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Chromosome Arrangement.

VIII. The Heterotype Division of Pollen Mother Cells in a Triploid Variety of the Narcissus Plant.

By

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With 17 Text-figures.

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The present paper comprises the statistical results of observations made on the chromosome arrangement in the stage of the nuclear plate in the heterotype division of pollen mother cells in "Poetarum", a triploid variety of the narcissus plant. The object of the present investigation is to learn :—

A. Whether or not the trivalent chromosomes are also arranged in the same manner as bivalents, the arrangement of which CANNON (1923)[1] has compared with that of MAYER's floating magnets.

B. In what manner they are arranged when they are not all trivalent complexes, but some are separated into two components, uni- and bivalent chromosomes, i. e. when these three kinds of elements exist in an equatorial plate mixed together[2].

To make clear these questions, I have observed 147 heterotype nuclear plates for the first question and 35 cases for the second.

A. THE ARRANGEMENT OF THE CHROMOSOMES IN CASES WHERE THEY ARE ALL TRIVALENT.

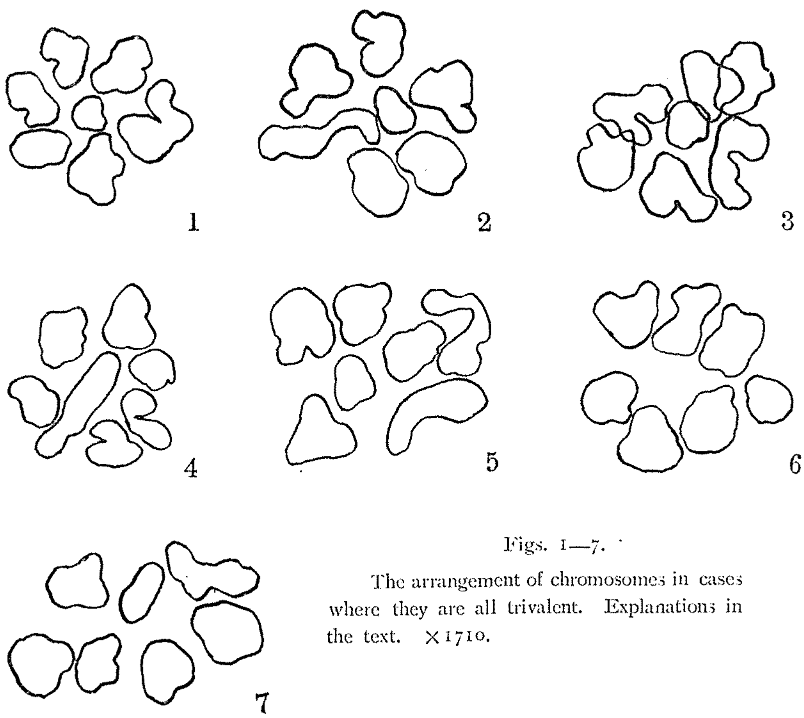
It has been reported in another paper that in this "triploid" variety there are found in the heterotype nuclear plate seven trivalent

1) Jour. Genetics XIII. 1923.
2) For closer descriptions, see NAGAO (Mem. Coll. Sci. Kyoto Imp. Univ., Ser. B, IV, Art. 8, 1929).

chromosomes, as many as the cardinal number of the plant. When the number of floating magnets is seven, one magnet occupies the central position and the other six take the outside positions forming a hexagon[1]. In a large number of the cases observed, the arrangement of the trivalent chromosomes resembles this arrangement of floating magnets, while in others it differs from the latter in a greater or less measure. The numerical results so far obtained for these two cases are as follows :—

1. Regular cases or cases where the chromosome arrangement shows resemblance to the arrangement of floating magnets (Figs. 1, 2). ....95 (65.3%).

2. Other cases where it differs from the latter in some way or other (Figs. 3—7)..52 (34.7%).



Figs. 1—7.
The arrangement of chromosomes in cases where they are all trivalent. Explanations in the text. ×1710.

1) See MIDZUNO (1916): "Theory of the Atom", Part II (in Japanese), Tokyo.

When we closely examine the latter irregular cases we find that we can classify them again into the following three main categories.

Category 1:—In this category, the chromosomes are arranged on the whole in the same manner as the floating magnets, but some of them are superposed upon one another (Fig. 3). It seems to be highly probable that cells presenting this type of arrangement have been fixed before all the chromosomes occupy their final positions, and therefore, we may call this type of configuration "Progressive form". Twenty-four cases of this form were counted.

Category 2:—Cases where the chromosomes are arranged in a circular form, with varying numbers of chromosomes occupying the central position, the number differing from that in the case of floating magnets. We call these forms of arrangement collectively "Modified form". We can distinguish further in the forms belonging to this category the following three different cases:

a. Two chromosomes occupy the central positions, the remaining five being arranged in the outer position surrounding the inner two (Fig. 5).

b. All seven chromosomes occupy the outer positions forming a ring with none in the central region (Fig. 6).

c. One trivalent complex which takes an elongated form, the components being joined end to end to one another, occupy the central position. In this case, the distal end of the chromosome is stretched out beyond the circumference of the ring of chromosomes (Fig. 4). If this long rod-shaped chromosome occupies an outside position, the arrangement resembles that of the floating magnets (Fig. 2).

Category 3:—Cases where the arrangement belongs to neither category 1 nor category 2. All the chromosomes are arranged without any definite order, this probably being due to the action of some external agencies such as fixatives (Fig. 7). We call this form "Irregular form".

The numerical results obtained for these forms are as follows:—

Progressive form		24	(16.1%)
Modified form			
	a 5		
	b 3	14	(9.3%)
	c 6		
Irregular form		14	(9.3%)
Total		52	(34.7%)

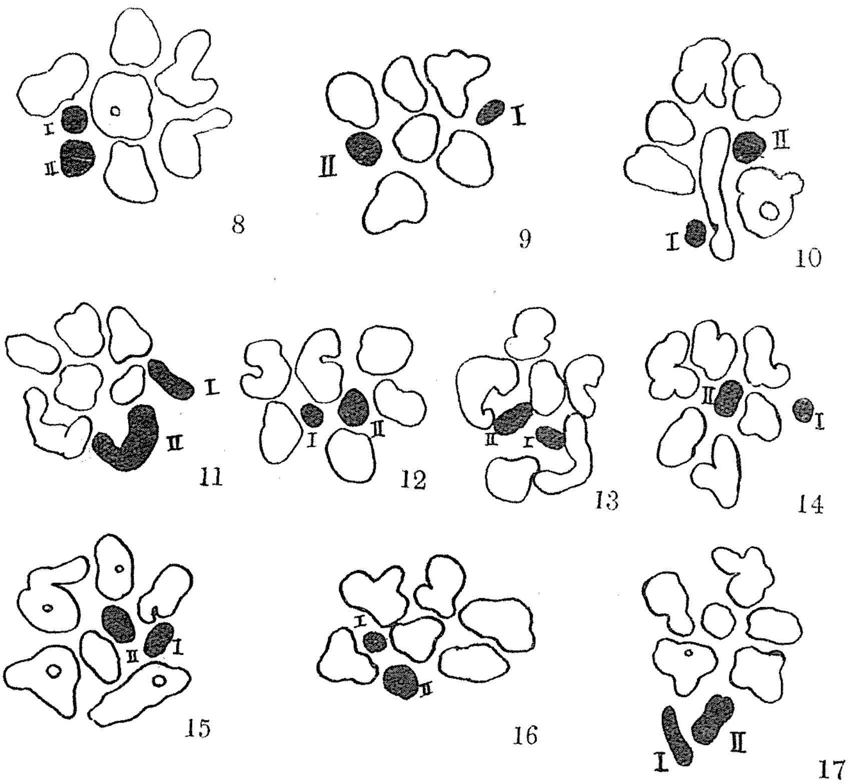
CONCLUSION.—(A)

In the majority of cases observed, the seven trivalent chromosomes are arranged in a similar manner to that of MAYER's floating magnets. The number of these cases amounts to 65.3% of all the cases observed. If cases of the progressive form are reckoned as transitory stages to the final distribution figure, the total rises to 81.4%.

B. ARRANGEMENT OF CHROMOSOMES IN CASES WHERE SOME OF THE TRIVALENT ELEMENTS ARE SEPARATED INTO UNI- AND BIVALENT COMPONENTS.

To clear up the second question raised in the introduction, some observations on the behavior of separated uni- and bivalent components of the trivalent elements were made. For simplification of the matter, only those cases were selected for observation, in which only one element had separated into uni- and bivalent components, while the other six elements all formed trivalent complexes. Though this case was the one with which we met most frequently among those having a number of separated components, I was able to observe only 35 of such cases for the present investigation. This number may be too small to draw a statistical conclusion, but some benefit may accrue from the results. The cases observed may be classified into the following four categories :

Category 1 :—Cases where the univalent and bivalent elements form the outer ring of chromosomes with the majority of the others, trivalent elements (Figs. 8—11). In Fig. 8, the univalent and bivalent elements stand side by side, but in Fig. 9 they are found in the positions diagonally opposite to each other. Fig. 10 corresponds to Fig. 4 with regard to the first question, A. In Fig. 11, two trivalents occupy the central positions, corresponding to Fig. 5 of question A.



Figs. 8—17. The arrangement of chromosomes in cases where one of the trivalent elements is separated into the uni- and bivalent components. Explanations in the text. ×1710.

Category 2:—Cases where both the univalent and bivalent elements occupy the central positions (Figs. 12—13). In Fig. 12, only the univalent and bivalent elements occupy the central positions, but in Fig. 13, besides them one of the trivalents is also found inside the chromosome ring.

Category 3:—Cases where only one of the two elements (univalent or bivalent) occupies the central position (Figs. 14—16). In Fig. 14, only the bivalent element occupies the central position, while the six trivalents form a ring, the univalent remaining outside the ring.

In Figs. 15 and 16, the bivalent and the univalent element respectively occupy the central position with one of the trivalents. It was not observed, however, that the univalent element alone occupies the central position without association of other elements, bivalent or trivalent, though such is often the case with the trivalent and sometimes also with the bivalent.

Category 4:—Cases where both the univalent and the bivalent remain outside the chromosome ring (Fig. 17). These cases may be looked upon as modified cases belonging to category 1.

The numerical results obtained for these four different categories are as follows:—

Category 1	23
,, 2	4
,, 3	5
,, 4	3
Total	35

CONCLUSION.—(B)

It is a notable fact that in more than half of the cases observed (Categories 1 and 4), univalent and bivalent chromosomes occupy the outer positions, forming a ring with the trivalents, or are left outside the chromosome ring, or to put it in other words, that only in a relatively small number of cases (Categories 2 and 3) does either univalent or bivalent, or both together occupy the central positions. The question as to what is meant by this fact is left for further investigation.

In conclusion I wish to express my heartiest thanks to Prof. Y. KUWADA for his kind direction throughout the work.

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