WOOL FOLLICLE TRAITS IN THE NSW PEPPIN MERINO STUD INDUSTRY: PRELIMINARY ESTIMATES FROM A SAMPLE SURVEY

B. J. Crook[1] and I. W. Purvis[2]

[1]Department of Animal Science, University of New England, Armidale NSW 2351
[2]CSIRO Division of Animal Production, Pastoral Research Laboratory, Armidale NSW 2350

SUMMARY

Population means and incidences for a range of wool follicle traits were estimated with known accuracy for the NSW Peppin Merino stud population. Average primary and secondary follicle densities within the population were 2.58 ± 0.13 and 58.07 ± 2.28 follicles per mm^2 respectively, with 7% of sheep at most estimated to exceed 80 secondary follicles per mm^2. The average S/P ratio was 24.21 ± 2.06 and for Dp/Ds ratio, 1.21 ± 0.03. At most, 3% of sheep within the population had S/P>50 and 18% had Dp/Ds<1. Residual correlations indicated a significant association involving between-fibre diameter variation and each of S/P, Dp/Ds and average fibre diameter at mid-sebaceous level, but no association with follicle density.
Keywords: Wool follicle traits, Merino, sample survey.

INTRODUCTION

There is widespread interest amongst many Merino breeders regarding characteristics of the wool follicle population of individual sheep and how this relates to the structure and quality of the fleece. This interest is reflected in the frequency of articles and editorials in the rural press, where a high secondary follicle density, a high secondary to primary follicle ratio and an average diameter of primary fibres less than that of secondary fibres has been advocated as a favourable combination of follicle traits. These "favourable types" are perceived to be associated with lower diameter variation, a trait unfavourably correlated both phenotypically and genetically with components of wool style (Taylor and Atkins 1992; Crook *et al.* 1995).

Due to the high commercial test cost, follicle measurements are generally restricted to selected rams and a small proportion of studs. Information on the frequency of these "favourable types" throughout the stud industry is therefore unknown. The survey results of Carter and Clarke (1957) are commonly used to define the expected follicle characteristics of Merino bloodlines and strains, while studies such as Mortimer and Atkins (1993) provide valuable information on genetic differences between- and within- bloodlines for total follicle density and S/P ratio. The aim of this paper is to present preliminary estimates of population means, incidences and sampling variances for a range of wool follicle traits in the Peppin Merino stud population of NSW. The data presented forms part of a larger study examining phenotypic associations between follicle, fibre and fleece traits within this population.

MATERIALS AND METHODS

Survey Design. A stratified two-stage sample survey was conducted for the Peppin Merino stud population of NSW, involving 28 of a possible 99 stud flocks. At least 10% of the unclassed hogget ewe flock was randomly selected from each stud. The survey was conducted from August 1992 to December 1993, with a total of 3290 ewes ranging in age from 12-18 months and wool growth at sampling from 5-11 months. Details of the survey design are given by Crook *et al.* (1995).

Skin Biopsy Collection and Processing. A single skin biopsy was taken from the midside of each sheep and fixed in 10% buffered formalin (Maddocks and Jackson 1988). These biopsies were embedded in paraffin wax and cut in transverse sections (8 μm thick) parallel to the skin surface at mid-sebaceous gland level. Sections were stained with haematoxylin, eosin and picric acid (Maddocks and Jackson 1988). For the present study, a subsample of 25 skin biopsies per stud was randomly chosen (representing 12.5-25% of samples per stud), then processed and analysed. This subsample size was determined after examining the effects of subsample size on the sampling variances of the population estimates and the within-flock phenotypic correlations between traits, using published (co)variance estimates (Carter and Clarke 1957; Mortimer and Atkins 1993).

Wool Follicle Measurements. All wool follicle measurements were made using a Leica Quantimet 600® image analysis system at x200 magnification, as described by McCloghry (1996). Only 563 of the 700 biopsies in the subsample were suitable for image analysis. The following traits were measured: primary (PDN), secondary (SDN) and total (TDN) follicle densities (follicles per mm^2 skin); ratio of secondary to primary follicles (S/P); average diameter of primary (PFD) and secondary (SFD) fibres; ratio of PFD to SFD, denoted Dp/Ds; standard deviation of diameter for primary (PSD) and secondary (SSD) fibres.

Estimation of Population Parameters. Data were used to estimate the population mean, sampling variance and 95% confidence interval for each trait, according to the survey design. Measurements for each of SDN, S/P and Dp/Ds were grouped together to enable estimation of the incidence of certain extreme types within the population, these extremes being: SDN (<40, ≥ 80), S/P ratio (<20, ≥ 50) and Dp/Ds (<1, ≥ 1.6). Residual correlations between the follicle traits were calculated after adjusting for stud flock (n=28) and operator (n=4) effects.

RESULTS

The average Peppin Merino ewe in NSW stud flocks, as a hogget, was characterised by 2.58 primary and 58.07 secondary follicles per mm^2 of skin, an S/P ratio of 24.2 and a Dp/Ds ratio of 1.2 (Table 1). Average total follicle density was 60.65 ± 2.36 follicles per mm^2 (range 27.3-114.6) while the average standard deviation of fibre diameter was 6.15 ± 0.29 μm for primary fibres (1.97-15.3) and 5.62 ± 0.27 μm for secondary fibres (2.95-10.4).

Population estimates for the incidence of certain follicle traits are shown in figure 1. Within the population surveyed, 5.4% (± 3.2) and 4.1% (± 2.5) of sheep were estimated to have secondary follicle densities of <40 and ≥ 80 per mm^2 respectively. On average, 34.8% (± 8.5) of the population had S/P<20 and 1.7% (± 1.2) had S/P≥50. Dp/Ds ratios <1 and ≥1.6 were associated with 13.4% (± 4.6) and 4.7% (± 2.3) of the population respectively.

Table 2 summarises the residual correlations obtained between all traits. PDN was positively correlated with SDN (0.43) and negatively correlated with S/P (-0.31). SDN was negatively correlated with SFD (-0.45). S/P was negatively correlated with all traits, but only those involving PFD, PSD and Dp/Ds were significantly large. Correlations between all diameter distribution traits (PFD, SFD, PSD, SSD) were significantly positive except for that between SFD and PSD (0.07). Dp/Ds was positively correlated with PFD (0.75), PSD (0.59) and SSD (0.25) but negatively with SFD (-0.24). Correlations involving TDN mirrored those obtained for SDN.

Table 1. Population means, standard errors and ranges for wool follicle traits

	PDN	SDN	S/P	Dp/Ds
Mean	2.58	58.07	24.21	1.21
SE	0.13	2.28	2.06	0.03
Range	0.48 - 5.39	25.9 - 110.0	7.2 - 115.7	0.79 - 1.93

DISCUSSION

This study demonstrates the usefulness of sample surveys in estimating wool follicle characteristics of the Merino stud population from a relatively small number of biopsy samples. All estimates will incorporate the effects of both genetic and non-genetic determinants of follicle and fibre attributes as well as their interactions with genotype. The impact of these factors on the estimates is unknown. However, it could be argued that by incorporating all sources of variation in the traits examined, the standard errors of the means may reflect the upper limits.

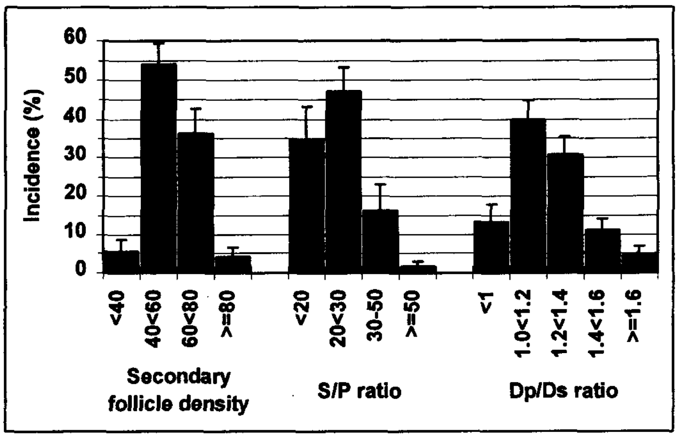

Figure 1. Population incidences for binomially-distributed follicle traits (95% upper confidence limits shown).

The results of this survey must be viewed within the context of the target population and the period of time in which it was conducted. Secondary follicle densities >60 per mm^2 were likely to be present in up to 49% of sheep, but only 7% at most were estimated to exceed 80 per mm^2. Up to 26% of the population could have had an S/P ratio >30, but the upper limit to the proportion with S/P>50 was likely to be 3%. The maximum values for PDN, SDN and S/P in the present study exceed those given by Carter and Clarke (1957). These authors also obtained an upper limit of 2.2 for Dp/Ds compared to 1.93 in the present study, but gave no indication of the incidence of such types in their data set. The present study indicates only 7% of the population was likely to have had a value >1.6 while up to 18% could have had Dp/Ds < 1.

Table 2. Residual correlations between follicle-based traits (n=563)

	PDN	SDN	S/P	PFD	SFD	PSD	SSD
SDN	0.43						
S/P	-0.31	0.15					
PFD	0.02	-0.19	-				
SFD	-0.16	-0.45	-	0.45			
PSD	0.05	-0.00	-	0.58	0.07		
SSD	-0.08	-0.09	-	0.48	0.35	0.50	
Dp/	0.14	0.12	-	0.75	-	0.59	0.25

The residual correlations indicate that between-fibre diameter variation (PSD and SSD), measured at mid-sebaceous gland level, was not significantly correlated with either PDN or SDN, but did increase significantly with increasing Dp/Ds. Also, as S/P increased, PSD decreased, but changes in SSD were unrelated. Both PSD and SSD increased with increasing PFD, while SFD influenced SSD only. No attempt is made here to interpret these associations in terms of "favourable" or "unfavourable". However, it is interesting to note that Carter and Clarke (1957) discuss an association between lamb Dp/Ds values and diameter variation within adult fleeces. In addition, Crook *et al.* (1995) report significant deteriorations in components of wool style as mid-side diameter variation increased. On this basis we speculate that an association between Dp/Ds and visual aspects of the fleece may exist by way of diameter variation, with low Dp/Ds sheep displaying superior visual fleece characteristics. Any association that may exist between SDN and wool style components is unlikely to be mediated by way of fibre diameter variation. The situation with S/P ratio is uncertain. These relationships are currently being investigated for the full survey data set.

ACKNOWLEDGMENTS

We would like to acknowledge the cooperation of the stud breeders who participated in the sample survey. We would also like to thank Mr Grant Uphill, Ms Chris Dennis and Ms Belinda Hickey (CSIRO Armidale) for their dedication in completing the histological analyses. This project was supported by Australian wool growers through the International Wool Secretariat (Project CBP327), in addition to the CRC for Premium Quality Wool.

REFERENCES

Carter, H.B. and Clarke, W.H. (1957) *Aust. J. Agric. Res.* **8**: 91.
Crook, B.J., Piper, L.R. and Mayo, O. (1995) *Aust. Assoc. Anim. Breed. Genet.* **11**: 591.
Maddocks, I.G. and Jackson, N. (1988) "Structural Studies of Sheep, Cattle and Goat Skin", CSIRO Division of Animal Production, Blacktown.
McCloghry, C.E. (1996) *Wool Tech. Sheep Breed.* (submitted).
Mortimer, S.I. and Atkins, K.D. (1993) *Aust. J. Agric. Res.* **44**: 1523.
Taylor, P. and Atkins, K.D. (1992) *Wool Tech. Sheep Breed.* **40**: 97.