MAKING SHEEP LESS ATTRACTIVE TO THE BLOWFLY

INTRODUCTION

D.G. SAVILLE*

Blowfly strike represents one of the most important management problems facing the sheep producer. Even when it does not cause death, it can lead to production losses in wool, live weight and reproductive performance. There are also substantial costs involved in the prevention and treatment of strike. The most recent Bureau of Agricultural Economics' survey suggested a total cost to the industry of $55m (Brideoake 1979).

The options open to the producer to control strike include such management practices as mulesing, docking to the optimum tail length, and jetting, as well as the longer term approach of breeding for reduced susceptibility. The first paper will attempt to review these management options and outline industry attitudes to the breeding of sheep for resistance to flystrike. Subsequent papers will report scientific evaluation of these attitudes to breeding. These will cover direct selection for increased resistance as well as evaluating some skin and wool characters as indirect selection criteria.

MANAGEMENT PRACTICES FOR CONTROLLING FLYSTRIKE

B.G. BAILLIE**

Management options open for blowfly control have changed little since the results of research by Belschner (1937) and Graham et al. (1947) were made available to the industry. This paper discusses the types of strike, their incidence, and control operations by management. Also the industry's attitude and approach to control by selection and breeding of sheep which are less susceptible to body strike is presented.

TYPES OF STRIKES AND THEIR INCIDENCE

(i) Breech strike. Breech strike (tail and crutch) is the most common form of strike and occurs to some degree in almost every flock, every year. Incidence and severity depends on the susceptibility of the sheep and predisposing factors such as scouring, caused by digestive disorders and internal parasites. There is limited information available on the incidence of various types of strike. Results of a field survey in New South Wales (Watts et al. 1979) in which an average of 80,000 sheep were observed over two consecutive years, showed that 62 per cent of all strikes recorded were breech strikes. Over the two years an average of 3.9 per cent of sheep were observed with breech strike. The incidence of breech strike for unmulesed Merinos was 10.6 per cent and for mulesed Merinos it was 1.5 per cent.

(ii) Body strike. Although of lower regular incidence than breech strike body strike is less predictable, is more difficult to control and has a greater potential to cause economic loss. Body strike mostly occurs during wet seasons. Fleece rot is usually the predisposing factor (Seddon 1931) and is more common in weaners and hoggets than older sheep. Experience shows that serious outbreaks of body strike occur about one year in four or five in the Tablelands and Slopes areas of New South Wales. The field survey conducted by Watts et al. (1979)

*Department of Agriculture, Trangie, N.S.W. 2823.
**Department of Agriculture, Gunnedah, N.S.W. 2380.
showed that the incidence of body strike in two consecutive years was 0.4 per cent and 3.2 per cent. The first year was relatively dry and the second was wet, particularly in the autumn months.

(iii) Other types of strike Poll strike is common in rams. Watts et al. (1979) reported that, of the 31 ram flocks surveyed, 11 had an incidence exceeding ten per cent. Pizzle strike can be a major cause of loss in wethers and rams. Strike can also occur in marking, mulesing, shearing and fighting wounds and on the after-birth stained udders of lambing ewes.

CONTROL BY MANAGEMENT

(i) Breech strike Breech strike is a perennial problem, particularly in scouring sheep. The predisposing causes of scouring can usually be avoided by controlling internal parasites and avoiding nutritional upsets by planned grazing management. Combined with this, radical mulesing at marking, docking tails no shorter than the second palpable joint, and crutching should largely overcome the problem. There is evidence (Graham et al. 1947; Dun 1964) supporting mulesing as an effective means of reducing breech strike and this practice has gained wide acceptance. Watts et al. (1979) reported that, in 1974, approximately 80 per cent of Merino ewes in New South Wales were mulesed. The effectiveness of mulesing is reduced when sheep are scouring badly (Watts and Luff 1978) particularly when associated with butted or short tails.

(ii) Body strike Many producers shear during the spring or autumn months to control body strike in potential problem areas. Shearing usually gives protection for at least two or three months.

The development of organophosphate resistance by Lucilia cuprina and the high labour component required for hand jetting has reduced producer reliance on insecticides. The introduction of the new blowfly insecticide Vetrazin (R), in late 1979, has renewed some producer confidence in chemical control. Vetrazin (R) is claimed to give longer periods of protection than other insecticides (Hart et al. 1979) and tests have indicated that Lucilia cuprina larvae, resistant to organophosphates, have not developed cross resistance to the new chemical.

The use of labour-saving jetting races is gaining popularity. Although this method of insecticide application is not as effective as hand jetting, preliminary field trial results (J. Herdegen unpublished data) and producer experiences have shown reasonable success.

(iii) Other types of strike Control of poll strike is limited to wigging and treatment with insecticides. The surgical operation of pizzle dropping is showing promise (Donnelly 1979) as a means of pizzle strike control.

CONTROL BY SELECTION AND BREEDING

To breed sheep which are less susceptible to flystrike is an additional approach to blowfly control particularly body strike control. Genetic means offer the opportunity to reduce the problem on a more permanent basis. There are a number of characters associated with the fleece, skin and conformation which can make sheep more susceptible to flystrike. In particular these are: fleece rot; wrinkle; conformation faults of the withers, back and shoulder blades; and mycotic dermatitis. Fleece rot is by far the greatest predisposing cause of body strike according to Seddon (1931) and Watts et al. (1980). This section of the paper will discuss industry attitudes and paces in relation to selection and breeding of sheep which are less susceptible to fleece rot and body strike.
Within the Merino industry it is believed that the fine wool Saxon strain and the medium wool Spanish strain are less susceptible to fleece rot than either the medium and strong wool Peppins or the strong wool South Australian strain. However, experience has shown that there are also considerable differences both between bloodlines and between studs within bloodlines. Some daughter studs located in high rainfall environments apply more selection pressure against fleece rot and associated characters than do their parent studs which are located in lower rainfall areas. The difference in fleece rot incidence and body strike between strains, bloodlines, studs and individual sheep indicates that there is potential through selection for producers to breed sheep which are less susceptible to fleece rot and body strike. In fact, this objective has been achieved by many sheepbreeders and classers in both flocks and studs. Breeders in the high rainfall Tableland areas of New South Wales are far more conscious of the need for selection against fleece rot than breeders in the lower rainfall Slopes and Plains areas. Sheep classer, John Coy (personal communication) estimates that the weight of selection pressure against fleece rot in high rainfall areas rates about 75 to 80 per cent relative to selection for or against all other characters. This selection pressure is reduced to 30 per cent or less in studs situated in the Slopes and Plains areas. In most situations sheep showing severe fleece rot, or sheep which have been struck on the body, are culled from the breeding flock. The low incidence of fleece rot in some years due to seasonal conditions makes it difficult to identify susceptible animals.

In addition to direct selection sheepbreeders have selected for other characters thought to be related to resistance to fleece rot and body strike. Fleece characteristics which the industry use as indicators of susceptibility are: yellowish or creamy colour; pencilly staples; open, dry, uneven and pointed tips of staples; low density; harsh handle; and lack of character. In contrast, fleece characteristics which appear to confer susceptibility to fleece rot are: bright white colour; good density; well defined crimp of good character; blocky tip; soft handle; and good staple length. Fleeces exhibiting these properties are believed to resist moisture intake.

Conformation faults of the withers, shoulders and back (devil's grip, swampy back and depressions between shoulder blades) tend to promote the retention of moisture making these localised areas more prone to fleece rot and strike. The incidence of these faults is usually very low and any animal with them are usually culled.

Attempts to eliminate fleece rot completely may be a mistake. Sheep classers believe that high selection pressure to eliminate fleece rot will lead to a decline in fleece weight. To maintain reasonable fleece weights a certain amount of fleece rot may have to be tolerated.

CONCLUSION

While breech strike, pizzle strike and poll strike continue to be significant problems, sound management practice combined with surgical operations can reduce the incidence of these types of strike to tolerable levels. Body strike is difficult, expensive and often impossible to control by management. The long term aim should be to breed sheep which are less susceptible to body strike. The industry realizes that there is variation between and within strains, bloodlines and studs for susceptibility to fleece rot. However, further research is needed to:
determine the value of direct selection methods to reduce susceptibility;
evaluate the effect of selection for fleece characters thought to be
indirectly associated with fleece rot; and
investigate the possibility of developing reliable objective or subjective
criteria for identifying susceptible sheep.

GENETIC IMPROVEMENT OF RESISTANCE TO BODY STRIKE

K.D. ATKINS*, B.J. McGUIRK* and K.J. THORNBERRY*

INTRODUCTION

This paper examines the potential for reducing the susceptibility of sheep
to fleece rot and body strike by direct selection. Information is provided on
the degree of genetic variability for fleece rot and body strike both between
and within-flocks of Merinos. Estimates of the repeatability and heritability
of fleece rot and its genetic relationship with body strike are presented.

MATERIALS AND METHODS

The analyses were done on two large data sets at Trangie Agricultural
Research Station.

(i) Control flock data Fleece rot was scored among hogget animals of both
sexes from a randomly selected control flock between 1962 and 1976. The animals
were scored along the top line immediately prior to shearing and scores ranged
from zero (no fleece rot) to five (very heavy fleece rot). Only the data on
incidence of fleece rot (unaffected or affected) are presented here.

Least squares analysis of variance was used to adjust fleece rot incidence
for the effects of year, sex and the interaction between year and sex. A half-
sib estimate of heritability was obtained from this analysis. The weighted
number of progeny per sire was 6.8, with 305 degrees of freedom for sires.

(ii) Strain comparison data The design of this research-programme has been
described in detail by McGUIRK et al. (1978). Briefly, 15 closed flocks of
Merino ewes were established, representing all the major Merino strains
comprising two fine wool, two medium non-Peppin, ten medium Peppin
and one strong wool bloodlines. The numbers of bloodlines reflects the relative importance of
the strains in New South Wales. Each of the 15 flocks contained 100 ewes which
have been joined to three new rams each year since 1975.

Weaners of both sexes born in spring 1975, 1976 and 1977 were scored for
fleece rot incidence at six-eight months of age. Adult ewes were again scored
for fleece rot incidence immediately prior to shearing (October). Observations
were available on two-year-old ewes in 1977, two and three year old ewes in
1978, and two, three and four year old ewes in 1979. Body strike incidence on
all animals was recorded when the struck areas were treated.

The incidence of fleece rot and body strike among weaners were analysed by
least squares analysis of variance for the effects of strain, flocks within
strain, sex, year, interactions between flocks and years, and sires within flocks
within years. The covariance between fleece rot and body strike was also
estimated using this model. Half-sib estimates of heritabilities and genetic
correlation were obtained from these analyses. The weighted number of progeny
per sire was 22.8, with 94 degrees of freedom for sires.

*Department of Agriculture, Trangie, N.S.W. 2823.
Animal production in Australia

The incidence of fleece rot among adult ewes, together with their weaner record, were used to estimate repeatability. Intra-class correlations were estimated within flocks and years of birth and then pooled (Turner and Young 1969). A total of 1,131 ewes (with an average of 2.96 records per ewe) contributed to the repeatability estimate.

RESULTS

(i) Flock differences. Strains, flocks within strain and the interactions of strains and flocks with years were all significant sources of variation in the incidence of fleece rot and body strike among weaners.

The ranking of the strains on decreasing incidence of both fleece rot and body strike was strong, medium and fine, and differences between strains increased as the mean yearly incidence increased (Table 1).

<table>
<thead>
<tr>
<th>Strain</th>
<th>Year of birth</th>
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<tbody>
<tr>
<td></td>
<td>1975</td>
</tr>
<tr>
<td>Fine wool</td>
<td>6.0</td>
</tr>
<tr>
<td>Medium wool</td>
<td>39.9</td>
</tr>
<tr>
<td>Strong wool</td>
<td>67.2</td>
</tr>
<tr>
<td>Mean</td>
<td>37.2</td>
</tr>
</tbody>
</table>

Variation between flocks within strains was as important as variation between strains as only 45 per cent of the between-flock variation in both fleece rot and body strike was accounted for by strain effects. For example, the ranges in flock means of fleece rot incidence for medium Peppins were 13% to 64%, 14% to 40% and 0% to 12% for animals born in 1975, 1976 and 1977 respectively (cf. Table 1).

(ii) Repeatability. Means for fleece rot incidence among ewe ages in adult ewes (run together at all times) were 19%, 11% and 9% for two, three and four year old ewes respectively. There were insufficient data for analysis of body strike incidence among adult ewes.

The average repeatability of fleece rot incidence was 3.12 ± 0.02. The 15 flocks were then subdivided into three groups of five flocks based on their average susceptibility. The average repeatabilities in these 'susceptible', 'intermediate' and 'resistant' groups were 0.19, 0.09 and 0.01 respectively.

(iii) Heritabilities and genetic correlation. The estimated within-flock heritabilities of fleece rot and body strike from the strain comparison data were 0.15 ± 0.05 and 0.03 ± 0.04 respectively. The average incidences of fleece rot and body strike were 23% and 7% respectively. The estimated genetic correlation between the two conditions exceeded 1.0.

The heritability of fleece rot from the control flock data was 0.18 ± 0.06. From this analysis, the years were subdivided into three groups (low, moderate and high incidence) on the mean yearly incidences. The heritability of fleece rot incidence was then re-estimated within each incidence level. These heritability estimates together with the estimate from the strain comparison...
trial are shown in Table 2 and can be seen to be related to the corresponding incidence of fleece rot.

<table>
<thead>
<tr>
<th>TABLE 2</th>
<th>Incidence level and heritability of fleece rot</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Incidence (%)</td>
</tr>
<tr>
<td>Control flock data</td>
<td></td>
</tr>
<tr>
<td>High incidence</td>
<td>78%</td>
</tr>
<tr>
<td>Moderate incidence</td>
<td>37%</td>
</tr>
<tr>
<td>Low incidence</td>
<td>16%</td>
</tr>
<tr>
<td>Strain comparison data</td>
<td>23%</td>
</tr>
</tbody>
</table>

DISCUSSION

Differences between strains in predisposition to fleece rot and body strike were similar to those reported by Dunlop and Hayman (1958). However, the large differences observed between bloodlines within the medium Peppin strain indicates that within that strain there is considerable scope for improving resistance to fleece rot by selecting between bloodlines.

There is also scope for genetic improvement within bloodlines and culling animals with fleece rot should lead to improvements in the resistance of a flock to fleece rot in both the current and future generations. In view of the high genetic correlation between fleece rot and body strike, such a selection programme should also increase resistance to body strike. The effectiveness of a direct selection programme will be affected by the incidence of fleece rot (Table 2). In this study, there was a close relationship between the heritability of fleece rot and its incidence, as is expected for a binomially distributed trait (Hill 1977).

INDIRECT SELECTION FOR INCREASED RESISTANCE TO FLEECE ROT AND BODY STRIKE

B.J. McGuirk and K.D. Atkins

INTRODUCTION

The major difficulty with direct selection for reduced predisposition to fleece rot and body strike is the variable and generally low incidence of these faults. An alternative approach is one of indirect selection, in which skin or wool characters are used as selection criteria to identify the more resistant animals. Indirect selection is generally the only option open to flock ram buyers as they are rarely offered rams showing evidence of fleece rot or body strike.

For an indirect selection programme to be effective, the character used as a selection criterion should show a number of features. It should:

- have a wide range of expression;
- be able to be scored or measured in all years;
- have a high heritability; and
- have a high genetic correlation with predisposition to fleece rot and body strike.
While there are no published estimates of genetic correlations with fleece rot or body strike, a number of wool and skin characters have been suggested as alternative selection criteria. These have generally been identified from within-flock comparisons of resistant and affected animals after an outbreak of fleece rot or body strike. The present study will examine the likely value of three such characters as indirect selection criteria, namely wool colour, character and handle. In earlier studies resistance to fleece rot has been found to be associated with white bright wool, good character and soft handle, with colour showing the most consistent relationship (Holdaway and Mulhearn 1934; Hayman 1953; Paynter 1961).

These same characters are also commonly claimed by sheepbreeders and classers to be useful when identifying resistant animals.

MATERIALS AND METHODS

Over a 15 year period ram and ewe hoggets in unselected Peppin Merino flocks at Trangie were scored for fleece rot as described by Atkins, McGuirk and Thornberry (these proceedings). For many of these animals colour and character was scored on a mid-side sample of greasy wool while handle was scored after scouring. Scores given were from one to five with a score of one denoting least and five greatest merit for the trait (Morley 1955). Information on all four characters was available on 1,256 animals.

RESULTS

Average scores for wool colour, character and handle were compared between animals without (score 0) and those with (scores 1 - 5) fleece rot, after removing the effects of sex and years. The only statistically significant difference was in wool colour, where the animals without fleece rot had a higher average score, indicating that their wool showed less discolouration (3.53 vs 3.13; \( P < .05 \)), The animals without fleece rot also had slightly high scores for character (3.37 vs 3.30; N.S.), but there was no difference in handle.

The association between colour and fleece rot was then examined in an analysis in which colour was included as an independent variable along with sex and years. Significant differences were found between colour scores in both the incidence of fleece rot (0 vs 1 and above) and overall fleece rot score (0 - 5) (Table 3). The phenotypic regressions of fleece rot incidence and score on wool colour were respectively -0.6 per cent/unit score and -0.262 units/unit score.

<table>
<thead>
<tr>
<th>Colour score</th>
<th>Frequency (%)</th>
<th>Incidence of fleece rot (%)</th>
<th>Fleece rot score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.4</td>
<td>60.0</td>
<td>1.57</td>
</tr>
<tr>
<td>2</td>
<td>14.7</td>
<td>65.0</td>
<td>1.41</td>
</tr>
<tr>
<td>3</td>
<td>35.4</td>
<td>49.0</td>
<td>1.08</td>
</tr>
<tr>
<td>4</td>
<td>31.0</td>
<td>31.0</td>
<td>0.81</td>
</tr>
<tr>
<td>5</td>
<td>15.4</td>
<td>33.0</td>
<td>0.60</td>
</tr>
</tbody>
</table>

Genetic correlations were then estimated between the wool traits and fleece rot in a half-sib analysis of variance (Table 4). The genetic and phenotypic correlations between colour and fleece rot incidence and score were similar and
Animal production in Australia

approximately -0.2. Genetic correlations with wool handle were of similar magnitude. The heritability estimates for the wool traits were all moderately high and similar to those reported by Morley (1955).

<table>
<thead>
<tr>
<th>Wool traits</th>
<th>Heritability</th>
<th>Phenotypic correlations</th>
<th>Genetics correlations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Incidence (%) Score (0-5)</td>
<td>Incidence (%) Score (0-5)</td>
</tr>
<tr>
<td>Colour</td>
<td>.61 (.11)</td>
<td>-.20 -.22</td>
<td>-.24 (.17) -.18 (.15)</td>
</tr>
<tr>
<td>Character</td>
<td>.48 (.11)</td>
<td>-.04 -.04</td>
<td>-.01 (.20) .08 (.17)</td>
</tr>
<tr>
<td>Handle</td>
<td>.66 (.11)</td>
<td>.0 .01</td>
<td>-.20 (.17) -.17 (.14)</td>
</tr>
</tbody>
</table>

The value of wool colour as an indirect selection criterion has been further examined, by estimating the relationship between colour scores among dams and fleece rot incidence in their offspring. This was carried out in a least squares analysis of variance, using a model which also took into account the year of birth of both the dam and her offspring and the sex of the offspring. The genetic regressions of fleece rot incidence and fleece rot score on colour score were estimated as -2.5 per cent and -0.091 units per unit change in colour score respectively.

These estimates can be used to predict the effect of selecting for improved wool colour on the incidence of fleece rot. For example, let us suppose that ram replacements are selected only from colour grade five and that the 60 per cent of hogget ewe replacement have an average score of 4.03, compared with a flock average of 3.40 (Table 3). The expected change in colour score is then the selection differential x heritability of wool colour (1.12 x 0.61) or 0.68 units per generation. The expected change in fleece rot is the product of the response in wool colour and the genetic regression of fleece rot on colour. The expected reduction is thus 1.7 per cent, from 45.7% to 44.0% per generation.

DISCUSSION

This study has confirmed the earlier reports of a phenotypic association between fleece rot and wool colour and demonstrated that the two are genetically correlated. However, while the heritability of wool colour is quite high, a genetic correlation with fleece rot of only -0.2 does not suggest that it would be a particularly useful indirect selection criterion. These studies are currently being extended to assess the value of other wool and skin characters as indirect selection criteria, along with a yield, staple length, crimp frequency and follicle density. The aim will be to examine both the separate effects of these traits in indicating predisposition and their value in an index which combines information on a number of possible indirect selection criteria.

One of the most widely used procedures for identifying promising indirect selection criteria is to compare groups of animals with and without fleece rot for a range of fleece and skin characters. One of the difficulties with past studies of this type is that results are presented simply in terms of average differences between the groups. Their value would be improved if phenotypic correlations with fleece rot or regressions of the character under examination...
Animal production in Australia

on fleece rot were presented. While a final assessment requires information on the heritability of the trait and its genetic correlation with fleece rot, the phenotypic and genetic correlations in the present study were of similar magnitude just as they are for most hogget wool traits (Brown and Turner 1968). The phenotypic regression can likewise be used as a preliminary estimate of the genetic regression, if multiplied by the square root of the ratio of the heritability of the trait being examined, to the heritability of fleece rot.

SKIN, WAX AND SUINT CHARACTERS AS POSSIBLE INDIRECT SELECTION CRITERIA

K. J. THORNBERY*, E.A.B. KOWAL* and K.D. ATKINS*

INTRODUCTION

The development of fleece rot lesions in sheep was described by Hayman (1953). He showed that prolonged wetting of the skin was necessary for the development of fleece rot and that the lesions were associated with thickening of the epidermis, shedding of cornified cells and subcutaneous oedema. Serous fluid leaks through the skin surface forming the characteristic matted band and provides an excellent growth medium for bacteria (Merritt and Watts 1979). Follicle plugs may also occur more frequently in the fleece rot lesions (Nay and Watts 1977) and these may break the continuity of the skin allowing leakage of serous fluid.

The current work at Trangie is endeavouring to quantify the histopathological changes that occur with the development of fleece rot. Increased stratum corneum thickness, increased capillary diameter and reduced skin surface wax thickness have all been observed with increased severity of fleece rot (E.A.B. Kowal unpublished data). Also skin surface characteristics are being identified which may differ between naturally different and susceptible animals. Hence there is a close connection between the histopathological description of fleece rot and the assessment of skin characters which could act as indirect selection criteria. The wax layer on the skin would appear to serve as a protective barrier to moisture, a barrier which must be broken before fleece rot will develop. Wax and suint characteristics of the fleece especially close or adjacent to the skin may reflect the integrity of this barrier, wax and suint characteristics of the fleece are also being evaluated as indirect selection criteria.

The major difficulties in assessing skin and fleece characteristics as indirect selection criteria are the number and cost of individual measurements needed to obtain reliable estimates of genetic correlations with fleece rot. We have attempted to overcome this problem by firstly identifying the most likely characters from the size of their between-flock correlations with fleece rot susceptibility. These can then be examined in more detail to obtain estimates of within-flock genetic correlations and heritabilities. On the basis of published information, Atkins and McGuirk (1976) concluded that in the Australian Merino the two correlation estimates were generally similar although not universally so.

MATERIALS AND METHODS

(i) Sheep All sheep used in the experimental work were hogget ewes from the Trangie Flock of 15 different bloodlines, representing the major strains in the Australian Merino population (see Atkins et al. these proceedings).

*Department of Agriculture, Trangie, N.S.W. 2823.
(ii) Wax and suint extraction  All extractions were made on 7 - 8 gm wool samples. These were taken from the mid-side which has been found to have wax and suint contents which are representative of the fleece as a whole (Thornberry and Atkins unpublished data). The wax was removed by soxhlet extraction with petroleum ether (Shell X222 (R)). The suint was removed by three washings with distilled water after soxhlet extraction. Both the wax and suint contents were expressed as percentages of the clean wool weight (Daly and Carter 1954).

RESULTS

(i) Variation between bloodlines  Wax and suint contents were estimated on three drops of hogget ewes from all flocks (15 months old, with 12 months wool growth). Fifteen hundred animals have now been sampled with a minimum of 42 sheep per flock. After removing the effects of years significant differences existed between strains and between bloodlines within strains for wax and suint content and wax:suint ratio (Table 5).

TABLE 5  Flock means for wax and suint content and wax:suint ratio

<table>
<thead>
<tr>
<th>Flock</th>
<th>Wax content*</th>
<th>Suint content*</th>
<th>Wax:suint ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine wool</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>18.3</td>
<td>9.2</td>
<td>2.20</td>
</tr>
<tr>
<td>2</td>
<td>23.2</td>
<td>7.0</td>
<td>3.20</td>
</tr>
<tr>
<td>Medium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>17.8</td>
<td>7.2</td>
<td>2.82</td>
</tr>
<tr>
<td>2</td>
<td>16.9</td>
<td>9.1</td>
<td>1.96</td>
</tr>
<tr>
<td>Non-Peppin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>18.8</td>
<td>9.1</td>
<td>2.19</td>
</tr>
<tr>
<td>2</td>
<td>22.0</td>
<td>8.5</td>
<td>2.67</td>
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<td>10</td>
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<td></td>
</tr>
<tr>
<td>1</td>
<td>14.3</td>
<td>8.6</td>
<td>1.71</td>
</tr>
</tbody>
</table>

Least significant difference  2.2  1.2  0.25

Within-flock Coefficient of Variation  28%  27%  36%

* Estimated as a percentage of the clean wool weight

(ii) Heritability estimates  Data from one drop of ewes (1976) were used to estimate heritability of wax and suint levels. Forty-four sires were represented with a weighted average number of progeny per sire of 5.2. Estimates of the within-flock heritability of wax and suint content and the wax:suinet ratio, with their standard errors are 0.52 (0.30), 0.35 (0.28) and 0.51 (0.30).

(iii) Correlations with fleece rot incidence  Ewes from three drops were routinely scored for fleece rot at eight months of age. Forty per cent of each drop was then artificially wetted at nine months. The average incidence over all
Animal production in Australia

Flocks for natural and induced fleece rot was 23 per cent and 50 per cent respectively.

The between-flock correlation between wax content and fleece rot incidence is of the order of -0.4 for both natural and induced fleece rot, while the correlation with suint content is low (Table 6).

<table>
<thead>
<tr>
<th>Conditions for development of fleece rot</th>
<th>Wax content</th>
<th>Suint content</th>
<th>Wax:suint ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural</td>
<td>-0.46</td>
<td>-0.04</td>
<td>-0.34</td>
</tr>
<tr>
<td>Artificial</td>
<td>-0.38</td>
<td>-0.05</td>
<td>-0.23</td>
</tr>
</tbody>
</table>

(iv) Variation along staples. In 1976, 250 ewes were sampled for wax and suint content both prior to and following artificial wetting. Staples were cut into a two centimetre proximal portion and the remainder cut in half and referred to as the medial and distal portions.

Prior to wetting wax and suint contents were highest in the proximal portion of the staple and lowest at the distal end (Table 7). The effect of wetting was to increase this trend, especially for suint content.

<table>
<thead>
<tr>
<th>Section of staple</th>
<th>Wax content</th>
<th>Suint content</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-wetting</td>
<td>Post-wetting</td>
</tr>
<tr>
<td>Proximal</td>
<td>22.3</td>
<td>22.2</td>
</tr>
<tr>
<td>Medial</td>
<td>20.8</td>
<td>17.5</td>
</tr>
<tr>
<td>Distal</td>
<td>14.9</td>
<td>8.6</td>
</tr>
</tbody>
</table>

(v) Correlations between staple segment and fleece rot incidence. Table 8 shows the between flock correlations between fleece rot and wax and suint proportion along the staple. Although the correlations between wax and fleece rot were similar for all portions of the staple, the relationship between suint and fleece rot varied markedly between different portions of the staple.

<table>
<thead>
<tr>
<th>Section of staple</th>
<th>Wax content</th>
<th>Suint content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximal</td>
<td>-0.46</td>
<td>0.56</td>
</tr>
<tr>
<td>Medial</td>
<td>-0.59</td>
<td>0.03</td>
</tr>
<tr>
<td>Distal</td>
<td>-0.69</td>
<td>-0.61</td>
</tr>
</tbody>
</table>
DISCUSSION

The available evidence suggests that both wax and suint deserve further investigation as possible selection criteria to improve resistance to fleece rot. The levels of phenotypic and genetic variation that exist in wax and suint indicate that both characters will respond to selection. The need now is to see if the within-flock genetic correlations are of similar magnitude to the between-flock correlations and to examine the effects of wax and suint content on other production characters.

Previous studies (Hayman 1953; Paynter 1961) have indicated a variable association between wax and suint content and fleece rot. The present results indicate that some variability may arise for suint content depending on whether a particular segment of the staple or the whole staple is sampled. The between-flock correlations with fleece rot are much higher for suint content in the basal portion of the staple compared with the whole staple.

The favourable between-flock associations between fleece rot and wax and suint content, indicate that a more detailed examination of skin characters would be useful in the search for indirect selection criteria. Skin surface wax thickness and the characteristics of the wool follicle and its accessory organs are obviously of particular interest. The search for such indirect selection criteria will be facilitated from comparisons of the RESISTANT and SUSCEPTIBLE selection flocks developed at Trangie (McGuirk et al. 1978).

SUMMARY AND CONCLUSIONS

D.G. SAVILLE

It is well established that mulesing and tail docking to optimum tail length will reduce susceptibility to breech and tail strike (Watts et al. 1979). Most Merino breeders have adopted mulesing as an effective means of controlling breech strike and other sheep breeds may also benefit from these management practices (Reid and Jones 1976).

Susceptibility to body strike can be influenced by shearing time, insecticides or breeding. The costs associated with insecticides are likely to lead to less reliance on this management tool particularly in extensive pastoral areas where breeding may offer the only feasible approach to control body strike.

Results have shown that strong wool strains tend to be more susceptible than fine wool strains, but medium Peppin and non-Peppin strains were not found to differ. The wide variation between medium Peppin bloodlines indicates scope for breeders to get immediate improvement through selection between bloodlines. It also indicates the danger in generalizing about strain differences and suggests that estimates of between bloodline differences in other strains are needed.

Repeatability and heritability estimates so far obtained indicate that the culling of young animals with fleece rot should lead to improvement in the level of resistance in both the current and succeeding generations, and also lead to increased resistance to fly strike.

The progress that can be made with direct selection depends on the incidence of flystrike or fleece rot in the flock. This poses a problem with the Merino industry because many of the studs are located in areas of low rainfall but sell rams to high rainfall regions. To overcome this problem an artificial wetting regime could be used to identify susceptible animals. Alternatively indirect
selection could be used. Correlations have been observed between fleece rot and colour, character and handle but these are not particularly high. The higher between-flock correlations between wax and suint and fleece rot suggest that a more detailed examination of these and related skin and fleece characters is required.

Selection for resistance to fly strike is only one of the factors that a sheepbreeder has to consider. The correlations between fleece rot susceptibility and other major production characters such as fleece weight, reproductive performance and body weight also need to be determined. Research is underway to estimate these correlations.

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REFERENCES


