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Palynological analysis of Lower Gondwana sediments exposed along the Umrar River, South Rewa Basin, Madhya Pradesh, India

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ABSTRACT

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The palynflora and other organic content in carbonaceous shales, exposed along Umrar River, District Umaria have been studied. The organic matter comprises rich black debris, biodegraded, amorphous and structured material, mainly composed of land-derived plant fragments, e.g., leaf cuticles, twigs, stem (elements with bordered pits, xylem and phloem tissues) and roots with their various degradational phases. The basal part of the sequence indicates reducing environment of deposition while upper part denotes a slow depositional setting under moderately oxidizing conditions. Two palynozones have been recognized: the basal-most sequence is characterized by the dominance of *Callumispora* and *Jayantisporites*, while the younger sequence is dominated by *Parasaccites–Plicatipollenites* and zonate triletes in association with striate-bisaccate pollen affiliated to the Lower and Upper Karharbari miofloras. Record of *Dictyotidium*, *Muraticava*, *Leiosphaeridia*, *Balmeella*, *Foveofusa* and *Tetraporina* suggests a brackish water regime during deposition of these sediments. The present study deals with the age of spores-pollen assemblages and the characteristics of organic matter in order to assess the depositional environment of lithologically undifferentiated, coal-bearing Early Permian strata of South Rewa Basin, Madhya Pradesh.

Key-words—Palynology, Organic matter, Early Permian, Umaria Coalfield, Madhya Pradesh, India.

सारांश

भारत में मध्यप्रदेश की दक्षिण रीवा द्रोणी की उमरार नदी के समांतर अनावरित निम्न गोंडवाना अवसादों का परागाणविक विश्लेषण

राम अवतार, माधव कुमार एवं नीरू प्रकाश

उमरिया जिले की उमरार नदी के समानान्तर अनावरित कार्बनयुक्त शैलों में परागाणु वनस्पतिजात तथा अन्य जैव पदार्थ का अध्ययन किया गया है। स्थलीय जैव पदार्थ अन्तर्वस्तु में प्रचुर मात्रा में काले-गहरे भूरे रंग के काष्ठ पादप ऊतक एवं सूक्ष्म जीवाणु प्रभावित संरचना विहीन तथा संरचना युक्त तत्व समाहित हैं। इन तत्वों में मुख्यतः स्थलीय-काष्ठ वृक्ष पौधों के ऊतकों एवं तन्तुओं के विभिन्न संरचनात्मक एवं सूक्ष्मजीवाणु-प्रभावित आस्थाओं के साथ पर्ण उपचर्मों, टहनियो, तनों, परिवेशित गत्तों, जाइलम एवं फ्लोएम ऊतकों से सम्बन्धित तत्व तथा जड़ो एवं उनके रूपान्तरित अवयव समायोजित है। पादप ऊतकों के काले मलवे की उपस्थिति इन सभी स्थलीय अवयवों का मंद निक्षेपण जमाव जो ऑक्सीकारण के फलस्वरूप निस्पादित हुआ है प्रस्तावित करती है। जिन दो परागाणु क्षेत्र का पहचान किया गया है उनमें सबसे प्रभावी अनुक्रम *केलुमीस्पोरा* एवं *जयन्तीस्पोरा* लक्षणित है, जब कि नवीन स्तरीय अनुक्रम क्रमशः निम्न एवं उपरी करहर बारी

परागाणु से सम्बन्धित रेखित-द्विसकोषी परागकण के साहयर्च में *पैरासेक्काईटिस-प्लीकेटीपालेनाइटिस* तथा पक्ति त्रिअरीय-द्विकोष्ठीय परागकण की प्रमुखता द्वारा निरूपित होती है। कुछ परागकण एवं बीजाणु जैसे *डिक्टिओडिनीयम, मुराटीकावा, लियोस्फिरीडिया, बाल्मील्ला, फोविओफुसा* तथा *टेटरापोरिना* की उपस्थिति इन स्तरीय शैलों के निक्षेपण के समय तटीय समुद्रीय जल से आंशिक सम्पर्क को इंगित करते है। प्रस्तुत अध्ययन का उद्देश्य मध्य प्रदेश के दक्षिण रीवा द्रोणी में प्राथमिक परमियन कोयला धारक स्तरकों की अविभेदित अश्मिकी के निक्षेपण पर्यावरण के मूल्याकन हेतु बीजाणु-परागकण तथा उनके काल समुच्चयों एवं जैव पदार्थो के लक्षणों का वर्णन करना है।

संकेत शब्द—परागाणुविज्ञान, जैव पदार्थ, प्रारंभिक परमियन, उमरिया कोयलाक्षेत्र, मध्यप्रदेश, भारत।

INTRODUCTION

THE carbonaceous sandy shale and sandstone beds exposed along the Umrar River and in adjoining hillocks near Umaria (between Long. 80°47'- 80°56' E: Lat. 23°29'- 23°38' N) represent Early Permian (Lower Gondwana) sediments. This sequence extends over 3-4 km^2 at southeast of the Umaria town.

Investigations of plant micro-and megafossil of Early Permian sequence of South Rewa Basin began with the contribution of Mehta (1944), who recorded two miospore taxa - *Pityosporites gondwanensis* and *Hymenozonotriletes* sp. Later, Maithy (1966) recorded *Gangamopteris cyclopteroides* Feistmantel, *Glossopteris indica* Schimper, *Noeggerathiopsis* sp., *Cordaicarpus zeilleri* Maithy, cf. *Gondwanidium* sp. and few equisetalean stems. Maithy (1968) later recorded 15 monosaccate miospore taxa and correlated the coal-bearing beds of the Umaria Coalfield with the Karharbari Stage, confirming the earlier opinion of Feistmantel (1884) and Hughes (1884). In addition to these studies, Tripathi (1952) recorded some megaspores from the coaliferous strata of Umaria Coalfield. Also, Lele and Chandra (1969, 1972) reported a Talchir palynoflora, including acritarch-like microfossils from this area. Saksena (1971) described miosopres from the Ganjra Nala section, while Lele and Chandra (1973) gave a detailed account of palynoassemblage from the Talchir boulder bed from Johilla Coalfield. Chandra and Lele (1979) provided a comparative account of palynoflora from the Talchir Formation of Birsinghpur Pali, Anuppur, Chirimiri, Manendragarh and Umaria coalfields. They established the *Plicatipollenites-Parasaccites* and *Prasaccites-Plicatipollenites* zones for the lower and upper part of the Talchir Formation respectively. Srivastava and Anand-Prakash (1984) and Anand-Prakash and Srivastava (1984) gave a detailed account of the Karharbari and Barakar palynofloras of Umrar River, Johilla River and Pali Coal Mine of the Umaria Coalfield. Chandra and Srivastava (1986) contributed a comparative account of palynoassemblages of the Umaria, Birsinghpur Pali, Anuppur and Chirimiri coalfields and established stratigraphical status of these sediments. Ram-Awatar (1996) described a Late Permian-Early Triassic transitional palynoflora in subsurface deposits (KU-1), 1 km North-West of Karkeli Railway Station, Umaria Coalfield.

The present paper deals with the palynology and depositional environment of the Karharbari Formation, exposed along Umrar River and evaluates the organic matter on the basis of their temporal and spatial distribution in this part of the Umaria Coalfield.

MATERIAL AND METHODS

The studied area is situated in east central part of the South Rewa Basin, 2 km northeast of Umaria Railway station. The sedimentary fill of 3.5 m thick section of carbonaceous shale rests over the lowermost coalseam of the Umaria Coalfield, which was submerged in water. Most of the beds are affected by faults and displacement at several places. In total, eleven samples containing coaly, carbonaceous and sandy shale were collected from the section exposed along Umrar River, near the Railway Bridge on the Katni-Bilaspur Railway Line (Fig. 1). For organic matter analysis, about 30 gram of sample was dissolved in dilute HCl (40%), followed by treatment with 40% HF. The insoluble residue was sieved through a 500-mesh sieve and slides were prepared using standard palynological techniques. For spores-pollen analysis, another 20 gram of each sample was treated with HF (40%) followed by HNO_3 and 5 % KOH solution and sieved through 500 mesh. The macerated residue in suitable quantity was smeared on cover slip with polyvinyl alcohol and mounted on glass slides with Canada-balsam. The organic matters were categorized after the classification of Masran and Pocock (1981) and Hart (1986). About 500-600 organic matter and 200 palynotaxa were counted in each sample to observe their frequency. The different types of organic matter and palynotaxa were quantified to estimate percentage abundance for each type in every sample, which reflects their pattern of distribution, as shown in Figs 2 and 3. All the slides, photonegatives and materials are housed at the Museum of the Birbal Sahni Institute of Palaeobotany, Lucknow.

GEOLOGY

The area was first surveyed by Medilicott (1860) and later by Hughes (1881). Gee (1928) proved the existence of workable coal seams in Umaria Coalfield. Further, Venkatappayya *et al.* (1960) surveyed the area in detail. Raja

Rao (1983) proposed the following litho-stratigraphc sequences :

Trap
Lametas
——————Unconformity——————
Supra-Barakar
Barakar
Talchir
——————Unconformity——————
Metamorphic

The Lower Gondwana sediments are deposited over Archeans, the basement rock, exposed towards western, northern and southern sides of Umaria town. The Lower Gondwana sediments are deposited along the Umrar River and few tributaries of Mahanadi River. Talchir Formation, the basal most formation of the Gondwana sequence overlaying the Archeans, consists of boulder bed, needle shale, siltstone and green sandstone. The marine fossiliferous beds are exposed about 3.5 km west from Umaria railway station at the vicinity of Narsarha Nala. The Barakar Formation overlies the Talchir Formation consisting of massive to medium coarse-grained sandstone associated with six coal seams. The succession of these sediments crop-out along the Umrar River. The Barakar Formation is ultimately overlained by the Supra-Barakar sequence in the northern part of the Umaria Coalfield.

FACIES ASSOCIATION

Two facies types have been recognized within 3.5 m thick sedimentary sequence: 1) arenaceous facies sandwiched within carbonaceous sandy shales, 2) argillaceous bottom coal and

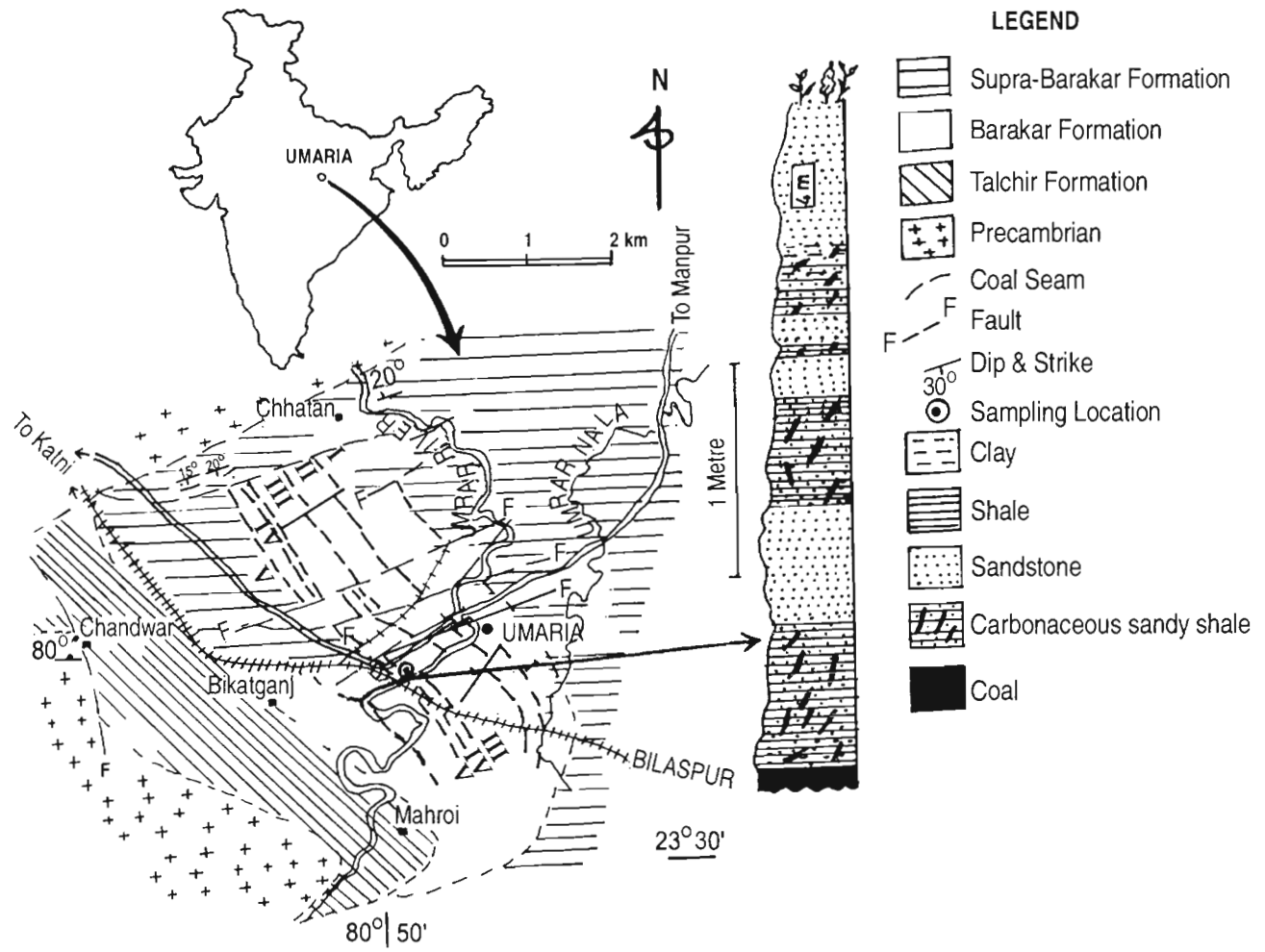

Fig. 1—Location of the area studied.

carbonaceous shales at places. Coal and carbonaceous shales yielded rich palynological contents while sandstones are barren. To explain differences in palynofacies, these lithounites and samples studied herein, are divided into five subunits (A-E):

Subunit	Sample numbers	Litho-type
A	1	Coal
B	2-4	Bottom carbonaceous sandy shale
C	5-7	Middle bed of carbonaceous shale
D	8	Top of middle carbonaceous shale
E	9-11	Top carbonaceous shale

PALYNOFACIES ANALYSIS

The distribution pattern of spore/pollen and other organic matter is enumerated as:

Subunit A — This is extension of topmost Seam-1 of Umaria Coalfield.

Organic matter characteristics: The coal facies is characterized by high frequency of biodegraded terrestrial organic matter (35.93%) followed by amorphous, black debris and spores-pollen.

Pollen-spores— *Callumispora* and *Jayantisporites* are dominant taxa followed by *Caheniasaccites*, *Striatopodocarpites*, *Parasaccites* and *Lacinitriletes*.

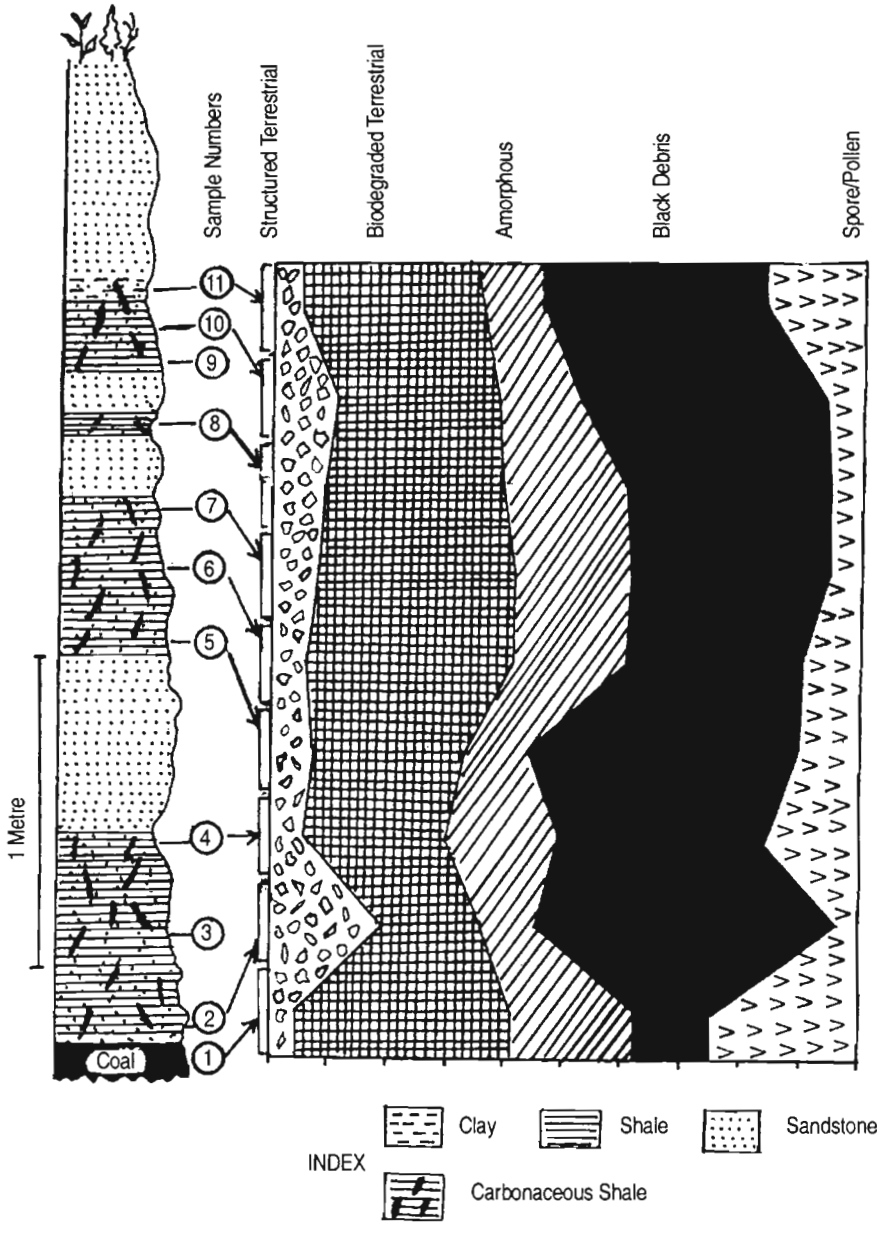

Fig. 2—Distribution pattern of organic matter types in the section.

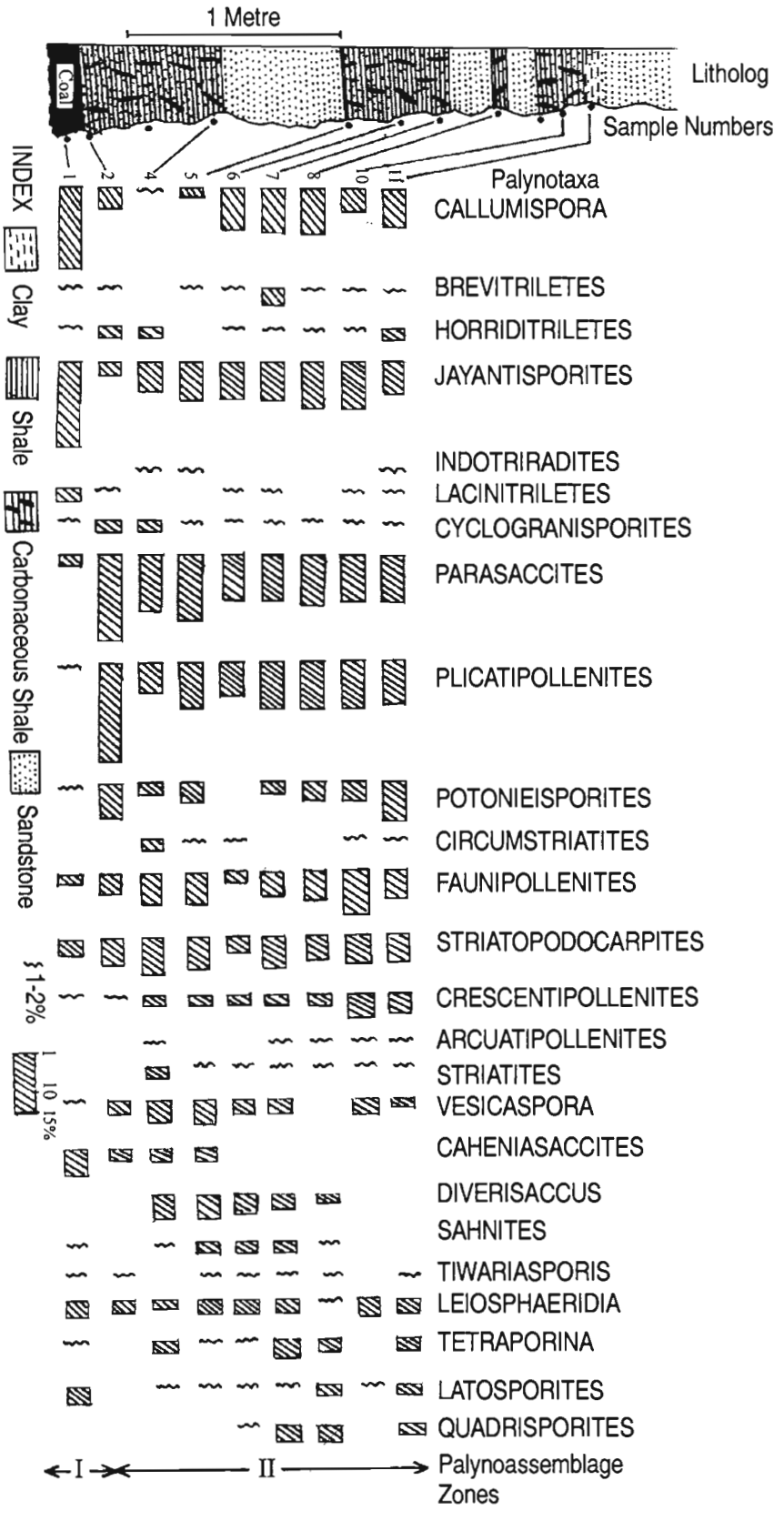

Fig. 3—Frequency abundance of spores-pollen assemblage.

Subunit B— This carbonaceous sandy shale unit is 80 cm thick, overlying the coaly facies containing fine layers of shale and sandy shale unit, underlain by a 60 cm thick whitish sandstone bed.

Organic matter characteristics— This unit represents high frequency of black debris (52-34%) showing a longest peak (Fig. 2), followed by biodegraded terrestrial (16-19%), amorphous and structured terrestrial organic matter. The rich black debris indicate oxidation of plant fragments entrapped between moderately coarse, silicified texture leaving pore spaces in the sediments, probably due to input of fine sandy material.

Pollen-spores— This unit represents rich *Parasaccites, Plicatipollenites* followed by *Potonieisporites, Callumispora, Caheniasaccites, Leiosphaeridia, Latosporites* and *Striatopodocarpidites* etc.

Subunit C — A 50 cm thick carbonaceous shale bed overlain by 15-20 thick sandstone bed.

Organic matter characteristics— The lower part of the unit shows dominance of black debris followed by biodegraded terrestrial and spores-pollen assemblage. The abundance of black debris and spores-pollen decreases in younger sequence of the unit while amorphous, biodegraded and structured terrestrial show no major change.

Pollen-spores—Characteristic taxa recorded in this unit are: *Parasaccites, Plicatipollenites, Jayantisporites, Callumispora, Striatopodocarpites, Faunipollenites, Vesicaspora, Diverisaccus, Leiosphaeridia, Tetraporina* and *Sahnites*.

Subunit D — A 8-10 cm carbonaceous shale bed is sandwiched between 15-20 cm thick sandstone at bottom as well as at the top of the unit.

Organic matter characteristics— The dominance of black debris has also been noticed in this unit. The frequency of amorphous and biodegraded terrestrial organic matters is lower than the bottom subunits, while pollen-spores are comparatively higher in frequency than subunit – C.

Pollen-spores— *Parasaccites, Plicatipollenites, Callumispora* and *Jayantisporites* are dominant taxa in this unit followed by *Faunipollenites, Striatopodocarpites, Quadrisporites, Latosporites* and *Crescentipollenites* etc.

Subunit E — A 25-30 cm carbonaceous shale bed overlained by about 10 cm thick clay bed and 1.5-2.0 cm thick sandstone.

Organic matter characteristics— The occurrence of rich black debris and biodegraded terrestrial matter associated with pollen-spores and amorphous organic matter characterizes this unit. Structured terrestrial organic matter is lesser (2-3%) than other units.

Pollen-spores—This unit is represented by *Plicatipollenites, Parasaccites, Jayantisporites, Callumispora, Striatopodocarpites, Crescentipollenites, Potonieisporites, Tetraporina, Latosporites, Leiosphaeridia* and *Vesicaspora*.

ORIGIN OF ORGANIC MATTERS

Six types of organic matter have been identified in the assemblage. They are structured and biodegraded terrestrial, amorphous, black debris, spore-pollen and resin globules showing evidences of mostly terriginous (continental) origin. The black debris is opaque in nature constituting a high frequency; it is followed by translucent structured terrestrial phytoclasts including yellowish leaf epidermal tissues. A large amount of black debris (dark brown-black and opaque in nature) consists of partially oxidized fragments of vascular plants e.g., woods with bordered pits, cortex and xylem tissues (Pl. 2). The fossil resin globules are sporadic yet recorded in many samples, may be derived from gymnospermous woods. The biodegraded and amorphous matters are the result of microbial decay during diagenesis of the sediment.

PLATE 1 →

(All the figures are enlarged ca. x 500, unless otherwise mentioned).

1. *Horriditriletes curvibaculosus* Bharadwaj & Salujha 1964
2. *Brevitriletes communis* (Bharadwaj & Srivastava) Tiwari & Singh 1981
3. *Jayantisporites conatus* Lele & Makada 1972
4. *Lacinitriletes badamensis* Venkatachala & Kar emend. Tiwari & Singh 1972
5. *Callumispora solitus* Bharadwaj & Salujha 1964
6. *Striatites solitus* Bharadwaj & Salujha 1964
7. *Tiwariasporis flavatus* Maheshwari & Kar 1967
8. *Jayantisporites pseudozonatus* Lele & Makada 1972
9. *Dentatispora gondwanensis* Tiwari 1965
10. *Plicatipollenites trigonalis* Lele 1964 (ca. x 400)
11. *Quadrisporites horridus* Hennely emend. Potonie' & Lele 1961
12. *Microfoveolatispora foveolata* Tiwari emend. Tiwari & Singh 1981
13. *Circumstriatites ovatus* Lele & Makada 1972
14. *Tetraporina suprava* Bose & Maheshwari 1969.
15. *Parasaccites obscurus* Tiwari 1965 emend. Tiwari *et al.* 1989
16. *Callumispora gretensis* (Bharadwaj & Srivastava) emend. Tiwari *et al.* 1989
17. *Dicappipollenites balmei* Tiwari & Vijaya 1995
18. *Crescentipollenites fuscus* Bharadwaj, Tiwari & Kar 1971
19. *Parasaccites plicatus* Lele & Makada 1972
20. *Sahnites gondwanensis* (Mehta) Pant 1955 emend. Tiwari & Vijaya 1984
21. *Potonieisporites neglectus* Potonie' & Lele 1961
22. *Parasaccites densicorpus* Lele 1975 emend. Tiwari *et al.* 1989
23. *Crucisaccites indicus* Srivastava 1970 emend. Tiwari *et al.* 1989
24. *Faunipollenites singrauliensis* Sinha 1972 emend. Tiwari *et al.* 1989

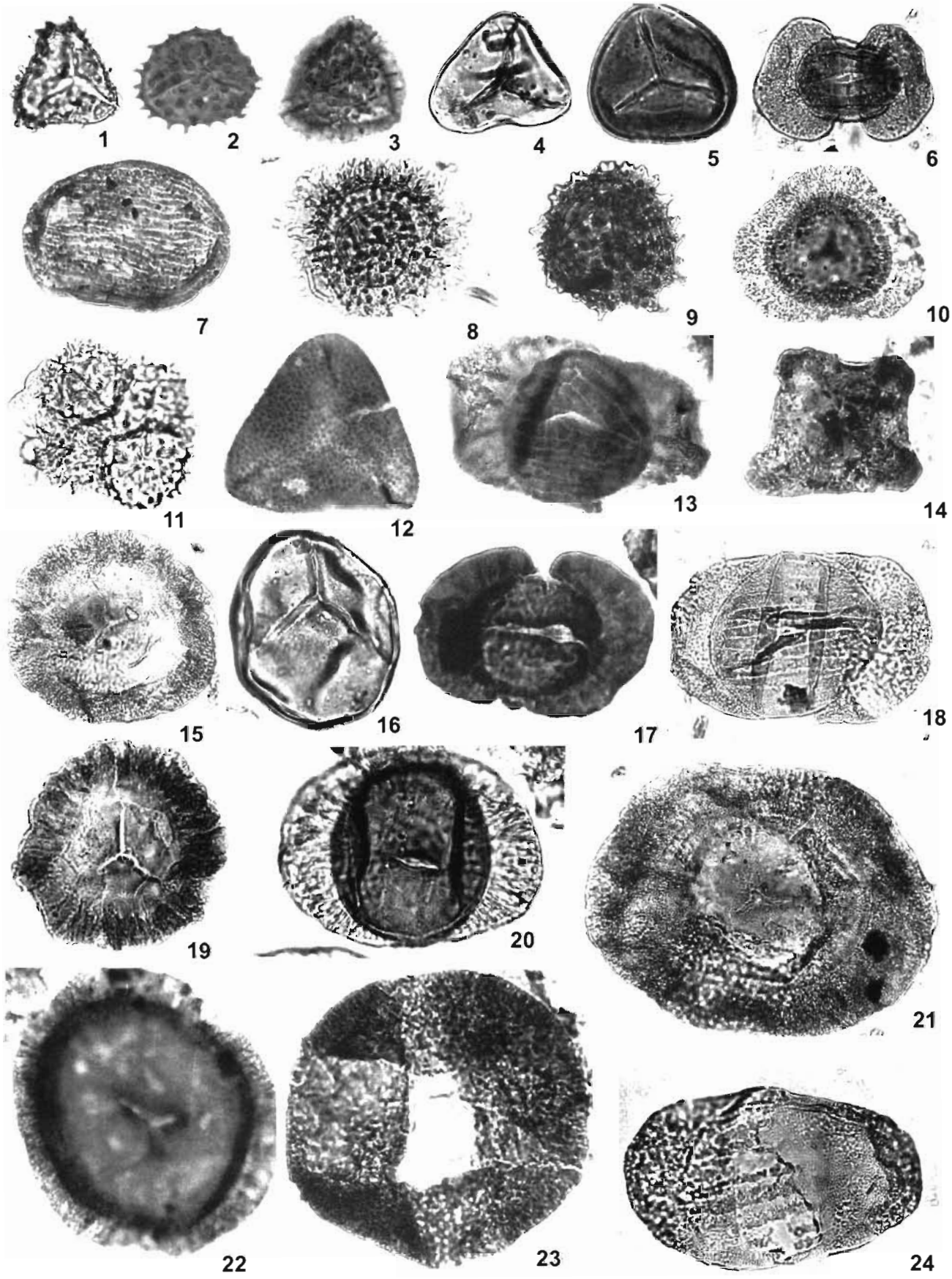

PLATE 1

PALYNOFACIES INTERPRETATION

The palynological analysis is used in determining the age of the sediments. The phytoclasts are the total acid resistant plant derived organic particles, determine the environment of deposition. The structured and non-structured constituents solely depend on biodegradation, non-biodegradation and their preservational factors. The abundance of organic matter is not closely determining the types of vegetation as palynotaxa linked with a particular type of plant or plant group. The frequency and pattern of distribution of various types of organic matter in vertical sequence (Fig. 2) are solely based on amount of vegetal matter and preservational potential during the burial in sediment. For instance the coal facies (sample no. 1) at the bottom of the section exhibit high frequency of biodegraded terrestrial matter followed by pollen-spores, amorphous and black debris indicating anoxic depositional setup. A considerable increase in the frequency of black debris and decrease of amorphous and biodegraded terrestrial organic matter in upper part of the section indicate prevalence of oxidizing environment and that persisted in the rest of upper part of the section. It might has been caused by incursion of arenaceous material.

PALYNOLOGICAL ASSEMBLAGES

The palynoassemblage recovered from all the productive samples consist of following 45 genera: *Arcuatipollenites, Balmeella, Brevitriletes, Caheniasaccites, Calamospora, Callumispora, Circumstriatites, Crescentipollenites, Crucisaccites, Cyclobaculisporites, Cyclogranisporites, Dentatispora, Dicappipollenites, Dictyotidium, Divaisaccus, Faunipollenites, Foveofusa, Ginkgocycadophytus, Horriditriletes, Indotriradites, Jayantisporites, Lacinitriletes, Latosporites, Leiosphaeridia, Leiotriletes, Microbaculispora, Microfoveolatispora, Muraticava, Parasaccites, Platysaccus, Plicatipollenites, Potonieisporites, Primuspollenites, Quadrisporites, Reticulatisporites, Sahnites, Scheuringipollenites, Striatites, Striamonosaccites, Striatopodocarpites, Tetraporina, Tiwariasporis, Vesicaspora, Vestigisporites* and *Virkkipollenites*. Some of the genera are illustrated in Plate 1.

Amongst the above mentioned genera – *Parasaccites, Plicatipollenites, Jayantisporites* and *Callumispora* play an important role in defining the Lower Gondwana sediments because of their prominence in the composition. The other genera which do not show abundance yet important are: *Striatopodocarpites, Faunipollenites, Potonieisporites, Crescentipollenites* and *Vesicaspora*. Besides these, the other age indicator taxa recorded in the assemblage are - *Crucisaccites, Circumstriatites, Dentatispora, Tiwariasporis* and *Indotriradites*. On the basis of quantitative distribution, two assemblage zones have been identified (Fig. 3).

Assemblage Zone I — This basal zone is characterized by the preponderance of *Callumispora*, (9.29 %) and *Jayantisporites* (9.58%). These taxa represent upto 21 percent in sample number-1 but generally decrease towards younger beds. *Callumispora, Jayantisporites, Parasaccites, Plicatipollenites* and a few psilate trilete spores indicate a Lower Karharbari affinity.

Assemblage Zone II —This zone is characterized by a notable increase in monosaccates: *Parasaccites* (12.4%) and *Plicatipollenites* (10.41%) followed by *Striatopodocarpites* (6.71%) and *Faunipollenites* (6.23%). This zone is recognized (sample nos. 2-11) by last appearance datum (LAD) of *Caheniasaccites*. Many other taxa also occur in this zone are *Sahnites, Latosporites, Faunipollenites, Potonieisporites Crescentipollenites* and *Tetraporina*. Record of *Crucisaccites monoletus, Tewariasporis flavatus, Indotriradites barakarensis* indicates a correlation of this assemblage with the Upper Karharbari palynoflora.

COMPARISON OF PALYNOASSEMBLAGE

The palynoflora from the Umrar River Section resembles with Karharbari palynoflora of other basins of Indian Gondwana. The dominance of *Callumispora gretensis* is known from Karharbari Seam of the Giridih Coalfield (Srivastava, 1973). *Jayantisporites* was first recorded from Talchir Formation of the Jayanti Coalfield by Lele and Makada (1972). Later, this palynotaxon was also reported from the Lower Karharbari sediments of the Chirmiri Coalfield at Paradol-Chirmiri Railway Cuttings (Srivastava, 1980b) and the North Karanpura Coalfeild (Srivastava, 1980a; Honhe area). However, in the Lower Permian sequence of the Umaria Coalfield and its vicinity, the genus has been recorded in greater abundance (Srivastava & Anand-Prakash, 1984; Tiwari & Ram-Awatar, 1989). The above account shows that the coal bed exposed along the Umrar River is an extension of the same group, i.e., Lower Karharbari Formation of Umaria coalfield.

The younger beds of the carbonaceous shale sequences (sample nos. 2-11) show maximum abundance of radial monosaccates (*Parasaccites* and *Plicatipollenites*) in association with *Callumispora* and zonate trilete genus *Jayantisporites*. The apiculate trilete in association with *Parasaccites* have also been recorded in the Korba Coalfield (Bhardwaj & Srivastava, 1973); the Kauakoh Nala Section at Chirmiri Coalfield (Srivastava, 1980b) also shows dominance of *Parasaccites*, but does not contain zonate trilete taxon as in the Umrar River Section. Similar type of palynoassemblages, with radial monosasccates have been recorded in zone-2 of the Karanpura Coalfield, Damodar Basin (Kar, 1973); Palynozone-3 of Ramagundam and Ramakrishnapuram area of Godavari Coalfield (Srivastava & Jha, 1989); Palynozone-2 of Managuru Coalfield (Srivastava & Jha, 1992) and Palynozone - C of Johilla Coalfield (Tiwari & Ram-Awatar, 1989). A comparable palynoflora has also been recorded from Borehole-

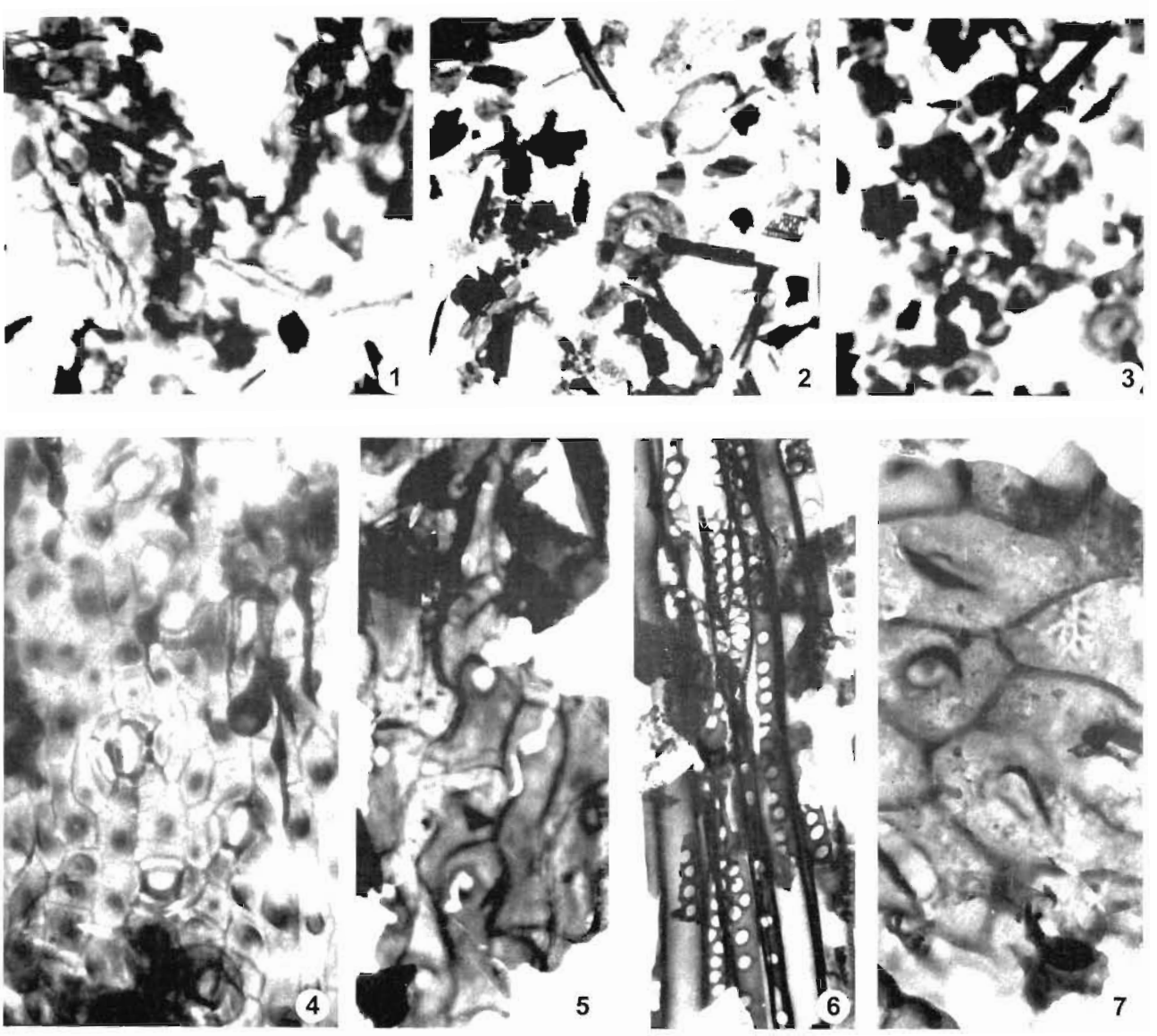

PLATE 2

1-3 Illustration of organic matter types. All photographs exhibit rich black debris (ca.x 100).

4 Leaf cuticle showing epidermal cells and stomatal apparatus, ca. x 100.

5. Leaf cuticle showing epidermal cells, ca x 250.

6 Woody fragments showing oval shaped bordered pits on tracheids, ca. x100

7 Enlarged leaf cuticle showing epidermal cells and elongated to oval shape thickening on periclinal walls and stomata, ca. x 400

RT-11 (Aassemblage – B) of Mand Raigarh Coalfield (Jana *et al*., 2002). Thus, these two palynozones (I and II) described from the Umrar River Section representing Lower and Upper Karharbari seams of Umria Coalfield, compare with the *Crucisaccites monoletus* Assemblage Zone of Tiwari and Tripathi (1992), delimited for the Karharbari Formation in Indian Gondwana.

CONCLUSIONS

The foregoing account reveals that a rich and diversified vegetation existed in the region during the deposition of these sediments. The palynoassemblage recovered from these sediments (Karharbari) has been assigned to 45 palynotaxa. It is well known that palynoflora of the Talchir Formation are qualitatively related with those of Karharbari Formation. The

dominant genera of the Talchir Formation viz., *Parasaccites, Plicatipollenites, Potonieisporites* and their associates such as *Virkkipollenites, Caheniasaccites* and *Vestigisporites* continued to occur in the Karharbari Formation. However, the certain key taxa of the Karharbari Formation viz., *Crucisaccites monosulcatus, Callumispora gretensis, Caheniasaccites decorus, Parasaccites obsicurus, Crescentipollenites rhombicus, Tiwariasporis gondwanensis* and *Dentatispora gondwanensis* delimit the Talchir-Karharbari formations. The lithological changes from the Talchir to Barakar Formation are gradational and there is a direct evidence for the break in the sedimentation. Therefore, the occurrence of Karharbari assemblage in this lithologically undifferentiated sequence is remarkable. Record of *Dictyotidium, Muraticava, Leiospharidia, Balmeella, Foveofusa* and *Tetraporina in* the assemblage suggests incursion of brackish water during the deposition of these beds. The organic matter contents mostly represent land derived material with *Tetraporina* that occur throughout the section, while other brackish water indicating taxa occur in few samples (see Unit -C) with minor frequency. The basal coal bed contains rich biodegraded terrestrial and amorphous organic matter indicating reducing environment where a considerable quantity of plant fragment undergone microbial decay. The fine clastic facies helped better preservation of these matters. In upper part of the section, the rich black debris indicates moderately oxidizing condition.

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