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Note

A new Robertsonian translocation, 8/23, in cattle

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Summary – A new Robertsonian translocation was found in 7 animals of the Grey Ukrainian breed. The translocated chromosome, analyzed by GTG- and RBG-banding, resulted from the fusion of chromosomes 8 and 23. C-banding suggested that the translocated chromosome has a double heterochromatic block. Synaptonemal complex analysis was performed using electron microscopy.

cattle / chromosome / Robertsonian translocation

Résumé – Une nouvelle translocation robertsonienne bovine, 8/23. *On a découvert une nouvelle translocation robertsonienne chez 7 représentants de la race Ukrainienne grise. Le chromosome fusionné, analysé par une technique de bandes GTG et RBG, est le résultat de la fusion des chromosomes 8 et 23. La technique de bande C suggère que le chromosome fusionné possède 2 blocs hétérochromatiques. L'analyse des complexes synaptonémiques a été effectuée au microscope électronique.*

bovin / chromosome / translocation robertsonienne

INTRODUCTION

Twenty-eight different centric fusion translocations are known in cattle of which 12 have been described with the method of banding (Berland *et al*, 1988). The most common is the 1/29 translocation, found with different frequencies in more than 40 breeds of cattle. Fusions of other pairs are rare (Gustavsson, 1979; Long, 1985).

The present communication describes a new Robertsonian translocation, revealed in Grey Ukrainian cattle.

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MATERIALS AND METHODS

Seven animals (3♀ and 4♂) of Grey Ukrainian cattle, heterozygous for a Robertsonian translocation, were studied. The information on relationships between the affected animals is absent.

Chromosomal preparations were made from blood cells, stimulated with PHAM (Difco). Delayed condensation was induced by ethidium bromide (Ikeuchi, 1984). CTG-banding (Sumner, 1972) and GTG-banding (Seabright, 1971) were conducted. RBG-banding was performed according to the modified FPG method (Perry and Wolf, 1974; Camargo and Cervenka, 1980; Rønne, 1983). The standard nomenclature of the cattle chromosomes was used (ISCNDA, 1990).

Preparations of surface-spread synaptonemal complexes (SCs) were made (Solari, 1980). A suspension of testis cells was spread on 0.2 M sucrose solution. Surface-spread cells were picked up on plastic-coated slides. The preparations were fixed in 4% paraformaldehyde solution. The spreads were stained with 50% silver nitrate solution (Howell and Black, 1980). They were then transferred and photographed using an electron microscope JEM-100 (Jeol). In total, 100 nuclei with the complete SC set at the pachytene stage were analyzed. Meiotic prophase stages were identified as described by Dollin *et al* (1989).

RESULTS

Routine staining of preparations revealed 59 chromosomes, including one biarmed autosome in all cells. This chromosome is similar to the X-chromosome in size and arm ratio (fig 1). C-banding shows 2 clear blocks, proximally distributed on the 2 arms of the aberrant chromosome (fig 2). Analysis of GTG- and RBG-banding patterns of prometaphase chromosomes shows that a centric fusion of chromosomes 8 and 23 took place (fig 3 and 4).

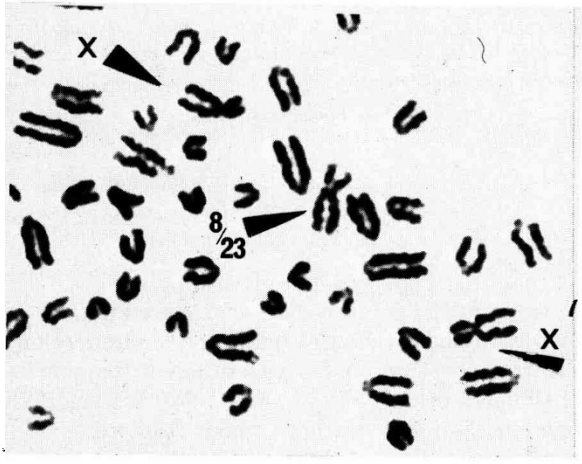

Fig 1. Part of the cell of 1 of the investigated cows (arrows show biarmed chromosomes).

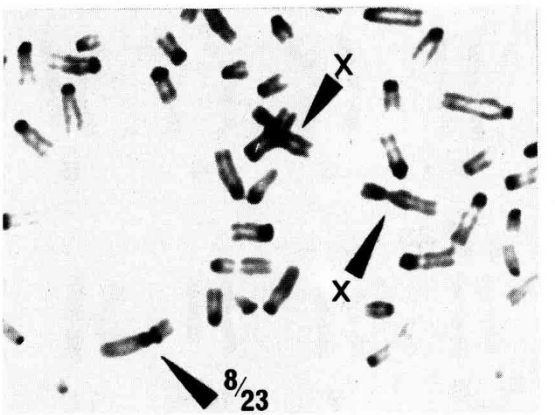

Fig 2. Part of the C-banded cell (arrows show biarmed chromosomes).

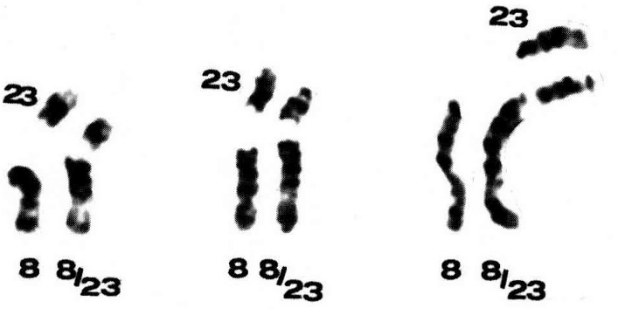

Fig 3. G-banding patterns of chromosomes 8/23, 8, 23 from 3 cells at different levels of condensation.

Fig 5 and 6 present SC microphotographs of the 8/23 trivalent. In contrast to the 1/29 translocation, which is easily identified by size, the 8/23 trivalent could be identified only by the presence of unpaired subcentromeric regions of its acrocentic elements at early pachytene. The delay in pairing can be noted in the subcentromeric region of one or both acro-centric chromosomes.

In the majority of mid- and late-pachytene cells, complete synapsis was observed throughout the total length of the trivalent and only in rare cases could we distinguish the Robertsonian trivalent from normal bivalents due to the dark staining of the attachment plaques at the subcentromeric regions of the acrocentric elements (fig 6).

No case of association between the trivalent and XY bivalent was observed. In fact the X and Y axes were associated end-to-end in approximately 1/3 of the pachytene cells. They never demonstrated a clear SC, even in these cases, and were dissociated in the rest of the pachytene cells. Axial splits of their terminal segments were frequently observed at mid- and late-pachytene.

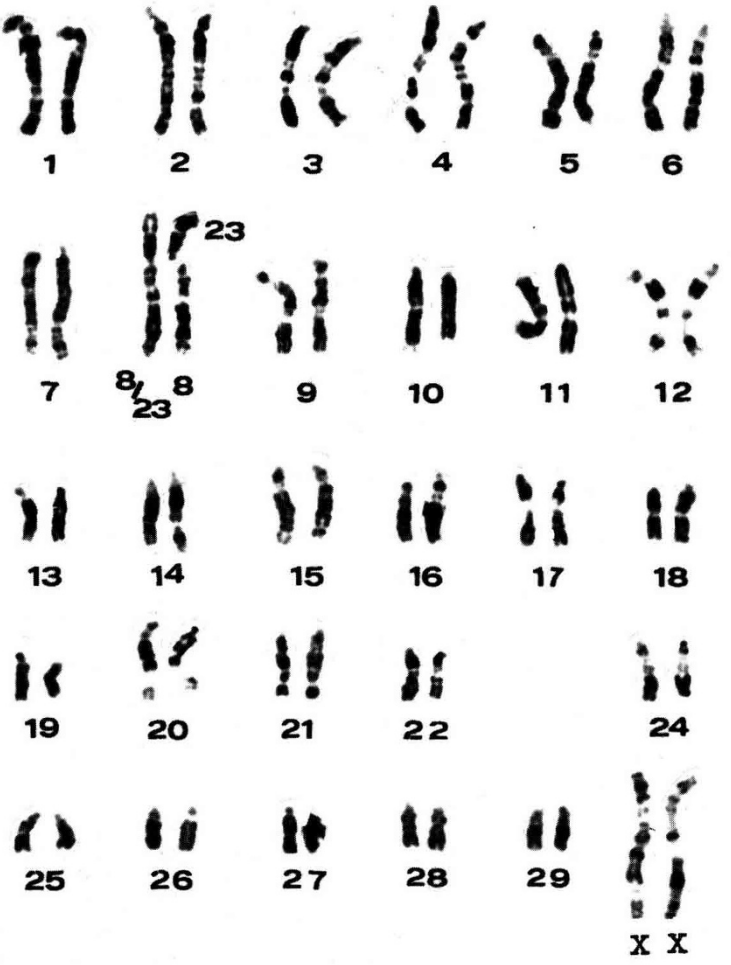

Fig 4. RBG-banding patterns of the cow, heterozygous for the 8/23 translocation.

DISCUSSION

The comparative analysis of GTG- and RBG-banding patterns of the translocation chromosome and its homologues has shown that the centric fusion occurred without obvious loss of chromosomal material. The presence of heterochromatic blocks in the proximal regions of the short and the long arms of the aberrant chromosome is also indicative of the lack of a large deletion in the subcentromeric regions of chromosomes 8 and 23. The possibility of suggested breakages near to the centromeres with minimal loss of chromosomal material is supported by the SC study. The 8/23 fusion in meiotic prophase is fairly similar behaviour to that of the heterozygous 1/29 translocation (Switonski *et al*, 1987). Compared with the heterozygous 1/29, the 8/23 fusion only differs in the rate of asynapsis in the

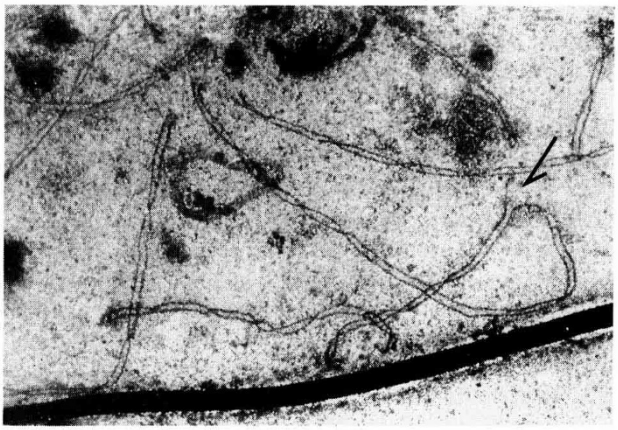

Fig 5. Electron microphotography of the synaptonemal complex of the bull heterozygous for the 8/23 translocation. Early pachytene; the arrow shows trivalent 8/23; the synapsis in pericentromeric region is delayed.

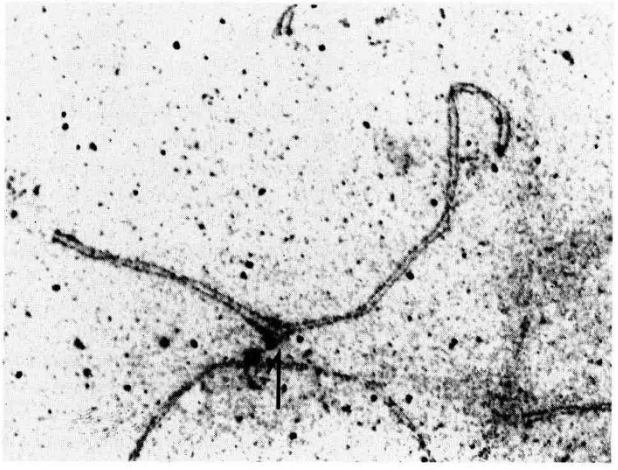

Fig 6. Electron microphotography of the synaptonemal complex of the bull heterozygous for the 8/23 translocation. Middle pachytene; the arrow shows the plates to which pericentromeric regions of acrocentrics are attached.

subcentromeric region, which is more rare and therefore observed during a shorter time in prophase. In addition, we found no trivalent with extensive nonhomologous synapsis of the subcentromeric segments of the acrocentric chromosomes, though configurations with unpaired subcentromeric segments were quite common (25% of the cases). 1/29 and 8/23 represent different mechanisms of translocation formation. If the fusion in the former was preceded by deletion, there was a fusion of

centromeres in the latter. It was shown earlier (Forejt *et al*, 1981) that translocation multivalents tended to associate with the sex bivalent. This can result in decreased fertility of the carriers. Trivalent 8/23 does not show such associations.

In all known cases of centric fusions in cattle, except for the 1/29 translocation, the newly formed biarmed chromosomes have 2 heterochromatic blocks. The 1/29 translocation differs by having only 1 heterochromatic block on the q-arm. The lack of a C-block on the short arm suggests a deletion of the subcentromeric region of chromosome 29, which has been supported by analysis of high-resolution banding patterns and SC analysis in heterozygotes. According to some authors (Evans *et al*, 1973; Popescu, 1977) translocations of the 1/29 type arise from an earlier formation. This idea is based on the fact that centric fusions that are not preceded by deletion in an arm are dicentric and can disintegrate with the passing of generations.

The 8/23 translocation described occurred without obvious loss of heterochromatin. This type of centric fusion is the most common, formed *de novo*, in cattle.

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