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CHROMOSOMAL MOSAIC AND VARIABLE MICROSPOROCYTES IN THE CULTIVARS OF *Antirrhinum majus* L.

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Key words : Meiotic behaviour, Cultivars, *Antirrhinum majus*

The gametic number in different cultivars of *Antirrhinum majus* is n = 8 except AmDcr and AmLiy which showed n = 8 and 16. The eight cultivars can be broadly divided into two chromosomal races. The intra-individual variation of the chromosome number may be due to mixoploidy in the natural populations. The structural changes like interchange and inversion may be factors for pollen sterility. The behaviour of chromosomes in the hybrid (AmLiy x AmDcr) is not in any way different from some of the cultivars belonging to this species. It is probable that different forms of *A. majus* are of hybrid origin and intervarietal hybridization is one of the main lines of evolution of different forms of snapdragon.

INTRODUCTION

Antirrhinum majus L., commonly known as snapdragon or dog flower, is an ornamental plant. The species has provided the first insights into the regulation of many developmental processes that are conserved in flowering plants (Hudson *et al*., 2008). *Antirrhinum* was recently placed in the family Plantaginaceae following a revision of the classical family Scrophulariaceae based on DNA sequence and variations (Olmstead *et al.*, 2001). It is an annual winter herb and is a native of Southern Europe and Northern America. The species distinguishes itself morphologically and shows great deal of variation chiefly in flower colour. The present investigation includes meiotic behaviour of eight cultivars and of the hybrid raised by crossing *AmDcr* and *AmLiy.*

MATERIAL AND METHODS

Materials for the present investigation include eight forms of *A. majus* L. which were grown in the garden of the department. The colour of the flower was lemon yellow, light yellow, dark carmine red, intermediate red, light red, dark pinkish, intermediate pink and light pink. Flower buds of suitable size were fixed in 1 : 3 acetoalcohol with a few drops of ferric chloride as mordant. All the stages of meiosis were obtained by squashing anthers in 2% acetocarmine. The slides were made permanent in acetic acid and butyl alcohol series and mounted in euparol. Studies of pollen grains fertility and sterility test were made on the basis of their stainability in acetocarmine.

RESULTS AND DISCUSSION

The height of the plant in different cultivars ranged from 86.4 to 150.9 cm, the leaf length from 4.42 to 9.36 cm, leaf breadth from 1.8 to 3.4 cm, internode length from 4.23 to 9.42 and mean number of flowers in an inflorescence from 30.0 to 69.0. The seeds were minute which varied from 225 to 425/ fruit.

The cultivars *AmLiy* and *AmDcr* showed the variable gametic number in the meiocytes as n = 8 and n = 16 (Fig. 1 & 2). The meiotic number in other six cultivars was n = 8. Thus, the eight cultivars (population) can be broadly divided into two chromosomal races in which *AmLiy* and *AmDcr* showed variability in chromosome number between individuals belonging to same populations whereas other six cultivars have the same gametic number.

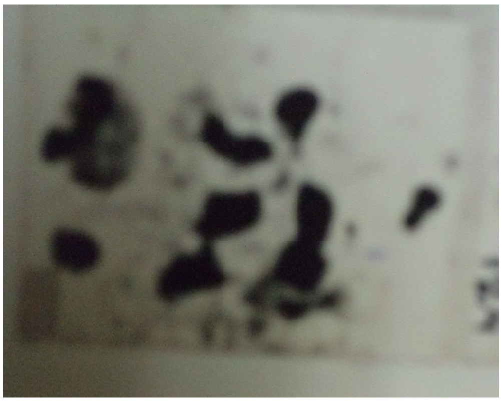

Fig. 1 Diakinesis, n = 8 (AmDcr).

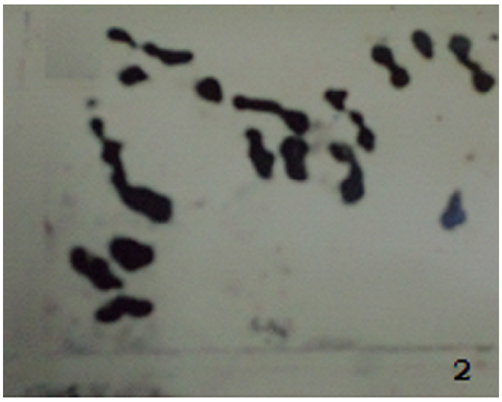

Fig. 2 Metaphase I, n = 16 (AmDcr).

The meiotic division in all the cultivars was non-synchornised. The chiasma frequency and half chiasma/ chromosome were also variable (Table 1). The clumping and stickiness of chromosomes, precocious separation (Fig. 3) univalents, trivalents, quadrivalents (Fig. 4) and multivalents (Fig. 5) besides normal bivalents were also observed. Translocation ring was observed in AmDp cultivar.

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Table - 1: Chromosome pairing and chiasma frequency at metaphase I in *A. majus*

Population	No. of PMCs studied	No. of bivalents/PMC				Total no. bivalent	No. of Chiasma/PMC			Terminalised Chiasmata			Half Chiasma per chromosome	Terminalisation coefficient
		Ring		Rod										
		Range	Mean	Range	Mean		Range	Mean	±S.E.	Range	Mean	±S.E.		
AmLy	50	4-6	5	2-4	3	8	13-15	13.96	0.16	9-12	10.66	0.39	0.81	0.76
AmLiy	50	3-6	4.5	2-5	3.5	8	11-14	12.5	0.42	9-12	10.5	0.46	0.78	0.84
AmDcr	50	2-7	4.5	1-6	3.5	8	10-15	13	0.67	8-13	10.9	0.61	0.81	0.79
AmIr	50	1-5	3.37	3-7	4.63	8	9-14	11.37	0.68	8-13	10.0	0.65	0.71	0.87
AmLr	50	4-6	5	2-4	3	8	12-14	13	0.26	7-14	10.75	0.97	0.81	0.82
AmDp	50	1-4	2.5	4-7	5.5	8	9-12	10.5	0.42	8-10	9.25	0.31	0.65	0.88
AmIp	50	2-5	4.2	3-6	3.8	8	10-13	12.2	0.42	6-10	9.1	0.42	0.76	0.75
AmLp	50	2-6	4	2-6	4	8	10-14	12	0.7	8-9	8.6	0.24	0.75	0.72

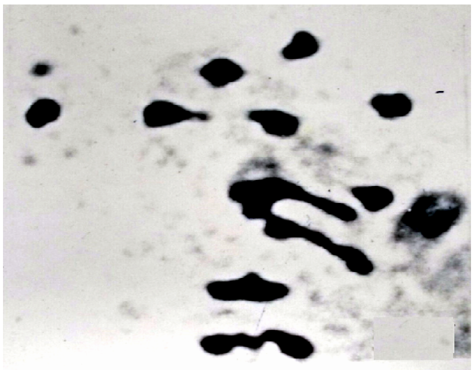

Fig. 3 Metaphase I, early separation (AmIr).

Fig. 4 Metaphase I, bivalents and quadrivalents (AmIr).

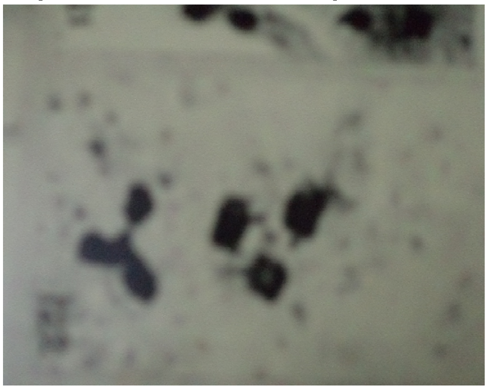

Fig. 5 Metaphase I, bivalents and multivalents (AmLiy).

The irregularities found at anaphase I and II were chromosomal bridges (Fig. 6), inversion bridges (Fig. 7), lagging bivalents, non-disjunction, unequal separation of chromosomes and disturbed polarity. Pollent sterility and variability in size were found to vary among these populations (Table 2).

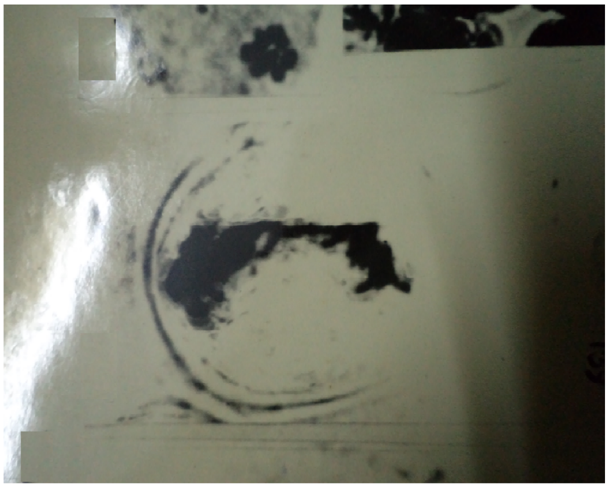

Fig. 6 Anaphase I, simple bridge (AmIr).

Fig. 7 Anaphase I, inversion bridge (AmIr).

Table - 2: Details of pollen analysis of *Antirrhinum majus*

Population	No. of pollen grain studied	No. of normal pollen grain	No. of sterile pollen grain	Percentage of sterile pollen grain		No. of variable pollen grain	Percentage of variable sized pollen grain	
				Mean	± S.E.		Mean	± S.E.
AmLy	1400	1198	197	14.07	0.92	5	0.35	0.58
AmLiy	580	375	85	14.65	1.46	120	20.68	1.68
AmDcr	900	734	160	17.77	1.27	6	0.66	0.26
Amlr	1145	895	240	20.96	1.2	10	0.87	2.28
AmLr	605	510	80	13.22	1.38	15	2.47	0.65
AmDp	500	290	300	60	2.19	10	2	0.62
Amlp	615	360	250	40.65	1.98	5	0.81	0.88
AmLp	820	585	230	28.04	1.57	5	0.6	0.26

The hybrid (a product of *AmDcr* and *AmLiy*) showed intermediate morphological characters (Table 3) and the flower colour was pinkish violet. The gametic number was n=8 (Fig. 8). The chromosomal association showed a range of 0-10 univalents, 3-8 bivalents and 0-1 quadrivalent (Table 4).

Table - 3: Inheritance of character between *AmDcr* and *AmLiy*

Sl. No.	Characters	*AmDcr* (Data in cm.)	*AmLiy* (Data in cm.)	F_1 (Data in cm.)
1	Plant height	124.4 ± 0.16	86.4 ± 0.83	144 ± 0.16
2	Stem			
	(a) Colour	Violent	Green	Light violet
	(b) Diameter	3.5	2.5	4
	(c) Internode length	6.2 ± 0.02	4.23 ± 0.07	7.0 ± 0.02
3	Leaf			
	(a) Shape	Ovate	Obovate	Linear ovate
	(b) Length	7.58 ± 0.43	8.34 ± 0.26	9.9 ± 0.06
	(c) breadth	1.8 ± 0.14	2.32 ± 0.16	2.5 ± 0.06
	(d) Colour	Dark green margin violet	Dorsal dark green, ventral violet	Green with ventral violet patches
4	Inflorescence No. of flower on main peduncle	60.9 ± 0.27	33.5 ± 0.44	80.0 ± 0.70
5	Flower (a) Diameter	8 – 8.5 cm	7.5 – 8.00	8.2 – 8.6 cm
	(b) Colour of Calyx	Light violet	Green	Light violet
	(c) Petal Colour	Dark carmine red	Light yellow	Pinkish violet
6	Fruit (a) Colour when young	Light violet	Green	Light violet
	(b) Colour when mature	Light violet	Green	Violet
7	Seed (a) Surface	Light smooth	Smooth	Light spiny
	(b) No./Fruit	350 - 375	250 - 275	48 – 60

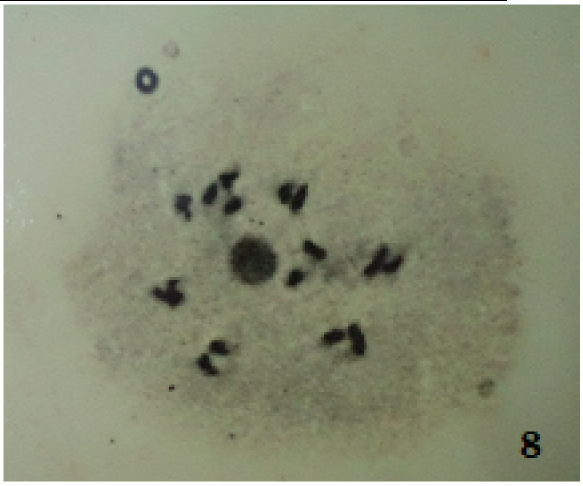

Fig. 8 Diakinesis n = 8 of F1 hybrid.

Table - 4: Nature and frequency of chromosomal association in F1 hybrid

Chromosome association				Frequency of PMCs
IV	III	II	I	
0	0	8	0	12
0	0	7	2	9
0	0	6	4	7
1	0	6	0	6
0	0	4	8	10
1	0	4	4	3
0	0	3	10	3

The number of chiasma/PMC in normal bivalent is 10.0 and half chiasma/chromosome is 0.62.

The anomalies like laggards, inversion bridges, simple bridges and persistent chromosomes were also scored in a large number of pollen mother cells.

The pollen grains were of variable size and pollen sterility (Fig. 9) was calculated to be 70 percent.

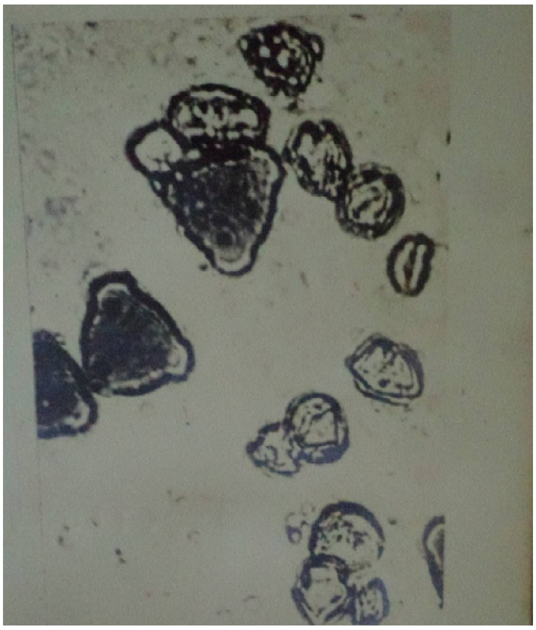

Fig. 9 Fertile and sterile pollen grains of F1 hybrid.

The above observations show that there is intra-populational numerical variation in the meiotic cells of AmLiy and AmDcr cultivars. It has also been observed that variation in the chromosome number is also reflected in the phenotype. Cronquist (1968) observed that in *A. majus*, certain populations may arise due to particular gene or gene complex, whereas Lavines (1968) suggested that chromosomal rearrangement and gene mutations are principally responsible for the diversifications between the cultivars. Mahal (1972) suggested that the diversification within the genus *Antirrhinum* is through transgressive gene action. Trivedi and Trivedi (1986) opined that the variation in chromosome number and colour of the flower are due to its heterogeneous nature within and between different populations.

The term chromosomal mosaic was used by Frankhauser (1945) to describe the variation in chromosome number within an individual arising as a result of spindle abnormalities or chromosome non-disjunction. Intraplant variation of chromosome numbers has also been reported in the somatic cells of *Nicotiana* hybrids (Shung-Jan-Yang, 1965) and in pollen mother cells of *Withania somnifera* (Anupama, 2011).

In natural population of *A. majus*, intraindividual variation of the chromosome number may be due to mixoploidy (Cohn, 1979). The same variations are found within a cultivar as well as between different cultivars. Urbanska Worythiewicz (1980) and Faverger (1981) think that variations observed in a single individual can be transmitted to a population, even to a race giving way to process of evolution.

The structural changes in the chromosomes of the cultivars AmIr and AmDp are inversions and translocations. The genetic system affected by such structural changes acts mainly as a means of holding together certain favourable gene combination (Darlington, 1973) and therefore of promoting immediate fitness at the expense of flexibility (Baker, 1965; Stebbins, 1971).

Intervarietal hybridization between the two cultivars of *A. majus* namely Am Dcr and AmLiy has been done and studied. The idea behind the cross was to know the process of natural hybridization among the different cultivars. The hybrid shows intermediate morphological characters, listed in table-3. The flower colour was pinkish violet in the hybrid, which proves that neither parents have the dominant character of the flower, but it is interesting to note that heterozygous combination of genes produce a new colouration. This may be due to incomplete dominance or interaction of genes.

The hybrid shows a range of 0-10 univalents, 3-8 bivalents and 0-1 quardrivalent. The bivalents were of both ring and rod type. At anaphase I, most of the pollent mother cells showed unequal segregation of chromosomes, laggards and bridges. The pollen sterility was calculated to be 70%.

The hybridization experiment in the *A. majus* proved that the cultivars may intercross easily, hence it indicates that these forms are genetically closely related.

The behaviour of chromosomes in the hybrid is not in any way different from some of the cultivars belonging to this species. Therefore, it is probable that different forms of *A. majus* are of hybrid origin and intervarietal hybridization is one of the main lines of evolution of different forms of snapdragon.

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