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Megaspore biostratigraphy of the Gondwana

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Dispersed megaspores are known from almost all the Gondwana horizons though they are comparatively rare. Approximately, 36 genera and 110 species are known from the Gondwana sediments. The number of genera and species is almost equally divided between Permian and Mesozoic Gondwana. Most of the formations except Talchir, Barren Measures and Upper Tiki have marker megaspore taxa at generic level. The above mentioned three formations have marker taxa only at species level. At the present state of our knowledge megaspores are found useful only for broader zonation. As far as age determination is concerned, the megaspores, as compared to other palynofossils, indicate younger ages.

Key-words—Megaspores, Biostratigraphy, Morphotaxonomy, Gondwana (India).

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सारांश

गोंडवाना का गुरुबीजाणु जैवस्तरविन्यास

हरिकृष्ण माहेश्वरी एवं रजनी तिवारी

विकीरित गुरुबीजाणु प्रायः सभी गोंडवाना संस्तरों से विदित हैं यद्यपि अपेक्षाकृत ये कम मिलते हैं। गोंडवाना अवसादों से इनकी लगभग 36 प्रजातियाँ एवं 110 जातियाँ ज्ञात हैं। परमी एवं मध्यजीवी गोंडवाना में इन प्रजातियों एवं जातियों की संख्या लगभग बराबर है। तालचिर, बेरन मेज़र्स एवं उपरि टिकी के अतिरिक्त अधिकतर शैल-समूहों में चिन्ह्य गुरुबीजाणु प्रजाति-स्तर पर विद्यमान हैं। वर्तमान ज्ञान के आधार पर गुरुबीजाणु केवल मोटे तौर पर मंडलन करने में उपयुक्त सिद्ध हुए हैं और जहाँ तक आयु निर्धारण का सम्बन्ध है गुरुबीजाणु अन्य परागाणविकरूपकों की तुलना में अल्पायु इंगित करते हैं।

EXTANT land plants can be divided into two categories on the basis of the spores they produce. Some plants produce almost uniform sized spores. Other plants produce two types of spores, micro- and mega-, which give rise to male and female gametophytes, respectively. In fossil condition where nature of gametophytes produced by the spores is not known, micro- and mega-spores are differentiated on the basis of their respective sizes. The cutoff point between the two has variously been put at 150 μm (Harris, 1961), 200 μm (Zerndt, 1934) and 300 μm (Schopf, 1938). Generally, spores larger than 200 μm in size are considered as megaspores.

Megaspores are known from almost all the horizons, late Devonian upwards. However, their quantitative occurrence, as compared to that of microspores, being rather rare, not much information is available regarding their morphological variation and distribution in time and space.

Megaspores in the Gondwana sediments were first isolated by Carruthers (1869) from the Brazilian

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coal beds though he thought them to be sporangia. Zeiller (1895) recognized their true nature as megaspores. One of the first reports of the occurrence of megaspores in the Indian Gondwana is by Mehta (1943) from the Singrauli Coalfield. Sitholey (1943) reported megaspores from the Triassic of Salt Range, now in Pakistan. The first detailed account of megaspores from the Permian Gondwana of India was published by Surange, Singh and Srivastava (1953) which was partly revised by Srivastava (1954). Dev (1961) and Singh, Srivastava and Roy (1964) published on megaspores from Early Cretaceous 'Gondwana'.

Chart 1 : Distribution of Megaspore species in Indian Gondwana Formations

NAME OF (A) TAXA ↓ / HORIZON (B) →	TALCHIR	KARHARBARI	BARAKAR	BARREN MEASURES	RANIGANJ	MAITUR	LOWER TIKI	UPPER TIKI	JABALPUR	BHUJ
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Duosporites dijkstrae										
Banksisporites indicus										
Duosporites congoensis										
Talchirella nitens										
Ancorisporites venkatachalae										
Barakarella prakashii										
Barakarella shuklae										
Duosporites tiwarii										
Jhariatriletes filiformis										
Shahdolia chaloneri										
Surangeaesporites karharbariensis										
Banksisporites utkalensis										
Barakarella pantii										
Bokarosporites rotundus										
Duosporites multipunctatus										
Talchirella trivedii										
Talchirella flavata										
Biharisporites spinosus										
Ancorisporites binaensis										
Banksisporites dijkstrae										
Banksisporites endosporitiferus										
Barakarella churuliaensis										
Biharisporites arcuatus										
Biharisporites distinctus										
Bokarosporites psilatus										
Canaliculites triangulatus										
Cystosporites indicus										
Duosporites irregularis										
Jhariatriletes binaensis										
Jhariatriletes comatus										
Jhariatriletes densus										
Lagenicula gondwanensis										
Mamillaespora grandis										
Mamillaespora superba										
Manumisporites distinctus										
Manumisporites høegii										
Pilatriletes mirzapurensis										
Ramispinatispora indica										
Ramispinatispora nautiyalii										
Singraulispora indica										
Singraulispora insignis										
Jhariatriletes damudicus										
Jhariatriletes srivastavae										
Pantiella waltonii										
Duosporites katrinalaensis										
Singhisporites baculatus										
Jhariatriletes baculosus										
Singhisporites radialis										
Noniasporites harrisii										
Surangeaesporites raniganjensis										
Talchirella densicorpa										

Chart-1 : Contd.

A ↓ / B→	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Banksisporites gondwanensis										
Banksisporites granulosus										
Banksisporites minuticorpus										
Banksisporites panchetensis										
Biharisporites malturensis										
Maiturisporites distinctus										
Maiturisporites indicus										
Maiturisporites spinotriletus										
Pantiella bharadwajii										
Pantiella bosei										
Talchirella dubia										
Talchirella sinuata										
Banksisporites major										
Banksisporites triassicus										
Grambastisporites nidhpurensis										
Lagenicula spinosa										
Mamillaespora sidhiensis										
Trikonia emarginata										
Banksisporites dettmannae										
Banksisporites gondwanensis										
Banksisporites pinguis										
Banksisporites tenuis										
Banksisporites sparsus										
Bokarosporites janarensis										
Erlansonisporites singhii										
Erlansonisporites triassicus										
Banksisporites sinuosus										
Hughesisporites variabilis										
Verrutriletes distinctus										
Verrutriletes minuticorpus										
Verrutriletes obscurus										
Horstisporites areolatus										
Saccarisporites lurzeri										
Minerisporites mineri										
Auriculozonospora reticulata										
Bacutriletes cutchensis										
Bacutriletes dijkstrae										
Bacutriletes srivastavae										
Bacutriletes kachchensis										
Dijkstraisporites filiformis										
Dijkstraisporites gcantii										
Dijkstraisporites triangulatus										
Erlansonisporites cf. erlansonii										
Erlansonisporites indicus										
Horstisporites biswasii										
Hughesisporites rajnathii										
Hughesisporites singhii										
Minerisporites auriculatus										
Minerisporites cutchensis										
Minerisporites dharesiensis										
Minerisporites mesosporeoides										
Minerisporites reticulatus										
Paxilliitriletes battenii										
Paxilliitriletes cutchensis										
Umiaspora bosei										
Valvisisporites minor										
Verrutriletes royii										
Verrutriletes stoliczkae										
Verrutriletes triangulatus										

After, Høeg, Bose and Manum (1955) proved the importance of the nature of the mesosporium (inner body) in morphotaxonomy of Gondwana megaspores from Zaïre, Pant and Srivastava (1961, 1964) improvised the technique and methodology and applied it to the morphotaxonomy of

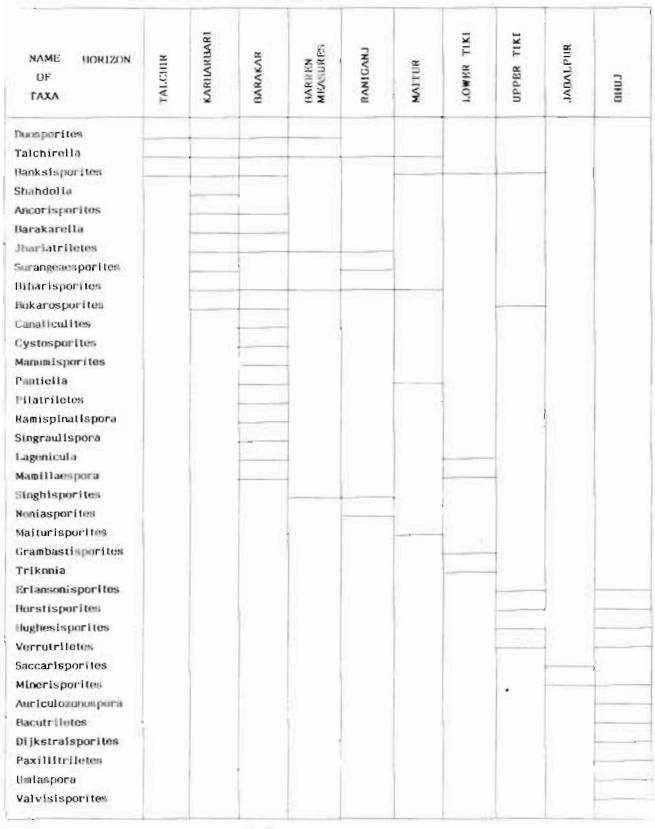

Chart 2—Distribution of megaspore genera in the Indian Gondwana formations.

megaspores from Permian Gondwana of India. Later workers have followed almost the same approach.

Megaspores are now known from: Early Permian Talchir Formation (Lele & Chandra, 1974); Early Permian Karharbari (basal Barakar) Formation (Bharadwaj & Tiwari, 1970; Pant & Mishra, 1986); Early Permian Barakar Formation (Bharadwaj & Tiwari, 1970; Lele & Srivastava, 1983; Pant & Mishra, 1986); Late Permian Barren Measures Formation (Kar, 1968; Bharadwaj & Tiwari, 1970); Late Permian Raniganj Formation (Bharadwaj & Tiwari, 1970; Agashe, 1979; Jha & Srivastava, 1984; Maheshwari & Bajpai, 1984); ?Triassic Lower Tiki Formation (Pant & Basu, 1979); Early Triassic Maitur Formation (Maheshwari & Banerji, 1975); Late Triassic Upper Tiki Formation (Banerji, Kumaran & Maheshwari, 1978); Early Cretaceous Jabalpur Formation (Dev, 1961); Early Cretaceous Bhuj Formation (Singh, Srivastava & Roy, 1964; Banerji, Jana & Maheshwari, 1984). References to more publications are given in bibliography.

DISCUSSION

Though, a number of workers have contributed to the study of Gondwana megaspores, yet not enough data has been generated to use megaspores for finer stratigraphic zonation and correlation. There are approximately 52 genera and 139 species of Gondwana megaspores out of which some 36 genera and 110 species are known from the Indian Gondwana.

Occurrences of fossil megaspore species in different formations of the Indian Gondwana (*sensu lato*) are plotted in Chart 1. Distribution of megaspores at generic level is summarised in Chart 2. From these distribution charts it is evident that though the megaspores are comparatively infrequent, yet their distribution pattern is such that broad megaspore biostratigraphic zones can be demarcated. As majority of megaspore species are of necessity based on a specimen or two, the incidence of variation within a species is not known. Even then, it seems that majority of them have a restricted distribution and can be, individually or collectively, used for zonation and correlation. Due to paucity of information such zonation has to be provisional. When more data is available a regional zonation scheme may be drawn.

From the distribution pattern it is evident that the megaspore taxa are endemic up to Lower Tiki (or Upper Pali of authors, i.e., the Nidhpuri beds) of probable latest Permian age. Upper Tiki (Tiki ormation *sensu stricto*, Late Triassic) onwards cosmopolitan genera start appearing, e.g. *Erlansonisporites, Horstisporites, Minerisporites*, etc. evidently representing beginning of a connection between Laurasia and Gondwana.

Two cenozones are identifiable, viz.,

A. *Talchirella-Banksisporites* Assemblage Zone (Talchir to Lower Tiki/Upper Pali).

B. *Erlansonisporites—Verrutriletes* Assemblage Zone (Tiki to Bhuj).

Following assemblage subzones are recognised:

A1. *Talchirella nitens—Duosporites dijkstrae* Assemblage Subzone (Talchir).

A2. *Talchirella trivedii—Ancorisporites venkatachalae* Assemblage Subzone (Karharbari/basal Barakar).

A3. *Talchirella trivedii—Ancorisporites binaensis* Assemblage Subzone (Barakar).

A4. *Talchirella densicorpa—Noniasporites harrisii* Assemblage Subzone (Raniganj).

A5. *Talchirella dubia—Banksisporites panchetensis* Assemblage Subzone (Maitur).

A6. *Banksisporites major—Lagenicula spinosa* Assemblage Subzone (Lower Tiki/Upper Pali).

B1. *Erlansonisporites triassicus—Verrutriletes distinctus* Assemblage Subzone (Upper Tiki/Tiki *sensu stricto*).

B2. *Dijkstraisporites—Paxillitriletes—Minerisporites* Assemblage Subzone (Bhuj-Jabalpur).

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