Cytology of *Encephalartos hildebrandtii* A. Br. & Bouche

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With one Plate in the Text

ABSTRACT

The chromosomes of *Encephalartos hildebrandtii* A. Br. & Bouche were studied from root tip cells ($2n=27$), and the plant was found to be a triploid on the basic chromosome number 9. Karyotype analysis has shown that the somatic complement consists of two sets of chromosomes, a diploid set of 18 chromosomes in nine pairs, and a haploid set of 9, and therefore it is suggested that this is an allotriploid.

This is the first report of a polyploid species in the genus *Encephalartos*, and also in the whole of the Cycadales.

THE genus *Encephalartos* comprises 20 species (Bailey, 1942) endemic to the south-eastern Africa. The chromosome numbers of eight species are known so far (Sax and Beal, 1934; Resende, 1940; Resende and Rijo, 1948; Viveiros, 1951, and Berrie, 1959), and the present report deals with the somatic chromosomes in another species—namely, *E. hildebrandtii* A. Br. & Bouche, which has been grown in the botanical garden of the University of Kerala.

For somatic chromosome studies, root tips were fixed in Carnoy's fluid after pretreatment with 8–oxyquinoline and simultaneous cooling in melting ice for two hours. Chromosome preparations were made according to simple acetocarmine squash technique. Twenty-seven chromosomes were observed during mitosis (Plate 1, A and B).

Except for the solitary report of $2n=16$ from sectioned materials of *E. altensteinii* (Sax and Beal, 1934), all counts for other species have given a diploid chromosome number of 18, which indicates that the basic chromosome number in *Encephalartos* is 9. The present species with $2n=27$ is thus a triploid based on this number. As far as we know this is the first report of a polyploid species in the genus *Encephalartos*, and also in the whole of the Cycadales.

A critical examination of the karyotype has shown that the 27 chromosomes of the somatic complement could be sorted out into two sets, 18 chromosomes constituting a diploid set of nine pairs, and the remaining nine chromosomes forming a haploid set (see Table 1 and Fig. 1). In the diploid set the chromosomes range from 11 to 16 μ in length and in the haploid set they vary in length from 11 to 23 μ. In other morphological characters of the chromosomes, like the position of centromeres, also there is some difference between the members of the two sets. In the diploid set, two pairs of chromosomes

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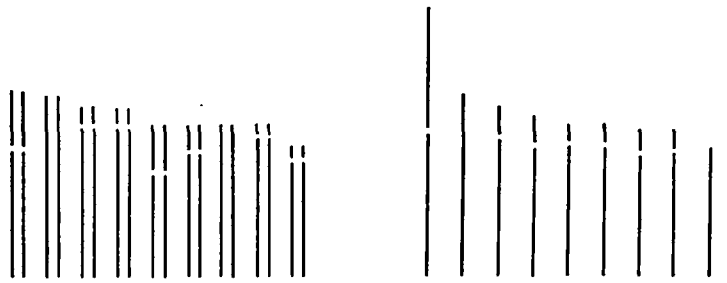


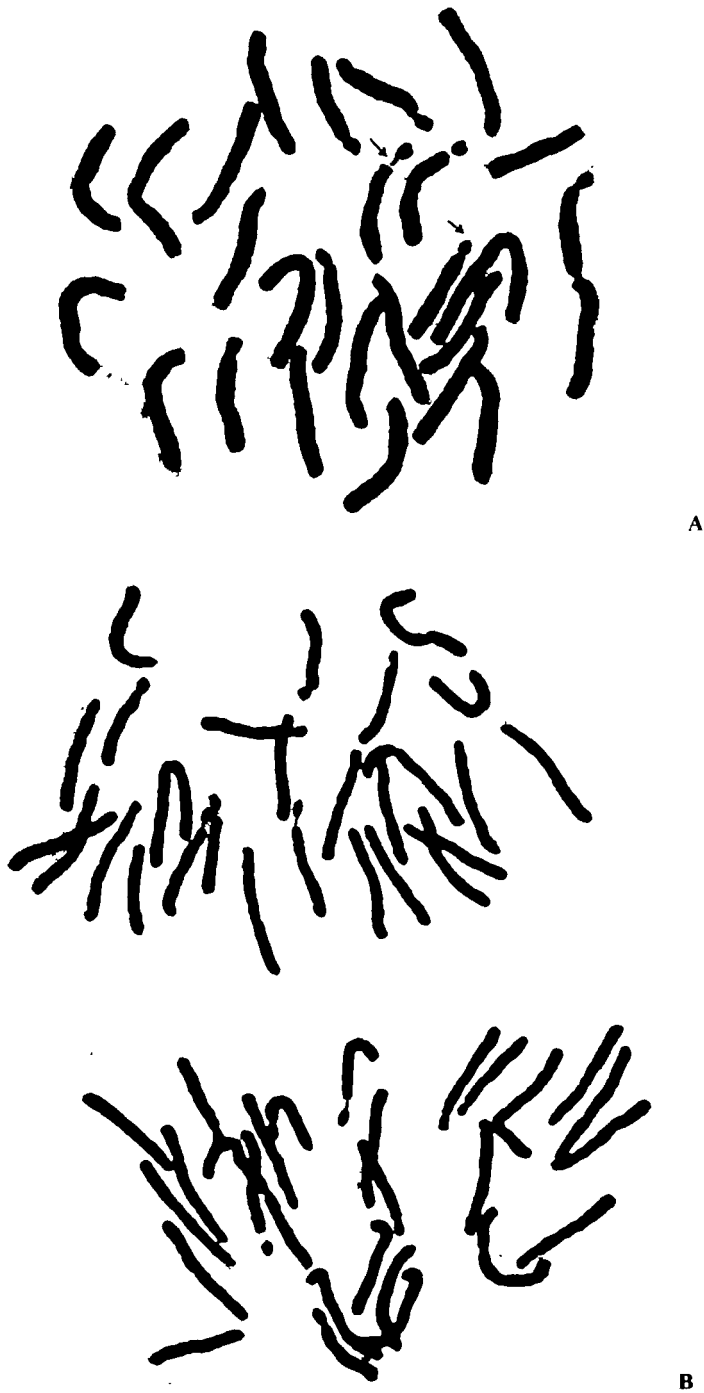
FIG. 1. Diagrammatic representation of the 27 somatic chromosomes. These can be sorted out as nine pairs constituting a diploid set and nine others not similar to these morphologically and making up a separate haploid set.

TABLE 1

Karyotype analysis in E. hildebrandtii *A. Br. & Bouche*

Chromosomes	Length of arm in μ		Total length in μ	Index	Centromere
	Short arm	Long arm			
DIPLOID SET					
I	5·00	11·00	16·0	0·45	sm
II	..	15·50	15·5	..	t
III	1·50	13·00	14·5	0·12	st
IV	1·50	13·00	14·5	0·12	st
V	4·00	9·00	13·0	0·44	sm
VI	2·25	10·75	13·0	0·21	st
VII	..	13·00	13·0	..	t
VIII	1·00	12·00	13·0	0·08	st
IX	1·50	9·50	11·0	0·16	st
HAPLOID SET					
1	10·50	12·50	23·0	0·84	sm
2	..	15·50	15·5	..	t
3	2·50	12·00	14·5	0·21	st
4	2·25	11·25	13·5	0·20	st
5	1·50	11·50	13·0	0·30	st
6	1·75	11·25	13·0	0·16	st
7	2·00	10·50	12·5	0·19	st
8	1·75	10·75	12·5	0·17	st
9	..	11·00	11·0	..	t

have submedian, five pairs have sub-terminal, and the remaining two pairs have apparently terminal centromeres. However, in the haploid set only one chromosome, the largest, shows sub-median constriction, and out of the remaining eight chromosomes six have sub-terminal and two have terminal centromeres. One of the chromosomes in the diploid set (arrow marked chromosome at 12 o'clock in Plate 1A) shows a small heterochromatic segment near the centromere region, and possibly this is associated with nucleolus organization. It may be that in this chromosome the centromere and the secondary constriction region are separated by a small heterochromatic



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segment, as a result of which the two appear as a single continuous gap. In the haploid set, however, one of the chromosomes (arrow marked one at 3 o'clock in Plate 1A) shows a small strip of heterochromatin at the end of its small arm, and this is possibly the region which functions as the nucleolus organizer in this set.

The chromosome situation and features of the karyotype described above reveal that the present material of *E. hildebrandtii* is an allotriploid. Possibly this triploid might have arisen as a result of hybridization between a tetraploid and a diploid species, but in the absence of report of any tetraploids so far in the genus it cannot be decided whether the triploid has arisen in this way. It is equally possible that the triploid may have originated by the union of an unreduced and a normal gamete respectively of two related species, the triploid individual so formed being maintained by a vegetative mode of reproduction through suckers.

Literature Cited

Bailey, L. H., 1942. *The Standard Cyclopedia of Horticulture*, vol. 1, p. 1113, Macmillan, New York.

Berrie, G. K., 1959. Mitosis in the microspore of *Encephalartos barteri* Carruth. *Nature, Lond.* **183**, 834–5.

Khoshoo, T. N., 1961. Chromosome numbers in Gymnosperms. *Silvae Genet.* **10**, 1.

Resende, F., 1940. *Chromosoma* **1**, 436. *Vide* Resende & Rijo (1948).

—— and Rijo, L., 1948. Structure of chromosomes as observed in root tips. V. Oliathero chromatin, chromatic agglutination and mutations. *Port. Acta. biol.* **2**, 117–48.

Sax, K., and Beal, J. M., 1934. Chromosomes of Cycadales. *J. Arnold Arbor.* **15**, 255–62.

Viveiros, A., 1951. *Revta Fac. Cienc. Univ. Lisb.* C **1**, 215. *Vide* Khoshoo, T. N. (1961).

Explanation of Plate

Plates A and B. Root tip squashes of *Encephalartos hildebrandtii* A. Br. & Bouche ×1,400.

A. Metaphase of mitosis showing 27 chromosomes.

B. Anaphase showing 27 daughter chromosomes each at the two poles.