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A NOTE ON THE INDUCTION OF OVULATION IN LACTATING RED DEER HINDS PRIOR TO THE BREEDING SEASON

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Methods of inducing ovulation 3 weeks prior to the onset of the breeding season were evaluated in lactating adult red deer. Following 11 days of intravaginal progesterone pre-treatment, hinds were either untreated (control), or given 300 i.u. PMSG i.m. or 500 mg/h GnRH s.c. by osmotic pump. All hinds were laparoscoped 7 days after progesterone withdrawal to record the presence or absence of a corpus luteum on the ovaries. Laparoscopy showed 0/13 control, 11/13 PMSG and 8/13 GnRH-treated hinds ovulated indicating that during lactation, both methods of inducing ovulation are similarly effective. However, although these treatments induced ovulation, fertility as assessed from calving records, was poor.

FARMED red deer normally calve in late spring and early summer (Kelly and Moore, 1977; Hamilton and Blaxter, 1980). Thus, it would be advantageous if breeding could be timed so that calving and the high nutritional demands of lactation coincided with seasonal pasture production. Previously, gonadotrophin-releasing hormone (GnRH) or PMSG have been used following progesterone pre-treatment to induce oestrus and ovulation in pubertal or yearling hinds and in non-lactating adult hinds. These treatments have resulted in the birth of calves during spring, some 3 to 6 weeks earlier than usual (Adam, Moir and Atkinson, 1985; Fisher, Fennessy, Suttie, Corson, Pearse, Davis and Johnstone, 1986; Moore and Cowie, 1986).

Lactation can affect reproductive performance in many species (see Lamming, 1978). In the wild, red deer under poor nutritional conditions either may fail to conceive during lactation and breed only in alternate years, or if conception does occur it may do so later during the breeding season in lactating compared with non-lactating hinds (Mitchell, McCowan and Nicholson, 1976; Clutton-Brock, Guinness and Albon, 1982). Although poor nutrition and lactation can influence fertility (Loudon, McNeilly and Milne, 1983), these effects may be less pronounced in farmed red deer. While Adam *et al.* (1985) reported lactating hinds conceived 16 days later than recently weaned hinds, Hamilton and Blaxter (1980) found no differences in the fertility of hinds lactating or weaned at the time of mating. Similarly, Adams *et al.* (1985) reported that lactation did not affect the induction of ovulation with progesterone and PMSG in anoestrous hinds.

The aim of the present experiment was to compare the efficacy of GnRH and PMSG treatment in inducing ovulation in lactating hinds about 3 weeks prior to the normal onset of the breeding season.

The experiment was conducted over a 2-year period with a total of 39 (19 in year 1 and 20 in year 2; no hind was used in successive years) lactating red deer (*Cervus elaphus*) hinds aged 27 to 28 months at the start of the experiment in each year. At the time of progesterone withdrawal their mean (s.d.) live weight was 89·0 (5·1) kg (87·4 (5·4) kg in year 1 and 90·4 (4·5) kg in year 2). Each suckled a single calf of mean (s.d.) age 87 (12) days and the live weights of calves belonging to each hind group were similar both before and after treatment. The

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combined results for the 2 years are presented unless otherwise stated.

All hinds were pre-treated with intravaginal implants containing 340 mg progesterone (Controlled Internal Drug Release devices, A.H.I. Plastic Moulding Co., Hamilton, NZ) for 11 days beginning on 23 February. At progesterone withdrawal (6 March), hinds were either untreated (control), given a single intramuscular injection of 300 i.u. PMSG (Folligon®, Intervet (Aust.) Pty. Ltd, Australia) or implanted subcutaneously, under local anaesthetic in the neck region immediately below the base of the ear, with an osmotic pump (Alzet®, Alza Corporation, Palo Alto, USA) designed to deliver 500 ng/h GnRH (Sigma Chemical Co., St Louis, USA) for 7 days. The pumps were removed under local anaesthetic 7 days later.

In year 1, the hinds were randomly allocated from within treatment groups to one of two single-sire mating groups of either nine or 10 hinds, for 7 days from the time of progesterone withdrawal until laparoscopy. Following laparoscopy, these hinds were then run with a single stag until the completion of the normal mating season (10 May) at which time the calves were weaned from the hinds. In year 2, no stags were run with the hinds as they were to be utilized in a separate experiment during the normal breeding season.

All hinds were laparoscoped under xylazine (Rompun®, Bayer, NZ Ltd, Pentone, NZ)/ fetanyl citrate plus azaperone (Fentaz®, Smith, Kline and French (NZ) Ltd, Auckland, NZ) anaesthesia to record the presence or absence of a corpus luteum on the ovaries 7 days (13 March) after progesterone withdrawal. Anaesthesia was reversed with yohimbine (Mackintosh and Van Reenen, 1984)/nalorphine hydrobromide (Lethidrone®, Wellcome Foundation, London, UK).

The day of calving in year 1 of the experiment was recorded by observing all hinds daily. Calving corresponding to conception at the induced ovulation was defined as the range in gestation length previously noted at Invermay (227 to 239 days) taken from 2 days after progesterone withdrawal. Calves were tagged 24 h after birth, matched with their dams by observing sucking and weighed on 21 January.

The proportion of hinds ovulating in each group were comparable in each year so the data have been combined and analyses performed using generalized linear models with a logit link and binomial errors (Nelder and Wedderburn, 1972). Analysis of variance was performed on the calving data and linear regression analysis on the calf weights in year 1.

None of the control hinds had a corpus luteum but both PMSG and GnRH treatment resulted in an increase in the proportion

TABLE 1

Number of hinds that had ovulated as recorded at laparoscopy

Group	Year	No.	No. ovulated
Control	1	6	0
	2	7	0
	Combined	13	0
PMSG	1	7	6
	2	6	5
	Combined	13	11
GnRH	1	6	3
	2	7	5
	Combined	13	8

TABLE 2

Calving data for the hinds treated and joined with stags in year 1 of the experiment

Group	No.	No. ovulated at laparoscopy	No. calved to induced ovulation	No. calving overall	Mean calving date	Calving spread
Control	6	0		6	29 Nov	4 Nov to 7 Dec
PMSG	7	6	1	6	20 Nov	26 Oct to 4 Dec
GnRH	6	3	2	5	18 Nov	24 Oct to 7 Dec

(85% and 62% respectively) of hinds ovulating (Table 1), there being no significant difference between PMSG and GnRH treatments. Of the PMSG-treated hinds, eight had single and three had double ovulations whereas all the GnRH-treated hinds that ovulated had single ovulations. The results were similar in both years.

In year 1, few (3/9) treated hinds calved at the time corresponding to conception at the induced ovulation (Table 2). Neither treatment had any significant effect on the proportion of hinds calving to the induced ovulation or calving before 15 November, the onset of the normal calving season. Similarly, treatment did not significantly affect calving dates. Overall 17/19 (90%) of hinds put to the stags calved with no significant differences between groups. Of the 17 calves born, five (three males and two females) were born prior to 15 November (the onset of the normal calving season — Moore and Cowie, 1986) and 12 (four males and eight females) after. Birth weights were not recorded. On 21 January, when aged 45 to 89 days, live weights ranged from 23·0 to 44·5 kg. The earliest born were the heaviest with live weight (LW) related to date of birth by the following equation:

$$LW = 175 - 0{\cdot}439 \times \text{days of the year}; \; r^2 = 0{\cdot}90.$$

Adult red deer at Invermay usually calve in late November given a 233-day gestation period (Kelly and Moore, 1977). Thus, conception would not normally be expected to occur before the end of March. In the present experiment, laparoscopy was performed some 2 weeks earlier (13 March) and, as expected, control hinds had no luteal structures. However, it is interesting that one of the control hinds did calve on 4 November, some 3 weeks earlier than the remaining controls and well in advance of normal calving at Invermay (Moore and Cowie, 1986). At laparoscopy this hind had what appeared to be a recently ruptured follicle and it may be that earlier calving was induced in this animal by association with the stag and/or hinds in oestrus (Iason and Guinness, 1985; Moore and Cowie, 1986). In the present study, progesterone treatment alone did not result in the formation of corpora lutea in any hind unlike the situation in the pubertal hind where ovulations were induced in a small proportion of hinds (Fisher *et al.*, 1986) and this difference is possibly an effect of lactation, reproductive maturity or stage of the season.

Clearly, as previously reported in pubertal and in non-lactating adult hinds (Adam *et al.*, 1985; Fisher *et al.*, 1986; Moore and Cowie, 1986), gonadotrophic stimulation in the form of either PMSG or GnRH is necessary to induce ovulations in lactating hinds prior to the breeding season. This is in agreement with Adam *et al.* (1985) who reported PMSG effectively induced ovulations in both lactating and weaned hinds and with similar studies utilizing progesterone and PMSG or GnRH in non-lactating fallow does (Asher and Macmillan, 1986; Asher and Smith, 1987). PMSG is effective in nearly all hinds but because of the dangers of excessive superovulation (three or more), which have been noted (Adam *et al.*, 1985), as well as inherent variations in responses between batches, a suitable technique utilizing GnRH would be of benefit. Osmotic minipumps are unlikly to gain commercial acceptance as a means of administering GnRH but are of experimental interest. Unlike PMSG, (Fisher *et al.*, 1986) GnRH apparently induces only single ovulations. Although we have no measurements of the effectiveness of GnRH delivered from subcutaneous osmotic pumps in the hind, continuous low-dose GnRH treatment is thought to stimulate the final stages of follicular maturation primarily by inducing an increase in LH concentrations (McNatty, Gibb, Dobson and Thurley, 1981). In comparison, PMSG has both LH- and FSH-like properties (see Papkoff, 1981). As PMSG appears slightly more effective than GnRH this might then reflect a requirement for FSH prior to ovulation in some hinds as has been suggested in the ewe (McLeod and McNeilly, 1987). Alternatively, as the dose rate of 500 ng/h is based on interpolation from work in pubertal hinds where rates between 200 and 800 ng/h were similarly effective in inducing ovulation in a proportion of the hinds (Fisher *et al.*, 1986), it may be that higher dose rates of GnRH are required to induce ovulation in all hinds. The

ovulatory response to low-dose GnRH treatment may be dependent on the follicular status of the animal prior to treatment and this aspect awaits a study of the pattern of follicular growth over the seasonal transition from anoestrus to reproductive competence.

Although treatment readily induced ovulations in most lactating hinds, fertility as assessed from calving records in year 1, was low. This is in agreement with other reports utilizing progesterone and PMSG or GnRH to induce early calving in the red hind (Adam *et al.*, 1985; Fisher *et al.*, 1986; Moore and Cowie, 1986) and the fallow doe (Asher and Macmillan, 1986; Asher and Smith, 1987). In comparison, similar treatments result in near normal fertility in the anoestrous ewe (e.g. Evans and Robinson, 1980; McLeod and Haresign, 1984). As melatonin-induced early breeding in either pubertal, or lactating or non-lactating adult hinds has resulted in apparently normal fertility utilizing melatonin- or photoperiod-treated stags (Webster and Barrell, 1985; Adam, Moir and Atkinson, 1986) it is tempting to suggest the low fertility in year 1 of the present experiment may have been due to the use of untreated stags. This conclusion is further supported by the marked increase in fertility recorded when seasonally advanced (melatonin-treated) stags were used to mate non-lactating hinds treated with progesterone and PMSG prior to the normal breeding season (G. H. Moore, unpublished data).

In terms of calf live weight, the advantages of an earlier birth date were clearly evident in January in the present experiment, on average an extra 0·44 kg for every day born earlier. While these advantages might be expected to diminish with age, in a similar experiment every day a hind calved earlier during the year corresponded to her calf weighing on average 0·3 kg heavier at weaning in March (M. W. Fisher and P. F. Fennessy, unpublished data). Adam and Moir (1987) also reported that earlier born animals had a significant weight advantage at weaning indicating production can be increased by advancing the onset of the breeding and thus calving seasons.

The present results indicate that in lactating farmed red deer, treatment with progesterone and either PMSG or GnRH are effective ways of inducing ovulation prior to the breeding season, but further work is required to improve conception rates at this time.

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REFERENCES

ADAM, C. L. and MOIR, C. E. 1987. A note on the effect of birth date on the performance of suckled red deer calves and their dams on low-ground pasture. *Animal Production* **44:** 330-332.

ADAM, C. L., MOIR, C. E. and ATKINSON, T. 1985. Plasma concentrations of progesterone in female red deer (*Cervus elaphus*) during the breeding season, pregnancy and anoestrus. *Journal of Reproduction and Fertility* **74:** 631-636.

ADAM, C. L., MOIR, C. E. and ATKINSON, T. 1986. Induction of early breeding in red deer (*Cervus elaphus*) by melatonin. *Journal of Reproduction and Fertility* **76:** 569-573.

ASHER, G. W. and MACMILLAN, K. L. 1986. Induction of oestrus and ovulation in anoestrous fallow deer (*Dama dama*) by using progesterone and GnRH treatment. *Journal of Reproduction and Fertility* **78:** 693-697.

ASHER, G. W. and SMITH, J. F. 1987. Induction of oestrus and ovulation in farmed fallow deer (*Dama dama*) by using progesterone and PMSG treatment. *Journal of Reproduction and Fertility* **81:** 113-118.

CLUTTON-BROCK, T. H., GUINNESS, F. E. and ALBON, S. D. 1982. *Red Deer: Behaviour and Ecology of Two Sexes.* University of Chicago Press, Chicago.

EVANS, G. and ROBINSON, T. J. 1980. The control of fertility in sheep: endocrine and ovarian responses to progestagen-PMSG treatment in the breeding season and in anoestrus. *Journal of Agricultural Science, Cambridge* **94:** 69-88.

FISHER, M. W., FENNESSY, P. F., SUTTIE, J. M., CORSON, I. D., PEARSE, A. J. T., DAVIS, G. H. and JOHNSTONE, P. D. 1986. Early induction of ovulation in yearling red deer hinds. *Proceedings of the New Zealand Society of Animal Production* **46:** 171-173.

HAMILTON, W. J. and BLAXTER, K. L. 1980. Reproduction in farmed red deer. 1. Hind and stag fertility. *Journal of Agricultural Science, Cambridge* **95:** 261-273.

IASON, G. R. and GUINNESS, F. E. 1985. Synchrony of oestrus and conception in red deer (*Cervus elaphus* L.). *Animal Behaviour* **33:** 1169-1174.

KELLY, R. W. and MOORE, G. H. 1977. Reproductive performance in farmed red deer. *New Zealand Agricultural Science* **11:** 179-181.

LAMMING, G. E. 1978. Reproduction during lactation. In *Control of Ovulation* (ed. D. B. Crighton, N. B. Haynes, G. R. Foxcroft and G. E. Lamming), pp. 335-353. Butterworths, London.

LOUDON, A. S. I., MCNEILLY, A. S. and MILNE, J. A. 1983. Nutrition and lactational control of fertility in red deer. *Nature, London* **302:** 145-147.

MACKINTOSH, C. G. and VAN REENEN, G. 1984. Comparison of yohimbine, 4-aminopyridine and doxapram antagonism of xylazine sedation in deer (*Cervus elaphus*). *New Zealand Veterinary Journal* **32:** 181-184.

MCLEOD, B. J. and HARESIGN, W. 1984. Induction of fertile oestrus in seasonally anoestrous ewes with low doses of GN-RH. *Animal Reproduction Science* **7:** 413-420.

MCLEOD, B. J. and MCNEILLY, A. S. 1987. Suppression of plasma FSH concentrations with bovine follicular fluid blocks ovulation in GnRH-treated seasonally anoestrous ewes. *Journal of Reproduction and Fertility* **81:** 187-194.

MCNATTY, K. P., GIBB, M., DOBSON, C. and THURLEY, D. C. 1981. Evidence that changes in luteinizing hormone secretion regulate the growth of the preovulatory follicle in the ewe. *Journal of Endocrinology* **90:** 375-389.

MITCHELL, B., MCCOWAN, D. and NICHOLSON, I. A. 1976. Annual cycles of body weight and condition in Scottish red deer, *Cervus elaphus*. *Journal of Zoology, London* **180:** 107-127.

MOORE, G. H. and COWIE, G. M. 1986. Advancement of breeding in non-lactating adult red deer hinds. *Proceedings of the New Zealand Society of Animal Production* **46:** 175-178.

NELDER, J. A. and WEDDERBURN, R. W. M. 1972. Generalized linear models. *Journal of the Royal Statistical Society* **A135:** 370-382.

PAPKOFF, H. 1981. Variations in the properties of equine chorionic gonadotropin. *Theriogenology* **15:** 1-11.

WEBSTER, J. R. and BARRELL, G. K. 1985. Advancement of reproductive activity, seasonal reduction in prolactin secretion and seasonal pelage changes in pubertal red deer hinds (*Cervus elaphus*) subjected to artificially shortened daily photoperiod or daily melatonin treatments. *Journal of Reproduction and Fertility* **73:** 255-260.

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