SPOROLOGICAL CORRELATION OF COALSEAMS IN BACHRA AREA OF NORTH KARANPURA COALFIELD, BIHAR, INDIA*

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ABSTRACT

18 m. channel samples of coal from eight bore holes in Bachra area of N. Karanpura Coalfield have been sporologically investigated. The mioflora of these coals exhibits dominance by an association of *Lophotriletes, Latosporites, Faunipollenites,* and *Sulcatisporites.* Miofloristically the samples segregate into two coal seams. Both seams are variously split during their lateral extent.

INTRODUCTION

KARANPURA Coalfield lies in Bihar in the northern part of Damodar river basin between latitude 23° 30′-23°56′ N and longitude 84°46′-85°28′E. From Bachra area (lat. 23°41′-23°43′N, long. 85°4′-85°6′E) in the northern part of this coalfield, 18 main channel overall coal samples from eight bore holes KBa 1-8 were sporologically investigated to determine their correlation. The various details regarding the samples are given in Table 1.

METHODS

Each sample was subjected to similar procedure of maceration and study. 5 gm. of material from each sample was treated with HNO_3 (Comm.) for 3 days followed by digestion with 10 per cent KOH after thorough washing with water. The macerates were mounted on slides in glycerine jelly. 500 miospores were counted from each sample at the generic level.

TABLE 1

Bachra Area, North Karanpura Coalfield

Sample No.	Bore Hole No.	Overall No.	Depth from Surface	Band Excluded	Thickenss
1	KBa_1	KBa 1/M.ch.ov.I	66′ to 71′0″	1	3½″
2	KBa_1	KBa 1/M.ch.ov.II	81′6″ to 85′0″	—	—
3	KBa_2	KBa 2/M.ch.ov.I	158′8″ to 170′0″	1,2,3	16½″
4	KBa_2	KBa 2/M.ch.ov.II	204′3″ to 214′2″	4,5,6,7	5′4½″
5	KBa_2	KBa 2/M.ch.ov.III	227′0″ to 234′8″	8,9,10,11	3′4″
6	KBa_3	KBa 3/M.chl.ov.I	92′6″ to 98′10″	1	10″
7	KBa_3	KBa 3/M.ch.ov.II	155′4″ to 180′8″	2,3,4,5,6,7	7′7″
8	KBa_4	KBa 4/M.ch.ov.I	101′4″ to 110′10″	1,2,3	39″
9	KBa_4	KBa 4/M.ch.ov.II	142′8″ to 148′6″	4.3,6,7	26¾″
10	KBa_4	KBa 4/M.ch.ov.III	159′10″ to 174′5″	8,9	22″
11	KBa_5	KBa 5/M.ch.ov.I	76′0″ to 80′2″	1,2	12½″
12	KBa_6	KBa 6/M.ch.ov.I	84′11″ to 90′8″	1,2,3	6½″
13	KBa_6	KBa 6/M.ch.ov.II	121′5″ to 140′8″	4,5,6,7	44½″
14	KBa_7	KBa 7/M.ch.ov.I	93′7″ to 97′6″	3	10½″
15	KBa_7	KBa 7/M.ch.ov.II	129′11″ to 144′3″	4,5,6,7	22½″
16	KBa_8	KBa 8/M.ch.ov.I	81′0″ to 90′9″	1,2	23″
17	KBa_8	KBa 8/M.ch.ov.II	131′9″ to 144′1″	4,5,6	33″
18	KBa_8	KBa 8/M.ch.ov.III	146′10″ to 158′10″	7,8	10″

*Results of investigations carried out in the scheme, "Palaeobotanical Investigation of Indian Coals (C.S.I.R.)".

RESULTS

The mioflora encountered in these coals is referable to the following spore genera (*sensu*-BHARADWAJ, 1962; BHARADWAJ & SALUJHA, 1964; BHARADWAJ & TIWARI, 1964a; TIWARI, 1964).

Leiotriletes, Punctatisporites, Cyclogranisporites, Verrucosisporites, Lophotriletes, Apiculatisporis, Horriditriletes, Microbaculispora, Cyclobaculisporites, Indotriradites, Latosporites, Parasaccites, Potonieisporites, Cuneatisporites, Primuspollenites, Rhizomaspora, Illinites, Striatopodocarpites, Faunipollenites, Vesicaspora, Sulcatisporites, Gnetaceaepollenites, Vittatina and *Ginkgocycadophytus*

Apart from these there are four genera, i.e. *Calamospora, Thymospora, Densipollenites* and *Welwitschiapites* which are also present in this assemblage, but since they are extremely rare and inconsistent, they are not given much importance in quantitative considerations. Some of the important genera are illustrated in Plates 1 and 2.

Sporological constitution of samples — The qualitative and quantitative sporological composition of the samples is given in Histogram I. It is apparent from this histogram that *Lophotriletes, Latosporites, Parasaccites, Faunipollenites* and *Sulcatisporites* are the spore genera which are prevalent in fair to high percentages consistently in all the samples and naturally are considered by us to be constituting the dominant association.

Nature of Variation — The tendency of variation exhibited by each genus out of the dominant association from older to younger seam in each bore hole is as follows:

Bore hole KBa_1 — *Lophotriletes* decreases, *Latosporites* is constant, *Parasaccites, Faunipollenites* and *Sulcatisporites* increase.

Bore hole KBa_2 — In the three successive samples *Lophotriletes* decreases appreciably and then increases a little again, *Latosporites* decreases and then increases, *Parasaccites* constantly decreases and *Faunipollenites* as well as *Sulcatisporites* appreciably increase and then decrease a little.

Bore hole KBa_3 — Between the two samples in succession, the tendencies are for *Lophotriletes* to decrease sharply, for *Latosporites* to increase sharply, for *Parasaccites* to decrease significantly, for *Faunipollenites* to decrease a little and for *Sulcatisporites* to increase sharply.

Bore hole KBa_4 — Among the three samples the tendencies are that *Lophotriletes* is virtually constant in the older two samples declining sharply in the youngest, *Latosporites* and *Parasaccites* decrease to increase again, but *Faunipollenites* and *Sulcatisporites* consistently increase.

Bore hole KBa_5 — Only one sample is represented from this bore hole.

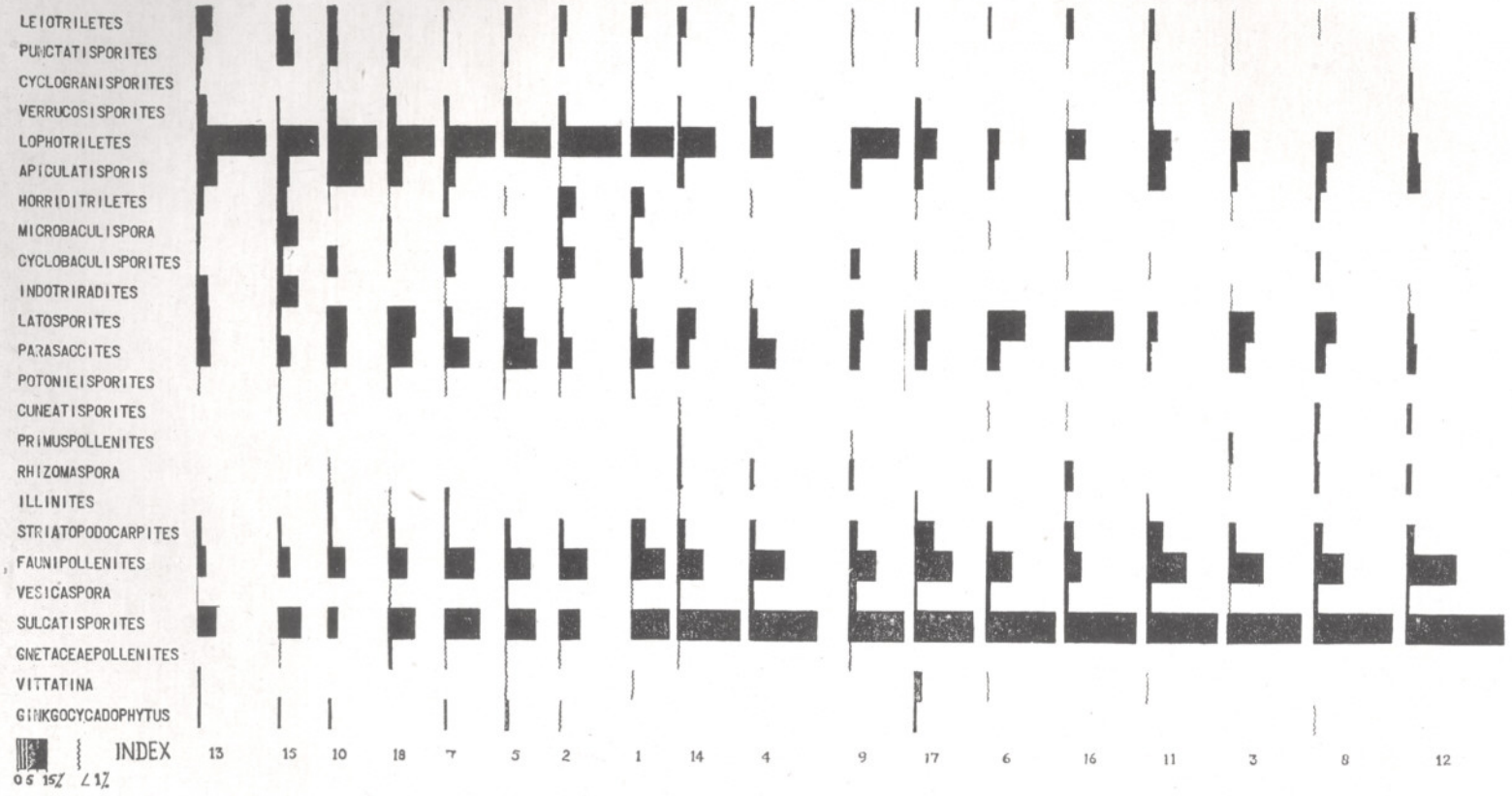
Bore hole KBa_6 — Between the two samples, *Lophotriletes* very sharply declines, *Latosporites* and *Parasaccites* decrease a little but *Faunipollenites* and *Sulcatisporites* increase very sharply.

Bore hole KBa_7 — In the two samples from this bore hole, *Lophotriletes*, and *Parasaccites* decline a little, *Latosporites* increases sharply and so do *Faunipollenites* and *Sulcatisporites*.

Bore hole KBa_8 — In the three samples in succession, *Lophotriletes* decreases, *Latosporites* decreases to increase substantially again, *Parasaccites* decreases consistently, *Faunipollenites* increases to decrease again and *Sulcatisporites* consistently, markedly increases.

Table 2 gives the percentages of the five quantitatively, significantly represented genera in each sample individually as well as collectively in their total representation. Considering the dominance percentage (TABLE 2 — total per cent) it is apparent that the samples show very wide range of variation from as low as 44 per cent to as high as 87·5 per cent. From this table it is apparent that *Lophotriletes* or *Sulcatisporites* contributes maximum individuality to the dominance. It has also been observed that in samples where *Lophotriletes* is high *Sulcatisporites* is low and *vice versa* but for a few samples which show exceptional behaviour. Hence it has become apparent that the chief determinants of dominance are either *Lophotriletes* or *Sulcatisporites*.

Extent of Variation — The quality of variation exhibited by each of the genera forming the association of dominants is graphically represented in Graphs 1-5. A perusal of these graphs reveals that the representation is widely different between most of the samples in succession regarding *Lophotriletes* and *Sulcatisporites*, less so for *Faunipollenites* and *Latosporites* and least marked in the distribution of *Parasaccites*. We are well aware (BHARADWAJ, 1966) that



HISTOGRAM I — Comparative histogram showing the percentage frequency of miospore genera encountered in 18 bore hole coal samples from Bachra Area, North Karanpura Coalfield, Bihar, India.

TABLE 2

Sample No.	*Lophotriletes*	*Sulcatisporites*	*Faunipollenites*	*Latosporites*	*Parasaccites*	Total %
1	21·0	19·0	16·5	2·5	11·0	70·5
2	30·5	10·0	13·5	2·0	6·0	61·5
3	9·0	38·0	18·0	12·5	7·0	84·5
4	10·5	33·0	17·0	3·5	13·0	77·0
5	22·5	15·0	12·5	9·0	15·5	74·5
6	5·5	34·5	12·5	18·5	6·5	77·5
7	25·0	17·5	13·5	3·5	12·0	71·5
8	8·0	39·0	14·5	10·0	4·5	76·0
9	24·0	27·0	13·0	6·0	4·0	74·0
10	24·0	4·5	8·0	9·0	8·5	54·0
11	10·5	35·5	20·0	5·0	1·5	72·5
12	5·0	49·5	25·0	3·5	4·5	87·5
13	34·0	9·0	4·0	6·0	6·5	59·5
14	18·5	31·5	12·5	9·0	5·5	76·5
15	20·0	11·0	5·5	1·5	6·0	44·0
16	9·5	35·0	8·0	23·5	1·5	77·5
17	10·5	29·5	19·0	7·5	5·0	72·0
18	23·0	13·0	9·0	13·5	11·5	70·0

Parasaccites is a genus of characteristic distribution for the strata of Talchir Series which is decidedly older than the age of the assemblages considered here. Hence the little affected variation of this genus between distinctly young to old assemblages in succession within one bore hole, is not surprising. In view of the fact that the distributional behaviour of *Parasaccites* is incompatible with that of the other dominant genera, especially *Lophotriletes* and *Sulcatisporites* of the mioflora vis-a-vis vegetation of the area, it seems reasonable to suppose that the percentage representation for *Parasaccites* in these samples has extraneous influence.

CORRELATION

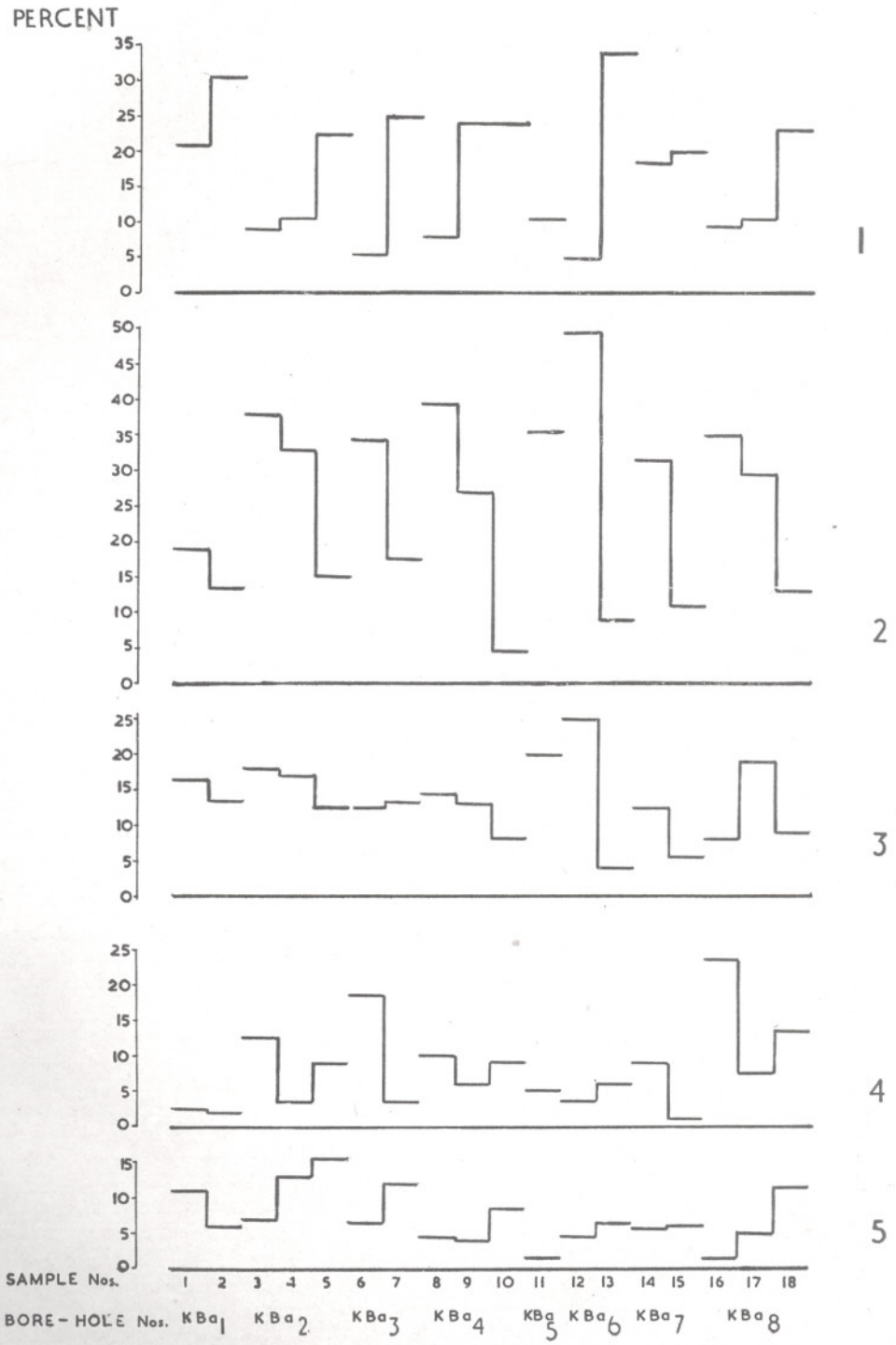
For the purpose of correlation of coal seams in one bore hole with those of the others in the area, normally the distribution of all the five spore genera constituting the dominant association should have been compared. But as the distribution of *Parasaccites* is suspected not to be normal and that its inclusion ameliorates the differences exhibited by the main genera *Lophotriletes* and *Sulcatisporites*, we have excluded this from consideration while comparing for correlation purposes.

Out of all the eight bore holes of which the samples were available, in three of them, viz. KBa_2, KBa_4, and KBa_8, three coal seams occur in succession (*see* Table 1). In all these the youngest of the three seams has uniformly low *Lophotriletes* and high *Sulcatisporites* incidence but the oldest of the three seams has reversed incidence, i.e. high *Lophotriletes* and low *Sulcatisporites*. In the middle seams the incidence of these two genera is either like the youngest or the oldest or a combination of both. Hence on the basis of this distinctive distribution, the percentages of all the four dominating genera have been made use of to seggregate the samples into two groups, i.e. Group I with high incidence of *Lophotriletes* and Group II with high incidence of *Sulcatisporites*, (Table 3).

In Group I, sample nos. 1, 2, 5, 7, 9, 10, 13, 14, 15 and 18 come together. In the miosporic composition of all these, the basic common factor is the high (more than 18%) percentage of *Lophotriletes*. As normally expected the percentage of *Sulcatisporites* is low (less than 10 per cent) in most of these samples but for sample nos. 9 and 14.

In Group II, sample nos. 3, 4, 6, 8, 11, 12, 16 and 17 are grouped together. These samples show the normal, high incidence (more than 29%) of *Sulcatisporites* and low (less than 11%) of *Lophotriletes*.

Considering the Total Dominance Percentages (T.D.P.) obtained in Table 3 for each sample of Group I, we find that they vary between 38 per cent and 71·5 per cent. Evidently this is very wide variation.



GRAPHS 1-5 — Showing the quantity of variation exhibited by each of the genera forming the association of dominants in the bore hole samples under study. 1. *Lophotriletes*, 2. *Sulcatisporites*, 3. *Faunipollenites*, 4. *Latosporites* and 5. *Parasaccites*.

TABLE 3

	Sample No.	*Lophotriletes*	*Sulcatisporites*	*Faunipollenites*	*Latosporites*	Dominance	
						Total % (T.D.P.)	Mean % (T.D.P.)
	1	21·0	19·0	16·5	2·5	59·0	57·5
	2	30·5	10·0	13·5	2·0	56·0	
G	5	22·5	15·0	12·5	9·0	59·0	59·0
R	7	25·0	17·5	13·5	3·5	59·5	59·5
O	9	24·0	27·0	13·0	6·0	70·0	58·0
U	10	24·0	4·5	8·0	9·0	45·5	
P	13	34·0	8·5	4·0	4·0	50·5	50·5
I	14	18·5	31·5	12·5	9·0	71·5	55·0
	15	20·0	11·0	5·5	1·5	38·0	
	18	23·0	13·0	9·0	13·5	58·5	58·5
	3	9·0	38·0	18·0	12·5	77·5	71·0
G	4	10·5	33·0	17·0	3·5	64·0	
R	6	5·5	34·5	12·5	18·5	71·0	71·0
O	8	8·0	39·0	14·5	10·0	71·5	71·5
U	11	10·5	35·5	20·0	5·0	71·0	71·0
P	12	5·0	49·5	25·0	3·5	83·0	83·0
	16	9·5	35·0	8·0	23·5	76·0	71·0
II	17	10·5	29·5	19·0	7·5	66·5	

Logically, if the samples of Group I were to represent a homogeneous vegetational cycle equivalent of one seam, the variation should have been very much narrower.

A critical analysis of the T.D.P. values reveals that out of the 10 samples included in Group I, the T.D.P. of four samples fall between 58·5 per cent and 59·5 per cent. In these samples even the comparative percentage representation of genera individually shows very little variation. Out of the remaining six samples, two samples have much higher T.D.P., i.e. 70-71·5 per cent. In these samples the incidence percentage for individual genera is fairly similar. The remaining four samples have lower T.D.P., i.e. 38-56 per cent, but among these the T.D.P. of none agrees with that of the other. Thus, inspite of high *Lophotriletes* incidence in all the 10 samples of Group I there seem to be three subgroupings. The question naturally arises how to interpret these differences, i.e. whether these are differences within one coal seam or that these represent three different coals seams deposited during one long phase of high *Lophotriletes* incidence? Our analysis establishes the former possibility to be true rather than the latter. In the case of samples 1 and 2 which lie successively in one bore hole, the differences in the incidence of the important genera individually (Histogram I, Table 1) is in keeping with the older or younger position of the samples. But the differences between their T.D.P. values is of only 3 per cent which is negligible. This, coupled with the small parting between these samples suggests them to be split of one seam. Their mean T.D.P. comes to 57·5 per cent which is quite near the T.D.P. value of four other samples.

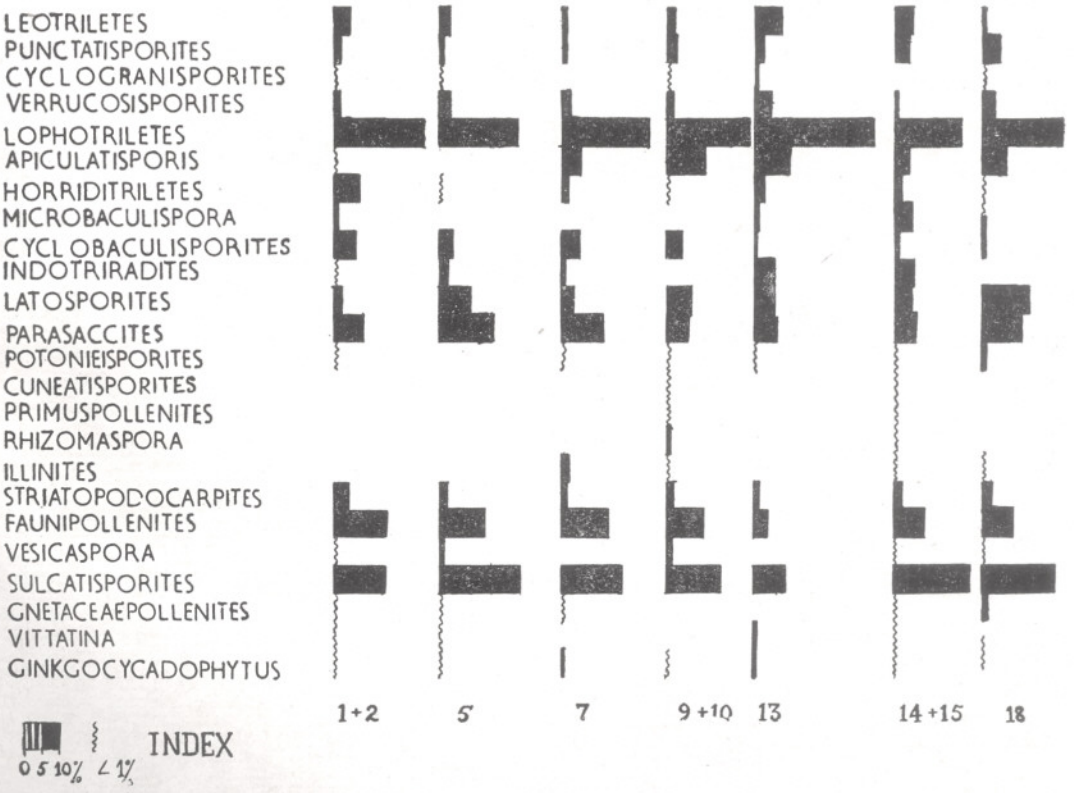
In the case of samples 10 and 15 each of which show the low T.D.P. values of 45·5 per cent and 38 per cent respectively we find that *Sulcatisporites* is quite low suggesting an older stage in the depositional cycle but *Lophotriletes* is correspondingly not so high as would be expected if we compare this with that of sample 13 which has the highest and lowest incidence of *Lophotriletes* and *Sulcatisporites* respectively in the whole miofloral succession. Why? It seems that the incidence of *Lophotriletes* has been depressed in samples 10 and 15 due to the higher incidence of the otherwise, normally low, trilete spore genera such as *Apiculatisporis* and *Cyclobaculisporites* in sample 10, and *Microbaculispora* and *Indotriradites* in sample 15, due to some local causes. It is a well known ecological fact that plants which have nearly similar ecological requirements, mostly of the same or similar class, may

TABLE 4

	Genera	Sample No. 13 — %		Sample No. 10 — %		Sample No. 15 — %	
1	*Lophotriletes*	34·0		24·0		20·0	
2	*Apiculatisporis*	10·0		17·5		5·5	
3	*Microbaculispora*	1·5	51·5	—	46·0	10·0	48·5
4	*Cyclobaculisporites*	1·0		4·5		2·5	
5	*Indotriradites*	5·0		—		10·5	
6	*Sulcatisporites*	9·0	13·0	4·5	12·5	11·0	16·5
7	*Faunipollenites*	4·0		8·0		5·5	

sometimes replace each other to a more or less extent in different parts of a basin yet maintain the normal quantitative balance with respect to other classes of plants in the vegetation. A comparison of percentage incidence of some spore genera as given for samples 13, 10 and 15 in Table 4 substantiates the above point.

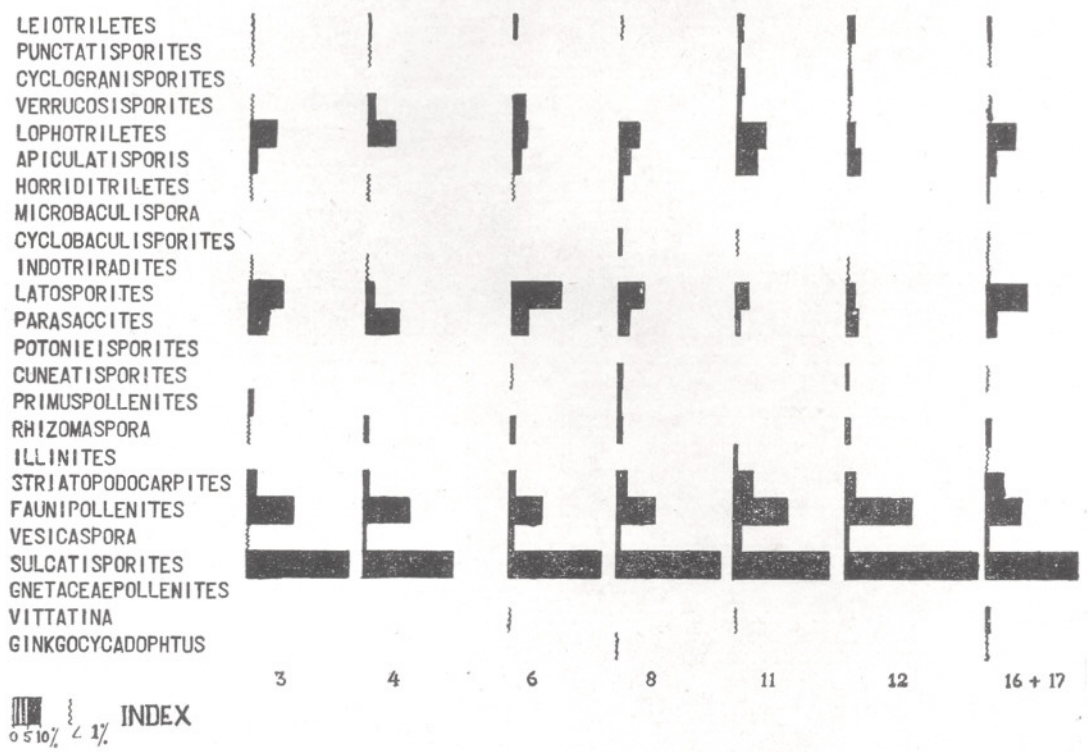
Considering the above evidence it is apparent that the differences in the T.D.P. values of samples 13, 10 and 15 are scarcely real and that these three samples stand correlated with each other. The low incidence of *Sulcatisporites* in them suggests them to be representing the older section in the high-*Lophotriletes*-incidence vegetational



Histogram II — Comparative histogram showing the percentage frequency of various miospore genera encountered in the samples of the older seam (Seam I).

cycle. On the other hand samples 9 and 14 which show very high *Sulcatisporites* incidence combined with high *Lophotriletes* are evidently the youngest in the vegetational cycle represented here by Group I and characterized uniformly with high *Lophotriletes* incidence.

Thus, it is apparent that the three subdivisions in Group I are the three successive stages in the vegetational cycle of high *Lophotriletes* incidence among which samples 13, 10 and 15 represent the oldest with nearly 50 per cent T.D.P., samples 1, 5 and 18 represent the middle with nearly 59 per cent T.D.P., and samples 9 and 14 represent the youngest sections with nearly 71 per cent T.D.P. If these three constitute one seam their mean T.D.P. comes to 59 per cent which is also the T.D.P. of sample 7 which represents the thickest seam in the succession and possibily represents almost the whole vegetational cycle of high *Lophotriletes* incidence. Considering that the two successive samples in each of the two bore holes KBa_4 and KBa_7, i.e. samples 10 and 9 as well as 15 and 14 respectively represent the oldest and the youngest sections in this vegetational cycle with the intervening non-coaliferous parting representing the middle section, the T.D.P. for these sets of samples comes to 58 per cent and 55 per cent respectively. Now a look at the comparative mean T.D.P. values for individual as well as compounded samples shows striking coherence suggesting that the samples of Group I are really correlated as parts or whole of a single seam. Samples 1 and 2 combinedly represent roughly the middle part of the seam and so do samples 5 and 18; sample 7 represents the whole seam; samples 10 and 9 as well as 15 and 14 represent the oldest and the youngest part respectively and sample 13 mostly the youngest and the middle part. Thus seam I corresponding to Group I, is variously split along its lateral extent. It is also fully developed only in a very short extent around the bore hole KBa_3. In and

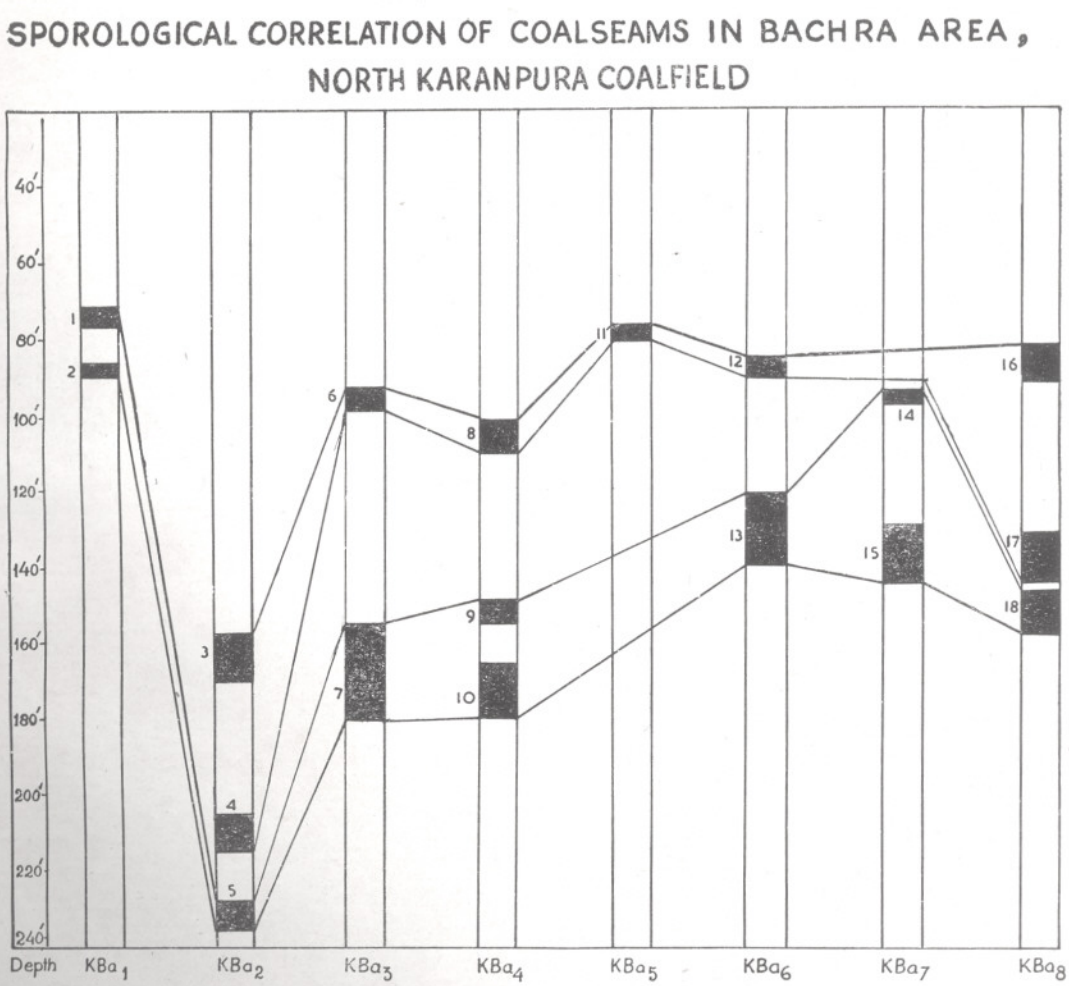


HISTOGRAM III — Comparative histogram showing the percentage frequency of various miospore genera encountered in the sample of the younger seam (Seam II).

around the other bore holes it is only partly developed the missing parts being non-coaliferous or having been washed out before preservation.

In the samples of Group II an almost similar situation exists as in the case of Group I. Taking a similar line of reasoning for interpretation as for Group I, we come to the conclusion that these also represent one seam. Samples 3 and 4 as well as 16 and 17 in the bore holes KBa_2 and KBa_8 represent the younger and the older splits respectively. A perusal of the mean T.D.P. values for Group II in Table 3 substantiates the striking homogeneity of most of the samples but for sample 12. This sample possibly represents the youngest section of this seam with the highest ever incidence of *Sulcatisporites* and lowest of *Lophotriletes*. In other bore holes this youngest section is not represented at all and they contain the oldest and the middle parts together or split into two. In the region of bore holes KBa_8 this seam has the maximum thickness of coal but it thins out appreciably through the regions of boreholes KBa_4, KBa_5, KBa_6 finally to disappear in the regions of bore holes KBa_1 and KBa_7.

Thus, in Bachra area of North Karanpura Coalfield in the region covered by bore holes KBa_1 to KBa_8, two coal seams occur. The older is designated as seam I (HISTOGRAM II; TABLE 3—Group I) and the younger as seam II (HISTOGRAM III; TABLE



TEXT-FIG. 1 — Sporological correlation of coalseams in Bachra Area, North Karanpura Coalfield.

3—Group II) here. Both these seams are variously split and have marked variation in the thickness. The correlation as interpreted on the basis of sprological study of the bore core coal samples is depicted in Text-fig. 1.

Before concluding finally we might as well examine yet another possibility that is whether the middle samples, nos. 4, 9, 14 and 17, could possibly be recognised as a middle seam distinct from the lower and the upper seam or not. In this context if we refer to Table 3, we find that the T.D.P. values of these samples are 64 per cent, 70 per cent, 71·5 per cent and 66·5 per cent respectively. In respect of coherence the T.D.P. values of 64 per cent and 66·5 per cent group themselves together as against 70 per cent and 71·5 per cent because there is a distinct gap between these sets of T.D.P. values. Besides this there is a striking difference in the incidence of *Lophotriletes* between these sets of samples. And above all if these samples are put together in spite of the above noted two indications of separation, the coherence achieved by us in the mean T.D.P. values, within Group I and II (TABLE 3) gets disturbed, so much so that there may have to be separated as many as 5 assemblages which, *prima facie*, is absurd. Hence we have rejected the possibility of recognizing a middle seam on sporological grounds. We believe that the line of reasoning adopted by us for the interpretation of sporological findings provides the greatest amount of agreement and the maximum compatibility with available data.

Stratigraphical — The mioflora contained in the two coalseams studied by us is comparable to that of Upper Barakars as known from Korba Coalfield (TIWARI, 1965 — Histogram I, Assemblage — KB). As compared to the miospore assemblage of West Bokaro Coalfield (TIWARI, 1965 — Histogram I, Assemblage — WB) that from Bachra seams appears to be older.

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EXPLANATION OF PLATES

(*All the figures are* × 500)

PLATE 1

1. *Leiotriletes* Ph. No. 387/8
2, 3. *Apiculatisporis* Ph. Nos. 387/13.
4. *Punctatisporites* Ph. No. 387/12.
5. *Latosporites* Ph. No. 387/31.
6, 7. *Lophotriletes*
8, 9. *Parasaccites* Ph. Nos. 387/24, 387/29.
10. *Striatopodocarpites* Ph. No. 387/12.

PLATE 2

11. *Faunipollenites* Ph. No. 387/18.
12. *Striatopodocarpites* Ph. No. 387/26.
13. *Cuneatisporites* Ph. No. 387/22.
14. *Rhizomaspora* Ph. No. 387/15.
15, 16. *Sulcatisporites* Ph. Nos. 387/1, 387/3.

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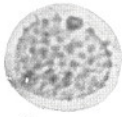

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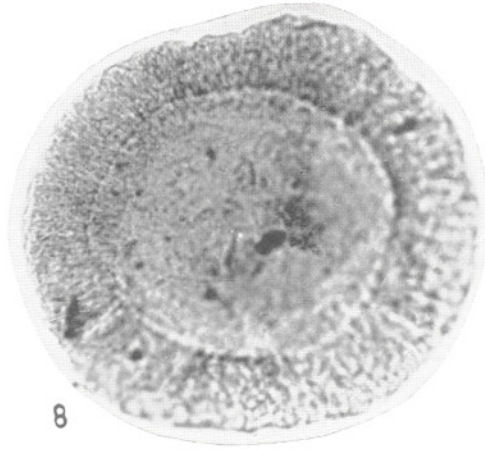

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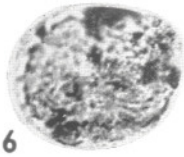

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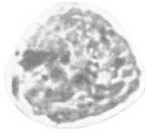

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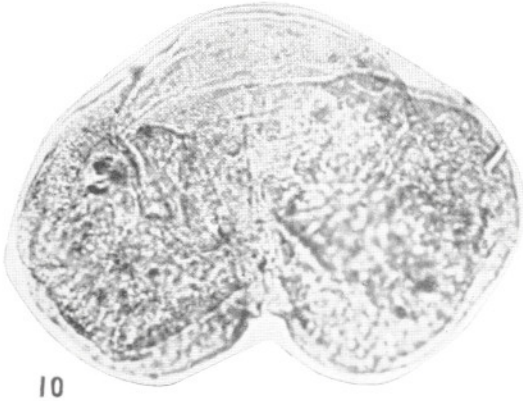

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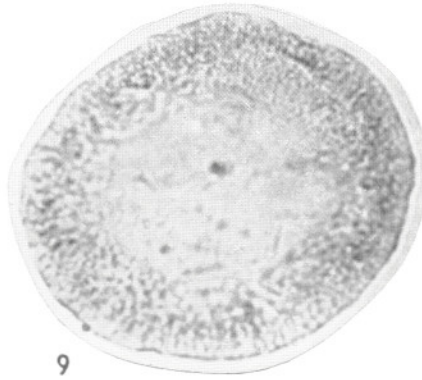

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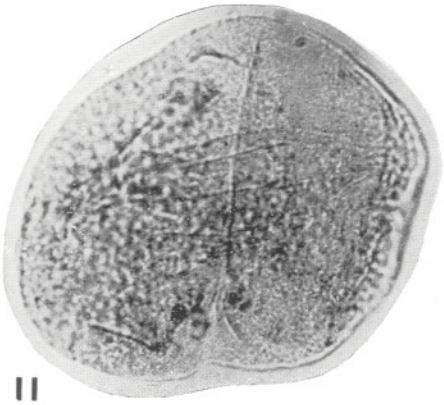

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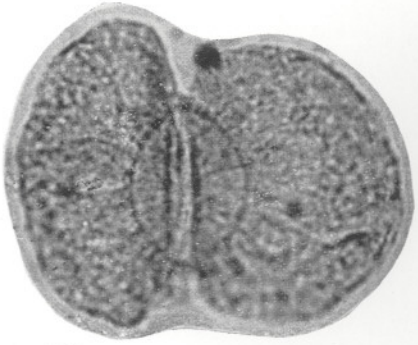

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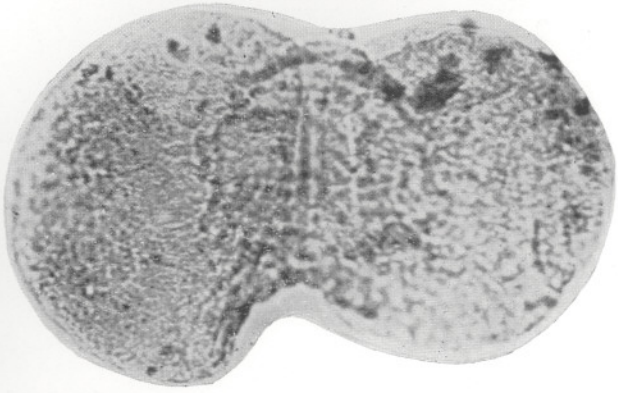

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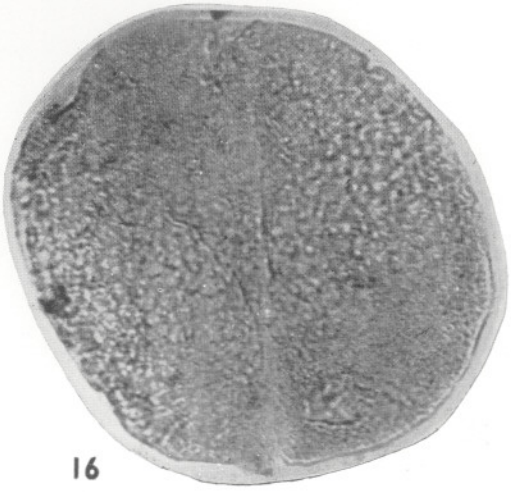

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