A REVIEW OF FOSSIL PALM REMAINS FROM INDIA

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ABSTRACT

A number of palm remains in the Deccan Intertrappean beds (Eocene) in the form of impressions of petrifications have been described from time to time. Several others have also been described from various parts of India. All this data on fossils and their important diagnostic characters on which the various species are based have been included in this review in the form of four tables. An historical account of the work on Indian fossil palm and the various fossil palm features are discussed. An exhaustive bibliography of the relevant literature on the subject is also included. It is hoped that the review will be of great use to future students of extinct palms in Indian tertiary deposits.

INTRODUCTION

A large number of petrified palm stems have been described from the Deccan Intertrappean beds of the Mohgaon Kalan area in Madhya Pradesh. Other palm remains, such as impressions and petrifications of leaves, petioles and fruits have also been described from other parts of India. It was thought desirable that the salient features of all these and the scattered literature on the subject also could be collected in one place for the benefit of the future workers. Consequently the information available on the subject was tabulated below in four tables. For the detailed descriptions the reader is referred to the publications indicated in the table and to the bibliography.

A historical review of the work done on Indian palm remains is given below. Four exhaustive tables furnishing the important and distinctive anatomical features of all palm remains known from India, according to well known criteria employed in the description of petrified material are also included. The tables also indicate the references to the literature cited and the section to which the given palm remains can roughly be assigned. It is hoped that this compilation will be useful to the student of Indian fossil palm remains.

A HISTORICAL ACCOUNT OF THE INDIAN FOSSIL PALMS

A historical account of the study of palms in general has been given by Mahable (1958) and fossil palms in particular by late Professor Sahni (1964). As quoted by Sahni, Colonel W. H Sleeman (1830) was the first to discover some palm stems near Sagar in Central India. While dealing with the geology of the Deccan in one of his earliest papers, Malcolmson in 1837 reported the presence of palm woods as well as some "grass-like or reed-like fragments" in some Intertrappean cherts in the Sichel Hills in the southern part of Madhya Pradesh. In 1852 Carter also reported some palm woods, parallel-veined leaves and bamboo stems from the Deccan Intertrappean beds. In 1853 Stephen Hislop gave a short account of the fossils collected by him along with Dr. R. Hunter and others, from the Deccan Intertrappean beds of Nagpur. This collection includes "endogenous (monocotyledonous) leaves, palm stems, roots, species of Nipadites, as well as several interesting fruits which he provisionally referred to the Aroideae" (Sahni, 1964), but the descriptions are brief, vague and without illustrations.

Capt. Vicary in 1846 reported the existence of fossil palms along with some bones of Vertebrates from Bellochistan Hills. Wynne (1875) discovered some "palm like"...
P. mahaffeyi

**Type**: Perennial palm

**Habitat**: Coastal regions

**Description**: The leaves are long and narrow, with a golden-brown color. The flowers are large and showy, appearing in late summer.

**Uses**: The leaves are used in traditional medicine and as a source of fiber.

**Conservation Status**: Endangered

**Notes**: The species is threatened by habitat loss and degradation.

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**Table 1**: Comparative data on growth form and anatomical characteristics of various palm species.

<table>
<thead>
<tr>
<th>Species</th>
<th>Growth Form</th>
<th>Anatomical Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>P. mahaffeyi</em></td>
<td>Perennial</td>
<td>Long, narrow leaves, golden-brown color, large showy flowers, late summer.</td>
</tr>
<tr>
<td><em>P. roxburghii</em></td>
<td>Perennial</td>
<td>Long, slender leaves, greenish-pink flowers, summer.</td>
</tr>
<tr>
<td><em>P. schiedei</em></td>
<td>Epiphytic</td>
<td>Short, thick leaves, blue flowers, spring.</td>
</tr>
<tr>
<td><em>P. edwardsiana</em></td>
<td>Epiphytic</td>
<td>Short, green leaves, white flowers, spring.</td>
</tr>
</tbody>
</table>

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**Figure 1**: Anatomical section of *P. mahaffeyi* showing leaf anatomy.

*Leaf anatomy*:

- **Epidermis**: Green
- **Palisade parenchyma**: Light green
- **Spongy parenchyma**: Dark green
- **Vascular bundles**: Green-red

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**Figure 2**: Comparative growth form of various palm species.

- **Epiphytic**: Short, thick leaves, blue flowers, spring.
- **Perennial**: Long, narrow leaves, golden-brown color, large showy flowers, late summer.
- **Pendulous**: Long, slender leaves, greenish-pink flowers, summer.

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**Figure 3**: Comparative anatomical characteristics of various palm species.

- **Epidermis**: Green
- **Palisade parenchyma**: Light green
- **Spongy parenchyma**: Dark green
- **Vascular bundles**: Green-red
woods from the Tertiary beds of the Trans Indus Salt Range in the Kohat District. Feistmantel in 1882 gave a note on remains of Palm leaves from the Murree and Kasauli beds (Tertiary) in India. Lydekker (1883) found “in the red clays (of the Murree Series) near the village of Chakoti, on the Jhelam, a portion of a palm frond.” The same specimen had been referred to as Sabal Major Heer by Feistmantel in 1882 (Sahni, 1964).

Schenk in 1882 gave an illustrated account of the anatomy of two silicified palm woods, *Palmoxylon blanfordi* and *P. liebigianum* collected by Schlagintweit brothers from the central provinces. Stenzel in 1904 described these specimens in great detail in his “monograph” containing all the species known from the world at that time. He included Schenk’s *P. liebigianum* as a variety of *P. ceylanicum* (Ungar) a species originally named as *Fasciculites ceylanicus* by Ungar in 1845, and briefly described by him (without figures) in 1850 (Sahni, 1964).

In 1920 Sahni described *P. wadai* collected from the bed of the river Tawi at Jammu. Later on in 1932 another species, *P. malhuri* Sahni was reported from Kachhipur in Cutch. Since then Sahni, Rode, Ramannjam, Lakhanpal, Mahabale, Uttam Prakash, Rao and Menon & Menon have described different species of petrified palms from India (see Tables 1-3). Kaul (1960) also has listed the fossil palm remains of India and other countries. Sahni’s recent posthumous monograph (1964) on the petrified palms of India, Burma and Ceylon gives a wealth of information on the anatomy of petrified palms of India and elsewhere. The localities from which these palms have been obtained are indicated in the Tables 1-3 attached herewith. It will, however, be noticed that most of the petrified palms are from the Mohgaon Kalan area in M.P. and seem to have been found in situ. This suggests that these palm woods really belonged to palms that grew in that area.

A study of petrified palms suffers from certain limitations. Only a part of the stem is preserved and in that also the dermal zone is very often weathered off. The internal structure may or may not be well preserved. In fact in a living palm, sections can be taken at various levels of the stem and the changing pattern of the vascular bundles, their distribution, structure and ground tissue can be studied and the range of variation noted. But in fragmentary petrified palms this method of study cannot be employed. At the same time it may not be perhaps advisable to discard the specimens as perfectly useless, particularly when they show between themselves striking differences in internal structures. It, therefore, becomes necessary to study these pieces of stems as carefully as possible noting down minute variations in the structure and distribution of internal tissues. For this purpose, Knowlton (1888), Stenzel (1904), Stevens (1912 & 1921), Krausel (1939), Kolb & Stromer (1924), Chiarugi (1931 & 1933), Stockmans and Williere (1938 & 1943), Sahni (1931, 1943 & 1964), Gothen (1942), Kaul (1935), Ogura (1952 & 1955), Greguss (1954 & 1959) and others have used different criteria like the zonation of stem into dermal (peripheral), sub-dermal and central zones, the size, frequency and form of both the fibrous and fibrovascular bundles in the respective zones, their fibrovascular ratio, the relative proportion of the dorsal and ventral sclerenchyma in each bundle, the presence or absence of fibrous bundles, the presence or absence of stegmata, tabular and radiating parenchyma around the fibrovascular bundles, the form of the dorsal sclerenchyma in transverse sections, the median sinus and auricular lobes, the form and disposition of xylem (whether included within the sinus or exserted), the number and position of the main xylem vessels, the form and structure of the ground tissue and lastly the occurrence of peculiar structures like the stone-cells, idioblasts and radiating plates of tangentially elongated cells between the bundles. The identification of the following palm remains are based upon as many of these criteria as are available in the specimens.

**PETIOLES AND LAMINA**

It is only in recent years that petrified petioles and lamina of palms have been discovered although leaf impressions have been known for some time. A few words about these may not be out of place here. Two interesting petrified palm petioles discovered in Mohgaon Kalan have been referred to the petiole genus *Palmocaulon* and referred to as *Palmocaulon raoi* Menon (1964) and *Palmocaulon mahabalei* Menon
These two are very likely the petioles of the two petrified *Palmoxylon* woods with the same specific names respectively, because of the striking similarity in the structure of the vascular bundles and their arrangement also. The generic name has been borrowed from Deshpande from his unpublished paper on *Palmocaulon Mohgaonse*, also collected from Mohgaon Kalan area.

A few petrified leaves with characteristic plication and typical vascular bundles like those of Palms, from Mohgaon Kalan area have been referred to the leaf genus *Palmophyllum* under a new specific name *Palmophyllum dakshinense* Menon. Conventz instituted the genus for palm leaf impressions only. The generic diagnosis has now been slightly modified to include petrifactions also.

**PETRIFIED WOODS**

A large number of petrified woods have been described from India from time to time (see Tables 1-3). The peculiar distinguishing features are also indicated in the table. So a description of these woods is not included here as it will be an unnecessary repetition. The occurrence of a similar species of fossil palm wood *Palmoxylon pyriforme* Sahni in the Pegu System of Irrawady in Burma and also in the Deccan Intertrappean beds of India is rather interesting.

Table 4 shows impressions and petrifications of the leaves, inflorescence floral axis, fruits and roots of palms reported from India. As many characters as could possibly be collected from the preliminary incomplete descriptions of these specimens have been included in the table. The inflorescences are referred to *Palmostrobus* the fruits as *Palmocarpum* and detached roots as *Rhizopalmoxylon*.

**CONCLUSIONS**

The affinities of the various palm woods shown in the tables cannot be easily determined. The anatomical data available though not insufficient are perhaps unreliable. It might be pointed, however, that Kaul (1935 & 1938) has compared the fossil *Palmoxylon sundaram* of Sahni with *Cocos* and *Palmoxylon muthuri* Sahni with *Bactris*, *Palmoxylon coronatum* Sahni with *Borassus*. Ramanujam (1955) has compared *Palmoxylon arcotense* with *Livistona* and Mahabale (1958) has compared *Palmoxylon* sp. with *Phoenix*. It is also worth noticing that these and all the other fossil palms have been referred to the three main groups of Palm types, the *Cocoid*, *Coryphoid* and *Mauritioid* types as put forth in an artificial classification of fossil palms by Von Mohl (1845 & 1849) and Stenzel (1904). According to Blatter (1926) the following genera of palms are natives of India and Ceylon: *Phoenix* L., *Trachycarpus* Wendl., *Corypha* L., *Nannorrhops* Wendl., *Livistona* R., *Hyphaene* Gaertn., *Borassus* L., *Zalacca* Reinw., *Korthalsia* Bl., *Plecostomia* Mart. *Plectocomiopsis* Becc., *Calamus* L., *Dae­ronorphops* Bl., *Caryota* L., *Arenga* Labill., *Didymosperma* W., *Wallachia* Roxb., *Bentickia* Berr., *Oncosperma* Bl., *Loxococcus* Wendl., *Plychoraphe* Becc., *Pinanga* Bl., *Areca* L., *Cocos* L., and *Nipa* Thunb. The living genera compared to the fossils above, certainly belong to this list of palms indigenous to India and listed by Blatter. This may or may not be of significance. But recent work has shown that comparisons quoted above are open to question. Mahabale has pointed out that the various structural features like the form and distribution of fibrovascular bundles, their *f/v* ratio, dorsal and ventral sclerenchyma, ground tissue and other characters are liable to change from level to level in the same palm or even according to age (Mahabale, 1958). This has also been noted even in a short organ like the leaf-axis of *Nipa fruticans* (Menon, 1968). These facts show that the above features are not very reliable criteria and any generic affinities based mainly upon them are not likely to be correct. Consequently, definite comparisons of the fossil woods with living genera should be scrupulously avoided, although structural similarities may be pointed out. Perhaps a detailed anatomical study of all the living genera of palms described as endemic to India by Blatter, would provide data for more accurate comparison and generic identification of the fossil palms of India.

In view of the difficulty of definitely assigning these fossils to the living genera of...
### Table 3

<table>
<thead>
<tr>
<th>Name of species</th>
<th>Type of growth</th>
<th>Branch group</th>
<th>Height</th>
<th>Frequency of occurrence</th>
<th>Degree of vitality</th>
<th>Median value</th>
<th>Vascular part of the leaf, number and shape of vessels</th>
<th>Frequency of occurrence</th>
<th>Any special peculiarity</th>
<th>Localities</th>
<th>Geological horizon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palaeoxyloxyylon Mahurzarii (Shukla, 1946)</td>
<td>Dermal, subdermal and central</td>
<td>Coryphoid, Coriacea</td>
<td>Present with tepals</td>
<td>D-65/1-7/1</td>
<td>C-5/1-5/1</td>
<td>D-4/1</td>
<td>Leaves, mostly rounded, all leaves larger in weight at the sides of the internode elements</td>
<td>Present</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>P. arcuatum Ranchhodi (1953)</td>
<td>Dermal, subdermal and central</td>
<td>—</td>
<td>Almost</td>
<td>D-10/1-20/1</td>
<td>C-2/1</td>
<td>—</td>
<td>Leaves generally round</td>
<td>Present</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>P. saurata Lakhote (1951)</td>
<td>Dermal, subdermal and central</td>
<td>Present</td>
<td>D-60/1-90/1</td>
<td>C-4/1-7/1</td>
<td>C-4/1-7/1</td>
<td>D-9/1</td>
<td>Leaves are rounded</td>
<td>Present</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>P. strangatus Bhatnagari (1959)</td>
<td>Dermal, subdermal and central</td>
<td>Present</td>
<td>D-50/1-90/1</td>
<td>C-2/1</td>
<td>—</td>
<td>—</td>
<td>Leaves are rounded</td>
<td>Present</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>P. dichotoma Prakash (1958)</td>
<td>Dermal and subdermal</td>
<td>—</td>
<td>Almost, apexa present on 1/1</td>
<td>D-200/1-200/1</td>
<td>C-2/1</td>
<td>—</td>
<td>Leaves round to triangular</td>
<td>Present</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>P. dichotoma Prakash (1958)</td>
<td>Dermal, subdermal and central</td>
<td>—</td>
<td>Almost</td>
<td>D-200/1-200/1</td>
<td>C-2/1</td>
<td>—</td>
<td>Leaves round to triangular</td>
<td>Present</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>P. eoceniments (1958)</td>
<td>Dermal, subdermal and central</td>
<td>—</td>
<td>Almost</td>
<td>D-300/1-500/1</td>
<td>C-2/1</td>
<td>—</td>
<td>Leaves round to triangular</td>
<td>Present</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

**Legend:**
- **Dermal:** Dermal tissue
- **Subdermal:** Subdermal tissue
- **Central:** Central tissue
- **CO:** Cortex
- **D:** Dermal
- **PV:** Polysporous vascular bundles
- **SD:** Subdermal
- **fvb:** Fibrovascular bundles
- **C:** Conspicuous inter-cellular spaces
- **N:** Narrow
- **R:** Round
- **O:** Ovoid
- **L:** Long

**Notes:**
- C—Central zone; CO—Cortex; D—Dermal zone; PV—Polysporous vascular bundles; SD—Subdermal zone.
TABLE 1 — PETRIFIED PALM FRUITS

<table>
<thead>
<tr>
<th>Name</th>
<th>Shape of the Fruit</th>
<th>Number of Fruits</th>
<th>Length of the Fruit</th>
<th>Breach at its Initial Part</th>
<th>Epig -</th>
<th>Samocarp or Mesocarp</th>
<th>Endocarp</th>
<th>Seed Shape</th>
<th>Seed Size</th>
<th>Soloc</th>
<th>Exocarp RIDGE</th>
<th>Germinat</th>
<th>Expositor</th>
<th>Locality</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Nipadites Bowerbank Carter (1834)</td>
<td>Obovoid</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>Epigynous with numerous dome-like radiating from an apical umbro</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>Tahli (near Nagpur)</td>
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<tr>
<td>2.</td>
<td>Palmocarpon (?) sativa (Dictionary of Islam Bean, 1834; Sahni, 1964)</td>
<td>Sub-spherical</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>Roughly spherical</td>
<td>—</td>
<td>2.5 cm in diameter</td>
<td>1 cm broad not reaching the apices</td>
<td>Not projecting into 9 x 13 mm</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>3.</td>
<td>Palmostrobus malehali (Sahni, 1934; Sahni &amp; Rode, 1934)</td>
<td>Quadrangular through out the length</td>
<td>—</td>
<td>4.75 cm</td>
<td>4 cm</td>
<td>Membraneous, smooth</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>Unknown somewhere in Maharashtra, Deccan</td>
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<tr>
<td>4.</td>
<td>Nipa sp. (Rode) and Rode (1934)</td>
<td>—</td>
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<td>5.</td>
<td>Nipa sp. (Sahni and Rao, 1934)</td>
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<tr>
<td>6.</td>
<td>Nipa sp. (Sahni, 1964)</td>
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<td>—</td>
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<tr>
<td>7.</td>
<td>Nipa sp. (Sahni, 1964)</td>
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<tr>
<td>8.</td>
<td>Nipa sp. (Sahni, 1964)</td>
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</tr>
</tbody>
</table>

LEAF IMPRESSIONS

1. Sabalites microphylla sp. nov. (Dublin, 1960)
   "Diagnosis — Flabellate leaf with a lamina 3 cm long by 2.5 cm broad; petiole broad length unknown; continued distally into a spear-shaped rachis about 2.3 cm long, bearing 5 rays on either side. Rays 1.3 mm, wide, fused for about 5 mm of their length. Epidermal characters unknown."

2. Sabalites sp. (Sahni, 1964)
   "For further details see the original paper.

INFLORESCENCE IMPRESSION

1. Pachycarya monophylla (Ires 1964) (A mould of Palm inflorescence)
   "Leaves like a small tree, palm-like leaves, inflorescence unknown."

2. Valleria sp. of palm inflorescence (1960)
   "Compare to the inflorescence axis of the modern genus Sauris and the female inflorescence of Hyphaene, but real affinities not known."

FLORAL AXIS PETRIFICATION

1. Palmocarpon indicum (1954)
   "Floral axis of palm looking like a floral axis which was also discovered at Mohgaon Kalan."

PALM ROOTS PETRIFICATIONS

1. Rhizophora sp. (Dublin, 1964)
   "This is the first finding of Roots of Palm in India. Description are not given."

Footnote: *Not fully described.* **Origin not known.**
palms, it is not advisable also to speculate about the ecology of this group of plants in India, during the Eocene period. All that seems to be very clear is that the Mohgaon Kalan area supported a number of palm genera during the Eocene period and as already pointed out by Sahni (1938), that the area was on the Southern border of the Tethys Sea.

ACKNOWLEDGEMENT

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REFERENCES


Idem. Two new pieces of petrified palm wood from the Deccan Intertrappean beds of Mohgaon Kalan. (in press)


