# SYNCHRONISATION OF THE OESTROUS CYCLE IN DEER

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## INTRODUCTION

Currently, there is considerable interest in the controlled breeding of farmed deer namely fallow deer, red deer and Canadian elk or wapiti. The applications lie in the advancement of the breeding season, synchronisation for artificial insemination (AI) and embryo transfer. Several aspects of controlled breeding have been covered at previous Deer Branch Conferences (Asher 1985; Barrell 1985; Fisher and Fennessy 1985, 1987; Fennessy et al 1986; Fennessy and Mackintosh 1988). This paper relates particularly to techniques for the synchronisation of ovulation (and oestrus) in farmed deer.

Oestrous synchronisation is important in AI, allowing insemination at a particular time, and so reducing costs which would be associated with insemination at an observed oestrus. In embryo transfer, synchronisation of the donor and recipient cycles is essential so that embryos are transferred to recipients at the same stage of the oestrous cycle. Synchronisation has also been used to spread the mating load when valuable stags are required to mate large numbers of hinds (Bringans and Lawrence 1988). Similar techniques are used to advance the breeding season (Asher and Macmillan 1986; Fisher et al 1986, 1989; Moore and Cowie 1986; Asher and Smith 1987.)

## BACKGROUND

Fallow deer and the red deer family are short-day breeders, requiring a period of decreasing day length to stimulate their seasonal reproductive cycles in the autumn. In fallow deer, the first oestrus of the season occurs in late April-early May, with the transition from oestrus to anoestrus characterised by the occurrence of one or more silent ovulations (i.e. absence of behavioural oestrus) associated with a short-lived corpus luteum (Asher 1985). The onset of the breeding season occurs earlier in red deer with some evidence for silent ovulations prior to first oestrus (Jopson et al 1990).

The hormonal pattern associated with luteal regression, follicular growth, oestrus and ovulation has been well described in the sheep (Henderson & McNatty 1988) with the initiation of luteolysis also thought to involve oxytocin (see Hunter et al 1989). Prostaglandin F2$\alpha$ from the uterus causes regression of the corpus luteum; during regression of the corpus luteum plasma progesterone concentrations fall and the pulse frequency of LH release from the pituitary increases leading to a steady increase in plasma LH concentration. The rising concentration of LH stimulates an increased production of androgen and oestradiol-17B by the developing ovarian follicle. Ultimately, the rising levels of oestradiol-17B induce oestrous behaviour. It seems likely that the basic patterns are similar in deer, although Asher et al (1986) suggest (based on their own work with fallow deer and a small amount of published data for red deer and white-tailed deer) that the role of oestradiol-17B in stimulating the preovulatory surge of LH and the expression of oestrous behaviour is equivocal. In this

respect, they suggested that although a role for androgens in the expression of oestrus in sheep and cattle is generally discounted, the elevation of serum androstenedione concentrations (which remained elevated for up to 12 hours after the onset of oestrus) may be linked to the occurrence of oestrous behaviour in fallow deer (Asher et al 1986).

**OESTRUS AND OVULATION**

Knowledge of the relative timing of luteal regression (and the decline in progesterone), the onset of oestrus and ovulation is important in defining the most appropriate timing for insemination in AI programmes. In the sheep, oestrus occurs within 48 hours of the initiation of luteolysis (Henderson and McNatty 1988) with ovulation about 24-48 hours after the onset of behavioural oestrus (Boshoff et al 1973; Quirke et al 1979). Although progestagen/gonadotrophin treatment can affect the relative timing of the onset of oestrus and ovulation, there is considerable evidence that the interval between the LH peak and ovulation is relatively constant (eg, 22-26 hours in ewes, Cumming et al 1973).

In red hinds oestrus occurs at about 48-72 hours after progesterone (CIDR) withdrawal, with the LH peak occurring at about 48 hours (M.W. Fisher, I.D. Corson and C. McMahon unpublished data). Assuming the same constant interval between the LH peak and ovulation as with ewes, ovulation would occur at about 72 hours after CIDR withdrawal. There is some evidence that the use of PMSG may advance oestrus relative to progesterone withdrawal.

Recent data (G.W. Asher, M.W. Fisher and J.F. Smith, unpublished data) show that ovulation in fallow deer occurs about 24 hours after the onset of oestrus. In this work oestrus occurred 30-60 hours after progesterone withdrawal or prostaglandin treatment, with oestrus averaging about 12 hours in length (in the absence of mating).

**SYNCHRONISATION METHODS**

There are two basic techniques for synchronizing oestrus and ovulation, both involving a synchronisation of the decline in plasma progesterone levels which is then naturally followed by an increase in LH release which can be expected to result in ovulation.

The two techniques are:

* Synchronisation of the timing of luteal regression by treatment with an analogue of the luteolytic agent, prostaglandin F2$\alpha$ (obviously this technique will be successful only in the presence of a corpus luteum), and

* Treatment of females with a source of exogenous progesterone for a period of time equal to or beyond the lifespan of the natural corpus luteum so that when the progesterone is removed, the plasma concentration of progesterone will fall.

PROSTAGLANDINS

The successful synchronisation of a female deer with prostaglandin is dependent on the presence of a responsive corpus luteum. In this respect, Glover (1985) found that a prostaglandin F2$\alpha$ analogue was luteolytic in Canadian wapiti when administered 11 or more days after ovulation (cycle length of 21 days compared with 18 days in red deer). In contrast, the

corpus luteum of the ewe is responsive from about day 4 of its 17 day oestrous cycle (Gordon 1983). Treatment of the wapiti prior to day 9 was unsuccessful, suggesting that the early corpus luteum is refractory to prostaglandin-induced luteolysis. Practically with a group of unsynchronised females this necessitates a double prostaglandin treatment with injections given 10 days apart to induce luteolysis followed by ovulation. Haigh et al (1988) treated red hinds with double prostaglandins (PG) but only 1 of 13 became pregnant; however 11 of 13 hinds given intravaginal medroxyprogesterone acetate for 7 days with a single PG on day 6 became pregnant to natural mating in the same experiment. Therefore it seems that PG-induced synchronisation was too early in the breeding season or that there was inadequate progesterone priming in the PG-only group. Over 90% of the hinds marked by the stags were marked between 52 and 89 hours after PG treatment. In fallow deer treated with prostaglandin on day 13 of the cycle, oestrus occurred at a mean 43 hours after treatment (500 mg cloprostenol, Estrumate, ICI) (Asher and Thompson 1989).

PROGESTERONE

The objective with exogenous progesterone supply is to inhibit follicular development so that at withdrawal, the drop in progesterone will permit further development leading to ovulation. Therefore, it would seem most appropriate that the plasma pattern of progesterone mimic the patterns of a natural oestrous cycle (Figure 1). Progesterone (CIDR) has been used to successfully synchronise oestrus in both fallow deer (Asher and Thompson 1989) and red deer (McMahon and Fisher unpublished data). In the latter study 23 of 34 red hinds (68%) became pregnant to natural matings within a 32 hour period 46 to 78 hours after CIDR withdrawal. In a previous study (P.F. Fennessy, G.H. Moore and R.P. Littlejohn unpublished data) 59 of 92 red hinds (64%) treated with CIDR/pregnant mare's serum gonadotrophin (PMSG) calved to natural matings with melatonin-treated red stags about 4 to 5 weeks prior to the normal breeding season.

Recent work at Invermay has involved comparisons of progesterone concentrations in ovariectomised hinds given various CIDR treatments. Table 1 and Figure 2 present data for three different types of CIDRs (Jopson et al 1990).

**Table 1** - Plasma progesterone concentrations (ng/ml) over 14 days in ovariectomised hinds with progesterone CIDRs (n = 10 per group).

| | 14 day plasma progesterone | | Final day plasma progesterone | |
|---|---|---|---|---|
| | Mean | Range | Mean | Range |
| Control | 0.30±0.03 | 0.09-0.81 | 0.29±0.11 | 0.02-0.87 |
| 9% CIDR-S | 1.44±0.08 | 0.52-2.49 | 0.73±0.10 | 0.44-1.07 |
| 12% CIDR-S | 1.84±0.09 | 1.00-3.64 | 1.29±0.23 | 0.53-2.22 |
| 12% CIDR-H | 1.60±0.09 | 0.72-3.47 | 0.97±0.19 | 0.43-1.87 |

None of the CIDR devices maintained progesterone concentrations as high as those noted during the natural oestrous cycles (Figure 1). The concentrations on the final day prior to withdrawal were relatively low and variable. In this respect, there could be benefits (i.e. improved synchrony) through using double CIDRs to increase progesterone

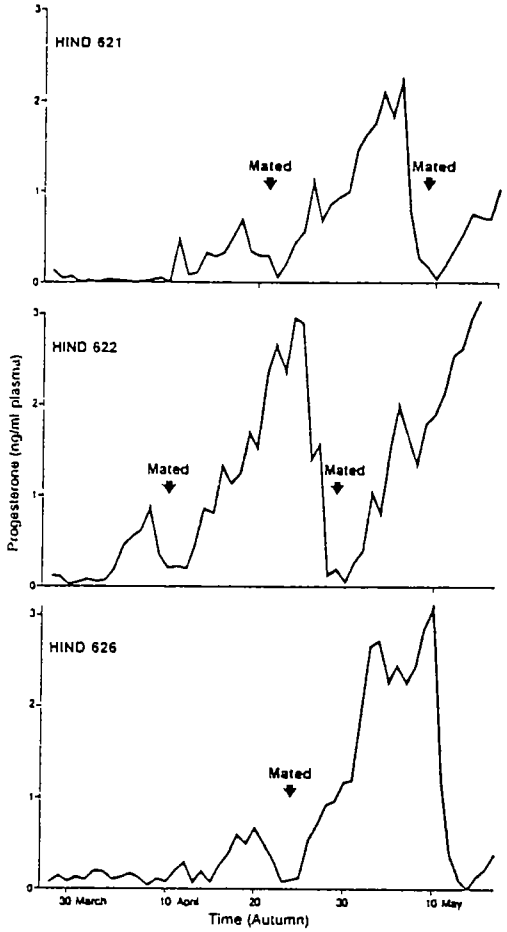


**Fig 1** - Plasma progesterone concentrations in three hinds over the transition from seasonal anoestrus to the normal oestrus cycle (arrow denotes mating by a vasectomised stag).

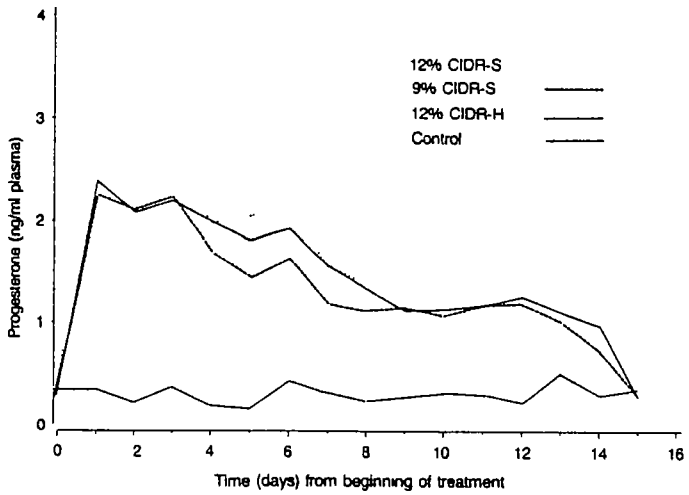


**Fig 2** - Mean plasma progesterone concentrations in ovariectomised hinds with progesterone CIDRs.

concentrations, because preovulatory changes in gonadotrophin secretion could occur in the presence of low progesterone concentrations as can occur in the ewe (Jeffcoate et al 1984). Certainly the progesterone concentrations required to inhibit oestrus and ovulation in the hind are not known. The use of an additional CIDR either by using two devices throughout or alternatively replacing the first CIDR at some stage through the cycle (generally 3 to 5 days before progesterone withdrawal) has been evaluated in AI experiments, but with little apparent effect (Fennessy et al 1987; Fennessy and Mackintosh 1988). However, theoretically maintaining a higher progesterone concentration should be beneficial when a tight synchrony of oestrus is desired.

In reviewing this area of work, Robinson (1982) noted that inadequate progestagen before oestrus and ovulation has a deleterious effect on a number of factors associated with fertility, including the incidence and duration of oestrus, the quantity of follicular oestrogen, the proportion of ova fertilised and embryonic development. As is the case with sheep (Robinson 1954), progesterone priming is necessary for hinds to exhibit behavioural oestrus (Meikle and Fisher unpublished data).

In practice, it is recommended that red hinds be treated with pregnant mares' serum gonadotrophin at progesterone withdrawal (Fennessy et al 1987) for 3 main reasons. The first reason is that in an AI programme, hinds are often inseminated prior to the onset of the normal breeding season, when progesterone/PMSG is known to improve the incidence of ovulation in hinds compared with progesterone alone (Fisher et al 1986). The second major reason is the concern that "stress" may reduce the incidence of ovulation in a group of hinds. In this respect, Bringans (1989) reported that only 50% of red hinds given progesterone alone ovulated compared with 90 - 95% of hinds given progesterone plus PMSG. The third reason for the use of PMSG is that in providing additional FSH- and LH-like activity, it may reduce the spread of ovulation in a group of hinds although in other species the data are equivocal (see Roche et al 1981). A low dose of PMSG (200-250 iu) is recommended so as to minimise the incidence of multiple ovulations. In fallow does, PMSG, even at a low dose of 200 iu, is contraindicated because of the high incidence of multiple ovulations (Asher & Smith 1987) coupled with the fact that progesterone alone has consistently induced ovulation in fallow does in work at Ruakura (Asher unpublished data).

In this paper we have concentrated on the use of progesterone CIDRs although any of the alternative progesterone or synthetic progestagen treatments can be expected to function satisfactorily so long as the plasma progestagen levels are sufficiently high. However CIDRs are readily available, easy to use and have a very high retention rate (in our experience virtually 100% retention).

**SUMMARY**

The principles of the synchronisation of oestrus are simple. As a straightforward practical technique for synchronizing large numbers of hinds, the progesterone CIDR (with PMSG at withdrawal in red hinds) is a highly satisfactory technique. Refinements such as the use of double CIDRs or CIDR replacement to ensure the maintenance of high progesterone concentrations throughout the period of exogenous progesterone are currently being evaluated.

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