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Cytogenetic studies in the Genus Cocos —

I. Chromosome number in *C. australis* and *C. nucifera* L. vars. *spicata* and *androgena*

? (identification?)

By

C. A. NINAN, R. V. PILLAI AND JOSY JOSEPH
Central Coconut, Research Station, Kasaragod

INTRODUCTION

THE family Palmae comprises a large group of palms of which 1100 species are recorded, distributed in 131 genera (Blatter, 1926). Despite the economic importance of genera like *Cocos*, *Areca*, *Borassus*, *Elaeis*, *Phoenix*, etc., very little work has been published on the cytology of this family and our knowledge of chromosome numbers is limited to 72 species (Sharma and Sarkar, 1956).

Cocos nucifera L. belonging to the tribe *Cocoineae* (Hutchinson, 1934) is one of the most important species from an economic point of view. In countries like India, Ceylon and Philippines, where it is cultivated as a major crop, it constitutes the general economic basis, in addition to providing many essential and accessory domestic materials. In spite of these, improvement work on this crop has not received adequate attention at the hands of scientific plant breeders, for the obvious reason that, unlike many other crop plants in which generations are much shorter, it is a perennial crop presenting unique breeding problems. The application of modern cytogenetic principles to the theory and methodology of coconut breeding has not so far been possible. There is even deplorable lack of fundamental cytological knowledge in *C. nucifera* L. and related species.

Santos (1928) was the first to report the haploid number of $n=16$ in Philippine materials of *Cocos nucifera* L. Confirmatory evidences of chromosome number have also been obtained in Indian materials of this species from different localities (Janaki Ammal, 1945; Venkatasubban, 1945; Sharma and Sarkar, 1956 and Abraham *et al*, 1960). Sharma and Sarkar (loc. cit.) have also reported the same number in *C. schizophylla* Mart. The present study embodies results of observations on *C. australis* Mart. and *C. nucifera* L. varieties *spicata* and *androgena*.

MATERIALS AND METHODS

Besides *Cocos nucifera* L., other species of this genus like *C. plumosa*, *C. australis*, *C. schizophylla*, *C. coronata*, *C. campestris* and *C. butyracea* are grown in the Central Coconut Research Station, Kasaragod, of which meiotic materials of *C. australis* alone were available for study. Somatic chromosome studies of these species are in progress and will be reported elsewhere. A few palms each of *C. nucifera* L. vars. *spicata* and *androgena* (male tree) are also available in this Station from which male flowers were obtained for study. In all varieties of *C. nucifera* studied, stages of meiosis could be obtained in the third inflorescence from the one that has opened, while in *C. australis* the fourth inflorescence from the fully opened one shows meiosis. Both the species are easy cytological materials and respond well to simple acetocarmine technique. The cytological and photographic techniques followed were similar to those described earlier (Ninan, 1955).

CYTOLOGICAL OBSERVATIONS

(1) *Cocos australis* Mart.

The cytology of this species has not so far been studied. Examination of pollen mother cells showed 15 bivalents during meiosis (Pl. I, fig. 1). The bivalents are all of the rod type and one of them shows a tendency for precocious separation. Anaphase separation in most cells is normal and 15 chromosomes could be seen moving to opposite poles (Pl. I, fig.3). Some pollen mother cells, however, show unequal separation, i. e. 14 and 16 chromosomes to opposite poles, lagging, formation of hexads, micronuclei, etc., resulting in pollen sterility.

(2) *C. nucifera* L. var. *spicata*

This variety differs from the omnibus variety *typica* only in the nature of the inflorescence. While the inflorescence in the *typica* palms is branched, that in *spicata* is unbranched and the flowers are arranged on the fleshy peduncle. The female flowers outnumber the male flowers which are mostly concentrated towards the top of the peduncle (see Pl. II, figs, 6 and 8).

This variety is of special cytogenetic interest in that upon open-pollination, *spicata* and *typica* progenies segregate in 1:1 ratio. This peculiar breeding behaviour of *spicata* palms has not so far been adequately explained though Prof. Haldane (1958) has suggested that the available evidence is compatible with the view that *spicata* is dominant over the normal (*typica*).

Examination of pollen mother cells from two *spicata* palms showed 16 bivalents during meiosis (Pl. I, fig. 2). Three bivalents are markedly larger than the others. Most of the bivalents are of the rod type. While regular formation of 16 bivalents is observed only rarely, most pollen

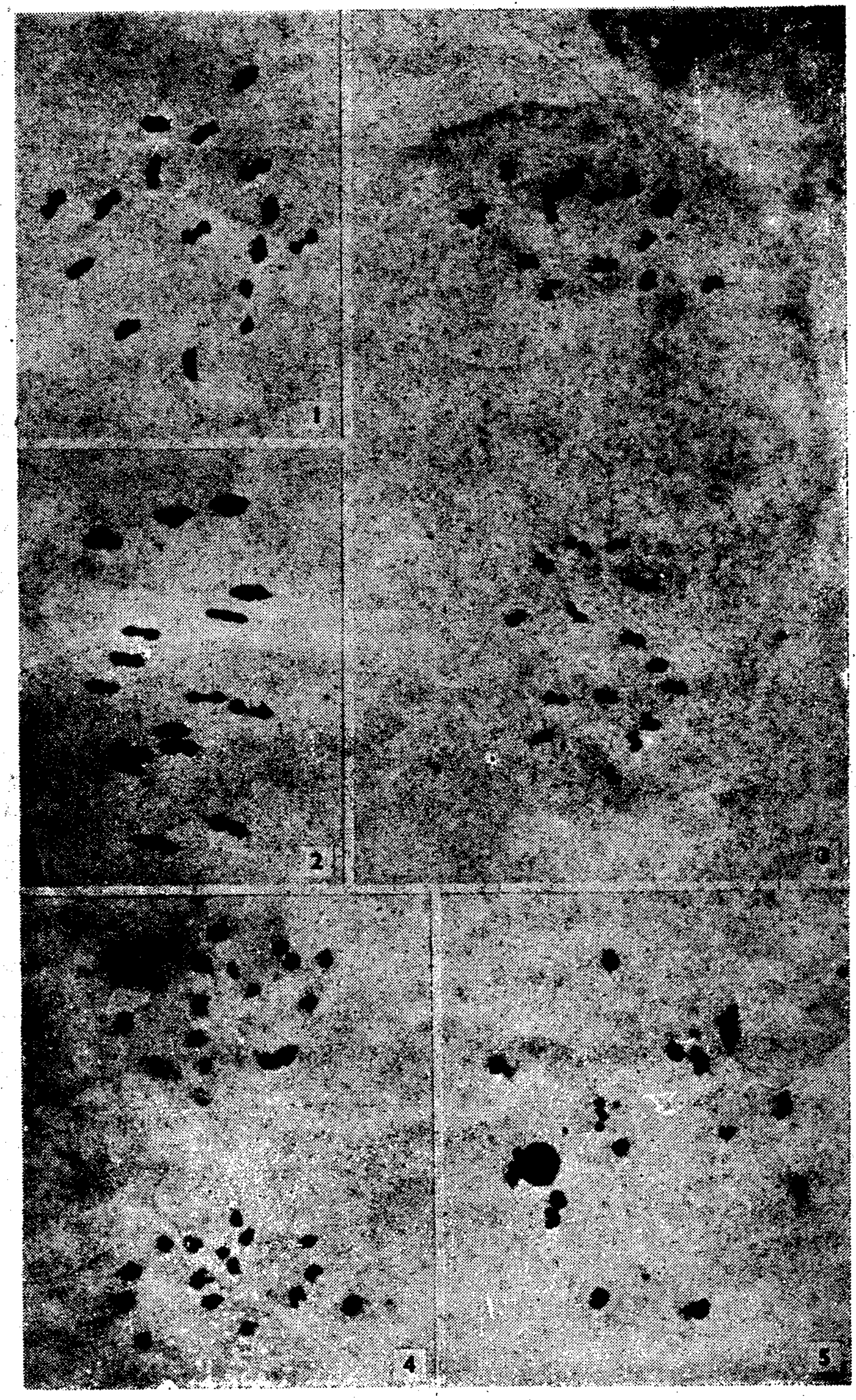

PLATE I

Explanation of figures given with the text

PLATE II

(From John & Narayana, 1942)
Explanation of figure given with the text

mother cells show associations of varying numbers of chromosomes, mostly groups of four, clearly indicating heterozygous translocations. Since the main intention of this paper is to report the chromosome number in this variety, details regarding structural hybridity and its bearing on the peculiar breeding behaviour of the *spicata* palms will be discussed in a later communication. Anaphase separation in cells with complete bivalent formations is regular and 16 chromosomes are seen moving to opposite poles (Pl. I, fig. 4). Meiotic irregularities including lagging of chromosomes, non-disjunction, unequal separation, formation of pentads, micronuclei, etc., have also been observed in this variety. Pollen sterility in the *spicata* palms studied is 10-15 per cent. while in the *typica* palms it is 3-5 per cent.

C. nucifera var. *androgena*

The inflorescence of this variety, otherwise known as the male coconut palm is illustrated in Pl. II, fig. 7. It is more robust than that of the ordinary tall variety and the spikes show secondary branching. The number of spikes in a male inflorescence varies from 200 to 350 as against 25-40 in the ordinary type and the number of male flowers in the former is nearly double that in the latter (John and Narayana, 1942).

Cytological examination showed 16 bivalents in most pollen mother cells (Pl. I, fig. 5) while a few others showed only 15 bivalents.

DISCUSSION

The purpose of the present note is to record chromosome numbers in *C. australis* Mart. and *C. nucifera* L. vars. *spicata* and *androgena*, of which there is no previous data. From the standpoint of chromosome numbers within the genus *Cocos*, the present observation of $n=15$ in *C. australis* as against $n=16$ in *C. nucifera* and *C. schizophylla* is very interesting in that the haploid number $n=15$ is a new number for the genus as also for the family Palmae. A perusal of chromosome numbers in the family Palmae (Sharma and Sarkar, loc. cit.) shows that the various species so far studied conform to cytological types with $n=18$, 16, 14, 13, 12 and 8, of which the numbers 16 and 18 predominate. The present observation of $n=15$ adds a new number to the list. In view of the presence of $n=16$ in *C. nucifera* and *C. schizophylla* and other genera of the tribe *Cocoineae*, so far studied (see Table below), it is reasonable to assume that $n=15$ in *C. australis* might have been derived by aneuploidy from ancestral types with $n=16$. If so, this provides a clear instance of numerical alterations of chromosomes playing a distinct role in speciation within the genus *Cocos*, as also in the tribe Cocoineae, which has so far been regarded as an instance of homogeneity in evolution (Sharma and Sarkar, loc. cit.). Similar instances are also provided by genera like *Licuala* ($n=18$ in *L. grandis* and $n=14$ in *L. peltata*) and *Arenga* ($n=13$ in *A. pinnata* and $n=16$ in *A. engleri*) (Darlington and Wylie, 1955).

TABLE 1

List of chromosome numbers in the tribe Cocoineae

Species	Chromosome number n	2n	Author
1. *Martinezia caryotaefolia*	—	32	Venkatasubban, 1945.
2. *M. erosa*	—	32	Sharma & Sarkar, 1956.
3. *Elaeis guineensis*	16	32	Janaki Ammal, 1945. Venkatasubban, 1945. Sharma & Sarkar, 1956.
4. *Cocos nucifera* var. *typica*	16	32	Santos, 1928. Janaki Ammal, 1945. Sharma & Sarkar, 1956. Abraham *et al*, 1960.
var. *androgena*	16	—	Present study
var. *spicata*	16	—	do
var. *nana*	16	—	do
5. *C. schizophylla*	16	32	Venkatasubban, 1945. Sharma & Sarkar, 1956.
6. *C. australis*	15	—	Present study.
7. *Attalea cohune*	—	32	Sharma & Sarkar, 1956.
8. *Butia capitata*	16	32	Janaki Ammal, 1945.
9. *Arecastrum romanzoffiana*	16	32	do

The chromosome number $n=16$ in *Cocos nucifera* does not appear to be a primitive one. Evidences have already been pointed out to show that this number might have been derived by allopolyploidy from an ancestral complement of 8 chromosomes (Sharma and Sarkar, 1956; Abraham *et al.* 1960), the regular bivalent formation in all species so far studied and the presence of $n=8$ in related species supporting this view.

Considering chromosome number and behaviour in the different varieties of *Cocos nucifera*, it is seen that while varieties like *typica*, *spicata*, *androgena* and *nana* (dwarf) exhibit the same haploid number, i. e. $n=16$, evidences of other peculiarities like translocation heterozygosity in *spicata* observed in the present study and 'chromosome mosaics' and inversions in *nana* (Nambiar and Swaminathan, 1960; Ninan and Ratnam, unpublished) point to the role played by structural chromosome alterations in inter-varietal evolution of the species. These aspects will be discussed in detail elsewhere.

SUMMARY

Chromosome numbers in *Cocos australis* Mart. (n = 15) and *C. nucifera* L. varieties *spicata* (n = 16) and *androgena* (n = 16) are reported for the first time. The haploid number n = 15 in *C. australis* is a new number for the genus as also for the family Palmae and is believed to be an aneuploid derivative of n = 16. Though the tribe Cocoineae of Palmae has been regarded as an instance of homogeneity in evolution, the present observation of n = 15 in *C. australis* shows that numerical alterations of chromosomes have also played a role in evolution within the tribe.

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CYTOGENETIC STUDIES IN THE GENUS COCOS — 1. CHROMOSOME NUMBER IN *C. AUSTRALIS* AND *C. NUCIFERA* L. VARS. *SPICATA* AND *ANDROGENA*

EXPLANATION OF FIGURES

Plate I

Fig. 1. Meiotic metaphase in *C. australis* Mart showing 15 bivalents in a pollen mother cell. Note the tendency for precocious separation in one of the bivalent chromosomes × 1500

Fig. 2 The same stage in a pollen mother cell of *C. nucifera* var. *spicata*, 16 bivalents can be clearly counted × 1500.

Fig. 3. Anaphase I in *C. australis*. 15 chromosomes each can be clearly seen at either pole. × 1500.

Fig. 4. The same stage in *C. nucifera* var. *spicata* showing 16 chromosomes separating to opposite poles × 1500.

Fig. 5. Diakinesis in *C. nucifera* var. *androgena* $n = 16$. Note the prominent nucleolus. × 1500.

Plate II

Fig. 6. An inflorescence of *C. nucifera* var. *typica* × 1/14.

Fig. 7. Inflorescence of the male coconut tree × 1/14.

Fig. 8. The unbranched inflorescence of a *spicata* palm × 1/14.