

Association of Homologous Chromosomes in the Somatic Cells of *Ornithogalum virens*¹

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Observations on some of the earliest drawings of mitotic cell division given by Strasburger (1905) and Overton (1905) clearly show the chromosomes lying in pairs. Overton (1909) emphasized the universal occurrence of somatic association of homologous chromosomes in all the dicotyledonous species studied by him. In subsequent years, however, the somatic association was viewed as an exceptional event occurring in only certain species (Newton 1924, Parthasarthy 1938 and others—reviewed by Tischler 1951) and its existence remained controversial to the extent that several workers (Bonnet 1914, S.G. Nawaschin 1926, M. Nawaschin 1936 and Matsuura 1937—reviewed by Tischler 1951) rejected it as merely a random association of chromosomes of similar size during somatic metaphase stage. In the recent years, the evidence in support of somatic association of homologous chromosomes has been increasing (Feldman *et al.* 1966, Hiraoka 1958, Steinitz—Sears 1963, Butterfass 1967 and Chauhan and Abel 1968).

Brown and Stack (1968) observed somatic pairing of homologues in *Haplopappus gracilis* and *Rhoeo discolor* and have indicated that species with low chromosome number are more suitable for such studies. The present investigation was conducted in *Ornithogalum virens*, which possesses 3 pairs of chromosomes, in order to take precise note of somatic association of chromosomes in this species.

Materials and methods

Root tips were taken from the germinating bulbs of *Ornithogalum virens* ($2n=6$) kept at a temperature of 25°C and were fixed in acetic-alcohol (3 parts absolute alcohol: 1 part glacial acetic acid saturated with iron acetate). Squashing was done in 2 per cent acetocarmine solution. Observations on association of homologous chromosomes were taken from dividing cells during prophase and metaphase stages. Photomicrographs were taken from the temporary squash preparations.

Results

The different cells were found to show considerable variation with respect to the extent of association of chromosomes. In many of the cells the chromosomes were seen to lie loosely arranged in pairs. In a relatively low number of cells the

¹ Experiment Station series no. 296.

chromosomes were associated closely with each other. The frequency of cells showing association of chromosomes in pairs is given in Table 1.

Table 1. Frequency of cells showing association of chromosomes during prophase and metaphase stages

Bulb no.	Total no. of cells studied	Prophase		Metaphase	
		Loosely aligned in pairs	Closely paired	Loosely aligned in pairs	Closely paired
1	100	15	4	10	2
2	118	21	6	8	1
3	126	13	4	20	6
4	85	11	3	12	1
5	90	19	4	6	—
6	78	13	2	10	3

That paired arrangement of chromosomes as observed in the different cells was between the homologous chromosomes and was not a random one, was indicated by the observations of mid-prophase cells where the individual chromosomes could be identified due to their morphology. As seen in Fig. 1, the two chromosomes of a pair have lightly staining areas at the corresponding points (arrow), which suggests that they are homologous. The other two chromosome pairs are similarly seen to be associations of homologous chromosomes. In Fig. 2, the two chromosomes of a pair are seen to be homologous as in both of them a darkly staining knob is seen at the identical points (arrow). The other two chromosome pairs also show association of their respective homologues.

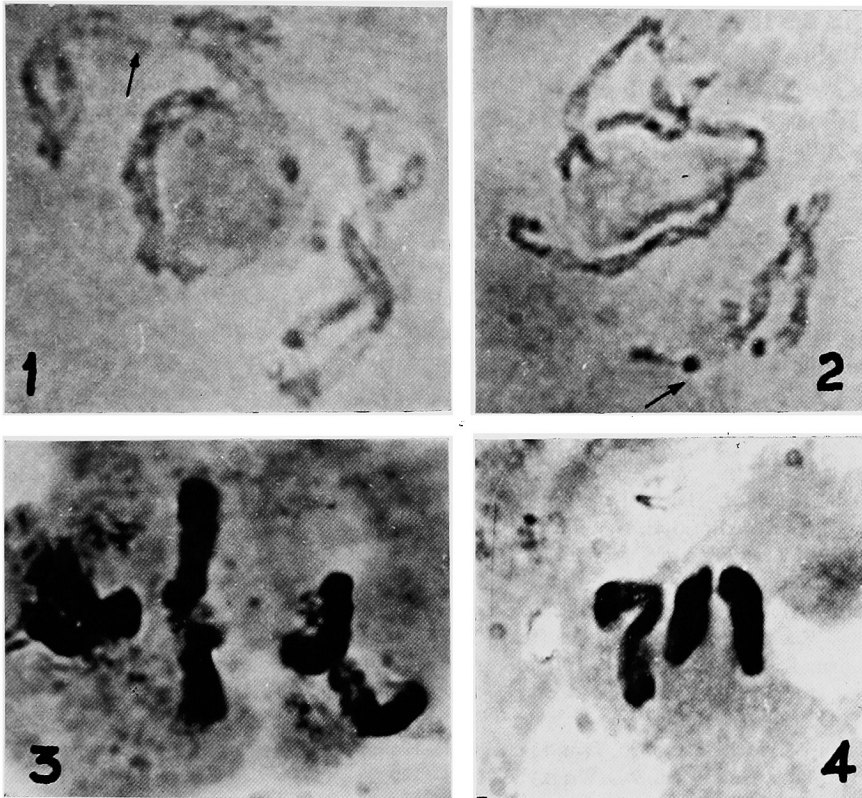
A very low frequency of cells was found to show 'pseudo-chiasmata' and 'false segregation' of the homologous chromosomes (Fig. 3). The presence of rare cells showing 3 bivalent-like structures (Fig. 4) further supported the observations that homologous chromosomes were associated in pairs. During a study of a large number of cells no haploid cell was observed. Hence, it was concluded that in extreme cases the homologous chromosomes may pair as closely as during meiosis to give bivalent-like structures.

Discussion

The observations suggest that the homologous chromosomes have a variable tendency to associate themselves in pairs in the somatic cells of *Ornithogalum virens*. The meiosis-like behaviour, viz.; bivalent configurations and 'pseudo-chiasmata', though observed in a very small number of cells, provides a very convincing evidence in support of the somatic association of homologous chromosomes in this species. Such extreme cases of somatic associations have also been reported by Battaglia (1947) who found reduction in chromosome number in somatic cells of the pistil of *Sambucus*. Mitra and Steward (1961) reported somatic metaphase pairing with 'pseudo-chiasmata' in single cell cultures of *Haplopappus gracilis*.

Brown and Stack (1968) have reported somatic pairing in the root tips of these plants.

Several reports of somatic association of homologous chromosomes have been reviewed by Tischler (1951) and Maguire (1967). It appears that the homologous chromosomes are capable of occasionally associating in pairs in the somatic cells of several organisms, which has been described as a primitive trait in evolution



Figs. 1-4: Photomicrographs of somatic nuclei from root tips of *Ornithogalum virens* showing association of homologous chromosomes. 1, mid-prophase showing three pairs of two chromosomes each. One of the chromosome pairs (arrow) shows association of homologous segments (lightly stained) of its chromosomes. 2, mid-prophase showing association of two chromosomes each. One of the pairs shows darkly staining knobs in both of the chromosomes (arrow). 3, metaphase showing pseudo-chiasma and apparent separation of homologous chromosomes. 4, metaphase showing closely paired homologous chromosomes. The dual structure is clearly seen in one of the pairs.

by Westergaard (1958). This phenomenon may result in rare cases of genetic recombination, as has been suggested to explain the occurrence of 'twin spots' in maize (Jones 1936) and 'somatic mutations' in *Tradescantia* (Mericle and Mericle 1967). It is difficult to ascertain the significance of this phenomenon in sexually reproduced plants. It may, however, be proposed that a relatively high frequency of somatic association of homologous chromosomes in *Ornithogalum virens* may

help in enhancing the genetic variability of the population, which is restricted due to the low chromosome number and predominantly vegetative reproduction in this species.

Summary

Homologous chromosomes were found to associate in pairs to a varying extent in the root tip cells of *Ornithogalum virens* ($2n=6$). In approximately 2 per cent cells, meiosis-like behaviour, viz; bivalent configurations and 'pseudo-chiasmata' were seen. It is proposed that somatic association of homologous chromosomes may be more prevalent in species with low chromosome number and having vegetative propagation.

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