Studies on Triploid *Allium triquetrum*

II. Metaphase I Univalents and Their Influence on Anaphase I Distribution

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Abstract. This work describes the relationship between the univalents seen at metaphase I and the distribution of dyads at anaphase I in the pollen mother cells of triploid *Allium triquetrum*. The orientation of the centromeres within the trivalents and bivalents at metaphase I towards the two poles of the pollen mother cells is random. The distribution of polar univalents towards the two poles at metaphase I is also random, as is the distribution of dyads at anaphase I in "low" univalent frequency collections. However, in a "high" univalent frequency collection, the distribution of dyads at anaphase I is non-random. There is an excess of cells with the most equal dyad distribution (13–14) and a paucity of cells with a 12–15 distribution. In low univalent frequency collections, the equatorial univalents are believed to remain in the equatorial region during anaphase I and are seen as laggards at late anaphase I. The remaining chromosomes move according to the metaphase I orientation of their centromeres to give a random distribution of dyads at anaphase I. In high univalent frequency collections it is argued that the non-random dyad distribution seen at anaphase I is the result of non-random movement of some of the equatorial univalents away from the equatorial region during anaphase I. The remaining equatorial univalents remain in the equatorial region and are seen as laggards at late anaphase I.

Introduction

The numerous previous investigations of meiosis I, meiosis II, and pollen grain mitosis I in triploids, and the somatic chromosome numbers of the progeny of a triploid parent fall into two major groups: those in which the distribution of chromosomes to the daughter cells is (a) random, (b) non-random. (Appendix Ia and b).

The departure from random chromosome segregation may occur because some chromosomes are left out of the telophase nucleus at meiosis I. Alterna-
tively, following initial random trivalent orientation at metaphase I, preferential chromosome segregation after reorientation or following univalent movement may change the frequency of like chromosomes moving to the same pole. Chromosome distributions may also be affected by the speed at which pollen grain nuclei reach post-meiotic mitosis (Darlington and Mather, 1944, 1961; Ved Brat, 1967; Gulcan and Sybenga, 1967). Alternatively either the survival of pollen grains containing particular combinations of chromosomes may be favoured or else particular chromosome combinations may be detrimental, even to the extent that the cell does not pass through pollen grain mitosis (Darlington, 1926). There may also be selection pressures against the offspring of triploids, particularly against those with aneuploid somatic chromosome numbers.

In this work the low, but rather constant, frequency of univalents at metaphase I was studied to determine the effect of these univalents on the distribution of dyads at anaphase I.

In any triploid the distribution of dyads at anaphase I expected on the basis of random segregation of chromosomes can be calculated from the binomial expression: 

\[(p+q)^x,\]

where \(x\) is the haploid chromosome number, and \(p\) and \(q\) (= 1 − \(p\)) are, respectively, the probabilities of a pole receiving one or two chromosomes from each trisome (Croxton, 1953).

Since the centromere is the region of chromosome orientation and segregation (Luykx, 1970), and since there is little or no reorientation of chromosomes during metaphase-anaphase I (Bauer et al., 1961), the prospective distribution of dyads at anaphase I can be predicted from the metaphase disposition of the centromeres relative to the two poles of the cell.

This paper gives the results of a study of centromere disposition at metaphase I, and the frequency, position, and type of the univalents present.

Materials and Methods

A triploid form of \(A.\ triquetrum\) (3X = 27) was studied (see Balog, 1979 for details of the plants). The inflorescences were fixed in acetic acid:alcohol (1:3) and stored in 70% alcohol at 4°C. They were then stained by the alcoholic HCl-carmine method of Snow (1963), and the contents of individual anthers were isolated as described in Balog (1978). The chromosome complement of \(A.\ triquetrum\) is also discussed in Balog (1978).

Throughout these studies, collections A and H are referred to as "high" univalent frequency collections, and collections B to F inclusive as "low" univalent frequency collections.

Results

Anaphase I

Anaphase I Dyad Distributions. Data from only three of the low univalent frequency collections (B, E, and F) are sufficient for analysis of anaphase I dyad distributions; the high univalent frequency collections are represented only by collection H, since collection A did not have a sufficient number of cells at anaphase to allow analysis.