

# ON THE OCCURRENCE OF TWO NEW FOSSIL WOODS BELONGING TO THE FAMILY LECYTHIDACEAE IN THE TERTIARY ROCKS OF SOUTH INDIA

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## ABSTRACT

Two new fossil woods are described here from the Tertiary of South India near Pondicherry. These resemble the modern woods of *Barringtonia* and *Careya* of the family Lecythidaceae.

## INTRODUCTION

TILL now the studies on petrified woods from the Cuddalore Series of South India have yielded a good variety of Angiosperms and Gymnosperms, especially Angiosperms. Among the angiospermic woods palms are represented by only three species. However, the majority of woods are dicotyledonous, belonging to the family Guttiferae, Dipterocarpaceae, Simaroubaceae, Sapindaceae, Anacardiaceae, Leguminosae, Rosaceae, Combretaceae, Alangiaceae, Sonneratiaceae, Euphorbiaceae, Celastraceae and Fagaceae.

The present paper adds two new fossil woods to the already known flora of Cuddalore Series. They belong to the family Lecythidaceae, being reported for the first time from this horizon. Previously fossil woods of Lecythidaceae are known from India from the Deccan Intertrappean Series near Nagpur, viz., *Barringtonioxylon deccanense* Shallom (1960) and *B. eoptero-carpareum* Prakash & Dayal (1965).

The material for the present investigation was collected from near Murattandichavadi and Pattanur, about 8-10 km. W.N.W. of Pondicherry, South Arcot district, Madras.

## GENERAL DESCRIPTION

Family — LECYTHIDACEAE

Genus — *Barringtonioxylon* Shallom, 1960

*Barringtonioxylon arcotense* sp. nov.

Pl. 1, Figs. 1, 3, 5; Text-figs. 1-5

This species is based on a small piece of silicified secondary wood. The preservation

is fairly satisfactory. The colour of the cut surface is yellowish brown.

**TOPOGRAPHY** — Wood diffuse-porous. Growth rings not observed. Vessels small to large (mostly medium) in size, solitary and in radial multiples of 2-4 (PL. 1, FIG. 1; TEXT-FIG. 1), evenly distributed, about 8-16 vessels per sq. mm.; tyloses present (PL. 1, FIGS. 1, 3). Parenchyma paratracheal and apotracheal; paratracheal parenchyma usually vasicentric to aliform and also aliform — confluent, joining a few neighbouring vessels (PL. 1, FIG. 1; TEXT-FIG. 1); apotracheal parenchyma not so abundant as paratracheal, diffuse, sometimes tending to arrange in tangential rows (PL. 1, FIG. 1; TEXT-FIG. 1). Xylem rays



*Barringtonioxylon arcotense* sp. nov.

TEXT-FIG. 1 — Cross-section showing nature and distribution of vessels and parenchyma.  $\times 70$ .

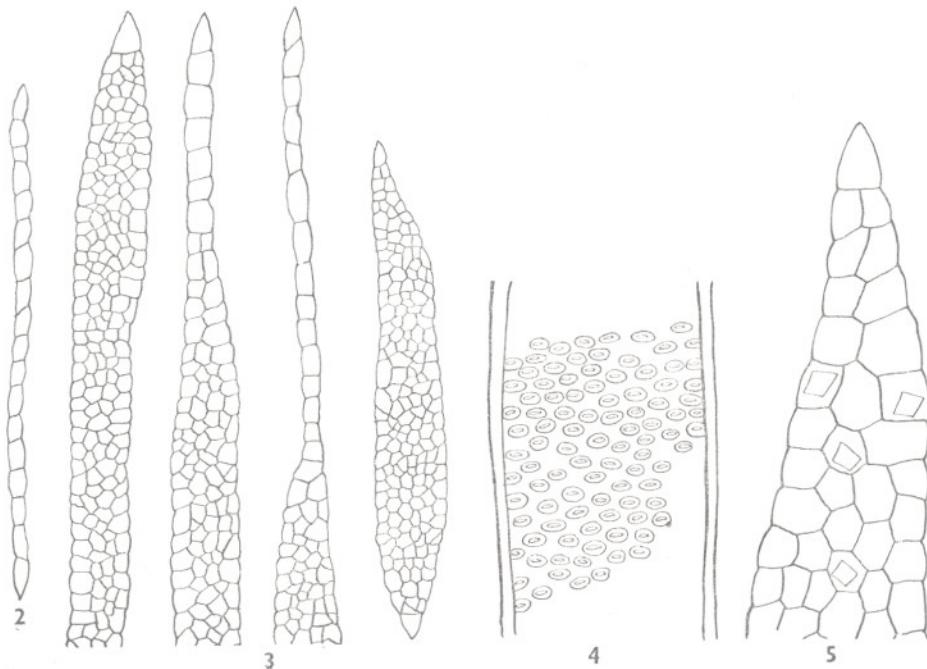
fine to broad, 16-200  $\mu$  wide in cross-section, separated by 2-6 tangential rows of fibres, 6-8 rays per mm., rays divisible on the basis of size and composition, (a) the uniserial, fine, 16-20  $\mu$  wide, up to 20 cells in height, homocellular, consisting wholly of upright cells (TEXT-FIG. 2); (b) the multiseriate rays 2-8 cells wide, up to 60 cells or more in height, heterocellular, consisting of procumbent cells through the median thickened portion and several rows of upright cells at both the ends, sheath cells also present (PL. 1, FIGS. 3-5; TEXT-FIG. 3). Fibres aligned between two consecutive rays without any pattern forming a narrow strip (PL. 1, FIG. 1).

ELEMENTS—*Vessels* circular to oval in cross-section (PL. 1, FIG. 1; TEXT-FIG. 1), t.d. 40-270  $\mu$ , r.d. 40-300  $\mu$ , moderately thick-walled, common walls 8-16  $\mu$  in thickness; vessel-members short to medium, 300-600  $\mu$  in length, with truncate or tapered ends; perforations simple; inter-vessel pits medium, alternate, oval, with lenticular apertures (TEXT-FIG. 4); vessel-parenchyma and vessel-ray pits not clearly

seen due to lack of preservation. *Parenchyma cells* oval or elongated, those confined to immediate vicinity of the vessels orbicular or peripherally flattened, while those of diffuse tangentially elongated, t.d. 20-32  $\mu$ , r.d. 24-52  $\mu$ . Upright *Ray cells* 60-80  $\mu$  in tangential height, 40-60  $\mu$  in radial length; procumbent cells 24-40  $\mu$  in tangential height, 60-100  $\mu$  in radial length; crystals present (TEXT-FIG. 5). *Fibres* angular, 16-25  $\mu$  in diameter, nonseptate, thick-walled, common walls 6-8  $\mu$  in thickness.

AFFINITIES—*Comparison with the Modern Woods.*

One of the most important anatomical characters of the present fossil wood is that the xylem rays are of two types (a) uniserial, homocellular, consisting of upright cells only; (b) multiseriate, 2-8 cells wide, heterocellular consisting of procumbent cells through the median portion and 1-several marginal rows of upright cells at both the ends, with sheath cells at the flanks. Such type of xylem rays are found in a number of dicotyledonous woods. Amongst them the important families are Dilleniaceae,



*Barringtonioxylon arcotense* sp. nov.

TEXT-FIGS. 2-5.—2. Uniserial xylem ray.  $\times 70$ . 3. Multiseriate xylem rays.  $\times 70$ . 4. Intervessel pits.  $\times 300$ . 5. A portion of ray magnified to show crystals.  $\times 200$ .

Ampelidaceae, Lecythidaceae, Araliaceae, Cornaceae, Myrsinaceae, Piperaceae and Chloranthaceae.

Besides ray characters, taking into consideration the other important features, such as vessels medium to large, solitary as well as in radial multiples of 2-4, tylosed, intervessel pits large, perforations simple; parenchyma paratracheal, vascentric to aliform-confluent, apotracheal, diffuse; fibres thick-walled, nonseptate — the present fossil wood shows resemblance with the woods of *Barringtonia* Forst. of the family Lecythidaceae (METCALFE & CHALK, 1950, pp. 631-636; DIEHL, 1935, pp. 1-15).

With a view to find out the nearest modern equivalent of the present fossil wood, microscopic examination of a number of woods of *Barringtonia* was made, viz. *Barringtonia acutangula* (Linn.) Gaertn., *B. angusta* Kurz, *B. asiatica* Kurz, *B. cymosa* C.F.C. Fischer, *B. macrostachya* Kurz, *B. musiformis* King, *B. pterocarpa* Kurz, and *B. racemosa* Bl. Besides thin sections, it was also compared with the published description and figures of *B. scorchedii* King (DESCH, 1957, pp. 251-252, Pl. 60, FIG. 1; SCHNEIDER, 1916, p. 178); *B. speciosa* Linn (KANEHIRA, 1921, p. 111, Pl. 22, FIGS. 128-129; METCALFE & CHALK, 1950, p. 633; MOLL & JANSSONIUS, 1914, pp. 489-494, FIG. 196); *B. spicata* Bl., *B. insignis* Miq. and *B. gigantostachya* Koord. et Valet. (MOLL & JANSSONIUS, loc. cit., pp. 494-502, FIG. 187). Out of these, *B. angusta* shows closest resemblance with the present fossil wood. However, in general, the other species of *Barringtonia* differ from the present fossil in the nature and distribution of parenchyma, size of the vessels and also in some cases the width of the rays.

*Comparison with the fossil species* — The present fossil wood, being closely allied to *Barringtonia*, resembles both the species of *Barringtonioxylon*, viz. *B. deccanense* Shallow (1960) and *B. eopterocarpum* Prakash & Dayal (1965) described from the Deccan Intertrappean Series, in having a number of common features. However, they differ from the present fossil wood especially in the nature and distribution of parenchyma. The parenchyma in *Barringtonioxylon deccanense* and *B. eopterocarpum* is represented by paratracheal and apotracheal; paratracheal parenchyma is scanty and the apotracheal is abundant, consisting

of uniseriate tangential rows forming reticulum with the xylem rays; whereas in the present fossil the paratracheal parenchyma is abundant and the apotracheal is sparse. Besides, the size of the vessels in the present fossil wood ranges from small to large, while in *Barringtonioxylon deccanense* and *B. eopterocarpum* the vessels are small to medium. Moreover, these species have been shown to resemble *Barringtonia acutangula* and *Barringtonia pterocarpa* respectively, while the present fossil wood resembles *Barringtonia angusta*.

The only other species of fossil wood of the family Lecythidaceae known from outside India is *Lecythioxylon brasiliense* Milanez (1935), described from the Cretaceous of Brazil. This species is closely allied to the modern genus *Lecythis*, which grows in South America. It differs from the present fossil wood mainly in having fine, wavy and regular apotracheal parenchyma bands.

In view of its closest resemblance with the modern woods of *Barringtonia*, the present fossil wood has been placed under the genus *Barringtonioxylon* Shallow. As it has already been shown that it is quite different from the hitherto known species of *Barringtonioxylon*, a new specific name *Barringtonioxylon arcotense* is proposed for it. The specific name indicates its occurrence in the South Arcot district, Madras.

*Present distribution of Barringtonia* Forst. — The genus *Barringtonia* consists of about 100 species (WILLIS, 1966, p. 120) of moisture loving trees and shrubs with mostly evergreen leaves. It is confined to the Old World, mostly littoral zone and are scattered from tropical Africa through the Indo-Malayan region to Formosa and eastward to northern Australia and Polynesia. About 9 species occur in the Indian region (PEARSON & BROWN 1932, p. 563) chiefly in Burma. *Barringtonia angusta* which has been found closely allied to the present fossil wood is now found in the coast of Tenasserim.

#### SPECIFIC DIAGNOSIS

*Barringtonioxylon arcotense* sp. nov.

*Wood* diffuse-porous. *Growth rings* absent. *Vessels* small to large, t.d. 40-270  $\mu$ , r.d. 40-300  $\mu$ , solitary as well as in radial multiples of 2-4, 8-16 vessels per

sq. mm.; vessel-members 300-600  $\mu$  in length, with truncated or tapered ends; perforations simple; intervessel pits large, 8-10  $\mu$  in diameter, alternate, bordered, with lenticular apertures; tyloses present. *Parenchyma* paratracheal, apotracheal; paratracheal parenchyma usually aliform to confluent, joining neighbouring vessels; apotracheal parenchyma diffuse, in widely spaced uniseriate tangential lines. *Xylem rays* fine to broad, 16-200  $\mu$  wide, 6-9 per mm.; ray tissue markedly heterogeneous; rays divisible on the basis of size and composition, (a) the uniseriate, fine, 16-20  $\mu$  wide, up to 20 cells in height, homocellular, consisting wholly of upright cells; multi-seriate rays 2-8 (mostly 4-6) cells and 20-200  $\mu$  wide, up to 60 cells in height, heterocellular, consisting of procumbent cells in the median thickened portion, and 1-several marginal rows of upright cells at both ends and flanks, crystals present. *Fibres* angular, 16-26  $\mu$  in diameter, nonseptate, thick-walled, common walls 6-8  $\mu$  in thickness.

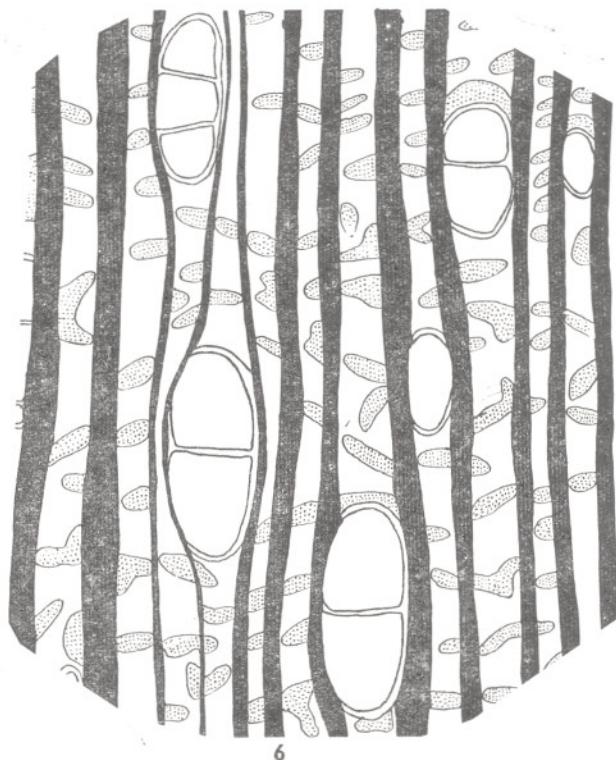
*Holotype* — B.S.I.P. Museum No. 33705.  
*Locality* — Near Murattandichavadi and Pattanur, about 8-10 km. W.N.W. of Pondicherry, South Arcot district, Madras.

## 2. *Careyoxylon pondicherriense* gen. et sp. nov.

Pl. 2, Figs. 6, 8; Text-figs. 6-10

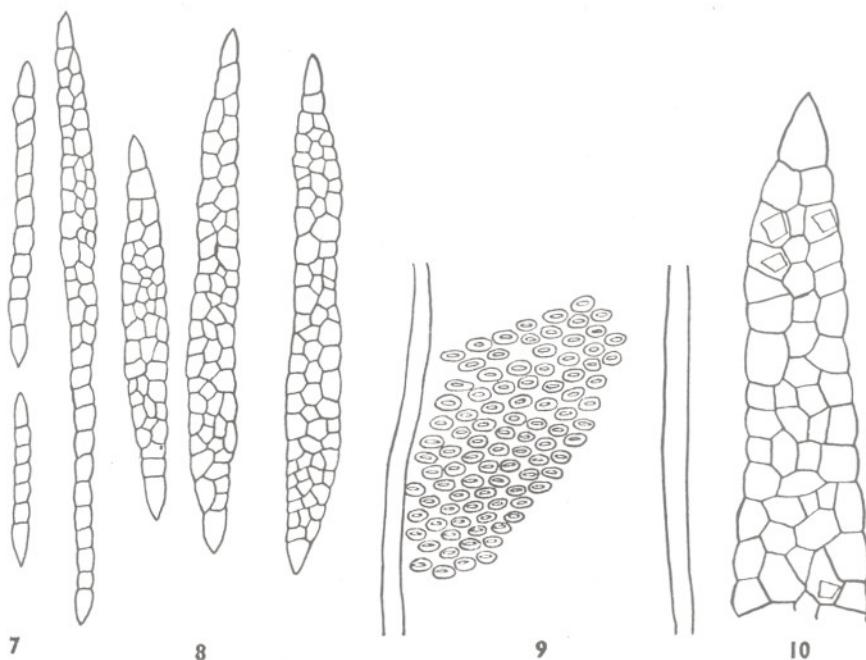
The fossil wood is represented by a single piece of silicified secondary wood. Prior to sectioning it was about 14 cm. in length and 6 cm. in diameter. The preservation is satisfactory.

**TOPOGRAPHY** — *Wood* diffuse-porous. *Growth rings* indistinct. *Vessels* small to large, solitary as well as in radial multiples of 2-5, mostly 2-3 (PL. 2, FIG. 6; TEXT-FIG. 6), evenly distributed, about 8-15 vessels per sq. mm.; tyloses present, abundant in foam-like masses occluding the vessels (PL. 2, FIG. 6). *Parenchyma* paratracheal, apotracheal; paratracheal parenchyma sparse, only a few cells associated with the vessels;



*Careyoxylon pondicherriense* gen. et sp. nov.

TEXT-FIG. 6 — Cross-section showing nature and distribution of vessels and parenchyma.  $\times 75$ .



*Careyoxylon pondicherriense* gen. et sp. nov.

TEXT-FIGS. 7-10—7. Uniserial xylem rays.  $\times 100$ . 8. Multiseriate xylem rays.  $\times 100$ . 9. Inter-vessel pits.  $\times 300$ . 10. A portion of ray magnified to show crystals.  $\times 200$ .

apotracheal parenchyma abundant, in uniserial tangential lines, separated by 1-6 tangential rows of fibres, cells often meet with the rays, and forming reticulum in cross-section (PL. 2, FIG. 6; TEXT-FIG. 6), uniserial parenchyma lines 6-10 per mm. Xylem rays fine to moderately broad, 16-60  $\mu$  wide, 1-4 seriate (PL. 2, FIG. 8; TEXT-FIGS. 7, 8), heterogeneous; uniserial rays homocellular to heterocellular, consisting wholly of upright as well as procumbent and upright cells, multiseriate rays up to 50 cells in height, heterocellular, consisting of procumbent cells through the median thickened portion and 1-several marginal rows of upright cells, occasionally joining uniserial extensions of other rays; a few upright cells also present at the flanks (TEXT-FIG. 8); rays 9-14 per mm.; each separated by 2-6 tangential rows of fibres. Fibres aligned in radial rows between two consecutive xylem rays.

ELEMENTS — Vessels circular to oval in cross-section (PL. 2, FIG. 6; TEXT-FIG. 6), t.d. 60-250  $\mu$ , r.d. 60-280  $\mu$ , thick-walled, common walls 8-16  $\mu$  in thickness; vessel-

members 375-900  $\mu$  in length, with truncated ends; perforations simple; intervessel pits large, 8-10  $\mu$  in diameter, alternate, bordered, with circular to lenticular apertures (TEXT-FIG. 9); vessel-parenchyma and vessel-ray pits not seen. Parenchyma cells circular or orbicular through tangential plane (TEXT-FIG. 6), t.d. 28-40  $\mu$ , r.d. 20-24  $\mu$ ; contents dark. Upright ray cells 40-60  $\mu$  in tangential height, 32-40  $\mu$  in radial length; procumbent cells 20-40  $\mu$  in tangential height, 48-80  $\mu$  in radial length; crystals present (TEXT-FIG. 10). Fibres oval to angular in cross-section, 16-28  $\mu$  diameter, nonseptate, thick-walled, common walls 4-8  $\mu$  in thickness.

AFFINITIES — Comparison with the modern woods.

The most important anatomical characters of this fossil wood is that the parenchyma is apotracheal, forming uniserial tangential lines separated by 1-6 radial rows of fibres, and the cells meet with the ray cells forming reticulum. In addition to apotracheal parenchyma, paratracheal parenchyma is also present as a few cells

associated with the vessels. Such type of parenchyma is found in as many as 40 families of dicotyledonous woods (METCALFE & CHALK, 1950). Besides, looking into other important gross features as well, the present fossil wood comes nearer to those of Lecythidaceae, Rubiaceae, Sapotaceae, Ebenaceae, Apocynaceae, Boraginaceae and Euphorbiaceae (METCALFE & CHALK, 1950; PEARSON & BROWN, 1932).

In the family Rubiaceae the comparable genera are *Sarcocephalus*, *Anthocephalus*, *Stephegyne*, *Hymenodictyon*, *Randia*, *Gardenia*, *Canthium*, *Morinda*, *Coffea* etc., which exhibit similar type of parenchyma and xylem rays as present in the present fossil wood. However, these rubiaceous genera differ from it in the size of the vessel and the nature of the intervessel pits. The vessels are comparatively smaller and open (without tyloses) and the intervessel pits are vested in all the above rubiaceous woods.

The type and distribution of parenchyma in Sapotaceae and Ebenaceae is also quite similar to the present fossil wood. However, the woods of the Sapotaceae also differ mainly in having vasicentric tracheids while those of Ebenaceae in possessing xylem rays 1-3 (mostly 1-2) seriate.

*Wrightia* and *Holarrhena* of the Apocynaceae resembles the present fossil wood in gross features, such as the type and distribution of parenchyma and to some extent xylem rays. However, on detailed comparison both these genera can be differentiated from it in the nature and distribution of vessels and intervessel pits. The vessels in the above genera are in several multiples, often forming long chain without tyloses, and the intervessel pits are vested.

The genus *Erhetia* of the Boraginaceae although resembles the present fossil wood in the type and distribution of parenchyma and vessels, differs in possession of vasicentric tracheids and absence of tyloses.

In the type and distribution of vessels and parenchyma the present fossil also resembles *Strombosia* of the family Olacaceae. However, this genus is somewhat different in having longer rays and scalariform perforations.

In the family Euphorbiaceae there are quite a number of genera which show many anatomical similarities with the present fossil wood, such as in the nature and distribution of parenchyma and vessels.

The comparable genera are *Buxus*, *Croton*, *Trewia*, *Mallotus*, *Exoecaria*, *Cyclostemon*, *Sapium*, *Aleurites*, etc. However, these genera differ, as whole, from the present fossil wood in having generally long and frequent uniseriate rays and besides this, they possess smaller vessels which are without tyloses.

A combination of the hitherto described anatomical characters is found only in the woods of the family Lecythidaceae. In all the important features, such as the scanty paratracheal and apotracheal parenchyma forming tangential lines and 1-4 seriate xylem rays—it resembles the woods of *Careya*, *Planchonia* and a few species *Barringtonia* (METCALFE & CHALK, 1932; DIEHL, 1935). The genus *Barringtonia* resemble the present fossil in having similar type and distribution of vessels, parenchyma and fibres, however, differs in a combination of all the anatomical features as discussed below. In almost all the species of *Barringtonia* the paratracheal parenchyma, i.e. aliform to aliform-confluent is also present in addition to apotracheal parenchyma which is represented by uniseriate tangential lines; whereas in the present fossil wood the apotracheal parenchyma is sparse, i.e. a few cells are associated with the tangential wall of the vessels. The other important difference is that the xylem rays in *Barringtonia* are comparatively higher and broader than the present fossil wood.

Among the other woods of Lecythidaceae the nearest resemblance of the present fossil wood is with *Careya* and *Planchonia*. Of these, *Planchonia* resembles in almost all the structural details except that in some species (e.g. *P. andamanica*) the fibres are septate while in other species (e.g. *P. pactabiles*) the rays are comparatively short and the uniseriates being more frequent than in the present fossil wood.

Of all the lecytidaceous woods it is only the genus *Careya* which shows close resemblance with the present fossil wood. A detailed comparative study with the thin sections of *Careya arborea* Roxb., *C. sphaerica* Roxb. has revealed that there is a great similarity of the present fossil wood with that of *C. arborea*.

Among the fossil woods of the family Lecythidaceae so far known as mentioned in the preceding pages, none of them is comparable with the present fossil wood as they have been shown to resemble the other

genera, *Lecythis* and *Barringtonia* respectively.

In view of its closest resemblance with the wood of the modern genus *Careya* the present fossil is designated as *Careyoxyylon* gen. nov., and specifically it is named as *Careyoxyylon pondicherriense* sp. nov.

*Present distribution of Careya* Roxb.—The genus *Careya* Roxb. consists of 5 species, distributed in the Indo-Malayan regions (WILLIS, 1966, p. 198). It extends from India eastward through Siam and Indochina to New China and New Britain. Of the Indian species, *C. herbacea* Roxb. is a small undershrub of grassland, found in Bengal and Uttar Pradesh. The other species, *C. arborea* is a large deciduous tree of the first class timber with a wide distribution in India and China. In India *C. arborea* has a wide distribution, extending from the Kangra district, Punjab, eastwards, through Uttar Pradesh and Bengal to Assam; through A.P., Chhota Nagpur, Bombay (Maharashtra), Madras, Mysore, Kerala and the plain and lower hill forests of Burma. Often found growing in moist localities in ravine and valley and sometimes scattered in grassland. In Ceylon it grows in grassy land throughout the moist region up to 500 m. (PEARSON & BROWN, 1932).

#### GENERIC DIAGNOSIS

##### *Careyoxyylon* gen. nov.

*Wood* diffuse-porous. *Growth rings* indistinct. *Vessels* small to medium or large in size, solitary as well as in radial multiples of 2-6, perforations simple; intervessel pits medium to large, bordered, with linear apertures, tylosed. *Parenchyma* paratracheal, apotracheal; paratracheal parenchyma scanty, a few cells associated with the vessels; apotracheal parenchyma forming often regular, uniseriate lines, separated by mostly 1-6 cells of fibres. *Xylem rays* 1-4 seriate, heterogeneous; uniseriate rays, homocellular to heterocellular, consisting wholly of upright cells as well as both

upright and procumbent; multiseriate rays, heterocellular, consisting of both the type of cells, large, with extension of several marginal uniseriate rows of upright cells; sheath cells occasionally present. *Fibres* septate to nonseptate, thick-walled.

*Genotype* — *Careyoxyylon pondicherriense* sp. nov.

#### SPECIFIC DIAGNOSIS

##### *Careyoxyylon pondicherriense* sp. nov.

*Vessels* small to large, t.d. 60-250  $\mu$ , r.d. 60-280  $\mu$ , solitary as well as in radial multiples of 2-5 (mostly 2-3), circular to oval; vessel-members truncated; perforations simple; intervessel pits large, 8-10  $\mu$  in diameter with linear to lenticular apertures; tyloses abundant in foam-like masses occluding the vessels. *Parenchyma* paratracheal, apotracheal; paratracheal parenchyma scanty, a few cells associated with the vessels; apotracheal parenchyma in narrow, uniseriate lines, separated by 1-6 radial rows of fibres, forming reticulum with the ray cells in cross-section. *Xylem rays* 1-4 seriate; ray tissue heterogeneous; uniseriate rays few, homocellular to heterocellular, consisting wholly of procumbent cells as well as both upright and procumbent; multiseriate rays heterocellular, consisting of procumbent cells through the median thickened portion and 1-several marginal rows of upright cells; sheath cells occasionally present, end to end fusion common, rays up to 40 cells in height. *Fibres* nonseptate, thick-walled, 4-8  $\mu$  in thickness.

*Holotype* — B.S.I.P. Museum No. 33706.

*Locality* — Murattandichawadi, about 8 km. W.N.W. of Pondicherry, South Arcot district, Madras.

#### ACKNOWLEDGEMENT

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### EXPLANATION OF PLATES

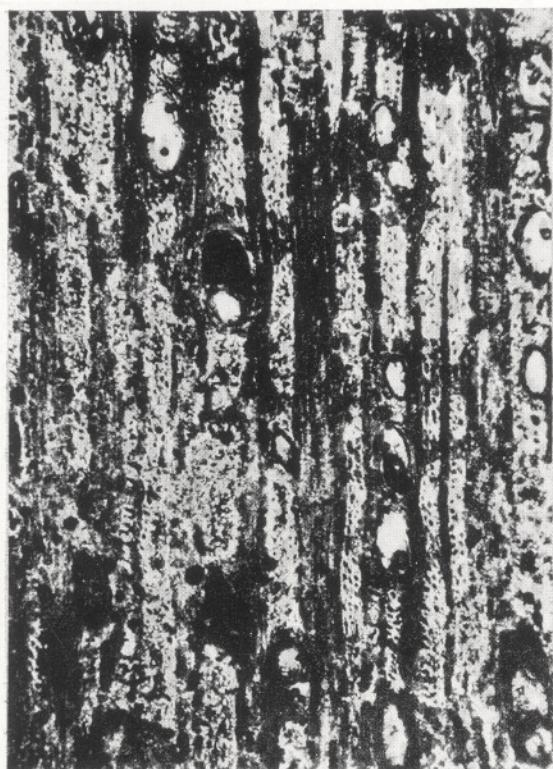
#### PLATE 1

1. *Barringtonioxylon arcotense* sp. nov.—Cross-section showing the nature and distribution of vessels, parenchyma and broad xylem rays.  $\times 50$ . (B.S.I.P. Museum, Slide No. 3512).
2. *Barringtonia angusta*—Cross-section showing nature and distribution of vessels, parenchyma and broad xylem rays.  $\times 50$ . (Slide No. B.S.I.Pw 665).
3. *Barringtonioxylon arcotense* sp. nov.—Tangential longitudinal section showing xylem rays.  $\times 35$ . (B.S.I.P. Museum, Slide No. 3513).
4. *Barringtonia angusta*—Tangential longitudinal section showing xylem rays.  $\times 35$ . (Slide No. B.S.I.Pw 665).
5. *Barringtonioxylon arcotense* sp. nov.—Magnified tangential longitudinal section showing xylem

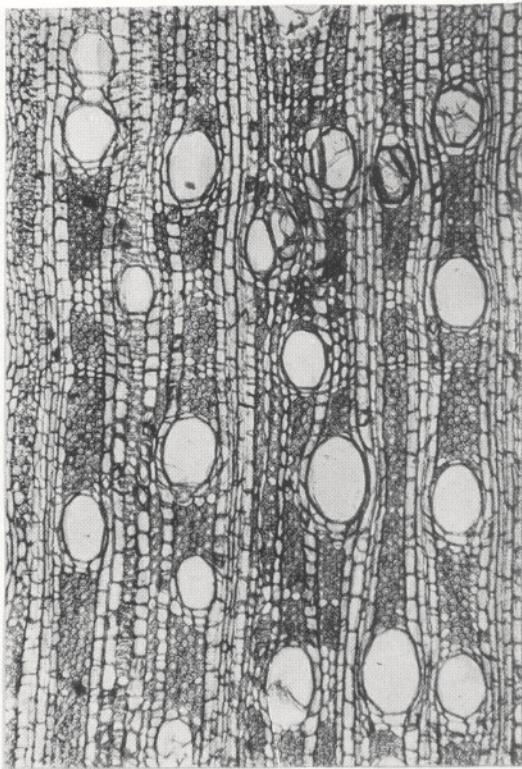
rays.  $\times 100$ . (B.S.I.P. Museum, Slide No. 3513).

#### PLATE 2

6. *Careyoxylon pondicherriense* gen. et sp. nov.—Cross-section showing nature and distribution of vessels (with tyloses) and parenchyma.  $\times 50$ . (B.S.I.P. Museum, Slide No. 3514).
7. *Careya arborea* Roxb.—Cross-section showing similar nature and distribution of vessels (with tyloses) and parenchyma as fossil.  $\times 50$ . (Slide No. B.S.I.Pw 696).
8. *Careyoxylon pondicherriense* gen. et sp. nov.—Tangential longitudinal section showing xylem rays.  $\times 90$ . (B.S.I.P. Museum, Slide No. 3515).
9. *Careya arborea*—Tangential longitudinal section showing similar xylem rays as in fossil.  $\times 90$ . (Slide No. B.S.I.Pw 696).



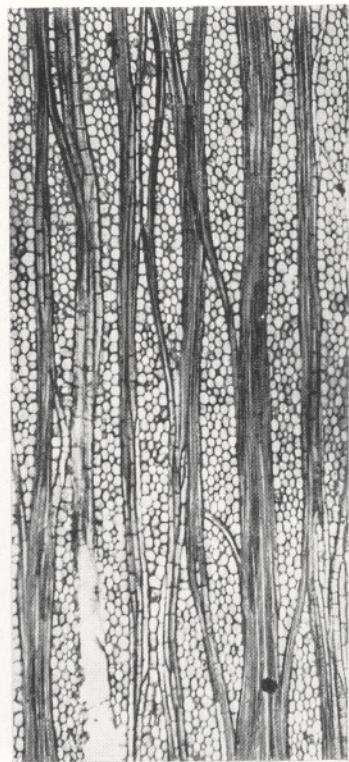
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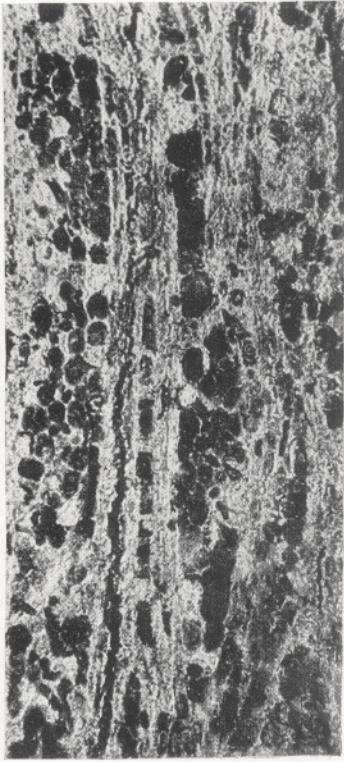
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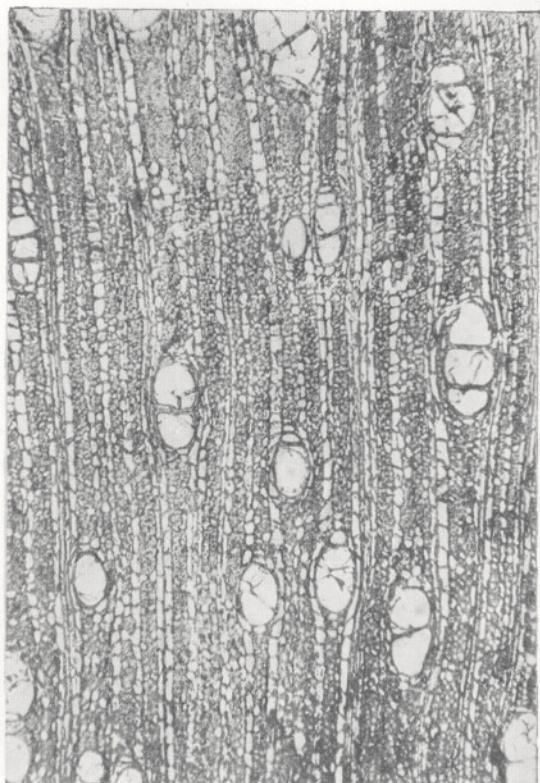
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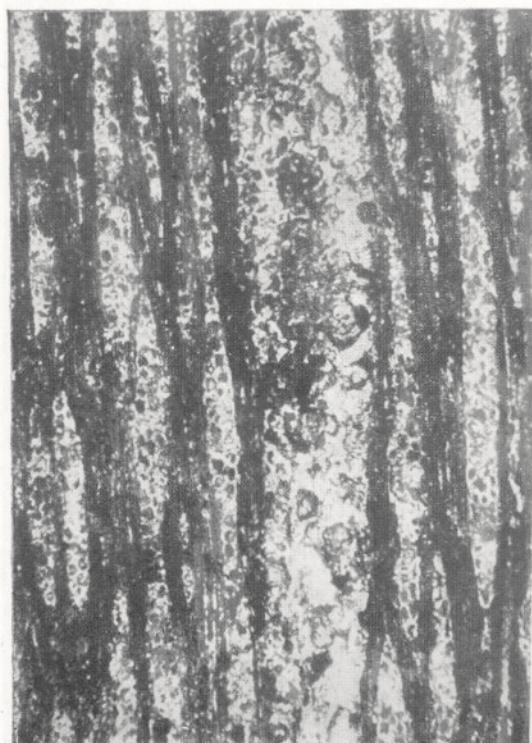
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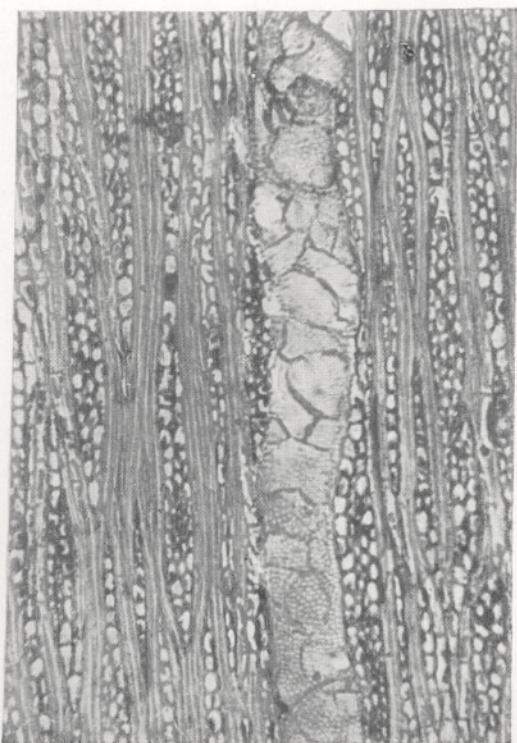
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7



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9