Journal of the Palaeontological Society of India
Volume, 53(2), December 2008: 159-168

ISSN 0522-9630

PERMIAN-TRIASSIC PALYNOFLORAL TRANSITION IN THE SATTUPALLI AREA, CHINTALAPUDI SUB-BASIN, GODAVARI GRABEN, ANDHRA PRADESH, INDIA

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ABSTRACT

Palynological investigation of sub-surface sediments of the borecore SSP-133 from the Sattupalli area, Chintalapudi Sub-basin has revealed presence of three palynoassemblages, one belonging to Late Permian (Raniganj) palynoflora and two belonging to Early Triassic (Panchet) palynoflora. Assemblage-I characterised by dominance of striate disaccate pollen chiefly, *Striatopodocarpites* and *Faunipollenites* alongwith presence of rare but stratigraphically significant taxa viz., *Strotersporites, Verticipollenites, Corisaccites, Guttulapollenites, Hamiapollenites, Falcisporites, Chordasporites, Crescentipollenites, Striatites, Striomonosaccites, Lunatisporites* represents Late Permian.

Assemblage II is characterised by high percentage, of taeniate disaccates chiefly, *Lunatisporites*, while Assemblage III is characterised by abundance of cingulate-cavate trilete spores, chiefly, *Lundbladispora* and *Densoisporites*. Striate disaccates show a sharp decline in these two assemblages. Early Triassic palynoflora has been recorded for the first time in the Sattupalli area indicating existence of the Panchet sediments in the Chintalapudi Sub-basin.

The study further supports the view studies of Jha and Srivastava (1996) that the Kamthi Formation represents Early Triassic (=Panchet Formation) overlying the Raniganj-equivalent sediments with a gradational contact.

Keywords: Palynology, Gondwana, Permian, Triassic, Godavari Graben

INTRODUCTION

The Chintalapudi Sub-basin represents south-easterly continuation of the Kothagudem Sub-basin of the Godavari Graben. To its further south-east lies the coastal Gondwana tract of the Krishna-Godavari Sub-basin. The stratigraphy of this sub-basin is not well understood. The Gondwana rocks of Chintalapudi Sub-basin were earlier referred to as the Kamthi Sandstone (Blanford, 1872), Kamthi Formation (Raja Rao, 1982), Chintalapudi Formation (Raiverman, 1985) and it was said that the sub-basin mainly consists of the Kamthi and there is general absence of the Barakar Formation and Barren Formation Measures over a large part of the sub-basin. Lakshminarayana and Murthy (1990) revised the stratigraphy of the Chintalapudi sub-basin in which the Barakars are overlain by the Kamthi Formation. Thus, a considerable gap in stratigraphic sequence is evident between the Lower Barakar Formation and the Upper Kamthi Formation. In order to date and correlate the coal-bearing and associated sediments and to better understand the stratigraphic frame-work of this sub-basin, palynological studies have earlier been carried out in various borecores from different areas of the Chintalapudi sub-basin viz., Ayyanapalli-Gompana, Chintalapudi (Srivastava and Jha, 1993), Bottapagudem (Jha, 2004), Gattugudem, (Jha, 2002), Amavaram (Srivastava and Jha, 1992) and Sattupalli (Srivastava and Jha, 1994, 1997). The occurrence of Talchir, Karharbari, Barakar and Raniganj palynoassemblages have been recorded in the Chintalapudi sub-basin, but there is no previous record of Early Triassic palynoflora in this sub-basin.

In a quest for getting more data regarding the palynology of the Kamthi Formation and Permian-Triassic transition in the Chintalapudi Sub-basin, palynological investigations of the samples in the borecore SSP-133 from the Sattupalli area were undertaken. These studies allow to record the Late Permian and Early Triassic palynoflora from the study area. This work adds to our existing knowledge about the palynoflora of the area (Srivastava and Jha, 1994, 1995) and is a part of our ongoing study on the palynology of the Sattupalli area.

MATERIAL AND METHODS

The palynomorphs were recovered by usual palynological maceration technique. The samples were treated with conc. hydrofluoric acid, conc. nitric acid and 5% potassium hydroxide. The slides were prepared in canada balsam and studied qualitatively by identifying the palynotaxa on the basis of morphographical characters and quantitatively by counting the percentage frequency of different taxa. Palynological slides have been deposited in the repository of Birbal Sahni Institute of Palaeobotany, Lucknow.

The borehole SSP-133 was drilled in Sattupalli Block III by Singareni Collieries Company Limited (SCCL), Kothagudem. The location of borehole SSP-133 has been shown in Fig. 1.

GEOLOGY

Sattupalli Block III falls in Sattupalli–Chintalapudi coal belt, which forms the southern part of the Godavari valley coalfields. Sattupalli Block III is located in the central part of the coal belt. Archaean gneisses, granite and schists form the basement for the Gondwana sequence in the area. The stratigraphic succession in the block based on surface and sub-surface data is shown in Fig. 2.

The sedimentary sequence beneath 3m soil cover from the top (3-69m) in upper part of the borecore SSP-133 consists of brown soft sandstone and fine-to medium-grained, white and violet sandstone. The underlying sequence (69-98m) consists of fine-grained, greenish grey sandstone, micaceous at places.

The middle part of the sequence (98-185m) consists of fine to coarse-grained, grey sandstone and siltstone, grey clay, shaly clay and clayey sandstone. The sandsstone is sometimes

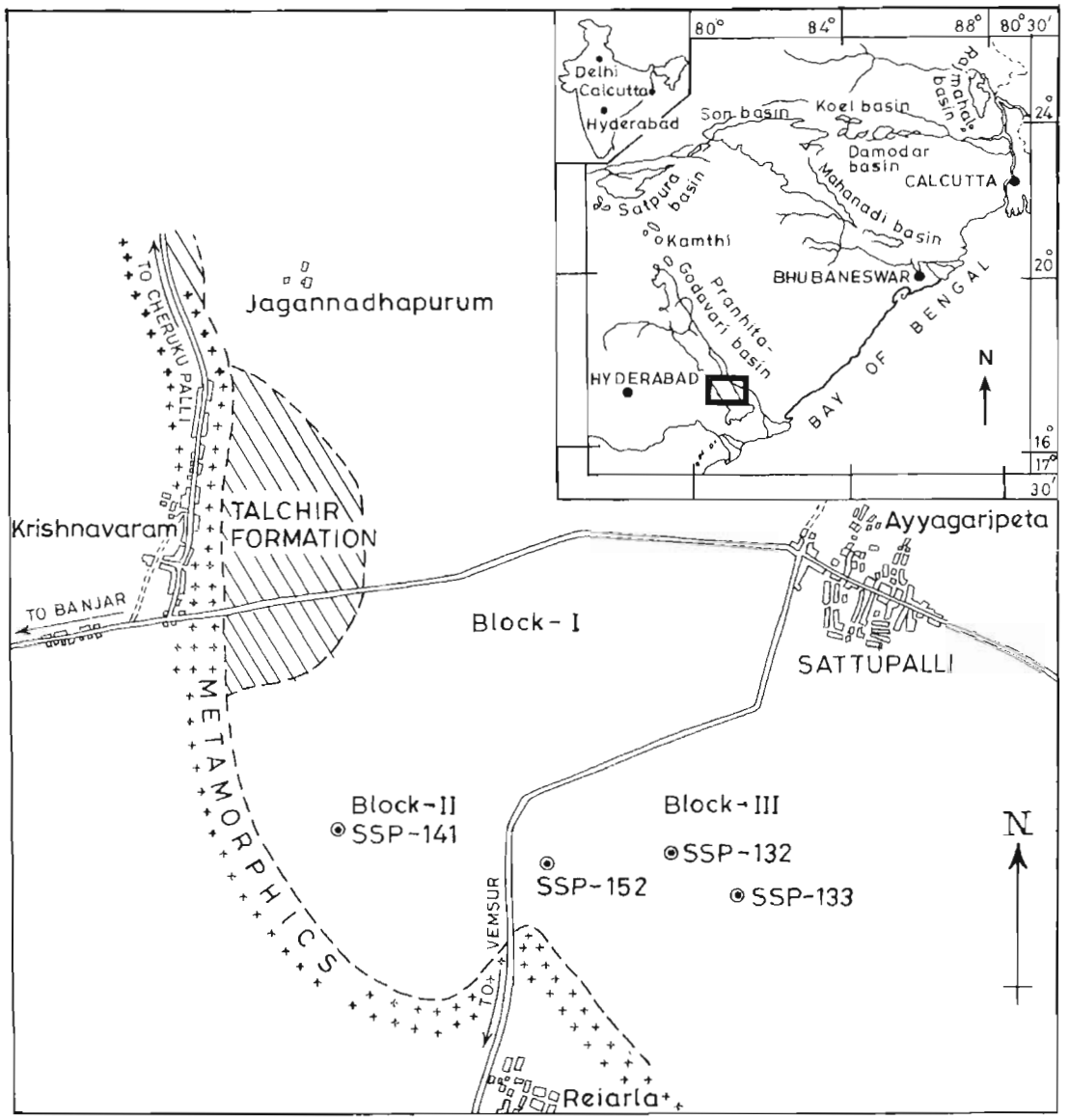


Fig. 1. Map of the Sattupalli area showing location of bore hole SSP-133 (after SCCL).

Age	Group	Formation	Lithology
Recent			Soil/alluvium
PERMIAN	GONDWANA	Kamthi	Medium to coarse-grained sandstone, grey and red clays with two thick carbonaceous horizons
		Barakar	Fine to medium-grained grey sandstone, clay shale carbonaceouss shale and coal seams
		Talchir	Fine-grained greenish sandstone, clay, shale and siltstone
Archaean Gneisses			

Fig. 2. Stratigraphic succession in Sattupalli Block III (after SCCL).

pebbly and brown. The sequence between 185-264 m consists of fine to medium-grained, grey sandstone, sometimes clayey. The Lower part of the sequence from 264-348 m consists of dark grey clay, carbonaceous shale, thin shaly coal and clayey sandstone with bands of coal/carbonaceous streaks. The borehole was closed at the depth of 352.00 m in the Kamthi Formation. The lithocolumn along with position of samples have been shown in Fig. 3.

PALYNOLOGY

On the basis of quantitative and qualitative distribution of various palynotaxa, three distinct palyno-assemblages have been recognized (Fig. 4). The vertical distribution of various palynotaxa in borecore SSP-133 has been shown in histogram (Fig. 5).

Assemblage-I

The Assemblage-I recognized between 268 and 344 m depth is characterized by dominance of striate disaccate pollen chiefly, *Striatopodocarpites* (40-46%) and *Faunipollenites* (10-20%).

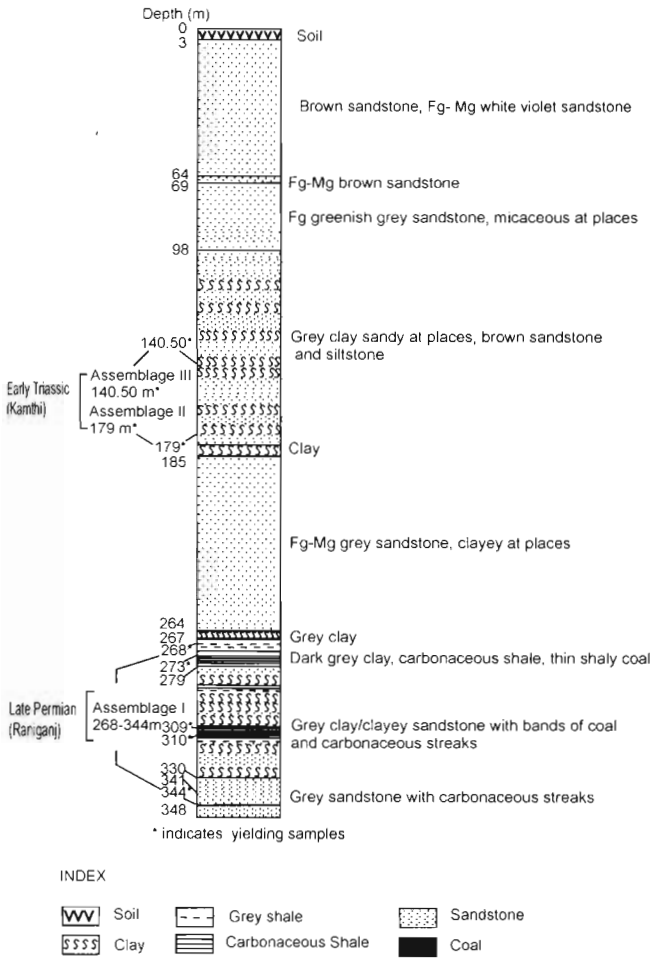


Fig.3. Litholog of bore core SSP-133 showing position of yielding samples.

The other striate disaccates recorded in the assemblage include *Crescentipollenites* (3-5%), *Strotersporites* (2-4%), *Verticipollenites* (2-3%), *Striatites* (4-6%). Non-striate disaccate *Scheuringipollenites* is subdominant (8-12%). Trilete spores are low in percentage and are represented by *Calamospora, Lophotriletes, Brevitriletes, Horriditriletes, Osmundacidites.* Taeniate pollen are represented by *Lunatisporites* (2-3%), *Corisaccites* (1%), *Guttulapollenites* (1-4%), *Hamiapollenites* (upto 3%). The taxa viz., *Falcisporites, Klausipollenites, Chordasporites* are present in low amount (1-2%).

Assemblage-II

This palynoassemblage is recorded in the grey shale sample at 179 m. The striate disaccate pollen chiefly, *Striatopodocarpites* and *Faunipollenites* show a sharp decline but the percentage of taeniate disaccates rises almost equal to that of striate disaccates. The taeniate genera are represented by *Lunatisporites* (16%), *Guttulapollenites* (3%), *Hamiapollenites* (2%), *Kamthisaccites* (1%). The nonstriate disaccates viz., *Falcisporites* (8%), *Klausipollenites* (4%), *Chardasporites* (4%) which were rare (1-2%) in the Assemblage-I show increase in percentage. Trilete spores are represented by *Cyathidites* (1%), *Osmundacidites* (2%) and *Lophotriletes* (2%).

Assemblage –III

This palynoassemblage is recorded in the grey clay sample at 140.50m. Cingulate cavate trilete spores viz. *Lundbladispora* (15%) and *Densoisporites* (10)%) increase in percentage while striate disaccate pollen continue to occur but with decreasing percentage. This palynoassemblage is characterized by the presence of stratigraphically significant taxa viz. *Playfordiaspora* (2%), *Falcisporites* (4%), *Chordasporites* (5%), *Klausipollenites* (5%), *Brachysaccus* (2%), *Guttatisporites* (1%), *Lunatisporites* (3%). Presence of *Inaperturopollenites* (12%) and *Leiosphaeridia* (3%) is significant.

Spore-pollen species identified in the Late Permian and Early Triassic palynoassemblages in borecore SSP-133, Sattupalli area, have been listed in Fig. 6. Some of the stratigraphically significant taxa are displayed in Pls. I and II.

DISCUSSION

The dominance of striate disaccate pollen grains along with rare occurrence of stratigraphically significant taxa viz., *Falcisporites, Chordasporites, Klausipollenites, Lunatisporites, Verticipollenites, Crescentipollenites, Strotersporites, Corisaccites, Guttulapollenites,* and *Hamiapollenites* is characteristic association in Palynoassemblage-I between 268 and 344m. In Lower Gondwana palynological succession, the striate disaccates show fairly good representation (subdominant component of the palynoflora) from the Lower Barakar (Early Permian), attain dominance in the Upper Barakar and continue to remain dominant up to the Raniganj Formation (Late Permian). Thus, the associated taxa become more important while identifying the assemblages in younger sequences. Presence of above-mentioned stratigraphically important taxa in the Palynoassemblage I is significant as it shows younger aspect of the palynoflora during the Permian, i.e. the assemblage is Late Permian in age. Hence, Palynoassemblage-I represents Raniganj-equivalent (Late Permian) palynoflora. It compares well with the Lower Raniganj palynofloras of Ramagundam, Ramakrishnapuram and Bhopalpalli areas (Srivastava and Jha 1988; Jha and Srivastava, 1996), Mailaram area (Srivastava and Jha, 1990), Chelpur area (Srivastava and Jha, 1987), Manuguru area (Srivastava and Jha, 1992) and Budharam area (Srivastava and Jha, 1995) in the Godavari Graben. These palynoassemblages are equivalent to *Striatopodocarpites-Faunipollenites* Assemblage Zone described by Tiwari and Tripathi (1992) in the dominance of striate disaccates *Striatopodocarpites* and *Faunipollenites.*

Some of the dominant striate disaccate taxa of Palynoassemblage-I, *viz.*, *Striatopodocarpites* and *Faunipollenites* continue to occur in Palynoassemblages II and III but their overall percentage decreases. On the other hand, the taeniate-cingulate-cavate taxa show increase in percentage frequencies in Assemblage II and III, i.e. *Lunatisporites* increases in percentage in Assemblage II and *Lundbladispora* and *Densoisporites* increase in percentage in Assemblage III, which distinguish these assemblages from underlying Raniganj-equivalent assemblage, i.e. Palynoassemblage-I. These genera make their earliest appearence in the Raniganj (=Lower Kamthi *sensu* Rajarao, 1982) where they are meagre and sporadic.

Early Triassic assemblage from Salt Range, Pakistan (Balme, 1970) has a predominance of the genus *Lunatisporites* (=*Taeniaesporites*) in association with *Densoisporites* and *Lundbladispora.* But the frequencies of these genera decline at the level of the Late Early Triassic.

The Australian Early Triassic mioflora (de Jersey 1968,

Formation	Assemblage	Sample no. & Depth (m)	Lithology	Quantitatively Important Taxa	Qualitatively Important Taxa	Remarks
K A M T H I	III	1- 140.50	Grey clay	*Lundbladispora* (15%) *Densoisporites* (10%) *Inaperturopollenites* (12%)	*Falcisporites* (4%) *Klausipollenites* (5%) *Chordasporites* (5%) *Guttatisporites* (1%) *Playfordiaspora* (2%) *Osmundacidites* (1%) *Brachysaccus* (2%) *Lunatisporites* (3%) *Leiosphaeridia* (3%)	Cingulate cavate phase marked change, **Early Triassic**
	II	2- 179	Clay	*Lunatisporites* (16%) *Falcisporites* (8%) *Klausipollenites* (4%) *Chordasporites* (4%) *Strotersporites* (8%) *Faunipollenites* (9%) *Striatopodocarpites* (16%)	*Guttulapollenites* (3%) *Cyathidites* (1%) *Osmundacidites* (2%) *Playfordiaspora* (1%) *Kamthisaccites* (1%) *Hamiapollenites* (2%)	Taeniate phase, marked change, lowering of striate disaccates **Early Triassic**
RANIGANJ	I	3- 268 4- 273 5- 309 6- 310 7- 341 8- 344.5 0	Shaly coal Grey clay Coal Coal Carb.shale Carb.shale	*Striatopodocarpites* (43%) *Faunipollenites* (15%) *Scheuringipollenites* (10%)	*Strotersporites* (3%) *Verticipollenites* (3%) *Corisaccites* (1%) *Guttulapollenites* (3%) *Hamiapollenites* (2%) *Falcisporites* (1%) *Chordasporites* (2%) *Crescentipollenites* (4%) *Striatites* (5%) *Striomonosaccites* (1%) *Lunatisporites* (2%) *Weylandites* (1%) *Klausipollenites* (1%)	Striate disaccate dominant phase, appearance of younger elements, **Late Permian**

Fig. 4. Showing palynocomposition of assemblages recorded in bore core SSP-133, Sattupalli area, Chintalapudi Sub-basin.

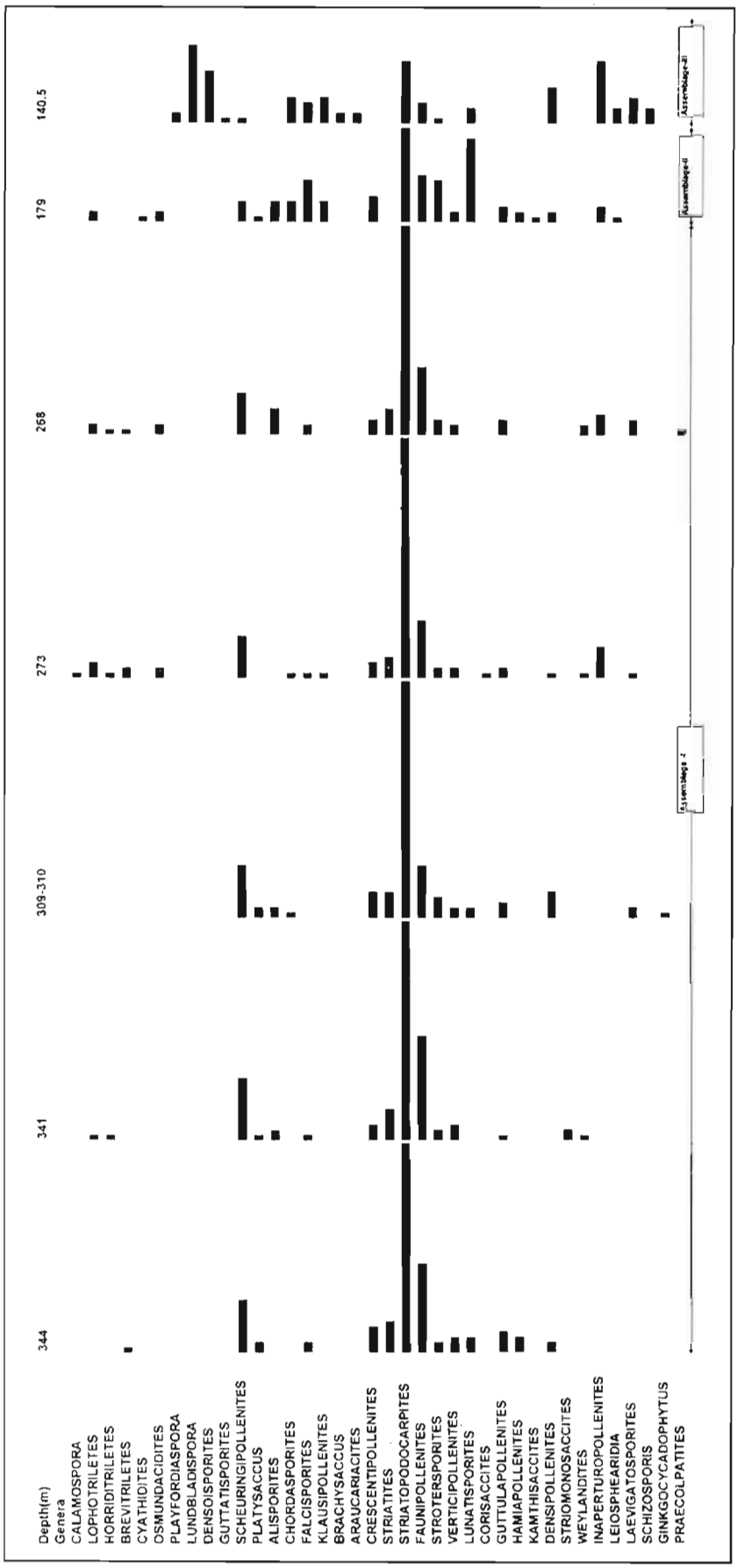
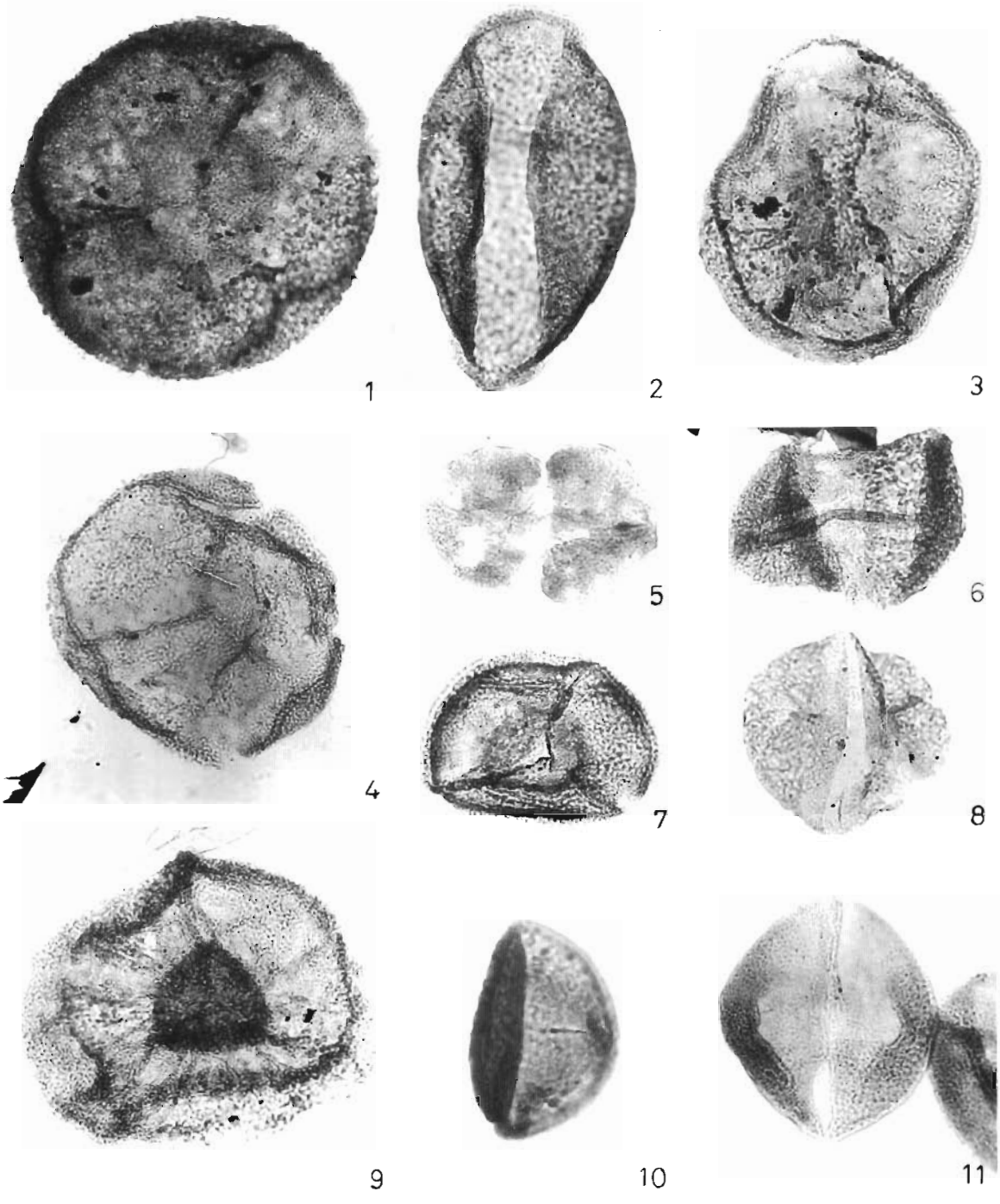


Fig. 5. Histogram showing vertical distribution and percentage frequencies of various palynotaxa in the borecore SSP-133, Sattupalli area, Chintalapudi Sub-basin.

Plate I



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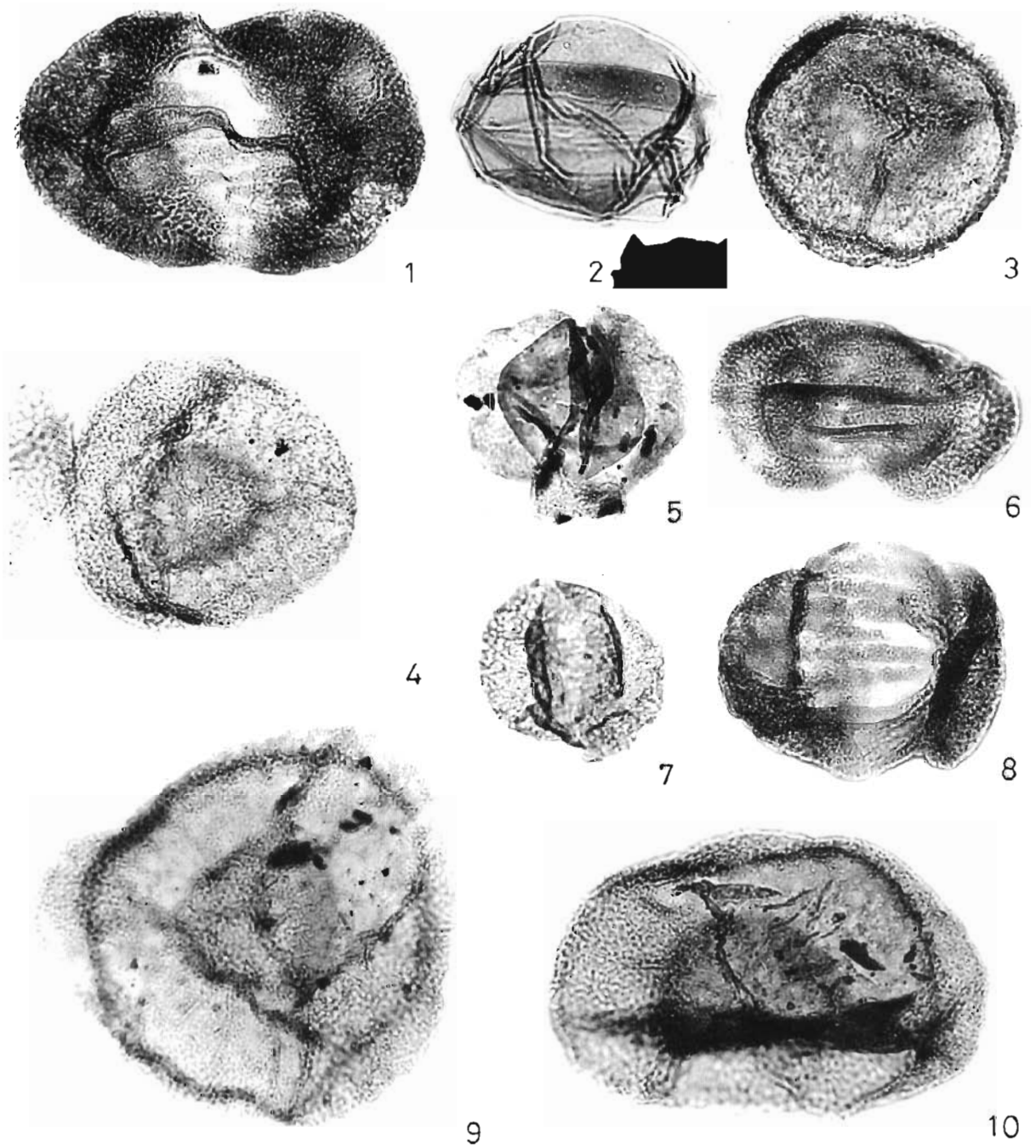
EXPLANATION OF PLATE I

1. ***Densoisporites*** BSIP slide no.13173, R-26
2. Unidentified BSIP slide no.13173, N-27/2
3. ***Lundbladispora*** BSIP slide no.13172, P-32/1
4. ***Lundbladispora*** BSIP slide no.13172, R-45/3
5. ***Lunatisporites*** BSIP slide no.13174, K-46/2
6. ***Chordasporites*** BSIP slide no.13172, N-45/3
7. ***Lundbladispora*** BSIP slide no.13173, S-34
8. ***Klausipollenites*** BSIP slide no.13173, N-40/1
9. ***Lundbladispora*** BSIP slide no.13172. P-50/1
10. ***Guttatisporites*** BSIP slide no.13174, L-54/2
11. ***Klausipollenites*** BSIP slide no.13174, R-39/2

Plate II



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EXPLANATION OF PLATE II

1. ***Strotersporites*** BSIP slide no.13173, M-35
2. ***Laevigatosporites*** BSIP slide no. 13173, G-28/4
3. ***Densoisporites*** BSIP slide no. 13173, P-31/4
4. ***Playfordiaspora*** BSIP slide no.13174, H-46/4
5. ***Lunatisporites*** BSIP slide no. 13174, R-37
6. ***Strotersporites*** BSIP slide no. 13174, N-34/1
7. ***Falcisporites*** BSIP slide no. 13174, G-36/3
8. ***Lunatisporites*** BSIP slide no. 13174, P-62/2
9. ***Lundbladispora*** BSIP slide no. 13173, P-43/3
10. ***Densipollenites*** BSIP slide no. 13172, P31

LATE PERMIAN	EARLY TRIASSIC
Brevitriletes communis (Tiwari) Bharadwaj & Syivastava emend. Tiwari & Singh, 1981	*Lophotriletes* sp.
B. unicus (Tiwari) Bharadwaj & Srivastava emend. Tiwari & Singh, 1981	*Cyathidites* sp.
Lophotriletes rectus Bharadwaj & Salujha, 1964	*Osmundacidites senectus* Balme, 1963
Lophotriletes sp.	*Playfordispora cancellosus* (Playford & Dettman) Maheshwari & Banerji, 1966
Calamospora sp.	*Densoisporites playfordii* Balme, 1963
Horriditriletes ramosus (Balme & Hennelly) Bharadwaj & Salujha, 1968	*D. nejburgii* (Schulz) Balme, 1970
Osmudacidites sp.	*D.* sp.
Laevigatosporites colliensis (Balme & Hennelly) Ventatachale & Kar, 1968	*Lundbladispora willmotti* Balme, 1963
Scheuringipollenites maximus (Tiwari) Tiwari, 1973	*L. brevicula* Balme, 1963
S. tentulus (Tiwari) Tiwari, 1973	*L. obsoleta* Balme, 1970
Densipollenites invisus Bharadwaj, 1962	*Guttatisporites* sp.
D. indicus Bharadwaj, 1969	*Striomonosaccites* sp.
D. densus Bharadwaj & Srivastava, 1969	*Platysaccus* sp.
D. magnicorpus Tiwari & Rana, 1981	*Alisporites* sp.
D. marginalis Jha, 1996	*Guttulapollenites hannonicus* Goubin, 1965
Platysaccus sp.	*Hamipollenites insolitus* Maheshwari & Salujha, 1964
Alisporites landianus Balme, 1970	*Kamthisaccites* sp.
A. indarrensis Segroves, 1969	*Klausipollenites* sp.
Klausipollenites sp.	*Falcisporites stabilis* Balme, 1970.
Guttulapollenites hannonicus Goubin, 1965	*Chordasporites australiensis* de Jersey, 1962
G. gondwanensis Goubin 1965	*Brachysaccus* sp.
Corisaccites alutus Venkatachala & Kar, 1966	*Crescentipollenites multistriatus* (Benerji & Maheshwari) Jha, 1996
Hamiapollenites insolitus Bharadwaj & Salujha, 1964	*Stroter sporites crassiletus* Jha, 1996
Lunatisporites ovatus (Goubin) Maheshwar & Banerji, 1966	*Verticipollenites* sp.
Stroter sporites communis Wilson, 1962	*Lunatisporites ovatus* (Goubin) Maheshwari & Banerji, 1975
S. wilsonii Klaus, 1963	*L. pellucides* (Goubin) Maheshwari & Banerji, 1975
Lueckisporites virkii Potonie & Klaus, 1954	*L. noviaulensis* (Leschik) Schevring, Tiwari & Rana, 1980
Verticipollenites debiles Venkatachala & Kar, 1968	*L. panchetensis* Tiwari & Rana, 1981
Crescentipollenites globosus (Maithy) Jha, 1996	*Densipollenites inuvsus* Bharadwaj & Salujha, 1964
C. fusus (Bharadwaj) Bharadwaj, Tiwari & Kar, 1974	*Laevigatosporites colliensis* (Balme & Hennelly) Ventatachale & Kar, 1968
C. gondwanensis (Maheshwari) Bharadwaj, Tiwari & Kar, 1974	*Inaperturopollenites* sp.
C. brevis (Bose & Kar) Bharadwaj, Tiwari & Kar, 1974	*Leiosphaeridia* sp.
C. multistriatus (Banerji & Maheswari) Jha, 1996	
Faunipollenites varius Bharadwaj, 1962	
F. parvus Tiwari, 1965	
F. bharadwajii Maheshwari, 1967	
Striatopodocarpites diffuses Bharadwaj & Salujha, 1964	
S. decorus Bharadwaj & Salujha, 1964	
S. brevis Sinha, 1972	
S. multistriatus Jha, 1996	
S. subcircularis Sinha, 1972	
Striatites communis Bharadwaj & Salujha, 1964	
S. parvus Tiwari, 1965	
Weylandites circularis Bharadwaj & Srivastava, 1969	
Inaperturopollenites sp.	
Schizosporis sp.	
Ginkgocycadophytus sp.	
Praecolpatites sinuosus (Balme & Hennelly) Bharadwaj & Srivastava, 1969	

Fig. 6. List of spore–pollen species identified in the Permian and Early Triassic succession in borecore SSP-133 from the Sattupalli area, Chintalapudi Sub-basin.

1970; Dolby and Balme, 1976) like the present assemblages is also characterized by taeniate and cingulate forms. However, the genus *Aratrisporites* which frequently occurs in the Australian Assemblage is absent in the present borecore from the Chintalapudi Sub-basin.

Thus, the positive evidence of change in palynocomposition of Assemblages is revealed at 179m by sharp decline in percentage of striate disaccates and rise in percentage of *Lunatisporites* (16%) and *Falcisporites* (8%) and occurrence of taxa viz., *Guttulapollenites* (3%), *Hamiapollenites* (2%), *Kamthisaccites* (1%), *Klausipollenites* (4%) and *Chordasporites* (4%). Assemblage III is strikingly different in having dominance of cingulate cavate spores i.e. *Lundbladispora* (15%) and *Densoisporites* (10)%) and further lowering in percentage of striate disaccates. Thus, three palynoassemblages demarcated in bore core SSP-133 from Sattupalli area essentially fall under two groups: 1. Palynoassemblage-I is of Late Permian age by virtue of dominance of striate disaccate pollen and appearance of some younger Early Triassic forms. 2. the Palynoassemblages II and III are strikingly different from the Palynoassemblage-I showing gradual disappearance of the characteristic showing genera of Assemblage-I, i.e. striate disaccates and consequent dominance of taeniate pollen and cingulate cavate triletes spores.

Palynoassemblages II & III records conclusive evidence of the presence of Lower Triassic sediments in the Sattupalli area. Existence of the Talchir, Barakar and Raniganj-equivalent sediments has already been proved in the Ayyanapalli Gompana area (Srivastava and Jha, 1993), Chintalapudi and Sattupalli areas (Srivastava and Jha, 1994) of Chintalapudi sub-basin. Presence of *Inaperturopollenites* and leiosphaerids in high percentage in Assemblage III is significant as they indicate shallow marine influence during the deposition of these sediments during Early Triassic (Balme, 1970).

Lithologically, the sequence from 267m to 344m show dark grey clay, sandstone, carbonaceous shale and thin shaly coal, grey sandstone with carbonaceous streaks. The Late Permian palynoflora has been demarcated in this sequence from 268-344m. Definite Triassic palynoflora has been recorded in grey clay at 179m while 75m thick grey sandstone sequence between 267 to 179m may encompass the other younger assemblages of the Raniganj Formation. But due to non availability of samples between this depth interval, nothing can be said conclusively. Definite presence of Triassic assemblage at 179m indicates that Permian/Triassic boundary passes somewhere between 267 and 179m. Lithologically, the changeover is observed between the sandstone at 185.77m and grey clay at 185m. The middle and upper part of the sequence between 179 to 98m and 98 to 69m represents the Kamthi Formation (Early Triassic). *Densoisporites, Lundbladispora* is much younger than *Lunatisporites* Assemblage and represents Late Early Triassic.

The present investigation leads to the conclusion that the carbonaceous coal shale, grey clay, grey sandstone horizon between 268 and 344 m in the borecore SSP-133 are equivalent to the Sondila seam-bearing coal horizon of the Godavari sub-basin and hold a greater promise of economically viable coal reserves in this area.

Early Triassic palynoflora equivalent to Panchet has been recorded for the first time in Chintalapudi sub- basin. The earlier view of the absence of this member (equivalent to Panchet Formation) in Sattupalli is ruled out palynologically. Thus, the Kamthi sediments (Jha and Srivastava, 1996) equivalent to the Panchet Formation are also present in the Sattupalli area. The transition from Late Permian to Early Triassic in Sattupalli is gradational similar to Budhuram (Srivastava and Jha, 1995) area, while a sudden change in palynoflora at this level is recorded in Mailaram area (Srivastava and Jha,1990).

The present data confirm the findings of Jha and Srivastava (1996) that the Kamthi Formation represents the Triassic sequence equivalent to the Panchet Formation overlying the Raniganj-equivalent sediments with a gradational contact. A perusal of the foregoing account reveals the existence of Panchet Formation in the Sattupalli area of the Chintalapudi sub-basin.

ACKNOWLEDGEMENTS

The author is thankful to Dr. N.C. Mehrotra, Director, Birbal Sahni Institute of Palaeobotany, Lucknow for providing facilities to carry out the research work and permitting me to publish the paper. Thanks are due to Sri M. Basva Chari, GM (Expl.) SCCL, Kothagudam for permitting me to collect the samples and providing the necessary details. The author is also thankful to Sri Subbareddy, Supt. Geologist, SCCL, Kothagudem, Sri Jyalasharif, Dy., Suptd., Geologist, and Sri Ajay Kumar Reddy, Sr. Geologist, Sattupalli for help in the field. Thanks are due to the official reviewer, Dr. Arun Kumar, KFUMP, Thahran, Souhi Arabia for giving useful suggestions.

REFERENCES

Balme, B.E.1970. Palynology of Permian and Triassic strata in the Salt Range and Surghar Range, western Pakistan, p. 305-455. In: *Stratigraphic boundary problems : Permian and Triassic of West Pakistan* 4, (Eds. Kummel, B. and Teichert, C.), Geology Department, Univ. Kansas.

Bharadwaj, D.C. 1975. Palynology in biostratigraphy and palaeoecology in Indian Lower Gondwana Formations. *Palaeobotanist*, **22**(2): 150-157.

Blanford, W. T. 1872. Description of the sandstone in the neighbourhood of the first barrier on the Godavari and in the country between the Godavari and Ellore. *Records of Geological Survey of India*. **6** (2) : 23-29

d Jersy, N.J. 1970 Triassic spores and pollen grains from Clematis Sandstone. *Publication Geological Survey of Queensland 338,Palaeontology Papers*, **14**: 1-44.

d Jersy, N.J. 1970 Early Triassic miospores from Rewan Formation. *Publication Geological Survey of Queensland 345, Palaeontology Papers*, **19**: 1-29.

Dolby, J. & Balme, B.E. 1976 Triassic palynology of the Cararvon Basin, Western Australia. *Review Palaeobotany and Palynology*, **22**: 105-168.

Jha, Neerja 2002 Palynological dating of sediments from Gattugudem area, Chintalapudi sub-basin, Andhra Pradesh. *Geophytology* **30**(1&2): 85-89.

Jha, Neerja 2004. Palynological dating of coal bearing sediments from the Bottapagudem area, Chintalapudi sub-basin, Andhra Pradesh, India. *Palaeobotanist*, **53**:61–67.

Lakshminarayana, G. and Murthy K.S. 1990. Stratigraphy of the Gondwana Formations in the Chintalapudi sub-basin , Godavari valley, Andhra Pradesh. *Journal of Geological Society of India*, **36**(1): 13-35.

Raiverman, V., Rao, M.R. and Pal. D. 1985. Stratigraphy and structure of the Pranhita-Godavari Graben. *Petroleum Asia Journal*, **8**(2): 174-189.

Rajarao C.S. 1982 Coalfields of India –2. Coal resources of Tamil Nadu, Andhra Pradesh, Orissa and Maharashtra. *Geological Society of India, Bulletin Ser.A*, **45**: 9-40

Srivastava, Suresh, C. and Jha, Neerja 1987. Palynology of Kamthi Formation from Chelpur area, Godavari Graben, Andhra Pradesh, India. *Palaeobotanist*, **35**(3):342-346.

Srivastava, Suresh, C. and Jha, Neerja 1988. Palynology of Kamthi

Formation in Godavari Graben, p. 123-132. In: *Concepts, limits and extension of Indian Gondwana* (Eds Venkatachala, B.S. and Maheshwari, H.K.), *Palaeobotanist*, **36**.

Jha, Neerja and Srivastava Suresh C. 1996 Kamthi Formation palynofloral diversity, p. 355-368. In: *Gondwana Nine* (Eds. Guha, P.K.S., Sengupta, S., Ayyasami, K. and Ghosh, R.N.), Oxford & IBH Publishing Co., Calcutta, 1.

Srivastava, Suresh C. and Jha, Neerja 1988. A Lower Triassic palynoassemblage from Budharam area, Godavari Graben, Andhra Pradesh, India. *Geophytology* **18**(1):124-125.

Srivastava, Suresh, C. and Jha, Neerja 1990. Permian–Triassic palynofloral transition in Godavari Graben, Andhra Pradesh, p. 92-97. In : *Proceedings of Symposium Vistas in Indian Palaeobotany*, (Eds. K.P. Jain & R.S. Tiwari), *Palaeobotanist*, **38**.

Srivastava, Suresh, C. and Jha, N. 1992. Palynostratigraphy of Permian sediments in Manuguru area, Godavari Graben, Andhra Pradesh. *Geophytology*, **22**:102-110.

Srivastava, Suresh, C. and Jha, Neerja 1992. Palynological dating of coal seams in Amavaram Area, Khammam District, A.P., India. *Geophytology*, **20**(2) : 161.

Srivastava, Suresh, C. and Jha, Neerja 1993. Palynostratigraphy of Lower Gondwana sediments in Chintalapudi Sub-basin,Godavari Graben, Andhra Pradesh. *Geophytology*, **23**(1) : 93-98.

Srivastava, Suresh, C. and Jha, Neerja 1994. Palynological dating of Lower Gondawana sediments in Sattupalli area, Chintalapudi sub- basin,Andhra Pradesh, India. *Palaeobotanist*, **42**(2) : 169-173.

Srivastava, Suresh, C. and Jha, Neerja 1995 Palynostratigraphy and correlation of Permian-Triassic sediment in Budharam area, Godavari Graben, India. *Journal of Geological Society of India*, **46**: 647-653.

Tiwari R.S. and Rana V. 1980. A Middle Triassic mioflora from India. *Biological Memoirs*, **5**(1) : 30-55.

Tiwari, R.S. and Tripathi, A. 1992. Marker assemblage zones of spore and pollen species through Gondwana sequence in India. *Palaeobotanist*, **40**, 194-236.

Manuscript Accepted July 2008