Some fossil woods from Tipam Sandstone of Assam and Nagaland

N. Awasthi & R. C. Mehrotra


The paper records four fossil woods, viz., Koompappixylon elegans Kramer, Bauhinia tertiara sp. nov., Bischofia palaegranica Awasthi and Laurinoxylon naginimariense sp. nov. from the Tipam Sandstone of Assam and Nagaland. These show close resemblance with the woods of extant genera, viz., Koompopsis, Bauhinia, Bischofia and Lauraceae, respectively. Occurrence of Koompamia in the Indian and southeast Asian Neogene sediments provides further evidence of a close phytogeographical link between Indian subcontinent and southeast Asia.

Key-words—Fossil woods, Fabaceae, Lauraceae, Bischofia, Tipam Sandstone, Late Miocene (India).

N. Awasthi & R. C. Mehrotra, Birbal Sahni Institute of Palaeobiology, 53 University Road, Lucknow 226 007, India.

Systematic Description

Family—Fabaceae (Leguminosae)

Genus—Koompappixylon Kramer 1974

Koompappixylon elegans Kramer 1974

Pl. 1, figs 1, 4, 6

Description—Wood diffuse-porous (Pl. 1, fig. 1). Growth rings not seen. Vessels small to large, t.d. 72-240 μm, r.d. 52-280 μm, round to oval, solitary and
in radial multiples of 2-6, rarely in tangential pairs, evenly distributed, 3-7 per sq mm (Pl. 1, fig. 1), perforations simple; vessel-members storied; intervessel pits bordered, alternate, 6-8 μm in diameter, vestured. Parenchyma paratracheal, aliform, confluent to confluent-banded, bands up to 5 cells thick (Pl. 1, fig. 1), strands storied. Xylem rays 1-3 (mostly 2) seriate, 6-8 per mm, storied (Pl. 1, fig. 6); ray tissue heterogeneous; uniseriate rays 4-15 cells or 80-280 μm in height, composed wholly of procumbent cells; multiseriate rays 6-21 cells or 140-400 μm in height, mostly consisting of procumbent cells, sometimes with single row of upright or square cells at one or both the ends (Pl. 1, fig. 4). Ripple marks present due to storied arrangement of vessel members, parenchyma strands and rays (Pl. 1, fig. 4).

Affinities—The above anatomical characters of fossil wood collectively indicate its close similarity with that of the Malayan Koompassia malaccensis and the fossil wood—Koompassioxylon elegans Kramer reported earlier from the Neogene of southeast Asia and Bengal (Kramer, 1974; Bande & Prakash, 1980).

Figured specimen—Museum specimen no. BSIP 36351.

Locality—Bimlapur, Dibrugarh District, Assam

Genus—Baubinia Linn.

Baubinia tertaria sp. nov.

Pl. 1, figs 3, 8; Pl. 2, figs 1-3

Single piece of well-preserved secondary wood measuring about 13 cm in length and 3 cm in width.

Description—Wood diffuse-porous (Pl. 2, fig. 1). Growth rings not observed. Vessels small to large, mostly medium in size, t.d. 72-180 μm, r.d. 72-280 μm, mostly solitary, occasionally in radial multiples of 2-4, evenly distributed, 3-11 per sq mm, oval in shape when solitary, with flat contact walls when in multiples (Pl. 2, fig. 1), tyloses present; perforations simple; vessel-members 100-380 μm long with oblique to horizontal ends, storied (Pl. 1, fig. 3), intervessel pits bordered, alternate, 4-8 μm in diameter, almost circular in shape with lenticular apertures (Pl. 1, fig. 8). Parenchyma vasicentric, having 3-5-celled sheath completely enclosing vessels, mostly aliform to confluent, banded. Joining several adjacent vessels (Pl. 2, fig. 1); parenchyma strands storied, cells 16-48 μm in width and 48-100 μm in length. Xylem rays 1-2 seriate, mostly uniseriate, 9-12 per mm, usually made up of procumbent cells, storied (Pl. 2, figs 2, 3); ray tissue weakly heterogeneous, rays 16-44 μm in width and 8-60 cells or 160-960 μm in height; procumbent cells 32-60 μm in radial length and 16-32 μm in tangential height; upright cells 44-48 μm in tangential height and 16-20 μm in radial length. Fibres moderately thick-walled, angular in cross section, 8-16 μm in diameter and 440-600 μm in length, non-septate (Pl. 2, figs 1, 3). Ripple marks present due to storied arrangement of vessel members, parenchyma strands and rays (Pl. 2, figs 2, 3).

Holotype—Museum specimen no. BSIP 36352.

Locality—Naginimara Village, Kongan Coalfield, Mon District, Nagaland.

Affinities—Presence of ripple marks due to storied arrangements of vessel members, parenchyma strands and xylem rays, tylosed vessels, vasicentric, aliform to confluent-banded parenchyma, predominantly uniseriate xylem rays and non-septate fibres indicate its affinity with Baubinia Linn. of Fabaceae (Metcalfe & Chalk, 1950; Rao et al., 1972). Wood slides of five species of Baubinia, viz., B. malabarica Roxb., B. mirandina Pittier, B. purpurea Linn., B. racemosa Lam. and B. variegata Linn. were examined for comparison of the fossil wood; the descriptions and photographs ofical aspects of fossil wood.

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1. Koompassioxylon elegans Kramer 1974: Cross section showing shape, size and distribution of vessels and parenchyma pattern, × 45; Slide no. BSIP 36351-I.
2. Koompassia malaccensis Maing. ex Bentb.: Cross section showing similar nature and distribution of vessels and parenchyma as in fossil, × 45
3. Baubinia tertaria sp. nov. Radial longitudinal section showing storied nature of vessel elements, × 100; Slide no. BSIP 36352-III.
4. Koompassioxylon elegans Kramer 1974: Tangential longitudinal section showing storied rays, × 45; Slide no. BSIP 36351-II.
5. Koompassia excelsa (Becc.) Taub.: Tangential longitudinal section showing similar storied rays, × 45.
6. Koompassioxylon elegans Kramer 1974: Tangential section showing details of ray cells, × 120; Slide no. BSIP 36351-III.
7. Lauritoxylon naginimariense sp. nov.: Radial longitudinal section showing oil cells in rays, × 120; Slide no. BSIP 36353-III.
8. Baubinia tertaria sp. nov.: Intervessel pits, × 600; Slide no. BSIP 36352-II.
9. Lauritoxylon naginimariense sp. nov.: Intervessel pits, × 600; Slide no. BSIP 36353-II.
two other species. B. foveolata Dalz. and B. retusa Ham. (Pearson & Brown, 1952; Rao et al., 1972) were also consulted. It has been found that the present fossil wood shows closest resemblance with B. racemosa and differs from other species in several features. B. purpurea and B. variegata differ from the fossil in the absence of ripple marks. In B. mirandina, the parenchyma is relatively less (vasicentric) and the rays are broader (1-3 seriate). While in B. foveolata, B. malabarica and B. retusa the amount of parenchyma is more than in the present fossil wood.

The fossil woods of Baubinia are of common occurrence in the Neogene deposits of India. They have been described as Baubinimum miocenicum Trivedi & Panjwani (1986) and B. palaemomala- baricum Prakash & Prasad (1984), both from the Siwalik beds of Kalagarh, Uttar Pradesh, cf. Baubinia from the Cuddalore Series of Cauvery Basin (Ramanujam & Rao, 1966) and Baubinimum deomalica Awasthi & Prakash 1987 from the Namsang beds of Deomali, Arunachal Pradesh. Fossil woods cf. Baubinia (Ramanujam & Rao, 1966), Baubinimum miocenicum and B. palaemomala-baricum differ from this Nagaland wood in having relatively broad and continuous parenchyma bands. Moreover, in B. miocenicum the xylem rays are broader. In B. deomalica the parenchyma is mostly banded, whereas in our fossil it is vasicentric to aliform-confluent. Therefore, the present fossil wood is assigned to Baubinia tertiara sp. nov.

Family—Lauraceae

Genus—Laurinoxylon Felix 1883

Laurinoxylon naginimariense sp. nov.
Pl. 1, figs 7, 9; Pl. 2, figs 4-6

This species is represented by a small piece of secondary wood measuring 7 cm in length and 2.5 cm in width.

Description—Wood diffuse-porous (Pl. 2, fig. 4). Growth rings indistinct. Vessels usually medium to large, occasionally small, rarely very small, t.d. 80-320 μm, r.d. 40-320 μm, mostly round to oval, sometimes flattened due to compression, usually solitary, occasionally in radial multiples of 2-3 (rarely up to 5), uniformly distributed, 2-6 per sq mm (Pl. 2, fig. 4); tyloses present; perforations simple; vessel-members 240-360 μm long with oblique to horizontal ends; intervessel pits bordered, alternate, minute, less than 4 μm in diameter, circular to oval in shape with linear apertures (Pl. 1, fig. 9). Parenchyma vasicentric to aliform, sometimes confluent joining adjacent vessels (Pl. 2, figs 4, 6); parenchyma cells 16-32 μm in diameter and 20-120 μm in length. Xylem rays 1-5 (mostly 2) seriate, 8-11 per mm, usually made up of procumbent cells; uniseriate rays 12-20 μm in width and 2-10 cells or 40-220 μm in height; multiseriate rays 24-72 μm in width and 5-25 cells or 88-340 μm in height (Pl. 2, fig. 5); ray tissue heterogeneous, rays homocellular to heterocellular (Pl. 1, fig. 7), consisting of procumbent cells and oil cells at one or both the ends; ray cells 40-80 μm in radial length and 16-40 μm in tangential height. Fibres moderately thick-walled, angular in cross section, 8-20 μm in diameter and 200-560 μm in length. Oil cells associated with rays either in the middle portion or at the margins of rays, also present scattered among fibres either singly or in pairs, 44-60 μm in tangential height and 40-52 μm in radial length (Pl. 1, fig. 7; Pl. 2, figs 4-6).

Holotype—Specimen no. BSIP 36353.

Locality—Naginimara Village, Kongan Coalfield, Mon District, Nagaland.

Affinites—In having mostly solitary vessels with occasional multiples, septate fibres, heterogeneous xylem rays, paratracheal parenchyma and oil cells, the present fossil wood shows resemblance with the members of the family Lauraceae.
PLATE 2
The family Lauraceae is homogeneous in wood anatomy, thus on the basis of individual genus differentiation is difficult. Therefore, all the lauraceous fossil woods described so far from different parts of the world are placed under the genus *Laurinoxyton* Felix 1883. From India, four species of *Laurinoxyton* are known. They are *Laurinoxyton tertiarum* Prakash & Tripathi 1974 from Tipam Sandstone of Hailakandi, Assam; *L. namsangensis* Lakhanpal et al. 1981 and *L. deomaliensis* Lakhanpal et al. 1981 from Namsang beds of Deomali, Arunachal Pradesh and *L. varkalaensis* Awasthi & Ahuja 1982 from the Neogene of Varkala, Kerala. The important characters of these fossil woods are summarized in Table 1. *Laurinoxyton tertiarum* differs from the present

Table 1—Important anatomical characters of *Laurinoxyton* Felix known from India

<table>
<thead>
<tr>
<th>FOSSIL SPECIES</th>
<th>GROWTH RINGS</th>
<th>VESSIONS</th>
<th>PARENCHYMA</th>
<th>XYLEM RAYS</th>
<th>FIBRES</th>
<th>OIL CELLS</th>
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<tr>
<td><em>Laurinoxyton tertiarum</em></td>
<td>Distinct</td>
<td>t.d. 60-120 μm, r.d. 80-300 μm, solitary and in radial multiples of 2-4; 8-10 per sq mm; tyloses present; perforations simple and scalariform</td>
<td>Scanty paratracheal, rarely forming uniseriate sheath</td>
<td>1-2 (mostly 2) seriate, 5-30 cells in height, single row of marginal upright or square cells present</td>
<td>Thick-walled, septate</td>
<td>Present in xylem rays, parenchyma cells and fibres</td>
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<td>Prakash &amp; Tripathi 1974</td>
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<td><em>L. namsangensis</em></td>
<td>Not seen</td>
<td>t.d. 75-300 μm, r.d. 75-405 μm, solitary and in radial multiples of 2-5; 8-10 per sq mm; tyloses profuse; perforations simple</td>
<td>Scanty paratracheal, rarely forming uniseriate sheath</td>
<td>2 seriate (rarely 3 seriate), 5-22 cells in height, single row of marginal upright or square cells present</td>
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<td>Present in xylem rays</td>
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<td>Lakhanpal et al. 1981</td>
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<td><em>L. deomaliensis</em></td>
<td>Present</td>
<td>t.d. 60-120 μm, r.d. 40-320 μm, solitary and in radial multiples of 2-5, occasionally up to 8, 12-44 per sq mm; tyloses present; perforations simple</td>
<td>Scanty paratracheal</td>
<td>1-2 (mostly 2) seriate, 5-30 cells in height, single marginal row of upright or square cells present</td>
<td>Moderately thick-walled, septate</td>
<td>Abundant; scattered singly among fibres</td>
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<td>Lakhanpal et al. 1981</td>
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<tr>
<td><em>L. varkalaensis</em></td>
<td>Not seen</td>
<td>t.d. 80-240 μm, r.d. 128-280 μm, solitary and in radial multiples of 2-4, closely placed; tyloses profuse; perforations simple</td>
<td>Paratracheal, 2-3 seriate sheath around vessels, sometimes aliform</td>
<td>1-3 (mostly 2) seriate, 12-45 cells high, 1-2 enlarged upright cells at the margins</td>
<td>Semi libriform to libriform, septate</td>
<td>Present among fibres and at the margins of rays</td>
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<td>Awashthi &amp; Ahuja 1982</td>
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<td><em>L. nagiini</em>-</td>
<td>Indistinct</td>
<td>t.d. 80-320 μm, r.d. 40-320 μm, solitary and in radial multiples of 2-5, 2-6 per sq mm; tyloses present; perforations simple</td>
<td>Vasicentric to aliform, sometimes confluent joining adjacent vessels</td>
<td>1-5 (mostly 2) seriate, hometoblastic to heterocellular, 5-25 cells in height</td>
<td>Moderately thick-walled, septate</td>
<td>Associated with xylem rays either in the middle portion or at the margins; also occurring as scattered cells among fibres</td>
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<td>vienae sp. nov.</td>
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fossil in having scalariform perforation plates. In *L. namsangensis* and *L. deomaliensis* the parenchyma is less, i.e., scanty paratracheal to uniseriate vacisentric than in the present fossil specimen. The parenchyma in *L. varkalaensis* is also scanty and the rays are narrower. Moreover, in the former the tyloses are abundant completely occluding the vessels.

In view of the above differences, the present fossil wood is placed under a new species, *Laurinoxylon naginimariense*. The specific name is derived after Naginimara, the type locality of the fossil wood.

**Family—Bischofiaceae**

**Genus—Bischofia Blume**

*Bischofia palaeojavanica* Awasthi 1989  
Pl. 2, figs 7, 8

Wood diffuse porous (Pl. 2, fig. 16). Growth rings not seen. Vessels usually small to medium, rarely large, t.d. 68-240 μm, r.d. 52-200 μm, solitary and in radial multiples of 2-5, round to oval, evenly distributed, 6-14 per sq mm; tyloses abundant (Pl. 2, fig. 7); perforations simple; vessel-members 100-520 μm long with oblique to horizontal ends; intervessel pits bordered, alternate, large, 10-14 μm in diameter, circular to oval in shape with lenticular apertures. Parenchyma absent, or rarely 1-2 cells may be present associated with vessels (Pl. 2, fig. 7). Xylem rays 1-5 seriate, 5-8 per mm; ray tissue heterogeneous, uniseriate rays consisting of upright cells only, 24-52 μm in width and 4-9 cells or 220-720 μm in height; multiseriate rays made up of procumbent cells in the central portion and 1-6 rows of upright cells at one or both the ends, 40-140 μm in width and 7-29 (rarely 50) cells or 360-1120 (rarely 1720) μm in height (Pl. 2, fig. 8); sometimes ray to ray fusion observed. Fibres moderately thick-walled, angular in cross section, 20-40 μm in diameter, septate (Pl. 2, fig. 8).

**Affinities**—In its anatomical characters the fossil wood resembles extant *Bischofia javanica* Bl. Among known fossil woods it resembles *Bischofia palaeojavanica* described by Awasthi (1989) from the Namsang beds near Deomali, Arunachal Pradesh.

**Figured Specimen**—Specimen no. BSIP 36354.

**Locality**—Naginimara Village, Kongan Coalfield, Mon District, Nagaland.

**DISCUSSION**

Of the four taxa added to the Tipam flora, the genus *Koompassia* is significant from the phyto-geographical point of view as it does not exist in the Indian subcontinent today. However, it is represented by four species distributed only in the Malayan Peninsula, Borneo and New Guinea (Willis, 1973). *K. malaccensis* Maing. ex Benth. is a large tree, about 30-50 m tall, though buttressed at the base, occurring throughout the lowland forest in swampy ground and also on hill sides in Malayan Peninsula and Indonesia, especially in Sumatra (Ridley, 1922; Desch, 1957). The fossil woods of *Koompassia* are also known from the Neogene of Bengal and Malayan Peninsula (Kramer, 1974; Bande & Prakash, 1980) indicating its wider distribution during that time. Like *Koompassia*, a few other elements, viz., *Dryobalanops* (Prakash & Tripathi, 1969b; Prakash & Tripathi, 1975), *Sindora* (Smith & Briden, 1979) Being sensitive to the changing environments, several such taxa which were growing luxuriantly in the Indian subcontinent under tropical and high humid conditions failed to regenerate thereafter.

**REFERENCES**


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