FOSSIL WOODS FROM THE TERTIARY OF EASTERN INDIA, 11

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ABSTRACT

Fossil woods resembling those of *Calophyllum, Shorea, Glu-Melanorrhoea, Cynometra, Afzelia-Intsia* and *Terminalia* are described here from the Tertiary of Assam and NEFA. They were collected from the beds of Buri-Dihing River near Jaipur and Namsang River at Deomali.

INTRODUCTION

In 1963 Drs. R. N. Lakhanpal and M. N. Bose made a rich collection of fossil woods from the beds of Buri-Dehing River near Jaipur, Assam, and the Namsang River near the headquarters of the Khonsa Forest Division at Deomali, NEFA [see TEXT-FIg. 1 in PRAKASH & AWASTHI, 1970]. Out of this collection, Prakash (1965a, 1966) and Prakash and Awasthi (1970) have already described a number of fossil woods resembling those of *Calophyllum, Terminalia, Afzelia-Intsia, Shorea, Holigarna, Cassia, Duabanga and Sideroxylon*.

In the present paper two new fossil woods resembling *Shorea and Terminalia* are being described. Besides, the woods of *Calophyllum, Glu-Melanorrhoea, Cynometra and Afzelia-Intsia* are also being recorded from these localities.

As mentioned in our earlier paper (PRAKASH & AWASTHI, 1970), the fossil woods collected from the beds of Buri-Dehing River are most probably from the Tipam series indicating an Upper Miocene age, while those from the bed of Namsang River near Deomali may be considered as Mio-Pliocene in age, probably being derived from the Namsang Beds (KRISHNAN, 1960; PASCOE, 1963).

SYSTEMATIC DESCRIPTION

GUTTIFERAE

*Calophyloxyylon* Lakhanpal & Awasthi, 1965

1. *Calophyloxyylon eoinophyllum* Prakash, 1966

Pl. 1, Figs. 1, 2

The fossil wood recorded here is a fairly well preserved piece of secondary xylem measuring about 6 cm in length and 4 cm in diameter. It shows the following important anatomical features:

Wood diffuse-porous, without distinct growth marks. Vessels 100-480 μ in diameter, exclusively solitary, arranged characteristically in oblique radial lines. Vasicentric tracheids present, forming 2-3 seriate sheath around the vessels. Parenchyma apotracheal in continuous or broken, closely spaced, tangential lines or bands of 2-4 cells wide. Xylem rays 1-2 seriate and 2-22 cells in height, heterocellular, consisting of 1-2 marginal rows of upright cells and the rest procumbent cells. Fibres nonseptate, thin-walled.

As these features are identical with those of *Calophyloxyylon eoinophyllum* Prakash (1966), the fossil wood is placed under the same species.

Specimen — B.S.I.P. Museum No. 34049.
Locality — Buri-Dehing River bed near Jaipur, Assam.
Horizon — Tipam Sandstones.
Age — Upper Miocene

DIPTEROCARPACEAE

*Shoreoxylon* Ded Berger, 1923

2. *Shoreoxylon deomaliense* sp. nov.

Pl. 1, Figs. 3, 4

This species is based on a single piece of fairly well-preserved fossil wood measuring 12 cm in length and 5 cm in width. Topography — Wood diffuse-porous (Pl. 1, Fig. 3). Growth rings not seen. Vessels
visible to the naked eye as small pin holes, small to large (mostly large), solitary, occasionally in radial multiples of 2, evenly distributed, about 8-16 vessels per sq. mm; tyloses present, thin-walled. Vasicentric tracheids not well preserved, difficult to distinguish from neighbouring fibres in cross-section. Parenchyma paratracheal and apotracheal, paratracheal parenchyma usually forming thin vasicentric sheath around the vessels, occasionally aliform to aliform-confluent (Pl. 1, Fig. 3); apotracheal parenchyma associated with the gum canals, forming concentric, tangential rings (Pl. 1, Fig. 3); diffuse parenchyma occasionally present. Xylem rays fine to moderately broad, 1-7 seriate, 6-9 rays per mm, each separated by 1-10 tangential rows of fibres; ray tissue heterogeneous; rays heterocellular, consisting of procumbent cells through the median portion and 1-8 marginal rows of upright cells at one or both the ends, 4-65 cells in height. Fibres aligned in radial rows between the two consecutive xylem rays. Gum canals visible to the naked eye as small pin holes, small to large (mostly large), circular, vestured. Vasicentric tracheids large, about 6-10 μ in diameter, as long as fibres; pits aligned in vertical rows, similar to vessel-tracheid pits. Parenchyma cells circular or oval, 32-60 μ in diameter; crystals present. Upright Ray cells 40-72 μ in tangential height, 28-48 μ in radial length; procumbent cells 16-32 μ in tangential height, 40-160 μ in radial length. Fibres angular (mostly hexagonal), about 12-32 μ in diameter, non-septate, thick-walled, walls 4-8 μ in thickness. Gum canals circular, 35-240 μ in diameter.

**Affinities**

Considering all the important anatomical features the present fossil shows a close similarity with the tribe Shoreae (especially with the genus Shorea) of the family Dipterocarpaceae (Metcalf & Chalk, 1950). However, it has not been possible to find its equivalent out of the modern species of Shorea, which are very similar to each other in anatomical details.

Two species of Shoreoxylon are already known from the Tertiary of Eastern India (Assam), viz. Shoreoxylon evidens Eyde (1963) and S. tipamense Prakash & Awasthi (1970), described from the Garo Hills and Buri-Dehing River bed near Jaipur respectively. Both these species show some resemblance with the present fossil. However, these can also be distinguished from it in the vessel distribution, and in the ray and fibre structure. Thus in Shoreoxylon evidens the vessels are solitary as well as in radial multiples of 2-4, the xylem rays are about 13-25 cells in height with a single marginal row of upright cells at one or both the ends, whereas in the present fossil specimen the vessels are mostly solitary, rarely in radial multiples of 2 and the xylem rays are up to 65 cells in height with 1-8 marginal rows of upright cells at one or both the ends. Similarly, the main difference between the present fossil wood and Shoreoxylon tipamense is that in the former the fibres are very thick-walled than those of the latter. Moreover, the vessels in S. tipamense are mostly in radial multiples of 2-3.

In addition to this, the other species of Shoreoxylon known so far from the Cenozoic rocks of India and abroad (Den Berger, 1923, 1927; Schweitzer, 1958; Navale, 1963; Prakash, 1965b; Ramamujam & Raghurama Rao, 1967), are also quite different from the present fossil wood. Therefore, the present fossil is described as a new species of Shoreoxylon, Shoreoxylon deomaliense, the specific name is after the fossil locality Deomali.

**Diagnosis**

Shoreoxylon deomaliense sp. nov.

Wood diffuse-porous. Growth rings absent. Vessels small to large, t.d. 64-256 μ, r.d. 64-320 μ, mostly solitary, occasionally in radial multiples of 2, evenly distributed, 8-16 per sq. mm; tyloses present, thin-walled; perforations simple; intervessel pits and pits leading to contiguous tracheids large, about 6-10 μ in diameter, alternate, circular, vestured. Vasicentric tracheids forming a narrow sheath of 1-2 cells around the vessels; pits vestured. Parenchyma paratracheal and apotracheal; paratracheal
parenchyma vasicentric to aliform, occasionally aliform-confluent; apotracheal parenchyma occasionally diffuse and also associated with the tangential rings of gum canals. Xylem rays 1-7 seriate; ray tissue heterogeneous; rays heterocellular, consisting of procumbent cells through the median thickened portion and 1-8 marginal rows of upright cells at one or both the ends, 4-65 cells in height. Fibres angular (mostly hexagonal), 12-32 \( \mu \) in diameter, non-septate, thick-walled, walls 4-8 \( \mu \) in thickness. Gum canals normal, vertical, in concentric tangential rings, 35-240 \( \mu \) in diameter.

*Holotype* — B.S.I.P. Museum No. 34050.  
*Locality* — Namsang River bed near Deomali, NEFA.  
*Horizon* — Namsang Beds.  
*Age* — Mio-Pliocene.

### ANACARDIACEAE

**Glutoxylon Chowdhury, 1934**

3. *Glutoxylon burmense* (Hold.) Chowdhury, 1952

Pl. 1 Figs. 5, 6

The fossil wood consists of a single piece measuring about 6 cm in length and 6 cm in width.

The characteristic features of this wood are:

Wood diffuse-porous, without growth marks. *Vessels* 64-400 \( \mu \) in diameter, solitary as well as in radial multiples of 2-8, with abundant tyloses and large, alternate, intervessel pits with lenticular apertures. *Parenchyma* paratracheal and apotracheal; paratracheal parenchyma scanty to vasicentric; apotracheal parenchyma in continuous or broken tangential lines, consisting of 1-3 cells in thickness, about 0.3 per mm. *Xylem rays* simple and fusiform; simple rays 1-2 (mostly 1) seriate, homocellular, consisting of procumbent cells only; fusiform rays 3-4 seriate with horizontal gum ducts in the centre; rays about 10-28 cells in height. *Fibres* non-septate, thin to thick-walled.

The fossil wood is identical to *Glutoxylon burmense* (Hold.) Chowdhury which has already been recorded from several Cenozoic localities in India (Chowdhury, 1936, 1952; Awasthi, 1966; Prakash & Tripathi, 1969).

*Specimen* — B.S.I.P. Museum No. 34051.  
*Locality* — Buri-Dehing River bed near Jaipur, Assam.  
*Horizon* — Tipam Sandstones  
*Age* — Upper Miocene.

### LEGUMINOSAE

**Cynometroxylon Chowdhury & Ghosh, 1946**

4. *Cynometroxylon indicum* Chowdhury & Ghosh, 1946

Pl. 2, Figs. 14, 15

The following important anatomical features are based on a piece of highly silicified wood measuring 30 cm in length and 14 cm in diameter.

Wood diffuse-porous. *Growth rings* not seen. *Vessels* 80-384 \( \mu \) in diameter, solitary as well as in radial multiples of 2-4, about 3-5 per mm with small to medium, vestured, intervessel pits. *Parenchyma* apotracheal in concentric tangential bands alternating with fibres bands of nearly same width, 4-6 bands per mm, each 3-6 cells in width. *Xylem rays* 1-3 seriate, heterocellular, consisting of procumbent and 1-2 marginal rows of upright cells at one or both the ends, about 5-25 cells in height. *Fibres* nonseptate, thick-walled.

The fossil wood is identical to already known species *Cynometroxylon indicum* Chowdhury and Ghosh (1946), described from the Tertiary of North Cachar Hills, Assam, and the Cuddalore Series of South India (Ramanujam & Raghu Ramarao, 1966).

*Specimen* — B.S.I.P. Museum No. 34052.  
*Locality* — Namsang River bed near Deomali, NEFA.  
*Horizon* — Namsang Beds  
*Age* — Mio-Pliocene.

### Pahudioxylon Chowdhury, Ghosh & Kazmi, 1960

5. *Pahudioxylon sahnii* Ghosh & Kazmi, 1961

Pl. 2, Figs. 7, 8

The following are the important anatomical features of a silicified piece of wood measuring about 7 cm in length and 4 cm in diameter.

Wood diffuse-porous. *Growth rings* delimited by fine lines of parenchyma,
**Terminalioxyylon Schonfeld, 1947**

6. *Terminalioxyylon coriaceum* sp. nov.

Pl. 2, Figs. 9, 11, 12

The present species is based on a single piece of silicified secondary wood measuring about 12 cm in length and 7 cm in diameter.

**Topography** — Wood diffuse-porous. Growth rings present, delimited by larger vessels towards the inner margin of the ring and broad and undulating terminal parenchyma bands (Pl. 2, Fig. 12). Vessels small to large, solitary as well as in radial multiples of 2-5 (mostly 2), those of early wood larger in size, gradually becoming smaller towards the end of the annal rings, 5-14 vessels per sq. mm; tyloses present, vessels also filled with orange to brownish contents. Parenchyma abundant, paratracheal and apotracheal; paratracheal parenchyma aliform to aliform-confuent or sometimes in broad and regular bands especially at the beginning of the annal rings (Pl. 2, Fig. 12); apotracheal parenchyma not so common, especially with a few short bands occurring in between the vessels. Xylem rays fine, close, 12-16 rays per mm, uniseriate, occasionally biseriate due to pairing of procumbent cells through the median portion, 2-24 cells in height; ray tissue homogeneous, rays homocellular, consisting of procumbent cells (Pl. 2, Fig. 19). Fibres aligned in radial rows between the two consecutive xylem rays. Gum canals vertical, traumatic, present in tangential, concentric bands, surrounded by parenchyma (Pl. 2, Fig. 11).

**Elements** — Vessels circular to oval, those of multiples, flattened at the places of contact, t.d. 48-320 μ, r.d. 12-288 μ, walls 8-16 μ in thickness; vessel-members 225-800 μ in length, with truncate ends; perforations simple; intervessel pits large, 8-10 μ in diameter, alternate, circular, vested, orifices linear to lenticular. Parenchyma cells more or less circular or angular, 20-50 μ in diameter. Ray cells 22-48 μ in tangential height, 40-100 μ in radial length; swollen crystalliferous cells sometimes present. Fibres angular (mostly hexagonal), 12-24 μ in diameter, septate, thick-walled, walls 4-6 μ thick.

Out of these, TerminalioxyI0n annamense Boureau (1950), T. edengense Boureau (1958), T. tertiarium Prakash (1966) and T. traumaticum Ramanujam (1966) possess vertical, traumatic gum canals. All the species of TerminalioxyI0n, including those with gum canals, differ markedly from the present fossil wood in several features. The main differences between the present fossil wood and those species having gum canals are in the distribution of the parenchyma and the size and arrangement of the vessels. Therefore, the present fossil wood is described as a new species of TerminalioxyI0n, T. coriaceum, the specific name indicating closest resemblance with Terminalia coriacea.

**DIAGNOSIS**

TerminalioxyI0n coriaceum sp. nov.

Wood diffuse-porous. Growth rings present, delimited by larger vessels towards inner margin of the ring and broad terminal parenchyma bands. Vessels small to large, solitary as well as in radial multiples of 2-5 (mostly 2), t.d. 48-320 μ, r.d. 32 to 288 μ; vessel-members 225-800 μ; perforations simple; tyloses wanting; intervessel pits, large, 8-10 μ, vestured. Parenchyma abundant, paratracheal and apotracheal; paratracheal parenchyma aliform to aliform-confluent or zonate, especially those bands occurring in the beginning of the rings broad, regular and wavy; apotracheal parenchyma occasionally present as few short bands. Xylem rays uniseriate, occasionally biseriate due to pairing of procumbent cells through the median portion; ray tissue homogeneous, rays homocellular, consisting wholly of procumbent cells; crystalliferous cells often swollen containing solitary crystals. Fibres mostly hexagonal, 12-24 μ in diameter, septate, thick-walled, walls 4-6 thick.


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THE PALAEOBOTANIST
EXPLANATION OF PLATES

PLATE 1


2. *Calophylloxylon eoinophyllum* Prakash—Tangential longitudinal section showing xylem rays. × 100. (B.S.I.P. Museum, Slide No. 3877).

3. *Shoreoxylon deornaliense* sp. nov.—Cross-section showing nature and distribution of vessels, parenchyma and gum canals. × 30. (B.S.I.P. Museum, Slide No. 3878).

4. *Shoreoxylon deornaliense* sp. nov.—Tangential longitudinal section showing xylem rays. × 60. (B.S.I.P. Museum, Slide No. 3879).

5. *Glutoxylon burmense* (Hold.) Chowdhury—Cross-section showing nature and distribution of vessels and parenchyma. × 43. (B.S.I.P. Museum, Slide No. 3880).


10. *Terminalia coriacea*—Tangential longitudinal section showing similar xylem rays. × 135.


12. *Terminalioxylon coriaceum* sp. nov.—Cross-section showing type and distribution of vessels and parenchyma. × 30. (B.S.I.P. Museum Slide No. 3888).


PLATE 2


10. *Terminalia coriacea*—Tangential longitudinal section showing similar xylem rays. × 135.


12. *Terminalioxylon coriaceum* sp. nov.—Cross-section showing type and distribution of vessels and parenchyma. × 30. (B.S.I.P. Museum Slide No. 3888).

