ON A NEW SPECIES OF *PHYLLOTHECA* (*P. SAHNII*) FROM THE SOUTH REWA GONDWANA BASIN, CENTRAL INDIA, AND ITS COMPARISON WITH *P. ETHERIDGEI* FROM THE NEWCASTLE SERIES, NEW SOUTH WALES, AUSTRALIA

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ABSTRACT

In Part I of this paper is described the new species *Phyllotheca Sahnii* based upon a carbonized crust in two counterparts, preserved in a dark grey micaceous shale from a horizon variously interpreted as Barakar or Karharbari in the South Rewa Gondwana basin, Central India (N. K. N. Aiyengar collection, Geological Survey of India, specimen No. K 25/522).

In Part II the closely allied form *Phyllotheca Etheridgei* Arber, from the Newcastle series, New South Wales, is described and figured in some detail on the basis of the type material received from the Australian Museum, Sydney, and Sedgwick Museum, Cambridge.

A comparison of the two forms shows that although closely allied, they are two distinct species of the genus.

INTRODUCTION

SEVERAL years ago the Director of the Geological Survey of India sent to Prof. Sahni for description a collection of fossil plants made by Mr. N. K. N. Aiyengar at the Ganjra Nalla (23·21° N.: 81·2° E.) and other localities in the South Rewa Gondwana basin, Central India. The collection, as a whole, has been worked out jointly by Prof. Sahni and myself. However, Prof. Sahni very kindly suggested that I should independently describe this species of *Phyllotheca* and compare it with *P. Etheridgei*. To facilitate this comparison he procured the original material of *P. Etheridgei* from the Australian Museum, Sydney, and from the Sedgwick Museum, Cambridge. My thanks are due to Dr. A. B. Walkom of Sydney and Mr. A. G. Brighton of Cambridge for their kindness in sending these valuable specimens on loan. To Prof. Sahni I am very grateful for his keen interest in my work, and for his constant guidance and inspiration.

DESCRIPTION

PART I

(a) *Phyllotheca Sahnii* sp. nov.

Pl. 1, Figs. 2-7; Pl. 2, Figs. 8-20

Technique — The preparations of cuticles and tracheides have ordinarily been made by a modified peel method. A drop of the thick solution of cellulose acetate in acetone is placed over the desired part and allowed to dry. It is then peeled off. The part of the impression comes out with the peel, which is dissolved and washed in several changes of acetone till the material is free from cellulose acetate. The material is further examined and selected for maceration in Schulze's solution.

This method makes it possible to separate out the desired part of the specimen for further treatment. It excludes all possibilities of error, and ensures precision and accuracy of results.

DIAGNOSIS — *Stems faintly ribbed longitudinally, articulate, swollen at the nodes. Leaf-sheath narrow and amplexicaul at the base, but spreading above into an open saucer-like peltate disc at least* 15 *mm. in diameter, consisting of about* 22 *segments, each with a thick prominent median vein and showing a number of striae, which seem to pass out from the veins at a wide angle, uniting at the ridges at the union of adjoining segments; segments ending bluntly* (*incomplete*).

The chief characters of the species are the amplexicaul base of the leaf-sheath with its spreading distal saucer-like disc, and the prominent tissue composed of obliquely placed elongated cells giving the appearance of striae on both the sides of a thick midrib in each segment of the sheath, which consists of about 22 segments in all.

Locality — Ganjra Nalla at the junction of Johilla river (23·21° N.: 81·2° E.), about 1½ miles south-west of Birsinghpur railway station on the Katni-Bilaspur branch of the Bengal Nagpur Railway in the South Rewa Gondwana basin, Central India.

Horizon — The fossiliferous bed, which is composed of dark grey micaceous shale alternating with coarse or fine-grained sandstone, is just below the Barakar coal seam, exposed on both banks of the river in this locality (HUGHES, 1881). Feistmantel (1882, p. 14), on the basis of the plant fossils, but depending more on Hughes's suggestion, assigns this horizon to the Barakars (Lower Permian), but FOX (1934, p. 189) thinks that it belongs to the Karharbari stage.

Holotype — Fragment A on rock specimen K 25/522 (PL. 1, FIG. 3) of the Geological Survey of India, Calcutta. Four fragments of *Phyllotheca* are preserved on this specimen, which is in two counterparts (PL. 1, FIGS. 3, 4), each of which shows all the fragments. The plant material is in the form of a soft and delicate, highly carbonized crust, which is capable of yielding good macerations (N. K. N. Aiyengar's collection, Geological Survey of India, Calcutta).

This new species of *Phyllotheca* is represented by four fragments (PL. 1, FIG. 3, A to D), all preserved on a single rock specimen K 25/522, which is in two counterparts, both of which show all the four fragments clearly.

The fragment A (PL. 1, FIG. 5) shows a well-preserved leaf-sheath. It is lying flat on the rock in the form of a very shallow saucer, 15 mm. in diameter, with a central scar of about 6 mm. marking the position of the stem which itself is not preserved. As the sheath is well represented on both the counterparts of the specimen, it seems to have been split neatly in the horizontal plane, through the middle of its thickness; the saucer appears concave in one counterpart and convex in the other. The upper and the lower epidermal surfaces being applied to the rock are not exposed to view. However, at one or two places it seems as if the cuticle is visible (PL. 1, FIG. 5 at x). By careful maceration of one of the patches (PL. 1, FIG. 7) the fragment of thickened tissue shown in Pl. 2, Fig. 9 was obtained. This tissue is formed of brown, rhomboidal elongated cells of large size. The continuous thick walls of the cells (PL. 2, FIG. 9) give the idea of a reticulum. These dark thick walls at places are split into finer longitudinal strips which create some suspicion as regards the nature of the tissue as a whole. No stoma has been observed in this tissue; on the contrary, the dark, thick continuous walls give the idea more of a strengthening tissue rather than that of an equisetaceous cuticle. Some of the cuticles obtained by maceration of the pieces of *Phyllotheca* impression show typical equisetaceous characters including stomata (PL. 2, FIGS. 10-12). This fact creates further doubt about the cuticular nature of the tissue described above. Transfers were attempted with several parts of the leaf-sheath, with the object of exposing the other surface so that the cuticle could be examined. But in every case the material was found to be too delicate and brittle for such treatment.

The distal margin of the leaf-sheath is not preserved anywhere, hence nothing can be said of the shape of the leaf-teeth. At two or three places (PL. 1, FIG. 5 at *) it appears as if there are portions of leaf-teeth preserved, but this appearance is very deceptive. The longest vein preserved is about 7 mm.

The plane of fracture between the counterparts having passed through the veins, these are seen very clearly in both the halves. The veins are thick and occupy almost one-third of the total breadth of each segment in the proximal part of the leaf-sheath. The margins along which one segment meets the next (PL. 1, FIG. 5) form ridges on one counterpart seen as dark raised lines on it (PL. 2, FIG. 8) and grooves on the other.

Striae — In the web of tissue on the two sides of each vein there are parallel striae, which seem to arise from the veins at a wide angle. The striae from the adjoining segments meet at the ridge; their true nature is not yet known. Several attempts have been made to macerate this striated web of tissue, but the extreme carbonization of the material does not allow one to get clear preparations because the tissues break into very fine pieces during the process. The general look of the fibrous carbonized structure gives the impression of the striae being of the nature of vascular tissue. In some macerations a few pitted tracheides (PL. 2, FIG. 18) have also been observed; but in a carbonized and crushed material like this there are possibilities that the tracheides of the veins might have got mixed up with a portion of the striated tissue between them. In these circumstances, and in the absence

of any decisive proof, no definite opinion can be expressed on the vascular nature of this tissue. Moreover, as no vascular tissue has ever been noticed in the web of any known equisetaceous leaf-sheath, the possibility of these striae being of the nature of a vascular tissue seems out of the question. The only alternative appears to be is that they form a strengthening tissue for the leaf-sheath. Walton (1936) has interpreted them as dark inclusions of the cells.

Tracheides — Several macerations were made from different parts of specimen A (Pl. 1, Fig. 3). Maceration of some of the carbonized matter from the central portion, that is the stem, has yielded in abundance beautifully preserved tracheides (Pl. 2, Figs. 13, 14) with a somewhat unexpected mixed type of pitting varying between round pits and scalariform bar thickenings, which throws interesting light upon the histology of the species. Similar tracheides (Pl. 2, Fig. 17) have also been obtained by the maceration of a vein from specimen A (Pl. 1, Fig. 3).

In some of the macerations of the sheath portion a few tracheides with bordered pits (Pl. 2, Figs. 15, 16) have also been recovered, but all the wood prepared directly and carefully from the carbonized stem and veins has yielded dark carbonized tracheides with simple pits. The average width of the tracheides is 5 microns. The round pits vary from 2 to 3 microns, but most of the pits are flattened and are broader along the breadth of the tracheides than along their length. The scalariform pits are 2 to 3 microns wide and up to 5 microns long.

Cuticle — A cuticle obtained directly from the carbonized leaf-sheath of fragment A by treating a small piece of rock having the carbonized impression with hydrofluoric acid to clear the carbonized matter of the sandy matrix is shown in Fig. 10. The possibility of its being the cuticle of *Phyllotheca* is great. The cuticle looks dark because of the carbonized matter sticking to it. It shows three complete stomata and an incomplete one, 32×16 microns (Pl. 2, Fig. 10), arranged in a line. These are separated from each other by small square cells, one between each two stomata. The two guard cells surrounding a clear pore measure 30 microns long and about 6 microns broad each. Some of the epidermal cells are rectangular and much elongated. These elongated cells join one another laterally by serrated sutures. Alternating with these are small square cells, 8×10 microns.

Another small piece from the *Phyllotheca* impression (fragment A) was kept for maceration in Schulze's fluid with the object of preparing some tracheides from the midrib and the striated web. This maceration has yielded a very small piece of cuticle (Pl. 2, Fig. 11) which has taken up the safranin stain very well. It shows elongated cells with strong sinuate walls. There is no stoma clearly preserved on this piece, though there are indications of a few very ill-preserved stoma-like structures. Nothing definite can be said about this tiny fragment.

Fragment B (Pl. 1, Fig. 3) shows a carbonized piece of stem, 4 mm. thick and 23 mm. long, with a single node bearing a section of a leaf-sheath of which only the proximal parts are preserved, including a short basal tube-like portion less than one mm. long, and a small portion of the disc or saucer-like expansion of the sheath. Some tracheides prepared from this stem (Pl. 2, Fig. 19) are fully comparable to those prepared from fragment A (Pl. 2, Figs. 13, 14).

Fragment C (Pl. 1, Fig. 6) is a small portion of an expanded sheath showing only five radiating linear lobes, the longest one measuring 11 mm. Maceration of a small piece from one of the segments has yielded tracheides of the same nature as found in fragment A.

A maceration of a peel from fragment C (the larger of the two counterparts) has yielded a cuticle (Pl. 2, Fig. 12), which is very similar to the carbonized dark cuticle obtained from fragment A in general structure; but there is no sign of carbonization on this piece, on the contrary, it looks fresh and clean. The cuticle as a whole is very thick. It has elongated rectangular cells, 13 microns broad and 37 microns or more long, with wavy or sinuate walls joined by sutures. There are no signs of papillae on the cells.

The only stoma clearly seen (Pl. 2, Fig. 12 at S) measures 31 microns long and 16 microns broad with a pore of about 13 microns in length. Each guard cell is 30×6 microns.

Fragment D (Pl. 1, Fig. 6) shows a stem with parallel lines. It measures 11 mm. long and about 6 mm. broad. There is no indication of a node on this piece. A maceration of a peel obtained from this stem has yielded a few tracheides (Pl. 2, Fig. 20) of the type obtained from fragment A, a fact

which shows that most probably this stem too belongs to the *Phyllotheca*, and represents a thicker and an older part of it.

Part II

(b) *Phyllotheca Etheridgei* Arber

Technique — The technique used in the case of *Phyllotheca Sahnii* described in part one of this paper could not be used here successfully as the impressions in this case (*P. Etheridgei*) are not in the form of a carbonized crust. However, several macerations of the matrix bearing the impression were tried. One of these has yielded a good small piece of a cuticle with stoma (Pl. 3, Fig. 26).

Locality and Material — The material of this species was received from two sources, the Australian Museum, Sydney, and the Sedgwick Museum, Cambridge. Three specimens of *P. Etheridgei* Arber were obtained from Sydney. Two of these, numbered F. 5470, are topotypes and actually belong to the collection from which Etheridge selected his types. These were collected by Mr. J. B. Henson from the Newcastle series or Upper Coal Measures at Shepherd's hill near Newcastle, New South Wales. The third specimen, numbered F. 29696, is from the same horizon at Merewether Beach, Newcastle, and was collected by Mr. C. F. Laceron in 1931.

The material sent by Mr. A. G. Brighton from the Sedgwick Museum consists of seven specimens numbered L 95, L 96 in two counterparts, a and b, and L 98 in four fragments, a to d, which are possibly pieces from either L 95 or L 96, mentioned by Arber (1905, pp. 26-28) as *P. Etheridgei* from the Newcastle series.

The Sydney and the Cambridge material both come from the same horizon, the Newcastle series, New South Wales, considered to be of Upper Permian age corresponding to the Raniganj stage of the Lower Gondwanas of India. The plant material is preserved in the form of beautiful impressions on soft, dull white, very fine grained, highly argillaceous sandstone. (The petrological examination of a sample of the rock was kindly made on my request by Dr. R. C. Misra of the Geology Department of Lucknow University.) The material does not yield well-preserved plant tissues on maceration. The maceration of the general matrix, too, has not given any clue of the plant tissues preserved in it, and so one has to depend on the study of the external features only.

(i) *Specimens from the Australian Museum, Sydney*

Pl. 3, Figs. 21-26; Pl. 4, Figs. 28-30; Pl. 5, Fig. 35

All the three specimens received from the Australian Museum bear beautiful impressions of fragments of stems and leaf-sheaths, preserved in various planes. Arber (1905, pp. 26-27) describes this species briefly as follows:

"Leaf-bearing stems articulate, faintly ribbed longitudinally, leaf-sheath large, narrow and clasping for about 3 mm. at the base, but expanding above into an open peltate disc with a diameter of 2·5 to 3 cm. The free segments are reduced to very short teeth, 3 mm. in length and 23 or more in number. A nerve traverses the sheath to each tooth, between the nerves there is a faint groove or depression and also the finest possible striae, arranged in a festoon-like manner."

The chief characters of this species are the short free teeth, and the sheath clasping at the base, but expanding distally into an open and spreading disc-like structure (Arber, 1905).

Specimen F. 5470

Small piece, Pl. 3, Figs. 21, 22

This specimen shows several fragments of *Phyllotheca*, all of which I am inclined to regard as belonging to the same species. There are about half a dozen leaf-sheaths and portions of longitudinally striated stems, one of which is 11 mm. broad and 35 mm. long. Two of the leaf-sheaths look different from the rest in that they have a much smaller disc-like part, which in one (Pl. 3, Fig. 21 at x) overbears very long and narrow tentacle-like leaf-teeth. The fused-up portion of the disc is only about 7 mm. in diameter, while some of the teeth are as long as 8 mm. (Pl. 3, Fig. 21). I would interpret these sheaths as belonging to young stems. The number of teeth is about the same as in the full-grown sheaths. This leaf-sheath reminds one of *Annularia* sp. with striated and free leaf-segments (Elias, 1931). The other sheaths are of the normal

type with a central bell-shaped part clasping the stem and a more or less flat expanded disc bearing short leaf-sheath. The number of teeth in the Indian species is considerably less, only about 22. The segments of these sheaths show fine striae as described by Arber (1905), and as seen in *P. Sahnii* sp. nov.

Specimen F. 5470

Bigger piece, Pl. 3, Figs. 23-26

This specimen has several fragments of laterally preserved stems, besides the usual flat leaf-sheaths, not all of them with their teeth preserved. Out of these only a young, laterally preserved stem and leaf-sheath are described here.

This laterally preserved piece seems to be a very young stem, 4·3 mm. long and slightly over a millimeter thick; it has longitudinally ribbed internodes and four nodes (PL. 3, FIG. 24). A leaf-sheath at a node shows the bell-shaped proximal part clasping the stem for about three millimeters, and the distal part of the disc broken up into several straight narrow leaf-teeth, bent downwards at various angles. These long leaf-teeth recall the tentacle-like processes described in the species seen in Pl. 3, Fig. 21. The internodes vary in length, the lowest one being the longest and the topmost the shortest. The rapid decrease in length of the internodes suggests that this piece is from the distal part of a stem.

A portion of a leaf-sheath on this specimen shows the segments ending in very clear and well-preserved triangular teeth (PL. 3, FIG. 25). This adds support to the view that most probably the teeth or the apical portion of the segments having reflexed tips curl down on drying and hence are not preserved in the majority of cases. If this is true, then the sheaths were probably thin and membranous unlike those in *P. Sahnii* where they are thick and strong.

The maceration of a part of the leaf-sheath in hydrofluoric acid has yielded a small fragment of cuticle with stomata. It is highly probable that this equisetaceous cuticle belongs to *P. Etheridgei*. The stomata are arranged in two rows, with the long axis running parallel to the rows. They are 9 microns broad and 11 microns long. The epidermal cells are not very well preserved; though their long, narrow rectangular shape can be clearly marked. A dark band between the two rows of stomata is suggestive of their distribution on the two sides of a ridge marking the position of a vein (PL. 3, FIG. 26). The shape of these stomata is comparable to those of *Equisetum debile* (PL. 3, FIG. 27).

Specimen F. 29696

(Pl. 4, Figs. 28-30)

The fragments on this specimen are of the nodal parts of the stem with leaf-sheaths, all laterally preserved. Arber's description of this species (ARBER, 1905, pp. 26-28) applies very closely to these specimens. The proximal portion of a sheath clasping the stem and gradually expanding distally into an open peltate disc is very clearly seen. Each segment of a sheath ends in a triangular tooth, 2 to 3 mm. in length (PL. 4, FIG. 28).

One of the fragments shows a longitudinal view of the stem and sheath at a node (PL. 4, FIG. 28). This is interesting as it is very closely comparable to fragment B (PL. 1, FIG. 3) of the Indian species described in this paper.

(ii) *Specimens from the Sedgwick Museum, Cambridge*

(Pl. 4, Figs. 31-33; Pl. 5, Fig. 34)

Only three out of the seven specimens received from the Sedgwick Museum, Cambridge, are described here. In general characters they are identical with those described above and there is no need to repeat the description.

Specimen L 95

(Pl. 4, Fig. 31)

A single piece of a stem with three nodes is seen with crumpled fragments of leaf-sheaths at the nodes. One of these sheaths shows very clearly the transverse striation and the leaf-teeth (PL. 4, FIG. 31, S). On the right-hand side in Fig. 31 there is a fragment of a *Glossopteris* leaf.

Specimens L 96 *a and L* 96 *b*

(Pl. 4, Figs. 32, 33; Pl. 5, Fig. 34)

These two specimens are counterparts and both of them show a very good and clear

fragment of a stem with three nodes and a flat leaf-sheath.

The leaf-sheaths at the nodes, though broken and incomplete, show almost all the features very distinctly. The stem is 4·4 cm. long and 0·4 cm. broad. The average length of the internodes, which are longitudinally ribbed, is 1·7 cm. One of the nodes shows the proximal bell-shaped portion of the leaf-sheath beautifully preserved.

The flat leaf-sheath preserved separately (bottom right, PL. 5, FIG. 34) shows the central portion, 4 mm. in diameter marking the position of the stem, with the sheath spreading around it, in which nearly 30 veins are clearly seen. Only a few of the teeth are preserved (compare fragment A of *Phyllotheca Sahnii* sp. nov.). The maximum diameter of the sheath is about 2·8 cm. The striation, too, is very well preserved (PL. 5, FIG. 34).

DISCUSSION

Comparison of P. Sahnii *sp. nov. with* P. Etheridgei *Arber*

The above description of *Phyllotheca Sahnii* from the South Rewa Gondwana basin and of *P. Etheridgei* Arber from the Newcastle series in Australia shows a remarkable similarity in the structure of these two plants. They resemble each other in their dimensions, in the form of the leaf-sheaths and their gradually opening into a disc-shaped structure and in the presence of transverse striations in the leaf-segments. Unfortunately, the leaf-teeth, which form an important diagnostic character, cannot be compared because in the Indian species they are not preserved at all. However, there are certain well-defined features which enable us to distinguish these two species in well-preserved specimens. These are shown in the following table :

Phyllotheca Sahnii sp. nov.	*Phyllotheca Etheridgei* Arber
1 Veins 22 in the leaf-sheath.	1 Veins exceed 31 in number.
2. Veins broad, striae thick making an acute angle, about 60 with the veins.	2. Veins thin, striae very fine making wide angle, about 80 with the veins.
3. Stomata of leaf-sheath much elongated, 32 × 16 microns.	3. Stomata of leaf-sheath oval and small, 11 × 9 microns.

Most probably the tips of the segments in both species have a tendency to curl back and hence in several cases they are not preserved.

The presence of striae in these species of *Phyllotheca* is a very interesting feature. Similar striations (longitudinal or feather-like) have been mentioned in a species of *Annularia* (ELIAS, 1931) from America. The true nature of the striae is still in the dark, but as stated above, they seem to suggest a web of mechanical tissue for strengthening the sheath. The presence of striae in the three Palaeozoic species of equisetaceous plants is of considerable interest and points to a common feature of some importance in their morphology.

Phyllotheca Etheridgei Arber is from the Newcastle series or Upper Coal Measures of Australia which are generally correlated with the Upper Permian. *Phyllotheca Sahnii* comes from a horizon stated to be immediately below the Barakar coal seam (HUGHES, 1881) which is regarded as equivalent to the Middle Coal Measures of Australia (Lower Permian). Assuming that Hughes was correct in regarding the coal seam in the South Rewa coalfields as Barakar, *P. Sahnii* would be distinctly the older species of the two. The close affinity between the two species, however, suggests that it would be worth while making sure of the correlation of the coal seams suggested by Hughes and commonly accepted without question by geologists ever since.

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EXPLANATION OF PLATES

All the prints have been taken from untouched negatives.

PLATE 1

1. Ganjra Nalla locality (23·21°N.: 81·2°E.) The thick band of carbonaceous shales containing plant fossils is seen between the two hammers, just above the bed of the nalla.

2 *Phyllotheca Sahnii* sp. nov., fragment A (leaf-sheath) and fragment B (stem with a node). Specimen K 25/522. × 3.

3. *P. Sahnii* sp. nov., general view of all the four fragments (A to D). Specimen K 25/522. × 1.

4. *P. Sahnii* sp. nov., general view of all the four fragments (A to D). Specimen K 25/522. × 1. Counterpart.

5. *P. Sahnii* sp. nov., fragment A (leaf-sheath) enlarged to show striae and a cuticle-like tissue at x. The * marks point to the elongated segments of the sheath. M, margin of the segment. V, median vein. S, the breadth of a single segment. Specimen K 25/522. × 5.

6. *P. Sahnii* sp. nov., fragment C (incomplete leaf-sheath). Specimen K 25/522. × 2½.

7. *P. Sahnii* sp. nov., micro-photograph of a portion of a leaf-sheath (fragment A, photo 5 at x) taken directly from the specimen to show the details of the cuticle-like structure *in situ*. V, vein. W, web. Specimen K 25/522. × 35.

PLATE 2

8. *P. Sahnii* sp. nov., fragment A, a part of the leaf-sheath enlarged to show the relation of the striae (s) with the veins (v). Specimen K 25/522. × 40.

9. Cuticle-like tissue from *P. Sahnii* sp. nov., fragment A (*see* FIG. 5 at x). Specimen K 25/522. Slide 441. × 134.

10. Cuticle obtained from fragment A of *P. Sahnii* sp. nov. Specimen K 25/522. Slide 437. × 390.

11. Cuticle from fragment A of *P. Sahnii* sp. nov. Specimen K 25/522. Slide 483. × 400.

12. A cuticle obtained by the maceration of a peel from fragment C of *P. Sahnii* sp. nov. A stoma is seen at S. Specimen K 25/522. Slide 420. × 400.

13. Tracheides from the impression of *P. Sahnii* sp. nov., fragment (from the centre). Specimen K 25/522. Slide 406. × 390.

14. Tracheides from the central carbonized portion of the stem of *P. Sahnii* sp. nov., fragment A. Specimen K 25/522. Slide 411. × 390.

15. Tracheides prepared by peel method from the sheath portion (marked x in FIG. 5) of fragment A of *P. Sahnii* sp. nov. Specimen K 25/522. Slide 413. × 63·5.

16. Tracheides shown in photo 15 at * enlarged. × 390.

17 Tracheides from the veins of the leaf-sheath, fragment A of *P. Sahnii* sp. nov. Specimen K 25/522. Slide 439. × 390.

18. Tracheides from the striae of the leaf-sheath, fragment A of *P. Sahnii* sp. nov. Specimen K 25/522. Slide 461 × 390.

19. Tracheides from fragment B of *P. Sahnii* sp. nov. Specimen K 25/522. Slide 412. × 390.

20. Tracheides from fragment D of *P. Sahnii* sp. nov. Specimen K 25/522. Slide 449. × 390.

PLATE 3

21. *P. Etheridgei* Arber, specimen F 5470 (smaller piece). × 1·1.

22. *P. Etheridgei* Arber, specimen F 5470 (smaller piece), the portion marked x in Fig. 21 enlarged. × 3.

23. *P Etheridgei* Arber, specimen F 5470 (bigger piece). × ½.

24. A young stem of *P. Etheridgei* Arber enlarged from a portion marked B in Fig. 23. Specimen F 5470. × 1½.

25. Leaf-sheath of *P. Etheridgei* Arber enlarged from a portion marked A in Fig. 23. Specimen F 5470. × 2½.

26. A cuticle obtained from specimen F 5470 of *P. Etheridgei* Arber. Slide 484. × 400 (*see* FIG. 23 at x).

27. A cuticle of *Equisetum debile*. Slide 482. × 134.

PLATE 4

28. *Phyllotheca Etheridgei* Arber, specimen F 29696. × 1

29. *P. Etheridgei* Arber. A node with a section of leaf-sheath enlarged, seen at A in Fig. 28. Specimen F 29696. × 3.

30. *P. Etheridgei* Arber, a leaf-sheath seen at B in Fig. 28 enlarged. Specimen F 29696. × 3.

31. *P. Etheridgei* Arber, specimen L 95. × 1.

32. *P. Etheridgei* Arber, specimen L 96 a. × 1.

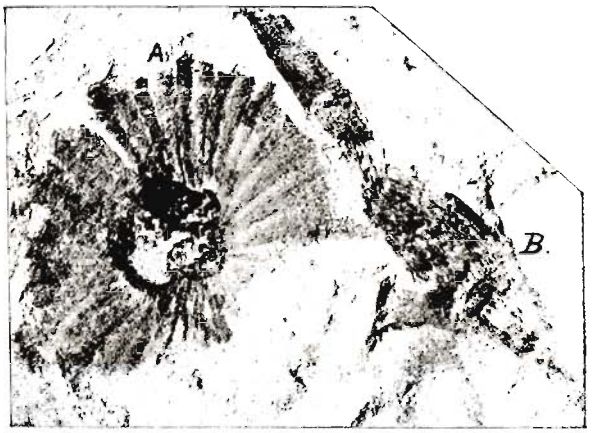
33. *P Etheridgei* Arber, specimen L 96 b. × 1.

PLATE 5

34. *P. Etheridgei* Arber, specimen L 96. × 2½.

35. *P. Etheridgei* Arber, specimen F 5470. × 4.

1



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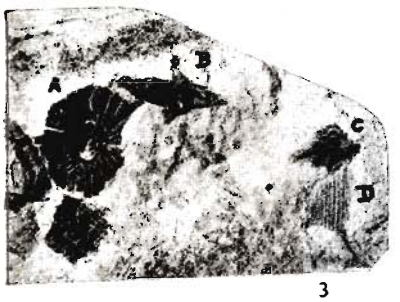

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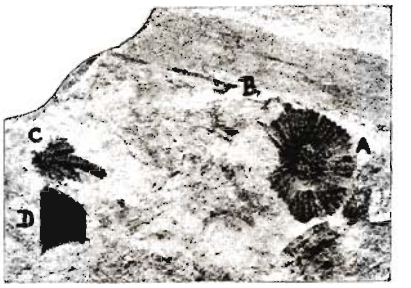

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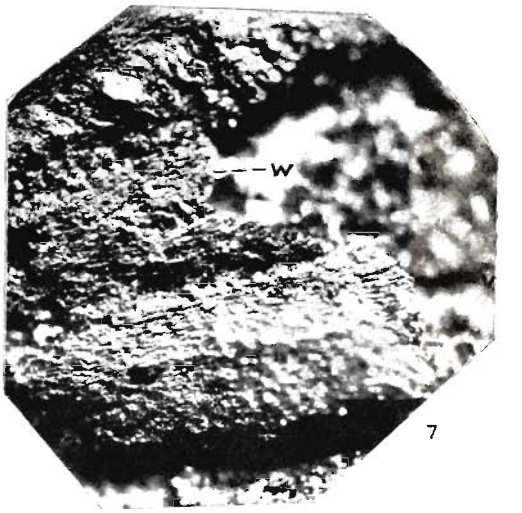

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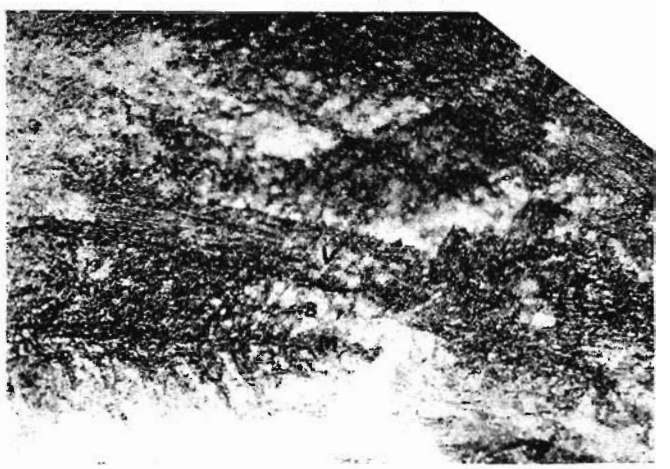

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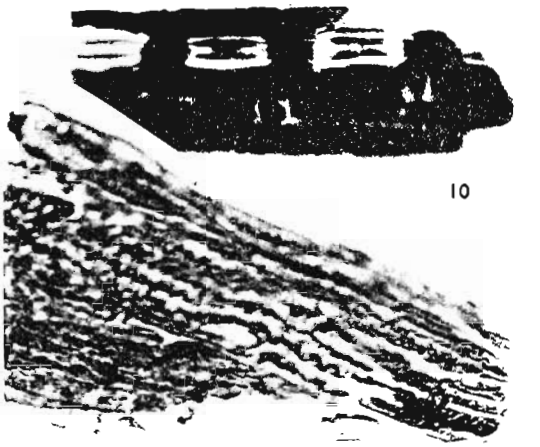

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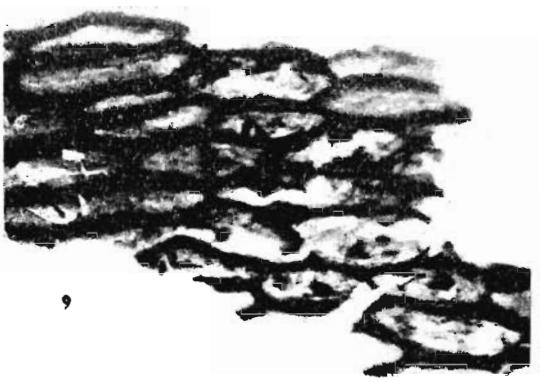

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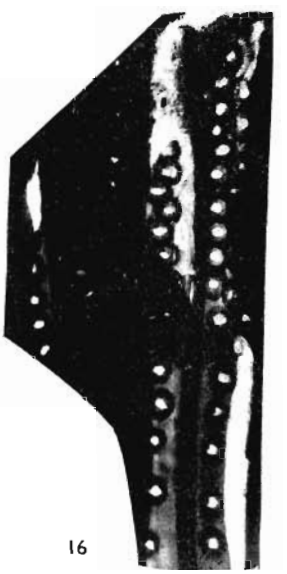

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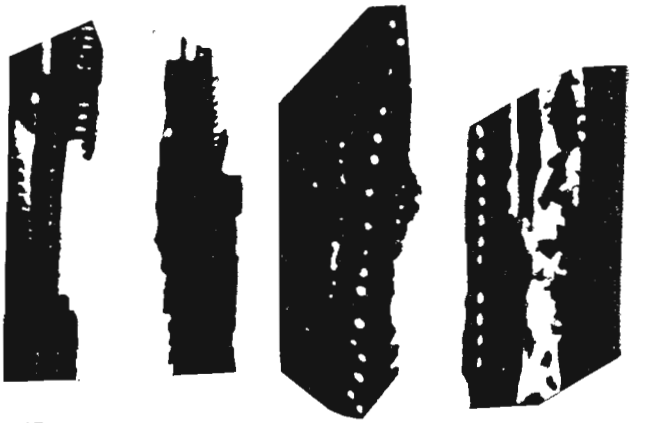

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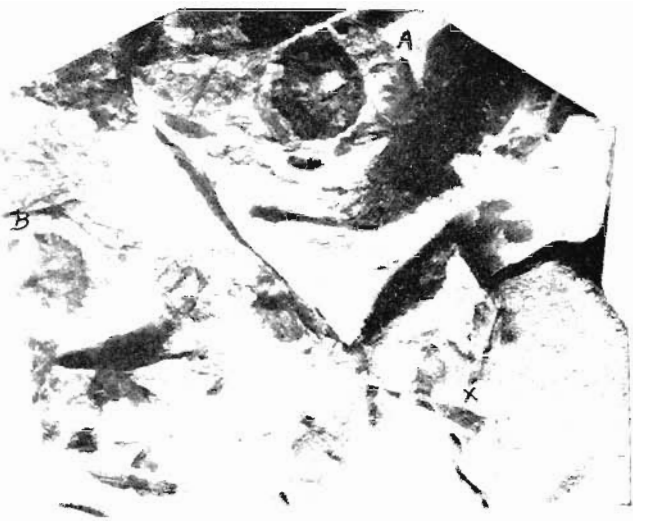

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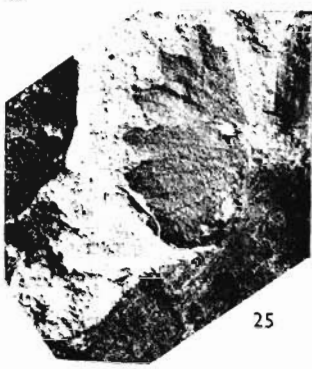

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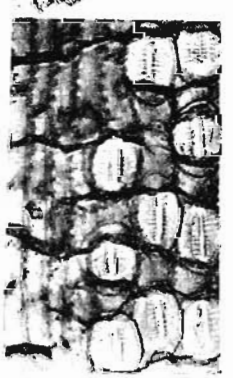

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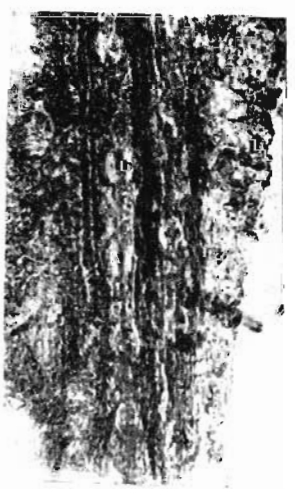

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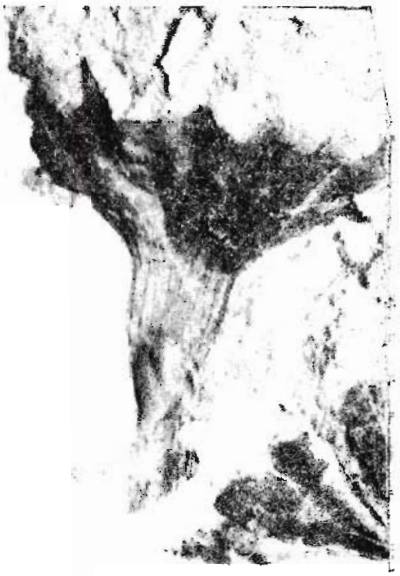

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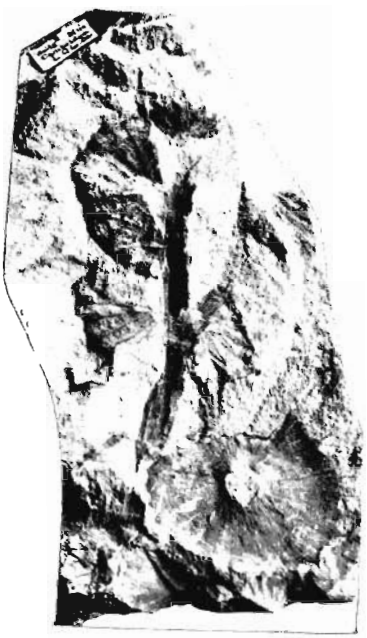

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