

# PALYNOLOGICAL SUCCESSION THROUGH RANIGANJ FORMATION (UPPER PERMIAN), RANIGANJ COALFIELD, INDIA

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## ABSTRACT

Raniganj Coalfield is the type-area for the Raniganj Stage of the Damuda Series (Lower Gondwana). Palynological analysis of a bore-core in Dishergarh area of this coalfield suggests a constant and continuous preponderance of striate disaccate genera, without any remarkable miofloral break within the succession. Apiculate trilete, non-striate disaccate and monoletes genera are next in order of frequency. The Raniganj mioflora can be differentiated from that of the underlying Barron Measures by the rarity of an enveloping monosaccate genus—*Densipollenites*, and substantial increase of triletes, while from that of the overlying Lower Panchet by the paucity of *Callumispora*, mesosporoid trilete and taeniate disaccate genera.

## INTRODUCTION

THE Raniganj Formation is a sequence of coalseams alternating with shales and sandstones. This includes the youngest deposits in the Damuda Series of the Lower Gondwana, being underlain by the Barren Measures and overlain by the Panchet Series. The Raniganj Stage is Upper Permian in age.

The significance of the present work lies in the fact that Raniganj Coalfield is the type area for the Raniganj Stage. Earlier to this, Ghosh and Sen (1948), Bharadwaj (1962), Shrivastava and Pawde (1962), Chandra (1962), Bharadwaj and Salujha (1965a, 1965b), Salujha (1965), Kar (1970a, 1970b), Satsangi, Chandra and Singh (1972), Sarb-adhikari (1972), Navale and Srivastava (1972) and Maheshwari (1974) have also worked out the miofloral assemblages in different parts of this coalfield. However, a complete sequence at one region has never been covered by these studies. On the other hand the present study is based on the bore core samples representing a more or less complete sequence, and therefore, a continuous spectrum of *sporae dispersae* could be obtained, from base to the top of this formation.

## MATERIAL AND METHODS

The material for the present investigation has been obtained from a bore-hole (B.H. No. NCRD-2; 22°40'N; 86°54'E, depth from the surface 1073.79 m) in Dishergarh Block 'A' of this coalfield (For map of Dishergarh 'Block A', see Bharadwaj & Tiwari, 1976). The samples as well as the details of the log (Table 1), were kindly supplied by the National Coal Development Corporation.

The samples were macerated by usual method of nitric acid and potassium hydroxide treatment. For determining the percentage frequency, two hundred specimens were counted at the generic level from each sample.

## MIOSPORE SPECTRUM IN B.H. NCRD-2

Out of 55 samples in the bore-hole NCRD-2 (Table 1), 49 have yielded the miospores. In majority of the samples, palynomorphs were abundant as well as in good state of preservation. The miospore genera which constitute the assemblage through the succession in this bore-hole are listed in Table 2.

The miospore genera marked with asterisks are rare and sporadic in occurrence; in many cases they are found in only one of the samples analysed here. Their record here, however, is significant in view of their substantial incidences in the older or younger deposition of the Gondwana sequence.

The quantitative analysis reveals that through the succession, the palynomorph suit consists of triletes—laevigate and apiculates, monoletes—laevigate and apiculates, monosaccates (very rare), disaccates—striate and non-striate, colpate, plicate and alete forms.

The break-down of the dominant, sub-dominant, common and rare incidences is

TABLE 1

Bore hole NCRD-2  
CAR/BH-48/NCRD-2 NCDC:

SL. No.	LAB SAMPLE No.	SAMPLE No.	THICKNESS (m)	DEPTH FROM SURFACE (m)	SEAM
1.	1	C1/64	0.43	186.71	Shale (& Sst.)
2.		C2/64	0.68	198.37	
3.		C3/64	0.38	199.05	
4.	2	C4/64	1.50	234.06	Bharatchak Seam (X)
5.		C5/64	1.60	234.56	
6.	3	C6/64	0.95	252.11	Shale (& Sst.)
7.		C7/64	0.33	256.23	
8.		C8/64	0.45	256.76	
9.		C9/64	0.28	270.26	
10.	4	C10/64	0.40	333.01	Gopalpur (IX)
11.	5	C11/64	0.26	342.99	Shale (& Sst.)
12.		C12/64	0.40	343.43	
13.		C13/64	0.26	369.66	
14.		C14/64	0.77	378.81	
15.	6	C15/64	1.50	416.36	Barachak (VIII)
16.		C16/64	1.64	417.86	
17.		C17/64	0.36	419.58	
18.	7	C18/64	0.43	447.53	Shale (& Sst.)
19.		C19/64	0.36	457.68	
20.		C20/64	0.22	471.96	
21.		C21/64	0.24	472.53	
22.		C22/64	0.05	474.77	
23.		C23/64	0.22	475.01	
24.		C24/64	0.80	497.65	
25.		C25/64	0.08	498.67	
26.		C26/64	1.17	538.86	
27.		C27/64	0.15	540.14	
28.		C28/64	0.80	547.93	
29.	8	C29/64	1.15	555.40	Lower Dhadka Seam (VII)
30.		C30/64	0.89	556.64	
31.		C31/64	0.32	557.98	
32.	9	C32/64	0.24	591.02	Shale (& Sst.)
33.		C33/64	0.25	591.78	
34.	10	C34/64	0.95	614.11	Shripur Seam (VI)
35.		C35/64	0.52	615.24	
36.	11	C36/64	0.33	652.88	Shale (& Sst.)
37.		C37/64	1.20	658.19	
38.		C38/64	0.29	668.46	
39.	12	C39/64	0.68	736.97	Raghunathbatty Seam (VA), Bhuradhemo Seam (V)
40.		C40/64	0.30	768.79	
41.	13	C41/64	0.32	783.95	Shale (& Sst.)
42.		C42/64	0.46	815.24	
43.		C43/64	0.37	830.58	
44.		C44/64	0.28	871.84	
45.		C45/64	0.27	890.93	

Contd.

TABLE 1

SL. No.	LAB SAMPLE No.	SAMPLE No.	THICKNESS (m)	DEPTH FROM SURFACE (m)	SEAM
46.	14	C46/64	3.90	930.12	Dishergarh Seam (IV)
47.	15	C47/64	0.12	935.25	Shale (& Sst.)
48.		C48/64	0.32	935.43	
49.		C49/64	0.55	946.91	
50.	16	C50/64	0.44	1024.37	Hatinal Seam (III)
51.		C51/64	0.62	1024.91	
52.	17	C52/64	0.40	1034.80	Shale (& Sst.)
53.		C53/64	0.59	1041.65	
54.		C54/64	0.30	1042.50	
55.	18	C55/64	1.39	1073.93	Sanctoria Seam (II)

TABLE 2

Miospore genera found in the sequence through Bore-hole NCRD-2 (For generic circumscription refer Bharadwaj, 1962, 1966; Tiwari, 1974a, 1974b; Lele, 1974)

- Leiotriletes* (Naum.) Pot. & Kr. 1954  
 \**Eupunctisporites* Bharad. 1962  
 \**Callumispora* Bharad. & Sriv. 1969  
 \**Hennellysporites* Tiwari 1968  
*Cyclogranisporites* Pot. & Kr. 1954  
 \**Granulatisporites* (Ibr.) Pot. & Kr. 1954  
*Verrucosisporites* (Ibr.) Pot. & Kr. 1954  
*Lophotriletes* (Naum.) Pot. & Kr. 1954  
*Apiculatisporis* (Ibr.) Pot. & Kr. 1956  
*Acanthotriletes* (Ibr.) Pot. & Kr. 1954  
*Brevitriletes* Bharad. & Sriv. 1969  
*Horriditriletes* Bharad. & Salujha 1964  
*Microbaculispora* Bharad. 1962  
 \**Brijajisporites* Tiwari 1967  
*Indospora* Bharad. 1962  
*Cyclobaculisporites* Bharad. 1955 ex Bharad. 1965  
*Microfoveolatispora* Bharad. 1962  
*Gondisporites* Bharad. 1962  
*Potonicitriradites* Bharad. & Sinha 1970  
 \**Indotrivadites* Tiwari 1964  
*Latosporites* Pot. & Kr. 1954  
 \**Punctatosporites* Ibr. 1933  
*Thymospora* Wilson & Venkatach. 1963  
*Spinosporites* Alp. 1958  
*Densipollenites* Bharad. 1962  
 \**Baraharites* Bharad. & Tiwari 1964  
 \**Crucisaccites* Lele & Maithy 1964  
*Striomonosaccites* Bharad. 1962  
*Cuneatisporites* Lesch. 1955
- Platysaccus* (Naum.) Pot. & Kl. 1954  
*Schizopollis* Venkatach. & Kar 1964  
 \**Lueckisporites* Pot. & Kl. emend. Pot. 1958  
*Striatites* Pant emend. Bharad. 1962  
*Primuspollenites* Tiwari 1964  
*Rhizomaspora* Wilson 1962  
*Lahirites* Bharad. 1962  
 \**Lunatisporites* Lesch. emend. Scheuring 1970  
*Crescentipollenites* Bharad., Tiwari & Kar 1974  
*Striatopodocarpites* Soritsch. & Sed. emend. Bharad. 1962  
*Hindipollenites* Bharad. 1962  
*Verticypollenites* Bharad. 1962  
*Faunipollenites* Bharad. 1962  
 \**Circumstriatites* Lele & Makada 1972  
 \**Distriatites* Bharad. 1962  
 \**Corisaccites* Venkatach. & Kar 1966  
*Illinites* (Kos.) Pot. & Kr. 1954  
 \**Klausipollenites* Janson. 1962  
*Vesicaspora* Schemel emend. Wils. & Venkatach. 1963  
*Scheuringipollenites* Tiwari 1973  
*Ibisporites* Tiwari 1967  
 \**Marsupipollenites* Balme & Henn. 1956  
*Ginkgocycadophytus* Samoil. 1953  
*Welwitschiapites* Bolchovit. 1953  
*Decusatisporites* Lesch. emend. Janson. 1962  
 \**Maculatasporites* Tiwari 1964  
 \**Pilasporites* Balme & Henn. emend. Tiwari & Navale 1967



as given below (also refer Histogram 1; Solid-blocks):

1. DOMINANT  
*Striatopodocarpites* 28-53% (Average 42.3%)
2. SUBDOMINANT  
*Striatites* 2.5-13% (Average 8.9%)  
*Faunipollenites* 2-24.5% (Average 8.6%)  
*Lahirites* 1-14% (Average 6.7%)  
*Latosporites* 1-13% (Average 4.9%)  
*Crescentipollenites* 0.5-10% (Average 4.7%)
3. COMMON  
*Vesicaspora* 0-10% (Average 3.3%)  
*Lophotriletes* 0-12.5% (Average 2.5%)  
*Scheuringipollenites* 0-7% (Average 2.3%)  
*Horriditriletes* 0-9.5% (Average 2.2%)  
*Verticypollenites* 0-6% (Average 1.6%)  
*Hindipollenites* 0-4.5% (Average 1.5%)  
*Thymospora* 0-8% (Average 1.2%)  
*Cyclobaculisporites* 0-6.5% (Average 1.1%)  
*Leiotriletes* 0-7% (Average 1.1%)
4. RARE  
(Average less than 1%)  
*Brevitriletes*, *Indospora*, *Cyclogranisporites*, *Verrucosisporites*, *Apiculatisporis*, *Acanthotriletes*, *Microbaculispora*, *Gondisporites*, *Potonicitiradites*, *Spinospores*, *Densipollenites*, *Striomonosaccites*, *Ibisporites*, *Cuneatisporites*, *Platysaccus*, *Schizopollis*, *Primuspollenites*, *Rhizomaspora*, *Illinites*, *Ginkgocycadophytus*, *Welwitschia-pites*, *Decussatisporites*.

5. VERY RARE AND INCONSISTENT IN OCCURRENCE  
Miospore genera marked with asterisks in Table 1.

The qualitatively important constituents of this mioflora are — *Lahirites*, *Hindipollenites*, *Verrucosisporites*, *Indospora*, *Gondisporites*, *Spinospores* and *Thymospora*.

The incidences of miospores when viewed from the zonation point of view, do not show any significant break or a change at any point. Although there are low increasing or decreasing tendencies in the percentages of certain genera, the uniform continuity in the trends of dominance and

subdominance is very well exhibited. Therefore, minor fluctuations are explicable as variations, but not as any miofloral break, in such a uniform sequence.

The miospore genera encountered in this sequence can be segregated in the following 11 groups. The average percentage frequencies of these groups are given below:

Miospore Groups	Average Percentage
1. Laevigate triletes	1.14
2. Apiculate triletes	7.29
3. Varitriletes	1.55
4. Zonate-Cingulate	0.54
5. Monoletes	6.62
6. Monosaccates	
a. enveloping	0.60
b. girdling	0.02
c. striate	0.05
7. Striate disaccates	74.31
8. Taeniate disaccates	0.03
9. Reticuloid-striate disaccates	0.50
10. Non-striate disaccates	6.85
11. Monocolpates and other	0.50
	100.00

It is thus evident from the above analysis that the striate disaccate genera dominate in the population, being 74.31 per cent. The apiculate trilete, non-striate disaccate and monolete genera are next in order of occurrence with a relatively much lower percentages. Other genera are rare, very rare or sporadic.

#### COMPARATIVE PROSPECT

Histogram 1 shows the results of the miospore analysis of the sample-groups in Bore hole NCRD-2 as well as certain other data from Barren Measures, Raniganj and Lower Panchet miofloras available from different sources. The frequencies of miospore genera in NCRD-2 are drawn in solid-blocks, while those from others are represented in line-blocks. The arrangement is sequential in case of NCRD-2 samples with interpolation of corresponding seams in between (line-blocks) for comparison. In case of NCRD-2 samples, the miospore percentage in coalseam samples as well as in alternating inter-coalseam shale and thin coal-band samples have been merged

separately, although every sample has been analysed individually. The arrangement of Barren Measure data is not strictly sequential and has been considered here from the comparison point of view. In the histogram, "Index-number" has been given to each column of miofloral frequency for the sake of convenience in discussion.

A perusal of Histogram 1 reveals that the Sibbabudih and Katri Nala (mean) mioflora (here Index no. 1) and Brahmni Coalfield mioflora (Index no. 2), both belonging to the Barren Measure Stage, contain a relatively higher percentage of the genus *Densipollenites* when compared to the general sequence of the Raniganj mioflora (Bharadwaj, Sah & Tiwari, 1965; Srivastava & Maheshwari, 1974). This significant occurrence is again marked in the bore hole K<sub>2</sub>, in North Karanpura Coalfield (Index no. 7; Kar, 1969b); however, this mioflora has been dated as Lower Raniganj by Kar (1969b). Similarly, the zone having no *Densipollenites* prominence in the bore hole K<sub>5</sub> (Index no. 4) in the North Karanpura Coalfield has been assigned to Barren Measures by Kar (1969a, 1973). In the generalized results of the top most Barren Measures, (Kar, 1971, Zone C; here Index no. 3) the genus *Densipollenites* is insignificant in frequency.

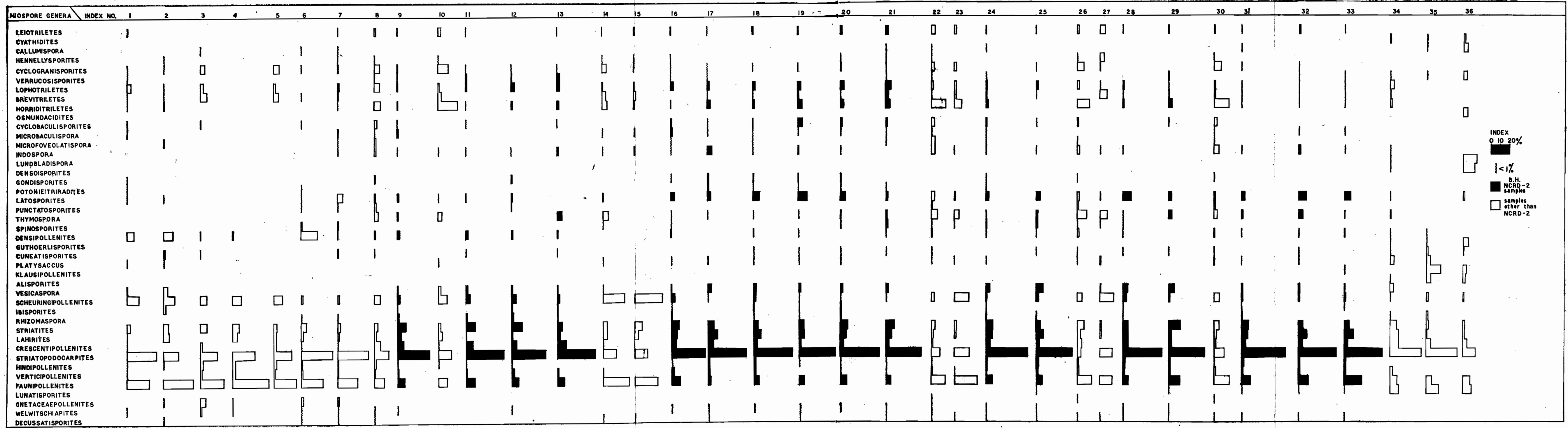
In the Raniganj Coalfield, Taltore Seam (Seam I)—the lowermost seam (Index no. 8; after Srivastava, 1963) does not contain significant *Densipollenites*. Although the shale bands within the sandstone which lies below the lowermost seam (Seam I) were not available for palynological studies, the lower trend of occurrence of the genus *Densipollenites* in the lowermost seam (Taltore Seam) of Raniganj Formation indicates its importance only for the Barren Measure mioflora. Barren Measures are the depositions, barren of significant coal-seams, between the topmost Barakar and the lowermost Raniganj coal measures. Since the lowermost coal seam (Taltore) of the Raniganj Formation in the type area does not contain significant *Densipollenites*, the miospore assemblages containing this genus in high percentage should be taken to be allied with the Barren Measure mioflora and those with low percentage are indicative of Raniganj miofloral affinity.

In Histogram 1, the seams II to X (as well as the intermediate shales in sandstone,

in bore hole NCRD-2; Index nos. 9, 11-13, 16, 21, 24, 25, 28, 29, 31-33 here drawn in solid blocks) show a continuous, monotonous striate disaccate predominance. The coal seams drawn here in line block for comparison, although show some variation, are also comparable with the general trends of striate disaccate occurrence. The apparent differences are probably due to the lateral variation in the particular seam. Index nos. 34, 35 and 36, the three assemblages from bore hole NCRD-6 (Bharadwaj & Tiwari, 1976) from the topmost Raniganj through Lower Panchet Series, have been drawn here in sequence. Index no. 34 is equivalent to Seam X and the topmost shale. It is obvious, therefore, that the *Densipollenites* rich mioflora of the Upper Raniganj beds described by Maheshwari (1974) in Nonia Nala section, has been found neither in bore hole NCRD-2 nor in NCRD-6. Index nos. 35 and 36 are lithologically within the Lower Panchets. The distinction between the topmost Raniganj mioflora Index no. 33, 34) and that of the Lower Panchet (Index no. 35 and 36) is evident in the Histogram. The Index no. 35 contains a median transitional mioflora while Index no. 36 shows distinctive mioflora with a number of new elements like *Osmundacidites*, *Lundbladispota*, cf. *Guthoerlisporites*, *Lunatisporites*; at the same time a considerable decline of the striated disaccate genera has also been recorded in this assemblage. The details of Raniganj-Panchet transition from palynological point of view, have been discussed by Bharadwaj and Tiwari (1976).

#### MIOFLORA IN RANIGANJ STAGE

The quantitative analyses of various miospore assemblages in the Raniganj sediments have been done by a number of workers (*loc. cit.*). With the present assemblage these assemblages coincide qualitatively as well as in the high frequency peaks of the striate-disaccate group. Thus, in the Raniganj Stage the super dominance of the striate disaccate genera continues through the entire succession. The triletes and the enveloping monosaccates, however, show smooth fluctuations at certain levels. Nevertheless, any sharp miofloral break or a sudden change at any point has not been located so far. This



INDEX  
0 10 20%  
█  
|<1%  
█ B.H. NCRD-2 samples  
□ samples other than NCRD-2

HISTOGRAM 1



leads to the conclusion that within the Raniganj Stage, there has been no major miofloral change.

### CONCLUSION

From the above account it is evident that the miospore assemblage in the Raniganj Stage comprises mainly of striate disaccate dominance along with some qualitatively important genera such as — *Lahiritites*, *Hindipollenites*, *Verrucosisporites*, *Indospora*, *Gondisporites*, *Spinisporites* and *Thymospora*. There is no indication of any major miofloral break or a change within this stage. Palynologically the whole sequence is uniform. In view of the huge thickness of the deposits in Raniganj Coalfield on one hand and a monotony of miofloral succession on the other, it could be presumed that the time of deposition of this formation is much less than what could generally have been thought of such a thick sediment.

From the mioflora of underlying Barren Measures, the Raniganj mioflora is distinguishable in having less of *Densipollenites*, *Scheuringipollenites*, *Barakarites* and more and varied forms of triletes in general. From the overlying Lower Panchets, one can identify the Raniganj mioflora by the rarity of taeniate disaccate pollen and a number of mesosporoid trilete forms in the latter apart from other elements.

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### EXPLANATION OF HISTOGRAM 1

The percentage frequencies of important miospore genera in the samples of bore-hole NCRD-2, Raniganj Coalfield, are drawn in solid blocks while those in other are plotted in the line-blocks (for detail explanation see the text also). The "Index Numbers" in the histogram are given for the sake of convenience in descriptive explanation.

### INDEX NUMBER

1. Sibbabudi and Katri nala assemblage (Average, Barren Measures, Jharia Coalfield; Bharadwaj, Sah & Tiwari, 1965).
2. Brahmi Coalfield (Average, Barren Measure assemblage; Srivastava & Maheshwari, 1974).
3. Jharia and North Karanpura Coalfield (Topmost Barren Measures; Zone C, Kar, 1971).
4. B.H. K<sub>5</sub>, N. Karanpura Coalfield (Upper Barren Measures, Kar, 1973; Text-fig. 13A).
5. B.H. K<sub>5</sub>, N. Karanpura Coalfield (Lower Raniganj; Kar, 1973; Text-fig. 13A).
6. B.H. K<sub>2</sub>, N. Karanpura Coalfield (Zone A, Raniganj; Kar, 1969b).
7. B.H. K<sub>2</sub>, N. Karanpura Coalfield (Zone B, Raniganj; Kar, 1969b).
8. Taltore Seam (Seam I, Raniganj Coalfield; S. K. Srivastava, 1963).
9. B.H. NCRD-2, Seam II (Sanctoria Seam) Lab. Sample no. 18 (refer table 1).
10. Poniaty Seam (Seam II); Barabani Colliery (Navale & Srivastava, 1972).
11. B.H. NCRD-2, Seam III (Hathinal Seam) Lab. Sample no. 16.
12. B.H. NCRD 2; Shale bands in sandstone between Seam III & IV; Lab. Sample no. 15.
13. B.H. NCRD-2, Seam IV (Dishergarh Seam) Lab. Sample no. 14.
14. Dishergarh Seam (Seam IV) Chinakauri & Banksimulla Collieries (Navale & Srivastava, 1972).
15. Samla Seam (Seam IV) Raniganj Colliery (Navale & Srivastava, 1972).
16. B.H. NCRD-2, Shale bands in sandstone between Seam IV & V; Lab. Sample no. 13.
17. B.H. NCRD-2, Seam V (Seam Raghunathbatty VA; Bhuradhem V), Lab. Sample no. 12.
18. B.H. NCRD-2, Shale bands in sandstone between Seams V & VI, Lab. Sample no. 11.
19. B.H. NCRD-2, Seam VI (Shripur Seam), Lab. Sample no. 10.
20. B.H. NCRD-2, Shale bands in sandstone between seams VI & VII, Lab. Sample no. 9.
21. B.H. NCRD-2, Seam VII (Lower Dhadka Seam), Lab. Sample no. 8.
22. Bonbahal Seam (Seam VII) Jote Dhem Colliery (Bharadwaj & Salujha, 1965).

23. Narain Kuri Seam (Seam VII) Ardhamgramkas Colliery (Navale & Srivastava, 1972).
24. B.H. NCRD-2, Shale bands in sandstone between seams VII & VIII, Lab. Sample no. 7.
25. B.H. NCRD-2, Seam VIII (Barachak Seam), Lab. Sample no. 6.
26. Jambad Bowlah Seam (Seam VIII) (Bharadwaj & Salujha, 1965a).
27. Nega Seam (Seam VIII) Damra Colliery (Navale & Srivastava, 1972).
28. B.H. NCRD-2, Shale bands between Seams VIII & IX, Lab. Sample no. 5.
29. B.H. NCRD-2, Seam IX (Gopalpur Seam), Lab. Sample no. 4.
30. Upper Kajora Seam (Seam IX), Jaipuria Kajora Colliery (Salujha, 1965).
31. B.H. NCRD-2, Shale bands in Sandstones between seams IX & X, Lab. Sample no. 3.
32. B.H. NCRD-2, Seam X (Bharatchak Seam), Lab. Sample no. 2.
33. B.H. NCRD-2, Shale bands above Seam X, Lab. Sample no. 1.
34. B.H. NCRD-6, (Assemblage-3, Bharadwaj & Tiwari, 1976).
35. B.H. NCRD-6, (Assemblage-2, Bharadwaj & Tiwari, 1976).
36. B.H. NCRD-6 (Assemblage-1, Bharadwaj & Tiwari, 1976).

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