# *SAPINDOXYLON INDICUM* SP. NOV., A NEW FOSSIL WOOD FROM THE TERTIARY BEDS OF SOUTH INDIA

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## ABSTRACT

A new species of fossil dicot-wood from the Tertiary beds of South India is described in detail and named *Sapindoxylon indicum* sp. nov. The genus *Sapindoxylon* is reported for the first time from India.

## INTRODUCTION

THE presence of dicot-woods in the rocks of Cuddalore Series (Tertiary) was first recognized by Ramanujam (1954). He recorded woods belonging to Guttiferae, Dipterocarpaceae, Anacardiaceae, Leguminosae, Sonneratiaceae and Euphorbiaceae. He also described in detail, *Caesalpinioxylon sitholeyi* (1954), *Acacioxylon indicum* (1954), two new species of *Terminalioxylon* Schonfeld (1956) and fossil woods of Dipterocarpaceae (1955) and Euphorbiaceae (1956). The rich occurrence of petrified woods in these beds of South Arcot prompted further investigations of this fossil flora. In a recent paper I have described (1955) two new species of *Terminalioxylon*. The presence of *Sapindoxylon* wood adds further to our knowledge of the fossil flora of this area.

## MATERIAL AND METHODS

The material was collected in the village Tiruchitambalam, South Arcot district, Madras. It is situated few miles W.N.W. of Pondicherry. Sandstones form the chief component of these rocks. They are variously coloured, loose textured, often ferruginous, argillaceous and gritty. The age of these beds is believed to be ranging from Pliocene to Miocene (WADIA, 1953; KRISHNAN, 1949). Fossil woods are embedded in the sandstones or sometimes scattered on the surface. Petrifactions are grey to light grey in colour. Only secondary xylem is present which is fairly well preserved. Anatomical details of the fossil woods were studied in the glycerine medium. Stains were not used as the natural colour of the rocks, possibly ferruginous, revealed the internal structure of the fossil fairly clearly.

## DESCRIPTION

### *Sapindoxylon indicum* sp. nov.

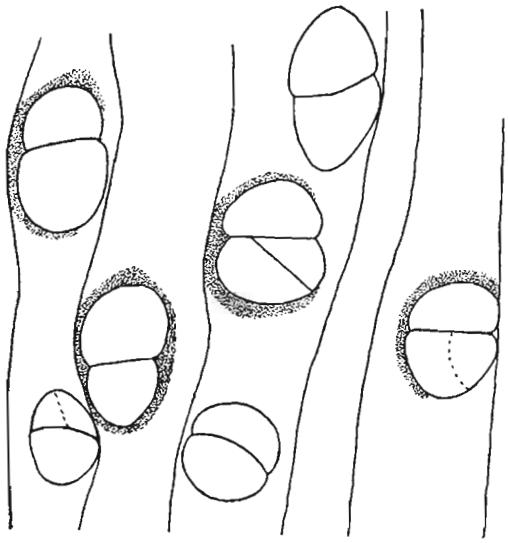
Pl. 1, Figs. 1-6; Text-figs. 1, 2

*Diagnosis* — Growth rings not distinguishable. Vessels small or medium-sized, ranging from 105 to 200 μ, solitary or more frequently in radial groups of two or three; perforation simple with numerous pits. Parenchyma scanty, limited to few cells round the vessels. Xylem rays homogeneous, uniseriate, 3-20 cells high and 14-20 μ broad. Fibres libriform, septate, 1165-1400 μ long and 14 μ broad.

Growth rings are not distinguishable either with the help of the hand lens or under the microscope.

Vessels are visible to the naked eye. They are seen as small or medium pores in the cross-section (PL. 1, FIG. 1). The distribution of vessels is not even. They are widely spread in the ground mass of the wood. Vessels are typically in groups of two or three or even more (PL. 1, FIGS. 1, 4; TEXT-FIG. 1). They are usually filled with solid deposits, often gum-like or crystals and tyloses (PL. 1, FIG. 4). The vessels are flanked on either side by rays (PL. 1, FIG. 1; TEXT-FIG. 1). The size of the vessels ranges from 108 to 165 μ in tangential diameter and 120 to 200 μ in radial diameter. Vessel segments are linear in shape, the length of which ranges from 135 to 545 μ. The vessels are thin-walled, elliptical, or oval in shape. Some of these are seen with oblique, vertical septa indicating division of the pore to form radial groups (PL. 1, FIGS. 1, 4; TEXT-FIG. 1). Perforations are not clearly visible due to the presence of heavy deposits in the vessels. However, at some places simple perforation can be seen. Intervascular pitting is typically alternate, consisting of simple, hexagonal pits (PL. 1, FIG. 6).

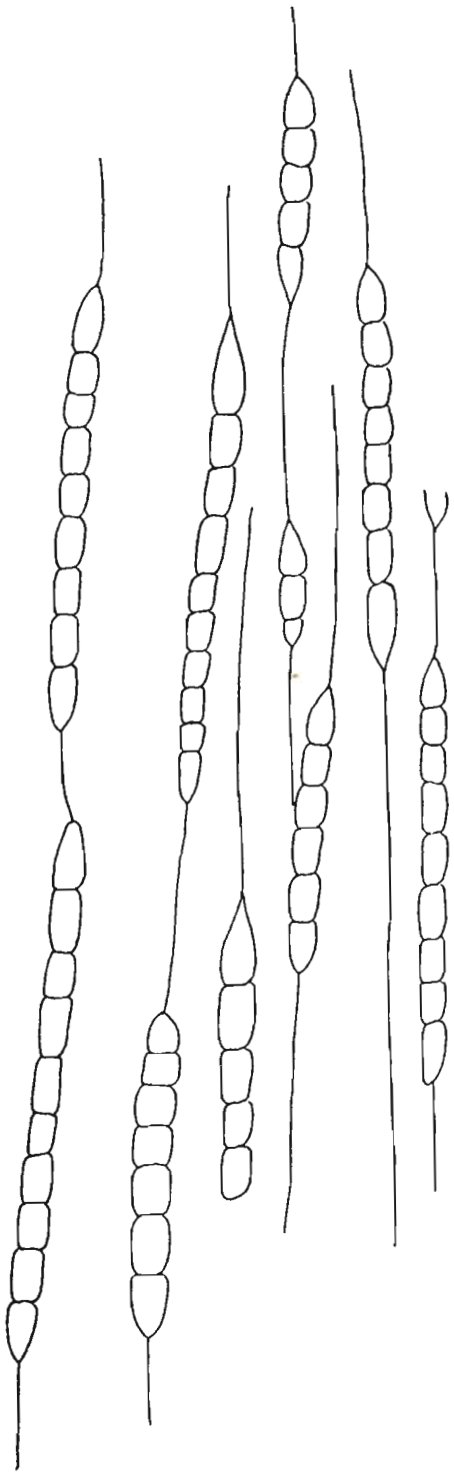
Parenchyma is characteristically scanty (PL. 1, FIGS. 1, 4; TEXT-FIG. 1). It is present near the vessel and is usually paratracheal (PL. 1, FIGS. 1, 4; TEXT-FIG. 1). Other types of parenchyma, namely



TEXT-FIG. 1 — *Sapindoxylon indicum* sp. nov. Cross-section showing the distribution of the radial vessels, and the scanty paratracheal parenchyma. × *Ca.* 140.

apotracheal and metatracheal, are not found. Cells of the parenchyma are small, thin, oval in shape ( PL. 1, FIG. 4 ). The size of the cells vary from 25 to 30 μ. Elsewhere the parenchyma is rather difficult to differentiate from other cells which form the ground mass of the fossil wood.

Rays are conspicuous and contiguous to both sides of the vessel. The number of rays range from 8 to 19 per sq. mm. as seen in cross-section ( PL. 1, FIG. 1; TEXT-FIG. 1 ) as well as in tangential section ( PL. 1, FIG. 3; TEXT-FIG. 2 ), xylem rays are prominent, numerous and are separated by fibres ( PL. 1, FIGS. 1, 4 ). Striking feature of these rays is that they are mostly uniseriate and homogeneous ( PL. 1, FIG. 2; TEXT-FIG. 2 ). They are usually composed of upright cells ( PL. 1, FIG. 5 ), the height of which is more than the width. The size of the rays varies from 10 to 15 μ in diameter and 3 to 20 cells in height. Ray cells are thin, oval, and measure 10-15 μ in diameter ( PL. 1, FIG. 2; TEXT-FIG. 2 ). They are not filled with deposits.



TEXT-FIG. 2 — *Sapindoxylon indicum* sp. nov. Tangential section showing the uniseriate, homogeneous rays. × *Ca.* 140.

TEXT-FIG. 2.

Fibres are thick-walled and form the ground mass of the wood ( PL. 1, FIGS. 1, 4 ). They are elongated and medium in length. In transverse section each fibre cell is round in shape, thick, and measures 14 μ in width ( PL. 1, FIG. 4 ). The length of each fibre is 1168-1400 μ. Generally some deposits seem to be present in the fibre cells.

## COMPARISON WITH MODERN FAMILIES

The fossil specimen shows certain similarities in its anatomical structures with some members of the modern families such as Anacardiaceae, Burseraceae, Rutaceae, Simarubiaceae, Aceraceae, Combretaceae, and Sapindaceae ( METCALFE & CHALK, 1950; PEARSON & BROWN, 1932, CHOWDHURY, 1945; MOLL & JANSSONIUS, 1908 ).

Few members belonging to Anacardiaceae resemble the fossil in having medium type of vessels, scanty nature of parenchyma and uniseriate rays. However, this family stands apart owing to the invariable occurrence of intercellular canals in the secondary wood and also in the arrangement of vessels and the rays. Generally in this family, vessels are ring porous type and rays are multiseriate.

Woods of Burseraceae possess small to medium-sized vessels with hexagonal plates, paratracheal, vasicentric, scanty parenchyma, rays which are uniseriate and few. These features are comparable to those of the fossil although the woods of Burseraceae differ in having intercellular canals in the secondary wood.

The radial type of vessels with simple perforation, exclusively uniseriate rays and the septate fibres of meliaceous woods are like those in the fossil specimen but their characteristic, paratracheal, vasicentric, aliform, confluent parenchyma constitutes a major difference, apart from other variations.

The typical multiple vessels and the exclusively uniseriate rays are the features of the family Rutaceae which can be compared with those of the fossil but the woods of Rutaceae differ in the nature of their parenchyma which is usually paratracheal, vasicentric, and the fibres which are non-septate and simple.

The genus *Terminalia* of Combretaceae resembles the fossil in having multiple vessels, uniseriate rays, but the nature of parenchyma and the pits in the two are different. In *Terminalia*, parenchyma is generally paratracheal, vasicentric as well as aliform and the pits are vestured in contrast to my fossils where the parenchyma is very scanty, almost restricted to a few cells and pits are simple.

Some woods of Simarubiaceae show certain features in common with the fossil. However, they differ in having ring porous type of vessels and multiseriate nature of rays.

Woods of Aceraceae also show certain similarities to the fossil but they generally have multiseriate rays with cells of different sizes and spiral parenchyma.

The moderate to small-sized, solitary or radial vessels, scanty parenchyma which consists of few cells round the pores, libriform septate fibres, and unseriate homogeneous rays as found in the fossil constitute a set of features met with in some genera of the family Sapindaceae.

Among these, the woods of *Pometia*, *Arytera*, *Mischocarpus* and *Schleichera* show similarities in many anatomical characters.

In *Pometia* ( MOLL & JANSSONIUS, 1908; METCALFE & CHALK, 1950 ) the woods resemble the fossil under consideration in some features, such as in having scanty paratracheal parenchyma, mostly uniseriate, homogeneous rays, and libriform fibres, but at the same time they differ sharply in the nature of the vessels and the parenchyma. In *Pometia*, the vessels are usually solitary, large in size, ranging up to 280 μ with distinct striations due to coalescent appertures and the parenchyma is slightly metatracheal in addition to the scanty paratracheal type.

The woods in the genus *Arytera* ( MOLL & JANSSONIUS, 1908 ) matches well with the fossil. The parenchyma is usually scanty, confined to the region of vessels, rays are mostly uniseriate, homogeneous and the fibres which form the ground mass of the wood are libriform. It differs from my fossil in having small vessels, 25-30 per sq. mm., and scattered cells of parenchyma in the ground mass of the wood.

Woods of *Mischocarpus* ( MOLL & JANSSONIUS, 1908 ) also agree in many features such as the scanty nature of parenchyma, uniseriate homogeneous rays and thick fibres. However, they differ in having smaller vessels, a larger number of which are usually grouped together and also in having scattered cells of parenchyma along with the scanty paratracheal type of parenchymatous cells in the region of the vessels.

The genus *Schleichera* (METCALFE & CHALK, 1950; PEARSON & BROWN, 1932) resembles in most of the structural details with the fossil. The resembling features are the medium-sized vessels, scanty paratracheal parenchyma, extremely fine, mostly uniseriate, homogeneous rays and thick-walled fibres. Although the fossil agrees in many features with this genus, yet some differences are also observed in the nature of the rays and the fibres.

*Sapindoxylon* as constituted by Kräusel (1920) is the genus which includes fossil woods showing anatomical characters comparable to the woods of Sapindaceae. My fossil, as is evident from the comparisons above, agrees to the general anatomy of the woods of Sapindaceae and I, therefore, include it in the genus *Sapindoxylon*.

## COMPARISON WITH OTHER SPECIES OF *SAPINDOXYLON*

No species of *Sapindoxylon* has been recorded so far from this country. All the species known have been described from other countries. They are *Sapindoxylon jansonii* Kräusel from the Tertiary of Sumatra, *S. klitzingi* (Pfeiffer & Van Heurn) Edwards from the Tertiary of Java, *S. stromeri* Kräusel from the Oligocene or Miocene of Egypt, *S. antioquiense* Schonfeld from the Tertiary of Columbia and *S. pleikuense* Boureau from the Tertiary of Indo-China.

In *S. pleikuense*, vessels are small, solitary, with scalariform perforation. Parenchyma is apotracheal and diffuse. Rays are two or three cells high with bordered pits. My specimen differs from *S. pleikuense* in having small, multiple vessels with simple perforations, usually uniseriate and homogeneous rays and parenchyma confined to few cells round the pores.

The Columbian fossil wood *S. antioquiense* differs from the Indian fossil wood in the thickened nature of the ray cells, in the presence of crystals in each parenchymatous cell and in the size of vessels, rays and parenchyma. These woods also resemble each other in having ill-defined growth rings, radial rows of vessels, paratracheal parenchyma and uniseriate rays.

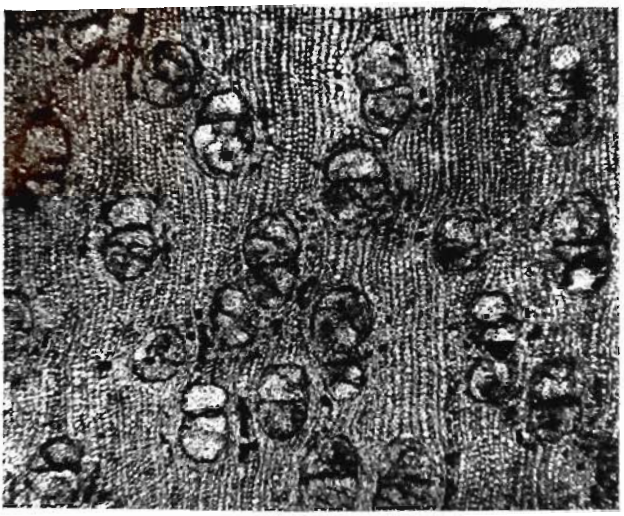
*S. stromeri* described from Egypt is distinct from my specimen because in the former, the pores are scattered yet very frequent, being 20-40 per sq. mm., and also showing conspicuous difference in the size of vessels, rays and parenchyma. However, the radial groups of vessels with bordered pits, libriform fibres, and the lack of growth rings are the features in which the South Indian fossil wood agrees to *S. stromeri*.

*S.* sp. (HOFFMAN, 1952) described from Austria does not resemble my fossil as the nature of pits, thickness of walls and the size of vessels, rays and the parenchyma, differ, in spite of similarities in the nature of vessels, rays and parenchyma.

The metatracheal bands of one or two series of parenchyma and solitary pores of *S. jansonii* are conspicuous characters which distinguish it from the South Arcot fossil, although both resemble in certain gross features.

The anatomical details of my specimen from South Arcot and its comparisons with

| SPECIES | VESSELS | PARENCHYMA | RAYS | FIBRES | AGE |
|---|---|---|---|---|---|
| *Sapindoxylon antiquiense* | Single or radial groups, 4-7 per sq. mm., perforated with numerous contiguous bordered pits | Scanty, paratracheal with one crystal in each cell | Layered cells horizontal, tangential walls with thickened knots | Libriform, constituting the ground mass of the wood | Tertiary |
| *S. stromeri* | Scattered or radial groups, 20-40 per sq. mm., perforated, round bordered pits, 60-100 $\mu$ broad | Scanty, paratracheal with a chambered crystal in each cell | Mostly one-layered, homogeneous, one crystal in each border cell | Libriform, forming the ground mass of the wood, with chambered crystals | do |
| *S. pleikuense* | Solitary, numerous, perforation-plate oblique, intervessel pitting scalariform | Apotracheal, diffuse, or in short uniseriate rows | Layered, heterogeneous, 2-3 cells high, 1-8 cells broad | Conspicuous, medium length with bordered pits | do |
| *S.* sp. | Single or radial groups of two, mutually flattened (equally divided), 2-8 per sq. mm. | Scattered, metatracheal, two-serried layers surrounding the vessels | Layered, 3-30 cells high, 2-5 cells broad, cells are higher than broad, with crystals | Libriform, forming the ground mass of the wood | do |
| *S. indicum* sp. nov. | Single or radial groups, 2-3 per sq. mm., perforation and bordered pits simple, 200-280 $\mu$ broad | Scanty, paratracheal, few cells round the pore | Mostly uniseriate (one layered), 8-20 cells high, one-cell broad | Libriform forming the ground mass of the wood | do |



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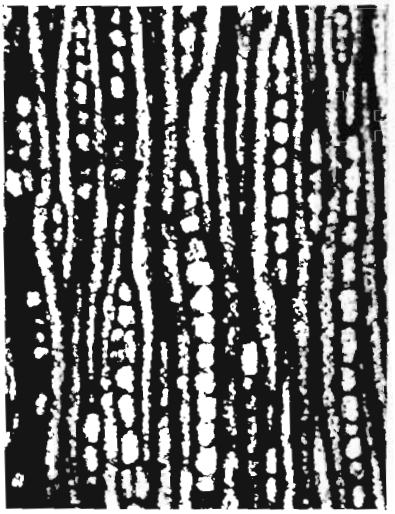

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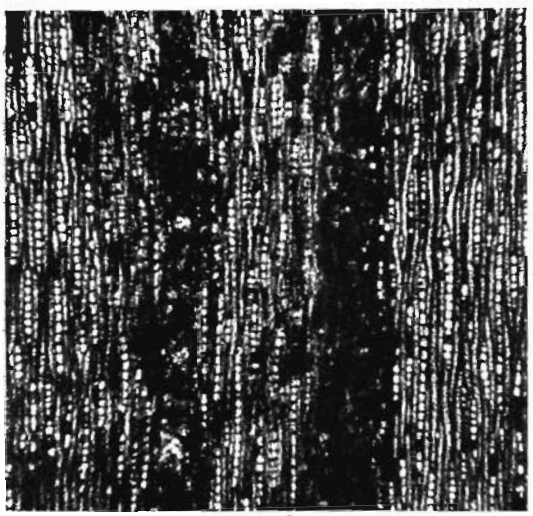

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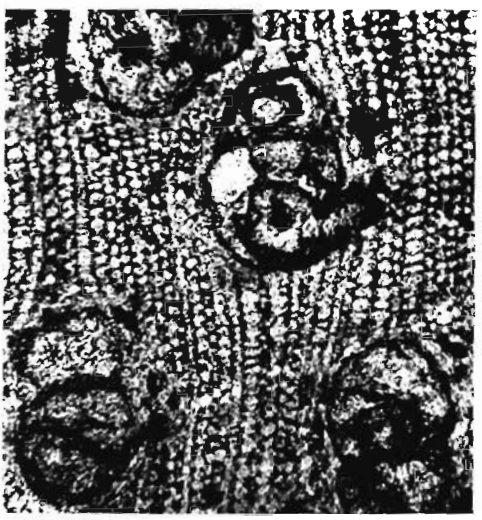

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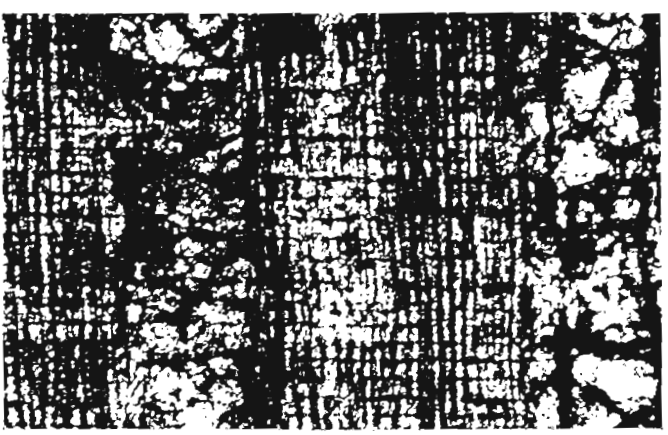

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the other fossil species of *Sapindoxylon* clearly show that it differs from them. It is, therefore, considered a new species for which I propose the name *Sapindoxylon indicum* sp. nov.

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## REFERENCES

BOUREAU, E. (1950). Contribution a L'Etude Paleoxylogique de L'Indochine. *Bull. Service Geol. L'Indochine.* **14**: 15-22.

CHIRAUGI, A. (1933). Legni fossile dells Somalia Italiana. *Palaeontogr. Italica.* **32**: 106-118.

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

Idem (1938). Two fossil dicotyledonous woods from Garo Hills of Assam. *Rec. Geol. Surv. India.* **73**: 247-266.

Idem (1945). Regional keys for identification of important timbers used in military areas of inspection. *Indian Forest Rec.* **3**: 1-55.

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. India.* **12**: 433-447.

CHOWDHURY, K. A. & TANDON, K. N. (1949). *Kayeoxylon assamicum* gen. et sp. nov. A fossil dicotyledonous wood from Assam. Ibid. **15**: 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 Tetiary of Burma. *Proc. 23rd Indian Sci. Cong.* (*Abstract*): 305.

HOFMANN, E. (1952). Pflanzenreste aus dem phosphoritvorkommen von Prambachkirchen in Oberösterreich. *Palaeontogr.* **92B**: 123-176.

KRÄUSEL, R. (1922). Fossile Hölzer aus dem Tertiär Von Süd Sumatra. *Verhandel. Geol. Mijnboüwk Genootsch. Nederl.* et *Kolon. Geol. Ser.* **5**: 231-287.

Idem (1939). Ergebnisse der Forschungsreisen Prof. E. Stromers in den Wüsten Ägyptens IV-Die fossilen Floren Ägyptens. *Abh. Bayer. Akad. Wiss.* N.F. **47**: 46-125.

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

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

MOLL, J. W. & JANSSONIUS, H. H. (1908). Mikrographitedes Holzes. *Leiden.*

NAVALE, G. K. B. (1955). On two new species of *Terminalioxylon* Schonfeld from the Tertiary beds of South India. *The Palaeobotanist.* **4**: 3540.

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

RAMANUJAM, C. G. K. (1953). 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. *J. sci. industr. Res. India.* **13B**: 146-147.

Idem (1954). On some silicified woods from near Pondicherry, South India. *The Palaeobotanist.* **3**: 40-50.

Idem (1955). On fossil woods of Dipterocarpaceae from the Tertiary rocks of South Arcot, Madras. *The Palaeobotanist.* **4**: 45-56.

Idem (1956). On fossil woods of Euphorbiaceae from the Tertiary rocks of South Arcot, Madras. *J. Indian Bot. Soc.* **35**: 284-307.

Idem (1956). On two new species of *Terminalioxylon* Schonfeld from the Tertiary of South Arcot district, Madras. *J. Indian Bot. Soc.* **35**: 104-113.

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

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

## EXPLANATION OF PLATE 1

*Sapindoxylon indicum* sp. nov.

1. Cross-section, showing the distribution of vessels, rays and parenchyma. × 40.
2. Tangential section enlarged to show the uniseriate, homogeneous rays. × 90.
3. Tangential section showing the distribution of rays and vessel segments. × 40.
4. Cross-section enlarged to show the radial group of the vessels and its contents, and also the scanty distribution of the paratracheal parenchyma. × 90.
5. Radial section showing the upright cells of the rays. × 90.
6. Tangential section enlarged to show the nature of the pitting. × 270.