

STUDIES IN THE GLOSSOPTERIS FLORA OF INDIA — 13.
BARAKAROXYLON, A NEW GENUS OF PETRIFIED WOOD
FROM THE LOWER GONDWANAS OF INDIA

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ABSTRACT

A *novo* combination — *Barakaroxylon jhariense* is proposed for the wood *Dadoxylon jhariense* Surange & Sah. This wood possesses a solid pith, with marginal vertically running secretory canals and secretory cells. Another new species of *Barakaroxylon*, i.e. *B. kraeuseli* is instituted. This wood is characterized by the presence of pitting only on the radial walls of the tracheids and secretory canals scattered all over the pith.

INTRODUCTION

A NUMBER of petrified woods are known from the Lower Gondwanas of India, and all of them have been assigned so far to the single form genus *Dadoxylon*. In 1956, Surange and Sah had described a wood with secretory canals tentatively under the name *Dadoxylon jhariense*. In a recent collection from the same locality some more woods of *D. jhariense* type were found. On detailed investigation of these woods it became clear that this type is of wide occurrence and possesses characters distinct enough to warrant a new generic name. It is, therefore, described here under — *Barakaroxylon jhariense*.

DESCRIPTION

1. *BARAKAROXYLON JHARIENSE*
(SURANGE & SAH) N. COMB.

Dadoxylon Jhariense Surange & Sah (1956)

Pith

The pith is solid, fairly large, 2 cm. in diameter. The pith cells are somewhat thick-walled, parenchymatous, circular, and loosely packed with intercellular spaces. The pith cells get bigger in size from the periphery towards the centre. In longitudinal section the pith cells are squarish or rectangular, and are arranged in tiers. Some of the dark pith cells are pitted; the pits are simple, and their arrangement varies (PL. 1, FIG. 1).

Both secretory canals and secretory cells are present in the pith. The canals are arranged on the periphery of the pith, and are of varying sizes. In transverse section they are oval or circular. Each canal is lined by small rectangular cells. The canals run longitudinally and are filled with silica.

The secretory cells are scattered all over the pith, and they occur isolated or in groups. They are somewhat thick walled and filled with dark-black substance. In longitudinal section the cells are narrow, sometimes quite long, but usually they are partitioned by cross walls (PL. 1, FIG. 2).

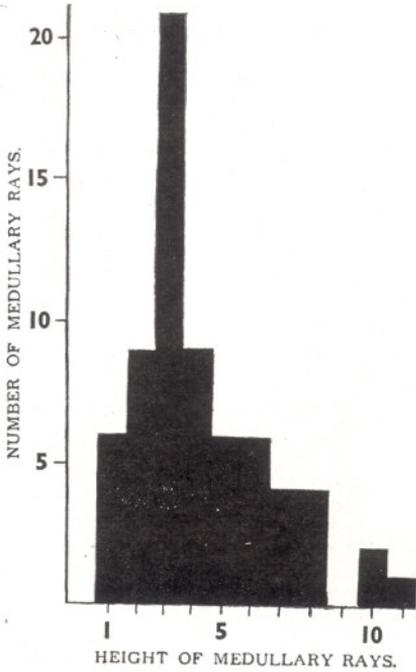
Primary xylem

The primary xylem forms a continuous ring encircling the pith, 5-12 cells wide and at some places projects deep into the pith. The primary xylem can be easily distinguished in a transverse section having thinner walls and the tracheids being rectangular or polygonal in shape. It is endarch. In longitudinal section the primary xylem shows spiral, scalariform and reticulate thickenings. However, reticulate thickenings are very rare.

Secondary xylem

The secondary xylem abuts on the primary xylem. Growth rings are distinct. Early wood zone is broader, 35-60 cells deep. The tracheids are thick-walled, rectangular, polygonal, and square in transverse section. The width of the early wood varies from 38 to 60 μ ; in exceptional cases up to 70 μ . The late wood zone is narrow, 3-4 cells deep; its tracheids are smaller transversely elongated, thick-walled and has small lumen. The width of the late wood varies from 16 to 21 μ . Intervening walls between the two tracheids are thick, and their thickness varies from 10 to 18 μ . The medullary rays are placed at the intervals of 1-11 tracheids.

Radial walls of the tracheids are pitted, from 1 to 4 seriate, commonly 2-3 seriate.



TEXT-FIG. 1 — Graph showing the frequency of medullary-ray cells (surface examined 12 mm.²).

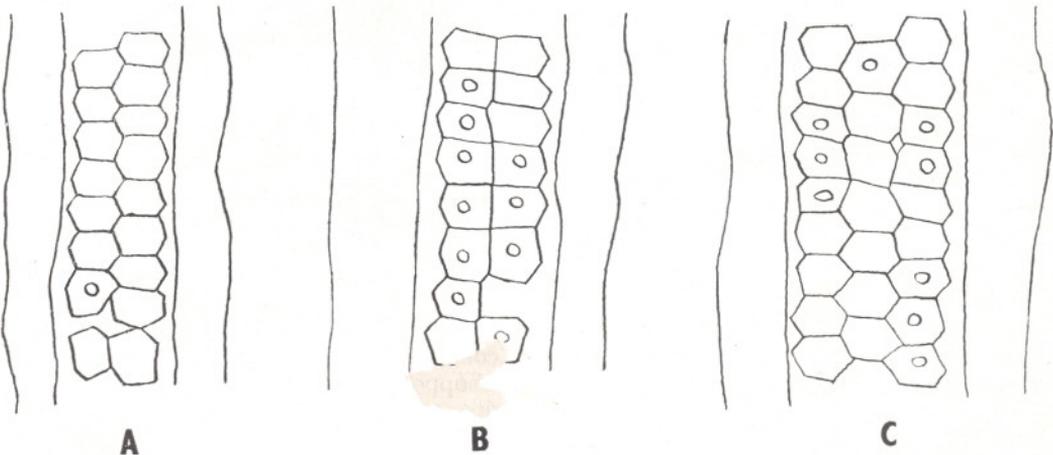
Uniseriate pits are arranged in a row. They are contiguous as well as separate. Biseriate pits are commonly contiguous, rarely separate and are placed alternate, subopposite, and rarely opposite. Triseriate and tetraseriate pits are arranged alternately. They are contiguous, flattened by mutual contact and

hexagonal or oval. The biseriate pits measure $10.5 \times 14 \mu$ to $14 \times 14 \mu$. Their coefficient ($e = d/D$), therefore, varies from 1 to 0.7. The uniseriate pits measure $12.5 \times 16 \mu$ to $7.0 \times 9.0 \mu$. The coefficient varies from 1 to 0.65. Pits bordered, with a circular or oval pore in the centre. The size of the pore varies from $3.5 \times 3.5 \mu$, $3.5 \times 3 \mu$ to $3.5 \times 4 \mu$. At some places the tracheids are placed end to end.

The medullary rays are smooth and their width varies from 24 to 35 μ . The number of cross-field pits varies from 2 to 6 (commonly 3-4). Pits bordered and oval in shape. The pore is not very distinct, it is probably oblique. The sizes of the field pit vary from $10.5 \times 12 \mu$ to $9 \times 10.5 \mu$.

Medullary rays are uniseriate or sometimes biseriate. The tangential wall of the medullary ray is unpitted. The height of the medullary rays varies from 1 to 22 cells. It has been observed that the height varies differently from the pith towards periphery as Table I shows.

The medullary ray cells are rectangular to oval in shape and $24-35 \mu \times 17.5 = 28 \mu$ in size. The density of the rays is 7 rays per millimetre square (surface examined 12 mm.²) The density of the number of ray cells per mm.² is $387/12 = 32/\text{mm}^2$ and neglecting the biseriate ray cells, it is $379/12 = 32/\text{mm}^2$. The average frequency of the biseriate rays and uniseriate rays is 7 and 93 per cent respectively. The maximum frequency is of 3-celled medullary rays (TEXT-FIG. 1).



TEXT-FIG. 2 — Part of the early wood tracheid in radial longitudinal section showing the arrangement of pits. $\times 500$.

TABLE 1

WOOD SPECIMEN NUMBER	SECTION NEAR PITH			SECTION AWAY FROM PITH		
	Distance from Pith, cm.	Height of Medullary Ray Cells	Average Cells	Distance from Pith, cm.	Height of Medullary Ray Cells	Average Cells
31720	1.5	1.12	4	10	1.22	7
31721	2	1.7	3	8	1.14	5
21733	4	1.9	3	8	1.17	5

The tangential walls of the tracheids are pitted; usually the pits are in one row or two, and separate or contiguous.

In the secondary xylem there are no resin canals or xylem parenchyma.

Comparison — Earlier the wood *Dadoxylon jhariense* was provisionally described under this name by Surange and Sah (1956). Later some more collection of material by one of us (P. K. MAITHY) revealed some anatomical information and established the distinctiveness of the type. The wood is, therefore, separated under a new generic name — *Barakaroxylon*.

The wood of *Barakaroxylon* is comparable to *Solenopitys* Kräusel and Dolianiti, *Solenoxylon* Kräusel and *Polysolenoxylon* Kräusel and Dolianiti as far as the presence of canals in the pith is concerned. But the comparison does not extend further because *Solenoxylon*

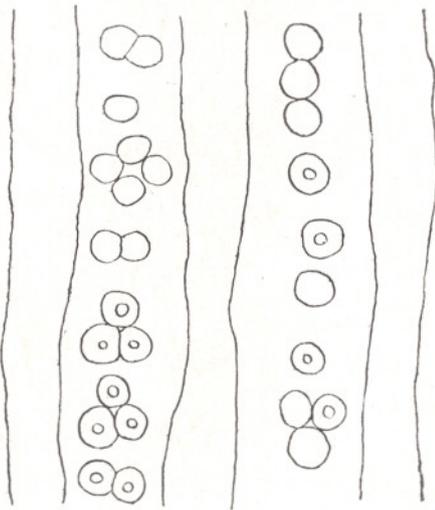
and *Solenopitys* have discoid piths, *Polysolenoxylon* shows longitudinal gaps between the canals, and in *Barakaroxylon* the pith is solid. In addition *Barakaroxylon* possesses secretory cells which are absent in the above three genera. Some genera such as *Megaporoxylon* Kräusel and *Trigonomyelon* (Zeiller) Walton possess secretory cells in the pith, but are easily distinguishable from *Barakaroxylon* by the absence of pith canals. The present wood is thus entirely different from all the known genera from the Lower Gondwanas of the Southern Hemisphere and, therefore, a new generic name is proposed for it.

Barakaroxylon gen. nov.

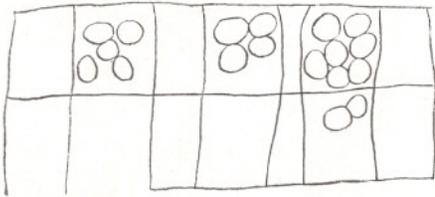
Diagnosis — Pith with secretory canals and secretory cells. Secretory canals are arranged longitudinally. Primary xylem endarch, secondary xylem with araucaroid pitting. No air gaps in pith.

Barakaroxylon jhariense n. comb.

Emended Diagnosis — Gymnospermous wood with secretory canals and secretory cells arranged in the peripheral region of pith. Pith cells pitted. Primary xylem endarch with spiral, scalariform and reticulate elements. Secondary wood with distinct growth zones. Early wood zone broader, 40-60 cells deep, and the size of the cells varies from 38 to 60 μ (70 μ). Late wood 2-4 cells, the cells 16-21 μ in size. The radial and tangential walls of the tracheids pitted, 1-4 seriate (common 2-3 seriate). Pits are alternate, subopposite or sometimes opposite. Mostly pits are contiguous, but rarely they are separate. The size of pits in biseriate varies from 14 \times 14 μ to 10.5 \times 14 μ and in uniseriate from 10.5 \times 16 μ to 7.0 \times 9.0 μ . Pits bordered, flattened by mutual contact,



TEXT-FIG. 3 — Tracheid in radial longitudinal section showing pits in groups of 2 or 3. \times 375.



TEXT-FIG. 4 — Cross-field pits. $\times 375$.

hexagonal or oval, with a small circular pore in the centre. The size of pore varies from $3.5 \times 3.4 \mu$. The number of cross-field pits 2-6 (commonly 3-4), oval, bordered and with a oblique pore. The size of the cross-field pits varies from $9-10.5 \times 9-12 \mu$. Medullary rays are commonly uniseriate, sometimes biseriate, 1-22 cells high, cells are rectangular to oval in tangential section. The maximum frequency is of 3-celled rays.

Holotype No. — 21733, Birbal Sahni Institute of Palaeobotany Museum.

Paratype No. — 31720/430 and 31721/430, Birbal Sahni Institute of Palaeobotany Museum.

Locality — 18th coal seam of Kharkhari Colliery, Jharia Coalfield.

Horizon — Barakar.

2. BARAKAROXYLON KRAEUSELI N. SP.

Only one piece of wood is known so far. The pith is badly preserved and fragile.

Pith

The pith is solid, circular in transverse section and 2 cm. in diameter. Pith cells are somewhat thick-walled parenchymatous, closely arranged with intercellular spaces, bigger towards the centre, smaller towards the periphery. Pith cells are square to rectangular in longitudinal section. Some cells are pitted.

Secretory canals are scattered all over the pith, mostly on the periphery, very small in size about 1.5-2 mm. in diameter. The canals in longitudinal section are long and are lined by small rectangular cells. The secretory cells are scattered all over the pith, isolated, thick-walled and are filled with black dark substance. In longitudinal section the secretory cells are septate.

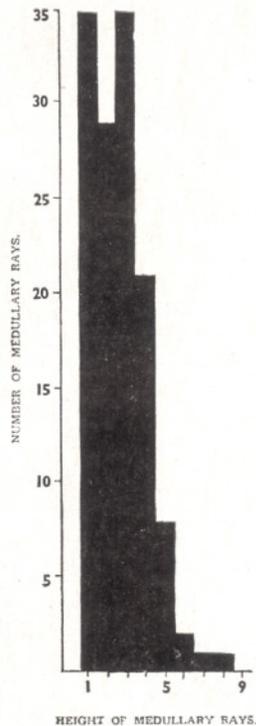
Primary Xylem

The primary xylem encircles the pith and is 5-12 cells in thickness. It is endarch, and consists of spiral, scalariform and reticulate elements. The reticulate elements are more common.

Secondary Xylem

The secondary xylem has distinct growth zones. Early wood zone is broader, 40-60 cells deep, square to rectangular, with size from 42 to 85 μ . Late wood 2-4 cells, small, thick-walled, transversely elongated with size from 14 to 31.5 μ . The intervening wall between the two tracheids is quite thick, about 3-10 μ . The medullary rays are placed at the intervals of 3-12 tracheids.

Tracheid wall radially pitted, 1-4 seriate, commonly biseriate and triseriate. Uniseriate pits are arranged in one row, mostly contiguous, sometimes separate. Biseriate pits are contiguous opposite, sometimes subopposite or alternate (PL. 1, FIGS. 3, 4; TEXT-FIGS. 2A, B). The percentage of opposite



TEXT-FIG. 5 — Graph showing the frequency of medullary ray cells (surface examined 12 mm.²).

to alternate is 50:50. Triseriate and tetra-seriate pittings are commonly contiguous, alternate or opposite (TEXT-FIG. 2C). Sometimes it is seen that the pits are placed separately in pairs, or in groups of three (PL. 1, FIG. 5; TEXT-FIG. 3). This tendency has been previously recorded in *Dadoxylon arberi* Seward (Walton). Bordered pits are oval or flattened by mutual contact. The size of the pits vary. In biseriate condition it may be $10.5 \times 10.5 \mu$, $9 \times 10.5 \mu$, $9 \times 12 \mu$, $9 \times 14 \mu$ or $10.5 \times 16 \mu$. The coefficient ($e = d/D$) in biseriate as well as uniseriate condition varies from 1 to 0.64. The uniseriate pits vary from $14 \times 16 \mu$ to $7 \times 7 \mu$. Pits commonly have a circular pore in the centre, and 4.5μ in diameter.

The number of cross-field pits is 1-7 (commonly 4), bordered, elliptic and contiguous (PL. 1, FIG. 6; TEXT-FIG. 4). The pore is not distinct. The size of the pits varies from $10.5 \times 10.5 \mu$, $9 \times 10.5 \mu$, $10.5 \times 14 \mu$, $9 \times 9 \mu$.

Medullary rays are commonly uniseriate, rarely biseriate (PL. 1, FIG. 7), with tangential wall unpitted and height from 1 to 16 cells. Cells of medullary rays are rectangular and $31.35 \times 14.21 \mu$ in size. The density of rays is 8 per square millimetre. The density of ray cells is $366/12 = 30/\text{mm}^2$, and neglecting the biseriate ray cells $357/12 = 29 \text{mm}^2$. The percentage of biseriate rays to uniseriate rays is 5 and 95 per cent respectively. The maximum frequency is of 1 and 3-celled medullary rays (TEXT-FIG. 5).

Tangential wall of the tracheids are unpitted. Resin canal or xylem parenchyma absent.

Comparison and Remarks — The present specimen resembles with *Barakaroxylon jhariense* in many respects but differs in the following characters.

Secretory canals are scattered all over the pith. In *Barakaroxylon jhariense* they are confined only to the peripheral region of the pith. In addition, in *B. kraeuseli* pits on the tangential wall of the tracheids are absent and the cross-field pit is single at some places. Finally in *B. kraeuseli* the pits are sometimes placed separately in groups of 2 or 3, which is not the case in *B. jhariense*. Because of these differences a new specific name is proposed for this wood.

Barakaroxylon kraeuseli n. sp.

Diagnosis—Solid pith, secretory canals and secretory cells scattered all over the pith. Endarch primary xylem, with spiral, scalariform and reticulate elements. Secondary wood with distinct growth zones. Early wood 40-60 cells deep, from 42 to 87 μ . Late wood 2-4 cells deep, 17-35 μ . Radial pitting 1-4 seriate. Uniseriate pits contiguous or separate. Biseriate pits are commonly contiguous, arranged opposite and alternate. Triseriate and tetraseriate commonly alternate, sometimes opposite. Pits are oval-circular. The sizes of the biseriate pits vary from $9-10.5 \mu$ to $10.5-16 \mu$, and the uniseriate pits from $7-14$ to $7-16 \mu$. Sometimes the pits have a tendency to be in groups of 2-3. The number of cross-field pits 1-7 (commonly 4). Pits bordered elliptic, and their size varies from $9-10.5$ to $9-14 \mu$. The tangential wall of the medullary rays are unpitted; cells rectangular and measure $31.35 \times 14.24 \mu$. The height of the medullary ray is from 1 to 16 cells. The maximum frequency is of 1 and 3 ray-celled medullary rays.

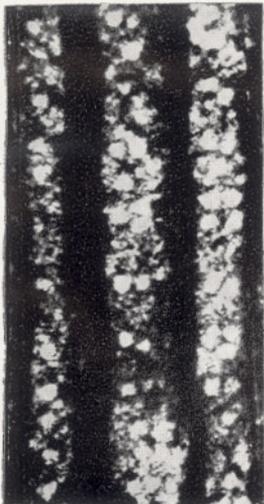
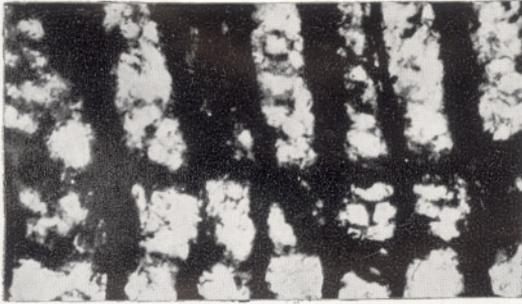
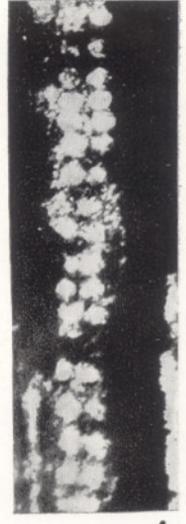
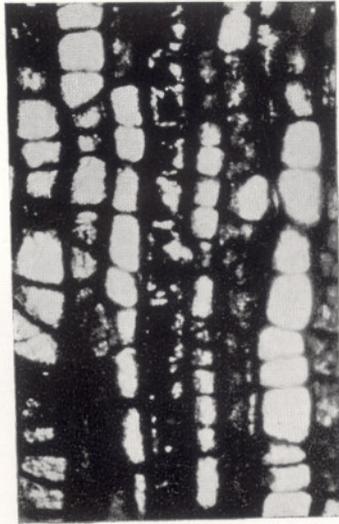
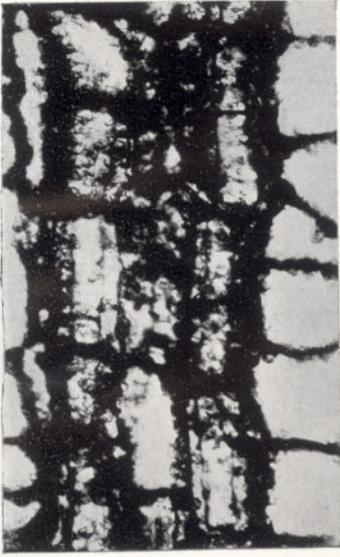
Holotype — 31723/483, Birbal Sahni Institute of Palaeobotany Museum.

Locality — 18th coal seam of Kharkhari Colliery, Jharia coalfield.

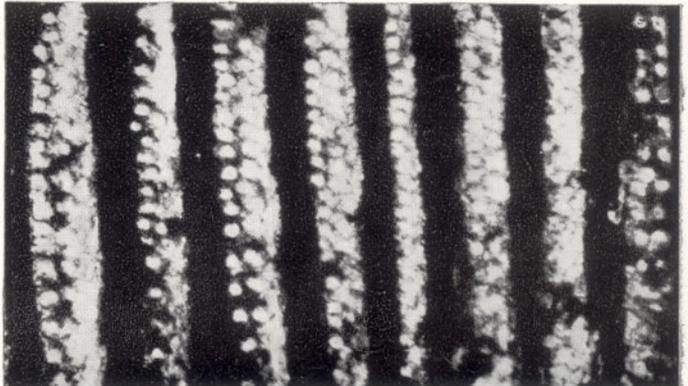
Horizon — Barakar.

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3



EXPLANATION OF PLATE 1

Barakaroxylon jhariense (Surange & Sah) n. comb.

1. A part of the longitudinal sections of the pith to show the pitted cells. $\times 200$.

2. Longitudinal section of the pith to show the secretory cells. $\times 80$.

Barakaroxylon kraeuseli sp. nov.

3. Radial longitudinal section of the tracheid to show the arrangement of the pitting. $\times 200$.

4. Part of radial section enlarged showing biseriate, contiguous and opposite pitting. $\times 200$.

5. Tracheids in radial section to show pits placed separately in groups of 2 or 3 and uniseriate pitting. $\times 200$.

6. Radial longitudinal section to show the cross-field pits and pitting of the tracheids. $\times 200$.

7. A part of secondary xylem in tangential section showing the distribution of medullary rays. $\times 100$