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# Permian megaspores from Godavari Graben, India: Present Status

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**ABSTRACT**

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A survey of megaspore studies from Permian of Ramagundam, Chelpur, Mailaram, Rampuram, Gundala and Kachinapalli areas of Godavari Graben, Andhra Pradesh indicates their qualitative and quantitative richness during the Late Permian. Out of seventy nine megaspore taxa recorded from Indian Lower Gondwana, twenty three are represented in this graben. Presence of *Biharisporites sparsus* in the Raniganj Formation of Kachinapalli area is particularly significant because it was previously recorded from Triassic and thus indicates an early appearance of Triassic taxon in Godavari Graben in Late Permian. Additionally, the survey also records a higher (eighteen) number of megaspore taxa in the Raniganj Formation. A distinct evolutionary trend is observed since exosporia of megaspores from the Barakar Formation are simple and those of the Raniganj Formation are complex and more diversified.

**Key-words**—Megaspores, Permian, Gondwana, Godavari Graben, India.

## भारत की गोदावरी द्रोणिका से प्राप्त पर्मियन गुरुबीजाणुः वर्तमान स्थिति

रजनी तिवारी एवं नीरजा झा

**सारांश**

आँध्र प्रदेश की गोदावरी द्रोणिका के रामागुंडम, चेलपुर, मैलाराम, रामपुरम, गुंडाला एवं कचिनापल्ली क्षेत्रों के पर्मियन से प्राप्त गुरुबीजाणु के अध्ययनों का सर्वेक्षण अंतिम पर्मियन के दौरान उनकी गुणात्मक व मात्रात्मक प्रचुरता दर्शाता है। इस द्रोणिका में, भारतीय निम्न गोंडवाना से अभिलिखित 79 गुरुबीजाणु वर्गकों में से 23 निरूपित हैं। कचिनापल्ली क्षेत्र के रानीगंज शैलसमूह में *बिहारीस्पोराइटिज स्पार्सस* की उपस्थिति विशेषकर महत्वपूर्ण है क्योंकि यह ट्राइऐसिक से अभिलिखित की गई थी तथा यह अंतिम पर्मियन में गोदावरी द्रोणिका के ट्राइऐसिक वर्गकों की प्रारंभिक उपस्थिति दर्शाता है। इसके अतिरिक्त, रानीगंज शैलसमूह के सर्वेक्षण में गुरुबीजाणु वर्गकों की अधिक संख्या (18) भी अभिलिखित होती है। एक भिन्न विकासीय प्रवृत्ति देखी गई है क्योंकि बराकार शैलसमूह से प्राप्त गुरुबीजाणुओं के बर्हिबीजाणु साधारण है तथा रानीगंज शैलसमूह के जटिल एवं अति विविध रुपायित है।

**संकेत-शब्द**—गुरुबीजाणु, पर्मियन, गोंडवाना, गोदावरी द्रोणिका, भारत।

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## INTRODUCTION

LOWER Gondwana megaspores from Godavari Graben of India were first studied by Jha and Srivastava (1984) from Raniganj Formation of Ramagundam and Chelpur areas. Later, Patil and Prem Chand (2001) reported megaspore genus *Ancorisporites* from Barakar Formation and Jha and Tewari (2003) provided detailed systematic description of dispersed megaspores from Raniganj Formation of Mailaram area of this graben. Jha *et al.* (2006) and Tewari *et al.* (2007) added to the record of Permian megaspores from Barakar Formation of Gundala area and Barakar and Raniganj formations of Kachinapalli area, respectively, which were found in association with abundance of microspores, cuticles, and wood fragments. Although megaspore studies from the other Lower Gondwana basins of India, viz. Damodar, Satpura, South Rewa and Wardha have been carried out earlier (Bharadwaj & Tiwari, 1970; Lele & Chandra, 1974; Lele & Srivastava, 1983; Pant & Mishra,1986; Tewari, 1991; Tewari & Maheshwari, 1992; Tripathi, 1997, 1998a, b, 1999; Tripathi & Mishra 1997, 2001; Srivastava & Tewari, 2001, 2002, 2004; Tewari *et al.*, 2004), detailed study from Godavari Graben has been taken up only recently. Consequently, the megaspores are now known from all the horizons of Lower Gondwana, viz. Talchir, Karharbari, Barakar, Barren Measures and Raniganj formations (Tewari *et al.*, 2004).

## PRESENT STATUS

Megaspore taxa from different areas (Fig. 1) of Godavari Graben are:

(1) **Gundala Area**-*Bokarosporites rotundus* Bharadwaj & Tiwari 1970, *Banksisporites utkalensis* (Pant & Srivastava) Tewari & Maheshwari 1992, *Talchirella trivedii* Pant & Srivastava 1961, *Gundalaspora spinosus* Jha *et al.* 2006 from Barakar Formation.

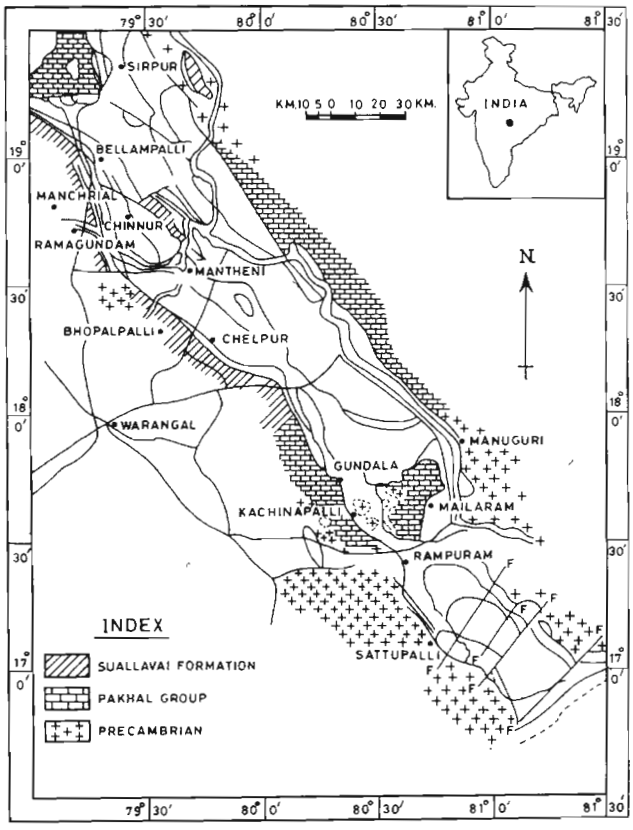



Fig. 1—Map of Godavari Graben showing areas of study.

(2) **Kachinapalli Area-** *Bokarosporites rotundus* Bharadwaj & Tiwari 1970, *Bokarosporites* sp. *in* Tewari *et al.* 2007, *Banksisporites utkalensis* (Pant & Srivastava) Tewari & Maheshwari 1992, *Singhisporites radialis* Bharadwaj & Tiwari 1970, *Ramispinatispora nautiyalii* Pant & Mishra 1986 from Barakar Formation and *Banksisporites utkalensis* (Pant & Srivastava) Tewari & Maheshwari 1992, *Biharisporites sparsus* Banerji *et al.* 1978, *Biharisporites* sp. *in* Tewari *et al.* 2007, *Jhariatriletes baculosus* Bharadwaj & Tiwari 1970, *Jhariatriletes damudicus* (Srivastava) Bharadwaj & Tiwari 1970, *Jhariatriletes filiformis* Tewari & Maheshwari 1992, *Jhariatriletes srivastavae* Bharadwaj & Tiwari 1970, *Ramispinatispora indica* Pant & Mishra 1986, *Penchiella* sp. *in* Tewari *et al.* 2007, *Singhisporites godavariensis* Tewari *et al.* 2007, *Singhisporites surangei* Potonié 1956 emend. Bharadwaj & Tiwari 1970 from Raniganj Formation.

| Taxa | Lower Gondwana formations | | | |
|---|---|---|---|---|
| | Karharbari | Barakar | Barren Measures | Raniganj |
| *Ancorisporites godavariensis* | | + | | |
| *Bokarosporites rotundus* | + | + | + | + |
| *Bokarosporites* sp. | | + | | |
| *Banksisporites utkalensis* | + | + | | + |
| *Gundalaspora spinosus* | | + | | |
| *Jhariatriletes baculosus* | | + | + | + |
| *Jhariatriletes srivastavae* | | + | + | + |
| *Jhariatriletes damudicus* | | + | | + |
| *Jhariatriletes filiformis* | + | | | |
| *Kamthispora mailaramensis* | | | | + |
| *Kamthispora ramanamurtyi* | | | | + |
| *Kamthispora raniganjensis* | | | | + |
| *Biharisporites sparsus* | | | | + |
| *Biharisporites spinosus* | + | + | | + |
| *Biharisporites* sp. | | + | | + |
| *Singhisporites baculatus* | | + | + | + |
| *Singhisporites surangei* | | + | | + |
| *Singhisporites radialis* | | + | + | + |
| *Singhisporites godavariensis* | | | | + |
| *Ramispinatispora indica* | | | | + |
| *Ramispinatispora nautiyalii* | | + | | + |
| *Penchiella* sp. | | | | + |
| *Talchirella trivedii* | + | + | | |

Fig. 2—Table showing distribution of megaspores recorded from Godavari Graben and other Indian Lower Gondwana basins.

(3) **Mailaram Area-** *Kamthispora raniganjensis* Jha & Tewari 2003, *K. mailaramensis* Jha & Tewari 2003, *K. ramanamurtyi* Jha & Tewari 2003 (Alete), *Bokarosporites rotundus* Bharadwaj & Tiwari 1970, *Banksisporites utkalensis* (Pant & Srivastava) Tewari & Maheshwari 1992, *Singhisporites radialis* Bharadwaj & Tiwari 1970, *S. baculatus* Bharadwaj & Tiwari 1970, *Biharisporites spinosus* (Singh) Bharadwaj & Tiwari 1970, *Ramispinatispora nautiyalii* Pant & Mishra 1986 (Trilete) from Raniganj Formation.

(4) **Chelpur-** *Singhisporites radialis* Bharadwaj & Tiwari 1970 from Raniganj Formation.

(5) **Ramagundam** - *Singhisporites radialis* Bharadwaj & Tiwari 1970 from Raniganj Formation.

(6) **Rampuram-** *Ancorisporites godavariensis* Patil & Premchand 2001 from Barakar Formation.

Vertical distribution of megaspores from Godavari Graben (Fig. 3) shows that *Bokarosporites rotundus* is long-ranging followed by *Banksisporites utkalensis, Jhariatriletes baculosus, Jhariatriletes srivastavae, Biharisporites spinosus, Singhisporites baculatus* and *Singhisporites radialis.*

Seventy nine megaspore taxa (Tewari *et al.*, 2004; Jha *et al.* 2006; Tewari *et al.*, 2007) are reported from Lower Permian of India of which twenty three taxa are recorded from various areas of Godavari Graben. Distribution pattern of megaspores recorded from Godavari Graben in different basins (Figs 2, 3) indicates that the taxa *Bokarosporites rotundus, Talchirella trivedii, Banksisporites utkalensis* and, to some extent, *Jhariatriletes baculosus* are distributed widely in most of the basins. Occurrence of *Biharisporites sparsus* is interesting since it is reported for the first time from Late Permian sediments of Godavari Graben. It has been earlier reported from the Triassic (Late Triassic–Tiki Formaton) by Banerji *et al.* (1978). Studies carried out on microfossils from Godavari Graben suggest presence of zonate/cingulate miospores assignable to Lycopsida. Early appearance of Early Triassic lycopsid spores in Late Permian has

| Taxa \ Basins | Godavari | South Rewa Gondwana | Wardha | Mahanadi | Satpura | Damodar |
|---|---|---|---|---|---|---|
| **Ancorisporites godavariensis* | B | | | | | |
| *Banksisporites utkalensis* | B, R | | B | B | B | K, B |
| **Biharisporites sparsus* | R | | | | | |
| **Biharisporites spinosus* | R | | | | | K, B |
| **Biharisporites* sp. | R | | | | | |
| *Bokarosporites rotundus* | B, R | K, B | B | B | K, B | K, B, BM |
| **Bokarosporites* sp. | B | | | | | |
| **Gundalaspora-spinosus* | B | | | | | |
| *Jhariatriletes baculosus* | R | B | B | | | BM |
| *Jhariatriletes srivastavae* | R | | | | | B, BM |
| *Jhariatriletes damudicus* | R | | | | | B |
| *Jhariatriletes filiformis* | R | | | | | K |
| **Kamthispora raniganjensis* | R | | | | | |
| **Kamthispora mailaramensis* | R | | | | | |
| **Kamthispora ramanamurtyi* | R | | | | | |
| **Penchiella* sp. | R | | | | | |
| *Ramispinatispora indica* | R | B | | | | |
| *Ramispinatispora nautiyalii* | B, R | B | | | B | |
| *Singhisporites baculatus* | R | | | | | B, BM |
| *Singhisporites surangei* | R | B | | | | B |
| *Singhisporites radialis* | B, R | | | | B | BM |
| **Singhisporites godavariensis* | R | | | | | |
| *Talchirella trivedii* | B | K, B | B | B | K, B | K, B |

K –Karharbari, B-Barakar, BM-Barren Measures, R-Raniganj.

* Megaspore taxa recorded only from Godavari Graben

Fig. 3—Table showing distribution of megaspores recorded from Godavari Graben vis-a-vis other Lower Gondwana basins of India.

been observed in subsurface sediments of Kamthi Formation in Chintalpudi sub-basin and Damodar, Mahanadi and Satpura basins (Jha, 2004; Jha & Srivastava, 1996).

It is interesting to note that prior to work on megaspores of Godavari Graben most of the Lower Gondwana megaspores were reported mainly from the Karharbari and Barakar formations. Megaspores from Godavari Graben are largely recorded from the Raniganj Formation indicating richness of lycopsids during Late Permian. Affinity of megaspores with lycopsids has been suggested on the basis of prevalence of heterospory and presence of spines on exosporium (Pant & Mishra, 1986). Megaspores from Barakar Formation are simple in structure and their exosporia are either laevigate, verrucate or simple spinate. In contrast, megaspores from Raniganj Formation are structurally more diversified and their exosporia show complex ornamentations varying from simple to multifurcate, stout, straight or curved spines and appendages. This indicates an evolutionary trend in morphological features through Permian (Fig. 4). Records of megaspores from Raniganj Formation are sporadic. Only five megaspore taxa are known from Damodar basin, viz. *Duosporites congoensis, Talchirella nitens, T. densicorpa, Surangesporites raniganjensis* and *Noniasporites harisii.* Of these, the genera *Duosporites* and *Talchirella* are verrucate, *Noniasporites* has rill-like structures and *Surangesporites* is zonate with elongated, rod-like, filamentous, simple or furcate processes.

The structural diversity and complexity thus reflects on the quantitative and qualitative richness of the megaspore assemblage in Godavari Graben. It indicates that a variety of lycopsids were growing in this Graben although the absence of their megafossils is intriguing.

## CONCLUSIONS

1. Majority of the megaspores recorded in Godavari Graben are from Raniganj Formation.
2. Megaspores exhibit structural complexity in exosporium ornamentation varying from simple

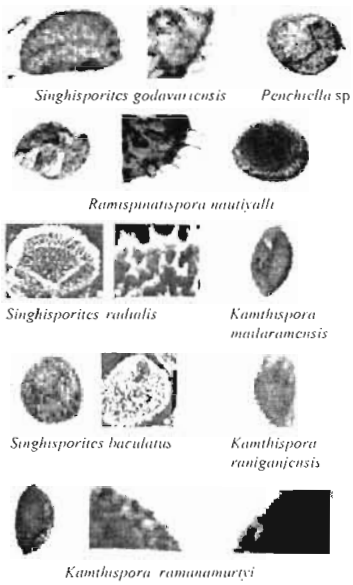
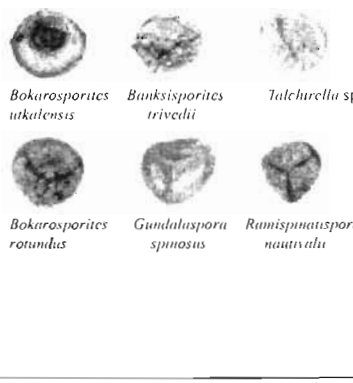
| Age | Formation | Taxa | Morpho-graphi-cal char. |
|---|---|---|---|
| Late Permian | Raniganj |  | Alete and trilete megaspores; shape circular to sub triangular, rarely oval; exosporium usually spinate. spines simple. bifurcate to multifurcate, straight, curved, filiform or stout; mesospo-rium oval or circular usually without cushions. |
| | Barren Measures | Not recorded | |
| Early Permian | Barakar |  | Trilete megaspores; shape circular to triangular; exosporium smooth to verrucate. rarely spinate; mesospo-rium circular to triangular with or without cushions |
| | Karharbari | Not recorded | |
| | Talchir | Not recorded | |

Fig. 4—Table showing evolutionary trend in morphological characters in megaspores of Godavari Graben.

to multifurcate, stout, straight or curved spines and appendages in Raniganj Formation.

3. Simplicity of exosporia in Barakar Formation and its complexity in Raniganj Formation points toward a distinct evolutionary trend.
4. Spinate exosporium of majority of the megaspores may indicate affinity with lycopsids, although, the megafossils of lycopsids are not on record.

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