

# ON FOSSIL FLORA OF GANJRA NALLA BED, SOUTH REWA : PART I. MACROFOSSILS

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## ABSTRACT

Fine-grained micaceous carbonaceous shales of Ganjra nalla bed (23:22:81.4E.) are overcrowded with carbonized impressions of *Glossopteris indica*, *G. browniana*, *G. decipiens*, *Gangamopteris cyclopteroides*, *Noeggerathiopsis hislopi*, some stems and several species of *Samaropsis*. A bryophytic sporogonium-like body has also been found. Description of *Samaropsis* and bryophytic sporogonium-like body has been published separately.

## INTRODUCTION

ALL the specimens described here were collected by the author from Ganjra nalla, near its junction with Johilla river, some 1½ miles south-west of Birsinghpur railway station (23:22:81.4) on Katni-Bilaspur branch of Southeastern Railway. A thick band of carbonaceous shale is exposed on the left bank of the nalla where it takes a sharp bend some 50 yards before it meets the Johilla river. This shale band is situated just below the coal seam of the Johilla coalfields, which are supposed to belong to the Barakar series (HUGHES, 1881, p. 126; and FEISTMANTEL, 1881, p. 14). It consists of fine-grained carbonaceous micaceous shale and sandstone deposited in alternate layers of various thickness.

First collection of fossil plants from this locality was made by T. W. H. Hughes and Hira Lal during 1880 (SINOR, 1923), and was described by Feistmantel (1882). It consists of *Glossopteris communis*, *Gangamopteris* cf. *cyclopteroides*, *Noeggerathiopsis hislopi* and several species of *Samaropsis* (seeds). Next collection was made by Shri N. K. N. Aiyengar. Shale piece No. K 25/522 was macerated by C. Virkki (1945) and later on by Mehta (1945) and several species of spores were described by them. A carbonized impression of *Phyllothea* preserved on this piece has been described by the author (SAKSENA, 1952). Later on the author collected several pieces of shales from this locality in 1932, 1944 and 1946 on which impressions of *Glossopteris indica*, *G. browniana*, *G. decipiens*, *Gangamopteris*

*cyclopteroides*, *Noeggerathiopsis hislopi*, two new species of *Samaropsis* (SAKSENA, 1955), a bryophytic sporogonium-like body (SAKSENA 1958) and some stems have been found.

In the present paper only the macroflora from the Ganjra nalla bed is described. The shales are very rich also in microflora which consists of microspores, megaspores, cuticles, tracheids and small seed like structures. The microflora shall be described in a separate paper.

The author is highly indebted to late Prof. Birbal Sahni for his guidance, advice and valuable suggestions. He is very thankful to Dr. A. P. Mathur, Principal, T.R.S. College, Rewa, and to the other authorities of Rewa State (now merged in Madhya Pradesh), who have very kindly allowed him study leave to carry on research at the University of Lucknow. He is also thankful to Dr. S. K. Pande and his students for their helpful suggestions and hints in describing the bryophytic sporogonium.

## DESCRIPTION

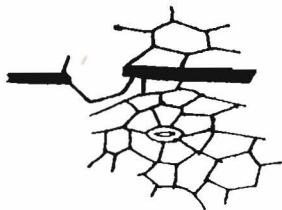
### (1) *Glossopteris indica* Schimper

Pieces of shales numbered R.S. 1/5, 1/6, 1/10 and 1/14 bear clear but incomplete impressions of *Glossopteris indica*. The impressions on 1/6 and 1/10 represent major portion of leaf. In some cases the basal portion and in some the middle portion of leaf is preserved. No impression shows the apex completely and very distinctly, however, a reasonably correct idea can be had from some of these impressions that the apex in these cases was acute. All the impressions show clearly the distinctive features of *Glossopteris indica*, that is persistent midrib which is quite distinct and is made up of several veins running parallel to each other, lateral veins numerous, crowded, subparallel, arched near the midrib and reaching the margin in most cases almost at right angles to it, meshes very narrow,

elongate and those near the midrib not distinctly much broader than those in the rest of the lamina.

The leaf impression on shale piece R.S. 1/6 is 11.4 cm. long and 3.7 cm. broad at the widest portion. In this impression the basal part is missing (PL. 1, FIG. 1). The impression on shale 1/10 is 13.8 cm. long and 5.4 cm. broad. In this impression both the base and the apex are missing.

It has been possible to obtain a few fragments of cuticle by the combined peel and maceration method from a portion marked 8 on the leaf impression on shale 1/6. Some of these fragments show both the upper and the lower cuticles, and one of the pieces shows a few ill preserved stomata, one of these is marked A (PL. 1, FIG. 4; TEXT-FIG. 1). The cuticle with the stomata is probably from the lower epidermis. In this the cells are more or less isodiametric and a few cells show signs of papilla on them. It is quite possible that other cells, which seem to be non-papillate might have



TEXT-FIG. 1

lost their papilla either due to bad preservation or during maceration. The stoma (PL. 1, FIG. 4 at A) is  $39\ \mu$  long and  $10.4\ \mu$  broad. The stomatal aperture is about  $30\ \mu$  long with two clear guard cells. The subsidiary cells are four to six in number and show no signs of papillae on them.

The upper cuticle is non-stomatal and has slightly elongated polygonal cells, which are distinctly papillate, though the papillae are not clearly seen in the photograph (PL. 1, FIG. 5). The cuticular structure described here agrees with that of *Glossopteris indica* described by Virkki (1939). In describing the cuticle of *Glossopteris communis* she (VIRKKI, 1939) has shown that *G. communis* differs from *G. indica* in having a layer of specialized cells (encircling cells) outside the non-papillate sub-

idiary cells. These encircling cells are not present in the case of *G. indica*.

### (2) *Glossopteris browniana* Brongniart

A fairly complete leaf impression is preserved on shale No. R.S. 1/9. The impression measures approximately 15 cm. long and 4.8 cm. broad at the widest portion near the apex (PL. 1, FIG. 6). It shows the following features which are characteristic of *Glossopteris browniana*.

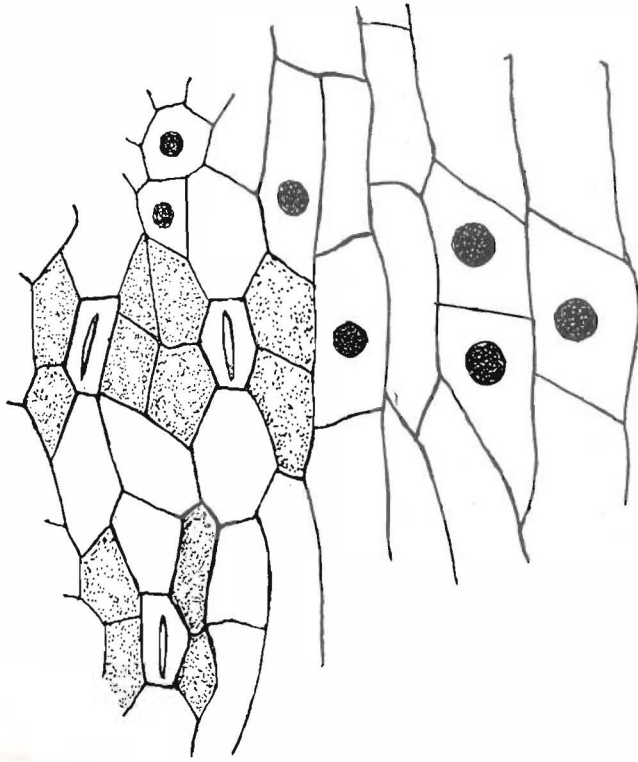
"Leaf spatulate, simple, asymmetrical, broadest near the apex, narrowing down gradually towards the base. Midrib broad, made up of several parallel veins, persisting to the apex; secondary veins numerous, crowded, anastomosing rare, meshes long and narrow, specially near the margin. Apex obtuse."

A few fragments of cuticle have been obtained by the modified peel method. One of these fragments shows two ill-preserved stomata and clear outline of epidermal cells. The stomata seem to be arranged in a row. One of the stomata (PL. 1, FIGS. 7, 8) is comparatively better preserved and shows the stomatal aperture, guard cells and a single row of subsidiary cells, four of which are clearly seen (PL. 1, FIG. 7). Subsidiary cells seem to be papillate. The stoma is  $34 \times 8\ \mu$ . The epidermal cells surrounding the stoma are polygonal and smaller in size than other cells of the epidermis which are rectangular and are arranged in rows. All the cells have straight walls, and in most cases no papillae are seen. The stoma and cuticle of *G. browniana* described here is very similar to the stoma of the same species figured by Virkki (1939).

### (3) *Glossopteris decipiens* Feistmantel

A fairly good leaf-impression is preserved on shale No. R.S. 1/15b with a counterpart marked R.S. 1/15c.

Leaf small, 2.8 cm. broad and 12 cm. long, linear, lanceolate, acute, midrib flat and broad at the basal portion of the leaf, and made up of a large number of distinct parallel veins, becoming narrower towards the apex, and not extending to the apex. Secondary veins numerous, fine, compact, arising at an acute angle from the midrib; meshes uniform, narrow, elongated and distinct near the midrib; base of the leaf not preserved.



TEXT-FIG. 2

There are two bladder-like bodies lying over this impression (PL. 1, FIG. 10, x and y). The nature of these bodies is not correctly known. These are described in details separately in this paper.

No cuticular preparation could be obtained from this impression.

#### (4) *Gangamopteris cyclopteroides* Feistmantel

There are two small leaf impressions, one on shale No. R.S. 1/13 (PLS. 1, 2, FIGS. 12, 13) and the other on shale No. R.S. 1/34 (PL. 1, FIG. 11), which are referred to this species. Probably these are the young leaves. However, the meshes formed by the veins, considering the small size of the leaves, are quite large. It is in this character only that these leaves differ slightly from the leaves commonly described as *Gangamopteris cyclopteroides*.

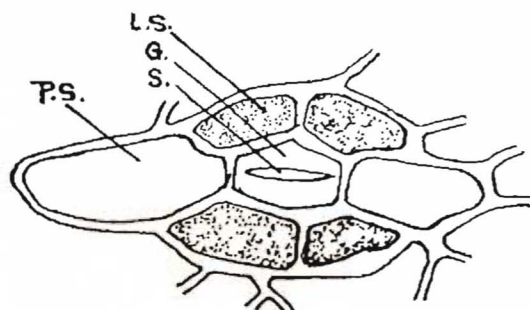
Fronds simple, entire, elliptical, more or less rhomboidal, midrib absent, nerves arising at the base and anastomosing to form a

network. Meshes broader at the middle portion than at the sides of the lamina; apex rounded, base truncate.

The specimen larger of the two is 4.4 cm. long and 2 cm. broad, while the smaller one is 3.1 cm. long and 1.3 cm. broad. No cuticular preparation could be obtained.

#### (5) *Noeggerathiopsis hislopi* (Bunb.)

The shales are over-crowded with the leaf impressions of *Noeggerathiopsis hislopi*. In some cases the shale piece is actually built up of these leaves pressed together along with the sandy matrix into a compact mass. On shale pieces R.S. 1/8, fairly complete leaf impression is preserved (PL. 2, FIG. 15). The impression of shale 1/29 (PL. 2, FIG. 14) seems to be of a branch, with several leaves, of *Noeggerathiopsis hislopi*. There are several cases of similar compressions which also give an idea of whorled arrangement. These have been published from time to time by various authors (FEISTMANTEL, 1882;



TEXT-FIG. 3

RENAULT & ZEILLER, 1888; ETHERIDGE, 1918; SEWARD & SAHNI, 1920 and WALKOM, 1921). On shale R.S. 1/35 only the basal portion of the leaf is preserved, which shows the dichotomous branching of veins very clearly (PL. 2, FIG. 19).

Leaf spatulate, apex rounded, lamina contracted at the base; veins numerous, strong, approximately 12 per cm. at the middle portion of the leaf, subparallel, meeting the margin at a very acute angle at various points in the distal half of the leaf. The veins branch dichotomously at a very acute angle. The forkings are specially numerous in the basal portion of a leaf, though not restricted to it (PL. 2, FIG. 19).

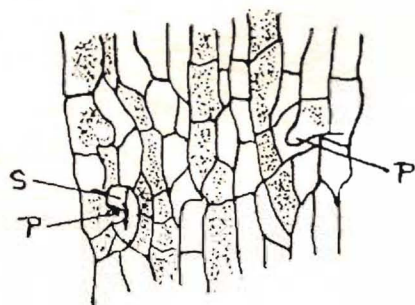
Leaf impression on R.S. 1/8 shows the veins very clearly (PL. 2, FIG. 15). It measures 12.3 cm. in length and 2.3 cm. in breadth near the apex. The largest leaf in this collection measures 14.8 cm. long and 2.9 cm. broad near the apex. The leaf narrows down gradually towards the base, which seems to be incomplete.

Fairly good but fragmentary cuticular preparations have been obtained from all the above-mentioned leaf impressions, and on the basis of similar cuticular structure all these are referred to *Noeggerathiopsis hislopi*. From leaf impression on shale piece No. R.S. 1/32 (not figured) large pieces of fairly well-preserved cuticles of *Noeggerathiopsis* have been obtained. These are similar in structure to the cuticles obtained from the leaf impressions figured in this paper.

The cuticles both from the lower as well as the upper epidermis of the leaf have been obtained. The structure of these cuticles resembles exactly with those of *Noeggerathiopsis* described by Seward & Sahni

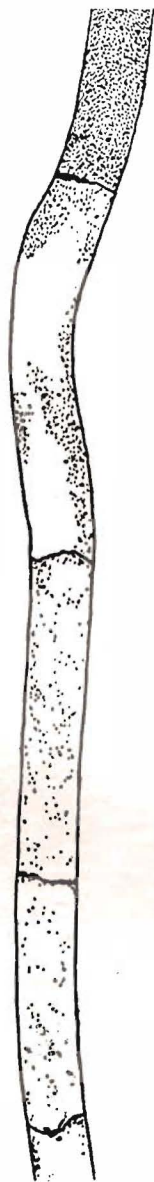
(1920). The upper cuticle has elongated, rectangular, non-papillate cells arranged in regular longitudinal rows. The cells vary from 80 to 200 microns or sometimes even more in length (PL. 2, FIG. 17) and 16 to 20 microns in breadth. A piece of upper cuticle has been found to possess a single pore (PL. 2, FIG. 18), which looks like a stoma but in this case no guard cells are visible.

The lower cuticle is differentiated into stomatiferous and non-stomatiferous bands alternating each other (PL. 2, FIGS. 16, 20). Stomatiferous band consists of stomata with guard cells, subsidiary cells and small polygonal irregularly arranged epidermal cells. The non-stomatiferous region is made of only one type of elongated, more or less rectangular straight-walled cells. All the epidermal cells of the lower epidermis have one papilla placed roughly in the middle of each cell (TEXT-FIG. 2). The papillae are blunt and sufficiently raised from the surface (TEXT-FIG. 4). The non-stomatiferous band is generally broader than the stomatiferous band (PL. 2, FIG. 20) and overlies a vein. It is up to 16 or even more cells broad. In the stomatiferous region the stomata are generally arranged in 6 to 8 irregular rows. The long axis of a stoma always lies parallel to a vein. The average number of stomata per square mm. is found to range from 140 to 150.



TEXT-FIG. 4

A stoma with the guard cells is represented by a clear rectangular area with a long stomatal opening in the centre (TEXT-FIG. 3). There are 4 to 6, usually 6, subsidiary cells encircling the stomatal apparatus; two of these are polar, abutting in the ends of the guard cells, and four are laterally placed. This type of stoma is very characteristic of



TEXT-FIG. 5

The problem whether *Noeggerathiopsis* should be included under the genus *Cordaites* has not yet been finally settled. In this connection only this much can be pointed out that the cuticles and the stomatal apparatus of *Noeggerathiopsis* as described here differs from that of *Cordaites* figured by Seward & Sahni (1920).

#### (6) Stem impressions

Several impressions of stems have been recorded on these shales from Ganjra nalla bed. The maceration of the carbonized portion from two of these stems has yielded fairly well-preserved tracheids. One of these stems shows equisetaceous characters.

*Stem impression on shale piece R.S. 1/14* — There are two stem impressions on the piece numbered R.S. 1/14. The thinner of the two is 21 cm. long and 0.9 cm. broad (TEXT-FIG. 5), with four nodes at the intervals varying from 3 to 5 cm. The other stem (not figured here) is about 2 cm. broad with a single node.

The maceration of the scrapings from the thinner stem in Schultz's solution has yielded a few small fragments of wood showing tracheids with bordered pits. The pits are circular and free, except a few which are contiguous. They are uniseriate and have oblique slit-like pores (PL. 2, FIGS. 21, 22). In the thick portion of the wood the crossing of the pores of the bordered pits on the two sides of a separating wall can very easily be seen. These characters of the wood faintly suggest its affinity with Gymnosperms, but on the basis of such a meagre data it is difficult to assign the stem to any particular class.

*Stem impression on shale numbered R.S. 1/22* — There is a small curved carbonized impression of a stem, approximately 55 mm. long and 7 mm. broad, preserved on shale No. R.S. 1/22 with a counterpart (PL. 2, FIGS. 23, 24). The impression shows two clear thick lines, each slightly more than 2 mm. thick, with equally broad space in between them, intercepted at intervals by transverse septa. Most probably these septa represent the nodes, the internodes being hollow. There are six nodes in this small piece of stem, but only in three of them the transverse septa are visible.

This stem reminds one of a calamitean stem figured by Scott (1920), with which it affords great resemblance. There is great

the genus *Noeggerathiopsis*. The length of the pore is 13-15  $\mu$  and the guard cells are 29  $\mu$  long and 7-8  $\mu$  broad. The polar subsidiary cells measure 16-32  $\mu$  or more while the lateral subsidiaries are 35-40  $\times$  16  $\mu$ . The epidermal cells in the stomatiferous region are mostly 40  $\mu$  long and those in the non-stomatiferous region are 50-100  $\mu$  or more in length (TEXT-FIG. 2).

possibility of this stem belonging to equisetaceous group.

A small crust from the stem on maceration has yielded several fragments of rather broad tracheids (PL. 2, FIG. 25) showing scalariform and reticulate thickenings clearly suggesting its pteridophytic nature.

#### (7) Bladder-like bodies of uncertain affinity

During the mass maceration of a few pieces of shale No. R.S. 1/30, two ellipsoid or spherical bladder-like compressed bodies were found (PL. 2, FIG. 27). Later on 6 to 8 similar bodies were found exposed freely on some of the shale pieces (R.S. 1/25 and 1/30) from the same locality, either sticking to or embedded in the matrix (FIG. 26, shown by arrow marks); and some have been found lying on the leaf impression of *Glossopteris* (PL. 1, FIG. 10 at x), but there is not the least indication of any kind of attachment in this case. Some half a dozen of these bodies, detached from the rock surface have been separately macerated and they have been found structurally identical with those recovered from mass maceration.

These bodies when seen lying on the rock surface, make double impressions in the form of two concentric circles (PL. 2, FIGS. 27, 28). The size including the outer impression varies approximately from 2.4-3 mm. broad to 3.4 mm. long. The inner impression is deeper and lodges a brown flat body. It is from this body that the membranous bladder is obtained on maceration. The outer impression forms only a shallow margin round the inner one, and is filled with coaly black substance which is destroyed during maceration. This clearly shows that these bodies have two layers, an outer one which has become extremely carbonized and brittle; it dissolves completely during maceration; and the inner

one which is cutinized and stands maceration well (PL. 2, FIG. 28).

On dissecting out the inner brown cutinized portion of the bladder like body it has been seen that the brown portion has again two layers, the external of which is very thin and membranous, and is made up of elongated straight-walled cells. The internal layer consists of central non-cellular structureless mass (PL. 2, FIG. 29). The outer membranous layer being extremely delicate easily gets wrinkled (PL. 2, FIGS. 29, 30).

The macerated body has one smooth, spherical end, and the other, opposite to the smooth one, is irregular, narrow and broken suggesting that this may be the point of attachment of the organ. The impression made by these bodies on the rock is also pointed at one end and rounded at the other (PL. 2, FIG. 27).

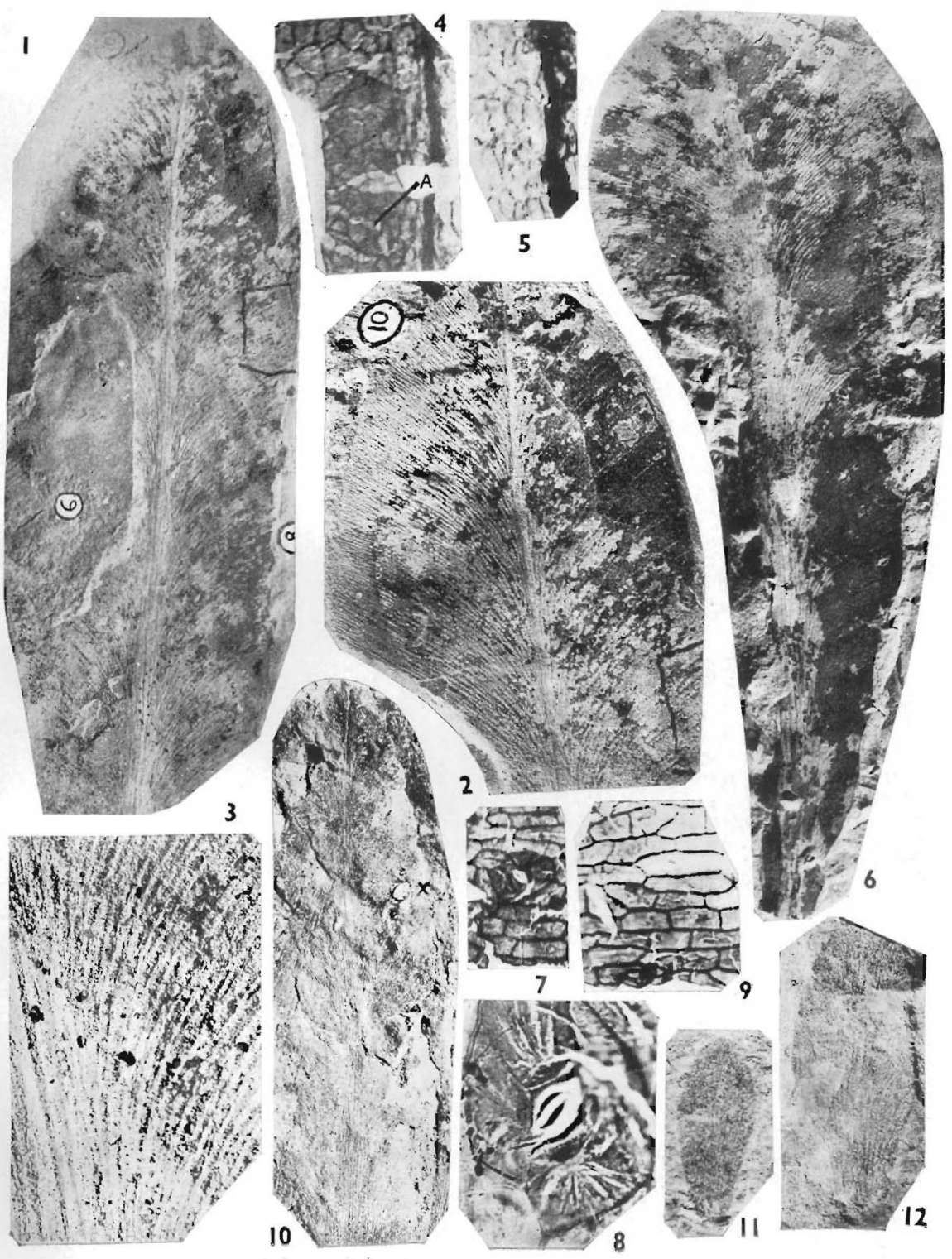
Several preparations of these bodies have been made but not one shows spores inside them. In fact there is no question of the spores being inside the bladder-like body as it is filled with non-cellular mass completely.

#### DISCUSSION

Some sac-like structures have been described by Arber (1905, p. 40) from a few specimens from New South Wales, Australia, found in the British Museum collection. He considers these bodies as the sporangium-like organs of *Glossopteris browniana*. Those are smaller in size than these bladder-like bodies, being 1.2-1.5 mm. along the major and 0.5-0.8 mm. along the minor axis, and differ from these bodies in shape too. Thus sac-like structures described by Arber stand no comparison to these bladder-like bodies. A suggestion of their being seeds seems worth consideration, however, at the present state of our knowledge, no further comments are possible.

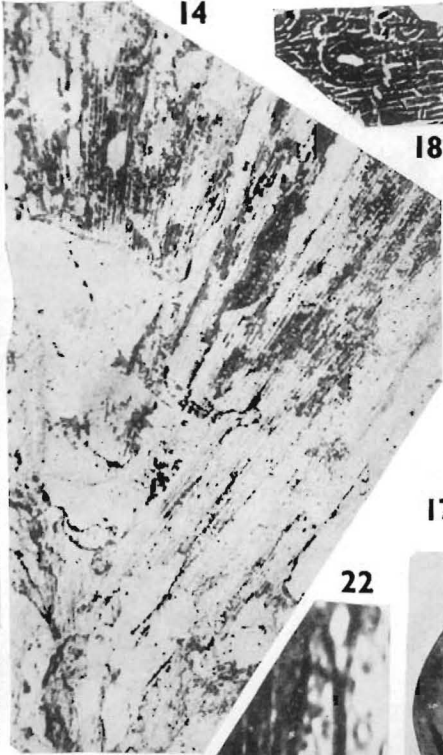
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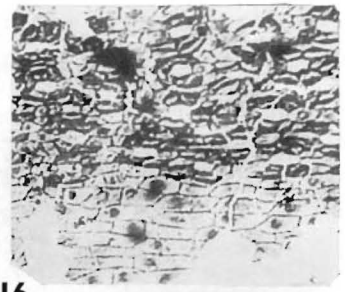
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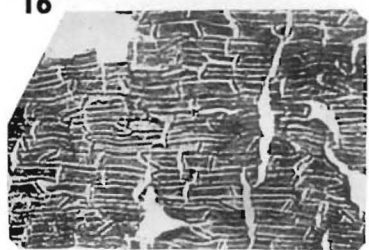
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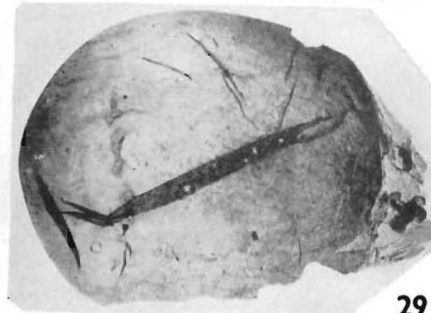
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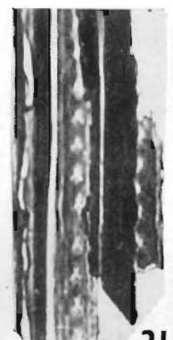
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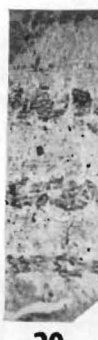
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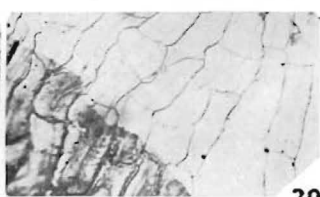
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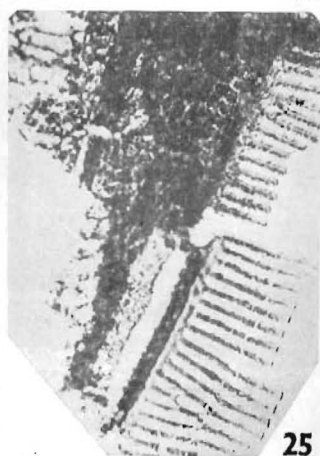
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## EXPLANATION OF PLATES

## PLATE 1

1. *Glossopteris indica* Schimper on shale No. R.S. 1/6.  $\times 1$ .
2. The apex of *G. indica* — Fig. 1 enlarged.  $\times 2$
3. A portion of *G. indica* marked in Fig. 1 enlarged to show the details of the veins.  $\times 5$ .
4. Cuticle of *G. indica* on shale R.S. 1/6. Slide No. 391.  $\times 105$ .
5. Cuticle of *G. indica* on shale R.S. 1/6. Slide No. 392.  $\times 105$ .
6. *Glossopteris browniana* Brongniart. On shale R.S. 1/9.  $\times 1$ .
7. A cuticle of *G. browniana* from shale R.S. 1/9. Slide 405(1).  $\times 105$ .
8. Cuticle of *G. browniana* shown in Fig. 7 enlarged to show a stoma in detail.
9. Cuticle of *G. browniana* on shale R.S. 1/9. Slide 405(2).  $\times 105$ .
10. *Glossopteris decipiens* Feistmantel on R.S. 1/15b.  $\times 1$ .
11. *Gangamopteris cyclopteroides* Feistmantel on shale 1/34.  $\times 1$ .
12. *G. cyclopteroides* on shale No. R.S. 1/13.  $\times 1$ .

## PLATE 2

13. *Gangamopteris cyclopteroides* in Fig. 12 enlarged.  $\times 2$ .
14. *Noeggerathiopsis histopi* (Bunb.). A bunch of leaves on shale R.S. 1/29.  $\times 1$ .
15. *N. histopi* on shale R.S. 1/8.  $\times 1$ .

16. Lower cuticle of *N. histopi* on shale R.S. 1/32. Slide 387.  $\times 87$ .
17. Upper cuticle of *N. histopi* on shale R.S. 1/32. Slide 390.  $\times 87$ .
18. Another piece of upper cuticle of *N. histopi* on shale R.S. 1/32. Slide 390.  $\times 87$ .
19. *N. histopi* on shale R.S. 1/35 to show the bifucation of veins.  $\times 1$ .
20. Cuticle of *N. histopi* to show alternation of stomatal and non-stomatal bands. Slide 319.  $\times 25$ .
21. Tracheids from the surface scrapings of the stem impression shown in text-fig. 5, on shale R.S. 1/14 (before alkali treatment). Slide 377.  $\times 400$ .
22. Tracheids from the coal found on the stem impression on shale R.S. 1/14. Slide 381.  $\times 400$
23. A stem impression on shale R.S. 1/22.  $\times 1$ .
24. Counterpart of the specimen shown in Fig. 23.  $\times 1$ .
25. Tracheids from the carbonized portion of the stem marked with \* in Fig. 24. 451 slide.  $\times 400$ .
26. Shale piece No. R.S. 1/30 showing the marks of the bladder-like structures.  $\times 4/5$ .
27. A bladder-like body *in situ*. Shale R.S. 1/25.  $\times 1$ .
28. A bladder-like body seen in Fig. 27 enlarged.  $\times 2\frac{1}{2}$ .
29. A bladder-like body with spores sticking to it. Shale R.S. 1/30. Slide 324.  $\times 17$ .
30. A bladder-like body — a portion enlarged to show the cell structure of the wall. Shale R.S. 1/3 Slide 294.  $\times 134$ .