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Cretaceous Nano Fossils of Sivaganga Formations of Cauvery Basin, Tamil Nadu

H. K. Murthy[1], T. Brahmaiah[2], U. Imran Basha[2] O Vijaya Kumari[2] & K .S .Sai Prasad[2*]
[1]*Department of Geology, Bangalore University, Bangalore, Karnataka, India*
Dept. of Geology, S.V.University, Tirupati[1]
[2] *Dept. of Geology, S.V.University, Tirupati, Andhra Pradesh, India*

Abstract: *The work undertaken pertains to the study of palynofosssils of the sediments obtained from lower cretaceous sediments of Sivaganga formations of Cauvery basin, Southern India. The sediments mostly comprises of conglomerates, sandstone and shale. The sediments after subjecting them to the standard macerations process of palynofossils separation yielded assemblages of Angiospermic pollens, Pteridospermic spores, Gymnospermic spores and pollens and Bryophytic spores. The present study of palynoflora of the Lower Cretaceous sediments of the Ariyalurarea and are found to be necessary for the following objectives - i) To recover palynofossils and determine their taxonomy and nomenclature in space and time, ii) To infer the age of Shivaganga Formation on the basis of palynofossils assemblage and iii) To understand the palaeo-environmental condition prevailed during the deposition of Lower Cretaceous sediments.*

I. Introduction

The Cauvery basin is located in the southern eastern part of peninsular India between Pondicherry in the north and Tuticorn in the south. The cretaceous shallow marine sediments exposed along the east coast of South Indian have occupied a prime place in paleontology and stratigraphy. The cretaceous succession of Southern India has attracted the attention of geoscientists all over the world, the reason being that it is a treasure house for rich and varied fauna, which helps in the inter-regional correlation of different cretaceous section across the globe. Palynology of the Mesozoic (Upper Gondwana) sediments of India, hitherto an unfortunately neglected field of study, has dramatically shot up into prominence during the last ten years. A number of Kutch, Saurashtra, Rajsthan, Rajmahal hills, Jabalpura, East coast of Andrapradesh, and the Cauvery Basin of Tamilnadu have been investigated palynologically and palynostratigraphically during the last ten years and consequently we now have a fairly clear perspective of the miospore assemblages of the diverse Mesozoic strata of India.

Ramanujam (1957) recorded a rich assemblage of pteridophytic spores and gymnospermous pollen grains (predominantly saccate) from the East coast Gondwanas (U. Jurassic) near Vemavaram in Andhra Pradesh. Although the botanical affinities of a number of these microspores were indicated, no binomial nomenclature was adopted in this study (Ramanujam, 1957). Subsequently, Kar and Sah (1970) published a well documented palynological study of the Vemavaram shales and commented upon their geological age. Venkatachala, Sharma and Jain (1972) provided a comprehensive study of the palyno-stratigraphy of the Jurassic-L. Cretaceous sub-surface sediments (borehole core sample) near Karaikal in the Cauvery Basin of Tamil Nadu. Sastri et al., (1977) gave a comprehensive account of the geology and stratigraphy of the Mesozoic-Tertiary sediments of the Cauvery Basin. They dealt with general stratigraphy; palynofossils and foraminifera based bio-stratigraphy; structural elements of the basin; and its tectonic evolution and sedimentation history. Later, Sastri et al (1981) gave a detailed account of the evolution of the Cauvery basin, while dealing with the evolution of the East coast of India from Permian to the end of cretaceous period.

Foote (1883) first recognized this litho-units in the outcrop area around Sivaganga town, and named it as Sivaganga Beds. Later on, it is renamed as Sivaganga Formation (Sastry et al., 1977; Banerji, 1982), and grouped with Upper Gondwana as its associated Therani plant beds recorded plant megafossilsof Ptilophyllum flora (Sastry et.al., 1977). This unit is excluded from the Gondwana, and now grouped into the Post-Gondwana Mesozoic succession as it recorded marine invertebrate and plant-micro-fossils, and occurs above the Jurassic unconformity. Indeed, this formation includes the rift-fill sediments, and represents the rift phase of the pericratonic.

The study of the present work is the result of the field observation and laboratory studies of palynofossils from the Sivaganga Formation, Tamilnadu, South India. The studied samples are mainly from outcrops, stream section and quarry section, covering the entire group of study area. The work of Shah and Singh (1972), Mamgain et al., (1973), Ramanujam and Srisailam (1974), Venkatachala and Kumar (1976), Ayyaswami and Gururaja (1977), Ramanujam and Verma (1977, 1981), Venkatachala et al., (1980), Verma and Ramanujam (1984), Maheshwari (1986), Venkatachala and Rajanikanth (1987), Tirupati and Vijay (1997),

Prasad and Pundeer (2002), covering different aspects of the study area and adjacent areas have been greatly utilized for comparisons. This has promoted the author to make a detailed study of palynoflora of the Lower Cretaceous sediments of the Ariyalurarea and are found to be necessary for the following objectives.

1) To recover palynofossils and determine their taxonomy and nomenclature in space and time.
2) To infer the age of Shivaganga Formation on the basis of palynofossils assemblage.
3) To understand the palaeo-environmental condition prevailed during the deposition of Lower Cretaceous sediments.

1.1 Geological Setting of Cauvery Basin

The late Jurassic to early Cretaceous rifting between India/Australia and India/Antarctica resulted in the formation of a number of NE–SW-trending basins in the Indian Precambrian crystallinebasement. The Cauvery Basin is the southernmost basin along the eastern margin of the Indian Sub-Continent, covering much of this part of India and extending a considerable distance offshore. The basin comprises several 'depressions'or sub-basins, with the Ariyalur–Pondicherry Depression in the north. The exposed successions are in the southern partof this sub-basin.

1.2 Location

On the east coast of southern, in the state of Tamil Nadu, a large alluvium covered coastal belt along Palk Strait and Cromandal coast forms a part of the Cauvery basin (Fig.1), which has attracted considerable attention of ONGC and a few international oil companies for oil exploration. The basin situated 160 to 460kms south of Madras city, encompasses an area of 25000 sq.km on-land and about 35000 sq. km offshore shelf. Of the later about 23000 sq. km falls in Indian territorial craters.

Fig 1. Sedimentary Basins of India. (After Tewari et.al., 1996)

1.4 Material And Method of Study

The samples collected are mainly from the outcrops, dug wells, road cuttings and the samples are collected in a random manner. The collected samples are carefully examined and stored in separate plastic bags in order to avoid contamination and mixing up of different samples. The samples after collection are labeled properly indicating the exact location and other geological details.Palynofossils are recovered from rock samples with the help of different physical and chemical methods. The laboratory processing is very important because if improper and nonscientific methods are employed, it may lead to poor recovery or complete loss of spore-pollen populations, or even change in size and shape of some palynofossils.

The recovery of palynofossils from rock samples is achieved in three major steps:

1. Cleaning,
2. Disaggregation and dispersal,
3. Separation

Pollen and spores that are collected in this way are subjected to mounting.

Identification

Photomicrographs of most of the palynofossils are magnified up to the order of 1000, 750 or 250times. Pollen grains mostly ranging in size up to 40µm are generally enlarged 1000 times, whereas those ranging between 40-100µm are enlarged 500 times. Here we observed pollen and spores using BX 36 OLYMPUS MICROSCOPE and were photographed under SEM to get details of microstructures and ornamentations. After it's been photographed, these photographed were compared with previous original literatures and identified correctly for further studies.

2.1 Stratigraphy of Cauvery Basin

The fossiliferous cretaceous rocks of Cauvery basin are distributed mainly in the sub-basins namely, Pondicherry, Vridhachala, Ariyalur, Tanjavur and Sivaganga. It was in 1958 that the oil and natural gas commission initiated systematic geological, geophysical and drilling activities for exploration of hydrocarbons. The surface exposure of sedimentary rocks had been studied and mapped by Blanford of Geological Society of India (GSI) in 1865, (Table-1) who had correlated them to the Cretaceous formations of England and France because of their rich ammonite fauna. Detailed study has helped to clarify the stratigraphic relationship and to understand subsurface facies variations and environment of deposition. It is now known that the exposed sedimentary sequence involves continental sediments, known as, Sivaganga beds overlain by marine sequence of Cretaceous / palaeocene rocks and finally the continental Cuddalore sandstone (containing large, mineable, lignite deposits at neyveli). The sedimentary section contains a number of transgressive regressive episodes. The lithology varies from conglomerate, sandstone and shale to limestone and dolomites.

Table-1: Lithostratigraphic Classification of Cauvery Basin :

Age		Formation	Member	Thickness (m)
Mio-Pliocene		Cuddalore Sandstone		>150
		Unconformity		
Danian	ARIYALUR GROUP	Niniyur	Periyakurichchi Biostromal	26
			Anandavadi Arenaceous	30
		Unconformity		
		Kallamedu		100
		Unconformity		
Maastrichtian		Ottakoil		40
		Unconformity		
		Kallankurichchi	Srinivasapuram Gryphean Limestone	18
			Tancem Biostromal	8
			Kattupiringiyam Inoceramus Limestone	8
			Kallar Arenaceous	6
		Unconformity		
Campanian		Sillakkudi	Varanavasi Sandstone	270
			Sadurbagam Pebbly Sandstone	80
Santonian			Varakuppai Lithoclastic Conglomerate	45
		Unconformity		
Coniacian		Garudamangalam	Anaipadi Sandstone	215
			Grey Sandstone	80
			Kulakkanattam Sandstone	45
		Unconformity		
Turonian		Karai	Odiyam Sandy Clay	175
			Gypsiferous Clay	275
		Unconformity		
Cenomanian		Dalmiapuram	Kallakkudi Calcareous Sandstone	60
			Olaipadi Conglomerate	65
			Dalmiya Biohermal Limestone	15
Albian			Varagupadi Biostromal Limestone	23
			Grey Shale	7
		Unconformity		
Aptian		Sivaganga	Terani Clay	30
			Kovandankurichchi Sandstone	24
Barremian			Basal Conglomerate	18
		Unconformity		
Archaen granitic gneiss				

The stratigraphy of Cauvery basin and a short description of various formations of Upper Gondwana sediments are as follows:

2.1.1 Shivaganga Formation

Oldest sediments in the basin form isolated small patches of continental upper Gondwana beds near Uttatur village in Trichinapalli district and a large exposure near Sivaganga in Ramnad district. These beds consist of clay, grey sandstones and grits containing calcareous concretions. They rest on Archaean gneisses and are overlain by marine cretaceous rocks. Gopal and Jacob (1955) collected and identified several plant fossils belonging to filicals, CycadophytaGinkhoales and Coniferales from Sivaganga beds. This data has been evaluated by Venkatachala (1977) and palynofossil evidence suggests a Lower Cretaceous age.

1) **Clay**-White to brownish colored clay and argillaceous siltstone that show transition from Kovandankurichchi member. Beds are massive to very thick in nature. Lower contact of this member is non-depositional surface.
2) **Grey sandstones** - Grain supported coarsening upward cyclic beds (20-100 cm thick each) of very coarse sandstones that show parallel, even and thin to thick bedding. Grains are well-sorted within each lamina and show rounded-well rounded shape. These represent recurrent sheet flow deposits probably in a sub-aqueous fan deltaic environment.
3) **Basal conglomerate** – Recurrent fining upward sequences of lithoclastic conglomerates of fluviatile and coastal marine environments. Lithoclasts are of gneissic basement rocks. Rests over basement rocks with distinct erosional surface. Upper contact is a non-depositional surface.

2.1.2 Fossil Data: Lithologically, the present investigated Late Gondwana sections mostly consists of fine, medium to coarse grained sandstone, marl, clay stone, red clays, hard massive limestone and white, buff to yellow shales. Important fossil bearing localities and fossil assemblages recovered from these areas are given below (PLATE-I & II).

Locality-I: Sivaganga Formation, Pasumpan Dist., Tamil Nadu

Horizon/Lithology: Coarse, pebally, gritty, argillaceous sandstone, paralic shale and clays.

Fossil assemblage: Ostracodes-species of Candona, HyocyprisStenocypris.

Foraminifera-species of Pelosina, Saccammina, Milliammina, Textularia, Trachammina, Lituola, Haplophragmoides, Ammobaculites and Pseudorephax. Shells of Molluscs were also recorded.

Plant fossils: Filicales-Cladophlebisindica, C. lobata (Oldh.), Actinopteris sp. Cycadophyta-Ptilophyllumacutifolium, P.cutchenseMorr., TaeniopterisspatulataMcClell., T. DensinervisFiest. Coniferales-Elatocladusplana (Fiest), BrachyphyllumexpansumSchimp.,Podozaminteslanceolatus Lind & Hutt. Gynkgoales-Ginkgoites cf. rajmahalensis,

G.erassipes Fiest.

The Sivaganga Formation, which is considered to be the southernmost 'Late Gondwana Unit'. The thin shale beds have yielded rare occurrence of arenaceous foraminifera, ostracodes and plant mega fossils. The species of Eucandona, Darwinula and Stenocypris occur rarely in the material, the carapaces are largely obliterated and impregnated with silty clay, their identification makes difficult and can not expect of much biostratraphic significance. The investigator has tried his level best to locate the host rocks but could't succeeded. This may be of inadequate sampling or they may have transported by water.The presence of arenaceous foraminifera such as Ammodiscus cretaceous, Ammobaculitesbume, Saccammina sp., Trachammina sp. Polychasmina sp. Suggests Neocomian-Aption age for the Sivaganga Formation. Similar arenaceous foraminifera are also reported from Sriperumbudur and Raghavapuram Formations (Gopal et al. 1957, Bhalla, 1969a). Based on the mega floral assemblage (Marattiopsis, Taeniopteris, Thinfeldia, Anomozamites, Ptylophyllum, Dictyozamites, and Brachyphyllum) middle to upper Jurassic age as been suggested an Early Cretaceous affinity. The Palynological assemblage (Venkatachala et al., 1972) recorded in the sub surfaces of the Sivaganga area confirm marine influence during Early Cretaceous.

PLATE-I

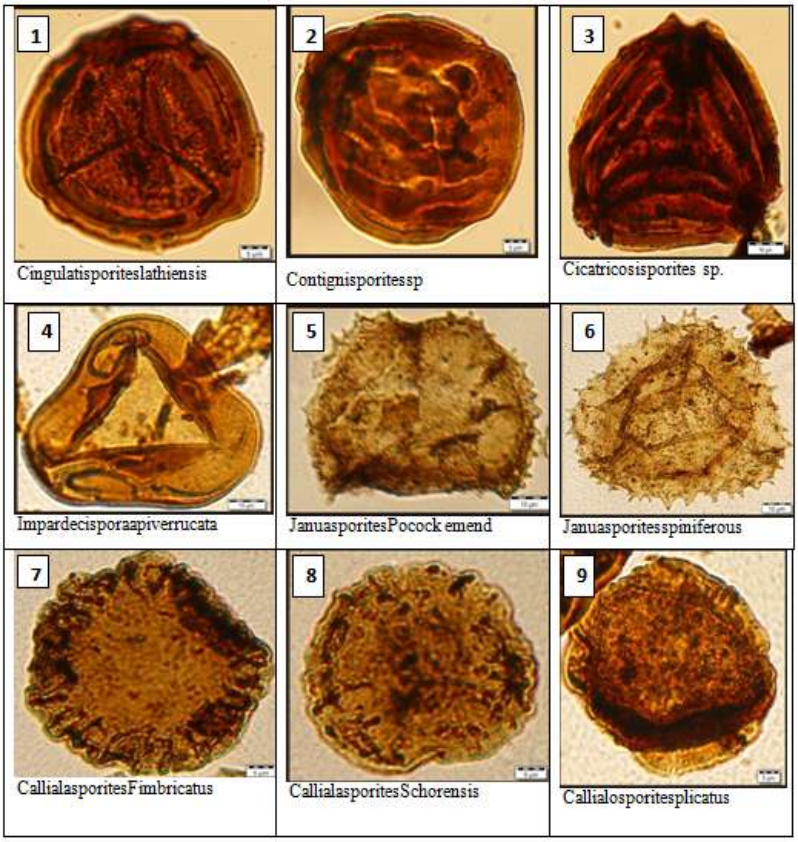
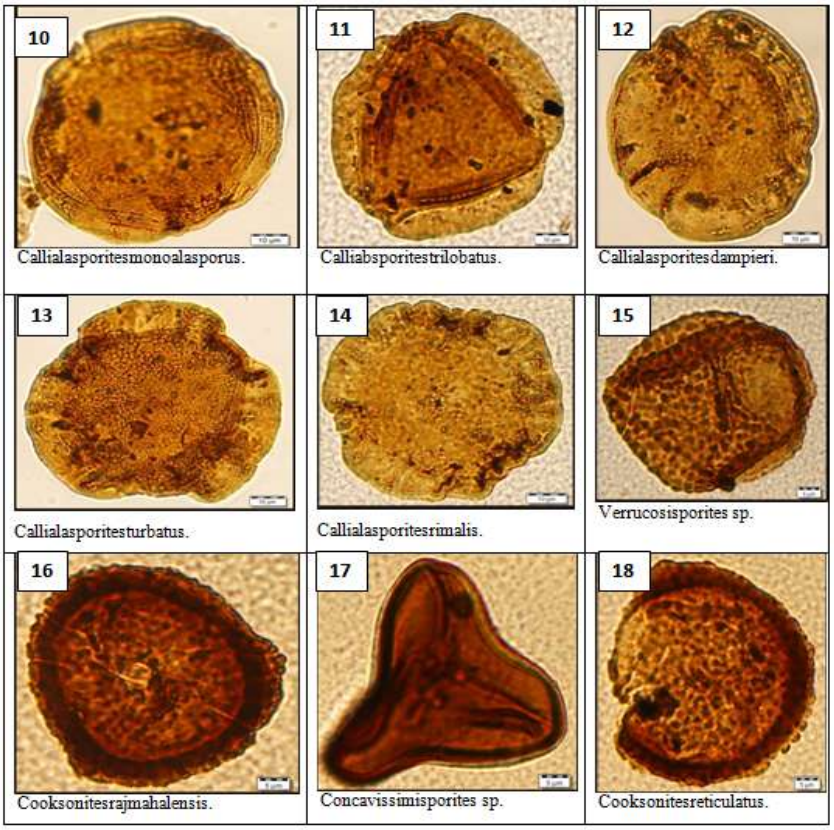


PLATE-II



Plates Explanation

Plate-I

1) Cingulatisporiteslathiensis:-

Cingulatisporitesformosus Venkatachala& Sharma 1974a.
Holotype : Venkatachala & Sharma 1974; Plate-I, fig. (1)size52µm (ca).
Horizon & Age : Early Cretaceous.
Locality : Puvanur shallow well, Vridhachalam area,Cauvery Basin, Tamil Nadu, SouthIndia.
Characteristic features : Size 25-30µm, sides concave with rounded angles labra 2µm thick, central body 12-17µm; exineinfragranulose; cingulum closely punctuate,6µm wide.

2) Contignisporitessp:-

Type species : Contignisporitesglebulentus Dettmann 1963.
Horizon & Age : Early Cretaceous. Tamil Nadu, South India.
Locality : Sivaganga formation. Penola Bore No.1 at 1.805-15ft. South Australia.
Characteristic features : Cingulate Sub triangular spore, trilete mark distinct, rays extend ± up to cingulum, central body distinct, exine proximally with or without murus in contact area, distally sculptured with ribs.

3) Cicatricasporites sp.

CicatricosisporitesannulatusArchangelsky&Gamerro 1966 b.
Holotype : Archangelsky&Gamerro 1966b; Plate-I, fig. 3. Size 48.5µm (ca).
Horizon & Age : Sivaganga formation. Early Cretaceous. Tamil Nadu, South India.
Locality : Santa Cruz. Province, Argeentina, South America.
Characteristic features : Circular, size 37-64.3µm, rays extend ¾ of radius, exine ± 2.5µm thick, proximal face with 3 sets of ribs in inter-radial region, distally two sets of ribs, 6-8 ribs in number, 2-3µm wide, 1.5µm apart, outer rib Continues around the apices, inner ribs run across the distal surface.

4) Impardecisporaapiverrcatau.

Impardecisporaapiverrucata (Couper) Venkatachala, Kar& Raza 1969 b
Holotype : Couper 1953; Plate-I, fig. 4.size 92µm.
Horizon & Age : Sivaganga formation. Early Cretaceous.
Locality : Cauvery basin. Tamil Nadu, South India.
Characteristic features : Size 60-100 µm, exine 2 µm thick, up to 3 µm at apices, Verrucae 3-6 µm in diameter, larger verrucae arranged in single row along trilete rays.

5) Januasporites sp.

Genus : JanuasporitesPocock emend. Singh 1964.
Type Species : Januasporites reticularis Pocock 1962.
Horizon & Age : Sivaganga formation. Early Cretaceous.
Locality : Cauvery basin. Tamil Nadu, South India.
Characteristic features : Zonate, broadly triangular spore, rudimentwary trilete scar, inconspicuous to distinct, exine reticulate, corrugate or spinose on both faces, reduced on proximal face, narrow hyaline ± circular thin area present on distal face, zona hyaline.

6) JanuasporitesSpiniferous:

Januasporitesspiniferus Singh 1964.
Holotype : Singh 1964; Plate-I, fig: 6 size 57.4µm.
Horizon & Age : Sivaganga formation. Early Cretaceous.
Locality : Cauvery basin.
Characteristic features : Size 55-60µm; spines hyaline 4-8µm long, 0.2-2 µm broad, variable in shape, sparse, tips broad, zona 2-5µm wide, distal thin area 28 µm across.

7) CallialasporitesFimbricatus.

Horizon & Age : Sivaganga formation. Early Cretaceous.
Locality : Cauvery basin. Tamil Nadu, South India.
Characteristic features : Size 58-87 µm; exine 1-3 µm thick, rarely up to 4 µm at apices, laevigate or feebly puncatate proximally, distinctly punctuate on distal face, puncta 1-1.5 µm in diameter, closely placed, exine in interray area usually denser.

8) **CallialasporitesSchorensis**. (Sing and Kumar) Kumar, 1973.
Holotype : Singh and Kumar, 1969, Plate-I fig: 9; size ± 82 µm,
Horizon & Age : Sivaganga formation. Early Cretaceous.
Locality : Cauvery basin. Tamil Nadu, South India.
Characteristic features : Size 76-86µm; central body circular, 70-82µm,Prosaccus very narrow, single lobed, 4-6µm wide,
Remarks: - Closely compares with C.microvelatus.

9) **Callialosporitesplicatus.** (Singh and Kumar) Kumar, 1973.
Holotype : Singh and Kumar, 1969; size 72 x 79 µm,
Horizon & Age : Sivaganga formation. Early Cretaceous.
Locality : Cauvery basin. Tamil Nadu, South India.
Characteristic features : Size 60-94µm; Central body triangular, distinct, 55-59 µm; having 4-6 µm thick folds, 3 in number, each at body – saccus attachment; prosaccus, indistinctly three-lobed, 12-17µm wide.
Remarks:- Comparable to C.trilobatus.

Plate-II
10) **Callialasporitesmonoalasporus:** Dev, 1961.
Holotype : Dev 1961; size 106.00 x 90 µm.
Horizon & Age : Sivaganga formation. Early Cretaceous.
Locality : Cauvery basin. Tamil Nadu, South India.
Characteristic features : Oval; Size 94-107 x 88-98 µm; central body oval, 72-86 x 56-72 µm, distinctly separated by an in complete fold at body – Sacus Contact; prosaccusmonowinged, not trilled, 9-19 µm wide,

11) **Calliabsporitestrilobatus**. (Balme) Dev 1961.
Holotype : Balme 1957; size 64 µm
Horizon & Age : Sivaganga formation. Early Cretaceous.
Locality : Cauvery basin. Tamil Nadu, South India.
Characteristic features : Size 65-91 µm; rounded triangular; vestigial Scar seldomly present; Central body sub triangular, ± 45-50 µm, exine 1-2 µm thick, rugose or wrinkled; prosaccus distinctly trilobed or single saccus partially notched in three lobes, finely granulate, marked by radial folds, ± 15 µm wide.

12) **Callialasporitesdampieri.** (Balme) Dev, 1961.
Holotype : Balme 1957: size 47 µm
Horizon & Age : Sivaganga formation. Early Cretaceous.
Locality : Cauvery basin. Tamil Nadu, South India.
Characteristic features : Size 53-78 µm; Central body large, rounded triangular, 37-53 µm exine micro granulate; prosaccus narrow, weakly frilled 8-15 µm wide.

13) **Callialasporitesturbatus.** (Balme) Schulz, 1967.
Holotype: Balme, 1957; size 64 µm
Horizon & Age : Sivaganga formation. Early Cretaceous.
Locality : Cauvery basin. Tamil Nadu, South India.
Characteristic features : Size 57-77 µm; no tetrad marking visible; thickened darker polar area identified, heavily folded, 36-50 µm; prosaccus an outer thinner extension, unfolded encircling the body, 7-14.5 µm wide.
Remarks:- Nature of central body and velum distinguishes this species from other species in genus callialosporites.

14) **Callialasporitesrimalis:** Singh etal, 1964
Holotype : Singh et al., 1964; size 80 x 74 µm
Horizon & Age : Sivaganga formation. Early Cretaceous.
Locality : Cauvery basin. Tamil Nadu, South India.
Characteristic features : Size 80-90 µm; Central body circular, ± 40 µm, demarcated by a thick, ± 4 µm broad peripheral rim, exine coarsely granulose, simulating a negative reticulum; prosaccusmonowinged, undulated, ± 8-10 µm wide.
Remarks: - In exine Sculpture C.rimalis is close to C.reticulatus, and similar to that C.monoalasporus in having a rim/fold around body.

15) **Verrucosisporites sp**. Verrucosisporites Ibrahim emend. Smith 1971.
Type Species : VerrucosisporitesVerr.
Horizon & Age : Sivaganga formation. Early Cretaceous.
Locality : Cauvery basin. Tamil Nadu, South India.
Characteristic features : Size Circular to roundly Triangular spore, trilete simple, ray-length variable ½ to full radius; exine pre-dominantly verrucate, but may include rugulae, coni, size reduced in contact area.

16) **Cooksonitesrajmahalensis,**
Cooksonitesrajmahalensis Tripathi, Tiwari & Kumar 1990.
Holotype : Tripathi, Tiwari & Kumar 1990; size 66 µm.
Horizon & Age : Sivaganga formation. Early Cretaceous.
Locality : Cauvery basin. Tamil Nadu, South India.
Characteristic features : Size 66-104 µm; central body 60-80 µm, beset with verrucae, verrucae 0.5-2 µm across; hilum upto 20 µm across, Cingulum 9-12 µm wide.

17) **Concavissimisporites sp.**
ConcavissimisporitesDelcourt&Sprumont emend.
Delcourt, Dettmann& Hughes 1963
Type Species : ConcavissimisporitesVerrucosus Delcourt&Sprumont 1955.
Horizon & Age : Sivaganga formation. Early Cretaceous.
Locality : Cauvery basin. Tamil Nadu, South India.
Characteristic features : Triangular spore, Concave to straight sides, trilet mark distinct, rays extend 2/3 to ¾ of radius; exine uniformly thick, Verrucose, Verrucae ± uniformly developed, evenly distributed all over.

18) **Cooksonitesreticulatus.**
CooksonitesreticulatusPocock 1962.
Holotype : Pocock 1962, size 72 µm
Horizon & Age : Sivaganga formation. Early Cretaceous.
Locality : Cauvery basin. Tamil Nadu, South India.
Characteristic features : Size 61-72 µm, exinemicroreticulate, muriless than 0.5 µm wide, lumen 2-3 µm across; muriends appear as apiculae at joints, hilum 30-40 µm across, Cingulum ± 15 µm wide, radially striated.

II. Palaeoecology and Age

Palaeocology is the study of the relationship between organisms of the geological past and their habitats and environment. Every organism is restricted in its distribution by the limitations of the environment to which it is adapted. Broad generalizations on palaeoecology can be synthesized based upon aspects of association of the microfossils and sediments. The potential of the science of palaeoecology have gained much momentum in the last few decades leading to an increasing refinement in the interpretation of palaeoenvironment (Briggs and Crowther, 1990: Dodd and Stanton, 1990). Ever since palaecoecology has been used in palaeoenvironmental reconstruction, workers have used various approaches by using the fossils and entombing sediments.The abundance of Ptillophylum in the Sivaganga floral assemblage may suggest their presence in the seaward margins of fluvio-deltaic palaeoenvironment of Cauvery basin.

The Pteridophytic spores are abundant and fairly uniform in their distribution. They mostly include *Cyatheaciditesannulata*, *Alsophiditesdensus and* others which are concluded to be autochonous; they are suggestive of warm and humid climates and swampy environments (Venkatachala and Sharma, 1974).The gymnosperms represented by *Callisporapotoniei* is allochthonous elements. The species are of upland habitate and are concluded to have flown into the depositional area from areas close to the basin margins as is also suggested by their distribution (Venkatachala and Sinha, 1986).

Palynology of subsurface sediments are known through the studies of Rao and Venkatachala (1971), Venkatachala et al. (1972), Vankatachala (1973, 1974), Maheshwari et al (1986) also recorded some palynotaxa. This palynoflora comprises distinct markers such as *Cooksonites, Neoraistrickia, Aequitriradites, Polycingulatisporites, Impardicispora, Staplinisporites, Ischyosporites, Cybelosporites, Klukisporites and Contignisporites*. Palynological evidences recorded in the subsurface of the Sivaganga area, as evidenced by a study well of subsurface sequence met within the Karaikudi well, confirm marine environment.

3.1.2 AGE

Stratigraphically, the position of Sivaganga Formation is in between the underlying Archaean rocks and the unconformably overlying Dalmiapuram Formation consisting of marine shale and reefoidal limestone of

Albian age. Chawdhari (1958) suggested that the plant beds of Terani seem to be homotaxial with the Jabalpur-tirupathi sequence. Considering the overall evidences, the age of Sivanganga Foramtion is suggestive of an early cretaceous age.Palynological and faunal evidence advocate a lower cretaceous age for the Sivaganga Formation. The subsurface samples from sediments equivalent of Sivaganga Formation of Cauvery basin, yielded palynofossils indicating Neocomian-aptian age (venkatachala et al., 1972; Venkatachala, 1977). Ammonoid and foraminiferal evidences are suggestive of an early cretaceous age (Banerji &Sastri, 1979; Banerji 1982).The fossil floral assemblage of the Sivaganga Formation also shows close resemblance with flora of Tabbowa series of Ceylon. The Tabbowa fossil assemblage comprises Cladophlebis, Sphenopteris, Taeniopteris, Ptilophyllum, Elatocladus and Brachyphyllum (Sitholey 1944). The forms like *Cladophlebisreversa, Taeniopterisspatulata and Elatocladusplana* are some of the closely resembling species in both the assemblage of Tabbowa and Sivaganga beds (Sukh Dev and Rajanikanth, 1988). Ayyaswami and Gururaj (1977) consider the flora of SivagangaForamtion to be Early Cretaceous in age.

III. Summary and Conclusion

The work undertaken pertains to the study of palynofosssils of the sediments obtained from lower cretaceous sediments of Sivaganga formations, Southern India. The sediments mostly comprises of conglomerates, sandstone and shale. The samples are collected from a well section, quarry section, nalla cutting and outcrops from the different location of the area. The sediments after subjecting them to the standard macerations process of palynofossils separation yielded assemblages of Angiospermic pollens, Pteridospermic spores, Gymnospermic spores and pollens and Bryophytic spores. Altogether samples were macerated and almost all of them yielded rich assemblage of palynotaxa.

The present study turns out to be significant from the view of recording rich assemblages of microfossils from the sediments of study area and interpretation of palaeoecology, depositional environment and age. The Sivaganga Formation considered as the Upper Gondwana representatives in the Cauvery Basin, indeed belong to the rift phase of the pericratonic Cauvery Basin as charecterised by the distinctive marine Late Jurassic- Early Cretaceous palynofloras. Most of the Ptilophyllum flora-bearing sediments were deposited during the Early Cretaceous and even a continuous succession with the Upper Cretaceous sediments from East Coast Krishna-Godavari and Cauvery Basin (Acharyya and Lahiri, 1991). Evidence from microfossils suggests a Lower Cretaceous age to Sivaganga Foramtion.

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