

FOSSIL WOODS OF *OUGENIA* AND *MADHUCA* FROM THE TERTIARY OF ASSAM

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ABSTRACT

Ougenia and *Madhuca* are recorded for the first time from India and abroad. They are known from the Tipam series near Hailakandi in District Cachar of Assam.

INTRODUCTION

FOSSIL woods resembling *Ougenia* of Leguminosae and *Madhuca* of Sapotaceae are described here from the Tipam sandstones exposed near the village Sultanicherra, about 30 km south of Hailakandi in Cachar District of Assam. *Ougenia* and *Madhuca* are known for the first time from India and abroad.

A rich flora is already known from the Tipam sandstones near Hailakandi (Prakash, 1972) and the present findings further add to our knowledge of the Middle Tertiary flora of this region.

SYSTEMATIC DESCRIPTION

Family — LEGUMINOSAE

Genus — *Ougenioxylon* gen. nov.

1. *Ougenioxylon tertiarum* sp. nov.

The present species is based on a fossil wood measuring about 5 cm in length and 3 cm in diameter.

Topography — Wood diffuse-porous (Pl. 1, fig. 1). **Growth rings** distinct, delimited by 1-2 cells thick lines of terminal parenchyma. **Vessels** small to large, mostly solitary, often in short radial rows of 2-4 (Pl. 1, fig. 1), 12-15 per sq mm; tyloses absent. **Parenchyma** paratracheal and apotracheal (Pl. 1, fig. 1; Text-fig. 1); paratracheal parenchyma abundant, mostly vasicentric to aliform, occasionally aliform-confluent, joining 2-4 or more vessels; apotracheal parenchyma diffuse, occurring



TEXT-FIG. 1 — *Ougenioxylon tertiarum* gen. et sp. nov. — Cross section showing vessel and parenchyma distribution $\times 25$. Slide no. 33916/5036.

as solitary cells and in 1-2 cells thick lines of terminal parenchyma. **Xylem rays** fine to medium, 1-4 (mostly 2-3) seriate (Pl. 1, fig. 3), 12-30 μ in width, 3-20 cells and 35-42 μ high, 8-10 per mm; ray tissue homogeneous (Pl. 2, fig. 5), rays homocellular, consisting wholly of procumbent cells, usually storied (Pl. 1, fig. 3). **Fibres** not aligned in radial rows.

Elements — **Vessels** thin-walled, the walls 4-5 μ , t.d. 40-260 μ , r.d. 60-300 μ , solitary vessels round to oval, those in radial multiples flattened at the places of contact; vessel-members storied, short, 150-280 μ in length, with truncated or tailed ends; perforations simple; intervessel pit-pairs small, 4-6 μ in diameter, vestured, border oval to elliptical with lenticular orifices (Pl. 2, fig. 6); vessel-parenchyma and vessel-ray pits not preserved. **Parenchyma cells** thin-walled, 14-30 μ in diameter, 40-198 μ in length, irregularly storied; parenchyma

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strands crystalliferous. *Ray cells* thin-walled, procumbent cells 18-24 μ in tangential height, 54-120 μ in radial length. *Fibres* thick-walled, walls 6-8 μ thick, semi-libriform to libriform, septate, polygonal in cross section, 20-30 μ in diameter, 500-1845 μ in length; interfibre pits not preserved. *Ripple marks* present, traceable to storied vessel segments, parenchyma strands and the xylem rays.

Affinities — There is a close agreement in almost all structural details of the present fossil wood with the wood structure of the modern genus *Ougenia* Benth. of the family Leguminosae. An examination of thin-sections, published description and photographs of the modern woods of *Ougenia* Benth., indicates closest resemblance with the wood structure of *Ougenia dalbergioides* Benth. (F.R.I. slide no. A3286/0-5309), (Pearson & Brown, 1932, pp. 352-354, fig. 126; Metcalfe & Chalk, 1950, pp. 520-523).

In both, the fossil wood and the modern wood of *Ougenia dalbergioides* (F.R.I. slide no. A3286/0-5309), the growth rings are marked by terminal parenchyma, the vessels are small to large, mostly solitary, often in short radial rows of 2-4, the perforations are simple, the intervessel pit-pairs are small, 4-6 μ in diameter, vested with lenticular orifices, the parenchyma is storied, mostly vasicentric to aliform occasionally aliform-confluent and also as diffuse solitary cells, the xylem rays are storied, 1-4 (mostly 2-3) seriate composed of procumbent cells only and the fibres are semi-libriform to libriform and septate.

It is important to note that a detailed study of the thin-sections from a number of wood specimens of *Ougenia dalbergioides* Benth. available at the Forest Research Institute, Dehra Dun has shown a wide range of variation in the parenchyma distribution and the nature and width of the xylem rays. In slide nos. 160/C5877, A1070/0-4440 and A3282/W. 1226, the paratracheal parenchyma is mostly aliform-confluent to confluent, sometimes aliform and rarely vasicentric and the xylem rays are 1-5 (mostly 2-3) seriate and distinctly storied, whereas in slide nos. A3284/p. 102 and A3285/p. 601, the paratracheal parenchyma is mostly aliform to aliform-confluent, and occasionally vasicentric and the xylem rays are 1-3 (mostly 2-3) seriate show-

ing storied tendency. In another specimen (slide no. A. 3268/0-5309), which resembles the present fossil wood, the paratracheal parenchyma is mostly vasicentric to aliform, occasionally aliform-confluent, and the xylem rays are 1-4 (mostly 2-3) seriate and regularly to irregularly storied.

Because of a close resemblance of the fossil wood with the wood structure of the modern genus *Ougenia* Benth., it has been assigned to a new organ genus *Ougenioxylon*. It is specifically named as *Ougenioxylon tertiarum* sp. nov.

So far there is no record of the fossil remains of the genus *Ougenia* Benth. from India and abroad. Therefore, the present finding is the first record of a fossil wood of *Ougenia* from India and outside.

Ougenia Benth. is a monotypic genus distributed only in India (Willis, 1966, p. 814). It is found from the Ravi eastwards to Bhutan, not common in Bihar and Orissa, except in Sambalpur, occurring throughout the Central Provinces, Central India, Rajputana, Khandesh, the Bombay, Deccan, Panch Mahals, South Deccan and North Kanara. It is not so common in South India, though found in Central and North Coimbatore, Ganjam, Madura, Coorg, Hyderabad and Mysore (Pearson & Brown, 1932, pp. 352, 353).

GENERIC DIAGNOSIS

Ougenioxylon gen. nov.

Wood diffuse-porous. *Growth rings* present. *Vessels* small to large, solitary as well as in short radial rows of 2-4 or more cells; vessel-members storied, short with truncated or tailed ends; perforations simple; intervessel pit-pairs small, vested with lenticular orifices. *Parenchyma* paratracheal and apotracheal; paratracheal parenchyma abundant, vasicentric, aliform and confluent; apotracheal parenchyma diffuse as scattered cells and terminal; parenchyma strands storied and crystalliferous. *Xylem rays* 1-5 (mostly 2-3) seriate; ray tissue homogeneous; rays homocellular consisting only of procumbent cells, regularly to irregularly storied. *Fibres* semi-libriform to libriform, septate. *Ripple marks* present.

Genotype — *Ougenioxylon tertiarum* sp. nov.

SPECIFIC DIAGNOSIS

Ougenioxylon tertiarum sp. nov.

Wood diffuse porous. *Growth rings* distinct, delimited by 1-2 cells thick lines of terminal parenchyma. *Vessels* small to large, t.d. 40-260 μ , r.d. 60-300 μ , mostly solitary, often in short radial rows of 2-4, round to oval in cross-section, 12-15 per sq mm; tyloses absent; vessel-members storied, short, 150-280 μ in length, with truncated or tailed ends; perforations simple; inter-vessel pit-pairs small, 4-6 μ in diameter, vestured, border oval to elliptical, with lenticular orifices. *Parenchyma* paratracheal and apotracheal; paratracheal parenchyma abundant, mostly vasicentric to aliform, occasionally aliform-confluent; apotracheal parenchyma diffuse as solitary cells and in 1-2 cells thick lines delimiting the growth rings; parenchyma strands storied and crystalliferous. *Xylem rays* fine to medium, 1-4 (mostly 2-3) seriate, 12-30 μ in width, 3-20 cells and 35-42 μ high, 8-10 per mm; ray tissue homogeneous, rays homocellular, consisting wholly of procumbent cells, regularly to irregularly storied. *Fibres* semi-libriform to libriform, walls 6-8 μ thick, septate, polygonal in cross section, 20-30 μ in diameter, 500-1854 μ in length; interfibre pits not preserved. *Ripple marks* present, traceable to storied vessel elements, parenchyma strands and xylem rays.

Holotype — B.S.I.P. Museum no. 33916.

Locality — Sultanicherra, near the Haila-District Cachar, Assam.

Family — SAPOTACEAE

Genus — *Madhucoxylon* gen. nov.

2. *Madhucoxylon cacharensis* sp. nov.

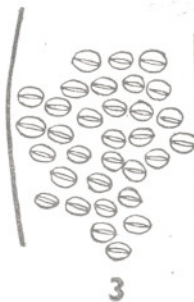
The material consists of a single piece of mature secondary xylem about 3 cm in length and 2 cm in diameter.

Topography — Wood diffuse-porous (Pl. 2, fig. 7). *Growth rings* indistinct. *Vessels* medium to large, occasionally solitary, the majority in short radial rows of 2-6 (mostly 2-3), evenly distributed without any definite pattern, 10-15 per sq mm; tyloses present (Pl. 2, fig. 7). *Tracheids* paratracheal,

vasicentric, clearly visible in longitudinal sections. *Parenchyma* paratracheal and apotracheal (Pl. 2, fig. 7; Text-fig. 2); paratracheal parenchyma scanty, occurring as 1-2 cells around the vessels; apotracheal parenchyma occurring as narrow, irregular, 1-3 (mostly 1-2) seriate lines. *Xylem rays* fine, 1-4 cells (Pl. 2, fig. 9) and 12-64 μ in width, 14-20 per mm in the normal wood, but broader, 1-7 cells and 13-108 μ in width, 6-34 cells or 96-600 μ high and closely placed in the region of knots; ray tissue heterogeneous (Pl. 2, fig. 9); uniseriate rays 10-15 μ in width, 1-5 cells and 20-80 μ high, homocellular or heterocellular, when homocellular, consisting wholly of upright cells, when heterocellular, consisting of procumbent cells in the middle portion and upright cells at both the ends; multiseriate rays



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TEXT-FIGS. 2 & 3 — *Madhucoxylon cacharensis* gen. et sp. nov. — 2. Cross section showing vessel and parenchyma pattern $\times 25$. Slide no. 33917/5040. 3. Intervessel pit-pairs $\times 330$. Slide no. 33917/5041.

2-4 seriate, 16-64 μ in width, 4-34 cells and 120-600 μ high, heterocellular, consisting of procumbent cells in the middle portion and 1-10 marginal rows of upright cells at one or both the ends (Pl. 2, fig. 9); end to end ray fusion very frequent. *Fibres* aligned in radial rows.

Elements — *Vessels* thin-walled, the walls 4-6 μ thick, t.d. 32-144 μ , r.d. 72-200 μ , round in cross section, those in radial multiples flattened at the places of contact; vessel-members short to medium-sized, 225-480 μ in length, with truncated or abruptly tailed ends; perforations simple; intervessel pit-pairs 6-9 μ in diameter, bordered, alternate, with oval to elliptical border and linear-lenticular apertures (Text-fig. 3); vessel-ray and vessel-parenchyma pits not preserved. *Tracheids* few, confined to the immediate vicinity of the vessels, 40-50 μ in diameter, 600-950 μ in length; pits large, 6-10 μ in diameter, oval to elliptical, with linear-lenticular, horizontal apertures. *Parenchyma cells* thin-walled, 20-32 μ in diameter, 40-140 μ in length. *Ray cells* thin-walled, procumbent cells 12-24 μ in tangential height, 40-120 μ in radial length; upright cells 28-60 μ in tangential height, 20-32 μ in radial length. *Fibres* libriform, walls 6-8 μ thick, nonseptate, 20-30 μ in diameter, 750-1820 μ in length, angular in cross section; interfibre pits not preserved.

Affinities — There is a close agreement in almost all the structural details of the present fossil wood with the wood structure of the modern genus *Madhuca* Gmel. of the family Sapotaceae (Pearson & Brown, 1932, pp. 671-678; Metcalfe & Chalk, 1950, pp. 871-880; Kribs, 1959, pp. 146-147). An examination of thin-sections, published description and photographs of a number of species of *Madhuca* reveals that the present fossil wood shows nearest resemblance with the wood structure of *M. butyracea* Roxb. and *M. latifolia* (Roxb.) Macb., but more to the former. This study includes the examination of thin-sections of *Madhuca longifolia* (Linn.) Meckb., *M. malabarica* (Bedd.) Parker; *M. indica* Gmel. and *M. butyracea* Roxb. and published description and photographs of *Madhuca* sp. (Metcalfe & Chalk, 1950), *M. indica* Gmel. syn. *Bassia latifolia* Roxb. and *M. latifolia* Linn. (Pearson & Brown, 1932, pp. 673-678, figs. 219, 220; Kribs 1959, pp. 146-147, fig. 310), *M. ramiflora* Merrill and

M. betis Merrill (Kanehira, 1924, p. 38), *M. posquieri* H. Lec. (Lecomte, 1926, pl. 44), *M. utilis* (Ridl.) Lam., *M. malaccensis* (King et Gamble) Lam., *M. rupicola* (King et Gamble) Lam., *M. tomentosa* Lam., and *M. sericea* Lam. (Desch, 1954, pp. 547-548, pl. 110, fig. 1).

In both the fossil wood and the modern wood of *Madhuca butyracea* the vessels are medium to large in size, the intervessel pit-pairs are alternate, bordered, the perforations are simple, the parenchyma is scanty paratracheal as well as apotracheal, occurring as 1-3 (mostly 1-2) cells thick, irregular, tangential lines, the xylem rays are 1-4 seriate with heterogeneous ray tissue and the fibres are libriform and non-septate. However, in the modern wood of *M. butyracea*, the amount of the parenchyma is slightly more than in the present fossil wood.

Because of close resemblance of the fossil wood with the modern wood of *Madhuca* Gmel., it is assigned to a new organ genus *Madhucoxylon*. It is specifically named as *Madhucoxylon cacharensis* sp. nov., the specific name indicating its occurrence in the District of Cachar in Assam.

This is the first record of the fossil wood belonging to the genus *Madhuca* Gmel. of the family Sapotaceae from India and abroad. So far, only seven species of fossil woods belonging to the family Sapotaceae are known. These are *Sapotoxylon taeniatum* Felix (1882) from Bavaria in South-East Germany, *S. pachtovae* Prakash, Brezinova & Awasthi (1974) from the Tertiary of South Bohemia, *Siderinium deomaliense* Prakash & Awasthi (1970) from the Mio-Pliocene of Deomali in Arunachal Pradesh, India, *Palaeosideroxylon flammula* and *Manilkaroxylon crystallophora* from the Upper Miocene of Castellane in France (Grambast-Fessard, 1968), *M. bohemicum* Prakash, Brezinova & Awasthi (1974) from the Tertiary of South Bohemia and *M. diluviale* Hofmann (1948) from Quaternary deposits of South America. However, all these are markedly different from the fossil wood described here.

The genus *Madhuca* Gmel. consists of 85 species (Willis, 1966, p. 685) distributed in Indochina, Indo-Malayan region especially in West Malaysia and Australia. Only 5 species occur in India (Troup, 1921, p. 646). *Madhuca butyracea* Roxb., with which

the present fossil wood shows closest resemblance occurs in the sub-Himalayan tract and outer Himalaya from the eastern Dun eastwards, frequent from Kumaon to Bhutan, ascending to 1,500 metres. In the hills it is found chiefly along the sides of ravines (Hooker, 1882, p. 546; Troup, 1921, p. 646).

GENERIC DIAGNOSIS

Madhucoxylon gen. nov.

Wood diffuse-porous. *Growth rings* distinct or indistinct. *Vessels* small to large, the majority in short radial rows; perforations simple; intervessel pit-pairs bordered, border oval or elliptical, with linear-lenticular orifices. *Tracheids* vasicentric; pits large, oval, bordered, with linear-lenticular orifices. *Parenchyma* paratracheal and apotracheal; paratracheal parenchyma scanty; apotracheal parenchyma in narrow, usually more or less continuous, occasionally anastomosing lines. *Xylem rays* 1-4 seriate or more; ray tissue heterogeneous. *Fibres* libriform, non-septate.

Genotype — *Madhucoxylon cacharensis* sp. nov.

SPECIFIC DIAGNOSIS

Madhucoxylon cacharensis sp. nov.

Wood diffuse-porous. *Growth rings* indistinct. *Vessels* medium to large, t.d.

32-144 μ , r.d. 72-200 μ , majority in short radial rows of 2-6 (mostly 2-3), occasionally solitary, heavily tylosed; vessel-members short to medium-sized, 225-480 μ in length with intervessel pit-pairs 6-9 μ in diameter, bordered, alternate, with oval to elliptical border and linear-lenticular apertures. *Tracheids* paratracheal, confined to immediate vicinity of vessels; vessel-tracheid pits large, 6-10 μ in diameter, oval to elliptical with wide border and linear-lenticular apertures. *Parenchyma* paratracheal and apotracheal; paratracheal parenchyma scanty, 1-2 cells adjacent to the vessels; apotracheal parenchyma occurring as narrow, 1-3 (mostly 1-2) seriate, irregular, tangential lines. *Xylem rays* fine, 1-4 cells and 12-64 μ wide, 14-20 per mm; ray tissue heterogeneous; uniseriate rays 10-15 μ in width, 1-5 cells and 20-80 μ high, homocellular or heterocellular, when homocellular consisting wholly of upright cells, when heterocellular consisting of upright cells at the margins and procumbent cells in the middle part; multi-seriate rays 2-4 seriate, 16-64 μ wide, 4-34 cells and 120-600 μ high, heterocellular, consisting of procumbent cells in the median thickened portion and marginal rows of 1-10 upright cells at one or both the ends; end to end ray fusion frequent. *Fibres* libriform, walls 6-8 μ thick, polygonal, nonseptate, 20-30 μ in diameter, 750-1820 μ in length; interfibre pits not preserved.

Holotype — B.S.I.P. Museum no. 33917

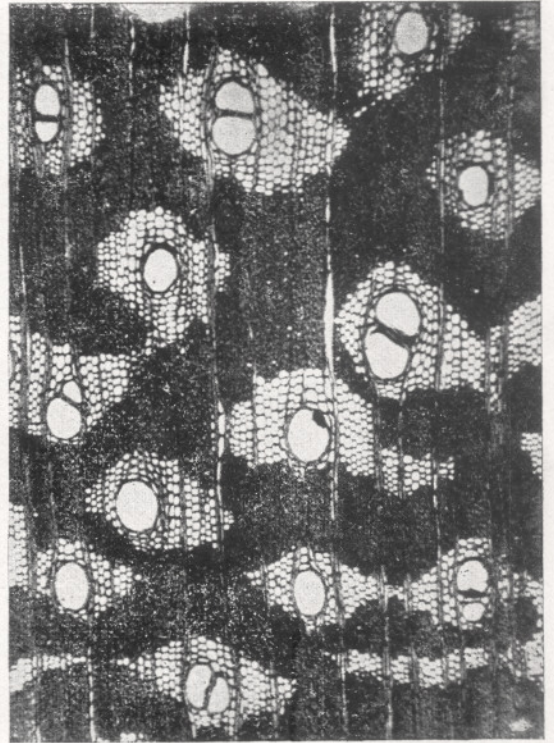
Locality — Sultaricherra, near Hailakandi, District Cachar, Assam.

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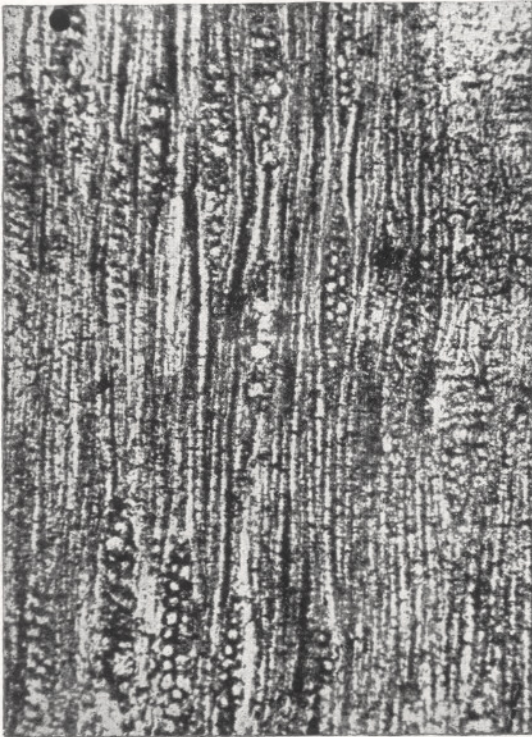
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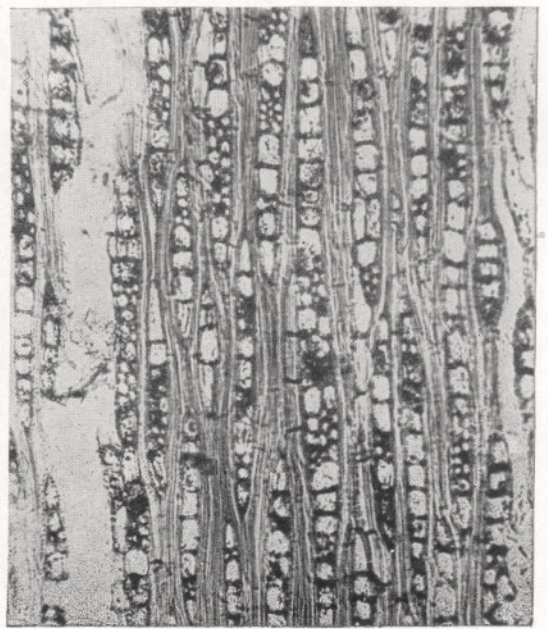
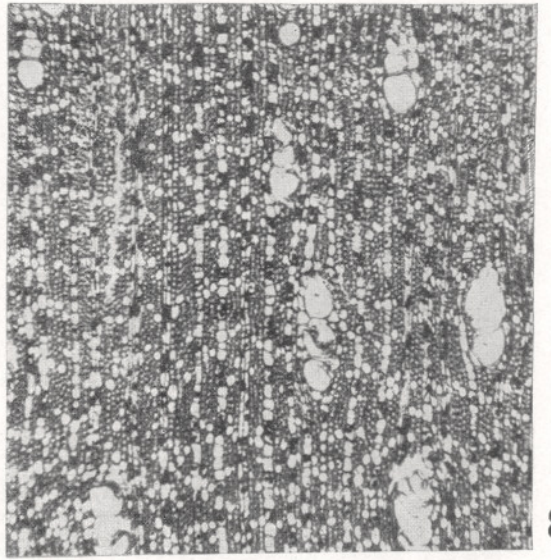
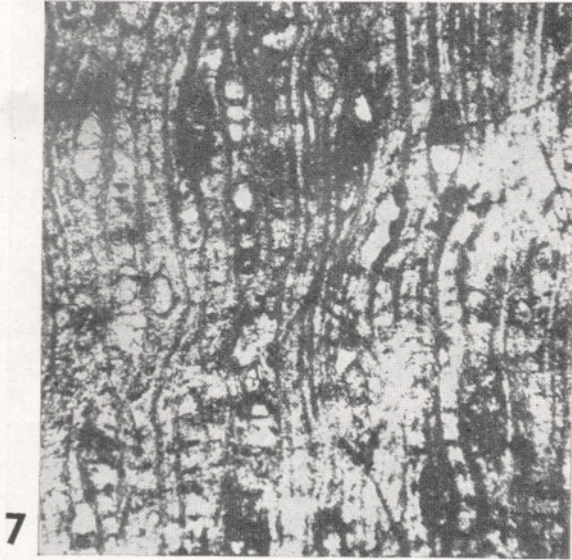
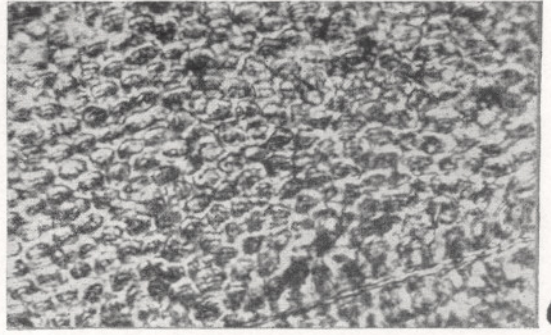
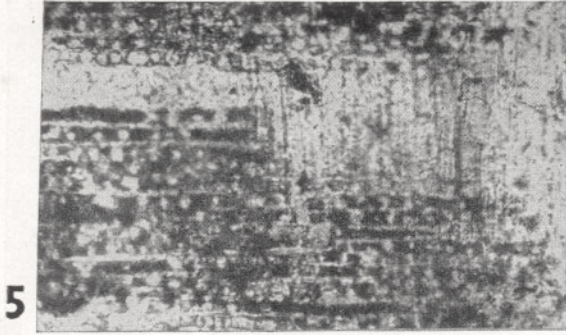
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EXPLANATION OF PLATES

PLATE 1

1. *Ougenioxylon tertiarum* gen. et sp. nov.— Cross section showing the vessel distribution and parenchyma pattern. $\times 30$. Slide no. 33916/5036.

2. *Ogenia dalbergioides* — Cross section showing similar vessel distribution and parenchyma pattern. $\times 30$.

3. *Ougenioxylon tertiarum* gen. et sp. nov.— Tangential longitudinal section showing ray type and their distribution. $\times 120$. Slide no. 33916/5037.

4. *Ogenia dalbergioides* — Tangential longitudinal section showing similar ray type and their distribution. $\times 120$.

PLATE 2

5. *Ougenioxylon tertiarum* gen. et sp. nov.— Radial longitudinal section showing homogeneous

xylem rays. $\times 120$. Slide no. 33916/5038.

6. *Ougenioxylon tertiarum* gen. et sp. nov.— Magnified intervessel pit-pairs. $\times 620$. Slide no. 33916/5039.

7. *Madhucoxylon cacharensense* gen. et sp. nov.— Cross section showing vessel distribution and parenchyma pattern. $\times 40$. Slide no. 33917/5040.

8. *Madhuca latifolia* — Cross section showing similar vessel distribution and parenchyma pattern. $\times 40$.

9. *Madhucoxylon cacharensense* gen. et sp. nov.— Tangential longitudinal section showing ray type and their distribution. $\times 90$. Slide no. 33917/5041.

10. *Madhuca latifolia* — Tangential longitudinal section showing similar ray type and their distribution. $\times 90$.