Journal of The Palaeontological Society of India
Vol. 42, 1997, pp 101-115

BIOSTRATIGRAPHIC AGE-DETERMINATION OF SRIPERUMBUDUR FORMATION IN BOREHOLE PBSD-1, PALAR BASIN, TAMIL NADU : A REASSESSMENT

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ABSTRACT

In Oragadam sub-basin of Palar basin, palynostratigraphic study in Borehole PBSD-1 has been taken-up to determine the biostratigraphic age for the sediments grouped as Sriperumbudur Formation, and underlying Talchir Formation. Palynoassemblages recovered between the depths 26.00 to 526.50 m contains dominance of *Callialasporites-Araucariacites* with onset of *Callialasporites* at 539.00 m depth. FAD *of Cicatricosisporites australienses, C. ludbrookiae* at 248.00 m depth deciphers a precise placement in the Mesozoic palynosequence, i.e., at the older level in *Microcachryidites antarcticus* zone of Indian peninsula, and *Cicatricosisporites australiensis* zone in Australia which extends from Tithonian-Valanginian in age. Prominence of radial monosaccate pollen (*Plicatipollenites, Parasaccites*) between 314.50 to 256.30 m suggests reworking of Talchir sediments in Borehole PBSD-1, with a mixed palynocomposition of Permian and Jurassic-Cretaceous palynotaxa between 475.30 - 539.00m.

INTRODUCTION

On the Indian peninsula, the coastal tracks represent stratigraphic sequence from Early Permian to Holocene. The Mesozoic Gondwana sediments overlie directly/indirectly on the metamorphic rocks with a stratigraphic break at base, where the Talchirs could be deposited in the East Coast sedimentary basins (Raja Rao, 1982).

In the Palar Basin, Tamil Nadu, the geological area is quite large, but poorly exposed. All the geological information about the area is available from the drilling of bore-cores, done by Geological Survey of India, ONGC and AMD (Kumar *et al.*, 1993) to explore the coal potential and hydrocarbon resources in the area.

During the years 1977-79, Geological Survey of India, delineated a number of sub-basins in the main Palar Basin. But the stratigraphic drilling has been done mainly in two sub-basins, i.e., Avadi and Oragadam (fig.1), after the first record of sedimentary formations described by Foote (1870) and Fiestmantel (1880).

The available drill-core data in the area of Tamil Nadu (Kumar *et al.*, 1993; Raheem, 1993) had provided information about the occurrence of coals, interstratified within the Mesozoic strata. Although, these coal-bands are thin layers at various depth-levels in the core, but needed understanding the stratigraphic status and their potentiality as well. Recently, the palynodating of such coal bearing Mesozoic sediments has been done by Tiwari *et al.*, (1996), to have supportive evidence confirming the occurrence of Mesozoic Gondwana coals along the east coast of India. Present palynological study further adds a confirmatory data and delineates precise stratigraphic status of Sriperumbudur sediments on the East Coast.

MATERIAL

In Oragadam sub-basin, the stratigraphic drilling had been done through Borehole PBSD-1, near Kandigai Village which is confined to the periphery of the main Palar Basin (fig.1).

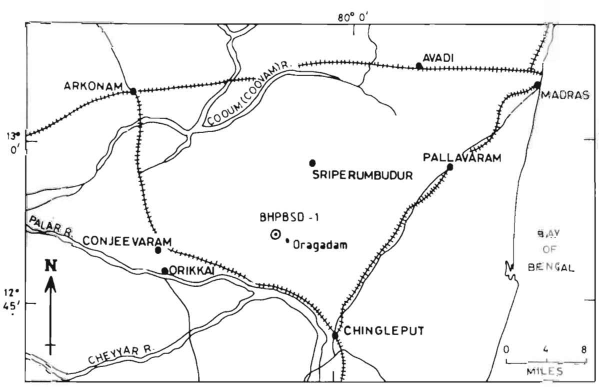

Fig. 1. Map showing location of Borehole PBSD-1 in Palar Basin.

This borehole cuts through a total thickness of 550.60 m, and lithosequence is assigned to two stratigraphic units. Based on lithic characters the cyclic sequence between 26.00-206.00 m, comprising sandstone, siltstone, grey shales and carbonaceous shales with nine thin bands of coal/shaly coal, has been grouped as Sriperumbudur Formation. The underlying "Talchir Formation" is delineated by pebble beds at 206.00 m, which is 344.60 m thick horizon downwards, having characteristic Talchir greenish-grey shales, sandstone package intercalated at places by pebbles/cobbles. It is the thickest unit recorded so far in Palar Basin (Kumaraguru and Sivsankaran, 1989).

The bore-core samples of Borehole PBSD-1, were sent to BSIP from GSI, to date the coal bearing Mesozoic strata in this area. Total 112 samples were processed for the recovery of palynomorphs. Table 1 shows the details

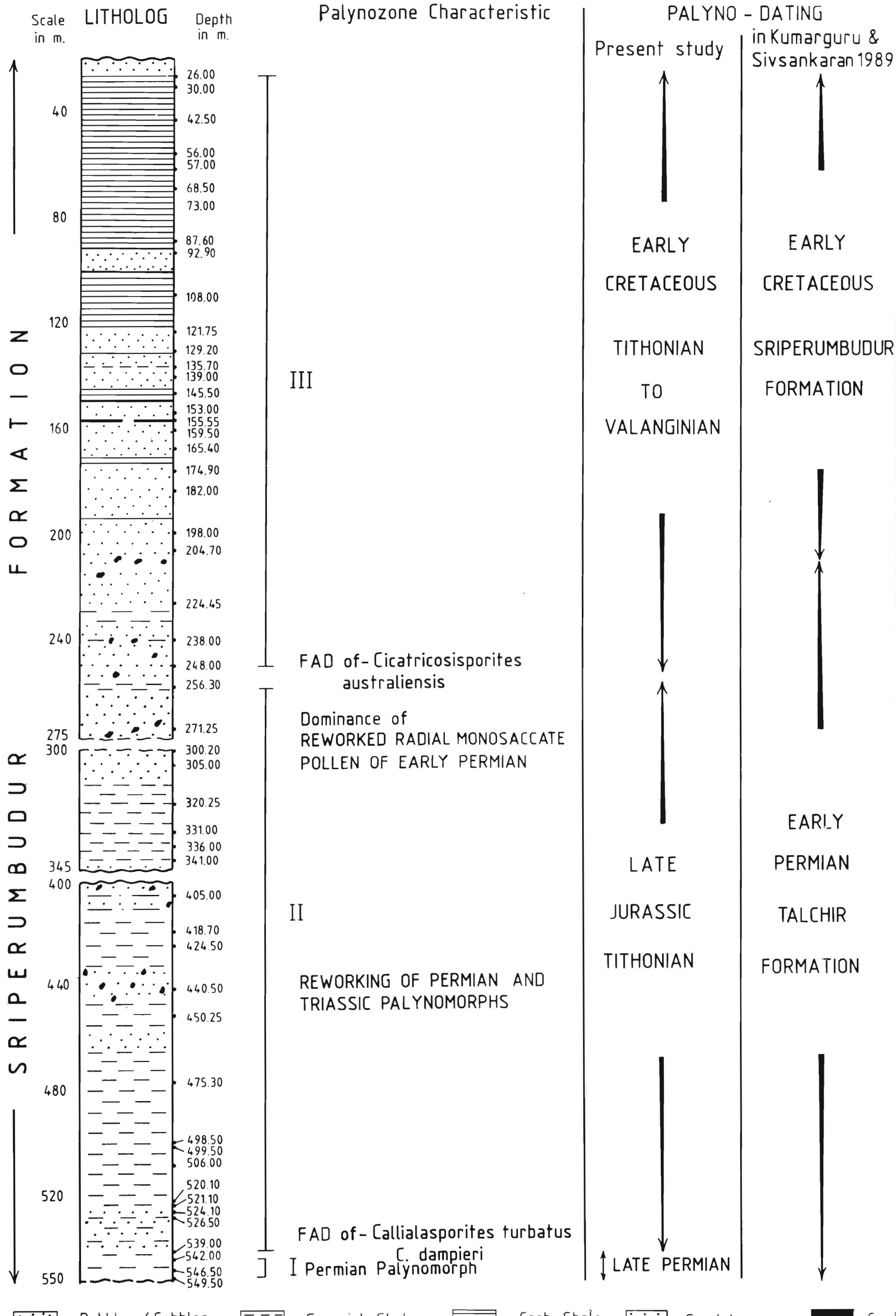

Fig. 2. Composite figure showing lithocolumn of Borehole PBSD-1, depth of yielding samples, palynozones identified with their characteristics and the palynodating of the sequence. Depth of samples of fairly yielding palynomorphs is given.

of samples along with their lithology. The position of productive samples, with fair to good yield, in the lithosucession (26.00-549.50 m) is shown in Figure-2. Samples with good productivity, in the occurrences of spore-pollen, have been analysed quantitatively and in the remaining (samples with an asterisk mark), only qualitative presence could be marked (Table 3).

Table 1 : Details of the Samples from Borehole PBSD-1, Near Kandigai, Village, Chingleput District, Tamil Nadu, Palar Basin.

Sl.No.	Sample No.	Depth of Sample	Lithology
1.	PBS-1	26.00m	Carb. Shale
2.	PBS-2	30.00m	Carb. Shale
3.	PBS-3	40.00m	Carb. Shale
4.	PBS-4	42.50m	Carb. Shale
5.	PBS-5	50.00m	Coal
6.	PBS-6	53.50m	Carb. Shale
7.	PBS-7	54.75m	Coal
8.	PBS-8	57.20m	Carb. Shale with coal streaks
9.	PBS-9	58.20m	Coal
10.	PBS-10	59.50m	Carb. Shale
11.	PBS-1	161.00m	Carb. Shale
12.	PBS-12	68.50m	Carb. Shale
13.	PBS-13	70.45m	Carb. Shale
14.	PBS-14	73.75m	Carb. Shale with coal laminae
15.	PBS-15	76.00m	Carb. Shale with coal streaks
16.	PBS-16	80.55m	Carb. Shale
17.	PBS-17	83.00m	Carb. Shale
18.	PBS-18	87.60m	Carb. Shale with coal streaks
19.	PBS-19	90.00m	Carb. Shale with coal streaks
20.	PBS-20	92.90m	Carb. Shale
21.	PBS-21	98.50m	Grey Shale
22.	PBS-22	102.05m	Sandy Shale with coal streaks
23.	PBS-23	105.50m	Carb. Shale
24.	PBS-24	108.00m	Sandy carb. shale with coal streaks
25.	PBS-25	113.50m	Carb. Shale
26.	PBS-26	121.75m	Shale with coal streaks
27.	PBS-27	123.70m	Fine grained sandstone with Carb. streaks
28.	PBS-28	129.20m	Carb. Shale with coal streaks
29.	PBS-29	132.40m	Carb. Shale
30.	PBS-30	135.70m	Carb. Shale
31.	PBS-31	139.00m	Shale
32.	PBS-32	143.00m	Sandstone
33.	PBS-33	145.50m	Sandstone with coal laminae
34.	PBS-34	151.30m	Shale with coal laminae
35.	PBS-35	153.00m	Carb. Shale with coal streaks
36.	PBS-36	155.55m	Carb. Shale with coal
37.	PBS-37	159.50m	Sandstone with carbonaceous matter
38.	PBS-38	162.80m	Sandstone with coal streaks
39.	PBS-39	165.40m	Clay with coal
40.	PBS-40	169.35m	Grey Shale
41.	PBS-41	174.90m	Sandstone with Carb. matter
42.	PBS-42	178.10m	Sandstone with coal
43.	PBS-43	182.00m	Sandstone with coal
44.	PBS-44	193.40m	Carb. Shale
45.	PBS-45	198.00m	Sandstone
46.	PBS-46	200.00m	Sandstone
47.	PBS-47	204.70m	Sandstone
48.	PBS-48	208.80m	Sandstone
49.	PBS-49	217.75m	Sandstone
50.	PBS-50	219.50m	Sandstone
51.	PBS-51	224.45m	Sandstone
52.	PBS-52	227.00m	Silty shale
53.	PBS-53	238.00m	Sandstone
54.	PBS-54	239.10m	Silty shale
55.	PBS-55	245.00m	Siltstone
56.	PBS-56	248.00m	Sandstone
57.	PBS-57	256.30m	Shale
58.	PBS-58	260.25m	Sandstone
59.	PBS-59	265.30m	Sandstone
60.	PBS-60	271.25m	Shale
61.	PBS-61	276.00m	Sandstone
62.	PBS-62	280.50m	Silty shale
63.	PBS-63	285.50m	Sandstone
64.	PBS-64	290.30m	Shale
65.	PBS-65	295.00m	Shale
66.	PBS-66	297.50m	Shale
67.	PBS-67	300.20m	Shale

68.	PBS-68	305.00m	Shale
69.	PBS-69	309.50m	Shale
70.	PBS-70	314.50m	Shale
71.	PBS-71	320.25m	Shale
72.	PBS-72	326.00m	Shale
73.	PBS-73	331.00m	Shale
74.	PBS-74	336.00m	Shale
75.	PBS-75	341.00m	Silty shale
76.	PBS-76	344.50m	Sandstone
77.	PBS-77	354.00m	Sandstone
78.	PBS-78	362.00m	Sandstone
79.	PBS-79	370.00m	Sandstone
80.	PBS-80	381.00m	Silty shale
81.	PBS-81	391.00m	Sandstone
82.	PBS-82	405.00m	Silty shale
83.	PBS-83	418.70m	Sandstone
84.	PBS-84	424.50m	Silty shale
85.	PBS-85	430.00m	Silty shale
86.	PBS-86	440.50m	Sandstone
87.	PBS-87	450.25m	Silty shale
88.	PBS-88	462.00m	Sandstone
89.	PBS-89	475.30m	Silty shale
90.	PBS-90	491.00m	Silty shale
91.	PBS-91	498.50m	Shale
92.	PBS-92	499.50m	Shale
93.	PBS-93	501.00m	Shale
94.	PBS-94	505.00m	Shale
95.	PBS-95	506.00m	Shale
96.	PBS-96	507.00m	Shale
97.	PBS-97	508.50m	Shale
98.	PBS-98	511.00m	Shale
99.	PBS-99	515.50m	Shale
100.	PBS-100	520.10m	Shale
101.	PBS-101	521.10m	Shale
102.	PBS-102	524.10m	Shale
103.	PBS-103	525.10m	Shale
104.	PBS-104	526.50m	Shale
105.	PBS-105	527.50m	Shale
106.	PBS-106	528.50m	Shale
107.	PBS-107	537.00m	Shale
108.	PBS-108	539.00m	Shale
109.	PBS-109	542.00m	Shale
110.	PBS-110	544.30m	Shale
111.	PBS-111	546.50m	Shale
112.	PBS-112	549.50m	Shale

In the total run of 517.50 m, lithology of the sediments vary from khaki greenish-grey shale, sandstone into grey to carbonaceous shale-sandstone package in the younger horizon, i.e., Sriperumbudur Formation. The change is gradual from Khaki-green facies into greyish sediments (fig.1).

The objective of palynologic study in Borehole PBSD-1, is to determine the biostratigraphic status of 523.50 m thick sequence comprising Sriperumbudur Formation and Talchir Formation on coastal Tamil Nadu. Lithologically, these two formational units have been delineated at 206.00 m depth.

PALYNO-COMPOSITION

The palynomorph species recorded in the present palynoflora are listed in Table 2 (Pl.I, figs. 1-27; Pl.II, figs. 1-10). From the qualitative search of palynospecies and quantitative count of spore-pollen genera it is evident that certain species are ubiquitous, others show restricted occurrences in the lithosequence of 523.50m thick strata. The pattern of distribution of palynofossils distinguishes three major palynozones. The details of each such palyno zone are discussed here with reference to their biostratigraphic status. Each palynozone has been refined taking into consideration both the relative abundance of dominant taxa and first occurrence of marker species which are typical for age determination in the marine and non marine palynosequences of Indian peninsula and Australia. The most significant changes are observed at depth levels 539.00, 526.50, and 248.00m. On the whole, the palynoassemblages recovered through 26.00-549.50m are moderately diverse. The qualitative and quantitative assessment of the spore-pollen taxa is given in Table 3 which displays remarkable disparity within the same kind of lithofacies. Reworking of Permian palynomorphs is observed through the sequence.

Table 2: List of species recorded in yielding samples of Borehole PBSD-1 Oragadam sub-basin of Palar Basin.

Aequitriradites spinulosus (Cookson and Dettmann) Cookson and Dettmann 1961 (Pl.I, fig.8)
Alisporites grandis Cookson 1947
Alsophyllidites sp. (Pl.I, fig.4)
Apiculatisporis sp.
Araucariacites australis Cookson 1947
Araucariacites fissus Reiser and Williams 1969
Araucariacites ghuneriensis Singh, Srivastava and Roy 1964 (Pl.I, fig.27)
Araucariacites sp. (Pl.I, fig.26)
Baculatisporites caumomensis (Cookson) Potonie 1956
Biformaesporites baculosus Singh and Kumar 1971
Biformaesporites sp. (Pl.I, fig.17)
Boseisporites punctatus Venkatachala 1969 (Pl. I, fig. 1)
Callialasporites dampieri (Balme) Dev 1961 (Pl.I, fig.20)

Callialasporites microvelatus Schulz 1966 (Pl.I, fig.22)
Callialasporites monoalasporous Dev 1961 (Pl.II, fig.7)
Callialasporites reticulatus Ramanujam and Srisalam 1974
Callialasporites triletes Singh, Srivastava and Roy 1964
Callialasporites trilobatus (Balme) Dev 1961 (Pl. I, fig. 23)
Callialasporites turbatus (Balme) Schultz 1967 (Pl.I, fig.24; Pl. II, fig. 10)
Callialasporites segmentatus (Balme) Srivastava 1963 (Pl.I, fig.21)
Callispora foveolata Maheshwari 1974 (Pl.I, fig.7)
Cedripites nudis Kar and sah 1970 (Pl.I, fig. 25)
Cicatricosisporites augustus (Pl.I, fig.2)
Cicatricosisporites australiensis (Cookson) Potonie 1956 (Pl. I, fig.3)
Cicatricosisporites hallei Delcourt and Sprumont 1953
Cicatricosisporites hughesii Dettmann 1963
Cicatricosisporites ludbrookiae Dettmann 1963
Cicatricosisporites minor (Bolkhovitina) Pocock 1962
Cicatricosisporites mohriodes Delcourt and Sprumont 1955
Cicatricosisporites pseudotripartitus (Bolkhovitina) Dettmann 1963 (Pl.I, fig.5)
Cingutriletes clavus (Balme) Dettmann 1963 (Pl.I, fig.11)
Classopollis chateaunovi Reyre 1970 (Pl.I, fig.12)
Classopollis classoides Pflug emend Pocock and Jansonius 1961
Concavissimisporites penolaensis Dettmann 1963
Contignisporites cooksonii (Balme) Dettmann 1963 (Pl.I, fig.6)
Contignisporites fornicatus Dettmann 1963 (Pl.I, fig.15)
Converrucosisporites sp.
Crassimonoletes minor Singh, Srivastava and Roy 1964
Crybelosporites stylosus Dettmann 1963
Cyathidites australis Couper 1953
Cyathidites minor Couper 1953
Cycadopites sakarigaliensis Sah and Jain 1965
Densoisporites indicus Kumar 1971
Densoisporites mesozoicus (Singh, Srivastava and Roy) Bharadwaj and Kumar 1972
Dictyophyllidites harisii Couper 1952
Duplexisporites problematicus (Couper) Playford and Dettmann 1965
Equisetosporites virginiaensis (Brenner) Singh 1971
Foveotriletes parviratus (Balme) Dettmann 1963
Ginkgoretectina sp.
Gleicheniidites circinidites (Cookson) Dettmann 1963 (Pl.I, fig.14)
Gleicheniidites senonicus Ross 1949
Impardecispora apiverrucata Venkatachala, Kar and Raja 1969 (Pl.I, fig.18)
Impardecispora verrucata Venkatachala, Kar and Raja 1969
Ischyosporites crateris Balme 1957
Klukisporites foveolatus Pocock 1962
Krauselisporites sp.
Leptolepidites major Couper 1958
Leptolepidites verrucatus couper 1958
Matonisporites sahii Varma and Ramanujam 1984
Microfoveolatisporites sp.
Murospora florida (Balme) Pocock 1962
Neoraistricia sp.
Osmundacidites wellmanii Couper 1957
Platysaccus sp.
Podocarpidites cristiexinus Sah and Jain 1965
Podocarpidites multesimus (Bolkhovitina) Pocock 1962
Podosporites tripakshii Rao emend. Kumar 1983
Polycingulatisporites crenulatus Playford and Dettmann 1965
Reticulatisporites pudens Balme 1937
Schizosporis parvus Cookson and Dettmann 1959
Schizosporis reticulatus Cookson and Dettmann 1959
Staplinisporites caminus (Balme) Pocock 1962 (Pl.I, fig.9)
Stereisporites pocockei Burger 1980
Taurocusporites minor Singh 1964 (Pl.I, fig.13)
Taurocusporites segmentatus Stover 1962 (Pl.I, fig.19)
Todisporites minor Couper 1958
Triletes tuberculiformis Cookson 1947
Type A, (Pl. I, fig. 10)
Undulatisporites pannuceus (Brenner) Singh 1971
Undulatisporites undulapolus Brenner 1963 (Pl.I, fig.16)

PALYNOZONE I

(Depth 546.50, 544.30, 543.50, 542.00m.)

At the older depth level in the sequence, the sediments are greenish- grey shale and sandstone. Recovery of spore-pollen is poor in general. The qualitative assessment of spore-pollen in the above samples indicates presence of Permian taxa *Scheuringipollenites, Faunipollenites, Striatopodocarpites, Crescentipollenites, Rhizomaspora, Parasaccites, Plicatipollenites,* ect. The qualitative diversity increases from older to younger levels. The sample at 542.00m depth, in addition has stray occurrences of the Triassic palynomorphs *Lundbladispora, Arcuatipollenites (=Lunatisporites)* and *Krempipollenites (=Klausipollenites)*. On comparison with the palynozonation of Gondwana sediments (Tiwari and Tripathi, 1992), a Late Permian age affiliation is evidenced.

PALYNOZONE II

(Depth 539.00-256.30m)

The sediments between this depth contains greenish-grey sandstone and shale lithofacies, but much of strata is represented by sandstone facies, intercalated with thin layers of greenish shale or silty shale. Hence, the recovery of spore-pollen is difficult in total run. Out of 48 samples, the occurrence of *Callialasporites, Araucariacites* is observed at 539.00m (with poor yield) and dominance of *Callialasporites* starts at 526.50m with abundance of *Araucariacites* at 524.10m depth. The other forms representing pteridophytic component (Table 3) are very scanty, only their presence is marked. However, definite presence of *Callialasporites turbatus, C. dampieri* at depth 539.00 onwards provides a distinct Upper Gondwana stratigraphic status to this part of lithosequence, rather than Talchir Formation suggested by Kumaraguru and Sivshankaran (1989).

From the close comparison of this palynocomposition with the known palynozones in Mesozoic palynosequence, which contain *Callialasporites-Araucariacites* prominence, it is derived that the above mentioned non-saccate gymnospermous pollen composition finds its placement at the oldest level in *Microcachryidites antarcticus* palynozone in Mesozoic palynosequence on Indian peninsula (Venkatachala 1974; Venkatachala *et al.* 1972, Venkatachala et al. 1980). No record of hilate and costate spore species of taxa *Aequitriradites, Cooksonites, Coptospora, Triporoletes* and *Cicatricosisporites* further evidences much older stratigraphic level for this part of lithosequence in Late Mesozoic biostratigraphy that may be placed at the transition of Jurassic- Cretaceous passage.

Remarks: The sediments between 314.50 to 256.30 m depth record dominance of radial monosaccate pollen *Parasaccites* and *Plicatipollenites* typical of Early Permian. This immediately reminds for Talchir Early Permian palynoflora. This sedimentary pile is sandwitched between the overlying and underlying strata containing Early Cretaceous palynocompostion. Therefore, the reworking of Talchir sediments is obviously evidenced.

The analysis of sediments from 539.00 to 475.30m depth has shown, together with Late Mesozoic palynocompostion, presence of Permian palynotaxa *Faunipollenites, Crescentipollenites, Striatopodocarpites, Sahnites, Scheuringipollenites, Parasaccites, Plicatipollenites, Potonieisporites, Caheniasaccites, Striomonosaccites* and *Densipollenites,* and Triassic forms *Lundbladispora, Arcuatipollenites* (=*Lunatisporites*) and *Alisporites* at 521.10, 520.10 and 475.30m depths. The sample at 475.30m depth and 501.00m depth have exclusively Permian and Triassic pollen with stray presence of *Callialasporites* and *Araucariacites* and no Mesozoic pteridophytic spore are recorded. Here reworking of Permian and Triassic sediments is envisaged during the deposition of these sediments. Varma and Ramanujam (1987) earlier reported

<table>
<tr><th rowspan="2">Age</th><th colspan="2">INDIAN</th><th colspan="2">AUSTRALIAN</th></tr>
<tr><th>Palyno-Zone in East Coast</th><th>Present-Study B.H. PBSD-1</th><th>Palyno-Zone in Australia</th><th>Age</th></tr>
<tr><td rowspan="6">NEOCOMIAN</td><td rowspan="6">Microcachryidites antarcticus Zone</td><td rowspan="4"></td><td rowspan="3">Foraminisporis wonthaggiensis</td><td>BARREMIAN</td></tr>
<tr><td>HAUTERIVIAN</td></tr>
<tr><td>VALANGINIAN</td></tr>
<tr><td rowspan="3">Cicatricosisporites australiensis</td><td rowspan="2">BARRIASIAN</td></tr>
<tr><td>PALYNOZONE -III</td></tr>
<tr><td>PALYNOZONE -II</td><td>TITHONIAN</td></tr>
</table>

Fig. 3. Biostratigraphic placement of Early Cretaceous Palynozones identified in Borehole PBSD-1 (present study) in the Mesozoic palynosequence established in Eastcoast of India (Venkatachala, 1974) and in Australia (after Burger, 1990a, b).

the occurrence of a number of the above Lower Gondwana palynotaxa as reworked elements in the Sriperumbudur Formation.

PALYNOZONE III

(Depth 248.00 -26.00m)

The Mesozoic sediments in this part of bore-core are greyish shales, silty shales and sandstone. In majority, the rock samples are soft sediments in their lithology. Hence, the number of productive samples is more than in the older horizon (fig.1). The dark-grey shales and fine grained silty shales contain taxonomically diverse palyno-composition. *Callialasporites* and *Araucariacites* are the main taxa, the other significant components in the association are - *Cicatricosisporites, Contignisporites, Leptolepidites, Lycopodiacidites, Murospora, Undulatisporites, Foveotriletes, Concavissimisporites, Impardecispora, Dictyophyllidites,* etc. which are fairly represented at various depth levels (Table 3). Only the hilate spores are absent from the scenerio except few specimens of *Aequitriradites* that too inconsistently. The sculptured trilete spores contribute significantly, however, their species diversity is at lower grade.

The most important finding in this palyno-composition is the record of *Cicatricosisporites australiensis, C. ludbrookiae, Contignisporites cooksonii, Murospora florida, Crybelosporites stylosus, Aequitriradites spinulosus,* the typical spore species in biostratigraphic age determination of a palynoassemblage in Lower Cretaceous palynoflora. So, the above mentioned association of age marker spore species compares with the *Cicatricosisporites australiensis* palynozone in Australian Mesozoic palynosequence (Helby *et al.,* 1987; Burger 1990a, 1990b) and is placed at the base level in *Microcachryidites antarcticus* palynozone on Indian peninsula (Venkatachala, 1974, Venkatachala, *et al.,* 1972).

Remarks: Sporadic presence of radial monosaccate *Parasaccites, Plicatipollenites* and *Potonieisporites* is recorded at 238.00, 224.45 92.00 m, depth. It reveals frequent reworking of Talchir sediments in Sriperumbudur beds.

DISCUSSION

In the main Palar Basin, Tamil Nadu the lithostratigraphic units, recognised in sub-surface sedimentaries, are based on the data obtained from the drilling of stratigraphic bore-cores in two sub-basins, i.e., Oragadam and Avadi. Here the younger part in the litho-sequence comprising of greyish shale, sandstone has been assigned to Sriperumbudur Formation in Early Cretaceous Upper Gondwana sequence and the older horizon separated by pebbly bed is grouped as Talchir

Table 3 : Relative occurrence of palynotaxa in the yielding samples of BRE hold PBSD-1 near Kandigai Village Tamilnadu. Index : +++ = > 20%, ++ = 10-20%, <10 = +, Sample Nos. with an asterisk mark are assessed for qualitative analysis due to poor yield of palynomorphs.

Sample No. / Palynotaxa	112, 111 109 *	108 *	104, 103 102	101, 100 95 *	92	91	89 *	87, 86	84, 83 82, 80	75, 74 73	72 *	71	69, 68 67 *	60	57	56, 55 54 *	53	51	47 *	45, 43 41, 39	37, 36 35, 33 31	30, 28 26, 24	20, 18	12	10, 8 7	4,2 1
1. Scheuringi-pollenites	+		+	+				+									+									
2. Parasaccites	+			+	+	+	+		+	+++	+	+++	+	+++	+++								+			
3. Plicatipollenites	+		+	+	+		+	+	+	+	+	+	+	+	+		+									
4. Divarisaccus														+	+											
5. Vestigisporites														+												
6. Sahnites						+	+		+																	
7. Potonieisporites				+		+	+			+	+		+	+	+											
8. Caheniasaccites					+		+			+	+		+													
9. Striamonosaccites				+																						
10. Densipollenites				+																						
11. Faunipollenites	+	+																								
12. Striato-podocarpites	+	+		+			+			+			+													
13. Leiosphaeridia	+		+									+														
14. Balmeella												+														
15. Tasmanites	+																									
16. Crescenti-pollenites	+			+			+							+	+											
17. Rhizomaspora	+																									
18. Krempipollenites	+																									
19. Lundbladispora	+			+																						
20. Arcuatipollenites	+						+																			

Sample No. / Palynotaxa	112, 111 109 *	108 *	104, 103 102	101, 100 95 *	92	91	89 *	87, 86	84, 83 82, 80	75, 74 73	72 *	71	69, 68 67 *	60	57	56, 55 54 *	53	51	47 *	45, 43 41, 39	37, 36 35, 33 31	30, 28 26, 24	20, 18	12	10, 8 7	4,2 1
21. Callialasporites		+	+++	+	+++	+	+	+	+ +	+ +	+	+		+	+		+	+++	+	+++	+++	+++	+++	+++	+++	+++
22. Dictyophyllidites			+		+												+					+	+		+	+
23. Converrucosis porites			+														+	+		+						
24. Araucariacites			+ +	+	+++	+	+	+	+ +	+++	+		+	+	+		+	+ +	+	+ +	+++	+++	+	+ +	+ +	+ +
25. Polycingulati-sporites			+																							
26. Cyathidites			+	+								+			+						+	+			+	+
27. Murospora			+	+														+		+	+	+				
28. Densoisporites			+													+				+		+			+	+
29. Gleicheniidites			+																		+	+				
30. Baculatisporites			+	+				+													+	+	+			+
31. Matonisporites				+	+				+			+						+		+		+				
32. Osmundacidites				+																	+	+				+
33. Contignisporites				+																	+	+		+		+
34. Alisporites				+			+																	+	+	+
35. Todisporites								+									+					+				
36. Klukisporites																+		+	+	+		+				
37. Podocarpidites					+											+	+	+			+	+	+		+	+
38. Cicatricosis-porites														+		+		+			+	+	+	+		+
39. Krauselisporites																+		+	+					+		+
40. Sterisporites																		+		+						+
41. Foveotriletes																		-								+

Sample No. / Palynotaxa	112, 111 109 *	108 *	104, 103 102	101, 100 95 *	92	91	89 *	87, 86	84, 83 82, 80	75, 74 73	72 *	71	69, 68 67 *	60	57	56, 55 54 *	53	51	47 *	45, 43 41, 39	37, 36 35, 33 31	30, 28 26, 24	20, 18	12	10, 8 7	4,2 1
42. Neoraistrickia																		+								
43. Polycingulati-sporites																		+	+							
44. Crybelosporites																		+		+	+	+	+			
45. Microfoveolati-sporites																		+					+			+
46. Leptolepidites																		+		+			+		+	+
47. Classopollis					+	+									+			+			+	+	+			+
48. Biformaesporites																		+					+		+	+
49. Cycadopites										+								+			+				+	+
50. Ginkgoretectina																		+				+				
51. Duplexisporites																		+								
52. Aequitriradites																		+				+	+		+	
53. Concavissimis-porites																		+	+	+			+			
54. Cooksonites																				+					+	
55. Schizosporis																				+		+				+
56. Impardecispora																				+		+	+			
57. Foraminisporis																				+						
58. Verrucosisporites																				+						
59. Reticuloido-sporites																				+	+	+				
60. Triletes																				+						
61. Foveosporites																				+						
62. Equisetosporis																				+						

Sample No. / Palynotaxa	112, 111	108	104, 103	101, 100	92	91	89	87, 86	84, 83	75, 74	72	71	69, 68	60	57	56, 55	53	51	47	45, 43	37, 36	30, 28	20, 18	12	10, 8	4,2
	109 *	*	102	95 *			*		82, 80	73	*		67 *			54 *			*	41, 39	35, 33 31	26, 24			7	1
63. Undulatisporites									+								+	+		+	+	+				
64. Crassimonoletes					+				+												+			+		
65. Lametatriletes																								+		
66. Apiculatisporis																					+					+
67. Podosporites																					+	+				+
68. Platysaccus																										+
69. Taurocusporites																				+	+	+	+			
70. Callispora																	+				+	+				
71. Cingutriletes																					+	+				
72. Retitriletes												+														
73. Staplinisporites																	+				+					
74. Lycopodiacidites																					+					
75. Microreticulatisporites																					+	+				

Formation, the basal lithounit in Lower Gondwana Sequence.

Such delineations based solely on transitional nature in lithofacies, colour and nature of intermitant pebble beds, do not always provide exact stratigraphic status to a lithounit and formational boundaries. For precise age determination in time transgressive lithosequences, only the study of spores-pollen helps, in solving the stratigraphic status through biozonation.

As discussed in the preceding part, lithologically the two formational units, i.e., Sriperumbudur and Talchir formations recognized in Borehole PBSD- 1 were delineated at 206.00m depth. However, the transitional greyish-greenish lithofacies transgresses downwards to much deeper (539.00m) depth. Moreover genus *Callialasporites* is recorded at 539.00m depth, which is the typical pollen taxa to mark the innovation of Jurassic palynoflora on Gondwanaland (Bharadwaj, 1972; Venkatachala, 1972; Helby et al. 1987). Hence, the sediments from 206.00 to 539.00m, certainly find a stratigraphic status in the Mesozoic sequence rather than in Early Permian Talchir Formation, earlier assigned by Kumaraguru and Sivsankaran (1989).

The poor yield of spore-pollen between 256.30-539.00m, could not help in search of Early Cretaceous age marker spore species - *Cicatricosisporites australiensis, C. ludbrookae, Crybelosporites stylosus* and *Aequitriradites spinulosus*, etc. in this part of Borecore PBSD-I.

In the subsequent younger horizon, the overlying part of so far referred Talchir Formation (248.00-206.00m), presence of Early Cretaceous palynotaxa at 248.00, 238.00, 224.45, 204.00m has been encountered (Table 2). And this palynocomposition is equated with Early Cretaceous palynozone.

A comparison of the present palynoflora with the known palynological record from Tamil Nadu - Kattavakkam (Ramanujam and Srisailam, 1974); Orikkai, (Ramanujam and Verma, 1977), Kancheepuram, (Ramanujam, Patil and Jaganath Rao, 1980) shows compositional similarity of Palynozone - III with the palynoflora from Kattavakkam and Orikkai described by Ramanujam and Varma (1977) and Varma and Ramanujam (1984). Both the palynofloras have dominance of gymnospermous pollen. The stratigraphically significant taxa *Crybelosporites, Cicatricosisporites, Taurocusporites, Undulatisporites, Callispora, Murospora, Impardecispora, Ichyosporites, Matonisporites, Biformaesporites, Foveosporites,* etc. are common in both assemblages.

Thus, the palynoassemblages identified in 26.00-539.00m (513.00m) thick strata of Borehole PBSD-1 in Oragadam sub-basin are precisely delimited taking into account the first appearance datum plane (FAD) for the taxa *Callialasporites* spp., a marker taxon for Jurassic palynoflora and *Cicatricosisporites* and *Aequitriradites*, the elements to mark the base of Early Cretaceous palynoflora.

CONCLUSIONS

From the given account about the palynoassemblages identified in 523.50m thick lithosequence of Borehole PBSD-1, the following facts are derived :

1. Definite records of *Callialasporites turbatus* and *C. dampieri* at 539.00m depth suggest the onset of Jurassic sedimentation within the lithounit of PBSD-1, which contains pebbles/cobbles in greenish-grey sediments earlier grouped as Talchir Formation.
2. Stray presence of *Cicatricosisporites australiensis, C. ludbrookiae* at 248.00m and, onwards certainly evidences an older level for the palynoassemblage recovered between 248.00-26.00m, in *Microcachryidites antarcticus* palynozone of Indian Mesozoic palynosequence. On comparision with the known FAD range of *Cicatricosisporites australiensis* in marine and nonmarine sequences of Australia, a Tithonian - Valanginian age is suggested for sediments of Sriperumbudur Formation in this area.
3. The above discussed palynological findings clearly reveal that Sriperumbudur formational lithounit is represented in the complete run of the bore-core except 549.50 to 542.00m depth which is Late Permian, and represents a time transgressive unit including Jurassic-Cretaceous transitional passage.
4. Reworking of Permian and Triassic sediments is envisaged during the deposition of Sriperumbudur beds. The occurrence of radial monosaccate pollen (*Plicatipollenites-Parasaccites*) dominated palynocompositions has been noted only at depths 314.50-256.30m. This observation evidences reworking of Talchir Early Permian sediments rather than representing, Talchir sediments, based on lithofacies characters.

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EXPLANATION OF PLATES

Plate I

(All photomicrographs are x 500)

1. *Boseisporites punctatus;* BSIP Slide No. 11734
2. *Cicatricosisporites augustus;* BSIP Slide No. 11733
3. *Cicatricosisporites australiensis;* BSIP Slide No. 11731
4. *Alsophyllidites* sp.; BSIP Slide No. 11725
5. *Cicatricosisporites pseudotripartites;* BSIP Slide No. 11727
6. *Contignisporites cooksonii;* BSIP Slide No. 11733
7. *Callispora foveolata;* BSIP Slide No. 11737
8. *Aequitriradites spinulosus;* BSIP Slide No. 11731
9. *Staplinisporites caminus;* BSIP Slide No. 11738
10. *Type A;* BSIP Slide No. 11734
11. *Cingutriletes clavus;* BSIP Slide No. 11733
12. *Classopollis chateaunovi;* BSIP Slide No. 11739
13. *Taurocusporites minor* BSIP Slide No. 11733
14. *Gleicheniidites circinidites;* BSIP Slide No. 11733
15. *Contignisporites fornicatus;* BSIP Slide No. 11743
16. *Undulatisporites undulapolus;* BSIP Slide No. 11733
17. *Biformaesporites* sp.; BSIP Slide No. 11736
18. *Impardecispora apiverrucata;* BSIP Slide No. 11736
19. *Taurocusporites segmentatus;* BSIP Slide No. 11732
20. *Callialasporites dampieri;* BSIP Slide No. 11729
21. *Callialasporites segmentatus;* BSIP Slide No. 11744
22. *Callialasporites microvelatus;* BSIP Slide No. 11726

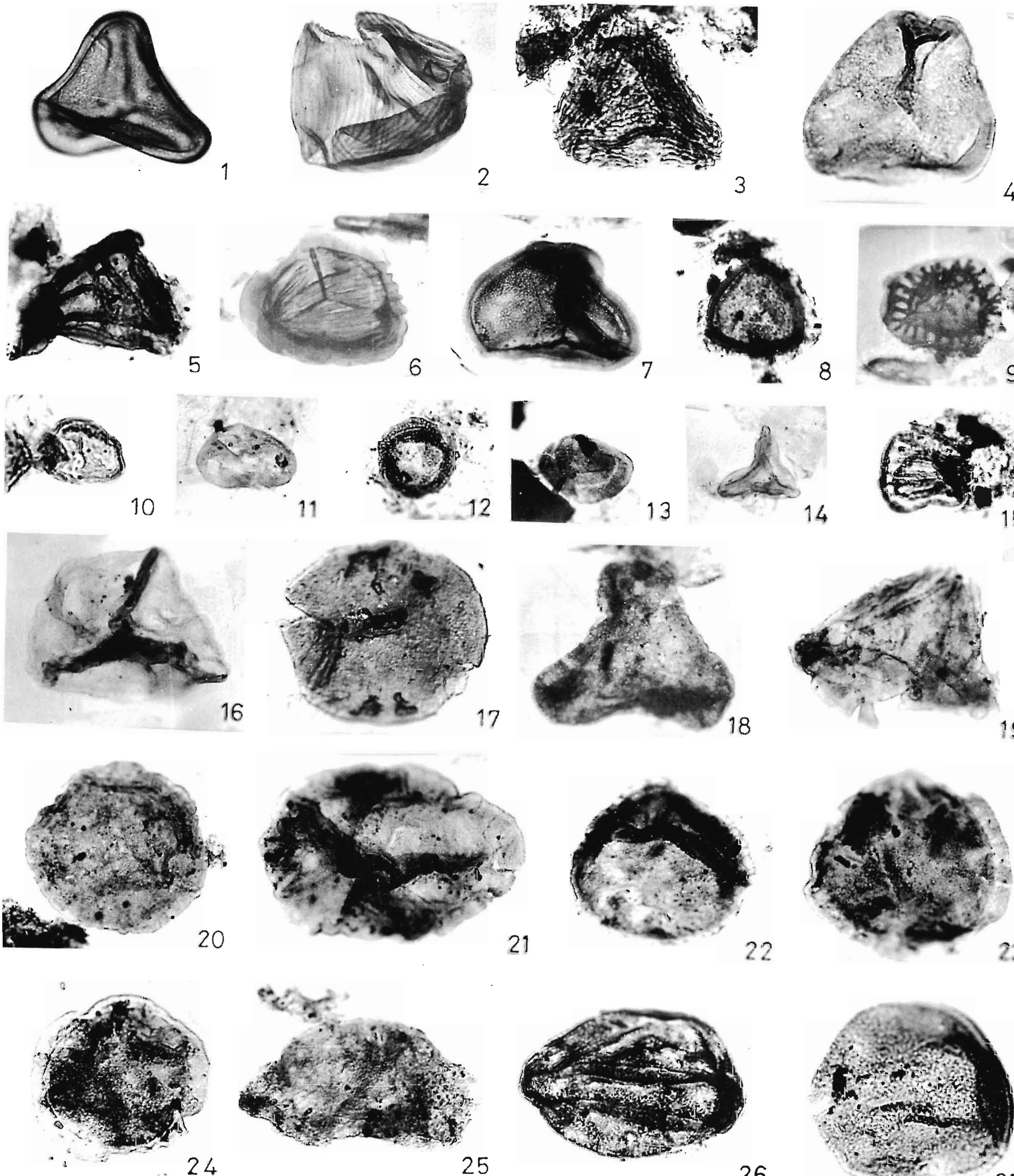
23. *Callialasporites trilobatus;* BSIP Slide No. 11728
24. *Callialasporites turbatus;* BSIP Slide No. 11726
25. *Cedripites nudis;* BSIP Slide No. 11730
26. *Araucariacites* sp.; BSIP Slide No. 11735
27. *Araucariacites ghuneriensis;* BSIP Slide No. 11734

Plate II

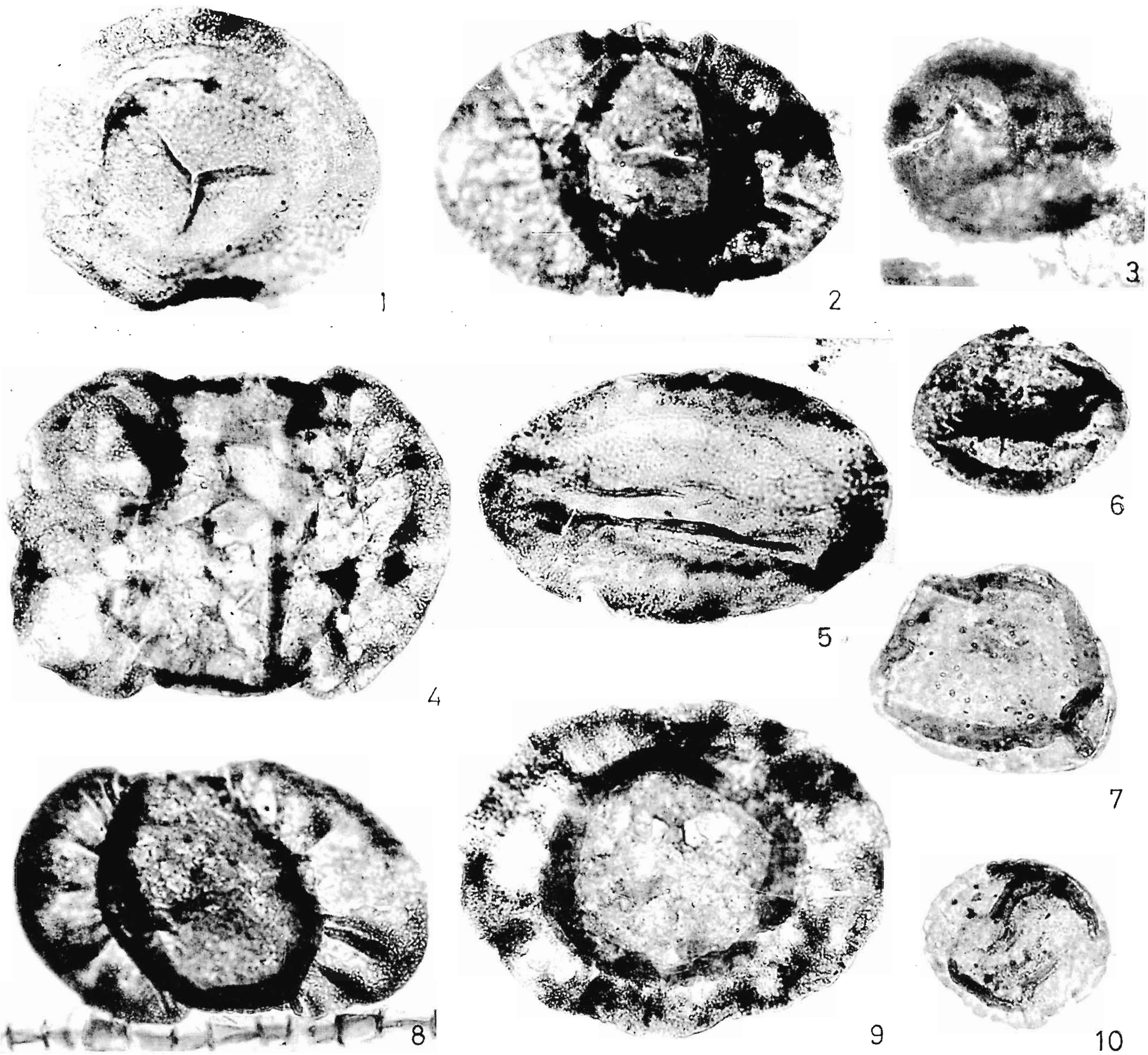
(All photomicrographs are x500)

1. *Parasaccites;* BSIP Slide No. 11740
2. *Potonieisporites;* BSIP Slide No. 11741
3. *Lundbladispora densispinosa;* BSIP Slide No. 11745
4. cf. *Arcuatipollenites;* BSIP Slide No. 11742
5. *Divarisaccus;* BSIP Slide No. 11740
6. *Alete;* BSIP Slide No. 11746
7. *Callialasporites monoalasporus;* BSIP Slide No. 11747
8. *Sahnites;* BSIP Slide No. 11741
9. *Plicatipollenites;* BSIP Slide No. 11740
10. *Callialasporites turbatus;* BSIP Slide No. 11741

 Plate I



Journal of The Palaeontological Society of India
Vol. 42, 1997



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