Chromosome variation in *Araceae*: II *

RICHARDIEAE TO COLOCASIEAE

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The salient features of chromosome studies in the *Araceae* by previous workers and their conflicting results, which stimulated this cytological survey of the family, have been outlined in the previous paper of this series (Marchant, 1970). This paper describes the karyotypes of representative species of a further three tribes (16 genera) of the classification by Hutchinson (1959) and illustrates still more the great diversity in basic chromosome number and karyotype in the family.

Material and methods

Root tip preparations were made from the living plant collections at Kew and stained according to standard techniques as described previously (Marchant, 1970). Voucher specimens are filed in the Kew Herbarium.

Results

Richardieae

There is a preponderance of the base number $x = 10$ in this tribe with *Aglaonema* Schott (Plate 1/1, p. 48 & Figs. 2/1 & 2/2, p. 50), *Anchomanes* Schott (Fig. 1/1, p. 48), *Homalomena* Schott and *Nephthytis* Schott all having $2n = 40$, with the exception of one decaploid species of *Aglaonema*, *A. treubii* Engl., with $2n = 100$ and *Nephthytis* in which both species, *N. afzelii* Schott (Plate 1/3) and *N. poissonii* (Engl.) N.E. Br. (Fig. 1/2) are hexaploid with $2n = 60$.

Several previous counts have been reported for *Aglaonema* species. Those of Pfitzer (1957) and Earl (1956) are all based on $x = 10$, though in some cases they differ in ploidy from my own counts. Gow (1908), Sharma & Bhattacharya (1966) quote conflicting numbers of $2n = 16$, and $2n = 42$ respectively for *Aglaonema pictum* Kunth, and Larsen (1969) $2n = 42$ for *A. simplex* Bl.

In *Homalomena* three species; *H.* aff. *humili* Hook. (Fig. 1/4, p. 48), *H. caerulescens* Jungh. ex Schott (Plate 1/2, p. 48 & Fig. 1/3) and *H. singaporense* Regel are $2n = 40$ while *H. wallisii* Regel has $2n = 42$. It is not clear whether the latter is a distinct change in basic number or due to the presence of fragments (B-chromosomes), but it is not possible positively to identify any such fragments in the material, at least until meiosis can be observed. The only two previous counts are $2n = 34$ for *H. rubescens* by Mookerjea (1955) and $2n = 42$ for *H. occulta* (Lour.) Schott by Larsen (1969). There thus seems to be a secondary basic number in this genus.

Among these $x = 10$ genera are two distinct groups based on a wide difference in chromosome size. *Aglaonema*, *Anchomanes* and *Nephthytis* have large chromosomes while in *Homalomena* species the chromosomes are small.

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* Continued from Kew Bull. 24: 322 (1970).

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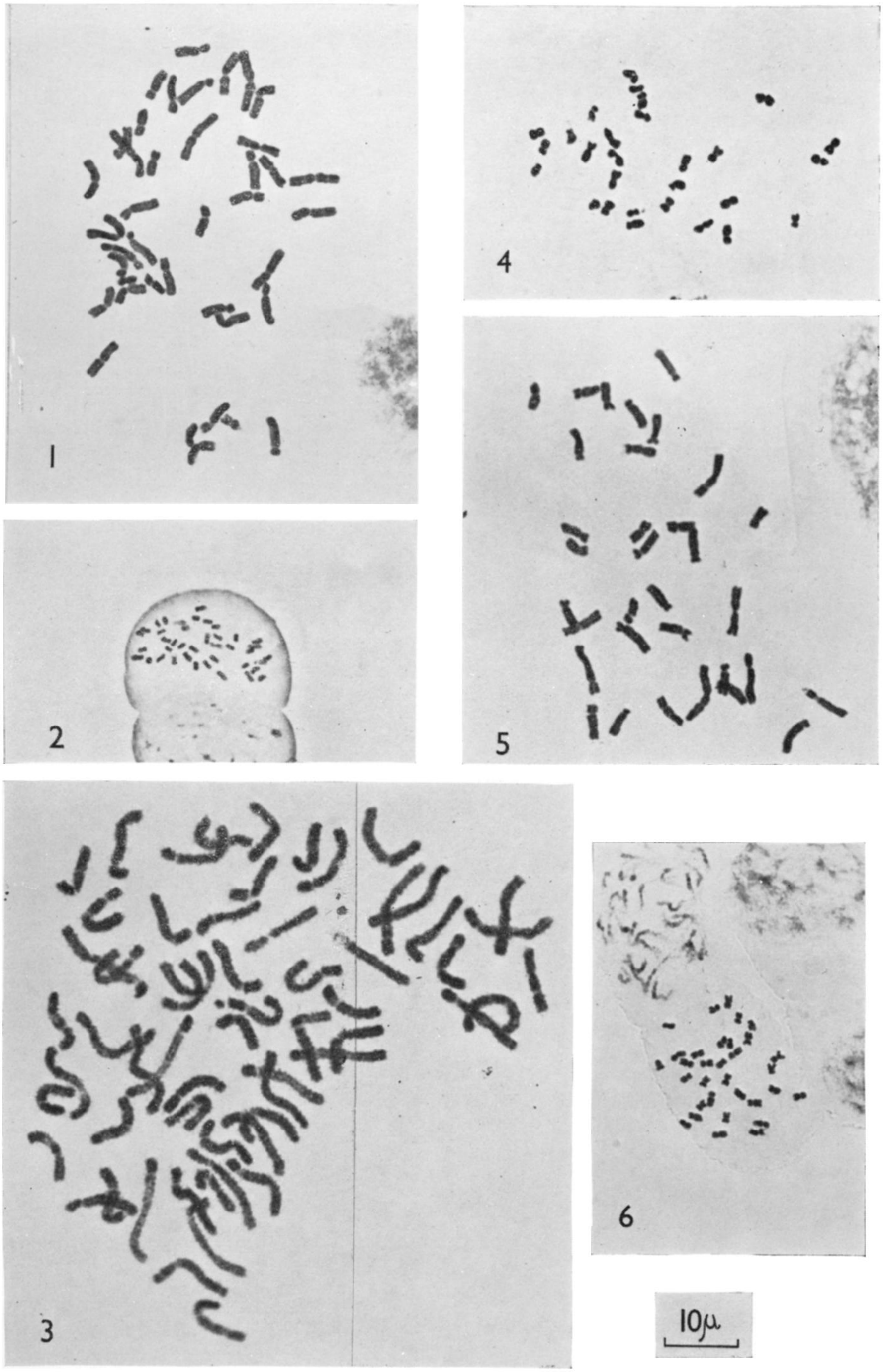
FIG. 1. **1,** *Anchomanes difformis,* 2n = 40. **2,** *Nephthytis poissonii,* 2n = 60. **3,** *Homalomena caerulescens,* 2n = 40. **4,** *Homalomena* sp. aff. *humili,* 2n = 40.

PLATE 1



Mitotic chromosomes of species of *Araceae*. **1,** *Aglaonema* sp. (2n = 40); **2,** *Homalomena caerulescens* (2n = 40); **3,** *Nephthytis afzelii* (2n = 60); **4,** *Schismatoglottis tecturata* 2n = 52); **5,** *Dieffenbachia barraquiniana* (2n = 34); **6,** *Zantedeschia tropicalis* (2n = 32).

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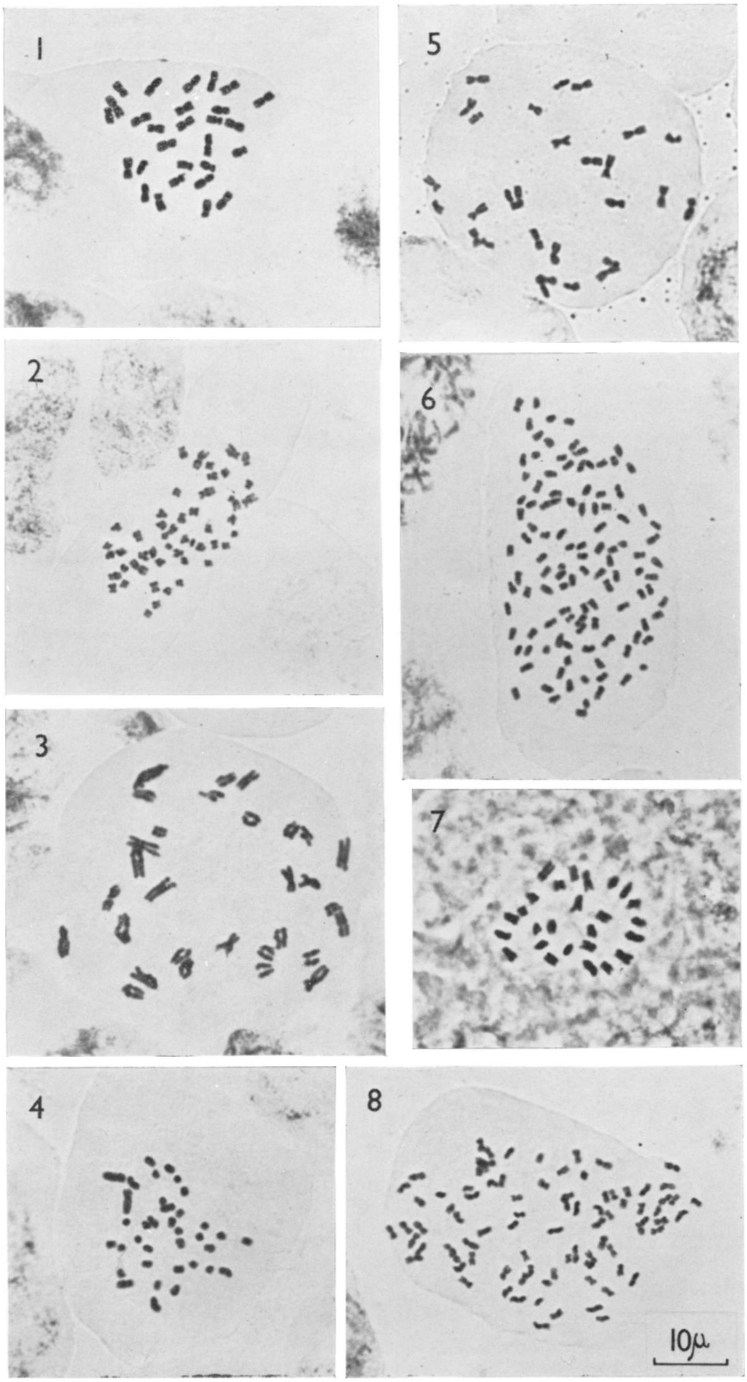
PLATE 2



Mitotic chromosomes of species of *Araceae*. **1,** *Alocasia longiloba* (2n=28); **2,** *Anubias* sp. aff. *hastifoliae* (2n = 48); **3,** *Caladium bicolor* (2n = 30); **4,** *Callopsis volkensii* (2n = 36); **5,** *Colocasia esculenta* (2n = 28); **6,** *Peltandra virginica* (2n = 112); **7,** *Xanthosoma violaceum* (2n = 26); **8,** *Ariopsis peltata* (2n = 86).

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Zantedeschia Spreng. is based on $x = 8$ with small chromosomes; $2n = 32$ has been found in *Z. albomaculata* Baill. (Fig. 2/4, p. 50), *Z. tropicalis* (N. E. Br.) Letty (Plate 1/6) and *Z. rehemannii* Engl. (Fig. 2/3.) These accord with previous counts of $2n = 32$ by Earl (1957).

Schismatoglottis Zoll. & Mor. with $x = 13$ and medium-sized chromosomes has two levels of ploidy ($2x$ and $4x$) in *S. wallichii* Hook., $2n = 26$, (Fig. 2/6) and *S. tecturata* Engl., $2n = 52$ (Plate 1/4). There is a B-chromosome in one of the diploids namely *S. concinna* Schott var. *immaculata* N. E. Br. with $2n = 26 + 1B$ (Fig. 2/5). Sharma & Bhattacharya (1966) and Mookerjea (1955) report counts of $2n = 52$ and $2n = 56$ respectively for two other *Schismattoglottis* species.

Less than half this tribe are available at Kew for cytological study.

Dieffenbachieae

This tribe has a high and presumably secondary basic number. *Heterolobium petiolulatum* Peter* (Fig. 3/3, p. 52) and three species of *Dieffenbachia* Schott (Plate 1/5 & Fig. 3/1) have $2n = 34$ and large chromosomes.

It is significant that the chromosome number, size and karyotype of *Gonatopus* species are very similar to that of *Zamioculca* sSchott in the tribe *Stylochitoneae* described in the previous paper (Marchant, 1970). Phenotypic features, especially the petiole structure of these two genera, are closely similar and there seems to be good cytological support for putting both these genera in the same tribe.

Information on the cytology of the *Dieffenbachieae* remains very incomplete with only two genera out of twelve being available for study.

Colocasieae

This tribe contains a series of lower base numbers, namely $x = 7$, 8 and 9 and two higher levels of $x = 13$ and 15 which must be of secondary origin.

Eleven species of *Alocasia* G. Don studied have a base number of $x = 7$ and $2n = 28$ medium-sized chromosomes (Plate 2/1 & Fig. 3/5), except octoploid *A. odora* (Roxb.) C. Koch and decaploid *A. lowii* Hook. (Fig. 3/4) with $2n = 70$. *A. cuprea* C. Koch and *A. sanderiana* Hort. ex Bull were counted as $2n = 28$ previously by Pfitzer (1957), while Larsen (1969) has recorded this same number for *A. navicularis* (C. Koch & Bouché) C. Koch & Bouché.

Remusatia Schott also falls within the $x = 7$ medium-sized chromosome group, *R. vivipara* (Lodd.) Schott having $2n = 56$ (Fig. 4/1) at the octoploid level. This species has been previously reported as $2n = 28$ (Mookerjea, 1955) and $2n = 42$ by Larsen (1969), who also records $2n = 28$ for *R. hookeriana* Schott.

Other genera with $x = 7$ have small chromosomes. *Colocasia* Schott has both diploid ($2n = 28$) in *C. esculenta* (L.) Schott (Plate 2/5 & Fig. 3/2) and hexaploid ($2n = 42$) in *C. antiquorum* Schott. The latter species has been counted by numerous previous workers, most of whom cite $2n = 28$ or 42 (Nakajima, 1936; Asana & Sutaria, 1939; Ito, 1942; Kurakubo, 1940; Sharma & Das, 1954; Mookerjea, 1955; Pfitzer, 1957; Rattenbury, 1957; Fukushima *et al*, 1962) but Rao (1947) and Delay (1951) cite $2n = 36$ and 48 respectively.

* I am grateful to J. Bogner, Botanischer Garten, München, for the information that *Heterolobium petiolulatum* Peter is in fact a *Gonatopus* and conspecific with the later described *G. latilobus* K. Krause.

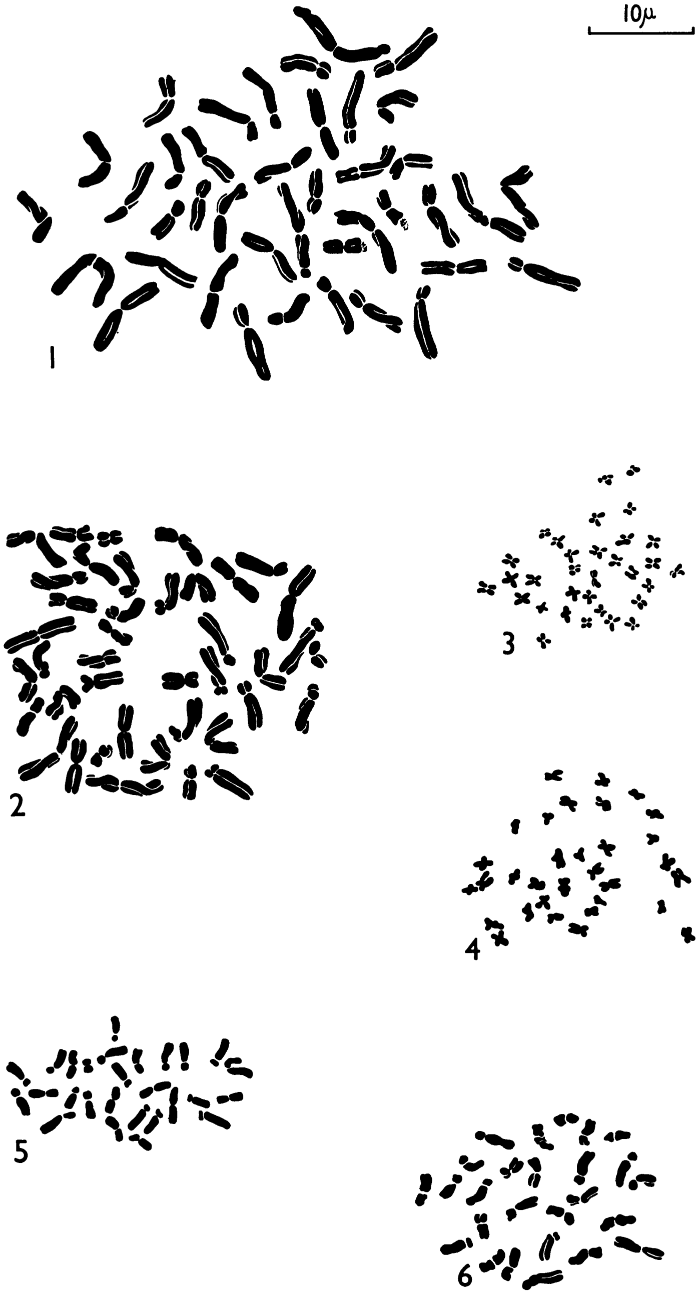

FIG. 2. **1,** *Aglaonema oblongifolium*, 2n = 40. **2,** *Aglaonema* sp., 2n = 40. **3,** *Zantedeschia rehmannii*, 2n = 32. **4,** *Zantedeschia albo-maculata*, 2n = 32. **5,** *Schismatoglottis concinna* var. *immaculata*, 2n = 26 + B. **6,** *S. wallichii*, 2n = 26.

Typhonodorum Schott is represented in the Kew collection by *T. lindleyanum* Schott at the high ploidy-level of 16x with 2n = 112 very small chromosomes. (Fig. 4/2, p. 53.)

The base of x = 8 is found in *Anubias* Schott, three species having 2n = 48 (Plate 2/2 p. 49 & Figs. 4/3 & 4/6) and small chromosomes. The *A. lanceolata* N.E. Br. count of 2n = 48 agrees with that of Pfitzer (1957).

The only x = 9 genus observed is *Callopsis* Engl. in which *C. volkensii* Engl. (Plate 2/4 & Fig. 4/4) and an unidentified species have 2n = 36 and small chromosomes.

Peltandra virginica (L.) Schott & Endl. is a high polyploid with 2n = 112 based on x = 7 (Plate 2/6). A previous count for *P. virginica* is 2n = 88 (Huttleston, unpublished). Obviously more attention needs to be paid to this genus.

Two species of *Xanthosoma* Schott have x = 13 with 2n = 26 in *X. atrovirens* C. Koch & Bouché var. *albo-marginata* (Fig. 4/5), *X. sagittifolium* (L.) Schott and *X. violaceum* Schott (Plate 2/7). The chromosomes are of medium size. Previous counts for these two species respectively by Janaki-Ammal (unpublished) and Pfitzer (1957) agree with my own.

The highest basic number of x = 15 is found in *Caladium bicolor* (Ait.) Vent. and two cultivars, all with 2n = 30 medium-sized chromosomes (Plate 2/3 & Fig. 4/7). This has been previously reported as 2n = 30 by Kurakubo (1940), Simmonds (1954) and Pfitzer (1957), but Ito (1942) reported 2n = 48.

Ariopsis peltata Nimmo provides a problem. My count of 2n = 86 from a root-tip (Plate 2/8) differs slightly from counts of the same species by both Malvesin-Fabre (1945) with 2n = 80 (x = 10) and Pfitzer (1957) with n = 42 (x = 7). The chromosomes are small making it difficult to detect any supernumerary chromosomes which may be present.

Another 8 genera of the *Colocasieae* remain to have their chromosomes studied.

Discussion

As in Marchant (1970) it is clear that broad chromosome variation exists in each of the tribes discussed and, although a few genera, such as x = 10 genera in the *Richardieae*, can be grouped together according to a common chromosome pattern, there is generally no overall pattern to be found by comparing the karyotypes from within a single tribe. Possible inter-tribal links cannot be adequately discussed until the end of this series of publications. Furthermore, the literature cited above in most instances relates only to particular species counted in the present investigation and is not intended to be an exhaustive review of *Araceae* chromosome counts. Where necessary further citations will be added in the discussion of taxonomic groupings in the final paper of this series.

Acknowledgment

I would like to thank Miss C. Brighton for her technical assistance.

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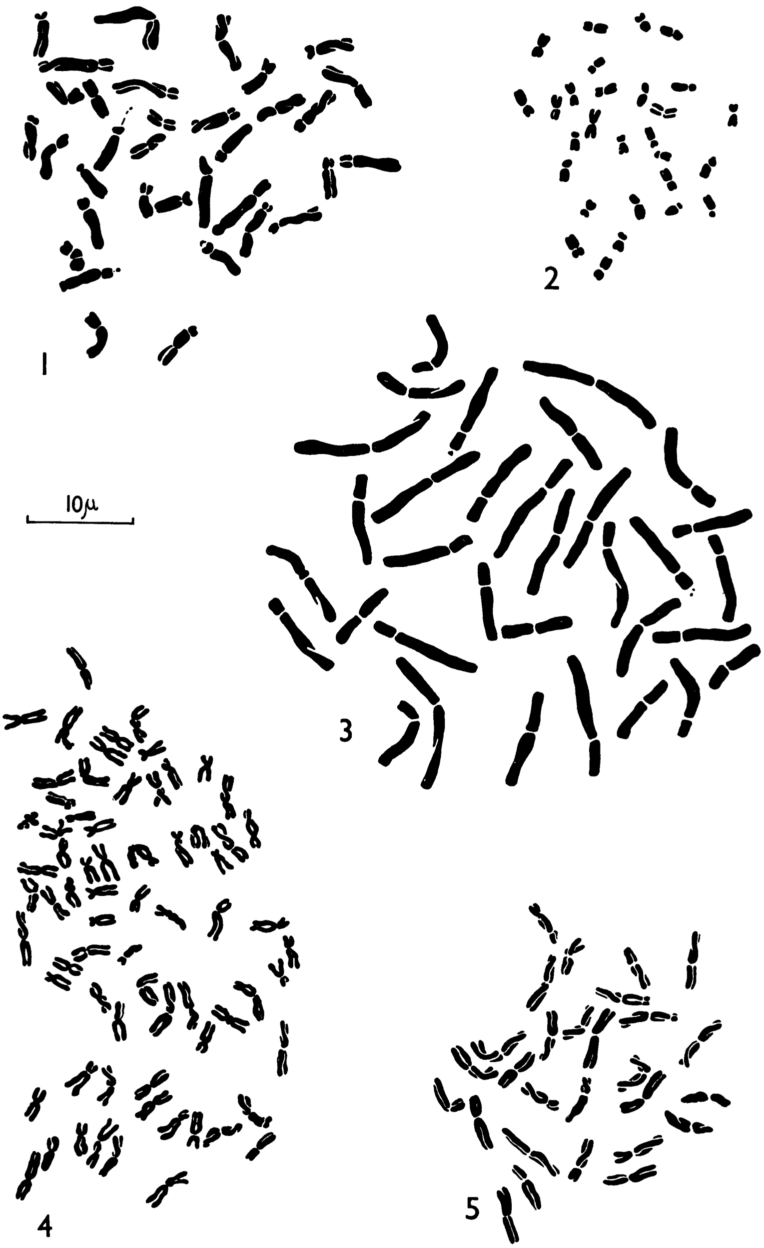

FIG. 3. **1**, *Deiffenbachia barraquiniana*, 2n = 34. **2**, *Colocasia esculenta*, 2n = 28. **3**, *Heterolobium petiolulatum*, 2n = 34. **4**, *Alocasia lowii*, 2n = 70. **5**, *Alocasia wavriniana*, 2n = 28.

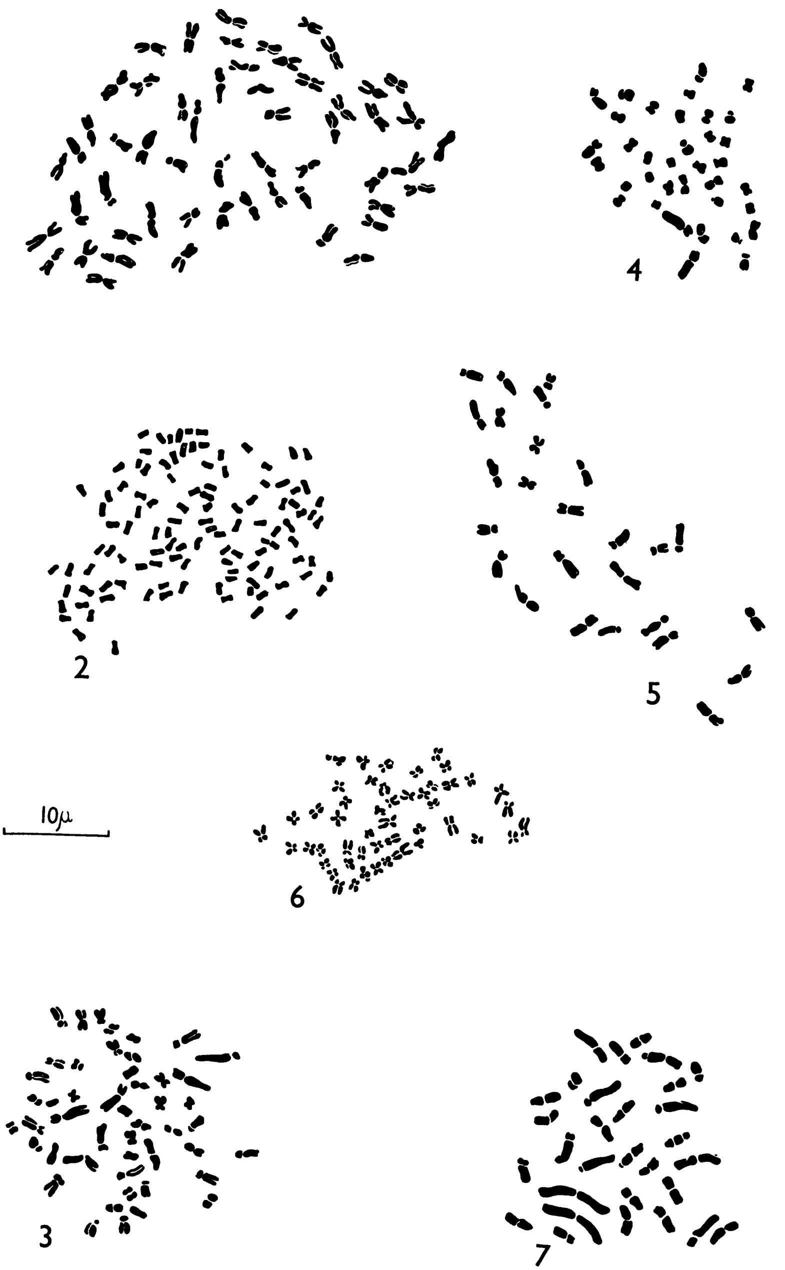

FIG. 4. **1**, *Remusatia vivipara*, 2n = 56. **2**, *Typhonodorum lindleyanum*, 2n = 112. **3**, *Anubias* sp. aff. *hastifoliae*, 2n = 48. **4**, *Callopsis volkensii*, 2n = 36. **5**, *Xanthosoma atrovirens* var. *albo-marginata*, 2n = 26. **6**, *Anubias afzelii*, 2n = 48. **7**, *Caladium bicolor*, 2n = 30.

TABLE 1. List of chromosome counts in the *Araceae*

Name	Kew Entry No.	Cytology Accession No.	Origin	Chromosome No. (2n)	Basic No. (*x*)	Size S.M.L. (small medium or large)	Previous Counts: Name	Previous Counts: Chromosome No. (2n)	Previous Counts: Author	Previous Counts: Date
Tribe **Richardieae**										
Aglaonema oblongifolium (Kunth) Schott		65.1361		40	10	L				
A. pictum Kunth		64.300	Malaya	40	10	L	*A. pictum*	16	Gow	1908
								42	Sharma & Bhattacharya	1966
A. pictum Kunth var. *versicolor* Hort.		63.1713		c.40	10	L		40	Pfitzer	1957
A. simplex Bl.	461.57	63.56	Malaya, *Mason*	40	10	L	*A. simplex*	60	Earl	1956
								60	Pfitzer	1957
								42	Larsen	1969
A. treubii Engl.	416.57	68.1538	Celebes, *Birdsey*	100	10	L	*A. treubii*	80	Pfitzer	1957
Aglaonema sp.		65.49		40	10	L				
Anchomanes abbreviatus Engl.	518.52	69.701	Tanzania, *Faulkner*	40	10	L				
A. difformis (Bl.) Engl.	386.61	65.277	Cameroun, *Letouzey*	40	10	L				
A. welwitchii Rendle	245.37	61.1153	Nigeria	40	10	L				
Homalomena caerulescens Jungh. ex Schott		69.69	Malaya	40	10	S	*H. rubescens*	34	Mookerjea	1955
H. humilis (Jack) Hook. f. var. *pumila* (Hook. f.) Furtado	372.58	63.1736	Cameron Highlands, Malaya, *Singapore Bot. Gard.*	c.40	10	S	*H. occulta*	42	Larsen	1969
Homalomena sp. aff. *humili* Hook.	393.64	68.1692	Indo-Malaysia, *Goodman*	40	10	S				
H. singaporense Regel		62.1708	New Guinea	40	10	S				
H. wallisii Regel		65.129	Colombia	42		S				
Nephthytis afzelii Schott	209.54	68.1632		60	10	L				
N. poissonii (Engl.) N. E. Br.	438.57	64.2048	Ibadan, Nigeria, *Keay* 37044	60	10	L				
Schismatoglottis concinna Schott var. *immaculata* N. E. Br.		68.1608	Borneo	26 + B	13	M	*S. neoguineensis* var. *variegata*	52	Sharma & Bhattacharya	1966
S. tecturata Engl.	335.58	68.1553	Kutching, Sarawak, *Holttum*	52	13	M	*S. wigmannii*	56	Mookerjea	1955
S. wallichii Hook.	399.60	63.2006	Malaya, *Holttum*	26	13	M				
Zantedeschia albo-maculata (Hook.) Baill.	205.65	65.978	*Glasnevin Bot. Gard.*	32	8	S	*Z. albo-maculata*	32	Earl	1957
Z. rehmannii Engl.	515.64	64.1831	South Africa, *Benjamin*	32	8	S	*Z. rehmannii*	32	Earl	1957
Z. tropicalis (N. E. Br.) Letty	515.64	69.660	South Africa, *Benjamin*	32	8	S				
Tribe **Dieffenbachieae**										
Dieffenbachia barraquiniana Versch. & Lem.		68.1539	Brazil	34	17	L	*D. barraquiniana*	34	Sharma & Bhattacharya	1966
D. oerstedtii Schott		65.1403		34	17	L				
D. picta (Lodd.) Schott	487.50	68.1540	Missouri Bot. Gard., *Pring*	34	17	L	*D. picta*	16	Gow	1908
								34	Mookerjea	1955
								34	Pfitzer	1957
								36	Sharma & Bhattacharya	1966
Gonatopus boivinii Engl.	494.67	68.1695	Tanzania, *Bogner*	34	17	L				
Heterolobium petiolatum Peter (*G. latilobus* K. Krause)	032.69	69.713	Near Mlinduro, Tanzania, *Bogner* 241	34	17	L				

Tribe **Colocasieae**										
Alocasia cuprea C. Koch	457.63	63.2042	N. Borneo, *Giles & Woolliams* PB 301	28	7	M	*A. cuprea*	28	Pfitzer	1957
„ „ „	514.58	69.88	Borneo *L. M. Mason*	28	7	M	*A. navicularis*	28	Larsen	1969
A. cucullata (Louv.) Schott	416.57	63.763	India, *Birdsey*	28	7	M				
A. denudata Engl.	514.58	63.1991	Borneo, *L. M. Mason*	28	7	M				
A. indica (Roxb.) Schott		63.1951	Malaya	28	7	M				
A. indica (Roxb.) Schott var. *metallica* Schott	209.55	63.1739	*Copenhagen Bot. Gard.*	28	7	M				
A. longiloba Miq.	687.61	69.155	Borneo, *L. M. Mason*	28	7	M				
A. lowii Hook.		63.1999	Borneo	70	7	M				
A. micholitziana Sand.	289.67	69.126	*R. H. Edwards*	28	7	M				
A. odora (Roxb.) C. Koch	263.58	63.300	Asia. *Glasnevin Bot. Gard.*	56	7	M				
A. sanderiana Hort. ex Bull × *downii*		63.2321		28	7	M	*A. sanderiana*	28	Pfitzer	1957
A. wavriniana Mast.	253.57	65.174	Celebes, *D. Barry*	28	7	M				
Alocasia sp.	457.63	63.1996	N. Borneo, *Giles & Woolliams* PB 313	28	7	M				
Anubias afzelii Schott		64.984		48	8	S				
A. lanceolata N. E. Br.	22.63	65.1359	W. Africa, *Shirley Aquatics*	48	8	S	*A. lanceolata*	48	Pfitzer	1957
Anubias sp. aff. *hastifoliae* Engl.	333.65	65.1383	*Bogner*	48	8	S				
Caladium bicolor (Ait.) Vent.		64.535		30	15	M	*C. bicolor*	30	Kurakubo	1940
								48	Ito	1942
								30	Simmonds	1954
								30	Pfitzer	1957
C. cv. 'Lord Derby'	464.62	64.536	*Barry Parks Dept.*	30	15	M				
C. cv. 'D. H. Cooke'	464.62	64.542	*Barry Parks Dept.*	30	15	M				
Callopsis volkensii Engl.	301.68	68.1649	Tanzania, *Bogner*	36	6, 9	S				
Callopsis sp.		65.175		c.36	6, 9	S				
Colocasia antiquorum Schott	547.67	69.65		42	7	S	*C. antiqourum*	42	Nakajima	1936
								28	Ito	1942
								28	Kurakubo	1940
								36	Rao	1947
								48	Delay	1951
							C. antiquorum var. *nymphaefolia*	28	Sharma & Das	1954
							C. antiquorum	42, 14	Mookerjea	1955
							C. antiquorum var. *aquatilis*	28	Pfitzer	1957
							C. antiquorum 2 vars.	28, 42	Fukushima et al.	1962
							C. antiquorum vars.	28, 42	Rattenbury	1957
C. esculenta (L.) Schott	455.63	68.1554	N. Borneo, *Giles & Woolliams* PB 266	28	7	S				
Peltandra virginica (L.) Schott & Endl.		69.725		112	7	S	*P. virginica*	88	Huttleston	Un-publ.
Remusatia vivipara (Lodd.) Schott	85.47	63.1677	*Stockholm Bot. Gard.*	56	7	M	*R. vivipara*	28	Mookerjea	1955
							R. hookeriana	28	Larsen	1969
Typhonodorum lindleyanum Schott		68.1410	Madagascar	112	7	S				
Xanthosoma atrovirens C.Koch & Bouche var. *albo-marginata* Hort.	519.62	65.471	Venezuela, *Siedal*	26	13	M	*X. atrovirens*	26	Pfitzer	1957
X. sagittifolium (L.) Schott		69.70	W. Indies, *Russell*	26	13	M	*X. sagittifolium*	26	Janaki-Ammal	Un-publ.
X. violaceum Schott	455.63	69.68	N. Borneo, *Giles & Woolliams* PB 274	26	13	M	*X. violaceum*	26	Pfitzer	1957
								24	Delay	1951
Ariopsis peltata Nimmo	210.50	69.657	*Leiden Bot. Gard.*	86	?	S	*A. peltata*	80	Malvesin-Fabre	1945
								84	Pfitzer	1957

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