HERITABILITIES AND PHENOTYPIC CORRELATIONS FOR PIGMENTATION TRAITS IN PEPPIN MERINO SHEEP

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INTRODUCTION

Dark fibres are a recognised fault affecting wool consumption (Cardellino 1978). Presence of this fault cannot be reliably predicted presale and, therefore, control depends on steps taken by the producers and preparers of greasy wool (Fleet 1990). An important source of dark fibres arises from the natural pigment melanin that is produced within some hair and wool follicle bulbs and in skin epidermis of certain areas. This ability is a function of specialised cells called melanocytes and the number, location, and activity of these cells is influenced by several genes (Silvers 1979).

Merino breeders have traditionally accepted the importance of reducing fibre pigmentation and some have adopted an approach of also selecting against skin or hoof and horn pigmentation ('Old Hand' 1953). There is now scientific evidence to indicate that non-fleece pigmentation in Merino sheep is related to the occurrence of isolated pigmented fibres in the fleece (Fleet 1990). However, these associations have been largely accounted for by the presence of pigmented leg and horn site hairs or dark birthcoat halo-hair (Fleet et al. 1987 and 1989).

This paper discusses estimates of the heritability of various pigment traits from a flock of Peppin Merino sheep and the phenotypic correlations between these characters and the concentration of isolated pigmented fibres detected in the hogget fleece.

MATERIALS AND METHODS

The sheep were located at Trangie Research Centre and part of the multiple-bloodline flock (Mortimer and Atkins 1989). The 515 Medium Peppin ewes measured (age 1.5 years) were progeny of 43 sires from four flocks. The largest flock (55% of the sheep) was the Trangie Fertility flock and the other three flocks represented industry flocks.

There were three annual collections of fleeces (12 months wool growth, post lamb shearing) and scores for various types of non-fleece pigmentation recorded from hoggets post shearing. For the last two years scores for dark halo-hair on the birth coat and pigmented eye lashes at hogget age were also recorded. The scores for non-fleece pigmentation involved assessment of degree or area of black-grey and brown-tan as well as the total pigmentation (Fleet et al. 1987). The various types of pigmentation assessed are identified in Table 1. At shearing, the skirted fleeces were individually bagged and then transported to Adelaide for measurement of isolated pigmented fibres.

The method of fleece sample preparation and measurement is reported in Fleet et al. (1987). Each of the duplicate fleece samples for each sheep were allocated at random to three or two (final year) observers. All dark fibres exceeding 20mm removed from the fleece samples were permanently mounted and checked with a biological microscope to confirm melanin pigmentation. The result for isolated pigmented fibre concentration (IPF) represents the number of pigmented fibres detected per 10g scoured staples.

The data were analysed by least squares analysis of variance with the IPF values and several non-fleece pigment scores being transformed (Log10 Value + 1). An initial analysis indicated significant differences ($P<0.05$) between observers for the transformed variable (LIPF) for IPF. Adjustments were made to the LIPF values, to compensate for these differences, for the subsequent analysis. This analysis included flock and year as main effects and flock x year interaction, which were tested with the sire (nested within flock x year) mean square, while the birth-rearing type and dam age main effects, and the other first order interactions were tested with the error mean square, and day of birth used as a covariate.

The heritabilities shown in Table 1 were estimated using variance components obtained from the restricted maximum likelihood method (SAS 1985). In this case the model included flock, year, other significant main effects and interactions treated as fixed effects and sire (nested within flock x year) treated as a random effect. The few types of non-fleece pigmentation with birth date being significant were adjusted prior to analysis. Phenotypic correlations (Table 1) and genetic correlations between the various types of non-fleece pigment and LIPF were calculated using variance and covariance components obtained by the same method. The genetic correlations obtained will be reported in a later publication. The estimates marked F are based on few observations (less than 30) with greater than the minimum score.

RESULTS AND DISCUSSION

Among the 515 fleeces measured there were 217 with varying concentrations of isolated pigmented fibres (IPF) detected in the fleece samples. Among those affected 48% had an IPF of less than 1 per 10g, 43% had between 1 to 10 per 10g and 9% had greater than 10 per 10g. As few as 1 to 100 dark fibres per kg of top can lead to problems in the production of white and pastel fabrics (Foulds et al. 1984). The pigmented fibre concentrations (all degrees evident) may not directly equate to the levels of dark fibres in processed wool. Nevertheless, it is important that the wool industry minimises the potential for dark fibre problems (including isolated pigmented fibres) and where practical identify lines of wool that have a dark fibre risk (Foulds 1988).

With few exceptions the only significant ($P<0.05$) main effects found by analysis of variance were sire or flock and in most cases the interactions and covariate were not significant. This result reflects that the pigmentation traits generally were not influenced by the environment factors considered.

Most types of non-fleece pigment had high heritabilities, for example - dark halo-hair 0.68 ± 0.24 and nose skin 0.74 ± 0.20 but the heritability for LIPF (0.16 ± 0.11) was surprisingly low (Table 1). One other reported estimate for the heritability of LIPF was 0.45 ± 0.22 obtained from Corriedale sheep (Fleet et al. 1990). Most types of non-fleece pigmentation had low positive phenotypic correlations with LIPF which is consistent with an earlier report (Fleet et al. 1987). Genetic correlations were also mainly positive with large standard errors. The phenotypic correlation between LIPF and the score for dark halo-hair was 0.35 and the genetic correlation was 0.73 ± 0.17. These findings are also consistent with earlier results (Fleet et al. 1989). Apart from the increased risk of isolated pigmented fibres in the hogget fleece, some types of hair pigmentation (i.e. dark halo-hair, leg and horn site hairs) may contribute directly to the potential for dark fibre problems.

The inheritance of leg hair pigmentation has been studied in other breeds and is known to be associated with an increased occurrence of isolated pigmented fibres in the fleece (Adalsteinsson 1975; Fleet et al. 1987; Fleet and Stafford 1989). Terril (1947) suggested that leg hair pigmentation was not simply inherited in Columbia and Targhee sheep and reported heritability estimates of 0.26±0.05 and 0.34±0.07, respectively. Adalsteinsson (1975) also proposed that tan hair on the legs, face and body of Icelandic sheep was not simply inherited and reported a heritability of 0.46±0.05. From a study of pigment traits on Corriedale sheep (Fleet et al. 1990 and unpublished results) the heritability estimate for pigmented leg hairs was 0.23±0.17.

Table 1 Heritabilities (H2) with standard errors (SE) for pigment traits and phenotypic correlations (Rp) with isolated pigmented fibres (LIPF) in the fleece

Type of pigment	Total H2±SE	Rp	Black/Grey H2±SE	Rp	Brown/Tan H2±SE	Rp
LIPF	0.16±0.11	.	.	.	.	.
Hoof	0.65±0.18	0.31	0.51±0.16	0.24	0.26±0.12	0.10
Leg hair$_{(1)}$	0.79±0.20	0.25	F 0.10±0.10	0.15	0.83±0.20	0.23
Leg hair$_{(2)}$	0.83±0.20	0.26	F 0.36±0.15	0.13	0.90±0.21	0.24
Face hair	0.18±0.11	0.12	F 0.19±0.10	0.04	F 0.05±0.08	0.11
Ear hair	0.25±0.12	0.20	F 0.16±0.11	0.22	F 0.13±0.10	0.06
Horn site hair	0.63±0.18	0.27	F 0.09±0.10	0.21	0.72±0.20	0.22
Eye lashes	0.50±0.25	0.32	NE	NE	0.54±0.26	0.31
Face skin	0.66±0.19	0.25	0.50±0.16	0.23	0.65±0.19	0.25
Ear skin	0.60±0.18	0.27	0.55±0.16	0.20	0.60±0.18	0.27
Nose-lips skin	0.74±0.20	0.22	0.51±0.16	0.26	0.76±0.20	0.21
In mouth	0.34±0.14	0.30	0.31±0.13	0.30	NE	NE
Eye skin	0.17±0.11	0.20	0.30±0.16	0.12	0.05±0.09	0.12
In ear skin	0.66±0.19	0.16	0.13±0.09	0.11	0.69±0.20	0.16
Tail skin	0.47±0.16	0.21	0.24±0.12	0.14	0.48±0.16	0.19
Halo-hair	0.68±0.24	0.35	.	.	.	.

F = Few animals (<30) with scores greater than the lowest score NE = Not estimable
Leg hair$_{(1)}$ = all legs Leg hair$_{(2)}$ = posterior of rear legs

In this study, the heritability estimate for leg hair pigmentation was 0.79±0.20. Furthermore, evidence from experiments based at Turretfield has indicated that presence of this character often segregates as if it were determined by a single dominant gene in Merino sheep (Fleet 1990). While this hypothesis may be too simplistic in a practical since it appears relevant for Merino sheep. The difference between Merino sheep and other breeds regarding the inheritance of leg hair pigmentation is intriguing and may relate to deficiencies in record taking (e.g. age of sheep) or selection for other pigment (e.g. dark hooves) and additive effects of several other genes which dilute or extend expression. These questions will be clarified by further analysis of data and other matings at Turretfield.

This work has shown that most types of non-fleece pigmentation have high heritabilities and should respond to selection. Furthermore, they seem to be related to the concentration of isolated pigmented fibres in the hogget fleece. However, whether Merino breeders need to be concerned about all of these types of non-fleece pigmentation, instead of concentrating on the best indicators of isolated pigmented fibres in the fleece (i.e. dark halo-hair and pigmented leg and horn site hairs), remains to be clarified.

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REFERENCES

ADALSTEINSSON, S. (1975). J. Agric. Res. Icel., 7: 55.
CARDELLINO, I.R.A. (1978). In "Boletin Technico" No. 3, p. 43-45, Secretariado Urugayo de le Lana.
FLEET, M.R., ROGAN, I.M., PONZONI, R.W. and STAFFORD, J.E. (1987). In "Merino Improvement programs in Australia", p. 175-180, Editor B.J. McGuirk (AWC, Melbourne).
FLEET, M.R. and STAFFORD, J.E. (1989). Animal Production, 49: 241.
FLEET, M.R., SMITH, D.H. and STAFFORD, J.E. (1989). Aust. J. Agric. Res., 40, 445.
FLEET, M.R., POURBEIK, T., ANCELL, P.M. and LYNCH, B.W. (1990). Wool Techn. Sheep Breed., 38: 29.
FLEET, M.R. (1990). Proc. Conf. Aust. Soc. Anim. Prod., 18: 204.
FOULDS, R.A., WONG, P. and ANDREWS, M.W. (1984) Wool Techn Sheep Breed, 32:91.
FOULDS, R A (1988). In "Sale of Wool by Description", p. 127-138, Editor H.W.M. Lunney, (CSIRO Division Wool Techn., Ryde).
MORTIMER, S.I. and ATKINS, K.D. (1989). Aust. J. Agric. Res., 40: 433.
'Old Hand' (1953). Reprinted in Past. Rev., 72, 464-465.
SAS (1985). SAS(R) User's Guide : Statistics, Version 5, SAS Institute Inc., Cary NC, USA.
SILVERS, W.K. (1979). "The coat colour of mice", Spinger-Verlag, New York.
TERRIL, C.E. (1947). Hered., 38: 89.