PALMOXYLON NARAYANAI, A NEW SPECIES OF PETRIFIED PALM STEMS FROM MOHGAON KALAN, INDIA

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ABSTRACT

A new species of petrified palm stem from Mohgaon Kalan (Madhya Pradesh, India) is described in detail. It appears to belong to the group Mauritia-like palm stems. Although resembling to some extent Palmoxylon sclerodermum Sahni, P. surangei Lakhanpal and P. puratanam Ramanujam, yet this specimen differs from these and all the other known fossil palm stems from India and abroad in several respects. It is, therefore, placed under a new specific name Palmoxylon narayanai.

INTRODUCTION

The petrified stem described in this paper is rectangular in form about 6.5 inches high and about 4 inches broad and 2.2 inches thick (Photo 1). On one margin both by appearance and anatomical structure can be recognised a narrow zone of about 0.8 cm. breadth, which appears to be the dermal zone (Photo 1, D). But this zone is not found all round the periphery of the stem—a fact which suggests that this is only a part of a bigger stem which has been weathered in a way so as to simulate a complete stem. But since the subdermal and central zones are also preserved (Photo 1, Sd & C) the interpretation of the structure of the stem, which might have been at least 14 inches in circumference, becomes easy.

DESCRIPTION

The specimen is brown in colour. The preservation, though not good, shows all the necessary structural details except the phloem. Staining with gentian violet and safranin brought out the structures a little more clearly.

ANATOMY

Judging by the distribution, frequency and size of the fibrovascular bundles the stem is divisible into the dermal, subdermal and central zones as in many other species of Palmoxylon.
The dermal zone is narrow about 0.8 cm. broad and is not very well preserved. The fibrovascular bundles in this zone are more crowded than in the subdermal and central zones (Fig. 1 A; Photo 2). The orientation of the fibrovascular bundles is more or less regular. They are of various shapes and sizes (Figs. 2 to 6). The average frequency is 105 and 110 per cm.². The bundles are rounded to ovate in shape. They measure 0.29 to 0.45 mm. along their longest axes and 0.25 to 0.41 mm. along their shortest axes. In these bundles the fibrous part is very much more than the vascular part (Figs. 2 to 6). The f/v ratio being 0.17/0.13 to 0.37/0.093 mm. The form of the fibrous part in most of the bundles is ovate. A median sinus and auricular lobes though not seen in all the bundles are clear in a few bundles (Figs. 2 and 6). The cells of the fibrous part in most of the bundles are moderately thick and polyhedral without any intercellular spaces (Fig. 7). The prominent xylem vessels, sometimes with slight parenchyma between them number two and are placed side by side, often even four vessels are seen (Fig. 6). Stegmata are absent on the fibrous part of the fibrovascular bundles. The ground tissue is not well preserved in this zone.

Subdermal zone is about 2.3 cm. broad. The fibrovascular bundles are further apart from each other. They number 60 to 66 per cm.². The orientation of fibrovascular bundles is irregular (Fig. 1 B; Photo 3). They are of different sizes and shapes (Figs. 8 to 19) and are smaller than the bundles in the dermal zone. They measure from 0.25 to 0.4 mm. along their longest axes and 0.17 to 0.37 mm. along their shortest axes. Their f/v ratio is 0.13/0.13 to 0.28/0.11 mm. The sclerenchyma varies in shape (Figs. 8 to 19) and the cells are not very clear because of their dark contents (Photo 3). The vascular part consists of 2 to 4 xylem vessels placed side by side. Stegmata are absent. Some fused bundles are also present in between the normal bundles (Fig. 20). The ground tissue consists of thin-walled parenchymatous cells of various shapes closely packed (Fig. 21; Photo 4).

Central zone is the widest part of this specimen and is about 4 cm. in breadth. The orientation of vascular bundles is irregular (Fig. 1 C; Photo 5). They are of different sizes and shapes (Figs. 22 to 28). They measure 0.27 to 0.41 mm. along their longest axes and 0.19 to 0.31 mm. along their shortest axes. Their frequency is 40 to 45 per cm.². In this region three types of bundles are present: (1) bundles with the sclerenchyma part bigger than the vascular part with a f/v ratio of 0.13/0.13 to 0.27/0.16 mm. (Fig. 22) (2) bundles with sclerenchyma part less than the vascular part with a f/v ratio of 0.13/0.21 to 0.17/0.20 mm. (Figs. 24 to 28) and (3) bundles with
Figs. 1–20
(In the bundles Sclerenchyma is shown black and Parenchyma blank)
sclerenchyma and vascular parts equally developed (Fig. 23). As in the
dermal zone here also the cells of the sclerenchyma are not clear due to the
presence of some black contents. Xylem vessels are usually 3-4, placed
side by side. Stegmata are absent round the fibrous part of the fibrovascular
bundles. Fused bundles are also present (Fig. 29). The ground tissue
resembles that of the subdermal zone (Fig. 21).

Leaf-trace bundles are present in all the three zones. The leaf-trace
bundles of the dermal zone show sclerenchyma and the vascular parts equally
developed (Figs. 30, 31 and 32) but in the subdermal and central zones the
vascular part is greatly developed, almost double that of the fibrous part
(Figs. 33 to 38; Photo 4). The vascular part in some of the leaf-trace bundles
in the dermal zone is produced into a tongue-like process (Fig. 31) but not
in the subdermal or central zones. There is no ventral sclerenchymatous
arc. In some of the leaf-trace bundles thin-walled parenchymatous cells
around the xylem vessels are seen (shown dotted in Figs. 32 and 36).
Radiating parenchyma is present all round the leaf trace bundles but no
tabular parenchyma is seen (Figs. 32, 34, 36 and 37; Photo 4). Leaf-trace
bundles are many in number in the central zone.

Fibrous bundles seem to be absent so far as we can make out from the
badly preserved material. The darkly stained round, seemingly cellular
structures seen in some of the sections (Figs. 21; Photos 3 and 5) are
not fibrous bundles but appear to be some contents of the cells. It has not
been possible to make out what exactly these contents are. They some-
times present a cellular appearance which we think is not natural.

Longitudinal sections show the metaxylem thickenings to be multiseriate
scalariform (Photo 6). No root or leaf bases are seen in this specimen.

Discussion and Comparison

Comparison with Indian species of Palmoxylon

Prof. Sahni (1931) gave a very short description of fourteen species of
Palmoxylon from India in his monograph on petrified palms. Later on
he described in detail Palmoxylon sclerodermum (1942) and Palmoxylon
sundaram (1946). Shukla (1946) described Palmoxylon sclerodermum Sahni
in further detail. After comparing our specimen with all these and other
species (Rode, 1933; Shukla, 1939; Ramanujam, 1953; Mahabale, 1958;
U. Prakash, 1958) known from India, it is found that a comparison is only
possible with three species of Indian Palmoxylon, i.e., Palmoxylon sclero-
dermum Sahni, P. surangei and P. puratanam.
Our specimen resembles *Palmoxylon sclerodermum* Sahni in the following characters: (1) The general appearance, orientation and distribution of fibrovascular bundles, (2) frequency of the bundles, (3) shape of the fibrovascular bundles of the dermal zone. In a number of other characters, however, the two species are distinctly separate. The f/v ratio of the fibrovascular bundles of *P. sclerodermum* Sahni in dermal, subdermal and central zones are 9/1-18/1, 20/1 and 23/1 respectively. In our species the f/v ratios in the corresponding zones are 1·3/1-4/1, 1/1-2·5/1, 1·61/1 to 1·7/1 respectively. The diameter of the bundles in *P. sclerodermum* Sahni is ·4-1 mm., about 1 mm. and 1 mm. in the dermal, subdermal and central zones respectively. In our specimen on the other hand the diameter of the vascular bundles in the dermal, subdermal and central zones are ·25 to ·41 mm., ·17 to ·37 mm. and ·19 to ·31 mm. respectively. The frequency of the bundles in the central zone of *P. sclerodermum* Sahni is 75 per cm.² and in our species it is 40 to 45 per cm.² Stegmata are present in *P. sclerodermum* Sahni while they are absent in our species. Cordate sclerenchyma, median sinus and auricular lobes are very clear in *P. sclerodermum* Sahni, but in our specimen the sclerenchyma is ovate, median sinus and auricular lobes are found in a few bundles of the dermal and subdermal zones only. Radiating parenchyma in *P. sclerodermum* Sahni is seen only round the vascular part of the leaf-trace bundles, while it is present all over the leaf-trace bundles in our specimen. The leaf-trace bundles in *P. sclerodermum* Sahni have a tongue-like vascular process with a ventral sclerenchymatous arc. In our species a tongue-like vascular process without ventral sclerenchyma is found in very few bundles in the dermal zone, but in other two zones they are completely absent. Leaf-trace bundles are absent in the central zone of *P. sclerodermum* Sahni but they are present in the central zone of our specimen.

Our specimen can be said to resemble *P. surangei* also in all the characters in which it resembles *P. sclerodermum*. But our species differs from *P. surangei* in the following characters: (1) Greater frequency of the bundles, (2) lesser f/v ratio, (3) absence of median sinus and auricular lobes in most of the bundles, (4) absence of the tabular parenchyma in the inner bundles of the dermal zone, (5) absence of ventral sclerenchymatous arc in the leaf-traces, (6) absence of tongue-like vascular process in the leaf-trace bundles of the subdermal and central zones, and (7) the ground tissue cells in *P. surangei* become broader and more rounded as they approach the centre, but in our species they are more elongated in the centre.

*Palmoxylon puratanam* (Ramanujam, 1958) described from South Arcot is similar to our fossil in the absence of stegmata, in the presence of leaf
traces throughout the stem, and lastly in the compact nature of the ground parenchyma. But our species differs from \textit{P. puratanam} in having greater frequency of fibrovascular bundles in dermal and central zones, in lesser f/v ratio, in diameter of the bundles, absence of tabular parenchyma, and ventral sclerenchyma in the leaf traces and in the varying form of cells of the ground tissue.

Our specimen shows very many differences with the other species of \textit{Palmoxyyla} known from India. A detailed comparison is therefore unnecessary.

\textit{Comparison with foreign Palmoxyyla}

A fairly close comparison is possible with \textit{Palmoxyylon densum} (Unger) Schenk. The resemblances are: (1) both \textit{Palmoxyylon densum} and our specimen are \textit{Mauritia}-like palms, where the bundles and the f/v ratio become somewhat smaller towards the inner part of the stem, (2) the general appearance and distribution of the fibrovascular bundles, and (3) the general form of the ground tissue is more or less similar in both.

As against these points of resemblance the differences are as follows: (1) In \textit{P. densum} the peripheral bundles generally have a single median vessel but in our specimen they have a pair of xylem vessels, (2) f/v ratio is greater in \textit{P. densum} than in our specimen, (3) the tongue-like vascular process with its ventral sclerenchymatous arc present in \textit{P. densum} is no doubt present in a few bundles of our specimen, but there is no ventral sclerenchyma, (4) in \textit{P. densum}, acute-angled auricular sinuses are seen, but it is not acute-angled in our specimen, and (5) fibrous bundles and stegmata are present in \textit{P. densum} while they are absent in our specimen.

It thus appears that the specimen described in this paper cannot be accommodated satisfactorily in any of the already known species. It is, therefore, placed under a new specific name \textit{P. narayanai}, after Prof. L. Narayana Rao to whom we are indebted to various acts of kindness and courtesy.

It is difficult to compare the specimen with any of the living forms because of inadequate data. But the few known facts suggest that it may belong to the group \textit{Mauritia}-like palms according to the combined scheme of Von Mohl (1849) and Stenzel (1904).

Our thanks are due to Dr. Uttam Prakash for many useful suggestions.
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**DIAGNOSIS**

Stem is 2·2 inches broad and about 6·5 inches long with reddish-brown colour and divisible into 3 zones.

*DermaL zone.*—Fibrovascular bundles regularly orientated, 105 to 110 per cm.², rounded to ovate in form; dorsal sclerenchyma bigger than vascular part; f/v ratio 17/13 to 37/093; diameter of bundles 25 to 41 mm.; pholem badly preserved; xylem vessels usually 2, side by side; stegmata absent. Leaf-trace bundles present. Radiating parenchyma all around the leaf-trace bundles. Ground tissue badly preserved but probably compact.

*Subdermal zone.*—Bundles irregularly orientated, 60 to 66 per cm.², smaller than in dermal zone. f/v ratio 13/13 to 28/11 mm.; diameter 17 to 37 mm.; dorsal sclerenchyma ovate. No median sinus or auricular lobes. Xylem vessels 2 to 4, usually arranged side by side. No stegmata. Leaf-trace bundles without ventral sclerenchyma and tongue-like vascular process. Radiating parenchyma all around the leaf-trace bundles. Ground parenchyma compact with thin-walled cells of various sizes.

*Central zone.*—Distribution of bundles as in subdermal zone. Fibrovascular bundles far apart from each other, 40 to 45 per cm.² Different types of bundles—bundles with sclerenchyma part bigger than xylem part with a f/v ratio 13/13 to 27/16, bundles with sclerenchyma part less than vascular part with a f/v ratio 13/21 to 17/20 mm. Diameter varying from 19 to 31 mm., xylem consists of 3 to 4 vessels. No stegmata. Leaf-trace bundles are just like in the subdermal zone. Ground tissue also is more or less same as in the subdermal zone.

Locality . Near Mohgaon Kalan.

Age . Eocene.

Type specimen . M 125 (kept in the Botany Department, Lucknow University).

**REFERENCES**


EXPLANATION OF TEXT-FIGURES

Text-Figs. 1-21. Fig. 1 A, B & C. The distribution of the fibrovascular bundles in the dermal, subdermal and central zones respectively, ×25. Fig. 2-6. Different kinds of bundles in the dermal zone, ×100. Fig. 7. One fibrovascular bundle showing the sclerenchyma cells, ×100. Figs. 8-19. Different kinds of bundles in the subdermal zone, ×100. Fig. 20. One fused bundle in the subdermal zone, ×100.

Text-Figs. 21-38. Fig. 21. A part of ground tissue in the subdermal zone, ×100. Figs. 22-28. Different kinds of bundles in the central zone, ×100. Fig. 29. One fused bundle in the central zone, ×100. Figs. 30-32. Leaf-trace bundles of the dermal zone showing both sclerenchyma and vascular parts equally developed, ×100. Figs. 33-35. Leaf-trace bundles of the subdermal zone, ×100. Figs. 36-38. Leaf-trace bundles of the central zone, ×100.
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PHOTOS. 1-6
**EXPLANATION OF PHOTOGRAPHS PLATE XI**

**PHOTO 1.** Transverse part of the specimen showing dermal, subdermal and central zones, \( \times 0.626 \).

**PHOTO 2.** Distribution of the bundles in the dermal zone, \( \times 26.8 \).

**PHOTO 3.** Distribution of vascular bundles in the subdermal zone, \( \times 26.8 \).

**PHOTO 4.** Nature of the ground tissue in the subdermal zone and the leaf-trace bundle with radiating parenchyma, \( \times 49.6 \).

**PHOTO 5.** Distribution of the vascular bundles in the central zone, \( \times 22.8 \).

**PHOTO 6.** Longitudinal section showing multiseriate scalariform thickening, \( \times 37.5 \).