

Palynostratigraphy of Permian succession from Binja Block, South Karanpura Coalfield, Jharkhand, India

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Palynological investigations are carried out on approximately 538.00-m thick Gondwana strata from borehole SKB-1, Binja Block, South Karanpura Coalfield in Jharkhand. Based on the distribution pattern of age marker palynotaxa, two distinct palynoassemblages are identified. Palynoassemblage-I in the lithologically designated Barren Measures and Barakar formations, between 552.00 and 53.20 m depth show dominance of striate bisaccate (*Striatopodocarpites*, *Crescentipollenites*, and *Faunipollenites*) and abundance of nonstriate bisaccate (*Scheuringipollenites*). Upward the Palynoassemblage-II (39.50–13.80 m depth) is rich in striate bisaccate (*Striatopodocarpites* and *Crescentipollenites*) and significant enveloping monosaccate *Densipollenites magnicarpus* pollen. These strata have been equated with Raniganj Formation of Latest Permian age. The First Appearance Datum (FAD) of *Arcuatipollenites pellucidus*, *Playfordiaspora cancellosa*, *Alisporites* sp., *Falcisporites* sp. and *Krempipollenites indicus* observed at 13.80 and 39.50 m depth, mark the transition of Permian into the Lower Triassic. The FADs of *Guttulapollenites* spp. at 49.10 and 504.70 m, *Goubinispora morondavensis* at 415.90 m, *Alisporites ovalis* and *Arcuatipollenites* sp. at 526.70 m is observed and suggest that these sediments are equivalent to Raniganj Formation, Late Permian in age.

1. Introduction

South Karanpura Coalfield is located in the western part of the Damodar valley, situated between latitudes 23°38'–23°45'N and longitudes 85°05'–85°28'E in the Ramgarh district of Jharkhand state. It covers an area of 194 km² (figure 1). Palynological work has been done in this coalfield, namely by Bhattacharya *et al.* (1957); Khan (1962, 1964); Bharadwaj and Tiwari (1968); Bharadwaj and Anand Prakash (1972); Lele and Chandra (1977); Lele and Kulkarni (1969); Bharadwaj and Tripathi (1978); Bharadwaj and Dwivdi (1981) and Bandyopadhyay (1984). Most of the work is on the coal bearing Barakar Formation.

Binja Block of this coalfield is situated in the southwestern part of the South Karanpura Coalfield where the rocks of the Barren Measures and Raniganj formations are exposed on the surface (figure 1). The main objective of the present analysis is to determine the palynological dating of the borecore SKB-1 at Binja Block, South Karanpura Coalfield. The taphonomic study on the same material is also attempted to understand the depositional environment.

2. General geology

This east–west trending elongated coalfield, occurring within Damodar–Koel River Valley Basins is

Keywords. Palynostratigraphy; Permian; Raniganj Formation; Barren Measures; Barakar Formation; Binja Block; South Karanpura Coalfield.

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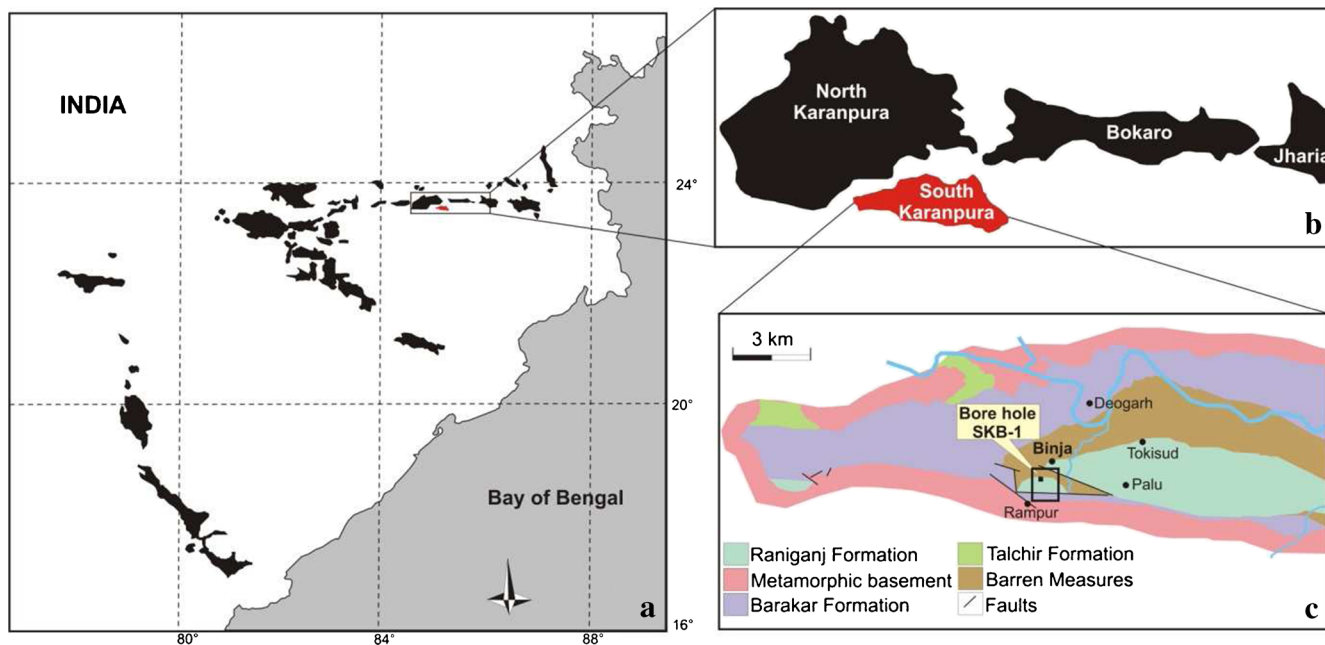


Figure 1. (a) Map showing coalfields in extrapeninsular India; (b) some coalfields in Damodar Koel River Valley, and (c) geological map of South Karanpura Coalfield showing location of borehole SKB-1 (after Raja Rao 1987).

Table 1. General stratigraphic succession in South Karanpura Coalfield (modified after Raja Rao 1987).

Age	Formation	Lithology	Thickness range (m) (approx.)
Gondwana Supergroup			
Lower Gondwana Group			
Early Cretaceous	Intrusive	Lamprophyre and dolerite dykes and sills.	
-----Unconformity-----			
Late Permian	Raniganj	Fine-grained sandstones; grey, medium to coarse grained, calcareous sandstones; grey shales (=mudstones); carb. shale; a few thin coal seams/bands.	610 m
Middle Permian	Barren Measures	Medium grained sandstones; siltstones; micaceous and carbonaceous shales; ironstone shales.	304–457 m
Early Permian	Barakar	Coarse grained sandstones, shales; about 42 economic coal seams.	1053 m
Early Permian	Karharbari	Pebbly-to-coarse grained sandstones, shales and coal seams.	74 m
Early Permian to Late Carboniferous	Talchir	Olive green shales/green mudstones; fine to medium-grained sandstones; conglomerate; rhythmites and diamictites.	3–16 m
-----Unconformity-----			
	Basement	Granite, gneisses, mica-schist, quartzite and limestone.	

Table 2. Lithostratigraphic succession in the borecore SKB-1.

Period	Formation	Lithology
Latest Permian	Raniganj Formation 13.80–37.70	Siltstones, micaceous shales and mudstones
Middle Permian	Barren Measures 37.70–429.15	Mudstones, carbonaceous shales, fine grained sandstones and coals
Late Early Permian	Barakar Formation 429.15–552.00	Carbonaceous shales, coaly shales and coals

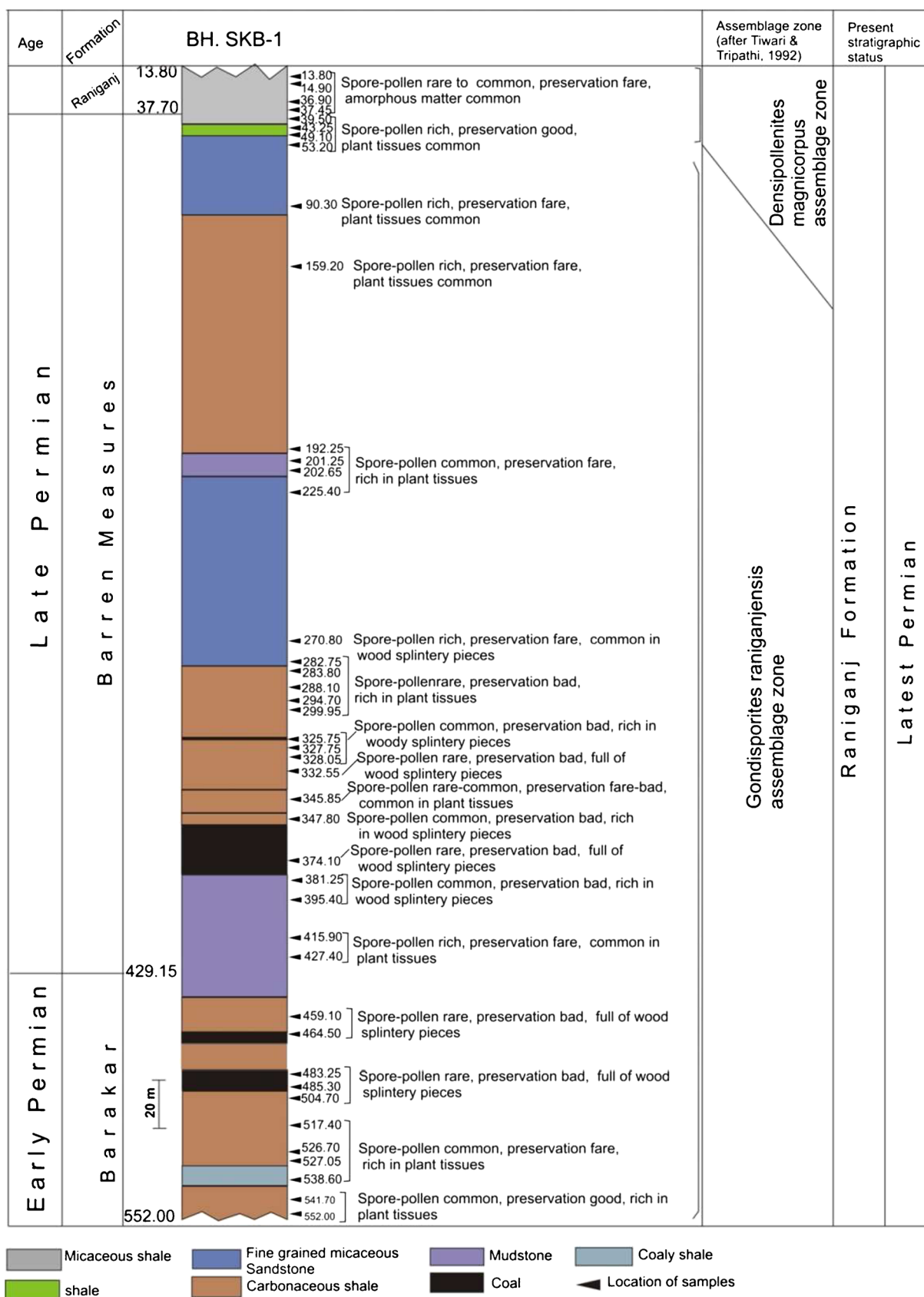


Figure 2. Lithocolumn in borehole SKB-1, to show different levels of occurrence of palynomorphs assemblage zone identified and their stratigraphic status.

bounded by metamorphic basement rocks to the north and south. The rocks of the Talchir Formation are mostly exposed in patches in lenticular fashion in the fringe areas along the northern,

southern, and eastern margins of the coalfield. A continuous succession from Talchir to Raniganj formations is preserved in this basin. Major parts of this basin are occupied by Barakar Formation,

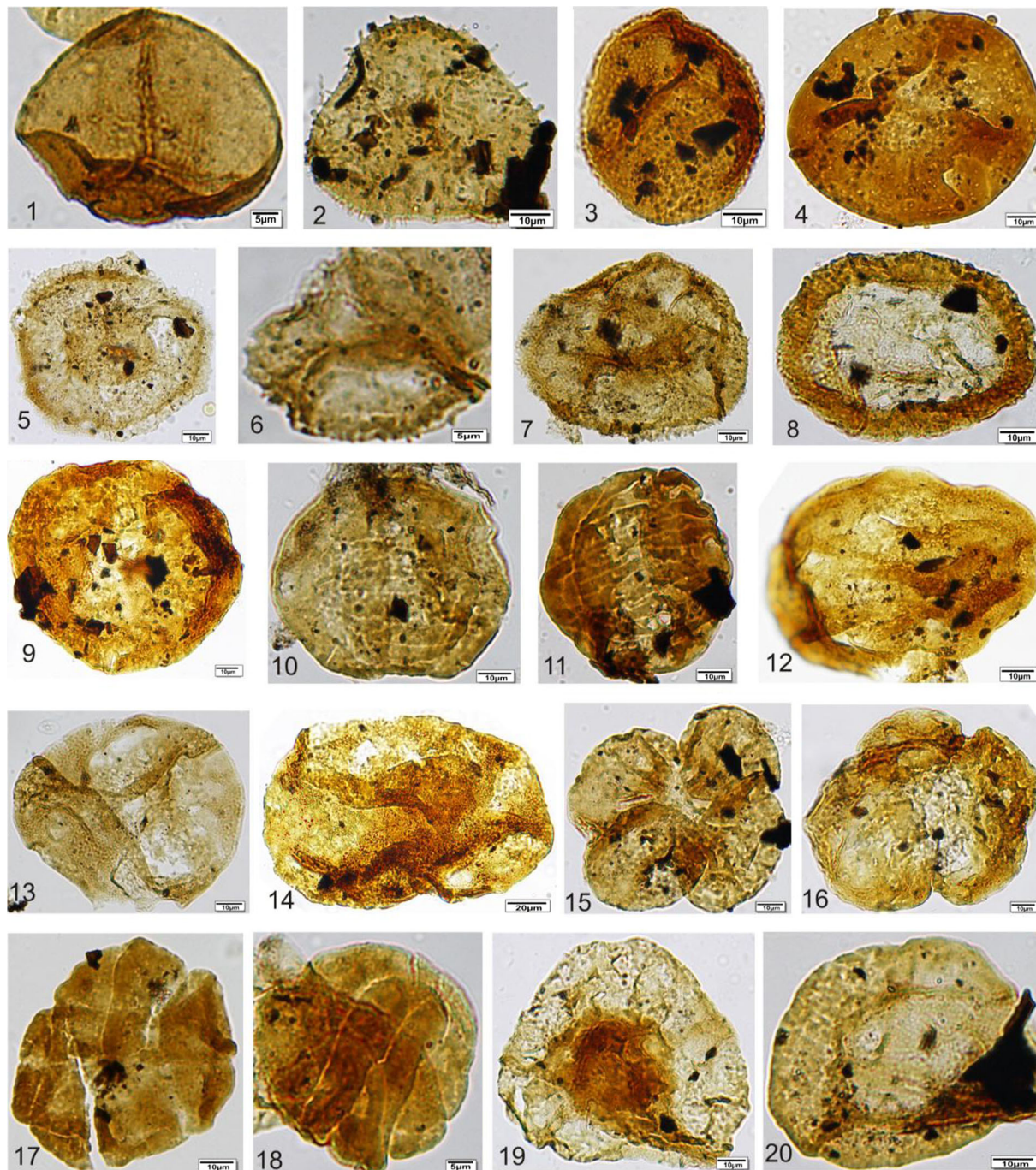


Plate I. 1. *Cyclogranisporites triletes* Kar (1970); 2. *Horriditriletes curvibaculus* Bharadwaj and Salujha (1964); 3. *Microbaculispora tentula* Tiwari (1965); 4. *Microfoveolatispora foveolata* Tiwari (1965); 5. *Gondisporites reticulatus* Tiwari and Ram-Awatar (1988); 6. *Indotriradites korbaensis* Tiwari (1964); 7. *Gondisporites* sp.; 8. *Parasaccites obscurus* Tiwari (1965); 9. *Barakarites crassus* Bharadwaj and Tiwari (1964); 10. *Striamonosaccites ovatus* Bharadwaj (1962); 11. *Distriasulcites ovatus* Venkatachala and Kar (1968); 12. *Densipollenites magnicorpus* Tiwari and Rana (1981); 13. *Densipollenites invisus* Bharadwaj and Salujha (1964); 14. *Densipollenites densus* Bharadwaj and Srivastava (1969); 15. *Goubinispora* sp.; 16. *Goubinispora morondavensis* (Goubin) and Rana (1981); 17. *Guttulapollenites gondwanensis* Goubin (1965); 18. *Guttulapollenites hannonicus* Goubin (1965); 19. *Playfordiaspora cancellosa* Maheshwari and Banerji emend. Vijaya (1995); 20. *Kamthisaccites kamthiensis* Srivastava and Jha (1986).

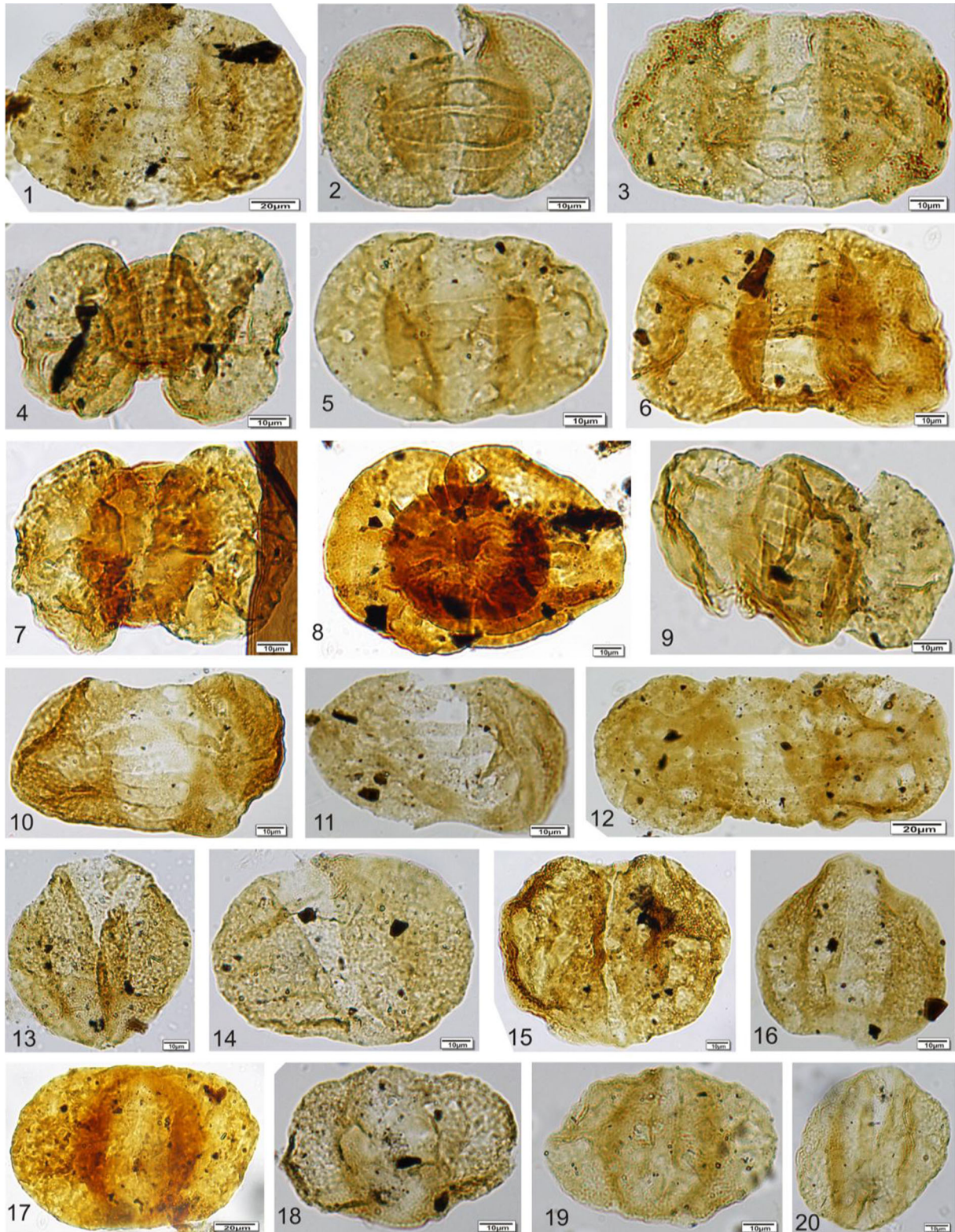


Plate II. 1. *Faunipollenites varius* Bharadwaj (1962); 2. *Striatites varius* Kar (1968); 3. *Striatopodocarpites magnificus* Bharadwaj and Salujha (1964); 4. *Verticypollenites gibbosus* Bharadwaj (1962); 5. *Crescentipollenites fuscus* (Bharadwaj) Bharadwaj, Tiwari and Kar (1974); 6. *Crescentipollenites* sp.; 7. *Platysaccus densicarpus* Anand-Prakash (1972); 8. *Rhizamospora triassica* Tiwari and Rana (1981); 9. *Distriatites bilateris* Bharadwaj (1962); 10. *Arcuatipollenites pellucidus* (Goubin) Tiwari and Vijaya (1995); 11. *Arcuatipollenites* sp.; 12. *Arcuatipollenites damudicus* (Tiwari and Rana) Tiwari and Vijaya (1995); 13. *Scheuringipollenites tentulus* Tiwari (1973); 14. *Scheuringipollenites barakarensis* Tiwari (1973); 15. *Scheuringipollenites maximus* Tiwari (1973); 16. *Krempipollenites* sp.; 17. *Alisporites ovalis* Kumar (1973); 18. *Alisporites* sp.; 19. *Satsangisaccites nidpurensis* Bharadwaj and Srivastava 1969; 20. *Krempipollenites indicus* Tiwari and Vijaya (1995).

which lies unconformably over the basement in large areas. To the east and northeast, Barakar Formation conformably overlies the older rocks whereas in the southern parts, it is faulted against the basement. In totality, this coalfield contains 42 regional Barakar coal seams within a thick pile of lower coal measure, though not all the seams are developed in any single block. The outcrops of Barren Measures and Raniganj are exposed at the central part (Raja Rao 1987).

Lamprophyre and dolerite dykes and sills are reported to occur at different stratigraphic levels within the Barakar, Barren Measures, and Raniganj formations.

Based on available literatures and unpublished Progress Reports of GSI, the generalized stratigraphic succession in the South Karanpura Coalfield (modified after Raja Rao 1987) is given in table 1.

3. Materials and methods

The study is based on the material from bore core SKB-1, total depth in the borecore is approximately 538.00 m (13.80–552.00 m). The borecore intersected through Raniganj, Barren Measures, and Barakar formations. The formational contact–Raniganj/Barren Measures is marked at 37.70 m and Barren Measures/Barakar at 429.15 m (table 2 and figure 2). In all 73 rock samples that were collected for palynological study, 42 samples yielded palynomorphs. Sediments are processed by standard maceration technique. For each sample, 50 gm of sediments were taken and crushed, were first treated with 40% hydrofluoric acid for 3–4 days to remove silica material, and then followed by

nitric acid for 5 days for digestion of humic matter. Then they were treated with 10% potassium hydroxide to release the humus. The maceral were mounted in polyvinyl alcohol and Canada balsam. Five slides from each sample were prepared and pollen-spores were observed under the transmitted light microscope.

4. Palynological observation

Borehole SKB-1 (13.80–552.00 m depth) from Binja Block of South Karanpura Coalfield has been worked out for the dating of the intersected strata. The samples comprise diverse lithofacies and recovery of spores and pollen is average and varies from poor to fair (Plates I and II). Besides, an abundance of wood shreds, plant tissues and organic matter were also observed. For details, see figure 2.

The overall composition of spore-pollen, i.e., diversity in their relative abundances along with the presence of significant age marker taxa (tables 3 and 4) at different depth intervals in the borehole SKB-1 are discussed here. Here two palynoassemblages are identified (figure 2 and table 3).

4.1 Palynoassemblage-I

Depth: 552.00–53.20 m; carbonaceous shales, micaceous shales, mudstones, fine-to-medium grained sandstones with charcoal, coaly shales, and coals (figure 2 and table 3).

In the strata between 53.20 and 552.00 m depth in borehole SKB-1 the assemblage contains dominance of species of *Striatopodocarpites* followed by *Crescentipollenites*, *Faunipollenites* and *Scheurini-*

Table 3. Palynodating in Borehole SKB-1 (13.80–552.00 m depth), South Karanpura Coalfield.

Lithostratigraphic formation	Assemblage identified	Placement in Palynozone (Tiwari and Tripathi 1992)	Present stratigraphic status		Remarks
			Formation	Age	
Raniganj 13.80–37.70 m–	Palynoassemblage-II (13.80–39.50 m)	<i>Densipollenites magnicarpus</i>	Raniganj	Late Permian	Equivalent to Raniganj Formation
Barren Measures –429.15m–		↑		↑	
	Palynoassemblage-I (53.20–552.00 m)	<i>Gondisporites raniganjensis</i>	Raniganj	Late Permian	
Barakar 552.00 m		↓		↓	

Table 4. List of spore-pollen species identified in Borehole SKB-1, South Karanpura Coalfield.

Simple Trilete Spore

- Brevitriletes unicus* Bharadwaj and Srivastava emend. Tiwari and Singh (1981)
Callumispora barakarensis Bharadwaj and Srivastava emend. Tiwari *et al.* (1989)
Cyclogranisporites gondwanentis Bharadwaj and Salujha (1964)
Cyclogranisporites triletes Kar (1970)
Cyclogranisporites sp.
Cyclobaculisporites minutus Bharadwaj and Salujha (1964)
Cyclobaculisporites indicus Bharadwaj and Salujha (1964)
Cyclobaculisporites sp.
Didecitriletes horridus Venkatachala and Kar emend. Tiwari and Singh (1981)
Horriditriletes curvibaculosus Tiwari (1965)
Microbaculispora barakasrensis Tiwari emend. Tiwari and Singh (1981)
Microbaculispora gondwanensis Bharadwaj (1962)
Microbaculispora tentula Tiwari (1965)
Microfoveolatispora foveolata Tiwari (1965)
Microfoveolatispora bokaroensis Tiwari (1965)

Zonate Trilete Spores

- Gondisporites reticulatus* Tiwari and Ram-Awatar (1988)
Gondisporites raniganjensis Bharadwaj (1962)
Gondisporites sp.
Indotriletes korbaensis Tiwari (1964)

Monosaccate Pollen

- Parasaccites obscures* Tiwari (1965)
Bharadwajipollis striatus Kar (1969)
Barakarites indicus Bharadwaj and Tiwari (1964)
Barakarites crassus Bharadwaj and Tiwari (1964)
Densipollenites densus Bharadwaj and Srivastava (1969)
Densipollenites invisus Bharadwaj and Salujha (1964)
Densipollenites magnicarpus Tiwari and Rana (1980)
Densipollenites indicus Bharadwaj (1969)
Parasaccites bilateralis Bharadwaj and Tiwari (1964)
Striomonosaccites ovatus Bharadwaj (1962)
Playfordiaspora cancellosa Maheshwari and Banerji emend. Vijaya (1995)
Kamthisaccites kamthiensis Srivastava and Jha (1986)
Goubinispora morondavensis (Goubin) Tiwari and Rana (1981)
Goubinispora morondavensis sp.

Nonstriate Bisaccate Pollen

- Platysaccus densus* Kar (1968)
Platysaccus ovatus Maithy (1965)
Platysaccus densicarpus Anand Prakash (1972)
Scheuringipollenites maximus (Hart) Tiwari (1973)
Scheuringipollenites tentulus (Tiwari) Tiwari (1973)
Scheuringipollenites barakarensis (Tiwari) Tiwari (1973)

Table 4. (Continued.)

- Alisporites ovalis* Kumar (1973)
Alisporites sp.
Krempipollenites indicus Tiwari and Vijaya (1995)
Krempipollenites sp.
Satsangisaccites nidpurensis Bharadwaj and Srivastava (1969)
- Striate Bisaccate Pollen
- Crescentipollenites gondwanensis* (Maheshwari) Bharadwaj *et al.* (1974)
Crescentipollenites fuscus Bharadwaj, Tiwari and Kar (1974)
Crescentipollenites sp.
Distriatites bilateris Bharadwaj (1962)
Distriamonocolpites ovalis Bharadwaj and Sinha (1969)
Distriasulcites ovatus Venkatachala and Kar (1968)
Faunipollenites singrauliensis Sinha (1972)
Faunipollenites varius Bharadwaj emend. Tiwari *et al.* (1989)
Rhizomaspora indica Tiwari (1965)
Rhizomaspora triassica Tiwari and Vijaya Rana (1981)
Rhizomaspora radiata Wilson (1965)
Striasulcites ovatus Venkatachala and Kar (1968)
Striasulcites tectus Venkatachala and Kar (1968)
Striatites communis Bharadwaj and Salujha (1964)
Striatites reticuloidus Tiwari (1965)
Striatites notus Bharadwaj and Salujha (1964)
Striatites rhombicus Bharadwaj and Salujha (1964)
Striatites gopalensis Srivastava (1970)
Striatites varius Kar (1968)
Striatopodocarpites magnificus Bharadwaj and Salujha (1964)
Striatopodocarpites ovatus (Maheshwari) Bharadwaj and Archana Dwivedi (1981)
Striatopodocarpites diffusus Bharadwaj and Salujha (1964)
Tiwariasporis gondwanensis (Tiwari) Maheshwari and Kar (1967)
Verticypollenites gibbosus Bharadwaj (1962)
Verticypollenites oblongus Bharadwaj (1962)
- Taeniate
- Guttulapollenites hannonicus* Goubin (1965)
Guttulapollenites gondwanensis Goubin (1965)
Guttulapollenites sp.
Arcuatipollenites ovatus Tiwari and Vijaya (1995)
Arcuatipollenites pellucidus (Goubin) Tiwari and Vijaya (1995)
Arcuatipollenites damudicus (Tiwari and Rana) Tiwari and Vijaya (1995)
Arcuatipollenites sp.
- Sulcate
- Weylandites indicus* Bharadwaj and Srivastava (1969)

Table 6. Palynocomposition of palynoaassemblages identified in borehole SKB-1, South Karanpura Coalfield.

Assemblage zone identified (after Tiwari and Tripathi 1992)	Lithology	Depth (m)	Palynocomposition	Significant age marker species	Age
II <i>Densipollenites magnicarpus</i>	Micaceous shale	13.80–43.00	<i>Densipollenites invisus</i> , <i>D. magnicarpus</i> , <i>Faunipollenites varius</i> , <i>Striatites</i> sp., <i>Verticipollenites oblongus</i> , <i>Distriatites bilateris</i> , <i>Crescentipollenites fuscus</i> , <i>C. gondwanensis</i> , <i>Primuspollenites</i> sp., <i>Sahnites</i> sp., <i>Leitotriletes</i> sp. and <i>Cyclobaculisporites indicus</i> . FADs of <i>Arcuatipollenites pellucidus</i> , <i>Krempipollenites</i> sp., <i>Falcisporites</i> sp. and <i>Alisporites</i> sp. are recorded.	<i>Densipollenites magnicarpus</i> , <i>Arcuatipollenites pellucidus</i> , <i>Playfordiaspora cancellosa</i> , <i>Alisporites</i> sp., <i>Falcisporites</i> sp. and <i>Krempipollenites indicus</i>	Late Permian–Lower Triassic
I <i>Gondisporites raniganjensis</i>	Carbonaceous shale, micaceous shale, mudstone, fine-medium grained sandstone with charcoals, coaly shale and coal	53.20–504.00	Dominance of palynotaxa <i>Striatopodocarpites</i> is followed by <i>Crescentipollenites</i> and <i>Scheuringipollenites</i> . Index species recorded here <i>Gondisporites raniganjensis</i> , <i>G. reticulatus</i> , <i>Arcuatipollenites</i> sp., <i>Guttulapollenites hammonicus</i> , <i>Distriomonosaccites ovalis</i> , <i>Verticipollenites oblongus</i> and <i>Distriatites bilateris</i> . Other associated taxa are <i>Microbaculispora barakarensis</i> , <i>Microfoveolatispora foveolata</i> , <i>Cyclogranisporites</i> sp., <i>Cyclobaculisporites</i> sp., <i>Didecitriletes horridus</i> , <i>Horriditriletes curvibaculosus</i> , <i>Rhizomaspora indica</i> , <i>R. monosulcata</i> , <i>Tiwariasporis gondwanensis</i> , <i>Faunipollenites varius</i> , <i>Platysaccus</i> sp., <i>Striasulcites tectus</i> , <i>Bharadwajipollis striatus</i> , <i>Schizopollis</i> sp., <i>Vestigisporites</i> sp., <i>Striamonosaccites ovatus</i> , <i>Densipollenites indicus</i> , <i>D. invisus</i> , <i>Weglandites indicus</i> and <i>Verticipollenites oblongus</i> .	<i>Gondisporites raniganjensis</i> , <i>Guttulapollenites hammonicus</i> , <i>Alisporites ovalis</i> , <i>Arcuatipollenites</i> sp.	Late Permian
	Carbonaceous shale and coaly shale	541.50–552.00	Dominance of <i>Striatopodocarpites</i> spp. and <i>Faunipollenites</i> spp., sub-dominance of <i>Scheuringipollenites</i> spp., and other associated palynomorphs namely <i>Striasulcites tectus</i> , <i>Striatites</i> spp., <i>Schizopollis wodehousei</i> , <i>Crescentipollenites fuscus</i> , <i>Sahnites</i> sp., <i>Vestigisporites</i> sp., Trilete represented by <i>Microbaculispora barakarensis</i> , <i>Microfoveolatispora foveolata</i> , <i>Cyclogranisporites</i> sp., <i>Cyclobaculisporites</i> sp., <i>Didecitriletes horridus</i> , <i>Horriditriletes curvibaculosus</i>	<i>Guttulapollenites hammonicus</i> , <i>Arcuatipollenites</i> sp.	Late Permian

gipollenites genera. Characteristic age marker species recovered in this assemblage are *Gondisporites raniganjensis*, *G. reticulatus*, *Guttulapollenites hannonicus*, *Distriomonosaccites ovalis*, *Verticipoollenites oblongus* and *Distriatites bilateris*. Other associated taxa are *Microbaculispora barakarensis*, *Microfoveolatispora foveolata*, *Cyclogranisporites* sp., *Cyclobaculisporites* sp., *Didectritiletes horridus*, *Horriditriteles curvibaculosus*, *Tiwarisporis gondwanensis*, *Rhizomaspora indica*, *R. monosulcata*, *Faunipollenites varius*, *Platysaccus* sp., *Striasulcites tectus*, *Bharadwajipollis striatus*, *Schizopollis* sp., *Vestigisporites* sp., *Striomonosaccites ovatus*, *Densipollenites indicus*, *D. invisus*, *Weylandites indicus* and *Verticipoollenites oblongus*.

Remarks: By the significant quantitative presentation of *Gondisporites raniganjensis*, *G. reticulatus* in the population of striate bisaccate pollen taxa, this assemblage is comparable to the *Gondisporites raniganjensis*, established in the Raniganj Formation of the Damodar Basin (Tiwari and Tripathi 1992) which is dated as Late Permian in age.

4.2 Palynoassemblage-II

Depth: 39.50–13.80 m; siltstones, micaceous shales, and mudstones (figure 2 and table 3). Palynoassemblage recovered in the interval of 13.80–39.50 m depth in borehole SKB-1 shows dominance of striated bisaccate pollen *Striatopodocarpites* spp. with increased frequency of enveloping monosaccate pollen *Densipollenites* (*D. invisus* and *D. magnicarpus*). The palynoassemblage is much diversified in having abundant striate bisaccate pollen – *Faunipollenites varius*, *Striatites* sp., *Verticipoollenites oblongus*, *Distriatites bilateris*, *Crescentipollenites fuscus*, *C. gondwanensis*, *Primuspollenites* sp. and *Sahnites* sp. The trilete spores are very rare and represented by *Leiotriletes* sp. and *Cyclobaculisporites indicus*. FADs of *Arcuatipollenites pellucidus*, *Krempipollenites* sp., *Falcisporites* sp., and *Alisporites* sp. are recorded in this interval.

Remarks: Palynoassemblage-II, compares with the *Densipollenites magnicarpus* palynoassemblage

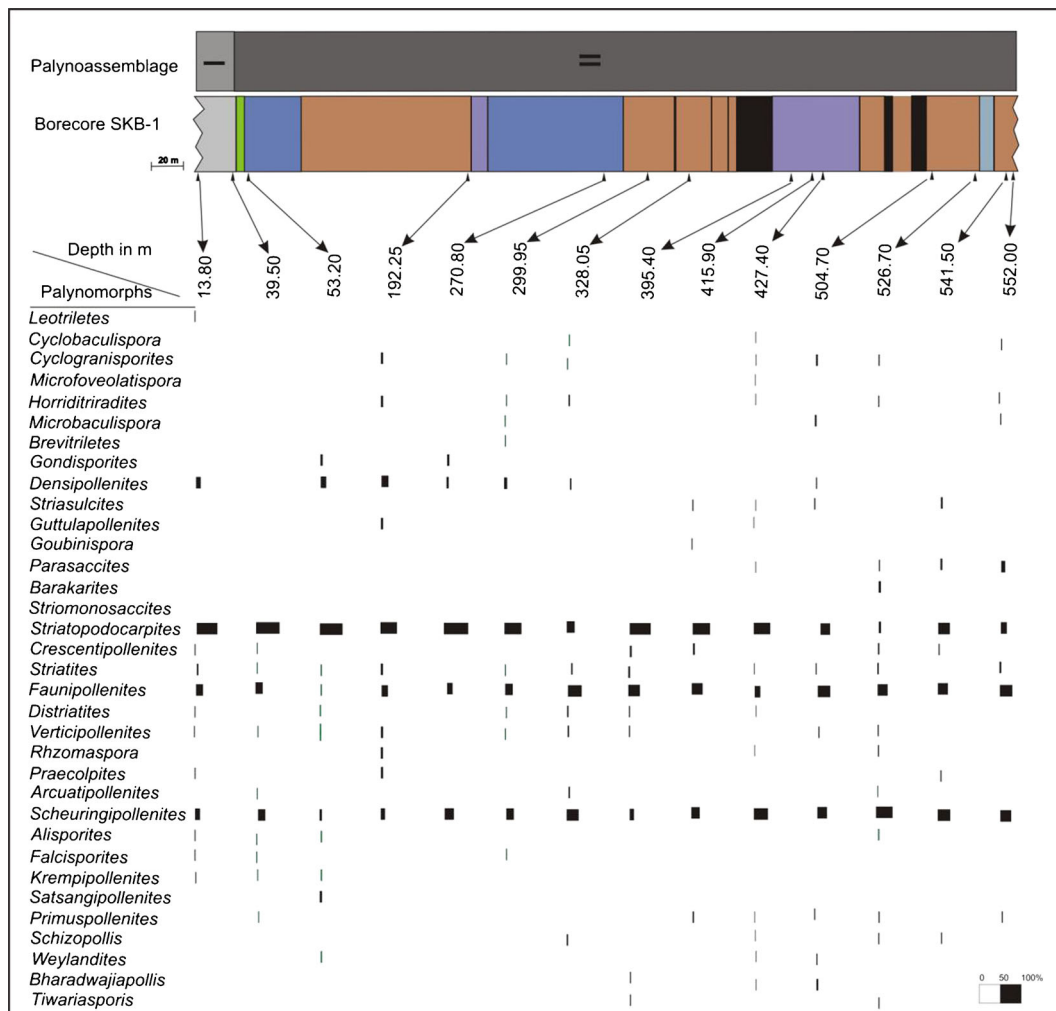


Figure 3. Distribution of important palynotaxa in the borecore SKB-1, South Karanpura Coalfield.

of Tiwari and Tripathi (1992) in having relatively fair occurrence of *D. magnicarpus* and this composition suggests the Latest Permian in age. The FADs of *Arcuatipollenites pellucidus*, *Playfordiaspora cancellosa*, *Krempipollenites indicus*, *Falcisporites* sp., and *Alisporites* sp. observed at 13.80, 14.90 and 39.50 m depths mark the transition from Permian to Triassic period.

5. Discussion

The recovery of palynomorphs in approximately 538.00 m (13.80–552.00 m) thick Gondwana strata is observed with both palynomorphs and palynodebris in equal proportion (figure 2). The palynodebris consists of lumps of organic matter and plant tissues that includes dark to brown woody splinters, amorphous matter (figure 2). This infers high energy flow regime during the deposition of the present studied material. Lithologically the formation intersected in the borecore are Raniganj, Barren Measures, and Barakar formations. The formational contacts – Raniganj and Barren Measures formations is delimited at 37.70 m depth, and Barren Measures and Barakar formations at 429.15 m depth (table 2). The palynological investigation reveals presence of two palynoassemblages. The vertical placement of the two palynoassemblages (I–II) identified, is based upon the stratigraphical importance of the age marker taxa and their relative occurrences along with other associated significant marker species (tables 3, 5, 6, and figure 3). On the basis of the standard palynozonation schemes established for the Permian successions in India (Tiwari and Tripathi 1992), the identified palynoassemblages are used to date the studied litho-succession in borehole SKB-1.

The palynoassemblage-I recorded in strata between 552.00 and 53.20 m depth in borehole is lithologically delimited as Raniganj, Barren Measures, and Barakar formations, contain a prolific palynoassemblage of striate bisaccate pollen taxa with fair presence of *Gondisporites raniganjensis*, *G. reticulates* and *Densipollenites magnicarpus* at 192.25 and 270.80 m depth and FADs of *Guttulapollenites* spp. at 415.90, 504.70, and 526.70 m; *Goubinospora* sp. at 415.90 m; *Alisporites ovalis*, and *Arcuatipollenites* sp. are at 552.00 m depth. This kind of composition correlates with *Gondisporites raniganjensis* palynoassemblage of Raniganj Formation, Damodar Basin which was considered Late Permian by Tiwari and Tripathi (1992).

In palynoassemblage-II, the significant record of enveloping monosaccate pollen *Densipollenites* and striate bisaccate pollen *Stiatopodocarpites* and *Crescentipollenites*, between 13.80 and 39.50 m

depth, corroborate this part with the Raniganj Formation of Latest Permian age (Tiwari and Tripathi 1992). FADs of Early Triassic palynomorphs, viz., *Arcuatipollenites pellucidus*, *Playfordiaspora cancellosa*, *Krempipollenites indicus*, *Alisporites* sp., and *Falcisporites* sp. mark these sediments to span Permian to Early Triassic transition.

6. Conclusion

The palynological study done in approximately 538.00 m thick Gondwana strata in the Borehole SKB-1, South Karanpura Coalfield revealed that:

- The strata between 552.00 and 53.20 m depths are lithologically identified as Barren Measures and Barakar formations. The palynoassemblage here contain an abundance of *Striatopodocarpites* spp., *Crescentipollenites* sp., *Faunipollenites varius*, *Densipollenites magnicarpus*, *Gondipollenites raniganjensis*, and *Scheuringipollenites* spp. The FAD of *Guttulapollenites hannonicus* at 504.00, 526.70 m are observed. This composition compares well with the Raniganj Formation of Late Permian in age.
- Lithological strata between 39.50 and 13.80 m depths are of Raniganj Formation. Palynological dating also indicates Latest Permian age by the presence of stratigraphic age marker species *Densipollenites magnicarpus*. The occurrence of Early Triassic palynomorphs like *Arcuatipollenites pellucidus*, *Playfordiaspora cancellosa*, *Krempipollenites* sp., *Falcisporites* sp., and *Alisporites* sp., suggest that these strata mark the transition from Permian into Lower Triassic period.
- The FAD of *Arcuatipollenites pellucidus* at 13.00, 39.50, 552.00 m; *Playfordiaspora cancellosa* at 13.00, 39.50 m; *Gondisporites raniganjensis*, *G. reticulates*, and *Densipollenites magnicarpus* at 13.00, 43.00, 192.25, and 270.80 m and *Guttulapollenites* spp. at 415.90, 504.70 and 526.70 m; and *Goubinispota* sp. at 415.90 m depth records the Late Permian (Raniganj Formation) age for the complete succession of the borehole SKB-1.
- The complete strata of borecore SKB-1 is dated as Late Permian in age.

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