REDUCING PIGMENTED FIBRES IN WHITE WOOL

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INTRODUCTION

The presence of dark fibres in white wool results in reduced profits or in cost recovery claims by wool processors and in reduced confidence in wool as an apparel fibre, which ultimately means lower prices for greasy wool. The allowances set by fabric manufacturers for contaminants are extremely small, typically no more than 3 contaminant faults per garment or per running metre of fabric, while spinners set limits of about 100 dark fibres per kg of top to guard against claims involving white and pastel fabrics and garments (Foulds 1988). Although dark fibres in wool are usually urine stained or melanin pigmented they can sporadically be of non-sheep origin, such as fodder bale twine which can render a top almost worthless (G. H. Michell & Sons Pty Ltd - pers. comm.).

Since 1980, the South Australian Department of Agriculture and CSIRO Division of Wool Technology (Sydney Laboratory), with financial support from the Wool Research and Development Council, have been conducting parallel projects on dark fibres in white wool. The CSIRO team has concentrated on developing detection metrology and reducing the risk of contamination by urine stain, while the Department of Agriculture team has investigated the sources of melanin pigmented fibres that wool growers may be able to minimise. This paper will summarise the main findings to date from the Department of Agriculture's research.

RECESSIVE BLACK OR BROWN FLEECE

White fleece is an effect of the dominant allele (W) at the Agouti locus. A black or brown lamb arises when both W alleles are replaced by other recessive alleles (w) at this locus (Dolling 1989). This sporadic occurrence in white flocks can arise when both parents are heterozygous. Our research with black sheep has indicated the following:

(1) Running black sheep in white sheep flocks showed that contact transfer of pigmented fibres to the white sheep can occur readily (Fleet et al. 1986). Therefore, coloured sheep should not be kept in flocks producing white wool for sale through normal commercial outlets. Furthermore, any coloured lambs should be eliminated from the flock as soon as possible after recognition. The normal shedding of fibres from the lamb coat could facilitate transfer.

(2) At least half the progeny of a Ww ram will also be heterozygous. It is therefore important to identify and cull Ww sheep in ram breeding flocks. It is commonly believed that non-fleece pigmentation (e.g. pigmented skin on the nose) can be used to distinguish Ww sheep, but this belief is unfounded in medium Peppin Merinos (Brooker 1968) and in strong-wool Merinos (Fleet et al. 1989). At present the only reliable method of identifying a Ww ram is by progeny testing using coloured or Ww ewes, but gene detection research (Hetzel and Fries 1988) could eventually provide a basis for routine tests.

(3) There was no difference in the prevalence of isolated pigmented fibres in skirted fleeces from WW and Ww sheep (Fleet et al. 1989). The fleece pigment inhibiting effects of W appear to completely dominate the effects of w; other unidentified genes control the incidence of isolated pigmented fibres in white sheep.

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PIEBALD

Piebald lambs have one or few asymmetrically located pigmented fibre spot(s). This type of pigmentation is thought to result from a recessive gene, independent of the Agouti locus, which shows low and variable penetrance. The extent of expression of the piebald genotype is thought to depend on other inhibitor genes which accumulate from selection against the fault (Brooker and Dolling 1969). The discrete but non-simple inheritance of this fault makes control difficult. Until a method of detecting this recessive gene is developed, the best approach seems to be culling affected animals and their sires.

We have found that the white fleece wool from piebald sheep generally had a low incidence of isolated pigmented fibres which was unrelated to size of the piebald spots (Fleet and Smith 1990). Despite this assurance, there is a real risk that piebald spots will be missed at shearing, either from oversight or due to greying with age, so it is important to identify and cull these sheep as soon as possible after recognition. As with other types of fleece pigmentation, sheep culled for this reason should be sold for slaughter only, to prevent transfer of the problem to another wool grower.

TEMPORARY PIGMENTED AREAS ON THE LAMB COAT

Merino lambs sometimes show dark areas which disappear as a result of post-natal pigment inhibition and shedding of halo-hair or removal by shearing. Usually such areas consist of tan halo-hair on the back-of-neck. It is a belief of some sheep breeders that these temporary pigmented areas do not affect the adult fleece (Dun and Eastoe 1970). However, research has shown there is a relationship (Fleet et al. 1989) between scores for pigmented halo-hair visible on the lamb coat and pigmented fibres in fleece wool after lamb shearing.

This relationship could arise because some of the pigmented fibres persist unrecognised at that location in the adult fleece and/or the pigmented halo-hair may be associated with the occurrence of hidden isolated pigmented fibres in other parts of the fleece. Measurements on a small number of affected hogget sheep (16 months age) have indicated higher concentrations of pigmented fibres, in staples from where the dark area was originally visible, compared to grid samples from the whole fleece. The present evidence supports that wool growers should look for this character and at least cull those lambs where it is readily discernible.

AGE-RELATED PIGMENTED SPOTS

Pigment producing cells (melanocytes) resident in the epidermis are normally inhibited in white Merino sheep (Forrest et al. 1985). However, in late adult life the melanocytes within localised areas of wool-bearing skin may become active and migrate to the follicle bulb producing a black/grey pigmented skin spot and pigmented wool fibres (Fleet and Forrest 1984). The development of these pigmented skin spots, mainly on the back-line and upper sides, shows an exponential increase with age (Kelley and Shaw 1942; Fleet and Forrest 1984) and has been shown to be induced by exposure of wool-bearing skin to ultraviolet light (Forrest and Fleet 1986). Age-related pigmented fibre spots occur independently of the genes for black/brown and piebald lambs (Fleet et al. 1985).

Shearers generally don’t recognise that pigmented fibres arise from these black/grey skin spots or due to their location on the body they are not seen. The present attitude to identifying this source of dark fibres in wool marketing is to assign a code indicating a higher level of risk for wool-from Merino sheep over 5.5 years old (Foulds 1989). However, Kelley and Shaw (1942) noted there was considerable variation in occurrence of this character within and between Merino flocks of different origin which presumably has some degree of genetic basis.
These pigmented wool fibres arise from skin that appears non-pigmented and are unlikely to be seen even when present in high concentrations (e.g., 50,000 per kg). In some cases the pigmented fibres relate to non-fleece pigmentation. Merino breeders have traditionally been concerned about non-fleece pigmentation but until recently there was no evidence to substantiate any relationship with wool quality. This lack of evidence has lead to advice (Dun and Eastoe 1970) and some Merino breeders to ignore non-fleece pigmentation in their selection policy. However, there are now several independent sets of evidence from the Department of Agriculture's research that have shown a link between certain types of non-fleece pigmentation and pigmented fibres in the skirted hogget fleece.

Our studies have involved Corriedale sheep, where selection for dark nose-skin and hooves is usual, and Merino sheep where the opposite policy often applies. In both cases, the best indicator of isolated pigmented fibres in fleece samples was the presence of pigmented fibres on the legs or horn sites ($r = 0.3$ to 0.5), while other types of non-fleece pigmentation added little improvement in accuracy of prediction. The scores for pigmented fibres on the legs or horn sites are associated with the presence or intensity of other types of non-fleece pigmentation, such as on the nose-skin and in the hooves (Fleet et al. 1987; Fleet and Stafford 1989). However, the Corriedale is a classic example of a breed in which dark nose-skin and hooves are usually intense without necessarily being associated with a high incidence of pigmented fibres on the legs, horn sites or through the fleece.

Based on observations from hogget progeny of a Trangie Fertility sire (Dun and Eastoe 1970) mated to South Australian (S.A.) Merino ewes, it was proposed that one source of isolated pigmented fibres, associated with the presence of pigmented fibres on the legs, may be an effect of a single dominant gene (Fleet 1985). Seven of this sire’s sons (hypothetical heterozygotes) were mated to “normal” S.A. Merino ewes without pigmented fibres on the legs. Most of the progeny groups showed close agreement to a 1:1 segregation ratio for leg fibre pigmentation. The overall result was 50 offspring with and 42 offspring without pigmented fibres on the legs (hogget records). The original sire was mated to a sample of the same ewes and all progeny (hogget records $n = 30$) had pigmented fibres on the legs. This evidence is consistent with the hypothesis that presence of such leg fibre pigmentation is controlled by a dominant allele at a single locus (Fleet et al. – unpublished).

Hogget fleeces from progeny of the seven half-sibling sires were measured and there was a marked increase in the incidence of isolated pigmented fibres among those sheep with pigmented fibres on the legs but segregation was not entirely consistent with the same apparent simple inheritance. The progeny of several other planned mating groups, where parental records were accumulated, have also shown close agreement with the single locus hypothesis for leg fibre pigmentation (i.e.: 1:1, 3:1 and 0:1 ratios). These results include progeny ($n = 349$) of sires and dams with and without leg fibre pigmentation that originated from private Merino flocks as well as from Trangie Fertility sires (Fleet et al. – unpublished). The large variation in degree of expression in leg fibre pigmentation is probably influenced by additive (dilution) effects of several other loci.

Other observations on individuals with pigmented fibres on the legs has shown that density of pigmented fibres at different sites in the fleece declined as distance from the legs increased (i.e. midback lowest). Also, repeat measurements on the same sheep at hogget age and later shearings have shown an age-related decline in pigmented fibres in the fleece (Fleet and Pourbeik 1990). The most recent data analysed involved hogget progeny of 20 Corriedale sires. There was considerable variation between sire progeny groups in the
occurrence of isolated pigmented fibres and the heritability estimate obtained was $h^2 = 0.45 \pm 0.22$ (Fleet et al. 1990).

Birthcoat halo-hair, piebald phenotype and age-related pigmented fibre spots also occur to a much greater degree among Merino sheep with leg fibre pigmentation (Fleet et al. - unpublished). The enhanced incidence/intensity of wool pigment faults and non-fleece pigmentation associated with leg fibre pigmentation may share a common basis, such as increased melanocyte migration in the skin of foetal and post-natal lambs, which is being investigated jointly with the University of Adelaide. Clearly wool growers should cull sheep with pigmented fibres discernible on the legs or horn sites, which can themselves be a source of dark fibres in processed wool and which, on extreme individuals, may be seen to extend diffusely into the fringes of the skirted fleece. State legislation exists in Western Australia and South Australia whereby an earmark of three holes in a row is registered for use on Ww sheep. It is suggested that this earmark be considered for all sheep culled for pigmentation faults.

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REFERENCES


The nomenclature used in this paper is that in use in the Australian sheep industry. The COGNOSAG nomenclature for W is A^W and for w is A^w (Dolling 1989).