

## SEASONAL VARIATION IN OESTRUS AND THE SECRETION OF PLASMA PROGESTERONE AND OESTRADIOL -17 $\beta$ IN THE SMALL EAST AFRICAN GOATS

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### SUMMARY

Oestrous cycles were monitored for a period of 9 months (March - November) in normocyclic Small East Africa goats to ascertain the relationship of their ovarian activity and changes in local climatic conditions. Plasma progesterone and oestradiol-17 $\beta$  were assayed in the same goats for a period of 5 months (May - November) using respective radioimmunoassays (RIA'S). Overt oestrus were detected with the aid of teaser bucks. Cyclicity was high and regular from March to the end of June in warm rainy season and decreased thereafter reaching minimum levels in mid-September in the dry cold season. Cyclicity was once again regular from Mid-October and November following the onset of short rains. The hormonal profiles paralleled the changes in the oestrous cycles. The results tentatively suggests that seasonality in ovarian activity do occur in the indigenous goats of East Africa in relation to changes in microclimatic conditions in this part of the tropics.

### INTRODUCTION

Seasonal breeding is a feature of sheep and goats in the temperate countries and is believed to be mediated by fluctuations of the pineal melatonin with changes in day lengths (Legan and Karsch 1980; Arend *et al.* 1983; Bittman *et al.* 1983; Almeida and Lincoln 1984). In the tropics where the day length is fairly constant, many indigenous livestock including sheep and goats have been reported to have regular ovarian cycles throughout the year (Sacker and Trail 1966; Devendra and Burns 1970; Peters *et al.* 1981). However, studies in India (Amble *et al.* 1964; Mishra and Biswas 1966) and Ghana (Devendra and Burns 1970) have reported seasonal ovarian activity in indigenous goats; cyclicity being regular during the rainy seasons when herbage growth is at maxima and decreases during hot dry seasons.

In East Africa, limited reproductive studies have been reported in the normocyclic indigenous goats in relation to changes in climatic conditions (Devendra and Burns 1970; Katongole and Gombe 1985). From the measurements of plasma progesterone and oestradiol - 17 $\beta$  levels in the Ugandan Small East African cyclic goats, Katongole and Gombe (1985) have recently reported that cyclicity is regular in the rainy season (March and April). During the same period the experimental goats were mated and became pregnant. However, decrease in cyclicity occurred after kidding from August up to the end of the year.

This paper presents the changes in oestrous cycles and plasma ovarian hormones in adult normocyclic nonpregnant Small East African goats obtained from Kenya and Tanzania over a period of nine months. The study provides a comprehensive and supporting evidence on the influence of climatic changes on the reproductive performance of the indigenous goats in East Africa.

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## MATERIALS AND METHODS

Twelve normocyclic Small East African goats aged 2-3 years and weighing 18-22 kg were bought from Central Tanzania (four goats) and Central Nyanza, Kenya (eight goats) and transferred to the Reproductive Biology Unit (RBU), Chiromo Campus, University of Nairobi in March, 1984. They were acclimatized for two months during which, were monitored through two oestrous cycles using male teasers with deviated penises to ascertain regularity of oestrous cyclicity. Seven hours of grazing period was provided daily throughout the study period, and at night goats were housed in clean airy pens. Additional supplementation especially during the dry season included hay, ewe pellets (Unga Ltd. Nairobi, Kenya) and mineral licks (Maclick<sup>®</sup>; Welcome Ltd. Kenya). Vit. B<sub>12</sub> (0.5 mg) was given i.m. weekly to offset cobalt deficiency in hay obtained from the Rift Valley of Kenya. Deworming was done at monthly intervals and incidental bacterial infections were treated with antibiotics.

Teaser bucks with deviated penises were used to monitor heat in does throughout the observation period. Does were observed for signs of heat for 30 minutes twice daily, in the morning before being taken to graze and at about 16.00 h after grazing from the pasture. Additional observations were made by trained animal attendants during grazing or any other time they were in contact with the animals.

All experimental goats were bled once (5 ml/goat) every other day between 8.00 to 9.00 h from May up to the end of November except during oestrus when blood samples were collected at six hourly intervals. Blood samples were transferred into EDTA containing polystyrene tubes and centrifuged at 4°C at 1500 g for 30 min. Duplicate one ml aliquots were frozen at -20°C until needed for hormonal

assays. Plasma progesterone and oestradiol -17 $\beta$  were assayed by respective Radioimmunoassays (WHO, 1984/1985) utilizing dextran-coated charcoal for separation of free from antibody bound steroids (O'hara *at al.* 1985; Mutayoba *at al.* 1988). The antisera to progesterone and oestradiol-17 $\beta$ , which were supplied by WHO, were raised against progesterone - 3CMO - BSA and oestradiol - 6CMO - BSA. The <sup>3</sup>H - tracers to both hormones were obtained from Amersham International, England.

The inter- and intraassay coefficient of variations for progesterone and oestradiol-17 $\beta$  assays have recently been reported elsewhere (Mutayoba *at al.* 1988) and varied between 6.5 to 13.2 % and 4 to 7%, respectively. The assay sensitivity at 90% level of confidence was 0.06 nmol/l and 10.3 pmol/l for progesterone and oestradiol assays, respectively. The hormonal values were averaged on a monthly basis for each goat. Peak luteal progesterone levels were averaged from 3 highest values determined in each luteal phase.

The rainfall was recorded on daily basis from the grazing compound at Chiromo using a standard gauge. The ambient temperatures were also recorded every day at around 15.00 h in the afternoon and both parameters were averaged on monthly basis. The hormonal and climatic data were analysed by one-way analysis of variance and Kramer's procedure (Kramer, 1956).

## RESULTS

### Oestrus cycles

Table 1 shows the number of cycling goats and the mean lengths of the oestrous cycles recorded over a period of 9 months beginning from March to the end of the November. Ovarian activity was highest from March to the end of June as all the

**Table 1: The mean lengths of oestrous cycles, luteal progesterone and preovulatory oestradiol-17 $\beta$  levels in goats.**

Approximate period months	Length of cycles (days)	Luteal progesterone (nmol/l)	Preovulatory oestradiol-17 $\beta$ (pmol/l)
March	19.4 $\pm$ 0.3 (10)		
	19.8 $\pm$ 0.4 (10)		
	19.9 $\pm$ 0.5 (12)	21.8 $\pm$ 0.8 <sup>c</sup>	840.8 $\pm$ 25.7 <sup>b</sup>
	20.6 $\pm$ 0.5 (12)	19.2 $\pm$ 0.7 <sup>a b c</sup>	792.8 $\pm$ 17.6 <sup>b</sup>
	21.1 $\pm$ 0.3 (12)	20.0 $\pm$ 0.9 <sup>b c</sup>	797.3 $\pm$ 23.8 <sup>b</sup>
Mid-June	19.9 $\pm$ 0.8 (10)	18.1 $\pm$ 0.9 <sup>a b</sup>	678.1 $\pm$ 57.0 <sup>a</sup>
	20.4 $\pm$ 0.8 (10)	18.5 $\pm$ 1.1 <sup>a b c</sup>	584.4 $\pm$ 33.5 <sup>a</sup>
	21.3 $\pm$ 0.7 (5)	19.3 $\pm$ 1.1 <sup>a b c</sup>	579.5 $\pm$ 19.6 <sup>a</sup>
Mid-August	23.0 $\pm$ 1.0 (2)	16.5 $\pm$ 1.1 <sup>a</sup>	582.5 $\pm$ 10.4 <sup>a</sup>
	0.00 $\pm$ 0.0 (0)	-	-
Mid-October	21.4 $\pm$ 0.5 (8)	16.4 $\pm$ 1.3 <sup>a</sup>	797.4 $\pm$ 32.9 <sup>b</sup>
November	19.4 $\pm$ 0.5 (8)	17.1 $\pm$ 0.9 <sup>a b c</sup>	627.1 $\pm$ 42.3 <sup>a</sup>

Values are Means  $\pm$  SEM

-Number in parenthesis represents cycling goats

-Means with superscripts in the same column do not differ significantly from each other (P < 0.05)

goats were cycling regularly, but this pattern decreased progressively from July and reached minimum levels in mid-September when all goats became anoestrus. No cyclicity was observed thereon until at the onset of short rains in mid-October when 10 out of 12 experimental goats came back on heat. Two of these goats became pregnant. The mean oestrous cycle length of 20.5  $\pm$  0.2 days (n=105) was recorded in these goats.

#### Hormonal levels

Figure 1 shows the mean monthly progesterone and oestradiol - 17 $\beta$  values in individual goats. Table 1 has the mean luteal progesterone and preovulatory oestradiol-17 $\beta$  levels and Figure 2 shows the mean monthly hormonal values of all the goats under study.

#### Plasma progesterone levels

The luteal progesterone values in individual goats ranged between 11.0 and 25.7 nmol/l. These wide ranges accounted for the significant differences in the mean luteal values in different cycles. The effect of season on luteal levels (Table 1, Figure 2) was equivocal as the slight decline in the hormonal values which was observed in September and mid-October during the acyclic period was not significantly different from most of the values observed from March onwards when ovarian activity was high. The progressive acyclic pattern observed in goats from July onwards accounted for the decline (P < 0.001) in individual and group mean monthly progesterone values from a range of 9.1 to 14.3 nmol/l (12.3  $\pm$  0.5 nmol/l) in May to a range of 1.1 to 1.7 nmol/l (1.3  $\pm$  0.1 nmol/l) in September. With the resumption of ovarian cycles in mid-October, the individual and group

values rose again up to a range of 8.2 to 13.2 nmol/l ( $10.1 \pm 0.8$  nmol/l) in eight cycling goats. Two other goats No. D<sub>1</sub> and

D<sub>4</sub> became pregnant and had mean monthly progesterone values of 20.1 and 22.6 nmol/l, respectively.

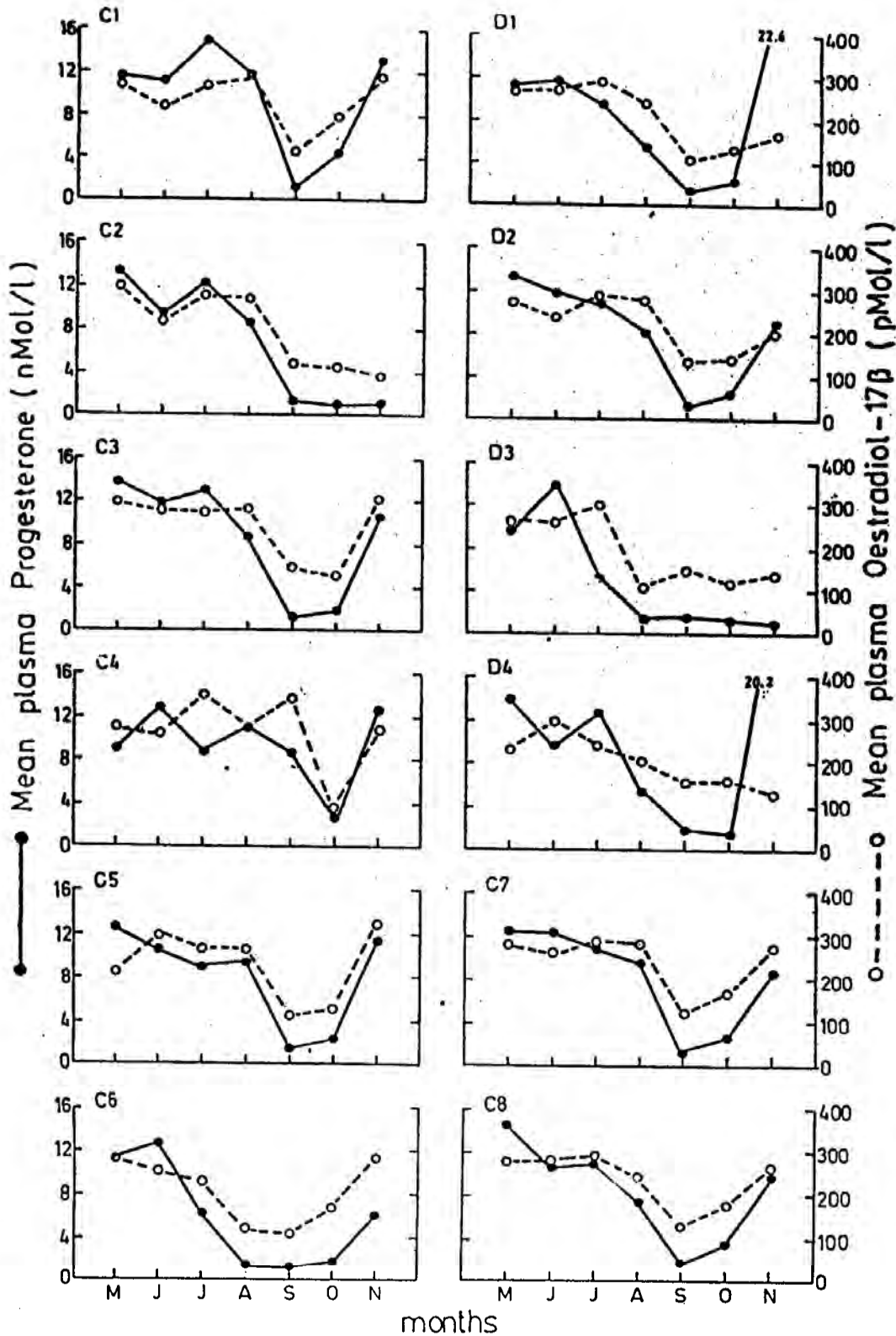


Figure 1: Monthly progesterone and oestradiol-17 $\beta$  levels in individual goats (C1-C8 Kenya goats D1-D4 Tanzanian goats)

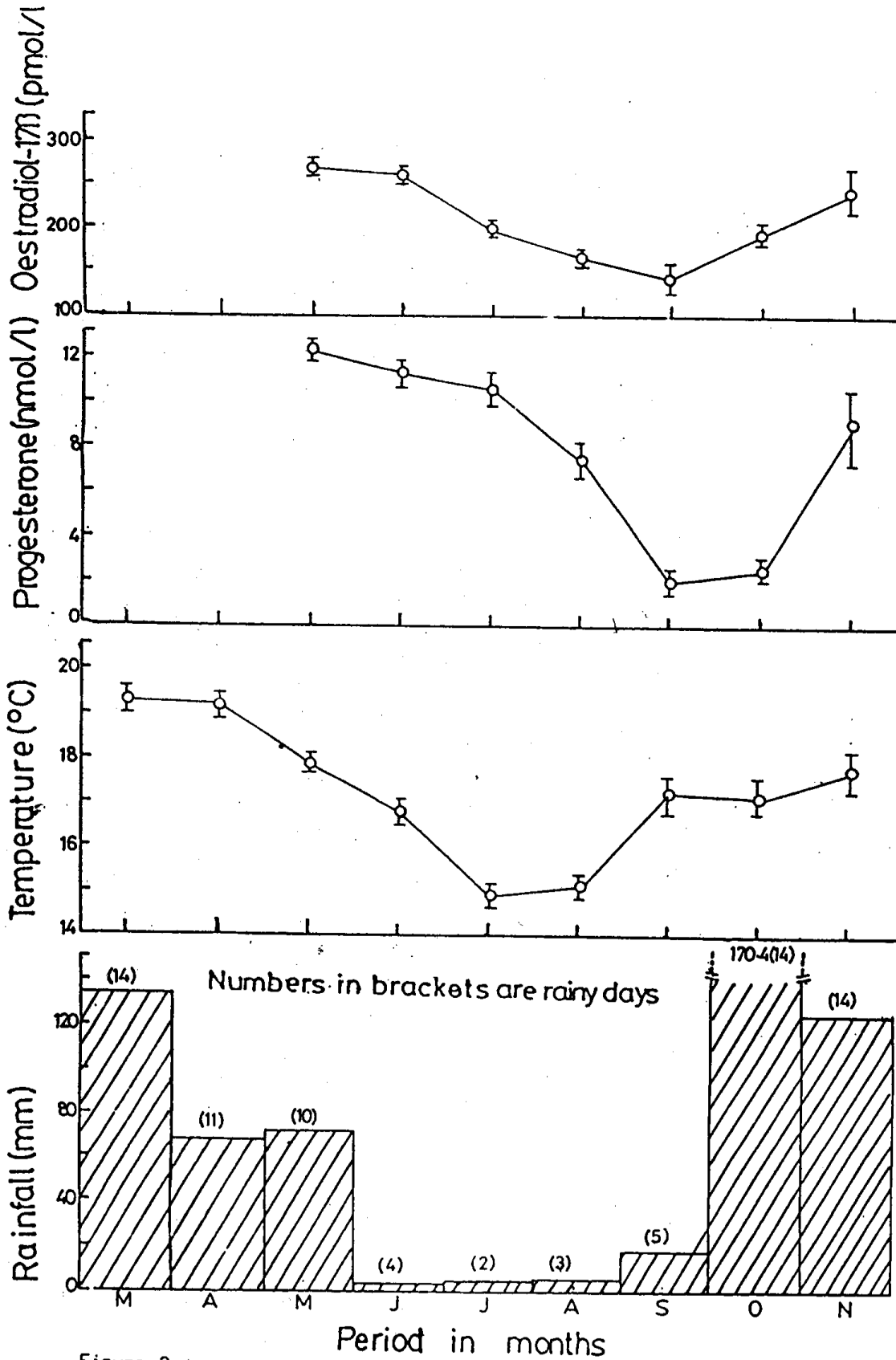


Figure 2

**Figure 2: Variation in the mean monthly (group) hormonal levels with changes in temperature and rainfall patterns.**

### Plasma oestradiol-17 $\beta$ levels

The preovulatory oestradiol -17 $\beta$  levels ranged between 650 and 960 pmol/l from May to Mid-July, and declined to values below 600 pmol/l towards the acyclic period in August and September (Table 1). These changes accounted for the significant decline in the mean preovulatory values from May to September ( $P < 0.001$ ) before picking up again from mid-October. The mean monthly values in individual goats (Figure 1) followed the same pattern as the highest values were obtained from May to the end of July (range 213.6 to 301.1 pmol/l in goat C1 and D3, respectively) and minimum levels in goat D1 (102.6 pmol/l) in September, and in goat C1 (99.0 pmol/l) in October. The corresponding group means (Figure 2) were  $270 \pm 3$  pmol/l in May and  $146.2 \pm 19.3$  pmol/l in September. Plasma oestradiol levels rose again from mid-October and November in the cycling goats but were still low in acyclic and two pregnant goats.

### Meteorological observations

A bimodal type of rainfall was recorded starting from March to mid-May and mid-October to November (Fig. 2). The heaviest rainfall was recorded in March (133.7 mm) and October (170.4 mm) and lowest in June (2.9 mm). Likewise, a cold dry period with occasional daily temperatures falling below 13°C was observed from mid-May to August, whereas, the other months were warm with high ambient temperatures of above 24°C in some days. Progressive decline in the monthly temperatures and rainfall from mid-May were associated with fast decline in the mean monthly oestradiol levels and a slow decline in progesterone levels and both reached lowest levels in September when all goats became acyclic. The rise in ambient temperatures from September was associated with the onset of short rains in mid-October and rise in

the monthly oestradiol levels from October and progesterone in November.

### DISCUSSION

Although the Small East African goat breed has been reported to be regular breeder with ovarian activity occurring throughout the year (Sacker and Trail 1966; Devendra and Burns 1970; Peters *et al.* 1981), the results of the present study, suggest that seasonal ovarian activity occurs in these goats. Ovarian activity was high during the warm rainy period in the months of March and mid-June. Subsequently ovarian activity declined to low levels during the cold dry period in the months of mid-June to mid-October. The activity picked up again in late October and November coinciding with short rains. Changes in ovarian activity could not have been influenced by seasonal changes in feed quality as goats received adequate supplemental feeds throughout the study period.

Although the hormonal levels in the present study are reported as monthly values combining both low and high (preluteal) and high and low (luteal) progesterone and oestradiol, respectively, they do relate well with the changes in climatic factors. The mean monthly progesterone and oestradiol levels were high during the warm rainy months and low during cold dry periods. The oestradiol levels of up to 870 pmol/l obtained during the preovulatory phase were higher than ranges previously reported in goats (Thornburn and Schneider 1972; Mgongo *et al.* 1983) but were closely similar to those recently reported in the Ugandan Small East African goats (Katongole and Gombe 1985). The disparity in the results might be due to difference in assay sensitivity and specificity of the antibody used. The antiserum used in this study was highly specific to Oestradiol-17 $\beta$  and its crossreactivity with analogues was <0.02% for Oestrone, Cortisol,

Testosterone and Progesterone and 0.8% for oestradiol (WHO 1984/85). The levels of progesterone obtained in these goats were comparable to those previously reported in the Small East African goats (Mgongo *et al.* 1983, Katongole and Gombe 1985; O'hara *et al.* 1985) and in other breeds of goats (Thornburn and Schneider 1972; Heap *et al.* 1975; Luckins *et al.* 1986).

Seasonal breeding is a feature of the small ruminants in the temperate countries and is photoperiodically controlled by changes in pineal melatonin (Bittman *et al.* 1983, Almeida and Lincoln 1984). In the tropics, although daylength variations are minimal, other climatic factors like high temperatures, variable amounts of rain and herbage growth might have an influence (Devendra and Burns 1970). The work with breeding ewes have indicated that, the environment which inhibit reproductive activity, produces an enhanced sensitivity of the hypothalamo-pituitary axis to the negative feedback action of the steroids especially to oestradiol (Goodman *et al.* 1981; 1982). During the exposure to inhibitory environments, oestradiol gains the capacity to suppress LH pulse frequency (Goodman *et al.* 1982) possible via the suppression of hypothalamic GnRH release (McLeod *et al.* 1983). Subsequently there is absence of follicles in the final stage of maturation, lack of preovulatory rise in estradiol secretion, LH surge and display of oestrus (Wheeler *et al.* 1977). It was observed in this study that, whereas a precipitous fall in the monthly and peak progesterone and peak oestradiol levels occurred during the anoestrous period, the basal oestradiol levels remained high suggesting the depression of the ovarian activity might have occurred due to the suppression of pituitary LH by oestradiol. The most likely suppressive environmental factors in this part of the region include the cold stress during the dry cold months and inadequate or poor nutrition which occurs as a result of the decline in nutritive value of the pastures during the dry

season.

It will be noted, however, that this study was conducted on few goats and for a short duration of 9 month. Usually a longer observation period of up to 2 years or more and involving a large group of animals is needed to ascertain the seasonal variations in the reproductive performance. Nevertheless, these results provide a detailed clinical and endocrinological data which closely complement the earlier report by Katongole and Gombe (1985) that high ovarian activity and pregnancies in the indigenous goats are observed between March and May and between November and December during the warm rainy period; possibly due to the "flushing" effect caused by good lush pastures and they become acyclic during the dry months.

#### ACKNOWLEDGMENTS

We are grateful to the RBU staff especially to Messrs J. Osaso, D. Ndegwa, F. Kariba, L. M'rewa and H. O. Odongo for the radioimmunoassay and Messrs V. Okelo and J. Kidwi for looking after the experimental animals and heat detection. This study was partly funded by the RBU research funds and the German Academic Exchange Service (DAAD/AFAA).

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