Plant fossils from upper beds of Raniganj Formation in Jharia Coalfield

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There are three major coal seams in the Raniganj Formation of Jharia Coalfield, viz., Mahuda, Bhurungia and Lohpiti, in ascending order The main constituents of the plant fossil assemblage from the roof shale of Lohpiti Seam, that underlies the Lohpiti Sandstone Member, are the leaf *Glossopteris shailae*, the stem *Araucarioxylon kumarpurensis* and the megaspore *Noniasporites harrisii*. A similar fossil assemblage has earlier been reported from the roof shales of Kajora Seam that underlies the Kumarpur Sandstone Member of Raniganj Formation in Raniganj Coalfield. The correlatability of Lohpiti Sandstone Member with Kumarpur Sandstone Member is established.

Key-words—Megafossils, Raniganj Formation, Permian (India).

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सारांश

झरिया कोयला-क्षेत्र में रानीगंज शैल-समूह के उपरि संस्तरों से अश्मित पादप

ऊषा बाजपेयी एवं रजनी तिवारी

झरिया कोयला-क्षेत्र के रानीगंज शैल-समूह में आरोही क्रम में महुदा, भुरुगिंया एवं लोहपिती नामक तीन प्रधान कोयला-सीम विद्यमान हैं। लोहपिती सीम के ऊपर स्थित शैल, जो लोहपिती बालुपत्थर सदस्य के नीचे स्थित है, से उपलब्ध पादपाश्म समुच्चय में **ग्लॉसॉप्टेरिस शैली** पत्ती, **ॲराकेरिऑक्सीलॉन कुमारपुरेन्सिस** तना एवं **नोनियास्पोराइटिस हेरिसाई** गुरुबीजाणु विद्यमान हैं। इसी प्रकार की पादपाश्मी समुच्चय कजोरा सीम के उपरिशायी शैलों से पहले अभिलिखित की गई है यह सीम रानीगंज कोयला-क्षेत्र में रानीगंज शैल-समूह के कुमारपुर बालुपत्थर सदस्य के नीचे स्थित है। लोहपिती बालुपत्थर सदस्य से कुमारपुर बालुपत्थर सदस्य का सहसम्बन्धन स्थापित किया गया है।

IN Jharia Coalfield, the Raniganj Formation is developed in south-western part in Mahuda sub-basin. Fox (1930) recognized four units in the Raniganj Formation of Jharia Coalfield, viz.,

Lohpiti Sandstone
Telmucha Coal Measures
Jamdiha Sandstone
Murulidih Coal Measures

Gee (1932) correlated the above units with those of the Raniganj Formation of Raniganj Coalfield.

Jharia Coalfield	*Raniganj Coalfield*
Lohpiti Sandstone	Kumarpur Sandstone
Telmucha Coal Measures	Nituria Coal Measures
Jamdiha Sandstone	Hijuli Sandstone
Murulidih Coal Measures	Sitarampur Coal Measures
Mahuda Sandstone	Ethora Sandstone

On the basis of contained mega-and microflora the age of the Raniganj Formation is considered to be Late Permian. Three coal seams are recognised in the Raniganj Formation of Jharia Coalfield, viz., Mahuda, Bhurungia and Lohpiti seams, in order of superposition. The first and the third seam locally split into bottom, middle and top. Thus the total number of seams is up to seven.

Not much is known about the fossil flora of the Raniganj Formation in Jharia Coalfield. Feistmantel (1881, pp. 134, 135) listed :

"*Schizoneura gondwanensis* Fstm., *Dicksonia hughesi* Fstm., *Asplenium whitbyense Heer, Macrotaeniopteris danaeoides* Royle, *Glossopteris communis* Fstm."

Maheshwari (1964, 1967) reported fossil wood and *Phyllotheca australis* from the area, to which Banerjee and Banerjee (1984) added *Trizygia speciosa*, *Phyllotheca griesbachii*, *Dichotomopteris major*, *D. lindleyii*, *Dizeugotheca phegopteroides*, *Neomariopteris polymorpha* and *N. lobifolia*.

MATERIAL

Plant fossils were collected by one of us (U.B.) from. (i) Shale above Lohpiti Top Seam, Lohpiti Colliery, pit no. 2. (*Glossopteris shailae*, *Vertebraria indica*, equisetaceous stems, *Neomariopteris hughesii* and fossil wood), (ii) Coal seam in Lohpiti Colliery, New Incline (fossil wood); (iii) Shale partition in Mahuda Seam, Bhatdih and Murulidih collieries (*Glossopteris* spp., *Vertebraria indica*); (iv) Roof shale, Mahuda Top Seam, Bhurungia Colliery (*Glossopteris* sp., *Vertebraria indica*).

Glossopteris shailae Bajpai 1986
Pl 1, figs 1-5

Description—The collection consists of more than twenty specimens, majority of which are incomplete The leaf compressions mostly have a carbonified crust. The overall shape of the leaves probably was lanceolate (Pl. 1, figs 1, 2) with rounded apex (Pl 1, fig. 4), narrow base (Pl. 1, fig. 5) and entire margin The leaf was widest in the middle part. The midrib is flat, striate and distinct in the basal region. Prominent pits are present between the striations (Pl 1, fig 1). Midrib is evanescent in the apical region (Pl. 1, fig. 5). The lateral veins emerge from midrib at very acute angles (1°-6°), take an outward curve and after successive dichotomies and anastomoses approach the margin at an angle between 60° to 69° in the apical region, 39° to 50° in the middle region and 28° to 35° in the basal region. The vein dichotomies usually are of gamma and lambda types, rarely of psi type and the cross-connections between the veins which form the meshes are usually of zeta type, rarely forming zeta series, and occasionally of psi-lambda types. The size of the meshes varies in different parts of the leaves. The shape of the meshes is usually arcuate near the midrib, rarely angled or deltoid and mostly trapezoidal elsewhere.

The leaf appears to be hypostomatic since cuticle of only one surface (probably lower) shows stomata. Stomata are rare. The upper cuticle of lamina is differentiable into vein and mesh areas through shape and arrangement of cells. Veins show anastomoses. The cells over the veins are elongate, rectangular to elongate-polygonoid and are arranged end-to-end in almost linear rows The cells over the mesh areas are irregular to polygonal in shape and are arranged irregularly The lateral walls of the cells are straight to slightly undulate. The surface walls are papillate, each cell showing a single, dome-shaped papilla.

The lower cuticle of lamina is also differentiable into vein and mesh areas in the same way as the upper cuticle. The cells over the veins are elongate rectangular or polygonoid, sometimes squarish and are arranged end-to-end in linear rows. The cells over the mesh areas are polygonal to irregular in shape (Pl 1, fig. 3) and are arranged irregularly. The lateral walls of the cells are straight to undulate. The surface walls of cells both over the veins and the meshes are non-papillate. The stomata are anomocytic (haplocheilic) and are irregularly distributed and oriented. The stomatal apparatus is monocyclic and has 5-6 subsidiary cells which are like other epidermal cells. The guard cells are sunken.

Dimensions

Overall size	. 5.1-13.0 × 1.6-2.8 cm
Width of midrib	
in basal region	: 3 mm
in middle region	: 1 mm
Number of veins in apical region	
near midrib	: 10 (10.7) 12/cm
near margin	: 24 (22) 26/cm
Number of veins in middle region	
near midrib	: 11 (12.5) 15/cm
near margin	: 21 (24) 27/cm

→

PLATE 1

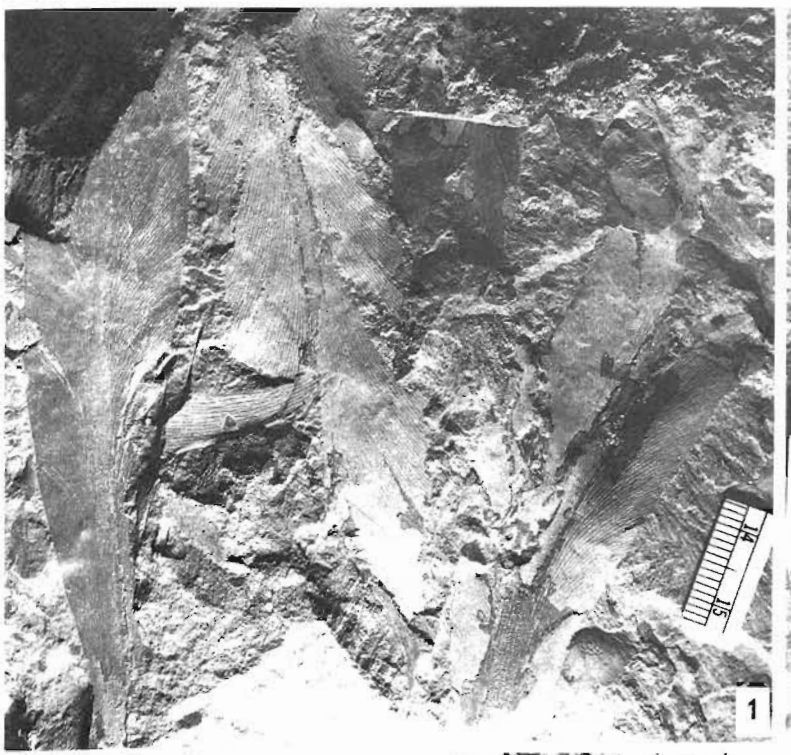
1,2. *Glossopteris shailae* Bajpai, leaves. × 1. Specimen nos. BSIP 36268, 36270

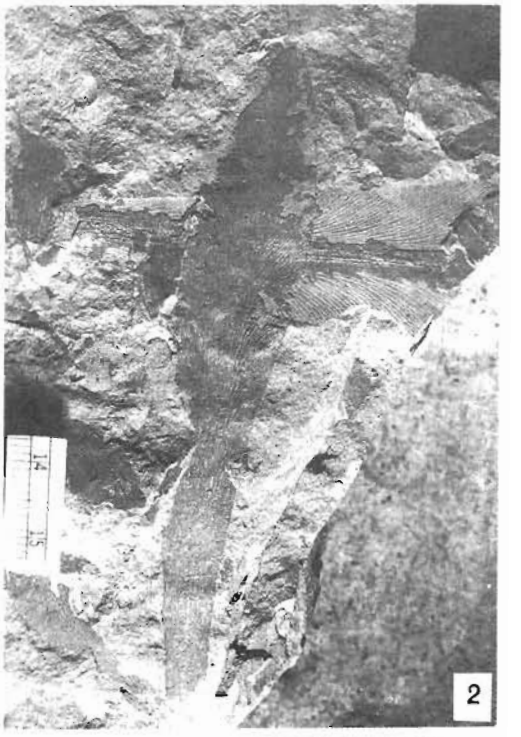
3. Lower cuticle of *G. shailae* showing stomata. × 150. Slide no. BSIP 36268.

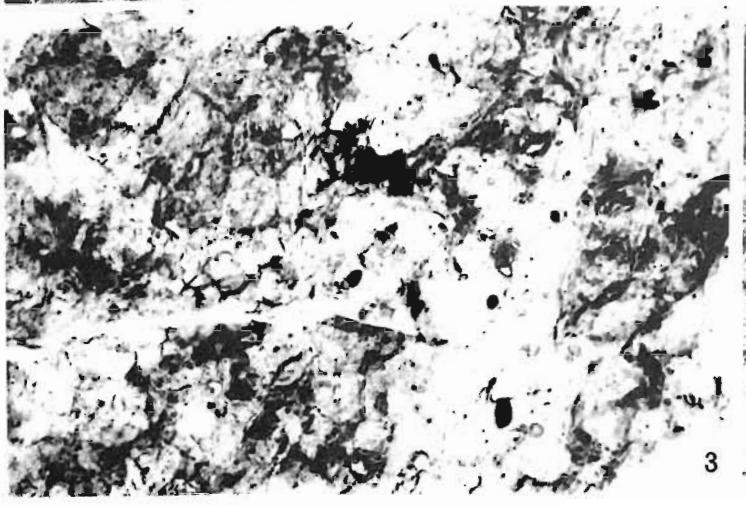
4,5 Apex and basal portions respectively of the leaf of *G. shailae* × 1 Specimen nos. BSIP 36269, 36271

6. Proximal view of a differentially macerated megaspore of *Noniasporites harrisii*, rill-like structures are also seen. × 100; Slide no. BSIP. 10097

7. A macerated megaspore of *Noniasporites harrisii* showing a dark circular mesosporium. × 100; Slide no. BSIP 10098.







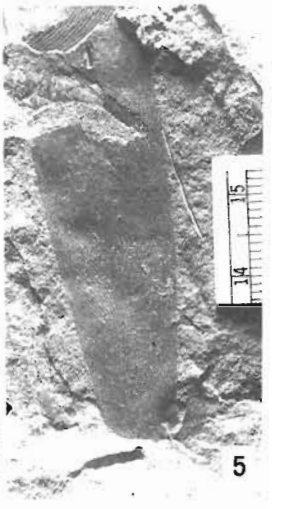


PLATE 1

Number of veins in basal region
near midrib : 8 (10.7) 13/cm
near margin : 15 (18) 23/cm
Size of meshes in apical region
in general : 1.7 (2.9) 5.8 × 0.4 (0.6) 0.7 mm
near midrib : 3.7 (4.2) 4.7 × 0.5 (0.6) 0.7 mm
in between : 4.6 (5.1) 5.8 × 0.4 (0.5) 0.8 mm
near margin : 1.7 (2.2) 2.5 × 0.4 (0.5) 0.6 mm
Size of meshes in middle region
in general 2.4 (3.5) 5.3 × 0.4 (0.6) 0.6 mm
near midrib : 2.8 (3.3) 4.3 × 0.4 (0.6) 0.6 mm
in between 3.8 (4.6) 5.3 × 0.5 (0.6) 0.6 mm
near margin : 2.4 (2.7) 3.0 × 0.4 (0.6) 0.6 mm
Size of meshes in basal region
in general : 1.2 (3.3) 5.1 × 0.4 (0.5) 0.6 mm
near midrib : 2.9 (4.0) 5.1 × 0.4 (0.5) 0.6 mm
in between : 2.7 (3.8) 4.8 × 0.4 (0.6) 0.6 mm
near margin 1.8 (2.2) 2.5 × 4 mm
Upper cuticle of lamina
Size of cells over veins: 40-116 × 24-40 μm
Thickness of cell walls over veins : 4-8 μm
Size of cells over meshes : 28-80 × 28-44 μm
Thickness of cell walls over meshes 2-4 μm
Height of papillae 12-20 μm
Diameter of papillae 12-16 μm
Thickness of papillae wall : 1-2 μm

Lower cuticle of lamina
Size of cells over veins: 28-60 × 24-40 μm
Thickness of cell walls over veins : 2-4 μm
Size of cells over meshes : 24-56 × 18-40 μm
Thickness of cell walls over meshes 1-2 μm
Size of stomata : 32-40 × 12-36 μm
Size of guard cells : 32-40 × 4-12 μm
Thickness of guard cell wall : 1-4 μm
Size of stomatal pore : 32-40 × 4-8 μm
Size of subsidiary cells: 32-100 × 36-68 μm
Thickness of subsidiary cell wall : 4 μm
Stomatal index : 1.78-2.54

Under Scanning Electron Microscope the leaf cuticle shows rod-shaped, 2-3 μm long bacteria (Pl. 2, fig. 5) that had completely degraded the cell margins, probably during biodiagenesis.

Araucarioxylon kumarpurensis Bajpai & Singh 1986

Pith and primary xylem are not preserved in any of the woods. The secondary xylem is preserved only in patches (Pl. 2, figs 4, 6). Its organisation is similar to that of *Araucarioxylon kumarpurensis*.

On most of the area, the lignin material is completely lost and therefore the details of the tissue are not seen. The bordered pits are often filled with crystalline structures (Pl. 2, fig. 2) which are restricted to pit pores. Due to complete absence of any biogenic remains it is difficult to comment on the mode of degradation of the woods.

Noniasporites harrisii Maheshwari & Bajpai 1984

Description—Megaspores are azonate, golden brown, circular to subcircular in outline in proximo-distal view. Tri-radiate rays are almost indistinguishable in incident and transmitted light but clearly seen under SEM. Contact ridges are not marked. Contact area is not well marked but is

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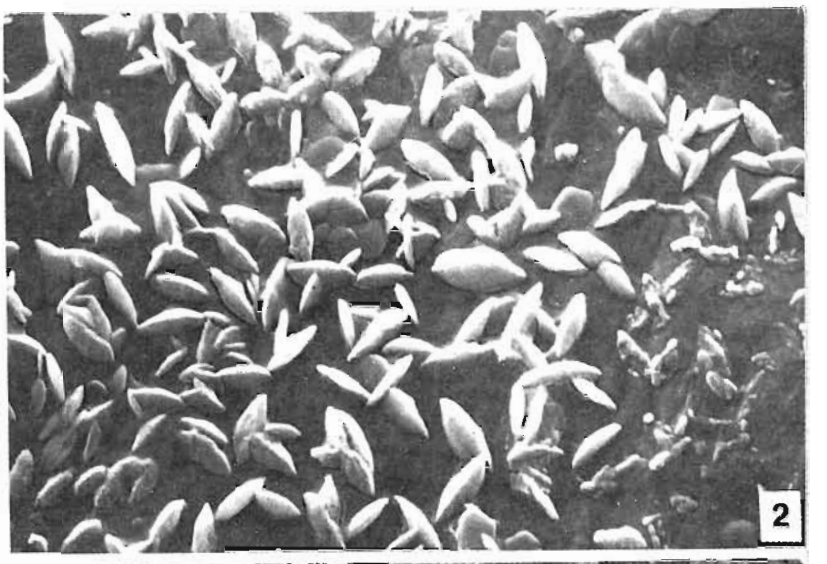
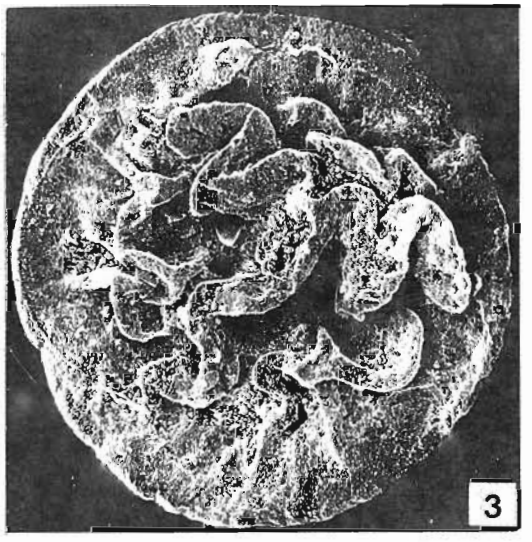
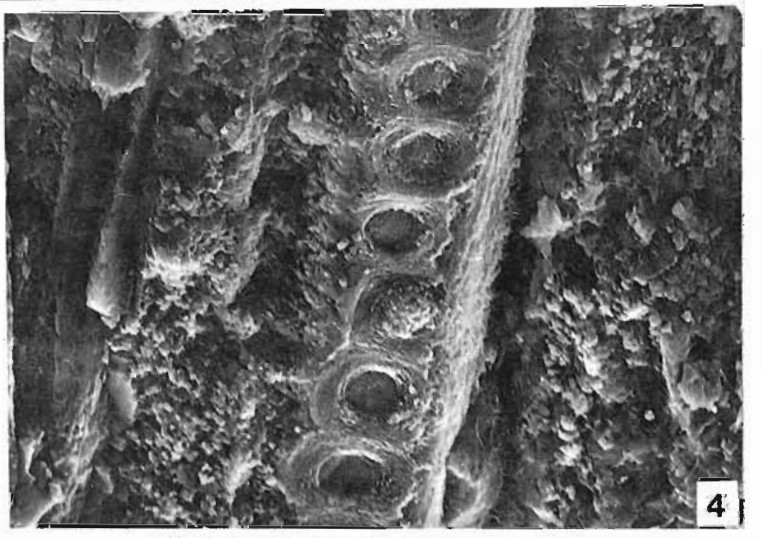
PLATE 2

1. Proximo-lateral view of *Noniasporites harrisii*. × 100.
2. Numerous crystalline bodies present in the pit pore of *Araucarioxylon kumarpurensis* Singh & Bajpai. × 4500.
3. Proximal view of *Noniasporites harrisii* showing the tri radiate ridges and rill-like structures. × 100.
4. Uniseriate bordered pits of *Araucarioxylon kumarpurensis*. × 90.
5. Bio-degradation of cuticle of *Glossopteris shailae* by colonies of rod-shaped bacteria. × 2200.
6. *Araucarioxylon kumarpurensis*; biseriate bordered pits on the radial walls of tracheids. × 100.







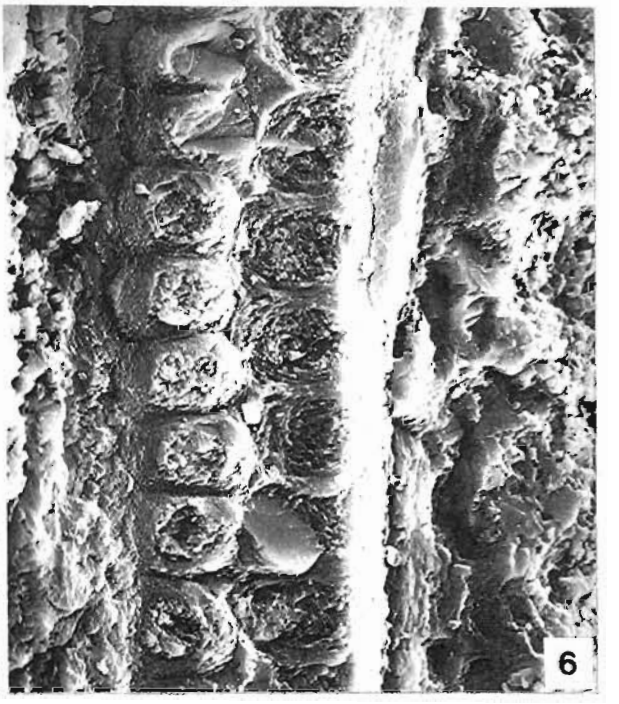


PLATE 2

defined by the presence of a number of fine rills (Pl 2, figs 1, 3). Exosporium is laevigate (Pl 1, fig. 6). Differential maceration in HNO_3 and KOH reveals thin, spherical, light-brown mesosporium without cushions (Pl 1, fig. 7).

Dimensions

Overall size	290-325 × 247-299 μm (dry condition); 325 × 312 μm (wet condition); 390 × 312 μm (after mounting in canada balsam).
Thickness of exine	36 μm (wet condition); 16 μm (after mounting in canada balsam).
Size of mesosporium:	260 × 221 μm (wet condition); 221 × 221 μm (after mounting in canada balsam).

DISCUSSION

The plant fossil assemblage of the Lohpiti Seam comprising *Glossopteris shailae*, *Araucarioxylon kumarpurensis* and *Nonasporites barrisii* is similar to that reported from Kumarpur Sandstone, Raniganj Formation, Raniganj Coalfield by Maheshwari and Bajpai (1984), Bajpai and Singh (1986) and Bajpai (1986). On the basis of data at hand, the floral assemblage associated with the Lohpiti Seam apparently is similar to that of the shale sequence slightly above the Kajora Seam of Kumarpur Sandstone. Thus, palaeobotanically also Lohpiti Sandstone Member of Jharia Coalfield is correlatable with Kumarpur Sandstone Member of Raniganj Coalfield, as earlier commented upon by Gee (1932) on the basis of field evidences.

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