

OCCURRENCE OF PLANT FOSSILS IN THE LOWER GONDWANA SUCCESSION OF SINGHRAULI COALFIELD, UTTAR PRADESH

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ABSTRACT—A small collection of plant fossils containing about 15 different elements is recorded for the first time from a new locality in the Barkar beds of the Singhrauli coalfield. Another new fossiliferous locality is discovered in the Talchirs of this area and the occurrence of scattered fossil woods is reported.

INTRODUCTION

A collection of Lower Gondwana plant fossils was undertaken by Prem Swarup and J. N. Singh during the course of the geological mapping and exploratory trenching work on the fire-clay deposits in Bansi, Misra and Makhrihoh (Kota) areas of south Mirzapur, U. P. in the years 1958-60. The plant fossils were tentatively identified by the above authors for incorporation in their paper entitled "Geology and Economics of the clay deposits of Bansi, Misra and Makhrihoh areas, district Mirzapur, Uttar Pradesh", which is under publication. The plant fossil material was subsequently sent to the Birbal Sahni Institute of Palaeobotany, Lucknow for detailed examination which was undertaken by one of us (K. M. L.). The present paper incorporates the results of the palaeobotanical study and gives, as far as the material permits, a brief description of the plants, occurring in the Talchir and Barkar Stages.

GEOLOGY OF THE PLANT-BEARING STRATA

The area falls in the easternmost part of the Singhrauli Coalfield extending into Uttar Pradesh. The formations in this area consist

of the Talchir Stage and the basal part of the Damuda Series, represented in the following sequence. (after Coulson 1939).

Lower Gondwana	}	Feldspathic sandstones, Carbonaceous shales, Coal & shales.	Barakars
	}	Calcareous Mudstones, sandstones and shales	Talchirs
Gneisses & schists		/ Transition series	Archaeans/ Bijawars ?

Talchir Stage

The Talchirs in the area under study consist of calcareous sandstones (occasionally nodular), mudstones, silty shales and also some fine-grained clastic limestone. Plant fossils were collected from the upper part of the Talchir Stage in a clayey sandstone exposed in the Balia Nala section west of Kota village (24°6' : 82°43').

Barakar Stage

The major part of the formation consists of buff or dull brownish, medium to coarse grained, compact feldspathic sandstones with interbedded buff (occasionally lithomargic) and grey shales, clay bands and coal seams. At places they are pebbly or gritty in nature

with pebbles ranging upto 5 cms. in diameter. Plant fossils described in this paper were collected from the carbonaceous shales and clay bands occurring in the lower part of the Barakar horizon in the Gaurbotha nala and Chirkakur hill sections south of Bansī village (24°10' : 82°48').

The following section (Table 1) has been compiled after measuring the sections in all the three localities *i. e.* Bansī, Misra and Makhrikhoh and by actual mapping of the members extending from one area into the other.

TABLE 1

Description of the member	Thickness	Locality	Fossils
13. <i>Upper Felspathic Sandstone</i> Pinkish or dirty buff, medium to coarse-grained occasionally gritty or pebbly, also ferruginous.	On the top (thickness not measured)	Bansī, Misra Makhrikhoh	Fossil woods (Scattered)
12. <i>Bansī Clay</i> Hard compact and thickly bedded. A few bands are thin and soft in nature. Interbands of paralava (vesicular rock) and ash like material are common and show evidence of burning.	12 ft.	Bansī area	<i>Glossopteris</i> sp., coniferous shoot (? <i>Buriadia</i>), described in the paper.
11. <i>Carbonaceous shale</i> Light grey and grey, well laminated, compact carbonaceous shale with mica.	10 ft.	Bansī area (Gaurbotha nala sec.)	Plants described in the paper.
10. <i>Thin lenticular coal seam</i> Discontinuous.	6 inches	Bansī area Gaurbotha nala sec.)	—
9. <i>Shale</i> Similar to member 6	3 ft.	—	—
8. <i>Felspathic sandstone</i> Similar to the upper sandstone (13)	30 ft.	—	—
7. <i>Misra clay</i> A pinkish or yellowish white hard sandy clay with abundant interbands of paralava (vesicular rock)	12 ft.	Misra hills	

TABLE 1 (contd.)

Description of the member	Thickness	Locality	Fossils
6. <i>Shale</i> Pinkish or dirty yellow, sandy well laminated and micaceous shale.	5 ft.	—	—
5. <i>Felspathic sandstone</i> Similar to other sandstones described above.	60 ft.	—	—
4. <i>Makhrikhoh clay</i> White, pink or yellowish white clay with lenticular interbanded shale, paralava and ash like material.	15 ft.	Makhrikhoh area	—
3. <i>Shales</i> Lithomargic yellow, pinkish sandy shale, sometimes micaceous.	5 ft. to 10 ft.	Khadia (nala sec.)	—
2. <i>Lower Felspathic Sandstone</i> Similar to member 13.	(App. 100 ft.)	—	—
1. <i>Talchir sandstone</i> Dirty yellowish, medium to coarse grained, sometimes micaceous or calcareous clayey sandstone.	(Not measured)	Kota village (nala sec.)	<i>Noeggerathiopsis hislopi</i> 'described in the paper

The members of the Talchir stage underlying the above referred sandstone (member 1) have not been examined.

PALAEOBOTANY

Plant fossils in the Talchirs

The first report of the occurrence of fossil plants in the Talchirs of the Singrauli coalfield was made by Lele (1966). These plants containing *Noeggerathiopsis hislopi*, *Gangamopteris cyclopteroides*, *G. cf. major*, *G. sp.*, *Samaropsis cf. goraiensis* and some stem impressions were discovered in the upper Talchirs exposed in the Saura nala, south east of Pipra village.

Some fragmentary plants were also found by Lele in the siltstones of an open quarry, about 3 miles west of Waidhan (24°4' : 82°38').

The present paper records yet another new locality (Member 1 of sequence in Table 1) where a bed of Talchir clayey sandstone contains plant fossils. The bed is exposed in the Balia nala, west of Kota village. Impressions of leaves are found in various planes oblique to the bedding planes which supports the current bedded character of the rock. The assemblage is almost predominated by long leaves of *Noeggerathiopsis hislopi* type. Some of the leaves are about 17 cm. long and 3.7 cm. wide near the apex. There are about 15-17

veins per centimeter in the widest part. Many leaves show evidence of splitting along veins which lends support to their being entombed under turbulent conditions of deposition. Besides *Noeggerathipsis* there are a few specimens which may belong to *Gangamopteris*. Casts of stems of unknown nature are occasionally found in this sandstone.

Plant fossils in the Barakar beds

Occurrence of *Glossopteris* flora in the coal-bearing Barakar beds of this area was first reported by Ahmad (See Krishnan, 1953). According to this report *Glossopteris* leaves were found in petrified state in the Makrikhoh area and several stray petrified woods were reported to be found scattered overground. As far as we know, the leaves found in this area and elsewhere are in the usual state of preservation. We have not come across any occurrence demonstrating a petrified state of leaves of the *Glossopteris* flora. Scattered fossil woods have been noticed by us in many places overground (see table) and it is difficult to ascertain the exact horizon containing these woods; possibly they may belong to the coal-bearing Barakars. These petrifications unfortunately do not reveal any anatomical details except for the indication of growth rings in certain cases. Their identification would therefore demand more search for favourably preserved woods.

All the plants, except *Noeggerathipsis hislopi* described in this paper have been collected from the Barakar beds, exposed in the Gaurbotha nala, south of Bansi village (vide map). The major part of this plant collection is from a carbonaceous shale (Member 11 of sequence in Table 1). This bed is overlain by a fire-clay bed which also contains sporadic remains of fragmentary plants. The coniferous shoot (Pl. 3, figs. 14 and 15) was found in the fire-clay bed. There are also few ill preserved *Glossopteris* remains. A brief description of these plants is given below in view of our almost complete lack of knowledge regarding the mega fossils of the coal-bearing strata of the

Singhrauli basin. It is hoped that the finding of the new locality and the plants recorded here will stimulate further search for more and better preserved fossil flora in this area. The figured specimens are kept at the museum of the Birbal Sahni Institute of Palaeobotany, Lucknow.

1. EQUISETALEAN STEM

(Pl. 3 fig. 7)

A few leaf-less impressions showing ribs as in the equisetalean genera *Schizoneura* and *Phyllothea* are present. The specimen figured here is 7 cm. long and 1.9 cm. wide. It shows about 10 ribs. No nodes are present.

2. GANGAMOPTERIS CYCLOPTEROIDES Feistm.

(Pl. 2 fig. 1)

The leaf figured here is incomplete for its apex and base. It measures 9 cm. in length and 3.4 cm. in width. The two halves on either side of the median axis are not symmetrical. Subparallel veins are distinctly seen in the median part. Secondary veins arise with a steep upward course and arch out towards margin and anastomose to form slightly broader and shorter meshes near median part, becoming narrower and longer towards margin.

3. GANGAMOPTERIS CYCLOPTEROIDES var.

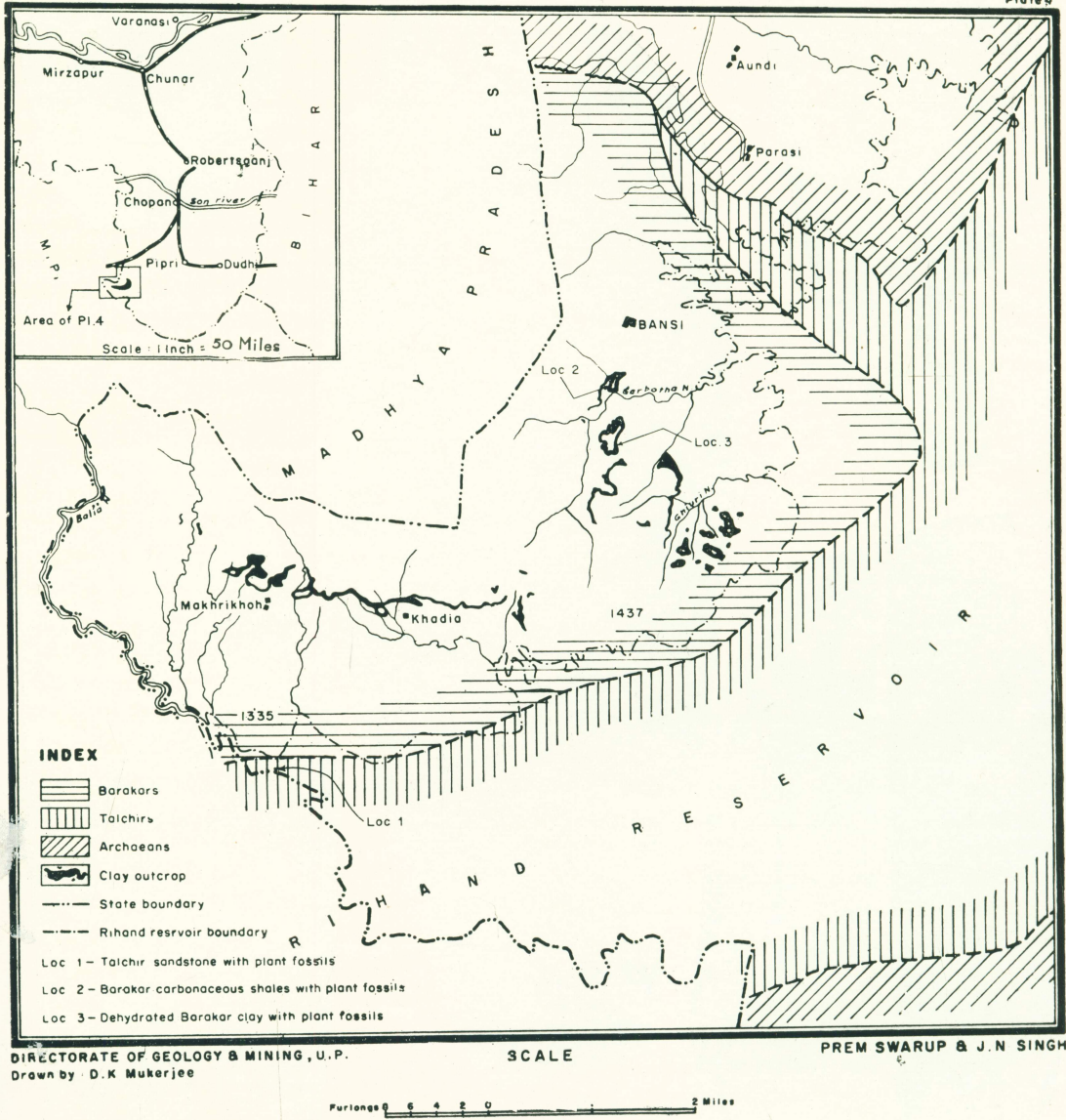
AREOLATA Feistm

(Pl. 2 figs. 2, 3)

The leaf figured here is incomplete showing a portion near the base. The preserved portion is about 7 cm. long, the base being about 9 mm. wide. Strong parallel veins are seen in the median portion, anastomosing to form long erect meshes. The lateral veins near the basal part form distinct polygonal meshes (fig. 3) while in the upper portion they are narrower and longer. This venation pattern is characteristic of *G. cyclopteroides* var. *areolata* Feistmantel (1879, p. 14) known from the Karharbari Stage.

GEOLOGIC MAP SHOWING CLAY DEPOSITS AND FOSSILIFEROUS LOCALITIES
MIRZAPUR DISTRICT, UTTAR PRADESH

Plate 4



TEXT-FIG. 1.



4. GANGAMOPTERIS sp. cf. *G. ANGUSTIFOLIA* McCoy
(Pl. 4 fig. 18)

The preserved portion of the leaf is about 4 cm. long and about 1 cm. wide. The median axis is like a low ridge without any sub-parallel veins. The lateral veins arise from the median line with gentle curvatures (about 30 degree) and anastomose to form rather equal sized, distinct, hexagonal meshes of almost equal size.

In view of the incomplete nature of the specimen (specially its overall shape) it is difficult to place it with certainty in the known species. However, it may be pointed out that its narrow shape and venation pattern is very near to that of *Gangamopteris angustifolia* McCoy.

5. GANGAMOPTERIS sp. A
(Pl. 2, fig. 4)

The specimen is almost complete except for its apex and base. The preserved portion measures 11 cm. long and 3.2 cm. wide on one side from the median axis (i. e. total maximum width about 6.4 cm.). The shape of the leaf is more or less elliptical. The median part is characterised by a distinct groove which gives a false suggestion of a midrib. Median subparallel veins are not present. Secondary veins are arched forming elongate polygonal meshes which are comparatively shorter and wider near the median line.

The present specimen does not compare with *G. cyclopteroides* owing to the presence of a median groove and absence of subparallel veins. A median groove is known in the South African species *Gangamopteris Stephensoni*

Plumstead (1962) but that species is very distinct in size, shape and venation.

6. GANGAMOPTERIS sp.
(Pl., 3 fig. 6)

A small specimen measuring 4.2 cm. in length and about 1.9 cm. wide on one side of the median line (i. e. total width about 3.8 cm.) is shown in Pl. 3 fig 6. The apex and base are not preserved. The median portion has subparallel veins from which the secondaries arise in a curve. Meshes are distinct, somewhat shorter and wider near the median line. The meshes are, however, not as elongate as is generally seen in *G. cyclopteroides*. The venation and appearance of the leaf recalls species like *G. Castellanosii* Archangelsky (1951) but in the absence of knowledge regarding the nature of the apex, the present specimen can not be specifically identified with certainty.

7. GLOSSOPTERIS COMMUNIS Feistm.
(Pl. 2, fig. 5)

Three good and fairly complete specimens are present in the collection, indicating a maximum width of about 7.5 cm. The specimen in Pl. 2 fig. 5 is perhaps the longest and most complete, measuring 20 cm. in length and 6.4 cm. in the widest middle portion. It is linear lanceolate in shape; the base and apex have been slightly broken. The striated midrib is about 3 mm. wide, somewhat narrowing upwards. Secondary veins arise with a curve and then run parallel at an angle of about 45° from the midrib. About 28-30 veins per cm. can be counted in the middle

EXPLANATION OF PLATE 2

1. *Gangamopteris Cyclopteroides* Feistm. X 1½, Barakar stage (bed 11).
2. *G. Cyclopteroides* var. *areolata* Feistm. X Ca. Nat. size, Barakar stage (bed 11) No. 33775.
3. Same as is fig. 2, basal part enlarged to show venation.
4. *Gangamopteris* sp. A X 9/11, Barakar stage (bed 11) No. 33776.
5. *Glossopteris communis* Feistm. X 7/8, Barakar stage (bed 11) No. 33778.

part of the leaf. The meshes are long and narrow. A carbonised crust is preserved on the leaf. The specimen is very closely similar to the common species *G. Communis* Feistm.

8. GLOSSOPTERIS INDICA FEISTM
(Pl. 3, fig. 8)

A few specimens, nearly as large as those of *G. communis* show on closer examination, the venation pattern of *G. indica*. The veins are arched near emergence but then take a parallel course at about 60° from the midrib. The meshes are distinctly somewhat wider and shorter near the midrib and become narrower and longer towards margin. There may be about 20 veins per cm. near midrib and about 30 per cm. near margin. The specimen figured here is quite representative of this species. It shows the lower half of the frond. The width is about 6 cm. and the midrib about 4 mm. A carbonized crust is preserved on the leaf.

9. GLOSSOPTERIS sp. cf. TAENIOPTEROIDES
(Pl. 3, fig. 9)

A few specimens, fairly broad and usually broken in length, are present. One of the more complete ones is figured here. It is 16 cms. long and 4.7 cms. wide on one side of the midrib (i. e. total width about 9.4 cms.). A portion of the leaf is figured here. The midrib is 3-4 mms. wide and prominently striated. Secondary veins emerge with a steep curve and then run parallel at about 60° from the midrib. Owing to very infrequent anastomosis, the venation appears rather taenioptero-

roid. One or two short meshes may be made out just near emergence, the rest portion of the leaf showing very rare anastomosis (Pl. 3 fig. 9). About 40 veins per cm. could be counted in the middle of the leaf. Perhaps they may be slightly more near margin.

The present specimen suggests nearest approach to the species *G. taeniopteroides*, although anastomosis is more common in that species than in the present case. Whether this difference is significant can only be ascertained by studying the variations from a large number of specimens. For the present, therefore, the specimen is placed near to *Glossopteris taeniopteroides*.

10. GLOSSOPTERIS sp.
(Pl. 4 fig. 12)

The specimen figured is 18 cm. long and about 4.9 cm. wide, representing more than the lower half. The base is drawn out and becomes as narrow as about 1 cm. The midrib is prominent and striated. Secondary veins curve out to form meshes somewhat comparable to those of *G. indica*. There are 30 veins per cm. near the midrib. The chief characteristic of this leaf is the presence of slender fibres running parallel to the secondary veins and ending blindly or joining the main veins. *G. fibrose* Pant (1958) and *G. hispida* Pant (1958) from Tanganyika are known to have fibres in the mesh region. The nervation in both these species is however much more erect and their cuticle is also known. Maheshwari (1965) has described a specimen of *Glossopteris* sp. from the Raniganj Stage which also has

EXPLANATION OF PLATE 3

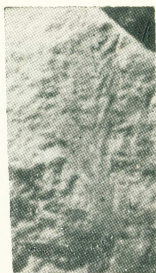
6. *Gangamopteris* sp. Nat. size, Barakar stage (bed 11) No. 33777.
7. *Equisetalean* stem X 5.5/7, Barakar stage (bed 11) No. 33773.
8. *Glossopteris indica* Schimp. X Ca 0.8, Barakar stage (bed 11) No. 33779.
9. *Glossopteris* sp. of *G. taeniopteroides* Feistm. X9/8, Barakar stage (bed 11) No. 33780.
10. *Samaropsis* sp. A X Nat. size. Barakar stage (bed 11) No. 33783.
11. *Samaropsis* sp. A X Nat. size. Barakar stage (bed 11) No. 33782.



LELE, SWARUP & SINGH : PLANT FOSSILS FROM SINGHRAULI COALFIELD



17



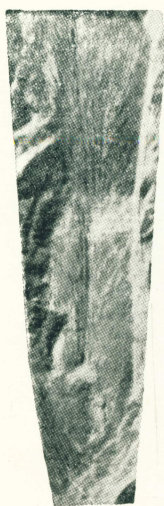
14



15



13



18



16



12

fibres. The concentration of veins in his form is however very low and can not be compared with the present specimen. It is therefore likely that when more material is available this specimen can be discriminated with certainty.

11. *SAMAROPSIS* sp. A
(Pl. 3, figs. 10, 11)

Some specimens of large platyspermic seeds are present in the material. Quite a few of them are incomplete, although they do indicate the rather common presence of the platysperms in the bed.

Two specimens are figured here in Pl. 3, figs. 10, 11. They measure 3.6×2.1 cms. and 2.8×1.6 cms. respectively. The sarcotesta spreads out horizontally on either side of the sclerotesta to give a horizontally oval shape to the specimens. The width of the sarcotesta is about 6-8 mm in the middle on one side. The sarcotesta has a depression or sinus on either ends. The sclerotesta is subcircular broadly pear shaped with a median ridge or groove and a number of finer striations. Two short beak-like structures apparently project out from the sclerotesta on one end of it.

In their general plan the platyspermic seeds are comparable to *Samaropsis johillensis* Saksena (1956) but the latter species has a distinctly inclined sarcotesta. The convenient designation *Samaropsis* can be tentatively used for the present seeds, although it is apparent that the genus *Samaropsis* is very large and warrants further segregation (Maithy, 1965).

12. *CORDAICARPUS*
(Pl. 4, fig. 13)

Numerous impressions of small subcircular to oval seeds are found scattered in the matrix of the shale. Occasionally they also occur in aggregates. In average they measure about 3 mms. in width and 4 mm. in length. The sarcotesta is not discernible. In some cases a very narrow border can be made out. Some specimens show a distinct median longitudinal ridge running along the whole length on the sclerotesta. Finer striations may also be present. The rock in Pl. 4 fig. 13 shows a number of these seeds one of which is indicated by the arrow mark. Probably these seeds belong to more than one species but in want of details they are presently described as *Cordaicarpus* sp.

13. CONIFEROUS SHOOT (?*BURIADIA*)
(Pl. 4, fig. 14, 15)

A solitary impression is obscurely present on a fireclay piece which represents the member 12 of the sequence in Table 1 and lies over the carbonaceous shale bed containing the other plant fossils. The small specimen (Pl. 4, fig. 14) shows spirally arranged leaves closely adpressed on the axis. About 7-8 of them can be seen on either side (fig. 15). They are triangular with pointed tips.

The specimen is too small and imperfect to allow even generic identification with the Lower Gondwana conifers viz. *Buriadia*, *Paranocladus* and *Walkomiella*. The appearance of

EXPLANATION OF PLATE 4

12. *Glossopteris* sp. X Ca 7/12, Barakar stage (bed 11) No. 33781.
13. *Cordaicarpus* sp. Nat. size Barakar stage (bed 11) No. 33784.
14. Coniferous shoot (*Buriadia*) X Nat. size. Barakar stage (bed 12) No. 33787.
15. Same as in fig. 15, enlarged X 3
16. Notched leaf X $1\frac{1}{2}$ Barakar stage (bed 11) No. 33785.
17. Stem impression Ca. Nat. size, Barakar stage (bed 11) No. 33786.
18. *Gangamoptersis* sp. of *G. angustifolia* Mc Coy X 9/7 Barakar stage (bed 11) No. 33775.

the specimen however recalls *Buriadia* more than others. Further search in the fireclay bed and the underlying as well as overlying strata is likely to yield better results.

14. NOTCHED LEAF

(Pl. 4, fig. 16)

A single specimen having a curious shape is present in the material. The leaf is more or less elliptical in outline measuring 3.5×2.5 cms. The base is not completely preserved. The apex has a deep cleft extending down to about 1.5 cm. and thereby dividing the leaf into two lobate segments. The venation is obscure. A few veins may perhaps be noticed running from the base upwards and diverging towards margin with gentle curvature. There is no evidence of a midrib nor any meshes can be ascertained. Leaves of this kind are not hitherto known from the Indian Lower Gondwana. Although this specimen is interesting, its identification must await more search in the bed for better preserved leaves.

15. BARK OR STEM IMPRESSIONS

(Pl. 4, fig. 17)

Few wide impressions possibly of some bark or stem, are present. These are occasionally as wide as 5 cms. and show no important details on the surface except some striations or scars (like branch scars). A coaly-film is also seen on some of them. Similar impressions have been encountered in good abundance in the Karharbari or Barakar strata of other areas. Their real affinity is uncertain.

CONCLUDING REMARKS

The present assemblage of plants consists of the following elements.

A. BARAKAR STAGE

1. Equisetalean stems.
2. *Gangamopteris cyclopteroides*.
3. *G. Cyclopteroides* var. *areolata*.

4. *G. sp. cf. G. augustifolia*.
5. *Gangamopteris sp. A.*
6. *Gangamopteris sp.*
7. *Glossopteris communis*.
8. *G. indica*.
9. *G. sp. cf. G. taeniopteroides*.
10. *Glossopteris sp.*
11. *Samaropsis sp. A.*
12. *Cordaicarpus sp.*
13. Coniferous shoot (? *Buriadia*).
14. Notched leaf.
15. Bark or stem impressions.

B. TALCHIR STAGE

1. *Noeggerathiopsis hislopi*.

In view of our complete lack of knowledge regarding the fossil flora of the Singhrauli Coalfield, the present contribution, although small is likely to encourage workers to search for more and better plant material in the new localities mentioned here or in other places.

It would be premature to make any categorical remarks on the stratigraphical implications of the flora, although it may be noticed that this assemblage has almost an equal proportion of *Glossopteris* and *Gangamopteris*. Probably the number of *Gangamopteris* leaves may prove to be somewhat larger. To add to this, the conspicuous presence of platyspermic seeds is remarkable, and the finding of the notched leaf is interesting. The coniferous shoot remains to be precisely identified. This identification may give us some significant clue, for the coniferous genera are hitherto known to be somewhat confined to particular horizons of the Lower Gondwana. When these gaps are filled it would be possible to see as to what extent the flora agrees with a Barakar age as attributed to it from our present field knowledge.

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