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A preliminary investigation into the use of testis size in cross-bred rams as a selection index for ovulation rate in female relatives

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Twenty one pairs of twins, all progeny of one sire, of which one was a male and the other a female, were weighed monthly from 3 to 14 months of age. Scrotal circumference (SC) and testes volume (TV) in rams were measured simultaneously. A vasectomized ram was used to detect oestrous in ewes at 18 months of age. Laparotomy was used to determine the ovulation rate. Statistically significant ($P<0,05$) phenotypic correlations are only indicated between the ages of 5 and 6 months. Correlations between these ages varied from 0,371 to 0,481. At 5 months of age all these coefficients are statistically significant ($r = 0,428$ to 0,466; $P<0,05$), which coincided with the attainment of puberty. When testis size measurements were adjusted for differences in body mass, all correlation coefficients became statistically non-significant ($r = 0,133$ to 0,348; $P>0,05$). Partial correlation coefficients between testis size and ovulation rate when body mass in both rams and ewes were fixed, varied from 4 to 7 months of age in the ram from 0,203 to 0,616. These correlations were statistically significant for TV at 6 months ($P<0,05$) and for SC at 7 months ($P<0,01$). Although prepubertal testis size would be of more practical value in selection for ovulation rate, testis size at puberty may be more valuable as an indication of ovulation rate in female relatives.

Een-en-twintig tweelinglammers, die nageslag van een vader, waarvan een 'n ramlam en die ander 'n ooilam was, is maandeliks vanaf 3- tot 14-maande-ouderdom geweeg. Testisomtrek (SC) en testisvolume (TV) is gedurende dié tyd gemeet. By die ooitjies is estrus op 18-maande-ouderdom deur 'n vasektomiseerde ram bepaal. Laparotomie is gebruik vir die bepaling van die ovulasietempo. Die verband tussen testisgrootte en ovulasietempo is in sommige gevalle net statisties betekenisvol tussen 5- en 6-maande-ouderdom (r = 0,371 tot 0,481; P<0,05). Slegs op 5-maande-ouderdom is alle koëffisiënte statisties betekenisvol (r = 0,428 tot 0,466; P<0,05), wat naastenby saamval met die bereiking van puberteit. Korreksie vir liggaamsmassa-verskille tussen ramme op dieselfde ouderdom het alle korrelasiekoëffisiënte statisties nie-betekenisvol gemaak (r = 0,133 tot 0,348; P>0,05). Parsiële korrelasiekoëffisiënte tussen testisgrootte en ovulasietempo, met die effekte van liggaamsmassa van beide ramme en ooie uitgeskakel, het van 4 tot 7 maande tussen 0,203 en 0,616 gevarieer. Hierdie koëffisiënte was vir TV op 6 maande (P<0,05) en vir SC op 7 maande (P<0,01) betekenisvol. Alhoewel testisgrootte voor puberteit van meer praktiese waarde in die seleksie vir ovulasietempo mag wees, wil dit voorkom of testisgrootte tydens puberteit 'n beter aanduiding van ovulasietempo by die ooi is.

Keywords: Sheep, twins, testis size, ovulation rate

Ovulation rate is an important component of ewe productivity. It influences the economic efficiency of meat production in sheep flocks. It is well known that this trait has a low heritability in less prolific breeds and that it responds slowly to selection (Bradford, 1985) due to large internal and external environmental effects (Dyrmundsson, 1981).

Ovulation rate imposes an upper limit to litter size. Selection for ovulation rate has yielded a heritability of 0,50 ± 0,07 which is higher than that for litter size (Hanrahan, 1980; 1982). Following the finding by Land (1973) that the expression of sexual traits in male and female animals are related, Bindon & Piper (1976) considered testis growth as the most promising indication of genetic merit in female ovulation rate. They pointed out that it overcomes most of the difficulties associated with other traits because of ease of measurement and a high heritability. Islam, Hill & Land (1976) and Eisen & Johnson (1981) selected mice on the basis of testis mass and showed a correlated response in ovulation rate and litter size in the females. In sheep Lee & Land (1985) carried out a selection experiment with testis mass as selection criterion. They showed limited response in ovulation rate. However, Hanrahan & Quirke (1982), using ovulation rate as selection criterion, indicated a response in testis diameter with a genetic correlation of 0,41.

The present study was undertaken to determine the phenotypic correlations between testis size at different ages in cross-bred (Meatmaster) rams and the ovulation rate of their full-sibs. Data were obtained from 21 twins, of which one was a male and the other a female. All lambs were born in the small one-sired flock of Meatmaster sheep (Schoeman & Combrink, 1987). Half-sibs were excluded from the analyses owing to restricted facilities. Rams were kept until 15 months of age and ewes until 18 months of age. All rams and ewes were on the same diet and were weighed monthly from 3 to 14 and 18 months of age respectively and scrotal circumference (SC) and testes volume (TV) measured simultaneously (Foote, 1969; Knight, 1977). Oestrous in ewes was observed by means of vasectomized rams and ovulation rate at 18 months of age by means of laparotomy in March, 1982 about 10 days after the onset of oestrous. Unfortunately only one laparotomy was done.

Association between testis size in the ram and the ovulation rate in the ewe was calculated by means of product-moment correlation (Snedecor & Cochran, 1967). Testis size at 3 – 14 months of age was correlated with both the untransformed and transformed ($\sqrt{X+1/2}$) ovulation data (Steel & Torrie, 1980). The data were unsuitable for the calculation of genetic correlations.

Statistically significant (P<0,05) positive correlations were obtained at 5 and 6 months of age only (Table 1). At 5 months of age all coefficients were significant (P<0,05), varying from r = 0,428 to 0,466. More or less 20% of the variation in ovulation rate is therefore accounted for by variation in testicular size. This age of maximum relationship coincided with the attainment of puberty in Meatmaster rams. As age of the rams increased, the size of the coefficients decreased correspondingly. This fall-off in the relationship with increasing age started to take place (8 – 9 months) at the peak of the breeding season (May – June). Seasonal changes are therefore not likely to cause this fall-off in relationship. It may therefore be more closely related to age of the ram itself.

In a divergent selection experiment for testis size, Lee & Land (1985) indicated a positive divergent correlated response for ovulation rate, litter size, the onset of oestrus, as well as the number of serves required for pregnancy in 19-month-old ewes of the two lines. They, however, concluded that most of the response arose through changes in fertility and not through changes in

Table 1 Influence of testis size of rams from 3 to 14 months of age on ovulation rate in twin-born ewes at 18 months of age (n = 21). Product-moment correlation coefficients

Age of rams in months	Untransformed ovulation rate values: Scrotal circumference	Untransformed ovulation rate values: Testes volume	Transformed ovulation rate values: Scrotal circumference	Transformed ovulation rate values: Testes volume
3	0,255	0,289	0,224	0,278
4	0,416	0,302	0,406	0,279
5	0,465[a]	0,466[a]	0,428[a]	0,443[a]
6	0,401	0,481[a]	0,371	0,461[a]
7	0,377	0,290	0,338	0,261
8	0,315	0,324	0,247	0,256
9	0,358	0,371	0,320	0,301
10	0,196	0,378	0,149	0,350
11	0,121	0,169	0,065	0,111
12	0,136	0,125	0,111	0,098
13	0,200	0,185	0,208	0,177
14	0,152	0,176	0,168	0,181

[a]P<0,05

ovulation rate. Hanrahan & Quirke (1982) determined a genetic correlation of 0,41 between testis size and ovulation rate when testis size was measured at 10 weeks of age and the ovulation rate represented by the sum of two ovulation rate measurements at 1 and 2 years of age. Ricordeau, Pelletier, Courot & Thimonier (1979), as cited by Land, Atkins & Roberts (1983), also reported a positive association (r = 0,43) between prepubertal testis size and ovulation rate in the Romanov breed. No relationship was however found between testis diameter and dam's reproductive performance in Dormer and SA Mutton Merinos (Kritzinger, Stindt & van der Westhuysen, 1984). Pubertal testis size may be more informative as an indication of ovulation rate in the ewe.

The correlations in the present study, although phenotypically, compared favourably to the genetic correlations found in the literature. However, with only one single sire, the covariance includes only one quarter of the additive genetic covariance. The genetic covariance would therefore be greater than might be implied from the presentation of the data. The pre-weaning maternal influence could not be calculated and the contribution of that possible environmental correlation is unknown. However, it seems obvious that it will decline with increasing age. The phenotypic correlation coefficients between body mass of rams between 4 and 7 months and body mass of the ewes at 18 months varied from 0,111 to 0,197 (P>0,05).

In order to account for the effect of body mass differences between rams of the same age, testis size measurements between 4 and 7 months were adjusted by means of covariance and correlated with the ovulation rate. Partial correlation coefficients between testis size and ovulation rate with the effects of the body mass of both the ram and ewe fixed, were also calculated. These correlations are presented in Table 2 as well as the correlations between testis measurements and body mass (r = 0,485 to 0,861; P<0,01). Although the coefficients for the adjusted data were non-significant (P>0,05), a positive relationship between testis size and ovulation rate in the ewe was indicated (r = 0,133 to 0,348). With the partial correlations, significant relationships are indicated for TV at 6 months (r = 0,452; P<0,05) and for SC at 7 months (r = 0,616; P<0,01). Purvis, Edey, Kilgour & Piper (1986) suggested that, although mass adjustment increases the heritability of testis size, it also results in a reduction in the genetic correlation between testis size and the female trait (e.g. ovulation rate) such that little or even no change in the female trait would result from selection on adjusted testis size.

Table 2 Simple and partial correlation coefficients between testis size (adjusted for body mass) and ovulation rate and between body mass and testis measurements from 4 to 7 months of age (n = 21)

Age of rams in months	Simple correlation coefficient between body mass and testes measurements		Simple correlation coefficient between testis size (adjusted for body mass) and ovulation rate		Partial correlation coefficient between testis size and ovulation rate (body mass effects fixed)	
	SC	TV	SC	TV	SC	TV
4	0,662[b]	0,603[b]	0,205	0,133	0,318	0,203
5	0,485[a]	0,570[b]	0,345	0,348	0,393	0,327
6	0,566[b]	0,861[b]	0,238	0,324	0,256	0,452[a]
7	0,833[b]	0,533[a]	0,311	0,207	0,616[b]	0,309

[a]P<0,05; [b]P<0,01

Although these findings suggest that testis size could be used as an indication of the ovulation rate in female relatives, it may be concluded that prepubertal size offers limited advantage as a selection criterion to improve ovulation rate. Selection of rams on testis size at puberty may lead to a higher correlated response in ovulation rate. The associations between testis size and the date of the onset of the breeding season and the length of the breeding season were unfortunately not investigated. Such investigations would have thrown more light on other aspects of reproduction and the possible use of testis size as a selection criterion for reproductive performance in sheep.

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