PALYNOSTRATIGRAPHY OF LOWER GONDWANA SEDIMENTS IN CHIRIMIRI COALFIELD, M. P., INDIA

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ABSTRACT

The miflora of Chirimiri Coalfield has been studied from the sediments exposed in Paradol-Chirimiri railway cutting and Kauakoh nala section. The palynological succession is divisible into two phases. The older phase contains a mioflora rich in radial monosaccates (*Parasaccites* + *Plicatipollenites*) associated with *Callumispora* from the typical khaki green shales of the Talchir Stage. The younger phase indicates the Karharbari Stage in Chirmiri Coalfield and is divisible into two sub-phases. The older sub-phase is marked by the dominance of *Callumispora* with appreciable decline of monosaccate pollen but increase of pteridophytic spore. In the younger sub-phase *Parasaccites* progresssively rises in dominance once again while varitriletes and zonate miospores reduces significantly.

INTRODUCTION

The Chirimiri Coalfield, 23° 15′ and 23° 08′ N and 82° 16′ and 82° 26′ E, lies as a detached Barakar block south of the most extensive Sonhat Coalfield. With a total area of about 130 sq. kms., the general topography is very rough being broken by the projection of Barakars into hilly blocks having steep sides above the surrounding planes. The coal deposits of the Chirimiri Coalfield are mostly assigned to Barakar Stage and are surrounded on three sides by almost horizontally lying Talchirs.

The spore and pollen contents of Chirimiri Coalfield were first described by Ganguly (1959) from coal seams of Pondri Colliery. Simultaneously, Bhattacharya (1959) also described the plant microfossils from the Kurasia seam of Kurasia Coalfield. Nearly a decade after, Bharadwaj and Srivastava (1969a, 1969b) studied the pollen contents among the bore hole samples of various coal seams of different collieries in Chirimiri Coalfield and besides establishing their correlation, the coal seams were suggested to belong to Lower Barakar Stage. Thus, the knowledge of the palynoflora of this coalfield is restricted only to the coal measures and is yet incomplete. In view of this fact the present investigation was carried out so as to reveal the succession of mioflora from the Talchir Stage up to the coal measures. Therefore, the western part of the coalfield was selected where a thick succession of rocks is exposed along nalas and tributaries. The details of samples collected are given in Table-1.

A good section of Talchir sediments, mostly needle shales, is exposed in Kauakoh nala, slightly north of the railway track. Further upstream, in the north, the Kauakoh nala exposes a long stretch of coarse-grained sandstone which is practically devoid of coal on the surface. However, the coal seams are, exposed in a small gorge west of Kauakoh nala in Saja Pahar. The coal seams are thin and contain low grade coal. In this section the Talchir rocks gradually merge into Barakars.

The railway cutting from Paradol to Chirimiri exposes Talchir sediments which gradually grade into Barakars near Chirimiri railway station. In this section the Talchir sediments have a low dip and are exposed for a greater distance west

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Table 1—Showing details of the samples collected from Chirimiri Coalfield

Sample No.	Description	Spore occurrence
	Kauakoh Nala section	
C/1	Talchir sandstone near the transition, north of the railway bridge	No spores
C/2	Khaki green needle shale	No spores
C/3	Coarse-grained sandstone overlying C/2	Spores present
C/4	Shaly coal exposed in a gorge in the feeder to Kauakoh nala in Saja Pahar	Spores present
C/5	Dull coal exposed in a gorge in the feeder to Kauakoh nala in Saja Pahar	Spores present
	Sediments exposed in Paradol-Chirimiri railway cutting	
	Section 1—from one mile west and up to the railway bridge on Kanakoh nala	
CR/1	Coarse-grained sandstone with carbonaceous streaks	Sponge spiucles present
CR/2	Coarse-grained sandstone	No spores
CR/3	Puckered sandstone with carbonaceous streaks	No spores
CR/4	Coarse grained sandstone with shale lense	Spores rare
CR/5	Coarse grined sandstone with shale lense	Spores rare
CR/6	Sandstone with coal lense	Spores rare
CR/7	Sandstone with coal lense	Spores rare
CR/8	Shaly sandstone	No spores
CR/9	Sandstones with coal lense	Spores present
	Section 2—between the railway bridge and railway station	
CR/10	Khaki green needle shale	Spores rare
CR/11	Grey shale intercalated in sandstone	Spores rare
CR/12	Current bedded sandstone	No spores
CR/13	Khaki green needle shale with assorted pebbles	Sponge spicules
CR/14	Mudstone	No spores
CR/15	Carbonaceous shale	Spores present
CR/16	Sandy shale with carbonaceous lense	Spores rare
CR/17	Coal seam-1 meter thick (weathered) near railway station	No spores

of Chirimiri. The contact between the Talchir sediments and the metamorphics could not be observed in this section. The Talchirs are mostly represented by the mudstone at the base and are overlain by needle shales. The other lithological units to follow above the needle shales are fine to coarse-grained sandstones which are extensively developed in the area. These sandstones are highly indurated and include, at places, many stringers of coal and carbonaceous shale. Hardly any outward sign of break in sedimentation, if at all, could be observed between the Talchir and Barakar rocks. The basal member of the Barakars is a fine-grained sandstone. Two coal seams are exposed in this sandstone unit very close to the Chirimiri railway station.

MATERIAL AND METHODS

In all 22 samples of coal, shale, shaly sandstone, needle shale and mudstone were collected from the two sections described above. Coal samples were subjected to similar maceration procedure in each case (sensu BHARADWAJ 1962, BHARADWAJ & SALUJHA 1964). Five grams of material was treated with commercial Nitric Acid for three days followed by digestion with 10 per cent KOH after thorough washing with water. Samples other than coal, however, needed a different line of treatment. They were first digested with Hydrofluoric acid in order to dissolve out the silica components. Needle shales and mud stones yielded spores directly but carbonaceous shales required further treatment similar to coal. Out of all the 22 samples macerated, 8 samples proved barren of spores and pollen, 2 samples contained only sponge spicule-like structures, 7 samples contained only a limited number of miospores and 5 samples yielded a rich mioflora. The quantitative analysis was possible only in seven samples. Nearly 200 miospores were counted for the quantitative estimation of the miofloral assemblage.

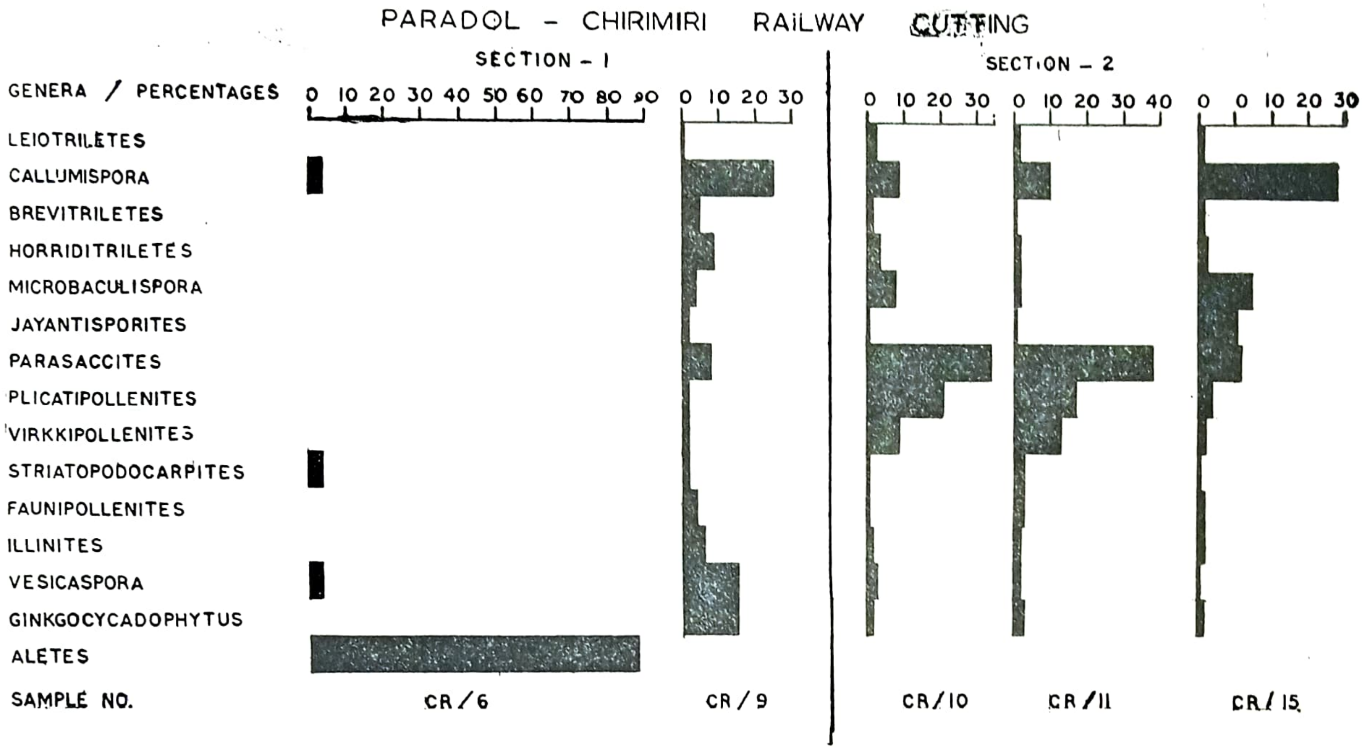
MIOFLORAL COMPOSITION

The sporae dispersae of Chirimiri Coalfield has been assigned to 35 genera (sensu BHARADWAJ 1962, BHARADWAJ & SALUJHA 1964, BHARADWAJ & TIWARI 1964, BHARADWAJ & SRIVASTAVA 1969b) which are listed below : *Leiotriletes*, *Callumispora*, *Hennellysporites*, *Cyclogranisporites*, *Apiculatisporis*, *Brevitriletes*, *Horriditriletes*, *Microbaculispora*, *Jayantisporites*, *Latosporites*, *Divarisaccus*, *Parasaccites*, *Caheniasaccites*, *Vestigisporites*, *Plicatipollenites*, *Virkkipollenites*, *Platysaccus*, *Striatites*, *Striatopodocarpites*, *Faunipollenites*, *Illinites*, *Vesicaspora*, *Scheuringipollenites*, *Ibisporites*, *Ginkgocycadophytus*, *Pilasporites*, *Hemisphaerium*, *Brazilea*, *Greinervillites*, *Pilasphaeridium*, *Leiosphaeridia*, *Spongocystia*, *Quadrisporites*, *Foveofussa* and *Botryococcus*.

Amongst these *Hennellysporites*, *Cyclogranisporites*, *Apiculatisporis*, *Latosporites*, *Divarisaccus*, *Caheniasaccites*, *Vestigisporites*, *Platysaccus*, *Striatites*, *Scheuringipollenites*, *Ibisporites*, *Brazilea*, *Greinervillites*, *Pilasphaeridium*, *Spongocystia*, *Foveofussa* and *Botryococcus* occur inconsistently and rarely too. Thus, they do not characterise the miofloral assemblage and therefore, their percentages have been merged along with their nearest allies so as to make the histogram more homogeneous. The nature of variation of different miospore genera in the succession has been shown in histograms 1 & 2. The most important components are *Callumispora*, *Parasaccites* and *Ginkgocycadophytus* which characterise the association by their dominant representation. To follow next to them are *Horriditriletes*, *Microbaculispora*, *Plicatipollenites* and *Virkkipollenites*. Their association with the dominants offer an interesting combination in the miofloral assemblage of the Chirimiri Coalfield.

PARADOL TO CHIRIMIRI RAILWAY CUTTING

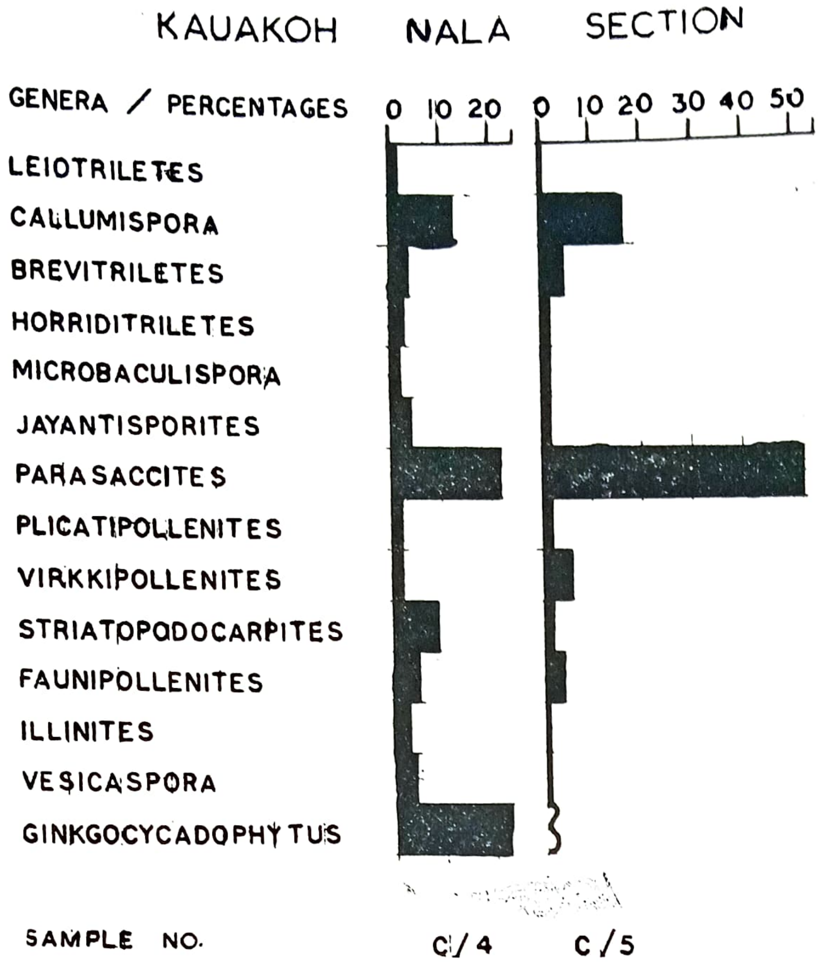
Section 1—The massive sandstones are exposed for a considerable distance in Section-1 which include streaks of coal and carbonaceous shale. Sample no. CR/1 has yielded poorly preserved sponge-spicule like structures while sample nos. CR/2 and CR/3 contained no miospores. Sample nos. CR/4 and CR/5 are alike in regard to miospore contents as they contained only few specimens of *Callumispora*, *Parasaccites*, *Virkkipollenites* and *Scheuringipollenites*. Qnantitative estimation of these samples could not be done due to the paucity of miospores. Sample no. CR/6 contains only limited number of spores and pollen grains but is rich in woody tracheids and alete miospores. This sample (Histogram-1) is characterised by the abundance of *Quadrisporites* (*Q. horridus*—48%) and *Hemisphaerium* (24%). The total percentage of alete sporomorphs amounts to 88 per cent while rest of the percentage is shared almost equally by striated and nonstriated disaccates and trilete miospores. Sample no. CR/7 is almost akin to sample no. CR/6. Sample no. CR/8 proved barren of miospores. Sample no. CR/9 is characterised by the richness of *Callumispora* (25%). *Ginkgocycadophytus* (15%) and *Vesicaspora* (15%) falls next to the dominant genus. The general dominance of this assemblage is marked by laevigate +apiculate triletes (36%). Nonstriated disaccates (21%) follow next to it. Colpate pollen grains (15%), monosaccate pollen grains (13%) and varitriletes (8.5%) share rest of the percentage.



Histogram 1. Percentage of miospores after redistributing the percentages of inconsistent genera into the consistent ones in Paradol to Chirimiri railway cutting, Chririmiri Coalfield.

Section 2—The succession in Section-2 starts with needle shales at the base and finally grades into sandstones containing coal seams at the top. Sample nos. CR/10 and CR/11 both contain a rich association of trilete bearing radial monosaccates. In sample no. CR/10, which is a needle shale, *Parasaccites* is dominant being represented up to 34 per cent. This is associated with *Plicatipollenites* (21%) and *Virkkipollenites* (9%). Thus, the total percentage of radial monosaccates reaches 64 per cent. Laevigate+apiculate triletes are present up to 16 per cent, while a sufficient number of varitriletes, chiefly *Microbaculispora tentula* Tiwari, is also present up to 8 per cent. In sample no. CR/11 also the radial monosaccates (68%) form the bulk of the assemblage. Sample no. CR/12 is a current bedded sandstone and contains no miospores. Sample no. CR/13 is a Khaki green needle shale containing numerous assorted pebbles. This sample as well as CR/14 did not yield miospores.

Sample no. CR/15 is a persistent bed of carbonaceous shale intercalated in sandstone. This sample is rich in miospores and is marked by the dominance of *Callumispora* (40%). *Microbaculispora* (*M. tentula*) has increased to 15 per cent and so also *Jayantisporites* (11%). *Parasaccites* (12%) marks a slight decrease in its percentage along with other monosaccate pollen grains. Thus, the assemblage is mainly represented by laevigate+apiculate triletes (45%). Next to follow them are radial monosaccates (18%), varitriletes



Histogram 2. Percentage of miospores after redistributing the percentages of inconsistent genera into the consistent ones in Kauakoh nala section, Chirimiri Coalfield.

(17%) and zonate triletes (12%). Sample no. CR/16 contained only few pollen grains of monosaccate pollen grains. Sample no. CR/17 did not yield miospores.

Kauakoh nala section

The Khaki green needle shales (sample nos. C/1, C/2) exposed north of the railway bridge does not contain any miospore. However, the coarse-grained sandstone (sample No. C/3) associated above the sample no. C/2 contains only few radial monosaccate pollen grains, chiefly *Parasaccites* but as the frequency of occurrence of the pollen is too low their quantitative estimation is not possible.

The two coal seams exposed in a small channel west of Kauakoh nala contains a rich mioflora. The older coal seam (sample no. C/4) is characterised by the combined dominance of *Ginkgocycadophytus* (24%) and *Parasaccites* (22%) followed by *Callumispora* (13%) and *Striatopodocarpites* (9%—Histogram 2). Compositely the mioflora is dominated by the radial monosaccates (26%). Next to it in decreasing order are the colpate pollen grains (24%), laevigate+apiculate triletes (18%) and striated disaccates (13%).

The younger coal seam (sample no. C/5) is marked by the dominance of *Parasaccites* which is present up to 52 per cent. *Callumispora* (17%) is associated very closely with the monosaccates. The total percentage of radial monosaccate pollen grains is 60 per cent. The representation of laevigate+apiculate triletes is 20 per cent while the colpates are reduced to rarity.

PALYNOSTRATIGRAPHY

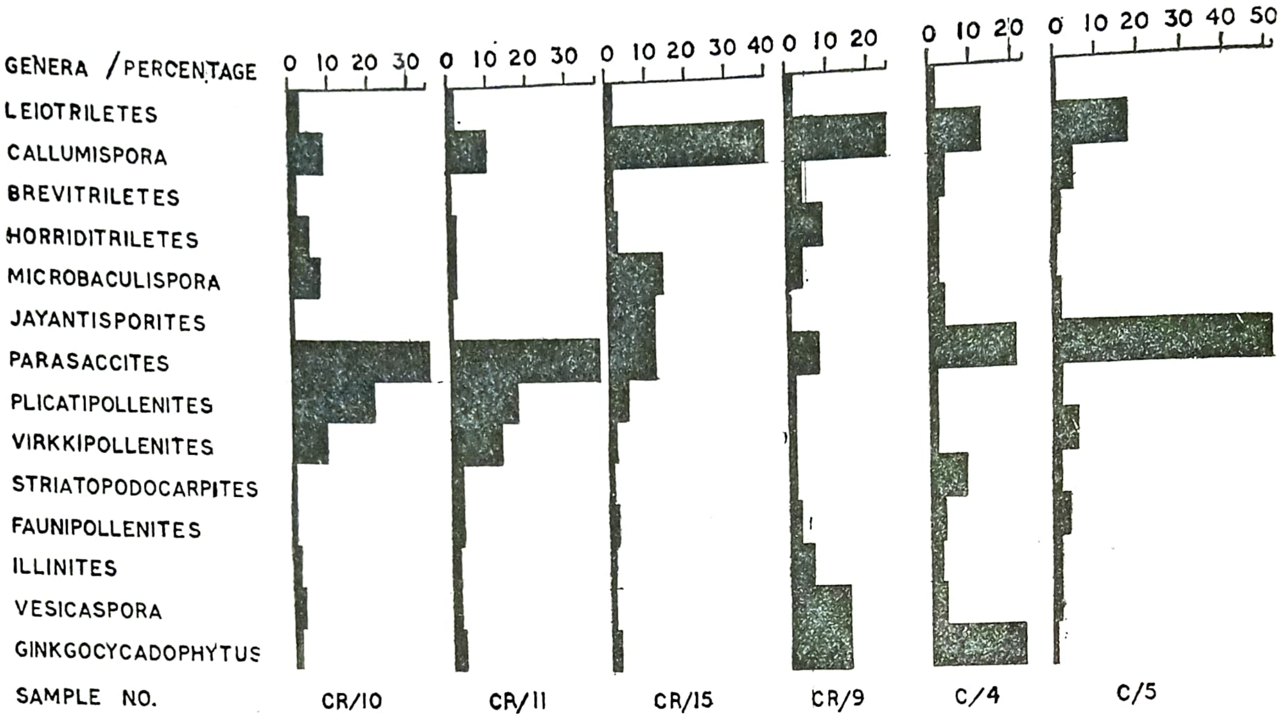
The miofloral assemblages described above gives an idea of vegetation as represented by their miospores. The section of rocks from Paradol to Chirimiri railway station has yielded encouraging results.

In Section-1 of Paradol to Chirimiri railway cutting, sandstones are extensively developed which are coarse grained and contain stringers of coal and carbonaceous shales in the upper part. These carbonaceous inclusions have yielded very peculiar assemblages. Sample no. CR/6 is exclusively rich in *Quadrisporites* and *Hemisphaerium*. *Pilasporites*, *Brazilea* and *Leiosphaeridia* further enrich the population of alete miospores. This is the first incidence in such abundance of the first two genera and hence, their comparison with a similar known occurrence in India is not possible. POTONIÉ AND LELE (1961) described a mioflora from the upper part of the Talchir Stage near Goraia in Johilla Coalfield, South Rewa Gondwana basin, which is fairly rich (percentage not mentioned) in *Quadrisporites*. The "*Quadrisporites* Assemblage" described by SEGROOVES (1970) representing the Upper Sakmarian of Perth Basin, Western Australia, contains only a small percentage of *Quadrisporites* sp. cf. *Q. horridus*. The occurrence of this genus in Perth Basin has been considered to be associated with the diminishing ice sheet and warming up of the climate during Upper Sakmarian.

Sample no. CR/9 is another stringer of coal in the sandstone and contains dominant percentage of *Callumispora* (Histogram 3). The dominance of *Callumispora* in association with radial monosaccate pollen grains has been observed in the Lower Karharbari Stage of Indian Lower Gondwanas (SRIVASTAVA, 1974). However, the presence of monocolpate pollen grains in such high amounts is characteristic of this assemblage. The only other record of this genus in India, once again, is from Goaraia (POTONIÉ & LELE, 1961 ; LELE, 1966, p. 89) where a combined subdominance of *Ginkgocycadophytus* along with *Potonieisporites* and *Quadrisporites* has been reported.

Thus, the above two samples, which are present as stringers in the massive sandstones show wide divergence palynologically. The evidence suggests that the lower part of the sandstone presents a different biofacies than the upper part which, however, is closer to the Lower Karharbari mioflora.

The mioflora in Section-2 begins with the abundance of radial monosaccates chiefly *Parasaccites* (Histogram-3, sample no. CR/10). Lithologically the succession begins with the needle shales, typical of the Talchir Formation. The abundance of monosaccate pollen grains in Talchirs is known from a number of coalfields of the Lower Gondwana of India. The miospore assemblage described by BHARADWAJ AND SRIVASTAVA (older subzone of Zone no. 1, 1973) and SRIVASTAVA (1973a) from Korba Coalfield bears a similar dominance of *Parasaccites*. The mioflora of Talchir Stage described by LELE AND KARIM (1971) and LELE AND MAKADA (1972) from Jayanti Coalfield is more diversified and shows a dominance of *Parasaccites* associated with *Virkkipollenites* and *Plicatipollenites*. The mioflora described from Manendragarh (BHARADWAJ *et al.*, 1979, Palynozone 2) shows a close resemblance in view of dominance of *Parasaccites* associated with *Plicatipollenites* and *Virkkipollenites* but differs in having *Divarisaccus* and *Potonieisporites*. The older phase of Zone no. 1 of Giridih Coalfield described by SRIVASTAVA (1973b) also resembles it to a great extent where a similar dominance of *Parasaccites* is recorded from the needle shales. Such a wide occurrence of closely resembling miofloras associated with almost similar lithologies suggests the occurrence of a well established palaeoflora during the Talchir Stage. Thus, the mioflora contained in sample no. CR/10 is considered to represent the oldest assemblage



Histogram 3. Succession of miofloras in Chirimiri Coalfield.

in the present investigation. Sample no. CR/11 also contains a mioflora similar to sample no. CR/10.

The mioflora contained in sample no. CR/15 represents a different stage in the succession in view of the dominance of laevigate+apiculate triletes. The abundance of *Callumispora* is associated characteristically with radial monosaccates (chiefly *Parasaccites*). Similar association is known to occur in the younger phase of Zone No. 1 of Korba Coalfield (Bharadwaj & Srivastava, *loc. cit.*) but the present assemblage is distinct in having *Microfoveolatispora* and *Jayantisporites* in sufficient numbers. The lower Karharbari seam in Giridih Coalfield (Srivastava, 1973b) also contains the dominance of *Collumispora*+ *Parasaccites* and is associated with *Brevitriletes* and *Microbaculispora* and evidently bears a very close resemblance with sample no. CR/15 which thus, represents the Karharbari Stage. Lele and Makada (1974) described a mioflora from the coal bearing sediments occurring just above the Talchirs near Banskupi village in Jayanti Coalfield. In this assemblage also *Callumispora* dominates over monosaccates and thus, bears closer resemblance with the mioflora of Chirimiri Coalfield. All the above miofloras occur immediately above the Talchir Stage mioflora in their respective coalfields much similar to that seen in Section-2 of Paradol to Chirimiri railway cutting and suggest a progressive succession of mioflora from Talchir Stage into the Karharbari Stage.

In Kauakoh nala section the Talchir sediments are exposed quite near the railway bridge (sample nos. C/1—C/3). Its mioflora is only poorly known. Whatever miospores were present resembled those from sample no. CR/10 of the railway cutting. Upstream in the nala occurs a good section of sandstones which rises continuously high up in the hills and exposes two coal seams in a stream near Saja Pahar. The lower coal seam sample no. C/4) contains high amounts of *Ginkgocycadophytus* and *Parasaccites* associated with *Callumispora*. The dominance of *Ginkgocycadophytus* has been recorded for the first time in Indian Lower Gondwana. As compared to the above in sample no. CR/9 of the Paradol to Chirimiri railway cutting *Ginkgocycadophytus* forms a subdominance jointly with *Vesica-*

spora, and this has been considered to represent the Lower Karharbari Stage. In the upper coal seam (sample no. C/5) *Parasaccites* rises to overall dominance with *Callumispora* subdominant and *Ginkgocycadophytus* negligible. These two coal seams may be compared with the older subzone of Zone No. 2 in Korba Coalfield (Bharadwaj & Srivastava, *loc. cit.*) relating to Upper Karharbari Stage. The dominance of radial monosaccates is associated with coal seams as compared to the radial monosaccate phase of Talchir Stage where it is associated with non-coal sediments. This forms the second dominant phase of radial monosaccates after the *Callumispora* phase observed in this succession.

Thus, the miofloral succession in Chirimiri Coalfield investigated here may be summarised as follows :

KARHARBARI	UPPER	C/5	*Parasaccites*	dominant
			Callumispora	subdominant
		C/4	*Parasaccites & Ginkgocycadophytus*	dominent
			Callumispora	Subdominant
	LOWER	CR/9	*Callumispora*	dominant
			Vesicaspora+*Ginkgocycadophytus*	subdominant
		CR/6	*Quadrisporites*+*Hemisphaerium*	dominant
			Triletes & Saccates	rare
		CR/15	*Callumispora*	dominant
			Monosaccates	Subdominant
TALCHIR		CR/11	*Parasaccites*	dominant
		CR/10	*Plicatipollenites & Virkkipollenites*	subdominant

DISCUSSION

The palynological investigations carried out from the Chirimiri Coalfield suggests that the miofloral succession in the area studied, commenced with the dominance of trilete bearing (radial) monosaccate pollen grains in the Talchir Stage (Histogram-3). The mioflora described may not represent the oldest Talchir as this assemblage has been recovered from Khaki green needle shales presumably much higher up in the Talchirs. Immediately above this mioflora succeeds the Lower Karharbari mioflora (Histogram 3), which is very much akin to that obtained from the Lower Karharbari seam of the type area in the Giridih Coalfield (Srivastava, 1973b) and therefore indicates the presence of Karharbari Stage in the Chirimiri Coalfield. Ganguly (1959) has studied the mioflora of a coal seem from Pondri Colliery which contained abundance of *Punctatisporites* (=*Callumispora*, more than 50%). Ganguly (1960) has also opined that there is no break in sedimentation from Talchir to Lower Barakar. Bhattacharya (1959) has studied the miofloras of coal seam nos. 1, 2 and 3 of Kurasia Coalfield and has observed similar abundance of *Punctatisporites* (=*Callumispora*) in all of them. These miofloras were then attributed to the Barakar Stage. However, with the present knowledge of sporae dispersae and the palynological succession in the Lower Gondwanas of India, it would be worthwhile to reconsider such a mioflora as representative of the Lower Karharbari substage. FERMOR (1914) and BISWAS (1955, p. 47) have also indicated the presence of Karharbari Stage on the basis of plant fossils in the Kurasia area but they were not confident enough since the megaflora resembled the typical Karharbari flora of the Giridih Coalfield but for *Gondwanidium validum* and *Buriadia heterophylla.*

The two coal seams exposed in a feeder channel west of Kauakoh nala have been considered to represent the Upper Karharbari substage in the Chirimiri Coalfield in view of the occurrence of similar mioflora in the older subzone of Zone No. 2 of Korba Coalfield (BHARADWAJ & SRIVASTAVA, 1973). As indicated by RAMIENGAR (1971) the area within the lease of Pure Chirimiri (Sajaphar of Birla Brothers) appears to be an isolated basin where the top 'main seam' is being worked. About 54 meters below the main seam another coal seam of considerable thickness has been recorded. DUTTA (1953) opines that the top seam corresponds with the Karakoh horizon of the Chirimiri Coalfield. However, the mioflora of these two coal seams, which occur much below the two coal seems exposed in the channel, west of Kauakoh nala, is not known so far. Therefore, it would be difficult to establish their further relationship. It would be interesting to work out their mioflora which may reveal the nature of succession below the *Parasaccites* dominant zone of Upper Karharbari substage. The Chirimiri mioflora described by BHARADWAJ AND SRIVASTAVA (1969a) from different bore holes has not been encountered in the present investigation apparently because it is younger.

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