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# Fossil woods of *Terminalia* and *Lagerstroemia* from the Late Cenozoic beds of Mahuadanr, Palamu District, Bihar

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Two fossil woods belonging to *Terminalia tomentosa* and *Lagerstroemia* sp. cf. *L. parviflora* have been described from the fossiliferous sandstone exposed near Mahuadanr, Palamu District, Bihar. Based on the earlier record of fossil wood of *Sindora* from this bed a Miocene-Pliocene age has been suggested.

**Key-words**—Xylotomy, Fossil woods, *Terminalia*, *Lagerstroemia*, Late Cenozoic (India)

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## सारांश

पलामऊ जनपद (बिहार) में महुआडांड के अनंतिम नूतनजीवी संस्तरों से टर्मिनलिया एवं लैगरस्ट्रोयमिया की अशिमत काष्ठें

गजेन्द्र प्रताप श्रीवास्तव एवं मोहन बलवंत बाँडे

पलामऊ जनपद में महुआडांड के समीपस्थ अनावरित पादपाशम-युक्त बालुपत्थर से टर्मिनलिया टोमेन्टोसा एवं लैगरस्ट्रोयमिया जाति सजातीय से० पार्विफ्लोरा से सम्बद्ध अशिमत काष्ठों का वर्णन किया गया है। इन संस्तरों से पहले से वर्णित सिन्दोरा की अशिमत काष्ठ के आधार पर इनकी मध्यनूतन-अतिनूतन आयु प्रस्तावित की गई है।

THE Upper Tertiary sedimentary deposits exposed near the village Mahuadanr in Palamu District, Bihar (84°06'40"E, 23°23'15"N) have been divided lithologically into three units (Puri & Mishra, 1982). The lowermost is a 2 m thick conglomerate bed, middle 3.0 m thick layer of sandstone with embedded petrified woods and 3.2 m of shales at the top which are rich in impressions of leaves, flowers, fruits, insects, birds as well as fishes. A rich collection of leaves, flowers and fruits has been described from the shale bed of this sequence (Bande & Srivastava, 1990). However, from the sandstone bed only a wood of *Sindora* has so far been described (Prakash *et al.*, 1988). During the course of present study petrified woods of two more taxa, viz., *Terminalia tomentosa* Wt. & Arn. and

*Lagerstroemia* sp. have been identified from the sandstone and described in this communication. The precise age of these sediments is still an open question. Puri and Mishra (1982) suggested an Upper Tertiary age to these deposits. On the basis of a close similarity of the fossil flora recovered from the shale unit with the surrounding vegetation of this area, Bande and Srivastava (1990) have suggested that the shale beds are not of great antiquity. In this connection presence of *Sindora* in the sandstone unit is significant. *Sindora* has so far been recorded only from the Miocene-Pliocene epochs of India (Prakash *et al.*, 1988). Thus, in all probability, the sandstone unit of this sequence is also Miocene-Pliocene in age and overlying shales are younger. The radiometric dating may ascertain the precise age of these deposits.

## SYSTEMATIC DESCRIPTION

### Family—Combretaceae

#### Genus—*Terminalia* Linn.

*Terminalia tomentosa* Wt. & Arn.

Pl. 1, figs 1-4

*Material*—Single piece of secondary wood measuring 10 cm in length and 6.5 cm in diameter.

*Description*—Wood diffuse porous. *Growth rings* present, delimited by terminal parenchyma. *Vessels* small to large, mostly solitary or in radial multiples of 2-4, evenly distributed, 2-8 per sq mm, usually filled with dark coloured contents, circular to oval when solitary, t.d. 80-200  $\mu\text{m}$ , r.d. 60-200  $\mu\text{m}$ ; 120-560  $\mu\text{m}$  long with oblique to transverse ends; perforations simple; intervessel pits bordered, alternate, 4-8  $\mu\text{m}$  in diameter, circular to oval in shape, sometimes polygonal due to crowding with lenticular apertures. *Parenchyma* paratracheal and apotracheal both; paratracheal parenchyma vasicentric to aliform-confluent, apotracheal parenchyma terminal forming narrow tangential lines indicating the inception of seasonal growth; parenchyma cells thin-walled, 20-32  $\mu\text{m}$  in diameter, 60-160  $\mu\text{m}$  in length; crystals present. *Xylem rays* closely spaced, 10-20 per mm, usually uniseriate, rarely biseriate, rays homocellular to weakly heterocellular, consisting of procumbent cells and upright or squarish cells, ray cells thin-walled and crystalliferous; procumbent cells 52-80  $\mu\text{m}$  in radial length and 20-48  $\mu\text{m}$  in tangential height; upright cells 40-50  $\mu\text{m}$  in radial length and 40-60  $\mu\text{m}$  in tangential height. *Fibres* aligned in radial rows in between the xylem rays, thick-walled, circular to polygonal in cross section, non-septate, 12-20  $\mu\text{m}$  in diameter and 360-680  $\mu\text{m}$  in length; interfibre pits not seen.

*Discussion*—Small to medium-sized vessels with paratracheal vasicentric aliform-confluent and apotracheal parenchyma, homo- to heterocellular

uniseriate rays with crystals and thick-walled, non-septate fibres are the diagnostic characters of the fossil wood suggesting its close resemblance with the modern wood of *Terminalia tomentosa*.

The fossil woods showing resemblance with those of *Terminalia* were earlier placed under the organ genus *Terminalioxylon* (Schönfeld, 1947). Later, Madel and Müller-Stoll (1973) emended the diagnosis of *Terminalioxylon* Schönfeld to include not only the fossil woods of *Terminalia* but also those of *Combretum* and *Anogeissus*. Prakash (1979), however, did not agree to it and suggested the retention of both the fossil genera *Terminalioxylon* Schönfeld and *Anogeissusoxylon* Navale for the fossil woods of *Terminalia* and *Anogeissus* respectively on the basis of presence of crystals in ray cells in *Anogeissus* and their occurrence both in parenchyma and ray cells in *Terminalia*. Fossil woods of *Terminalia* showing close similarity with modern wood of *Terminalia tomentosa* are known from most of the Neogene exposures of India (Ghosh & Roy, 1980; Lakhanpal *et al.*, 1981, 1984; Prakash & Dayal, 1968; Prakash, 1966; Ramanujam, 1956).

*Terminalia tomentosa* was earlier regarded as a species by botanists and foresters but later on it was found that it is a complex as it shows a wide range of morphological variations. After a critical examination of this complex by Parkinson (1937) it was revealed that *Terminalia tomentosa* exhibits a mixture of characters of *Terminalia crenulata*, *T. coriacea* and *T. alata*. On comparing the fossil wood with the woods of various species of *Terminalia* at the xylarium of Forest Research Institute, Dehradun, it was found that the cross section of the fossil wood matches with *T. tomentosa* but the tangential longitudinal section resembles *T. coriacea*. Under the circumstances the fossil wood has been described as *Terminalia tomentosa* Wt & Arn.

*Terminalia tomentosa* is a large tree growing in the sub-Himalayan region from Ravi eastward ascending up to 1,300 m, common throughout India, including Chota Nagpur region and Myanmar. It thrives best in heavy clay soil (Brandis, 1906).

## PLATE 1

*Terminalia tomentosa* Wt. & Arn.

1. Cross-section showing the distribution of vessels and parenchyma  $\times 30$  (BSIP Slide no. 36305-I).
2. Tangential longitudinal section showing the nature and distribution of xylem rays  $\times 30$  (BSIP slide no. 36305-II).
3. Intervessel pit pairs  $\times 150$  (BSIP Slide no. 36305-II).
4. Radial longitudinal section showing ray tissue  $\times 80$  (BSIP Slide no. 36305-III).

*Lagerstroemia* sp. cf. *L. parviflora* Roxb.

5. Cross section showing the distribution of vessels and parenchyma  $\times 30$  (BSIP Slide no. 36306-I).
6. A portion of cross section further enlarged to show apotracheal parenchyma  $\times 80$  (BSIP Slide no. 36306-I).
7. Tangential longitudinal section showing the nature and distribution of xylem rays  $\times 30$  (BSIP Slide no. 36306-II).
8. Intervessel pit pairs  $\times 150$  (BSIP Slide no. 36306-III).

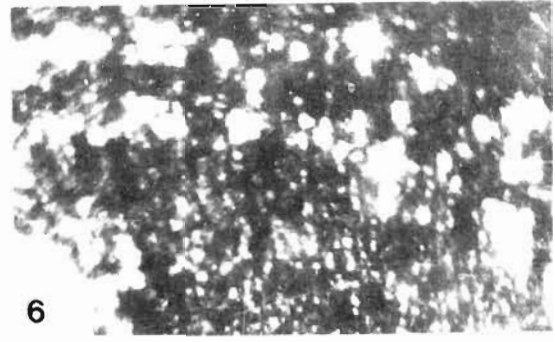
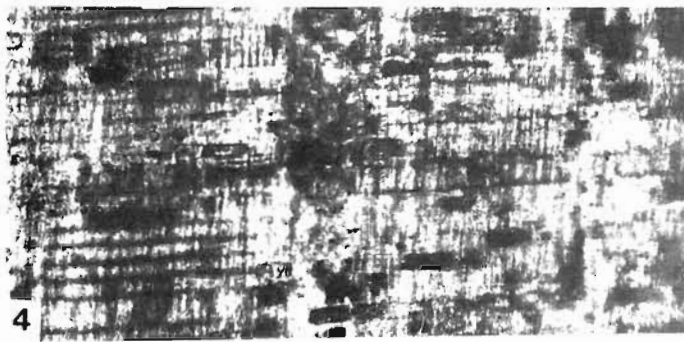
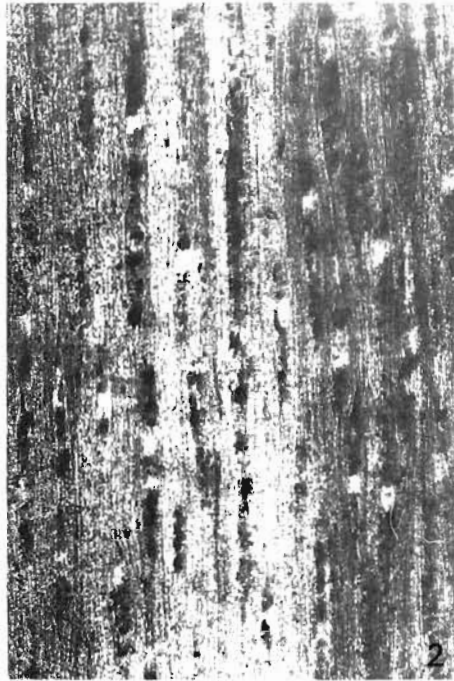


PLATE 1

**Family—Lythraceae**

**Genus—*Lagerstroemia* Linn.**

*Lagerstroemia* sp. cf. *L. parviflora* Roxb.

Pl. 1, figs 5-8

**Material**—A single piece of secondary wood measuring 11 cm in length and 7 cm in diameter; the preservation is fairly good.

**Description**—Wood diffuse-porous to semi-ring porous. *Growth rings* present, delimited by larger vessels at the beginning of the ring. *Vessels* small to large, solitary and in radial multiples of 2-4 or in groups, circular to oval when solitary, uniformly distributed, 3-12 per sq mm, filled with gummy contents and tyloses; t.d. 60-280  $\mu$ m, r.d. 50-300  $\mu$ m, vessel members 180-400  $\mu$ m in length with oblique to transverse ends; perforations simple, intervessel pit pairs bordered, alternate, 6-8  $\mu$ m in diameter, circular to oval in shape with lenticular apertures, vested. *Parenchyma* paratracheal and apotracheal; paratracheal parenchyma vasicentric to aliform-confluent to banded, bands usually discontinuous, 1-4 seriate; apotracheal parenchyma sparse, diffuse or in small patches, parenchyma cells thin-walled, 16-32  $\mu$ m in diameter and 48-180  $\mu$ m in length. *Xylem rays* fine, closely spaced, 8-14 per mm, almost uniseriate, rarely biseriate due to pairing of cells, 2-19 cells or 80-800  $\mu$ m high; rays homocellular, made up of procumbent cells only; ray cells thin-walled, 16-24  $\mu$ m in tangential height and 60-100  $\mu$ m in radial length, crystalliferous. *Fibres* aligned in radial rows in between the xylem rays, oval to polygonal in cross section, thick-walled, septate, 8-16  $\mu$ m in diameter and 440-680  $\mu$ m in length; crystalliferous strands present, divided into several chambers containing solitary crystals; interfibre pits not seen.

**Discussion**—Diffuse to semi-ring-porous wood, small to large vessels with simple perforations and alternate bordered pits, paratracheal vasicentric to banded as well as apotracheal parenchyma, homogeneous uniseriate xylem rays and septate fibres with chambered crystals are the diagnostic characters of the fossil wood, which clearly indicate its affinity with the modern wood of *Lagerstroemia* of the family Lythraceae (Pearson & Brown, 1932; Metcalfe & Chalk, 1950; Kribs, 1959; Ramesh Rao & Purkayastha, 1982). Thin sections of *Lagerstroemia calyculata*, *L. floribunda*, *L. hypoleuca*, *L. lanceolata*, *L. microcarpa*, *L. parviflora*, *L. speciosa*, *L. tomentosa* and *L. villosa* were examined to know the affinity of the fossil at the species level and it was found that it shows resemblance with the modern wood of *L. parviflora*, *L. hypoleuca*, *L. speciosa* and *L. lanceolata* syn. *L. microcarpa* which can not be distinguished

anatomically with certainty. However, they can be separated into two groups on the basis of parenchyma distribution.

Group I—	Parenchyma in the late wood usually more or less in continuous bands	<i>L. hypoleuca</i> and <i>L. speciosa</i>
Group II—	Parenchyma in late wood not in continuous bands	<i>L. lanceolata</i> and <i>L. parviflora</i>

Thus, the fossil indicates its affinity with *Lagerstroemia lanceolata* and *L. parviflora*. Of these, *L. parviflora* occurs in the present day forests of Chota Nagpur Plateau. Therefore, the possibility of the fossil belonging to this species is comparatively more. Accordingly, it has been described as *Lagerstroemia* cf. *L. parviflora*.

Fossil woods of *Lagerstroemia* are known only from the Neogene exposures in India. *Lagerstroemioxylon eoflosreginum* comparable to *Lagerstroemia flosreginae* has been described from the Tipam Sandstone in Assam and Miocene of Kachchh (Prakash & Tripathi, 1970; Lakhanpal *et al.*, 1984). Awasthi (1981) has described *Lagerstroemioxylon arcotense* from the Cuddalore sandstone without suggesting its affinities with any particular species of *Lagerstroemia*. From Namsang beds of Arunachal Pradesh yet another fossil wood of *Lagerstroemia*, *Lagerstroemioxylon deomaliensis*, comparable to *Lagerstroemia villosa*, has been described (Lakhanpal *et al.*, 1981). Thus, it should be interesting to note that none of these fossils have been shown to possess affinities with either *L. parviflora* or *L. lanceolata* syn. *L. microcarpa*.

*Lagerstroemia* Linn. is a genus of about 50 species of trees and shrubs distributed in the Indo-Malayan region and Polynesia, chiefly from southeast Asia to Australia (Willis, 1973). *Lagerstroemia parviflora* is a moderate-sized tree widely distributed throughout greater parts of India. It occurs in the sub-Himalayan region from the Yamuna eastwards through Bihar (including Chota Nagpur region), Bengal to Assam ascending to 950 m, central and south India distributed as far south as the Nilgiris-Orissa and eastern part of Andhra Pradesh (Wood, 1903; Brandis, 1906; Haines, 1910). The other species *Lagerstroemia lanceolata* is a large tree occurring in the western peninsula extending east as far as Bellary (Brandis, 1906).

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