

Desynapsis in *Zinnia haegeana* L.

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A cytogenetic study in the genus *Zinnia* belonging to Compositae is currently under way in this laboratory and as many as 10 species were available for such a study. Of the available species of *Zinnia*, *Z. haegeana* is a species grown throughout the world for its ornamental value. During the study of meiosis in two plants of this species, desynapsis was very conspicuous in one plant. The details of meiosis in the normal and desynaptic plant are communicated in this paper.

Material and methods

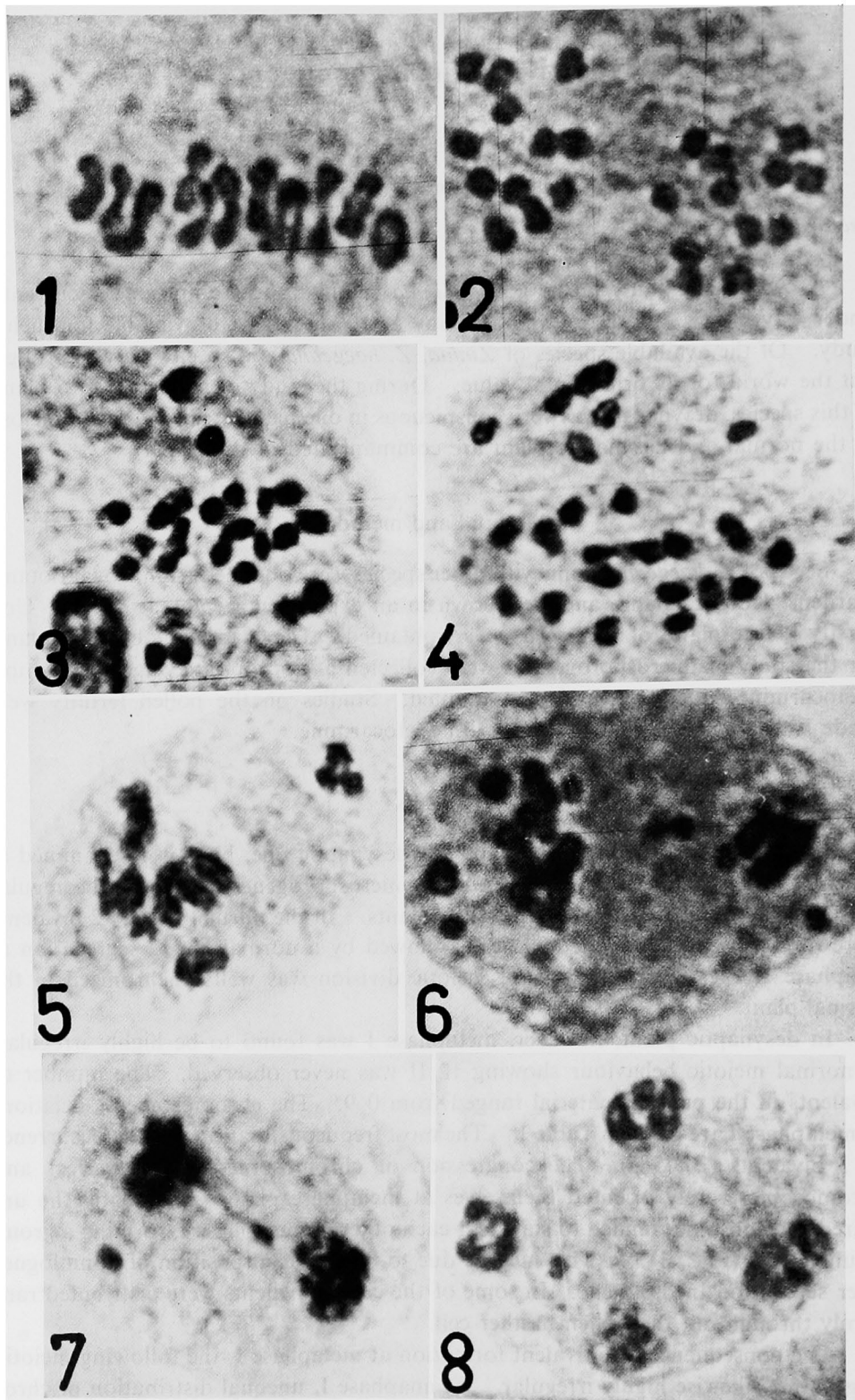
Seeds of *Z. haegeana* along with other species were obtained from Royal Botanic Gardens, Kew, England, and were sown in an experimental plot at Meerut University. Two plants of *Z. haegeana* were obtained. The heads from both the plants for the study of microsporogenesis were collected at appropriate stages and simple acetocarmine squash method was adopted. Studies on the pollen fertility were made by staining the pollen grains with acetocarmine.

Results

In both the plants the normal and the desynaptic one, buds were examined at different stages of division. The study of microsporogenesis revealed the regular chromosome number $2n=24$ for both the plants. In the normal plant, 12 bivalents were formed as a rule at metaphase I, followed by a normal 12:12 segregation at anaphase I (Figs. 1, 2). Also, the meiotic division was well synchronized in the normal plant.

In desynaptic plant, however, metaphase I was found to be highly irregular. A normal meiotic behaviour showing 12 II was never observed. The number of bivalents in the present material ranged from 0-9. The chromosome associations at metaphase I are given in Table 1. The most frequent situation was the occurrence of 3 bivalents (20.45%). The congression of chromosomes was imperfect and chromosomes rarely oriented themselves at metaphase plate. Frequently the unpaired chromosomes tended to stay near each other at metaphase I, forming a group of univalents (Figs. 3-5). This may be due to the adjacent position of homologues after separation in diplotene. In some of the cells univalents were distributed randomly through out the pollen mother cell.

As a consequence of univalent formation at metaphase I, the following meiotic stages were likewise highly irregular. At anaphase I, unequal distribution of chromosomes to the poles was very common and a normal 12:12 segregation was ob-



Figs. 1-8. 1 and 2. Meiosis in a normal plant of *Zinnia haegeana*. 1, metaphase I with 12 bivalents. 2, anaphase I with 12:12 disjunction. 3-8. Meiosis in a desynaptic plant of *Zinnia haegeana*. 3-5, metaphase I showing univalents. 6-7, anaphase I showing unequal distribution and lagging of chromosomes. 8, quartet stage showing a micronucleus.

Table 1. Chromosome associations at MI in desynaptic plant of *Z. haegeana*

No. of cells observed	No. of PMC's										
	9 _{II}	8 _{II}	7 _{II}	6 _{II}	5 _{II}	4 _{II}	3 _{II}	2 _{II}	1 _{II}	0 _{II}	
88	1	3	5	6	12	13	18	15	8	0	
%	1.11%	3.40%	5.68%	6.59%	13.6%	14.7%	20.45%	17.06%	9.09%	7	7.95%

Table 2. Chromosome distributions at AI in desynaptic plant of *Z. haegeana*

No. of cells observed	Chromosome distribution at AI												
	12-12	13-11	14-10	15-9	16-8	17-7	18-6	19-5	20-4	21-3	22-2		
72	1	2	4	7	6	8	11	10	9	8	6		
%	1.38%	2.76%	5.55%	9.72%	8.33%	11.11%	15.2%	13.8%	12.3%	11.11%	8.13%		

served in only one out of 72 cells examined. The data on chromosome distribution at anaphase II are given in Table 2. Occasionally certain chromosomes reached the poles prior to the rest of complement (Fig. 6). A variable number of chromosomes lagged at anaphase I. Chromatin bridges were also noted. Anaphase II was also irregular and sometimes chromosomes could not be incorporated in the main nuclei, resulting in the formation of micronuclei. The number of nuclei ranged from 3 to 5, instead of the normal feature of 4 nuclei per mother cell. At sporad stage, in addition to tetrads, triads and pentads were therefore common. Large variation in pollen size was observed. Pollen fertility was almost nil. No seeds could be obtained from this plant. Only 1-2 rudimentary seeds per capitulum were seen in 4-5 capitula. Life span of this plant was slightly less than the normal plant growing along side.

Discussion

Zinnia has an important place among ornamentals of the family Compositae. *Z. haegeana* is cultivated throughout the world for the characteristic compact flowers on comparatively smaller plants. The garden varieties of today have evolved through extensive hybridization. Hence, spontaneous occurrence of such anomalies is not surprising. However, present study is a first report of desynapsis in *Zinnia*

The degree of desynapsis reported in various plant taxa is varied. Based on the degree of failure of pairing, Prakken (1943) recognized three categories under desynapsis, namely 'weak', 'medium strong' and 'complete'. The 'weak' category is characterized by a nearly normal meiotic behaviour. In medium strong category some of the chromosomes remain unpaired at metaphase I. In complete desynapsis, occurrence of bivalent associations is extremely rare and univalent configurations is the general rule. The meiotic behaviour of the desynaptic plant in the present study conforms to the medium strong category which has been previously described in *Crepis capillaris* (Richardson 1935), *Secale cereale* (Prakken 1943), *Pisum sativum* (Koller 1938), *Nicotiana tabacum* (Clausen 1931), *Zea mays* (Beadle 1933), parasorghums and eusorghums (Magoon *et al.* 1961, Sadasivaiah and Magoon 1965) and *Amorphophallus companulatus* (Magoon and Sadasivaiah 1967).

Desynapsis has been attributed to a variety of causes such as gene action, loss of a chromosome pair, apomixis, structural and numerical changes of chromosomes in addition to environmental causes like, temperature, humidity and soil conditions. In the present study, environmental effect is ruled out since both normal and desynaptic plants were grown under similar environmental conditions. In the present material, desynapsis appears to have been brought about by spontaneous gene mutation. It is obvious, that no explanation can be put forward since the progenies of desynaptic plant could not be studied due to complete absence of seed. However, instances of gene controlled desynapsis have been widely reported for several taxa including *Triticum* (Li *et al.* 1945), *Tradescantia* (Celarier 1955), *Hordeum* (Enns and Larter 1960, 1962), *Bothriochloa* (Chheda and deWet 1961), *Avena* (Dyck and Rajhathy 1965), *Lolium* (Ahloowalia 1969), *Lycopersicum* (Soost 1951, Moens 1969), *Oryza* (Misra and Sastry 1969).

Such spontaneous desynaptic strains may find their implication in the isolation of trisomic lines since unequal distribution of chromosomes at anaphase I, leads to formation of aneuploid gametes; which in turn, would produce aneuploid plants, if pollinated by pollen from normal plants.

References

- Beadle, G. W. 1933. Further studies of asynaptic maize. *Cytologia* 4: 269-287.
- Celarier, R. P. 1955. Desynapsis in *Tradescantia*. *Cytologia* 20: 69-83.
- Chheda, H. R. and deWet, J. M. J. 1961. Desynapsis in *Bothriochloa* hybrid. *Proc. Okl. Acad. Sci.* 41: 14-19.
- Clausen, R. E. 1931. Inheritance in *Nicotiana tabacum* XI. The fluted assemblage. *Amer. Nat.* 65: 316-331.
- Dyck, P. L. and Rajhathy, T. 1965. A desynaptic mutant in *Avena strigosa*. *Can. J. Genet. Cytol.* 7: 418-421.
- Enns, H. and Larter, E. N. 1960. Note on the inheritance of *ds*, a gene governing meiotic chromosome behaviour in barley. *Can. J. Pl. Sci.* 40: 570-571.
- and Larter, E. N. 1962. Linkage relations of *ds*: a gene governing chromosome behaviour in barley and its effect on genetic recombination. *Can. J. Genet. Cytol.* 4: 263-266.
- Koller, P. C. 1938. Asynapsis in *Pisum sativum*. *J. Genet.* 36: 275-306.
- Li, H. W., Pao, W. K. and Li, C. 1945. Desynapsis in common wheat. *Am. J. Botany* 32: 92-101.
- Magoon, M. L., Ramanna, M. S. and Shambulingappa, K. G. 1961. Desynapsis and spontaneous chromosome breakage in *Sorghum purpureosericeum*. *Indian J. Genet.* 21: 87-97.
- Misra, R. N. and Sastry, S. V. S. 1969. Desynapsis and intragenomic differentiation in cultivated species of *Oryza*. *Cytologia* 34: 1-5.
- Moens, P. B. 1969. Genetic and cytological effects of three desynaptic genes in tomato. *Can. J. Genet. Cytol.* 11: 857-869.
- Prakken, R. 1943. Studies of asynapsis in rye. *Hereditas* 29: 475-95.
- Richardson, M. M. 1935. Meiosis in *Crepis* III. Failure of pairing in *Crepis capillaris* (L) Waller. *J. Genet.* 31: 119-143.
- Sadasivaiah, R. S. and Magoon, M. L. 1965. Studies of desynapsis in *Sorghum*. *Genetica* 36: 307-314.
- Soost, R. K. 1951. Comparative cytology and genetics of asynaptic mutants in *Lycopersicon esculentum* Mill. *Genetics* 26: 410-434.
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