OSMUNDITES SAHNII SP. NOV., A NEW SPECIES OF PETRIFIED OSMUNDACEOUS RHIZOMES FROM INDIA

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ABSTRACT

The paper describes a petrified osmundaceous rhizome discovered from near Bindrabun in the Jurassic of the Rajmahal Hills, Bihar.

The specimen made up of vertically growing leaf bases and roots, includes three stems in it. Each stem has a broad sclerenchymatous outer cortex, surrounding a narrow inner cortex. The stele consists of 50-70 individual strands arranged in a circle surrounding the sclerenchymatous pith. Most of the strands are continuous with one another. The medullary strands are absent. The C-shaped leaf traces are each enclosed in a sclerotid ring with several protoxylem groups. Several sclerenchymatous strands are found scattered in the pith of the trace as well as in the stipular wing. No sclerenchymatous tissue is noticed in contact with the stele of the leaf trace.

The specimen differs from the other Jurassic species of *Osmundites* in the distribution of sclerenchymatous strands in the leaf bases.

INTRODUCTION

THE geological history of Osmundaceae has recently been reviewed by Arnold (1952). The only fossils with possible Osmundaceous affinities known from India are the leaf impressions described as *Cladophlebis denticulata* and *C. indica.* (SAHNI & RAO, 1933, p. 189; SAHNI, 1934, p. 263; GANJU, 1946, p. 61) and *Cladophlebis* sp. (SAHNI, loc. cit.). The present specimen is the first petrified fossil of this family from India. It was discovered by the author in 1954 lying stray on the eastern slope of the Goalipahar bordering Hisiganj village about 4½ miles south of Bindrabun (Brindabun) dak bungalow. Bindrabun lies four miles north of Tinpahar Railway Station on the loopline in the Rajmahal Hills, Bihar. Silicified woods and poorly preserved cherty boulders are frequently met with in this locality.

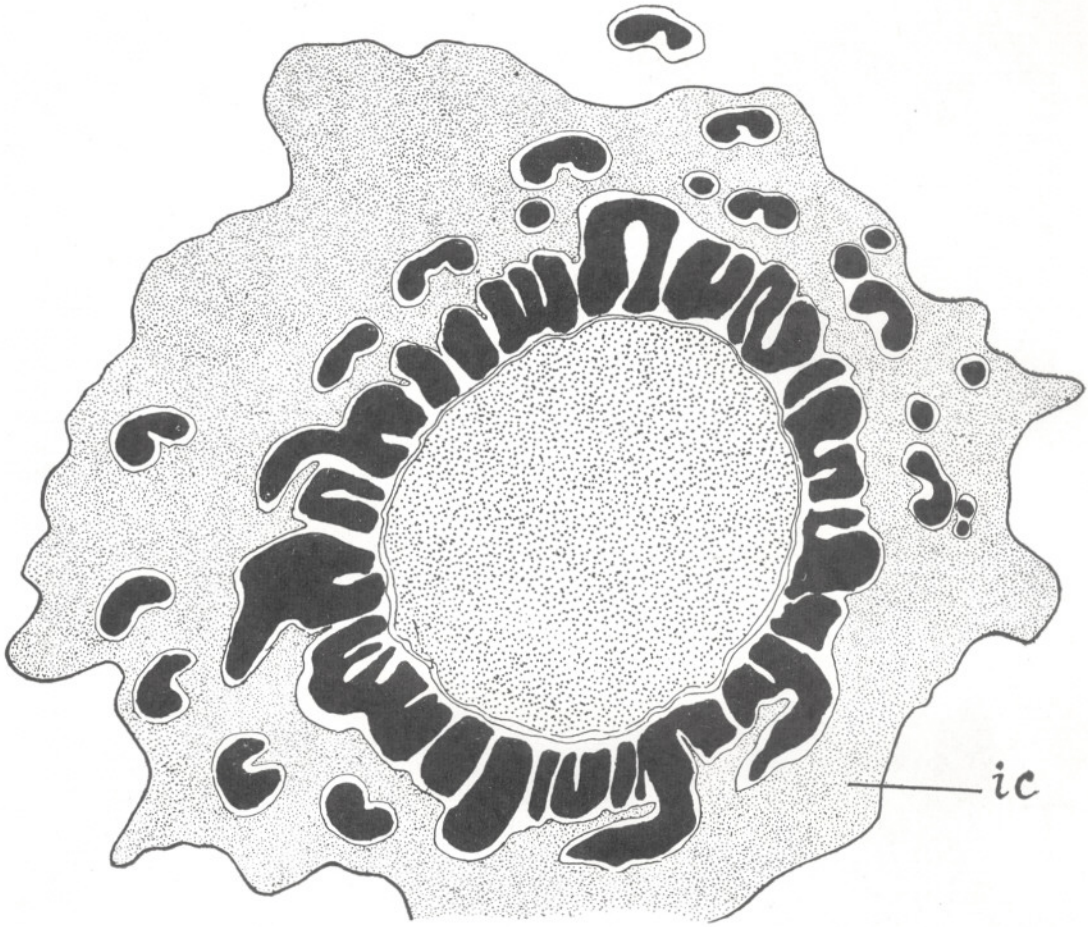
DESCRIPTION

Osmundites Sahnii sp. nov.

The silicified specimen (PL. 1, FIG. 1) measuring 20-21 cm. in length, 18 cm. in breadth and about 18 cm. in thickness is more or less an irregular conical piece. It is made up of vertically growing leaf bases and roots which are also visible externally. Within the leaf-base mantel there are three stems of which there is no external indication. The stems like the leaf bases are vertical and parallel to each other. The longest stem, 12-14×1-1·5 cm., is unbranched. Lying close to it is another stem, 3-4×1-2·5 cm., which bifurcates to give rise to two branches. The third piece, about 6×2 cm., is flattened but does not show any branching. These three stems lie isolated in the specimen and no organic connection between them is seen.

The stem in cross-section (PL. 2, FIG. 2; TEXT-FIG. 1) measures 1-2·6 cm. in diameter. The outer cortex, 4-6 mm. thick, is sclerenchymatous and well preserved and is of light colour as distinguished from the dark-coloured inner cortex which is extremely narrow, up to about 1 mm. thick and devoid of any cellular structure. The stele, 0·8-1·5× 0·6-0·7 cm., is more or less oval to circular in shape. The stele is made up of 50-70 individual strands. Some of the strands are continuous but a complete continuity in all the strands is not met with. The xylem elements are well preserved and consist only of tracheids; parenchymatous cells being entirely absent. The xylem tracheid is 12-15 elements thick. At certain spots the tracheids show a speckled appearance the kind of which has also been reported in *Osmundites skidegatensis*, *Osmundites dunlopi*, and also in the living Osmundas and Todeas (PENHALLOW, 1912; KIDSTON & GWYNNE-VAUGHAN, 1907, p. 761; PL. 45, FIG. 9). The speckled nature of the tracheids is due to the presence of more than one vertical series of pits on the walls of the tracheids, a character also seen in our specimen.

The soft peripheral tissues such as the phloem, endodermis and pericycle are not preserved; their position in some cases is marked by an empty space. The pith (PL. 2, FIG. 3) is made up of thick-walled parenchymatous cells in which no tracheids are found.

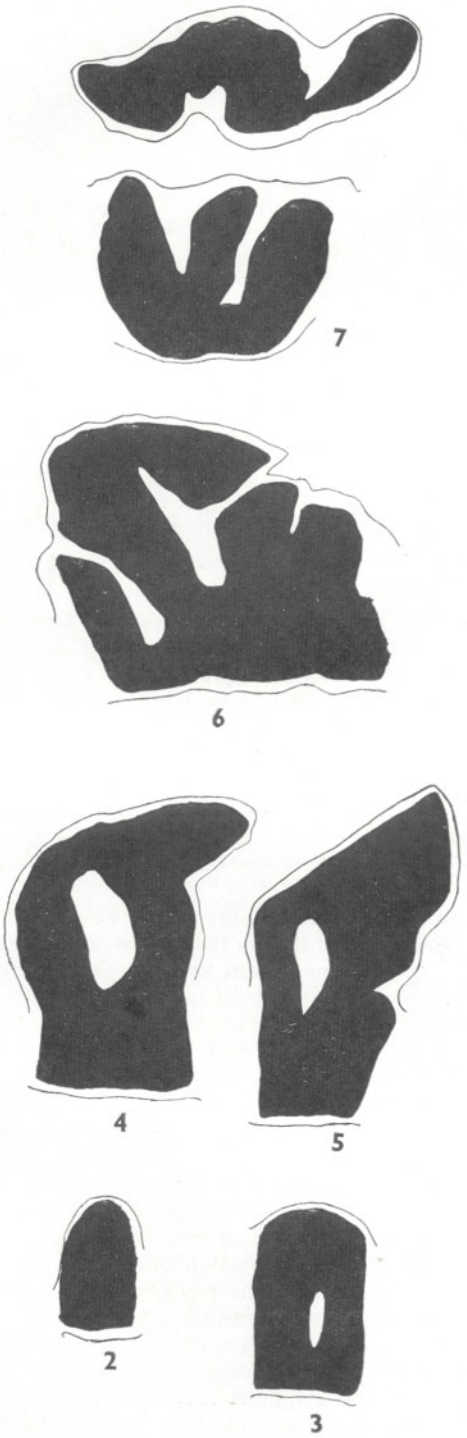


TEXT-FIG. 1 — A cross-section of a stem. × 7·5; *i.c.*, inner cortex.

The Departure of the Leaf trace — To begin with the xylem strand is a solid mass enclosing the mesarch protoxylem which cannot be recognized (TEXT-FIG. 2). A little later the island of parenchyma begins to appear (TEXT-FIG. 3); it is at this stage that the mesarch protoxylem becomes recognizable. The island of parenchyma increases in size with the increase of the xylem strand. In the outer region the xylem strand gradually arches out and its concavity becomes continuous with the pith (TEXT-FIG. 4). Gradually the two arms of the arch become constricted off one by one from the xylem strand which is ultimately left behind by the departing trace as a U- or V-shaped structure (TEXT-FIGS. 5-7).

The leaf traces so originated possess a single adaxial protoxylem and as a general rule keep their concavities facing the xylem ring, whether they turn oblique or retain the same position in which they originated. In one of the slices it is noted that one of the leaf traces shows unusually an inverse orientation with its concavity facing away from the xylem ring (TEXT-FIG. 8).

The Base of the Petiole — The leaf trace as it enters the petiole, increases in size, becomes curved and crescent-shaped. It widens to become a semicircle and ultimately a horse-shoe-shaped structure. To start with the protoxylem group is median and single. It increases and divides into two and later into several groups. The leaf trace is enclosed in a sclerotid ring. In the young leaf bases very few sclerotid strands are found scattered inside both the ring and the wings. The stipular wings in the proximal region of the



TEXT-FIGS. 2-7 — Showing the origin of the leaf trace. × 17.

petiole base are short and gradually expand as the petiole grows in size. The petiole bases measure 4-15 × 5-6 mm. in size. The thin-walled parenchyma surrounding the leaf trace and forming the tissue of the stipular wing is well preserved. In older leaf bases several sclerotid strands are found irregularly scattered inside the sclerotid ring and also in the stipular wings (PL. 2, FIG. 4; TEXT-FIGS. 9, 10). No strands are noted in close proximity with the xylem strand of the leaf base. One comparatively large and thick sclerotid strand is also noted in the middle of each half of the wing besides several small ones in this region. The winged petiole bases are very closely depressed and are undisturbed by the outgoing adventitious roots. These roots are not many and consequently several leaf bases remain unpenetrated. The cortex and the pith of the leaf trace (PL. 2, FIG. 5) are made up of circular to oval parenchymatous cells. The phloem, pericycle and endodermis are not well preserved.

The metaxylem is 3-4 elements thick (PL. 2, FIG. 6) except at the incurved margins where it is 4-5 elements thick. The protoxylem groups are 12-15 in number. In cross-section the stelar strand is C-shaped with incurved margins and in some leaf bases the strand is wavy and of various outlines such as the inverted V or W (TEXT-FIGS. 11-13) which may be due to pressure from within or due to fossilization.

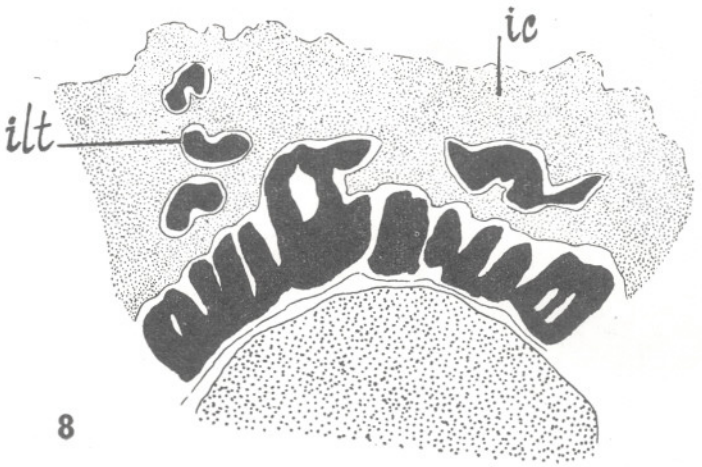
There does not seem to be any distinction between the leaf bases of scale leaves and those of ordinary leaves.

Roots — The roots run parallel through the cortex of the stem in between the leaf bases. They also bore their way through the stipular wings. No case has been seen where the roots have penetrated through the sclerotid ring. They show occasional dichotomy.

The root stele is a diarch plate (PL. 2, FIG. 7). It is surrounded by a thin-walled outer cortex which forms a narrow zone and a very large thick-walled inner cortex. Roots arise from the leaf traces (PL. 2, FIG. 8) even before they become free from the stele of the stem. The root has been found to arise at one time from each margin of the leaf trace.

Osmundites Sahnii sp. nov.

Diagnosis — Petrified rhizome made up of vertically growing leaf bases and roots



TEXT-FIG. 8 — A part of the cross-section of the rhizome showing an inversely orientated leaf trace. × 7·5; *i.c.*, inner cortex.

including variable number of dichotomously branched or unbranched stems. Stem, about 1-2·6 cm. in diameter, with 4-6 mm. broad outer sclerenchymatous cortex, surrounding a narrow inner cortex; stele about 0·8-1·5 × 0·6-0·7 cm., comprising 50-70 individual strands arranged in a ring and surrounding the sclerenchymatous pith devoid of xylem strands; most of the strands continuous with one another. Departure of the leaf traces as usual in the Osmundaceae. C-shaped leaf trace enclosed in a sclerotic ring with several protoxylem groups. Stipular wings made up of parenchymatous tissue. Several sclerenchymatous groups in the pith of the petiolar trace as well as in the stipular wings. No sclerenchyma tissue noted in contact with the stele of the trace. Root diarch and occasionally dichotomized.

Locality — Goalipahar near Hisiganj village, 4½ miles south of Bindrabun (Brindabun).

Horizon — Upper Gondwanas, Rajmahal series, Jurassic.

Collection — Holotype No. 16586 of the Birbal Sahni Institute of Palaeobotany Museum where its slices and the microscope slides are preserved.

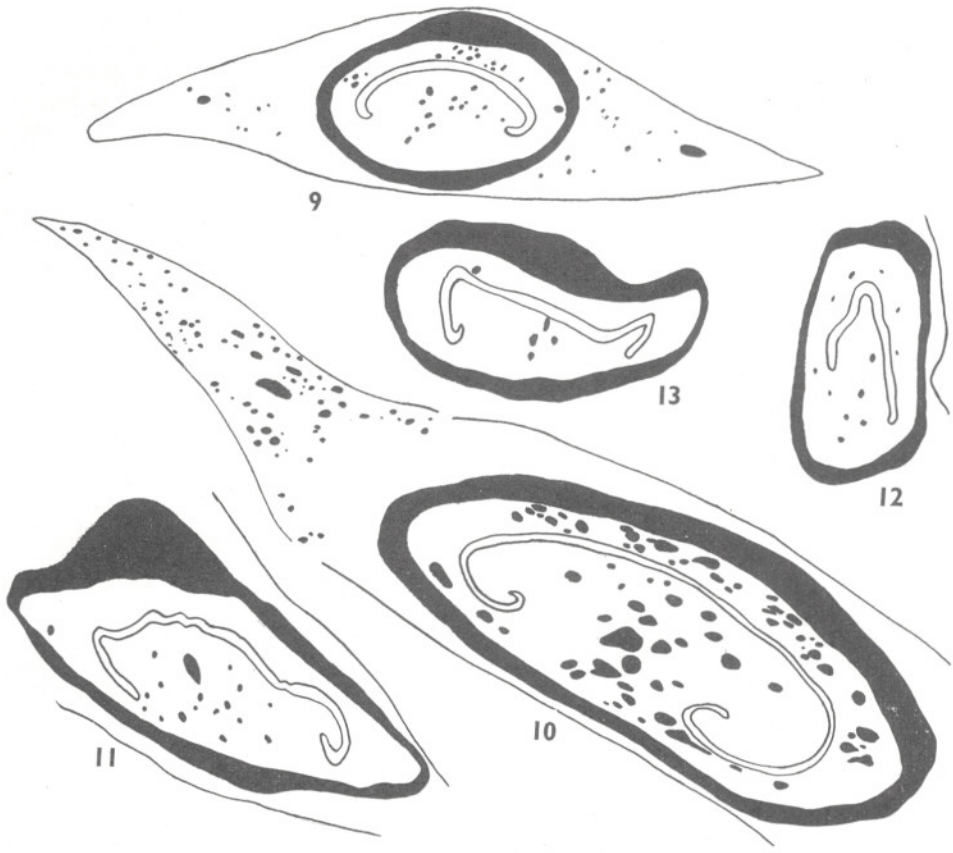
COMPARISION AND DISCUSSION

There are only two well-defined species of petrified *Osmundites* known so far from the Jurassic horizon, viz. *O. dunlopi* from the Jurassic of New Zealand, Central Australia and Queensland (KIDSTON & GWYNNE-VAUGHAN, 1907; SINNOTT, 1914; EDWARDS, 1933; SAHNI, 1920); and *O. gibbiana* from the Jurassic of New Zealand and Queensland (KIDSTON & GWYNNE-VAUGHAN, loc. cit.; SAHNI, loc cit.). *Osmundites aucklandicus* (MARSHAL, 1926) described from the upper Jurassic of New Zealand, according to Edwards (loc. cit., p. 662), is identical with *O. dunlopi*.

In its general anatomy *O. Sahnii* resembles *O. dunlopi* and differs from it in the absence of a continuous xylem ring, in the presence of a xylem parenchyma in the leaf trace and in the absence of the sclerotid strands in immediate contact with the leaf trace and also in the origin of the root traces (KIDSTON & GWYNNE-VAUGHAN, 1907, pp. 760-763).

In the nature of the xylem ring with some distinct medullary rays the specimen resembles *O. gibbiana*. The Rajmahal fossil further resembles it in the presence of xylem parenchyma in the leaf trace and also in the absence of the sclerotid strands in immediate contact with the leaf trace. The origin of the leaf trace is also similar in both (KIDSTON & GWYNNE-VAUGHAN, loc. cit., pp. 764-766).

The Rajmahal specimen differs from *O. gibbiana* in the origin of the root trace which arises in our specimen even before the leaf trace has become free from the xylem ring. The chief character in which *O. Sahnii* differs from *O. gibbiana* lies in the distribution



TEXT-FIGS. 9-13 — Cross-sections of two leaf bases showing distribution of the sclerenchyma in the sclerotid ring as well as in the wings. × 4·5. 11-13 — T.S. of part of leaf bases showing the inverted V- or W-shaped wavy stelar strands. × 4·5.

of sclerenchymatic strands in the stipular wings which in the wings of *O. gibbiana* are arranged in a single series but are irregularly scattered with occasionally one prominent strand in the wings of *O. Sahnii*.

In the nature and distribution of the sclerenchymatous strands in the wings and the sclerotid ring, *O. Sahnii* comes closer to *O. Kolbei*, a Wealden species but differs from it in large number of the sclerotid strands in the petiole base and the absence of the medullary strands.

From the other species of *Osmundites* known from the Cretaceous and the Tertiary horizons, *O. Sahnii* differs chiefly in the distribution of the sclerotic strands in the petiole bases.

Comparisons with the living Osmundaceae can only be made with the genera *Osmunda* and *Todea*, both of which possess a stelar pattern as in the fossil while *Leptopteris*, the third living genus in the family, possesses a solenostele. The living *Osmunda* is distinguished from *Todea* by the absence of a transverse commissure formed by the fusion of the upper part of the stipular wings across the adaxial side of the petiole (KIDSTON & GWYNNE-VAUGHAN, 1907, pp. 766, 767) and also in the absence of the lamina on the fertile fronds (COPELAND, 1947, p. 21). In the absence of the other vegetative and fertile remains of *O. Sahnii* it is not possible to apply this distinction to the Rajmahal fossil. It is, however, believed that the greater continuity of the xylem and the smaller number of the medullary rays characterize *Todea* stems while the stems of *Osmunda* possess more numerous medullary rays (SEWARD & FORD, 1903, p. 244). But there are considerable variations to be

found regarding this both in *Todeas* and *Osmundas*. Therefore, these characters may not help in the identification of the fossil with any of these two living genera (SEWARD & FORD, loc. cit.; KIDSTON & GWYNNE-VAUGHAN, 1907, p. 767). The nature and distribution of the sclerotid strands in the petiole bases of living and fossil *Todeas* and *Osmundas* has been found to be a more reliable distinguishing character and in this respect the Rajmahal fossil differs from *Osmunda regalis, Todea barbara, Osmunda javanica, Todea hymenophylloides, Todea superba, Osmunda cinnamomea* and *O. claytoniana* (KIDSTON & GWYNNE-VAUGHAN, loc. cit., PL. 6, FIGS. 6-12) the leaf bases of all of which have entirely different type of distribution of the sclerotid strands.

Osmunda, the sole living representative of Osmundaceae in India today, is represented by three species, *O. regalis*, *O. claytoniana* and *O. javanica* (BEDDOME, 1892, pp. 448-450). *O. javanica* is believed by Beddome (loc. cit.) to be a cultivated species, *O. regalis* is common to both the north and the south of India while *O. claytoniana* is only confined to North India. These three living species as shown above are widely different from *Osmundites Sahnii*.

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EXPLANATION OF PLATES

PLATE 1

1. The Specimen. Natural size.

PLATE 2

2. T.S. of a stem showing the outer cortex, *o.c.*, inner cortex *i.c.*, the stelar region and pith. × 6.

3. T.S. of a part of pith enlarged showing the thick-walled parenchymatous tissue. × 40.

4. T.S. through a part of a leaf base showing the distribution of the sclerenchyma in the wing and in the ring. × 8.

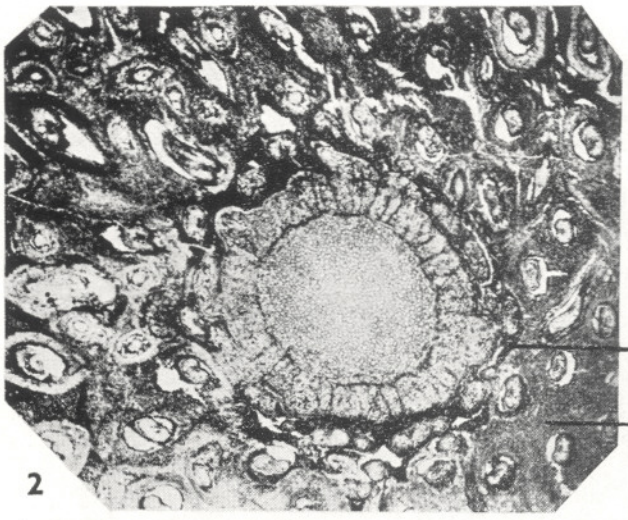
5. T.S. of the pith of the petiole base. × 35.

6. A part of a petiolar stelar strand showing the metaxylem and protoxylem groups. × 60. *m.*, metaxylem; *pr.*, protoxylem.

7. T.S. showing two dichotomously branched roots. × 36.

8. T.S. showing the origin of a root. × 36.

9. Tracheids showing sclariform pitting in longitudinal section. × 100.



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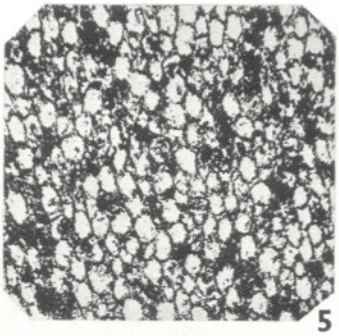

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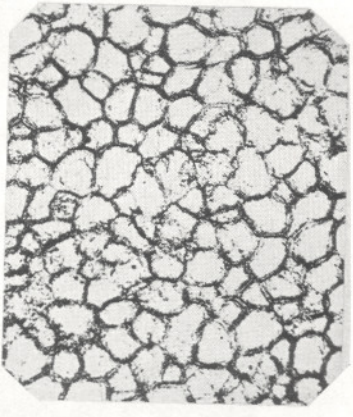

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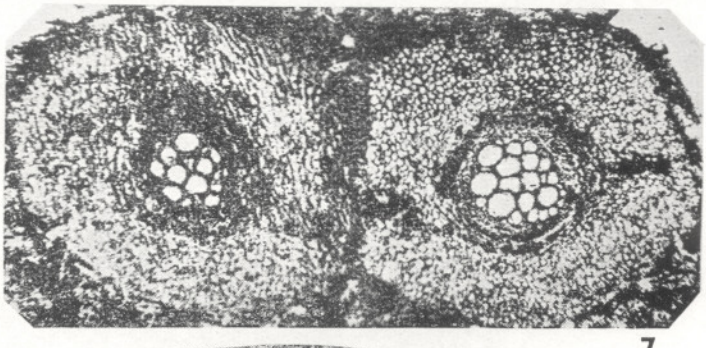

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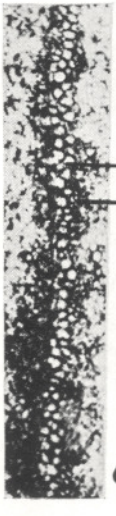

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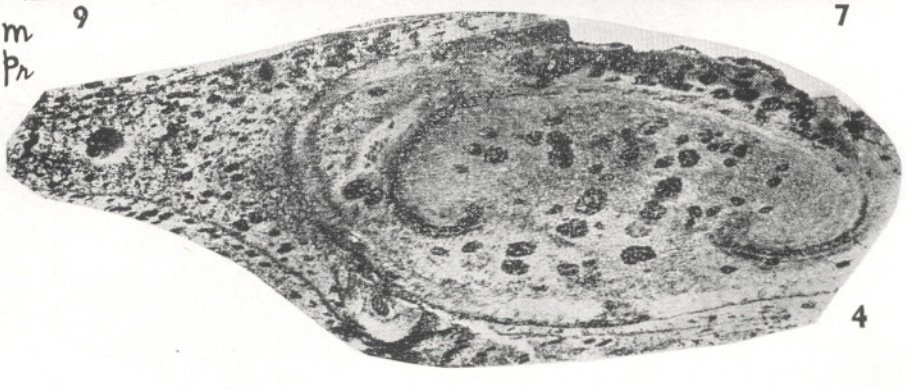

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