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FOSSIL WOODS BELONGING TO STERCULIACEAE AND LYTHRACEAE FROM THE CUDDALORE SERIES NEAR PONDICHERRY

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ABSTRACT

Two petrified woods from the Cuddalore Series near Pondicherry are described. One of these shows closest resemblance with the woods of Sterculiaceae and the other with those of *Lagerstroemia* of Lythraceae. They have been named as *Sterculioxylon pondicherriense* sp. nov. and *Lagerstroemioxylon arcotense* sp. nov. respectively.

Key-words — Xylotomy, Sterculiaceae, Lythraceae, Petrified woods, Mio-Pliocene, Cuddalore Series, India.

साराँश

पाँडिचेरी के समीपस्थ कुडलोर श्रेणी से स्टरकुलिएसी एवं लायथ्रेसी कुलों के काष्ठाश्म – नीलाम्बर अवस्थी

पाँडिचेरी के निकटस्थ कुडलोर श्रेणी से प्राप्त दो अश्मीभूत काष्ठों का वर्णन किया गया है । इनमें से एक स्टरकुलिएसी कुल की काष्ठों से तथा दूसरी लायथ्रेसी कुल की **लेजरस्ट्रोयमिया** की काष्ठों से घनिष्ठतम् समानता प्रदर्शित करती है। इन्हें क्रमशः **स्टरकुलिऑक्सीलॉन पाँडिचेरियेन्से** न० जा० तथा **लेजरस्ट्रोयमिऑक्सीलॉन आर्कोटेन्से** न० जा० से नामांकित किया गया है।

INTRODUCTION

FROM the Cuddalore Series near Pondicherry, South India a number of woods are known belonging to both gymnospermous and angiospermous families, viz., Podocarpaceae, Palmae, Guttiferae, Dipterocarpaceae, Sapindaceae, Anacardiaceae, Leguminosae, Rosaceae, Combretaceae, Lecythidaceae, Sonneratiaceae, Alangiaceae, Sapotaceae, Ebenaceae, Ulmaceae and ?Fagaceae (see Awasthi, 1974, 1977a, 1977b, 1979a, 1979b, 1979c). Investigation of more petrified woods from the Murattandichavadi area near Pondicherry has further revealed the presence of a few more dicotyledonous woods which are new for the area. Two of them show closest resemblance with some of the woods of *Sterculia* and allied genera of Sterculiaceae and *Lagerstroemia* of Lythraceae respectively, and are being described in the present paper.

DESCRIPTION

FAMILY — STERCULIACEAE

Genus — *Sterculioxylon* Kräusel, 1939

Sterculioxylon pondicherriense sp. nov.

Pl. 1, figs 1-5

This species is based on a small piece of petrified wood measuring 6×3 cm. The preservation is satisfactory.

Topography — Wood diffuse-porous (Pl. 1, fig. 1). *Growth rings* not seen. *Vessels* medium to large, mostly medium, embedded in tangential parenchyma bands (Pl. 1, figs 2, 3), solitary and in radial multiples of 2-4, occasionally up to 7, evenly distributed, about 5-10 vessels per sq mm; tyloses or tyloses-like structures present, thick-walled (Pl. 1, fig. 4). *Parenchyma* paratracheal, banded, bands broad, 3-21 cells wide, regular, somewhat straight, completely enclosing the vessels, alternating with

fibre bands of almost equal width (Pl. 1, figs 1-3), about 3-6 bands per mm. *Rays* very broad (Pl. 1, figs 3-4), up to 25 seriate and 360 μm wide, 2-4 per mm in cross section; uniseriate rays occasional, short; multiseriate rays up to 100 cells or (1,550 μm high), ray tissue heterogeneous; rays homocellular to heterocellular, consisting of procumbent cells or sometimes with 1 or 2 marginal rows of upright to square cells at one or both the ends (Pl. 1, fig. 5), sheath cells also present. *Fibres* visible as light bands, alternating with parenchyma bands of almost equal width, at some places thinner than parenchyma bands (Pl. 1, figs 1-3).

Elements — Vessels circular to oval, t.d. 100-280 μm, r.d. 50-280 μm, thick-walled, wall thickness 8-12 μm; perforations simple; vessel-members short, truncate or slightly enclined, inter-vessel pits occasionally seen, small to medium, 4-6 μm in diameter, alternate with small circular or slit-like apertures, vessels filled with dark contents. *Parenchyma cells* rectangular, those occurring in the immediate vicinity of vessels peripherally flattened, t.d. 20-40 μm, r.d. 16-28 μm, thick-walled, common walls 4-6 μm in thickness; crystalliferous strands present. *Ray cells* upright or square and procumbent; upright or square cells 20-40 μm in tangential height, 20-32 μm in radial length; procumbent cells 12-20 μm in tangential height, about 60-200 μm in radial length; crystals occasionally seen. *Fibres* mostly angular in cross section, 12-24 μm in diameter, thick-walled with narrow lumen, common walls 6-10 μm in thickness, nonseptate; pits not seen.

Affinities

Comparison with the Modern Woods — The above features of the fossil particularly the broad parenchyma bands and broad xylem rays with sheath cells indicate its affinities with those members of Sterculiaceae which have more or less similar parenchyma and xylem rays. The genus *Sterculia* is one of them which can be compared with the present fossil. In her study of the modern woods of the family Sterculiaceae, Chattaway (1937) has divided the species of *Sterculia* into two groups A and B, according to the type and distribution of parenchyma. In group A, she included those sterculias which consist of metatracheal (now classified under apotracheal) parenchyma predominantly in uniseriate lines, while in group B, placed those species which have mostly broad parenchyma bands. Since the present fossil possesses broad parenchyma bands it would be most appropriate to compare it with the species of *Sterculia* belonging to the latter group, viz., *Sterculia appendiculata* K. Schum ex Engl., *S. blancoi* Rolfe, *S. blumei* G. Don, *S. cinerea* A. Rich., *S. coccinea* Roxb., *S. elegantiflora* Hutch. & Dalz., *S. oblonga* Mast., *S. pallens* Wall., *S. rhinopetala* K. Schum. and *S. urens* Roxb. Besides, there are quite a few more sterculiaceous woods which also possess broad parenchyma bands and are closely allied to *Sterculia*, viz., *Erythropsis fulgens* (Wall. ext. Mast) Ridley (=*Sterculia fulgens* Wall.), *Firmiana colorata* (Roxb.) R.Br. (=*Sterculia colorata* Roxb.), *Pterygota alata* (Roxb.) R.Br. (=*Sterculia alata* Roxb.), *Scaphium wallichii* Scott & Engl. (=*Sterculia scaphigera* Wall.), *Sterculia guttata* Roxb., *S. populifolia* Roxb. and *S. tragacantha* Lindley.

The present fossil wood was compared with all these species from their sections as well as published descriptions and figures (Chattaway, 1937, pp. 313-365, pls 29-31; Chowdhury & Ghosh, 1958, p. 211, 217, 218, pl. 27, figs 159, 161, 162; Desch, 1958, pp. 581-583, pl. 114, fig. 2; Henderson, 1953, pls 68, 69, figs 362, 364; Kribs, 1959, pp. 153-154, figs 468, 469; Metcalfe & Chalk, 1950, pp. 247-249, fig. 61; Normand, 1955, pp. 244-245, pls 101-104). It was found that the fossil wood shows similarity with most of the above species. Although there is a close agreement in all anatomical features between the present fossil and *Firmiana colorata*, particularly in having very broad rays which are up to 25 cells in width, the possibilities of its being still more closer with the other species of *Firmiana* or *Sterculia* cannot be ruled out since they could not be available for comparison.

Comparison with the Fossil Species — The genus *Sterculioxylon* was created by Kräusel (1939) to include the fossil woods resembling those of *Sterculia* of the family Sterculiaceae. Since then nine species of this genus have been described so far from India and abroad. They are *Sterculioxylon aegyptiacum* (Unger) Kräusel (1939) from the Tertiary of Egypt and also from the Post Eocene of Tibesti in Sahara (Boureau, 1949), *S. giarabubense* (Chiarugi) Kräusel (1939) from the Lower

Oligocene to Lower Miocene of North Africa, *S. rhenanum* Müller-Stoll & Müller-Stoll (1949) from the Eocene of south-west Germany, *S. freulonii* Boureau (1957) from the Post Eocene of Libya, *S. foetidense* Prakash (1973) from the Tertiary of Burma, *S. dattai* Prakash & Tripathi (1974) from the Middle Miocene near Hailakandi, Assam, *S. kalagarhense* Trivedi & Ahuja (1978) from the Siwalik beds of Kalagarh, Uttar Pradesh, *S. deccanensis* Lakhanpal *et al.* (1978) from the Deccan Intertrappean beds near Mandla, Madhya Pradesh and *S. varmahii* Lakhanpal *et al.* (1981) from the Miocene-Pliocene of Deomali, Arunachal Pradesh.

As in *Sterculia*, the nature and distribution of parenchyma in *Sterculioxylon* also varies to a great extent. In some of its species the parenchyma is aliform-confluent to distinctly banded, bands being usually broad, while in others it is diffuse to diffuse-in-aggregate or forming closely spaced uniseriate lines. Such variation has also been observed in several other genera of Sterculiaceae, e.g. *Firmiana*, *Erythropsis*, *Scaphium*, *Pterygota*, *Pterocymbium*, etc. In fact, in all other anatomical features, these genera are closely allied to *Sterculia*. Hence, the genus *Sterculioxylon* Kräusel should be considered in a broad sense to include all the fossil woods resembling *Sterculia* as well as the above genera of Sterculiaceae which are anatomically very similar to it.

In view of this the present fossil wood, which is more closer to *Firmiana colorata* (Roxb.) R. Br. (=*Sterculia colorata* Roxb.) is assigned to the genus *Sterculioxylon* Kräusel (1939).

Among the above species of *Sterculioxylon*, *S. foetidense*, *S. dattai* and *S. deccanensis* differ quite markedly from the present fossil in having parenchyma diffuse to diffuse-in-aggregate or forming uniseriate to occasionally biseriate lines. The present fossil although exhibiting similarity with *S. varmahii* in having almost similar parenchyma bands shows quite marked difference in the width of rays which are up to 25 seriate, whereas in the latter they are up to 10 seriate. *Sterculioxylon kalagarhense* can also be differentiated in having traumatic gum canals. The remaining species are also quite different in possessing mostly aliform-confluent parenchyma. In *S. freulonii* the parenchyma bands are also present in addition to aliform confluent, but the rays are narrower than in the present fossil.

From the above comparison it is quite evident that the present fossil is different from all the species of *Sterculioxylon* known so far. It is, therefore, named as *Sterculioxylon pondicherriense* sp. nov.

Firmiana colorata (Roxb.) R.Br., one of the nearest modern equivalents of *Sterculioxylon pondicherriense*, is found in the sub-Himalayan tracts from Jamuna eastwards, central, western and southern India, Burma and the Andamans.

Diagnosis

Sterculioxylon pondicherriense sp. nov.

Wood diffuse-porous. *Growth rings* not seen. *Vessels* medium to large, t.d. 100-280 μm, r.d. 50-280 μm, solitary or in radial multiples of mostly 2-4, occasionally up to 7, evenly distributed, about 5-10 vessels per mm, intervessel pits small to medium, 4-6 μm in diameter, bordered, alternate with small, circular or slit-like apertures; tyloses not seen, vessels filled with dark contents. *Parenchyma* banded, bands broad, 3-21 cells wide, alternating with fibre bands, regular, somewhat straight, completely enclosing the vessels, about 3-6 bands per mm, crystalliferous strands present. *Rays* very broad, up to 25 cells and 360 μm wide, 2-4 per mm, uniseriates occasionally, short; multiseriates up to 100 cells and 1,550 μm high; rays homocellular to heterocellular, consisting of procumbent cells and 1 or 2 marginal rows of upright to square cells, sheath cells also present. *Fibres* alternating with parenchyma bands, sometimes thinner than parenchyma bands, thick-walled, nonseptate.

Holotype — B.S.I.P. Museum no. 3538/1478.

Locality — Murattandichavadi near Pondicherry, South Arcot District, Tamil Nadu.

Horizon & Age — Cuddalore Series; Miocene-Pliocene.

Family — Lythraceae

Genus — *Lagerstroemioxylon* Mädler, 1939

Lagerstroemioxylon arcotense sp. nov.

Pl. 2, figs 5-10

The species described here is represented by a piece of petrified secondary wood

measuring about 14×6 cm. The preservation is fairly good.

Topography — Wood diffuse-porous to semi-ring porous (Pl. 2, figs 6-8). *Growth rings* present, delimited by 1-2 (usually 1) rows of bigger and mostly solitary vessels at the inception of the spring wood and a dark zone of dense fibres in the outer margin of ring, about 2-5 rings per cm. *Vessels* visible to the naked eye against the light as dark crowded dots, small to large, those occurring at the inceptions of spring wood bigger, forming 1-2 (mostly 1) rows (Pl. 2, figs 6-8), sometimes abruptly grading into smaller vessels (Pl. 2, fig. 7), solitary and also in radial multiples of 2-5, rarely up to 8, somewhat uniformly distributed, about 5-20 vessels per sq mm, tylosed. *Parenchyma* abundant, paratracheal, aliform to aliform-confluent or confluent (Pl. 2, figs 6-8), aliform parenchyma completely encircling the vessels and extending laterally across several rays, narrowing gradually forming 1-2 seriate lines, some aliform-confluent parenchyma extensions often forming as almost regular thin, wavy lines or moderately broad bands, sometimes aliform-confluent extensions forking into two and joining with those of neighbouring vessels, besides a few short thin apotracheal bands or lines also present. *Rays* fine, uniseriate (Pl. 2, fig. 9), rarely biseriate due to paired cells through the median portion, about 12-16 rays per mm in cross-section, 3-12 cells in height; ray tissue homogeneous; rays homocellular, composed wholly of procumbent cells (Pl. 2, figs 9, 10). *Fibres* aligned in radial rows between two consecutive rays (Pl. 2, fig. 8).

Elements — Vessels circular to oval, t.d. 60-280 μm, r.d. 40-280 μm, walls 8-16 μm; perforations simple, nearly horizontal to oblique; vessel-members truncate or attenuately tailed, about 400-800 μm in height; intervessel pits large, polygonal through crowding, about 8-12 μm in diameter, alternate, bordered, vestured, with linear orifices; vessels filled with tyloses and dark contents. *Parenchyma cells* oval to angular, 20-40 μm in diameter, infiltration dark. *Ray cells* procumbent, 24-32 μm in tengential height, 20-120 μm in radial length; crystals not seen, infiltration dark. *Fibres* non-libriform to semi-libriform, angular in cross section, small, 12-32 μm in diameter, thick-walled, walls 4-6 μm, septate; crystalliferous strands present, divided into several locules containing solitary crystals, pits not seen.

Affinites

Comparison with the Modern Woods — The most important features of the fossil wood are: (i) diffuse-porous to semi-ring porous, having usually single row of bigger vessels at the inception of spring wood and rest small to medium-sized, (ii) parenchyma aliform to aliform-confluent and confluent, (iii) xylem rays uniseriate, homogeneous, and (iv) fibres septate and crystalliferous. These features collectively indicate that the affinities of the fossil are with the woods of *Lagerstroemia* of the family Lythraceae.

For identification of the fossil, thin sections of *Lagerstroemia*, viz., *L. calyculata* Kurz, *L. colletii* Craib., *L. floribunda* Jack, *L. flos-reginae* Retz., *L. lanceolata* Wall., *L. hypoleuca* Kurz, *L. macrocarpa* Wall., *L. parviflora* Roxb., *L. venusta* Wall., and *L. villosa* Wall. Besides, it was also compared with the published descriptions and figures of the woods of many other species of *Lagerstroemia* (Lecomte, 1926, pl. 51; Chowdhury, 1932, pl. 5; Pearson & Brown, 1932, pp. 575-597, figs 190-196; Metcalfe & Chalk, 1950, pp. 652-654, fig. 147A-B; Kanehira, 1924, pp. 12-13; Kribs, 1959, p. 104, figs 233, 234; Moll & Janssonius, 1914, pp. 585-593, fig. 207; Henderson, 1953, fig. 240). From this it was found that the fossil wood shows a general similarity with most of the species of *Lagerstroemia*.

In the nature and distribution of vessels and parenchyma, *Lagerstroemia flos-reginae* and *L. lanceolata* appear to be quite closer to the present fossil wood. However, in other characters they do not match exactly with it. In *L. flos-reginae* the xylem rays are 1-3, rarely 4-seriate, the parenchyma bands are broader and the vessels are also larger than in the present fossil. Similarly, *L. lanceolata* also differs to some extent in having mostly aliform-confluent parenchyma bands but they are not so thin and abundant as in the present fossil. Thus it is difficult to decide that which of the species of *Lagerstroemia* is closest to our fossil.

Comparison with the Fossil Woods — So far four species of fossil woods of *Lagerstroemia* are known, viz., *Lagerstroemioxylon durum* Mädler (1939) from the Tertiary of

Frankfurt, West Germany; *L. eoflos-reginum* Prakash & Tripathi (1970) from the Tipam Series (Middle Miocene) of Hailakandi, Assam, India; *Lagerstroemioxylon parenchymatosum* Prakash (1973) from the Tertiary of Burma; *L. irrawaddiensis* Prakash and Bande (1980) from the Tertiary of Burma and *L. deomaliensis* Lakhanpal *et al.* (1981) from the Tertiary of Deomali, Arunachal Pradesh, India.

Since the present fossil wood is closely comparable to *Lagerstroemia*, it shows gross resemblance with the above fossil in shape, size and distribution of parenchyma and the type of rays. However, it differs from these in having some significant characters. In *Lagerstroemioxylon durum* the vessels are smaller, i.e. their t.d. and r.d. are 30-110 μm and 19-120 μm respectively, and the rays are 1-3 (mostly 1-2) seriate, whereas in the present fossil the vessels are up to 280 μm in diameter and the rays are uniseriate. *Lagerstroemioxylon eoflos-reginum* differs from our fossil in having parenchyma bands comparatively wider and straight and the rays more in height, i.e. up to 65 cells; whereas in our fossil the aliform-confluent parenchyma lines are numerous and thinner and the xylem rays are only up to 12 cells in height. In *L. parenchymatosum* also the aliform-confluent parenchyma lines are not so thin as in our fossil. Moreover, the vessels in *L. parenchymatosum* are grading into smaller vessels from early to late wood. Thus it is evident that the present fossil is different from the above known species. and therefore it is named as *Lagerstroemioxylon arcotense* sp. nov.

The genus *Lagerstroemia* L. consists of about 50 species found in tropical Asia to North Australia (Willis, 1973, p. 630). There are about 11 species occurring in the Indian region. Out of which only three species, viz., *L. rotteleri* Clarke, *L. lanceolata* Wall. and *L. flos-reginae* Retz. are found in the deciduous forests of South India, especially on the western coast.

Diagnosis

Lagerstroemioxylon arcotense sp. nov.

Wood diffuse-porous to semi-ring porous. *Growth rings* present, delimited by a row of bigger vessels at the inception of spring wood and a zone of dense fibres at the outer margin of ring. *Vessels* small to large, large or bigger at the beginning of annual ring, sometimes abruptly grading into medium to small, solitary as well as in radial multiples of 2-5, rarely up to 8, about 5-20 vessels per sq mm. *Parenchyma* paratracheal, aliform to confluent, bands or lines usually narrow, extending across several rays, also forking and joining with those of neighbouring vessels, short apotracheal or broken confluent bands or lines often present. *Rays* uniseriate, rarely biseriate due to pairing of procumbent cells, short, up to 12 cells in height, homocellular, consisting of procumbent cells only, about 12-16 rays per mm. *Fibres* non-libriform to libriform, 12-32 μm in diameter, thick-walled, walls, 4-6 μm, septate; crystalliferous strands present, divided into several locules containing solitary crystal.

Holotype — B.S.I.P. Museum no. 35339/288.

Locality — Tiruchitambalam, near Pondicherry, South Arcot District, Tamil Nadu.

Horizon & Age — Cuddalore Series; Miocene-Pliocene.

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EXPLANATION OF PLATES

PLATE 1

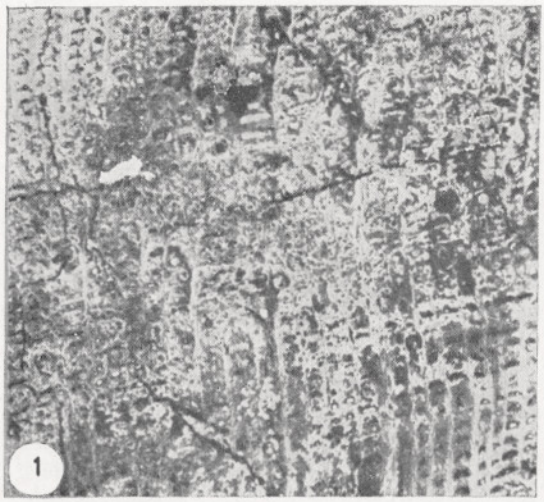
Sterculioxylon pondicherriense sp. nov.

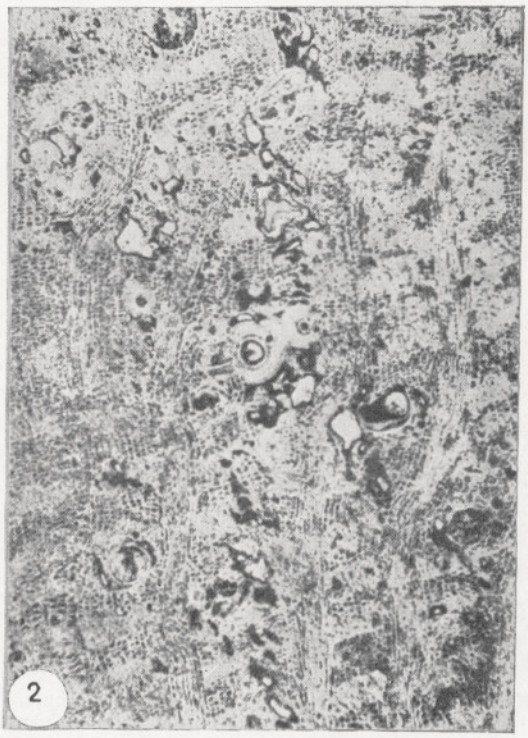
1. Cross section showing nature and distribution of vessels and parenchyma. × 6. B.S.I.P. Museum slide no. 6017.
2. Cross section magnified showing vessels and parenchyma bands. × 30. B.S.I.P. Museum slide no. 6018.
3. Another cross section magnified showing vessels and parenchyma bands. × 35. B.S.I.P. Museum slide no. 6017.
4. Tangential longitudinal section showing rays. × 30. B.S.I.P. Museum slide no. 6019.
5. Radial longitudinal section showing heterocellular nature of rays. × 80. B.S.I.P. Museum slide no. 6020.

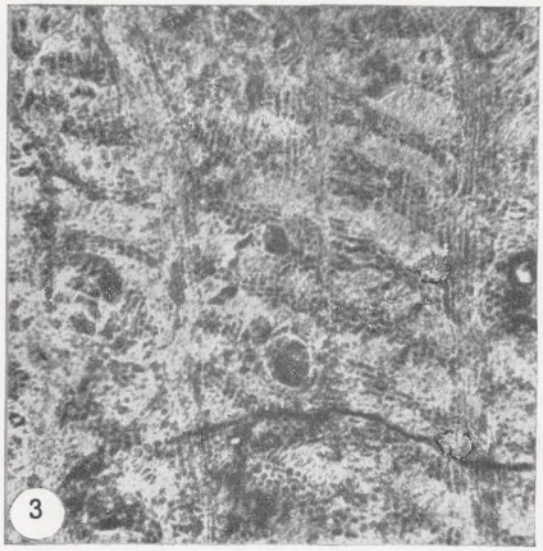
PLATE 2

Lagerstroemioxylon arcotense sp. nov.

6. Cross section showing nature and distribution of vessels and parenchyma. × 8. B.S.I.P. Museum slide no. 6021.
7, 8. Cross sections magnified showing graded pores and aliform to confluent parenchyma. × 30. B.S.I.P. Museum slide no. 6022.
9. Tangential longitudinal section showing rays. × 90. B.S.I.P. Museum slide no. 6024.







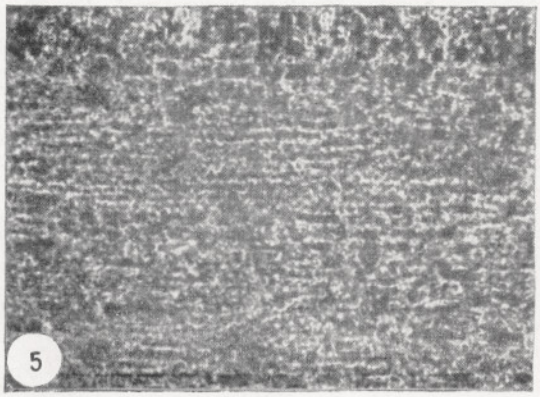
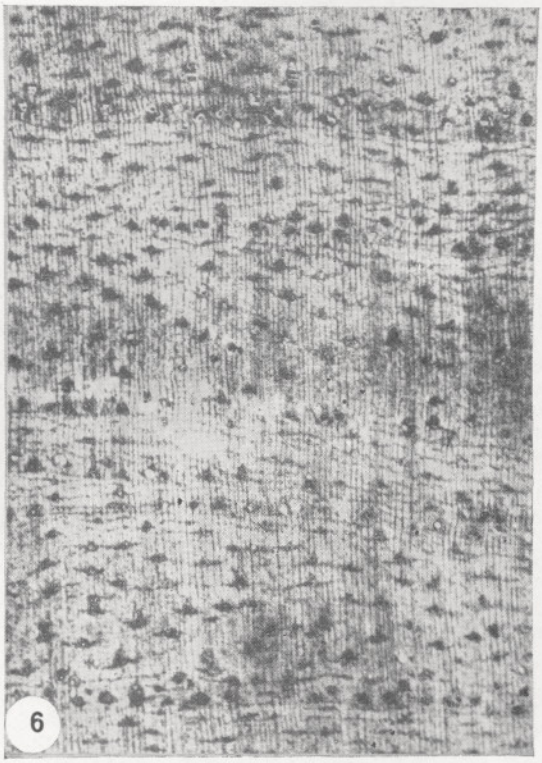
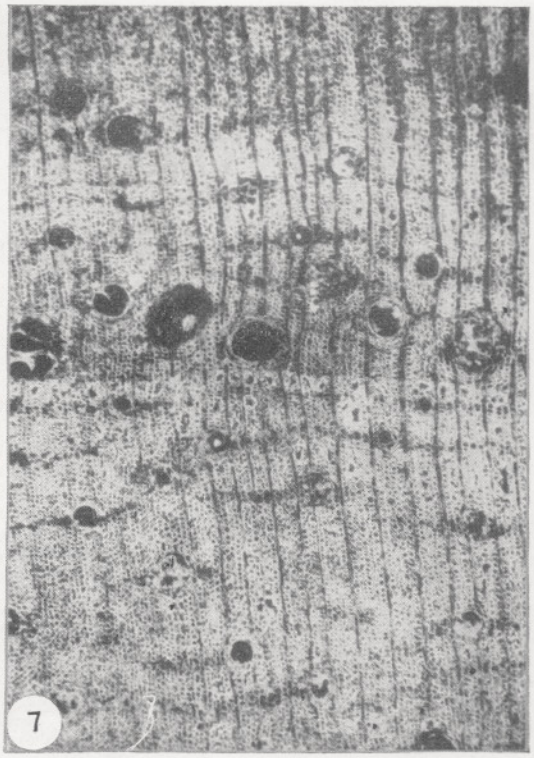


PLATE 1





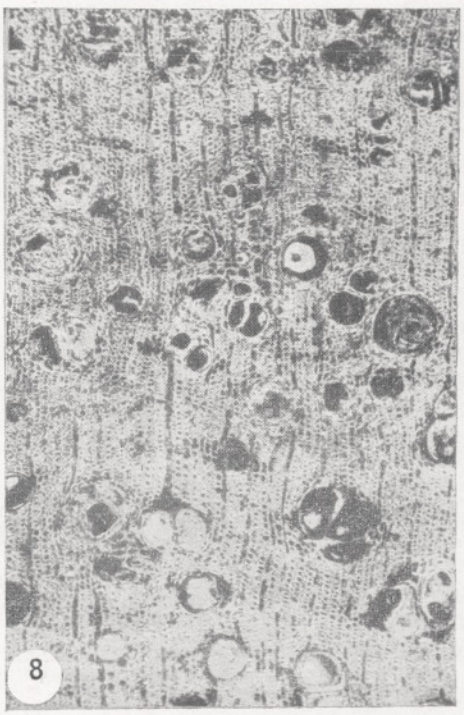


PLATE 2