Radiation-Induced Chromosomal Rearrangement in Annual Chrysanthemum

The fact that certain plant species in nature have evolved interchange-multiples, which include all or most of their chromosomes, points to the possibility of inducing such chromosomal rearrangements experimentally. The present investigation was planned to induce chromosomal interchanges by experimental means with a view to studying the consequences of chromosomal rearrangements on reproductive potential of the plants carrying them. *Chrysanthemum carinatum* was selected as the experimental material on the basis of earlier observations indicating chromosomal polymorphism for interchange heterozygosity to be an adaptive feature of several annual chrysanthemum populations[1].

Dry seeds were subjected to an acute X-ray dose of 15 Kr at an operating voltage of 50 Kv and an X_1 population of 200 plants was raised from these seeds. A cytological analysis of chromosome associations during microsporogenesis revealed that 87 plants of the X_1 population were heterozygous for one to three interchanges, whereas the control plants were characterized by the regular formation of nine bivalents (Figure 1). Plants carrying three interchanges were intercrossed among themselves and the F_1 seeds thus obtained were irradiated with X-rays with a dose of 10 Kr. Cytological observations on the following generation marked out plants heterozygous for five interchanges and forming a multiple association involving 12 of the 18 chromosomes (Figure 2). Plants with five interchanges were again intercrossed and the hybrid seeds were re-exposed to 10 Kr of X-rays. A study of meiotic chromosome associations in the next 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 synthesize individuals carrying more than five interchanges have not succeeded so far, probably because of the limitations imposed on viability.

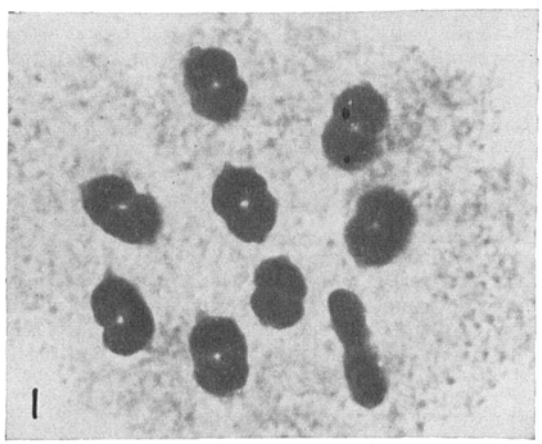

Fig. 1. Photomicrograph of a pollen mother cell showing nine bivalents (×2200).

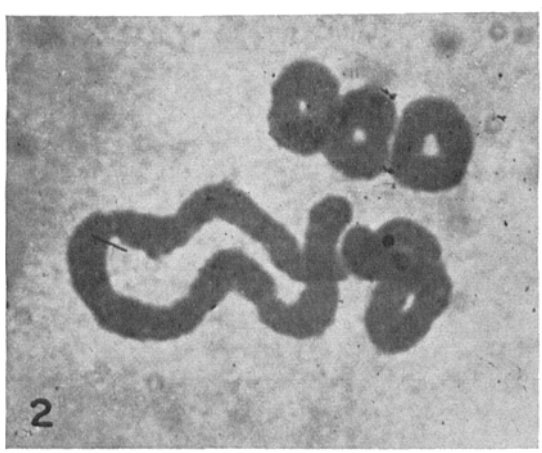

Fig. 2. Photomicrograph of a pollen mother cell showing a multiple of 12 chromosome and three bivalents (× 2320).

Three plants of the $\odot^{12}$ stock were analyzed cytologically and 40 pollen mother cells were studied in each of them. Multiple association, which formed quite regularly, showed disjunctional orientation at metaphase in 27.5 to 47.5% of the pollen mother cells. Pollen fertility showed a range from 30.2 to 55.1%, while seed fertility varied from 27.9 to 48.3%. Apart from low fertility, growth of these plants was considerably retarded. Flower bearing, and consequently the total seed production, was also adversely affected.

Similar attempts have been reported by several workers; for example, larger rings were built by intercrossing different lines and then reselecting plants with the larger rings for further intercrosses[2,3]. YAMASHITA[4] produced a ring including all the 14 chromosomes of diploid wheat in which both parents of the cross contributed interchanges. WATANABE[5] reported isolation of $\odot^{12}$ plants in *Tradescantia paludosa* by repeatedly treating the axiliary buds with X-rays. Complete ring formation is also well known to occur in natural populations of *Oenothera* $\odot^{14}$, *Paeonia* $\odot^{10}$ and *Rhoeo* $\odot^{12}$. The fact that these species have evolved rings involving all of their chromosomes, while some others are unable to withstand even slight chromosomal rearrangements, calls for a study of the factors responsible for this differential behaviour[6].

Zusammenfassung. Zur Synthese eines Stammes von *Chrysanthemum carinatum* wurde Röntgenbestrahlung angewandt. Es wurde beobachtet, dass zwischen 12 der 18 Chromosomen ein Wechselverhältnis bestand und sie während der Meiosis eine multiple Assoziation eingingen.

R. S. RANA

Botany Division, Indian Agricultural Research Institute, New Delhi (India), April 1, 1964.

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[6] I am grateful to Dr. H. K. JAIN and Dr. M. S. SWAMINATHAN for their interest in this study.