Complex systems of chromosomal interchanges form striking features of evolutionary development in the genera Oenothera, Paeonia and Rhoeo. It is now recognized that a rather large number of unrelated plant genera possess similar, though not so extensive, chromosomal rearrangements (Burnham, 1956). The present investigation on the factors favouring survival of chromosome interchanges was undertaken with a view to enquiring into the nature of those events that occur spontaneously.

Material and Methods

A winter garden annual, Chrysanthemum carinatum Schousb., was chosen for the present study following observations on the wide spread occurrence of interchange heterozygosity in this species (Rana and Jain, 1964a). An X-ray dose of 15 kR at an operating voltage of 50 kV directed over dry seeds was employed for inducing the interchanges. For meiotic analysis, buds were fixed in Carnoy’s fixative and the anthers were stained in acetocarmine. For a study of the karyotype, dividing chromosomes in the root-tip cells were obtained. Root-tips were fixed in acetic-alcohol and subsequently stained by the Feulgen’s technique after hydrolysing in N HCl for 16 minutes at 60°C. Measurements of chromosomes were made from camera lucida drawings of metaphase plates from slides prepared in a strictly comparable manner and these were then converted into relative lengths, that is, percentage value of each chromosome length was calculated from total chromatin length of a metaphase plate. Chromosome index (short/long arm) of each chromosome was also determined.

Experimental results

1. Radiation-induced interchanges

An analysis of meiotic chromosome associations during microsporogenesis revealed that X1 population consisted of 113 structurally homozygous plants showing regular formation of 9 bivalents (Fig. 1) and 87 interchange heterozygotes forming multiple chromosome associations of various sizes indicating the presence of one to three interchanges (Figs. 2—4). While a majority of the interchange heterozygotes formed
a single multiple of four chromosomes, the largest multiple association observed in the X₁ population was that involving eight chromosomes.

Plants carrying three interchanges were intercrossed among themselves and the F₁ seeds thus obtained were irradiated with an X-ray dose of 10 Kr. Cytological observations on the following generation marked out plants carrying four or five interchanges and forming rings or chains of as many as 10 or even 12 chromosomes (Figs. 5—7). Plants having four and five interchanges were intercrossed and the hybrid seeds were re-exposed to 10 Kr of X-rays. A study of meiotic chromosome associations in the subsequent generation showed that although individuals heterozygous for one to five interchanges were frequent yet none of them combined in it more than five interchanges. Further attempts to synthesise plants carrying more than five interchanges have not succeeded so far probably because of the limitations imposed on viability.