Effect of season on ovarian and pituitary activity in cows

K. P. McNatty, D. Heath, S. Lun, K. M. Henderson, N. Hudson, M. Gibb, J. McDiarmid, G. W. Montgomery*, D. C. Thurley

Wallaceville Animal Research Centre, Ministry of Agriculture and Fisheries, Upper Hutt

ABSTRACT

The preovulatory follicle in oestrous cycling Angus cows was larger ($P<0.01$) and contained more granulosa cells ($P<0.01$) in May and June than in October. Also in May and June, the corpora lutea were heavier ($P<0.05$) and secreted more progesterone ($P<0.01$) than in October. In contrast, the luteinizing hormone peak frequency and plasma prolactin concentrations were higher ($P<0.01$) in October than in May and June.

Seasonal differences in ovarian activity are probably a direct consequence of seasonal differences in pituitary gonadotrophin secretion.

Keywords: Cows; seasonal influences; ovaries; pituitary hormones; granulosa cells; corpus luteum; LH; progesterone; prolactin

INTRODUCTION

The development of ovarian follicles to ovulation is controlled in part by luteinizing hormone (LH) which originates from the pituitary gland. In New Zealand Romney ewes a reduced frequency of LH secretion is a principal cause of anovulation during seasonal anoestrus (McNatty *et al.*, 1981). In contrast to sheep, cattle may ovulate and breed throughout the year. Nevertheless, it is thought that some seasonal reproductive mechanisms exist in this species. In non-pregnant cows, there is a circa-annual pattern of pituitary prolactin secretion with the highest and lowest concentrations in peripheral plasma being recorded in the summer and winter respectively (Tucker, 1982). Whether oestrous cycling cows experience circa-annual rhythms in LH secretion however, is not known.

In cattle, the dominant (oestrogen-secreting) follicle may vary in diameter from 7 to 18 mm with the respective numbers of granulosa cells [i.e., the precursor corpus luteum (CL) cells] in these follicles varying from 7 to 36 million (McNatty *et al.*, 1984 a). Since granulosa cells do not undergo cell division in the newly-formed CL, the size of the CL and its capacity to secrete progesterone is determined primarily by the size of the preovulatory follicle and its cellular composition before ovulation. Thus, if circa-annual rhythms of LH secretion exist in cattle then one might anticipate some seasonal effects on preovulatory follicular development and CL function.

The purpose of this study was to determine whether such differences in ovarian and pituitary activity occur in oestrous cycling Angus cows (aged 4.7 ± 0.3 y; s.e.m.). Twenty-one animals were ovariectomised in May or June and 12 in October. Four other animals aged 4.3 ± 0.5 y (s.e.m.) were bled weekly throughout the year to establish the circa-annual pattern of prolactin secretion. Details concerning animal management, dating of the oestrous cycle, ovarian microdissection and hormone assays are reported in detail elsewhere (McNatty *et al.*, 1984 b).

RESULTS AND DISCUSSION

Overall, plasma concentrations of LH, LH peak frequency, amplitude and duration did not differ between days -5 and -1 of the oestrous cycle. But, significant time-of-year effects were observed in the pattern of LH secretion. During May and June, mean LH concentration (1.6 ± 0.08 ng/ml), LH peak amplitude (0.7 ± 0.2 ng/ml) and LH peak duration (20.0 ± 4.7 min) (n = 9 animals) were not different from the respective values for October (1.6 ± 0.07 ng/ml, 1.0 ± 0.1 ng/ml and 19.2 ± 2.0 min, n = 11 animals. However, the mean LH peak frequency in May and June (0.6 ± 0.2 peaks per 6 h) was significantly lower ($P<0.01$) than for October (2.8 ± 0.7 peaks/6 h).

The mean ± s.e.m. plasma concentrations (ng/ml) of prolactin in non-pregnant Angus cows for each month from January to December were 142 ± 18, 123 ± 16, 59 ± 19, 53 ± 11, 25 ± 4, 24 ± 4, 63 ± 10, 49 ± 11, 103 ± 45, 124 ± 18, 201 ± 52 and 348 ± 44 respectively. There was a correlation between log prolactin level and mean hours of daylight. ($r = 0.92$, $P<0.01$). There was no effect of the day of the oestrous cycle (day -5 to $+1$) on the mean diameter

* Invermay Agricultural Research Centre, Ministry of Agriculture and Fisheries, Mosgiel.

of the dominant follicle or on its number of granulosa cells during either May and June or October. When data for dominant follicles from days −5 to +1 were pooled there were significant time of year effects on follicular diameter and cell number. For May and June, the respective diameter and granulosa-cell numbers (mean ± s.e.m.) were 11.2 ± 0.5 mm and 11.6 ± 0.9 million whereas for October, the respective values were 8.9 ± 0.05 mm ($P<0.01$ compared to May-June) and 7.6 ± 0.8 million ($P<0.01$ compared to May-June).

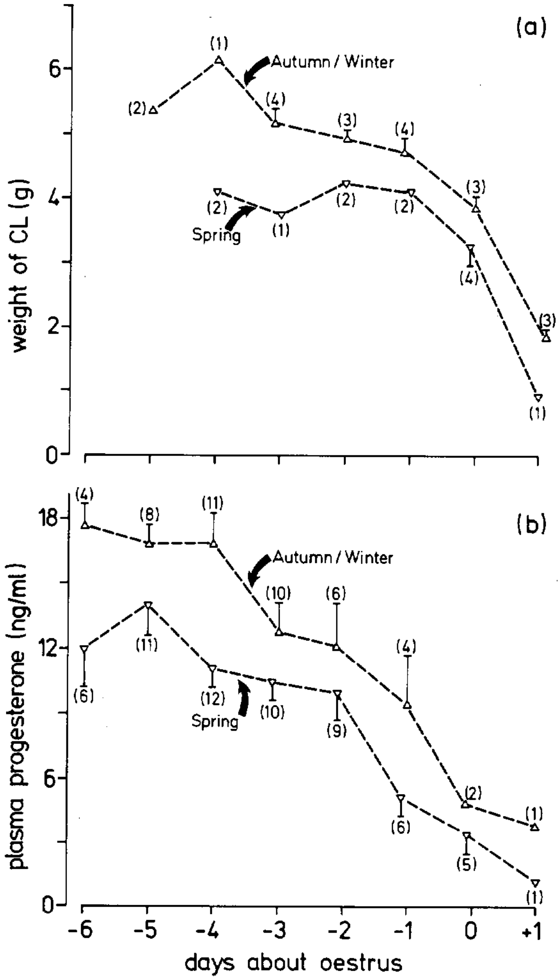

FIG. 1 Changes in the weight of corpora lutea (CL) (Fig. 1a) and the plasma progesterone concentration (Fig. 1b) in cattle cycling during May-June (△——△) or October (▽——▽) on different days of the oestrous cycle relative to the day of oestrus (day 0). Values are means ± s.e.m. and number of CL or animals blood-sampled are in parenthesis (from McNatty *et al.*, 1984 b).

When all data were pooled with respect to the day of the cycle, progesterone concentrations in plasma declined progressively from day −5 to day +1 whereas a decline in luteal weight was only obvious on days 0 and +1 (Fig. 1). CL weights were higher ($P<0.05$) in May-June compared to October. Plasma progesterone concentrations also were higher in May-June ($P<0.01$) compared to October.

Seasonal differences in preovulatory follicular development and CL function have been demonstrated in cattle grazing on open pasture. The nutritional qualities of the pasture available to the animals were not examined so that the significance of this parameter on the effects observed cannot be commented upon. The seasonal differences in LH secretion and ovarian activity occurred at 2 markedly different levels of prolactin secretion. However, in cattle there is insufficient knowledge on the interrelationships between prolactin, LH pulse frequency and/or ovarian activity to infer that the seasonal changes in LH secretion and/or ovarian activity were a direct consequence of seasonal alterations in prolactin secretion. Nevertheless, it seems reasonable to conclude that the seasonal differences in the growth of the preovulatory follicle and size of the CL are a direct consequence of seasonal differences in gonadotrophin secretion.

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