HEAT STRESS AND GROWTH OF THE CONCEPTUS IN SHEEP

G. ALEXANDER* and D. WILLIAMS*

Summary

It is known that foetal growth is retarded by exposure of ewes to high ambient temperature for most of pregnancy. We have now shown that heat also inhibits the growth of the placenta, and that a marked reduction in placental and foetal growth results when the application of heat is restricted to the last third of pregnancy. These effects were produced in a hot room by exposure to 112°F (44°C) and a very high humidity for 9 hr/day and to 90°F (32°C) and a moderate humidity for the remaining 15 hr/day; there was no solar radiation. The effects were much reduced when ewes were removed to the cooler external atmospheric conditions for these 15 hr/day.

I. INTRODUCTION

Yeates (1953, 1956 and 1958) showed that foetal growth was retarded when pregnant ewes were exposed to high ambient temperatures, but there was no critical comparison of the effectiveness of the various heating regimes employed, and scant consideration was given to the effects on the placenta. A recent study is described below. The object was to examine the effect of heat, at different stages of pregnancy, on placental size and foetal weight.

II. MATERIALS AND METHODS

Medium-woolled Peppin Merino ewes, three to seven years old, were subjected to various regimes of heat exposure during pregnancy (Table 1). The experiment was originally based on a regime of exposure in a "hot room" to air temperatures of 112°F (44°C) and a water vapour pressure of 33 mm Hg, between 8 a.m. and 5 p.m. daily, and to normal animal house temperatures for the remaining 15 hr (Treatments 2, 40-96 days, Table 1). Monthly average temperatures in the animal house during the experiment (March to July) were 65-84°F (18-29°C) maximum and 46-60°F (8-16°C) minimum. This regime was similar to that of Yeates (1958) except that our daily exposure to severe heating was 2 hr longer, and our animals were exposed to lower night temperatures in an attempt to counteract the depression of appetite by heat. Exposure commenced on the 40th day of pregnancy and ewes were each offered daily rations of 20g/kg of body weight of a mixture of oat grain and lucerne chaff (1: 1). Unheated control ewes (Treatments 1, Table 1) were held in the animal house throughout each 24 hr and were offered only 15g/kg of the same diet, since the food intake of heated ewes was expected to be variable, with a mean of less than 20g/kg.

Some ewes in each group were killed on the 96th day of pregnancy (Treatments 1 a and 2a, Table 1) and foetuses and placental cotyledons were weighed. Since the results indicated that the heat exposure had been without effect, a more extreme regime was applied from the 96th day of pregnancy to some of the

*C.S.I.R.O., Division of Animal Physiology, Ian Clunies Ross Laboratory, Prospect, N.S.W.

TABLE 1

The effect of various regimes of heating during pregnancy on food intake, foetal weight and cotyledon weight

No.	Daily Treatment Regimes: 40th-96th Day of Pregnancy	Daily Treatment Regimes: 97th-144th Day of Pregnancy	No. of Ewes*	Mean Food Intake ± SEM (g/kg/day): 40-96 days	Mean Food Intake ± SEM (g/kg/day): 97-144 days	Mean Foetal Wt. ± SEM (kg)	Mean Wt. of Cotyledons ±SEM (g)
1a	Unheated	Killed on 96th day	4 (1)*	13.5 ± 1.5 (15.0)*	— —	0.66 ± 0.03 (0.64)*	494 ± 36 —
1b	Unheated	Unheated	4 (1)*	15.0 ± 0 (15.0)*	13.3 ± 1.2† (13.0)*	3.60 ± 0.14 (2.29)*	512 ± 55 —
1c	Unheated	9 hr severe heat 15 hr moderate heat	6	15.4 ± 0.4‡	14.9 ± 1.4	2.73 ± 0.12	267 ± 9
2a	9 hr severe heat 15 hr unheated	Killed on 96th day	4	14.7 ± 2.1	—	0.66 ± 0.03	479 ± 21
2b	9 hr severe heat 15 hr unheated	9 hr severe heat 15 hr unheated	6 (1)*	16.4 ± 2.0 (12.4)*	18.9 ± 0.8 (15.5)*	3.26 ± 0.18 (2.75)*	405 ± 33 —
2c	9 hr severe heat 15 hr unheated	9 hr severe heat 15 hr moderate heat	7	15.9 ± 1.7	13.6 ± 1.3	2.64 ± 0.10	257 ± 16

* Mean values for the three twin bearing ewes are shown in brackets; all other figures refer to single-bearing ewes.

† Includes one ewe that mated while already pregnant, and received **15g/** kg/day during what proved to be the last 7 weeks of pregnancy.

‡ Includes one ewe offered **17.3g/kg** day in error.

remaining control and heated ewes; in addition to the exposure for 9 hr at 112°F, as above, these ewes were subjected to 90°F (32°C) and water vapour pressure of approximately 18 mm Hg for the remaining 15 hr daily in the hot room (Treatments lc and 2c, Table 1) . Rectal temperatures of heated ewes at about 4.30 p.m. were usually about 105°F (41 °C) . This new regime was similar to that used by Yeates (1958). Since, in our hands, this treatment had depressed appetites in the previous year to a mean of about 13 g/kg/day, rations of unheated ewes were decreased to this level from the 96th day of pregnancy, while ewes on the new regime were offered 20g/kg. Actual mean food intakes are shown in Table 1.

Ewes were killed on the 144th (± 1) day of pregnancy and the foetuses and cotyledons were weighed.

III. RESULTS

Differences in mean foetal weight and mean cotyledon weight between ewes kept in the animal house and ewes exposed to heat for only 9hr/day were small and not significant (Table 1), both at the 96th day (Treatments la and 2a) and 144th day (Treatments lb and 2b). However, the mean weights in ewes under Treatments lb and 2b were substantially and significantly greater than the mean weights in ewes exposed to the more severe regime from the 96th day (Treatments lc and 2c). The mean weights appeared little affected by 9 hr of heating daily prior to the 96th day, as there was little difference between Treatments lc and 2c.

Although food intake of heated ewes was very variable, and the mean intake of ewes heated for only 9 hr/day was about 5g/kg higher than in other groups during late pregnancy (Table 1) , birth weight appears to have been little influenced by nutrition (Figure 1).

IV. DISCUSSION

The results indicate that, when day temperatures are high, foetal growth may be little affected unless temperatures at night are also high. By contrast, in the experiment of Yeates (1956), a substantial reduction in birth weight (0.8 kg) was achieved in the absence of night heating, but with the very high water vapour pressure of 42 mm Hg, at 112°C, applied for 7 hr daily for the whole of pregnancy.

The results also show that a substantial reduction in birth weight (0.9 kg) can occur when heat exposure is confined to the last third of pregnancy, thus confirming a suggestion of Yeates (1953).

It is also clear that the application of heat during late pregnancy considerably reduces placental weight; the reduction appears to be an "active" process since the placenta reaches its maximum size about half way through pregnancy (Barcroft & Kennedy 1939; Cleote 1939), i.e. before the continuous heating began. Placental insufficiency resulting from this reduction in size may be responsible, at least in part, for the reduction in foetal size.

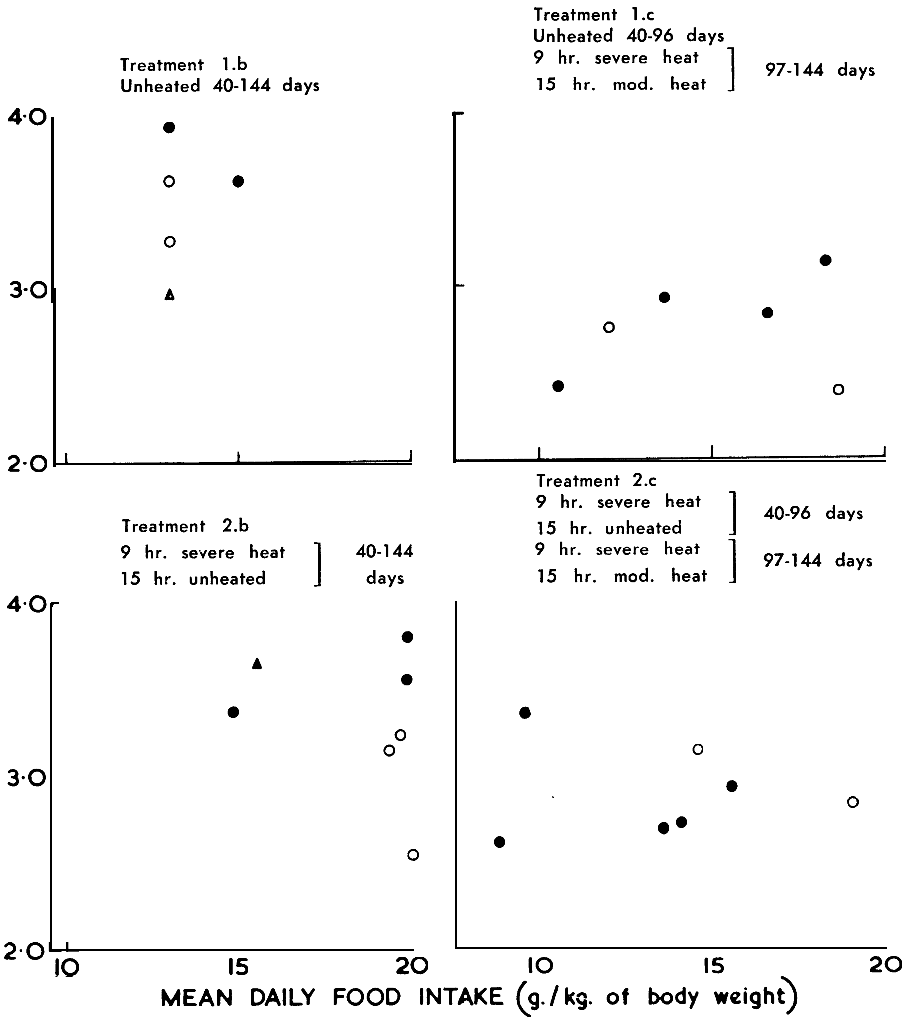

Fig. 1.—Relation of birth weight to mean daily food intake between the 97th and 144th day of pregnancy in ewes subjected to various regimes of heating during pregnancy.

● single males
○ single females
▲ twin males } Mean of pair, with 29% correction added
△ male and female twins } (Hammond 1932).

V. REFERENCES

BARCROFT, J. and KENNEDY, J. A. (1939). The distribution of blood between the foetus and the placenta in the sheep. ***Journal of Physiology* 95: *173.***

CLEOTE, J. H. L. (1939).—Prenatal growth in the Merino sheep. ***Onderstepoort Journal*** of ***Veterinary Science*** **13: 417.**

HAMMOND, J. (1932). Growth and Development of Mutton Qualities in the Sheep. (Oliver & Boyd: Edinburgh and London).

YEATES, N. T. M. (1953). The effect of high air temperature on reproduction in the ewe. ***Journal of Agricultural Science 43:*** 199.

YEATES, N. T. M. (1956). The effect of high air temperature on pregnancy and birth weight in Merino sheep. ***Australian Journal of Agricultural Research 7: 435.***

YEATES, N. T. M. (1958). Foetal dwarfism in sheep—an effect of high atmospheric temperature during gestation. ***Journal of Agricultural Science*** **51: 84.**