PHYLLANTHINIUM BANGALAMODENSE: A NEW SPECIES OF FOSSIL EUPHORBIACEOUS WOOD FROM THE "CUDDALORE SERIES" OF INDIA

G. K. B. NAVALE
Birbal Sahni Institute of Palaeobotany, Lucknow

ABSTRACT

The anatomy of a petrified dicotyledonous wood is described from the Tertiary rocks of the Cuddalore series, South India. The fossil specimen shows close resemblances with the woods of the Phyllanthoidae group of Euphorbiaceae.

INTRODUCTION

FROM the Tertiary rocks of the Cuddalore series, South India, three genera of fossil woods of Euphorbiaceae collected from Mortandra, South Arcot District, Madras, have been already described by Ramanujam (1956).

The present material consists of a few small pieces of highly silicified woods collected recently at Bangalamod near Pondicherry. The fossil woods are embedded in the Cuddalore sandstones (KRISHNAN, 1956). The details of the area, age and topography have already been described in my previous papers (NAVALE, 1955, 1956 & 1958). It is interesting to note that mostly dicotyledonous woods are found in this area. The preservation of the fossil specimen is fairly satisfactory. A careful study of the structural details have been made and compared with the modern woods.

DESCRIPTION

Vessels are scarcely visible to the naked eye. They are seen as small pores through the hand lens. Vessels are less frequent, more or less uniform in distribution (PL. 1, FIG. 1; TEXT-FIG. 1) without showing any definite pattern. They are typically small, characteristically in radial multiples of 2 to 5 cells (PL. 1, FIGS. 1, 3; TEXT-FIG. 1). Solitary vessels are round in shape, and rare. Vessels in radial rows are slightly flattened at the point of contact (PL. 1, FIGS. 1, 3; TEXT-FIG. 1). Frequently vessels are contiguous with rays (PL. 1, FIG. 1; TEXT-FIG. 1). Vessels are sometimes filled with brown deposits and tyloses (PL. 1, FIGS. 1, 4). Vessel segments are short, truncate and tailed (PL. 1, FIG. 5). Vessel pits are medium in size, abundant, alternate, bordered, having more or less horizontal orifices (PL. 1, FIG. 5). Vessel-ray pits are simple, small, rounded and many per cell (TEXT-FIG. 3).

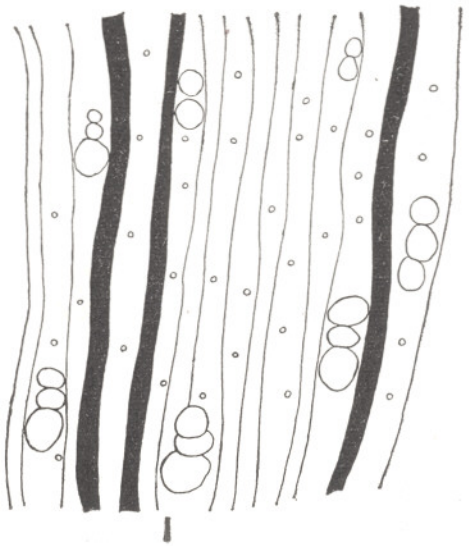
Parenchyma is scarcely visible even with the help of the hand lens. It is exclusively apotracheal and occurs frequently as diffused, scattered cells (PL. 1, FIG. 1; TEXT-FIG. 1) in the ground mass of the wood, also at some places forming short irregular strands. Very often it is difficult to differentiate the cells of parenchyma from the fibres. Parenchyma cells are very small, round to oval, and filled with contents (PL. 1,FIGS. 1, 3; TEXT-FIG. 1). Pits in the cells of parenchyma have not been seen.

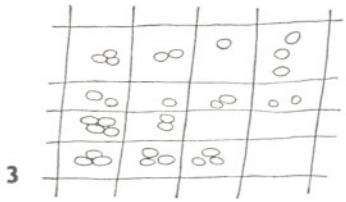
Rays are distinct, numerous and distributed uniformly (PL. 1, FIGS. 2, 6). They are one to few cells wide and several millimetres high (PL. 1, FIG. 6; TEXT-FIG. 2). Also small dissected rays are intermingled with high rays (PL. 1, FIGS. 2, 6; TEXT-FIG. 2). Uniseriate rays are medium to high and composed of vertical cells (PL. 1, FIG. 2; TEXT-FIG. 2). Multiseriate rays are composed of small procumbent cells which are more or less angular or round in shape. They are heterogeneous, mostly having many vertical cells in the end rays (PL. 1, FIGS. 4, 6; TEXT-FIG. 2). Linkage in the rays is fairly common (PL. 1, FIG. 6). Ray cells are small, angular, round and usually filled with contents (PL. 1, FIGS. 2, 6).

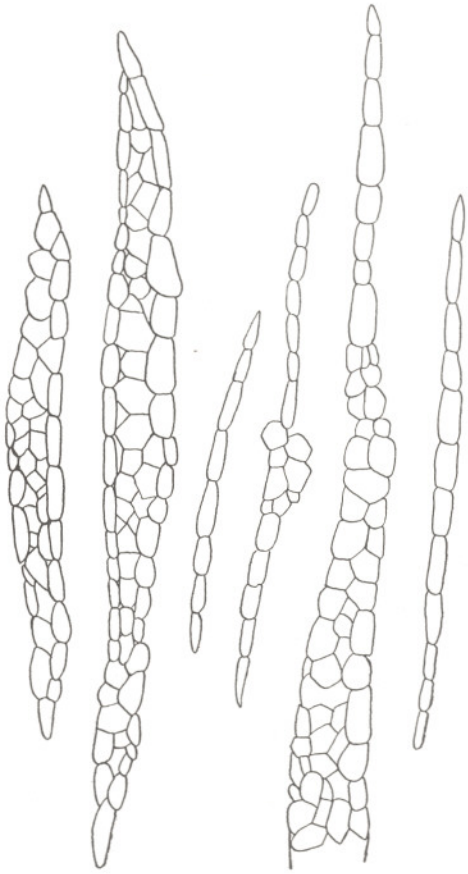
Fibres form the ground mass of the wood. They are more or less round in cross-section and arranged in radial rows (PL. 1, FIGS. 1, 3). Fibres are libriform and septate (PL. 1, FIG. 6). Fibre pits are scarcely visible. They are small, scanty and round in shape.

COMPARISONS WITH LIVING WOODS

The salient structural features of the specimen are the typically small, multiple rows of







TEXT-FIGS. 1-3—1, cross-section showing the nature and distribution of rays, parenchyma and vessel. × *ca.* 140. 2, tangential section showing the nature of rays. × *ca.* 250. 3, radial section showing vessel-ray pits. × *ca.* 480.

vessels; the medium sized, alternate, bordered intervessel pits having more or less horizontal orifices; the diffused scattered cells of apotracheal parenchyma; the distinct, heterogeneous, high, one to few seriate rays and thick, septate fibres. This assemblage of features indicates the comparability of the woods in the living families Pittosporaceae, Flacourtiaceae, Burseraceae, Sapotaceae, Ebenaceae and Euphorbiaceae. The woods of the Pittosporaceae show similarities with the fossil in some characters but they can be easily separated due to the presence of exclusively homogeneous rays. Similarly few members of Flacourtiaceae (*Doyalis* and *Taraktogens*) although agreeing in some features yet markedly differ in having scalariform perforation in the vessels and very broad rays. The anatomical details of the wood of *Garuga* and *Bursera* of Burseraceae reveal many similarities with the fossil, however the presence of conspicuous gum ducts separates them widely from the fossil. The genus *Bassia* of Sapotaceae agrees with the present specimen in the nature of vessels, parenchyma and rays but markedly differs in the arrangement of vessels which is conspicuously in oblique rows and in having vasicentric tracheids and limited rays. Woods of *Diospyros* in Ebenaceae show similarities in many structural details with the present fossil but can be easily separated from the fossil by the nature of rays and parenchyma. Most of the species of *Diospyros* have distinct growth rings, homogeneous, uniseriate rays and abundant apotracheal parenchyma in tangential bands.

The detailed and careful examination of the wood and reference to the available literature shows that the fossil under investigation indicates strong affinities to certain woods of Euphorbiaceae. This family is composed of genera having wide range of characters. On the basis of the wood anatomy, the family is divided into two, namely Phyllanthoidae and Crotonoideae.

Phyllanthoidae is divided into *Aporosa* type and *Glochidion* type (METCALFE & CHALK, 1950; JONSSONIUS, 1929).

The *aporosa* type of woods (*Aporosa, Baccaurea, Dicoelia, Maesobotrya, Protomegabaria* and *Richeria*) have medium to small vessels, simple or scalariform perforation, small, alternate pits; abundant, apotracheal, scattered and numerous short uniseriate strands of parenchyma; uniformly distributed limited rays having highly heterogeneous ray cells and unseptate fibres.

The *Glochidion* type of woods (*Antidesma, Aporosella, Hymenocardia, Bischoffia, Glochidion* and *Phyllanthus*) are characterized by vessels having a simple perforation and medium alternate, bordered pits; absence of parenchyma or very few cells near the vessels; multiseriate high rays and thick, septate fibres.

The Crotonoideae (*Croton, Acalypha, Euphorbia, Mallotus, Pogonophora, Actinostemon, Agrostitachys, Celaenodendron, Codiaeum, Dimorphocalyx, Fontainea, Gymnanthes, Lasiocroton, Leucocroton, Pausandra, Pycnocoma, Sebastiania, Hevea, Jatropha* and others) is distinguished by the presence of vessels with simple perforation, typically medium to large, intervessel pits; distinct, abundant paratracheal parenchyma varying from scattered cells to continuous tangential bands; exclusively uniseriate, or 2-3 cells wide heterogeneous rays and short to medium septate fibres.

Comparing the fossil under investigation with the above two groups, the members of the Crotonoideae can be distinctly differentiated from the fossil in the nature of vessels, parenchyma and rays. But Phyllanthoidae agrees in most of the anatomical details with the fossil such as in having small multiple vessels with simple or scalariform perforation and small to medium-sized alternate pitting; scanty apotracheal, diffused parenchyma and highly heterogeneous, multiseriate rays.

Considering the *Aporosa* group of Phyllanthoidae, the present fossil resembles in the nature of vessels, rays and parenchyma, yet it differs in some conspicuous features. The fibres in the *Aporosa* type of woods are distinctly aseptate, vessel pits are small to minute and parenchyma is fairly abundant. The members of the *Glochidion* group agree with the fossil in the nature of vessels, fibres and intervessel pits but at the same time show distinct differences in the nature of parenchyma and rays. In the woods of *Glochidion* group, parenchyma is characteristically absent or at the most confined to few cells near the vessels, whereas in my fossil it is fairly common as diffused apotracheal cells and sometimes even in short, irregular, abrupt strands. Also rays in the fossil material do not agree. So, exact resemblances to either of the group is not shown by the fossil although it markedly agrees with the members of Phyllanthoidae in general anatomical characters. Large number of available wood sections prepared from the woods of this family and references to literature reveal its closer similarities with the woods of *Aporosa, Richeria, Antidesma* and *Glochidion*. However, it should be noted that the fossil does not agree to any one of them in each and every respect.

COMPARISONS WITH FOSSIL EUPHORBIACEOUS WOODS

Three Euphorbiaceous woods are recorded from the Tertiary rocks of South India. They are *Putranjivoxylon puratanum, Bridelioxylon cuddalorense* and *Glochidioxylon tertiarum* (RAMANUJAM, 1956).

The fossil under investigation agrees in gross structural details with all the above species although it is distinctly different. Considering *P. puratanum*, it shows resemblances to some extent in the nature of parenchyma. However, the distinctly aseptate fibres; typically numerous, groups of 2-5 or more vessels, 20-30 vessels per sq. mm. with minute intervessel pits; limited, one to two seriate, thin, heterogeneous rays, not more than 2-3 cells wide, the multiseriate parts being limited to relatively small portions of each ray and composed of relatively small, distinctly procumbent cells, and also the pits between vessels and ray cells are the major differences. Similarly *B. cuddalorense* can be easily separated from the present fossil under consideration, due to its marked differences in the nature of parenchyma which is paratracheal and vasicentric. Although *G. tertiarum* agrees with the present

fossil in the overall nature of vessels, parenchyma and rays yet wide dissimilarities are seen in some characters. In *G. tertiarum*, growth rings are recognizable, vessels are very abundant and without tyloses; parenchyma is almost absent or confined to few cells indicating affinities to the *Glochidion* group whereas my specimen in contrast lacks growth rings; vessels are limited with brown deposits and tylotic out-growths; parenchyma is distinct, diffuse and scattered as numerous small cells.

Also two fossil Euphorbiaceous woods, *Euphorbioxylon krauseli* and *Glochidioxylon sahnii*, have been described from the Deccan Intertrappean beds of Madhya Pradesh (PRAKASH, 1958). Comparing my fossil with *Euphorbioxylon krauseli* the latter differs in having paratracheal parenchyma, vestured pits and limited rays. Similarly, *Glochidioxylon sahnii* also differs in many features. *G. sahnii* possesses smaller vessels, very scanty parenchyma, limited to few cells near the vessels and numerous broad heterogeneous rays.

Euphorbioxylon speciosum (FELIX, 1887), *E. lefrancii* (BOUREAU, 1951), *Paraphyllanthoxylon arizonense* (BAILEY, 1924), *Dryoxylon drypeteoides*, (BANCROFT, 1932), *Phyllanthinium pseudohobashiraishi* (OGURA, 1933, 1943) and *Haveoxylon microporosum* (KRUSE, 1954) are other fossil woods refered to the family Euphorbiaceae. *E. speciosum* differs from the present fossil in having mostly solitary vessels and distinctly paratracheal parenchyma. *E. lefrancii* resembles the present fossil little as it possesses paratracheal parenchyma, uniseriate, heterogeneous rays, aseptate fibres and solitary vessels. *P. arizonense* does not agree with my specimen in the nature of parenchyma which is paratracheal and rays which are very broad and high. *D. drypeteoides* shows marked dissimilarities in having numerous, closely set uniseriate tangential lines of apotracheal parenchyma and weak heterogeneous rays. *P. pseudohobashiraishi* although resembles in the nature of pitting, fibres and rays yet differs in having paratracheal, scanty vascicentric parenchyma. *H. microporosum* can also be eliminated easily because of its abundant paratracheal parenchyma, limited heterogeneous rays and aseptate fibres in contrast to my specimen.

NAME OF THE FOSSIL AND DIAGNOSIS

It can be seen from the detailed anatomical studies that the fossil under investigation clearly indicates its affinities with the group Phyllanthoidae of Euphorbiaceae. Bailey (1924) designated *Paraphyllanthoxylon* for fossil woods showing apparent similarities with the Phyllanthoidae of Cretaceous horizon. Ogura (1933) instituted a new generic term *Phyllanthinium* for his fossil wood showing similarities with the Phyllanthoidae group. Recently Ramanujam (1956) created three more generic terms for fossil woods of Euphorbiaceae. They are (1) *Putranjivoxylon* for fossil woods resembling the modern genus *Putranjiva*, (2) *Bridelioxylon* for those fossil woods having affinities with the genus *Bridelia* and (3) *Glochidioxylon* for the fossil woods of the *Glochidion* group of Euphorbiaceae.

But the present fossil specimen combines one or two characters of both of *Glochidion* and *Aporosa* type of woods of Phyllanthoidae. Therefore it is included in the genus *Phyllanthinium* (OGURA, 1933) which includes the fossil woods resembling the modern woods of *Aporosa* and *Glochidion* types of Phyllanthoidae in Euphorbiaceae. Ramanujam has suggested to name the fossils of Phyllanthoidae group after its sub-groups (*Aporosa* and *Glochidion* types) rather than the broad genus (*Phyllanthinium*) on the basis of wood anatomy of the living. But the present fossil falls neither in the *Glochidion* nor in the *Aporosa* group although one or more characters resemble to each one of the groups. Therefore it is more judicious to place such fossils in the genus *Phyllanthinium* (OGURA, 1933). As the only known species of *Phyllanthinium*, *P. pseudohobashiraishi* differs in a number of details from my specimen, I describe it as a new species of *Phyllanthinium*.

DIAGNOSIS

***Phyllanthinium bangalamodense* sp. nov.**

General — Diffuse-porous wood.

Growth Rings — Indistinct.

Vessels — Small, 80-120 μ in diameter, indistinct even to the hand lens, less frequent, 4-5 per sq. mm., distinctly in multiples of 2-5, thick-walled, round when solitary and slightly flattened when radial, brown deposits frequent, occassionally tyloses also present; vessel segments short to medium, 300-500 μ, truncate or tailed, vessel pits abundant, alternate, medium in size, bordered, orifices horizontal; vessel ray pits medium, round, simple, many per cell.

Parenchyma — Fairly common, apotracheal, distinctly diffused, abundant, scattered in the cells of the fibres, sometimes in short,

abrupt strands; cells round to polygonal, 35 μ in diameter.

Rays — Numerous, evenly distributed, 1-4 cells broad, 10-50 cells high; ray cells with deposits, heterogeneous, 1-6 marginal rows; uniseriate to few seriate, uniseriates made up of upright cells, high; multiseriate rays high, made up of procumbent cells with 1-10 upright end ray cells; linkage of different rays common.

Fibres — Medium to long, libriform, septate; more or less round in cross-section, arranged in radial rows, forms ground mass of the wood; fibre cells small, 2 μ in diameter.

Holotype—No. 4963, Museum, Birbal Sahni Institute of Palaeobotany.

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EXPLANATION OF PLATE 1

1. Cross-section showing the distribution of vessels, rays and parenchyma (Type Slide No. 770). × 15.

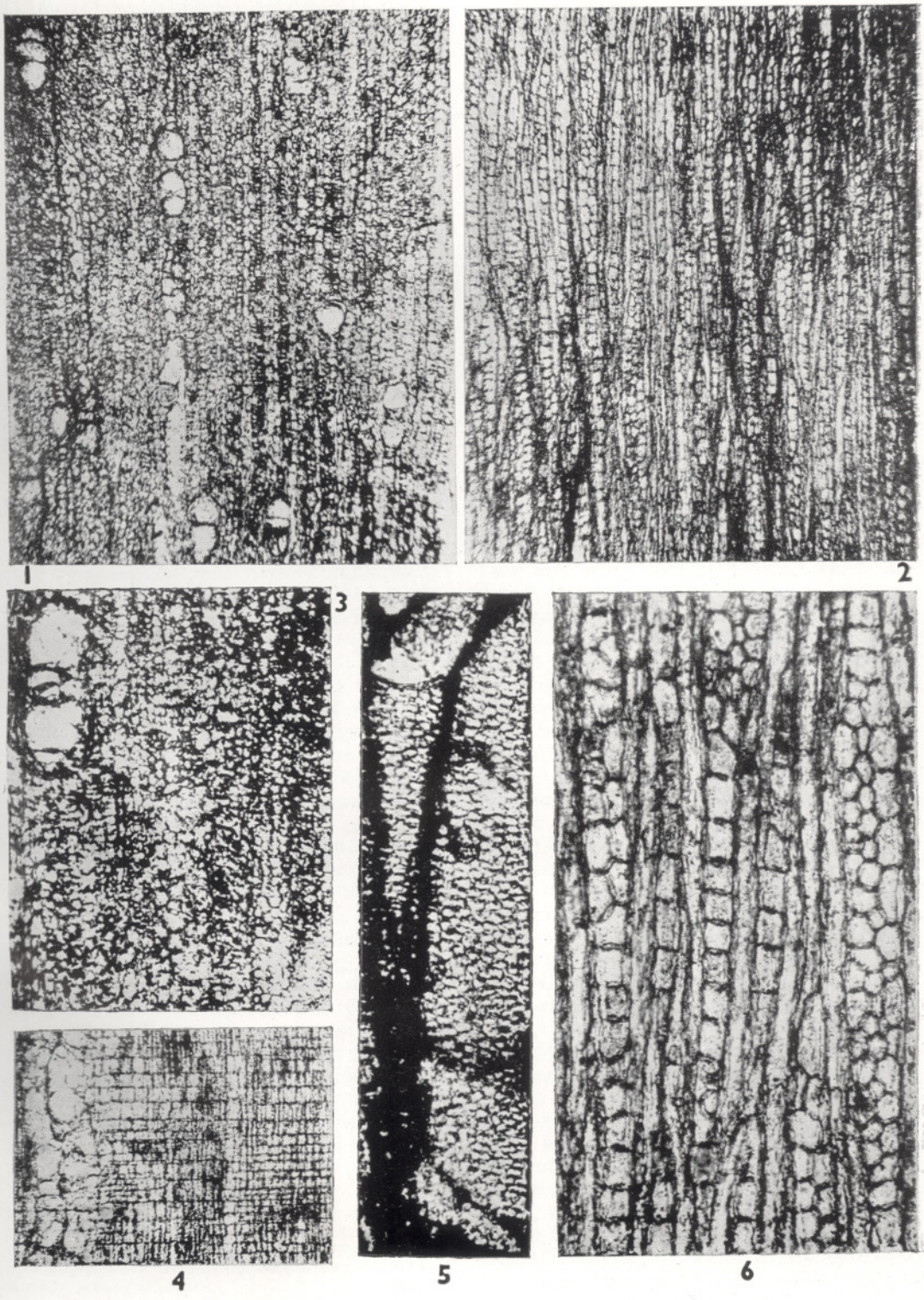
2. Tangential section showing the distribution of rays (Type Slide No. 772). × 35.

3. Cross-section magnified showing the diffuse parenchyma and the ground mass of fibre cells (Type Slide No. 771). × 50.

4. Radial section showing the heterogeneous nature of cells and contents in vessel segment (Type Slide Nos. 774, 775). × 35.

5. Tangential section showing vessel pits (Type Slide No. 772). × 100.

6. Tangential section enlarged showing the nature of rays (Type Slide No. 773). × 100.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