Early and Late Triassic palynoassemblages from subsurface Supra-Barakar sequence in Talcher Coalfield, Orissa, India*

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Tripathi Archana 1996. Early and Late Triassic palynoassemblages from subsurface Supra-Barakar sequence in Talcher Coalfield, Orissa, India. *Geophytology* **26** (1): 109-118.

Lithologically the bore hole TP-8 from the north-eastern region of Talcher Coalfield, Orissa intersects the Talchir, Karharbari, Barakar and Supra-Barakar formations. The contact between Barakar and Supra-Barakar has been marked at 368.00 m depth. The palynoflora (Assemblage-I) recovered from the lithologically classified Barakar Formation has shown the presence of a distinct Late Permian affiliation when compared to the Late Permian Raniganj assemblages of the Raniganj Coalfield. A distinct and sharp palynofloral break is recorded at the commencement of the Supra-Barakar sequence. The quantitative representation of characteristic palynotaxa and totality of the palynoassemblage reveal the presence of three distinct assemblages in the Supra- Barakar sediments. The Assemblage II and III at 350.00 and 334.00 to 307.30 meters respectively represent Early Triassic while Assemblage IV at 238.30 to 151.30 meter depth reveals Late Triassic age connotation. The presence of acritarchs in appreciable frequencies in Triassic assemblage is recorded for the first time from India.

Key-words—Palynostratigraphy, Acritarchs, Permian, Triassic, Talcher Coalfield, Orissa.

INTRODUCTION

THE Talcher Coalfield represents the South-eastern region of Son-Mahanadi graben. In the recent past it has been explored extensively for the coal reserves by the Geological Survey of India. Earlier the coal deposits of this coalfield have also been analysed palynologically for dating and correlation of coal-bearing sediments (Das, 1958; Bharadwaj & Srivastava, 1969; Navale & Srivastava, 1971; Srivastava, 1984; Tripathi 1993, 1995 in Press). Recently, for the first time, Tiwari, Tripathi and Jana (1991) have reported a Late Permian Raniganj assemblage from Madalia River section near Patrapara Village in the north-western part of the coalfield. In continuation of our efforts to understand the palynosequence in Talcher Coalfield, sediments in core from the bore hole TP-8 were undertaken for analysis. The borehole was drilled (1004.00 m. deep) near Tentuloi Village (Fig. 1) in the Chendipada Block of Talcher Coalfield by Mineral Exploration Corporation Limited. The sequence of this bore hole has been lithologically identified as Talchir, Karharbari, Barakar and Supra-Barakar with Talchir/Karharbari boundary at 992.00 m and Barakar/Supra-Barakar boundary at 368.00 m depth. The Barakar and underlying sediments are argillaceous containing coal, whereas, Supra-Barakar are without coal and mainly arenaceous in nature (Fig. 2).

All the palynological slides are stored in the Museum of Birbal Sahni Institute of Palaeobotany, Lucknow.

MATERIAL

Presently, the Supra-Barakar sediments from 40.00 to 368.00 m representing Kamthi Formation and the underlying coal-bearing sediments upto 516.24 m in the sequence, lithologically identified as of Barakar Formation, were palynologically analysed. The latter includes a 32.10 m thick coal horizon, besides many thin coal bands above and under it (Fig. 2).

PALYNOLOGICAL ASSEMBLAGES

In all, 28 samples yielded spore and pollen out of which the quantitative analysis could be done only for

* Paper presented at Golden Jubilee Conference, The Palaeobotanical Society, Lucknow, 16-18 November, 1995.

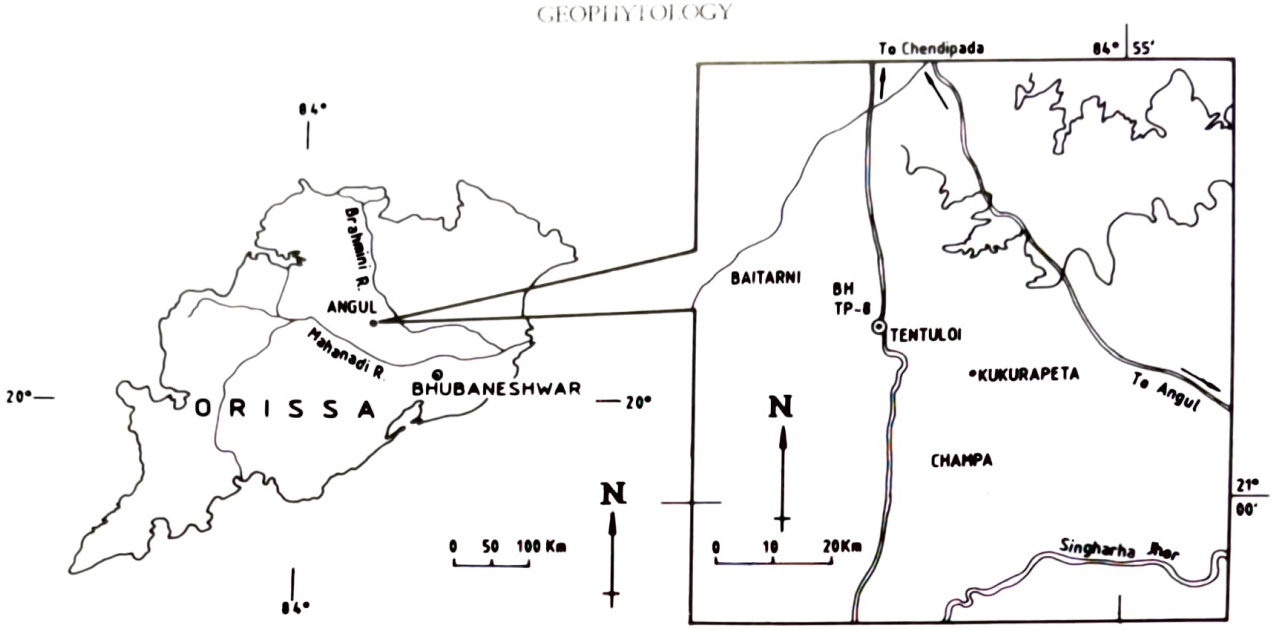


Fig. 1. Map of Talcher Coalfield showing the location of bore hole TP-8.

five samples. However, other yielding samples were also examined but only for assessing the presence of various taxa. Following species (in alphabetical order) have been recorded in the palynoflora :

Alisporites asansoliensis Mahesh. & Ban. 1975

Alisporites damudicus Tiw. & Rana 1981

Alsophyllidites sp. (Pl. 2, Fig. 6).

Arcuatipollenites ovatus (Goub.) Tiw. & Vijaya 1995 (Pl. 2, Fig. 12).

Arcuatipollenites pellucidus (Goub.) Tiw. & Vijaya 1995 (Pl. 2, Fig.11).

Arcuatipollenites sp. (Pl. 2, Fig. 9).

Brachysaccus sp.

Brevitriletes communis Bharad. & Sriv. emend. Tiw. & Singh 1981

Caheniasaccites indicus Sriv. 1970 (Pl. 1, Fig. 11)

Calamospora mesozoica Coup. 1958

Callialasporites sp.

Callumispora gretensis (Balme & Henn.) Bharad. & Sriv. emend. Tiw. *et al.* 1989 (Pl. 1, Fig. 1)

Concavissimisporites sp. (Pl. 2, Fig. 5)

Crescentipollenites fuscus (Bharad.) Bharad. *et al.* 1974

Cyathidites australis Coup. 1953

Densipollenites densus Bharad. & Sriv. 1969 (Pl. 1, Fig. 8)

Densipollenites indicus Bharad. 1962

Densipollenites invisus Bharad. & Sal. 1964

Densipollenites magnicorpus Tiw. & Rana 1981

Densoisporites complicatus Balme 1970

Densoisporites playfordii Balme 1970 (Pl. 2, Fig. 1)

Dictyotriletes sp. (Pl. 2, Fig. 4)

Falcisporites stabilis Balme 1970 (Pl. 1, Fig. 4)

Faunipollenites perexiguus Bharad. & Sal. 1965

Faunipollenites varius Bharad. emend. Tiw. *et al.* 1989

Foveosporites triassicus Kumar. & Mahesh. 1980 (Pl. 2, Fig. 3)

Ginkgocycadophytus sp. (Pl. 1, Fig. 5)

Gondisporites raniganjensis Bharad. 1962 (Pl. 1, Fig. 2)

Goubinispora morandavensis (Goub.) Tiw. & Rana 1981

Guttatisporites ambiguus Tiw. & Rana 1980

Guttatisporites guttatus Vissch. 1966 (Pl. 2, Fig. 7)

Krempipollenites indicus Tiw. & Vijaya 1995

Lundbladispora brevicula Balme 1970

Lundbladispora microconata Bharad. & Tiw. 1977 (Pl. 2, Fig. 2)

Lundbladispora raniganjensis Tiw. & Rana 1981

Microbaculispora tentula Tiw. 1965

Navalesporites spinosus Sarate & Ram-Awatar 1984 (Pl. 1, Fig. 3)

Nevesisporites velatus de Jer. & Patt. 1964 (Pl. 2, Fig. 10)

Parasaccites obscurus Tiw. 1965 (Pl. 1, Fig. 12)

Platysaccus sp.

Playfordiaspora annulata Tiw. & Rana 1980 (Pl. 2, Fig. 15)

Playfordiaspora cancellosa Mahesh. & Ban. 1975

Plicatipollenites indicus Lele 1964

Polycingulatisporites sp.

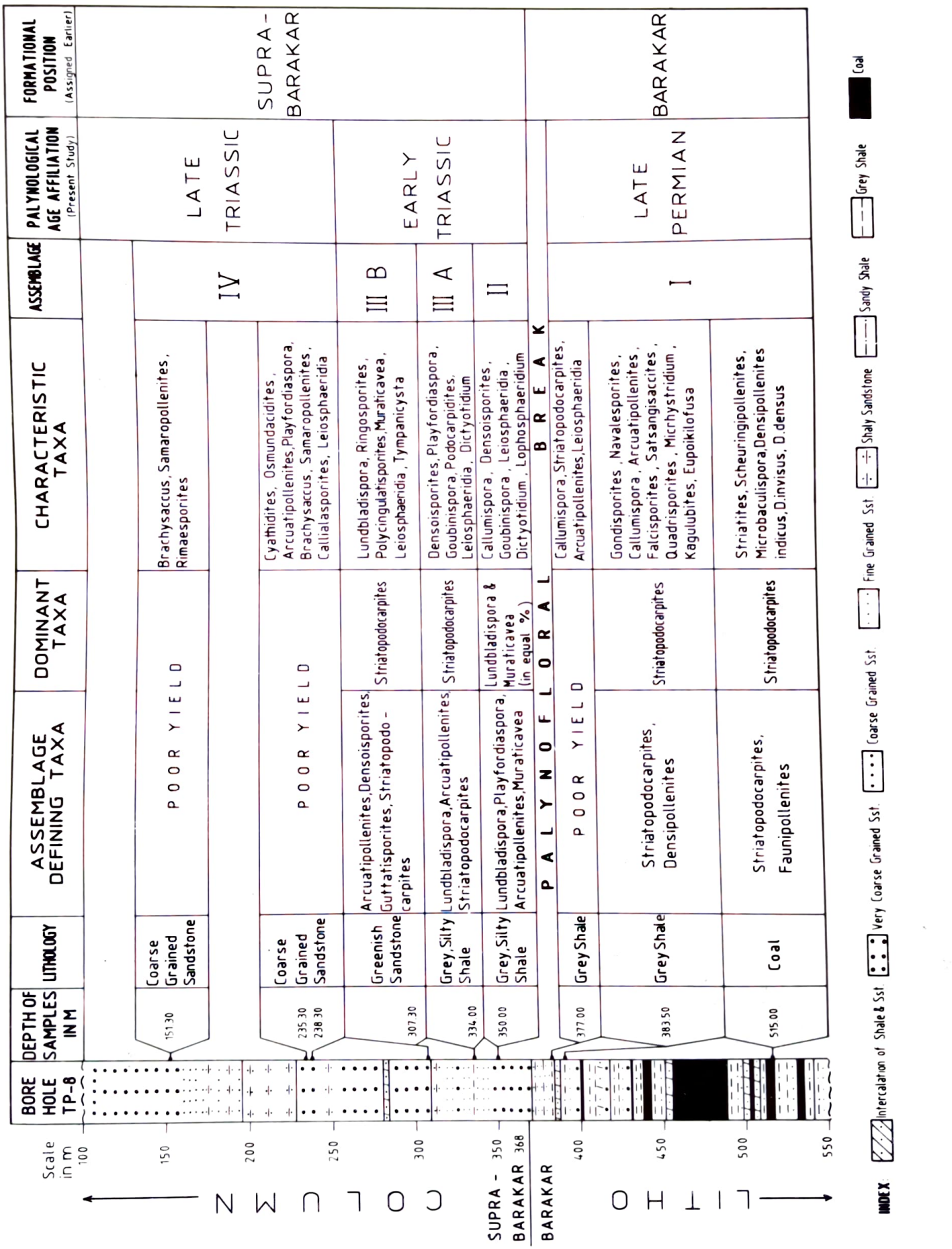
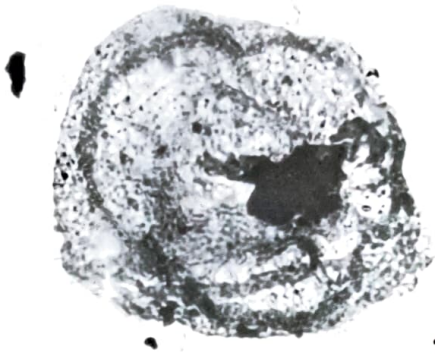


Fig. 2. Composite figure showing litholog of bore hole TP-8 with lithological boundary, depth of samples analysed palynologically, palynological characteristics and assemblages identified with palynological age affiliation.


1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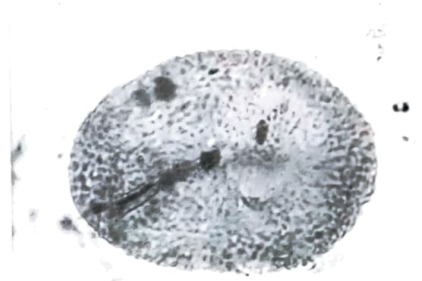
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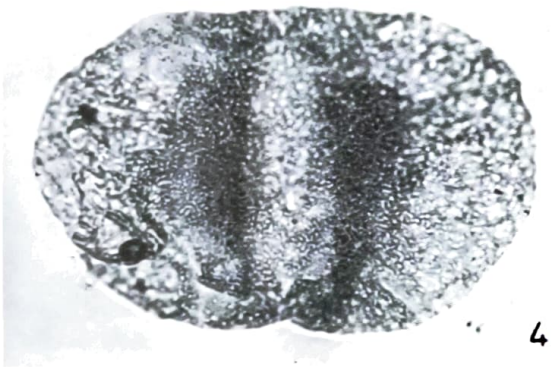
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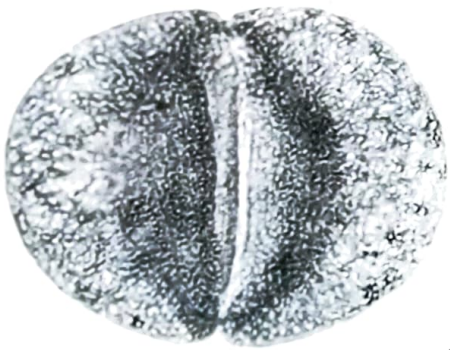
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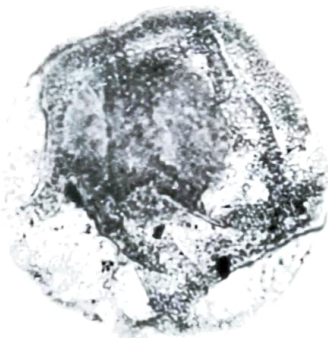
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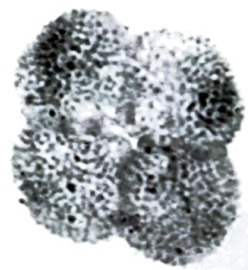
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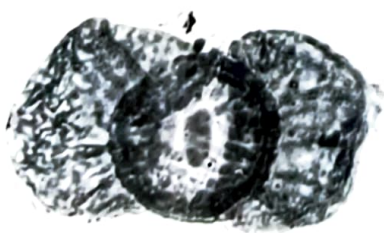
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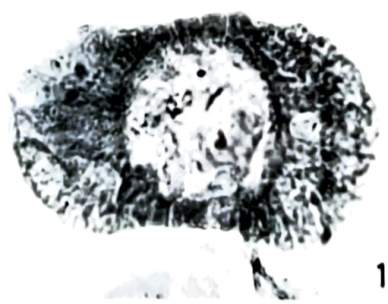
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Plate-1

(All phomicrographs are x 500)

1. *Callumispora gretensis*, 350 m depth, BSIP Slide No. 11699.
2. *Gondisporites raniganjensis*, 383 m depth, BSIP Slide No. 11700.
3. *Navalesporites spinosus*, 383 m depth, BSIP Slide No. 11700.
4. *Talcisporites stabilis*, 383 m depth, BSIP Slide No. 11700.
5. *Ginkgocycadophytus* sp., 383 m depth, BSIP Slide No. 11700.
6. *Striatopodocarpites magnificus*, 383 m depth, BSIP Slide No. 11700.
7. *Satsangisaccites nidpurensis*, 383 m depth, BSIP Slide No. 11701.
8. *Densipollenites densus*, 383 m depth, BSIP Slide No. 11700.
9. *Quadrisporites horridus*, 350 m depth, BSIP Slide No. 11698.
10. *Striatites notus*, 515 m depth, BSIP Slide No. 11702.
11. *Caheniasaccites indicus*, 350 m depth, BSIP Slide No. 11699.
12. *Parasaccites obscurus*, 350 m depth, BSIP Slide No. 11699.

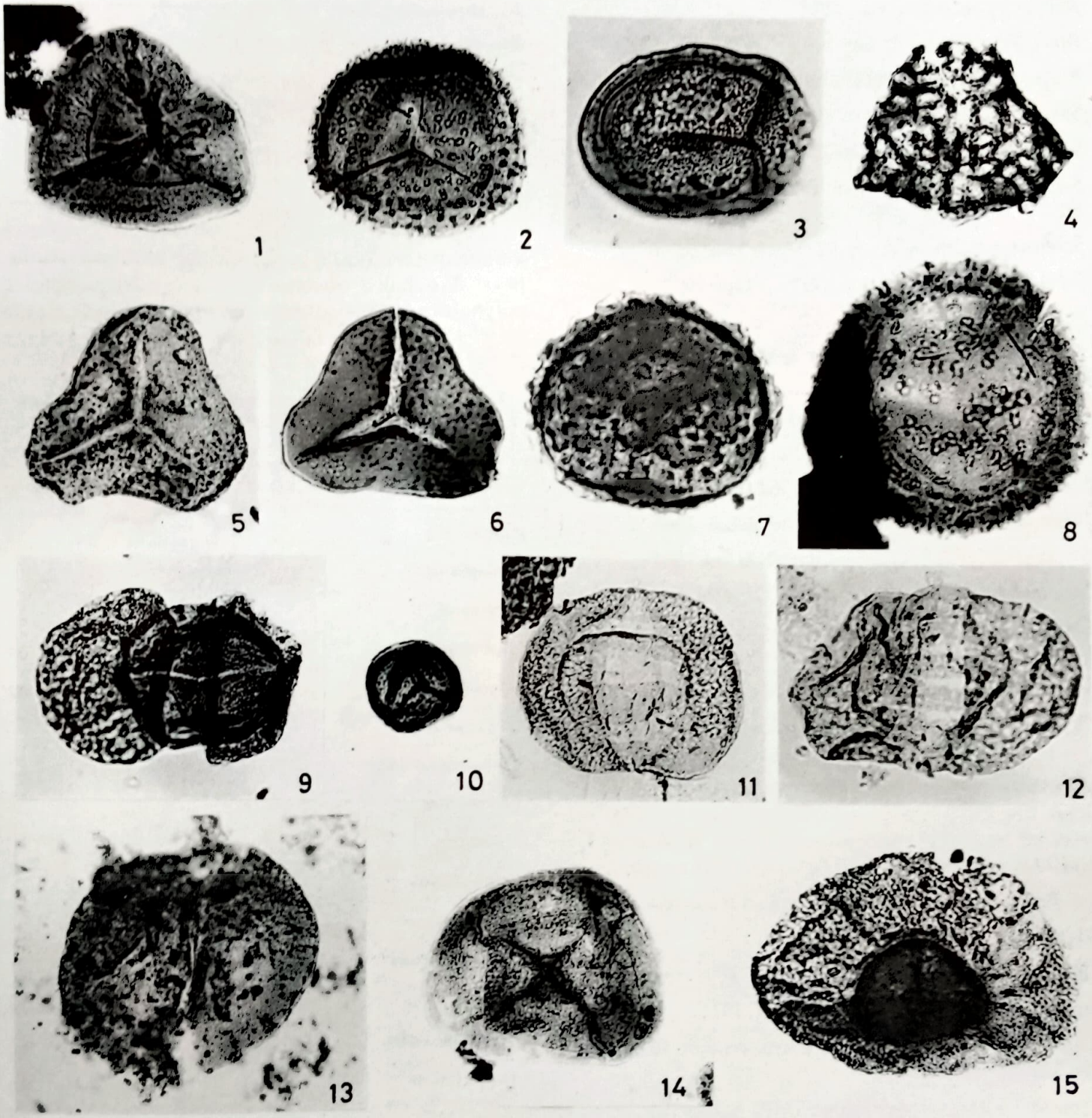

Plate 2

(All photomicrographs are X 500)

1. *Densoisporites playfordii*, 307 m depth, BSIP Slide No. 11696.
2. *Lundbladispora microconata*, 307 m depth, BSIP Slide No. 11696.
3. *Foveosporites triassicus*, 307 m depth, BISP Slide No. 11696.
4. *Dictyotriletes* sp., 350 m depth, BISP Slide No. 11699.
5. *Concavissimisporites* sp., 350 m depth, BSIP Slide No. 11699.
6. *Alsophyllidites* sp., 350 m depth, BISP Slide No. 116968
7. *Guttatisporites guttatus*, 350 m depth, BISP Slide No. 11699.
8. *Spinotriletes* sp., 307 m depth, BISP Slide No. 11696.
9. *Arcuatipollenites* sp., 307 m depth, BISP Slide No. 11696.
10. *Nevesisporites velatus*, 307 m depth, BISP Slide No. 11696.
11. *Arcuatipollenites pellucidus*, 307 m depth, BISP Slide No.11696.
12. *Arcuatipollenites ovatus*, 383 m depth, BISP Slide No. 11700.
13. *Rimaepollenites potoniei*, 151.30 m depth, BISP Slide No. 11703.
14. *Staurosaccites minutus*, 307 m depth, BISP Slide No. 11696.
15. *Playfordiaspora annulata*, 350 m depth, BISP Slide No. 11699.

Rhizomospora indica Tiw. 1965

Rimaesporites potoniei Lesch. 1955 (Pl. 2, Fig. 13)

Ringosporites fossulatus (Balme) Tiw. & Rana 1980

Sahnites thomasii Pant emend. Tiw. & Singh 1984

Samaropollenites speciosus Goub. 1965

Satsangisaccites nidpurensis Bharad. & Sriv. 1969 (Pl. 1, Fig. 7)

Scheuringipollenites maximus (Hart) Tiw. 1973

Scheuringipollenites tentulus (Tiw.) Tiw. 1973

Spinotriletes sp. (Pl. 2, Fig. 8)

Staurosaccites minutus Kumar. & Mahesh. 1980 (Pl. 2, Fig. 14)

Striamonosaccites ovatus Bharad. 1962

Striatites communis Bharad. & Sal. 1964

Striatites notus Bharad. & Sal. 1964 (Pl. 1, Fig. 10)

Striatopodocarpites decorus Bharad. & Sal. 1964

Striatopodocarpites diffusus Bharad. & Sal. 1964

Striatopodocarpites dubrajpurensis Tripathi *et al.* 1990

Striatopodocarpites magnificus Bharad. & Sal. 1964 (Pl. 1, Fig. 6)

Verrucosisporites densus Bharad. & Tiw. 1977

Verticipollenites gibbosus Bharad. 1962

Remarks- The Gondwana palynomorphs so far assigned to the genera *Lunatisporites* Leschik emend. Scheuring 1970 and *Klausipollenites* Jansonius 1962 are referred here to *Arcuatipollenites* Tiwari & Vijaya 1995 and *Krempipollenites* Tiwari & Vijaya 1995, respectively.

Following acritarch taxa are also recorded :

Alete Type A (Pl. 3, Fig. 3)

Dictyotidium Eis. 1938 (Pl. 3, Figs 4, 7, 8)

Eupoikilofusa Cramer 1970 (Pl. 3, Fig. 10)

Inaperturopollenites Thom. & Pfl. emend. Pot. 1958 (Pl. 3, Fig. 12)

Kagulubites Bose & Mahesh. 1967 (Pl. 3, Fig. 13)

Leiosphaeridia (Eis.) Down. & Sarj. 1965

Lophosphaeridium Timof. ex Down. 1963

Micrhystridium Defl. 1937 (Pl. 3, Fig. 9)

Muraticavea Wican. 1974 (Pl. 3, Figs 1, 2)

Quadrisporites Henn. emend. Pot. & Lele 1961 (Pl. 1, Fig. 9)

Schismatosphaeridium Stap. *et al.* 1965 (Pl. 3, Fig. 11)

Tympanicysta Balme 1980 (Pl. 3, Fig. 5)

Type B (Pl. 3, Fig. 6)

Figure 3 depicts the quantitative representation of various palynomorph groups in the sequence studied here. A detailed analysis of relative frequencies of palynotaxa and the qulitative composition indicate that the yielding samples fall under four main assemblages (Table 1, Figure 2).

Table 1 - Percentage distribution of Acritarch taxa, spores and pollen in samples, with high yield of palynofossils, of BH TP-8, Talcher Colafield, Orissa. + = Presence

Taxa/Depth in meter	383.00	350.00	334.00	307.30
Leiosphaeridia	0.8	2.2	0.8	2.9
Lophosphaeridium		0.7		
Muraticavea		20.2		2.2
Tympanicysta				0.7
Dictyotidium		3.5	0.8	0.7
Alete Type A		0.7		
Schismatosphaeridium		+		
Quadrisporites	2.2			
Kagulubites	+			
Micrhystridium	+			
Eupoikilofusa	+			
Inaperturopollenites	+			
Spores	4.5	26.7	23.4	17.6
Monosaccate Pollen	12.9	26.0	6.3	1.4
Bisaccate Pollen	79.6	20.0	68.7	74.5

The quantitative categories defined are >10%-- abundant; 5% - 10%- common; 1% - 5% -- rare; and <1% – sporadic.

Plate 3

1,2. *Muraticavea*, 1,350.00 m. depth, BISP Slide No. 11699; 2, 307.00 m depth, BISP Slide No. 11697.
3. Alete Type A, 350.00 m depth, BISP Slide No. 11698.
4,7,8. *Dictyotidium*, 4, 307 m depth, BISP Slide No. 11697; 7,8, 350.00 m depth, BISP Slide No. 11699, 11698.
5. *Tympanicysta*, 350.00 m depth, BISP Slide No. 11699.
6. Type B, 350.00 m depth, BISP Slide No. 11699.
9. *Micrhystridium*, 383.00 m depth, BISP Slide No. 11700.
10. *Eupoikilofusa*, 383.00 m depth, BISP Slide No. 11700.
11. *Schismatosphaeridium*, 350.00 m depth, BISP Slide No. 11699.
12. *Inaperturopollenites*, 383.00 m depth, BISP Slide No. 11700.
13. *Kagulubites*, 383.00 m depth, BISP Slide No.11701.

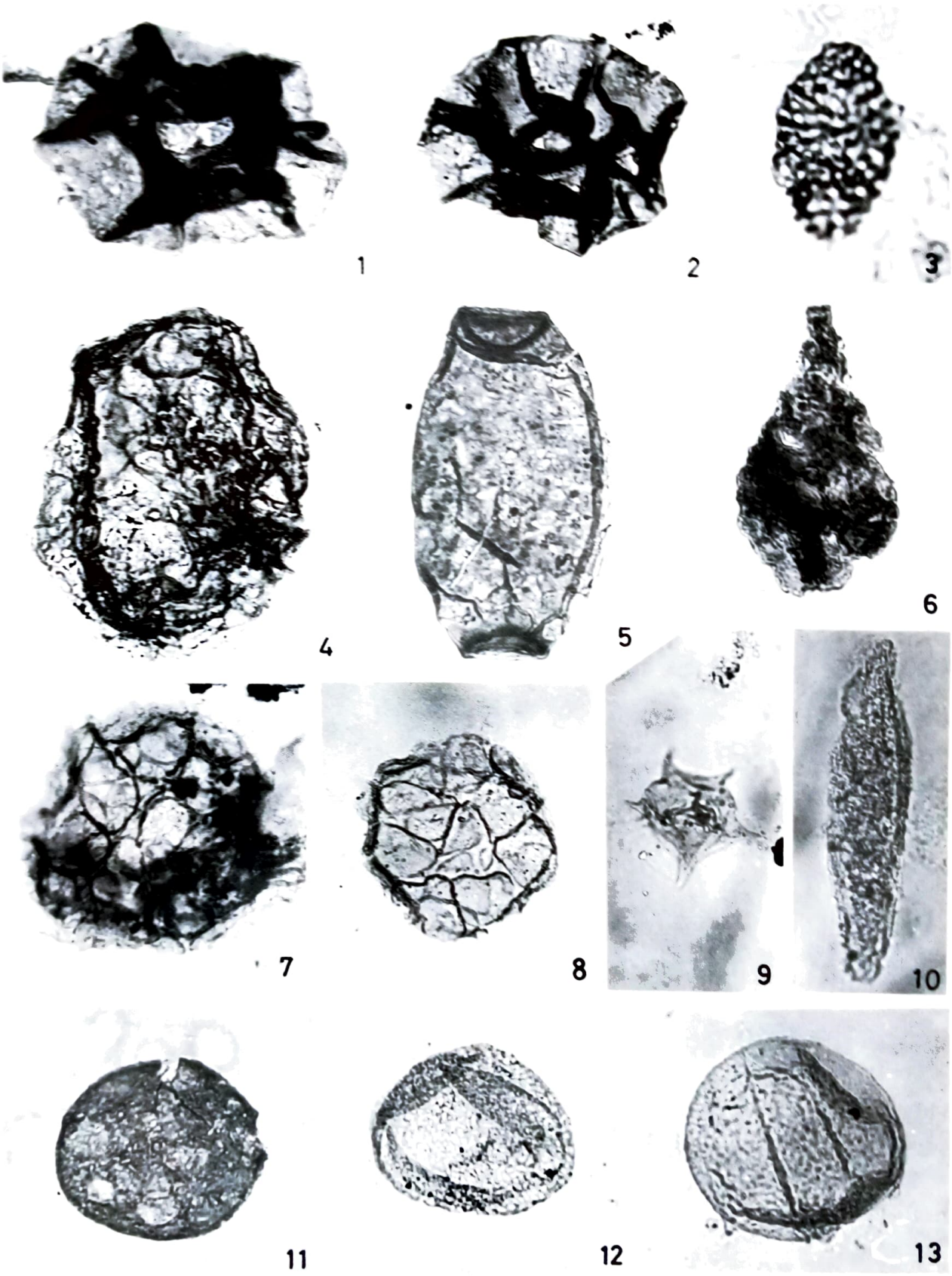

Plate 3

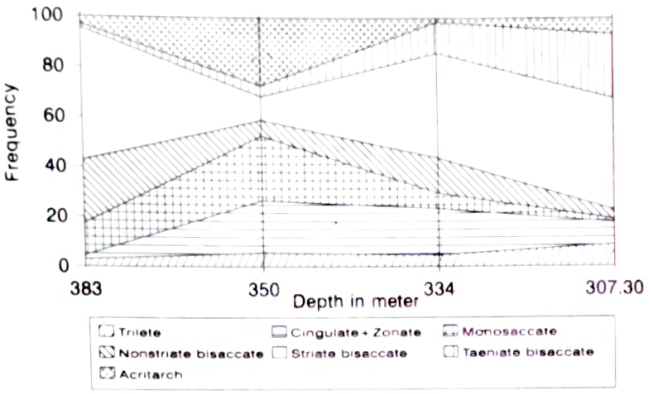

Fig. 3. Representation of palynomorph groups in Late Permian and Late Early Triassic assemblages in bore hole TP-8, Talcher Coalfield, Orissa.

Assemblage I: (Depth 515, 383, 377 m; Lithology - compact grey shale, coal) - The yield of palynofossils at 515 and 383 m depth is rich, hence, these samples could be analysed quantitatively. The poor yield at 377 m depth permitted only a qualitative analysis. The assemblage is dominated by *Striatopodocarpites*, associated with common occurrence of *Faunipollenites* and *Densipollenites*. The other qualitative characteristic taxa present are *Gondisporites, Navalesposites, Callumispora* and *Microbaculispora*. The genus *Densipollenites* is represented by species *D. indicus, D. invisus, D. densus, D. magnicorpus*. The palynocomposition of sample at depth 383 m is typical in having sporadic presence of *Arcuatipollenites, Satsangisaccites, Falcisporites, Quadrisporites*. In association with spores and pollen acritarchs are also recorded sporadically during a qualitative search of marker taxa. Presence of *Micrhystridium* is noteworthy.

Remarks- At this level, the assemblage is defined by taxa *Gondisporites, Navalesporites, Densipollenites* spp., *Arcuatipollenites, Satsangisaccites* and acritarchs. This assemblage is present in the sediments below the lithological Barakar and Supra-Barakar boundary which is drawn above the top most coal band (at about 372 m) in the coarse-grained sandstone facies.

Assemblage II: (Depth- 350.00 m; Lithology - compact grey, silty shale)-The assemblage has dominance of *Lundbladispora* and acritarch *Muraticavea* with equal percentages. The taxa with abundant to common occurrence are *Parasaccites, Playfordiaspora, Arcuatipollenites, Striatopodocarpites*. The other characteristic forms are *Callumispora, Osmundacidites, Densoisporites, Goubinispora, Sahnites, Vestigisporites*.

Remarks- At this level the assemblage is defined by taxa *Lundbladispora, Playfordiaspora, Arcuatipollenites* and acritarch- *Muraticavea*. The sediments above 350.00 m depth are fine - to very coarse grained sandstone while the underlying sediments are coarse to very coarse grained sandstone.

Assemblage III: The yield and preservation of palynomorphs is very good. The overall palynological composition is the same from 334.00 to 307.30 m depth. However, variations in the finer details are observed in the dominance and subdominance of taxa. Hence, two sub-assemblages could be identified.

Assemblage III A: (Depth-334.00 m; Lithology -compact grey, silty shale)- Here *Striatopodocarpites* is the dominant taxon. Cingulate-cavate spore *Lundbladispora* is subdominant. The forms with common occurrence are *Arcuatipollenites* and *Alisporites*. The other characteristic palynotaxa with rare or sporadic presence are *Densoisporites, Cyathidites, Concavissimisporites, Alsophyllidites, Playfordiaspora* and *Goubinispora*. The acritarchs are sporadically present.

Remarks- This assemblage is defined by *Lundbladispora, Arcuatipollenites* and *Striatopodocarpites*. The sediments above 334.00 m depth are mainly fine to coarse-grained sandstone while underlying strata have thin bands of sandy shale also.

Assemblage IIIB: (Depth -307.30 m; Lithology - greenish sandstone) - At this level also the dominant taxon is *Striatopodocarpites*. The taeniate genus *Arcuatipollenites* is subdominant. The other characteristic forms falling in the rare category (1-5%) are— *Densoisporites, Lundbladispora, Guttatisporites, Osmundacidites* and *Alisporites*. The taxa recorded sporadically are— *Ringosporites, Polycingulatisporites, Spinotriletes, Foveosporites, Goubinispora* and *Guttulapollenites*. The acritarchs are also present, but in low frequency.

Remarks- The assemblage is defined by taxa *Arcuatipollenites, Densoisporites, Guttatisporites* and *Striatopodocarpites*. It differs from Assemblage IIIA in low frequency of *Lundbladispora*. The sediments above 307.30 m depth are very coarse-grained sandstone while underlying ones are shaly sandstone and fine to coarse-grained sandstone.

Assemblage IV: (Depth-238.30 m; 235.30 m; 151.30 m; Lithology - coarse grained sandstone)-The yield of spore-pollen is poor, hence no quantitative analysis could be done. The qualitative composition reveals the presence of palynotaxa *Cyathidites, Osmundacidites, Alsophyllidites, Arcuatipollenites, Playfordiaspora, Brachysaccus, Rimaesporites, Samaropollenites, Callialasporites, Primuspollenites* and *Striatopodocarpites*.

Remarks- This assemblage is differentiated from Assemblage III by presence of *Brachysaccus, Rimaesporites,*

Samaropollenites and *Callialasporites*. The sediments from 238.30 to 151.30 m depth are mostly medium to very coarse-grained sandstone with few bands of fine-grained sandstone and shaly sandstone.

DISCUSSION

The palynological analysis of the yielding samples from the upper part of lithologically identified Barakar sediments (depth level 515.00 and 383.00 m) has revealed the presence of striate bisaccate in dominance, associated with appreciable frequency of *Densipollenites*. The other qualitatively important taxa recorded are--*Gondisporites*, *Navalaesporites*, *Callumispora*, *Quadrisporites* and acritarchs at 383 m depth. The presence of *Falcisporites*, *Satsangisaccites* and sporadic occurrence of *Arcuatipollenites* together with *Densipollenites indicus*, *D. invisus*, *D. densus* and *D. magnicorpus* provide evidence for the Late Permian aspect of the assemblage at 515 to 377 m depth when compared with the assemblages from Damodar Basin (assemblage RIA of Tiwari & Singh 1986 and *Densipollenites magnicorpus* Assemblage Zone of Tiwari & Tripathi, 1992).

The sediments lithostratigraphically classified as Supra-Barakar by MECL have yielded rich palynoflora between 350.00 to 307.00 m depth. The palynoflora is dominated by cavate-cingulate spore *Lundbladspora (L. raniganjensis, L. brevicula, L. microconata)* associated with *Arcuatipollenites pellucidus*, *A. ovatus*, *Arcuatipollenites* sp., *Playfordiaspora cancellosa*. Other qualitatively significant taxa present are *Callumispora gretensis*, *Verrucosisporites densus*, *Goubinispora morandavensis* and *Densoisporites complicatus*. Interestingly this assemblage shows presence of acritarchs in high frequency. On comparison with the Triassic palynossemblages from the Damodar Basin it shows compositional similarities with the PIV B - *Lundbladispora-Arcuatipollenites* Assemblage (Tiwari & Singh, 1986) and *Playfordiaspora cancellosa* Assemblage Zone (Tiwari & Tripathi, 1992). Therefore, an Early Triassic age is evident for this palynoassemblage. The poor representation of palynofossils in Assemblage IV does not permit a precise placement in the standard palynosequence. However, comparison of Assemblage IV with other known Middle and Late Triassic palynofloras (Maheshari & Kumaran, 1979; Kumaran & Maheshwari, 1980; Tiwari & Rana 1980; Tripathi, Tiwari & Kumar, 1990) indicates that the presence of taxa *Brachysaccus*, *Rimaesporites*, *Samaropollenites*, *Callialasporites* imparts an younger aspect within the Late Triassic.

The palynological studies have revealed a Late Permian age for the sediments which also include coal horizon and were conventionally considered as of Barakar Formation. The Supra-Barakar Kamthi Formation has yielded Late Early Triassic and Late Triassic palynoassemblages. The abrupt change in the palynoflora between 377.00 and 350.00 m depth indicates hiatus during the deposition of Late Permian and Late Early Triassic sediments in this area. The high incidence of acritarchs indicates brackish water regime during the deposition of these sediments. The acritarchs are reported for the first time from Early Triassic sediments of Peninsular India.

ACKNOWLEDGEMENT

The author is grateful to Dr. R. S. Tiwari, Former Director, Birbal Sahni Institute of Palaeobotany for useful discussions during the progress of this work and for the permisssion to present the data in the Golden Jubilee Conference of the Palaeobotanical Society. Thanks are also dure to the authorities of Mineral Exploration Corportation limited for the help in collection of bore core material.

REFERENCES

Bharadwaj D. C. & Srivastava S. C. 1969. Palynological correlation of coal seams in Talcher Coalfield, Orissa, India. *Palaeobotanist* **17**(2) : 152-156.

Das D. K. 1958. On the microfossil content of Barakar coals of Talcher Coalfield, Orissa. *Q. Jl. geol. Min. metall. Soc. India* **30**(4) : 233-234.

Kumaran K. P. N. & Maheshwari H. K. 1980. Upper Triassic *Sporae dispersae* from the Tiki Formation-2. Miospores from the Janar Nala Section, South Rewa Gondwana Basin, India. *Palaeontographica* **B 173** : 26-84.

Maheshwari H. K. & Kumaran K. P. N. 1979. Upper Triassic *Sporae dispersae* from the Tiki Formation-1. Miospores from the Son River Section between Tharipathar and Ghiar, South Rewa Gondwana Basin. *Palaeontographica* **B 171** : 137-164.

Navale G. K. B. & Srivastava S. C. 1971. Petropalynological study of the coals exposed near Gopalprasad of Talcher Coalfield, Orissa, India. *Palaeobotanist* **18**(3) : 258-263.

Srivastava S. C. 1984. Palynological succession *in* Lower Gondwana sediments in a bore hole, Talcher Coalfield, Orissa. *In* : Tiwari, R. S. *et al.* (eds) - *Proc. 5th Indian Geophytological Conference Lucknow* (1983) : 119-128, The Palaeobotanical Society, Lucknow.

Tiwari R. S. & Rana V. 1980. A Middle Triassic mioflora from India. *Biol. Mem.* **51**(1) : 30-55.

Tiwari R. S. & Rana V. 1981. *Sporae dispersae* of some Lower and Middle Triassic sediments from Damodar Basin, India. *Palaeobotanist* **27**(2) : 190-220.

Tiwari R. S. & Singh Vijaya 1986. Palynological evidences for Permo-Triassic boundary in Raniganj Coalfield, Damodar Basin, India. *Bull. geol. Min. metall. Soc. India* **54** : 256-264.

Tiwari R. S. & Tripathi Archana 1992. Marker Assemblage Zones of spore-pollen species through Gondwana Palaeozoic and Mesozoic Sequence in India. *Palaeobotanist* **40** : 199-236.

Tiwari R. S., Tripathi Archana & Jana B. N. 1991. Palynological evidence for Upper Permian Raniganj coals in western part of Talcher Coalfield, Orissa, India. *Curr. Sci.* **61**(6) :407-410.

Tiwari R. S. & Vijaya 1995. Differential morphographic identity of Gondwanic palynomorphs. *Palaeobotanist* **44** : 62-115.

Tripathi Archana 1993. Palynosequence in subsurface Permian sediments in Talcher Coalfield, Orissa, India. *Geophytology* **23**(1) : 99-106.

Tripahti Archana 1995. Palynosequence and palynofacies analysis of subsurface Permian sediments in Talcher Coalfield, Orissa. *Palaeobotanist* (in press).

Tripathi Archana, Tiwari R.S. & Kumar P. 1990. Palynology of subsurface Mesozoic sediments in Rajmahal Basin, Bihar. *Palaeobotanist* **37**(3): 367-388.

(Received : 23.8.1996; Accepted : 16.10.1996)