ON TWO NEW SPECIES OF *TERMINALIOXYLON* SCHONFELD FROM THE TERTIARY BEDS OF SOUTH INDIA

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ABSTRACT

The paper describes the anatomical details of two new species of *Terminalioxylon*, *T. mortandrense* and *T. Sahnii*, collected from the Tertiary beds of South Arcot. The structure of these fossil woods shows close resemblances with those of the living genus *Terminalia*.

INTRODUCTION

THE fossiliferous localities of South Arcot district, Madras, contain a large number of petrified woods. Sahni (1931) described a fossil coniferous wood, *Mesembrioxylon Schmidianum*, and a species of palm, *Palmoxylon pondicherriense*. Recently Ramanujam (1953, 1954) carried out investigations on fossil woods of this area and has described two new species of *Mesembrioxylon*, a new species of *Palmoxylon*, woods belonging to Guttiferae, Sonneratiaceae, Leguminosae, Celastraceae, Euphorbiaceae, and also woods of *Mangifera*, *Shorea* and *Albizzia*.

The material for this investigation was collected by a party from Birbal Sahni Institute of Palaeobotany. The areas visited are in South Arcot and Trichinopoly districts of Madras State. Large number of petrified woods were collected near the villages Tiruvakkarai and Mortandra (also called Mortandi). The fossil locality of Tiruvakkarai is at a distance of 14 miles from Pondicherry and that of Mortandra is about 7 miles. The fossiliferous area is a rugged terrain of small hillocks, ridges, caves and ravines. Fossil woods occur in Cuddalore series consisting of Cuddalore sandstones of argillaceous and ferruginous nature. Fossil woods are either embedded in the sandstones or found scattered on the surface.

A great part of the Cuddalore series is considered to be Pliocene in age but some part of it is of older horizons (WADIA, 1953). It is said to range from Eocene to Pliocene. The present paper deals with two new species of *Terminalioxylon*. Ramanujam (1956) has recently described two species of *Terminalioxylon* from the same area. Two species of *Terminalioxylon* (Schonfeld) have been recorded from Tertiary of Columbia. Boureau (1950) also describes a species of *Terminalioxylon* from Indo-China.

The material investigated consisting of about 20 pieces of petrified wood was collected at Mortandra. Petrifactions are grey to light grey in colour blotched with brown and black. Many sections for detailed study were made by grinding from all the three planes.

DESCRIPTION

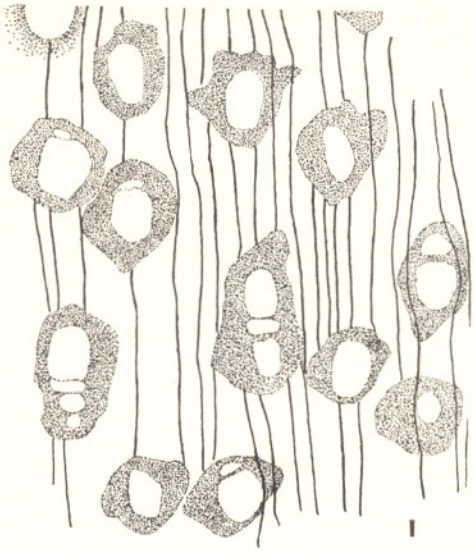
1. *Terminalioxylon mortandrense* sp. nov.

Diagnosis — Vessels closely placed and medium sized, 140-170 μ, perforations simple with vestured pits. Rays homogeneous and 10-20 cells in height, uniseriate and 10-15 μ broad. Parenchyma paratracheal and vasicentric. Fibres thin, elongated, and septate.

Description — Growth rings are not visible to the naked eye or under the microscope.

Vessels are medium sized, visible without the help of the microscope. They are usually open but at times filled with dark contents. Distribution of vessels is uneven. They are generally solitary but may also sometimes be in radial groups. Vessels are always encircled by parenchyma. Usually 4-5 vessels per sq. mm. can be counted. These are thin-walled, round in shape and without any pattern (PL. 1, FIG. 1; TEXT-FIG. 1). Larger vessels measure 140-170 μ. Perforations are simple and horizontal. Pits are numerous, crowded, and vestured (PL. 1, FIG. 4; TEXT-FIG. 2). Rays are conspicuous on both sides of the vessels.

Parenchyma lies in the vicinity of vessels. It is paratracheal, vasicentric and sometimes extends laterally across the rays and forms eyelets (PL. 1, FIG. 1; TEXT-FIG. 1). Parenchyma is 5-6 layered. There are no tangential bands but occasionally parenchyma of contiguous vessels tends to join. Cells of the parenchyma are thin, round in cross-section and measure 3 μ in diameter.



TEXT-FIG. 1 — *Terminalioxylon mortandrense* sp. nov. Transverse section showing the distribution of vasicentric parenchyma, vessels and rays. × *Ca.* 140.

Fibres are thin, elongated and medium in length. They run in a zigzag manner between the pores (PL. 1, FIG. 3). Each individual cell is round or squarish in transverse section (PL. 1, FIG. 1). Pits are not preserved. Fibres are septate and non-libriform.

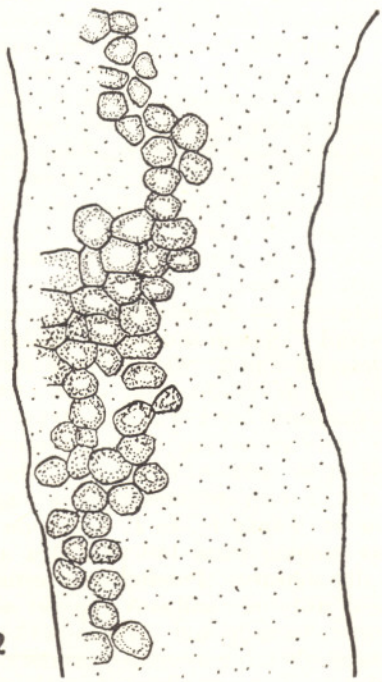
Rays are prominent, uniseriate (PL. 1, FIG. 3), numerous, homogeneous (PL. 1, FIG. 2) and are separated by 3-5 fibres. Larger rays measure 10-15 μ in diameter. The height of the ray varies from 10 to 20 cells. Cells are thin and oval. Dark crystals are sometimes observed in the ray cells (PL. 1, FIG. 3). The number of rays may be 9-10 per sq. mm.

2. *Terminalioxylon Sahnii* sp. nov.

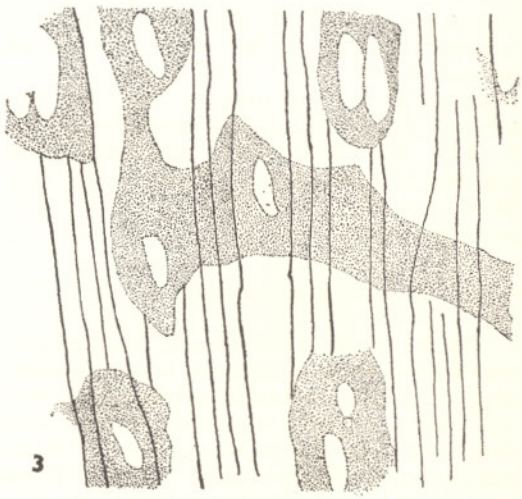
Diagnosis — Vessels not crowded, small or medium sized, ranging from 110 to 140 μ; perforations simple with vestured pits. Rays conspicuous on either side of the vessel, and 20-40 cells in height. Parenchyma paratracheal aliform, confluent and forming tangential bands here and there. Fibres thick, zigzag and non-septate.

Description — Growth rings are not visible to the naked eye or even under the microscope.

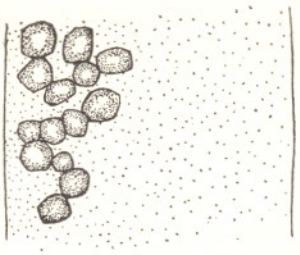
Vessels are small or medium in size. They are visible to the naked eye as small dots, and are usually 2-3 per sq. mm. Vessels are



TEXT-FIG. 2 — *Terminalioxylon mortandrense* sp. nov. Tangential section showing vestured pits. × *Ca.* 630.



TEXT-FIG. 3 — *Terminalioxylon Sahnii* sp. nov. Transverse section showing the distribution of vessels, banded parenchyma, and rays. × *Ca.* 140.



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TEXT-FIG. 4 — *Terminalioxylon Sahnii* sp. nov. Tangential section showing vestured pits. × *Ca.* 630.

always encircled abundantly all-round by parenchyma. They are generally solitary. Larger vessels measure 120-140 μ in diameter (PL. 1, FIG. 5; TEXT-FIG. 3). Shape of the individual vessel is oval to elliptical. Perforations are simple. Pits are minute and vestured (TEXT-FIG. 4).

Parenchyma lies close to the vessel. It is paratracheal vasicentric and some times extends to few seriate bands (PL. 1, FIG. 5; TEXT-FIG. 3). Parenchyma of contiguous vessels may occasionally join to form uneven bands. They are 5-6 layered. Cells of the parenchyma are small, thin and 1·5 μ in size.

Fibres are small, round and chain-like in cross-section (PL. 1, FIG. 5). They are elongated and non-septate. They form a fairly thick mass in between the pores and closely traversed by rays (PL. 1, FIG. 7). Fibres are twisted and run irregularly.

Rays are clear, prominent and numerous, separated by 2-5 fibres. Larger rays measure 30 μ in diameter. Rays are uniseriate (PL. 1, FIG. 7), homogeneous (PL. 1, FIG. 6), 20-40 cells in height. The number of rays may be 9-10 per sq. mm. Dark crystals are sometimes observed in the ray cells (PL. 1, FIG. 7).

DISCUSSION

The moderate-sized vessels, paratracheal and vasicentric parenchyma, uniseriate rays, elongated fibres and other general characters lead one to compare these fossil woods with families Leguminosae, Anacardiaceae, Sapindaceae and Combretaceae. These fossils show certain similarities with some members of Leguminosae in having medium-sized vessels with inner contents and paratracheal vasicentric parenchyma. Leguminous woods, however, differ in many features such as in having larger vessels in addition to medium-sized ones and in having ring porous arrangement of the vessels. Pits too are usually simple whereas in my fossils pits are vestured. In Leguminosae parenchyma exhibits variation in shape and size, and is conspicuous. The paratracheal parenchyma ranges from aliform and confluent to zonate types forming bands in regular series but in the fossils described here, the paratracheal parenchyma is not of diversed type, and is usually vasicentric to aliform, occasionally forming thin bands. The rays in Leguminosae are generally multiseriate whereas these fossils have exclusively uniseriate rays. My specimens show certain similarities of structure to Anacardiaceae also. However, the two differ in the nature of pores and rays. In Anacardiaceae generally vessels are fairly big and of ring porous type. They do not have any vestured pits. The presence of gum canal cells and multiseriate rays are also different as compared to my fossils. Some genera of Sapindaceae resemble the fossils in having uniseriate rays and medium to small-sized vessels but differ in the amount of parenchyma developed which is generally very scanty. Among Combretaceae the genus *Terminalia* shows close similarities to my fossil specimens. Characters which give indication to *Terminalia* woods are the type of vessels, parenchyma, rays and fibres. Vessels are generally of medium size and diffused with simple or vestured pits. Parenchyma is usually paratracheal and aliform. Occasionally it forms bands. Fibres are elongated and often septate. Rays are generally uniseriate.

Comparison — Terminalioxylon mortandrense and *T. Sahnii* show close similarities to *T. speciosum* and *T. Felixi*. The latter are the two fossil *Terminalia* woods described from the same area (RAMANUJAM, 1956). Apart from these two species there are no published records in India. A comparison indicates certain differences with my fossil specimens (TABLE 1). In *T. speciosum* vessels are big ranging from 180 to 270 μ and are generally solitary. Parenchyma forms paratracheal, aliform, confluent type in addition to diffuse parenchyma. Rays are uni- to biseriate and heterogeneous. Considering these features in *T. mortandrense* vessels are medium sized, solitary, radial and range from 120 to 180 μ. Parenchyma is paratracheal, vasicentric, and sometimes aliform. Rays

TABLE 1

Species	Vessels	Parenchyma	Rays	Fibres	Age
Terminalioxylon narango Schonfeld	Diffuse, medium-sized, 120-160 μ, solitary, also in radial groups	Abundant; paratracheal aliform confluent	Mostly uniseriate, 15-20 μ in diameter, 20-25 cells in height	Libriform	Tertiary
Terminalioxylon porosum Schonfeld	Uniform, large, 150-300 μ, solitary, sometimes in radial groups	Abundant; paratracheal aliform confluent, 2-3 layered	Mostly uniseriate, 15 μ in diameter, 20-40 cells in height	Libriform	Tertiary
Terminalioxylon annamense Boureau	Diffuse, tendency to oblique nature, solitary, also radial, large, 150-300 μ in diameter	Paratracheal aliform and also apotracheal, contains secretory cells	Uniseriate to biseriate with homogeneous and heterogeneous cells	Libriform and septate	Tertiary
Terminalioxylon speciosum Ramanujam	Diffuse, large, 180-270 μ, solitary	Abundant; diffuse, paratracheal aliform and sometimes confluent type	Uniseriate and biseriate, 15-20 μ in diameter, 10-25 cells in height and heterogeneous	Libriform and aseptate	Tertiary
Terminalioxylon Felixi Ramanujam	Medium sized, 130-150 μ, solitary	Not abundant; paratracheal aliform sheaths and also apotracheal	Mostly uniserate, 20 cells in height and homogeneous	Libriform and aseptate	Ter iary
Terminalioxylon mortandrense sp. nov.	Diffuse, 120-180 μ, medium sized, solitary and in radial groups of 2-3	Not abundant; paratracheal vasicentric and rarely aliform not forming sheaths	Mostly uniseriate, 10-15 μ in diameter, 10-20 cells in height and homogeneous	Septate	Tertiary
Terminalioxylon Sahnii sp. nov.	Diffuse, 120-130 μ, solitary	Abundant; paratracheal, often as tangential bands of 4-5 layers	Mostly uniseriate, 20-cells in height, 30 μ in diameter and homogeneous	Aseptate	Tertiary

are exclusively uniseriate and homogeneous. *T. Felixi* although possesses medium sized, solitary type of vessels comparable to *T. Sahnii*, its parenchyma is both apotracheal as well as paratracheal of confluent type and scanty. In *T. Sahnii* parenchyma is abundant and of paratracheal type only forming tangential bands. Apotracheal parenchyma is absent. Rays are uniseriate in both cases but in *T. Sahnii* rays are 20-40 cells in height. *Terminalioxylon narango* and *T. porosum* are two species of fossil *Terminalia* described (Schonfeld, 1947) from the Tertiary of Columbia. A comparison of my specimens with South American species of *Terminalioxylon* reveals distinct differences. Vessels in the latter are large, 200-300 μ in diameter, but in my specimens vessels range from 110 to 170 μ only. Parenchyma is distinctly paratracheal and aliform in Columbian species. *T. mortandrense* possesses only paratracheal vasicentric parenchyma in the vicinity of vessels. In *T. Sahnii*, parenchyma is paratracheal and aliform, forming thin bands by its lateral extension. Rays and fibres of *T. mortandrense* are similar to *T. narango* and that of *T. Sahnii* are comparable to *T. porosum*. Boureau (1950) described *Terminalioxylon annamense*, a fossil wood resembling the living wood of *Terminalia*, from the Tertiary of Indo-China. This specimen shows many features in common to South Indian fossils. However, my fossils differ in having medium-sized vessels without areoles, vasicentric aliform type of parenchyma without secretory canals and uniseriate rays of homogeneous cells. From the above comparisons although fossils under consideration resemble other species of *Terminalioxylon* in gross features still there are certain distinct differences which necessitate their separation from others as distinct species.

Detailed anatomical studies on woods of *Terminalia* from India, such as *T. tomentosa*, *T. belerica*, *T. chebula* and *T. myriocarpa*, were carried out by me in order to find out the nearest living representative of these new fossil species. Detailed anatomical descriptions of *T. procera*, *T. Manii*, *T. paniculata*, *T. Oliveri* and *T. Arjuna* (Pearson & Brown, 1932; Chowdhury, 1932, 1935, 1942, 1945; Gamble, 1900) were also available for comparison. *Terminalioxylon mortandrense* shows close similarities to *Terminalia Arjuna*, *T. tomentosa* and *T. paniculata*. They have medium-sized vessels, with vestured pits, rays are homogeneous, uniseriate and 10-15 μ in width. Fibres are elongated frequently septate. Parenchyma is paratracheal in its variations. The fossil species, however, differs in having smaller vessels, and the parenchyma mostly paratracheal and vasi-

centric. *Terminalioxylon Sahnii* also resembles all the three above-mentioned living species closely but it differs from them in having small vessels, thick, unseptate fibres, and elongated 30 μ wide rays each containing 20-40 cells. Both *Terminalioxylon mortandrense* and *T. Sahnii,* though comparable in broad features to *Terminalia balerica, T. tomentosa, T. procera, and T. myriocarpa,* however, differ in certain features, for these species generally have large vessels, rays, and fibres as well as paratracheal vasicentric and mostly banded type parenchyma. *T. Oliveri* and *T. Manii* can also be easily differentiated from the fossils by their small or extremely small vessels, sparse parenchyma and uni- or biseriate rays.

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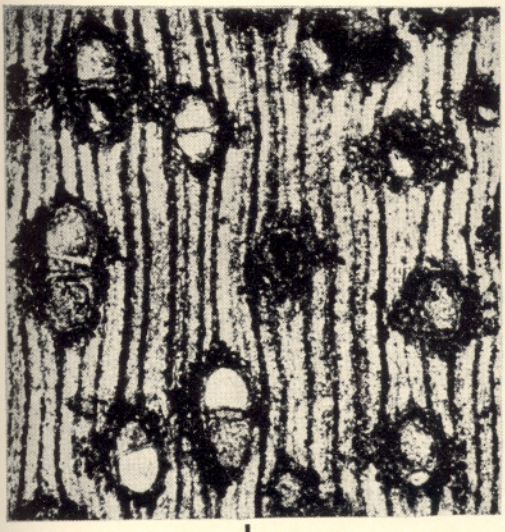
EXPLANATION OF PLATE 1

Terminalioxylon mortandrense sp. nov.

1. Transverse section showing the distribution of vessels, vasicentric parenchyma and rays. × 40.
2. Radial section showing the homogeneous nature of rays having squarish cells. × 40.
3. Tangential section showing uniseriate rays. × 1200.
4. Tangential section showing vestured pits. × 1600.

Terminalioxylon Sahnii sp. nov.

5. Transverse section showing the distribution of vessels, banded parenchyma, and rays. × 40.
6. Radial section showing the homogeneous nature of rays having squarish cells. × 40.
7. Tangential section showing uniseriate rays. × 1200.



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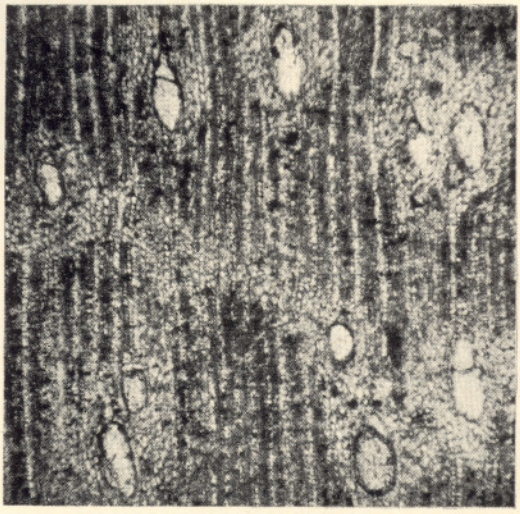

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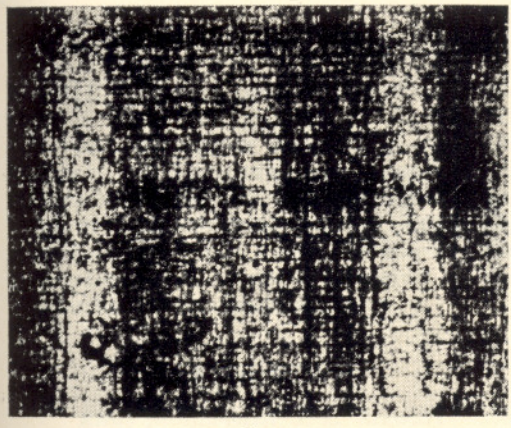

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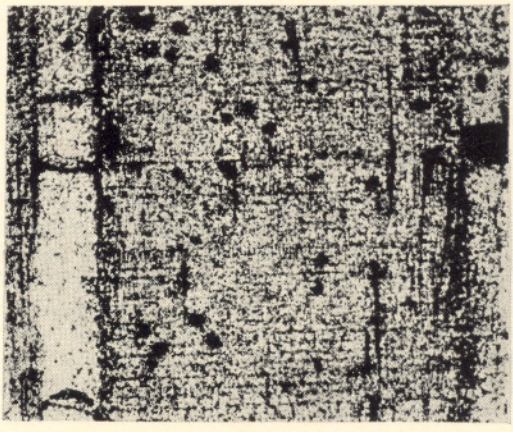

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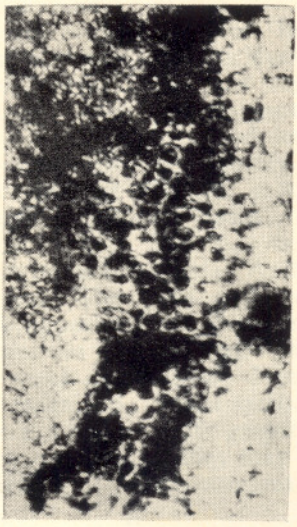

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