

STUDIES IN THE GLOSSOPTERIS FLORA OF INDIA— 44. RANIGANJ PLANT MEGAFOSSILS AND MIOSPORES FROM AURANGA COALFIELD, BIHAR

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ABSTRACT

Eleven species of *Glossopteris*, viz., *G. communis*, *G. sp. cf. G. nidpurensis*, *G. divergens*, *G. retifera*, *G. browniana*, *G. stricta*, *G. decipiens*, *G. fusa*, *G. sp.*, *G. conspicua*, *G. leptoneura* and scale leaves have been described in detail.

The miospore assemblage (18 genera & 36 species) is dominated by striate-disaccates and triletes alongwith a good percentage of *Densipollenites*. Three species, *Fauni-pollenites multistriatus*, *Striatopodocarpites haploxyloides* and *Striatites obliquus* are new,

Key-words — *Glossopteris* Flora, Miospores, Upper Permian, Raniganj Stage (India).

सारांश

भारतवर्ष के ग्लॉसॉप्टेरिस वनस्पति जात का अध्ययन-44। औरंगा-कोयला-क्षेत्र, बिहार से रानीगंज पादप-गुरुजीवाश्म तथा मिओ बिजाणु-अश्विनी कुमार श्रीवास्तव

ग्लॉसॉप्टेरिस की 11 जातियाँ अर्थात् ग्लॉ कम्प्युनिस, ग्लॉ जा०, ग्लॉ निडपुरेन्सिस, ग्लॉ रेटिफेरा, ग्लॉ ब्राउनियाना, ग्लॉ स्ट्रिक्टा, ग्लॉ डेसीपियन्स, ग्लॉ फ्यूसा, ग्लॉ जा०, ग्लॉ कान्सपिकुवा, ग्लॉ लेप्टोप्न्यूरा तथा शल्क पत्रों का विस्तृत वर्णन किया गया है।

मियोबिजाणु-समुच्चय (18 प्रजातियाँ एवं 36 जातियाँ) स्ट्रायेट-डाइसेकेटस एवं ट्राइलिटोज से अधिरुद्ध हैं और साथ ही साथ डेन्सीपोलिनाइटिस की भी प्रचुर प्रतिशतता है। तीन जातियाँ, फ्रॉनीपोलिनाइटिस मल्टीस्ट्रायेटस, स्ट्रायेटोपोडोकारपाइटिस हैप्लोक्सीलोनायडिस तथा स्ट्रायेटाईटिस आबलिक्वस, नई हैं।

INTRODUCTION

FEISTMANTEL (1881a, 1881b, 1886) first reported the following plant fossils from the Raniganj beds of the Jagaldagga and Tubed area of Auranga Coalfield:

Schizoneura gondwanensis Feistmantel, *Vertebraria indica* Royle, Equisetaceous stalk, *Macrotaeniopteris daneoides* Feistmantel, *Glossopteris angustifolia* Brongniart, *G. Communis* Feistmantel, *G. conspicua* Feistmantel, and *Squamae*.

Later in 1959, Bhattacharyya, B. described the Raniganj plant fossils from the Jagaldagga and Pandepura localities. Bhattacharyya, A. K. (1963) recorded some plant fossils from the area around Deobar.

Unfortunately, the Raniganj miospores have not so far been recorded from the

Auranga Coalfield. Therefore, the present investigation for the first time records the presence of Raniganj miospore assemblage in the Auranga Coalfield.

The present megafossil as well palynological sample sites exposed in Sukri River, near Rajbar Village (see Map, Srivastava, 1977) have been geologically mapped under Barakar by Rizvi (1972) but the palaeobotanical evidence now insinuate a Raniganj age for the beds.

MATERIAL AND METHODS

The megafossils have been found as impressions on the dark brown highly sandy, micaceous shale, collected from a section exposed in a small nala cutting in north-east bank of Sukri River, about 2.5 km north-west of Rajbar Village (Srivastava,

1977). All the megafossil impressions were studied under the incident light and also under strong reflected light.

The miospores have been recovered from the carbonaceous shale samples collected from a section exposed in north-west bank of Sukri River about 1.5 km north-east of Tubed Village. The samples of microfossils were macerated by Schultz's method.

All the figured specimens and type slides are preserved at the Museum of Birbal Sahni Institute of Palaeobotany, Lucknow.

DESCRIPTION

MEGAFLORA

For the study of *Glossopteris* species all the available figured records have been examined and their placement has been discussed with reference to holotype or typical examples selected from the original author's material. In addition, idealized diagrams have also been given to explain the concept of species.

Genus — *Glossopteris* (Brongniart) Sternberg, 1825

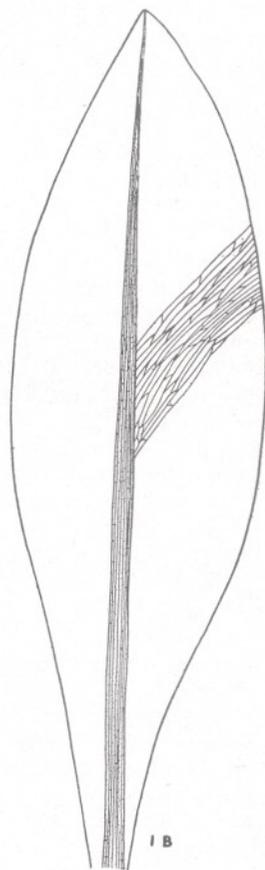
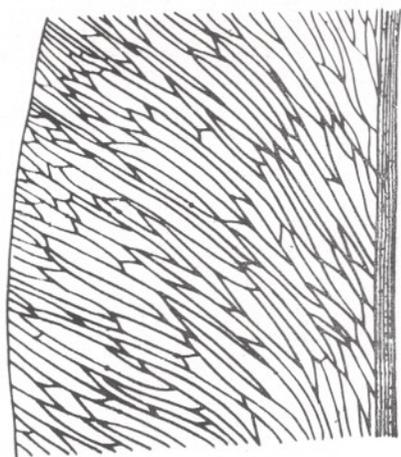
Glossopteris communis Feistmantel, 1876

Pl. 1, figs 1, 2; Text-fig. 1A, B

Typical Example from Feistmantel, 1881a, pl. 36, fig. 2—Leaf, long, oblong, lanceolate; 26.1 cm long, 6.4 cm broad; apex acute;

tip slightly broken; base tapering; midrib 5 mm thick near the base, 1.7 mm broad near the apex, striated, grooved; secondary veins arise at acute angle, arch at 40° to 45°; meshes narrow, elongate, hexagonal, 7 to 11 mm long and 4.0 to 0.7 mm broad; veins 17 to 22 per cm.

Description—There are thirty-five incomplete specimens of different portions of leaf in the collection. In the figured leaf, apex is not preserved, base contracted, and margin entire. The preserved portion is lanceolate in shape, 11.8 cm long and 3.4 cm broad at its widest part. Midrib distinct, persistent, striated, 2.8 mm broad near the base and 1 mm near the apical portion. The secondary veins arise from the midrib at an acute angle and soon arch out at an angle of 45° and reach the margin.



TEXT-FIG. 1 — A. *Glossopteris communis* Feistmantel, enlarged line drawing of a part of the leaf represented on Pl. 1, fig. 1 × 3. B. Idealized diagram of *Glossopteris communis*.

They dichotomize and anastomose to form long, linear, narrow, hexagonal meshes throughout the leaf. The meshes are 3 to 8 mm long and 0.15 mm broad. The density of veins is 8 to 16 per cm near the midrib and 18 to 20 per cm near the margin.

Comparison—The present specimens closely agree in their general shape and venation pattern with a typical specimen described by original author (Feistmantel, 1881, pl. 36, fig. 2; see also observations in the beginning). The leaves described by Feistmantel (1881a, pl. 32, fig. 2; 1886, pl. 2, figs 1, 2) and Maheshwari and Gyan Prakash (1965, pl. 2, fig. 14) are also similar with the present specimens.

Discussion—In 1876, Feistmantel proposed the name of this species for the leaves recovered from the Talchir and Karharbari stages of the Lower Gondwana without giving a diagnosis, description and illustration. In 1879, leaf (pl. 17, figs 1, 2) belonging to this species was described by Feistmantel from the Karharbari Stage of the Karharbari Coalfield, Bihar, India. Later in 1881a, he described this species in detail with a number of diagrams showing variation within the species.

Pant and Gupta (1968) selected a lectotype for *G. communis* from the collection of Feistmantel (1881a, specimen no. 5088) which yielded a cuticle. But this specimen (see Feistmantel, 1881a, pl. 31, fig. 5) represents only a fragment of the leaf which lack morphological detail. Moreover, Feistmantel was himself in doubt about the identity of this specimen with *G. communis* and therefore suggested an alternative name *G. ingens* for the fragment in case it turned out to be new (see Feistmantel, 1881a; explanation of pl. 31, fig. 5).

It is, therefore, unfortunate that the lectotype of *G. communis* has been based on a dubious specimen. From morphological stand point, *G. communis* is represented more typically by other specimens of Feistmantel, of which one is indicated in the beginning with brief description.

Zeiller (1896) and Arber (1905) have considered this species under *G. indica* Schimper but the original photograph of the specimen of *G. browniana* var. *indica* (Brongniart, 1828, pl. 62, fig. 2) shows few, open hexagonal meshes near the midrib and narrow, elongate meshes in rest of the leaf whereas in *G. communis* secondary veins

arise at an acute angle and arch to form narrow, elongate meshes throughout the lamina. It seems, therefore, necessary to maintain the specific status of *G. communis* Feistmantel.

Concept of the Species—The morphological features of *G. communis* Feistmantel can be summarized as follows (Text-fig. 1B).

Leaves elliptical, lanceolate, spatulate; apex narrow, acute, base elongate, contracted; midrib well-developed, thick, persistent up to the apex; secondary veins arise at acute angle, arch at 30°-55°; meshes long, narrow.

Following specimens from the published records are considered typical of *G. communis* Feistmantel.

- 1879 *G. communis* Feistmantel, pl. 17, figs. 1 2 (fragmentary).
- 1881a *G. communis* Feistmantel, pl. 24; pl. 25, figs 1, 2; pl. 26, figs 1, 4; pl. 27, fig. 1; pl. 32, fig. 2; pl. 35, figs 1-3; pl. 36, figs 1, 2; pl. 37, figs 3, 4; pl. 38, figs 1, 2; pl. 40, fig. 4.
- 1882 *G. communis* Feistmantel, pl. 12, figs 1 1a; pl. 17, figs 13, 14.
- 1886 *G. communis* Feistmantel, pl. 2A, figs 1, 2a; pl. 11A, figs 6, 8; pl. 12A, figs 1, 5b, 6a.
- 1890a *G. communis* Feistmantel, pl. 17, figs 2, 6.
- 1890b *G. communis* Feistmantel, pl. 1, figs 1, 1a; pl. 3, fig. 1.
- 1955 *G. communis* Sen, fig. 1.
- 1956 *G. communis* Srivastava, pl. 2, fig. 12.
- 1962 *G. communis* Plumstead, pl. 5, figs 1-6.
- 1965 *G. communis* Maheshwari & Gyan Prakash, pl. 2, fig. 14.
- 1965 *G. communis* Maithy, pl. 5, fig. 31.
- 1966 *G. cf. communis* Rigby, pl. 33, figs 33, 34.
- 1971 *G. communis* Kulkarni, text-fig. 7.

Following specimens are considered as reliable records of *G. communis* Feistmantel:

- 1881a *G. browniana* Feistmantel, pl. 29, figs 3, 8; pl. 27, fig. 4.
- 1886 *G. indica* Feistmantel, pl. 12A, figs 2, 6b; pl. 14, fig. 7.
- 1890a *G. browniana* Feistmantel, pl. 17, fig. 4.
- 1902 *G. indica* Zeiller, pl. 1, fig. 1; pl. 2, figs 1-4; pl. 3, figs 1-3.
- 1908 *G. browniana* Seward & Leslie, text-figs 4, 5.

- 1912 *G. indica* Seward, pl. 1, fig. 1; pl. 1, figs 2, 3.
 1922 *G. indica* Kurtz, pl. 9, fig. 9; pl. 10, figs BBl, B2.
 1922 *G. indica* Walkom, pl. 2, figs 10-13a.
 1928 *G. indica* Edwards, fig. 1A.
 1934 *G. indica* Harrington, pl. 1, fig. 3.
 1941 *G. browniana* Read, pl. 5, figs 3, 4, 6.
 1941 *G. indica* Read, pl. 4, figs 1, 2, 4; pl. 5, figs 1, 2, 5.
 1957 *G. indica* Archangelsky, pl. 7, fig. 2.
 1960 *G. indica* Høeg & Bose, pl. 11, fig. 6; pl. 14, figs 5, 6.
 1963 *G. indica* Cridland, pl. 1, figs 30-32.
 1963 *G. indica* Saksena, pl. 1, figs 1-3.
 1966 *G. browniana* Rigby, pl. 35, fig. 48.

The following specimens are considered as doubtful records of *G. communis* Feistmantel:

- 1956 *G. conspicua* Plumstead, pl. 8, figs 1, 2.
 1962 *G. cf. conspicua* Plumstead, pl. 4, figs 5, 6.

The following specimens are considered distinct from *G. communis* Feistmantel:

- 1881a *G. communis* var. *stenoneura* Feistmantel, pl. 32, fig. 3; pl. 33, fig. 1; pl. 38, fig. 5.
 1890b *G. communis* Feistmantel, pl. 2, fig. 2.

Glossopteris sp. cf. *G. nidpurensis* Srivastava, 1971

Pl. 2, fig. 6; Text-fig. 2A, B.

Description—There is one solitary incomplete leaf impression showing the lower half

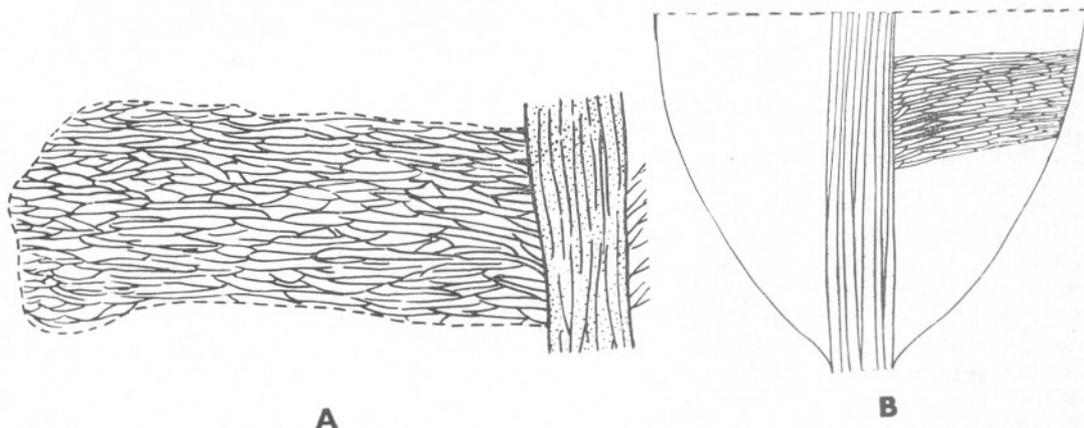
of the lamina. Leaf 6.6 cm long and 5.8 cm broad at its widest part. Apex is missing. Both the margins converge to form a companulate base. Midrib thick, striated, 7 to 8 mm broad throughout the preserved length. Secondary veins arise at acute angle; just after emergence they curve upwards and run almost at right angle; dichotomize and anastomose to form short and broad meshes near the midrib and narrow, elongate meshes near the margin. Meshes are 2 to 2.5 mm long and 0.2 mm broad near the midrib and 2.5 to 3.00 mm long and 0.1 mm broad near the margin. The density of veins is 15 to 17 per cm near the midrib and 25 to 27 per cm near the margin.

Comparison—The present specimen, in its broad shape, characteristically thick midrib and venation pattern resembles the holotype of *G. nidpurensis* Srivastava (1971, pl. 1, fig. 1). The cuticular comparison is not possible as the specimen is devoid of carbonized crust. The holotype as well as the present specimen show that the lateral margin of the leaf converge abruptly near the base and form a companulate base; this feature has not earlier been described by Srivastava (1971).

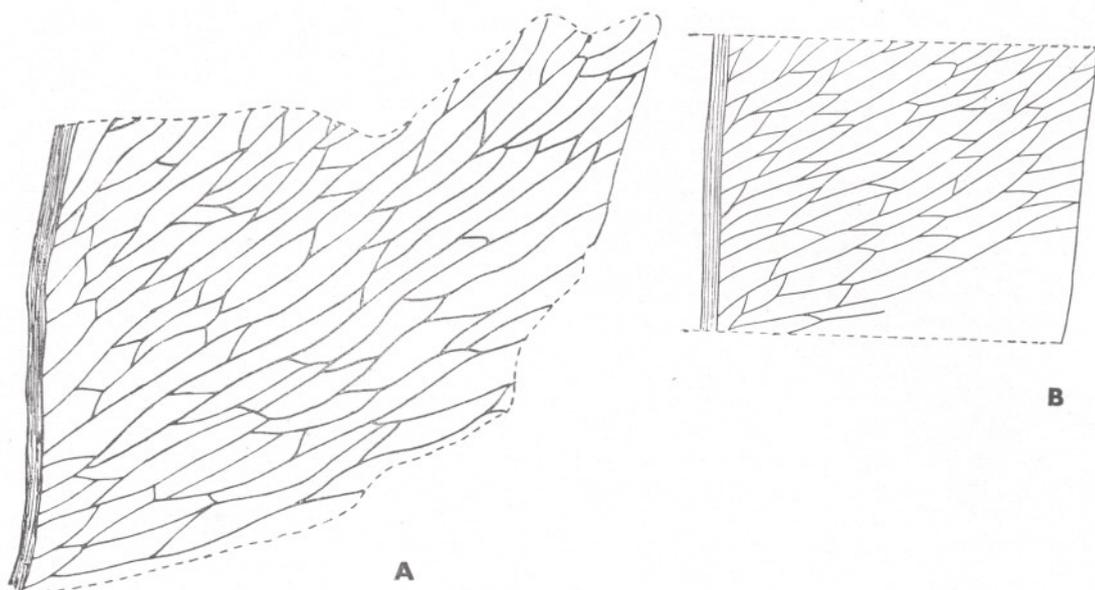
Glossopteris divergens Feistmantel, 1881a

Pl. 2, fig. 8; Text-fig. 3A, B

Typical Example from Feistmantel, 1881a, pl. 28, fig. 3—Leaf incomplete, only lamina on one side of the midrib preserved; apex, base not preserved; margin entire; 7.1 cm



TEXT-FIG. 2 — A. *Glossopteris* sp. cf. *G. nidpurensis* Srivastava, enlarged line drawing of a part of the leaf represented on Pl. 2, fig. 6 \times 3. B. Idealized diagram of *Glossopteris nidpurensis*.



TEXT-FIG. 3—A. *Glossopteris divergens* Feistmantel, enlarged line drawing of a part of the leaf represented on Pl. 2, fig. 8 \times 3. B. Idealized diagram of *Glossopteris divergens*.

long, 3.2 cm broad; midrib strong, 1.7 mm broad, preserved only up to 2.5 cm; secondary veins directed upwards towards apical portion (55° to 60°), almost horizontal in middle and downwards in lower portion; meshes broad, elongate, trapezoidal, 5 to 14 mm long and 12.2 to 1.7 mm broad; veins 6 to 8 per cm.

Description—There is a solitary leaf impression showing lamina only on one side of the midrib. Leaf 2.2 cm long and 4.5 cm broad. The shape is unknown. Apex and base not preserved, margin entire. Midrib distinct, 1 mm broad and raised. Secondary veins arise from the midrib at an acute angle and soon arch out at 50° and run almost up to the margin. They dichotomize and anastomose to form broad, fairly elongate, trapezoid meshes. The meshes are 6 to 12 mm long and 1.5 to 2.0 mm broad. The density of veins is 6 to 8 per cm near the midrib.

Comparison—The present specimen in its venation pattern fairly resembles a typical specimen (Feistmantel, 1881a, pl. 28, fig. 3; also see brief observations given in the beginning).

Discussion—Feistmantel (1881a) instituted this species from the Raniganj Stage

of the Raniganj Coalfield. Another specimen was subsequently recorded by Srivastava (1956) but it shows features distinct from those of typical *G. divergens*. The present specimen is therefore the second authentic record of the species from India. The leaves of *Glossopteris divergens* are regarded by Feistmantel (1881a) as characteristic in possessing secondary veins showing divergens at three places from the midrib, although this feature is not clearly born out by the figures of Feistmantel. The course of veins seems to be uniform but definite comment can not be expressed as midrib is not preserved throughout the length. However, from the position of the midrib in lower region, it appears that the veins are almost horizontal in the middle and lower part of the leaf.

Concept of the Species—The morphological features of *G. divergens* Feistmantel can be summarized as follows (Text-fig. 3B).

Leaf shape, apex and base unknown, margin entire, midrib strong, secondary veins emerge at an acute angle, run oblique to \pm parallel up to the margin, meshes broad, elongate, trapezoidal and of the same size throughout the lamina.

The following known records are considered as typical of *G. divergens* Feistmantel:

1881a *G. divergens* Feistmantel, pl. 28, figs. 3, 4.

The following specimen is considered distinct from *G. divergens* Feistmantel:

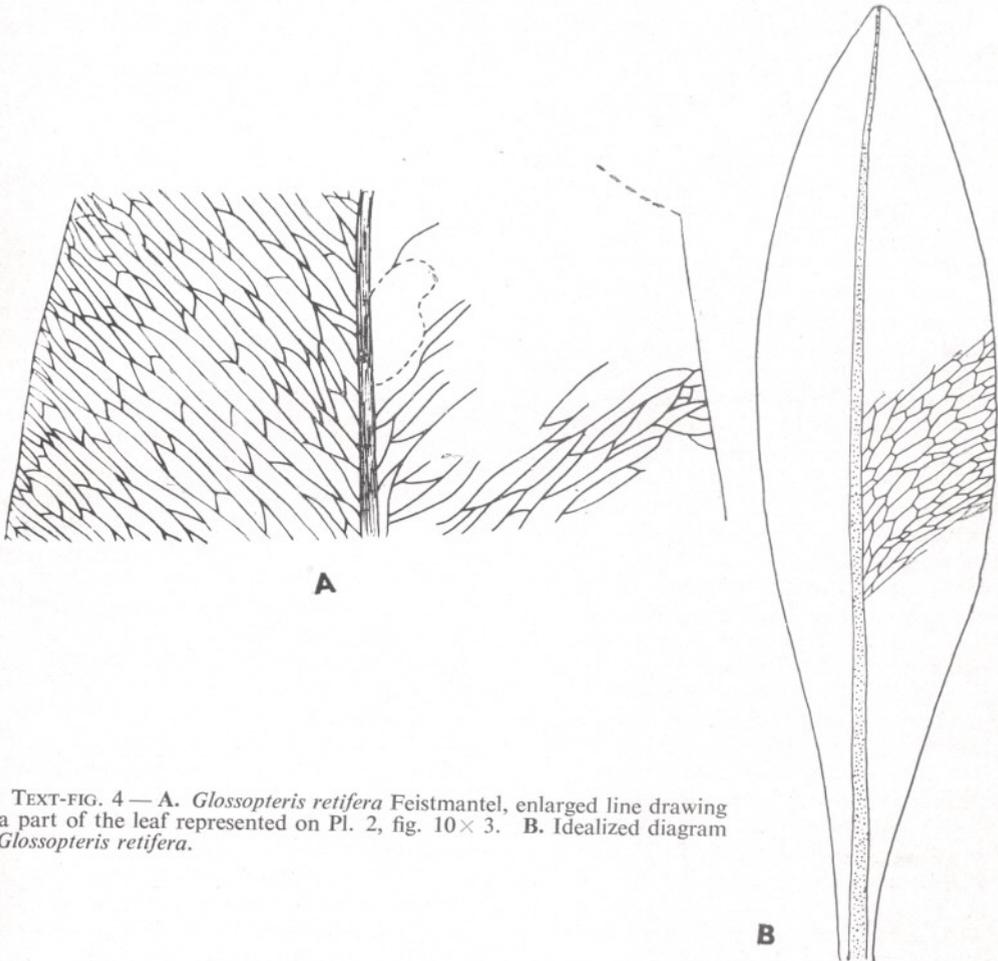
1956 cf. *G. divergens* Srivastava, pl. 2, fig. 7.

Glossopteris retifera Feistmantel, 1881a
Pl. 2, fig. 10; Text-fig. 4A,B

Typical Example from Feistmantel, 1881a, pl. 28, fig. 10 — Leaf incomplete, 6.6 cm long, 3.5 cm broad; obovate?, lanceolate; apex, base not preserved, margin entire; midrib 2.00 mm thick, marked with

1-2 longitudinal lines; secondary veins arise at 45°; meshes, square, hexagonal 3 to 5 mm long, 1.5 to 2.0 mm broad; veins 10 to 14 per cm.

Description — There are three incomplete leaf impressions in the collection. The figured leaf is 6.00 cm long and 3.8 cm broad at its widest part. The shape of leaf is exactly not known but may have probably been lanceolate. Apex acuminate; base not preserved. Midrib is distinct, 2 mm thick and shows 1 to 2 longitudinal lines over the surface. Secondary veins arise at an angle of 45°, dichotomize and anastomose to form broad, open, polygonal, meshes. Meshes are equal in size, measuring 4.6 mm long and 0.5-1 mm broad. The density of veins is 7-10



TEXT-FIG. 4 — A. *Glossopteris retifera* Feistmantel, enlarged line drawing of a part of the leaf represented on Pl. 2, fig. 10 $\times 3$. B. Idealized diagram of *Glossopteris retifera*.

per cm near the midrib and 12-19 per cm near the margin.

Comparison — In their venation pattern, the present specimens are identical with a typical specimen described by Feistmantel (1881a, pl. 28, fig. 10, see also brief observations in the beginning), and the leaf described by Maheshwari and Gyan Prakash (1965, pl. 3, fig. 19).

Discussion — Feistmantel (1881a) instituted this species from the Raniganj Stage of the Raniganj Coalfield, West Bengal, India.

A perusal of the published records shows that the leaves described as *G. retifera* by Seward and Leslie (1908), Walton (1929), Plumstead (1952, 1956) from the Karroo Formation of Africa and by Archangelsky (1958) from the Permian of Golondrian Series of Laguna Polina, Argentina possess distinct characters than those of *G. retifera* Feistmantel described from the Lower Gondwana of India. They are spatulate with a broad, obtuse apex and petiolate base. Secondary veins arise at an acute angle, run parallel up to the margin and form 1-2 open square meshes near the midrib and open elongate meshes near the margin. In the typical Indian example of *G. retifera*, however, the secondary veins arise at an angle of 40°-45° and meshes are open, hexagonal, throughout the lamina. Banerjee (1972) has already merged some of these leaves described by Plumstead (1952, 1956) and Archangelsky (1958) under *G. tortuosa* Zeiller.

Concept of the Species — The morphological features of *G. retifera* Feistmantel can be summarized as follows (Text-fig. 4b).

Leaf shape unknown, lanceolate?, apex acute?, base contracted; margin entire; midrib thick, persistent up to the apex; secondary veins arise at 40°-45°; meshes open, square-shaped, hexagonal to polygonal; veins 8-10 per cm.

The following specimens from the known records are typical of *G. retifera* Feistmantel:

- 1881a *G. retifera* Feistmantel, pl. 28, figs 2, 7, 10; pl. 41, fig. 9
 1889 *G. retifera* Feistmantel, pl. 4, fig. 3.
 1956 *G. retifera* Srivastava, pl. 5, figs 32, 33.
 1965 *G. retifera* Maheshwari & Gyan Prakash, pl. 3, fig. 19.

The following specimens are considered as doubtful records of *G. retifera* Feistmantel:

- 1886 *G. retifera* Feistmantel, pl. 4, fig. 1 (left hand figured).
 1922 *G. retifera* Kurtz, pl. 10, fig. 90 (fragmentary).

The following specimens are considered distinct from *G. retifera* Feistmantel:

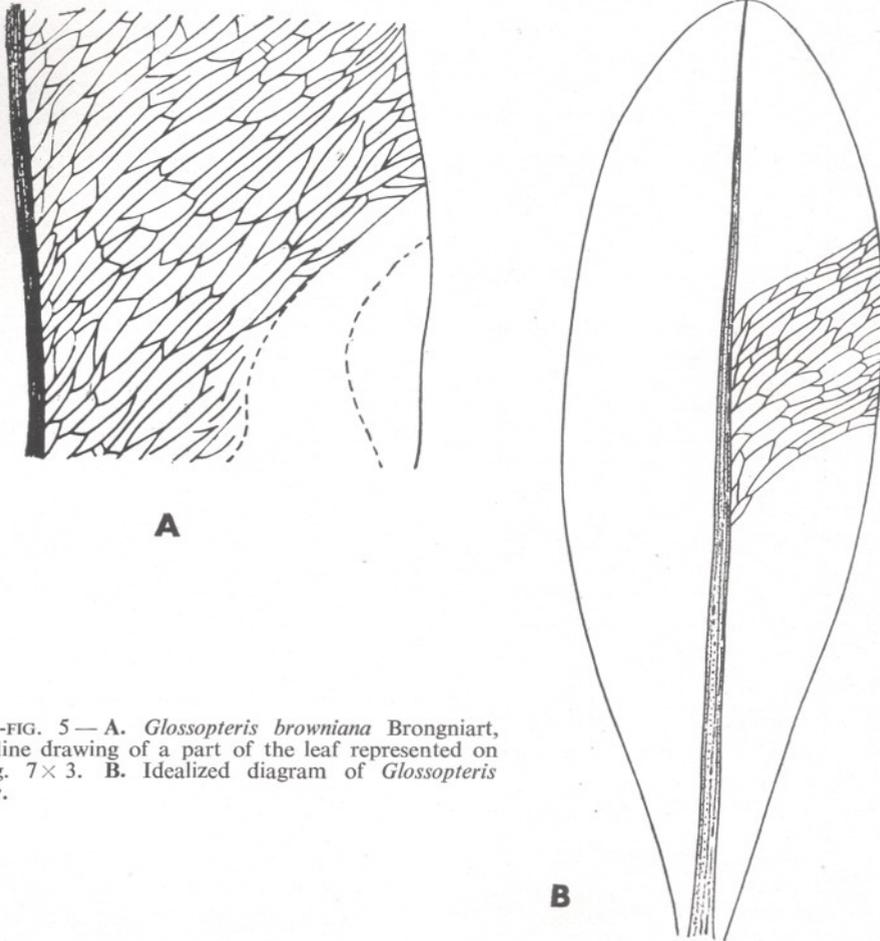
- 1867 *Dictyopteris* (?) *simplex* Tate, pl. 4, fig. 6, fragmentary (= *G. retifera* cf. Arber, 1905).
 1881a *Sagenopteris polyphylla* Feistmantel, pl. 41, figs 3, 4 (= *G. retifera* Arber, 1905).
 1889 *G. tatei* Feistmantel, pl. 4, fig. 8 (= *G. retifera* of Arber, 1905).
 1908 cf. *G. retifera* Seward & Leslie, text-fig. 7.
 1929 *G. retifera* Walton, pl. c, fig. 22.
 1952 *G. retifera* Plumstead, pl. 51, figs 1-6; pl. 52, figs 1-5.
 1956 *G. retifera* Plumstead, Pl. 12, figs 1, 2; pl. 13, fig. 14; pl. 14, figs 1-4.
 1958 *G. retifera* Archangelsky, pls 40, 41.

Glossopteris browniana Brongniart, 1828

Pl. 2, fig. 7; Text-fig. 5A, B

Typical Example from Brongniart, 1828, pl. 62, fig. 1 (Leaf at left corner) — Leaf spatulate, 16.8 cm long, 4.6 cm broad, apex obtuse, base contracted, margin entire; midrib distinct, 2.5 mm broad near the base, 0.3 mm broad near the apex; secondary veins arise at 45°-50°; meshes open, short, 1-2 mm long, 0.7-1.00 mm broad near the midrib and open, elongate 10-12 mm long and 1-1.3 mm broad in rest of the lamina, veins 6-8 per cm.

Description — There are eight incomplete leaf impressions present in the collection. The figured leaf is 9.2 cm long and 3.8 cm broad at its widest part. The shape is probably spatulate to lanceolate. Apex and base not preserved, margin entire. Midrib distinct, striated, 1.3 mm broad near the base and 0.5 mm near the apical region. Secondary veins arise from the midrib at an angle of 45°. They dichotomize and anastomose to form open, nearly rectangular meshes near the midrib and narrow polygonal near the margin. The meshes are 4-6 mm long and 0.7-1.2 mm broad near the midrib and 1.3-5 mm long and 0.5-0.7 mm broad near the margin.



TEXT-FIG. 5—A. *Glossopteris browniana* Brongniart, enlarged line drawing of a part of the leaf represented on Pl. 2, fig. 7×3. B. Idealized diagram of *Glossopteris browniana*.

Density of veins 9-12 per cm near the midrib and 16-20 per cm near the margin.

Comparison—The specimens agree in their general shape and venation pattern with a typical specimens described by the original author (Brongniart, 1828, pl. 62, fig. 1; see also observations in the beginning) and the leaf described by Maheshwari and Gyan Prakash (1965, pl. 2, fig. 17).

Discussion—In 1828, Brongniart instituted this species. Later, he described two varieties under this species, viz., *G. browniana* var. *australasica* (from mines of Huille of Hawkesbury River, Australia, pl. 62, fig. 1) and *G. browniana* var. *indica* (from Rana Gunja near Rajmahal, India, pl. 62, fig. 2). Schimper (1869) raised the Indian form to specific

rank as *G. indica* and the name *G. browniana* is now confined to the leaf with open meshes, i.e. the variety *australasica*.

Concept of the Species—The morphological features of *G. browniana* Brongniart can be summarized as follows (Text-fig. 5b):

Leaf spatulate to lanceolate, apex broad, acuminate, base contracted, margin entire; midrib distinct, sometimes striated; secondary veins arise at 40°-45°; meshes broad, hexagonal near the midrib and narrow, elongate, polygonal near the margin.

A critical survey of the known records shows that the following specimens can be considered typical of *G. browniana* Brongniart:

1828 *G. browniana* var. *australasica* Brongniart, pl. 62, figs 1, 2a.

- 1881a *G. browniana* Feistmantel, pl. 29, figs 1, 2, 6.
 1882 *G. browniana* Feistmantel, pl. 12, fig. 4; pl. 20, fig. 3.
 1889 *G. browniana* Feistmantel, pl. 4, fig. 4
 1890a *G. browniana* Feistmantel, pl. 16, figs 3, 4; pl. 17, figs 3, 7.
 1890b *G. browniana* Feistmantel, pl. 5, fig. 2.
 1890a *G. parallela* Feistmantel, pl. 9, figs 2, 4.
 1897 *G. browniana* Seward, pl. 23, fig. 1.
 1904 *G. browniana* Seward, pl. 4, fig. 1.
 1911 *G. browniana* Halle, pl. 1, figs 27-29.
 1956 *G. browniana* Srivastava pl. 1, fig. 3.
 1958 *G. browniana* Plumstead, pl. 2, figs 1, 2; pl. 3, figs 1-4.
 1962 *G. browniana* Plumstead, pl. 8, figs 1, 7, 8.
 1965 *G. browniana* Maithy, pl. 5, fig. 32.
 1965 *G. browniana* Maheshwari & Prakash, pl. 2, fig. 17; text-fig. 8a-c.
 1971 *G. browniana* Kulkarni, pl. 1, fig. 7; text-fig. 4.

The following specimens are regarded as doubtful records of *G. browniana* Brongniart:

- 1881a *G. browniana* Feistmantel, pl. 24, fig. 4; pl. 29, figs 3, 8.
 1904 *G. browniana* var. *indica* Seward, pl. 4, fig. 2.
 1922 *G. browniana* Walkom, pl. 2, figs 9, 9a.
 1958 *G. browniana* var. *cornelium* Plumstead, pl. 10, figs 1-5a; pl. 2, figs 1, 2; pl. 3, figs 1-4.

The following specimens are regarded as distinct from *G. browniana* Brongniart:

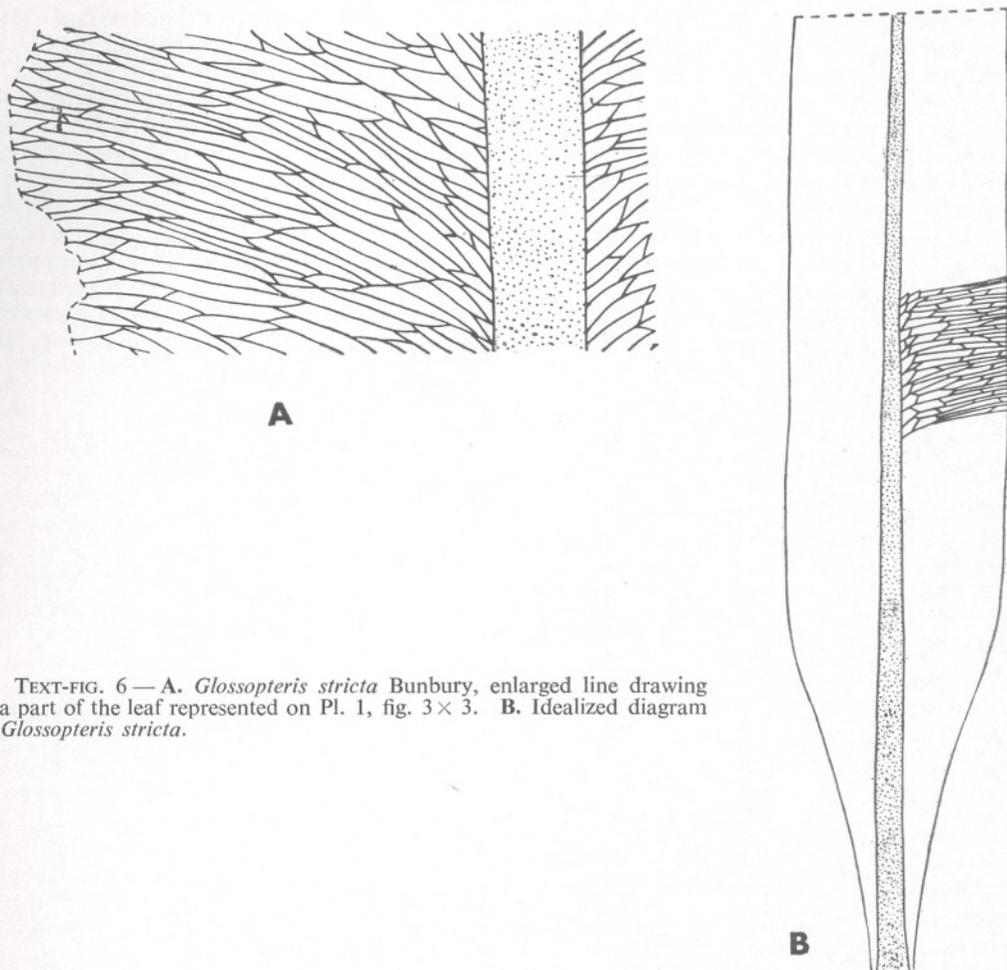
- 1828 *G. browniana* var. *indica* Brongniart, pl. 62, fig. 2.
 1849 *G. reticulum* Dana, pl. 13, fig. 2 (= *G. browniana* of Arber, 1905).
 1861 *G. browniana* var. *australasica* Bunbury, pl. 8, fig. 5.
 1867 *G. browniana* Tate, pl. 4, figs 5a, 7a, 7b.
 1881a *G. intermittens* Feistmantel, pl. 33, figs 2-4 (= *G. browniana* of Arber 1905).
 1881a *G. browniana* Feistmantel, pl. 29, figs 3, 8; pl. 27, fig. 4.
 1882 *G. (?) cordata* Feistmantel, pl. 20, fig. 1 (= *G. browniana* of Arber, 1905).
 1890a *G. parallela* Feistmantel, pl. 9, figs 2-4 (= *G. browniana* of Arber, 1905).

- 1890a *G. clarkei* Feistmantel, pl. 13, figs 4, 4a (= *G. browniana* of Arber, 1905).
 1890a *G. browniana* var. *praecursor* Feistmantel, pl. 13, figs 5, 6 (= *G. browniana* of Arber, 1905).
 1890a *G. linearis* Feistmantel, pl. 16, figs 1, 2; pl. 19, figs 3, 4; pl. 20, fig. 6 (= *G. browniana* of Arber, 1905).
 1890a *G. wilkinsonii* Feistmantel, pl. 20, figs 1, 1a (= *G. browniana* of Arber, 1905).
 1890a *G. browniana* Feistmantel, pl. 17, fig. 4.
 1897 *G. browniana* var. *angustifolia* Seward, pl. 21, figs 1, 4a.
 1897 *G. browniana* var. *indica* Seward, pl. 21, figs 2, 3.
 1904 *G. browniana* var. *angustifolia* Seward, pl. 4, figs 3, 4.
 1908 *G. browniana* Seward & Leslie, text-figs 4, 5.
 1922 *G. browniana* Walkom, pl. 9, figs 47, 47a.
 1923 *G. browniana* Seward & Walton, pl. 20, fig. 11.
 1928 *G. browniana* Walkom, text-figs 1, 1a.
 1934 *G. browniana* Harrington, pl. 2, figs 1, 2.
 1941 *G. browniana* Read, pl. 5, figs 3, 4, 6.
 1952 *G. browniana* Plumstead, pls 43, 44; text-fig. 1a, b.
 1955 *G. browniana* Lele, pl. 2, figs 21, 22.
 1956 *G. browniana* Plumstead, pl. 1, fig. 1.
 1958 *G. browniana* Archangelsky, pls 36, 37.
 1962 *G. browniana* Saksena, pl. 1, figs 7, 8.

Glossopteris stricta Bunbury, 1861

Pl. 1, fig. 3; Text-fig. 6A, B

Typical Example from Feistmantel, 1881-a, pl. 37, fig. 1 — Leaf incomplete, lamina on one side of the midrib preserved, 27.7 cm long, 3.6 cm broad; apex base not preserved, but base seems to be petiolate; midrib broad, 4-6 mm thick; secondary veins arise at acute angle; meshes, open, polygonal, 0.5-1.0 mm long and 0.5-0.7 mm broad near the midrib and narrow, linear, 3-4 mm long and 0.3 mm broad near the margin;



TEXT-FIG. 6 — A. *Glossopteris stricta* Bunbury, enlarged line drawing of a part of the leaf represented on Pl. 1, fig. 3 \times 3. B. Idealized diagram of *Glossopteris stricta*.

veins 12-14 per cm near the midrib and 22-30 per cm near the margin.

Description — There is a solitary incomplete leaf impression in the collection. The leaf is 17.3 cm long and 4.2 cm broad at its widest part. The shape is unknown. Apex missing, and margin entire. Both the margins of leaf are converging to form a distinct petiolate base. Midrib distinct, grooved, thick, 5.00 mm broad at the base and 3.00 mm broad at the incomplete apical portion. The secondary veins arise from the midrib at an acute angle and run straight to the margin and almost parallel to each other. They dichotomize and anastomose to form square, polygonal, 0.8 to 1.5 mm long and 0.5-1.0 mm broad meshes near the midrib narrow and linear, hexagonal,

4-8 mm long and 0.5 mm broad meshes in rest of the lamina. The density of veins is 12-14 per cm near the midrib and 22-25 per cm near the margin.

Comparison — The present specimen in its venation pattern compare well with a typical example described by Feistmantel (1881a, pl. 37, figs 1, 2; see also brief observations in the beginning), and the leaf described by Kulkarni (1971, pl. 1, fig. 5).

Discussion — Bunbury (1861) instituted this species from Silewada and Kampti locality of Nagpur, Maharashtra, India. The figure of *G. stricta* given by Bunbury (pl. 9, fig. 5) does not show the distinct venation pattern. However, the characters described above are well-cited by him in his description. In 1881a, Feistmantel has des-

cribed this species in detail with a number of diagrams showing variation within the species.

Concept of the Species — The morphological features of *G. stricta* Bunbury can be summarized as follows (Text-fig. 6B) :

Leaves long, narrow, strap-shaped ; apex unknown, base petiolate?, margin entire; midrib broad, strong; secondary veins arise at acute angle, run \pm straight; meshes few, broad, polygonal near the midrib and linear hexagonal in rest of the lamina.

The following specimens from published records are considered typical *G. stricta* Bunbury :

- 1861 *G. stricta* Bunbury, pl. 9, fig. 5.
 1881a *G. stricta* Feistmantel, pl. 37, figs 1, 2; pl. 38, fig. 3.
 1882 *G. stricta* Feistmantel, pl. 21, fig. 11.
 1886 *G. stricta* Feistmantel, pl. 4, figs 6, 6a.
 1905 *G. stricta* Arber, pl. 4, fig. 1.
 1958 *G. stricta* Archangelsky, pl. 46.
 1962 *G. stricta* Plumstead, pl. 10, figs 1-4.
 1971 *G. stricta* Kulkarni, pl. 1, fig. 5.

The following specimens are considered reliable records of *G. stricta* Bunbury :

- 1902 *G. damudica* Zeiller, pl. 4, figs 5, 6.
 1956 *G. damudica* Srivastava, pl. 6, figs 3, 7.
 1958 *G. damudica* Archangelsky, pl. 34.

The following specimens are considered doubtful records of *G. stricta* Bunbury :

- 1928 *G. indica* Edwards, fig. 2
 1956 *G. browniana* Srivastava, pl. 1, fig. 1.

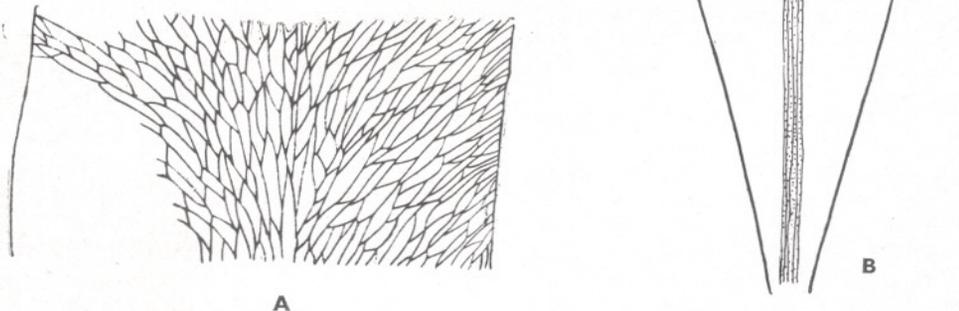
The following specimens are considered distinct from *G. stricta* Bunbury :

- 1953 *G. stricta* Dolianiti, pls 1, 2.
 1958a *G. stricta* Plumstead, pls 18-20.

Glossopteris decipiens Feistmantel, 1879

Pl. 3, fig. 13; Text-fig. 7A, B

Typical Example from Feistmantel, 1879, pl. 18, fig. 4 — Leaf complete 17.4 cm long, 3.5 cm broad, oblong, spatulate shape; apex broadly acuminate, base narrow, basal angles auriculate, margin entire; midrib 3 to 1 mm thick, present only up to 12 cm length then divides into fine secondary veins, in the lower portion secondary veins arise from the midrib at an acute angle, meshes narrow, oblong, 3 to 6 mm long and 0.4 to 0.6 mm broad; veins 17 to 20 per cm.



TEXT-FIG. 7 — A. *Glossopteris decipiens* Feistmantel, enlarged line drawing of a part of the leaf represented on Pl. 3, fig. 13 $\times 3$. B. Idealized diagram of *Glossopteris decipiens*.

Description — There is a solitary incomplete leaf impression showing the upper half of lamina. The specimen is 7.0 cm long and 2.8 cm broad at its widest part. The shape of leaf is exactly not known, probably it was oblong, spathulate. Apex broad, acuminate, base absent and margin entire. Midrib present up to 4.3 cm and then diffuses into fine secondary veins near the apex. Secondary veins arise from the midrib at an acute angle, dichotomize and anastomose to form narrow, oblong meshes throughout the lamina. The meshes are 1-2 mm long and 0.3-0.5 mm broad. The density of veins is 8-10 per cm near the midrib and 15-17 per cm near the margin.

Comparison — The present specimen agrees in its venation pattern and midrib character with a typical example of *G. decipiens* described by Feistmantel (1879, pl. 18, fig. 4; see also observations given in the beginning).

Discussion — Feistmantel (1879) regarded this species as transition, between the leaf of *Glossopteris* and *Gangamopteris*. Plumstead (1962) suggested that the evanescent nature of midrib is a character of secondary importance. But an examination of original and other known records strongly indicates that the evanescent nature of midrib is of diagnostic value to the species, *G. decipiens* Feistmantel.

Concept of the Species — The morphological features of *G. decipiens* Feistmantel can be summarized as follows (Text-fig. 7B):

Leaf narrow, spathulate, apex broad, acuminate, rounded, margin entire, midrib strong, striated, present only up to 2/3 of the length of the leaf, then diffusing into fine secondary veins, secondary veins arise at acute angle; meshes narrow, oblong, polygonal.

In view of the above criteria, the following specimens from the known records are considered typical of *G. decipiens* Feistmantel:

- 1879 *G. decipiens* Feistmantel, pl. 18, figs 3-5; pl. 24, fig. 6.
1934 cf. *G. decipiens* Harrington, pl. 1, fig. 4.

The following specimens are considered doubtful records of *G. decipiens* Feistmantel:

- 1923 *G. indica* cf. *G. decipiens* Seward & Walton, pl. 21, fig. 15.
1965 *G. decipiens* Maheshwari, pl. 2, fig. 12.

The following specimens are considered distinct from *G. decipiens* Feistmantel:

- 1879 *Sagenopteris* (?) *stoliczkana* Feistmantel, pl. 13, fig. 4 (= *G. decipiens* of Arber, 1905)
1958a *G. decipiens* Plumstead, pl. 1, fig. 1.
1962 *G. decipiens* Plumstead, pl. 7, figs 1-4.
1971 *G. decipiens* Kulkarni, pl. 1, fig. 1.

Glossopteris fusa Kulkarni, 1971

Pl. 2, fig. 9; Text-fig. 8A, B

Description — There are two complete leaf impressions in the collection. The figured leaf is narrow spathulate in shape, 5.2 cm long and 1.5 cm broad at its widest part. Apex obtuse, base contracted and margin entire. The midrib region is occupied by 6-7 parallel running strands which in due course form secondary nerves and ultimately 1 strand reaches the apex. The secondary veins form long, narrow, rectangular meshes of equal size throughout the lamina. The meshes are 3-5 mm long and 0.3 mm broad. The density of veins is 12-15 per cm near the midrib and 15-18 per cm near the margin.

Comparison — The present specimens closely compare with the holotype of *G. fusa* Kulkarni in their shape and venation pattern. The figured specimens of Kulkarni (1971, pl. 2, figs 16-18) and the present specimens show that the midrib region is occupied by parallel running strands which in due course form secondary veins and ultimately 1 or 2 strands reach the margin. This character results in the evanescent appearance of the midrib.

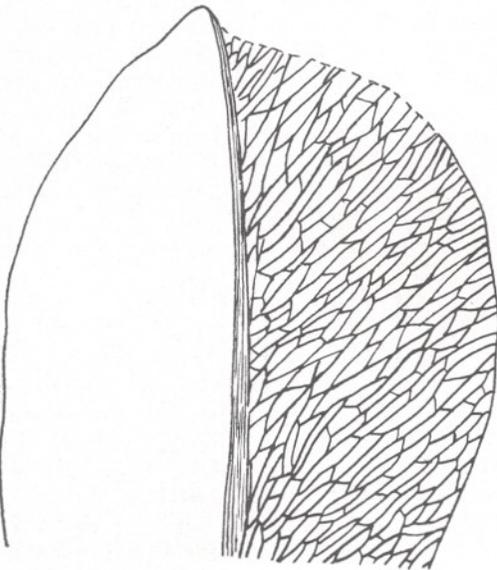
Glossopteris sp.

Pl. 1, figs 4, 5; Text-fig. 9

Description — A solitary incomplete leaf impression is present. The specimen measures 4.1 cm long and 1.6 cm broad at its widest part. Apex obtusely rounded; base absent. The margin is entire. Midrib distinct, persistent throughout the preserved length, 1.5 mm broad, gradually narrower towards the apex. Secondary veins emerge at an angle of 45° but due to oblique preservation of the lamina, the angle of veins



TEXT-FIG. 8 — A. *Glossopteris fusa* Kulkarni, enlarged line drawing of a part of the leaf represented on Pl. 2, fig. 9 \times 2. B. Idealized diagram of *Glossopteris fusa*.



TEXT-FIG. 9 — *Glossopteris* sp., enlarged line drawing of a part of the leaf represented on Pl. 1, fig. 4 \times 2.

shows some variation. The veins dichotomize and anastomose to form short, hexagonal, honey-comb-like meshes throughout the lamina. Meshes open, broad, elongate near the midrib measuring 0.7-2 mm long and 0.3-0.7 mm broad while near the margin close, broad, shorter, measuring 0.4-0.7 mm long and 0.2-0.3 mm broad. The density of veins is 16-20 per cm near the midrib and 27-30 per cm near the margin.

Comparison — As the specimen is incomplete, its comparison can be made only on the basis of venation pattern. In its open hexagonal mesh pattern it resembles *G. browniana* (Brongniart, 1828, pl. 62, fig. 1). However, in *G. browniana* meshes are oblong, polygonal near the midrib but they become somewhat narrower towards the margin whereas in the present specimen meshes are hexagonal and broad throughout the lamina. Due to lack of complete specimens no specific name has been proposed for the leaf which may turn out to be a distinct species.

Glossopteris conspicua Feistmantel, 1881

Pl. 2, fig. 11

Description — The Raniganj leaves are incomplete, 2-4 cm long, 1.0-1.5 cm broad. The apex and base are not preserved. The margin is entire. The midrib is 1 mm broad, striated. Secondary veins arise at an angle of 45°. They form open, polygonal, 2-3 mm long and 0.5-0.7 mm broad meshes. The density of veins is 4-6 per cm throughout the lamina.

Remarks — The species has been discussed in detail under Barakar flora of the Auranga Coalfield (see Srivastava, 1977).

Glossopteris leptoneura Bunbury, 1861

Pl. 3, fig. 14

Description — The Raniganj leaves are narrow, linear in shape, 8-9 cm long and 1.5-2 cm broad. The apex acute, base contracted and margin entire. Midrib distinct and 1 mm broad. Secondary veins arise at acute angle, arched out and form fine linear, narrow, 3-5 mm long and 0.2 mm broad meshes. The density of veins is 20-25 per cm throughout the lamina.

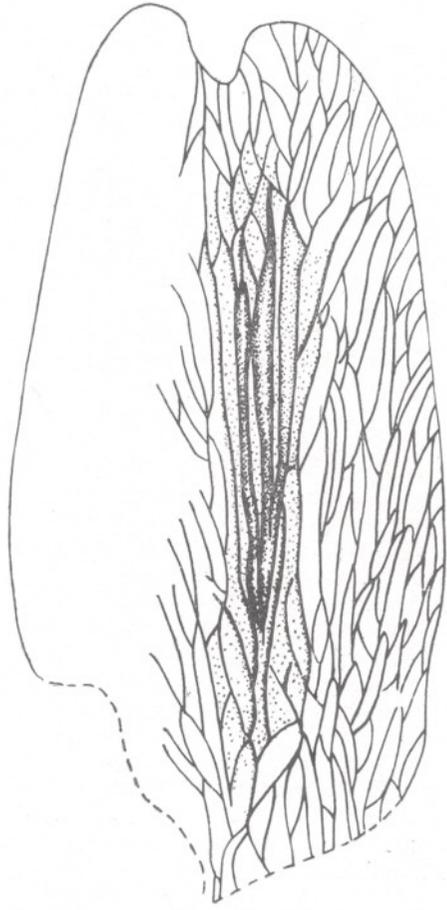
Remarks — For detail description and discussion of the species see Srivastava (1977).

SCALE LEAVES

Pl. 2, fig. 12; Pl. 3, fig. 15; Text-fig. 10

Description — There are two almost complete specimens present in the collection. The figured leaves are spatulate in shape measuring 4.5 cm long and 1.8-2.4 cm broad at its widest part. Surface is smooth. The apex broad, obtuse and notched. Base broad, slightly convergent and the margin entire. The veins arise from the base. There are 3-4 thick parallel interconnecting veins present in the middle. After anastomoses and dichotomy they form open, oblong, polygonal meshes. The meshes are 6-12 mm long and 1-2 mm broad in the middle and 4-8 mm long and 1.5 mm broad near the margin.

Comparison — The present specimens are large in size and possess a spatulate broad to notched apex. The broad shape and obtuse apex compare with *Glottolepis rugosa* Bose & Srivastava (1970, pl. 1, figs 1-5) but the latter species has a rugosa leaf



TEXT-FIG. 10 — Scale leaf, enlarged line drawing to show the venation details $\times 3$.

surface. *Palmatophyllites lacerata* (Feistmantel) Maithy (1965, pl. 2, figs 16-20) differs from the present leaves in having deep lobed margin.

MIOFLORA

The following 18 genera and 36 species have been recorded from the Raniganj assemblage of the Auranga Coalfield. Species marked with an asterisk have been described :

Leiotriletes brevis Sinha, 1972; *Cyclobaculisporites proprius* Bharadwaj & Salujha, 1965a; *Horriditriletes curvibaculosus* Bharadwaj & Salujha, 1964; *Brevitriletes communis* Bharadwaj & Srivastava, 1969; *B.*

unicus (Tiwari) Bharadwaj & Srivastava, 1969 ; *B. levis* (Balme & Hennelly) Bharadwaj & Srivastava, 1969 ; *B. baculatus* Sinha, 1972 ; *Latosporites colliensis* (Balme & Hennelly) Bharadwaj, 1962 ; *Laevigatosporites punctatus* Venkatachala & Kar, 1968 ; *Mammialetes mammus* Kar, 1969b ; *Densipollenites indicus* Bharadwaj, 1962 ; *D. invisus* Bharadwaj & Salujha, 1964 ; *D. densus* Bharadwaj & Srivastava, Shyam C., 1969 ; *D. brevis* Lele & Srivastava (1977) ; *Striomonosaccites ovatus* Bharadwaj, 1962 ; *Faunipollenites varius* Bharadwaj, 1962 ; *F. perexiguus* Bharadwaj & Salujha, 1964 ; * *F. multistriatus* sp. nov. ; * *Striatopodocarpites haploxytonoides* sp. nov. ; *S. magnificus* Bharadwaj & Salujha, 1964 ; *Striatites subtilis* Bharadwaj & Salujha, 1964 ; *S. notus* Bharadwaj & Salujha, 1964 ; *S. rhombicus* Bharadwaj & Salujha, 1964 ; *S. alius* Venkatachala & Kar, 1968 ; * *S. obliquus* sp. nov. ; *S. barakarensis* Sinha, 1972 ; *Lahirites parvus* Bharadwaj & Salujha, 1964 ; *Verticypollenites secretus* Bharadwaj, 1962 ; *V. finitimus* Bharadwaj & Salujha, 1964 ; *V. debilis* Venkatachala & Kar, 1968 ; *Rhizomaspora fimbriata* Tiwari, 1965 ; *Mahudapollenites wilsonii* Bandyopadhyaya, 1972 ; *Scheuringipollenites maximus* (Hart) Tiwari, 1973 ; *S. barakarensis* (Tiwari), Tiwari, 1973 ; *S. ovatus* (Hart) Lele & Srivastava (1977) ; *Distriamonocolpites ovalis* Bharadwaj & Sinha, 1969.

Anteturma — *Pollenites* Potonié, 1931
Turma — *Saccites* Erdtman, 1947
Subturma — *Disaccites* Cookson, 1947
Infraturma — *Striatites* Bharadwaj, 1962

Genus — *Faunipollenites* Bharadwaj, 1962

Faunipollenites multistriatus sp. nov.

Pl. 3, figs 16, 17; Text-fig. 11

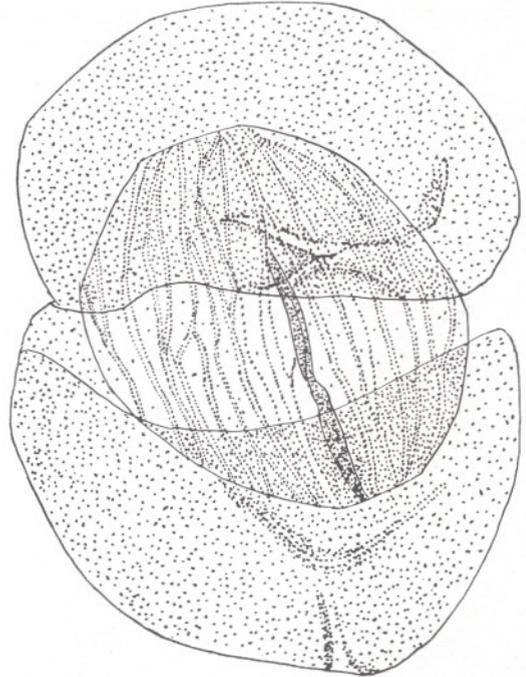
Holotype — Pl. 3, fig. 16 ; Slide no. 5032.

Type Locality — Sukri River Section, near Tubed Village, Auranga Coalfield, Bihar.

Horizon & Age — Raniganj Stage, Upper Permian.

Diagnosis — Size range 104-120 × 70-80 μ ; central body obscure, circular to horizontally oval, 58-64 × 60-68 μ ; horizontal striations 12-18 μ, branched, sulcus 20-24 μ wide.

Description — Bilateral, disaccate diploxytonoid ; body thin, intramicroreticulate ;



TEXT-FIG. 11 — *Faunipollenites multistriatus* sp. nov., drawing of the holotype showing large number of striations × 950.

sacci hemispherical, attachment full, straight to convex, intrareticulation fine.

Comparison — The present species resembles *F. copiosus* Bharadwaj & Salujha (1965) in larger number of striations (9-11). However, distinguishes in having a still larger number of branched striations (12-18) and in its smaller size. Other species of *Faunipollenites* differ chiefly in their smaller number of striations.

Genus — *Striatopodocarpites* (Soritsch & Sedowa) Bharadwaj, 1962

Striatopodocarpites haploxytonoides sp. nov.

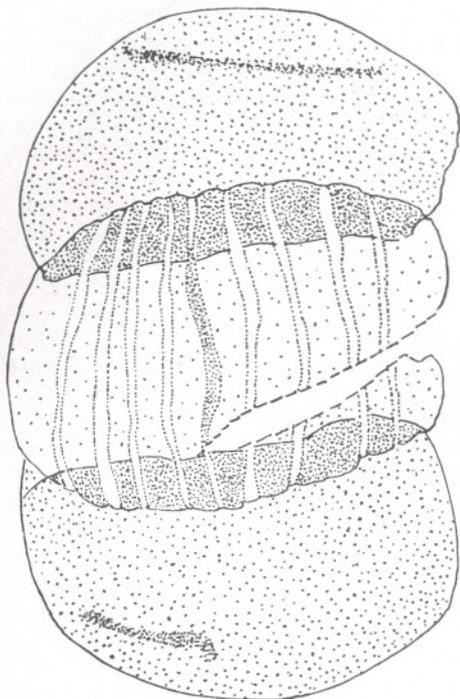
Pl. 3, figs 18, 19; Text-fig. 12

Holotype — Pl. 3, fig. 18 ; Slide no. 5033.

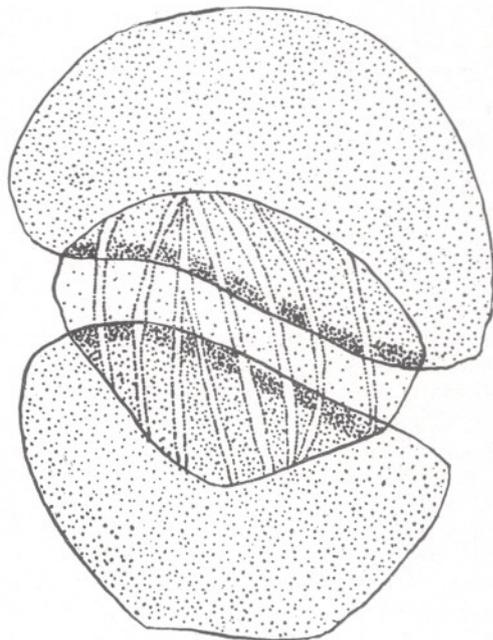
Type Locality — Sukri River Section, near Tubed Village, Auranga Coalfield, Bihar.

Horizon & Age — Raniganj Stage, Upper Permian.

Diagnosis — Size range 100-110 × 62-70 μ ; central body circular to oval, 62-68 × 47-50 μ ; horizontal striations 9-11, unbran-



TEXT-FIG. 12 — *Striatopodocarpites haploxyloides* sp. nov., drawing of the holotype showing haploxyloid saccus attachment $\times 950$.



TEXT-FIG. 13 — *Striatites obliquus* sp. nov., drawing of the holotype showing oblique striations $\times 950$.

ched, running parallel; sacchi haploxyloid, sulcus $24-36 \mu$ wide, straight to convex.

Description — Bilateral, disaccate, haploxyloid; body exine thin, fine intramicroreticulate; sacchi hemispherical, height less than the body, attachment full, straight to \pm convex, intrareticulation fine to medium.

Comparison — The present species distinguishes from other species in having haploxyloid saccus. It compares in its general organisation with *Lueckisporites amplus* described by Balme and Hennelly (1955, pl. 3, fig. 27) but the latter has a granulose exine.

Genus — *Striatites* (Pant) Bharadwaj, 1962

Striatites obliquus sp. nov.

Pl. 3, figs 20, 21; Text-fig. 13

Holotype — Pl. 3, fig. 20; Slide no. 5032.

Type Locality — Sukri River Section, near Tubed Village, Auranga Coalfield, Bihar.

Horizon & Age — Raniganj Stage, Upper Permian.

Diagnosis — Size range $74-92 \times 43-52 \mu$, body circular to oval, rarely rhomboid, $33-45 \times 44-52 \mu$, rim absent; striations 8-12, branched, often orientated in oblique manner; sulcus $9-20 \mu$ broad, straight to \pm convex.

Description — Disaccate, bilateral, diploxyloid, body exine thin, intramicroverrucose; most of the striations show a strong tendency to run oblique to the horizontal axis, vertical partitions absent; sacchi hemispherical, attachment full, straight to nearly convex, intrareticulation fine.

Comparison — The present species distinguishes from all the known species in the presence of thin body exine and oblique striations present over the body. In shape and size it compares with *S. varius* described by Kar (1968b, pl. 2, fig. 55).

COMPARISON AND DISCUSSION

The present megafloreal assemblage is characterized by the frequent presence of open mesh species of *Glossopteris*. The open

mesh species are *G. browniana*, *G. retifera*, *G. conspicua*, *G. divergens*, *G. stricta* and *Glossopteris* sp. The narrow mesh species are *G. communis*, *G. fusa*, *G. sp. cf. G. nidpurensis*, *G. decipiens* and *G. leptoneura*.

Raniganj plant fossils from the Lower Gondwana of India have first been reported by Feistmantel (1881a, 1886, 1881b). Strikingly, he has recorded many open mesh species of *Glossopteris*, viz., *G. browniana*, *G. retifera*, *G. conspicua*, *G. divergens*, and *G. formosa*. All of these except *G. formosa* are found in the present material. The first detailed study of *Glossopteris*, both morphological as well as cuticular, was carried out by Srivastava (1956) from the Raniganj Stage of the Raniganj Coalfield. The open mesh species, viz., *G. retifera*, *G. conspicua*, *G. browniana*, *G. formosa*, *G. sp. cf. G. divergens* and *G. taenioides* are common in the assemblage. In the Auranga Coalfield most of these forms are also encountered.

Recently from the Raniganj beds of the Raniganj Coalfield, Pant and Gupta (1968, 1971) and Pant and Singh (1971) have erected many new species of *Glossopteris* on the basis of cuticular evidences. Amongst them *G. bengalensis*, *G. radiata*, *G. rhabdotaenioides*, *G. obscura*, *G. transversalis*, *G. nautiyalii*, *G. longifolia*, *G. singularis* and *G. damudica* represent a significant proportion of open mesh forms. Many of these new species (based on cuticles) bear close resemblance on the morphological basis with *G. retifera*, *G. conspicua*, *G. divergens*, *G. browniana* and *G. damudica*. Maheshwari (1965) has studied the morphological details of the impressions of *Glossopteris* from the Raniganj Coalfield. In this case also the assemblage is rich in the open mesh species, viz., *G. intermedia*, *G. longicaulis*, *G. tortuosa*, *G. verticillata* and *G. euryneura*. These species are not present in the Auranga megafloora, however, in its open mesh characters they show resemblance with the present assemblage. Maheshwari and Prakash (1965) have recorded the megafloora from the Rajmahal Hills, which they consider as the Barakar assemblage. However, it is notable that the assemblage is rich in the open mesh species, viz., *G. damudica*, *G. browniana*, *G. retifera* and *G. formosa* which impart a strongly younger aspect to the assemblage closely comparable to that of the Raniganj Stage.

From the foregoing observations it is evident that the prevalence of open mesh *Glossopteris* forms may serve as a significant feature for recognizing the Raniganj Stage. Recent palaeobotanical review of the Raniganj flora has led some workers to similar contention (Maithy, 1974a, 1974b). *G. retifera* and *G. divergens* are found confined to the Raniganj Stage. Surange (1966) has expressed that there may be some species which will be confined to the various stages. Indeed, Shah, Singh and Sastry (1971) have considered *G. retifera* and *G. conspicua* both open mesh species as index forms for the Raniganj Stage.

The present megaflooral assemblage is rich in the open mesh *Glossopteris* species and also contains the index forms, viz., *G. retifera* and *G. conspicua*. These facts strongly favour the assignment of the flora to the Raniganj Stage.

The mioflora here assigned to the Raniganj Stage is recovered from a different site (exposed in the Sukri River near Tubed Village). The assemblage is dominated by striate-disaccates and triletes with some amount of *Densipollenites* (monosaccate) and monoletes.

The mioflora of the Raniganj Stage has earlier been reported by Bharadwaj (1962), Bharadwaj and Salujha (1964, 1965a, 1965b), and Kar (1968b, 1969a, 1969b, 1973). All these assemblages show the dominance of disaccates and the triletes increase in quantity whereas *Densipollenites* is not consistently represented.

Kar (1973) has studied the Raniganj assemblage of the North Karanpura Basin and explained that the Lower Raniganj Stage is dominated by striate-disaccates, viz., *Striatopiceites*, *Strotersporites* and *Sulcatisporites* are also common. Triletes, viz., *Apiculatisporis* and *Lophotriletes* are well-represented. Bharadwaj (1971, 1974) has analysed the Raniganj miofloral assemblage to show that the Lower Raniganj is predominated by striate-disaccate along with a good percentage of triletes and monoletes whereas *Densipollenites* is very low and inconsistently represented.

The present miofloral assemblage is also dominated by the striate-disaccates, viz., *Faunipollenites*, *Striatites*, *Lahirites*, *Verticillipollenites*; triletes, viz., *Brevitriletes*, *Leio-triletes*; monolete, viz., *Latosporites* along with *Densipollenites*.

Thus the miofloral aspect of the Auranga Coalfield assemblage bears close correspondence with the Raniganj miofloras described so far. A Raniganj age to the present mioflora seems, therefore, very appropriate. The presence of *Densipollenites* in the Auranga mioflora may be a reflection of local influence.

The miofloral and megafloreal evidence from the Auranga Coalfield have a direct bearing on the stratigraphic position of the beds. In hitherto published geological accounts (Rizvi, 1972), the present sampling localities in the Sukri River near Rajbar, and Tubed area have been shown to belong to the Barakar Stage. However, the present findings of typical Raniganj mega- and miofloras strongly indicate that the fossil localities under investigation represent beds

of the Raniganj Stage. Incidentally, the Raniganj boundary (Rizvi, 1972) lies only about 1 km from the fossil sites in the Rajbar area. The palaeobotanical data presented here may seem to necessitate a closer field geological investigation concerning the demarcation of the Raniganj boundary in the Sukri River section near Rajbar Village.

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EXPLANATION OF PLATES

PLATE 1

- Glossopteris communis* Feistmantel showing a distinct midrib. Specimen no. 19/1391. \times Nat. size.
- A portion of the leaf in fig. 1 enlarged to show the details of venation. \times 3.
- Glossopteris stricta* Bunbury showing a lower part of leaf with thick midrib. Specimen no. 9/1391. \times Nat. size.
- Glossopteris* sp. showing upper part of a leaf with distinct midrib. Specimen no. 36/1391. \times 2.
- A portion of the leaf in fig. 4 enlarged to show the details of venation. \times 3.

PLATE 2

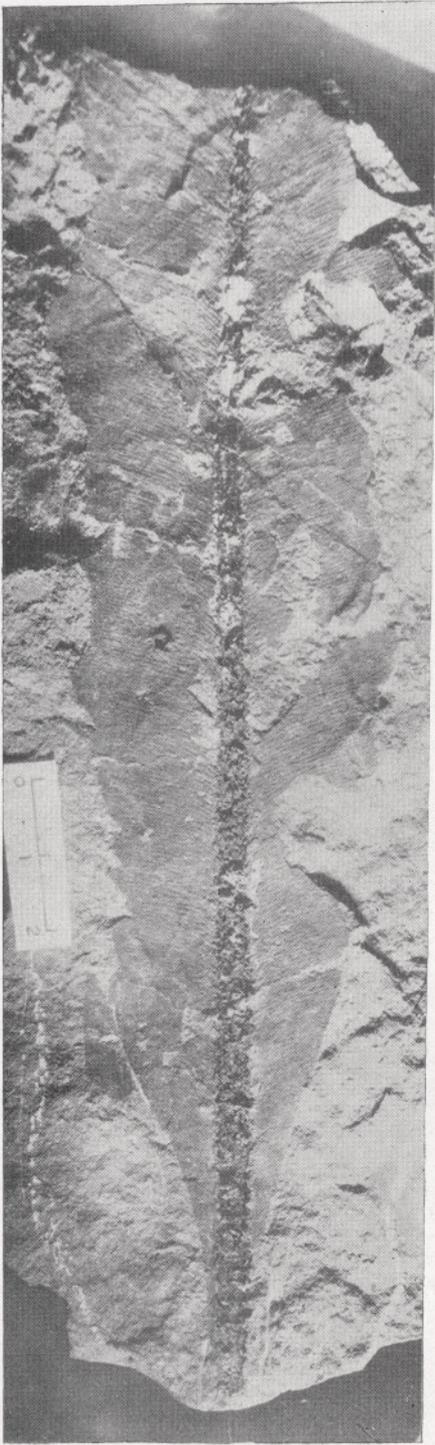
- Glossopteris* sp. cf. *G. nidpurensis* Srivastava showing lower portion of the leaf with broad midrib. Specimen no. 3/1391. \times Nat. size.
- Glossopteris browniana* Brongniart showing the middle portion of the leaf with distinct midrib. Specimen no. 11/1391. \times Nat. size.
- Glossopteris divergens* Feistmantel showing a fragment of leaf preserved only on one side of the midrib. Specimen no. 43/1391. \times 2.
- Glossopteris fusa* Kulkarni showing a complete leaf with striated midrib. Specimen no. 18/1391. \times 2.
- Glossopteris retifera* Feistmantel showing a fragmentary leaf with distinct midrib. Specimen

no. 42/1391. \times Nat. size.

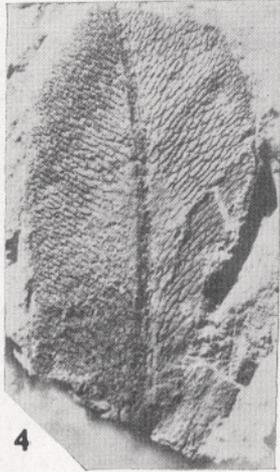
- Glossopteris conspicua* Feistmantel showing a median portion of the leaf with striated midrib. Specimen no. 12/1401. \times 2.
- Scale leaf showing emarginate apex. Specimen no. 16/1391. \times Nat. size.

PLATE 3

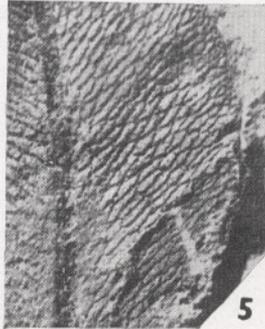
- Glossopteris decipiens* Feistmantel showing the upper part of leaf with evanescent midrib. Specimen no. 31/1391. \times 2.
- Glossopteris leptoneura* Bunbury showing narrow linear leaf with distinct midrib. Specimen no. 25/1391. \times Nat. size.
- Small leaf showing spatulate shape. Specimen no. 49/1391. \times Nat. size.
- Faunipollenites multistriatus* sp. nov. (Holotype). Slide no. 5032. \times 500.
- Faunipollenites multistriatus* sp. nov. Slide no. 5031. \times 500.
- Striatopodocarpites haploxyloides* sp. nov. (Holotype). Slide no. 5033. \times 500.
- Striatopodocarpites haploxyloides* sp. nov. Slide no. 5031. \times 500.
- Striatites obliquus* sp. nov. (Holotype). Slide no. 5032. \times 500.
- Striatites obliquus* sp. nov. Slide no. 5032. \times 500.



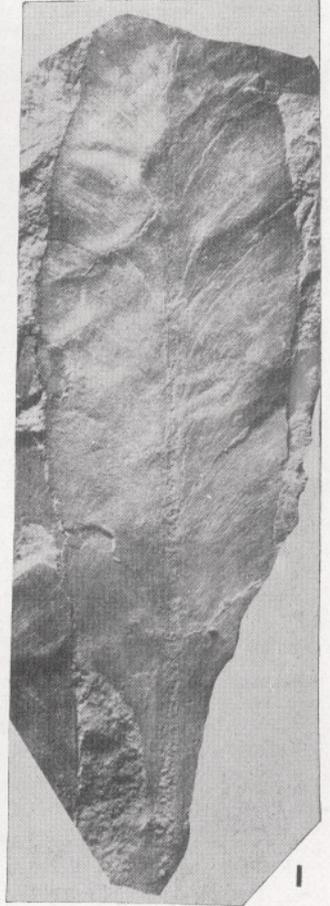
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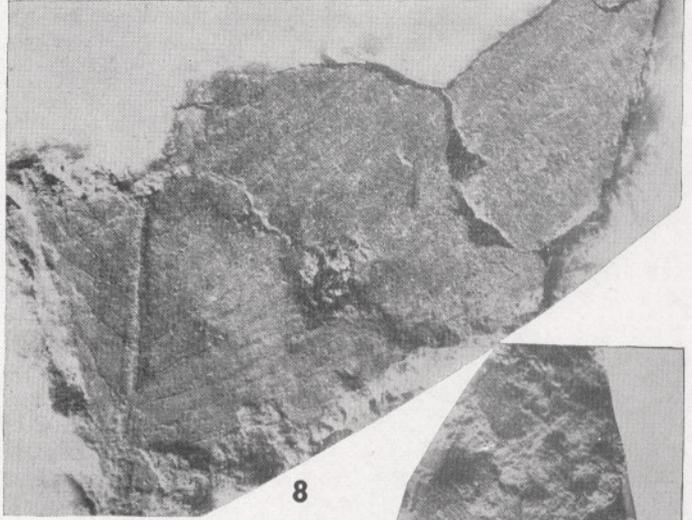
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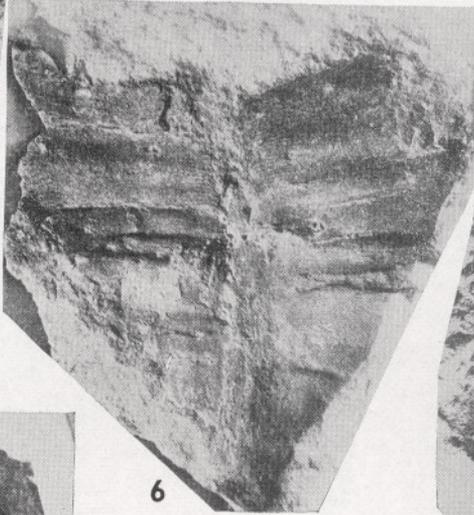
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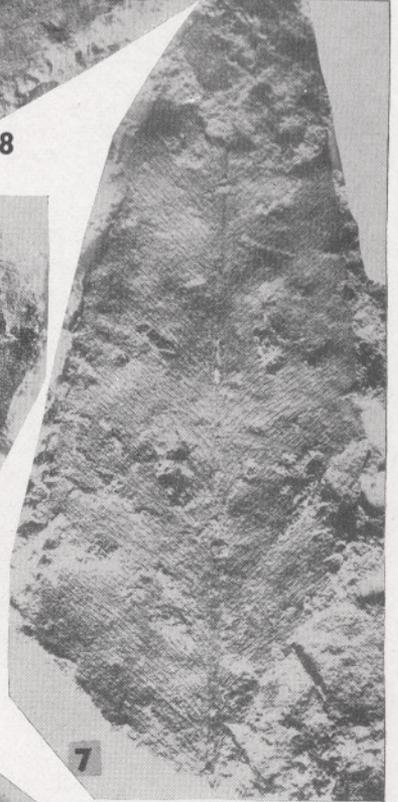
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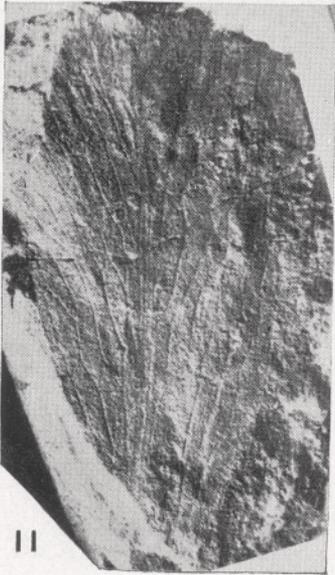
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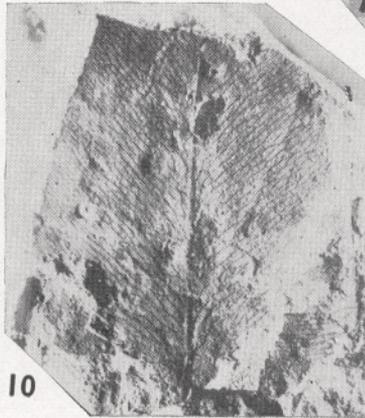
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