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# Cell Inclusions in Vegetative Structure of Young Palms

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The occurrence and types of cell inclusions, or ergastic substances, in 19 species of seedling palms are described. Two types of silica bodies occur in these palms—'hat-shaped or conical' type and 'spherical or druse-like'. Starch grains have been observed in all the plant organs, the hilum of grains may be concentric or eccentric. Large starch grains occur in *Caryota urens*, and smaller ones in *Roystonea regia*, *Cocos nucifera* and *Rhapis excelsa*. Calcium oxalate occurs as bundles of raphide needles in distinct raphide sacs, in the mesophyll of lamina, and cortex of root stem and petiole. Tannins occur in almost all the palms in mesophyll cells, ground parenchyma of leaf axis, root and stem.

**Key Words: Cell inclusions, Silica bodies, Palms, Stegmata, Starch grains, Tannin**

## Introduction

The cell inclusions, or ergastic substances, are products of metabolism, and may appear and disappear at different periods in the life of a cell (Esau 1958). Different types of cell inclusions have been reported in adult palms (Eberwein 1903, Rosanoff 1871, Solla 1884, Tomlinson 1961 and others). Tomlinson (1961) observed two types of silica bodies in adult palms—hat-shaped and spherical, and other cell inclusions, i.e., starch, calcium oxalate, and tannin. The present study is confined to the vegetative organs of young palms, and the objective of the present study is to report the occurrence and types of different cell inclusions in the seedlings.

## Materials and Methods

Seedlings up to 30 months were raised at the Crop Garden of the Indian Statistical Institute, Calcutta: *Areca catechu* L., *A. triandra* Roxb., *Arenga pinnata* (Wurmb.) Merr., *Borassus flabellifer* L., *Calamus tenuis* Roxb., *Caryota urens* L., *Chrysalidocarpus lutescens* H.A. Wendl., *Cocos nucifera* L., *Elaeis guineensis* Jacq., *Hyphaene dichotoma* (White) Furtado, *Livistona rotundifolia* (Lama.) Mart., *Phoenix reclinata* Jacq., *P. rupicola* Anders., *P. sylvestris* (L.) Roxb., *P. pusilla* Gaertn., *Rhapis excelsa* (Thunb) Henry., *Roystonea regia* (H.B.K.) Cook, *Salacca zalacca* (Gaertn.) Voss, and *Veitchia merrillii* (Becc.) Moore. The stem and root were cut into small pieces, fixed in formalin-acetic acid-alcohol (FAA), and pieces of lamina and petiole in Nawaschin (Craf III) fluid for 48 hr. These materials were softened and desilicified with equal parts of commercial (48%) hydrofluoric acid and glycerol-alcohol (10% glycerol, 70% ethanol) for three days (see Uhl 1969).

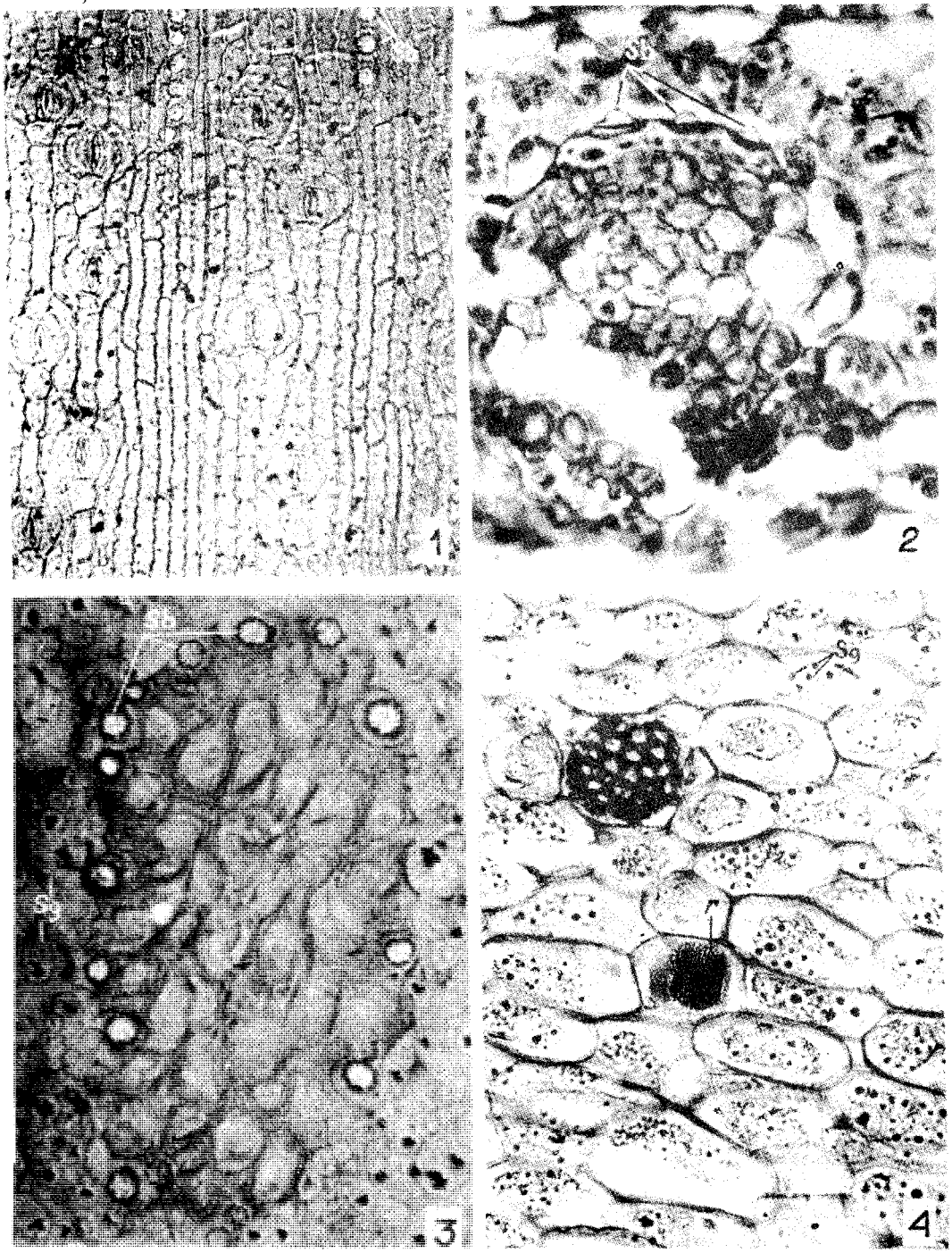
After prolonged washing in running water, the desilicified tissues were dehydrated in graded ethyl alcohol and, finally, embedded in paraffin (see Sass 1958). 12–20 μm sections were stained in safranin and fast green, and mounted in balsam. The epidermal peels of lamina were obtained by the method described earlier (Ghose & Davis 1973).

## Results

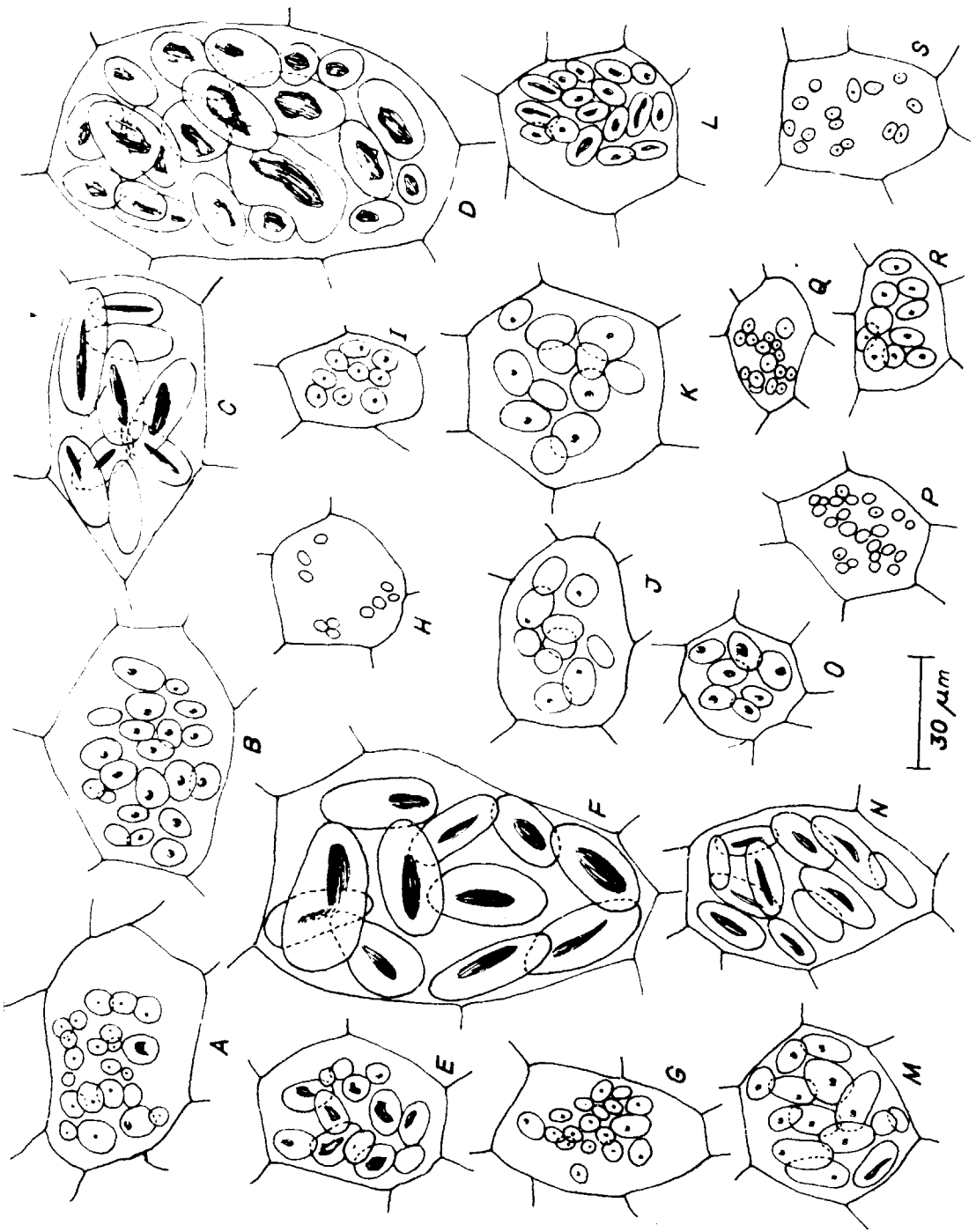
Various types of inclusions occur in different organs of palms: silica, starch, calcium oxalate, and tannin. Sometimes, they serve as a diagnostic character.

### *Silica Bodies*

Silica bodies are common in small silica cells, the stegmata. The silica cells are arranged in longitudinal files, adjacent to fibrous sheaths of vascular bundles, and nonvascular fibrous strands. The silica cells are abundant in stem and leaf. Occasionally, they also occur adjacent to cortical fibres of some roots (*Hyphaene*). In *Phoenix* (figure 1) stegmata develop in longitudinal files almost in the surface layer, but appear to be situated in the hypodermal region. Two types of




**Figures 1–4** Anatomy of lamina, stem and petiole; **1,** *Phoenix sylvestris,* abaxial epidermis of lamina to show stegmata with spherical silica bodies (×330); **2,** *Caryota urens,* transection of lamina; stegmata with conical (hat-shaped) silica bodies, adjacent to vascular bundle (×538); **3,** *Borassus flabellifer,* transection of stem cortex to show spherical silica bodies adjacent to fibre bundles, and starch grains (×350); **4,** *Areca catechu,* transection of petiole to show raphide and starch grains (×350) *sb,* silica bodies; *sg,* starch grains; *r,* raphide




**Figures 5 A–S** Starch grains in cortical parenchyma of stem; **A**, *Areca catechu*; **B**, *A. triandra*; **C**, *Arenga pinnata*; **D**, *Borassus flabellifer*; **E**, *Calamus tenuis*; **F**, *Caryota urens*; **G**, *Chrysalidocarpus lutescens*; **H**, *Cocos nucifera*; **I**, *Elaeis guineensis*; **J**, *Hyphaene dichotoma*; **K**, *Livistona rotundifolia*; **L**, *Phoenix reclinata*; **M**, *P. rupicola*; **N**, *P. sylvestris*; **O**, *P. pusilla*; **P**, *Rhapis excelsa*; **Q**, *Roystonea regia*; **R**, *Salacca zalacca*; **S**, *Veitchia merrillii*

silica bodies (see also Tomlinson 1961) have been observed by us:

1. Conical or hat-shaped, with flattened base—*Arenga* and *Caryota* (figure 2)
2. Spherical or druse-like—*Areca, Borassus* (figure 3), *Calamus, Chrysalidocarpus, Cocos, Elaeis, Hyphaene, Livistona, Phoenix* (figure 1), *Rhapis, Roystonea, Salacca* and *Veitchia.*

*Starch Grains*

Starch grains are abundant in almost all the plant organs, especially petiole (figure 4), cortex of stem (figures 3, 5A-S), and mature root. The size of grains varies considerably even between different organs of the same plant, usually ellipsoidal or spherical (figures 5A, I, Q) in *Areca catechu, Elaeis* and *Roystonea.* The hilum of grains may be concentric, or eccentric. Larger grains (figures 5C, D, F, N) are common in *Arenga, Borassus, Caryota* and *Phoenix,* and smaller (figures 5H, P, Q, S) in *Cocos, Rhapis, Roystonea* and *Veitchia.* The grains occur in the parenchymatous cells of cortex of root, stem, and petiole.

*Calcium Oxalate*

Calcium oxalate occurs as bundles of raphide needles (figure 4) in distinct sac-like cells, the raphide sacs. These are common in all parts of palms especially the mesophyll of lamina. They occur scattered in the cortex of root and stem, and peripheral chlorenchyma of petiole. Individual raphide sacs are cylindrical and long, and lie parallel to the long axis of surface. In roots the raphide sacs become modified as mucilage canals, and are cylindrical and elongated. In transection of roots such canals have a wide lumen and thick walls.

*Tannin*

Tannin occurs as darkly-stained contents in mesophyll cells and ground parenchyma of leaf axis, root, and stem. Tannin deposits have also been noticed in xylem and phloem parenchyma, and parenchymatous sheaths of vascular bundles.

The important finding of the present study is the occurrence of very stable forms of silica-bodies, i.e., conical and spherical, and they are specific to certain taxa. This specificity is also noticed in adult palms (Tomlinson 1961). Mahabale and Udwadia (1960) and Tomlinson (1961) reported starch grains, tannin and raphides in adult palms. These inclusions reported here indicate that they occur even at the very early stage of a palm. However, it appears that their quantity is relatively less in young palms.

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