PHYTOSTRATIGRAPHICAL SUCCESSION IN THE *GLOSSOPTERIS* FLORA OF INDIA

SUCESSÃO FITOESTRATIGRÁFICA NA FLORA DE GLOSSOPTERIS DA ÍNDIA

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Resumo: O nível no qual a Flora de *Glossopteris* apareceu não é conhecido na Índia. Restos fragmentados de plantas, esporos e grãos de pólen têm sido registrados, provenientes de camadas diretamente sobrepostas a camadas com matações glaciais. Os fósseis vegetais mais antigos conhecidos são gimnospermas e são representados por espécies de *Gangamopteris* e *Pantophyllum*. A assembléia palinológica a partir desse nível é dominada por grãos de pólen monossacados. A assembléia sucessiva mostra um crescimento no número de espécies de *Glossopteris*, e o primeiro aparecimento de pteridófitas bem definidas na flora. Os carvões gondvânicos mais antigos foram depositados nesse nível. A zona seguinte é constituída por uma macro-assembléia dominada por verdadeiras *Glossopteris*, e a assembléia palinológica reflete um aumento nítido na percentagem de grãos de pólen dissacados estriados. É seguido por uma macro-assembléia muito empobrecida que, entretanto, é rica em grãos de pólen *Densipollenites*. A assembléia mais jovem é a mais rica em variedades e números de pteridófitas e gimnospermas, que é refletida tanto na macro como na microflora.

Palavras-chave: Flora de *Glossopteris*; Gondwana; India.

Abstract: The level at which the *Glossopteris* Flora appeared in India is not known. Fragmentary remains of plants and spore-pollen have been reported from the beds directly overlying the glacial boulder bed. The earliest known plant fossils are gymnospermous and are represented by species of *Gangamopteris* and *Pantophyllum*. The palynological assemblage from this level is predominated by monosaccate pollen. The succeeding assemblage shows an increase in the number of *Glossopetris* species, and the first appearance of definite *pteridophytes* in the flora. Oldest Gondwana coals were laid down at this level. The next zone is a true *Glossopteris* dominated assemblage, the palynological assemblage reflecting a marked increase in the percentage of disaccate-striate pollen. It is followed by a very impoverish assemblage which, however, is rich in *Densipollenites* pollen. The younger assemblage is richest in variety and numbers of pteridophytes and gymnosperms, which is reflected in macro- and micro-flora.

Keywords*: Glossopteris* Flora; Gondwana; India.

INTRODUCTION

The late Late Carboniferous glaciation that covered most of the Indian Peninsula was followed by the deposition of a great thickness of sediments, primarily in a fresh-water fluviatile/lacustrine environment. These deposits, which were first identified in central India, overlie the Vindhyan Supergroup with a major hiatus spanning

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Ordovician to Late Carboniferous (Wadia 1975). There were occasional incursions of the sea in the Early Permian that left intermittent marine deposits, such as, those along the Son-Narmada lineament (Kapoor & Maheshwari 1991, Figure 2d). Henry Benedict Medlicott (1872, see Holland 1926, p. 78) of the Geological Survey of India (GSI) named this sequence as the Gondwana System in the draft of his report on the Satpura Basin. Ottokar Feistmantel formally resurrected the name Gondwana System in 1876.

As a result of Feistmantel's (1876-1882) monumental studies on the flora of this sequence, at least three successive floras could be identified which were covered by an all encompassing term the Gondwana Flora. Though Medlicott visualised the Gondwana (sequence) purely as a stratigraphical unit, Feistmantel and later investigators gave more importance to the contained plant fossils. Thus, in later years the coastal marine sediments with a *Ptilophyllum* association and the Himalayan marine sediments with a *Glossopteris* association also became part of the Gondwana 'System'.

In 1984, the Geological Survey of India undertook an exercise to bring precision in the definition of the term Gondwana in the stratigraphic sense and came out with a recommendation (Kapoor & Singh 1988). The recommendation had two major drawbacks, (i) it made provision for identification of Gondwana stratigraphic units on the basis of floral/faunal remains having Gondwanan affinity; though the *Ptilophyllum* association can not be said to be an exclusively Gondwanan flora, and (ii) it did not give weightage to the post-Mahadeva hiatus (Datta *et al.* 1983).

Venkatachala & Maheshwari (1991) reexamined the issue and formally named the sequence as the Gondwana Supergroup - "a continuous sequence of sediments laid down in the peninsular India, that comprises a glacigene unit at the base and a red-bed facies at the top, being respectively preceded and succeeded by a large hiatus. The sediments are essentially terrigenous, occasionally thin marine horizons may be intercalated. The main lithologies are tillite/tilloid, sandstone, argillaceous and carbonaceous shales and coal. The Gondwana Supergroup, on the basis of rich mega- and micro-fossils as well as rare animal remains is dated to range between basal Permian and Late Triassic, possibly including the earliest Jurassic". There is about 28 billion metric tonnes of coal in the Indian Gondwana. Another 70 billion metric tonnes is projected at depths of more than 600 meters. One to 1.5 trillion cubic meters of Coal Bed Methane is estimated to be present in the Indian Gondwana.

The standard succession of the Gondwana Supergroup in the Damodar Graben is shown in table 1.

Gondwana Supergroup	<<<<<<<<<<<<<<<<<<<<	---------- hiatus ----------
	Mahadeva Group	Supra Panchet Formation
	Panchet Group	Hirapur Formation
		Maitur Formation
	Damuda Group	Raniganj Formation
		Kulti Formation
		Barakar Formation
	Talchir Group	Talchir Formation
	<<<<<<<<<<<<<<<<<<<<	---------- hiatus ----------

TABLE 1: Gondwana Supergroup in the Damodar Group.
QUADRO 1: Supergrupo Gondwana, Grupo Damodar.

The sedimentaries of the Gondwana Supergroup, except for those of the Hirapur Formation and the Mahadeva Group, contain a characteristic floral association that shows the presence of ubiquitous leaf fossil *Glossopteris* along with other plant fossils, macro-, meso-, and micro-fossils. However, the mere presence of leaves of the genus *Glossopteris* or its allies in a sediment does not necessarily make it a part of the Gondwana Supergroup (Maheshwari & Bajpai 1988). For example, the *Glossopteris* containing beds in the Kashmir Himalaya are grouped as the Perigondwana sequence. But all these do comprise the *Glossopteris* Floral Province.

FIRST APPEARANCE OF *GLOSSOPTERIS* FLORA ON THE INDIAN SUBCONTINENT

The level at which a changeover from the *Nothorhacopteris* Flora to *Glossopteris* Flora took place on the Indian subcontinent has not been deciphered so far. The former is known only from the Himalayan region and reportedly has a remarkable resemblance with the assemblage described from Peru. Its main elements are *Pseudobumbudendron chaloneri, P. meyenii, P. fenestrata, Spondylodendron wallaramensis, Archaeosigillaria subcostata, A. minuta, Lepidosigillaria quadrata, Lepidodendropsis liddarensis, L.* sp. *cf. L. peruviana, Cyclostigma* sp. *cf. C. pacifica, Rhacopteris ovata, Triphyllopteris lescuriana, Rhodea* sp. *cf. R. subpetiolata, Nothorhacopteris argentinica, Palmatopteris* sp. *cf. P. furcata,* etc. (Gothan & Sahni 1937, Høeg *et al*. 1957, Pal & Chaloner 1979, Singh *et al*. 1982, and others).

Evidently there is not a single element in this assemblage that could be taken as a praecursor of the *Glossopteris* Flora. Even in the Salt Range of Pakistan, the Tobra Formation (Asselian) that forms the base of Gondwanan Facies unconformably overlies the Cambrian sediments. Vijaya (1998) has suggested that the Stephanian age strata may be absent on the Gondwana Supercontinent. A *Glossopteris* type leaf, however, has been reported from the NBG flora of Argentina (Lopez-Gamundi *et al*. 1992). Leary (1993) has suggested that the Late Carboniferous *Lesleya* of the Euramerican Flora is the ancestor of Permian glossopterids.

THE *GLOSSOPTERIS* FLORA OF INDIA

The major elements of the *Glossopteris* Flora of India, besides the ubiquitous *Glossopteris*, are species of a number of other genera. These are listed in appendix-1. Lycopsid macrofossils are virtually absent, except for *Cyclodendron leslii*.

The first attempt to classify the Indian Gondwana on the basis of contained plant macrofossils was evidently made by Feistmantel (1876) who recognised a lower *Glossopteris* Flora and an upper *Ptilophyllum* Flora. Feistmantel's (1882) recognition of a transitional flora containing *Thinnfeldia (=Dicroidium)* prompted Vredenberg (1910) to recognise a third unit - the *Dicroidium* Flora. Surange (1966) compiled a list of taxa reported from each formational unit of the lower Gondwana. Maheshwari (1992) recognises provincialism in the distribution of plant macrofossils.

A lot of data had been generated by the end of the 1960s on the pollen and spores contained in the Gondwana sediments. Shah, *et al.* (1971) organised the available data on plant macro- and micro-fossils and fresh-water and marine fauna and came up with a broad biostratigraphic zonation of the Indian Gondwana (*sensu lato*) comprising 5 Assemblage Zones and 11 Assemblage Sub-zones. These are represented in table 2.

Though this zonation suffers from some infirmities, yet it continues to be standard as far as macro-fossil zonation is concerned. This zonation, the part that is relevant to the *Glossopteris* Flora, is detailed below with certain modifications.

GLOSSOPTERIS FLORA - ZONATION BASED ON PLANT MACROFOSSILS

A - *GANGAMOPTERIS* ASSEMBLAGE ZONE

This zone is dominated by species of the leaf genera *Gangamopteris* and *Pantophyllum* (=*Noeggerathiopsis*). The sphenophylls and the cycadophytes are conspicuous by their absence. dominant element. A conifer-like twig *Paranocladus indica*, a seed-bearing fructification *Arberia umbellata* and a seed *Talchirospermum indicum* are restricted to this sub-zone. Recently, a number of enigmatic fossils, possibly those of bryophytes, have been reported from this zone (Chandra 1995).

The assemblage comprises equisetalean stems, *Glossopteris* indica, *Vertebraria indica*, *Gangamopteris angustifolia, G. buriadica, G. clarkeana, G. cyclopteroides* (6 varieties), *G. intermedia, G. major, G. spathulata, Pantophyllum spathulata, Maheshwariella furcata, Samaropsis goraiensis*, etc.

According to data available so far this sub-zone is restricted to the Talchir Formation of early Early Permian Age.

A2 - *BOTRYCHIOPSIS VALIDA-BURIADIA SEWARDII* ASSEMBLAGE SUB-ZONE

This sub-zone has a close affinity with the previous sub-zone in the dominance of species of the genera *Gangamopteris* and *Pantophyllum*. Species of the genera *Botrychiopsis* and *Rubidgea* are so far not known outside this sub-zone; *Buriadia sewardii* is occasionally found in younger assemblages (Banerjee 1973). Four

Age	Formation	Assemblage Zone	Assemblage Sub-zone
Wealden	Bansa	*Ptilophyllum*	*Weichselia-Onychiopsis*
U. Jurassic	Jabalpur		*Pagiophyllum-Brachyphyllum*
M. Jurassic	Rajmahal		*Dictyozamites-Pterophyllum*
Rhaetian	Parsora	*Dicroidium*	
Carnian-Norian	Tiki	*Labyrinthodont*	*Ceratodus-Metaposaurus*
			? ?
Scythian	Hirapur		*Dicynodont*
	Maitur		*Lystrosaurus*
Tatarian	Raniganj	*Glossopteris*	*G. retifera-G. Conspicua*
Kazanian	Ironstone		*Cyclodendron*
	Barakar		*Barakaria-Walkomiella*
Artinskian	Karharbari	*Gangamopteris*	*Gondwanidium-Buriadia*
Sakmarian	Talchir		*Noeggerathiopsis-Paranocladus*

TABLE 2: Biostratigraphic Zonation of the Indian Gondwana.
QUADRO 2: Zoneamento Bioestratigráfico do Gondwana Indiano.

A1 - *PANTOPHYLLUM SPATHULATA-PARANOCLADUS INDICA* ASSEMBLAGE SUB-ZONE

This sub-zone is characterised by the appearance of several elements of the *Glossopteris* Flora. Apparently there are no hold-overs from the earlier floras. *Gangamopteris* is the species of *Phyllotheca, Giridia indica* (a fertile equisetale), 11 species of *Gangamopteris*, 5 species of *Glossopteris, Ottokaria bengalensis* (a dorsiventral foliose seed-bearing fructification attached to a *Glossopteris communis*-type leaf), 11 species of *Pantophyllum, Caulophyllites indica, Paranocladus sahnii* and a number of species

of fossil seeds are restricted to this sub-zone.

This sub-zone is restricted to the basal part of the Barakar Formation (=Karharbari Formation, late Early Permian) of the peninsular Gondwana and is best expressed in the Giridih Coalfield. In the Kashmir Himalaya, equivalent of this sub-zone is found in the Nishatbagh Florule, which though lacks the characteristic plant fossils. It is interesting to note that outside India species of the genus *Botrychiopsis* are restricted to strata of latest Carboniferous to earliest Permian in age (Rigby 1989).

B - *GLOSSOPTERIS* ASSEMBLAGE ZONE

This zone has overwhelming presence of species of the leaf genus *Glossopteris*. Species of the genera *Botrychiopsis*, *Rubidgea* and *Buriadia* have disappeared and species of the genera *Gangamopteris* and *Pantophyllum* are on the way out. Sphenophylls make their first definite appearance.

B1 - *LELSOTHECA ROBUSTA-POLYSOLENOXYLON JHARIENSE* ASSEMBLAGE SUB-ZONE

In this sub-zone species of the genus *Glossopteris* become dominant, and those of the genus *Gangamopteris* are relegated to a secondary position. The sphenophyll *Trizygia speciosa* makes it first appearance, so also do the equisetale *Lelstotheca robusta*, fern *Asansolia phegopteroides*, glossopterid *Palaeovittaria kurtzii*, *Rhabdotaenia danaeoides*, *Dictyopteridium sporiferum* (a dorsiventral foliose seed-bearing fructification of the glossopterids), the conifer-like *Walkomiella indica*, *Barakaria dichotoma*, the cycadophytic *Pseudoctenis balli* and the fossil wood of *Polysolenoxylon*-type. Three species of *Sphenophyllum*, *Neomariopteris barakarensis*, 6 species of *Glossopteris*, and "solenoid wood" (for example, *Polysolenoxylon jhariense*) are restricted to this sub-zone. This sub-zone is well expressed in the Barakar Formation (late Early Permian) of Damodar Graben.

In the northern part of the Rajmahal Basin, while the general composition of flora at this level remains the same, *Barakaria* and *Walkomiella* have not been reported, and ginkgopsids, such as, *Ginkgoites*, *Rhipidopsis* and *Saportaea* are recorded (Maheshwari & Bajpai 1992). Other interesting fossils in the Rajmahal florule are *Dactylophyllum* digitata-type fronds (Bajpai 1992a,b), and branched fructifications *Veekaysinghia durgavatiae* and *Birbalsahnia divyadarshanii* (Bajpai & Maheshwari 1991). It is interesting to note that *Dactylophyllum digitata* is known from the Late Carboniferous of Australia (Morris 1975). From a level in this section, a palynoflora containing *Potonieisporites* and *Hamiapollenites* has been recovered (unpublished). It is to be noted that elsewhere in India, species of the genus *Potonieisporites* are confined to the Early Permian strata and those of the genus *Hamiapollenites* to the Late Permian strata.

In the Kashmir Himalaya, this sub-zone is represented in the Mamal Formation (late Early Permian), which also contains some Cathaysian-type elements, for example, *Sphenophyllum thonii*, *Lobatannularia* spp., *Kashmiropteris meyenii*, *Kawizophyllum dunpathrensis*, *Taeniopteris kashmirensis*, *Psygmophyllum* spp., etc.

B2 - *CYCLODENDRON LESLII* ASSEMBLAGE SUB-ZONE

This sub-zone is extremely poor in macrofossil contents. A few species of the genus *Glossopteris* are on record. The lycopod species *Cyclodendron leslii* Kräusel is restricted to this sub-zone, that too in the ironstone shale band of Barren Measures (=Kulti Formation) in the Jharia Coalfield.

B3 - *BELEMNOPTERIS WOODMASONIANA-RANIGANJIA BENGALENSIS* ASSEMBLAGE SUB-ZONE

In this sub-zone species of the genus *Glossopteris* predominate, both in variety and number of individuals; about 40 species of the genus are restricted to this zone. Species of the genera *Dictyopteridium*, *Palaeovittaria* and *Rhabdotaenia*, which appeared in the *Lelstotheca robusta-Polysolenoxylon jhariense* Assemblage Sub-zone, are better expressed here. Fossil wood does not have any secretory canals, though over 25 species have been reported. *Kendostrobus cylindricus*, possibly a male fructification of the Dictyopteridiumaceae, has so far been reported only from this zone. Seed-bearing fructifications of the Dictyopteridiumaceae found in this zone include *Gonophylloides indicus*, *Jambadostrobus pretiosus*, *Ottokaria raniganjensis*, *Plumsteadia indica*, *P. lanceolata*, *Scutum spp.*, *Senotheca murulidihensis*, *Venustostrobus ghusikensis*, *V. indicus*, etc.

This sub-zone includes floras from the Raniganj Formation (Late Permian) of the Damodar Graben.

B4 - *ERETMONIA UTKALENSIS-LIDGETTONIA INDICA* ASSEMBLAGE SUB-ZONE

The floristic composition of this sub-zone is more or less similar to that of the *Belemnopteris woodmasoniana-Raniganjia bengalensis* Assemblage Sub-zone. More than a dozen species of *Glossopteris* are restricted to this sub-zone. This sub-zone is characterised by the almost exclusive representation of fructifications of the Eretmoniaceae. These include *Eretmonia hinjridaensis*, *E. ovata*, *E. utkalensis*, *Glossotheca immanis*, *G. orissiana*, *G. utkalensis*, *Lidgettonia indica* and *L. mucronata*. Other fructification species restricted to this sub-zone include *Denkania indica*, *Scutum elongatum*, *S. indicum*, *S. sahnii and Utkalia dichotoma*.

This sub-zone is best represented in the Hinjir Formation of Mahanadi Graben (late Late Permian, equivalent to upper part of Raniganj Formation of Damodar Graben and lower part of Kamthi Formation of Godavari Graben).

B5 - *GLOSSOPTERIS SENII-LEPIDOPTERIS INDICA* ASSEMBLAGE SUB-ZONE

This zone is marked by the first appearance of species of the genus *Lepidopteris* and rapid decline of species of the genus *Glossopteris*. Important elements of this sub-zone are *Rhabdotaenia*, *Nidistrobus*, *Satsangia* (a glossopterid fructification), and possibly *Dicroidium*. This sub-zone (*Gopadia-Glottolepis-Dicroidium* Assemblage Zone of Sukh-Dev 1988) is recognised only in the lower part of Pali Formation (latest Permian to earliest Triassic) exposed in the Gopad River near Nidhpuri hamlet in South Rewa Basin. Maheshwari & Chandra (1994) date this zone as late Late Permian on the basis of contained plant macro- and palyno-fossils.

B6 - *DICROIDIUM-GLOSSOPTERIS* ASSEMBLAGE SUB-ZONE

This sub-zone (*Lepidopteris-Dicroidium-Glossopteris*

Assemblage Zone of Sukh-Dev 1988) is equivalent to the *Lystrosaurus* Assemblage Sub-zone of Shah *et al*. This sub-zone is characterised by the concurrent presence of the genera *Dicroidium* and *Glossopteris*, along with *Schizoneura gondwanensis, Trizygia speciosa, Neomariopteris* spp., *Vertebraria indica, Rhabdotaenia* sp., *Pseudoctenis* sp., *Lepidopteris* sp., etc. It has been dated as early Early Triassic.

Elements of the *Glossopteris* Flora are not found above this level.

GLOSSOPTERIS FLORA - ZONATION BASED ON SPORES AND POLLEN

After the initial publication on pollen and spores contained in the Indian Gondwana sedimentaries by Virkki (1937), a comprehensive database has evolved on the palynofossils during the last six decades. Genera of microspores and pollen are listed in appendix-2. Earlier zonation schemes were basically enumeration of taxa specific to each formation (Bharadwaj 1970, Venkatachala 1972, Maheshwari *et al.* 1978, Tiwari & Tripathi 1988). Only recently attempts have been made to identify palynological zones on the basis of composition of palynological assemblages and distribution of morphographical characters.

Vijaya & Tiwari (1992) identified eight biohorizons in the Gondwana Supergroup on the basis of FADs and LADs of palynofossils. These are (in ascending order):

Biohorizon -VIII : Striate-disaccate extinction Phase;
Biohorizon -VII : *Lunatisporites-Playfordiaspora* Phase;
Biohorizon -VI : Monosaccate extinction Phase;
Biohorizon -V : *Corisaccites* Phase;
Biohorizon -IV : *Densipollenites-Barakarites* Phase;
Biohorizon -III : *Crucisaccites-Tuberisaccites* Phase;
Biohorizon -II : *Crescentipollenites-Rugasaccites* Phase;
Biohorizon -I : *Potonieisporites-Cannanoropollis* Phase.

These biohorizons demarcate eight interbiohorizons zones, namely:

8. *Playfordiaspora* Interbiohorizon Zone (Maitur Formation, upper part of T_1, T_2 and base of T_3): Distinctive appearance of the genus *Playfordiaspora*, dominance of apiculate trilete spores and taeniate pollen.

7. *Klausipollenites* Interbiohorizon Zone (uppermost Raniganj Formation and lower part of Maitur Formation, top of P_2 and lower of T_1): appearance of disaccate taeniate pollen.

6. *Verticipollenites* Interbiohorizon Zone (Kulti and Raniganj Formations, P_2).

5. *Barakarites* Interbiohorizon Zone (Barakar Formation, upper part of P_1): Monosaccate elements on the wane, disaccate-nonstriate pollen with simple organisation diversify.

4. *Densipollenites* Interbiohorizon Zone (uppermost Karharbari and lowermost Barakar Formations, Artinskian-Kungurian): Absence of characteristic elements of Interbiohorizon 3.

3. *Crucisaccites* Interbiohorizon Zone (lower upper Talchir Formation to upper Karharbari Formation, Early Sakmarian to Late Artinskian): Characteristic elements are *Crucisaccites, Stellapollenites, Corisaccites* and *Guttulapollenites*.

2. *Parasaccites* Interbiohorizon Zone (lower Talchir to lower part of upper Talchir Formation, Late Asselian to Early Sakmarian): First appearance of disaccate-striate pollen, dominance of *Parasaccites*, appearance of double-folds on the central body of *Potonieisporites*.

1. *Potonieisporites* Interbiohorizon Zone (lowest part of Lower Talchir Formation, Early to early Late Asselian): Characteristic elements - *Potonieisporites, Plicatipollenites, Parasaccites* and *Cannanaropollis*. Disaccate-striate pollen absent.

Tiwari & Tripathi (1992) collated data on the distribution of spore/pollen species in the Indian Gondwana and came up with a palynozonation scheme that is outlined below.

11. *Playfordia cancellosa* Assemblage Zone (=Playfordiaspora cancellosa Assemblage + *Decisporits variablis* Assemblage of Maheshwari *et al.* 1978, Maitur Formation, Scythian): Disaccate-striate pollen decline, disaccate-taeniate pollen become more prominent, some new cavate-zonate and apiculate spore species appear. Important taxa are *Lundbladispora wartii, L. densispinosa, L. microconata, Convertubisporites contactus, Triplexisporites playfordii, Verrucosisporites narmianus, Densoisporites playfordii, Playfordiaspora, Ringosporites ringus, Crescentipollenites fuscus, Lunatisporites pellucidus, L. ovatus, L. noviaulensis,* etc.

10. *Klausipollenites schaubergeri* Assemblage Zone (=*Klausipollenites schaubergeri* Assemblage of Maheshwari *et al.* 1978, lower Maitur Formation, Early Scythian): Base of this assemblage zone is marked by the appearance of *Verrucosisporites triassicus, V. narmianus* and *Lunatisporites pellucidus*. *Indotriradites mamillatus, Verrucosisporites densus, Lundbladispora baculata, L. densispinosa* disappear within the zone. Important elements are *Callumispora fungosa, Lundbladispora brevicula, Densoisporites playfordii, Playfordiaspora cancellosa, Alisporites asansoliensis, Klausipollenites schaubergeri, Lunatisporites diffusus, L. ovatus, Gondwanipollenites decorus,* and *Crescentipollenites fuscus.*

9. *Densipollenites magnicorpus* Assemblage Zone (Raniganj Formation, latest Permian): *Gondisporites reticulatus, Klausipollenites schaubergeri and Lunatisporites diffusus* appear at the base of this zone, whereas *Gondisporites raniganjensis* and *Densipollenites magnicorpus* disappear at the top of the zone. Important taxa of this zone are *Lundbladispora brevicula, Gondisporites reticulatus, Densipollenites* spp., *Crescentipollenites* spp. and *Welwitschiapites tenuis*.

8. *Gondisporites raniganjensis* Assemblage Zone (Raniganj Formation, upper Late Permian): *Distriomonosaccites ovalis, Hamiapollenites bilateris* and *Verticipollenites oblongus* disappear at the base of this zone. The top of the zone is marked by appearance of *Lundbladispora brevicula, Playfordiaspora cancellosa* and

Lunatisporites diffusus. Other significant taxa in this zone are *Indospora clara, Cyclobaculisporites minimus, Microfoveolatispora gondwanensis* and *Gondisporites raniganjensis.*

7. *Densisporites densus* Assemblage Zone (Kulti Formation, lower Late Permian): First occurrence of *Densipollenites densus* defines the base of the zone, while *Didecitriletes ericianus*, *Verticipollenites oblongus* and *Hamiapollenites bilateris* appear at the top of the zone. Significant taxa of this zone are *Verrucosisporites ambiplicatus, Gondisporites raniganjensis, Bharadwajipollis striatus, Densipollenites* spp., *Striatites notus* and *S. communis*.

6. *Protohaploxypinus varius* Assemblage Zone (upper Barakar Formation, late Early Permian): *Cyclogranisporites gondwanensis, Didecitriletes horridus, Horriditriletes curvibaculosus, Gondwanipollenites tiwarii* and *Schizopollis disaccoides* appear at the base of the zone, while *Cyclobaculisporites minimus, Gondisporites raniganjensis, Densipollenites densus, Gondwanipollenites ovatus* and *Verticipollenites crassus* appear at the top of the zone. Important taxa are *Cyclogranisporites gondwanensis, Brevitriletes communis, Microbaculispora tentula, M. gondwanensis, M. indica, Barakarites indicus, Striomonosaccites ovatus, Corisaccites alutas, Striatites communis, Lahirites rarus* and *Vittatina lata*.

5. *Scheuringipollenites barakarensis* Assemblage Zone (lower Barakar Formation, late Early Permian): The base of the zone is marked by the appearance of *Indotriradites sparsus, Densipollenites indicus, Rhizomaspora indica* and *Striatites communis*, while the top is demarcated by the first appearance of *Horriditriletes curvibaculosus, Corisaccites alutas* and *Barakarites indicus*. *Scheuringipollenites* spp. are abundant throughout the zone. Associated taxa include *Corisaccites vanus, Striasulcites tectus, Weylandites lucifer, Paravesicaspora indica, Primuspollenites levis*, etc.

4. *Crucisaccites monoletus* Assemblage Zone (Karharbari Formation, late Early Permian): *Tiwariasporis gondwanensis, Marsupipollenites triradiatus, Welwitschiapites magnus* and *Stellapollenites talchirensis* appear at the base of the zone, and *Indotriradites korbaensis, Dentatispora gondwanensis and Rhizomaspora indica* appear at the top of the zone. Monosaccate pollen are abundant. Associated palynotaxa include *Callumispora gretensis, C. barakarensis, Verrucosisporites donarii, Parasaccites obscurus, P. korbaensis, Crucisaccites monoletus, C. latisulcatus, Caheniasaccites decorus, Crescentipollenites rhombicus, C. limpidus*, etc.

3. *Parasaccites korbaensis* Assemblage Zone ((Talchir Formation, early Early Permian): Appearance of *Divarisaccus lelei* marks the base of the zone and first appearance of *Crucisaccites monoletus* marks the top of the zone. Other palynotaxa comprising the assemblage are *Callumispora gretensis, Jayantisporites indicus, J. seudozonatus, Parasaccites korbaensis, Tuberisaccites indicus, Circumstriatites obscurus*, etc.

2. *Plicatipollenites gondwanensis* Assemblage Zone (Talchir Formation, early Early Permian): *Crescentipollenites fuscus, Tuberisaccites tuberculatus* and *Caheniasaccites densus* appear at the base of the zone, while *Microbaculispora tentula* and *Microfoveolatispora foveolata* appear at the top of the zone at which level *Parasaccites densicorpus* and *Potonieisporites crassus* disappear.

1. *Potonieisporites neglectus* Assemblage Zone (Talchir Formation, early Early Permian): Disaccate-striate pollen are not on record from this zone which has a predominance of radial monosaccate pollen. Important constituents are *Plicatipollenites gondwanensis, P. indicus, Parasaccites densicorpus, P. obscurus, Potonieisporites neglectus, P. crassus* and *P. magnus*. Elements of this assemblage zone have been found in sediments close to the tillite (Lele & Karim 1971). It may be noted that in Europe the genus *Potonieisporites* appears in the Stephanian and suddenly increases in the Asselian, the latter episode has been related to the retreat of "Pennsylvanian Ice Age" (Wagner & Prins 1991).

GLOSSOPTERIS FLORA - ZONATION BASED ON MEGASPORES

Sufficient data is not available on the distribution of the megaspore taxa in the *Glossopteris* Flora. However, certain megaspore species are known to have restricted distribution (Maheshwari & Tewari 1988, Bajpai 1992). Appendix-3 lists names of megaspore genera recorded from the *Glossopteris* Flora.

6. Maitur Formation: *Banksisporites gondwanensis, B. granulosus, B. minuticorpus, B. panchetensis, Biharisporites maiturensis, Maiturisporites distinctus, M. indicus, M. spinotriletes, Pantiella bharadwajii, P. bosei, Talchirella dubia* and *Talchirella sinuata*.

5. Raniganj Formation: *Noniasporites raniganjensis, Surangeaesporites raniganjensis, Talchirella densicorpa.*

4. Kulti Formation: *Singhisporites baculatus, Jhariatriletes baculosus.*

3. Barakar Formation: - *Ancorisporites binaensis, Banksisporites dijkstrae, B. endosporitiferus, Barakarella churulaensis, Biharisporites arcuatus, B. distinctus, Bokarosporites psilatus, Canaliculites triangulatus, Cystosporites indicus, Duosporites irregularis, Jhariatriletes binaensis, J. comatus, Lagenicula gondwanensis, Mamillaespora grandis, M. superba, Manumisporites distinctus, M. høegii, Trilaevipellites multipulvinatus.*

2. Karharbari Formation: *Ancorisporites venkatachalae, Barakarella prakashii, B. shuklae, Duosporites D. multipunctatus, D. tiwarii, Jhariatriletes filiformis, Shahdolia chaloneri, Surangeaesporites karharbariensis.*

1. Talchir Formation: *Srivastavaesporites indicus, Duosporites dijkstrae, Trilaevipellites talchirensis.*

On the basis of megaspores a single assemblage zone, that is, *Talchirella-Banksisporites* Assemblage Zone is recognised with six assemblage sub-zones, each of which seems to relate to one formational unit. These sub-zones are:

6. *Talchirella dubia-Banksisporites panchetensis* Assemblage Sub-zone (**Maitur**);

Formations	Macrofossil Assemblage Sub-zones	Interbiohorizon Zones	Palynological Assemblage Zones	Megaspore Zones
MAITUR	*Dicroidium-Glossopteris*	*Playfordiaspora*	*Playfordiaspora cancellosa*	*Talchirella dubia-Banksisporites panchetensis*
	Glossopteris senii-Lepidopteris indica	*Klausipollenites*	*Klausipollenites schaubergeri*	
RANIGANJ			*Densipollenites magnicorpus*	*Talchirella densicorpa-Noniasporites harrisii*
	Eretmonia utkalensis-Lidgettonia indica	*Verticipollenites*	*Gondisporites raniganjensis*	
	Belemnopteris woodmasoniana-Raniganjia bengalensis			
KULTI	*Cyclodendron leslii*		*Densipollenites densus*	*Duosporites katinalaensis-Singhisporites baculatus*
BARAKAR	*Lelstotheca robusta-Polysolenoxylon jhariense*	*Barakarites*	*Protohaploxypinus varius*	*Talchirella trivedii-Ancorisporites binaensis*
		Densipollenites	*Scheuringipollenites barakarensis*	
KARHARBARI	*Botrychiopsis valida-Buriadia sewardii*	*Crucisaccites*	*Crucisaccites monoletus*	*Talchirella trivedii-Ancorisporites venkatachalae*
TALCHIR	*Pantophyllum spathulata-Paranocladus indica*	*Parasaccites*	*Parasaccites korbaensis*	*Talchirella nitens-Duosporites dijkstrae*
			Plicatipollenites gondwanensis	
		Potonieisporites	*Potonieisporites neglectus*	

*TABLE 3: A generalised comparison of different phytozonation schemes for the **Glossopteris** Flora of India.*
*QUADRO 3: Comparação generalizada de esquemas de fitozoneamento diferentes para a Flora de **Glossopteris** da India.*

5. *Talchirella densicorpa-Noniasporites harrisii* Assemblage Sub-zone (**Raniganj**);

4. *Duosporites katrinalaensis-Singhisporites baculatus* Assemblage Sub-zone (**Kulti**);

3. *Talchirella trivedii-Ancorisporites binaensis* Assemblage Sub-zone (**Barakar**);

2. *Talchirella trivedii-Ancorisporites venkatachalae* Assemblage Sub-zone (**Karharbari**);

1. *Talchirella nitens-Duosporites dijkstrae* Assemblage Sub-zone (**Talchir**).

CONCLUDING REMARKS

The phytostratigraphic zones projected for the *Glossopteris* Flora of India have been derived after collating and analysing published information. These zones give a standard picture, but are not necessarily represented in all the basins where the *Glossopteris* Flora developed. Each basin had its own depositional environment, and taphonomic processes may have affected preservation of plant fossils (Spicer 1991) differently in different basins. In general, plant macrofossils are comparatively abundant in strata closely associated with coal seams, and often are localised in pockets, whereas plant microfossils have a more uniform distribution in the sediment. In the early days fossils were sometimes reported from randomly collected samples; the geographical and stratigraphical location was ambiguously worded (for example, Lower Gondwana, Giridih Coalfield, India). Hence it is now difficult to place such fossils correctly in the stratigraphical column. Though for palynofossils this situation has more or less been corrected with the availability of core/cutting samples from deep bore holes, a more definitive inter-basinal correlation of palynological assemblages is yet to be undertaken. A tentative comparison of phytostratigraphical zones projected on the basis of macroflora, spores-pollen, and megaspores is shown in table 3.

At this period of time it is difficult to visualise if a similar or equivalent phytostratigraphical zonation is expressed in the *Glossopteris* Flora of other Gondwana continents. Latitude, altitude, vicinity to sea, climate, edaphic, and other factors play an important role in composition of the vegetation of a region. Subjective identification and erroneous naming of fossils (Chandra & Surange 1979, Anderson & Anderson 1985, Kovács-Endrödy 1991) also make it difficult to correlate different assemblages. Historical phases may be similar but occurring at different times. For example,

(i) Evans (1969) regards the appearance of the *Glossopteris* Flora to mark the base, and its extinction as the top of the Permian System in Australia. However, in glossopteroid leaves have been reported from the Upper Carboniferous of Transvaal (Plumstead 1966) and Walikale beds of Zaire (Høeg & Bose 1960). In India, the genus *Glossopteris* ranges into Early Triassic sediments.

(ii) In South America and Zaire, the *Potoniesporites-Plicatipollenites* Zone is followed by a *Densosporites-Cristatisporites* Zone (Maheshwari & Bose 1969, Archangelsky & Marques 1980), but in the *Glossopteris* Flora of India the latter zone is conspicuously absent.

(iii) In Australia, the genus *Botrychiopsis* ranges from Stephanian into Kazanian (Rigby 1993), whereas in India, the genus appears only in Early Permian (Karharbari Formation, ?Artinskian).

(iv) The genus *Walkomiella* was initially reported from the Upper Permian New Castle Series of Australia (Florin 1940), but in India this genus is restricted to the Barakar Formation (late Early Permian) and in Africa to the Middle Ecca (LeRoux 1964).

However, one zone that could be taken as a pan-Gondwana zone is the "solenoid wood" biozone, which occurs in Irati Formation of Brazil, Lafonian sequence of Malvinas (Falkland Islands), Mt. Bastian, Mt. *Glossopteris* and Weller Formations of Antarctica, White-Band Formation of South Africa and Barakar Formation of India (Mussa 1986). Equivalents of the *Belemnopteris woodmasoniana-Raniganjia bengalensis* Assemblage Zone may possibly be recognised in the Middle Ecca Flora of South Africa (Kovács-Endrödy 1990) and Moranbah Coal Measures of Queensland, Australia (Rigby 1978). The *Potoneiesporites* Zone is also expressed all over the Gondwana Supercontinent (Schopf & Askin 1980) but in India it appears at a level younger than that in Antarctica, Argentina and Australia (Playford 1990, Azcuy & Gutiérrez 1984, Kemp *et al.* 1977).

APPENDIX-1

BRYOPHYTES
Bryothallites Chandra 1995
Capsulites Saksena 1958
Hepaticites Walton 1925
Saksenaphyllites Chandra 1995
Sphagnophyllites Pant & Basu
Talchirophyllites Chandra 1995
Umariaphyllites Chandra 1995

LYCOPSIDS
Cyclodendron Kräusel 1928
Lepidostrobus Brongniart 1828

EQUISETALES
Barakaria Seward & Sahni 1920
Bengalia Maheshwari et al. 1989
Giridia Pant *et al*. 1981
Lelstotheca Maheshwari 1972
Lobatannularia Kawasaki 1927
Phyllotheca Brongniart 1828
Rajmahaliastachys Banerjee & D'Rozario 1999
Raniganjia Rigby 1963
Schizoneura Schimper & Mougeot 1844
Sharmastachys Banerjee & D'Rozario 1999
Tulsidabaria Banerjee & D'Rozario 1999

SPHENOPHYLLS
Benlightfootia Lacey & Huard-Moine 1967
Sphenophyllum König 1825
Trizygia Royle 1839

FERNS
Asansolia Pant & Misra 1976
Botrychiopsis Kurtz 1895
Chitraphyllum Banerjee 1999
Cuticulatopteris Pant & Misra 1983

Damudopteris Pant & Khare 1974
Damudosorus Pant & Misra 1977
Dichotomopteris Maithy 1974
Kawizophyllum Kapoor 1969
Khania Chandra & Singh 1988
Leleopteris Srivastava & Chandra 1982
Maheshwariopteris Bajpai 1992
Neomariopteris Maithy 1974
Pantopteris Chandra & Rigby 1983
Rewaphyllum Srivastava 1984
Santhalea Maithy 1977
Trithecopteris Pant & Misra 1977

GLOSSOPTERIDS
Belemnopteris Feistmantel 1876
Deogarhia Banerjee 2000
Diphyllopteris Srivastava 1978
Gangamopteris McCoy 1875
Glossopteris Brongniart 1828
Maheshwariphyllum Srivastava 1992
Palaeovittaria Feistmantel 1876
Rhabdotaenia Pant 1958
Rubidgea Tate 1867
Sagitophyllum Pant *et al.* 1984
Surangephyllum Chandra & Singh 1986

GLOSSOPTERID FRUCTIFICATIONS
Arberia White 1908
Denkania Surange & Chandra 1973
Dictyopteridium Feistmantel ex Zeiller 1902
Dolianitia Millan 1967
Eretmonia du Toit 1932
Glossotheca Surange & Maheshwari 1970
Gonophylloides Maheshwari 1967
Jambadostrobus Chandra & Surange 1977
Kendostrobus Surange & Chandra 1974
Lidgettonia Thomas 1958
Ottokaria Zeiller 1902
Partha Surange & Chandra 1973
Plumsteadia Rigby 1968
Satsangia Srivastava & Maheshwari 1973
Scutum Plumstead 1952
Senotheca Banerjee 1969
Venustostrobus Chandra & Surange 1977

SPORANGIA
Arberiella Pant & Nautiyal 1960
Lithangium Pant & Nautiyal 1960
Polytheca Pant & Nautiyal 1960

FRUCTIFICATIONS OF UNCERTAIN AFFINITY
Birbalsahnia Bajpai & Maheshwari 1991
Bosea Srivastava 1975
Lelestrobus Srivastava 1984
Nidistrobus Bose & Srivastava 1973
Pteruchus Thomas 1933
Utkalia Chandra 1984
Veekaysinghia Bajpai & Maheshwari 1991

SCALE LEAVES
Bankolaea Banerjee 1984
Ghoshialepis Banerjee 1984
Glottolepis Bose & Srivastava 1970
Gondwanolepis Banerjee 1984
Gopadia Bose & Srivastava 1970
Mahudaea Banerjee 1970
Squamae Nathorst 1876

CORDAITE-LIKE
Cordaites Unger 1850
Euryphyllum Feistmantel 1879
Noeggerathiopsis Feistmantel 1879
Pantophyllum Rigby 1984

CYCADOPHYTES
Kashmiropteris Kapoor ex Kapoor *et al*. 1991
Pseudoctenis Seward 1911
Pteronilssonia Pant & Mehra 1963
Pterophyllum Brongniart 1828
Taeniopteris Brongniart 1832

CONIFER-LIKE
Birsinghia Pant *et al.* 1995
Buriadia Seward & Sahni 1920
Paliandrolepis Pant *et al.* 1995
Paranocladus Florin 1940
Searsolia Pant & Bhatnagar 1995
Walkomiella Florin 1944

GINKGOPSIDS
Ginkgoites Seward 1919
Handapaphyllum Chandra & Singh 1989
Psygmophyllum Schimper 1870
Rhipidopsis Schmalhausen 1879
Saportaea Fontaine & White 1880
Sidiphyllites Srivastava 1984

SEEDS
Alatocarpus Lele 1969
Bulbospermum Pant *et al*. 1985
Cordaicarpus Geinitz 1862
Cornuspermum Banerjee 1969
Indocarpus Surange & Chandra 1974
Karharbariospermum Srivastava & Chandra 82
Maheshwariella Pant & Nautiyal 1963
Nidispermum Manik 1988
Otofeistia Pant *et al*. 1985
Platycardia Pant & Nautiyal 1960
Pterygospermum Pant & Nautiyal 1960
Rotundocarpus Maithy 1965
Samaropsis Göppert 1864
Spermatites Miner 1935

Stephanostoma Pant & Nautiyal 1960
Stereocarpus Surange 1958
Talchirospermum Srivastava & Chandra 1982
Walkomiellospermum Pant & Srivastava 1964

FOSSIL WOOD
Araucarioxylon Kraus emend. Maheshwari 1972
Arauspiropitys Pant & Singh 1987
Australoxylon Marguerier 1973
Barakaroxylon Surange & Maithy 1962
Baieroxylon Greguss 1961
Catervoxylon Pant & Singh 1987
Chapmanoxylon Pant & Singh 1987
Dadoxylon Endlicher emend. Maheshwari 1972
Damudoxylon Maheshwari 1967
Indoxylon Surange & Maithy 1963
Kamthioxylon Mahabale & Vagyani 1980
Kaokoxylon Kräusel 1956
Kendoxylon Pant & Singh 1987
Megaporoxylon Kräusel 1956
Nandorioxylon Biradar & Bonde 1981
Palaeospiroxylon Prasad & Chandra 1980
Paracatervoxylon Pant & Singh 1987
Parapalaeospiroxylon Pant & Singh 1987
Parapalaeoxylon
Planoxylon Stopes 1916
Polysolenoxylon Kräusel & Dolianiti 1928
Protophyllocladoxylon Kräusel 1939
Prototaxoxylon Kräusel & Dolianiti 1928
Sclerospiroxylon Prasad 1982
Taxopitys Kräusel 1928
Trigonomyelon Walton 1925
Vertebraria Royle 1839
Zalesskioxylon Lepekhina *et al.* 1966

INCERTAE SEDIS
Benlightfootia Lacey & Huard-Moine 1966
Caulophyllites Pant & Singh 1979
Chakrea Srivastava 1984
Cheirophyllum Pant & Singh 1978
Chirimiria Srivastava & Chandra 1992
Gondwanophyllites Srivastava 1987
Gondwanophyton Maithy 1974
Gopadia Srivastava 1986
Lepidopteris Schimper 1869
Nidia Bose & Srivastava 1974
Pachwarophyllum Prasad & Maithy 1990
Rewaphyllum Srivastava 1984
Senia Khan 1969

APPENDIX-2

Acanthotriletes Naum. ex Potonié & Kremp 1954
Apiculatisporis Potonié & Kremp 1954
Balmeela
Barakarites Bharadwaj & Tiwari 1964
Bharadwajipollis Kar 1968
Brevitriletes Bharadwaj & Srivastava 1969
Caheniasaccites Bose & Kar
Callumispora Bharadwaj & Srivastava 1969
Cannanoropollis Potonié & Sah 1956
Circumstriatites Lele & Makada 1972
Corisaccites Venkatachala & Kar 1966
Crescentipollenites Bharadwaj et al. 1974
Crucisaccites Lele & Maithy 1964
Cuneatisporites Leschik 1955
Cyclofoveolatispora
Cyclogranisporites Potonié & Kremp 1954
Densipollenites Bharadwaj 1962
Densoisporites Weyland & Krieger 1953
Dentatispora Tiwari 1964
Didecitriletes Venkatachala & Kar 1964
Distriamonocolpites Bharadwaj & Sinha 1969
Distriatites Bharadwaj 1962
Divarisaccus Venkatachala & Kar 1966
Ephedripites Bolkhovitina ex Potonié 1958
Falcisporites Leschik 1955
Faunipollenites Bharadwaj 1962
Ginkgocycadophytus
Gnetaceaepollenites Thiergart 1938
Godavarisporites Tiwari & Moiz 1971
Gondisporites Bharadwaj 1962
Gondwanipollenites Bose & Maheshwari 1969
Gondwanopollis Lele & Maithy 1969
Goubinispora Tiwari & Rana 1981
Guttulapollenites Goubin 1965
Hamiapollenites Wilson 1962
Hennellysporites Tiwari 1968
Hindipollenites Bharadwaj 1962
Horriditriletes Bharadwaj & Salujha 1964
Greinervillites Bose & Kar 1967
Ibisporites Tiwari 1968
Imparitriletes Tiwari & Singh 1981
Indotriradites Tiwari 1964
Insignisporites Bharadwaj & Dwivedi 1977
Jayantisporites Lele & Makada 1972
Kamthisaccites Srivastava & Jha 1988
Klausipollenites Jansonius 1962
Lacinitriletes Venkatachala & Kar 1964
Lahirites Bharadwaj 1962
Lophotriletes Naum. ex Potonié & Kremp 1954
Lueckisporites Potonié & Klaus 1954
Lunatisporites Leschik emend Scheuring 1970
Lundbladispora Balme emend Playford 1965
Maculatasporites Tiwari 1964
Marsupipollenites Balme & Hennelly 1956
Microbaculispora Bharadwaj 1962
Microfoveolatispora Bharadwaj 1962
Navalesporites Sarate & Awatar 1984
Parasaccites Bharadwaj & Tiwari 1964
Parastriopollenites Maheshwari 1967
Paravesicaspora Klaus 1964

Pilasporites Balme & Hennelly 1956
Platysaccus Naumova 1937
Playfordiaspora Maheshwari & Banerji 1975
Plicatipollenites Lele 1964
Potonieisporites Bhardwaj 1955
Potonieitriradites Bharadwaj & Sinha 1969
Praecolpatites Bharadwaj & Srivastava 1969
Primuspollenites Tiwari 1964
Protohaploxypinus Soritseva & Sedova 1957
Psilalacinites Kar 1969
Punctatisporites Ibrahim 1933
Quadrisporites Balme & Hennelly 1956
Raniganjiasaccites Kar 1969
Rhizomaspora Wilson 1962
Rimaspora Lele & Maithy 1969
Ringosporites Tiwari & Rana 1981
Rugasaccites Lele & Maithy 1969
Sahnites Mehta 1954
Satsangisaccites Bharadwaj & Srivastava 1969
Scheuringipollenites Tiwari 1973
Schizopollis Venkatachala & Kar 1964
Simeonospora Balme 1970
Stellapollenites Lele 1965
Striasulcites Kar 1964
Striatites Pant ex Bharadwaj 1962
Striatoparvisaccites see Lele 1975 Pb 22
Striatopodocarpites Soritseva & Sedova 1956
Striomonosaccites Bharadwaj 1962
Thymospora Wilson & Venkatachala 1963
Tiwariasporis Maheshwari & Kar
Tuberisaccites Lele & Makada 1969
Verrucosisporites Potonié & Kremp 1954
Verticipollenites Bharadwaj 1962
Vesicaspora Schemel 1957
Vestigisporites Balme & Hennelly 1956
Vittatina Luber ex Wilson 1962
Welwitschiapites
Weylandites Bharadwaj & Srivastava 1969

APPENDIX-3

Ancorisporites Pant & Mishra 1986
Banksisporites Dettmann 1961
Barakarella Lele & Srivastava 1983
Biharisporites Potonié 1956
Bokarosporites Bharadwaj & Tiwari 1970
Bulbosia Pant & Mishra 1986
Canaliculites Pant & Mishra 1986
Cystosporites Schopf 1936
Duosporites Høeg, Bose & Manum 1955
Grambastisporites
Hughesisporites Potonié 1956
Jhariatriletes Bharadwaj & Tiwari 1970
Lagenicula Potonié & Kremp 1954
Maiturisporites Maheshwari & Banerji 1975
Mammilaespora Pant & Srivastava 1961
Manumisporites Bharadwaj & Tiwari 1970
Noniasporites Maheshwari & Bajpai 1984
Pantiella Maheshwari & Banerji 1975
Pilatriletes Pant & Mishra 1986
Ramispinatispora Pant & Mishra 1986
Rewatriletes Pant & Mishra 1986
Saccarisporites Dev 1961
Shahdolia Pant & Mishra 1986
Singhisporites Potonié 1956
Singraulispora Pant & Mishra 1986
Srivastavaesporites Bharadwaj & Tiwari 1970
Surangeaesporites Bharadwaj & Tiwari 1970
Talchirella Pant & Srivastava 1961
Trilaevipellites Lele & Chandra 1974
Umariaspora Tripathi & Mishra 1998
Verrutriletes Potonié 1956

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