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## PLASMA LEVELS OF PROGESTERONE AND OESTRADIOL-17 $\beta$ IN REINDEER (RANGIFER TARANDUS TARANDUS) DURING PREGNANCY

By

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BLOM, A. K., Ø. V. SJAASTAD and E. JACOBSEN: *Plasma levels of progesterone and oestradiol-17 $\beta$  in reindeer (Rangifer tarandus tarandus) during pregnancy.* Acta vet. scand. 1983, 24, 287—294. — The plasma concentrations of progesterone and oestradiol-17 $\beta$  during pregnancy and the first 20 days after parturition were estimated in reindeer. The concentration of progesterone in the period 75—25 days prior to parturition was significantly higher than in the period 200—75 days prior to parturition ( $P < 0.001$ ). During the last 25 days before parturition the concentration decreased significantly. The concentration of oestradiol-17 $\beta$  was in most cases below 70 pg/ml until 50 days prior to parturition. During the last 25 days of pregnancy there was a significant increase in oestradiol-17 $\beta$  and the ratio progesterone/oestradiol-17 $\beta$  was markedly lower than in the period 75—25 days before calving.

reindeer; gestation; plasma; progesterone;  
oestradiol-17 $\beta$ .

The changes in plasma oestrogens and progesterone during pregnancy and around the time of parturition vary widely between species (see e.g. Bedford *et al.* 1972). Large differences also exist among ruminant species. In ewes, an enormous rise in oestradiol precedes parturition by only a couple of days, whereas in goats and cows there is a steady rise during the last part of pregnancy. At parturition there is a drastic decline in oestradiol in all the above-mentioned ruminants.

Also in plasma progesterone there are large differences between ruminant species as to the time course of changes in the concentration during pregnancy. In cows (Donaldson *et al.* 1970)

and goats (*Thorburn & Schneider 1972*), plasma progesterone, which in these species is of ovarian origin, increases abruptly shortly after mating whereafter it is fairly stable until close to parturition. In sheep, on the other hand, plasma progesterone, which is partly of foeto-placental origin, increases steadily during the last half of pregnancy (*Bassett et al. 1969*). In all these species the fall in plasma progesterone towards parturition takes place at a time with high, or increasing, oestrogen concentrations, a change that facilitates myometrical contractions.

The plasma concentration of progesterone and oestradiol in reindeer during pregnancy was estimated. It was deemed of special interest to study whether the changes around the time of parturition are indicative of the participation of these hormones in the induction of calving.

#### MATERIALS AND METHODS

The plasma concentration of progesterone was measured by the protein-binding technique described by *Johansson (1969)* and slightly modified by *Fylling (1970)*. Oestradiol-17 $\beta$  was estimated by radioimmunoassay as described by *Austad et al. (1976)*. The variability of the values in the present paper is consistently given as the standard deviation (s).

Blood samples from the jugular vein were obtained by using heparinized vacutainer sets. The blood was centrifuged within short time of sampling and the plasma stored at  $-20^{\circ}\text{C}$  until analysed.

#### *Animals and feeding*

**S e r i e s 1.** Five female reindeer, 5–8 years old, were studied. The animals were kept in outdoor pens. Twice a day they were fed pelleted reindeer food (RF 71) with a crude protein concentration of 13.7 % (*Jacobsen & Skjenneberg 1979*) in amounts corresponding to 1.2 feed units/animal/day during the winter period and 1.5 feed units/animal/day from 1 month prior to parturition and onwards. The animals came into heat in the middle of September and were allowed the company of a male from this time onwards. The time of mating was not easily established and the exact date can be given for only 3 of the animals. In these 3 animals mating took place September 19, September 27 and October 18 and the gestation periods were

236, 237 and 226 days, respectively. Blood samples were taken throughout the gestation period at fairly regular intervals, but more frequently around the time of mating and near the time of expected parturition.

**Series 2.** This study was done 1 year earlier than the experiments in Series 1. Fourteen pregnant reindeer, 4–9 years old, were studied. Plasma progesterone was estimated on 3 different occasions during the last 60 days of gestation and on days 1, 5, 10 and 20 after parturition. Plasma oestradiol-17 $\beta$  was estimated in only 8 of the animals. The animals were offered pelleted reindeer food, soya bean meal and lichen in amounts of 1.0–1.4 feed units/animal/day prior to parturition and 1.5–2.1 feed units/animal/day from parturition onwards. In addition, the animals were given a supplement of a commercial mineral mixture.

### RESULTS

**Series 1.** The concentrations of plasma progesterone in the period 240–200 days prior to parturition were significantly higher ( $P < 0.001$ ) than those obtained earlier than 240 days before parturition. In the period 240–75 days prior to parturi-

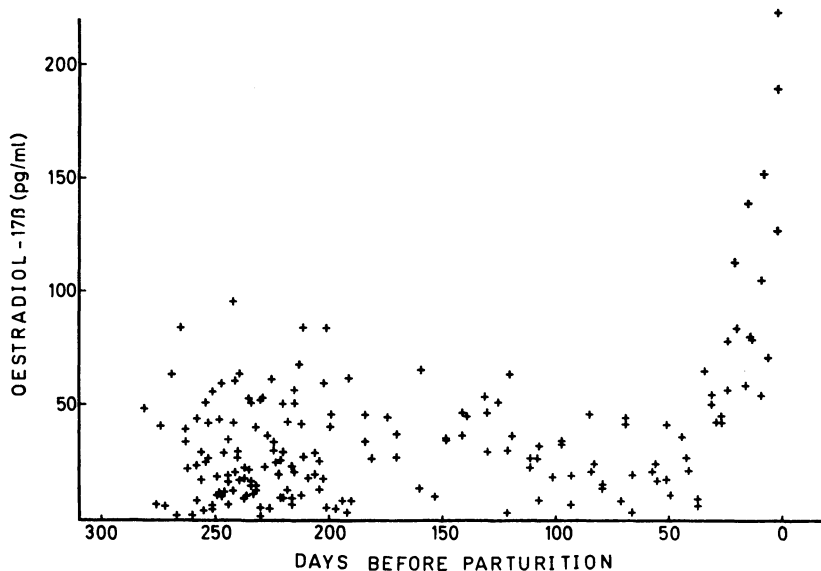


Figure 1. Plasma concentration of progesterone during pregnancy in 5 female reindeer.

Table 1. Differences in the plasma concentrations of progesterone and oestradiol-17 $\beta$  in different periods before and after parturition.

Series No.	Hormone estimated	Time interval (days)	No. of mals anti-	No. of observations	Mean $\pm$ s per ml. plasma	Significance of differences between a) and b)
1.	progesterone	a) 300—240 before part.	5	42	1.8 $\pm$ 1.4 ng/ml	P < 0.001
		b) 240—200 — —		62	4.0 $\pm$ 3.2 —	
	progesterone	a) 50— 25 before part.	5	11	10.9 $\pm$ 5.0 ng/ml	P < 0.001
b) 25— 0 — —		14		5.0 $\pm$ 2.4 —		
	oestradiol	a) 50— 25 before part.	5	12	34 $\pm$ 19 pg/ml	P < 0.001
		b) 25— 0 — —		15	107 $\pm$ 50 —	
2.	progesterone	a) 50— 25 before part.	14	14	9.5 $\pm$ 2.6 ng/ml	P < 0.05
		b) 25— 0 — —		23	7.2 $\pm$ 3.5 —	
	oestradiol	a) 50— 25 before part.	8	6	140 $\pm$ 85 pg/ml	P < 0.05
b) 25— 0 — —		11		236 $\pm$ 76 —		
	progesterone	a) 60— 0 before part.	14	42	7.9 $\pm$ 3.3 ng/ml	P < 0.001
		b) 0— 20 after part.		56	2.2 $\pm$ 2.7 —	
	oestradiol	a) 60— 0 before part.	8	23	171 $\pm$ 94 pg/ml	P < 0.001
		b) 0— 20 after part.		32	50 $\pm$ 38 —	

Values exceeding the standard curve (progesterone > 20 ng/ml, oestradiol-17 $\beta$  > 300 pg/ml) were given the numerical values of 20 ng/ml and 300 pg/ml in the statistical analyses.

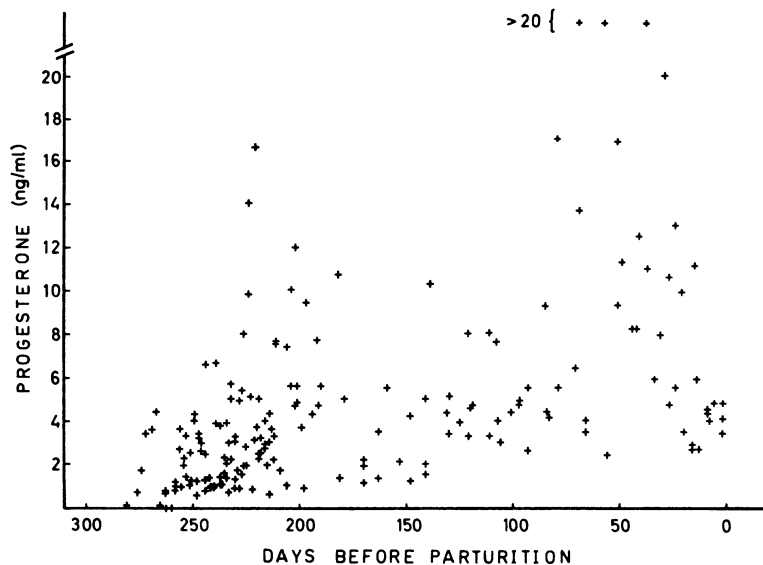


Figure 2. Plasma concentration of oestradiol-17 $\beta$  during pregnancy in 5 female reindeer.

tion no marked changes in plasma progesterone were observed (Fig. 1). The progesterone concentrations in the period 75—25 days were significantly higher than those in the period 200—75 days ( $P < 0.001$ ). During the last 25 days of pregnancy there was a significant decrease in plasma progesterone (Table 1).

The concentration of oestradiol-17 $\beta$  was in most cases below 70 pg/ml until about 50 days before parturition (Fig. 2). During the last part of pregnancy there was a marked increase in plasma oestradiol (Fig. 2, Table 1).

The ratio progesterone/oestradiol-17 $\beta$  was 322 in the period 50—25 and 48 in the period 25—0.

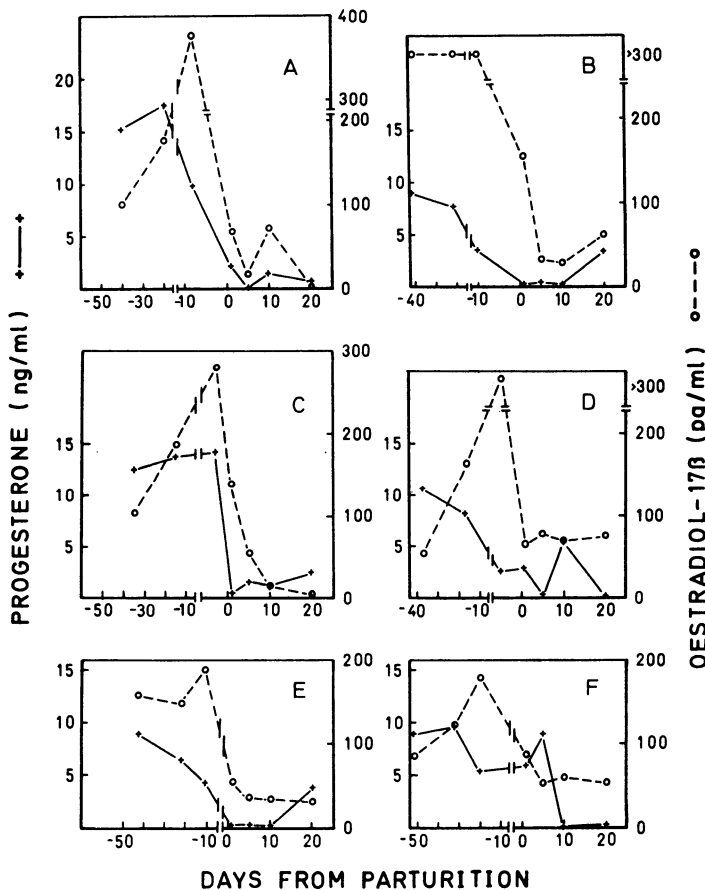


Figure 3. Plasma concentrations of progesterone and oestradiol-17 $\beta$  before and after parturition in 6 female reindeer.

Series 2. The plasma values of progesterone in the last part of pregnancy were higher than those found after parturition (Table 1). The time relationship between parturition and the decrease in plasma progesterone varied considerably between animals (Fig. 3). Occasionally, quite high progesterone values were found after parturition.

The concentrations of plasma oestradiol-17 $\beta$  were generally higher in Series 2 than in Series 1. As in Series 1 there was an increase in plasma oestradiol in the last part of pregnancy. The magnitude as well as the pattern of this increase varied somewhat between animals (Fig. 3). In 1 animal (Fig. 3B) the exact profile of the curve prior to parturition could not be established due to lack of plasma for additional analyses. In all animals there was an abrupt fall in plasma oestradiol-17 $\beta$  close to the time of parturition.

The average ratio progesterone/oestradiol-17 $\beta$  in the period 50—25 in this series was 68 whereas the corresponding figure for the period 25—0 was 30.

#### DISCUSSION

Large differences between species exist as to the concentrations and the time-related changes of plasma progesterone and oestrogens during pregnancy (*Bedford et al.* 1972). In women, the concentrations of plasma progesterone and oestrogens during late pregnancy are about 10 and 100 times higher than the corresponding values in cows. Further, whereas there is a consistent decrease in plasma progesterone prior to parturition in most species this does not seem to be the case in women.

In reindeer, the plasma concentrations of progesterone and oestrogens during pregnancy were found to be of the same order as in cows (*Bedford et al.* 1972) and goats (*Thorburn & Schneider* 1972). Even though ovariectomy was not performed in the present study, the results indicate that plasma progesterone is partly of foeto-placental origin since there was a significant increase in plasma progesterone in the last part of pregnancy. The possibility also exists, however, that increased production takes place in the ovaries during the last part of pregnancy due to development of secondary corpora lutea which in reindeer reach maximal size about 1½ month before parturition (*Leader-Williams & Rosser* 1983). It is also remotely possible that the increase in plasma progesterone is not due to increased production

but to a change in the kinetics of metabolism of the hormone. A marked decrease in metabolic clearance rate during pregnancy due to production of a progesterone-binding protein has been demonstrated in guinea-pigs (*Illingworth et al.* 1970).

Unfortunately, the sampling procedure was too infrequent in the present study to establish the exact time-relationship between the changes in plasma concentration of the estimated hormones and the onset of parturition. Nevertheless, the progesterone-withdrawal theory for induction of parturition is applicable to the results obtained. Furthermore, the rapid increase in plasma oestrogens towards the last part of gestation would represent an important trigger of parturition by stimulation of the myometrical activity. It is noteworthy that in each individual animal, the peak oestrogen concentration was found in the sample taken close to the time before parturition.

The changes in plasma progesterone and oestradiol in red deer have recently been reported (*Kelly et al.* 1982). In contrast to our findings in reindeer, they found that the plasma progesterone as well as oestradiol were equally high in the first part of pregnancy as in the period preceding the prepartal decrease. Because of the relative constancy of progesterone throughout pregnancy and the relationship between the number of corpora lutea and the progesterone concentration, *Kelly et al.* concluded that most, if not all, the progesterone during pregnancy is provided by luteal tissue. Similar conclusions as to the origin of progesterone have been reached also in white-tailed deer (*Plotka et al.* 1982). Although our results are indicative of an extra-ovarial production of progesterone in late pregnancy in reindeer, additional experiments, including ovariectomy, are needed to confirm this.

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#### SAMMENDRAG

##### *Plasma konsentrasjoner av progesteron og østradiol-17 $\beta$ hos reinsdyr (Rangifer tarandus tarandus) under drektighet.*

Plasmakonsentrasjonene av progesteron og østradiol-17 $\beta$  ble undersøkt under drektighet og de første 20 dagene etter kalving hos reinsdyrsimler. Plasmakonsentrasjonen av progesteron i perioden 75—25 dager før kalving var signifikant lavere enn i perioden 200—75 dager før kalving ( $P < 0.001$ ). I de siste 25 dagene før kalving var det en signifikant reduksjon i plasma progesteron. Plasmakonsentrasjonen av østradiol-17 $\beta$  var i de fleste tilfeller under 70 pg/ml inntil 50 dager før kalving. I de siste 25 dager av drektigheten var det en signifikant økning i plasma østradiol-17 $\beta$  og ratio progesteron/østradiol-17 $\beta$  falt markert i forhold til perioden 75—25 dager før kalving.

(Received August 15, 1983).

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