

PALAEOBOTANY AND STRATIGRAPHY OF THE COAL-BEARING BEDS OF THE DALTONGANJ COALFIELD, BIHAR

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Abstract

The present paper deals with the plant fossils and the miospores recovered from the coal-bearing beds of the Daltonganj Coalfield. On basis of these plant fossil evidences the stratigraphical positions of these beds in the Lower Gondwana succession are discussed.

INTRODUCTION

HITHERTO, the age of the different coal-bearing sedimentary formations lying above the Talchirs in the Daltonganj Coalfield is a stratigraphical problem. Earlier Feistmantel (1886) and in recent years Lele and Maithy (1966) described the megafossils from the coal-bearing beds of the Daltonganj Coalfield. The plant fossils recorded are Equisetalean stems, *Phyllothea*, *Gangamopteris*, *Glossopteris*, *Noeggerathiopsis*, *Buriadia*, *Samaropsis* and *Cordaicarpus*. On basis of these evidences both Feistmantel (*l.c.*) and Lele and Maithy (*l.c.*) opined that the coal-bearing beds in Rajhara Colliery, Daltonganj Coalfield, are homotaxially equivalent to the Karharbari Stage of the Giridih Coalfield. To ascertain the stratigraphical position of the complete succession of the coal-bearing sedimentary formation in the Daltonganj Coalfield, the study of the megafossils and miospores has been undertaken. The results obtained are described in the following pages.

The coalfield is about 50 miles west of Hazaribagh town and is traversed by North Koel river, a tributary of Son. The field is long irregularly shaped tract, with very tortuous boundaries. It is about 50 miles in length from East to West and varies in breadth from 1 to 8 miles; its total area being 200 square miles. Inside the basin whose boundaries appear natural ones, several inextensive inlier of gneisses occur. The only formations represented are the Talchirs, the Karharbaris and the Barakars. In the Talchirs, the usual rocks are sandstones being more prevalent than shales, whilst the boulder beds are well developed. The rocks of the Karharbari age are bluish-grey sandstones, gritty in nature, contain

large amount of feldspar. The Barakar rocks are sandstones, slightly calcareous, more or less yellowish-white in colour.

The river and nala exposes the coal-bearing beds at several places. However, from only four shale bands exposures the plant fossils and miospores are recorded. The four shale band exposures are located as follows:

- I. About 2 furlongs east of Amanat-Jinjoi river junction, on the North bank of Jinjoi river. A shale bed of grey micaceous shale; 3 feet thick which is overlain by grit. Dip NE.
- II. From thick shale and sandstone intercalations lying in between Rajhara bottom and Pandwa top seams in the Rajhara Colliery. The depth of the fossil material is about 90 feet from surface. The dip is NE. A major fault is present above the Pandwa Top seam.
- III. Beds exposed about 400 yds. north of the junction of Sadabaha and Lobjee rivers on the East bank of Sadabaha river. This bed is lying actually above the top Rajhara seam. The sequence of beds is as follows:
 3. 10' sandstone, fine-grained, bluish-white in colour.
 2. 2' coaly shale, dark black in colour, more or less brittle.
 1. 20' alternating bands of Carbonaceous shales and sandstones.Fossils from both beds No. 1 and No. 2 have been recorded.
- IV. Beds exposed on the East bank of the Lobjee river near Rajhara Colliery. The bed has ferruginous sandy micaceous shales.

DESCRIPTION

A. MEGAFOSSILS

Phyllothea Brongn.

Phyllothea sahnii Saks. emend. Townrow

The collection contain impressions of stems with and without leaves. Stems ribbed and

articulated, 3-4 mm. wide. Nodal and internodal zones are distinct. The length of the internodal zones varies from 1 to 3 cm. Ribs and furrows are continuous both at the nodal and internodal zones. Leaf sheaths closely adpressed to stems, narrow, amplexicaul at the base, spreading somewhat above into open saucer-like shape and has 18-22 free leaf segments, radiating out more or less at right angles. Some of the leaf sheaths and leaf segments are preserved dorsiventrally. They show that the leaf segments are coherent at the base and somewhat spreading out in form of saucer. Free leaf segments are linear, 1.5-2.5 cm. long, acute apex. Each one of them has one median vein.

The specimens compare well with *P. sahnii* Saksena (1952) recorded from Ganjra Nalla Beds and Maithy (1965c) recorded from the Karharbari beds, Giridih Coalfield.

Phyllothea crassa sp. nov.

Pl. 1, Figs. 1-3

Diagnosis — Stem articulated, fairly long; nodal and internodal zones distinct. Internodal zone 1.4-5 cm. long, width 0.5-2.5 cm. Surface of stem with alternate ridges and grooves, 5-12 in number in the widest part; ridges and grooves continuous. Leaves emerge from nodal zones, coherent basally to form a small cup; each leaf is linear, 3-6 cm. long, 2-3 mm. broad, apex blunt. The leaves are spreading out from the stem. Each leaf has one median vein, distinct and continuous up to apex. Adventitious roots emerge from the nodal zone of the stems, 4-5 cm. long and 1-2 mm. broad. Roots branch frequently by dichotomy until they become thin and hair-like.

Syntypes — 33817/833, 33818/833, 33819/833 Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — Lobjee river exposure, near Rajhara Colliery, Daltonganj Coalfield.

Description — The zone in which fossils occur is characterized by overwhelming abundance of the impression of stems. The stems are fairly long. No definite branching is marked. Stems jointed and ribbed with distinct zones of nodes and internodes. Internodes are 1 to 4.5 cm. long. Internodal zone 0.2-0.4 cm. long. Stem width varies from 0.5 to 2.5 cm. Ribs and furrows are continuous at the node and internode zones. Leaves emerge from the nodal region (Pl. 1, Fig. 1). At the basal

zone they are coherent forming a small cup. The major length of the leaves is free. They spread out at nearly right angle to stem. A disc shaped impression shows (Pl. 1, Fig. 2) that the leaf segments are fused at the base forming a very small cup. The number of free segments counted are 24 in number. Each free segment is linear in shape, broader towards base and narrow at apex. The end is bluntly pointed. Each segment has one prominent median vein which is persistent along full length of the leaf.

Adventitious roots emerge from the nodal zone of the stem (Pl. 1, Fig. 3). The roots are 4-5 cm. long and 1-2 mm. broad. The adventitious roots branch frequently by dichotomy, ultimately they become thin and very short. Some of the roots show a median line in the centre. Probably this represent a vascular bundle.

Comparison — Although, a dozen species of *Phyllothea* are known from the Southern Hemisphere, but the present species compare only with *P. brookvalensis* Townrow (1955) to a certain extent. The present form is, however, distinct from *P. brookvalensis* in having leaves broader towards base and narrower towards apex. In *P. brookvalensis* the leaves are uniformly broad. *P. ampla* Surange and Kulkarni (1968) differs in having leaf sheath closely adpressed to stem and saucer-shaped cup.

Sphenopteris Brongn.

Sphenopteris polymorpha Feistm.

The shales collected from Lobjee and Sadabaha junction exposure contain impression of the large number of fronds. The fronds are tripinnate. The primary rachis is incomplete, still it is very long measuring 17 cm. long and 0.4 cm. broad. It has several fine striations. The secondary rachises emerge alternately from the main rachis on both the sides. The distance in between the emergence of secondary rachises is 1-2.5 cm. The secondary rachises are fairly long, 4-8 cm. Each secondary rachis bears pinna rachises alternately at a distance of 0.5-0.8 cm. Pinnae 0.5 cm. to 3 cm. long. Pinnae lanceolate, pointed (acute) towards apex. Pinnules deeply lobed, separated from one another and arranged alternately. The pinnules are sessile and attached to the rachis along the full basal width of the

pinnule (PL. 1, FIG. 4). Pinnules triangular in outline, small 2.5 mm. with \pm acute apex. Median nerve distinct. Secondary veins emerge at acute angle, dichotomous and flexuosus.

Gangamopteris McCoy

Gangamopteris cyclopteroides Feistm.

The collection contains several impressions of this type of leaves. Leaves compare well with the specimens of Feistmantel (1879, PL. 10, FIG. 1) and Maithy (1965d, PL. 1, FIG. 1). Some of the incomplete forms are very wide, measuring about 10 cm. from the median region on one side. In these leaves the meshes of the median veins are very pronounced and big. The meshes are 3-4 mm. wide.

Gangamopteris mucronata Maithy

The collection contains about twenty incomplete leaf impressions. Only the middle and the apical portions are preserved. The specimens recorded compare well with those of Maithy (1965d, PL. 3, FIGS. 17-19) recorded from the Karharbari Stage, Giridih Coalfield, both in its shape and venation.

Gangamopteris obliqua McCoy

The collection contains about ten specimens. Of them only two are complete. The specimens recorded agree well in its shape and venation with *G. obliqua* McCoy recorded by Feistmantel (1881, PL. 2, FIG. 5) and Maithy (1965d, PL. 3, FIG. 20) from the Karharbari Stage, Giridih Coalfield.

Glossopteris Sternb.

Glossopteris indica Schimper

Many of the specimens recorded from the Daltonganj Coalfield are complete. In their venation and shape they compare well with the figures of *Glossopteris indica* Feistmantel (1881, PL. 24A, FIG. 1).

Glossopteris communis Feistmantel

Twenty incomplete specimens are in the collection. In their venation they compare with *Glossopteris communis* Feistmantel (1881, PL. 26A, FIG. 2).

Glossopteris brownii Brongn.

Ten incomplete specimens are in the collection. They compare in their venation with *G. brownii* described by Feistmantel (1881, PL. 29A, FIG. 3).

Noeggerathiopsis Feistm. emend.

Maithy

Noeggerathiopsis hislopi (Bunb.) Feistm.
emend. Maithy

The collection has a good number of leaf impressions with carbonized crust. On maceration the crusts do not yield any cuticle. The specimens recorded compare in its shape and venation with *Noeggerathiopsis hislopi* described by Maithy (1965b, PL. 1, FIGS. 1, 2) from the Karharbari Stage, Giridih Coalfield.

Buriadia fragilis sp. nov.

PL. 1, FIGS. 5-7

Diagnosis — Shoots irregularly branched, thicker shoots leafless or with loosely arranged scattered leaves; penultimate or ultimate branches bear fragile, flat, heteromorphic leaves, i.e. simple or bifid type; leaves crowded or laxed, spirally arranged at small angles; simple leaves linear narrow, bluntly pointed and decurrent base; bifid leaves narrow, towards distal end somewhat wider due to incision of apical zone of leaves into two apex. Each leaf has one median vein, \pm distinct. In bifid leaf it dichotomises into two and each apices is supplied with one veinlet.

Syntype — 33820/839, 33821/839 Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — From the shale band intercalations lying in between Rajhara bottom and Pandwa top seams in the Rajhara Colliery.

Description — The collection contains several stems with and without foliage. Stems irregularly branched. The width of the stem varies from 0.4 to 0.8 cm. Stem surface is smooth. Branches emerge irregularly from the main stem (PL. 1, FIG. 5). Their emergence position is either alternate, sub-opposite or opposite. The thick axes bear few attached leaves or none, but the ultimate and penultimate branches bear numerous leaves arranged in cyclic order. Leaves are usually crowded or they may be

somewhat laxed. Leaves are heteromorphic (PL. 1, FIGS. 6, 7). They are either simple with one pointed apex or bifid, i.e. distally the apex is divided into almost two equal points. Leaves are \pm flat and frail in nature. Each leaf has one median vein. In bifid leaves the median vein dichotomises almost at the half length of leaf and supplies one veinlet to each apices. The ultimate end of the branches do not show presence of any leaf with multifid apex.

Comparison — *Buriadia fragilis* is distinguished from *Buriadia sewardii* Sahni (1928) in having smooth stem, and flat, frail, linear leaves.

Cordaicarpus Geintz

Cordaicarpus zeilleri Maithy

The collection contains about twenty seeds agreeing closely with *Cordaicarpus zeilleri* Maithy (1965e; PL. 1, FIGS. 1, 2) recorded from the Karharbari beds, Giridih Coalfield. However, the specimens from the Daltonganj Coalfield are comparatively bigger.

Platycardia Pant & Nautiyal

Platycardia jugus sp. nov.

PL. 2, FIGS. 11, 12

Diagnosis — Platyspermic seeds, small, 3-4 mm. \times 2-3 mm., \pm triangular in outline, apex acute, base rounded; margin thick, raised (= ridge), with a distinct median ridge from apex to base, cuticle of integument, thin, cells elongate — rectangular or trapezoidal, margins of cell wall straight; cuticle of nucellus thick, cells pentagonal, hexagonal or trapezoid in outline, joined by end walls, margins of cell wall sinuous, \pm thick and somewhat raised.

Holotype — 33823/947. Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — From junction of Lobjee and Sadabaha river, about 2 furlongs upstream.

Description — The collection contains 30 impressions and compressions of platyspermic seeds. Seed outline is an isobilateral triangle. The apex is acute and the base is rounded. The margin of seeds is somewhat raised resulting \pm a marginal ridge like structure. The seeds contain a median ridge from apex to base (PL. 2, FIG. 11). The seeds with carbonized crust on maceration yielded well preserved cuticles (PL. 2,

FIG. 12). The outer cuticle, i.e. of integument is thin-walled, cells \pm elongate — rectangular in outline. The size of the cells vary from 80-120 \times 10-20 μ . The cells of the integument in the zone of ridge is distinct. Cells are very narrow and elongate and more densely cutinized. The surface of the cells of the integument is smooth. The cells of nucellus are thick-walled, cutinized and the margin of the cells is thick. Towards the basal portion of the nucellus, the cells are comparatively shorter in size and the margin of the cells is more thick, whereas the cells towards the apical portion are more elongate.

Comparison — *Platycardia bengalensis* Pant & Nautiyal (1960) differs in the absence of ridge.

Rotundocarpus Maithy

Rotundocarpus striatus Maithy

PL. 1, 2; FIGS. 8-10

The collection has 100 impressions and compressions of seeds comparable with *Rotundocarpus striatus* Maithy (1965a, PL. 2, FIG. 14) recorded from the Karharbari stage of the Giridih Coalfield. Seeds wingless, radiospermic, 6-10 mm. \times 3-4 mm., spindle shaped, strongly convex and bulge out of rock surface, apex and base pointed, surface with few vertical striations (PL. 1, FIG. 8). Many of the seeds with carbonized crust on maceration yielded cuticles, an outer coat, i.e. integument and an inner coat, i.e., nucellus. The outer coat is thinner than inner coat. Cells of the integument polygonal, hexagonal, rectangular, trapezoid and triangular in outline joined by their end or anticlinal walls (PL. 1, FIG. 9). Margins of the cells \pm straight and thin. The surface of the cells is smooth. The cells of the nucellus are thick, hexagonal or polygonal in outline. Margin is sinuous, thick and raised. The exine surface of the cells show several irregular small peg-like projections (PL. 1, FIG. 10).

Samaropsis Goppart

Samaropsis goraiensis Surange & Lele

The collection contains ten specimens comparable with *S. goraiensis* Surange & Lele (1956) recorded by Maithy (1965a, PL. 1, FIGS. 9, 10) from the Karharbari Stage, Giridih Coalfield.

B. MIOSPORES

Virkki (1945) described miospores from a shale collected from the coal-bearing bed of the Daltonganj Coalfield. In that description the old type system has been followed for taxonomic description.

The miospore assemblage described from the coal-bearing succession of the Daltonganj Coalfield comprises 51 species belonging to 29 genera. Only the new species (marked by asterisks) and few others are described and compared in detail in the following description:

- **Leiotriletes* sp.
- Punctatisporites ganjrensis* Lele & Maithy, 1969
- Cyclogranisporites gondwanensis* Bharad. & Sal., 1964
- Apiculatisporites levis* Balme & Henn., 1956b
- A. filiformis* Tiwari, 1965
- Didectritiletes horridus* Venkat. & Kar, 1965
- D. spinosus* Lele & Maithy, 1969
- Dentatispora indica* Tiwari, 1964
- Plicatipollenites indicus* Lele, 1964
- P. gondwanensis* Lele, 1964
- P. trigonalis* Lele, 1964
- **P. bilateralis* sp. nov.
- Virkkipollenites trigonalis* Lele, 1964
- V. mehtae* Lele, 1964
- V. obscurus* Lele, 1964
- V. densus* Lele, 1964
- Rugasaccites poyplicatus* Lele & Maithy, 1969
- Parasaccites karharbarensis* Maithy, 1965
- P. korbaensis* Bharad. & Tiwari, 1964
- P. radialis* Lele & Maithy, 1968
- Pachysaccus solaris* Lele & Maithy, 1969
- Caheniasaccites diffusus* Lele & Maithy, 1968
- Stellapollenites talchirensis* Lele, 1965
- Crucisaccites latusulcatus* Lele & Maithy, 1964
- C. monoletus* Maithy, 1965
- **Divarisaccus densus* sp. nov.
- Potonieisporites neglectus* Pot. & Lele, 1959
- Vestigisporites diffusus* Maithy, 1965
- V. densus* Singh, 1964
- V. rudis* Balme & Henn., 1955
- Rhizomaspora reticulata* Lele & Maithy, 1968
- Striatites karharbarensis* Maithy, 1965
- S. densus* Maithy, 1965
- S. incirus* Maithy, 1965
- **S. haploxyylonoides* sp. nov.

- Lahiites rhombicus* Maithy, 1965
- Lunatisporites amplus* Potonié, 1958
- Faunipollenites varius* Bharad., 1962
- F. goraiensis* Maithy, 1965
- F. parvus* Tiwari, 1965
- Illemites delasauei* Grebe & Schweit, 1962
- Alisporites oblongus* Maithy, 1965
- **A. haploxyylonoides* sp. nov.
- Platysaccus ovatus* Maithy, 1965
- **Cuneatisporites densus* sp. nov.
- **C. indica* sp. nov.
- Sulcatisporites ovatus* Bharad., 1962
- Sulcatisporites maximus* Singh, 1964
- S. barakarensis* Tiwari, 1965
- Welwitschiapites minutus* Maithy, 1965
- W. magnus* Maithy, 1965
- Vittatina scutata* Bharad., 1962
- Ginkgocycadophytus cymbatus* Pot. & Lele, 1959

TAXONOMIC DESCRIPTION

- Anteturma — *Sporites* H. Pot.
- Turma — *Triletes* (Rein) Pot & Kr.
- Subturma — *Azonotriletes* Lub.
- Infraturma — *Laeuvigati* (B & K.) Pot & Kr.

Genus — *Leiotriletes* (Noums.) Pot & Kr.

Leiotriletes sp.

The grains recorded are comparable to the forms recorded by Maithy (1965e, PL. 1, FIG. 1) from the Karharbari Stage of the Giridih Coalfield.

- Anteturma — *Pollenites* R. Pot.
- Turma — *Saccites* Erdtm.
- Subturma — *Monosaccites* (Chity.) Pot & Kr.
- Infraturma — *Apertacorpiti* Lele

Genus — *Plicatipollenites* Lele

Plicatipollenites bilateralis sp. nov.

Pl. 3, Fig. 13

Diagnosis — Size range 90-120 μ ; outline distinctly oval, body small, \pm vertically oval to triangular, dense, exine intramicroreticulate; trilete mark indistinct, saccus wider along horizontal axis and narrower along the vertical axis, exine intrareticulate, surface with microradial folds, body infold system lies well apart from body periphery, distinctly triangular. Saccus intrareticulate.

Holotype — Pl. 3, Fig. 13; Slide No. 3192, Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — From shale bands exposed, about 400 yds. North of junction of Sadabaha and Lobjee rivers on the west bank of Sadabaha river.

Description — The grains are distinguished by their distinct oval outline, dense small body and triangular infold system. The saccus is more dilated laterally. The surface of the saccus has microradial folds. The body is \pm oval or triangular in outline. In comparison to the overall size of the grain the size of the body is comparatively much smaller. The infold system lies well apart from the body margin. It is distinctly triangular in outline. The three arms of the fold components show considerable angularity and are placed very closed to one another leaving a small body free area in the centre.

Comparison — In its triangular fold components it compares to *P. trigonalis* Lele (1964), however, the present grains differ in having distinctly oval outline and dense small body.

Subturma — *Rotati* Lele

Genus — *Divarisaccus* Venkat. & Kar

Divarisaccus densus sp. nov.

Pl. 3, Fig. 14

Diagnosis — Monosaccate, oval-elliptical pollen, size range 120-160 μ ; central body oval, dense, intramicroreticulate. Proximal attachment apparently subequatorial, distal attachment bilateral, parallel to longer axis; saccus encircling the central body very wide, coarsely intrareticulate. Zones of distal saccus attachment associated with two vertical semilunar folds.

Holotype — Pl. 3, Fig. 14, Slide No. 3190, Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — From the shale band exposed on the West bank of Sadabaha river, about 400 yds. North of Sadabaha and Lobjee river junction.

Description — Pollens mostly oval. Central body oval-elliptical, distinct, dense brown in colour, exine intramicroreticulate. Proximal attachment of saccus to central body is apparently subequatorial, attachment zone devoid of any body fold. Distal attachment bilateral, attachment region distinct and associated with two distinct

semilunar body folds. Saccus fairly wide, 30-40 μ , encircling the central body, strongly built and coarsely intrareticulate, mesh size 1-3 μ , lumina shallow.

Comparison — *Divarisaccus lelei* Venkat. & Kar (1966) differs in having obscure body and narrow saccus.

Subturma — *Disaccites* Cookson
Infraturma — *Striati* Pant

Genus — *Striatites* (Pant) Bharad.

Striatites haploxyloides sp. nov.

Pl. 3, Fig. 15

Diagnosis — Size range 80-110 μ , overall outline \pm oval; body \pm oval to subcircular, mediumly thick, exine microverrucose; 6-7 horizontal striations, unbranched; sacci \pm equal to body or less, attachment of saccus straight, distal sulcus narrow, zones of attachment associated with two vertical body folds. Saccus exine intrareticulate, muri and lumina of equal size.

Holotype — Pl. 3, Fig. 15; Slide No. 3190, Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — From the shale bands exposed on the West bank of Sadabaha river. About 400 yds. North of Sadabaha and Lobjee river junction.

Description — The grains are haploxyloloid, and more or less oval in outline. The body is more or less circular oval in outline and mediumly thick. Sacci are \pm equal to body size or less. The attachment is straight and is always associated with two distinct vertical body infolds.

Comparison — *Striatites irregularis* Tiwari (1965) compares in its outline but differs in having irregularly branched striations with interconnections.

Infraturma — *Disaccimonoleti* Klaus

Genus — *Alisporites* Daugh

Alisporites haploxyloides sp. nov.

Pl. 3, Figs. 16, 17

Diagnosis — Grains haploxyloloid, Size range 90-120 μ ; body \pm oval, distinct, thick, exine microverrucose; sacci spherical, distal saccus free body area very narrow, zones of saccus attachment associated with two

distinct body infolds, saccus intrareticulate, muri and lumina of equal size.

Holotype — Pl. 3, Fig. 16; Slide No. 3192, Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — From the shale bands exposed on West bank of Sadabaha river. About 400 yds. North of Sadabaha and Lobjee river junction.

Description — The overall outline of the grain is oval, whereas the body is distinctly vertically oval. Body 100-140 μ in size, thick and dark coloured. Mark and striations absent. Distal saccus free body area is a narrow vertical zone. Attachment zone of sacchi associated with prominent vertical, straight, body folds. Sacchi \pm double the body size.

Comparison — The only comparable species is *Alisporites oblongus* Maithy (1965e) recorded from the Karharbari Stage of the Giridih Coalfield. However, it is distinguished in the presence of oblong body, wide distal saccus free body area, sacchi \pm equal to body size.

Genus — *Cuneatisporites* Leschik

Cuneatisporites densus sp. nov.

Pl. 3, Figs. 18-20

Diagnosis — Size range 100-160 μ , diploxy-lonoid, body thick, dense, rhomboidal shape, exine intramicroreticulate, margin of the body show nodular appearance; sacchi \pm 3 to 4 times bigger than body, distal attachment, straight; distal sacchi free area extremely narrow, saccus intrareticulate, muri and lumina of equal size.

Holotype — Pl. 3, Fig. 18; Slide No. 3192, Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — From the shale bands exposed on the West bank of Sadabaha river. About 400 yds. North of Sadabaha and Lobjee river junction.

Description — Grains distinctly diploxy-lonoid. Body is rhomboidal-shaped. The margin shows nodular appearance. Exine intramicroreticulate. Sacchi \pm 4 times bigger than body. Sacchi distally attached very closely and leaves a very narrow area. Body infold system absent.

Comparison — *Cuneatisporites flavatus* Bose & Kar (1966) differs in having thin

body, smooth margin of the body and wide distal saccus free body area.

Cuneatisporites indica sp. nov.

Pl. 3, Figs. 21, 22

Diagnosis — Size range 80-110 μ , grains oval in outline; body distinct, thick, vertically oval, both the ends pointed, exine intramicroreticulate. Saccus \pm 3 times bigger than body or more, they may be deeply notched or laterally connected; sacchi distally closely attached to body, attachment straight, distal saccus free body area extremely narrow; zones of sacchi attachment associated with two distinct vertical body infolds. Saccus exine intrareticulate.

Holotype — Pl. 3, Fig. 21; Slide No. 3192, Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality — Shale bands exposed on the West bank of Sadabaha river. About 400 yds. North of Sadabaha and Lobjee river junction.

Description — Grains show a variability in overall outline. They show either the sacchi are constricted on both the ends or one end or the sacchi joined laterally on both ends. In cases the sacchi are laterally dilated.

Comparison — *Cuneatisporites indica* is distinguished from all the species by its distinct thick oval body with pointed ends and subspherical sacchi.

C. PALAEOBOTANY AND STRATIGRAPHY OF THE OUTCROPS OF THE COAL BEARING BEDS

The coal-bearing sediments are exposed at number of places in the Daltonganj Coalfield by rivers and nalas. However, from only four exposures plant fossils and miospores could be recovered. Their stratigraphical position in the Lower Gondwana succession is discussed below on basis of plant fossil contents.

I. Bed exposed about 500 yds. away from the Amanat-Jinjo river junction on the right bank of Jinjo river

Gangamopteris cyclopteroides, *Glossopteris indica* and *Cordaicarpus cordai* are recorded from these beds. Among these forms the first and the last form is more common. *Glossopteris indica* is rare. Though, the

typical index genera of the Karharbaris, *Gondwanidium* and *Buriadia* are missing still the dominance of *Gangamopteris* and *Cordaicarpus* indicates that the beds are Karharbari in age. This is further supported by the occurrence of typical Karharbari megafossils and miospores from the overlying younger beds.

II. *From the shale beds lying in between Rajhara bottom seam and Pandwa top seam:*

The plant fossil recorded from this bed are, viz. *Phyllothea sahnii*, *Gangamopteris cyclopteroides*, *Glossopteris indica*, *Noeggerathiopsis hislopi*, *Buriadia fragilis* sp. nov., *Cordaicarpus zeilleri*, *Samaropsis goraiensis* and *Rotundocarpus striatus*. Feistmantel (1886) and Lele and Maithy (1966) have opined on basis of plant fossils that the beds are homotaxial to the Karharbari Stage. The present record of plant fossils further substantiates the fact that the beds are Karharbari in age by the dominant occurrence of *Noeggerathiopsis*, *Gangamopteris*, gymnospermic seeds alongwith *Phyllothea*, and the typical characteristic element of the Karharbari *Buriadia*. This flora shows a close comparison to the Karharbari Stage flora of the Giridih Coalfield (MAITHY, 1966b), however, comparatively poor in plant fossil contents.

The miospores recorded from this bed are:

Leiotriletes sp., *Punctatisporites* sp., *Pachysaccus solaris*, *Plicatipollenites indicus*, *Divarisaccus densus*, *Virkkipollenites obscurus*, *V. densus*, *Rugasaccites polyplacatus*, *Parasaccites korbaensis*, *Stellapollenites talchirensis*, *Crucisaccites latisulcatus*, *Potonieisporites neglectus*, *Vestigisporites diffusus*, *V. densus*, *Rhizomaspora reticulata*, *Striatites karharbarensis*, *Faunipollenites varius*, *Illemites delasauei*, *Platysaccus ovatus* and *Welwitschiapites minutus*.

The preservation of the miospores is poor. The assemblage shows dominance of monosaccates, 'Apertacorpiti' and 'Amphisaccati' genera. Triletes are very scarce. This assemblage closely compares both in qualitative and quantitative characters with the miospore assemblage of the Karharbari Stage earlier described from Giridih (MAITHY, 1965e), Umaria (MAITHY, 1966a, 1968) and Ganjra nalla beds (LELE & MAITHY, 1969).

III. *Beds exposed about 400 yds. North of the junction of Sadabaha and Lobjee rivers on the west bank of Sadabaha river:*

From this spot the plant fossils recorded are:

Gangamopteris cyclopteroides, *Gangamopteris obliqua*, *Gangamopteris mucronata*, *Glossopteris indica*, *Glossopteris communis*, *Platycardia jugus* sp. nov.

Though, the characteristic elements of the Karharbari Stage, viz., *Buriadia* and *Gondwanidium* are unrecorded from these bed, but the dominance of *Gangamopteris* and gymnospermic seeds are in favour of the fact that the beds are homotaxial to the Karharbari Stage. This fact is supported by the miospore assemblage recorded from this bed. The miospores recorded are as follows:

Leiotriletes sp., *Punctatisporites* sp., *Cyclogranisporites gondwanensis*, *Apiculatisporites levis*, *A. filiformis*, *Didecitriletes horridus*, *D. spinosus*, *Dentatispora indica*, *Pachysaccus solaris*, *Plicatipollenites indicus*, *P. trigonalis*, *P. bilateralis*, *Divarisaccus densus*, *Virkkipollenites triangularis*, *V. mehtae*, *V. obscurus*, *V. densus*, *Parasaccites karharbarensis*, *P. korbaensis*, *P. radiatis*, *Stellapollenites talchirensis*, *Crucisaccites latisulcatus*, *C. monoletus*, *Caheniasaccites diffusus*, *Vestigisporites densus*, *V. rudis*, *Rhizomaspora reticulata*, *Striatites karharbarensis*, *S. densus*, *S. incirus*, *S. haploxylonoides*, *Lahriles rhombicus*, *Faunipollenites varius*, *F. goraiensis*, *F. parvus*, *Lunatisporites amplus*, *Illemites delasauei*, *Alisporites oblongus*, *A. haploxylonoides*, *Platysaccus ovatus*, *Cuneatisporites densus*, *C. indica*, *Sulcatisporites densus*, *C. indica*, *Sulcatisporites ovatus*, *S. barakarensis*, *S. maximus*, *Welwitschiapites minutus*, *W. magnus*, *Vittatina scuta* and *Ginkgocycadophytus cymbatus*.

Among these the following genera are dominant, viz., *Plicatipollenites*, *Virkkipollenites*, *Divarisaccus*, *Parasaccites*, *Crucisaccites*, *Potonieisporites*, *Vestigisporites*, *Potonieisporites*, *Vestigisporites*, *Striatites*, *Faunipollenites*, *Platysaccus*, *Cuneatisporites*. The trilete genera are extremely rare.

This miospore assemblage compares closely to the assemblage described from the Karharbari stage of the Giridih (MAITHY, 1965e), Umaria (MAITHY, 1966a, 1968) and Ganjra nalla beds (LELE & MAITHY, 1969).

IV. *Plant fossils exposed in the beds of Lobjee river cutting near Rajhara Colliery:*

The fossiliferous outcrop is a ferruginous sandy micaceous shale bed exposed on surface several feet above the underlying coal-bearing sequence of the Daltonganj Coalfield. The plant fossil evidence from this horizon is as follows:

Phyllothea crassa sp. nov., *Sphenopteris polymorpha*, *Glossopteris communis*, *G. indica*, *G. brownii*, *Samaropsis goraiensis* and *Platycardia jugus* sp. nov.

It is striking to note that the above assemblage does not possess any plant elements of stratigraphical significance, therefore, it is difficult to say with certainty whether the outcrops belong to the Karharbaris or Barakars. The flora shows the absence of *Gangamopteris* and *Noeggerathiopsis*, the dominant elements of the

Karharbaris. *Glossopteris* is a dominant constituent and is represented by three species. In addition to this the occurrence of the Barakar element *Sphenopteris* is noted and which is also not uncommon. The flora shows the occurrence of *Platycardia* and *Samaropsis* which is also known from the underlying beds. Thus, the fossil bed has an mixed flora of the younger i.e. Barakars and older beds, i.e. Karharbaris, however, the elements of the younger horizon are dominant.

This suggests that the bed is representing either a transitional stage in between Karharbaris and Barakars or the lowermost part of Barakars. Comparative flora was recorded by Feistmantel (1879, p. 43) from the Lukme and Bhaddua hills of the Giridih Coalfield. These beds are supposed to be representing topmost part of the Karharbari Stage.

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EXPLANATION OF PLATES

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

PLATE 1

1. *Phyllothece crassa* sp. nov. An unbranched stem showing attached leaf sheath at the node. Nat. Size. Specimen No. 33817/838.

2. *Phyllothece crassa* sp. nov. An detached leaf sheath. Nat. Size. Specimen No. 33818/838.

3. *Phyllothece crassa* sp. nov. An unbranched articulated stem with branched roots emerging from nodal zone. Nat. Size. Specimen No. 33819/838.

4. *Sphenopteris polymorpha*. Nat. Size. Specimen No. 33119/838.

5. *Buriadia fragilis* sp. nov. An branched stem with few leaves. Nat. Size. Specimen No. 33820/839.

6. *Buriadia fragilis* sp. nov. An portion of branch with spirally arranged leaves. Nat. Size. Specimen No. 33822/839.

7. *Buriadia fragilis* sp. nov. Apical portion of an axis with spirally arranged unifid and bifid leaves. $\times 3$. Specimen No. 33821/839.

8. *Rotundocarpus striatus* Maithy $\times 2$. Specimen No. 33824/839.

PLATE 2

9. Outer cuticle of the *Rotundocarpus striatus* Maithy. $\times 200$. Slide No. 3189.

10. Inner cuticle of the *Rotundocarpus striatus* Maithy. $\times 200$. Slide No. 3189.

11. *Platycardia jugus* sp. nov. A large number of seeds in compressed state. $\times 3$. Specimen No. 33823/947.

12. An macerated seed of *Platycardia jugus* sp. nov. with outer and inner cuticle $\times 40$. Slide No. 3188.

PLATE 3

13. *Plicatipollenites bilateralis* sp. nov. $\times 500$. Slide No. 3192.

14. *Divarisaccus densus* sp. nov. $\times 500$. Slide No. 3190.

15. *Striatites haploxytonoides* sp. nov. $\times 500$. Slide No. 3190.

16-17. *Alisporites haploxytonoides* sp. nov. $\times 500$. Slide No. 3192.

18-20. *Cuneatisporites densus* sp. nov. $\times 500$. Slide No. 3191.

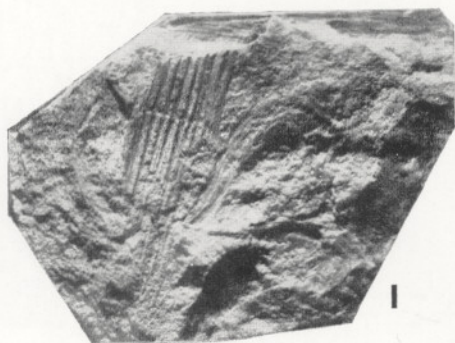
21-22. *Cuneatisporites indica* sp. nov. $\times 500$. Slide No. 3190, 3192.



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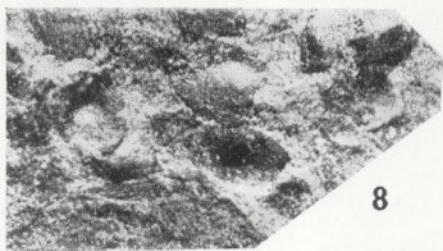
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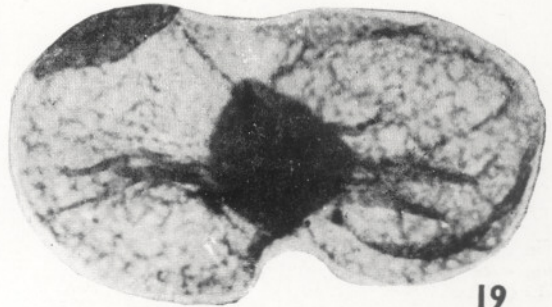
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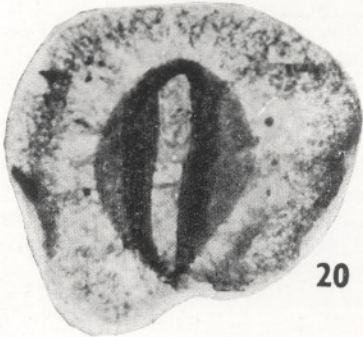
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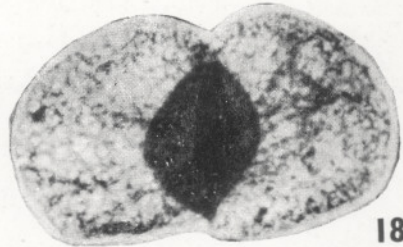
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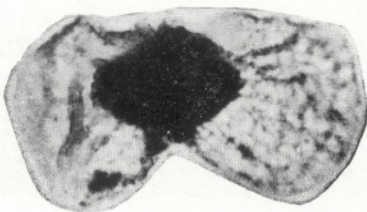
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