SOME ANGIOSPERM CHROMOSOME NUMBERS

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ABSTRACT. Chromosome numbers are reported for 44 species and hybrids belonging to a variety of Angiosperm families. Detailed studies of meiosis were made in hybrids belonging to the Cistaceae. The results are summarized in Tables 1 and 2.

The chromosome counts reported here are all of plants in cultivation in the Royal Botanic Garden, Edinburgh. Many of these were grown from material collected on expeditions, particularly by Mrs O. M. Hilliard and Mr B. L. Burtt in Southern Africa, but others are not of known wild origin. The majority of the counts were made as a result of requests by taxonomists on the Royal Botanic Garden Staff.

The propionocarmine or acetocarmine squash technique was used in all preparations.

Results are summarised in Tables 1 and 2, illustrated in Fig. 1, a–j and Plate 10, and in some cases are briefly discussed below. Herbarium specimen numbers and specific authorities are given in the Tables.

CISTACEAE

Cistus. Four species and six interspecific hybrids of *Cistus* were examined; all had 2n = 18 which appears to be the universal number of the genus.

Detailed meiotic observations were made in the hybrids, four of which had also been examined by Dansereau, 1940. The most irregular meiosis occurred in *C.* x *skanbergii* (*C. monspeliensis* x *parviflorus*), a hybrid between rather distantly related sections of the genus. At first meiotic metaphase many pollen mother cells showed considerable numbers of univalents (up to 14), probably as a result of precocious separation of weakly associated bivalents; the bivalents themselves were all rods and some were composed of strikingly heteromorphic homologues. The anaphase disjunction was rather irregular and many cells had 10 + 8 or 11 + 7 in the daughter groups at first telophase; odd chromosomes which had failed to travel to the poles and were lying in the cytoplasm were also common. At later stages micronuclei and supernumerary spores were frequent. Dansereau, 1940, also observed considerable meiotic irregularity in this intersectional hybrid.

Meiosis was more regular in all the other hybrids. In *C.* x *purpureus* (*C. ladaniferus* x *villosus*) no aberrant figures were seen, but in *C.* x *aguilari* (*C. ladaniferus* x *populifolius*), *C.* x *corbariensis* (*C. populifolius* x *salviifolius*), *C.* x *florentinus* (*C. monspeliensis* x *salviifolius*) and *C.* x *laxus* (*C. hirsutus* x *populifolius*) some first meiotic metaphases showing univalents occurred (see Table 1) and a fair number of second meiotic metaphases showed 10 at one pole and 8 at the other.

Unusual behaviour of the nucleolus during the meiotic cycle was observed in *C.* x *corbariensis* C. 9223, *C.* x *aguilari* and *C.* x *skanbergii*. The nucleolus behaved normally until diakinesis but then was replaced by either dozens of

TABLE I. CISTACEAE

(Parentage of hybrids given at the end of the Table.)

	Cultivated herbarium no.	Chromosome no. & assoc. (meiosis)	Approx. % pollen fertility	Previous counts
Cistus laurifolius L.		n = 9(M2)	—	2n = 18 (7 counts, see Federov)
C. palhinhaii Ingram	C. 7021	9_{II}	65	2n = 18 Rodriguez, 1954
C. populifolius L.		9_{II}	95	2n = 18 (5 counts)
C. villosus L.	C. 7005	9_{II}	85	2n = 18 (7 counts)
C. x aguilari O. E. Warb.		9_{II}, $8_{II}\ 2_{I}$ (MI); 9 + 9, rarely 10 + 8 (M2)	10	
C. x corbariensis Pourr.	C. 7002	9_{II} (MI)	10	9_{II}, $8_{II}\ 2_{I}$, $7_{II}\ 4_{I}$, $6_{II}\ 6_{I}$ (MI); 9 + 9 (M2) Dansereau, 1940
	C. 9223	9_{II}, $1_{III}\ 7_{II}\ 1_{I}$ (MI); 9 + 9 & fairly commonly 10 + 8 (M2)	10	
C. x florentinus Lam.	C. 7007	9_{II}, $8_{II}\ 2_{I}$ (MI); 9 + 9, 10 + 8 (M2)	10	9_{II} (MI); 9 + 9, 10 + 8 (M2); Dansereau, 1940
C. x laxus Dryand.	C. 6998	9_{II}, $6_{II}\ 6_{I}$ (MI)	10	9_{II}, $8_{II}\ 2_{I}$ (MI); 9 + 9, 10 + 8 (M2) Dansereau, 1940
	C. 7017	9 + 9, 10 + 8 (M2)	—	(as x C. platysepalus Sweet)
C. x purpureus Lam.	C. 7000	9_{II} (MI) 9 + 9 (M2)	5	
C. x skanbergii Lojac	C. 7018	9_{II}, $8_{II}\ 2_{I}$, $7_{II}\ 4_{I}$, $6_{II}\ 6_{I}$, $5_{II}\ 8_{I}$, $4_{II}\ 10_{I}$, $3_{II}\ 12_{I}$, $2_{II}\ 14_{I}$ (MI); v. uneven disjunction at AI	< 1	9_{II}, $8_{II}\ 2_{I}$ (MI); 9 + 9, 10 + 8, 11 + 7 (M2) Dansereau, 1940
Halimium lasianthum Spach var. formosum	C. 7029	9 + 9 (M2)	60	2n = 18 Snoad, 1955
H. umbellatum (L.) Spach	C. 9222	9_{II} (MI); 9 + 9, 10 + 8 (M2)	20	2n = 18 Proctor, 1955
x Halimiocistus ingwersenii E.F. Warb.	C. 7030	$2_{II}\ 14_{I}$, 18_{I} (MI); very uneven disjunction at AI.	0	2n = 18, Snoad, 1955

Parentage of hybrids:

Cistus x *aguilari* O. E. Warb.	=	*C. ladaniferus* L. x *populifolius* L.
C. x *corbariensis* Pourr.	=	*C. populifolius* L. x *salviifolius* L.
C. x *florentinus* Lam.	=	*C. monspeliensis* L. x *salviifolius* L.
C. x *laxus* Dryand.	=	*C. hirsutus* Lam. x *populifolius* L.
C. x *purpureus* Lam.	=	*C. ladaniferus* L. x *villosus* L.
C. x *skanbergii* Lojac.	=	*C. monspeliensis* L. x *parviflorus* Lam.
x *Halimiocistus ingwersenii* E. F. Warb.	=	*Halimium umbellatum* (L.) Spach x *Cistus hirsutus* Lam.

very small nucleoli or a smaller number of somewhat larger ones (Fig. 1, a & b, Plate 10, A & B); presumably these small nucleoli were produced by disintegration of the original large one. The small nucleoli persisted through meiosis and usually some were included in the tetrad nuclei whilst others remained in the cytoplasm. This unusual nucleolar behaviour was also observed in the intergeneric hybrid x *Halimiocistus ingwersenii* and in *Halimium umbellatum*.

Pollen fertility, as estimated by stainability in acetocarmine, did not exceed 10% in any of the hybrids, and in *C.* x *skanbergii*, where meiosis was most irregular, did not exceed 1%.

Halimium and x **Halimiocistus.** Meiosis in the two *Halimium* species examined, *H. lasianthum* and *H. umbellatum*, was regular apart from the occurrence of a few second meiotic metaphases with 10 chromosomes at one pole and 8 at the other.

In the intergeneric hybrid x *Halimiocistus ingwersenii* (*Halimium umbellatum* x *Cistus hirsutus*), meiosis was extremely irregular. Diplotene cells showed most of the chromosomes associated in loose pairs but no chiasmata were observed. At first meiotic metaphase fourteen of the fifteen pollen mother cells examined showed 18_{I} whilst the other had 2_{II} 14_{I}. Later stages of meiosis were very irregular with daughter nuclei of varying chromosome number from $n = 11$ to $n = 5$ and many lagging chromosomes lying in the cytoplasm (Fig. 1, d, Plate 10, D). As might be expected, the pollen was completely abortive.

Clearly this intergeneric hybrid presents a fairly extreme case of chromosomal sterility.

Compositae

Ambrosia psilostachya. Root tips of a plant grown from seed collected near Durban, S Africa (where the species is an introduced weed), showed $2n = 108$ in the majority of cells, but some cells had only half this number. Chromosome races of this species are known in Central and North America with $2n = 72$, 108 and 144, and the polysomaty observed in our stock is interesting in the context of the tendency to chromosomal variability in the species.

Dipsacaceae

Scabiosa siamensis. There is some difficulty in deciding whether this species should be placed in *Scabiosa* or *Pterocephalus*. Its ally *S. bretschneideri* Batalin has been transferred to *Pterocephalus* as *P. bretschneideri* (Batalin)

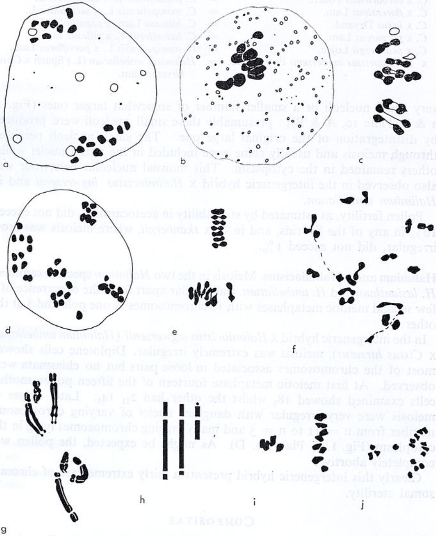

FIG. 1. a-g & i-j. Camera lucida drawings of squash preparations × 1200, g of root-tip, the others of PMC. a, *C.* x *corbariensis* C. 9223, T1, 10 chromosomes at one pole and 8 at the other, 6 larger nucleoli drawn in outline, smaller ones shown as dots; b, *C.* x *corbariensis* C. 9223, M1, showing cytoplasm full of small nucleoli; c, *C.* x *florentinus*, M1, 8_{II} 2_{I} (univalents in outline), note the chromosomes associated in the uppermost two bivalents are of different sizes; d, x *Halimiocistus ingwersenii*, T2, showing 2 nuclei with 11 chromosomes and 2 with 7; e, *Barberetta aurea*, M1, 15_{II}; f, *Aeollanthus njassae*, M1, 17_{II} (2 already dissociating); g, *Dipcadi marlothii*, root-tip, 2n = 6; h, *Dipcadi marlothii*, idiogram, × 1800; i, *Pentapterygium serpens*, M1, 12_{II}; j, *Phacocapnos pruinosus*, M1, 16_{II}.

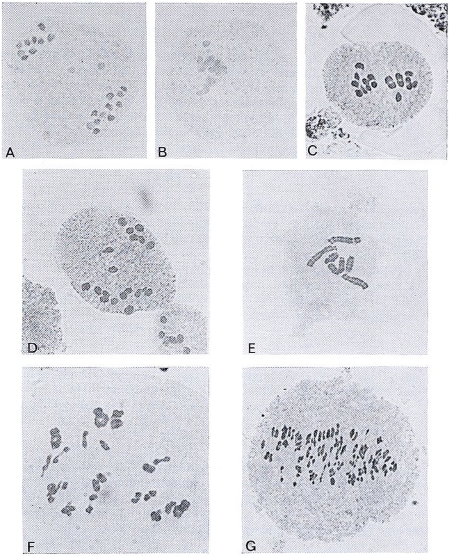

PLATE 10. A, *C. x corbariensis* C. 9223, photo of Fig. 1a, some nucleoli shown in the figure are here out of focus; B, photo of Fig. 1b; C, *Cistus x corbariensis* C. 9223, PMC, MI, 8_{II} 2_{I}, some bivalents already dissociating; D, X *Halimiocistus ingwersenii*, PMC, TI, 10 chromosomes at one pole, 6 at the other and 2 laggards in the centre; E, *Dipcadi marlothii*, root tip, $2n = 6$; F, *Scilla* aff. *natalensis*, PMC, MI, probably 20_{II}; G, *Homalanthus populneus*. PMC, MI, 76_{II}. All by approx 1000.

Pritzel, but until further studies have been completed by Mr B. L. Burtt it seems unwise to change the existing name of *S. siamensis*. The chromosome count (2n = 16) is interesting because it fits *Scabiosa* sect. *Scabiosa* rather than *Pterocephalus* (2n = 18, where known).

Haemodoraceae

Barbaretta aurea. This count was reported by Hilliard & Burtt, 1971, but we have also included it here to make it more accessible to cytologists. Meiosis is regular and 15 bivalents occur at first meiotic metaphase (Fig. 1, e). There is a strong tendency for secondary association of bivalents to occur and groups varying in number from 3–8 were observed. As far as is known, this is the first chromosome count from the tribe *Haemodoreae* and the haploid number of n = 15 has not been recorded in the family before.

Labiatae

Aeollanthus. The occurrence of 2n = 34 in *Aeollanthus canescens*, *A. elongatus* and *A. njassae* ties in with the chromosome numbers recorded for the related genus *Pycnostachys*, where four of the species for which numbers are available have 2n = 34 and the fifth 2n = 68. *Neohyptis*, a monotypic genus, also belonging to the sub-family *Ocimoideae*, also has 2n = 34 (Morton, 1962).

The only other species of *Aeollanthus* for which cytological information is available is *A. pubescens* Benth. where Morton (1962) reports 2n = 36. This species therefore differs in chromosome number from the three counted by us, and from the related *Pycnostachys*.

Gomphostemma. It is an interesting coincidence that *G. strobilinum* var. *variegatum* should also have 2n = 34. This number is not common in the Labiatae and, apart from the group in the *Ocimoideae* discussed above, has only been recorded in odd species in a few genera.

Liliaceae

Dipcadi marlothii (2n = 6). The karyotype of this species is shown in Fig. 1, h. The two pairs of long chromosomes are both subtelocentric, whilst the small pair has a constriction in the middle which is probably the centromere but could conceivably be a secondary constriction. All three pairs of chromosomes have small terminal satellites and these are particularly tiny on the smallest pair.

Chromosomal information is available for three other African species of *Dipcadi*. Fernandes & Neves (1962) found 2n = 12 with all chromosomes subtelocentric in *D. viride* (L.) Moench and Jones & Smith (1967) obtained similar results in *D.* ? *gracillimum* Bak., whilst La Cour (1945) and De Wet (1957) reported 2n = 18 in *D. glaucum* Bak. 2n = 8 occurs in the European *D. serotinum* (L.) Medik. and as in *D. marlothii* all chromosomes have satellites (Levan, 1944, Chennaveeraiah & Mahabale, 1959). When counts for some Indian species are included, the following haploid numbers have been reported in the genus: 3, 4, 6, 9, 10 and 17. Clearly there is a considerable dysploid series which, as in *Ornithogalum*, has reached the n = 3 level.

Scilla hyacinthina (Sect. *Ledebouria*). 2n = 26. This count from African material adds another number to the range already known from this species in India (see Table 2). The conspecificity of the African and Indian material, however, requires confirmation.

Scilla aff. **natalensis**. (Sect. *Scilla*). The number of this species could not be determined exactly as we could not be absolutely certain in any figure whether there were 20_{II} or 21_{II} (Plate 10 F). In either case the count differs from that recorded by De Wet, 1957.

PAPAVERACEAE

Meconopsis discigera is one of the two species placed by Taylor (1934) in the separate subgenus *Discogyne* on account of the remarkable expansion of the base of the style. The chromosome count of 2n = 56 corresponds to that already known from nine species of the subgenus *Meconopsis* (Ratter, 1968).

SCROPHULARIACEAE

The counts for *Dermatobotrys saundersii* and *Teedia lucida*, belonging to related genera counted for the first time, are both 2n = 38.

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TABLE 2

	Cultivated herbarium No.	Chromosome No. Meiotic	Mitotic (2n)	Previous counts
Compositae				
Ambrosia artemisiifolia L.	C. 8531*		36	2n = 36 (5 counts, see Federov)
A. maritima L.	C. 8530*		36	
A. psilostachya DC.	C. 8352*		108 (54 in a few cells)	n = 36, 54, 72, see Payne et al. 1964.
Anthemis chia L.		9_{II}		
A. pontica Willd.	C. 1227	18_{II}		
A. tinctoria L.		9_{II}		2n = 18 (7 counts)
Matricaria macrotis Rech.f.	C. 6085		18	
Othonna cf. carnosa Less.	C. 8204*		20	2n = 20 Nordenstam, 1967.
Sonchus gigas Boulos ex Humbert	C. 6745*		36	2n = 36 Boulos, 1959, 1970.
Dipsacaceae				
Scabiosa siamensis Craib	C. 8348*		16	

TABLE 2—continued

Ericaceae				
Diplycosia heterophylla Blume	C. 6650*	18_{II}		
Pentapterygium serpens Klotz	C. 9485	12_{II}		2n = 24 Callan, 1941
P. rugosum Hook. x serpens	C. 9486	12_{II}		
Euphorbiaceae				
Homalanthus populneus (Giesel) Pax	C. 9484	76_{II}		2n = 36 Perry, 1943
Fumariaceae				
Phacocapnos pruinosus Bern.	C. 8291*	16_{II}		
Haemodoraceae				
Barberetta aurea Harv.	C. 5143*	15_{II}		Already reported in Hilliard & Burtt, 1971
Labiatae				
Aeollanthus canescens Gürke	C. 8356*	17_{II}		
A. elongatus Briq.	†		34	
A. njassae Gürke	C. 9096*	17_{II}		Already reported in Hedge, 1972.
Gomphostemma strobilinum Wall. var. variegatum Craib	C. 8327*		34	
Liliaceae				
Dipcadi marlothii Engl.	C. 8201*		6	
Scilla hyacinthina (Roth) Macbride (= S. indica Baker)	C. 5959*	13_{II}		2n = 30, 44, 45, 46, 58, 60. Rao, 1956. (similar counts given by other workers, all under *S. indica*, see Federov)
S. aff. natalensis Planch.	C. 5932*	20_{II} or 21_{II}		2n = 32 De Wet. 1957.
Papaveraceae				
Meconopsis discigera Prain		n = 28 (MI)	56	
Phytolaccaceae				
Trichostigma peruvianum H. Walt.	C. 9398	36_{II}		
Rosaceae				
Geum capense Thunb.	C. 8354*	21_{II}		

TABLE 2—continued		Meiotic	Mitotic (2n)	Previous counts
Neillia sinensis Oliv. var. sinensis	C. 642*	9_{II}		
Rubiaceae				
Pentas coccinea Stapf	C. 9488	10_{II}		2n = 20 Fagerlind, 1937.
Scrophulariaceae				
Dermatobotrys saundersii Bolus	C. 8347*		38	
Teedia lucida Rudolphi	C. 8302*	19_{II}		
Tropaeolaceae				
Tropaeolum tricolorum Sweet	C. 9487	26_{II}		n = 26, Huynh, 1967

* Material of known wild origin; source given in Table 3.

† *Aeollanthus elongatus* was grown from seed received from the Instituto de Investigação Agronómica de Angola. Root tip counts were made but the plants died before flowering.

TABLE 3. Source of material of known wild origin.

Compositae	
Ambrosia artemisiifolia	*Ward* 6861. S. Africa, nr. Durban, Isipingo Flats.
A. maritima	*Ward* 6860. S. Africa, nr. Durban, Isipingo Flats.
A. psilostachya	*Ward* 6862. S. Africa, nr. Durban, Isipingo Flats.
Othonna cf. *carnosa*	*Hilliard & Burtt* 6677. S. Africa, Cape, Barkly East distr., Naude's Nek.
Sonchus gigas	*Ram.* s.n. S. Africa, Natal, Pietermaritzburg.
Dipsacaceae	
Scabiosa siamensis	*Smitinand* s.n. Thailand, Chiengmai, Doi Chiengdao.
Ericaceae	
Diplycosia heterophylla	*Woods* 1046. Java, Gunong Pangrango nr. Tjibodas.
Fumariaceae	
Phacocapnos pruinosus	*Hilliard & Burtt* 6670. S. Africa, Cape, Barkly East distr., Naude's Nek.
Haemodoroceae	
Barberetta aurea	*Hilliard & Burtt* 3476. S. Africa, Natal, Alfred distr., Mt. Ngeli.
Labiatae	
Aeollanthus canescens	*Hilliard* 5254. S. Africa, Natal, Van Reenens Pass.
A. njassae	*Hilliard & Burtt* 6418. Malawi, Mt. Mlanji.
Gomphostemma strobilinum var. *variegatum*	*Burtt* 5588. Thailand, Chiengmai, Doi Gutep.
Liliaceae	
Dipcadi marlothii	*Hilliard & Burtt* 5901. (seed only). S. Africa, Natal, Vryheid distr., road below Enyati.

TABLE 3—continued

Scilla hyacinthina	*Hilliard & Burtt* 4344.	Malawi, S. Vipya plateau, Bimbyai hills.
S. aff. *natalensis*	*Hilliard & Burtt* 4655.	Malawi, Mt. Mlanji.
Rosaceae		
Geum capense	*Hilliard* 5203.	S. Africa, Cape, Maclear district, ascent to Naude's Nek.
Neillia sinensis var. *sinensis*	*Wilson* 189.	China, W. Hupeh. 1907.

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