Palynological dating of subsurface sequence of Middle Pali Member, Sohagpur Coalfield, M.P., India*

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The palynological assemblage recovered from bore-hole SPB-17 (depth 75.00-321.85 m) from Sohagpur Coalfield, representing the Middle Pali Member, contains a total of 41 spores and pollen genera. The common forms are *Densipollenites, Scheuringipollenites, Faunipollenites, Striatopodocarpites, Crescentipollenites, Striatites* and *Lahirites*. On the basis of this analysis, it has been concluded that the assemblage is comparable with that of the Raniganj Formation of Damodar Graben. Occurrence of leiosphaerids is suggestive of marine influence in the area.

INTRODUCTION

SOHAGPUR Coalfield is the biggest coal-bearing area in the South Rewa Gondwana Basin, covering about 3000 sq. km. It comprises three sub-basinal structures in the region from east to west, viz., Jhagrakhand, Kotma-Jamunia and Burhar-Amali.

From Sohagpur Coalfield, the palynological data is little known. Navale and Tiwari (1967) have given a petro-palynological report of Barakar coals from Churcha seam, while Bharadwaj and Srivastava (1971) established the correlation of coal seams in bore-holes from Bhashkarpara, Kutkona and Batura blocks of this coalfield.

GEOLOGICAL SETTING

In Sohagpur Coalfield, the stratigraphical sequence comprises Talchir, Barakar, Pali and Parsora formations. The name "Pali Formation" was given by Hughes (1881) for those rocks which were exposed near Pali village (23^0 24' : 81^0 4'), Bara Daigaon (23^0 22' : 81^0 02') and Karkati ($23^0$22': 81^0 09'). Later, Lele (1964) designated same horizon as "Daigaon Stage". So far, no type section has been formally designated to Pali Formation. However, the rocks exposed in Johilla River section between Beohari Hill (near Tiki) and Neosi (23^0 36' : 81^0 12') are generally considered as the type section (Datta, Singh & Satsangi, 1977).

The Pali Formation, as exposed in Johilla River section, overlies the Barakar Formation and underlies the Parsora Formation. The measured thickness of the Pali Formation varies from 300-500 m. Earlier, the coal deposits were reported only from the Barakar Formation, while the Pali Formation was supposed to be barren of coal. Recently, in Johilla Coalfield thick coalseams have been found in the Middle Pali Member (Datta & Mitra, 1982), but from Sohagpur Coalfield no workable seam has been reported so far. The general lithology of Pali Formation is given below (Datta & Mitra, 1982; Datta, Mitra & Bandyopadhya, 1983; Raja Rao, 1983; Datta, 1989).

Formation	Member	Lithology
Pali	Upper	Coarse-grained, ferruginous, gritty sandstone; fine to medium-grained buff, white, brown or yellow coloured sandstone; sometimes micaceous claystone with granite wash.
	Middle	Fine to medium-grained sandstone ; micaceous sandstone, buff to grey coloured sandstone, carbonaceous shale; laminated shale, coaly shale and thin coalseam.
	Lower	Cross-bedded sandstone, white to grey in colour, arenaceous clay with patches of red and green sandstone. Buff to brown coloured sandstone.

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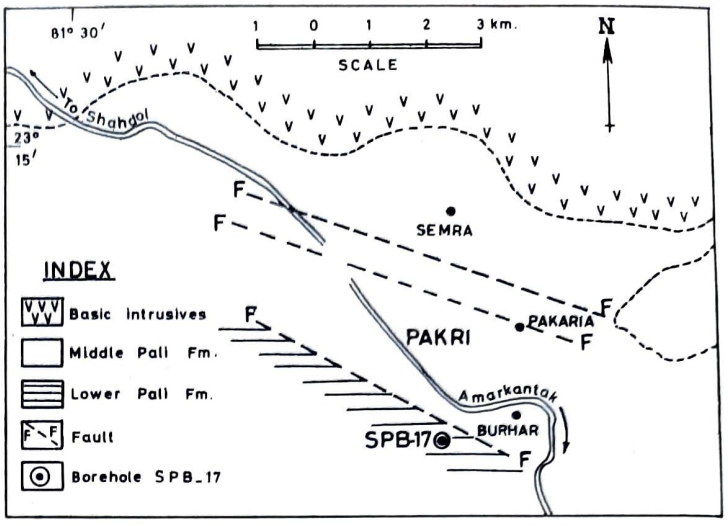
The upper contact of the Pali Formation is characterized by gradual elimination of feldspar and appearance of lilac-coloured clay within the sandstone unit, while the lower contact is marked by the Damuda coal measures.

Materials— Recently, Geological Survey of India has drilled a number of bore-holes in Sohagpur Coalfield to search coal in the Pali Formation. For the present study, samples from bore-hole SPB-17 were analysed palynologically. The bore-hole is located in Pakaria Block in West Central part of Sohagpur Coalfield, in between Barhmani-Chilpi fault, about 2 km west from Burhar Railway station (Map 1). For palynological investigation, 112 samples were macerated out of which 26 samples, listed below, were found productive.



Map 1. Geological map of Sohagpur Coalfield (after S.Adhikari & B.K. Hore, 1989) showing the location of bore-hole.

Sl. No.	Sample No.	Depth in meter	Lithology
1.	SPB 17/20	71.00-75.00	Carb. streak in sandstone
2.	SPB 17/28	95.50-98.50	Clay (grey shale)
3.	SPB 17/29	98.50-99.00	Carbonaceous shale
4.	SPB 17/30	99.00-100.00	Carbonaceous shale
5.	SPB 17/44	135.00-137.00	Fine-grained sandstone
6.	SPB 17/47	138.00-140.00	Black micaceous shale with bright lusture
7.	SPB 17/48	140.00-142.00	Carb. streak in sandstone
8.	SPB 17/51	145.00-156.00	Claystone (Brown colour)
9.	SPB 17/54	159.00-160.00	Fine-grained sandstone (greenish)
10.	SPB 17/59	176.00-177.00	Carbonaceous shale
11.	SPB 17/63	185.00-186.00	Carbonaceous shale
12.	SPB 17/67	193.00-194.00	Carbonaceous shale
13.	SPB 17/73	220.50-223.15	Carbonaceous shale
14.	SPB 17/74	223.15-224.15	Fine-grained sandstone
15.	SPB 17/80	237.00-237.80	Mudstone
16.	SPB 17/82	240.70-241.70	Fine-grained sandstone
17.	SPB 17/88	249.50-253.85	Carb. streak in sandstone
18.	SPB 17/90	261.15-264.65	Mudstone
19.	SPB 17/92	266.65-269.70	Carbonaceous shale
20.	SPB 17/93	269.70-271.70	Coal
21.	SPB 17/96	277.15-278.00	Shale
22.	SPB 17/97	278.00-280.00	Liminated shale
23.	SPB 17/101	284.25-285.25	Coal
24.	SPB 17/106	288.53-289.53	Coaly shale
25.	SPB 17/107A	299.40-302.95	Coal
26.	SPB 17/111	316.35-321.85	Carb. streak in sandstone

PALYNOFOSSIL ASSEMBLAGE

Forty-one spore/pollen genera listed below have been identified in bore-hole SPB-17.

Triletes

Callumispora Bharadwaj & Srivastava 1969 emend. Tiwari *et al.* 1989
Brevitriletes Bharadwaj & Srivastava 1969 emend. Tiwari & Singh 1981
Dentatispora Tiwari 1964
Cyclogranisporites Potonié & Kremp 1954
Cyclobaculisporites Bharadwaj 1955
Lophotriletes Naumova ex Potonié & Kremp 1954
Microbaculispora Bharadwaj 1962
Microfoveolatispora Bharadwaj 1962
Verrucosisporites Ibrahim emend. Smith *et al.* 1971
Indotriradites Tiwari 1964

Gondisporites Bharadwaj 1962

Monolete

Latosporites Potonié & Kremp 1954 emend. Potonié 1966

Monosaccates

Parasaccites Bharadwaj & Tiwari emend. Tiwari *et al.* 1989
Plicatipollenites Lele 1964
Potonieisporites Bharadwaj emend. Bharadwaj 1964
Densipollenites Bharadwaj 1962
Barakarites Bharadwaj & Tiwari 1964
Striomonosaccites Bharadwaj 1962

Non-Striate disaccate

Scheuringipollenites Tiwari 1973
Alisporites Daugherty emend. Nilson 1958
Klausipollenites Jansonius 1962

Striate disaccates

Faunipollenites Bhardwaj emend. Tiwari *et al.* 1989
Rhizomaspora Wilson 1962
Striatopodocarpites Soritsch. & Sedova emend. Bharadwaj 1962
Crescentipollenites Bharadwaj, Tiwari & Kar 1974
Striatites Pant emend. Bharadwaj 1962
Verticipollenites Bharadwaj 1962
Hamiapollenites Wilson emend. Tschudy & Kosanke 1966
Distriatites Bharadwaj 1962
Lahirites Bharadwaj 1962

Taeniate pollen

Lueckisporites Potonié & Klaus emend. Bharadwaj 1974
Lunatisporites Leschik emend. Scheuring 1970
Corisaccites Venkatachala & Kar 1966
Guttulapollenites Goubin emend. Venkatachala, Goubin & Kar 1969

Non-striate disaccate with monolete mark

Sahnites Pant emend. Tiwari & Singh 1984

Alete spores

Quadrisporites Hennelly emend. Potonié & Lele 1961
Leiosphaeridia Eisenack emend. Downie & Sarjeant 1963

Other genera

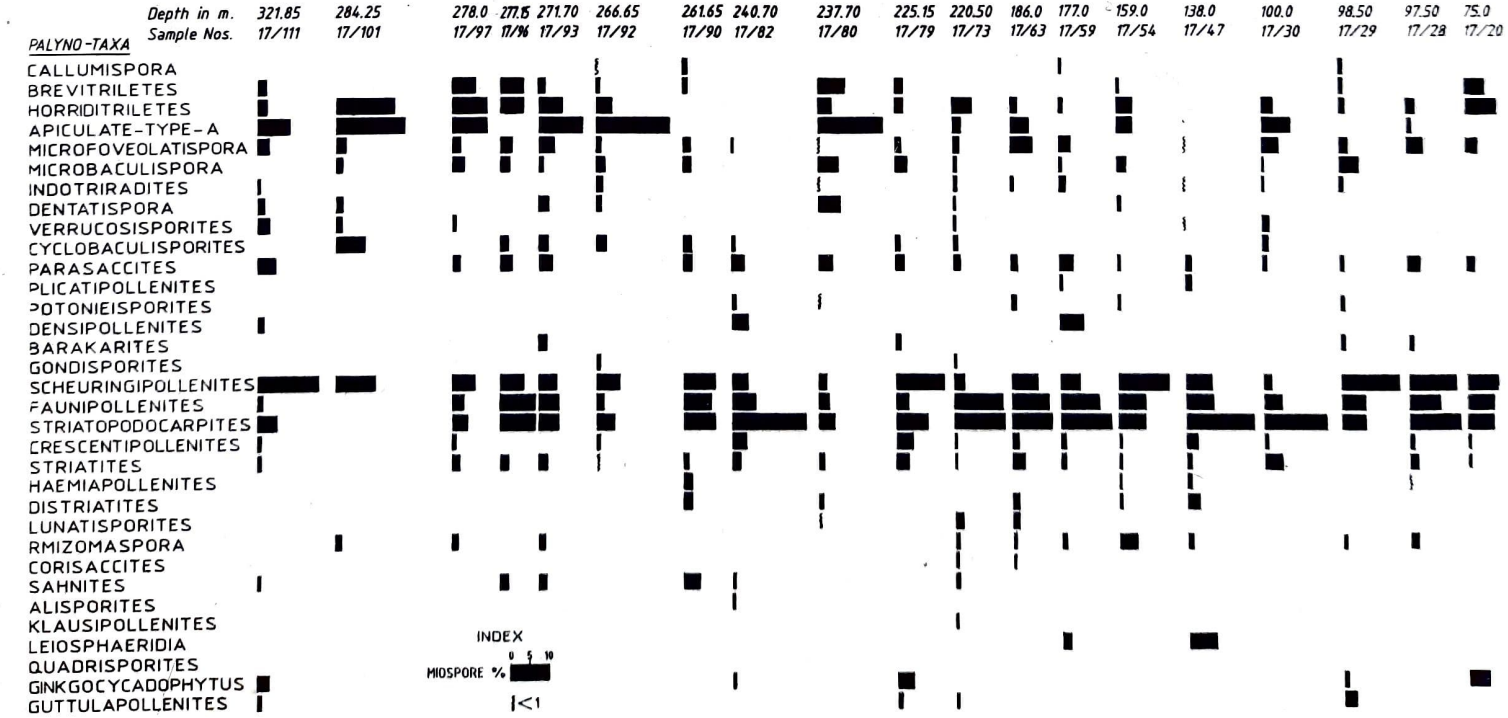
Weylandites Bharadwaj & Srivastava 1969
Ginkgocycadophytus Luber ex. Samoloivich 1953
Ephedripites Bolkhovitina 1953, Krutzseh 1961

Tiwariasporis Maheshwari & Kar 1967

Generic composition, correlation and dating of sequence

In all 41 genera of spores and pollen have been identified and stratigraphic distribution of important taxa has been plotted (Text-fig. 1) which show uniform pattern of frequency. The dominating elements are *Scheuringipollenites, Striatopodocarpites, Faunipollenites* (<25%) while the subdominant elements are *Crescentipollenites* and *Horriditriletes* (15-25%); rest of the forms are common (2-15%). Besides, the rare forms include *Klausipollenites, Weylandites* and *Alisporites.*

On the basis of qualitative analysis a Late Permian age have been assigned to this assemblage (see Bharadwaj, 1962; Bharadwaj & Salujha, 1965; Salujha, 1965; Lele & Srivastava, 1979; Tiwari *et al.*, 1981). Comparison of the present assemblage with that of Churcha Seam analysed by Navale and Tiwari (1967) has revealed that *Leiotriletes, Retusotriletes, Lophotriletes,*



Text-figure 1. Percentage frequency of important miospore genera through bore-hole SPB-17, Pakaria Block, Sohagpur Coalfield.

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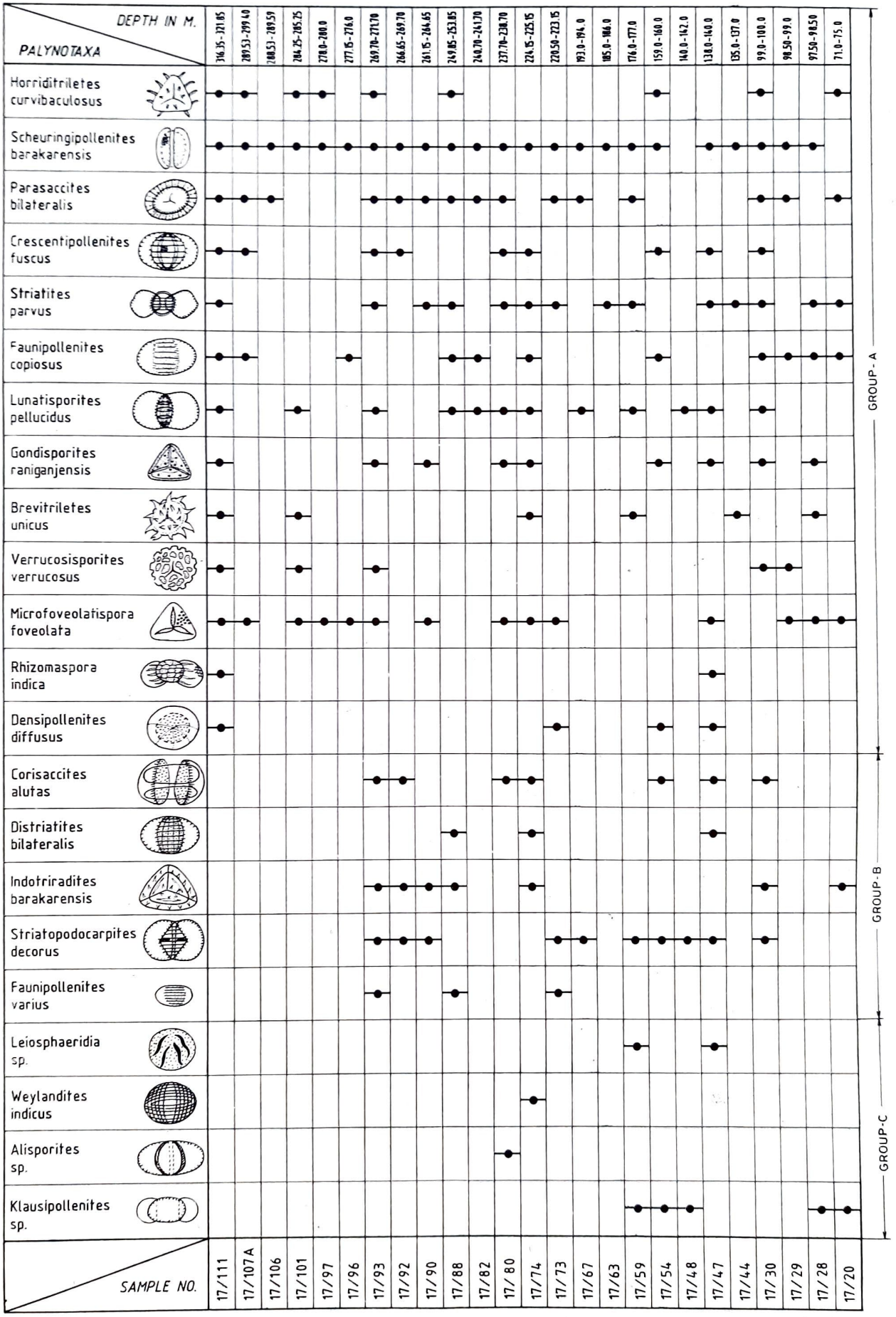

Text-figure 2. Distributional pattern of species in the Middle Member of Pali Formation in bore-hole SPB-17, Sohagpur Coalfield.

Parasaccites, *Illinites* (*Sahnites*) and *Indotriradites* are dominant in the latter assemblage while in the present assemblage they are rare or absent. Dominance of *Faunipollenites*, *Scheuringipollenites* and *Striatopodocarpites* in the present assemblage indicates younger aspect than the Churcha Seam.

The palynological assemblages of Sohagpur Coalfield described by Bharadwaj and Srivastava (1971) is characterized by the dominance of zonate and apiculate triletes spores viz., *Brevitriletes*, *Horriditriletes* and *Indotriradites* along with *Microbaculispora* (see histograms 1-4 of Bharadwaj & Srivastava, 1971). While the other forms, like *Scheuringipollenites* and striate groups are less significant. In the present assemblage the disaccates, *Scheuringipollenites*, *Striatopodocarpites* and *Faunipollenites* are in dominance and also some forms indicating younger aspect like—*Lunatisporites*, *Weylandites* and *Alisporites* are also recorded. The present assemblage is, therefore, younger to all palynofloras reported from the Sohagpur Coalfield.

From Pali Formation, the first palynological assemblage was reported by Tiwari and Ram-Awatar (1986) from bore-core (JHL-27A) 4 km SE of Nawrozabad (R.S.) in Johilla Coalfield. The present assemblage is comparable with the patterns given in Histogram 1 of Tiwari & Ram-Awatar (1986), except that *Satsangisaccites*, *Infernopollenites* and *Brachysaccus* are absent. In the absence of taxa *Lundbladispora*, *Osmundacidites*, *Playfordiaspora*, *Satsangisaccites*, *Laricoidites* the present assemblage differs from that of the Dargaon-Salaia and Korar Palyno-assemblage (UKD - 8) (Tiwari & Ram-Awatar, 1987a, b) and therefore, is older in age. The Nidpur palynoflora (Tiwari & Ram-Awatar, 1990) from Pali sequence is still younger because the taeniate pollen are more significantly represented. However, the palynoassemblage of the northern limb of the "Nidpur bed" (Tiwari & Ram-Awatar, 1990; text-fig.3) shows resemblance in having dominance of striate disaccate. Thus it is evident that the present palynological assemblage is older in age than those of the Upper Member of Pali Formation. Record of Leaiid estheriids—*Hemiacycloleaia*, *Monoleaia*, from Richai Hill exposed in western part of Sohagpur Coalfield, also support a Late Permian age of Middle Pali Mamber (Ghosh *et al.* 1988).

Species distribution pattern

Palynological analysis of the bore-core samples collected from Lower and Middle members of the Pali Formation (depth from 321.85-44.00 m Lower Member, and 43.00-12.00 m Middle Member) has revealed that distributional pattern of spore-pollen genera in the Middle Pali are more or less monotonous.

To determine the distributional pattern and vertical range of species, 22 qualitatively important taxa were selected. A set of 8 slides of each productive samples were scanned to confirm the definite presence or absence of the species. The results of such analysis are depicted in Text-figure 2; a perusal of which suggests that 3 groups of population can be differentiated within the Middle Pali Member.

Group A — The important species are-*Horriditriletes curvibaculosus*, *Scheuringipollenites barakarensis*, *Striatites parvus*, *Faunipollenites copiosus*, *Lunatisporites pellucidus*, *Gondisporites raniganjensis*, *Microfoveolatispora foveolata*, *Brevitriletes unicus*, *Densipollenites diffusus*, *Verrucosisporites verrucosus*, *Rhizomaspora indica*, *Parasaccites bilateralis*, *Crescentipollenites fuscus*. These species occur in each productive samples (depth 316.35-321.85-71.00-75.00 m) their absence in a few samples is, however, attributed to their low frequency.

Group B — In addition to the above species, in Group B some more species viz., *Corisaccites alutas*, *Indotriradites barakarensis*, *Striatopodocarpites decorus*, *Faunipollenites varius*, *Distriaties bilateralis* are recorded above the depth of 269.70-271.70 m-71.00-75.00m.

Group C — As it is clear from Text-figure 2, that a few younger elements, viz., *Klausipollenites* sp., *Alisporites* sp. and *Weylandites indicus* though sporadic, are recorded for the first time in the sequence (in samples Nos., 17/80, 74, 59). So also leiosphaerids are recorded only in two samples (17/59,47); this indicates that 'Group C' represents the Pali in closing phase of upper Middle Member of the Pali Formation.

DISCUSSION

There are two views regarding the classification of Pali Formation. According to Sinha and Chowdhury (1980); Datta and Mitra, (1982); Datta, Mitra and Bandyopadhyay (1983) and S.K. Shome (per com. 1983) the Pali Formation is divisible into three members, viz., Lower, Middle and Upper. Another school of thought (Raja Rao, 1983; Datta, 1989) maintains the bipartite division having Lower and Upper Members. So far, two distinct palynological assemblages have been indentified in the Pali Formation one equated with the Upper Member and the other with the Middle (Tiwari & Ram-Awatar, 1986, 1987a,b).

The sediments of the Lower Pali Member have not yielded the palynofossils so far, probably because of the coarse-grained to ferruginous nature of the sandstone and red to mottled-coloured clays as observed in bore-hole samples studied presently.

In two samples (17/47,59) smooth walled leiosphaerids have been recorded which suggest a probable marine influence in the Pali Formation. Such forms have also been recorded from Talchir Formation of Umaria and Manendragarh (Lele & Chandra, 1969) and Barakar and Karharbari formations in the Johilla and Umaria coalfields (Anand-Prakash & Srivastava, 1984; Srivastava & Anand-Prakash, 1984). Sinha (1969) has recorded similar and allied forms, such as, *Hemisphaerium* and *Circulisporites* from Jhingurdha seam of the Singrauli Coalfield. The aspect of the marine influence have been discussed by Venkatachala and Tiwari (1988) and the occurrence of *Leiosphaeridia* in Sohagpur Coalfield in the Middle Pali Member is interesting from the environment point of view.

CONCLUSION

From the palynological study it is concluded that the Middle Member of the Pali Formation is correlatable with the Raniganj Formation. The Upper Member shows Permian/Triassic affinities as recorded by Tiwari and Ram-Awatar (1987a) in Johilla Coalfield.

Presence of leiosphaerids indicates a probable shallow marine influence in the Upper Permian sequence in Sohagpur Coalfield.

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Plate 1

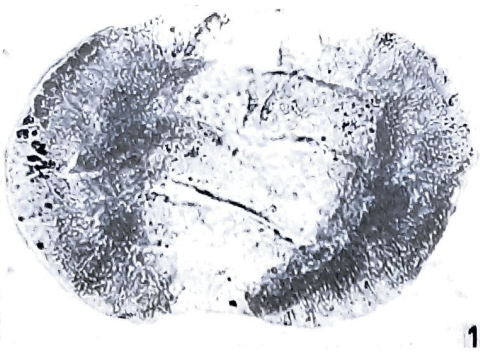
(All photomicrographs are enlarged, Ca. x 500; Coordinate on Leitz. Microscope No. 512799/066300).

1. *Lunatisporites* Sl. no. BSIP. 10711; Coordinate : 15 x 111.
2. *Hamiapollenites* Sl. no. BSIP. 10712; Coordinate : 9 x 107.
3. *Striatopodocarpites* Sl. no. BSIP. 10715; Coordinate : 23 x 110.
4. *Alisporites* Sl. no. BSIP. 10710; Coordinate : 10 x 112.
5. *Lueckisporites* Sl. no. BSIP. 10716; Coordinate : 17 x 107.

6,8. Gondisporites Sl. no. BSIP. 10712, 10715; Coordinates: 9 x 107, 40 x 96.

7,16. *Leiosphaeridia* Sl. no. BSIP. 10714, 10710; Coordinates: 14 x 106, 35 x 103.

9. *Scheuringipollenites* Sl. no. BSIP. 10711; Coordinate : 7 x 107.
10. *Rhizomaspora* Sl. no. BSIP. 10714; Coordinate : 17 x 103.
11. *Lahirites* Sl. no. BSIP. 10716; Coordinate : 13 x 95.
12. *Faunipollenites* Sl. no. BSIP. 10715; Coordinate : 23 x 108.
13. *Striatites* Sl. no. BSIP 10713; Coordinate : 17 x 109.
14. *Crescentipollenites* Sl. no. BSIP. 10713; Coordinate : 7 x 109.
15. *Corisaccites* Sl. no. BSIP. 10712; Coordinate : 32 x 97.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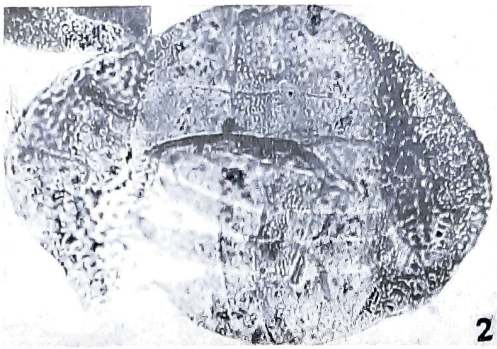
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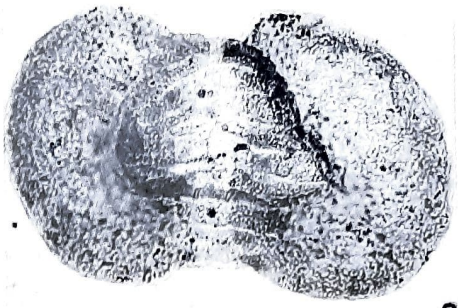
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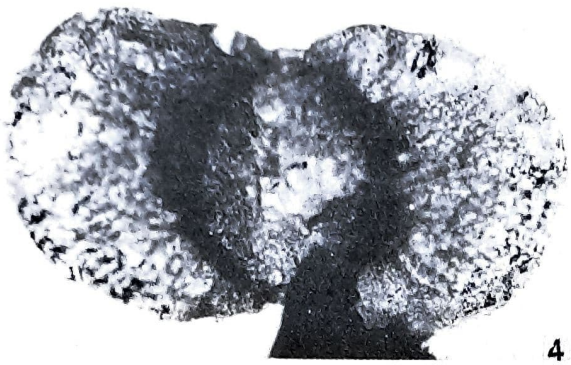
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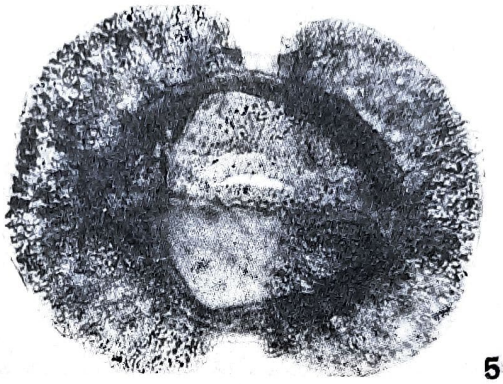
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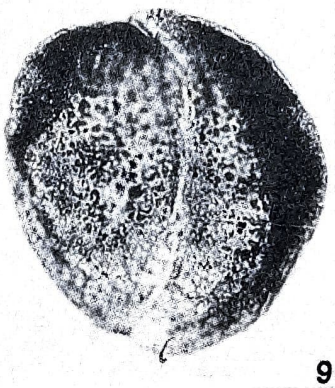
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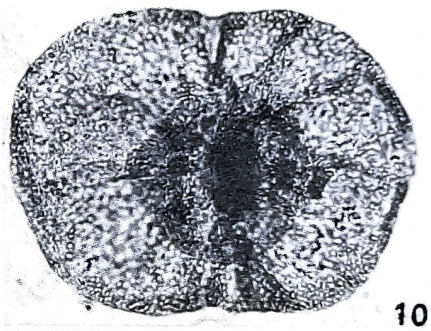
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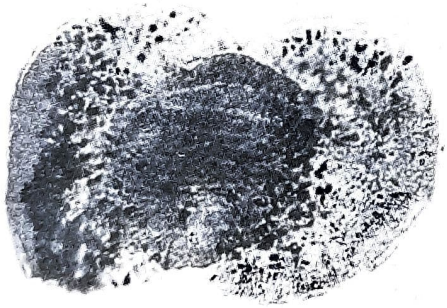
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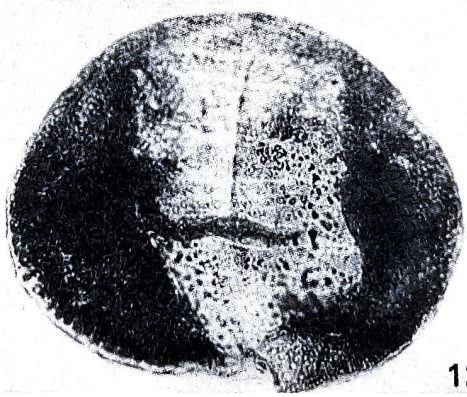
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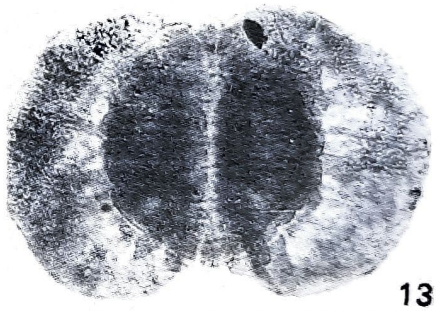
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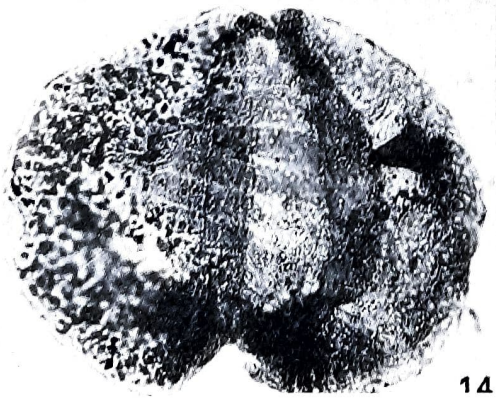
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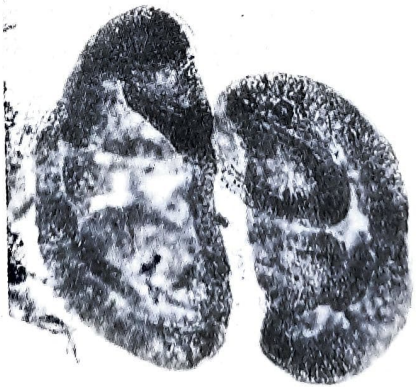
15


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Plate 1

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