CHROMOSOME NUMBERS OF SOME PRIMITIVE ANGIOSPERMS

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ABSTRACT. The chromosome numbers of some primitive Angiosperms are given in Table 1. Those of *Trochodendron aralioides* and *Tetracentron sinense* differ from previous records which placed them in the n = 19 Magnoliaceae series and this is of importance in considering their relationships.

Chromosome numbers have provided interesting information on the interrelationships of primitive Angiosperms belonging to the orders Magnoliales, Laurales and Hamamelidales (Whittaker, 1933, Raven & Khyos, 1965, Ehrendorfer et al. 1968). However, although many species have already been examined cytologically, others are still unknown, and some of the earlier counts should certainly be checked. This note deals with some counts made on plants in cultivation at the Royal Botanic Garden, Edinburgh. Voucher specimens are preserved under the C. numbers quoted in Table I, where authorities are also given.

Chromosome counts were made in propionocarmine squashes of anthers, or in some cases of vegetative buds or root-tips. The counts are summarized in Table I, illustrated in Fig. 1, a-h and Plate 9, and discussed below.

Winteraceae

Two of the species examined, *Drimys lanceolata* and *D. piperita*, belong to the exclusively Old World Section *Tasmannia*, whilst *D. winteri* belongs to the New World section *Drimys*.

The count of 2n = 26 obtained from a female plant of *D. lanceolata* conforms to the n = 13 reported for other members of the section. Similar counts have been recorded in this species by a number of workers (see Table 1) but there are also previous reports of 2n = 28 (Gulline, 1955) and 2n = 38? (Janaki Ammal, 1945). The last count suggests a relationship with the n = 19 of the Magnoliaceae but, as pointed out by Raven & Khyos (1965), is more probably a count of a triploid individual.

D. piperita was grown from seed collected in the field in Papua, New Guinea by the Division of Botany, Department of Forests, Lae, and sent to us by the courtesy of Dr J. S. Womersley. Two plants grown from the same seed collection were available for study, one of which was diploid (2n = 26) and the other tetraploid (2n = 52). The diploid showed regular meiosis with formation of 13 bivalents at MI, but in the tetraploid quadrivalents, trivalents and univalents were common and secondary associations were conspicuous (Plate 9, C). The tetraploid showed other characters typical of a raw autopolyploid: larger flowers (average petal length 13·2 mm as compared to 9·5 mm in the diploid), larger stomata (36 μm long compared to 28 μm) and a high percentage of abortive pollen.

Our count of 2n = 86 in *D. winteri* corresponds to that made by Raven &

TABLE 1

	Cultivated herbarium No.	Chromosome No. Meiotic (PMC)	Mitotic (2n)	Previous Counts	
Winteracaee					
Drimys lanceolata (Poir.) Baill.	C.9492		26 (veg. bud)	$2n = 26$	Hotchkiss, 1955; Smith-White, 1955; Raven & Khyos, 1965
				$2n = 28$	Gulline, 1955
				$2n = 38$?	Janaki Ammal, 1945 (under the synonym *D. aromatica* F. Muell.)
D. piperita Hook.f.	C.7208	13_{II}			
D. piperita	C. 7209	$2n = 52$ (complex meiosis involving multivalent formation)			
D. winteri Forst.	C. 6902	43_{II}		$2n = \pm 72$	Strasburger, 1905
				$2n = \pm 76$,	Whitaker, 1933;
				$MI{:}43_{II}$	Raven & Khyos, 1965
Illiciaceae					
Illicium cauliflorum Merr.	C. 9406	14_{II}	28 (root tip)		
I. henryi Diels	C. 9405		28 (root tip)		
Lardizabalaceae					
Akebia trifoliata Koidz.	C. 9493	16_{II}		$2n = 32$,	Funabiki, 1958
Decaisnea fargesii Franch.	C. 1104	15_{II}		$MI{:}15_{II}$,	Simonet & Miedzyrzecki, 1932
Holboellia angustifolia Wall.			32 (anther tissue)		
Lardizabala biternata Ruiz. & Pav.	C. 4905		28 (veg. bud.)	$2n = 28$,	Langlet, 1928
				$MI{:}14_{II}$,	Tschischow, 1956
Stauntonia hexaphylla Decne.			32 (anther tissue)		
Magnoliaceae					
Michelia figo Spreng.	C. 9494	19_{II}		$2n = 38$,	Janaki Ammal, 1952
				$n = 19$,	Nanda, 1962; Raven, 1962
				(all under	synonym *M. fuscata* Blume)

Eupteleaceae					
Euptelea franchetii van Tiegh.	C. 5316		28 (veg. bud.)		
E. pleisosperma Hook.f. & Thom.	C. 5318		28 (veg. bud)		
Trochodendraceae					
Trochodendron aralioides Sieb. & Zucc.	C. 2601 C. 9496	20_{II} 20_{II}		2n = 38	Whitaker, 1933
Tetracentraceae					
Tetracentron sinense Oliv.	C. 9495		± 48 (veg. bud)	2n = 38,	Whitaker, 1933

Khyos (1965); the same number has been recorded in three other genera of Winteraceae: *Bubbia, Pseudowintera* and *Belliolum* (see Ehrendorfer et al. 1968 for references).

Illiciaceae

Illicium cauliflorum and *I. henryi* both belong to the *Cymbopetalum* section of the genus. *I. cauliflorum* was collected by Mr B. L. Burtt in Sarawak, whilst *I. henryi* is a Chinese species which was obtained from another botanic garden. Counts of 2n = 28 were made in pollen mother cells and root tips (Fig. 1, c & h). Secondary constrictions are very common in the longer chromosomes and the tendency for these to break in the production of root-tip squash preparations often makes chromosome counting difficult. We observed two pairs of telocentric chromosomes in the majority of cells (idiogram, Fig. 1, h), but in some there appeared to be three pairs, perhaps due to excess contraction obscuring centromeres.

The chromosome number agrees with that found by Stone & Freeman, 1968, in *I. parviflorum* Michx. ex Vent., the only other species of *Cymbopetalum* for which chromosomal information is available. The idiograms given by these workers for *I. parviflorum* and *I. floridanum* Ellis show the prevalence of secondary constrictions in these species also. Stone & Freeman also observed telocentric chromosomes: four pairs in *I. parviflorum* (2n = 28) and two pairs in *I. floridanum* (2n = 26).

Lardizabalaceae

Chromosome numbers are recorded for the first time for the genera *Holboellia* and *Stauntonia*; the number 2n = 32 corresponds with that already known for four species of *Akebia* (see Federov, 1969).

The count of 2n = 30 in *Decaisnea fargesii* confirms that made by Simonet & Miedzyrzecki in 1932, and the 2n = 38 observed in the Chilean *Lardizabala biternata* is in accord with previous records.

Eupteleaceae

The counts of 2n = 28 in *Euptelea pleiosperma* Hook. f. & Thoms. and the closely related *E. franchetti* V. Tiegh. correspond to those made in *E. polyandra* Sieb. & Zucc. by Whitaker (1933) and Sugiura (1936).

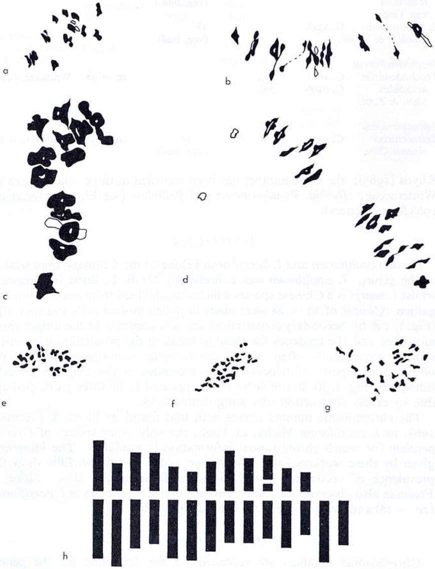

FIG. 1. a-g, camera lucida drawings of squash preparations, × 1200. a, *Akebia trifoliata* PMC, M1, 15_{11} 2_1, the univalents are drawn in outline and are the result of disjunction of a bivalent; b, *Decaisnea fargesii* PMC, M1, 15_{11}, two bivalents are shown in outline to increase the clarity of the figure; c, *Illicium cauliflorum* PMC, M1, 14_{11}, one drawn in outline; d, *Michelia figo*, PMC, 18_{11} 2_1, the univalents are the result of disjunction of a bivalent; e, *Euptelea franchetii*, veg. bud, $2n = 28$; f, *Lardizabala biternata*, veg. bud $2n = 28$; g, *Drimys lanceolata*, veg. bud, $2n = 26$; h, *Illicium cauliflorum*, idiogram × 4,000—most of the secondary constrictions have been omitted since they do not appear constantly in all the figures.

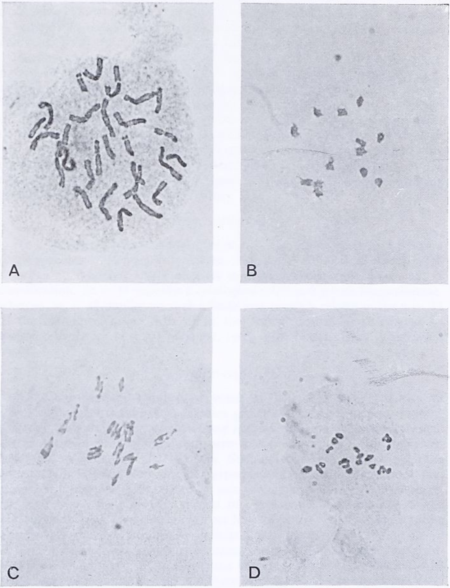

PLATE 9. Squash preparations × 1250. A, *Illicium henryi*, root tip, $2n = 28$; B, *Drimys piperita* C.7208, P.M.C. diakinesis, 13_{II}; C, *Drimys piperita*, C. 7209, MI, $2n = 52$ associated mainly as bivalents but with some multivalents (note quadrivalent on the far left), note also secondary associations (the accurate counts were obtained from TI); D, *Trochodendron aralioides*, PMC, MI, 20_{II}, the largest bivalent is on the left but is lying in such a way that it fails to show its full size.

TROCHODENDRACEAE

Meioses were examined in two plants of *Trochodendron aralioides*, both of which had 2n = 40 associated as 20 bivalents at MI (Plate 9, D). There was a considerable variation in the size of bivalents; one in particular was noted as being conspicuously larger than any of the others and was clearly recognizable in all of the many pollen mother cells examined.

The only previous count made in *Trochodendron* was that of Whitaker, 1933, who recorded the number 2n = 38 as in Magnolias. Whitaker considered therefore that cytology indicated an affinity of *Trochodendron* with Magnoliaceae rather than with *Euptelea* with which it had been associated by Hutchinson (1921). Our count of 2n = 40 clearly vitiates this argument: the number could be derived by dysploid reduction of the hexaploid of an x = 7 series, of which *Euptelea* represented the tetraploid level, just as easily it could be related to the n = 19 of *Magnolia*. In fact the occurrence of one conspicuously large pair of chromosomes suggests that a dysploid involving centric fusion might have taken place.

TETRACENTRACEAE

We obtained a number of counts of 2n = ± 48 from vegetative buds of a single specimen of *Tetracentron sinense*. This count differs from the 2n = 38 recorded by Whitaker and is of some theoretical importance in schemes of classification. 2n = 38 indicates a cytological relationship with Magnoliaceae, whereas 2n = 48 implies no such affinity and possibly relates to the x = 12 of the Hamamelidaceae with which the Tetracentraceae is associated by most modern workers (e.g. Cronquist, 1968; Hutchinson, 1969; Takhtajan, 1969).

DISCUSSION

The chromosome numbers reported in this paper, in common with almost all others recorded in families generally admitted to be primitive, represent polyploid derivatives, if one accepts that the probable ancestral chromosome number of the Angiosperm was n = 7 as suggested by Raven & Khyos, 1965, and by other workers. Such polyploidy has a bearing on the argument of whether the first Angiosperms had a homomorphic multiple-allele self-incompatibility system or not. Whitehouse, 1950, for instance, has maintained that the very success of the Angiosperms was due to the possession of such a system, but others have objected that its absence in the present-day primitive families is a serious flaw in the argument. It should be remembered, however, that the most common and primitive type of multiple-allele, self-incompatibility system is the gametophytic system which breaks down when polyploidy occurs, and therefore we should not expect to find it in these primitive polyploid relict families, even if it characterized their diploid ancestors. The occurrence of dioecious and monoecious systems in Illiciaceae, Lardizabalaceae, Winteraceae, etc. perhaps represents the substitution of other mechanisms to promote outbreeding after the loss of a multiple-allele self-incompatibility system.

The numbers recorded here for *Trochodendron* and *Tetracentron* indicate that n = 19 is not so widespread amongst primitive Angiosperms as previously thought. It would be interesting to check the chromosome number of *Cercidiphyllum*, which has affinities with these genera and was reported as 2n = 38 by Whitaker 1933, but we have so far found the mitotic chromosomes in vegetative buds too small to allow accurate observation.

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