HERITABILITIES AND GENETIC CORRELATIONS FOR BODY WEIGHTS AND REPRODUCTIVE TRAITS IN ANGUS CATTLE

A.C. Parratt[1], Bennett, G.L.[2], Hunter, J.C.[1], and Baker, R.L.[1]

1 Ruakura Animal Research Station, Ministry of Agriculture and Fisheries, Private Bag, Hamilton

2 Production Systems Research Unit, Roman L. Hruska U.S. Meat Animal Research Center, P.O. Box 166, Clay Center, Nebraska 68933, U.S.A.

INTRODUCTION

Heritabilities of reproductive rates in cows are low. Maijala (1978) reviewed heritabilities of calving interval, service period, services per conception and non-return rate in dairy cows, and concluded that heritabilities were around 3 percent. Besides low heritabilities, these traits are not expressed in early life, for accurate and effective selection progeny-test programmes would be required.

Regular annual calf production requires expression of oestrus during a restricted breeding season. Beef production systems that mate heifers to calve as 2-year-olds with a single yearly 8-week mating period require late-born heifers to express oestrus by 15 months of age. Early-born calves have until 17 months of age. In cows, post-partum oestrus must occur before the end of the breeding season. Furthermore, it is desirable for both heifers and cows to express oestrus as many times as possible if they do not initially conceive.

Morris (1980a,b) has reviewed factors associated with lifetime production that are expressed in heifers. Heifer mating weight, early conception to yearling mating and pelvic dimensions are heifer traits that have some phenotypic relationship to subsequent performance. There may also be some genetic component to this relationship.

Smith et al. (1976) have estimated heritability of age at first oestrus as .63±.31, and Laster et al. (1979) has reported a heritability of .41±.17, indicating genetic variation in this phenotypically variable trait. The means however were considerably lower in these U.S. studies than in N.Z.

There is little information reported on the relationship between age at puberty and subsequent reproductive performance. It seems logical for age at puberty to be related to heifer conception rate as part of a progressive maturing process. One can also speculate that a heifer genetically disposed to early puberty may also be disposed to shorter post-partum anoestrus, but no evidence has been reported.

Testicular size in males has been suggested as an indicator of female reproduction in sheep (Land et al. 1978). The physiological basis behind this suggestion is that ovaries and testes respond to some of the same endocrine signals which are (possibly) under genetic control.

More recently, there has been interest in the relationship between scrotal circumference in bulls and age at puberty in heifers. A breed relationship between bull scrotal circumference and half-sister age at puberty has been reported (Lunstra et al. 1978). In addition, a relationship among inbred lines of -.71 has been reported (Brinks et al. 1978).

Heritabilities reported for yearling scrotal circumference have been moderate to high, .38+.16 to .68+.15 (Latimer et al. 1982, Knights, 1983, MacNeil et al. 1984). Scrotal circumference appears to be correlated with growth rate and androgen production. In sheep, selection for weight adjusted testicle size has resulted in distinctly lighter mature weight (Land et al. 1980). Beef cattle systems research has shown that cows with higher reproductive rates and lighter mature weights relative to their immature growth rates, are more efficient.

METHODS AND ANIMALS

Between 1979 and 1984 data were collected on 776 female and 960 male calf progeny of 70 purebred Angus sires. Both male and female weights were collected monthly postweaning. All males were kept entire and retained until after yearling weighing. Scrotal circumference was recorded in June, August and October on all male progeny. All female progeny were retained until post-heifer (15 month) mating. Age at first oestrus was determined in the following manner. Each year teaser bull marks were used to determine oestrus before November, entire bulls thereafter. A heifer was said to have exhibited oestrus when she had been marked twice within a 45-day period. The exception to this was when a heifer was marked with a single mark during the last 45 days of recording, including the actual mating period. These heifers were considered to have expressed oestrus on the date of marking. Because a proportion of heifers did not show oestrus before the end of mating, age at first oestrus was analysed either after excluding those that had not exhibited oestrus (AFO) or, by including animals that had not exhibited oestrus but with data converted to standard normal deviates as if oestrus age was an ordered categorical response (Fernando, Billingsly and Gianola, 1983); the latter measure being designated standardised oestrus age (SOA).

Data were analysed using mixed model techniques described by Schaeffer, Wilton and Thompson (1978). Their methodology permits simultaneous estimation of components of variance and covariance when within-animal crossproducts or sums between two traits do not exist, such as for scrotal circumference and age at first oestrus.

RESULTS AND DISCUSSION

Heritabilities and genetic correlations for the reproductive traits and weights involved in the analyses are presented in Table 1.

Table 1. Genetic relationships between reproductive traits and body weight

	Male Traits						Female Traits				
	Jun Wt	Aug Wt	Oct Wt	Jun Sc	Aug Sc	Oct Sc	AFO	SOA	Jun Wt	Aug Wt	Oct Wt
Male Trait											
Jun Wt	0.19										
Aug Wt	0.89	0.28									
Oct Wt	0.80	0.92	0.26								
Jun Sc	0.20	0.12	0.00	0.58							
Aug Sc	0.23	0.25	0.13	1.00	0.53						
Oct Sc	0.18	0.20	0.10	0.95	0.96	0.38					
Female Trait											
AFO	0.40	0.26	0.22	-0.05	-0.20	0.03	0.36				
SOA	0.56	0.47	0.39	0.09	-0.21	0.06	1.00	0.38			
Jun Wt	0.86	0.67	0.84	-0.11	0.01	0.24	-0.33	-0.18	0.41		
Aug Wt	0.67	0.78	0.91	-0.20	-0.04	0.20	-0.36	-0.25	0.97	0.58	
Oct Wt	0.90	0.74	0.96	-0.37	-0.23	0.02	-0.36	-0.27	0.92	0.96	0.58

[1] AFO - age at first oestrus; SOA - standardised age at first oestrus; JUNE - June scrotal circumference; AUG - August Scrotal circumference; OCT - October scrotal circumference

[2] Heritabilities on diagonal; genetic correlations below diagonal.

Genetically, SOA and AFO appear to measure the same biological trait. Conceptually and statistically SOA has greater appeal by accounting for animals failing to exhibit oestrus and statistically transforming data to incorporate null observations. Heritability for AFO is similar to estimates from overseas (Range 0.2 to 0.67). Genetic correlations between scrotal circumference and AFO (or SOA) are low and alter with age of bull half-sibs. Estimates are lower than those reported by Brinks et al. (1978) or King et al. (1983), being -0.71 and -1.07 respectively. Genetic correlations between scrotal circumference measures over time are very high and consistent suggesting that either the trait could be treated as a single repeated measurement or only one (June or August) measure need be recorded.

Genetic parameters for male and female traits either analysed separately or as separate experimental units are also presented in Table 1. There is a complete reversal in sign for correlations between weights and measures of age at first oestrus when analysing weight data for each sex separately. For example, the genetic correlation between June weight in females and AFO was -0.33, whereas for June weight in males and AFO the correlation was 0.40. This suggests that different selection emphasis on body weight is appropriate in males and females for improvement of reproductive maturity in heifers - for males it is important to be genetically heavier whilst for females it may be more important to be at a given age and weight rather than simply bigger.

REFERENCES

Brinks, J.S., McInerney, M.J., Chenoweth, P.J. (1978). Proc. West. Sec. Amer. Soc. Anim. Sci. 29: 28.

Fernando, R.L., Billingsly, R.D., Gianola, D. (1983). J. Anim. Sci. 56: 1047-1056.

Knights, S. (1983). M.Sc. Thesis. Univ. of Illinois, Urbana.

Land, R.B., Carr, W.R., Lee, G.J. (1980). In: Selection Experiments in Laboratory and Domestic Animals. Ed. A. Robertson, CAB.

Laster, D.B., Smith, G.M., Cundiff, L.V., Gregory, K.E. (1979). J. Anim. Sci. 48: 500-508.

Latimer, F.G., Wilson, L.L., Caw, M.F. (1982). J. Anim. Sci. 54: 473-479.

Lunstra, D.D., Ford, J.J., Echternkamp, S.E. (1978). J. Anim. Sci. 46: 1054-62.

MacNeil, M.D., Cundiff, L.V., Dinkel, C.A., Koch, R.M. (1984). J. Anim. Sci. 58: 1171-1180.

Maijala, K. (1978). Wld. Rev. Anim. Prod. 14(4): 65-72.

Morris, C.A. (1980a). Animal Breeding Abst. 48: 655-676.

Morris, C.A. (1980b). Animal Breeding Abst. 48: 753-767.

Schaeffer, L.R., Wilton, J.W., Thompson, R. (1978). Biometrics 34: 199-208.

Smith, G.M., Fitzhugh, H.A., Cundiff, L.V., Cartwright, T.C., Gregory, K.E. (1976). J. Anim. Sci. 43: 389-395.