

# A FOSSIL PALM FRUIT *HYPHAENEOPALMUM INDICUM* GEN. ET SP. NOV. FROM THE DECCAN INTERTRAPPEAN BEDS, INDIA

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## ABSTRACT

A silicified palm fruit collected from the Deccan Intertrappean beds near Shahpura in Mandla District of Madhya Pradesh has been described. It shows close resemblance with the fruits of modern *Hyphaene* Gaertn., and has been described under a new genus *Hyphaeneopalmum*, instituted to include fossil fruits belonging to the modern taxa of *Hyphaene* alliance of Borassoid group of palms.

*Key-words* — Silicified palm fruit, *Hyphaeneopalmum*, Palmae, Deccan Intertrappean beds, India.

## सारांश

भारत के दक्खिन अन्तर्द्वीपी संस्तरों से एक ताड़ फलाण्डम — हाइफ़ीनोकार्पम इन्डिकम नव प्रजाति व जाति — मोहन बलवंत बाँडे, उत्तम प्रकाश एवं कृष्ण अम्बवानी

मध्य प्रदेश के मांडला जनपद में शाहपुरा के समीपस्थ दक्खिन अन्तर्द्वीपी संस्तरों से एकत्रित एक सिलिकीभूत ताड़ के फल का वर्णन किया गया है। यह वर्तमान हाइफ़ीनी गेयटन<sup>०</sup> के फलों से सजातीयता प्रदर्शित करता है तथा इसे एक नव प्रजाति के अन्तर्गत वर्णित किया गया है। यह नव प्रजाति ताड़ों के बोरेसॉयड समूह के हाइफ़ीनी सहगण के वर्तमान वर्गों से सम्बन्धित फलाण्डमों को सम्मिलित करने के लिए स्थापित की गई है।

## INTRODUCTION

**F**OSSIL palms form a major group of the Indian Palaeogene flora. Practically all the parts of a palm tree, viz., stem, roots, petioles, leaves, fruits, flowers, etc. have already been described in fossil state from the Deccan Intertrappean beds of India (Prakash, 1972; Lakhanpal, 1973; Chitale & Kate, 1974). The petrified flower *Deccananthus savitrii* Chitale & Kate (1974) is known from Mohgaonkalan and is said to show affinities with Palmae. Besides, a petrified inflorescence *Monocotyl-ostrobus bracteatus* showing similarity with that of Palmae has also been recently described from the Deccan Intertrappean beds of Mohgaonkalan (Lakhanpal, Prakash & Bande, 1975, 1982).

Palm fruits occur quite commonly in the Indian Tertiaries especially in the Deccan

Intertrappean beds of Mohgaonkalan. However, as in the case of fossil palm stems, the identification of these fruits with any extant taxa of Palmae is usually not possible although it can be said with certainty that a particular fossil fruit belongs to Palmae. A few forms which have been reliably identified with modern taxa from the Indian Tertiaries are *Cocos* (Kaul, 1951) and *Nipa* (Sahni & Rode, 1937; Lakhanpal, 1952). Otherwise, the palm fruits are usually placed under the artificial genus *Palmocarpum* Miquel (1853) instituted to include fossil fruits of Palmae.

A silicified palm fruit collected from the Deccan Intertrappean beds near Sahpura in Mandla District of Madhya Pradesh is being described here. Besides, a number of fossil dicotyledonous woods have also been described recently from this locality by Bande and Prakash (1980, 1982).

## DESCRIPTION

FAMILY — PALMAE

Genus — *Hyphaeneocarpon* gen. nov.*Hyphaeneocarpon indicum* gen. et sp. nov.

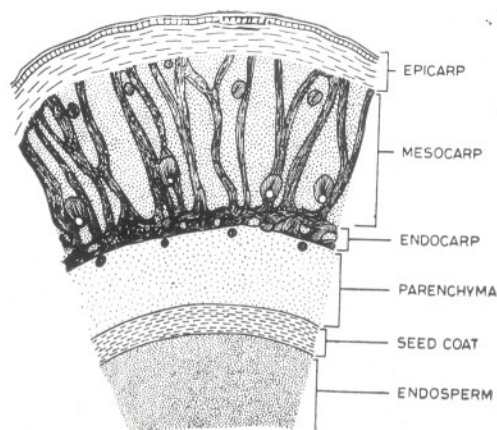
Pl. 1, figs 1-7; Text-figs 1, 2

**Material** — It consists of a single specimen of silicified fruit without a stalk, oval in shape but somewhat laterally compressed due to pressure during fossilization. The fruit was first studied and photographed under reflected light and then a cross section was prepared to study its anatomical details.

## MORPHOLOGY

**Gross Features** — The fossil fruit is a typical drupe measuring 4 cm in length and about 3.2 cm in diameter (Pl. 1, fig. 1). It is unilocular and oval in cross section (Pl. 1, fig. 2). The *Pericarp* or fruit wall is well-preserved except on one side, and 0.9 cm in thickness. *Epicarp* is smooth and unevenly preserved. *Mesocarp* is massive with radially arranged fibres (Pl. 1, fig. 1; Text-fig. 1). *Endocarp* is thick and fibrous. A zone of parenchymatous cells is present in between the endocarp and the seed (Pl. 1, fig. 2; Text-fig. 1). *Seed* is solitary, more or less circular in cross section and 1.4 cm in diameter (Pl. 1, fig. 2). *Endosperm* is homogeneous and shrunken towards one side of the seed (Pl. 1, fig. 2).

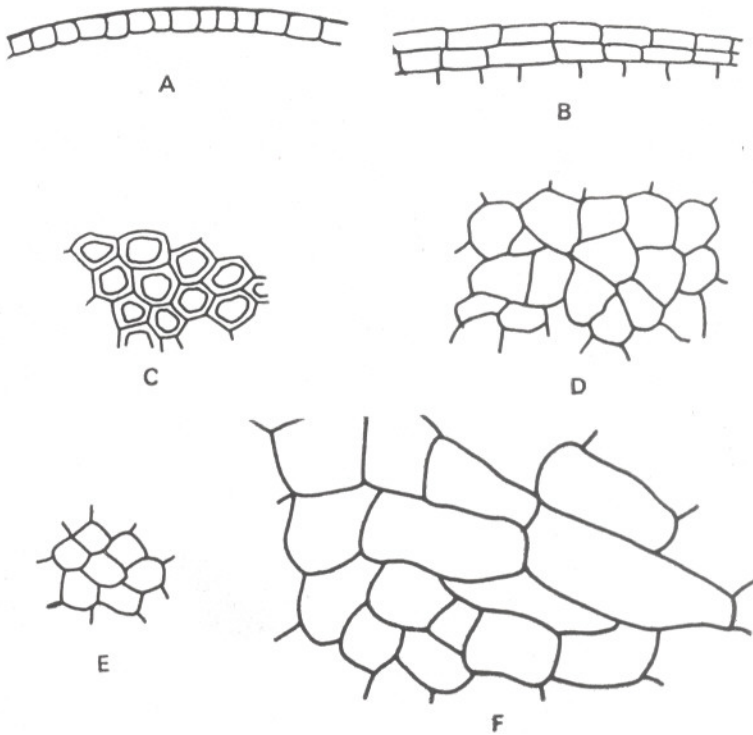
**Anatomy** — *Epicarp* 200-250  $\mu\text{m}$  in radial thickness and divisible into epidermis and hypodermis. *Epidermis* single layered, preserved at places only and made up of squarish cells, 12-16  $\mu\text{m}$  in diameter (Text-fig. 2A). *Hypodermis* made up of two zones; 2-3 layers of rectangular, thin-walled cork cells without intercellular spaces (Text-fig. 2B) towards the outer side. Cork cells 16-25  $\mu\text{m}$  in tangential length and 8-12  $\mu\text{m}$  in radial width, then followed by 8-10 layers of thick-walled, polygonal cells (Text-fig. 2C). *Mesocarp* massive, about 3 mm in radial thickness, and mostly composed of highly lignified, radially running fibrous strands distributed in the parenchymatous ground tissue (Text-fig. 1). Some of the fibre strands appear to radiate from the endocarp. A zig-zag row of fibrovascular bundles



TEXT-FIG. 1 — *Hyphaeneocarpon indicum* gen. et sp. nov. — A portion of the fruit wall magnified to show the distribution of various zones (semi-diagrammatic).  $\times 16$ .

present in the inner region of the mesocarp (Text-fig. 1). Parenchyma cells forming the ground tissue thin-walled, variously shaped and 40-150  $\mu\text{m}$  in size (Text-fig. 2D). *Endocarp* situated in the middle of the fruit wall measures about 700-800  $\mu\text{m}$  in radial thickness. It consists of a cylinder of tangentially and vertically traversing fibrous strands which are haphazardly arranged and enclosing in between the islets of parenchyma (Pl. 1, fig. 5; Text-figs 1, 2E). Individual fibres highly lignified and polygonal in cross section. Parenchyma islets are made up of thin-walled, circular to angular cells, about 8-12  $\mu$  in size (Text-fig. 2E). Endocarp encloses, towards its inner side, a zone of parenchymatous tissue. Parenchyma cells forming this zone are thin walled, oval to circular in shape and about 30-100  $\mu\text{m}$  in size (Pl. 1, fig. 4; Text-fig. 2F). A few fibrous bundles appear to be present near the periphery of this zone. *Seed coat* is about 300  $\mu\text{m}$  thick, made up of compactly arranged, thick-walled cells. *Endosperm* homogeneous and consisting of thin-walled cells with brown contents (Pl. 1, fig. 6).

**Affinities** — The structural features of the fossil fruit indicate that it belongs to Palmae. However, the difficulty in identifying a fossil palm fruit with the extant palm taxa is tremendous. It is mainly due to lack of detailed information regarding the fruit morphology and anatomy of various genera and species of palms, their reference collec-



TEXT-FIG. 2—*Hyphaeneocarpon indicum* gen. et sp. nov.— Cellular details of the various zones of fruit wall: A, a portion of single layered epidermis,  $\times 130$ ; B, cork cells of the epicarp,  $\times 130$ ; C, thick-walled polygonal cells of the epicarp,  $\times 130$ ; D, parenchymatous cells of the ground tissue of the mesocarp,  $\times 130$ ; E, thin-walled cells of the endocarp islets,  $\times 130$ ; F, parenchyma cells below the endocarp,  $\times 320$ .

tion being very rare. The outstanding contributions on this subject are those of Guerin (1949) and Murray (1973). During the investigations on the fruits and seeds of palms Biradar and Mahabale (1969), Mahabale and Kulkarni (1975) and Robertson (1977) have referred to the endocarp structure in *Phoenix*, *Livistona* and *Jubaeopsis* respectively. A good contribution has recently been made by Pandey (1979) who worked out the fruit anatomy of 51 species of palms representing 32 genera from 8 out of 15 major divisions of Palmae (Moore, 1973). This detailed study has indicated that in case of palm fruits the structure of the endocarp is of great significance in dividing this large family into smaller groups on the basis of its fruit anatomy. Pandey (1979) and Kulkarni and Pandey (1980) have grouped the endocarp of palm fruits into six major types as given below:

*Type 1*—Endocarp single layered, organized by the locular epidermis. This type

is found in *Sabal*, *Phoenix*, *Caryota*, *Arenga*, *Wallichia* and *Hyophorbe*.

*Type 2*—Endocarp many layered, solely of sclerotic cells, not including the vascular bundles and the locular epidermis. This type is restricted to Coryphoid palms.

*Type 3*—Endocarp composite, consisting mostly of fibrous strands, islets of parenchyma and fibrovascular bundles, it is situated in the middle of the fruit wall, several layers away from the locular epidermis. All Borassoid palms studied have endocarp of this type.

*Type 4*—Endocarp consists of sclerosed fibrous sheaths of one to many inner rows of vascular bundles of the fruit wall along with sclerotic parenchyma in between the vascular bundles extending up to and often involving sclerotic locular epidermis. All Areoid palms studied show this type of endocarp.

*Type 5*—Composition and structures as in type IV, but extremely sclerosed with

'eyes' or 'pores' where the endocarp formation is restricted to the sclerotic locular epidermis alone. Endocarp of all Coccoid palms belongs to this type.

*Type 6* — Fruit wall is covered with polished and sclerified overlapping scales. The ground tissue of the entire fruit wall more or less sclerotic forming a bony cover, functionally representing the endocarp. Examples of this type are *Raphia* and *Calamus*.

It is quite clear from the above classification that the type of endocarp which occurs in the present fossil palm fruit, i.e. endocarp situated in the middle of the fruit wall, consisting mostly of fibrous strands, enclosing in between the islets of parenchyma, has been designated by Kulkarni and Pandey (1980) as Type 3. This is a characteristic type of endocarp of all the Borassoid palms. However, this type of endocarp has also been described in *Nipa* by Guerin (1949). But the fruit of *Nipa* is quite distinct from the present fossil fruit in its quadrangular shape with prominent ridges and a well-defined umbo and in possessing a distinctly grooved seed.

In 1973, Moore included 7 genera and 56 species under the Borassoid palms; these have been grouped into the following two distinct alliances including a number of palm taxa.

1. *Borassus* alliance — *Borassodendron*  
*Latania*  
*Borassus*  
*Lodoicea*
2. *Hyphaene* alliance — *Hyphaene*  
*Medemia*  
*Bismarckia*

Studies on the fruit anatomy of all these genera (Guerin, 1949; Murray, 1973; Pandey, 1979) indicate that in the genera included under *Borassus* alliance the mesocarp is made up of vertically running fibres, while in the genera placed under *Hyphaene* alliance the mesocarp is made up of radiating strands of fibres distributed in the parenchymatous ground tissue. As the second type of mesocarp is seen in the present fossil fruit, the affinities of this fruit should be traced to *Hyphaene*, *Medemia* and *Bismarckia* which are included under *Hyphaene* alliance. In *Bismarckia nobilis* Hildeber & H. Wendl., which is the only species of this genus, Guerin (1949) has shown that the fruit is usually trilocular, while it is unilocal

in the present fossil. Of the remaining two genera, fruit slides and description of two species of *Hyphaene*, viz., *Hyphaene indica* and *H. buscii* were available for comparison. A detailed comparison shows that the fruits of both these modern species resemble very closely the present fossil fruit in their anatomical details except in the size of the fruit which is slightly bigger in the extant species. The fruits of *H. indica* available for study measure about 4.8 cm in length and 3.6 cm in diameter as compared to the fossil fruit from Shahpura which measures about 4 cm in length and 3.2 cm in diameter.

As we do not have any information regarding the fruit morphology of the third genus of this alliance, viz., *Medemia* Wuert ex H. Wendl., it is not possible to compare it with the same. However, it can be said with certainty that the present fossil fruit belongs to the *Hyphaene* alliance of the Borassoid group of palms and shows a very close resemblance with the modern fruits of *Hyphaene*. *Medemia* Wuert ex H. Wendl. is a monotypic genus with only one species, *M. abiadensis* H. Wendl. restricted to Africa, Arabia and Europe. On the other hand, *Hyphaene* Gaertn. includes 41 species distributed all over tropical and subtropical Africa, Arabia and western India. Only one species, *H. indica* Becc., is found in India distributed all along the western coast up to Goa (Moore, 1973). Thus, the present day distribution of *Medemia* and *Hyphaene* suggests a greater possibility of the present fossil belonging to *Hyphaene* rather than to *Medemia*. One more evidence which indirectly supports this probability is the fact that a palm petiole showing a close resemblance with that of *Hyphaene* has been recently described from the Deccan Intertrappean beds of Wardha District in Maharashtra (Shete & Kulkarni, 1980). This indicates the presence of this genus in the Deccan Intertrappean flora of India.

Five species of fossil palm fruits assigned to *Palmocarpus* Miquel (1853) are known from the Deccan Intertrappean beds of India. These are *Palmocarpus insigne* Mahabale (1950), *P. mohgaonense* Prakash (1954), *P. indicum* Prakash (1960), *P. sulcatum* Prakash (1960), and *P. splendidum* Trivedi & Chandra (1973). As in none of these species the mesocarp is made up of radiating fibres distributed in the mass of paren-

chymatous tissue, this single character is sufficient to separate the present fossil fruit from these known species of *Palmocarpon*. Because the present fossil fruit forms the first record of a palm fruit of this type from all over the world and shows a close resemblance with the modern fruits of *Hyphaene*, it is described here under a new genus, *Hyphaeneocarpon* instituted to include fossil fruits belonging to *Hyphaene* alliance of the Borassoid group of palms. The specific name *Hyphaeneocarpon indicum* suggests its occurrence in the Tertiary of India.

#### GENERIC DIAGNOSIS

*Hyphaeneocarpon* gen. nov.

*Drupe* unilocular and single seeded. *Pericarp* massive composed of epicarp, mesocarp and endocarp. *Epicarp* thin and smooth; *mesocarp* thick made up of radiating strands of fibres distributed in the parenchymatous ground tissue; *endocarp* composite, situated in the middle of the fruit wall, consisting of tangentially and vertically running anastomosing fibrous strands with islets of parenchyma followed by a zone of parenchymatous cells. *Seed* solitary, seed coat single zoned; *endosperm* homogeneous made up of thin-walled cells.

*Genotype* — *Hyphaeneocarpon indicum* sp. nov.

#### SPECIFIC DIAGNOSIS

*Hyphaeneocarpon indicum* sp. nov.

A unilocular, single seeded drupe, 4 cm in length and 3.2 cm in diameter, oval in cross-section. *Pericarp* 9 mm in thickness divisible into epicarp, mesocarp and endocarp. *Epicarp* 200-250  $\mu\text{m}$  in radial thick-

ness and divisible into epidermis and hypodermis; *epidermis* single layered, made up of squarish cells, 12-16  $\mu\text{m}$  in diameter; *hypodermis* made up of two zones, 2-3 layers of thin-walled cork cells towards outer side followed by 8-10 layers of thick-walled, polygonal cells. *Mesocarp* massive, about 3000  $\mu\text{m}$  in radial diameter, mostly composed of highly lignified radially running fibrous strands distributed in the parenchymatous ground tissue. A zig-zag row of fibrovascular bundles is present in the inner region of this zone; parenchyma cells of the ground tissue thin-walled. *Endocarp* situated in the middle of the fruit wall, measuring 700-800  $\mu\text{m}$  in radial thickness, made up of a cylinder of tangentially and vertically traversing, haphazardly arranged fibrous strands enclosing in between the islets of parenchyma; individual fibres highly lignified; parenchyma cells, forming islets thin-walled. A zone of thin-walled parenchymatous tissue is present towards the inner side of the endocarp. A few fibrous bundles appear to be present towards the periphery of this zone. *Seed* solitary, oval in shape; seed coat about 300  $\mu\text{m}$  thick, made up of compactly arranged, thick-walled cells; *endosperm* homogeneous, composed of thin-walled cells.

*Holotype* — B.S.I.P. Museum no. 35408.

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## EXPLANATION OF PLATES

*Hyphaeneocarpum indicum* gen. et sp. nov.

1. The fossil fruit in reflected light.  $\times 2$ .
2. Cross section of the fruit showing the fruit wall with a single seed in the centre.  $\times 2.5$ . Slide no. 6182.
3. Mesocarp of the fruit wall showing bands of radiating fibres.  $\times 100$ . Slide no. 6182.
4. Cells of parenchymatous zone of fruit wall just below the endocarp.  $\times 100$ . Slide no. 6182.
5. Endocarp showing haphazardly arranged fibres enclosing islets of parenchyma (P).  $\times 100$ . Slide no. 6182.
6. Dark coloured seed coat enclosing endosperm(E).  $\times 100$ . Slide no. 6182.
7. A fibrovascular bundle of the mesocarp.  $\times 90$ . Slide no. 6182.

