AESCHYNOMENE TERTIARA, A NEW FOSSIL WOOD FROM THE DECCAN INTERTRAPPEAN BEDS AT MAHURZARI NEAR NAGPUR, INDIA

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ABSTRACT

A new species of *Aeschynomene*, *A. tertiara* is described here from the Intertrappean beds of Mahurzari near Nagpur. The present finding forms the first fossil record of this genus. It is represented by about 300 modern species and is chiefly a tropical genus with a few species occurring in warm temperate areas. About one half of the species are hydrophytes found in marshes, mud holes, wet meadows, and along stream banks.

INTRODUCTION

NUMEROUS fragments of silicified woods are scattered in the fields at the base of small hills near the village of Mahurzari in the Nagpur district of Maharashtra Pradesh. So far only a few fossils are known from the Intertrappean beds of this locality (PRAKASH, 1955, 1958; SHALLOM, 1958, 1959, 1960) which was discovered recently. However, these beds have yielded quite a rich flora from other localities (PRAKASH, 1960, TABLE 1) of which the well known are Mohgaon Kalan and Sausar in the Chhindwara district of Madhya Pradesh and Rajahmundry in South India whence forms belonging to algae, fungi, charophytes, water-ferns, conifers and a number of monocotyledons and dicotyledons are known. These commonly show remarkable preservation in their minute details of anatomy.

The dicotyledonous woods from the Intertrappean beds are being intensively studied with regard to their botanical identification and interpretation and a number of genera have been determined.

In the present paper the author describes a petrified wood of the genus *Aeschynomene* of the family Leguminosae (Papilionaceae) from the locality of Mahurzari. As far as he is aware, the present description forms the first fossil record of this genus. The existence of *Aeschynomene* in the Intertrappean beds furnishes further proof to the palaeobotanical evidence that most of the Deccan flora thrived in pools, lakes and swampy habitats.

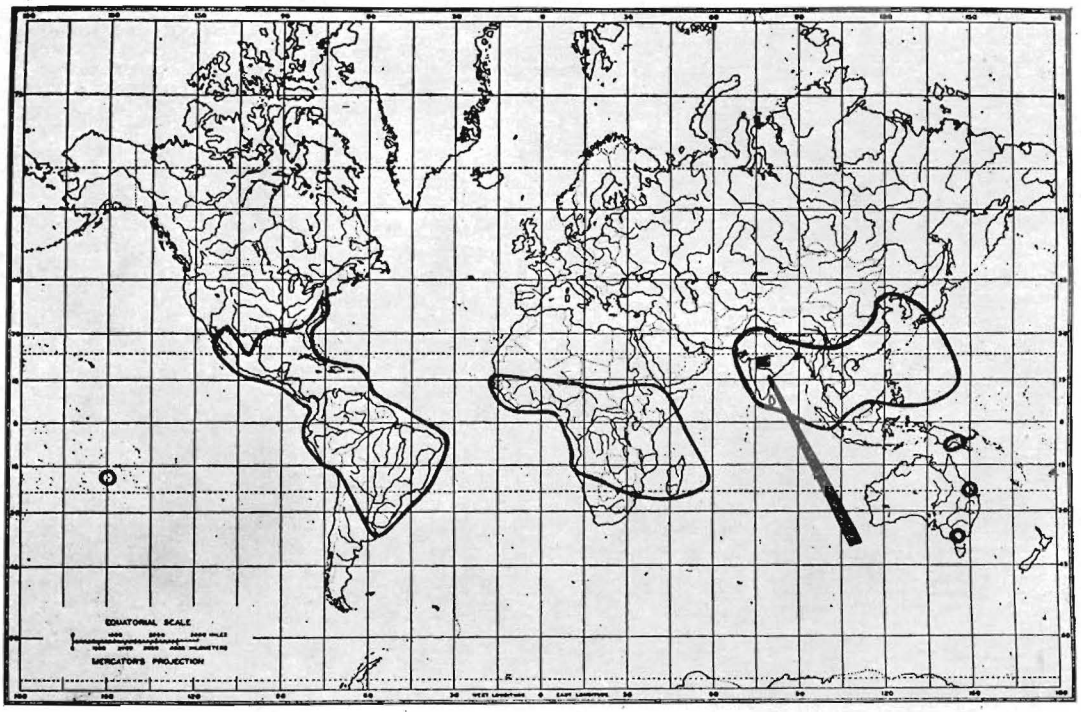
The genus *Aeschynomene* of the tribe Hedysareae is widely distributed in the modern flora and comprises a number of species representing herbs, shrubs or small trees. As far as the author is aware, no fossil woods of any members of this tribe are so far known from any part of the world. Fruits and seeds of Hedysareae, however, were reported by Hislop (CARTER, 1854) and Hislop & Hunter (1855) from the Intertrappean beds of Takli in the neighbourhood of Nagpur. No further work was carried out on these fruits and seeds, and it is very unfortunate that such valuable specimens are impossible to trace at the present time.

Assignment of the present fossil wood to *Aeschynomene* is as follows: *Aeschynomene tertiara* Prakash sp. nov. (PLS. 1, 2, FIGS. 1-10.)

DESCRIPTION

This fossil wood is represented by a single piece measuring 11 cm. in length and 6 cm. in diameter and consists of only secondary xylem. Although pith is not present, the specimen shows a region very near to it (PL. 2, FIG. 7). Structural preservation of the fossil is remarkably good. *Growth rings* inconspicuous with tangential bands of parenchyma simulating growth rings (PL. 2, FIG. 7); wood diffuse porous.

Vessels are impossible to see with the naked eye. However, under a hand lens, they are seen as small dots (PL. 2, FIG. 7). They are usually small, occasionally of medium size and distributed quite widely (PL. 1, FIGS. 1, 5). When seen in a cross-section, the vessels and fibre cells look almost alike except that the vessels are slightly thicker-walled and often plugged with black or brown gummy deposits (PL. 1, FIG. 1).



TEXT-FIG. 1 — Geographic distribution of the fossil (black rectangle — arrow pointing) and living (encircled areas — after Rudd, 1955) *Aeschynomene*.

The vessels are solitary as well as in pairs and sometimes in radial or tangential rows of 3-5 cells (PL. 1, FIGS. 1, 5). Very rarely clusters of vessels also occur. They are mostly angular, sometimes oval in cross-section and often arranged along the tangential parenchyma bands (PL. 1, FIGS. 1, 5). Perforations are simple and the perforation plates are horizontal to slightly inclined (PL. 2, FIGS. 6, 8). The vessel elements are short with usually truncate ends. The intervascular pit-pairs are bordered, alternate to opposite or sub-opposite, and often almost of scalariform type (PL. 1, FIGS. 3, 4; PL. 2, FIG. 8) with linear to extended apertures. Vessel-ray pits are bordered and numerous per cell (PL. 2, FIG. 9).

Parenchyma is very scanty and can be seen in narrow, 1-4 seriate (usually 1-2), occasionally slightly wavy, continuous or broken tangential bands which are more or less parallel, sometimes equidistant and often touching the vessels (PL. 1, FIGS. 1, 5; PL. 2, FIG. 7). Occasionally 1-2 or few parenchyma cells are scattered in the ground-mass of the wood, some of which are also found in association with the vessels. The parenchyma cells are relatively thicker-walled than the fibre cells and possess fairly large lumina. They are usually tangentially elongated in cross-section and rarely crystalliferous. Both fusiform and strand parenchyma appear to be present.

Xylem rays are scarcely visible to the naked eye. However, with a hand lens they are seen as fine lines traversing the surface of the wood. They are homogeneous, composed of procumbent cells, mostly uniseriate, rarely partially biseriate, non-storied and 1-11 cells high (PL. 2, FIGS. 6, 10). The rays are most commonly 1-6 cells high, the cells being oblong or narrow and vertically elongate in shape as seen in tangential section. Occasionally the ray cells are oval in shape, rather than vertically elongated.

Fibres form the ground-mass of the secondary xylem (PRAKASH, 1961) with its cells arranged in distinct radial rows between the rays (PL. 1, FIGS. 1, 5). They are thin-walled with large lumina and quadrangular to polygonal in cross-section (4 to 6-sided)

(PL. 1, FIG. 5). Sometimes walls of some of the cells are slightly irregular presumably owing to deformation during preservation. In longitudinal section, the cells are short and fusiform in shape (PL. 2, FIG. 6). The pits of the lateral walls of fibre cells are simple and more prominent and numerous on the radial than on the tangential walls (PL. 1, FIG. 2).

DIAGNOSIS

Growth rings inconspicuous with tangential bands of parenchyma simulating growth rings.

Vessels usually small, occasionally of medium size, tangential diameter 45-110 μ, radial diameter 52-90 μ, thin-walled, mostly angular, sometimes oval in cross-section, solitary as well as in pairs and sometimes in radial or tangential rows of 3-5 elements, widely spaced about 2-3 per sq. mm. Vessel elements short 150-210 μ long. Perforation plates exclusively simple, horizontal to slightly inclined. Intervascular pit-pairs bordered, alternate to opposite or subopposite and often almost of scalariform type with linear to extended apertures. Tyloses absent but vessels commonly plugged with gummy deposits. Vessel distribution diffuse.

Parenchyma very scanty and occurs in 1-4 seriate, narrow, continuous or broken tangential bands, almost parallel to each other and in 1-2 or few diffuse cells, also sometimes in association with the vessels encircling them partially; cells usually tangentially elongated in cross-section, 15-25 μ in radial and 40-50 μ in tangential diameter, rarely crystalliferous; both fusiform and strand parenchyma appear to be present; cell walls 3-4 μ thick.

Rays homogeneous composed of procumbent cells, nonstoried, mostly uniseriate, rarely partially biseriate, 15-50 μ wide; 1-11 cells high (usually 1-6) and 40-560 μ high; up to 8-12 rays per mm. Ray cells usually oblong or narrow and vertically elongate as seen in tangential section.

Fibres form the ground-mass of the secondary xylem, angular in cross-section (4-6 sided), 45-80 μ in tangential and 41-100 μ in radial diameter; walls thin with a large lumen; cells fusiform, short, about 188-408 μ in length; unstoried; pits simple, more numerous on the radial than on the tangential walls.

Locality and Geologic Occurrence — Mahurzari (21°14′ N; 79°1′ E) near Bharatwada railway station, about eight miles from Nagpur. Early Tertiary (most probably Eocene), Deccan Intertrappean series of Maharastra Pradesh, India.

Material — A single specimen of silicified mature secondary xylem measuring 6×11 cm. The curvature of the growth rings and the fact that the innermost wood is obviously close to the pith indicates that the stem, of which this specimen is a small fragment, had a diameter of at least 12 cm.

Holotype — B.S.I.P. Museum No. 10301, represented by one specimen and ground thin sections.

AFFINITIES AND DISCUSSION

Structural features of the fossil wood indicate, after extensive comparison, that its closest affinities are with the modern genus *Aeschynomene*. There is close agreement in almost all details except a few which are of minor nature. This wood also shows resemblance to the mature secondary xylem of *Alstonia spathulata* Bl. of the family Apocynaceae. There is a good deal of structural difference among the various species of *Alstonia* and all of them except *A. spathulata* differ quite markedly from the fossil. The wood of *Alstonia spathulata* is very light and shows remarkable structural similarity with the fossil wood in the size, shape and distribution of vessels, in the structure of rays and fibres. However, it differs from the fossil under consideration in the distribution of parenchyma, in the occasional presence of latex tubes in the rays and in the nature of intervascular pit-pairs. In *Alstonia spathulata*, the parenchyma is mostly terminal and diffuse. The terminal parenchyma is always in thick bands, usually 4-6 or even 7-8 cells broad, while the diffuse parenchyma is found in short, irregular lines of 1-3 cells thick. In addition the intervascular pit-pairs in *A. spathulata* are bordered with the pits arranged in alternate rows; the apertures being linear and short (BEIJER, 1927, FIGS. 31-33, PHOTO 6).

In addition to *Alstonia spathulata*, there are a number of other light-weight woods but all of them differ quite markedly from the present fossil wood (KANEHIRA, 1933a, 1933b; KANEHIRA, YATSUTAKE & SHIGEMATSU 1933; ROWLEE, 1921; SOLEREDER, 1908).

The genus *Aeschynomene* with which our fossil shows closest affinities comprises a large number of species which are herbs, shrubs, or small trees, as much as 8 m. tall (RUDD, 1955, 1959; JACKSON, 1893, PT. I, pp. 50-51). The Intertrappean fossil wood compares closely with an undetermined species from Siam (Yale wood collection No. 16552) and differs from all other named species available for comparison in a number of features such as in the distribution of the parenchymatous tissue, in the absence of storied fibres and rays as well as in a number of other details (SOLEREDER, 1908, pp. 275-276; METCALFE & CHALK, 1950, pp. 519-525).

The size and distribution of vessels in *Aeschynomene tertiara* agrees with the distributional pattern in *Aeschynomene* sp. from Siam. The tangential diameter (45-110 μ) of the vessels in the fossil wood is more or less similar to that of the modern species (41-102 μ). In both the extant and fossil species the vessel perforations are simple, the perforation plates being almost horizontal or slightly inclined and the intervascular pitpairs are bordered, alternate, opposite to sub-opposite and sometimes almost of scalariform type.

Solereder (1908, pp. 275-276, FIG. 117a; TAUBERT, 1894, p. 319) and Metcalfe & Chalk (1950, p. 523, FIGS. 117a-d) report that the parenchyma constitutes the greater part of the secondary xylem in the genus *Aeschynomene* and forms a ground-mass in which fibres and vessels are arranged. Recently it has been shown that the fibres form the greater part of the tissues in the secondary xylem of *Aeschynomene* forming a ground-mass of the wood in which the parenchyma and vessels are distributed (PRAKASH, 1961).

In the fossil wood the fibre cells are quadrangular to polygonal in cross-section, fusiform, unstoried and show numerous simple pits on the lateral walls. This is almost identical to what is seen in the modern wood of *Aeschynomene* sp. from Siam except that the size of the cells differ in both the species (45-80 μ in tangential, 41-100 μ in radial diameter, and 188-408 μ in length in *Aeschynomene tertiara*, while 61-102 μ in tangential, 61-122 μ in radial diameter and 306-602 μ in length in *Aeschynomene* sp.). However, in some species of this genus the fibres are distinctly storied and variously shaped in longitudinal sections.

The ray structure and its distribution in both the fossil and extant species from Siam are quite similar. In both the rays are homogeneous, unstoried, mostly uniseriate, rarely partially biseriate, and about 1-11 cells high. It should be noted in this connection that the rays are storied in somes pecies of *Aeschynomene* (METCALFE & CHALK, 1950, p. 525).

Very little wood parenchyma is present in the fossil occurring in the form of 1-4 diffuse cells and 1-4 seriate bands arranged almost concentrically being equidistant at certain places. The cells are slightly thick-walled.

The pattern of distribution of the parenchyma in the modern wood of *Aeschynomene* sp. is similar to that in *A. tertiara* except that the cells are thin-walled, and the tangential bands are narrow (1-2 seriate) and slightly more separated in *Aeschynomene* sp. than in *A. tertiara*. In other species of the genus the parenchyma occurs in aliform patches about the vessels, e.g. *A. elaphroxylon*, *A. aspera*, *A. hispida*, *A. americana*, etc. (SOLEREDER, 1908).

The close agreement in major diagnostic features as well as in numerous microscopic details of anatomical structure provides convincing evidence that the Intertrappean fossil wood is assignable to genus *Aeschynomene*.

Determination of the degree of affinity necessitates evaluation of only a few observable differences between the Eocene and the modern wood of *Aeschynomene* sp. These differences are limited to the size of vessels and fibre cells, and the thickness and distance between the thin tangential bands of parenchymatous tissue, otherwise the fossil species is quite similar to that of the living species.

The fossil wood has been placed in the extant genus as it does not seem to serve any useful purpose to add ' oxylon ' to its generic name. In recent years there seems no uniform practice with regard to naming fossil woods and it has become solely a matter of personal choice whether or not to add ' oxylon ' to a generic name. I believe it would further the interest of palaeobotany if some uniform procedure is adopted. Here, I would like to suggest that the fossil woods which show the characters of the modern genera and closely resemble living species should be described without the addition of the suffix ' oxylon ' to

the generic name. However, in such other cases where it is not possible to assign the fossil wood to any genus the addition of 'oxylon' to the tribe or family name may be resorted to. The addition of 'oxylon' to the generic name should necessarily indicate near relationship to the extant genus although structural differences are such that the modern generic name cannot be used without this nomenclatural qualification.

About 300 species have been ascribed to the genus *Aeschynomene*. Approximately one half of them have been described from New World material, the others from the Old World, principally from Africa.

It is chiefly a tropical genus (TEXT-FIG. 1), with a few species occurring in warm temperate areas. In America, presumably native, it ranges from about lat. 40° N to 35° S along the Atlantic Coast and from lat. 28° N to 17° S on the Pacific side. In the Old World the distribution is principally in Africa, south-eastern Asia, and in the Pacific Islands, apparently including both native species and introduced American weeds (RUDD, 1955).

About one half of the species are hydrophytes, found in marshes, mud holes, rice paddies, wet meadows and along stream banks. The others are more xeric, found in dry waste places, pine barrens, oak woods, caatinga and savanna, or on rocky hillsides and sandy beaches. A few species are cultivated as ornamentals; many are weeds (RUDD, 1959).

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REFERENCES

BEIJER, J. D. (1927). Die vermehrung der radialen Reihen in Cambium. *Recueil Trav. Bot. Néerlandais* **24**(4): 631-786.

CARTER, H. J. (1854). Summary of the Geology of India, between the Ganges, the Indus and Cape Comorin. *Jour. Bombay Branch Royal Asiatic Soc.* **5**: 179. Reprinted in Geological Papers on Western India, ed. H. J. Carter, 1857. Education Soc. Press, *Bombay*: 628-776.

GAMBLE, J. S. (1902). A manual of Indian Timbers. *London*.

HISLOP, S. & HUNTER, R. (1855). On the geology and fossils of the neighbourhood of Nagpur, Central India. *Quart. Jour. Geol. Soc. London* **11**(3): 345. Reprinted in Geological Papers on Western India, ed. H. J. Carter, 1857. Education Soc. Press, *Bombay*: 247-288.

HOOKER, J. D. (1879). The Flora of British India **2**. *London*.

JACKSON, B. D. (1893). Index Kewensis, Part I. *Oxford*.

KANEHIRA, R. (1933a). On a light-weight wood drifted on the shores of Caroline Islands. *Jour. For. Soc. Jap.* **15**: 113-116.

Idem (1933b). On light-weight woods [In Japanese]. *Jour. For. Soc. Jap.* **15**: 601-615. *Trop. Woods* **37**: 52-53; 1934.

KANEHIRA, R., YATSUTAKE, K., & SHIGEMATSU, M. (1933). On light-weight woods. *Jour. For. Soc. Jap.* **15**: 601-615.

METCALFE, C. R. & CHALK, L. (1950). Anatomy of the Dicotyledons **1, 2**. *Oxford*.

PRAKASH, U. (1955). On the structure and affinities of *Sahnipushpam glandulosum* sp. nov., from the Deccan Intertrappean series. *The Palaeobotanist* **4**: 91-100.

Idem (1958). Studies in the Deccan Intertrappean Flora: 4. Two fossil dicotyledonous woods from Madhya Pradesh. *The Palaeobotanist* **7**(1): 12-20.

Idem (1960). A survey of the Deccan Intertrappean Flora of India. *Amer. Jour. Palaeontology* **34**(5): 1027-1040.

Idem (1961). Fibres in the secondary xylem of *Aeschynomene*. *Jour. Arnold Arboretum* **42** (4): 442-446.

ROWLEE, W. W. (1921). Tropical trees with light-weight woods. *Jour. N.Y. Bot. Gard.* **22**(256): 75-78.

RUDD, V. E. (1955). The American species of *Aeschynomene*. *Contr. United St. Nat. Herb.* **32**(1): 1-172.

Idem (1959). The genus *Aeschynomene* in Malaysia (*Leguminosae-Papilionatae*). *Reinwardtia* **5**(1): 23-36.

SHALLOM, L. J. (1958). A fossil dicotyledonous wood from the Deccan Intertrappean beds of Nahurzari. *J. Indian bot. Soc.* **37**(4): 492-498.

Idem (1959). *Simarubaceoxylon mahurzari* gen. et sp. nov., a new fossil wood from the Deccan

Intertrappean beds of Mahurzari. *Curr. Sci.* **28**(4): 168, 169.

Idem (1960). Fossil dicotyledonous wood of Lecythidaceae from the Deccan Intertrappean beds of Mahurzari. *J. Indian bot. Soc.* **39**(2): 198-203.

SOLEREDER, H. (1908). Systematic Anatomy of the Dicotyledons **1**. *Oxford.*

TAUBERT, P. (1894). Leguminosae in *Die Natürlichen Pflanzenfamilien* by Engler, A. and K. Prantl. **3**(3). *Leipzig.*

EXPLANATION OF PLATES

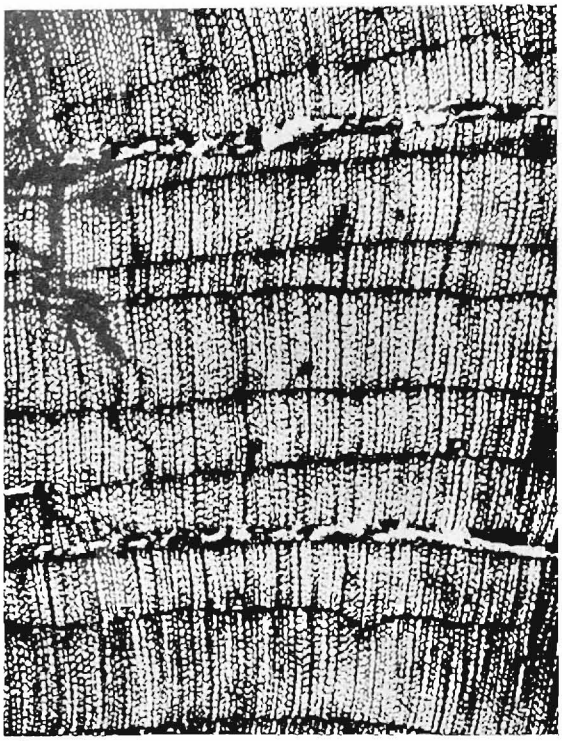
Aeschynomene tertiara Prakash sp. nov

PLATE 1

1. Cross-section showing the distribution of vessels and parenchyma. × 13·5.
2. Pits on the lateral walls of the fibre cells. × 260.
3. Intervascular pit-pairs highly magnified. Note the opposite to sub-opposite and scalariform type. × 260.
4. Another section showing highly magnified intervascular pit-pairs of opposite and scalariform type. × 260.
5. Cross-section magnified to show the shape and size of the vessels, fibres, and parenchymatous cells. × 30.

PLATE 2

6. Tangential longitudinal section to show the distribution and type of xylem rays. × 75.
7. Cross-section of the fossil wood slightly magnified to show its gross features. Note the tangential, almost concentric lines of parenchymatous tissue and the vessel dots. × 1·5.
8. Simple perforation and bordered alternate and opposite intervascular pit-pairs. × 260.
9. Vessel-ray pits highly magnified. × 260.
10. Radial longitudinal section to show the nature of xylem rays. × 40.



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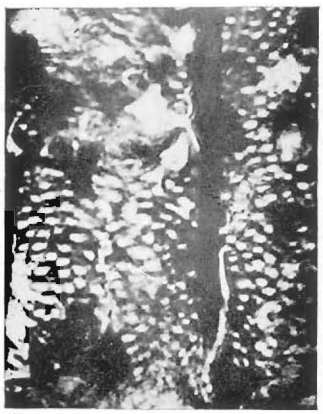

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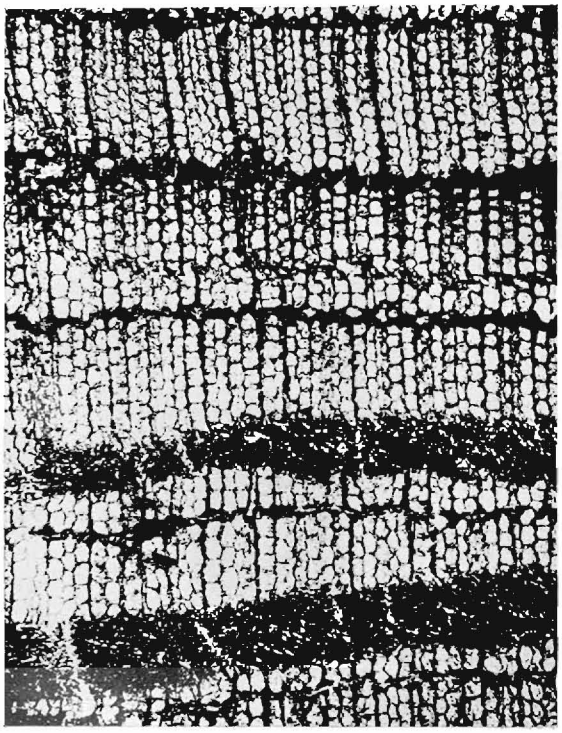

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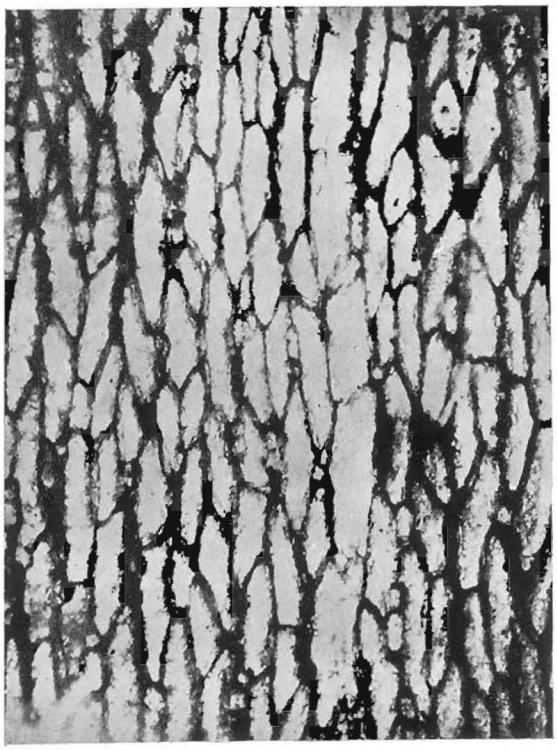

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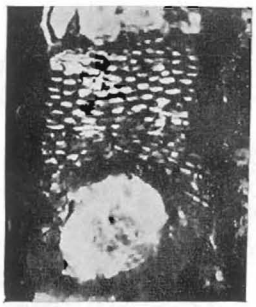

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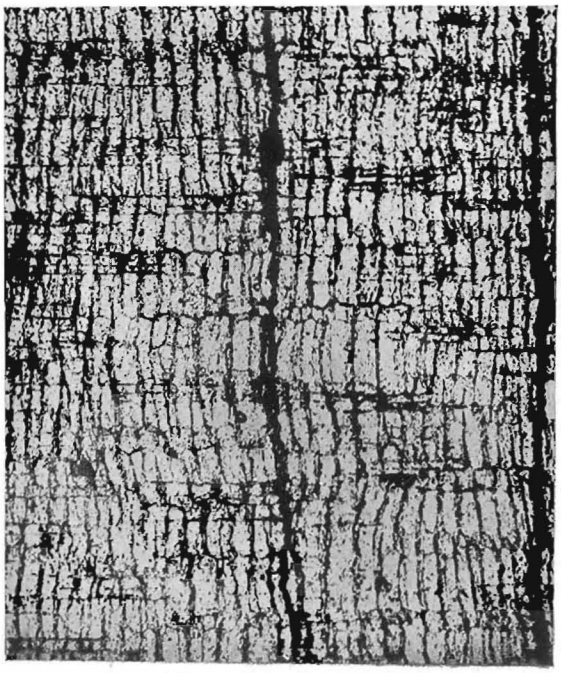

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