

DISTRIBUTION OF THE 1/29 AND 14/20 ROBERTSONIAN TRANSLOCATION IN
ROMANIAN SIMMENTAL (ROMANIAN SPOTTED) SIREs

Distribución de los translocaciones Robertsonianas 1/29 y 14/20 en
los toros de raza Simmental tipo rumano

D.D.CIUPERCESCU*

ROMANIA

By far the most common chromosomal abnormality in domestic cattle is a centric fusion of chromosomes, known as Robertsonian translocation (Robertson, 1916). Since the first descriptions of the 1/29 translocation in cattle (Gustavsson and Rockborn, 1964; Gustavsson, 1966), at least 10 other centric fusions comprising different autosome pairs, in more than 30 breeds from over 24 countries have been identified (Blazak and Rldridge, 1977; Gustavsson, 1979; Livescu and Ciupercescu, 1980; Popescu, 1980). This is primarily a consequence of the fact that in many countries, including Romania, several populations of A.I. bulls are nowadays routinely karyotyped.

Since 1977 more than 200 Romanian Simmental A.I. sires, tested or in course of being tested, have been analysed cytogenetically in our laboratory. In 1979, Ciupercescu et al. found the 1/29 Robertsonian translocation in phenotypically normal Romanian Simmental bulls and later, Ciupercescu (1980 a; 1980 b) has described a new centric fusion identified as 14/20 by measurements only. This paper reports further studies undertaken on bulls found to be heterozygous for the 1/29 or 14/20 Robertsonian translocations and the results of G and C-banding studies are presented.

MATERIALS AND METHODS

The two hundred bulls tested cytogenetically have been reared in a performance testing program and belonged to the "Entreprise for sire testing and production of frozen semen" (SEMTST). All bulls were of Simmental cattle type and consisted of Romanian Spotted breed, Swiss Simmental, Austrian Piebald, or crossbreeds of these breeds for all being given the name of "Romanian Simmental".

Blood samples were collected from the middle coccygeal vein, and mitotic preparations were obtained by means of a modified procedure of Moorehead et al. method (1960). For the animals bearing a chromosomal abnormality, the analyses were repeated at least twice. The slides were either Giemsa stained, or treated according to the G-band (Seabright, 1971) and C-band techniques (Summer, 1972). The identification of the chromosomes involved in the centric fusions was based on the standardisation formulated by the Reading Conference, 1976 (Ford et al., 1980).

RESULTS

Of the 200 Romanian Simmental A.I. sires analysed cytogenetically three (1.5 %) were found heterozygous for the 1/29 Robertso-

* Institute of Agriculture "Dr.P.Groza", str.Mănăştur Nr.3, R-3400, Cluj-Napoca, Romania

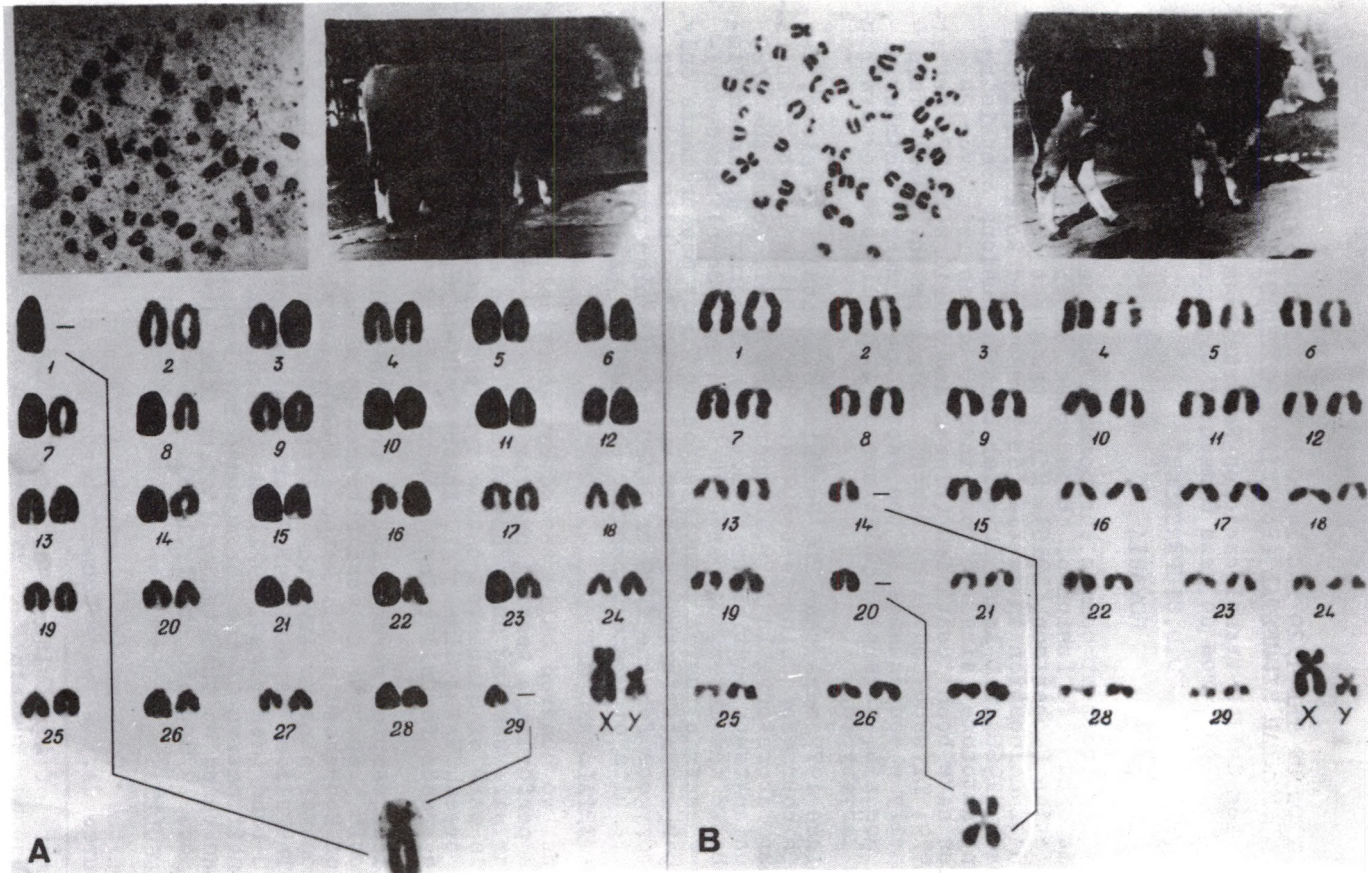


Fig.1. Metaphases and karyotypes from the Romanian Simmental bulls. A-proband W, $2n=59, XY t(1;29)$. B-proband O, $2n=59, XY t(14;20)$.

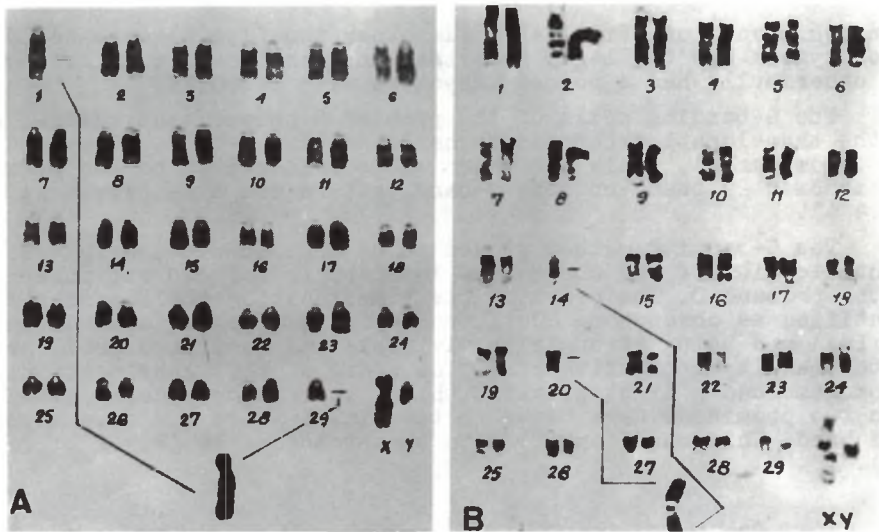


Fig.2. G-banded karyotypes. A-proband R, $2n=59,XY t(1;29)$.
 B-proband O, $2n=59,XY t(14;20)$.

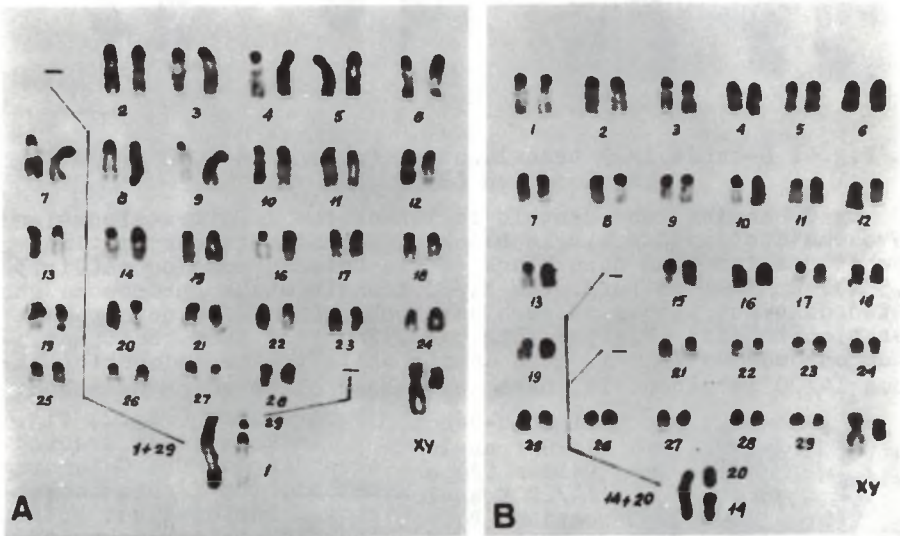


Fig.3. C-banded karyotypes. A-proband R, $2n=59,XY t(1;29)$.
 B-proband O, $2n=59,XY t(14;20)$.

nian translocation (Fig.1 A) while other two (1.0 %) were found heterozygous for the 14/20 Robertsonian translocation (Fig.1 B). The other bulls had a normal karyotype with $2n=60,XY$.

The G-banding cells of the proband R showed that the q-arm of the translocation chromosome has a similar G-band pattern to the chromosome 1, while the p-arm was considered to be one of the chromosomes 29 based on both G-band pattern and size (Fig.2 A; Fig.4 A).

The G-banding method proved to be most productive in the identification of the chromosome involved in the centric fusion of the proband O. The p-arm of the translocation chromosome was identified as chromosome 20. It possessed two positive bands, the proximal one being strongly subdivisible and separated from the distal band by a negative band. The q-arm of the translocation chromosome had a light proximal third, increasingly dark distally, with two prominent dark bands in the distal third and a weak positive band. This was identified to be chromosome 14 (Fig.2 B; Fig. 4 B).

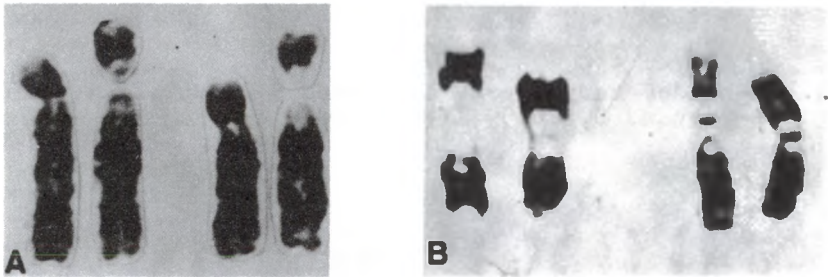


Fig.4. G-bands 1/29 translocation (A) and 14/20 translocation (B)

By C-banding, the centric region of the 1/29 translocation chromosome displayed a single block of C-band heterochromatin somewhat smaller than each block of the unfused homologues (Fig.3 A; Fig.5 A). On the contrary, the 14/20 translocation chromosome showed two distinct blocks of such heterochromatin, with no apparent alteration in size (Fig.3 B; Fig.5 B). The fact that the translocation chromosome 1/29 is monocentric while the translocation chromosome 14/20 is dicentric, have also been observed on G-banded

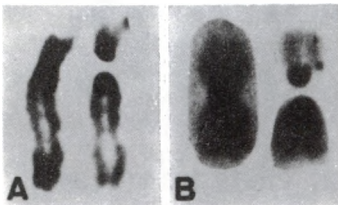


Fig.5. C-bands preparations (Fig.2; Fig.4).

In most cells treated according to the C-banding method, the X chromosome showed two distinct but extremely small blocks of constitutive heterochromatin present within each proximal third of the p-arms

(Fig.3).

DISCUSSION

Many reports are related to the 1/29 Robertsonian translocation which has been found in Simmental type of cattle and its frequency varies little in different countries. Considering only the results based on more than 100 cattle sampled, Harvey(1976) reported a frequency of 2.7 % in Great Britain, Mayr and Schleger(1977) found 2.5 % in Austria, Tschudi et al.(1977) found 3.2 % in Switzerland. An average frequency of 2.0-3.0 % of the 1/29 Robertsonian translocation within Simmental type of cattle could be of considerable importance. It is well known the fact that the daughters of carrier bulls show a lowering in fertility (Gustavsson, 1969; Refsdal, 1976) and a reduced fertility has occasionally been observed in affected bulls as well (Dyrendahl and Gustavsson, 1979; Cribru and Popescu, 1980). These observations underline the importance of introducing eradication programs in cattle breeding and also of developing cytogenetic investigations and methodology in veterinary medicine.

The 14/20 Robertsonian translocation has been described only by Logue and Harvey(1978) so far in Swiss Simmental cattle and it proved to be the same translocation as the 11-12/15-16 reported by Bruère and Chapman (1973). However, this type of centric fusion seems to be more frequent than it appears if the 13/21 translocation described by Kovacs et al.(1973) in a Canadian Holstein and the 7-11/20-25 translocation reported by Darré et al.(1974) were in fact 14/20 as Logue and Harvey (1978) suggested. It would be very useful if other such translocations of the middle-sized chromosomes that were reported in different breeds and countries (Livescu and Ciuperescu, 1980) and which were identified by measurement only, could be re-examined by banding methods.

The C- and G-band studies of these two Robertsonian translocations allow the conclusion that they are similar to the corresponding translocations reported elsewhere. The 1/29 Robertsonian translocation showed always a single block of C-band heterochromatin in the centromeric region; such data were summarized by Popescu(1977) and Gustavsson(1979).

The 14/20 Robertsonian translocation seems to have been produced in a different manner since the translocation chromosome showed two blocks of C-band heterochromatin at the primary constriction. Similar types of dicentric chromosomes were also reported by Eldridge (1974), Popescu(1977), Logue and Harvey (1978).

The fact that the 1/29 translocation is monocentric while the 14/20 translocation is dicentric indicates the occurrence of at least two different mechanisms of centric fusion in cattle. It is interesting to note that the monocentric 1/29 translocation is widespread, while the dicentric Robertsonian translocations have only been observed in a few cases.

Although it is generally accepted that the X chromosome of cattle is devoid of constitutive heterochromatin, two very small blocks of C-band heterochromatin could be seen within each proxi-

mal third of the p-arms, providing the preparations are of a very high quality. Such observation has also been reported by Di Berardino and Iannuzzi (1980).

Further work on the various Robertsonian translocations in cattle will be carried out for a better understanding of the mechanisms involved in certain phenotypic effects.

SUMMARY

More than 200 Rumanian Simmental A.I. sires were analysed cytogenetically between 1977 and 1981. Three of them (1.5%) were found heterozygous for the 1/29 Robertsonian translocation, while other two (1.0%) were found heterozygous for the 14/20 Robertsonian translocation. The chromosomes involved in the centric fusion were identified by measurements and G-banding studies.

By C-banding, the centric region of the 1/29 translocation chromosome displayed a single block of C-band heterochromatin, somewhat smaller than each block of the unfused homologues. On the contrary, the 14/20 translocation chromosome showed two distinct blocks of such heterochromatin, with no apparent alteration in size. The fact that the translocation chromosome 1/29 is monocentric while the translocation chromosome 14/20 is dicentric has also been observed on G-banded preparations. In most cells treated according to the C-banding method, the X chromosome showed two distinct but extremely small blocks of constitutive heterochromatin present within each proximal third of the p arms.

RESUMEN

Entre los años 1977 y 1981 han sido analizados desde el punto de vista citogenético más de 200 toros de raza Simmental tipo rumano utilizados para inseminación artificial. Tres de estos (1,5%) fueron heterocigotos para la translocación Robertsoniana 1/29, mientras que dos (1,0%) se han conseguido heterocigotos para la translocación Robertsoniana 14/20. Los cromosomas implicados en la fusión centrica han sido identificados por medidas y por estudios de las bandas G.

Por las bandas C se han observado que el cromosoma translocado 1/29 presenta en la región del centromero un solo bloque de heterocromatina constitutiva algo más pequeña que cada uno de los bloques de cromosomas homólogos que no han sufrido fusión. Al contrario, el cromosoma translocado 14/20 presentó dos bloques de heterocromatina sin ninguna modificación aparente de su dimensión. El hecho que el cromosoma translocado 1/29 es monocentrico, y el cromosoma translocado 14/20 es dicentrico fue igualmente observado con la ayuda de las bandas G.

En la mayoría de las células tratados por las bandas C el cromosoma X presentó dos bloques distintos de heterocromatina constitutiva de dimensiones extremadamente pequeñas situadas entre cada una de las terceras partes proximales de los brazos p.

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