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LITHOSTRATIGRAPHY AND PALYNOSTRATIGRAPHY OF THE LOWER GONDWANA FORMATIONS IN THE HUTAR COALFIELD, PALAMAU DISTRICT, BIHAR, INDIA

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ABSTRACT

The paper deals with the various aspects of lithostratigraphy of the Hutar Coalfield alongwith the palynoflora recovered from the various formations. The palynozonation of the Lower Gondwana formations has been done on the basis of palynofloras recovered from the samples belonging to three measured sections along Deori Nala, Saphi Nala and Koel River. Extension of these zones in various other nalas of the Hutar Coalfield has been traced. Comparison of these palynozones with those in other Lower Gondwana coalfields has also been done. Assemblage Zone 5 of the Barakar Formation contains a palynoflora similar to the Barren-Measure Formation of other coalfields.

Key-words — Palynostratigraphy, Lithostratigraphy, Lower Gondwana, Hutar Coalfield, India.

सारांश

बिहार (भारत) में पालामऊ जनपद के हुतार कोयला-क्षेत्र में अधरि गोंडवाना शैल-समूहों का शैलस्तरिकीय एवं परागाणुस्तरिकीय अध्ययन – मनोज शुक्ला

प्रस्तुत शोध-पत्र में विभिन्न शैल-समूहों से उपलब्ध परागाणविक वनस्पतिजात के साथ-साथ हुतार कोयला-क्षेत्र की शैलस्तरिकी के विभिन्न पहलुओं का विवेचन किया गया है। अधरि गोंडवाना शैल-समूहों का परागाणविक मंडलन देवरी नाला, साफी नाला एवं कोयल नदी के साथ-साथ तीन अनुमापित खंडों के नमूनों से प्राप्त परागाणविक-वनस्पतिजात के आधार पर किया गया है। हुतार कोयला-क्षेत्र के दूसरे भिन्न-भिन्न नालों में इन खंडों का विस्तार अन्वेषित किया गया है। इन परागाणविक मंडलों की तुलना अन्य अधरि गोंडवाना कोयला-क्षेत्रों से भी की गई है। बाराकार शैल-समूह के समुच्चय-मंडल – 5 से ऐसा परागाणविक वनस्पतिजात प्राप्त हुआ है जो कि अन्य कोयला-क्षेत्रों के बैरन मेज़र्स शैल-समूहों से मिलता-जुलता है।

INTRODUCTION

THE Hutar Coalfield (latitude, 23°44′ to 23°52′ and longitude, 83°53′ to 84°11′) lies in east-west trending Gondwana belt along Koel Valley. Earlier, Ball (1880) and Rizvi (1972) prepared the detailed geological maps of this coalfield. They recognized only three groups of sediments, viz., Talchir, Barakar and Mahadeva. Recently, Shukla (1982) demarcated the Karharbari Formation in this coalfield and revised the geological map of Rizvi (1972). The presence of Karharbari sediments was earlier inferred by Festimantel (1886) on the basis of plant fossils, viz., *Glossopteris indica*, *G. damudica*, *Gangamopteris cyclopteroides* var. *attenuata*, *G. cyclopteroides* var. *subauriculata*, coniferous branch and equisetaceous stems, found near the northern mergin of the Hutar Coalfield. Ghosh, Singh and Acharyya (1977) reported the presence of Barren Measures Formation in the Hutar Coalfield without giving any details. Palynological analysis of the Talchir Formation has been done by Lele and Shukla (1981).

The Gondwana sediments in the Hutar Coalfield form a syncline. They are surrounded on all sides by Archaeans. The Talchir Formation rests nonconformably over the Archaeans. The Talchir sediments

are succeeded by the Karharbari Formation. A conglomerate between the Talchir and Karharbari sediments indicates a hiatus between these two formations. The Karharbari-Barakar boundary is mostly faulted except in the east and north-eastern parts of the coalfield. Normal contacts are marked by the ridge forming chocolate brown to red Lower Barakar sandstone in this coalfield. Dhankutia, Dhaj and Ranimai hillocks mark this contact in the eastern and north- north-eastern portion of the coalfield. The Barakar sandstone is overlain by massive red sandstone of the Mahadeva Formation with an angular unconformity.

LITHOSTRATIGRAPHY

The Archaeans surrounding the Hutar Coalfield belong to a series of metamorphic rocks consisting of granites, gneisses with mica, hornblende and quartz veins. Regionally these rocks are uniform in nature.

The area in the south of the Hutar Coalfield is covered by granite gneisses, in which quartz veins having general trend of E15° N-W 15°S are also seen. Some of these veins are up to 30 cm thick. Towards north-west, black synite is present. In the west of the coalfield, the area is covered with gneisses, traversed by pegmatite and quartz veins. Granite gneisses traversed by dolerite dykes are seen in the East of the coalfield. These dykes are trending east-west.

Talchir Formation

This formation is distinguishable into the following three members in ascending order. The scheme proposed by Ghosh and Mitra (1969) has been followed here for stratigraphic classification.

1. *Basal Sandstone Conglomerate Member* — It is characterized by lateral and vertical variations in the lithology from conglomerate to sandstone. Towards southern side of the coalfield the boulder bed is seen grading into sandstone and shale. Some conglomeratic lenses have also been noticed in the sandstone. Boulders and pebbles forming these beds range from 1 cm to 1 m in size and are subrounded in nature. Striations on the boulders are rarely seen. The granite gneisses, vein-quartz, amphibolite schist, pegmatite, quartzite and Jespar form most of the pebbles while boulders are made of granite gneisses. They are embedded in a sandy matrix.

The sandstone varies from fine to medium grained and is poorly sorted. In a vertical section the member shows pseudostratification.

2. *Shale Member* — This member overlies the Basal Sandstone Conglomerate Member. It shows two lithological facies:

(i) *Shale facies* comprising greenish-yellow, fine-grained splintery shales which break into small needle-like fragments.

(ii) *Rhythmite facies* is represented by varves and shale siltstone alternations. The varves are best exposed in the Saphi Nala near Ukamnar Village and in the Behra Nala near Putvagarh Village. They show alternation between dark green clayey and light grey silty layers. These layers invariably exhibit graded appearance within the laminae and vary in thickness Variation is more frequent in the light coloured silty layers. Laterally as well as vertically the varves grade into shales. In the Ukamnar area they are seen affected by reverse faulting. Ripple marks, current bedding, slump structure, etc. are also observed in the sediments associated with them. The shales, immediately overlying the varves, show dropstones.

The siltstone alternation are exposed in Deori Nala, Ukamnar area and the Behra Nala exposures. The silty layers vary in thickness from 2-20 cm and can be distinguished from the shales due to differential type of weathering, massive appearance and compact nature. These beds are laterally traceable in the field for long distances.

3. *Upper Sandstone Member* — It is coarse-grained and greenish in colour and constituted mostly of immature subrounded quartz grains and rock fragments. The sandstone is overlain by a conglomerate.

Karharbari Formation

The Karharbari Formation in the Hutar Coalfield is seen overlying the Talchir

Formation without any discordance in dips, but the beds of the two formations are separated by a bed of conglomerate indicating a hiatus. This conglomerate bed is noticeable both in the Koel and the Deori Nala sections. Some good sections of the Karharbari Formation are exposed in deeper nala — and river-cuttings through the Barakar sandstones. This formation consists of thick succession of gritty ferruginous sandstones separated by thin coal-shale beds.

1. *Basal Conglomerate Member* — The pebbles are mostly of granite gneiss, hornblende-schist, mica schist, chlorite-schist, quartzite, vein-quartz, Talchir Shale and epidiorites, which are set in a fine sandy matrix. In the past, this conglomerate was classified with the Talchir boulder beds due to apparent lithological similarities. In the present work it is taken as a basal unit of the Karharbari Formation, as it marks the beginning of the Karharbari cycles of sedimentation.

2. *Gritty Sandstone Member* — It consists of two distinct types of sediments, viz., sandstones and coal-shales. Four coal-shale beds have been observed in the Deori Nala Section, where the Karharbari Formation is best exposed.

Sandstones — They are medium-to coarse-grained, reddish brown, poorly sorted and mainly composed of subrounded quartz and feldspar grains. Occasionally, the sandstones are gritty to pebbly. At places iron nodules are also seen in the sandstone. These nodules are often washed off by water action, leaving behind rounded cavities. Frequently the sandstones are strongly, current-bedded with laminae sloping towards east.

Coal-Shales — The coal beds show sharp contacts with the sandstone on the upper side while the lower contact is transitional passing through coaly shale-shale-sandy shale to sandstone. The coal is generally dull, hard, compact, non-banded and durain type in appearance. Rarely lenses of vitrain are also seen. The shales occurring near the sandstones are rich in sandy material and show transitional contact with sandstones whereas, the shales present near the coal seams are rich in carbonaceous material. The shales are generally grey but also show various shades of black colour.

Barakar Formation

It has been divided into following three members:

1. *Compact red Sandstone Member* — It is a characteristic member which can be taken as marker horizon to separate the Barakar and Karharbari formations. Due to hard and compact nature of the sediments in this member it stands out in the form of a number of hillocks which mark the Karharbari-Barakar boundary. The sandstone is red to chocolate brown, coarse-grained and poorly sorted. Occasionally, the lenses of conglomerate are also present. Pebbles are mostly of quartz.

2. *Gritty Sandstone Member* — This member is also composed of two distinct lithologies, viz., gritty sandstone and coal shale.

Sandstone — It is coarse grained and occasionally gritty. The grains are subrounded. Lenses of conglomerate made up of immature quartz pebbles are also seen. It is less ferruginous than the Karharbari sandstones. Iron nodules are also rare. At few places, carbonaceous grits associated with shale beds have also been seen.

Coal-Shale bed — The lower Barakar sediments of this coalfield are characterized by thick and frequent coal seams. The coal is generally shaly and dull in nature. The coal seams show gradational contact with sandstones passing through shale and sandy shale beds. Sometimes thin streaks of coaly matter are also seen in the sandstones associated with these beds.

3. *Ferruginous Sandstone-Shale Member* — It consists of two types of lithologies, viz., the sandstones and clay-shale beds.

Sandstone — It is gritty to pebbly, ferruginous, mostly constituted of poorly sorted immature quartz grains. In extreme west, near the Barakar-Mahadeva contact, these sandstones show a typical greenish-black colour. The sandstones in general have a tendency to become more pebbly near top.

Clay and shales — This zone shows near absence of carbonaceous matter. The shales are fine-grained and show various green and red shades. The clays are massive, non-laminated and yellow in colour. Occasionally, their surface is stained with iron. The significant feature of these shale

and clay beds is their similarity with the Talchir shales. This type of lithology is not common in the Barakar Formation of other areas.

MAHADEVA FORMATION

It is represented by a thick massive sandstone which dips 10-12° in S 25°W. It overlies the Barakar Formation with a marked angular unconformity. The hills formed by these sandstones have steep escarpment with uneven top. The sandstones are feldspathic at the base with an occasional thin bed of red ferruginous shale. Extension of the various members in the Hutar Coalfield is given in Table 1.

MATERIAL

Three sections along Deori Nala, Koel River and Saphi Nala were measured. The samples were collected along these and other nala and river cuttings. Details of samples in these sections alongwith the thickness of individual beds is shown in Text-fig. 1 and Table 2. Palynozonation has been done in the three measured sections and their extension has also been traced in other sections.

MIOFLORAL COMPOSITION AND DISTRIBUTION

Forty-six genera and 98 species of pollen and spores are represented in the miofloral complex present in the Hutar Coalfield. The palynofossils, recorded from each formation, are listed below:

Talchir Formation

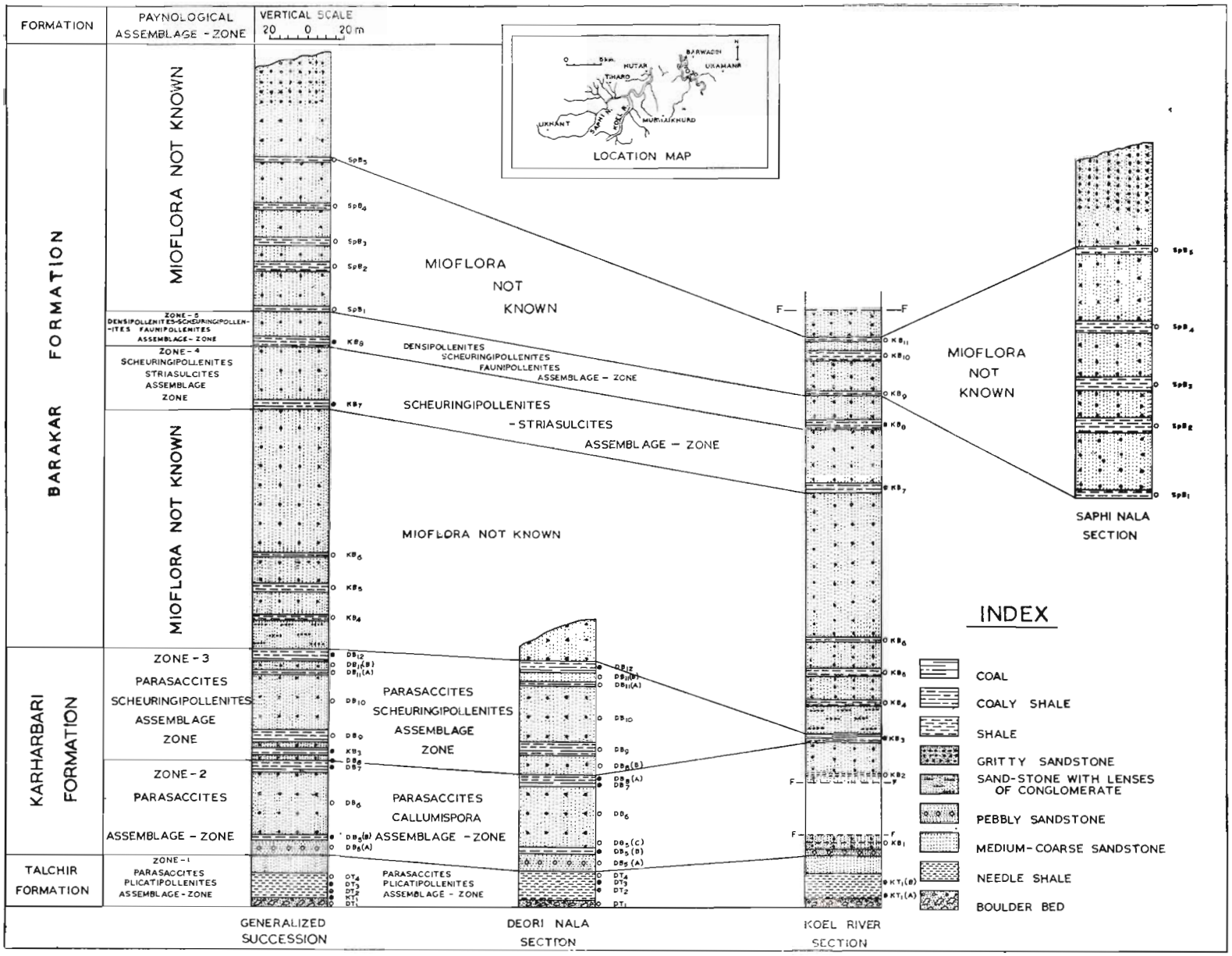
Psilalacinites triangulus Kar, 1969; *Callumispora tenuis* var. *minor* Bharadwaj & Srivastava, 1969; *Verrucosisporites* sp.; *Horriditriletes curvibaculosus* Bharadwaj & Salujha, 1964; *Jayantisporites pseudozonatus* Lele & Makada, 1972; *J. conatus* Lele & Makada, 1972; *Plicatipollenites indicus* Lele, 1964; *P. gondwanensis* (Balme & Hennelly) Lele, 1964; *P. trigonalis* Lele, 1964; *P. diffusus* Lele, 1964; *P. densus* Srivastava, 1970; *Cannanoropollis obscurus* (Lele) comb. nov. (= *Virkkipollenites obscurus* Lele, 1964, pl. 2, fig. 17, p. 60); *Potonieisporites neglectus* Potonié & Lele, 1961; *P. jayantiensis* Lele & Karim, 1971; *P. densus* Maheshwari, 1967; *P. crassus* Lele & Chandra, 1973; *Parasaccites distinctus* Tiwari, 1965; *P. bilateralis* Tiwari, 1965; *P. obscurus* Tiwari, 1965; *P. diffusus* Tiwari, 1965; *P. talchirensis* Lele & Makada, 1972; *P. densicorpus* Lele, 1975; *Tuberisaccites tuberculatus* (Maheshwari) Lele & Makada, 1972; *Caheniasaccites distinctus* Lele & Makada, 1972; *Vesicaspora* sp.; *Faunipollenites goraiensis* (Potonié & Lele) Maithy, 1965; *Crescentipollenites amplus* (Balme & Hennelly) Lele & Shukla, 1981.

Karharbari Formation

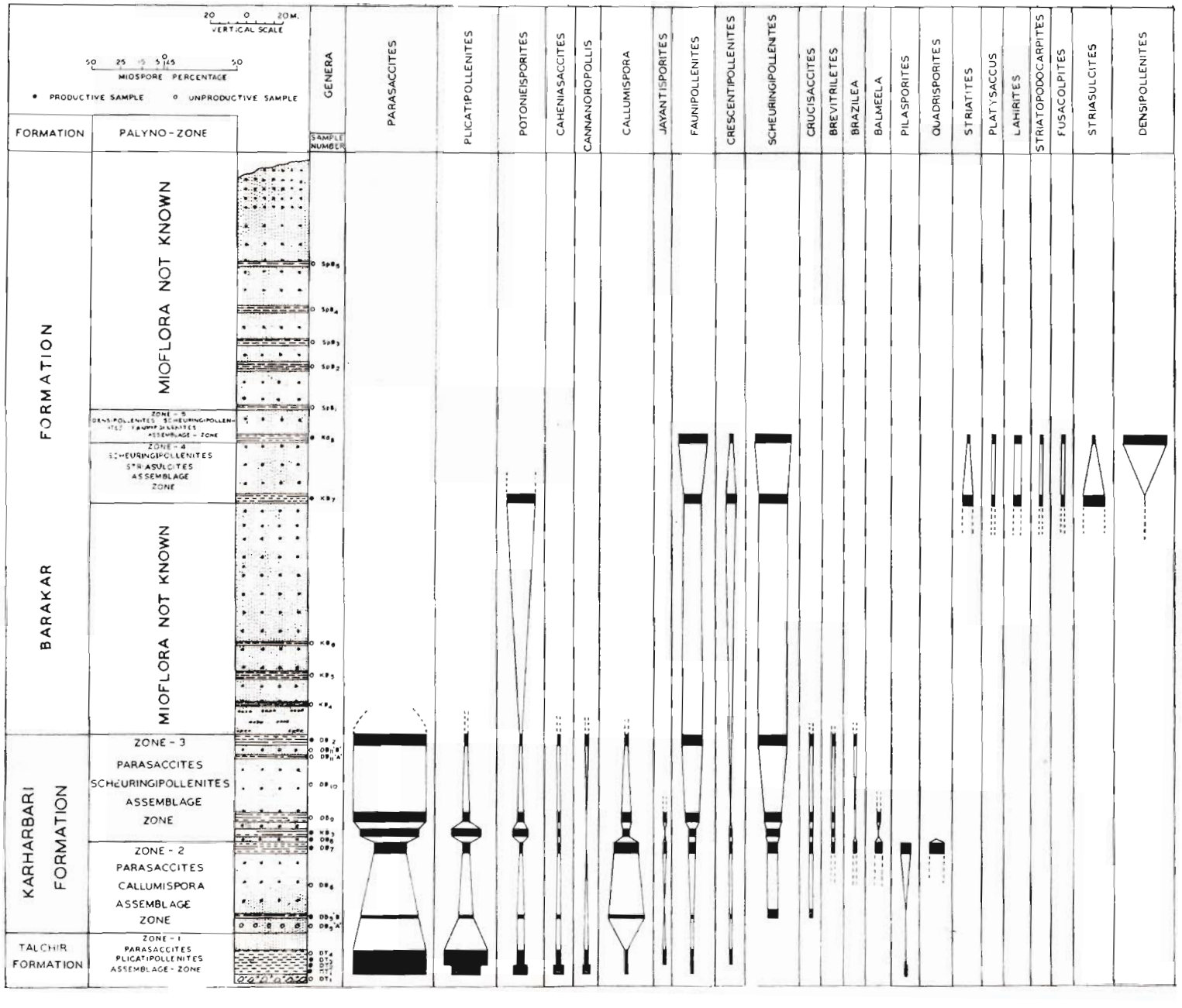
Callumispora tenuis; *C. tenuis* var. *minor*; *Leiotriletes* sp., *Brevitriletes levis* (Balme & Hennelly) Bharadwaj & Srivastava, 1969; *Microbaculispora indica* Tiwari, 1965; *Jayantisporites pseudozonatus* Lele & Makada, 1972; *Plicatisporites distinctus* Lele & Makada 1972; *Tiwariasporis simplex* (Tiwari), Maheshwari & Kar, 1967; *Pilasporites calculus* Balme & Hennelly, 1973; *Brazilea punctata* Tiwari & Navale, 1967; *Greinervillites undulatus* Bose & Kar, 1967; *Balmeela tetragona* Pant & Mehra, 1953; *B. gigantea* Bose & Maheshwari, 1968; *Quadrisporites horridus* (Hennelly) Potonié & Lele, 1961; *Parasaccites korbaensis* Bharadwaj & Tiwari, 1964; *P. distinctus*; *P. diffusus*; *P. obscurus*; *P. bilateralis*; *P. densicorpus*; *P. plicatus* Lele & Makada, 1972; *P. invasus* Tiwari, 1968; *Crucisaccites latisulcatus* Lele & Maithy, 1964; *C. indicus* Srivastava, 1970; *Stellapollenites talchirensis* Lele, 1965; *S. indicus* Lele & Kulkarni, 1970; *Stellapollenites* sp., *Divarisaccus lelei* Venkatachala & Kar, 1966; *Caheniasaccites decorus* Lele & Makada, 1972; *C. granulatus* Lele & Makada, 1972; *C. granulatus* Lele & Chandra, 1972; *Plicatipollenites indicus*; *P. gondwanensis*; *P. diffusus*; *P. trigonalis*; *Kibambites corius* Bose & Kar, 1967; *Cannanoropollis orientalis* (Tiwari) comb. nov. (= *Virkkipollenties orientalis* Tiwari, 1968, p. 23, pl. 34, fig. 38); *Potonieisporites triangulatus* Tiwari, 1965; *P. monosaccoides* (Bose & Maheshwari) Lele, 1975; *P. neglectus*; *P. jayantiensis*; *P. densus*; *P.* sp. cf.

TABLE 1 — EXTENSION OF LITHOSTRATIGRAPHIC UNITS IN THE HUTAR COALFIELD

Formation	Members	Deori Nala (South)	Deori Nala (North)	Koel River (North)	Saphi Nala (North)	Behra Nala	Saphi (Ukamnar area)	Kelha Nala	Ghorasum Nala	Duria-khar	Chelha-Panikhar
Mahadeva	Ferruginous pebbly sandstone				+						
----------	ANGULAR UNCONFORMITY			(Fault)							
Barakar	Ferruginous sandstone-shale			+	+	+		+		+	+
	Gritty sandstone			+		+				+	+
	Compact red sandstone			+			+				
----------								(fault)			
Karharbari	Gritty sandstone	+	+	+			+	+	+		
	Basal conglomerate	+		+			+				
----------	EROSIONAL BREAK			(Fault)							
Talchir	Upper sandstone		+	+		(Fault)	+				
	Shale	+	+	+		+	+				
	Basal sandstone conglomerate	+	+	+		+					
----------	NONCONFORMITY										
Archean	Granite, gneiss schists	+	+	+			+				


FORMATION
PAYNOLOGICAL ASSEMBLAGE - ZONE
VERTICAL SCALE
20 0 20 m
BARAKAR FORMATION
MIOFLORA NOT KNOWN
ZONE - 5
DENSIPOLLENITES-SCHEURINGIPOLLENITES FAUNIPOLLENITES ASSEMBLAGE - ZONE
ZONE - 4
SCHEURINGIPOLLENITES STRIASULCITES ASSEMBLAGE ZONE
MIOFLORA NOT KNOWN
KARHARBARI FORMATION
ZONE - 3
PARASACCITES SCHEURINGIPOLLENITES ASSEMBLAGE ZONE
ZONE - 2
PARASACCITES ASSEMBLAGE - ZONE
TALCHIR FORMATION
ZONE - 1
PARASACCITES PLICATIPOLLENITES ASSEMBLAGE - ZONE
LOCATION MAP
HUTAR
TIHARO
BARWADIH
UKAMARA
UKHANT
SAPHI
KOEL
MURIJAKHURD
MIOFLORA NOT KNOWN
DENSIPOLLENITES SCHEURINGIPOLLENITES FAUNIPOLLENITES ASSEMBLAGE - ZONE
SCHEURINGIPOLLENITES - STRIASULCITES ASSEMBLAGE - ZONE
MIOFLORA NOT KNOWN
PARASACCITES SCHEURINGIPOLLENITES ASSEMBLAGE ZONE
PARASACCITES CALLUMISPORA ASSEMBLAGE - ZONE
PARASACCITES PLICATIPOLLENITES ASSEMBLAGE - ZONE
MIOFLORA NOT KNOWN
SAPHI NALA SECTION
INDEX
COAL
COALY SHALE
SHALE
GRITTY SANDSTONE
SAND-STONE WITH LENSES OF CONGLOMERATE
PEBBLY SANDSTONE
MEDIUM-COARSE SANDSTONE
NEEDLE SHALE
BOULDER BED
GENERALIZED SUCCESSION
DEORI NALA SECTION
KOEL RIVER SECTION

TEXT-FIG. 1


20 0 20M.
VERTICAL SCALE
50 25 0 5 25 50
MIOSPORE PERCENTAGE
PRODUCTIVE SAMPLE
UNPRODUCTIVE SAMPLE
FORMATION
PALYNO-ZONE
SAMPLE NUMBER
GENERA
PARASACCITES
PLICATIPOLLENITES
POTONIEISPORITES
CAHENIASACCITES
CANNANOROPOLLIS
CALLUMISPORA
JAYANTISPORITES
FAUNIPOLLENITES
CRESCENTIPOLLENITES
SCHEURINGIPOLLENITES
CRUGISACCITES
BREVITRILETES
BRAZILEA
BALMEELA
PILASPORITES
QUADRISPORITES
STRIATITES
PLATYSACCUS
LAHIRITES
STRIATOPODOCARPITES
FUSACOLPITES
STRIASULCITES
DENSIPOLLENITES
BARAKAR FORMATION
MIOFLORA NOT KNOWN
ZONE - 5
DENSIPOLLENITES SCHEURINGIPOLLENITES TRIPOLISPORITES ASSEMBLAGE - ZONE
ZONE - 4
SCHEURINGIPOLLENITES STRIASULCITES ASSEMBLAGE ZONE
MIOFLORA NOT KNOWN
KARHARBARI FORMATION
ZONE - 3
PARASACCITES SCHEURINGIPOLLENITES ASSEMBLAGE ZONE
ZONE - 2
PARASACCITES CALLUMISPORA ASSEMBLAGE ZONE
TALCHIR FORMATION
ZONE - 1
PARASACCITES PLICATIPOLLENITES ASSEMBLAGE - ZONE

TEXT-FIG. 2

TABLE 2 — DETAIL OF SAMPLES COLLECTED FROM OTHER NALAS, EXPOSING LOWER GONDWANA BEDS (BESIDES THREE MAIN TRAVERSES) IN THE HUTAR COALFIELD

No.	Sample No.		Formation	Location
1	DT15	Needle shale with siltstone	Talchir	Near Barwadih Village in Deori Nala
2	BT2, BT3	Needle shale with siltstone	Talhchir	Behra Nala, N-W of Dhaj Pahar
3	DB16	Shale — Coal	Karharbari	Deori Nala, near Hutar Colliery
4	K1K2	Coal	Karharbari	Kelha Nala, nearly 100 meter from confluence of the Kelha Nala and Deori Nala
5	GB2	Shale — Coal	Karharbari	Ghorasum Nala, near its confluence with Deori Nala
6	SB10	Coaly shale	Karharbari	Satbahni Nala, 0.5 km south-east of Hot-water spring
7	SB1	Carbonaceous shale	Barakar	Satbahni Nala
8	SB3	Sandy carbonaceous shale	Barakar	do
9	SB8	Shale	Barakar	do
10	CB3	Sandy carbonaceous shale	Barakar	Chelha-Panikhar Nala

P. lelei Maheshwari, 1967; *Scheuringipollenites maximus* (Hart) Tiwari, 1973; *S. barakarensis* (Tiwari) Tiwari, 1973; *S. tentulus* (Tiwari) Tiwari, 1973; *Ibisporites diplosaccus* Tiwari, 1968; *Korbapollenites* sp.; *Faunipollenites varius* Bharadwaj, 1962; *F. perexiguus* Bharadwaj & Salujha, 1964; *F. parvus* Tiwari, 1964; *Crescentipollenites fuscus* (Bharadwaj) Bharadwaj, Tiwari & Kar, 1974; *Ginkgocycadophytus cymbatus* (Balme & Hennelly) Potonié & Lele, 1961.

Barakar Formation

Indotriradites surangei Tiwari, 1965; *Densipollenites indicus* Bharadwaj, 1962; *D. invisus* Bharadwaj & Salujha, 1964; *D. minimus* Venkatachala & Kar, 1968; *D. brevis* Lele & Srivastava, 1977; *Crucisaccites* sp., *Vesicaspora distincta* Tiwari, 1965; *Plicatipollenites indicus*; *Potonieisporites concinnus* Tiwari, 1965; *P. triangulatus*; *P. monosaccoides*; *P. bilateralis* Singh, 1964; *P. densus*; *Potonieisporites* sp., *Illinites delasaucei* (Potonié & Klaus) Grebe & Schweitzer, 1962; *Scheuringipollenites maximus*; *S. barakarensis*; *S. tentulus*; *Platysaccus hingirensis* Tiwari, 1964; *Ibisporites diplosaccus*; *Korbapollenites* sp., *Rhizomaspora fimbriata* Tiwari, 1965; *Faunipollenites varius*; *F. perexiguus* Bharadwaj & Salujha, 1965; *F. parvus*; *F. goraiensis*; *F. bharadwajii* Maheshwari, 1967; *Faunipollenites* sp-, (cf. Tiwari, 1965). *Striatopodocarpites labrus* Tiwari, 1965; *S. decorus* Bharadwaj & Salujha, 1964; *Lahirites fructus* Tiwari, 1965; *L. alutas* Venkatachala & Kar, 1968; *L. rarus* Bharadwaj & Salujha, 1965; *L. incertus* Bharadwaj & Salujha, 1965; *Crescentipollenites fuscus*; *C. globosus* (Maithy), Bharadwaj, Tiwari & Kar, 1974; *Striatites implicatus* Bose & Maheshwari, 1968; *S. cancellatus* (Balme & Hennelly) Potonié, 1956; *S. multistriatus* (Balme & Hennelly) Tiwari, 1965; *S. ornatus* Venkatachala & Kar, 1968; *Distriatites insolitus* Bharadwaj & Salujha, 1964; *Ginkgocycadophytus cymbatus*; *Fusacolpites fusus* Bose & Kar, 1966; *Striasulcites tectus* Venkatachala & Kar, 1968; *S. ovatus* Venkatachala & Kar, 1968.

PALYNOLOGICAL SUCCESSION

Palynological succession of the Lower Gondwana sediments in the Hutar Coalfield has been worked out on the basis of percentage distribution of genera (Text-fig. 2). However, some species found in the miofloral assemblage of the Hutar Coalfield show a restricted distribution in time (Table 3) and therefore are useful at least for broad local correlation.

TABLE 3 — DISTRIBUTION OF MIOSPORES SPECIES IN THE LOWER GONDWANA FORMATION OF THE HUTAR COALFIELD

SPECIES	TALCHIR	KARHARBARI	BARAKAR
Parasaccites talchirensis	×		
Plicatipollenites densus	×		
Potonieisporites crassus	×		
Caheniasaccites distinctus	×		
Cannanoropollis obscurus	×		
Parasaccites densicorpus	×	×	
Plicatipollenites trigonalis	×	×	
Plicatipollenites gondwanensis	×	×	
Parasaccites plicatus		×	
Callumispora tenuis		×	
Brevitriletes levis		×	
Crucisaccites indicus		×	
Scheuringipollenites tentulus		×	×
Potonieisporites concinnus			×
Potonieisporites barralis			×
Faunipollenites perexiguus			×
Faunipollenites bharadwajii			×
Crescentipollenites globosus			×
Illinites delasaucei			×
Striatites multistriatus			×
Striatites ornatus			×
Distriatites insolitus			×
Rhizomaspora fimbriata			×
Striatopodocarpites labrus			×
Striatopodocarpites decorus			×
Lahirites rarus			×
Lahirites incertus			×
Lahirites alutus			×

The palynological succession in the Hutar Coalfield is divided into 5 Assemblage-zones.

1. *Parasaccites-Plicatipollenitcs Assemblage Zone* — This zone is marked by the dominant presence of *Parasaccites* and *Plicatipollenites*. Other important genera are — *Potonieisporites*, *Caheniasaccites*, *Cannanoropollis*, *Callumispora*, *Jayantisporites*, *Vesicaspora*, *Limitisporites*, *Faunipollenites*. It is best identified in the Deori Nala Section, though it is also encountered within the Koel River and Behra Nala sections. The miospore frequency distribution is shown in Table 4.

2. *Parasaccites-Callumispora Assemblage Zone* — This zone is marked by the dominant presence of *Parasaccites* and *Callumispora*. The other important genera present in the zone are *Plicatipollenites*, *Scheuringipollenites*, *Faunipollenites*, *Caheniasaccites*, *Potonieisporites*, *Crescentipollenites* and *Crucisaccites*. An important feature of this zone is the presence of alete genera, viz., *Quadrisporites*, *Balmeela*, *Pilasporites* and *Brazelia* in the upper part (sample no. DB_7-DB_8) of the zone. This zone is identified in the Deori Nala Section only. The miospore frequency distribution is shown in Table 5.

3. *Parasaccites-Scheuringipollenites Assemblage Zone* — This zone shows the dominant presence of *Parasaccites* and *Scheuringipollenites*. Other important genera are *Faunipollenites*, *Plicatipollenites*, *Callumispora*, *Potonieisporites*, *Caheniasaccites*, *Brevitriletes*, *Crucisaccites*, *Jayantisporites*, *Microbaculispora*, *Tiwariasporis*, *Balmella*, *Brazelia*, *Stellapollenites*, *Vesicaspora*, *Divarisaccus*, *Kibambites*, *Cannanoropollis* and *Ibisporites*. Genera like *Scheuringipollenites*, *Crucisaccites* and *Faunipollenites* gradually increase while *Callumispora*, *Brevitriletes*, *Plicatipollenites* and *Potonieisporites* gradually decrease. This zone is best exposed in the Deori Nala Section though it is also encountered within the Koel River Section, Kelha Nala, Ghorasumi Nala and Satbahni Nala. The miospore frequency distribution is given in Table 5.

4. *Scheuringipollenites-Striasulcites Assemblage Zone* — This zone is marked by the dominant presence of *Scheuringipollenites* and *Striasulcites*. Other important genera present include *Potonieisporites*, *Faunipollenites*, *Striatites*, *Crescentipollenites*, *Lahirites*, *Platysaccus*, *Tiwariasporis*, *Vesicaspora*, *Illinites*, *Ibisporites*, *Striatopodocarpites*, *Distriatites*, *Ginkgocycadophytus* and *Fusacolpites*. This zone is best exposed in the Koel River Section, though it is also encountered with in Chelha-Panikhar Nala and Satbahni Nala. Miospore frequency is given in Table 6.

5. *Densipollenites-ScheuringipollenitesFaunipollenites Assemblage Zone* — This Assemblage-zone is marked by the dominant

TABLE 4 — DISTRIBUTION OF PALYNOMORPHS IN VARIOUS SAMPLES OF THE TALCHIR FORMATION (ASSEMBLAGE ZONE-1) IN THE HUTAR COALFIELD

	Deori Nala		Koel River	Behra Nala	
	DT_2+DT_3	DT_{15}	KT_1	BT_3	BT_4
Psilalacinites	+	—	—	—	—
Callumispora	2	6.5	3	4	2
Verrucosisporites	+	—	—	—	+
Horriditriletes	+	—	—	—	+
Jayantisporites	0.7	2	—	+	1
Parasaccites	51.9	53	54	59	56
Tuberisaccites	0.2	—	—	—	—
Caheniasaccites	3.2	4.5	8.5	5	4
Vesicaspora	0.7	1	—	—	—
Cannanoropollis	3.2	4.5	8.5	5	4
Plicatipollenites	31.7	21.5	19.5	22	24
Potonieisporites	5.7	8.5	12.5	8	8
Faunipollenites	0.5	—	0.5	—	2
Crescentipollenites	0.2	0.5	—	—	+
Foveofusa	—	—	+	+	—
Botryococcus	—	—	+	—	—

occurrence of genera *Densipollenites*, *Scheuringipollenites* and *Faunipollenites*. Genera *Striasulcites*, *Platysaccus*, *Crescentipollenites*, *Striatites*, *Fusacolpites*, *Lahirites*, *Rhizomaspora* and *Verticipollenites* are also present.

This zone is best developed in the Koel River Section, though it is also encountered with in Satbahni Nala. Miospore frequency is given in Table 6.

DISCUSSION

The Lower Gondwana succession in the Hutar Coalfield has been divided into Talchir, Karharbari and Barakar formations. Palynologically, it is divided into 5 zones, viz., (i) *Parasaccites-Plicatipollenties* Assemblage-zone, (ii) *Parasaccites-Callumispora* Assemblage-zone, (iii) *Parasaccites-Scheuringipollenites* Assemblage-zone, (iv) *Scheuringipollenites-Striasulcites* Assemblage-zone, and (v) *Densipollenites-Scheuringipollenites - Faunipollenites* Assemblage - zone. The lithostratigraphic units and palynostratigraphic units show a close agreement (Table 7).

Assemblage-zone 1 represents the mioflora of the Talchir Formation in this coalfield. This zone is dominated by radial monosaccates (85%) genera like: *Parasaccites* and *Plicatipollenites*, whereas the triletes (1.9%) and bisaccates (0.6%) are rare. This zone shows resemblance with miofloral zones in the North Karanpura (Zone I of Kar, 1973), Korba (lower part of Zone-1 of Bharadwaj & Srivastava, 1973), Mohpani (Zone-1 of Bharadwaj & Anand-Prakash, 1972), Giridih (older part of Zone 1 of Srivastava, 1973), Bokaro (late Talchir flora of Lele, 1975), Jayanti (middle to upper set of Talchir flora of Lele & Makada, 1972), Johilla (late Talchir mioflora of Chandra & Lele, 1979) and Manendragarh area (Bharadwaj *et al.*, 1979). All these miofloras show dominance of radial monosaccates, *viz.*, *Parasaccites*, *Cannanoropollis* and *Plicatipollenites* with *Potonieisporites*, *Caheniasaccties* and *Vesicaspora* ranging from rare to subdominant. Triletes, especially *Callumispora*, do not form more than 9% of the assemblage except for one sample each in the Jayanti and Korba coalfields.

Records of bisaccate pollen are quite inconsistent in the Talchir Formation and they should not be allowed to diffuse the real picture which is primarily based on radial monosaccates and triletes. Earlier, the only broadly possible zonation in the Talchir flora was given by Lele (1975), i.e. of late and early Talchir flora based on the diversification and paucity of genera. Lower middle and upper set of miofloras in the Jayanti Coalfield (Lele & Makada, 1972) are all part of late Talchir mioflora.

TABLE 5 — SHOWING DISTRIBUTION OF VARIOUS MIOSPORES IN THE KARHARBARI FORMATION (ASSEMBLAGE ZONE-2 AND 3) OF HUTAR COALFIELD

(DB=Deori Nala; KB=Koel River; KlB=Kelha Nala; GB=Ghorasum Nala; SB=Satbahni Nala)

Genera	Zone-2					Zone-3						
	Sample No. DB5	DB7 (A)	DB7 (B)	DB8 (A)	DB8 (B)	DB9	DB12	DB16	KB_3	KlB_2	GB_2	SB_{10}
Callumispora	24	16	10	31.5	17.8	8	1	2.5	6.5	6	3	2
Leiotriletes	—	2	—	—	3.5	—	—	—	—	—	0.5	1
Brevitriletes	—	3	0.5	0.5	2.5	2	0.5	1.5	1	—	2	—
Microbaculispora	—	2	—	—	3.5	1	—	2.5	—	—	0.5	—
Jayantisporites	—	2	0.5	—	3.5	1	—	—	—	—	—	—
Plicatipollenites	—	—	0.5	1	—	—	—	—	—	—	1.5	1
Tiwariasporis	—	—	—	—	—	—	1·5	0.5	—	1	0.5	—
Pilasporites	—	1	20	0.5	7	—	—	0.5	—	1	1	1
Brazilea	—	—	3	0.5	2	—	1.5	—	—	—	—	—
Greinervillites	—	—	1	—	—	—	—	—	—	—	1.5	—
Balmeela	—	2	17.5	—	2	1	—	—	—	1	—	—
Quadrisporites	—	—	42.5	—	—	—	—	—	—	—	—	—
Parasaccites	44	34	1.5	42	18.5	49	47	38	37.5	44	35.05	60
Crucisaccites	1	—	—	3	—	1	3	1.5	1	—	3	—
Stellapollenites	—	—	—	—	—	—	1	0.5	0.5	0·5	1.5	—
Divarisaccus	—	—	—	—	—	—	0.5	0.5	—	—	1	—
Caheniasaccites	4	2	0.5	2	2	2	2	5.5	2.5	1	3	3
Plicatipollenites	11	16	—	3	7	6	2.2	8	18.6	3	6	13
Kibambites	—	—	—	—	—	—	2.0	0.5	—	—	1	3
Cannanoropollis	—	—	—	0.5	—	—	1.5	2	—	—	2.5	—
Potonieisporites	4	5	—	2.5	6.5	6	1.7	3.5	10.5	—	2.5	1
Scheuringi-pollenites	8	6	2.5	9.5	12	13	20	23.5	17.5	32	18.05	11
Ibisporites	—	—	—	—	—	—	0.6	—	—	—	—	—
cf. *Korbapollenites*	—	—	—	—	—	—	—	0.5	0.6	1	1	—
Faunipollenites	1	8	—	4	9.5	9	14	5.5	4.6	9	11.05	3
Crescentipollenites	2	—	—	0.5	1	—	—	3	5.1	1	2.5	1
Ginkgocycado-phytus	1	1	—	—	1	—	—	—	—	—	—	—

TABLE 6 — DISTRIBUTION OF MIOSPORES IN VARIOUS SAMPLES OF BARAKAR FORMATION (ASSEMBLAGE-ZONE-4 AND 5)

(KB=Koel River; CB=Chelhapanikhar Nala; SB=Saibahni Nala)

GENERA	ZONE-4			ZONE-5		
	KB_7	CB_3	SB_8	KB_8	SB_1	SB_6
Microbaculispora	—	—	—	+	+	+
Indotriradites	+	+	+	—	—	—
Densipollenites	+	+	+	36	38	39
Vesicaspora	1	2	3	—	—	—
Plicatipollenites	+	—	—	—	—	—
Potonieisporites	20	10	12	—	—	—
Scheuringipollenites	20	22	23	25	22	18
Illinites	1	+	1	—	—	—
Ibisporites	3	3	3	—	—	—
Platysaccus	3	3	3	1	2	1
Rhizomaspora	—	—	—	2	1	3
Faunipollenites	12	15	15	22	23	28
Striatopodocarpites	+	+	—	3	4	4
Lahirites	4	3	2	5	4	3
Crescentipollenites	8	8	8	1	2	1
Striatites	8	11	9	2	1	1
Distriatites	1	1	1	—	—	—
Fusacolpites	2	4	3	1	2	+
Striasulcites	17	17	15	1	1	3
Ginkgocycadophytus	1	1	1	—	—	1

The three zones given by Tiwari (1975) are somewhat hypothetical and need to be demonstrated in continuous succession. Recently, Chandra and Lele (1979) published an exhaustive study of the Talchir miofloras from a number of areas in South Rewa Gondwana Basin in which they identify two miofloral zones in the Talchir Formation. The lower zone is characterized by the prevalence of *Plicatipollenites* over *Parasaccites*; whereas in the upper zone the picture is reversed. A similar conclusion has been drawn by Bharadwaj *et al.* (1979) from their study of the Manendragarh Talchir miofloras.

Assemblage zone-2 represents mioflora of the lower part of the Karharbari Formation. This mioflora shows a sudden increase in the triletes and decrease in monosaccates. This abrupt change in miofloral picture indicates a hiatus between the deposition of the Talchir and the Karharbari formations. This hiatus is also indicated by the presence of a conglomeratic horizon above the Talchir Formation, both in the Koel River Section near Hutar Village and in the Deori Nala section near Barwadih Village.

This zone shows resemblance with miofloral zones in the North Karanpura (Zone II of Kar, 1973), Korba (upper subzone in Zone 1 of Bharadwaj & Srivastava, 1973), Giridih (younger part in Zone 1 of Srivastava, 1973), Raniganj (*Callumispora* zone of Tiwari, 1973), Umrer Quarry, Nagpur (Zone 1 of Bharadwaj & Anand Prakash, 1974), Jayanti Coalfield (flora of samples D18 and 19, Lele & Makada 1974), West Bokaro Coalfield (Anand-Prakash, Srivastava & Tiwari, 1979) and Auranga Coalfield (Lele & Srivastava, 1979). Zone II of the Mohpani Coalfield which shows a flora dominated by *Sulcatisporites* (= *Scheuringipollenites*) and apiculate genus *Brevitriletes*, is miofloristically nearer to the Lower Barakar mioflora and hence has been placed there in the present work.

Assemblage-zones 1 and 2 of the Hutar Coalfield together correspond with the Zone 1 of the Korba Coalfield (Bharadwaj & Srivastava, 1973) and Zone 1 of the Giridih Coalfield (Srivastava, 1973). However, in both these coalfields two sets of mioflora, i.e. lower and upper are recognized which compare with the Assemblage-zone 1 and 2 of the Hutar Coalfield respectively.

TABLE 7 — COMPARISON OF LITHOSTRATIGRAPHIC AND PALYNOSTRATIGRAPHIC UNITS IN THE HUTAR COALFIELD

Formation	Lithostratigraphy				Palynostratigraphy			
	Member	Deori Nala	Koel River	Saphi Nala	Biozone	Deori Nala	Koel River	Saphi Nala
MAHADEVA				+	Mioflora not known			+
BARAKAR	Sandstone shale — clay Member		+	+	do		+	+
	Sandstone Coal-shale Member		+		Zone V *Densipollenites — Scheuringipollenites — Faunipollenites* Assemblage zone		+	
					Zone IV *Scheuringipollenites — Striasulcites* Assemblage zone		+	
	Compact red Sandstone Member		+		Assemblage not known	-?-?-?-?-?-?-?-?-?-?-?-?-?-?		
KARHARBARI	Sandstone and shale coal Member	+	+		Zone III *Parasaccites — Scheuringipollenites* Assemblage zone	+	+	
					Zone II *Parasaccites — Callumispora* Assemblage zone	+		
	Basal conglomerate Member	+	+					
TALCHIR	Upper Sandstone Member	+	+					
	Shale-Varve-siltstone Member	+	+		Zone I *Parasaccites — Plicatipollenites* Assemblage zone	+	+	
	Basal-sandstone — conglomerate Member	+	+					
ARCHEAN		+	+					

Assemblage-zone 3 represents the mioflora of the upper part of the Karharbari Formation. This zone shows the dominance of the genera *Parasaccites* and *Scheuringipollenites*. *Callumispora*, which was dominant in Assemblage-zone 2, gradually declines in this zone. Thus, miofloristically zone 2 and 3 do not show any sudden change. Lithostratigraphically too, the beds yielding the mioflora of Assemblage-zone 2 and 3 are conformable.

The best development of the Karharbari Formation may be seen in the Deori Nala Section and consequently both the palynozones of this formation are represented here. The Karharbari Formation thins out towards west and consequently in the Koel River Section very small thickness of the Karharbari sediments are represented. The beds which should have the mioflora of Assemblage-zone 2 are also thin on this side. Unfortunately, these beds did not yield any mioflora. Further, the bed which yielded the mioflora of the zone 3, is also thin.

Assemblage-zone 3 shows resemblance with miofloral zones in North Karanpura (Zone III of Kar, 1973), Korba (Zone II of Bharadwaj & Srivastava, 1973), Raniganj (*Parasaccites* Zone of Tiwari, 1973) and Umrer Quarry, Nagpur (Zones II & III of Bharadwaj & Anand-Prakash, 1974).

The lower and middle part of the Barakar Formation in this coalfield is represented by huge thickness of chocolate brown sandstone with lenses of conglomerate (best seen in the Ranimai, Dhaj, Chelha, Panchpahari and Dhankutia hillocks), carbonaceous grits and gritty sandstone (Koel River Section) but it did not yield any mioflora. Elsewhere the lower — middle Barakar flora is represented by dominance of *Scheuringipollenites* apiculates and zonate trilete genera (Tiwari, 1974).

Assemblage-zone 4 represents the mioflora of the upper part of the Barakar Formation. The mioflora of this assemblage shows the first appearance of many striate-bisaccate and colpate pollen and sudden disappearance of the spores of lower plants. This flora is quite distinct from the miofloral assemblage of the Assemblage-zone 3. This sudden change in the miofloristic picture is due to the absence of any miofloral evidences from lower and middle parts of the Barakar. Further, this zone of the Coalfield is part of the Upper Barakar mioflora which is dominated by striate-bisaccates and *Scheuringipollenites* with triletes as rare forms (Tiwari, 1974; Bharadwaj, 1971). *Striasulcites* may also form significant proportion of the flora (Kar, 1973). The high incidence of *Potonieisporites* in the Hutar Coalfield is somewhat exceptional to the known Upper Barakar miofloras. This Assemblage-zone shows some resemblance with miofloral zone in the North Karanpura (Zone-VI of Kar, 1973) and the Raniganj Coalfield (*Striatopodocarpites-Faunipollenites* zone of Tiwari, 1973).

Assemblage-zone 5 shows first appearance and dominance of the genus *Densipollenites*. *Potonieisporites* which formed 20 per cent of the mioflora in Assemblage-zone 4 is absent. The monocolpate genus *Striasulcites* (1%) also shows a sudden decline. This change strongly suggests a miofloral break between the Assemblage-zones 4 and 5. Incidentally, the mioflora of Assemblage-zone 5 shows a general similarity with the middle Barren Measures mioflora in the dominance of bisaccates and *Densipollenites* and in absence of triletes (Bharadwaj, 1971; Kar, 1973). It is also important that the lithology of beds immediately overlying this zone is devoid of carbonaceous facies, and thus shows a general similarity with the Barren Measures Formation.

Besides, this zone compares with the miospore assemblages described from Barren Measures of the Jharia Coalfield (Bharadwaj, Sah & Tiwari, 1965), North Karanpura Coalfield (Kar, 1969), and Brahmni Coalfield (Srivastava & Maheshwari, 1974). All these have abundance of genus *Densipollenites*.

This assemblage has been recovered from sediments which normally on the basis of lithology are grouped with the upper part of the Barakar Formation. However, the palynological evidence indicates that these sediments may be homotaxial with a part of the Barren Measures Formation. Further field and laboratory work are recommended to solve this problem.

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