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## POLLEN GRAINS OF *COCOS NUCIFERA* LINN.

BY

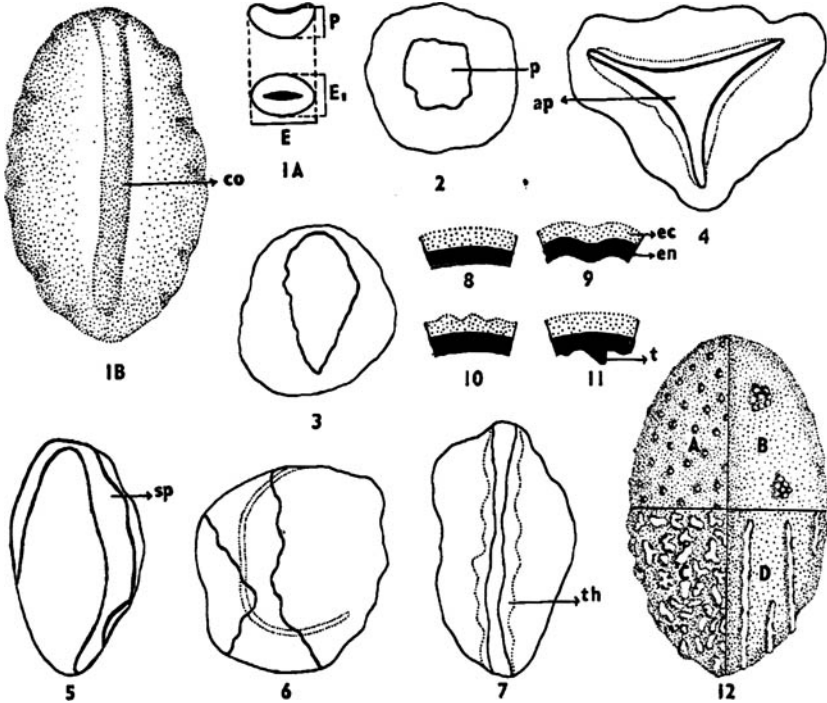
P. K. K. NAIR and MITHILESH SHARMA

The study of pollen grains of cultivated plants has attained great importance in recent years due to its effective application in interpretations of the taxonomy and inter-relationships of cultivated varieties. In the cultivated plants, variations in pollen are a common fact and such variations vary with the different species. Pollen study of the varieties of *Canna* (3), *Bougainvillea*, *Hibiscus* and *Euphorbia pulcherrima* (6), and also of some cereal grasses (7) has shown the frequency of pollen variations in the different varieties to be an index with which to interpret the taxonomy of the plants.

The present investigation deals with the pollen morphology of eight varieties of *Cocos nucifera*, collected from plants growing in the Experimental Farm of the Central Coconut Research Station, Kayamgulam, Allepy District, Kerala State (India). In making the pollen preparations, the acetolysed (treated with a mixture of 9 parts acetic anhydride and 1 part conc.  $H_2SO_4$ ) and unacetolysed grains stained by safranin were combined in the same slide (4). In taking the percentage of sterility, only the unacetolysed grains, devoid of protoplasm were considered. The terminology used in the pollen descriptions is that used by Nair (5). In taking size measurements (Fig. 1 A) at least 10 grains were considered.

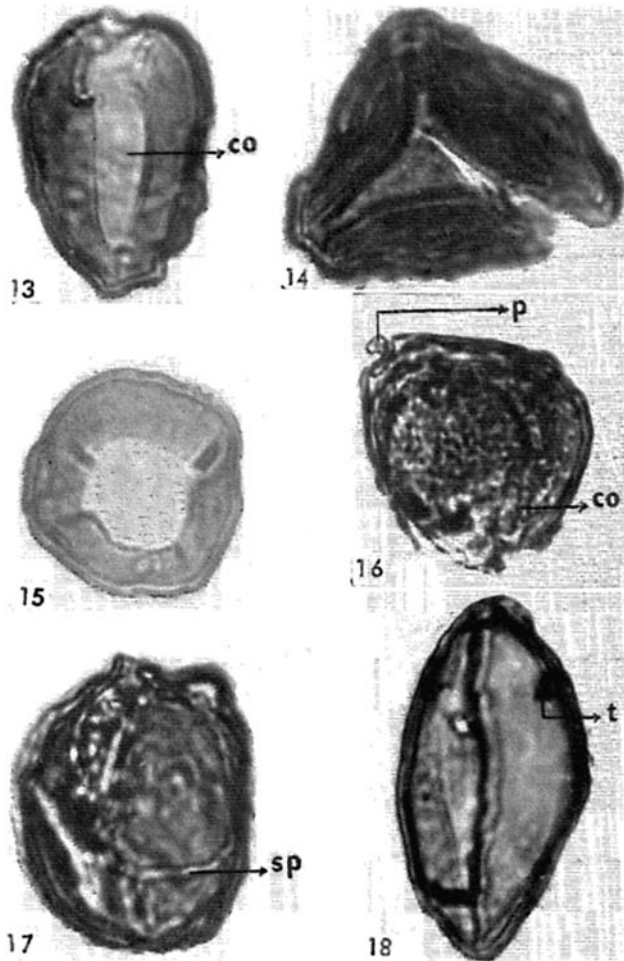
### Observations

Typically (Figs. 1 B and 13) pollen grains of *Cocos nucifera* are 1-colpate, tenuimarginate, elongate in shape [colpus distal in position; Erdtman (1)], and the ectine surface is psilate or with a faint granulate pattern. Taking all the varieties together, variations are seen in the apertures, shape, exine strata, and ectine ornamentation. Also, there are variations in the percentage of sterility, and in the volume of protoplasm contained in the non-sterile grains. The data are summarised in Tab. I.



Figs. 1-12. Pollen morphology of *Cocos nucifera*.—1: A, Pollen size measurements; B, typical pollen grain; 2: spheroidal grain with a pore; 3: spheroidal grain with a colpus; 4: trichotomocolpate grain; 5 and 6: spiraperturate grains; 7: one colpate grain with a thickened colpus margin; 8-11: exine strata; 12 A-D: various surface patterns, A: granulate; B: groups of granules, C and D: mottled. ap: triradiate aperture, co: colpus, ec: ectine, en: endine, sp: spiral, t: tubercle, th: thickening. Magnifications: 1 B and 12,  $\times 500$ ; 2-7,  $\times 250$ ; 8-12,  $\times 1000$ .

**POLLEN VARIATIONS.**—Size and shape: Both spheroidal (Figs. 2, 3 and 15) and elongated grains occur in varying percentages in every variety. Spheroidal grains are maximum in Dwarf orange (66%), followed by West coast brown (43%), Philippines (39%), Laccadive (28%), West coast red (27%), West coast green (25%), Tall  $\times$  Dwarf (15%), and West coast tall (13%). Unlike the variations in shape, pollen size does not vary much, falling within a range of  $49 \mu$  (i.e. longest diameter, E) to  $58 \mu$  in the elongated acetolysed grains, and  $38-47 \mu$  in the spheroidal ones. However, in unacetolysed grains, size is less, being  $43-58 \mu$  (E) in the elongated grains and  $32-44 \mu$  in the spheroidal ones. It follows that acetolysis causes a slight increase in pollen size. The rate of size increase is different in the



Figs. 13-18. Photomicrographs of pollen grains of *Cocos nucifera* ( $\times 750$ ).—13: typical pollen grain; 14: trichotomocolpate grain (slightly broken on one side); 15: spheroidal grain with a pore; 16: colpo-porate grain; 17: spiraperturate grain; 18: grain showing endinous tubercles.

co: colpus; p: pore probably with an operculum; sp: spiral aperture; t: tubercle.

various varieties, maximum occurring in West coast red ( $32 \mu$  increased to  $42 \mu$ ), while there is no substantial increase in West coast tall.

Aperture: Apart from the typical 1-colpate type, there are 1-colpate (pore wide, diameter  $21 \mu$ ; Figs. 2 and 15 some slightly elongated,  $34 \times 28 \mu$ ), trichotomocolpate (Figs. 4 and 14) and spiraperturate

Table I. Pollen Morphology of *Cocos nucifera*.

Name of variety	Size ( $\mu$ ) and frequency (%) spheroidal grains	Size ( $\mu$ ) and frequency (%) of elongated grains		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
		P	E <sub>1</sub> E <sub>2</sub>																
"Dwarf orange"	U 44 66 %	U	29 × 46 × 32	31 %	-	+	+	-	+	+	-	+	-	-	-	-	8	+	-
	A 47	A	25 × 50 × 28																
"Laccadive"	U 40 28 %	U	23 × 46 × 27	72 %	-	+	-	+	-	+	-	+	-	-	-	-	14.5	+	-
	A 46	A	51 × 32																
"Philippines"	U 43 39 %	U	25 × 49 × 32	61 %	-	+	-	+	-	+	-	+	-	-	-	-	8	+	-
	A 42	A	50 × 27																
"Tall Dwarf"	U 35 15 %	U	21 × 48 × 26	85 %	-	+	-	+	-	+	+	+	-	-	+	+	33.5	+	+
	A 38	A	32 × 52 × 27																
"West coast brown"	U 36 43 %	U	27 × 41 × 26	57 %	+	+	-	+	-	+	+	+	-	-	-	-	55.5	+	+
	A 40	A	52 × 29																
"West coast green"	U 37 25 %	U	27 × 43 × 33	75 %	-	+	-	+	-	-	+	+	-	+	-	-	2	+	-
	A 46	A	50 × 37																
"West coast red"	U 32 2 %	U	17.5 × 45 × 24	98 %	+	+	-	+	-	+	+	+	-	+	-	-	51	-	+
	A 42	A	25 × 55 × 28																
"West coast tall"	U 41 13 %	U	30 × 58 × 30	87 %	-	+	+	+	+	+	+	+	-	+	+	+	73.5	-	+
	A 42	A	49 × 28																

1, monoporate; 2, monocolpate; 3, trichotomocolpate; 4, spiraperturate (disyncolpate); 5, tenuimarginate apertures; 6, crassimarginate apertures, margins uneven (endine with endocracks); 7, crassimarginate apertures, margins even; 8, endine with tubercles; 9, exine psilate; 10, LO-pattern; 11, exine mottled; 12, exine with granules in small groups; 13, sterility (per cent); 14, protoplasma abundant; 15, protoplasma scarce. — A, acetolysed grains; U, unacetolysed grains; +, present; -, absent.

(Figs. 5, 6 and 17). In some grains of West coast tall, a colpus and a pore combined in the same grain (colpo-porate; Fig. 16) seemingly occur. The above types are only of rare occurrence and also are found in various combinations in the different varieties. All the types except the 1-porate ones occur in the West coast tall.

The colpus is either crassimarginate (Fig. 7) or tenuimarginate. In West coast green all the grains are tenuimarginate and in other varieties both types occur. Also, the thick margin is either straight, or uneven as in West coast tall.

Exine strata: The exine is about  $2.5 \mu$  thick, and conspicuously folded or remains unfolded, both types being present in the same variety, and often presents a wavy outline towards the inner margin, forming small finger-like tubercles (Fig. 11 t).

Exine ornamentation: Ectine surface is generally psilate (Fig. 1 B) but in a few grains of West coast tall and Tall  $\times$  Dwarf, the surface is granulate, granules being sometimes in groups, while the folds of exine present a mottled appearance in West coast green, West coast red, and West coast tall (Fig. 12 A-D).

POLLEN STERILITY.—Sterility is highest in West coast tall (73.5 %) followed by West coast brown (55.5 %), West coast red (51 %), Tall  $\times$  Dwarf (33.5 %), Laccadive (14.5 %), Dwarf orange and Philippines [8 % each; 33–33 % in Philippines according to Aldaba, 1921 (2)], and West coast green (2 %). From a study of several varieties, an average of 25 % sterility (range 23–28 %) is reported for *Cocos nucifera* (2).

PROTOPLASM.—The protoplasm in unacetolysed grains is either abundant as in the grains of Dwarf orange, Laccadive, Philippines, and West coast green, or scarce as in West coast red and West coast tall. Both conditions occur together in Tall  $\times$  Dwarf, and West coast brown.

### Discussion

The fact that the effects of cultivation find expression in pollen as noted in herbs like *Canna* (3) and cereals (7) or shrubs like *Bougainvillea* and *Hibiscus* (6) has its parallel in the arboreal species *Cocos nucifera*. In the latter species, pollen grains are basically 1-colpate, and elongate along the equator of the grain as in most other monocots. It is reported that pollen grains are spheroidal in shape when fresh, and later become elongated (2). However, in the present study, both elongated and spheroidal grains have been found to occur in varying

percentages in the different varieties, the maximum percentage of spheroidal grains occurring in Dwarf orange (66 %), and the minimum in West coast red. Other pollen variations include those of the colpus type [trichotomocolpate; see also Erdtman, (1); 1-porate, spiraperturate etc.], the colpus margin being either tenuimarginate or crassimarginate, exine strata showing endinous tubercles and also foldings, and ectine surface psilate, granulate or mottled patterns. The above variations occur in various combinations in the different species. All the variation types occur in West coast tall; the minimum is in Laccadive. Incidentally, West coast tall, showing an array of pollen variations, is a tall variety which often is cross pollinated as compared with the self-pollinated dwarfs (2). Similarly, sterility is also maximum in West coast tall.

Apart from the variations in exine morphology, there are also differences in the amount of protoplasm contained in the pollen grains. There is an abundance of protoplasm in most varieties, but in all the grains of "West coast red" and "West coast tall", and in some of those of "West coast brown" and Tall  $\times$  Dwarf, protoplasm is scarce. The presence of grains with abundant protoplasm and those with a scarce amount in Tall  $\times$  Dwarf, may be taken as an index to the hybrid nature of the variety.

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