DO MERINO HOGGETS WITH 'POSITIVE MICRON' WOOL HAVE A PROPENSITY FOR 'MICRON BLOWOUT'?

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SUMMARY

Woolgrowers prefer to breed sheep which do not increase markedly ('blowout') in average fibre diameter (FD) during the sheep's lifetime. The staple crimp : FD relationship in hoggets is one possible indirect criterion for FD stability. Analysis of data from the Trangie D-flock suggests that hoggets which measure finer than their crimp or wool count indicates (known as `positive micron') are more likely to blowout in FD during their lifetime (which is expected from theory). However, they may breed sheep which are less likely to blowout with age.

INTRODUCTION

There is a common belief in industry that sheep (and bloodlines) vary in their ability to maintain, or increase less than average, average fibre diameter (FD) throughout their lifetime or when feed is plentiful, i.e. express lower `micron blowout'. Atkins (1990) reported the average increase in FD from one year of age to adult age was 1.2μm in the Trangie multiple bloodline breeding flock (D-flock). He estimated the heritability of FD stability (defined as the regression of FD deviation on age) as 0.23. Cottle et al. (1993) reported that the estimated breeding values of sires tested on central sire evaluation sites for relative change in FD between one and two years of age varied from -1.1 to +1.1 μm, suggesting large genetic variation exists between sires.

Sheep breeders would benefit if an efficient indirect selection criterion for FD stability was found in young sheep, as this would remove the need to keep sheep until later ages before making selection decisions based on FD change (Atkins 1990). Possible indirect criteria include FD variability, FD/crimp relationships and differences between sites on the sheep in average FD, e.g. rump to midside. FD variabilities (standard deviation and coefficient of variation) were found to have very low correlations, both genetically and phenotypically, with FD stability so are of limited use (Taylor and Atkins 1992).

When the environment (e.g. nutrition) changes, FD can alter significantly while crimp stays fairly constant (unless the change is severe) as one crimp takes about seven days to form (Norris 1931), independent of the environment and fibre shape. In studies of Merino strains by Dunlop (1962) crimp frequency was the trait least influenced by the environment and most influenced by the strain of sheep. A fine-woolled sheep in a good season may produce the same FD wool as a strong-woolled sheep in a poor season but the wools retain their characteristic crimp (Roberts and Dunlop 1957). Because of these relationships sheep which measure finer than their crimp or count indicates (known as `positive micron') often have a high wool value, as their broader count is indicative of a favourable wool growth rate:FD combination. However, some studbreeders suspect that sheep with this characteristic, e.g. 60^s wool that measures 21 μm rather than 23μm, are more likely to experience 'micron blowout' (J. Litchfield, pers. comm). In order to determine if the crimp/FD relationship in hoggets may be used as an early selection criterion for lifetime FD performance it is necessary to have lifetime measurements from a large number of sheep. The data from the Trangie D-Flock provided such a source of information.

MATERIALS AND METHODS.

Traits and observations

The data reported here were derived from a multiple bloodline breeding flock at Trangie Agricultural Research Centre, described by Mortimer and Atkins (1989). Fifteen bloodlines (or source flocks), each of about one hundred breeding ewes, were managed as a single unit between 1975 and 1989. Sires were only used once and two to three were used in each flock each year. Selected ewes were shorn annually in October up to six years of age. The dataset used here was from the ewes born in 1975-79, thus the last records were taken in 1985 when the 1979 born ewes were six years old. The birth and rearing status and date of birth were recorded for each ewe born. At shearing, midside samples were obtained from each fleece and FD determined by the air flow method. A total of 1,757 ewes, the progeny of 222 individual sires, had hogget FD (HFD), hogget crimps per inch (HCPI) and at least two adult FD records.

Average adult FD (AFD) was calculated as the mean performance of the 2 to 6 year old FD records. Micron blowout (BLOW) was calculated as AFD - HFD, a high value representing low FD stability. The 'relative FD' (RelFD) was calculated as expected HFD - observed HFD. Expected HFD was calculated for each strain separately from the linear regressions of HFD on HCPI. Wools with a positive relFD value (positive micron) were finer than their crimp indicated, i.e. they looked 'broader' than they measured .

Mathematical and Statistical Analysis

A least squares analysis of variance procedure was used to analyse the data. The effects of year, birth-rearing type, strain and flock within strain were fitted, together with significant first order interactions. The random effect of sires nested within flock x year was also fitted and used to test the significance of the strain, flock within strain and year by flock variables. All other effects were tested against the residual mean squares. Birthdate was also fitted to the model as a regression variable. Using these models, least squares means were estimated for strain and flock, with heritability, genetic and phenotypic correlations estimated from between- and within- sire (co)variances using Henderson's Method 3 (Henderson 1953).

RESULTS

The mean performance of each strain and flock and the significance of fixed effects for the FD and crimp parameters are given in Tables 1-2. Strain, flock within strain and sires within flocks (x year) all had significant effects on micron blowout. Fine wool and non-Peppin Merinos were more stable in FD. There were large variations between medium wool flocks and between sires in micron blowout. The estimated phenotypic correlations, heritabilities and genetic correlations of the measured and derived traits are given in Table 3. The heritability of BLOW was estimated as 0.20 (0.07 s.e.) which was, as expected, similar to the results of Atkins (1990). Genetic and phenotypic correlations of -0.27 and 0.22 respectively were found between micron blowout and RelFD. Estimated heritability of RelFD was 0.43.

Table 1. Mean squares from analyses of variance of measured traits

Source	df	HFD (µm)	HCPI (no.)	AFD (µm)	BLOW (µm)	RelFD (µm)
Year	4	121.1**	57.7**	5.7*	88.3**	95.2**
Birth/Rearing	2	33.2**	10.4*	14.4**	5.4**	26.6**
DOB	1	13.5**	30.3*	ns	5.6*	6.5**
Strain	3	316.0**	1510**	455.7**	18.3**	ns
Flock:Strain	11	46.4**	67.1**	46.4**	5.6*	43.9**
Yr x Flock	56	ns	ns	ns	2.0*	ns
Sire:YrxFlock	155	3.1**	5.7**	4.1**	1.24**	2.7**
Residual	1499	1.5	3.1	1.8	0.9	1.5

Table 2. Least squares means, constants and significance levels for flock and strain effects

	HFD (µm)	HCPI (no)	AFD (µm)	BLOW (µm)	RelFD (µm)
Overall Mean	20.76	10.71	21.78	1.02	-0.04
Strain					
Fine	-1.83^{a}	4.06^{a}	-2.19^{a}	-0.36^{a}	-0.14^{a}
Medium Non Peppin	0.56^{bc}	-0.64^{b}	0.44^{b}	-0.12^{a}	0.04^{a}
Medium Peppin	0.34^{b}	-0.89^{b}	0.47^{b}	0.12^{b}	0.11^{a}
Strong	0.92^{c}	-2.52^{c}	1.28^{c}	0.36^{b}	0.00^{a}
Flock					
F(1)	-1.94^{a}	4.82^{a}	-2.20^{a}	-0.26^{bc}	-0.16^{bcd}
F(2)	-1.71^{a}	3.29^{b}	-2.18^{a}	-0.47^{b}	-0.13^{bcd}
MNP(1)	1.10^{bi}	-0.69^{cg}	1.13^{b}	0.04^{de}	-0.50^{b}
MNP(2)	0.02^{cdf}	-0.59^{cg}	-0.25^{c}	-0.28^{b}	0.57^{e}
MP(1)	0.29^{de}	0.75^{d}	0.07^{cd}	-0.22^{bc}	-0.23^{bcd}
MP(2)	0.44^{eg}	-1.21^{e}	0.64^{ef}	0.20^{ef}	0.10^{d}
MP(3)	0.60^{egh}	-0.28^{c}	0.65^{efg}	0.04^{de}	-0.29^{bc}
MP(4)	-0.19^{f}	-1.26^{e}	0.27^{de}	0.46^{g}	0.73^{e}
MP(5)	-0.31^{f}	-0.48^{c}	-0.22^{c}	0.09^{de}	0.67^{e}
MP(6)	-0.03^{f}	-1.23^{e}	0.41^{e}	0.44^{g}	0.58^{e}
MP(7)	-0.25^{f}	-0.35^{c}	-0.40^{c}	-0.15^{bcd}	0.58^{e}
MP(8)	0.79^{bg}	-1.97^{f}	1.08^{bg}	0.29^{efg}	-0.07^{cd}
MP(9)	0.86^{bh}	-2.00^{f}	0.99^{bf}	0.13^{def}	-0.13^{bcd}
MP(10)	1.29^{i}	-0.89^{eg}	1.22^{b}	-0.07^{ed}	-0.83^{a}
S(1)	0.81^{bg}	-2.39^{f}	1.19^{b}	0.39^{fg}	0.06^{d}

DISCUSSION

When RelFD is calculated as: expected HFD (from the regression of HFD on any hogget trait (X)) - observed HFD, it can be shown (J. James, pers. comm.) that, given $K=\sigma_{AFD}/\sigma_{HFD}$ (=1.06 from our phenotypic data):

$$r_{BLOW,RelFD}=-[K(r_{HFD,AFD}-r_{HFD,X}r_{AFD,X})-(1-r^2_{HFD,X})]/[\sqrt{[(1-r^2_{HFD,X})(K^2+1-2r_{HFD,AFD}K)]}] \quad (1)$$

Table 3. Heritabilities (bold, diagonal), genetic correlations (below diagonal) and phenotypic correlations (above diagonals) for measured or derived traits.

	HFD	HCPI	AFD	BLOW	RelFD
HFD	**0.55±.09**	-0.25	0.76	-0.22	-0.95
HCPI	-0.58±.18	**0.42±.08**	-0.21	0.03	-0.06
AFD	0.93±.04	-0.43±.17	**0.61±.09**	0.47	-0.71
BLOW	0.17±.23	0.19±.23	0.53±.16	**0.20±.07**	0.22
Rel FD	-0.97±.27	0.37±.18	-0.94±.23	-0.27±.22	**0.43±.08**

Equations 1-3 can be applied to phenotypic or genetic variances and covariances. When X=HCPI, the value of $r_{BLOW,RelFD}$ is positive when substituting phenotypic values from Table 3 into Eqn. 1, if $K < 1.33$. Thus the belief that hoggets with positive micron will blowout more has been demonstrated to occur in practice and is shown to be expected from theory, but the relationship between BLOW and RelFD may have no biological basis. Any traits correlated with HFD and AFD could be expected to be related to BLOW in a similar manner. Interestingly, the genetic correlation between BLOW and RelFD was negative (-0.27 ± 0.22), which suggests these sheep may breed progeny which are less likely to blowout.

It can also be shown that $cov(BLOW,HFD)=\sigma^2_{HFD}[r_{HFD,AFD}.K-1]$ (2) and on substituting our phenotypic parameters is expected to be slightly negative, whereas $cov(BLOW,AFD)=\sigma^2_{AFD}[(1-r_{HFD,AFD})/K]$ (3) and is expected to be positive. Thus, within each strain the phenotypic correlation between hogget FD and 'blowout' was about -0.22, whereas the relationship with adult FD was about +0.47. The estimated genetic correlation between HFD and BLOW was 0.17±0.23, whereas when the complete D-Flock dataset (3300 ewes) was analysed using REML, a correlation of -0.20 was found (Atkins 1990). Substitution of genetic parameters in Table 3 into Eq. 2 results in a positive covariance estimate. If sheep are selected for decreased HFD, BLOW is also expected to decrease slightly as the correlated response (decrease) in AFD is expected to be slightly greater than HFD response ($r_{G(HFD,AFD)}.K.h_{AFD}/h_{HFD}=1.04$). The relative response of FD stability to indirect selection for RelFD (via crimp) was estimated to be 14% higher than indirect selection via HFD.

This raises the question - is there any other hogget selection criterion which can reduce AFD more rapidly than HFD, given that hogget traits are likely to be more highly correlated with HFD than with AFD? Estimates of the economic value of fibre diameter stability and the genetic relationships between HFD, RelFD and lifetime fleece weight would need to be determined before RelFD (based on any correlated trait) could be recommended as an additional selection criterion.

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