STUDIES IN THE DECCAN INTERTRAPPEAN FLORA: TWO PALM WOODS FROM MOHGAON KALAN

U. PRAKASH

Birbal Sahni Institute of Palaeobotany, Lucknow

ABSTRACT

The present paper deals with the anatomy of two new species of *Palmoxylon*, *P. dakshinense* and *P. chhindwarense*, collected from the Intertrappean beds of Mohgaon Kalan in Chhindwara District of Madhya Pradesh.

INTRODUCTION

TWO new species of petrified palm stems are described here from the well-known locality of Mohgaon Kalan in the Deccan Intertrappean Series of Chhindwara District in Madhya Pradesh. So far only two species of *Palmoxylon*, *P. hislopi* and *P. kamalam* have been briefly described by Rode (1933) from the same locality. *P. kamalam* has been further described by Shukla (1939) from Reserve Forest area between Pupuldoh and Paraspani villages.

Apart from Mohgaon Kalan, the Deccan Intertrappeans have yielded a rich collection of fossil palms from other localities also (SCHENK, 1882; STENZEL, 1904; SAHNI, 1931, 1943, 1946; RODE, 1934; SHUKLA, 1941, 1946; LAKHANPAL, 1955).

DESCRIPTION

Monocotyledoneae

PALMAE

1. *Palmoxylon dakshinense* sp. nov.

The descriptive terminology used here is the same as suggested by Professor Sahni (1943) in his paper on *Palmoxylon sclerodermum*.

The fossil palm wood measures 4·5-5·5 cm. in diameter and 8·5 cm. in length from which a number of sections were prepared for study. The preservation of the wood is quite satisfactory except in the cortical region where it is extremely poor.

Cortex — It is incomplete and only 5 mm. in thickness. It contains numerous circular to oval fibrous bundles of different sizes, scattered irregularly in the ground tissue (TEXT-FIG. 1). Among the fibrous bundles are seen small fibrovascular bundles of different shapes (TEXT-FIG. 1). The fibrovascular bundles are irregularly orientated, 50-112 μ in size and usually possess 2-3 vessels. A number of small, round to oval, canal-like structures are also seen in the ground parenchyma of this region. They are 64-80 μ in diameter and appear to be gum or resin canals. The ground tissue is made up of parenchymatous cells with slightly irregular outline.

Dermal Zone — It is about 5 mm. thick. In cross-section the fibrovascular bundles are normally orientated and closely placed (PL. 1, FIGS. 1, 9). They are small, usually elliptical to obovate, only 160-560 μ in size, and possess 1-2 vessels (PL. 1, FIGS. 7, 9). Sometimes they are somewhat orbicular or reniform or even variously shaped. The vessels are placed side by side and generally have irregular outline. The vascular part is either completely included or partly excluded. The auricular lobes are more or less roundly pointed (PL. 1, FIG. 9). No stegmata are to be seen round the fibrous part of the bundles and the phloem is not preserved. The fibrovascular bundles number 200-270 per cm.^{2} and their f/v ratio is 10 : 1 to 16 : 1. The leaf-traces are sporadic. The fibrous bundles are altogether absent. The ground tissue of this region is rather compact with scanty and small intercellular spaces (PL. 1, FIGS. 7, 9). It is made up of lobed cells (PL. 1, FIG. 7; TEXT-FIG. 2).

In one of the cross-sections towards the periphery of this zone are two small oval to ovate structures (PL. 1, FIG. 2) with a few round to oval cells in the middle bounded by a number of radially disposed cells. A somewhat similar structure is also seen in *Palmoxylon rutherfordi* (STOCKMANS & WILLIERE, 1943a, PL. 5, FIG. 9) described from Belgium.

Subdermal Zone — The fibrovascular bundles are again regularly orientated, comparatively more sparse, 50-90 per cm.^{2}, and generally orbicular to obovate, although oval shape is not uncommon (PL. 1, FIGS. 4, 5).

TEXT-FIGS. 1, 2 — *Palmoxylon dakshinense* sp. nov. 1, distribution of the fibrovascular bundles (*fv.b.*) in the cortical zone. Two fibrous bundles (*f.b.*) are also seen among the fibrovascular bundles. Fibrous bundles cross-hatched, selerenchyma solid black, xylem parenchyma and phloem patch left unshaded. × 60. 2, ground tissue cells of dermal zone. × 146.5.

A few bundles lying towards the centre are reniform in shape (PL. 1, FIG. 6). The fibrovascular bundles are big, 600-900 μ in diameter and their f/v ratio varies from 12 : 1 to 17 : 1. The vascular part of the fibrovascular bundles consists of mostly two vessels showing slightly irregular outline (PL. 1, FIG. 5).

The auricular lobes of the dorsal sclerenchyma are more or less round or somewhat pointed and the median sinus is concave (PL. 1, FIGS. 4, 5) and sometimes quite deep. The phloem is not preserved. There are no purely fibrous bundles and the stegmata are also absent. The tabular parenchyma is present round the fibrous part of the fibrovascular bundles and it appears to be usually in one layer. The radiating parenchyma is also present round the vascular part of the bundles (PL. 1, FIGS. 4, 5, 6). The ventral sclerenchyma is present in all the bundles (PL. 1, FIG. 5) and it is sometimes well developed in those lying far away from the periphery. A few bundles towards the centre are irregularly orientated (PL. 1, FIG. 6), which shows that this part may be very close to the central region. The leaf-trace bundles are fairly common in this region (PL. 1, FIG. 6).

The ground tissue (PL. 1, FIG. 5) is distinct from that of the dermal region in that it shows a highly lacunate condition. It is formed of a network of narrow cells, generally Y-shaped, enclosing conspicuous, polygonal intercellular spaces, usually big enough to be visible to the naked eye.

In the longitudinal sections (PL. 1, FIG. 8), however, the cells of the ground tissue are generally small, squarish to rectangular and sometimes round. They are usually arranged in chains or tiers.

The protoxylem vessels show spiral pitting whereas the pitting of the metaxylem vessels is of scalariform type (PL. 1, FIG. 3).

The *leaf-trace bundles* are present throughout the cross-section of the wood but are best seen in the subdermal region. These are easily distinguishable by their well-developed vascular part which projects far out of the median sinus as a tongue-like process. In addition to the usual pair of big vessels, there are a number of small to medium-sized vessels bounded by a ventral sclerenchymatous arch.

The fibrous part of the fibrovascular bundles is composed of thick-walled, pentagonal to hexagonal cells, each with a small central lumen (PL. 1, FIG. 7). In cross-section, the cells increase in size from the posterior to the anterior side of the bundles.

COMPARISON AND DISCUSSION

Palmoxylon dakshinense is characterized by the presence of lacunate ground tissue, hence it is to be compared only with those species of Palmoxyla which possess porous fundamental tissue. A number of species showing lacunate ground tissue have been described from India and outside. The Indian species are *Palmoxylon blanfordi* Schenk (SCHENK, 1882; STENZEL, 1904), *P. wadiai* Sahni (1931), *P. mathuri* Sahni (1931), *P. jammuense* Sahni (1931), *P. kamalam* Rode (1933), *P. hislopi* Rode (1933) and *P. arcotense* Ramanujam (1953).

Palmoxylon blanfordi resembles *Palmoxylon dakshinense* to a certain extent but differs from it in having radial parenchyma all round the fibrovascular bundles and in the absence of posterior sclerenchymatous arch. A detailed comparison between *P. dakshinense* and *P. blanfordi* is not possible because in the latter species only the central region is known.

With *Palmoxylon jammuense*, *P. dakshinense* resembles in the general form of the fibrovascular bundles, in the nature of the ground tissue of the subdermal zone as seen in the cross-section and in the presence of radiating parenchyma over the vascular part of the fibrovascular bundles, otherwise in other characters they are quite apart.

The petrified palm wood from Cutch, *Palmoxylon mathuri* is peculiar in that the fibrovascular bundles are very small in size with their characteristic form, and the ground tissue is like a loose network with exceedingly slender fibrous bundles. The differences between the two species are, therefore, quite obvious.

Palmoxylon dakshinense also differs from *P. wadiai* from Jammu (Punjab) and *P. arcotense* from South India in having radiating parenchyma round the vascular part of the fibrovascular bundles. It is further distinguished from *P. wadiai* in the absence of thick-walled cells scattered in the ground tissue. Similarly from *P. arcotense* the present species shows a number of other important differences which are: the frequency of the fibrovascular bundles in different regions of *P. dakshinense* is more (200-270; 50-90 per cm.^{2}) than in *P. arcotense* (110; 50-65 per cm.^{2}); and the lacunae are more angular in *P. dakshinense* than in *P. arcotense* where they are more or less oval.

There are also quite obvious differences between *Palmoxylon dakshinense* and *P. kamalam* (Rode, 1933, pp. 81, 82; Shukla, 1939), another palm wood from Mohgaon Kalan. *P. dakshinense* is distinguished from *P. kamalam* in the absence of radial parenchyma all round the fibrovascular bundles, in the presence of posterior sclerenchyma and lastly in the absence of linear dark regions just midway between the neighbouring bundles, which serve to divide the whole ground mass of *P. kamalam* into distinct compartments.

Palmoxylon dakshinense resembles somewhat more closely with *P. hislopi* which is also described from Mohgaon Kalan. They resemble each other in the presence of radiating and tabular parenchyma and also to some extent in the nature of the ground tissue as seen in the cross-section. However, there are more obvious differences between the two. They are: the f/v ratio of the bundles of subdermal region is more in *P. dakshinense* (12 : 1 to 17 : 1) than in *P. hislopi* (7 : 1); the frequency of the bundles of subdermal region is more (80-120 per cm.^{2}) in *P hislopi* than in *Palmoxylon dakshinense* (50-90 per cm.^{2}); the shape of the bundles in *P. hislopi* with their fibrous part orbicular or ovate and usually flat median sinus is quite different from that of *P. dakshinense*; and lastly the posterior sclerenchymatous arch is present in *P. dakshinense* and absent in *P. hislopi*.

P. dakshinense also shows some similarity with the foreign species *Palmoxylon ligerinum* (Crie, 1892; Stockmans & Williere, 1943b) in the nature of the ground tissue. But there are more important differences between the two. They are: (1) the absence of gum or resin canals in *P. ligerinum*; (2) the completely excluded vessels in *P. ligerinum*; (3) the shape of the bundles in *P. ligerinum*, the fibrous part being hemispherical with a flat median sinus; and (4) the presence of densely packed cap of 1-3 layers of parenchyma round the fibrous part of the fibrovascular bundles in *P. ligerinum*. In *P. dakshinense* this type of parenchyma (tabular parenchyma) is also present but it usually occurs in one layer of cells.

Palmoxylon dakshinense is, therefore, quite distinct from all the species known so far from India and outside.

Diagnosis

Fibrovascular bundles irregularly orientated and variously shaped in cortical zone; closely placed, 200-270 per cm.^{2}, usually elliptical to obovate, and regularly orientated in dermal zone; comparatively more sparse, 50-90 per cm.^{2}, orbicular to obovate and oval, rarely reniform and regularly orientated in subdermal zone. F/v ratio 10 : 1 to 16 : 1 in dermal zone and 12 : 1 to 17 : 1 in subdermal zone. Fibrous bundles with stegmata only in cortical zone. Both tabular and radiating parenchyma present in subdermal zone. Ground tissue more or less compact with lobed cells in dermal zone, highly lacunate in the subdermal zone.

Leaf-traces common in subdermal zone. Gum- or resin-canal like structures present the cortical zone.

Locality — Mohgaon Kalan in Chhindwara district of Madya Pradesh.

Horizon — Deccan Intertrappean Series.

Age — Tertiary (probably Eocene).

Type Specimen — B.S.I.P. Museum No. 5574.

2. *Palmoxylon chhindwarense* sp. nov.

The present specimen is 9-10 cm. in diameter and shows excellent preservation in most of the parts. Here all the three zones are present but unfortunately the cortex is only partly preserved.

Cortical Zone — The preservation of this region is very poor. It is about 12 mm. in the thickest part of the specimen and contains a number of fibrovascular bundles which are irregularly orientated. The ground tissue of this region appears to be composed of loosely arranged thin-walled cells.

Dermal Zone — The fibrovascular bundles in this region are crowded, regularly orientated (PL. 2, FIG. 17) and slightly compressed showing various forms. They are small, 200-624 μ in diameter (PL. 2, FIGS. 11, 17) and provided with one or two big, circular to oval vessels. The fibrovascular bundles are 297 to 625 per cm.^{2} The f/v ratio is 4·5 : 1 to 8 : 1. The auricular lobes of the fibrovascular bundles are bluntly pointed and the concavity of the median sinus is quite deep. The vessels (PL. 2, FIGS. 11, 17) are either completely excluded or partly included. Purely fibrous bundles and the stegmata are altogether absent. The radiating parenchyma is absent but the tabular parenchyma is present round the fibrous part of the fibrovascular bundles (PL. 2, FIG. 11) and usually occurs in two layers of cells. The ground parenchyma (PL. 2, FIG. 11) consists of rather compactly placed, thin-walled, round to oval cells. The leaf-traces are very rare in this region.

Subdermal Zone — The fibrovascular bundles (PL. 2, FIG. 12) are usually regularly orientated and comparatively sparse, being 156 to 250 per cm.^{2} They are of various shapes, and often show one or more flat sides (PL. 2, FIG. 12). The bundles are 692-720 μ in diameter and their f/v ratio varies from 3 : 1 to 5 : 1. Usually there are two big, circular to oval vessels (PL. 2, FIG. 12) placed side by side in the vascular part of the bundles. Mostly these vessels are completely excluded but sometimes they are partly included. The auricular lobes (PL. 2, FIG. 12) are round to bluntly pointed and the median sinus is concave to somewhat flat (PL. 2, FIG. 12). Ventral sclerenchyma appears to be present. Xylem parenchyma is well preserved, but the phloem is rarely preserved. The neighbouring bundles are 0·04-0·7 mm. apart. Radiating parenchyma is absent but the tabular parenchyma is present round the fibrous part of the bundles. There are no purely fibrous bundles and the leaf-traces are sporadic. Stegmata are also absent. The general ground tissue is quite distinct from that of the dermal zone in that it shows slightly lacunate condition due to the formation of small intercellular spaces. This condition, which is well developed in the central zone, has its beginning in the subdermal zone.

Central Zone — The cross-section (PL. 2, FIG. 10) shows a large number of rather widely scattered fibrovascular bundles with irregular orientation in a well-developed lacunate ground tissue. The fibrovascular bundles (PL. 2, FIG. 10) are orbicular to oval, although reniform shape is not uncommon. They are 580-800 μ in diameter and 60 to 130 per cm.^{2} The neighbouring bundles are 0·08-1·5 mm. apart. There are usually two big, circular to oval vessels lying side by side and in general completely excluded (PL. 2, FIG. 10). No stegmata are found round the bundles. The arms of the dorsal sclerenchyma are usually round (PL. 2, FIGS. 10, 14) and the median sinus is concave to slightly flat (PL. 2, FIGS. 10, 13, 14). Ventral sclerenchyma is present. F/v ratio is mostly 2·5 : 1 to 3 : 1. The xylem parenchyma is well preserved but the phloem tissue is only preserved in patches. The tabular parenchyma (PL. 2, FIG. 14) is present in 1-2 layers of cells but the radiating parenchyma is absent.

The ground tissue (PL. 2, FIGS. 10, 13) consists of narrow more or less rectangular cells, often of various shapes, forming loose meshes with conspicuous intercellular spaces, big enough to be visible to the naked eye (0·02-0·25 mm.). Very rarely, the cells between the neighbouring bundles are closely placed leaving very small lacunae. In longitudinal sections (PL. 2, FIG. 15), the cells of the ground tissue are small, round to oval or tangentially elongated with rounded to angular ends. They are usually

arranged in tiers. Sometimes they also form chains.

The pitting of the big metaxylem vessels is of scalariform type (PL. 2, FIG. 16).

The leaf-traces are frequent in this region and show a number of small vessels in addition to big vessels (PL. 2, FIG. 13).

COMPARISON AND DISCUSSION

The palm wood described here differs markedly from the hitherto known Indian species with lacunar ground tissue (SCHENK, 1882; STENZEL, 1904; SAHNI, 1931; RODE, 1933; SHUKLA, 1939; RAMANUJAM, 1953).

Palmoxylon chhindwarense shows wide differences from both the Jammu species, viz. *Palmoxylon jammuense* Sahni (1931) and *Palmoxylon wadiai* Sahni (1931). From *P. jammuense, P. chhindwarense* differs in the presence of ventral sclerenchyma and tabular parenchyma in the bundles and in the absence of radiating parenchyma round the vascular part of the fibrovascular bundles. Also from *P. wadiai*, the present species is distinguished in the presence of tabular parenchyma over the fibrous part of the fibrovascular bundles and in the absence of numerous scattered, thick-walled cells in the ground tissue.

Both the species of palm wood, viz. *Palmoxylon hislopi* Rode (1933) and *Palmoxylon kamalam* Rode (RODE, 1933; SHUKLA, 1939), from the Deccan Intertrappean Series, are also quite distinct from *P. chhindwarense*. *P. hislopi* differs from the present species in having radiating parenchyma round the vascular part of the bundles. Similarly, *P. kamalam* is quite distinct from *P. chhindwarense* in having radial parenchyma all round the fibrovascular bundles, in the absence of tabular parenchyma round the fibrous part of the bundles, and lastly in the presence of distinct compartments in the ground tissue enclosing 1-2 fibrovascular bundles.

Palmoxylon mathuri Sahni (1931) from Cutch, differs from *P. chhindwarense* in having exceedingly slender fibrous bundles in the ground tissue looking like a loose network of cells, and in the presence of very small fibrovascular bundles with their characteristic form.

Palmoxylon arcotense Ramanujam (1953) differs from *P. chhindwarense* in the low frequency of the bundles (20-110 per cm.^{2}), in slightly high f/v ratio of the bundles (15 : 1; 8 : 1 to 5 : 1; 3 : 1 to 2 : 1), and lastly in the absence of ventral sclerenchyma in the fibrovascular bundles.

Palmoxylon chhindwarense also differs quite markedly from *P. dakshinense* Prakash described in the preceding pages. The distinguishing characters are: the presence of radiating parenchyma in association with the fibrovascular bundles in *P. dakshinense*; the low frequency (200-270; 50-90 per cm.^{2}) and the high f/v ratio (10 : 1 to 16 : 1; 12 : 1 to 17 : 1) of the fibrovascular bundles in the dermal and subdermal zones of *P. dakshinense*; the orbicular to obovate shape of fibrovascular bundles of subdermal zone in *P. dakshinense* as opposed to variously shaped bundles, often with one or more flat sides in the corresponding region of *P. chhindwarense*; the presence of canal-like structures in the dermal zone of *P. dakshinense;* and lastly the type of lacunar ground tissue formed of a network of Y-shaped cells in *P. dakshinense*. However, in *P. chhindwarense* the ground tissue consists of narrow, more or less rectangular cells, often of various shapes forming loose meshes.

Palmoxylon chhindwarense only approaches the foreign species, *Palmoxylon ligerinum* Crie (CRIE, 1892; Stockmans & WILLIERE, 1943b) in some features. In both, the tabular parenchyma (STOCKMANS & WILLIERE, 1943b, PL. 2, FIG. 1) is present and the nature of ground tissue is somewhat similar (loc. cit., PL. 1, FIG. 4). However, the two species differ in several points. The differences are: (1) the shape of the bundles in *P. ligerinum*, the fibrous part being hemispherical with a typically flat median sinus; (2) the presence of radiating parenchyma round the vascular part of the fibrovascular bundles in *P. ligerinum*; and (3) in having 1-3 layers of tabular parenchyma in *P. ligerinum* as against 1-2 layers in *P. chhindwarense*.

Palmoxylon chhindwarense is, therefore, distinct from all the species known so far from India and outside and described under a new specific name. The specific name given to the fossil indicates the district from which the fossil palm was collected.

DIAGNOSIS

Fibrovascular bundles irregularly orientated in cortical zone; crowded, 297-625 per cm.^{2}, of various forms and regularly orientated in dermal zone; comparatively sparse,

156-250 per cm.^{2}, variously shaped, often with one or more flat sides, usually regularly orientated in subdermal zone; scattered widely and irregularly, 60-130 per cm.^{2}, and orbicular to oval in central zone. F/v ratio 4·5 : 1 to 8 : 1 in dermal, 3 : 1 to 5 : 1 in subdermal and mostly 2·5 : 1 to 3 : 1 in central zone. Tabular parenchyma present but radiating parenchyma absent. Ground tissue rather compact with round to oval cells in dermal zone, slightly lacunate in subdermal zone, and highly lacunate in central zone, with quite big intercellular spaces (0·02-0·25 mm.). Leaf-traces present.

Locality — Mohgaon Kalan, in Chhindwara district of Madhya Pradesh.

Horizon — Deccan Intertrappean Series.

Age — Tertiary (probably Eocene).

Type specimen — B.S.I.P. Museum No. 5571.

ACKNOWLEDGEMENT

I take this opportunity to express my sincere thanks to Prof. K. R. Surange for his kind help and criticism during the progress of this work.

REFERENCES

*Crie, L. (1892). Recherches sur les Palmiers silicifiés des terrains Crétacés de l' Anjou. *Bull. Soc. Etudes. Scient. Angers.* Nouvelle Série, 21.

Lakhanpal, R. N. (1955). *Palmoxylon surangei*, a new species of petrified palms from the Deccan Intertrappean Series. *The Palaeobotanist.* **4**: 15-21.

Ramanujam, C. G. K. (1953). *Palmoxylon arcotense* sp. nov., a fossil palm resembling the living genus *Livistona* from South India. *Ibid.* **2**: 89-91.

Rode, K. P. (1933). Petrified palms from the Deccan Intertrappean beds — II. *Q. J. Geol. Min. Met. Soc. India.* **5**(3): 75-83.

Idem (1934). A note on the petrified palms from Mohgaon Kalan, District Chhindwara, C.P. *Proc.* 21*st Indian Sci. Cong. Bombay.* (3): 349.

Sahni, B. (1931). Materials for a monograph of the Indian petrified palms. *Proc. Acad. Sci. U.P.* **1**: 140-144.

Sahni, B. (1943). A new species of petrified palm stems, *Palmoxylon sclerodermum* sp. nov., from the Deccan Intertrappean Series. *J. Indian bot. Soc.* **22** (2-4): 209-224.

Idem (1946). A silicified *Cocos*-like palm stem, *Palmoxylon* (*Cocos*) *sundaram* from the Deccan Intertrappean beds. *Ibid.* (*M.O.P. Iyengar Commemoration Volume*): 361-374.

*Schenk, A. (1882). Die von den Gebrüdern Schlagintweit in Indien gesammelten fossil Hölzer; in Engler, *Bot. Jahr. für Systemat.* **3**. *Leipzig.*

Shukla, V. B. (1939). On *Palmoxylon kamalam* Rode, from the Deccan Intertrappean Series with especial reference to the importance of ground tissue in the classification of palms. *Rec. Geol. Surv. India.* **74**(4): 492-503.

Idem (1941). Central Provinces (Intertrappean Beds). Palaeobotany in India — II. *J. Indian bot. Soc.* **21**(3, 4): 221.

Idem (1946). *Palmoxylon sclerodermum* Sahni from the Eocene beds of Nawargaon, Wardha District, C.P. *Ibid.* **25**(3): 105-116.

Stenzel, K. G. (1904). Die fossile Palmenhölzer. Palaeontologie und Geologie Österreich-ungarns und des Orients. *Mitt. des. Geol. U. Pal. Ins. der Universitat Wien.* **16**: 107-287.

Stockmans, F. & Williere, Y. (1943a). Palmoxylons Paniséliens de la Belgique. *Mém. Musée. Royal Hist. Nat. Belgique.* **100**: 3-75.

Idem (1943b). Figuration nouvelle du *Palmoxylon ligerinum* Crié. *Ibid.* **19**(24): 1-4.

*Not seen by me.

EXPLANATION OF PLATES

Plate 1

Palmoxylon dakshinense sp. nov.

1. A part of the polished transverse surface of the fossil under low magnification to show the cortical, dermal and subdermal regions. Note small and crowded bundles in dermal region. × 2.

Cor. r. — cortical region, *d. r.* — dermal region, *sd. r.* — subdermal region.

2. An oval body with round to oval cells in the middle bounded by a number of radially disposed cells. × 110.

3. Scalariform pitting of metaxylem vessels. × 210.

4. Subdermal zone enlarged. Note the lacunate ground tissue. × 15.

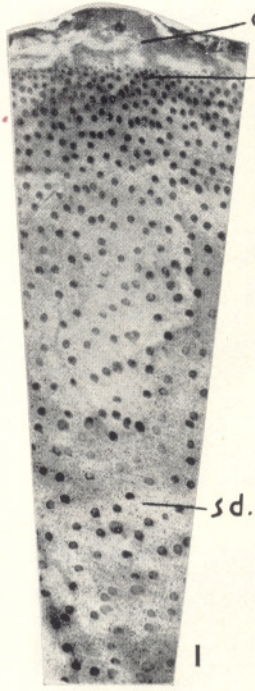
5. The ground tissue between the two neighbouring fibrovascular bundles of the subdermal zone. × 40.

6. Few irregularly orientated fibrovascular bundles. × 15.
7. A fibrovascular bundle from the dermal zone with surrounding ground parenchyma. × 90.
8. Longitudinal section of a part of the stem. × 30.
9. A part of the outer region of the stem showing cortical and dermal zones. × 10.

Plate 2

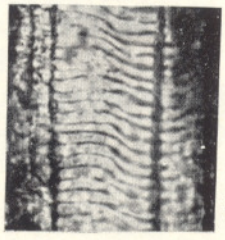
Palmoxylon chhindwarense sp. nov.

10. Central zone slightly enlarged to show the irregular orientation of the fibrovascular bundles. Also note the lacunate ground tissue. × 10.
11. Two fibrovascular bundles from the dermal zone with surrounding parenchyma. × 90.
12. Subdermal zone enlarged. Note the distribution, shape and size of the fibrovascular bundles. × 10.
13. Two leaf-trace bundles from the central zone with surrounding lacunate ground tissue. × 25.
14. A fibrovascular bundle from the central zone with tabular parenchyma. × 85.
15. Longitudinal section of a part of the stem. × 30.
16. Scalariform thickenings under high power. × 200.
17. Dermal zone slightly enlarged. Note the shape, size and distribution of the fibrovascular bundles. × 10.

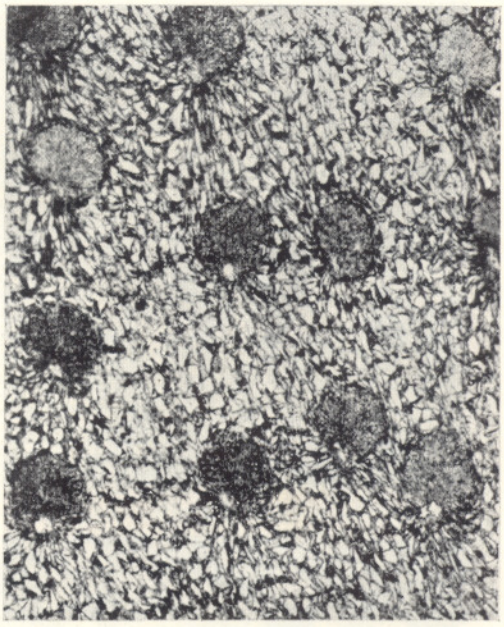


1

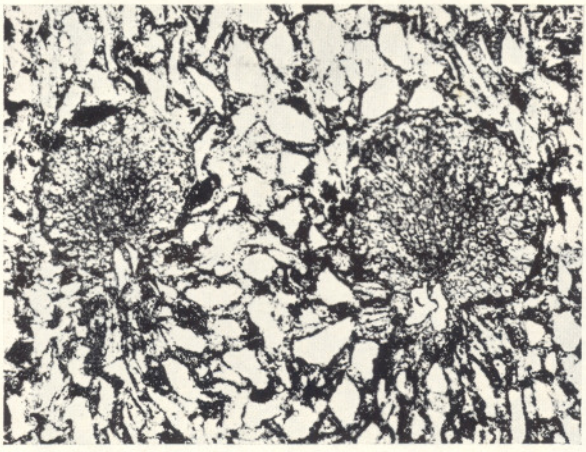
2



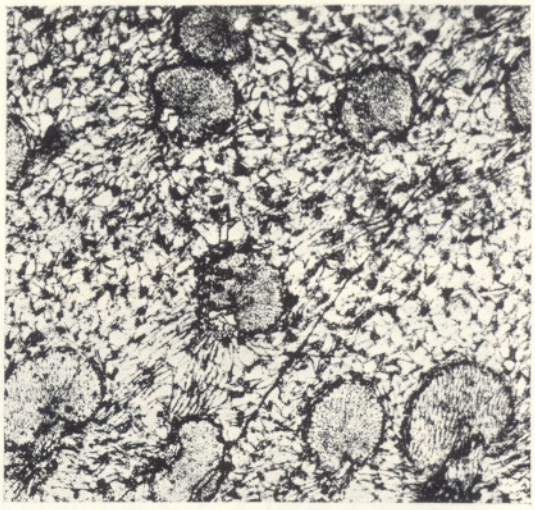
3



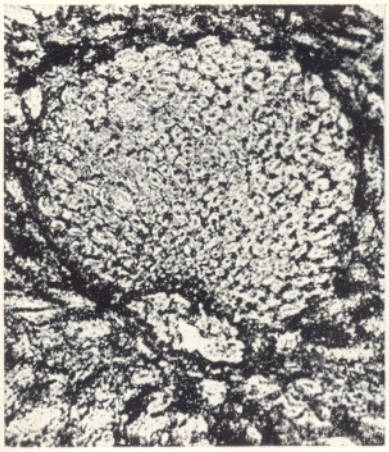
4



5

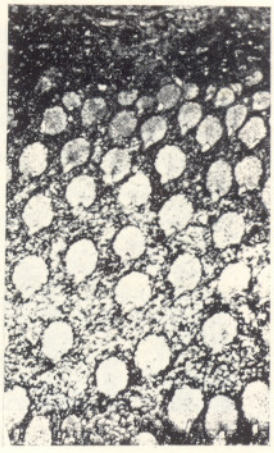


6

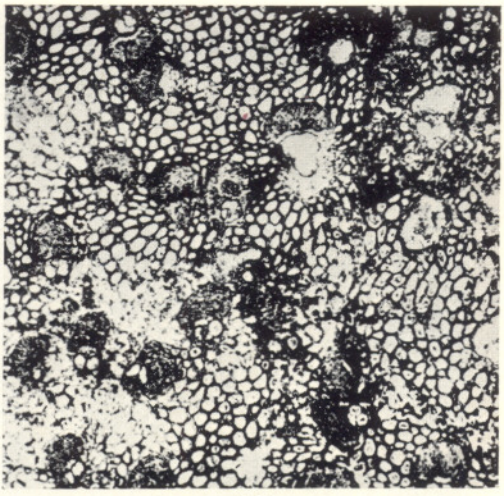


7

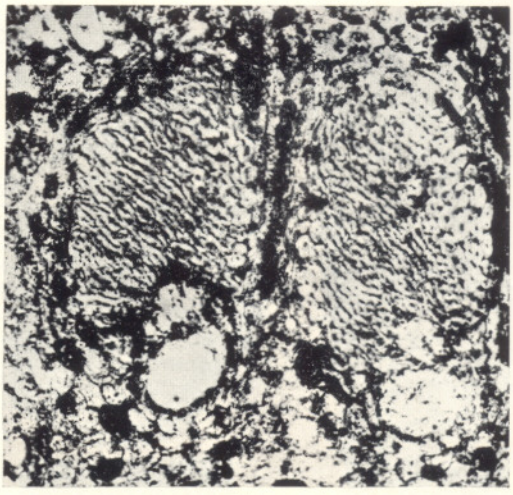
8



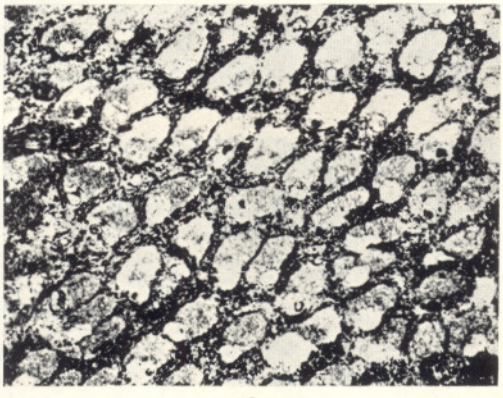
9



10



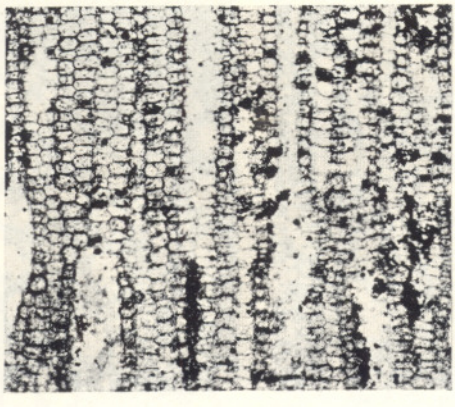
11



12

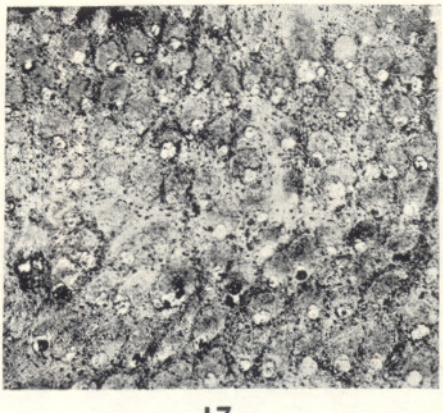
14

13



15

16



17