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THE INHERITANCE OF HAIR LENGTH IN KARAKUL SHEEP WITH SPECIAL REFERENCE TO ITS RELATIONSHIP WITH SKIN THICKNESS AND HAIR THICKNESS COMPONENTS

J.A. Nel, G.J. van Zyl* and B.N. Jansen**
University of the Orange Free State, Bloemfontein

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OPSOMMING: DIE ERFBAARHEID VAN HAARLENGTE EN DIE VERBAND DAARVAN MET VELDIKTE EN HAARDIKTE BY KARAKOELSKAPE

'n Studie oor die oorerflikheid van gemete haarlengte is uitgevoer op 'n populasie van 1595 karakoellammers wat die nageslag van 100 ramme verteenwoordig. 'n Waarde van 0,35 ($\pm$0,08) is vir die oorerflikheid (h^2) van gemete haarlengte verkry. Fenotipiese en genetiese korrelasies tussen gemete waardes van haarlengte, veldikte, primêre, sekondêre en totale haardikte is beraam.

SUMMARY:

The inheritance of measured hair length was studied in a population of 1595 karakul lambs sired by 100 rams. An estimate of 0,35 ($\pm$0,08) was obtained for heritability (h^2) of hair length. Phenotypic and genetic correlations between measured values of hair length, skin thickness, primary, secondary and total hair thickness were estimated.

It is common practice in karakul sheep breeding to base selection on the visual appraisal of karakul lambs and to apply a scoring system for the main characters viz; curl type, pattern, hair quality and hair length. Measurement is practically restricted to birth weight only but this character plays a minor role in lamb selection. The reason for not measuring the most important selection traits is that satisfactory measuring techniques are wanting. Metric traits such as hair length, hair thickness and skin thickness are always considered but described subjectively.

Hair length has been shown to be economically important (Nel, 1966; Schoeman & Nel, 1969 and van Niekerk, 1972). It was deemed necessary to carry out a specific investigation on measured values of these three characters and their interrelationships in a suitable experimental set-up. A comprehensive study was undertaken by Van Zyl (1973) on skin thickness, Jansen (1974) on hair thickness and by the authors of this paper on hair length in the same base population of pelt samples. Some of the data of the former two authors have been made available for completing the study reported here.

Measurement of hair length and hair thickness presents a formidable task. Measuring skin thickness on raw pelts is easier but perhaps not quite straight-forward. It was also the intention to develop practical measuring techniques in this study.

Procedure

Material

Altogether 1595 pelt samples were taken by S.J. Schoeman from the edge of raw karakul pelts (more or less the central abdominal region of the lamb). The samples were obtained in a high grade karakul flock belonging to R.G. Niemöller near Pofadder, C.P. The pelts were obtained from ram lambs sired by exactly 100 rams which were progeny-tested for selection of superior rams for the stud flock. Two sires produced 6 and 9 pelts for this investigation and the rest between 10 and 23 pelts each, averaging approximately 16 progeny per sire. Of the 1595 pelt samples, seven were unsuitable for length measurements and thus omitted from calculations.

Measurements

Hair length was measured on small pelt samples by using a commercial hair straightener. The hair fibres were dampened first and with the aid of the paste straightened sidewards by finger so that they could be measured from the straight skin edge to the hair tip with a white calibrated ruler plate. The average of three measurements by each of four independent measures was obtained and this represented the average hair length. Since the primary hair fibres are also the long fibres in the karakul pelt the hair length measurement actually reflects the length of these fibres.

Hair thickness was obtained on 150 fibres by means of a projection microscope. By studying the distributions, the fibre population was divided into the primary and secondary fibre groups and in this manner primary thickness and secondary thickness could be obtained in addition to general hair thickness of each sample.

The average skin thickness was obtained from dehaired skin samples. Twelve measurements were taken – three each by four measures – immediately after the samples had been kept at a relative humidity of 98 per cent for 14 hours.

The half-sib correlation method was used to estimate the heritability and subsequently the phenotypic and genetic correlations. The heritabilities of skin thickness and hair thickness components were estimated by Van Zyl (1973) and Jansen (1974) in separate studies.

* Departement Landbou-tegniese Dienste, Privaatsak X13184, Windhoek, S.W.A.
**Hardap, Mariental, S.W.A.

Results and discussion

In Table 1 the relative frequency distribution of hair length measurements is given. The average hair length was 9,69 mm with a standard deviation of 1,89. The range varied between 4,67 and 18,08 mm. Van Niekerk (1972) obtained a value of 8,27 mm in the same flock on 2 379 pelts but he measured the hair length on the raw pelts with a tweezer and calibrated ruler plate. The distribution seems to be comparatively normal and the data were therefore considered acceptable for the estimates of heritability and correlations. A slight skewness is observed which may be due to directional selection for shorter hair in shallow curl types.

Table 1

The relative frequency distribution of hair length measurements

Interval (mm)	Frequency	Relative frequency (%)
3	0	0,00
4	3	0,19
5	14	0,88
6	82	5,16
7	187	11,78
8	300	18,89
9	343	21,60
10	305	19,21
11	169	10,64
12	98	6,17
13	61	3,84
14	15	0,94
15	6	0,38
16	2	0,13
17	2	0,13
18	1	0,06
	1588	100,00

A coefficient of variation of 19,51 per cent was calculated. Schoeman (1968) calculated the coefficients of variation of hair length in several pelt production flocks and they varied between 10,39 and 22,19 per cent. His measurements were also obtained on the mid-side of raw pelts with a tweezer and calibrated ruler plate. In six different pelt groups consisting of more than 100 pelts each, an average coefficient of variation of 18,22 per cent was calculated from his figures.

Heritabilities

The heritability of selection traits is important to the breeder in so far as they indicate the genetic importance of economic characters and the best avenues of improving such characters i.e. through flock management or selection, or both. The extent of expected future improvement through selection depends on the degree of the heritabilities of characters considered in selection. It has been shown by Van Zyl (1973) that skin thickness is not really economically important. Jansen (1974) revealed that the various hair thickness components are not economically important either. These findings suggest that even if these characters were highly hereditary it might not be wise to consider them in selection in this particular flock at present.

The heritability estimates and standard errors are given in Table 2.

Table 2

Heritability estimates of pelt characters with the standard errors

Secondary hair thickness	0,33 (0,08)
Primary hair thickness	0,40 (0,08)
General hair thickness	0,50 (0,09)
Skin thickness	0,15 (0,06)
Hair length	0,35 (0,08)

The heritability of skin thickness was calculated by Van Zyl (1973) and those of the hair thickness components by Jansen (1974). It shows that secondary, primary and general hair thickness as well as hair length have rather high heritabilities. The conspicuous hair fibres are, of course, the long thick primary fibres. If it is necessary to reduce average hair thickness, the h^2 of 0,40 indicates that phenotypic selection based on measurement should be effective. However, this will require a partitioning of primary and secondary fibre populations which is an expensive and time-consuming task. Therefore, it may be preferable to select on measured total hair thickness which is also highly heriditary, $h^2 = 0,50$. Incidentally, the corresponding heritability estimate by Rolfes (1958) on measured general hair thickness was 0,51 which agrees exceptionally well with the one obtained here.

The heritability of measured hair length is also high, $h^2 = 0,35$ ($\pm$0,08)and is in fair agreement with that of Van Niekerk (1972) for measured hair length on raw pelts, $h^2 = 0,281$ ($\pm$ 0,06). In another study Werner (1960) reported an estimate of 0,11 ($\pm$0,06).

In the case of skin thickness the heritability estimate is low, $h^2 = 0,15$ ($\pm$0,06) and it will, therefore, be unwise to include this character in lamb description and to stress it in individual selection. It may be preferable to control the level of nutrition during the latter part of gestation provided that skin thickness has been proven to be of economic importance.

Phenotypic correlations

By including the data obtained on skin thickness by Van Zyl (1973) and primary, secondary and general hair thickness by Jansen (1974), the phenotypic and genetic correlations could be calculated among these characters and also with hair length.

The phenotypic correlations are given in Table 3. In general these correlations are low. Moderate correlations are those between secondary and primary hair thickness (r = 0,37) and between primary and total hair thickness (r = 0,54). A rather important though low negative correlation was observed between general hair thickness and hair length (r = –0,22) thus indicating that a decrease in hair length is associated with an increase in general hair thickness. Should this trend also exist in the genetic correlation a problem may arise in selection for shorter hair as is the case in the shallow and watered-silk types.

Table 3

Phenotypic correlations among pelt characters in Karakul sheep

	Primary hair thickness	Total hair thickness	Skin thickness	Hair length
Sec. hair th.	0,37	–0,16	0,14	0,05
Primary hair th.	–	0,54	0,19	–0,06
Total hair th.		–	0,04	–0,22
Skin thickness			-	0,20

In a study on hair quality in the four main curl types (Watered-silk, shallow, developed shallow and pipe curl) Steyn (1964) *inter alia* calculated the correlation coefficients between several measured traits in black karakul lambs. His calculations where hair length is involved are of particular importance in the present study. He found low insignificant correlations between primary hair length and primary hair thickness within the different curl types. The correlation coefficients varied from + 0,044 to –0,148. In the present study a low negative phenotypic correlation of –0,06 was observed between primary hair length and primary hair thickness. The correlation between primary hair length and skin thickness was also very low (r = 0,093) and insignificant in Steyn's study. In the present study a low correlation coefficient of 0,20 between hair length and skin thickness was obtained.

Genetic correlations

The genetic correlations among these characters are shown in Table 4. The most important features are:

Table 4

Genetic correlations among pelt characters

	Primary hair thickness	Total hair thickness	Skin thickness	Hair length
Secondary hair th.	0,27	–0,52	0,14	0,01
Primary hair th.	–	0,43	–0,04	–0,26
Total hair thickness		–	–0,05	–0,35
Skin thickness			–	–0,15

1. A moderate negative genetic correlation between secondary hair thickness and total hair thickness (r_A = –0,52) suggests that selection for a lower average hair thickness will lead to an increase in secondary hair thickness. Due to the relative shortness of the secondary fibres this correlated response may not be of much practical importance
2. A moderate positive genetic correlation between primary and total hair thickness (r_A = 0,43) suggests that selection for thinner primary hair fibres will lead to a reduction of general hair thickness.
3. A moderate to low negative genetic correlation between hair length and general hair thickness (r_A = –0,35) actually shows that selection for hair length, conversely, selection for shorter hair will lead to a thicker general hair population. Casual observation seems to support this view and it may be of appreciable practical importance in shallow curl breeding where selection for shorter hair is stressed.
4. A low negative genetic correlation (r_A = –0,26) was found between hair length and primary hair thickness.
5. Evidently there is no correlation of any great consequence between skin thickness and fibre thickness components or hair length. The correlation with hair length actually differs in sign in the phenotypic and genetic associations.

The general impression left by this study is that breeders will have to reconsider their views on these traits in lamb selection. While skin thickness and hair thickness are described as a routine practice little justification seems to exist for this practice. Apart from their apparent economic insignificance the accuracy of visual appraisal may be questioned. In this respect it seems fortunate that they are rather unimportant since measurement would have been expensive especially in the case of hair thickness.

While hair length was found to be of economic importance by several authors it can also be measured rather cheaply, although not accurately, on the live lamb. If necessary small pelt samples can be taken from the mid-side of the live stud lamb for more accurate measurement. The relatively high heritability shows that it can be influenced by selection.

On the whole the phenotypic and genetic correlations among these traits are rather low. This is fortunate since strong undesirable genetic correlations between hair length and the other traits might have caused correlated responses which could have been harmful.

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