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Low Calving Rates in Brahman Cross Cattle

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Summary. It is suggested that the low calving rate of crosses between *Bos taurus* cows and Brahman bulls in the F2 generation, in later generations and in breeds derived from the cross, could be due to the difference between the *Bos taurus* Y and the *Bos indicus* Y if this difference is due to a translocation between the Y and an autosome. It is suggested that such a translocation could set up a balanced polymorphism and perpetuate low calving rates against selection.

Key words: Cattle production – *Bos taurus* – Brahman cross – Infertility – Polymorphism – Translocation

Introduction

Breeds of beef cattle of *Bos taurus* origin grow well and have high calving rates in temperate climates, but in tropical and subtropical ones, they lose appetite and become susceptible to disease. They are apt to lose proper control of body temperatures and as a result, add active wasting and low calving rates to their other disabilities (Frisch and Vercoe 1978 a, b).

American Brahmans, which, according to Kelley (1959) have been selected from a mixture of Gir, Nellore and Kankrej, with some admixture of *Bos taurus* at some stage, are well adapted to the tropics but they have a low performance; they grow slowly, mature late and have low calving rates. It has been suggested that sensitivity of their calving rates to the environment, particularly to continuous poor feeding during the stress of lactation, is a defence against an erratic environment built into their make-up by natural selection. A cross between the Brahman and *Bos taurus* breeds is expected to be provided with adaptation to the tropics from the Brahman parent and high performance from *Bos taurus*. This expectation is very generally borne out by experience of the F1 generation, but the F2, though it remains adapted to the tropics, grows well and resists disease, has a calving rate that is almost, if not quite, as low as the calving rate of the Brahman itself. Crosses between the Africander and *Bos taurus* on the other hand do not have markedly lower calving rates in the F2.

Performance

At Belmont, the Australian Meat and Livestock Cooperation's property in Central Queensland, two estimates have been given of the F1 performances over the same years. In one, calving rate was corrected for a number of variables (Seebeck 1973); in the other, it was not (Lampkin and Kennedy 1965). Calving rates were as shown in Table 1.

The calving rate of the Brahman F1 is higher when the data are corrected. The six Brahman bulls which sired this F1 were highly variable. They scored relative to the mean +22, +35, +8, +4, –32, –37, falling into three groups. In the F2, for which there is only a corrected estimate, the AX and HS remain consistent with the F1 but the BX have fallen dramatically. Performance of BX bulls from later generations was variable taken as a whole, but individual performances were not given.

A trial with Santa Gertrudis, a breed derived from a Brahman cross, is available for comparison (Shipp, Wiltbank and Parish 1977). In this trial, heifers were fed to over 300 kg before being mated; in one lot, 80 heifers were mated to 4 bulls, in another each of 4 bulls was mated to 20 heifers. Some three quarters of the heifers had reached maturity (being observed in oestrus at least twice) before joining. Conception rates after 45 days of mating were 66% in single matings and 70% in the mass mating. At 60 days the success rate was still only 68% and 70% respectively. Bulls in the single matings were of two kinds. Two sired 50% each and two 80% each. Considering the number of cows put to the bull, the relatively mild

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Table 1. Calving rates of Africander Cross, Braham Cross and Hereford/Shorthorn cross cattle

	Africander cross (AX) % Calving*	No.	*Brahman cross* (BX) % Calving	No.	*Shorthorn/Hereford cross* (HS) % Calving	No.
F1 (a)	76.4	521	81.2	449	70.1	291
F1 (b)	77.3	466	73.8	424	[56.0	427]
F2 (a)	76.8	868	60.7	798	67.1	515

(a) From Seebeck (1973); (b) From Lampkin and Kennedy (1965). Figures in brackets include Shorthorn x Shorthorn and Hereford x Hereford matings

* % Calving: Per cent of live calves born from cows mated to single bulls, 30-35 to each bull, for a 7 week mating period

climate and the level of nutrition, this performance is comparable to that of the Belmont Brahman cross cows of the F2 and later.

Other authors quote performances with less detail and often without mentioning the length of the mating period. Mahadevan et al. (1972) found calving rates of 63% for Santa Gertrudis, 62% for Sahiwals and 55% for Brahmans. The Santa Gertrudis were given the best grazing. Warnick et al. (1967) found a calving rate of 68% in Santa Gertrudis and 69% in Brahmans. Meade et al. (1959) found that both breeds had a calving rate of 57%. It appears to be generally true that adaptation to local conditions measured as temperature regulation, disease resistance and growth superior to the non-adapted parent survive into later generations from the F1 of the Brahman cross; calving rates do not, at least in stressful conditions.

A possible exception to the low calving rate of Brahman crosses is the Droughtmaster, a breed like the Santa Gertrudis, derived in the first instance from a Brahman cross. Although Rudder et al. (1976a) and Rudder et al. (1976b) report that as males on a similar cross section of females, Brahman, Santa Gertrudis, Droughtmaster, Hereford and Belmont Red sires had calving rates of 63%, 71%, 75%, 86% and 85% respectively and that Santa Gertrudis cross, Droughtmaster cross and Belmont Red cross females mated to a representative cross section of bulls calved at the rate of 71%, 75% and 86% respectively, the Queensland Department of Primary Industries (Annual Report 1975 et seq.), records consistently high calving rates for its Droughtmaster herd in excess of 90%. As it is generally found that the Brahman cross which is such a successful one in most ways has a low calving rate in later generations, it is worth considering what the reason for this failure might be and if it has a ready cure.

Hypotheses

Fertility is a sensitive characteristic and dependent on many genes, which selection will take some time to sort out. Nevertheless, the length of time over which low calving rates have persisted in the Brahman crosses and the complete contrast with the Africander cross argue against a simple additive genetic explanation and suggest a balanced polymorphism. If there is one, it could be dependent on a balance between a number of genes or a chromosomal conformation.

One possibility is that a balanced polymorphism is in some way connected with the Y chromosome. The Y chromosome of *Bos taurus* has two equal arms. In *Bos indicus*, including the American Brahman, the Y chromosome has only one arm. The exact nature of this difference is not clear (Potter et al. 1979). All breeds derived from crosses in which the original bulls were Brahman will have an *indicus* Y chromosome. The suggestion that the Y chromosome may be concerned, gains support from the fact that the Africander has a *Bos taurus* Y chromosome and no fertility problems in F2, whereas the Brahman has the *Bos indicus* Y and has problems in F2 and later generations. It is also of interest that some Droughtmasters have a *Bos taurus* Y (Potter et al. 1979).

It has been shown that in the BX at Belmont low calving rates are due to both the bull and the cow. BX cows mated to AX bulls have a lower calving rate than AX cows mated to the same bulls. AX cows and BX cows mated to BX bulls have lower calving rates than AX cows and BX cows mated to AX bulls. The low calving rates in BX cattle is thus a feature partly of the bull and partly of the cow (Seifert et al. in press).

A deficient Y chromosome will not of itself explain low calving rates in females, nor lower calving rates in F2 than in F1, since both generations of males carry the same Y. But if the crossbreds are derived from a Brahman male as they usually are, so that the Y always comes from the Brahman, a translocation from the Y to the X or from the Y to an autosome, could under the right conditions set up a stable chromosomal polymorphism which would ensure continued low calving rates in the population as a whole, though some bulls and cows would be highly fertile. There is no cytological evidence of such a translocation so far.

For the purposes of the hypothesis it is not necessary that there be a translocation from Y to another chromosome. The reverse would have the same result. What is required is some relation between the Y and another chromosome in the genome which results in low calving rates and in crosses in interactions between chromosome types. I shall illustrate the idea by referring to a translocation between the Y and an autosome or the Y and the X chromosome. Conditions for a stable sex-linked polymorphism have been studied by Bennett (1958). What is known from observation about the calving rates of Brahman crosses is that the F1 animals, male and female, have relatively high calving rates by comparison with the Brahman and the *Bos taurus* breeds in a stressful tropical environment but the F2 does not; in F2 calving rates usually fall below those of the *Bos taurus* breeds. Consider the possibility that the Brahman Y has been formed by one arm becoming translocated to the X and let us represent the Brahman Y by the symbol Λ and the Brahman X by the symbol X. We then have the following genotypes in the course of making the cross:

	P1	Λχ	x	XX	
	F1	ΛX	x	χX	good calving rates
F2 and later	}	ΛX	:	χX	As in F1
	}				
generations	}	Λχ	:	XX	As in P1
	}		:	χχ	

If F2 is to be as poor as the Brahman, it must be the females that fail for the two sorts of bull in F2 are either like the Brahman or like F1 and on average will be better than the pure Brahman. We must suppose that for some reason XX females of F2 with a genetic background adapted to tropical stress have poor calving rates, though in a genetic background not adapted to tropical stress, they have calving rates greater than those of the Brahman. It is not possible to say whether females fall into clear cut classes with respect to calving rates as it is not generally possible to rank them with any accuracy. It is difficult to fit this hypothesis to the data. It is also difficult to see why Λχ, the Brahman configuration, which has a complete chromosomal complement, should be less fertile than the F1, ΛX which is missing a piece of the Y.

An alternative is that the arm of the Y missing in Brahmans has been translocated to an autosome. Let us designate the Brahman Y by the symbol Λ as before and the autosome carrying the arm from Y as 7 and the normal autosome 1. The genotypes will be

	P1	XΛ77	x	XX11
	F1	XΛ71	x	XX71
F2 and later	{	XΛ77	:	XX77
	{			
generations	{	XΛ71	:	XX71
	{			
	{	XΛ11	:	XX11

We know from F1 that XΛ71 and XX71 are successful and have good calving rates. We expect XΛ77 to be poor as it is the Brahman configuration. XΛ11 is deficient in an arm of the Y and may be entirely or almost entirely sterile. XX77 is the Brahman configuration and XX11 the *Bos taurus* one. It follows that F2 females should be better than Brahmans and low calving rates in F2 a male rather than a female trait unless the frequency of 77 is high. The conditions for equilibrium are complex in detail and have been described by Bodmer (1965). In general the mean fitness of the two homozygotes in each sex must be less than the fitness of the corresponding heterozygotes.

This may well be so in this model. It is also possible to suppose that selection in favour of 11 in females is balanced by selection against 11 in males. In both the sex-linked and the autosomal model, the presence of the Brahman Y is essential to provide low fertilities in Λχ in one case and XΛ11 in the other. It follows that if the cross were made the other way, so that the Y was a normal one, for a time some individuals with low fertility would appear owing to the translocation on the X or autosome, as the case may be, but no balance would be set up and selection would remove the translocation chromosomes and with it the low calving rate quite quickly.

Although there is no proof that the low calving rates in Brahman crosses are the result of a balanced chromosomal polymorphism, the introduction of a *Bos taurus* Y into the cross is so simple that it seems worth trying.

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