

PALMOXYLON ARVIENSIS SP. NOV. FROM THE DECCAN INTERTRAPPEAN BEDS OF NAWARGAON, WARDHA DISTRICT MAHARASHTRA

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ABSTRACT

The paper deals with the anatomy of a new species of *Palmoxylon*, *P. arviensis*, collected from the Deccan Intertrappean beds of the village Nawargaon. It shows compact ground tissue in the dermal, slightly spongy in the subdermal and highly lacunar in the central zone of the stem. The wood also possesses fibrovascular bundles with cordate dorsal sclerenchymatous sheath and belongs to the group Cordata (Stenzel, 1904).

Key-words — *Palmoxylon*, Anatomy, Deccan Intertrappean beds, Eocene (India).

सारांश

वर्धा जनपद, महाराष्ट्र में नवरगाँव की अन्तर्द्वीपी संस्तरों से पामॉक्सिलॉन आर्वियेन्सिस न० जजा० — कृष्ण अम्बवानी

यह शोध-पत्र नवरगाँव की दक्खिन अन्तर्द्वीपी संस्तरों से एकत्रित पामॉक्सिलॉन की एक नवीन जाति, पा० आर्वियेन्सिस, से संबंधित है। यह काष्ठ तने के त्वचीय खंड में सुसंहत, उपत्वचीय खंड में कुछ स्पंजी तथा मध्य खंड में अत्यन्त रिक्तिकामय भरण ऊतक प्रदर्शित करता है। इस काष्ठ में हृदयाकार पृष्ठ दृढ़ोतकी आच्छद युक्त वाहिनी बंडल भी विद्यमान हैं तथा यह स्टेन्जल (1904) के कॉर्डेटा समूह से संबंधित है।

INTRODUCTION

A NEW species of fossil palm stem has been described here in detail. The specimen was collected by the author in 1977 from the Deccan Intertrappean beds exposed about 2 km north-east of the village Nawargaon (21°1' North; 78°35' East) in Wardha District, Maharashtra. It is a rusty brown stump, complete in cross section measuring about 20 cm in diameter and 30 cm in length. It possesses cortical, dermal, subdermal and central zones and show a gradual transition from compact nature of the ground tissue in the dermal to highly lacunar condition in the central zone of the stem.

So far only a few fossil woods are known from Nawargaon. Out of them four are palm woods, viz., *Palmoxylon nawargaonensis* Shukla (1941), *P. sclerodermum* Sahni (Shukla, 1946), *P. deccanense* Sahni (1964) and *P. livistonoides* Prakash & Ambwani (1980). Two palm

petioles, *Palmocaulon costapalmatum* Kulkarni & Patil (1977b) and *P. hyphaeneoides* Shete & Kulkarni (1980) as well as a dicot wood *Aristolochioxylon prakashii* Kulkarni & Patil (1977a) were also described from these beds.

DESCRIPTION

Genus — *Palmoxylon* Schenk, 1882

Palmoxylon arviensis sp. nov.

Cortical Zone — This zone is about 0.5 cm thick consisting of fibrous and fibrovascular bundles scattered in the parenchymatous ground tissue. The fibrous bundles are small, usually round and measure about 120-280 μm in size, whereas the fibrovascular bundles are usually round to oval, slightly irregularly oriented and measure about 240-600 μm in size. The dorsal sclerenchymatous sheath of the fibrovascular bundles is mostly cordate,

sometimes reniform. The fibrovascular bundles possess generally one rarely two excluded metaxylem vessel. The ground tissue is compact and consists of mainly round to oval as well as radially elongated cylindrical parenchymatous cells (Pl. 1, fig. 1). Stegmata are seen both in the fibrous and fibrovascular bundles of this zone.

Dermal Zone — The fibrovascular bundles in this zone are closely placed, about 150 per cm² and show regular orientation with xylem facing towards centre of the stem (Pl. 1, fig. 2). They measure 200×500-600×1200 μm in size and are of variable shapes ranging from round, oval to elongated. The dorsal sclerenchymatous sheath is mostly cordate rarely reniform (Pl. 1, fig. 2). The f/v ratio of the fibrovascular bundles varies from 3/1-14/1. The median sinus is angular to concave and the auricular lobes are rounded whereas the auricular sinus is insignificant. Each fibrovascular bundle shows mostly one rarely two excluded metaxylem vessels. A layer of tabular parenchyma is present around the fibrous part of the fibrovascular bundles, but the radiating parenchyma is absent. Stegmata are present both in the fibrous bundles as well as fibrous part of the fibrovascular bundles. A few leaf-trace bundles are also present in this zone.

Subdermal Zone — The fibrovascular bundles in this zone are quite bigger in size and slightly apart. They are about 70-75 per cm² and show regular orientation (Pl. 1, fig. 3). The shape of these bundles is variable from rounded to oval, sometimes subtriangular to elongated. They measure 1000 × 1000-1000 × 1500 μm in size. The f/v ratio varies from 15/1-40/1. The dorsal sclerenchymatous sheath is mostly cordate, sometimes reniform with angular to concave median sinus. The auricular sinus is indistinct. The auricular lobes are rounded (Pl. 1, fig. 3). Generally one sometimes two excluded metaxylem vessels are present in each fibrovascular bundle (Pl. 1, fig. 3). A layer of tabular parenchyma is present around the fibrous part of the fibrovascular bundle. Radiating parenchyma is absent. Leaf-trace bundles are frequently seen in this zone. Stegmata are present around the fibrous bundles as well as the fibrous part of the fibrovascular bundles. Phloem is badly preserved and represented by a lacuna.

Central Zone — The fibrovascular bundles in this zone appear to be more or less similar to those of the subdermal zone, but sometimes they are slightly smaller, sparsely placed and a few bundles are very close to each other. The frequency of the fibrovascular bundles in this zone varies from 50-55 per cm². They show irregular orientation (Pl. 1, fig. 4) and are mostly rounded, sometimes oval in shape and measure 1000 × 1000-1000 × 1200 μm in size. The f/v ratio varies from 20/1-35/1. Dorsal sclerenchymatous sheath is generally cordate rarely reniform. Median sinus is triangular to concave. The auricular lobes are generally rounded and the auricular sinus is indistinct. Generally the xylem portion of the fibrovascular bundles is badly preserved but a few bundles show well-preserved xylem. Each fibrovascular bundle has generally two excluded metaxylem vessels. A layer of tabular parenchyma is present around the fibrous part of the fibrovascular bundles. The radiating parenchyma is present around the xylem portion of the leaf-trace bundles (Pl. 1, fig. 5) which are frequently seen in this zone. Stegmata are seen around the fibrous part of the fibrovascular bundles and fibrous bundles (Pl. 1, fig. 6). Fibrous bundles are very rare in this zone. Phloem is badly preserved and represented by a lacuna.

Ground Tissue — The ground tissue of this species shows a gradual transformation from compact nature in the dermal to highly lacunar condition in the central zone (Pl. 1, figs 2-4, 7). The ground tissue is compact in the dermal zone and composed of round to oval as well as radially elongated parenchymatous cells (Pl. 1, fig. 2). In the subdermal zone, small intercellular spaces appear giving the ground tissue more or less spongy nature. The parenchymatous cells of the ground tissue occupy slightly wider portion than in the dermal zone. Further, towards the central zone still larger portion of the ground tissue is occupied by the parenchymatous cells which is highly lacunar (Pl. 1, fig. 7). It consists of usually long cylindrical as well as branched parenchymatous cells. A very few round and oval cells may also be seen.

Fibrous Bundles — The fibrous bundles although present throughout the stem, but their frequency decreases from the dermal

towards the central zone. They are frequently present in the dermal zone, become less frequent in subdermal and scanty in the central zone. They measure 40-50 μm in size. Each fibrous bundle is made up of 15-20 fibre cells.

Diminutive Fibrovascular Bundles—These bundles are seen throughout the stem. They are very small, measuring 200-400 μm in size and similar in structure to those of the bigger fibrovascular bundles. Each bundle has usually one to two metaxylem vessels.

Leaf-trace Bundles—They are present throughout the stem and are very common in the central zone. They are easily recognized by their protruded tongue-like vascular part with a number of small vessels. The pitting of the metaxylem is scalariform while the protoxylem shows spiral to annular thickenings.

COMPARISON WITH OTHER PALM WOODS

Among the large number of Indian fossil palm woods described so far, the present fossil wood is nearly comparable to *Palmoxylon sclerodermum* (Sahni, 1943; Shukla, 1946) and *P. intertrappeum* (Sahni, 1964) from the Deccan Intertrappean beds of Wardha District.

Although, *Palmoxylon arviensis* resembles more closely to *Palmoxylon sclerodermum* Sahni (Shukla, 1946) but shows marked differences from it. *P. sclerodermum* differs from *P. arviensis* in size, frequency and the fibrovascular ratio of the fibrovascular bundles. It also shows difference in median sinus, a number of xylem vessels in each fibrovascular bundle, tabular parenchyma, nature of the ground tissue as well as in certain other important characters. The fibrovascular bundles are $400 \times 800 \mu\text{m}$ in dermal, about $1000 \mu\text{m}$ in subdermal and central zones of *P. sclerodermum*, whereas they are $200 \times 500-600 \times 1200 \mu\text{m}$ in dermal, $1000 \times 1000-1000 \times 1500 \mu\text{m}$ in subdermal and $1000 \times 1050-1000 \times 1200 \mu\text{m}$ in the central zone of *P. arviensis*. The median sinus is cordate in *P. sclerodermum* while it is angular to concave in *P. arviensis*. Further, f/v ratio of the fibrovascular bundles is 9/1-18/1 in dermal, 20/1 in subdermal and 23/1 in the central zone of *P. sclerodermum* while it is more in the present species being 3/1-14/1 in dermal,

15/1-40/1 in subdermal and 20/1-35/1 in the central zone. The frequency of the fibrovascular bundles is $105/\text{cm}^2$ in dermal, $75/\text{cm}^2$ in subdermal and $65-70/\text{cm}^2$ in central zone of *P. sclerodermum* whereas it is $150/\text{cm}^2$ in dermal, $50-75/\text{cm}^2$ in subdermal and $50-55/\text{cm}^2$ in the central zone of *P. arviensis*. It shows that the frequency of the fibrovascular bundles in the dermal zone of *P. arviensis* is much more than the dermal zone of *P. sclerodermum*. The number of the metaxylem vessels in each fibrovascular bundle in *P. sclerodermum* as mentioned by Sahni (1943) is usually one, sometimes two in the dermal and one to two in the subdermal zone but Shukla (1946) mentions their number as usually one in the dermal, and two in the subdermal and the central zones. However, from the study of the type slides of both the specimens described by the above authors and also from the photographs as well as text-figures given by Shukla (1946, pl. 6, fig. 4; text-fig. 4, pp. 107-110, 113) it is clear that there are generally two, rarely one, metaxylem vessels in the dermal zone whereas 3-4 vessels in the subdermal and the central zones.

The ground tissue also shows difference in both the species. It is described as lacunar throughout the stem in *Palmoxylon sclerodermum* (Shukla, 1946, pp. 107-110, 113), but on examination of the type slides of *P. sclerodermum* it has been found that the ground tissue is compact in the dermal zone while slightly lacunar in subdermal and central zones. However, in *P. arviensis* there is a gradual transformation from compact nature of the ground tissue in the dermal zone to highly lacunar in the central zone of the stem. The ground parenchyma in the dermal zone of *P. sclerodermum* is composed of round to oval as well as radially elongated cells, while in the subdermal and the central zones it is formed of mostly isodiametric, lobed as well as variously shaped cells with small intercellular spaces. However, in the present species the cells in the dermal and subdermal zones are somewhat similar to that of the ground parenchymatous cells in *P. sclerodermum* but in the central zone they are mostly cylindrical as well as branched parenchymatous cells forming bigger lacunae. The tabular parenchyma in *P. sclerodermum* is in 1-2 layers while in

P. arviensis it is only in one layer around the fibrous part of the fibrovascular bundles.

Presence of palisade-like row of thin-walled cells has been reported in the ground tissue of *Palmoxylon scleroderмум* while it is absent in *P. arviensis*. *P. scleroderмум* also shows the presence of idioblasts in the ground tissue but they are absent in the present species. Diminutive fibrovascular bundles have not been reported in *P. scleroderмум*, while they are present throughout the stem in *P. arviensis*.

Palmoxylon intertrappeum also resembles *Palmoxylon arviensis* in certain characters. However, it differs from *P. arviensis* in having lower frequency of the fibrovascular bundles, which is 140/cm² in the dermal and 19-21/cm² in the subdermal zone of *P. intertrappeum*, while it is 150/cm² in the dermal and 70-75/cm² in the subdermal zone of *P. arviensis*. The f/v ratio in the dermal and subdermal zones of *P. intertrappeum* varies from 16/1-32/1 and 9/1-10/1 respectively, whereas it is 3/1-14/1 in the dermal and 15/1-40/1 in the subdermal zone of *P. arviensis*. Stegmata are absent in *P. intertrappeum* while they are present in *P. arviensis*.

The ground tissue is compact in the dermal but much lacunar in the subdermal zone of *P. intertrappeum* whereas it is compact and scanty in the dermal and slightly lacunar in the subdermal zone of *P. arviensis*.

Palmoxylon arviensis, although resembling *P. densum* (Unger) Schenk (1882) in general anatomical features, also differs from it in having reniform dorsal sclerenchymatous sheath and in the f/v ratio of the fibrovascular bundles is 7/1-14/1 in outer zone and 3/1-7/1 in the inner zone of *P. densum* showing that the f/v ratio in the inner zone is very less to that of *P. arviensis*. The median sinus is reniform and the auricular sinus is acute in *P. densum*. Besides, the ground tissue is compact throughout the stem in *P. densum* and the radiating parenchyma is observed around the fibrous part of the fibrovascular bundles.

Palmoxylon fladungi (Unger) Stenzel (1904) also shows some important anatomical differences from that of *P. arviensis*. The fibrovascular bundles of *P. fladungi* have reniform sclerenchymatous sheath with generally two metaxylem vessels throughout the stem. They are also bigger in size

measuring 1500 × 2000 μm and their frequency is 30/cm², which is very less as compared to *P. arviensis*. The diminutive fibrovascular bundles are also absent in *P. fladungi*.

DIAGNOSIS

Stem shows cortical, dermal, subdermal and central zones. Fibrovascular bundles in the cortical zone round to oval, 240-600 μm in size, slightly irregularly oriented; fibrous bundles scattered. Fibrovascular bundles regularly oriented in dermal zone, round, oval to elongated with generally one, rarely two excluded metaxylem vessels, 200 × 500-600 × 1200 μm in size, about 150/cm² with mostly cordate sometimes reniform dorsal sclerenchymatous sheath; f/v ratio 3/1-14/1; median sinus mostly angular to concave, auricular lobes rounded, auricular sinus indistinct; tabular parenchyma present, radiating parenchyma absent; fibrous bundles scanty, stegmata present; diminutive fibrovascular bundles present.

Fibrovascular bundles in subdermal zone regularly oriented with generally one to two excluded metaxylem vessels, round to oval sometimes subtriangular, 1000 × 1000-1000 × 1500 μm in size and 70-75 per cm²; dorsal sclerenchymatous sheath cordate sometimes reniform; f/v ratio 20/1-40/1; median sinus angular, auricular lobes rounded, auricular sinus indistinct; tabular parenchyma present; diminutive bundles present; fibrous bundles and stegmata present.

Fibrovascular bundles in central zone more or less similar to subdermal zone, slightly smaller, sparsely placed, irregularly oriented, 1000 × 1050-1000 × 1200 μm in size, 50-55 per cm²; dorsal sclerenchymatous sheath mostly cordate rarely reniform; f/v ratio 20/1-35/1; median sinus angular to concave, auricular lobes rounded, auricular sinus indistinct; tabular parenchyma present around fibrous part of fibrovascular bundle; radiating parenchyma present only around vascular part of the leaf-trace bundles; fibrous bundles scanty, stegmata present, diminutive fibrovascular bundles present.

Ground tissue compact in cortical and dermal zones, slightly spongy in subdermal and highly lacunar in central zone.

Material—A big piece of stem wood measuring 30 cm long and 20 cm in diameter.

Holotype—B. S. I. P. Museum no. 35320.

Locality—Nawargaon, Wardha District, Maharashtra.

Horizon—Deccan Intertrappean Series.

Age—Eocene.

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EXPLANATION OF PLATE

PLATE I

Palmoxylon arviensis sp. nov.

1. Cross section of cortical zone showing ground tissue parenchyma, fibrous as well as fibrovascular bundles. $\times 60$. Slide no. 5921.
2. Cross section of the dermal zone showing regular orientation of the fibrovascular bundles, note the compact nature of bundles. $\times 10$. Slide no. 5921.
3. Cross section of the subdermal zone showing regular orientation of the fibrovascular bundles with one to two excluded metaxylem vessels. $\times 10$. Slide no. 5921.
4. Cross section of the central zone showing irregular orientation of the fibrovascular bundles, note the lacunar condition of the ground tissue. $\times 10$. Slide no. 5921.
5. Enlarged leaf-trace bundles to show radial parenchyma around the xylem portion. $\times 30$. Slide no. 5921.
6. Longitudinal section of the stem showing stigmata. $\times 100$. Slide no. 5922.
7. Cross section of the stem enlarged to show the form of the ground parenchyma, note the bigger lacunae. $\times 60$. Slide no. 5921.

