CHROMOSOME ELIMINATION EN BLOC IN SACCHARUM*

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INTRODUCTION

Variation in somatic and gametic chromosome numbers in *Ribes nigrum* (Vaarama 1949) and *Eruca sativa* (Rajan et al., 1950) has been attributed to the formation of accessory spindle and subsequent "elimination of chromosomes en bloc".

In sugarcane, Parthasarathy (1951), after examining the slides of megasporogenesis in Co. 421 prepared by Subramaniam (1946), concluded that the mechanism of elimination accounts for the anomalous chromosome numbers in certain hybrids. According to him "this kind of abnormality is only characteristic of megaspore mother cells and is not found in the pollen mother cells". Raghavan (1954) recorded "elimination of chromosomes en bloc" through the formation of the accessory spindle during the first meiotic metaphase in the pollen mother cells of *S. robustum*. This is not found in EMC's.

Bremer (1959) has many objections against the phenomenon of "en bloc elimination of chromosomes" and has "the conviction that there is no question of an elimination of chromosomes en bloc". He feels that the occurrence of a parthenogenetic derivative having a lower number than the mother plant is caused by "an endoduplicational division of a part of the chromosomes (which) must have taken place in the megaspore from which the plant originated". He also wonders why the elimination should not occur both in the EMC and PMC of the same material.

Sam Price (1961) considers that "the mechanism called chromosome elimination 'en bloc' is nothing unusual". According to him "crosses cited to illustrate the effect of chromosome elimination 'en bloc' did more to discredit the idea than to promote it, for the crosses usually involved complex hybrid canes from which aneuploid offspring should have been expected as a matter of course".

RESULTS AND DISCUSSION

Detailed investigations are under way at this Institute to understand whether the chromosome variation is through elimination of chromosomes as suggested by Parthasarathy (1951) and Raghavan (1954), or through partial endo-duplication as explained by Bremer (1959), or both. The author is unable to agree with Price (1961) that "no special mechanism is required to explain the production of unusual chromosome number". While chromosome variation may be nothing unusual in polyploids,

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surely the mechanism by which this takes place in sugarcane needs investigation and explanation.

Observations on the elimination of chromosomes 'en bloc' during meiosis in mega- and microspore mother cells, of Co. 602, a complex hybrid variety used at Coimbatore, are recorded below.

Accessory spindle has been noticed in the mega- and microspore mother cells (Figs. 1 and 2). The further development of the cells with accessory spindle has been studied during the microsporogenesis.

Prophase I has been normal in all the microspore mother cells. Only one group of chromosomes is present at this stage (Fig. 3). Metaphase I is also normal except for the presence of double plate metaphase in 5 to 10 percent of the cells (Fig. 4) and an occasional occurrence of triple plate metaphase (Fig. 5). The Spindles of the two metaphase plates are usually oriented parallel to each other or sometimes at an angle. Of the two groups one is larger than the other. The number of bivalents could not be counted for want of suitable plates; but, judged from the size of the groups, considerable variation in chromosome numbers within groups appears possible. Detailed studies on Metaphase I and II and anaphase I and II are expected to be made during the ensuing flowering season.

The main group completes the first and second meiotic divisions in the usual manner, whereas the chromosomes of the accessory group do not pass beyond the metaphase stage. During anaphase I the accessory group moves to one pole (Fig. 6) without undergoing anaphase separation. With the progress of the division in the cell, the accessory group moves towards the cell wall (Figs. 7 and 8). The chromosomes of this group show signs of degeneration and completely disappear from the cell.

Accessory grouping is observed during metaphase II as well (Fig. 9). This
Figs. 3-9. Cameralucida drawings representing the formation of the accessory spindle and subsequent elimination of chromosomes 'en bloc' during microsporogenesis in Co. 602.

3 - Microspore mother cell at Prophase I; 4 - Microspore mother cell with double plate metaphase I; 5 - Triple plate metaphase I in the microspore mother cell; 6 - Anaphase I in the microspore mother cell. The accessory group which is still at metaphase I has moved to one pole while the main group is in anaphase I; 7 - The accessory group which is still at metaphase I is near the cell wall at one pole while the main group has completed telophase I; 8 - The formation of dyad of spores. The accessory group is included in one of the dyads. It degenerates and completely disappears from the dyad before it enters the second meiotic division; 9 - Double plate metaphase II in one of the dyads.

Fig. 10. A tryad of microspores.

Group which is newly formed is presumed to be eliminated during the completion of the second meiotic division.

Meiotic irregularities, other than the presence of some laggards, commonly associated with the meiosis of high polyploids, are not noticed. However, tryad of microspores (Fig. 10) but not pentad of spores and micronuclei are noticed.

During the megasporogenesis a dyad of spores is produced after meiosis I. After elimination of the chromosomes 'en bloc' the chalazal dyad receives only less than n number of chromosomes. The micropylar dyad which has received the accessory group completes the second meiotic division and degenerates. The chalazal dyad nucleus divides producing two spores whose chromosome number is less than n. Their nuclei fuse producing a fusion nucleus which has less than 2n chromosome complement.
The following explanation is offered with regard to the chromosome number of the two types of seedlings from Co. 602 reported by Subba Rao et al. (1960). The thin canes with 96 chromosomes may be presumed to have been produced by the elimination of 11 bivalents from the megaspore during meiosis and fusion of the two innermost chalazal spores. This fusion nucleus with 96 chromosomes develops parthenogenetically. The thick type with 118 chromosomes is obtained by the fusion of the two innermost chalazal spore nuclei after normal meiosis in the megaspore mother cell and subsequent parthenogenetic development.

In variety Co. 603, it has been noticed that the innermost haploid chalazal spore of the tetrad functions as the megagametophyte mother cell (Alexander, 1964). In this case it is likely that chromosome variation may be due to partial endo-duplication. Further studies are under way.

The above observations are presented in support of the point that the chromosome elimination 'en bloc' during meiosis is possible both in mega- and microspore mother cells. The occurrence of such an elimination both in the mega- and microspore mother cells removes one of the major objections of Bremer against the acceptance of this phenomenon.

ACKNOWLEDGEMENT

The assistance rendered by Shri R. Umeshwarlal in preparing the microtome sections is highly appreciated.

REFERENCES