EFFECT OF TEMPERATURE UNDER FIELD CONDITIONS ON THE REPRODUCTIVE PERFORMANCE OF EWES

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It has been established that reproductive performance of ewes during the breeding period is adversely affected by constant high ambient temperatures of 32 to 35°C (Alliston & Ulberg, 1957, 1961; Dutt, Ellington & Carlton, 1959; Dutt, 1963) and favourably affected by constant low ambient temperatures of 16 to 21°C (Alliston & Ulberg, 1957; Wilson, Godley & Hurst, 1961; Godley, Wilson & Hurst, 1966). In commercial practice, however, ewes are subjected to prevailing diurnal atmospheric conditions. Any occurrence of heat stress in ewes during the breeding period is likely to be limited to a portion of a particular 24-hr period. Thus, heat stress under natural diurnal temperature variation may have less adverse effects on the ova, their fertilization, development and subsequent lambing percentage as compared with the effects of constant, prolonged heat stress. Few detailed reports of this nature are available, however, and have been limited to conditions simulating normal diurnal variability (Yeates, 1956; Ryle, 1961; Smith, Bell & De Chanee, 1966; Thwaites, 1967, 1969). The purpose of this investigation was to evaluate natural differences in atmospheric temperature during the summer breeding period at two geographic locations for their effect on the reproductive performance of ewes.

The data were collected over a 2-year period at two locations, Experiment and Blairsville, Georgia. Experiment is 299 m in elevation and Blairsville, 246 km north of Experiment, is 584 m in elevation in the Georgia Mountain area. The ewes at Experiment were crossbreds, approximately 50% Hampshire and 50% Rambouillet. During the first year, the ewes at Blairsville were all high grade Hampshires. During the second year, approximately 50% were high grade Hampshire and the remainder were first-cross Dorset × Hampshire. Because the ewes at each location differed in genotype, a representative number of the ewes at Experiment was moved each year to Blairsville and a representative portion of the Blairsville ewes was moved to Experiment in May and returned to their original locations in mid-September. All ewes were sheared just before transfer in May. Immediately after transfer of the ewes, raddled vasectomized rams were turned in with all ewes to detect the first

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oestrus following anoestrus. Two days after first oestrus, each ewe was assigned to a particular pasture for breeding with consideration for the date of first oestrus, the age of the ewe and the breed of the ewe where applicable. Each year, some of the ewes at each location served as a controls while other ewes received a subcutaneous injection of 1000 i.u. PMSG on either the 13th or 14th day (oestrus=Day 0) of the oestrous cycle. The PMSG was given to increase multiple ovulations followed by multiple fetuses, thus providing conditions which were assumed to be more sensitive than those in ewes not receiving PMSG for detecting the effect of temperature on early embryonic mortality.

One intact raddled ram which had been tested for fertility was placed with each set of ewes and stayed with them continuously for 17 days. The ewes

Table 1. Mean maximum and minimum temperatures shown by years, location and months

Year	Date	Experiment		Blairsville	
		Mean max.	Mean min.	Mean max.	Mean min.
First	May 16 to 31	31.1	16.7	26.9	8.6
	June 1 to 30	31.5	18.7	27.0	13.3
	July 1 to 31	32.8	21.0	26.8	15.6
	Aug. 1 to 31	31.1	20.4	28.3	16.2
	Sept. 1 to 14	31.1	18.7	28.0	14.2
Second	May 16 to 31	26.0	13.1	20.4	6.1
	June 1 to 30	28.6	17.5	23.9	12.2
	July 1 to 31	31.0	19.6	26.1	13.6
	Aug. 1 to 31	30.1	19.4	26.9	13.9
	Sept. 1 to 14	30.4	20.5	27.6	14.4

Temperatures are expressed in °C.

were then rotated between sets as a means of reducing possible ram effects. Intact rams remained with ewes until mid-September each year. All ewes stayed continuously on bermuda grass (*Cynodon dactylon*) pasture during the summer and autumn. Subsequently, they were fed good quality hay and a grain mixture which permitted them to stay in a weight-gaining condition up to lambing. The data were analysed by analyses of variance using the method of fitting constants.

The mean maximum temperature averaged 5°C cooler at Blairsville than at Experiment during June and July when most of the ewes were bred (Table 1). During these 2 months, there were 28 days in the first year and 11 days in the second year when the temperature exceeded 32.2°C at Experiment, but at no time during either summer was this temperature exceeded at Blairsville.

Of the 277 ewes mated (marked by intact rams), thirty-three failed to lamb. The number of oestrous periods which each of these ewes had while exposed to intact rams was analysed by analysis of variance. Neither of the four main effects (year, source of ewe, summer location, hormone treatment) nor their first-order interactions significantly affected the number of their oestrous periods which had a least squares mean of 1.51. Possibly, some of these ewes which did not conceive on first or second oestrus, with intact rams, i.e. the ewes' second or

third oestrus since their first was with vasectomized rams, subsequently entered a period of anoestrus. Research in Alabama (Shelton, 1966) indicated that oestrous activity during the summer months reaches a peak during June and subsides to anoestrus during July and August in certain ewes. There is also a possibility (Thwaites, 1969) that embryonic deaths occurred at a developmental stage late enough to prevent some of the thirty-three ewes from returning to oestrus for breeding before mid-September.

Table 2. Least squares means and constants for factors associated with ewe productivity

Item	% Ewes not lambing	% Lamb crop in terms of:		
		Lambs born	Lambs born alive	Lambs alive 48 hr after birth
<i>Results based on a total of 277 ewes mated by intact rams, of which thirty-three failed to lamb</i>				
Least squares mean	15.4	123	108	98
Year 1	15.0	124	111	103
Year 2	15.8	122	104	93
Source of ewes	Experiment	7.5**	132	117
	Blairsville	23.3**	115	97
Summer Experiment	18.5	119	106	96
location Blairsville	12.4	127	109	100
Hormone treatment	Control	101**	95*	85*
	PMSG	18.5	145**	121*
<i>Results based on the 244 mated ewes which subsequently lambed</i>				
Least squares mean	—	146	127	115
Year 1	—	146	129	119
Year 2	—	146	125	111
Source of ewes	Experiment	—	141	127
	Blairsville	—	151	127
Summer Experiment	—	147	129	117
location Blairsville	—	146	125	113
Hormone treatment	Control	—	115**	108**
	PMSG	—	178**	147**

* $P < 0.05$ between two vertical means within a sub-set.

** $P < 0.01$ between two vertical means within a sub-set.

The conception rate of the 244 ewes which lambed was not significantly affected by either of the four main effects or their first-order interactions. Least squares mean conception rate was 1.12 for these ewes.

Table 2 shows the results of analyses of variance for factors associated with ewe productivity on the basis of ewes mated (mated by intact rams) and ewes that lambed. The least squares mean indicated that 15.4% of the ewes which were mated did not lamb. The percentage of ewes not lambing ($P < 0.01$) and the number of lambs alive 48 hr after birth ($P < 0.05$) were significantly affected by source of ewes only in the 'ewes mated' analyses. The PMSG treatment significantly increased the percentage of lambs born and living both in terms of

ewes mated and ewes lambing, showing that the ewes given PMSG had a higher ovulation rate and more embryos per ewe than the control ewes.

Of the forty-two first-order interactions among the main effects for ewes bred and for ewes lambing, only ewe source $\times$ hormone treatment for the percentage of ewes not lambing was significant ($P < 0.05$). It showed that among ewes at Experiment a higher percentage of the control ewes failed to lamb as compared with those treated with PMSG while the opposite was true for Blairsville ewes.

Although the location at Blairsville was cooler than at Experiment during the breeding period, summer location was not a significant source of variation in any of the measures of ewe productivity examined. Furthermore, the lack of statistical significance for the first-order interaction of hormone treatment $\times$ summer location indicated that any difference in heat stress due to location was not detected in the ewes treated with PMSG which, presumably, were more sensitive to heat stress than the control ewes. A greater difference in environmental temperature than that which occurred between the locations at Blairsville and Experiment, and a greater heat stress than that which was imposed at Experiment, are probably needed before a statistically significant difference in various measures of ewe productivity can be detected. Thus, these results provide information which should be useful in identifying areas of natural diurnal temperature which are not likely to affect reproductive performance in ewes.

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