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Inheritance of loose wool bulk in Romney and Perendale sheep

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ABSTRACT
Genetic parameters of loose wool bulk were estimated by half-sib correlation for Romney ewe and ram hogget fleeces sampled at Tokanui Research Station, Romney and Perendale ewe hogget fleeces sampled at Rotomahana Research Station and Perendale ewe hogget fleeces sampled from 5 industry flocks. Daughter-dam analyses were used to estimate similar parameters for Perendale ewe fleeces sampled at Whatawhat a Hill Country Research Station.

Heritability estimates for loose wool bulk were 0.34 ± 0.08 (Tokanui) and 0.35 ± 0.16 (Rotomahana) for Romneys and 0.93 ± 0.28 (Rotomahana), 0.42 ± 0.08 (Industry) and 0.70 ± 0.16 (Whatawhata) for Perendales. Selection for loose wool bulk can be expected to bring about little change in greasy fleece weight, a decrease in staple length and little change in mean fibre diameter for the Romney but an increase in mean fibre diameter for the Perendale.

High heritability estimates and other circumstantial evidence are suggestive of simple inheritance of bulk in Perendales.

Keywords Loose wool bulk; Romney; Perendale; inheritance; fleece weight; staple length; fibre diameter.

INTRODUCTION
Loose wool bulk is an objective fleece characteristic with financial significance for wools produced into carpet yarn by the semi-worsted process (Elliott, 1984). Improved loose wool bulk results in a higher “apparent value” in the finished carpet (Carnaby and Elliott, 1980). With the production of carpet yarn by this process being a major end-use of New Zealand grown crossbred type wool it would be beneficial for individual wool producers to be able to increase the loose wool bulk of their clips.

There is a large variation in loose wool bulk between wools from different breeds ranging from less than 20 cm²/g for Leicester/Lincoln to over 35 cm²/g for Downcross (Carnaby and Elliott, 1980). The range for the 3 most numerous crossbred wool type breeds is considerably less (Table 1). Differences of greater than 15% in loose wool bulk have been shown to produce a detectable difference in yarn bulk (Carnaby and Elliott, 1980). Loose wool bulk of the Border Leicester and the Romney are similar and not influenced by crossbreeding (Table 1). The Perendale however, is intermediate between the Romney and the Cheviot with both the Perendale and Cheviot having a greater within-breed variation than the other breeds listed in Table 1. The different distributions have been illustrated by Elliott (1981). The difference in loose wool bulk between the Romney, Perendale and Cheviot is also of commercial significance. Aspects of the inheritance of loose wool bulk in the Coopworth are not considered further.

This paper presents a summary of results from 4 sources on the inheritance of loose wool bulk in Romney and Perendale sheep.

EXPERIMENTAL
Midside wool samples were taken at hogget shearing in October from several groups of sheep as part of 4 separate trials. Samples were individually measured for staple length, loose wool bulk (Bigham et al., 1984) and mean fibre diameter (Lynch and Michie, 1976). Greasy fleece weight was also recorded.

The mating procedure and location of the 4 trials were:

Trial 1: 1924 Romney ewe and ram hoggets born within single sire mated groups of approximately 20 progeny/sire at Tokanui Research Station between 1969 and 1972.

Trial 2: 387 Romney and 400 Perendale ewe hoggets born within single sire mated groups of approximately 20 progeny/sire at Rotomahana Research Station between 1979 and 1981.

Trial 3: 2116 Perendale ewe hoggets born within single sire mating groups of
TABLE 1 Mean ± SD (frequency) loose wool bulk for Border Leicester, Romney and Cheviot fleece wool and the derived Coopworth and Perendale crossbreeds.

<table>
<thead>
<tr>
<th>Age</th>
<th>Border Leicester</th>
<th>Coopworth</th>
<th>Romney</th>
<th>Perendale</th>
<th>Cheviot</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hogget</td>
<td>-</td>
<td>21.1 ± 3.1(84)</td>
<td>20.4 ± 2.5(49)</td>
<td>26.4 ± 3.1(143)</td>
<td>29.2 ± 4.0(75)</td>
<td>Sumner et al. 1981</td>
</tr>
<tr>
<td></td>
<td>19.7± 1.6(16)</td>
<td>20.2± 1.2(46)</td>
<td>21.6± 1.6(25)</td>
<td>23.3± 3.0(40)</td>
<td>24.7± 3.5(22)</td>
<td>Elliott, 1981</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>20.6± 2.8(387)</td>
<td>26.2± 3.5(400)</td>
<td>-</td>
<td>Bigham, unpublished</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>33.2± 3.6(107)</td>
<td>-</td>
<td>Sumner and Bigham, unpublished</td>
</tr>
<tr>
<td>Ewe</td>
<td>-</td>
<td>22.4± 1.3(42)</td>
<td>20.7± 1.5(49)</td>
<td>25.9± 3.1(40)</td>
<td>-</td>
<td>Carnaby and Elliott 1980</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>21.2± 2.4(171)</td>
<td>20.0± 2.5(190)</td>
<td>25.3± 4.0(175)</td>
<td>-</td>
<td>Sumner and Bigham, unpublished</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>28.8± 4.4(138)</td>
<td>-</td>
<td>Sumner and Bigham, unpublished</td>
</tr>
</tbody>
</table>

approximately 15 progeny/sire (chosen at random) in 5 industry flocks in the central region of the North Island between 1981 and 1983.


In Trials 1 to 3 sires were considered to have been randomly allocated to their mates with respect to loose wool bulk and to be representative of the variation present within their breed. Paternal half-sib analyses of variation using mixed-model least squares procedures were used to derive heritability estimates. For Trial 4, sires were unknown and heritability was estimated from the regression of daughter on dam.

RESULTS AND DISCUSSION

Heritability

Derived heritability estimates are given in Table 2. Estimates for the Romney are in good agreement with previous estimates reported by Bigham et al. (1983) and by Watson et al. (1977), for resistance to compression in the Australian Merino. Estimates for the Perendale are consistently higher than those for the Romney. Heritability estimates for the other measured characteristics within both breeds were in good agreement with other published estimates.

TABLE 2 Heritability estimates for loose wool bulk

<table>
<thead>
<tr>
<th>Trial</th>
<th>Romney</th>
<th>Perendale</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.34 ± 0.08</td>
<td>-</td>
<td>Half-sib</td>
</tr>
<tr>
<td>2</td>
<td>0.35 ± 0.16</td>
<td>0.93 ± 0.28</td>
<td>Half-sib</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>0.42 ± 0.08</td>
<td>Half-sib</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
<td>0.70 ± 0.16</td>
<td>Daughter-dam</td>
</tr>
</tbody>
</table>

Genetic Correlations

Estimates of genetic correlations between loose wool bulk and fleece weight, staple length and mean fibre diameter are given in Table 3. Selection for loose wool bulk would be expected to have little effect on greasy fleece weight. Staple length can be expected to decrease with the decrease being greater for the Perendale than the Romney. Similarly while mean fibre diameter of the Romney would not be expected to change, mean fibre diameter of the Perendale is likely to increase. Similar expectations to those for the Perendale have been reported for greasy fleece weight, staple length and mean fibre diameter (airflow) by Watson et al. (1977) following selection for resistance to compression in the Australian Merino.

TABLE 3 Genetic correlation between loose wool bulk and other measured wool traits

<table>
<thead>
<tr>
<th>Trial</th>
<th>Fleece weight</th>
<th>Staple length</th>
<th>Fibre diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Romney</td>
<td>1 0.07 ± 0.17</td>
<td>-0.17 ± 0.17</td>
<td>-0.09 ± 0.16</td>
</tr>
<tr>
<td></td>
<td>2 -0.27 ± 0.32</td>
<td>-0.35 ± 0.43</td>
<td>0.26 ± 0.32</td>
</tr>
<tr>
<td>Perendale</td>
<td>2 0.09 ± 0.29</td>
<td>-0.92 ± 0.16</td>
<td>0.29 ± 0.28</td>
</tr>
<tr>
<td></td>
<td>3 -0.15 ± 0.16</td>
<td>-0.47 ± 0.18</td>
<td>0.41 ± 0.14</td>
</tr>
</tbody>
</table>

Major Gene Hypothesis

The following circumstantial evidence suggests that the expression of loose wool bulk may be due to the action of one or, at the most, relatively few genes:

- large between-breed variation in loose wool bulk with the mid-range genotypes having a higher within-breed variation than the low-range genotypes (Elliott, 1981) and in particular...
ii) similar variation within the Cheviot and Perendale which is greater than within the Romney

iii) higher heritability estimates for loose wool bulk in Perendales.

The regression approach of Fain (1978) for investigating the presence of a major gene was used to examine the relationship between the variance of half-sib families and their mean for loose wool bulk among the Perendale families in Trials 2 and 3. Given the presence of a major gene effect on loose wool bulk, the variance of families of half-sibs containing heterozygotes should be greater than those containing homozygotes. Since ewes were allocated to rams at random within both trials this should be reflected by a curvilinear relationship between the variance and the mean. While there was a significant linear relationship between the variance and the mean no quadratic relationships were detected.

The possibility of a major gene segregating in these flocks should not however be entirely ruled out on the basis of this analysis. Fain (1978) suggests that a linear relationship could be due to extreme or varying gene frequencies of a major gene and its allele(s) in different families or flocks, or to dominance.

Genetic control of loose wool bulk is being further investigated using an assortive mating programme in Perendale industry flocks (Trial 3) and in Romney, Perendale and Cheviot flocks at Whatawhata Hill Country Research Station. Early results have given evidence of strong inheritance through sire-progeny ties and reasonable agreement with Mendelian expectations.

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