

Palynodating of sub-surface sediments from Kuraloi Block, Ib-River Coalfield, Jharsuguda, Odisha, Son-Mahanadi Graben, India

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ABSTRACT

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The sub-surface samples for the present study were collected from the Bore-Core No. IBK-A2 which was drilled at south-west part (Kuraloi block) of Ib-River Coalfield, Jharsuguda District, Odisha. Two Palynoassemblages have been identified in the 529.18 m deep bore core. The Palynoassemblage-I showing dominance of *Faunipollenites* – *Striatopodocarpites*, followed by *Scheuringipollenites*, *Cyclogranisporites*, *Cyclobaculisporites*, *Rhizomaspota*, *Microbaculispora*, *Striatites*, *Alisporites*, *Ibisporites*, *Falcisporites*, etc. belongs to upper Barakar Palynoflora (Late Early Permian). Palynoassemblage-II having the dominance of *Striatopodocarpites* and sub-dominance of *Faunipollenites* followed by *Verticypollenites*, *Crescentipollenites*, *Rhizomaspota*, *Striatites*, *Alisporites*, *Densipollenites*, *Distriatites*, *Striamonosaccites*, *Scheuringipollenites*, *Striapollenites*, *Ephedripites*, *Callumispota*, *Cyclogranisporites*, *Cyclobaculisporites*, *Ibisporites*, *Parasaccites*, etc. belongs to Raniganj Palynoflora (Late Permian). The dominance of striated disaccates and sub-dominance of non-striated palynoflora along with enormous distribution of triletes and taeniate spores, such as *Densoisporites*, *Lundbladispota* and *Arcuatipollenites* shows Late Permian (Raniganj) affinity.

Key-words—Palynology, Permian, Lower Gondwana, Ib-River Coalfield, Jharsuguda, Odisha, Son-Mahanadi Graben, India.

कुरलॉइ खंड, ईब-नदी कोयला क्षेत्र, झरसुगुडा, उड़ीसा, सोन-महानदी द्रोणिका, भारत से प्राप्त उप-पृष्ठीय अवसादों का परागानुआयुनिर्धारण

के.एल. मीणा एवं एस.एस.के. पिल्लै

सारांश

मौजूदा अध्ययन के लिए उप-पृष्ठीय नमूने जो कि ईब-नदी कोयला क्षेत्र, जिला झरसुगुडा, उड़ीसा में कुरलॉइ खंड के दक्षिण-पश्चिम भाग में खोदे गए वेध छिद्र सं. आई.बी.के.-ए2 से इकट्ठे किए गए। दो परागानुसमुच्चय 529.18 मी. गहरे वेध-छिद्र में पहचाने गए हैं। परागानुसमुच्चय-I *स्युरिंगीपोल्लेनाइटिस*, *सायक्लोबेकुलीस्योराइटिस*, *सायक्लोबेकुलीस्योरा*, *राइजोमोस्योरा*, *मोइक्रोबेकुलीस्योरा*, *स्ट्रिएटाइटिस*, *एलिस्योराइटिस*, *आइबीस्योराइटिस*, *फाल्सीस्योराइटिस*, इत्यादि की अनुगामी *फॉर्नीपोल्लेनाइटिस*-*स्ट्रिएटोपोडोकार्पाइटिस* की प्रभुत्वता दर्शाती हुई ऊपरी बरकार परागानु पेड़-पौधों (पश्च पूर्व पर्मियन) की है। दूसरी परागानुसमुच्चय-II *वर्टिसिपोल्लेनाइटिस*, *क्रसेंटीपोल्लेनाइटिस*, *राइजोमोस्योरा*, *स्ट्रिएटाइटिस*, *एलिस्योराइटिस*, *डेन्सीपोल्लेनाइटिस*, *डिस्ट्रायटाइटिस*, *स्ट्रायमोनोसेक्काइटिस*, *स्युरिंगीपोल्लेनाइटिस*, *स्ट्रायपोल्लेनाइटिस*, *एफेड्रिपाइटिस*, *केल्लुमिस्योरा*, *सायक्लोबेकुलीस्योराइटिस*, *सायक्लोबेकुलीस्योरा*, *आइबीस्योराइटिस*, *पैरासेक्काइटिस*, इत्यादि की अनुगामी *स्ट्रायटोपोडोकार्पाइटिस* की प्रभुत्वता और *फॉर्नीपोल्लेनाइटिस* की उप-प्रभुत्वता प्राप्त रानीगंज परागानु पेड़-पौधों (पश्च पूर्व पर्मियन) की है। ट्राइलिटिज व टीनिपेट बीजाणुओं जैसे कि *डेन्सियोस्योराइटिस*, *लुंडब्लेडिस्योरा* और *अर्कुटीपोल्लेनाइटिस* के बृहत वितरण सहित रेखित द्विविस्पुटों की प्रभुत्वता तथा गैर-रेखित परागानु पेड़-पौधों की उप-प्रभुत्वता पश्च पूर्व पर्मियन (रानीगंज) बंधुता दर्शाती है।

संकेत-शब्द—परागानुविज्ञान, पर्मियन, पश्च गोंडवाना, ईब-नदी कोयला क्षेत्र, झरसुगुडा, उड़ीसा, सोन-महानदी द्रोणिका, भारत।

INTRODUCTION

The Ib-River Coalfield is located in the south-eastern part of NW-SE trending Mahanadi Master Basin belt between $21^{\circ}30'$ to $22^{\circ}14'$ N and $83^{\circ}32'$ to $84^{\circ}10'$ E. It embraces the Hingir sub-basin in the north and Rampur sub-basin in the south. The geological mapping of this coalfield was first carried out by Ball (1871) and this basin was resurveyed by Mehta and Anandalwar (1960), Raja Rao (1982), Chaudhury (1988), Mukhopadhyay (1987, 1989), Pal *et al.* (1992) and Geological Survey of India (1997). The Ib-River Gondwana belt is named after the river Ib, a tributary of Mahanadi. It covers part of Jharsuguda, Sundargarh and Sambalpur districts of Odisha State. Gondwana sediments spread further north-west into the adjoining part of Chhattisgarh and comprise the Mand-Raigarh and Korba coalfields. The palynological investigations in Ib-River Coalfield are limited to a brief note by Tiwari (1968) from Brajraj Nagar area, Jharsuguda District, Maiti, 1994 from Bore-Core No. IBH-16 from Sundargarh District; Meena, (1998) from Bore-Core No. IBSH-6 near Gopalpur Village, Sundargarh District; Meena (1999) from Chaturdhara Nala Section near Gopalpur Village, Sundargarh District; Meena (2000) from Bore-Core No. IBH-6 near Hingir Railway Station, Jharsuguda District; Meena (2004) from Basundhara Nala Section; Meena and Goswami (2004) from Bore-Core IBT 2, 3 and 7 near central part of basin of Tangadih area and Tewari *et al.* (2009) from

Bore-Core IBK-A2 (Kuraloi Block). The present study material has been collected from Bore-Core No. IBK-A2 which was drilled in the south western part of Kuraloi Block A, near Belpahar area, Jharsuguda District, Odisha.

MATERIAL AND METHODS

The Kuraloi area (Block-A) is situated on the south-western side of Ib-Hingir Basin, Jharsuguda District, Odisha. The location of the Bore-Core is shown in Fig. 1. For the present study 45 samples from Bore-Core No. IBK-A2 cutting across Barakar-Barren Measures-Raniganj successions were collected (Fig. 2). The sediments include grey shale, carbonaceous shale, sandy shale, sandstones and coal. Out of these, fifteen samples yielded palynomorphs and only nine samples have countable number of palynomorphs for quantitative analysis.

For the recovery of palynomorphs the samples were first treated with HCL and HF for 2 or 3 days for removal of carbonates and silica and thereafter washed with water. The samples were treated with concentrated HNO_3 for 4-5 days. After thorough digestion, samples were washed with tap water and sieved by 150 μm and 400 μm sieves. Alkali treatment was done to get the clear palynomorphs. Five to six slides were prepared from each sample by using polyvinyl alcohol mixture and slides were mounted in Canada Balsam. Slides were dried

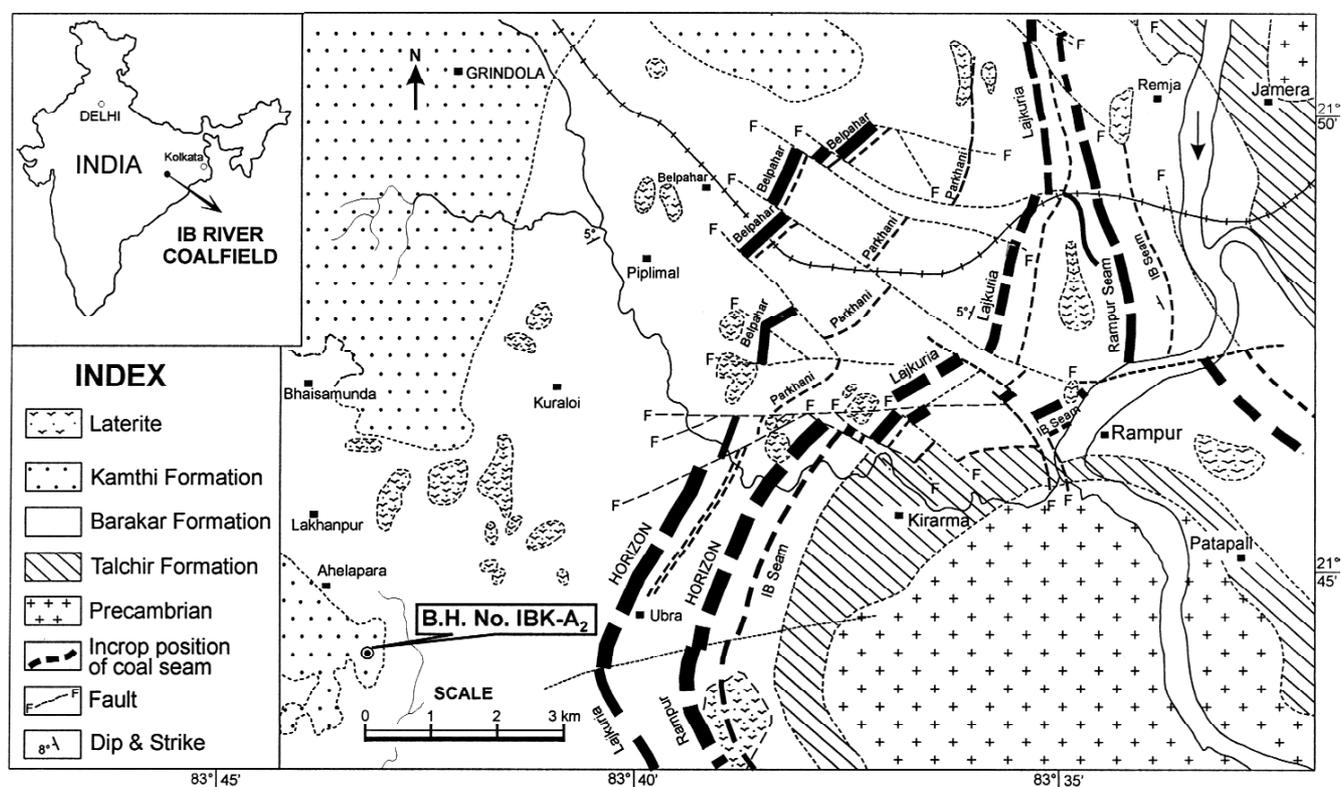


Fig. 1—Map showing the location of Bore-Core No. IBK-A2.

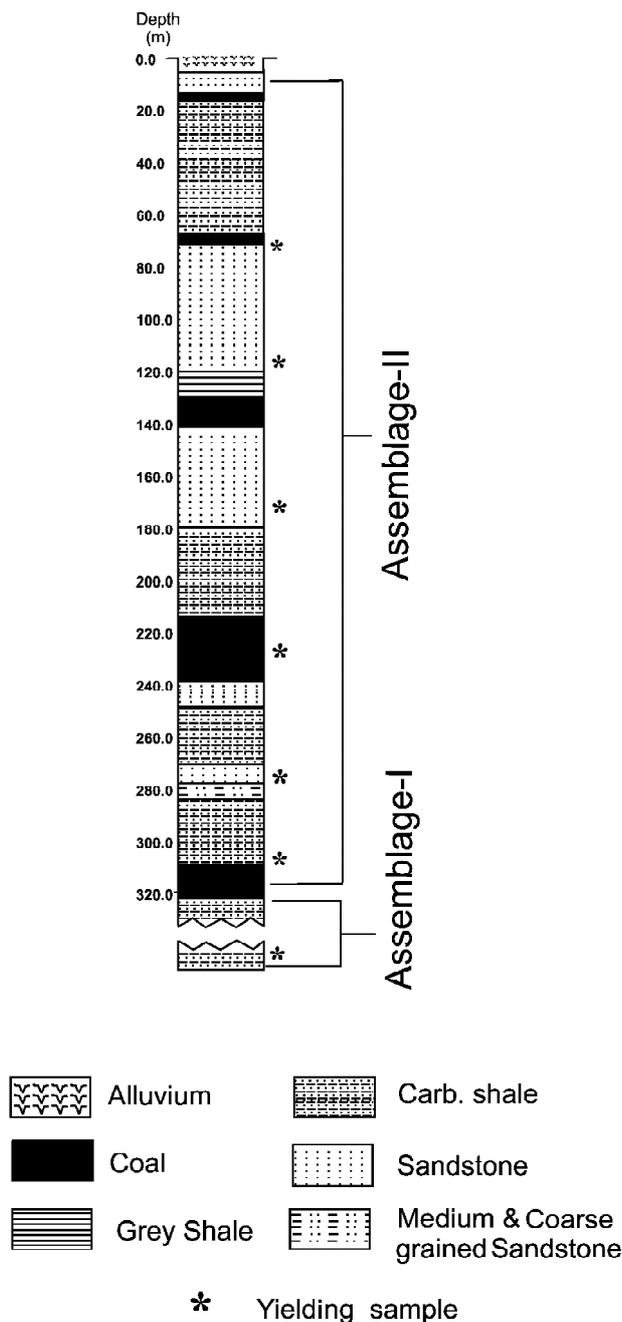


Fig. 2—Lithology of Bore-Core No. IBK-A2 showing yielding samples.

in the oven and studied for qualitative and quantitative analysis. At least two hundred specimens were observed for making palynofloras and plotting of histogram (Fig. 3).

GENERAL GEOLOGY

Among the five major coal bearing sedimentary basins of peninsular India that are situated on the east coast of India,

Mahanadi is the major one. The Ib- River Coalfield is located in southeastern part of NW-SE trending Mahanadi Master Basin belt between 21°30' to 22°06' North (latitude) and 83°37' to 84°10' East (longitude). Ib River embraces the Hingir sub-basin in the north and Rampur sub-basin in the south. In Mahanadi Basin the Gondwana sediments are exposed in two different sub-basins:

(A) Basin comprising lower to upper Gondwana sediments with coal measures towards the west.

(B) Sub-basins in the east having rocks only from the upper Gondwana.

Gondwana sediments spread further north west into the adjoining part of Madhya Pradesh and comprise the Mand Raigarh and Korba coalfields.

The low hillocks formed by the Kamthi beds are the prominent topographic feature of the area and out of these, the Belphar hill range on the north is the most prominent. The main drainage is the Ib River, tributary of the River Mahanadi. It flows generally in southerly direction through the coalfield and discharges into the Hirakund Reservoir, which has submerged the southern fringe of the coalfield. The Bhedan, Lilari, Lamtibahal and Chelkutia nalas, which join the Ib River, comprise other drainage channels within the coalfield. The geological succession in the Ib- River Basin has been given in Fig. 4.

PALYNOLOGICAL ASSEMBLAGES

As a result of quantitative analysis of productive samples, two palynofloras have been recognized. However, the palynological results clearly reflect the missing of Barren Measures flora. The Palynoflora-I from 496 m to 376 m recorded with dominance of *Faunipollenites* and sub-dominance of *Scheuringipollenites*, with the presence of *Striatipollenites*, *Verticipollenites*, *Rhizomaspora*, *Ibisporites*, *Cyclogranisporites*, *Cyclobaculisporites*, *Ephedripites*, etc. (Figs 3 & 5). Hence the palynoflora - I shows the affinities with Upper Barakar Palynoflora indicating late Early Permian age.

The Palynoflora - II recovered from 301.76 m to 7.15 m has the dominance of *Striatopodocarpites* and sub-dominance of *Faunipollenites* along with the presence of *Diastriatites*, *Cyclogranisporites*, *Microbaculispora*, *Parasaccites*, *Ephedripites*, *Callumisporea* and *Densipollenites magnicarpus*, etc. (Figs 3 & 5). The appearance of *Arcuatipollenites* along with trilete spores such as *Densoisporites* and *Lundbladisporea* are in significant percentages. Lithologically, this Bore-Core intersects through Barakar, Raniganj, Barren Measures Formation in the Kuraloi area in the South-western part of Ib-River Coalfield, Odisha. The whole Palynoflora-II is equivalent to Raniganj flora and assigned a Late Permian age.

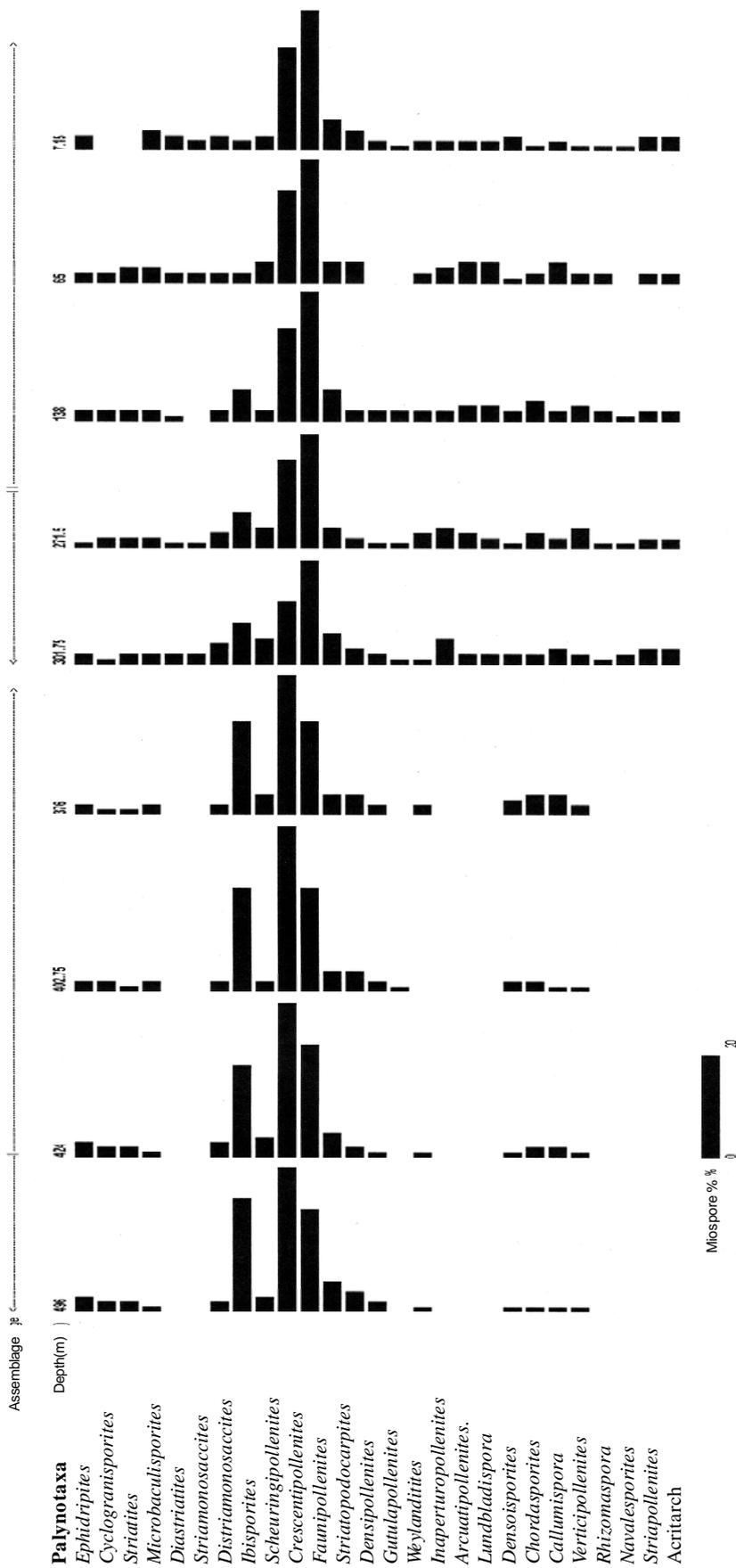


Fig. 3—Histogram showing percentage frequency of significant palynotaxa recovered from Bore-Core No. IBK-A2.

Age	Group	Formation	Lithology (Thickness in meters)
Recent		Alluvium/ Laterite	Recent gravel and conglomerate
Early to Middle Triassic	Middle Gondwana	Upper Kamthi = Kamthi	Conglomerate, red shale with <i>Dicroidium</i> flora (Pal <i>et al.</i> , 1992) and coarse ferruginous-sandstone with clasts (150 m+)
-----Unconformity-----			
Late Permian	Lower Gondwana	Kamthi = Raniganj	Fine to medium grained well sorted sandstone, siltstone, clay bed, shale, coal. Palynofloral assemblage is dominated by <i>Striatopodocarpites</i> , <i>Faunipollenites</i> , <i>Crescentipollenites</i> and <i>Arcuatipollenites</i> (180 m)
Middle Permian		Lower Kamthi=Barren Measures	Grey shale, carbonaceous shale, fine to coarse-grained sandstone, clay and ironstone nodules/shales. Palynofloral assemblage is dominated by <i>Striatopodocarpites</i> , <i>Faunipollenites</i> , <i>Crescentipollenites</i> and <i>Arcuatipollenites</i> (250 m+)
Early Permian		Barakar	Feldspathic sandstone, grey and carbonaceous shales, fireclay and thick coal seams. Upper Barakar palynofloral assemblage is dominated by <i>Faunipollenite</i> , <i>Striatopodocarpites</i> , <i>Scheuringipollenites</i> , <i>Rhizomaspora</i> , etc. where as Lower Barakar palynofloral assemblage is dominated by <i>Brijrajisporites</i> , <i>Primuspollenites</i> , <i>Lahirites</i> , <i>Sulcatisporites</i> , <i>Cuneatisporites</i> , <i>Platysaccus</i> , <i>Apiculatisporis</i> , etc. (350-500 m). Conglomerate, carbonaceous sandstone with fresh feldspar grains containing thin coal bands-only along the NW margin of the basin (30-65 m)
Early Permian		Karharbari	Conglomerate, carbonaceous sandstone with fresh feldspar grains containing thin coal bands-only along the NW margin of the basin (30-65 m)
Early Permian		Talchir	Diamictites, greenish sandstone, olive coloured needle shales and rhythmites (130 m+)
-----Unconformity-----			
Precambrian			Granites, gneisses, amphibolites, migmatites

Fig. 4—Geological succession of the Ib-River Basin, Odisha (after Chaudhury, 1988; CMPDI, 1987; Pal *et al.*, 1992 & GSI, 1997).

DISCUSSION

The pioneer worker on megafossils in this area was Feistmantel (1880), who described *Schizoneura gondwanensis*, *Vertebraria indica*, *Sphenopteris* sp., *S. polymorpha* and few species of *Glossopteris*, viz. *G. indica*, *G. damundica* and *G. browniana* from the Lower Kamthi rocks exposed at the Ganjan Hill, Girundla Kuraloi and Belpahar areas. *Dicroidium* was recorded from red shale bed of the Kamthi Formation by Pal *et al.* (1992), *Sphenopteris polymorpha* was reported from Barakar Formation to the east of Patrapali, Ib-River Coalfield by Mehta and Anandalwar (1960). Singh and Chandra (1995) recorded preserved *Vertebraria* axis from the pinkish-grain shales of Barakar Formation exposed near Brajra Nagar Railway Station. *Senothecha murulidihensis*, a glossopteridae fructification was discovered from

carbonaceous shales of Lakura Colliery by Singh and Chandra (1989). Singh and Chandra (1999) reconstructed a fern plant *Neomariopteris hughesii* based on specimen collected from the Barakar Formation.

The present study reveals that except V seam (i.e. Ib-seam), no other seams have yielded Barakar type of palynoassemblages (i.e. Palynoassemblage I). The other four overlain seams have yielded Raniganj type of palynomorphs (i.e. Palynoassemblage II).

CONCLUSION

Two distinct palynoassemblages have been recovered in Bore-Core No. IBK-A2 from Kuraloi Block-A Belpahar area, Jharsuguda District, Ib-River Coalfield, Odisha. Palynoassemblage-I shows the dominance of *Faunipollenites*

Lithological data			Palynological data	
S. No.	Lithology	Formation	Qualitative/ quantitative genera	Remarks
Depth 7.15- 301.76 (m)	Medium – coarse grained sandstone, sandstone, grey shale, carbonaceous shale & coal	Supra-Barakar (Kamthi)	Dominance of <i>Striatopodocarpites</i> & sub-dominance of <i>Faunipollenites</i> , <i>Verticypollenites</i> , <i>Crescentipollenites</i> , <i>Rhizomaspora</i> , <i>Striatites</i> , <i>Alisporites</i> , <i>Densipollenites</i> , <i>Distriatites</i> , <i>Striamonosaccites</i> , <i>Scheuringipollenites</i> , <i>Striapollenites</i> , <i>Ephedripites</i> , <i>Callumispora</i> , <i>Cyclogranisporites</i> , <i>Cyclobaculisporites</i> , <i>Ibisporites</i> , <i>Parasaccites</i> , etc.	Raniganj Palynoflora (Late Permian)
Depth 376-496 (m)	Fine grained sandstone, sandstone, grey shale, carbonaceous shale & coal	Barakar	Dominance of <i>Faunipollenites</i> – <i>Striatopodocarpites</i> , <i>Scheuringipollenites</i> , <i>Cyclogranisporites</i> , <i>Cyclobaculisporites</i> , <i>Rhizomaspora</i> , <i>Microbaculispora</i> , <i>Striatites</i> , <i>Alisporites</i> , <i>Ibisporites</i> , <i>Falcisporites</i> , etc.	Upper Barakar Palynoflora (Late Early Permian)

Fig. 5—Showing depth wise representation of important palynomorphs in Bore-Core IBK-A2.

and *Striatopodocarpites*, followed by *Ibisporites*, *Distriatites*, *Alisporites*, *Densipollenites*, *Rhizomaspora*, *Cyclogranisporites*, *Cyclobaculisporites*, etc. This composition of palynoflora indicates the Late Early Permian (equivalent to Upper Barakar Formation) age for these sediments (Fig. 6).

The Palynoassemblage-II has the dominance of *Striatopodocarpites* – *Faunipollenites* followed by *Rhizomaspora*, *Verticypollenites*, *Striatites*, *Distriatites*, *Distriamonosaccites*, *Striamonosaccites*, *Ibisporites*, *Parasaccites*, *Densipollenites*, *Cyclogranisporites*, *Cyclobaculisporites*, *Callumispora*, *Verrucosiporites*, *Ephedripites*, etc. Besides the above major palynomorphs, the appearance of some younger elements in Palynoassemblage - II are *Arcuatipollenites*, *Densosporites* and *Lundbladispota*. Hence, this part of the sequence is

suggested to be of Late Permian (equivalent to Raniganj) age (Fig. 6).

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PLATE 1

(1 cm = 20 µm)



- Ibisporites diplosaccus* Tiwari 1968.
- Densipollenites invisus* Bharadwaj & Salujha 1969.
- Chordasporites klawusii* Kumaran & Maheshwari 1980.
- & 11. *Laevigatosporites callosus* Balme 1970.
- Arcuatipollenites* sp. Tiwari 1964.
- Striatopodocarpites nidpurensis* Bharadwaj & Srivastava Shyam C. 1969.
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- Microbaculispora gondwanensis* Bharadwaj 1962.
- Primuspollenites levis* Tiwari 1964.
- Barakarites crassus* Tiwari 1965.
- Novisporites Magnus* Bharadwaj 1957.

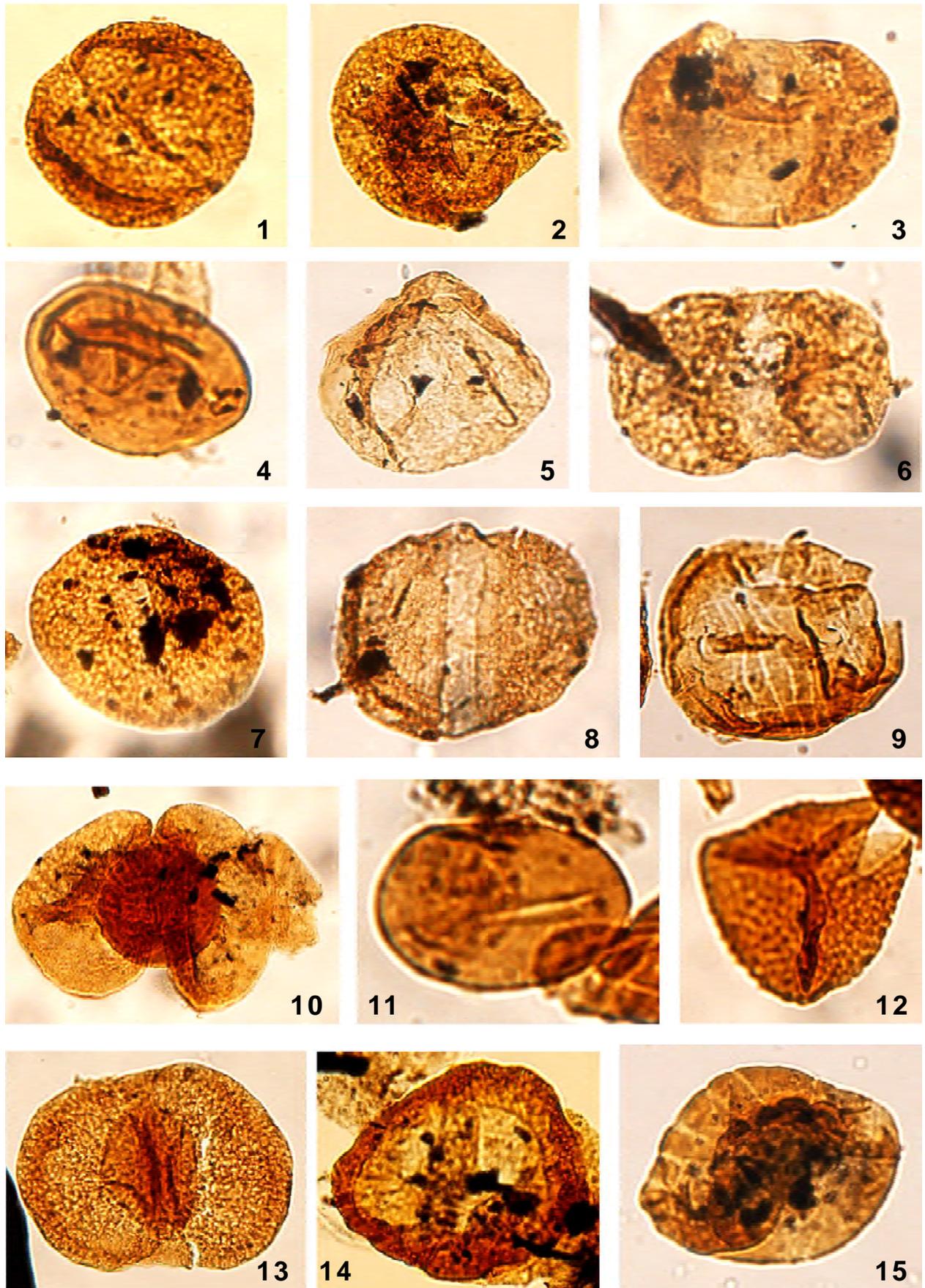


PLATE 1

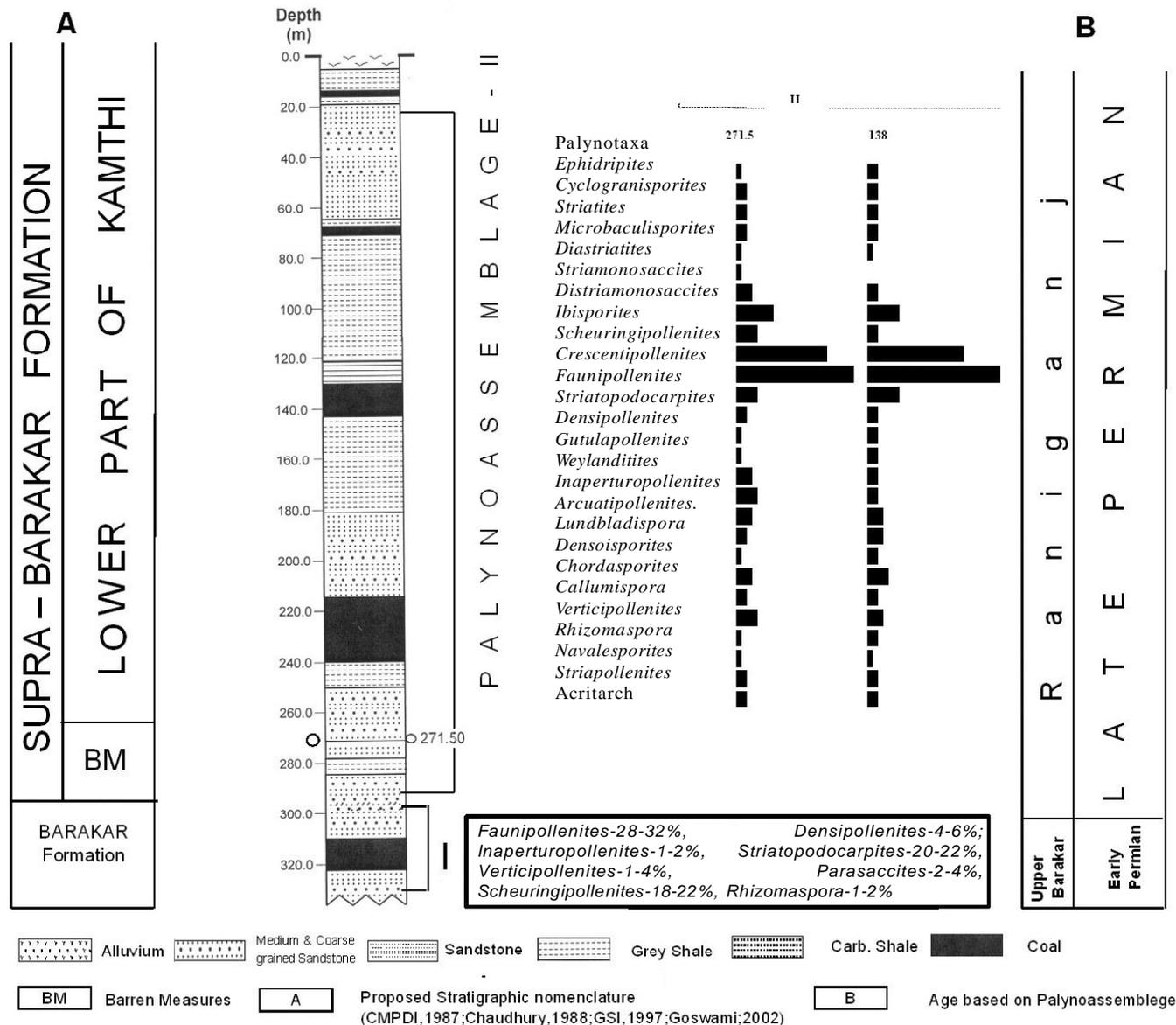


Fig. 6—Litholog of Bore-Core IBK-A2 showing depth of sediments yielding the corresponding palynoassemblages.

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