ON SOME SILICIFIED WOODS FROM NEAR PONDICHERRY, SOUTH INDIA

C. G. K. RAMANUJAM
Birbal Sahni Institute of Palaeobotany, Lucknow

INTRODUCTION

THE paper deals with three new species of fossil woods of which one belonging to the genus *Mesembrioxylon* is coniferous and the other two dicotyledonous. All the three species have been collected from near a village called Murttanqi (or also as Mortandra) 5 miles W.N.W. of Pondicherry in the South Arcot district of Madras State. The fossiliferous locality is about 2-3 sq. miles in diameter and presents a very imposing view with its numerous petrified trunks lying irregularly scattered on the ground. Some of the trunks are found partially buried in the soil. Besides silicified trunks which dominate the landscape in this area, hardly any other organic remains are found; the only other fossils to be met with are some Gastropods.

The whole fossiliferous area near Pondicherry is a plain, dotted with hillocks not more than 100 ft. high, with ridges, caves and ravines. The hillocks are formed of Cuddalore series, which are made up of argillaceous and silicified sandstones with lumps and veins of chert. The Cuddalore series belongs to the Tertiary, and so far nothing has been decided definitely about the exact age of these sandstones. They are believed to range from Eocene to Pliocene (SAHNI, 1931). Krishnan (1949) regards the Cuddalore series to be Miocene, while Wadia (1952) considers a great part of this series to be of Pliocene age, and some parts younger. The series as a whole lies along the east coast and overlies the various coastal deposits of Mesozoic age. A variously shaded and mottled loose-textured gritty sandstone is the principal component of these rocks. The petrified trunks usually occur embedded in these sandstones, but many have been loosened by weathering and consequently lie scattered on the ground.

The occurrence of *Mesembrioxylon*, a podocarpaceous form-genus, appears to be very common in various rock formations of India (SAHNI, 1931; RAMANUJAM, 1953[1]; BHARDWAJ, 1953; SURYANARAYANA, 1953). From South India the only published records of fossil dicotyledonous woods are the two small notes by the author (RAMANUJAM, 1953[2], 1954) in which the presence of the families Guttiferae, Dipterocarpaceae, Anacardiaceae, Leguminosae, Sonneratiaceae and Euphorbiaceae has been reported. It is quite surprising that the study of fossil dicotyledonous woods in India has been very limited, in spite of their abundant occurrence in other localities. The woods reported from other areas so far represent only five families, namely Guttiferae, Dipterocarpaceae, Anacardiaceae, Leguminosae and Combretaceae(?) (CHOWDHURY, 1936, 1938, 1953; CHOWDHURY & GHOSH, 1946; CHOWDHURY & TANDAN, 1949; GUPTA, 1936; RODE, 1936). The author is of the opinion that many of the fossil woods in India referable to dicotyledons are unfortunately imperfectly preserved, and this might probably be the reason why their study has been neglected.

MATERIAL AND METHODS

The specimens collected are pieces from large trunks about 1-2 ft. in diameter and 4-6 ft. in length. The fossils range in colour from greyish to deep brown. They contain only secondary wood, the preservation of which is quite satisfactory. The preservation, particularly of the coniferous wood, is very good. For each wood studied several transverse, tangential and radial sections were made. The sections were generally thinly ground, but in some cases somewhat thicker sections proved useful for obtaining an idea of the gross structure. While dealing with the dicotyledonous woods, the examination of the polished surface of the wood in reflected light was of great help in studying the distribution of vessels and xylem parenchyma. The sections were usually not stained as the natural colour of the petrifaction made the tissues fairly prominent. The photographs and text-figures were made after mounting the slides in liquid paraffin, as

it was observed that the sections mounted in Canada balsam became too transparent for investigating the finer anatomical details.

GENERAL DESCRIPTION

Class — GYMNOSPERMAE
Genus — *Mesembrioxylon* Seward
Mesembrioxylon speciosum sp. nov.

Description — The fossil has only the secondary xylem preserved. The growth-rings are quite distinct and can be seen with the naked eye. They are usually broad with a very well-developed spring wood and a meagrely developed summer wood. The transition from spring to summer wood is generally abrupt, but sometimes rather gradual. The tracheids of the spring wood are square to polygonal in cross-section and 40-50 μ across; they are thin-walled, the wall being only 2-4 μ thick. The summer wood is mostly narrow, about 2-5 cells wide, with considerably thick-walled tracheids (wall 10-14 μ thick) which are as a rule laterally stretched, and 25-35 μ across. The fossil does not contain any resin canals. Xylem parenchyma is quite abundant in the form of scattered cells all through the wood (TEXT-FIG. 1; PL. 1, FIG. 1); the cells are always filled with black resinous substance. In longitudinal section the cells of the xylem parenchyma are placed one above the other in fairly long vertical rows, the end walls being either transverse or slightly inclined (PL. 1, FIGS. 2, 3).

The tangential section shows that the xylem rays are uni- to biseriate with the former condition predominant (TEXT-FIGS. 1, 2; PL. 1, FIG. 2). The rays are parenchymatous, 1-18 cells high, the average height being 6 cells. They vary from 100 to 450 μ in length and 35 to 70 μ in width. The ray cells are thin to thick-walled and oval to elliptic. The horizontal and tangential walls of the ray cells are perfectly smooth; pits are only found in the radial walls of these cells. The pits are 2-4 per field (TEXT-FIG. 4; PL. 1, FIG. 4), distinctly bordered, rather small and arranged irregularly. The border is round to oval, while the aperture is slit-like and vertical or a little obliquely placed. The tangential walls of the tracheids do not show any pitting.

The bordered pits seen on the wall of tracheids in radial section (TEXT-FIG. 3; PL. 1, FIG. 4) are uni- to biseriate. The pits are circular and usually separate, but sometimes just contiguous without any flattening. When biseriate, they are opposite or sub-opposite. An important feature of the wood is the presence of rims of Sanio. These rims (TEXT-FIG. 3; PL. 1, FIG. 4) are very distinctly preserved and can be seen both among the uniseriate and biseriate pits. The pits are 10-15 μ in diameter with small, circular pores which are almost always preserved.

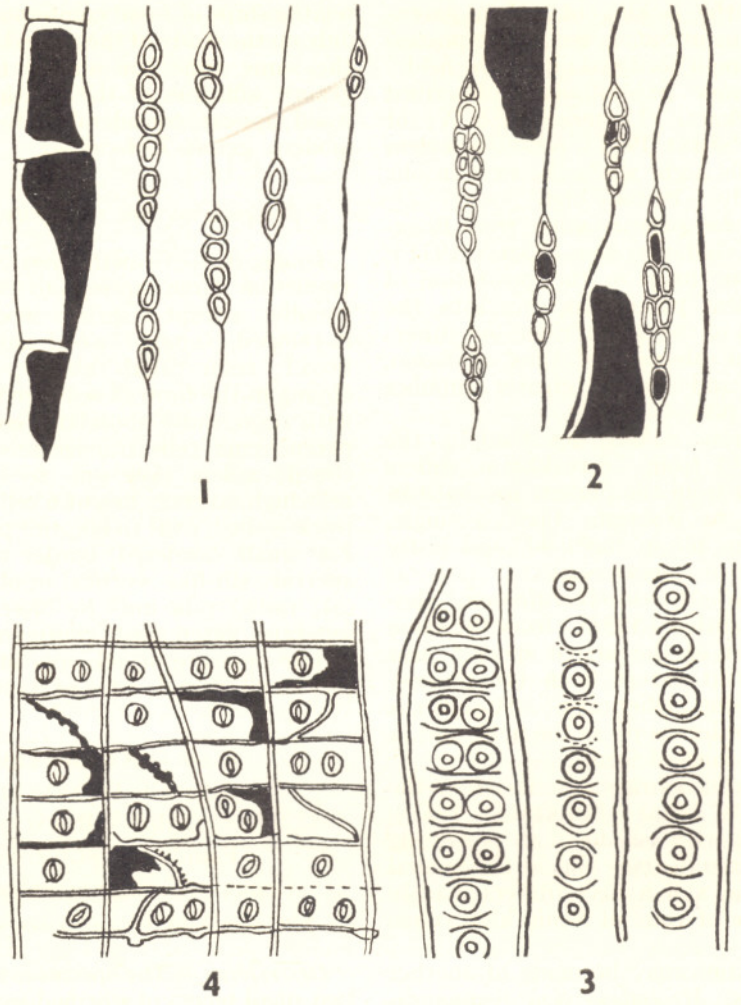
Discussion — All the afore-mentioned characters indicate that our fossil agrees *in toto* with the form-genus *Mesembrioxylon* created by Seward (1919). At the same time it may also be easily compared and unless all the important characters are considered together, may even be confused with the form-genus *Cupressinoxylon*. There has always been a considerable difficulty in distinguishing the genus *Mesembrioxylon* from *Cupressinoxylon* as both exhibit somewhat similar combination of characters. But one distinguishing feature is that of the nature of the field pitting, as has been recognized by Seward (1919), and Sahni (1931) which in *Mesembrioxylon* consists of one or two large simple pits or two or more small bordered pits with the pore placed vertically, while in *Cupressinoxylon* it consists of two or many small bordered pits with the pore placed horizontally. Our fossil, it can be said easily, agrees with *Mesembrioxylon* not only in the general features but also in the characteristic nature of the field pitting.

Of the many species of *Mesembrioxylon* described from outside India only a few are comparable with the present South Indian wood.

Mesembrioxylon Woburnense, described by Stopes (1915) from Bedfordshire, while agreeing with our fossil in general, differs in the possession of only uniseriate xylem rays, and in the nature of the field pitting, which consists of one or two large simple pits.

Mesembrioxylon Hookeri, described by Arber (1904) from Tasmania, resembles the present specimen to some extent in the height of the xylem rays, in the possession of abundant parenchyma, and distinct rims of Sanio, but differs in the presence of tangential pitting on the tracheids, a single large simple field pit (Eiporen), and in the absence of biseriate rays and biseriate radial pits.

Mesembrioxylon fusiforme, described by Sahni (1920) from Queensland, shows as in



TEXT-FIGS. 1-4 — *Mesembrioxylon speciosum* sp. nov. 1, tangential section showing the xylem rays and xylem parenchyma. × 140. 2, tangential section showing the biseriate xylem rays. × 140. 3, radial section showing the bordered pits and rims of Sanio. × 280. 4, radial section showing the field pitting. × 280.

the present fossil a well-marked seasonal development, distinct rims of Sanio, short uniseriate rays and uniseriate circular pits in the radial walls of the tracheids. The Queensland species can, however, easily be distinguished in the absence of xylem parenchyma and biseriate rays, and in the field pitting which consists of 1-2, often 3-4 long, simple, fusiform pits.

Mesembrioxylon Sewardi (SAHNI, 1920), described from the same locality as that of the above species, agrees with our fossil in general features, but differs in the possession of tangential pitting, the presence of a single large, simple pit in the field, and lastly in the absence of biseriate rays.

Of the Indian species of *Mesembrioxylon* (SAHNI, 1931; RAMANUJAM, 1953; BHARDWAJ, 1953; SURYANARAYANA, 1953), each one of them is sharply distinguished from the present wood in one or another well-marked difference.

Thus, *Mesembrioxylon malerianum*, described from Maleri stage, Tiki, Rewah, and *M. Parthasarathyi*, described from the Sripermatur group (SAHNI, 1931), differ from

our fossil in the lacking of xylem parenchyma and rims of Sanio, and in the possession of many small bordered pits in the field.

Mesembrioxylon Schmidianum, described from Tiruvakkarai, 13 miles W.N.W. of Pondicherry (SAHNI, 1931), possesses xylem rays 2-100 cells high, while the rays in our species are only 1-18 cells high.

Mesembrioxylon godavarianum, from Bogapalmila in the Godavari area (SAHNI, 1931), agrees with our fossil in the possession of abundant xylem parenchyma, and in the general height of the xylem rays, but differs sharply in the absence of rims of Sanio, growth-rings and in its greater number (2-6) of field pits.

Mesembrioxylon Sahnii, described by the author (1953[1]) from Tiruvakkarai, differs very markedly from the present specimen in possessing 1- to 3-seriate rays, a single, simple fusiform pit in the field, and lastly in the absence of rims of Sanio.

Mesembrioxylon tiruvakkaraianum, described by the author (1953[1]) from the same locality as that of the above species, also differs to a great extent from the present fossil in possessing higher rays (3-50 cells), a large, single borderless pit in the field, and in the absence of rims of Sanio.

Mesembrioxylon indicum, described from the Rajmahal Hills, Bihar (BHARDWAJ, 1953), while agreeing with our fossil in possessing well-marked growth-rings and in the general features of the xylem rays, differs sharply in the absence of rims of Sanio and xylem parenchyma.

Lastly, mention may be made of another Indian species, *Mesembrioxylon tirumangalense*, recently described by Suryanarayana (1953) from the Sripermatur stage. It differs from our species to a great extent in the absence of rims of Sanio, xylem parenchyma and in the nature of its field pitting.

From the above comparisons it would be evident that the present specimen differs from all the hitherto described species of *Mesembrioxylon* and consequently warrants the creation of a new species.

The author has also compared the fossil specimen with a few modern species of *Podocarpus* and *Dacrydium*, viz. *P. latifolia*, *P. wallichianus*, *P. amara* and *D. cupressinum*, and found that the podocarpaceous affinities of the fossil wood are very well marked. But unfortunately from the present state of our knowledge, it would not be possible to find out the exact generic relationships of fossil coniferous woods based only on the study of the secondary wood. At the same time the author feels that the generic affinities of the South Indian fossil wood appear considerably to be with the modern genus *Podocarpus*.

Mesembrioxylon speciosum sp. nov.

Diagnosis — Growth-rings well marked, transition from spring to summer wood usually abrupt, spring wood very well developed, summer wood narrow, 2-5 cells broad; resin canals absent, xylem parenchyma in the form of scattered cells filled up with resin, quite abundant, end walls of the parenchyma cells transverse or slightly inclined; xylem rays uni- to biseriate, 1-18 cells high, average height 6 cells, cells thin to thick-walled, oval to elliptic; pits in the field 2-4, small, bordered, border round to oval, aperture slit-like, vertical or obliquely vertical; radial pits uni- to biseriate, circular, separate, often just contiguous, when biseriate opposite or sub-opposite, pore of the pits small, round; rims of Sanio distinct.

Class — ANGIOSPERMAE
Subclass — DICOTYLEDONAE
Order — ROSALES
Family — LEGUMINOSAE
Genus — *Caesalpinioxylon* Schenk

1. *Caesalpinioxylon Sitholeyi* sp. nov.

Description — The species is represented by two small pieces of silicified wood. They do not show any distinct growth-rings to the naked eye. However, a careful examination under the microscope shows that the seasonal development is present, although the growth marks are rather faint. These faint growth marks are recognized only due to the differences in the thickness of the walls of the fibres.

The vessels are quite distinct to the naked eye. They are small to sometimes medium in size, moderately thick-walled and circular to oval in cross-section. They are diffuse, mostly solitary, although radial groups of 2-3 vessels are not uncommon (PL. 1, FIGS. 5, 6). The vessels are either usually empty or filled with a dark coloured substance. They do not possess any tyloses. The perforations are exclusively simple, horizontal or slightly inclined. The intervessel pitting

is very distinctly preserved. The pits are very small, alternate, and rounded with lenticular apertures. Vessel-ray pitting is simple; the pits again are small, rounded and many per cell, usually in two rows alternating with each other (TEXT-FIG. 6; PL. 2, FIG. 9). The vessel-parenchyma pits are not found, probably due to poor preservation.

The fibres are generally not distinctly preserved. However, some carefully ground sections have shown their nature and distribution tolerably well. These sections had to be rather thick to enable the fibres to be seen properly. The fibres are libriform to semi-libriform and considerably thick-walled. They are squarish to polygonal in cross-section and aligned in regular radial rows. They are non-septate and of medium length. The pits to the fibres are very inconspicuous; are very small, simple or narrowly bordered, circular and numerous per fibre. These pits can be seen in both the tangential and the radial sections.

The parenchyma is abundant and represents the most conspicuous and well-preserved of all the tissues. To the naked eye it appears as light-coloured patches around the vessels, and also linking up a few vessels tangentially, against the darker background of the fossil (PL. 1, FIG. 5). The parenchyma is typically paratracheal (TEXT-FIG. 5; PL. 1, FIGS. 5, 6). It is either in narrow aliform sheaths or in irregular confluent bands or patches. An interesting feature of the parenchyma under investigation is its storied nature. At many places the storied nature is more or less quite distinct, although the cells of the individual stories are rather short. The cells of the parenchyma in cross-section are rounded, somewhat thick-walled and either empty or plugged with some brown-coloured deposit. Pits to these cells are simple, circular, many per cell and placed in two rows alternating with each other.

The xylem rays are rather indistinct to the naked eye. They are moderately numerous and show a definite tendency towards storied arrangement (PL. 2, FIG. 7). At many places a few of the rays in a storey tend to be higher than the others, thereby disturbing the uniformity of the height of the rays. The rays are 1-3 seriate (TEXT-FIGS. 7, 8) of which the 2-3 seriate condition is predominant. They are mostly 12-18 cells high, although at some places the height of the rays reaches about 30 cells. The rays are all homogeneous (PL. 2, FIG. 8) being formed of rounded procumbent cells of various sizes. The horizontal and tangential walls of the rays appear smooth. The ray cells are mostly thick-walled and infiltrated with some dark-coloured deposit.

The fossil does not possess either vertical or horizontal secretory canals.

There are no ripple marks.

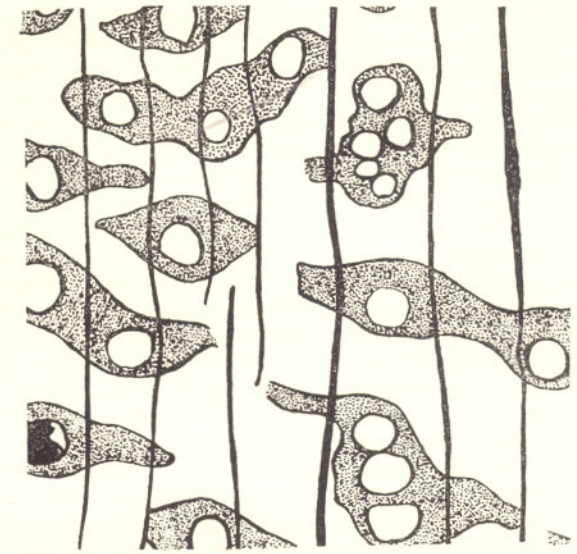
Comparison with the Living Species — The xylem parenchyma, xylem rays and the diffuse nature of the vessels, coupled with their intervessel pitting, are the distinguishing characters of the fossil. Comparison with the modern families has shown that the fossil somewhat resembles families like Sapindaceae, Urticaceae and Leguminosae. Of these it differs from the members of Sapindaceae and Urticaceae in the storied tendency of its rays, the distinct storied arrangement of the parenchyma cells and also in its characteristic intervessel and vessel-ray pitting (METCALFE & CHALK, 1950; PEARSON & BROWN, 1932; GAMBLE, 1922).

Of the modern members of Leguminosae, our fossil shows particular resemblance with the genera of the sub-family Caesalpineae, like *Tamarindus, Afzelia, Caesalpinia, Poinciana* and *Aldina*. A comparison with the woods of these genera has revealed a close similarity with the wood of the type of *Caesalpinia*. The similarity holds good in the nature and distribution of the vessels and fibres, in the distribution and storied arrangement of parenchyma, and lastly in the details of the xylem rays.

Comparison with the Fossil Species — Of the comparatively few species of fossil dicotyledonous woods described from India, only *Cynometroxylon indicum* reported by Chowdhury and Ghosh (1946) from the Tertiary of Assam represents the Caesalpinian wood. The latter differs very greatly in more than one respect from our species. In *Cynometroxylon indicum* the parenchyma is in the form of numerous apotracheal bands, the cells of which are not storied, and the rays are heterogeneous with no storied tendency whatsoever.

From outside India although a good many fossil leguminous woods have been described, only a few are comparable with the present fossil.

Caesalpinia Nathorsti, described by Schuster (1910) from the Tertiary of Uruguay, agrees with our fossil in general features, but differs



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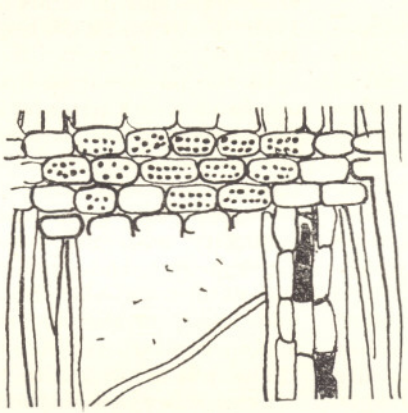

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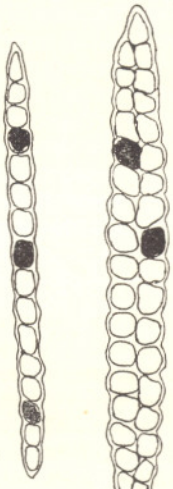

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TEXT-FIGS. 5-8 — *Caesalpinioxylon Sitholeyi* sp. nov. 5, semi-diagrammatic cross-section showing the distribution of the parenchyma. × 35. 6, vessel-ray pitting. × 280. 7, 8, homogeneous xylem rays. × 280.

markedly in the nature of its parenchyma which is not storied and represented mostly by vasicentric sheaths, and in the rays which do not exhibit any tendency towards storied arrangement.

Chiarugi (1933) has described three interesting species of *Caesalpinioxylon*, viz. *C. miguiritinum*, *C. Ducis-Apruti*, and *C. Zaccarinii*, from the Plio-Pleistocene of Somaliland in Africa. They can be sharply distinguished from the present specimen in one or another important character. Thus in *Caesalpinioxylon miguiritinum*, vertical gum ducts are present. In *Caesalpinioxylon Ducis-Apruti* the intervessel pits are simple, and the parenchyma is relatively scanty in the form of narrow vasicentric sheaths. In *Caesalpinioxylon Zaccarinii* the parenchyma

is scanty and primarily diffuse. In none of these three Somaliland species the parenchyma and the rays show either a storied arrangement or any tendency towards it.

Leguminoxylon Edwardsi (KRÄUSEL, 1939) from the Tertiary of Egypt agrees more or less closely with our fossil in the size, shape and arrangement of the vessels, in the distribution of parenchyma, and in the nature of the fibres. At the same time the differences between the two species are marked. Thus in *Leguminoxylon Edwardsi* the rays are mostly uniseriate, heterogeneous and irregularly distributed, while in the present specimen they are mostly 2-3 seriate, homogeneous and show a tendency towards storied nature; besides in *Leguminoxylon Edwardsi* the parenchyma cells are not storied while in the present fossil they are clearly storied.

It is evident from the above comparisons that the fossil under investigation differs from all the hitherto described species. As the affinities of our fossil are with the members of Caesalpineae, in particular, it is grouped under *Caesalpinioxylon* Schenk (1890).

The author is of the opinion that the South Indian fossil is nearer the genus *Caesalpinia* than any other member of that family. The fossil wood is specifically named after the author's respected teacher Dr. R. V. Sitholey.

Caesalpinioxylon Sitholeyi sp. nov.

Diagnosis — Growth-rings present but faint, distinction between early and late wood not sharp.

Vessels diffuse, quite indistinct to the naked eye, small to sometimes medium, 75-110 μ, mostly solitary, sometimes in radial groups of 2-3, round to oval, thick-walled; perforations simple, horizontal or slightly inclined; intervessel pits very small, alternate, border rounded, aperture lenticular; vessel-ray pits simple, very small, rounded, many per cell usually in two alternating rows.

Fibres libriform to semi-libriform, squarish to polygonal in cross-section; unseptate, 1,200-1,450 μ in length; pits inconspicuous, circular, simple or narrowly bordered.

Parenchyma abundant, distinct to the naked eye as light-coloured patches; typically paratracheal, either in narrow aliform patches or in irregular confluent sheaths; distinctly storied; cells rounded, thick-walled, 35 μ in diameter, empty or plugged with brown contents; pits simple, circular, many per cell.

Rays indistinct to the naked eye, moderately numerous, 8-11 per millimetre, show definite tendency towards storied arrangement; 1-3 seriate, mostly 2-3 seriate, 12-18 cells high; homogeneous with rounded procumbent cells, ray cells thick-walled usually filled with some dark deposit.

Secretory canals absent.

Ripple marks not found.

Genus — *Acacioxylon* Schenk

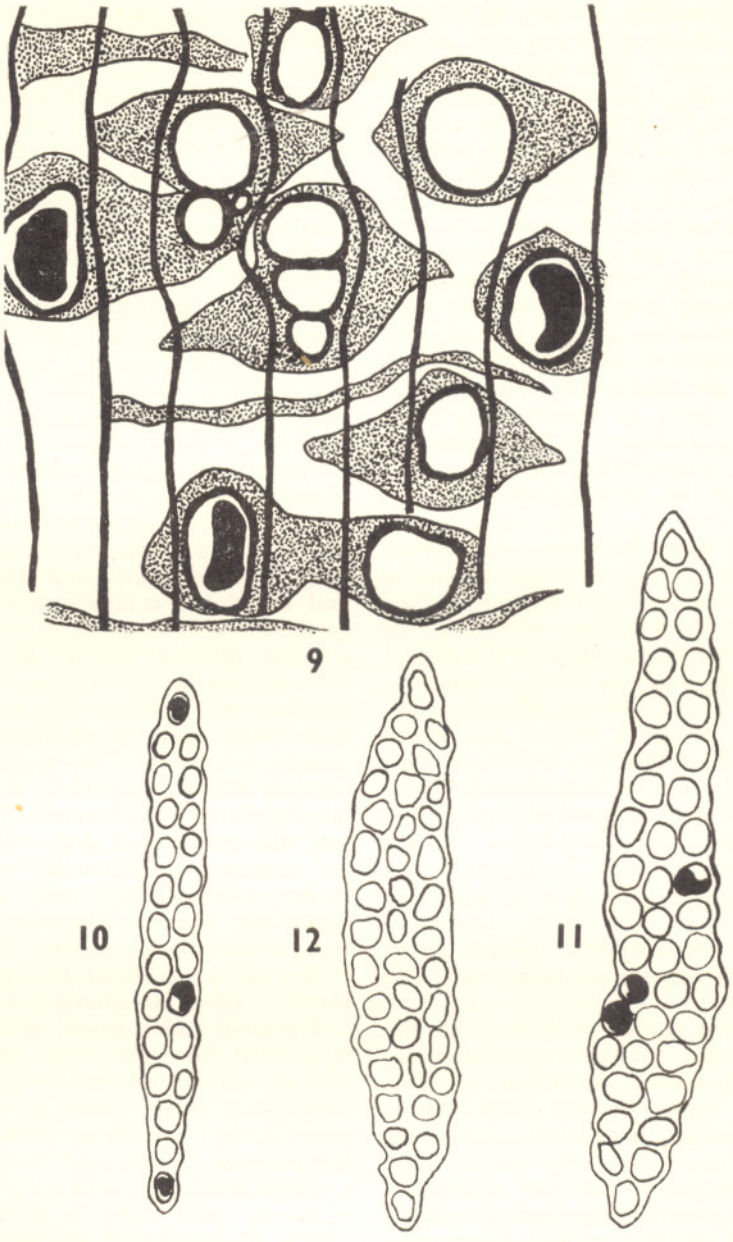
2. *Acacioxylon indicum* sp. nov.

The species is represented by two small pieces of highly silicified wood.

The growth-rings are very indistinct. The vessels are scanty but evenly distributed. They are generally placed singly or in pairs and sometimes in series or radial groups of 3-4 (PL. 2, FIG. 10). Frequently the vessels are also grouped in irregular clusters. In cross-section the vessels are either spherical or elliptical. They are large, thick-walled and either open or plugged with a dark gummy substance. The vessels do not contain any tylosic ingrowths. The perforations are simple and horizontal. The intervessel pits are very small and numerous. They are roughly circular with very inconspicuous apertures preserved rather poorly. Vessel-ray and vessel-parenchyma pits are same as the intervessel pits.

The fibres are libriform and of medium length. They are angular in cross-sections and arranged in regular radial rows. The fibres are typically septate. The septa, probably due to poor preservation, are not always distinct; at some places they are more or less blurred. Interfibre pitting is simple; the pits are circular and very minute.

The parenchyma, as in the previous species, is clearly preserved. It is very distinctly visible to the naked eye as light-coloured patches against the dark background of the fossil wood. The parenchyma is very abundant and of two types, paratracheal and apotracheal (TEXT-FIG. 9; PL. 2, FIGS. 10, 11). Of these types the former is in predominant occurrence; it is represented by thick aliform or aliform-confluent sheaths of 1-5 or 6 seriate. The apotracheal parenchyma is represented by irregular tangential bands and also by diffused cells or cell groups,



TEXT-FIGS. 9-12 — *Acacioxylon indicum* sp. nov. 9, semi-diagrammatic cross-section showing the distribution of the parenchyma. × 35. 10, a biseriate homogeneous ray. × 280. 11, 12, triseriate homogeneous rays. × 280.

the bands being 1-3 cells thick. The cells of the parenchyma in cross-section are either round or oval or sometimes elliptical, and are empty or filled with a dark solid gummy substance. These cells do not show any storied arrangement, nor there is any tendency towards that nature. Pits of the parenchyma are simple, very small and numerous per cell.

The rays are visible to the naked eye as more or less fine lines. They are fairly closely set, 3-5 seriate, and 10-18 cells high

(TEXT-FIGS. 11-13; PL. 2, FIG. 12). The majority of the rays are 2-4 seriate and about 12 cells high. The rays in general are typically homogeneous and contain only procumbent cells, round to oval in outline. The cells of the rays are considerably thick-walled and, as a rule, are plugged with a dark, solid gummy deposit. Pitting to the horizontal and tangential walls of the ray cells is not seen. The rays do not exhibit any storied arrangement.

Comparison with the Living Species — The comparison of the fossil with the modern plants shows that it can be compared with the families like Urticaceae, Combretaceae and Leguminosae. The members of Urticaceae and Combretaceae, although agreeing with the fossil in some features, differ rather sharply in one or the other diagnostic character. A few species of *Terminalia* are particularly interesting in this respect. They resemble our fossil in a considerable way in the general features. At the same time they differ in the intervessel pitting and in the possession of very narrow rays (1-2 seriate), the cells of which contain single crystals.

The family Leguminosae contains many well-known woody genera like *Acacia*, *Albizzia*, *Afzelia* and *Tamarindus* which come rather nearer the fossil. *Afzelia* and *Tamarindus*, however, differ in possessing frequently initial bands of parenchyma, storied tendency of parenchyma and the rays, the latter being mostly very short and narrow. The fossil also differs from the species of *Albizzia* in possessing more abundant parenchyma, which is aliform-confluent as well as in tangential bands, in the frequent occurrence of the vessels in irregular clusters, and in completely lacking the tendency towards the storied nature of the rays. With the species of *Acacia*, however, the comparison holds good in almost all the important characters.

Comparison with the Fossil Species — Of the fossil woods of Leguminosae described from India and outside India, only a few species are really comparable to the present specimen.

Cynometroxylon indicum (CHOWDHURY & GHOSH, 1946) and *Leguminoxylon burmense* (GUPTA, 1936) described from India offer little comparison with the present fossil wood.

Schenk (1890) described from the Tertiary rocks of Egypt two fossil woods of Leguminosae resembling the modern genus *Acacia*. These are *Acacioxylon antiquum* and *Acacioxylon vegae*. Both these species have been redescribed in detail by Kräusel (1939). The fossil wood under investigation resembles these species rather closely and differs from them only in the characters of specific importance. Thus *Acacioxylon antiquum* resembles the present specimen in the diffuse nature of the vessels, in the intervessel pitting, nature of the fibres and to some extent the distribution of the parenchyma, but differs in possessing comparatively smaller vessels and narrower rays. Besides, diffused parenchyma is absent in the Egyptian species. *Acacioxylon vegae*, although resembling our fossil to a great extent, can, however, be distinguished in possessing higher rays, in the greater abundance of metatracheal parenchyma, and in the absence of diffused parenchyma. Intervessel pitting and pits to the fibres and parenchyma have not been described in *Acacioxylon vegae* and hence the comparison cannot go any further.

Leguminoxylon acaciae Kräusel (1939), described from the Tertiary of Egypt, resembles our fossil in the size, shape and distribution of vessels, in the nature of fibres and to some extent in the distribution of parenchyma, but differs in the lack of tangential bands of apotracheal parenchyma, and in the possession of very narrow rays.

Leguminoxylon piptadeniae Hofmann (1952), described from the Oligocene of Austria, while agreeing with the South Indian fossil in general features, differs rather markedly in lacking apotracheal parenchyma and in the possession of heterogeneous rays.

The fossil under investigation, as has been mentioned above, resembles the modern genus *Acacia*. It is, therefore, grouped under the genus *Acacioxylon* Schenk (1890). As it differs from all the hitherto reported species, it has been given a new specific name *Acacioxylon indicum*.

Acacioxylon indicum sp. nov.

Diagnosis — Growth-rings very indistinct; vessels diffused, scanty in distribution, 2-4 per millimetre, solitary or in pairs, sometimes in radial groups of 3-4, frequently in irregular clusters, circular or elliptical, large, 220-250 μ, thick-walled, open or plugged with a dark, gummy deposit; tyloses wanting; perforations simple, horizontal; intervessel pits very small, numerous, circular; vessel-ray and

vessel-parenchyma pits same as intervessel pits.

Fibres libriform, of medium length, 1,150-1,500 μ, angular in cross-section, arranged in regular radial rows; typically septate, pits to the fibres simple, circular, very minute.

Parenchyma very abundant, distinctly visible to the naked eye as light-coloured patches against the darker background of the fossil; paratracheal as well as apotracheal, the former predominant, aliform or aliform-confluent sheaths 1-5 or 6 cells thick, the latter in tangential bands of 1-3 cells thick and also as diffused cells or cell groups; parenchyma cells 40 μ in diameter, round to oval or elliptical, empty or filled with a dark, gummy deposit; not storied; pits simple, very small, circular, numerous per cell.

Rays visible to the naked eye as more or less fine lines; 6-9 per millimetre, 2-5 seriate, 10-18 cells high; typically homogeneous made up of thick-walled round to oval procumbent cells, filled with a dark, gummy deposit; rays not storied.

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REFERENCES

ARBER, E. A. N. (1904). *Cupressinoxylon Hookeri* sp. nov., a large silicified wood tree from Tasmania. *Geo. Mag.* **1**(5): 7.

BHARDWAJ, D. C. (1953). Jurassic woods from Rajmahal Hills, Bihar. *The Palaeobotanist.* **2**: 59-70.

CHIARUGI, A. (1933). Legni fossile dells Somalia Italiana. *Palaeontographia Italica.* **32** (1): 106-118.

CHOWDHURY, K. A. (1936). A fossil dicotyledonous wood from Assam. *Ann. Bot.* **50**: 500-510.

Idem (1938). Two fossil dicotyledonous woods from the Garo Hills, Assam. *Rec. Geol. Surv. Ind.* **73**(2): 247-266.

Idem (1953). On the Tertiary flora of Eastern India. *The Palaeobotanist.* **1**: 121-125.

CHOWDHURY, K. A. & GHOSH, S. S. (1946). On the anatomy of *Cynometroxylon indicum* gen. et sp. nov. A fossil dicotyledonous wood from Nailalung, Assam. *Proc. Nat. Inst. Sci. Ind.* **12**(8): 433-447.

CHOWDHURY, K. A. & TANDAN, K. N. (1949). *Kayeoxylon assamicum* gen. et sp. nov. A fossil dicotyledonous wood from Assam. Ibid. **15**(2): 59-66.

GAMBLE, G. S. (1922). A Manual of Indian Timbers. *London.*

GUPTA, K. M. (1936). *Leguminoxylon burmense* gen. et sp. nov. A dicotyledonous wood from the Tertiary of Burma. *Proc. 23rd Ind. Sci. Cong.* (Abstract): 305.

HOFMANN, E. (1952). Pflanzenreste aus dem Phosphoriworkomen von Prambachirchen in Öberostrreich. *Palaeontographica.* **92**(2): 123-176.

KRÄUSEL, R. (1939). Ergebnisse der Förschungs reisen Prof. E. Stormers in den Wünsten Ägyptens. IV — Die Fossilen Floren Ägyptens. *Abh. Bayer. Akad. Wiss. New Series.* **47**: 46-125.

KRISHNAN, M. S. (1949). Geology of India and Burma. *Madras.*

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

PEARSON, R. S. & BROWN, H. P. (1932). Commercial timbers of India. *Govt. of India Publication.*

RAMANUJAM, C. G. K. (1953[1]). On two new species of *Mesembrioxylon* from the vicinity of Pondicherry, South India. *The Palaeobotanist.* **2**: 101-106.

Idem (1953[2]). Fossil woods resembling *Mangifera, Shorea* and *Albizzia* in the Tertiary rocks of South India. *Curr. Sci.* **22**: 336-337.

Idem (1954). Fossil woods belonging to Guttiferae, Celastraceae, Leguminosae, Sonneratiaceae, and Euphorbiaceae from the Tertiary rocks of South Arcot district, Madras. *Jour. Sci. Industr. Res.* **13B**: 146-147.

RODE, K. P. (1936). A silicified dicotyledonous wood *Dryoxylon mohagaonense* sp. nov. from the Deccan Intertrappean beds of India. *Jour. Ind. Bot. Soc.* **15**(2): 131-138.

SAHNI, B. (1920). Petrified plant remains from the Queensland Mesozoic and Tertiary formations. *Queens. Geo. Surv.* **267**: 22-28.

Idem (1931). Revisions of Indian fossil plants, Part II — Coniferales (b. petrifactions). *Mem. Geo. Surv. Ind., Pal. Indica.* N.S. **11**: 54-77.

SCHENK, A. (1890). Palaeophytologie. Handb. Paleont. 2. *München.*

SCHUSTER, J. (1910). Uber Nicolien und Nicolien ähnliche Hölzer. *Kungl. Svenska, Veten. Handl.* **45**(6): 3-18.

SEWARD, A. C. (1919). Fossil plants. **4**. *Cambridge.*

STOPES, M. S. (1915). Catalogue of the Cretaceous flora, II. Lower Greensand and (Aptian) plants of Britain. *London.*

SURYANARAYANA, K. (1953). *Mesembrioxylon tirumangalense*, a new species from the Sripermatur group near Madras. *Jour. Ind. Bot. Soc.* **32**(4): 159-164.

WADIA, D. N. (1953). Geology of India. *London.*

EXPLANATION OF PLATES

PLATE 1

Figs. 1-4, *Mesembrioxylon speciosum* sp. nov.

1. Cross-section showing the scattered cells of the resiniferous xylem parenchyma. × 35.
2. Tangential section showing the nature of the xylem rays and xylem parenchyma. × 35.
3. A part of Fig. 2 enlarged. × 95.
4. Radial section showing the tracheidal pitting and pits in the field. Note the rims of Sanio. × 200.

Figs. 5-9, *Caesalpinioxylon Sitholeyi* sp. nov.

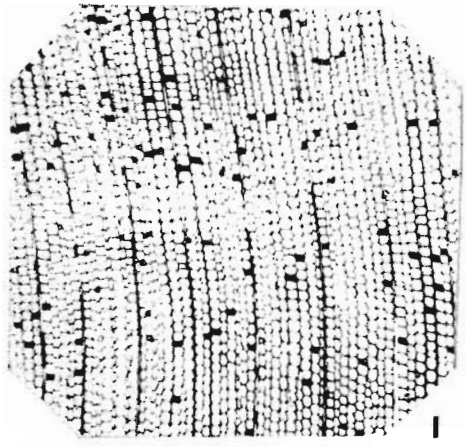
5. Polished transverse surface of the fossil under low magnification to show the gross structure. × 3.
6. Cross-section showing the size, shape and distribution of vessels and parenchyma. × 35.

PLATE 2

7. Tangential section showing the nature of the rays. Note the tendency of the rays towards storied arrangement. × 50.
8. Radial section showing the homogeneous nature of the rays. × 35.
9. Radial section showing intervessel and vessel-ray pitting. × 200.

Figs. 10-12, *Acacioxylon indicum* sp. nov.

10. Polished transverse surface of the fossil under low magnification to show the general structure. × 2.
11. Cross-section showing the nature of the parenchyma. × 35.
12. Tangential section showing the nature of the rays. × 35.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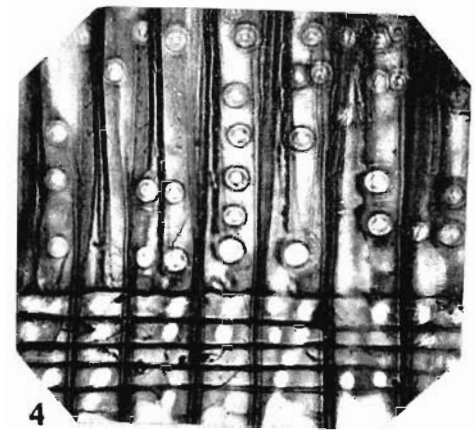
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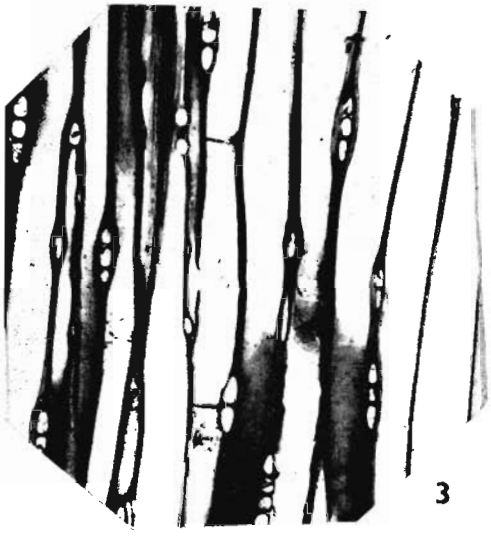
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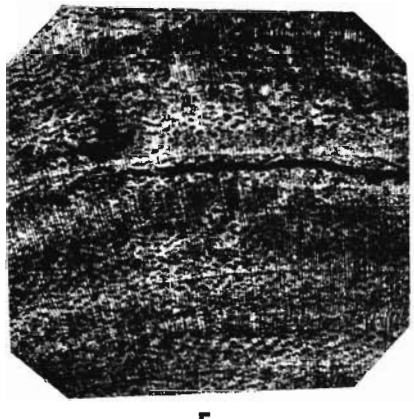
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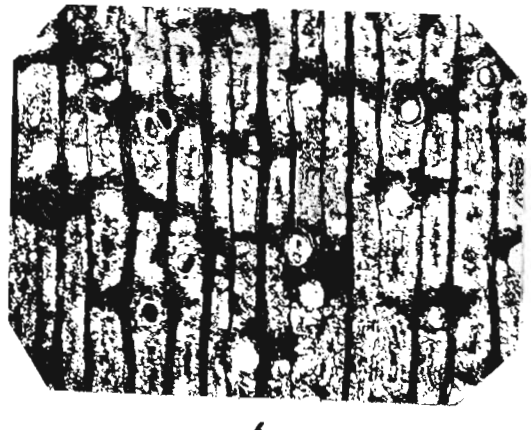
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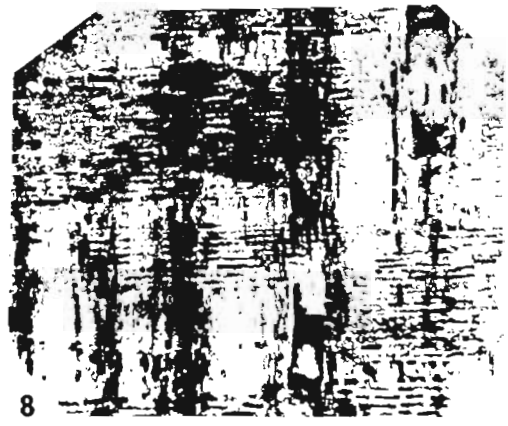

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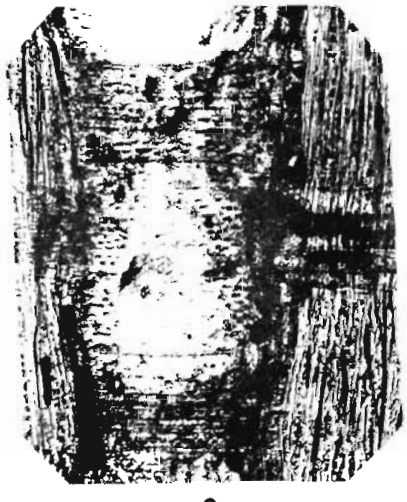

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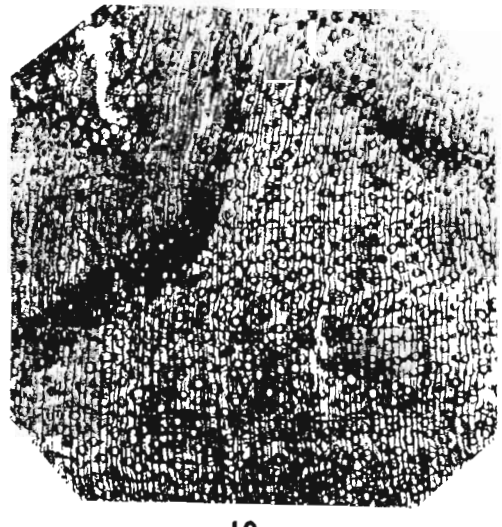

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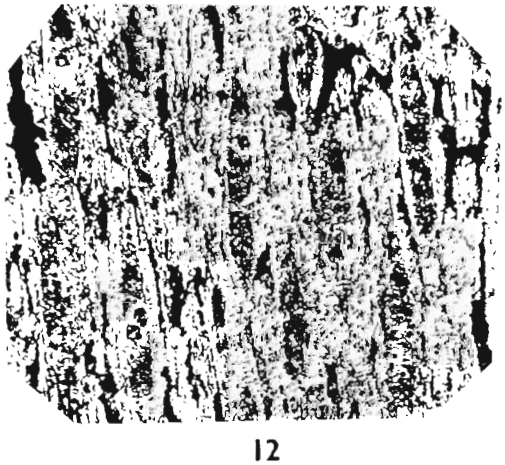

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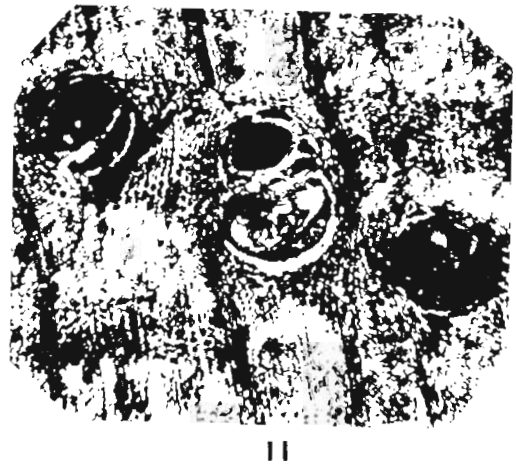

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