Studies on the Chromosome Numbers in Higher Plants, with Special Reference to Cytokinesis, II

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The studies on the numbers of chromosomes in plants have been carried out to an increasingly greater extent and they have indeed contributed to the progress in experimental genetical studies, though the work that has been done is nevertheless still far from being sufficient, especially among families rather than in a genus. The present work is a continuation of the studies which have been in progress since 1926.

Material and methods

Materials used for this study were taken from 27 species, belonging to 18 genera, raised from seeds which were imported from Europe. The reagent used for fixing the materials was the Farmer's fluid which was modified by the writer and used since 1920, because he believes that chromosomes should be fixed under conditions as nearly uniform as possible in order to compare their size and form in different plants examined.

The mode of cell division

The plants described below all show the furrowing process in the mode of partition wall formation of the pollen mother cells (cf. Sugiura 1936b).

Numbers of the chromosomes

Chrysanthemum rupestre (Compositae) (Fig. 1).

It has 9 meiotic chromosomes as other species in this genus. They are V-shaped at the first anaphase.

Acicarpa tribuloides (Calyceraceae) (Fig. 2).

This family has been quite unknown in karyological studies except Dahlgren's (1915). The pollen mother cells are smaller than those of the above mentioned *Chrysanthemum* and especially the filar shaped meiotic chromosomes much smaller than the latter. The meiotic chromosomes are 8 in number, while Dahlgren thought there were about 8.

Stylidium adnatum (Stylidiaceae) (Fig. 3).

There has been no chromosome count in this family up to the present time. The meiotic chromosomes, being spherical at the

second metaphase, are 15 in number. The pollen mother cells are far larger than those of *Acicarpa* in spite of the fact that *S. adnatum* is of small size in our green house.

Globularia cordifolia (Globulariaceae) (Fig. 4).

This family has been little studied in chromosome counts. The meiotic chromosomes are spherical and 10 in number.

Maurandia purpurea (Scrophulariaceae) (Fig. 5).

The meiotic chromosome number is 12, 4 of which are in the centre, the remaining 8 making a ring.

M. scandens (Fig. 6).

The chromosome number in the somatic cells, according to Heitz, is 24, but the writer counted ten meiotic chromosomes, one of which is situated at the centre in the first meiotic metaphase.

Browallia grandiflora (Solanaceae) (Fig. 7), *B. demissa* (Fig. 8), *B. viscosa* (Fig. 9).

Formerly the writer studied some plants in *Browallia*, each of which had all 11 meiotic chromosomes except *B. speciosa* which had 22 meiotic chromosomes. He now also counted 11 meiotic chromosomes in the above mentioned species.

Salvia dumetorum (Lamiaceae) (Fig. 10).

The meiotic chromosome numbers hitherto studied in the genus *Salvia* were 9, 10 and 11, according to our investigation. We find the number 7 in the present species. According to Scheel (1930), the same number was also found in *S. pseudosilvestris* and *S. recognita*. But in recent years the same number was also found in *S. Candelabrum*, *grandiflora*, *nemorosa*, *officinalis* and *scabiosaefolia*.

Thus it seems that *Salvia* belongs to Tischler's *Carex* type. The meiotic numbers hitherto found in this genus are 6, 7, 8, 9, 10, 11, 12, 13, 16, 18, 20, 22 and 32.

Heuchera sanguinea (Saxifragaceae) (Fig. 11).

Formerly Schoennagel (1930) counted 7 meiotic chromosomes in this plant which has been confirmed by the present count. Quite recently Skovsted (1934) found 3 fragmental chromosomes in addition to the normal 7 meiotic chromosomes in a form of the present plant, but there were found no such chromosome fragments in our material.

Cleome spinosa (Capparidaceae) (Fig. 13).

Considering Taylor's, Tischler's, Ufer's and the writer's results the genus *Cleome* seems to belong to Tischler's *Carex* type. The meiotic number of chromosomes is 12, but Ufer counted 10.

Cleome Candelabrum $n = 16$ (Fig. 12).

Meiotic chromosomes are spherical and smaller than those of *spinosa*.

Dactylaema micrantha $n = 16$ (Fig. 14).

The genus *Dactylaema* has not yet been studied cytologically.

Table 1. Number and size (μ) of chromosomes in plants

Plants investigated	Fig.	Chromosome Number (n)	First metaphase (μ)	First anaphase (μ)	Second metaphase (μ)	Second anaphase (μ)
<i>Chrysanthemum rupestre</i>	1	9			1.75×0.75	
<i>Acicarpa tribuloides</i>	2	8			0.63×0.35	
<i>Stylidium adnatum</i>	3	15			1.00	
<i>Globularia cordifolia</i>	4	10	0.75			
<i>Maurandia purpurea</i>	5	12		0.62		
<i>M. scandens</i>	6	10	0.75×0.55			
<i>Browallia grandiflora</i>	7	11		2.0×1.0		
<i>B. demissa</i>	8	11		1.5×1.0		
<i>B. viscosa</i>	9	11	1.5×1.0			
<i>Salvia dumetorum</i>	10	7			0.75	
<i>Heuchera sanguinea</i>	11	7			1×0.75	
<i>Cleome Candelabrum</i>	12	16		0.75		
<i>C. spinosa</i>	13	12				
<i>Dactylaema micrantha</i>	14	16		0.5		
<i>Cheridonium</i>		6	1.00			
<i>Franchetianum</i>	15					
<i>Glaucium corniculatum</i>	16	6				0.75
<i>Papaver Argemone</i>	17	21	1.0			
<i>P. dubium</i>	18	21	1.125			
<i>P. pinnatifidum</i>	19	14	1.13			
<i>P. commutatum</i>	20	7	1.25			
<i>P. alpinum</i>	21	7	1.3			
<i>P. oreophilum</i>	22	7	1.13; 0.62			
<i>Lychnis lagascae</i>	23	12			0.75	
<i>Portulaca pusilla</i>	24	9			1.25×0.7	
<i>Calandrinia Menziessi</i>	25	24			0.5	
<i>C. procumbens</i>						
<i>Mesembryanthemum</i>						
<i>criniflorum</i>	26	9				
<i>Thelygonum japonicum</i>	27	11		1.25		

Glaucium corniculatum (Papaveraceae) (Fig. 16).

The meiotic number of chromosomes is 6 as in *G. Serpieri*.

Papaver Argemone ($n = 21$) (Fig. 17), *P. dubium* ($n = 21$) (Fig. 18), *P. pinnatifidum* ($n = 14$) (Fig. 19), *P. commutatum* ($n = 7$) (Fig. 20), *P. alpinum* ($n = 7$) (Fig. 21), *P. oreophilum* ($n = 7$) (Fig. 22).

Since Tahara's studies on the genus *Papaver*, the study of the chromosome count has become more and more active recently. Ljungdahl (1922), Yasui (1921), Winge (1925) were the chief contributors. The writer, having already counted the chromosome numbers in several species in this genus, has studied anew other species mentioned above.

In *Papaver* it seems that there are no such significant differences in chromosome sizes among diplont, tetraplont, hexaplont, etc. as far

as the present study is concerned. Those species having 7 meiotic chromosomes are *P. alpinum*, *commutatum* and *oreophilum*, among which the last species has 6 normal chromosomes and one very small one, as shown in Fig. 22. The meiotic number of chromosomes in *P. alpinum* and *dubium* were found by Ljungdahl (1922) to be 7 and 14, but the writer's count in *dubium* shows 21. *P. commutatum* was also found by Philip to have the same number 7.

Figs. 1-27. $\times 3300$. 1, *Chrysanthemum rupestre*. IA. 2, *Acicarpa tribuloides*. IIM. 3, *Stylidium adnatum*. IIM. 4, *Globularia cordifolia*. IM. 5, *Maurandia purpurea*. IA. 6, *M. scandens*. IM. 7, *Browallia grandiflora*. IA. 8, *B. demissa*. IA. 9, *B. viscosa*. IA. 10, *Salvia dumetorum*. IIM. 11, *Heuchera sanguinea*. IIM. 12, *Cleome Candelabrum*. IA. 13, *C. spinosa*. IM. 14, *Dactylaema micrantha*. IIM. 15, *Cheridonium Franchetianum*. IM. 16, *Glaucium corniculatum*. IIA. 17, *Papaver Argemone*. IM. 18, *P. dubium*. IM. 19, *P. pinnatifidum*. IM. 20, *P. commutatum*. IM. 21, *P. alpinum*. IM. 22, *P. oreophilum*. a. IM. b. IM. (side view). 23, *Lychnis lagascae*. IIM. 24, *Portulaca pusilla*. IIM. 25, *Calandrinia Menziesii*. IIM. 26, *Mesembryanthemum criniflorum*. IIM. 27, *Thelygonum japonicum*. IA.

Lychnis lagascae (Caryophyllaceae) (Fig. 21).

The genus *Lychnis* was previously studied by Blackburn (1928-29) and found to have 12 meiotic chromosomes. This species has also 12 meiotic chromosomes.

Portulaca pusilla (Portulacaceae) (Fig. 24).

Since Tjebbes counted 9 meiotic chromosomes in *P. grandiflora*, Hagerup, Okura and Blackburn also found the same number in the above named plant. The size of the pollen mother cells is rather larger in comparison with the external appearances of anthers. The furrowing process commences even in the second metaphase.

Calandrinia Menziesii (Fig. 25), *C. procumbens*.

The meiotic number of chromosomes in *Calandrinia* was first counted by the writer. Previously three species were studied and their meiotic chromosomes were found to be 8, 19, 12 and 24 respectively. Thus it seems that this genus is polyphylogenetic from the karyological point of view.

Mesembryanthemum criniflorum (Aizoaceae) (Fig. 26).

The writer has already studied some plants in *Mesembryanthemum* and counted 9 meiotic chromosomes in them. The same number is also found in this species.

Thelygonum japonicum (Thelygonaceae) (Fig. 27).

Thelygonaceae has only the genus *Thelygonum*, in which only 3 species are found, namely *Th. Cynocrambe*, *Th. macranthum* and *Th. japonicum*. The former two are annual while the latter is perennial. It is very interesting to note that Schneider (1913) found the meiotic number of chromosomes in *Th. Cynocrambe* to be 10, while the writer counted 11 in *Th. japonicum*.

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Literature

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