STUDIES IN THE DECCAN INTERTRAPPEAN FLORA — 3. ON A NEW SPECIES OF FOSSIL WOODS OF EUPHORBIACEAE FROM THE INTERTRAPPEAN BEDS OF MADHYA PRADESH

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ABSTRACT

The paper describes a new species of fossil wood of Euphorbiaceae from the Deccan Intertrappean beds of Keria (21°59′40″N.; 79°10′15″E.) in Madhya Pradesh. The fossil wood is named as *Euphorbioxylon krauseli*.

INTRODUCTION

THE present paper deals with a new species of fossil wood belonging to Euphorbiaceae collected from the Deccan Intertrappean beds of Keria (21°59′ 40″N.; 79°10′15″E.) about two miles south-west of the well-known locality of Mohgaon Kalan in Chhindwara district of Madhya Pradesh. So far only two dicot woods have been reported from the Deccan Intertrappean series. They are *Dryoxylon mohgaoense* (RODE, 1936; PRAKASH, 1956) and a *Sonneratia*-like wood (VERMA, 1950) both described from the locality of Mohgaon Kalan.

As regards the fossil woods of Euphorbiaceae from the Indian horizons, recently Ramanujam (1956) described three new genera from the Tertiary rocks of Mortrandra in the South Arcot district of Madras. They are *Putranjivoxylon puratanam, Bridelioxylon cuddalorense* and *Glochidioxylon tertiarum* showing resemblances to the modern genera *Putranjiva, Bridelia* and the wood-type of *Glochidion* group of the section Phyllanthoideae.

The preservation of the fossil wood is quite satisfactory and the anatomical details are clear. At some places the presence of iron oxide enhances the clarity of its tissues. For a detailed study a number of sections were prepared by grinding from all the three planes.

DESCRIPTION

Genus — *Euphorbioxylon* Felix

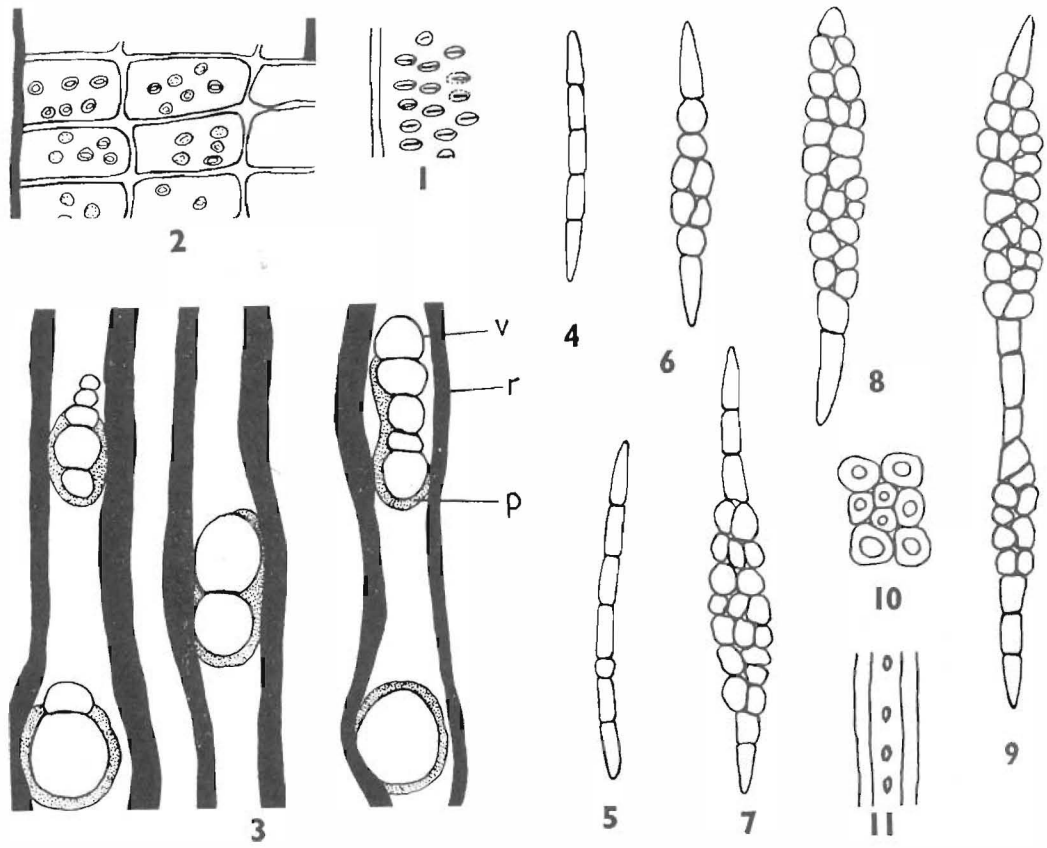
Euphorbioxylon krauseli sp. nov.

The fossil wood consists of only secondary xylem. It is 9 cm. in length and about 7 cm. in diameter. It shows the structure of a diffuse-porous wood.

Growth rings are recognizable by the naked eye or through a hand lens (PL. 1, FIG. 4). They are faintly marked.

Vessels are visible to the naked eye as dots against the ground-tissue of the wood. They are numerous, medium-sized to small or very small, thick-walled, and round to oval in cross-section (PL. 1, FIG. 1). They are sometimes solitary, but mostly in radial groups of 2 to several members (PL. 1, FIG. 1). The radial groups of 2-7 vessels are very common. Tyloses are lacking but the vessels are sometimes plugged with a dark brown substance (PL. 1, FIGS. 1, 2). Perforations are simple and the perforation plates are generally horizontal but sometimes slightly inclined and frequently curved. The intervessel pits are quite distinct. They are vestured as well as bordered. The vestured pits (PL. 1, FIG. 3) are medium-sized, somewhat alternate and arranged in more or less vertical rows. The bordered pits (PL. 1, FIG. 8; TEXT-FIG. 1) are medium-sized and alternate. The aperture is linear to lenticular and usually horizontal, while the border is oval to slightly oblong. The vessel-ray pits are bordered (PL. 1, FIG. 5; TEXT-FIG. 2), medium-sized, circular to slightly elongated and few per cell. The vessel-parenchyma pits are simple and also few per cell.

Wood Parenchyma — It is impossible to locate the parenchyma by the naked eye. However, under the microscope it can be easily detected, although it is not very well preserved. It is, however, present in limited amount. The parenchyma is of paratracheal type, which occurs in association with the vessels (PL. 1, FIG. 7; TEXT-FIG. 3) encircling them completely or partially. It is usually present in 1-2 layers of cells. The parenchyma cells are thin-walled, and those contiguous to the vessels are flattened to conform to the vessel-wall, while the rest are usually oval. Pits between the parenchyma cells could not be detected.



(Semi-diagrammatic camera lucida sketches)

TEXT-FIGS. 1-11 — 1, magnified intervessel pits. × 386·5. 2, radial longitudinal section of a vessel showing vessel-ray pitting. × 386·5. 3, cross-section of the wood showing distribution of the parenchyma (*p*). *V*, vessel; *r*, ray. × 80. 4, uniseriate ray with upright cells only. × 146·5. 5, another uniseriate ray with both upright and procumbent cells. × 146·5. 6, biseriate ray showing upright end cells and procumbent cells of varying size and shape. × 146·5. 7, triseriate ray showing upright end cells and procumbent cells of varying size and shape. × 146·5. 8, a triseriate heterogeneous ray with mostly procumbent cells. × 146·5. 9, another ray showing end to end ray fusion. × 146·5. 10, fibres under high magnification, note their alignment, size and shape. × 240. 11, magnified inter-fibre pits. × 386·5.

Xylem rays are indistinct to the naked eye, but with a hand lens they are seen as radiating lines on the transverse surface of the specimen. They are fine (PL. 1, FIG. 2), 1-3 seriate (mostly triseriate), closely spaced and heterogeneous (PL. 1, FIG. 6). The rays are often fusiform (PL. 1, FIG. 2) and divisible on the basis of size and composition into two types: (a) uniseriate rays — very few, consisting wholly of upright cells or with few procumbent cells (TEXT-FIGS. 4, 5); (b) 2-3-seriate rays — quite common (PL. 1, FIG. 2), consisting wholly of procumbent cells through the central portion and terminating above and below in uniseriate margins of 1 to several (up to 8) horizontal rows of upright cells (TEXT-FIGS. 6, 7). Usually there are only 1-3 horizontal rows of upright cells at the uniseriate margins of these rays. Rarely these rays possess upright cells at only one of their margins (TEXT-FIG. 8). Frequently end to end ray fusions by the upright cells are also seen forming compound rays (PL. 1, FIG. 2; TEXT-FIG. 9). The rays are 3-44 cells in height. The ray cells are slightly thick-walled (PL. 1, FIG. 2) and sometimes loosely arranged. Some of them contain some deposits. The ray cells show few simple pits.

Fibres are well preserved only at some places and occur continuously throughout

the wood, arranged in distinct radial rows (PL. 1, FIG. 7). They are semi-libriform to libriform. In cross-section, the fibres are round to oval or sometimes slightly angular (PL. 1, FIG. 7; TEXT-FIG. 10) with fairly thick walls. They also show variation in size. The fibres are septate and show gradual tapering at their ends (PL. 1, FIG. 2). The interfibre pits are more conspicuous on the radial than on the tangential walls. They are simple, rounded and many per cell (TEXT-FIG. 11).

Ripple marks are absent.

Gum canals are absent.

COMPARISON AND DISCUSSION

So far only a few fossil woods of the family Euphorbiaceae are known from the Tertiary formations. They are *Euphorbioxylon speciosum* (FELIX, 1888) from the Tertiary of Columbia, *Dryoxylon drypeteoides* (BANCROFT, 1932) from the Miocene (?) beds of East Africa, *Phyllanthinium pseudo-hobashiraishi* (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, *Putranjivoxylon puratanam*, *Bridelioxylon cuddalorense*, and *Glochidioxylon tertiarum* from the Tertiary rocks (? Cuddalore series) of South India (RAMANUJAM, 1956).

Amongst the Euphorbiaceous fossil woods described from India, only *Bridelioxylon cuddalorense* Ramanujam from South India resembles *Euphorbioxylon krauseli* in the presence of radial vessel groups, in the vestured intervessel pits, and in having thick-walled, septate fibres. However, it differs from *E. krauseli* in having diffuse parenchyma in addition to vasicentric type and in 1-4-seriate, heterogeneous xylem rays. In *E. krauseli*, the parenchyma encircles the vessels completely or partially and the xylem rays are 1-3 seriate, heterogeneous and often with somewhat loosely arranged cells.

Among the fossil woods of Euphorbiaceae described from outside India, the only comparable ones are *Dryoxylon drypeteoides* (BANCROFT, 1932) and *Phyllanthinium pseudo-hobashiraishi* (OGURA, 1932; WATARI, 1943).

Dryoxylon drypeteoides Bancroft from the Miocene (?) of Africa resembles *Euphorbioxylon krauseli* in the nature of the vessels and in the rays. However, the African species differs greatly in the presence of fine, uniseriate, closely set, tangential lines of parenchyma, and in the absence of vestured intervessel pits.

Phyllanthinium pseudo-hobashiraishi Ogura from the Tertiary of Japan resembles *Euphorbioxylon krauseli* in the presence of growth rings and somewhat in the nature of parenchyma and rays. However, it differs from the present fossil wood in having large to medium-sized vessels, usually in groups of 2-4 cells, and in the absence of vestured intervessel pits. Moreover, the vessels in *P. pseudo-hobashiraishi* are profusely tylosed and the parenchyma is crystalliferous.

Comparison with the Living Species — The structural features of the present fossil wood are such as are very commonly met with in a number of dicotyledonous families. The occurrence of vestured pits on the vessel-walls, however, is a very significant feature. These pits are reported in the secondary wood of genera of twenty-four dicotyledonous families (METCALFE & CHALK, 1950, vol. 2, p. 1350). The important families are Combretaceae, Euphorbiaceae (only in *Bridelia* and *Cleistanthus*), Leguminosae, Myrtaceae, Lythraceae and Sonneratiaceae, etc.

Considering the important characters of the fossil wood, viz. vessels sometimes solitary but mostly in radial groups, vestured type of intervascular pitting, limited paratracheal parenchyma completely or partially encircling the vessels, heterogeneous xylem rays and thick-walled, septate fibres, two families (out of twenty-four families with vestured pits) are known which possess these characters in a manner somewhat similar to that exhibited by the fossil specimen. These families are Euphorbiaceae and Oleaceae. The family Oleaceae is characterized by ring-porous or semi-ring-porous woods and typically small vessels (except *Linociera*) which are often dentritic. In this family the genus *Forestiera* only possesses vestured pits. But in *Forestiera* the fibres are unseptate and the rays sometimes possess 4-10 marginal rows of square or upright cells (METCALFE & CHALK, 1950, vol. 2, pp. 897-899). This family, therefore, can easily be eliminated.

On the other hand, the family Euphorbiaceae shows the important characters of the fossil wood. The woods of Euphorbiaceae show markedly heterogeneous characters and are grouped under the following four types on the basis of their anatomical features (METCALFE & CHALK, 1950, vol. 2, pp. 1208,

1209). They show marked differences particularly in the parenchyma pattern and ray characters.

1. PHYLLANTHOIDEAE:
   (a) Group A (*Aporosa* Type)
   (b) Group B (*Glochidion* Type)
   (c) Group C (other Phyllanthoideae)
2. CROTONOIDEAE

The combination of the anatomical features exhibited by the Intertrappean fossil wood indicates a definite relation with the wood of *Glochidion* type of the family Euphorbiaceae. The *Glochidion* type of wood structure is found in the genera *Bischofia, Glochidion, Phyllanthus, Antidesma, Acalypha, Aporosella, Hymenocardia, Bridelia* and *Cleistanthus*. A comparison with the above genera reveals that the fossil wood shows resemblance to the genera *Bridelia* and *Cleistanthus* in size and arrangement of the vessels, vestured intervessel pitting, fibres and the parenchyma (METCALFE & CHALK, 1950, vol. 2, p. 1220, FIG. 293D; JANSSONIUS, 1930, vol. 10, pp. 480-491, 494-505, FIGS. 318, 319; PEARSON & BROWN, vol. 2, pp. 875-877, FIG. 273). I have also cut and examined the sections of the living woods of *Bridelia retusa, B. tomentosa, B. stipularis, Cleistanthus collinus* and *C. myrianthus*.

The genus *Cleistanthus*, however, differs from the fossil in its minute intervessel pits and the type of medullary rays which are usually very long and often uniseriate. The genus *Bridelia*, on the other hand, resembles more the fossil wood although it also shows some differences. The points of similarity (especially of *B. stipularis* and *B. tomentosa*) with the fossil wood are: (1) the diffuse-porous nature of the wood and the presence of growth rings; (2) medium-sized to small or very small vessels, arranged in radial groups, or isolated; (3) the presence of vestured and bordered intervessel pits; (4) the presence of thick-walled, septate fibres; and (5) the presence of fine, 1-3-seriate, heterogeneous medullary rays. However, the living wood of *Bridelia* slightly differs from the fossil wood in the nature of parenchyma. The wood of *Bridelia*, besides having paratracheal parenchyma, usually also possesses some scattered cells of parenchyma. It is, therefore, quite obvious that the present fossil wood, although showing a near approach to the genus *Bridelia*, does not resemble it in each and every respect.

As the present fossil wood is a member of Euphorbiaceae with a nearest approach to genus *Bridelia*, hence it is described under the genus *Euphorbioxylon* Felix. It is specifically named as *Euphorbioxylon krauseli* sp. nov., after Krausel.

Diagnosis — Growth rings faintly marked. Vessels 16-40 per sq. mm., medium-sized to very small, 29-164 μ in tangential diameter, 22-199 μ in radial diameter, solitary and in radial groups of 2 to several vessels, radial groups of 2-7 vessels common, thick-walled, round to oval; tyloses absent; vessels sometimes plugged with a dark brown deposit; perforations simple, perforation plates horizontal to slightly inclined and frequently curved; intervessel pits vestured and bordered; vessel-ray pits bordered and few per cell; vessel-parenchyma pits simple and few per cell.

Wood parenchyma limited, paratracheal; parenchyma cells in 1-2 layers, thin-walled, oval to slightly elongated; pits between the parenchyma cells not seen; cells about 18 to 28 μ in diameter.

Xylem rays moderately numerous, closely arranged, 10-13 per mm.; heterogeneous; fine, 1-3-seriate (mostly 3-seriate), 21-50 μ in width; 3-44 cells in height, 128-880 μ in length; uniseriate rays few, composed wholly of upright cells or both upright and procumbent cells; 2-3-seriate rays common with 1 to several marginal rows of upright cells and procumbent cells in the middle, rarely upright cells present at only one end, end to end ray fusion frequent; ray cells slightly thick-walled, sometimes filled with some deposit.

Wood fibres semi-libriform to libriform, thick-walled, round to oval or sometimes angular, arranged in distinct radial rows of short to medium length, 720-1040 μ; typically septate; interfibre pits simple, rounded and many per cell.

Locality — Keria in Chhindwara district of Madhya Pradesh.

Age — Early Tertiary.

Type Specimen — B.S.I.P. No. 5587.

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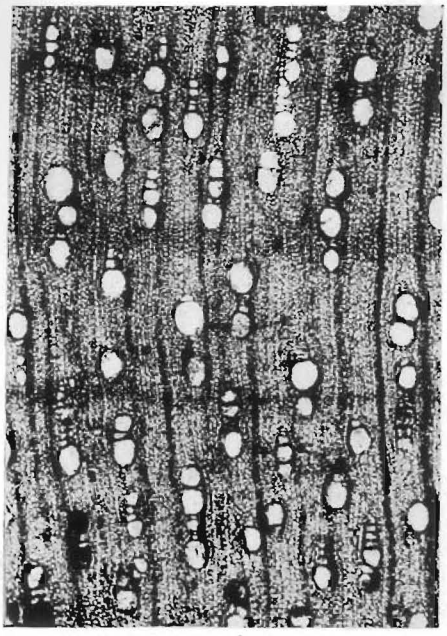

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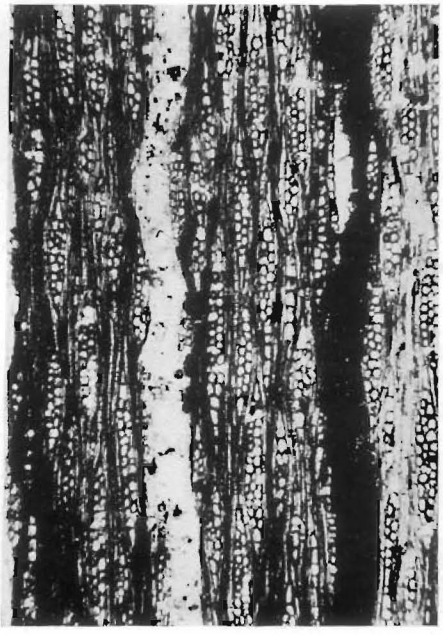

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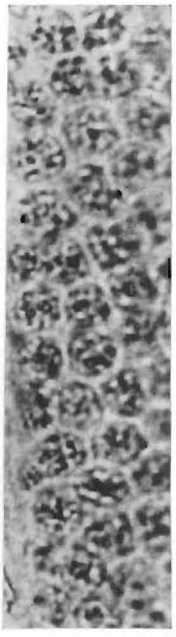

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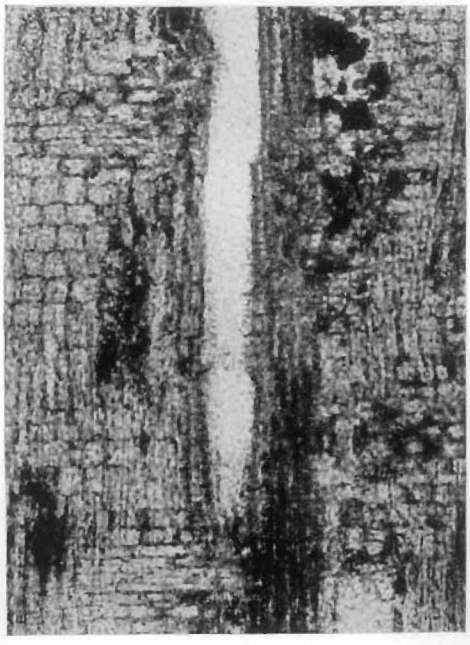

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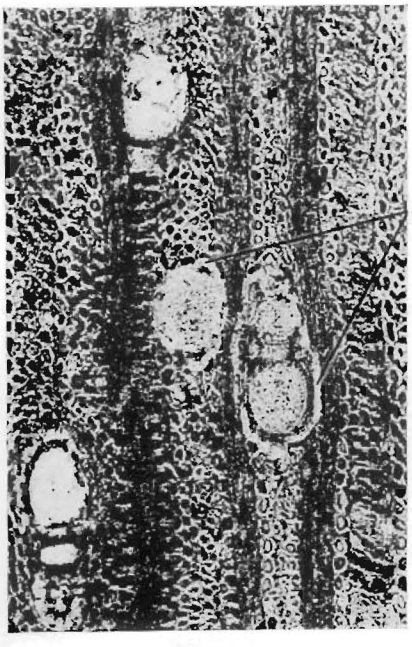

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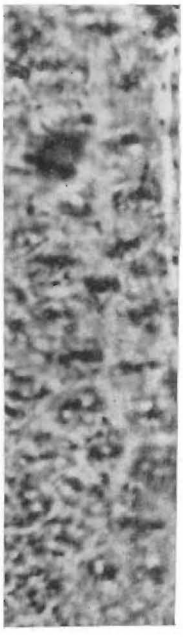

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EXPLANATION OF PLATE 1

Euphorbioxylon krauseli sp. nov.

1. Cross-section showing the size and distribution of vessels (*v*). Note the radial vessel groups. × 32.
2. Tangential longitudinal section showing the distribution and nature of the rays. × 52.
3. Vestured intervessel pits highly magnified. × 840.
4. Cross-section of the fossil under low magnification to show the gross structure. × 2·5.
5. Radial longitudinal section showing vessel-ray pitting. × 465.
6. Radial longitudinal section showing the heterogeneous nature of xylem rays. × 85.
7. Cross-section enlarged to show the nature of parenchyma (*p*). Also note thick-walled fibres. × 93.
8. Bordered intervessel pits highly magnified. × 840.