

A PETRIFIED PALM STEM, *PALMOXYLON SUPERBUM*,
SP. NOV. FROM KERIA, DECCAN INTERTRAPPEAN SERIES,
IN CHHINDWARA DISTRICT, M.P.

B. S. TRIVEDI & C. L. VERMA

Botany Department, Lucknow University, Lucknow

ABSTRACT

In the present paper a new species of *Palmoxylon*, *Palmoxylon superbum* sp. nov. is described from the Deccan Intertrappean beds. The palm woods were collected from Keria, a village about 3.2 kilometers south of Mohgaon kalan, in Chhindwara district, M.P. The species is characterized by fundamental porous ground tissue and belongs to the subgroup Cordata of petrified palm woods.

INTRODUCTION

A NEW species of petrified palm stems is described here. The petrified palm pieces were collected by us in December 1968 from Keria, a village which is about 3.2 kilometers south of the well known locality of Mohgaon Kalan in the Deccan Intertrappean series in Chhindwara district M.P. Some pieces of palm woods are well preserved and are new. So far only one species of *Palmoxylon*, *P. Surangei* has been described by Lakhanpal (1955) from this locality. The specimen described here is quite a large piece of petrified palm wood, consisting of cortical, dermal, subdermal and central zones.

Many sections, both longitudinal and transverse have been cut for detailed anatomical studies. No stain has been used because the structures are very clear and preservation is excellent in all parts of the wood.

After thorough and detailed investigations, it has been found that this piece of stem represents a new species of *Palmoxylon* belonging to the subgroup Cordata of petrified palm stems. The descriptive terminology used here is the same as suggested by Prof. B. Sahni (1943).

DESCRIPTION

MONOCOTYLEDONEAE

PALMMAE

Palmoxylon superbum sp. nov.

External Characters—The specimen is quite large, brown in colour, which before

sectioning, measured 8 cm. in length and 5.5 cm. in diameter. In hand specimen the cortical zone is clearly seen, next to the cortex are the dermal, subdermal and central zones.

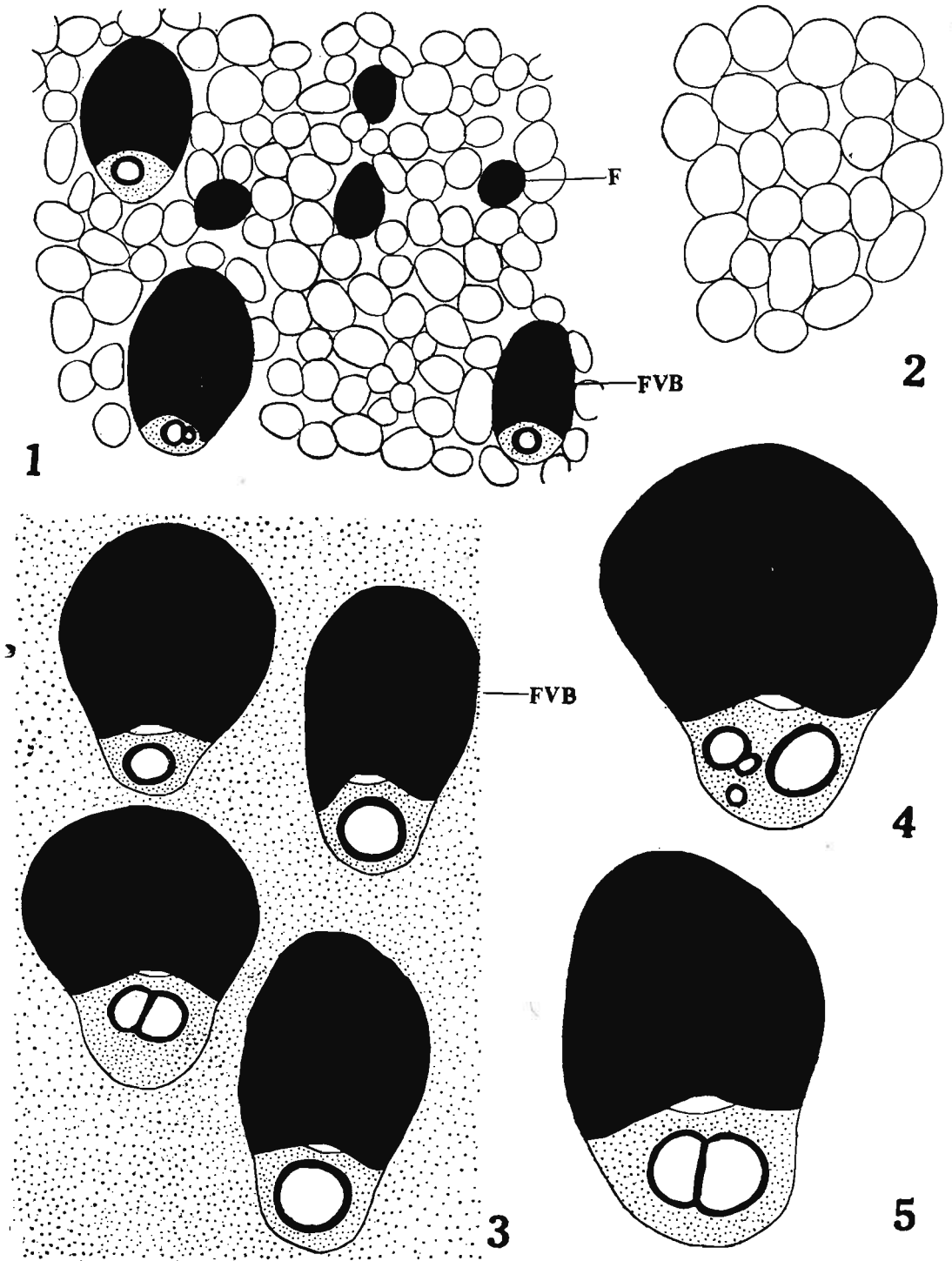
Anatomy

Cortex—It is incomplete and 0.6 cm. in thickness. It consists of numerous fibrous bundles which are usually circular to slightly oval or elongated in cross sections, and are scattered in ground tissue (TEXT-FIG. 1; PL. 1, FIG. 1). The fibrovascular bundles measure 165-380 μ in diameter and usually possess 1 or 2 vessels. The ground tissue is made up of Parenchymatous cells, circular to oval in cross section (TEXT-FIG. 2) and are loosely arranged forming intercellular spaces.

Dermal Zone—This zone is about 1.2 cm. thick. In this zone fibrovascular bundles are closely placed and are normally oriented (TEXT-FIG. 3; PL. 1 FIG. 2). The fibrovascular bundles are small and are of various shape and size. They measure 330-455 μ in diameter and usually possess 1-2 vessels (TEXT-FIG. 7; PL. 1, FIG. 2). Stegmata have been observed round the fibrous part of the bundles and the phloem cells are clearly visible. The average frequency is 100-130 per cm.² and their F/V ratio is 9:1 to 12 : 1. Purely fibrous bundles are absent in this zone. The ground tissue is parenchymatous, cells are somewhat round (TEXT-FIG. 8), rather compact with small intercellular spaces.

Subdermal Zone—This zone is about 1.5 cm. thick. The fibrovascular bundles are regularly oriented (TEXT-FIG. 9) towards the periphery of this zone becoming gradually irregular towards the central zone. They are comparatively more widely spaced, 60-70 per cm.², generally broadly oval to slightly ovate in cross section. The fibrovascular bundles are small, 330-412 \times 495-578 μ , and their F/V ratio is 10 : 1 to 17 : 1.

The dorsal sclerenchyma is broadly round, the xylem usually consists of 2-3



TEXT-FIGS. 1-5 — 1. A part of cortex showing purely fibrous bundles and fibrovascular bundles, 2. few cortical cells. 3. Distribution of fibrovascular bundles (FVB) in dermal zone. 4-5. Different kinds of fibrovascular bundles in dermal zone.

metaxylem vessels placed side by side and 1-2 small protoxylem vessels; phloem cells are clearly seen between xylem and median sinus. The auricular lobes are more or less round and the median sinus concave. Tabular parenchyma is present round the fibrous part of the fibrovascular bundle but radiating parenchyma is absent round the vascular part of the bundles. The ventral sclerenchyma is present here.

The purely fibrous bundles occur in this zone and consist on an average of more than 25 fibres. They are about 85-125 μ in diameter. The stigmata are present in both fibrous bundles and in the fibrous part of the fibrovascular bundles.

The ground tissue is lacunate, it is formed by a network of narrow cells enclosing conspicuous polygonal intercellular spaces. (TEXT-FIG. 12).

The leaf trace bundles also occur in the subdermal and central zone but are best seen in this zone. In these bundles xylem is greatly developed, approximately double that of the normal fibrovascular bundles.

Central Zone—In this zone fibrovascular bundles are irregularly oriented and are widely placed in well developed lacunate ground tissue (TEXT-FIG. 13; PL. 1, FIG. 3). The average frequency is 40-45 per cm^2 and their F/V ratio is 1.5: 1 to 2:1.

The fibrovascular bundles are big, they are generally oval to slightly ovate or sometime slightly elongate in cross section; big bundles measure $602 \times 412 \mu$ and small bundles $412 \times 330 \mu$. There are usually 2-3 vessels in the xylem placed side by side (PL. 1, FIG. 3). Phloem cells are very well preserved (TEXT-FIG. 26). Dorsal sclerenchyma is broadly oval, ventral sclerenchyma is also present. Median sinus is concave, auricular lobes are some what rounded. Tabular parenchyma is present round the fibrous part of the fibrovascular bundles but radiating parenchyma is absent.

Purely fibrous bundles (TEXT-FIGS. 13, 28) are present in this zone. The stigmata are present both in fibrous bundles and the fibrous part of the fibrovascular bundles. They are spherical in shape and are arranged in rows, (PL. 1, FIG. 4).

The pitting of metaxylem vessels is of multiseriate scalariform type (PL. 1, FIG. 5). The perforated end walls of the vessels are obliquely placed and show 3 to 6 widely spaced parallel bars of thickening (TEXT-FIG. 22). The pitting of the protoxylem

vessels is of spiral type (TEXT-FIG. 23).

The leaf trace bundles are also seen in this zone (TEXT-FIG. 17). The structure of ground tissue is essentially the same as in the subdermal zone, but because of the wide spaces between the bundles and the network of narrow cells, the intercellular spaces become larger as one proceeds towards the centre. The cells of the ground tissue in longitudinal section are small, square to rectangular and are arranged in tiers (PL. 1, FIG. 4).

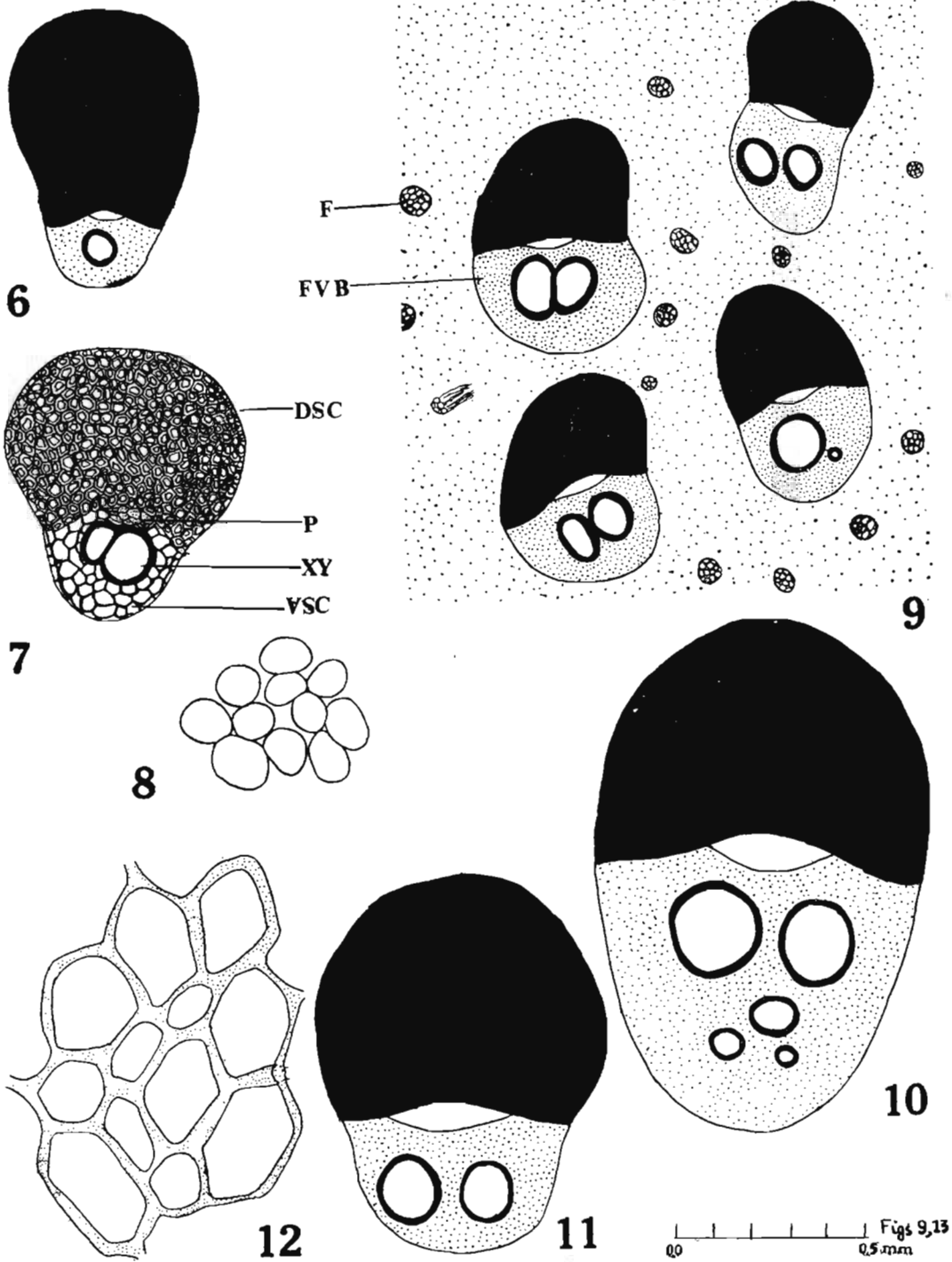
DISCUSSION AND COMPARISON

A large number of petrified palm woods referable to the artificial genus *Palmoxylon* have been described from India and abroad. The species reported here falls under the subgroup Cordata of Sahni's Scheme of classification of petrified palm stems which is based on the classification of Von Mohl (1849) and Stenzel (1904). The species described here is characterized by well developed lacunate ground tissue. Of the already described petrified palm woods from India, only *P. blanfordi* Schenk (1882), *P. Wadiai* Sahni (1931, 1964), *P. mathuri* Sahni (1931, 1932) *P. jammuense* Sahni (1931), *P. kamalam* Rode (1933), *P. hislopi* Rode (1933), *P. arcotense* Ramanujam (1953), *P. dakshinense* Prakash (1958), *P. chhindwareense* Prakash (1958), *P. eocenum* Prakash (1961) have fundamental porous ground tissue.

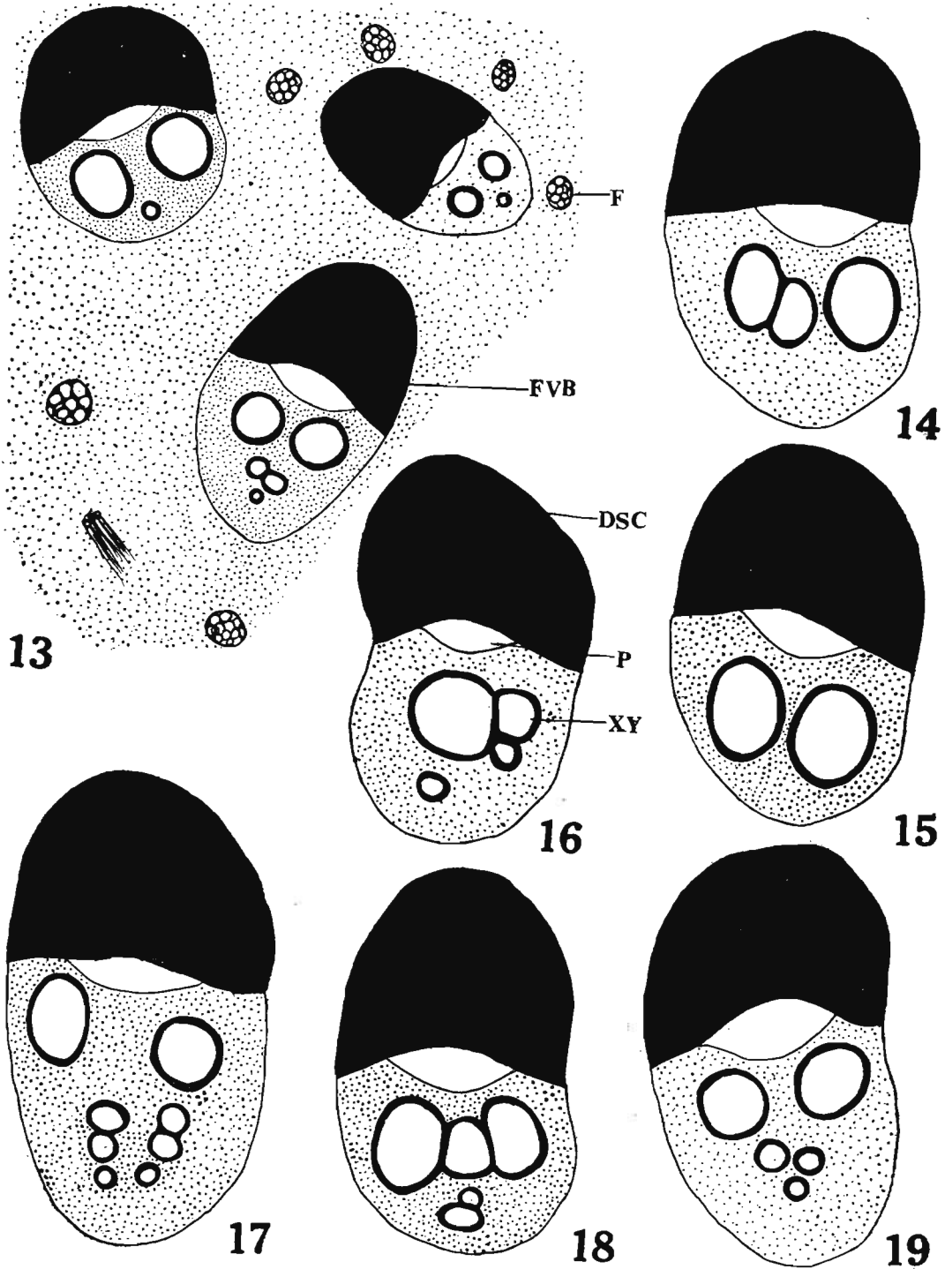
The present species has been compared with *P. dakshinense*, *P. chhindwareense*, *P. eocenum* and *P. surangei* in detail (Table 1); other species have also been compared and their characters are shown in a tabular form in (Table 2).

P. superbum shows some similarity with *P. ligerinum* (STOCKMANS & WILLIERE, 1943) in the nature of fundamental lacunate ground tissue, but present species is quite distinct in many characters.

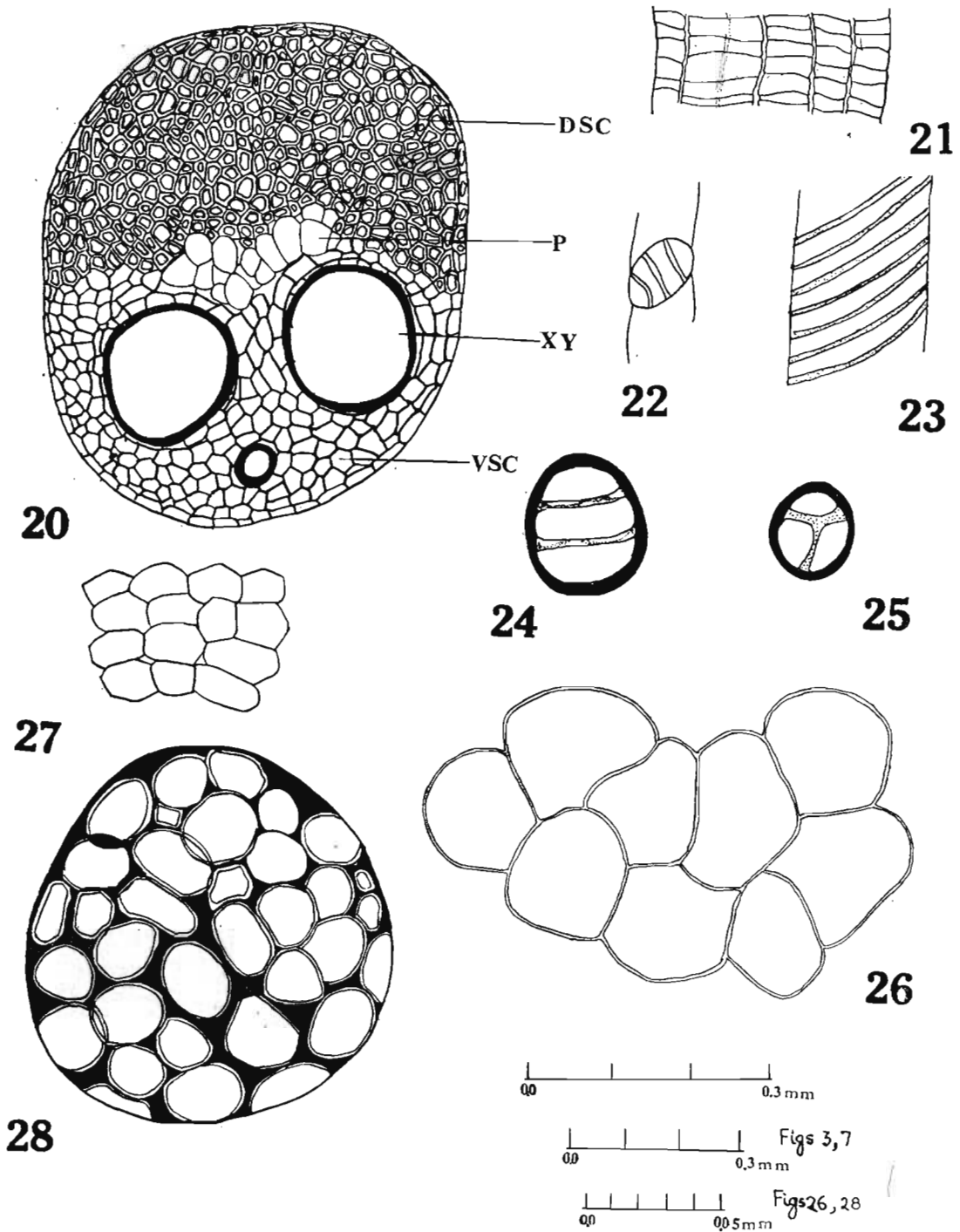
After a detailed investigation and comparison of all known species of *Palmoxylon* from India and outside, it has been found that the present species is quite distinct and is not identical with any species described so far from India or outside; hence it is given a new specific name *P. superbum*. The specific epithet expresses the quality of its preservation.



TEXT-FIGS. 6-12 — 6. Fibrovascular bundle of dermal zone near the boundary of the cortex. 7. A fibrovascular bundle of dermal zone showing dorsal sclerenchyma (DSC), xylem (xy) and phloem (P). 8. Few cells of ground tissue in dermal zone. 9. A part of subdermal zone showing the distribution of fibrous (F) and fibrovascular bundles. 10-11. Different kinds of fibrovascular bundles in subdermal zone. 12. Few cells of lacunate ground tissue of subdermal zone.



TEXT-FIGS. 13-19 — 13. A part of central zone showing fibrovascular bundles and fibrous bundles. 14-16 & 18-19. Different kinds of fibrovascular bundles in the central zone. 17. Leaf trace bundle.



TEXT-FIGS. 20-28 — 20. A fibrovascular bundle of central zone showing all the tissues, 21. Multi-seriate scleriform thickenings of metaxylem elements, 22. Vessel end wall showing three parallel bars of thickening, 23. Spiral type of thickenings in protoxylem elements, 24-25. Vessels showing bars, 26. Phloem cells enlarged, 27. Few cells of lacunate ground tissue in L.S. arranged in tiers, 28. Purely fibrous bundle enlarged.

TABLE 1 — DETAILED COMPARISON OF PALMOXYLON SUPERBUM SP. NOV.

NAME OF SPECIES	SIMILARITIES	DISIMILARITIES
1. <i>P. dakshinense</i> Prakash (1958)	(i) General appearance and orientation of fibrovascular bundles	(i) Frequency of fibrovascular bundles (<i>P. superbum</i> ; 100-130, 60-70/cm ²) (<i>P. dakshinense</i> ; 200-270; 50-90/cm ²).
	(ii) General form of leaf-trace bundle	(ii) F/V ratio (<i>P. superbum</i> 9: 1 to 12: 1; 10: 1 to 17: 1, <i>P. dakshinense</i> 10: 1 to 16: 1; 12: 1 to 17: 1)
	(iii) presence of ventral sclerenchyma	(iii) Absence of radiating parenchyma in <i>P. superbum</i>
	(iv) presence of lacunate ground tissue	(iv) Both fibrous bundles and stegmata present in <i>P. superbum</i> ; in <i>P. dakshinense</i> only stegmata present in fibrous part of dermal bundles
2. <i>P. chhindwarensis</i> Prakash (1958)	(i) Distribution of fibrovascular bundles	(i) Frequency of bundles (100-130: 60-70: 40-45/cm ² in <i>P. superbum</i> ; 297-625; 156-250; 60-130/cm ² in <i>P. chhindwarensis</i>)
	(ii) presence of lacunate ground tissue	(ii) F/V ratio (9: 1 to 12: 1; 10: 1 to 17: 1; 1.5: 1 to 2: 1 in <i>P. superbum</i> , 4.5: 1 to 8: 1; 3: 1 to 5: 1; 2.5: 1 to 3: 1 in <i>P. chhindwarensis</i>)
	(iii) presence of posterior sclerenchyma	(iii) both fibrous bundles and stegmata present in <i>P. superbum</i> , altogether absent in <i>P. chhindwarensis</i>
	(iv) structure of leaf trace bundle	
	(v) presence of tabular parenchyma	
3. <i>P. eocenum</i> Prakash (1961)	(i) Orientation of bundles in different zone	(i) Frequency (<i>P. superbum</i> , 100-130; 60-70; 40-45/cm ² , <i>P. eocenum</i> 300-366; 66-132; 30-60/cm ²)
	(ii) presence of lacunate ground tissue	(ii) F/V ratio (<i>P. superbum</i> , 9: 1 to 12: 1; 10: 1 to 17: 1; 1.5: 1 to 2: 1, <i>P. eocenum</i> 6.5: 1 to 10.5: 1; 3: 1; 2.5: 1 to 3.5: 1)
	(iii) general form of leaf-trace bundle	(iii) Cordate sclerenchyma in <i>P. superbum</i> reniform in <i>P. eocenum</i>
		(iv) presence of ventral sclerenchyma in <i>P. superbum</i> (absent in <i>P. eocenum</i>)
		(v) Fibrous bundle and stegmata present in <i>P. superbum</i> , both absent in <i>P. eocenum</i> .
4. <i>P. surangei</i> Lakhanpal (1954)	(i) Orientation of fibrovascular bundles	(i) Frequency (100-130; 60-70; 40-45/cm ² in <i>P. superbum</i> ; 90-95; 45-50; 25/cm ² in <i>P. surangei</i>)
	(ii) Form of dorsal sclerenchyma	(ii) F/V ratio (9: 1 to 12: 1; 10: 1 to 17: 1; 1.5: 1 to 2: 1 in <i>P. superbum</i> , 7/8 rare-7: 1; 5: 1 to 6: 1; 4: 1 in <i>P. surangei</i>)
	(iii) Presence of fibrous bundles and stegmata	(iii) Ventral sclerenchyma present in <i>P. superbum</i> , absent in <i>P. surangei</i>
	(iv) presence of tabular parenchyma	(iv) Lacunate ground tissue in <i>P. superbum</i> , compact in <i>P. surangei</i> .

DIAGNOSIS

Genus-Palmoxylon

SUBGROUP-CORDATA

Palmoxylon superbum sp. nov.

(Plate 1, Text-figs. 1-28)

Fibrovascular bundles and fibrous bundles irregularly orientated, size in cortical

zone varies. Dermal bundles 100-130 per cm², F/V ratio 9: 1 to 12: 1, regularly orientated, median sinus concave, vessels 1-2. Subdermal bundles regularly orientated, 60-70/cm², F/V ratio 10: 1 to 17: 1, median sinus concave, vessels 2-3. Central bundles irregularly orientated, 40-45 per cm², F/V ratio 1.5: 1 to 2: 1, median sinus deep, concave, auricular lobes rounded; Fibrous

TABLE 2

NAME OF SPECIES	PARTS AVAILABLE	SUB-GROUP	CORTEX	FREQUENCY OF FIBROVASCULAR BUNDLES PER CM ²	F/V RATIO OF THE BUNDLE	SIZE OF BUNDLE IN mm	MEDIAN SINUS AND AURICULAR LOBES	XYLEM VESSELS	PHLOEM	LEAF TRACE BUNDLE	POSTERIOR SCLERENCHYMA	GROUND TISSUE			FIBROUS BUNDLE, STIGMATH
												General parenchyma	Tabular parenchyma	Radiating parenchyma	
<i>P. blanfordi</i> schenk (1892)	Central	Reniformia	—	14 cm ²	2-3/1	—	shallow and broad, lobes rounded	2	not preserved	—	absent	lacunar	present	present	absent, stigmata present in the outer part of sclerenchyma
<i>P. wadii</i> Sanhi (1937)	Subdermal and central	Reniformia	—	SD 30/cm ²	2.5/1 to 4/1	1 × 1.3 mm	deep and rounded, lobes rounded	1-2	not preserved	present	present	Lacunar, scattered thick walled cells also present	absent	absent	both absent
<i>P. mathuri</i> (Sahni, 1931)	Central	Reniformia	—	24-25/cm ²	2/3	0.3-0.4 × 0.5-0.6mm	deep and broad, lobes rounded	2	not preserved	—	absent	lacunar	—	—	Fibrous bundles and stigmata present
<i>P. jammuense</i> (Sahni, 1931)	Subdermal	Lunaria	—	13/cm ²	12-16/1	1.50 × 1.45 mm	small, rounded or angular, lobes narrowly rounded, angular	1-2	not preserved	present	absent	lacunar	2-3 layer	—	both absent
<i>P. kalmalam</i> (Rode 1933)	subdermal nearly central zone	Complanata	—	70/cm ²	1.5-2/1	—	flat, lobes rounded	2	not preserved	—	—	extremely lacunar	—	present	both absent
<i>P. hislopi</i> (Rode, 1933)	subdermal	Lunaria	—	65-104/cm ²	58/1	—	sinus rounded, lobes us. angular	2	not preserved	—	—	lacunar	present	—	both absent
<i>P. arcotense</i> (Ramanujam, 1953)	Dermal, subdermal, central	Reniformia (?)	—	D. 110/cm ² SD. 50-65/cm ² C. 20-25/cm ²	D 15/1, SD 5/1 to 8/1, C 2/1 to 3/1	D 0.05-10, SD 0.17, C 0.10-0.2	orbicular to reniform, lobes rounded	2	—	rarely present	absent	lacunar	absent	absent	both absent
<i>P. dakshinense</i> (Prakash, 1958)	cortex incomplete dermal, subdermal	Cordata	numerous fibrous and few fibrovascular bundles	D. 200-270/cm ² SD. 50-90/cm ²	D 10/1-16/1, SD 12/1-17/1	D 0.16-0.56, SD 0.60-0.90	sinus concave, lobes pointed	1-2	not preserved	present	present	lacunar	present	present	fibrous bundle absent, stigmata present in fibrous part of dermal bundle
<i>P. chhindwarensis</i> (Prakash, 1958)	cortex, dermal, subdermal, central	Cordata	fibrovascular bundles present	D. 297-625/cm ² SD. 156-250/cm ² C 60-130 cm ²	D 4.5/1-8/1, SD 3/1-5/1, C 2.5/1-3/1	D 0.2-0.62, SD 0.69-0.72, C 0.58-0.80	sinus deep, concave, lobes round, sometimes pointed	1-2	not seen clearly	present	present	lacunar	present	absent	both absent
<i>P. eocenum</i> (Prakash, 1961)	Dermal, subdermal, central	Reniformia	—	D. 300-366/cm ² SD. 66-132/cm ² C 30-60/cm ²	D. 6.5/1-10.5/1, SD 3/1, C 2.5/1-3.5/1	D. 0.28-0.56, SD. 0.52-0.94, 0.24-0.40, small bundle C 0.60-1.07, 0.40-0.27	sinus concave, lobes rounded to pointed	1-2	not preserved	sporadic	—	lacunar	present	present	both absent
<i>P. superbum</i> sp. nov.	cortex, dermal, subdermal, central	Cordata	fibrous and fibrovascular bundles	D. 100-130/cm ² SD 60-70/cm ² C 40-45/cm ²	D. 9/1 to 12/1, SD 10/1 to 17/1, C 1.5/1-2/1	D. 0.33-0.45, SD. 0.33-0.41 × 0.49-0.57, C 0.60 × 0.41, 0.41 × 0.33	sinus concave, lobes rounded	D. 1-2 SD us. 2 C 2-3,	well preserved	present in subdermal central zone, rarely dermal	present	extremely lacunar	present	absent	both fibrous bundle and stigmata present, stigmata spherical

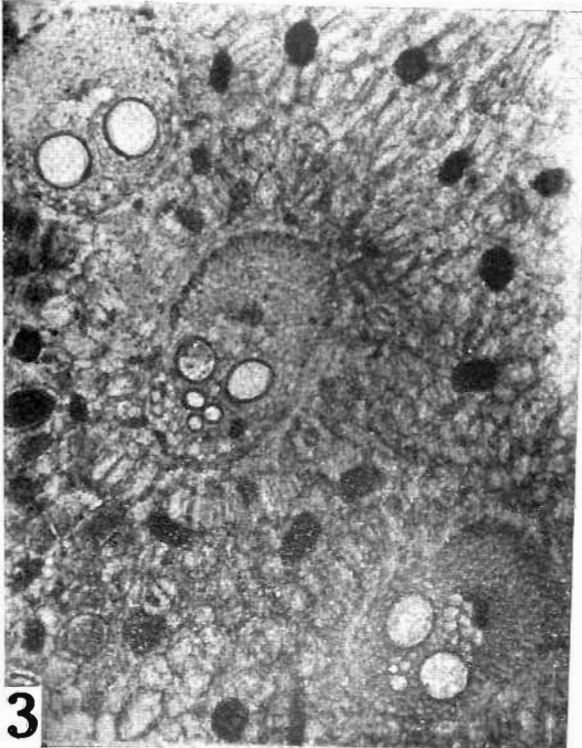
D — Dermal zone, SD — Subdermal zone, C — Central zone.



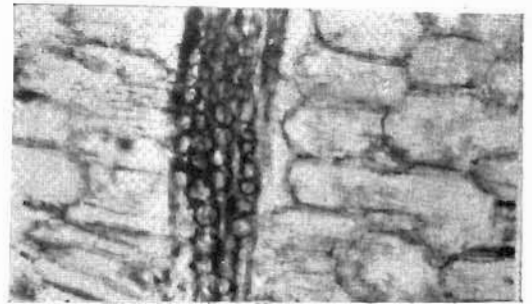
1



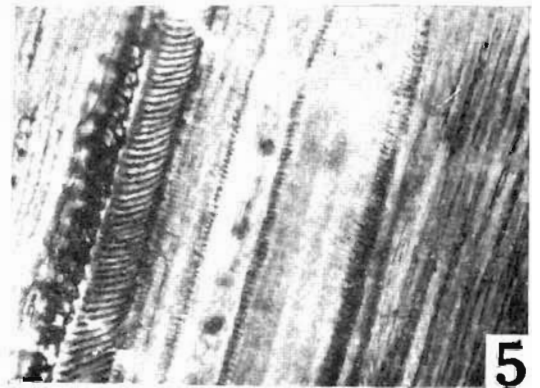
2



3



4



5

bundles present in cortical, subdermal, and central zones, 85-125 μ in diameter; stigmata present both in fibrous bundles and in fibrous part of the fibrovascular bundles. Leaf trace bundles present in dermal, rare in subdermal and central zones. Ventral sclerenchyma present. Ground tissue lacunate in subdermal and central zones.

Locality — Keria, a village in Chhindwara district, Madhya Pradesh, about 3.2 kilometers south of the well known locality of Mohgaon Kalan.

Horizon and age — Deccan Intertrappean series. Tertiary (Probably Eocene).

Collection — Specimen No. K/80, at present with Dr. B.S. Trivedi, Botany Department Lucknow University, Lucknow.

ACKNOWLEDGEMENTS

Junior author is grateful to University Grants Commission for the financial aid, with the help of which it was possible to carry out this work.

REFERENCES

- LAKHANPAL, R. N. (1955). *Palmoxylon surangei*, a new species of petrified palms from the Deccan Intertrappean series. *Palaeobotanist*, **4**: 15-22.
- PRAKASH, U. (1958). Studies in the Deccan Intertrappean flora: Two-palm woods from Mohgaon Kalan. *Palaeobotanist*, **7**(2): 136-142.
- Idem (1961). *Palmoxylon eocenum* sp. nov. from the Deccan Intertrappean beds of Mahurzari. *Ibid.* **10**(1): 6-9.
- 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. *Q. Jl. geol. Min. metall. Soc. India*, **5**(2): 75-83.
- SAHNI, B. (1931). Materials for a monograph of the Indian petrified palms. *Proc. Acad. Sci. U.P.* **1**: 140-144.
- Idem (1932). *Palmoxylon mathuri* a new species of Petrified palms, from Cutch, western India. *Proc. 19th Indian Sci. Congr.*: 322.
- Idem (1943). A new species of petrified palm stems *Palmoxylon scleroderium* sp. nov. from the Deccan Intertrappean series. *J. Indian Bot. Soc.* **22**(2-4): 209-224.
- Idem (1964). Revisions of Indian fossil plants, Part III Monocotyledens: 1-89.
- *SCHENK, A. (1882). Dei Von den Gebrüderm schlagintweit in Indian gesammelten fossil Hölzer, in *Engler, Bot. Jahrb. Fur. systemat.* **3** Leipzig.
- STENZEL, K. G. (1904). Fossile Palmenhölzer, *Palaeontologie und geologie österreich-ungarns und des orientis*, **14**: 107-287.
- VON MOHL, HUGO (1849). On the structure of palm stem. Ray society reports and papers on Botany: 1-92 London.
- *STOCKMANS, F. & WIELLIERE, Y. (1943). Figuration Nouvelle de *Palmoxylon ligerinum*, *Bull. Musé. Roy Hist. Nat. Belgique*, **19**: 1-4.

*Not seen in original.

EXPLANATION OF PLATE

PLATE 1

1. Part of a cross section of cortical region showing the distribution of fibrovascular bundles and fibrous bundles. $\times 18$.

2. Part of a cross section of dermal zone showing the regularly distribution of fibrovascular bundles. $\times 18$.

3. Part of a cross section of central zone showing three fibrovascular bundles and purely fibrous bundles. $\times 18$.

4. A part of ground tissue in L.S. showing the stigmata and cells arrangement. $\times 44$.

5. A Part of longitudinal section through vessel showing multiseriate scalariform and spiral type of thickening. $\times 44$.