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SEX DIFFERENCES IN THE HERITABILITES OF ECONOMIC TRAITS IN SOUTH AFRICAN MERINO SHEEP

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OPSOMMING: GESLAGSVERSKILLE IN DIE OORERFLIKHEDE VAN EKONOMIESE EIENSKAPPE IN SUID-AFRIKAANSE MERINOSKAPE

Oorerflikhede van nege produksie kenmerke, gemeet op 1 236 ram- en 1 371 ooinageslag gebore in die Tygerhoek-Merinokudde van dieselfde 73 vaders gedurende 1971 tot 1977, is met behulp van halfsib variansie analise metodes bereken. Die oorerflikhede van sewe liggaamsmassa en wolproduksie kenmerke by ooie het dié van ramme met 10,9 tot 46,7 persent oorskry. Daar was egter geen verskil tussen geslagte met betrekking tot die oorerflikheid van kartelfrekwensie nie, terwyl die oorerflikheid van veseldeursnit by ramme hoër was as by ooie. Ondersoek van die data het aangetoon dat die verskil tussen die oorerflikhede soos verkry met die twee geslagte verklaar kan word deur 'n effens groter genetiese komponent vir meeste kenmerke by die ooie in vergelyking met ramme.

SUMMARY:

Heritabilities of nine production traits measured in 1 236 ram and 1 371 ewe progeny born from the same 73 sires in the Tygerhoek Merino Flock from 1971 to 1977, were estimated by halfsib analysis procedures. The heritability values obtained for seven body mass and wool production characters in ewes exceeded those of rams by 10,9 to 46,7 per cent. However, there was no sex difference in the heritability of crimp frequency while the heritability of fibre diameter was slightly higher in rams than in ewes. Scrutiny of the data showed that the sexual disparity in heritability values may be explained by a slightly greater genetic component for most characters in ewes compared to rams.

Introduction

The heritability of economic characters in farm animals is one of the basic parameters determining the breeding plan, rate of genetic gain and of improvement in the economy of production. Estimates of heritability are normally based on female animals as economic reasons prevent the keeping of large numbers of male animals. However, if large differences exist in the genetic variances of traits in male and female animals, breeding plans and predictions of genetic response will have to be adjusted accordingly.

The first indication of a sex differences in the heritabilities of economic traits in sheep was reported by Kyle and Terrill (1953). They obtained higher heritability values for wool mass and some of its components in Rambouillet, Targhee, and Columbia ewes than in rams of the corresponding breed and age. However, none of these differences were statistically significant. In Merino sheep Young, Turner and Dolling (1960) found indications of a sex difference in the heritability of clean wool mass, body mass and fibre diameter which was slightly higher in ewes than in rams. On the other hand rams had slightly higher values for wrinkle score and crimp number. The only significant sex difference in heritability obtained by Young *et al.* (1960) was for fibre diameter with a value of 0,466 for ewes and 0,120 for rams. Heydenrych (1975), working with Merino sheep, also found indications of a possible sex difference in heritability, with the values for ewes generally higher than those for rams. Since 1975 the data of two additional years have been collected and the results are presented in the present paper.

Procedure

Data collected in the breeding experiment with Merino sheep at the Tygerhoek Experimental Farm near Riviersonderend in the South Western Cape (Heydenrych, 1975; Heydenrych, Vosloo & Meissenheimer, 1977), were used for the present analysis. In 1969 the 800 Merino ewes, ranging in age from 1,5 to 5,5 years, were divided into five equal groups (1 to 5) by stratified sampling within age groups according to their wool production at 18 months of age. Replacement rams for Groups 1 and 3 were selected for high clean wool mass at 18 months of age and those for Groups 2 and 4 were selected for a wider ratio of secondary: primary (S/P) wool follicles in the lamb's skin at three months of age. On the other hand, ewe replacements for Groups 1 and 2 were selected for a high clean wool mass at 18 months of age, while those for Groups 3 and 4 were selected for a high corrected body mass at 42 days of age. Group 5 served as an unselected control.

At the end of 1975 the total number of ewes was reduced to 500. A new Group 1 of 150 ewes was founded on the best ewes from Groups 1 and 3 based on their 18 month clean wool production. Ram and ewe replacements for the new Group 1 are selected on 18 month clean wool production. Similarly a new Group 2, containing 150 ewes, was formed, taking ewes from Groups 2 and 4. In the new Group 2 ram and ewe replacements are selected on S/P ratio. In both cases care was taken to retain the original age structure.

All lambs were reared together up to an age of four months, after which ram and ewe lambs were kept separately, but on similar grazing under similar managerial conditions. No selection took place before measurement of the nine production characters studied, was completed.

Data from lambs born in Groups 1 to 4 from 1971 to 1976 were pooled for the estimation of the heritabilities of nine production traits measured. Lambs born in the Control Group were excluded as only ram progeny groups greater than ten were considered for computation. Means and standard deviations of traits were determined by standard statistical procedures, while halfsib analysis procedures were followed for the estimation of heritability.

Prior to computation all data were corrected for differences in year of birth, age of dam and weaning status (size of litter in which lamb was born and reared).

Results and Discussion

The means, standard deviations and coefficients of variation for nine production traits measured in the Tygerhoek Merino Flock, are presented in Table 1.

From the summarised data in Table 1 it is clear that differences between ram and ewe lambs in body mass were rather small at birth (circa 6 per cent), increasing to a substantial difference of 29,4 per cent at 18 months of age. Differences in wool production at the same age, were of the same magnitude as the disparity in body mass. On the other hand, differences in wool quality traits at the two tooth stage, were small and negligible. It is also clear from Table 1 that, notwithstanding the magnitude of differences between sexes, the coefficients of variation of specific traits (over all years) were very similar for ram and ewe progeny. These results conform very well to those of Young *et al.* (1960) and substantiate their conclusions that in Merino rams and ewes the phenotypic variance of production traits is correlated to their respective means.

Table 1

Means ± SD and coefficients of variation for nine production traits in Merino sheep (1 236 ram and 1 371 ewe progeny measured from 1971 to 1976)

Trait	All lambs*			Ram lambs**			Ewe lambs**			Differences between means of rams and ewes %
	Mean	± SD	CV %	Mean	± SD	CV %	Mean	± SD	CV %	
Birth mass (kg)	3,95	0,55	13,95	4,07	0,58	14,18	3,84	0,54	14,08	6,0
42-Day body mass (kg)	12,12	1,80	14,82	12,50	1,87	14,93	11,77	1,77	15,02	6,2
18-Month body mass (kg)	50,03	5,35	10,69	56,80	6,15	10,82	43,91	5,02	11,43	29,4
Greasy fleece mass (kg)	6,20	0,83	13,35	6,87	0,94	13,61	5,59	0,79	14,10	22,9
Clean fleece mass (kg)	4,12	0,59	14,24	4,56	0,67	14,69	3,72	0,54	14,64	22,6
Clean yield (%)	66,42	4,31	6,48	66,07	4,34	6,57	66,72	4,46	6,69	1,0***
Staple length (mm)	7,28	0,72	9,86	7,35	0,73	9,92	7,22	0,73	10,08	1,8
Fibre diameter (μ)	20,17	1,29	6,40	20,35	1,37	6,73	20,00	1,31	6,54	1,7
Crimp frequency (/25 mm)	10,15	1,28	12,57	9,99	1,31	13,16	10,30	1,28	12,40	3,1***

* Data corrected for year of birth, age of dam, weaning status and sex of lamb

** Data corrected for all factors except sex of lamb

***Values of ewes exceeding those of rams

Table 2

Sire components of variance for nine production traits expressed as coefficients of variance

Trait	Sire component as coefficient of variance (%)		Percentage difference $(\frac{2-1}{1} \times 100)$
	Rams (1)	Ewes (2)	
Birth mass	2,96	3,25	9,80
42-Day body mass	2,93	3,49	19,11
18-Month body mass	3,80	4,55	19,74
Greasy fleece mass	4,44	4,96	11,71
Clean fleece mass	2,44	2,61	6,97
Clean yield	3,89	4,69	20,57
Staple length	2,29	2,58	12,66
Fibre diameter	2,26	2,09	−7,52
Crimp frequency	2,84	2,72	−4,23

Table 3

Heritability of nine production traits in Merino sheep

Trait	Heritability ± SE				Percentage difference $(\frac{2-1}{1} \times 100)$
	Ram lambs* (1)		Ewe lambs** (2)		
Birth mass	0,17	0,07	0,21	0,07	23,5
42-Day body mass	0,15	0,06	0,22	0,07	46,7
18-Month body mass	0,49	0,10	0,63	0,12	28,6
Greasy fleece mass	0,42	0,10	0,49	0,10	16,7
Clean fleece mass	0,28	0,08	0,41	0,09	46,4
Clean yield	0,55	0,11	0,61	0,11	10,9
Staple length	0,21	0,07	0,26	0,07	23,8
Fibre diameter	0,45	0,10	0,41	0,09	−9,8
Crimp frequency	0,19	0,07	0,19	0,06	0,0

* Number of sires = 73, number of lambs = 1 236, k-value = 16,9
**Number of sires = 73, number of lambs = 1 371, k-value = 18,7

On these grounds no sex difference in heritabilities would be expected assuming, of course, that the genetic variances of the two sexes are also equal. In the present study, however, it was found that the sire component of variance expressed as coefficients of variation was somewhat smaller in rams than in ewes (see Table 2). The only exceptions were in the case of crimp frequency and fibre diameter where the genetic variance for rams was relatively larger than for ewes. As will be demonstrated in Table 3 these were the only two traits where the heritabilities of ewes did not excede those of rams.

The heritabilities of nine production traits measured in the Tygerhoek Merino Flock, are presented in Table 3. The heritability values given in Table 3 for clean and greasy fleece mass, 18 month body mass and fibre diameter in ewes, compared fairly well to those reported by Bosman (1958). The present values for rams, however, were rather lower than those obtained by Bosman *op. cit.* Furthermore, all the heritability values given in Table 3 fall well within the respective ranges of values summarised from literature by Turner and Young (1969) except for the heritability of crimp frequency (0,19 compared to a range of 0,4 to 0,6).

Comparison of the heritability values given in Table 3, indicates higher values for ewes than for rams for seven of the nine production traits. These differences ranged from 10,9 per cent (clean yield) to 46,7 per cent (42-day body mass). On the other hand, there was no apparent sex difference in the heritability of crimp frequency, while the heritability of fibre diameter was a little higher in rams than in ewes. The somewhat larger coefficients of variation for the sire components of variance in ewes than in rams (see Table 2), indicate that the observed differences are not necessarily the result of a scale effect and might be caused by real genetic differences between the sexes. However, owing to the substantial standard errors of the estimated heritability values, caused by the limited data and the normal difficulties in the calculation of genetic parameters, none of the observed differences were statistically significant. Furthermore, it should be pointed out that the recurring observation of a sex difference in heritability in seven out of the nine traits studied, does not necessarily add support to the thesis that the sex difference is real. The fact is that all the heritability values were estimated on the same animals and the observations were therefore, not statistically uncorrelated. On the other hand, concluding on the little evidence available at present, that the apparent differences do not exist may hold serious implications and other workers investigating similar data should take note of this phenomenon.

The effect of a possible sex difference in heritability values on the predicted selection response can be illustrated by a hypothetical example in which the heritability value for ewes is held constant, while the value for rams is varied. The generally accepted heritability value for two tooth clean fleece mass is 0,4 while the standard deviation of this trait in South African Merino sheep is approximately 0,6 kg. Selecting 2 per cent of the young rams and 40 per cent of the young ewes, this leads to an expected genetic response of 0,4 $(\frac{2,238 + 0,958}{2})$ 0,6 = 0,38 kg per generation. However, if this heritability of 0,4 for clean fleece mass is taken as a value based on ewes only, it will be found that the expected response will be reduced by 10 per cent for every 0,06 units reduction in the heritability of rams. That is, if the expected selection response is calculated for rams and ewes separately before combining it into a final value.

The result of the present investigation tends to emphasise the importance of ewe selection in sheep improvement schemes and supports the high priority given to ewe selection in modem group breeding schemes.

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