On the arrival at the Department of Obstetrics and Gynaecology the gilts were placed in pens, three per pen, in two stables. In each stable there were one or more boars throughout the period.

The animals were fed according to breeding-stock standards (*Eriksson et al. 1972*). The ration was calculated according to the mean weight per animal in each pen. The gilts were weighed once a week until their first heat, thereafter every 14th day.

The heat control, started when the gilts were four months of age, was performed twice daily (in the morning and late afternoon). It comprised a careful inspection of the vulva in respect of reddening and swelling and a check of the standing reflex with and without a vasectomized boar. If the gilt was standing at just one occasion, the length of oestrus was set to 0.5 day. Standing at two consecutive observations was recorded as 1.0 day and so on.

For determination of the peripheral plasma level of progesterone, blood samples were taken from the gilts once a week during the entire heat control period as from four months of age. They were usually taken from an ear vein and were collected in

heparinized tubes. After centrifugation the plasma was separated and stored in plastic tubes at -20°C until assay. The progesterone content was determined radioimmunologically (Bosu *et al.* 1976).

Five to 12 day after the first, third and fifth heats laparoscopy was performed by the method described by Wildt *et al.* (1973). The ovaries were inspected in respect of macroscopic appearance and number of corpora lutea. The laparoscopy was done under general anaesthesia (pentotal sodium 5 % i.v.).

After the sixth heat (day 6—16 in the oestrous cycle) the gilts were slaughtered and the genital organs removed and examined macroscopically, especially in respect of the morphology of the ovaries. Samples from the uterine mucosa were examined histologically.

Statistical analyses were made by standard methods (Snedecor 1966).

The significance levels are indicated as follows:

$P > 0.05$ not significant ns; $0.05 > P > 0.01$ almost significant *; $0.01 > P > 0.001$ significant **; $P < 0.001$ highly significant ***.

RESULTS

Sexual maturity

The average age of the gilts at their first heat was 188.8 ± 13.48 days (variation 166—204 days), the average weight 108.5 ± 12.18 kg (84—131 kg). The average weights at the times of heats 1—6 are shown in Fig. 1. Sexual maturity occurred penwise. The

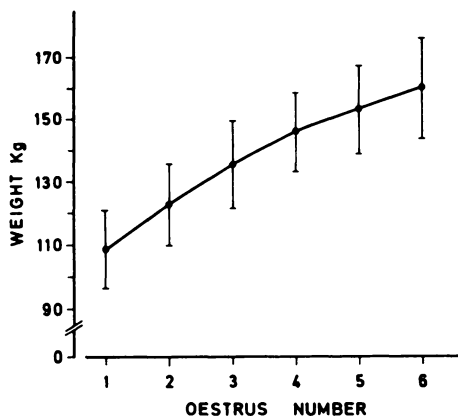


Figure 1. The average weights of the gilts at the times of oestrus 1 to 6.

variation was thus one, four, nine and 12 days, respectively, between individuals in the pens and up to 38 days between all individuals.

Oestrous cycle

The lengths of the five oestrous cycles studied are shown in Table 1. No statistically significant differences were found between the lengths of the various cycles. The average cycle length for individual gilts varied between 18.8 ± 1.51 and 21.3 ± 0.76 days.

Table 1. Length of oestrous cycle (days) from heat 1 to heat 6 in 11 gilts.

Heat:	1—2	2—3	3—4	4—5	5—6
\bar{x}	20.7	20.2	20.8	19.9	20.6
s (x)	0.90	1.19	1.10	1.34	1.43
range	19.5—22.5	18.0—22.0	19.0—22.0	17.0—21.5	19.0—24.0
number	11	11	11	11	11

Pro-oestrus

By pro-oestrus is meant the time during which swelling and/or reddening of the vulva was observed up to the occurrence of standing reflex. The average total duration of pro-oestrus and the time during which swelling and reddening occurred in the six heats are shown in Table 2. Significant differences were found in respect of the lengths of the various pro-oestrous periods (Table 5). Between the second and third pro-oestrous periods there was a significant shortening both of the total pro-oestrus and of the durations of swelling and reddening.

Oestrus

By oestrus, or heat, is meant the time during which the gilts exhibited standing reflex. The occurrence of swelling and reddening (duration) during the whole of this time and the total length of oestrus are shown in Table 3, the results of the statistical analysis in Table 5. No significant difference was found as regards the total length of oestrus (except between heats 3 and 4, $0.01 < P < 0.05$). As regards swelling and reddening significant

Table 2. Duration (days) of pro-oestrus and of individual external pro-oestrous symptoms in 11 gilts during the first six pro-oestrous periods.

	Pro-oestrus 1			Pro-oestrus 2		
	I	II	III	I	II	III
\bar{x}	2.0	1.7	2.0	1.9	1.6	1.9
s (x)	0.67	0.52	0.67	0.74	0.61	0.74
range	1.0—3.0	1.0—2.5	1.0—3.0	0.5—3.0	0.5—2.5	0.5—3.0
number	11	11	11	11	11	11
	Pro-oestrus 3			Pro-oestrus 4		
	I	II	III	I	II	III
\bar{x}	0.8	0.7	0.9	0.7	0.6	1.0
s (x)	0.76	0.56	0.70	0.79	0.54	0.84
range	0.0—2.5	0.0—1.5	0.0—2.5	0.0—2.0	0.0—1.5	0.0—2.5
number	11	11	11	11	11	11
	Pro-oestrus 5			Pro-oestrus 6		
	I	II	III	I	II	III
\bar{x}	0.9	1.0	1.1	1.0	1.0	1.3
s (x)	1.16	0.79	1.05	0.74	0.72	0.68
range	0.0—3.0	0.0—2.0	0.0—3.0	0.0—2.5	0.0—2.0	0.0—2.5
number	11	11	11	11	11	11

I = swelling.

II = reddening.

III = total duration of pro-oestrus.

differences were found in 12 of 18 analyses on comparison of the first and second with subsequent heats. The duration of swelling and reddening was thus longer in the first two heats.

The total length of oestrus shown in Table 3 corresponds to the time the gilts stood to a boar. Table 4 shows, in addition to this time, the time during which the gilts exhibited standing reflex at solely manual heat control, i.e. without the presence of a boar. The duration of the standing reflex at manual heat control varied somewhat between the successive heats, but not significantly. The duration of the standing reflex was consistently shorter, on average, when heat control was done in the absence of a boar.

Table 3. Duration (days) of oestrus and of individual external oestrous symptoms in 11 gilts during the first six heats.

	Heat 1			Heat 2		
	I	II	III	I	II	III
\bar{x}	2.0	1.9	2.0	1.5	1.5	2.1
s (x)	0.45	0.54	0.45	0.84	0.63	0.54
range	1.5—3.0	1.0—3.0	1.5—3.0	0.5—3.0	0.5—2.5	1.5—3.0
number	11	11	11	11	11	11
	Heat 3			Heat 4		
	I	II	III	I	II	III
\bar{x}	1.1	1.2	2.3	0.7	0.6	1.9
s (x)	0.81	0.90	0.47	0.90	0.68	0.77
range	0.0—2.5	0.0—2.5	1.5—3.0	0.0—2.5	0.0—1.5	1.0—3.0
number	11	11	11	11	11	11
	Heat 5			Heat 6		
	I	II	III	I	II	III
\bar{x}	0.5	0.7	1.9	0.7	0.4	1.9
s (x)	0.65	0.85	0.51	0.90	0.55	0.97
range	0.0—1.5	0.2—2.5	1.0—2.5	0.0—3.0	0.0—1.5	(0.5)—3.5
number	11	11	11	11	11	11

I = swelling.

II = reddening.

III = total duration of oestrus.

Table 4. Duration (days) of standing reflex in gilts during six successive heats.

	Heat 1		Heat 2		Heat 3	
	A	B	A	B	A	B
\bar{x}	2.0	1.5	2.1	1.7	2.3	1.8
s (x)	0.45	0.39	0.54	0.51	0.47	0.61
range	1.5—3.0	1.0—2.0	1.5—3.0	1.0—2.0	1.5—3.0	1.0—3.0
number	11	11	11	11	11	11
	Heat 4		Heat 5		Heat 6	
	A	B	A	B	A	B
\bar{x}	1.9	1.5	1.9	1.2	1.9	1.1
s (x)	0.77	0.99	0.51	0.61	0.97	1.14
range	1.0—3.0	0.0—3.0	1.0—2.5	0.5—2.5	(0.5)—3.5	0.0—3.0
number	11	11	11	11	11	11

A = in presence of a vasectomized boar.

B = in absence of a vasectomized boar.

Table 5. Results of statistical analyses of pro-oestrus and oestrus.

Pro-oestrus:	1-2	1-3	1-4	1-5	1-6	2-3	2-4	2-5	2-6	3-4	4-5	5-6
Total duration	ns	**	**	*	*	*	*	ns	*	ns	ns	ns
Swelling	ns	***	***	*	**	**	**	ns	**	ns	ns	ns
Reddening	ns	**	***	*	**	**	**	ns	*	ns	ns	ns
Oestrus:												
Total duration	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	ns	ns
Swelling	ns	*	**	***	**	ns	*	**	ns	ns	ns	ns
Reddening	ns	ns	**	**	***	ns	*	*	***	ns	ns	ns

Progesterone determination

All gilts had low progesterone values before their first observed heat (0—0.75 nmol/l).

Based on the concentrations in individual gilts during the five cycles studied a mean curve for the variation of progesterone during the oestrous cycles was calculated (Fig. 2). The average course for the 11 gilts during each of the five cycles is presented in Fig. 3. From these curves it is seen that the progesterone levels of all animals varied on a cyclical pattern.

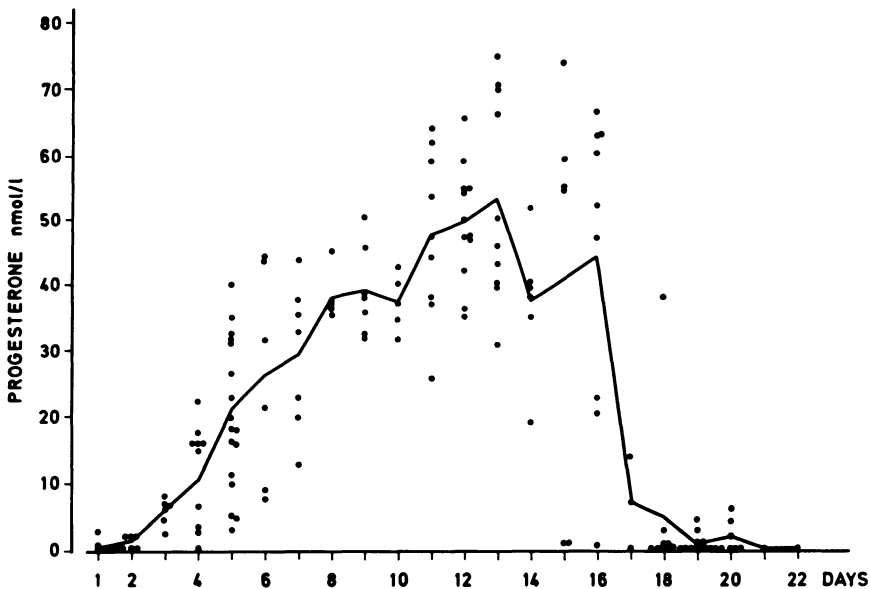


Figure 2. The mean curve for the variation of progesterone during the oestrous cycles.

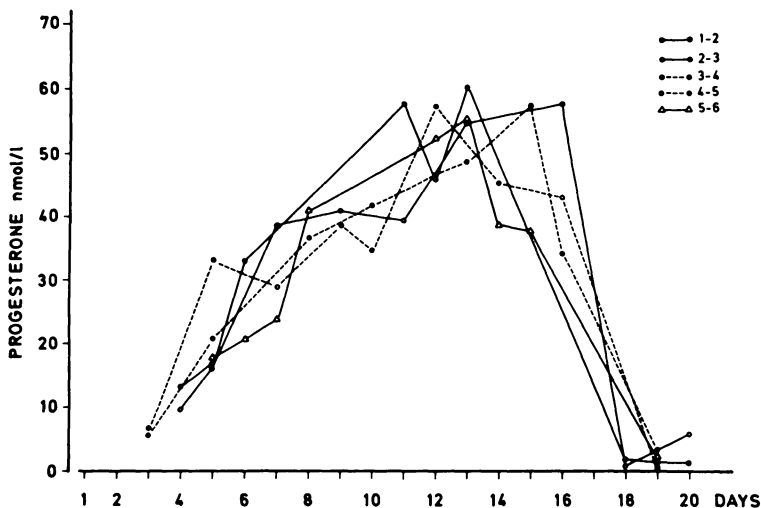


Figure 3. The mean variation of progesterone for the 11 gilts during each of five oestrous cycles.

Laparoscopy

The gilts were examined by laparoscopy after the first, third and fifth heats, the numbers of corpora lutea being noted (Table 6). The average numbers of corpora lutea increased from heat 1 to 3 ($0.01 < P < 0.05$) and from heat 3 to 5 ($0.01 < P < 0.05$).

Table 6. Number of corpora lutea observed on laparoscopic examination of ovaries.

	Oestrous cycle 1	Oestrous cycle 3	Oestrous cycle 5
\bar{x}	9.5	11.1	13.1
s (x)	2.12	1.53	2.18
range	6—13	8—15	10—16
number*	10	10	10

* One gilt excluded owing to problems with anaesthesia.

Post-mortem examination

No pathological abnormalities were found on post-mortem examination of oviducts, uterus, cervix and vulva, nor on histological examination of the uterine wall. The ovaries were particularly examined and the number and appearance of the corpora lutea were noted (Table 7). The number of corpora lutea

Table 7. Results of post-mortem examination of ovaries.

	I	II	III
\bar{x}	12.7	2.5	15.2
s (x)	3.61	3.27	1.94
range	6—18	0—10	12—18
number	11	11	11

I = solid corpora lutea and corpora lutea with cavity < 3 mm.

II = corpora lutea with cavity 3—12 mm.

III = total number of corpora lutea.

with central cavity varied between gilts and averaged 2.5 per animal.

DISCUSSION

In this study the gilts had their first heat at a mean age of 189 days and a mean weight of 109 kg. This is in close conformity with the findings in a recent study of sexual maturity in Swedish crossbred gilts (*Karlbom et al.* 1980, to be published).

The occurrence of sexual maturity was to some extent synchronized within the pens. The reason for this might be the pheromones that a female pig is considered to secrete during pro-oestrus and oestrus and which affect the sexual functions of others in the same pen.

All gilts in this prolonged study had six heats during the period of observation. One of the gilts differed, however, in that she exhibited only very weak external oestrous symptoms at her sixth heat. She stood only sporadically to a boar during half a day on that occasion.

The length of the interval between heats varied from heat to heat both in individual animals and between animals, but was always within the range of physiological variation (17—24 days). The variation in length of the oestrous cycle of individual animals was, however, not significant. The progesterone curves in Figs. 2 and 3 exhibit a similar cyclical pattern for the five oestrous cycles recorded. The progesterone patterns conform closely with those found in earlier studies on Swedish crossbred gilts (*Larsson et al.* 1975, *Karlbom et al.*).

The number of corpora lutea, established by laparoscopy, increased in successive heats (Table 6). This observation is in conformity with earlier studies (e.g. *Anderson & Melampy* 1972, *Brooks & Cole* 1974). The larger number of corpora lutea in

oestrous cycles 3 and 5 did not, however, result in a higher progesterone level during the same cycles (Fig. 3).

All gilts in the present study had regular heats during the entire period of observation. The notion advanced by pig breeders that some gilts have one or at most two oestrous cycles and thereafter pass into anoestrous state (see the introduction) could thus not be verified. As the pig is a poly-oestrous animal, a sexually mature gilt should normally come on heat regularly during an unlimited period provided that she is not pregnant.

The duration of external symptoms in the form of swelling and reddening during pro-oestrus and oestrus became shorter with successive oestrous cycles. The changes were most marked during the pro-oestrus. The average length of the pro-oestrus was about two days in the first and second cycles and one day as from the third. In some gilts no pro-oestrous symptoms at all were observed as from the third oestrous cycle. This phenomenon is not described in the literature. Conceivable causes of the weakened signs of oestrus might be a different endocrine pattern in the blood and/or changed sensibility of the vulval tissue to the hormonal stimulation during pro-oestrus/oestrus.

In the present study the length of the oestrus (the standing reflex) did not vary significantly with the number of the heat (Table 3). On the other hand the average duration of oestrus was consistently rather longer when heat control was done with a boar in direct contact with the gilt. *Willemse & Boender* (1967) also found that the duration of the standing reflex was longer in the presence of a boar. *Signoret & du Mesnil du Buisson* (1961) and *Schenk* (1967) could provoke standing reflex in only 40—48 % of female pigs in the absence of boar stimulus. In the present study there was a boar in the same stable as the gilts during the whole period, which probably contributed to the deviating results.

The relatively large mean number of cystic corpora lutea found in the post-mortem examination was due particularly to two gilts which had more than 50 % cystic corpora lutea. One of these gilts exhibited very weak oestrous symptoms at her sixth heat some days before slaughter. A relation may therefore conceivably exist between the percentage of cystic corpora lutea and the strength of the external oestrous symptoms. The significance of cystic corpora lutea from the fertility aspect, however, still remains to be investigated.

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SAMMANFATTNING

Studier av brunst och äggstocksaktivitet hos gyltor under fem brunst-cykler.

Avsikten med undersökningen var att studera ett antal gyltor under de första brunsterna med avseende på brunstens duration och yttre tecken i relation till äggstocksfunktionen. Undersökningen omfattade 11 gyltor av korsningsras (sv. lantras × yorkshire). Brunst-

kontroll utfördes två gånger dagligen och omfattade noggrann inspektion av blygden samt kontroll av ståreflexen med och utan vasekto-merad galt. Äggstockarna inspekterades efter 1:a, 3:e och 5:e brunst med hjälp av laparoskopi. Blodprov för progesteronbestämning togs en gång per vecka under hela observationsperioden. Könsorganen undersöktes efter slakt.

Alla gyltor visade brunst regelbundet under hela observationsperioden. Rodnad och ansvällning av blygden observerades under signifikant längre tid vid 1:a och 2:a förbrunsterna än vid efterföljande förbrunster. Brunstens längd varierade ej signifikant med stigande brunstnummer. Ståreflexens längd var genomgående kortare då brunstkontrollen utfördes utan medverkan av galt. Samtliga gyltor hade låga progesteronvärden före sin 1:a observerade brunst. Progesteronnivån i blodet varierade under de fem studerade brunstcyklerna enligt ett periodiskt mönster. Antalet corpora lutea ökade från brunst 1 till 5.

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Reprints may be requested from: A.-M. Andersson, the Department of Obstetrics and Gynaecology, Faculty of Veterinary Medicine, Swedish University of Agricultural Sciences, S-750 07 Uppsala, Sweden.