The influence of season on tonic luteinizing hormone (LH) and progesterone levels in cattle in a subtropical environment

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Plasma LH and progesterone levels were measured daily from the sixth to the fifteenth day of the oestrous cycle in Friesland cows during December (summer) of one year, and April/May (autumn), June/July (winter) and September (spring) of the following year. Five to seven cows were sampled per season, and they were subjected to a plane of nutrition designed to maintain body mass throughout the experimental period. Mean tonic LH levels during autumn (2,26 ± 0,07 ng/mℓ) were significantly ($P \leqslant 0{,}01$) higher than those obtained during summer (1,95 ± 0,06 ng/mℓ) and spring (1,94 ± 0,07 ng/mℓ), but not significantly higher than those obtained during winter (2,15 ± 0,07 ng/mℓ). The mean area under the LH curve for cows sampled during autumn was significantly ($P \leqslant 0{,}05$) greater than that for cows sampled during summer and spring. The season did not influence progesterone concentrations. The possible reasons for the seasonal differences in tonic LH secretion are discussed.

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Plasma LH- en progesteroonvlakke is daagliks vanaf die sesde tot die vyftiende dag van die estrussiklus by Frieskoeie gedurende Desember (somer) van een jaar, en April/Mei (herfs), Junie/Julie (winter) en September (lente) van die daaropvolgende jaar gemeet. Vyf tot sewe koeie per seisoen is bestudeer. Die voeding van die diere het min gevarieer oor die eksperimentele periode. Gemiddelde basale LH-vlakke gedurende die herfs (2,26 ± 0,07 ng/mℓ) was betekenisvol ($P \leqslant 0{,}01$) hoër as dié gedurende die somer (1,95 ± 0,06 ng/mℓ) en die lente (1,94 ± 0,07 ng/mℓ), maar nie betekenisvol hoër as dié gedurende die winter (2,15 ± 0,07 ng/mℓ) nie. Die gemiddelde area onder die LH-kurwe vir koeie waarvan monsters gedurende herfs verkry is, was ook betekenisvol ($P \leqslant 0{,}05$) groter as dié vir koeie gedurende die somer en die lente. Seisoen het nie progesteroonvlakke beïnvloed nie. Die moontlike redes vir die seisoensgebonde verskille in basale LH-afskeiding word bespreek.

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Introduction

Evidence has been obtained to support the viewpoint amongst farmers that the season of the year exerts an influence on the reproductive efficiency of cattle. Various authors, including Hillin & Rupel (1960), Labhsetwar, Tyler & Casida (1963) and Gwazdauskas, Wilcox & Thatcher (1975) have reported reduced reproductive performance during the summer months and attributed this effect mainly to temperature. Mercier & Salisbury (1947) and Sweetman (1950) reported lowest reproductive efficiency during the winter period and Bonsma (1951) concluded that conception rates were higher during autumn and spring than during the other seasons. The conflicting and often confusing results relating season to reproductive efficiency in cattle may be due to differences in climatic conditions during studies, and the failure to recognize the level of nutrition as a factor affecting reproductive performance (Terblanche, 1974). Season exerts an influence on the sexual activity of sheep (Hunter, 1962; Watson & Radford, 1966). A knowledge of the influence of season on the reproductive ability of cattle is important to obtain maximum breeding efficiency in the dairy herd and in intensive beef systems, especially in tropical and subtropical regions. It is known for example that excessively high temperatures change the duration of the oestrous cycle, shorten the oestrous period, diminish the intensity of oestrous, and if the heat stress is of a sufficient magnitude, it can induce anoestrus (Fuquay, 1981). The object of this investigation was therefore to study the influence of season on tonic LH and progesterone secretion since the secretory patterns of these two hormones have been related to conception rates in cattle (Carstairs, Morrow & Emery, 1980).

Procedure

The experiment was conducted from December of one year to September of the following year at the Cedara Agricultural Research Station which is situated approximately 1 060 m above sea level, and at latitude 29°32′ and longitude 30°17′. The area receives a mean annual rainfall of 900 mm, mainly during the summer (October – March) months. Summers are hot and winters cold with frequent frost (Figure 1). The area falls within Bioclimatic Group 3, as defined by Phillips (1973).

Minimum and maximum temperatures, relative humidity and daylight length during the course of this experiment were obtained from the meteorological data section at Cedara Agricultural Research Station.

To avoid the confounding effects of lactation and pregnancy on LH and progesterone secretion, a herd of twenty non-lactating and non-pregnant Friesland cows (four to nine years of age) was used in this study. All the cows were cycling normally at the commencement of the experiment. The feeding regime imposed on the herd consisted of natural veld grazing, supplemented with mineral or urea-containing licks from the fifteenth of October to the fifteenth of May and *Eragrostis curvula* hay (fed *ad lib.*) supplemented with a mineral lick from the sixteenth of May to the fourteenth of October. This programme aimed at mass maintenance in the cows, thereby eliminating the influence, if any, of gain or loss in body mass on LH and progesterone secretion. The body mass of the cows was measured at fortnightly intervals throughout the experiment. Blood samples were obtained from a proportion of the cows during each of four sampling periods, i.e. during summer (11 – 24 December), autumn (26 April – 7 May), winter (29 June – 11 July) and spring (8 – 22 September).

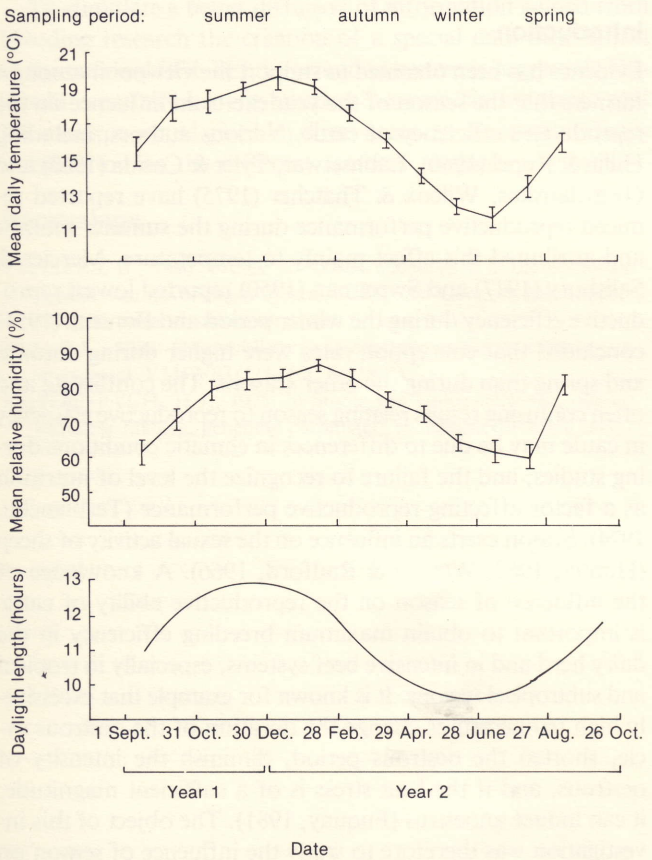

Figure 1 Changes in climatological parameters during the experimental period.

To establish the occurrence of oestrus prior to each sampling period the cows were joined with an active, masculinized teaser cow in the early morning (05h30 – 07h00) and later afternoon (17h00 – 18h30). From days six to fifteen of the oestrous cycle (day of oestrous = day one) blood samples were obtained daily at 07h00 from seven cows during the summer, five cows during the autumn, six cows during the winter and six cows during the spring sampling periods. During each sampling period a different set of cows was drawn from the herd for blood collection, on the basis of them having exhibited heat within a four to five day period. This procedure was adopted to prevent the use of excessively long sampling periods. Certain cows were sampled in more than one sampling period. The blood samples were heparanized and centrifuged within 30 minutes of collection. The plasma obtained was stored at – 15 C° pending analysis.

All plasma samples obtained were analysed for progesterone and LH. The method described by Butcher (1977) was used for progesterone, and the levels were corrected for recovery of tritiated progesterone added to plasma, which varied from 72 to 86 %. Progesterone concentrations were not corrected for water blank values, which varied from 15 to 25 pg/mℓ water. The intra- and inter-assay coefficients of variation for the progesterone level of a poolled plasma sample measured in each of the individual assays were 8,6 and 10,7 % respectively. LH was measured according to the method described by Niswender, Reichert, Midgley & Nalbandov (1969) and validated by Lishman (1972) in this laboratory, except for a few modifications to procedure to attain greater sensitivity. The initial dilution of anti-serum to LH was changed from 1:100 000 to 1:160 000, and the incubation of the anti-LH serum with standards and unknown plasma samples prior to the addition of labelled LH was increased from 24 to 48 hours. The sensitivity was 0,24 ng LH/mℓ plasma. The LH levels in all plasma samples collected in this study were measured in a single assay, thereby eliminating inter-assay variation. The intra assay coefficient of variation was 11,8 %.

Hormone levels, cow masses and meteorological parameters obtained during the four seasons were subjected to analyses of variance. Regression analysis was used to study the relationship between hormone levels and meteorological parameters.

Results

Figure 1 illustrates various climatological parameters measured over the experimental period. Mean daily temperatures during the spring (16,7 ± 0,6°C), summer (17,9 ± 0,3°C) and autumn (16,1 ± 0,7°C) sampling periods did not differ significantly from each other, but were significantly ($P \leqslant 0,05$) higher than the mean temperature during the winter sampling period. The mean daily relative humidity during the spring (78,9 ± 3,4 %), summer (83,0 ± 3,3 %) and autumn (75,6 ± 2,2 %) was also significantly higher than that measured during the winter sampling period (63,9 ± 3,3 %). As expected season exerted a significant ($P \leqslant 0,01$) influence on daylight length (Figure 1). It is evident from Figure 2, in which mass changes in the herd of cows prior to and during the experimental period are presented, that relatively small mass changes occurred, and that these were unrelated to season. The mean masses of the cows sampled during each of the four sampling periods did not differ significantly, and the body mass of cows was not significantly correlated with LH or progesterone levels.

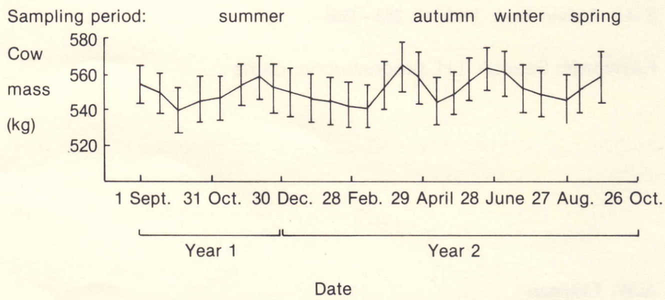

Figure 2 Changes in body mass of cows during the experimental period.

Tonic LH levels measured from day six tot fifteen of the oestrous cycle fluctuated from day to day at relatively low levels (Figure 3). The day of the oestrous cycle did not significantly influence LH levels, although there was a trend for these to decline between days six and fifteen of the cycle, notably during the summer and autumn sampling periods. Mean LH levels obtained over the ten day sampling period during autumn (2,26 ± 0,07 ng/mℓ) were significantly ($P \leqslant 0,01$) higher than those obtained during summer (1,95 ± 0,06 ng/mℓ) and spring (1,94 ± 0,07 ng/mℓ) but not those obtained during winter (2,15 ± 0,07 ng/mℓ). The mean area under the LH curve (an indication of the total quantity of LH released) for autumn (20,1 ± 0,7 mm^2) was also significantly ($P \leqslant 0,05$) greater than the mean for summer (17,7 ± 0,59 mm^2) and spring (17,4 ± 0,64 mm^2). The day of the oestrous cycle significantly ($P \leqslant 0,05$) influenced progesterone secretion, and mean levels on each of days thirteen to sixteen were significantly ($P \leqslant 0,05$) higher than those measured on each of days five to eight of the cycle. It is however evident from Figure 3 that season did not significantly influence the pattern or the total quantity of progesterone secreted.

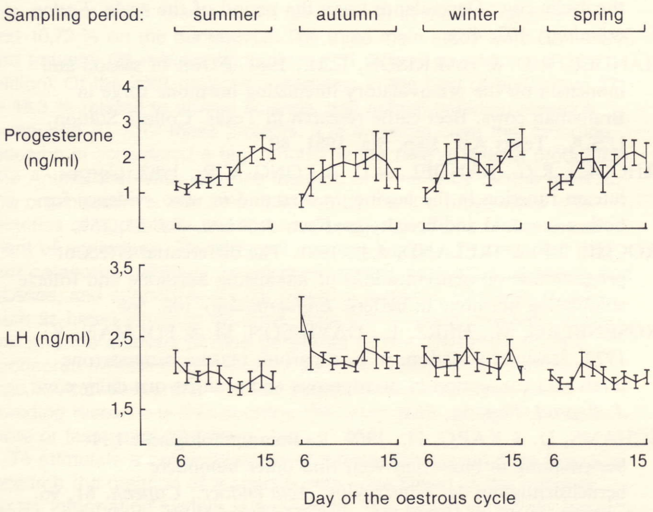

Figure 3 Mean daily tonic LH and progesterone levels in cows during four seasons of the year.

Discussion

The pattern of LH secretion measured during the luteal phase of the oestrous cycle in this study (Figure 3) is similar to that obtained by Sprague, Hopwood, Niswender & Wiltbank (1971), Echternkamp & Hansel (1973) and Arije, Wiltbank & Hopwood (1974), although the magnitude of day to day variations in tonic LH levels in the present study was smaller than that obtained by the aforementioned workers. Schams & Karg (1969) and Hansel & Snook (1970) noted that secondary LH surges, the peak levels of which were significantly higher than normal tonic levels, occurred during the luteal phase of the cycle in certain cows. More frequent sampling than was performed in the present study may be necessary to detect such secondary surges. In the present study the day of the oestrous cycle did not significantly influence tonic LH levels, a finding in agreement with that of Rahe, Owens, Fleeger, Newton & Harms (1980), although these workers found that the frequency and amplitude of individual surges varied significantly during different stages of the luteal phase of the cycle.

Season exerted a significant influence on tonic LH secretion in the present study (Figure 3). To our knowledge no such influence of season on LH secretion has previously been reported, although Randel & Harrison (1981) found that the incidence of pre-ovulatory LH peaks varied amongst five consecutive months of the year, but concluded that this phenomenon was controlled by nutritional factors. Madan & Johnson (1973) have noted that a heat load sufficient to raise the core temperature of heifers by 1 to 1,5°C depressed both tonic and pre-ovulatory peak LH levels. Results obtained in the present study suggest that factors other than temperature and relative humidity might exert an influence on tonic LH secretion. Thus, the correlation coefficient describing the relationship between these climatological parameters and tonic LH levels were not significant, and although autumn tonic levels were significantly higher than those measured during spring and summer, daily temperatures and relative humidities did not differ significantly amongst these seasons. On examining the climatological data presented in Figure 1 together with LH levels illustrated in Figure 3 it appears more likely that the gradual decrease in daylight length which preceded the autumn sampling period resulted in the significantly higher tonic LH levels during this season, as opposed to the lower LH levels measured during spring and summer, the two seasons preceded by an increase in daylight length. Tonic LH levels and daylight length measured over the four seasons were significantly ($P \leqslant 0,01$) correlated ($r = -0,67$). It is a well established fact that a decrease in daylight length results in increased sexual activity in sheep at high latitudes (Hafez, 1952).

Season exerted no influence on progesterone levels measured during the present study (Figure 3), but in view of the considerable animal to animal variation in progesterone levels obtained, a larger sample may be necessary to accurately measure a seasonal effect in cows. Rhodes, Randel & Long (1982) have recently found that corpora lutea removed from cattle during winter have a lessened capacity to release progesterone *in vitro* than those removed during summer. Previous research results relating climate, and notably temperature, to progesterone secretion were somewhat inconsistent. It was observed by Rosenberg, Herz, Davidson & Folman (1977) that progesterone levels were lower during summer than during winter and Stott & Wiersma (1973) found that high environmental temperatures depress progesterone secretion. Conversely Mills, Thatcher, Dunlap & Vincent (1972), Gwazdauskas, Thatcher & Wilox (1973) and Abilay, Johnson & Madan (1975) showed that the stress of a relatively high temperature is associated with increased progesterone secretion. There is clearly a need to accurately establish the influence of temperature on progesterone secretion in different localities, since a positive causal relationship has been established between conception rate and the quantity of progesterone secreted during the oestrous cycle preceeding conception (Folman, Rosenberg, Herz & Davidson, 1973; Rosenberg *et al.,* 1977; Carstaris *et al.,* 1980).

Convey, Beck, Neitzel, Bostwick & Hafs (1977), Roche & Ireland (1981) and Ireland & Roche (1982) obtained evidence indicating that progesterone plays a leading role in the regulation of tonic LH secretion in the cow. In this context it is interesting to note that the inverse relationship between progesterone and LH levels measured in the present study was flexible (Figure 3), and it therefore appears that factors other than progesterone may be involved in the control of tonic LH secretion in cattle.

The finding that season influenced tonic LH secretion under subtropical conditions (present study), and the ability of the corpus luteum to secrete progesterone *in vitro* (Rhodes *et al.,* 1982) points to the need for further research into the influence of season on the secretion of these and other reproductive hormones. Furthermore, it should be established whether seasonal differences in the secretory patterns of these hormones are related to the inherent fertility of cows during different seasons of the year.

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