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BIRTHCOAT CHARACTERS AND THEIR GENETICAL SIGNIFICANCE

by

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In the study of fibre types and collections of fibres composing the lamb's fleece we spell out something about the forces at work in the roots of the fibres. This is satisfying to human curiosity. At the same time we want to exploit these forces for our gain.

Directions are to be indicated in which there is reasonable likelihood that this new detailed knowledge will aid wool-growing by making selection more accurate for wool deemed, for one human purpose or another, more desirable. The economic characters discussed are:-

1. Evenness of fibre length and diameter, accompanied by evenness in count throughout the fleece.
2. Freedom from kemp in sheep with wool of hairy Mountain type.

It is suggested that the methods of selection proposed should be put to practical test.

The fibres composing the hairy coat of a mammal are usually of more than one kind; They differ in size and shape, and they start to grow at different times. It is a very general rule that the earlier a fibre type starts to grow, in the laying down of the coat, the coarser it is, and that as fibres of the original coat begin their development progressively later, the smaller they are. We can easily understand that the foundation members secure advantages and that the late-comers fit in as best they may. The lamb's coat frequently provides an exception to the rule just stated, an exception which seems surprising, but we must remember that the coat of the sheep is a most unusual covering for a mammal in that most of the fibres of domesticated sheep continue to grow indefinitely. In most mammals any one fibre grows for a matter of days, weeks, or a few months only, then stops growing, and after a shorter or longer time is shed. These two quite special features of the coat of the sheep are at least in some measure connected.

To state the first exception more precisely, in some arrays it often happens, in the same tiny area of the skin, that some fibres are smaller, notably finer, not only than fibres that begin to grow earlier than they do, but smaller than some fibres that begin to grow a little later. The smallness of the fibres in question is attributed to the so-called pre-natal check, which evidently catches some follicles not well enough established to stand up well to the checking force, but developed to a stage at which they are more vulnerable than fibres which enter upon their careers a short time later. It is evident that ordinarily the check is at its most powerful for only a relatively short time. To this the larger size of the later starting fibres bears testimony.

The pre-natal check is also held responsible for features of the fibre-tips grown before birth. These differences in the sculpturing of the tips are much used in the classification of fibre types. Here it is not so much a matter of certain fibres showing more marked effects of the pre-natal check in their tips than fibres beginning to grow later. The significant point is that a more powerful check produces greater effects, and keeps down the size of a larger proportion of early starting fibres, than does a weaker check.

The sculpturing action of the pre-natal check is seen specially well in the tip of a sickle-fibre. This fibre type takes its name from the sickle-shaped apical end, which commonly soon attains appreciable thickness, but a neck region, between the base of the sickle-end and the point on the fibre reached

when the lamb is born, is fine. In many sickle-fibres the portion grown after birth is coarser, the fine neck being like unto a written record of what the check has done.

We naturally wonder what is the physical basis of the pre-natal check. Dr. Nancy Galpin speaks in terms of crowding of follicles in the skin in the busy days before birth when so large a proportion of the fleece is launched. She has studied the balance between the rate of adding follicles and the rate of skin expansion. A possibility that seems worth considering is that it may be rate of skin expansion, more or less irrespective of density of follicles, which is fundamental.

The pre-natal check supplies the basis of the classification of my fibre type arrays. A fibre type array is a series of fibre types arranged in the order in which they start their development. All but the latest types have pierced the skin definitely before birth. The arrays, of which there are four or five main ones, are classified according as the effects of the pre-natal check are less or more marked. An array, therefore, may be more "tough" or more "depressed". It is likely too, that the time of starting to grow of the first fibres in a given area of the foetus, that is, the age or stage of development of the foetus, or part of the foetus, has something to do with the type and coarseness of the earlier fibres in the array. This needs checking by further pre-natal studies, but it is difficult not to believe that early initiation tends to coarseness.

In christening the several arrays Dr. K.M. Rudall solved an awkward problem in nomenclature very neatly. He called them after topographical features ranging from Plateau to Plain. Transitions between arrays and variations within arrays I am sure I may be permitted largely to neglect. Named in the order of their toughness, the chief arrays are: Plateau, Saddle, Ravine, Valley, and Plain. Leaving Plateau until later, we will start with Saddle. In Saddle (and also in Plateau), none of the early starting fibres are caused to remain fine after birth by the pre-natal check. All the sickle-fibres go coarse after birth, and there is a transition from coarse sickle-fibres to the earliest starting curly-tip fibres, i.e. those with most curls in the tip. In Ravine there is the same transition from coarse sickle-fibres to coarse curly-tip fibres, but within the sickle-series there is evidence of a pre-natal check operating powerfully for only a short time. Some of the sickle-fibres stay fine after birth. In Valley the check is intense for a longer time, hitting the earliest starting curly-tip fibres as well as the late-starting sickle-fibres - sometimes, indeed, very many, even all the sickle-fibres. Sometimes too, the effects of the check extend well along the curly-tip series. Finally there is the Plain array. Now in all arrays there are fine fibres at the late end of the array. It is not surprising that follicles founded in skin already well crowded should not be able to grow robust fibres. In depressed arrays other than Plain there are two lots of fine fibres, those fine because of my pre-natal check, those fine because they come in at the tail of the array, though the reason for the fineness of both lots is doubtless of the same kind. In between the two lots, in the array, are stouter fibres. In Plain Array there are no fibres at all coarse in that intermediate position. The effects of the check extend well along the array, and the tail starts early.

Now focus attention on the beginning of the array. In any of the arrays described there is a lot of variation in the pre-curly-tip group of fibres, as it is convenient to call them, those beginning to grow before the curly-tip fibres. Of halo-hairs there may be many, medium numbers, few or none. And the abundance of halo-hairs is very strongly inherited. This, it may be mentioned, provides one way to avoid kemp. The halo-hairs stop growing when the lamb is six or eight weeks old and soon shed. More will be said about shedding shortly. Halo-hairs are big

birthcoat kemps. They are succeeded by other fibres grown in the same roots, and these successors may be later kemps, which may continue to be grown, one after the other, in the same follicle. If you have no halo-hairs you need not worry about later kemps. But of kemp more anon. Just now, like Mr. Goot, I am thinking of something more subtle than selecting against such obvious objects as halo-hairs.

In arrays with no halo-hairs the pre-curly-tip fibres have a chance to be refined. We may have no fibres intermediate between halo-hairs and sickle-fibres, the so-called super-sickle-fibres - unpleasing name - or those present may be of only a modest type as classified by the stoutness of their tips. Or the pre-curly-tip fibres may remain fine after birth. Probably the general start in the particular region of the body has been late, even the first fibres being nipped by the pre-natal check. To arrays which are cramped at their start we may apply the term truncated. Now fibre type array is strongly inherited. Breed for Saddle on the back of the lamb, we have found, and you largely get Saddle. Let both parents be of Valley Array on the back, and the great majority of the lambs are likewise Valley on the back. Furthermore, refinement at the beginning of the array is probably strongly inherited too, though here we must rely on argument from the English Wensleydale, from which specimens have been sent out to me since I found my way round fibre type arrays. In numerous Wensleydale specimens we have failed to find a single coarse pre-curly tip fibre.

This is where Mr. Goot comes in, with a thesis which we are anxious to see put to the test. This is his tentative conclusion, which we want to see tested in the best of Romney and Corriedale flocks. Choose an array that is well depressed, that is, with the pre-natal check intense and sustained. Actually, for the Romney, he votes for Valley rather than Plain on the britch, suspecting that Plain may give wool finer than desired for the breed. Besides, let the first starting fibres be well refined. Then, Mr. Goot concludes, you have a chance, good enough to merit thorough investigation, of maximum evenness in diameter and length within the staple. He is able to present evidence that when the first starting fibres are refined, some fibres which otherwise would have pierced the skin after birth get a better start and pierce the skin before birth. There is, in short, a nearer approach to equality of opportunity for all fibres. Further, there is good reason to regard the britch as the key region, so that to choose a britch with an array of the sort indicated probably tends to general evenness, both within the staple and between regions, over the body. Mr. Goot is drawing our attention to a new basis for selection. And this selection, it is to be remembered, would be carried out in young lambs. Whether selection with the aid of this detailed knowledge will achieve more than selection without it is a question to be decided by trial.

Here I would remark that the probable broad significance of the strong inheritance of fibre type array has been urged upon me by Dr. McMahon. His statistical studies have shown how powerful is the influence of non-genetic factors upon late-developing features, like fleece weight and much of conformation. Both he and I, however, have obtained evidence of the stronger inheritance of early-developing features, and for certain birthcoat characters this is impressive. If, therefore, correlation be established between fibre type array and later characterization, this is likely to help both in direct selection of breeding sheep, and in selection via progeny testing of sires. In both these ways we could save time if we could judge young lambs.

The proposal passed on from Mr. Goot has reference to good New Zealand wool. My fibre type work also has bearing on the problem of kemp in Mountain breeds overseas. Specially favourable material for this purpose is available in my experimental sheep with enormously kempy birthcoats. These animals have been bred in pursuit of knowledge about hairiness, and they have proved instruct-

ive in various ways. But first let me report on my earlier education on kemp in milder sheep. And even before this I would offer a few words on shedding. Pre-curly-tip fibres that are coarse in the region grown after birth quite often shed, and sometimes, indeed, some curly-tip fibres shed. The freedom of shedding of these pre-curly-tip fibres varies. The halo-hairs virtually always shed. The sickle-fibres concern us specially in this present story of kemp. Any proportion - from all to none - may shed. And here I want to make a theoretical point. Fine sickle-fibres do not shed, save abnormally and that very rarely. They are severely affected by the pre-natal check, so we may believe it is the pre-natal check which causes them to grow indefinitely. If this be true, the pre-natal check is probably likewise the cause of the persistent growth of early starting fibres that are coarse after birth. The pre-natal check, I believe, prevents the follicles from working so hard that they have to take a rest. That explanation of persistent growth has long been a favourite idea with me. And I would add this, without elaboration. If I am right in this theorizing, the intensity of the check which can prevent shedding is less than the intensity needed to keep a sickle-fibre fine after birth.

Now think about kemp with more practical bias. I am still concerned with milder coats, not N-type. Halo-hairs are followed by other fibres grown in the same follicles, which may be kemp, or persistent fibres more or less hairy, or even not hairy at all. Different succession situations are illustrated by photographs of samples in benzol from the back of a completed hogget fleece. In all these the halo-hairs are abundant.

1. The halos are followed by a crop of kemps and these in turn by another crop.
2. One crop of kemps follows the halo-hairs. Then the lamb reforms, growing respectable fibres instead of more kemps in the halo-hair follicles.
3. The halos are not followed by kemps at all.

It is possible to tell a simple story about succession in halo-hair follicles. Halos are immediately followed by ample kemp only when the big-ended sickle-fibres shed very freely. This is a simple correlation upon which I need not enlarge. When the halos are followed by much kemp, you have still further kemp only if the pre-natal check is weak - is Saddle or mildly checked Ravine. If the check is intense, as in Valley, you get little or no kemp later even though you have had many halo-hairs for a start, and an abundant crop of kemps succeeding them. Evidently the halo-hair follicles are so knocked by the check that, when winter comes, they are not vigorous enough to grow kemp. Now Valley, as stated already, is strongly inherited. To breed for Valley is one way of breeding against kemp. This fact is not of particular significance in New Zealand, but it easily may be elsewhere.

Now my tough customers. Animals like my N-type are wanted on the mountains of harsher climates. In passing - this coat is inherited in very pretty Mendelian fashion. I hate to omit the story, but I must. In N-type the fibre type array is Plateau. There are no sickle-fibres, no pre-curly-tip fibres, that is, with fine necks free from medulla. From halo-hairs we proceed to tough necked super-sickle-fibres to tough curly-tipped, that is hairy-tipped - curly-tip fibres, and characteristically, the big curly-tip fibres, like the earlier starting fibres, are very hairy in the post-natal region. In Mountain sheep this hairiness is acceptable. The coat suits the climate, and is good for carpets, but you don't want kemps. As in the other arrays, the freedom of shedding of the big birthcoat fibres varies greatly. Big curly-tip fibres, in addition to pre-curly-tip fibres may shed freely. If the birthcoat fibres shed freely the fibres that follow them will include a vast amount of kemp, and then, I believe

save by an unexplained fluke, you are condemned to abundant kemp throughout the life of the animal. Plateau is a tough array. You have no after-effect of a vigorous pre-natal check to help you out. But you have one chance to escape kemp. If comparatively few big birthcoat fibres shed, then, not only do fewer follicles have the chance to grow kemp afterwards, but many of the follicles which do shed their first occupants will afterwards produce, not kemp, but persistent hairy fibres, quite acceptable in a hairy carpet wool. And here I can give detailed advice in terms of fibre types. So, I want to try the effect of selection - in a breeding flock - for very poor shedding of birthcoat fibres. I want to try this with the specially favourable material that has come my way, and I want it to be tried in the mountains of the Northern Hemisphere. And the selection proposed, let it be emphasised, would be carried out in young lambs.

Thus is there meaning in this hair-splitting work. The forces growing the fleece and the inheritance of those forces are coming to be understood, and meaning is emerging for selection in breeding for wool. And I like to think that this work shows how, in Applied Biology, you may not only solve practical problems which would remain unsolved without fundamental research, but gain knowledge of theoretical interest from the study of your flocks at herds.

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