WOODY TISSUE RESEMBLING THE WOODS OF EBENACEAE IN THE MICROSTRUCTURE OF NEYVELI LIGNITE

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ABSTRACT

While studying the microstructure of Neyveli lignite, the author recognized a fossil dicotyledonous wood structure resembling the woods of Ebenaceae (*Diospyros* or *Maba*) in the woody portion of the lignite. The present paper records the microscopic study of the woody structure.

INTRODUCTION

LIGNITE or Brown coal occurs in many parts of India. Intensive mining and use of lignite has been taken up in Neyveli, Madras State, and also actively considered for mining in Palana near Bikaner, Rajasthan State and in Kashmir, Jammu and Kashmir State.

Neyveli lignite is named after the village Neyveli in South-Arcot district, Madras State, in which it was discovered as a single largest deposit of lignite or brown coal in India.

The lignite is associated with Tertiary Cuddalore Sandstones and clays (NAVALE, 1961). The deposit is laid on an uneven floor due to which abrupt changes in thickness are seen within short distances. The lignite bed is sandwiched between high pressure artesian aquifers all over the field which might cause difficulties in mining due to soft water logged, semiconsolidated nature of the deposit.

Lignite appears to have been formed from both woody and peaty types of material. It is light to dark brown in colour, and soft friable and woody in texture. A systematic study of the Petrographic components of the lignites has been made elsewhere (NAVALE, 1965), however, this paper reports only the woody structure identified in one of the polished blocks studied.

MATERIAL AND METHODS

The material investigated was collected from Pilot quarry one mile north of the Neyveli Railway Station. Although the thickness of the pilot seam is about 60 feet, yet only 12 feet thick lignite was exposed when the collection was made and the rest was in water.

The surface of the seam was dressed to reach fresh portions, and samples were collected foot by foot of $3' \times 2'$ as described in my earlier papers (NAVALE, 1963, 1964, 1965).

The microscopic preparation of the lignite was made by polished surface technique for determining its constituents. The lignite after being properly sized for embedding in putties, was embedded in Palatal which was prepared by mixing 100 grams of resin with 3 grams of catalyser and few drops of activiser. After proper embedding, grinding was done with carborundum powders of different grades (NAVALE, *loc. cit*), until uniform scratch free surface was obtained. Polishing was done on revolving disc using Al. oxide (grade nos. 1, 2 and 3) until fine, scratch free, glossy surface was obtained for microscopic examination.

DESCRIPTION

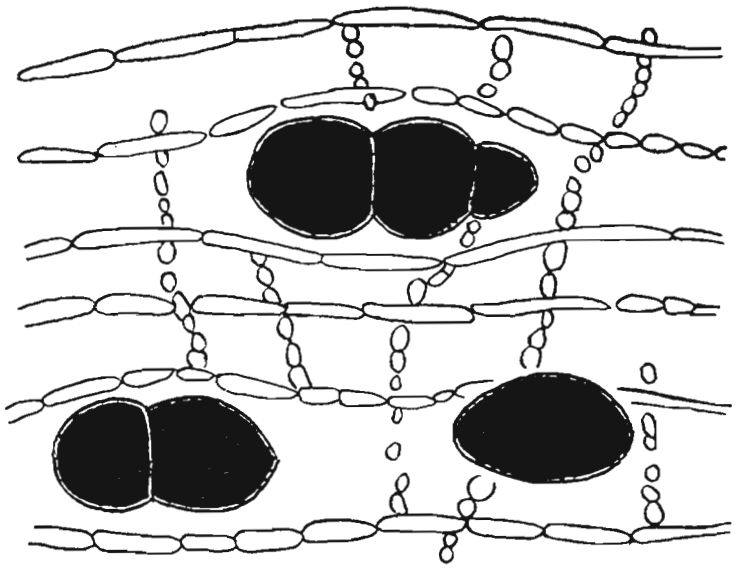
Megascopic characters — The lignite appears to be partly woody and partly peaty. It is light brown to dark brown in colour and has soft, friable and fine texture. Cracks and cleavages are commonly seen which cause splits and breaks. Resin bodies are seen as reddish specks.

Microscopic characters — As mentioned earlier, only microscopic structure of the wood identified as revealed in transverse section has been considered here. The wood is brownish black or darkish brown in colour.

Growth rings — Inconspicuous or absent.

Vessels (PL. 1, FIGS. 1, 3 & 4; TEXT-FIG. 1) — Small to medium sized, 130-150 μ in diameter, usually oval in shape, filled with dark contents, arranged in radial lines or in tapering rows of 2-4, frequently forming echelon, evenly distributed, 4-12 per mm.^{2}; vessel segments fairly long; truncate, thick-walled.

Parenchyma (PL. 1, FIGS. 1 & 3; TEXT-FIG. 1) — Paratracheal parenchyma scanty,



TEXT-FIG. 1 — T.S. of the lignite woody structure showing radial rows of vessels, apotracheal parenchyma and fine rays. × *ca* 110.

usually forming thin incomplete sheaths around the pores; apotracheal parenchyma abundant, inpart diffused, most part in concentric fine, mostly one seriate cells separated by broader bands of fibres which form fine reticulum with the rays.

Fibres (PL. 1, FIGS. 1 & 3) — Semilibriform to libriform, fine to very fine, occasionally contiguous to the vessels, more or less angled, smaller than parenchyma cells, alligned in radial rows in concentric bands which alternate with the concentric lines of zonate parenchyma.

Rays (PL. 1, FIG. 5; TEXT-FIG. 1) — Fine to very fine, uniform appearing as narrow lines, separated by 1 to 10 fibres, mostly one seriate sometime two, almost homogeneous.

DISCUSSION

Affinities — Black or darkish brown woody structure; small to medium sized few to moderately few vessels in radial tapering rows of 2-5, frequently forming echelon; partly diffuse and mostly one seriate apotracheal parenchyma cells, uniseriate to occasional biseriate rays are the most important microstructural features exhibited by the fossil. Considering the above anatomical features collectively, the lignite microstructure shows close affinities with the anatomical features of the woods of Sapotaceae and Ebenaceae (PEARSON & BROWN, 1932; GAMBLE, 1902). Among the two families, the woods of Sapotaceae differ by having larger radial lines of pores with characteristic oblique arrangement and tracheids always in the immediate vicinity of vessels. Ebenaceaous woods, particularly *Diospyros* and *Maba* resemble very close with the fossil wood. Woods of Ebenaceae have uniform structure to such an extent that even two different genera namely *Maba* and *Diospyros* cannot be separated. However, the fossil might belong to *Diospyros* closer, considering phytogeography and distribution of the genus. Anatomical descriptions and microphotographs of wood species of *Diospyros ehretioides*, *D. melanoxylon*, *D. tomentosa*, *D. ebenum*, *D. burmanica*, *D. marmorata* have been compared. Microstructure of *D. ehretioides* does not compare with the fossil specimen as it possesses always larger vessels more than 180 μ. Likewise *D. burmanica* and *D. marmorata* differ from the fossil in having invariably smaller vessels less than 130 μ. Woods of *D. ebenum*, (PL. 1, FIG. 2), *D. melanoxylon* (PL. 1, FIG. 6) and *D. tomentosa* resemble well with the fossil in general microstructural features. The living species have no diagnostic anatomical characters which differentiate each other and therefore it is viewed

that the fossil might resemble one of these species.

Comparison with the fossil species — So far only one species of fossil wood belonging to the family Ebenaceae is known from India, viz., *Ebenoxylon indicum* from NEFA (GHOSH & KAZMI, 1958). The fossil wood structure compares in most of the features namely small sized multiple vessels of two to four, apotracheal thin, tangential line of one or two cells parenchyma, uniseriate rays and absence of tracheids.

From outside India, *E. aegyptianum* (HOFMANN, 1944) comparable to *Diospyros*, *E. knolli* (HOFFMANN, 1952) and *E. hofmannae* (GREGUSS, 1956) are some of the woods of *Ebenaceae* comparable to the fossil though differing in matters of detail.

Distribution of the family Ebenaceae (Diospyros-Maba) — *Diospyros-Maba* which resemble the fossil in microstructural details are chiefly tropical woody trees. They are of Indo-Malayan region although distributed in both hemispheres. In India, *Diospyros* wood is found mostly in South India.

It would be interesting to cite here some of the common families existed during Mio-Pliocene, as recorded by the author and others (NAVALE, 1955-1963; RAMANUJAM, 1953-1963; LAKHANPAL & AWASTHI, 1963) in South Arcot, Madras from where the lignite was collected in order to know the extant forest type and climatic conditions. The woody families recognized were Combretaceae, Dipterocarpaceae, Leguminosae, Guttiferae, Anacardiaceae, Simaroubaceae, Euphorbiaceae, Castanaceae, Sapindaceae and others. The present record reports for the first time the occurrence of Ebenaceae in the area. Evidently the fossil flora suggests "Moist, Deciduous Rain Forest Type" of vegetation and its climate during the Mio-Pliocene period.

Ebenaceous wood is the only wood known in lignite apart from pollen and spores already known (RAO, 1955; NAVALE, 1961; RAMANUJAM, 1963, 1966). An effort to identify more and more microstructures of lignite along with spores and pollen may throw light on the palaeoecological condition of deposition, nature and formation of the huge lignite deposit.

CONCLUSION

Microstructure of one of the polished blocks of lignite, revealed in a portion, a dicotyledonous wood structure resembling the woods of Ebenaceae (*Diospyros* or *Maba*).

Associated with other fossil records already known so far, the present recognition of the family Ebenaceae indicates "Moist Deciduous Forests" type and its environmental condition during the Mio-Pliocene period during which the present lignite was formed, It may be possible to assess the condition of deposition, the nature and formation of lignite if an extensive microstructural and palaeobotanical analysis of lignite is made in the area.

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EXPLANATION OF PLATE

1. T.S. of the woody lignite showing angiospermic woody structure — Note vessels in radial rows, fine concentric, one-seriate cells of parenchyma and fine narrow rays. × 110.

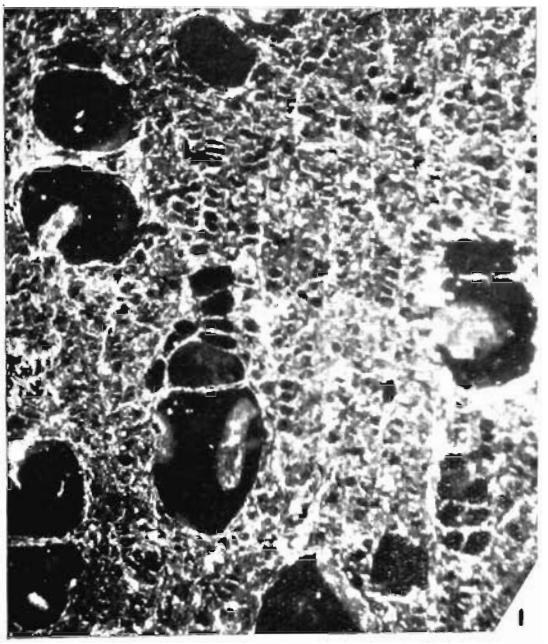
2. T.S. of a modern wood of *Diospyros ebenum* showing close resemblance to the fossil woody lignite. × 110.

3. T.S. of fossil wood of lignite showing one-seriate apotracheal parenchyma and ground mass of fibres. × 150.

4. L.S. of the woody lignite showing thick-walled vessels. × 240.

5. T.S. of another fossil wood showing 2-4 radial rows of vessels and fine rays. × 110.

6. T.S. of a modern wood of *Diospyros melanoxylon* showing close resemblance to the fossil. × 110.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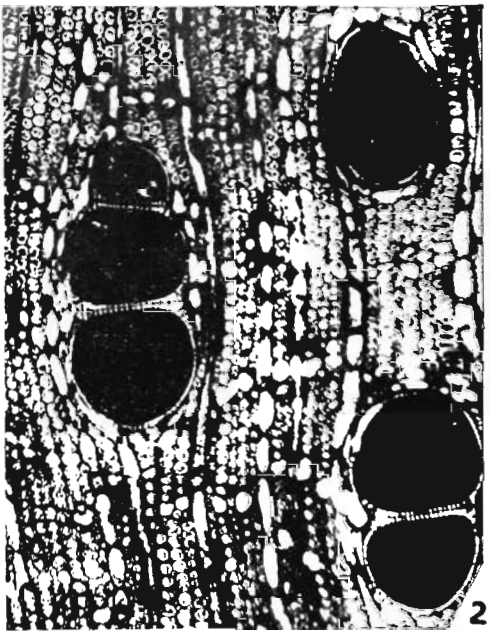
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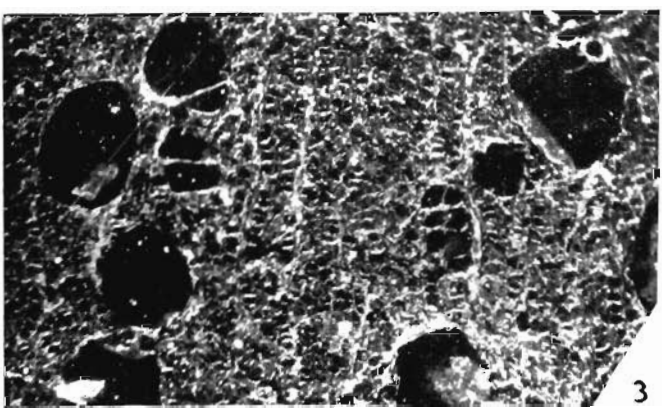
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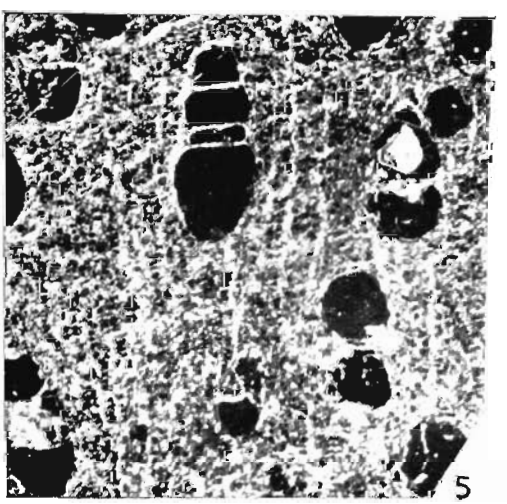
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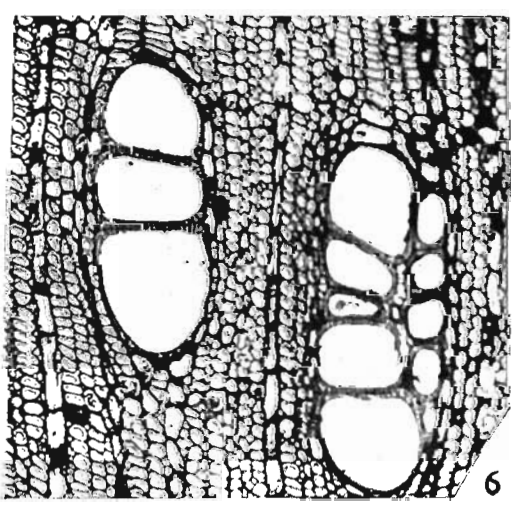
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