



OCCURRENCE OF MEGASPORES IN THE LOWER GONDWANA SEDIMENTS OF THE GUNDALA AREA, GODAVARI GRABEN, A. P., INDIA

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ABSTRACT

Permian megaspores are reported from the Barakar Formation of the Gundala area, Godavari Graben, Andhra Pradesh, India. The assemblage comprises the taxa *Bokarosporites rotundus*, *Banksisporites utkalensis*, *Talchirella trivedii* and a new genus *Gundalasporea spinosus*. Quantitatively, the megaspores are not as abundant as in other areas of Godavari Graben. Structurally also, their exosporia are not complex, being laevigate, verrucate and simple spinate as compared to the highly modified exosporia of megaspores of other areas of the same graben. Nevertheless, their occurrence is significant since it indicates presence of cryptogams probably of lycopsid or sphinopsid affinity in the area. Moreover, occurrence of a new genus viz. *Gundalasporea spinosus* adds to the knowledge and diversity of megaspore assemblage in the Godavari Graben.

Keywords: Megaspores, Lower Gondwana, Barakar Formation, Gundala area, Godavari Graben

INTRODUCTION

The Gundala block is a part of Lingala-Koyagudam coal belt on the western margin of the Godavari subbasin (Fig.1). The entire Lower Gondwana succession comprising Talchir, Barakar, Raniganj and Kamthi is preserved in this coal belt. Palynological (microspore) studies were undertaken in order to date and correlate the coal-bearing and associated sediments of the Lower Gondwana sequence in the area. Fortunately, occurrence of megaspores was also recorded along with microspores, cuticles and tracheids. The Lower Gondwana megaspores are reported earlier from all the horizons of the major Gondwana basins of India (Tewari, 1991; Tewari and Maheshwari, 1992; Tripathi, 1997, 1998a,b, 1999; Tripathi and Mishra, 1997, 2001; Srivastava and Tewari, 2001, 2002, 2004; Tewari *et al.*, 2004). Permian megaspores from the Godavari Graben have been reported from the Ramagundem, Chelpur (Jha and Srivastava, 1984), Rampuram (Patil and Prem Chand, 2001), Mailaram (Jha and Tewari, 2003) and Kachinapalli areas. This is the first detailed systematic study of megaspores from the Upper Karharbari/Barakar Formation (Early Permian) of the Gundala area, Godavari Graben. Megaspore taxa identified in the assemblage include *Bokarosporites rotundus*, *Banksisporites utkalensis*, *Talchirella trivedii* and a new genus *Gundalasporea spinosus*.

MATERIAL AND METHOD

The present megaspore assemblage has been recovered from the carbonaceous shales of bore cores SGK2 from Gundala area, Godavari Graben, Andhra Pradesh. The samples were processed for recovery of megaspores firstly with conc. hydrofluoric acid for 3-4 days and washed thoroughly with water, then treated with conc. nitric acid for 2-3 days and then with 5% potassium hydroxide. The specimens were then picked under low power binocular microscope, dried, measured and photographed for exosporium features, e.g. shape, nature of triradial mark and the contact ridges, and ornamentation. Differentially controlled maceration of different specimens in conc. HNO₃ and KOH revealed the mesosporium. Each specimen

was again measured and photographed at this stage (wet/mac-erated) under transmitted light using a high power objective for details of ornamentation and mesosporium. The slides were finally mounted in canada balsam. All the slides have been deposited in the repository of BSIP museum.

SYSTEMATIC DESCRIPTION

Genus *Bokarosporites* Bharadwaj and Tiwari, 1970

Type species: *Bokarosporites psilatus* Bharadwaj and Tiwari, 1970

Bokarosporites rotundus Bharadwaj and Tiwari, 1970
(Pl. I, fig.7)

Description: Megaspores identified only in wet condition, azonate, circular to subcircular in proximo-distal orientation, tri-radial ridges faint, arcuate ridges not clear; exosporium laevigate; mesosporium thin, transparent, subcircular, almost 3/4 of the spore diameter, devoid of cushions.

Dimensions: wet condition - overall size 500-750x550-830µm, width of tri-radial ridges 30µm, (length could not be measured), width of arcuate ridges 20µm, size of mesosporium 240-400x360-550µm.

Comparison: Megaspores are comparable with *Bokarosporites rotundus* (Bharadwaj and Tiwari, 1970, pl. I, figs 9-10, 14) in shape, nature of exosporium and mesosporium.

Occurrence: Bore core SGK-2, depth - 97.60-98.47m, Upper Karharbari/Lower Barakar (Early Permian).

Genus *Banksisporites* Dettmann, 1961 emend. Banerji, Kumaran and Maheshwari, 1978

Type species: *Banksisporites pinguis* (Harris) Dettmann, 1961

Banksisporites utkalensis (Pant and Srivastava) Tewari and Maheshwari, 1992
(Pl. I, fig.2)

Description: Megaspores trilete, azonate, circular to subcircular in proximo-distal orientation, tri-radial ridges straight to wavy; 3/4 spore radius long in dry condition, end up at distinct arcuate ridges; exosporium verrucate, verrucae uniformly distributed; differential maceration in conc. HNO₃

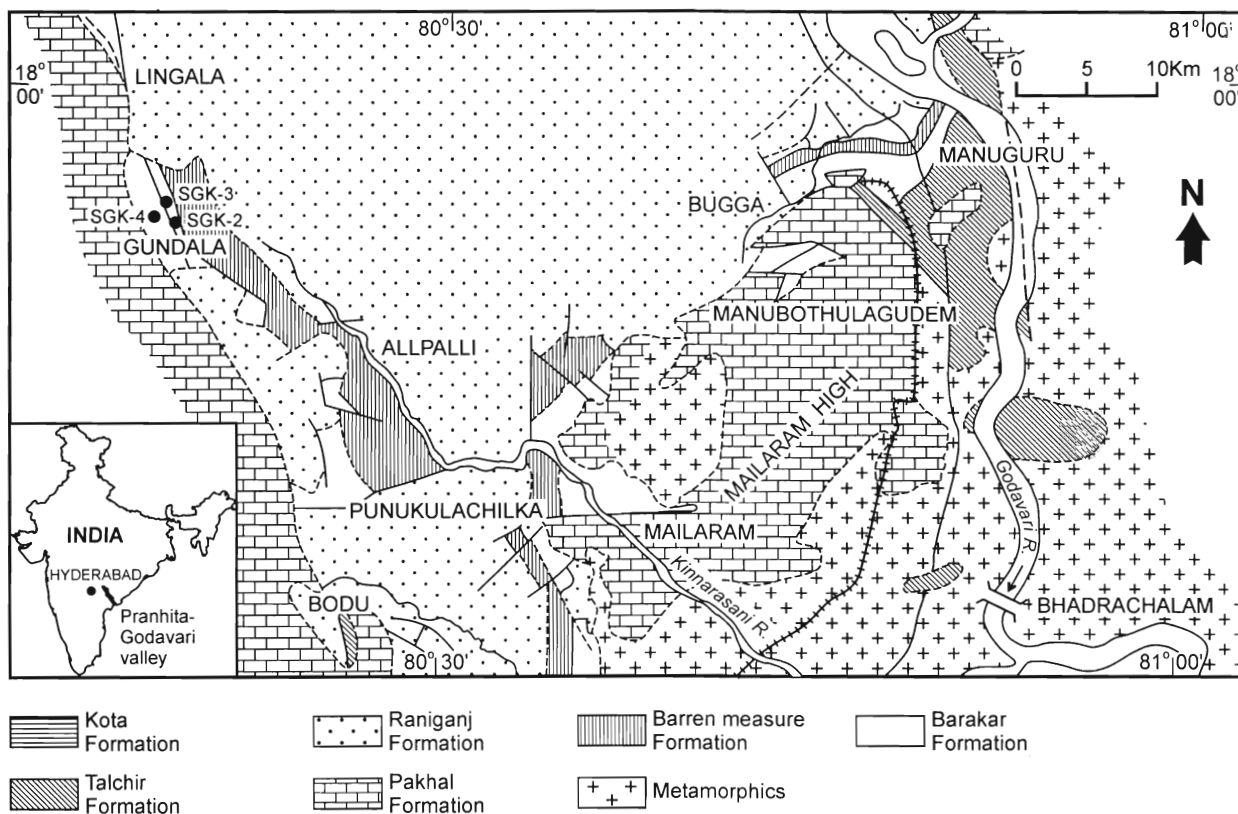


Fig. 1: Geological map of the Gundala area showing location of bore cores (after MECL).

and KOH dissolves the megaspore

Dimensions: In (a) dry condition - overall size 570x630µm, size of tri-radiate ridges 120-270x60µm, width of arcuate ridges 60µm, size of verrucae 15-15µm

Comparison: Megaspores are comparable in shape, nature of exosporium and mesosporium with *Banksisporites utkalensis* (Tewari and Maheshwari, 1992, pl.2, fig. 7, pl. 6, figs. 1,7).

Occurrence: Bore core SGK-2, depth- 97.60-98.47m, Upper Karharbari/Lower Barakar (Early Permian).

Genus *Talchirella* Pant and Srivastava, 1961 emend.

Bharadwaj and Tiwari, 1970

Type species: *Talchirella trivedii* Pant and Srivastava, 1961

Talchirella trivedii Pant and Srivastava, 1961 emend.

Bharadwaj and Tiwari, 1970

(Pl. I, figs. 1, 4-5)

Description: Megaspores trilete, azonate circular or triangular in proximo-distal view, tri-radiate ridges straight to curved, 3/4 spore radius long, distinct, ending up at arcuate ridges, latter distinct in dry condition; exosporium verrucate, verru-

cae uniformly distributed; differential maceration in conc. HNO₃ and KOH dissolves verrucae, tri-radiate and arcuate ridges, reveals thin, transparent, circular mesosporium with numerous cushions arranged trigonally along the tri-radiate mark.

Dimensions: In (a) dry condition - overall size 600x630µm, size of tri-radiate ridges 180-300x30-60µm, width of arcuate ridge 30-60µm, size of verrucae 15x15-30µm, (b) wet condition - overall size 620x650µm, size of mesosporium 300x310µm, diameter of cushions 5-5µm.

Comparison: Megaspores compare well in shape, nature of exosporium and mesosporium with *Talchirella trivedii* (Bharadwaj and Tiwari, 1970, pl.4, figs. 1-12, pl.5, figs. 1,2; Tewari and Maheshwari, 1992, pl.1, figs. 4,6-7,9-10).

Occurrence: Bore core SGK-2, depth- 102.45-102.84m, Upper Karharbari/Lower Barakar (Early Permian).

***Gundalaspora* n. gen.**

Type species: *Gundalaspora spinosus* n., gen. and n. sp.

Derivation of name: The genus is named after the Gundala area, Godavari Graben from where it has been recovered.

Generic diagnosis: Megaspore triangular in proximo-dis-

EXPLANATION OF PLATE I

(Scale for Figs.1,3,4,6,7 same as in 2; for Fig.5 scale same as in 9, each division =0.1mm)

1. *Talchirella trivedii*, megaspore in dry condition.
2. *Banksisporites utkalensis*, megaspore in dry condition
3. *Gundalaspora spinosus*, megaspore in dry condition.
- 4,5. *Talchirella trivedii*, megaspore in wet condition showing numerous cushions on mesosporium BSIP slide no.13121.

- 6,8,9 *Gundalaspora spinosus*, megaspore in wet condition showing spines and triangular pitted mesosporium BSIP slide no.13122a.
7. *Bokarisporites rotundus*, megaspore in wet condition showing smooth exosporium and mesosporium. BSIP slide no.13122b.

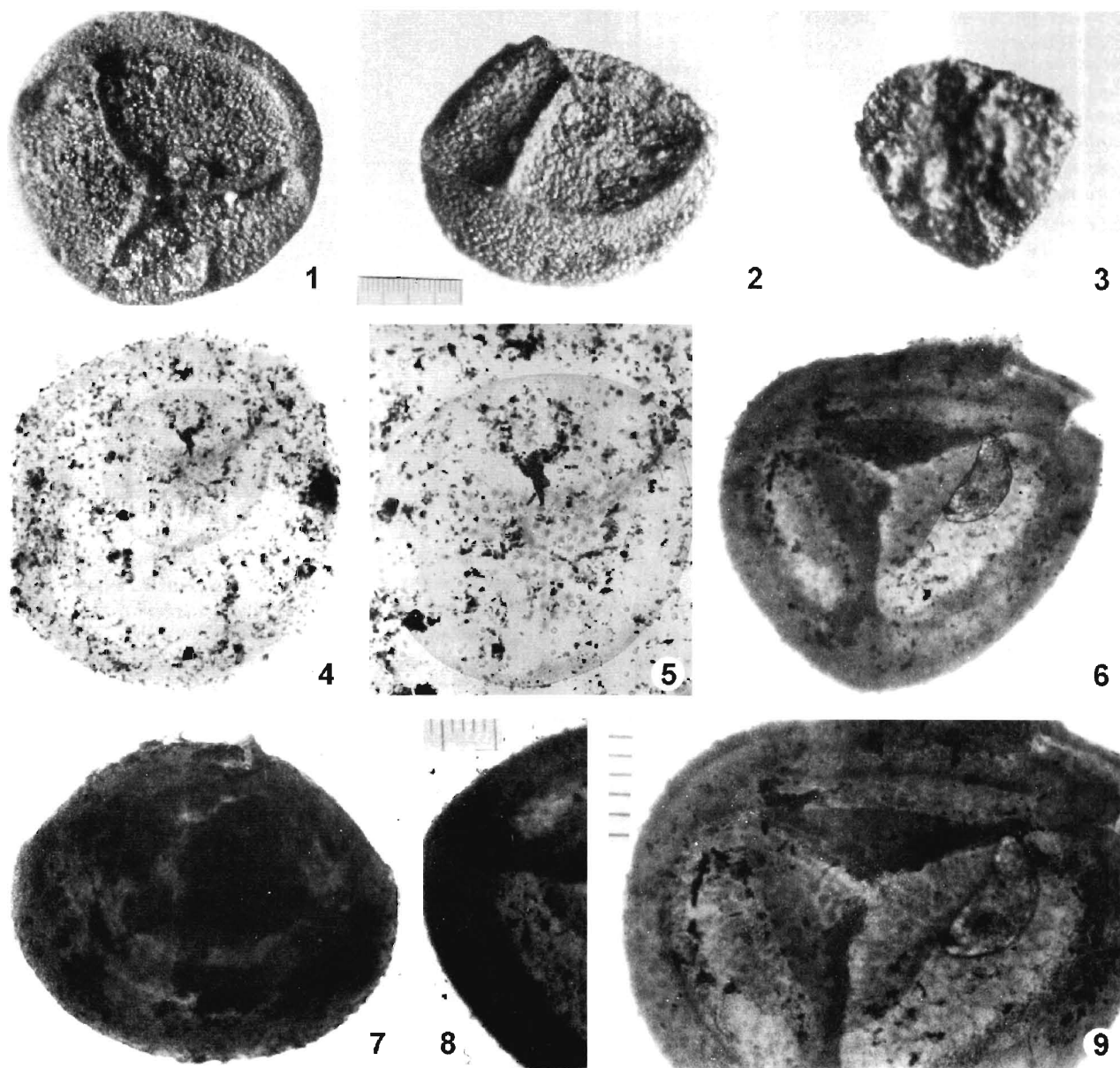


Table 1: Distribution of Megaspores in different areas of Godavari Graben.

Taxa	Rampuram	Chelpur	Ramgundem	Kachinapalli	Mailaram	Gundala
<i>Ancorisporites godavariensis</i>	+		+			
<i>Banksisporites utkalensis</i>				+	+	+
<i>Biharisporites sparsus</i>				+		
<i>Biharisporites spinosus</i>					+	
<i>Biharisporites</i> sp.				+		
<i>Bokarosporites rotundus</i>				+	+	+
<i>Bokarosporites</i> sp.				+		
<i>Gundalasporea-spinosus</i>						+
<i>Jhariatriletes baculosus</i>				+		
<i>Jhariatriletes srivastavae</i>				+		
<i>Jhariatriletes damudicus</i>				+		
<i>Jhariatriletes filiformis</i>						
<i>Kamthispora raniganjensis</i>					+	
<i>Kamthispora mailaramensis</i>					+	
<i>Kamthispora ramanamurthyi</i>					+	
<i>Penchiella</i> sp.				+		
<i>Ramispinatispora indica</i>				+		
<i>Ramispinatispora nautiyalii</i>				+		
<i>Singhisporites baculatus</i>					+	
<i>Singhisporites surangei</i>				+		
<i>Singhisporites radialis</i>		+	+	+	+	
<i>Singhisporites godavariensis</i> sp. nov.				+		
<i>Talchirella trivedii</i>						+

tal orientation, azonate, trilete, tri-radiate ridges distinct, end up at arcuate ridges, latter distinct, exosporium spinate, spines simple, mesosporium triangular with cushions.

Comparison: *Gundalasporea*: is distinct from all the known megaspores in possessing spinate exosporium and triangular mesosporium with cushions. The megaspore is comparable with *Duosporites congoensis* Høeg, Bose and Manum (1955, pl.1, figs.1-3, pl.2, figs.1-2,4-5) in triangular shape and pitted mesosporium but differs in having spinate exosporium and tri-radiate ridges ending up at arcuate ridges, *Duosporites* has verrucate exosporium and tri-radiate ridges extending beyond the arcuate ridges.

Gundalasporea spinosus n. sp.

(Pl. I, figs. 3,6,9)

Holotype: BSIP Slide no: **13122a**

Age & horizon: Early Permian, Upper Karharbari/Lower Barakar Formation.

Locality: Gundala Area, Godavari Graben, Andhra Pradesh, India.

Deviation of name: The new species is named on its spinose character.

Specific Diagnosis: Megaspore trilete, azonate, triangular in proximo-distal orientation; tri-radiate ridges distinct, straight to wavy, more than 3/4 spore radius long, ending up at arcuate ridges, latter distinct, exosporium spinate, spines simple, sparsely arranged, broad at base with pointed apices, ornamentation more prominent on margin, sparse on rest of the spore body; mesosporium thin, transparent, triangular, occupying 1/2 of spore cavity with number of cushions arranged trigonally around tri-radiate mark.

Description: There is only one specimen, yet it is distinct enough for a new specific circumscription. In dry condition, it is triangular in shape, apparently verrucate with faint tri-radiate and arcuate ridges. However, differential maceration in

conc. HNO₃ and 5% KOH reveals distinct spines on margin, tri-radiate and arcuate ridges. Besides, a triangular mesosporium is also revealed which is pitted with a number of cushions arranged trigonally around tri-radiate mark.

Dimensions: In (a) dry condition - overall size 450x480µm, size of tri-radiate ridges 140x60µm, width of arcuate ridges 60µm, size of spines (appearing verrucae in dry condition) - 15x15µm (b) wet condition - overall size 570x500µm, size of tri-radiate ridges 150-170x20-25µm, width of arcuate ridges 10-25µm, length of spines 20-40µm, width of spines at base 20-25µm, width of spines at apex 5-10µm, size of mesosporium 200x250µm, diameter of cushions 10x10µm.

Comparison: *Gundalasporea spinosus* n. sp. is comparable with *B. spinosus* (Bharadwaj and Tiwari, 1970, pl.18, figs.14-19) in having spinate exosporium but differs in triangular shape and pitted mesosporium. Similarly, it resembles *Duosporites multipunctatus* (Høeg and Bose 1960, Pl.31, figs.9,10) in shape and possessing number of cushions arranged trigonally around tri-radiate mark in mesosporium but differs in exosporium ornamentation and nature of tri-radiate and arcuate ridges. It also resembles *Talchirella trivedii* Pant and Srivastava (Bharadwaj and Tiwari, 1970 pl.4, figs.1-12, pl.5. figs.1,2; Tewari and Maheshwari, 1992, pl.1, figs.4,6-7,9-10) in shape and nature of mesosporium but differs in ornamentation which is verrucate in *T. trivedii*. Similarly, it can be compared with *Barakarella pantii* (Lele and Srivastava, 1983, pl. 3, figs. 25-27, Tewari and Maheshwari, 1992, pl. 3, figs. 2, 8, 10-11), somewhat in shape and nature of mesosporium but differs in having spinate ornamentation (ornamentation is baculate in *Barakarella*).

Occurrence: Bore core SGK-2, depth- 97.60-98.47m, Upper Karharbari/Lower Barakar, Early Permian

DISCUSSION

In the Godavari Graben, megaspores have been reported

Table 2: Stratigraphical and geographical distribution of megaspore species from Gundala area, Godavari Graben in India.

Taxa / Formation	Karharbari	Barakar	Barren Measures	Raniganj
<i>Bokarosporites rotundus</i>	D,SR,S	D,SR,S W,M	D	G
<i>Banksisporites utkalensis</i>	D	D,SW,M		G
<i>Gundalaspora spinosus</i>		G		
<i>Talchirella trivedii</i>	D,SR,S	D,SR,S W,M		

Legend: D - Damodar Basin, S - Satpura basin, W - Wardha Basin, G - Godavari Basin, SR - South Rewa Gondwana Basin, M - Mahanadi Basin.

from the Mailaram (Jha and Tewari, 2003), Kachinapalli (Jha *et al.*, 2005), Chelpur and Ramagundem (Jha and Srivastava, 1984), and Rampuram areas (Patil and Prem Chand, 2001) (Table 1). Present detailed systematic study of the megaspores from the Gundala area indicates that the megaspores of this area are not as abundant as in other areas of the Godavari Graben, viz. Mailaram and Kachinapalli. Megaspores from Mailaram, Kachinapalli, Chelpur and Ramagundem areas and they largely belong to the Raniganj Formation. Structurally also, their exosporia are highly diversified, being simple to multifurcate, stout, straight and curved. In contrast, megaspores from the Barakar Formation of the Gundala area are simple in structure and their exosporia are either laevigate, verrucate or simple spinate. This probably indicates the evolutionary trend in structural features during Permian. The occurrence of megaspores is also significant since it indicates presence of cryptogams (lycopsids, sphenopsids) in the area. Stratigraphical and geographical distribution of megaspores of the Gundala area in the Indian Lower Gondwana basins (Table 2) shows that *Bokarosporites rotundus* and *Banksisporites utkalensis* are long ranging and widely distributed. Interestingly, the megaspores of the Gundala area have not so far been reported from the Talchir Formation. *Talchirella trivedii*, though widely distributed, is known so far from Early Permian only. Presence of a distinct new taxon *Gundalaspora spinosus* adds to the existing knowledge of megaspores in the Godavari Graben. More efforts are required for the recovery of megaspores in the area for better understanding of their vertical distribution and diversity.

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