ATTAINMENT OF PUBERTY IN RAMS SELECTED ON WEANING WEIGHT

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SUMMARY

Age, weight and stage of maturity at puberty were examined in ram lambs from three lines of Merino sheep differing in mature size. Two definitions of puberty were used: maximum testis growth rate and mature penis development. Analysis on 26 rams was carried out by fitting a logistic function to live weight, testicular diameter and penis development data from each animal.

Patterns of live weight, testicular diameter and penis development over time were similar across lines. Significant differences in age and weight at puberty of the different lines were explained by differences in mature size, while stage of maturity at puberty, by both definitions, was similar for the three lines.

Keywords: Puberty, rams, Merino, mature size, testis diameter, penis development.

INTRODUCTION

Selection for or against live weight at a certain age is widely advised practice in the sheep and cattle industries. Such selection programs result in changes in mature size (Barlow 1984), but their effects on reproductive parameters are not well documented.

The relationship between age at puberty and live weight has been reviewed by Dyrmundsson (1973). However there is little evidence in the literature concerning the relationship between age and live weight at puberty, and stage of maturity. Stage of maturity is defined here as live weight at any age as a proportion of mature live weight.

Though puberty has been defined as the age at which fertilization can first take place (Asdell 1949) the gradual nature of the onset of spermatogenesis and related physiological and morphological changes in ram lambs have led to a number of other definitions based on penis development (Pretorius and Marincowitz 1968), parameters of spermatogenesis (Courot 1962) and testicular (Skinner and Rowson 1968) and hormonal changes (Schanbacher et al. 1975). Inconsistent relationships between stage of maturity and puberty between breeds reviewed by Sutama (1983) may in part be explained by these differences in the definition of puberty.

This study examines Merino ram lambs from three lines differing in mature live weight and estimates age, live weight and stage of maturity for each line at puberty when puberty is defined by either maximum testicular growth rate or mature penis development.

MATERIALS AND METHODS

Animals

Ten ram lambs born in the spring of 1983 from each of three lines of medium-
Peppin Merinos developed at the Agricultural Research Centre, Trangie, since 1951 and selected for high (W+) and low (W-) weaning weight and a randomly selected control (R) were used in this study.

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The ram lambs were randomly chosen at weaning from groups born at Armidale and were then fed ad libitum a 55% lucerne nut, 45% oaten grain ration while housed from January 1984 to May 1984. They were subsequently given an ad libitum sorghum grain and hay ration in a feedlot. Two W- rams died during the course of the study and no replacements were available.

Measurements

Measurements of live weight (WT), testicular diameter (TDM) and penis development (PD) were taken fortnightly from November 1983 to June 1984 and thereafter at six-weekly intervals. Fleece weight corrections were made on WT based on average fleece weights for each line. TDM was taken as the sum of both testes corrected for skin thickness (Land and Sales 1977), while the subjective scoring system developed by Pretorius and Marincowitz (1968) was used to estimate PD. This scoring system ranges from 1 (immature) to 5 (mature) with increasing score describing morphological changes associated with decreasing adhesion of the Processus urethra and glans penis to the preputial mucous membrane.

Analysis

Logistic models (1) (forming sigmoid shaped curves) were fitted for individual animals for the relationship between AGE and WT and TDM.

\[ Y_i = \frac{A_i}{1 + B_i e^{C_i T_i}} \]

where

- \( Y_i \) = WT or TDM for the \( i^{th} \) ram
- \( A_i \) = WT or TDM at maturity for the \( i^{th} \) ram
- \( B_i \) and \( C_i \) = parameters affecting the shape of the curve
- \( T_i \) = AGE in days of the \( i^{th} \) ram

A slightly altered model was fitted for PD to account for the restricted range in scores (2)

\[ Y_i = 1 + \frac{A_i}{1 + B_i e^{C_i T_i}} \]

where \( T_i \), \( A_i \), \( B_i \) and \( C_i \) are as for (1) and \( Y_i \) is PD score. Differences in predicted mature live weight (\( A_i \)) and curve shape (\( B_i \) and \( C_i \)) were examined by least squares analysis of variance for TDM, WT and PD.

Age at puberty was defined as either,

i) age at the predicted maximum change in TDM (APTDM) or
ii) age at the predicted attainment of PD score = 5 (APPD).

The parameter APTDM was estimated by equating the second derivative of model (1) to zero. The parameter APPD was estimated by backsolving (2) for PD = 5. Corresponding predicted live weights at puberty were estimated by solving (1) in WT for APTDM and APPD to give predicted live weight at the time of maximum change in TDM (WTPTDM) and at the time of PD reading 5 (WTPPD). Predicted stage of maturity at puberty was estimated by dividing WTPTDM and WTPPD by the \( A_i \) to give predicted stage of maturity at maximum TDM change (MPTDM) and at attainment of PD = 5 (MPPD).
Differences between lines in predicted age, predicted live weight and predicted stage of maturity at puberty were tested by least squares analysis of variance. Differences between least squares means were tested by using an F-test protected, Duncan’s multiple range procedure (Steele and Torrie 1980). Data from two rams (1R, 1W-) were excluded as they did not satisfy convergence criterion of models (1) and (2).

RESULTS

There were significant differences in predicted mature fleece-free live weight between all three lines as shown by the A values for WT in Table 1. However, there were no differences between lines for predicted mature testicular diameter nor in the shape parameters (B and C) for WT, TDM or PD.

Table 1 Least squares means (±S.E.) for predicted mature live weight (WT) (kg) and predicted mature testicular diameter (TDM) (mm) for W+, R and W- rams

<table>
<thead>
<tr>
<th>Trait</th>
<th>Line</th>
<th>n</th>
<th>Predicted Mature Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>WT</td>
<td>W+</td>
<td>10</td>
<td>56.0 ± 1.76ab</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>8</td>
<td>48.3 ± 1.76bc</td>
</tr>
<tr>
<td></td>
<td>W-</td>
<td>8</td>
<td>39.1 ± 2.10c</td>
</tr>
<tr>
<td>TDM</td>
<td>W+</td>
<td>10</td>
<td>754 ± 20.6a</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>8</td>
<td>739 ± 20.6a</td>
</tr>
<tr>
<td></td>
<td>W-</td>
<td>8</td>
<td>719 ± 23.0a</td>
</tr>
</tbody>
</table>

* Means with unlike superscripts within trait are significantly different, P < 0.05.

Table 2 Least squares means (±S.E.) for predicted age at puberty (AP) (days) predicted live weight at puberty (WTP) (kg), and predicted stage of maturity at puberty (MP) estimated for testicular diameter (TDM) and penis development (PD) in W+, R, and W- rams

<table>
<thead>
<tr>
<th>Trait</th>
<th>Line</th>
<th>n</th>
<th>AP</th>
<th>WT</th>
<th>MP</th>
</tr>
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<tbody>
<tr>
<td>TDM</td>
<td>W+</td>
<td>10</td>
<td>157</td>
<td>10.1a</td>
<td>23.6</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>8</td>
<td>157</td>
<td>10.6b</td>
<td>22.2</td>
</tr>
<tr>
<td></td>
<td>W-</td>
<td>8</td>
<td>196</td>
<td>12.0b</td>
<td>18.2</td>
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</table>

<table>
<thead>
<tr>
<th>Trait</th>
<th>Line</th>
<th>n</th>
<th>APFD</th>
<th>WTPPD</th>
<th>MPFD</th>
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<tbody>
<tr>
<td>PD</td>
<td>W+</td>
<td>10</td>
<td>175</td>
<td>7.0a</td>
<td>27.2</td>
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<tr>
<td></td>
<td>R</td>
<td>8</td>
<td>182</td>
<td>7.4a</td>
<td>25.2</td>
</tr>
<tr>
<td></td>
<td>W</td>
<td>0</td>
<td>220</td>
<td>0.3h</td>
<td>20.9</td>
</tr>
</tbody>
</table>

* Means within trait and parameter groupings with different superscripts are significantly different, P < 0.05.

Rams from the W- line were significantly older and lighter than W+ rams for both definitions of puberty (Table 2). W- rams were also significantly older than the R rams for both definitions of puberty. There was no difference between the lines in predicted stage of maturity at puberty.
DISCUSSION

Based on the predicted maximum rate of change in testicular diameter, random bred ram lambs in the current study reached puberty at $152.2 \pm 10.6$ days of age and $22.2 \pm 1.3$ kg live weight (Table 2). Comparable figures for the predicted attainment of a mature penis development status were $181.9 \pm 7.4$ days and $25.2 \pm 1.4$ kg. These values compare well with the reports of Dun (1955) and Pretorius and Marincowitz (1968). The predicted values for mature live weight and testicular diameter for all lines, also compare favourably with measured values (Davis et al. 1984).

The results in Table 2 indicate that there are differences between the $W^+$ and $W^-$ lines in predicted age and predicted live weight at puberty. However these differences are largely a function of mature size since there is no difference between the lines in stage of maturity at puberty for either definition.

With no differences in the shape parameters the patterns of change in TDM, PD and WT with AGE were the same across lines suggesting that similar physiological mechanisms operated in each case. Overall, there is thus no suggestion that selection for weaning weight over 12 generations has had any effects on puberty in the ram lambs.

In the current experiment puberty predicted by mature penis development is at an older age, heavier live weight and later stage of maturity than that predicted by maximum testicular growth rate (Table 2). This result is in general agreement with the literature (Watson et al. 1956; Pretorius and Marincowitz 1968).

REFERENCES