A STUDY OF SOMATIC CHROMOSOME COMPLEMENTS OF TALL AND DWARF COCONUTS (*COCOS NUCIFERA* L.) AND ITS BEARING ON INTERVARIETAL VARIATION AND EVOLUTION IN COCONUTS

T. G. RAVEENDRANATH AND C. A. NINAN

Department of Botany, University of Kerala, Kariavattom, Trivandrum, Kerala, India.

ABSTRACT

A comparison of the somatic chromosome complements of West Coast Tall, Chowghat Dwarf Green, and Chowghat Dwarf Orange coconuts has been made. The chromosome number in all these varieties is $2n = 32$. There is considerable similarity in karyotypic features among the three varieties. The karyotype of the W. C. Tall is seen to be more asymmetric with four submedian and twelve median chromosomes and that of the Dwarf Green least asymmetric with one submedian chromosome and 15 median chromosomes. Total chromatin content is also more in Dwarf Green than in Tall. Though the above observations indicate that the Dwarfs are less specialised than Talls, evidences from morphology, breeding system, and meiotic behaviour support the derivation of Dwarfs from Talls.

Consistent karyological features distinguishing Talls and Dwarfs were also seen. Thus in Talls, as also in Spicata (which is phenotypically a Tall), a secondary constriction was seen on the long arm of the 6th chromosome. In both Dwarf Green and Orange, a secondary constriction on the long arm of the 3rd chromosome was invariably present. The need for further studies on the karyotypes of different geographic races of Talls and Dwarfs is stressed.

INTRODUCTION

THE important varieties of coconuts occurring in India are West Coast Tall, Chowghat Dwarf Orange, and Chowghat Dwarf Green. The Tall coconuts are complete out-breeders while the Dwarfs are predominant selfers with some degree of out-crossing. Among the two Dwarf varieties mentioned above, Dwarf Green is believed to be more pure, the degree of out-crossing being about 5%, whereas Dwarf Orange shows adaptation for about 20% out-crossing (Rao and Koyamu, 1955).

The Dwarfs are considered by many to have been derived from the Talls. Some are of the view that they are of mutant origin (Handover, 1919; Anonymous, 1921; Jack and Sands, 1922; Dwyer, 1938), while others consider them to have originated by progressive inbreeding from the Talls (Swaminathan and Nambiar, 1961). Evidences on morphology, breeding system, and meiotic behaviour of the Talls and Dwarfs, no doubt, support an origin of the Dwarfs from ancestral Talls, but the exact mode of their origin is not yet clearly understood. Detailed studies of the somatic complements of these varieties were, therefore, taken up to see whether there are observable karyotypic differences between Talls and Dwarfs and the results are presented in this paper.

MATERIAL AND METHODS

The materials for the present study were collected from palms growing in the experimental farm of the Department of Botany, Kerala University. Somatic chromosome studies of all the varieties were made from embryos obtained from six months old tender nuts using acetocarmine squash technique. For karyotype analysis five metaphase cells with well spread chromosomes

were selected from each variety. Measurements of chromosomes were made from prints enlarged 3000 times and they were converted into relative lengths (the length of each chromosome expressed as a percentage of the total chromatin length of the complement). The arm ratio was determined for each chromosome following Levan *et al.* (1964). The chromosomes were numbered from 1 to 16 serially in descending order of length.

OBSERVATIONS

West Coast Tall

Somatic chromosome preparations of this variety from embryo squashes showed 32 chromosomes in all the cells (Fig. 1). The length of individual chromosomes varied from 1·67 μ to 4·33 μ. Out of the 16 pairs, 12 pairs showed median primary constrictions and the remaining 4 pairs had submedian constrictions. The long arm of the 6th pair showed a secondary constriction in all preparations. The length of the segment beyond the secondary constriction was 0·50 μ. In addition to this, secondary constrictions were present either in one or the other of the following pairs in different embryos: long arm of the 1st pair, long arm of the 2nd pair, and short arm of the 12th pair. None of the embryos showed more than two secondary constrictions including that on the 6th pair. Details of the karyotype of this variety are presented in Table I.

Chowghat Dwarf Orange

Embryo squash preparations showed $2n = 32$ chromosomes (Fig. 2). The length of the chromosomes varied from 1·42 μ to 3·50 μ. Out of the 16 pairs of chromosomes, 13 pairs showed median constrictions and the remaining 3 pairs had submedian constrictions. Secondary constriction was invariably present

TABLE I

Details of the karyotypes of the West Coast Tall, Chowghat Dwarf Orange, and Chowghat Dwarf Green coconuts

Chromosome No.	Chromosome length in μ			Relative length			Arm ratio LA/SA*			Centromeric position		
	WCT	CDO	CDG	WCT	CDO	CDG	WCT	CDO	CDG	WCT	CDO	CDG
1	4·33	3·50	4·84	9·13	9·59	8·84	1·36	1·63	1·26	m	m	m
2	3·67	3·00	4·31	7·74	7·95	7·87	2·13	1·77	1·81	sm	sm	sm
3	3·59	2·33 +0·67	3·46 +0·67	7·56	7·95	7·54	1·53	1·15	1·26	m	m	m
4	3·50	2·84	4·07	7·38	7·53	7·43	2·24	1·42	1·54	sm	m	m
5	3·50	2·75	3·94	7·38	7·29	7·19	1·63	1·35	1·50	m	m	m
6	3·50 +0·50	2·58	3·77	7·38	6·84	6·88	1·11	1·38	1·40	m	m	m
7	3·25	2·41	3·57	6·85	6·39	6·51	2·00	1·90	1·27	sm	sm	m
8	3·00	2·25	3·47	6·32	5·96	6·33	1·26	1·08	1·21	m	m	m
9	2·92	2·25	3·43	6·15	5·96	6·26	1·34	1·08	1·25	m	m	m
10	2·67	2·25	3·23	5·63	5·96	5·89	1·28	1·08	1·15	m	m	m
11	2·59	2·17	3·17	5·46	5·75	5·78	1·21	1·17	1·59	m	m	m
12	2·58	2·09	2·93	5·43	5·53	5·34	1·58	2·11	1·59	m	sm	m
13	2·50	1·91	2·93	5·26	5·06	5·34	1·50	1·30	1·59	m	m	m
14	2·33	1·67	2·43	4·91	4·42	4·43	1·80	1·49	1·35	sm	m	m
15	1·83	1·58	2·30	3·86	4·19	4·20	1·44	1·10	1·23	m	m	m
16	1·67	1·42	2·20	3·51	3·76	4·01	1·50	1·11	1·13	m	m	m

WCT—West Coast Tall CDO—Chowghat Dwarf Orange CDG—Chowghat Dwarf Green

* Long Arm/Short Arm

in the long arm of the 3rd pair, the size of the segment beyond the constriction being 0·67 μ. The secondary constriction in the long arm of the 6th pair, a characteristic of the Talls, was absent in this variety. Details of the karyotype are shown in Table I.

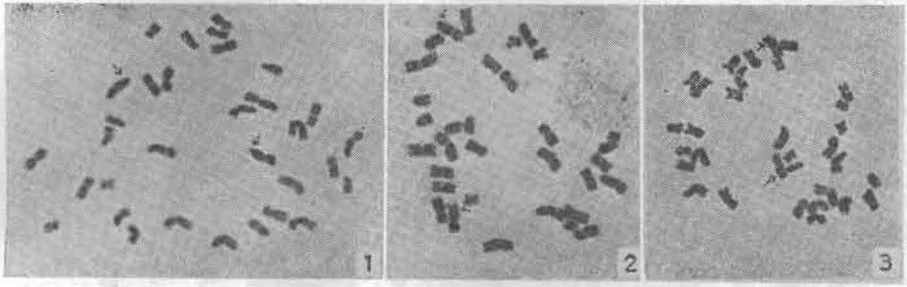
Chowghat Dwarf Green

This variety also showed $2n = 32$ chromosomes (Fig. 3). The length of the chromosomes ranged from 2·20 μ to 4·84 μ. Fifteen out of the 16 pairs of chromosomes were median and one pair was submedian. As in the case of Dwarf Orange, a secondary constriction was invariably present in the long arm of the 3rd chromosome pair in all the cells examined, the length of the chromosome segment beyond the constriction being 0·67 μ. In addition to this, some embryos showed secondary constrictions on the long arm of the 6th pair also. Details of the karyotype of this variety are presented in Table I.

3·76 to 9·11. During the present study, it has been found that in this variety, the relative lengths of chromosomes of embryo cells varied from 3·51 to 9·13. Data on relative chromosome lengths of this variety are not available in the report of Sharma and Sarkar (1956), but comparison of data from the Tall variety palms studied at Kasaragod (Nambiar and Swaminathan. 1960) and Trivandrum reveals essential uniformity in relative chromosome lengths from root tip and embryo cells of the West Coast Tall variety palms from these two locations.

Comparison of gross features of the chromosome complements of the West Coast Tall and Dwarf varieties reveals certain interesting facts. They all share the identical chromosome number of $2n = 32$. In all the three varieties, there is a preponderance of chromosomes with median constriction (Fig. 4 *a*, *b*, *c*). There is, thus, a good deal of similarity in karyotypic features in the three varieties. This is brought out in Fig. 5*a*.

Examination of Fig. 5*a* also reveals the



FIGS. 1–3. Somatic chromosomes of *Cocos nucifera* L. All figures, ×1,125. Fig. 1. A somatic cell from an embryo of the West Coast Tall variety showing 32 chromosomes. Fig. 2. A cell from an embryo of Chowghat Dwarf Orange showing 32 chromosomes. Fig. 3. An embryo cell of Chowghat Dwarf Green showing $2n = 32$ chromosomes.

DISCUSSION

The somatic chromosome number ($2n = 32$) and details of karyotype of the Tall variety of coconuts (*Cocos nucifera* L. var. *typica*) have been reported earlier (Sharma and Sarkar, 1956; Nambiar and Swaminathan, 1960). While these reports are based on observations of root tip squashes, the present study has been made from embryo squashes.

According to Nambiar and Swaminathan (1960), the relative lengths of chromosomes from root tip cells of the Tall variety palms at Kasaragod studied by them ranged from

close karyotypic similarity of Dwarf Green and Orange, and, at the same time, brings out the minor variations between the Talls and Dwarfs. In the West Coast Talls, thus, chromosomes 2, 4, 7, and 14 are submedian and the rest median. In Dwarf Orange, chromosomes 2, 7, and 12 are submedian and the others are median. In Dwarf Green, however, only the 2nd pair is submedian, all the others being median. It is known (Stebbins, 1950) that in many higher plants, karyotypic evolution has been from complete symmetry to asymmetry. Considered from this angle, West Coast Talls show more

evolved karyotype than those of Dwarf Orange and Dwarf Green. The total chromatin content is also more in Dwarf Green than in West Coast Tall (Fig. 5*b*). Sharma and Sarkar (1956) have also found that total chromatin content in the chromosome complement is more in wild species of palms than in cultivated ones. Among the three varieties, the Dwarf Green, thus, appears to be the most primitive.

The Dwarf coconuts have, by a consensus of opinion, been considered to have arisen from ancestral tall palms (Anonymous, 1921; Ninan and Satyabalan, 1964; Swaminathan and Nambiar, 1961). Reduction, fusion, and change in symmetry are the three types of karyomorphological changes taking place during the evolutionary specialisation in vascular plants (Stebbins, 1950) and the overall reduction in phenotypic features in the Dwarf coconuts, such as the plant height, longevity, size of vegetative organs, fruits, seeds, etc., as compared to the Talls, shows that they are, no doubt, more specialised. This is also accompanied by a change in the genetic system from cross-fertilization in Talls to almost complete self-fertilization in some Dwarfs. And, self-fertilizers are known to have been "victims

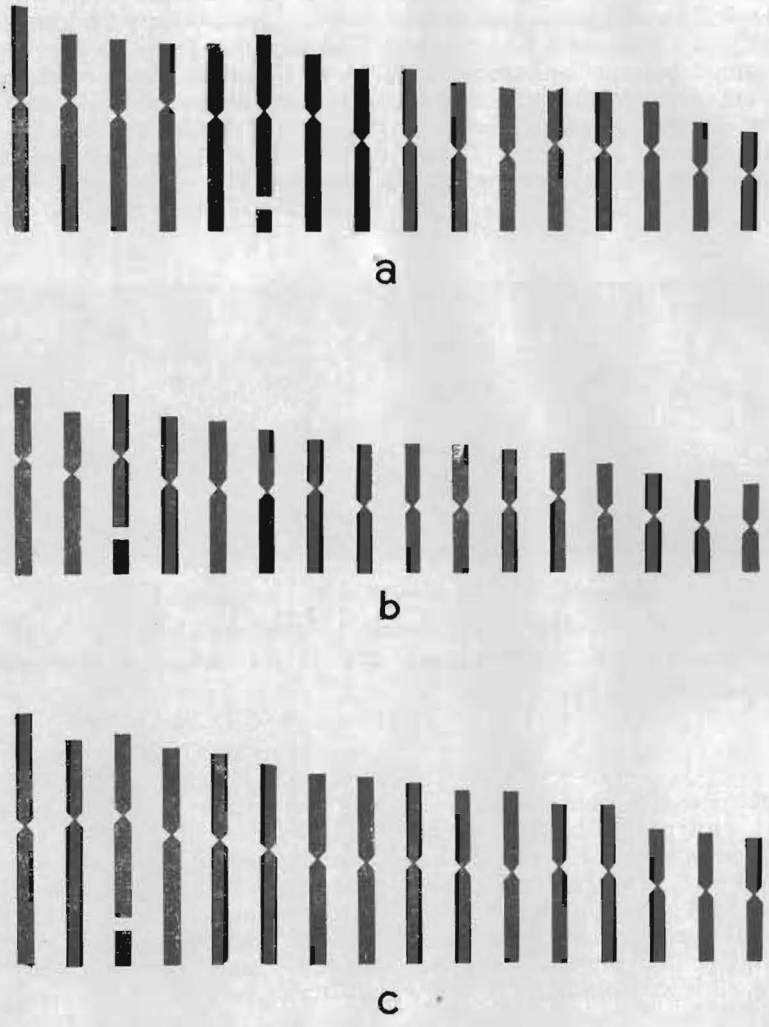


FIG. 4. Idiograms of *Cocos nucifera* L. (*a*) West Coast Tall; (*b*) Chowghat Dwarf Orange; (*c*) Chowghat Dwarf Green.

of an unlucky accident" having almost always arisen from cross-fertilizing ancestors (Stebbins, 1957). The Dwarfs also show less stable meiosis than Talls, and it has been proposed that ancestral types show more stable meiosis (Lindquist, 1960). These points contribute further to the view that the Dwarfs are derived from Tall palms; but data on karyological features discussed above do not support this view. Hence, critical studies on the karyotypes of the different races of Dwarfs would be of help in tracing their mode of origin.

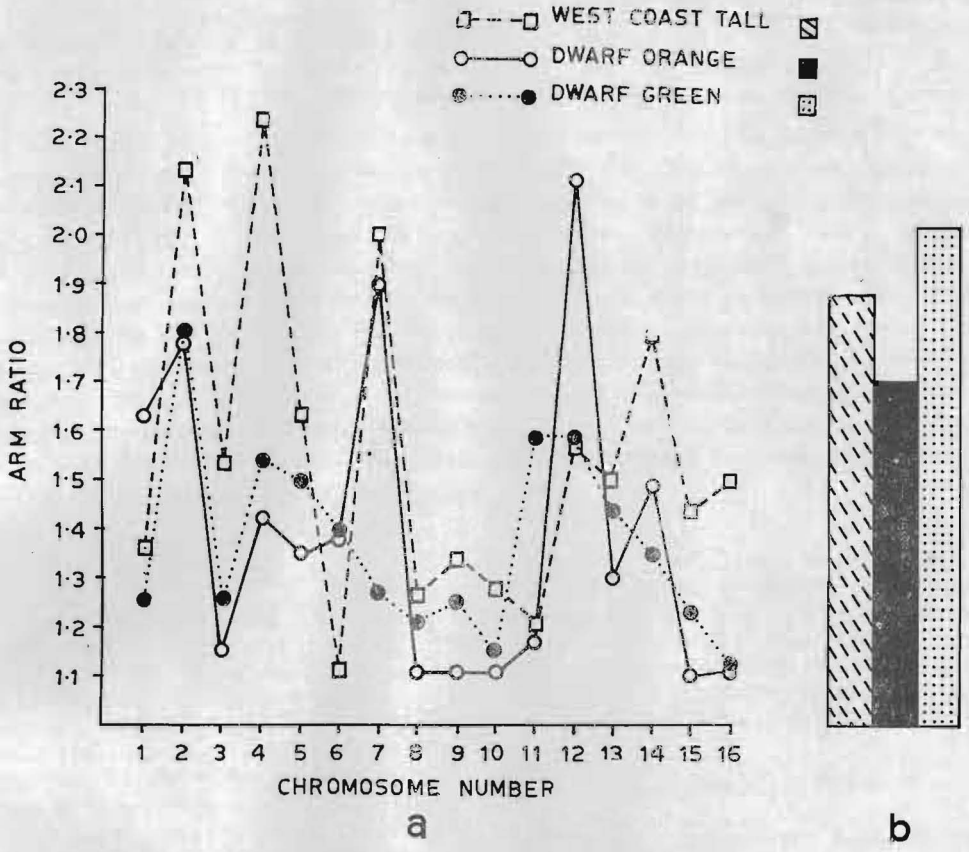


FIG. 5. (*a*) Graph showing comparison of karyotypic features in West Coast Tall, Dwarf Orange and Dwarf Green coconuts. (*b*) Histogram showing total chromatin content in the West Coast Tall, Dwarf Orange and Dwarf Green coconuts.

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