A PRELIMINARY ESTIMATE OF THE HERITABILITY OF UTERINE CERVICAL DIAMETER IN TROPICALLY ADAPTED BEEF CATTLE

T.M. Finch[1], N.N. Jonsson[1] and C.M. Wade[2]
[1]The University of Queensland, Brisbane, Australia.
[2]Whitehead/MIT Center for Genome Research, Cambridge, Massachusetts, USA.

SUMMARY
Mean uterine cervical diameter, parity and parentage information was recorded from 246 Santa Gertrudis females in southern Queensland. A linear model was fitted to estimate the effects of parity on cervical diameter. The sire variance component was also analysed to provide an estimate of the heritability of cervical size. The effect of parity on cervical size was found to be highly significant (α= 0.01). As level of parity increased so did cervical size. The sire variance component was significant resulting in a heritability of 0.6±0.27 This suggests that uterine cervical size is a moderate to highly heritable trait.
Keywords: *Bos indicus*, fertility, cervix uteri, heritability

INTRODUCTION

The beef cattle industry of northern Australia is composed mainly of tropically adapted cattle such as the Brahman, Droughtmaster and Santa Gertrudis. These cattle are suited to tropical climates due to their tick and drought resistance. However, *Bos indicus* cattle have a reputation for lower fertility when compared to many *Bos taurus* breeds. There are many causes of low fertility in cattle including sub-nutrition, parasitism and congenital abnormalities. A discussion of many of these factors can be found in most livestock reproduction texts.

One of the areas of particular interest in *Bos indicus* cattle is conformation of the uterine cervix. It has been reported that uterine cervical size is greater in *Bos indicus* cattle than *Bos taurus* breeds (Gonzalez *et al.* 1983; Roberts 1986). While much research has been conducted to study the anatomy and physiology of the cervix at a cellular level, little has been done to examine the effects of the size and shape of the cervix as a whole. Varner *et al.* (1983) noted that the size and shape of the cervix had a significant effect on the pregnancy rate. A cone shaped cervix (a cervix where caudal diameter was greater than or equal to 1.5 cm greater than cranial diameter), was associated with a lowered pregnancy rate in cattle less that five years of age. It was also reported that the incidence of a coned cervix was 71% in Santa Gertrudis females compared to a 16% incidence in the *Bos taurus* animals studied. A protocol for culling females based on these criteria has been suggested (Edlington 2000). These criteria are certainly of use when selecting replacement females or when evaluating the fertility of a particular animal. It would also be useful for producers to know whether or not the trait of an enlarged or coned cervix was heritable. There is the possibility that this would enable producers to cull sires from their herd that were producing female offspring with cervical dimensions that could lead to infertility. This study was designed to investigate the effects of parity on uterine cervical size and estimate the heritability of cervical size using sire analysis.

MATERIALS AND METHODS

The study used 246 Santa Gertrudis females from four different properties in Southern Queensland. Caudal and cranial cervical diameters were measured with transrectal B-mode ultrasound using the Aloka SSD-500 scanner and a 5MHz linear probe. The sire, dam, and parity level for each animal were also recorded. The total number of sires used was 36. The average number of records per sire was 6.46, with the minimum number of records per sire being four and the maximum 19.

Seventeen of the animals scanned had no pedigree data available. In these cases, tail hair samples were collected and submitted to the University of Queensland Veterinary Blood Grouping Laboratory for parentage determination by polymerase chain reaction (PCR) using 15 standard microsatellite markers on an AB3700 automated sequencer (Applied Biosystems Australia). The panel of markers used is expected to provide 99% exclusion probability in line with paternity studies previously conducted on Santa Gertrudis cattle (Vankan and Faddy 1999).

Parity levels obtained ranged from zero to six with a mean parity of 1.07 offspring per female. Data was stored using the Microsoft Access database. Analysis was carried out using Residual Maximum Likelihood (ASREML) (Gilmour *et al.* 1999) procedures. The model fitted was :

$$CxD = \mu + Parity + Property + SireID \qquad (1)$$

where CxD is the mean of cranial and caudal cervical diameters in mm and μ is the constant term. SireID was random while all other factors were fixed. Age was not fitted as it was unrecorded for many cows and was heavily confounded with parity.

RESULTS AND DISCUSSION

Only 3.3 percent of the cervices measured in this study met the criteria of a 'coned' cervix as reported by Varner *et al.* However, this could be due to heavy selection pressure on the part of producers that we visited. Cattle who fail to conceive are routinely culled from the herds of producers included in this study. The nature of the infertility was not defined for each animal and therefore it is possible that many animals with large, 'cone shaped' cervices were culled from the herds before inclusion in this study.

Table 1. Mean uterine cervical diameter for each level of parity recorded

Parity Level	Number of records	Mean cervical diameter±s.e (mm)
0	170	25.44 ± 4.79
1	24	36.69 ± 6.05
2	23	34.48 ± 6.01
3	14	37.12 ± 6.89
4	8	39.06 ± 4.97
5	2	53.10 ±11.24
6	5	46.47 ± 8.26

Measurements taken of the cervix had a mean of 29.15mm and standard deviation of 7.92. In agreement with common experience, parity significantly ($\alpha = 0.01$) increased mean cervical diameter.

Table 1 shows the mean cervical diameter for the 7 different parity levels analysed. Data were scarce for levels of parity greater than 3 calves. However, it is evident from the available data that cervical size increases with parity. This conclusion is supported by many other studies that state that pluriparous cows have a larger cervix than nulliparous animals (Gonzalez *et al.* 1983; Roberts 1986; Khasatiya *et al.* 1998).

Sire effects were significant (Component/Standard Error=2.03) resulting in an estimate of heritability of 0.60±0.27. This is the first time that a relationship between sire and uterine cervical size in cows has been demonstrated. Traditionally, reproductive traits are considered to be poorly heritable (Meyer *et al.* 1990). However, most measures of reproductive fertility used in the literature are factors relating to time, such as age at first calving and calving interval, that are subject to many environmental factors. In contrast, when measures of fertility involving the measurement of physical structures are conducted, heritability is generally greater. For example, the heritability for pelvic area, an important fertility trait in the prevention of dystocia, is reported to be between 0.56 and 0.99 (Morrison *et al.* 1986; Green *et al.* .1988; Naazie 1991). In this study, not all dams were known, so an estimate of the heritability using an animal model was not obtained. Instead the reported heritability is estimated from the sire component of variance. The reported heritability is significantly greater than zero and appears to be consistent with other heritabilities reported on traits of physical dimension.

Mis-matched parentage may have resulted in some pedigree errors in the data. 229/246 animals scanned in this study were the product of single sire matings. However, there is a possibility that producer records contain inaccuracies due to bulls moving between yards because of fence damage, or due to clerical errors.

In previous studies, the method of cervix examination has been rectal palpation. Cervical size and conformation can be estimated in this way. However, the lack of an objective scoring system for cervical size makes it difficult to compare cervical traits in this manner. Ultrasound has many advantages. It is a simple, safe and relatively uninvasive technique of visualising and measuring internal structures (Laing 1998). Ultrasound scanning was particularly useful in this study because it allowed the comparison of images taken by different operators in order to establish a standard protocol for taking cervical measurements. This aided in the reduction of error across this study.

In conclusion, there is a strong phenotypic relationship between parity and uterine cervical size. Sire effects also determine uterine cervical size in daughters. A more extensive study will accurately quantify this effect, separate caudal and cranial measurements and associate cervix phenotype with reproductive success.

REFERENCES

Edlington, D. (2000) *J. Aust. Assoc. Cattle Vet.* **13**:25.

Gonzalez, R., Soto Bellosa, E. and Bohorquez, R. (1983) *Therio*. **19**:759

Green, R.D., Brinks, J.S. and LeFever, D.G. (1988) *J Anim. Sci.* **66**(11):2842.

Gilmour, A. R., Cullis, B. R., Welham, S. J., Thompson, R. (1999) "ASREML User manual." NSW Agriculture, Orange NSW

Khasatiya, C.T., Dhami, A.J., Shan, R.G. and Kavani, F.S. (1998) *Ind. Vet. J.* **75**:426

Laing, J.A., Brinley-Morgan, W.J. and Wager, W.C. (1988) "Fertility and infertility in veterinary practice." Bailliere Tindall, London.

Meyer, K., Hammond, K., Parnell, P.F., MacKinnon, M.J. and Sivarajasingam, S. (1990) *Livest. Prod. Sci.* **25**:15.

Morrison, D.G., Williamson, W.D. and Humes, P.E. (1986) *J. Anim. Sci.* **63**(2):432.

Naazie, A., Makarechian, M. and Berg, R.T. (1991) *J. Anim. Sci.* **69**(12):4793

Roberts, S.J. (1986) "Veterinary Obstetrics and Genital Diseases (Theriogenology)" Woodstock, Vermont.

Vankan, D.M. and Faddy, M.J. (1999) *Anim. Genet.* **60**:355.

Varner, D.D., Hinrichs, K., Garcia, M.C., Osborne, H.G., Blanchard, T.L. and Kenney, R.M. (1985) *Therio.* **24**:109.