

SPOROLOGICAL SUCCESSION AND AGE OF JHINGURDAH SEAM, SINGRAULI COALFIELD, M.P., INDIA

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ABSTRACT

165 meter thick Jhingurdah Seam, the top-most seam of Singrauli Coalfield, M.P., India, has been studied quantitatively. The quantitative studies have revealed that the 165 meter thick bore core belongs to one seam and its mioflora is closely comparable with the mioflora of Upper Barakar Stage in Damuda basin.

GEOLOGY OF SINGRAULI COALFIELD

THE Singrauli Coalfield, contained between the latitudes 23°47' to 24°12' N and longitudes 81°45' to 82°48' E is about 2072 sq. km. in area. The coalfield has been geologically mapped by F. R. Mallet (1868-69, 1871-72), and recently by K. C. Joshi (Report unpublished). Ahmad (1955), and Basu (1965) have also published on the geology of this coalfield.

Physiographically this area may be described as a plateau rising about 200 metres from the plains. The area has a gentle slope towards the north and steep escarpments on the south and east. The surface is mainly covered by soil but here and there the Barakar sandstones crop out.

The Lower Gondwanas in this area lie unconformably over the Bijawar shales with pockets or bands of carbonaceous and coaly matter.

At the base of the Lower Gondwanas are the Talchirs which have boulder beds at the base with their constituents greenish to greyish-green shales, greyish-green quartzite and dolerite upto 20 cm. in size, showing glacial striations.

The Karharbari Stage consists of fine grained sandstones with greenish streaks, pebbly grains and bands of Talchir material at places.

The Barakar Stage consists of medium to coarse grained, massive, highly felspathic and kaolinized sandstones, ferruginous fire clay, shale, carbonaceous shale and coal seams.

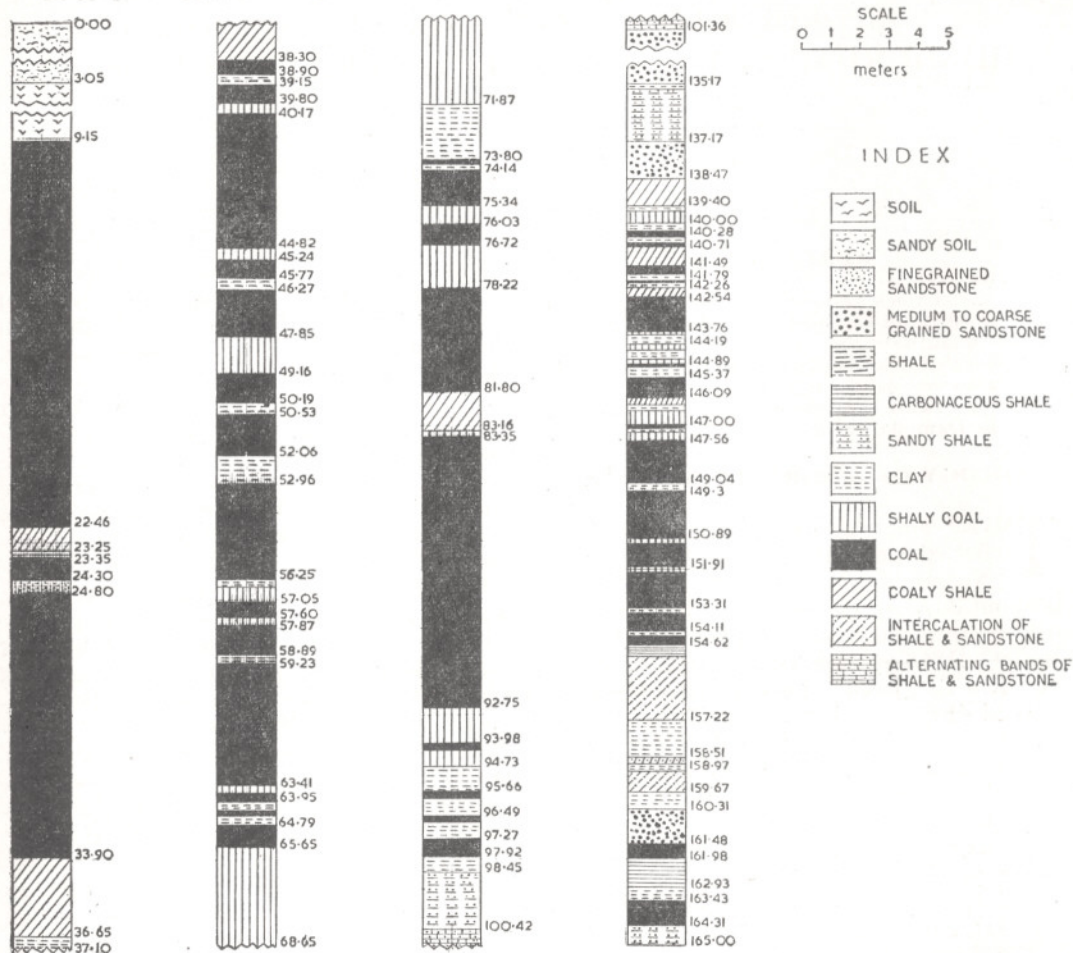
K. C. Joshi in his report (unpublished) on Singrauli Coalfield has divided the Barakars into Lower Barakar and Upper Barakar

Stages. According to him, the rocks of the "Lower Barakar" Substage are devoid of any workable coal seams though the coal bands are met with at various horizons. The total thickness of this substage is estimated to be 250 metres. His "Upper Barakar" Substage contains the most important coal seams as well as clay and shale bands. The total thickness of this substage has been estimated as 430 metres. The thickness of the coal in this horizon is about 55 metres.

The Barakars are overlain by a zone, of about 125 metres thickness, of very coarse-grained, ferruginous, yellow sandstones with occasional greenish sandstone bands. This zone is stratigraphically taken to be equivalent to Barren Measures Stage or Ironstones Shale in this area. But no distinct unconformity has been noticed between the Upper Barakars and the Barren Measures. The Barren Measures in this area, in general, consist of medium to coarse-grained, gritty sandstone and ferruginous shale bands. This horizon is succeeded by Raniganj Stage, estimated to be about 400 metres thick. The rocks consist of fine to coarse-grained felspathic sandstones, white and grey clays with ferruginous bands, carbonaceous shales and coal seams. This stage of the area is of much economic importance because it contains Jhingurdah Seam — the thickest seam (74.37 metres) of India and is probably the second thickest seam of the world.

MATERIAL

Material for the present study was collected from a 165 metres long bore-hole core (Bore-hole No. NCSJ-4) drilled by National Coal Development Corporation in Waidhan area of Sidhi District. Coal samples were collected approximately metrewise and a separate sample was also prepared for each shale band. In all 126 samples were collected belonging to coal and shale bands. The stratigraphical succession is given in Text-figure 1.



TEXT-FIG. 1 — Lithological section of Jhingurdah seam obtained from bore-hole core No. NCSJ-4 (by courtesy of N.C.D.C.).

METHODS

The method followed here for the maceration of coal samples was the same as employed by Bharadwaj and Saluja (1964). In case of shale samples the following technique was employed.

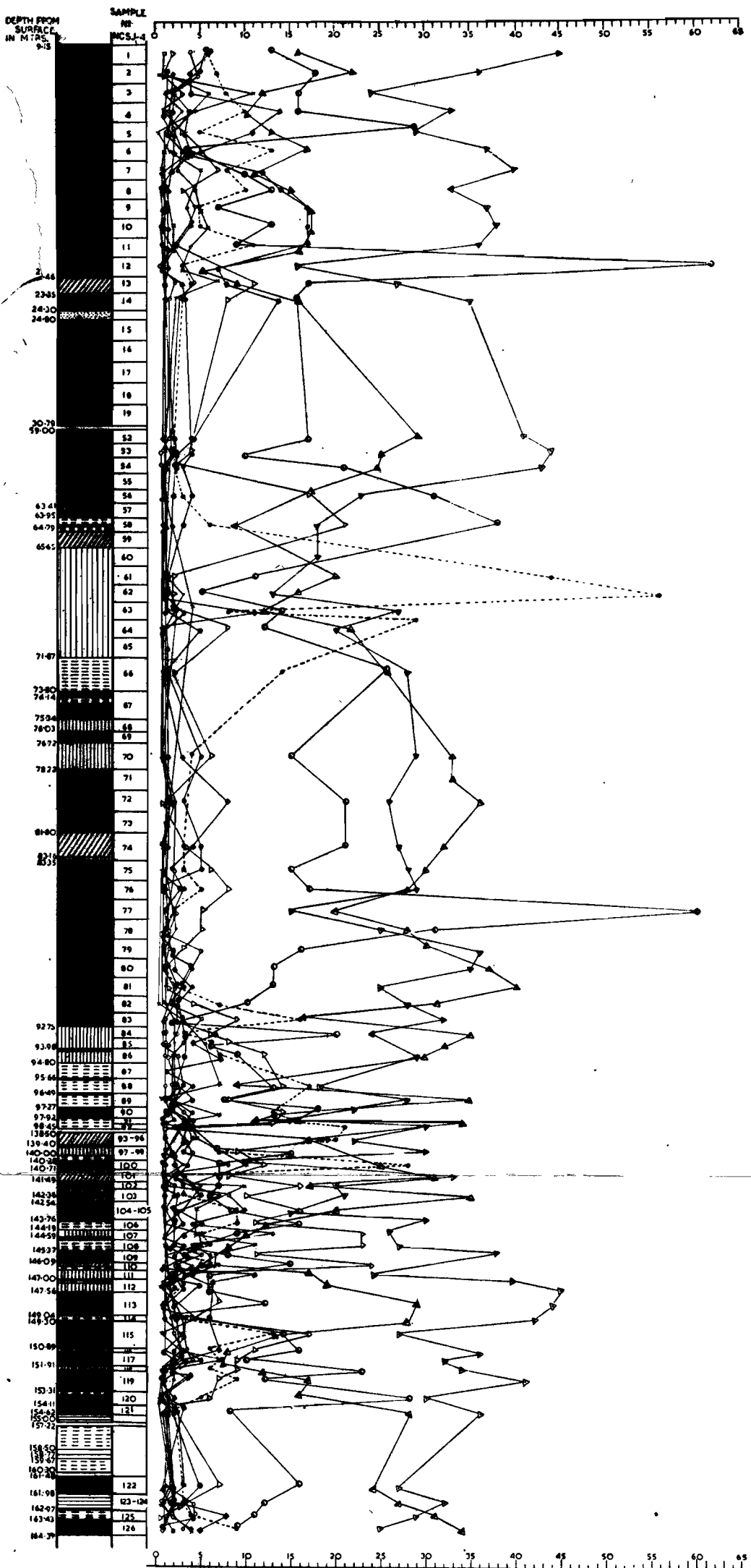
The shale samples after crushing and washing were treated with 40 per cent hydrofluoric acid in polythene jars for about 48 hours and were periodically stirred. After the complete dissolution of silica the material was washed free of acid and boiled in concentrated hydrochloric acid to remove the precipitate. Again it was washed acid free with water and then treated with commercial nitric acid. Further treatment was similar to that followed for coal samples.

Usually it was not necessary to heat KOH solution, though in certain cases the strength of the solution had to be raised upto 25 per cent. In few cases a second treatment with dilute hydrofluoric acid had to be given after maceration in nitric acid.

About four slides were prepared from each sample in glycerine jelly. 200 miospores per sample were counted from pre-marked areas taken at random.

MIOFLORISTIC COMPOSITION

The miospore assemblage from the Jhingurdah seam consists of 46 genera and 110 species. Their quantitative and qualitative representation is as follows (HISTOGRAMS 1 & 2).



INDEX

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|--|------------------------|--|--------------------|--|---------------------|
| | COALY SHALE | | LEIOTRILETES | | STRIATOPODOCARPITES |
| | COAL | | CYCLOGRANISPORITES | | STRIATOPICIEITES |
| | FINE GRAINED SANDSTONE | | LOPHOTRILETES | | VESICASPORA |
| | SHALE | | BREVITRILETES | | SULCATISPORITES |
| | SHALY COAL | | HORRIDITRILETES | | ALETE SPORES |
| | CARBONACEOUS SHALE | | PLATYSACCUS | | |
| | | | STRIATITES | | |
| | | | LAHIRITES | | |

Histogram 1 — Graphic representation of the changes occurring in the mioflora of Jhingurdah seam.

Leotriletes is represented by a single species, *L. brevis*. It is almost uniformly distributed throughout the seam being 1 per cent or less except in sample nos. NCSJ-4/102 and NCSJ-4/104 where it is 4.5 and 5 per cent respectively.

Miospores referable to genus *Punctatisporites* are very rare and only a few specimens of this genus have been recovered.

Genus *Cyclogranisporites*, represented by one species, *C. barakarensis*, is fairly well represented in almost all the samples except in the sample no. NCSJ-4/79 where it is less than 1 per cent and in sample nos. NCSJ-4/61, NCSJ-4/62 and NCSJ-4/64, where it suddenly shoots upto 42, 55.5 and 28 per cent respectively.

A few miospores referable to genus *Planisporites* have been found, but quantitatively they are insignificant.

Verrucosisporites is rare and is 1 per cent or less in most of the samples.

Lophotriletes with a single species, *L. rectus*, is well represented in some samples but significantly absent or less than 1 per cent in other samples. It is maximum in sample no. NCSJ-4/107, being 13 per cent.

Genus *Brevitriletes*, a new organization described by Bharadwaj and Srivastava (1969), is represented by four species, viz., *B. minutus*, *B. jhingurdahiensis*, *B. crassus* and *B. baculatus*. This genus is one of the subdominating units in most of the samples except in sample nos. NCSJ-4/12 and NCSJ-4/126 where it is absent. It is highest in the sample no. NCSJ-4/96 being 24 per cent and lowest in the sample no. NCSJ-4/92 being less than 1 per cent.

Horriditriletes with 4 species, viz. *H. curvibaculosus*, *H. novus*, *H. brevis* and *H. pseudoseptatus* is absent in most of the samples, but is highest (11 per cent) in sample nos. NCSJ-4/3 and NCSJ-4/106, in rest of the samples it ranges from less than 1 per cent to 10.3 per cent.

Microbaculispora and *Cyclobaculisporites* are represented by single species each, viz. *M. tentula* and *C. minutus* respectively. These are present only in few samples and are poorly represented, always being less than 1 per cent.

Microfoveolatispora with two species *M. bokaroensis* and *M. indica*, is meagre in percentage or absent in most of the samples but is highest in sample no. NCSJ-4/120, being 6.5 per cent.

Polonicitriradites, although represented by three species, *P. barakarensis*, *P. tenuis* and *P. tuberculatus*, is quantitatively very poorly represented.

Latosporites represented by one species, *L. colliensis*, shows considerably fair representation only in few samples, being highest in sample no. NCSJ-4/108 and much rare (less than 1 per cent) in a number of other samples.

Monosaccate pollen grains are quantitatively unimportant but are represented by a number of genera. *Barakarites* is rare and only few specimens of this genus have been recovered. *Parasaccites* is represented by 4 species, *P. diffusus*, *P. bilateralis*, *P. irregularis* and *P. singrauliensis*; *Parastriopollenites* by 3 species, *P. limbatus*, *P. gondwanensis* and *P. irregularis*; *Divarisaccus*, *Tuberisaccites* and *Striomonosaccites* are represented by single species each, i.e. *D. strengeri*, *T. singrauliensis* and *S. sp.* respectively.

Platysaccus is represented by two species, *P. sp. A.* and *P. sp. B.* In the present assemblage it is usually found less than 1 per cent to 2 per cent.

Cuneatisporites with one species, *C. sp.*, is quantitatively insignificant.

Primuspollenites, qualitatively the most important genus, is represented by 5 species, viz. *P. singrauliensis*, *P. distinctus*, *P. brevicorpus*, *P. ovatus* and *P. sp.* It is poorly represented in most of the samples, being less than 1 per cent to 2 per cent. Genus *Rhizomaspora* is represented by two species, *R. fimbriata* and *R. sp. cf. R. singula* but is quantitatively insignificant.

Leuckisporites is recorded in low percentages, usually less than 1 per cent. It is represented by 3 species, viz., *L. singrauliensis*, *L. crassus* and *L. sp.* The genus *Taeniaesporites* with one species, *T. sp.* is quantitatively not important.

Striatites with 4 species, *S. paravus*, *S. tentulus*, *S. reticuloidus* and *S. barakarensis*, shows poor quantitative representation in the present assemblage.

Schizopollis with four species, *S. extremus*, *S. distinctus*, *S. jhingurdahiensis* and *S. sp.*, is quantitatively very meagre in the assemblage.

Lahirites represented by eight species, viz. *L. rarus*, *L. rotundus*, *L. reticuloidus*, *L. singrauliensis*, *L. barakarensis*, *L. rhombicus*, *L. sp.* and cf. *L. sp.*, is present in all the samples from less than one per cent to

6.11 per cent. It is highest in the sample no. NCSJ-4/103.

Lunatisporites represented by one species, *L. barakarensis*, is quantitatively insignificant.

Striatopodocarpites with six species, *S. crassus*, *S. labrus*, *S. magnificus*, *S. brevis*, *S. ovalis* and *S. subcircularis*, is fairly well represented in most of the samples ranging from less than 1 per cent to 16 percent being highest in sample nos. NCSJ-4/9, NCSJ-4/10 and NCSJ-4/11.

Striatopiceites (= *Faunipollenites* Bharad.), one of the two dominant genera, is represented by four species, viz. *S. varius*, *S. parvus*, *S. perexiguus* and *S. singrauliensis*. This genus is the most dominant factor in most of the samples, the percentage ranging from 5 to 36 per cent.

Distriatites, though represented by two species, viz., *D. distinctus* and *D. indicus*, is quantitatively not important.

Vesicaspora with 3 species, viz., *V. distincta*, *V. ovata* and *V. brevis* show meagre representation in almost all the samples. *Illinites* represented by one species, viz. *I. hennellyi* is quantitatively insignificant.

Sulcatisporites and *Ibisporites* being the most important and dominant genera are represented by 3 and 1 species respectively, viz. *S. maximus*, *S. barakarensis*, *S. minutus* and *I. jhingurdahiensis*. The combined percentage of these genera ranges from 9 per cent to 45 per cent. These genera are dominant in most of the samples.

Vittatina and *Ginkgocycadophytus* with two species each, viz. *V. africana*, *V. sp.* and *G. sp. A.*, *G. sp. B.* are very meagerly represented in the present assemblage.

Distriamonocolpites is represented by two species, viz. *D. ovalis* and *D. circularis*. Quantitatively it is insignificant.

Pollen grains referable to the genus *Decussatisporites* and represented by single species, are quantitatively not important.

The alete miospores collectively counted represent a large number of genera, i.e. *Maculatasporites* with one species, viz. *M. gondwanensis*; *Greinervillites* having two species, viz. *G. undulatus* and *G. irregularis*; *Hemisphaerium* represented by five species — *H. singrauliensis*, *H. indicus*, *H. finitimus*; *H. sp.* and cf. *H. indicus*, *Pilasporites* with two species — *P. brevis* var. *A.*, *P. brevis* var. *B.*, *P. simplex* var. *minor*, *P. simplex* var. *major*; *Hindisporis* with a single species, viz. *H. senii*; *Peltacystia*

with one species — *P. indicus*. The quantitatively important genera among those mentioned above are *Pilasporites*, *Hemisphaerium* and *Peltacystia*. These genera are fairly well represented in most of the samples. They are most dominant in sample nos. NCSJ-4/12 (61.9 per cent), NCSJ-4/56 (31.0 per cent), NCSJ-4/58 (38.0 per cent) and NCSJ-4/77 (60.4 per cent) and are lowest (3.0 per cent) in sample nos. NCSJ-4/92 and NCSJ-4/93.

MIOFLORISTIC SUCCESSION

Histograms 1 & 2

It is evident from the detailed quantitative study of the miofloral succession in the Jhingurdah Seam that the following miospore genera dominate in the overall assemblage:

Cyclogranisporites

Striatopiceites

Sulcatisporites (incl. *Ibisporites*)

Aletes (incl. *Pilasporites*, *Hemisphaerium*, *Peltacystia*)

Besides the above mentioned genera the following ones are also significantly present in the seam:

Lophotriletes

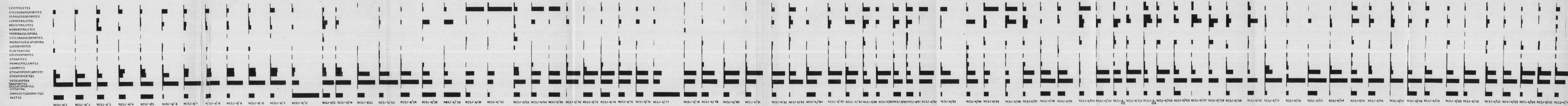
Horriditriletes

Brevitriletes

Striatopodocarpites

Rest of the genera are considered less important due to their insignificant representation and inconsistent behaviour in the miofloral distribution when the assemblage is considered as a whole.

The alete miospores are quite prominent in the Jhingurdah mioflora but a close perusal of their distribution (HISTOGRAM 1) suggests that their frequency of occurrence is very inconsistent and does not indicate any regular tendency to characterize any floristic change. Moreover, these miospores do not show any comparable morphographical characters which could bring them nearer to the gymnospermous or pteridophytic miospores. The possibility of their being Hystrichospherids can also be ruled out because of the absence of big projections or processes. With the bryophytic and algal spores, some lines of similarities in morphological characters can be drawn, e.g. a few alete forms with splitting tendency recovered from the present assemblage can be compared with the present day desmids, and some other alete mio-



Histogram 2 - Quantitative distribution of microfossils in Jhingurdah seam.

spores such as *Pilasporites* and *Greinervillites* resemble with the spores of mosses and liverworts illustrated by Erdtman (1957). Such apparent resemblance with the lower plant groups might indicate a relationship but it is evident that the specific affinities of the alete miospores found here, with any plant group, is a matter of conjecture and their inclusion in the stratigraphic considerations should be done with a caution. Moreover, in the present case, their abrupt dominance or disappearance indicates effect of local conditions.

Keeping the above facts in view, a careful comparison of the miospore frequency pattern of individual samples suggests that there are some trends of variation in the composition from the oldest to the youngest deposition. Thus, starting from the basal sample no. NCSJ-4/126 (HISTOGRAMS 1 & 2) we see that besides the bisaccate pollen grains, the trilete group also plays a major part in composing the assemblage. In sample nos. NCSJ-4/126 to NCSJ-4/111, the trilete group is not that much significant, but in the successive overlying samples it increases markedly and its significant presence can be noticed upto the sample no. NCSJ-4/82. The bisaccate genera remain the dominating ones in most of the above samples which is a characteristic feature of the whole assemblage of Jhingurdah seam. The group of alete miospores does not behave abnormally in any of these samples.

In the samples from NCSJ-4/81 to NCSJ-4/70 the trilete group declines to a noted degree, showing thereby a definite trend of miofloristic variation. In this group of samples, the alete forms behave more or less constantly except in the sample no. NCSJ-4/77 where they dominate over the bisaccate group. As already stated, the alete group is less important and if its percentage is merged with the rest of the genera proportionately, the picture becomes more uniform.

Younger to the previous group, the succession consisting of sample nos. NCSJ-4/66 to NCSJ-4/61 contains a yet different type of miospore association (see HISTOGRAMS 1 & 2). Here the genus *Cyclogranisporites* is outstanding in dominance with a decline in the middle (sample NCSJ-4/63). This is probably a facial change and indicates a specific period of deposition. However, the bisaccate group remains as a characteristic group, though not in dominance.

The youngest deposition represented by samples NCSJ-4/58 to NCSJ-4/1, is more or less uniform in its miofloral composition (HISTOGRAM 1). However, sample nos. NCSJ-4/51 to NCSJ-4/12 did not yield any miospores inspite of repeated macerations. The remaining samples of this group show a dominance of bisaccate miospores but for the sample no. NCSJ-4/12 where aletes are in majority. The latter seems to be a specific depositional phase and the abrupt dominance of alete group does not have any bearing on the whole assemblage. But for this, the samples behave uniformly in their miofloral contents and are characterized by the typical members of the total assemblage of the Jhingurdah seam.

The above analysis reveals that although there are apparent changes or a few irregularities in the patterns exhibited in the succession (HISTOGRAMS 1 & 2), no sharp miofloristic break is evident. The picture of dominant association of various miospore genera passes on gradually from older phase to the youngest without depicting any substantial alteration in the sporological composition. It is interesting to note (HISTOGRAM 2) that the miospore compositions at the bottom and the top of the seam are very similar. This is suggestive of more or less uniform depositional conditions, with minor variations. The miofloral continuity also indicates that the vegetation had undergone only a little change during such a wide depositional period. The trends of variation in the miospore groups as discussed above are, however, not unexpected in such a big thickness of deposition. It is concluded, therefore, that in the Jhingurdah seam the mioflora shows a homogeneous succession without any remarkable break.

The miofloristic succession of the underlying Purewa seam has been recently worked out by Tiwari (1969). It is interesting to note that mioflora of Purewa seam can be compared with that of Jhingurdah mioflora as they share all common dominant genera except one. *Sulcatisporites*, *Ibisporites* and aletes dominate in both seams. The only difference, is the dominance of *Striatopiceites* in Jhingurdah which is not so abundant in the Purewa seam.

AGE OF THE JHINGURDAH SEAM

A comprehensive knowledge of miospore assemblages from various stages of Lower

Gondwana of India, have been worked out during the recent years. The miofloral composition of Raniganj Stage has been described by Bharadwaj (1962) and Bharadwaj and Salujha (1964, 1965a, 1965b) while the Barren Measures mioflora is known from the works of Bharadwaj, Sah and Tiwari (1965) and Kar (1966) and the mioflora of Lower and Upper Barakar stages is known well from the analysis by Bharadwaj and Tiwari (1964), and Tiwari (1965). Recently a qualitative and quantitative account of various dispersed miospores in Lower Gondwanas has been given by Bharadwaj (1966), which includes a synthesis of previous work. This forms the basis for the comparisons given below:

Raniganj Stage — In this uppermost horizon of Lower Gondwana formations, it has been found that the following genera are either important individually or in association with others:

Horriditriletes, *Indospora*, *Thymospora*, *Striatites*, *Lunatisporites*, *Striatopiceites* and *Sulcatisporites*.

Besides the above listed miospores the following genera are also quantitatively important:

Leiotriletes, *Cyclogranisporites*, *Verrucosisporites*, *Lophotriletes*, *Cyclobaculisporites*, *Microfoveolatispora*, *Gondisporites*, *Latosporites*, *Punctatosporites*, *Densipollenites*, *Verticypollenites* and *Hindipollenites*.

The prominence of *Thymospora* and *Horriditriletes* in association with *Indospora*, *Gondisporites* and *Densipollenites* in it makes the Raniganj Stage different from the Jhingurdah seam where these genera are either absent or very poorly represented.

Further, in Jhingurdah seam, the following characteristically important miospore genera occur which are not present in the Raniganj Stage:

Lueckisporites
Primuspollenites

Ironstone Shale Stage — From what we know, the significant genera of the Ironstone Shale Stage are the following:

Gondisporites, *Barakarites*, *Striatites*, *Striatopiceites*, *Densipollenites* and *Sulcatisporites*.

In addition to the above mentioned genera, the following ones occur rarely:

Leiotriletes, *Punctatisporites*, *Granulatisporites*, *Verrucosisporites*, *Apiculatisporis*, *Lophotriletes*, *Microbaculispora*, *Indotriradites*, *Latosporites*, *Acanthotriletes*, *Microfoveolatispora*, *Parasaccites*, *Potonieisporites*, *Lunatis-*

porites, *Rhizomaspora*, *Primuspollenites*, *Verticypollenites* and *Platysaccus*.

The following genera from the above listed significant ones do not occur in Jhingurdah Seam:

Gondisporites
Densipollenites
Barakarites

The association of these genera is also characteristic of Ironstone Shale Stage. This shows that the mioflora of Ironstone Shale Stage appears different from Jhingurdah seam miospore assemblage.

Barakar Stage — The Barakar Stage is subdivided miosporically into two substages (see BHARADWAJ & TIWARI, 1964; TIWARI, 1965; BHARADWAJ, 1966), viz., 1. Upper Barakar, 2. Lower Barakar.

In the Lower Barakars, the index miospore association is:

Retusotriletes, *Lophotriletes*, *Microbaculispora*, *Indotriradites*, *Latosporites*, *Striatopiceites* and *Sulcatisporites*.

This association does not occur in the mioflora of Jhingurdah seam.

Upper Barakar — Miospore assemblage of Upper Barakar substage (BHARADWAJ & TIWARI, 1964; Assemblage E and TIWARI, 1965; HISTOGRAM 1, WB) contains following significant miospores genera:

Apiculatisporis (*Brevitriletes* ?), *Lophotriletes*, *Cyclobaculisporites*, *Latosporites*, *Primuspollenites*, *Rhizomaspora*, *Striatopiceites* and *Sulcatisporites*.

As compared to the above, in the miospore assemblage of Jhingurdah seam the prominent genera are:

Cyclogranisporites, *Lophotriletes*, *Brevitriletes*, *Horriditriletes*, *Latosporites*, *Lahirites*, *Striatopiceites*, *Striatopodocarpites*, *Sulcatisporites* and *Aletes* (*Pilasporites*, *Hemisphaerium*, *Peltacystia*).

The above assemblage corresponds nearest to that of Upper Barakar. *Sulcatisporites* and *Striatopiceites* are dominant in both the assemblages. Most of the trilete and monolete forms are also commonly present in the Jhingurdah seam and Upper Barakar Substage. The monosaccate genera are very rare in both the assemblages. *Primuspollenites*, the rare but important genus, is also present in both the assemblages. However, the alete forms are abundant in the Jhingurdah seam while they are absent in the Upper Barakar assemblages (BHARADWAJ & TIWARI, 1964; TIWARI, 1965). As they are regarded to be the fresh water

plankton, their quantitative importance for the stratigraphic purpose is considered to be negligible.

CONCLUSION

The over 165 meters thick succession of coal and shale representing Jhingurdah Top and Bottom seams was a continuous phase of deposition as evident from palynological investigation. The spore assemblages in shaly or the coaly facies of the seam were neither consistently similar nor significantly dissimilar. The spores of water plankton are prominently associated with the spores of the land vegetation around, in the assemblages. In the Lower Gondwana coals of India such planktonic remains have been reported only from South Karanpura Coalfield besides the Singrauli Coalfield.

With regard to the age, the miospore assemblage from the Jhingurdah seam is closely comparable to the miospore assemblage of Upper Barakar (BHARADWAJ &

TIWARI, 1964; TIWARI, 1965 — HISTOGRAM 1, WB). Besides the presence of an association of spores characteristic for Upper Barakar times the absence of such genera typical for Raniganj Stage as *Indospora*, *Gondisporites*, *Densipollenites* and *Thymospora* substantiates our contention. It is quite interesting to remark that Purewa seam which underlies the Jhingurdah, and presumed to have been deposited during Upper Barakar times, is palynologically very close to the latter.

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