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WOOL FOLLICLE AND FLEECE CHARACTERS OF F_1 AND F_2 BORDER LEICESTER×ROMNEY SHEEP

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SUMMARY

Variability of fibre dimensions and wool follicle populations of F_1 and F_2 generations of Border Leicester × Romney sheep has been compared. Similar comparisons have been made between crossbred sheep and samples of the parent breeds.

Mean values for primary fibre diameter, secondary fibre diameter, mean fibre diameter, primary/secondary fibre diameter ratio and secondary/primary follicle ratio of the F_1 and F_2 sheep were intermediate between those of the parent breeds. Follicle density was higher for the crossbred sheep though little significance can be attached to this.

Comparison of variances of F_1 and F_2 sheep showed that the only significant increase in variability in the F_2 generation was in diameter of primary fibres.

THE crossbreeding of recognized purebreeds of livestock has for long been a feature of animal husbandry. It is done in an attempt to combine desirable genetic material possessed in part by each parent breed and the objective is to produce an animal adapted to a certain environment or one which excels in a particular form of production. The aims and achievements of crossbreeding of sheep have been reviewed by Rae (1952).

Because the first generation crossbred sheep is generally successful, there is a tendency for breeders to interbreed the crossbred animals in the hope that all the desirable characteristics of the first-cross animal will be reproduced in succeeding generations. But some uncertainty exists concerning the outcome of such a breeding policy. Breeders fear most that characters will segregate so that in later generations some animals come to possess an assortment of parental characters of lesser merit than those of the first-cross animal.

In surveying the results of interbreeding of specific crosses in cattle, Robertson (1949) has pointed out that, for obvious physical features, which depend for their expression on simple genetic situations, segregation does occur. But, for productive characters which depend on many pairs of genes for their expression, segregation of characters is difficult to detect. He further points out that the major proportion of variation found in productive characters is controlled by the environment so that variation resulting from segregation of characters characteristic of one or other of the parent breeds is likely to be a small and insignificant part of the total variation.

The work reported here is concerned with variability of some wool follicle and fibre characteristics of first-cross and interbred Border Leicester × Romney sheep. The motive for using these crossbred sheep is increased lamb production. This can be achieved (Coop and Clark, 1965). But, since the crossbred is used as a dual-purpose sheep, it is important to take notice of the fleece in such a system of breeding.

MATERIALS AND METHODS

ANIMALS

The sheep used in this study were:

(1) Forty-six unselected F_1 ewes sired by five stud Border Leicester rams and out of aged stud Romney ewes that were assembled from a number of flocks.

(2) Sixty-two unselected F_2 ewes bred from an earlier F_1 generation produced by the parent sheep mentioned in (1) above.

(3) Forty-nine unselected stud Romney ewes from a flock which supplied some of the Romney ewes used for crossbreeding.

(4) Twenty-three unselected Border Leicester rams from a flock which supplied two of the five rams used to produce the F_1 generations.

F_1 and F_2 sheep were born in August and September, 1960, and were together from birth until skin samples were taken in March, 1962, when they were approximately 18 months old. Since there was a common environment, it is most unlikely that it had any significant influence on variability of fleece characters.

Animals of groups (3) and (4) were born in 1962 and 1958, respectively, and reared on a different property from the F_1 and F_2 sheep. Skin samples were taken when group (3) were 15 months old and group (4) 12 months old.

The F_1 and F_2 sheep were part of a flock established by I. E. Coop (pers. comm.) and the Romney and Border Leicester sheep were part of the Lincoln College stud flocks.

Actual values for fleece characters of the Romney and Border Leicester sheep cannot be compared too closely with those for the F_1 and F_2 sheep. However, the different environment of the Romney ewes of group (3) and the Border Leicester rams of group (4) is unlikely to have had a noticeable effect on variability within groups. A reasonably valid comparison of within-group variability, embracing all four groups of sheep, can therefore be made.

SAMPLING AND SKIN PROCESSING

Skin samples were taken from the right midside position with a trephine of 1 cm diameter and were processed according to the method described by Carter and Clarke (1957). Cross-sections of 8 μ thickness were cut at sebaceous gland level and these were stained with haemotoxylin, eosin and picric acid.

MEASUREMENT

Secondary/Primary Follicle Ratio

The method used by Carter and Clarke (1957) for determining follicle ratios for Merino sheep, namely counting follicles within a number of small fields, was found to be unreliable when used to measure material used in the present study. This material has a low follicle population and a low follicle ratio and the chance inclusion or exclusion of trios of primary follicles in a small field can have an exaggerated influence on follicle ratios. Repeatable results were obtained by identifying and counting primary and secondary follicles in two large fields projected at a magnification of 150 × and each containing approximately 100 follicles. For counting purposes, aberration on the periphery of the large field was ignored.

Fibre Diameter

Skin sections were projected at a magnification of 500× and the minimum diameter of 50 primary and 50 secondary fibres was measured.

Although minimum diameter measurements are an underestimate of true fibre diameter, they are the most satisfactory in the present circumstances. For example, check measurements with a bidiameter scale gave a maximum-minimum diameter ratio of 1.4 which is in excess of the expected value of approximately 1.2 (Sidey, 1935). The high value is no doubt due to oblique cutting of the section and the error caused by this is not constant.

Mean fibre diameter was calculated using the following formula:

$$\text{mean fibre diameter } (\bar{d}) = \frac{(\bar{d}P \times 1) + (\bar{d}S \times S/P)}{1 + S/P}$$

where $\bar{d}$ = mean fibre diameter
$\bar{d}P$ = mean diameter of primary fibres
$\bar{d}S$ = mean diameter of secondary fibres
S/P = secondary/primary follicle ratio

Follicle Density

Estimates of follicle density were made by counting follicles in 12 random fields each representing 1 mm^2 of

TABLE 1: FIBRE DIMENSIONS AND FOLLICLE POPULATIONS OF BORDER LEICESTER × ROMNEY F_1 AND F_2 GENERATIONS, AND FOR PUREBRED ROMNEY AND BORDER LEICESTER SHEEP

	Border Leic. × Romney F_1	*Border Leic. × Romney F_2*	*Romney*	*Border Leic.*
Primary fibre diam. ($\bar{d}P$) (μ)				
Mean	42.0	40.0	43.2	38.7
CV%	6.75	10.78	6.72	11.39
Secondary fibre diam. ($\bar{d}S$) (μ)				
Mean	35.4	36.2	34.2	39.5
CV%	7.61	8.61	7.13	9.65
Mean fibre diam. ($\bar{d}$) (μ)				
Mean	36.5	36.8	35.5	39.4
CV%	6.43	6.43	6.65	9.98
Ratio $\bar{d}P/\bar{d}S$				
Mean	1.19	1.11	1.27	0.98
CV%	10.40	12.01	7.53	4.91
Secondary/primary follicle ratio (S/P)				
Mean	5.00	4.98	5.40	4.73
CV%	15.21	13.32	22.78	19.72
Follicle density ($P+S$/mm^2)				
Mean	12.4	12.4	10.8	10.5
CV%	19.18	24.72	12.48	19.32

the cross-section. Appropriate adjustment was made to compensate for skin shrinkage during processing.

Statistical Analysis

Since concern is not so much with finite values for characters but primarily with the question of possible increase in variability with crossbreeding, and with interbreeding of crossbreds, a test for homogeneity of variances is required. This is provided by Bartlett's Test (Steel and Torrie, 1960). Bartlett's test was used for determination of (1) homogeneity of variances within F_1 and F_2 generations, and (2) homogeneity of variances within all four groups. In addition to Bartlett's Test, analysis of variance was used to establish the significance of differences between the means for characters.

RESULTS

Mean values and coefficients of variation for the characters studied are given in Table 1. Table 2 contains a summary of the results of statistical tests.

DISCUSSION

Except for follicle density, mean values for F_1 and F_2 generations are intermediate between those of the parent

TABLE 2: SUMMARY OF STATISTICAL TESTS OF HOMOGENEITY OF VARIANCES AND MEANS OF FIBRE DIMENSIONS AND FOLLICLE POPULATIONS OF BORDER LEICESTER × ROMNEY F_1 AND F_2 GENERATIONS AND FOR PUREBRED ROMNEY AND BORDER LEICESTER SHEEP

Character	*Homogeneity of Variances* Within F_1, F_2, Romney & B. Leic.	*Homogeneity of Variances* Within F_1 & F_2	*Analysis of variance of means of F_1, F_2, Romney & B. Leic.*
Primary fibre diameter ($\bar{d}P$)	**	**	**
Secondary fibre diameter ($\bar{d}S$)	**	NS	**
Mean fibre diameter ($\bar{d}$)	**	NS	**
Ratio $\bar{d}P/\bar{d}S$	**	NS	**
Secondary/primary follicle ratio (S/P)	**	NS	**
Follicle density ($P+S/mm^2$)	**	NS	**

**: $P<0.01$; NS: $P>0.05$.

breeds. The fact that follicle density is higher in F_1 and F_2 sheep is not necessarily of importance. The Romney and Border Leicester sheep were not the parents of the F_1 sheep nor were the F_1 sheep the parents of the F_2 sheep. Since follicle populations are numerically complete long before the age at which these sheep were sampled, differences in average body surface area at sampling could have been responsible for some part of the differences found.

Despite the fact that it is not usual to find a large difference in fibre dimensions and follicle population between Romney and Border Leicester sheep, analysis of variance indicates that there are highly significant differences within the group of four means for each character studied. This is not of great relevance to the present study except to note that, apart from follicle density, the major differences are between means for Romney and Border Leicester sheep and not between means for F_1 and F_2 sheep.

The test for homogeneity of variances for F_1 and F_2 is not statistically significant for all characters except diameter of primary fibres. Variability among these fibres is significantly greater in the F_2 generation. The negative result for other characters indicates that interbreeding of F_1 sheep has not led to a significant increase in variability. It is interesting to note that despite an increase in variability of diameter of primary fibres, variability of mean fibre diameter is similar in both F_1 and F_2. This can occur if the high variability of primary diameter within the group is associated with a high variability of secondary diameter and provided that many of the sheep with the higher values for mean primary fibre diameter have the lower values for secondary fibre diameter. This kind of compensatory growth effect has been demonstrated by Fraser (1951).

When all four groups of sheep are considered together, there are highly significant differences in homogeneity of variances for all characters. Except for primary fibre diameter, which has already been considered, it is apparent that this situation can result from differences between the crossbred sheep and the parent breeds, evident for S/P ratio, or from differences between the parent breeds evident for mean fibre diameter, or from a combination of both causes as for the ratio $\bar{d}P/\bar{d}S$.

In studies of density in F_1 and F_2 generations of Border Leicester × Merino sheep, Schinckel and Hayman (1960) found a significant increase in variance in the F_2 generation while Pattie and Smith (1964) found a non-significant decrease. The present data show a small but non-significant increase. However, the variability (expressed as CV%) shown by the Border Leicester sheep is of the same order as the variability shown by the present F_1 and F_2 generations, the F_1 and F_2 generations of Pattie and Smith and 3 out of 4 of the F_2 generations in the study by Schinckel and Hayman. At the same time, the Romney sheep in the present investigation, and the F_1 generation and the two parental breeds of Schinckel and Hayman, exhibit substantially less variability. The important point is that, although variability of density of crossbred sheep seems to be high, it is not consistently in excess of the variability to be found in purebred stock of the parent breeds.

The only other characters that appear to have been studied are follicle ratios and mean fibre diameter (Pattie and Smith, 1964). Results are consistent with the data reported here in that no significant increases in variability from F_1 to F_2 generations were recorded. Schinckel and Hayman record an increase in variability of fibre weight (output per follicle). By inference, this means an increase in fibre dimensions and it might justifiably be assumed that variability of fibre diameter increased. This is contrary to the conclusions of Pattie and Smith and those from the present data.

The results of this study are consistent with the proposal made by Robertson (1949) that, for productive characters controlled by many genes, variability is unlikely to increase following interbreeding of crossbred animals. Of six follicle and fibre characteristics studied, only one, primary fibre diameter, showed a significant increase in variability in the F_2 generation.

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