MALLOTOXYLON KERIENSE GEN. ET SP. NOV., A FOSSIL DICOTYLEDONOUS WOOD FROM THE DECCAN INTERTRAPPEAN SERIES, INDIA

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ABSTRACT

The paper describes a new fossil wood from the Deccan Intertrappean beds of Keria (21°59′40″N; 79°10′15″E) in Madhya Pradesh. The structure of this fossil wood shows close resemblance with that of the living genus *Mallotus* of the Euphorbiaceae.

INTRODUCTION

THE present paper deals with the anatomical details of a new Deccan Intertrappean wood collected from Keria (21° 59′ 40″ N; 79° 10′ 15″ E), about two miles south-west of the well known locality of Mohgaon Kalan in District Chhindwara, Madhya Pradesh. The exact fossiliferous locality is situated about 500 yards to the north of the village Keria. Although this place is quite rich in fossil woods, so far only two have been described from here. The first is *Palmoxylon surangei* (LAKHANPAL, 1955) and the second is *Euphorbioxylon kraeuselii*[1] (PRAKASH, 1957). The present find is a further addition to our knowledge of the fossil flora of this locality.

The fossil specimen investigated was a fairly well-preserved petrified wood discovered partly embedded in a big piece of chert. Its external surface was rusty brown but when cut, the interior appeared dark brown to almost black. A number of ground sections were prepared from all the three planes, viz., the transverse, tangential longitudinal and radial longitudinal. The slides were examined after smearing with glycerine. No stains were used as the natural colour of the petrifaction revealed the internal structure quite clearly.

Comparison of the fossil wood with the living was made with the large number of authentic samples and slides of modern woods at the Wood Anatomy Branch of the Forest Research Institute, Dehra Dun. The descriptive terminology used here conforms to that proposed by the International Association of Wood Anatomists, 1957.

DESCRIPTION

The petrified wood described here consists of pith, secondary xylem and a portion of the bark. Before cutting it measured about 15 cm. in length and 8 cm. in diameter.

Topography — *Wood* diffuse-porous (PL. 1, FIG. 3). *Pith* present. *Growth rings* indistinct (PL. 1, FIG. 1). *Vessels* appearing as pin points to the naked eye, clearly visible under the microscope, small to medium-sized, mostly moderately small, solitary and in numerous radial multiples of 2-4 or more cells (PL. 1, FIGS. 3, 4), distributed without any pattern, 6-18 per sq. mm., rarely in short double rows, usually with rays contiguous on one or both the sides, sparsely tylosed (PL. 1, FIG. 7); vessel-ray pits similar to intervascular pit-pairs, several to each ray cell, with wide aperture and narrow border; vessel-parenchyma pits not observed. *Parenchyma* clearly visible only under the microscope, paratracheal and apotracheal; paratracheal parenchyma sparse, as few cells associated with the vessels; apotracheal parenchyma abundant, as scattered cells or more commonly as short irregular and interrupted uniseriate lines (PL. 1, FIG. 4) bridging the narrow gaps between the adjacent rays. *Xylem rays* not distinct with the naked eye, even with a hand lens their outlines obscure, fine, 1-3 cells (PL. 1, FIG. 2) and 16-45 μ broad, rather closely distributed, 8-14 per mm., ray tissue markedly heterogeneous (PL. 1, FIGS. 2, 5); divisible on the basis of size and composition into two types: (a) uniseriate rays homocellular, consisting wholly of upright cells (PL. 1, FIG. 2), 225-750 μ and 7-13 cells high; (b) multiseriate rays 2-3 seriate, 675-1500 μ high, heterocellular, consisting of procumbent cells through the thickened central portion, with uniseriate marginal extensions of up to

1. Originally spelt as *krauseli* by the author.

10 upright cells (PL. 1, FIG. 2), marginal extensions of different rays sometimes confluent. *Fibres* nicely preserved only at some places, aligned in radial rows, these rows interrupted by the lines of apotracheal parenchyma.

Elements — *Pith cells* parenchymatous, circular or oval (PL. 1, FIG. 6) sometimes with dark deposits, t.d. 30-75 μ. *Vessels* with thin to slightly thicker wall, t.d. 45-120 μ, r.d. 45-105 μ, circular or oval, in radial groups flattened at the place of contact; vessel-members medium-sized to sometimes large, 400-840 μ long, truncate or with tailed ends; perforations simple, perforation plates horizontal to oblique; intervascular pit-pairs bordered, alternate (PL. 1, FIG. 8), medium-sized to large, 8-10 μ, border usually oval, sometimes hexagonal through crowding, aperture lenticular and horizontal. *Parenchyma cells* thin-walled, circular or oval in cross-section, t.d. 15-20 μ, r.d. 12-14 μ, without infiltration. *Ray cells* thin-walled; procumbent cells t.d. 12-40 μ, r.d. 16-40 μ; upright cells t.d. 16-20 μ, r.d. 40-57 μ, sometimes with infiltration. *Fibres* non-septate, thin to moderately thick-walled, squarish or polygonal in transverse section, t.d. 12-19 μ; interfibre pits not observed.

DISCUSSION

Comparison with the Living Species — The combination of structural features exhibited by the Intertrappean fossil is found in varying degrees in a number of dicotyledonous families of which the important ones are Ebenaceae, Sapotaceae, Apocynaceae and Euphorbiaceae. With these four a detailed comparison is made below.

In the Ebenaceae (METCALFE & CHALK, 1950, pp. 880-886), there are two genera *Diospyros* and *Maba* that could be compared with the fossil. A number of species of these genera such as *Diospyros ehretioides, D. melanoxylon, D. burmanica, D. chloroxylon, D. brandisiana, D. ebenum, D. lotus, D. microphylla, D. kaki, D. dasyphylla, Maba buxifolia, M. merguensis, M. andamanica* and *M. nigrescens* were studied, some from their thin sections of the living woods while others from their figures and detailed descriptions (METCALFE & CHALK, 1950; PEARSON & BROWN, 1932, pp. 689-708; GAMBLE, 1902, pp. 452-463). It has, however, been observed that woods of these two genera differ from the fossil in some important structural details. In them the intervessel pits are small to minute and the xylem rays are mostly uniseriate or with occasional biseriate parts and typically short, being less than 1 mm. in height.

Among the modern Sapotaceae (METCALFE & CHALK, 1950, pp. 871-880) the woods of *Dichopsis, Mimusops* and *Bassia* show similarity with the fossil in gross features. But a detailed microscopic study on the woods of *Dichopsis elliptica, D. obovata, D. polyantha, Mimusops elengi, M. hexandra, M. littoralis, Bassia latifolia, B. longifolia B. butyracea* and *B. malabarica* has revealed certain fundamental differences as in these plants vasicentric tracheids are invariably present, the intervessel pits are small and the fibres are very thick-walled.

In the Apocynaceae (METCALFE & CHALK, 1950, pp. 905-917), many genera have specialized wood structure characterised by the presence of vasicentric tracheids, latex tubes, exclusively uniseriate rays or included (interxylary) phloem. After eliminating all such genera, *Holarrhena* and *Wrightia* could be compared with the present fossil wood. But in both these genera the vessels are very small to extremely small and their frequency (Number per sq. mm.) is too large (In *Holarrhena* 40-71 per sq. mm., in *Wrightia* 27-45 per sq. mm.) to be compared favourably with the fossil. Moreover, the intervessel pits are small to minute and vestured.

Lastly, the Euphorbiaceae has a number of genera which show a combination of characters similar to what is seen in the fossil. Euphorbiaceae is a markedly heterogeneous family (METCALFE & CHALK, 1950, pp. 1207-1235; JANSSONIUS, 1929) and for that reason the woods of this family are mostly grouped under two distinct types — the *Phyllanthoideae* (*Aporosa*- and *Glochidion*-type) and the *Crotonoideae*.

The *Aporosa*-type of woods are characterised by vessels often with scalariform perforation plates, small to minute intervessel pits and the xylem rays which are 4-17 cells wide and several mm. high. These characters distinguish the members of this type from the Intertrappean fossil.

The *Glochidion*-type of woods also differ from our fossil in having little or practically no parenchyma, in the composition of xylem rays and in possessing septate fibres.

A survey of all the available woods of the modern Crotonoideae indicates that the closest resemblance of the fossil wood is with the modern genus *Mallotus*. The fossil wood also shows a somewhat superficial resemblance, in gross features, with the wood structure of the extant genus *Drypetes*. However, the presence of minute intervessel pits, very thick-walled fibres and the ray structure in *Drypetes* distinguish it from the Intertrappean fossil.

Thin sections of *Mallotus philippinensis* and *M. albus* were examined. At the same time descriptions of six other species, viz., *M. roxburghianus*, *M. nepalensis*, *M. andamanicus* (GAMBLE, 1902), *M. blumeanus*, *M. ricinoides* and *M. floribundus* (JANSSONIUS, 1930) were also available for comparison. An examination of all the available data reveals that the nearest affinities of the fossil within this genus are with the species *M. philippinensis* although there are some variations.

Except for the slight variation in size, the distribution of the vessels in our fossil wood agrees with the distributional pattern in *M. philippinensis*. The tangential diameter of the vessels in the fossil species is 45-120 μ whereas in the extant wood it is 45-170 μ. In both, the perforations are simple and the intervascular pit-pairs are medium-sized to large (8-10 μ in the fossil and 8-11 μ in the modern wood), bordered, alternate with usually oval border and lenticular and horizontal aperture. Tyloses have also been observed in some specimens of *M. philippinensis*.

The nature and distribution of parenchyma appears to be almost identical in both as also the fibre structure.

Tertiary of Colombia; *Dryoxylon drypeteoides* (BANCROFT, 1932) from the Miocene (?) beds of East Africa; *Phyllanthinium pseudohobashiraishi* (OGURA, 1932; WATARI, 1943) from the Tertiary of Japan; *Euphorbioxylon lefrancii* (BOUREAU, 1951) from the Tertiary of Algeria; *Heveoxylon microporosum* (KRUSE, 1954) from the Eocene of Eden Valley, Wyoming, U.S.A.; *Aleurites miocenica* (WATARI, 1956) from the Miocene beds of Isikawa Prefecture, Honsyu; *Piranheoxylon stockmansi* (GRAMBAST, 1961) from the Eocene of Belgium; *Putranjivoxylon puratanum*, *Bridelioxylon cuddalorense*, *Glochidioxylon tertiarum* (RAMANUJAM, 1956), *Bischofioxylon miocenicum* (RAMANUJAM, 1960) and *Phyllanthinium bangalamodense* (NAVALE, 1960) from the Tertiary rocks (? Cuddalore Series) of South India; *Euphorbioxylon kraeuselii* (PRAKASH, 1957) and *Glochidioxylon sahnii* (PRAKASH, 1958) from the Intertrappean Series of India; *Paraphyllanthoxylon arizonense* (BAILEY, 1924) from the Cretaceous Colorado group of Arizona and *Paraphyllanthoxylon idahoense* (SPACKMAN, 1948) from the Cretaceous of Wayan, Idaho, U.S.A. and *Euphorbioxylon bridelioides* (SALARD, 1961) from the Tertiary of Peru.

Quite recently Mädel (1962) has described three new fossil euphorbiaceous woods, viz., *Paraphyllanthoxylon capense*, *Bridelioxylon fibrosum* and *Securinegoxylon biseriatum* from the Upper Cretaceous of South Africa. In this paper she has revised the names of a number of already known species into new combinations as given in the table below:

PREVIOUS NAME	REVISED NAME ACCORDING TO MÄDEL
Phyllanthinium pseudohobashiraishi Ogura	*Paraphyllanthoxylon pseudohobashiraishi*
Glochidioxylon tertiarum Ramanujam	*Paraphyllanthoxylon tertiarum*
Glochidioxylon sahnii Prakash	*Paraphyllanthoxylon sahnii*
Euphorbioxylon kraeuselii Prakash	*Bridelioxylon kraeuselii*
Bischofioxylon miocenicum Ramanujam	*Bridelioxylon miocenicum*
Aleurites miocenica Watari	*Aleuritoxylon miocenicum*

The composition of xylem rays in the fossil and the modern wood is basically similar, except for some minor differences. In the extant wood the upright cells of the xylem rays contain abundant crystals whereas in the fossil wood the crystals have not been seen.

Comparison with the Fossil Species — A number of fossil woods assigned to Euphorbiaceae are known from a wide range from many parts of the world. They are *Euphorbioxylon speciosum* (FELIX, 1887) from the

She has also changed the name of *Carpinoxylon pfefferi* Platen (1908) into *Paraphyllanthoxylon pfefferi* (Platen) Mädel (loc. cit.).

Accordingly the fossil wood described by Navale (1960) under the genus *Phyllanthinium* as *P. bangalamodense* should also be renamed as *Paraphyllanthoxylon bangalamodense* (Navale) comb. nov.

Of all the euphorbiaceous fossil woods so far described from various parts of the world only *Putranjivoxylon puratanum*, *Glochidio-*

xylon tertiarum, *Dryoxylon drypeteoides* and *Heveoxylon microporosum* can be compared with the present Intertrappean fossil.

However, *Putranjivoxylon puratanum* Ramanujam differs from the present fossil in the absence of tyloses in the vessel, in possessing scalariform perforations, small intervessel pits and the ray cells which are abundantly crystalliferous.

Paraphyllanthoxylon tertiarum (Ramanujam) Mädel also differs from the present fossil in the absence of tyloses, in having very scanty parenchyma as diffuse cells and the fibres which are septate and very thick-walled.

Dryoxylon drypeteoides Bancroft compared especially with the wood of *Drypetes* sp., is very imperfectly preserved and the anatomical details have been described from the cross surface only. Consequently the present fossil cannot be compared with the East African species in all its details. However, it differs from the present fossil in the absence of tyloses, in having small intervessel pits, very thick-walled fibres and supposed slightly heterogeneous rays.

Heveoxylon microporosum Kruse also differs from the Keria fossil in having fine intervessel pits and in the apotracheal parenchyma which is in the form of multiseriate bands. Moreover, in *H. microporosum* the frequency of the vessels is too large (30-100 per sq. mm.) to be favourably compared with the present fossil.

Because of its close resemblance with the wood structure of *Mallotus*, the present fossil wood has been named *Mallotoxylon* gen. nov. It is specifically named as *Mallotoxylon keriense* sp. nov., after the name of its locality.

Mallotus, a large genus of trees and shrubs, comprising about 120 species (WILLIS, 1957), is spread over a wide area covering India, Burma, Madagascar, Australia, Tropical Africa, the Philippines, Cochin-China and Malayan Archipelago. About 20 species are represented in the modern Indian flora. *Mallotus philippinensis* Muell. Arg., with which the fossil shows its nearest resemblance, "is a ubiquitous shrub or a small much-branched tree of India and Burma which also extends far afield into Ceylon, the Malayan Peninsula and Archipelago, Australia, China and Formosa" (PEARSON & BROWN, 1932, p. 888). In India this evergreen plant occurs in Sub-Himalayan tract and outer hills from the Indus eastwards, ascending occasionally to nearly 5,000 ft. into the region of *Pinus longifolia* and *Quercus incana*, in Bengal, Chota Nagpur and Indian Peninsula. This is a very common tree in sal forest and in certain types of mixed and scrub forest (TROUP, 1921, p. 837).

DIAGNOSES

Mallotoxylon gen. nov.

Wood diffuse-porous. *Growth rings* indistinct. *Vessels* small to medium-sized, solitary and in radial multiples of 2-4 or more cells; vessel-members small to medium-sized, sometimes large; perforations simple; intervascular pit-pairs medium-sized to large, bordered, alternate. *Parenchyma* apotracheal and paratracheal. *Xylem rays* fine, 1-3 (-4) seriate, divisible on the basis of size and composition into two types; ray tissue markedly heterogeneous. *Fibres* non-septate, thin to moderately thick-walled.

Genotype — *Mallotoxylon keriense*

Mallotoxylon keriense sp. nov.

Vessels moderately small, solitary and commonly in radial multiples of 2-4 or more cells, without any pattern, plugged with tyloses; vessel-members small to medium-sized, sometimes large, truncate or with tailed ends; perforations simple, horizontal or slightly oblique; intervascular pit-pairs medium-sized to large, 8-10 μ, bordered, alternate with lenticular and horizontal aperture and circular or oval border. *Parenchyma* as few cells associated with the vessels and more commonly as scattered cells or short irregular uniseriate lines (apotracheal). *Xylem rays* fine, 1-3 seriate, of two distinct types; the uniseriate, homocellular, of upright cells only; the multiseriate, heterocellular, consisting of procumbent cells in the thickened portion, with up to 10 marginal upright cells; ray tissue markedly heterogeneous. *Fibres* non-septate, thin to moderately thick-walled, polygonal in cross-section.

Holotype — B.S.I.P. Museum No. 32735.

Locality — Keria, Chhindwara district, Madhya Pradesh.

Horizon — Deccan Intertrappean Series.

Age — Early Tertiary (probably Lower Eocene.)

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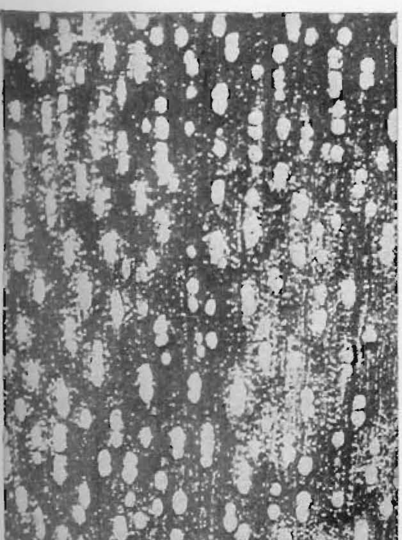

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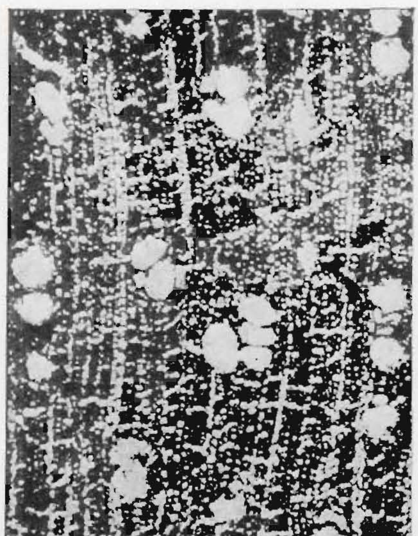

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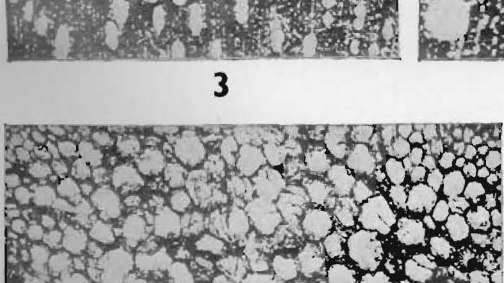

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EXPLANATION OF PLATE 1

Mallotoxylon keriense gen. et sp. nov.

1. Cross-section of the fossil to show the gross features. × 1.
2. Tangential longitudinal section to show the distribution and nature of the xylem rays. × 50.
3. Cross-section at low magnification to show the distribution of the vessels. Note the vessel multiples. × 15.
4. Cross-section showing the nature and distribution of the parenchyma. × 50.
5. Radial longitudinal section showing the heterogeneous ray tissue. × 190.
6. Cross-section of the wood showing the pith cells. × 50.
7. Part of a vessel in longitudinal section showing tyloses. × 170.
8. Intervascular pit-pairs. × 450.