FOSSIL WOOD OF *TETRAMELES* FROM THE DECCAN INTERTRAPPEAN BEDS OF MOHGAONKALAN, MADHYA PRADESH

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ABSTRACT

A new fossil dicotyledonous wood is described from the Deccan Intertrappean beds of Mohgaonkalan (21°1′ N; 79°11′ E), District Chhindwara, Madhya Pradesh. It has been assigned to a new genus of fossil woods, *Tetrameleoxylon* and named as *T. prenudiflora* sp. nov., because of its marked similarity in wood structure to the modern *Tetrameles nudiflora* R. Br. of the Datiscaceae.

INTRODUCTION

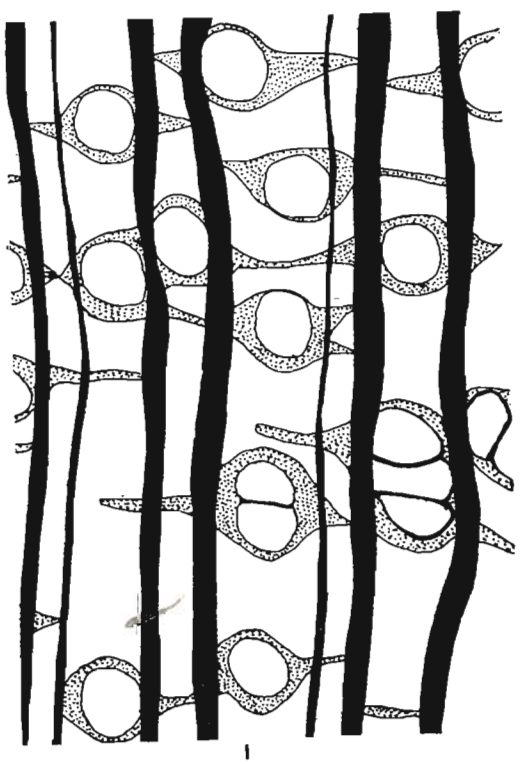
OF all the plant-bearing localities of the Deccan Intertrappean Series so far discovered, Mohgaonkalan has yielded the richest angiospermic fossil flora. Although the fossil dicotyledonous woods are of frequent occurrence in this locality, only a few of them have so far been described (RODE, 1936; VERMA, 1950; PRAKASH, 1959; SHALLOM, 1960, 1964). The present find is a further addition to our rather meagre knowledge of the fossil woods of Mohgaonkalan.

The fossil wood was studied from its ground sections and identified after comparison with the slides of a large number of modern woods. It shows marked similarity, although not identity, with the wood structure of the only species of *Tetrameles*, *T. nudiflora* R. Br. Hence it has been assigned to a new genus of fossil woods, *Tetrameleoxylon* and described as *Tetrameleoxylon prenudiflora* sp. nov.

DESCRIPTION

The fossil specimen, on which the present species is based, is a piece of silicified secondary wood measuring about 19 cm. in length and 9·5 cm. in diameter. It is earthy brown externally and almost black on the cut surface. The anatomical details of the fossil are excellently preserved.

Topography — Wood diffuse-porous (PL. 1, FIG. 1; TEXT-FIG. 1). *Growth rings* present, delimited only by the crowding of smaller vessels. *Vessels* visible to the naked eye as small dots, moderately large to medium-sized and small, mostly solitary, sometimes in radial groups of 2-3 (mostly 2), rarely also in clusters of 2-3 or even 4, evenly distributed, 3-5 per sq. mm. (PL. 1, FIG. 1; TEXT-FIG. 1); tyloses absent. *Xylem parenchyma* typically paratracheal, forming



TEXT-FIG. 1 — *Tetrameleoxylon prenudiflora* gen. et sp. nov. Cross-section showing shape, size and distribution of vessels and aliform to confluent parenchyma (Stippled). × 45.

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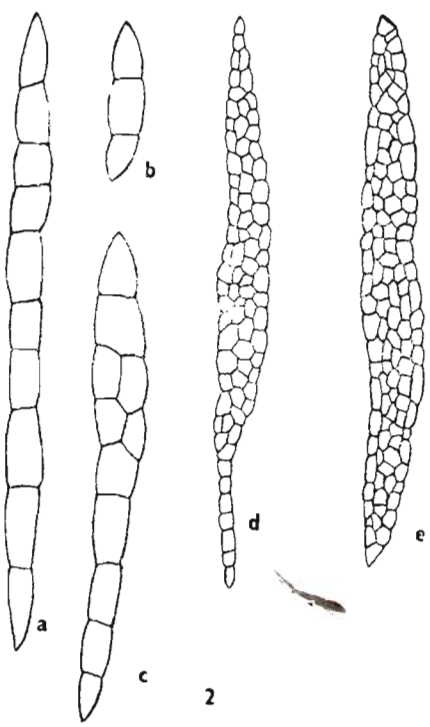
vasicentric sheaths, 2-3 (rarely 4) cells thick around the vessels, often aliform with lateral extensions up to adjoining rays or even extending beyond them up to adjacent pores (PL. 2, FIG. 5; TEXT-FIG. 1); aliform extensions 3-6 cells thick near the vessels, slightly narrowing outwards (PL. 2, FIG. 5); parenchyma strands storied. *Xylem rays* visible with a hand lens as prominent straight lines on the cross surface of the wood, separated by 3-14 rows of fibres, fine to broad, 1-6 (mostly 3-5) seriate and 24-150 μ broad (PL. 1, FIG. 3; TEXT-FIGS. 2a-e), closely spaced, 4-5 per mm; non-storied; ray tissue heterogeneous (PL. 2, FIG. 11); uniseriates 3-10 cells and 90-315 μ in height, 24 μ in average width, composed only of upright cells or both upright and procumbent cells (TEXT-FIGS. 2 a,b); multiseriate (2-6 seriate) rays, 6-87 cells or 195-1995 μ high and 48-150 μ wide, composed only of procumbent cells or of both procumbent and upright cells (PL. 1, FIG. 3; TEXT-FIGS. 2c-e); the heterocellular multiseriate rays consisting entirely of procumbent cells in the broad central portion of the rays usually with 1-2 rows of marginal upright cells at one or both the ends although uniseriate extensions of 1-7 rows of upright or square cells not uncommon (TEXT-FIG. 2d); sheath cells occasionally present on the flanks of the rays (TEXT-FIG. 2e). *Fibres* well preserved, aligned in radial rows between the two consecutive rays, showing marked variation in size, smaller fibres being mixed up with the bigger ones; storied (PL. 2, FIG. 6), sometimes slightly irregular.

Elements — Vessels thin-walled, round to oval in cross-section when solitary, sometimes slightly irregular due probably to pressure during fossilization, those in groups flattened at places of contact (PL. 1, FIG. 1), t.d. 90-240 μ, r.d. 90-255 μ; vessel-members usually short, 150-405 μ in length, with truncate ends; perforations exclusively simple; intervascular pits well preserved, bordered, oval to orbicular in shape, alternate (PL. 2, FIG. 8), crowded, 6-8 μ in diameter; pit-apertures horizontal, linear to lenticular, sometimes coalescent (PL. 2, FIG. 8); vessel-parenchyma pits clearly seen, many per cell, larger than the intervessel pits, simple, elliptical in shape and variously oriented (PL. 2, FIG. 9); vessel-ray pit not seen. *Parenchyma strands* 2-4 celled; cells thin-walled, oval to angular in cross-section, 375-450 μ in length, 30 μ in average diameter. *Ray cells* thin-walled, often filled with dark brown contents; procumbent cells circular to oval in shape in the tangential longitudinal section, with radial length 90 μ, tangential height 30 μ; upright cells square to rectangular in shape, radial diameter 40 μ, tangential height 50 μ. *Fibres* thin-walled, about 2-3 μ in thickness, non-libriform, non-septate (PL. 2, FIG. 6), polygonal to oval in cross-section, 375-405 μ in length; r.d. 16-50 μ, t.d. 12-48 μ; interfibre pits not observed.



TEXT-FIG. 2 — *Tetrameleoxylon prenudiflora* gen. et sp. nov. Xylem rays seen in the tangential longitudinal section — a & b, uniseriate homocellular × 190; c, biseriate heterocellular. × 190; d, multiseriate with up to 6 rows of marginal upright cells. × 70; e, multiseriate with sheath cells at the flanks. × 70.

DISCUSSION

The diagnostic features exhibited by the fossil wood are: (1) Predominantly solitary vessels, (2) vasicentric parenchyma with occasional aliform extensions, (3) storied parenchyma strands, (4) 1-6 seriate, homocellular to heterocellular xylem rays, the

uni- and biseriates being rare, (5) occasional presence of sheath cells on the flanks of the multiseriate rays, (6) intervascular pitting bordered, pits 6 μ in diameter, oval to orbicular in shape with linear to lenticular, often coalescent apertures and (7) distinctly storied, thin-walled fibres.

These characters of the secondary xylem individually occur in remotely related groups and genera of the modern dicotyledons and none of them, if considered alone, is sufficient to provide a clue to the taxonomic affinities of the wood. Consequently a search is to be made for a type in which a similar combination of characters can be found as met with in the fossil wood from Mohgaonkalan. An exhaustive survey indicates that these structural features occur together, although in varying degrees, in members of the Verbenaceae, Lecythidaceae, Moraceae and Datiscaceae.

In Verbenaceae, the genus *Vitex* is comparable to the present fossil in certain gross features, but differs markedly from it in possession of such other characters as the septate and non-storied fibres, the nature and width of the xylem rays and in having scanty vasicentric parenchyma.

The genus *Combretodendron* of the Lecythidaceae shows similarities with the fossil in the distribution and nature of vessels, parenchyma and xylem rays; but differs from it in having scanty vasicentric parenchyma, presence of tyloses and non-storied fibres.

In Moraceae, the wood of the genus *Artocarpus* approaches the fossil in a number of anatomical features. The resemblances are in the possession of large-sized vessels occurring solitary or occasionally in groups of 2-3, their distribution pattern in cross-section, the vasicentric parenchyma often with short wings, occasionally connecting 2-3 pores, and in the heterogeneous, broad (1-6 cells wide) xylem rays. Occasional presence of sheath cells as well as storied fibres similar to the fossil wood, are also known in some species of *Artocarpus*. However, they differ in the amount of vasicentric parenchyma which is much more abundant in *Artocarpus* which also has shorter rays than in the fossil wood. The tyloses, which are totally absent in the fossil, are very abundant in *Artocarpus*.

The family Datiscaceae shows, to the maximum extent, the combination of structural features possessed by the fossil wood and a very close approximation in almost all anatomical structures is to be found in the genus *Tetrameles*. The fossil wood also shows resemblance to the mature secondary xylem of *Octomeles* of the same family. Both *Tetrameles* and *Octomeles* are very similar in wood structure except that the intervascular pitting is slightly larger, with linear to lenticular apertures extending to the border, in the former as opposed to smaller (4-5 μ) pitting with circular apertures in the latter. Also, in *Tetrameles* the vessels show somewhat oblique alignment in cross-section and occasional sheath cells are present in the xylem rays. Contrary to this, *Octomeles* does not show any oblique alignment of vessels in the cross-section and sheath cells are much more frequent in this genus. Vessel-parenchyma pits are smaller in *Octomeles* than in *Tetrameles*.

The genus *Tetrameles* is represented by a single species *T. nudiflora* R. Br. in the modern flora. The Intertrappean fossil wood resembles very closely the wood of this species.

The shape, size and distribution pattern of vessels in the fossil wood and in *T. nudiflora* are almost identical (Pl. 1, Figs. 1-2). Both are diffuse porous with the solitary vessels predominating; vessel groups and clusters being rare. Tangential and radial diameters of the vessels in the present wood are quite comparable to the measurements secured from secondary xylem of *Tetrameles nudiflora*. In both, the vessel perforations are simple and the intervascular pitting is bordered, alternate, of the same size, and oval to orbicular with horizontal, linear apertures often coalescent (Pl. 2, Figs. 7-8).

The distribution of xylem parenchyma is almost similar in both, being vasicentric to aliform and of confluent type (Pl. 1, Figs. 1-2).

The xylem rays of the fossil wood and those of *Tetrameles nudiflora* are basically similar. In both, they are 1-6 (mostly 3-5) seriate with the uni- and biseriates rare, closely spaced, homogeneous to heterogeneous. This similarity of the rays extends to minute details of their shape, size, distribution and composition (Pl. 1, Figs. 3-4; Pl. 2, Figs. 11-12). The sheath cells too, are of rare occurrence both in the living genus and in the fossil wood.

Lastly, the fibre structure is also identical in both *Tetrameles nudiflora* and the present

wood (PL. 1, FIGS. 3-4; PL. 2, FIG. 6). It is non-septate, thin-walled and storied to the same degree. Further, the smaller fibres in the extant wood are similarly distributed amongst the larger ones, looking like intercellular spaces in cross-section.

The only observable differences between the woods of *T. nudiflora* and the fossil are (i) the lack in the fossil wood of the tendency of oblique alignment of vessels which is present in the modern species and (ii) a little more abundant parenchyma around the vessels of *T. nudiflora* with shorter aliform extensions, while in the fossil the parenchyma is less abundant and the aliform extensions are comparatively longer. However, the very close similarity even in the numerous microscopic details of anatomical structure, provides sufficient basis for identifying the present fossil wood with the modern genus *Tetrameles*.

No fossil woods of *Tetrameles* and other members of the Datiscaceae are so far known either from India or abroad. To indicate the very close anatomical similarity of the fossil wood with the modern *Tetrameles nudiflora* it is proposed to name it as *Tetrameleoxylon prenudiflora* gen. et sp. nov.

The family Datiscaceae, consisting of 3 genera and 5 species occurs in North Tropical and Sub-Tropical regions of the earth. The species of *Tetrameles* and *Octomeles* are large trees while the genus *Datiscus* consists of two species of shrubs. The genus *Octomeles* with two species is native to the Malay Archipelago, while *Tetrameles* with a single species, *Tetrameles nudiflora*, is a large tree of India, Burma, East Pakistan, Ceylon and Java (PEARSON & BROWN, 1932, p. 607; VAN STEENIS, 1953, TEXT-FIG. 1).

In India, *Tetrameles nudiflora* grows in two widely separated regions. It is found in Eastern Himalayas, in Sikkim and Bhutan up to an elevation of 2,000 ft., in Assam, specially in Surma Valley and Garo hills, and the Andaman Islands. It is also fairly common in the Buxa, Kurseong, Kalimpong and Jalpaiguri districts of West Bengal; this being geographically contiguous to the Burma and Java regions. On the other hand, it grows in the plains and hills of the Western Ghats from Konkan to Travancore, specially the Malabar coast and in the low country of Ceylon (GAMBLE, 1902).

GENERIC DIAGNOSIS

Tetrameleoxylon gen. nov.

Wood diffuse porous. *Growth rings* present. *Vessels* small to moderately large, mostly solitary, sometimes in radial groups of 2-3, evenly distibuted; tyloses absent. *Xylem parenchyma* paratracheal, often aliform; parenchyma strands storied. *Xylem rays* fine to broad, 1-6 seriate; ray tissue heterogeneous; sheath cells occasionally present. *Fibres* non-libriform, non-septate, thin-walled and storied.

Genotype — *Tetrameleoxylon prenudiflora* sp. nov.

SPECIFIC DIAGNOSIS

Tetrameleoxylon prenudiflora sp. nov.

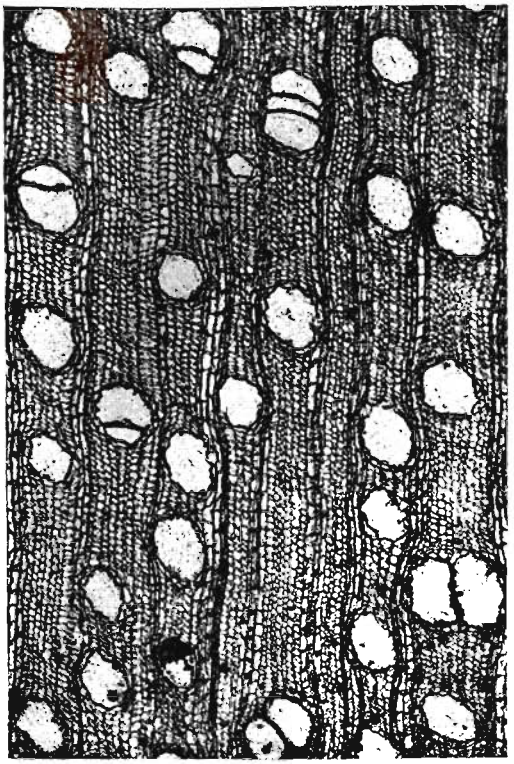
Growth rings present, marked by crowding of smaller vessels. *Vessels* small to moderately large, t.d. 90-240 μ, r.d. 90-255 μ, mostly solitary, sometimes in radial groups of 2-3 (mostly 2), rarely in clusters; vessel-members usually short; perforations simple; intervascular pitting bordered, alternate, oval to obricular, 6-8 μ in diameter with pit-apertures horizontal, linear to lenticular, sometimes coalescent; vessel-parenchyma pitting elliptical, larger than the intervascular pitting, irregularly oriented; tyloses absent. *Wood parenchyma* paratracheal, vasicentric sheaths 2-3 (rarely 4) cells thick, often aliform, sometimes confluent, aliform extensions 3-6 cells broad near the vessel, slightly narrower outwards; parenchyma strands storied, 2-4 celled; parenchyma cells thin-walled. *Xylem rays* homogeneous to heterogeneous; non-storied; 1-6 (mostly 3-5) cells or 24-150 μ wide; uniseriates and biseriates rare; uniseriate rays 3-8 cells high, usually of upright cells; multiseriate (2-6 seriate) rays 6-87 cells or 195-1995 μ high, 48-150 μ wide, usually consisting of procumbent cells only, sometimes with 1-2 (rarely up to 6) rows of marginal upright cells at one or both ends; sheath cells occasionally present on the flanks. *Fibres* non-libriform, thin-walled, non-septate, oval to angular in cross-section, 375-405 μ in length, storied, sometimes irregular.

Holotype — B.S.I.P. Museum No. 33076.

Locality — Mohgaonkalan, District Chhindwara, Madhya Pradesh.

Horizon — Deccan Intertrappean Series.

Age — Tertiary (probably Early Eocene).



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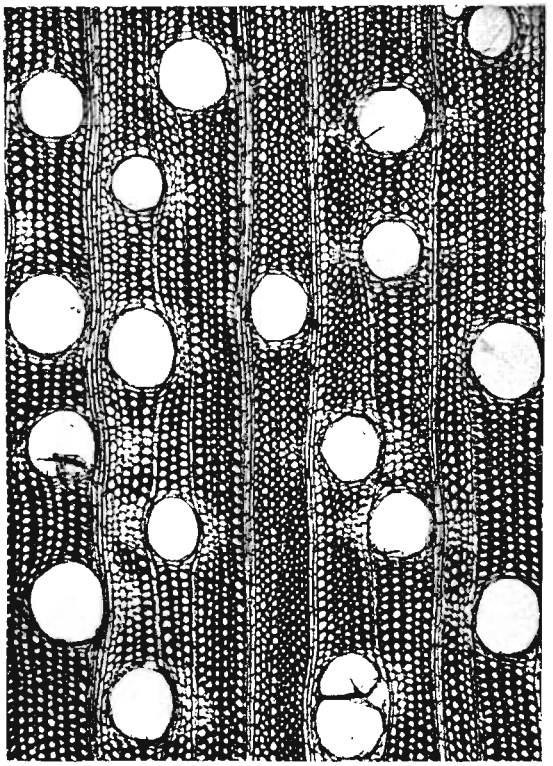

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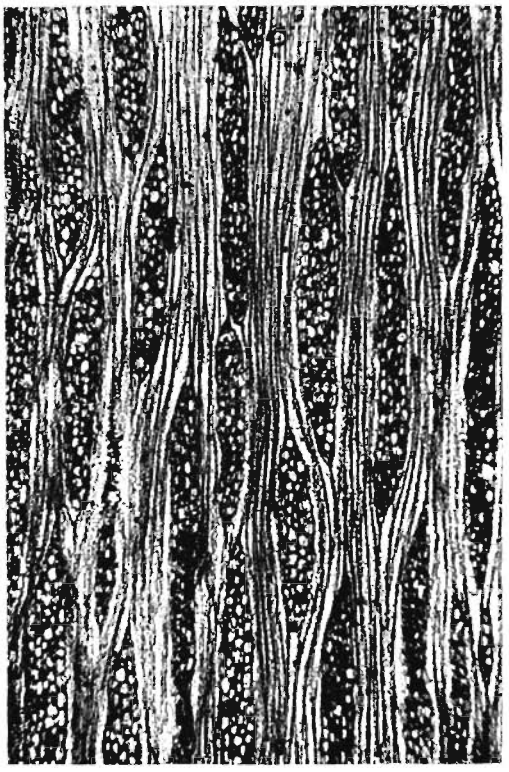

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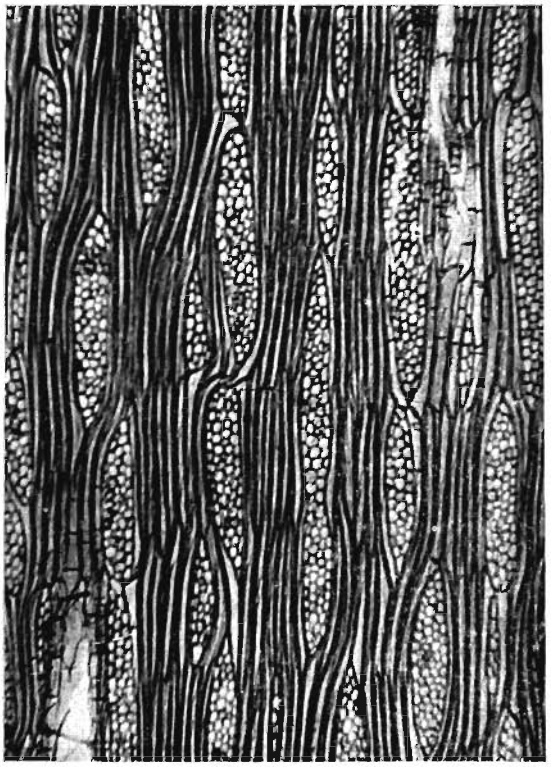

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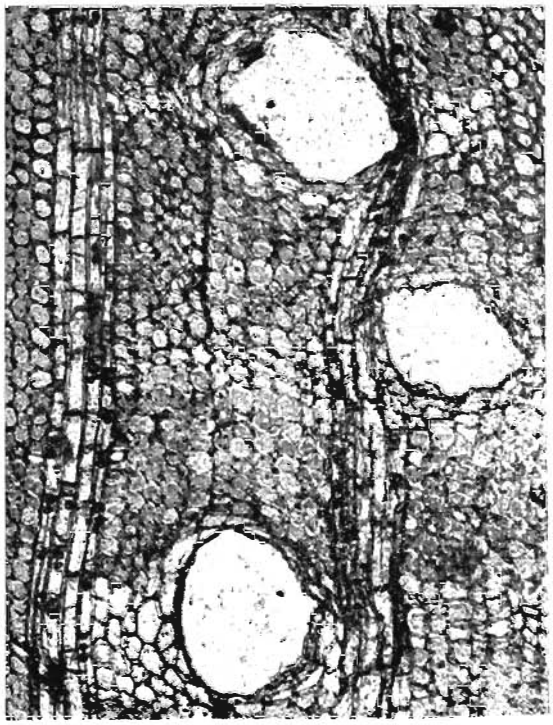

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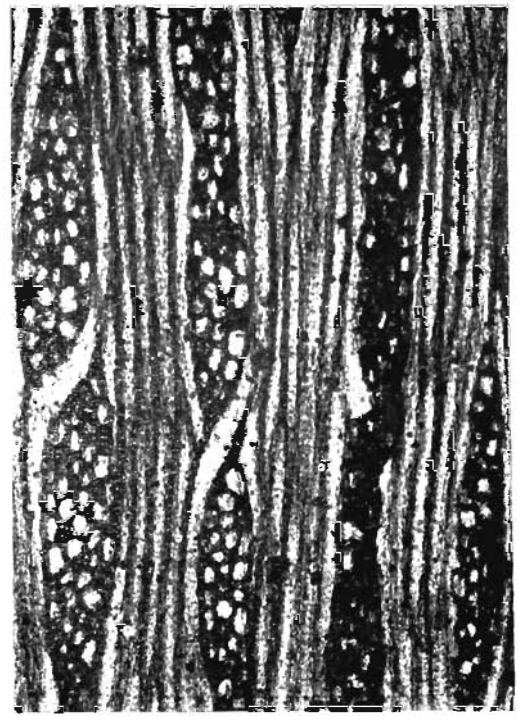

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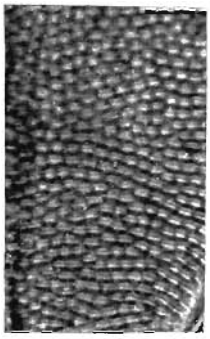

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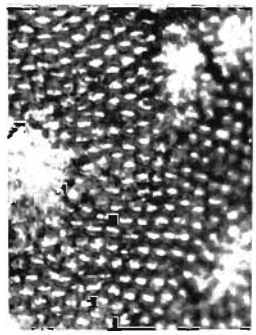

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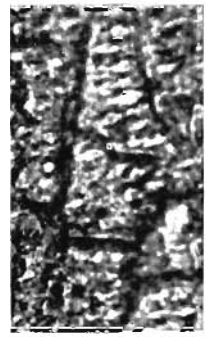

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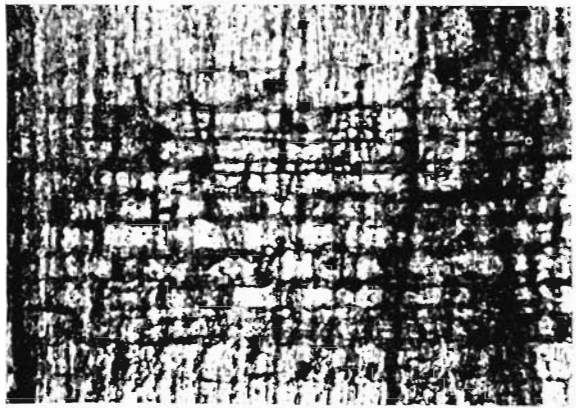

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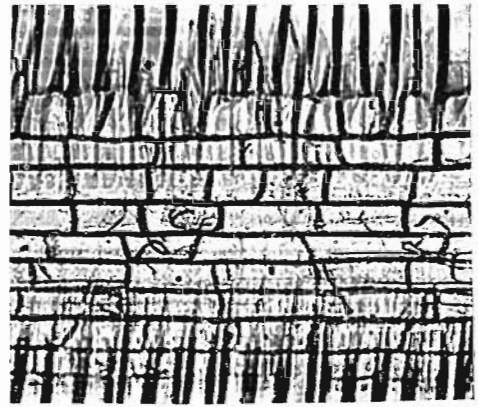

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EXPLANATION OF PLATES

PLATE 1

1. Cross-section of the fossil wood to show the shape, size and distribution of vessels. Note the close similarity with the modern wood shown adjacent. × 36.

2. Cross-section of *Tetrameles nudiflora*. × 36.

3. Tangential longitudinal section of the fossil wood. Note the distribution, shape and size of the xylem rays closely similar with those of the modern wood shown next. × 45.

4. Tangential longitudinal section of *Tetrameles nudiflora*. × 45.

PLATE 2

5. Part of cross-section of the fossil wood magnified to show the nature and distribution of the xylem parenchyma. × 90.

6. Tangential longitudinal section of the fossil wood magnified to show the ray structure and the storied fibres. × 90

7. Intervessel pit-pairs of *Tetrameles nudiflora*, similar to those of the fossil. × 250.

8. Intervessel pit-pairs of the fossil wood. × 250.

9. Vessel-parenchyma pits of the fossil wood. × 250.

10. Vessel-parenchyma pits of *Tetrameles nudiflora* similar to those of the fossil. × 250.

11. Radial longitudinal section of the fossil showing the heterocellular rays. Note similarity with the modern wood shown adjacent × 120.

12. Radial longitudinal section of *Tetrameles nudiflora*. × 120.