CONIFEROCAULON LATISULCATUM SP. NOV. FROM THE RAJMAHAL HILLS, BIHAR, WITH REMARKS ON THE AFFINITIES OF THE GENUS

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ABSTRACT

A new species of a petrified wood referable from its external characters to *Coniferocaulon* Fliche is described. This genus has previously been recorded from the Rajmahal Hills in the form of casts, but the anatomical details are given here for the first time. On the basis of these the affinities of the genus have been discussed.

Coniferocaulon latisulcatum is closely comparable to some species of *Mesembrioxylon* Seward in having a narrow pith with scattered stone cells; uniseriate, low medullary rays; scattered xylem parenchyma; radial pits usually arranged in a single row, separate or contiguous, and circular, but sometimes flattened, rarely biseriate, opposite or sub-opposite; and in having pits with oblique pores in the cross-field. The wood is also closely comparable to that of *Podocarpus ferruginoides* Compt.

The characters of this species of *Coniferocaulon* are, as a whole, more suggestive of a Podocarpinean affinity rather than Araucarian.

INTRODUCTION

OUR knowledge of the stems belonging to the genus *Coniferocaulon* is confined only to their external characters, except for some tracheids showing Abietineous pitting obtained by Stopes (1915, p. 163; TEXT-FIG. 47) from a Lower Greensand Cast. The stem is characterized by having its surface irregularly grooved in a transverse direction with occasional elliptical protuberances.

The first record of similar stem dates back to 1862 when Mackie figured a fossil Dragon tree from Kent which was later named by König as *Dracaena benstedtii* (SEWARD, 1919, p. 445) noticing its resemblance to stems of *Dracaena*. Later Seward (1896, p. 216) pointed out its resemblance to stems of *Zamia* which do not retain the armour of leaf bases and gave a new generic name *Benstedtia* to avoid implication of relationship with modern genera.

In 1900 Fliche figured stems with similar surface characters from the Lower Cretaceous of France as *Coniferocaulon colymbeaeforme* comparing them to the stems of *Araucaria imbricata*. Similar stems have been recorded by Seward from Uitenhage (Wealden) series of South Africa as *Benstedtia* sp. (1903, pp. 34-37) and from Sutherland as *Coniferocaulon colymbeaeforme* (1911, p. 690); the latter showing a small pith suggestive of conifer.

From India similar stem impressions have been described by Bancroft (1913, pp. 72, 73), and Sahni (1931, PL. 12, FIG. 53, p. 78) from the Rajmahal Hills as *Coniferocaulon*. Recently Gupta (1954, PL. 3, FIGS. 15, 16, p. 22) described similar impressions from Rajmahal under a new specific name, *C. rajmahalense*.

From the above review it is evident that stems of this general type are described under two names, *Benstedtia* and *Coniferocaulon*. The former name is used for specimens where only the surface characters are preserved and their coniferous affinity cannot be established (they might be Cycadean). *Coniferocaulon* is used for stems which show some indication of coniferous nature.

A large number of stems showing external characters typical of *Coniferocaulon* were collected in the Rajmahal Hills. The majority of them are only preserved as casts. However, some specimens from Amarjola (PL. 1, FIG. 1) are petrified, and fairly well preserved. The casts are very similar to those described by Bancroft (1913) and Sahni (1931) as *Coniferocaulon* sp. The petrifactions show certain external features fairly distinct from those of the specimens referred to *Coniferocaulon rajmahalense* and hence are described as a new species. This specimen was earlier (SAH, 1958, p. 337) reported as *Coniferocaulon amarjolense*. However, a new specific name *'latisulcatum'* is now proposed, based on the characteristic external surface markings of the wood.

Genus *Coniferocaulon* Fliche

Coniferocaulon latisulcatum sp. nov.

Diagnosis — *Stem surface* irregularly grooved forming transversely elliptical but broad areas. *Growth rings* sharply marked. *Pith*

small, having rounded, nearly isodiametric cells and scattered stone cells; special hexagonal cells capping the secondary xylem wedges in the pith. *Primary xylem* present in groups at the internal end of the secondary xylem. *Secondary xylem* compact with well-differentiated early and late wood zones. Radial pits in early wood tracheids mostly uniseriate, circular, bordered, contiguous or separate; rarely biseriate, opposite or sub-opposite; contiguous and flattened. Pits in the late wood tracheids uniseriate, bordered, separate or contiguous. *Medullary rays* 1-8 cells high, essentially uniseriate. Pits in the cross-field, 1-2, usually one, circular and bordered; pore oblique. *Parenchymatous cells* with transverse end walls fairly common.

Locality — Amarjola, Amrapara, Santal Parganas, Bihar.

Horizon — Rajmahal series.

Collection — Holotype: Specimen No. 3341; preserved in the Museum of the Birbal Sahni Institute of Palaeobotany.

DESCRIPTION

The petrified stems from Amarjola show fairly well-preserved external features, but only one specimen (PL. 1, FIG. 1) has well-preserved internal characters. The stem is cylindrical, 4·5 cm. long and about 2 cm. broad, with the surface bearing irregular ridges running transversely and enclosing elliptical areas. These areas are broader and fewer in number than those found in *Coniferocaulon rajmahalense*. Moreover, the protuberances or depressions within these areas are not seen in the Amarjola specimens.

Transverse Section — The stem (PL. 1, FIG. 2) consists of a narrow pith surrounded by a broad, compact zone of secondary xylem, a thin band of phloem and bark.

The outer region of the cork-cambium is not well preserved. Ray cells are crushed leaving big cavities. Rows of thick-walled cells of phloem are seen at some places alternating with these. Traces of cambium appear as tabular cells between the secondary xylem and phloem bands.

The secondary xylem is compact with sharply marked growth rings (PL. 1, FIG. 2), about 18 in number. Under the microscope the early and late wood bands are well differentiated (PL. 1, FIG. 3; TEXT-FIG. 1). The early wood tracheids are slightly larger in size, thin-walled, longer than broad and vertically placed. The late wood tracheids are smaller in size, thick-walled and nearly rounded. The early wood tracheids are about three times as numerous as the late wood tracheids. A few thin-walled parenchyma cells are irregularly scattered over the secondary wood. Primary xylem is endarch, occurring in groups at the ends of the secondary xylem wedged into the pith.

The pith is small (PL. 2, FIG. 6), irregular in outline, consisting mainly of large, thick-walled, rounded parenchyma cells. Some thin-walled hexagonal cells are seen capping the xylem wedges (PL. 2, FIG. 5). A few stone cells occur scattered in the pith (PL. 2, FIG. 6).

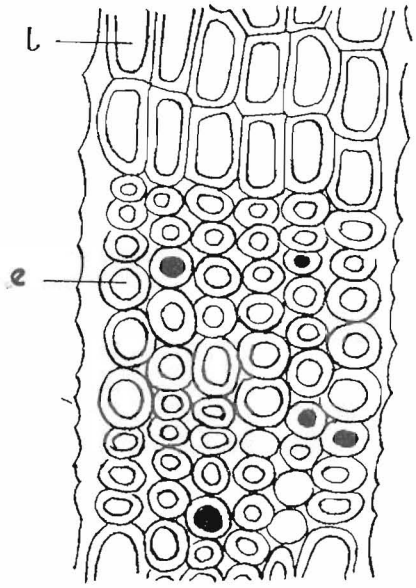
Tangential Section — The xylem rays are small, numerous, but not very crowded (PL. 1, FIG. 4). They are essentially uniseriate and 1-8 cells high (usually 4-6). The ray cells are small, slightly higher than broad, measuring 22 × 13 μ (TEXT-FIG. 2). Biseriate rays are rare. At some places 1-2 pits may be seen in the tangential walls of the ray cells, but none in the tangential walls of the tracheids. Parenchyma cells with transverse end walls are fairly common, some of them probably contained resin.

Radial Section — Pitting in the radial walls of both the early wood and late wood tracheids is fairly well preserved. Pits in the early wood tracheids are mostly uniseriate, rarely biseriate, circular and bordered (PL. 2, FIGS. 7-8; TEXT-FIG. 3). When uniseriate, the pits are usually contiguous, though separate pits are not rare. When biseriate, they are opposite or sub-opposite, circular, contiguous or separate, and flattened due to contact. The pits are fairly large, measuring 12-15 μ in diameter; pore circular and narrow, about 4 μ across. Crassulae absent.

In the late wood tracheids pits are uniseriate, separate or contiguous and comparatively smaller, 8-10 μ in diameter (PL. 2, FIG. 9), with circular pores. Pitting in the protoxylem tracheids is not seen.

There is usually only one bordered circular pit in the cross-field, almost occupying the entire area (PL. 2, FIG. 10). Some rays have two bordered, circular pits in each such field. The pore appears to be broadly oval and slightly inclined (TEXT-FIG. 4).

The pith cells are relatively thick-walled, parenchymatous, longer than broad or transversely compressed and packed in vertical rows. The stone cells are much larger than the pith cells and more thick-walled.



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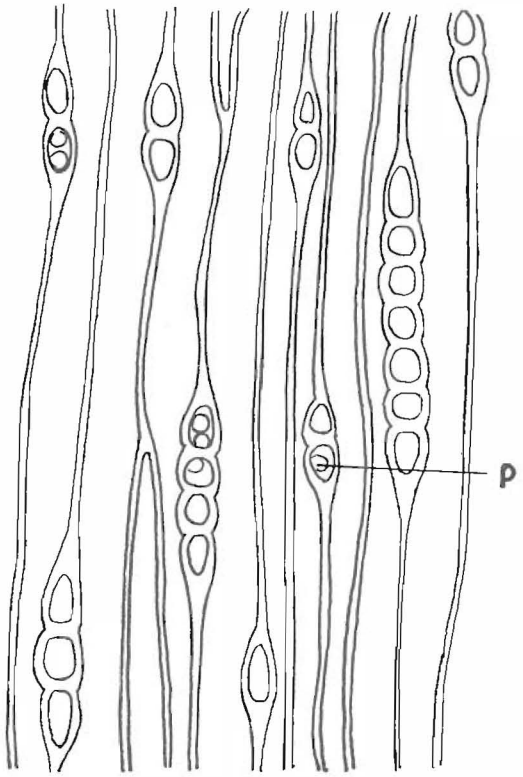

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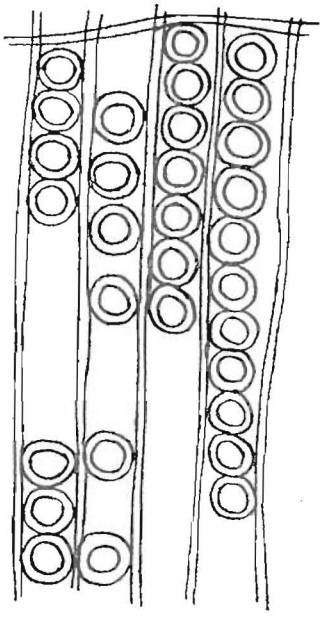

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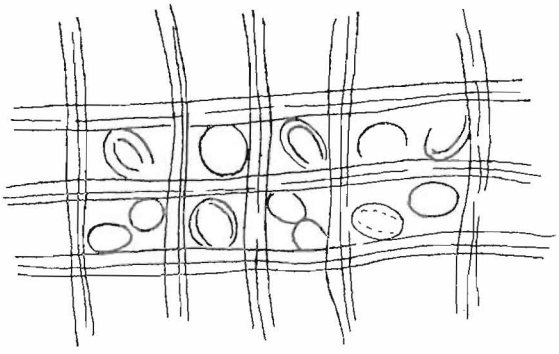

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TEXT-FIGS. 1-4—1, part of the secondary wood in transverse section showing well-marked growth rings (*l*, late wood tracheids, larger and more developed; *e*, early wood tracheids, comparatively smaller and rounded). × 450. 2, part of the secondary wood in tangential section showing uniseriate medullary rays (*p*, pits in ray cells). × 450. 3, part of the early wood tracheids in radial section showing uniseriate, circular pits. × 450. 4, part of secondary wood in radial section showing pits in the field. × 500.

COMPARISONS

The fossil here described is characterized by its narrow pith with scattered stone cells; sharply-marked growth rings; uniseriate, low medullary rays; tracheids with uniseriate or sometimes biseriate opposite pits; 1-2 pits in the cross-field; and scattered parenchyma. It accordingly comes nearest to *Mesembrioxylon* (*Podocarpoxylon* of Gothan) Seward (1919, pp. 173, 203). Similar characters are also sometimes found in the genus *Dadoxylon* (*Araucarioxylon*), but in such cases the Araucarian pitting is predominant. Several species of *Mesembrioxylon* and *Dadoxylon* have been recorded from the Mesozoic and Tertiary formations of India (SAHNI, 1931; SURYANARAYANA, 1953, 1955; VERMA, 1954), while only one species of *Mesembrioxylon* and two species of *Dadoxylon* are so far known from the Rajmahal Hills (SAHNI, 1931; BHARDWAJ, 1953). In individual features *Coniferocaulon latisulcatum* may well compare with some of these.

Among the Rajmahal species of *Dadoxylon* (*Araucarioxylon*), *Coniferocaulon latisulcatum* resembles *Dadoxylon jurassicum* Bhardwaj (1953) only in its narrow pith with scattered stone cells and uniseriate, low medullary rays, while recalling *D. rajmahalense* Sahni (1931; SURYANARAYANA, 1955) it compares in possessing distinct growth rings and uniseriate, low medullary rays; and in having a single row of contiguous or separate pits in the radial walls of the tracheids. But both these species essentially differ from *C. latisulcatum* in having predominantly 2-3 rows of alternate contiguous pits forming hexagons in the radial walls of the tracheids. In contrast to the other species of *Dadoxylon*, too, *C. latisulcatum* differs essentially in having uniseriate, separate, circular or sometimes contiguous flattened pits in the radial walls of the tracheids.

Coniferocaulon latisulcatum also resembles to a considerable extent some of the species of *Mesembrioxylon*. *M. indicum* Bhardwaj (1953) comes close to *C. latisulcatum* in possessing well-defined growth rings; uniseriate, low medullary rays; 1-2 pits in the field with inclined pores; single row of separate, circular or sometimes contiguous flattened pits in the radial walls of the tracheids, and in the presence of stone cells in the pith. *Coniferocaulon latisulcatum*, however, differs in having well-differentiated early and late wood zones, xylem parenchyma, and sometimes two rows of opposite or sub-opposite, contiguous and flattened radial pits, which in *M. indicum* are uniseriate and separate. *Mesembrioxylon godaverianum* Sahni (1931, p. 59), a Jurassic species from Kota-Maleri stage, resembles *C. latisulcatum* only in having a single row of radial pits or occasionally two rows of sub-opposite or even alternate pits. The pits are, however, always circular in the former species, while in *C. latisulcatum* they are usually contiguous and flattened when occurring in two rows. *Mesembrioxylon godaverianum*, moreover, differs in the absence of growth rings, in the presence of abundant resin parenchyma and in having 2-6 pits in the cross-field.

Mesembrioxylon parthasarathyi Sahni (1931, p. 60), another Jurassic species, differs in possessing faintly-marked growth rings; higher (1-18 cells) medullary rays; 2-6 pits in the cross-field; and in the radial pits being always in a single row. *Mesembrioxylon schimidianum* Sahni (1931, p. 54), a Tertiary species, is distinguished by its very high medullary rays (up to 100 cells).

As regards the foreign species, *Coniferocaulon latisulcatum* shows some resemblance to *Mesembrioxylon* (*Podocarpoxylon*) *woburnense* Stopes (1915, pp. 211-216; SEWARD, 1919, p. 207) from the Lower Greensand of Bedfordshire, and *Mesembrioxylon* sp. (? *Podocarpoxylon* of Gothan) from the Bathonian rocks of Russian Poland (SEWARD, 1919, p. 206), in its well-marked growth rings and low medullary rays, as well as in having xylem parenchyma, separate or contiguous, slightly flattened bordered pits on the radial walls of the tracheids, and 1-2 pits in the cross-field. They differ, however, from *C. latisulcatum* in having crassulae and bordered pits on the tangential walls of the tracheids.

In respect to the living genera, the Amarjola fossil approaches nearest to *Podocarpus ferruginoides* Compt. (GREGUSS, 1951, PL. 21, FIGS. 81-84, pp. 112, 113), in having sharply marked growth rings, uniseriate and low medullary rays and similar pitting in the radial walls of the tracheids. *Podocarpus ferruginoides* also has one or two pits in the cross-field with narrow inclined pores.

On the basis of internal anatomy the Amarjola wood is thus closely comparable with *Mesembrioxylon* among the fossil genera and with *Podocarpus* among the living.

AFFINITIES

From the structure of the wood there is no doubt that *Coniferocaulon latisulcatum* shows a close agreement with conifers. An Araucarian affinity for similar fossil woods was first suggested by Fliche (1900) who compared them with *Araucaria imbricata,* though enough support for this opinion was lacking. Stopes (1915, pp. 159-164), however, found more definite evidence for their coniferous (Abietinean) affinity, in the presence of uniseriate, bordered, separate and circular pits in some specimens labelled *Benstedtia.* Bancroft (1913), Sahni (1931) and also Gupta (1954) appear to be more in favour of their being coniferous.

Coniferocaulon latisulcatum, however, shows closer affinities with *Mesembrioxylon* than with *Dadoxylon* (*Araucarioxylon*). The genus *Mesembrioxylon* is considered to be composed mostly of Podocarpinean conifers, owing to the presence of podocarpoid pits (pore being narrow and inclined) in the radial walls of the medullary ray cells and in having uniseriate, low medullary rays. The almost complete absence of Araucarian arrangement of the radial pits and the presence of podocarpoid pits in the radial walls of the ray cells in my specimen are more suggestive of Podocarpinean than Araucarian affinity. The close similarity of the Amarjola wood with that of *Podocarpus ferruginoides* is another supporting evidence in favour of a Podocarpinean affinity.

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EXPLANATION OF PLATES

PLATE 1

Coniferocaulon latisulcatum sp. nov.

1. The stem showing the transverse grooves forming islands. Note the few and comparatively broader grooves. × 1. Loc. Amarjola. Reg. No. 3341.

2. Transverse section of the stem showing a very narrow pith, surrounded by a broad zone of secondary xylem. Note the sharply marked growth rings. × 8. Slide No. 3341/1.

3. Transverse section of the stem enlarged to show the well-differentiated early and late wood tracheids. Note cells of part of cambium and cork cambium. × 90. Slide No. 3341/1.

4. Tangential section of the secondary wood showing small and numerous medullary rays. Note the low height of the rays and ray parenchyma with transverse end walls. × 130. Slide No. 3341/7.

PLATE 2

Coniferocaulon latisulcatum sp. nov.

5. Transverse section of part of the pith, enlarged to show the thin-walled hexagonal cells capping the xylem wedges. × 500. Slide No. 3341/1.

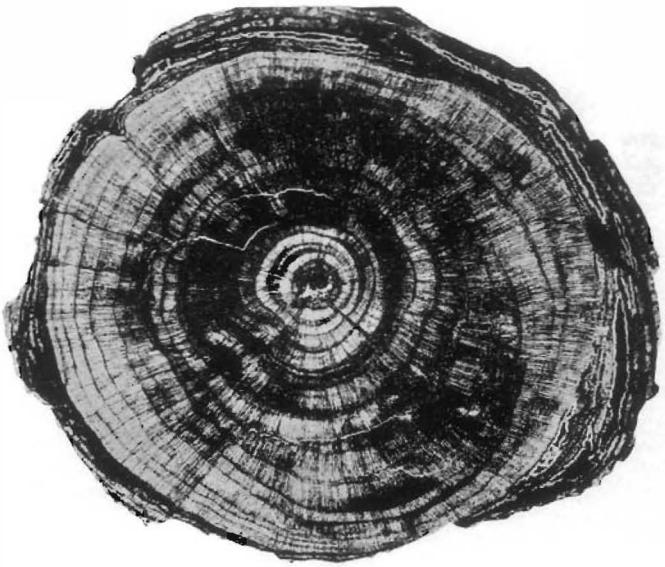
6. The pith region of the stem, enlarged to show the primary xylem occurring in groups at the ends of the secondary xylem wedging into the pith. Note the stone cells scattered between the pith cells. × 90. Slide No. 3341/1.

7. Part of spring wood tracheids in radial section showing uniseriate, circular, or biseriate, subopposite, contiguous, circular or flattened pits. × 500. Slide No. 3341/4.

8. Part of the spring wood tracheids showing biseriate, opposite or sub-opposite, contiguous and flattened pits. × 500. Slide No. 3341/5.

9. Part of autumn wood tracheids showing circular, separate or contiguous radial pits in a single row. × 500. Reg. No. 3341 5.

10. Part of medullary ray cells in radial section showing 1-2 pits in each field. × 500. Reg. No. 3341/6.



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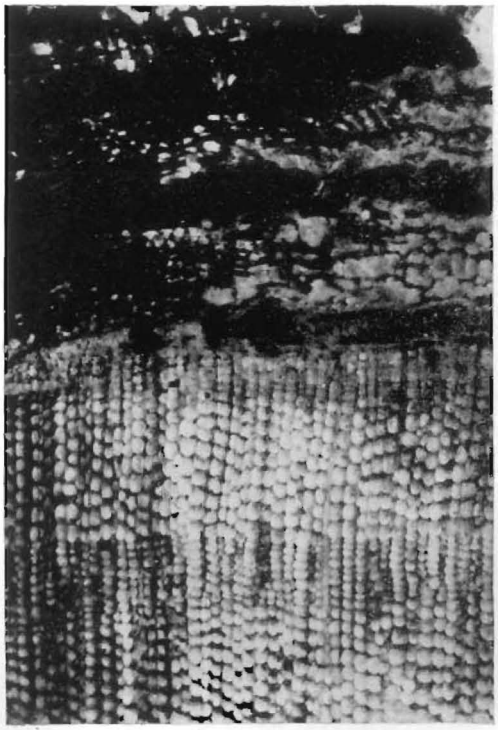

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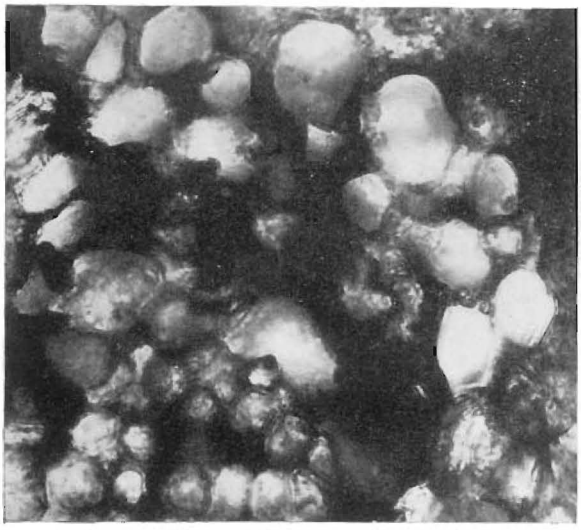

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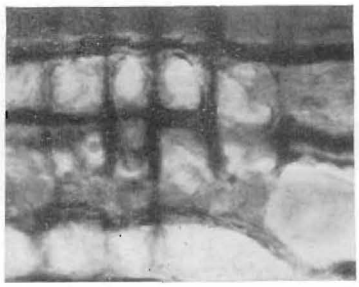

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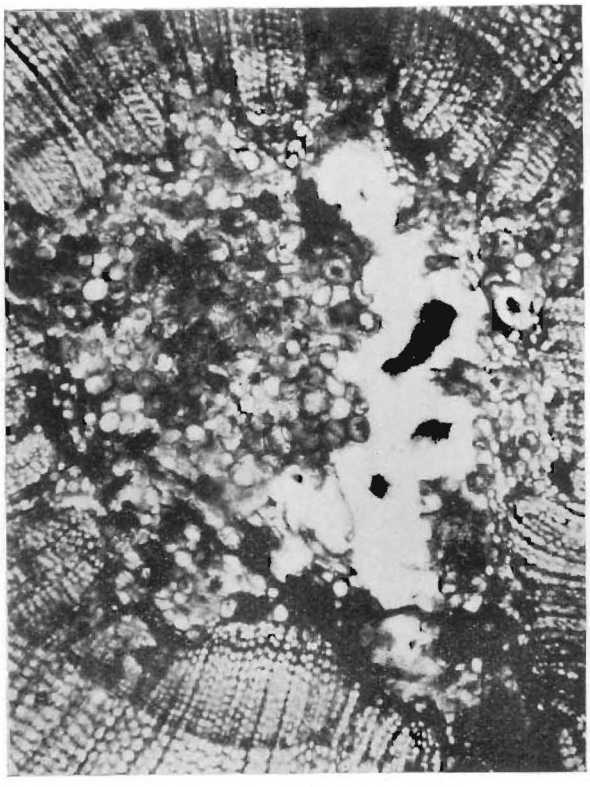

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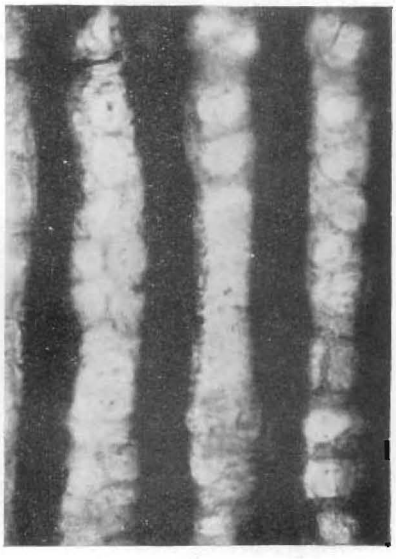

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