Marker Assemblage-Zones of spores and pollen species through Gondwana Palaeozoic and Mesozoic sequence in India

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Most of the palynozonation schemes so far proposed for the Gondwana Sequence of India are based on quantitative representation of spore-pollen genera. These proposals have limited value for interbasinal correlation. The present synthesis deals with a model for species-based stratigraphy. Palynologically well studied Permian and Triassic sequences in the Damodar Graben and Permian, Triassic and Cretaceous sequences in the adjacent Rajmahal Basin have been taken as key regions to establish the zonation scheme. Based on the FADs and LADs and totality of composition of selected species, twenty Species Assemblage-Zones have been recognised. The reorganisation of this data through computer has also resulted into the identification of thirty Species Acme-Zones.

Key-words—Palynology, Palynozonation, Stratigraphy, Palaeozoic-Mesozoic, Gondwana, India.

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साराँश

भारत के गोंडवाना पुराजीवी एवं मध्यजीवी अनुक्रम में बीजाणु एवं परागकण जातियों के सूचक समुच्चय मंडल

राम शंकर तिवारी एवं अर्चना त्रिपाठी

भारत के गोंडवाना अनुक्रम हेतु अभी तक प्रस्तावित परागाणुमंडल योजनाओं में से अधिकत्तर बीजाणु-परागकण प्रजातियों के परिमाणात्मक निरूपण पर आधारित हैं। इन प्रस्तावों का अन्तरद्रोणीय सहसम्बन्धन मूल्याँकन सीमित है। प्रस्तुत संश्लेषण जातियों पर आधारित स्तरविन्यास के मॉडल से सम्बद्ध है। दामोदर द्रोणी में परमी एवं त्रिसंघी अनुक्रमों तथा राजमहल द्रोणी में परमी, त्रिसंघी एवं क्रीटेशी अनुक्रमों के परागाणविक अध्ययन के आधार पर मंडलन योजना विकसित की गई है। एफ-ए-डी० एवं एल-ए-डी० तथा छाँटी गई जातियों की समग्र संरचना के आधार पर 20 जाति समुच्चय मंडल बनाये गये हैं। इन्हीं आँकड़ों को कम्प्यूटर द्वारा पुनर्व्यवस्थित करके 13 जाति-एक्मे-मंडल प्रस्तावित किये गये हैं।

THE study of spores and pollen, dispersed in the Gondwana Sequence of India, dates back to nineteen-thirties (Virkki, 1937). During the last five decades enormous data has been generated on morphotaxonomy and palynostratigraphy (Venkatachala & Kar, 1970; Venkatachala *et al.*, 1972; Venkatachala, 1974; Lele, 1974; Tiwari, 1974a, b; Maheshwari *et al.*, 1978; Maheshwari & Jana, 1988; Tiwari & Tripathi, 1988). Identification of distinctive organizations and exine characters in spores and pollen has established the identity of Gondwana palynoflora (Tiwari & Vijaya, 1988). However, it is evident that the splitter syndrome in morphological delineation of species has resulted in the unwieldy growth of morphotypical population. Statistically based taxa could check this explosion. The former approach, to some extent, has added subjectivity to the application of palyno-species in stratigraphy.

For Indian Gondwana Sequence, the collage of distribution patterns of palynotaxa in temporal dimension had been proposed from time to time (Bharadwaj, 1970; Venkatachala, 1972, 1974; Chandra & Lele, 1980; Tiwari & Tripathi, 1988), but most of these zonation schemes are genus-based. These proposals had their importance in deciphering the increasing diversity and totality of vegetational changes through time. The epiboles of supra-specific taxa and the assembly of total constituents in palynoflora are bimodal expressions,

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the former representing an acme-zone and the latter an assemblage-zone. Such syntheses had their utmost value in depicting the changing palynological compositions through time and implicitly in stratigraphy. Nevertheless, the existing schemes in India have their limitations because the importance of percentage frequency of supra-specific taxa has been over-emphasized as a stratigraphic parameter. Such numerical abundance could have an ecological bias. So also, the generic assemblage-zones generally formulated for Indian stratigraphy could be useful as an environmental indicators but their value for inter-basinal correlations is limited. So far no effective analysis of spatial behaviour of these taxa has been attempted. Therefore application of generic epiboles as well as generic assemblages in stratigraphy needs a concerted effort for refinement.

The present attempt is a synthesis designed towards achieving species-based stratigraphy of the Indian Gondwana. This palynological model deals with the well-studied profiles of the Permian and Lower Triassic sequences of Damodar Graben for plotting the species occurrences, and the Upper Gondwana data from the adjacent Rajmahal Basin has been added to complete the span of time up to Lower Cretaceous. For comparative assessment of palynozones, the Mesozoic data from marine-tagged sequences of Kachchh, Rajasthan and Cauvery Basin have also been taken into account. The materials taken for the synthesis are listed in Table 1.

DATABASE

The basal datum for Gondwana Sequence is the classical Talchir Formation with marine fauna comprising eurydesma-productus-connularia groups. These glacial and fluvio-glacial deposits are dated as Early Permian (Asselian; Sastry *et al.*, 1977). The megaplant assemblage and the palynoflora support a Permian affinity rather than the Carbo-Permian aspect for the Talchir Formation (Venkatachala & Tiwari, 1988).

The history of the subsequent sequence is well documented in the thick series of terrestrial, fluviatile and lacustrine sediments (about 7 km in thickness) which span from Early Permian to the end of Early Cretaceous. The Glossopteris flora dominates the scene during the Permian Period. It declines considerably at the Permo-Triassic boundary wherein a new flora, viz., the Dicroidium flora, makes its appearance. The latter datum has been identified at the Raniganj-Panchet interformational boundary. This conclusion is supported by estheriids and palyno-stratigraphic studies (Ghosh *et al.*, 1988; Tiwari & Vijaya, 1992). The flora, fauna and lithology have been the major parameters for defining the stratigraphic units of the Mesozoic. Recent K-Ar dates (105 ± 5 Ma) for the Rajmahal traps have provided an anchor line of Aptian-Albian age (McDougall & McElhinny, 1970; Agrawal & Rama, 1976; Baksi *et al.*, 1987). This necessitated a revision of the earlier views. The

Table 1—The details of profiles/outcrops considered as database for the present study (also see Map 1)

HORIZON	COALFIELD/AREA	SECTION/BORE HOLE	REFERENCES
Talchir	West Bokaro Coalfield, Bihar	Dudhi River Section	Lele, 1975
Talchir	Hutar Coalfield, Bihar	Section in Deori Nala, Koel River, Behra Nala, Saphi Nala, Jhapidhora Nala	Lele & Shukla, 1980
Talchir	Jayanti Coalfield, Bihar	Section in Patharjore Nala	Lele & Karim, 1971
Talchir	Jayanti Coalfield, Bihar	Patharjore Nala section, Barisari Village	Lele & Makada, 1972
Talchir	Giridih Coalfield, Bihar	Suknid River, Karharbari Village	Lele, 1966
Talchir	Jayanti Coalfield, Bihar	Section in tributary of Patharjore Nala, Misra Village	Lele & Makada, 1974
Karharbari		Banskupi Colliery samples	
Karharbari Barakar	W. Raniganj Coalfield, Bihar	Sections along Sonbad Nala, Pusai Nala and Khudia Nala, Pusai Shampur area	Tiwari, 1973b
Karharbari	Auranga Coalfield, Bihar	Section in Gowa Nala, Gowa Village	Lele & Srivastava, 1980
Barakar		Sukri River Section, near Gurtur Village	
Kulti		Sukri River Section, near Rajbar Village	
Raniganj		Sukri River Section, near Tubed Village	
Karharbari	Giridih Coalfield, Bihar	Colliery samples and stream cuttings	Maithy, 1965
Barakar	West Bokaro Coalfield, Bihar	Colliery samples	Tiwari, 1965
Barakar	North Karanpura Coalfield, Bihar	Section in rivulet, at Badam Village	Venkatachala & Kar, 1968a
Barakar		Section in rivulet, near Pukra-Buruadeeh Colliery, Lungatoo	Venkatachala & Kar, 1968c
Barakar	South Karanpura Coalfield, Bihar	Colliery samples	Bharadwaj & Dwivedi, 1981

Contd.

Table 1—Contd.

HORIZON	COALFIELD/AREA	SECTION/BORE HOLE	REFERENCES
Barakar	Pachwara Coalfield, Bihar	Exposures along Bansloi River, near Bargo and Alubera, Bansoli Valley	Maheshwari, 1967
Kulti Raniganj Panchet	E. Raniganj Coalfield, West Bengal	B.H. RNM3 (23°35′45″ : 87°13′55″), up to 930.00 m, Burdwan District	Rana & Tiwari, 1980
Kulti Raniganj	E. Raniganj Coalfield, West Bengal	B.H.RNM2 (23°35′30″ : 87°12′30″), up to 657.00 m, Burdwan District	Tiwari & Rana, 1984
Panchet Mahadeva		B.N.RNM4 (23°34′30″ : 87°13′03″), up to 107-135 m depth, Burdwan District	
Kulti	Jharia Coalfield, Bihar	B.H.JK5 (23°44′86″; 29′28″), 3,926 ft. deep, Dhanbad	Kar, 1968a
Kulti	North Karanpura Coalfield, Bihar	B.H.K5, 337.30 m deep, Baral-Raniganj-Kevendai area, Hazaribagh District	Kar, 1969a
Raniganj	W. Raniganj Coalfield, Bihar	Colliery samples	Bharadwaj, 1962
Raniganj			Bharadwaj & Salujha, 1964, 1965
Raniganj	North Karanpura Coalfield, Bihar	B.H.K2,352.57 m deep, Raniganj-Kavendai area, Hazaribagh District	Kar, 1969b
Raniganj		Section in river running across Lungatoo, Bukragaon Village	Kar, 1968b
Raniganj Panchet	E. Raniganj Coalfield, West Bengal	B.H. NCRD 660.00-352.40 m depth in Disergarh, Asansol Region	Bharadwaj & Tiwari, 1977
Raniganj Panchet	E. Raniganj Coalfield, West Bengal	Section in a tributary of Damodar River, near Saturbandh Village	Tiwari & Rana, 1981
Panchet Mahadeva		B.H.RD1, 532.48-600.58 m depth, near Durgapur, Burdwan District	
Panchet	East Bokaro Coalfield, Bihar	Dhardharia Nala Section, West of Jurwa Village	
Raniganj	Brahmani Coalfield, Bihar	Road section, Chaipani Village	Tiwari & Tripathi, 1984
Raniganj	Pachwara Coalfield, Bihar	Bansloi River section, near Tattitola Village	Mandal & Maithy, 1981
Panchet	Raniganj Coalfield, West Bengal	B.H.RE9 (23°40′ : 87°20′) 31.00-84.05 m deep, in Laudoha area	Kar, 1970
Panchet	Raniganj Coalfield, West Bengal	Section along north western branch of Nonia Nala, Burdwan District	Maheshwari & Banerji, 1975
Panchet		Section at Junction of Junat and Damodar River	Banerji & Maheshwari, 1975
Panchet	Auranga Coalfield, Bihar	Sukri River Section, 0.8 km from Kaima and 1.6 km South-west of Tubed	Banerji & Maheshwari, 1977
Dubrajpur Rajmahal	Rajmahal Basin, Bihar	B.H.RJR2, 884.25 m deep, near Kazigaon	Tripathi, Tiwari & Kumar, 1990
Rajmahal		Section exposed at Sakrigali Ghat and Basko	Sah & Jain, 1965
Rajmahal		Well Section near Mandro	Maheshwari & Jana, 1983
Lathi	Rajasthan	Well near Jaisalmer (26°54′30″; 70°57′00″), 1,257 ft deep	Srivastava, 1966
Jaisalmer		Well near Barragoan (26°51′30″ : 70°11′00″), 965 ft deep	
Lathi Jaisalmer	Rajasthan	Well at Chhor Village (11°9′9″ : 27°45′49″), Jaisalmer District	Lukose, 1972
Jhurio Jhamara Jhuran Bhuj	Kachchh	B.H. in Banni South of Paccham Island, 618.00-1,760 mm depth	Koshal, 1975
Jhuran	Kachchh	Pur River and Khari River Section, near Bhuj	Venkatachala, Kar & Raza, 1969
Bhuj	Kachchh	Pur River Section, near Trambau; Pat Section, near Bhuj	Venkatachala, 1969
	Kachchh	Section exposed in a pond, near Dayapar Village	Venkatachala & Kar, 1972

absence of Jurassic sediments from most of the terrestrial Gondwana has been advocated (Datta, Mitra & Bandyopadhaya, 1983).

The basic units of stratigraphy in the Indian Gondwana were initially identified on the basis of distinctive lithology, rich floras and sporadic faunas (Sastry *et al.*, 1977). In due course of time the biostratigraphic zones were identified and consistent efforts were made to tag them with lithostratigraphic units, particularly in the Lower Permian. However, in the younger sequence, the megafloral assemblages exercised main control for

Map 1—Map of India showing various basins from where data has been incorporated for the present study. **1**, Damodar; **2**, Koel; **3**, Deogarh; **4**, Rajmahal; **5**, Jaisalmer; **6**, Kachchh; **7**, Cauvery.

stratigraphy till the sixth decade of the present century. Thereafter, palynology was employed as an effective parameter for refining biostratigraphy.

In view of the differential history of deposition for each graben, and because of the lack of marine controls, chronostratigraphy on a precise international scale could not be established with a high degree of confidence. Nevertheless, the biostratigraphic zones have been fairly well-defined, some of which are regionally persistent and have broader time connotation. The megafloral biostratigraphy has limitations of preservation and numerosity of specimens. Therefore, palynology is a suitable discipline which can play a significant role in refining the biostratigraphy and in establishing a biochronological scheme for the Indian Gondwana.

Damodar Graben

The Raniganj, Jharia, Bokaro, Karanpura, Auranga and Hutar basins of the main Damodar Valley and Giridih and Jayanti basins of subsidiary parallel belt provide rich information on the distribution of spore-pollen species. These areas show classic development of basal glacigene Talchir Formation and subsequent Karharbari, Barakar, Kulti and Raniganj formations. The Karharbari Formation grossly resembles the Barakar Formation in its lithological attributes having substantial coal facies, although the former contains specks of needle shales in its sandstone units reworked from the underlying Talchir Formation. Floristically, the Talchir and Karharbari formations are bracketted together. In the post-Talchir succession the continuous pile of deposition having mostly coal-shale-sandstone suites, ranges up to uppermost Permian. The intervening Kulti Formation although contains coals, but the seams are not thick enough for exploitation, hence earlier it was termed as Barren measures. The beginning of Triassic Period is marked by the deposition of the coal-less Panchet Formation which in most areas conformably overlies the Raniganj Formation.

The Panchet Formation is characterised by khaki-green and red beds containing Dicroidium flora and vertebrate fauna of Early Triassic age (Sastry *et al.*, 1977). The deposition of Panchet Formation has witnessed a break in the Middle Triassic Period, followed by Supra-Panchet Formation of coarse conglomerate, ferruginous sandstone and red shales, which is supposed to extend up to Upper Triassic. After this sequence, the deposition ceased in the Damodar graben.

Rajmahal Basin

The data for the present study has been obtained mainly from subsurface of Rajmahal Basin (Table 1). The Permian and Lower Triassic history of Rajmahal Basin closely compares with that of the Raniganj Basin—except for some lithological variations and reduced thickness in the former. Following the deposition of Barakar Formation the litho-sequence was conventionally recognised as Dubrajpur Formation which was interrupted by the volcanic activity at its upper reaches. However, the Dubrajpur Formation has been now proved to range from Upper Permian to Lower Cretaceous (Tiwari *et al.*, 1984; Sengupta, 1988; Tripathi, 1989) both by palynological and plant fossil assemblages.

Kachchh

The Mesozoic Sequence in Kachchh is classified as Jhurio, Jhumara, Jhuran and Bhuj formations, ranging in age from Middle Jurassic (Bathonian) to Early Cretaceous (Albian—?Santonian). These formations are tagged with the marine fauna for their age (Biswas, 1977). The palynological details which are considered for comparison in the present study are from various outcrop sections representing, in part, Jhuran (Katrol) and Bhuj formations. Additionally, the data from wells in Banni and Nirona areas provide a complete reference succession from Late Triassic (Rhaetic-Liassic) to Early Cretaceous (Table 1).

Rajasthan

In Rajasthan, the Mesozoic sedimentary package has been defined as Lathi Formation and the overlying Jaisalmer Formation to which Early to Middle Jurassic age is assigned. The Lathi sediments are mainly arenaceous representing deltaic environment, while Jaisalmer sequence was deposited under marine environment (Narayanan *et al.*, 1961 *in* Lukose, 1972). Palynological details from two records (Srivastava, 1966; Lukose, 1972) provide the data-base for the Lower and Middle Jurassic which constitutes a reference succession for comparison with the main data.

BIOSTRATIGRAPHIC UNITS AND SPORE-POLLEN SPECIES

The International Subcommission on Stratigraphic Classification (1971, 1972, *in* Hedberg, 1976) defined the zone as a commonly used term to denote a minor stratigraphic interval in any category of stratigraphic classification. There are many types of zones depending on stratigraphic parameter. The biozone is one of such zones which represents the basic unit of biostratigraphic classification, it encompasses a body of rock defined or characterized by its fossil contents.

The biozones, in general, include four types of zones—Assemblage-Zone, Range-Zone, Acme-Zone, and Interval-Zone (Hedberg, 1976). For achieving high resolution in biostratigraphy these four major zones should be used in conjunction with each other. In other words, same strata can be handled in terms of more than one type of biozones. It may be more effective identification of datum if more than one zones coincide for the same succession in their lower and upper limits.

The present synthesis attempts to identify spore-pollen species assemblage zones (not in terms of species range-zones) based on the data available from one key region (Damodar-Rajmahal depositional domain). Presently, the range-zones have not been determined because of the geographically limited scope of the area covered under study. Also, the numerical abundance of each species is not yet known and hence the acme-zones of species cannot be objectively identified at the present juncture.

The utility of any system of biozonation is related with the number of events recognized in the given sequence of sediments. The more such levels are established in geographically wide area, the higher is the stratigraphic resolution. This is all the more important because each kind of zonation system has some lacunae (Schoch, 1989). Keeping this in view, the same data on species distribution in the Permian, Triassic, Jurassic and Lower Cretaceous has been handled here in two different combinations to sift maximum information for recognition of datum planes, viz., species assemblage-zones and epibole of number of species in individual genus. The presently proposed assemblage zones, based on the occurrence of spore-pollen species, have been identified after a multi-tier sieving and reshufling of data. To start with a thorough scanning of the published literature from the areas under consideration was done and all the species in each area were listed according to their stratigraphic occurrences. After scrutiny of synonymy and nomenclatural validity the species were shortlisted. Those morphotypes which were based on poorly preserved specimens or possessed little distinctive characters were rejected. Further sieving of the composite data was done to discard most common and very long-ranging species and apparent variants.

The zone-types which now emerge from the stair-case arrangement of species against the lithostratigraphic column, as achieved by sorting through LOTUS package, are the Assemblage Zones. They represent distinctive natural assemblages of most of the principal spore-pollen species. The practicability of the assemblage zone lies in the fact that for any particular zone it is not essential that all the defined elements need be present in order to assign the strata to the assemblage zone. As mentioned earlier in the text, an assemblage zone is largely an indicator of environment but at the same time it is also a general pointer of geological age. The species-assemblage-zone has a defined age connotation as compared to the generic assemblage zones because the species change faster than the genera on the evolutionary path. As depicted in Table 2, the name of each assemblage zone is derived from the prominent and diagnostic constituent species normally found in the said zone. Although the stratotype designation is not mandatory, it has been cited here, as far as possible, in accordance with the recommendations of the International Stratigraphic Guide.

From the rearrangement of the same data, another type of zones—the acme-zones, have emerged in which case the species are grouped together according to their generic affiliation (Table 3). Normally the acme-zones are defined to be based on abundance or development of certain forms. There are two ways to define the abundance or development, one in which the frequency of specimens of a certain species is the highest, and the other in which the number of species within a genus reaches the maximum. As stated above, since the percentage frequency of individual species is not known, the maximum proliferation of species represented by their number within a genus has been taken as a criterion for acme-zone. It may be mentioned that the generic acme-zone known so far in the Gondwana Sequence are different from the acme-zone being proposed in this paper. The former are based on generic abundance and the latter are defined on epibole in the number of species of a particular genus along the stratigraphic column. To differentiate the two, the names have been given in different ways, e.g., *Parasaccites* Acme-Zone and *Parasaccites* spp. Acme-Zone, respectively.

In Table 2, the first and the last occurrences of species are depicted. The Last Appearance Datum (LAD) may be distorted by reworking of taxa and thus affect the authenticity of the ranges, particularly when their record is not continuous in time prior to the last appearance, and the specimens are very scantily and inconsistently found. The First Appearance Datum (FAD) is a very useful parameter for stratigraphy, but has also certain limitations in the long range spatial correlation. Any given species normally can not make its first appearance simultaneously at several geographically widely separated regions, particularly in different latitudinal belts. This is because of time factor involved in migration from its original first appearance site. nevertheless, the FADs are useful parameters to demarcate a zone in a particular region. If the FADs and LADs are defined at the steady first appearance and last appearance levels, respectively, these datums gain considerable weightage. In the present synthesis, a mere record of a species—one specimen in more than four slides with large coverslips of 20 × 40 mm size, or its sporadic rarest occurrence at any level has not been taken for FAD or LAD as suggested by Gradstein (1983).

SPORE-POLLEN SPECIES ASSEMBLAGE-ZONES

The basic units of biostratigraphy, identified and described below are the species Assemblage Zones which represent lithologic strata. The spore-pollen species contained in the strata constitute the natural assemblage of distinctive characters.

The list of principal spore-pollen species in each assemblage zone is depicted in the stair-case diagram (Table 2). For the reference section, original works are cited or described in brief, wherever possible. The earlier proposed comparable zones have been compared or equated with the present zones, or if the earlier propositions are in wide use and conventionally accepted to be effectively useful, they have been adapted after redefinition. The top and bottom limits of each assemblage zone proposed here are defined by the

Table 2 — Spore-pollen species-based assemblage-zone through Gondwana Sequence of Damodar-Rajmahal basins. For comparative assessment Mesozoic palyno-sequence from Jaisalmer, Kachchh and Cauvery basins also intercalated. J=Jaisalmer, JH=Jhumara, JHUR=Jhuran, DUBR=Dubrajpur.

Index : ** Damodar and Rajmahal, ++ Jaisalmer and Kachchh, \\ Cauvery, — not recorded, >> inconsistent presence

	Period	L. Permian						U. Permian			L. Triassic		M. Triassic	U. Triassic				L. Juras	M-U. Juras	L.-Cretaceous			J/C	L.-Cretaceous	
	Palyno-species / Formation	Talchir		Karhar-bari		Barakar		Kulti	Raniganj		Panchet		Supra-Panchet	Dubrajpur			Pre-Lathi	Lathi	J, JH, JHUR	Katrol	Siv-ganga	Bhuj	DUBR contd.	Raj-mahal	
	Assemblage-zone	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	"XIX"	XIX	XX	XX "D-E"	XX "F"	XX "G"
1	Verrucosisporites cf. donarii in Lele 1975	1 **																							
2	Parassacites densicorpus Lele 1975	2 **	**																						
3	Potonieisporites crassus Lele & Ch.1973	3 **	**																						
4	Potonieisporites magnus Lele & Karim 1971	4 **	**	**																					
5	Potonieisporites neglectus Pot.& Lele 1961	5 **	**	**	**																				
6	Plicatipollenites gondwanensis (Balme & Henn.) Lele 1964	6 **	**	**	**	**	**																		
7	Parasaccites obscurus Tiw.1965	7 **	**	**	**	—	**	**	**																
8	Plicatipollenites indicus Lele 1964	8 **	**	**	**	—	**	**	—	**	**														
9	Jayantisporites cf. conatus in Lele 1975	9	**																						
10	Striatoparvisaccites circularis Lele 1975	10	**																						
11	Striatoparvisaccites indicus Lele 1975	11	**																						
12	Caheniasaccites densus Lele & Karim 1971	12	**	**																					
13	Rugasaccites obscurus Lele & Maithy 1969	13	**	**																					
14	Sahnites elongatus (Lele & Karim) Tiw. & Singh 1984	14	**	**																					
15	Tuberisaccites tuberculatus (Mah.) Lele & Mak.1972	15	**	**																					
16	Plicatipollenites densus Sr.1970	16	**	**	**																				
17	Plicatipollenites trigonalis Lele 1964	17	**	**	**																				
18	Parasaccites bilateralis Tiw.1965	18	**	**	**	**	**																		
19	Sahnites thomasi Pant em. Tiw.& Singh 1984	19	**	**	**	**	**																		
20	Crescentipollenites fuscus (Bh.) Bh. et al.1974	20	**	**	**	**	**	**	**	**	**	**	**												
21	Faunipollenites perexiguus Bh.& Sal.1965	21	**	**	**	**	**	**	**	**	**														
22	Callumispora gretensis (B.& H.)Bh.& Sr. em. Tiw.et al.1989	22	**	**	**	**	**	**	—	**	**	**	**												
23	Caheniasaccites decorus Lele & Mak.1972		23	**	**																				
24	Caheniasaccites ovatus Bose & Kar 1966		24	**	**																				
25	Crucisaccites latisulcatus Lele & Maithy 1964		25	**	**																				
26	Tuberisaccites lobatus Lele & Mak.1972		26	**	**																				
27	Faunipollenites varius Bh. em. Tiw.et al.1989		27	**	**	**	**	**	**	**	**	**	**												
28	Scheuringipollenites maximus (Hart) Tiw.1973a		28	**	**	**	**	**	**	**	**	**	**	**											
29	Microbaculispora tentula Tiw.1965		29	**	**	—	**																		
30	Vestigisporites novus Tiw.1965		30	**	**	—	**																		
31	Parasaccites korbaensis Bh.& Tiw.1964		31	**	**	—	**	**	**	**	**	—	**												
32	Microfoveolatispora foveolata Tiw. em. Tiw.& Singh 1981		32	**	**	—	**	—	**	**	—	**													
33	Lacinitriletes badamensis Venk.& Kar em. Tiw.& Singh 1981		33	**	—	**	**	**	**	**															
34	Ginkgocycadophytus novus Sr.1970		34	**	—	—	**																		
35	Divarisaccus lelei Venk.& Kar 1966a		35	**	—	—	**	**	—	**															
36	Caheniasaccites distinctus Lele & Mak.1972		36	**																					
37	Circumstriatites obscurus Lele & Mak.1972		37	**																					
38	Circumstriatites talchirensis Lele & Mak.1972		38	**																					

39 Cyclogranisporites plicatus Allen 1965	39	**							
40 Jayantisporites indicus Lele & Mak.1972	40	**							
41 Jayantisporites pseudozonatus Lele & Mak.1972	41	**							
42 Parastriopollenites indicus Lele & Mak.1972	42	**							
43 Parastriopollenites segmentatus Lele & Mak.1972	43	**							
44 Plicatisporites distinctus Lele & Mak.1972	44	**							
45 Striasulcites sp. in Lele & Mak.1972	45	**							
46 Tuberisaccites varius Lele & Mak.1972	46	**							
47 Vestigisporites nigratus Lele & Karim 1971	47	**							
48 Vestigisporites notus (Lele & Karim) Tiw. & Singh 1984	48	**							
49 Barakarites gondwanensis Maithy 1965		49	**						
50 Callumispora barakarensis Bh.& Sr. em. Tiw. et al.1989		50	**						
51 Crescentipollenites limpidus (Balme & Henn.) Lele & Sr.1977		51	**						
52 Crescentipollenites rhombicus in Lele & Mak. 1974		52	**						
53 Crucisaccites monoletus Maithy em. Tiw. et al.1989		53	**						
54 Distriamonocolpites circularis Sinha 1972		54	**						
55 Tiwariasporis gondwanensis (Tiw.) Mah. & Kar 1967		55	**						
56 Welwitschiapites magnus Maithy 1965		56	**						
57 Stellapollenites talchirensis Lele 1965		57	**	**	**				
58 Verrucosisporites donarii Pot.& Kr.1955		58	**	**	**	**	**	**	
59 Densipollenites indicus Bh.1962		59	**	**	**	**	**	**	**
60 Scheuringipollenites barakarensis (Tiw.) Tiw.1973a		60	**	**	**	**	**	**	**
61 Sahnites barrelis (Tiw.) Tiw.& Singh 1984		61	**	—	**				
62 Laevigatosporites colliensis Venk.& Kar 1968a		62	**	—	**	**	**	**	
63 Ginkgocycadophytus cymbatus (Balme & Henn.) Pot.& Lele 1961		63	**	—	**	**	—	**	
64 Marsupipollenites triradiatus Balme & Henn.1956		64	**	—	—	—	—	—	**
65 Brevitriletes communis Bh.& Sr. em. Tiw.& Singh 1981			65	**	**				
66 Corisaccites varius Venk.& Kar 1966b			66	**	**				
67 Dentatispora gondwanensis Tiw.1965			67	**	**				
68 Distriatites distinctus Sinha 1972			68	**	**				
69 Indotriradites korbaensis Bh.& Tiw.1964			69	**	**				
70 Paravesicaspora indica (Tiw.) Bh.& Dwi.1981			70	**	**				
71 Primuspollenites levis Tiw.1964			71	**	**				
72 Faunipollenites singrauliensis Sinha 1972			72	**	**	**			
73 Platysaccus densus Kar 1968a			73	**	**	**			
74 Striasulcites tectus Venk.& Kar 1968b			74	**	**	**			
75 Indotriradites korbaensis Tiw.1964			75	**	**	**	**		
76 Ibisporites diplosaccus Tiw.1968			76	**	**	**	**	**	
77 Rhizomaspora indica Tiw.1965			77	**	**	**	**	**	
78 Scheuringipollenites ovatus (B.& H.) Bh.& Dwi.1981			78	**	**	**	**	**	
79 Striatites notus Bh.& Sal.1964			79	**	**	**	**	**	
80 Verticipollenites gibbosus Bh.1962			80	**	**	**	**	**	
81 Striatites communis Bh.& Sal.1964			81	**	**	**	**	**	**
82 Weylandites lucifer (Bh.& Sal.) Foster 1976			82	**	**	**	—	**	
83 Lophotriletes rectus Bh.& Sal.1964			83	**	**	—	**	**	**
84 Barakarites indicus Bh.& Tiw.1964				84	**				

Contd.

Table 2 — *Contd.*

Index : ** Damodar and Rajmahal, ++ Jaisalmer and Kachchh, \\ Cauvery, — not recorded, >> inconsistent presence

Palyno-species / Period	L. Permian						U. Permian			L. Triassic		M. Triassic	U. Triassic				L. Juras	M-U. Juras	L.- Cretaceous			J/C	L.- Cretaceous	
Formation	Talchir			Karhar-bari	Barakar		Kulti	Raniganj		Panchet		Supra-Panchet	Dubrajpur			Pre-Lathi	Lathi	J, JH, JHUR	Katrol	Siv-ganga	Bhuj	DUBR contd.	Raj-mahal	
Assemblage-zone	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	"XIX"	XIX	XX	XX "D-E"	XX "F"	XX "G"
85 Cyclofoveolatispora minutus Venk.& Kar 1968c					85	**																		
86 Didecitriletes horridus Venk.& Kar 1965					86	**																		
87 Ginkgocycadophytus vetus (B.& H.) Tiw.1965					87	**																		
88 Insignisporites barakarensis Bh.& Dwi.1977					88	**																		
89 Lueckisporites crassus Sinha 1972					89	**																		
90 Maculatasporites indicus Tiw.1964					90	**																		
91 Microbaculispora indica Tiw. em. Tiw.& Singh 1981					91	**																		
92 Microbaculispora villosa (B.&H.) Bh.1962					92	**																		
93 Microfoveolatispora bokaroensis Tiw.1965					93	**																		
94 Paravesicaspora distincta (Tiw.) Bh.& Dwi.1981					94	**																		
95 Potonieitriradites barakarensis Bh.& Sinha 1969					95	**																		
96 Striatites naditoliensis Bh.& Dwi.1981					96	**																		
97 Tiwariasporis flavatus Mah.& Kar 1967					97	**																		
98 Vestigisporites rudis Balme & Henn.1955					98	**																		
99 Vittatina permagna Tiw.1965					99	**																		
100 Welwitschiapites simplex Tiw.1965					100	**																		
101 Weylandites dubius (Venk.& Kar) Bh.& Dwi.1981					101	**																		
102 Lahirites lungatooensis Venk.& Kar 1968c					102	**	**																	
103 Schizopollis disaccoides Venk.& Kar 1964					103	**	**																	
104 Schizopollis wodehousei Venk.& Kar 1964					104	**	**																	
105 Vittatina lata Wils.1962					105	**	**																	
106 Indospora clara Bh.1962					106	**	**	**	**															
107 Praecolpatites sinuosus (B.& H.) Bh.& Sr.1969					107	**	**	**	**															
108 Striatites multistriatus (B.& H.) Tiw.1965					108	**	**	**	**															
109 Densipollenites invisus Bh.& Sal.1964					109	**	**	**	**	**														
110 Horriditriletes curvibaculosus Bh.& Sal.1964					110	**	**	**	**	**														
111 Lahirites rarus Bh.& Sal.1964					111	**	**	**	**	**														
112 Striomonosaccites ovatus Bh.1962					112	**	**	**	**	**														
113 Cyclogranisporites gondwanensis Bh.& Sal.1964					113	**	**	**	**	**	**	**												
114 Striatopodocarpites decorus Bh.& Sal.1964					114	**	**	—	**	**	—	—	—	—	**									
115 Corisaccites alutas Venk.& Kar 1966b					115	**	**	—	**															
116 Guttulapollenites hannonicus Goubin 1965					116	**	**	—	**															
117 Rhizomaspora costa Venk.& Kar 1968b					117	**	**	—	**															
118 Welwitschiapites tenuis Bh.& Sal.1964					118	**	**	—	**															
119 Microfoveolatispora raniganjensis Bh. em. Tiw. & Singh 1981					119	**	—	**																
120 Microbaculispora gondwanensis Bh.1962					120	**	—	**	**															
121 Corisaccites distinctus Venk.& Kar 1968c					121	**	—	—	**															
122 Hennellysporites diversiformis Tiw.1968					122	**	—	—	**															
123 Lahirites angustus Venk.& Kar 1968a					123	**	—	—	**															
124 Striatopodocarpites tiwarii (Tiw.) Bh.& Dwi.1981					124	**	—	—	**															
125 Bharadwajipollis striatus Kar 1969a						125	**																	
126 Praecolpatites biplicatus (Kar) Bh.& Dwi.1981						126	**																	
127 Verrucosisporites ambiplicatus Kar 1968a						127	**																	
128 Densipollenites brevis Lele & Sr.1977						128	**	**	**															
129 Gondisporites raniganjensis Bh.1962						129	**	**	**															

130 *Hindipollenites indicus* Bh.1962	130	••	••	••						
131 *Striatopodocarpites ovatus* (Mah.) Tiw.& Rana 1980	131	••	••	••						
132 *Verticipollenites crassus* Bh.& Sal.1964	132	••	••	••						
133 *Densipollenites magnicorpus* Tiw.& Rana 1981	133	••	••	••						
134 *Densipollenites densus* Bh.& Sr.1969	134	••	••	••	••					
135 *Striatopodocarpites rotundus* (Mah.) Bh.& Dwi.1981	135	••	••	••	••					
136 *Platysaccus fuscus* Goubin 1965	136	••	••	••	••	—	—	••		
137 *Cyclobaculisporites minimus* Kar 1968a	137	••	—	••						
138 *Didecitriletes ericianus* (B.& H.) Venk.& Kar 1965		138	••							
139 *Lophotriletes rarus* Kar 1968		139	••							
140 *Vestigisporites disectus* Hart em. Tiw.& Singh 1984		140	••							
141 *Distriamonocolpites ovalis* Bh.& Sinha 1969		141	••	••						
142 *Distriatites bilateris* Bh.1962		142	••	••						
143 *Distriomonosaccites ovalis* Bh.& Sal.1964		143	••	••						
144 *Lahirites singularis* Bh.& Sal.1964		144	••	••						
145 *Verticipollenites oblongus* Bh.1962		145	••	••						
146 *Crescentipollenites gondwanensis* Bh.et al.1974			146	••						
147 *Crescentipollenites sellingi* (Sal.) Tiw.& Rana 1980			147	••						
148 *Cyclobaculisporites indicus* Bh.& Sal.1964			148	••						
149 *Gondisporites reticulatus* Tiw.& Ram-Awatar 1989			149	••						
150 *Indospora macula* Bh.& Sal.1964			150	••						
151 *Marsupipollenites striatus* (B.& H.) Foster 1975			151	••						
152 *Striatites rhombicus* Bh.& Sal.1964			152	••						
153 *Thymospora gondwanensis* Bh.& Sal.1964			153	••	••					
154 *Verrucosisporites gondwanensis* Sr.1970			154	••	••					
155 *Weylandites indicus* Bh.& Sr.1969			155	••	••					
156 *Crescentipollenites bengalensis* (Mah.& Ban.) Tiw.& Rana 1981			156	••	••	••	••			
157 *Densoisporites complicatus* Balme 1970			157	>>	••					
158 *Lunatisporites diffusus* Bh. & Tiw. 1977			158	>>	••					
159 *Osmundacidites senectus* Balme 1963			159	>>	••					
160 *Alisporites asansoliensis* Mah.& Ban.1975			160	>>	••	••				
161 *Indotriradites cuspidus* (B.) Bh.& Tiw.1977			161	>>	••	••				
162 *Lunatisporites ovatus* (Goubin) Mah.& Ban. 1975			162	>>	••	••				
163 *Alisporites damudicus* Tiw.& Rana 1981			163	>>	••	••	••			
164 *Densoisporites playfordii* Balme 1970			164	>>	••	••	••			
165 *Lundbladispora brevicula* Balme 1970			165	>>	••	••	••			
166 *Lundbladispora microconata* Bh.& Tiw.1977			166	>>	••	••	••			
167 *Callumispora fungosa* (Balme) Bh.& Tiw.1977			167	>>	••	••	••	••		
168 *Inaperturopollenites nebulosus* Balme 1970			168	>>	••	••	••	••		
169 *Alisporites landianus* Balme 1970			169	>>	••	••	••	••	••	
170 *Goubinispora morondavensis* (Goubin) Tiw.& Rana 1981			170	>>	••	••	••	••	••	••
171 *Klausipollenites schaubergeri* (Pot.& Kr.) Jans.1962			171	>>	••	••	••	••	••	••
172 *Playfordiaspora cancellosa* Mah.& Ban.1975			172	>>	••	••	••	••	••	••
173 *Rhizomaspora triassica* Tiw.& Rana 1981			173	>>	••	—	••			
174 *Densoisporites contactus* Bh.& Tiw.1977			174	>>	••	—	••	••		
175 *Aratrisporites fischeri* Kl.1960				175	••					
176 *Biretisporites* sp. in Kar 1970				176	••					
177 *Granuloperculatipollis flavatus* Kar 1970				177	••					
178 *Convertubisporites contactus* Ban.& Mah.1975				178	••	••				
179 *Verrucosisporites triassicus* Bh.& Tiw.1977				179	••	••	••			
180 *Pretricolpipollenites bharadwajii* Balme 1970				180	••	••	••	••		
181 *Verrucosisporites narmianus* Balme 1970				181	••	••	••	••		
182 *Lunatisporites pellucidus* (Goubin) Mah.& Ban.1975				182	••	••	••	••	••	

Contd.

Table 2 — *Contd.*

Index : ** Damodar and Rajmahal, ++ Jaisalmer and Kachchh, \\ Cauvery, — not recorded, >> inconsistent presence

Palyno-species / Period	L. Permian						U. Permian			L. Triassic		M. Triassic	U. Triassic				L. Juras	M-U. Juras	L.-Cretaceous			J/C	L.-Cretaceous	
Formation	Talchir			Karhar-bari		Barakar	Kulti	Raniganj		Panchet		Supra-Panchet	Dubrajpur			Pre-Lathi	Lathi	J, JH, JHUR	Katrol	Siv-ganga	Bhuj	DUBR contd.	Raj-mahal	
Assemblage-zone	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	"XIX"	XIX	XX	XX "D-E"	XX "F"	XX "G"
183 Cyathidites australis Coup.1953									183	**	**	**	—	—	—	—	++	++	++	—	—	**		
184 Cycadopites follicularis Wils.& Webst.1946									184	**	**	**	—	—	—	—	—	—	—	—	—	**		
185 Indotriradites mammilatus Bh.& Tiw.1977										185	**													
186 Indotriradites wargalensis (Balme) Bh.& Tiw.1977										186	**													
187 Lundbladispora baculata Bh.& Tiw.1977										187	**													
188 Lundbladispora densispinosa Bh.& Tiw.1977										188	**													
189 Lundbladispora warti Tiw.& Rana 1981										189	**													
190 Ringosporites ringus Tiw.& Rana 1981										190	**													
191 Guttatisporites ambiguus Tiw.& Rana 1980										191	**	**												
192 Lunatisporites noviaulensis (Lesch.) Scheuring 1970										192	**	**												
193 Novitasporites triassicus Tiw.& Rana 1981										193	**	**												
194 Triplexisporites playfordii (de Jer.& Hamilt.) Foster 1979										194	**	**												
195 Verrucosisporites densus Bh.& Tiw.1977										195	**	**	—	—	**									
196 Orbella indica Tiw.& Rana 1981										196	**	—	**											
197 Osmundacidites pilatus Tiw.& Rana 1981										197	**	—	**											
198 Araucariacites australis Cooks.1947										198	**	—	—	—	—	—	—	—	++	\\	++	**	**	**
199 Camisporites raniganjensis Tiw.& Rana 1980											199	**												
200 Lundbladispora reticulata Tiw.& Rana 1981											200	**												
201 Lundbladispora willmotti Balme 1963											201	**												
202 Nevesisporites vallatus de Jer.& Patten 1964											202	**												
203 Playfordiaspora annulata Tiw.& Rana 1980											203	**												
204 Ringosporites fossulatus (Balme) Tiw.& Rana 1980											204	**												
205 Vitreisporites pallidus (Reiss.) Nils.1958											205	**	—	—	—	—	—	—	—	—	—	**		
206 Chordasporites minutus Kar et al. 1972												206	**											
207 Converrucosisporites lunzensis Bh.& Singh 1964												207	**											
208 Foveosporites mimosae de Jer.& Hammil.1967												208	**											
209 Polycingulatisporites sp. in Tripathi et al.1990												209	**											
210 Rajmahalispora reticulata Tiw. et al.1984												210	**											
211 Rajmahalispora rugulata Tiw. et al.1984												211	**											
212 Rajmahalispora triassica Tiw. et al.1984												212	**											
213 Falcisporites minutosaccus Kum.& Mah.1980												213	**	**										
214 Klausipollenites staplinii Jans.1962												214	**	**										
215 Nidipollenites monoletus Bh.& Sr.1969a												215	**	**	**									
216 Satsangisaccites triassicus Bh.& Sr.1969a												216	**	**	**									
217 Foveosporites triassicus Kum.& Mah.1980												217	**	—	**									
218 Conbaculatisporites baculatus Bh.& Singh 1964													218	**										
219 Convolutispora perfecta Kum.& Mah.1980													219	**										
220 Infernopollenites claustratus Dolby & Balme 1976													220	**										
221 Staurosaccites densus Kum.& Mah. em. Tripathi et al.1990													221	**										
222 Staurosaccites tharipatharensis Mah.& Kum.1979													222	**										
223 Brachysaccus indicus Kum.& Mah.1980													223	**	**									
224 Brachysaccus ovalis Maedler 1964													224	**	**									
225 Gabonisporis papillosus Tripathi et al.1990													225	**	**									
226 Gabonisporis vigourouxii Boltenhagen 1967													226	**	**									

227 Guttatisporites elegans Visscher 1966	227	••	••									
228 Guttatisporites guttatus Visscher 1966	228	••	••									
229 Staurosaccites marginalis Kum.& Mah. 1980	229	••	••									
230 Staurosaccites quadrifidus Dolby in Dolby & Balme 1976	230	••	••									
231 Striatopodocarpites dubrajpurensis Tripathi et al.1990	231	••	••									
232 Podocarpidites grandis Sah & Jain 1965	232	••	••	—	—	—	++	—	++	—	—	••
233 Podocarpidites typicus Sah & Jain 1965	233	••	—	—	—	—	—	—	—	—	—	••
234 Converrucosisporites jenensis Reinh.1984		234	••									
235 Dictyotriletes aulius Rigby in Rigby & Heckel 1977		235	••									
236 Dubrajisporites bulbosus Tiw.& Tripathi 1987		236	••									
237 Dubrajisporites triassicus Tiw.& Tripathi 1987		237	••									
238 Podocarpidites rarus Singh et al.1964		238	••									
239 Verrucosisporites carnarvonensis de Jer.& Hamilt.1967		239	••									
240 Podocarpidites alareticulatus Sah & Jain 1965		240	••	—	—	—	—	—	—	—	••	
241 Acquitriradites minor Maedler 1964			241	++								
242 Alisporites sp. in Koshal 1975			242	++								
243 Concavisporites sp. in Koshal 1975			243	++								
244˙ Convolutispora microrugulata in Koshal 1975			244	++								
245 Dictyophyllidites sp. in Koshal 1975			245	++								
246 Klausipollenites sp. in Koshal 1975			246	++								
247 Klausipollenites cf. vestitus in Koshal 1975			247	++								
248 Lunatisporites sp. in Koshal 1975			248	++								
249 Lundbladispora sp. in Koshal 1975			249	++								
250 Podocarpidites sp. in Koshal 1975			250	++								
251 Rhaetipollis germanicus Schulz 1967			251	++								
252 Verrucosisporites sp. in Koshal 1975			252	++								
253 Vitreisporites sp. in Koshal 1975			253	++								
254 Podocarpidites sp. In Koshal 1975			254	++								
255 Spheripollenites sp. in Koshal 1975				255	++							
256 Staplinisporites sp. in Koshal 1975				256	++							
257 Callialasporites barragaonensis Sr.1966				257	++	++						
258 Cingulatisporites lathiensis Sr.1966				258	++	++						
259 Dictyotriletes crateris (Balme) Sr.1966				259	++	++						
260 Ginkgocycadophytus deterius (B.) Dev 1961				260	++	++						
261 Monosulcites couperi Dev 1961				261	++	++						
262 Triangulatisporites mathurii Sr.1966				262	++	++						
263 Trilobozonosporites verrucatus (Lantz) Sr.1966				263	++	++						
264 Classopollis minor Pocock & Jans.1961				264	++	++	++					
265 Matonisporites cooksonii Dettm.1963				265	++	++	++					
266 Callialasporites triletes Singh et al.1964				266	++	++	++	\\				
267 Callialasporites dampieri (Balme) Dev 1961				267	++	++	++	\\	++	••	••	
268 Callialasporites segmentatus (Balme) Dev 1961				268	++	++	++	\\	++	••	••	
269 Callialasporites trilobatus (Balme) Dev 1961				269	++	++	++	\\	—	••	••	
270 Classopollis classoides Pfl. em. Pocock & Jans.1961				270	++	++	++	—	++			
271 Callialasporites granulatus Venk. & Kar 1972					271	++	++					
272 Callialasporites monoalasporus Dev 1961					272	++	++	\\				
273 Callialasporites lenticularis (Doering) Venk. & Kar 1969					273	++	++	—	++			
274 Cicatricosisporites sp. in Koshal 1975					274	++				•		
275 Contignisporites sp. in Koshal 1975					275	++						
276 Klukisporites sp in Koshal 1975					276	++						

Contd.

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Index : ** Damodar and Rajmahal, ++ Jaisalmer and Kachchh, \\ Cauvery, — not recorded, >> inconsistent presence

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Assemblage-zone	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	"XIX"	XIX	XX	XX "D-E"	XX "F"	XX "G"
277 Alsophyllidites bellus Venkatach. et al.1969																		277	++					
278 Biretisporites potoniaei Delc. & Sprum.1955																		278	++					
279 Boseisporites praeclarus Dev em. Singh et al.1964																		279	++					
280 Concavisporites crassus Venk. et al.1969																		280	++					
281 Concavissimisporites crassatus (Del.& Spr.) Del. et al.1963																		281	++					
282 Concavissimisporites veriverrucatus (Coup.) Singh 1964																		282	++					
283 Concavissimisporites verrucosus (Del.& Spr.) Del. et al.1963																		283	++					
284 Contignisporites cooksonii (Balme) Dettm.1963																		284	++					
285 Contignisporites kutchensis Venk. et al.1969																		285	++					
286 Coptospora sp. in Venk. et al.1969																		286	++					
287 Foveotriletes foveolus Venk. et al.1969																		287	++					
288 Foveotriletes triangulus Venk. et al.1969																		288	++					
289 Impardecispora uralensis (Bolk.) Venk. et al.1969																		289	++					
290 Klukisporites apunctus Venk. et al.1969																		290	++					
291 Klukisporites kutchensis Venk.in Venk. et al.1969																		291	++					
292 Klukisporites scaberis (Cooks.& Dettm.) Dettm.1963																		292	++					
293 Matonisporites kutchensis Venk.1969																		293	++					
294 Trilobosporites sp. in Venk. et al.1969																		294	++					
295 Contignisporites glebulentus Dettm.1963																		295	++	\\				
296 Podocarpidites ellipticus Cooks.1947																		296	++	\\	++	**		
297 Podocarpidites multesimus (Bolkho.) Pocock 1962																		297	++	\\	++	**		
298 Cicatricosisporites australiensis (Cooks.) Pot.1956																		298	++	\\	—	**	**	**
299 Retitriletes austroclavatidites (Rouse) Doring et al.1963																		299	++	\\	—	**	**	
300 Classopollis torosus (Reiss.) Coup.1958																		300	++	—	++			
301 Microcachryidites antarcticus Cookson 1947																		301	++	—	++			
302 Podosporites tripakshi Rao em. Kumar 1984																		302	++	—	++	**	**	
303 Podocarpidites cristiexinus Sah & Jain 1965																		303	++	—	++	**	**	**
304 Impardecispora trioreticulosa (Cooks.& Dettm.) Venk.et al.1969																		304	++	—	++	—	**	
305 Concavissimisporites penolaensis Dettm.1963																		305	++	—	—	**		
306 Coptospora kutchensis Venk.1969																		306	++	—	—	**		
307 Todisporites minor Couper 1958																		307	++	—	—	**		
308 Alsophilidites exilis Sah & Jain 1965																		308	++	—	—	—	—	**
309 Cyathidites trilobatus Sah & Jain 1965																		309	++	—	—	—	**	
310 Impardecispora purverulentus (Verbits.) Venk. et al.1969																		310	++	—	++			
311 Ceratosporites equalis Cooks. & Dettm. 1958																			311	\\				
312 Contignisporites multimuratus Dettm.1963																			312	\\				
313 Retitriletes reticulmsporites Doering et al.1963																			313	\\				
314 Baculatisporites comaumensis (Cooks.) Pot.1956																			314	\\	—	**		
315 Cicatricosisporites ludbrooki Dettm.1963																			315	\\	—	**	**	**
316 Stereisporites antiquasporites (Wils.& Webs.) Dettm.1963																			316	\\	—	—	—	**
																				317	++			

317 Aequitriradites indicus Singh et al.1964					
318 Aequitriradites triangulatus Singh et al.1964	318	++			
319 Alsophyllidites densus Singh et al.1964	319	++			
320 Concavissimisporites subverrucosus Venk.1969	320	++			
321 Cooksonites minor Venk.1969	321	++			
322 Cyathidites ghuneriensis Singh et al.1964	322	++			
323 Deltoidospora pseudoreticulata Singh et al.1964	323	++			
324 Deltoidospora rhytisima Rouse 1957	324	++			
325 Impardecispora apiverrucata (Coup.) Venk. et al.1969	325	++			
326 Leptolepidites sp. in Venk.& Kar 1972	326	++			
327 Staplinisporites caminus (B.) Pocock 1962	327	++			
328 Trilobosporites bemissartensis (Del.& Sprum.) Pot.1956	328	++			
329 Trilobosporites triangularis Venk. et al. 1969	329	++			
330 Podosporites microsaccatus Dettm.1963	330	++	••	••	
331 Araucariacites cooksonii Singh et al.1964	331	++	••	••	••
332 Callialasporites circumplectus Kumar 1973		332	••		
333 Callispora potoniei Dev em. Bh.& Kumar 1972		333	••		
334 Contignisporites dettmannii Singh & Kumar 1966		334	••		
335 Cooksonites rajmahalensis Tripathi et al.1990		335	••		
336 Foraminisporis sp. in Tripathi et al.1990		336	••		
337 Klukisporites varigatus Couper 1958		337	••		
338 Klukisporites venkatachalae Tripathi et al.1990		338	••		
339 Leptolepidites major Couper 1958		339	••		
340 Leptolepidites verrucatus Couper 1953		340	••		
341 Murospora florida Balme em. Dettm.1963		341	••		
342 Santhalisporites bulbosus Tripathi et al.1990		342	••		
343 Aequitriradites verrucosus (C.& D.) Cooks.& Dettm. 1961		343	••	••	
344 Callialasporites lametaensis Kumar 1973		344	••	••	
345 Aequitriradites spinulosus (C.& D.) Cooks.& Dettm. 1961		345	••	—	••
346 Classopollis indicus Mah. 1974		346	••	—	••
347 Coptospora verrucosa Tripathi et al.1990		347	••	—	••
348 Labiipollis granulatus Maedler 1964		348	••	—	••
349 Santhalisporites baskoensis (Sah & Jain) Tripathi et al.1990		349	••	—	••
350 Triporoletes reticulatus (Pocock) Playf.1971		350	••	—	••
351 Dictyophyllidites haradensis Kum.1973			351	••	
352 Alisporites baskoensis Sah & Jain 1965				352	••
353 Cicatricosisporites hallei Del.& Sprum.1955				353	••
354 Cingulatisporites notaclarus Sah & Jain 1965				354	••
355 Concavissimisporites minor Sah & Jain 1965				355	••
356 Converrucosisporites santalensis Sah & Jain 1965				356	••
357 Converrucosisporites sinuotectus Sah & Jain 1965				357	••
358 Dacrycarpites australiensis Cooks.& Pike 1953				358	••
359 Densoisporites mesozoicus Singh et al.1964				359	••
360 Divisisporites ovalis Sah & Jain 1965				360	••
361 Foraminisporis cf. asymmetricus Sah & Jain 1965				361	••
362 Impardecispora purverulenta (Verb.) Venk. et al.1969				362	••
363 Ischyosporites irregularis Sah & Jain 1965				363	••
364 Osmundacidites minutus Sah & Jain 1965				364	••

Table 3 — Spore-pollen species sorted on generic affiliation to define the species Acme-zones. J=Jaisalmer, JH=Jhumara, JHU=Jhuran, DUBR=Dubrajpur.
Index : ** Damodar and Rajmahal, ++ Jaisalmer and Kachchh, \\ Cauvery, — not recorded.

Palyno-species / Period	L.Permian						U. Permian			L. Triassic		M. Triassic	U. Triassic				L. Juras	M-U. Juras	L.-Cretaceous			J/C	L.-Cretaceous	
Formation	Talchir			Karhar-bari	Barakar		Kulti	Raniganj		Panchet		S.-Panchet	Dubrajpur			Pre-Lathi	Lathi	J, JH, JHUR	Katrol	Siv-ganga	Bhuj	DUBR contd.	Raj-mahal	
Assemblage-zone	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	"XIX"	XIX	XX	XX "D-E"	XX "F"	XX "G"
1 Araucariacites australis										1	**	—	—	—	—	—	—	—	++	\\	++	**	**	**
2 Araucariacites ghoshii																				2	++			
3 Araucariacites cooksonii																		3	++	—	++	**	**	
4 Araucariacites ghuneriensis																				4	++	**		
5 Barakarites gondwanensis			5	**																				
6 Barakarites crassus					6	**																		
7 Barakarites decorus					7	**																		
8 Barakarites densicorpus					8	**																		
9 Barakarites glabrus					9	**																		
10 Barakarites implicatus					10	**																		
11 Barakarites indicus					11	**																		
12 Barakarites triquetrus					12	**																		
13 Barakarites dubius					13	**	**	—	**															
14 Caheniasaccites densus	14	**	**																					
15 Caheniasaccites distinctus		15	**																					
16 Caheniasaccites decorus		16	**	**																				
17 Caheniasaccites ovatus		17	**	**																				
18 Caheniasaccites flavatus			18	**																				
19 Caheniasaccites granulatus			19	**																				
20 Caheniasaccites indicus			20	**																				
21 Callialasporites barragaonensis																21	++	++						
22 Callialasporites jaisalmerensis																22	++	++						
23 Callialasporites dampieri																23	++	++	++	\\	++	**	**	**
24 Callialasporites trilobatus																24	++	++	++	\\	++	**	**	**
25 Callialasporites granulatus																	25	++	++	—	++			
26 Callialasporites lenticularis																	26	++	++	—	++			
27 Callialasporites monoalasporus																	27	++	++	\\	++			
28 Callialasporites ovatus																		28	++	—	++			
29 Callialasporites punctatus																		29	++	—	++			
30 Callialasporites triletes																		30	++	\\	++			
31 Callialasporites lucidus																		31	++	—	++			
32 Callialasporites segmentatus																		32	++	\\	++	**	**	**
33 Callialasporites circumplectus																					33	**		
34 Callialasporites lametaensis																					34	**		
35 Callialasporites grandis																		35	++	—	++	**	**	
36 Circumstriatites obscurus		36	**																					
37 Circumstriatites ovatus		37	**																					
38 Circumstriatites talchirensis		38	**																					
39 Circumstriatites cf. obscurus			39	**																				
40 Crescentipollenites talchirensis	40	**	**																					

41 Crescentipollenites ampulus		41	••	••	—	—	••	••	••						
42 Crescentipollenites globosus			42	••											
43 Crescentipollenites rhombicus			43	••											
44 Crescentipollenites limpidus			44	••											
45 Crescentipollenites brevis				45	••	••									
46 Crescentipollenites fuscus				46	••	••	••	••	••	••	••	••			
47 Crescentipollenites notabilis					47	••									
48 Crescentipollenites karii						48	••								
49 Crescentipollenites hirsutus						49	••	—	••						
50 Crescentipollenites implicatus							50	••	••						
51 Crescentipollenites gondwanensis								51	••						
52 Crescentipollenites sellingi								52	••						
53 Crescentipollenites santhalensis								53	••	••					
54 Crescentipollenites bengalensis								54	••	••	••	••			
55 Densipollenites indicus				55	••	••	••	••	••	••					
56 Densipollenites invisus					56	••	••	••	••	••					
57 Densipollenites minimus					57	••	••	••	••						
58 Densipollenites brevis						58	••	••	••						
59 Densipollenites densus						59	••	••	••						
60 Densipollenites magnicorpus						60	••	••	••						
61 Dubrajisporites bulbosus														61	••
62 Dubrajisporites isolatus														62	••
63 Dubrajisporites triassicus														63	••
64 Dubrajisporites unicus														64	••
65 Hindipollenites oblongus					65	••									
66 Hindipollenites formosus					66	••	••								
67 Hindipollenites sp.					67	••	—	—	••						
68 Hindipollenites globossus						68	••	••	••						
69 Hindipollenites indicus						69	••	••	••						
70 Hindipollenites rajmahalensis								70	••						
71 Hindipollentites oblongus								71	••						
72 Horriditriletes novus		72	••	—	—	••									
73 Horriditriletes bulbosus					73	••									
74 Horriditriletes pseudoseptatus					74	••									
75 Horriditriletes rampurensis					75	••									
76 Horriditriletes curvibaculosus					76	••	••	••	••	••					
77 Horriditriletes brevis								77	••						
78 Horriditriletes cf. ramosus								78	••						
79 Jayantisporites cf. conatus	79	••													
80 Jayantisporites conatus		80	••												
81 Jayantisporites indicus		81	••												
82 Jayantisporites pseudozonatus		82	••												
83 Lahirites singularis		83	••	—	—	—	—	••	••						
84 Lahirites rhombicus			84	••	—	••									
85 Lahirites parvus				85	:•	••	••	••	••						
86 Lahirites rotundus				86	••	••	—	—	••						
87 Lahirites bokaroensis					87	••									
88 Lahirites fractus					88	••									
89 Lahirites karanpuraensis					89	••									
90 Lahirites levicorpus					90	••									
91 Lahirites lungatooensis					91	••	••								

Contd.

Table 3 — *Contd.*

Index : ** Damodar and Rajmahal, ++ Jaisalmer and Kachchh, \\ Cauvery, — not recorded.

Palyno-species	Period	L. Permian						U. Permian			L. Triassic		M. Triassic	U. Triassic				L. Juras	M-U. Juras	L. Cretaceous			J/C	L. Cretaceous	
	Formation	Talchir		Karhar-bari		Barakar		Kulti	Raniganj		Panchet		S.-Panchet	Dubrajpur			Pre-Lathi	Lathi	J, JH, JHU	Katrol	Siv-ganga	Bhuj	DUBR contd.	Raj-mahal	
	Assemblage-zone	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	"XIX"	XIX	XX	XX "D-E"	XX "F"	XX "G"
92 Lahirites navicula						92	**	**																	
93 Lahirites alutas						93	**	**	**	**															
94 Lahirites incertus						94	**	**	**	**	**														
95 Lahirites raniganjensis						95	**	**	**	**	**														
96 Lahirites rarus						96	**	**	**	**	**														
97 Lahirites angustus						97	**	—	—	**															
98 Lahirites minutus						98	**	—	—	**															
99 Lahirites kajoraensis							99	**	**	**															
100 Lahirites lepidus							100	**	**	**															
101 Lahirites levistriatus										101	**														
102 Lahirites triassicus										102	**														
103 Lahirites sp.															103	**									
104 Lunatisporites asansoliensis										104	**														
105 Lunatisporites damudicus										105	**														
106 Lunatisporites diffusus										106	**	**													
107 Lunatisporites ovatus										107	**	**													
108 Lunatisporites sp.										108	**	**													
109 Lunatisporites noviaulensis										109	**	**	**												
110 Lunatisporites pellucidus										110	**	**	**	**	—	—	—	**							
111 Lundbladispora brevicula										111	**	**	**												
112 Lundbladispora baculata										112	**														
113 Lundbladispora densispinosa										113	**														
114 Lundbladispora raniganjensis										114	**	**													
115 Lundbladispora warti										115	**	**													
116 Lundbladispora microconata										116	**	**	**												
117 Lundbladispora obsoleta										117	**	**	**												
118 Lundbladispora reticulata												118	**												
119 Lundbladispora willmotti												119	**												
120 Microbaculispora tentula				120	**	—	**																		
121 Microbaculispora indica						121	**																		
122 Microbaculispora villosa						122	**																		
123 Microbaculispora gondwanensis								123	**	**															
124 Microfoveolatispora foveolata			124	**	**	—	**	—	**	**	—	**													
125 Microfoveolatispora bokaroensis						125	**																		
126 Microfoveolatispora raniganjensis						126	**	—	**																
127 Microfoveolatispora sp.							127	**																	
128 Parasaccites densicorpus	128	**	**																						
129 Parasaccites obscurus	129	**	**	**	**	—	**	**	**																
130 Parasaccites perfectus		130	**	**																					

131 Parasaccites bilateralis		131	••	••	••	••	••																		
132 Parasaccites korbaensis			132	••	••	—	••	••	••	••	••	—	••												
133 cf.Parasaccites radiplicatus				133	••																				
134 Parasaccites ovatus							134	••																	
135 Plicatipollenites gondwanensis	135	••	••	••	••	••	••																		
136 Plicatipollenites indicus	136	••	••	••	••	—	••	••	—	••	••														
137 Plicatipollenites maculatus		137	••	••																					
138 Plicatipollenites stigmatus			138	••																					
139 Plicatipollenites diffusus			139	••	••																				
140 Plicatipollenites trigonalis		140	••	••	••																				
141 Plicatipollenites densus		141	••	••	••																				
142 Plicatipollenites cf.magnus				142	••																				
143 Plicatipollenites densicorpus					143	••	••																		
144 Plicatipollenites plicatus					144	••	••																		
145 Plicatipollenites ovatus						145	••	••																	
146 Plicatipollenites giganticus							146	••																	
147 Plicatipollenites gondwanensis							147	••																	
148 Plicatipollenites reticulatus									148	••															
149 Plicatipollenites triangularis									149	••															
150 Podocarpidites rarus																						150	••		
151 Podocarpidites grandis														151	••	••	—	—	—	++	—	—	••	••	••
152 Podocarpidites alareticulatus															152	••	—	—	—	—	—	—	—	••	
153 Podocarpidites typicus															153	••	—	—	—	—	—	—	••		
154 Podocarpidites canadensis																			154	++					
155 Podocarpidites densus																			155	++	—	++			
156 Podocarpidites minisulcus																			156	++					
157 Podocarpidites ornatus																			157	++					
158 Podocarpidites multesimus																			158	++	\\	++	••		
159 Podocarpidites cristiexinus																			159	++	—	—	••	••	••
160 Podocarpidites ellipticus																			160	++	\\	++	••		
161 Potonieisporites crassus	161	••	••	••																					
162 Potonieisporites magnus	162	••	••	••																					
163 Potonieisporites monosaccoides	163	••	••	••																					
164 Potonieisporites mutabilis	164	••	••	••																					
165 Potonieisporites neglectus	165	••	••	••	••																				
166 Potonieisporites densus			166	••																					
167 Potonieisporites jayantiensis			167	••	••																				
168 Potonieisporites lelei		168	••	••	••	—	••																		
169 Potonieisporites elegans				169	••																				
170 Potonieisporites cf. novicus				170	••																				
171 Potonieisporites triangulatus				171	••	—	••																		
172 Potonieisporites sp.					172	••	••	••																	
173 Potonieisporites barrelis						173	••																		
174 Potonieisporites concinnus						174	••																		
175 Potonieisporites raniganjensis									175	••															
176 Primuspollenites dicavus					176	••	••																		
177 Primuspollenites levis					177	••	••																		
178 Primuspollenites obscurus					178	••	••																		
179 Primuspollenites brevicorpus						179	••																		
180 Primuspollenites densus						180	••																		
181 Primuspollenites distinctus						181	••																		

Contd.

Table 3 — *Contd.*

Index : ** Damodar and Rajmahal, ++ Jaisalmer and Kachchh, \\ Cauvery, — not recorded.

Palyno-species																								
Period	L. Permian						U. Permian			L. Triassic		M. Triassic	U. Triassic				L. Juras	M-U. Juras	L.-Cretaceous			J/C	L.-Cretaceous	
Formation	Talchir		Karhar-bari		Barakar		Kulti	Raniganj		Panchet		S.-Panchet	Dubrajpur			Pre-Lathi	Lathi	J, JH, JHU	Katrol	Siv-ganga	Bhuj	DUBR contd.	Raj-mahal	
Assemblage-zone	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	"XIX"	XIX	XX	XX "D-E"	XX "F"	XX "G"
182 Primuspollenites linterus					182	**																		
183 Primuspollenites ovatus					183	**																		
184 Primuspollenites singrauliensis					184	**																		
185 Rhizomaspora singula		185	**	—	—	**	**																	
186 Rhizomaspora sp.			186	**	—	**	—	—	**															
187 Rhizomaspora indica				187	**	**	**	**	**															
188 Rhizomaspora costa					188	**	**																	
189 Rhizomaspora fimbriata					189	**	—	**	**															
190 Rhizomaspora costa								190	**															
191 Rhizomaspora biharia								191	**	**	**													
192 Rhizomaspora triassica								192	**	**	—	**												
193 Rhizomaspora divaricata									193	**	**													
194 Sahnites cf. congoensis		194	**																					
195 Sahnites elongatus		195	**																					
196 Sahnites cf. hexagonalis		196	**																					
197 Sahnites cf. methoris		197	**																					
198 Sahnites thomasi		198	**	**	**	**																		
199 Sahanites barrelis			199	**																				
200 Sahnites gondwanensis			200	**	**	**																		
201 Scheuringipollenites barakarensis		201	**	**	**	**	**	**	**	**														
202 Scheuringipollenites tentulus		202	**	**	**	**	**	**	**															
203 Scheuringipollenites maximus		203	**	**	**	**	**	**	**	**	**	**	**											
204 Scheuringipollenites ovatus				204	**	**	**	**	**															
205 Staurosaccites densus												205	**											
206 Staurosaccites marginalis												206	**											
207 Staurosaccites quadrifidus												207	**											
208 Staurosaccites tharipatharensis												208	**											
209 Striatites densus			209	**																				
210 Striatites medius			210	**																				
211 Striatites karharbarensis			211	**	**	**																		
212 Striatites incirus			212	**	—	**																		
213 Striatites tentulus			213	**	—	**	**	**	**															
214 Striatites alius				214	**	**	**	**	**															
215 Striatites barakarensis				215	**	**	**	**	**															
216 Striatites notus				216	**	**	**	**	**															
217 Striatites rhombicus				217	**	**	**	**	**															
218 Striatites subtilis				218	**	**	**	**	**															
219 Striatites communis				219	**	**	**	**	**	**														

220 Striatites varius					220	••	••	••	—	••	••			
221 Striatites parvus					221	••	••	—	••					
222 Striatites solitus					222	••	••	—	—	••	••	••		
223 Striatites gopalensis						223	••							
224 Striatites lectus						224	••							
225 Striatites naditoliensis						225	••							
226 Striatites reticuloides						226	••							
227 Striatites multistriatus						227	••	••	••	••				
228 Striatites ornatus						228	••	—	—	••				
229 Striatites tectus						229	••	—	—	••				
230 Striatites obliquus								230	••	••				
231 Striatites ganjerensis									231	••				
232 Striatites obtusus									232	••				
233 Striatites ornatus									233	••				
234 Striatites rhombicus									234	••				
235 Striatites levistriatus										235	••			
236 Striatites panchetensis										236	••	••		
237 Striatopodocarpites sp.			237	••	••									
238 Striatopodocarpites diffusus					238	••	••	••	••	••	••			
239 Striatopodocarpites crassistriatus					239	••	••	—	—	••				
240 Striatopodocarpites ovalis					240	••	••	—	—	••				
241 Striatopodocarpites lentisaccatus						241	••	••						
242 Striatopodocarpites magnificus						242	••	••	••	••	••			
243 Striatopodocarpites decorus						243	••	••	••	••	••	—	—	••
244 Striatopodocarpites labrus						244	••	—	••	••	••	••		
245 Striatopodocarpites crassus						245	••	—	—	••				
246 Striatopodocarpites subcircularis						246	••	—	—	••				
247 Striatopodocarpites plicatus							247	••						
248 Striatopodocarpites ovatus							248	••	••	••				
249 Striatopodocarpites perfectus							249	••	••	••	••			
250 Striatopodocarpites rotundus							250	••	••	••	••			
251 Striatopodocarpites venustus							251	••	••	••	••			
252 Striatopodocarpites globosus								252	••					
253 Striatopodocarpites copiosus									253	••				
254 Striatopodocarpites tojmensis									254	••				
255 Striatopodocarpites brevis									255	••	••			
256 Striatopodocarpites rarus									256	••	••			
257 Striatopodocarpites oblongatus									257	••	••	••	••	
258 Striatopodocarpites raniganjensis										258	••			
259 Striatopodocarpites multistriatus										259	••	••		
260 Striatopodocarpites gopadensis											260	••		
261 Striatopodocarpites dubrajpurensis													261	••
262 Tuberisaccites tuberculatus			262	••										
263 Tuberisaccites varius			263	••										
264 Tuberisaccites lobatus			264	••	••									
265 Tuberisaccites jhingurdahiensis						265	••							
266 Verrucosisporites cf.donarii	266	••												
267 Verrucosisporites sp.		267	••	••										
268 Verrucosisporites varius			268	••										
269 Verrucosisporites donarii				269	••	••	••	••	••	••				
270 Verrucosisporites distinctus					270	••								
271 Verrucosisporites ambiplicatus							271	••						

Contd.

Table 3 — *Contd.*

Index : ** Damodar and Rajmahal, ++ Jaisalmer and Kachchh, \\ Cauvery, — not recorded.

Palyno-species	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	"XIX"	XIX	XX	XX "D-E"	XX "F"	XX "G"
Period	L. Permian						U. Permian			L. Triassic		M. Triassic	U. Triassic				L. Juras	M-U. Juras	L.- Cretaceous			J/C	L. Cretaceous	
Formation	Talchir			Karhar-bari		Barakar	Kulti	Raniganj		Panchet		S.-Panchet	Dubrajpur			Pre-Lathi	Lathi	J, JH, JHU	Katrol	Siv-ganga	Bhuj	DUBR contd.	Raj-mahal	
272 Verrucosisporites diversus								272	**															
273 Verrucosisporites gondwanensis								273	**	**														
274 Verrucosisporites narmianus								274	**	**	**	**	**											
275 Verrucusisporites warti									275	**														
276 Verrucosisporites cf. conatus									276	**	**													
277 Verrucosisporites morulae									277	**	**													
278 Verrucosisporites triassicus									278	**	**	**												
279 Verrucosisporites densus									279	**	**	**	**											
280 Verrucosisporites bosei									280	**	**	—	**											
281 Verrucosisporites racemus												281	**											
282 Verrucosisporites camarvonensis												282	**											
283 Verrucosisporites kazgigaonensis												283	**											
284 Verrucosisporites dubius																					284	**		
285 Verticipollenites mineosus				285	**	**	**																	
286 Verticipollenites finitimus				286	**	**	**	**	**															
287 Verticipollenites gibbosus				287	**	**	**	**	**															
288 Verticipollenites subcircularis				288	**	**	**	**	**															
289 Verticipollenites debilis					289	**	**	**	**															
290 Verticipollenites secretus					290	**	**	**	**															
291 Verticipollenites crassus						291	**	—	**															
292 Verticipollenites oblongus							292	**	**															

first and last occurrences of some species in the Damodar-Rajmahal depositional domain, and it is envisaged that these limits can be identified by one or more species cited here.

Some of the important species pertaining to various zones are illustrated in Plates 1 to 10; for other species citations of original authors are given in Table 2.

I. *Potonieisporites neglectus* Assemblage-Zone

This is the lowermost assemblage zone found in the basal beds of Talchir Formation. The least diversified flora contains mainly girdling radial and bilateral monosaccate pollen. The striate-disaccates are not recorded.

The earliest palynoflora of Permian in India is marked by this zone. The top of this assemblage zone is defined by the oldest occurrence of *Crescentipollenites fuscus* (= *C. talchirensis*) and several first appearances, e.g., *Faunipollenites perexiguus, Tuberisaccites tuberculatus, Sahnites thomasi, Jayantisporites* sp., *Parasaccites bilateralis.*

Composition—Plicatipollenites gondwanensis, P indicus, Parasaccites densicorpus, P. obscurus, Potonieisporites neglectus, P. crassus, and *P. magnus* constitute the major population, *Verrucosisporites*—type of spores are very sporadic in occurrence.

Horizon—Talchir Formation.

Remarks—This assemblage zone is recognised by the absence of striate-disaccate pollen and preponderance of *Plicatipollenites, Parasaccites* and *Potonieisporites.* When compared with the generic acme-zones already known from Lower Permian, the *Potonieisporites neglectus* Assemblage-Zone constitutes a part of the oldest segment of Composition-I: *Plicatipollenites-Parasaccites* Zone-A, of Tiwari and Tripathi (1988).

Reference section—Lele, 1975 (text-figure 1, p. 220), Dudhi River Section; Sample nos. B 17/662, B 19/662; Siltstone units above the first boulder bed at the metamorphic basement, West Bokaro Coalfield, Bihar.

II. *Plicatipollenites gondwanensis* Assemblage-Zone

At this level the palynoflora suddenly diversifies qualitatively. A variety of striate-disaccates, monosaccates and zonate spore-pollen taxa make their appearance. The distinction from the *Potonieisporites neglectus* Assemblage-Zone is sharp. At generic level, *Parasaccites* and *Plicatipollenites* continue to dominate the population.

The base of this assemblage zone is defined by the oldest occurrence of *Crescentipollenites fuscus, Tuberisaccites tuberculatus* and *Caheniasaccites densus* (and FAD of several other species shown in Table 2). First occurrence of *Microbaculispora tentula* and *Microfoveolatispora foveolata* and LAD of *Parasaccites densicorpus* and *Potonieisporites crassus* (Table 2) mark the top of this assemblage zone.

Composition—Plicatipollenites gondwanensis, Callumispora gretensis, Parasaccites bilateralis, Caheniasaccites densus, Crescentipollenites fuscus (= C. talchirensis), Jayantisporites cf. *conatus, Tuberisaccites tuberculatus, Potonieisporites magnus.*

Horizon—Talchir Formation.

Remarks—With reference to the generic acme-zone, the *Plicatipollenites gondwanensis* Assemblage-Zone is a part of Composition-I : *Plicatipollenites-Parasaccites* Zone-A, of Tiwari and Tripathi (1988). The species acme-zone defined by the epiboles of number of species in the genera *Plicatipollenites* and *Potonieisporites* are recorded in this zone (Table 3).

Reference section—Lele, 1975 (text-fig. 1, p. 220), Dudhi River Section, Sample no. B 9/662, Siltstone below the last boulder bed in the section; West Bokaro Coalfield, Bihar.

III. *Parasaccites korbaensis* Assemblage-Zone

This zone represents a level of further diversification in having several new entries, such as pteridophytic apiculate and lycopsid spores, ginkgo-cycadoid pollen, and several monosaccates. First occurrence of *Divarisaccus lelei* and those of several other species (Table 2) define the base, and the oldest occurrence of *Crucisaccites monoletus* marks the top of this assemblage zone.

Composition—Parasaccites korbaensis, Callumispora gretensis, Jayantisporites indicus, J. pseudozonatus, Tuberisaccites indicus, Circumstriatites obscurus, C. talchirensis, Divarisaccus lelei, Ginkgocycadophytus novus, Plicatipollenites spp., *Parasaccites* spp. (as shown in Table 2).

Horizon—Talchir Formation.

Remarks—As regards the generic acme-zone, the Composition-I : *Parasaccites-Plicatipollenites* Zone-B of Tiwari and Tripathi (1988) encompasses the *Parasaccites korbaensis* Assemblage-Zone since the monosaccate group still continues to dominate numerically. The *Parasaccites, Sahnites, Tuberisaccites, Jayantisporites* and *Circumstriatites* spp. acme-zones are documented in this assemblage zone (Table 3). This incidence is a characteristic feature.

Reference section—Lele and Makada, 1972 (pp. 62, 63), section exposed in Patharjore Nala, Jayanti Coalfield, Bihar.

PERIOD	EPOCH	FORMATION	ZONE NUMBERS	SPORE-POLLEN SPECIES ASSEMBLAGE-ZONE	SPP. ACME-ZONE (Epibole of species no. in the genus.)	COMPOSITION BASED ON GENERIC DOMINANCE
CRETACEOUS	LOWER	RAJMAHAL	XX	*Microcachryidites antarcticus*	*Araucariacites, Podocarpidites*	[7] *Assemblage from Basko and Sakrigali ghat*; [4] *Assemblage F*; [4] *Assemblage D, E*
CRETACEOUS	LOWER	RAJMAHAL / JHURAN	XIX	*Callialasporites segmentatus*	*Callialasporites, Podocarpidites*	[6] *Callialasporites segmentatus Zone*
JURASSIC	U.	JHURAN / JHUMARA / JAISALMER	XVIII	*Callialasporites trilobatus*		[5] *Callialasporites trilobatus Zone*
JURASSIC	M.	JHUMARA / JAISALMER				
JURASSIC	L.	LATHI	XVII	*Classopollis minor*		[5] *Classopollis-Gliscopollis Zone*
TRIASSIC	UPPER	PRE-LATHI	XVI	*Rhaetipollis germanicus*		[5] *R. germanicus Assemblage IX*
TRIASSIC	UPPER	S. PANCHET / DUBRAJPUR	XV	*Dubrajisporites triassicus*	*Dubrajisporites*	[4] *Assemblage C*
TRIASSIC	UPPER	S. PANCHET / DUBRAJPUR	XIV	*Brachysaccus ovalis*	*Brachysaccus*	[4] *Assemblage B*
TRIASSIC	UPPER	S. PANCHET / DUBRAJPUR	XIII	*Rajmahalispora rugulata*	*Rajmahalispora*	[4] *Assemblage A*
TRIASSIC	M.	S. PANCHET / DUBRAJPUR	XII	*Goubinispora morandavensis*		[3] *Goubinispora Zone*
TRIASSIC	LOWER	PANCHET / DUBRAJPUR	XI	*Playfordiaspora cancellosa*	*Lunatisporites, Lundbladispora*	[1] VI { *Lundbladi.-Densoi. Zone (D)* [2] PIV; *Lunati.-Verrucosi. Zone (C)* [2] PIII; *Verrucosi.-Callumi. Zone (B)* [2] PII } — [8] *P. cancellosa Assemblage II*
TRIASSIC	LOWER	PANCHET / DUBRAJPUR	X	*Klausipollenites schaubergerii*	*Verrucosisporites*	[1] VI { *Striato.-Klausi. Zone (A)* [2] PI } — [8] *K. schaubergeri Assemblage I*
PERMIAN	UPPER	RANIGANJ	IX	*Densipollenites magnicorpus*	*Crescenti., Striatopodo., Vertici., Densipoll.*	[1] V { *Striato.-Crescenti. Zone (D)* [2] RI A; *Striato.-Densi. Zone (C)* [2] RI B
PERMIAN	UPPER	RANIGANJ	VIII	*Gondisporites raniganjensis*	*Densipollenites, Verticipollenites, Scheuringipollenites*	*Striato.-Gondi. Zone (B)* [2] RII A; *Striato.-Fauni. Zone (A)* [2] RII B }
PERMIAN	UPPER	KULTI	VII	*Densipollenites indicus*	*Densipollenites, Verticipollenites, Scheuringipollenites*	[1] V { *Densipollenites-Striatopodo. Zone (A)* }
PERMIAN	LOWER	BARAKAR	VI	*Faunipollenites varius*	*Faunipollenites, Barakarites, Microbaculispora, Scheuringi.*	[1] III { *Faunipollenites-Scheuringi. Zone (B)*
PERMIAN	LOWER	BARAKAR	V	*Scheuringipollenites barakarensis*	*Scheuringipollenites*	*Scheuringi.-Faunipollenites Zone (A)* }
PERMIAN	LOWER	KARHARBARI	IV	*Crucisaccites monoletus*	*Caheniasaccites*	[1] II { *Parasaccites-Callumispora Zone (B)*; *Callumispora-Parasaccites Zone (A)* }
PERMIAN	LOWER	TALCHIR	III	*Parasaccites korbaensis*	*Parasaccites, Tuberisaccites, Jayantisporites, Circumstriatites*	[1] I { *Parasaccites-Plicatipollenites Zone (B)*
PERMIAN	LOWER	TALCHIR	II	*Plicatipollenites gondwanensis*	*Plicatipollenites, Potonieisporites*	*Plicatipollenites-Parasaccites Zone (A)* }
PERMIAN	LOWER	TALCHIR	I	*Potonieisporites neglectus*		

Text-figure 1—Composite Table depicts the correlation between spore-pollen Species Assemblage Zones and Generic Acme-Zones. The sequence of formations has been compositely structured on the basis of sequences in Damodar Graben, Rajasthan and Kachchh and Rajmahal Basin to represent a complete span of Gondwana Sequence. For tagging with chronostratigraphic scale, a conventional scheme is followed (GSI Lexicon, 1977). The ordinal number in the last column refers to the original references for various compositions, as follows: **1.** Tiwari & Tripathi, 1988; **2.** Tiwari & Singh, 1986; **3.** Tiwari & Rana, 1980; **4.** Tiwari, Kumar & Tripathi, 1984; **5.** Koshal, 1975; **6.** Venkatachala, Sharma & Jain, 1972; Venkatachala, 1974; **7.** Sah & Jain, 1965; **8.** Maheshwari, Kumaran & Bose, 1978.

IV. *Crucisaccites monoletus* Assemblage-Zone

This zone is related with *Parasaccites korbaensis* Assemblage-Zone by virtue of the continuing abundance of the monosaccate pollen but it aquires new character by the first appearance of several and varied striate-nonsaccate, striate-disaccate and apiculate trilete species. The base of this assemblage zone is marked as FAD of

Tiwariasporis gondwanensis, Marsupipollenites triradiatus, Welwitschiapites magnus, and *Stellapollenites talchirensis*, while the oldest records of *Rhizomaspora indica, Indotriradites korbaensis* and *Dentatispora gondwanensis* defines the top.

Composition—*Crucisaccites monoletus, C. latisulcatus, Callumispora gretensis, C. barakarensis, Caheniasaccites decorus, Parasaccites obscurus, P. korbaensis, Crescentipollenites rhombicus, C. limpidus, Verrucosisporites donarii, Tiwariasporis gondwanensis, Distriamonocolpites circularis, Stellapollenites talchirensis.*

Horizon—Karharbari Formation.

Remarks—In relation to the generic acme-zone, the *Crucisaccites monoletus* Assemblage-Zone compares with the Composition II of Tiwari and Tripathi (1988). However, two subdivisions of Composition II : *Callumispora-Parasaccites* Zone-A and *Parasaccites-Callumispora* Zone-B were identified but it is not, as yet, possible to define these units on the basis of species occurrence. The present zone is also characterised by the *Caheniasaccites* spp. Acme-Zone.

Reference section—Lele and Makada, 1974 (p. 82), Section along tributary of Patharjore Nala, Jayanti Coalfield, Bihar; Tiwari, 1973b (map 1, p. 168), Section along Sonbad Nala, Sample no. 17-35 and Section along Pusai Nala Sample no. 8, Raniganj Coalfield, Bihar.

V. *Scheuringipollenites barakarensis* Assemblage-Zone

A marked change is recorded in this assemblage zone in relation to the preceding *Crucisaccites monoletus* Assemblage-Zone; the abundance of monosaccate pollen is replaced by the nonstriate disaccate taxa *Scheuringipollenites* spp. The base of this assemblage zone is marked by the oldest record of *Rhizomaspora indica, Indotriradites sparsus, Striatites communis, Verticipollenites gibbosus* and *Densipollenites indicus*, while the top is demarcated by the oldest occurrence of *Corisaccites alutas, Horriditriletes curvibaculosus* and *Barakarites indicus.*

Composition—*Scheuringipollenites barakarensis, S. maximus, Faunipollenites varius, Corisaccites vanus, Striasulcites tectus, Weylandites lucifer, Paravesicaspora indica, Primuspollenites levis.*

Horizon—Lower Barakar Formation.

Remarks—The *Scheuringipollenites barakarensis* Assemblage-Zone compares with the Composition III : *Scheuringipollenites-Faunipollenites* Zone-A of Tiwari and Tripathi (1988) in respect of the generic acme-zone. The epibole of species in the genus *Scheuringipollenites* begins in this zone and continues in the next three succeeding assemblage zones (Table 3).

Reference section—Tiwari, 1973b, (map 1; p. 168); Section along Pusai Nala, Sample No. 10-46/5, Raniganj Coalfield, Bihar.

VI. *Faunipollenites varius* Assemblage-Zone

Qualitatively, a diverse array of species by way of new appearances (FAD) of several striate-saccates and nonsaccates, colpates and apiculate triletes (zonates and azonates) is recorded at this level. The oldest occurrence of *Didecitriletes horridus, Striatopodocarpites tiwarii, Horriditriletes curvibaculosus, Schizopollis disaccoides* and *Cyclogranisporites gondwanensis* defines the base of the assemblage zone. The oldest occurrence of *Verticipollenites crassus, Densipollenites densus, Striatopodocarpites ovatus, Cyclobaculisporites minimus* and *Gondisporites raniganjensis* delimits the top line (Table 2).

Composition—*Barakarites indicus, Microbaculispora tentula, M. gondwanensis, M. indica, Brevitriletes communis, Cyclogranisporites gondwanensis, Striatites communis, Lahirites rarus, Corisaccites alutas, Striomonosaccites ovatus, Schizopollis disaccoides, Vittatina lata, Praecolpatites sinuosus* (Table 2).

Horizon—Upper Barakar Formation.

Remarks—This zone relates with the generic acme-zone described as Composition-III : *Faunipollenites-Scheuringipollenites* Zone-B by Tiwari and Tripathi (1988). This zone is also diagnosed by the epiboles of the number of species in *Barakarites, Lahirites, Microfoveolatispora, Horriditriletes, Faunipollenites, Microbaculispora, Primuspollenites* and *Striatites.* The *Scheuringipollenites* spp. Acme-Zone which started in the preceding zone also continues.

Reference section—Tiwari, 1973b (map 1; p. 168); Section along Khudia Nala, Sample no. 47, 67a-81, Raniganj Coalfield, Bihar.

VII. *Densipollenites densus* Assemblage-Zone

This zone is identified on the basis of several first occurrences of species (Table 2). The oldest occurrence of *Densipollenites densus* defines the base while the oldest occurrence of *Didecitriletes ericianus, Verticipollenites oblongus* and *Distriatites bilateris* marks the top of this zone.

Composition—*Striatites notus, S. communis, Densipollenites invisus, D. densus, D. brevis, D. indicus, Striatopodocarpites ovatus, S. decorus, Verticipollenites crassus, Gondisporites raniganjensis, Bharadwajipollis striatus,* *Verrucosisporites ambiplicatus.*

Horizon—Kulti Formation.

Remarks—Beside the continuing epibole of species in *Scheuringipollenites,* the begining of species Acme-Zone of genera *Densipollenites* and *Verticipollenites* is recorded here (Table 3), which continues into the next younger assemblage zone. With regard to the generic acme-zone, the *Densipollenites densus* Assemblage-Zone relates well with the Composition IV: *Densipollenites-Striatopodocarpites* Zone-A, delimited by Tiwati and Tripathi (1988).

Reference section—Tiwari *et al.* (1981, map 1, p. 221): palynological composition studied in Jamunia River section from levels at sample nos. JMR-1 to JMR-26, Jharia Coalfield, Bihar. The strata is identified by being devoid of major coal seams, which are otherwise present in the underlying Barakar Formation and overlying Raniganj Formation. With these formations the contact of the reference strata is faulted (Fox, 1930, pp. 77-89).

VIII. *Gondisporites raniganjensis* Assemblage-Zone

The oldest occurrence of *Distriomonosaccites ovalis, Distriatites bilateris* and *Verticipollenites oblongus* defines the base and sporadic as well as unsteady first occurrence of *Lundbladispora brevicula, Playfordiaspora cancellosa. Lunatisporites diffusus* marks the top of the zone.

Composition—Several of the disaccate pollen species found in the preceding assemblage zone continue to prevail in the present zone. A further diversification is evident in this assemblage; additionally, *Indospora clara, Cyclobaculisporites minimus, Microfoveolatispora gondwanensis, Gondisporites raniganjensis* occur significantly (Table 2).

Horizon—Raniganj Formation (Late Permian).

Remarks—In the terms of generic acme-zone, *Gondisporites raniganjensis* Assemblage-Zone is related with the Composition V : *Striatopodocarpites-Faunipollenites* Zone-A, and *Striatopodocarpites-Gondisporites* Zone-B delimited by Tiwari and Tripathi (1988), and with the Assemblage R-II, A and B of Tiwari and Singh (1986). However, such subdivisions are possible only on the basis of generic percentage frequency. *Gondisporites raniganjensis* Assemblage-Zone exhibits the continuity of *Verticipollenites, Scheuringipollenites* and *Densipollenites* spp. acme-zones.

Reference section—Rana and Tiwari, 1980 (pp. 113, 114); Bore hole RNM-3, (23°35′45″ : 87°13′55″), 912 to 481 m depth; Raniganj Coalfield, Bihar.

IX. *Densipollenites magnicorpus* Assemblage-Zone

The basic nature of this assemblage zone continues to be broadly similar as in *Gondisporites raniganjensis* Assemblage-Zone. However, sporadic appearance of *Lundbladispora brevicula, L. microconata, Lunatisporites diffusus* and *Klausipollenites schaubergeri* marks the identity of this assemblage zone.

The prominence of *Densipollenites magnicorpus* and the first appearance of *Gondisporites reticulatus, Klausipollenites schaubergeri* and *Lunatisporites diffusus* define the base and LADs of *Gondisporites raniganjensis* and *Densipollenites magnicorpus* marks the top of this assemblage zone.

Composition—*Crescentipollenites gondwanensis, C. sellingi, C. bengalensis, C. fuscus, Densipollenites densus, D. magnicorpus, D. indicus, D. invisus, Welwitschiapites tenuis, Indospora macula, Klausipollenites schaubergeri, Lundbladispora brevicula, Gondisporites reticulatus.*

Horizon—Raniganj Formation (latest Permian).

Remarks—On the ground of generic dominance the *Densipollenites magnicorpus* Assemblage-Zone corresponds to the Composition V : *Striatopodocarpites-Densipollenites* Zone-C and *Striatopodocarpites-Crescentipollenites* Zone-D of Tiwari and Tripathi (1988), and Zone-RI, A and B of Tiwari and Singh (1986). The epiboles of number of species in the genera *Crescentipollenites* and *Striatopodocarpites* appear in this assemblage zone, while *Densipollenites* and *Verticipollenites* spp. acme-zones

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PLATE 1 →

(All photomicrographs are × 500)
Lower Permian palynotaxa.

1. *Potonieisporites neglectus*
2. *Plicatipollenites gondwanensis*
3. *Tuberisaccites tuberculatus*
4. *Parasaccites bilateralis*
5. *Plicatipollenites trigonalis*
6. *Parasaccites densicorpus*
7. *Plicatipollenites indicus*
8. *Callumispora gretensis*
9. *Sahnites thomasi*
10. *Jayantisporites conatus.*

Species in 1, 2, 6, 7 signify *Potonieisporites neglectus* Assemblage-Zone, FAD of species in 3-5, 8-10 define *Plicatipollenites gondwanensis* Assemblage-Zone.

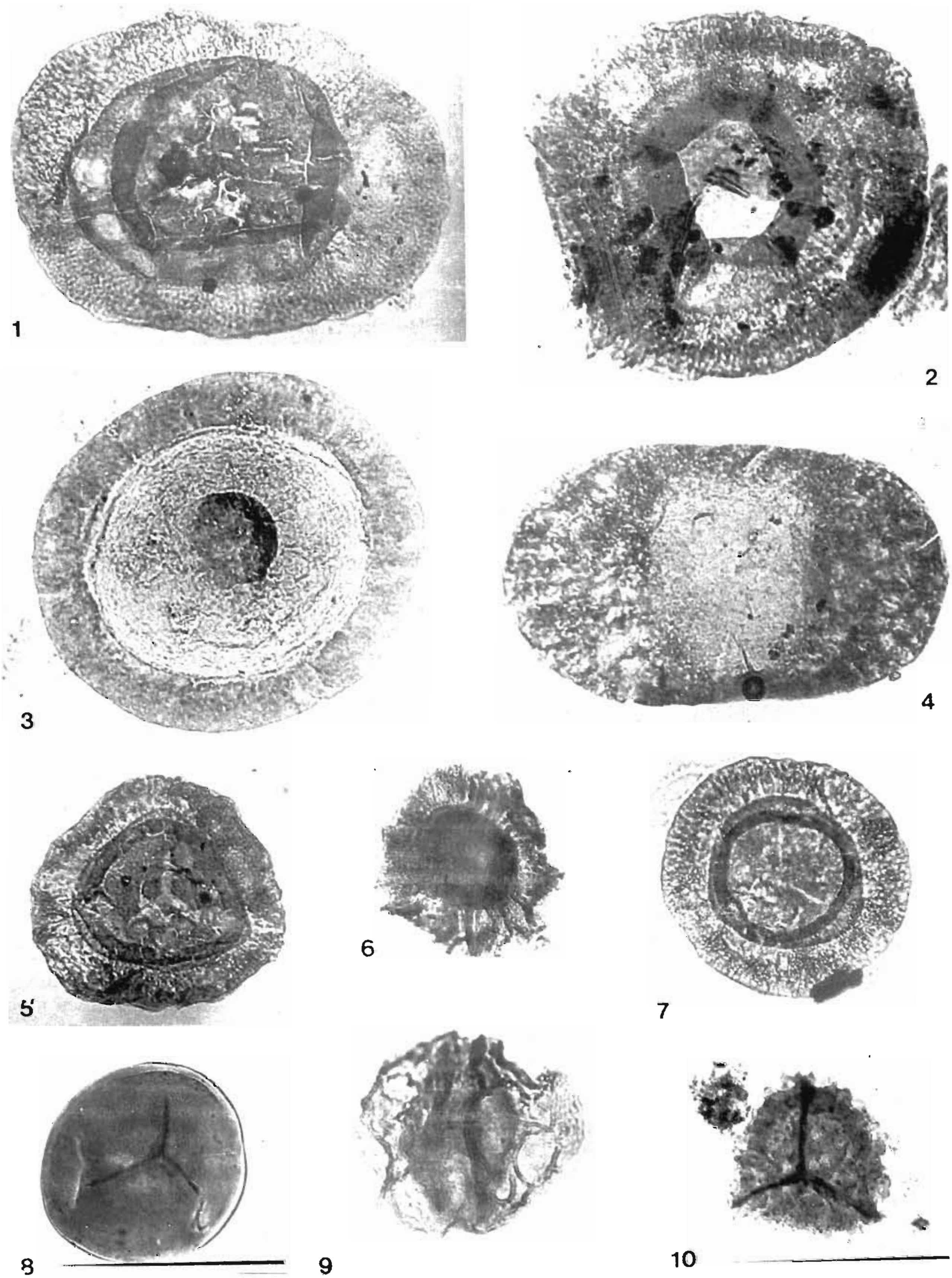

PLATE 1

continue from the preceding zone.

Reference section—Bharadwaj and Tiwari, 1977 (map 1; pp. 27, 28); Bore-hole NCRD-6, depth 358.40 to 287.30 m, Raniganj Coalfield, Bihar; Rana & Tiwari, 1980 (pp. 113, 114); Bore-hole RNM-3 (23°35′45″ : 87°30′55″), depth 422 to 218 m, East Raniganj Coalfield, West Bengal.

X. *Klausipollenites schaubergeri* Assemblage-Zone

(*Klausipollenites schaubergeri* Assemblage-I, Maheshwari *et al.*, 1978).

This assemblage zone shows the continuation of several species, particularly of striate disaccates, from the preceding assemblage zone. The cavate cingulate-zonate spores, non-striate disaccate and taeniate pollen species which made their sporadic appearance in *Densipollenites magnicorpus* Assemblage-Zone become consistent and diversified in the *Klausipollenites schaubergeri* Assemblage-Zone.

The base of the present zone is marked by the consistent appearance of *Verrucosisporites triassicus, V. narmianus* and *Lunatisporites pellucidus.* The oldest occurrence of *Indotriradites mamillatus, Verrucosisporites densus, Lundbladispora baculata, L. densispinosa* defines the top of this assemblage zone.

Composition—*Crescentipollenites fuscus, Striatopodocarpites decorus, Callumispora fungosa, Densipollenites densus, Lundbladispora brevicula, Densoisporites playfordii, Playfordiaspora cancellosa, Alisporites asansoliensis, Klausipollenites schaubergeri, Lunatisporites diffusus* and *L. ovatus* (Table 2).

Horizon—Lower Panchet Formation (Early Scythian).

Remarks—The definition of *Klausipollenites schaubergeri* Assemblage-I of Maheshwari, Kumaran and Bose (1978) is elaborated here. This assemblage zone encompasses the generic acme-zone Composition VI : *Striatopodocarpites-Klausipollenites* Zone-A delimited by Tiwari and Tripathi (1988) and Assemblage-PI of Tiwari and Singh (1986). The *Verrucosisporites* spp. Acme-Zone is also recorded in the present assemblage zone (Table 3).

Reference section—Bharadwaj and Tiwari, 1977 (map 1; pp. 27, 28); Bore-hole NCRD-6, 215 m depth; Raniganj Coalfield, Bihar.

XI. *Playfordiaspora cancellosa* Assemblage-Zone

(*Playfordiaspora cancellosa* Assemblage-II, Maheshwari *et al.*, 1978).

This assemblage zone reveals further proliferation of species which appeared for the first time in *Klausipollenites schaubergeri* Assemblage-Zone. A decline in the prominence of striate disaccate species is also recorded. Several new entries of taeniate disaccate, cavate-zonate and apiculate trilete species are documented (Table 2).

The base of this assemblage zone is marked by the oldest common occurrence of *Lunatisporites pellucidus, L. ovatus* and several species of *Lundbladispora* and *Densoisporites* as shown in Table 3. At present, it is rather difficult to define the top of this assemblage-zone as the Middle Triassic flora is poorly known; however, the dominance of *Goubinispora morondavensis* and *G. indica* in the subsequent assemblage zone identifies the top.

Composition—*Crescentipollenites fuscus, Lunatisporites pellucidus, L. ovatus, L. noviaulensis, Lundbladispora warti, L. densispinosa, L. microconata, Convertubisporites contactus, Triplexisporites playfordii, Verrucosisporites narmianus, Densoisporites playfordii, Playfordiaspora cancellosa, Ringosporites ringus,* etc. (Table 2).

Horizon—Panchet Formation (Scyathian).

Remarks—The definition of *Playfordiaspora cancellosa* Assemblage-II of Maheshwari, Kumaran and Bose (1978) is revised and enlarged here. It also incorporates the *Decisporis variabilis* Assemblage-III of Maheshwari *et al.* (1978) as their delimitation is not feasible at present. This assemblage zone compares well with the Composition VI : *Verrucosisporites-Callumispora* Zone-B, *Lunatisporites-Verrucosisporites* Zone-C and *Lundbladispora-Densoisporites* Zone-D delimited by →

PLATE 2

(All photomicrographs are × 500)
Lower Permian palynotaxa.

1. *Parastriopollenites segmentatus*
2. *Divarisaccus lelei*
3. *Microbaculispora tentula*
4. *Stellapollenites talchirensis*
5. *Jayantisporites pseudozonatus*
6. *Caheniasaccites decorus*
7. *Circumstriatites talchirensis*
8. *Tuberisaccites lobatus*
9. *Parasaccites korbaensis*
10. *Crucisaccites monoletus*
11. *Caheniasaccites distinctus.*

FAD of species in 1-9, 11 define *Parasaccites korbaensis* Assemblage-Zone and FAD of species in 10 marks *Crucisaccites monoletus* Assemblage-Zone.

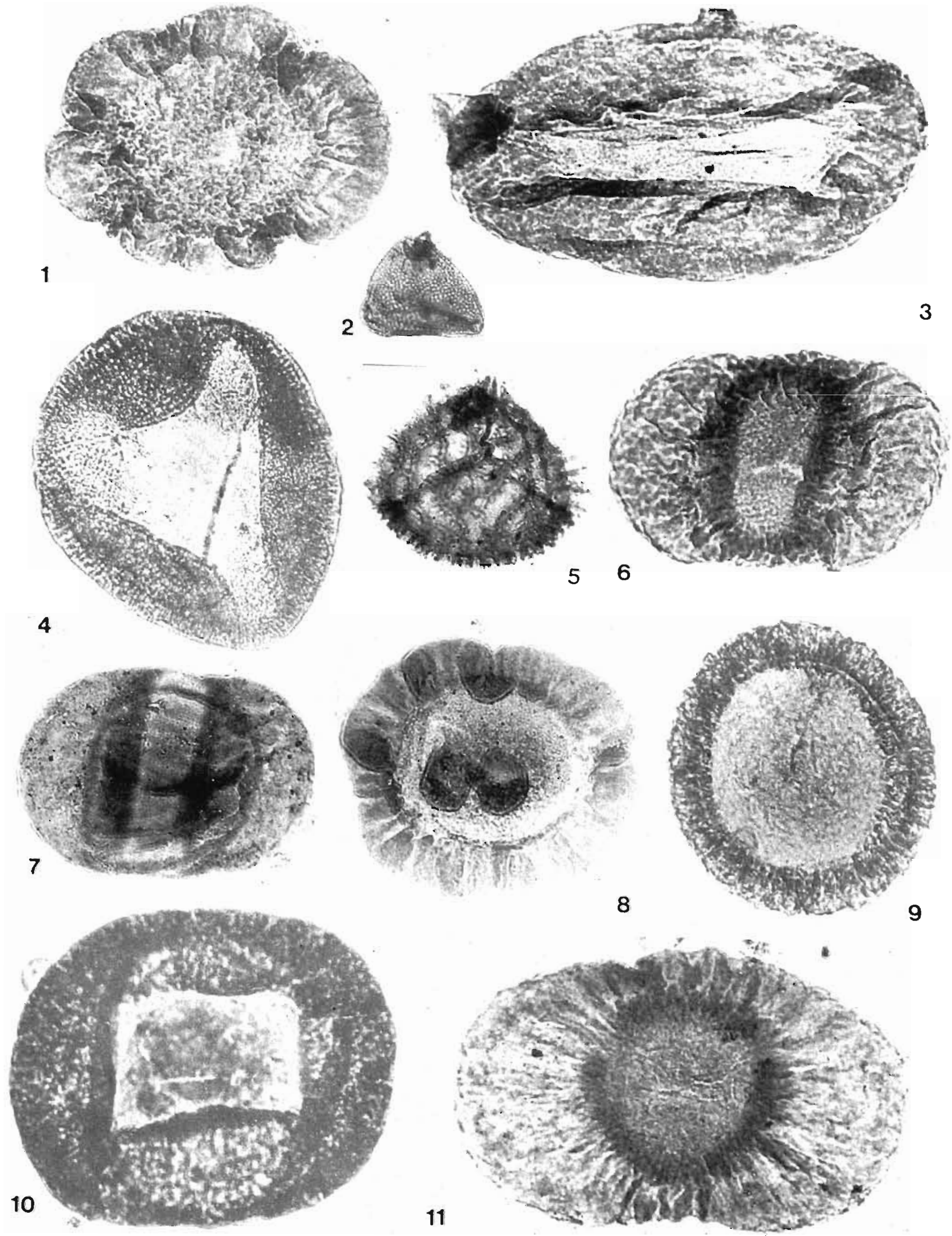

PLATE 2

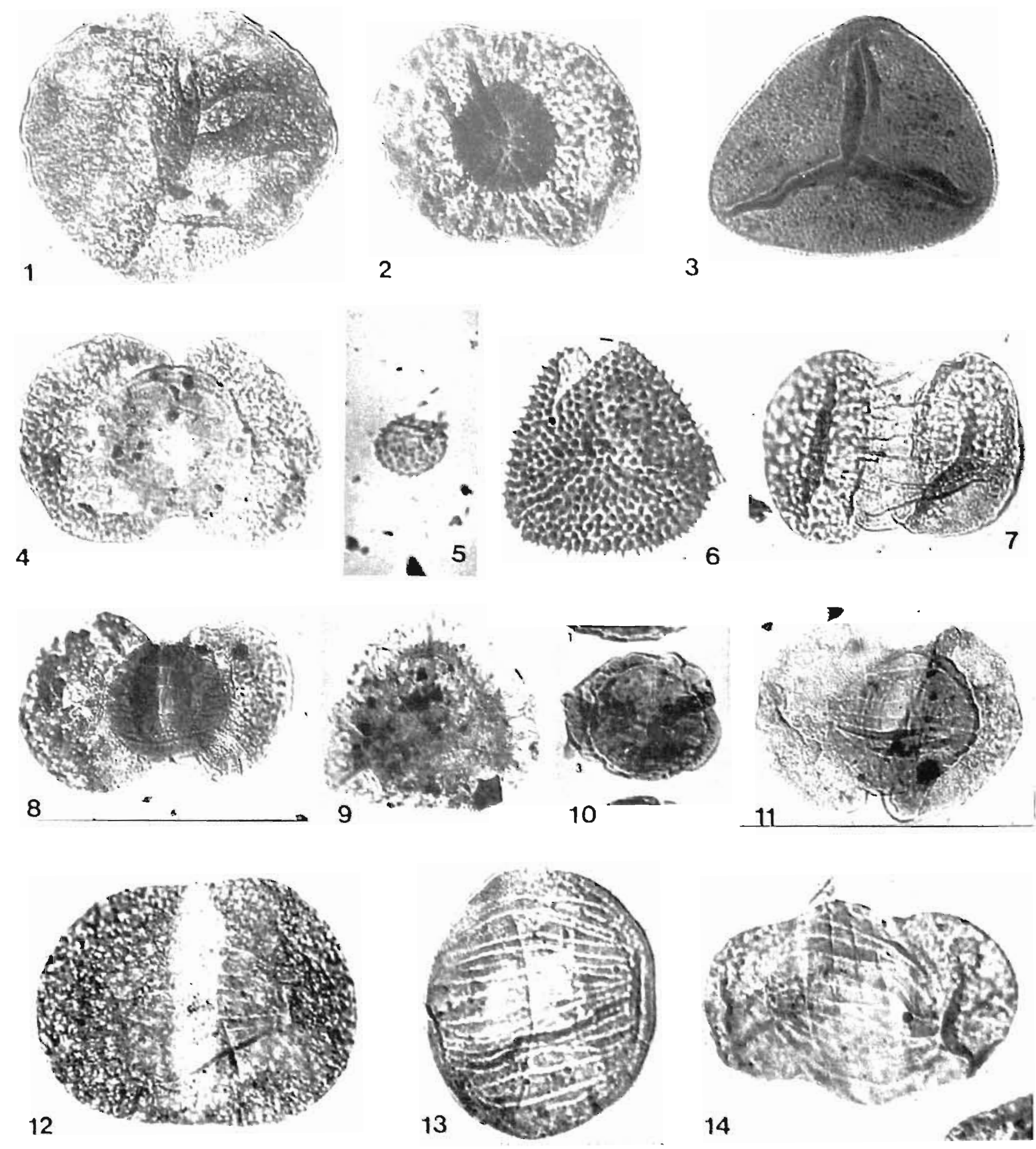

PLATE 3

(All photomicrographs are × 500)

Lower Permian spore-pollen species

1. *Scheuringipollenites barakarensis*
2. *Rhizomaspora indica*
3. *Microbaculispora gondwanensis*
4. *Striatites communis*
5. *Brevitriletes communis*
6. *Didecitriletes horridus*
7. *Striatopodocarpites decorus*
8. *Verticipollenites gibbosus*
9. *Indotriradites korbaensis*
10. *Schizopollis wodehousei*
11. *Striatites solitus*
12. *Faunipollenites varius*
13. *Striasulcites tectus*
14. *Distriatites distinctus*

FAD of species in 1, 2, 4, 9, 12 marks *Scheuringipollenites barakarensis* Assemblage-Zone and FAD of species in 3, 6, 8, 10, 11, 13, 14 define the *Faunipollenites varius* Assemblage Zone

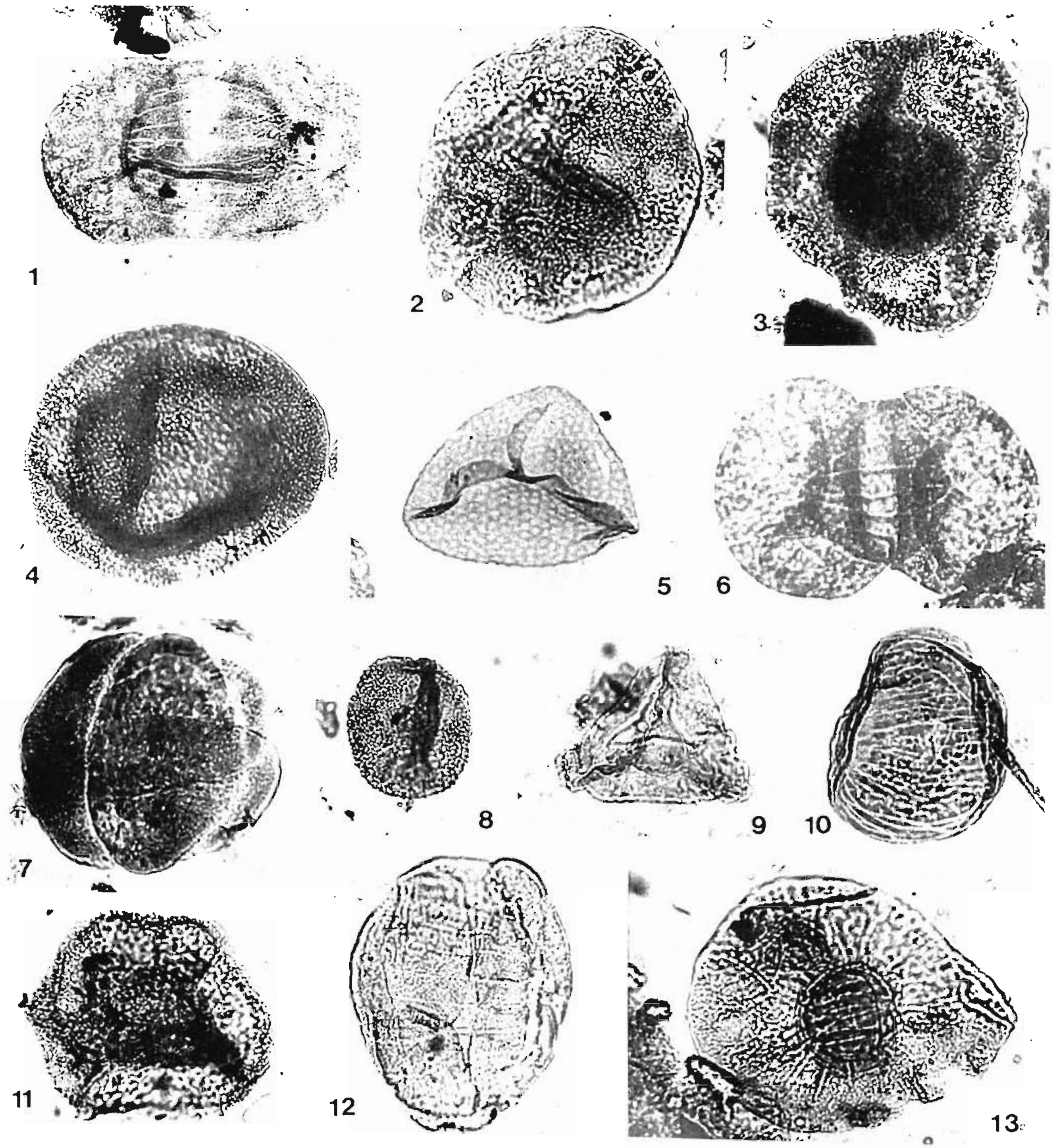

PLATE 4

(All photomicrographs are × 500)
Characteristic Upper Permian palynotaxa.

1. *Striatopodocarpites magnificus*
2. *Densipollenites indicus*
3. *Densipollenites densus*
4. *Densipollenites magnicorpus*
5. *Microfoveolatispora raniganjensis*
6. *Crescentipollenites fuscus*
7. *Gutullapollenites hannonicus*
8. *Cyclobaculisporites minutus*
9. *Indospora clara*
10. *Marsupipollenites striatus*
11. *Gondisporites raniganjensis*
12. *Distriamonocolpites ovalis*
13. *Distriamonosaccites ovalis*

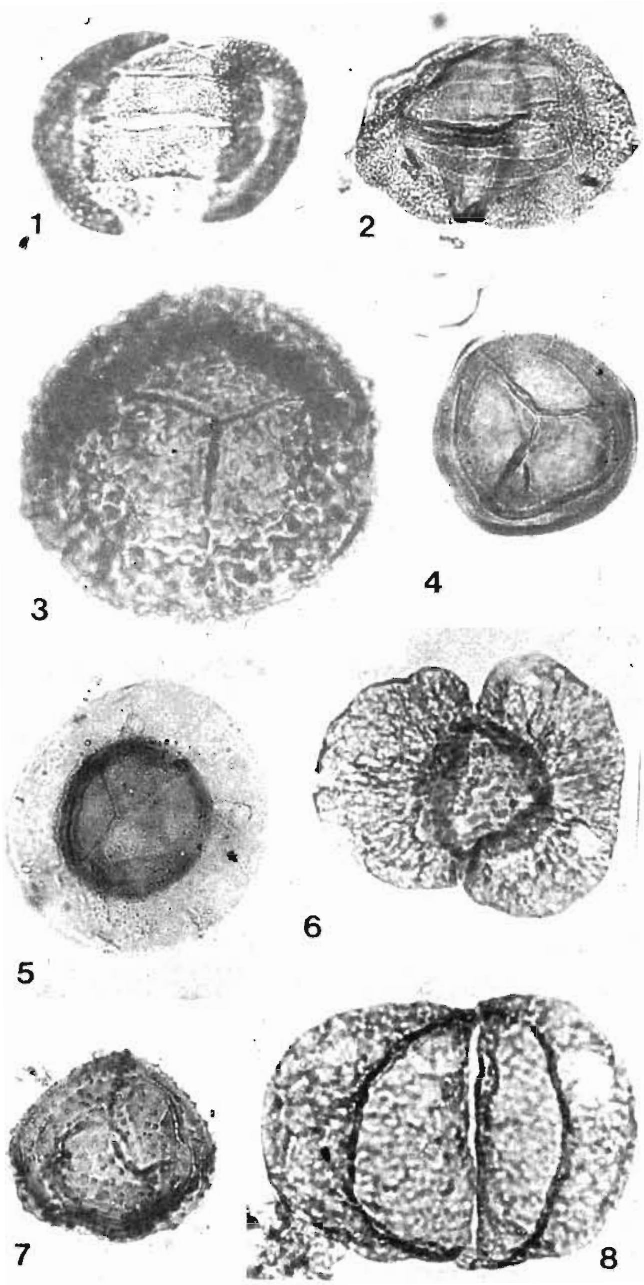

PLATE 5

(All photomicrographs are × 500)

Lower Triassic spore-pollen species defining *Klausipollenites schaubergeri* Assemblage-Zone.

1. *Lunatisporites pellucidus*
2. *Lunatisporites diffusus*
3. *Verrucosisporites narmianus*
4. *Densoisporites playfordii*
5. *Playfordiaspora cancellosa*
6. *Rhizomaspora biharia*
7. *Lundbladispora microconata*
8. *Alisporites asansoliensis*

Tiwari and Tripathi (1988) based on generic acme-zone.

The compositions delimited by Tiwari and Singh (1986) as P-II, P-III and P-IV also equate with the present assemblage zone. The distinctive nature of the *Playfordiaspora cancellosa* Assemblage-Zone is further corroborated with the record of *Lunatisporites* and *Lundbladispora* spp. acme-zones (Table 3) during the same span.

Reference sections—A complete representation of this assemblage zone is not recorded in one section, hence three sequences are cited: Bharadwaj and Tiwari, 1977 (map 1; pp. 27, 28); Bore-hole NCRD-6, depth 123 to 86 m; Raniganj Coalfield, Bihar; Singh and Tiwari, 1982 (p. 181), Bore-hole RAD-2, depth 460-260 m, Raniganj Coalfield, West Bengal; Tiwari and Singh, 1983 (p. 228), Bore-hole RAD-5; depth 481-455 m; East Raniganj Coalfield, West Bengal.

XII. *Goubinispora morondavensis* Assemblage-Zone

The dominance of *Goubinispora* has been identified to be individualistic for this assemblage zone. From the *Playfordiaspora cancellosa* Assemblage-Zone the present zone is differentiated on the basis of restricted species—*Lundbladispora reticulata, L. willmotti, Playfordiaspora annulata, Carnisporites raniganjensis.*

The general composition, beside the above species, is marked by the presence of *Lunatisporites noviaulensis, L. pellucidus, Lundbladispora microconata, Verrucosisporites densus, Guttatisporites ambiguus, Nevesisporites vallatus, Novitasporites triangulus* and *Ringosporites fossulatus.* Certain species which are present in *Playfordiaspora cancellosa* Assemblage-Zone are absent from the present zone, viz., *Lundbladispora baculata, L. densispinosa, Ringosporites ringus, Lunatisporites damudicus, L. ovatus.*

The next younger assemblage-zone (i.e., *Rajmahalispora rugulata* Assemblage-Zone) recognised in the present account from the Rajmahal Basin can be differentiated by the presence of *Foveosporites, Polypodiisporites, Verrucosisporites racemus, Converrucosisporites* and *Rajmahalispora.* However, so far these two zones have not been found in a single sequence.

Horizon—Supra-Panchet, *pars* (Early Middle Triassic).

The palynological details studied from bore-hole RNM-4 (23°34′30″ : 87°13′03″); depth 59 m, East Raniganj Coalfield, West Bengal is considered for reference (Tiwari & Rana, 1984).

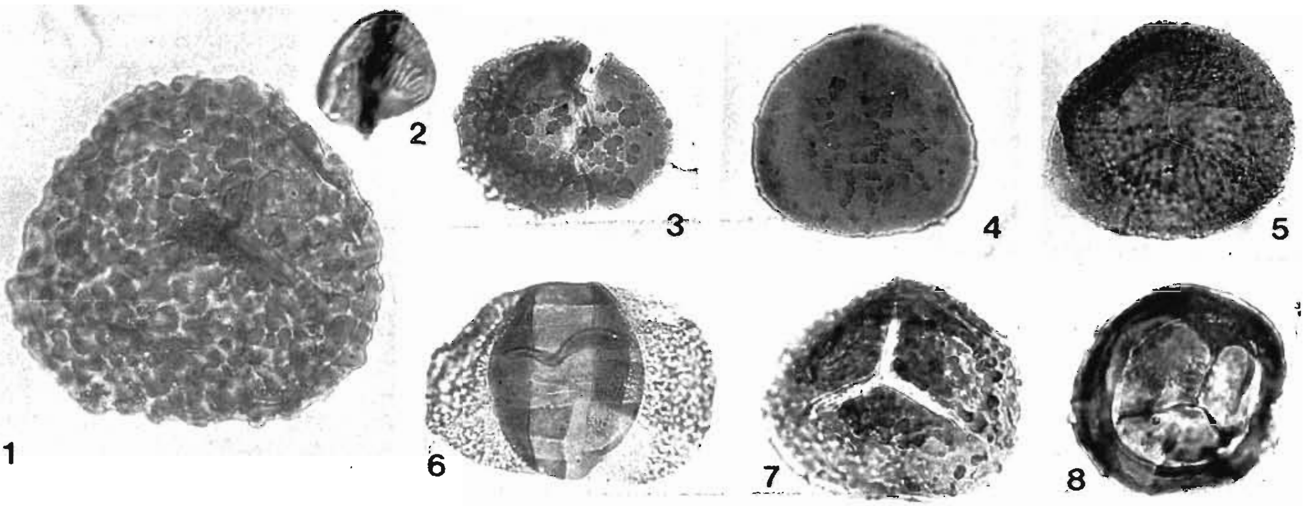

PLATE 6

(All photomicrographs are × 500)

Lower Triassic palynotaxa characterising *Playfordiaspora cancellosa* Assemblage-Zone.

1. *Verrucosisporites densus*
2. *Triplexisporites playfordii*
3. *Verrucosisporites warti*
4. *Lundbladispora densispinosa*
5. *Lundbladispora raniganjensis*
6. *Lunatisporites noviaulensis*
7. *Convertubisporites contactus*
8. *Ringosporites ringus*. × 750.

XIII. *Rajmahalispora rugulata* Assemblage-Zone

The unique trilete spore *Rajmahalispora* represented by the species *R. triassica, R. rugulata* and *R. reticulata* characterises this assemblage zone. Besides, *Foveosporites mimosae, F. triassicus, Converrucosisporites lunzensis, Chordasporites minutus, Orbella indica, Playfordiaspora cancellosa, Lunatisporites pellucidus*, etc. contribute to the composition.

From the next younger assemblage zone—*Brachysaccus ovalis* Assemblage-Zone, recognised in the present account, the present zone can be differentiated by the absence of the genera *Convolutispora, Conbaculatisporites, Staurosaccites* and *Brachysaccus*, etc. On the basis of epibole of species the *Rajmahalispora* spp. Acme-Zone is also recorded in this assemblage zone.

Horizon—Dubrajpur Formation, *pars* (Carnian).

The palynological details studied from Bore-hole RJR-2, Rajmahal Basin, Bihar, depth 842-671.05 m (Tiwari *et al.*, 1984, map 1; pp. 208, 212-214) is considered here for reference.

XIV. *Brachysaccus ovalis* Assemblage-Zone

The genera *Staurosaccites* and *Brachysaccus* are abundantly represented in this zone, although the species of non-striate disaccates (*Satsangisaccites, Klausipollenites*) continues to occur.

composition—Lunatisporites pellucidus, Goubinispora morondavensis, Playfordiaspora cancellosa, Conbaculatisporites baculatus, Infernopollenites claustratus, Staurosaccites quadrifidus, S. tharipatharensis, S. densus, Brachysaccus indicus, B. ovalis, Guttatisporites elegans. The number of species in the genus *Staurosaccites* show an epibole which defines the *Staurosaccites* spp. Acme-Zone (Table 3).

Horizon—Dubrajpur Formation, *pars* (Early Norian).

Palynological details recorded from Bore-hole RJR-2, Rajmahal Basin, Bihar, depth 441.90 to 441.40 m (Tiwari *et al.*, 1984; map 1, pp. 208, 211) is considered as reference data.

XV. *Dubrajisporites triassicus* Assemblage-Zone

A continuation of elements of the previous assemblage zone prevails but the genus *Dubrajisporites* with its four species characterise the present zone, and the species of non-striate disaccate—*Brachysaccus, Satsangisaccites, Falcisporites* and *Klausipollenites* are also abundantly recorded (Table 2).

Composition—Foveosporites triassicus, Playfordiaspora cancellosa, Staurosaccites quadrifidus, Brachysaccus ovalis, Striatopodocarpites dubrajpurensis, Gabonisporis papillosus,

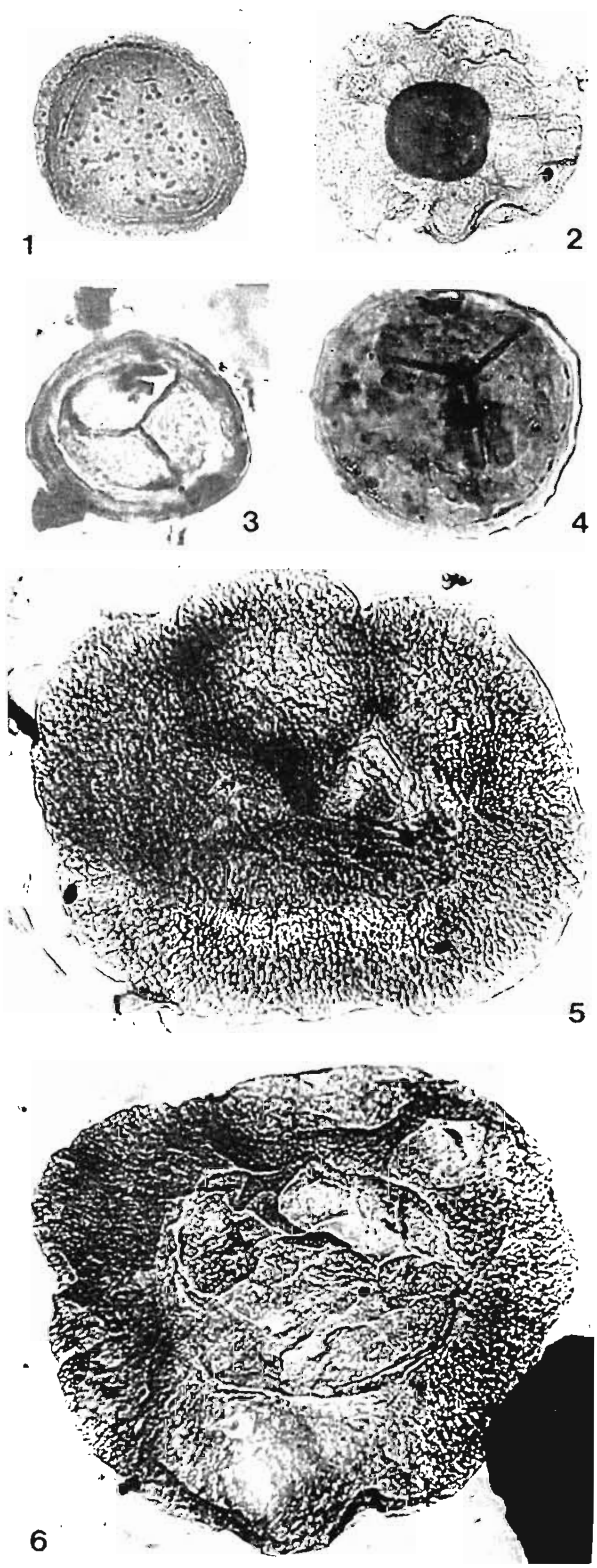

PLATE 7

(All photomicrographs are × 500 unless otherwise stated)

Middle Triassic spore-pollen species signifying *Goubinispora morondavensis* Assemblage-Zone.

1. *Lundbladispora willmotti*
2. *Playfordiaspora annulata*
3. *Ringosporites fossulatus* × 750
4. *Guttatisporites ambiguus*
5. *Goubinispora morondavensis*
6. *Goubinispora indica*

Guttatisporites elegans, G. guttatus, Dictyotriletes aulius, Podocarpidites typicus, P. alareticulatus and *P. rarus*, etc. (Table 2). *Dubrajisporites* spp. Acme-Zone is recorded at this level as indicated by the epibole of number of species in this genus (Table 3).

Horizon—Dubrajpur Formation, *pars.* (Early Norian).

Remarks—The presence of *Podocarpidites alareticulatus, P. rarus* and *P. typicus* together with the species of *Dubrajisporites* gives an younger aspect to this assemblage zone than the Assemblage defined by Maheshwari, Kumaran and Bose (1978) from Janar Nala, South Rewa Gondwana Basin. This assemblage zone is recorded by Tiwari, Kumar and Tripathi (1984, map 1, pp. 208, 211) in bore-hole RJR-2, 398.20-398.99 m depth, Rajmahal Basin, Bihar.

The following 4 assemblage zones are described as reference zones only for comparative assessments of the subsequently described zones found in the Rajmahal Basin.

XVI. *Rhaetipollis germanicus* Assemblage—Zone

Rhaetipollis germanicus Assemblage-IX : Maheshwari *et al.*, 1978—This assemblage zone is characterised by the presence of *Rhaetipollis germanicus, Aequitriradites minor* and *Classopollis* and the dominance of non-striate disaccate pollen species.

The composition records the taxa *Dictyophyllidites, Klausipollenites, Lunatisporites* (incl. *Taeniaesporites*), *Verrucosisporites, Scheuringipollenites, Podocarpidites, Vitreisporites, Striatisaccus, Klausipollenites* sp., cf. *K. vestitus, Lundbladispora, Concavisporites* and *Convolutispora.* This assemblage zone is recorded from a well in Banni, South of Patcham Island, Kachchh, 1,620-1,760 m depth (Koshal, 1975, p. 79), which is considered as reference material. Koshal has dated it as Rhaetic-Liassic.

XVII. *Classopollis minor* Assemblage-Zone

(*Gliscopollis-Classopollis* Zone Koshal, 1975)

The palynoflora is characterised by the abundance of *Classopollis* and *Spheripollenites* species. The other significant forms present are *Cyathidites, Gleichenidites, Verrucosisporites, Callialasporites trilobatus. C. triletes, C. segmentatus, Staplinisporites, Classopollis minor, C. classoides, Podocarpidites* spp. and *Matonisporites cooksonii.* The palynological details of this zone are recorded from a well (1,620-1,161 m depth) in Banni, South of Patcham Island, Kachchh (Koshal, 1975) to which an Early Jurassic age has been assigned. A comparable assemblage is also recorded from a well drilled in Lathi Formation near Chhor Village (71°9'9" : 27°45'49"), south-east of Jaisalmer (Lukose, 1972, p. 156).

XVIII. *Callialasporites trilobatus* Assemblage-Zone

(*Callialasporites trilobatus* Zone; Koshal, 1975)

The status of various assemblages known at present from Middle to Upper Jurassic is not very clear. However, for comparing the data of Rajmahal Basin, which concerns the subject of the present communication, the assemblages from Kachchh basin are considered.

From Kachchh three comparable assemblages are known—one *Callialasporites trilobatus* Zone (Koshal, 1975: Banni; South of Patcham Island, 1,161-833 m depth, Middle to Upper Jurassic); and two assemblages from Jhuran Formation (= Katrol Formation, Kimmeridgian to Valaginian, Biswas, 1971); one by Venkatachala and Kar (1970) and another by Maheshwari and Jana (1988).

It is important to note that the *Callialasporites trilobatus* Assemblage-Zone makes a segment of continuous sequence in Banni well, delimited at its base by *Classopollis minor* Assemblage-Zone of Early Jurassic age. The abundance of several species of *Callialasporites* and the presence of *Densoisporites, Gleicheniidites, Klukisporites, Cicatricosisporites, Araucariacites, Classopollis (C. minor, C. classoides, C. itunensis)* characterise this zone. This zone has been dated as Middle to Late Jurassic by Koshal (1975); although he has not equated this sequence with the lithostratigraphic units, the data suggests that the assemblage belongs to Jhumara-Jhuran formations.

The species composition (Zone "XIX", Table 2) in the assemblage described by Venkatachala, Kar and Raja (1969) and Venkatachala and Kar (1970)

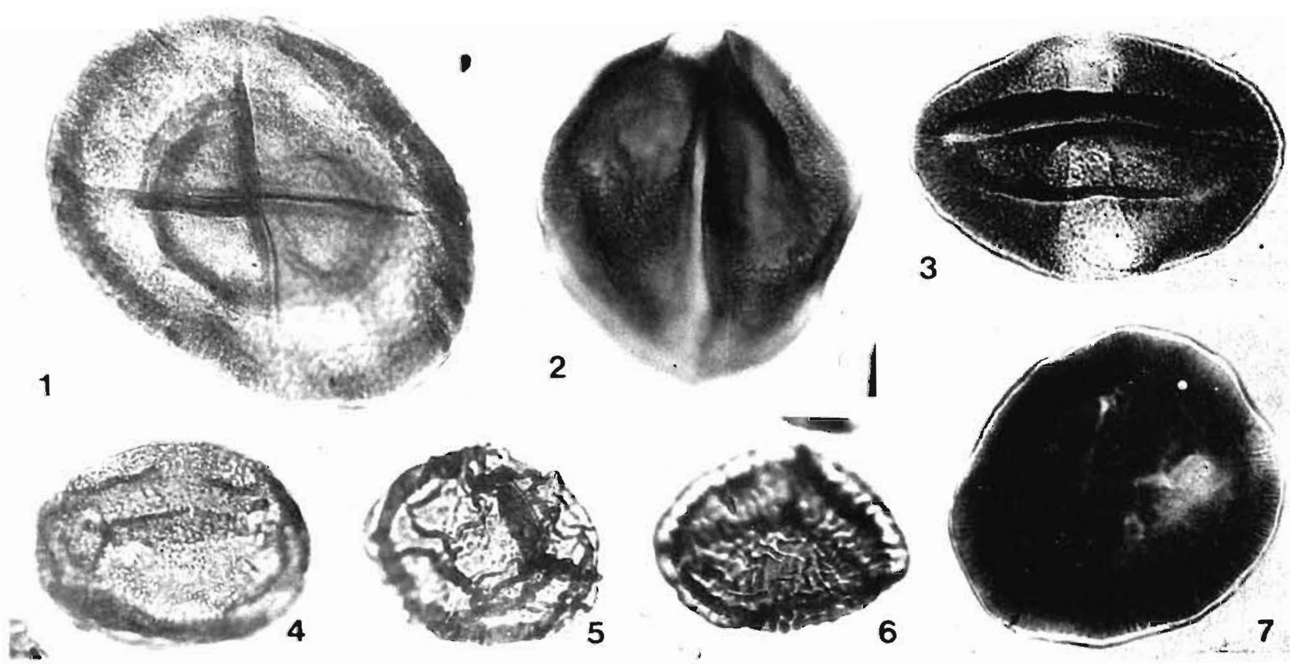

PLATE 8

(All photomicrographs are × 500)

Upper Triassic palynotaxa.

1. *Staurosaccites densus*
2. *Brachysaccus triassicus*
3. *Infernopollenites claustratus*
4. *Foveotriletes triassicus*
5. *Rajmahalispora reticulata*
6. *Rajmahalispora rugulata*
7. *Staurosaccites quadrifidus*

FAD of species in 4-6 characterise *Rajmahalispora rugulata* Assemblage-Zone and FAD of species in 1-3, 7 define *Brachysaccus ovalis* Assemblage-Zone.

suggests a broader correlation with the next zone—i.e., *Callialasporites segmentatus* Assemblage-Zone (Zone XIX, Table 2). Maheshwari and Jana (1988) described the generic composition of the palynoassemblage from Jhuran Formation as Palynozone-I; in totality of forms it is closely comparable with Zone-I of Venkatachala and Kar (1970). The presence of the taxa *Cicatricosisporites, Klukisporites, Contignisporites, Boseisporites, Coptospora* and *Aequitriradites* is significant.

XIX. *Callialasporites segmentatus* Assemblage-Zone

(*Callialasporites segmentatus* Zone; Venkatachala, Sharma & Jain, 1972)

Venkatachala, Sharma and Jain (1972, text-fig. 3) and Venkatachala (1974, text-fig. 1) recognised *Callialasporites segmentatus* Zone from Karaikal well-D (3,055-3,060 m depth), Cauvery Basin which is characterised by the presence of following species (Zone-XIX, Text-figure 1): *Araucariacites australis, Ceratosporites equalis, C. acutus, Stereisporites antiquasporites, Classopollis classoides, Podocarpidites ellipticus, P. multesimus, Contignisporites glebulentus, C. multimuratus, Cicatricosisporites ludbrooki, C. australiensis, Baculatisporites comaumensis, Callialasporites dampieri, C. monoalasporus, C. segmentatus, C. trilobatus, C. triletes, Retitriletes austroclavatidites, R. reticulumsporites*, etc. This assemblage zone was originally dated as Tithonian. However, recently it has been reassigned to Early Cretaceous (Barriasian) because of the presence of *Cicatricosisporites australiensis* (*see* Sastry *et al.*, 1981; Singh & Venkatachala, 1988).

XX. *Microcachryidites antarcticus* Assemblage-Zone

(*Microcachryidites antarcticus* Assemblage : Venkatachala, Sharma & Jain, 1972)

This assemblage zone has been defined originally from Cauvery Basin by Venkatachala, Sharma and Jain (1972) and Venkatachala (1974, text-fig. 1, p. 482, Karaikal Well-D. 2,420-2,860 m depth). It is in continuation of the *Callialasporites segmentatus* Assemblage-Zone. The diagnostic species are *Microcachryidites antarcticus, Podosporites tripakshi, P. microsaccatus, Spheripollenites scabris, Leptolepidites major, Klukisporites scaberis, Cooksonites variabilis, Aequitriradites verrucosus, Staplinisporites caminus, Trilobosporites triangulus, Impardecispora apiverrucata, I. uralensis* and *Appendicisporites distocornitatus*.

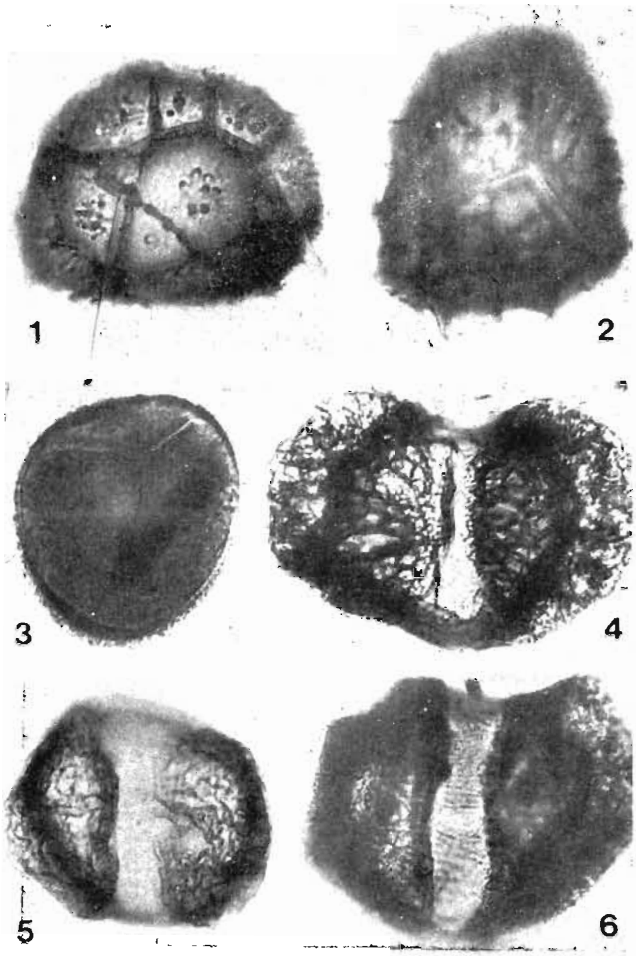

PLATE 9

(All photomicrographs are × 500)

Characteristic spore-pollen species of *Dubrajisporites triassicus* Assemblage-Zone.

1. *Dubrajisporites unicus*
2. *Dubrajisporites triasscus*
3. *Gabonisporis vigrauxii*
4. *Podocarpidites rarus*
5. *Podocarpidites alareticulatus*
6. *Striatopodocarpites dubrajpurensis*

In broader connotation the palynoassemblages so far known from Dubrajpur and Rajmahal formations, assignable to Jurassic/Cretaceous and Lower Cretaceous (Sah & Jain, 1965; Maheshwari & Jana, 1983; Tiwari *et al.*, 1984) are placed under the *Microcachryidites antarcticus* Assemblage-Zone. This is considered as a working model at present for the sequential positioning of the Rajmahal assemblages because they still need detailed study.

The following informal zones, recognised in Rajmahal Basin, are included in *Microcachryidites antarcticus* Assemblage-Zone.

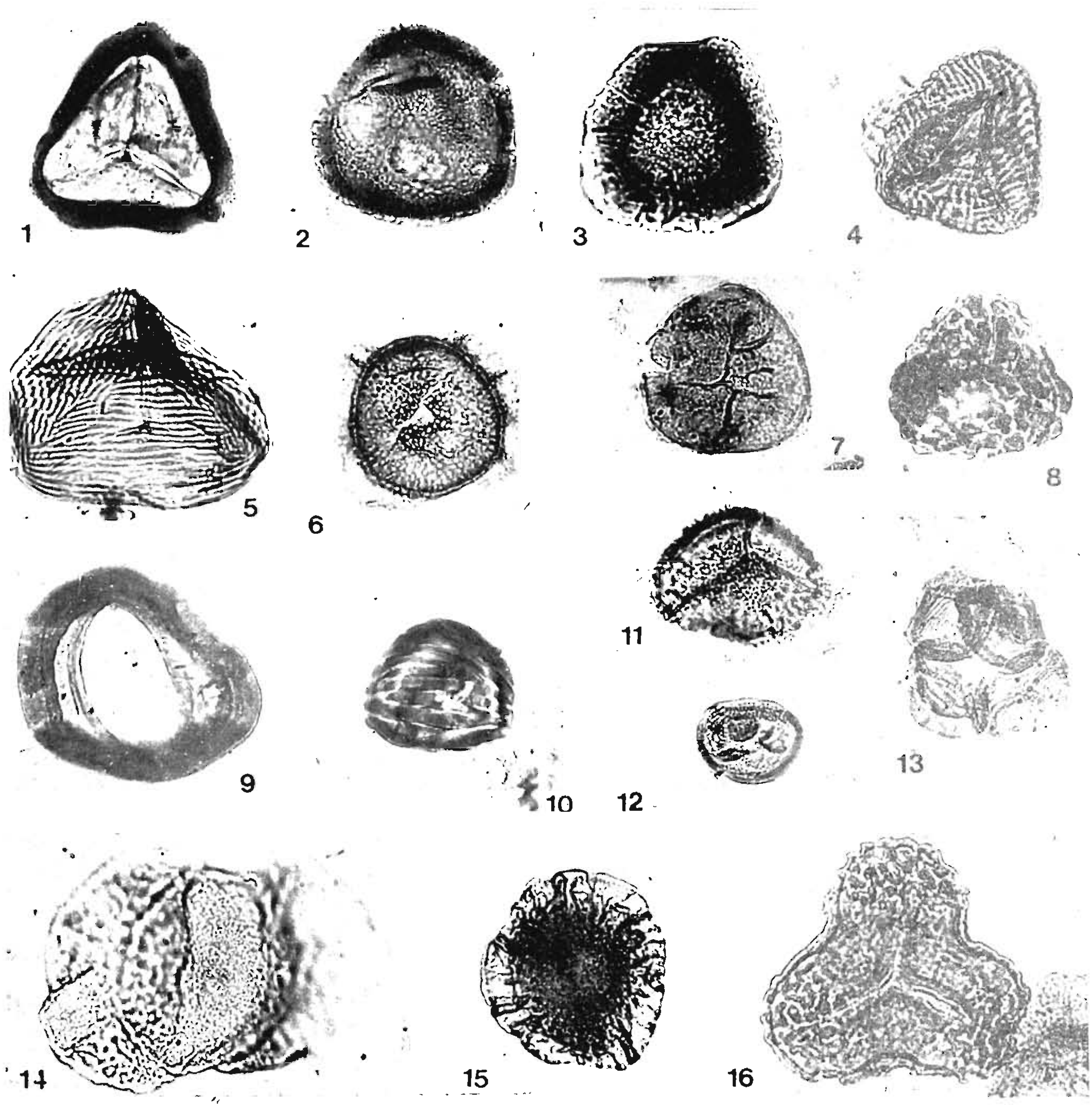

PLATE 10

(All photomicrographs are × 500)

Characteristic palynotaxa of *Microcachryidites antarcticus* Assemblage-Zone.

1. *Murospora florida*
2. *Coptospora verrucosa*
3. *Cooksonites rajmahalensis*
4. *Cicatricosisporites hallei*
5. *Cicatricosisporites australiensis*
6. *Aequitriradites spinulosus*
7. *Triporoletes reticulatus*
8. *Leptolepidites verrucatus*
9. *Coptospora kutchensis*
10. *Contignisporites dettmanni*
11. *Santhalisporites bulbosus*
12. *Podosporites tripakshi*
13. *Classopollis classoides*
14. *Podocarpidites ellipticus*
15. *Callialasporites segmentatus*
16. *Impardecispora trioreticulosa*

Assemblage-Zone D and E (Zone XX "D-E" in Table 2)—This includes Assemblage D and E of Tiwari *et al.* (1984, text-fig. 2, bore-hole RJR-2, Rajmahal Basin, 102.76-91.00 m) where the distinction was based on the percentage frequency of the genera *Callialasporites* and *Podocarpidites.* A further search of species in these materials has revealed that on the basis of species occurrence the Assemblage-Zone D and E cannot be separated.

The assemblages as such are dominated by the coniferous pollen grains *Podocarpidites/Araucariacites.* The significant constituents present are *Concavissimisporites penolaensis, Santhalisporites bulbosus, Klukisporites varigatus, Matonisporites dubius, Coptospora kutchensis, C. verrucosa, Aequitriradites spinulosus, Contignisporites dettmanni, Leptolepidites verrucatus, L. rimatus, L. major, Triporoletes reticulatus, Cicatricosisporites australiensis, C. ludbrooki, Araucariacites* spp., *Callialasporites* spp., *Podocarpidites* spp., *Labiipollis mesozoicus, L. granulatus* and *Podosporites tripakshi* (Table 2). The *Callialasporites, Podocarpidites* and *Araucariacites* spp. Acme-Zones are clearly observed in this assemblage zone (Table 3).

Various assemblage zones from the Kachchh Basin have been plotted (marked as + in Table 2) for the comparative assessment of the "Assemblage-Zones D and E" which remarkably share several of the characteristic elements with the *Callialasporites trilobatus* Assemblage-Zone, viz., *Callialasporites trilobatus, C. dampieri, C. segmentatus, Coptospora kutchensis, Cicatricosisporites australiensis, Concavissimisporites penolaensis, Podosporites microsaccatus* and *P. tripakshi* (Table 2).

There is a similar situation when the *Callialasporites segmentatus* zone of Venkatachala (1974) is compared. In addition to the above mentioned species, however, a few first appearances of the species having an younger affiliation, are also recorded, e.g., *Aequitriradites spinulosus, Leptolepidites major, Podosporites tripakshi, P. microsaccatus, Cicatricosisporites australiensis, Contignisporites dettmanni, Foraminisporis* sp., *Coptospora kutchensis* and *Baculatisporites comaumensis.*

Most of these species are considered to be age determinant for the beginning of cretaceous (Venkatachala, 1974). But some of these supposedly marker of the Neocomian (*Aequitriradites spinulosus, Cicatricosisporites australiensis* and *Contignisporites dettmanni* have been recorded from the Tithonian as well (Singh & Venkatachala, 1988; Maheshwari & Jana, 1988; Helby *et al.*, 1987; Burger, 1988). The consistent occurrence of these species has been definitely located at the base of *Microcachryidites antarcticus* Assemblage from the Cauvery Basin (Venkatachala, 1974) which qualify for Early Cretaceous. But, inspite of this valuable data, it cannot be ascertained that this assemblage marks the beginning of the Early Cretaceous because there is a gap of about 195 m of sediments between *Callialasporites segmentatus* and *Microcachryidites antarcticus* Assemblages.

In view of these facts, the Late-Jurassic/Early Cretaceous age given to these assemblages by Tiwari *et al.* (1984) is corroborated by the observations made by Singh and Venkatachala (1988) that the floral changes which occurred at the Late Jurassic level continue into the Early Cretaceous. However, the lack of data on continuous sequence from Upper Jurassic to Lower Cretaceous does not permit to define the species which can demarcate the FAD for the base of Lower Cretaceous.

Assemblage-Zone F (Zone XX "F" in Table 2)—This assemblage is not rich in palynofossils, and its close similarity is observed with "Assemblage-Zones D and E" analysed above. The new entrant *Dictyophyllidites haradensis* (Table 2) is recorded as a solitary example. This Assemblage-Zone F is recorded from Bore-hole RJR-2, Rajmahal Basin, Bihar, 69.75-40.65 m depth (Tiwari *et al.*, 1984) representing the Rajmahal Formation (Early Cretaceous).

Assemblage-Zone G (Zone XX "G" in Table 2)—This assemblage zone is recorded from the Intertrappean sediments of Rajmahal Formation at Sakrigalighat and Basko, Rajmahal Basin, Bihar (Sah & Jain, 1965, p. 264). The basic species composition indicates a relationship with the "Assemblage-Zone F". However, a number of additional new elements are documented in "Assemblage-Zone XX G", viz., *Concavissimisporites minor, Osmundacidites minor, Trilobosporites purverrulentus, Cingulatisporites notaclarus, Podosporites (= Trisaccites) microsaccatus, Dacrycarpites australiensis, Converrucosisporites santalensis* and *C. sinuotectus,* etc. (Table 2). The assemblage from a well near Mandro (Maheshwari & Jana, 1983) records *Densoisporites mesozoicus* and *Cicatricosisporites hallei* as new entrants.

Besides, in the Intertrappean sediments of Rajmahal Formation in bore-hole RJNE-32 near Kirtanya (Tripathi & Tiwari, 1991; Tripathi, 1991), some angiospermous pollen with reticulate columellate exine and monocolpate, trichotomosulcate and tricolpate aperture-types have been recorded together with typical Early Cretaceous palynomorphs.

DISCUSSION

The synthesis of the data discussed in the preceding pages recognises 12 assemblage zones based on spore-pollen species (Column I-XII) in the Damodar Graben, spanning through the sequence from Talchir to Supra-Panchet formations. In the Rajmahal Basin four assemblage zones (column XIII, XIV, XV & XX) are recognised to represent the Upper Triassic, Jurassic/Cretaceous and Lower Cretaceous sequences (Text-figure 1). In order to structure comprehensive model of successive assemblage zones, the data from Rajasthan, Kachchh and Cauvery basins has been intercalated where 4 assemblage zones (XVI-XIX) have been recognised. This arrangement provides an opportunity of direct comparison amongst the various assemblage zones in Rajmahal Basin with reference to their placement in the temporal scale.

Conventionally the epibole zones are based on the dominance in percentage frequency of the taxa. For the first time, in the present analysis the species acme-zones have been identified on the number of species in various genera. Such an approach has resulted into a very significant parameter which reinforces the individuality of the species assemblage zones. It is evident from Text-figure 1 that in some assemblage-zones several genera show the epiboles of the number of their species.

The composition of palynoassemblages based on generic dominance is fairly well established in the Gondwana Sequence; some of these updated assemblage zones have been tagged with the spore-pollen species assemblage zones proposed here.

The distribution pattern of selected species has revealed events of stratigraphic significance (Table 2).

Lower Permian

The impoverished assemblage (total 9 species; 2 pteridophytic, 1 alete, rest gymnospermous) of the lowest Talchir level (Zone-1) successively diversifies into a rich flora by the beginning of Karharbari Formation. The three assemblage zones (Zone I to III) identified in the Talchir Formation are indicative of gradual and continuous amelioration of the climate where the vegetation has flourished to its maximum by the time the glaciers retreated completely. The Karharbari assemblage (Zone-IV) shows a major continuation of elements from the underlying Talchir Formation except that some species are mutually exclusive in their occurrence.

The advent of Barakar flora witnesses the incoming of several new species which continue to flourish in the subsequent younger horizons; on the other hand many of the species belonging to the radial monosaccate group which flourished during Talchir and Karharbari also continue to occur. The clear cut demarcation between the Lower Barakar (Zone V) and Upper Barakar (Zone VI) are very well depicted in their species distribution (Table 2).

Upper Permian

In the two fold system of classification of the Permian the boundary between Lower Permian and Upper Permian is drawn between the Barakar and Kulti formations. In qualitative aspect of genera and species, however, the demarcation of the two is not very well defined. The differences in species distribution indicate a subtle change (Table 2). Nonetheless, the species acme-zones provide a useful parameter for identification of this level (Table 3). In Barakar the epibole of number of species in the genera *Scheuringipollenites, Faunipollenites, Barakarites* and *Microbaculispora,* etc. are recorded, while in Kulti Formation the species acme-zone of the genera *Densipollenites, Verticipollenites* and *Scheuringipollenites,* etc. are well documented.

The palynoassemblage of Kulti Formation (Zone-VII) forms a more or less monotonous continuum to the Raniganj assemblage (Zone-VIII). The most significant change has occurred at the close of the Raniganj Formation (Zone IX) and at the beginning of the Panchet Formation (Zone X) which is taken as the Permo-Triassic transition. At this level 175 spore-pollen species (39 pteridophytic) are on record at the close of Permian. Out of these, only 38 species (6 pteridophytic) continue into Triassic while 84 species appear as new entrants in Early Triassic; the pteridophytic spores constitute the major part by being 48 species in number. The behaviour pattern of the species distribution at P/Tr boundary thus signals one of the most outstanding changes in the history of Gondwana floristics.

Triassic

The Early Triassic Panchet Formation is the stage for termination of several Permian species. Progressively numerous new sets of species appear which diversify through the Lower and Middle Triassic (Table 2). The Upper Triassic (Upper Carnian, Lower Norian) again experiences an influx of entirely new species although these assemblages, in general, had a close relationship with the Lower (Zone X, zone XI) and Middle Triassic (Zone XII) groups of species. The new entrants in Zone XIII, XIV and XV of Late Triassic (species of *Staurosaccites, Barchysaccus, Infernopollenites, Dubrajisporites, Rajmahalispora,* etc.) had obviously a short history of existence as they do not occur in the Lower Jurassic sediments.

Jurassic/Cretaceous

The area of study concerns with the Rajmahal Basin but the Jurassic and Lower Cretaceous assemblages Zones XVI to XX from Rajasthan and Kachchh basins have been interpolated for comparison and assessment of the Infra- and Intertrappean asemblages in this basin. It is very clear from Table 2 that the Jhuran (= Katrol Assemblage (Zone "XIX") is distinguished from the Bhuj assemblage (Zone XIX) by having several species of restricted distribution in both (see details in Venkatachala & Kar, 1970, pp. 83, 84). The distinction between the two are very sharp. The Assemblages D and E of Bore-hole RJR-2 (Zone XX "D-E", Table 2) stand apart from the Katrol and Bhuj Assemblages except for the long ranging species (*Podocarpidites, Callialasporites* and *Araucariacites*).

The Assemblage F of Bore-hole RJR-2 (Zone XX "F", Table 2) is impoverished. The Sakrigalighat, Basko and Mandro assemblages, together considered here as Zone XX "G", are again highly diversified; most of its components were unknown in the older zones and hence they stand apart from the Zone XX (Bhuj) and Zone XX "D-E" (Rajmahal). Inspite of distinct offset mode between the Katrol (Zone "XIX"), Bhuj (Zone XX) and Rajmahal (Zone XX "D-E") there are certain trends of comparison between Katrol and Rajmahal assemblages; the common presence of *Coptospora kutchensis, Concavissimisporites penolaensis, Cicatricosisporites australiensis, Retitriletes austroclavatidites, Podosporites tripakshi*, etc. which points out important linkage between the Katrol assemblage and Assemblage D-E of Rajmahal. On the other hand, the latter are remotely related with the Sakrigalighat which is dated as Early Cretaceous (Singh & Venkatachala, 1988). On the face value, the Lower Cretaceous Bhuj assemblage (Zone XX) and the Assemblage D-E of Rajmahal cannot be clubbed together intimately. Tiwari, Kumar and Tripathi (1984) placed the Infratrappean Assemblage D-E at Upper Jurassic/Lower Cretaceous level. However, there are several gaps yet to be filled to complete the story of the Jurassic-Cretaceous transition span. The sequence of evidences depicted in Table 2 reveals that the succession of palynofloral assemblages from Upper Jurassic to Lower Cretaceous had been at low pace. But the Neocomian palynoflora has changed at a faster rate and the isolated areas had an ecology bias for the growth of various species; hence the matching of synchronous assemblages which are distantly apart may not suggest the real age bracket.

CONCLUSIONS

For achieving the goal of species based palynostratigraphy through the span of Indian Palaeozoic and Mesozoic Sequence, a model based on data from the Damodar Graben and Rajmahal Basin has been constructed. The following main conclusions are drawn:

1. Based on the FADs and LADs of selected species, and also the totality of species composition twenty Species Assemblage Zones have been identified which demarcate various datums.
2. The authenticity of Species Assemblage Zone is reinforced by the recognition of thirty Species Acme-Zones based on the epiboles of number of species in various genera. These epiboles either coincide with one assemblage zone or encompass more than one.
3. The least diversified spore-pollen flora of the earliest Talchir horizon enormously radiates by the end of Talchir Formation and continues to flourish during the rest of the Permian time.
4. The behaviour pattern of species distribution evidences for the most outstanding change at the Permian/Triassic boundary in the history of Gondwana floristics.
5. During Upper Triassic a marked change is recorded by the influx of several new species having short stratigraphic range which result into a distinct alteration in the species pattern at the Late Triassic/Early Jurassic level.
6. At the Late Jurassic/Early Cretaceous datum major event in the species change-over is not represented. The continuum of flora is reflected by spores/pollen; however, there are gaps in information for precise location of the change.

REFERENCES

Agrawal JK & Rana FA 1976. Chronology of Mesozoic volcanics of India. *Proc. Indian Acad. Sci.* **84A** (4) : 157-179.

Allen KC 1965. Lower and Middle Devonian spores of north and central Vestspitsbergen. *Palaeontology* **8** (2) : 687-748.

Bakshi AK, Ray Barman T, Paul DK & Farrar E 1987. Wide spread Early Cretaceous flood basalt volcanism in eastern India: geochemical data from the Rajmahal-Bengal-Sylhet traps. *Chemical Geol.* **63** : 133-141.

Balme BE 1963. Plant microfossils from the Lower Triassic of Western Australia. *Palaeontology* **6** (1) : 12-40.

Balme BE 1970. Palynology of Permian and Triassic strata in the Salt Range and Surghar Range, West Pakistan. *Stratigraphic boundary problems : ermian and Triassic of West Pakistan,* *spl. publ.* **4** : 306-453. Univ. of Kansas.

Balme BE & Hennelly JPF 1955. Bisaccate sporomorphs from Australian Permian sediments. *Aust. J. Bot.* **3** (1) : 89-98.

Balme BE & Hennelly JPF 1956. Trilete sporomorphs from Australian Permian sediments. *Aust. J. bot.* **4** (3) : 240-260.

Banerji J & Maheshwari HK 1975. Palynomorphs from the Panchet Group exposed in Sukri River, Auranga Coalfield, Bihar. *Palaeobotanist* **22** : 158-170.

Banerji J & Maheshwari HK 1977. A Lower Triassic mioflorule from Junut, Raniganj Coalfield. *Palaeobotanist* **24** : 146-148.

Bharadwaj DC 1962. The miospore genera in the coals of Raniganj Stage (Upper Permian), India. *Palaeobotanist* **9** : 68-106.

Bharadwaj DC 1970. Palynological subdivisions of the Gondwana Sequence in India. *In* Haughton SH *et al.* (editors)—*Proc. II int. Gondw. Symp.* Univ. Cape Town, South Africa 1970 531-536. C.S.I.R. Scientia, Pretoria, South Africa.

Bharadwaj DC & Dwivedi A 1977. *Insignisporites* gen. nov. : a new cavate miospore genus from Barakar Stage (Lr. Gondwana) of India. *Geophytology* **7** : 113-120.

Bharadwaj DC & Dwivedi A 1981. Sporae dispersae of the Barakar sediments from South Karanpura Coalfield, Bihar, India. *Palaeobotanist* **27** : 21-94.

Bharadwaj DC & Kumar P 1972. On the status of some miospore genera from the Mesozoic Era. *Palaeobotanist* **19** : 214-224.

Bharadwaj DC & Salujha SK 1964. Sporological study of Seam VIII in Raniganj Coalfield, Bihar (India)—Part 1, Description of Sporae dispersae. *Palaeobotanist* **12** : 181-215.

Bharadwaj DC & Salujha SK 1965. A sporological study of Seam VIII (Jote Dhemo Colliery) in the Raniganj Coalfield, Bihar (India). *Palaeobotanist* **13** : 30-41.

Bharadwaj DC & Sinha HP 1964. An Upper Triassic miospore assemblage from the coals of Lunz, Austria. *Palaeobotanist* **12** : 28-44.

Bharadwaj DC & Singh V 1969. Some new miospores from Lower Gondwana coals. *In*: Santapau H *et al.* (editors)—*J. Sen Memorial Vol.* : 7-16. Botanical Society Bengal, Calcutta.

Bharadwaj DC & Srivastava SC 1969. A Triassic mioflora from India. *Palaeontographica* **B125** : 119-149.

Bharadwaj DC & Tiwari RS 1964. On two new monosaccate genera from Barakar Stage of India. *Palaeobotanist* **12** : 139-146.

Bharadwaj DC & Tiwari RS 1977. Permian-Triassic miofloras from the Raniganj Coalfield, India. *Palaeobotanist* **24** : 26-49.

Bharadwaj DC, Tiwari RS & Kar RK 1974. *Crescentipollenites* gen. nov. : a new name for hitherto known *Lunatisporites* Leschik from the Lower Gondwanas. *Geophytology* **4** : 141-146.

Biswas SK 1971. Note on the geology of Kutch. *Q. J. geol. Min. metall. Soc. India* **43** : 220-235.

Biswas SK 1977. Mesozoic rock stratigraphy of Kutch, Gujarat. *Q. J. geol. Min. metall. soc. India* **49** (3, 4) : 1-51.

Boltenhagen E 1967. Spores et pollen du Cretace Superieur du Gabon. *Pollen Spores* **9** : 335-355.

Bose MN & Kar RK 1966. Palaeozoic Sporae dispersae from Congo. 1 : Kindu-Kalima and Walikale regions. *Ann. Mus. R. Afr. Cent., ser. 8°, Sci. geol.* **53** : 1-238.

Burger D 1990. Australian Phanerozoic timescales : Jurassic biostratigraphic charts and explanatory notes. *Bureau Min. Resources Austr. Rec.* **38** : 1-32.

Chandra A & Lele KM 1980. Talchir miofloras from South Rewa Gondwana Basin, India and their biostratigraphical significance. *In Proc. IV int. Palynol. Conf., Lucknow (1976-77)* **2** : 117-151. Birbal Sahni Institute of Palaeobotany, Lucknow.

Cookson IC 1947. Plant microfossils from the lignite of Kerguelen Archipelago. *B.A.N.Z. Antarctic Res. Exp. 1929-31, Rep.* A2 : 127-142.

Cookson IC & Dettmann ME 1958. Some trilete spores from Upper Mesozoic deposits in the Eastern Australian region. *Proc. R. Soc. Vict.* **70** : 95-128.

Cookson IC & Dettmann ME 1961. Reappraisal of the Mesozoic miospore genus *Aequitriradites. Palaeontology* **4** : 425-427

Cookson IC & Pike KM 1953. A contribution to the Tertiary occurrence of the genus *Decrydium* in the Australian region. *Aust. J. Bot.* **1** : 474-484.

Couper RA 1953. Upper Mesozoic and Cainozoic spores and pollen grains from New Zealand. *N. Z. geol. Surv. Paleont. Bull.* **22** : 1-77

Couper RA 1958. British Mesozoic microspores and pollen grains: a systematic and stratigraphic study. *Palaeontographica* **B103** : 75-179.

Datta NR, Mitra ND & Bandyopadhyay SK 1983. Recent trends in the study of Gondwana basins of peninsular and Extra-peninsular India. *In* Bhandari LL *et al.* (editors)—*Petroliferous basins of India, Petrol. Asia J.* : 159-170.

De Jersey NJ & Hamilton M 1967. Triassic spores and pollen grains from the Moolayember Formation. *Publs. geol. Surv. Qd* **336** : *Palaeont. Pap.* **10** : 1-61.

De Jersey NJ & Patten RJ 1964. Jurassic spores and pollen grains from the Surat Basin. *Publs. geol. Surv. Qd* **322** : 1-18.

Delcourt AF, Dettmann ME & Hughes NF 1963. Revision of some Lower Cretaceous microspores from Belgium. *Palaeontology* **6** (2) : 282-292.

Delcourt AF & Sprumont G 1955. Les spores et grins de pollen du Wealden du Hainaut. *Mem. Soc. Belg. Geol.* **4** : 1-73.

Dettmann ME 1963. Upper Mesozoic microfloras from South eastern Australia. *Proc. R. Soc. Vict.* **77** (1) : 1-148.

Dev S 1961. The fossil flora of the Jabalpur Series-3. Spores and pollen grains. *Palaeobotanist* **8** : 43-56.

Dolby JH & Balme BE 1976. Triassic palynology of the Carnarvon Basin, Western Australia. *Rev. Palaeobot. Palynol.* **22** (2) : 105-168.

Döring H, Krutzsch W, Mai D & Schulz E 1963. Diskussions beitrag zur sporengattung *Retitriletes. In* Krutzsch W (Editor)—*Atlas der Mittel-und jungtertiaren sporen und pollen-sowie der Mikroplanktonformen des nördlichen Mitteleuropas.* Life II Veb Deutsch. Verl. Wiss, Berlin.

Foster CB 1975. Permian plant microfossils from the Blair Athol Coal Measures, Central Queensland, Australia. *Palaeontographica* **B154** (5-6) : 121-171.

Foster CB 1979. Permian plant microfossils of the Blair Athol Coal Measures, Baralaba Coal Measures and Basal Rewan Formation of Queensland. *Publs. geol. Surv. Qd* **372** *Palaeont. Pap.* **45** : 1-244.

Fox CS 1930. The Jharia Coalfield. *Mem. geol. Surv. India* **56** : 1-255.

Ghosh SC, Datta A, Nandi A & Mukhopadhyay S 1988. Estheriid zonation in the Gondwana. *Palaeobotanist* **36** : 143-153.

Goubin N 1965. Description et répartition du ;principaux pollenites Permiens Triassiques et Jurassiques des Sondages du Bassin de Morondava (Madagascar). *Rev. Inst. Francais Petrol* **20** (10) : 1415-1461.

Gradstein FM 1983. Stratigraphy and the fossil record. *In* Gradstein FM (Editor)—*IV Int. Short Course on New concepts and methods in stratigraphy* : 1-30. Indian Institute of Technology, Kharagpur.

Hedberg HD 1976. International stratigraphic guide : a guide to stratigraphic classification, terminology and procedure. *Int. Subcommission on stratigraphic classification of IUGS Commission on Stratigraphy.* John. Wiley & Sons, New York.

Helby R, Morgan R & Partridge AD 1987. A palynological zonation of the Australian Mesozoic palynology. *In* Jell PA (Editor)—*Association of Australian Palaeontologists, Sydney* : 1-94.

Jansonius J 1962. Palynology of Permian and Triassic sediments, Peace River area, Western Canada. *Palaeontographica* **B110** : 35-98.

Kar RK 1968a. Palynology of the Barren Measures Sequence from Jharia Coalfield, Bihar, India-2. General palynology. *Palaeobotanist* **16** : 115-140.

Kar RK 1968b. Palynology of the North Karanpura Basin, Bihar, India-3. Raniganj exposure near Lungatoo, Hazaribagh District. *Palaeobotanist* **16** : 273-282.

Kar RK 1969a. Palynology of the North Karanpura Basin, Bihar, India-4. Subsurface palynology of the Bore-hole no. K5. *Palaeobotanist* **17** : 9-21.

Kar RK 1969b. Palynology of the North Karanpura Basin, Bihar, India-5. Palynological assemblage of the bore-core no. K2, Raniganj Stage (Upper Permian). *Palaeobotanist* **17** : 101-120.

Kar RK 1970. Sporae dispersae from Panchet (Lower Triassic) in the Bore-core no. RE9, Raniganj Coalfield, West Bengal. *Palaeobotanist* **18** : 50-62.

Kar RK, Kieser G & Jain KP 1972. Permo-Triassic subsurface palynology from Libya. *Pollen spores* **14** (4) : 389-454.

Klaus W 1960. Sporen der Karnishen Stufe der Ostalpinen Trias. *Jb. Geol B. A. Sonderbd.* **5** : 107-183.

Koshal VN 1975. Palynozonation of Mesozoic subsurface sediments of Banni, Kutch, Gujarat. *Q. J. geol. Min. metall. Soc. India* **4** (2) : 79-82.

Kumar P 1973. The sporae dispersae of Jabalpur Stage, Upper Gondwana, India. *Palaeobotanist* **20** : 91-126.

Kumar P 1984. Stratigraphic significance of polysaccate pollen occurring in Mesozoic and Tertiary sediments. *In* Sharma AK *et al.* (editors)—*Proc. Evolutionary Botany and Biostratigraphy, Curr. Trends in Life Sci.,* **10** : 597-611.

Kumaran KPN & Maheshwari HK 1980. Upper Triassic Sporae dispersae from the Tiki Formation 2 : Miospores from Janar Nala section, South Rewa Gondwana Basin, India. *Palaeontographica* **B173** : 26-84.

Lele KM 1964. Studies in the Talchir flora of India-2. Resolution of the spore genus *Nuskoisporites* Pot. & Kl. *Palaeobotanist* **12** : 147-163.

Lele KM 1965. Studies in the Talchir flora of India-3. *Stellapollenites* : a new monosaccate pollen genus from the South Rewa Gondwana Basin. *Palaeobotanist* **13** : 109-113.

Lele KM 1966. Studies in the Talchir flora of India-4. Quest for the early traces and subsequent development of the Glossopteris flora in the Talchir Stage. *Symp. Floristics Stratigr. Gondwanaland (1964)* : 85-97. Birbal Sahni Institute of Palaeobotany, Lucknow.

Lele KM 1974. Palaeozoic monosaccate miospores. *In* Surange KR *et al.* (editors)—*Aspects & Appraisal of Indian Palaeobotany* : 232-252. Birbal Sahni Institute of Palaeobotany, Lucknow.

Lele KM 1975. Studies in the Talchir flora of India-10. Early and Late Talchir microfloras from the West Bokaro Coalfield, Bihar. *Palaeobotanist* **22** : 219-235.

Lele KM & Chandra A 1973. Studies in the Talchir flora of India-8. Miospores from the Talchir Boulder Bed and overlying needle shales in the Johilla Coalfield (M.P.), India. *Palaeobotanist* **20** : 39-47.

Lele KM & Karim R 1971. Studies in the Talchir flora of India-6. Palynology of the Talchir Boulder Bed in Jayanti Coalfield, Bihar. *Palaeobotanist* **19** : 52-69.

Lele KM & Maithy PK 1964. An unusual monosaccate spore from Karharbari Stage, Giridih Coalfield, India. *Palaeobotanist* **12** : 307-312.

Lele KM & Maithy PK 1969. Miospore assemblage of the Ganjra Nalla beds, South Rewa Gondwana Basin, with some remarks on the age of the beds. *Palaeobotanist* **17** : 298-309.

Lele KM & Makada R 1972. Studies in the Talchir flora of India-7. Palynology of the Talchir Formation in the Jayanti Coalfield, Bihar. *Geophytology* **2** : 41-73.

Lele KM & Makada R 1974. Palaeobotanical evidences on the age of the coal-bearing Lower Gondwana Formation in the Jayanti Coalfield, Bihar. *Palaeobotanist* **21** : 81-106.

Lele KM & Shukla M 1980. Studies in the Talchir flora of India-12. Palynology of the Talchir Formation of Hutar Coalfield. *Geophytology* **10** : 231-238.

Lele KM & Srivastava AK 1977. A mioflora of Barren Measures age from the Auranga Coalfield Bihar. *Palaeobotanist* **24** : 118-124.

Lele KM & Srivastava AK 1980. Lower Gondwana (Karharbari to Raniganj Stage) miofloral assemblages from the Auranga Coalfield and their stratigraphical significance. *In Proc. 4th int. palynol. Conf., Lucknow (1976-77)* **2** : 152-164. Birbal Sahni Institute of Palaeobotany, Lucknow.

Lukose NG 1972. Palynological evidence on the age of Lathi Formation, western Rajasthan, India. *In* Ghosh AK *et al.* (editors)—*Proc. Seminar Palaeopalynol. Indian Stratigr., Calcutta (1971)*: 155-166.

Mädler K 1964. Die geologische Verbreitung von sporen und pollen in der Deutschen Trias. *Beih. geol. Jb.* **65** : 1-147.

Maheshwari HK 1967. Studies in the Glossopteris flora of India-29. Miospore assemblage from the Lower Gondwana exposures along Bansoli River in Rajmahal Hills, Bihar. *Palaeobotanist* **15** : 258-280.

Maheshwari HK 1974. Lower Cretaceous palynomorphs from the Bansa Formation, South Rewa Basin, India. *Palaeontographica* **B146** : 21-55.

Maheshwari HK & Banerji J 1975. Lower Triassic palynomorphs from the Maitur Formation, West Bengal, India. *Palaeontographica* **B152** (4-6) : 149-190.

Maheshwari HK & Jana BN 1983. Cretaceous spore pollen complexes from India. *In* Maheshwari HK (Editor)—*Proc. Symp. on Cretaceous of India : Palaeoecology, palaeogeography and time boundaries* : 158-192. Indian Association of Palynostratigraphers, Lucknow.

Maheshwari HK & Jana BN 1988. Palynozonation of Jhuran and Bhuj formations in Kutch Basin. *Palaeobotanist* **36** : 177-182.

Maheshwari HK & Kar RK 1967. *Tiwariasporis* gen. nov. : a new spore genus from the Permian of Congo and India. *Curr. Sci.* **36** (14) : 369-370.

Maheshwari HK & Kumaran KPN 1979. Upper Triassic sporae disporsae from the Tiki Formation-1 : miospores from the Son River Section between Tharipathar and Ghiar, South Rewa Gondwana Basin. *Palaeontographica* **B171** (4-6) : 137-164.

Maheshwari HK, Kumaran KPN & Bose MN 1978. The age of the Tiki Formation with remarks on the miofloral succession in the Triassic Gondwana of India. *Palaeobotanist* **25** : 254-265.

Maithy PK 1965. Studies in the Glossopteris flora of India-27. Sporae dispersae from the Karharbari beds in the Giridih Coalfield, Bihar. *Palaeobotanist* **13** : 291-307.

Mandal J & Maithy PK 1981. Palaeobotany of Tattitola Bed in Pachwara Coalfield, Santhal Pargana, Bihar with remarks on the age of the bed. *Palaeobotanist* **27** : 12-20.

McDougall I & McElhinny MW 1970. The Rajmahal Traps of India : K-Ar ages and palaeomagnetism. *Earth and Planet. Sci. Letters* **9** : 371-378.

Nilsson T 1958. Uber das Vorkommen eines mesozoischen Sapropelgesteins in Schonen. *Lunds Universitats Arsskrift.* N.F., Avd. 2, **54** : 1-112.

Playford G 1971. Lower Carboniferous spores from the Bonaparte

Gulf Basin, Western Australia and Northern Territory. *Bull. Bur. Miner. Resour. Geol. Geophys. Aust.* **115** : 1-104.

Pocock SAJ 1962. Microfloral analysis and age determination of strata at the Jurassic-Cretaceous boundary in the Western Canada plains. *Palaeontographica* **B111** (1-3) : 1-95.

Pocock SAJ & Jansonius J 1961. The pollen genus *Classopollis* Pflug 1953. *Micropaleontology* **7** (4) : 639-449.

Potonié R 1956. Synopsis der Gattungen der Sporae dispersae Pt. I *Beih. geol. Jb.* **23** : 1-103.

Potonié R & Kremp G 1955. Die Sporae dispersae des Ruhrkarbons, ihre Morphographie und Stratigraphie mit Ausblicken auf Arten anderer Gebiete und Zeitabschnitte. *Palaeontographica* **B98** (1-3) : 1-136.

Potonié R & Lele KM 1961. Studies in the Talchir flora of India-1. Sporae dispersae from the Talchir beds of South Rewa Gondwana Basin. *Palaeobotanist* **8** : 22-37.

Rana V & Tiwari RS 1980. Palynological succession in Permian-Triassic sediments in bore-hole RNM-3, East Raniganj Coalfield, West Bengal. *Geophytology* **10** : 108-124.

Reinhardt P 1964. Über die sporae dispersae der Thüringer Trias. *Monatsber, Dtsch, Akad. Wiss. Berlin* **6** : 46-56.

Rigby JF & Hekel H 1977. Palynology of the Permian sequence in the Springsure Anticline, Central Queensland. *Publs. geol. Surv. Qd.* **363**, *Palaeont. Pap.* **37** : 1-76.

Rouse GE 1957. The application of a new nomenclatural approach to Upper Cretaceous plant microfossils from Western Canada. *Can. J. Bot.* **35** : 349-375.

Sah SCD & Jain KP 1965. Jurassic spores and pollen grains from the Rajmahal Hills, Bihar, India : with a discussion on the age of the Rajmahal Intertrappean beds. *Palaeobotanist* **13** : 264-290.

Sastry MVA, Acharyya SK, Shah SC, Satsangi PP, Ghosh SC, Raha PK, Singh G & Ghosh RN 1977. Stratigraphic Lexicon of Gondwana Formation of India. *Geol. Surv. India Misc. Publ.* No. 36 : 1-170.

Sastry VV, Venkatachala BS & Narayanan V 1981. The evolution of the East Coast of India. *Palaeogeog. Palaeoclimat. Palaeoecol.* **36** : 23-54.

Scheuring BW 1970. Palynologische und palynostratigraphische Untersuchungen des Keupers im Bolchentunnel (Solothurner Jura). *Schweizerische Paläontologische Abh.* **88** : 1-119.

Schoch RM 1989. *Stratigraphy principles and methods.* Van Nostrand Reinhold, New York.

Schultz E 1967. Sporenpaläontologische unterschungen rätoliassischer Schichten im Zentralteil des Germanischen Beckens. *Paläontologische Abhandlungen* Abt B (*Paläobotanik*) **2**, **3** : 542-633.

Sengupta S 1988. Upper Gondwana stratigraphy and palaeobotany of Rajmahal Hills, Bihar, India. *Geol. Surv. India, Palaeont. indica* **48** : 1-182.

Singh C 1964. Microflora of the Lower Cretaceous Mannville Group, east Central Alberta. *Res. Counc. Alberta Bull.* **15** : 1-238.

Singh HP & Kumar P 1966. Some observations on the genus *Contignisporites* Dettmann 1963. *Palaeobotanist* **15** : 93-97.

Singh HP, Srivastava SK & Roy SK 1964. Studies on the Upper Gondwana of Cutch. 1-Mio-and macrospores. *Palaeobotanist* **12** : 282-306.

Singh HP & Venkatachala BS 1988. Upper Jurassic-Lower Cretaceous spore-pollen assemblages in the peninsular India. *Palaeobotanist* **36** : 168-196.

Singh V & Tiwari RS 1982. Pattern of miofloras through Permo-Triassic transition in Bore-hole RAD-2, East Raniganj Coalfield, W. Bengal. *Geophytology* **12** : 181-186.

Sinha V 1972. Sporae dispersae from Jhingurdah Seam, Singrauli Coalfield (M.P.), India. *Palaeobotanist* **19** : 175-201.

Srivastava SK 1966. Jurassic microflora from Rajasthan, India. *Micropaleontology* **12** : 87-103.

Srivastava S C 1970. Miofloral investigations in some coals of Talcher Coalfield (Orissa), India. *Palaeobotanist* **18** : 154-166.

Tiwari RS 1964. New miospore genera in the coals of Barakar Stage (Lower Gondwana) of India. *Palaeobotanist* **12** : 250-259.

Tiwari RS 1965. Miospore assemblage in some coals of Barakar Stage (Lower Gondwana) of India. *Palaeobotanist* **13** : 168-214.

Tiwari RS 1968. Palynological investigations of some coal seams in the Ib-River Coalfield, Orissa, India. *Palaeobotanist* **16** : 222-242.

Tiwari RS 1973a. *Scheuringipollenites*, a new name for the Gondwana sporomorphs so far assigned to "*Sulcatisporites* Leschik 1955" *Senckenb. Leth.* **54** (1) : 105-117.

Tiwari RS 1973b. Palynological succession in the Barakar type area. *Geophytology* **3** : 166-183.

Tiwari RS 1974a. Palaeozoic Cryptogamic spores. *In* Surange KR, Lakhanpal RN & Bharadwaj DC (editors)—*Aspects & Appraisal of Indian Palaeobotany* : 84-99. Birbal Sahni Institute of Palaeobotany, Lucknow.

Tiwari RS 1974b. Palaeozoic disaccate pollen. *In* Surange KR, Lakhanpal RN & Bharadwaj DC (editors)—*Aspects & Appraisal of India Palaeobotany* : 253-269. Birbal Sahni Institute of Palaeobotany, Lucknow.

Tiwari RS, Kumar P & Tripathi A 1984. Palynodating of Dubrajpur and Intertrappean beds in subsurface strata of north-eastern Rajmahal Basin. *In* Tiwari RS *et al.* (editors)—*Proc. V Indian geophytol. Conf., Lucknow (1984)* : 207-225. The Palaeobotanical Society, Lucknow.

Tiwari RS & Ram-Awatar 1989. Sporae dispersae and correlation of Gondwana sediments in Johilla Coalfield, Son Valley Graben, Madhya Pradesh. *Palaeobotanist* **37** : 94-114.

Tiwari RS & Rana V 1980. A Middle Triassic mioflora from India. *Biol. Mem.* **5** : 30-55.

Tiwari RS & Rana V 1981. Sporae dispersae of some Lower and Middle Triassic sediments from Damodar Basin, India. *Palaeobotanist* **27** : 190-220.

Tiwari RS & Rana V 1984. Palynodating of Permian and Triassic sediments in two bore-holes from the eastern limits of Raniganj Coalfield, West Bengal. *In* Sharma AK *et al.* (editors)—*Proc. Evolutionary botany and biostratigraphy, Calcutta (1979), Curr. Trends in Life Sci.* **10** : 425-449. Today & Tomorrow Publishers & Print., Delhi.

Tiwari RS & Singh V 1981. Morphographic study of some dispersed trilete miospores (Infraturma-Varitrileti) from Lower Gondwana of India. *Palaeobotanist* **27** : 252-296.

Tiwari RS & Singh V 1983. Miofloral transition at Raniganj-Panchet boundary in East Raniganj Coalfield and its implication on Permo-Triassic time boundary. *Geophytology* **13** : 227-234.

Tiwari RS & Singh V 1984. Morphographic study of *Jugasporites* Complex. *In* Tiwari RS *et al.* (editors)—*Proc. V Indian geophytol Conf., Lucknow (1983)* : 169-206. The Palaeobotanical society, Lucknow.

Tiwari RS & Singh V 1986. Palynological evidences for Permo-Triassic boundary in Raniganj Coalfield, Damodar Basin, India. *Bull. geol. Min. metall. Soc. India* **54** : 256-264.

Tiwari RS, Srivastava SC, Tripathi A & Singh V 1981. Palynostratigraphy of Lower Gondwana sediments in Jharia Coalfield, Bihar. *Geophytology* **11** : 220-237.

Tiwari RS, Srivastava SC, Tripathi A & Vijaya 1989. Morphographic study of Permian palynomorphs : *Callumispora, Parasaccites, Crucisaccites* and *Faunipollenites*. *Palaeobotanist* **37** : 215-266.

Tiwari RS & Tripathi A 1984. A report of Raniganj mioflora from sediments of Dubrajpur Formation in Brahmini Coalfield, Rajmahal Basin. *Geophytology* **14** : 244-245.

Tiwari RS & Tripathi A 1987. *Dubrajisporites,* a new trilete reticulate miospore genus from Late Triassic of the Rajmahal Basin, India. *Alcheringa* **11** : 139-149.

Tiwari RS & Tripathi A 1988. Palynological zones and their climatic inference in the coal-bearing Gondwana of peninsular India. *Palaeobotanist* **36** : 87-101.

Tiwari RS, Tripathi A & Kumar P 1984. *Rajmahalispora,* a new cingulate spore genus from the Triassic of Rajmahal Basin, India. *Palaeobotanist* **32** : 188-196.

Tiwari RS & Vijaya 1988. Reflection of relationship of Tethyan palynoflora. *Palaeobotanist* **36** : 339-353.

Tiwari RS & Vijaya 1992. Permo-Triassic boundary on the Indian peninsula. *In* Sweet WC *et al.* (editors)—*Permo-Triassic events in the Eastern Tethys* : 37-45. Cambridge University Press, Cambridge.

Tripathi A 1989. Palynological evidence for the presence of Upper Permian sediments in the northern part of Rajmahal Basin, Bihar. *J. geol. Soc. India* **34** : 198-207.

Tripathi A 1991. Advent of angiospermous pollen in India and its spatial relationship in Gondwanaland. *In* Findlay, RH *et al.* (editors)—*Gondwana* **8** : *assembly, evolution and dispersal.* A. A. Balkema, Rotendam.

Tripathi A & Tiwari RS 1991. Early Cretaceous angiospermous pollen from the Intertrappean beds of Rajmahal Basin. *Palaeobotanist* **39** : 50-56.

Tripathi A, Tiwari RS & Kumar P 1990. Palynology of the subsurface Mesozoic sediments in Rajmahal Basin, Bihar. *Palaeobotanist* **37** : 367-388.

Venkatachala BS 1969. Palynology of the Mesozoic sediments of Kutch-4 : spores and pollen from the Bhuj exposures near Bhuj, Gujarat. *Palaeobotanist* **17** : 208-219.

Venkatachala BS 1972. Observation on some palynological contributions to Indian stratigraphy. *Palaeobotanist* **19** : 284-296.

Venkatachala BS 1974. Palynological zonation of the Mesozoic and Tertiary subsurface sediments in the Cauvery Basin. *In* Surange KR, Lakhanpal RN & Bharadwaj DC (editors)—*Aspects & Appraisal of Indian Palaeobotany* : 476-496. Birbal Sahni Institute of Palaeobotany, Lucknow.

Venkatachala BS & Kar RK 1964. *Schizopollis* Venkatachala & Kar : a new pollen genus from the Permian of North Karanpura Coalfield, Bihar, India. *Grana Palynol.* **5** (3) : 413-424.

Venkatachala BS & Kar RK 1965. Two new trilete spore genus from the Permian of India. *Palaeobotanist* **13** : 337-340.

Venkatachala BS & Kar RK 1966a. *Divarisaccus* gen. nov. : a new saccate pollen genus from the Permian sediments of India. *Palaeobotanist* **15** : 102-106.

Venkatachala BS & Kar RK 1966b. *Corisaccites* gen. nov. : a new saccate pollen genus from the Permian of Salt Range, West Pakistan. *Palaeobotanist* **15** : 107-109.

Venkatachala BS & Kar RK 1968a. Palynology of the Karanpura sedimentary basin, Bihar, India-1 : Barakar Stage at Badam. *Palaeobotanist* **16** : 56-90.

Venkatachala BS & Kar RK 1968b. Palynology of Kathwai shales, Salt Range, West Pakistan-1. shales 25 ft above the Talchir Boulder bed. *Palaeobotanist* **16** : 156-166.

Venkatachala BS & Kar RK 1968c. Palynology of the North Karanpura Basin, Bihar, India-2 : Barakar exposures near Lungatoo, Hazaribagh District. *Palaeobotanist* **16** : 258-269.

Venkatachala BS & Kar RK 1969. Palynology of the Mesozoic sediments of Kutch, W. India-6 : three new species of *Applanopsis* with remarks on the morphology of the genus. *In* Santapau H *et al.* (editors)—*J. Sen Mem. Vol.* : 33-44. Botanical Society Bengal, Calcutta.

Venkatachala BS & Kar RK 1970. Palynology of the Mesozoic sediments of Kutch, W. India-10. Palynological zonation of Katrol (Upper Jurassic) and Bhuj (Lower Cretaceous) sediments in Kutch, Gujarat. *Palaeobotanist* **18** : 75-86.

Venkatachala BS & Kar RK 1972. Palynology of the Mesozoic sediments of Kutch, W. India-9. Palynological fossils from the Bhuj exposures near Dayapar, Kotch District, Gujarat State. *In* Ghosh AK *et al.* (editors)—*Proc. Sem. Palaeopalynol. Indian Stratigr., Calcutta (1971)* : 166-171.

Venkatachala BS, Kar RK & Raza S 1969. Palynology of the Mesozoic sediments of Kutch, W. India-5. Spores and pollen from Katrol exposures near Bhuj, Kutch District, Gujarat State. *Palaeobotanist* **17** : 184-207.

Venkatachala BS, Sharma KD & Jain AK 1972. Palynological zonation of Jurassic-Lower Cretaceous sediments in the subsurface of Cauvery Basin. *In* Ghosh AK *et al.* (editors)—*Proc. Sem. Palaeopalynol. Indian Stratigr., Calcutta (1971)* : 172-187.

Venkatachala BS & Tiwari RS 1988. Lower Gondwana marine incursions : periods and pathways. *Palaeobotanist* **36** : 24-29.

Virkki C 1937. On the occurrence of winged spores in the Lower Gondwana rocks of India and Australia. *Proc. natn. Acad. Sci. India* **6** : 428-431.

Visscher H 1966. Palaeobotany of the Mesophytic-III Plant microfossils from the Upper Bunter of Henglo, The Netherlands. *Acta Bot. neerl.* **15** : 316-375.

Wilson LR 1962. Permian plant microfossils from the Flowerpot Formation, Creer Country. Oklahoma. *Okla. geol. surv. Circ.* **49** : 5-50.

Wilson LR & Webster RM 1946. Plant microfossils from a Fort Union coal of Montana. *Amer. J. Bot.* **33** : 271-278.