Chromosome variation in *Araceae*: IV*

AREAE

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Chromosome numbers of species in a further eleven genera of *Araceae* are here illustrated and described. As in the previous papers of this series Hutchinson's (1959) taxonomic classification has been used as the basis for organization because of its relative simplicity, a feature which is not, however, reflected in the diversity of karyotype and basic number which has emerged.

MATERIALS AND METHODS

The same techniques of chromosome preparation using root tips, were used as described in a previous paper (Marchant, 1970). Voucher specimens (sheet and spirit material) are filed in the Kew herbarium.

RESULTS

Table I is arranged in alphabetical order of genera since intergeneric chromosome relationships are not sufficiently obvious.

Only a few species of the large genus *Arisaema* Mart. have had their chromosomes counted in this investigation. They are consistent in the basic number of $x = 7$, with either $2n = 28$ (Plate 4/1, p. 402 & Fig. 1/1, p. 401) or $2n = 56$, and medium-sized chromosomes. (Table 1, p. 396.) It is an indication of the size of the genus that none of the four species counted have had their chromosome numbers reported previously, although many others have been published, most notably by Bowden (1940) and Ito (1942).

The same basic number of $x = 7$ with medium-sized chromosomes holds for the closely related genera *Arisarum* Mill. and *Arum* L. *Arisarum proboscideum* (L.) Savi ($2n = 28$) has been previously reported with two levels of chromosome number, namely $2n = 28$ and $2n = 42$ by Fabbri (1967). *A. vulgare* Targ. Tozz. has $2n = 56$ (Plate 4/2) although previously recorded as $2n = 52$ by Jones (1957). The three species of *Arum* reported have chromosome numbers ($2n = 28$, $2n = 56$ and $2n = c.84$) corresponding to previous counts (Table 1), although *A. maculatum* L. is known to exhibit a range of levels of polyploidy. Plate 4/3 and Fig. 1/2 show $2n = 28$ in *Arum creticum* Boiss. & Heldr. and in *Arum* sp.

Dracunculus Mill. is considered to be quite closely related to *Arum* (Engler, 1920) and judging by the chromosome counts of $2n = 28$ (Plate 5/1 and Fig. 1/5) for two species (Table 1) it appears that the basic number is also $x = 7$. Larsen (1960) also counted *D. canariensis* Kunth with $2n = 28$ but Delay (1951) reported $2n = 32$ for *D. vulgaris* Schott.

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* Continued from Kew Bull. 25: 329 (1971).

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TABLE 1. List of chromosome

Name	Kew Entry No.	Cytology Accession No.	Origin
Tribe **Areae**			
Arisaema atrorubens Bl.	61–67	69.795	München Bot. Gart.
A. candidissimum W. W. Sm.	568–31	69.827	Glasnevin Bot. Gard.
A. leschenaultii Bl.	376–61	62.205	Cult., *Marr*
A. schimperianum Schott	597–61	67.733	Kenya, Endebess, *Tweedie*
Arisarum proboscideum (L.) Savi	K.6106	68.1704	Spain, Cadiz, near Los Barrios, *Molesworth-Allen*
A. vulgare Targ. Tozz.	174–62	69.796	Portugal, *Sampaio*
" " "		69.78	Crete, Askypon Plain, *Marr* 1396
Arum creticum Boiss. & Heldr.		69.73	Crete, 1965, *B. Chatwyn*
A. italicum Mill.		69.105	Naturalized in Royal Botanic Gardens, Kew
A. maculatum L.		69.110	England, Surrey, Tadworth, *Marchant*
Arum sp.	K5087	69.83	Iraq, Quaradagh, *Wheeler-Haines* W1521
Biarum carratracense (Haensel) Font Quer	436–58	69.1169	S. Spain, *Brinton-Lee*
B. eximium (Schott & Kotschy) Engl.		68.1701	Turkey, *Mathew s.n.*,
" " " "		69.1456	R. H. S. Gard., Wisley, ex *Davis s.n.*
B. kotschyi Schott		69.956	Turkey, Maraş, *Mathew & Tomlinson* 4101
B. platyspathum Bornm.	528–67	69.137	Iran, Ardekan, S. Zagros Mts., *Grey-Wilson et al.* in *SZEB* 18
B. tenuifolium (L.) Schott var. *abbreviatum* (Schott) Engl.		69.81 & 68.1699	Yugoslavia, Pestani, Lake Ochrid, Macedonia, *Mathew & Tomlinson* 4629
" " " "		69.955	Greece, Mt. Parnes, *Mathew* 5134
Biarum sp.		69.1165	Afghanistan, Faizabad Distr., *Furze* 6330
Cryptocoryne affinis N.E. Br.	450–63	69.879	Cult., *Skilton*
" " " "	332–54	69.819	Cult., Brno Bot. Gard., Czechoslovakia
C. beckettii Thwaites ex Trimen	518–49	69.878	Cult., ex Ceylon, *R. G. Perry Ltd.*
C. ciliata (Roxb.) Fisch. ex Schott	493–59	61.142	Cult., *Shirley Aquatics*
" " " "	460–67	69.820	Cult., *Horeman*
C. griffithii Schott	513–63	69.900	Cult., Agric. Research Stn. Šumperk, Temenice, Czechoslovakia

counts in the *Araceae*

Chromosome No. (2n)	Basic No. (x)	Size, S.M. or L. (small, medium or large)	PREVIOUS COUNTS			
			Name	Chromosome No. (2n)	Author	Date
56	7	M	Many other species	24	Sharma & Mukhopadhyay	1965
				26	Numerous authors	
				28	,, ,,	
				56	,, ,,	
				66–68	Sokolovskaya	1966
				c. 140	Ito	1942
56						
28						
28						
28	7	M	*A. proboscideum*	28, 42	Fabbri	1967
56			*A. vulgare*	52	Jones	1957
56						
28	7	M				
ca. 84			*A. italicum*	64	Delay	1951
				84	Lovis	1954
					Prime	1954
					Jones	1957
56			*A. maculatum*	56, 84	Maude	1940
				28	Löve & Löve	1942
				56	Lovis	1954
				56	Prime	1954
				56	Gadella & Kliphuis	1963
28						
22		M				
16		M				
16		M				
ca.96		M				
24		M				
26		M				
26		M				
ca.96		M				
34	17					
34						
28	7					
22	11		*C. ciliata*	28		
22						
34	17					

Name	Kew Entry No.	Cytology Accession No.	Origin
C. longispatha Merrill	723–68	69.824	*C. Karel Rataj*, ex Oxford Bot. Gard., *Roby* 596
C. lutea Alston	358–57	61.136	Indonesia, *Alston*
C. nevillii Trimen ex Hook. f.	332–54	61.133	Cult., Brno Bot. Gard., Czechoslovakia
C. purpurea Ridley	86–68	69.823	Cult., ex Singapore, *Horeman*
C. thwaitesii Schott	102–67	69.902	Cult., *Horeman*
C. cf. wendtii de Wit	309–67	69.876	Cult., *Horeman*
C. willisii Engl. ex Baum	533–48	69.877	*Brunner*
Cryptocoryne sp.	203–53	69.821	Cult., *Shirley Aquatics*
Cryptocoryne sp. No. 2	358–57	62.458	Cult., *Shirley Aquatics*
Dracunculus canariensis Kunth	504–66	66.1575	Tenerife, Los Silos, *Kunkel*
D. vulgaris Schott		65.488	
,, ,, ,,		69.135	*Riversley*
Humbertina crassifolia Buchet	639–69	70.63	Madagascar, Massif de l'Ankarana, *Bogner* 278
Lagenandra lancifolia (Schott) Thwaites	59–61	64.452	*Shirley Aquatics*, cult. ex Ceylon
L. ovata (L.) Thwaites	59–61	63.2011	*Shirley Aquatics*, cult. ex Ceylon
Lagenandra thwaitesii Engl.	549–61	63.2012	Cult., *Shirley Aquatics*
,, ,, ,,	,,	62.889	,, ,, ,,
L. toxicaria Dalzell	735–62	65.1183	*Shirley Aquatics*, Cult., ex Ceylon
,, ,, ,,	,,	69.816	,, ,, ,, ,,
Pinellia pedatisecta Schott	345–67	69.702	Cult., Strasbourg Bot. Gard.
P. ternata (Thunb.) Breitenb.	394–54	69.794B	*Anley*
P. tripartita (Bl.) Schott	197–65	65.475	Cult., Uppsala Bot. Gard.
P. pedatisecta Schott	240–62	69.659	Cult., *W. Schwabe*
Protarum sechellarum Engl.	362–62	63.1730	Seychelles, *Jeffrey*
Sauromatum venosum (Ait.) Kunth	339–62	68.1290	India, Malabar Hill, Bombay, *Stanislaus*
,, ,, ,, ,,	18–62	64.180	Kenya, Mt. Elgon, *Tweedie*
,, ,, ,, ,,		64.540	Tanzania
,, ,, ,, ,,	470–62	68.1289	Tanzania, Iringa Dist., *Polhill & Paulo* 1750
Typhonium giraldii (Baroni) Engl.		69.781	

Chromosome No. (2n)	Basic No. (x)	Size, S.M. of L. (small, medium or large)	PREVIOUS COUNTS			
			Name	Chromosome No. (2n)	Author	Date
36	9					
28	7					
28						
34	17					
42	7					
28						
28	7					
34						
28	7					
28	7	M	*D. canariensis*	28	Larsen	1960
28			*D. vulgaris*	32	Delay	1951
28	7					
54	6 or 9	S				
36	6 or 9	S				
36						
36						
36						
36						
36						
26	13	M				
115			*P. ternata*	116	Ito	1942
				128	Malvesin-Fabre	1945
				129	Darlington	1945
				28	Huttleston in Darlington & Wylie	1955
52			*P. tripartita*	26	Kurakubo	1940
				52	Ito	1942
26						
28	7	M				
26						
26			*S. venosum* (as *S. guttatum*	26	Grafl	1939
				32	Malvesin-Fabre	1945
				26	Tschermak-Woess	1954
				26	Earl	1955
26	13	M				
26						
54	9	S	Several other species	52	Ito	1942
				26	Simmonds	1954
				c. 160	Briggs in Evans	1962
				c. 118	,, ,,	1962
				16	Sharma & Mukhopadhyay	1965
				18	,, ,, ,,	1965

The other genus with $x = 7$ is *Protarum* Engl., *P. sechellarum* Engl. having $2n = 28$ medium-sized chromosomes. (Fig. 2/2, p. 402.) It has not previously had its chromosomes counted.

The genus *Biarum* presents a very curious assortment of basic numbers (Table 1). *B. carratracense* (Haensel) Font Quer with $x = 11$, *B. platyspathum* Bornm, with $x = 12$ (Plate 4/4, p. 402), *B. tenuifolium* (L.) Schott with $x = 13$ and the high polyploids *B. kotschyi* Schott and an unidentified species both with $x = 8$ or 12 ($2n = c.96$) apparently form a basic number series. Two specimens of *B. eximium* (Schott & Kotschy) Engl. have $2n = 16$ giving a fourth basic number of $x = 8$. With another eleven species to be counted this genus would be an interesting group for more intensive cytotaxonomic study.

It is of interest that in the complement of some genera in this tribe there are chromosomes with heterochromatic ends (H – segments). These are clearly seen in *Biarum* and *Dracunculus* (Figs. 1/3 and 1/5) but are less obvious in *Arum.* (Fig. 1/2.)

The genus *Cryptocoryne* Fisch. ex Wydl. is entirely aquatic. It contains a great variety of basic numbers (Table 1) from $x = 7$ in several species, *e.g. C. thwaitesii* Schott (Plate 4/7), to $x = 9$ in *C. longispatha* Merrill (Plate 4/6) and $x = 11$ in *C. ciliata* (Roxb.) Fisch. ex Schott (Fig. 1/4), all with small chromosomes except *C. ciliata.* There are also species, *C. affinis* N.E. Br. and *C. griffithii* Schott, with $x = 17$ (Plate 4/5). The only previously reported chromosome count, for *C. ciliata*, is $2n = 28$ ($x = 7$) by Tjio (1948) which is not in agreement with my own count of $2n = 22$ ($x = 11$).

Another aquatic and closely related genus *Lagenandra* Dalz., is based on $x = 9$ with small chromosomes. Four species (Table 1) have $2n = 36$. (Fig. 1/6.) No previous counts have been recorded.

Three species of *Pinellia* Tenore, *P. pedatisecta* Schott, *P. wawrae* Engl. and *P. tripartita* (Bl.) Schott are based on $x = 13$ with $2n = 26$ (Plate 5/4) for the first two and $2n = 52$ (Fig. 2/1) for the last (Table 1). Previous counts for *P. tripartita* are $2n = 26$ (Kurakubo, 1940) and $2n = 52$ (Ito, 1942). A fourth species, *P. ternata* (Thunb.) Breitenb. had $2n = 115$ (Plate 5/3) which does not fit a base number of $x = 13$. Perhaps significantly, Ito (1942) reported $2n = 116$ for this species but Huttleston (unpub. ex Darlington & Wylie, 1955: 375) and Malvesin-Fabre (1945) report $2n = 28$ and $2n = 128$ respectively. If identifications for these previous counts have been correct this is clearly a genus with many polyplotypes amongst its species.

Sauromatum Schott is also based on $x = 13$ with medium-sized chromosomes. The only species counted, *S. venosum* (Ait.) Kunth (Plate 5/5 & Fig. 2/3), has $2n = 26$. Three previous counts, under the synonymous name *S. guttatum* (Wall.) Schott agree with $2n = 26$ (Grafl, 1939; Tschermak-Woess, 1954; Earl, 1955) but $2n = 32$ reported by Delay (1951) is at variance.

Humbertina crassifolia Buchet with $2n = 54$ small chromosomes (Plate 5/2) is apparently based on $x = 9$. The same number is found in *Typhonium giraldii* (Baroni) Engl. which apparently, is also based on $x = 9$ (Plate 5/6, p. 403), but the many published counts for seven other species of this latter genus show an extraordinarily wide range of numbers with $x = 8, 9, 13, 25$ and several high polyploids (Ito, 1942; Simmonds, 1954; Briggs and Evans, 1962: 13; Sharma & Mukhopadhyay, 1965; Mitra & Datta, 1967).

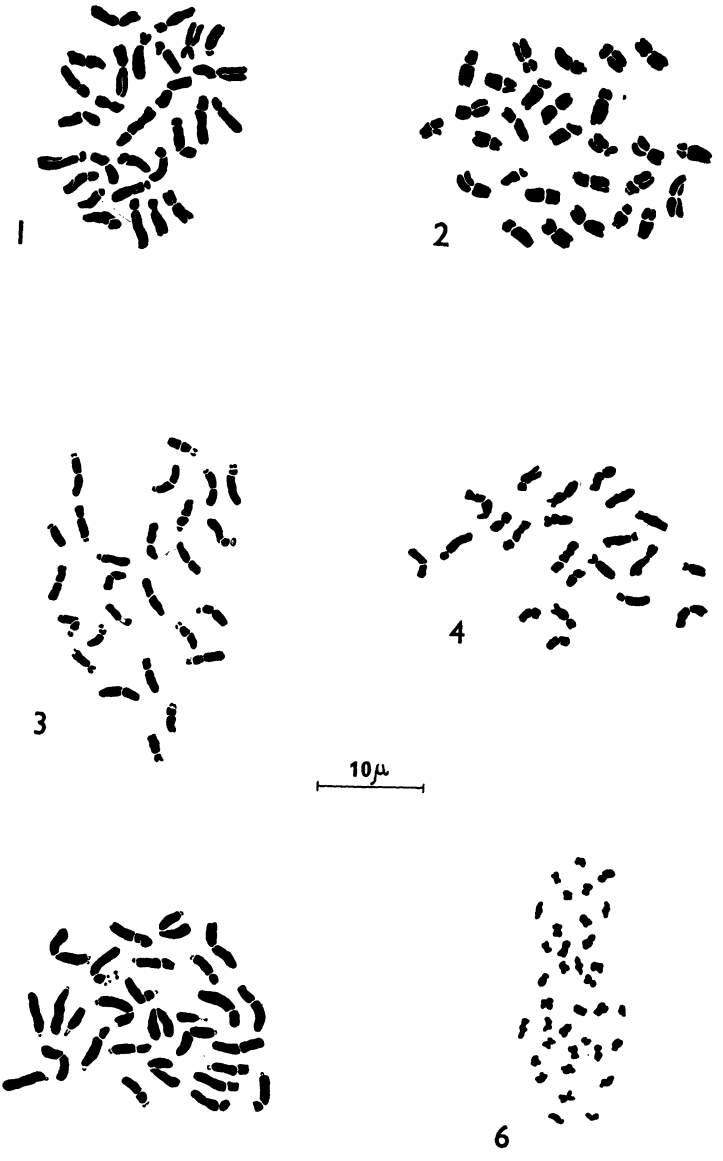


FIG. 1. Somatic chromosome complements in some members of the tribe *Areae*. **1**, *Arisaema leschenaultii*, (2n = 28); **2**, *Arum* sp. (2n = 28); **3**, *Biarum tenuifolium* var. *abbreviatum* (2n = 26); **4**, *Cryptocoryne ciliata* (2n = 22); **5**, *Dracunculus vulgaris* (2n = 28); **6**, *Lagenandra thwaitesii* (2n = 36).

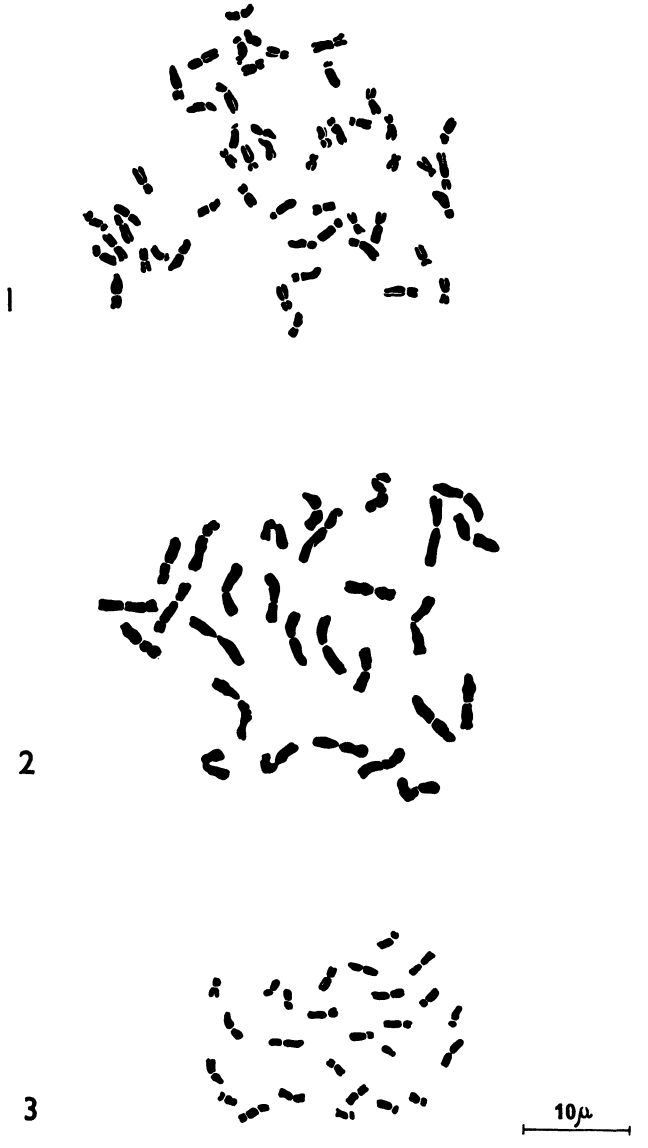
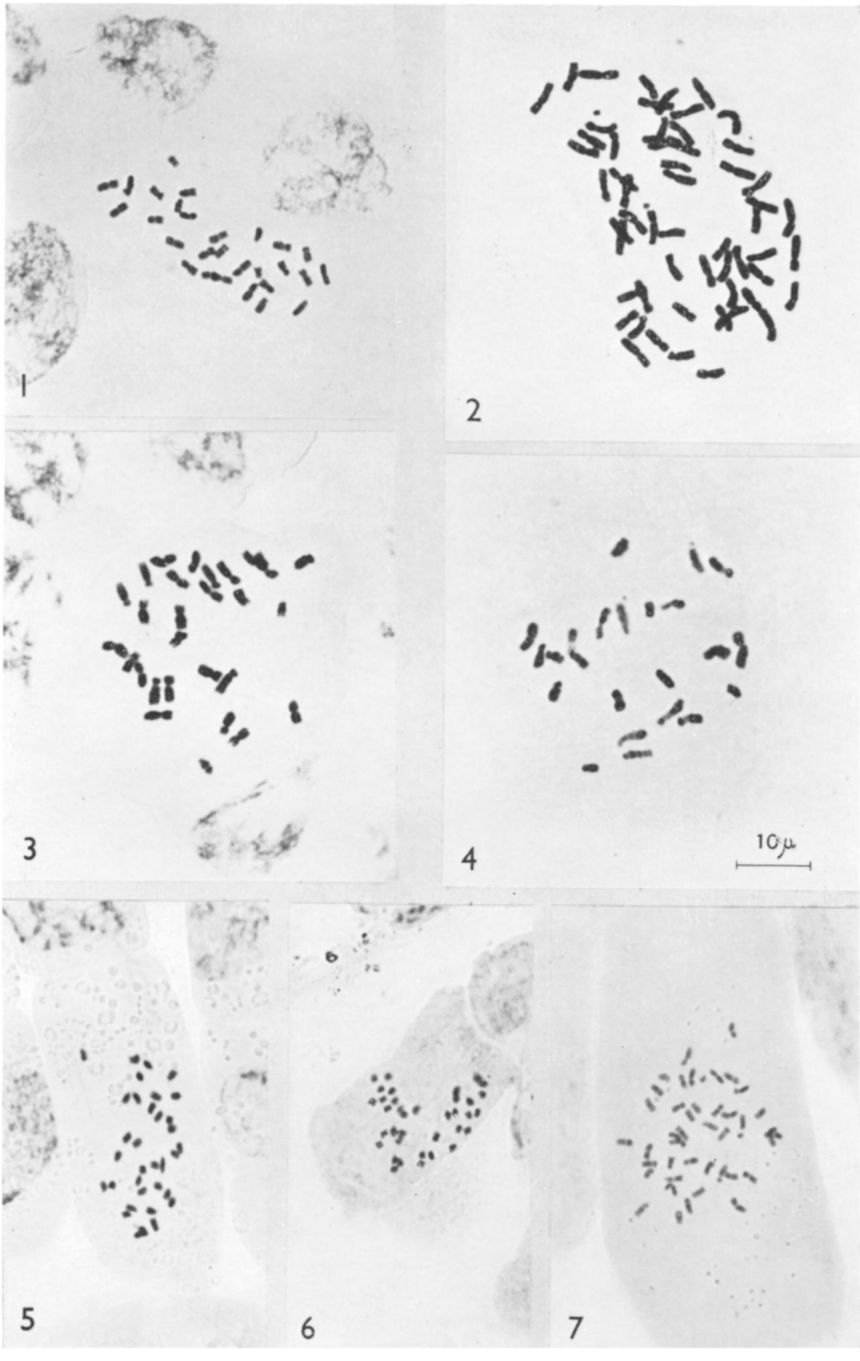


FIG. 2. Somatic chromosome complements in some members of the tribe *Areae*. **1**, ***Pinellia tripartita*** (2n = 52); **2**, *Protarum sechellarum* (2n = 28); **3**, *Sauromatum venosum* (**2n = 26**).

PLATE 4



Somatic chromosome complements from root tips in the tribe *Areae*. **1,** *Arisaema schimperianum*, 67.733 (2n = 28); **2,** *Arisarum vulgare*, 69.796 (2n = 56); **3,** *Arum creticum*, 69.73 (2n = 28); **4,** *Biarum platyspathum*, 69.137 (2n = 24); **5,** *Cryptocoryne affinis*, 69.819 (2n = 34); **6,** *C. longispatha*, 69.824 (2n = 36); **7,** *C. thwaitesii*, 69.902 (2n = 42).

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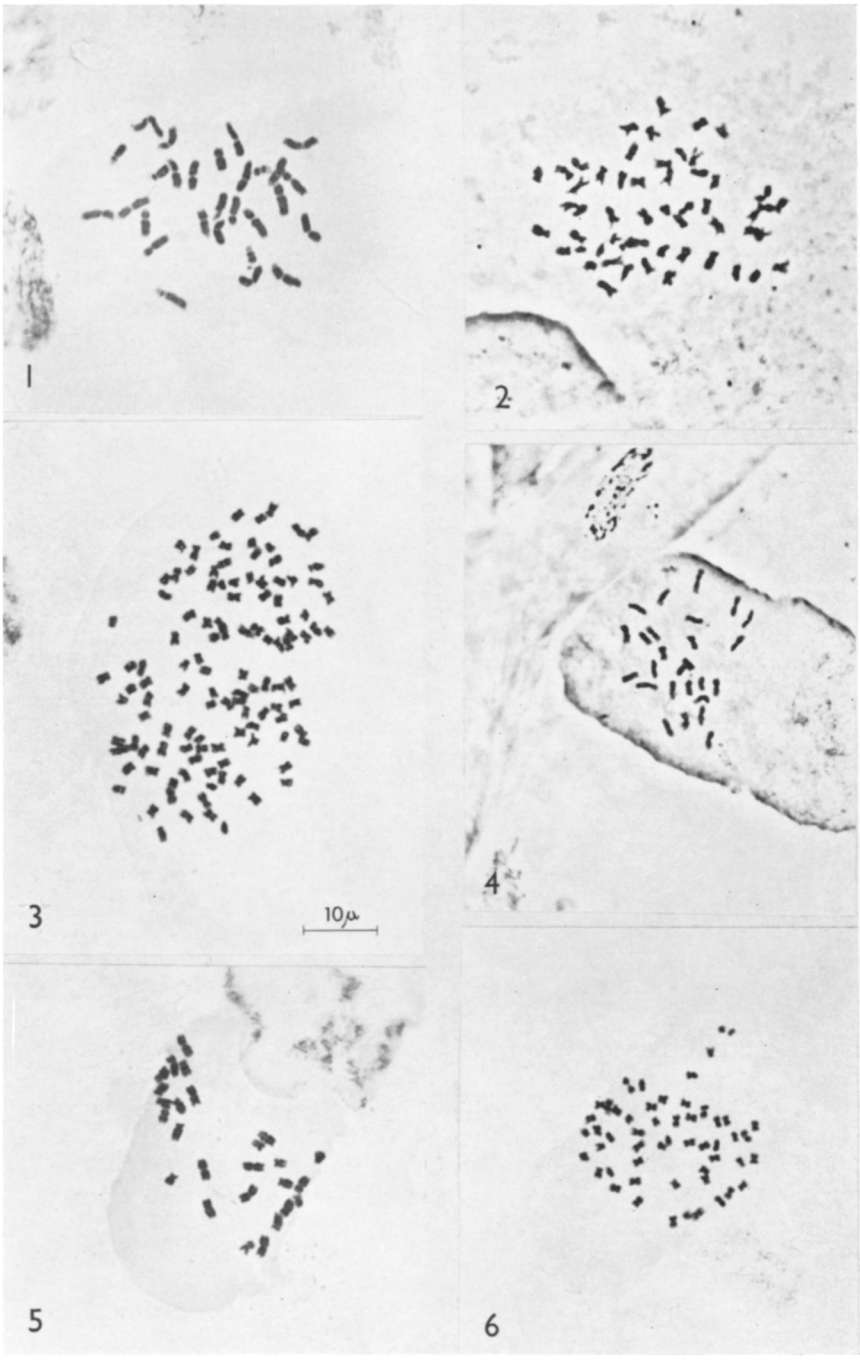
PLATE 5



Somatic chromosome complements from root tips in the tribe *Areae*. **1,** *Dracunculus canariensis*, 66.1572 (2n = 28); **2,** *Humbertina crassifolia*, 70.63 (2n = 54); **3,** *Pinellia ternata*, 69.794B (2n = 115); **4,** *P. pedatisecta*, 69.702A (2n = 26); **5,** *Sauromatum venosum*, 68.1289 (2n = 26); **6,** *Typhonium giraldii*, 69.781 (2n = 54).

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Discussion

This large tribe does not appear to be characterized by any one basic number, though $x = 7$ and $x = 13$ occur with relatively high frequency. Since $x = 13$ is probably secondarily derived from $x = 7$, the genera with these two base numbers group together quite well on both cytological and taxonomic grounds. However, there are those genera with base numbers which do not conform, namely *Humbertina*, *Typhonium*, *Biarum*, *Cryptocoryne* and *Lagenandra*. The two latter are considered closely related by Engler (1920) and indeed some species of *Cryptocoryne* do have a base number of $x = 9$ which occurs in *Lagenandra*. Some genera, particularly *Cryptocoryne* and *Biarum*, show a wide variation in basic number between species, and with no obvious numerical relationships. They could be evolving relatively rapidly. Further generic affinities can be considered in the next and final paper on this family.

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