Selection for Fibre Number in Merino Sheep

CARTER[1] has reviewed work on the hair follicle group in sheep. This review emphasizes breed differences in the ratio of secondary to primary follicles, but does not mention any previous work on selection within a breed. Some preliminary results of a selection experiment are therefore presented, in which changes in both primary and secondary follicle counts per unit skin area have been demonstrated.

One section of a flock of medium-wool Australian merinos at the National Field Station, Cunnamulla, Queensland, consists of pairs of families, in which selection is for a high or low value of a single character. In one pair the character under selection is fibre number per unit area of taut skin (N), measured by the technique described by Turner et al.[2], which does not differentiate fibres from primary and secondary follicles. The groups were founded with animals drawn from one flock, chosen as being of average body-size, but ewes for the high group (HN) being required to have a fibre number above the mean plus one standard deviation, and those for the low group (LN), a fibre number below the mean minus one standard deviation. The foundation rams were chosen from the same flock as the ewes, the most extreme available being selected. Recruitment is from within each family, selection being made at 15–16 months of age.

Although follicle counts have not been required in selection, a skin sample has been taken from the centre of each clipped area immediately after removal of the wool sample. Counts per mm.² of primary (P) and secondary (S) follicles have been made and the ratio S/P (R) calculated, using the techniques described by Carter and Dowling[3].

The mean fibre number for unselected progeny of the HN group each year has been consistently above the mean for those of the LN group. Of great interest is the fact that differences in both P and S contribute to the differences in N, the HN progeny having higher mean counts than the LN progeny for both types of follicle. Over the three sets of progeny now available, the weighted mean differences are 0.50 ± 0.13 for P and 19.1 ± 3.3 for S, both being significant at the 0.1 per cent level. The weighted mean difference in R is 3.2 ± 1.1 (significant at the 1 per cent level), the HN progeny again having a higher value than the LN.

The classic picture of the follicle population in the sheep is one of a series of groups, each containing a trio of primary follicles, with associated secondaries. If it is assumed that the number of primaries in a group remains unchanged, then changes in P indicate changes in the number of groups, while changes in R indicate changes in group-size. The two sources of change may possibly differ in their effect on the amount of wool produced per unit area of skin, and the relative importance of each is not yet known. Further investigations on this point are in progress.

Observed changes in S and P can be separated into those arising from the purely mechanical effect of changes in surface area, in which the total follicle number on the sheep is not altered, and those arising from environmental and genetic influences on the follicles themselves, in which the follicle number is altered. The purely mechanical effects have been eliminated in the present data by adjusting counts for difference in body-weight, taking surface area as approximately proportional to (body-weight)²ᐟ³. It has sometimes been suggested that R should be used as an indicator of follicle or fibre population, because it is independent of mechanical changes due to variation in surface area. Since the present results have shown that P, S and R can all be influenced by selection, increases in R will not necessarily indicate increases in $(S + P)$, as can be shown by the following discussion.

If we denote changes in P by δP, in S by δS and in R by δR, then we have :

$$R + \delta R = \frac{S + \delta S}{P + \delta P}$$

$$= R\left(1 + \frac{\delta S}{S} - \frac{\delta P}{P} - \frac{\delta S . \delta P}{S . P} + \frac{(\delta P)^2}{P^2} + \cdots \right)$$

Changes in R will thus depend on the relative size of $\dfrac{\delta S}{S}$ and $\dfrac{\delta P}{P}$, and the following will hold :

(1) If $\delta P = 0$, R will change with δS, and will be an indicator of $(P + S)$.

(2) If $\left| \dfrac{\delta S}{S} \right| = \left| \dfrac{\delta P}{P} \right|$, both being of the same sign, R will be constant, irrespective of changes in $(P + S)$. Proportional changes in S and P could arise from the mechanical effect of changes in body-size, in which case R would be of value in comparing follicle populations. Such changes could also arise, however, if the number of follicle groups increased but R remained the same ; in this case R could be misleading if used alone in comparing follicle populations.

(3) If $\left| \dfrac{\delta S}{S} \right| < \left| \dfrac{\delta P}{P} \right|$, both being of the same sign, R will decrease when $(P + S)$ is increasing (that is, δS positive) but increase when $(P + S)$ is decreasing (that is, δS negative).

Thus if follicle counts are used in comparing sheep, both P and R are necessary to obtain an estimate of the follicle population, together with body-weight, to enable an adjustment to be made for variation in surface area.

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[3] Carter, H. B., and Dowling, D. F., Aust. J. Agric. Res., 5, 745 (1954).