

STUDIES IN THE GLOSSOPTERIS FLORA OF INDIA —
 39. ON SOME NEW PLANT FOSSILS FROM THE KARHARBARI
 BEDS, GIRIDIH COALFIELD, INDIA

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ABSTRACT

Four new plant fossils *Gangamopteris oblanceolata* sp. nov., *Euryphyllum obovatum* sp. nov., *Dolianitia karharbarensis* sp. nov. and *Buriadia florinii* sp. nov. are described from the Karharbari beds, Giridih Coalfield.

INTRODUCTION

PLANT fossils from the Karharbari beds, Giridih Coalfield have earlier been described by Feistmantel (1879) and Zeiller (1902). In recent years Maithy (1965a-e) has described the plant fossils from these beds. In a recent collection some new plant fossils were encountered from the Karharbari beds, Giridih Coalfield. They are, therefore, described here in detail.

DESCRIPTION

GANGAMOPTERIS McCoy

Gangamopteris oblanceolata sp. nov.

Pl. 1, Figs. 1, 2

1879 — *Gangamopteris major* Feistmantel, pl. 16, fig. 2, 2a.

1965e — *Gangamopteris* ? *major* Maithy, pl. 2, fig. 8.

Diagnosis — Leaves \pm symmetrical, spatulate shape, apex obtuse to obtusely pointed, base narrow tapering. Median veins obscure, persistent from apex to base, forming elongate meshes by inter-connections. Secondary veins arise at acute angle, course \pm erect, somewhat arched towards the margin, anastomosed to form narrow elongate meshes of \pm uniform size. Margin entire.

Neotype — Specimen No. 19965, Birbal Sahni Institute of Palaeobotany.

Locality — Central pit, Srirampur Colliery, Giridih Coalfield.

Horizon — Karharbari Stage.

Age — Lower Permian.

Description — There are ten specimens in the collection and some of them are \pm complete. Leaves are mostly spatulate

or spatulate-lanceolate in shape. The spatulate leaves have mostly broad obtuse apex (PL. 4, FIG. 1) and the narrower leaves (spatulate-lanceolate) tend to show somewhat roundly obtuse apex (PL. 1, FIG. 2). Leaves have narrow tapering base. One of the margins of the leaf base shows more curvature than the other. Median subparallel veins are not prominent. Secondary veins are given out from the median veins at acute angle. The veins in the median portion are \pm erect and show radiating curvature towards the margin. The course of the veins is \pm straight. The maximum width of the leaf is above the $\frac{3}{4}$ length of the leaf. The density of the veins is 12-16 per cm.

Comparison and Discussion — Feistmantel (1879) proposed *Gangamopteris major* for those leaves with a characteristic elliptical shape and \pm pointed apex. Subsequently under this species he placed some leaves with spatulate shape with broad round apex in view of the close similarity in venation (PL. 16, FIG. 2). Maithy (1965e) opined that the latter leaves needs a separation on morphological grounds from *Gangamopteris major* and, subsequently, placed them under *G. ?major* in view of its distinct shape. In a recent collection some more complete leaves were recorded and a critical morphological analysis of them shows that they differ from *G. major* in the following salient points.

<i>Gangamopteris major</i> Feistm.	<i>Gangamopteris oblanceolata</i> sp. nov.
1. Rhomboidal shape	1. Spathulate shape
2. Petiolate base	2. Gradually tapering base
3. Maximum width above 2/3 length of the leaf.	3. Maximum width above 3/4 length of the leaf.
4. Margins of leaf base shows equal curvature.	4. One of the margins of the leaf base shows greater curvature than the other.

These morphological distinctions warrant separation of these forms from *Gangamopteris major*, and, henceforth a new specific name *Gangamopteris oblanceolata* is proposed. Since the specimen described by Feistmantel in 1879 is not traceable in the collection of the Geological Survey of India, therefore, a Neotype is designated here.

EURYPHYLLUM Feistmantel

Euryphyllum obovatum sp. nov.

Pl. 1, Fig. 3

Diagnosis — Leaf \pm symmetrical, shape spatulate, apex broadly obtuse, base narrow tapering, basal end truncated; curvature of leaf margins symmetrical; subparallel veins emerging from base, dichotomous, closely spaced, density 15 to 20 veins/cm. width; towards the upper half of the leaf in the central portion the veins are erect subparallel and in lateral portion \pm divergent and arched towards the margin.

Holotype — 19949, Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — Central pit, Srirampur colliery, Giridih Coalfield.

Horizon — Karharbari Stage.

Description — A solitary specimen in the collection measuring 5.6 cm long and 2 cm broad. The maximum widest region is about 1/5th from the apex. The basal portion of the leaf is drawn longer. The basal end of the leaf is truncated.

Comparison and Discussion — *Euryphyllum whittianum* recorded by Feistmantel (1879) and Maithy (1965c) differs in having asymmetrical leaf outline, \pm roundly pointed apex and less density of veins. Further in *E. obovatum* the base is longer drawn in comparison to *E. whittianum*.

In its morphological characters *Euryphyllum* Feistmantel closely compares to *Noeggerathiopsis* Feistmantel. The former is characterized in possessing erect, dichotomous, subparallel veins in the median portion and arching veins towards the margin in lateral portion of the leaf, whereas the latter genus has dichotomous, erect, subparallel veins throughout the leaf. This only morphological distinction was considered by Feistmantel (1879), Seward and Sahni (1920) and Maithy (1965 e) as a distinct generic character, however, Arber (1905) considered it to be of specific impor-

tance. The present record of another species of *Euryphyllum* supports the fact that the genus has a distinct generic entity with different morphological forms with similar type of venation like the earlier described species of *Euryphyllum*.

The taxonomic position of both these genera still remains an open question. Views have been expressed in past (SEWARD, 1917; SEWARD & SAHNI, 1920) to consider *Noeggerathiopsis* synonymous to the northern genus *Cordaites* in view of their close similarity in external characters. However, Lele and Maithy (1964), Maithy (1965 c) and Pant and Verma (1964) favoured the retention of two distinct generic names because of (i) the general prevalence of certain structural differences between them; (ii) the complete absence of indubitable fructifications of *Cordianthus* type in the Glossopteris flora and (iii) the imperfect knowledge of the internal anatomy of *Noeggerathiopsis*.

The distinct character of the fossils of the Glossopteris flora is also an additional criteria for disfavoured to consider *Noeggerathiopsis* and *Euryphyllum* members of the group *Cordaitales*. Edward (1955), Kräusel (1961) and Plumstead (1962) have emphasized the difference between similar looking elements in the northern and Gondwanaland fossils. Their observations have also indicated that no fossil member is common to both the flora.

Thus, the taxonomic position of these forms remains open. *Noeggerathiopsis* and *Euryphyllum* are both commonly found in the Talchir and the Karharbari Stages of India. Usually these are encountered along with the Glossopteridalean remains, viz. *Glossopteris*, *Gangamopteris* and *Rubidgea*. Therefore, it will not be very unwise to think about the two genera *Noeggerathiopsis* and *Euryphyllum* to be alike forms of Glossopteridales, and probably allied members. This is supported by close parallelism in morphological and epidermal structures with the members of Glossopteridales and the so-called Cordaitalean remains of the Glossopteris flora.

Morphologically *Rubidgea* Tate and *Euryphyllum* Feistmantel stand very close to these forms. *Rubidgea* compares to *Euryphyllum* in its venation character except by the presence of distinct median subparallel veins like *Gangamopteris* McCoy. Thus *Rubidgea* stands as an intermediate

form between *Gangamopteris* and *Euryphyllum*. Similarly *Palaeovittaria* resembles *Noeggerathiopsis* in absence of a distinct midrib in the basal portion, a characteristic of *Glossopteris* leaves. Thus, we find the existence of a morphological parallelism in between the Glossopteridalean leaves and so called Cordaitean leaves of Glossopteris flora.

In the past several workers contributed to the epidermal structure of *Glossopteris* (SRIVASTAVA, 1956; SURANGE & MAHESHWARI, 1962; HØEG & BOSE, 1960) and *Gangamopteris* (HØEG & BOSE, 1960; MAITHY, 1965e, 1968) leaves. The cuticles of these remains are either hypostomatic or amphistomatic, surface papillate or non-papillate, stomata haplocheilic, subsidiary cells monocyclic or amphicyclic and stomal orientation irregular. The epidermal structure of *Noeggerathiopsis* has been described in detail in recent years by Lele and Maithy (1964) and Pant and Verma (1964). It compares to the cuticles of *Glossopteris* and *Gangamopteris* in all the characters except in the orientation of stomata, which is linear or longitudinal. Pant and Verma (1964 b) recently described the cuticle of *Palaeovittaria raniganjensis* sp. nov., which has a linear orientation of stomata and expressed the view that in this character the form stands very closer to *Noeggerathiopsis*. Thus, the past observations on the epidermal structure suggests that the angle of divergence and interconnections in between the veins play a significant role in the orientation of stomata. Thus, the parallel morphological and epidermal structure of *Noeggerathiopsis* and *Euryphyllum* with the earlier known Glossopteridalean members converge to support the fact that these two genera are also the members of the Order Glossopteridales.

DOLIANITIA Millan

Dolianitia karharbarensis sp. nov.

Pl. 1, Figs. 4, 5; Text-fig. 1, a, b

Diagnosis — Deeply striated branched axis, main axis branching oppositely into two and subsequently dividing into irregular branches. Small branches with blunt end emerge from these forked branches irregularly.

Holotype — Specimen No. 33692/660, Birbal Sahni Institute of Palaeobotany.

Locality — Bengal Nagpur open quarry, Srirampur Colliery, Giridih Coalfield.

Horizon — Karharbari Stage.

Description — The collection has only two specimens preserved in form of impression on a single shale along with *Buriadia sewardii*. The specimen figured in (PL. 1, FIG. 5, TEXT-FIG. 1A) has a median axes with deep



TEXT-FIG. 1, A-B — *Dolianitia karharbarensis* sp. nov. $\times 3$.

grooves and elevated ridges. Median axes 1 cm long and 0.5 cm broad. It dichotomizes into two. Both the branches are opposite to each other. From these branches emerge out small branches with broad base and truncated apex. The other specimen (PL. 1, FIG. 4; TEXT-FIG. 1, B) branches very irregularly into number of branches. From these branches arise small branches with truncated ends.

Comparison — *Dolianitia karharbarensis* differs from *D. crassa* Millan (1967) in the

absence of distinct seed-like structure in the ultimate branches. From *D. alternata* Millan (*l.c.*) and *D. opposita* Millan (*l.c.*) it differs in having composite type of branching, i.e. both alternate and opposite, whereas the first Barzilean species is characterized by alternate branching and the latter Brazilian species by opposite branching.

BURIADIA Sew & Sahni

Buriadia florinii sp. nov.

Pls. 1, 2, Figs. 6-12; Text-fig. 2A, B

Diagnosis — Sterile shoots, irregularly branched, covered with spirally arranged forked and unforked leaves. Leaves bifacial, oblanceolate; apex acute, either unifid or bifid. Cuticle epistomatic; non-stomatiferous and stomatiferous surface non-papillate. Stomatal orientation linear, haplocheilic, subsidiary cell, 5-7 in number, monocyclic or partially amphycyclic. Subsidiary cells with rudimentary papillae, covering the stomatal opening.

Holotype — Specimen No. 33694. Birbal Sahni Institute of Palaeobotany.

Locality — Central pit, Srirampur Colliery, Giridih Coalfield.

Horizon — Karharbari Stage.

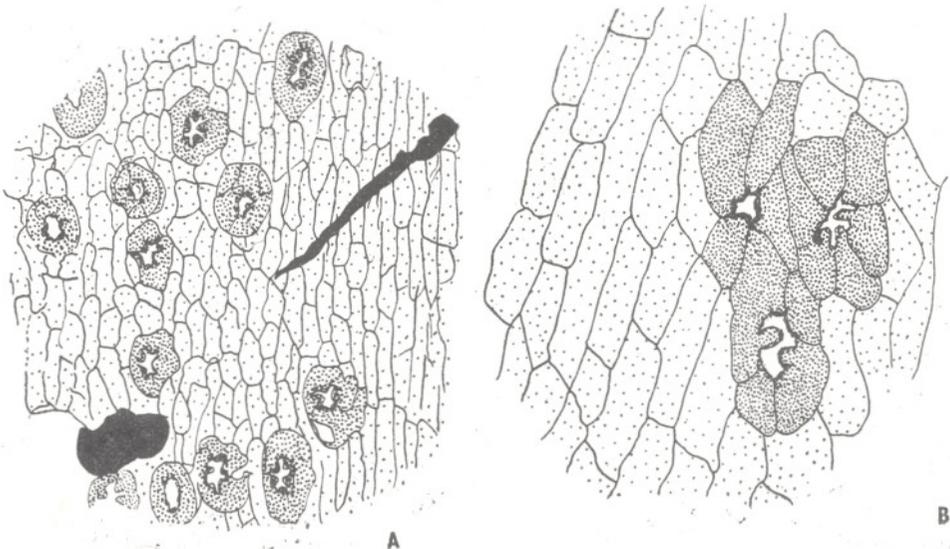
Description — The collection includes fifty compressions of sterile shoots. Perhaps

they represent lateral ultimate branches. Many of the shoots show irregular branching at different levels. The shoots are covered by spirally arranged forked and unforked leaves in cyclic order. Leaves are bifacial with oblanceolate outline. Apex bluntly pointed both in the forked and unforked leaves. Leaf base is sessile and cuneate. Leaves are widest at the middle portion. Veins persistent from apex to base. In bifid leaves the vein dichotomizes into two at the 1/3 level from the leaf base, and each apex is supplied by one vein.

Epidermal Structure — Stomata present only on one surface, whether on the upper or lower is not determinable.

Non-stomatiferous Surface — The cells are long, narrow, rectangular with straight parallel sides and present a regular pattern (PL. 2, FIG. 9). They are arranged more or less in longitudinal rows and most of them have square ends, though they are sometimes slanted or occasionally obtusely pointed. They range from 25 to 38 μ in width and 82 to 114 μ in length. There is no indication of the presence of any kind of specialized cells.

Stomatiferous Surface — Stomata are confined to the middle portion of the leaf, leaving the two margins. The cells are similar in shape to those of the other surface, but somewhat smaller in size. The marginal cells are larger to those occurring in between



TEXT-FIG. 2, A-B — *Buriadia florinii* sp. nov., Cuticle of the stomatiferous surface. A \times 100. B \times 400.

stomatal rows. The anticlinal walls of the cells are straight, but the cells are variously rounded or pointed. The cells are non-papillate (PL. 2, FIG. 10).

The stomata occur (PL. 2, FIG. 10; TEXT-FIGS. 2, 4) in 3 or more slightly irregular rows that are separated by 2-6 epidermal cells. The regularity of arrangement of stomata one below the other is broken at places, giving a slightly irregular arrangement of rows. The stomata in each row is separated by 2-4 epidermal cells (and sometimes more), but at places 2-3 stomata are contiguous (laterally or end to end). They are orientated in the longitudinal direction of the leaf. The stomata are encircled by 4-7 (usually 5-6) subsidiary cells that form an oval mass with stomatal opening in centre (PL. 2, FIGS. 11, 12; TEXT-FIG. 2,B). One and sometimes both polar subsidiary cells extend out noticeably further than the lateral walls. Typically they are somewhat wedge shaped. The size of the subsidiary cells is 100-120 μ long and 40-60 μ wide. The subsidiary cells bear stout

papillae which are not always preserved on their inner walls. These extend into oval opening above the actual stomatal slit. Occasionally two stomata share one common subsidiary cell. Guard cells generally not visible, but occasionally a lens-shaped slit-like opening is seen. Some stomata have one or two encircling cells.

Comparison — Morphologically *Buriadia heterophylla* (Feistm.) Sew. & Sahni (1920) and *Buriadia florinii* sp. nov. compare closely, however, the two differ in the following characters:

<i>B. heterophylla</i>	<i>B. florinii</i>
1. Leaf triangular in outline.	1. Leaf oblanceolate in outline.
2. Apex acute (sharply pointed).	2. Apex bluntly pointed (\pm rounded).

Pant and Nautiyal (1967) have recently described the cuticle of *Buriadia heterophylla*. *B. heterophylla* differs in possessing the papillae on cells of the stomatiferous surface and the presence of marginal hairs.

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EXPLANATION OF PLATES

(All specimens and slides are preserved at the Museum of the Birbal Sahni Institute of Palaeobotany, Lucknow)

PLATE 1

1. *Gangamopteris oblanceolata* sp. nov., a spatulate leaf with broad obtuse apex. $\times 1$. sp. no. 19965.

2. *Gangamopteris oblanceolata* sp. nov., leaf with narrow obtuse apex. $\times 1$. sp. no. 19965.

3. *Euryphyllum obovatum* sp. nov. $\times 1$. sp. no. 19949.

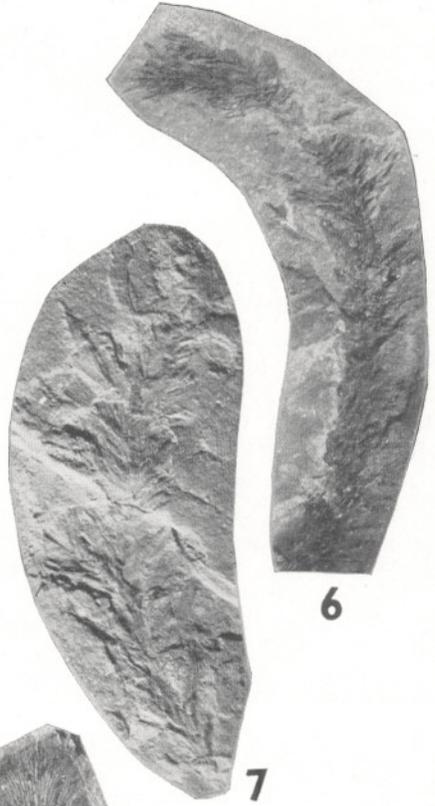
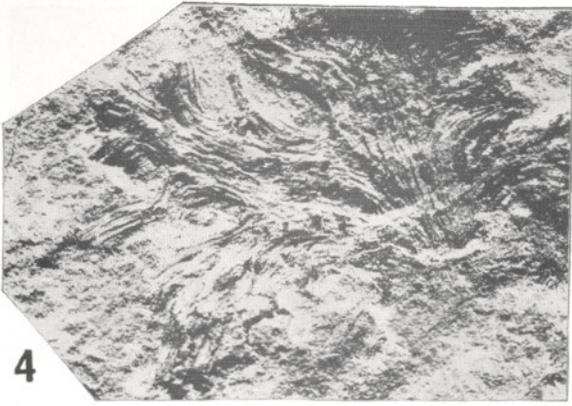
4-5. *Dolianitia karharbarensis* sp. nov. $\times 3$. sp. no. 33692/660.

6-8. *Buriadia florinii* sp. nov. Shoots covered with forked and unforked leaves. (Figs. 1, 2 $\times 1$;

Fig. 3, $\times 2$). Specimen nos. 33694/424, 19971 and 33691.

PLATE 2

9-12. Cuticle of the *Buriadia florinii* leaves. 9. Non-stomatiferous surface. $\times 100$. 10. Stomatiferous surface. $\times 100$. 11. A stomata enlarged to show hanging papillae of the subsidiary cells covering the stomatal opening. $\times 500$. 12. Two stomata enlarged with a common polar subsidiary cells. $\times 500$.





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