Chromosome variation in *Araceae*: III*

PHILODENDREAE to PYTHONIËAE

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This is the third in a series of papers on the chromosome numbers and karyotypes of the family *Araceae*. As with treatments of the tribes in the earlier papers there are many genera not available at Kew for cytological study. It is anticipated that some of these will be acquired during current or pending plant collecting expeditions. A total of seven genera from a further four tribes of Hutchinson's (1959) classification are dealt with in this paper.

MATERIALS AND METHODS

Chromosome preparations were made by the feulgen squash method as described in the first paper of this series (Marchant, 1970). Photographs and drawings are here reproduced at comparable magnification to those in previous papers. Voucher specimens, spirit material and some colour transparencies are filed at Kew.

The literature cited below in most instances relates only to particular species counted in the present investigation and is not intended as an exhaustive review of *Araceae* chromosome counts. Where appropriate, further citations will be added in the discussion in the final paper of this series.

RESULTS

Philodendreae

The genus *Culcasia* P. Beauv. exhibits a high degree of polyploidy based on $x = 7$ with small chromosomes. Of the three separate clones counted two have been identified as *C.* aff. *scandenti* (Willd.) P. Beauv. and *C. scandens*, with $2n = 42$ (Fig. 1/1, p. 324) and $2n = 84$ (Pl. 3/1, p. 324) respectively. A third clone, probably also *C. scandens* but not yet determined at Kew, also had $2n = 84$. Neither of the previous counts of $2n = 32$ (Delay, 1951) and $2n =$ c. 40 (Mangenot & Mangenot, 1962) agree with the basic number of $x = 7$ found in this investigation.

Three specimens of the large genus *Philodendron* Schott have been studied, all based on $x = 8$ with small chromosomes and $2n = 32$. These are probably all *P. micans* (Klotzsch) C. Koch although received at Kew as *P. micans*, *P. scandens* C. Koch & Sello var. *cuspidatum* (C. Koch & Bouché) Engl. and *P. surinamense* (Schott) Engl. respectively. (Fig. 1/2 & Pl. 3/2.) Some of the previous counts are based on $x = 8$ with $2n = 32$ in *P. radiatum* (Mookerjea, 1955) and in *P. squamiferum* and *P. cuspidatum* (Sharma & Mukhopadyay, 1965) but the latter authors also report $2n = 30$, 33 and 36 for other species. My own counts support the basic number of $x = 8$.

Syngonium Schott presents a problem with basic numbers. Three species have

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* Continued from Kew Bull. 25: 56 (1970).

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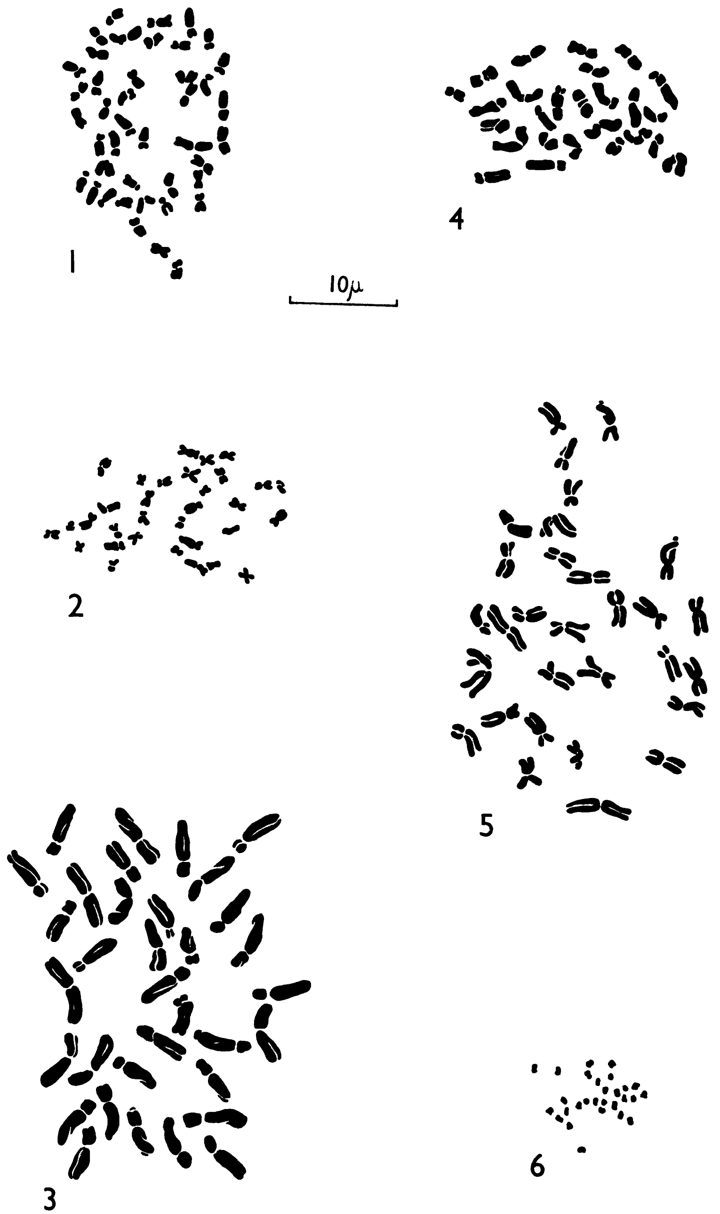

FIG. 1. Mitotic chromosome complements in some Araceae. **1,** *Culcasia* aff. *scandens* (2n = 42); **2,** *Philodendron micans* (2n = 32); **3,** *Spathicarpa sagittifolia* (2n = 34); **4,** *Syngonium wendlandii* (2n = 26); **5,** *Syngonium* sp.* (2n = 30); **6,** *Pistia stratiotes* (2n = 28).

* See footnote on p. 325.

PLATE 3

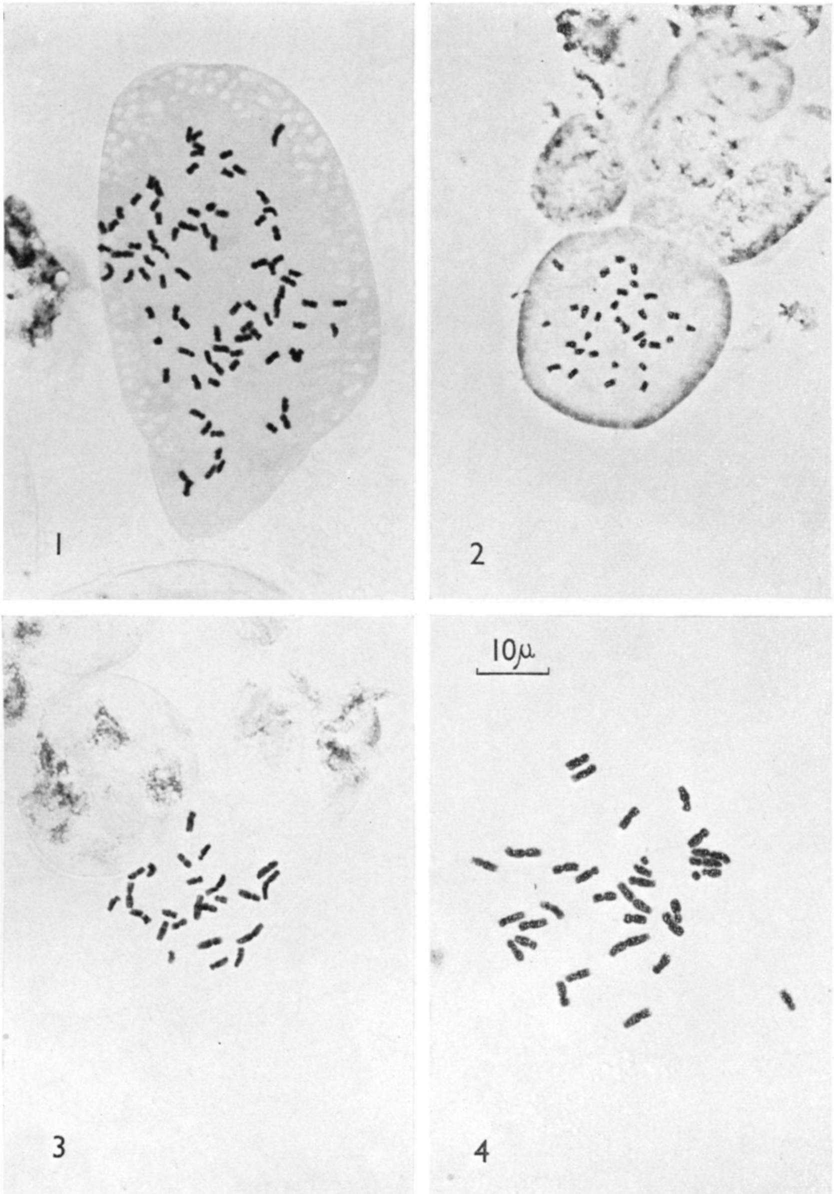

Plate 3. Somatic chromosome complements from root tips in the tribe *Philodendreae* **1,** *Culcasia* sp. (2n = 84); **2,** *Philodendron micans* (2n = 32); **3,** *Syngonium wendlandii* (2n = 24); **4,** *Syngonium* sp.* (2n = 30).

* See footnote on p. 325.

PLATE 4

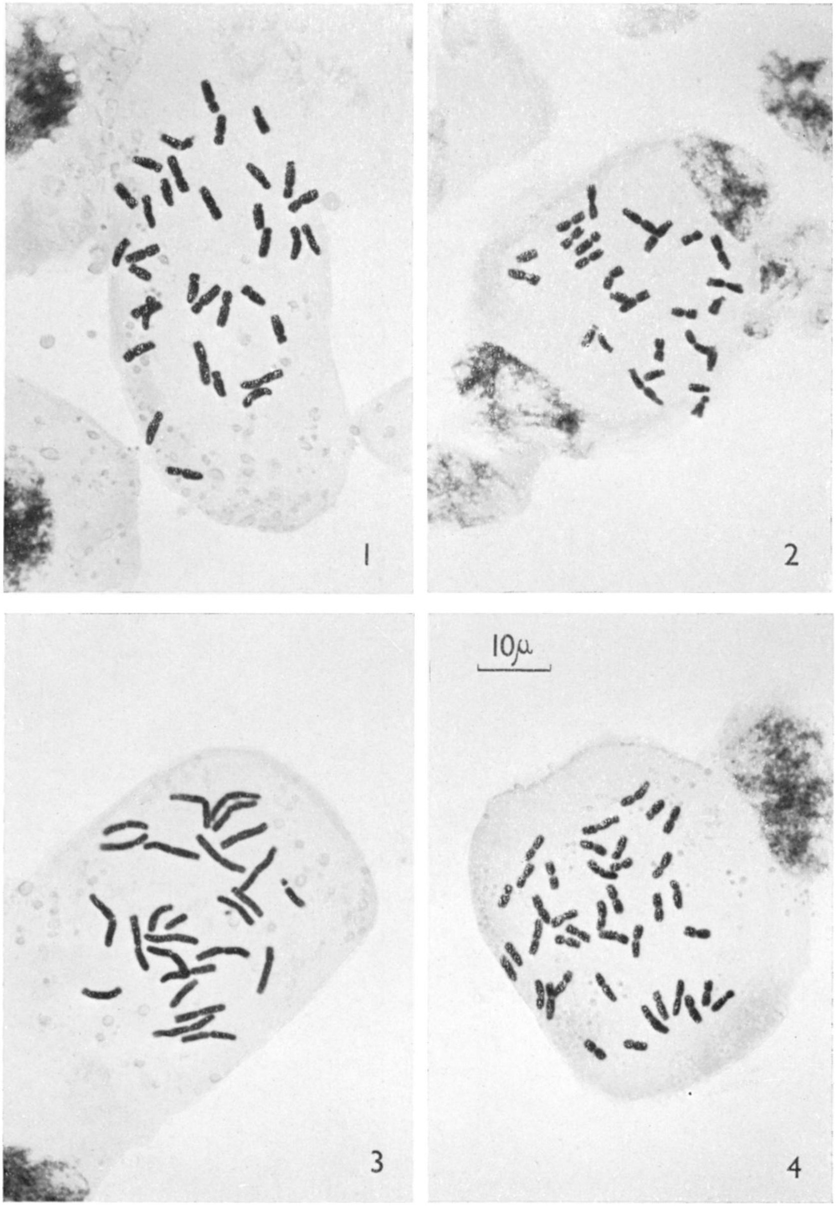

PLATE 4. Somatic chromosome complements from root tips in the tribes *Spathicarpeae* and *Pythonieae*. **1,** *Spathicarpa sagittifolia* (2n = 34); **2,** *Pseudodracontium siamense* (2n = 26); **3,** *Amorphophallus maximus* (2n = 26); **4,** *A. bulbifer* (2n = 39).

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been counted (Table 1, p. 328) but each has a different chromosome number and indeed a different basic number. All have medium-sized chromosomes. *Syngonium wendlandii* Schott has 2n = 24 (Fig. 1/4 & Pl. 3/3), *Syngonium* sp. near *vellozianum* Schott 2n = 26 and another *Syngonium* sp. (*Whitmore* 886)* 2n = 30 (Fig. 1/5 & Pl. 3/4). The only other recorded count, by Pfitzer (1957), is 2n = 24. The generic identity of the 2n = 26 plant has been confirmed at Kew and it can only be inferred that the genus, although small (10 species) has more than one basic number.

Less than half of the total of seven genera of this tribe have been available at Kew for chromosome counts. Mangenot & Mangenot (1958) report 2n = 42 ($x = 7$) for *Cercestis* Schott, a genus related to *Culcasia* in Hutchinson's classification.

Spathicarpeae

In this small tribe only *Spathicarpa sagittifolia* Schott has been studied at Kew. It has 2n = 34 ($x = 17$) small chromosomes (Fig. 1/3, p. 324 & Pl. 4/1, opposite), agreeing with Pfitzer (1957). During this investigation of *Araceae* four other genera have also been found with the secondary basic number of $x = 17$ but these all differ from *Spathicarpa* in having distinctly large chromosomes.

Pistiëae

This is a monogeneric tribe, represented only by the floating aquatic *Pistia* L. The single species *P. stratiotes* L. has 2n = 28 small chromosomes with a basic number of $x = 7$ (Fig. 1/6).

Pythoniëae

The genus *Amorphophallus* Bl. ex Decne. contains some 90 species distributed through tropical Africa and Indo-Malaysia, a few of which have previously had their chromosomes counted, with varying numbers reported.

According to counts made at Kew there are two basic numbers in the genus, namely $x = 13$ and $x = 14$. Species with $x = 13$ (2n = 26) are *A. abyssinicus* (A. Rich.) N. E. Br., *A. gallaënsis* (Engl.) N. E. Br., *A. gomboczianus* Pichi-Sermolli, *A. hildebrandtii* (Engl.) Engl. & Gehrm. (Fig. 2/1, p. 326), *A. maximus* (Engl.) N. E. Br. (Pl. 4/3), *A. siamensis* Gagnep., *A. titanum* Becc. and *A. bulbifer* (Roxb.) Bl. (Pl. 4/4). None of these except *A. bulbifer* has previously had its chromosomes counted. *A. goetzii* (Engl.) N. E. Br. also has 2n = 26 but with an additional very small centric fragment. Those species with $x = 14$ are in the minority in the Kew collection namely *A. prainii* Hook. f. and two accessions of *A. campanulatus* (Roxb.) Bl. ex Decne. (Fig. 2/2). The latter is one of the few species for which there are previous reports of a chromosome number and on this there is a difference of opinion. Asana & Sutaria (1937) report 2n = 26 while Patel & Narayana (1937) report 2n = 28. Larsen (1969) reports counts of 2n = 26, 2n = 28 for two *Amorphophallus* species from Thailand not studied in this investigation. Whether, in relation to the genus as a whole, there is any true significance in the much greater proportion of species found to have $x = 13$ is speculative but it suggests that $x = 13$ is the more successful and possibly derived basic number.

* Since this paper went to press the material of *Syngonium* sp. (*Whitmore* 886, E.No. 703-60) (2n = 30) has been determined by Dr. D. H. Nicholson of the Smithsonian Institution as a species of *Anthurium*.

FIG. 2. Mitotic chromosome complements in some *Araceae*. **1**, *Amorphophallus hildebrandtii* (2n = 26); **2**, *A. campanulatus* (2n = 28); **3**, *Pseudodracontium siamense* (2n = 26).

The karyotypes of *Amorphophallus* vary between species, for instance *A. hildebrandtii* with $x = 13$ (Fig. 2/1) has a much more asymmetrical karyotype than *A. bulbifer* with $x = 13$ (Plate 4/4). There is also an overall chromosome size difference whereby species with $x = 13$, *e.g. A. hildebrandtii* (Fig. 2/1) and *A. goetzii* have distinctly larger chromosomes than those with $x = 14$ *e.g. A. campanulatus* (Fig. 2/2) and *A. prainii.*

Amorphophallus bulbifer is the only species studied with a triploid chromosome number of 2n = 39 ($x = 13$) (Plate 4/4). This differs from the previously recorded count of 2n = 36 (Chandler, 1943). Meiosis has not been studied but it is very likely that meiotic sterility will ensue from such a chromosome constitution. However, a fairly efficient means of vegetative propagation is available by way of bulbils that are produced at the apex of the petiole. These readily develop into new plants when they become detached.

No diploid or tetraploid races of *A. bulbifer* have been reported, though the triploid is evidence that one or both must have existed at some time. It is therefore impossible to determine whether bulbils are a developmental response to triploidy or have always been a characteristic of *A. bulbifer* making possible the by-passing of sexuality and hence the successful establishment and persistence of the triploid race. Triploids are not unknown in the genus

Amorphophallus, for Tjio (1948) determined the chromosome number of *A. rivieri* as 2n = 39 and a diploid race of this species has also been reported (Olah, 1956).

One further genus studied in *Pythoniëae*, namely *Pseudodracontium* N. E. Br., has a chromosome number of 2n = 26 ($x = 13$) in two accessions of *P. siamense* Gagnep. (Fig. 2/3.)

The tribe is poorly represented at Kew and only two of the eight genera have been studied. Both Hutchinson and Engler consider *Amorphophallus* and *Pseudodracontium* to be closely related and their basic chromosome numbers certainly support this. However, the karyotype of *Pseudodracontium* is divergent from *Amorphophallus* in having a large number of secondary constrictions and what appear to be distal heterochromatic regions.

Discussion

It is difficult to detect intra-tribal chromosome relationships in the tribes described in this paper. *Spathicarpeae* and *Pistiëae* are represented by only one genus each and, of the two larger tribes, *Philodendreae* contains a very miscellaneous collection of basic numbers. $x = 6, 7, 8, 13$ and 15* could be regarded as a basic number series but it would be foolhardy to draw any conclusions while so many genera are as yet unrepresented.

Pistia L. is the sole representative of the tribe *Pistiëae* but it is important in terms of relationships between the *Araceae* and outside families. Taxonomically it is believed to form a link with *Lemnaceae*, which are regarded as being essentially very reduced *Araceae*. Indeed, the chromosomes of *Lemna* L. are very small and comparable with *Pistia* in size if not in uniformity, but they have quite different basic numbers of $x = 10$ and 11 (Blackburn, 1933).

Finally, insofar as the tribe *Pythoniëae* has been studied, there does appear to be some degree of cohesion between the genera *Amorphophallus* ($x = 13$, 14) and *Pseudodracontium* ($x = 13$), though we do not known how well this relationship will hold good when chromosomes of the five other genera are studied.

Acknowledgments

My thanks are due to my colleagues, Miss C. A. Brighton for her assistance and Mr. T. Harwood for photographic illustrations.

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* See footnote on p. 325.

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

Name	Kew Entry No.	Cytology Accession No.	Origin	Chromosome No. (2n)	Basic No. (*x*)	Size S., M. or L. (small, medium or large)	PREVIOUS COUNTS			
							Name	Chromosome No. (2n)	Author	Date
Tribe: **Philodendreae**										
Culcasia near *scandens*	301–68	68.1659	Tanzania, Usambara Mts., *Bogner*	42	7	S	*C. scandens*	32	Delay	1951
,, ,,	170–66	69.104	Ibadan, Forestry Dept., *F.H.I.* 57748	84	7	S	*C. scandens*	c.40	Mangenot & Mangenot	1962
Culcasia sp.	170–66	68.1605	Ibadan, Forestry Dept., *F.H.I.* 57747	84	7	S				
Culcasia sp. No. 00476	52–69	70.74	Tanzania, *Bogner* 250	42	7	S				
Philodendron micans	382–68	69.129	Barbados, *J. Bannochie*	32	8	S				
P. (received as *P. scandens* var. *cuspidatum*)	450–57	69.98	Rochford & Son	32	8	S	*P. cuspidatum*	30	Sharma & Mukhopadyay	1965
P. (received as *P. surinamense*)	273–66	68.1503	Kertje Bot. Gard.	32	8	S				
Syngonium wendlandii	416–57	69.294	Costa Rica, *Birdsey*	24	6, 12 or 13	M				
Syngonium sp. near *vellozianum*	365–64	68.1550	Nicaragua, *C. H. Lankester*	26			*S. vellozianum*	24	Pfitzer	1957
Syngonium sp.*	703–60	68.1549	Equador, *Whitmore* 886	30	15	M				
Tribe: **Spathicarpëae**										
Spathicarpa sagittifolia		63.1681	Brazil	34	17	L	*S. sagittifolia*	34	Pfitzer	1957
Tribe: **Pistiëae**										
Pistia stratiotes	410–63	65.559	Sapony Estate, N. Borneo, *Giles & Wooliams*	28	7	S	*P. stratiotes*	28	Blackburn	1933
Tribe: **Pythoniëae**										
Amorphophallus abyssinicus		65.125	Zambia	26	13	L				
A. bulbifer	300–47	68.1406	India, *McConn*	39	13	L	*A. bulbifer*	36	Chandler	1943
A. campanulatus	446–61	63.1701	India, *Womersley*	28	14	L	*A. campanulatus*	26	Asana & Sutaria	1937
								28	Patel & Narayana	1937
A. gallaënsis	580–53	63.1700	Somalia, *Bally* 9351A	26	13	L	*A. kerrii*	26	Larsen	1969
A. gomboczianus	77–65	65.336	Between Gelib & Brava, Ethiopia, *F. G. Meyer* 9071	26	13	L	*A. longituberosus*	28	Larsen	1969
A. goetzii	478–56	63.1679	Tanzania, Songea, *Milne-Redhead & Taylor* 9998	26(+1f)	13	L				
A. hildebrandtii	719–67	68.1405	Madagascar, *Bogner* 168	26	13	L				
A. maximus	100–67	68.1601	Kenya, Tsavo Nat. Park, *Greenway*	26	13	L				
A. prainii	258–56	63.1707	Schrage	28	14	L				
A. siamensis	8–31	64.283	Siam, *Kerr*	26	13	L				
A. titanum	474–63	69.870	Sumatra, *H. C. DeWit*	26	13	L	*A. titanum*	26	Tjio	1948
Pseudodracontium siamense	414–35	64.1142	Siam, *Collins*	26	13	M				
P. siamense	399–33	62.203	Darjeeling	26	13	M				

*See footnote on page 325.

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Flora of Java.*—The third volume of 'Flora of Java', which completes the publication of this important local tropical flora, is devoted to the monocotyledons. Following the generous policy originally adopted by Backer regarding the inclusion of cultivated and naturalized species, a large number of these occur in this final volume. *Bromeliaceae*, for example, which is not native in Malesia, is represented by 13 genera containing 34 species. The major family in the volume is the *Orchidaceae*, comprising 139 genera. This is provided with an 8-page introduction, which includes a detailed account of the floral morphology of orchids. The account of the '*Poaceae* (*Gramineae*)' includes the bamboos. In the *Zingiberaceae* the interpretation of the inflorescence of some genera is at variance with that of Holttum. As in the previous volumes the final breaks in the key consist virtually of species-descriptions, which are sometimes lengthy and therefore cumbersome to use. The key to the two species of *Globba* consists of the 33-line description of one contrasting with the 24-line description of the other. It would have been helpful if the main contrasting characters had been made to stand out in italics.

There are important notes in the 'Addenda et Corrigenda' which should not be overlooked. Under *Commelinaceae*, *Murdannia*, *Belosynapsis* and *Aclisia*

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* *Flora of Java.* By C. A. Backer & R. C. Bakhuizen van den Brink Jr. Vol. 3. Pp. 761. Wolters-Noordhoff N.V., Groningen, 1968. Price Fl, 90.