

STUDIES IN THE GLOSSOPTERIS FLORA OF INDIA —
25. PTERIDOPHYTIC AND GINKGOALEAN REMAINS FROM THE
KARHARBARI BEDS, GIRIDIH COALFIELD, INDIA

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ABSTRACT

The present paper contains a description of some Pteridophytic and Ginkgoalean plant remains from the Karharbari stage of the Giridih coalfield. The plant described are *Phyllothea*, *Schizoneura*, cf. *Cyclodendron*, *Gondwanidium*, *Sphenopteris* and *Ginkgophyton*.

INTRODUCTION

THE records of pteridophytic remains from the Lower Gondwanas of India date back to 1828 when Brongniart described *Schizoneura* (*Zeugophyllites*) from Raniganj (previously known Ranagunje) near Rajmahal. Royle (1833) recorded *Sphenophyllum* and *Alethopteris* from Bardwan Coalfield, Raniganj. Bunbury (1861) recorded *Sphenopteris*, *Phyllothea* and *Cyclodendron* (*Knorria*) from Nagpur. Later Feistmantel (1876, 1879, 1881) described a number of pteridophytic remains from the coalfields of India. Zeiller (1902) and Seward & Sahni (1920) added few more forms to our knowledge. Saksena (1952, 1954) described a new species of *Phyllothea* from the Ganjra nala beds. Srivastava (1954) and Surange (1956) described some forms from the Raniganj coalfield. Recently Surange & Prakash (1962) have added one new genus *Stellothea* to our pteridophytic records. These records of pteridophytic remains have been assigned to the following genera:

Sphenophyllum (Royle) McClelland
Schizoneura Schimper & Mougéot
Phyllothea Brongniart
Stellothea Surange & Prakash
Raniganjia Rigby
Cyclodendron Kräusel
Gondwanidium Gothan
Pecopteris Brongniart
Sphenopteris Brongniart
Alethopteris Sternberg
Ptychocarpus Weiss
Merianopteris Feistmantel
Belemenopteris Feistmantel

The present paper deals with the pteridophytic remains collected from the Karharbari stage, Giridih Coalfield.

DESCRIPTION

EQUISETALES

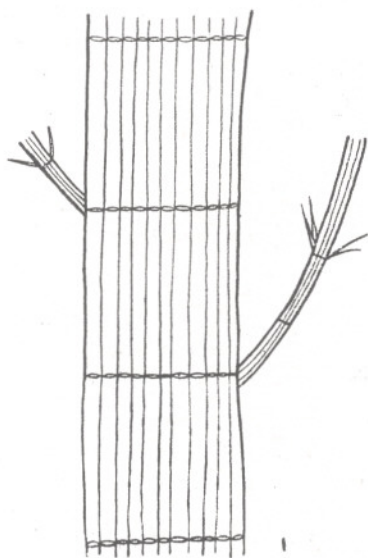
Phyllothea Brongniart

Phyllothea indica Bunbury

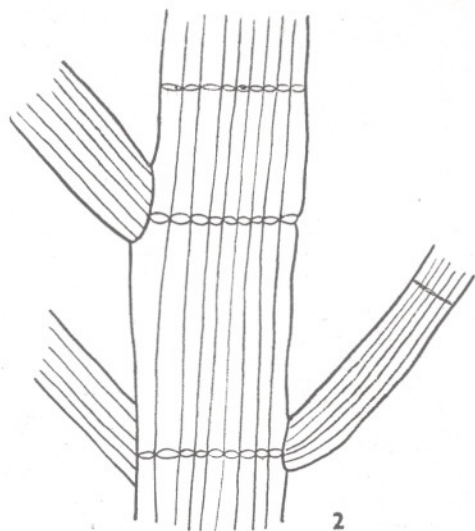
Pl. 1, Figs. 1, 2; Text-figs. 1, 2

Description — A large number of specimens are in collection from the Bengal-Nagpur quarry and 16 B pit of the Giridih coalfield. The main stem is leafless, articulated, divided into nodes and internodes. The nodes are 1.3-5 cm. apart. Each node is a transverse furrow and is 1.0 mm. wide. Stem 1-3 cm. wide, internodes ribbed longitudinally, ribs convex somewhat flattened, furrows in between the ribs are narrow. Ribs are continuous across several nodes and internodes, 12-18 in number. From the leafless main stem, arise leafy shoots from the nodal region. The leafy shoots are given out only on one direction (PL. 1, FIG. 1) from each alternate nodes or from each nodes. In few specimens the leafy shoots arise on both sides of the main stem, they are either opposite or alternate at the nodes (TEXT-FIG. 1). In one case two leafy shoots arise oppositely at the node and just above this node another leafy shoot arises only in one direction (TEXT-FIG. 2). The leafy shoots are comparatively narrow than the main stem, 2-5 mm. broad, articulated. The nodes are 1.5-2.5 cm. apart, ridges and furrows opposite at the nodes. The leafy shoots are unbranched or branched into two (PL. 1, FIG. 2).

Leaf sheath, about 3.5 mm. long and 2.5 mm. broad at the top, is in the form of a shallow cup which measures 1.5-2.5 mm. in diameter. Isolated leaf sheaths show commissural furrows inside. The rim of the cup is flattened horizontally, 12-18 free leaf-segments radiate out between 40° and 60°.



TEXT-FIG. 1 — *Phyllothecca indica*, a main stem with two lateral leafy shoot branches. $\times 1$.



TEXT-FIG. 2 — *Phyllothecca indica*, a main stem with leafy shoots attached oppositely on the same node, and at the next node another leafy shoot on only one side. $\times 1$.

Individual leaf segments are straight, narrow, about 1.2 cm. long and 1 mm. broad, the apex is not tapering to a point. Single midrib is visible for whole length of the leaf.

Comparison and Discussion — The specimens from the Karharbari beds, Giridih coalfield agree well with *Phyllothecca indica*

Bunbury (FEISTMANTEL, 1881; PL. XII A, FIGS. 6-8; TOWNROW, 1956, TEXT-FIG. 2 B-D, F).

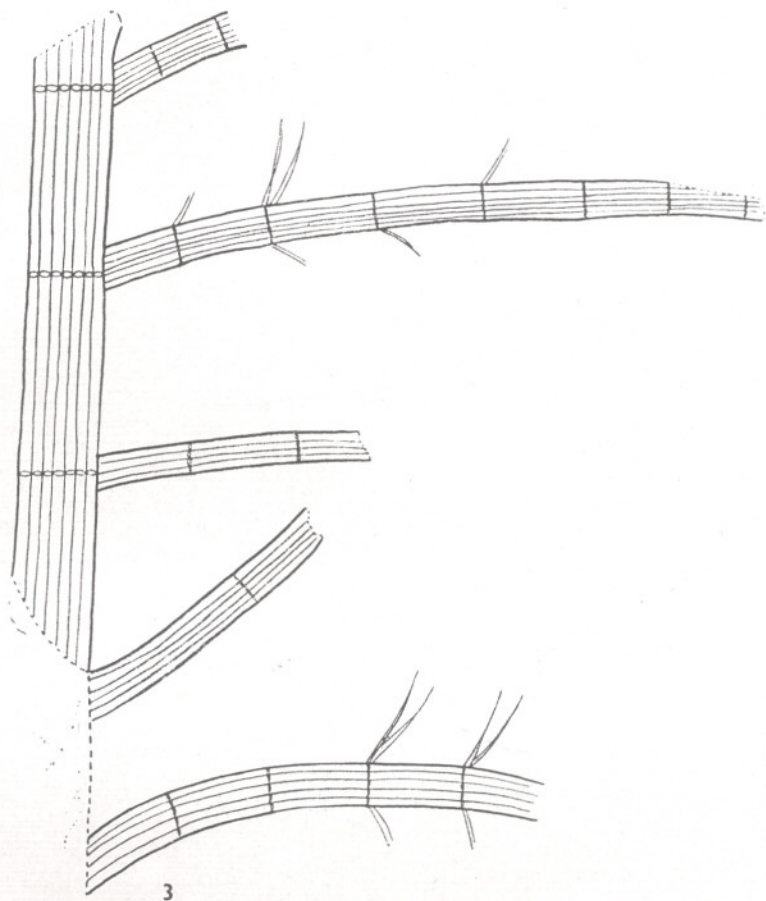
In past, large number of leafless equisetaceous stems have been recorded in form of impressions, pith casts or compressions associated commonly with *Phyllothecca* and *Schizoneura*. These detached stems have been assigned by various workers in past either to *Phyllothecca* or *Schizoneura*. However, it is extremely difficult to find out any distinguishing features in these stems on the basis of which they could be assigned to either of the two genera, as has been earlier pointed out by Seward (1898). Høeg & Bose (1960) found equisetaceous stems in association with *P. australis* Brongniart and pointed that they may belong to the same plant. The present record of *P. indica* in organic connection with leafless equisetaceous stem now definitely demonstrates that if not all, at least some of these equisetaceous stems might belong to *Phyllothecca*.

Phyllothecca indica was so far only known from the Raniganj stage of the Damuda system. The present finding is the first record from the Karharbari beds and, therefore, extends its range below the Raniganj.

Phyllothecca sahnii Saksena emend Townrow

Pl. 1, Fig. 3; Text-fig. 3

Description — The specimens consist of leafless main stem, articulated, divided into nodes and internodes. Each node is a transverse furrow, ± 1 mm. broad, internodes ribbed longitudinally, ribs convex or somewhat flattened. Ribs at cross nodes are continuous at several nodes and internodes. Leafy shoots arise from the nodal zone, they are alternate or opposite (TEXT-FIG. 3). Leafy shoots are 5-10 mm. broad, ribbed longitudinally and swollen at nodes. The nodes are at a distance of 1-2 cm. The leaf sheath is closely adpressed to the stem when laterally preserved, narrow amplexicaul at the base, spreading somewhat above into an open saucer-like shape. From this 20-22 leaf segments radiate out at right angles to the axis. In few cases the leaf sheaths and leaf segments (PT. 1, FIG. 3) are preserved dorsiventrally. They show the amplexicaul nature of leaf sheaths at base and spreading somewhat above into an open saucer. Each leaf sheath is 12 mm. in diameter and consists of about 18-22 segments.



TEXT-FIG. 3 — *Phyllotheca sahnii*, a main stem with lateral leafy shoots. $\times 1$.

The leaf sheaths are slightly concave on the adaxial and convex on the abaxial side. Free leaf segments are linear, narrow, tapering to a point, 14-33 mm. long and ± 1 mm. broad at the base and are spreading straight from the leaf sheath.

Comparison and Discussion — *Phyllotheca sahnii* Saksena (1952) was described from the Ganjra nala beds, South Rewa Gondwana Basin, but the specimens were incomplete, and only the leaf sheaths were preserved. Townrow (1956) recorded a few specimens which were more complete and showed the characters of leaves and striae, therefore, he emended the diagnosis of the species. The present specimens from the Karharbari beds agree with *P. sahnii* Saksena (SAKSENA, 1952, PL. 1, FIGS. 2-6; TOWNROW 1956, TEXT-FIG. 3A, B), however, the length of the leaf

segments is comparatively longer than the specimens of Townrow.

P. sahnii Saksena is recorded for the first time from the Karharbari beds, Giridih coalfield, and the present records further substantiate that the Ganjra nala beds are homotaxial to the Karharbari beds as was earlier pointed by Saksena (1952).

Schizoneura Schimp. & Moug.

Schizoneura wardii Zeiller

Pls. 1, 2, Figs. 4, 6

Description — Only few specimens in the collection. The one figured in Pl. 2, Fig. 6 shows an articulated stem, surface faintly striated. Leaves arise from the nodal region, about 10-16, partly conate at the base,

1.5-4 cm. long and 1.5-3 mm. broad, erect, more rarely arched and recurved, narrow and linear. The other specimen in (PL. 1, FIG. 4) is a star-shaped impression on a sandy micaceous shale. No carbonized crust is preserved on leaf surface. There are 14 free leaf-segments, 2-2.5 cm. long and 2-4 mm. broad, segments narrow at the base and gradually becoming broader distally. Leaf segments united at the base. The surface of the leaves appear to be rather thick and uniformly striated lengthwise by very fine and close lines, which in the middle region becomes better defined and constitute more or less a distinct midrib.

Comparison and Discussion — *Schizoneura wardii* Zeiller (1902) is closely comparable to *Phyllothea* Brongniart in the presence of the number of free leaf segments, but the former differs from the latter by the absence of formation of a cup at the base. The present specimens are closely comparable with those of Zeiller (1902, PL. 6, FIGS. 5-9). Another comparable form has recently been recorded by Høeg & Bose (1960, PL. 4, FIG. 3) from Greinerville. f. 5, assise de transition of Belgian Congo.

Plumstead (1963) recorded a fructification, *Vannus gondwanensis* attached to *Gangamopteris* which she considers identical to *Schizoneura wardii* Zeiller. In the present collection the specimens, however, do not show any characteristic feature of *Vannus gondwanensis* described by Plumstead, i.e. the presence of hollow impression at the widest part near the apex of the bract (leaf segments) and the hairy surface of the cup. Besides, in the Indian specimen the leaf segments are in attached condition with the equisetalean stem, whereas the specimen of *V. gondwanensis* are considered to be attached with *Gangamopteris*. Therefore, Plumstead's consideration for placing *S. wardii* under *V. gondwanensis* has no justification and it will be more suited for the present to keep both of them separate. Plumstead (1962) described *Annularia* sp. from the Lower Gondwanas of Antarctica, as one can judge from the photograph it appears to be *Schizoneura wardii*.

Schizoneura cf. *gondwanensis* Feistmantel

Pl. 3, Fig. 7

Description — Only few specimens in the collection and all of them are incomplete due to which a detailed comparison was

not possible. The one in Pl. 3, Fig. 7 shows an articulated stem with distinct ridges and grooves, nodes and internodes distinct. Near the stem an incomplete leaf sheath measuring 3×1.3 cm. is seen. About 9 subparallel nerves originate from a common point and are situated nearly 1 mm. apart.

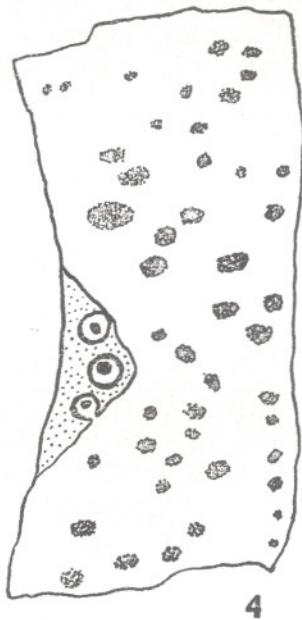
LYCOPODIALES

Cyclodendron Kräusel

cf. *Cyclodendron* sp.

Pls. 1, 2, Figs. 5, 8; Text-fig. 4

Description — There are a few imperfectly preserved unbranched cylindrical stem casts. The one figured in Pl. 1, Fig. 5 is 4.5 cm. long 1.8 cm. broad and the other in Pl. 2, Fig. 8 is 12 cm. long and 11.5 cm. broad; leaf or leaf cushions absent. Leaf scars small, centrally depressed, 2 mm. wide, transversely oval or subcircular, closely placed, arranged somewhat spirally.



TEXT-FIG. 4 — cf. *Cyclodendron* sp. $\times 2$.

Comparison and Discussion — Our knowledge of Indian Palaeozoic Lepidophytes is very scanty. The only examples known are *Bothrodendron* sp. (?) found in the Ironstone shales of the Raniganj Coalfield by Seward & Sahni (1920), and *Knorria* sp. by Bunbury (1861) from the Lower Gondwanas of Nagpur. Recently some specimens of *Cyclodendron*

have been recorded from the Ironstone shales of Jharia coalfield (SURANGE, 1964). The specimens from the Karharbari beds are referred to as cf. *Cyclodendron* sp. due to its imperfect preservation.

FILICALES

Gondwanidium Gothan

Remarks — Carruthers (1879) first described a frond from the Brazilian coal beds under the name *Odontopteris plantiana*. Feistmantel (1876) described these fronds under *Neuropteris valida* from the Karharbari beds, India; he later (1879) transferred them to the Triassic genus *Neuropteridium* Schimper, in view of the fact that in the former genus, i.e., *Neuropteris*, fronds are bipinnate or tripinnate, whereas in *Neuropteridium* it is simple pinnate. This name was used by several workers (KURTZ, 1894; SEWARD, 1903) until Gothan (1927, 1941) pointed out that the Gondwana forms differ markedly from the Northern Triassic genus *Neuropteridium* in the simple pinnate nature of the frond; asymmetrical, lobed pinnules and the absence of a midrib in the pinnules. Hence, a new generic name *Gondwanidium* was proposed by Gothan (1927) for the Gondwana *Neuropteridium*. Gothan also pointed the resemblance between *Gondwanidium* and *Cardiopteris*. However, the later differs in its orbicular shape and less lobed pinnules. Besides, the genus *Cardiopteris* is northern in distribution.

Gondwanidium in India has been recorded from the Giridih coalfield (FEISTMANTEL, 1879), Deogarh Coalfield (PURI, 1953), North Karanpura Coalfield, (PURI, 1952 & See KRISHNAN, 1954) and Palasthali, Raniganj Coalfield (BANERJI, 1958). Outside India, it has been recorded from the Middle Ecca of South Africa (SEWARD, 1903), Tubaro series, Brazil (WHITE, 1908; LUNDQVIST, 1919; DOLIANITI, 1953) and Bajo Series, Argentina (KURTZ, 1894). Frenguelli (1944, 1946) recorded *Gondwanidium* with the typical Carbonaceous flora of Argentina, although its identification is doubtful. From the examination of the photograph it appears to be *Eremopteris*, which has also been recorded in the same collection and shows a close agreement in characters. The question can only be settled definitely when the original specimens are re-examined. *Gondwanidium* has also been recorded from the Angara, but the identification of the Angara forms

remains an open question in view of the lack of knowledge about the relationships between the Angara and Gondwana floras.

The position of *Gondwanidium* still remains a palaeobotanical puzzle. In view of its resemblances with northern fern fronds it was placed under Filicales by early workers, however, uptill now no fertile pinnules have been recorded. Seward (1903) opined that *Gondwanidium* bore gymnospermous, rather than filicinean reproductive organs like the northern Palaeozoic genera *Alethopteris* and *Neuropteris*. The systematic position of *Gondwanidium* cannot be resolved until the future discovery of its fructification.

Gondwanidium indicum sp. nov.

Pls. 2, 3, Figs. 9-16; Text-fig. 5

Diagnosis — Frond simple pinnate, rachis cylindrical, bearing sessile pinnules, entire in the lower part of the frond, more or less ovate and gradually becoming longer and lobed towards the apical end, apex of pinnules broadly rounded; veins arising from the base, curved and spreading towards the margin of pinnules with repeated dichotomy. Epidermis of rachis composed of rectangular cells, arranged in rows. Epidermis of pinnules distinguished into stomatiferous and non-stomatiferous surface. Cells of non-stomatiferous surface rectangular, square or trapezoid and arranged in rows; cell wall sinuous. Cells of stomatiferous side similar. Stomata irregularly distributed and orientated, haplocheilic in structure.

Holotype — 32998/503, Birbal Sahni Institute of Palaeobotany.

Isotype — 31398/426 & 31415/426, Birbal Sahni Institute of Palaeobotany.

Locality — Jubille pit and Deep pit, Karharbari colliery, Giridih coalfield.

Horizon — Karharbari stage.

Description — The description is based upon several detached and incomplete specimens from the Jubille and the Deep pit. The rachis is cylindrical with few ridges, slightly tapering, 2.5 mm. wide (PL. 2, FIG. 9). Pinnules sessile, attached to rachis by their complete base and arranged alternately. The pinnule margins are sinuous. Pinnules are of varying shape and size. In the lower part of the rachis pinnules are small, 1.5 × 1.5 cm., ovate, unlobed, with a broadly obtuse apex (PL. 2, FIG. 11) while towards the upper part they are elongate, spatulate, 3 × 2.5 cm. in size and slightly

Thus, in view of the above mentioned differences and lack of knowledge about the epidermal structure, it is preferred to retain the Indian and the Argentina specimens under two distinct names.

The present species from the Giridih coalfield shows a close agreement in external characters with *G. validum* Feistm. but in view of the lack of knowledge of the epidermal structure in *G. validum* the present species is placed under a new specific name.

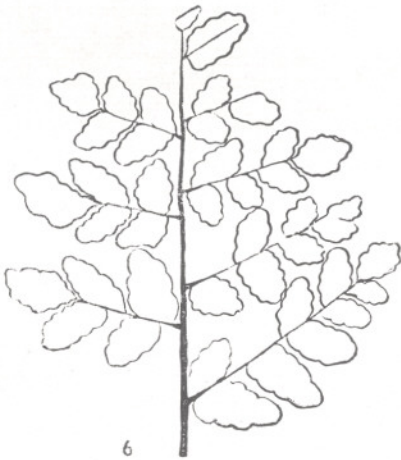
From the Angara flora two species of *Gondwanidium* are known, viz. *G. sibiricum* Petunnikow and *G. petiolatum* Neuburg (1948). *G. sibiricum* is distinguished by elongate and much lobed pinnules and *G. petiolatum* has a characteristic petiolate base.

Sphenopteris Brongniart

Sphenopteris sp.

Pl. 3, Figs. 17, 18; Text-fig. 6

Description — A carbonized impression of the apical portion of a bipinnate frond showing nine lanceolate pinnules arranged alternately. Pinnules are more or less oval, not very closely set, with slightly lobed margin and contracted base.



TEXT-FIG. 6 — *Sphenopteris* sp. $\times 2$.

Comparison and Discussion — The present specimen compares in the form, shape and size of the pinnules with those of *Sphenopteris lobifolia* Morr., described by Arber (1905: 136, 137; PL. 5, FIGS. 2, 3) and Srivastava (1954, PL. 1, FIGS. 1, 2). How-

ever, in view of the unsatisfactory state of preservation it is described as *Sphenopteris* sp. The present specimen is the first record of the genus *Sphenopteris* from the Karharbari beds.

GINKGOALES

The records of Ginkgoales like remains from the Indian Lower Gondwanas is very meagre. The first record is *Rhipidiopsis densinervis* Feistmantel (1881) from the Kamthi beds. Later, in 1886, he described *Rhipidiopsis ginkgoides* Schmal. from the Barakars of Auranga Coalfield. It was later transferred to a new species *R. gondwanensis* by Seward (1919) due to its small size. Seward (1907, 1912) described *Psymgophyllum hollandi* and *Psymgophyllum haydeni* from the Lower Gondwana beds of Kashmir. Ganju (1943) described a new species, viz. *Psymgophyllum sahnii* from the Gangamopteris beds, Kashmir. Zalessky (1918) and Høeg (1943) commented that the assignment of these Gondwana leaves to *Psymgophyllum* Schimper is not free from doubt and most probably these Gondwana leaves will constitute a natural genus of their own when more details are known. Therefore, due to the uncertain affinities of these Gondwana *Psymgophyllum* leaves Høeg & Bose (1960) provisionally transferred them to the form genus *Ginkgophyton* Zalessky. Although the genus have been instituted only for detached leaves, whereas Gondwana leaves have been found in attached condition to an axis. For the same reasons the fragmentary remains from the Giridih coalfield are assigned to *Ginkgophyton* spp. Their chief interest being that they represent a hitherto unrecorded element in the Karharbari flora.

Ginkgophyton Zalessky

Ginkgophyton spp.

Form A

Description — An imperfectly preserved wedge-shaped lamina (PL. 3, FIG. 19) 3×3.5 cm., obcordate, incised at the apical end to form two lobes. The distal margin of the lobes are rounded and entire. This form is easily distinguished from the known species of *Ginkgophyton* (HØEG & BOSE, 1960) by the presence of a smaller incision at the apex, whereas other forms have deeper incision.

Form B

Description — A very small leaf, obcordate in shape, with lamina deeply incised into two cuneate lobes and measuring 6×6 mm. (PL. 3, FIG. 21). The lobes have rounded apex and an entire margin. The venation of the lamina is not distinct. A thin coaly carbonized crust is present on the surface but did not yield a cuticle. This form although imperfectly preserved is easily distinguished from all the known species of *Ginkgophyton* by its very small size.

Form C

Description — As in *Ginkgophyton* lobes, the preserved part of specimen is wedge-shaped and from the pointed end of the wedge

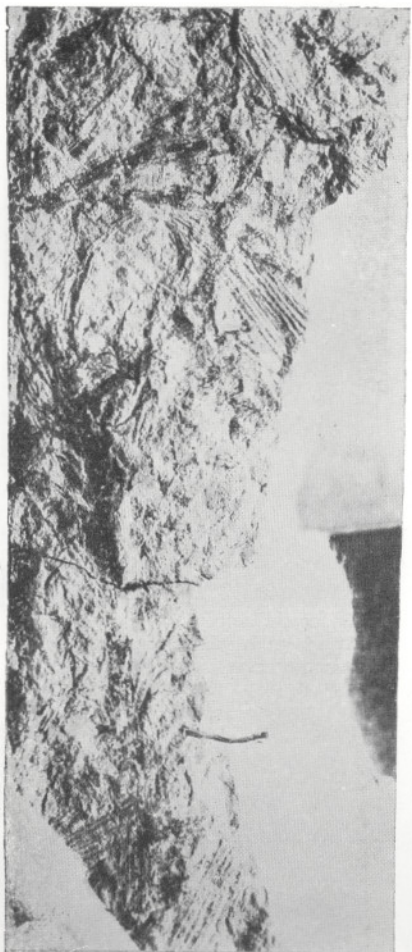
a number of forked veins are seen to diverge towards the broad entire margin (PL. 3, FIG. 20). There is, however, no evidence of an incision in the preserved part (3 cm. × 1.8 cm.) to support its assignment to *Ginkgophyton* with certainty. A possibility is that the leaf was originally fairly large and the preserved part represents only one of the lobes or even part of a lobe.

ACKNOWLEDGEMENT

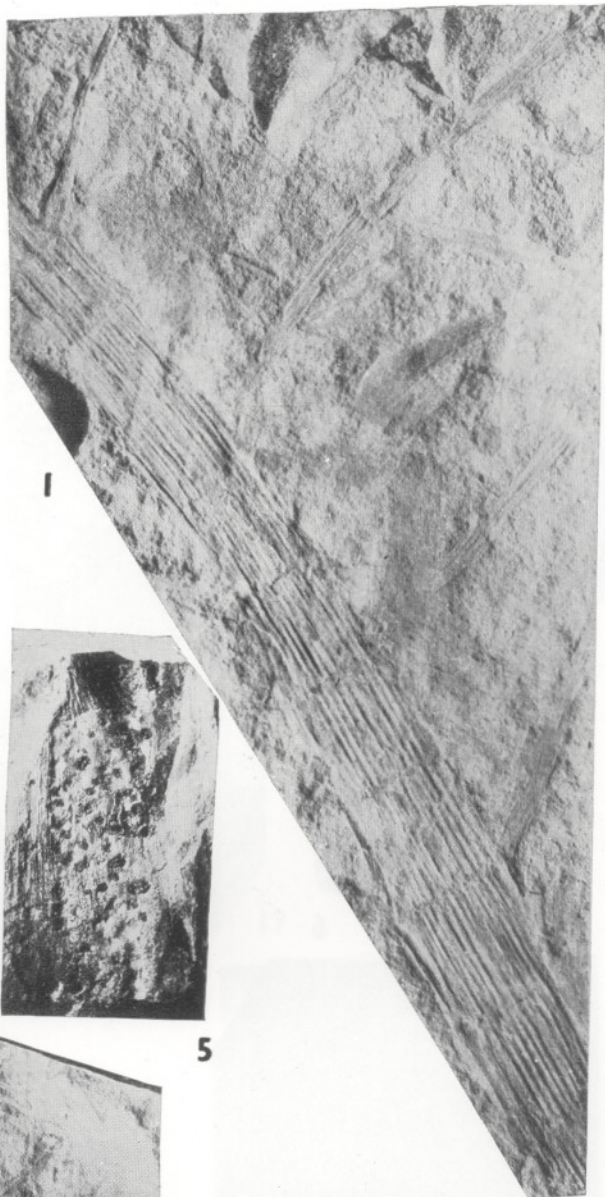
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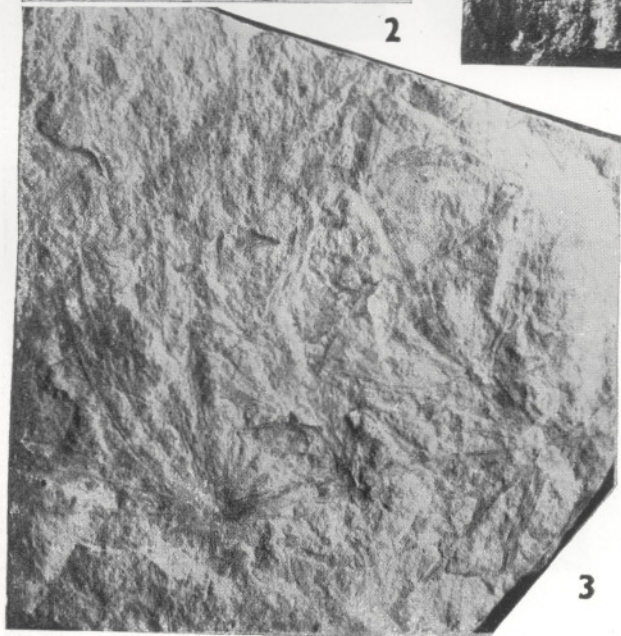
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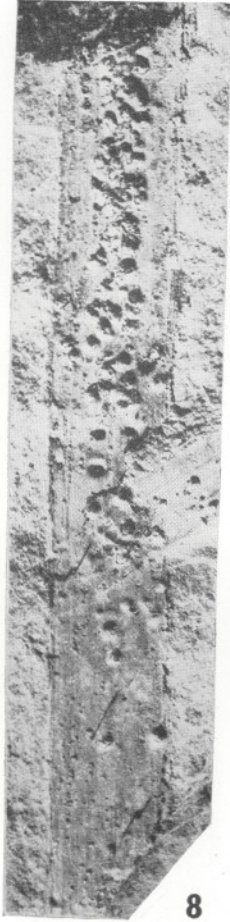
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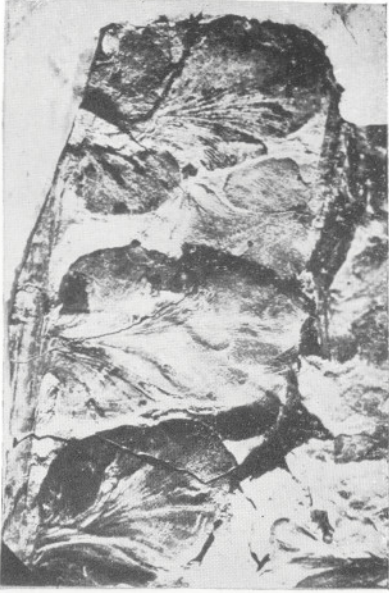
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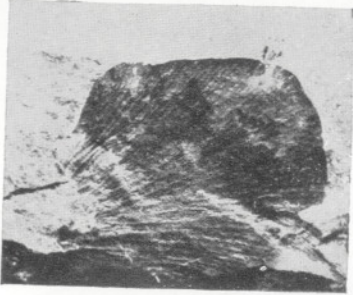


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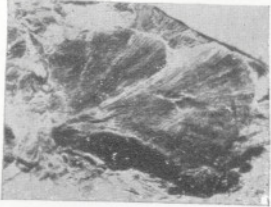
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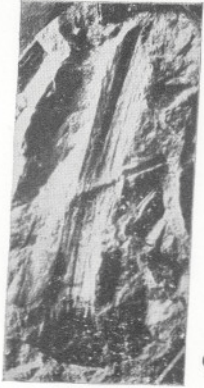
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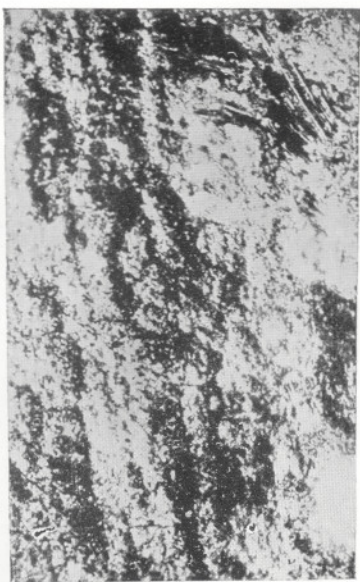
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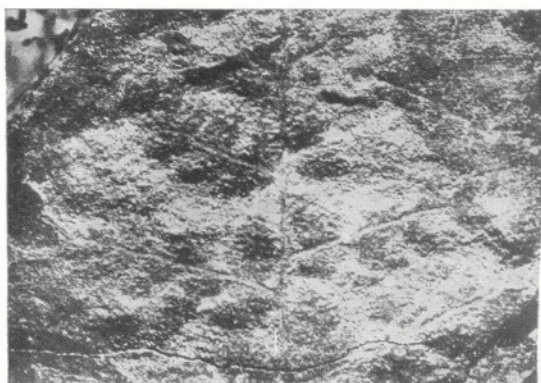
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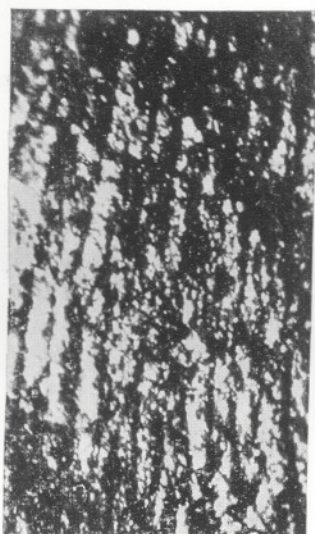
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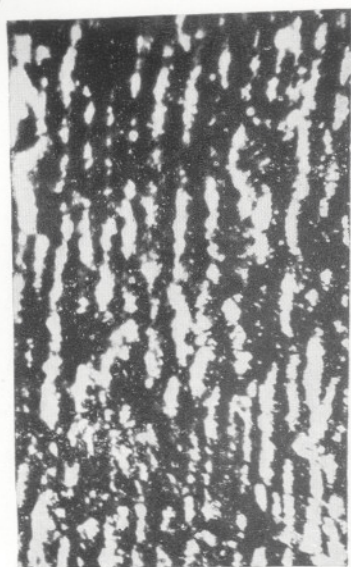
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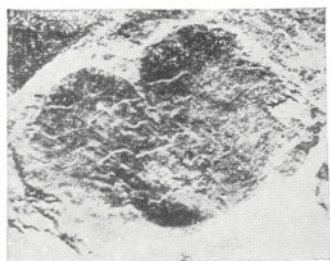
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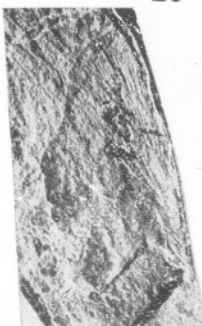
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EXPLANATION OF PLATES

PLATE 1

1. *Phyllothea indica*, the figure showing main leafless stem with attached leafy shoot stems. × 1. Specimen No. 32994/607. Locality, Bengal Nagpur.
2. *Phyllothea indica*, another stem with leaves. × 1. Specimen No. 32995/425. Locality, 16 B. pit.
3. *Phyllothea sahnii* Saksena, showing secondary stem with leaf sheath, one of the leaf sheath has been preserved dorsiventrally. × 1. Specimen No. 32996/660. Locality, Bengal Nagpur quarry.
4. *Schizoneura wardii* Zeiller. × 1. Specimen No. 32997/499. Locality, Central pit.
5. cf. *Cyclodendron* sp. × 1. Specimen No. 31381/424. Locality, Central pit.

PLATE 2

6. *Schizoneura wardii* Zeiller, another specimen showing stem with leaf sheath. × 1. Specimen No. 33069/499. Locality, Central pit.
7. *Schizoneura* cf. *gondwanensis*. × 1. Specimen No. 31397/425. Locality, Central pit.
8. Cf. *Cyclodendron*. × 1. Specimen No. 8571. Locality, Central pit.
9. *Gondwanidium indicum* sp. nov., A basal part of rachis. × 1. Specimen No. 31393/426. Locality, Jubille pit.

10. *Gondwanidium indicum* sp. nov., the holotype. × 1. Specimen No. 32998/503. Locality, Jubille pit.
11. *Gondwanidium indicum* sp. nov., an unlobed pinnule. × 1. Specimen No. 31398/426. Locality, Jubille pit.
12. Fig. 11 enlarged to show venation characters in detail. × 2.
13. *Gondwanidium indicum* sp. nov., a trilobed pinnule. × 1. Specimen No. 31415/426. Locality, Jubille pit.

PLATE 3

14. *Gondwanidium indicum*, cells of over the rachis under incident light. × 200.
15. *Gondwanidium indicum*, cells of the non-stomatiferous surface of the pinnule. × 200.
16. *Gonwanidium indicum*, cells of the stomatiferous surface of the pinnule. × 200.
17. *Sphenopteris* sp. × 1. Specimen No. 32999/499. Locality, Central pit.
18. Fig. 17 enlarged to show pinnule. × 2.
19. *Ginkgophyton* sp. Form-A. × 1. Specimen No. 31316/424. Locality, Central pit.
20. *Ginkgophyton* sp. Form-C. × 1. Specimen No. 31341/424. Locality, Central pit.
21. *Ginkgophyton* sp. Form-B. × 8. Specimen No. 33000/499. Locality, Central pit.