BODY TEMPERATURE AND FERTILIZATION IN THE COW*

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Summary. Rectal temperatures of 934 Jersey and Australian Illawarra Shorthorn dairy cows were recorded during summer months immediately before artificial insemination. They ranged from 98.8°F to 105.0°F (mean 101.6 ± 0.9°F) and were related directly to stage of oestrus, supporting an earlier report of a thermal response at oestrus. Thus, the temperature of the cow's genitalia may be high during oestrus; and the sperms may be subjected to such environment for several hours after insemination.

In addition, the data support the hypothesis that the normal diurnal rhythm of body temperature is restored some hours before ovulation occurs. Under such conditions, high rectal temperatures at the time of insemination were not inimical to the subsequent fertilization process. Indeed, in one group of cows, inseminated at a late stage of oestrus, fertility was better \( P < 0.05 \) in cows with elevated temperatures than in those with low values.

INTRODUCTION

The performance of cattle under high ambient temperature has received close attention during recent decades (Findlay & Beakley, 1954; McDowell, 1958; Yeck, 1959). The studies have related particularly to heat-regulating mechanisms, although some aspects of milk and beef production in the hot environment have been investigated (Johnston, 1958; Warwick, 1958; Mahadevan, 1958).

Reproductive function in the hot environment has not received the attention it would seem to warrant. Thus, in a study of 17,000 calvings to Zebu cows in Nyasaland, mating was unrestricted and the peak of conceptions occurred during the hot summer months (Wilson, 1946).

Under controlled mating conditions, other husbandry considerations, such as seasonal fluctuations in available feed, may influence the choice of breeding programme. Nevertheless, in tropical and sub-tropical Queensland, where mating is restricted in varying degrees, the bulk of conceptions are effected during the hot months.

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Records from the Atherton Tablelands of north Queensland (17° to 18° S) indicate that about 31.5% of dairy cows conceive during December, January and February (Pegg, personal communication). Amongst purebred Hereford beef studs in south-east Queensland, 49.8% of 3004 cows conceived during the same part of the year (Fallon, 1961).

However, there are indications that high ambient temperature may not be optimal for reproductive efficiency. Thus, seminal degeneration under hot conditions has been well documented, and attention has focused on the unique function of the scrotal vascular system in heat regulation in the ram (Harrison & Weiner, 1949; Moule, 1960) and in the bull (Kirby & Harrison, 1954).

Reports of seasonal effects on bovine fertility are conflicting (Schindler, 1957; Ulberg, 1958; Yeck, 1959), but may be resolved in terms of the hypothesis of Mills and Senior (1930) that human fertility declines under extreme ambient temperatures (above 70°F and below 40°F), a contention that has received Australian support (Macfarlane & Spalding, 1960).

At Kansas, a seasonal difference has been noted in the rate of fertility decline of chilled semen (Fryer, Marion & Farmer, 1958); and a summer depression in semen fertility has been observed in north Queensland.

Rather more controversial has been the influence of high temperatures on fertility in the cow. Certainly, experimental studies have indicated that fertilization and embryonic survival are susceptible to heat stress in the ewe (Shah, 1956; Yeates, 1956; Alliston & Ulberg, 1957, cited by Ulberg, 1958; Dutt, 1960). However, in the cow such functions have been investigated on few occasions and with inconclusive results.

*Bos taurus* cows in temperate regions exhibit oestrus for an average of 18 to 19 hr and ovulate some 10 to 11 hr later (Hansel, 1959). The optimal time for artificial insemination (AI) under such conditions, extends from 24 to 7 hr before ovulation (Trimberger & Davis, 1943).

Recent studies on sperm migration within the cow's genital tract (Van-Demark, 1958) indicate that the sperms are effectively subjected to the environment of the upper tract soon after insemination. Thus, before ovulation and fertilization occur, the sperms may have been within the female tract for many hours. During that time the cow's genitalia are involved in the body's reactions to its environment. In addition, there is evidence that the phenomenon of oestrus contributes to the cow's endogenous heat load (Wrenn, Bitman & Sykes, 1958; Fallon, 1959).

In order to assess the significance of the thermal component of oestrus on subsequent fertilization efficiency, an investigation was undertaken under field conditions.

**MATERIALS AND METHODS**

The inauguration of dairy cattle AI services in Queensland has been reported (Fallon, 1958). At Nambour and Kingaroy, units are operated by the Department of Agriculture for the purpose of evaluating young sires, the AI services being restricted to Jersey and Australian Illawarra Shorthorn (A.I.S.) cattle, respectively.
In 1958, the State's first co-operative AI group started on the Atherton Tablelands of north Queensland. Semen of Jersey and A.I.S. sires is used, an increasing preference for A.I.S. semen being evident.

Observations were made during the October to January period of 1958-59 at Nambour and during the same period of 1959-60 at Nambour, Kingaroy and Atherton. Rectal temperatures were recorded immediately before AI; other annotations included the time when oestrus was first noted and when AI was performed. Fertility was calculated on the basis of the '60 to 90-days non-return rate'.

RESULTS

Body temperature and fertility records for 934 cows were considered (Table 1). The temperature of A.I.S. cows at Kingaroy was higher than that of Jersey cows at Nambour and of cows of both breeds at Atherton. However, the data were bulked for subsequent considerations.

About two-thirds of the cows (613) commenced oestrus during the night and were first noted in the morning, usually between 5 and 7 a.m. The remainder were first observed on heat in the afternoon, usually between 4 and 6 p.m.

### Table 1

**MEAN RECTAL TEMPERATURE OF COWS BEFORE A.I.**

<table>
<thead>
<tr>
<th>Region</th>
<th>South latitude</th>
<th>Breed*</th>
<th>No.</th>
<th>Rectal temperature (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atherton</td>
<td>17 to 18°</td>
<td>J.—A.I.S.</td>
<td>453</td>
<td>101.58 ± 0.87</td>
</tr>
<tr>
<td>Kingaroy</td>
<td>26 to 27°</td>
<td>A.I.S.</td>
<td>224</td>
<td>101.78 ± 0.85</td>
</tr>
<tr>
<td>Nambour</td>
<td>26 to 27°</td>
<td>J.</td>
<td>257</td>
<td>101.59 ± 0.93</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>J.—A.I.S.</td>
<td>934</td>
<td>101.63 ± 0.89</td>
</tr>
</tbody>
</table>

* J = Jersey; A.I.S. = Australian Illawarra Shorthorn.

### Table 2

**RECTAL TEMPERATURES THROUGHOUT THE OESTROUS PERIOD**

<table>
<thead>
<tr>
<th>Group</th>
<th>Oestrus noted</th>
<th>AI time</th>
<th>No.</th>
<th>Rectal temperature (°F)</th>
<th>Difference</th>
<th>Significance (P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>p.m.—I*</td>
<td>p.m.—I</td>
<td>7</td>
<td>102.74 ± 0.81</td>
<td>B—C</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>B</td>
<td>a.m.—II</td>
<td>p.m.—II</td>
<td>216</td>
<td>101.49 ± 0.87</td>
<td>B—F</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>C</td>
<td>p.m.—II</td>
<td>p.m.—II</td>
<td>93</td>
<td>101.27 ± 0.80</td>
<td>B—G</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>D</td>
<td>a.m.—III</td>
<td>p.m.—III</td>
<td>4</td>
<td>101.25 ± 0.43</td>
<td>C—F</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>E</td>
<td>a.m.—I</td>
<td>a.m.—I</td>
<td>369</td>
<td>101.76 ± 0.85</td>
<td>C—G</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>F</td>
<td>a.m.—I</td>
<td>p.m.—I</td>
<td>216</td>
<td>101.75 ± 0.92</td>
<td>F—G</td>
<td>n.s.</td>
</tr>
<tr>
<td>G</td>
<td>p.m.—I</td>
<td>a.m.—II</td>
<td>19</td>
<td>101.03 ± 0.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>a.m.—II</td>
<td>p.m.—II</td>
<td>9</td>
<td>101.13 ± 0.97</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* I = day oestrus noted; II, III = subsequent days.
Most inseminations were performed during a 5-hr period, about two-thirds (608) between 10 a.m. and noon, and the remainder between noon and 3 p.m. Body temperatures were virtually the same, whether measured before noon (101.6 ± 0.8°F) or after noon (101.6 ± 0.9°F).

Table 3
RECTAL TEMPERATURE OF COWS CONCEIVING AND OF COWS RETURNING TO SERVICE

<table>
<thead>
<tr>
<th>Group</th>
<th>Oestrus noted</th>
<th>Ai time</th>
<th>Non-returns</th>
<th>Returns</th>
<th>Fertility (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>No.</td>
<td>Temp. (°F)</td>
<td>No.</td>
</tr>
<tr>
<td>A</td>
<td>p.m.—I*</td>
<td>p.m.—I</td>
<td>6</td>
<td>102-7 ± 0-9</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>a.m.—II</td>
<td>a.m.—II</td>
<td>141</td>
<td>101-5 ± 0-9</td>
<td>75</td>
</tr>
<tr>
<td>C</td>
<td>p.m.—II</td>
<td>a.m.—II</td>
<td>57</td>
<td>101-2 ± 0-9</td>
<td>36</td>
</tr>
<tr>
<td>D</td>
<td>a.m.—III</td>
<td>a.m.—III</td>
<td>1</td>
<td>101-8</td>
<td>3</td>
</tr>
<tr>
<td>E</td>
<td>a.m.—III</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>F</td>
<td>a.m.—I</td>
<td>a.m.—I</td>
<td>204</td>
<td>101-7 ± 0-9</td>
<td>165</td>
</tr>
<tr>
<td>G</td>
<td>p.m.—I</td>
<td>p.m.—I</td>
<td>124</td>
<td>101-7 ± 0-9</td>
<td>92</td>
</tr>
<tr>
<td>H</td>
<td>a.m.—II</td>
<td>a.m.—II</td>
<td>11</td>
<td>100-9 ± 0-5</td>
<td>8</td>
</tr>
<tr>
<td>I</td>
<td>p.m.—II</td>
<td>p.m.—II</td>
<td>2</td>
<td>100-9</td>
<td>7</td>
</tr>
</tbody>
</table>

Total 546 101-6 ± 0-9 388 101-7 ± 0-9 58-5

* I = day oestrus noted; II, III = subsequent days.

When the data are considered in relation to the stage of oestrus at which the temperatures were recorded (Table 2 and Text-fig. 1), it is apparent that they are consistent with the thesis that a thermal response operates during oestrus and is completed before ovulation (Fallon, 1959).

The fertility data (Table 3) indicate that most inseminations were performed at recommended times. It is interesting that, irrespective of the stage of oestrus at which Ai was effected, the body temperatures of cows that returned to service were higher (101.7 ± 0.9°F) than of those that did conceive (101.6 ± 0.7°F) though not significantly so.
As a corollary, fertility was depressed in cows with high body temperatures, though not significantly (Table 4). However, cows in Group B present a rather special case. The group comprised cows that were observed in oestrus in the evening and that were inseminated next morning. As a whole, the group was more fertile ($P < 0.05$) than comparable Groups C, F and G. In addition, cows
of Group B with elevated temperatures were more fertile \( P < 0.05 \) than those with low temperatures (see Text-fig. 2).

**DISCUSSION**

Reviewing the literature concerning body temperature in cattle, King (1955) concluded that, with diurnal changes, the acceptable maximum in the healthy dairy cow might be set at 102.3°F. Such body temperatures may be exceeded in a hot environment and the animal's ability to maintain a mean temperature of 101°F has been used as a basis for assessing heat tolerance (McDowell, 1958). In view of such considerations, it is of interest that oestrus imposes a thermal load on the cow which is not readily dissipated. Thus, in the present study, although measurements were made usually before the diurnal peak, 18.1% of 934 records were in excess of 102.3°F, the incidence of high temperatures being related directly to the stage of oestrus.

As well as re-affirming the proposal of a thermogenic component of oestrus, the present data also lend support to the hypothesis that the animal's normal diurnal temperature rhythm is restored before ovulation occurs (Fallon, 1959). In this context it is noteworthy that high body temperatures at the time of insemination are not inimical to subsequent fertilization efficiency (Table 4). Indeed, in the case of cows observed in oestrus in the evening and inseminated during the next morning, fertility was better \( P < 0.05 \) when body temperature was high than when it was low. Such an observation would suggest that cows with low temperature were closer to ovulation than is considered optimal for AI, or had actually ovulated. In other groups, the situation is not so readily explained since body temperature and fertility were not significantly related.

The nature of the thermal response at oestrus remains undetermined. Farris (1954) has demonstrated increased locomotory activity in the cow at oestrus, which may contribute to the heat load. However, there is evidence that the response may be elicited even in a lame cow (Fallon, 1959). Bligh (1955) has shown that rectal measurements faithfully reflect the deep body temperature in the bovine; and Watanabe & Takamine (1959) have reported that both rectal and cervical temperatures are elevated at oestrus in the cow. Thus, it is apparent that the temperature within the cow's genital tract may remain at a high level during oestrus. Obviously, such high temperatures, at least until a few hours before ovulation, are not incompatible with adequate preparation of the tract for fertilization. In addition, sperms are able to retain their fertilizing capacity though subjected to high temperatures within the female genital tract for several hours before ovulation. Indeed, such a regime may be optimal for sperm 'capacitation', though some studies suggest that temperature requirements for 'capacitation' are not critical (Braden & Austin, 1953; Chang, 1959).

The studies reported here indicate that increased body temperature *per se* is not inimical to fertility, but is of significance only insofar as it indicates the stage of oestrus at which the cow is bred.

There is no suggestion that the high body temperatures were associated with heat stress in its usual connotation. Although the animals were of *Bos*
taurus type, they were fairly well adapted to their sub-tropical environment. Thus, it remains for the studies to be extended to consider the situation under adverse environmental conditions, and particularly in heat-stressed cattle.

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REFERENCES

Dutt, R. H. (1960) Temperature and light as factors in reproduction among farm animals. J. Dairy Sci. 43, 123.
King, J. O. L. (1955) Variations in the quantity and quality of milk yielded by diseased cows while their body temperatures were elevated. Vet. Rec. 67, 432.