STUDIES IN THE GLOSSOPTERIS FLORA OF INDIA — 3. PLANT FOSSILS FROM THE TALCHIR NEEDLE SHALES FROM GIRIDIH COALFIELD

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ABSTRACT

The paper describes for the first time the occurrence of an interesting microflora and a few plant impressions obtained during 1955 from the Talchir needle shales (Talchir stage) of the Giridih coalfield, Bihar. Among the microfossils four types of one-winged spores and three types of two-winged spores have been recognized. The plant impressions include *Gangamopteris cyclopteroides* Fstm., *Noeggerathiopsis Hislopi* (Bunb.), a *Noeggerathiopsis* sp. and certain carbonized stems and ? petiole or rachis impressions.

The present findings furnish the first record of fossils from the Talchir needle shales (stage) which was hitherto regarded as unfossiliferous. It also strengthens the belief that the earlier Glossopteris flora was contemporaneous with the Ice Age.

THE lowest beds of the Lower Gondwana of India are known as Talchir series. It is characterized by a glacial boulder bed at the base which is overlain by Talchir needle shales (stage) and sandstones. The topmost stage is known as the Rikba stage. The plant fossils which are known from the Talchir series so far have only been found from the uppermost stage — the Rikba stage. The lower beds represented by the needle shales were hitherto regarded as unfossiliferous. Microspores were discovered by Virkki (1946) within a few feet above the boulder bed in the Punjab Salt Range, but the findings of identifiable megafossils were hitherto confined to the uppermost stage of the Talchir series. The present discovery of fossil leaf impressions in the needle shales (stage), therefore, now provides a definite evidence of life at the beginning of the Gondwana era.

The present collection of plant fossils was obtained from a section of Talchir needle shales exposed along the Sukni river (" Sooknid " of HUGHES, 1869, p. 11) of the Giridih coalfield, Bihar. The Sukni river is regarded as the best ground in the entire area for the study of the needle shales which characterize the Talchir stage. The fossiliferous spot lies on the north bank of the river, about one mile north-west of Karharbari town and about two furlongs north-west of Maheshmundi village. At this place only Talchir needle shales are met with, rising to a height of about 15-20 ft. Hughes has, however, estimated the total thickness of the needle shales to about 600 ft. in this area.

The shales are bluish grey to earthy green in colour and break characteristically into small needles and hatchet-shaped fragments on their weathered surface. The Talchir boulder conglomerate bed overlain by needle shales is exposed in the river bed at a distance of about two furlongs from the fossil spot. It has not been possible to ascertain the exact height of the fossiliferous spot above the boulder bed, but it may not be very much.

Most of the recognizable fossils were obtained from just near the base of the section. Other fossils, containing mostly indeterminable fragments, were collected within a height of 6 ft. from the base. This collection was made by one of us (K. M. LELE) under the leadership of the late Dr. P. N. Srivastava in 1955.

DESCRIPTION

A — PLANT IMPRESSIONS

Genus *Gangamopteris* McCoy

1. *Gangamopteris cyclopteroides* Fstm.

There is one complete specimen and two fragmentary impressions which are assigned to the species *Gangamopteris cyclopteroides* Fstm.

The complete specimen (PL. 1, FIG. 2), measuring $4{\cdot}1 \times 1{\cdot}8$ cm., is broadly lanceolate, symmetrical with a broadly round apex and somewhat contracted base. The preservation of the frond is not sufficiently satisfactory to show clear anastomoses. It is, however, observed that the veins radiate from the base and forming a few sub-parallel median nerves go out towards the margin at a somewhat acute angle (PL. 1, FIG. 12). Meshes, wherever seen, appear to be fairly long and probably broader towards the median line. Midrib is absent.

The two other fragments (PL. 1, FIGS. 5, 8) show the presence of secondary veins which in one specimen (FIG. 8) are seen to bifurcate near the position of the midrib. They do not show many characters which would justify their separation and, therefore, are included under the same species.

Our specimens are rather smaller in size than those recorded by Feistmantel (1879) from the Talchir-Karharbari beds of India. However, they possess all the specific characters of *G. cyclopteroides*.

Genus *Noeggerathiopsis* Fstm.

2. *Noeggerathiopsis Hislopi* (Bunb.) Fstm.

The specimen (PL. 1, FIG. 3) is small, incomplete, spathulate and measures 3·7 × 1·7 cm. It shows a clear dichotomy of the diverging veins (PL. 1, FIG. 4) which reach the margin probably a little below the broadest part of the frond. Veins prominent.

Similar fronds have been recorded by Feistmantel (1879) from the Karharbari beds, especially those small fronds figured in Pl. 19, Figs. 3-5. This may be a young frond or more probably since the plants were living in intensively cold climate the fronds may have been smaller in size. It may be mentioned that all the fronds we have obtained from the needle shales are small in size.

3. *Noeggerithiopsis* sp.

The specimen (PL. 1, FIG. 6) does not resemble *Noeggerathiopsis Hislopi*. The frond is small and appears to be leathery. It measures 3 cm. in length and 1 cm. at the broadest part. It is more or less oval to lanceolate with a roundly acute apex and contracted base. It is comparatively broader near the middle part. The veins (PL. 1, FIG. 1) dichotomize as in the genus *Noeggerathiopsis*, but they are more numerous than found in *N. Hislopi*. Besides, it appears that the veins start reaching the margin quite near the base. In the absence of more and better preserved specimens, the frond is referred to *Noeggerathiopsis* sp. It, however, shows no satisfactory agreement with the known records and, therefore, may turn out to be a new species of *Noeggerathiopsis*.

Insertae Sedis

4. CARBONIZED IMPRESSION

There are a number of small carbonized impressions. Pl. 1, Fig. 7, shows probably an impression of an unbranched stem.

Another fragment (PL. 1, FIG. 10), measuring 1·2 × 0·2 cm., exhibits a clear dichotomy. Can this be a petiole or a rachis of a leaf?

B — MICROFOSSILS

The shales have yielded a large number of spores which can be assigned to four one-winged types and three two-winged types.

1. *One-winged spores*

Type 1 (PL. 2, FIGS. 13, 14)

Spores considerably large and show a good deal of variation in size, coarse in texture; body distinct, round, 105 μ in diameter, with a thick rim, about 12 μ wide; triradiate mark prominent but sometimes absent (PL. 2, FIG. 14), open and extending up to the periphery of the body, maximum width of an open ray 17 μ; wing round, about 27 μ broad, uniform all around the body, frilled, radially striated, margin of the wing uneven, attachment apparently marginal; ornamentation reticulate.

Size of the spores 159 μ. The smallest spore of this type (PL. 2, FIG. 14) measures 105 μ.

The spore shows a good deal of agreement with certain forms described under the genus *Endosporites* Wilson & Coe. It is closely comparable with *E. globiformis* (Ibrahim) S.W.B. recorded by Knox (1950, p. 331). Spores resembling ours have also been recorded from the Lower Gondwanas of Australia and India by Virkki (1946). Spore **51** recorded by Virkki from Salt Range (1946, pp. 112, 122) and from Pali beds, South Rewa (1946, p. 149), is probably the closest match for our spore. However, the triradiate mark in our spores extends up to the periphery of the body which distinguishes it from that of Virkki. A spore recorded by Sen (1953, TEXT-FIG. 1) from the Karharbari coalfield, although apparently comparable, is also distinguishable by the presence of a short triradiate mark.

Type 2 (Pl. 2, Fig. 17)

Spore round; body round, 90 μ in average diameter, with a thick rim about 4 μ wide; triradiate mark distinct, short, 18 μ long and 3 μ broad; wing round, 14 μ broad, uniform all round the body, frilled attachment probably marginal; ornamentation reticulate.

Size of the spore 120 μ.

This spore is distinguished from type 1 by means of its shorter triradiate mark, relatively narrow wing and less broad rim round the body.

This spore type is closely comparable with spore 45 and spore 46 recorded by Virkki (1946) from a number of Lower Gondwana localities. It also exhibits characters met with in the genus *Endosporites*.

Type 3 (Pl. 2, Fig. 18)

Spore perhaps over-macerated; elliptical, body not clearly seen; triradiate mark short, open; a ray measures 18 μ in length; outer margin of the wing uneven; ornamentation probably reticulate.

Size of the spore 175 × 143 μ.

The spore bears some resemblance in regard to the size and shape with Virkki's spore 31 recorded from Salt Range (1946, pp. 120, 137). Our spore, however, shows a short triradiate mark which is a distinguishing feature. To a certain extent resemblances are also met with in Virkki's spore 3 and spore 4 (1946, pp. 140, 145) but both of them are devoid of any triradiate mark.

Type 4 (Pl. 1, Fig. 9)

Spore more or less oval; body roundly elliptical, 58 × 63 μ, lighter in colour than the wing, dehiscence mark absent; wing showing more lateral expansion on either side of the body and thinning out at the poles; breadth of the wing on the side 20 μ; ornamentation reticulate.

Size of the spore 100 × 77 μ.

The comparatively greater expansion of the wing towards the lateral side and its thinning at the poles indicates a tendency towards a biwinged development.

This spore does not satisfactorily compare with any of the known Indian spores.

2. *Two-winged spores*

Type 1 (Pl. 2, Fig. 15)

Spore roundly oval; body elliptical, 66 × 93 μ, body wall somewhat thick, striations not visible; wings lateral, semicircular, attachment intramarginal; distance between the inner margins of the wings 15 μ; ornamentation reticulate.

Size of the spore 120 × 93 μ.

This spore recalls Virkki's spore 82 and spore 83 recorded from Pali beds (1946, p. 153) and Salt Range (1946, pp. 124, 134, 153). Our spore, however, does not show striations on the body.

Type 2 (Pl. 2, Fig. 16)

Spore laterally expanded; body more or less round, 69 × 78 μ, body wall about 13 μ thick towards the sides, striations not visible, dehiscence mark absent; wings lateral, thinly covering the poles, inner margins of the wings not seen, attachment probably marginal, ornamentation reticulate.

Size of the spore 138 × 93 μ.

In regard to resemblances, reference may be made to Virkki's spore 89 and spore 93 from Pali beds (1946, p. 155). Our spore is, however, distinct in having a large, thick-walled and round body without any indication of striations or slit.

Type 3 (Pl. 1, Fig. 11)

Spore somewhat oval, body oval, 48 × 58 μ, showing thickenings on the side, thickness being about 12 μ, striations or dehiscence mark not visible; wings laterally expanded, semicircular, attachment probably marginal, ornamentation reticulate.

Size of the spore 114 × 58 μ.

The spore has some resemblance with the previous type. The chief distinction, however, lies in the fact that the transverse axis of the wings in this spore does not exceed that of the body.

Some of the spores recorded by Virkki (1946) from the Lower Gondwana may be compared with our spore. Among these, spore 76 from Salt Range (1946, p. 139) can be compared to a greater extent, although our specimen differs in the absence of a slit and pitted wings.

DISCUSSION

The present discovery of leaf impressions and spores in the lower beds of Talchir series in Giridih coalfield shows that the needle shales are fossiliferous. At present we have only a few plants with us which do not allow a detailed comparison with Rikba or Karharbari floras. An extensive search is now needed to bring to light more of these earlier forms of the Glossopteris flora.

So far no fossils were recorded from Talchirs in the Giridih coalfield, which led Fox (1931, p. 221) to remark that, " to speak of a Talchir flora, appears unnecessary if we find no flora in the type areas in the Talchir series . . . ". With these finds there remains no justification for this contention. At present it may perhaps be mentioned that the forms which we have obtained from needle shales are similar to those reported from Rikba and Karharbari. A comprehensive collection from Talchir series will no doubt put us in a better position to investigate the relationship between Talchir, Rikba and Karharbari stages. At present the flora is known by a comprehensive name as Talchir-Karharbari flora.

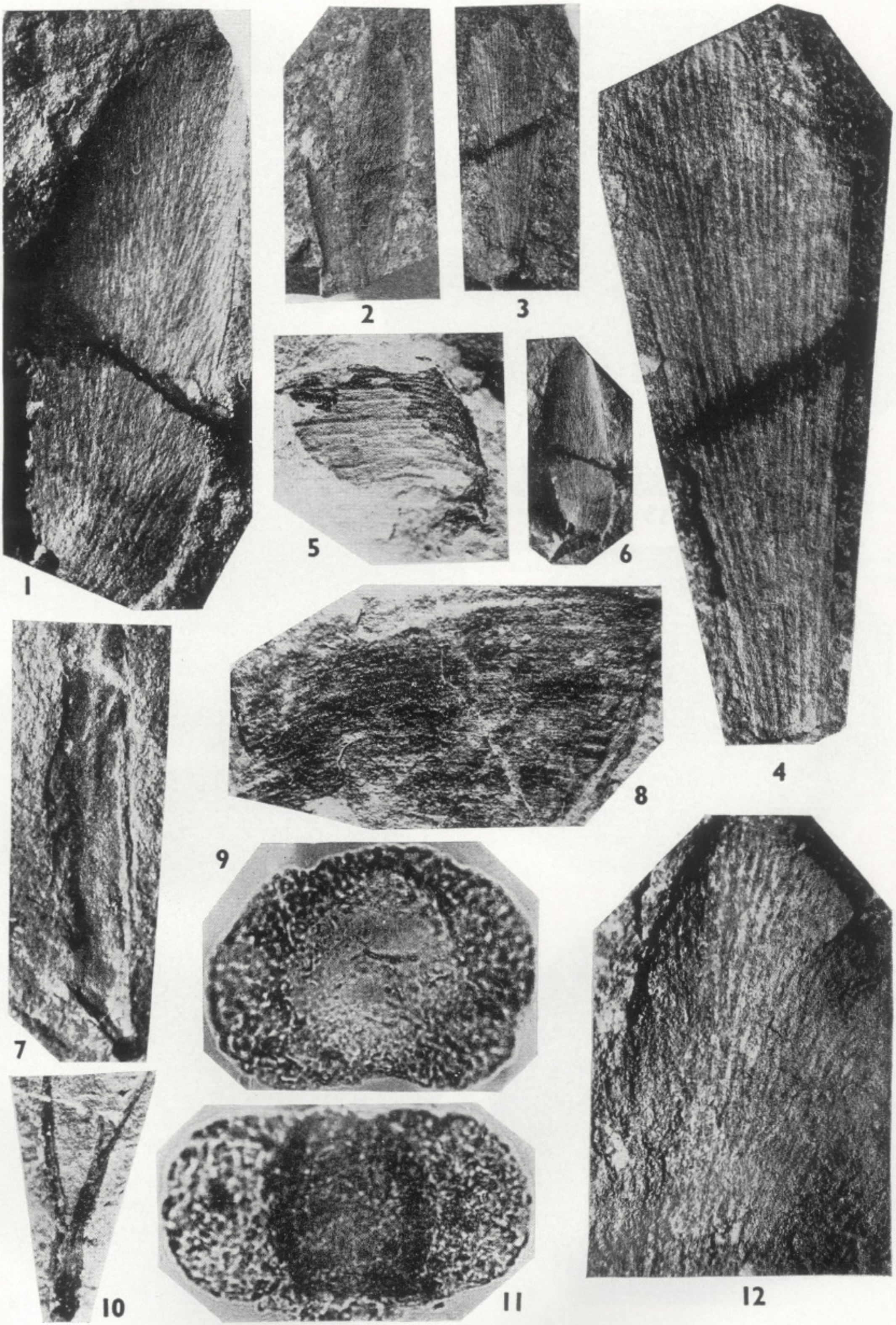
There is another important consideration and that is the exact relation of the Gondwana flora to the Ice Age. It is believed that Glossopteris flora had already come into existence before the land was free of ice. Leslie (1921) discovered *Gangamopteris* immediately below Dwyka tillite in South Africa and later Du Toit (1924) brought forth similar evidence from another locality in the same region. *Gangamopteris* and *Glossopteris* have also been found in beds interstratified with the relics of glaciation in Australia (SAHNI, 1926; WALTON, 1929). Pant (1949) reported a number of spore types from Bacchus Marsh Tillite from Australia. In India Virkki (1938, 1946) discovered a number of spore types from horizons only 1½ and 25 ft. above the Talchir boulder bed in the Salt Range of the Punjab (Pakistan).

From India *Glossopteris* and other fossil impressions are known from a horizon only about 20-25 ft. above the Talchir boulder bed in the Salt Range of the Punjab (VIRKKI, 1938). Its position in the stratigraphical scale is, however, not clearly understood. From near Kathwai, about 25 ft. above the boulder bed, similar flora as mentioned above has been obtained (KRISHNAN, 1949, p. 248). If this flora is equivalent to that from Conularia beds (KRISHNAN, 1949, p. 312) then according to Krishnan (1949, p. 313) Conularia beds are the equivalents of Rikba plant beds of the Karanpura coalfield. If this be the case, then the present fossils discovered from the needle shales will be older than those obtained from Rikba and the Salt Range.

Virkki (1946) has also described spores from a horizon 1½ and 4½ ft. above the boulder bed from near Kathwai. The exact height of these two horizons above the glacial bed is also somewhat in doubt. According to Wadia (VIRKKI, 1946, p. 107) " the basal zone above which the 1½ feet were measured is not the original boulder bed but a resorted deposit of glacial debris overlying the true Talchir horizon ". He adds, however, that the difference in age between original moraine and the assorted deposit cannot have been considerable. It is difficult to ascertain the chronological relationship of these horizons in the Salt Range with those of the needle shales of Talchir stage in the Giridih coalfield.

The plant fossils in Talchir needle shales at least show convincingly the contemporaneity of the earlier forms of the Glossopteris flora with the Ice Age. Fox (1931, p. 225) has vividly visualized how the Talchir rocks must have been formed. According to him Talchir shales have been laid down in quiet waters. He further states, " the remarkable similarity of the typical Talchir rocks throughout the Indian Peninsula might possibly be accounted for, if we believe them to be the crushed and powdered product of rocks of various kinds — the result of the abrasive action of the slow moving great ice sheets. This rock powder and larger material will be churned up and form finally an intimate admixture with the ice. The waters draining such ice would be muddy with suspended silt, and the floating ice would spread such material very evenly as it thawed on waters of extensive lakes. *No reliable evidence of life has been found in the boulder bed or the strata immediately succeeding it*, but in the highest beds the presence of the debris of a terrestrial flora has been found."

We can well imagine the hardy plants, remnants of which are preserved in the needle shales, must have been thriving in some hospitable places when the enormous ice sheets were actually thawing on the waters of extensive lakes and into which some of these plants were carried to be buried under the burden of fine suspended silt released by the thawing ice sheets.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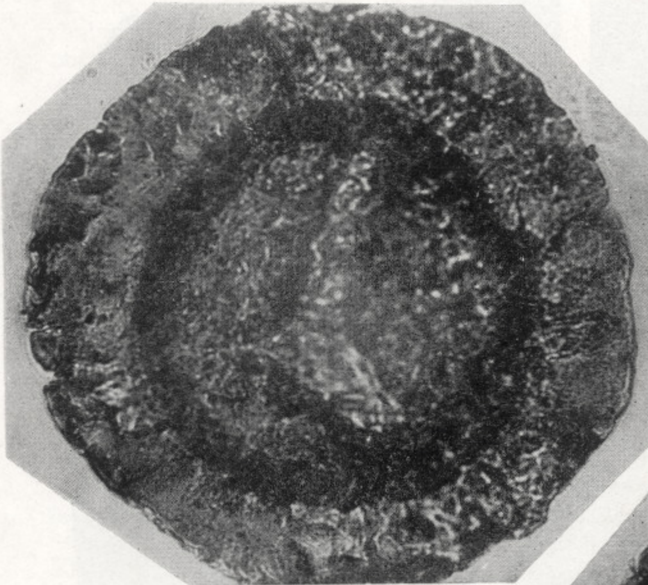

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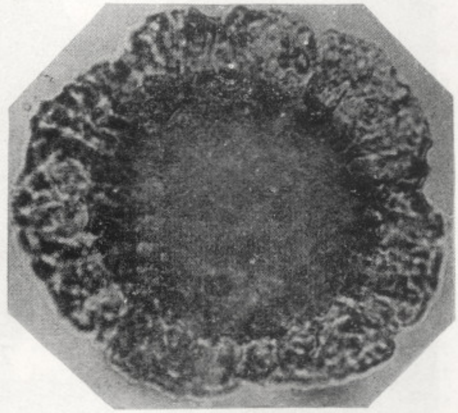

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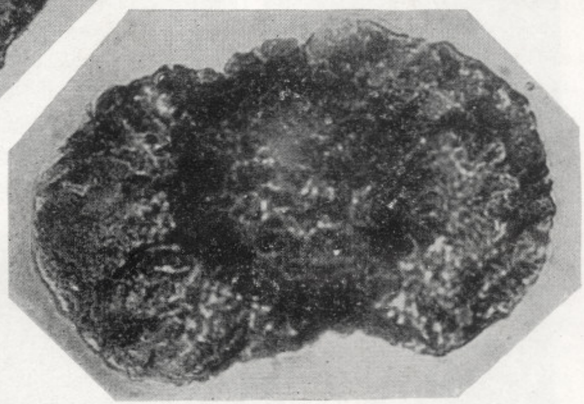

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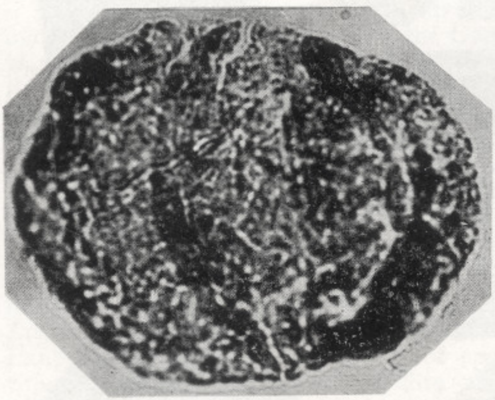

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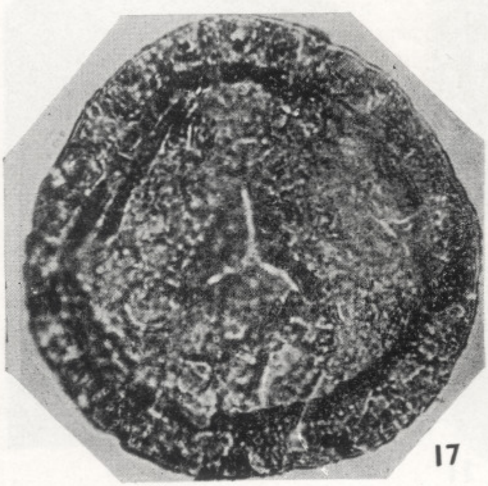

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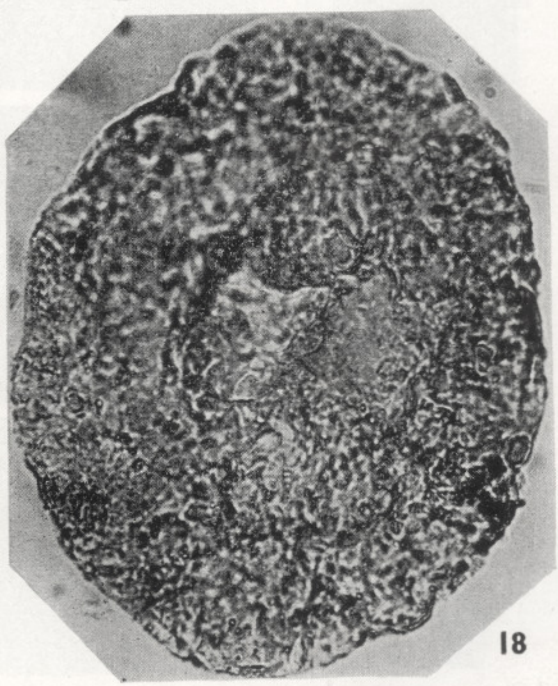

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REFERENCES

FEISTMANTEL, O. (1879). The Flora of the Talchir-Karharbari Beds. *Mem. Geol. Surv. India Pal. Indica.* **3**(1).

FOX, C. S. (1931). The Gondwana system and Related Formations. *Mem. Geol. Surv. India.* **58**.

HUGHES, T. W. H. (1869). The Karharbari Coalfield. Ibid. **7**: 209-246.

KNOX, E. M. (1950). *Trans. & Proc. Bot. Soc. Edinburgh.* **35**(3).

KRISHNAN, M. S. (1949). Geology of India, *Madras.*

LESLIE, T. N. (1921). Observations on Some Fossil Plants from the Permo-carboniferous of Vereeniging. (*Pres. Add.*) *Proc. Geol. Soc. S. Afr.* 29-30.

PANT, D. D. (1949). On the Occurrence of *Pityosporites* Seward in a Lower Gondwana Tillite from Australia and its Possible Relationships with *Glossopteris. Proc.* 36*th Ind. Sci. Cong. Allahabad.* (4): 10-11.

SAHNI, B. (1926) The Southern Fossil Floras: A Study in the Plant Geography of the Past. (*Pres. Add.*) *Proc.* 13*th Ind. Sci. Cong. Bombay*: 229-254.

SEN, J. (1953). *Bull. Nat. Inst. Sci. India.* No. 2.

DU TOIT, A. L. (1924). The Contribution of South Africa to the Principles of Geology. (*Pres. Add.*) *S. Afr. Jour. Sci.* **21**: 52-78.

VIRKKI, C. (1938). A Lower Gondwana Flora from Salt Range, Punjab. *Proc.* 25*th Ind. Sci. Cong. Calcutta.* (3): 150-151.

Idem (1946). Spores from the Lower Gondwanas of India and Australia. *Proc. Nat. Acad. Sci. India.* **15**(4-5): 93-176.

WALTON, J. (1929). Palaeobotanical Evidence for the Age of the Later Palaeozoic Glaciation in South Africa. *Nature. October* 19.

EXPLANATION OF PLATES

PLATE 1

1. *Noeggerathiopsis* sp. Specimen in Fig. 6 enlarged to show dichotomizing veins. × 3.
2. *Gangamopteris cyclopteroides* Fstm. × Nat. size.
3. *Noeggerathiopsis Hislopi* (Bunb.) × Nat. size.
4. Fig. 3 enlarged to show dichotomizing veins. × 3.
5. *Gangamopteris cyclopteroides* Fstm. A fragment showing secondary veins bifurcating near the midrib position. × 5.
6. *Noeggerathiopsis* sp. × Nat. size.
7. Carbonized stem impression. × 5.
8. *Gangamopteris cyclopteroides*. A fragment showing arched secondary veins. × 5.
9. One-winged spore, type 4. × 500.
10. Carbonized impression showing dichotomy. × 5.
11. Two-winged spore, type 3. × 500.
12. *Gangamopteris cyclopteroides* Fstm. Apical part of specimen in Fig. 2 enlarged to show venation and anastomoses. × 5.

PLATE 2

(*All photomicrographs,* × 500)

13. One-winged spore, type 1.
14. Smallest one-winged spore, type 1.
15. Two-winged spore, type 1.
16. Two-winged spore, type 2.
17. One-winged spore, type 2.
18. One-winged spore, type 3.