DARK FIBRE AND SKIN PIGMENTATION IN NEW ZEALAND WOOL SELECTION FLOCKS

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SUMMARY

Merino, Merino x Romney backcross, Romney, and Texel x Romney wool selection flocks were investigated in two years for isolated pigmented fibres in fleece samples, and their relationship with non-fleece pigmentation. Most bare skin and hair fibres areas were significantly different between breeds. Isolated pigmented fibres in hoggets were positively correlated with pigmented horn site fibres, but negatively correlated with pigment surrounding the eyes, and correlations with other non-fleece traits were low. Heritabilities for isolated pigmented fibres, pigmented horn site fibres and pigmented leg fibres were low, but hoof pigmentation and most of the bare skin areas were higher.

INTRODUCTION

The need to minimise pigmented fibre contamination in wool is dictated by industry requirements for white wool tops. The contamination threshold in tops for manufacture of white or pastel products is 1 to 100 dark fibres per kg of white wool (Foulds et al. 1984). Sources of this fault are urine stain, pigment and non-wool, which are controlled largely by flock management (Fleet 1990). Dark coloration in wool originates from melanin pigment, produced by melanocytes in the epidermis (Ryder 1980). White fleeces depend on the presence of a single dominant colour inhibiting factor that suppresses melanocyte activity (Ryder 1980). Isolated pigmented fibres (IPF) appear in some fleeces of young sheep, and they emerge at random from skin that appears non-pigmented (Fleet 1990). Most IPF are missed by shearers and shedhands, even when they are present in very high concentrations (Fleet 1990). Pigmentation of hooves and in hairs on horn sites and legs were the best indicators of IPF in Merino and Corriedale fleeces. The concentration of IPF (estimated heritability, h^2=0.16 to 0.45) was positively correlated with these traits (r=0.3 to 0.5), (Fleet et al. 1987; Fleet 1990; Fleet et al. 1991a). This paper discusses the relationships found between various types of non-fleece pigmentation (NFP) and with the incidence of IPF in Merino, Merino x Romney (backcross), Romney, and Texel x Romney selection flocks.

EXPERIMENTAL

Approximately 415 sheep from wool selection research flocks of Merino superfine, Romney fleeceweight, Texel x Romney (TR) high bulk, and (Merino x Romney) x Merino (backcross) (MRM) flocks, were investigated for NFP and IPF, in 1993 as 1-year old hoggets and adult ewes, and again as adults in 1994. The study included fine-combing Merino ewes (n=130, 2-4 years age) and ewe hoggets (n=40), MRM ewe and wether hoggets (n=96), Romney ewe hoggets (n=60), and TR ewes (n=50, 2-years age) and ewe hoggets (n=38). Animals were scored for NFP of hooves, bare skin areas and hair fibre areas using the system of Fleet et al. (1989). Fleece staple samples (about 10g per animal) were collected from a total of 14 sites (ie 7 sites per side), (Fleet and Pourbeik 1990). Staples were inspected for IPF with a CSIRO Dark Fibre Detector (Foulds et al. 1984) and the number of dark wool and kemp fibres recorded. Concentration of pigmented fibres (LPFC) and kemps (LPKC) were expressed as (No. fibres/10g clean staples) and then

the values were transformed (ie Log(PFC + 2.5)). Mean fibre diameter was measured for all fleeces. Breed least squares means were estimated from a least square model containing breed and sex and year within breed as fixed effects, and age as a quadratic covariate. Repeatabilities were estimated by REML, with animal as a random effect in addition to the above model. Heritabilities were estimated from a paternal half-sib REML analysis, with sire as a random effect in addition to the model used for repeatabilities.

RESULTS AND DISCUSSION

Breeds were significantly different (P<0.05) for the majority of bare skin and hair fibre areas, with highest values in the TR flock (Merino<MRM<Romney<TR), but the breeds were similar for LPFC, and LPKC (Table 1). The TR and Romney flocks tended to have different scores for bare skin and hair fibre areas. Merinos were significantly different (P<0.05) from MRM for mean fibre diameter and most other traits, and they also showed a tendency to have less pigment than Romney and TR flocks, except for hair fibre areas. In general, the results for Merinos were in broad agreement with reports of other studies of pigmentation in Merino sheep (Fleet et al. 1989, 1991b).

Table 1 Least squares means, ± standard error of means for Merino, Merino backcross (MRM), Romney, and Texel x Romney (TR), for mean fibre diameter, and various pigmentation traits

Trait	Breed[A]			
	Merino	MRM	Romney	TR
Pigmented fibre conc. (LPFC)[B]	1.00±0.04^{a}	1.11±0.04^{b}	1.01±0.06^{ab}	1.07±0.03^{ab}
Pigmented kemp conc. (LPKC)[C]	0.94±0.02^{a}	0.97±0.02^{a}	0.96±0.04^{ab}	1.05±0.02^{b}
Mean fibre diameter (μm)	17.8±0.04^{a}	23.1±0.09^{b}	34.5±0.23^{c}	34.6±0.12^{c}
Leg fibres, total	7.95±0.15^{a}	8.90±0.16^{b}	8.34±0.21^{a}	11.73±0.16^{c}
Leg fibres, hind posterior	1.97±0.07^{a}	2.50±0.07^{b}	2.11±0.09^{a}	3.40±0.07^{c}
Horn site fibres	2.01±0.05^{a}	2.47±0.06^{b}	2.15±0.08^{a}	3.52±0.06^{c}
Ear skin & fibres	2.48±0.07^{a}	3.19±0.08^{b}	4.72±0.10^{c}	4.71±0.07^{c}
Nose/lips skin	1.80±0.08^{a}	3.58±0.08^{b}	5.25±0.11^{c}	5.58±0.08^{d}
Inside mouth skin	1.02±0.06^{a}	1.39±0.07^{b}	3.29±0.09^{c}	3.46±0.07^{c}
Skin around eyes	4.01±0.10^{b}	4.94±0.10^{d}	2.90±0.14^{a}	4.50±0.10^{c}
Eyelashes	1.41±0.04^{b}	1.83±0.04^{c}	1.31±0.07^{ab}	1.24±0.05^{a}
Face spot fibres	1.04±0.04^{a}	1.34±0.04^{b}	1.13±0.05^{a}	1.81±0.04^{c}
Under tail skin	1.67±0.07^{b}	1.38±0.08^{a}	2.92±0.10^{c}	4.08±0.07^{d}
Between legs skin	0.97±0.04^{a}	1.28±0.05^{b}	1.64±0.06^{c}	2.18±0.05^{d}
Hooves	4.10±0.24^{a}	9.61±0.26^{b}	19.9±0.34^{c}	19.9±0.25^{c}

[A] Means in same row followed by a common superscript do not differ significantly (P>0.05).
[B] Log(PFC + 2.5) [C] Log(PKC + 2.5)

The concentration of pigmented fibres identified in each breed are shown in Table 2. The Merino flock had the most samples free of IPF, with the highest concentrations occurring in Romney and TR flocks.

Table 2 Distribution of fleeces (%) according to pigmented fibre concentration in fleece staple samples from individuals of each breed

Breed	Pigmented fibre concentration (No./10g)				N
	0	0.1-0.9	1.0-9.9	>10	
Merino	90	1	9	0	179
Merino backcross	80	0	16	4	95
Romney	65	28	7	0	46
Texel x Romney	76	12	11	1	163

The various types of NFP, except skin around the eyes, were positively correlated (P<0.001). Hooves were correlated (P<0.001) with nose/lips skin, inside mouth skin, ear skin and fibres (r=0.71 to 0.83); and horn site fibres (HSF) were correlated (P<0.001) with both sets of pigmented leg fibres (total and hind posterior; r=0.58). Most of the relationships with skin around the eyes were either low positive or negative and non-significant, which was probably due to increased variability through black pigment pervading tan areas with increasing age (Fleet et al. 1991b). There was general agreement with other reports of correlations of hooves with nose/lips skin, and ear skin and fibres (Fleet et al. 1987). In our study, correlations of LPFC with NFP were mostly low positive and non-significant, with the exception of a significant (P<0.05) negative correlation of LPFC with skin around the eyes (r=-0.08). However, when analysed by age, LPFC in 1-year old hoggets was positively correlated (P<0.01) with HSF (r=0.25) and negatively correlated (P<0.05) with skin around the eyes (r=-0.18), (Table 3). The low correlation of LPFC with HSF and the non-significant correlations of LPFC with pigmented leg fibres and hooves were unexpected, and suggested there may be another factor(s) involved. The influence of pigment substitution (eg black replacing tan fibres on ears) with increasing age (Fleet et al. 1991b) was examined, with a re-analysis of the results by age for black NFP only. It was found LPFC was positively correlated (P<0.05) with HSF, total leg fibres, and nose/lips skin (r=0.16 to 0.19). This finding could be due to an age-related decline, with sheep aged 2.5 years or older having lower concentrations of IPF than 1.5 year old sheep (Fleet and Pourbeik 1990). Similar correlations were obtained after adjusting for breed. In a previous study of 1-year old Corriedale hoggets, Fleet et al. (1990) reported low correlations for LPFC with scores for NFP areas (r=0 to 0.15). In general, correlations of LPFC with HSF, hooves or pigmented leg fibres reported for 1 to 2-year old Merino and Corriedale flocks are between 0.08 and 0.47 (Fleet et al. 1987, 1990, 1991a).

Table 3 Correlations of concentration of pigmented fibres (LPFC)[A] in the fleece with non-fleece pigmentation traits

Age (yrs)	n	Horn site fibres	Leg fibres total	Leg fibres hind posterior	Ear skin & fibres	Skin around eyes	Nose/lips skin	Hooves
1	158	0.25**	0.13ns	0.12ns	0.11ns	-0.18*	0.15ns	0.10ns
2	258	-0.06ns	-0.10ns	-0.11ns	-0.04ns	-0.02ns	-0.03ns	-0.04ns
3	90	0.06ns	-0.09ns	-0.09ns	0.12ns	-0.01ns	0.07ns	0.04ns

[A] Log (PFC + 2.5) ** P<0.01 * P<0.05 ns = not significant

Repeatabilities were highest for hooves and bare skin areas of nose/lips, inside mouth and under tail, (Table 4). Higher repeatabilities for bare skin areas were probably indicative of the ease of consistent scoring compared with hair fibre areas. Lower repeatabilities for HSF, total and hind posterior leg fibres were possibly due to difficulties in identifying genuine dark fibres in areas affected by staining and ingress of

dirt. Fleet et al. (1991b) reported high repeatabilities in Merinos, with an interval between assessments of four years.

Heritability estimates were highest for hooves, the bare skin inside mouth, under tail, and ear skin and fibres, and generally low for other traits (Table 4). The heritability of LPFC (h^2=0.07±0.08), although unexpectedly low, was similar to a reported value for Merinos (Fleet et al. 1991a), but considerably lower than estimates of 0.45±0.22 for a Corriedale flock (Fleet et al. 1990). Estimates of heritability of HSF, total and hind posterior leg fibres, were also lower than expected. These results indicate that direct selection of individuals against IPF is unlikely to be rapid. Clarification of the appropriate age and definition of non-fleece traits, and their genetic correlation will determine whether they are useful for selecting against IPF.

Table 4 Heritability, repeatability with standard errors (SE) for non-fleece pigmentation, and concentration of pigmented fibres (LPFC) traits

Trait	Heritability ± SE	Repeatability ± SE
Pigmented fibre conc. (LPFC)[A]	0.07±0.08	0.18±0.07
Hooves	0.23±0.10	0.66±0.03
Nose/lips skin	0.02±0.06	0.65±0.03
Inside mouth skin	0.41±0.19	0.48±0.04
Under tail skin	0.26±0.20	0.43±0.05
Ear skin & fibres	0.23±0.14	0.25±0.05
Skin around eyes	0.09±0.10	0.19±0.06
Horn site fibres	0.06±0.06	0.15±0.05

[A] Log(PFC +2.5)

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