Testicular development in Dorper, Döhne Merino and crossbred rams

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Testicular development from 3 to 14 months of age was examined in Dorper (DD), Döhne Merino (DM) and crossbred (Meatmaster; MM) rams. Testicular measurements included testis volume (TV), diameter (TD), length (TL) and scrotal circumference (SC). Both TD and SC were highly repeatable and positively correlated with live body mass and other testicular measurements. Both SC and TD showed significant breed differences ($P<0,05$) from 3 to 10 months of age which disappeared later on. Non-linear equations were fitted for testicular measurements on age for each breed group. Testicular growth patterns are more similar in the mutton breed types (DD and MM) and differ from dual-purpose DM. This difference probably indicate earlier puberty in the DD and MM breeds. In an attempt to account for body size differences, a SC : live body mass ratio is recommended as a practical selection criterion. A more rapid decrease in this ratio is indicated in the DD and MM breeds compared to the DM, probably because of later puberty in the latter. Individual ratios within and between breed groups varied from 0,378 to 0,948 cm/kg.

Testisontwikkeling is tussen 3 en 14-maande-ouderdom in Dorper (DD), Döhnemerino (DM) en kruisings (Vleismeester; MM) ondersoek. Testismates het volume (TV), deursnee (TD), lengte (TL) en skrotumomtrek (SC) ingesluit. Beide TD en SC is hoogs herhaalbaar en positief met liggaamsmassa en ander testismaatstawwe gekorreleer. Beide SC en TD het betekenisvol ($P<0,05$) tussen rasse vanaf 3-tot 10-maande ouderdom verskil, waarna geen betekenisvolheid aangetoon is nie. Nie-lineêre vergelykings vir testismates op ouderdom is vir elke ras gepas. Die patroon van testisgroei stem meer ooreen tussen die vleistipes (DD en MM) en verskil van die dubbeldoel-DM. Hierdie verskil is moontlik die gevolg van vroeër puberteit by die DD en MM. In 'n poging om die effek van verskille in liggaamsgrootte te oorkom is 'n SC : lewendemassa-verhouding as 'n moontlike praktiese seleksiemaatstaf aanbeveel. 'n Vinniger afname in hierdie verhouding is in die DD en MM in vergelyking met die DM aangedui, waarskynlik as gevolg van later puberteit in die geval van laasgenoemde. Individuele verhoudings binne en tussen groepe het vanaf 0,378 tot 0,948 cm/kg gevarieer.

Keywords: Testicular development, repeatability, Dorper, Döhne Merino, crossbred, rams.

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Introduction

Genetic improvement in reproductive performance of ewes is restricted by the inability of the direct selection of males. Male factors were therefore largely ignored and more emphasis was placed on factors influencing reproductivity of the female.

The use of testis measurements to predict male reproductive efficiency and as a possible indicator of female reproductive capabilities of female relatives has been investigated by several research workers (Land, 1973; Islam, Hill & Land, 1976; Eisen & Johnson, 1981; Land, Atkins & Roberts, 1983; Kritzinger, Stindt & van der Westhuysen, 1984). Selection studies in sheep have shown a correlated improvement in female reproduction owing to selection for increased testes size.

Testicular development patterns were intensively investigated in mice, sheep, cattle and swine (Carr & Land, 1975; Coulter, Larson & Foote, 1975; Islam, *et al.*, 1976; Venter, Rossouw & Neville, 1977; Schinckel, Johnson, Pumfrey & Zimmerman, 1983; Cameron, Fairnie, Curnow, Keogh & Lindsay, 1984; Purvis, Kilgour, Edey & Piper, 1984; Schinckel, Johnson & Kittok, 1984; Notter, Lucas, McClaugherty & Copenhaver, 1985; and many others). Testicular growth may be an indicator of the reproductive performance of rams. Several authors indicated that males with larger testes at a constant age and corrected mass have either greater sperm production or higher daily sperm output (Hahn, Foote & Seidel, 1969; Islam & Land, 1977; Cameron, *et al.*, 1984; Purvis, *et al.*, 1984) and probably also superior mating efficiency in cattle, sheep and swine (Dufour, Fahmy, & Minvielle, 1984).

Testicular dimensions in rams are also effected by breed (Carr & Land, 1975; Hanrahan & Quirke, 1977; Shrestha, Fiser, Langford & Heaney, 1983; Notter, *et al.*, 1985). Rate of testis growth was found to be more rapid in ram lambs of breeds with high prolificacy compared to non-prolific breeds. This was considered as reflecting differences in the rate of development of sexual function. Land & Carr (1975) and Land (1977) concluded that the rate of testicular growth in lambs is related to the reproductive potential of their own breed. Measurement is relatively simple and can be done accurately in the live animal.

The objective of this study was to describe the pattern of testicular growth in rams of three breeds from 3 to 14 months of age.

Procedure

Data were obtained from 30 Dorper (DD), 40 Döhne Merino (DM), and 23 Meatmaster (MM; S.A. Mutton Merino × Ile de France × Dorper × Dormer × Romanov × Finn-sheep crossbred) single born ram lambs produced at the experimental farm of the University of Pretoria. All lambs were from adult ewes and were born during April 1982 and weaned at 10 weeks of age. Testis measurements

were taken monthly from 3 up to 14 months of age. All rams were subjected to the same environmental conditions.

Testis development was obtained by measuring testis volume (TV), length (TL), diameter (TD) and scrotal circumference (SC) *in situ* as described by Knight (1977) and other authors. The first mentioned measurement involves the displacement of water in a cylinder. Testis length was measured with a caliper from the upper point to the lowest point of the palpated epididymis (Illius, Haynes & Lamming, 1976; Knight, 1977). Scrotal circumference measurements were made using a flexible tape at the largest diameter of the testes and scrotum (Foote, 1969; Coulter, Larson & Foote, 1975). Testis diameter measurements were taken with a caliper at the anterior-posterior position on each testis at its maximum width. The method described by Islam & Land (1977) was used to correct testis diameter for scrotal skin thickness by subtracting twice the skin thickness from the measured testis diameter. The means of both left and right testis length and diameter were taken as the testis length and diameter respectively for individual animals.

An analysis of variance for unequal subclass numbers was carried out to study the effects of breed, age and live body mass on testicular development. Scheffe's multiple range test was used to test for specific statistical differences between breeds at each age (Steel & Torrie, 1980).

Simple correlation coefficients were calculated between the different measurements as well as estimates of repeatabilities calculated by correlation between all ages (3 - 14 months) for each measurement. Regression equations were fitted for body mass, TD, TV and SC on age to describe testis development patterns in the three breeds using the SAS linear regression procedure model.

Results and Discussions

Breed, age and body mass were related to differences in testicular measurements ($P<0,05$). Live body mass showed breed differences ($P<0,05$) from 3 to 14 months of age. In general DM rams were lighter than both DD and MM rams, although the differences gradually declined from 3 to 14 months of age (35,3% between DD and DM at 3 months and 13,1% at 14 months of age). There were, however, no significant differences ($P<0,05$) between the DD and MM breeds at any age and a significant difference between the DM and MM breeds occurred at 5, 7 and 12 months of age only.

Both scrotal circumference (SC) and testis diameter (TD) showed statistically significant differences from 3 to 10 months of age. These differences were not evident from 11 months of age. Although DD rams averaged 35,3% heavier at 3 and 13,1% heavier at 14 months of age, their SC averaged 57,3% larger at 3 and only 1,8% larger at 14 months of age. Shrestha, *et al.* (1983) compared five breeds and also indicated significant differences up to 10 months only. There were, however, no significant breed differences for SC at 9 months of age. Although differences occurred between the three breeds, the DD and MM are more likely to correspond in both SC and TD as also indicated in Figure 1. These curves fitted for each breed group indicated a linear relationship of body mass on age and quadratic and cubic polynomial equations for testicular measurements on age.

Breed differences for testis length (TL) existed between DD and DM as well as MM and DM from 3 to only 6 months of age. The same holds true for the differences between MM and DM.

A decrease of testis length took place between 6 - 8 months of age for all three breeds. This reduction represents 9,2; 3,7 and 11,3% for the DD, DM and MM breeds respectively. Shrestha, *et al.* (1983) also indicated a reduction in testis length from 6 to 8 months of age. It coincided more or less with puberty. During puberty the FSH blood concentration normally reaches a peak and causes hypertrophy of the Sertoli cells and an increase in diameter of seminiferous tubules (Lincoln, 1979). According to Foster, Mickelson, Ryan, Coon, Drongovski & Holt (1978) and Lincoln (1979) an increase in both volume and activity of the Leydig cells is caused by the secretory pattern of LH. This hormonal and structural change causes, according to Venter (personal communication), a reduction in testis length which also corresponds with a change in testis consistency.

In general it appeared that rams of meat type breeds such as the DD and MM tended to have larger testes for a period of time, compared to the dual-purpose breeds such as the DM. However, the significance of these differences varied as the ram progressed in age and tended to disappear at later ages. This tendency is in agreement with work done by Shrestha ,*et al.* (1983).

Differences in testicular growth patterns between breeds involved scaling effects owing to differences in body size. Notter, *et al.*, (1985) was of the opinion that the age at which testicular size is measured may influence the correlated response that can be expected in female reproductive traits and that in rams that differ in body size, the pattern of testicular development over time may be more informative than any single measure of testicular size. In an attempt to account for body size in comparing the DD, DM and MM groups, SC : body mass ratios were subsequently calculated (Figure 2), indicating a more rapid decrease in the ratio in the DD and MM breeds compared to the DM. This means a more rapid increase in body mass relative to SC in the DD and MM. This difference would probably indicate earlier puberty in the DD and MM breeds with the point of inflection of these curves almost a month earlier in DD and MM compared to the DM. Observed differences between breeds are largely a function of differences in the rate of attainment of sexual maturity. Individual ratios varied within and between (pooled for all ages) these breeds from 0,378 to 0,948 cm/kg, indicating the large variation and selection possibilites.

Testicular size followed approximately the same profile as testosterone concentration with breed differences being more pronounced during the breeding season (Dufour, *et al.*, 1984). The seasonal fluctuation in testicular size is under the influence of serum luteinizing hormone (LH) concentration (Schanbacher & Lunstra, 1976) via melatonin. Islam & Land (1977) also used testicular size as an indicator of the length of the breeding season. Significant differences ($P<0,05$) for SC at 10 months of age and for TV

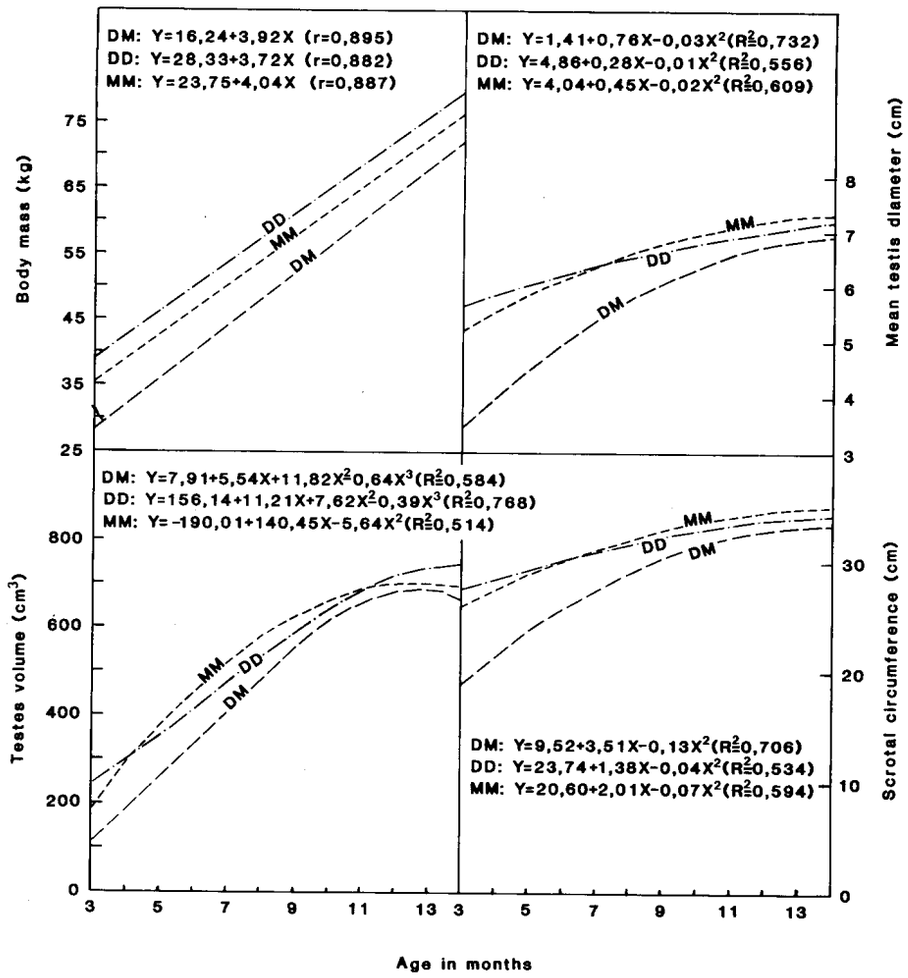

Figure 1 Body mass and testicular measurements by age of rams of three breeds (DD, Dorper; DM, Döhne Merino; MM, Meatmaster)

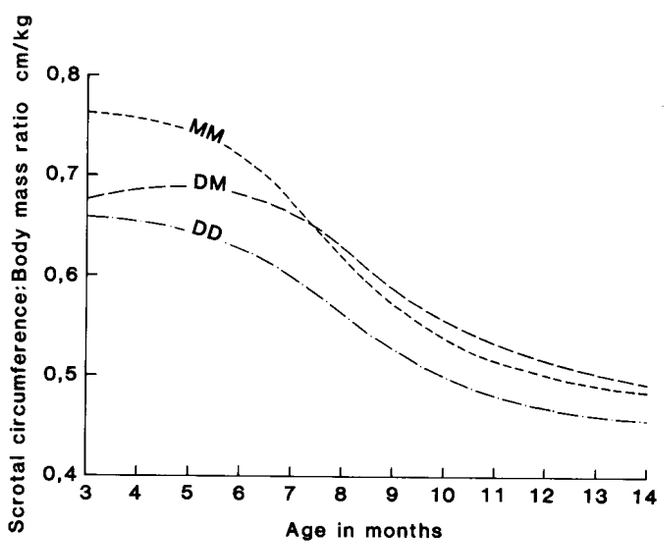

Figure 2 Scrotal circumference : Body mass ratio differences between three breeds (DD, Dorper; DM, Döhne Merino; MM,Meatmaster).

at 10 and 13 months of age respectively resembled approximately the beginning of the breeding season (February), although the length of the breeding seasons for DD, DM and MM is believed not to differ very much.

Testicular growth patterns are more similar in the DD and MM rams. This similarity is somewhat unexpected because of the contribution of the more prolific breeds to the MM. Dickerson & Laster (1975) and Notter, *et al.*(1985) reported earlier puberty and maturation in Finn-cross lambs. The data of the MM were, however, not sufficiently detailed to allow estimation of the genetic contribution of the Finnish and Romanov breeds to these crosses.

Estimates of simple correlation coefficients between live body mass and testicular measurements over all ages, presented in Table 1, were highly significant ($P<0,01$). Correlation coefficients between body mass and TD ($r=0,735 - 0,873$), body mass and SC ($r=0,743 - 0,850$) and between TD and SC ($r=0,954 - 0,975$) tended to be higher than between other measurements. These positive correlations between testis size and body mass are in agreement with results reported by Carr & Land (1975) and other authors.

Repeatabilities calculated from correlations between repeated measurements from 3 to 14 months of age are also presented in Table 1. The repeatability estimates for body mass varied from 0,838 to 0,881. For the various testis measurements SC and TD tended to give the highest repeatabilities indicating that it is a more reliable method of determining testis size. These results are in accordance

Table 1 Correlation coefficients between body mass and testes measurements and repeatabilities for body mass and testes measurements

			Simple correlation coefficients				
	Breed	*n*	SC	TL	TD	TV	Repeatability
Body	DD	360	0,743	0,353	0,735	0,822	0,881
mass	DM	480	0,850	0,810	0,873	0,757	0,879
	MM	276	0,754	0,528	0,755	0,625	0,838
SC	DD	360		0,587	0,954	0,813	0,725
	DM	480		0,941	0,961	0,777	0,706
	MM	276		0,841	0,975	0,667	0,614
TL	DD	360			0,574	0,528	0,499
	DM	480			0,920	0,702	0,629
	MM	276			0,834	0,525	0,587
TD	DD	360				0,925	0,662
	DM	480				0,787	0,565
	MM	276				0,664	0,688
TV	DD	360					0,638
	DM	480					0,370
	MM	276					0,478

with results of Shrestha, *et al.* (1983). Coulter, Rounsaville & Foote (1976) and Purvis, *et al.*, (1984) also recommended TD and SC as best measurements to determine testicular growth.

Conclusions

Testicular development and size has become an important issue in livestock breeding. It serves as an indicator of ram fertility and increases the probability of rams impregnating more females when under heavy breeding pressure. It furthermore serves as a possible indicator of female reproductive capabilities of female relatives.

Rams of mutton type breeds tended to have larger testes compared to dual purpose breeds. However, initial differences disappeared at later ages. Observed differences in testicular measurements between breeds are largely a function of differences in the rate of attainment of sexual maturity. Scaling effects owing to differences in body size within age groups cause problems in selection. In an attempt to account for body size differences, a SC : body mass ratio is recommended. From a practical point of view, this holds advantages as a possible selection criterion. Within-breed variation was relatively high.

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