BASIS FOR STANDARDIZED KARYOTYPIC NOMENCLATURE IN CATTLE

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SUMMARY

It is suggested that the standard bovine karyotype adopted at the *Reading Conference* in 1976 (Ford et al. 1980) and reconfirmed in France in 1989 (DiBerardino et al., in press) remain as the accepted karyotype. Nomenclature used to describe cytogenetic aberrations has generally followed the pattern adopted for human chromosomes and it is suggested that this be continued. A high resolution karyotype standard could be considered. Further research on normal variants such as fragile sites is needed.

INTRODUCTION

A standardized bovine karyotype was agreed upon at the *Reading Conference* (1976) (Ford et al. 1980). This karyotype was reviewed in 1989 in France and no substantive changes were made.

THE NORMAL KARYOTYPE

At the beginning of the century, histological techniques gave only poor results . Krallinger (1931) established the diploid number of chromosomes at 60 using testicular material. During the following years, this number was confirmed and the sex chromosomes were identified as a large metacentric X chromosome and a small metacentric Y chromosome (Makino 1944). At the end of the fifties, the combination of various techniques: the use of cultured cells, the replacement of the squash method with hypotonic shock and air-drying, and the induction of lymphocyte division by plant lectins, has permitted the morphology of all cattle chromosomes to be established. However, cattle chromosomes, like those of the majority of domestic Bovidae cannot be easily distinguished using solid staining. Banding techniques are necessary to differentiate each pair of chromosomes. Numerous scientists have applied these techniques: Q-banding (Hansen, 1972), G-banding (Lin et al. 1977), R-banding (Popescu, 1975), C-banding (Hansen, 1973), T-banding (Gustavsson, 1980) and NOR-banding (DiBerardino et al., 1979).

PRINCIPLES OF STANDARDIZED NOMENCLATURE

In general the nomenclature used for domestic animals follows that adopted for human chromosomes at a series of international conferences (Denver, 1960; Chicago, 1966; Paris, 1971; ISCN, 1978; ISCN, 1981). The results of these conferences are summarized in *An International System for Human Cytogenetic Nomenclature* (1985).

The first attempt at standardization of the bovine karyotype took place at the Reading conference in 1976 (Ford et al. 1980) where the GTG-banded karyotype published by Lin et al. (1977) was adopted. In 1989, this was reconfirmed and a standardized R-banded karyotype (RBA) was set at the Jouy-en-Josas Conference (DiBerardino et al., in press). The acrocentric autosomes are arranged only by size, in descending order since no other subgroups by centromere placement are possible. The sex chromosomes follow.

The karyotypic nomenclature always consists of the total number, followed by a comma and the sex chromosomes. Therefore the normal karyotype of a bull is 60,XY and of a cow is 60,XX.

A. Banding Techniques

Several banding techniques, including G, Q, R, C, T and NOR, are available. A three letter designation can be used for G, Q, R, and C banding to describe more precisely which method was used. In this case the first letter indicates the banding pattern obtained; the second the type of bands, i.e. flourescent, trypsin, heat; and the third the stain used (ISCN 1985, p.44). The NOR regions are located on telomeres of chromosomes 2, 3, 4,1 1, and 29 (Ford et al. 1980).

Bands are numbered from the centromere to the telomere. In the case of the sex chromosomes, the short arm is designated p and the long arm q. The autosmes are considered to have a q arm. Regions of the chromosome are delineated by landmarks and are also numbered distally from the centromere. A specific band is therefore designated by the chromosome number, arm, region, and band with no punctuation between, i.e. 1p33.

B. Abnormalities and Variants

Aberrations in the karyotype are written after the number and sex chromosomes when they occur. When two different cell lines are found, as is typically the case in freemartins, both are identified and separated by a slash, i.e. 60, XX/60,XY. The order has no association with the frequencies of the respective cell lines but should follow from low total number to higher (ISCN 1985, p. 24).

The common aberrations and the symbol used for each is:

trisomy	+	dicentric	dic
monosomy	-	inversion	inv
translocation	t	deletion	del
ring	r	duplication	dup
isochromosome	i	fragile site	fra

Therefore autosomal trisomies (Coates et al. 1988) such as that of chromosome 17 first reported by Herzog and Höhn (1968) would be written 61,XX,+17. The karyotype of a bull with the Robertsonian translocation of chromosomes 1 and 29 first described by Gustavsson (1966) and found in many breeds of cattle should be referred to as 59,XY,t(1;29). In the case of reciprocal translocations, the breakpoints should also be indicated as was done by Mayr et al. (1983) , i.e. 60,XY,t(8;15)(21;24). The inversion of chromosome 16, described by Popescu (1977) should be written 60,XY,inv(16). The breakpoints were not delineated in this case.

Variants and/or polymorphsims of the normal karyotype have not been described often for cattle. However the Y chromosome is described as being of variable length, by Cribiu (1975) and later by others. Variants involving constitutive heterochromation have also been observed (Popescu, 1974). Fragile sites have not been studied extensively in cattle although Herzog et al. (1977) and DiBerardino et al. (1983) have described them and Bouvet (1988) has found several on the X chromosome in "baldy calf syndrome". Such fragile sites could be written as 60,XY,fra(X)(q31). Mosaic tetraploidy has been mentioned by Hare and Singh (1979) and Galli et al. (1987) and found not uncommonly in low levels in our laboratory (SMS), suggesting this may also be a normal variant in bovine lymphocyte karytoypes.

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