A FOSSIL DICOTYLEDONOUS WOOD RESEMBLING THE MODERN *TAMARINDUS* FROM THE TERTIARY ROCKS OF SOUTH ARCOT DISTRICT, MADRAS

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ABSTRACT

A fossil dicotyledonous wood resembling closely the wood of the modern species of *Tamarindus* has been described in detail for the first time from the Tertiary rocks of India. The fossil was collected from near Mortandra in the Cuddalore series, 5 miles NW. of Pondicherry; it has been named *Tamarindoxylon antiquum* gen. et sp. nov.

INTRODUCTION

THE material consists of a few pieces of fairly well-preserved silicified woods collected from near Mortandra, in the Cuddalore series, 5 miles NW. of Pondicherry. The geological age of the fossiliferous locality is believed to be Miocene (KRISHNAN, 1956). The investigations conducted so far have unravelled a fairly rich Tertiary flora considerably modern in its aspects, comprising as it does a large number of well-preserved dicotyledonous woods belonging to such diverse families like Guttiferae, Dipterocarpaceae, Celastraceae, Anacardiaceae, Leguminosae, Combretaceae, Sonneratiaceae and Euphorbiaceae (RAMANUJAM, 1953b, 1954a, 1954b, 1955a, 1955b, 1956a, 1956b), with a sprinkling of palms (SAHNI, 1931; RAMANUJAM, 1953a, 1958). Of the leguminous woods *Caesalpinioxylon sitholeyi* and *Acacioxylon antiquum* have been described in detail. In the present communication it is intended to describe minutely the wood anatomy of a silicification resembling very closely the modern species of *Tamarindus*.

DESCRIPTION

The fossil superficially shows faint growth-rings which, however, become very indistinct when examined under the microscope.

The wood is diffuse-porous. The vessels are, as a rule, small and hence inconspicuous to the unaided eye. They are mostly solitary, while radial pairs or groups of three are also seen rather frequently (PL. 1, FIG. 1). When solitary, the vessels are rounded to oval and when in radial groups they are flattened, often markedly so at both the ends. The vessels are distributed rather widely and here and there are placed contiguous to the xylem rays deflecting them either to the left or right as the case may be. The cavities of the vessels are usually plugged with some yellowish brown deposit, which either completely occludes the vessels or occurs in the form of small or big droplets. The vessel-members are medium, with their end-walls usually truncate; sometimes the narrow extremities of these elements extend beyond the perforated facets to appropriate themselves into short tapering ends or tails. The perforations are simple, and usually inclined. The intervessel pits are large, bordered, alternate and hexagonal to often polygonal (TEXT-FIG. 2). The apertures of these pits are narrow and horizontally elliptical or in rare cases rounded. The vessel-ray pits are narrowly bordered, fairly large, flattened and rounded to transversely elliptical and many per cell (TEXT-FIG. 2).

The fibres are angular in cross-section and aligned very closely and irregularly in radial seriations interrupted at many places by the xylem parenchyma strands. The fibres are libriform and medium in their length. In the majority of cases the fibres are non-septate, but here and there, distributed without any regular plan, are also met with typically septate fibres. These septate fibres are usually thinner and slightly shorter when compared to the non-septate fibres. Pitting to the fibres is clearly seen in the tangential sections; the pits are simple, rounded or narrowly elliptical and aligned in a linear manner (TEXT-FIG. 3).

The xylem parenchyma is the most conspicuous of all the tissues. It is visible

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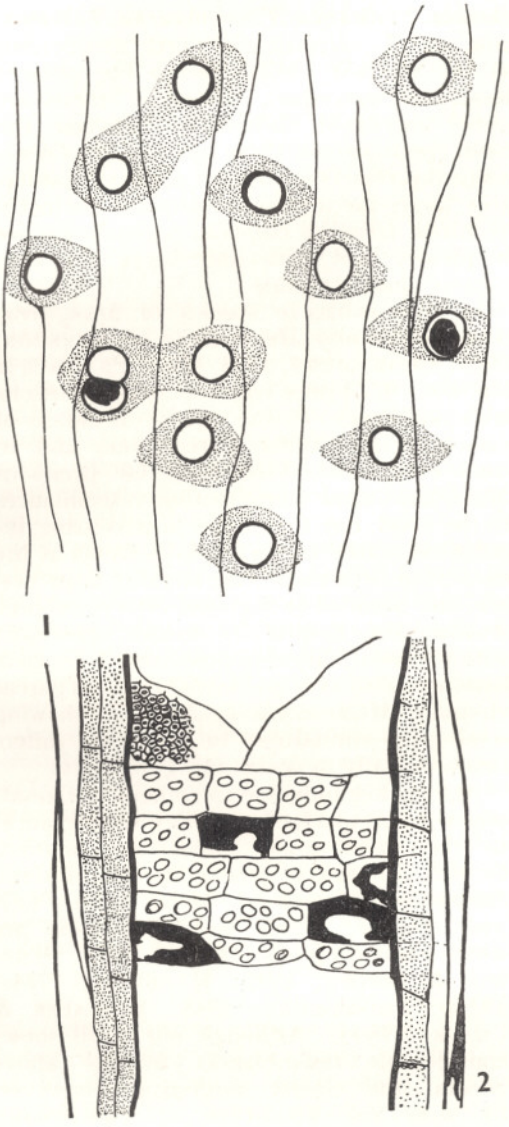
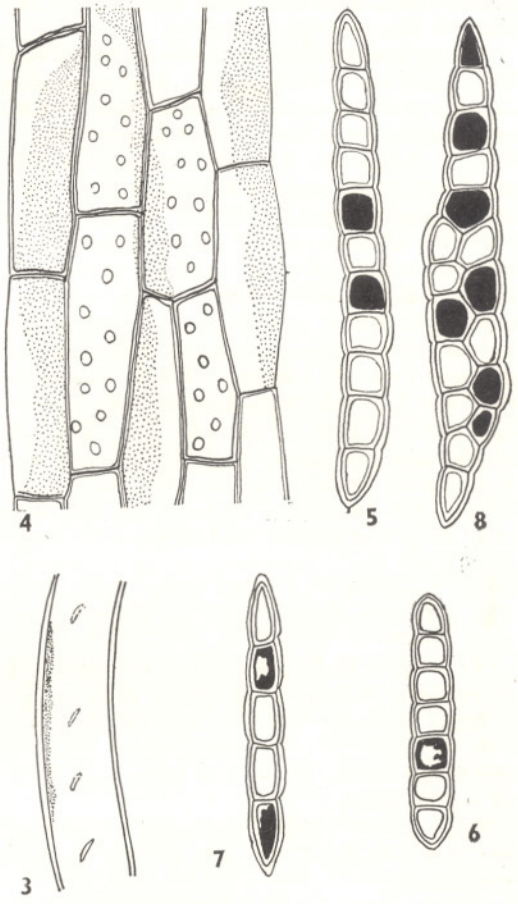


TEXT-FIGS. 1-2 — *Tamarindoxylon antiquum* gen. et. sp. nov. 1, semi-diagrammatic cross-section showing the distribution of the xylem parenchyma. × 45. 2, vessel-ray pitting. × 225.



TEXT-FIGS. 3-8 — *Tamarindoxylon antiquum* gen. et sp. nov. 3, part of a fibre highly magnified showing simple pits. × 375. 4, xylem parenchyma cells showing simple pits. × 225. 5, 6, uniseriate homogeneous rays with procumbent cells. × 225. 7, uniseriate ray with vertical cells. × 225. 8, biseriate homogeneous ray. × 225.

to the naked eye as buff-coloured patches in the immediate vicinity of the vessels against the darker background of the fossil. The parenchyma is abundant and paratracheal. As a rule, it is aliform, occasionally becoming confluent (PL. 1, FIGS. 1, 2). The aliform sheaths are predominant and form definite eyelets or diamond-shaped patches with the vessels. The sheaths are 2-5 cells thick. When confluent the parenchyma is either transversely or obliquely aligned (TEXT-FIG. 1). The parenchyma cells adjoining the rim of the vessel are flattened and conform to the latter and those away from it are more or less isodiametric; they are usually empty, but occasionally filled up with a dark brownish deposit. From longitudinal sections it is found that the cells of the parenchyma are not storied. Here and there pitting to the parenchyma cells is also preserved; the pits are fairly large, circular to elliptical, and seem to be simple (TEXT-FIG. 4). No crystalliferous

parenchyma cells have been observed in any part of the sections prepared.

The xylem rays are numerous and very fine. They are only 1-2-seriate. The uniseriate rays are predominant and, when biseriate, they are usually so at the central region (PL. 1, FIG. 3; TEXT-FIG. 8). The rays, as a rule, are short, being only 5-20 cells high. They are homogeneous (PL. 1, FIG. 4) and in the majority of cases consist only of procumbent cells of round to oval outlines as seen in tangential sections (TEXT-FIGS. 5, 6). According to Kribs' system of classification the xylem rays of this fossil come under Homogeneous Type III (KRIBS, 1936). When the rays are 2-5 cells high, they usually possess only vertical cells (TEXT-FIG. 7). The cells of the rays are either empty or plugged with a yellowish brown deposit. Pits to the ray cells in the tangential sections are met with only at a few places, and unless a thorough search for these structures is made, there is every possibility of their being overlooked. The pits are simple, oval to elliptical and very small.

As a rule, the xylem rays are irregularly distributed, but at some places they show a definite tendency towards echelon alignment (PL. 1, FIG. 3). The tangential facets of the fossil, however, do not show any traces of ripple marks.

Gum ducts, either horizontal or vertical, are not observed in any of the sections prepared.

DISCUSSION

Comparisons with the Living Species — The aforementioned characters of the fossil wood invite comparisons with the members of some modern families like Sapindaceae, Meliaceae, Rutaceae, Moraceae, Combretaceae, Anacardiaceae and Leguminosae, particularly with the last four families.

A few species of *Artocarpus* in Moraceae appear to show some similarities to our fossil. But the differences in this case outweigh the similarities. Thus, in *Artocarpus* although the vessels are mostly solitary and diffuse, they are considerably large, the confluent type of parenchyma is more consistent and the xylem rays are moderately broad and heterogeneous (KANEHIRA, 1924a, 1924b; JANSSONIUS, 1940; PEARSON & BROWN, 1932; METCALFE & CHALK, 1950).

In Combretaceae certain species of *Terminalia* provide some rather striking resemblances to the fossil specimen. *Terminalia chebula*, *T. catappa*, *T. myriocarpa*, *T. tomentosa* and *T. oleracea* are worth mentioning so far as their similarities to the present fossil are concerned. However, there are some important differences between the fossil specimen and these species. In *Terminalia* the vessels are almost always considerably large, the intervessel pits are distinctly vestured, terminal bands of parenchyma are frequently met with and lastly the rays possess single crystals.

In Anacardiaceae species of *Mangifera*, *Anacardium* and *Melanochyla* (SOLEREDOR, 1908; CHOWDHURY, 1933, 1945; PEARSON & BROWN, 1932) offer noteworthy comparisons with our fossil. In the structural details of vessels, fibres, xylem parenchyma and to some extent the xylem rays the species of *Mangifera* show considerable resemblances to the fossil, but they differ in possessing regular concentric bands of parenchyma at the ends of growth-rings, considerably large vessels, and rounded to flattened intervessel pits. *Anacardium*, despite its broad agreement with the fossil, differs in possessing 2-3-seriate heterogeneous rays and initial bands of parenchyma. *Melanochyla* again, while showing some gross similarities to the fossil, differs fundamentally in possessing gum ducts.

Among Leguminosae, members of Caesalpineae particularly show many resemblances to the fossil wood under investigation. In this connection genera like *Caesalpinia*, *Parkinsonia*, *Acrocarpus*, *Melanoxylon*, *Pterogyne*, *Bussea*, *Afzelia* and *Tamarindus* are worth comparing (SOLEREDOR, 1908; PEARSON & BROWN, 1932; KANEHIRA, 1924a, 1924b; CHOWDHURY, 1945; METCALFE & CHALK, 1950). Although our fossil shows considerable resemblances to the above genera, the closest similarities, however, lie with the wood-type of *Tamarindus*. In the species of *Caesalpinia*, *Parkinsonia*, *Acrocarpus*, *Melanoxylon*, *Bussea* and *Pterogyne* the xylem rays are relatively broad, being consistently 2-4-seriate, and both the parenchyma and the xylem rays are more or less distinctly storied. In *Afzelia* the vessels are very large, 2-3-seriate rays are more commonly seen, and terminal bands of xylem parenchyma are frequently met with; further, the xylem parenchyma is storied in this genus. With the wood-type of *Tamarindus*, however, our fossil agrees in all the major diagnostic characters of its xylotomy. In fact, the relationship holds good when applied to some of the minute details too.

Comparisons with the Fossil Species — Caesalpinioxylon nathorsti Schüster (1910), described from the Tertiary of Uruguay, is comparable with the South Indian fossil in its uniformly distributed, mostly solitary vessels, in its intervessel pitting, and libriform unseptate fibres. But the Uruguay species differs significantly in the general nature of its xylem parenchyma which is consistently vasicentric and in its relatively broad xylem rays.

Leguminoxylon edwardsi (Kräusel, 1939), described from the Tertiary of Egypt, exhibits resemblances to our fossil in its small solitary vessels arranged in a diffuse manner, in the nature of the intervessel pitting and in possessing mostly uniseriate, short xylem rays; differences, however, are there in its thick metatracheal bands of parenchyma and heterogeneous rays.

Caesalpinioxylon mogadaense Boureau (1950), described from the Lower Miocene of Algeria, shows quite a few similarities to our fossil. But it differs in its large vessels with circular intervessel pits and initial parenchyma, besides vasicentric-confluent type.

Leguminoxylon afzelioides Boureau (1952), described from the Tertiary of Indo-China, while showing several gross similarities to our fossil, differs, however, in possessing considerably large vessels, concentric bands of xylem parenchyma besides vasicentric to aliform type and lastly in possessing mostly three-seriate fusiform rays.

Leguminoxylon matrohense Boureau (1952), described from the same locality as that of the above species, has been compared by Boureau with *Tamarindus indica* and hence obviously shows many similarities to the South Indian fossil wood. Some important differences, however, do exist between these two species. Thus, whereas the vessels occur very commonly in radial groups of 2-3 in the Indo-China species, they are mostly solitary in our specimen, intervessel pits are circular and somewhat separate in Boureau's species in contrast to the angular pits of our fossil and lastly some diffuse parenchyma strands in addition to *parenchyma juxtavasculari*s are found in the Indo-China species, while such strands are not observed in the South Indian species.

Lastly *Caesalpinioxylon sitholeyi* Ramanujam (1954a), described recently from the Tertiary of South Arcot district, differs from the fossil under study in the storied nature of its xylem parenchyma and in its mostly 2-3-seriate xylem rays. Further, it may also be mentioned that confluent parenchyma is very abundant in *C. sitholeyi* than in the present wood.

The fossil under investigation has been named *Tamarindoxylon antiquum* gen. et sp. nov. by virtue of its close similarities to the wood type of the modern species of *Tamarindus*.

Holotype — S.A. 25 of the Department of Botany, Andhra University, Waltair.

DIAGNOSIS

Tamarindoxylon gen. nov.

A diffuse-porous wood.

Growth-rings very indistinct.

Vessels small, mostly solitary, circular, containing some yellowish brown deposit; vessel-members medium, end-walls usually truncate; perforations simple, more or less inclined; intervessel pits fairly large, bordered, hexagonal or polygonal, alternate; pit apertures rounded or horizontally elliptical; vessel-ray pits narrowly bordered, larger than intervessel pits, transversely elliptical or rounded, many per cell; vessel-parenchyma pits similar to vessel-ray pits.

Fibres libriform, medium, mostly non-septate, angular in cross-section, in irregular radial seriations, septate fibres found occasionally; pits simple, rounded or elliptical, few and linearly aligned.

Xylem parenchyma abundant, paratracheal; mostly aliform, sometimes confluent, in very short transverse or oblique bands; parenchyma 2-5 cells thick, cells flattened or oval to elliptical; pits simple, fairly large, circular to elliptical, many per cell.

Xylem rays numerous, very fine, 1-2-seriate, uniseriates predominant, 5-20 cells high, diffuse, sometimes showing echelon tendency; rays homogeneous III type, with rounded to oval procumbent cells; pits to tangential walls simple, rounded.

Tamarindoxylon antiquum sp. nov.

General characters as for the genus.

Vessels 60-120 μ in dia.; 6-14 per sq. mm. Solitary vessels, 70 per cent; radial pairs, 20 per cent; radial groups of three, 10 per cent. Vessel elements 300-575 μ long, intervessel pits 9 μ in dia.

Fibres 1300-1550 μ long, 8-16 μ in dia., walls 2-5 μ thick; septate fibres 900-1150 μ

long, walls 2-3·5 μ thick; pits 1·5-3 μ in dia., linearly placed.

Xylem parenchyma mostly aliform; cells 22-35 μ in dia., 65-95 μ long; pits 3·5-7·5 μ in dia.

Xylem rays 10-18 per mm., uniseriates 85 per cent, biseriates 15 per cent; rays 15-25 μ broad, 5-20 cells or 60-250 μ high.

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EXPLANATION OF PLATE 1

Tamarindoxylon antiquum gen. et. sp. nov.

1. Transverse section to show the nature and distribution of vessels and xylem parenchyma. × 35.

2. Another transverse section slightly enlarged to show clearly the nature and distribution of fibres and parenchyma cells. × 70.

3. Tangential section to show the details of xylem rays. × 70.

4. Radial section to show the homogeneous nature of the xylem rays. × 70.

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3

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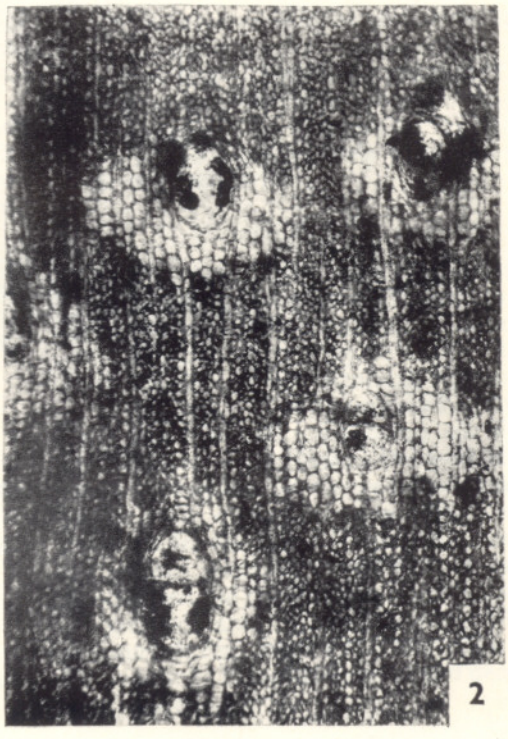

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