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The relationship of the incidence of medullated fibres to the dimensional properties of mohair over the lifetime of Angora goats

B.A. McGregor[a,*], K.L. Butler[b], M.B. Ferguson[c]

[a] Institute for Frontier Materials, Deakin University, Geelong, Victoria 3220, Australia
[b] Biometrics Unit, Future Farming Systems Research Division, Department of Primary Industries, Werribee, Victoria 3030, Australia
[c] The New Zealand Merino Company Ltd., P.O. Box 25160, Christchurch 8024, New Zealand

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ABSTRACT

In a range of animals, increasing mean fibre diameter (MFD) of fibre is associated with an increasing incidence of medullated fibres (Med). It would thus be expected that Med in mohair fleeces, from animals in a flock, would be related to the MFD of those fleeces. MFD of mohair is not the only dimensional attribute of fibres. Med in mohair is phenotypically and genetically related to the size of animals. This study examined how Med is related to dimensional properties of mohair over the lifetime of Angora goats and how the relationship varies with other lifetime factors. The relationship found is then examined to determine the extent that the relationship can be explained by variations in animal size of the goats. Measurements were made over 11 shearing periods on a population of Angora goats representing the current range and diversity of genetic origins in Australia, including South African, Texan and interbred admixtures of these and Australian sources. Records of breed, sire, dam, date of birth, dam age, birth weight, birth parity, weaning weight, live weight, fleece growth and fleece attributes were taken for castrated males (wethers). Animals' fleece-free live weight (FFLwt, kg) were determined for each goat at shearing time by subtracting the greasy fleece weight from the live weight recorded immediately prior to shearing. The average of the FFLwt at the start of the period and the FFLwt at the end of the period was calculated. Two restricted maximum likelihood (REML) models were developed to relate Med to MFD, staple length (SL) and other lifetime factors. One model allowed FFLwt in the model and the other excluded FFLwt. With the exception of the 1.5 years shearing, Med strongly increased with increasing MFD whether or not adjustments were made for FFLwt measurements. In particular Med increased by 2.0% for each 1 μm increase in MFD, with no adjustment for FFLwt measurements, and increased by 1.5% for each 1 μm increase in MFD, with adjustment for FFLwt measurements. Within each shearing interval increasing average FFLwt was associated with increasing incidence of Med in a similar way to that which has been previously reported without including MFD in the model. There was no evidence that SL needed to be included in the models for Med. Mohair grown by the goats of Mixed genetic background grew mohair which had a higher incidence of Med at ages 2 and 2.5 years and the trend was apparent in other shearing periods. We can conclude that there is both a large response of Med to live weight and a large response to MFD, and that these

* Corresponding author. Tel.: +61 3 9386 3102; fax: +61 3 52 272 539.
E-mail addresses: bruce.mcgregor@deakin.edu.au, bmcgregor@sub.net.au (B.A. McGregor).

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responses are largely functionally separate. While the response to MFD is in accord with earlier work, there is an unrelated and unreported physiological mechanism that favours the production of Med in larger Angora goats. Clearly, larger Angora goats are biologically different compared with smaller animals from the same flock, in ways that are not purely related to the allometrics of size.

1. Introduction

In mohair, medullation of mohair fibres appears to only occur once the fibre exceeds 20 μm in diameter (Lupton et al., 1991). It would thus be expected that the incidence of medullation in mohair fleeces, from animals in a flock, would be related to the mean fibre diameter (MFD) of those fleeces. Such a generalised relationship has been observed in wool (Auber, 1952; Shah et al., 1971; Scobie et al., 1993; Sienra et al., 2011) and in alpaca (McGregor, 2006).

Medullation incidence in mohair is known to be phenotypically and genetically related to the size of animals (Nicoll et al., 1989; Bolormaa et al., 2010; McGregor, 2010a; McGregor et al., 2013c). MFD is also known to be phenotypically and genetically related to the size of the animals (Shelton and Bassett, 1970; Yalçin et al., 1979; Nicoll et al., 1989; Gifford et al., 1991; Snyman and Olivier, 1996; Bolormaa et al., 2010; McGregor, 2010a; McGregor et al., 2012). It would thus be plausible that medullation incidence and MFD might be related purely due to their common relationship with animal size.

MFD of mohair is not the only dimensional attribute of fibres. Fibre length is also important. If medullation incidence is related to MFD, then it is plausible that medullation incidence may be related to fibre length, although Gifford et al. (1991) found no phenotypic relationship between mohair staple length and a subjective medullation score.

This study examined how the incidence of medullated fibres is related to dimensional properties of mohair over the lifetime of Angora goats and how the relationship varies with other lifetime factors. The relationship found is then examined to determine the extent that the relationship can be explained by variations in animal size of the goats.

2. Materials and methods

2.1. General

We used Angora goats involved in a previous report where shearing interval had a major effect on the incidence of medullated fibres and other fleece attributes (McGregor and Butler, 2008). However, the present work, was not focussed on the effect of shearing interval. Management details have been provided by McGregor and Butler (2008) and McGregor et al. (2012, 2013a,b,c). In brief, Angora goats ($n = 94$) born in September 2002 in a progeny testing evaluation at Horsham, Victoria, (36°42′50″S, 142°18′30″E, altitude 180 m) with pedigree breeding records from known sires, were grazed on pasture from birth until 6 years of age. The goats were progeny of various genetic sources including sires of 100% South African origin ($n = 2$), 100% Texan origin ($n = 4$), and other interbred admixtures that included sires of South African, Texan and Australian origin ($n = 4$). These sires were representative of the genotypes available in Australia (Ferguson and McGregor, 2004, 2005). Records of dam, birth weight, birth parity, live weight, fleece growth and fleece quality were taken for castrated males (wethers, $n = 94$). All animals were shorn every 6 months from 6 months of age, except as described below. One month after shearing in February 2004 the goats were transported to Attwood, Victoria (37°40′S, 144°53′E, altitude 135 m) and grazed as a flock until November 2008.

2.2. Management

Goats were grazed as 1 flock, at near the recommended stocking rate on improved annual pasture (McGregor, 2010a,b). Goats were moved between paddocks to match feed requirements. Shelter was available in the form of covered and enclosed building that was always accessible and could accommodate all goats. Fresh water was provided in all paddocks. During most years in autumn and winter, pastoral conditions were affected by drought and supplementary feeding was undertaken following Australian practice (McGregor, 2005) from mid May to early September to maintain live weight (McGregor and Butler, 2008). A mineralised stock block was always available (Ridley AgriProducts Pty. Ltd., Melbourne) with the following content: minimum content Ca 4.9%; P 1%; S 2%; Cu 600 mg/kg; Co 60 mg/kg; I 60 mg/kg; Zn 1000 mg/kg; Fe^{2+} 1100 mg/kg; Se 5 mg/kg; based on NaCl 75 to 85%.

The goats were given a full crutching and wigging 3 months prior to any shearing. Goats were vaccinated against 5 in 1 *Clostridia spp*. and "drenched" with an effective anthelmintic to control gastro-intestinal parasites no more frequently than once per year.

All goats were weighed to the nearest 0.2 kg one day prior to any shearing except for the third shearing when the nearest live weight prior to shearing was taken 3 months earlier at 15 months of age and following shearing 1 month later. All goats were fasted overnight prior to shearing or crutching. Goats were returned to pasture together following shearing. Fleece-free live weights (FFLwt) were determined for each goat at shearing time by subtracting the greasy fleece weight from the live weight recorded immediately prior to shearing. Average FFLwt between shearings (AvFFLwt) was determined as the average of the FFLwt at the start of the period and the FFLWt at the end of the period. Live weight change (LwtCh) was the change in FFLwt over the period between shearings.

2.3. Design

The goats studied were the castrated male progeny of a sire evaluation project (Ferguson and McGregor, 2004, 2005). Between February 2004 and February 2006 the goats were part of a replicated experiment studying the influence of shearing treatments. There were 4 or 8 individual goat replicates of 21 treatments arranged as a 7 shearing treatments by 3 genetic strains factorial (McGregor and Butler, 2008). The shearing treatments were:

- Three different 6-month shearing intervals, each with different months of shearing: February–August, April–October, June–December;
- Two 12-month shearing intervals with different months of shearing: August–August, September–September;
- One 3-month shearing interval (Often treatment); and
- One 7-month winter shearing interval, February–September.

Genetic strain was based on sire line as follows:

- South African: sires 100% South African bloodline;
- Texan: sires 100% Texan bloodline; and
- Mixed: sires of approximately 50% South African and 50% Texan bloodlines.

Some strains of wethers, whose breeding did not fit within these criteria, were culled.