ON TWO NEW SPECIES OF *MESEMBRIOXYLON* FROM THE VICINITY OF PONDICHERRY, SOUTH INDIA

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INTRODUCTION

UP till now the published records of petrified woods from South India are rather scanty. Sahni (1931) described a few species of *Mesembrioxylon*, viz. *M. godaverianum* (near Bogapalmila in the Godavari district), *M. Schmidianum* (near Tiruvakkarai), *M. Parthasarathyi* (near Vellum, 5 miles south of Sripermatur) and one undetermined species; two species of *Cupressinoxylon*, viz. *C. coramandelinum* (near Madras) and *C. alternans* (near Raghavapuram, Godavari district); and lastly a single undetermined species of *Dadoxylon* (near Uttatur, Trichinopoly area).

During a tour of South India in December 1951, I had an opportunity to collect a large number of fossil woods near the village of Tiruvakkarai, 13 miles WNW of Pondicherry. The fossiliferous area gives the appearance of a petrified forest, containing gigantic fossil trunks some of which measure 35 to 50 ft. in length. The present paper deals with the structure of some trunks of woods, 4 to 8 ft. long and nearly 2 ft. in diameter.

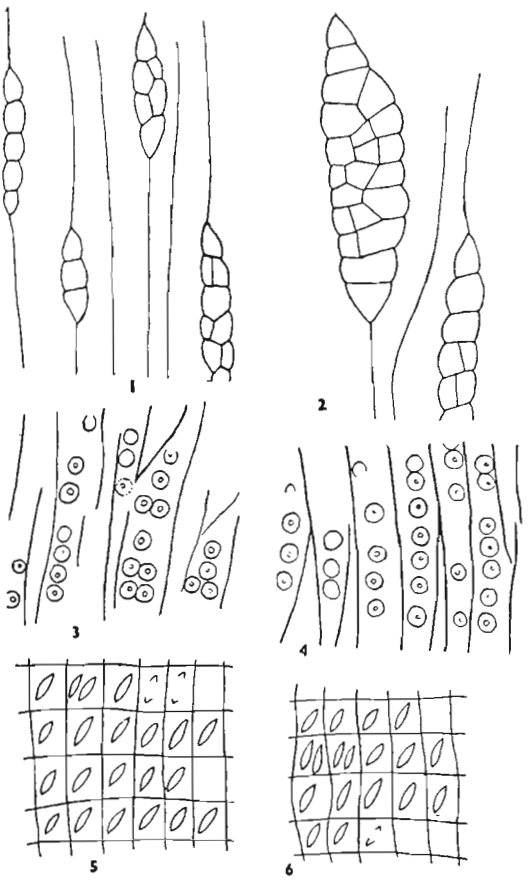
Concerning the geological age of the fossiliferous locality at Tiruvakkarai, Sahni (1931) says: "The way in which the fossils lie scattered on the ground often forming natural bridges across ravines which have been cut under them by streams of rain water suggests that they have been gradually washed out of the grits and left approximately *in situ*. There are, however, no water-worn surfaces or other evidence of the relics having been transported since fossilization, there can thus be no doubt that they are of the same age as the rocks in which they are preserved. These Trivicary grits, as the rocks are locally named, belong to the Cuddalore series... The horizon is said to range from Eocene to Pliocene." On the basis of the material described in the present paper it is not possible to add anything to the view regarding the age of the fossiliferous beds.

DESCRIPTION

Mesembrioxylon Sahnii sp. nov.

Only the secondary xylem is preserved in the blocks representing this species. The preservation is on the whole fairly good. Growth rings are clearly defined (PL. 1, FIG. 1). Transition from early to late wood is generally abrupt but sometimes more or less gradual. Early wood is quite broad but not regular in thickness. At one portion of the cross-section it is rather limited in its breadth and the cells are generally arranged in regular rows, but occasionally irregularly arranged with sinuous walls which probably is due to the heavy crushing, crumpling and contortions during the period of fossilization. When regular, the tracheids are more or less square or polygonal in cross-section, 30-40 μ in diameter. They are thin-walled, wall being 6 μ thick. Late wood is always narrow, about 3 to 6 cells wide, with rather thick-walled tracheids (wall 10 μ thick) which are a bit tangentially stretched, 20-25 μ in size having a rather narrow lumina. Resin canals and resin parenchyma are entirely lacking. No traumatic resin canals are visible. Medullary rays are prominent and numerous. They are generally uni- to biseriate (FIGS. 2, 3; TEXT-FIG. 1), very rarely triseriate (TEXT-FIG. 2) with rather thin-walled oval cells which are sometimes almost circular, as seen in tangential section, and are about 20 $\times$ 16 μ. The rays are usually 1 to 20 cells in height, the average height being 8 cells. Ray tissue is always parenchymatous. Tangential walls of the wood elements and rays are unpitted. Neither the tracheids nor the medullary rays contain any resinous matter. In some tangential sections clear branch traces are to be seen (PL. 1, FIG. 4).

The rather small bordered pits on the radial walls of the tracheids are predominantly uniseriate, very rarely biseriate, most of them being isolated from each other by a considerable distance. When biseriate,



TEXT-FIGS. 1-6 — *Mesembrioxylon Sahnii* sp. nov. 1, medullary ray tissue in the tangential section. × 400. 2, a rarely seen triseriate medullary ray. × 400. 3, 4, bordered pitting in the radial section. × 400. 5, 6, fusiform field pits. × 400.

the pits are always opposite and when contiguous, they are not flattened. The pits are 9 μ with generally small and circular pores (TEXT-FIGS. 3, 4; PL. 1, FIG. 5). Rims of Sanio are absent. In each field there is generally a single (rarely two) fusiform simple pit (TEXT-FIGS. 4, 5; PL. 1, FIG. 6). Rarely there are two almost round borderless pits in the field (PL. 1, FIG. 7), the pores being rather faint and more or less vertical.

For comparisons with the various species of the genus reference may be made to Table I.

Diagnosis — Growth rings well defined, transition from early to late wood generally abrupt, resin canals and resin parenchyma lacking, radial pits nearly always uniseriate, circular, mostly separate, sometimes contiguous but not flattened, pore of the pits mostly round, rims of Sanio absent, medullary rays uni- to biseriate, very rarely triseriate, varying from 1 to 20 cells in height, on an average 8 cells, cells rather thin-walled, oval, abietinious pitting absent, field pits one or rarely two, fusiform and borderless.

Mesembrioxylon tiruvakkaraianum sp. nov.

This species also is represented only by the secondary xylem. The preservation is fairly satisfactory. Growth rings are clearly visible to the naked eye, but, under the microscope there is no distinction between spring and autumn wood (PL. 2, FIG. 1). Resin parenchyma is sparsely represented. Resin canals are absent. Traumatic resin canals are not seen. The tracheids are usually arranged in regular rows and roughly square in outline with thickened walls. They are 45-50 μ. Thickness of the wall about 10 μ.

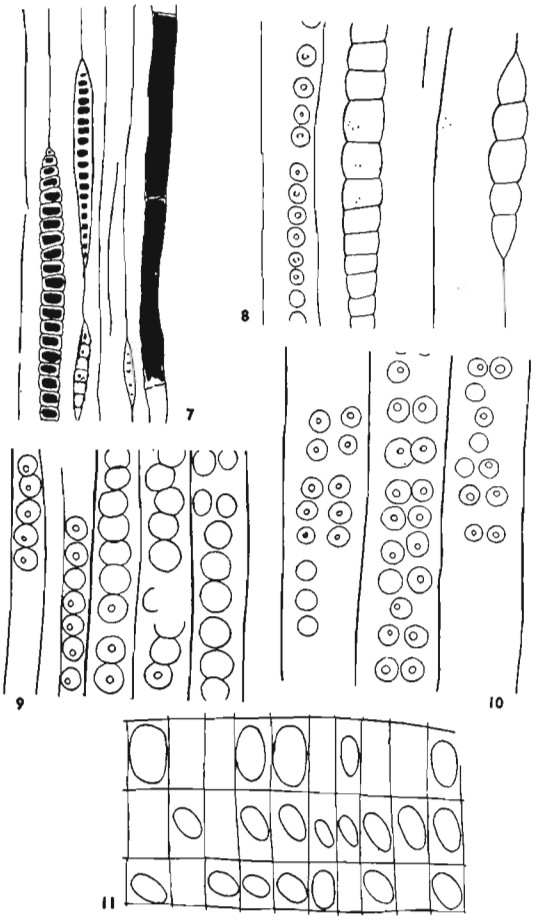
Medullary rays are exclusively uniseriate (TEXT-FIG. 7, PL. 2, FIG. 2). They are 3 to 50 cells in height, the average being 18 cells. The ray cells are generally isodiametric and 15 μ in diameter. They are rather thick-walled and contain black resinous matter. Pitting on the tangential walls of the tracheids is not uncommon (TEXT-FIG. 8). Pits are bordered, uniseriate, circular, separate or slightly contiguous, and are 10 μ in diameter. The pores are not well preserved. End walls of the sparsely present resin parenchyma are usually transverse (TEXT-FIG. 7).

The radial pits rather large in size are always uni- to biseriate (TEXT-FIGS. 9, 10; PL. 2, FIGS. 3-5), isolated or contiguous. When biseriate, they are always opposite. The pits are 25 μ in diameter with rather large circular pores. Rims of Sanio are not seen. Each field is completely filled up with a single large rounded or oval pit which apparently is borderless (Eiporen, TEXT-FIG. 11; PL. 2, FIGS. 6, 7).

If compared with *M. Sahnii*, the present species differs in having very deep medullary rays which are nearly always uniseriate, in the presence of sparsely present resin parenchyma, in the abundant occurrence of biseriate bordered pitting and last but not least in having a single large simple rounded or oval pit filling the field.

TABLE I

Species	Growth rings	Medullary ray tissue	Xylem parenchyma	Bordered pitting	Field pitting	Rims of Sanio	Age
M. Woburnense Stopes	Well marked	Uniseriate, mostly 3 cells deep, but vary from 1 to 25 cells, uniform	Abundant	1 to 2 rows scattered opposite	One large circular or oval pit, often two such pits per field	Present	—
M. bedfordense Stopes	Well marked	Uniseriate, up to 8 cells, uniform	Abundant	Uniseriate, in chains, of 3 to 10, flattened by contact	One large circular oval pit, sometimes with a border	—	—
M. Gothani Stopes	Well marked	Uniseriate, 2 to 4 cells deep, uniform	Sparsely present	Uniseriate, separate	1 to 2 large oval pits, obliquely placed	—	—
M. Solmsi Stopes	Well developed	Uniseriate, inconspicuous, very low	Abundant	Subopposite, uniseriate, separate	Not preserved	—	—
M. Schwendae Kubart	Well marked	Uniseriate, 1 to 13 cells deep	Present	1 to 2 rows opposite or subopposite	1 to 3, often 5 in the field bordered with an obliquely vertical pore	—	Cretaceous and Tertiary
M. aparenchymatosum Gothan	—	Uniseriate	Absent	—	1 to 2 elliptical circular pits	—	Tertiary
M. antarcticum Gothan	—	Uniseriate	Sparsely present	Uniseriate, separate	—	—	Tertiary
M. Mulleri Schenk	—	—	—	Uniseriate and widely separate	Highly absent, oblique	—	Pliocene
M. Hookeri: Cupressinoxylon Hookeri Arber	Well marked	Uniseriate, very rarely up to 20 cells	Abundant	Uniseriate, separate, tangential pitting present	Single large simple pit	Clearly shown	Tertiary
M. Shanense Sahni	Scarcely visible	Uniseriate, very low, usually 1 to 2 cells high	Not seen	Uniseriate, circular, separate	One large borderless pit (Eipo-ren)	—	Jurassic
M. Sewardi Sahni	Abrupt transition from early to late wood	Uniseriate, 1 to 4 cells high	Present	Uniseriate, separate, tangential pitting present	One large circular borderless pit	Present	Jurassic
M. Schmidianum (Schilden) Sahni	Faintly marked	Uniseriate, rarely biseriate, 2 to 100 cells in height, uniformly thick-walled cells	Scanty cells many times longer than broad	Uni- or biseriate, circular, usually separate	One or two large, pores slit-like, obliquely vertical	—	Tertiary (exact age unknown)
M. godaverianum Sahni	Absent	Uniseriate, 2 to 15 cells high, uniform	Abundant, full of resin	Uniseriate, contiguous but rounded, if biseriate subopposite or even alternate	2 to 6 bordered pits, pore slit-like, obliquely vertical	—	Jurassic
M. malerianum Sahni	Distinct to the naked eye but disappear under the microscope	Uniseriate, very low, scarcely 3 cells in height	Absent	Uniseriate, contiguous but circular, pore oblique	3 to 10, usually 4 to 6, border oval or circular, pore narrow, obliquely vertical	Not seen	Maleri (Upper Gondwana)
M. Parthasarathyi Sahni	Faintly marked	Uniseriate, 1 to 18 cells high	Not preserved, if any	Always uniseriate, separate or contiguous	2 to 5 or 6 round bordered, pore narrow, obliquely vertical	—	Sripremature Group (Kota stage Upper Gondwana)
M. sp.	Well marked, very narrow	1 to 3-seriate, frequently biseriate, 5 to 45 cells high	Not seen	—	1 to 3 large, frequently two, placed one above the other, circular or oval	—	Sripremature Group (Kota stage Upper Gondwana)
M. fusiforme Sahni	Well marked	Uniseriate, usually 3 to 5 cells high, cells higher than broad	Not seen	Uniseriate, just contiguous, elliptic or almost circular	1 to 2 long, simple fusiforms, pits obliquely from wall to wall; sometimes 3 or 4 smaller ones	Conspicuous	Tertiary(?)
M. fluviale Sahni	Narrow growth rings	Usually 3 to 4 cells, highest 8-ray cells, higher than broad	Present	Uniseriate, either separate or circular, or just contiguous and elliptic	1 to 2 simple oblique pits	—	Tertiary(?)
M. Sahnii n. sp.	Well marked	Uni- to triseriate, 1 to 20 cells in height, average height 8 cells, ray cells isodiametric	Lacking	Nearly always uniseriate, circular, separate or contiguous but not flattened	Single fusiform pit without any border	Not seen	Tertiary(?)
M. tiruvakkaraianum n. sp.	Faint	Uniseriate, 3 to 50 cells in height, average height 18 cells. Cells rather thick-walled	Sparse, end walls transverse	Uni- to biseriate, separate, opposite when biseriate, tangential pitting present	Large single borderless pit fills the field	Not seen	Tertiary(?)



TEXT-FIGS. 7-11 — *Mesembrioxylon tiruvakkaraianum* sp. nov. 7, tangential section showing the uniseriate medullary rays and resin parenchyma. × 200. 8, uniseriate bordered pits on the tangential walls of the tracheids. × 400. 9, 10, bordered pitting in the radial section. × 400. 11, field pitting. × 400.

M. Schmidianum described by Sahni (1931) from the same area resembles to some extent the present species. The faint growth rings, the scanty resin parenchyma and the height of the medullary rays are the features which are common to both the species. The differences at the same time are none the less prominent. The absence of the biseriate medullary rays, the presence of tangential pitting, the rather low height of medullary rays when compared to *M. Schmidianum* and finally the presence of a single large borderless pit in the field are the characters that distinguish *M. tiruvakkaraianum* from *M. Schmidianum*.

For comparisons with other species, see Table I.

Diagnosis — Growth rings faintly marked, resin canals absent, resin parenchyma sparsely present with transverse end walls, radial pits of tracheids uni- to biseriate, usually separate, always opposite, tangential pits circular, uniseriate, medullary rays rather long (up to 50 cells), cells thick-walled, field pit single rounded or oval, large and borderless.

DISCUSSION

Fossil woods, showing apparent similarity with the genera *Podocarpus*, *Dacrydium* and *Phyllocladus* which belong to the family Podocarpaceae, are referred to the artificial genus *Mesembrioxylon* by Seward (1919). The genus, as defined by Seward himself, comprises woods in which "the general features are similar to those associated with *Cupressinoxylon*, but the xylem parenchyma may not be always present and the medullary ray cells have one or two large simple pits, or two or more smaller bordered pits in the field, the pore being rather vertical than horizontal" (SEWARD, 1919).

Gothan originally created two genera, *Podocarpoxylon* agreeing in all its characters with *Podocarpus* and *Dacrydium*, and *Phyllocladoxylon* generally agreeing with *Phyllocladus*. Gothan's *Podocarpoxylon* generally stands for woods lacking resin canals and possessing xylem parenchyma not necessarily confined to a particular region of the annual ring. In *P. aparenchymatosum* Gothan, however, xylem parenchyma is absent. The bordered pitting is uni- to biseriate; when biseriate, the pits are opposite. Rims of Sanio are present and the pits in the field are podocarpoid, i.e. a few apparently bordered pits characterized by elliptical or linear pore which is vertical or oblique. Sometimes the field pits may be large and simple. Medullary rays are uniseriate and generally of low height. The genus *Phyllocladoxylon* resembles, in almost all the important features, *Podocarpoxylon* but differs chiefly in the presence of large simple pits (Eiporen) in the field. No clear indication of rims of Sanio, no resin canals and no resin parenchyma are to be seen in *Phyllocladoxylon*. With such slight anatomical differences between *Podocarpoxylon* and *Phyllocladoxylon*, it is very difficult to keep these two genera apart. Seward, therefore, created the genus

Mesembrioxylon with the intention of merging both these genera into one. Stopes (1915) agreed in the idea that there should not be two separate generic names, but united Gothan's two genera under a single genus *Podocarpoxylon*. The use of the name *Podocarpoxylon*, either as defined by Gothan or Stopes, implied a very definite relationship to the recent genus for which there are hardly any potent reasons. Seward says: " In this instance as in many others, the anatomical characters do not enable us to assign fossil species to a position within the coniferales sufficiently definite to be denoted by the use of a name implying close relationship to a particular genus as distinct from a group of allied types " (1919, p. 203). Thus it seems preferable to refer the present woods to the form genus *Mesembrioxylon*. They may be compared to some extent to the recent *Podocarpaceae*, but we cannot prove definitely, as yet, that there is any real affinity to that family.

ACKNOWLEDGEMENTS

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EXPLANATION OF PLATES

PLATE 1

Mesembrioxylon Sahnii sp. nov.

1. Transverse section showing the growth rings. × 50.
2. Tangential section showing uni- and biseriate nature of the medullary rays. × 50.
3. Irregularly arranged tracheids in tangential section probably caused by heavy crushing and crumpling during fossilization. × 50.
4. Branch trace in a tangential section. × 50.
5. Part of the radial section showing the uniseriate circular and separate bordered pits. × 200.
6. Fusiform pits in the field. × 200.
7. Field with two faintly bordered pits. × 200.

PLATE 2

Mesembrioxylon tiruvakkaraianum sp. nov.

1. Transverse section. × 50.
2. Tangential section showing the uniseriate medullary rays. × 200.

3-5. Bordered pitting in the radial section. × 200.

6, 7. Pits in the field. × 200.

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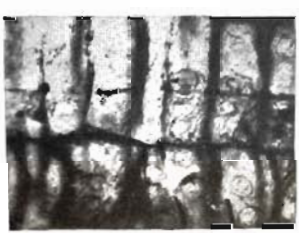

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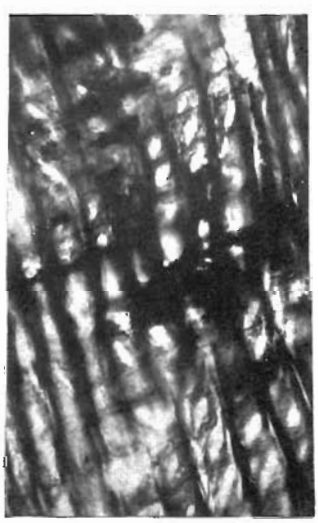

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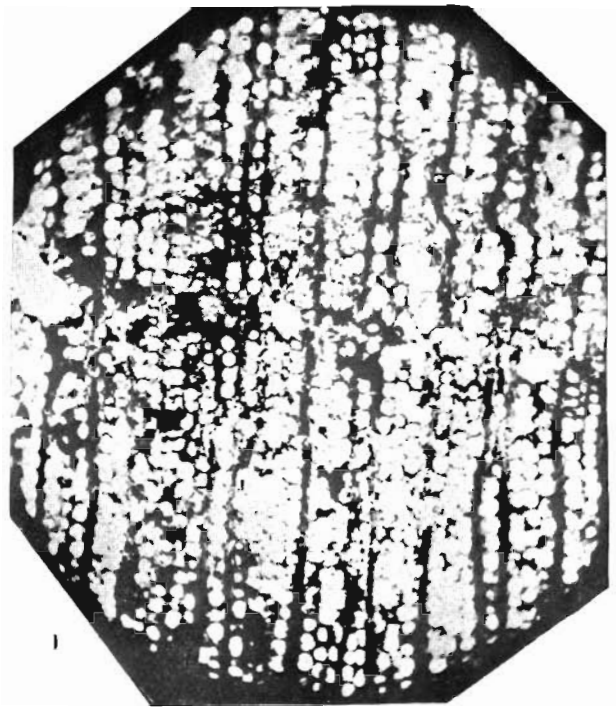
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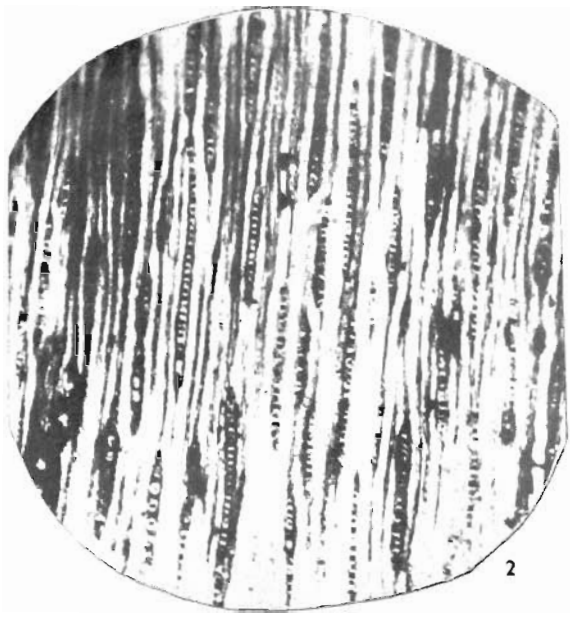
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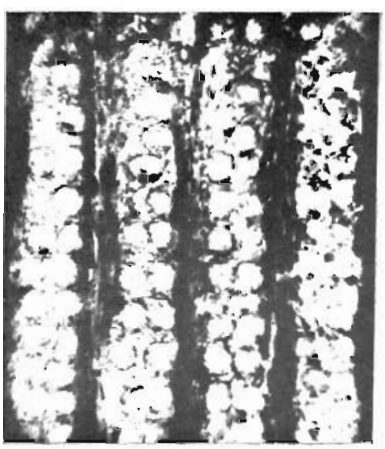
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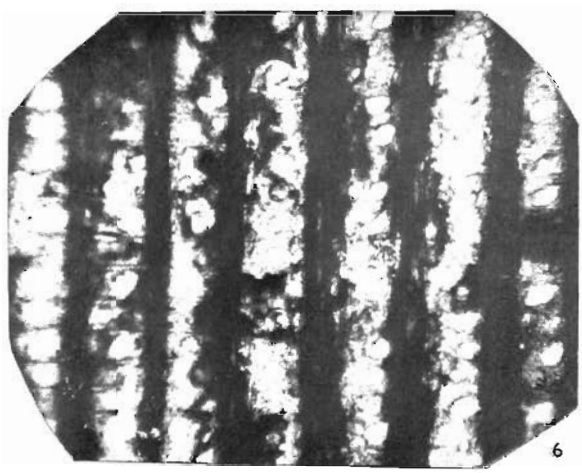
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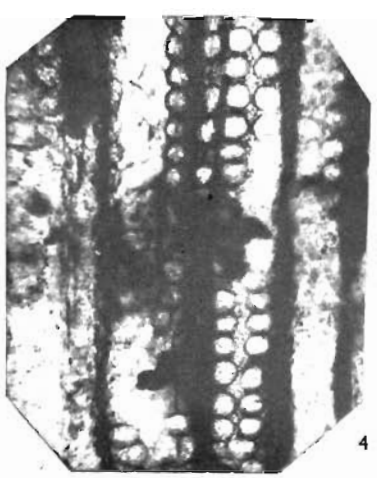
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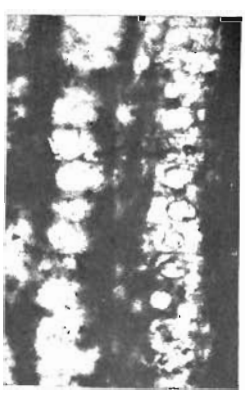
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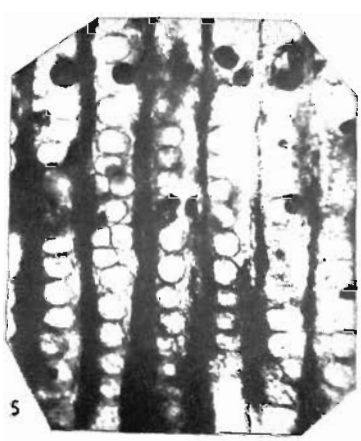
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